REPORT

Lake Conjola Coastal Management Program

Stage 3 - Identify and Evaluate Options

Client: Shoalhaven City Council

Reference: PA2591-WM-RP-0004-240726
Status: Final/5.0
Date: 26 July 2024

Royal HaskoningDHV
Enhancing Society Together

HASKONING AUSTRALIA PTY LTD.

Level 15
99 Mount Street
North Sydney NSW 2060
Australia
Water & Maritime

+61 2 8854 5000 **T**
project.admin.australia@rhdhv.com **E**
royalhaskoningdhv.com **W**

Document title:	Lake Conjola Coastal Management Program
Subtitle:	Stage 3 - Identify and Evaluate Options
Reference:	PA2591-WM-RP-0004-240726
Your reference	
Status:	Final/5.0
Date:	26 July 2024
Project name:	Lake Conjola CMP
Project number:	PA2591
Author(s):	Matthew Potter

Drafted by:	Matthew Potter
Checked by:	Greg Britton
Date:	26 July 2024
Approved by:	Greg Britton
Date:	26 July 2024

Classification
Project related

Royal HaskoningDHV

Table of Contents

Table of Tables

Table of Figures

Appendices

1 Introduction

1.1 General

In accordance with the NSW Coastal Management Framework and the *Coastal Management Act 2016* (CM Act), the future management of Lake Conjola will be governed by a Coastal Management Program (CMP).

The Lake Conjola CMP will identify coastal management issues and the actions required to address these issues in a strategic and integrated way within the CMP study area, which includes the waterbody of Lake Conjola (including Berringer Lake), its adjacent foreshores, its catchment area, and the Lake entrance to the ocean.

The CMP is being developed and delivered in accordance with the staged approach of the NSW Coastal Management Manual (refer **Figure 1-1**).

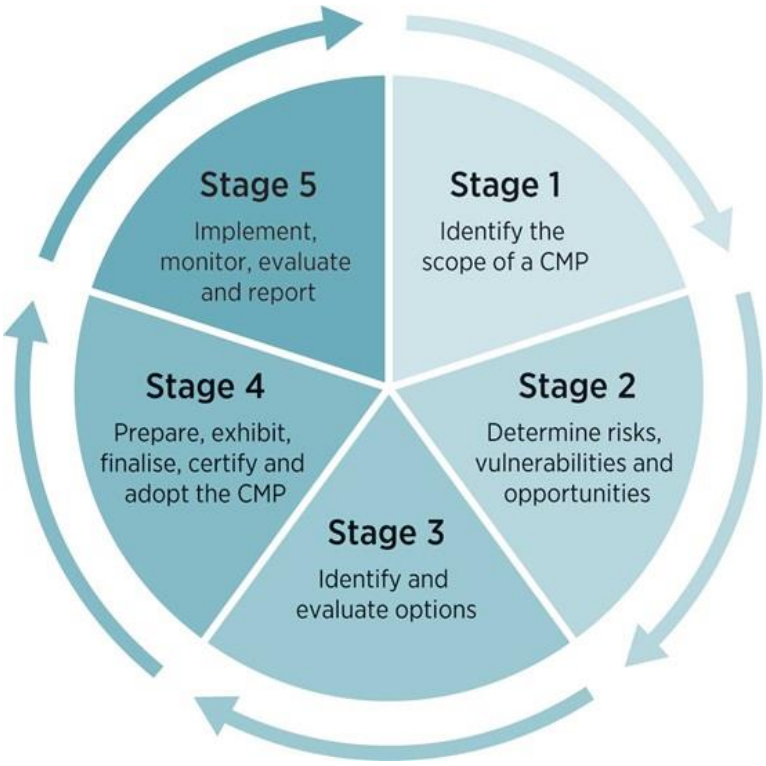


Figure 1-1: Staging of the CMP process

Stage 1 of the CMP process was completed with the adoption of the Shoalhaven CMP Scoping Study (Advisian, 2020) by Council in June 2020. This established the framework for future CMPs, and included community consultation, comprehensive surveys, and review and consolidation of previous studies.

Stage 2 of the CMP has recently been completed and is documented in three reports, comprising:

- Report A – “Environmental, Social & Cultural Assets and Attributes” (RHDHV, 2023a), provides a review of the physical and social attributes and assets within the Lake Conjola catchment, as well as noting the various pieces of legislation that afford protection to these attributes;

- Report B – “Threats and Risk Assessment” (RHDHV, 2023b), describes the range of, extent, and potential impact of threats posed by coastal hazards on these attributes, as well as providing an initial consideration of potential mitigation options and actions; and,
- Report C – “Entrance Processes and Entrance Management Options” (RHDHV, 2023c), provides a review of coastal processes and entrance dynamics, past and current entrance management practices, as well as consideration of potential options for management of the entrance into the future.

The objective of Stage 3 of the CMP process is to identify and evaluate management options, and to select preferred coastal management actions for inclusion in the CMP that is to be prepared in Stage 4.

1.2 Approach to Stage 3

An initial long list of management actions was compiled from the risk assessment process completed during Stage 2 (refer Stage 2 – Report B (2023b)), with additional actions developed to enable the integrated and strategic management of the study area for the Lake Conjola CMP within the broader Shoalhaven coastal zone. A coarse filter incorporating several criteria was applied to this long list to confirm which actions would be accepted to present for Stage 3 community and stakeholder consultation. The actions were consolidated and presented in a written summary and an online GIS mapped format for community and stakeholder engagement.

Feedback received from the Stage 3 consultation was used to refine the potential management actions for the Lake Conjola CMP. In addition, new actions suggested from the consultation were added if they were considered to have merit from a coastal management perspective and were applicable to the scope of the CMP. A cost benefit analysis was completed on those management options that required significant expenditure to implement, namely options for entrance management and foreshore protection.

1.3 Structure of this Report

This report, CMP Stage 3 – Identify and Evaluate Options, is set out in the following manner:

- **Section 1** provides an introduction to the report.
- **Section 2** identifies the actions and options under consideration and those selected for consultation.
- **Section 3** summarises the scope and outcomes of Stage 3 consultation activities.
- **Section 4** presents a cost benefit analysis of selected options.
- **Section 5** presents an assessment of entrance management options.
- **Section 6** presents a description of the identified CMP actions to be taken through to Stage 4 of the CMP process.
- **Section 7** summarises the next steps in the CMP process.
- **Section 8** provides a list of references.

Table 1-1 summarises the four main steps identified for Stage 3 within section 3.2 the *NSW Coastal Management Manual Part B: Stage 3 – Identify and evaluate options* (NSW Government and OEH, 2019) and where these are addressed in sections of this report.

Table 1-1: Steps in Stage 3 within Coastal Management Manual and relevant report sections

Stage 3 steps within Coastal Management Manual	Relevant Report Section
Step 1: Confirm the strategic direction for each section of the coast	Addressed in Stage 2 – Report A (2023a).
Step 2: Identify the potential options for integrated management of all relevant coastal management areas	**Section 2** – Step 1: Option Identification
Step 3: Evaluate potential actions • Feasibility • Viability • Acceptability	Feasibility: **Section 2** – Step 1: Option Identification – coarse filter assessment Viability: **Section 2** – Step 1: Option Identification – coarse filter assessment **Section 4** – Cost Benefit Analysis of Selected Options Acceptability: **Section 3** – Community and Stakeholder Engagement
Step 4: Putting it together • Business plan • Management pathways	Included within Stage 4 CMP report.

2 Step 1: Option Identification

2.1 Overview

The sections below outline the process followed to develop an initial long list of management actions for consideration in Stage 3 of the CMP, application of a coarse filter approach to evaluate the actions against several different criteria, and the refinement and consolidation of the long list of actions for presentation during community and stakeholder engagement undertaken as part of Stage 3 (refer **Section 3**).

2.2 Stage 2 Risk Assessment

A threat-based risk assessment was completed as part of Stage 2 of the CMP and is documented in Stage 2 – Report B (2023b). This risk assessment considered a wide range of threats (including coastal/tidal inundation, population growth, stormwater erosion, exotic plant/animal species, entrance dynamics, user conflicts, water quality) and the associated hazards they present. The potential impact of these threats was evaluated for several key interconnected risk assessment themes, comprising public safety, infrastructure, environmental, and public amenity. The risk assessment identified broad indicative control measures against each risk, which were used to develop a long list of potential management actions for further prioritisation and refinement in Stage 3 of the CMP process.

2.3 Long List of Actions

As noted above, a long list of actions was initially developed from the risk assessment control measures identified in Stage 2 – Report B (RHDHV, 2023b). This was refined to include the entrance management options considered in Stage 2 – Report C (RHDHV, 2023c). Additional actions were developed to enable the integrated and strategic management of the study area for the Lake Conjola CMP within the broader Shoalhaven coastal zone.

2.4 Coarse Filter Assessment

The long list of actions were evaluated using a coarse filter assessment procedure against several criteria, namely:

- **Capital/Operational Cost** – magnitude of costs to implement the action initially
- **Ongoing Costs per annum** – magnitude of ongoing maintenance or implementation costs over the life of the action
- **Risk Mitigation** – being the ability of the action to reduce the threat for which the action has been designed or targeted, or otherwise, the provision of important data or knowledge about the target threat by the action
- **Environmental Impact** – degree of environmental impact associated with the action
- **Social Impact** – degree of social impact associated with the action
- **Cultural Heritage Impact** – degree of cultural heritage impact associated with the action
- **Community Acceptability** – which is based upon general feedback from this locality and other coastal areas regarding the action or type of action
- **Reversible / Adaptable in the Future** – being the ability for the action to be modified or removed in the future, should the situation change, and an alternative approach be required
- **Legal / Approval Risk** – to highlight the legislative and approval requirements (or impediments) to implementing an action within the current legal framework
- **Ease of Implementation** – to highlight where certain actions may or may not be technically feasible or would require significant engineering (or other) investigations and construction / implementation capabilities

The coarse filter assessment followed a ‘traffic light’ colour system with each action being given a ‘go’, ‘slow’ or ‘stop’ score against each criterion as follows:

- **GO**, with a score of 1
- **SLOW**, and proceed with caution, with a score of 0: or,
- **STOP**, with a score of -1.

The ‘traffic light’ rating system for the coarse filter assessment is summarised in **Table 2-1**. Each of the criterion were given a weighting, and the score for each action was based on direct addition of weighted scores against each criterion. The aggregate scores and the frequency and nature of ‘stop’ scores were used to determine an overall assessment outcome of Go, Slow or Stop, which is summarised in **Table 2-2**. Only actions with a Go or Slow overall assessment outcome were considered further in the development of the Lake Conjola CMP. An exception to this was the consideration of ‘engineering works to create permanent entrance channel’ (see reference EM10 in **Table 2-2**). This action was not supported by the coarse filter outcome but was progressed into consultation due to history of community interest and opportunity to present and discuss issues with this option.

The coarse filter assessment determined that most of the actions had an overall assessment outcome of Go or Slow. A number of individual actions with common themes were consolidated into broader actions developed and refined for the purposes of Stage 3 consultation (refer **Section 2.5**).

Table 2-1: Coarse Filter Assessment Criteria and Scoring System

Outcome	Capital/Operational Cost	Ongoing Costs p.a.	Risk Mitigation	Environmental Impact	Social Impact	Cultural Heritage Impact	Community Acceptability	Reversible / Adaptable in the Future	Legal / Approval Risk	Ease of Implementation
STOP	Very expensive (>$500,000)	Very expensive (>$150,000)	Option is unlikely to be effective / substantially reduce targeted threats	Significant impact on the Lake Conjola environment	Significant social impact	Significant impact on cultural heritage	Unlikely to be acceptable to community and politically unpalatable; Extensive community education, endorsement by Minister(s) and Council required	Option is irreversible once implemented; option limits alternative options in the future	Will require an EIS and/or Govt program to implement; There is a residual risk that approval will not be obtainable for the proposed works / strategy	Requires substantial engineering investigations and capabilities; financial funding mechanisms etc. to implement
SLOW	Moderately expensive ($100,000 - $500,000)	Moderately expensive ($25,000 - $150,000)	Option will not necessarily reduce targeted threat(s) but will provide important knowledge / data about the threat OR Option will bring a minor reduction in the targeted threat(s)	Potential impact on Lake Conjola environment that needs to be assessed and may require mitigation measures	Potential social impact that needs to be assessed and may require mitigation measures	Potential impact on cultural heritage that needs to be assessed and may require mitigation measures	Would be palatable to some, not others (~50/50 response); Briefing to Councillors, GM and community education required	Option is reversible or adaptable but at considerable cost / effort	Will require Govt approvals to be implemented, or assistance through existing Govt program	Requires further engineering designs, financial assistance (which is likely to be available) etc. to be implemented
GO	Limited cost (<$100,000)	Limited cost (<$25,000)	Option will be very effective in eliminating / reducing / remediating its target threat(s)	No impact on the Lake Conjola environment	No social impact	No impact on cultural heritage	Is very politically palatable, acceptable to community; Minimal education required	Option can be easily adapted for future circumstances or should impacts not occur, option would not negatively impact future generations	No or minimal government approvals required to implement	Requires little to no further investigations and/or funding assistance to be implemented

Table 2-2: Traffic light coarse filtering of management actions

REF. NO.	CMP ACTION	Capital/Operational Cost	Ongoing Costs p.a.	Risk Mitigation	Environmental Impact	Social Impact	Cultural Heritage Impact	Community Acceptability	Reversible / Adaptable in the Future	Legal / Approval Risk	Ease of Implementation	AGGREGATE SCORE	OVERALL ASSESSMENT	Responsibility (Lead Agency)	Comments
	Weighting	**1**	**1**	**2**	**2**	**2**	**2**	**2**	**1**	**1**	**1**				
LG1	Maintain appropriate land zoning to protect coastal dune systems	GO	GO	GO	GO	GO	GO	GO	GO	GO	GO	15	GO	Council	Business as usual, zoning is already established to protect dune systems. Action NOT progressed to consultation.
LG2	Develop and maintain a program of community engagement with coastal communities about coastal hazard risk	GO	GO	SLOW	GO	GO	GO	GO	GO	GO	GO	13	GO	Council	Action progressed to consultation as Action LG10.
LG3	Develop and execute a communications plan for Stage 5 of the CMP	GO	GO	SLOW	GO	GO	GO	GO	GO	GO	GO	13	GO	Council	Action progressed to consultation as Action LG7.
LG4	Continue Council's program of mapping endangered ecological communities (EECs) across coastal reserves	GO	GO	SLOW	GO	GO	GO	GO	GO	GO	GO	13	GO	Council	Action progressed to consultation as Action LG8.
LG5	Maintain and enhance ecological communities in coastal reserves	GO	SLOW	GO	GO	GO	GO	GO	GO	GO	SLOW	13	GO	Council	Action progressed to consultation as Action LG9.
LG6	Continue to work collaboratively with National Parks and Wildlife Service staff and volunteers to implement the NSW South Coast Shorebird Recovery Program	GO	GO	GO	GO	GO	GO	GO	GO	GO	GO	15	GO	Council	Action progressed to consultation as Action LG5.
LG7	Review and update all Council management plans (AMPs), relevant to the coastal zone	GO	GO	SLOW	GO	GO	GO	GO	GO	GO	GO	13	GO	Council	Action progressed to consultation as Action LG11.
LG8	Develop a program for regular and ongoing monitoring of coastal assets and infrastructure	GO	GO	SLOW	GO	GO	GO	GO	GO	GO	SLOW	12	GO	Council	Action progressed to consultation as Action LG12.
LG9	Activate "Coastal Hazard Emergency Action Sub-Plans" (CZEAS) for each beach after storm events	SLOW	GO	GO	GO	GO	GO	GO	GO	GO	GO	14	GO	Council	LGA-wide response on beaches is not relevant to Lake Conjola. Combined with action to develop/implement CZEAS for Lake Conjola. Action progressed to consultation as Action PM2.
LG10	Develop and implement a program of dune vegetation management and rehabilitation	SLOW	SLOW	GO	GO	GO	GO	GO	GO	GO	SLOW	12	GO	Council	This would be beneficial for Lake Conjola entrance area to mitigate wind-blown sand transport and stabilise dunes against wave overwash. Action progressed to consultation as Action LG6.
LG11	Protect coastal dune systems from vegetation vandalism	GO	GO	GO	GO	GO	GO	GO	GO	GO	GO	15	GO	Council	Business as usual, existing vegetation vandalism policy is already in place. Action NOT progressed to consultation.
LG12	Undertake a LGA wide coastal zone Aboriginal Cultural Heritage Survey, and development of local protection/management plans	GO	GO	GO	GO	GO	GO	GO	GO	GO	SLOW	14	GO	Council	Part of broader LGA-wide program. Include Lake Conjola study area in this survey. Action progressed to consultation as Action LG16.

REF. NO.	CMP ACTION	Capital/Operational Cost	Ongoing Costs p.a.	Risk Mitigation	Environmental Impact	Social Impact	Cultural Heritage Impact	Community Acceptability	Reversible / Adaptable in the Future	Legal / Approval Risk	Ease of Implementation	AGGREGATE SCORE	OVERALL ASSESSMENT	Responsibility (Lead Agency)	Comments
LG13	Engage with relevant Local Aboriginal Land Councils and local Traditional Owner Groups to develop a cultural educational and awareness program	GO	GO	SLOW	GO	GO	GO	GO	GO	GO	GO	13	GO	Council	Part of broader LGA-wide program. Action progressed to consultation as Action LG17.
LG14	Provide opportunities and help build capacity to local Aboriginal Ranger programs, to enhance their role in management of Sea Country	GO	GO	GO	GO	GO	GO	GO	GO	GO	GO	15	GO	Council	Part of broader LGA-wide program. Action progressed to consultation as Action LG18.
FB1	Establish ongoing monitoring program to inform actions	GO	GO	SLOW	GO	GO	GO	GO	GO	GO	SLOW	12	GO	Council	Consolidate monitoring into actions for foreshore treatment and management of stormwater runoff. Action progressed to consultation within Action FB1 and Action FB2.
FB2	Consider diversion of hazardous stormwater runoff and redirection of surcharge flows	SLOW	GO	GO	SLOW	GO	GO	GO	SLOW	GO	STOP	9	SLOW	Council	Consolidate into combined action for management of stormwater runoff. Action progressed to consultation within Action FB2.
FB3	Stabilisation of existing stormwater outlets and improvement of energy dissipation	SLOW	GO	GO	SLOW	GO	GO	GO	SLOW	GO	SLOW	10	SLOW	Council	Consolidate into combined action for management of stormwater runoff. Action progressed to consultation within Action FB2.
FB4	Installation of warning signage near stormwater outlets	GO	GO	SLOW	GO	GO	GO	GO	GO	GO	SLOW	12	GO	Council	Consolidate into combined action for management of stormwater runoff. Action progressed to consultation within Action FB2.
FB5	Investigate/enforce appropriate and permissible use of public foreshores by private interests (e.g. retaining walls, jetties, watercraft); in collaboration with TfNSW, Crown Lands, Fisheries	GO	GO	GO	GO	SLOW	GO	SLOW	GO	SLOW	GO	10	SLOW	DPI-Fisheries	Action undertaken in conjunction with development of Domestic Waterfront Structure Strategies led by DPI-Fisheries. Action progressed to consultation as Action FB5.
FB6	Work with farmers/landowners to support change in farming practices (e.g. stock access to water)	GO	GO	GO	GO	SLOW	GO	GO	GO	GO	GO	13	GO	Council / NSW LLS	Action progressed to consultation as Action FB4.
FB7	Re-grading of eroded areas to restore foreshore profile by Council maintenance staff	GO	GO	SLOW	SLOW	GO	GO	GO	GO	GO	SLOW	10	SLOW	Council	Better to establish riparian vegetation or apply foreshore protection treatments in areas of concern. Action considered to be progressed to consultation within Action FB1 as a possible treatment for bank erosion, in combination with riparian vegetation and/or foreshore protection.
FB8	Develop/Implement formalised watercraft (i.e. dinghies, kayaks etc.) storage systems (e.g. racks, tie-up points, permitting system) in foreshore areas around the lake	SLOW	GO	GO	GO	GO	GO	GO	GO	SLOW	SLOW	12	GO	Council	May need funding through TfNSW Boating Now program. Action progressed to consultation as Action FB3.

REF. NO.	CMP ACTION	Capital/Operational Cost	Ongoing Costs p.a.	Risk Mitigation	Environmental Impact	Social Impact	Cultural Heritage Impact	Community Acceptability	Reversible / Adaptable in the Future	Legal / Approval Risk	Ease of Implementation	AGGREGATE SCORE	OVERALL ASSESSMENT	Responsibility (Lead Agency)	Comments
PM1	Review/Amend/Implement flood and inundation development and planning controls within LEP/DCP that are applied to new development, including consideration of non-habitable areas and tidal/coastal inundation events	GO	GO	GO	GO	GO	GO	GO	GO	SLOW	SLOW	13	GO	Council	Action progressed to consultation as Action PM1.
PM2	Consider amending flood controls within DCP to allow raising property grounds levels through use of fill	GO	GO	GO	SLOW	GO	GO	GO	SLOW	SLOW	SLOW	10	SLOW	Council	Flood controls are considered to be outside the scope of the CMP. Action NOT progressed to consultation.
PM3	Prepare and implement Coastal Zone Emergency Action Subplan (CZEAS)	GO	SLOW	GO	GO	GO	GO	GO	GO	GO	GO	14	GO	Council / NSW SES	CZEAS for Lake Conjola proposed to be developed as part of CMP. Action progressed to consultation as Action PM2.
PM4	Review/Amend land-use controls and categorisation	GO	GO	GO	GO	GO	GO	SLOW	GO	SLOW	SLOW	11	GO	Council	Combine into one action, along with review of future zoning. Action progressed to consultation as Action PM3.
PM5	Review current and potential future zoning of land within the Lake Conjola catchment	GO	GO	GO	GO	GO	GO	SLOW	GO	SLOW	SLOW	11	GO	Council	Combine into one action, along with review of land-use controls and categorisation. Action progressed to consultation as Action PM3.
EM1	Consideration of emergency entrance management interventions	GO	GO	GO	SLOW	GO	GO	GO	GO	GO	GO	13	GO	Council	This action is inherent in the development of a revised Entrance Management Policy from the outcomes of work completed in the CMP. Action consolidated into Action EM1 for consultation.
EM2	Consideration of illegal community initiated openings in entrance management policy	GO	GO	SLOW	GO	GO	GO	GO	GO	GO	GO	13	GO	Council	This action is inherent in the development of a revised Entrance Management Policy from the outcomes of work completed in the CMP. Action consolidated into Action EM1 for consultation, and is also addressed by community education as part of Action EM2.
EM3	Temporary fencing to create exclusion zones and prevent public access to hazardous areas (e.g. during mechanical entrance openings)	GO	GO	SLOW	GO	SLOW	GO	SLOW	GO	GO	GO	9	SLOW	Council	This action is inherent in the development of a revised Entrance Management Policy from the outcomes of work completed in the CMP. Action consolidated into Action EM1 for consultation.
EM4	Re-grading to restore beach profile by Council maintenance staff	GO	GO	GO	GO	GO	GO	GO	GO	GO	GO	15	GO	Council	This action is inherent in the development of a revised Entrance Management Policy from the outcomes of work completed in the CMP. Action consolidated into Action EM1 for consultation.
EM5	Improve public education on the impacts and safety risks of Lake openings	GO	GO	SLOW	GO	GO	GO	GO	GO	GO	GO	13	GO	Council	Action progressed to consultation as Action EM2.
EM6	Future review of entrance management policy	GO	GO	SLOW	GO	GO	GO	GO	GO	SLOW	SLOW	11	GO	Council	This action is inherent in the development of a revised Entrance Management Policy from the outcomes of work completed in the CMP. Action consolidated into Action EM1 for consultation.

REF. NO.	CMP ACTION	Capital/Operational Cost	Ongoing Costs p.a.	Risk Mitigation	Environmental Impact	Social Impact	Cultural Heritage Impact	Community Acceptability	Reversible / Adaptable in the Future	Legal / Approval Risk	Ease of Implementation	AGGREGATE SCORE	OVERALL ASSESSMENT	Responsibility (Lead Agency)	Comments
EM7	Excavation of pilot channel in response to triggers	GO	GO	SLOW	GO	GO	GO	GO	GO	GO	GO	13	GO	Council	This action is inherent in the development of a revised Entrance Management Policy from the outcomes of work completed in the CMP. Action consolidated into Action EM1 for consultation.
EM8	Maintenance of a 'dry notch' + excavation of pilot channel	GO	GO	SLOW	GO	GO	GO	SLOW	GO	GO	SLOW	10	SLOW	Council	This potential action is inherent in the development of a revised Entrance Management Policy from the outcomes of work completed in the CMP. Action consolidated into Action EM1 for consultation.
EM9	Modified 'managed entrance' approach with occasional dredging of ebb tide channel + excavation of pilot channel	STOP	GO	GO	SLOW	GO	GO	GO	GO	SLOW	SLOW	9	SLOW	Council	This potential action is inherent in the development of a revised Entrance Management Policy from the outcomes of work completed in the CMP. Action consolidated into Action EM1 for consultation.
EM10	Engineering works to create permanent entrance channel	STOP	GO	GO	STOP	STOP	SLOW	STOP	STOP	STOP	STOP	-7	STOP	Council	This potential action is not supported by the coarse filter outcome, but progressed into consultation due to history of community interest and opportunity to present and discuss issues with this option. Action consolidated into Action EM1 for consultation.
IN1	Installation of informative signage/education campaign (in collaboration with SES)	GO	GO	SLOW	GO	GO	GO	GO	GO	GO	GO	13	GO	Council / NSW SES	Emergency response during flooding is considered to be outside the scope of the CMP. Action NOT progressed to consultation.
IN2	Relocation/reconstruction of assets that could be submerged	STOP	GO	GO	GO	GO	GO	GO	SLOW	SLOW	STOP	9	SLOW	Council	Action consolidated with other management measures and progressed to consultation as Action IN1.
IN3	Remove valuable assets from ground floor areas	GO	GO	SLOW	GO	GO	GO	GO	GO	GO	GO	13	GO	Council / Residents / Businesses	Action consolidated with other management measures and progressed to consultation as Action IN1.
IN4	Retrofit or relocate public infrastructure	STOP	GO	GO	GO	GO	GO	GO	SLOW	SLOW	STOP	9	SLOW	Council	Action consolidated with other management measures and progressed to consultation as Action IN1.
IN5	Allow water to pass through buildings (e.g. Caravan Park) with less damage by opening doors/entry points	GO	GO	STOP	GO	GO	GO	STOP	GO	GO	GO	7	SLOW	Council / Residents / Businesses	Emergency response during flooding is considered to be outside the scope of the CMP. Action NOT progressed to consultation.
IN6	Consider temporary road closures depending on extent of inundation	GO	GO	GO	GO	STOP	GO	SLOW	GO	GO	GO	9	GO	Council / NSW SES	Emergency response during flooding is considered to be outside the scope of the CMP. Action NOT progressed to consultation.
IN7	Arrange alternative temporary access (e.g. waterborne access with vessels) to manage bridge/road closures	GO	GO	GO	GO	GO	GO	GO	GO	GO	SLOW	14	GO	Council / NSW SES	Emergency response during flooding is considered to be outside the scope of the CMP. Action NOT progressed to consultation.
IN8	Installation of temporary warning signage	GO	GO	SLOW	GO	GO	GO	GO	GO	GO	GO	13	GO	Council / NSW SES	Emergency response during flooding is considered to be outside the scope of the CMP. Action NOT progressed to consultation.

REF. NO.	CMP ACTION	Capital/Operational Cost	Ongoing Costs p.a.	Risk Mitigation	Environmental Impact	Social Impact	Cultural Heritage Impact	Community Acceptability	Reversible / Adaptable in the Future	Legal / Approval Risk	Ease of Implementation	AGGREGATE SCORE	OVERALL ASSESSMENT	Responsibility (Lead Agency)	Comments
IN9	Temporary fencing to prevent public access to hazardous areas	GO	GO	GO	GO	SLOW	GO	SLOW	GO	GO	GO	11	GO	Council / NSW SES	Emergency response during flooding is considered to be outside the scope of the CMP. Action NOT progressed to consultation.
IN10	Develop/Implement Lake water level forecasting system to inform emergency entrance management interventions and community response	SLOW	SLOW	GO	GO	GO	GO	GO	GO	GO	SLOW	12	GO	Council	Development of forecasting system has been initiated by Council. Action progressed to consultation for community information purposes as Action IN2.
WQ1	Continue groundwater monitoring and reporting program, including assessment of: - likelihood of the nutrient plume continuing to migrate and affecting Lake Conjola and / or Pattimores Lagoon, and if so the likely impacts - whether the mass and concentration of TN and TP being discharged into the groundwater can be further reduced - potential options for interception and additional treatment of the groundwater	GO	GO	SLOW	GO	GO	GO	GO	GO	GO	GO	13	GO	Shoalhaven Water	Groundwater quality monitoring program is already in place. Action progressed for community information purposes as Action WQ1.
WQ2	Continue and refine surface water monitoring and reporting program, including: - improved consistency of sampling (spatial/temporal distribution and parameters analysed) - inclusion of algal bloom monitoring - increased review and public dissemination of Aquadata water quality monitoring results	SLOW	SLOW	SLOW	GO	GO	GO	GO	GO	GO	GO	11	GO	Council	Water quality monitoring program is already in place. Action progressed for community information purposes as Action WQ2.
WQ3	Implement signage and closure of areas in the event of poor water quality conditions for recreation	GO	GO	GO	GO	SLOW	GO	GO	GO	GO	GO	13	GO	Council	Action consolidated within Action WQ2 for consultation.
WQ4	Consider opportunities for sewage treatment and discharge improvements	GO	GO	GO	GO	GO	GO	GO	GO	GO	SLOW	14	GO	Shoalhaven Water	Action consolidated within Action WQ1 for consultation.
WQ5	Encourage inclusion of Stormwater Quality Improvement Devices (SQIDs) or raingardens in private development activities	GO	GO	GO	GO	GO	GO	GO	GO	GO	GO	15	GO	Council	Action consolidated within Action WQ3 for consultation.
WQ6	Undertake maintenance of existing stormwater improvement devices	GO	GO	GO	GO	GO	GO	GO	GO	GO	SLOW	14	GO	Council	This action is covered by Council's asset management plans for stormwater drainage infrastructure. Action consolidated within Action LG11 for consultation.

REF. NO.	CMP ACTION	Capital/Operational Cost	Ongoing Costs p.a.	Risk Mitigation	Environmental Impact	Social Impact	Cultural Heritage Impact	Community Acceptability	Reversible / Adaptable in the Future	Legal / Approval Risk	Ease of Implementation	AGGREGATE SCORE	OVERALL ASSESSMENT	Responsibility (Lead Agency)	Comments
WQ7	Identify and monitor potential source sites that could leach contaminants into the Lake (e.g. landfill)	GO	GO	SLOW	GO	GO	GO	GO	GO	GO	SLOW	12	GO	Council	No evidence to suggest that this is currently occurring or a significant concern. Action NOT progressed to consultation.
WQ8	Amend/Implement water quality development and planning controls within LEP/DCP that are applied to new development	GO	GO	GO	GO	GO	GO	GO	GO	SLOW	GO	14	GO	Council	Action consolidated within Action WQ3 for consultation.
WQ9	Consider development and implementation of water quality targets for existing and future land use within the Lake Conjola catchment, utilising the "Risk-based Framework for Considering Waterway Health Outcomes in Strategic Land-use Planning Decisions" (OEH, 2017)	GO	GO	SLOW	GO	GO	GO	GO	GO	GO	GO	13	GO	Council	Action consolidated within Action WQ3 for consultation.
WQ10	Investigate and manage sewage overflows	SLOW	SLOW	GO	GO	GO	GO	GO	GO	GO	SLOW	12	GO	Shoalhaven Water	No evidence to suggest that this is currently occurring or a significant concern. Action NOT progressed to consultation.
WQ11	Stormwater management system improvements	SLOW	GO	GO	GO	GO	GO	GO	SLOW	SLOW	STOP	10	SLOW	Council	Consolidated into combined action for management of stormwater runoff. Action progressed to consultation within Action FB2.
WQ12	Improve community education on the factors influencing water quality and mitigation actions	GO	GO	SLOW	GO	GO	GO	GO	GO	GO	GO	13	GO	Council	Action consolidated within Action LG10 for consultation.
WQ13	Collaboration with agencies e.g. LLS to provide support for changing detrimental land use practices	GO	GO	SLOW	GO	SLOW	GO	GO	GO	GO	GO	11	GO	Council	Action consolidated within Action FB4 for consultation.
WQ14	Investigate locations of any remaining active septic systems and assess potential impacts on Lake water quality	GO	GO	SLOW	GO	GO	GO	GO	GO	GO	SLOW	12	GO	Council	Action progressed to consultation as Action WQ4.
WQ15	Review DCP Pollution reduction targets for new developments to ensure consistency with risk-based framework and avoid landuse intensification in high risk areas	GO	GO	SLOW	GO	GO	GO	GO	GO	SLOW	GO	12	GO	Council	Action consolidated within Action WQ3 for consultation.
EV1	Preparation of a Marine Vegetation Management Strategy to identify high priority hotspot areas and management actions to address deterioration	GO	GO	SLOW	GO	GO	GO	GO	GO	SLOW	SLOW	11	GO	DPI-Fisheries	Action consolidated within Action EV1 for consultation.
EV2	Reservation of land to allow for spatial migration of vegetation/habitat	STOP	GO	GO	GO	SLOW	GO	SLOW	GO	SLOW	STOP	6	SLOW	Council	Land acquisition costs could be considerable. Action consolidated within Action EV1 for consultation.

REF. NO.	CMP ACTION	Capital/Operational Cost	Ongoing Costs p.a.	Risk Mitigation	Environmental Impact	Social Impact	Cultural Heritage Impact	Community Acceptability	Reversible / Adaptable in the Future	Legal / Approval Risk	Ease of Implementation	AGGREGATE SCORE	OVERALL ASSESSMENT	Responsibility (Lead Agency)	Comments
EV3	Consider sand scraping to reinforce vegetated dune for protection purposes	GO	GO	SLOW	GO	GO	GO	GO	GO	GO	GO	13	GO	Council	Action is covered within dune management in lake entrance area, progressed to consultation as Action LG6.
EV4	Repair damage to habitats following storm/inundation events	SLOW	GO	GO	GO	GO	GO	GO	GO	GO	SLOW	13	GO	Council	Action is covered by Action LG9 and Action EV1 progressed to consultation.
EV5	Consider acquisition and protection of key locations, notably Coastal Wetlands and Littoral Rainforest areas	STOP	GO	GO	GO	GO	GO	GO	GO	SLOW	STOP	10	SLOW	Council	Land acquisition costs could be considerable. Action consolidated within Action EV1 for consultation.
EV6	Council support of volunteer based rehabilitation initiatives such as Bushcare, community based revegetation campaigns, and other community "ownership" projects	GO	GO	GO	GO	GO	GO	GO	GO	GO	GO	15	GO	Council	Action consolidated within Action EV1 for consultation.
EV7	Undertake rehabilitation works in damaged vegetated areas	SLOW	SLOW	GO	GO	GO	GO	GO	GO	GO	GO	13	GO	Council	Action consolidated within Action EV1 for consultation, and is also linked to Action LG9 and Action FB1.
EV8	Dune, foreshore and wetland maintenance programs undertaken by Council and contractors	SLOW	SLOW	GO	GO	GO	GO	GO	GO	GO	GO	13	GO	Council	Action is covered by Action LG6, Action LG9 and Action EV1 progressed to consultation.
EV9	Implementation of weed and pest control programs by Council/external agencies	GO	GO	GO	GO	GO	GO	GO	GO	GO	GO	15	GO	Council	Business as usual, weed/pest control programs already exist. Action consolidated within Action EV1 for consultation.
EV10	Improve community education on both native and pest species, how to identify species, and how to report pest species	GO	GO	SLOW	GO	GO	GO	GO	GO	GO	GO	13	GO	Council	Action consolidated within Action LG10 for consultation.
EV11	Install signage and fencing in key areas to protect vegetation and habitats	GO	GO	GO	GO	SLOW	GO	SLOW	GO	GO	GO	11	GO	Council	Action consolidated within Action EV1 for consultation.
EV12	Enforcement of existing policies/controls on access restrictions	GO	GO	GO	GO	SLOW	GO	SLOW	GO	GO	GO	11	GO	Council	Action consolidated within Action EV1 for consultation.
RA1	Collaborate with TfNSW appropriate management of users, e.g. number of vessels within Lake Conjola	GO	GO	SLOW	GO	SLOW	GO	SLOW	GO	SLOW	GO	8	SLOW	Council	Business as usual, communication between TfNSW-Maritime and Council regarding management of waterway usage is ongoing. Action NOT progressed to consultation.
RA2	Create/enforce time limits on parking in highly popular locations	GO	GO	GO	GO	SLOW	GO	SLOW	GO	GO	GO	11	SLOW	Council	Business as usual. Action NOT progressed to consultation.
RA3	Create/enforce Council policies on the use of open spaces and the coastal zone	GO	GO	GO	GO	SLOW	GO	SLOW	GO	GO	GO	11	SLOW	Council	Business as usual. Action NOT progressed to consultation.

REF. NO.	CMP ACTION	Capital/Operational Cost	Ongoing Costs p.a.	Risk Mitigation	Environmental Impact	Social Impact	Cultural Heritage Impact	Community Acceptability	Reversible / Adaptable in the Future	Legal / Approval Risk	Ease of Implementation	AGGREGATE SCORE	OVERALL ASSESSMENT	Responsibility (Lead Agency)	Comments
RA4	Collaborate with TfNSW to implement appropriate actions within the "Boating Plan of Management - Lake Conjola Estuary" (NSW Maritime Authority, March 2005)	STOP	GO	GO	GO	GO	GO	GO	GO	SLOW	SLOW	11	SLOW	Council	Boating Plan of Management (2005) is now superseded by South Coast Boating Network Plan (2023). Capital works such as boat ramp upgrades may have significant cost.
RA5	Consider collaboration with TfNSW regarding reviewing and enforcement of current and potential controls on watercraft	GO	GO	GO	GO	SLOW	GO	SLOW	GO	SLOW	GO	10	SLOW	Council	Business as usual, communication between TfNSW-Maritime and Council regarding management of waterway usage is ongoing. Action NOT progressed to consultation.
RA6	Consider review of navigation aids (e.g. channel markers)	GO	GO	GO	GO	GO	GO	GO	GO	SLOW	GO	14	GO	TfNSW-Maritime	Business as usual, TfNSW-Maritime undertake ongoing monitoring/review. Action NOT progressed to consultation.
RA7	Review boating speed limits	GO	GO	SLOW	GO	SLOW	GO	SLOW	GO	SLOW	GO	8	SLOW	TfNSW-Maritime	Business as usual, TfNSW-Maritime undertake ongoing monitoring/review. Action NOT progressed to consultation.
RA8	Review boat ramp advisory signage	GO	GO	SLOW	GO	GO	GO	GO	GO	GO	GO	13	GO	Council	Business as usual, TfNSW-Maritime undertake ongoing monitoring/review. Action NOT progressed to consultation.

2.5 Management Actions for Consultation

From the initial long list of 82 actions, 64 actions were progressed and 18 actions were eliminated. The 64 actions progressed from the long list were consolidated into 33 management actions prior to Stage 3 consultation. The management actions that were progressed to Stage 3 consultation were presented in an A3 summary brochure, which is provided in **Appendix A**.

3 Step 2: Community and Stakeholder Engagement

3.1 Overview

Consultation during Stage 3 of the CMP process was undertaken with the community and key stakeholder representatives from government agencies. The consultation asked for feedback on potential management actions that had been developed following the completion of technical studies and community consultation as part of Stage 2 of the CMP. The potential management actions covered a range of topics including:

- Planning and Management Arrangements for the Lake Conjola Catchment Area
- Management of Foreshore Areas and Bank Erosion
- Entrance Management Interventions
- Preparation and Response to Inundation Events
- Maintaining and Improving Water Quality
- Protection and Rehabilitation of Estuarine and Riparian Vegetation and Habitat
- Maintaining and Improving Recreation and Amenity.

Community consultation was facilitated by Council's 'Get Involved' webpage over a consultation period extending from 5 July 2023 to 27 August 2023. The webpage provided access to the potential management actions documented in an A3 summary brochure and also mapped on a publicly accessible interactive GIS platform online. Community feedback was able to be provided through several submission options, comprising:

- Online Survey Tool;
- Map-based Feedback Portal;
- Map-based Suggestion Portal; and,
- Email Submissions.

Consultation with government agency stakeholders was undertaken to obtain their input during the development of the A3 summary brochure and in meeting workshops.

A factsheet was prepared to summarise Stages 2 and 3 online community engagement and responses to the matters raised, and was issued on Council's 'Get Involved' webpage.

A summary of the feedback obtained from community and stakeholder engagement is provided below.

3.2 Online Survey Tool

The Online Survey Tool included several questions to establish demographics of respondents and two open questions regarding view on the proposed management actions, comprising:

- Are there any particular proposed management actions that you do/do not support? Please elaborate below.
- Do you have any additional comments or suggestions on the proposed management actions you would like to provide?

A total of 244 submissions were received from the online survey. The majority of responses were from local residents, whilst a significant response was received from Lake Conjola property owners that lived outside the area. 95% of responses were received from the 35-84 year age range, with good

representation of age groups over this range with 30.7% being 35-49 years, 21.7% being 50-59 years, 28.7% being 60-69 years, and 13.9% being 70-84 years. 84% of respondents indicated that they would like to be kept informed about the progress of the CMP, indicating a high level of engagement and interest amongst respondents.

The following topic areas were mentioned in the submissions received:

- Entrance Management – 83%
- Dredging – 63%
- Water Quality – 43%
- Flood Management – 9%
- Foreshore Management – 3%
- Navigation and Boating Access – 3%
- Lake Ecology – 3%
- Watercraft Storage – 2%
- Stormwater Management – 1%
- Aboriginal Cultural Heritage – 1%
- Dune Management – <1%
- Bushfire Management – <1%
- Private Structures – <1%

As indicated above, the primary focus of most respondents was on entrance management with 75% of respondents expressing a preference to keep the entrance open. Where support for a particular entrance management approach was given, 61% supported dredging to assist with entrance management, 7% supported maintenance of a permanently open entrance with engineering works (i.e. breakwaters), and <1% (1 respondent) indicated support for the maintenance of a 'dry notch'.

The majority of respondents supported the position held by Conjola Community Association (CCA), which was evidenced by the number of duplicate submissions supporting entrance management 'Option 3'. This is a reference to the Category 3 options – modified 'managed entrance' (pilot channel) discussion presented in Stage 2 – Report C (RHDHV, 2023c), involving occasional dredging to maintain the position of the natural ebb tide channel aligned behind the sand spit and directed towards the Cunjurong shoreline in conjunction with excavation of a pilot channel in response to certain triggers if the entrance is closed. However, the CCA position is a variation to this approach being the use of a Decision Support Tool to initiate occasional dredging with the objective to keep the entrance open.

The intent of the modified 'managed entrance' approach is for occasional dredging to be used only for the purpose of maintaining the position of the natural ebb tide channel, aligned behind the sand spit and directed towards the Cunjurong shoreline (refer **Figure 5-19** and **Section 5.5**). This dredging would be implemented as required to avoid the need on occasions for excavation of a 'long' pilot channel which may impact response time to alleviate flooding in the event that lake water level triggers support the decision to open a closed entrance.

The use of dredging to maintain an open entrance is not considered to be an economically viable option, as this would likely require more frequent campaigns and/or dredging in response to episodic events that are difficult to predict and plan for. The lake entrance can be closed rapidly as a result of coastal storms depositing significant quantities of sand into the entrance and storm washover depositing or infilling progressively over a longer period of time.

The following **Table 3-1** summarises how feedback received during Stage 3 is being considered in the refinement and evaluation of the potential management actions that were consulted as part of Stage 3. All responses have been categorised using the following categorisation:

- **Considered in Stage 3**: Where suggestions were:
  - A new idea/suggestion that could be included in the long list of potential management options for the CMP.
  - An idea/ suggestion that was already covered by an existing option, or was a comment on an existing option.
- **General comment:** Where a general comment was provided that was not specifically related to an individual option. These general viewpoints were still considered in the CMP development.
- **Considered, but not progressed to Stage 3**: Where suggestions fell into one of the following categories:
  - They were outside the scope of a CMP – but could be picked up by a different Council plan or strategy.
  - They were located outside of the CMP study area boundary – could therefore be dealt with by another CMP (such as the CMP for an estuary or river system).
  - The suggestion was either inconsistent or incompatible with Council and/or State Government policy.

Royal HaskoningDHV

Table 3-1: Management action feedback from Online Survey Tool

Description	Considered in Stage 3?	Comment
Improvement of application process for private jetty/pontoon structures.	**Considered in Stage 3**	*This is already being actioned through the Domestic Waterfront Structure Strategies, which is referred to in the description under Action FB5. https://www.marine.nsw.gov.au/projects/domestic-waterfront-structure-strategies*
Do not support LG5.	**Considered in Stage 3**	*Action LG5 involves continuation of collaborative works with NPWS staff and volunteers to implement the NSW South Coast Shorebird Recovery Program. This is a key ongoing commitment for Council to implement across the entire local government area.*
I am very disappointed that council have chosen to take away portable toilet at haviland boat ramp. I am finding human excreta in the area extremely offensive. It is ridiculous to think people having been out boating for hours are expected to hold their need to Toilet until getting to amenities when there is nothing available in conjola park.	**Considered in Stage 3**	*Action RA1 includes seeking funding for detailed design and construction of Stage 2 of the boat ramp works at Havilland Street, Conjola Park. These works include the installation of an amenities block.*
It seems strange an ICOLL is having a permanent opening plan being considered as part of a management plan. Considerations should include impact on native species, as well as impact of tidal inundation re: rising sea levels.	**Considered in Stage 3**	*The option to maintain a permanent entrance has been progressed into consultation due to the history of community interest and the opportunity to present and discuss issues with this option. It will be assessed as part of Stage 3 along with other alternate entrance management options.*
Both sides of Conjola Creek (including Hazel Robotham Reserve and the salt marsh) need to be included in FB1 Investigate, remediate and monitor impacted or vulnerable bank areas - Reinstatement of riparian vegetation buffer.	**Considered in Stage 3**	*We will include both sides of Conjola Creek at Fishermans Paradise within the mapping for Action FB1 – reinstatement of riparian vegetation buffer, to capture* Hazel Robotham Reserve.
I support the proposed CMP, especially ensuring appropriate management of water quality, the opening of the lake and endangered species.	**Considered in Stage 3**	*This is considered to be a general feedback comment.*
LG4: 10 years is too long for a review. Legislation, guidelines and research are frequently evolving. The coast and associated landscapes are also frequently evolving, influenced by many factors including extreme	**Considered in Stage 3**	*Action LG4 refers to immediate review of Council coastal management planning policies to reflect the findings of the CMP. The 10 year timeline for ongoing reviews is consistent with the timeframe for future updating of the CMP.*

Description	Considered in Stage 3?	Comment
weather events. 10 years will not appropriately capture this and should be reviewed more frequently.		
FB2: Include the need for ground cover in foreshore areas. This will help reduce the effects of runoff, erosion and associated sedimentation and turbidity.	**Considered in Stage 3**	*Action FB2 identifies 7 locations where riparian vegetation could be used to filter runoff, and 5 locations where hard drainage channels have been proposed to be replaced with grassed and vegetated swales. These actions would include the establishment and maintenance of groundcover at these locations.*
FB4: Include comment for education of landholders with the impacts of fertiliser and/or pesticide addition to land adjacent to foreshore areas. Also include comment on education about the impacts of weeds / pests / introduced species around foreshore areas, and how they can be easily spread by poor management if not controlled.	**Considered in Stage 3**	*Action FB4 relates to uncontrolled stock access to bank areas and associated erosion. These educational aspects would be covered under Action LG10.*
WQ3: Education of the community regarding stormwater quality, discharge areas and pollution risks.	**Considered in Stage 3**	*Stormwater management is primarily an issue for Council to manage with appropriate infrastructure and controls, such as those proposed under Action FB2. These educational aspects would be covered under Action LG10.*
I support EM1 & EM2 as the priorities. I still do not agree with Lake Conjola being identified as an ICOL, when it does not meet the parameters of an ICOL.	**Considered in Stage 3**	*Entrance management options will be further assessed in the cost benefit analysis completed for selected CMP options.*
The canal which runs behind Aney Street along to Pattimores Lagoon should be dredged due to the silt & contaminants build up from storm water running into the waterway. This waterway runs to a protected Lagoon and runs out into the lake system so any pollution from storm water drains impacts the flora and fauna of the lake system.	**Considered in Stage 3**	*This area falls under Council's Canal Estate Management Plan. Review and update of this plan would be undertaken under Action LG11.*
CMP to Acknowledge of Traditional Connection of Jerrinja Tribal Group. CMP to Respect Jerrinja Traditional Lore within Cultural Boundaries.	**Considered in Stage 3**	*Actions LG16, LG17 and LG18 address cultural heritage and the connection of the Jerrinja Tribal Group to the land areas within the CMP study area.*
I support for the lake to be kept open through dredging of the opening when needed by coastal management to prevent flooding of residential properties. To dredge sand within the lake to be moved to another	**Considered, but not progressed to Stage 3**	*The use of dredging to maintain an open entrance is not considered to be an economically viable option, as this would likely require more frequent campaigns and/or dredging in response to episodic events that are difficult to predict and plan for. The lake entrance can be*

Description	Considered in Stage 3?	Comment
location. I do not support a breakwall to keep the lake open. I support the sand spit to be a permanent bird reserve with no dog access that needs to be enforced by rangers. I support the need to improve fish stocks in the lake by keeping the lake open, restricting fishing in the lake until fish stocks improve significantly.		*closed rapidly as a result of coastal storms depositing significant quantities of sand into the entrance and storm washover deposits or infilled progressively over a longer period of time.* *Entrance management options will be further assessed in the cost benefit analysis completed for selected CMP options.*
Do support pro-active management of an open entrance. Managed open entrance proved itself to work between 1999 and 2012 - which coincides with the last time the southern ebb channel was dredged to the northern entry to the lake.	**Considered in Stage 3**	*Entrance management options will be further assessed in the cost benefit analysis completed for selected CMP options. This will include the modified 'managed entrance' approach where occasional dredging is to be used only for the purpose of maintaining the position of the natural ebb tide channel, aligned behind the sand spit and directed towards the Cunjurong shoreline. This dredging would be implemented as required to avoid the need on occasions for excavation of a 'long' pilot channel which may impact response time to alleviate flooding in the event that lake water level triggers support the decision to open a closed entrance.*
It looks like there are very thought and considered plans for the area with sensitivity to the environmental needs, well balanced with the needs of visitors and community.	**Considered in Stage 3**	*This is considered to be a general feedback comment.*
Dredging for improved boating access into Berringer Lake.	**Considered, but not progressed to Stage 3**	*Installation of new 4 knot speed limit signs at the entry to Berringer Lake is proposed by Transport for NSW as part of their ongoing management of waterway navigation. Dredging of channels has the potential to improve navigation, but is expensive and can have a range of environmental impacts that need to be considered, including impacts to seagrasses. These impacts would need to be weighed up against any potential benefits from improved navigation and minimising boat propeller damage to seagrasses.*
Kayak tie-up point in front of the Island View Caravan Park and the adjacent reserve.	**Considered in Stage 3**	*It is assumed that this location refers to Lake Conjola Waterfront Holiday Park. There is a mapped Action FB3 location on the Interactive Mapping for formalised watercraft storage at this reserve location.*
Ensure that foreshore areas between the water tank and the lake entry on the northern side of the lake are protected.	**Considered in Stage 3**	*This would be covered by Action EV1.*

Description	Considered in Stage 3?	Comment
Management of the wetland area on the northern edge of the lake from Lake Berringer to the mouth of Lake Conjola.	Considered in Stage 3	*This would be covered by Action EV1.*
Keeping the Lake entrance open.	Considered in Stage 3	*Entrance management options will be further assessed in the cost benefit analysis completed for selected CMP options.*
Investigation of the impact of the release of effluent into the filtration system of the sewerage works on localised flooding on properties on the southern end of the township (Sandgroper Crescent).	Considered in Stage 3	*The investigation of these potential impacts can be added to the scope of future groundwater monitoring and assessment under Action WQ1.*
The management and monitoring actions outlined are welcomed.	Considered in Stage 3	*This is considered to be a general feedback comment.*
I want to keep the lake open.	Considered in Stage 3	*Entrance management options will be further assessed in the cost benefit analysis completed for selected CMP options.*
Disabled access to Lake Conjola from Cunjurong side.	Considered in Stage 3	*Council is due to commence an engagement with a specialist coastal engineering consultancy, this financial year, to assess the suitability of appropriate sites across the Shoalhaven for potential all ability beach access. The completion of the above assessment will inform Council of locations that could be determined to be financially and socially viable.*
As I walk past the Lake Conjola entrance and up and down the beach daily, I am now extremely concerned that the tidal flow into the Lake has diminished, the channel has also silted up with sand and the water clarity is becoming increasingly poorer. If this continues to deteriorate, (once again) both the marine life and vegetation will be at risk AGAIN. Please consider a permanent Lake opening as a HIGH priority for our beautiful Lake system.	Considered in Stage 3	*The option to maintain a permanent entrance has been progressed into consultation due to the history of community interest and the opportunity to present and discuss issues with this option. It will be assessed as part of Stage 3 along with other alternate entrance management options.*
I am not sure a permanent wall for the entrance would work. A program of dredging before it gets very bad and closes.	Considered in Stage 3	*The option to maintain a permanent entrance has been progressed into consultation due to the history of community interest and the opportunity to present and discuss issues with this option. It will be assessed as part of Stage 3 along with other alternate entrance management options.*

Description	Considered in Stage 3?	Comment
		The use of dredging to maintain an open entrance is not considered to be an economically viable option, as this would likely require more frequent campaigns and/or dredging in response to episodic events that are difficult to predict and plan for. The lake entrance can be closed rapidly as a result of coastal storms depositing significant quantities of sand into the entrance and storm washover deposits or infilled progressively over a longer period of time.
The lake only floods when the sand build up at the entrance forms a wall and with East Coast Low raising Lake water level quickly, the lake will flood. If the lake is open any flood occurrence is extremely rare, of less severity and brief. Evidenced by locals who have lived here for 60 to 70 years. I am wary of dredging strategies as shown by expensive failures at previous dredging. The dumping of dredged sand on the southern side of the beach was disastrous as sand returned completely into the lake within months (all ocean sand moves south to north through big seas unless stopped by rock natural or man made). The dredge areas with the lake (channel on Cunjurong side fail only lasting a short time). The famous tourist attraction of the lake Conjola sand hill near the boat ramp disappeared with dredging dump waste. Sand needs to be dumped north of the entrance to prevent coming back in to the lake.	Considered, but not progressed to Stage 3	*The use of dredging to maintain an open entrance is not considered to be an economically viable option, as this would likely require more frequent campaigns and/or dredging in response to episodic events that are difficult to predict and plan for. The lake entrance can be closed rapidly as a result of coastal storms depositing significant quantities of sand into the entrance and storm washover deposits or infilled progressively over a longer period of time.* *Entrance management options will be further assessed in the cost benefit analysis completed for selected CMP options.*
I support keeping the lake open to the ocean as i have been coming here for the last fifty years and seen the lake close a number of times. When the lake is closed and you get lots of heavy rain then there is a realistic chance we get flooded. Some of these times could have been prevented if the council had listened to the residents. One of our recent floods occurred because the council failed to mechanically open it because it happened on a weekend !!! Yet in northern Sydney the councils knew the rain front was coming and prepared openings to minimize any flooding. Our council opened it a day after flooding occurred. Flooding can occur	Considered in Stage 3	*As per Action IN2, Council have recently invested in a study to develop a flood warning system to be implemented at Lake Conjola. This will improve the accuracy of flood forecasting and Council's response which may include entrance management in response to adopted triggers for action.*

Description	Considered in Stage 3?	Comment
with the lake open but is usually very rare and minor but with the lake closed its always often and major.		
It all looks good and very complete..I hope it follows with action not just ideas. Important is Protect habitats, protect and fix vulnerable banks, possible development of storage area for small boats, kayaks, etc. Most important is to keep the entrance of Lake Conjola open to protect the lake environmentally.	**Considered in Stage 3**	*This is considered to be a general feedback comment.*
I would like Council to purchase a dredging machine to be left at Lake Conjola. It is my understanding that in the 1960's & 1970's there were multiple dredges in the lake.	**Considered, but not progressed to Stage 3**	*The use of dredging to maintain an open entrance is not considered to be an economically viable option, as this would likely require more frequent campaigns and/or dredging in response to episodic events that are difficult to predict and plan for. The lake entrance can be closed rapidly as a result of coastal storms depositing significant quantities of sand into the entrance and storm washover deposits or infilled progressively over a longer period of time.*
Incomplete stormwater management works causing flooding on Lake Conjola Entrance Road.	**Considered in Stage 3**	*This matter would be captured in the review and update of asset management plans (including stormwater drainage infrastructure) undertaken under Action LG11.*
Approved tie-up points and launching location/facilities for outrigger canoes for use by Conjola Stingrays Outrigger Canoe Club.	**Considered in Stage 3**	*There is a mapped Action FB3 location on the Interactive Mapping for formalised watercraft storage at the Yooralla Bay (Conjola Park) reserve location used by the Conjola Stingrays Outrigger Canoe Club.*
I support working to keep the lake open permanently. As soon as it closes everybody knows local lives start being affected negatively.	**Considered in Stage 3**	*The option to maintain a permanent entrance has been progressed into consultation due to the history of community interest and the opportunity to present and discuss issues with this option. It will be assessed as part of Stage 3 along with other alternate entrance management options.*
I fully support the consultation and collaboration with the Indigenous community and the efforts to preserve the natural environment and protect vulnerable native fauna.	**Considered in Stage 3**	*This is considered to be a general feedback comment.*

Description	Considered in Stage 3?	Comment
I am concerned about the number of caravan parks that allow permanent vans to be situated so close to the Lakes Edge. These should be replaced with casual sites. I am also concerned about the number of van parks and the effect on the health of the Lake and environment. I am also concerned about the safety of residents during natural disaster events due to the lack of alternate escape routes. There needs to be more than one access road. This is also an issue for Sussex Inlet.	Considered in Stage 3	*The management of caravans on existing approved sites is a matter for individual business owners to consider. Action PM1 includes the review of development and planning controls that apply to new development within flood prone land areas. Emergency response and evacuation is a matter for NSW State Emergency Service to address, as the lead combat agency for flood, storm and tsunami response, and is outside the scope of the CMP.*
They need to keep the lake open.	Considered in Stage 3	*Entrance management options will be further assessed in the cost benefit analysis completed for selected CMP options.*
Clearing of undergrowth near Over 55s Ingenia Village for bushfire management.	Considered, but not progressed to Stage 3	*Bushfire management is not a relevant matter to be addressed in the CMP.*
I was present at the 2020 flood event and watched the water continue to slowly rise and flood the lower floor of my house. At the time there was no rain and the weather was quite calm and sunny. When the lake entrance was opened, the water receded within an hour. If the entrance was open or had been opened earlier, my house would not have been flooded. Council had been warned of the impending weather event the week before it occurred and choose not to open the lake until the water level reached the trigger level. This occurred about 11pm the previous evening and of course it was not possible to open the lake at this time. Maintaining an open entrance will minimise the number of flooding events thereby minimising the risk to the local community.	Considered in Stage 3	*Entrance management options will be further assessed in the cost benefit analysis completed for selected CMP options.*
I want to keep the lake open at all costs.	Considered in Stage 3	*Entrance management options will be further assessed in the cost benefit analysis completed for selected CMP options.*
Dredge the entrance before it closes.	Considered, but not progressed to Stage 3	*The use of dredging to maintain an open entrance is not considered to be an economically viable option, as this would likely require more frequent campaigns and/or dredging in response to episodic events that are difficult to predict and plan for. The lake entrance can be*

