

Final Report

Saltwater Creek Entrance Management Plan

Kempsey Shire Council

3 March 2025



Document Status

Version	Doc type	Reviewed by	Approved by	Date issued
V01	Draft Report	ND/ABM	ND/ABM	8.12.2021
V02	Revised Draft	CJB	CJB	18.01.2022
V03	Final Draft	CJB	CJB	29.03.2022
V04	Final Report	CJB	CJB	03.03.2025

Project Details

Project Name	Saltwater Creek Entrance Management Plan
Client	Kempsey Shire Council
Client Project Manager	Ron Kemsley
Water Technology Project Manager	Chris Beadle
Water Technology Project Director	Tony McAlister
Authors	Christopher Beadle, Kelsey Sanborn, Neil Dufty
Document Number	21010360_R02_V04_SaltwaterCk_EMP



COPYRIGHT

Water Technology Pty Ltd has produced this document in accordance with instructions from Kempsey Shire Council for their use only. The concepts and information contained in this document are the copyright of Water Technology Pty Ltd. Use or copying of this document in whole or in part without written permission of Water Technology Pty Ltd constitutes an infringement of copyright.

Water Technology Pty Ltd does not warrant this document is definitive nor free from error and does not accept liability for any loss caused, or arising from, reliance upon the information provided herein.

Suite 3, Level 1, 20 Wentworth Street
Parramatta NSW 2150
Telephone (02) 8080 7346
ACN 093 377 283
ABN 60 093 377 283





CONTENTS

1	INTRODUCTION	1
1.1	Background	1
1.2	The Area to Which this Plan Applies	1
1.3	Objectives for Entrance Management	1
1.4	Coastal Management Context	2
2	STUDY AREA DESCRIPTION	3
3	GOVERNANCE CONTEXT	5
3.1	Overview	5
3.2	Legislation	6
3.3	Policy Context	11
3.4	Summary of Potential Approvals	12
4	HISTORICAL MANAGEMENT ARRANGEMENTS	14
5	MANAGEMENT ISSUES	16
5.1	Entrance Dynamics	16
5.2	Estuarine Flooding	20
5.3	Estuarine Water Quality	28
5.4	Estuarine Ecology	30
5.5	Social and Cultural, and Economic Values	31
5.6	Potential Impacts of Climate Change on Entrance Management	32
6	STAKEHOLDER ENGAGEMENT	34
6.1	Community Engagement	34
6.2	Stakeholder Engagement with NSW Government Agencies	37
7	ENTRANCE MANAGEMENT APPROACH	39
7.1	Overarching Approach	39
7.2	Entrance Management for Flood Mitigation	40
7.3	Approach to Managing Estuarine Water Quality	43
7.4	Temporary Entrance Closure Works	44
8	ENTRANCE MANAGEMENT PROCEDURES – ENTRANCE OPENING	46
8.1	Roles and Responsibilities	46
8.2	Decision-Making Framework	46
8.3	Notify	48
8.4	Monitor	48
8.5	Assess: Decision Making Guidance	49
8.6	Decide	51
8.7	Communicate	51
8.8	Act: Procedural Notes	51
8.9	Monitoring and Reporting	53



9	ENTRANCE MANAGEMENT PROCEDURE - ENTRANCE CLOSING	55
9.1	Overview	55
9.2	When Entrance Closure is Appropriate	55
9.3	Consultation and Communication Protocols	55
9.4	Roles and Responsibilities	55
9.5	Procedural Notes	56
10	RECOMMENDATIONS	58
10.1	Review and Update of this Procedure	58
10.2	Long Term Management Approaches	58
10.3	Other Recommendations	58
11	REFERENCES	61

APPENDICES

Appendix A Monitoring Form

LIST OF FIGURES

Figure 1-1	The area to which this EMP applies	2
Figure 2-1	Aerial of Saltwater Creek and Lagoon (Source: KSC)	3
Figure 2-2	The entrance berm at Saltwater Creek	4
Figure 3-1	Land tenure at the Saltwater Creek entrance	5
Figure 3-2	Land tenure across the broader Saltwater Creek and Lagoon estuary	6
Figure 3-3	R&H SEPP mapping for Saltwater Creek and Lagoon	10
Figure 4-1	Example of temporary entrance closure from June 2014 (source: Google Earth)	15
Figure 5-1	Entrance berm closed (left) and open (right)	16
Figure 5-2	Estuary water levels from 2004 to 2021	17
Figure 5-3	Recorded berm heights at estuary entrance – closed condition	19
Figure 5-4	Recorded berm heights at estuary entrance – open condition	19
Figure 5-5	Visible bedrock strata at the estuary entrance	20
Figure 5-6	The German Bridge at Saltwater Creek. Image captured in November 2021 when the estuary was closed with recorded water level of 1.36 m AHD.	21
Figure 5-7	Longitudinal profile of flood behaviour (WBM Oceanics, 2006b)	22
Figure 5-8	Spatial depiction of bridge constriction for 5% AEP event (WBM Oceanics, 2006b)	23
Figure 5-9	Rate of rise during the 2016 flood event	24
Figure 5-10	SWR Caravan Park – elevation and wastewater infrastructure	25
Figure 5-11	Recorded water levels and rainfall during November 2021 opening event	27
Figure 5-12	Outflow of naturally ‘tea-like’ tannin rich water from Saltwater Creek	28
Figure 5-13	Upward and landward translation of an ICOLL berm under SLR (Hanslow, Davis, You, & Zastawny, 2000)	32
Figure 6-1	The community engagement process	34
Figure 6-2	Community Survey Q4: Please rank your biggest concern regarding management of the entrance? (1 being the biggest concern)	35
Figure 6-3	Community meeting at the Saltwater Creek entrance (closed entrance berm in background)	36



Figure 7-1	Berm height management - breakout process	41
Figure 8-1	Overview of the entrance management decision-making framework	47
Figure 8-2	Entrance management schematic	54
Figure 9-1	Photographic marker point – for monitoring entrance conditions	57
Figure 10-2	Examples of entrance condition tracking for Narrabeen Lagoon	59
Figure 10-3	Potential location for Coast Snap camera cradle at Monument Point Headland.	60

LIST OF TABLES

Table 3-1	Activities requiring concurrence under the FM Act	8
Table 5-1	Berm Height Statistics (n=19)	18
Table 5-2	Design Flood Levels in m AHD	21
Table 5-3	Flood events exceeding 1.8 m AHD MHL Gauge from 2004 to 2021	23
Table 5-4	Inundation thresholds at the Caravan Park	24
Table 6-1	Community Survey Question 1: How strongly do you agree that the estuary should be managed in this way? [Total: 29 respondents]	35
Table 7-1	Flood mitigation trigger levels	42
Table 7-2	ANZECC WQ guidelines	43



1 INTRODUCTION

1.1 Background

The Saltwater Creek and Lagoon estuary entrance naturally alternates between being open or closed to the ocean. These types of estuaries are referred to as Intermittently Closed and Open Lakes and Lagoons (ICOLLs).

Whilst the intermittent nature of the entrance condition is a natural process, sometimes the natural processes of ICOLLs can be at odds with nearby built environments and social and recreational amenity. When the entrances of such estuaries build up with sand (creating a sand berm), the entrance can close resulting in a loss of connectivity with the ocean. This can result in a number of social, and environmental impacts, including:

- Increased inundation risk to fringing properties and infrastructure - due to the reduced ability of the estuary to drain during rainfall events; and
- Water quality impacts - as when closed the estuary lacks the mechanism of regular tidal flushing, and water quality issues resulting from catchment activities can be exacerbated

For these reasons, many ICOLLs across New South Wales are manually or artificially opened to the ocean by authorities to 'drain' the estuary. However, artificially opening ICOLLs can adversely affect estuary health and has also historically led to incidences of estuarine fauna mortality (e.g., fish kills).

Therefore, an Entrance Management Plan (EMP) is required to enable Kempsey Shire Council (Council) and the community to plan how the estuary entrance should be managed, or other works undertaken. Adoption of a flexible and adaptable 'best practice' EMP is crucial to ensure that the environmental and social values of the estuary are protected. The EMP provides specific focus on short-term time frames (of around 10-15 years), whilst acknowledging potential future changes related to climate change and sea level rise impacts.

This EMP has been prepared to ensure sustainable environmental and management outcomes for the estuary on behalf of Council, with funding and technical assistance from the NSW Department of Climate Change, Energy, the Environment and Water (DCCEEW), and in consultation with various State agencies and other relevant stakeholders including local community members and indigenous peoples' representatives.

1.2 The Area to Which this Plan Applies

The area covered by this EMP is shown in Figure 1-1. The EMP applies to the catchment of the estuary which comprises the waterway, foreshores and land adjacent to the estuary up to the tidal limit of the tributary creeks and the extent of the drainage catchment directly contributing to the estuary waterways. The area relevant to this EMP also includes the proposed route to enable excavator access to the entrance.

1.3 Objectives for Entrance Management

This EMP advocates minimum entrance intervention, with preference for returning to a "natural as possible" breakout regime and recommends a procedure for management of the entrance that minimises the need for artificial opening in the long term. The objectives of the EMP are to:

- Ensure entrance opening follows as natural as possible regime, within flooding and property inundation constraints;
- Responsibly and practically mitigate the impacts of coastal and catchment flooding;
- Gain broad based community understanding and support for management of the lake entrance;
- Clarify responsibilities and accountabilities in relation to entrance management; and

- Document the protocols for entrance management that determine whether intervention is required.



Figure 1-1 The area to which this EMP applies

1.4 Coastal Management Context

This EMP has been prepared as part of the broader Kempsey Shire Council Coastal Management Program (CMP). The CMP will cover the entire coastal zone of the Kempsey Shire Local Government Area (LGA), including the open coastline and tidal waterways of its various estuaries.

A CMP is required for better outcomes in estuary system management under the new NSW Coastal Reforms. It initiates an integrated and coordinated estuary and catchment management approach that aims to maintain and enhance the social, cultural, economic and environmental values with coordination between local councils, State Government agencies and other relevant stakeholders.

Based on the recommendation of the Stage 1 Scoping Study (Water Technology, 2021), Kempsey Shire Council with the support of DCCEE has commissioned this CMP Stage 2 - Entrance Management Study and Plan.

The EMP will be included in the pending Kempsey LGA CMP, and implementation of recommended/supported entrance management actions will subsequently commence following Certification by the Minister and adoption of the CMP by Council.



2 STUDY AREA DESCRIPTION

The Saltwater Creek and Lagoon estuary is an ICOLL that is connected to the ocean via a narrow entrance on the western side of Trial Bay at South West Rocks (Figure 2-1). From its entrance adjacent to Monument Point, the creek heads in an approximately east-south-easterly direction for around 3.2 km where it opens into the Saltwater Lagoon Broadwater, with a waterway area of around 0.3 km² (approximately 750 m by 350 m).

The estuary itself is very shallow with an average depth of around 0.3 m (OEH, 2018b). Generally, bed levels in the creek extend down to around -0.7 m AHD and those in the lagoon to around +0.3 m AHD (MHL, 2002).

The estuary is fed by several small tributaries that drain a relatively steep catchment area of around 1,100 ha. Catchment land use is relatively diverse, comprising urban and rural areas and national parks. The lagoon water body itself sits within Hat Head National Park which, along with Arakoon National Park, spans much of the southern and eastern portion of the catchment.

The town of South West Rocks is situated to the immediate east of the estuary and contains a relatively small permanent population of around 5,600.



Figure 2-1 Aerial of Saltwater Creek and Lagoon (Source: KSC)

The estuary entrance oscillates between an open and closed condition based on the balance of catchment (runoff) and coastal (waves, tides) processes within the Trial Bay area. When open, the estuary is weakly tidal and when closed water levels generally fluctuate in response to rainfall, evaporation, and groundwater flows. This irregular cycle has a significant effect on the hydrological and ecological processes operating within the estuary and, as a result, a range of values and risks across Saltwater Creek and Lagoon are naturally linked to the entrance and its state of connection to the open ocean. The intermittent opening and closing of the estuary directly controls estuarine water levels and water quality, tidal-exchange and flushing, riparian vegetation, estuarine habitats and estuarine morphology and siltation.



Figure 2-2 The entrance berm at Saltwater Creek

3 GOVERNANCE CONTEXT

3.1 Overview

Responsibility for management of ICOLL entrances usually lies with the local council under its duty of care to the local community to manage water quality and land subject to flooding.

However, any works within an ICOLL entrance may require approval depending on land tenure and the applicable planning framework. Artificial entrance management is generally assessed under Part 5 of the EP&A Act, where the determining authority (e.g., council or a public agency) is responsible for assessing the environmental impacts. Therefore, tenure needs to be clearly established to determine responsibility for entrance management and required approval processes (NSW DPI-Fisheries, 2020). A map of land tenure at the Saltwater Creek entrance is provided in Figure 3-1. Figure 3-2 depicts the land tenure around the broader estuary. Figure 3-1 and Figure 3-2 show that:

- Most of the entrance berm is located on Council managed Crown reserve. Notably part of the seawards face of the berm is located in 'unidentified Crown land', seaward of the Council managed Crown reserve. Council is not authorised to manage this part of the entrance;
- The creek downstream of the German Bridge is Crown land and waterway; and
- Saltwater Creek drains a shallow lagoon that is located within Hat Head National Park and the foreshore borders Arakoon National Park.



Figure 3-1 Land tenure at the Saltwater Creek entrance



Figure 3-2 Land tenure across the broader Saltwater Creek and Lagoon estuary

3.2 Legislation

The following legislation has been considered in development of this EMP.

3.2.1 Local Government Act 1993

Under Division 2 (Section 35) of the *Local Government Act 1993* (LG Act), community land is required to be used and managed in accordance with the following:

- The plan of management applying to the land (which will only have relevance to activities on Council Managed Reserves); and
- Any law permitting the use of the land for a specified purpose or otherwise regulating the use of the land.

The relevant Plan of Management (PoM) for Saltwater Creek would likely be the Kempsey LGA CMP. The intention for this EMP procedure is for it to form part of the certified CMP.

3.2.2 Crown Land Management Act 2016

The Department of Planning, Housing, and Infrastructure- Crown Lands (DPHI-Crown Lands) is responsible for the administration and/ or management of Crown land under the *Crown Land Management Act 2016* (CLM Act). Crown land includes submerged Crown land, seabed and subsoil to three nautical miles from the



coastline of NSW that is within the limits of the coastal waters of the State. The CLM Act requires that environmental, social, cultural heritage and economic considerations be considered in decision-making about Crown land.

Council Managed Crown Land

Under the previous *Crown Lands Act 1989*, local councils proposing to remove gravel, sand or any other material (including by mechanical entrance management activities and/or maintenance dredging) on Crown land were required to obtain a licence from DPHI-Crown Lands under Part 4, Division 1 of the CLM Act.

However, under the new CLM Act (Specifically Division 3.4), for locations where a council has been appointed the Crown Land Manager of the subject Crown land, Council is authorised to manage the Crown land as if it were public land within the meaning of the LG Act. In the circumstances that a tenure from the Crown should no longer be required for the environmental management activity being undertaken by Council, the approval sections will therefore need to focus on the requirements of the LG Act

Crown Waterway

Where artificial entrance management works occur on Crown waterway or directly (Minister) managed Crown land, a PoM will have no effect, and a licence will be required under Section 1.15(1) the CLM Act.

Other Issues

The reserve purpose for Council managed Crown reserve (R82364) is Public Recreation. Consultation with DPHI-Crown Lands has identified that an artificial entrance opening may be inconsistent with the reserve purpose, and there may potentially require a separate authorisation under the CLM Act.

3.2.3 Fisheries Management Act 1994

The objectives of the *Fisheries Management Act 1994* (FM Act) are to conserve, develop and share the fishery resources of the State for the benefit of present and future generations.

Any proposal to artificially open / berm scrape an Intermittently Closed and Open Lakes and Lagoons (ICOLLs) is likely to trigger the dredging and reclamation provisions of Part 7, Division 3 of the FM Act - due to required excavation works at the berm. Therefore, a permit under s200 of the FM Act would be required to be obtained by Council for entrance opening works.

Alternatively, if the entrance opening works are authorised by another public authority (other than a local government authority) such as DPHI-Crown Lands, then s199 of the FM Act would prevail, and the public authority would be required to consult with and consider any matters concerning the proposed work that are raised by DPIRD-Fisheries prior to issuing the licence.

The provisions of Division 3, Part 7 of the FM Act are likely to be relevant to any works associated with the works to the opening of Saltwater Creek. The provisions relate to the protection of aquatic habitat. Although flood mitigation works would be precluded from requiring consent under the State Environmental Planning Policy (Infrastructure) 2007 (ISEPP), the provisions of the FM Act are still applicable and as part of the Review of Environmental Factors (REF) process concurrence from the DPIRD-Fisheries may be required for certain activities. Table 3-1 outlines relevant provisions of the FM Act that would apply to works to the opening of the estuary.



Table 3-1 Activities requiring concurrence under the FM Act

Section	Activities
198-202	A permit under s200 of the FM Act would be required to be obtained by Council for entrance opening works. Alternatively, if the entrance opening works are authorised by another public authority (other than a local government authority) such as DPHI-Crown Lands, then s199 of the FM Act would prevail, and the public authority would be required to consult with and consider any matters concerning the proposed work that are raised by DPIRD-Fisheries prior to issuing the licence.
219-220	A permit is required when barriers to the movement of fish including water course crossings are to be constructed or modified. Any proposed works to the opening is unlikely to create a barrier to the movement of fish. However, such specifics would need to be confirmed within the REF. Nonetheless, temporary closure of the entrance would generate such a barrier, and hence a permit would be required under s219 of the FM Act.
204-205	Any works to the opening would likely be restricted to area of the sand berm. Any works must not affect mangroves or other protected marine vegetation. If marine vegetation would be harmed by flood mitigation works a permit must be sought from the Minister before works commence. Clause 205 (2) states that <i>A person must not harm any such marine vegetation in a protected area, except under the authority of a permit issued by the Minister under this Part.</i> It is unlikely that any such vegetation would be affected by activities associated with the works to the opening of Saltwater Creek, however the REF must confirm this.
Schedule 4, 4A, 5 and 6	The REF prepared for works associated with works to the opening would need to consider any presence of local threatened aquatic habitat for flora or fauna. Key Threatening Processes (KTPs) would need to be considered in preparation of the REF.

3.2.4 Coastal Management Act 2016

The *Coastal Management Act 2016* (CM Act) establishes the framework and sets out the objectives for coastal management in NSW. The purpose of the CM Act is to manage the use and development of the coastal environment in an ecologically sustainable way, for the social, cultural and economic well-being of the people of NSW (DPIE, 2019).

