Sussex Inlet, St Georges Basin, Swan Lake and Berrara Creek Coastal Management Program

Stage 2 Detailed Risk Assessment

Shoalhaven City Council

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311015-00158 – CS-REP-005 Rev0

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A	Draft for Internal Review	M. Priestley	C. Adamantidis		29.07.22	[Initial. Surname]	[App date]
B	Draft for Customer Review	M. Priestley	C. Adamantidis	C. Adamantidis	30.08.22		
C	Final Draft	M. Priestley	C. Adamantidis	C. Adamantidis	23.12.22		
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Executive summary

This report has provided a Detailed Risk Assessment identifying key management issues and threats, based on stakeholder engagement and further studies undertaken during Stage 2 of the Coastal Management Program (CMP) for St Georges Basin/Sussex Inlet, Swan Lake and Berrara Creek. This report documents the risk assessment and provides commentary on the existing levels of risk, identifying the issues of highest risk for St Georges Basin and Sussex Inlet, Swan Lake and Berrara Creek.

The *Coastal Management Act* 2016 requires councils to follow a risk management process when preparing their Coastal Management Programs (CMPs) and identifying where management actions are required. This includes identifying and assessing risks and benefits to environmental, social and economic values and evaluating and selecting management actions to address those risks.

In Stage 1 of the CMP process, councils prepare a first-pass risk assessment. That was a qualitative risk assessment using available information, to help inform the scope of the CMP. The first-pass risk assessment was undertaken as part of the Stage 1 Scoping Study covering the entire Shoalhaven coastal zone. This report presents the Stage 2 Detailed Risk Assessment, with a focus on the St Georges Basin/Sussex Inlet, Swan Lake and Berrara Creek estuaries. The Detailed Risk Assessment builds upon the first-pass assessment undertaken during Stage 1, identifying in greater detail the risks and opportunities within the estuary and reflecting the findings of the detailed estuary processes and estuary health assessments completed during Stage 2 of the CMP.

This Risk Assessment has been undertaken in accordance with the process outlined in AS/NZS ISO 31000: Risk Management – Principles and Guidelines and identified in Part B of the NSW Coastal Management Manual (OEH, 2018). The purpose of the Risk Assessment is to highlight priorities for management actions while recognising the uncertainties associated with natural systems and future scenarios.

Risk can be quantified as the integration of probability (i.e., frequency analysis of the hazard) and consequences. The Risk Assessment documented herein has considered both the "likelihood" (or probability) of the hazard occurring and the "consequence" to define the level of risk.

A detailed Risk Register has been developed that categorises the risks for the Sussex Inlet/St Georges Basin, Swan Lake and Berrara Creek estuaries in terms of the four coastal management areas as referred to in the State Environmental Planning Policy (Resilience and Hazards) 2021:

i) coastal wetland and littoral rainforest area

ii) coastal vulnerability area

iii) coastal environment area

iv) coastal use area.

The risks are categorised as environmental, risks to infrastructure, safety, amenity or financial risks in accordance with Shoalhaven Council's internal risk assessment framework. The risk register is intended to be used as a living document that can act as a tool for the development of management actions for the CMP and a method for ongoing assessment of the effectiveness of the management actions.

The Risk Register has been developed in collaboration with stakeholders, including asset managers, Agency representatives and the community through the community engagement undertaken for the project. An asset-focused Risk Register has been developed with input from Council's internal asset

managers, following a workshop held in June 2022, to identify the risks to public assets, particularly from the hazards of erosion and inundation. A separate, more general Risk Register focussing on the full range of risks has been developed based on feedback from the community during the community engagement sessions. The Register focusses on risks related to the six main themes considered in the community engagement sessions, namely:

- Cultural and Social
- Water Quality
- Foreshore Erosion
- Ecological Environment
- Tidal Inundation and Sea Level Rise
- Navigation and Safety

The Risk Register was workshopped with Agency stakeholders in July 2022 to identify any additional risks pertinent to the six themes, as well as to identify potential management actions to mitigate the risks. Eighty discrete risks were identified through this process, each with existing management controls and additional controls identified to manage the risks into the future. Twenty-eight risks relating to asset management were identified in the Asset Risk Register.