Description	Considered in Stage 3?	Comment
		closed rapidly as a result of coastal storms depositing significant quantities of sand into the entrance and storm washover deposits or infilled progressively over a longer period of time.
All I can say is dredging the lake doesn't work !!!	**Considered in Stage 3**	*This is considered to be a general feedback comment.*
Open the lake permanently as is Lake Illawarra.	**Considered in Stage 3**	*The option to maintain a permanent entrance has been progressed into consultation due to the history of community interest and the opportunity to present and discuss issues with this option. It will be assessed as part of Stage 3 along with other alternate entrance management options.*
Dredging to keep lake open	**Considered, but not progressed to Stage 3**	*The use of dredging to maintain an open entrance is not considered to be an economically viable option, as this would likely require more frequent campaigns and/or dredging in response to episodic events that are difficult to predict and plan for. The lake entrance can be closed rapidly as a result of coastal storms depositing significant quantities of sand into the entrance and storm washover deposits or infilled progressively over a longer period of time.*
Support dredging to keep lake open	**Considered, but not progressed to Stage 3**	*The use of dredging to maintain an open entrance is not considered to be an economically viable option, as this would likely require more frequent campaigns and/or dredging in response to episodic events that are difficult to predict and plan for. The lake entrance can be closed rapidly as a result of coastal storms depositing significant quantities of sand into the entrance and storm washover deposits or infilled progressively over a longer period of time.*
Very general in principle but no info on what are the priorities	**Considered in Stage 3**	*This is considered to be a general feedback comment.*
Please open the Lake - it will die without our support!	**Considered in Stage 3**	*Entrance management options will be further assessed in the cost benefit analysis completed for selected CMP options.*
Option 1: The entrance area is allowed to behave naturally. Mechanical intervention in the form of excavation of a pilot channel occurs only in response to certain triggers. Ignoring it fixes nothing. "Certain triggers" seem to translate to "NO triggers".	**Considered in Stage 3**	*Entrance management options will be further assessed in the cost benefit analysis completed for selected CMP options.*

Description	Considered in Stage 3?	Comment
Option 4: Engineering works are constructed in the entrance area, such as entrance breakwaters, to create a permanently open entrance, in which case there would be no requirement for a pilot channel. Initial outlay would be beneficial in the long run, but won't allow for future council neglect. This will also allow for tourism-related development options in the lake with passage to the ocean.	**Considered in Stage 3**	*The option to maintain a permanent entrance has been progressed into consultation due to the history of community interest and the opportunity to present and discuss issues with this option. It will be assessed as part of Stage 3 along with other alternate entrance management options.*
I do not support closure of the lake.	**Considered in Stage 3**	*Entrance management options will be further assessed in the cost benefit analysis completed for selected CMP options.*
Ensure lake entrance remains open for better water quality and to prevent flooding. Action should be taken before entrance closes instead of waiting for a flood.	**Considered in Stage 3**	*Entrance management options will be further assessed in the cost benefit analysis completed for selected CMP options.*
Continuation and maintaining the lake channel to the ocean to ensure we don't have lake stagnation, algal blooms or loss of a natural beauty and resource.	**Considered in Stage 3**	*Entrance management options will be further assessed in the cost benefit analysis completed for selected CMP options.*
Council enforce maintenance of vacant land to reduce bushfire risk.	**Considered, but not progressed to Stage 3**	*Bushfire management is not a relevant matter to be addressed in the CMP.*
Keep the lake open or we flood, simple.	**Considered in Stage 3**	*Entrance management options will be further assessed in the cost benefit analysis completed for selected CMP options.*
I support option 4 as a best case (ie gold plated solution), with a secondary choice of option 3. As a long time resident of the Illawarra/Shoalhaven area I recall the days when both Lake Illawarra and Lake Conjola have been disgusting sespits, this has been when both lakes have had no or poor openings to the ocean.	**Considered in Stage 3**	*Entrance management options will be further assessed in the cost benefit analysis completed for selected CMP options.*

Description	Considered in Stage 3?	Comment
We (Europeans) have built up and changed the environment around Lake Conjola, we have a responsibility to actively manage and ensure that Lake Conjola maintains a healthy ecosystem.		
The lake should be maintained a lot of people from Sutherland shire visit lake conjola. There has to be a long term solution why all does the entrance close now when I was younger it never closed there has to be a reason and answer.	**Considered in Stage 3**	*Entrance management options will be further assessed in the cost benefit analysis completed for selected CMP options.*
Keep the lake open	**Considered in Stage 3**	*Entrance management options will be further assessed in the cost benefit analysis completed for selected CMP options.*
Keep the lake open at all times	**Considered in Stage 3**	*Entrance management options will be further assessed in the cost benefit analysis completed for selected CMP options.*
I support option 3 regarding the lake occasional dredging of the lake and keeping it open.	**Considered in Stage 3**	*Entrance management options will be further assessed in the cost benefit analysis completed for selected CMP options.*
I believe Option 3 with use of the DST is the most effective option to manage the lake entrance and will also act as a vital measure to reduce the risk of flooding (of both public and private assets), will prevent algal bloom and other water quality issues impacting the lake in future and will deliver further benefits to all populations living around or in the lake.	**Considered in Stage 3**	*Entrance management options will be further assessed in the cost benefit analysis completed for selected CMP options.*
The current actions of the past have made it difficult to react at short notice for emergency situations and also to further mitigate damage to the marine ecosystem. I support the 4th option being a permanent opening. If funds are not available at present I would like to see the project set up to be triggered once funding is made available by council/state gov. As a long term resident of the Illawarra I have seen the great improvement of lake Illawarra since the creation of a permanent opening. I lived on the lake until I was 35 and spent most weeks on the lake.	**Considered in Stage 3**	*The option to maintain a permanent entrance has been progressed into consultation due to the history of community interest and the opportunity to present and discuss issues with this option. It will be assessed as part of Stage 3 along with other alternate entrance management options.*

Description	Considered in Stage 3?	Comment
Needs to be a change to management of the entrance.	**Considered in Stage 3**	*Entrance management options will be further assessed in the cost benefit analysis completed for selected CMP options.*
Lake mouth needs dredging, at least up to Chinaman's Island. Primarily for boat navigation, very difficult to get boats past entrance caravan park as it is too shallow in the marked channel. Also, some of the channel markers need moving.	**Considered, but not progressed to Stage 3**	*TfNSW-Maritime is responsible for ongoing management of navigation within Lake Conjola. At this stage dredging for the purpose of improving navigation is not proposed within the South Coast Boating Network Plan, which documents the current plans for improvements to boating access and navigation within south coast waterways.*
Continually dredge the sand from the Lake to keep it open. I feel that when the lake is open and the water is crystal clear it is such an attraction to Lake Conjola and much better for the fish etc.	**Considered, but not progressed to Stage 3**	*The use of dredging to maintain an open entrance is not considered to be an economically viable option, as this would likely require more frequent campaigns and/or dredging in response to episodic events that are difficult to predict and plan for. The lake entrance can be closed rapidly as a result of coastal storms depositing significant quantities of sand into the entrance and storm washover deposits or infilled progressively over a longer period of time.*
I do not support anything that does not involve mechanical opening or a permanent break wall. Lake conjola IS NOT AN ICOLL. Lake conjola is a tourist attraction, because of the lake ! Tourism has built the village and surrounding areas. If the lake remains closed, there will be no tourism and no money.	**Considered in Stage 3**	*Entrance management options will be further assessed in the cost benefit analysis completed for selected CMP options.*
I run a business at Lake Conjola that depends on tourists. When the lake is open we are 200% busier than went it is closed. We also never flood as bad.	**Considered in Stage 3**	*Entrance management options will be further assessed in the cost benefit analysis completed for selected CMP options.*
Waiting for lake levels to rise and cause danger to properties before attending to the re opening of the lake. Keep the lake open at all times.	**Considered in Stage 3**	*Entrance management options will be further assessed in the cost benefit analysis completed for selected CMP options.*
KEEP THE LAKE OPEN!!! Yes…the lake needs to be open too maintain the beauty and natural wonders.	**Considered in Stage 3**	*Entrance management options will be further assessed in the cost benefit analysis completed for selected CMP options.*
Keep the lake open.	**Considered in Stage 3**	*Entrance management options will be further assessed in the cost benefit analysis completed for selected CMP options.*

Description	Considered in Stage 3?	Comment
Option 3, however I don't want the lake to close before action is taken to reopen the lake like many times before. We have been through 2 major flooding events which were totally preventable had Council taken appropriate action well prior to trigger levels. Keep the entrance open permanently. Allocate a budget to keep Lake Conjola entrance open at all times.	**Considered in Stage 3**	*The intent of the modified 'managed entrance' approach is for occasional dredging to be used only for the purpose of maintaining the position of the natural ebb tide channel, aligned behind the sand spit and directed towards the Cunjurong shoreline. This dredging would be implemented as required to avoid the need on occasions for excavation of a 'long' pilot channel which may impact response time to alleviate flooding in the event that lake water level triggers support the decision to open a closed entrance.* *As per Action IN2, Council have recently invested in a study to develop a flood warning system to be implemented at Lake Conjola. This will improve the accuracy of flood forecasting and Council's response which may include entrance management in response to adopted triggers for action.*
1. If the lake is closing, open the lake before it closes. 2. Elect only "one" Government Body to make a common sense decision in regard the opening of the lake in the event of a likely closing of the lake. 3. If there is no one available to make a common sense decision regarding point #2, please contact the Lake Conjola Community association or any resident of the Village of lake Conjola to organise the necessary equipment and personnel to keep the lake open at the expense of the Shoalhaven Council. 4. If the Shoalhaven council, governing bodies and coastal management plan allow the lake to be closed again, Shame on you.	**Considered in Stage 3**	*Entrance management options will be further assessed in the cost benefit analysis completed for selected CMP options.*
I support keeping the lake open.	**Considered in Stage 3**	*Entrance management options will be further assessed in the cost benefit analysis completed for selected CMP options.*
I don't support the closing of the lake. EM1 a revised entrance management policy and keeping the entrance perm open.	**Considered in Stage 3**	*Entrance management options will be further assessed in the cost benefit analysis completed for selected CMP options.*

Description	Considered in Stage 3?	Comment
Lake Conjola needs to be kept open by continually dredging the sand and removing it.	Considered, but not progressed to Stage 3	*The use of dredging to maintain an open entrance is not considered to be an economically viable option, as this would likely require more frequent campaigns and/or dredging in response to episodic events that are difficult to predict and plan for. The lake entrance can be closed rapidly as a result of coastal storms depositing significant quantities of sand into the entrance and storm washover deposits or infilled progressively over a longer period of time.*
I do not support the options of letting the lake close and wait for a trigger level before possible mechanical opening of the lake. The lake needs to be flushed out daily through tidal change activity influenced by the ocean's tidal changes to maintain a safe water quality. It doesn't make sense to approve an oyster lease if the lake cannot maintain a good water quality.	Considered in Stage 3	*Entrance management options will be further assessed in the cost benefit analysis completed for selected CMP options.*
I do not support closing the lake.	Considered in Stage 3	*Entrance management options will be further assessed in the cost benefit analysis completed for selected CMP options.*
The lake has always historically opened and closed with the prevailing long term weather conditions. In recent history continual manual openings promoted the proliferation of the noxious marine weed Caulerpa taxifolia. See https://www.dpi.nsw.gov.au/.../seaweed/caulerpa-taxifolia. This marine pest was only eradicated a decade ago with a closed entrance, as nature intended, returning lake water salinity to its status quo. It is understood the waterway is aesthetically pleasing to the human eye when the entrance is open to the sea. Longing for a forever open waterway at Conjola is a selfish human point of view. Your option 1 above is best for the healthy future of the waterway, especially the fish stocks. People who purchase property or rent van sites on known floodplains, as displayed on the planning document they are availed to prior to settlement, and then go on to demand government agencies totally prevent any flooding to their property need to look themselves in the mirror.	Considered in Stage 3	*Entrance management options will be further assessed in the cost benefit analysis completed for selected CMP options.*

Description	Considered in Stage 3?	Comment
Stop listening to the "mob" mentality of the uninformed and selfish residents of Lake Conjola who want the waterway to permanently look like the Whitsundays. The waterway always was and always will be an ICOLL. Human mechanical intervention since the 1960's has only ever harmed the waterway, disturbing sand dunes and introducing Caulerpa Taxifolia. The natural environment of the waterway has evolved to cope with opening and closing lakes. It's about time the humans did too.		
Just keep it open and the lake healthy please!	**Considered in Stage 3**	*Entrance management options will be further assessed in the cost benefit analysis completed for selected CMP options.*
Please keep the lake open. Either by dredging or a breakwall. The lake needs to stay open.	**Considered in Stage 3**	*The use of dredging to maintain an open entrance is not considered to be an economically viable option, as this would likely require more frequent campaigns and/or dredging in response to episodic events that are difficult to predict and plan for. The lake entrance can be closed rapidly as a result of coastal storms depositing significant quantities of sand into the entrance and storm washover deposits or infilled progressively over a longer period of time.* *The option to maintain a permanent entrance has been progressed into consultation due to the history of community interest and the opportunity to present and discuss issues with this option. It will be assessed as part of Stage 3 along with other alternate entrance management options.*
I would like to see that the council maintain the lake to stay open. PLEASE KEEP THE LAKE OPEN.	**Considered in Stage 3**	*Entrance management options will be further assessed in the cost benefit analysis completed for selected CMP options.*
I support option 3.	**Considered in Stage 3**	*Entrance management options will be further assessed in the cost benefit analysis completed for selected CMP options.*
Do not wait for the lake to close do maintenance dredging. The Conjola community voted back in 1989 to do Maintenance dredging as per the chart for Manly Hydraulics have. It is concerning that you don't care about the beauty of the lake when it is opened to the sea.	**Considered, but not progressed to Stage 3**	*The use of dredging to maintain an open entrance is not considered to be an economically viable option, as this would likely require more frequent campaigns and/or dredging in response to episodic events that are difficult to predict and plan for. The lake entrance can be closed rapidly as a result of coastal storms depositing significant quantities of sand into the entrance and storm washover deposits or infilled progressively over a longer period of time.*

Description	Considered in Stage 3?	Comment
Permanent dredging to ensure the entrance remains open. think it's important to keep the entrance open at all times.	Considered, but not progressed to Stage 3	*The use of dredging to maintain an open entrance is not considered to be an economically viable option, as this would likely require more frequent campaigns and/or dredging in response to episodic events that are difficult to predict and plan for. The lake entrance can be closed rapidly as a result of coastal storms depositing significant quantities of sand into the entrance and storm washover deposits or infilled progressively over a longer period of time.*
My property is very close to the water and am very concerned of flooding (95 Lake Conjola Entrance Rd). On this basis, I am in support of maintaining the entrance to be open to alleviate flooding. It's difficult to understand proposed actions/options within the proposed management actions document, however I'm of the view continually dredging the sand from the lake to keep it open is the required action. In addition to this, now that there are oyster lease back in the lake, the entrance needs to be open to allow these leases to function.	Considered, but not progressed to Stage 3	*The use of dredging to maintain an open entrance is not considered to be an economically viable option, as this would likely require more frequent campaigns and/or dredging in response to episodic events that are difficult to predict and plan for. The lake entrance can be closed rapidly as a result of coastal storms depositing significant quantities of sand into the entrance and storm washover deposits or infilled progressively over a longer period of time.*
Dredging the lake when needed.	**Considered in Stage 3**	*Entrance management options will be further assessed in the cost benefit analysis completed for selected CMP options.*
I do not support the lake being managed only as an emergency occurs. We need to act prior to with controlled dredging.	**Considered in Stage 3**	*Entrance management options will be further assessed in the cost benefit analysis completed for selected CMP options.*
I only support option 3 of the management plan which is to keep the lake open at all times and provide regular dredging to ensure that it stays that way. Under no circumstances should the lake be allowed to close and further degradation to occur. I fully support the proposal put forth by the Lake Conjola community association.	**Considered in Stage 3**	*The intent of the modified 'managed entrance' approach is for occasional dredging to be used only for the purpose of maintaining the position of the natural ebb tide channel, aligned behind the sand spit and directed towards the Cunjurong shoreline. This dredging would be implemented as required to avoid the need on occasions for excavation of a 'long' pilot channel which may impact response time to alleviate flooding in the event that lake water level triggers support the decision to open a closed entrance.*
We live in Edwin Avenue and the Council don't even maintain drainage. The stormwater flows directly into our property because of lack of maintenance.	**Considered in Stage 3**	*This matter would be captured in the review and updated of asset management plans (including stormwater drainage infrastructure) undertaken under Action LG11.*

Description	Considered in Stage 3?	Comment
Action PM1 could also refer to reviewing relevant provisions of Chapter 2 Coastal Management of the SEPP (Resilience and Hazards) 2021 particularly regarding the mapping of Coastal Management Areas.	**Considered in Stage 3**	*The consideration of relevant provisions of the Resilience and Hazards SEPP can be included under the description of Action PM1.*
I support to keep the lake open by dredging regularly as I have encountered floods in the past years due to resent government political views.	**Considered, but not progressed to Stage 3**	*The use of dredging to maintain an open entrance is not considered to be an economically viable option, as this would likely require more frequent campaigns and/or dredging in response to episodic events that are difficult to predict and plan for. The lake entrance can be closed rapidly as a result of coastal storms depositing significant quantities of sand into the entrance and storm washover deposits or infilled progressively over a longer period of time.*
I do not support option 1 and 2. The approach needs to be proactive to maintain an open lake permanently. Regular dredging (not just when it will become an emergency situation), so a modified version of option 3 would be ideal and what I support. My second choice is potentially the break wall, option 4 (as it is the only option you offer for a permanent opening) but not ideal. Our family wants the lake permanently open. Do the job right, be proactive. There are other lakes in NSW that manage to do this eg Narrabeen.	**Considered in Stage 3**	*The use of dredging to maintain an open entrance is not considered to be an economically viable option, as this would likely require more frequent campaigns and/or dredging in response to episodic events that are difficult to predict and plan for. The lake entrance can be closed rapidly as a result of coastal storms depositing significant quantities of sand into the entrance and storm washover deposits or infilled progressively over a longer period of time.* *The option to maintain a permanent entrance has been progressed into consultation due to the history of community interest and the opportunity to present and discuss issues with this option. It will be assessed as part of Stage 3 along with other alternate entrance management options.* *Proactive entrance management options including the maintenance of a dry notch and/or occasional dredging for the purposes of maintaining the position of the natural ebb tide channel will be further assessed in the cost benefit analysis completed for selected CMP options.*
Please keep Lake Conjola entrance open permanently, regularly maintain the opening & not act on it as a measure after the entrance has closed or has silted at the opening causing risk of flooding & poor water quality.	**Considered in Stage 3**	*Entrance management options will be further assessed in the cost benefit analysis completed for selected CMP options.*
Dredging option 3	**Considered in Stage 3**	*Entrance management options will be further assessed in the cost benefit analysis completed for selected CMP options.*

Description	Considered in Stage 3?	Comment
EM1 should be a permanent opening. Council is too slow to respond if lake is closed and weather conditions prevailing cause inundation to properties and infrastructure.	**Considered in Stage 3**	*The option to maintain a permanent entrance has been progressed into consultation due to the history of community interest and the opportunity to present and discuss issues with this option. It will be assessed as part of Stage 3 along with other alternate entrance management options.*
A permanent opening should be maintained. This not only protects properties and infrastructure from inundation but also provides a healthy lake environment. This is nothing new and lessons should have been learnt from the past.	**Considered in Stage 3**	*The option to maintain a permanent entrance has been progressed into consultation due to the history of community interest and the opportunity to present and discuss issues with this option. It will be assessed as part of Stage 3 along with other alternate entrance management options.*
Early intervention to maintain the opening of the lake to prevent inundation and stagnation of the lake.	**Considered in Stage 3**	*Entrance management options will be further assessed in the cost benefit analysis completed for selected CMP options.*
support leaving the lake open, option 3	**Considered in Stage 3**	*Entrance management options will be further assessed in the cost benefit analysis completed for selected CMP options.*
Option 3. The lake needs to be kept open for the health of the lake, wildlife and residents and visitors.	**Considered in Stage 3**	*Entrance management options will be further assessed in the cost benefit analysis completed for selected CMP options.*
I support option 3 for dredging of the lake before the entrance closes and to keep the lake open for the health of the lake, residents, visitors and aquatic life.	**Considered in Stage 3**	*The intent of the modified 'managed entrance' approach is for occasional dredging to be used only for the purpose of maintaining the position of the natural ebb tide channel, aligned behind the sand spit and directed towards the Cunjurong shoreline. This dredging would be implemented as required to avoid the need on occasions for excavation of a 'long' pilot channel which may impact response time to alleviate flooding in the event that lake water level triggers support the decision to open a closed entrance.*
I support option 3 of dredging the Lake, this needs to be done before the lake closes to keep the lake open. Having the lake closed is not of benefit to anyone or anything in Lake Conjola.	**Considered in Stage 3**	*The intent of the modified 'managed entrance' approach is for occasional dredging to be used only for the purpose of maintaining the position of the natural ebb tide channel, aligned behind the sand spit and directed towards the Cunjurong shoreline. This dredging would be implemented as required to avoid the need on occasions for excavation of a 'long' pilot channel which may impact response time to alleviate flooding in the event that lake water level triggers support the decision to open a closed entrance.*

Description	Considered in Stage 3?	Comment
EM1 - strongly support a well managed dredging program when needed such as now! Little point in some of the programs e.g FB1,PM1 unless the entrance and channels are managed to maximise the benefits of good tidal flows without a breakwall.	**Considered in Stage 3**	*Entrance management options will be further assessed in the cost benefit analysis completed for selected CMP options.*
LG1 does not include community or business (oyster farmers) involvement??	**Considered in Stage 3**	*The CMP working group established under Action LG1 should include staff from Council, relevant state government agencies, and other groups.*
There are a lot of proposed management actions which may benefit long term however immediate and urgent action is needed to correct the many errors in Council management over the last 50 years. LG2 (Maintain a full-time CMP Coordinator) would be an excellent first step.	**Considered in Stage 3**	*This is considered to be a general feedback comment.*
Lake open. Jetty's. Connecting bike bath. Everything is great and needs to do fine.	**Considered in Stage 3**	*This is considered to be a general feedback comment.*
A healthy lake is my main priority. As vice president of the Lake Conjola Fishing Club I get to see first hand the importance of keeping the lake open and healthy. The endless schools of mullet and tailor moving in and out of the lake had only just started to return but now the lake about to close again. Since the lake was open the has also been only very minor flooding even though we have some very wet years, apart from this year, since the fires. This compares to many floods during the years of closure as records should show. Everything points to the importance of an open lake.	**Considered in Stage 3**	*Entrance management options will be further assessed in the cost benefit analysis completed for selected CMP options.*
The sand has now built up east of Chinaman's Island to the point where boat access east is only possible for the smallest of boats and the only fix may be dredging.	**Considered, but not progressed to Stage 3**	*TfNSW-Maritime is responsible for ongoing management of navigation within Lake Conjola. At this stage dredging for the purpose of improving navigation is not proposed within the South Coast Boating Network Plan, which documents the current plans for improvements to boating access and navigation within south coast waterways.*

Description	Considered in Stage 3?	Comment
Yes keep lake open by dredging the sand.	Considered, but not progressed to Stage 3	*The use of dredging to maintain an open entrance is not considered to be an economically viable option, as this would likely require more frequent campaigns and/or dredging in response to episodic events that are difficult to predict and plan for. The lake entrance can be closed rapidly as a result of coastal storms depositing significant quantities of sand into the entrance and storm washover deposits or infilled progressively over a longer period of time.*
Fix it before it gets worse each and every time.	**Considered in Stage 3**	*This is considered to be a general feedback comment.*
I would like to see the lake kept open to the ocean to maintain better water quality. This can be done through dredging the entrance.	Considered, but not progressed to Stage 3	*The use of dredging to maintain an open entrance is not considered to be an economically viable option, as this would likely require more frequent campaigns and/or dredging in response to episodic events that are difficult to predict and plan for. The lake entrance can be closed rapidly as a result of coastal storms depositing significant quantities of sand into the entrance and storm washover deposits or infilled progressively over a longer period of time.*
Generally supportive of all, with particular mention of FB3 (watercraft storage) and RA1 (Havilland St Boat Ramp Stage 2), as both would enhance the facilities available to the local community.	**Considered in Stage 3**	*This is considered to be a general feedback comment.*
Yes. In regards to EM1 (Entrance Management Policy), which - in my view - is the most important point in this CMP, and the options embedded within EM1, I'd like to outline my strong support of Option 3 (occasional dredging to sustain an open channel within the natural ebb tide channel), but with the condition that I don't want the situation to wait until the lake is closed before the dredging commences. As a long-term owner in the area, who lived through the last lake closure, the condition of the lake, before it was reopened, was atrocious and unnecessarily so. My position is that Option 3 be used together with the Decision Support Tool (DST) within the M2 framework (already in place), to proactively keep Lake Conjola open permanently. The lake environment is so beautiful at the moment, with the clear lake opening and all that brings, that I simply cannot imagine why we would let	Considered, but not progressed to Stage 3	*The intent of the modified 'managed entrance' approach is for occasional dredging to be used only for the purpose of maintaining the position of the natural ebb tide channel, aligned behind the sand spit and directed towards the Cunjurong shoreline. This dredging would be implemented as required to avoid the need on occasions for excavation of a 'long' pilot channel which may impact response time to alleviate flooding in the event that lake water level triggers support the decision to open a closed entrance.* *The use of dredging to maintain an open entrance is not considered to be an economically viable option, as this would likely require more frequent campaigns and/or dredging in response to episodic events that are difficult to predict and plan for. The lake entrance can be closed rapidly as a result of coastal storms depositing significant quantities of sand into the entrance and storm washover deposits or infilled progressively over a longer period of time.*

Description	Considered in Stage 3?	Comment
the lake close again with all the associated issues - when we have Option 3 with use of the DST available to manage keeping the lake open proactively. This, in my view, is the most important management action of all those included in the CMP and Option 3 (with DST) has my strong support. I'm 100% against Option 1 and Option 2, and while Option 4 would also be good (permanent breakwater structure) - I suspect it's politically unlikely to get approval hence Option 3 being my preferred one.		
Management Action IN1 refers management plans for public assets. I would submit that there are also significant private assets being put at risk through allowing the lake to close, with no proposed plans being put forward for their protection. As well as increased flood risk to housing, previous long-term closure of Lake Conjola has been associated with loss of oyster production, mangrove and seagrass dieback, algae along the foreshores, public health issues due to elevated bacteria and viruses, degradation of the foreshore habitat, decline in fish, crustacean and seabird populations and an overall decline in the beauty of the lake.	**Considered in Stage 3**	*Regarding Action IN1, it is not Council's responsibility to prepare management plans for private assets.* *Entrance management options will be further assessed in the cost benefit analysis completed for selected CMP options.*
Would like the lake to be open Option 3	**Considered in Stage 3**	*Entrance management options will be further assessed in the cost benefit analysis completed for selected CMP options.*
Yes. Regarding the EM1 Entrance Management Policy options, I choose Option 2: The entrance area is managed by way of a dry notch approach whereby the sand levels in the entrance area (above water level) are regularly mechanically groomed to facilitate an easier mechanical opening when required, i.e., less excavation is necessary to open the lake when trigger levels are met.	**Considered in Stage 3**	*Entrance management options will be further assessed in the cost benefit analysis completed for selected CMP options.*
I support all the proposed management actions, particularly as they relate to erosion management, dunal rehabilitation, asset rebuild & upgrades and illegal structure and craft storage management. Great work Coastal team!	**Considered in Stage 3**	*This is considered to be a general feedback comment.*

Description	Considered in Stage 3?	Comment
Need to ensure Council fund the actions appropriately and maintain any new or upgraded assets, via ongoing funding.		
I support Option 1 - leave the lake to operate naturally.	**Considered in Stage 3**	*Entrance management options will be further assessed in the cost benefit analysis completed for selected CMP options.*
We support the Lake being kept open on a permanent basis. We have lived here for 16 years and if the lake is kept open we have less flooding if not open it becomes dirty, smells fish disappear, tourism drops off and the lake becomes unsafe to swim in.	**Considered in Stage 3**	*Entrance management options will be further assessed in the cost benefit analysis completed for selected CMP options.*
I support option 3, with occasional dredging of the natural (towards Cunjurong Point side) channel, the normal flow channel connecting to the Conjola boat ramp and at least as far as the Post Office Store. The big sand bars inside the entrance area should be reduced as well, possibly by 50%. Part of the dredged sand should be replaced onto the big dune south of the Spit, with the remainder transported to the southern end of the beach, where it can naturally replenish the eroded dunes along the length of the beach. These dunes should be lightly planted with native beach grass, not Marram or Tea tree scrub.	**Considered in Stage 3**	*Occasional dredging of the ebb tide channel behind the sand spit will be considered as an option under Action EM1, with the main purpose being the facilitation of pilot channel excavation in the event that coastal storm washover has infilled the natural ebb tide channel. Dune stabilisation at the lake entrance is addressed by Action LG6.*
Option 3 is the only way, we need to dredge lake when ever required.	**Considered in Stage 3**	*Entrance management options will be further assessed in the cost benefit analysis completed for selected CMP options.*
Option 3: EM = Entrance Management Interventions the lake should be dredged and kept open	**Considered, but not progressed to Stage 3**	*The intent of the modified 'managed entrance' approach is for occasional dredging to be used only for the purpose of maintaining the position of the natural ebb tide channel, aligned behind the sand spit and directed towards the Cunjurong shoreline. This dredging would be implemented as required to avoid the need on occasions for excavation of a 'long' pilot channel which may impact response time to alleviate flooding in the event that lake water level triggers support the decision to open a closed entrance.*

Description	Considered in Stage 3?	Comment
		The use of dredging to maintain an open entrance is not considered to be an economically viable option, as this would likely require more frequent campaigns and/or dredging in response to episodic events that are difficult to predict and plan for. The lake entrance can be closed rapidly as a result of coastal storms depositing significant quantities of sand into the entrance and storm washover deposits or infilled progressively over a longer period of time.
I support action that is most likely to keep the lake open in the current circumstances.	**Considered in Stage 3**	*Entrance management options will be further assessed in the cost benefit analysis completed for selected CMP options.*
I do not support all of LG4. A review after 10 years is to long.	**Considered in Stage 3**	*Action LG4 refers to immediate review of Council coastal management planning policies to reflect the findings of the CMP. The 10 year timeline for ongoing reviews is consistent with the timeframe for future updating of the CMP.*
I do not support RA1 clearing more vegetation for an additional 20 cars at Havilland St boat ramp	**Considered in Stage 3**	*This action is included within the South Coast Boating Network Plan. Stage 1 and Stage 2 of the Havilland St boat ramp works have been subject to relevant environmental assessment.*
I very strongly support EM1 to create a permanent opening of Lake Conjola into the ocean.	**Considered in Stage 3**	*Entrance management options will be further assessed in the cost benefit analysis completed for selected CMP options.*
EV= Cover or remediate the exposed tree roots between the council caravan park and the last house on the foreshore as elderly people have trouble negotiating the exposed roots would cause a serious injury.	**Considered in Stage 3**	*This foreshore area is captured by a mapped Action FB1 on the Interactive Mapping for upgrading of existing foreshore protection. Consideration of public safety in regard to pedestrian foreshore access can be included in the scope of this action.*
RA= Maintain all areas for recreation and improve existing amenities.	**Considered in Stage 3**	*This is considered to be a general feedback comment.*
EM= Council to remove the build up of sand around the entrance on both sides of the lakes entrances. Surely the sand can be used by council once washed as the build-up will surely close the entrance then there will be a bigger job like a mechanical opening or having to dredge a channel.	**Considered in Stage 3**	*Entrance management options will be further assessed in the cost benefit analysis completed for selected CMP options. These will include options to improve the efficiency of mechanical opening, such as the maintenance of a 'dry notch' and occasional dredging to be used only for the purpose of maintaining the position of the natural ebb tide channel, aligned behind the sand spit and directed towards the Cunjurong shoreline.*
Dredge the entrance	**Considered in Stage 3**	*Entrance management options will be further assessed in the cost benefit analysis completed for selected CMP options.*

Description	Considered in Stage 3?	Comment
I do not support Dredging only when in flood.	**Considered in Stage 3**	*Entrance management options will be further assessed in the cost benefit analysis completed for selected CMP options.*
do not support a breakwall. do not support opening only when in flood. need to manage BEFORE it gets worse and closes completely again.	**Considered in Stage 3**	*Entrance management options will be further assessed in the cost benefit analysis completed for selected CMP options.*
Managed lake entrance together with DST to keep lake open.	**Considered in Stage 3**	*The intent of the modified 'managed entrance' approach is for occasional dredging to be used only for the purpose of maintaining the position of the natural ebb tide channel, aligned behind the sand spit and directed towards the Cunjurong shoreline. This dredging would be implemented as required to avoid the need on occasions for excavation of a 'long' pilot channel which may impact response time to alleviate flooding in the event that lake water level triggers support the decision to open a closed entrance.*
Do not support the LG4 Review Councils coastal management planning policies every 10 years. With climate change on our doorstep a 10 year review period seems an inappropriate length of time for a review. Should be at least every 5 years.	**Considered in Stage 3**	*Action LG4 refers to immediate review of Council coastal management planning policies to reflect the findings of the CMP. The 10 year timeline for ongoing reviews is consistent with the timeframe for future updating of the CMP.*
We support putting in place a flood management system which includes opening the lake when flooding is imminent or when the blocked Lake entrance causes it to overfill. An east coast low has caused flooding twice in the last 7 years in these circumstances. Give the residents who live in a flood zone an increased sense of safety from floods and that SCC will act in our favour at last and into the future.	**Considered in Stage 3**	*As per Action IN2, Council have recently invested in a study to develop a flood warning system to be implemented at Lake Conjola. This will improve the accuracy of flood forecasting and Council's response which may include entrance management in response to adopted triggers for action.*
I do not support a closed lake or minimally flowing lake. I support an open tidal lake. I support option 3.	**Considered in Stage 3**	*The intent of the modified 'managed entrance' approach is for occasional dredging to be used only for the purpose of maintaining the position of the natural ebb tide channel, aligned behind the sand spit and directed towards the Cunjurong shoreline. This dredging would be implemented as required to avoid the need on occasions for excavation of a 'long' pilot channel which may impact response time to alleviate flooding in the event that lake water level triggers support the decision to open a closed entrance.*

Description	Considered in Stage 3?	Comment
A closed lake is detrimental and has many negative impacts on the health of the lake for many animal and plant species. We want a permanent open and tidal lake. We support option 3. Please do not allow the lake to close - it's a major flood risk and will negatively impact everyone who lives at Lake Conjola, has a business at Lake Conjola or just simply visits.	**Considered in Stage 3**	*The intent of the modified 'managed entrance' approach is for occasional dredging to be used only for the purpose of maintaining the position of the natural ebb tide channel, aligned behind the sand spit and directed towards the Cunjurong shoreline. This dredging would be implemented as required to avoid the need on occasions for excavation of a 'long' pilot channel which may impact response time to alleviate flooding in the event that lake water level triggers support the decision to open a closed entrance.* *Entrance management options will be further assessed in the cost benefit analysis completed for selected CMP options.*
Do not allow the lake to close.	**Considered in Stage 3**	*Entrance management options will be further assessed in the cost benefit analysis completed for selected CMP options.*
Repair collapsing bank areas and retain the Edwin Ave reserve access to water areas.	**Considered in Stage 3**	*Public access to existing swimming areas will be maintained by any proposed foreshore treatments under Action FB1.*
Just keep the lake open, dredge it when it gets to this level & don't just put the sand in another place in the lake take it away. Please listen to the people who live at Lake Conjola.	**Considered in Stage 3**	*Entrance management options will be further assessed in the cost benefit analysis completed for selected CMP options.*
Option 3 Occasionally dredging and removal of the sand so it doesn't slip back into the lake.	**Considered in Stage 3**	*Entrance management options will be further assessed in the cost benefit analysis completed for selected CMP options.*
LG4, the CMP needs to be reviewed more then every 10 years, this is not a viable solution.	**Considered in Stage 3**	*Action LG4 refers to immediate review of Council coastal management planning policies to reflect the findings of the CMP. The 10 year timeline for ongoing reviews is consistent with the timeframe for future updating of the CMP.*
Please keep the lake open to the ocean at green island.	**Considered in Stage 3**	*Entrance management options will be further assessed in the cost benefit analysis completed for selected CMP options.*
The lake needs to be manually kept open.	**Considered in Stage 3**	*Entrance management options will be further assessed in the cost benefit analysis completed for selected CMP options.*

Description	Considered in Stage 3?	Comment
Keep the lake open, for a healthy environment. Keep the lake open, do not let it close otherwise in a rain event, council infrastructure and homes flood.	Considered in Stage 3	*Entrance management options will be further assessed in the cost benefit analysis completed for selected CMP options.*
I do not support Option 1 the lake entrance needs to be open to avoid flooding when heavy rainfall and stormwater raise the level of the lake. Occasional dredging to keep the lake open in Option 3 of the plan I support this action, don't wait till the lake is closed, this will avoid flooding of residential areas and parks, damage to properties and roads. The lake is tidal not ICOL.	Considered in Stage 3	*Entrance management options will be further assessed in the cost benefit analysis completed for selected CMP options.*
Certainly in support of creating and maintaining a permanent lake entrance. The lake is such a beautiful waterway and there is obvious benefit with improved water quality due to the lake entrance remaining open over the last couple of years.	Considered in Stage 3	*Entrance management options will be further assessed in the cost benefit analysis completed for selected CMP options.*
We would like to request to keep the Sandra Street beach open for kayaks only.	Considered in Stage 3	*Council is undertaking work to promote kayak use in this area with the Jetty Replacement and Kayak Facility project at Yooralla Bay, Conjola Park https://www.shoalhaven.nsw.gov.au/Council/News/Jetty-Replacement-and-Kayak-Facility-%E2%80%93-Yooralla-Bay-Conjola-Park* *The mapped Action FB1 to restore riparian vegetation along the foreshore adjacent to Sandra Street can be amended to incorporate the promotion and consideration of boating use that is consistent with the use and management objectives of the area.*
It is absolutely imperative to keep the lake entrance open. The social, economic and emotional damage to the community via flooding when the entrance closes cannot be allowed to recur. The most effective solution remains to construct a permanent opening via sea walls.	Considered in Stage 3	*The option to maintain a permanent entrance has been progressed into consultation due to the history of community interest and the opportunity to present and discuss issues with this option. It will be assessed as part of Stage 3 along with other alternate entrance management options.*
Emergency meeting point shelter at Havilland Street Boat Ramp.	Considered, but not progressed to Stage 3	*Emergency meeting points are not a relevant matter to be addressed in the CMP, and are considered elsewhere in consultation with NSW State Emergency Service as the lead combat*

Description	Considered in Stage 3?	Comment
		agency for flood, storm and tsunami response and/or NSW Rural Fire Services as the lead combat agency for bush fires.
No doing anything about the lake entrance closing! Please keep it open!!	**Considered in Stage 3**	*Entrance management options will be further assessed in the cost benefit analysis completed for selected CMP options.*
Option 3, don't let the entrance close. The lake will suffer if to is left to close.	**Considered in Stage 3**	*The intent of the modified 'managed entrance' approach is for occasional dredging to be used only for the purpose of maintaining the position of the natural ebb tide channel, aligned behind the sand spit and directed towards the Cunjurong shoreline. This dredging would be implemented as required to avoid the need on occasions for excavation of a 'long' pilot channel which may impact response time to alleviate flooding in the event that lake water level triggers support the decision to open a closed entrance.*
I support Option 3.	**Considered in Stage 3**	*Entrance management options will be further assessed in the cost benefit analysis completed for selected CMP options.*
Please avoid Option 4.	**Considered in Stage 3**	*The option to maintain a permanent entrance has been progressed into consultation due to the history of community interest and the opportunity to present and discuss issues with this option. It will be assessed as part of Stage 3 along with other alternate entrance management options.*
The storm water drainage feeding into swamps. What about mosquitoes? Especially in the camping areas.	**Considered, but not progressed to Stage 3**	*Management of mosquitoes in existing wetland areas is considered to be outside the scope of the CMP.*
How can we keep the lake edges from eroding? The suggestion in the proposal seems piecemeal.	**Considered in Stage 3**	*Action FB1 identifies a number of different foreshore areas that have been impacted or are vulnerable to erosion, and are mapped for investigation and monitoring. These areas would be remediated either with establishment or restoration of riparian vegetation or low-level seawall construction works.*
The breakwall. I support low environmental impact and prevention of flooding, rather than reaction to flooding. Number 3 seems closest.	**Considered in Stage 3**	*Entrance management options will be further assessed in the cost benefit analysis completed for selected CMP options.*

Description	Considered in Stage 3?	Comment
The lake should remain open at all times. Not waiting for a trigger before dredging.	Considered in Stage 3	*Entrance management options will be further assessed in the cost benefit analysis completed for selected CMP options.*
Yes. Regarding the EM1 Entrance Management Policy options, I choose Option 3 occasional dredging, but I DON'T want to wait for the lake to close and lake levels to rise to trigger levels before the lake can be reopened. I want Option 3 to be used together with the Decision Support Tool (DST) within the M2 Framework (which is already in place) to keep Lake Conjola open. I am also concerned regarding comments in Management Action WQ1 on the need for "ongoing assessment of the likelihood of the nutrient plume continuing to migrate and affecting Lake Conjola and / or Pattimores Lagoon". Annual Groundwater Monitoring Reports on the Conjola Regional Sewerage Scheme operations by external consultants, Earth2Water, repeatedly warn that there is: "potential (moderate) risk to aquatic ecosystem at Pattimores lagoon and Conjola estuary, especially during periods of low flushing, shallow water and stagnation which occurs during estuary mouth closures (estuary entrance). Excessive nutrients at the lagoon (and estuary) may cause algal blooms due to the TN (nitrogen) and TP (phosphorus) loads associated with the treated effluent". Annual Earth2Water Reports also "suggest that precautionary measures are required for the estuary & lagoon, especially during mouth closure when stagnant conditions may trigger algal blooms". Management Action IN1 refers to management plans for public assets. However, private assets are similarly at risk, without similar plans being put forward for their protection. As well as increased flood risk to housing, previous long-term closure of Lake Conjola has been associated with loss of oyster production, mangrove and seagrass dieback, algae along foreshores, public health issues related to elevated bacteria and viruses,	Considered in Stage 3	*The intent of the modified 'managed entrance' approach is for occasional dredging to be used only for the purpose of maintaining the position of the natural ebb tide channel, aligned behind the sand spit and directed towards the Cunjurong shoreline. This dredging would be implemented as required to avoid the need on occasions for excavation of a 'long' pilot channel which may impact response time to alleviate flooding in the event that lake water level triggers support the decision to open a closed entrance.* *The use of dredging to maintain an open entrance is not considered to be an economically viable option, as this would likely require more frequent campaigns and/or dredging in response to episodic events that are difficult to predict and plan for. The lake entrance can be closed rapidly as a result of coastal storms depositing significant quantities of sand into the entrance and storm washover deposits or infilled progressively over a longer period of time.* *Entrance management options will be further assessed in the cost benefit analysis completed for selected CMP options.* *Regarding the potential risk of algal blooms, this is addressed by the ongoing assessment of groundwater monitoring results as part of Action WQ1 and by the inclusion of algal bloom monitoring in the surface water quality monitoring program as part of Action WQ2. Stage 2 CMP reporting indicated that the annual ecosystem health rating of Lake Conjola for "Chlorophyll a / Algal Abundance" has been either A (excellent) or B (very good) based on available records and assessments.* *Regarding Action IN1, it is not Council's responsibility to prepare management plans for private assets.*

Description	Considered in Stage 3?	Comment
loss of income, degradation of foreshore habitat, decline in fish, crustacean and sea bird populations and an overall decline in the beauty of the lake. I believe Option 3 with use of the DST is the most effective option to manage the lake entrance and will also act as a vital measure to reduce the risk of flooding (of both public and private assets), will prevent algal bloom and other water quality issues impacting the lake in future and will deliver further benefits to all populations living around or in the lake.		

3.3 Map-based Feedback Portal

The Map-based Feedback Portal comprised an online GIS platform that enabled the community to review a number of 'mappable' actions from the potential management actions list, and lodge votes in support of particular actions and/or submit comments. A review of the results indicates that the voting function had relatively low utilisation when compared to the Online Survey Tool, with 1-2 votes typically submitted for a select number of individual management actions and only 49 votes submitted against a total of 77 mapped actions. Submitted comments were limited and are summarised in **Table 3-2** below along with comments.

Table 3-2: Map-Based Feedback Portal summary of submissions

Description	Considered in Stage 3?	Comment
Recommendation that the investigation of permissibility of foreshore structures is implemented along all of Fishermans Paradise foreshore.	**Considered in Stage 3**	*This is already being actioned through the Domestic Waterfront Structure Strategies, which is referred to in the description under Action FB5. https://www.marine.nsw.gov.au/projects/domestic-waterfront-structure-strategies*
Reinstatement of riparian vegetation on both sides of Conjola Creek in combination with management of boat speed.	**Considered in Stage 3**	*This will be considered through Action EV1.*
Dune management at lake entrance area to include: improved signage, barriers and tracks to control access; provision of garbage bins; and control of off-lead dog access.	**Considered in Stage 3**	*Dune management will be considered as part of Action LG6.*
Noting that previous attempts to re-vegetate the entrance dunes have been unsuccessful, due to wind erosion and regular occupation/use of area by families and children.	**General comment**	*Dune management will be considered as part of Action LG6.*
Potential issue of grass swales causing blockage/ponding in flat foreshore areas.	**Considered in Stage 3**	*Action FB1 and FB2 would consider the impacts of a proposed design for managing stormwater runoff based on local hydrology.*
Consideration of 'open managed entrance option' from PBP (1999).	**Considered in Stage 3**	*Entrance management options will be further assessed in the cost benefit analysis completed for selected CMP options.*
Investigation of the impact of discharge into the dune exfiltration system on flooding of properties along Sandgroper Crescent.	**Considered in Stage 3**	*The investigation of these potential impacts can be added to the scope of future groundwater monitoring and assessment under Action WQ1.*
Upgrade beach access (through the entrance dunes) to make it more inclusive to individuals who use wheelchairs.	**Considered in Stage 3**	*Council is due to commence an engagement with a specialist coastal engineering consultancy, this financial year, to assess the suitability of appropriate sites across the Shoalhaven for potential all ability beach access. The completion of the above assessment will inform Council of locations that could be determined financially and socially viable.*

3.4 Map-Based Suggestion Portal

The Map-Based Suggestion Portal comprised a separate online GIS map platform that enabled users to submit a suggested management action at an identified point on the map. A total of 26 suggestion points were submitted. Those that warranted further consideration are summarised in **Table 3-3** below along with comments.

Table 3-3: Map-Based Suggestion Portal summary of submissions

Location	Description	Considered in Stage 3?	Comment
Conjola National Park (Cunjurong foreshore)	Protect niche habitat of dendrobium teretifolium? growing on casuarinas. Also closely monitor illegal camping in same area and repair heavily eroded car access road.	**Considered in Stage 3**	*Protection of habitat would be covered by Action EV1. Monitoring of illegal camping and repair of access road would be a matter for NPWS to manage and police.*
Cunjurong Point foreshore	Provision of disabled access to beach.	**Considered in Stage 3**	*Council is due to commence an engagement with a specialist coastal engineering consultancy, this financial year, to assess the suitability of appropriate sites across the Shoalhaven for potential all ability beach access. The completion of the above assessment will inform Council of locations that could be determined financially and socially viable.*
Entrance sand spit	Provision of disabled access to beach.	**Considered in Stage 3**	*This would require a walkway to be established through the dunes from the caravan park and through the inherently dynamic area of the sand spit, with wind-blown sand and coastal storm washover being problematic for maintenance of an access walkway suitable for disabled access.* *Council is due to commence an engagement with a specialist coastal engineering consultancy, this financial year, to assess the suitability of appropriate sites across the Shoalhaven for potential all ability beach access. The completion of the above assessment will inform Council of locations that could be determined financially and socially viable.*
Entrance channel and dunes	Dredge sandbar & channel inside entrance, at least as far as Lake Conjola store. Pumped south along Conjola beach & onto the big dune south of entrance. Dune widened & stabilised by sand filled geosausages. Native grasses, not Marram or tea trees.	**Considered in Stage 3**	*Occasional dredging of the ebb tide channel behind the sand spit will be considered as an option under Action EM1, with the main purpose being the facilitation of pilot channel excavation in the event that coastal storm washover has infilled the natural ebb tide channel. Dune stabilisation at the lake entrance is addressed by Action LG6.*

Location	Description	Considered in Stage 3?	Comment
Beach area west of Lake Conjola Post Office	This small area is the only shallow sand access to the lake for several hundred metres. Used by families, swimmers and paddlers all year round. It would be disastrous to have a wall or barrier to the lake.	**Considered in Stage 3**	*Public access to existing swimming areas will be maintained by any proposed foreshore treatments under Action FB1.*
Canal into Pattimores Lagoon	Dredging of canal due to silt build up from storm drains through to lake opening as this was to be maintained by Council.	**Considered in Stage 3**	*This area falls under Council's Canal Estate Management Plan. Review and update of this plan would be undertaken under Action LG11.*
Havilland St Boat Ramp (Conjola Park)	Suggest to designate this area as a Safer Place with an assembly point and non-combustible shelter with storage for satellite phone, etc. Conjola Park has no emergency assembly point and this will be the largest hardscaped area in the village.	**Considered, but not progressed to Stage 3**	*Emergency meeting points are not a relevant matter to be addressed in the CMP, and are considered elsewhere in consultation with NSW State Emergency Service as the lead combat agency for flood, storm and tsunami response and/or NSW Rural Fire Services as the lead combat agency for bush fires.*
Havilland St Boat Ramp (Conjola Park)	Containment basins to catch runoff from boat washdown at Conjola Park boat ramp. Something to prevent runoff reaching the Lake from the berm alongside Havilland Street that was created during construction of the boat ramp.	**Considered in Stage 3**	*Havilland St Boat Ramp does not have a dedicated boat washdown area. Stormwater provisions are provided to cater for surface runoff from road and parking areas.*
Havilland St Boat Ramp (Conjola Park)	We would like the kayak storage units to be sturdy and lockable so that local residents can lock their kayaks up there.	**Considered in Stage 3**	*This matter is addressed by Action FB3. The nature of watercraft storage systems provided would be dependent on the funding and options available.*
Beach area adjacent to Sandra St (Conjola Park)	Request that Sandra St beach remains as a launching space for non motorised water craft – eg kayaks. For residents of Sandra, Esme, Cameron and Stewart Streets the location of the planned kayak launch near Hoylake Grove is too distant and too hilly.	**Considered in Stage 3**	*Council is undertaking work to promote kayak use in this area with the Jetty Replacement and Kayak Facility project at Yooralla Bay, Conjola Park https://www.shoalhaven.nsw.gov.au/Council/News/Jetty-Replacement-and-Kayak-Facility-%E2%80%93-Yooralla-Bay-Conjola-Park*

Location	Description	Considered in Stage 3?	Comment
			The mapped Action FB1 to restore riparian vegetation along the foreshore adjacent to Sandra Street can be amended to incorporate the promotion and consideration of boating use that is consistent with the use and management objectives of the area.
Yooralla Bay (Conjola Park) north-west foreshore area	EV1 Consider reservation of land to allow for spatial migration of vegetation/habitat under sea level rise. Supportive only if there is confirmed to be NIL impact to existing private land use and any future development for residential houses and blocks adjoining or across the road from EV1 – e.g. 60 Kurrajong Crescent and houses and blocks on Valley Drive. Private land on Valley Drive is linked to the reserve by the under-road culvert which brings stormwater into the creek/reserve, so important that Valley Drive is unaffected by EV1.	**Considered in Stage 3**	*The management of land potentially impacted by spatial migration of vegetation/habitat under sea level rise would require consultation with any existing landowners that may be affected. Reservation of affected land is one option, another option may be to work collaboratively with landowners to protect migrating vegetation/habitat that has ecological value.*
Yooralla Bay (Conjola Park) foreshore reserve area	Note proposal by local association to place a lockable storage unit for outriggers on this reserve, while using the beach to launch (outriggers cannot use the planned kayak launch).	**Considered in Stage 3**	*There is a mapped Action FB3 location on the Interactive Mapping for formalised watercraft storage at the Yooralla Bay (Conjola Park) reserve location used by the Conjola Stingrays Outrigger Canoe Club.*
Conjola Park	Kerb & guttering on Kurrajong Crescent & other non guttered streets in Conjola Park & West Lake Conjola to assist with preventing runoff into lake.	**Considered in Stage 3**	*This matter would be covered under the scope of Action FB2.*
Fishermans Paradise and Conjola Creek foreshores	This whole Crown road foreshore can be physically and administratively fenced/adjusted to provide better outcomes. This would require survey and fencing/planting resources additional Crown Lands administrative actions but is possible along 2 large landholdings.	**Considered in Stage 3**	*The involvement of Crown Lands to manage these areas would be a good outcome for protection/rehabilitation/maintenance of riparian vegetation, and would be considered under Action FB1.*

3.5 Email Submissions

A total of five (5) email submissions were received during the Stage 3 consultation period and throughout the course of the CMP development. The matters raised in these submissions are summarised in **Table 3-4** below along with comments.

Table 3-4: Email submissions summary

Description	Considered in Stage 3?	Comment
The existing shallow sandy beach access area at the grassed reserve area to the west of the Post Office / General Store at Conjola Village is a highly valued area for swimming that is used by young families. Deterioration or erosion of the area has been observed for over 50 years. It was requested that safe access to the lake provided by this beach area is retained, and is not impacted by installation of rock protection or barriers along the foreshore.	**Considered in Stage 3**	*Public access to existing swimming areas will be maintained by any proposed foreshore treatments under Action FB1.*
Request for wheelchair access to be provided to Cunjurong Point Beach from the Cunjurong Point Boat Ramp.	**Considered in Stage 3**	*Council is due to commence an engagement with a specialist coastal engineering consultancy, this financial year, to assess the suitability of appropriate sites across the Shoalhaven for potential all ability beach access. The completion of the above assessment will inform Council of locations that could be determined financially and socially viable.*
Golf balls were reported to be located in the water adjacent to both the Ingenia Caravan Park and Council Caravan Park at Conjola Village and were considered to be spoiling the lake environment.	**Considered, but not progressed to Stage 3**	*The behaviour of patrons at both caravan parks will need to be policed to manage this issue and is a matter for both businesses to resolve. This matter is outside the scope of the CMP.*
Support for management of the entrance with a modified 'managed entrance' approach with occasional dredging to sustain the position of the natural ebb tide channel. However, it is suggested that dredging is used to prevent the entrance from closing in conjunction with a decision support tool based on monitoring of the M2 tidal constituent from analysis of data obtained from the Lake Conjola tide gauge.	**Considered in Stage 3**	*The intent of the modified 'managed entrance' approach is for occasional dredging to be used only for the purpose of maintaining the position of the natural ebb tide channel, aligned behind the sand spit and directed towards the Cunjurong shoreline. This dredging would be implemented as required to avoid the need on occasions for excavation of a 'long' pilot channel which may impact response time to alleviate flooding in the event that lake water level triggers support the decision to open a closed entrance.* *The use of dredging to maintain an open entrance is not considered to be an economically viable option, as this would likely require more frequent campaigns*

Description	Considered in Stage 3?	Comment
		and/or dredging in response to episodic events that are difficult to predict and plan for. The lake entrance can be closed rapidly as a result of coastal storms depositing significant quantities of sand into the entrance and storm washover deposits or infilled progressively over a longer period of time. *Entrance management options will be further assessed in the cost benefit analysis completed for selected CMP options.*
Concerns regarding the potential impacts of the nutrient plume from the Lake Conjola Regional Sewerage Scheme impacting water quality within the lake, particularly when the entrance is closed. These concerns relate to algal blooms.	**Considered in Stage 3**	*Review of water quality monitoring undertaken by Council indicates that surface water quality within the lake has not been significantly influenced by entrance condition (i.e. open or closed) or a single large source of pollutants such as the nutrient plume. The risk of interaction of the nutrient plume with surface water will be managed by continued monitoring and assessment of groundwater quality in conjunction with surface water quality monitoring within the lake (including algal bloom monitoring) as noted under Action WQ1 and Action WQ2.*
Concerns regarding the die-off of trees at Conjola Creek during a prolonged inundation event in 2019 and the subsequent ongoing impact of fallen dead trees along the banks of Conjola Creek on bank erosion and waterway recreation.	**Considered in Stage 3**	*During long periods of Lake closure, some foreshore vegetation (such as Casuarinas) may die from prolonged exposure to elevated water levels (i.e. waterlogging). However, this is a natural process with riparian vegetation gradually advancing and retreating along the foreshore in response to varying water levels over time. Potential loss of riparian vegetation can be managed by ensuring there are sufficient replacement plants growing on the landward side of the foreshore (i.e. maintaining or establishing riparian buffer areas) and planting or allowing natural rehabilitation of more suitable species that can tolerate wet, salty soils, such as saltmarsh and mangroves.* *The restoration of riparian vegetation in foreshore areas of publicly-owned land is captured in Action FB1 and Action EV1, while consultation and collaboration with private landholders to improve foreshore management practices is captured in Action FB4 and Action EV1.*

Description	Considered in Stage 3?	Comment
Bank erosion at Conjola Creek was also considered to be further exacerbated by boating activity and exceedance of the designated 4 knot speed limit. 4 knot zone signage was also noted to need upgrading.	Considered, but not progressed to Stage 3	*TfNSW-Maritime is responsible for management of navigation within Lake Conjola and undertake ongoing review/monitoring of boating activity in conjunction with regular communication with Council. The policing and maintenance of regulatory signage within the 4 knot zone would be captured by business as usual activities and is outside the scope of the CMP. Council will provide this information to TfNSW-Maritime for their consideration.*

3.6 Stakeholder Engagement with Government Agencies

Consultation with government agency stakeholders was undertaken to obtain their input during the development of the A3 summary brochure. A draft version of the A3 summary brochure was issued to representatives from DPI[1]-Fisheries, DCCEEW-EHG[2], DPHI[3] – Crown Lands, Local Land Services, and Transport for NSW. It is noted that Council staff and a DCCEEW-EHG representative were involved in the development and review of the draft A3 summary brochure. It was requested agencies provide any feedback they may have prior to release of the information for community consultation purposes. Formal endorsement of the various actions was not sought at this time. Agency representatives were also invited to attend a meeting on 28 June 2023 to discuss any feedback they may have. The feedback received was used to refine the content of the A3 summary brochure prior to the community consultation period.

A further meeting workshop on entrance management was held on 20 July 2023, with representatives from RHDHV, Council, DCCEEW-EHG, DPI-Fisheries, and DPHI-Crown Lands in attendance. At this workshop RHDHV presented the findings of modelling work completed on various entrance management options. During the meeting it was requested that further information was circulated regarding the importance of the ebb tide channel, in relation to the modified 'managed entrance' approach presented as the 'Category 3' entrance management option in Stage 2 – Report C (RHDHV, 2023c). RHDHV subsequently prepared a technical memorandum to document the relevance of the ebb tide channel to entrance management and the rationale behind the 'Category 3' entrance management option. This was submitted to agency representatives on 27 September 2023 for their information and is provided as **Appendix B**.

[1] *NSW Department of Primary Industries*
[2] *NSW Department of Climate Change, Energy, the Environment and Water – Environment and Heritage Group*
[3] *NSW Department of Planning, Housing and Infrastructure*

4 Step 3: Cost Benefit Analysis of Selected Options

4.1 Overview

A more detailed options assessment process including a Cost Benefit Analysis (CBA) was applied to entrance management options (Action EM1 and Action EM3).

The following sections outline the cost inputs, approach and methodology, and results from in the CBA undertaken by Gillespie Economics (refer **Appendix C**) in accordance with the NSW Treasury CBA guidelines (NSW Treasury, 2023). The results of the economic assessment in conjunction with the consideration of other non-economic factors were used to determine the preferred actions for implementation as part of the CMP.

4.2 Cost Inputs

4.2.1 Entrance Management Options

The entrance management options under consideration within the CBA comprised:

- Option 1 Base Case
- Option 2 Dry Notch Maintenance
- Option 3 Occasional Ebb Tide Channel Dredging and Dry Notch Maintenance

It is noted that the option to construct engineering works to create a permanent entrance channel (i.e. Option 4 Permanent Entrance Channel) was excluded from the CBA at an early stage due to the consideration of the unacceptable adverse impacts on environmental and social values of the Lake and high capital costs associated with this option. This assessment is presented in **Section 5** of this report.

A description is provided below of the main components of entrance management options and associated annualised and discrete costs applied over the 30-year CBA analysis period.