The CM Act defines the coastal zone as comprising four coastal management areas:

1. Coastal wetlands and littoral rainforests area
2. Coastal vulnerability area
3. Coastal environment area
4. Coastal use area.

The CM Act establishes management objectives specific to each of these management areas, reflecting their different values to coastal communities. These coastal management areas are mapped as part of the *State Environmental Planning Policy (Resilience and Hazards) 2021* (R&H SEPP) – and is depicted in Figure 3-3. This shows that:

- A significant portion of the estuary waterway and its catchment is classified as Coastal Wetlands;
- A significant portion of the estuary waterway and foreshore is classified as Coastal Environment Area (CEA) and Coastal Use Area (CUA); and
- The estuary entrance falls within both the Coastal Use and Coastal Environment areas.



3.2.5 Marine Estate Management Act 2014

The *Marine Estate Management Act 2014* (MEM Act) forms part of the NSW Marine Estate Management Framework. The framework comprises statutory instruments, strategies, assessment plans and policy settings, and is administered under the auspices of the Marine Estate Management Authority (MEMA).

The objective of the MEM Act is to foster strategic and integrated management of the NSW marine estate, including the marine waters, coasts and estuaries (MEMA, 2018). The key legislative instruments under the MEM Act include:

- Marine Estate Management Regulation 2017;
- Marine Estate Management (Management Rules) Regulation 1999; and,
- Aquatic Reserves Notification 2015.

It should be noted that one of the objectives of the CM Act (and of the broader CMP process) is to support the objectives of the MEM Act.

3.2.6 Environmental Planning and Assessment (EP&A) Act 1979

Section 5.5 of the *Environmental Planning and Assessment Act 1979* (EP&A Act) states that a determining authority (in this case, Kempsey Shire Council), in its consideration of an activity shall examine and take into account to the fullest extent possible, all matters affecting or likely to affect the environment by reason of that activity.

Although flood mitigation works would be permitted without consent on any land (see Section 3.3.1), the requirements of Section 5 of the EP&A Act 1979 must be fulfilled.

As part of the licencing process under the CLM Act, a determined environmental assessment, undertaken in accordance with the EP&A Act, must be submitted with any Crown Land licence application. DPHI - Crown Lands strongly recommends that Council consult with relevant agencies, including DPIRD-Fisheries, as part of preparing these environmental assessments. Feedback from agencies should be considered and incorporated into the assessment, as appropriate. Noting that under s199 of the FM Act, Crown land licence applications that involve 'dredging and reclamation' must be referred to DPIRD-Fisheries for their consideration, and before a licence can be issued

The assessment should consider the impacts associated with repeat openings over a long period and under a range of conditions, rather than a single opening, so that it does not have to be reproduced each time an opening is necessary.

3.2.7 National Parks and Wildlife Act 1974

A significant portion of the estuary catchment is comprised of national park, namely:

- Hat Head National Park: occupies the entirety of the lagoon waterbody, its surrounding foreshore and significant portions of the catchment to the east of the lagoon; and
- Arakoon National Park: comprises much of the foreshore and catchment to the north of Saltwater Creek, including the Little Bay picnic area.

Both of these national parks have existing PoMs. However, a single PoM for both of the parks is currently being developed by NSW National Parks and Wildlife Service (NPWS) as an update to the existing plans.

NPWS is responsible for the care, control and management of the park in accordance with the *National Parks and Wildlife Act 1974* and National Parks and Wildlife Regulation and is subject to the provisions of the Act.

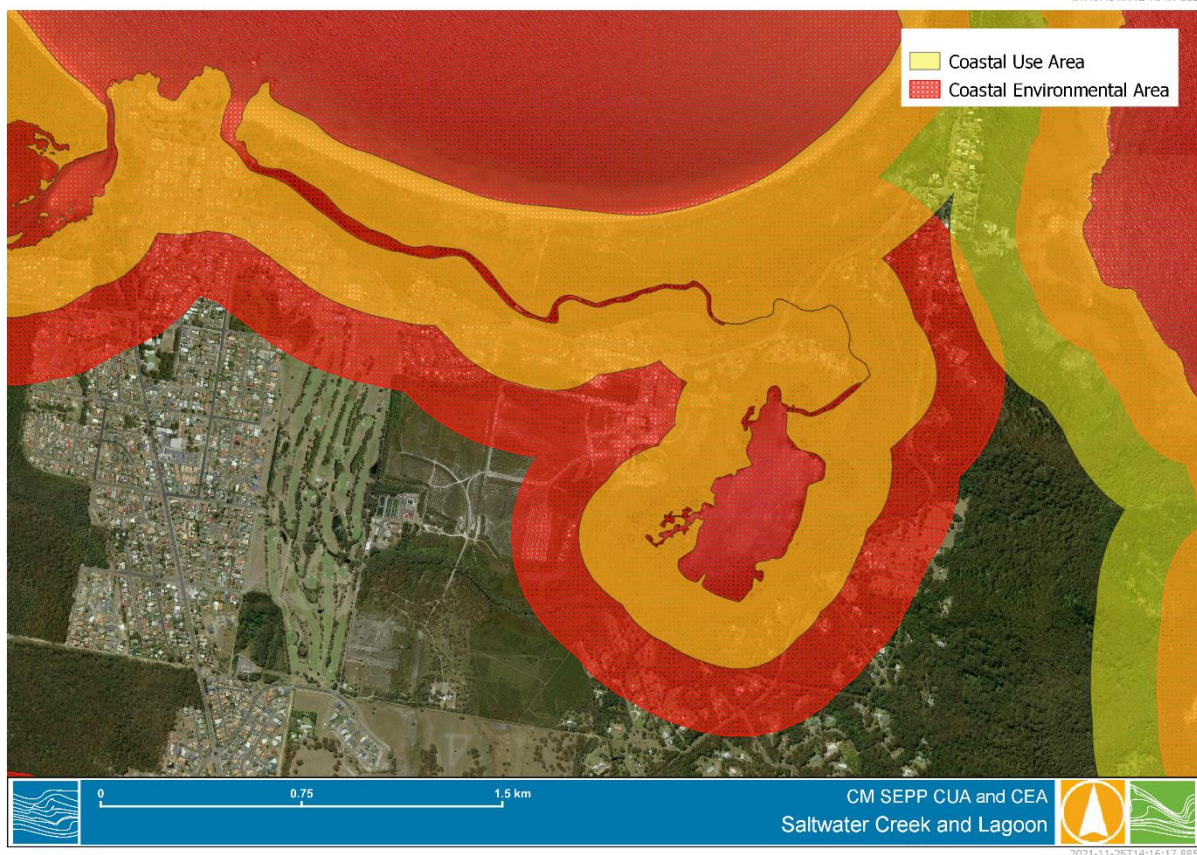


Figure 3-3 R&H SEPP mapping for Saltwater Creek and Lagoon



3.3 Policy Context

3.3.1 State Environmental Planning Policy (Infrastructure) 2007

The State Environmental Planning Policy (Infrastructure) 2007 (ISEPP) aims to facilitate the effective delivery of infrastructure across the state. Division 7, Clause 50 of the ISEPP permits development on any land for the purpose of flood mitigation work to be carried out by, or on behalf of, a public authority without development consent.

Kempsey Shire Council is proposing to use mechanical opening of the estuary entrance for flood mitigation purposes, and therefore the entrance management works would be defined as “infrastructure” works under Division 7, Clause 50 of the ISEPP.

Although flood mitigation works would be permitted without consent on any land, the requirements of Part 5 of the EP&A Act must be fulfilled, and Council would be required to prepare a REF for proposed works to open Saltwater Creek.

3.3.2 State Environmental Planning Policy (Resilience and Hazards) 2021

State Environmental Planning Policy (Resilience and Hazards) 2021 (R&H SEPP) updates and consolidates into one integrated policy a series of previously enforced SEPPs, including: SEPP 14 (Coastal Wetlands), SEPP 26 (Littoral Rainforests) and SEPP 71 (Coastal Protection), including clause 5.5. of the Standard Instrument – Principal Local Environmental Plan.

The R&H SEPP commenced on 3 April 2018 and gives effect to the objectives of the CM Act from a land use planning perspective, by specifying how development proposals are to be assessed if they fall within the coastal zone.

The R&H SEPP streamlines coastal development assessment requirements, identifies development controls for consent authorities to apply to each coastal management area to achieve the objectives of the CM Act, and establishes the approval pathway for coastal protection works.

The estuary entrance falls within both the coastal environment and the coastal use areas. Therefore, clauses 2.10 to 2.15 list matters that must be considered prior to granting development consent on land within these coastal management areas respectively. However, as noted in Section 3.3.1, development consent would not be required for the proposed works.

3.3.3 NSW DPIRD Policy and Guidelines for ICOLL Entrance Management

The NSW DPIRD Policy and Guidelines for Fish Habitat Conservation and Management 2013 state the following (NSW DPI-Fisheries, 2013):

1. Any proposals to artificially open ICOLLs must be authorised by a permit from the Minister or authorised by NSW DPIRD or other public authority after consultation with the Minister under the FM Act.
2. NSW DPIRD supports minimal interference with ICOLL barriers and advocates natural processes being allowed to operate to the greatest extent possible.
3. NSW DPIRD does not support the artificial opening of an ICOLL unless the proponent can demonstrate that the social, environmental, and economic benefits greatly outweigh any potential adverse impacts.
4. NSW DPIRD supports using estuary management plans and environmental assessment processes to analyse the issues relating to opening a particular ICOLL, and to develop an entrance management plan. Proposals for artificial openings which are to be carried out according to a formulated entrance management plan are more likely to be approved.



Furthermore, guidelines for mechanical opening from DPIRD include:

- The decision to open an ICOLL should be made on the basis of factual data on:
 - verified water levels and the nature and extent of associated flooding impacts - which should be referenced to a standard datum (e.g., Australian Height Datum) obtained from appropriately sited staff gauges, or automatic water level recorders; and
 - quantitative evidence of changes to relevant water quality parameters (especially nutrient and bacterial levels) produced by monitoring programs designed specifically to assess water quality pre- and post-opening.
- In the event that the criteria for an artificial opening are met, breaching should be conducted during a falling tide (if possible, around a spring tide) so that the potential for establishing an entrance channel long enough to flush the water body is enhanced.
- In the long-term, local councils and government agencies should aim to reduce the need for artificial manipulation by taking active measures to remove, relocate or otherwise manage items of low-lying infrastructure that currently necessitate breaches below the natural breakout range, and by adopting catchment management practices that:
 - reduce the inputs of nutrients and pollutants from point and diffuse sources;
 - prevent the transfer of flood prone and riparian land on the margins of ICOLLs into private ownership;
 - prevent the future development or subdivision of flood-prone and riparian lands by adopting appropriate zonings and buffers in relevant land use planning instruments; and
 - implement community awareness campaigns to enhance the broad-based understanding and support for the environmentally responsible management of ICOLLs.
- NSW DPIRD will require proponents to carefully monitor the impacts of extraction activities including:
 - rates of sediment infilling post-works;
 - upstream and downstream impacts; and
 - immediate habitat changes.

3.4 Summary of Potential Approvals

Entrance Opening

- Works to the opening of the entrance for the purpose of flood mitigation are permitted without development consent under Clause 50 of the ISEPP.
- As the entrance management works are to occur on Crown waterway or directly (Minister) managed Crown land, an authorisation from DPHI-Crown Lands is required under Section 5.30 the CLM Act.
- As part of the DPHI-Crown Lands licence application process, the following would be required under the CLM Act:
 - A determined environmental assessment must be submitted with any Crown Land licence application. This assessment must also fulfill the requirements of Part 5 of the EP&A Act. Therefore, Council is required to prepare a REF for proposed works.
 - Furthermore, under s199 of the FM Act, Crown land licence applications that involve 'dredging and reclamation' must be referred to DPIRD-Fisheries for their consideration. As part of this process, Council would be required to consult with and consider any matters concerning the proposed work that are raised by DPIRD-Fisheries prior to DPHI-Crown Lands issuing a licence.



- It is recommended that an REF is prepared, and approvals obtained, on a rolling basis to allow a proactive planning approach to occur, rather than a reactive approach when water levels are rising.
- It may be possible for Council to obtain a head licence that covers entrance management works across all of their ICOLL estuaries.

Entrance Closing

- Works to temporarily close the entrance would require a permit from Fisheries under s219 of the FM Act, as they generate a barrier to fish passage.



4 HISTORICAL MANAGEMENT ARRANGEMENTS

Entrance Opening

Before rules were established requiring permission from DPIRD-Fisheries and NSW DCCEEW, the entrance was routinely artificially opened for many years by Council or by local residents (BMT WBM, 2013). The opening of the entrance remains a contentious issue due to its complex impacts on water quality, recruitment and populations of fish and wetland bird species, biodiversity, local flooding, and recreational uses of the water body.

The Saltwater Creek and Lagoon Estuary Management Plan (WBM Oceanics, 2006a) recommended the development of a formal entrance management policy for the estuary. Subsequently, Council manages the entrance in accordance with interim entrance management protocols (Kempsey Shire Council, 2007a). The protocols outline the conditions under which mechanical opening of the entrance are to be undertaken. These are:

- 1) **Water Levels or Flooding:**
 - a) From the end of Easter school holidays to two (2) weeks prior to September school holidays when water levels reach or exceed 2.0 m AHD; or
 - b) For the remainder of the year when water levels reach and/or exceed 1.8 m AHD.
- 2) **Water Quality Thresholds.** At any time during the year if recorded water quality parameters exceed the following thresholds
 - Dissolved oxygen 4 mg/L (minimum)
 - pH 6.0 (minimum)
 - Temperature 35°C (maximum)
 - Secchi depth 1.0 metres (minimum)
 - Faecal coliforms 600 counts/100mL (maximum) ⁽¹⁾
 - Enterococci 60 counts/100mL (maximum) ⁽²⁾
 - Odour - significant malodour generation
 - Oils and grease - presence of significant surface slicks

Note: (1) Alternative threshold is four (4) consecutive records greater than 150 counts/100mL

(2) Alternative threshold is four (4) consecutive records greater than 35 counts/100mL

It should be noted that the water quality criteria for opening have never been triggered at Saltwater Creek.

The interim policy adopts a mechanical opening level that is relatively close to the natural breakout level of the lagoon (WBM Oceanics, 2006b; WBM Oceanics, 2006a) which is consistent with the philosophy of minimal intervention generally advocated by DPIRD-Fisheries (DPI, 2018) by allowing natural processes to operate to the greatest extent possible. As a result, mechanical opening of the entrance has occurred on only three (3) occasions since 2006. Two (2) of those occasions occurred within one week in early 2010 when the pedestrian foot bridge was being constructed. The third occasion was following a significant storm/flood event circa 2013 (Kempsey Shire Council, pers. comm. April 2020).

Entrance Closure

As discussed in Section 5.5, the South West Rocks Surf Life Saving Club (SLSC) has historically undertaken temporary artificial entrance closure during major surf carnival events – in order to ensure safe beach access for emergency services vehicles, and safe passage to the beach for participants and onlookers. This has involved the creation of a closed entrance berm, and where necessary, the creation of a “sand bridge” across the entrance so that emergency vehicles have access to the beach for the event.

This process has involved the SLSC obtaining a dredging and reclamation permit through DPIRD-Fisheries in advance of a major event and then:

- Undertaking closure several days prior to the event, usually on a Thursday (as events are typically held across a weekend) and establishing a “sand bridge” from the SLSC across to Trial Bay Front Beach.
- Leaving the entrance closed for the duration of the event, with machinery on stand-by; and
- Disestablishing the sand bridge and reopening the entrance after the event, typically on a Monday.

An example of this activity is provided in Figure 4-1, which depicts a temporary entrance closure in June 2014 (as captured by Google Earth).



Figure 4-1 Example of temporary entrance closure from June 2014 (source: Google Earth)



5 MANAGEMENT ISSUES

5.1 Entrance Dynamics

5.1.1 ICOLL Behaviour

Saltwater Creek and Lagoon is an ICOLL. The estuary is separated from the ocean by a sand beach barrier or berm, which forms and breaks down depending on the movement and redistribution of sand and sediments by waves, tides, flood flows and winds (DPI, 2018). The estuary opens and closes to the ocean naturally in a constant but irregular cycle. Examples of open and closed entrance conditions are provided in Figure 5-1.



Figure 5-1 Entrance berm closed (left) and open (right)

Generally, coastal process such as tides and waves tend to push sand from offshore into the entrance, which gradually closes the entrance. Conversely, when there is sufficient intensity and volume of catchment inflows into the lagoon (usually following heavy rainfall), water levels in the estuary rise in response as the estuary fills. Eventually the water in the ICOLL will spill over the entrance sand berm and drain to the ocean. The force of the backed-up water then quickly scours an entrance channel through the beach and reopens the ICOLL to the ocean (DPI, 2018).

When ICOLLs are open they become tidal, with seawater moving into and out of the estuary with the daily tidal cycle. However, during this state, the estuary experiences a significantly attenuated tide range (compared to the open ocean) due to hydraulic energy losses through the narrow and shallow estuary entrance – with the extent of the flood tide delta generally controlling the tide range within the estuary. Tidal exchange of water through the lagoon entrance, even when scoured, is generally inefficient. Tidal energy losses through the entrance result in the water volume entering the lagoon on each rising tide not fully draining on each falling tide. This process results in a higher mean water level inside the ICOLLs compared to the mean sea level outside. This super-elevation varies based on entrance condition, the stage of the tidal spring-neap tide cycle and the volume of catchment inflows, and is typically around 0.5 to 0.8 m inside the estuary.

Without further large freshwater flows into the estuary from the catchment, the ICOLL will eventually close off to the sea. When the estuary is closed, it does not exchange water with the ocean and water levels within it fluctuate depending on rainfall, catchment inflows, groundwater flows and evaporation.

The continuous but irregular cycle of entrance opening and closing depends on the balance of these processes. During wetter periods, many ICOLLs remain open to the ocean for months or even years at a time. In times of drought and reduced rainfall, ICOLL entrances close more frequently and stay closed for longer periods of time (DPI, 2018). However, historical records show that about 70% of the ICOLLs in NSW are closed for the majority of the time (DPI, 2018).



A hydrodynamic processes assessment for the Saltwater Lagoon (Alluvium, 2021) indicated that:

- The estuary is closed around 58% of the time, and open 42% of the time;
- The average duration of closed conditions is approximately 84 days, with the longest recorded period of 336 days (26 July 2005 – 27 June 2006);
- The average duration of open conditions is approximately 60 days with the longest recorded period of 310 consecutive days (27 July 2020 – 2 June 2021); and
- The average water level at which entrance openings occur is approximately 1.6 m AHD.