Each Risk Register provides a Likelihood and Consequence score for each risk and assigns a Risk Rating based on these scores. The Risks have been rated for Present Day, as well as for a 20 year, 50 year and 100 year planning period. The Risk Registers are provided in Appendix A.

Table 1 – Identified High or Extreme Risks and Root Causes at St Georges Basin

KEY: Likelihood: AC = Almost Certain, L = Likely. P = Possible, U = Unlikely, R = Rare
Consequence: C = Catastrophic, Maj = Major, Mod = Moderate, Min = Minor, I = Insignificant

							Present Day					20 years					50 years					100 years				
Estuary	Coastal Management Area	Risk Category	Risk Description	Root Cause	Consequence	Existing Controls	Lkihood (1-5)		Consq.(1-5)		Pre Treatment Rating	Lkihood (1-5)		Consq.(1-5)		Pre Treatment Rating	Lkihood (1-5)		Consq.(1-5)		Pre Treatment Rating	Lkihood (1-5)		Consq.(1-5)		Pre Treatment Rating	Potential Management Actions
St. Georges Basin	Coastal Wetlands and Littoral Rainforest	Water Quality	Poor water quality inputs from tributaries (nutrients and suspended solids, DO and turbidity).	Pollution inputs into tributaries, including sediment pollution into estuary from development activities	Impacts on estuary ecology	Zoning/development controls within catchment area, control of urban runoff, community education, water quality monitoring program	5	AC	2	Min	10 High	5	AC	2	Min	10 High	5	AC	2	Min	10 High	5	AC	2	Min	10 High	Revised Water Quality Monitoring Program (including event monitoring). Review and where necessary upgrade or retrofit erosion and sediment controls. Identification of key development sites as root cause and more stringent regulation. Continue to apply Neutral or Beneficial Effect (NorBE) on water quality for all greenfield development proposed in the catchments of the St Georges Basin, Swan Lake and Berrara Creek as a minimum standard. Application of the risk-based framework for stormwater management to be considered into the future, particularly where it demonstrates a higher level of water quality mitigation than NorBE, likely to be more relevant for infill development and development of already cleared land.
St. Georges Basin	Coastal Environment	Ecological Environment	Damage to estuarine vegetation, seagrass beds	Impact of jetties / waterfront structures on seagrass	Damage to seagrasses	Boating restrictions, NSW DPI mapping, vessel speed limits	5	AC	3	Mod	15 High	5	AC	3	Mod	15 High	5	AC	3	Mod	15 High	5	AC	3	Mod	15 High	Restricted vessel access to known/mapped seagrass areas, more stringent regulation on vessel speed limits, public education
St. Georges Basin	Coastal Environment	Ecological Environment	Threats to shorebirds around foreshore and islands in St Georges Basin	Disturbance of habitat and shorebird nesting due to public access and domestic/feral animals	Loss of shorebird habitat and changes to estuary ecology.	Access to islands managed by Jerrinja tribe. South Coast Shorebird Recovery Program	3	P	4	Maj	12 High	3	P	4	Maj	12 High	3	P	4	Maj	12 High	3	P	4	Maj	12 High	Community education, signage, restoration of disturbed habitat, feral animal control. Continuation of the South Coast Shorebird Recovery Program within St Georges Basin
St. Georges Basin	Coastal Environment	Water Quality	Impacts on estuary health	Climate change resulting in more frequent extreme events (drought, bushfires, flooding)	Impacts on water quality and estuary ecology	Water quality and estuary health monitoring program by Council DPE-EHG state-wide estuary health monitoring	3	P	4	Maj	12 High	3	P	4	Maj	12 High	4	L	4	Maj	16 High	5	AC	4	Maj	20 Extreme	Revised Council water quality monitoring program to include assessment of future impacts of drought, bushfires, flooding Report on the results of Councils WQ monitoring and any impacts on estuary health undertaken following the 2019-20 Bushfires. Continued monitoring of estuary health by DPE-EHG
St. Georges Basin	Coastal Environment	Ecological Environment	Damage to foreshore vegetation, saltmarsh	Illegal clearing, introduced animals (e.g. dogs). Illegal clearing is a problem especially in Tomerong Creek catchment. Mowing/damage to no-mow zones due to perceived risk following bushfires	Loss of habitat and changes to estuary ecology. Decreased buffering capacity.	Education	3	P	3	Mod	9 High	3	P	3	Mod	9 High	3	P	3	Mod	9 High	3	P	3	Mod	9 High	Stringent regulation on illegal clearing, replanting of targeted areas, better protection of significant ecological zones and maintaining no-mow zones, wildlife corridors and habitats. Specific surveys to map important ecological areas (e.g. Stingray habitat)
St. Georges Basin	Coastal Vulnerability	Tidal Inundation and Sea Level Rise	Flooding	Sea Level Rises and changes to estuary hydraulics	Impact on foreshore infrastructure, access	Development controls	4	L	3	Mod	12 High	4	L	4	Maj	16 High	4	L	5	C	20 Extreme	5	AC	5	C	25 Extreme	Improved stormwater infrastructure to account for increased runoff during inundation events. Adaptation planning and potential moving of at risk infrastructure / redesign and siting of access points
St. Georges Basin	Coastal Vulnerability	Foreshore Erosion	Foreshore Erosion	Vessel waves, wind waves, high water levels, sea level rise. Erosion from boat wakes around boat ramps, including specifically around Boathaven Boat Ramp.	Damage to foreshore infrastructure and foreshore vegetation	Foreshore protection structures, development controls, vessel speed limits	4	L	3	Mod	12 High	4	L	3	Mod	12 High	4	L	3	Mod	12 High	4	L	3	Mod	12 High	Maintenance of structures as required, more stringent regulation on vessel speed limits, apply recommended actions from foreshore erosion Decision Support Tool
St. Georges Basin	Coastal Use	Navigation and Safety	Conflict between users of powered and non-powered craft	High demand for recreational use, increased demand due to COVID	Threat to recreational amenity	Provision of dedicated facilities for powered and non-powered vessel users	3	P	3	Mod	9 High	3	P	3	Mod	9 High	4	L	3	Mod	12 High	4	L	3	Mod	12 High	Community education for boaters/kayakers regarding water safety
St. Georges Basin	Coastal Use	Cultural and Social	Lack of public foreshore access	High private ownership of foreshore areas	Reduced foreshore access	Provision of additional foreshore recreation reserves	3	P	3	Mod	9 High	3	P	3	Mod	9 High	3	P	3	Mod	9 High	3	P	3	Mod	9 High	Explore opportunities to connect missing links in foreshore walk around St Georges Basin by provision of boardwalk below HWM, strategic acquisition, need for access to easements for utilities etc.
St. Georges Basin	Coastal Use	Navigation and Safety	Lack of public boating facilities	High demand for recreational use	Crowding at existing facilities	Routine maintenance of existing boating facilities	3	P	3	Mod	9 High	4	L	3	Mod	12 High	4	L	3	Mod	12 High	4	L	3	Mod	12 High	Demand study and upgrade of existing boating facilities if needed
St. Georges Basin	Coastal Vulnerability	Tidal Inundation and Sea Level Rise	Isolation during inundation or bushfires such as	Sea Level Rise and inundation	Damage to infrastructure, loss of	Development controls, monitoring, flood warning	2	U	4	Maj	8 Mod	3	P	4	Maj	12 High	4	L	4	Maj	16 High	4	L	4	Maj	16 High	Community education on risk of not following evacuation orders, community education to enhance understanding of inundation risk,