It should be noted that the occurrence of severe coastal storm washover events has been incorporated into the cost distribution that was applied over the CBA analysis period. A number of storm washover events in conjunction with a period of minimal rainfall would typically be required to cause significant infilling and blockage of the ebb tide channel that would typically run behind the entrance spit, and possibly trigger ebb tide channel dredging. These events cause significant disruption to regular entrance intervention activities (i.e. mechanical opening and dry notch maintenance) that are included in Option 1 and Option 2, and would trigger the initiation of an ebb tide channel dredging campaign as part of Option 3. Due to the natural variability associated with severe coastal storm washover events, the CBA cost distribution considers a 10-year frequency for these events with sensitivity analysis completed for a 5-year and 15-year frequencies.

4.2.1.1 Option 1 Base Case

The ‘base case’ for entrance management involves the continuation of the current practice of mechanical opening of the entrance in response to lake water level triggers. The planned implementation and operation of a Total Flood Warning System[4] (TFWS) is also assumed to be in place as part of the base case. The capital costs of implementation and ongoing maintenance and operation costs of the TWFS

[4] *Proposed to be implemented at three ICOLL catchments within the Shoalhaven LGA, including Lake Conjola. The system will comprise a network of rainfall and water level gauges, a predictive flood warning and decision support tool for use by Council and SES, and a remote berm monitoring station at Lake Conjola entrance.*

have been included in the CBA as benefits are derived from operation of the TFWS in the analysis. However, the costs of the TFWS will be funded outside of the CMP under the floodplain management program. A summary of the costs applied for Option 1 is provided in **Table 4-1**.

Table 4-1: Option 1 Base Case – Summary of CBA Cost Inputs

Activity	Cost
TFWS Installation Cost	$160,000
TFWS Maintenance Cost	$35,000 p.a.
Mechanical opening (typical years)	$5,000 p.a.
Mechanical opening (ebb tide channel infill year)	$5,000 p.a.
Mechanical opening (2 years post ebb tide channel infill)	$7,500 p.a.

The estimated costs for implementation and maintenance of the TFWS are documented in MHL (2023) and comprise:

- Installation costs = $160,000 (range of $120,000 to $160,000);
- Predictive flood warning system maintenance = $15,000 p.a. (range of $5,000 to $15,000 p.a.); and,
- Gauge maintenance costs (two gauges) = $20,000 p.a. (range to $3,000 to $10,000 p.a. per gauge).

A review of Council records over a 28-year period (1992-2020) determined that approximately 16 mechanical openings had been completed in this time (i.e. once every 1.75 years). However, this included the period between 1999 and 2010 when the entrance remained open following the 1999 dredging campaign and may not represent typical 'base case' conditions due to the influence of dredging. It is noted that other factors such as at or below average rainfall and predominance of La Nina phases of the Southern Oscillation Index (SOI) (result in anti-clockwise rotation of Conjola Beach and existence of a narrower beach berm near the entrance) during this period would have contributed to the entrance remaining open for an extended period of time (refer to further discussion in **Section 5.1.4** and **Section 5.1.5**). If this period is excluded, then the frequency for mechanical opening would be around one opening per year on average which has been adopted for the purposes of the CBA. It should be noted that historically the frequency of mechanical openings has been irregular (e.g. clusters of mechanical openings under closed conditions and extended periods of several years of open entrance conditions are evident in available records, refer Stage 2 – Report C (RHDHV, 2023c)) in response to the natural variability of the processes that contribute to the entrance condition.

For the purposes of the CBA, it has been assumed that the pilot channel for mechanical opening would be excavated in the 'northern spit zone' (refer to **Figure 5-9**) to minimise shorebird disturbance, and for consistency with other options (dry notch maintenance as part of Option 2 would also be undertaken in the northern spit zone). A pilot channel in this area could be up to 200m long (refer **Figure 4-1**) to access the ebb tide channel behind the entrance spit. Based on pilot channel geometry comprising 200m length, 2m width (one bucket-width), base level at 0m AHD, average berm level at 1.5m AHD, and near-vertical sideslopes, an excavation volume of approximately 600m^3 would be required. This could be achieved by a local contractor in a single working day[5] at a cost of $5,000 per mechanical opening. This represents an annualised cost of $5,000 p.a. (one mechanical opening per year) applied under typical conditions.

[5] *Note that the excavation works could be made more efficient by deployment of additional equipment if required in Councils response to an emergency situation.*

During an ebb tide channel infill period additional effort would be required to excavate a pilot channel through the entrance shoals to access the downstream limit of the ebb tide channel that may be stranded further to the south. Based on an extended pilot channel length of 400m (refer **Figure 4-2**), the excavation volume would increase to approximately 1,200m^3 and could a single working day[6] to complete at a cost of $5,000. As such, the annualised cost for mechanical opening applied to each ebb tide channel infill year is $5,000 p.a.

Practical experience and modelling has demonstrated that excavation of a longer pilot channel results in a less effective breakout of the entrance. To account for the additional effort required to manage the entrance following an ebb tide channel infill year, a 50% increase in the annualised cost for typical conditions (i.e. $7,500 p.a.) has been applied for the subsequent 2-year period to allow time for the entrance to 'reset' back to its average behaviour.

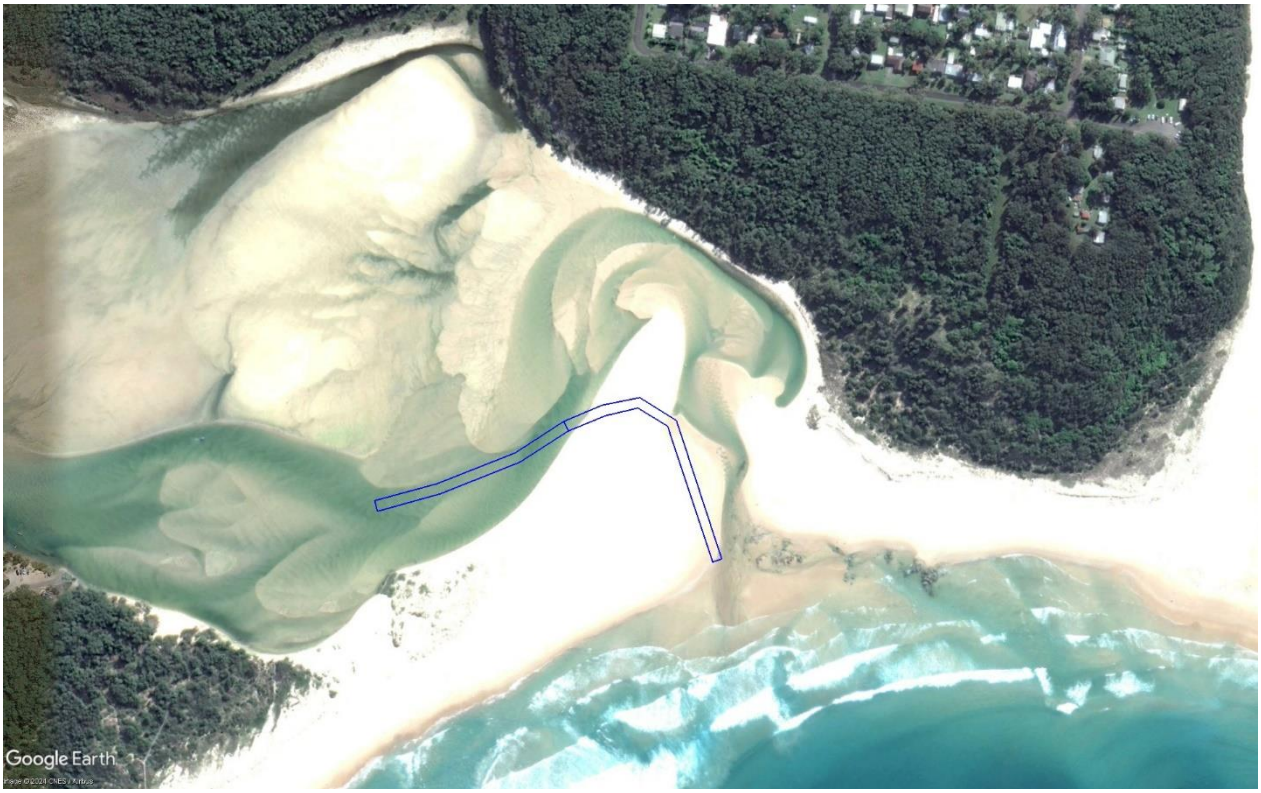


Figure 4-1: Indicative arrangement of typical pilot channel (200m length) in northern spit zone (source: Google Earth Pro dated 31 March 2016)

[6] *Note that the excavation works could be made more efficient by deployment of additional equipment if required in Councils response to an emergency situation.*

Figure 4-2: Indicative arrangement of longer pilot channel (400m length) in northern spit zone (source: Google Earth Pro dated 29 September 2018)

4.2.1.2 Option 2 Dry Notch Maintenance (and Berm Lowering)

This option involves the maintenance of a shallow channel through the entrance spit during closed entrance periods, referred to as a 'dry notch'. This practice would be similar to that already employed by Council at Shoalhaven Heads and at other Intermittently Closed and Open Lakes and Lagoons (ICOLLs) in NSW, such as the Manly Lagoon entrance at Queenscliff Beach within the Northern Beaches LGA. The purpose of maintaining the dry notch as a low point through the entrance spit would be to improve flood response time by reducing the excavation required to mechanically open the entrance. In emergency response situations this may only require removal of the 'plug' retained through the beach face at the seaward end of the dry notch alignment to facilitate release of flood waters under elevated lake water level conditions. In addition, pre-emptive berm lowering of the crest level of the sand plug and the berm along the alignment of the dry notch should be considered in advance of a significant rainfall event, informed by the TWFS. A summary of the costs applied for Option 2 is provided in **Table 4-2**.

Table 4-2: Option 2 Dry Notch Maintenance – Summary of CBA Cost Inputs

Activity	Cost
TFWS Installation Cost	$160,000
TFWS Maintenance Cost	$35,000 p.a.
Dry notch maintenance (typical years)	$1,200 p.a.
Dry notch maintenance (ebb tide channel infill year)	$10,000 p.a.
Mechanical opening (typical years)	$5,000 p.a.
Mechanical opening (ebb tide channel infill year)	$5,000 p.a.
Mechanical opening (2 years post ebb tide channel infill)	$7,500 p.a.

For the purposes of the CBA, it has been assumed that the dry notch would be maintained in the northern spit area to minimise shorebird disturbance. Based on a dry notch length of 130m, 50m width, maintained base level of 1.2m AHD, average berm level at 1.5m AHD, and 1V:3H side slopes, and excavation volume of around 2,000m^3 could be required for each maintenance campaign (refer **Figure 4-3** and **Figure 4-4**). This could be completed in a day of work by a local contractor at a cost of approximately $5,000. It is estimated that around two (2) maintenance campaigns could be required per year during a period of entrance closure giving a total cost of $10,000. However, the annualised cost applied within the CBA has been factored by the long-term average closed entrance percentage of 12%, giving an annualised cost of $1,200 p.a. for dry notch maintenance under typical conditions.

It is assumed that the entrance is closed for 100% of the time during an ebb tide channel infill year, resulting in an annualised cost applied for these years of $10,000 p.a, which is based on cost estimates and parameters as described for Option 1.

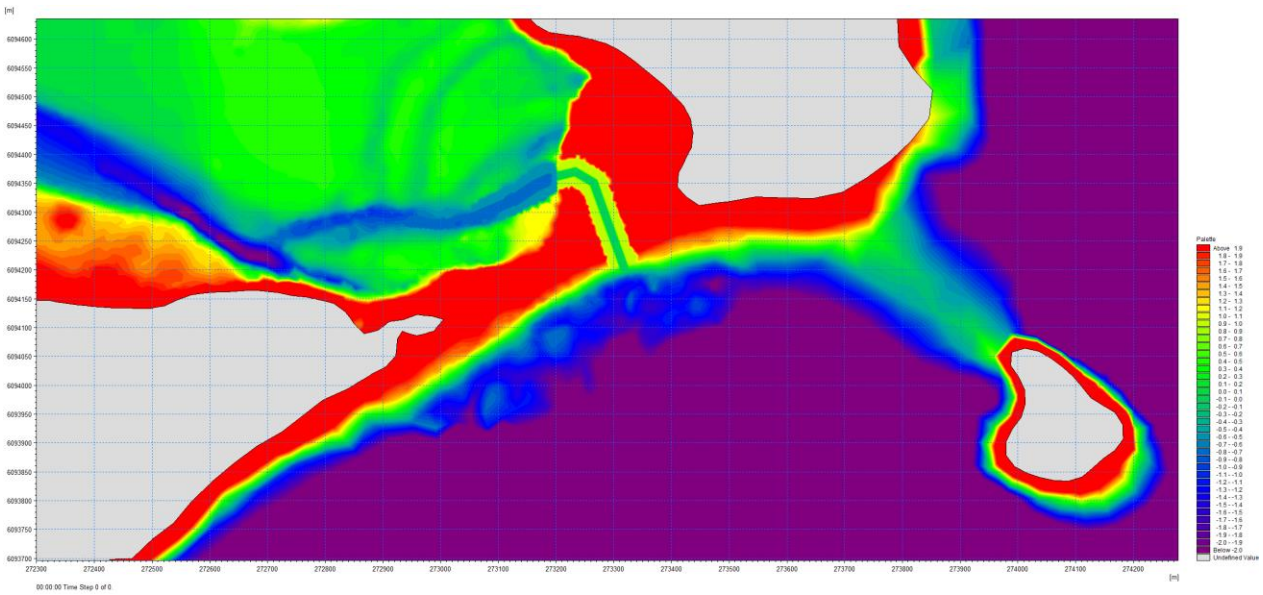


Figure 4-3: Depiction of the dry notch plus pilot channel in the numerical model of the lake entrance

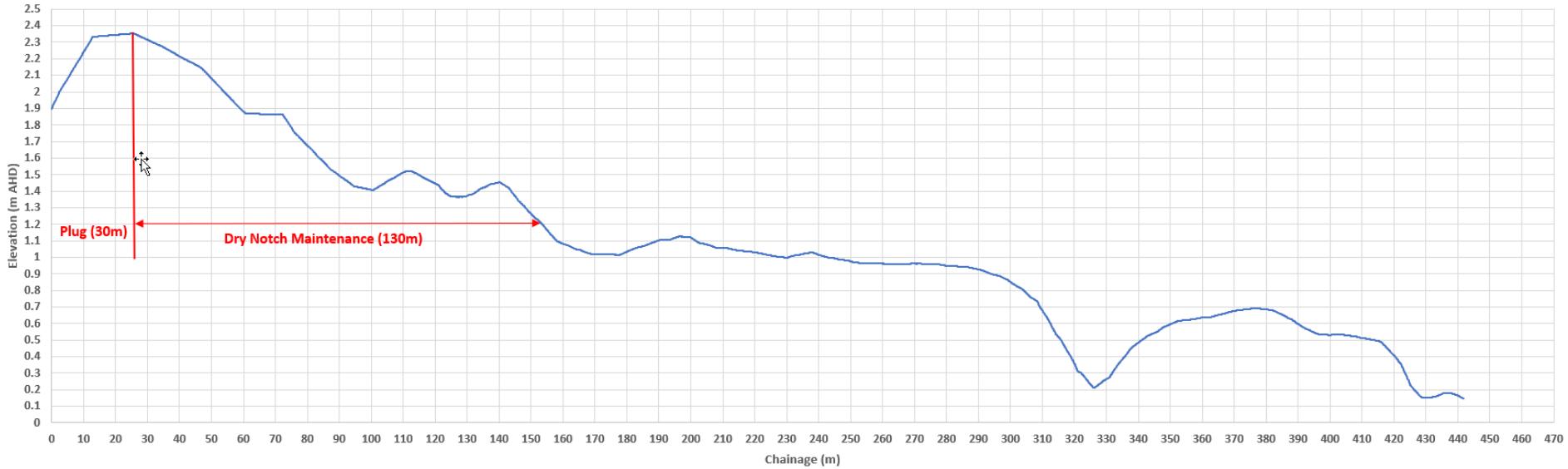


Figure 4-4: Longitudinal section along indicative dry notch alignment (2018 survey)

Option 2 also includes the continuation of the current practice of mechanical opening of the entrance in response to lake water level triggers. With the maintained dry notch in place, a pilot channel with 200m length, 2m width (one bucket-width), base level at 1.2m AHD, average berm level at 1m AHD, near-vertical sideslopes, and an approximately 30m long plug through the beach face at 2m AHD would require around 500m^3 of excavation. This could be completed in less than a day at a cost of $5,000 per mechanical opening, resulting in an annualised cost of $5,000 p.a. (one mechanical opening per year) applied under typical conditions.

During an ebb tide channel infill period additional effort would be required to excavate a 400m long pilot channel with an estimated excavation volume of 1,000m^3. This could be achieved in a single working day at a cost of $5,000. As such, the annualised cost for mechanical opening applied to each ebb tide channel infill year is $5,000 p.a.

Similar to the approach applied for Option 1, an increased annualised cost of $7,500 p.a. for mechanical opening has been applied for the 2-year period following an ebb tide channel infill year.

4.2.1.3 Option 3 Occasional Ebb Tide Channel Dredging and Dry Notch Maintenance

This option involves the occasional dredging of the ebb tide channel in conjunction with dry notch maintenance and continuation of mechanical opening in response to lake water level triggers. Dredging would be completed on an as-required basis in response to severe coastal storm washover events that result in significant infilling and blockage of the ebb tide channel running behind the entrance spit. The initiation of an ebb tide channel dredging campaign would be triggered if excavation of a pilot channel directly through the northern spit zone (refer **Figure 5-9**) to link with the ebb tide channel is not practicable for emergency response due to the significant time required for excavation. A summary of the costs applied for Option 3 is provided in **Table 4-3**.

Table 4-3: Option 3 Occasional Ebb Tide Channel Dredging – Summary of CBA Cost Inputs

Activity	Cost
TFWS Installation Cost	$160,000
TFWS Maintenance Cost	$35,000 p.a.
Dry notch maintenance (typical years)	$1,200 p.a.
Mechanical opening (typical years)	$5,000 p.a.
Hydrographic survey (ebb tide channel infill year)	$10,000
Ebb tide channel dredging campaign (ebb tide channel infill year)	$1,528,000

Monitoring of ebb tide channel infilling would be facilitated by completion of a hydrographic survey in each ebb tide channel infill year at a cost of $10,000 in conjunction with survey from the remote berm monitoring station established as part of the TFWS.

Occasional dredging of the ebb tide channel would be undertaken by a dredging contractor with a small cutter suction dredger (CSD) pumping to a nearby beach nourishment area. The dredged slurry would be received in a bunded dewatering area established using local beach sand. The dredged material would be reworked along the beach with a dozer working in conjunction with an excavator. The dredged ebb tide channel would have nominal dimensions of 20m base width, -0.8 AHD base level and 1V:3H sideslopes (refer **Figure 4-5**). Based on the scope of previous dredging campaigns it is considered that a reasonable indicative volume of up to 20,000m^3 could be dredged in a single campaign. A breakdown of the indicative cost estimate for a single dredging campaign of approximately $1.5M is summarised in **Table 4-4** and

includes allowances for construction costs, design, planning approval and contractor procurement, construction management, and a 30% contingency.

Figure 4-5: Indicative arrangement of ebb tide channel dredging

Table 4-4: Option 3 Occasional Ebb Tide Channel Dredging – Dredging Cost Estimate

Item	Unit	Quantity	Rate	Cost
Site Establishment				**$350,000**
Mobilisation of plant and equipment	Lump Sum			
Site establishment, including fencing, site compound, signage, environmental controls	Lump Sum			
Preconstruction documentation, including SWMS, Contractors EMP, Quality Plan, Construction Program	Lump Sum			
Dredging				**$520,000**
Pre- and post-dredging surveys	Item	2	$10,000	$20,000
Dredging from ebb tide channel and pumping to beach nourishment location	m^3	20,000	$15	$300,000
Dewatering of material with bunded settlement pond	m^3	20,000	$5	$100,000
Reworking of dredged material along beach profile with a dozer	m^3	20,000	$5	$100,000
Site Disestablishment	**Lump Sum**			**$150,000**
CONSTRUCTION COSTS (TOTAL)				**$1,020,000**
Design, Planning Approval and Contractor Procurement	**Lump Sum**			**$100,000**
Construction Management	**10%**			**$102,000**
Contingency	**30%**			**$306,000**
TOTAL COST PER DREDGING CAMPAIGN				**$1,528,000**

Maintenance of a dry notch would also be undertaken for Option 3, in a similar manner to that completed for Option 2, at an annualised cost of $1,200 p.a. under typical conditions. Mechanical opening of the entrance in response to lake water level triggers would be continued at an annualised cost of $5,000 p.a. under typical conditions.

During ebb tide infill years, it is assumed that the entrance would remain open following the dredging campaign and that no entrance intervention (mechanical opening or dry notch maintenance) would be required. It is also assumed (based on experience from historical dredging, refer **Section 5.1.5**) that the period of no entrance intervention would extend for a further period of 2 years for a 5-year dredging frequency, 5 years for a 10-year dredging frequency, and 7 years for a 15-year dredging frequency. As noted in **Section 4.2.1**, due to the natural variability associated with severe coastal storm washover events, the CBA cost distribution considers a 10-year frequency for dredging campaigns with sensitivity analysis completed for a 5-year and 15-year frequencies. It should also be noted that in addition to the assumed benefits of occasional ebb tide channel dredging, there are other natural variables such as rainfall events, beach rotation and ocean storm events that can influence the duration of open entrance conditions (refer **Section 5.1.4**).

4.2.2 Flood Damages Assessment

A damage assessment was conducted to establish baseline flood damages for catchment flooding for both an open and closed entrance scenario, using the design flood modelling results from the Lake Conjola Floodplain Risk Management Study and Plan (BMT WBM, 2013a). The assessment followed the methodology set out in the Flood Risk Management Guideline MM01 (DPE, 2023) and the accompanying NSW Flood Damage Assessment Tool (DT01), which is the recommended method for conducting flood damage assessments in NSW. Peak water level grids for the PMF[7], 100, 50, 20, 10, and 5-year ARI events from the modelled open and closed entrance scenarios were provided, as well as a floor level survey conducted in May-June 2011 (Peter Smith & Co, 2011). The survey data included the floor level and ground level for each property and additional information such as property type for approximately 1,000 properties in Burrill Lake[8] and Lake Conjola.

The peak water levels and floor level survey data were input to the NSW Flood Damage Assessment tool to produce an Average Annual Damage (AAD) value for the open and closed entrance scenarios. **Table 4-5** summarises the included and excluded categories of costs in the assessment.

Table 4-5: Flood damages assessment cost category inclusions and exclusions

Included / Excluded	Damage Category	Description
Included	Structural	Residential Commercial
	Internal	Residential Commercial
	External	Residential
	Intangible	Mental health impacts Loss of trading costs Clean up costs
Excluded	Intangible	Risk to life Relocation
	External	Vehicle damages

All residential buildings were classified as residential single storey default size with an area of 220 m^2, while commercial properties (such as shops and administration buildings) were classified as commercial default average size with an area of 418 m^2. Other buildings (such as sheds, pump stations and amenities blocks) were classified as commercial low to medium sized with an area of 186 m^2. A regional uplift factor was applied to the structural damages based on the Shoalhaven City Council LGA and the baseline dollar values in the NSW Flood Damage Assessment tool were adjusted for inflation from Q1 2022 to Q1 2024 (the time of this assessment). The AADs of the baseline flood damages are summarised in **Table 4-6** below.

Table 4-6: Summary of baseline AAD values

Catchment Flooding Entrance Closed AAD	Catchment Flooding Entrance Open AAD
$8,610,927	$6,204,057

[7] *Probable Maximum Flood*
[8] *Burrill Lake properties were excluded from the flood damages calculations.*

Following the establishment of baseline AAD values, a Cost Benefit Analysis (CBA) was undertaken to understand the potential benefit of installing a TFWS in conjunction with the maintenance of a dry notch for reducing flood damages. Under closed entrance conditions, the installation of a TFWS would result in an improved response to implement entrance intervention measures (i.e. mechanical opening). The maintenance of a dry notch would further improve response time by reducing the excavation effort for mechanical opening. To represent the benefit of this improved response time for the options under consideration within the CBA, the modelled peak flood levels from the Lake Conjola Floodplain Risk Management Study and Plan were reduced in accordance with the values summarised in **Table 4-7**. These values were nominated based on the results of previous modelling of the February 2020 flood event (including the reduction in peak flood level from an earlier entrance opening) and other available flood modelling results from floodplain risk management studies and plans prepared for Lake Conjola (BMT WBM 2013a, 2013b). The resultant peak flood levels were then used to determine the closed entrance flood damages and associated AAD for Options 1, 2, and 3.

Table 4-7: Peak flood level reductions applied to closed entrance modelling results

ARI	Reduction in Peak Flood Level (m)		
	Option 1	Option 2	Option 3
5 year	0.33	0.38	0.38
10 year	0.25	0.30	0.30
20 year	0.17	0.21	0.21
50 year	0.10	0.14	0.14
100 year	0.05	0.08	0.08
PMF	0.03	0.04	0.04

The AAD values for ‘closed entrance’ and ‘open entrance’ conditions were averaged to estimate the AAD for a ‘heavily shoaled’ intermediate condition. The long-term occurrence percentages (determined from previous analysis to be 12% closed entrance, 64% open entrance, and 24% heavily shoaled) for each of these three entrance conditions were then applied to each AAD value to calculate a ‘Factored AAD’ for each option. The resultant Factored AAD values are presented in **Table 4-8** and were applied to each year of the CBA analysis period.

Table 4-8: Factored AAD values for entrance management options

Option	Entrance Closed AAD	Entrance Open AAD	Heavily Shoaled AAD	Factored AAD
% Occurrence	12%	64%	24%	-
Option 1	$4,939,187	$6,204,057	$5,571,622	**$5,900,488**
Option 2	$4,544,314	$6,204,057	$5,374,186	**$5,805,719**
Option 3	$4,544,314	$6,204,057	$5,374,186	**$5,805,719**

4.3 Cost Benefit Analysis

A cost benefit analysis using the above cost inputs has been undertaken by Gillespie Economics and is documented in the economic assessment report provided in **Appendix C**. The approach and methodology for the CBA is detailed within the economic assessment report and the outcomes of the analysis are summarised in the following sections for the entrance management options under consideration. A

summary of the key steps in the CBA, definition of economic terms, and adopted input parameters is provided below.

The key steps in the CBA are summarised below:

- **Step 1: Define the problem and the need for action.**
- **Step 2: Establish the base case** against which to assess the potential incremental economic, social, and environmental impacts of changes due to the project.
- **Step 3: Define the management options to be considered.**
- **Step 4: Identify the incremental costs and benefits of options.**
- **Step 5: Quantify the physical changes** from the base case resulting from management options. This would focus on the incremental changes to a range of factors (for example, environmental, economic, social) resulting from the project.
- **Step 6: Estimate the monetary value of these changes** and aggregate these values in a consistent manner to assess the outcomes. Where market prices exist, they are a starting point for valuations of both outputs and of inputs used for production. For non-market goods, as for many environmental impacts and some social impacts, the aim is to value them as they would be valued in monetary terms by the individuals who experience them.
- **Step 7: Estimate the Net Present Value (NPV)** of the project's future net benefits, using an appropriate discount rate.
- **Step 8: Undertake sensitivity analysis** on the key range of variables, particularly given the uncertainties related to specific benefits and costs.
- **Step 9: Assess the distribution of costs and benefits** across different groups.
- **Step 10: Report CBA results**, including all major unquantified impacts so the appraisal addresses and incorporates all material relevant to the decision maker.

Discounting future costs and benefits by the NSW Government recommended discount rate reduces the significance of costs and benefits in the future. An analysis timeframe of 30 years was adopted for the CBA.

Costs and benefits occurring in different time periods require discounting to present value so that the benefits can be compared to costs on a common basis. The discount rates adopted in the CBA are those recommended in NSW Treasury (2023) and comprise a recommended discount of 5% with sensitivity testing at 3% and 7%.

The Net Present Value (NPV) is determined by the difference between the discounted present value of the benefits and the present value of the costs. A positive NPV indicates that the present value of benefits is greater than the costs, and an option can be justified from an economic efficiency perspective.

The Benefit Cost Ratio (BCR) is determined by the ratio of the discounted benefits against the discounted costs. A BCR greater than one indicates that the expected benefits outweigh the costs of an option, and that it is potentially economically viable.

4.3.1 Entrance Management Options

As noted in **Section 4.2.1**, due to the natural variability associated with severe coastal storm washover events, the CBA cost distribution considers a 10-year frequency for these events with sensitivity analysis completed for a 5-year and 15-year frequencies. For the 10-year frequency analysis, the timing and frequency of costs is summarised in **Table 4-9**.

Table 4-9: Timing and Frequency of Costs for 10-year Frequency of Ebb Tide Channel Infill Conditions

Costs	Option 1	Option 2	Option 3
TFWS Installation Costs	Year 1	Year 1	Year 1
TFWS Maintenance Costs	Annual	Annual	
Mechanical Opening costs – normal years	Years 2-10, 12-20, 22-30	Years 2-10, 12-20, 22-30	Years 7-10, 17-20, 27-30
Mechanical Opening – infill years	Years 1, 11, 21	Years 1, 11, 21	-
Dry notch maintenance cost – normal years	-	Years 2-10, 12-20, 22-30	Years 7-10, 17-20, 27-30
Dry notch maintenance cost – infill years	-	Years 1, 11, 21	-
Hydrographic survey	-	-	Years 1, 11, 21
Dredging costs	-	-	Years 1, 11, 21

The net present value (NPV) of options, relative to Option 1 – base case, are presented in **Table 4-10** for a 10-year frequency of ebb tide channel infill conditions. This indicates that Option 2 provides a positive NPV and hence is justified from an economic efficiency perspective. Option 3 has a negative NPV, indicating that the present value of costs is greater than the present value of benefits.

The key driver of this result is that Option 3 is over 80 times more costly (primarily due to dredging costs) while providing no additional reduction in AAD.

Table 4-10: Incremental Costs and Benefits of Options – 10-year Frequency of Ebb Tide Channel Infill Conditions (Present Value at 5% Discount Rate)

	Option 2	Option 3
Potential Costs		
Incremental Total Flood Warning System Installation Costs	$0	$0
Incremental Total Flood Warning System Maintenance Costs	$0	$0
Incremental Mechanical Opening Costs (normal years)	$0	$0
Mechanical Opening Costs (infill years)	$0	$0
Dry notch maintenance costs (normal years)	$16,172	$6,321
Dry notch maintenance costs (infill years)	$18,960	$0
Hydrographic survey (infill years)	$0	$18,960
Dredging costs (infill years)	$0	$2,897,092
Sub-total	***$35,132***	***$2,922,373***
Potential Benefits		
Reduced Mechanical Opening Costs (normal years)	$0	$49,857
Reduced Mechanical Opening Costs (infill years)	$0	$9,480
Reduced flood damage	$1,456,840	$1,456,840
Sub-total	***$1,456,840***	***$1,516,177***
Net Benefit	**$1,421,708**	**-$1,406,196**
Benefit Cost Ratio (BCR)	**41.47**	**0.52**

Table 4-11 shows the results of the analysis for a 5-year and 15-year frequency for infill of the ebb tide channel. This indicates that for Option 2 the frequency of infill conditions has little effect on the NPV of the option. However, for Option 3 the frequency of infill conditions has a large impact. Net costs are considerably larger the more frequent the infill conditions occur. This is because of the more frequent dredging that is required under this option.

Under all frequencies of infilling, Option 2 has a positive net present value and hence is desirable from an economic efficiency perspective. Option 3 has a negative net present value under all options.

Large changes in unit cost and benefit assumptions would not change the results or the ranking of options. For instance, reduced flood damages would need to almost double for Option 3 to have a positive NPV. However, this would also increase the NPV of Option 2 relative to Option 3. Dredging costs would need to almost halve for Option 3 to have a positive NPV. But even under this extreme assumption Option 2 would still have a higher NPV.

Table 4-11: Incremental Costs and Benefits of Options – 5-Year and 15-Year Frequency of Ebb Tide Channel Infill Conditions (Present Value at 5% Discount Rate)

	5-year Frequency		15-year Frequency	
	OPTION 2	OPTION 3	OPTION 2	OPTION 3
Potential Costs				
Incremental Total Flood Warning System Installation Costs	$0	$0	$0	$0
Incremental Total Flood Warning System Maintenance Costs	$0	$0	$0	$0
Incremental Mechanical Opening Costs (normal years)	$0	$0	$0	$0
Mechanical Opening Costs (infill years)	$0	$0	$0	$0
Dry notch maintenance costs (normal years)	$14,389	$6,844	$16,754	$6,960
Dry notch maintenance costs (infill years)	$33,816	$0	$14,105	$0
Hydrographic survey (infill years)	$0	$33,816	$0	$14,105
Dredging costs (infill years)	$0	$5,167,039	$0	$2,155,233
Sub-total	***$48,205***	***$5,207,699***	***$30,859***	***$2,176,298***
Potential Benefits				
Reduced Mechanical Opening Costs (normal years)	$0	$47,158	$0	$47,365
Reduced Mechanical Opening Costs (infill years)	$0	$16,908	$0	$7,052
Reduced flood damage	$1,456,840	$1,456,840	$1,456,840	$1,456,840
Sub-total	***$1,456,840***	***$1,520,906***	***$1,456,840***	***$1,511,257***
Net Benefit	**$1,408,635**	**-$3,686,793**	**$1,425,981**	**-$665,041**
Benefit Cost Ratio (BCR)	**30.22**	**0.29**	**47.21**	**0.69**

Table 4-12 indicates that the above results are not sensitive to changes in the discount rate.

Table 4-12: Incremental Costs and Benefits of Options by Frequency of Ebb Tide Channel Infill Conditions at Varying Discount Rate (Present Value)

Frequency of Ebb Tide Channel Infill Conditions		Option 2			Option 3		
Discount Rate		3%	5%	7%	3%	5%	7%
5-year	NPV	$1,797,438	$1,408,635	$1,136,218	-$4,461,744	-$3,686,793	-$3,127,032
	BCR	30.91	30.22	29.56	0.30	0.29	0.28
10-year	NPV	$1,814,372	$1,421,708	$1,146,578	-$1,509,189	-$1,406,196	-$1,318,739
	BCR	43.05	41.47	39.97	0.56	0.52	0.48
15-year	NPV	$1,819,976	$1,425,981	$1,149,903	-$538,548	-$665,041	-$741,053
	BCR	49.47	47.21	45.06	0.78	0.69	0.62

The CBA can be used to identify who initially bears the costs and who obtains the benefits of intervention options. **Table 4-13** identifies the magnitude of incremental costs and benefits for Options 2 and 3 with 10-

year Frequency of Ebb Tide Channel Infill Shoaling Conditions (Present Value at 5% Discount Rate) and the incidence of these costs and benefits.

All costs will be borne by Council. Beneficiaries are owners of flood prone assets. These may include Council, residents, and holiday home/caravan owners.

Table 4-13: Incidence of Costs and Benefits for Option 2 and 3 with 10-year Frequency of Ebb Tide Channel Infill Conditions (Present Value at 5% Discount Rate)

	Option 2	Option 3	Incidence of Costs and Benefits
Costs			
Dry notch maintenance costs (normal years)	$16,172	$6,321	Council
Dry notch maintenance costs (infill years)	$18,960	$0	Council
Hydrographic survey (infill years)	$0	$18,960	Council
Dredging costs (infill years)	$0	$2,897,092	Council
Benefits			
Reduced Mechanical Opening Costs (normal years)	$0	$49,857	Council
Reduced Mechanical Opening Costs (infill years)	$0	$9,480	Council
Reduced flood damage	$1,456,840	$1,456,840	Owners of Flood Prone Assets

4.3.2 Entrance Management Analysis Outcomes

The CBA found that Option 2 provides a positive NPV and hence is justified from an economic efficiency perspective. Option 3 has a negative NPV, indicating that the present value of costs is greater than the present value of benefits.

The key driver of this result is that Option 3 is over 80 times more costly (primarily due to dredging costs) while providing no additional reduction in AAD. This result was not sensitive to changes in the discount rate and changes in assumptions regarding the frequency of infill conditions.

There is potential for some incremental recreation benefits of Options 2 and 3 relative to the base case as they both result in reduced flooding relative to the Option 1 (the base case). However, the benefit would be the same for Options 2 and 3, as these options result in the same level of AAD reduction. While inclusion of these potential benefits would increase the NPV of both options it would not change the ranking of the Options.

If additional recreation benefits or other general community well-being benefits were to arise from the more frequently open lake entrance under Option 3 compared to Option 2, this may improve the NPV of Option 3. However, this remains an untested proposition.

5 Entrance Management Options Assessment

5.1 Introduction

5.1.1 General

This section sets out an assessment of the entrance management options for Lake Conjola to determine which option(s) should be included in the Lake Conjola CMP. The options fall into four categories involving progressively greater levels of mechanical intervention at the entrance, as summarised below, and were developed in the report Lake Conjola Coastal Management Program Stage 2 – Determine Risks, Vulnerabilities and Opportunities: Report C – Entrance Processes and Entrance Management Options (RHDHV, 2023c).

- Category 1: The entrance area is allowed to behave naturally. Mechanical opening of the entrance in the form of excavation of a pilot channel is carried out in response to lake water level triggers;
- Category 2: The entrance area is managed by way of a dry notch approach whereby the sand levels in the entrance area (above water level) are regularly mechanically groomed to facilitate an easier mechanical opening (excavation of a pilot channel), when lake water level triggers are met;
- Category 3: The entrance area is managed by way of occasional dredging following a severe storm washover event, whereby a channel is sustained in the position of the natural ebb tide channel to avoid the need to excavate an overly long pilot channel to achieve a mechanical opening following a severe storm washover event, when lake water level triggers are met. This management approach could also be combined with maintenance of a dry notch; and,
- Category 4: Engineering works are constructed in the entrance area, such as entrance breakwaters, to create a permanently open entrance, in which case mechanical opening would not be required.

The assessment of options for entrance management has been informed by a range of matters, including:

- an analysis of entrance conditions and behaviour over the period 1916 to 2019 as reported in RHDHV (2023c);
- review of natural breakouts and mechanical openings over the periods 1937 to 2011 and 2012 to 2022, with particular emphasis on seven mechanical openings by Council over the period 7 December 2010 to 10 February 2020, as reported in RHDHV (2023c);
- review of dredging carried out in the entrance area in 1999 and 2016 as reported in RHDHV (2023c);
- a numerical modelling study of several key factors that influence the effectiveness of the Category 1, 2, and 3 options; namely, lake water level triggers for mechanical opening, length of the pilot channel, and timing of a mechanical opening relative to ocean tide. In addition, the study directly modelled the dry notch and the permanent entrance. A copy of the numerical modelling study report is included in **Appendix D** of this report. Selected information from **Appendix D** is included within this section;
- flood studies and floodplain risk management studies and plans prepared for Lake Conjola (BMT WBM, 2007, 2013a, 2013b);
- the outcomes of the Cost Benefit Analysis included in **Section 4**; and,
- community and government agency consultation.

The following sections summarise a number of key matters prior to consideration of individual management options.

5.1.2 The main purpose of entrance management – mitigation of the flooding risk

The driver(s) for entrance management has changed over time. During the 1990s, at the time of preparation of the Lake Conjola Estuary Management Plan (Shoalhaven City Council, 1998) and the Lake Conjola Entrance Study (Patterson Britton, 1999), there was no reticulated sewage system and wastewater treatment plant for the Lake Conjola communities. Septic tank systems were in place and the inundation of these systems when the entrance was closed, together with the absence of tidal flushing at such times, was a significant water quality issue for Lake Conjola in addition to the flooding issue.

The Conjola Wastewater Treatment Plant (WWTP) commenced operations in 2008 as part of the Conjola Regional Sewerage Scheme (CRSS). The WWTP is located south of Lake Conjola and discharges treated effluent into a dune exfiltration system.

Assessment of surface water quality data within the Lake carried out as part of the development of the CMP has shown that water quality is generally good, including when the entrance is closed, and should no longer be considered a driver for mechanical intervention at the entrance in normal circumstances (RHDHV, 2023b). Nevertheless, there is a need to continue to monitor surface water quality and groundwater quality (related to the nutrient plume from the WWTP dune exfiltration system) to ensure the future ecosystem health and recreational attributes of the Lake.

It follows that the primary reason for entrance management is managing the risk associated with flooding. As such, there is a strong nexus between entrance management as outlined in the CMP and the floodplain risk management strategy for Lake Conjola (BMT WBM, 2013a), as noted in the following section.

Examples of inundation of foreshore development in the February 2020 flood are shown in **Figure 5-1** and **Figure 5-2**. The peak water level recorded near the entrance in this event was approximately 2.0m AHD and corresponded to approximately a 10% Annual Exceedance Probability (AEP) event or, in other words, an event that would be expected to be exceeded on average every 10 years.

During the February 2020 event an estimated 34 homes were subject to above-floor flooding. This is evident from **Figure 5-3** which shows the number of properties with floor levels and ground levels below certain AEP flood levels, as determined in BMT WBM (2013a). It is evident from **Figure 5-3** that properties start to be subject to above-floor flooding at a lake level of approximately 1.3m AHD.

Figure 5-1: Flooding of houses in Lake Conjola Village on 10 February 2020 (courtesy of Ms Kristen Bird)

Figure 5-2: Flooding of one of the upstream caravan parks at Lake Conjola on 10 February 2020 (www.sbs.com.au)

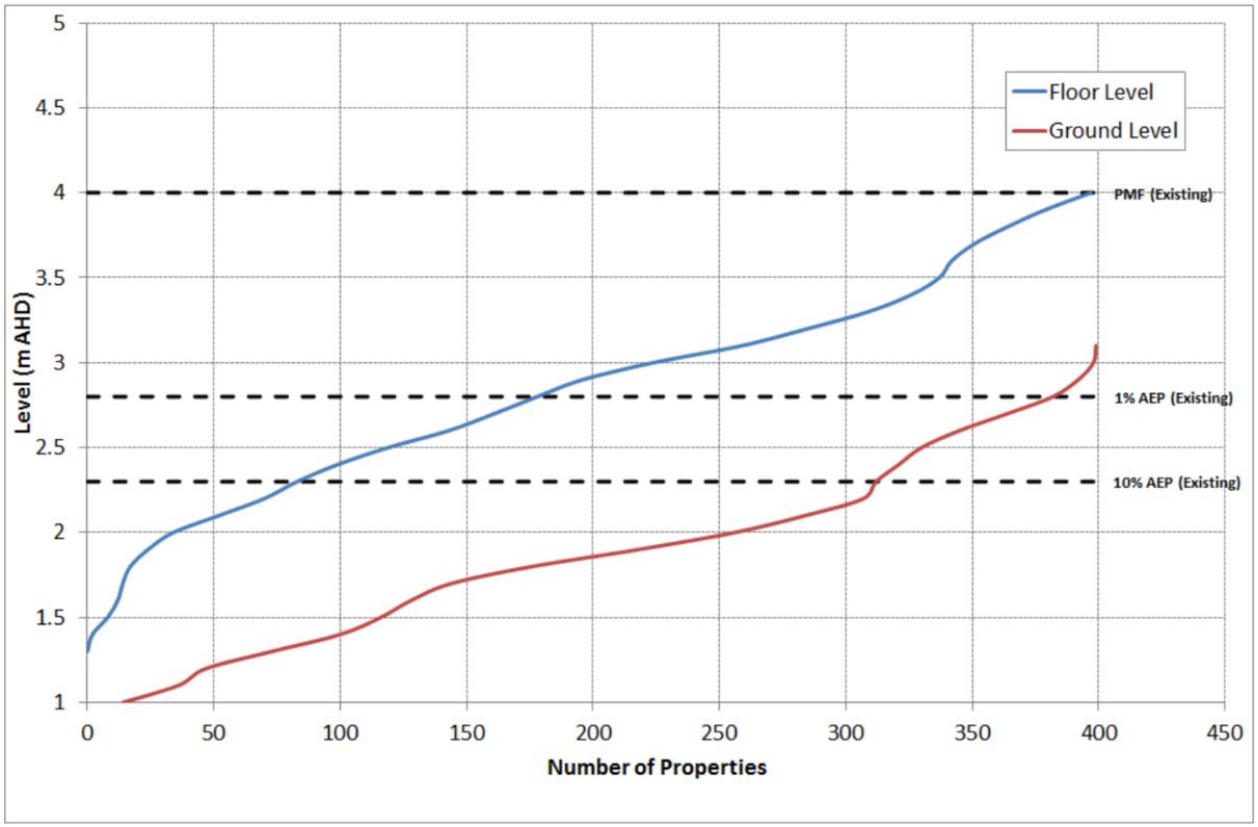


Figure 5-3: Number of properties with floor levels and ground levels below certain flood levels (source: BMT WBM, 2013a)

5.1.3 The nexus between the CMP and the floodplain risk management strategy for Lake Conjola

Since it is clear the primary reason for entrance management under the CMP is managing the risk associated with flooding, it is essential that the CMP and the floodplain risk management strategy for Lake Conjola are closely linked.

It is useful to briefly summarise here some of the key elements of the floodplain risk management strategy so that development of the CMP is cognisant of them.

As a short-term measure in the strategy, Council is proposing to develop a Total Flood Warning System (TFWS) for Lake Conjola. The TFWS will provide improved forecasting of predicted Lake water levels and hence improved flood warning. It is anticipated that the TFWS would facilitate an earlier intervention response at the entrance (mechanical opening) in the order of 6 to 12 hours (MHL, 2023). Such an earlier intervention would lead to a significant reduction in peak flood level, as demonstrated in the numerical modelling carried out in relation to the February 2020 flood event (reduction of 0.2 to 0.3m, refer Section 4 of numerical modelling study report in **Appendix D**).

Due to the benefits of the TFWS, it has been assumed it would exist alongside the recommended entrance management option(s) within the CMP. For this reason, the CBA outlined in **Section 4** adopts the TFWS for all options.

In the short-to-medium term, the floodplain risk management strategy is Voluntary House Raising (VHR), in conjunction with the short-term strategy. In the longer-term, the strategy involves raising of key land parcels (such as mosaic filling of lots and road raising), or retreat of existing development, in conjunction with the short and medium-term options.

In order to implement the strategy, Council would need to update the Lake Conjola Floodplain Risk Management Study and Plan (BMT WBM, 2013a). This is a separate but related exercise to the implementation of the Lake Conjola CMP.

5.1.4 Historic Lake Conjola entrance stability (open or closed) and main mechanisms affecting stability

Entrance stability (i.e. an open or closed lake entrance) for Lake Conjola over the period 1937 to 1999 was investigated by Patterson Britton (1999). Historical records of entrance condition, whether open or closed, are also available over the period 1916 to 2019 on a monthly basis compiled by Council. The above sets of information were assessed in RHDHV (2023c) and are summarised below.

Patterson Britton (1999) concluded that:

- over the 62-year period 1937 to 1999 the cumulative total percentage of time the entrance was closed and open (including heavily shoaled) was 15% and 85% respectively;
- entrance closures are caused by severe ocean storms;
- periods of entrance stability correspond with periods of little ocean storm activity; and,
- the key to entrance stability (reducing the likelihood of entrance closure) is reducing the destabilising impact of severe ocean storms, that is preventing or mitigating storm washover deposits (sand) entering the channel behind the sand spit[9].

Based on the Council records over the period 1916 to 2019, the entrance was open 88% of the time and closed for 12% of the time, which is a similar result to the assessment in Patterson Britton (1999).

The percentage of time Lake Conjola is open to the ocean is relatively high in comparison to other NSW ICOLLs. For example, it is noted in Council's Coastal Fact Sheet - Lake Conjola Management that about 70% of ICOLLs in NSW are closed most of the time, that is greater than 50% of the time (information sourced from DPI – Fisheries website[10]). Narrabeen Lagoon on Sydney's Northern Beaches, which is heavily managed at the entrance for purposes mostly of flood mitigation (major entrance clearance operations [sand removal] are carried out approximately every four years) is open approximately 75% of the time compared to approximately 85% to 88% for Lake Conjola.

A specific further analysis of entrance stability was also carried out as part of the CMP in the preparation of RHDHV (2023c) and covered the 50-year period 1971 to 2021. It examined the trends for entrance stability in relation to rainfall, ocean storms, and the potential influence of cycles of the El Nino and La Nina phases of the Southern Oscillation Index (SOI) which can cause open coast beach rotation (widening and narrowing of the beach) and hence affect the stability of the entrance to a coastal lake which passes through the beach. The relevant beach in this case is Conjola Beach, which is more than 3.5km long.

[9] *As the occurrence of ocean storms cannot be controlled, in effect this meant reducing the surface area of the sand spit and/or increasing the elevation of the spit and/or stabilising the spit through increasing the vegetation cover.*

[10] https://www.dpi.nsw.gov.au/fishing/habitat/aquatic-habitats/wetland/coastal-wetlands/management-of-coastal-lakes-and-lagoons-in-nsw

A number of conclusions were reached from the above specific analysis:

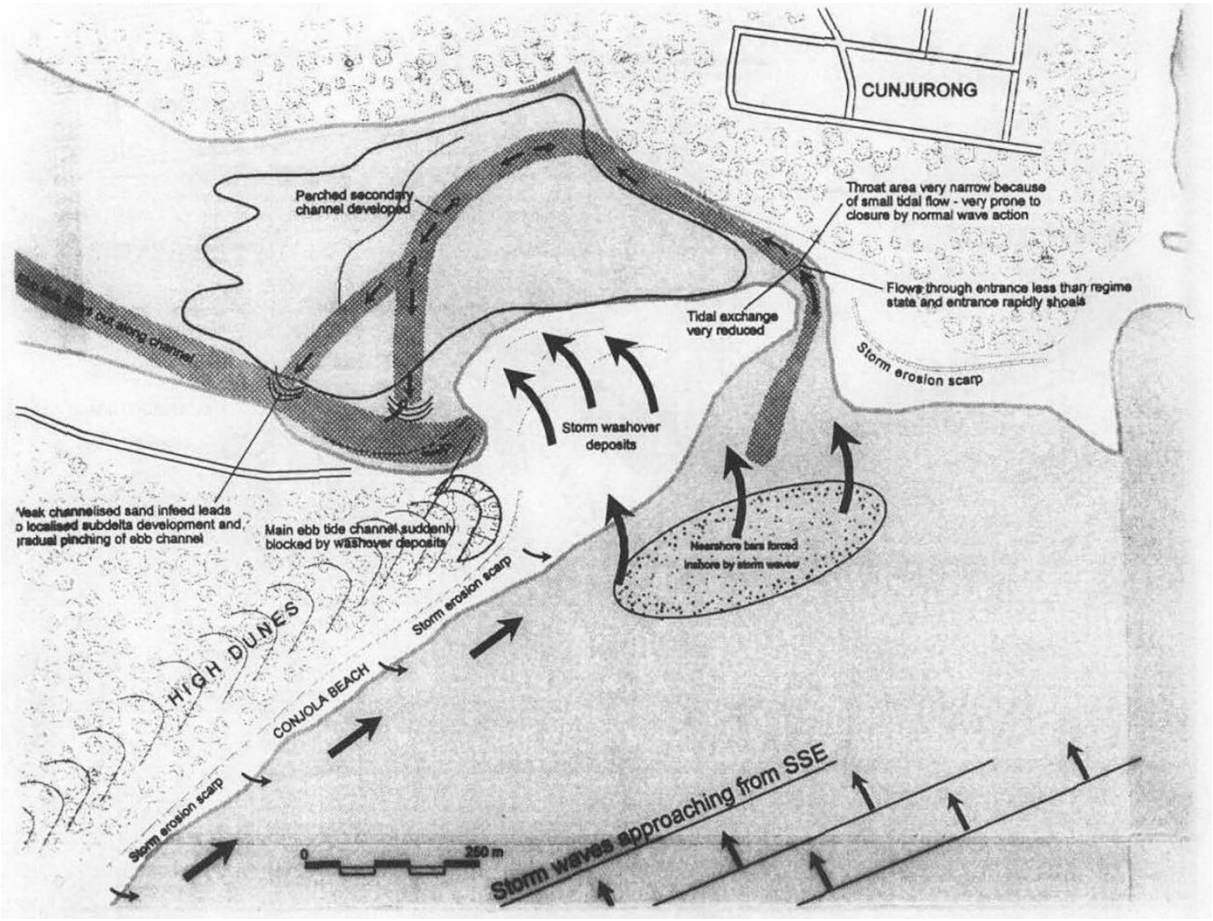
- rainfall is a key mechanism for keeping the entrance open, or causing the entrance to open if it is closed, however even in below average rainfall years the entrance can stay open in the absence of significant ocean storms;
- ocean storms are the key mechanism for closing the entrance, due to storm washover of the sand spit, but high rainfall years can dominate over ocean storms; and,
- the El Nino and La Nina phases of the SOI can influence entrance conditions, all other things being equal, with the El Nino phase tending to influence entrance closure (lower than average rainfall, clockwise rotation of Conjola Beach causing widening of the beach at the northern end) and the La Nina phase tending to influence entrance open conditions (higher than average rainfall, anti-clockwise rotation of Conjola Beach causing narrowing of the beach at the northern end).

Entrance closure as a result of severe ocean storms was described in detail in Patterson Britton (1999). This situation was termed the Storm Washover Entrance State and was one of four basic characteristic entrance states for Lake Conjola identified and described in Patterson Britton (1999). A schematic representation of the Storm Washover Entrance State is shown in **Figure 5-4** and a real-world example at Lake Conjola is shown in the aerial photograph in **Figure 5-5**.

Under the Storm Washover Entrance State the following is evident:

- the washover sand cuts off (infills) the primary natural ebb tide channel/fluvial channel that is otherwise typically situated behind the entrance sand spit and directed towards Cunjurong Point; and,
- due to the infilling of the primary ebb tide channel, it becomes ‘perched’ on the large flood tide sand delta inside the entrance, leading to sudden and substantially diminished tidal flows, with further washover leading to entrance closure.

The impact of storm washover and infilling of the primary natural ebb tide channel is the rationale for consideration of the Category 3 option of occasional dredging to sustain the position of the primary natural ebb tide channel. This is further discussed in **Section 5.5**.



Storm Washover Entrance State - Broad features:

- **washover deposits i.e. 'fans' cut off fluvial channel/primary ebb channel;**
- **ebb channel becomes perched on flood delta lobes leading to suddenly and substantially diminished tidal flows;**
- **flood tide tends to re-establish northern perimeter channel;**
- **sediment infeed is reduced but continues to pinch primary ebb channel which eventually disappears;**
- **further washover leads to closure.**

Figure 5-4: Schematic representation of Storm Washover Entrance State (source: PBP, 1999)

Figure 5-5: Aerial photograph showing an example of the Storm Washover Entrance State and indicative pilot channel alignment from northern spit zone shown in blue linework (source: Nearmap, dated 15 July 2018)

5.1.5 Historic dredging in the entrance area

Two dredging campaigns have been carried out in the entrance area of Lake Conjola over the past approximately 25 years; namely, dredging carried out during the period November to December 1999 primarily associated with the risk of closure of the entrance by storm washover of the spit, and dredging carried out in 2016 for navigation access improvements. The latter dredging was not related to entrance management and is not considered further here.

The 1999 dredging and dredge material disposal involved the following main elements:

- dredging of the main ebb tide channel behind the entrance sand spit;
- disposal of a proportion of the dredge material along the southern shoreline of the Lake to address an erosion issue;
- disposal of the remaining dredge material on the entrance sand spit to extend the dune northwards and mitigate the ability for waves to washover the sand spit and infill the main ebb tide channel; and,
- dredging of a channel between the Cunjurong boat ramp and the main ebb tide channel to improve local navigation.

It is considered that the dredging of the main ebb tide channel and the associated raising of the entrance sand spit (extension northwards of the dune) would have contributed to sustaining an open entrance for an extended time, since:

- the availability of an ebb tide channel is important for scouring the entrance and maintaining the Lake open;
- storm washover is a clear mechanism for entrance closure and raising the sand spit would have reduced the impact of this process;
- rainfall during the period 1999 to 2010 was not above average but generally at or below average (hence not 'dominant'), noting that rainfall is a key mechanism for keeping the entrance open; and,
- there was an over-representation of ocean storm events during the period 1999 to 2010 which are a key mechanism for closing the entrance (due to washover of the sand spit).[11]

Having said the above, consideration of the cycles of the El Nino and La Nina phases of the SOI over the period 1999 to 2011 (RHDHV, 2023c) suggest that the sustained open entrance over this period would have likely also been influenced beneficially by the predominance of La Nina phases (anti-clockwise rotation of Conjola Beach and existence of a narrower beach berm near the entrance).

In summary, the availability of a dominant ebb tide channel and mitigation of the risk of a storm washover, achieved if necessary by dredging and targeted placement of dredge material, are considered to have a positive influence on sustaining an open entrance. However, it also needs to be recognised that the occurrence of ocean storms, rainfall, and El Nino/La Nina phases of the SOI, over which there is no control, also have strong influences on entrance behaviour in terms of an open/closed entrance condition.

5.1.6 Structure of the remaining sections

The remaining sections in **Section 5** are structured in the following way:

- **Section 5.2** sets out a discussion of a number of key factors that influence the effectiveness of a mechanical opening of the entrance;
- **Section 5.3** sets out an assessment of the Category 1 option comprising a TFWS plus mechanical opening of the entrance by excavation of a pilot channel in response to a lake water level trigger (referred to as Option 1);
- **Section 5.4** sets out an assessment of the Category 2 option comprising a TFWS plus maintenance of a dry notch combined with excavation of a pilot channel in response to a lake water level trigger (referred to as Option 2);
- **Section 5.5** sets out an assessment of the Category 3 option comprising a TFWS plus occasional dredging to sustain a natural ebb tide channel combined with maintenance of a dry notch and excavation of a pilot channel in response to a lake water level trigger (referred to as Option 3);
- **Section 5.6** sets out an assessment of the Category 4 option of creating a permanently open entrance (referred to as Option 4); and,
- **Section 5.7** sets out a summary of the assessment of the options, together with recommendations.

[11] *In all, as reported in RHDHV (2023c) in the period 1999 to 2010, there were a total of seven so-called Category 'A' storms (offshore significant wave height in range 5.0m to 6.0m) and two so-called Category 'X' storms (offshore significant wave height greater than 6.0m). Based on significant wave height data from the Batemans Bay offshore waverider buoy and the analysis by Glatz et al (2017) a lesser number of such storms over an 11 year period would be expected on average.*

As noted earlier, the Category 1, 2, and 3 options (Options 1, 2, and 3) all consider that a Total Flood Warning System (TFWS) is in place.

5.2 Key Factors that Influence the Effectiveness of a Mechanical Opening

5.2.1 General

There are a number of key factors that influence the effectiveness of a mechanical opening. The factors examined as part of preparation of the CMP comprised:

- lake water level trigger;
- location of a pilot channel and dry notch;
- dimensions of a pilot channel and dry notch; and,
- timing of a mechanical opening relative to ocean tide level.

The influence of the above factors was assessed based on a number of approaches; review of seven mechanical openings carried out by Council over the period 7 December 2010 to 10 February 2020 (refer RHDHV, 2023c), discussions with Council and DCCEEW officers, and a numerical modelling study. The focus of the numerical modelling was hydrodynamics (water level and flows) and sediment transport). As noted earlier, a copy of the numerical modelling study report is included in **Appendix** D of this report. The reader is referred to **Appendix** D for more detail.

It became apparent during the numerical modelling study that the influence of the location of a pilot channel and dry notch could be more simply assessed by varying the length of the pilot channel/dry notch as this is the main outcome of varying the location of the pilot channel/dry notch.

It is also important to appreciate that a number of model limitations apply to the numerical modelling study. This arises because it is not possible to model every physical process in the entrance area and since additional refinements to the model would lead to unreasonable model run times. The power of the modelling is the ability to assess the relative behaviour/sensitivities of different influencing factors on mechanical opening effectiveness, plus the main impacts of various management options. The results of the modelling need to be interpreted in conjunction with a real-world understanding of lake entrance behaviour.

The bed levels in the entrance area adopted for the numerical modelling were based on a 2018 survey when the entrance was closed. The bed levels were then adjusted to simulate the various entrance conditions corresponding to the different entrance management options, i.e., pilot channel, dry notch, and dredging of an ebb tide channel.