The study also noted that the entrance condition at Saltwater Creek is influenced by large scale climatic drivers, such as the El Niño Southern Oscillation (ENSO). In general, a sustained positive ENSO index (termed La Niña) results in above-average rainfall along the NSW coastline – and more frequent periods of entrance opening. Conversely, a sustained negative ENSO index (termed El Niño) results in below average rainfall and is associated with prolonged droughts and entrance closure.

5.1.2 Estuary Hydrodynamics

Recorded water level data within the lagoon from 2004 to 2021 are presented in Figure 5-2. These water levels have been recorded since July 2004 by a water level gauge operated by Manly Hydraulics Laboratory (MHL) around 50 m downstream from the German Bridge on Phillip Drive. This data shows that when the estuary entrance is open, the tidal range within the lake is generally less than 0.3 m. The tidal phase lag between the lagoon and the open ocean is around 1-2 hours (MHL, 2002) and the tidal limit of the estuary is reported as being around 4.3 km upstream from the entrance (Roper, et al., 2011).

The tidal prism, which is the volume of water in the estuary between High Water Solstice Springs and Indian Spring Low Water, is approximately 25,000 m³ (MHL, 2002). Average tidal flow velocity is estimated to be 6 cm/s in the creek and 0.2 cm/s in the lagoon. As more than half of the tidal prism is captured in the creek, and the average tidal velocity is low, flushing of the system is also very low (less than 10% of the estuary volume, indicating a timing of at least 30 days when the entrance is open).

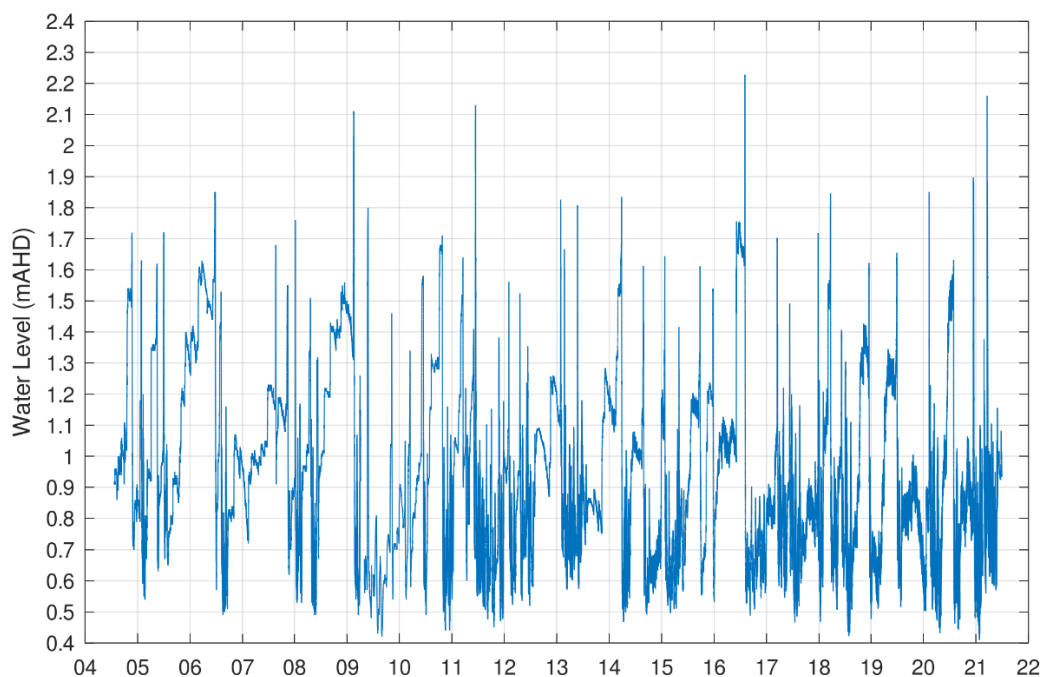


Figure 5-2 Estuary water levels from 2004 to 2021



5.1.3 Entrance Berm Behaviour and Natural Breakout Range

As with all ICOLLs, the height of the entrance berm is dynamic and variable and results from prevailing coastal processes (Hanslow, Davis, You, & Zastawny, 2000). Berm survey data collected intermittently by Kempsey Shire Council between 2010 to 2016 is depicted in Figure 5-4 below, which shows transects of the berm running east-west from the surf club, transecting the entrance channel. This figure shows that when the entrance is closed, the natural “saddle point” is typically between 1.2 to 1.7 m AHD. This corresponds to the natural breakout range for the estuary. Statistical analysis of berm heights is provided in Table 5-1, which shows that the 95% confidence intervals for berm saddle level are 1.0 to 1.8 m AHD. The highest recorded saddle point is 1.67 m AHD.

Table 5-1 Berm Height Statistics (n=19)

Parameter	Value
Average berm saddle height	1.4 m AHD
Standard deviation	0.2 m
95% Confidence Interval Range (Indicator of natural breakout range)	1.0-1.8 m AHD
Maximum recorded saddle point	1.67 m AHD

This estimate for the natural breakout range is generally supported by water level gauge records (see Figure 5-2), which also demonstrate historical peak flood levels after breakout are commonly between 1.1 and 1.9 m AHD. However, it should be noted that using peak flood levels as a proxy for berm height can be problematic, as the estuary floods even during an open entrance condition (see Section 5.2). Nonetheless, the water level data is broadly consistent with the berm height analysis.

This indicates that the historical entrance trigger levels for mechanical opening (at 1.8 to 2.0 m AHD) have been at the upper end of the ‘natural breakout range’ of the estuary – and this is demonstrated by the infrequent requirement for mechanical openings over the last 20 years.

When closed, the dry berm width (in the shore normal direction) is commonly between 20 and 40 metres (see Figure 1-1, Figure 2-2, and Figure 4-1).

An occasional artificial opening of the entrance within the natural breakout range is not likely to have a significant environmental impact since it falls within the expected natural variation. However, over the longer term, numerous artificial openings especially at a comparatively low water level are likely to have a significant environmental impact, since the natural frequency and duration of opening and closing to the ocean will be significantly altered.

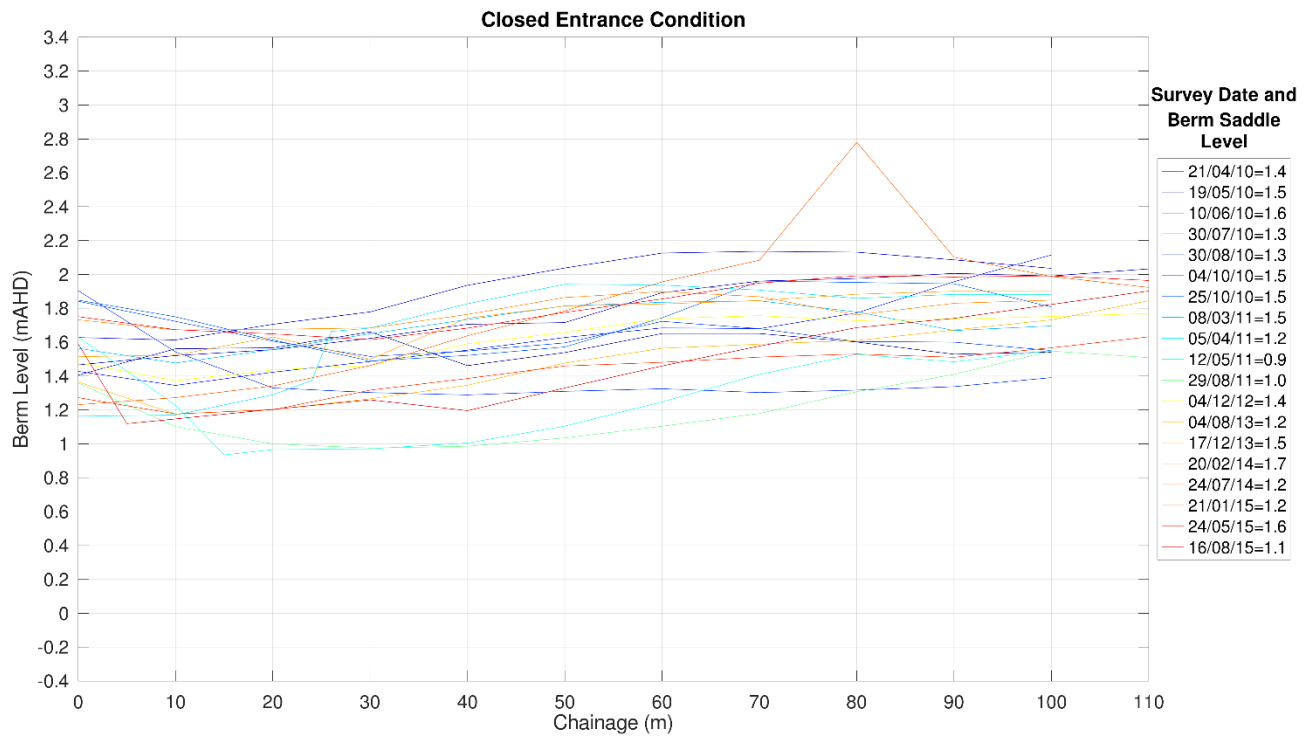


Figure 5-3 Recorded berm heights at estuary entrance – closed condition

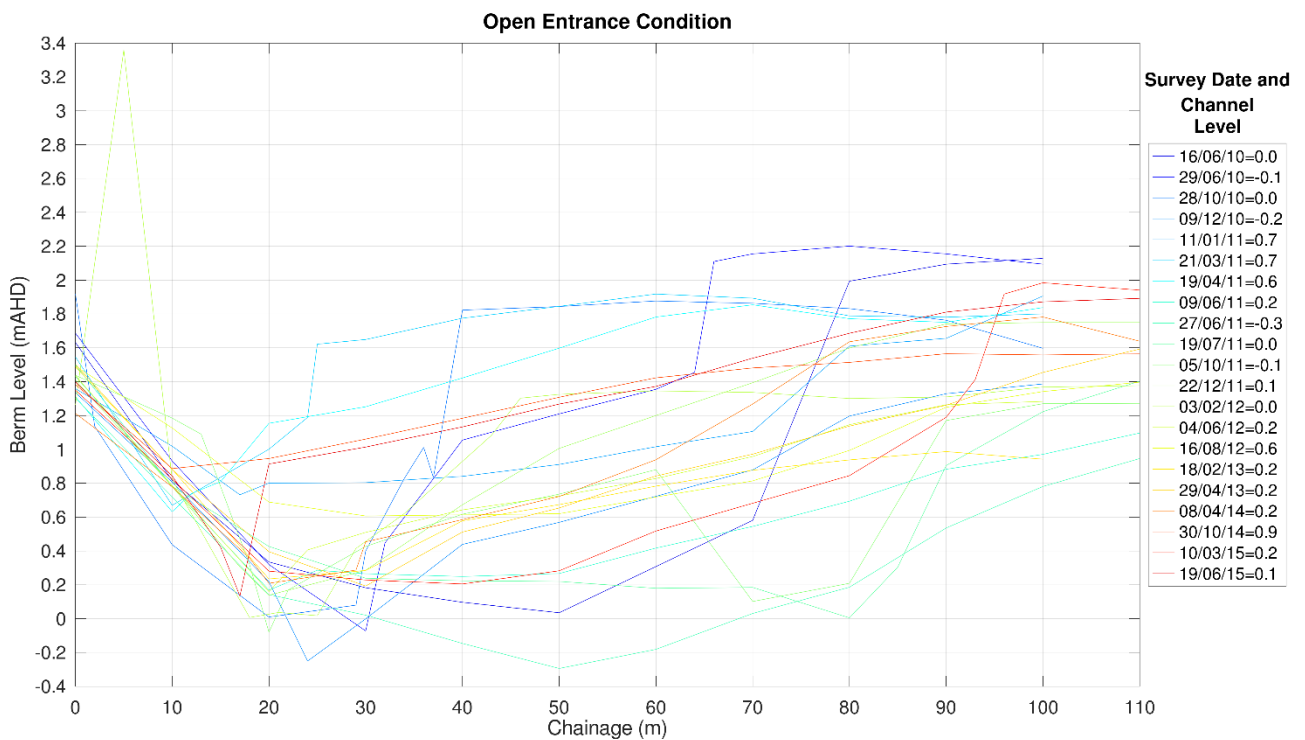


Figure 5-4 Recorded berm heights at estuary entrance – open condition

Bed Rock Stratum

When open, scour of the entrance is generally inhibited by a variable subsurface bedrock stratum that underlays the entrance berm – see Figure 5-5. This rock sill acts to limit the depth of entrance scour during breakout events, and in doing so limits the degree of ocean connectivity when the estuary is open.



Figure 5-5 Visible bedrock strata at the estuary entrance

5.2 Estuarine Flooding

The Macleay region is periodically exposed to storm activity originating in the sub-tropics of the north and the mid-latitudes of the south. To the north are tropical cyclones, which occur during the summer months and depressions developing into easterly troughs. Further south, low pressure systems such as cut-off lows, migratory lows and east coast lows, are a major source of severe weather, particularly in the colder months. These systems are all capable of generating storm surges and elevated coastal storm tides, as well as intense rainfall and associated catchment flooding.

Therefore, the estuary experiences periodic flooding due to high intensity rainfall hitting the small, relatively steep catchment. Rainfall typically falls as occasional high intensity bursts, and the estuary is noted to respond rapidly to rainfall.

5.2.1 Flood Behaviour and Design Flood Levels

Flood behaviour in Saltwater Creek was assessed in the Saltwater Creek Flood Study (WBM Oceanics, 2006b). Design flood levels for a range of Average Recurrence Interval (ARI) events are provided in Table 5-2 and Figure 5-7. Key findings of the study include:

- The main feature controlling flood levels in Saltwater Lagoon is the German Bridge on Phillip Drive– see Figure 5-6. The results of the flood study indicate that the bridge and its abutments act as a significant hydraulic constriction during flooding events. The abutments of the bridge significantly narrow the creek beneath it, acting as a horizontal constriction. Furthermore, the deck of the bridge has a depth of around 0.5 m with an obvert level of around 1.8 m AHD (based on visual site inspections), which acts as a vertical constriction during flood events.
- This constriction creates a sharp water level gradient through the section of the creek where the bridge is located. As a result, water levels upstream of the bridge (and in the lagoon body) can be 0.2 to 0.5 m higher than those levels observed downstream of the bridge. This can be observed clearly in Figure 5-7 and Figure 5-8, which depict the longitudinal profile of design flood levels.
- Flood levels across the floodplain upstream of the German Bridge show little spatial variance (that is, flood levels across the Lagoon foreshores are almost identical) due to the proportionally wide conveyance that the lagoon offers for the flood flows.



- The state of the entrance does have an influence on upstream flood levels to some degree. However, this influence diminishes with distance upstream from the entrance, and reduces significantly upstream of the German Bridge – which is the main hydraulic constriction.
 - In fact, the flood study determined that for a 100 year ARI (1% AEP) flooding event, an entrance berm level of +3.0 m AHD results in flood levels only 0.3 m higher than an entrance berm level of +2.0 m AHD.
 - This is also demonstrated by the record of historical flood events (see Section 5.2.2), which shows that two of the four largest flood events in the last 20 years have occurred when the entrance was *open* prior to the rainfall event.
- This demonstrates that the state of the entrance has only a limited impact on the magnitude of peak flood levels within the estuary - and therefore entrance management is limited in its ability to act as an effective flood mitigation tool for rare and severe flood events.
- The flood study results also show that there is a hydraulic water level gradient between the entrance and the water level gauge (50 m downstream from the bridge). This results in water levels at the gauge being around 0.1 to 0.2 m higher than water levels at the entrance during a design flood event.



Figure 5-6 The German Bridge at Saltwater Creek. Image captured in November 2021 when the estuary was closed with recorded water level of 1.36 m AHD.

Table 5-2 Design Flood Levels in m AHD

ARI	Entrance	German Bridge	Lagoon Body	Golf Course
Distance Upstream from Entrance	<500 m	~2,900 m	~3,250 m	~5,800 m
5 yr (2.0 m AHD Berm Level)	2.2	2.3	2.6	3.1
20 yr (2.0 m AHD Berm Level)	2.2	2.4	2.9	3.2
100 yr (2.0 m AHD Berm Level)	2.2	2.6	3.1	3.3
100 yr (2.5 m AHD Berm Level)	2.8	2.7	3.2	3.4
100 yr (3.0 m AHD Berm Level)	3.2	3.2	3.4	3.5



ARI	Entrance	German Bridge	Lagoon Body	Golf Course
Probable Maximum Flood (PMF)	3.7	4.3	4.5	4.5

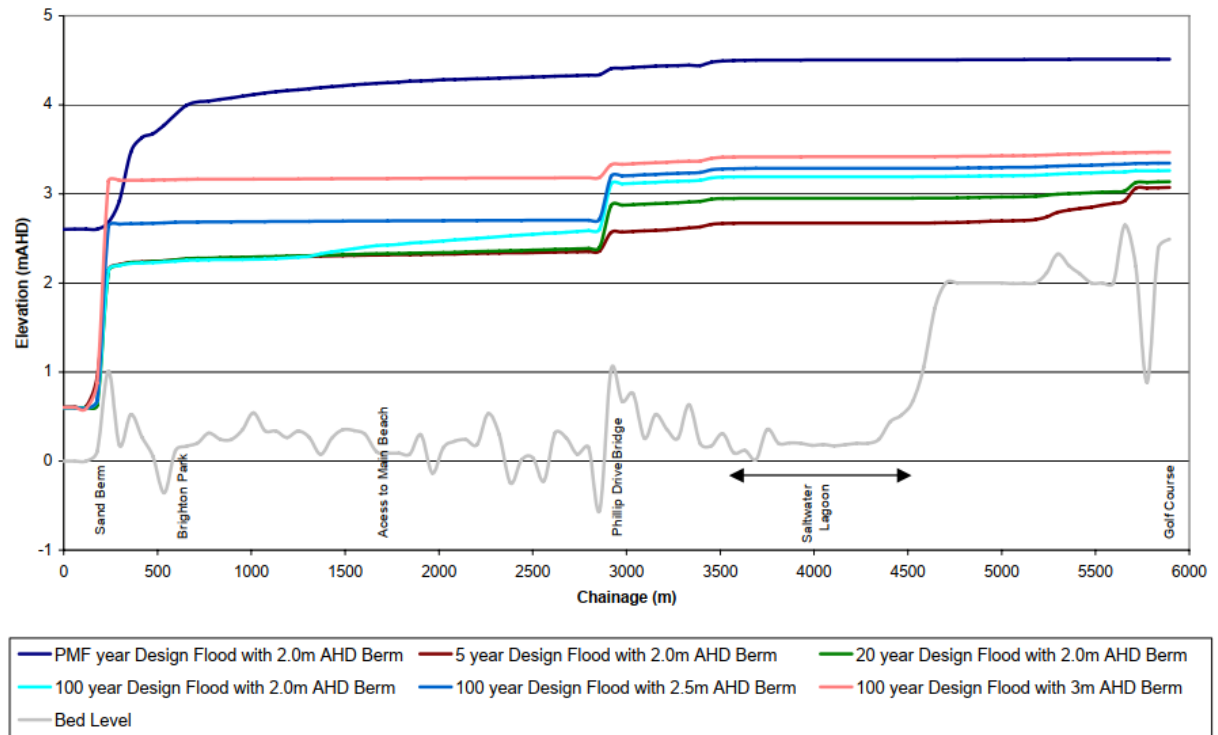


Figure 5-7 Longitudinal profile of flood behaviour (WBM Oceanics, 2006b)