KEY: Likelihood: AC = Almost Certain, L = Likely. P = Possible, U = Unlikely, R = Rare
Consequence: C = Catastrophic, Maj = Major, Mod = Moderate, Min = Minor, I = Insignificant

							Present Day						20 years						50 years						100 years					
Estuary	Coastal Management Area	Risk Category	Risk Description	Root Cause	Consequence	Existing Controls	Lkihood (1-5)		Consq.(1-5)		Pre Treatment Rating		Lkihood (1-5)		Consq.(1-5)		Pre Treatment Rating		Lkihood (1-5)		Consq.(1-5)		Pre Treatment Rating		Lkihood (1-5)		Consq.(1-5)		Pre Treatment Rating		Potential Management Actions
			access to Princes Highway being cut.		community access, impact on tourists	system and flood evacuation procedures																									works to raise key evacuation routes above inundation levels Implementation of findings of the St Georges Basin Floodplain Risk Management Study and Plan (including emergency management aspects) Update of the Shoalhaven City Local Floodplan with the results of most recent modelling and studies
St. Georges Basin	Coastal Vulnerability	Tidal Inundation and Sea Level Rise	Tidal and Coastal Inundation of caravan parks on Crown Land	Sea Level Rise and inundation	Damage to infrastructure, loss of critical services, injury or death	Measures developed in Climate change and inundation Adaptation Report	3	P	4	Maj	12	High	3	P	4	Maj	12	High	4	L	4	Maj	16	High	4	L	4	Maj	16	High	Investigate tidal and coastal inundation risk to two low-lying caravan parks on Crown Land in St Georges Basin and work with low-lying caravan parks to update their emergency response plans to prepare for and respond to coastal hazards in the short term, and adapt to changing tidal and coastal inundation in the longer term. Implementation of findings of the St Georges Basin Floodplain Risk Management Study and Plan (including emergency management aspects)
St. Georges Basin	Coastal Environment	Ecological Environment	Impacts on estuary health from unauthorised dirt-bike and 4WD access	Access by 4WD and dirt bikes to sensitive estuarine areas	Trampling of sensitive vegetation, erosion	4WD/motorbike access management	3	P	3	Mod	9	High	3	P	3	Mod	9	High	3	P	3	Mod	9	High	3	P	3	Mod	9	High	Community education/signage, enforcement in areas where access not permitted

Table 2 – Identified High or Extreme Risks and Root Causes at Sussex Inlet

KEY: Likelihood: AC = Almost Certain, L = Likely. P = Possible, U = Unlikely, R = Rare
Consequence: C = Catastrophic, Maj = Major, Mod = Moderate, Min = Minor, I = Insignificant

							Present Day					20 years					50 years					100 years					
Estuary	Coastal Management Area	Risk Category	Risk Description	Root Cause	Consequence	Existing Controls	Lkihood (1-5)		Consq.(1-5)		Pre Treatment Rating	Lkihood (1-5)		Consq.(1-5)		Pre Treatment Rating	Lkihood (1-5)		Consq.(1-5)		Pre Treatment Rating	Lkihood (1-5)		Consq.(1-5)		Pre Treatment Rating	Potential Management Actions
Sussex Inlet	Coastal Use	Navigation and Safety	Lack of vessel storage and no mooring options, long wait list for recreational vessels for new moorings	High demand for recreational boating	Reduced recreational amenity, economic opportunity cost	Mooring licences for registered moorings	4	L	3	Mod	12 High	4	L	3	Mod	12 High	4	L	3	Mod	12 High	4	L	3	Mod	12 High	Identify locations for vessel storage and potential to accommodate new registered moorings at alternative sites outside of the estuary. Support the implementation of the MEMS Domestic Foreshore Structure Strategy through the promotion of and reference to the strategy though the provision of planning advice and via Council's website