5.2.2 Lake Water Level Trigger

The influence of the lake water level trigger on the effectiveness of the mechanical opening, based on actual mechanical openings, was assessed through consideration of:

- the lake water level recorded at the time of the opening;
- the rate of drop of lake water level, indicative of the magnitude of the breakout flow;

- the strength of the tidal response in the lake following the opening; noting that a greater tidal range (difference between high water and low water) would be indicative of a more well-developed breakout channel); and,
- the period of time for which the entrance remained open (not always documented in Council records but sometimes able to be inferred from lake water level records and assessment of vertical aerial photography).

To assist with the general interpretation of the effectiveness of the mechanical opening, consideration was also given to the offshore wave climate (storminess), ocean tide level, and rainfall leading up to, during, and following, the mechanical opening event. All the relevant information was plotted on a common time graph to assist with interpretation.

Examples of the graphical representation of the information for two mechanical openings, one on 7 December 2010 and one on 21 March 2011, are shown in **Figure 5-6** and **Figure 5-7** respectively. It is evident from a comparison of the two graphs that the mechanical opening on 21 March 2011 created a more well-developed breakout channel (greater rate of lake water level drop and stronger tidal signal following the breakout). This would have been assisted by the continuing rainfall in March 2011 at the time of opening. The counter issue is that the lake water level in March 2011 reached a peak of approximately 1.3m AHD whereas the peak water level in December 2010 was lower at approximately 1.1m AHD, hence more extensive flooding in Conjola Village occurred in March 2011 even though the mechanical opening was more effective.

The full assessment of all seven mechanical openings is presented in RHDHV (2023c). The main conclusion with respect to lake water level trigger and mechanical opening effectiveness is that mechanical openings at a lake water level lower than approximately 1.1m AHD would appear to be problematic, while recognising that a range of other factors can also influence the effectiveness of mechanical opening events, e.g., continuing rainfall and the occurrence of ocean storms.

The assessment also underlined the benefit of an earlier response time/intervention for mechanical opening in response to predicted heavy rainfall with the entrance closed. The proposed TFWS will facilitate earlier intervention (approximately 6 to 12 hours) and lead to a significant reduction in flood risk for Lake Conjola.

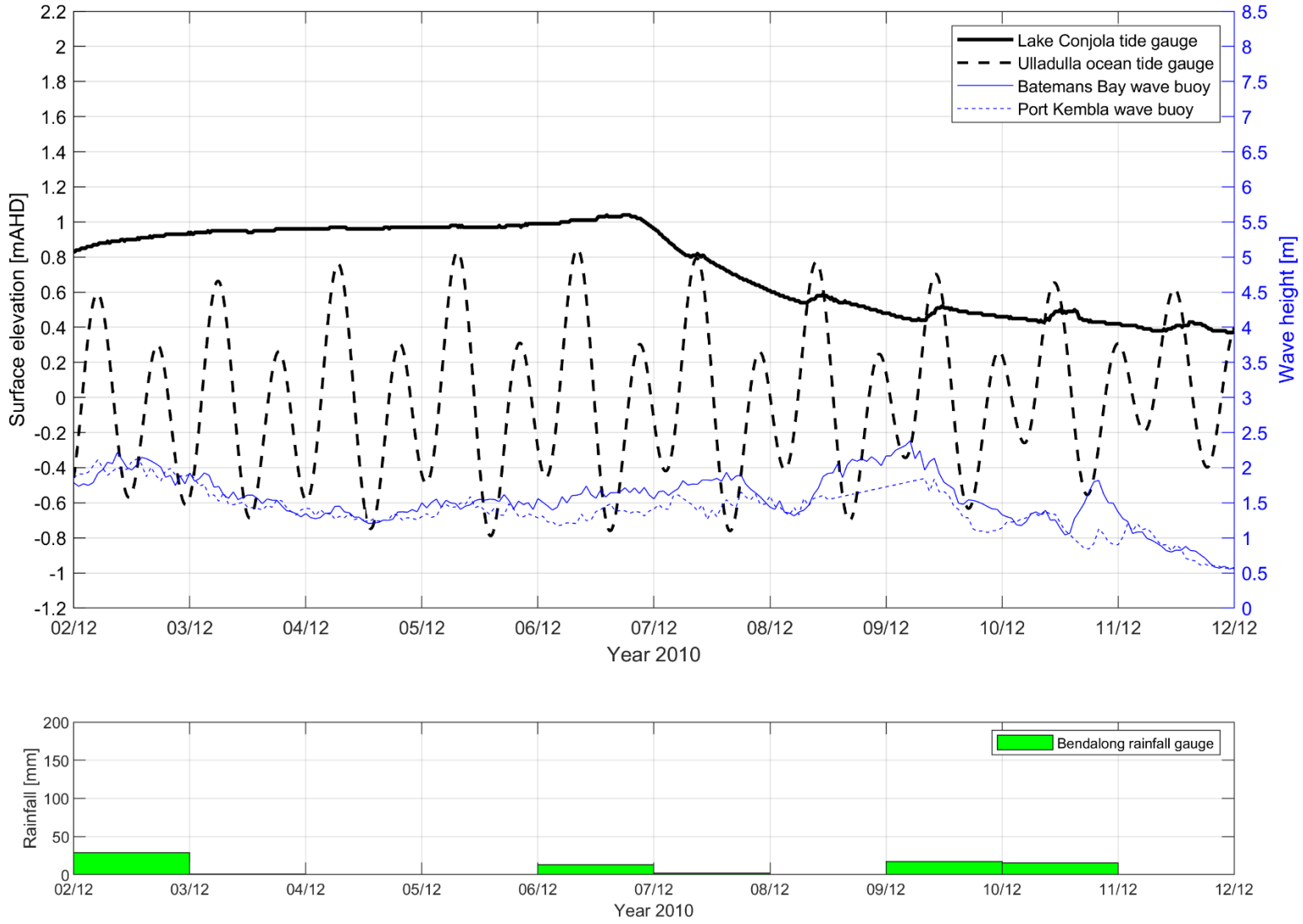


Figure 5-6: Water level, rainfall, and wave records for the mechanical opening on 7 December 2010

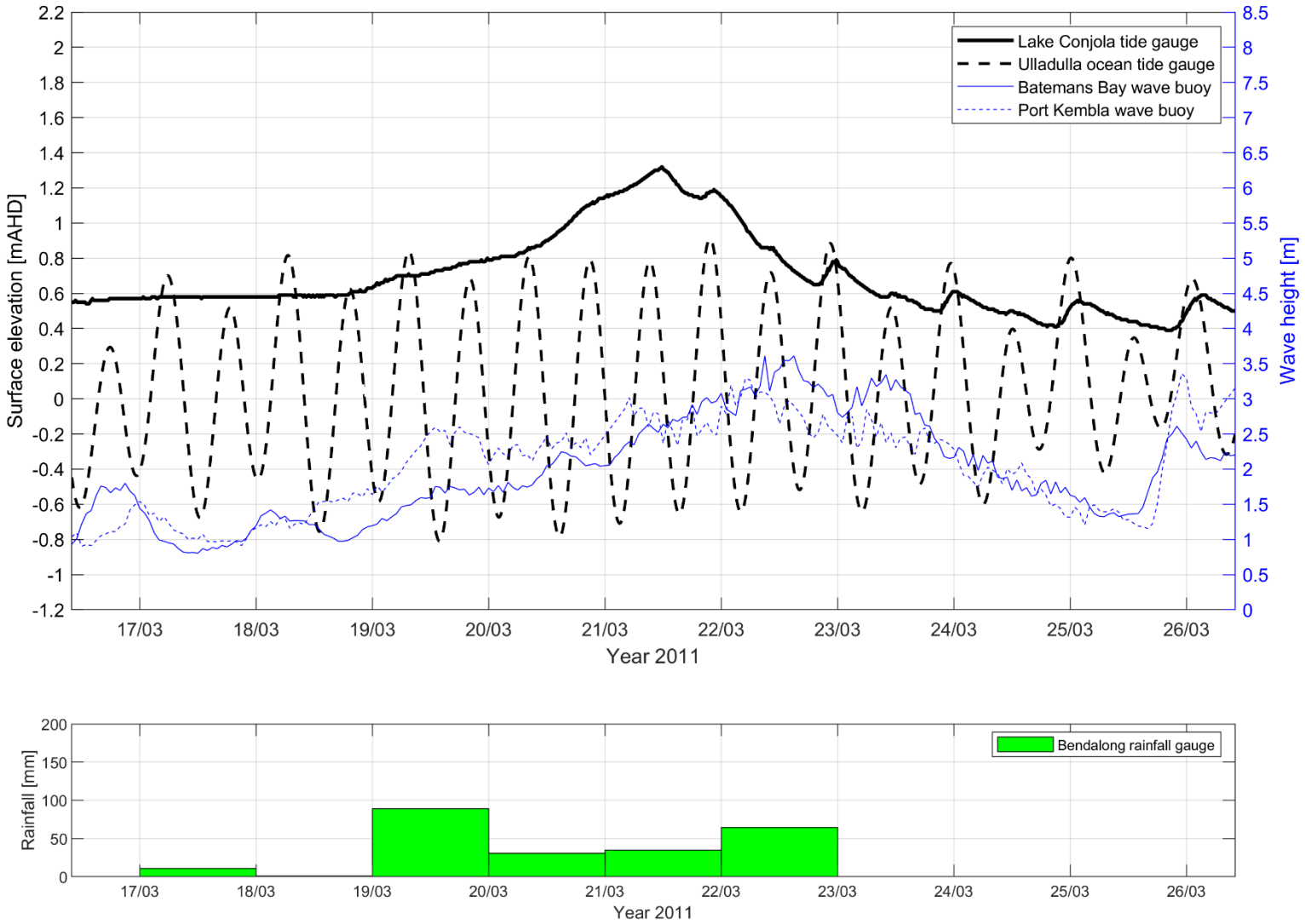


Figure 5-7: Water level, rainfall, and wave records for the mechanical opening on 21 March 2011

The numerical modelling study assessed the effectiveness of a mechanical opening for four lake water level triggers; namely, 0.8m AHD, 1.0m AHD, 1.2m AHD, and 2.0m AHD. The lake level value of 2.0m AHD did not represent a potential trigger level within any revised Entrance Management Policy. It was adopted in the numerical modelling simulations in consultation with Council and DCCEEW to fully explore the sensitivity of water level difference between Lake Conjola and the Tasman Sea (head difference) on the effectiveness of a mechanical opening.

The effectiveness of the mechanical opening was assessed based on the rate of drop of lake water level and the degree of scour in the breakout channel.

The results of the modelling are illustrated schematically in **Figure 5-8**. Further detail is provided in **Appendix D**. The results show that the higher the lake water level trigger the more effective the mechanical opening, evident from the more rapid drop in lake water level and the greater channel scour, all other factors such as channel length, channel width, and phasing of the opening with ocean tide being equal. The results of the numerical modelling can be attributed to the larger head difference between the lake and the sea for higher lake water level triggers and are consistent with the assessment of actual mechanical openings referred to above and detailed in RHDHV (2023c).

It follows that for a mechanical opening to be as effective as possible the opening should be initiated at as high a lake level as feasible without impacting adversely on flooding risk. Planning and preparation for an opening can take place at lower lake levels, particularly with the benefit of a TFWS.

The above findings will be used to inform the draft Entrance Management Policy prepared as part of the CMP.

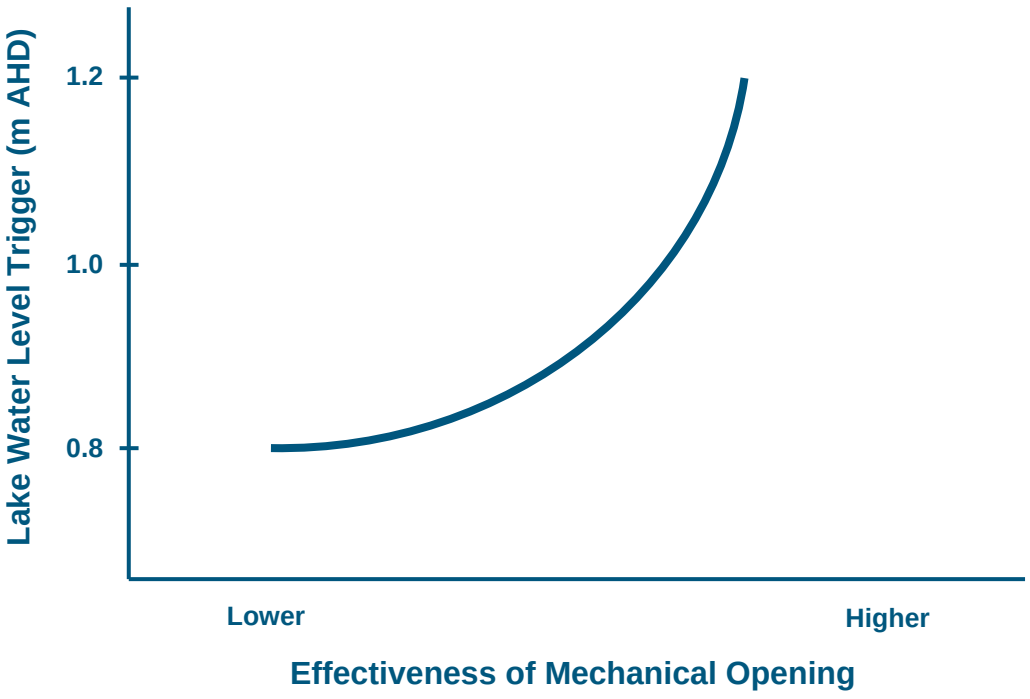


Figure 5-8: Schematic representation of relationship between lake water level trigger and effectiveness of a mechanical opening

5.2.3 Location (Length) of a Pilot Channel and Dry Notch

The Interim Entrance Management Policy for Lake Conjola, Appendix C (GHD, 2013) divided the entrance area (sand spit) into three zones – a southern spit zone, mid spit zone, and northern spit zone (refer **Figure 5-9**). Mechanical opening was not permitted in the southern spit zone due to the risk of dune instability and concerns in relation to threatened bird species. Furthermore, during the shorebird nesting season (September to March) mechanical opening was not permitted in the mid spit zone, only the northern spit zone.

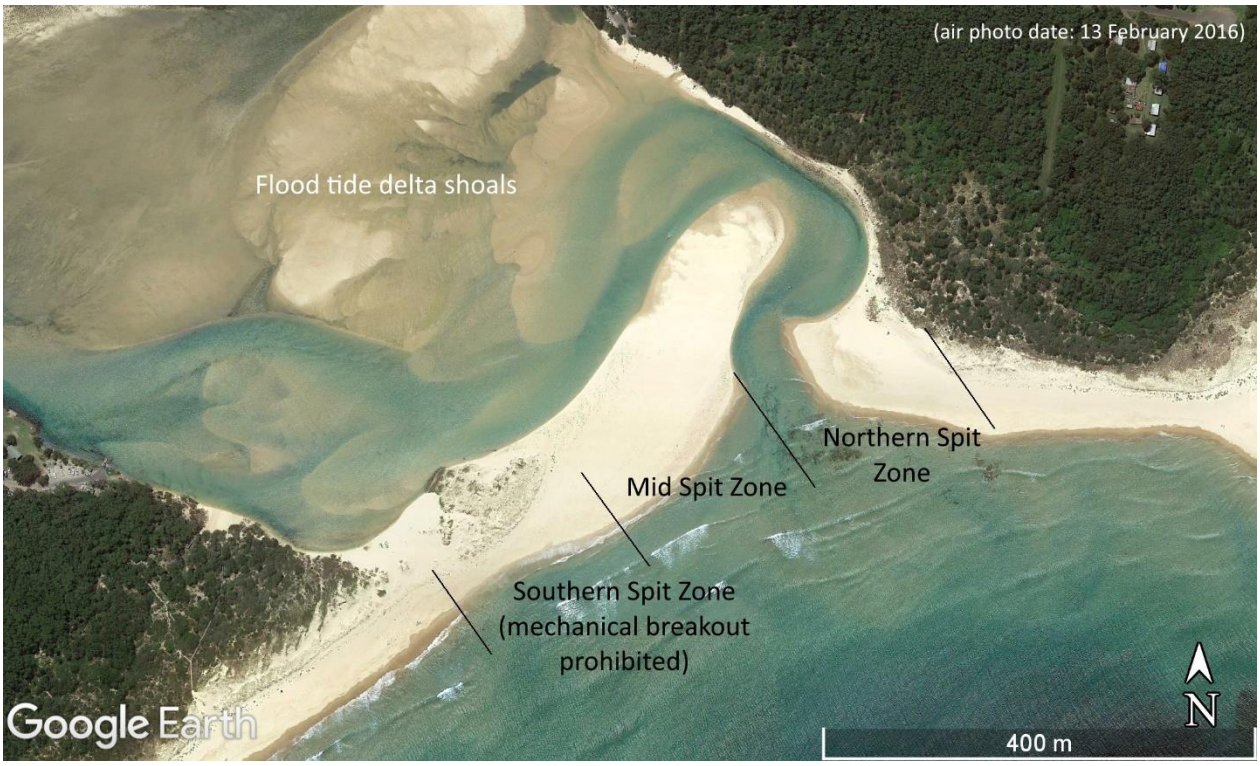


Figure 5-9: Southern, Mid and Northern Spit Zones

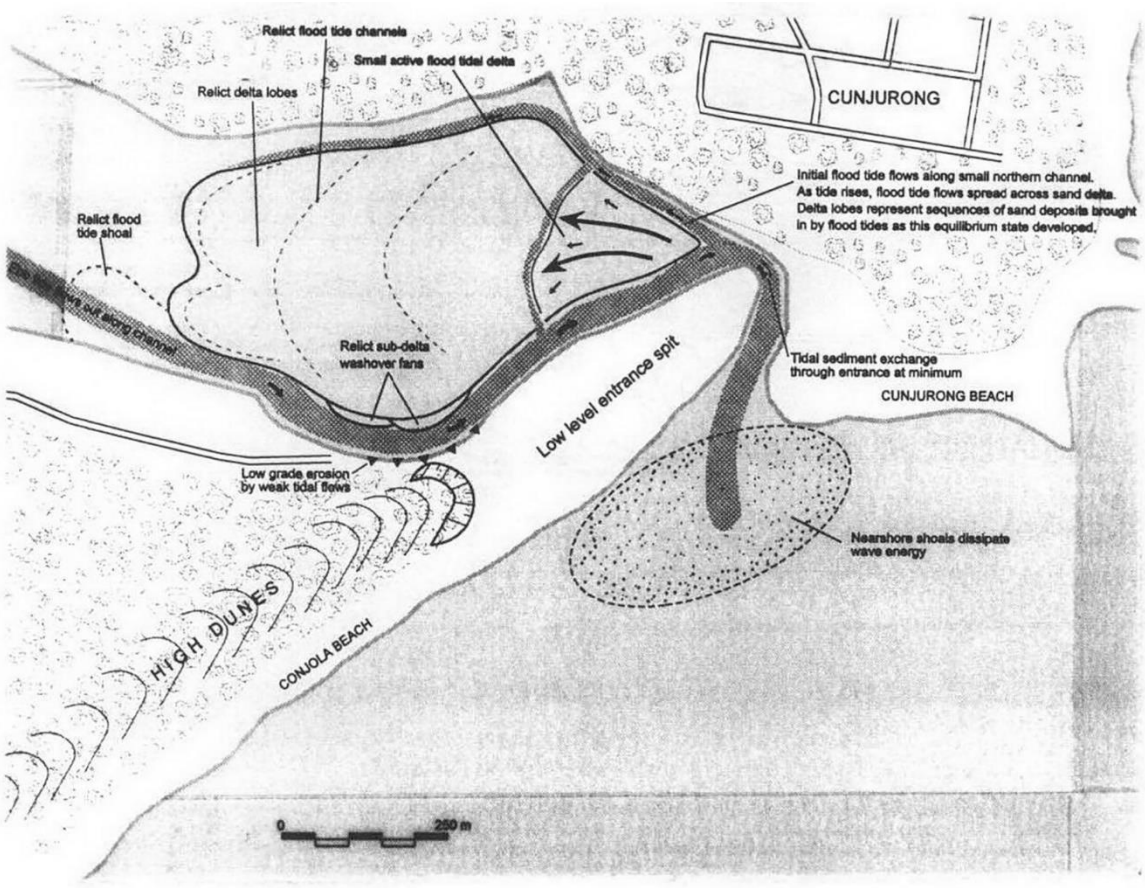
In practice, it is expected that any dry notch (with pilot channel incorporated) would need to be located in the northern spit zone as it may require regular maintenance at any time of the year and would otherwise cause disturbance during the shorebird nesting season. In discussions with Council and DCCEEW officers it was also decided for purposes of the assessment of entrance management options that a 'pilot channel only' option should also position the channel in the northern spit zone.

It is relevant that Patterson Britton (1999) considered that a pilot channel should be located towards the north of the entrance sand spit, which would have been in the northern spit zone subsequently defined in GHD (2013), on the basis that:

- the northern foreshore has the least exposure to wave energy (a benefit) because of the Green Island wave shadow and the wave energy dissipation caused by the nearby nearshore shoals; and,
- a channel in the north represented a steady end state (so-called Regime Entrance State) that the entrance naturally and gradually establishes in the absence of any sudden changes caused by major floods and storms. A schematic representation of the Regime Entrance State is shown in **Figure 5-10** and a real-world example for Lake Conjola is shown in **Figure 5-11**.

In siting the pilot channel/dry notch in the northern spit zone, it would be prudent not to initiate the channel excavation over the natural rock outcrops known to exist in proximity to Cunjurong Point, to avoid the risk of the channel 'hanging up' on the rock outcrops which could limit scour and development of channel. It is possible over time the channel could migrate northwards over the rock outcrops, but this is a natural process.

A consequence of a pilot channel/dry notch being located in the northern spit zone is that at times the pilot channel/dry notch would need to be 'long' to connect to the deeper water (natural ebb tide channel) typically located landward and adjacent to the spit. This would especially be the case after any severe storm washover event when the natural ebb tide channel may be infilled and be truncated much further to the south (for example refer **Figure 5-5**).



Regime Entrance State - Broad features:

- **entrance is hard against the northern shoreline and the channel is quite narrow;**
- **small tidal exchange with limited tidal range in lake – average lake level is elevated well above mean sea level;**
- **flood tide delta and low level entrance spit relatively stable but prone to instability from:**
  - **floods cutting through spit and opening up lake and rejuvenating tidal exchange,**
  - **severe coastal storm overtopping the entrance sand spit and pushing large deposits of sand westwards and potentially closing the entrance,**
  - **lengthy dry spell (several years) allowing windblown sand to slowly close off the narrow entrance channel.**

Figure 5-10: Schematic representation of Regime Entrance state (source: PBP, 1999)

Figure 5-11: Aerial photograph showing an example of the Regime Entrance State (source: Google Earth Pro, dated 13 February 2016)

Due to the large potential variability in pilot channel length, a wide range of channel lengths were considered in the numerical modelling study; namely 50m, 100m, 150m, 200m, and 300m. The effectiveness of the mechanical opening as a function of channel length was again assessed on the basis of the rate of drop of lake water level and the degree of scour in the breakout channel.

The results of the modelling are illustrated schematically in **Figure 5-12**. Further detail is provided in **Appendix D**. The results show that the shorter the pilot channel length the more effective the mechanical opening, evident from the more rapid drop in lake water level and greater channel scour, all other factors such as initial lake water level, channel width, and phasing of the opening with ocean tide being equal. The results can be attributed to the greater hydraulic gradient (slope of the water surface) and reduced friction in the shorter channels compared to the longer channels.

It follows that a situation where the required excavation for the pilot channel is overly long should be avoided if possible. Allowing the water level in the lake to rise as a means of reducing the pilot channel length needs to be carefully managed due to the associated flooding risk.

The above findings will be used to inform the draft Entrance Management Policy prepared as part of the CMP.

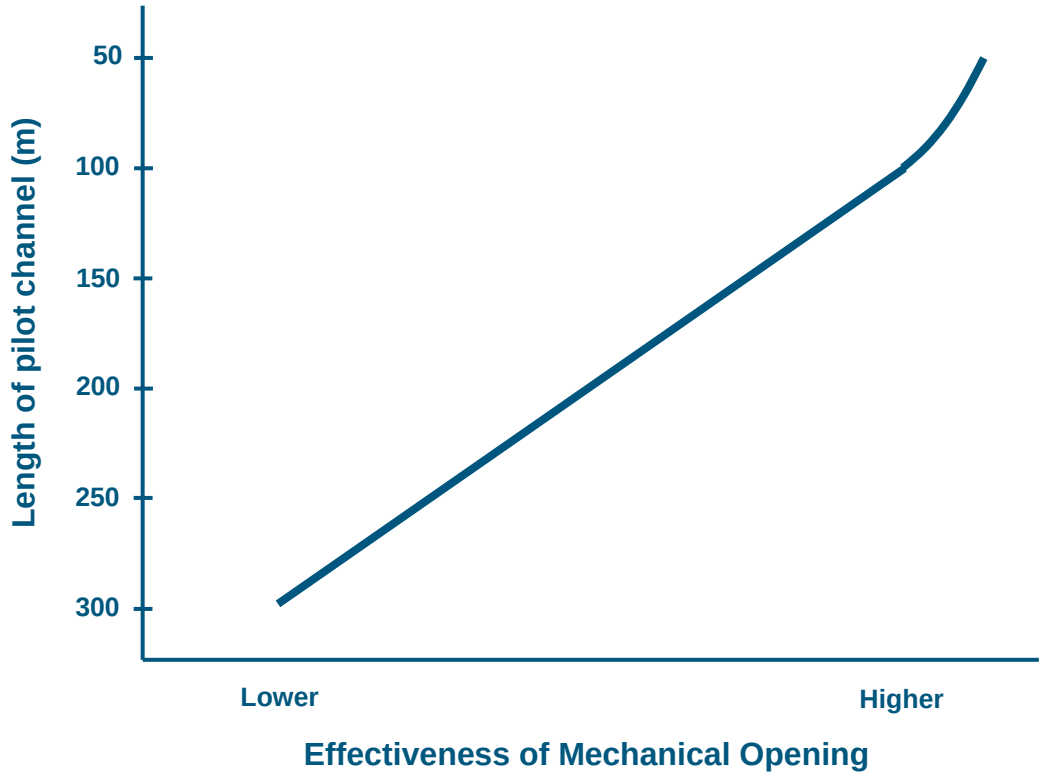


Figure 5-12: Schematic representation of relationship between length of pilot channel and effectiveness of a mechanical opening

5.2.4 Dimensions of a pilot channel and dry notch

The dimensions of the pilot channel and dry notch were not varied significantly during the numerical modelling since typical dimensions were reasonably well established from historical practice and/or were influenced by modelling efficiency such as run times.

The following dimensions of a pilot channel and dry notch were typically adopted in the numerical modelling:

- pilot channel:
    - width: 12m
    - bed level: 0m AHD (constant level i.e., flat grade)
- dry notch:
    - width: 50m
    - bed level: 1.0m AHD (constant level, i.e., flat grade)

5.2.5 Timing of a mechanical opening relative to ocean tide level

The effectiveness of a mechanical opening as a function of the timing of the opening relative to ocean tide level was investigated by timing the opening at the following times:

- Mean High Water Springs (MHWS)

- Mean Sea Level (MSL) – rising tide
- Mean Sea Level (MSL) – falling tide
- Mean Low Water Springs (MLWS)

The modelling simulations were carried out for an initial lake water level of 1.2m AHD, a channel length of 200m, and a pilot channel width of 12m.

The results of the modelling showed little apparent sensitivity between mechanical opening effectiveness and timing of the opening relative to ocean tide level. Further detail is provided in **Appendix D**. The lack of sensitivity could be influenced by the modelling limitations referred to earlier.

It is likely that the optimal timing of a mechanical opening relative to ocean tide level will continue to be strongly influenced by practical experience gained over time. Based on experience to date, it is understood that it is the intention of Council to initiate a mechanical opening around ocean high tide, subject to other factors such as the safety of operations, as in practice such timing has generally proven to be the most effective, i.e., leads to a well scoured entrance and generally longer period of entrance open conditions. This greater effectiveness is thought to be related to the longer duration of sustained positive head difference between the lake and the ocean over time as the ocean tide level falls.

The approach adopted by Council is considered reasonable and reflects the approach taken by a number of other Australian Councils in the management of the entrance to ICOLLs in NSW.

It is also relevant that Patterson Britton (1999) investigated the relative benefit of the timing of the so-called ‘point of breakout’ relative to ocean tide level. The ‘point of breakout’ was defined as the time at which the breakout channel is scouring vertically and horizontally at its greatest rate. It is therefore important to appreciate that the ‘point of breakout’ is a different point in time to the initiation of the mechanical opening (the ‘point of breakout’ being later in time).

Patterson Britton (1999) concluded that for maximum effectiveness (scouring of a well-developed breakout channel) the ‘point of breakout’ should coincide with ocean low tide (this was based on a pilot channel length of 200m and a width of 10m). This finding is not inconsistent with an initiation of the mechanical opening around ocean high tide due to the period of time for the scouring processes to fully develop.

Lastly, due to the adverse effect that large waves can have on the effectiveness of a mechanical opening (by elevating ocean water levels due to wave setup thereby reducing head difference, plus increasing sediment movement within the entrance, thereby tending to close the entrance) it is important to schedule a mechanical opening, where practicable, during mild wave conditions.

5.3 Option 1 – TFWS plus Pilot Channel Only

5.3.1 Description

In addition to the TFWS, Option 1 would involve the following main features:

- Pilot channel located in the northern spit zone.
- Pilot channel approximately 2m wide (one bucket-width) and bed level approximately 0m AHD.
- Pilot channel of variable length depending on the entrance closure process, possibly up to 300 to 400m in length after a severe coastal storm washover event.

- Frequency of mechanical opening once per year on average.
- Excavation of the pilot channel by excavator.
- Disposal of sand from the pilot channel excavation on the spit the north of the pilot channel (noting that excavation of the pilot channel would be conducted from the north side of the channel, hence access to the south of the channel for disposal would not be possible), and/or beach nourishment to the north, and/or restoration of erosion areas on the northern lake foreshore.

Images of excavation of a pilot channel and disposal of excavated sand are shown in **Figure 5-13** and **Figure 5-14** respectively.

Figure 5-13: Mechanical opening of Lake Conjola entrance in June 2019 (source: D. Wiecek, DCCEEW)

Figure 5-14: Contractors placing sand near northern dunes after removing it from the entrance of Lake Conjola on 13 June 2019 (source: Illawarra Mercury)

5.3.2 Performance of Option 1

The flood mitigation benefit of Option 1 is essentially related to the implementation of the TFWS, which allows an earlier intervention at the entrance (mechanical opening) in the order of 6 to 12 hours and a consequent reduction in the peak flood level (refer **Table 4-7**).

Option 1 therefore represents an improvement over the historic management of the entrance for flood mitigation (due to introduction of the TFWS), however further improvement is provided by Option 2 which exhibits additional net benefit, as noted in the following section.

5.4 Option 2 – TFWS plus Dry Notch and Pilot Channel

5.4.1 Description

In addition to the TFWS, Option 2 would involve the following main features:

- Dry notch and pilot channel located in the northern spit zone (pilot channel within the footprint of the dry notch).
- Dry notch 50m wide and bed level 1.2m AHD.
- Short sand plug retained at the seaward end of the notch, crest level of the plug approximately 2m AHD.
- Pilot channel approximately 2m wide (one bucket-width) and bed level approximately 0m AHD.
- Dry notch and pilot channel of variable length depending on the entrance closure process, possibly up to 300 to 400m after a severe coastal storm washover event.
- Frequency of maintenance of the dry notch two times per year when the entrance is closed.
- Frequency of mechanical opening once per year on average.
- Maintenance of dry notch by excavator (or dozer) and excavation of pilot channel by excavator.
- Disposal of sand from the dry notch excavation on the spit to the south of the dry notch to increase the height of the spit (preferred subject to bird nesting season), and/or beach nourishment to the north, and/or restoration of erosion areas on the lake foreshore.
- Disposal of sand from the pilot channel excavation on the spit to the north of the pilot channel (noting that excavation of the pilot channel would be conducted from the north side of the channel, hence access to the south of the channel for disposal would not be possible), and/or beach nourishment to the north, and/or restoration of erosion areas on the northern lake foreshore.

An example of a dry notch which is maintained at the entrance to Manly Lagoon within the Northern Beaches Council LGA is shown in **Figure 5-15**. The dry notch is maintained by a dozer which is stored locally and can be mobilised rapidly to remove the sand plug when flooding risk is predicted.

Figure 5-16 depicts the simulation of the dry notch (in yellow) and pilot channel (in green) in the numerical model at the entrance to the lake.

Figure 5-15: Example dry notch maintained at the entrance to Manly Lagoon, Queenscliff Beach (January 2020)

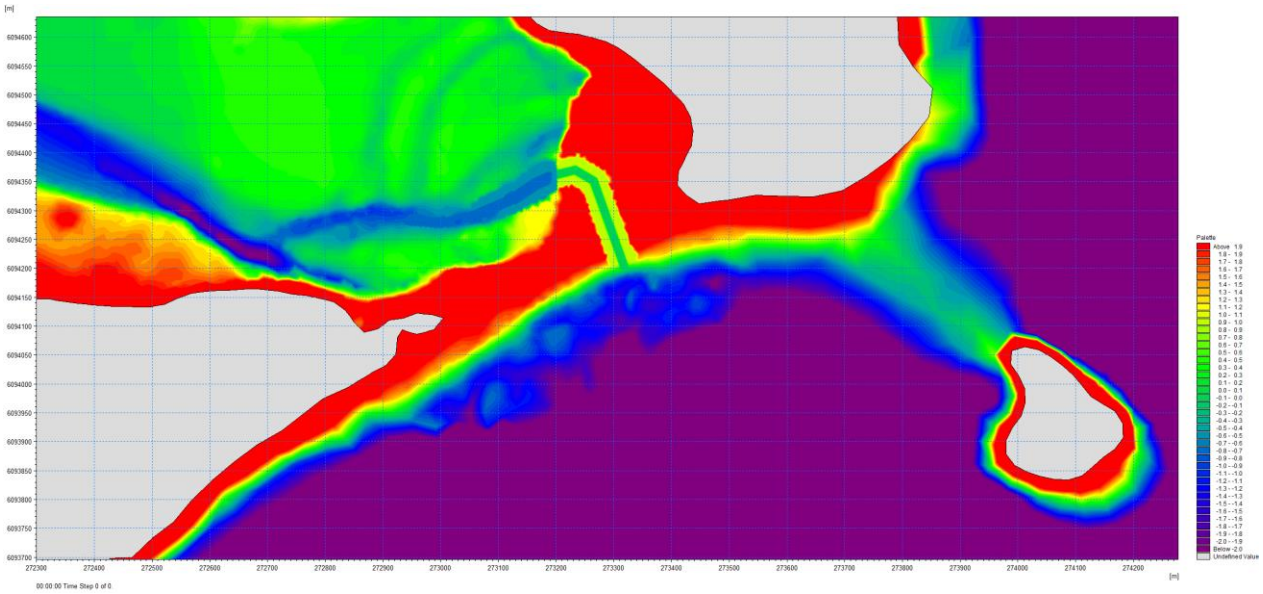


Figure 5-16: Depiction of the dry notch plus pilot channel in the numerical model of the lake entrance

5.4.2 Performance of Option 2

Option 2 provides additional flood mitigation benefit compared to Option 1 since, in addition to the common TFWS, the dry notch has two further benefits:

- It provides additional hydraulic conveyance (greater rate of discharge of flood waters) for the equivalent lake water level due to the larger cross-sectional flow area provided by the dry notch in

combination with the pilot channel. Hence there would be a quicker drop in lake water level following mechanical intervention.

- The quantity of excavation required to create the pilot channel, including allowance for removal of the sand plug, would be less than if a dry notch did not exist. Hence the time required for excavation on site would be less allowing earlier timing of a breakout.

The above additional flood mitigation benefits are reflected in the estimated greater reduction in peak flood level (refer **Table 4-7**).

The dry notch can also be maintained at a relatively low cost. Together with the additional flood mitigation benefits, this results in a superior cost benefit outcome compared to Option 1 (refer **Section 4**).

5.5 Option 3 – TFWS plus Occasional Dredging of Ebb Tide Channel, Dry Notch and Pilot Channel

5.5.1 Description

Prior to a description of Option 3, it is relevant to provide some discussion of the ebb tide channel which exists at the entrance to Lake Conjola during typical 'entrance open' conditions and the influence that the loss of this channel, due to storm washover events, may have on entrance management.

Typical entrance open conditions for Lake Conjola are also referred to as the Regime Entrance State (Patterson Britton, 1999), as noted earlier and depicted schematically in **Figure 5-10** and shown in a real world example for Lake Conjola in **Figure 5-11**. Under these conditions the following is evident:

- A primary ebb tide channel runs roughly parallel to the beach behind the entrance sand spit, towards Cunjurong Point.
- An initial flood tide flow occurs along a smaller northern channel, then as the tide rises the flood tide flows spread across the sand delta and consequently lobes of sand are formed representing sequences of sand deposits bought in by the flood tide.
- The entrance channel conveying the ebb tide and flood tide is hard against the northern shoreline near Cunjurong Point and is relatively narrow.

The ebb tide and flood tide flow paths under typical entrance open conditions can also be replicated in the RHDHV tidal hydrodynamic model. **Figure 5-17** and **Figure 5-18** show the peak ebb tide and flood tide flows respectively for a mean spring tidal range in the ocean. The magnitude of the tidal current (metres per second, m/s) is indicated by the colour coding. The direction of the current is indicated by the arrows. The following is evident:

- During the peak of the ebb tide, the majority of the flow is concentrated along the channel behind the entrance sand spit. It then whips around the tip of the sand spit before dissipating rapidly in the nearshore beach zone.
- During the peak of the flood tide, while a large proportion of the flow follows the channel behind the sand spit, the flow also spreads out widely across the sand delta.

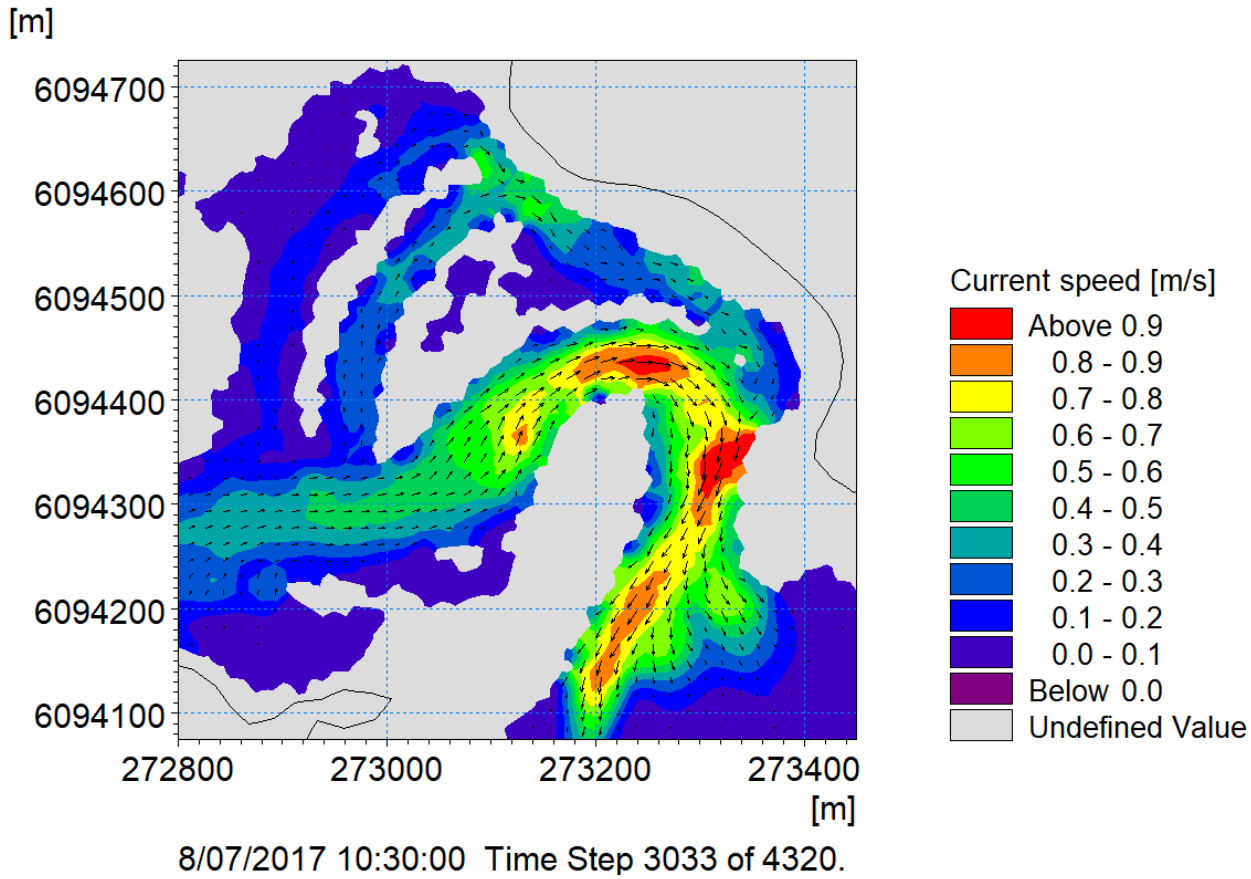


Figure 5-17: Current speed and direction during peak of the ebb tide for a mean spring tidal range in the ocean

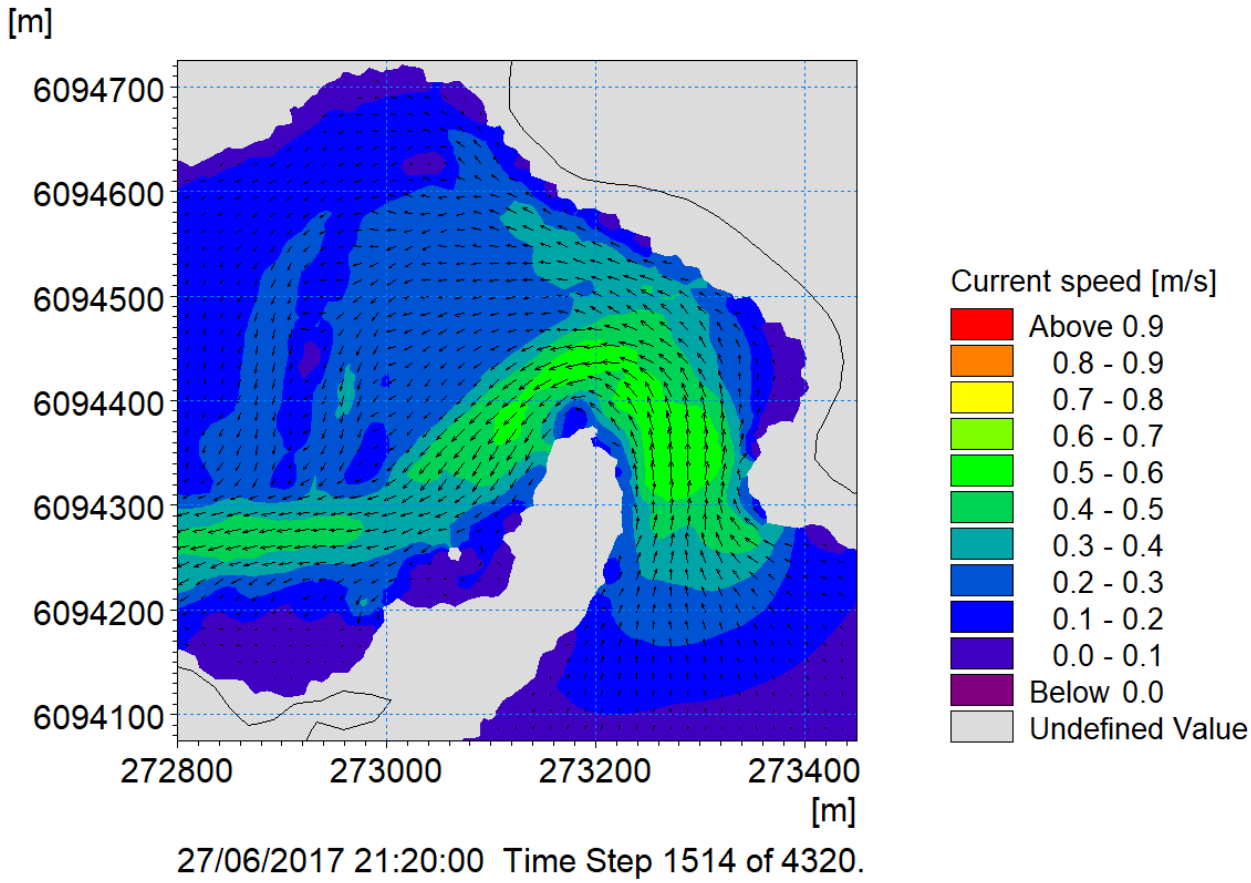


Figure 5-18: Current speed and direction during peak of the flood tide for a mean spring tidal range in the ocean

During major to severe ocean storms waves wash over the entrance spit, carrying sand, and lead to infilling in the entrance area to the Lake. Entrance closure is likely to ensue under these conditions. Such a situation is referred to as the Storm Washover Entrance State (Patterson Britton, 1999) as noted earlier and depicted schematically in **Figure 5-4** and shown in an aerial photograph in **Figure 5-5**.

Under the Storm Washover Entrance State, the following is evident:

- the washover sand deposits, or 'fans' of sand, cut off the fluvial/primary ebb tide channel; and,
- the primary ebb tide channel becomes 'perched' on the sand delta, leading to sudden and substantially diminished tidal flows, with further washover leading to closure.

Following closure of the entrance, sand berm levels on the seaward side of the spit would typically reach a level above 2m AHD due to wave and wind processes. Opening of the lake under such conditions would only occur in significant rainfall/flooding or by mechanical intervention on a larger scale.

Inclusion of Option 3 has been proposed to address the consequences of a severe storm washover event whereby the primary ebb tide channel becomes cut off/perched, the sand berm level increases in elevation, e.g., to 2m AHD or higher, and a pilot channel excavated to connect to deeper water upstream would otherwise be overly 'long', adversely affecting response time and flooding risk.

Option 3 is depicted graphically in **Figure 5-19** and would involve the following main features, in addition to the TFWS:

- Dry notch and pilot channel located in the northern spit zone (pilot channel within the footprint of the dry notch).
- Dry notch 50m wide and bed level 1.2m AHD.
- Short sand plug retained at the seaward end of the notch, crest level of the plug approximately 2m AHD.
- Pilot channel approximately 2m wide (one bucket-width) and bed level approximately 0m AHD.
- Dry notch and pilot channel do not exceed a maximum length of approximately 200m due to occasional dredging to sustain the natural ebb tide channel following a severe coastal storm washover event.
- Frequency of occasional dredging variable (sensitivity) – 5, 10 and 15 years.
- Frequency of mechanical openings reduced (in other words, the average interval between mechanical openings increased) due to more effective mechanical opening then if no dredging was carried out.
- Maintenance of dry notch by excavator (or dozer) and excavation of pilot channel by excavator.
- Dredging carried out by estuary size cutter suction dredger (hydraulic dredging with disposal via a pipeline).
- Disposal of sand from the dredging and the dry notch excavation on the spit to the south of the entrance to increase the height of the spit (preferred subject to bird nesting season), and/or beach nourishment to the north, and/or restoration of erosion areas on the lake foreshore.
- Disposal of sand from the pilot channel excavation on the spit to the north of the pilot channel (noting that excavation of the pilot channel would be conducted from the north side of the channel, hence access to the south of the channel for disposal would not be possible), and/or beach nourishment to the north, and/or restoration of erosion areas on the northern lake foreshore.

Figure 5-19: Diagram summarising the concept for Option 3 – air photo date 14 September 2018

Examples of hydraulic dredging of sand within a lake system and disposal to a sand spit and beach are shown in **Figure 5-20** and **Figure 5-21**.

Figure 5-20: Management of sand slurry discharge within a bunded beach area at The Entrance, Central Coast

Figure 5-21: Management of sand slurry discharge within a bunded beach area at Blacksmiths Beach

5.5.2 Performance of Option 3

The cost benefit analysis (CBA) found that Option 3 had a negative net present value (NPV), indicating that the present value of costs is greater than the present value of benefits (refer **Section 4**). The key driver for this result is the substantially higher cost of the option while providing no additional benefit relative to Option 2 in relation to the average annual damages incurred due to flooding, for the assumptions adopted in the CBA.

It is apparent that Option 3 should not be favoured over Option 2 or Option 1. However, there is considered to be a case for inclusion of the occasional dredging component of Option 3 within the CMP as a contingency measure (only) in conjunction with Option 2, for a number of reasons:

- Inclusion of occasional dredging provides the opportunity (subject to obtaining the necessary approvals, refer below) to re-establish the natural ebb tide channel (or ‘re-set' the entrance) in the event of a severe storm washover event that renders the flooding risk unacceptable.
- The CBA analysis assumes that Option 3 provides the same flood damages benefit as Option 2, although it is possible that Option 3 may reduce the annualised flood damages for the more frequent flooding events since the entrance may be open for a greater percentage of time on average for Option 3 as a result of the dredging. This situation could also enhance recreation and tourism benefits.
- Inclusion of occasional dredging could assist the local community well-being through knowledge that such a contingency measure is potentially available in the scenario when excavation of a pilot channel directly through the northern spit zone to link with a stranded ebb tide channel is not practicable for emergency response to flooding due to the significant time required for excavation.

Implementation of occasional dredging would be subject to obtaining the necessary approvals. Since obtaining approvals could take some time and the occurrence of a severe storm washover event could be sudden, documentation to assist with obtaining the necessary approvals should be compiled in advance where practical.

5.6 Option 4 – Permanent Entrance Channel

5.6.1 Description

Creation of a permanent entrance at Lake Conjola has been raised within the community historically and during the process of consultation conducted as part of preparation of the CMP. The primary motivation for a permanent entrance is the management of flooding. Management of water quality has also been raised as a reason for creation of a permanent entrance, however with the establishment of the Conjola Wastewater Treatment Plant (WWTP) and elimination of septic tank systems, water quality should no longer be considered a driver for mechanical intervention at the entrance in normal circumstances, as noted earlier in **Section 5.1.2**.

Patterson Britton (1999) considered the consequence of a permanent entrance formed by twin rock breakwaters. The width of the entrance channel was 50m and the entrance channel bed level was -2m AHD. The conceptual arrangement of the twin breakwaters adopted to form a permanent entrance is shown in **Figure 5-22**. The concept also included a wave spending beach inside the entrance to mitigate erosion of the northern foreshore of the lake and unacceptable wave climate at the Cunjurong boat ramp as a result of the greater ocean wave penetration. In addition, a rock training wall was proposed along the inside of the entrance sand spit south of the entrance together with dune stabilisation.

The creation of a permanent entrance by twin rock breakwaters was also considered in BMT WBM (2013a). In this study, an entrance channel width of 125m and entrance bed level of -4m AHD was adopted. Again the concept included a rock training wall along the inside of the entrance sand spit south of the entrance and dune stabilisation. The conceptual design of the permanent entrance is shown in **Figure 5-23**.

A relatively recent real-world example of the creation of a permanent entrance at a lake can be found at Lake Illawarra. This permanent entrance was created in 2007 in response to significant community pressure regarding poor water quality and estuary health at times when the entrance was closed during drought periods. The project included twin entrance breakwaters, internal training walls and dune stabilisation. The completed permanent entrance is shown in **Figure 5-24**.

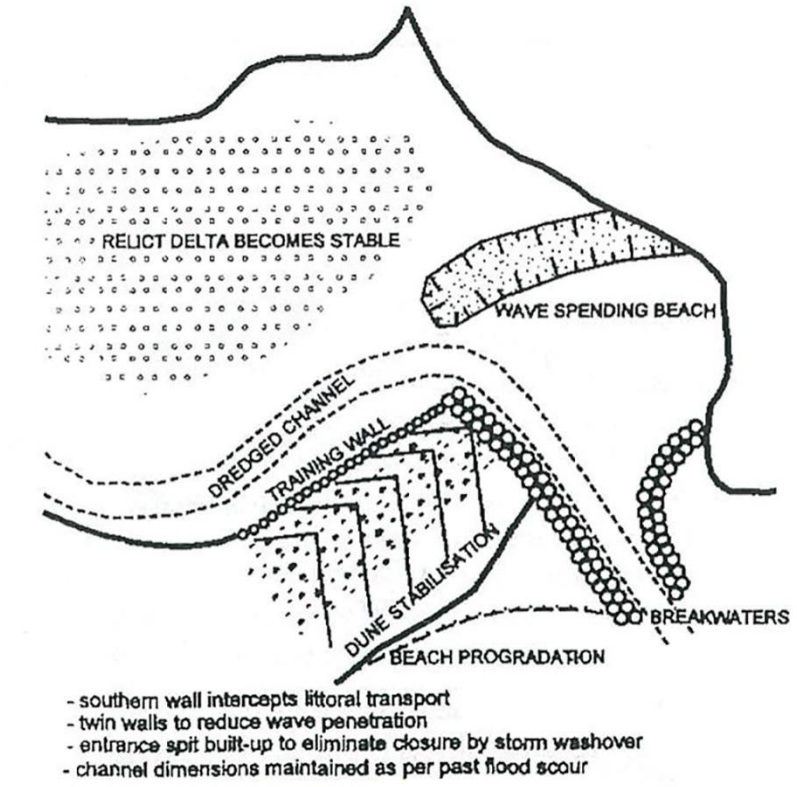


Figure 5-22: Conceptual arrangement for a permanent entrance adopted in Patterson Britton (1999)

Figure 5-23: Conceptual arrangement for a permanent entrance adopted in BMT WBM (2013a)

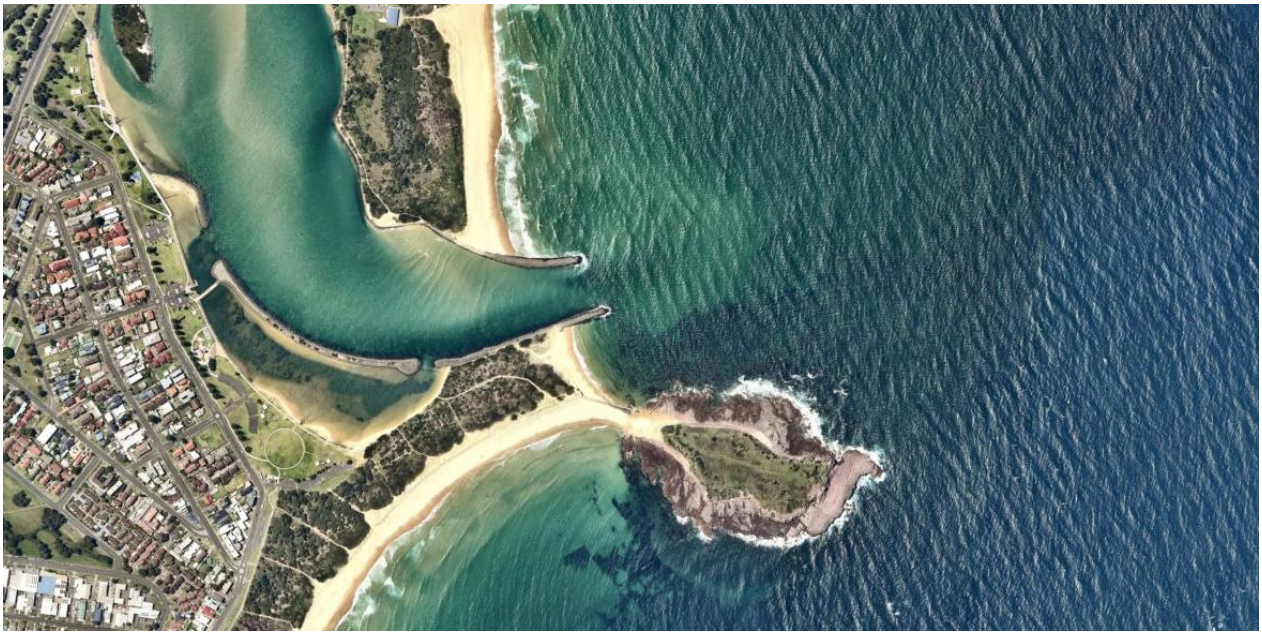


Figure 5-24: Lake Illawarra permanent entrance

5.6.2 Performance of Option 4

The performance of a permanent entrance in terms of flood mitigation was considered in BMT WBM (2013a) and is summarised below.

The performance of a permanent entrance in terms of its impact on tidal hydrodynamics was numerically modelled as part of the CMP process and is also summarised below. The outcome of the numerical modelling can also be used to infer other impacts, such as ecological impacts. In addition, a number of consequences of the creation of a permanent entrance at Lake Illawarra in relation to tidal hydrodynamics and ecology are outlined, as they provide insights to the potential impacts of the creation of a permanent entrance at Lake Conjola.

5.6.2.1 Flood Mitigation

BMT WBM (2013a) determined the potential change in flooding behaviour with construction of an open entrance, for both catchment flooding and oceanic flooding conditions, for three planning horizons, 2013 (existing), 2050, and 2100. The change in peak flood level near the entrance from a typical shoaled entrance to an open entrance as per the design concept shown in **Figure 5-23** is summarised in **Table 5-1**.

The results in **Table 5-1** indicated that only a modest reduction in peak flood levels would be achieved with a large open entrance (reduction up to 0.10m or 10cm). This was due to the existence of other controls within the lower lake which limit how much flow can be conveyed towards the entrance, in particular the ‘pinch points’ in the channels around the various islands. Accordingly, irrespective of the entrance dimensions, the hydraulic controls imposed by these narrower sections still influence peak flood levels.

On the other hand, larger reductions in peak flood levels due to oceanic flooding were determined. These reductions in peak flood levels were attributable to the reduction in wave setup at the entrance due to the

removal of the shoals and the degree of wave breaking. The reduction in wave setup offsets the increased flow of ocean water into the lake through the large open entrance.

The catchment flooding condition is the dominant flooding mechanism. The relatively small change in peak flood level for the catchment flooding condition means that a significant number of existing properties would still be subject to flooding (for example, based on **Figure 5-3**, for the 1% AEP event, the reduction in number of existing properties flooded would probably be less than 20 from a previous total of approximately 380).

It follows that creation of a large permanently open entrance does not eliminate the flood risk.

Table 5-1: Change in peak flood level (m) with an open entrance (after BMT WBM, 2013a)

Event Conditions	Planning Horizon		
	Existing (2013)	2050	2100
5% AEP Catchment Flooding Event	-0.09	-0.09	-0.08
5% AEP Ocean Flooding Event	-0.5	-0.5	-0.7
1% AEP Catchment Flooding Event	-0.10	-0.07	-0.06
1% AEP Ocean Flooding Event	-0.5	-0.6	-0.8

5.6.2.2 Tidal Hydrodynamics

The numerical modelling of the impact of a permanent entrance on tidal hydrodynamics was carried out utilising a six week period of actual ocean tides in June-July 2017. The dimensions adopted for the open entrance were based on the open entrance design concept outlined in Patterson Britton (1999), i.e., entrance channel width 50m and entrance channel bed level -2m AHD.

Figure 5-25 shows a plot of lake tidal range (high tide and low tide) over the six week period for an open entrance (shown shaded) compared to typical entrance conditions (shown hatched). It is evident from **Figure 5-25** that creation of a permanent entrance would have the following effects within the lake:

- the tidal range would increase;
- the average water level would be lower;
- the low tide level would be significantly lower, by around 0.2m; and,
- high tide level would be relatively unchanged.