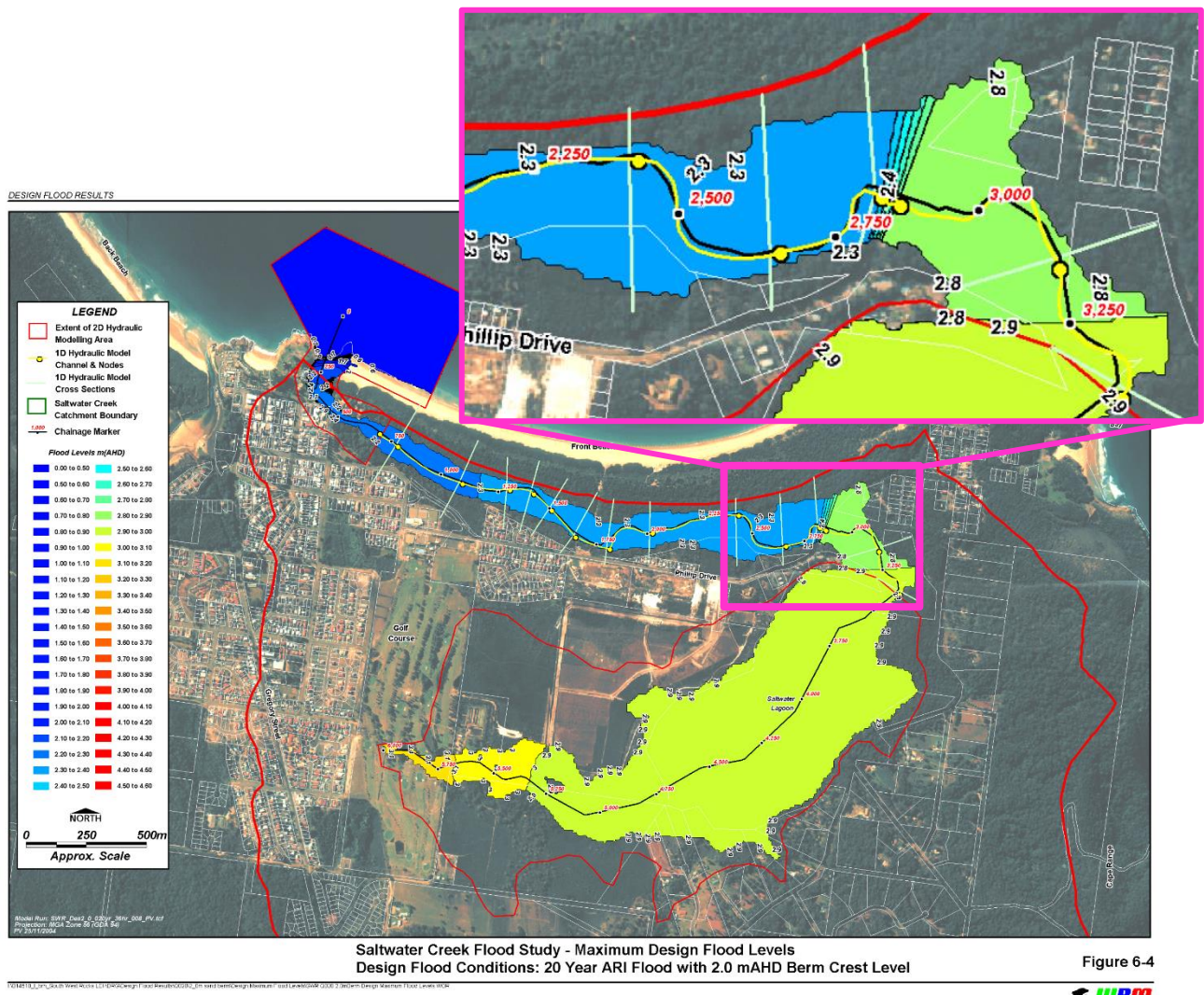


Figure 5-8 Spatial depiction of bridge constriction for 5% AEP event (WBM Oceanics, 2006b)

5.2.2 Historical Flood Events

The largest inundation events recorded at the gauge are depicted in Figure 5-2 and summarised in Table 5-3, along with the state of the entrance prior to occurrence of the rainfall event. These are the only four occasions where water levels exceeded 2.0 m AHD at the gauge. It shows that two of the four largest flood events in the last 20 years have occurred when the entrance was open prior to rainfall.

Table 5-3 Flood events exceeding 1.8 m AHD MHL Gauge from 2004 to 2021

Date	Peak Level (m AHD)	Entrance Condition
3 August 2016	2.23	Natural breakout
19 March 2021	2.16	Open prior to event
14 June 2011	2.13	Open prior to event
16 February 2009	2.11	Natural breakout

5.2.3 Rate of Rise

The recorded rate of rise (in terms of metres per hour) across a range of previous flood events has been assessed based on historical water level data. It shows that the rate of rise of lagoon water levels is commonly in the range of ~0.05 m/hour during severe rainfall events, but on rare occasions may reach as high as 0.1 m/hour. The rate of rise recorded during the 2016 inundation event is provided in more detail in Figure 5-9; it showed a rate of rise peaking at nearly 0.1 m/hour, however this maximum rate of rise occurred around 12 hours before peak flood levels.



Figure 5-9 Rate of rise during the 2016 flood event

5.2.4 Inundation of Assets

The surrounding terrain is relatively steep immediately adjacent to the creek, with flatter, more low-lying land occurring in the vicinity of the South West Rocks Caravan Park – which is positioned where the creek meets the lagoon body. The caravan park is built on relatively low-lying flood-prone land. Of particular concern for the caravan park is the southern foreshore that fringes the lagoon body. Topographic contours and wastewater infrastructure for the site are mapped in Figure 5-10 showing that most severe inundation occurs along the southern boundary of the park on NPWS land (this section of the park is leased from NPWS). The south-west corner of the park is particularly low lying and is the first location to experience inundation during a flood event.

The levels at which infrastructure around the park become inundated are summarised in Table 5-4. The high proportion of tourists that visit the site, particularly in the summer, further increases the risk profile of the site, as tourists are unlikely to be familiar with local flood behaviour and flood risk.

Table 5-4 Inundation thresholds at the Caravan Park

Level (m AHD)	Affected infrastructure
1.7	Minor inundation of 6 open air non-powered and powered and camping lots and tent sites in the south-west corner of the park
1.8	Complete inundation of 6 open air non-powered and powered and camping lots and tent sites in the south-west corner of the park
2.0	Inundation of up to 18 open air non-powered and powered and camping lots

Level (m AHD)	Affected infrastructure
2.1	Inundation of up to 30 open air non-powered and powered and camping lots
2.5	Access road into the park from Phillip Drive. Sewage pump station, and permanent accommodation infrastructure including villas and cabins infrastructure
3.0+	Manager's residence, cottages and other permanent infrastructure,

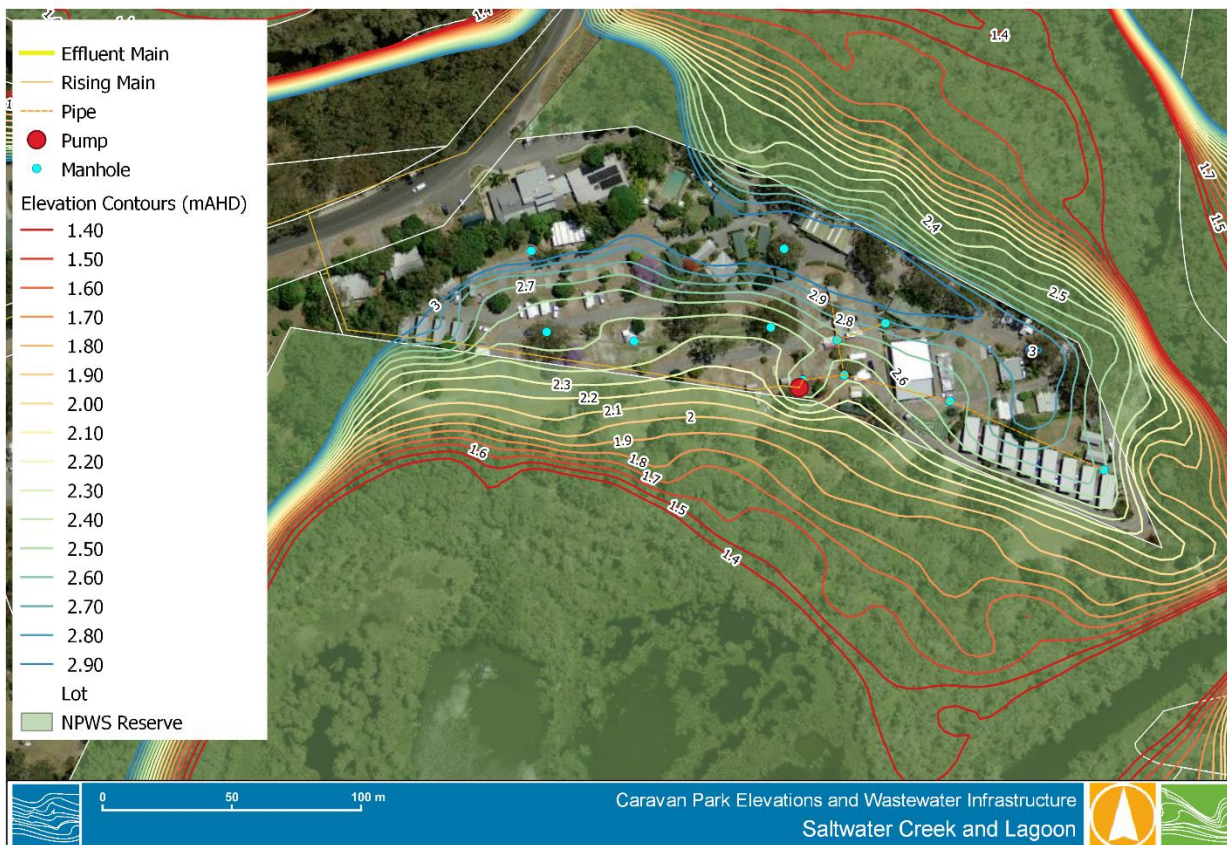


Figure 5-10 SWR Caravan Park – elevation and wastewater infrastructure

5.2.5 Case Study: November 2021 Breakout Event

A case study of an opening event occurred in mid-November 2021. Water level gauge records are provided in Figure 5-11, along with hourly rainfall measurements from nearby gauges at Aldavilla (32 km south-west of the estuary) and Stuarts Island (around 25 km to the north). Details of the event are as follows:

- Gauge records indicate that the estuary had been closed since early June 2021, and the water level prior to the rainfall event was 1.35 m AHD.
- Anecdotal reports of berm height survey prior to opening (as surveyed by the Caravan Park manager) was a berm level of around 1.7 m AHD. However, it is considered that the accuracy of this measurement is likely to be ± 0.2 m given the difficulty in finding the “saddle point” of the berm. Visual inspection indicated that the saddle point of the berm crest level was around 0.2 to 0.3 m above the still water level.
- In between the 20th and the 22nd of November, intense rainfall occurred across the mid-north coast. From the commencement of rainfall to the commencement of entrance opening:
 - 60mm of rainfall was recorded at Aldavilla; and



- 68 mm of rainfall was recorded at Stuarts Island. Rainfall was particularly intense at Stuarts Island on the afternoon of the 21st of November, when 27 mm was recorded in a single hour.
- It is likely that the rainfall in the Saltwater Creek catchment was comparable to that recorded at these gauges.
- Water levels started rising more rapidly on the morning of the 22nd of November, with levels rising from around 1.41 m AHD at 05:00 to 1.67 m AHD at 16:00. During this period, the rates of rise at the gauge temporarily peaked at around 0.06 m/hour but were generally less than 0.05 m/hour.
- Breakout occurred at 16:00 on the 22nd of November, with the peak gauge level recorded at 1.67 m AHD. This would suggest that the natural saddle point in the berm level was in the vicinity of 1.6 m AHD at the time. This is consistent with the natural breakout range discussed in Section 5.1.3.

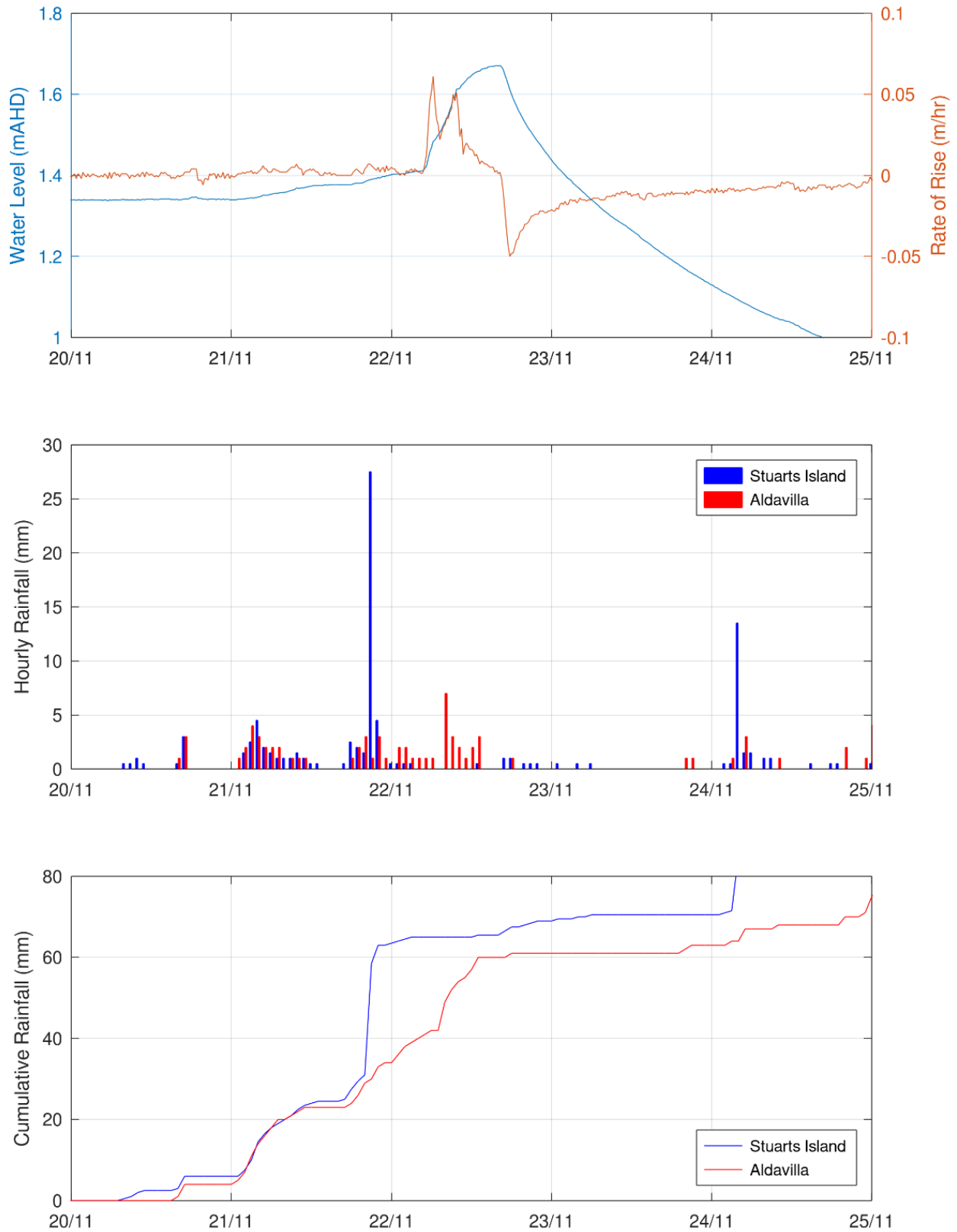


Figure 5-11 Recorded water levels and rainfall during November 2021 opening event

5.3 Estuarine Water Quality

5.3.1 Water Quality in the Estuary

Water quality in ICOLLs is highly variable due to the combined effects of catchment runoff (and any entrained contaminants), entrance dynamics, a tendency to stratify under some conditions, and the influence of groundwater inputs from surrounding low-lying catchments. While water quality variation may appear extreme relative to permanently open tidal systems, in many cases this variation should be considered natural and an integral part of the greater coastal ecosystem (DPIE, 2021).

A relatively common property among smaller systems such as Saltwater Creek is the influence of tannin-rich groundwater and wetland runoff inputs. Tannins are responsible for the 'tea-like' brown water appearing in these systems and should be regarded as a natural attribute of the system (DPIE, 2021).



Figure 5-12 Outflow of naturally 'tea-like' tannin rich water from Saltwater Creek

The estuary has historically experienced poor water quality (MHL, 2002; DEC, 2006) resulting from several different factors. Like most urban waterways, Saltwater Creek becomes quite degraded following rainfall events as urban runoff flows into the lagoon through the golf course drain, and into the creek via stormwater outlets. The estuarine system essentially retains everything that is discharged to it including all sediment, nutrients, and other pollutants (WBM Oceanics, 2006a) as the system is not regularly flushed out through tidal exchange. Even when the entrance is open, there is limited flushing and mixing within the creek and especially within the lagoon (as ocean water only moves in and out of the lower section of the creek). When the entrance is closed, Saltwater Creek can become stratified, which means that the bottom waters can experience poorer water quality (with low oxygen levels) than the surface waters (WBM Oceanics, 2006a).