Sussex Inlet	Coastal Use	Foreshore Erosion	Foreshore Erosion	Erosion from tidal flows and natural meandering of channel, lack of riparian vegetation or failing bank protection ad hoc public access to waterway from foreshore	Sand entering/ moving within estuary channel causing hazard to navigation, damage to foreshore infrastructure and foreshore vegetation, loss of foreshore recreation area and loss of access to waterway	Ad-hoc foreshore protection structures, vessel speed limits, channel markers	4	L	4	Maj	16 High	4	L	4	Maj	16 High	4	L	4	Maj	16 High	4	L	4	Maj	16 High	Develop appropriate foreshore management actions or apply recommended actions from foreshore erosion Decision Support Tool. Maintenance of structures where these have been deemed to be effective, more stringent regulation on vessel speed limits. Altered location of channel markers as channel position changes
Sussex Inlet	Coastal Environment	Ecological Environment	Damage to seagrass beds at entrance to St Georges Basin	Damage to seagrass around some existing boating facilities (jetties, pontoons and boat ramps - boat moorings and damage caused by boats in shallow areas).	Damage to seagrasses	Public education, provision of dedicated anchorage area	3	P	3	Mod	9 High	3	P	3	Mod	9 High	3	P	3	Mod	9 High	3	P	3	Mod	9 High	Implementation of the Domestic Waterfront Structures Strategy for St Georges Basin and Sussex Inlet to reduce impacts to seagrass in the future
Sussex Inlet	Coastal Vulnerability	Tidal Inundation and Sea Level Rise	Isolation during inundation or bushfires such as access to Princes Highway being cut.	Sea Level Rise and inundation	Damage to infrastructure, loss of community access, impact on tourists	Development controls, monitoring, flood warning and flood evacuation procedures	3	P	4	Maj	12 High	3	P	4	Maj	12 High	4	L	4	Maj	16 High	5	AC	4	Maj	20 Extreme	Implementation of findings of the St Georges Basin Floodplain Risk Management Study and Plan (including emergency management aspects). Update Shoalhaven Local Flood Plan with the results of most recent modelling and studies. Community education on risk of not following evacuation orders, community education to enhance understanding of inundation risk, works to raise key evacuation routes above inundation levels
Sussex Inlet	Coastal Environment	Tidal Inundation and Sea Level Rise	Damage to estuarine vegetation	Sea Level Rise and inundation, conflict between maintenance of no-mow areas and public recreational uses	Loss or changes to biodiversity, landward migration of estuarine vegetation	Provision of no-mow areas	2	U	3	Mod	6 Mod	3	P	3	Mod	9 High	4	L	3	Mod	12 High	4	L	3	Mod	12 High	Community education on no-mow areas and enforcement, landward retreat of Council infrastructure e.g. playgrounds from vulnerable low-lying areas
Sussex Inlet	Coastal Vulnerability	Tidal Inundation and Sea Level Rise	Coastal and tidal inundation of infrastructure	Low lying development, lack of tourist awareness of flooding	Damage to infrastructure, loss of community access, impact on tourists	Development controls, monitoring, flood warning and flood evacuation procedures	4	L	4	Maj	16 High	4	L	4	Maj	16 High	5	AC	5	C	25 Extreme	5	AC	5	C	25 Extreme	Improved stormwater infrastructure to account for increased runoff during inundation events. Investigate feasibility of raising infrastructure and review development controls for floor elevations for residential dwellings, refer to and implement findings of the St Georges Basin Floodplain Risk Management Study and Plan (including emergency management aspects). Update Shoalhaven Local Flood Plan
Sussex Inlet	Coastal Use	Navigation and Safety	Poor navigation conditions into the Basin and near the entrance, and at Chris Creek and Alamein	Shoaling of channel	Impact on navigation	Monitoring, estuary maintenance/dredging	5	AC	4	Maj	20 Extreme	5	AC	4	Maj	20 Extreme	5	AC	4	Maj	20 Extreme	5	AC	4	Maj	20 Extreme	Undertake a detailed investigation into the feasibility of targeted dredging as per the Boating and Navigation Study. Such investigation would involve detailed seagrass mapping, sediment sampling, and sediment transport modelling. Undertake ongoing monitoring of sand movements via regular survey to assess long term sustainability of dredging.