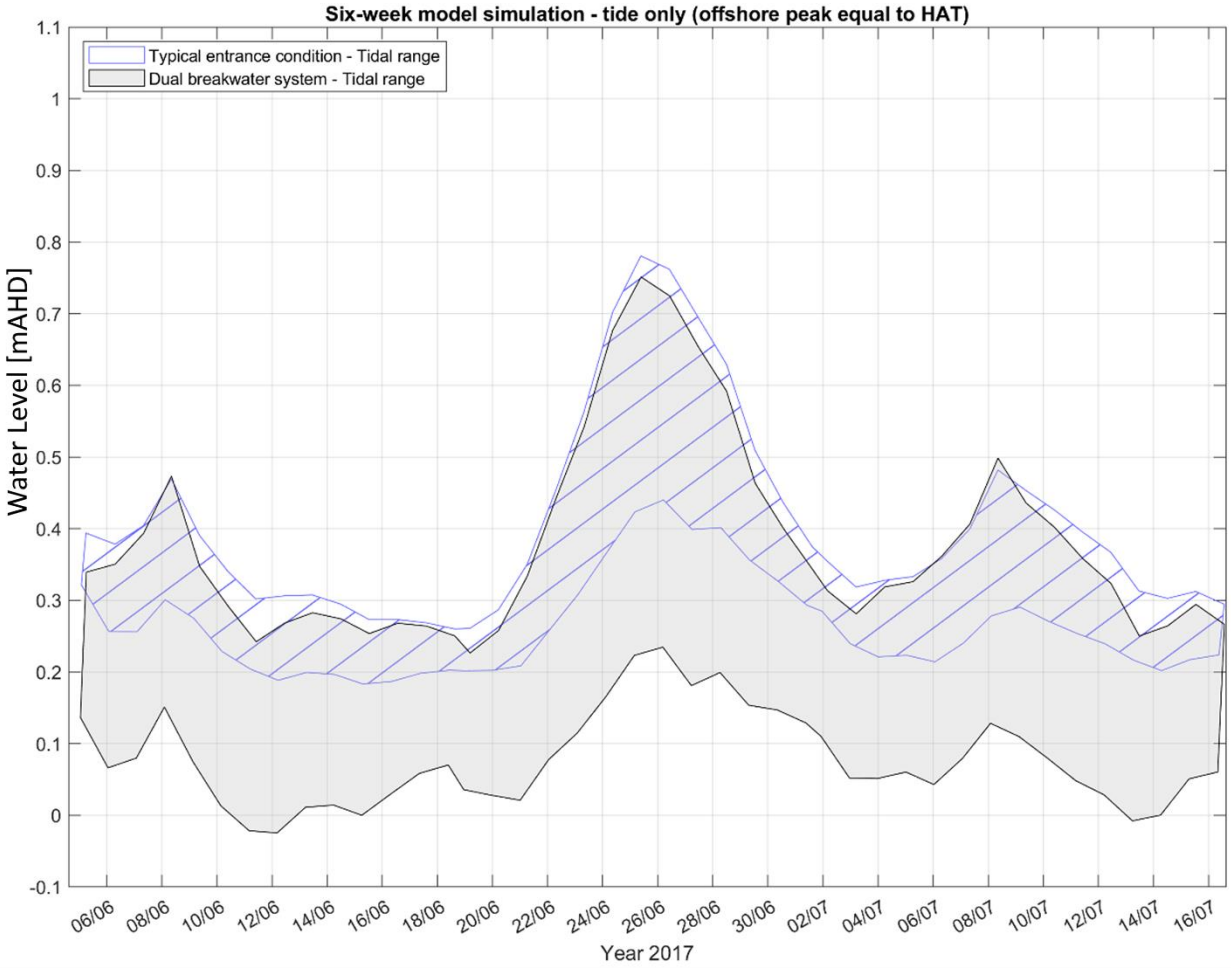


Figure 5-25: Permanent entrance channel – lake level time-series

The above outcomes are the result of a reduction in the so-called 'shallow water effects' on tidal propagation into the lake due to the existence of the permanent deeper channel.

The above changes would have a number of consequences on lake ecology and recreation. Examples include:

- loss of seagrass due to an increased exposure to air and solar radiation, particularly over the hotter summer months, in response to the lowering of low tide level;
- the lake becoming more like the ocean in the lower reaches due to an increase in salinity, impacting the nature of the estuarine ecosystem;
- the lake becoming shallower at low tide leading to enhanced suspension of bed sediments, and increased turbidity, impacting light availability for aquatic vegetation; and,
- the lake becoming shallower at low tide impacting on navigation and recreation generally.

Lake Illawarra represents a real-world example of the changes to tidal hydrodynamics and ecology that can occur as a consequence of the creation of a permanent entrance. Some of these changes are listed below, further detail is outlined in Wiecek et al (2016):

- hydrodynamic changes included an increase in tidal range, lowering of average water level and low tide level, and an increase in tidal prism (the volume of water flowing into and out of the lake on the flood and ebb tide) with consequent increases in tidal velocities. The changes in tidal prism and tidal velocities in turn caused changes to the patterns of shoaling and scour, resulting in significant deepening of channels, accretion on the flood and ebb tide deltas, and foreshore erosion leading to damage to assets along parts of the entrance channel; and,
- from an ecological perspective, changes have included an increase in mangrove colonisation, a loss of saltmarsh, and a loss of seagrass.

5.6.3 Economic considerations

BMT WBM (2013a) estimated the cost of the permanent entrance works described in their report to be in the range $20 million to $40 million (2013 dollars).

The concept design for a permanent entrance adopted in the numerical modelling was not as extensive as that presented in BMT WBM (2013a), even so the estimated capital cost would be expected to be in the range $20 million to $30 million or higher (2024 dollars).

5.6.4 Conclusion

A permanent entrance involves a very high capital cost and achieves only a relatively small change (reduction) in peak flood level for catchment flooding. Similar or greater reductions in peak flood level are estimated to be delivered at substantially lower cost by other options which include a Total Flood Warning System (TFWS), combined with a pilot channel only, pilot channel plus dry notch, and pilot channel plus dry notch plus occasional dredging of the ebb tide channel. As such, a permanent entrance cannot be justified from a flood mitigation perspective. This was also the conclusion reached in BMT WBM (2013a).

In addition, a permanent entrance would have a number of adverse hydrodynamic and ecological impacts, as referred to above. Furthermore, the permanent entrance would detract significantly from the natural character of the Lake Conjola entrance.

For the above reasons, a permanent entrance option has not been pursued further and was not included in the Cost Benefit Analysis of entrance management options.

5.7 Summary and Recommendations for Entrance Management

Of the four options considered for management of the entrance to Lake Conjola, Option 2 – TFWS plus Dry Notch and Pilot Channel is recommended as the core option for inclusion in the CMP. In addition, it is recommended that the occasional dredging component of Option 3 be included within the CMP as a contingency measure (only) in conjunction with Option 2, with implementation of dredging subject to obtaining the necessary approvals. A draft Entrance Management Policy will be prepared based on the adoption of Option 2.

Documentation to assist with obtaining the necessary approvals should be compiled in advance, where practical, as the issue which the occasional dredging seeks to address, an unacceptable flooding risk due to a severe storm washover event, can occur suddenly.

Option 2 provides a superior cost benefit outcome compared to Option 1 – TWFS plus Pilot Channel Only.

Option 4 – Permanent Entrance Channel is not supported due to its very high cost, restricted benefits, and a range of adverse impacts.

6 Identified Management Actions

6.1 LGA-Wide Management Actions

6.1.1 LG1 Establish a CMP Governance Framework

This will include:

- Establish a CMP working group, to oversee the implementation of the CMP and ensure that it meets its objectives
- Members should include staff from Council, relevant state government agencies, and other groups
- Clearly define the purpose, objectives and functions of the working group
- Define the roles and responsibilities of the working group members
- Execute the function of the working group

6.1.2 LG2 Establish one new Full Time Equivalent (FTE) Coast & Estuary Officer role within Council

Establish one new Full Time Equivalent (FTE) Coast & Estuary Officer role within Council - in order to develop the implementation strategy of Council's Lake Conjola CMP, (including long-term funding options) and build Council's capacity to respond.

6.1.3 LG3 Enact the CMPs Monitoring, Evaluation and Reporting (MER) Program to track progress and report on outcomes

This will include:

- Ongoing monitoring of CMP Actions
- Annual review of actions to ensure they are appropriate and current, with completed actions documented
- Ongoing reporting of progress
- Documentation of the effectiveness of the proposed strategies and actions will be reported as part of Council's Annual Report (which is part of the IP&R framework), including progress towards or full achievement of the performance targets included for each action.

6.1.4 LG4 Review Councils coastal management policies every 10 years

Review Council's coastal management planning policies for the 10-year CMP implementation lifecycle. This should include consideration of the latest environmental data, observed coastal hazard impacts, and state government policies. The review should consider:

- The Shoalhaven City Council Sea Level Rise Framework
- The Shoalhaven City Council Coastal Hazard Mapping
- Lake Conjola Entrance Management Policy
- Council's various planning instruments

6.1.5 LG5 Continue to collaborate with government agencies and research institutions

Continue to collaborate with State and Federal government agencies, universities and others on projects and research that focuses on:

- Climate change impacts on coastal and estuarine processes and landforms, including new data on sea level rise, storm behaviour, sediment transport processes, entrance management and stability and coastal and estuarine monitoring
- Impact of sea level rise on estuarine macrophytes and supratidal forests
- Coastal lake entrance behaviour (sediment budget, morphology, opening and closing regimes) with sea level rise and other aspects of climate change and climate variability
- Impact of private moorings and maritime infrastructure on seagrasses, and impacts of unattended vessels on bank stability
- Ecological services and functions of estuarine species and most effective vegetation structure to enhance foreshore resilience
- Boating safety and navigation
- Management of foreshore erosion
- The protection of threatened and migratory shorebirds (i.e. through the South Coast Shorebird Recovery Project)

6.1.6 LG6 Develop and implement a program of dune vegetation management and rehabilitation

Strategically manage and rehabilitate coastal dune systems through weeding, revegetation, erosion control, asset maintenance, feral animal control and fauna surveys – at the entrance spit and entrance channel foreshore immediately west of the spit (Action LG6.01), and on the northern side of the entrance channel at Cunjurong Beach (Action LG6.02) (refer **Figure 6-1**).

Works should support the ecological restoration of identified Threatened Ecological Communities (TECs) based on Council's 2023 report *Assessment of Endangered Ecological Communities In Coastal Hazard Areas: Shoalhaven LGA Tidal Inundation and Coastal Erosion Study Sites* (Ecoplanning, 2023). Dune vegetation management will also include collaborating with, and supporting, Council endorsed Bushcare groups through providing educational opportunities, resources, mentoring and technical support. Collaboration with NPWS and the NSW South Coast Shorebird Recovery Program would also be required.

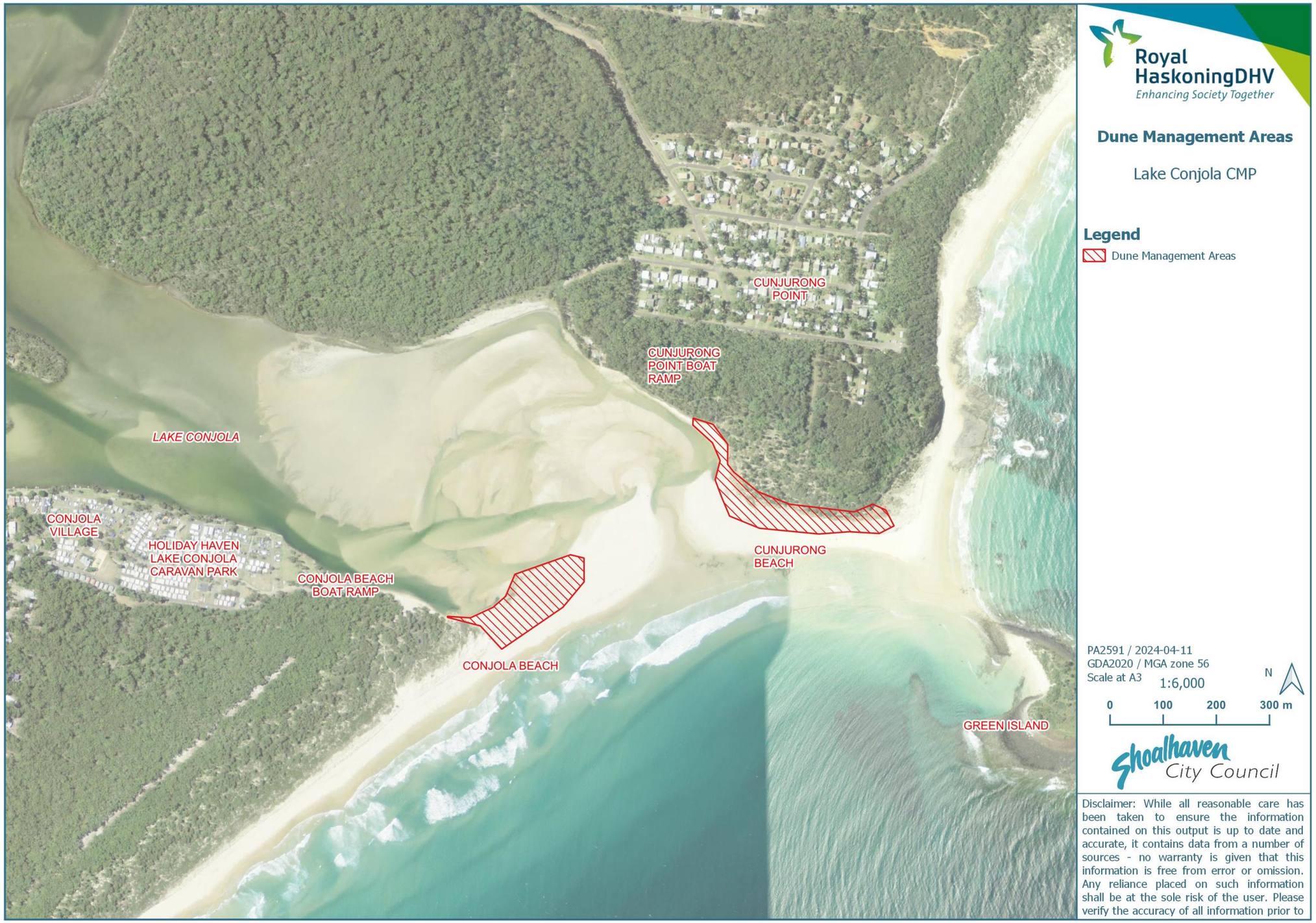


Figure 6-1: Dune Management Areas

6.1.7 LG7 Develop and execute a communications plan for Stage 5 of the CMP

Present information on Council's website and in community engagement activities that shows:

- The purpose of the CMP.
- The CMP background, and an overview of the NSW Coastal Management Framework.
- Key CMP information, including reports available for public consumption.
- The status of CMP Actions, with details of the actions and recent updates/progress.
- Information pertaining to upcoming community consultation events, and avenues for engagement.
- Links to relevant materials such as the NSW Coastal Management Framework, and the Marine Estate Management Strategy.
- How coastal zone systems function and how integrated management responses benefits Council and local communities.

6.1.8 LG8 Continue Council's program of mapping threatened ecological communities (TECs) across coastal reserves

Continue to carry out existing survey program to ground-truth and map the distribution and condition of TECs in coastal hazard risk areas using the Biodiversity Conservation Act, Biodiversity Assessment Methodology. This mapping will be used to update Council's LEP Terrestrial Biodiversity Map, inform the Biodiversity Values Map, and provide further education for the public on the Council website.

6.1.9 LG9 Develop and maintain a program of community engagement with coastal communities about coastal hazard risk

Engage with foreshore reserve property owners, residents, beach goers, and community youth around issues such as:

- The importance and value of dune vegetation (e.g. trapping wind-blown sand and maintaining dune resilience, ecological functions and buffering against coastal hazards)
- Recognising Aboriginal cultural heritage on the coast and within estuaries
- Managing the interface between coastal bushland, estuary foreshore and private property, including edge impacts, encroachments, garden refuse dumping, vegetation retention, and weed management
- Importance of foreshore vegetation in providing shade and wind protection, stabilising foreshores, reducing erosion, filtering runoff, improving water quality and providing habitat
- Illegal pruning, poisoning and removal of trees, private vehicle access and illegal structures/items which restrict public use of the reserve. Enforce regulations outlined in Councils Vegetation Vandalism Prevention Policy POL22/24 in high conservation areas as a priority.
- ICOLLs, their entrance dynamics, ecology and water quality
- Principles and drivers of ICOLL entrance management, understanding of Council's policy and operational procedures, and to discourage illegal openings (refer Action EM2)

Education programs should be enacted every 5 years.

6.1.10 LG10 Review and update all Council asset management plans (AMPs), relevant to the Lake Conjola study area

Review and update all asset management plans (AMPs), relevant to the Lake Conjola coastal zone. AMPs by asset type will be updated by relevant asset custodian.

Include an asset management approach to provide for replacement, relocation or retrofitting of public assets that are currently in coastal risk areas – including boat ramps, wharves, jetties, water and wastewater infrastructure, stormwater drainage infrastructure, foreshore protection infrastructure, roads and access tracks. The update of AMPs should be prepared considering current and future coastal hazard impacts, including the impacts of coastal and tidal inundation, and should outline plans and mitigation strategies to reduce the risk from such hazards. The Stage 2 Risk Assessment should be used to inform the update of AMPs to account for coastal hazard impacts.

AMPs are to be aligned with the emergency action sub-plan.

6.1.11 LG11 Develop and implement a program for regular and ongoing monitoring of Council-managed coastal assets and infrastructure

This action involves the development and implementation of a monitoring program designed to assess and track the condition of various assets and infrastructure, including:

- Foreshore protection structures (revetments, seawalls)
- Recreational assets including viewing platforms & coastal and foreshore access tracks
- Maritime and boating infrastructure (i.e. jetties, boat ramps) and related ancillary infrastructure (i.e. fish cleaning tables)
- Stormwater infrastructure
- Stormwater outlets
- Sewer and water infrastructure

The program should be integrated into Councils broader asset management program.

6.1.12 LG12 Undertake an estuary-wide Aboriginal Cultural Heritage Survey, and development of local protection/management plans

This action will involve engaging with the relevant Local Aboriginal Land Councils, Traditional Owner groups and an archaeologist to undertake an updated cultural heritage survey of the coastal zone within the Lake Conjola CMP Study Area – and in doing so:

- fill existing information gaps with the LGA-wide Aboriginal Cultural Heritage Mapping; and,
- update the Aboriginal Heritage Information Management System (AHIMS).

It is anticipated that there would be three main tasks for this action:

1. Consultation with the relevant Local Aboriginal Land Councils and Traditional Owners and knowledge holders.
2. An Aboriginal cultural heritage assessment, which should include survey field work, and recording of cultural heritage sites (such as middens sites) and detailed documentation of findings.

3. The development and prioritisation of local, site specific management plans for protection and preservation of these sites.

6.1.13 LG13 Engage with relevant Local Aboriginal Land Councils and local Traditional Owner Groups to develop a cultural educational and awareness program

This action will involve engaging with relevant Local Aboriginal Land Councils and local Traditional Owner groups to develop and roll out a cultural educational and awareness program – related to the Aboriginal Cultural Heritage (ACH) of the coastal zone. Design of the program should be led by either relevant Local Aboriginal Land Councils or local Traditional Owner groups.

The program could involve educational methods such as:

- School programs including planting days, stewardship sites and hands on activities
- Signage at local sites such as beaches, estuaries, and headlands (including the use of QR codes that includes elders speaking about the history of the area)
- Brochures and information provided to tourists at caravan parks and information centres
- Cultural tours to provide greater awareness of ACH values to both the local community and to the large population of seasonal visitors

6.1.14 LG14 Provide opportunities and help build capacity to local Aboriginal Ranger programs, to enhance their role in management of Sea Country

This action will involve working with relevant Local Aboriginal Land Councils and local Traditional Owner groups to bolster existing ranger programs and facilitate a greater role for these programs in coastal management across the Shoalhaven LGA.

- This would involve working with and supporting the ranger team coalition to help enhance/boost their capacity and awareness of coastal management.
- Where possible, utilise Aboriginal ranger teams (in conjunction with other suitable land rehabilitation contractors) to undertake on ground works associated with dune restoration and monitoring programs.
- Work collaboratively to help develop the next generation of junior rangers to be part of future coastal management across the Shoalhaven LGA.

This action is consistent with Initiative #4 of the NSW Marine Estate Management Strategy – which aims to: “Increase Aboriginal participation in Sea Country management, planning and monitoring through employment and training of Aboriginal people at a regional and local level”.

6.2 Manage Foreshore Areas and Bank Erosion

6.2.1 FB1 Investigate, remediate and monitor impacted or vulnerable bank areas

This action will involve detailed design of foreshore management activities followed by remediation of bank areas within Lake Conjola that have been impacted or are vulnerable to erosion. The main tasks for this action will include:

- Preparation of detailed site assessments and designs for foreshore management activities including treatment of eroding and unprotected foreshore areas and working with relevant stakeholders to enable establishment or restoration of riparian vegetation where identified as lacking as environmental protection works.
- Preparation of detailed designs for areas of inconsistent foreshore protection works, which include consideration of opportunities for installation of environmentally friendly seawalls (DECC, 2009) and a uniform approach to foreshore management activities.
- Establishment of an ongoing monitoring program to inform remediation actions. This monitoring would be included in Councils asset management program as per Action LG11.
- Progressive implementation of riparian vegetation restoration (as per Action EV1) and/or foreshore protection remediation works. Integrate riparian vegetation (including estuarine plants like mangroves and reeds) management with stabilisation works to reduce erosion, improve bank stability, and enhance biodiversity. Consider site-specific revegetation and maintenance plans, particularly where existing riparian vegetation is in reasonable condition. It is noted that several foreshore protection actions completely involve riparian vegetation restoration (i.e. Actions FB1.01, FB1.11, FB1.12, FB1.13 and FB1.14, refer **Table 6-1**), and would be undertaken as part of Action EV1.
- Community engagement and consultation - Engage with the community, especially in high use areas for boating, water sports or other recreational activities, to inform and involve them in the stabilisation and restoration process. Ensure that any restrictions or changes to community use of areas are communicated well in advance and are undertaken with community understanding and support.
- Collaboration and coordination - Foster collaboration with Local Land Services and other relevant stakeholders for integrated and effective bank stabilisation and riparian restoration along the Lake Conjola foreshore. Coordinate with adjacent private landowners and agency landowners to extend the benefits of stabilisation and restoration works beyond Council owned or managed lands where possible and appropriate.

Foreshore areas of publicly-owned land that have been identified as priority areas for remediation are shown on **Figure 6-2** and **Figure 6-3**, and are summarised in **Table 6-1**. This includes the potential construction of upgraded foreshore protection along the lake embankment between Conjola Beach Boat Ramp and the foreshore reserve to the west of the Post Office at Conjola Village (refer **Figure 6-3**). This length of foreshore includes the parcel of Crown land covering the Conjola Beach Boat Ramp and the Holiday Haven Lake Conjola Caravan Park, and the parcel of Council-owned foreshore reserve adjacent to Carroll Avenue.

The capital costs for construction of foreshore management activities at Conjola Village have been estimated for each section of foreshore based on liaison with local Contractors and pricing from previous projects, and are summarised in **Table 6-2**. An allowance of 10% of the construction cost has been applied to account for the costs of design, approvals and project management. An allowance of 1% of the construction cost has been applied for annual maintenance works.

It is noted that there are other areas of privately owned foreshore land that would benefit from restoration of a riparian vegetation buffer, including the eastern shoreline of the lower reach of Conjola Creek and both sides of Conjola Creek upstream of Fishermans Paradise. The protection and restoration of riparian vegetation (i.e. environmental protection works) in these areas would require collaboration with landowners in conjunction with Action FB4.

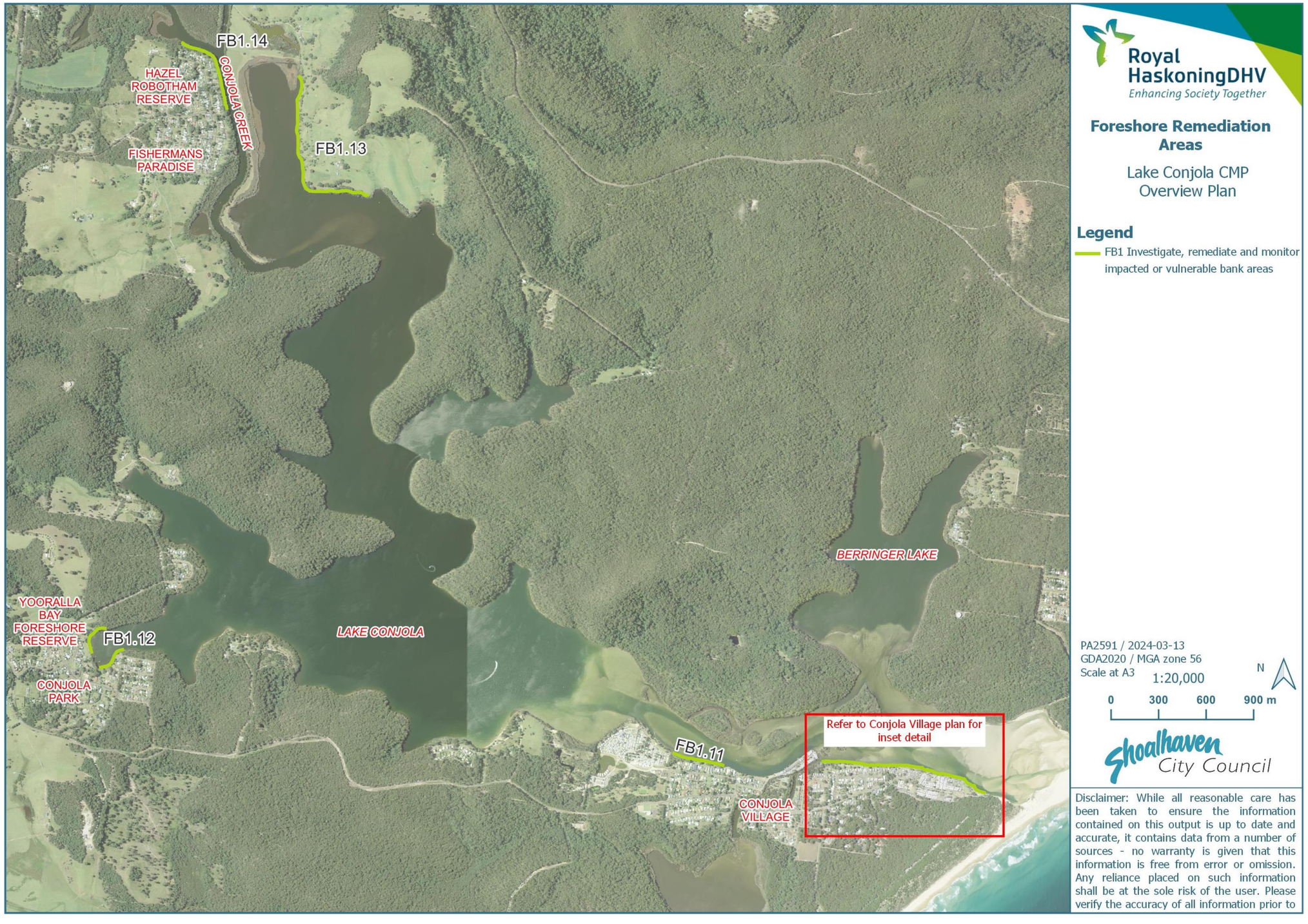


Figure 6-2: Foreshore remediation areas – Overview Plan

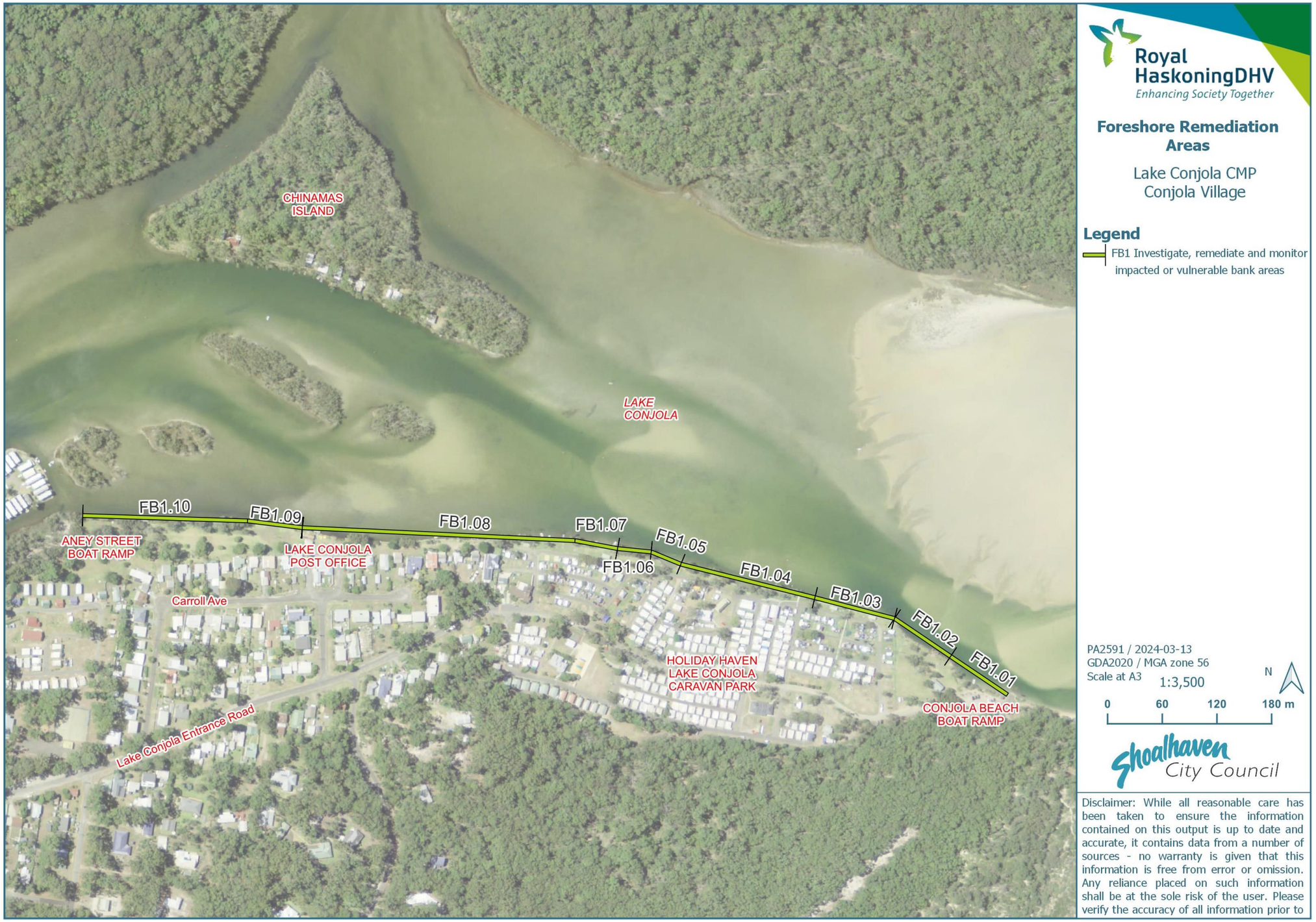


Figure 6-3: Foreshore remediation areas – Conjola Village

Table 6-1: Priority public foreshore areas for remediation

Sub-action Reference	Location	Description of treatment	Foreshore Length (m)
FB1.01	Conjola Village - foreshore adjacent to boat ramp carpark	Restoration of riparian vegetation.	81
FB1.02	Conjola Village - foreshore west of boat ramp carpark	Repair of existing foreshore protection in accordance with the principles of the Environmentally Friendly Seawall Guidelines (DECC, 2009).	77
FB1.03	Conjola Village - eastern portion of Caravan Park foreshore	Upgrade existing rock protection and construct new rock protection where it does not exist in accordance with the principles of the Environmentally Friendly Seawall Guidelines (DECC, 2009). Upgrading to include raising crest level and improving filtration design. Retain existing localised swimming areas. As an alternative to new rock protection, consider integrating riparian vegetation (including estuarine plants like mangroves and reeds) management with stabilisation works to reduce erosion, improve bank stability, and enhance biodiversity.	91
FB1.04	Conjola Village - central portion of Caravan Park foreshore	Upgrade existing rock protection and construct new rock protection where it does not exist in accordance with the principles of the Environmentally Friendly Seawall Guidelines (DECC, 2009). Upgrading to include raising crest level and improving filtration design. Remove existing concrete works. As an alternative to new rock protection, consider integrating riparian vegetation (including estuarine plants like mangroves and reeds) management with stabilisation works to reduce erosion, improve bank stability, and enhance biodiversity.	157
FB1.05	Conjola Village - Caravan Park central swimming area embayment	Upgrade existing rock protection and construct new rock protection where it does not exist in accordance with the principles of the Environmentally Friendly Seawall Guidelines (DECC, 2009). Upgrading to include raising crest level and improving filtration design. Retain existing localised swimming areas. As an alternative to new rock protection, consider integrating riparian vegetation (including estuarine plants like mangroves and reeds) management with stabilisation works to reduce erosion, improve bank stability, and enhance biodiversity.	39
FB1.06	Conjola Village - section west of central swimming area embayment	Upgrade existing rock protection and construct new rock protection where it does not exist in accordance with the principles of the Environmentally Friendly Seawall Guidelines (DECC, 2009). Upgrading to include raising crest level and improving filtration design. Remove existing concrete works. As an	38

Sub-action Reference	Location	Description of treatment	Foreshore Length (m)
		alternative to new rock protection, consider integrating riparian vegetation (including estuarine plants like mangroves and reeds) management with stabilisation works to reduce erosion, improve bank stability, and enhance biodiversity.	
FB1.07	Conjola Village - western portion of Caravan Park foreshore	Upgrade existing rock protection and construct new rock protection where it does not exist in accordance with the principles of the Environmentally Friendly Seawall Guidelines (DECC, 2009). Upgrading to include raising crest level and improving filtration design. Retain existing localised swimming areas. As an alternative to new rock protection, consider integrating riparian vegetation (including estuarine plants like mangroves and reeds) management with stabilisation works to reduce erosion, improve bank stability, and enhance biodiversity.	48
FB1.08	Conjola Village - western portion of Caravan Park foreshore to Post Office	Upgrade existing rock protection and construct new rock protection where it does not exist in accordance with the principles of the Environmentally Friendly Seawall Guidelines (DECC, 2009). Upgrading to include raising crest level and improving filtration design. As an alternative to new rock protection, consider integrating riparian vegetation (including estuarine plants like mangroves and reeds) management with stabilisation works to reduce erosion, improve bank stability, and enhance biodiversity.	304
FB1.09	Conjola Village - Post Office to western foreshore reserve	Construct environmentally friendly seawall treatment within the open reserve area (saltmarsh berm, riparian vegetation) in accordance with the principles of the Environmentally Friendly Seawall Guidelines (DECC, 2009). Retain access to foreshore in places for fishing.	61
FB1.10	Conjola Village - western foreshore reserve to Aney St Boat Ramp	Restoration of riparian vegetation.	182
FB1.11	Conjola Village - Edwin Avenue Reserve	Restoration of riparian vegetation.	323
FB1.12	Conjola Park - Yooralla Bay foreshore reserve	Restoration of riparian vegetation.	408
FB1.13	Fishermans Paradise - road reserve along foreshore perimeter of farmland at 142 Murrays Road	Restoration of riparian vegetation.	1134

Sub-action Reference	Location	Description of treatment	Foreshore Length (m)
FB1.14	Fishermans Paradise - Hazel Robotham Reserve foreshore	Restoration of riparian vegetation.	551

Table 6-2: Foreshore Protection at Conjola Village – Summary of Estimated Implementation Costs

Reference	Description of treatment	Length	Construction Cost			Design/ Approvals/PM	Maintenance Cost
		(m)	Fixed Costs ($)*	Rate ($/m)	TOTAL ($)	(10%)	(1% p.a.)
FB1.02	Repair of existing foreshore protection in accordance with the principles of the Environmentally Friendly Seawall Guidelines (DECC, 2009).	76.7	$35,000	$1,200	$127,040	$12,704	$1,270
FB1.03	Upgrade existing rock protection and construct new rock protection where it does not exist in accordance with the principles of the Environmentally Friendly Seawall Guidelines (DECC, 2009). Upgrading to include raising crest level and improving filtration design. Retain existing localised swimming areas.	90.5	$35,000	$1,200	$143,600	$14,360	$1,436

Reference	Description of treatment	Length	Construction Cost			Design/ Approvals/PM	Maintenance Cost
FB1.04	Upgrade existing rock protection and construct new rock protection where it does not exist in accordance with the principles of the Environmentally Friendly Seawall Guidelines (DECC, 2009). Upgrading to include raising crest level and improving filtration design. Remove existing concrete works.	156.8	$35,000	$1,500	$270,200	$27,020	$2,702
FB1.05	Upgrade existing rock protection and construct new rock protection where it does not exist in accordance with the principles of the Environmentally Friendly Seawall Guidelines (DECC, 2009). Upgrading to include raising crest level and improving filtration design. Retain existing localised swimming areas.	38.9	$35,000	$1,200	$81,680	$8,168	$817

Reference	Description of treatment	Length	Construction Cost			Design/ Approvals/PM	Maintenance Cost
FB1.06	Upgrade existing rock protection and construct new rock protection where it does not exist in accordance with the principles of the Environmentally Friendly Seawall Guidelines (DECC, 2009). Upgrading to include raising crest level and improving filtration design. Remove existing concrete works.	37.1	$35,000	$1,500	$90,650	$9,065	$907
FB1.07	Upgrade existing rock protection and construct new rock protection where it does not exist in accordance with the principles of the Environmentally Friendly Seawall Guidelines (DECC, 2009). Upgrading to include raising crest level and improving filtration design. Retain existing localised swimming areas.	47.7	$35,000	$1,200	$57,240	$5,724	$572

Reference	Description of treatment	Length	Construction Cost			Design/ Approvals/PM	Maintenance Cost
FB1.08	Upgrade existing rock protection and construct new rock protection where it does not exist in accordance with the principles of the Environmentally Friendly Seawall Guidelines (DECC, 2009). Upgrading to include raising crest level and improving filtration design.	303.5	$35,000	$1,200	$399,200	$39,920	$3,992
FB1.09	Construct environmentally friendly seawall treatment within the open reserve area (saltmarsh berm, riparian vegetation) in accordance with the principles of the Environmentally Friendly Seawall Guidelines (DECC, 2009). Retain access to foreshore in places for fishing.	60.7	$100,000	$3,400	$306,380	$30,638	$3,064
TOTALS		**811.9**			**$1,475,990**	**$147,599**	**$14,760**

* Fixed costs include mobilisation/demobilisation of equipment, site establishment/disestablishment, preliminaries, environmental controls etc.

6.2.2 FB2 Management of Stormwater Runoff

This action will involve detailed design followed by implementation of management works for identified foreshore areas where uncontrolled stormwater runoff or discharge is impacting on public amenity and safety, foreshore stability, or lake water quality. In some areas this could be undertaken in conjunction with implementation of riparian vegetation restoration and/or seawall remediation works as per Action FB1. The main tasks for this action would include:

- Preparing detailed designs for the specific areas identified (refer **Figure 6-4** and **Figure 6-5**) where surface water runoff pathways and stormwater discharge outlets could be modified to better filter runoff and improve lake water quality.
- Considering opportunities for:
    - diversion of hazardous stormwater runoff and redirection of surcharge flows
    - stabilisation of existing stormwater outlets and improvement of energy dissipation
    - installation of warning signage near stormwater outlets to identify hazards
    - filtering of runoff with provision of a riparian vegetation buffer along the foreshore edge (2 locations, refer **Figure 6-4** and **Figure 6-5**)
    - at source interception of runoff with raingardens or similar
    - replacement of hard drainage channels with grassed and vegetated swales (5 locations, refer **Figure 6-4** and **Figure 6-5**)
    - installation of stormwater quality improvement devices (SQIDs) such as gross pollutant traps
- Establishment of an ongoing monitoring program to inform mitigation actions. This monitoring would be included in Councils asset management program as per Action LG11.
- Progressive implementation of mitigation works.

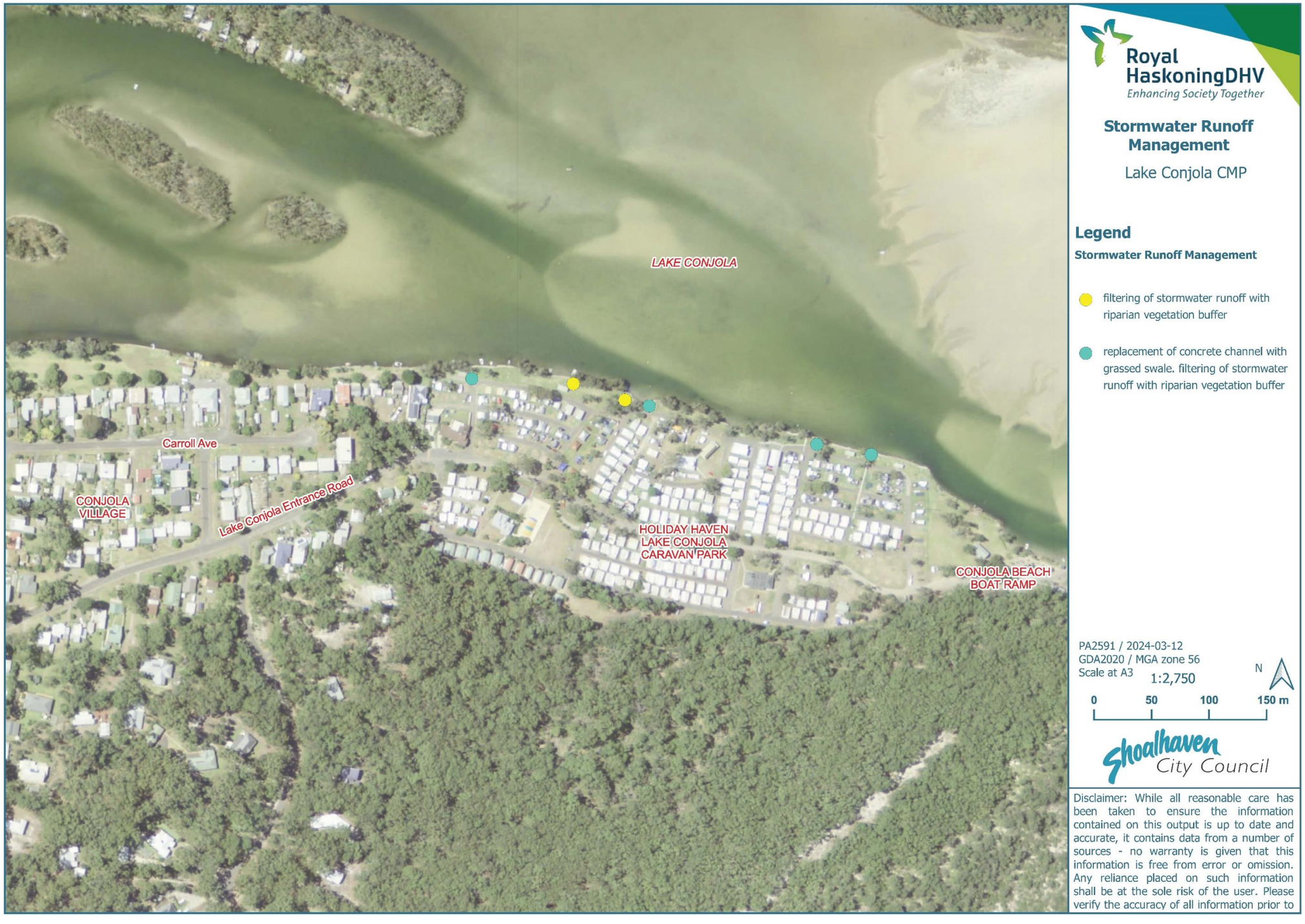


Figure 6-4: Stormwater runoff management – Conjola Village

Figure 6-5: Stormwater runoff management – Conjola Park

6.2.3 FB3 Management of Watercraft Storage

This action will involve the implementation of a removal program for ad hoc stored watercraft (e.g. dinghies, canoes, kayaks etc.) that are abandoned, derelict or illegally stored in public foreshore areas accordance with Council's Foreshore Reserves Policy (POL19/76) (refer **Figure 6-6**). This will be undertaken in conjunction with the construction of formalised watercraft storage systems (e.g. dinghy/kayak racks, tie-up points, permitting system) in the identified foreshore areas around the Lake (refer **Figure 6-6**). Ongoing monitoring and policing would be required to prevent re-occurrence of ad hoc watercraft storage.

6.2.4 FB4 Management of uncontrolled stock access to foreshore areas to enhance and protect riparian vegetation

This action will involve working collaboratively with farmers/foreshore landowners in conjunction with NSW Local Land Services (LLS) to support change in farming practices to mitigate foreshore erosion (e.g. stock access to lake foreshore). This would be done in conjunction with other site-specific measures in identified deteriorated foreshore areas including:

- Engage with property owners to provide education on the importance of managing livestock access to foreshores and the broader environmental benefits. Offer guidelines, support, and potential incentives for compliance to promote proactive landholder involvement.
- Foster a close collaboration with Local Land Services (LLS) as the lead agency to support property owner engagement, education, and the implementation of livestock management measures. Discuss the viability of proposed actions with LLS to ensure alignment with broader environmental and community objectives.
- Reinstatement of a riparian vegetation buffer along foreshore areas (as per Action FB1, refer to **Figure 6-2**). This initiative will require voluntary agreement and cooperation from landholders along with support from LLS.
- Installation of fencing to prevent foreshore stock access (foreshores of upper Lake Conjola and Conjola Creek near Fishermans Paradise, refer **Figure 6-7**).
- Establish a framework to monitor and evaluate the effectiveness of livestock management, fencing, and revegetation initiatives, ensuring ongoing alignment with environmental objectives and continuous improvement.

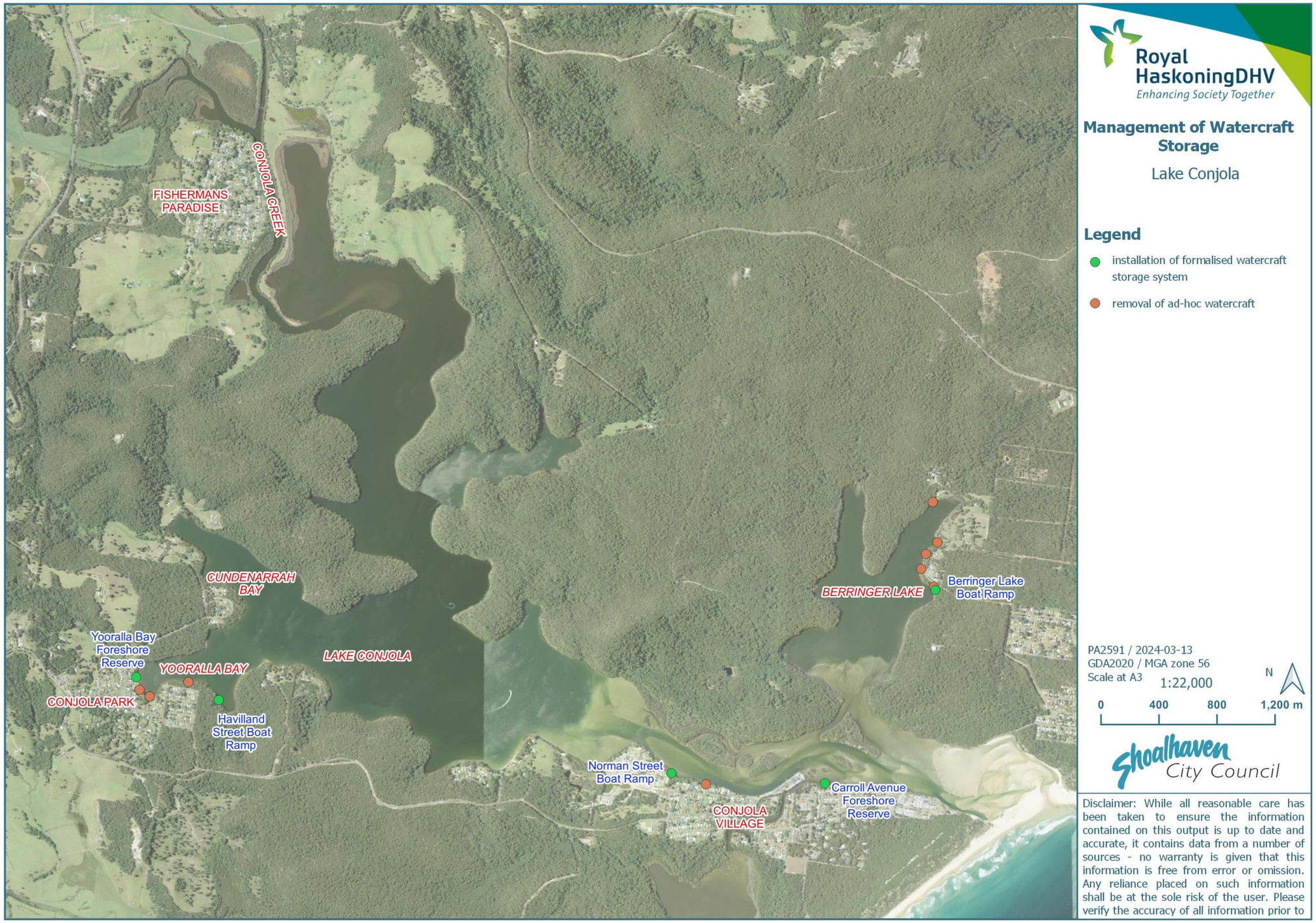


Figure 6-6: Management of watercraft storage

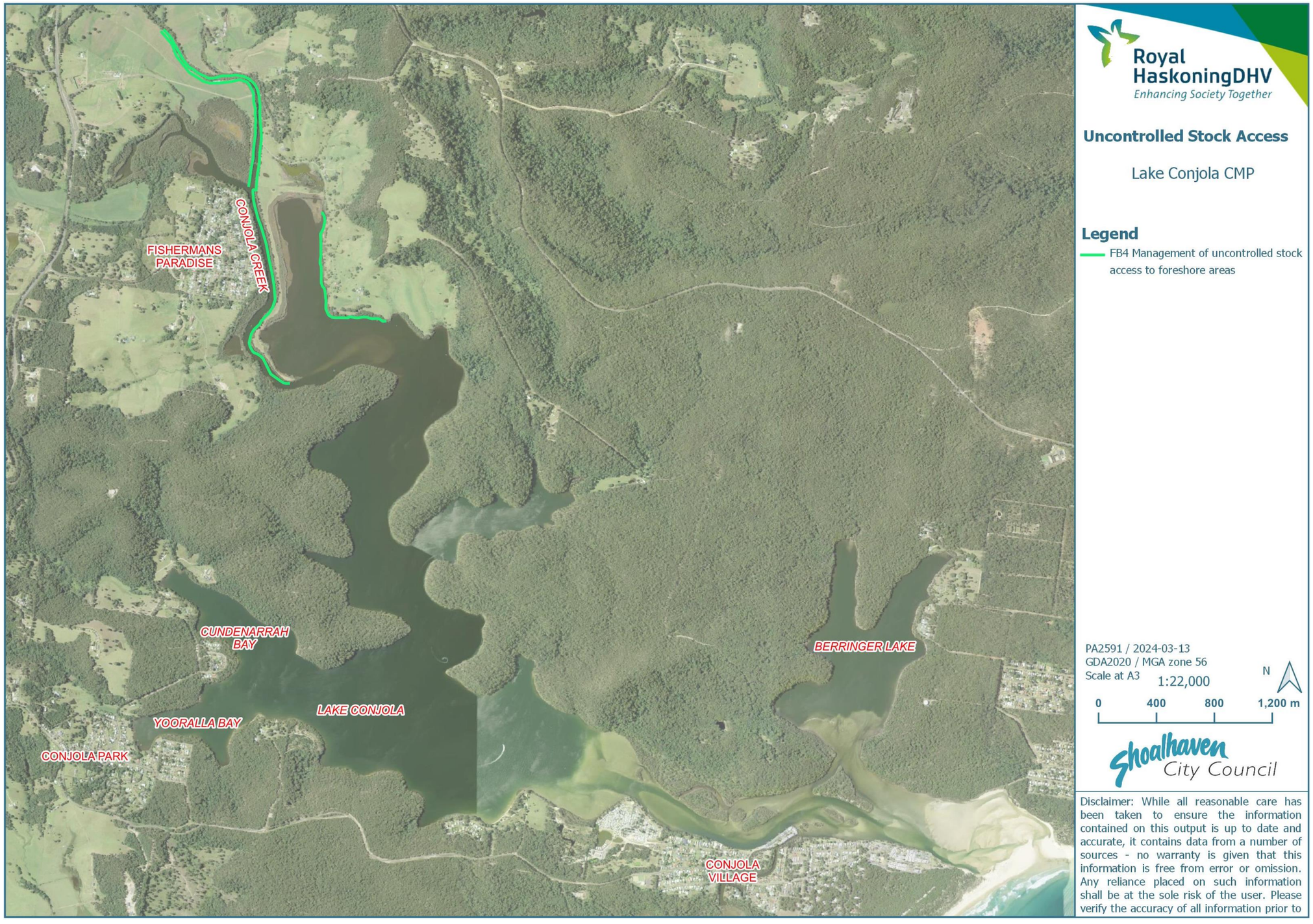


Figure 6-7: Management of uncontrolled stock access

6.3 Improve Planning and Management Arrangements for the Lake Catchment Area

6.3.1 PM1 Review, update and maintain tidal and coastal inundation development and planning controls to reduce future coastal hazard impacts

This action will involve review, update and maintenance of relevant development and planning controls within the Shoalhaven Local Environmental Plan (LEP) 2014 and Shoalhaven Development Control Plan (DCP) 2014 that apply to new development within areas impacted by coastal hazards. This should include consideration of controls for non-habitable areas and incorporation of tidal/coastal inundation events as a hazard and suitable planning controls for management of permanent inundation associated with tidal inundation into the future with sea level rise. Council will be responsible for updating and maintaining notation to section 10.7 (5) certificates for properties affected by coastal hazards consistent with NSW Government legislation.

Initial review (and ongoing periodic review) of future zoning of land within the Lake Conjola catchment. This should be undertaken with consideration of the protection and rehabilitation of existing estuarine and riparian vegetation and habitat, future migration of vegetation/habitat, and future inundation of land by tidal/coastal inundation processes under sea level rise.

Initial review (and ongoing periodic review) of land use controls and categorisation within the Lake Conjola catchment should be undertaken in the context of the Waterway Health Risk Assessment completed for Lake Conjola, which identified areas where land use intensification should be avoided (refer to red areas shown on **Figure 6-8**). Consideration should also be made to encourage land management and zoning that enables the migration of wetland ecosystems with sea level rise.

Support the implementation of the Marine Estate Management Strategy (MEMS) domestic waterfront structure strategies through the promotion of and reference to the strategy though the provision of planning advice and via Council's website.

This action also includes the preparation of a Planning Proposal to map and introduce a Coastal Vulnerability Area (CVA) for the estuary and modify and update the LEP and DCP. The planning proposal will seek formal inclusion of a CVA into the *State Environmental Planning Policy (Resilience and Hazards) 2021*.

This activity will be undertaken in conjunction with Action LG4.

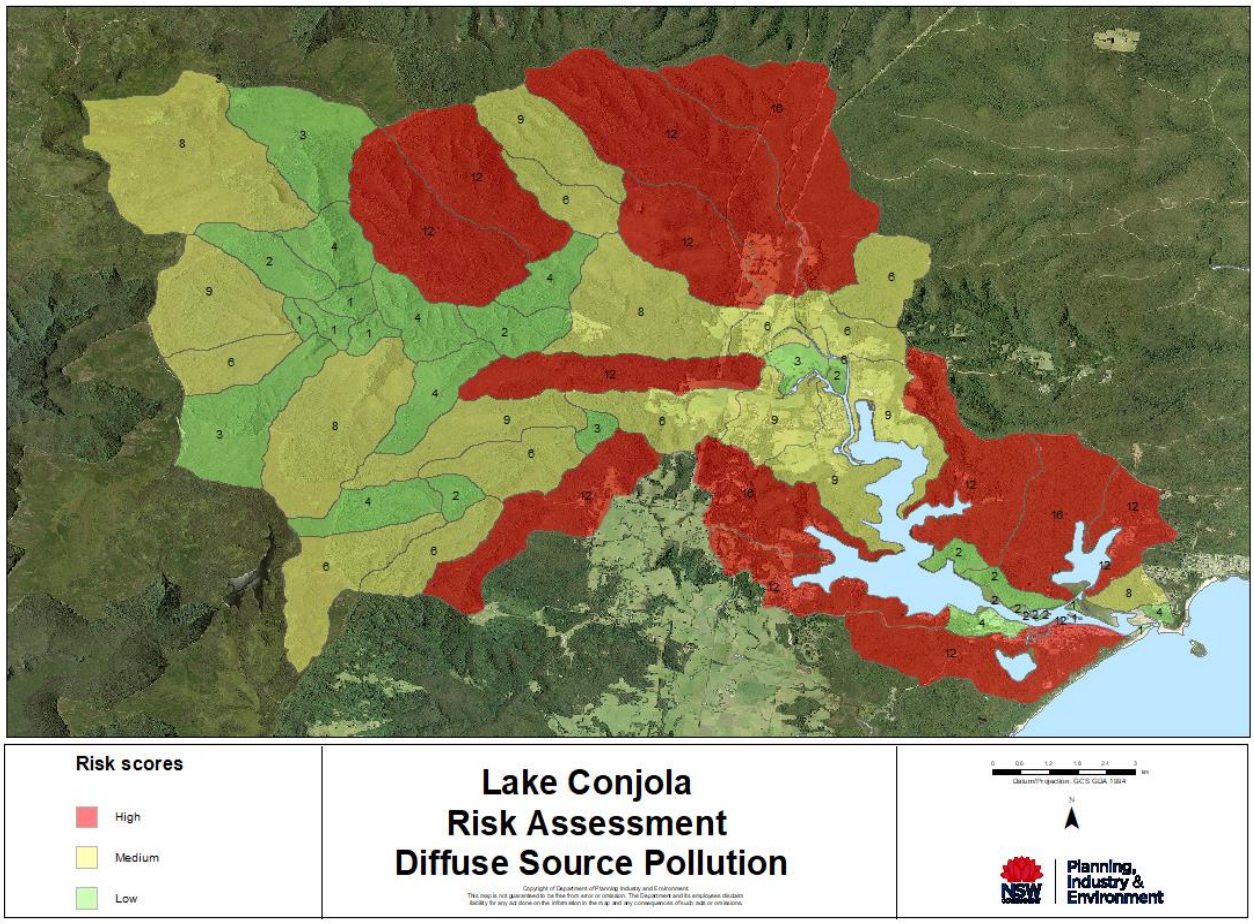


Figure 6-8: Lake Conjola Diffuse Source Pollution Risk Assessment overlaid on satellite image (source: DPIE, 2020)

6.3.2 PM2 Activate and implement Coastal Zone Emergency Action Subplan (CZEAS)

This action will involve the implementation of a Coastal Zone Emergency Action Subplan (CZEAS) for Lake Conjola developed as part of the Lake Conjola CMP. This will primarily address emergency response to relevant coastal hazards as defined in the *Coastal Management Act 2016* and will need to be consistent with the Shoalhaven City Local Flood Emergency Sub Plan 2021.

6.4 Entrance Management Interventions

6.4.1 EM1 Implement revised Entrance Management Policy

The Entrance Management Policy will be finalised as part of the finalisation and certification of the Lake Conjola CMP.

This action will involve the preparation of an updated Lake Conjola Entrance Management Policy based on the draft finalised through the CMP, as well as the ongoing implementation of the policy actions and procedures. A Review of Environmental Factors (REF) will need to be prepared to support the implementation of the EMP prior to final agency sign-off and approval of the EMP.

6.4.2 EM2 Improve public education on the impacts and safety risks of Lake openings

This action will be undertaken in conjunction with the program of community engagement developed for Action LG9. Council already has a wealth of entrance management information available (i.e. on their website) which can be utilised to support the objectives of future educational campaigns. The objectives would be to improve community knowledge of the principles and drivers of ICOLL entrance management, understanding of Council's policy and operational procedures, and to discourage illegal openings.

6.4.3 EM3 Prepare generic REF and approval applications for contingency ebb tide channel dredging and implement if required

To streamline the approvals process for contingency ebb tide channel dredging (refer **Section 5.5**), it is recommended that a generic REF is prepared along with likely approval application documentation for dredging works. The generic REF would cover the nominal scope of work, basis of design for the dredged channel, and potential environmental impacts and associated mitigation measures. The final REF for each dredging campaign would be informed by site investigations at the time that dredging is planned. Investigations may include aquatic ecology survey, sediment sampling and analysis, and hydrographic survey to confirm the extent of dredging required, and other studies required for the completion of a comprehensive REF. Approval application documentation would be prepared for the following relevant licences and permits:

- Dredging licence under the *Crown Lands Management Act 2016*; and,
- Permit to harm marine vegetation under Part 7 of the *Fisheries Management Act 1994*.