Very large freshwater inflows can completely flush the creek, however regular rainfall only generates limited mixing and exchange. This results in long residence times in deeper areas of the creek and lagoon (MHL, 2002). With regards to estuary flushing, previous studies (MHL, 2002) have indicated that:

- The flushing efficiency factor for the estuary (the fraction of tidal prism volume entering the system that remains after the next tidal cycle) was likely less than 10% flushing, with an estimated flushing time for the entire estuary of around 30 days with the entrance open.
- Even under open entrance conditions, there is a nutrient retention and recycling rate in the system of around 95% - and thus almost all of nutrients are retained and cycled within the system.

Low oxygen levels recorded in the creek and lagoon are the result of the natural breakdown (decay) of organics (e.g. seagrass, leaves, branches, algae). Eutrophication occurs in the creek and lagoon system when the water



body is enriched with organic matter, leading to the depletion of dissolved oxygen. While high levels of chlorophyll can support larger fish populations, it can be problematic if sustained over long periods of time due to resulting noxious odours, overall poor water quality, fish kills, and human health issues upon contact with the water body (Roper, et al., 2011). These factors can also be associated with high turbidity caused by elevated suspended sediment load, which can smother or otherwise negatively impact benthic organisms and habitats within the estuary.

5.3.2 Water Quality, Decanting and Fish Kills

During entrance breakout events, estuaries with Saltwater Creek's physical configuration (a long shallow creek and a deeper central basin) can experience a process whereby it is predominantly the surface water layer that drains, leaving behind hypoxic water trapped in deeper parts of the central basin. This process is referred to as 'decanting' (Wiecek, 2001). Furthermore, the drawdown, or rush of water out of the estuary may cause a rapid decrease in oxygen in the water, by drawing the stagnant water out of the upper reaches of the estuary creeks and into the main basin. These processes result in a risk of fish kill events occurring, even in natural breakout situations.

In general, the occurrence of fish kills is highly unpredictable, however a significant mitigating factor is the size of the rainfall event (and hence the quantity of oxygenated freshwater inputs) that initiates breakout. Larger events will tend to cause greater flushing of hypoxic waters with overland runoff and will also result in greater channel scour allowing fish easier passage to the ocean (DPIE, 2021).

Management approaches to reduce the likelihood of fish kills include:

- Promotion of "natural openings" by scraping the beach berm prior to heavy rainfall – as opposed to "mechanical openings" where the entrance is directly opened by machinery; and
- Ensuring opening events coincide with rainfall (where possible)

It is important to note that while fish kills are often perceived to be the result of pollution or contamination of waters, they may also result from natural causes. NSW DPIRD maintains a database of fish kills in NSW. It contains over 1,400 records dating back to the early 1970s. The data suggests that on average 40 fish kills are reported to NSW DPIRD each year. Since many smaller kills go unnoticed and others remain unreported, the real number of kills is considered to be significantly larger (NSW DPI-Fisheries, 2013).

Fish kills have been recorded in the estuary both before and after entrance openings, the most recent of which occurred after a breakout event in 2004. However, there is little data available regarding the cause of this event or its overall impacts on estuarine ecology.

5.3.3 Water Quality and Entrance Management

Artificially opening estuary entrances is often perceived as a 'quick fix' to address water quality problems stemming from causes such as inadequate stormwater treatment from urban areas or inadequate erosion control measures in the catchment. Best practice for estuary management is based on addressing the source of the water quality issues rather than treating the symptoms by artificially opening entrances to 'flush' an estuary. Opening ICOLLs to improve water quality and estuary health is generally not recommended and could (despite best intentions) have undesired negative impacts on the estuary.

Some advice provided by DCCEEW in regard to artificially opening ICOLLs, and water quality impacts includes (DPIE, 2021):

- Opening at Lower Water Levels:
 - As outlined above, tidal prisms and exchange in the estuary is relatively low. Therefore, water quality in the estuary basin will not be significantly improved by dry weather opening. Low-level opening will only impact water quality in the lower estuary reach (around the flood-tide delta), and only during



incoming tides. Sediment, nutrient, debris and faecal contamination will continue to enter the estuary from the catchment, and therefore opening the entrance will not improve water quality while catchment sources remain active.

- Opening at low water levels is generally not recommended as there is not enough hydraulic head differential between the estuary and the ocean to sufficiently scour the entrance. Under such conditions, rapid entrance reclosure is common, and therefore any potential water quality benefits are also short term and temporary.
- Opening at High or Moderate Water Levels:
 - If estuary breakout and opening occurs in response to relatively small rainfall events, there is an increased risk of decanting surface water without sufficient catchment inflow to flush hypoxic bottom waters from the system. This increases the likelihood of fish kills.

Therefore, there is no need for flushing the estuary to improve water quality under 'normal' conditions. Nevertheless, there may be instances where artificial opening is justified to address extreme water quality issues in the waterway.

5.4 Estuarine Ecology

The study area supports tropical, subtropical and temperate terrestrial and marine ecosystems. It supports and sustains very diverse biodiversity that is of National, State, Regional and Local importance. Among many studies, the two predominant historic studies that have assessed ecological processes across the study area are:

- The Saltwater Creek Estuary Process Study (MHL, 2002); and
- The Saltwater Creek Catchment Flora and Fauna Study (Kendall and Kendall, 2003).

Some of the main environmental concerns identified for Saltwater Creek and Lagoon are outlined below:

- The Saltwater Creek and Lagoon has a variety of aquatic, riparian and terrestrial vegetation. Virtually all the estuary is designated as a R&H SEPP Coastal Wetland.
- The lagoon is known to be home to a variety of species of fish. Ecological sampling undertaken as part of (MHL, 2002) identified over 15 species of fish such as snub-nosed garfish (*Arrhamphus sclerolepis*), mullet, gobies (*Favonigobius exquisites*), whiting (*Sillago ciliata*) and crescent perch (*Terapon jarbua*). At least three of the species, including yellowfin bream, tarwhine and sand whiting, spawn in coastal waters, indicating an ecological link with the adjacent coastline.
- The study area provides particularly valuable habitat for local birdlife. Wading birds feed and roost on many intertidal flats and marshes and many migrating birds have been recorded in the vicinity of the study area (MHL, 2002). Over 29 species of threatened, vulnerable and/or endangered bird species are mapped on the Protected Matters Search Tool developed by the Department of Environment and Energy. Furthermore, species that are endangered in NSW that have been observed in the vicinity of Saltwater Creek and Lagoon (according to the BioNet Atlas of NSW Wildlife) include the Little Tern, the Black-necked Stork, the Pied Oystercatcher, the Curlew Sandpiper, and the Beach Stone-curlew, which are critically endangered.
- Historical studies have concluded that the estuary does not support large areas of seagrasses and mangroves which are common in South West Rocks Creek and the Macleay River. However, both studies note that some small pockets of seagrasses and mangroves exist throughout the estuary, though no comprehensive mapping of these vegetation communities has been undertaken to date. It should be noted that as part of Stage 2 of the CMP process, Council has commissioned a new Saltwater Creek Vegetation Mapping & Condition Assessment.



5.5 Social and Cultural, and Economic Values

5.5.1 Social Values

The shallow waterways and its surrounding vegetation provide a range of community services and recreational opportunities such as canoeing, swimming, bushwalking, fishing, cycling and nature observation. As a major tourist destination, South West Rocks is subject to significant seasonal population changes – with a strong increase in recreational uses during the summer holiday period. However, tourists are not the only users of the estuary, with the local community also using the estuary for the remaining non-holiday periods of the year.

There is a large caravan park (Section 5.2.4) in the low-lying area directly adjacent to Saltwater Lagoon, which is on land leased from Hat Head National Park. The South West Rocks Country Club also has a low-lying golf course adjacent to Saltwater Lagoon, which the creek flows through.

Surf Carnivals and Beach Access

Located at the estuary entrance, on Trial Bay Front Beach, the South West Rocks SLSC is a highly active surf club that has been in operation since 1919. The club frequently hosts Surf Sports carnivals in a variety of events from nippers to surf boat rowing. These carnivals can attract thousands of beach users to Trial Bay Front Beach over the course of a weekend.

It is important to note that the condition of the entrance has significant impacts on local beach access. Engagement with the SLSC has indicated the following:

- When the entrance is open, access to Trial Bay Front Beach from the SLSC is essentially cut-off, and this represents a safety issue – as beach users may injure themselves walking through the creek between the club and the beach.
- Furthermore, any emergency access for vehicles (including ambulances) can also be an issue, as when the entrance is open access to the beach for vehicles is only possible from either the Cardwell St vehicle access point, or the eastern end of Trial Bay Front Beach, some 3 km from the SLSC and high use beach area. Furthermore, vehicles are not always able to drive from the eastern end of the beach back to the SLSC due to beach erosion which results in a beach that is too narrow to safely drive on (as the waves lap up to the dunes).

Therefore, the SLSC has historically undertaken temporary artificial entrance closure works during major surf carnival events in order to ensure safe beach access for emergency service vehicles, and safe passage to the beach for the community. This process is discussed in Section 4.

5.5.2 Indigenous Heritage Values

The Macleay Valley Region has a rich and continuing indigenous heritage, with cultural history extending back in time more than 40,000 years (NPWS, 1998). South West Rocks is located in the traditional lands of the Dunghutti nation. Extending from the eastern coast to the tablelands in the west, Dunghutti country encompasses Kempsey, Bellbrook, and the towns of the Macleay Valley Coast. The Dunghutti people traditionally were hunters and gatherers, who lived in harmony with the land, and their pattern of life was governed by sacred laws, handed down through countless generations (MVC, 2020). Traditionally, Monument Point (at the estuary entrance) was a place of gathering and ceremony for the Dunghutti, Gumbaynggir and Biripi nations with the headland representing a 'song line' or 'energy line' between Mount Yarrahapinni and the hills around Arakoon (Kempsey Shire Council, 2020a).

Analysis of the NSW Office of Environment and Heritage's Aboriginal Heritage Information Management System (AHIMS) database shows 29 indigenous heritage sites recorded in the approximate catchment area of the estuary. An interrogation of the National Native Title Register (NNTR) found no existing or pending federal native title claims across the study area catchment. The extent of claims made under the *NSW Aboriginal Land Rights Act 1983* across the study area is not known at this time. In terms of the implementation

phase of the EMP, where there are unresolved claims lodged on Crown land, any dealings/works on Crown land will generally require the consent of the relevant Local Aboriginal Land Council.

5.6 Potential Impacts of Climate Change on Entrance Management

As the morphology of the entrance berm is a product of the interaction between fluvial, tidal and wave processes, any impact on these processes associated with climate change may also affect the entrance behaviour, resulting in a new 'dynamic equilibrium'. Specifically, climate change is expected to result in changes to the Saltwater Creek entrance behaviour due to the following processes (Haines & Thom, 2007):

- **Mean sea level rise**, will pose a serious risk to coastal communities due to inundation and erosion. Between 1993 and 2009, the rate of global sea-level rise was estimated to be 3.2 ± 0.4 mm/year (Church & White, 2011). Depending on future carbon emission pathways, as defined by the Intergovernmental Panel on Climate Change (IPCC) Sixth Assessment Report (IPCC, 2020) sea levels around eastern Australia could rise between 0.63 to 1.10 m by 2100. In these circumstances, built infrastructure may be potentially at risk, including drainage pathways, abutments, and adjoining roadways. Undeveloped shorelines may be equally vulnerable, with potential significant ecological implications (Glamore, Rayner, & Rahman, 2016).
- **Entrance morphodynamics**: Disruptions from sea-level rise, littoral sand transport, and changes to rainfall and flooding behaviour are likely to result in an upward and landward shift in the beach profile, and potentially increased size, height and extent of the entrance berm (Hanslow, Davis, You, & Zastawny, 2000). This would then require higher water levels to precipitate a natural entrance breakout. As shown in Figure 5-13, an increase in mean sea level will result in an elevation of the base and maximum water levels, as well as the berm height within the ICOLL. This will cause inundation of additional properties in the low-lying areas adjacent to the lagoon and creek as the water level rises. It will likely require additional management of the ICOLL entrance to alleviate water level rise in the creek and lagoon due to prolonged entrance closure, as well as the consideration of other measures to alleviate nuisance flooding including relocation or modification of built infrastructure.

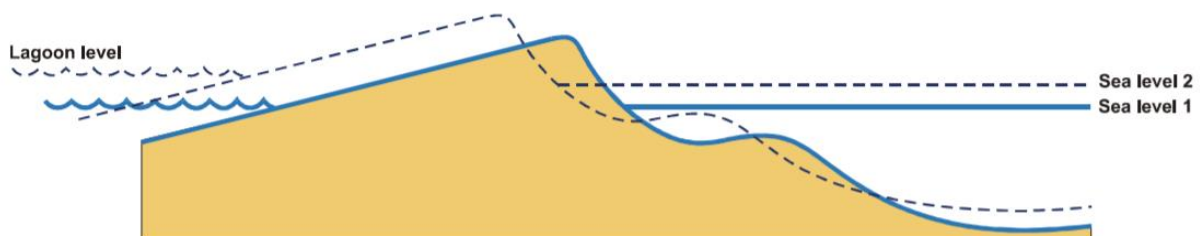


Figure 5-13 Upward and landward translation of an ICOLL berm under SLR (Hanslow, Davis, You, & Zastawny, 2000)

- **Tidal Inundation**: As sea level rise increases, it is expected that the frequency and severity of tidal inundation (also referred to as "sunny day flooding") will increase over time. This may lead to the progressive drowning of intertidal environments and freshwater habitats and increase the rate of landward displacement of estuarine shorelines and riparian ecosystems.
- **Estuarine Flooding**: With warmer weather, storms and rainfall events are predicted to become increasingly intense in both the near and far future (IPCC, 2013). Combined with sea level rise, this will have major implications for the severity of flooding in the estuary. Typically, closed ICOLLs are predicted to have an increase in available water storage volume with the lagoon and creek as the berm height increases in response to sea level rise, increasing the potential for inundation of the estuary fringe as natural entrance breakouts are reduced.



- **Ocean and Estuarine Impacts:** In addition to sea level rise, climate change is expected to result in changes to the water quality (temperature, salinity, turbidity, suspended solids) and chemistry (oxygen, nutrients, pH and alkalinity, Chlorophyll-a) of coastal and estuarine systems. This will also affect estuarine heat budgets, hydrodynamic and mixing (in particular after rainfall) and sediment dynamics. This includes ocean acidification and the impacts of warmer oceans on soft coral and fisheries (Adapt NSW, 2019).

As part of Stage 2 of the CMP process, Kempsey Shire Council has undertaken Coastal Vulnerability Area (CVA) mapping for their LGA coastline. The development of the CVA map has included consideration of seven coastal hazards; (1) beach erosion, (2) shoreline recession (3) coastal lake or watercourse entrance instability, (4) coastal inundation, (5) coastal cliff or slope instability, (6) tidal inundation and (7) erosion and inundation under tides, waves, and catchment floodwaters (JBPacific, 2021).



6 STAKEHOLDER ENGAGEMENT

6.1 Community Engagement

Entrance management typically draws high levels of community interest and is often a controversial issue with a range of differing viewpoints across the community. The goal of engagement with communities and other stakeholders is to obtain a high level of support for the EMP. Although it would be ideal to achieve total consensus in support, this is not always achievable with polarised and intransigent viewpoints that exist across the community.

To attempt to achieve a high level of community support, the project employed a three-step community engagement approach allied with engagement with other stakeholders. The three steps are provided in Figure 6-1, and described in detail below.

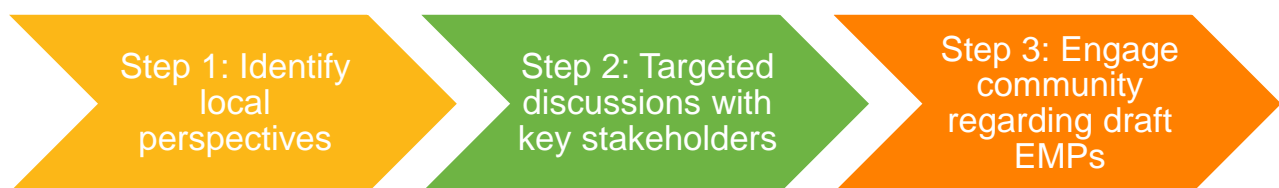


Figure 6-1 The community engagement process

Initially, Kempsey Shire Council developed a *Your Say Macleay* webpage for the project – in order to provide local community members with information about the project and how they can be involved. The webpage included:

- A project bulletin and three-minute informative video about the project and the principles of entrance management;
- A series of Frequently Asked Questions (FAQs) regarding entrance management and the NSW State Government's Policies on ICOLL management; and
- Links to information about the wider Kempsey Shire LGA CMP.

6.1.1 Step 1: Identification of Community Perspectives

Community Survey

The first step in the community engagement process was to identify local viewpoints and perspectives. The original intention for the project was to undertake an in-person community information session and workshop. However, COVID-19 restrictions during this stage of the project prevented the possibility of face-to-face engagement methods. Therefore, an online community survey was utilised for this task.

The survey was open from the 9th of August to the 31st of August 2021 in order to ascertain local community viewpoints and attitudes towards entrance management. 41 responses were received during the survey period, and answers to key questions regarding entrance management are provided in Table 6-1.

In order to ascertain community priorities, respondents were asked to rank their greatest, or most prominent concern regarding entrance management. Respondents ranked the various issues from (1) greatest concern, to (5) lowest concern. Results are provided in Figure 6-2.

These results demonstrated that the community has a strong preference for maintaining processes within the natural system, with:



- “Maintaining natural ecosystems and environmental processes” clearly ranked as the highest concern amongst the community; and
- Over 80% of the community either “definitely agree” or “somewhat agree” that the estuary should be left to open and close naturally.

Maintaining good water quality ranked as the second most prominent value, followed by flood risk mitigation.