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							Present Day						20 years						50 years						100 years						
Estuary	Coastal Management Area	Risk Category	Risk Description	Root Cause	Consequence	Existing Controls	Lkihood (1-5)		Consq.(1-5)		Pre Treatment Rating		Lkihood (1-5)		Consq.(1-5)		Pre Treatment Rating		Lkihood (1-5)		Consq.(1-5)		Pre Treatment Rating		Lkihood (1-5)		Consq.(1-5)		Pre Treatment Rating		Potential Management Actions
Sussex Inlet	Coastal Use	Navigation and Safety	Difficulty navigating over entrance bar at low tide	Shallow entrance channel	Reduced access to open ocean from Sussex Inlet	Safety warning signs	4	L	3	Mod	12	High	4	L	3	Mod	12	High	4	L	3	Mod	12	High	4	L	3	Mod	12	High	Community education, signage, improve navigation aids, investigate feasibility of providing a boat ramp on the ocean side of the entrance as per CMP Boating and Navigation Study. Undertake targeted consultation with LALC regarding this option
Sussex Inlet	Coastal Use	Navigation and Safety	Poor navigation safety at night	Lack of lighting on navigation aids	Impact on navigation and safety for night-time navigation	None	5	AC	3	Mod	15	High	5	AC	3	Mod	15	High	5	AC	3	Mod	15	High	5	AC	3	Mod	15	High	Provision of lighting on navigation aids
Sussex Inlet	Coastal Use	Navigation and Safety	Conflict between users of powered and non-powered craft	High demand for recreational boating	Amenity, safety	Routine maintenance of existing boating facilities	4	L	3	Mod	12	High	4	L	3	Mod	12	High	4	L	3	Mod	12	High	4	L	3	Mod	12	High	Demand study and upgrade of existing boating facilities where required
Sussex Inlet	Coastal Vulnerability	Foreshore Erosion	Accelerating erosion risk to cabins near estuary mouth	Foreshore erosion due to flood flows, rainfall/runoff over slope, slope stability, and ocean waves, proximity of cabins to beach	Amenity, safety	none	3	P	3	Mod	9	High	3	P	3	Mod	9	High	3	P	3	Mod	9	High	3	P	3	Mod	9	High	Consider risk to cabins and build landward. Review development controls within CVA mapped areas – Development of a Planning Proposal to map a CVA
Sussex Inlet	Coastal Use	Navigation and Safety	Reduced coastal amenity and compromised recreational use	Need for channel optimisation, sand nourishment/maintenance to revetment walls, review of the Canals Management Plan at Riviera Keys	Damage to revetment walls, increased channel sedimentation, impact on navigation and recreational amenity	Review Riviera Keys Canals Management Plan	5	AC	3	Mod	15	High	5	AC	3	Mod	15	High	5	AC	3	Mod	15	High	5	AC	3	Mod	15	High	Review Riviera Keys Canals Management Plan
Sussex Inlet	Coastal Environment	Ecological Environment	Impacts on estuary health from ad-hoc development and unapproved structures	Unchecked tourist development - caravans, ad-hoc jetties, caravan park, unapproved structures	Compromised estuary health	Development controls	5	AC	3	Mod	15	High	5	AC	3	Mod	15	High	5	AC	3	Mod	15	High	5	AC	3	Mod	15	High	Better monitoring and enforcement of illegal activities such as construction of unapproved structures