Ebb tide channel dredging is a contingency measure that is available in the scenario when excavation of a pilot channel directly through the northern spit zone to link with a stranded ebb tide channel is not practicable for emergency response to flooding due to the significant time required for excavation. Implementation of a contingency ebb tide channel dredging campaign would be subject to obtaining the necessary approvals.

6.5 Maintain and Improve Water Quality

6.5.1 WQ1 Work with Shoalhaven Water to consider findings of ongoing groundwater monitoring, including the need for any interception or additional treatment

This action will involve Council reviewing the results of the groundwater monitoring and reporting program required by legislation for the effluent discharged into the dune exfiltration system as part of the Conjola Regional Sewerage Scheme. This program should include ongoing assessment of:

- the likelihood of the nutrient plume continuing to migrate and affecting Lake Conjola and / or Pattimores Lagoon, and if so the likely impacts;
- the capacity of the groundwater system and environment (estuary and lagoon) to naturally attenuate the nutrients;
- whether the mass and concentration of nitrogen and phosphorus being discharged into the groundwater can be further reduced; and,
- potential options for interception and additional treatment of the groundwater.

6.5.2 WQ2 Continue and implement refined surface water monitoring and reporting program

This action will involve the implementation of the refined surface water monitoring and reporting program as documented in Environmental Data Analysis (2023). This monitoring program includes the maintenance of the Aquadata online portal for public access to water quality sampling results. The monitoring program will be implemented with consideration of the following:

- completing sampling consistently at a selected (rationalised) number of sites that are representative and provide adequate spatial coverage across the lake waterbody, to facilitate improved analysis of events impacting water quality. Sixteen prioritised sites were identified in Environmental Data Analysis (2023);
- recording of a range of ancillary information during each water sampling site visit to aid in interpretation of collected data, including weather conditions, recent rainfall quantity and dates, water levels, tide condition, and open/closed status of the entrance;
- inclusion of algal bloom monitoring;
- increased review, interpretation and public dissemination of Aquadata water quality monitoring results; and,
- implementation of warning signage and communications, as well as closure of lake areas in the event of poor water quality conditions for primary contact recreation (e.g. swimming, water skiing etc.).
- Continue to work with Councils Environmental Health Officers to monitor and better understand any potential impacts from remaining on-site septic tanks on lake water quality. Ensure compliance and enforcement continues on any septics not performing in accordance with current requirements.

Align with Council's Integrated Environmental Monitoring Program.

6.5.3 WQ3 Develop and implement water quality controls into future development

This action will involve a review and update of the water quality development and planning controls within the Shoalhaven Local Environmental Plan (LEP) 2014 and Shoalhaven Development Control Plan (SDCP) 2014 that apply to new development within the Lake Conjola catchment area. This review will consider the following aspects:

- pollutant reduction targets for future development within the Lake Conjola catchment to be based on Neutral or Beneficial Effect (NorBE) for all greenfield development;
- possible future application of the "Risk-based Framework for Considering Waterway Health Outcomes in Strategic Land-use Planning Decisions" (OEH, 2017) for Lake Conjola;
- avoiding land use intensification in high risk areas as per mapping in "Shoalhaven Local Government Area Estuary Health Diffuse Source Pollution Risk Assessment Mapping" (DPIE, 2020); and,
- inclusion of a range of Stormwater Quality Improvement Devices (SQIDs) to meet NorBE outcomes including incorporating wetlands and raingardens in private and public development.

This action is to be implemented considering and consistent with Action FB2 and Action LG10.

6.6 Protect and Rehabilitate Estuarine and Riparian Vegetation and Habitat

6.6.1 EV1 Protect and/or rehabilitate riparian and foreshore areas to enhance estuarine vegetation

This action will involve a range of measures and environmental protection works to ensure the protection of existing riparian and estuarine vegetation, as well as rehabilitation of currently impacted areas, and would consider the following aspects:

- consider acquisition and protection of key locations, notably Coastal Wetlands and Littoral Rainforest areas (refer **Figure 6-11**), and working with landholders to investigate options for modified land management or conservation agreements, voluntary acquisition based on incentives and funding such as Blue Carbon where future funding sources may be available;
- encourage implementation of buffers and land management practices to allow for spatial migration of vegetation/habitat under sea level rise (refer **Figure 6-12**) in conjunction with Action PM1. This would require consultation with private landholders. For public lands, Council to consider rezoning identified wetland migration areas for conservation purposes when updating the LEP;
- installation of informative signage and fencing in key areas to protect vegetation and habitats;
- Council support of volunteer based rehabilitation initiatives such as Bushcare/Parkcare/Dunecare, community based revegetation campaigns, and other community "ownership" projects. Natural areas requiring restoration and environmental protection works will also be identified through cultural engagement and cultural surveys (Actions LG12-LG14). Where culturally sensitive restoration sites are identified, the engagement of Aboriginal rangers and contractors will be prioritised;
- continuation of existing Council programs for pest control (e.g. foxes, rabbits, Indian Mynas) and weed management and biosecurity;
- enforcement of existing policies/controls on access restrictions to sensitive areas (e.g. boating and pedestrian access);
- undertake rehabilitation works in damaged vegetated areas and ongoing implementation of ecological restoration and environmental protection works in Council-managed coastal reserves with reference to the objectives of the associated coastal management areas. These works would be informed by ground-truthing surveys (refer Action LG8) and should support the ecological restoration of identified Threatened Ecological Communities (TECs) based on Council's 2023 report *Assessment of Endangered Ecological Communities In Coastal Hazard Areas: Shoalhaven LGA Tidal Inundation and Coastal Erosion Study Sites* (Ecoplanning, 2023), refer **Figure 6-9** and **Figure 6-10**. Prioritisation will be given to areas that comprise areas of Coastal Wetland and Littoral Rainforest (refer **Figure 6-11**) and/or house TECs, and targeted weed species control works. Tidal flows and natural tidal regimes should be considered in undertaking ecological restoration works;
- Restoration of riparian vegetation areas (consistent with Actions FB1.01, FB1.11, FB1.12, FB1.13 and FB1.14, refer to **Figure 6-12**) and implement environmental protection works to enhance ecological communities in coastal and estuarine reserves;
- Continued estuarine macrophyte mapping for the lake waterbody and foreshores as part of a Marine Estate Management Strategy project; and,

- Establish a monitoring and evaluation framework to assess the effectiveness of vegetation restoration and control measures, ensuring alignment with environmental goals and continuous improvement. This should be included within the Shoalhaven Integrated Environmental Monitoring Program.

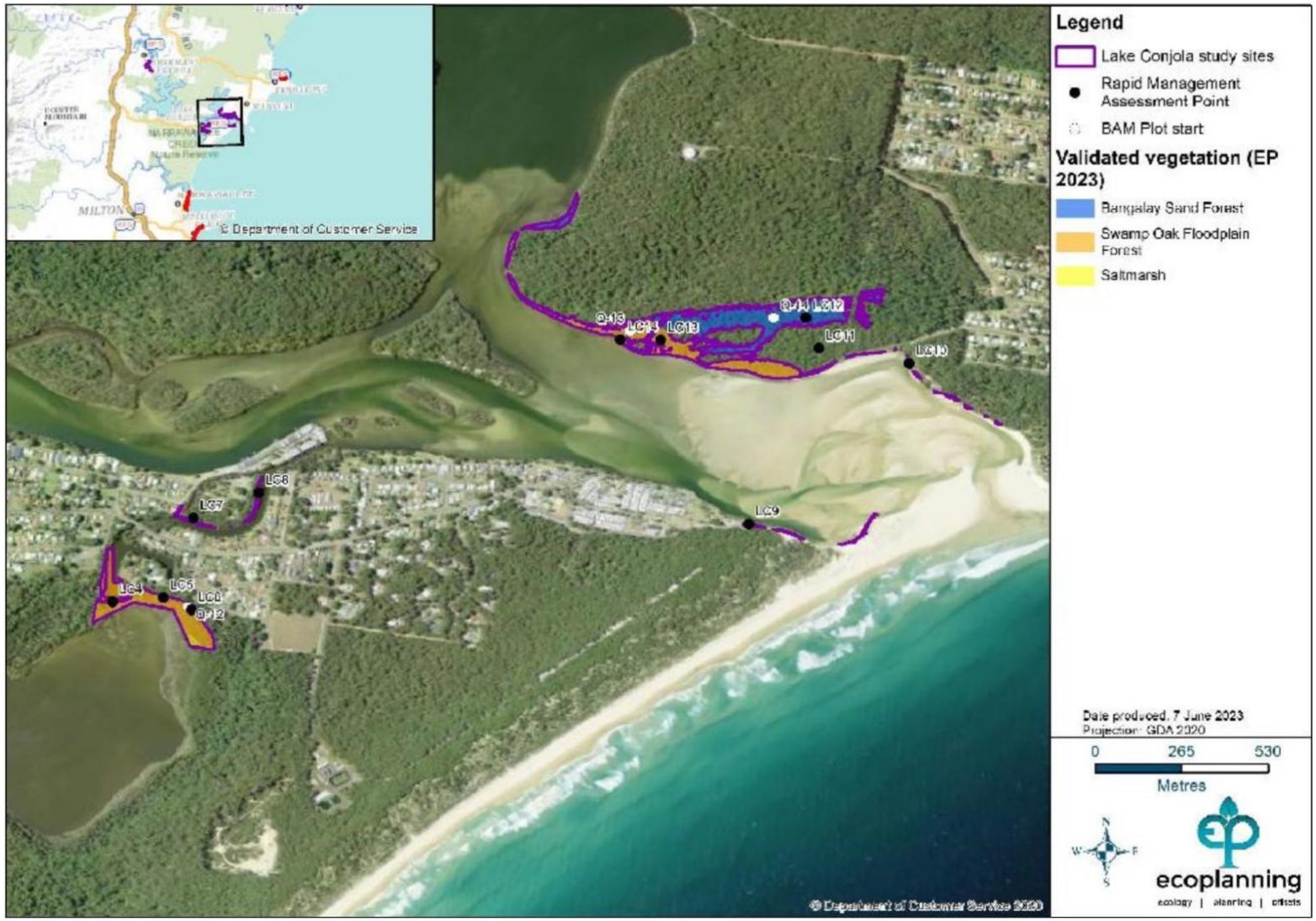


Figure 6-9: Mapped threatened ecological communities in tidal inundation sites – Lower Lake Conjola (source: Ecoplanning, 2023)

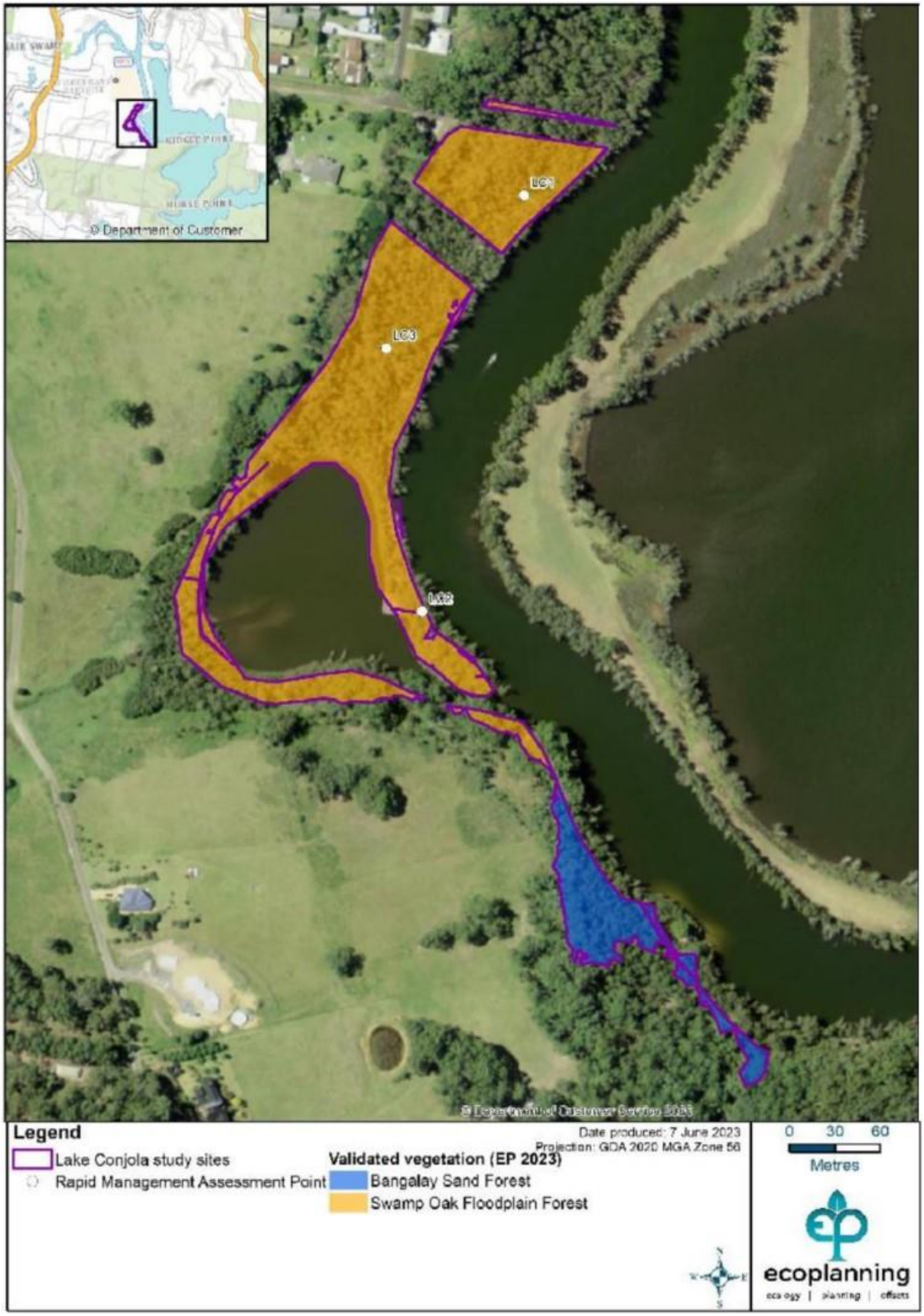


Figure 6-10: Mapped threatened ecological communities in tidal inundation sites – Fishermans Paradise (source: Ecoplanning, 2023)

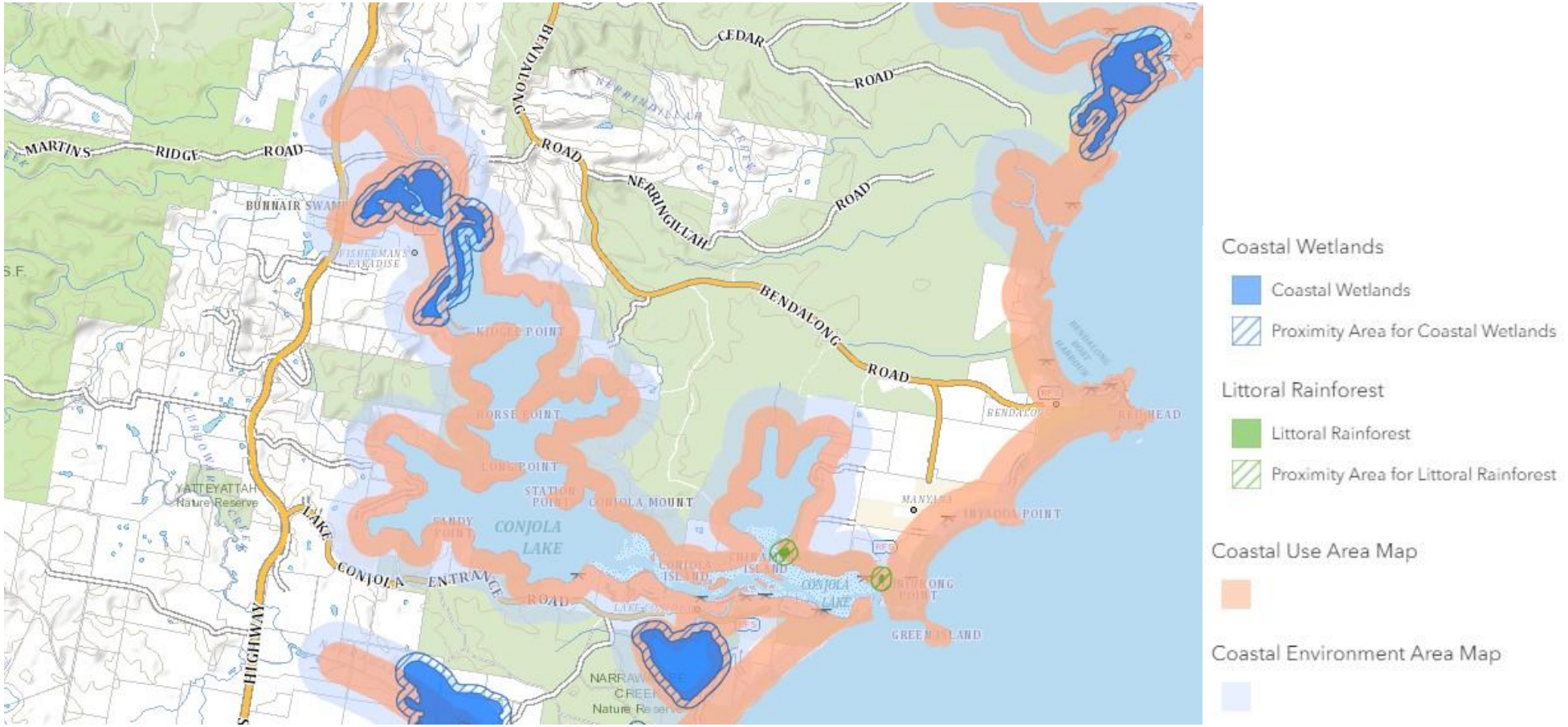


Figure 6-11: RH SEPP Coastal Management Area Mapping (source: NSW ePlanning Spatial Viewer)

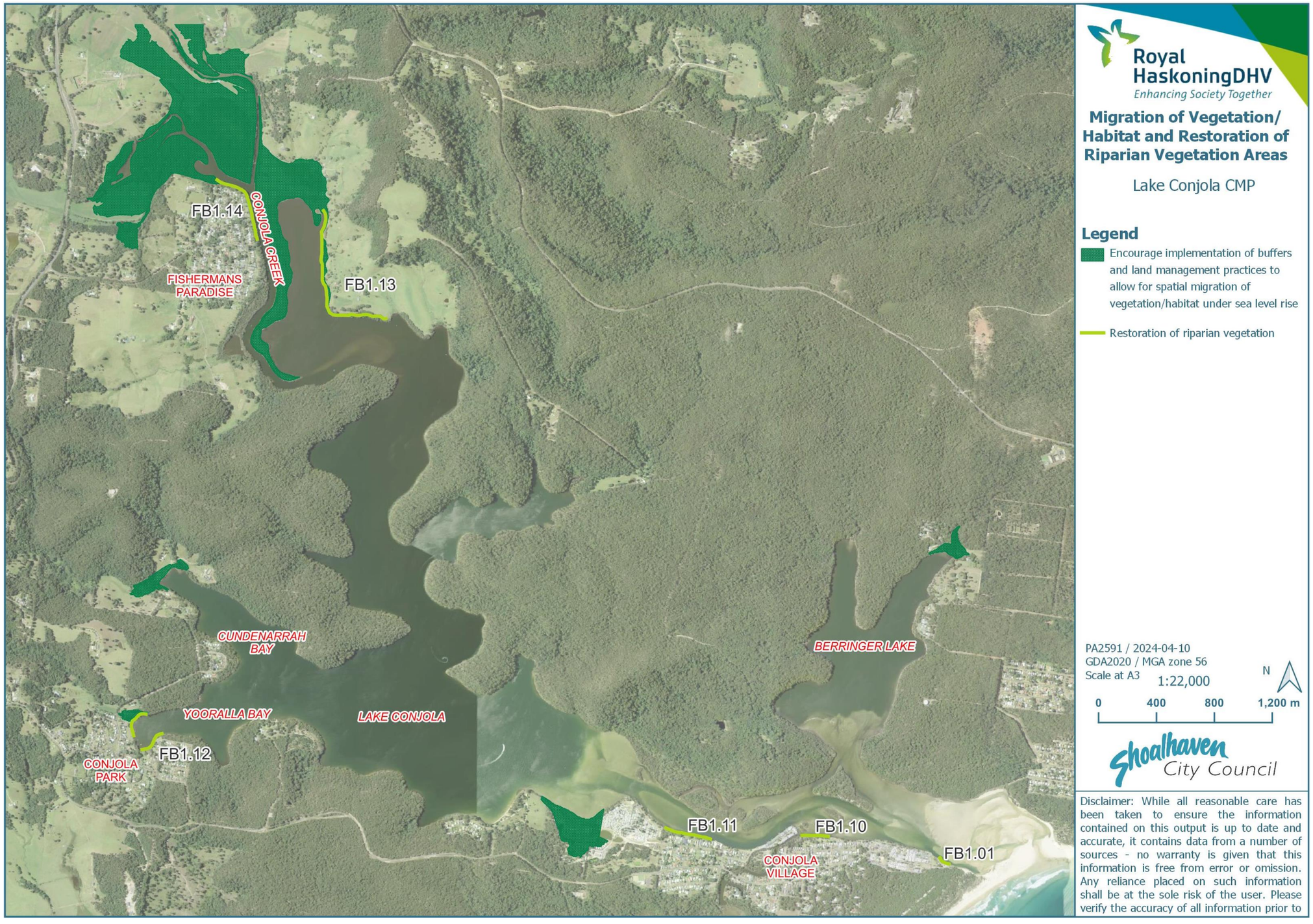


Figure 6-12: Future areas of potential migration of estuarine vegetation/habitat and restoration of riparian vegetation

6.7 Maintain and Improve Recreation and Amenity

6.7.1 RA1 Improvement and enhancement of boating access and navigation in Lake Conjola

This action aims to provide a structured, coordinated, and community-inclusive approach towards addressing the boating and navigation issues identified within the Lake Conjola Estuary. This should align with the priorities and opportunities identified through the Stage 2 Risk Assessment. Council should include boating infrastructure within the CMP study area within the update of the Council's Assessment Management Systems and Plans (refer to Action LG10). This should include at a minimum establishing a framework to regularly conduct thorough condition assessments at boat ramps, ensuring they meet safety standards and user requirements and structural investigations to identify necessary upgrades and repairs for safe and functional facilities.

Council to seek suitable sources of funding to implement the potential upgrades of boating and navigation facilities at Council-managed boating infrastructure, to improve safety and reduce conflicts. Upgrades should implement best practice with reference to relevant Guidelines and Standards and examples from other areas. Investigations will be required for design and environmental approvals for upgrades. This action relates to site specific actions listed for individual estuaries.

Key opportunities relating to upgrade of boating infrastructure include:

- seeking funding for and completing detailed design and construction of Stage 2 of the boat ramp works at Havilland Street, Conjola Park, comprising:
    - an additional 20 car-trailer spaces and turning bay;
    - amenities block;
    - tap for wash down bay; and,
    - provision of non-powered craft dry storage.

Council will continue engaging with the community to gather feedback on proposed upgrades and ensure alignment with user needs and expectations. Additionally, this action will involve consultation and collaboration with Transport for NSW, and will identify opportunities for alignment with the South Coast Boating Network Plan. Funding sources may include programs administered by TfNSW for boating infrastructure.

6.7.2 RA2 All-ability access to Lake Conjola from Cunjurong side

This action will involve the investigation of the feasibility of providing all-ability access to the beach area at Lake Conjola entrance from the Cunjurong Point side. This could possibly involve (subject to feasibility assessment) the provision of ramped access alongside the Cunjurong Point Boat Ramp leading to a low-level elevated walkway through bushland along the foreshore until the existing beach track to Cunjurong Point Road, where access to the beach could be provided. If the potential all-ability access works are considered to be technically, financially and socially viable then they would be implemented as a capital works project. This would involve detailed design, approvals and permits, community consultation, and construction of the works. Engagement to occur with disability advocacy groups and accessibility experts to ensure that improvements meet the needs of all community members. This initiative aims to promote inclusive enjoyment of the foreshore while respecting environmental sensitivities and local ecological balance.

7 Next Steps

The next stage of the CMP process is Stage 4 which involves:

- preparation of a draft CMP;
- public exhibition for a minimum of 28 days;
- review of submissions and amendments to the draft CMP if required;
- presentation of the updated CMP to the Southern CMP Advisory Committee;
- formal adoption of the CMP by Council;
- submission of the CMP to the Minister for certification;
- publishing the certified CMP in the Gazette; and,
- making the CMP available to the community.

The CMP document will include the following structure and content:

- Executive summary
- Introduction
- Snapshot of issues
- Stakeholder and Community Engagement
- Actions to be implemented by Council and by Public Authorities
- CMP Recommended Changes to Relevant Planning Controls
- A Business Plan identifying the capital, operational and maintenance costs, timings, and potential funding sources for management actions
- Coastal Zone Emergency Subplan (CZEAS)
- Monitoring, Evaluation and Reporting Program
- Maps
- Reference list
- Glossary

8 References

Advisian (2020), *Shoalhaven CMP Scoping Study*, prepared for Shoalhaven City Council, August 2020.

BMT WBM (2007), *Lake Conjola Flood Study*, Final Report R.N0758.004.05, July 2007.

BMT WBM (2013a), *Lake Conjola Floodplain Risk Management Study and Plan*, Final Report R.N1778.001.04, February 2013.

BMT WBM (2013b), *Lake Conjola Floodplain Risk Management Study and Plan: Entrance Sensitivity Report*, Final Report R.N1778.002.00, April 2013.

Crown Lands (2021), *Five-Year Crown Lands Licence to Open Lake Conjola*, Licence RN 625288, 16 September 2021.

Department of Environment & Climate Change NSW [DECC] (2009), *Environmentally Friendly Seawalls: A Guide to Improving the Environmental Value of Seawalls and Seawall-lined Foreshores in Estuaries*, June 2009.

Department of Planning and Environment [DPE] (2023), *Flood Risk Management Measures – Flood risk management guideline MM01*, August 2023.

Department of Planning, Infrastructure and Environment [DPIE] (2020), *Draft Shoalhaven Local Government Area Estuary Health Diffuse Source Pollution Risk Assessment Mapping*.

Ecoplanning (2023), *Assessment of Endangered Ecological Communities In Coastal Hazard Areas: Shoalhaven LGA Tidal Inundation and Coastal Erosion Study Sites*.

Environmental Data Analysis (2023), *Lake Conjola Monitoring Site Prioritisation to Support Shoalhaven City Council's Future Routine Water Quality Monitoring Program*, 15 August 2023.

GHD (2013), *Lake Conjola Interim Entrance Management Policy*, prepared for Shoalhaven City Council, August 2013.

Manly Hydraulics Laboratory [MHL] (2023), *Shoalhaven ICOLL Catchments Flash Flood Warning System Scoping Study: Stages 1 to 3 – Review and Flood Warning System Options*, draft report prepared for Shoalhaven City Council, October 2023.

NSW Government and Office of Environment and Heritage [OEH] (2019), *NSW Coastal Management Manual Part B: Stage 3 – Identify and evaluate options*.

NSW Treasury (2023), *TPG23-08 NSW Government Guide to Cost-Benefit Analysis*, February 2023.

Patterson Britton (1999), *Lake Conjola Entrance Study*, prepared for Shoalhaven City Council, Issue No.2, May 1999.

Peter Smith & Co. (2011), *FLOOR LEVEL SURVEY – Burrill Lake & Conjola Floodplain Risk Management Study*, 27 June 2011.

RHDHV (2023a), *Lake Conjola Coastal Management Program Stage 2 Determine Risks, Vulnerabilities and Opportunities: Report A – "Environmental, Social & Cultural Assets and Attributes"*, prepared for Shoalhaven City Council, February 2023.

RHDHV (2023b), *Lake Conjola Coastal Management Program Stage 2 Determine Risks, Vulnerabilities and Opportunities: Report B – "Threats and Risk Assessment"*, prepared for Shoalhaven City Council, February 2023.

RHDHV (2023c), *Lake Conjola Coastal Management Program Stage 2 Determine Risks, Vulnerabilities and Opportunities: Report C – "Entrance Processes and Entrance Management Options"*, prepared for Shoalhaven City Council, March 2023.

Shoalhaven City Council [SCC] (1998), *Lake Conjola Estuary Management Plan*, September 1998.

Shoalhaven City Council [SCC] (2021), *Review of Environmental Factors – Management of Lake Conjola Entrance*.

Shoalhaven City Council [SCC] (2022), *Shoalhaven 2032 – Community Strategic Plan*.

Shoalhaven City Council [SCC] (2023), *Delivery Program Operational Plan & Budget 2023/24*.

Wiecek, D., Regena, C., Laine, R., and Williams, R.J. (2016), *Quantifying change and impacts to Lake Illawarra from a permanent opening*, NSW Coastal Conference, Coffs Harbour, November 2016.

Appendix A: CMP Actions Summary for Community Engagement

Lake Conjola
Coastal Management Program

Planning and Environment

LGA-Wide Management Actions

LG1 Establish a CMP Governance Framework

- Establish a CMP working group, to oversee the implementation of the CMP and ensure that it meets its objectives
- Members should include staff from Council, relevant state government agencies, and other groups
- Clearly define the purpose, objectives and functions of the working group
- Define the roles and responsibilities of the working group members
- Execute the function of the working group

LG2 Maintain a full-time CMP Coordinator

Maintain a full-time Coastal Management Program Coordinator role – in order to coordinate the development and execution of Council's suite of CMPs, develop the implementation strategy (including long-term funding options) and build Council's capacity to respond to coastal issues and risks.

LG3 Enact the CMPs Monitoring, Evaluation and Reporting (MER) Program to track progress and report on outcomes

This will include:

- Ongoing monitoring of CMP actions
- Annual review of actions to ensure they are appropriate and current
- Ongoing reporting of progress

LG4 Review Councils coastal management planning policies every 10 years

Review Council's coastal management planning policies for the 10 year CMP implementation lifecycle. This should include consideration of the latest environmental data, observed coastal hazard impacts, and state government policies. The review should consider:

- The Shoalhaven City Council Sea Level Rise Framework
- The Shoalhaven City Council Coastal Hazard Mapping
- Lake Conjola Entrance Management Policy
- Council's various planning instruments

LG5 Continue to work collaboratively with National Parks and Wildlife Service staff and volunteers to implement the NSW South Coast Shorebird Recovery Program

Continue to work collaboratively with National Parks and Wildlife Service (NPWS) staff and volunteers to implement the NSW South Coast Shorebird Recovery Program to:

- Raise awareness amongst residents and visitors of migratory shorebirds which are protected under international agreements
- Manage the impacts of vehicles, pest animals, and dogs on beaches, especially in regard to the breeding success of migratory shorebirds

LG6 Develop and implement a program of dune vegetation management and rehabilitation

Strategically manage and rehabilitate coastal dune systems through weeding, revegetation, erosion control, asset maintenance, feral animal control and fauna surveys – at the entrance spit, entrance channel foreshore immediately west of the spit, and on the northern side of the entrance channel.

Dune vegetation management will also include collaborating with, and supporting, Council endorsed Bushcare groups through providing educational opportunities, resources, mentoring and technical support. Collaboration with NPWS and the NSW South Coast Shorebird Recovery Program would also be required.

Click on the icon to access the Interactive Mapping portal online.

Lake Conjola
Coastal Management Program

Planning and Environment

LGA-Wide Management Actions

LG7 Develop and execute a communications plan for Stage 5 of the CMP

Present information on Council's website and in community engagement activities that shows:

- The status of CMP actions
- How coastal zone systems function and how integrated management responses benefits local communities

LG8 Continue Council's program of mapping endangered ecological communities (EECs) across coastal reserves

Carry out surveys to ground-truth and map the distribution and condition of EECs in coastal erosion risk areas using the *Biodiversity Conservation Act 2016*, Biodiversity Assessment Methodology.

LG9 Maintain and enhance ecological communities in coastal reserves

This action includes the ongoing implementation of ecological restoration works in coastal reserves, which would be informed by the Marine Vegetation Management Strategy (refer Action EV1) and ground-truthing surveys (refer Action LG8). Prioritisation will be given to areas that house endangered ecological communities (EECs), and targeted weed species control works.

Shoalhaven Landcare

LG10 Develop and maintain a program of community engagement with coastal communities about coastal hazard risk

Engage with foreshore reserve property owners, residents, beach goers, and community youth around issues such as:

- Recognising Aboriginal cultural heritage on the coast and within estuaries
- The importance and value of dune vegetation (e.g. trapping wind-blown sand and maintaining dune resilience, ecological functions and buffering against coastal hazards)
- Managing the interface between coastal bushland, estuary foreshore and private property, including edge impacts, encroachments, garden refuse dumping, vegetation retention, and weed management
- Importance of foreshore vegetation in stabilising foreshores, reducing erosion, creating habitat, filtering runoff to improve water quality

- Illegal pruning, poisoning and removal of trees, private vehicle access and illegal structures/items which restrict public use of the reserve. Enforce regulations in high conservation areas as a priority.

LG11 Review and update all Council asset management plans (AMPs), relevant to the Lake Conjola study area

Review and update all asset management plans (AMPs), relevant to Lake Conjola. AMPs by asset type will be updated by relevant asset custodian.

Include an asset management approach to provide for replacement, relocation or retrofitting of public assets that are currently in coastal risk areas – including boat ramps, wharves, jetties, water and wastewater infrastructure, stormwater drainage infrastructure, foreshore protection infrastructure, roads and accessways.

LG12 Develop a program for regular and ongoing monitoring of coastal assets and infrastructure

Undertake monitoring of assets and infrastructure exposed to coastal hazards including:

- Foreshore protection structures (revetments, seawalls,)
- Recreational assets including viewing platforms & coastal accessways
- Stormwater outlets and wastewater infrastructure

Include this monitoring in Councils asset management program.

Click on the icon to access the Interactive Mapping portal online.

Lake Conjola
Coastal Management Program

Planning and Environment

LGA-Wide Management Actions

LG16 Include the Lake Conjola study area in a LGA wide coastal zone Aboriginal Cultural Heritage Survey, and development of local protection/management plans

This action would involve engaging with the relevant Local Aboriginal Land Councils, Traditional Owner groups and an archaeologist to undertake an updated cultural heritage survey of the coastal zone – and in doing so:

a) fill existing information gaps with the LGA-wide Aboriginal Cultural Heritage Mapping and

b) update the Aboriginal Heritage Information Management System (AHIMS)

It is anticipated that there would be three main tasks for this action:

- Consultation with the relevant Local Aboriginal Land Councils and Traditional Owners and knowledge holders.
- An Aboriginal cultural heritage assessment, which should include survey field work, and recording of cultural heritage sites (such as middens sites) and detailed documentation of findings.
- The development and prioritisation of local, site specific management plans for protection and preservation of these sites.

LG17 Engage with relevant Local Aboriginal Land Councils and local Traditional Owner Groups to develop a cultural educational and awareness program

This action would involve engaging with relevant Local Aboriginal Land Councils and local Traditional Owner groups to develop and roll out a cultural educational and awareness program – related to the Aboriginal Cultural Heritage (ACH) of the coastal zone. Design of the program should be led by either relevant Local Aboriginal Land Councils or local Traditional Owner groups.

The program could involve educational methods such as:

- School programs including planting days, stewardship sites and hands on activities
- Signage at local sites such as beaches, estuaries, and headlands (including the use of QR codes that includes elders speaking about the history of the area)
- Brochures and information provided to tourists at caravan parks and information centres
- Cultural tours to provide greater awareness of ACH values to both the local community and to the large population of seasonal visitors

LG18 Provide opportunities and help build capacity to local Aboriginal Ranger programs, to enhance their role in management of Sea Country

This action would involve working with relevant Local Aboriginal Land Councils and local Traditional Owner groups to bolster existing ranger programs and facilitate a greater role for these programs in coastal management across the Shoalhaven LGA.

- This would involve working with and supporting the ranger team coalition to help enhance/boost their capacity and awareness of coastal management.
- Where possible, utilise Aboriginal ranger teams to undertake on ground works associated with dune restoration and monitoring programs.
- Work collaboratively to help develop the next generation of junior rangers to be part of future coastal management across the Shoalhaven LGA.

This action is consistent with Initiative #4 of the NSW Marine Estate Management Strategy – which aims to: “Increase Aboriginal participation in Sea Country management, planning and monitoring through employment and training of Aboriginal people at a regional and local level”.

Click on the icon to access the Interactive Mapping portal online.

Lake Conjola
Coastal Management Program

Planning and Environment

Manage Foreshore Areas and Bank Erosion

FB1 Investigate, remediate and monitor impacted or vulnerable bank areas

This action would involve detailed design followed by remediation of bank areas within Lake Conjola that have been impacted or are vulnerable to erosion. The main tasks for this action would include:

- Preparation of detailed designs for treatment of eroding and unprotected foreshore areas (refer to Interactive Mapping) and working with relevant stakeholders to enable establishment or restoration of riparian vegetation where identified as lacking.
- Preparation of detailed designs for areas of inconsistent foreshore protection works, which include consideration of opportunities for installation of environmentally friendly seawalls and a uniform approach to foreshore protection.
- Establishment of an ongoing monitoring program to inform remediation actions. This monitoring would be included in Councils asset management program as per Action LG12.
- Progressive implementation of riparian vegetation restoration and/or seawall remediation works.

FB2 Management of stormwater runoff

This action would involve detailed design followed by implementation of management works for identified foreshore areas where uncontrolled stormwater runoff or discharge is impacting on public amenity and safety, foreshore stability, or lake water quality. In some areas this could be undertaken in conjunction with implementation of riparian vegetation restoration and/or seawall remediation works as per Action FB1. The main tasks for this action would include:

- Preparing detailed designs for the specific areas identified (refer to Interactive Mapping) where surface water runoff pathways and stormwater discharge outlets could be modified to better filter runoff and improve lake water quality.
- Consider opportunities for:
  - diversion of hazardous stormwater runoff and redirection of surcharge flows
  - stabilisation of existing stormwater outlets and improvement of energy dissipation
  - installation of warning signage near stormwater outlets to identify hazards
  - filtering of runoff with provision of a riparian vegetation buffer along the foreshore edge (7 locations, refer Interactive Mapping)
  - at source interception of runoff with raingardens or similar
  - replacement of hard drainage channels with grassed and vegetated swales (5 locations, refer Interactive Mapping)
  - installation of stormwater quality improvement devices (SQIDs) such as gross pollutant traps
- Establishment of an ongoing monitoring program to inform mitigation actions. This monitoring would be included in Councils asset management program as per Action LG12.
- Progressive implementation of mitigation works.

FB3 Management of watercraft storage

This action would involve the implementation of a removal program for ad hoc stored watercraft (e.g. dinghies, canoes, kayaks etc.) that are abandoned, derelict or illegally stored in public foreshore areas (refer to Interactive Mapping). This would be undertaken in conjunction with the development and implementation of formalised watercraft storage systems (e.g. dinghy/kayak racks, tie-up points, permitting system) in the identified foreshore areas around the lake (refer to Interactive Mapping). Ongoing monitoring and policing would be required to prevent re-occurrence of ad hoc watercraft storage.

Click on the icon to access the Interactive Mapping portal online.

Lake Conjola
Coastal Management Program

Planning and Environment

Manage Foreshore Areas and Bank Erosion

FB4 Management of uncontrolled stock access to foreshore areas

This action would involve working collaboratively with farmers/foreshore landowners in conjunction with NSW Local Land Services (LLS) to support change in farming practices (e.g. stock access to lake foreshore). This would be done in conjunction with other site specific measures in identified deteriorated foreshore areas including:

- reinstatement of a riparian vegetation buffer along foreshore areas (as per Action FB1, refer to Interactive Mapping)
- installation of fencing to prevent foreshore stock access (foreshores of upper Lake Conjola and Conjola Creek near Fishermans Paradise)

FB5 Investigate appropriate and permissible use of public foreshores by private structures

This action would involve investigation of identified areas of the lake where public access to or along the foreshore may be impeded by the presence of private foreshore access ramps, jetties or pontoons. The investigation would include recognition of current leases/licences for foreshore structures and identification of illegal structures for removal. Possible areas that need to be checked include: the southern foreshore between Conjola Beach Boat Ramp and Aney St Boat Ramp; the southern foreshore between BIG4 Caravan Park and Deepwater Resort; and the Conjola Creek foreshore at Fishermans Paradise.

This action would be undertaken in conjunction with the development of Domestic Waterfront Structure Strategies for priority estuaries in NSW (https://www.marine.nsw.gov.au/projects/domestic-waterfront-structure-strategies), including Lake Conjola. These strategies aim to address the threats of waterfront development including lack of compliance, loss of public access to the waterfront and overly complex regulatory regimes. The objective of the strategies would be to help maintain access to public waterfront areas and identify and protect sensitive environmental areas. This initiative is being led by DPI – Fisheries in partnership with local Councils; DPE – Crown Lands; DPE – Planning and Assessment; DPE – Environment, Energy and Science; Transport for NSW; and DPE – Natural Resources Access Regulator.

Click on the icon to access the Interactive Mapping portal online.

Lake Conjola
Coastal Management Program

Planning and Environment

Improve Planning and Management Arrangements for the Lake Catchment Area

PM1 Review tidal and coastal inundation development and planning controls within LEP/DCP

This action would involve review of relevant development and planning controls within the Shoalhaven Local Environmental Plan 2014 and Shoalhaven Development Control Plan 2014 that apply to new development within flood prone land areas. This should include consideration of controls for non-habitable areas and incorporation of tidal/coastal inundation events as a hazard and suitable planning controls for management of permanent inundation associated with tidal inundation into the future with sea level rise.

PM2 Prepare and implement Coastal Zone Emergency Action Subplan (CZEAS)

This action would involve the preparation of a Coastal Zone Emergency Action Subplan (CZEAS) for Lake Conjola as part of the Lake Conjola CMP. This will primarily address emergency response to relevant coastal hazards as defined in the *Coastal Management Act 2016* and will need to be consistent with the Shoalhaven City Local Flood Emergency Sub Plan 2014.

PM3 Review future zoning of land and land use controls and categorisation within the Lake Conjola catchment

This action would involve the initial review (and ongoing periodic review) of future zoning of land within the Lake Conjola catchment. This should be undertaken with consideration of the protection and rehabilitation of existing estuarine and riparian vegetation and habitat, future migration of vegetation/habitat, and future inundation of land by tidal/coastal inundation processes under sea level rise.

Initial review (and ongoing periodic review) of land use controls and categorisation within the Lake Conjola catchment should be undertaken in the context of the Waterway Health Risk Assessment completed for Lake Conjola, which identified areas where land use intensification should be avoided.

This activity would be undertaken in conjunction with Action LG4.

Click on the icon to access the Interactive Mapping portal online.

Lake Conjola
Coastal Management Program

Shoalhaven City Council

NSW GOVERNMENT Planning and Environment

Entrance Management Interventions

EM1 Implement revised Entrance Management Policy

This action will be informed by the assessment work completed as part of the Lake Conjola CMP, which includes a review of trigger lake water level, breakout channel location and geometry, and ocean tide conditions for optimisation of mechanical openings. Also under investigation are alternative entrance management options including the maintenance of a 'dry notch', a modified managed entrance approach with occasional dredging of ebb tide channel, and engineering works to create a permanent entrance channel.

The outcomes of the work completed in the Lake Conjola CMP would be incorporated into an updated Lake Conjola Entrance Management Policy.

EM2 Improve public education on the impacts and safety risks of Lake openings

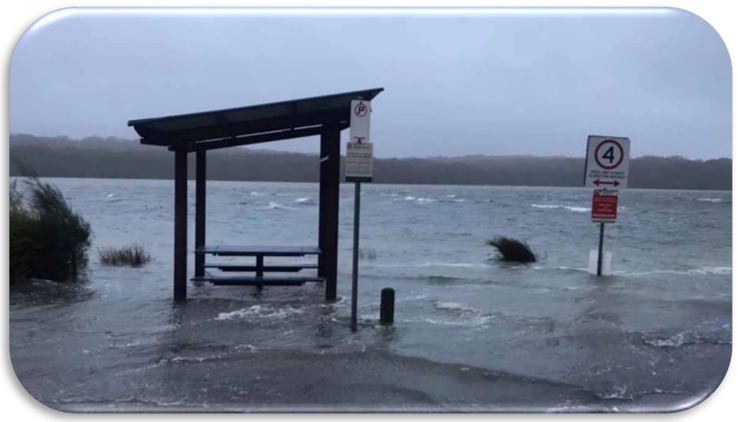
This action would be undertaken in conjunction with the program of community engagement developed for Action LG5. Council already has a wealth of entrance management information available (i.e. on their website) which can be utilised to support the objectives of future educational campaigns. The objectives would be to improve community knowledge of the principles and drivers of ICOLL entrance management, understanding of Council's policy and operational procedures, and to discourage illegal openings.

Preparation and Response to Inundation Events

IN1 Develop future management plans for public assets impacted by inundation

This action would involve the development of management plans for public assets that are predicted to be impacted by coastal and tidal inundation in the future and/or could be hazardous when submerged. The management plans would be informed by the Risk Assessment undertaken as part of Stage 2 and the establishment of an ongoing monitoring program included in Councils asset management program as per Action LG12. Actions within the management plans for particular assets could include:

- monitoring of the frequency of inundation and associated public amenity and public safety impacts
- relocation/reconstruction of assets that could be submerged
- closure of assets during periods of inundation
- removal of valuable assets from ground floor areas
- retrofitting or relocation of public infrastructure



IN2 Develop and implement Lake water level forecasting system

This action would involve the development of a water level forecasting system that uses forecast rainfall and ocean water level along with the prevailing entrance condition to estimate the level and extent of inundation on the foreshores of Lake Conjola. The system could be used by Council to plan entrance management interventions and also as a tool in flood emergency situations for the State Emergency Service (SES). The system could have in-built capability to issue notifications (e.g. SMS text messages or similar) to relevant personnel in Council and SES regarding predicted inundation events and could be used to plan road closures, evacuation routes, and the issuing of flood evacuation warnings to residents.

Council have initiated this process by recently engaging a consultant to deliver the Shoalhaven ICOLL Catchments Flash Flood Warning System Scoping Study.

Click on the icon to access the Interactive Mapping portal online.

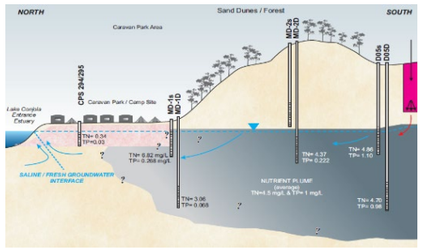
Lake Conjola
Coastal Management Program

Maintain and Improve Water Quality

WQ1 Work with Shoalhaven Water to consider findings of ongoing groundwater monitoring, including the need for any interception of additional treatment

This action would involve Council reviewing the results of the groundwater monitoring and reporting program required by legislation for the effluent discharged into the dune exfiltration system as part of the Conjola Regional Sewerage Scheme. This program should include ongoing assessment of:

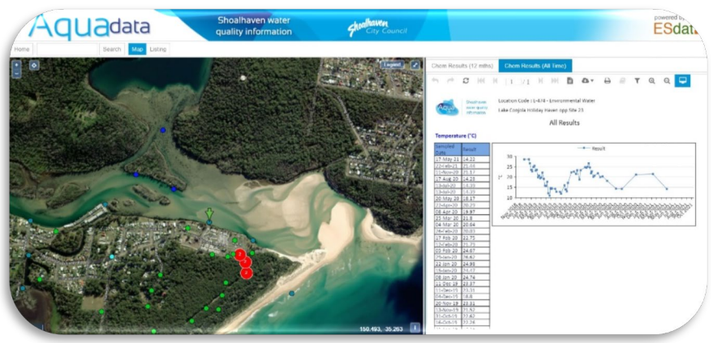
- the likelihood of the nutrient plume continuing to migrate and affecting Lake Conjola and / or Pattimores Lagoon, and if so the likely impacts
- the capacity of the groundwater system and environment (estuary and lagoon) to naturally attenuate the nutrients
- whether the mass and concentration of nitrogen and phosphorus being discharged into the groundwater can be further reduced
- potential options for interception and additional treatment of the groundwater



WQ2 Continue and refine surface water monitoring and reporting program

This action would involve the refinement and continuation of the existing surface water monitoring and reporting program, including maintenance of the Aquadata online portal for public access to water quality sampling results. Recommended refinements to the existing program include:

- completing sampling consistently at a selected (rationalised) number of sites that provide adequate spatial coverage across the lake waterbody, to facilitate improved analysis of events impacting water quality
- recording of a range of ancillary information during each water sampling site visit to aid in interpretation of collected data, including weather conditions, recent rainfall quantity and dates, water levels, tide condition, and open/closed status of the entrance
- inclusion of algal bloom monitoring
- increased review, interpretation and public dissemination of Aquadata water quality monitoring results
- implementation of warning signage and closure of lake areas in the event of poor water quality conditions for primary contact recreation (e.g. swimming, water skiing etc.)



WQ3 Develop and implement water quality controls into future development

This action would involve a review and update of the water quality development and planning controls within the Shoalhaven Local Environmental Plan (LEP) 2014 and Shoalhaven Development Control Plan (SDCP) 2014 that apply to new development within the Lake Conjola catchment area. This review would consider the following aspects:

- Pollutant reduction targets for future development within the Lake Conjola catchment to be based on Neutral or Beneficial Effect (NorBE) for all greenfield development
- Possible future application of the "Risk-based Framework for Considering Waterway Health Outcomes in Strategic Land-use Planning Decisions" (OEH, 2017) for Lake Conjola.
- avoiding land use intensification in high risk areas as per mapping in “Shoalhaven Local Government Area Estuary Health Diffuse Source Pollution Risk Assessment Mapping” (DPIE, 2020)
- inclusion of a range of Stormwater Quality Improvement Devices (SQIDs) to meet NorBE outcomes including incorporating wetlands and raingardens in private and public development

WQ4 Investigate and manage potential sewage inflows

In operation from 2008, the Conjola Wastewater Treatment Plant (WWTP), owned and operated by Shoalhaven Water, enabled the majority of properties around Lake Conjola to transition away from on-site septic tanks, mitigating significant potential diffuse sources of bacteriological pollution into the waterbody. Continue to work with Councils Environmental Health Officers to better understand any potential impacts from remaining septics on lake water quality. Ensure compliance and enforcement continues on any septics not performing in accordance with current requirements.

Click on the icon to access the Interactive Mapping portal online.

Lake Conjola
Coastal Management Program

Protect and Rehabilitate Estuarine and Riparian Vegetation and Habitat

EV1 Protect and/or rehabilitate riparian and foreshore areas to enhance estuarine vegetation

This action would involve a range of measures to ensure the protection of existing riparian and estuarine vegetation, as well as rehabilitation of currently impacted areas, and would consider the following aspects:

- consider acquisition and protection of key locations, notably Coastal Wetlands and Littoral Rainforest areas, and working with landholders to investigate options for modified land management or voluntary acquisition based on incentives and funding such as Blue Carbon where future funding sources may be available
- reservation of land to allow for spatial migration of vegetation/habitat under sea level rise (refer Interactive Mapping)
- installation of informative signage and fencing in key areas to protect vegetation and habitats
- Council support of volunteer based rehabilitation initiatives such as Bushcare/Parkcare/Dunecare, community based revegetation campaigns, and other community "ownership" projects
- continuation of existing Council programs for pest control (e.g. foxes, rabbits, Indian Mynas) and weed management and biosecurity
- enforcement of existing policies/controls on access restrictions to sensitive areas (e.g. boating and pedestrian access)
- undertake rehabilitation works in damaged vegetated areas, in conjunction with Action LG9 and Action FB1 (refer Interactive Mapping)
- Revegetation of riparian areas in 9 locations (as per Action FB1, refer to Interactive Mapping)
- Possible future preparation of a Marine Vegetation Management Strategy for the lake waterbody and foreshores as part of a Marine Estate Management Strategy project. This strategy would review and build on the existing work of the CMP.

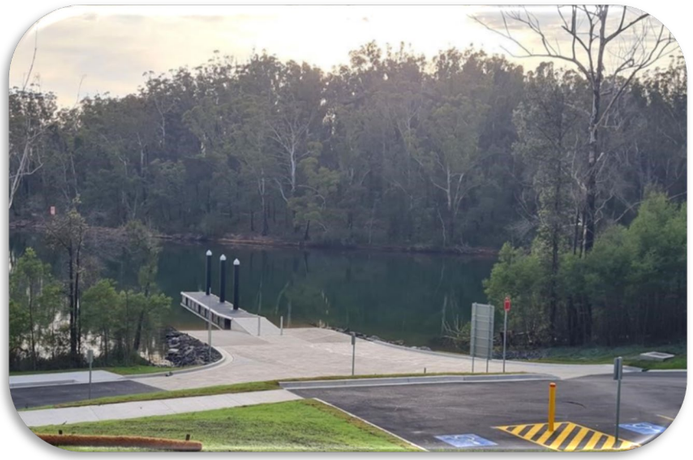
Click on the icon to access the Interactive Mapping portal online.

Maintain and Improve Recreation and Amenity

RA1 Improvement and enhancement of boating access and navigation in Lake Conjola

This action would involve the implementation of the following improvements to boating access and navigation in collaboration with Transport for NSW and in accordance with the South Coast Boating Network Plan:

- seek funding for and complete detailed design and construction of Stage 2 of the boat ramp works at Havilland Street, Conjola Park, comprising:
  - an additional 20 car-trailer spaces and turning bay;
  - amenities block;
  - tap for wash down bay; and,
  - provision of non-powered craft dry storage.



Appendix B: Ebb Tide Channel Technical Memo

Note / Memo

Haskoning Australia PTY Ltd.
Water & Maritime

To:	Nigel Smith & Braiya White
From:	Greg Britton
Date:	15 September 2023
Copy:	
Our reference:	PA2591-RHD-ME-0001
Classification:	Project related
Checked by	Matt Potter

Subject: **Lake Conjola – Entrance Management Discussions – Ebb Tide Channel Relevance**

---

1. INTRODUCTION

On 20 July 2023 Greg Britton of Royal HaskoningDHV (RHDHV) made a presentation to Shoalhaven City Council (Council) and Agencies (Department of Planning and Environment (Environment and Heritage Group), Department of Planning and Environment (Crown Lands), Department of Primary Industries – Fisheries) on the numerical modelling work carried out by RHDHV to inform entrance management options for Lake Conjola. During the presentation reference was made to the dominant or primary ebb tide channel which exists at the entrance to Lake Conjola during typical 'entrance open' conditions and the influence the loss of this channel, due to storm washover events, may have on entrance management options, in particular the possible need for the so-called Category 3 management options – modified 'managed entrance' (pilot channel).

Subsequent to the presentation, Council sought additional information on the ebb tide channel to provide to the State Government Agencies to illustrate the processes and entrance management considerations as they relate to the ebb tide channel.

This Memo has been prepared to provide the additional information about the ebb tide channel. The Memo repeats certain information from the RHDHV Stage 2 Report C (05/Final, dated 29 March 2023) where considered important for context but aims to keep this repetition brief, as Report C has already been reviewed by Council and Agencies (Department of Planning and Environment (Environment and Heritage Group), Department of Planning and Environment (Crown Lands), Department of Primary Industries – Fisheries). Documents referenced in the Memo are from Report C.

2. CHANNELS IN THE ENTRANCE AREA OF LAKE CONJOLA UNDER TYPICAL ENTRANCE OPEN CONDITIONS

Typical entrance open conditions for Lake Conjola are also referred to as the Regime Entrance State (Patterson Britton, 1999; RHDHV, 2023). These conditions are depicted schematically in Figure 2-1 and are shown in an aerial photograph in Figure 2-2. Under these conditions the following is evident:

- a primary ebb tide channel runs roughly parallel to the beach behind the entrance sand spit, towards Cunjurong Point;
- an initial flood tide flow occurs along a smaller northern channel, then as the tide rises the flood tide flows spread across the sand delta and consequently lobes of sand are formed representing sequences of sand deposits bought in by the flood tide; and

- the entrance channel conveying the ebb tide and flood tide is hard against the northern shoreline near Cunjurong Point and is relatively narrow.

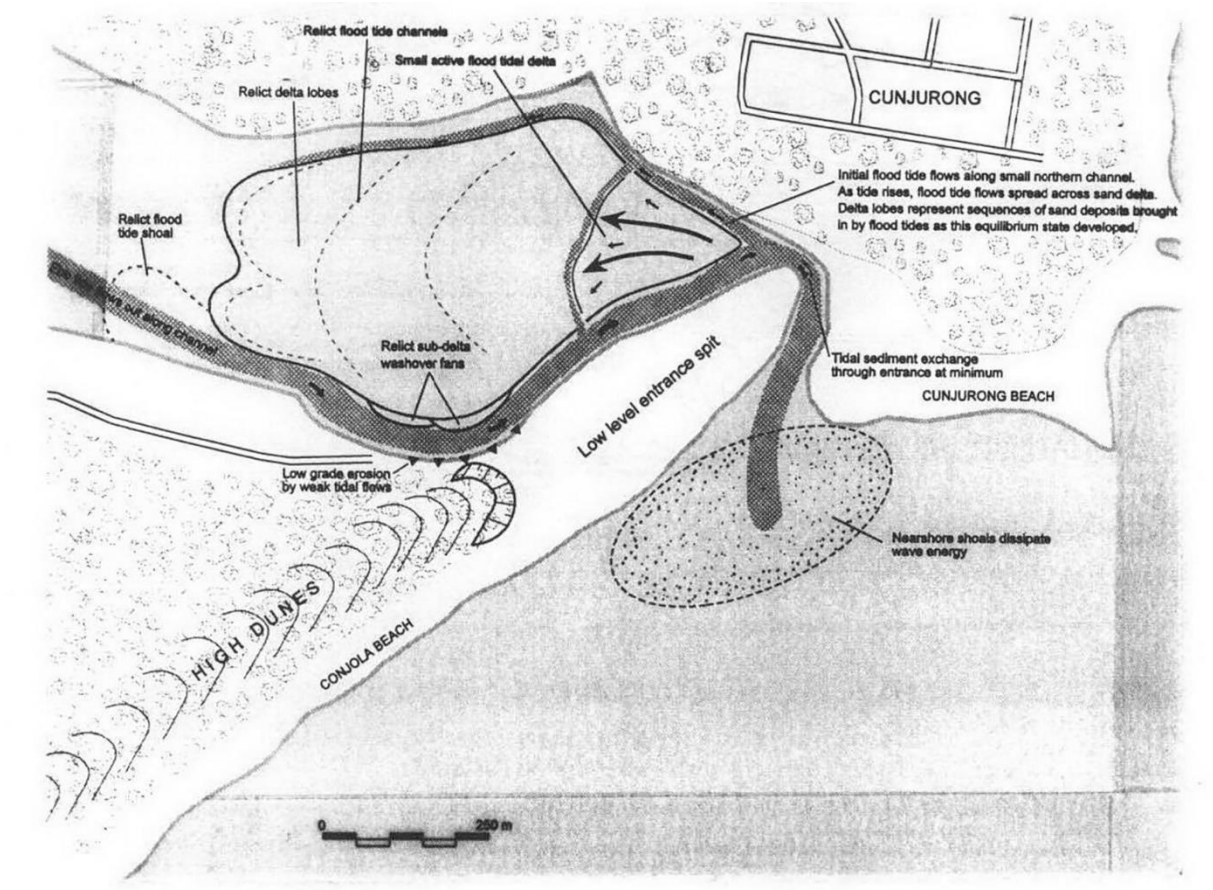


Figure 2-1 Schematic of Regime Entrance State (Figure 2-8 from RHDHV Report C, March 2023)

Figure 2-2 Air photo showing Regime Entrance State (from Council Coastal Fact Sheet: Lake Conjola Management, D19/412886)

The ebb tide and flood tide flow paths under typical entrance open conditions can also be replicated in the RHDHV tidal hydrodynamic model. Figure 2-3 and Figure 2-4 show the peak ebb tide and flood tide flows respectively for a mean spring tidal range in the ocean. The magnitude of the tidal current is indicated by the colour coding. The direction of the current is indicated by the arrows. The following is evident:

- during the peak of the ebb tide, the majority of the flow occurs along the channel behind the entrance sand spit. It then whips around the tip of the sand spit before dissipating rapidly in the nearshore zone; and
- during the peak of the flood tide, while a large proportion of the flow follows the channel behind the sand spit, the flow also spreads across the sand delta.