Table 6-1 Community Survey Question 1: How strongly do you agree that the estuary should be managed in this way? [Total: 29 respondents]

Entrance Management Approach	Definitely agree	Somewhat agree	Neither agree nor disagree	Somewhat disagree	Definitely disagree
It should be left to open/close naturally	27	6	1	4	3
Mechanical opening if/when properties surrounding the estuary are under threat of flooding	14	3	5	7	12
Mechanical opening if/when water quality in the estuary is degraded	20	7	1	8	5
Mechanical opening to allow recreational vessel navigation in and out of the estuary	5	1	1	9	25

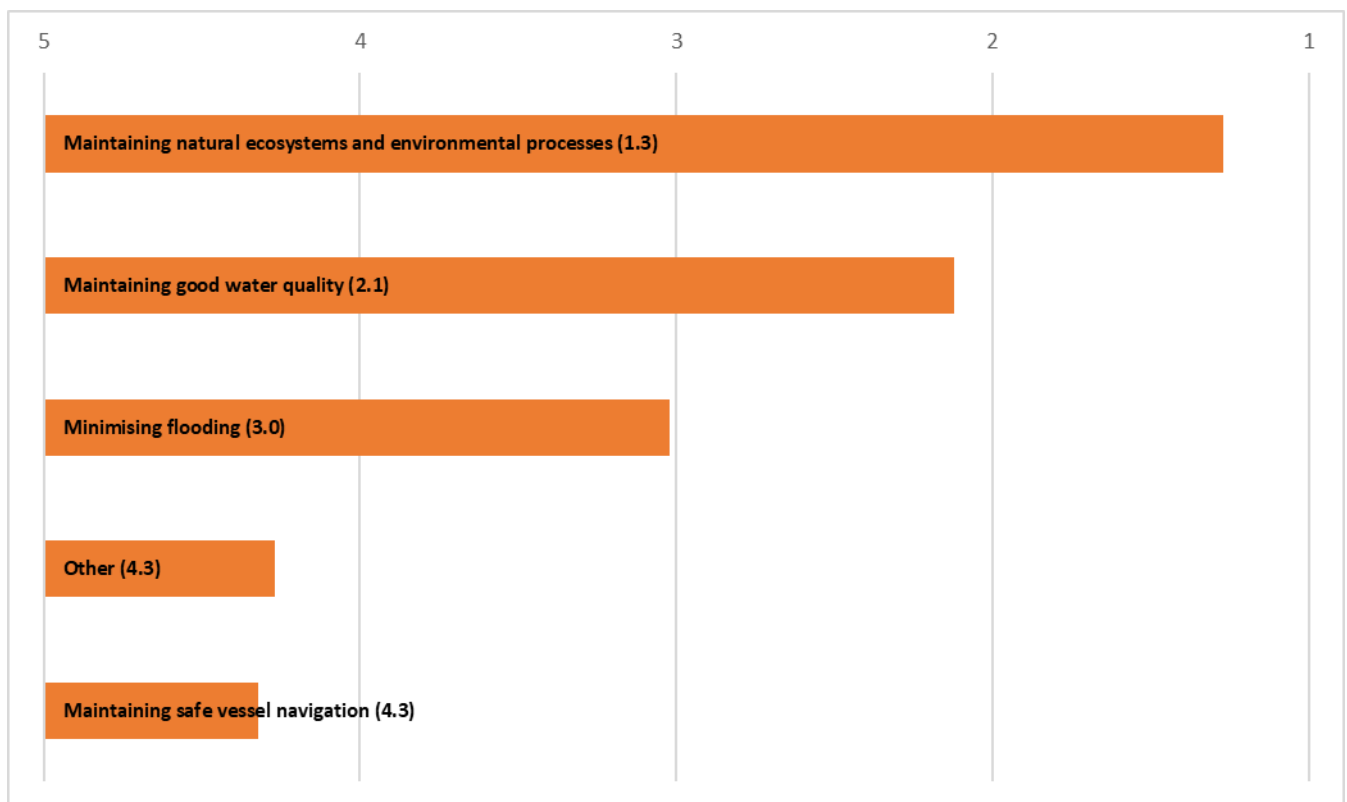


Figure 6-2 Community Survey Q4: Please rank your biggest concern regarding management of the entrance? (1 being the biggest concern)

Targeted Engagement

During the first engagement step, a targeted engagement process was undertaken with several community stakeholders who held a specific interest in entrance management as identified by the Saltwater Creek and Lagoon CMP Stage 1 Scoping Study (Water Technology, 2020). This took the form of “virtual” discussion of around one hour in length with:

- The South West Rocks Caravan Park;
- The South West Rocks SLSC; and
- Community members from South West Rocks Dune Care and Voices of South West Rocks.

The purpose of these discussions was to use qualitative social research methods to delve deeper to ascertain specific viewpoints and values with regards to entrance management.

6.1.2 Step 2: Targeted Community Discussions

Community Discussions

The second step of the engagement process involved undertaking targeted community discussions to gauge the viewpoints of draft EMP procedures. A community meeting/information session was held on the 1st of November 2021 at the Saltwater Creek entrance – see Figure 6-3.



Figure 6-3 Community meeting at the Saltwater Creek entrance (closed entrance berm in background)

The purpose of this targeted discussion session was to:

- Report back the findings of the Step 1 Community Survey;
- Provide information to the local community regarding the various issues involved in entrance management;
- Outline a draft position for management of the entrance; and
- Receive in-person community feedback regarding the draft position and other related viewpoints/concerns.



A total of 13 community members attended the event and a range of viewpoints and responses were recorded. These included:

- The overwhelming sentiment from the community meeting was that a “natural” approach to estuary management was preferred. Participants voiced support for managing the entire system holistically, in an environmentally sustainable manner.
- Participants wanted to ensure that beach access could be maintained even if a dry notch was dug out on the berm.
- Entrance closure to enable emergency access during Surf Life Saving events was generally supported, as it was recognised as being important to public safety. However, the participants would like to ensure the entrance is restored following the event and believe having a before and after photo record would be useful.
- Water quality concerns were also raised, and there was concern over possible health risks to children swimming in the closed creek.
- The point was raised that there are unofficial openings carried out by community members that will likely continue to happen.

Targeted Engagement

During the second engagement step, a targeted engagement process was undertaken with several community stakeholders who held a specific interest in entrance management. This took the form a series of face-to-face discussions held on the 1st and 2nd of November 2021, each of around one hour in length with:

- Figtree Descendants Aboriginal Corporation: The project team met with representatives of this organisation in order to discuss:
 - Indigenous cultural heritage values of Saltwater Creek;
 - The viewpoints of the Figtree Descendants towards entrance management; and
 - In-person feedback regarding the draft EMP position and other related viewpoints/ concerns.
- The South West Rocks Caravan Park: The project team met with the park manager and undertook a walking tour of the park, inspecting the various locations that are susceptible to inundation, and undertaking topographic surveys of key locations in order to determine ground levels.
- The South West Rocks SLSC: The project team met with the SLSC President, in front of the SLSC clubhouse at the entrance berm. The discussion revolved around barriers and constraints to historical entrance opening and closing arrangements, and opportunities to optimise the process.

Each of these groups indicated in-principle support for the proposed approach of this EMP.

6.1.3 Step 3: Engage Community Regarding Draft EMPs

The final step in the engagement process will be to ascertain community feedback on the draft EMPs. The EMPs will be included as part of the wider Kempsey LGA Coastal Management Program. Feedback on the EMPs will therefore be garnered from the local community when the CMP goes to public exhibition.

6.2 Stakeholder Engagement with NSW Government Agencies

During development of the EMP, stakeholders from a range of relevant public authorities were actively engaged with. A key component of this engagement was a stakeholder workshop, undertaken on the 23rd of August 2021. Attendees at the workshop included representatives from Council, DCCEEW(BCS) , DPIRD-Fisheries, DPHI-Crown Lands and Transport for NSW. Representatives from NPWS were not available to



attend, but were engaged separately including in the field on the 1st of November 2021. The key objectives of the workshop were to:

- Identify management roles and, responsibilities and legislation in relation to entrance management;
- Confirm details of historical entrance management arrangements, and the “on-the-ground” reality of how those arrangements have been practically implemented;
- Discuss historical barriers and constraints to effective management, and opportunities to respond and adapt to future challenges; and
- Identify relevant stakeholders for additional engagement.

The workshop was highly interactive and participatory. Follow-up with stakeholders was undertaken on a regular basis throughout development of the EMP.



7 ENTRANCE MANAGEMENT APPROACH

7.1 Overarching Approach

The overarching approach of this EMP is to advocate the general principle of minimal intervention. NSW DPIRD-Fisheries supports minimal interference with ICOLL barriers and advocates natural processes being allowed to operate to the greatest extent possible. During development of this EMP, the South West Rocks community demonstrated significant support for a minimal intervention approach. This EMP therefore applies this approach - except where trigger conditions for intervention are reached.

Therefore, this EMP outlines the following:

- Decision making criteria for *if* and *when* entrance management intervention should occur; and
- Determining the most suitable method of *how* entrance management will be undertaken, namely:
 - Berm height management; or
 - Direct mechanical opening.

7.1.1 Decision Making Criteria (If and When)

This EMP outlines guidance for entrance management based on the following matters of interest:

- Flood mitigation within the catchment, particularly with regard to nuisance inundation of the South West Rocks Caravan Park, and residential properties fringing the estuary.
- Water Quality within the estuary – under rare circumstances where water quality may affect human health and safety during peak usage periods. Artificial opening of the estuary for these purposes should only take place if agreement between relevant public authorities is reached.

As discussed in Section 8.2, while the entrance management framework provided in this document provides a strong scientific basis for determining the most appropriate course of action – the decision of which approach to take will ultimately belong to Council, in conjunction with relevant public authority stakeholders (Section 8.3).

7.1.2 Entrance Management Methods (How)

Entrance management is complex, and a flexible approach is therefore beneficial. The final course of action may be one of three potential options for entrance management, listed below in order of low intervention (most preferred) to high intervention (least preferred):

Option 1: Do Nothing

The overarching approach of this EMP is to advocate the general principle of minimal intervention and allowing the estuary to operate naturally to the greatest extent possible. This EMP therefore applies an approach of non-intervention - except where trigger conditions for intervention are reached.

Option 2: Berm Height Management

This involves managing the height of the berm such that it does not exceed a pre-determined level, using mechanical equipment to implement a “dry notch” or “saddle point” in the entrance berm which the water can then preferentially flow across. If maintained correctly, the notch would breach when the lake water level reaches the appropriate level during a runoff event.

This approach is intended to reduce the likelihood of fish kills through the promotion of natural openings - by scraping the beach berm prior to heavy rainfall events and allowing the opening events to coincide with rainfall



and freshwater inflows. Selection of an appropriate berm height management level should be in consideration of:

- Adoption of a “minimal interference” approach by implementing a berm height management level within the natural breakout range, thereby allowing natural processes to operate to the greatest extent possible; and
- Responsible and practical mitigation of flooding and inundation impacts across the estuary - by ensuring that the berm height management level (also referred to as the “berm saddle level”) also considers the levels and nature of fringing foreshore infrastructure.

An added advantage of the berm height management approach is that as it involves managing the berm prior to a storm event it avoids having to activate machinery and conduct work at the berm during potentially dangerous conditions, such as heavy rainfall, energetic waves, and eroded beach states.

Option 3: Mechanical Opening

Direct mechanical opening has commonly been used in entrance management across NSW in recent decades. However, while direct mechanical opening can often be expedient, it can also result in an increased risk of fish kill events, and rapid re-closing of the estuary. Therefore, there has been a recent shift in NSW towards managing ICOLL opening through berm height management – as opposed to direct mechanical opening.

However, it is important to acknowledge that in rare circumstances, a direct mechanical opening approach may also be necessary or more appropriate. This may include during times when degraded water quality poses a significant threat to human health and safety, or ecological processes - where there is a need to act urgently – as assets around the estuary are low-lying, and emergency situations are possible. Therefore, a flexible approach is required - and in the event of entrance closure, Council should liaise with relevant agencies listed in Section 8.3 in order to determine the most suitable opening method.

7.2 Entrance Management for Flood Mitigation

7.2.1 Purpose and Limitations

The primary purpose of entrance management at Saltwater Creek is to minimise nuisance flooding at the South West Rocks Caravan Park and residential properties fringing the estuary.

However, as discussed in Section 5.2, it is noted that entrance management is limited in its ability to mitigate rare and severe flooding. The main feature controlling flood levels in Saltwater Lagoon is the German Bridge on Phillip Drive – see Figure 5-6. The bridge and its abutments act as a significant hydraulic constriction during flooding events, and based on this, the state of the entrance has only a limited impact on the magnitude of peak flood levels upstream of the bridge.

Entrance management should therefore not be perceived or advertised as a “silver bullet” to alleviate all flooding within the estuary. Rather, the process of entrance management is intended to mitigate the impacts of less severe inundation events – referred to as “nuisance flooding”.

7.2.2 The Berm Height Management Approach

The approach of berm height management includes three main components:

- **The Alert Water Level:** When the estuary is closed, Council should immediately commence monitoring estuary water levels. When the recorded water level inside the closed estuary is high enough that the next major rainfall event could result in nuisance flooding – then the entrance management protocols should commence. Therefore, when water levels reach the Alert Water Level, Council should be on “alert” to start the entrance management process.



- **Berm Saddle Level:** If a significant rainfall event is forecast, Council should survey the level of the closed entrance berm. If the natural saddle point of the berm (i.e., the natural breakout level) is above this level – then the entrance berm is to be scraped so that it does not exceed this level. Later during a rainfall event, the estuary will overtop the entrance berm at this level and break out. This is intended to replicate the natural breakout process and reduce the risk of fish kills.
 - A threshold rainfall event to trigger this action is more than 60mm over the coming 72 hours. The case study opening event described in Section 5.2.5 indicates that this quantity of rainfall is likely to be sufficient to result in nuisance flooding if commencing at a high (closed) water level.
- **The Nuisance Flooding Level:** This is the desired maximum level of nuisance inundation that scraping the entrance berm intends to minimise. The Berm Saddle Level and the Alert Water Level are essentially determined by working backwards from Nuisance Flooding Level.

These three components are described in the schematic shown in Figure 7-1. The specific levels for these triggers are provided in Table 7-1, along with justification for their adoption.

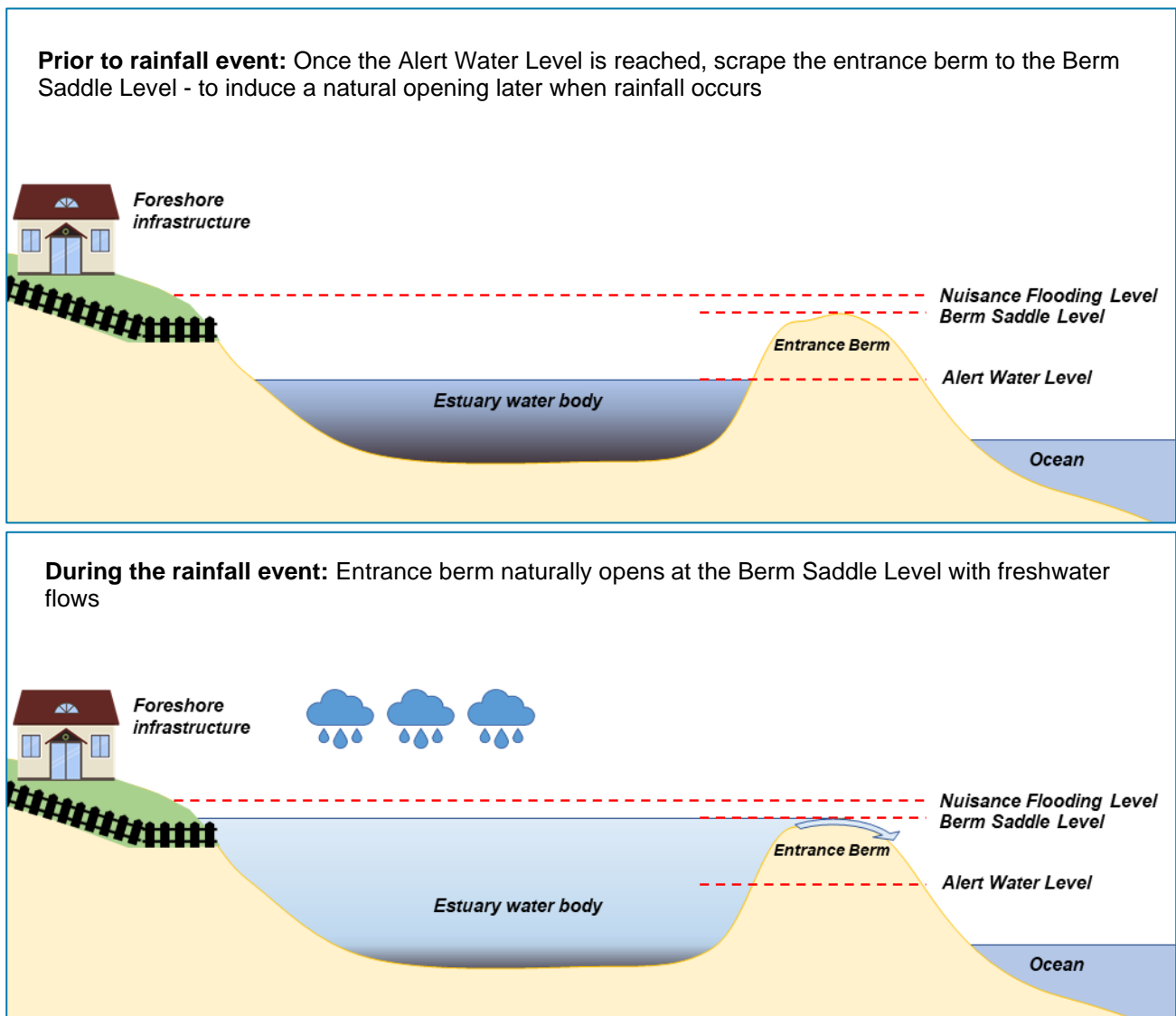


Figure 7-1 Berm height management - breakout process



Table 7-1 Flood mitigation trigger levels

<i>Description and rationale</i>		<i>Level (mAHD)</i>
Nuisance Flooding Level	<p>The Nuisance Flooding Level intends to minimise flooding at the South West Rocks Caravan Park, and residential properties fringing the estuary for lower AEP events.</p> <p>Section 5.2.4 shows that more severe flooding of the Caravan Park occurs at estuary levels of around 2.0 to 2.1 m AHD.</p>	2.1
Berm Saddle Level	<p>The saddle level has been determined with consideration of nuisance flooding of assets at the Caravan Park. Results of the Saltwater Creek Flood Study indicate that during a 20% AEP flood event, a steep hydraulic gradient is present in the creek, resulting in a water level around 0.3 to 0.4 m higher at the Caravan Park than the entrance – and potentially 0.6 m higher for a 5% AEP event (see Section 5.2). Therefore, in order to ensure that a level of 2.0 to 2.1 m AHD is not exceeded at the Caravan Park, the berm saddle level should be set at 1.7 m AHD.</p> <p>Section 5.1.3 discusses the berm behaviour for the estuary, and shows that the natural breakout range is between 1.2 and 1.8 m AHD. Therefore, the adopted berm saddle level of 1.7 m AHD is considered to be at the upper end of this range (and equivalent to the highest recorded saddle point in the berm).</p> <p>It is therefore anticipated that requirements for berm scraping will be relatively infrequent, as the berm height is most commonly below this level. An occasional artificial opening of the entrance within the natural breakout range is not likely to have a significant environmental impact since it falls within the expected natural variation.</p>	1.7
Alert Water Level	<p>When the estuary is closed, Council should commence monitoring estuary water levels. When the recorded water level reaches this trigger value, Council should be on “alert” to start the entrance management process.</p>	1.3



7.3 Approach to Managing Estuarine Water Quality

7.3.1 Overview

As discussed in Section 5.3 the most effective and sustainable way of managing ICOLL water quality is through improved management of catchment and floodplain runoff into the estuary. This will likely be addressed in the forthcoming Kempsey Shire Council CMP.