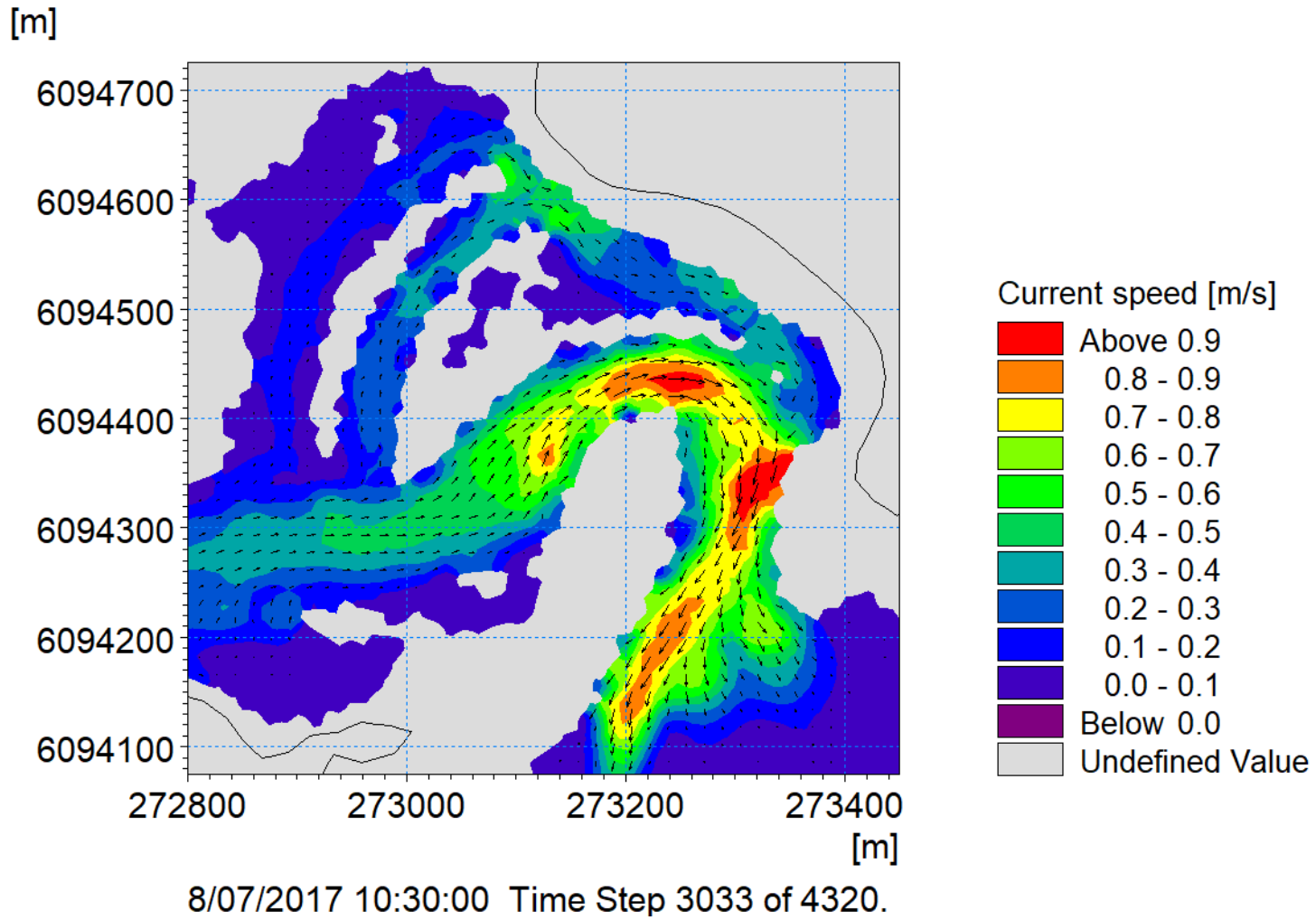


Figure 2-3 Current speed and direction during peak of the ebb tide for a mean spring tidal range in the ocean

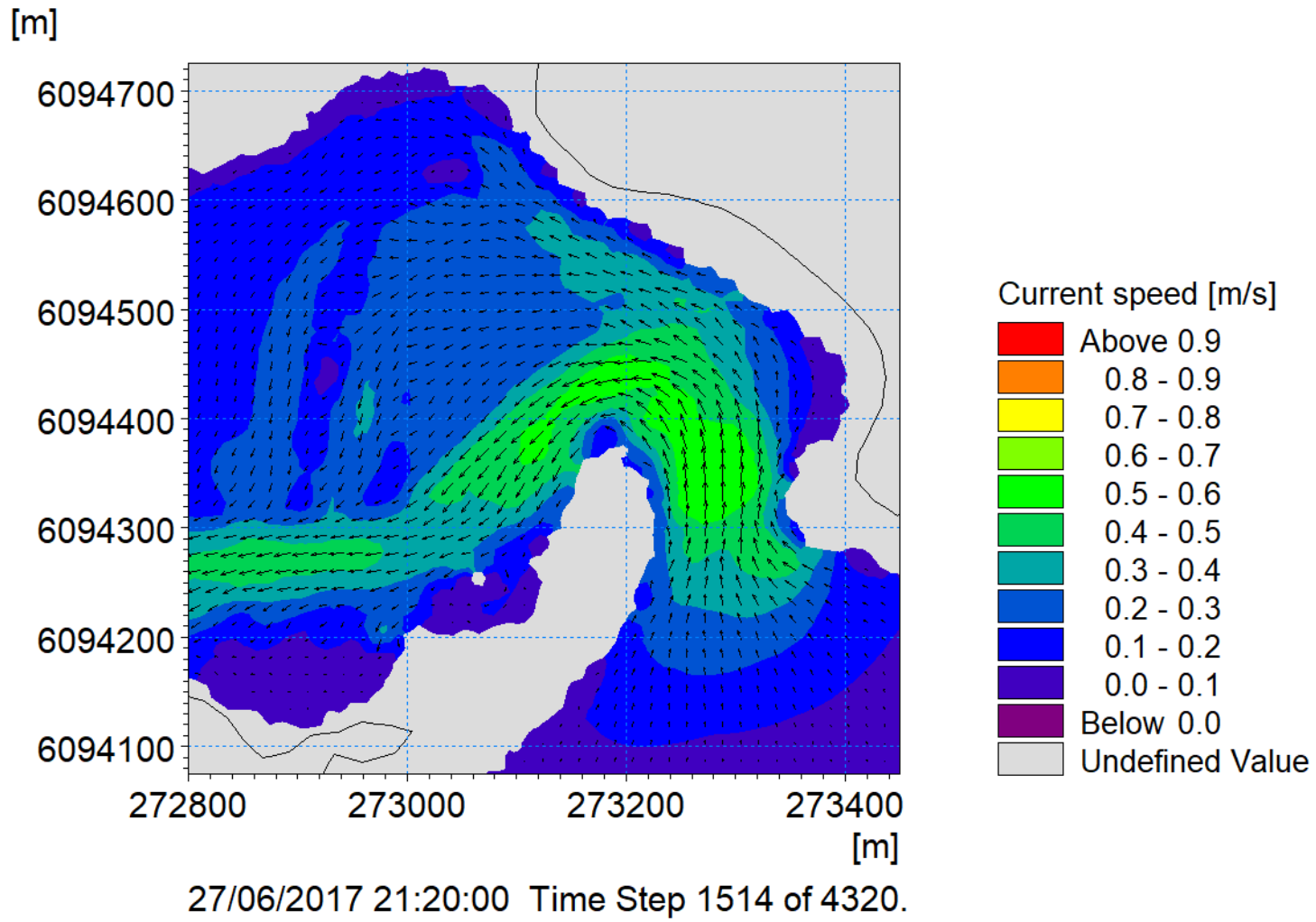


Figure 2-4 Current speed and direction during peak of the flood tide for a mean spring tidal range in the ocean

3. STORM WASHOVER, ENTRANCE CLOSURE, EFFECT ON CHANNELS

Waves during major to severe ocean storms wash over the entrance spit leading to infilling in the entrance to the Lake. Entrance closure is likely to ensue under these conditions. Such a situation is referred to as the Storm Washover Entrance State (Patterson Britton, 1999; RHDHV, 2023). These conditions are depicted schematically in Figure 3-1 and are shown in an aerial photograph in Figure 3-2. Two further images are shown in Figure 3-3.

Under the Storm Washover Entrance State the following is evident:

- the washover sand deposits, or 'fans' of sand, cut off the fluvial/primary ebb tide channel; and
- the primary ebb tide channel becomes 'perched' on the sand delta, leading to sudden and substantially diminished tidal flows, with further washover leading to closure.

Following closure of the entrance, sand berm levels on the seaward side of the spit would typically reach a level above 2m AHD due to wave and wind processes. Opening of the lake under such conditions would only occur in significant rainfall/flooding or by mechanical intervention.

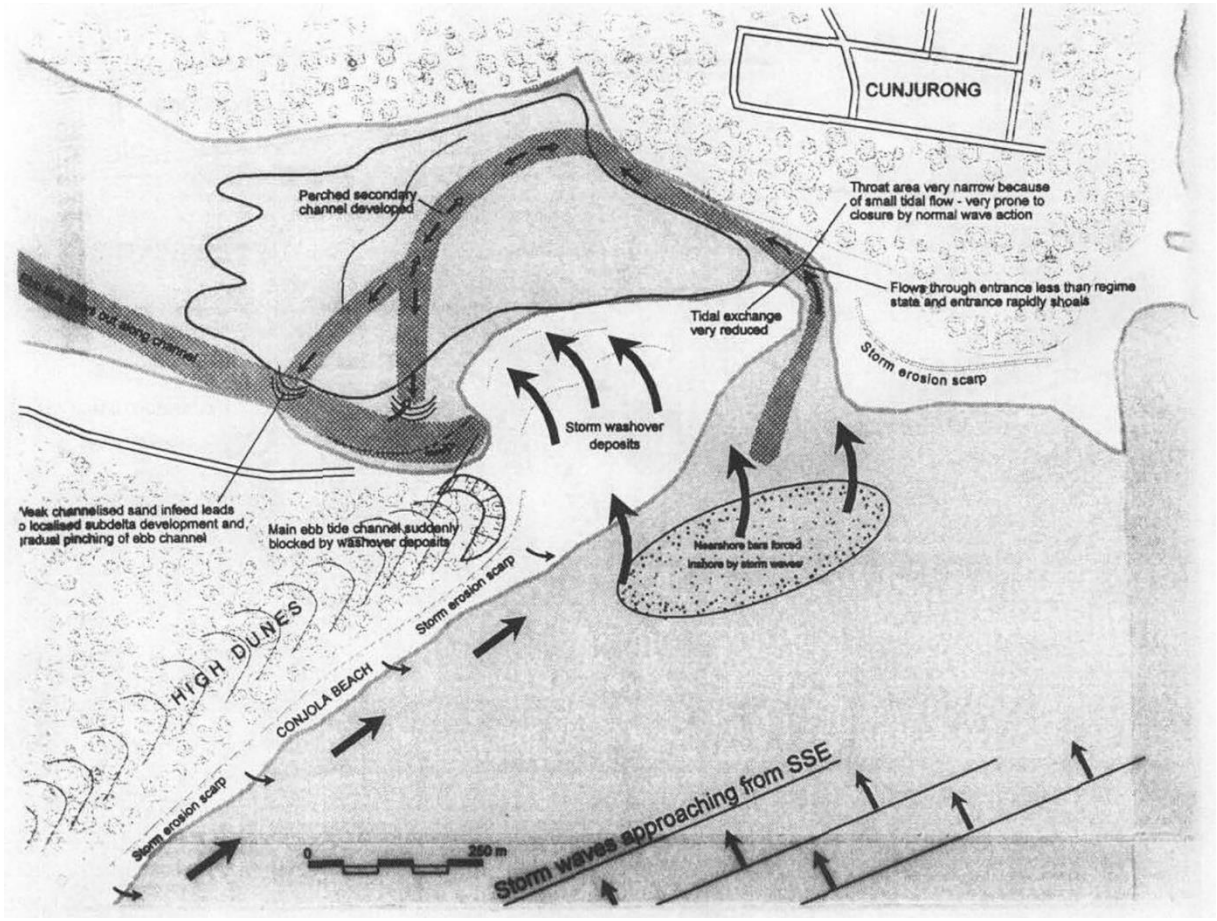


Figure 3-1 Schematic of Storm Washover Entrance State (Figure 2-11 from RHDHV Report C, March 2023)

Figure 3-2 Air photo showing Storm Washover Entrance State (from Council Coastal Fact Sheet: Lake Conjola Management, D19/412886)

Figure 3-3 Loss of distinct ebb tide channel due to storm washover – September 2011 (top) and September 2018 (bottom) (Figure 5-1 from RHDHV Report C, March 2023)

4. RATIONALE FOR CATEGORY 3 ENTRANCE MANAGEMENT OPTION – MODIFIED 'MANAGED ENTRANCE' (PILOT CHANNEL)

The Category 3 entrance management option as described in Report C comprises:
The entrance area is managed by way of occasional dredging whereby a channel is sustained in the position of the natural ebb tide channel, aligned behind the sand spit and directed towards the Cunjurong shoreline. Excavation of a pilot channel would also form part of this approach. It could also be combined with maintenance of a dry notch.

Inclusion of this Category of management option has been proposed to address the consequences of a storm washover event whereby the primary ebb tide channel becomes cut off/perched, the sand berm level increases in elevation, e.g. to 2m AHD or higher, and a pilot channel excavated to connect to deeper water upstream would be overly 'long', affecting response time and flooding risk. The required length of the pilot channel may also be affected by presence of shorebirds.

As an alternative to this management option, it would be possible to await a significant rainfall event that would increase the lake water level and render the required pilot channel shorter. Due to a number of circumstances, such a situation occurred in February 2020 (not by design). However, by this stage the lake water level had peaked at approximately 2m AHD in the entrance area, equivalent to about a 10% AEP (10 year ARI) flood event under current conditions, and would have caused above-floor flooding of an estimated 70 properties (BMT WBM, 2013a, b).

The Category 3 entrance management option was actually depicted graphically in Report C, reproduced below in Figure 4-1.

Figure 4-1 Diagram summarising concept for Category 3 entrance management options – air photo date 14 September 2018 (Figure 5-4 from RHDHV Report C, March 2023)

I trust this Memo provides the additional information Agencies are seeking. The intention would be to assess the Category 3 entrance management options in Stage 3 of the CMP unless otherwise directed by Council.

Appendix C: Cost Benefit Analysis Report

Economic Assessment

Lake Conjola Entrance Management Options

Prepared for

Royal HaskoningDHV

By

Gillespie Economics
Email: gillespieeconomics@gmail.com
Web: gillespieeconomics.com

May 2024

Contact Details

Dr Robert Gillespie
Principal, Gillespie Economics
Ph: 0419 448 238
Web: gillespieeconomics.com
Email: gillespieeconomics@gmail.com

Table of Contents

1. INTRODUCTION

1.1 General

Royal HaskoningDHV (RHDHV) was engaged by Shoalhaven City Council (Council) to prepare the Lake Conjola Coastline Management Program (CMP) within Council's local government area (LGA). The CMP was prepared in accordance with the Coastal Management Act 2016 and the State Environmental Planning Policy (SEPP) (Resilience and Hazards) 2021, both of which refer to the requirement for Council's to prepare a CMP.

Gillespie Economics was engaged by RHDHV to prepare a cost benefit analysis (CBA) in support of the Lake Conjola CMP. This CBA was generally prepared in accordance with the Guidelines for using cost-benefit analysis to assess coastal management options (DPIE 2020). Where it diverges from these guidelines an explanation is provided.

1.2 Study Area

Lake Conjola is located 50 km south of Nowra covering a surface area of 7km2 and draining a small catchment area of 145 km2 of mostly forested land managed by State Forests and National Parks and Wildlife Service. Lake Conjola is a wave dominated barrier estuary that is also an ICOLL (Intermittently Closed and Open Lake and Lagoon) that can stay open for periods of years but can also be subject to closure due to entrance shoaling. The lake is separated from the ocean by a shallow inlet constituting the marine delta of the Lake, which includes a complex series of channels and shoals. This area is on average 1 m deep and around 3 km long. Upstream of the marine delta, there is a rapid drop-off in the bathymetry (known locally as "The Step") and the lake widens to a sandy inner basin area which is around 10 m deep. The entrance to the lake is composed of a delta of clean marine sand which forms a berm to close the lake.

Challenges at Lake Conjola identified from the Stage 1 Scoping Study for the CMP include water quality (both actual and perceived), flooding and tidal inundation, entrance management, sedimentation of the entrance area, navigability for recreational craft, and preservation of Aboriginal heritage and shorebird nesting areas.

1.3 Study Objectives and Context

The purpose of the Lake Conjola CMP is to identify coastal management issues and the actions required to address these issues in a strategic and integrated way within the CMP study area, which includes the waterbody of Lake Conjola (including Berringer Lake), its adjacent foreshores, its catchment area, and the Lake entrance to the ocean.

The primary objective of this study is to undertake an economic assessment (CBA) of a shortlist of entrance management options identified by RHDHV. A CBA is also undertaken of a proposal for foreshore protection works within Lake Conjola.

2. COST BENEFIT ANALYSIS METHOD

2.1 Introduction

Economic assessment is primarily concerned with identifying changes in aggregate community welfare, associated with alternative resource use patterns. CBA is the standard technique applied to estimate these welfare changes.

2.2 CBA Method

CBA has its theoretical underpinnings in neoclassical welfare economics. CBA applications in NSW are guided by these theoretical foundations as well as NSW Treasury (2023). CBA applications for coastal hazards are further guided by DPIE (2020) *Guidelines for using cost-benefit analysis to assess coastal management options*.

CBA is concerned with a single objective of economic efficiency. It provides a comparison of the present value of aggregate benefits to society, because of a project, policy, or program, with the present value of the aggregate costs. These benefits and costs are defined and valued based on the microeconomic underpinnings of CBA. In particular, the values held by individuals in the society are relevant, including both financial and non-financial values. Provided the present value of aggregate benefits to society exceeds the present value of aggregate costs (i.e. a net present value of greater than zero), a project is considered to improve the well-being of society and hence relative to the 'without project' scenario is desirable from an economic efficiency perspective. Where there are multiple alternatives, the option with the highest net present value is preferable.

2.3 Definition of Society

CBA includes the consideration of costs and benefits to all members of society i.e. consumers, producers and the broader society as represented by the government.

The most inclusive definition of society includes all people, no matter where they live or to which government they owe allegiance to (Boardman et al. 2001). However, in practice most analysts define society at the national level based on the notion that the citizens of a country share a common constitution that sets out fundamental values and rules for making collective choices and that the citizens of other countries have their own constitutions that make them distinct societies (Boardman et al. 2001).

While most applications of CBA are performed at the national level, "*to incorporate national distinctions in a CBA is far easier said than done. Thus, many CBAs end up estimating the net benefits for global society, if only implicitly*" (Bureau of Transport Economics 1999, p. 2).

NSW Treasury (2023) guide on how to undertake CBA is applicable to NSW government initiatives. Its focus is therefore on NSW Government agencies. In this respect, NSW Treasury (2023, p. 10) states that *"CBA aims to measure the full impacts of any government decision or action on the households, businesses, governments, non-government organisations and natural assets in a specified community, known as the referent group. In this Guide, the referent group comprises the residents of New South Wales."*

To fully inform NSW decision-makers, the CBA can also include analysis of local and/or multi-jurisdictional impacts where relevant or required (for instance, by legislation). In cases where an initiative generates costs or benefits to neighbouring Australian jurisdictions, the CBA should report both:

- A central estimate showing costs and benefits to the NSW community, and
- Separate results showing any interstate costs and benefits.

DPIE (2020) identifies that "*The perspective adopted in a CBA should be determined by the purpose of the analysis. Where CBA is being used as a decision-support tool for councils assessing coastal management options, the focus of the CBA will be the local government area (LGA), and the overall frame of reference will be the LGA community as a whole. Even though councils do not operate as independent entities and council decisions can have impacts beyond LGA boundaries, the CBA will be concerned only with the question of whether the LGA community will be better off because of a particular management option being adopted. Where a broader state focus is sought, the CBA should adopt a statewide perspective.*"

For the purpose of this analysis, the CBA is undertaken from a NSW perspective initially with distributional analysis to also consider the costs and benefits to the Shoalhaven LGA community.

2.4 Identification of Incremental Costs and Benefits

In CBA the mechanisms that link resources i.e. land, labour and capital, to individual and community wellbeing (costs and benefits) are use of the resources (for example, commercial and non-commercial activities), and non-use (such as the preservation of natural ecosystems, species or special areas) (James and Gillespie 2002).

2.5 Measures of Economic Value

The economic values of goods and services to the community are measured by the consumer and producer surplus they provide.

Producer surplus values are relevant to government operations, such as management of dredging operations, provision of foreshore protection works etc, and market-based activities such as commercial tourism, and are measured via market data. Producer surplus is the difference between the costs of the inputs used in the provision of a good or services (economic cost to producers) and the price received for the goods and services (total benefit/revenue to producers). In practical terms, it is the net revenue that is earned by producers (James and Gillespie 2002). In some instances, for example government management of natural areas, the producer surplus may be negative i.e. just a cost with no associated revenue.

Consumer surplus values are relevant to non-market uses e.g. all types of non-commercial recreational activity, as well as non-use values. Consumer surplus is the difference between a person's willingness to pay (WTP) for a good or service (the total benefit to the consumers) and what they have to pay (the cost to the consumer i.e. consumer expenditure).

In the CBA framework a reduction in producer or consumer surplus is a cost, while an increase is a benefit.

2.6 Valuation of Nonmarket Costs and Benefits

A number of methods have been developed for valuing nonmarket (consumer surplus) impacts (Freeman III, 2003). These comprise revealed preference methods and stated preference methods (Whitten and

Bennett 2001; Bennett 1999). Revealed preference methods rely on observing the actual behaviour of consumers (Rolfe et al. 2004) in *"markets that are specifically related to the nonmarket value under consideration to infer value estimates"* (Bennett 1999, p 1). Stated preference methods rely on surveys of individuals to elicit values for a hypothetical environmental change (Freeman III, 2003).

In the absence of any primary nonmarket valuation study, it is necessary to use benefit transfer (BT). This is the approach used in this study. BT borrows economic values from so-called "study sites" for application to a site that must be evaluated (the "policy site"). However, with BT the user is constrained to the environmental attributes, metrics, levels of attributes and context of the source study.

Whether undertaking a primary valuation study or using benefit transfer, valuation of costs and benefits first requires quantification of the physical impacts of policies. This relies on the assessment of other experts e.g. engineers, ecologists etc to identify the magnitude of biophysical impacts. Only once the magnitudes of physical effects are identified can they be valued using market and nonmarket valuation methods or BT.

For the CBA of the CMP options, physical quantification of impacts relied on expert advice from Royal HaskoningDHV.

Valuation of all impacts is neither practical nor necessary. Only those impacts which are likely to have a material bearing on the outcome of the analysis need to be considered in CBA (NSW Government, 2012). Where benefits and costs cannot be quantified these items should be included in the analysis in a qualitative manner (NSW Treasury, 2007). The focus in the CBA of the CMP options was on the main impacts of the options.

2.7 Time Frame

DPIE (2020) identifies that "*The CBA evaluation period should be long enough to capture all costs and benefits attributable to the option under consideration. The timeframe should reflect the expected economic life of the principal asset (e.g. coastal protection works). This timeframe is generally deemed to be the expected design life of the principal asset. It is recommended that long-term projects use a 30-year timeframe post construction, consistent with the NSW Government Guide to Cost-Benefit Analysis, Policy and Guidelines Paper TPP17-03 (2017), and where applicable, a residual value for impacts beyond that time period. However, where predictable and relevant, a longer timeframe can be adopted, as has been done for CBAs of seawalls with a design life of 50 years.*"

NSW Treasury (2023) states that the analysis period should be long enough to capture all significant costs and benefits of the initiative. An analysis period of 30 to 60 years for is suggested for capital infrastructure projects and an analysis period of up to 20 years is suggested for recurrent projects to match funding commitments.

Discounting future costs and benefits by the NSW Government recommended discount rate reduces the significance of costs and benefits beyond 20 to 30 years in the future. Consequently, for this analysis a timeframe of 30 years is used.

2.8 Discounting

Costs and benefits occurring in different time periods require discounting to present value so that the benefits can be compared to costs on a common basis. Discounting reflects the fact that individuals and society prefer a dollar today to a dollar in the future.

There are two main approaches to determining the appropriate discount rate:

- the social time preference rate (STPR) - consumer's rate of time preference i.e. society's view of what at the margin is an appropriate tradeoff for individuals between now and the future.
- the social opportunity cost of capital (SOC) - represents real return on capital or producer's rate of discount (NSW Treasury 2007).

DPIE (2020) recommends a discount rate of 7% with sensitivity testing using a 4% and 10% rate consistent with NSW Treasury. NSW Treasury (2023) has now revised its recommended discount to 5% reflective of the SOC with sensitivity testing at 3% and 7%. These are the discount rates used in this CBA.

2.9 Risk and Uncertainty

The net present value (NPV) estimates presented in most *ex-ante* cost benefit analyses are based on future values being achieved with certainty. However, future values are subject to risk and uncertainty. In economic analysis, there is a difference between risk and uncertainty. Risk is measurable; it refers to situations with known probabilities. Uncertainty in contrast is vague; as it is characterised by a lack of information on the likelihood of occurrence of different impacts.

One way of incorporating risk into a CBA is to use expected values instead of certain values. This requires the range of potential outcomes being assigned probabilities. Expected values are the certain values multiplied by the probability of their occurrence. Where outcomes require a sequence of future events to occur, expected values will depend upon the product of the probabilities of each sequential event. The result is an expected net present value (ENPV). Other approaches include Monte Carlo simulations.

When uncertainty is encountered in an economic appraisal, the most commonly applied technique is sensitivity analysis. This involves changing the values of critical variables and discount rates used in the analysis to determine how the overall CBA results might be affected.

For this CBA, probability information was not available. Consequently, only sensitivity analysis was undertaken.

2.10 Consideration of the Distribution of Costs and Benefits

While CBA, undertaken at different scales, can provide qualitative and quantitative information on how costs and benefits are distributed, welfare economics and CBA are explicitly neutral on intra and intergenerational distribution of costs and benefits. There is no welfare criterion in economics for determining what constitutes a 'fair and equitable' distribution of costs and benefits. Judgments about intra and intergenerational equity are subjective and are therefore left to decision-makers.

Nevertheless, it should be noted that the costs and benefits included in a CBA are defined and valued based on the values held by individuals in the current generation. There is no way to measure the value that future

generations may hold for impacts of current day projects as they are not here to express it. However, as identified by Boardman et al. (2001) this is not considered a serious problem for CBA because:

- Few policies involve impacts that only appear in the far future. Consequently, the WTP of people alive today can be used to predict how future generations will value them.
- Most people alive today care about the wellbeing of their children, grandchildren, and great grandchildren, whether or not they have yet been born. They are therefore likely to include the interests of these generations to some extent in their own valuations of impacts. Because people cannot predict with certainty the place that their future offspring will hold in society, they are likely to take a very broad view of future impacts.
- Discounting used in CBA also reduces the influence of costs and benefits that occur a long way into the future.

Furthermore, increased wealth generated by projects that have a net benefit to the current society can be used to improve the services (e.g. health, school and community services) and the environment (e.g. protected areas) that are passed on to future generations.

As identified by the Productivity Commission (2006), a policy option that provides the highest net benefit, as indicated by CBA, would also be consistent with the principles of ecologically sustainable development.

2.11 Consideration of Other Objectives of Government

CBA does not address other objectives of governments. Decision-makers therefore need to consider the economic efficiency implications of a project, as indicated by CBA, alongside the performance of a project in meeting other often conflicting goals and objectives of government.

2.12 Key Steps in Cost Benefit Analysis

The key steps in CBA are summarised below.

Step 1: **Define the problem and the need for action**

Step 2: **Establish the base case** against which to assess the potential incremental economic, social, and environmental impacts of changes due to the project.

Step 3: **Define the management options to be considered**.

Step 4: **Identify the incremental costs and benefits of options**

Step 5: **Quantify the physical changes** from the base case resulting from management options. This would focus on the incremental changes to a range of factors (for example, environmental, economic, social) resulting from the project.

Step 6: **Estimate the monetary value of these changes** and aggregate these values in a consistent manner to assess the outcomes. Where market prices exist, they are a starting point for valuations of both outputs and of inputs used for production. For non-market goods, as for many environmental impacts and some social impacts, the aim is to value them as they would be valued in monetary terms by the individuals who experience them.

Step 7: **Estimate the Net Present Value (NPV)** of the project's future net benefits, using an appropriate discount rate.

Step 8: **Undertake sensitivity analysis** on the key range of variables, particularly given the uncertainties related to specific benefits and costs.

Step 9: **Assess the distribution of costs and benefits** across different groups.

Step 10: **Report CBA results**, including all major unquantified impacts so the appraisal addresses and incorporates all material relevant to the decision maker.

Source: OEH (2018)

3. COST BENEFIT ANALYSIS OF LAKE CONJOLA ENTRANCE MANAGEMENT[1]

3.1 Identification of the Problem

The floodplains of Lake Conjola have been developed over time and are subject to periodic flooding particularly when the lake entrance is closed. Actions to limit flooding impacts include management of the entrance opening.

A number of different types of intervention options at the entrance are possible to reduce the flooding impacts in Lake Conjola. However, from an economic efficiency perspective, interventions are only desirable if the benefits of the interventions exceed the costs of the interventions.

Where there are multiple alternative intervention options, the intervention option with the greatest net benefit is preferred from an economic efficiency perspective. This is the subject of the CBA.

3.2 Base Case (Option1)

The base case is the scenario that would arise if no new specific entrance management interventions (investments or management actions) were taken to address flooding risks in Lake Conjola. It is a 'business as usual' option, rather than a 'do nothing' approach, and hence includes a continuation of currently programmed actions. For this analysis, it is assumed that the base case (Option 1 in the CMP) involves the continuation of the current practice of mechanical opening of the entrance (excavation of a pilot channel) in response to lake water level triggers. However, the planned implementation and operation of a Total Flood Warning System (TFWS) under the floodplain management program, as opposed to the CMP, is also assumed to be in place as part of the base case, as well as for other options.

3.3 Alternative Management Options

RHDHV has developed the following two main alternative entrance management options[2] to reduce the flood impacts in Lake Conjola:

- Option 2 Dry Notch Maintenance includes:
    - the continuation of the current practice of mechanical opening of the entrance in response to lake water level triggers.
    - the planned implementation and operation of a TFWS.
    - maintenance of a shallow excavated zone through the entrance spit during closed entrance periods, referred to as a 'dry notch'.
- Option 3 Occasional Ebb Tide Channel Dredging and Dry Notch Maintenance includes:
    - the continuation of the current practice of mechanical opening of the entrance in response to lake water level triggers.
    - the planned implementation and operation of a TFWS.

[1] This section is based on information provided by Royal HaskoningDHV and information from Royal HaskoningDHV (2023).
[2] It is noted that the option to construct engineering works to create a permanent entrance channel was excluded from the CBA at an early stage due to the consideration of the unacceptable adverse impacts on environmental and social values of the lake and the high capital costs associated with this option.

- maintenance of a shallow excavated zone through the entrance spit during closed entrance periods, referred to as a 'dry notch'.
- occasional dredging of the ebb tide channel within the entrance area in response to a severe storm washover event.

3.4 Identification of Incremental Costs and Benefits

Each intervention may have a range of potential costs and benefits relative to the base case. To facilitate the identification and valuation of incremental costs and benefits of options over time, two types of years are distinguished, normal years and infill years. Normal years refers to those years where there are normal conditions at the entrance channel. Infill years refer to those years where there are additional entrance shoals due to a severe storm washover event and hence greater effort is required for any mechanical opening.

Table 3.1 summarises the main potential costs and benefits of entrance management interventions at Lake Conjola.

Under the base case (Option 1) and Options 2 and 3 there will be capital and operating costs associated with the TFWS. However, these costs are the same for each option and so there are no incremental costs of Options 2 and 3 associated with the TFWS.

Under Option 2 the mechanical opening costs in normal years are the same as the base case (Option 1) because there is only a very minor reduction in volume to be removed due to the maintenance of a dry notch. For Option 3 mechanical opening costs are less overall because under this option the entrance is expected to be open more often due to the effects of dredging during infill years and for several years afterwards and would not require mechanical opening during these times.

For infill years, the mechanical opening costs for Option 2 are the same as the base case (Option 1) because the maintenance of the dry notch only results in a minor reduction in the volume required to be removed for pilot channel excavation. There are no mechanical opening costs incurred during infill years for Option 3 and for several years afterwards due to the expected benefits of an open entrance condition from occasional dredging of the entrance in these infill years.

An annual dry notch maintenance cost in normal years is a feature of both Option 2 and Option 3 and hence relative to the base case there is an additional cost of these Options. However, the cost of Option 3 is less than that for Option 2 because dredging increases the number of years that the entrance is open and hence reduces the number of normal years where dry notch maintenance is required.

An annual dry notch maintenance cost in infill years is also applicable to Option 2. However, it is not required for Option 3 because occasional dredging of the entrance addresses the infill.

For Option 3 there are also costs associated with hydrographic survey and dredging campaigns.

On the benefit side, Option 2 and 3 reduce peak flooding levels and hence reduce average annual flood damage costs. These benefits are the same for Options 2 and 3.

Table 3.1 – Costs and Benefits Items for Each Investment Option and Direction of Change Relative to Base Case

Costs and Benefits	Base Case Option 1	Option 2	Option 3
Total Flood Warning System Installation Costs (Capital Costs)	XX	XX	XX
Total Flood Warning System Maintenance Costs)	XX	XX	XX
Mechanical Opening Costs (normal years)	XX	XX	X
Mechanical Opening Costs (infill years)	XX	XX	X
Dry notch maintenance costs (normal years)		XX	X
Dry notch maintenance costs (infill years)		XX	
Hydrographic survey (infill years)			XX
Dredging costs (per campaign)			XX
Avoided flood damage	X	XX	XX

Note: The number of Xs indicates the relative size of the costs.

Table 3.2 converts Table 3.1 to just the incremental costs of Options 2 and 3. This is the basis of the CBA.

Table 3.2 – Costs and Benefits Items for Each Investment Option Relative to Base Case

Potential Costs	Option 2	Option 3
Incremental Total Flood Warning System Installation Costs (Capital Costs)		
Incremental Total Flood Warning System Maintenance Costs)		
Mechanical Opening Costs (normal years)		
Mechanical Opening Costs (infill years)		
Dry notch maintenance costs (normal years)	XX	X
Dry notch maintenance costs (infill years)	XX	
Hydrographic survey (infill years)		XX
Dredging costs (per campaign)		XX
Potential Benefits		
Reduced Mechanical Opening Costs normal years)		X
Reduced Mechanical Opening Costs (infill years)		X
Reduced flood damage	X	X

Note: The number of Xs indicates the relative size of the costs.

It should be noted that assessment of surface water quality data within the Lake was carried out as part of the development of the CMP. This showed that water quality is satisfactory, including when the entrance is closed. Consequently, there are no incremental benefits of Options 2 and 3 in relation to water quality.

3.5 Quantification and Valuation of Costs and Benefits

3.5.1 Biophysical Assumptions

It is difficult to accurately predict the behaviour of the coastal processes, and the physical and monetary impacts on stakeholders under the different options. It is therefore necessary to make several assumptions about the impact of options and the response of stakeholders.

The central analysis assumes that infill of the ebb tide channel due to a severe storm washover event occurs every 10 years. However, the results were also tested for a 5-year and 15-year frequency of infill of the ebb tide channel.

For the 10-year frequency analysis, the timing and frequency of expenditures is summarised in Table 3.3.

Table 3.3 – Timing and Frequency of Costs for 10-Yearly Infill Shoaling Conditions Scenario

Costs	Option 1	Option 2	Option 3
TFWS Installation Costs	Year 1	Year 1	Year 1
TFWS Maintenance Costs	Annual	Annual	Annual
Mechanical Opening costs – normal years	Years 2-10, 12-20, 22-30	Years 2-10, 12-20, 22-30	Years 7-10, 17-20, 27-30
Mechanical Opening - infill years	Years 1, 11, 21	Years 1, 11, 21	
Dry notch maintenance cost - normal years		Years 2-10, 12-20, 22-30	Years 7-10, 17-20, 27-30
Dry notch maintenance cost – infill years		Years 1, 11, 21	
Hydrographic survey			Years 1, 11, 21
Dredging costs			Years 1, 11, 21

3.5.2 Costs

Cost assumptions are summarised in Table 3.4.

Table 3.4 – Cost Assumptions

	Base Case (Option 1)	Option 2	Option 3
TFWS Installation Costs	$160,000	$160,000	$160,000
TFWS Maintenance Cost (per annum)	$35,000	$35,000	$35,000
Mechanical Opening costs - normal years (per annum)	$5,000	$50004,514	$5,000
Mechanical Opening - infill years (per annum)	$5,000	$5,000	
Mechanical Opening - post infill year (per annum)	$7,500	$7,500	
Dry notch maintenance cost – normal years (per annum)		$1,200	$1,200
Dry notch maintenance cost - infill years (per annum)		$10,000	
Hydrographic survey - (per dredging campaign)			$10,000
Dredging costs (per dredging campaign)			$1,528,000

3.5.3 Benefits

The primary benefit of Options 2 and 3, relative to Option 1 (Base Case) is to reduce the average annual damage (AAD) cost of flooding. Royal HaskoningDHV estimated the AAD for each option based on previous studies that estimate AAD for different entrance conditions, the frequency of different entrance conditions, and estimates of reductions in peak flood levels for different flood frequencies from implementation of each option. The results are reported in Table 3.5.

Table 3.5 – Factored AAD Values for Entrance Management Options

Option	Entrance Open AAD (64%)	Entrance Closed AAD (12%)	Heavily Shoaled AAD (24%)*	Factored AAD
2013 FRMS&P	$6,204,057	$8,610,927	-	-
Option 1	$6,204,057	$4,939,187	$5,571,622	**$5,900,488**
Option 2	$6,204,057	$4,544,314	$5,374,186	**$5,805,719**
Option 3	$6,204,057	$4,544,314	$5,374,186	**$5,805,719**

* Heavily shoaled AAD = average of entrance open AAD & entrance closed AAD

3.5.4 Estimation of Net Present Value of Options

The net present value of options, relative to the base case, are presented in Table 3.6. This indicates that Option 2 provides a positive NPV and hence is justified from an economic efficiency perspective. Option 3 has a negative NPV, indicating that the present value of costs is greater than the present value of benefits.

The key driver of this result is that Option 3 is over 80 times more costly (primarily due to dredging costs) while providing no additional reduction in AAD.

Table 3.6 – Incremental Costs and Benefits of Options – 10-year Frequency of Infill Shoaling Conditions (Present Value at 5% Discount Rate)

	OPTION 2	OPTION 3
Potential Costs		
Incremental Total Flood Warning System Installation Costs	$0	$0
Incremental Total Flood Warning System Maintenance Costs	$0	$0
Incremental Mechanical Opening Costs (normal years)	$0	$0
Mechanical Opening Costs (infill years)	$0	$0
Dry notch maintenance costs (normal years)	$16,172	$6,321
Dry notch maintenance costs (infill years)	$18,960	$0
Hydrographic survey (infill years)	$0	$18,960
Dredging costs (infill years)	$0	$2,897,092
Sub-total	***$35,132***	***$2,922,373***
Potential Benefits		
Reduced Mechanical Opening Costs (normal years)	$0	$49,857
Reduced Mechanical Opening Costs (infill years)	$0	$9,480
Reduced flood damage	$1,456,840	$1,456,840
Sub-total	***$1,456,840***	***$1,516,177***
Net Benefit	**$1,421,708**	**-$1,406,196**
BCR	**41.47**	**0.52**

3.5.5 Sensitivity Analysis

Table 3.7 shows the results of the analysis for a 5-year and 15-year frequency for infill of the ebb tide channel.

This indicates that for Option 2 the frequency of infill conditions has little effect on the NPV of the option. However, for Option 3 the frequency of infill conditions has a large impact. Net costs are considerably larger the more frequent the infill conditions occur. This is because of the more frequent dredging that is required under this option.

Under all frequencies of infilling, Option 2 has a positive net present value and hence is desirable from an economic efficiency perspective. Option 3 has a negative net present value under all options.

Large changes in unit cost and benefit assumptions would not change the results or the ranking of options. For instance, reduced flood damages would need to almost double for Option 3 to have a positive NPV. However, this would also increase the NPV of Option 2 relative to Option 3. Dredging costs would need to almost halve for Option 3 to have a positive NPV. But even under this extreme assumption Option 2 would still have a higher NPV.

Table 3.7 – Incremental Costs and Benefits of Options – 5-Year and 15-Year Frequency of Infill Shoaling Conditions (Present Value at 5% Discount Rate)

	5-YEAR		15-YEAR	
	OPTION 2	**OPTION 3**	**OPTION 2**	**OPTION 3**
Potential Costs				
Incremental Total Flood Warning System Installation Costs	$0	$0	$0	$0
Incremental Total Flood Warning System Maintenance Costs	$0	$0	$0	$0
Incremental Mechanical Opening Costs (normal years)	$0	$0	$0	$0
Mechanical Opening Costs (infill years)	$0	$0	$0	$0
Dry notch maintenance costs (normal years)	$14,389	$6,844	$16,754	$6,960
Dry notch maintenance costs (infill years)	$33,816	$0	$14,105	$0
Hydrographic survey (infill years)	$0	$33,816	$0	$14,105
Dredging costs (infill years)	$0	$5,167,039	$0	$2,155,233
Sub-total	***$48,205***	***$5,207,699***	***$30,859***	***$2,176,298***
Potential Benefits				
Reduced Mechanical Opening Costs (normal years)	$0	$47,158	$0	$47,365
Reduced Mechanical Opening Costs (infill years)	$0	$16,908	$0	$7,052
Reduced flood damage	$1,456,840	$1,456,840	$1,456,840	$1,456,840
Sub-total	***$1,456,840***	***$1,520,906***	***$1,456,840***	***$1,511,257***
Net Benefit	**$1,408,635**	**-$3,686,793**	**$1,425,981**	**-$665,041**
BCR	**30.22**	**0.29**	**47.21**	**0.69**

Table 3.8 indicates that the above results are not sensitive to changes in the discount rate.

Table 3.8 – Incremental Costs and Benefits of Options by Frequency of Infill Shoaling Conditions at Varying Discount Rate (Present Value)

		Option 2			Option 3		
Frequency of Infill Shoaling Conditions		**3%**	**5%**	**7%**	**3%**	**5%**	**7%**
5-Year	NPV	$1,797,438	$1,408,635	$1,136,218	-$4,461,744	-$3,686,793	-$3,127,032
	BCR	30.91	30.22	29.56	0.30	0.29	0.28
10-year	NPV	$1,814,372	$1,421,708	$1,146,578	-$1,509,189	-$1,406,196	-$1,318,739
	BCR	43.05	41.47	39.97	0.56	0.52	0.48
15-Year	NPV	$1,819,976	$1,425,981	$1,149,903	-$538,548	-$665,041	-$741,053
	BCR	49.47	47.21	45.06	0.78	0.69	0.62

3.5.6 Distribution of Costs and Benefits

The CBA can be used to identify who initially bears the costs and who obtains the benefits of intervention options. Table 3.9 identifies the magnitude of incremental costs and benefits for Options 2 and 3 with 10-

year Frequency of Infill Shoaling Conditions (Present Value at 5% Discount Rate) and the incidence of these costs and benefits.

All costs will be borne by Council. Beneficiaries are owners of flood prone assets. These may include Council, residents, and holiday home/caravan owners.

Table 3.9 – Incidence of Costs and Benefits for Option 2 and 3 with 10-year Frequency of Infill Shoaling Conditions (Present Value at 5% Discount Rate)

	OPTION 2	OPTION 3	INCIDENCE OF COSTS AND BENEFITS
COSTS			
Dry notch maintenance costs (normal years)	$16,172	$6,321	Council
Dry notch maintenance costs (infill years)	$18,960	$0	Council
Hydrographic survey (infill years)	$0	$18,960	Council
Dredging costs (infill years)	$0	$2,897,092	Council
BENEFITS			
Reduced Mechanical Opening Costs (normal years)	$0	$49,857	Council
Reduced Mechanical Opening Costs (infill years)	$0	$9,480	Council
Reduced flood damage	$1,456,840	$1,456,840	Owners of Flood Prone Assets

4. COST BENEFIT ANALYSIS OF FORESHORE PROTECTION[3]

4.1 Introduction

There are a number of foreshore areas of publicly-owned land that have been identified as priority areas for remediation. This includes the potential construction of upgraded foreshore protection along the lake embankment between Conjola Village Boat Ramp and the foreshore reserve to the west of the Post Office at Conjola Village. This length of foreshore includes the parcel of Crown Land covering the Conjola Village Boat Ramp and the Holiday Haven Lake Conjola Caravan Park, and the parcel of Council-owned foreshore reserve adjacent to Carroll Avenue.

4.2 Costs

The costs for construction and maintenance of foreshore protection works have been estimated for each section of foreshore, based on liaison with local contractors and pricing from previous projects, and are summarised in Table 4.1.

Table 4.1 – Costs of Foreshore Protection at Conjola Village

Foreshore Area Reference	Length (m)	Fixed Costs ($)	Rate ($/m)	Capital Cost	Design/Approvals/PM (10%)	Maintenance Cost (1% p.a.)
FB1.02	76.7	$35,000	$1,200	$127,040	$12,704	$1,270
FB1.03	90.5	$35,000	$1,200	$143,600	$14,360	$1,436
FB1.04	156.8	$35,000	$1,500	$270,200	$27,020	$2,702
FB1.05	38.9	$35,000	$1,200	$81,680	$8,168	$817
FB1.06	37.1	$35,000	$1,500	$90,650	$9,065	$907
FB1.07	47.7	$35,000	$1,200	$57,240	$5,724	$572
FB1.08	303.5	$35,000	$1,200	$399,200	$39,920	$3,992
FB1.09	60.7	$100,000	$3,400	$306,380	$30,638	$3,064
Totals	**811.9**			**$1,475,990**	**$147,599**	**$14,760**

Table 4.2 calculates the present value of costs over time using the recommended NSW Treasury discount rates.

Table 4.2 – Present Value of Costs of Foreshore Protection at Conjola Village

Foreshore Area Reference	Discount Rate		
	3%	5%	7%
FB1.02	$159,341	$151,409	$145,179
FB1.03	$180,111	$171,145	$164,103
FB1.04	$338,900	$322,030	$308,780
FB1.05	$102,448	$97,348	$93,342
FB1.06	$113,698	$108,038	$103,593
FB1.07	$71,794	$68,220	$65,413
FB1.08	$500,699	$475,774	$456,199
FB1.09	$384,279	$365,150	$350,126
Total	**$1,851,271**	**$1,759,114**	**$1,686,735**

[3] This section is based on information provided by Royal HaskoningDHV and information from Royal HaskoningDHV (2023).

4.3 Benefits

Potential benefits of foreshore protection work include:

- reduction of erosion and hence reduction in adhoc costs of remediation.
- reduction of erosion and hence reduction in loss of foreshore land.
- amenity improvement for those using the foreshore area and for homes that have foreshore access.
- safety improvement for those using the foreshore.
- improvement in health of foreshore trees impacted by erosion.
- benefits from environmentally friendly seawall construction and any aquatic vegetation reestablishment.

Two types of information are required to estimate the economic value of the abovementioned benefits, quantity of the improvement, e.g. how many accidents would be avoided per year, and unit value, e.g. what is the average cost per accident that is avoided or community WTP to avoid the risk of accident. This level of information is not available currently and hence a more quantitative CBA is not possible.

However, since economic benefits are defined in terms of community WTP for the outcomes listed above, foreshore protection works can be considered using threshold value analysis. In this framework, the cost of providing foreshore protection works provides the threshold value that the benefits (community WTP) would need to exceed to make the benefits of the works exceed the costs.

Using this framework, the community of Shoalhaven LGA would in aggregate need to be willing to pay more than $1.76M (present value) for the benefits of foreshore protection, to make investment in foreshore protection works economically efficient. This is equivalent to an average one-off payment (WTP) of $38 per household, or an annual payment (WTP) for 5 years of $8.65, or an annual payment (WTP) for 10 years of $4.85.

The threshold WTP per household is smaller if the households of NSW are considered to be the relevant referent group.

In the absence of a nonmarket valuation study to test the level of community WTP, it is left to the decision-maker to consider whether community WTP would likely reach the required threshold.

5. CONCLUSION

Lake Conjola experiences flooding and tidal inundation. Entrance management is a means of mitigating flooding impacts.

A CBA was undertaken of two alternative entrance management options relative to the base case (Option 1) of continuation of current and programmed management:

- Option 2 – maintenance of a dry notch.
- Option 3 – maintenance of a dry notch and occasional ebb tide channel dredging in response to infill caused by severe storm washover events.

The CBA found that Option 2 provides a positive NPV and hence is justified from an economic efficiency perspective. Option 3 has a negative NPV, indicating that the present value of costs is greater than the present value of benefits.

The key driver of this result is that Option 3 is over 80 times more costly (primarily due to dredging costs) while providing no additional reduction in AAD. This result was not sensitive to changes in the discount rate and changes in assumptions regarding the frequency of infill conditions.

There is potential for some incremental recreation benefits of Options 2 and 3 relative to the base case as they both result in reduced flooding relative to the Option 1 (the base case). However, the benefit would be the same for Options 2 and 3, as these options result in the same level of AAD reduction. While inclusion of these potential benefits would increase the NPV of both options it would not change the ranking of the Options.

The use of AAD to estimate the benefits of reduced flooding is consistent with the guidelines and general practice. However, the use of AAD rather than the community's WTP to reduce the risk of flooding may understate the value of reducing flood impacts. This is because AAD estimates are focused on property damage accruing to property owners and not the WTP of the impacted property owners AND the general community to reduce flooding risk. WTP is the more conceptually correct measure of benefits. Notwithstanding, because Options 2 and 3 result in the same AAD reduction, community WTP may not change the ranking of options. It may however increase the NPV of both options.

If additional recreation benefits or other general community well-being benefits were to arise from the more frequently open lake entrance under Option 3 compared to Option 2, this may improve the NPV of Option 3. However, this remains an untested proposition.

6. REFERENCES

Bennett, J. (1999) *Some Fundamentals of Environmental Choice Modelling*, Choice Modelling Research Reports, Research Report No. 11.

Boardman, A., Greenberg, D., Vining, A. and Weimer, D. (2001) *Cost-Benefit Analysis: Concepts and Practice*, Prentice Hall, USA.

Bureau of Transport Economics (1999) *Facts and furphies in Benefit Cost Analysis: transport*, Commonwealth of Australia.

Freeman III, A. Myrick. (2003) *Economic Valuation: What and Why*. In A Primer on Nonmarket Valuation, Eds Champ, P., Boyle, K. and Brown, T. Kluwer Academic Publishers, London.

James, D. and Gillespie, R. (2002) *Guideline for economic effects and evaluation in EIA*, prepared for Planning NSW.

NSW Department of Planning, Infrastructure and Environment (2020) *Guidelines for using cost-benefit analysis to assess coastal management options*.

NSW Government (2012) *Guideline for the use of Cost Benefit Analysis in mining and coal seam gas proposals*

NSW Treasury (2007) *NSW Government Guidelines for Economic Appraisal*, Policy and Guideline Paper TPP07-5.

NSW Treasury (2017) *NSW Guide to Cost-Benefit Analysis*, Policy and Guideline Paper TPP 17-03.

NSW Treasury (2023) *NSW Government Guide to Cost-Benefit Analysis*, TPG23-08.

Office of Environment and Heritage (2018) *Guidelines for using cost-benefit analysis to assess coastal management option*s, Office of Environment and Heritage, Sydney.

Productivity Commission (2006) *Waste Management, Productivity Commission Inquiry Report No. 38,* Commonwealth of Australia

Rolfe, J. Alam, K., Windle, J. and Whitten, S. (2004) *Designing the Choice Modelling Survey Instrument for Establishing Riparian Buffers in the Fitzroy Basin*, Research Report No. 3, Establishing the Potential for Offset Trading in the Lower Fitzroy River Research Reports, Central Queensland University, Emerald, QLD.

Royal HaskoningDHV (2023) *Lake Conjola Coastal Management Program: Stage 3 Identify and Evaluate Options,* prepared for Shoalhaven City Council.

Whitten, S. and Bennett, J.W. (2001) *Non-market values of wetlands: A choice modelling study of wetlands in the Upper South East of South Australia and the Murrumbidgee River floodplain in New South Wales*, Private and Social Values of Wetlands Research Reports, University of NSW, Canberra, Australia.

Appendix D: Entrance Management Options Numerical Modelling Report

REPORT

Lake Conjola Entrance Management Options Assessment

Numerical Modelling

Client: Shoalhaven City Council

Reference: PA2591-RHD-XX-XX-RP-X-0001

Status: Final/3.0

Date: 16 April 2024

Royal HaskoningDHV

Enhancing Society Together

HASKONING AUSTRALIA PTY LTD.

Level 15
99 Mount Street
North Sydney NSW 2060
Australia
Water & Maritime

+61 2 8854 5000 **T**
project.admin.australia@rhdhv.com **E**
royalhaskoningdhv.com **W**

Document title:	Lake Conjola Entrance Management Options Assessment
Subtitle:	Numerical Modelling
Reference:	PA2591-RHD-XX-XX-RP-X-0001
Your reference	
Status:	Final/3.0
Date:	16 April 2024
Project name:	Lake Conjola CMP
Project number:	PA2591
Author(s):	Arjen Overduin

Drafted by:	Arjen Overduin
Checked by:	Matt Potter
Date:	16.04.2024
Approved by:	Greg Britton
Date:	16.04.2024

Classification
Project related

Table of Contents

Table of Tables

Table of Figures

1 Introduction

A numerical modelling study has been undertaken to inform the assessment of a range of entrance management options for the Lake Conjola entrance as part of the Lake Conjola Coastal Management Program (CMP). These entrance management options fall into four categories involving progressively greater levels of mechanical intervention at the entrance, summarised as follows:

- Category 1: The entrance area is allowed to behave naturally. Mechanical opening of the entrance in the form of excavation of a pilot channel is carried out in response to lake water level triggers;
- Category 2: The entrance area is managed by way of a dry notch approach whereby the sand levels in the entrance area (above water level) are regularly mechanically groomed to facilitate an easier mechanical opening (excavation of a pilot channel), when lake water level trigger levels are met;
- Category 3: The entrance area is managed by way of occasional dredging whereby a channel is sustained in the position of the natural ebb tide channel to avoid the need to excavate an overly long pilot channel to achieve a mechanical opening following a severe storm washover event, when lake water level triggers are met. This management approach could also be combined with maintenance of a dry notch; and
- Category 4: Engineering works are constructed in the entrance area, such as entrance breakwaters, to create a permanently open entrance, in which case mechanical opening would not be required.

The numerical modelling study considered several key factors that influence the effectiveness of the Category 1, 2 and 3 options. In addition, the study directly modelled the Category 2 dry notch, and the Category 4 permanent entrance. The several key influencing factors were as follows:

- Alternative lake water level triggers for mechanical entrance opening;
- Length of the pilot channel; and
- Timing of a mechanical entrance opening relative to ocean tide (for this purpose three tidal planes, i.e., MLWS, MSL and MHWS, occurring in the 2008 (April) Ulladulla Harbour tide record were utilised).

Following the above, the February 2020 flood event and subsequent mechanical entrance opening is discussed. A number of key data was available for this event, including lake level, ocean tide level, an estimate of catchment inflow based on hydrologic modelling (using the existing hydrological model provided by Council), and photographic evidence of the mechanical entrance opening providing insight into the approximate breakout channel length and depth. This enabled a reasonable calibration exercise for a breakout event. Following the calibration exercise, a number of alternative mechanical breakout scenarios were assessed for this February 2020 flood event. These comprise:

- Inclusion of a dry notch;
- Earlier opening (6.30AM instead of 11AM); and
- Earlier opening including dry notch.

The numerical modelling assessment is set out in this document, presenting a factual description of model inputs and model simulations completed, under the following main headings:

- Model system and limitations in **Section 2**;

- Modelling simulations in **Section 3**; and,
- February 2020 Flood Event in **Section 4**;
- References in **Section 5**.

2 Model Specifications

2.1 Model System

The MIKE 21 software package has been adopted for use in this study. MIKE 21 is a computer program that simulates flows, waves, sediment transport and ecology in rivers, lakes, estuaries, bays, coastal areas and seas in two dimensions. MIKE is developed by the Danish Hydraulic Institute (DHI).

The Flexible Mesh (FM) version of MIKE 21 has been adopted as it allows the spatial resolution of the computational grid to be locally increased in areas of interest, e.g., at the lake entrance (order of 3m spatial resolution), while the resolution in other areas can be coarser to help maintain acceptable model run times (main lake body, offshore). The spatial discretisation of the equations in MIKE 21 FM is performed using a cell-centred finite volume method. Two MIKE 21 modules are used in the present study:

- Hydrodynamic module (simulation of water level variations and flows in response to a variety of forcing functions on flood plains, in lakes, estuaries and coastal areas); and
- Sediment transport module (simulation of the erosion, transport, settling and deposition of sediment in marine, brackish and freshwater areas).

For the simulations of sediment transport (entrance breakout) the above two modules were coupled.

2.2 Model Mesh and Bathymetry

The model mesh and bathymetry utilised in this assessment is presented in **Figure 2-1**. The inset to this Figure shows, marked by the cross ('x'), the location at which the time-series for bed level changes in the model are extracted (as presented in subsequent sections of this report), as well as the entrance mesh in more detail. The colours represent the level of the bed of the lake and the beach nearshore zone measured below Australian Height Datum (AHD), which is approximately mean sea level at present, or in other words the water depth below present mean sea level.

The bed levels in the entrance area were based on a 2018 survey when the entrance was closed. The bed levels were then adjusted to simulate the various entrance conditions corresponding to the different entrance management options, e.g., pilot channel, dry notch, dredged ebb tie channel, etc.

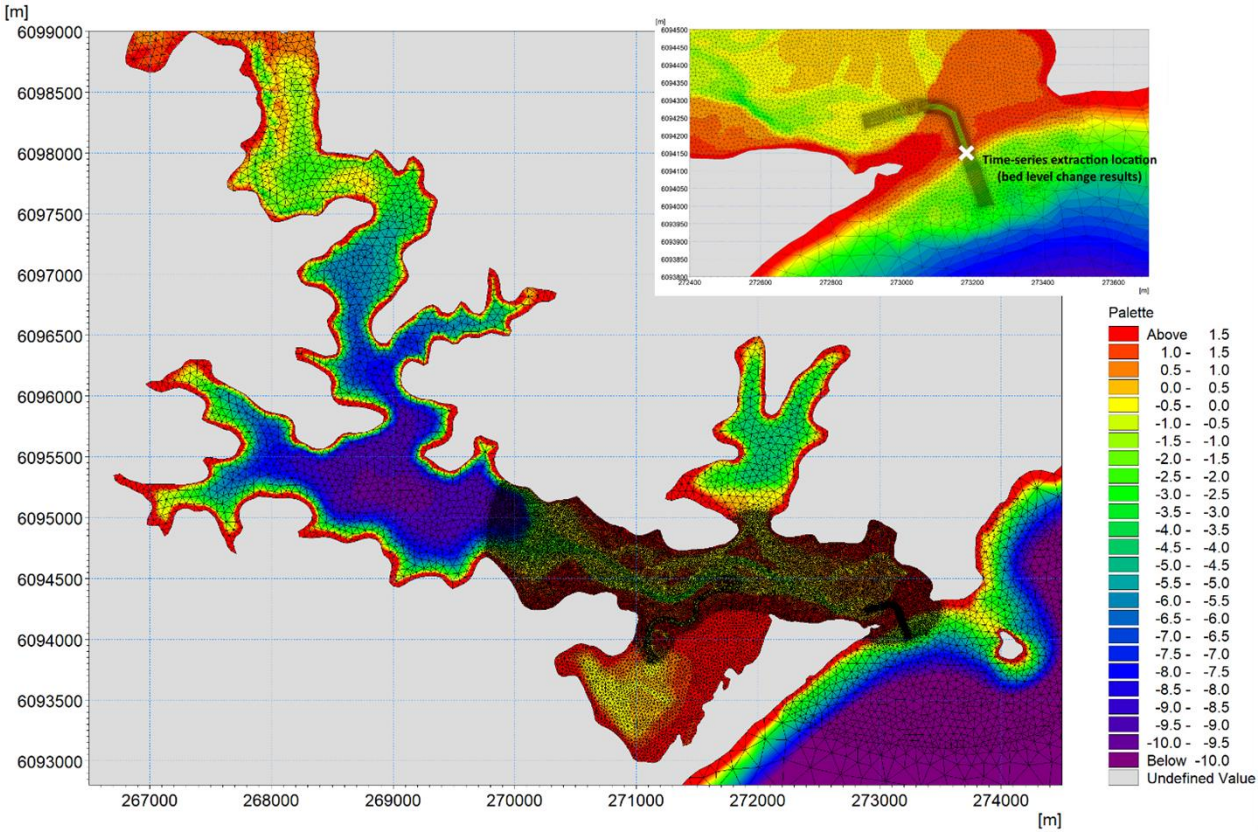


Figure 2-1: Model mesh and bathymetry

2.3 Model Limitations

A number of model limitations apply to the numerical modelling study, as follows:

- The localised vertical flow is not well-represented due to the depth-averaged nature of MIKE21;
- The model works under the assumption that the magnitude of the vertical velocity is insignificant compared to the magnitude of the horizontal velocity (quasi-hydrostatic conditions), which is not the case during the initial stages of a breakout when flow is highly turbulent or supercritical (featuring very rapid flow and vertical hydraulic jumps);
- The bank erosion/collapse process within the breakout channel is not well-represented (this is compensated by an additional initial entrance bed erosion allowance). Improvements are possible when multiple mesh elements are included to represent a steep bank, however this would lead to unreasonable model simulation times;
- The model does not include ocean waves or sand transport along the beach; and
- Other than for simulation of the February 2020 flood event, the model does not include the effect on lake level of ongoing rainfall.