However, artificial opening may (in rare cases) be required as a temporary measure to address extreme water quality issues where severe environmental and public health risks may exist. It should be noted that the previous entrance management protocols for the estuary had water quality criteria for opening that were never triggered (Section 4). This indicates that the need for opening based on water quality is likely to be very rare for Saltwater Creek - and only implemented under exceptional circumstances.

It is often difficult to include triggers to address a broad range of potential water quality scenarios and associated uncertainties – and many EMPs do not include specific trigger values for opening estuaries based on water quality. A good example is the Woolgoolga Lake EMP (Coffs Harbour City Council, 2019b). A range of factors need to be considered during a poor water quality event, such as:

- Environmental and public health risks posed by the water quality issue;
- The extent to which artificial opening will mitigate the water quality issue; and
- The consequent environmental and public health risks along the adjoining coastline following artificial opening of the estuary.

This EMP recommends that opening for water quality purposes should not be undertaken unless poor water quality can be evidenced through monitoring data. It is recommended that any water quality event is assessed on an individual basis and any decision to open should be made by Council with advice/approval from relevant stakeholders (see Section 8). Artificial opening of the estuary should only take place if agreement between relevant agencies is reached. Under such conditions, opening of the estuary should be supplemented with investigations into the cause of the poor water quality.

7.3.2 Guidance for Management Decisions

Recommendations are provided herein to guide discussions between stakeholders for a scenario where Council may consider opening the estuary on the grounds of water quality:

- Water quality conditions are more appropriate as a trigger for entrance management actions during high use periods when primary contact recreation is more prevalent - nominally for the period from September school holidays to Easter school holidays.
- Guidance is provided below in the form of ANZECC (2000) guidelines for primary contact recreation (such as swimming, bathing and other direct water-contact activities). The guidelines state that estuary waters should generally be free from faecal contamination, pathogenic organisms and other hazards (e.g., toxic chemicals) to protect the health and safety of users. Additional guidance is provided for protection of aquatic organisms, with regard to low dissolved oxygen and asphyxiation of aquatic organisms, particularly fish.

Table 7-2 ANZECC WQ guidelines

Water quality parameter	ANZECC (2000) Threshold Value
Faecal coliforms	<ul style="list-style-type: none">■ Median from 4 consecutive samples taken during closure > 150 organisms /100mL; or■ Any one sample > 600 organisms/100mL



Water quality parameter	ANZECC (2000) Threshold Value
Enterococci	<ul style="list-style-type: none">▪ Median from 4 consecutive samples taken during closure > 35 organisms /100mL; or▪ Any one sample >60 organisms/100mL
pH	<ul style="list-style-type: none">▪ < 5.0
Dissolved Oxygen (DO)	<ul style="list-style-type: none">▪ < 4 mg/L

The method of mechanical opening should consider potential ecological and human health risks. If monitoring for faecal coliforms and enterococci indicates a significant risk to human health and safety for primary recreation, then direct mechanical opening may be a more suitable approach so that risks are mitigated more readily – rather than scraping the berm and waiting potentially weeks or months for sufficient rainfall to facilitate an opening.

If there is no significant risk to human health and safety, then berm height management may be more appropriate to reduce the risk of fish kills associated with direct mechanical opening.

7.4 Temporary Entrance Closure Works

As discussed in Section 5.5, the South West Rocks SLSC has historically undertaken temporary artificial entrance closure during major surf carnival events – in order to ensure safe beach access for emergency service vehicles, and safe passage to Trial Bay Front Beach for the community. For this work, the SLSC has sought approval through a dredging and reclamation permit from DPIRD-Fisheries.

This temporary closure process was discussed with the local community and stakeholders in development of the EMP (Section 6), with the following noted:

- The South West Rocks SLSC stressed that emergency access to the beach is crucial for major surf carnival events. Whilst two beach access points for vehicles exist farther further east along Trial Bay Front Beach, it is commonly unsafe for vehicles to drive along the beach as the beach can be narrow and waves lap up to the base of the dunes. Therefore, a lack of safe alternatives for access from the eastern end of Trial Bay Front Beach means that temporary entrance closure is sometimes required to responsibly manage public safety risk.
- Temporary entrance closure to enable emergency access during Surf Life Saving events was generally supported by the community, as it was recognised as being important to public safety. However, the community would like to ensure the entrance condition is restored to its prior state following the event (see Section 6.1).
- The public authority stakeholder group acknowledged the significant public safety risk associated with lack of adequate emergency vehicle access for major carnivals that involve thousands of beach users. However, it was also recognised that impacts on the ICOLL opening and closing regimes should be minimised to the greatest extent possible. A responsible management approach should therefore consider the appropriate frequency and duration of temporary artificial entrance closures in order to minimise impacts to hydrodynamic and ecological processes.
- The South West Rocks Caravan Park noted that a closed entrance increases its flood risk. Whilst it is not opposed to temporary artificial entrance closures, it also noted that it has not been made aware of such works in the past, and needs to be notified so that it can manage its flood emergency procedures.

As discussed in Section 5.1, the estuary is closed around 58% of the time, and open 42% of the time, with relatively frequent oscillations between open on closed cycles – the average duration of a closed condition is 84 days and an open condition 60 days (Alluvium, 2021). Therefore, it is expected that infrequent and



temporary artificial closures of 3-4 days will not have significant impacts on local hydrodynamic and ecological processes – as long as the estuary is returned to its prior entrance state after completion of the works.

It should be noted that works to close the entrance would require a permit from Fisheries under s219 of the FM Act, as they generate a barrier to fish passage.

A recommended procedure for temporary entrance closure works is outlined in Section 9.



8 ENTRANCE MANAGEMENT PROCEDURES – ENTRANCE OPENING

8.1 Roles and Responsibilities

The primary responsibility for implementation of entrance management protocols is with Kempsey Shire Council. These responsibilities include obtaining relevant licences and approvals (see Section 3.4), and direction and supervision of all works on site to ensure that they are carried out in accordance with these protocols, and relevant standards and codes of practice.

8.2 Decision-Making Framework

A summary of the decision-making framework is depicted in Figure 8-1. The framework is to be initiated, informed, and supported by monitoring of key environmental parameters. The decision needs to consider environmental, social and economic factors including the range of viewpoints of the local community towards entrance management.

The procedures for entrance management include the following:

- **Notify** relevant public authorities that the entrance is closed, and that the monitoring and decision-making process has commenced;
- **Monitor** key environmental and social parameters that affect decision making;
- **Assess** environmental and social parameters against guidance set out in the framework;
- **Decide** on the most appropriate course of action based on available data;
- **Communicate** the course of action with relevant public authorities and the South West Rocks community;
- **Act** based on an informed, consultative process; and
- **Reporting**: Monitoring and reporting are essential for informing future management and determining improvements to the procedure.

The framework in Figure 8-1 summarises a range of considerations, intended to provide guidance for the determination of the eventual course of action. This is not intended as a rigid decision-making tool. Rather, flexibility is always beneficial, as “on the ground” conditions can change quickly, and a broad range of potential environmental, social and economic scenarios can exist in reality.

Therefore, while the framework provides a strong scientific basis for determining the most appropriate course of action – the decision of which approach to take will ultimately belong to Council, in conjunction with relevant public authority stakeholders (Section 8.3).





8.3 Notify

In the event of entrance closure, the first step will be for Council to notify the following agencies:

- DCCEEW(BCS) ;
- DPHI-Crown Lands;
- DPIRD-Fisheries; and
- NPWS.

Council should inform these agencies that the entrance is closed, and commence the entrance management decision making process. This process should consider the environmental and social parameters outlined in Section 8.4.

8.4 Monitor

8.4.1 Water Levels

- When the estuary is closed, water levels should be monitored daily, with a focus on monitoring during and after rainfall events.
- **Estuary Water Levels:** Water levels in the estuary are automatically monitored and recorded by Manly Hydraulics Laboratory (MHL) – Saltwater Creek Station (ID: 206460) - and reported online. The water level recorder is located around 50 m downstream from the German Bridge on Phillip Drive. The instrument records the water level every 15 minutes and is visible on the MHL website (<https://mhl.nsw.gov.au/>).
- **Ocean Water Levels:** The nearest ocean tide gauge is located at Port Macquarie (Station ID: 207420), around 40 km south of the estuary entrance. This location is sufficiently proximate to be representative of the coastal ocean tide levels at the estuary entrance. Predicted tides can be accessed via at the BOM at: http://www.bom.gov.au/oceanography/projects/ntc/nsw_tide_tables.shtml

8.4.2 Rainfall Monitoring

- Predicted rainfall and other weather forecasts can be accessed via the Bureau of Meteorology (BOM) web page (<http://www.bom.gov.au/wat/>)

8.4.3 Water Quality Monitoring

- Once the estuary closes, Council officers are to carry out periodic water quality monitoring of the estuary. Water quality monitoring should be carried out on a monthly basis, and immediately after significant rainfall events (> 60 mm in 24 hours).
- In order to inform decision making in entrance management, it is recommended that water quality monitoring is undertaken of the following parameters:
 - Dissolved oxygen
 - pH
 - Faecal coliforms
 - Enterococci
- A hand-held water quality multi-probe is to be used to determine results for dissolved oxygen and pH. With respect to faecal coliforms and enterococci, water samples are to be collected and provided to a suitable microbiological laboratory for analysis. Sampling procedures shall be followed in accordance with laboratory requirements, with samples delivered to the lab not less than 24 hours after collection. Samples are to be chilled during storage and transportation to the laboratory. With respect to bacteria, a combined sample using waters taken from all sampling sites (minimum of 3 within lower section of creek) should be provided to the laboratory for analysis.



- Water quality conditions are to be determined by averaging results from sampling at a minimum of three sites within the lower section of Saltwater Creek, behind the entrance berm, no less than 20 metres apart.

8.5 Assess: Decision Making Guidance

The framework in Figure 8-1 summarises a range of decision-making pathways intended to provide guidance for the determination of an eventual course of action. Based on prevailing environmental and social conditions, entrance management may be one of three potential options: (1) Do Nothing, (2) Berm Height Management, or (3) Direct Mechanical Opening.

The purpose of this section is to provide additional detail to support the framework in Figure 8-1.

Step 1: Water Level Monitoring

1. In the first instance, Council should monitor the water level of the estuary. The alert level of 1.3 m AHD will be based on water level data automatically monitored at 15-minute intervals by Manly Hydraulics Laboratory (MHL) at the Saltwater Creek gauge.
 - a. If the alert level of 1.3 m AHD is exceeded at the gauge, Council will monitor rainfall forecasts to predict if water levels are likely to rise significantly and pose a flood risk. **Proceed to Step 2.**
 - b. If estuary water level is below 1.3 m AHD at the gauge, then there is not considered to be an immediate nuisance flooding and inundation risk.
 - i. At this point, other criteria for entrance opening may be considered. **Proceed to Step 3.**

Step 2: Forecast Rainfall and Berm Height Monitoring

2. Council should monitor rainfall forecasts, to assess if there is increased risk of nuisance inundation.
 - a. If a significant rainfall event (>60 mm) is forecast for the next 72 hours, then:
 - i. Council should proceed to undertake site assessment to survey the height of the entrance berm, and determine if berm scraping is required. During site assessment, Councils designated officers will assess the site and observe relevant factors, including:
 - The condition/height of sand berm;
 - Survey equipment should be used to survey levels of the berm, and determine the level (in m AHD) of the natural “saddle point” (i.e., the expected natural breakout level);
 - The best location to scrape the berm noting that this should generally occur to the east of the main rocky outcropping, in order to maximise the potential for entrance scour (see Figure 8-2) and replicate the natural entrance flow path; and
 - Safety and access arrangements.
 - ii. If the lowest point in the berm (and thus the expected natural breakout level), is confirmed to be above the desired berm saddle level of 1.7 m AHD – **Consider Option 2: Berm Height Management: See Section 8.8 for berm scraping procedures. Proceed to Step 5.**
 - i. Note that if an elevated ocean tide above the berm saddle level of 1.7 m AHD is forecast, then reducing the berm height in this scenario may allow ocean inundation to enter the estuary - and place infrastructure at risk. In this scenario, an intact berm will act as a barrier providing the estuary with protection. Therefore, the works should be timed appropriately in order to manage the balance of forecast rainfall and ocean tides.



- iii. If the lowest point in the berm (and thus the expected natural breakout level), is confirmed to be below the desired berm saddle level of 1.7 m AHD, then no physical action may be required. During the next major rainfall event, the berm will naturally overtop at a low level - **Consider Option 1: Take No Action. Proceed to Step 5.**

1. At this point, other criteria for entrance opening may be considered. **Proceed to Step 3.**

Step 3: Water Quality Monitoring

3. As outlined in Section 8.4.3, after the entrance closes, Council staff are to carry out water quality monitoring on a monthly basis, and immediately after significant rainfall events. Guidance is provided in Section 7.3 to help inform whether water quality parameters may precipitate an opening event.
 - a. If any of the water quality parameters breach guideline levels, then a range of factors need to be considered, such as:
 - i. Environmental and public health risks posed by the water quality issue;
 - ii. The extent to which artificial opening will mitigate the water quality issue; and
 - iii. The consequent environmental and public health risks along the adjoining coastline following artificial opening of the estuary.

Artificial opening of the estuary for water quality purposes should only take place if agreement between relevant agencies in Section 8.3 is reached.

The method of opening should consider potential ecological and human health risks. Some guidance is provided in Section 7.3 to inform decision making:

- iv. If monitoring for faecal coliforms and enterococci indicates a significant risk to human health and safety for primary recreation, then direct mechanical opening may be a more suitable approach. **Consider Option 3: Direct Mechanical Opening: Proceed to Section 8.8 for mechanical opening procedures. Proceed to Step 5.**
- v. Otherwise, berm height management is recommended for opening to reduce the potential for fish kills. **Consider Option 2: Berm Height Management: Proceed to Section 8.8 for berm scraping procedures. Proceed to Step 5.**
- b. If none of the water quality parameters breach guideline levels, then there is unlikely to be sufficient environmental or human health risk to warrant artificial opening – and it is possible that no action is required. **Consider Option 1: Take No Action.**
 - i. At this point, other criteria for entrance opening may be considered. **Proceed to Step 4.**

Step 4: Exceptional Circumstances

4. While the framework provides a strong scientific basis for determining the most appropriate course of action – the decision of which approach to take will ultimately rest with Council, in conjunction with key stakeholders.

Whilst the framework provides guidance for entrance management from flooding and water quality perspectives, entrance management decision making needs to also consider exceptional circumstances that may present a risk to the environmental, social, and cultural values of the estuary such as chemical/pollutant spills, fish kills, algal blooms, or infrastructure related issues. Any such issues identified through monitoring or community & stakeholder engagement will be highlighted and forwarded to relevant authorising agencies for consideration in the decision making process..



Proceed to Step 5.

8.6 Decide

Step 5: Decide

5. The framework in Figure 8-1 summarises a range of considerations, intended to provide guidance for the determination of the eventual course of action. While the framework provides a strong scientific basis for determining the most appropriate course of action – the decision of which approach to take will ultimately belong with Council, in conjunction with public authority stakeholders (Section 8.3).

Proceed to Step 6.

8.7 Communicate

Step 6: Communicate

6. Once decided, the course of action should be communicated to relevant stakeholders and the community – prior to undertaking any specific course of action. This includes
- DCCEEW(BCS): To provide technical advice and confirm agreement with the proposed approach. Council should also confirm whether shorebirds are known to be nesting in the vicinity of the Saltwater Creek entrance. If nesting shorebirds are found to be breeding at the entrance site, entrance management works should take this into consideration.
 - DPHI-Crown Lands: As entrance berm and any proposed works would be undertaken on Crown land tenure.
 - DPIRD-Fisheries: To provide technical advice and confirm agreement with the proposed approach; and
 - NPWS: As Saltwater Lagoon is located within Hat Head National Park, NPWS has expressed a desire to be informed of entrance management works, and be consulted in the decision-making process.
 - a. Any matters concerning the openings that are raised by the above agencies should (where reasonable and feasible) be satisfactorily addressed by Council prior to the commencement of entrance opening works.
 - b. The decision should also clearly be communicated to the local community. Kempsey Shire Council should generate media release and social media communications to inform the community of the works.
 - c. South West Rocks Caravan Park should also be notified of the works.

Proceed to Step 7.

8.8 Act: Procedural Notes

Step 7: Act

This section provides procedural notes for entrance management options that require on ground works:

- Option 2: Berm Height Management and
- Option 3: Direct Mechanical Opening



8.8.1 Option 2: Berm Height Management

Once the decision has been made to undertake a berm scraping, the following procedure should be undertaken:

- When a decision to act is made, Council's personnel and machinery will be deployed to the entrance if the site assessment considers it appropriate and safe.
- The recommended access point for the 4WD backhoe operator to access the beach is via the accessway next to the Surf Club access ramp. Depending on the state of the entrance prior to the works, access to the beach may be best achieved by either the ramp to the north of the SLSC, or the ramp to the south (see Figure 8-2). The machine will access the site as much as possible via the established roads and access ways. Particular care should be taken to avoid damage to or disturbance of vegetated areas of sand dunes.
- Appropriate pedestrian safety measures are to be put in place during the works. This should take the form of either signage, or Council staff present on site to prevent pedestrian access within 20 m of machinery and the entrance.
- Survey equipment to be used to survey levels of the berm and confirm a height above the nominated berm saddle level of 1.7 m AHD.
- The excavator/backhoe then proceeds to scrape the berm to the appropriate level while continually cross-referencing levels with survey equipment. The dry channel should measure at least 5 m across. Figure 8-2 shows the recommended location of the works.
- Once the nominated berm saddle level is achieved, the operator is to smooth the dry channel batter slopes to make the dry channel safe for pedestrian traffic.
- Although the volume of scraped sand is expected to be small, the excavated sand should be retained on Trial Bay Front Beach and not removed from the system. The sand should ideally be placed on the beach, and spread evenly across the beach foredune in a manner such that no vegetation is disturbed.
- After the scraping works, Council personnel and machinery are to remain on stand-by, until:
 - The forecast rain eventuates, and the estuary opens of its own accord; or
 - The operation is cancelled by Council's designated officers.
- Declines in water quality at adjacent surf beaches may occur as a result of the estuary breakout. Council should consider the need to notify the community of this issue for at least the first 7 days after the opening has occurred.

8.8.2 Option 3: Direct Mechanical Opening

If the decision is made to undertake direct mechanical opening, the following procedure should be undertaken:

- The mechanical opening is to be planned so that where possible the actual opening of the estuary occurs shortly after the tide turns from high to low, preferably for the lower of the two low tides of the day.
- The recommended point for the 4WD backhoe operator to move on to the beach is via the accessway next to the Surf Club access ramp. Depending on the state of the entrance prior to the works, access to the beach may be best achieved by either the ramp to the north of the SLSC, or the ramp to the south (see Figure 8-2). The machine should access the site as much as possible via established roads and access ways. Particular care should be taken to avoid damage to or disturbance of vegetated areas of sand dunes.



- Appropriate pedestrian safety measures are to be in place during the works. This should take the form of either signage, or Council staff present on site to ensure that pedestrians remain more than 20 m away from machinery and the entrance.
- The channel should generally be positioned as close as practical to the natural flow path of the estuary when open (see Figure 8-2).
- The opening should be deep enough for scouring flow to develop, at least 1 m. The 4WD backhoe operator is to dig a 'pilot' excavation channel starting at the ocean end of the berm and moving progressively towards the creek. The pilot channel is to be around one bucket-width (commonly 2 m or less) and the bed should be graded down to the ocean. The last section of the channel (at the creek end) should be kept closed, and where possible, opened shortly after the next high turns from high to low tide (i.e., to the lower of the two low tides of the day).
- In terms of timing, ideally the initial breaching should occur 30 minutes after the published high tide time (adjusted for daylight saving time when appropriate). Initiation of a breakout at this time is likely to result in the most effective and sustained mechanical breakout due to the increasing hydraulic head difference between the water in the creek and the ocean through the progression of the breakout.
- Although the volume of scraped sand is expected to be small, the excavated sand should be retained on the beach and not removed from the system. The sand should ideally be placed on Trial Bay Front Beach, and spread evenly across the beach foredune in a manner such that no vegetation is disturbed.
- Declines in water quality at adjacent surf beaches may occur as a result of the estuary breakout. Council should consider the need to notify the community of this issue for at least the first 7 days after the opening has occurred.

8.9 Monitoring and Reporting

Monitoring and reporting are essential for informing future management and determining improvements to the procedure. At a minimum the following should be recorded:

- Water level of estuary prior to opening (obtain from MHL water level recorder);
- Date and time of opening;
- Location and dimensions of works (width, depth, length);
- Ocean swell conditions (wave height and direction)
- Preceding rainfall;
- Date of natural closure of the entrance;
- Digital photographs of the opening and breakout development.

The information is to be recorded on a standard monitoring sheet, provided in Appendix A.



Figure 8-2 Entrance management schematic



9 ENTRANCE MANAGEMENT PROCEDURE - ENTRANCE CLOSING

9.1 Overview

As per the historical arrangements, if temporary entrance closure is desired by the SLSC, then the SLSC should apply for a dredging and reclamation permit through DPIRD-Fisheries – and adhere to all conditions of that licence.

Additional protocols and procedures for guiding the works are provided below.

9.2 When Entrance Closure is Appropriate

- The temporary entrance closures should only be permitted for major carnivals, where it is deemed that the public safety benefit of temporary entrance closure outweighs the potential environmental impacts.
- The duration of temporary entrance closure should be kept as short as possible. That is, the estuary closure should occur no earlier than two days before a carnival and be reopened no later than the day after it is concluded.
- Works should not be undertaken if a significant rainfall event is forecast for the proposed period of temporary entrance closure – as this increases flood risk within the estuary. The threshold for this should be >60 mm forecast for the proposed closure period.

9.3 Consultation and Communication Protocols

Prior to any works taking place, the SLSC is required to notify key stakeholders (such as the South West Rocks Caravan Park) of the proposed temporary entrance closure – and the proposed timing and duration of the works. The SLSC is required to contact the following:

- DPIRD-Fisheries: To obtain the relevant dredging and reclamation permit, and seek advice regarding licence conditions;
- Kempsey Shire Council: So that Council can prepare a media release informing the community of the closure;
- DCCEEW(BCS) : To provide technical advice and confirm agreement with the proposed closure;
- DPHI-Crown Lands: As the entrance berm and any proposed works would be undertaken on Crown land.
- NPWS: As Saltwater Lagoon is located within Hat Head National Park, NPWS has expressed a desire to be informed of entrance management works, and consulted in the decision-making process.
- South West Rocks Caravan Park: In order to alert park management that flood risk will be temporarily elevated for the duration of the works.

Any matters concerning the openings that are raised by the above agencies should (where reasonable and feasible) be satisfactorily addressed by the SLSC prior to the commencement of entrance closure works.

Furthermore, Kempsey Shire Council, once notified by the SLSC, should generate a media release to inform the community of the works. This should be undertaken before and after the works.

9.4 Roles and Responsibilities

South West Rocks SLSC is responsible for execution of the temporary entrance closure works.



9.5 Procedural Notes

The following management approach is recommended:

- As per the current arrangement, if temporary entrance closure is desired by the SLSC, then the SLSC should apply for a dredging and reclamation permit through DPIRD-Fisheries – and adhere to all licence conditions.
- Once the SLSC has liaised with DPIRD-Fisheries and obtained a licence, it must inform the local stakeholders described in Section 9.3.
- Council should generate a media release to inform the community of the works.
- The SLSC is responsible for the cost and execution of the works.
- The recommended point for the 4WD backhoe operator to move onto the beach is via the accessway next to the Surf Club access ramp. Depending on the state of the entrance prior to the works, and local tide and wave conditions, the berm may be accessed from a number of routes – including the ramp to the north of the SLSC, the ramp to the south (see Figure 8-2), or even to approach the berm from the east – traversing the machinery across the beach from one of the access points in Eastern Trial Bay.
- Prior to the commencement of any works, the SLSC should take a photo of the entrance from the marker point depicted in Figure 9-1. This marker point is located directly to the south of the entrance – at the Memorial Avenue car park (up on the hill, looking down at the entrance). An example of a photograph taken from this spot is depicted in Figure 2-2. A camera-cradle, similar to those utilised by CoastSnap could be installed for this task (<https://www.coastsnap.com/>). The photograph should be provided to Council and DPIRD-Fisheries.
- Earthmoving equipment should be on stand-by for the duration of the closure. If a sudden forecast of rainfall develops (>60 mm) during the closure period, the entrance should be returned to its prior open condition before the rainfall occurs.
- After the event, the SLSC should return the entrance to its previous level of connectivity – replicating the pre-works entrance channel width and depth to the best of its ability. Confirmation of this step should be provided to both Council and DPIRD-Fisheries in the form of photographic evidence. A second photo should be taken from the marker point depicted in Figure 9-1 demonstrating that the entrance has been returned to its prior condition.



Figure 9-1 Photographic marker point – for monitoring entrance conditions



10 RECOMMENDATIONS

10.1 Review and Update of this Procedure

This EMP should be reviewed every ten years, or (as required) in response to changes in relevant legislation. Review of the EMP procedure should include analysis of all monitoring data collected over that period to ensure that predictions and assumptions outlined in it are adequate.

It is also recommended that Council engage with the South West Rocks Caravan Park after each berm scraping and associated breakout event. The purpose of this will be to discuss and document the inundation impacts at the park, and potential refinement/optimisation of the procedure - based on performance of the EMP in mitigating inundation.

A review of the trigger level should also be conducted in relation to the latest floor level data and levels of any other infrastructure on low lying land at risk of inundation from floodwaters. If any of the low-lying assets listed in this policy are removed or modified, the trigger level should be reviewed and the policy updated as required.

10.2 Long Term Management Approaches

Long term management of the entrance should also be considered in the context of findings and management actions in the broader Kempsey Shire LGA CMP.

As per advice from NSW DPIRD-Fisheries, the long-term approach of ICOLL management should be to reduce the need for artificial manipulation by taking active measures to remove, relocate or otherwise manage items of low-lying infrastructure that currently necessitate breaches below the natural breakout range, and adopting catchment management practices that:

- Reduce the inputs of nutrients and pollutants from point and diffuse sources;
- Prevent transfer of flood prone and riparian land on the margins of ICOLLs into private ownership;
- Prevent future development or subdivision of flood-prone and riparian lands by adopting appropriate zonings and buffers in relevant land use planning instruments; and
- Implement community awareness campaigns to gain broad based understanding and support for the environmentally responsible management of ICOLLs.

For Saltwater Creek and lagoon, this will involve the need to address flood risk at the caravan park in the medium to long term. As sea level rise increases the mean estuary water level, the park will become inundated on an increasingly frequent basis. Therefore, this will necessitate more frequent intervention in order to mitigate this risk. As discussed in Section 10.1, inundation impacts at the park should be documented after each event, and this will provide a strong basis for determining long term management actions. These actions could include:

- The implementation of earthen levees, or raising some sections of the park (using fill) to mitigate flood risk. This would need to consider potential impacts on broader flood risk and local ecology (flora and fauna); and/or
- Strategic realignment or relocation of park facilities above nuisance flooding levels.

10.3 Other Recommendations

It is recommended that a permanent survey mark (PSM) be installed at the estuary entrance to facilitate rapid surveys of the berm. A suitable location for a marker could be on the sandstone steps in front of the SLSC building.



It is recommended that a *CoastSnap* monitoring station be established for the estuary entrance and Front Beach. Coast Snap is low-cost citizen science method for mapping shoreline change which harnesses smartphone images collected by the community and uploaded to social media platforms – see Figure 10-1. The relatively small up-front costs involve installation of a smartphone camera cradle, which needs to be installed at an elevated location overlooking the study site. For this task, a station could be installed at the Monument Point headland – looking eastwards towards the estuary entrance and Trial Bay Front Beach.

Information collected by this station will greatly assist in developing an understanding of entrance opening and closing processes – and the local morphological processes at play at the estuary entrance (see Figure 10-2).



Figure 10-1 Examples of CoastSnap camera cradles at the Lake Cathie entrance (left) and Narrabeen Lagoon entrance (right)

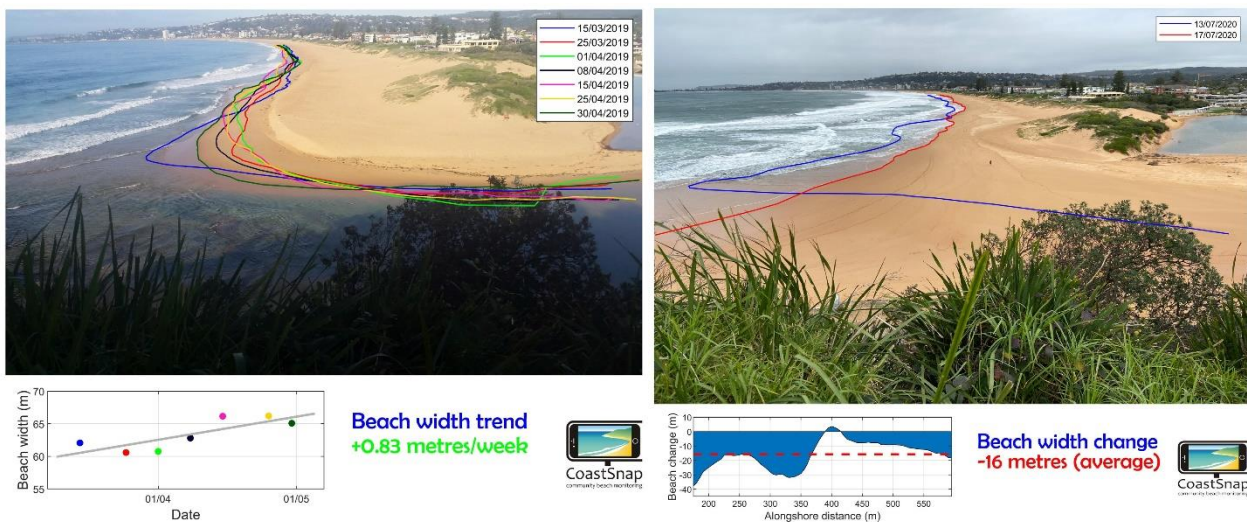


Figure 10-2 Examples of entrance condition tracking for Narrabeen Lagoon



Figure 10-3 Potential location for Coast Snap camera cradle at Monument Point Headland.



11 REFERENCES

- Adapt NSW. (2019). *Impacts of climate change*. Retrieved from <https://climatechange.environment.nsw.gov.au/Impacts-of-climate-change>
- Alluvium. (2021). *Saltwater Creek and Lagoon Estuary CMP Stage 2 - Hydrodynamic Processes Assessment (Draft)*.
- ANZECC/ARMCANZ. (2000). *Australian and New Zealand Guidelines for Fresh and Marine Water Quality*. . Australian and New Zealand Environment and Conservation Council and Agriculture and Resource Management Council of Australia and New Zealand.
- BMT WBM. (2013). *Kempsey Coastal Processes and Hazards Definition Study*.
- Church, J., & White, N. (2011). Sea-level rise from the late 19th to the early 21st century. . *Surveys in geophysics*, 32, 585-602.
- Coffs Harbour City Council. (2019b). *Woolgoolga Lake Entrance Management Procedure*. Coffs Harbour City Council.
- CSIRO. (2017). Church, J.A., McInnes, K.L., Monselesan, D., O'Grady, J., 2017. *Sea level rise and allowances for Coastal Councils around Australia—Guidance material*.
- DEC. (2006). *Beachwatch Partnership Program State of the Beaches 2004-2005*.
- DPI. (2018). *Management of coastal lakes and lagoons in NSW*. Retrieved from <https://www.dpi.nsw.gov.au/fishing/habitat/aquatic-habitats/wetland/coastal-wetlands/management-of-coastal-lakes-and-lagoons-in-nsw>
- DPIE. (2019). *Coastal Management*. Retrieved from <https://www.planning.nsw.gov.au/Policy-and-Legislation/Coastal-management>
- DPIE. (2021). *Form and function of NSW intermittently closed and open lakes and lagoons: Implications for entrance management*. State of NSW and Department of Planning, Industry and Environment .
- Glamore, W., Rayner, D., & Rahman, P. (2016). *Estuaries and climate change. Technical Monograph prepared for the National Climate Change Adaptation Research Facility. Water Research Laboratory of the School of Civil and Environmental Engineering, UNSW* .
- Haines, P., & Thom, B. (2007). Climate change impacts on entrance processes of intermittently open/closed coastal lagoons in New South Wales, Australia. *Journal of Coastal Research*, 242-246.
- Hanslow, D., Davis, G., You, B., & Zastawny, J. (2000). Berm height at coastal lagoon entrances in NSW. *Proc. 10th ann. NSW coast. conf., Yamba*.
- JBPacific. (2021). *Coastal vulnerability maps and associated Technical Report*.
- Kempsey Shire Council. (2007a). *Flood Management Procedures – Saltwater Creek South West Rocks*.
- Kempsey Shire Council. (2020a). *Kempsey Shire heritage - South West Rocks*. Retrieved from <https://www.kempsey.nsw.gov.au/heritage/south-west-rocks.html>
- Kendall and Kendall. (2003). *Saltwater Creek Catchment Flora and Fauna Study*.
- MEMA. (2018). *New South Wales Marine Estate Management Strategy*. .
- MHL. (2002). *Saltwater Creek Estuary Process Study*.
- MVC. (2020). *About the Macleay Valley Coast - Our History*. Retrieved from Macleay Valley Coast: <https://macleayvalleycoast.com.au/about/history/>
- NPWS. (1998). *Hat Head National Park Plan of Management*.
- NSW DPI-Fisheries. (2013). *Fisheries NSW Policy and Guidelines for Fish Habitat Conservation and Management*. NSW Department of Primary Industries, a part of the Department of Trade and Investment, Regional.
- NSW DPI-Fisheries. (2020). *Management of coastal lakes and lagoons in NSW*. Retrieved December 21, 2020, from <https://www.dpi.nsw.gov.au/fishing/habitat/aquatic-habitats/wetland/coastal-wetlands/management-of-coastal-lakes-and-lagoons-in-nsw#:~:text=Larger%20ICOLLS%20are%20often%20more,open%20to%20maintain%20fish%20stocks>.
- OEH. (2018b). *Estuaries of NSW*. Retrieved from <https://www.environment.nsw.gov.au/topics/water/estuaries/estuaries-of-nsw>
- Roper, T., Creese, B., Scanes, P., Stephens, K., Williams, R., Dela-Cruz, J., . . . Fraser, M. (2011). *Assessing the conditions of estuaries and coastal lake ecosystems in NSW*.
- Water Technology. (2021). *Saltwater Creek and Lagoon CMP Stage 1 Scoping Study*.
- WBM Oceanics. (2006a). *Estuary Management Study and Plan - Saltwater Creek and Lagoon, South West Rocks*.
- WBM Oceanics. (2006b). *Saltwater Creek Flood Study - Final Report*.



Wiecek, D. (2001). *Trophic status of selected estuaries on the far south coast of New South Wales with largely cleared catchments*. University of Wollongong.



APPENDIX A MONITORING FORM





Entrance Monitoring Form	
Opening date / time	
Natural opening, or Council initiated	
Berm Height Management, or direct mechanical opening?	
Opening Water Level (mAHD)	
Berm Height (mAHD)	
Summary of conditions (rainfall, swell etc)	
Type plant onsite & contractor	
Location of works	
Date / time works commenced	
Date / time works finished	
Date of subsequent closure	
Notes	

Melbourne

15 Business Park Drive
Notting Hill VIC 3168
Telephone (03) 8526 0800

Sydney

Suite 3, Level 1, 20 Wentworth Street
Parramatta NSW 2150
Telephone (02) 8080 7346

Brisbane

Level 5, 43 Peel Street
South Brisbane QLD 4101
Telephone (07) 3105 1460

Adelaide

1/198 Greenhill Road
Eastwood SA 5063
Telephone (08) 8378 8000

Perth

Ground Floor, 430 Roberts Road
Subiaco WA 6008
Telephone (08) 6555 0105

New Zealand

7/3 Empire Street
Cambridge New Zealand 3434
Telephone +64 27 777 0989

Wangaratta

First Floor, 40 Rowan Street
Wangaratta VIC 3677
Telephone (03) 5721 2650

Geelong

51 Little Fyans Street
Geelong VIC 3220
Telephone (03) 8526 0800

Wimmera

597 Joel South Road
Stawell VIC 3380
Telephone 0438 510 240

Gold Coast

Suite 37, Level 4, 194 Varsity Parade
Varsity Lakes QLD 4227
Telephone (07) 5676 7602

watertech.com.au