As a consequence of the above limitations, the power of the numerical modelling is the ability to assess the relative behaviour/sensitivities of the various entrance management options. The results of the modelling need to be interpreted in conjunction with a real-world understanding of the entrance breakout behaviour.

3 Modelling Simulations

3.1 Lake trigger level

3.1.1 Scenarios

The Interim Entrance Management Policy (GHD, 2013) sets a lake trigger level for a planned opening (lake level at which opening of the entrance is initiated) at 1.0m AHD and a trigger level for an emergency opening at 1.2m AHD (refer **Table 3-1**). The Five-Year Crown Lands Licence to Open Lake Conjola (Licence RN 625288, NSW Crown Lands, 2021) sets trigger levels as low as 0.8m AHD in the case of the 'prolonged low-level inundation' scenario (refer **Table 3-2**). The trigger levels in the current NSW Crown Lands Licence supersede the trigger levels in the 2013 Interim Entrance Management Policy. Sections of the community have advocated for a trigger level of 0.8m AHD (refer Section 3.5 of RHDHV, 2023).

Table 3-1: Interim Entrance Management Policy (2013) triggers for mechanical opening of the entrance

Trigger	Description
Planned opening at 1.0m AHD	• place plant and equipment on standby at 0.8m AHD; • if moderate or heavy rainfall is ongoing or predicted and water level reaches 0.9m AHD, prepare pilot channel for opening; and • commence opening when water level is at or exceeding 1.0m AHD.
Emergency opening at 1.2m AHD	• water levels are rising rapidly and a flood event is occurring or predicted; • open entrance in the shortest and quickest way possible, if situation permits, at a water level above 1.2m AHD.

Table 3-2: Five year Crown Lands licence intervention trigger levels

Scenario	Action	Intervention Trigger
Prolonged low-level inundation	Planning for an opening	The lake stabilises at or above 0.8m AHD for a period of three consecutive months
	Open lake to sea	10-day-mean water level is reached or exceeded and maintained at or above 0.8m AHD for more than three consecutive months
Possible flooding (refer Note 1)	Get ready	0.7m AHD
	Prepare Pilot Channel	0.8m AHD
	Planned Opening	1.0m AHD
Evidence of water quality risks and hazards	Liaison with DPI-Fisheries and Crown Lands	Red alert as described in Guidelines for Managing Risks in Recreational Water (NHMRC, 2008) (refer Note 2)
	Open lake to sea	Red alert level (NHMRC, 2008) and concurrence from DPI-Fisheries and Crown Lands has been received

Notes:

1. Possible flooding means – 'high lake water levels, and heavy rain of more than 150mm in 24 hours or more than 300mm over 3 days is forecast and likely to impact the Lake Conjola catchment or which has been received in the catchment'. It is of interest to assess the approximate Average Recurrence Interval (ARI) of these two rainfall triggers based on Bureau of Meteorology data for the Lake Conjola catchment. This indicates that 150mm in 24 hours is approximately a 2 to 5 year ARI event and 300mm over 3 days is approximately a 10 year ARI event. This suggests that the 150mm in 24 hours is more likely to potentially trigger the 'possible flooding' scenario.
2. The 'red alert' is the 'red level (action mode)' in the National Health and Medical Research Council (NHMRC) Guidelines and is triggered when the presence of certain algae and cyanobacterium exceed specified levels. At such times the local authority and health authority are required to warn the public that the water body is considered to be unsuitable for primary and secondary contact recreational use.

For purposes of modelling the effectiveness of a mechanical breakout via a pilot channel, the following lake trigger levels have been considered. Note that these trigger levels represent the lake level at the time discharge commences within the pilot channel:

- 0.8m AHD;
- 1.0m AHD;
- 1.2m AHD; and,
- 2.0m AHD .

The 2008 (April) Ulladulla Harbour tide record was utilised for modelling as three typical tidal planes, i.e., MLWS, MSL and MHWS, occur in this period.

It was necessary to adopt a general berm level in conjunction with the lake water level and pilot channel dimensions. Based on available survey data when the lake entrance is closed, a berm level of 2m AHD has been adopted.

The lake trigger level of 2.0m AHD represents a water level that could be reached if the berm level reached 2m AHD or above and mechanical intervention had not been possible; it does not represent a proposed trigger value within any Entrance Management Policy. It was also adopted in the simulations in consultation with Council and the Department of Planning and Environment (DPE) to fully explore the sensitivity of water level difference (head difference) between the lake and the Tasman Sea on the effectiveness of a mechanical breakout.

3.1.2 Results

Figure 3-1 presents the lake water level and discharge (through the mechanically opened entrance) time-series for three of the trigger level values outlined above, for a particular breakout channel length (200m - flat grade), breakout channel width (12m), breakout channel invert/bed level (0.0m AHD), and timing of the breakout relative to ocean tide (opening at Mean High Water Springs [MHWS]).

The results show that the higher the lake trigger level, the greater the entrance channel scour and rate of drop in lake water level (all other factors such as channel length, channel width, and phasing of the breakout with the ocean tide being equal). This is attributed to the larger head difference over the entrance and the associated increased scour potential (refer **Figure 3-2** which shows the deeper bed level scour as the lake trigger level increases). In terms of the rate of drop in lake water level, the approximate time for the lake level to drop by 0.1m from the time of breakout is as follows as the trigger level increases (ill = initial lake level):

- ill = 0.8m AHD: 23.8hrs;
- ill = 1.0m AHD: 10.8hrs; and,
- ill = 1.2m AHD: 7.3hrs.

The results of the numerical modelling are consistent with the examination of the effectiveness of seven actual mechanical breakouts carried out by Council between 2010 and 2020, as reported in RHDHV (2023). This examination also revealed the strong dependency between initial lake water level at the time of an opening and the effectiveness of the breakout channel that forms, concluding that mechanical openings at a lake water level less than approximately 1.1m AHD appear to be problematic, albeit recognising that a range of other factors can also influence the effectiveness of breakouts, such as the degree of continuing rainfall and the occurrence of ocean storms.

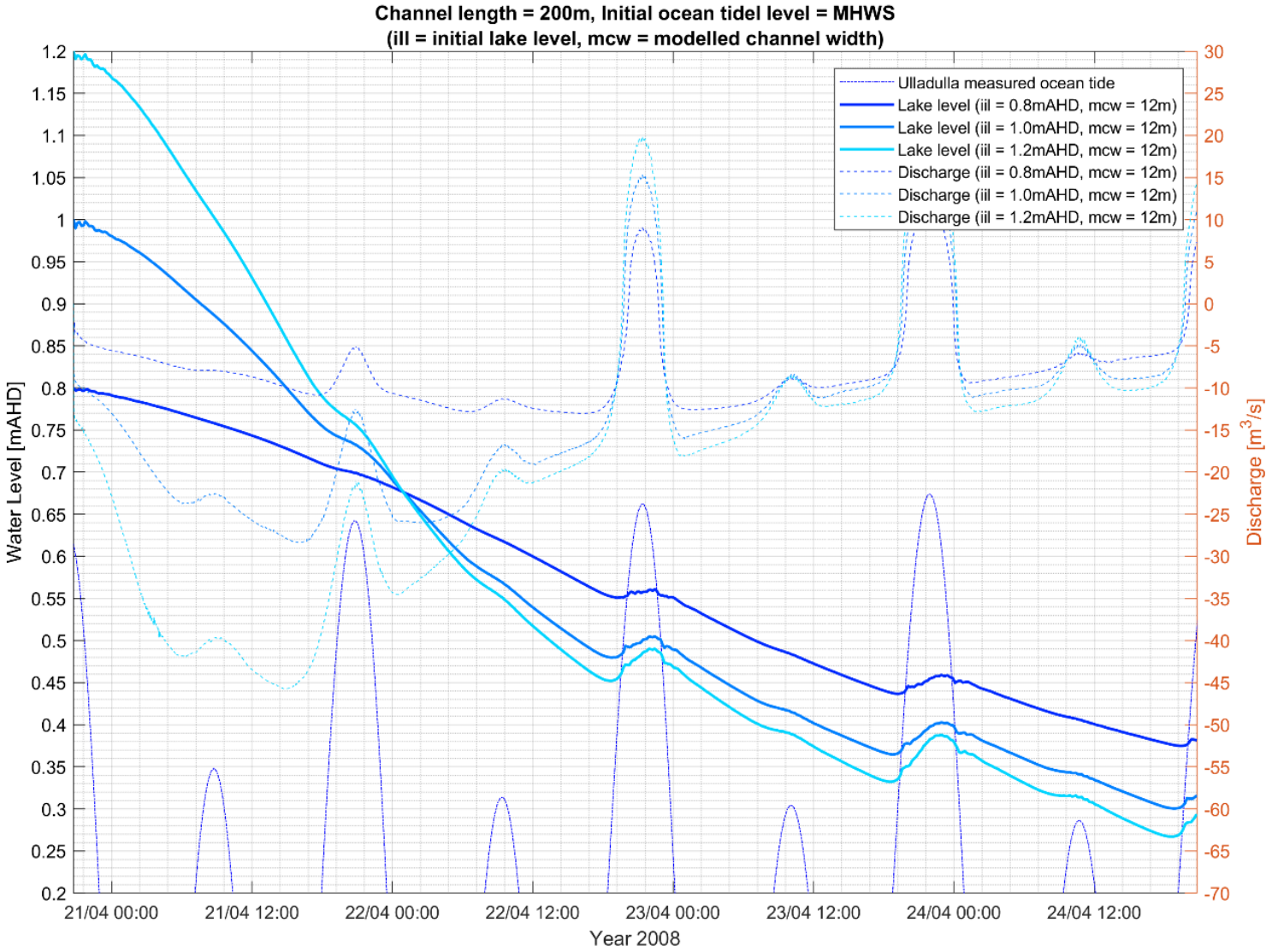


Figure 3-1: Lake trigger level assessment: lake level and discharge (over entrance) time-series

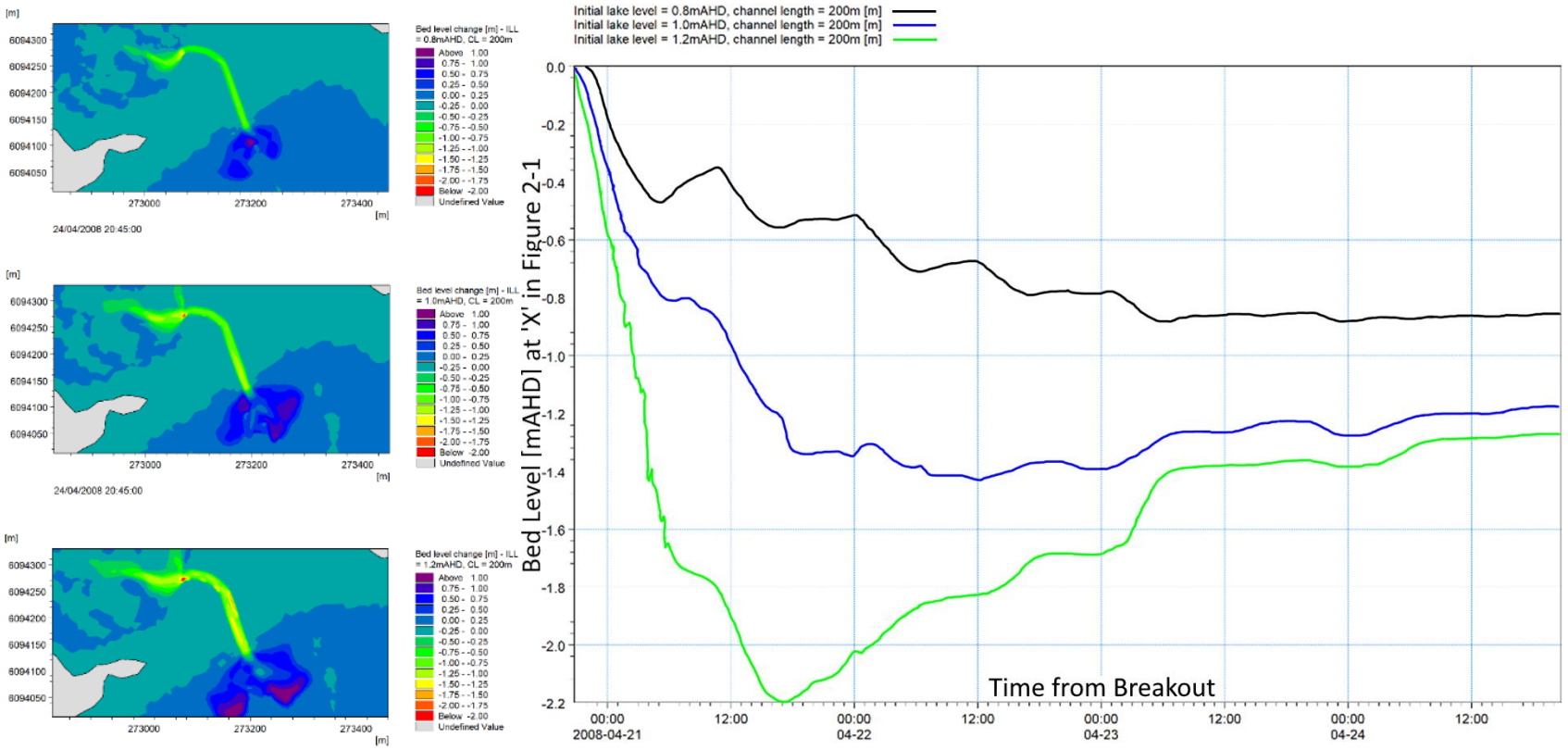


Figure 3-2: Lake trigger level assessment: bed level change time-series

3.2 Breakout Channel Length

3.2.1 Scenarios

For the purposes of modelling the effectiveness of a mechanical breakout via a (flat grade) pilot channel of varying lengths (this in effect considers the influence of water surface gradient between the lake and ocean), the following breakout channel lengths have been considered:

- 50m;
- 100m;
- 150m;
- 200m; and,
- 300m.

3.2.2 Results

Figure 3-3 presents the lake water level and discharge time series for a range of channel lengths, for a particular lake trigger level (1.2m AHD), channel width (12m), and timing of the breakout relative to ocean tide (opening at MHWS).

The results show that the shorter the breakout channel length, the more effective the breakout, evident from a more rapid drop in lake water level and deeper bed level scour (refer **Figure 3-4**), (all other factors such as initial lake level and phasing of the breakout with ocean tide being equal. For example, the approximate time for the lake level to drop by 0.1m from the time of breakout is as follows as the pilot channel length increases (cl = channel length):

- cl = 50m: 4.1hrs;
- cl = 100m: 4.8hrs;
- cl = 150m: 6.0hrs
- cl = 200m: 7.3hrs
- cl = 300m: 10.0hrs.

The above results show that increasing the channel length leads to disproportionally lower rates of the lake level dropping. It follows that a situation where the required excavation for the breakout channel is overly long should be avoided if possible.

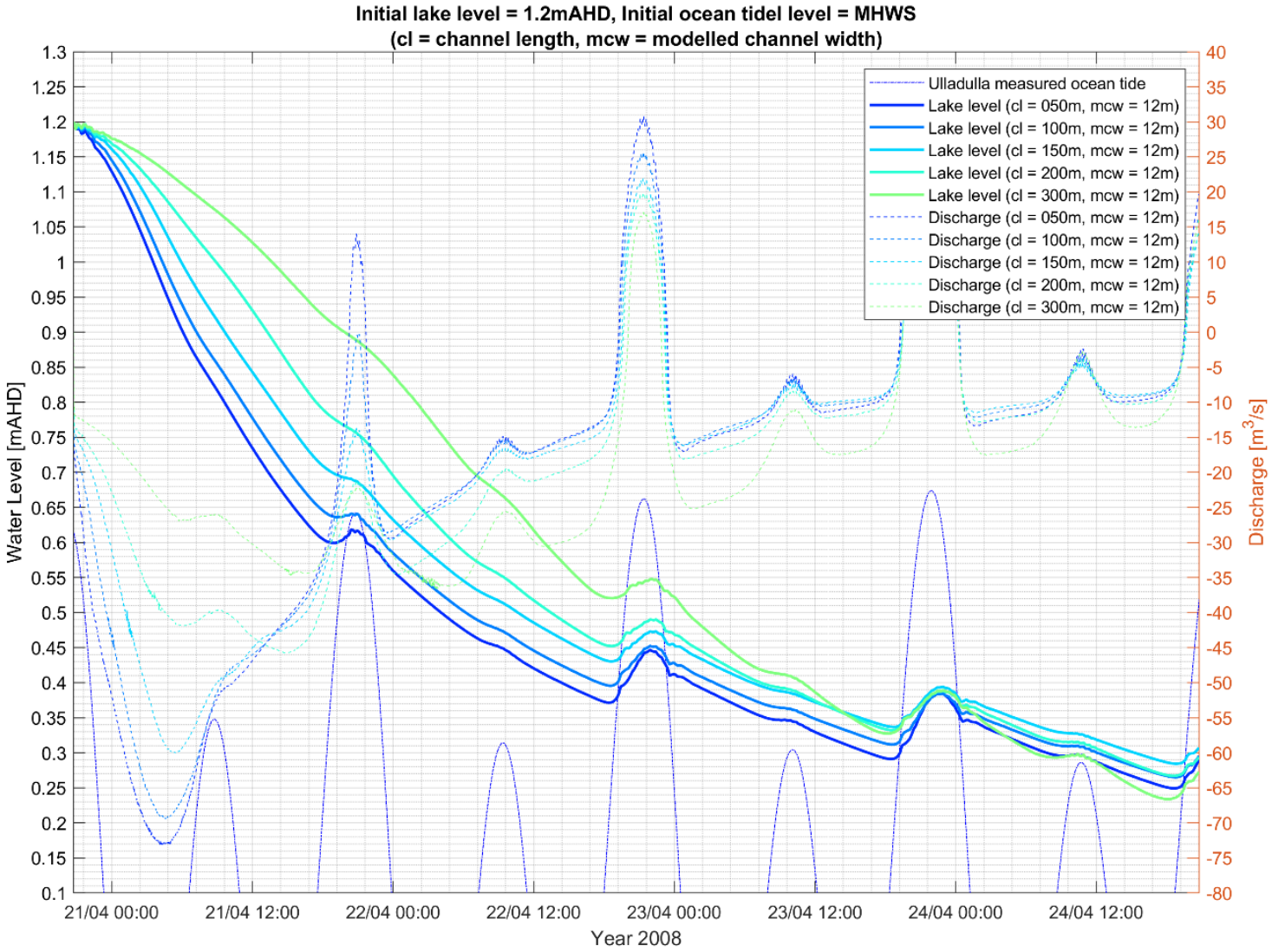


Figure 3-3: Breakout channel length assessment: lake level and discharge (over entrance) time-series

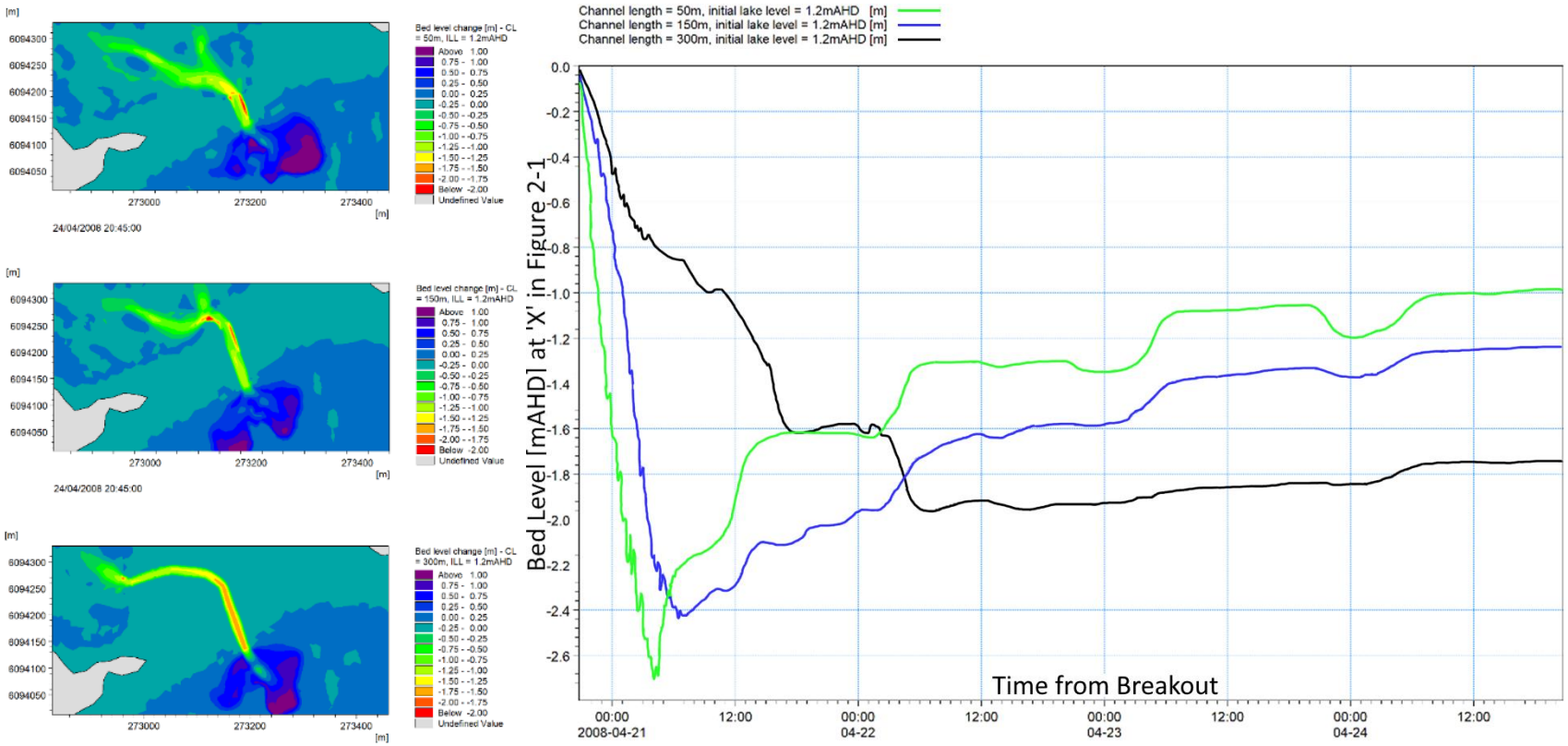


Figure 3-4: Breakout channel length assessment: bed level change time-series

3.3 Timing of Ocean Tide

3.3.1 Scenarios

For purposes of modelling the effectiveness of the timing of entrance opening relative to ocean tide level, the following ocean tide levels at the time of opening have been considered (MSL = Mean Sea Level, MLWS = Mean Low Water Springs). Modelling was carried out for a lake trigger level of 1.2m AHD, a channel length of 200m, and a channel width of 12m.

- MHWS;
- MSL (rising tide);
- MSL (falling tide); and,
- MLWS.

3.3.2 Results

The results (refer **Figure 3-5**) show little apparent sensitivity of breakout channel effectiveness as a function of timing of breakout relative to ocean tide. During the first approximately 18 hours it appears an initial ocean tide level of MLWS performs best (albeit it is very similar to MSL (falling) and MHWS) with the lake level dropping from 1.2m AHD to 1.1m AHD some 1.5 hours faster than when the initial ocean tide level is equal to MSL (rising).

In practice, the level of the predicted ocean tides is often affected (increased) by tidal anomalies such as storm surge and wave setup from large swell conditions, so it is important in the execution of a mechanical opening to monitor the actual and predicted ocean tide and wave conditions (refer RHDHV, 2023). Typically, a mechanical breakout is timed for low swell conditions if possible so that the effect of wave action on ocean water level, and the amount of sand transport in the nearshore zone, is reduced.

It is likely that the optimal timing of a mechanical breakout relative to ocean tide level will continue to be strongly influenced by practical experience gained over time of breakout channel effectiveness relative to ocean tide phasing. Based on experience to date, it is understood that the intention of Council is to initiate the mechanical opening around ocean high tide, subject to other factors such as safety of operations on the beach, as in practice this has generally proven to be the most effective from an ocean tide phasing perspective, i.e., provides a well scoured entrance and generally longer period of open entrance conditions. This approach is considered reasonable and reflects the approach taken by other Councils that manage similar systems, such as Northern Beaches Council in the management of the entrance to Narrabeen Lagoon.

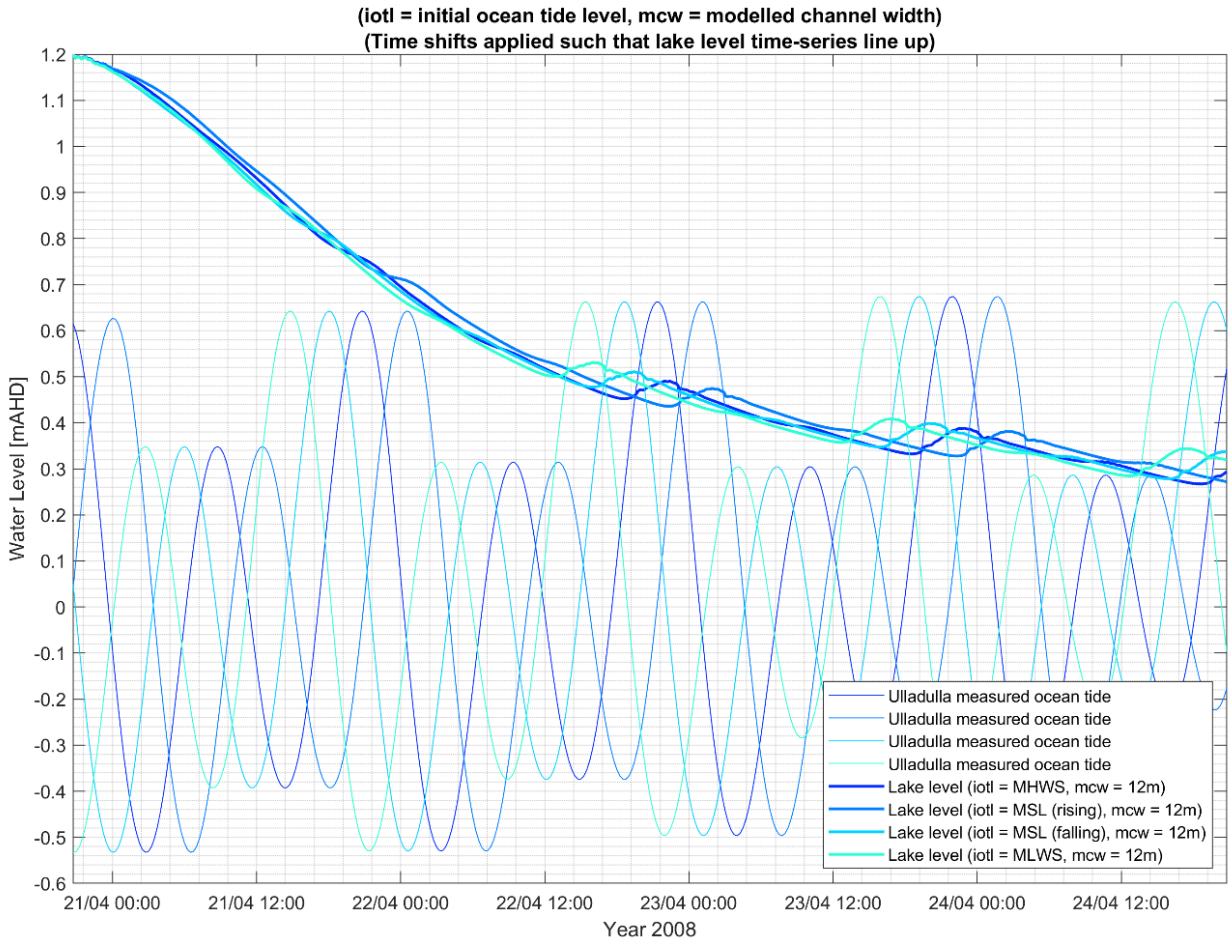


Figure 3-5: Timing of ocean tide assessment: lake level and discharge (over entrance) time-series

3.4 Dry Notch

3.4.1 Scenarios

A ‘dry notch’ is a lowering of the entrance sand berm to a nominated level (+1.0m AHD has been adopted for modelling purposes) behind a retained berm ‘plug’, designed to speed up the mechanical opening process by reducing the required quantity of excavation to initiate the breakout. The dry notch also provides additional available hydraulic conveyance at the initiation of the breakout as the width of the dry notch is made wider than the pilot breakout channel. Depiction of dry notch in the model is presented in **Figure 3-6** (a 50m-wide lowered area with an excavated breakout channel located within this area).

The dry notch has been examined for three lake trigger levels; 1.0m AHD, 1.2m AHD and 2.0m AHD. The breakout channel length, width, and invert/bed level were fixed at 200m, 12m, and 0.0m AHD, respectively.

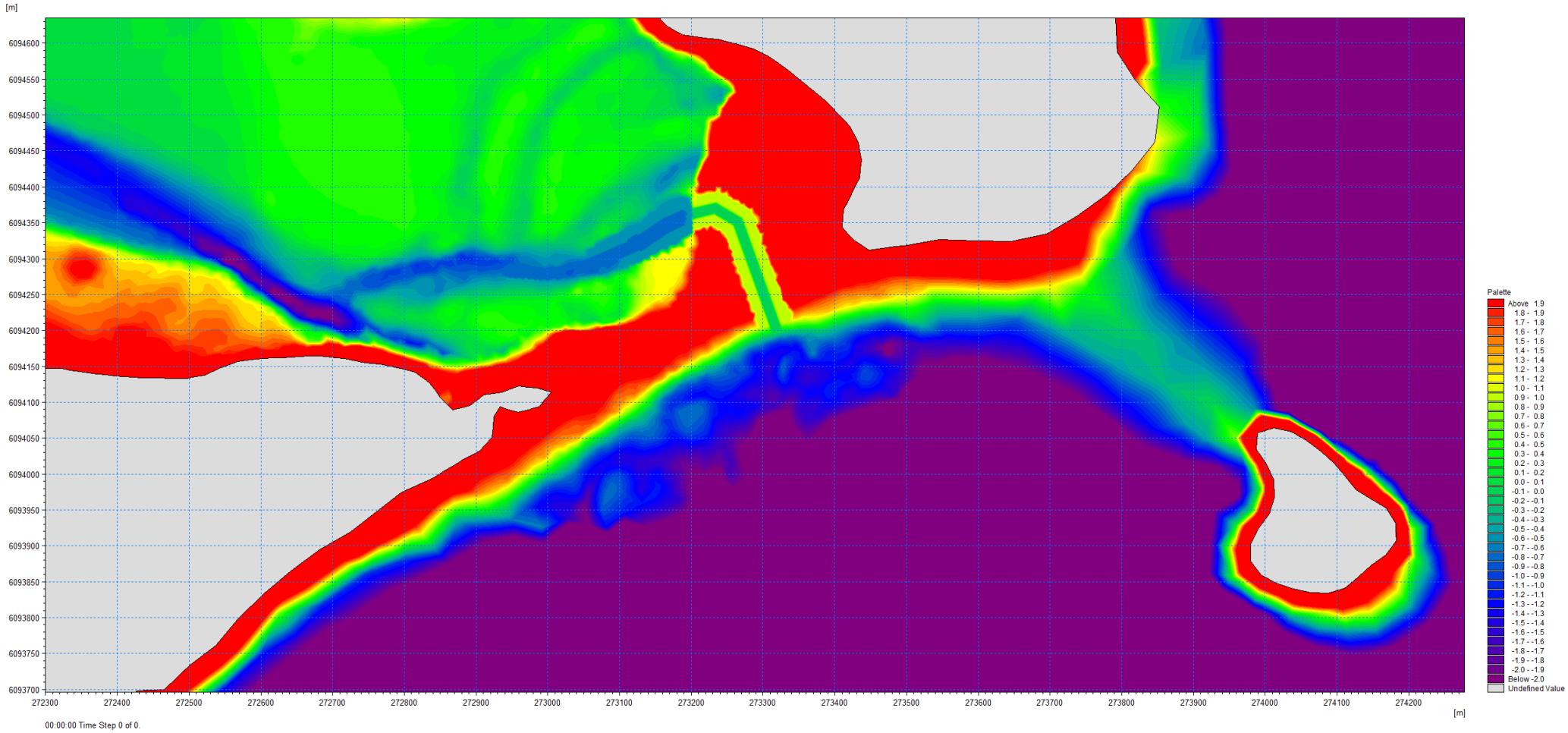


Figure 3-6: Depiction of the dry notch in the model

3.4.2 Results

The results (refer **Figure 3-7**) show that the presence of a dry notch improves breakout effectiveness, resulting in a more rapid drop in lake water level. At the same time, the presence of a dry notch would reduce the time required for excavation of breakout channel, hence allowing earlier initiation of breakout, which is another benefit. For the purpose of this assessment, a high spring tide with a peak of around +1.0m AHD naturally occurring in the Ulladulla tide gauge record was sought as the ocean water level condition for breakout simulation. The March 2021 period shown in **Figure 3-7** satisfied this requirement.

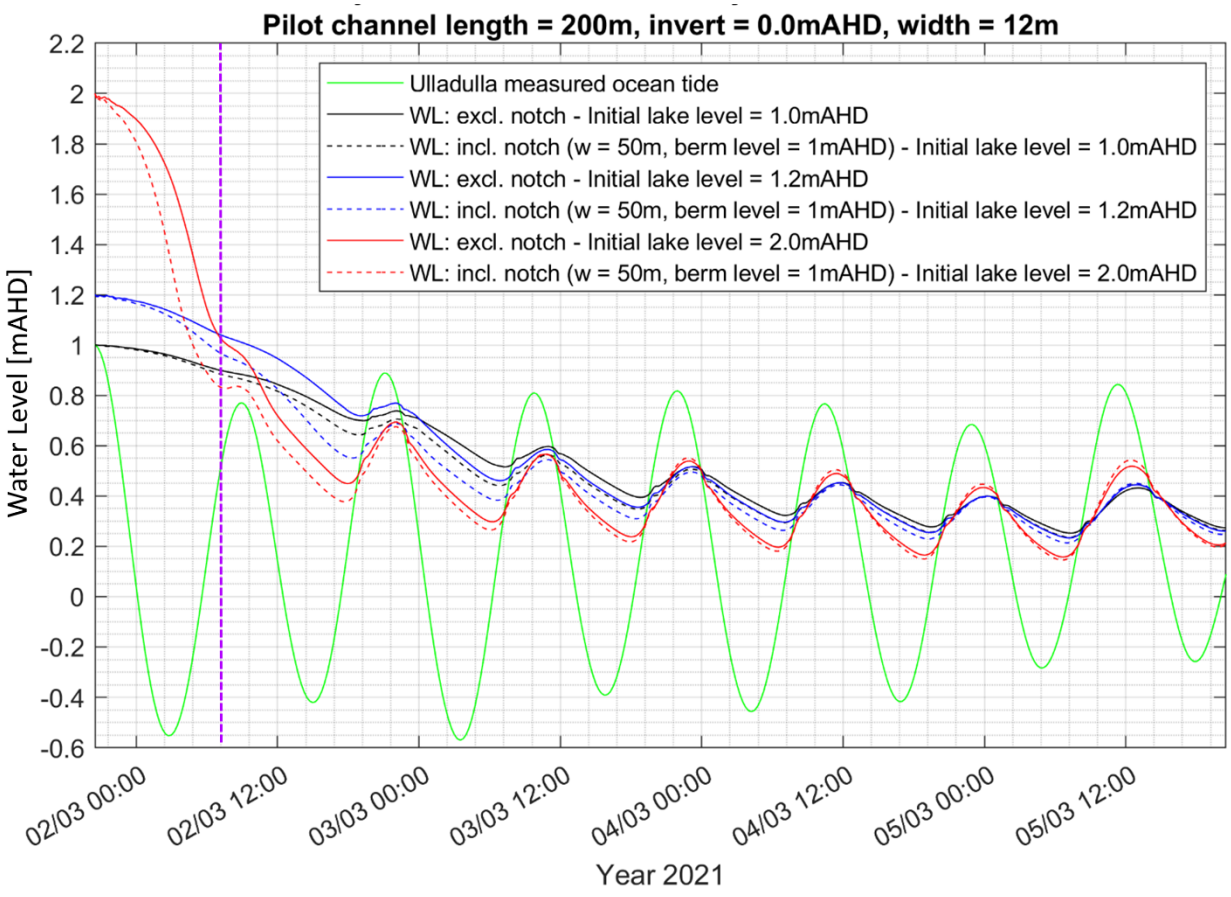


Figure 3-7: Dry notch assessment: lake level time-series

The effectiveness of the varying initial lake levels, both including and excluding a dry notch, over the first ten hours following the initiation of breakout (magenta dashed line in **Figure 3-7**) was quantified by determining the lake level draw-down rate and discharge. Results are presented in **Table 3-3**.

Table 3-3: Dry notch assessment - lake level draw-down rates and discharges over the first ten hours post breakout

Initial lake level [m]	Dry Notch	Avg. lake level draw-down rate [cm/hr]	Avg. discharge through breakout opening [m^3/s]	Max. discharge through breakout opening [m^3/s]
1.0	No	0.9	18	30
1.0	Yes	1.1	20	33
1.2	No	1.5	29	47
1.2	Yes	2.2	41	71
2.0	No	9.1	172	306
2.0	Yes	10.9	212	341

3.5 Permanent Entrance Channel (Training Walls)

3.5.1 Scenarios

A permanent channel at the entrance to the lake would be achieved by the construction of training walls (breakwaters). Depiction of a permanent entrance channel in the model is shown in **Figure 3-8**. A real-life example of training walls (at Lake Illawarra) is presented in **Figure 3-9**.

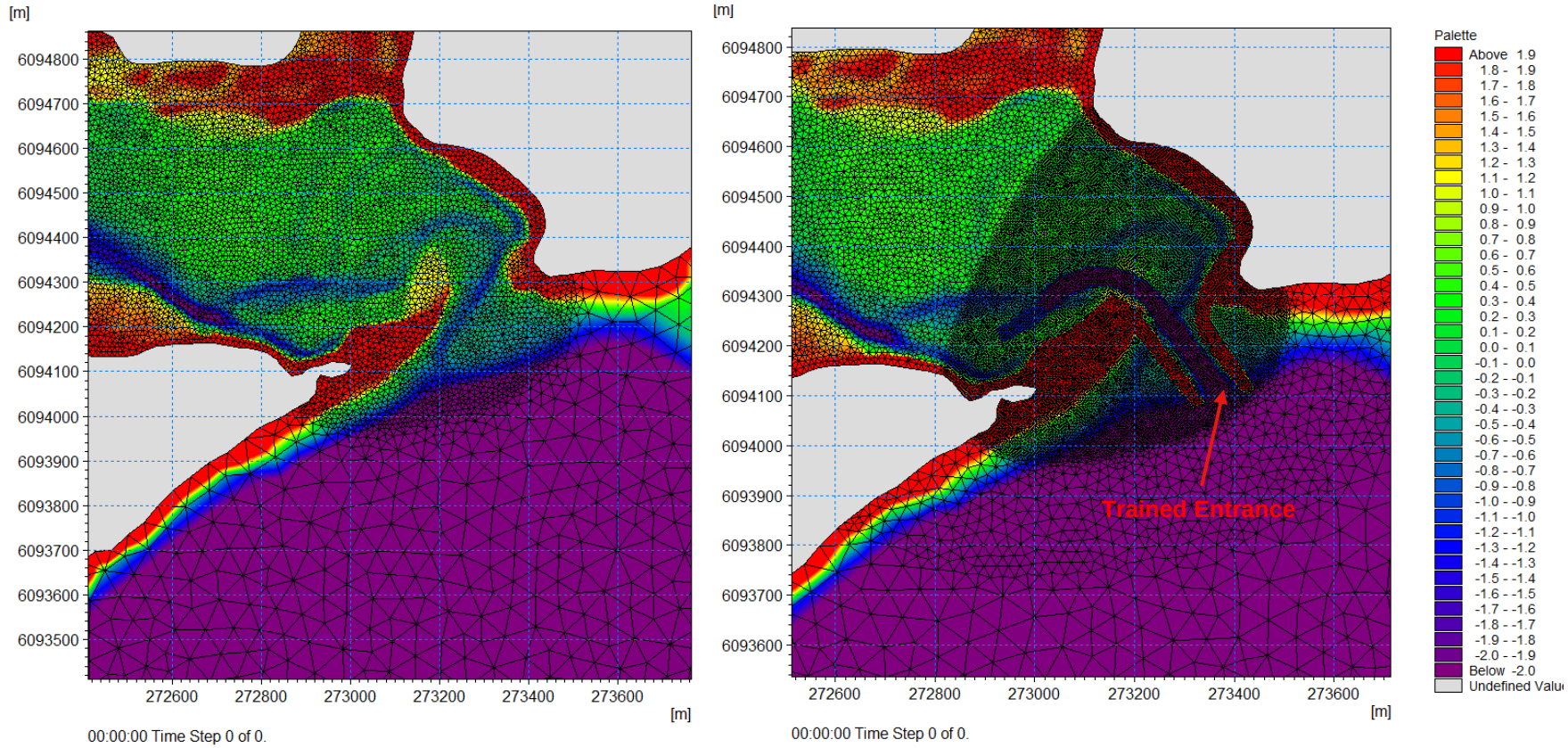


Figure 3-8: Permanent entrance channel: incorporation into the model mesh and bathymetry

Figure 3-9: Lake Illawarra entrance training walls (source: Google Earth Pro dated 23 December 2022)

3.5.2 Results

A permanent entrance channel would lead to a range of effects on lake water level as listed below and shown in **Figure 3-10**. As a consequence, adverse impacts would be expected on lake ecology and recreational use of the lake.

- Lowering of mean lake level;
- Increase in lake tidal range (difference between high tide level and low tide level); and,
- Lowering of low tide level (by up to approx. 0.2m).

It is also relevant to note that previous flood modelling (BMT WBM, 2013) has shown that Lake Conjola can still be subject to flooding with an open entrance, hence a permanent entrance would not necessarily prevent Lake Conjola township from flooding.

In addition,, it should also be noted that previous modelling of tidal inundation and coastal inundation (RHDHV, 2021) demonstrates that these ocean-driven processes can cause flooding impacts to the low-lying foreshores of Lake Conjola when the entrance is open (as would always be the case with a permanent entrance), particularly under the influence of future sea level rise.

A real-life example of the changes that can occur within a lake system as a result of the creation of a permanent entrance can be found at Lake Illawarra (refer **Figure 3-9**). A permanent entrance to this Lake was created in 2007 in response to significant community pressure regarding concerns with poor water quality and estuary health at times when the entrance was closed during drought periods. Since creation of the permanent entrance, a number of hydrodynamic, physical, and ecological changes to the Lake have been observed.

Hydrodynamic changes have included an increase in tidal range, a lowering of the average water level and low tide water level, and an increase in the tidal prism (the volume of water flowing into and out of the Lake on the flood and ebb tide) with consequent increases in tidal velocities. The changes in tidal prism and tidal velocities have in turn caused changes to the patterns of shoaling and scour, resulting in significant deepening of channels, accretion on the flood and ebb tide deltas, and foreshore erosion and damage to assets along parts of the entrance channel. From an ecological perspective, changes have included an increase in mangrove colonisation, a loss of saltmarsh, and a loss of seagrass.

Further detail of the changes to Lake Illawarra as a result of the creation of a permanent entrance are outlined in Wiecek et al (2016).

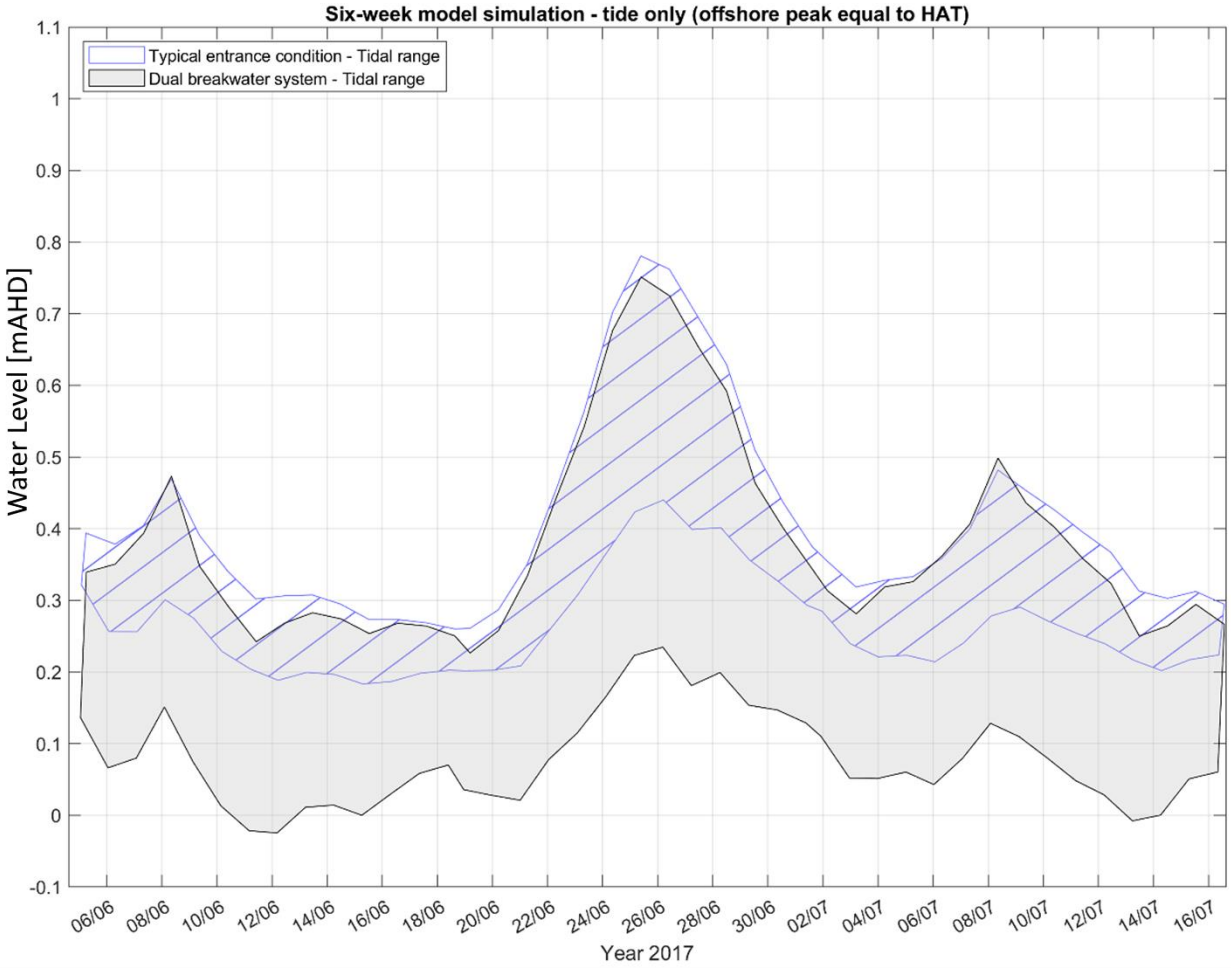


Figure 3-10: Permanent entrance channel: lake level time-series

4 February 2020 Flood Event

4.1 Calibration

Figure 4-1 presents results of the calibration exercise undertaken for the February 2020 flood event. The calibration (red graph) shows reasonable agreement with measured lake level down to 0.7m AHD, and very good agreement once the lake level is influenced by the tide (around 0.7m AHD) down to the first low water trough (around 0.4m AHD).

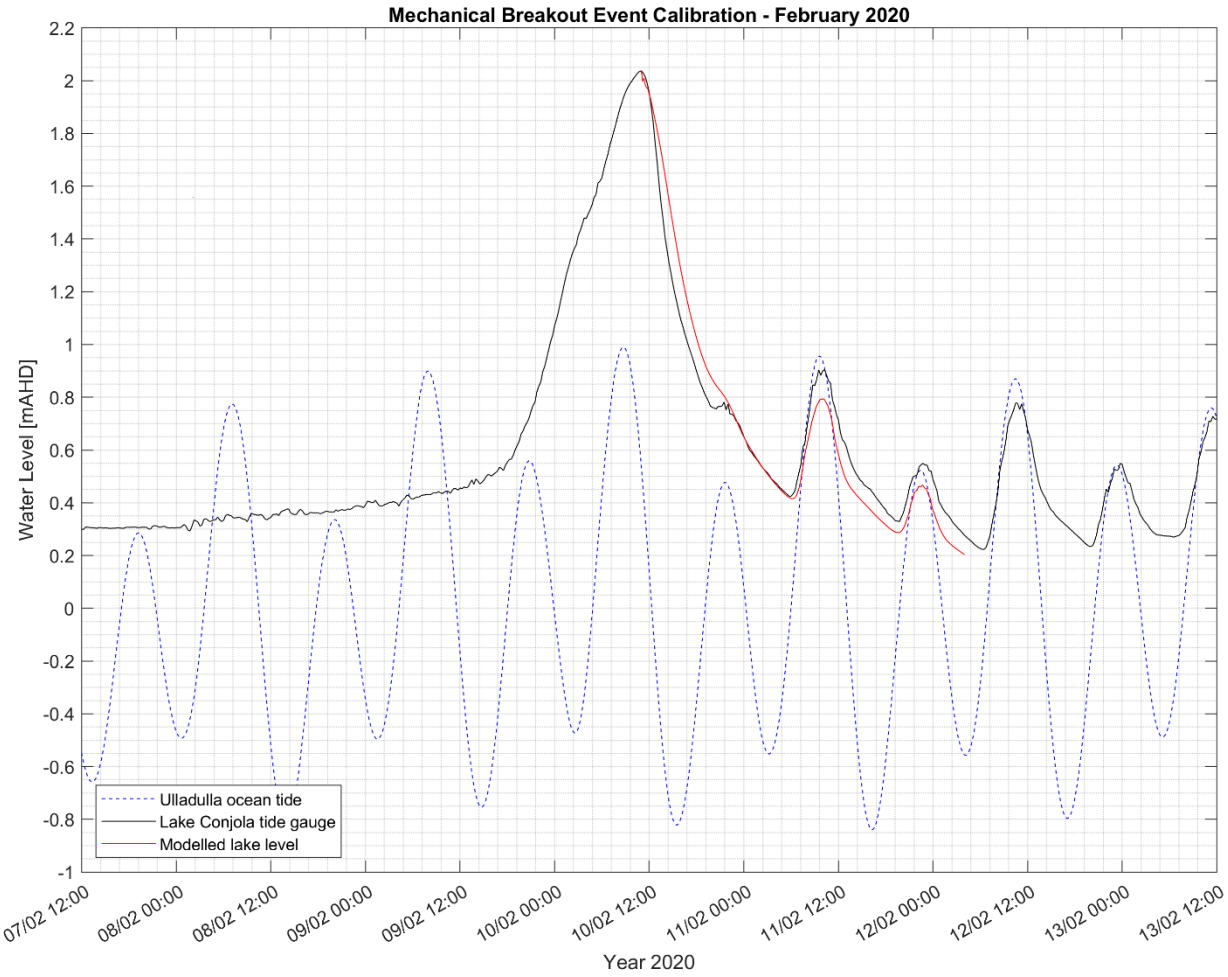


Figure 4-1: February 2020 flood event: calibration

4.2 Alternative Mechanical Breakout Scenarios for February 2020 Flood Event

The results (refer **Figure 4-2**) show that the adoption of a dry notch and the ability for earlier intervention could reduce the severity of flood events (comparing peak lake levels during the flood for the various scenarios). The earlier opening (at a lower lake level) naturally led to a lower peak lake level (>0.2m) of around +1.8m AHD (as opposed to around +2.05m AHD). Inclusion of a notch resulted in a further reduction of the peak lake level (around 0.04m) and minor improvement in lowering lake level quicker

compared to the model run of an earlier opening without a notch. The benefit of a dry notch is expected to be understated by the numerical modelling results since the modelling considers only the effects of the additional conveyance provided by the notch and not the added benefit of the reduced excavation quantity which would allow an even earlier breakout timing.

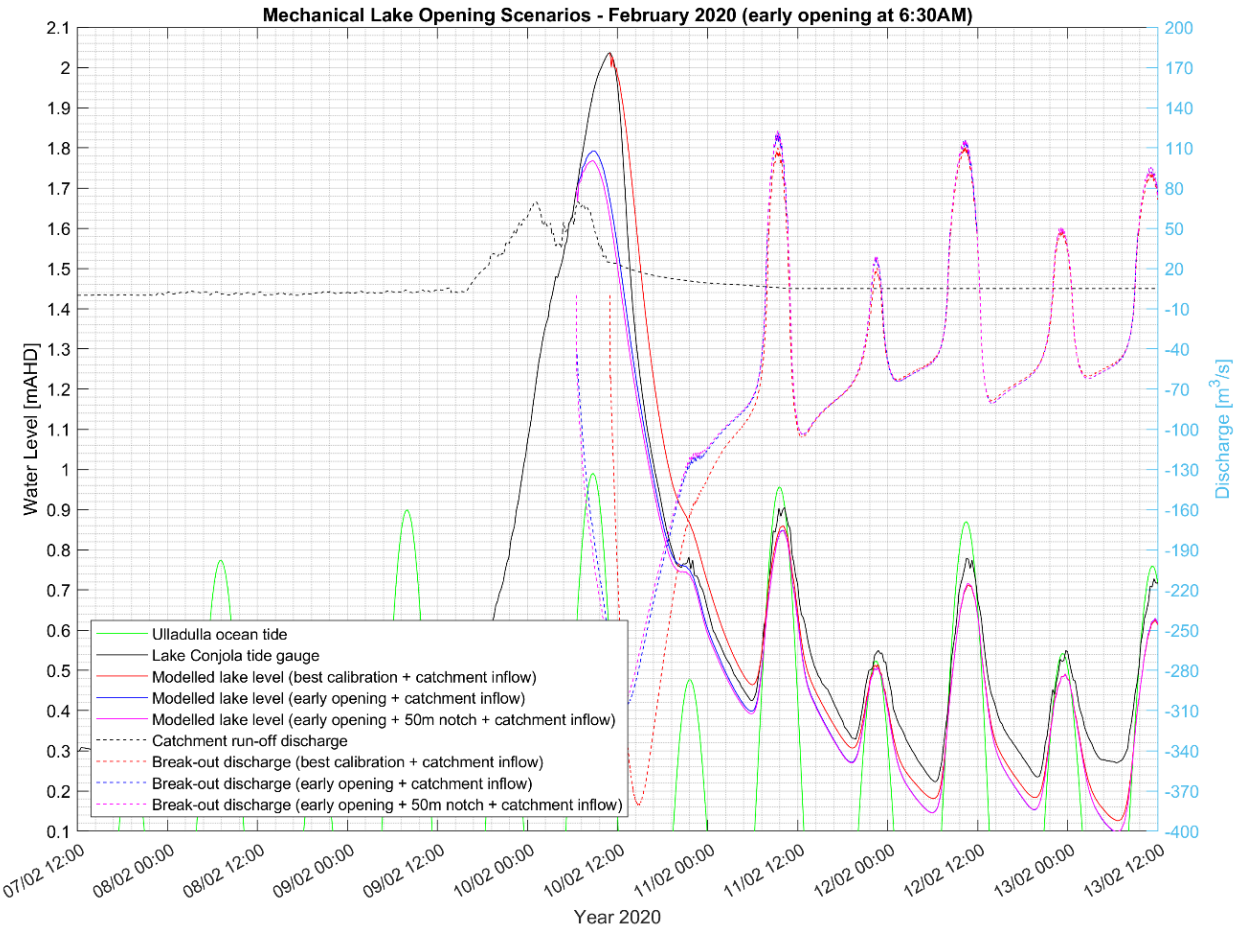


Figure 4-2: February 2020 flood event: alternative mechanical breakout scenarios

5 References

BMT WBM (2013), Lake Conjola Floodplain Risk Management Study and Plan, Final Report R.N1778.001.04, February 2013.

GHD (2013), Lake Conjola Interim Entrance Management Policy, prepared for Shoalhaven City Council, August 2013.

NSW Crown Lands (2021), Crown Land Licence RN 625288, October 2021.

RHDHV (2021), Lake Conjola CMP - Stage 2 - Tidal and Coastal Inundation Modelling Report. Prepared for Shoalhaven City Council. PA2591-RHD-ZZ-XX-RP-Z-0002. S0/P01.01, 03 December 2021.

RHDHV (2023), Lake Conjola Coastal Management Program - Stage 2 - Determine Risks, Vulnerabilities and Opportunities. Report C - "Entrance Processes and Entrance Management Options". Prepared for Shoalhaven City Council. PA2591-SCC-CMP-Stage 2 Report C-0003. Final/05, 29 March 2023.

Shoalhaven City Council (2021), Review of Environmental Factors – Management of Lake Conjola Entrance, 17 May 2021.

Wiecek, D, Regena, C, Laine, R, and Williams, RJ (2016), Quantifying change and impacts to Lake Illawarra from a permanent opening, NSW Coastal Conference, Coffs Harbour, November 2016.

Royal HaskoningDHV is an independent consultancy which integrates 140 years of engineering expertise with digital technologies and software solutions. As consulting engineers, we care deeply about our people, our clients and society at large. Through our mission Enhancing Society Together, we take responsibility for having a positive impact on the world. We constantly challenge ourselves and others to develop sustainable solutions to local and global issues related to the built environment and the industry.

Change is happening. And it's happening fast – from climate and digital transformation to customer demands and hybrid working. The speed and extent of these changes create complex challenges which cannot be addressed in isolation. New perspectives are needed to accommodate the broader societal and technological picture and meet the needs of our ever-changing world.

Backed by the expertise of over 6,000 colleagues working from offices in more than 20 countries across the world, we are helping organisations to turn these challenges into opportunities and make the transition to smart and sustainable operations. We do this by seamlessly integrating engineering and design knowledge, consulting skills, software and technology to deliver more added value for our clients and their asset lifecycle.

We act with integrity and transparency, holding ourselves to the highest standards of environmental and social governance. We are diverse and inclusive. We will not compromise the safety or well-being of our team or communities – no matter the circumstances.

We actively collaborate with clients from public and private sectors, partners and stakeholders in projects and initiatives. Our actions, big and small, are driving the positive change the world needs, and are enhancing society now and for the future.

Our head office is in the Netherlands, and we have offices across Europe, Asia, Africa, Australia and the Americas.

EuroCompliance certification ISO37001 EuroCompliance certification ISO37301

royalhaskoningdhv.com

Royal HaskoningDHV
Enhancing Society Together