Table 3 – Identified High or Extreme Risks at Swan Lake

KEY: Likelihood: AC = Almost Certain, L = Likely. P = Possible, U = Unlikely, R = Rare
Consequence: C = Catastrophic, Maj = Major, Mod = Moderate, Min = Minor, I = Insignificant

							Present Day					20 years					50 years					100 years					
Estuary	Coastal Management Area	Risk Category	Risk Description	Root Cause	Consequence	Existing Controls	Lkihood (1-5)		Consq.(1-5)		Pre Treatment Rating		Lkihood (1-5)		Consq.(1-5)		Pre Treatment Rating		Lkihood (1-5)		Consq.(1-5)		Pre Treatment Rating		Lkihood (1-5)		Consq.(1-5)		Pre Treatment Rating		Potential Management Actions
Swan Lake	Coastal Environment	Ecological Environment	Impacts on estuary health	Boating, inadequate habitat protection, urban encroachment, invasive species	Compromised estuary health	Development controls	5	AC	3	Mod	15	High	5	AC	3	Mod	15	High	5	AC	3	Mod	15	High	5	AC	3	Mod	15	High	Greater protection to natural vegetation and nesting areas, tighter controls on powered boats, targeted ecological surveys to monitor communities, updated macrophyte mapping
Swan Lake	Coastal Environment	Ecological Environment	Erosion of dunes, damage to dune vegetation	Natural channel migration	Damage to dune vegetation at eastern bend of estuary channel, risk of entrance breakthrough	Entrance Management Plan, public education	4	L	3	Mod	12	High	4	L	3	Mod	12	High	4	L	3	Mod	12	High	4	L	3	Mod	12	High	Monitor and update Entrance Management Plan to reduce risk of opening at The Gap
Swan Lake	Coastal Vulnerability	Tidal Inundation and Sea Level Rise	Coastal inundation of infrastructure	Low lying development	Damage to infrastructure/loss of community access	Entrance Management, development controls	3	P	3	Mod	9	High	3	P	3	Mod	9	High	4	L	4	Maj	16	High	5	AC	4	Maj	20	Extreme	Improved stormwater infrastructure to account for increased backflows during coastal inundation events. Adaptation planning, raising/moving of at-risk infrastructure or access points e.g. access to The Springs Cabins. Updated development controls within CVA mapped areas. Updated entrance management policy
Swan Lake	Coastal Environment	Ecological Environment	Introduced species threatening native wildlife	Past landuse practices	Threat to estuary ecology	Feral animal control methods, fencing	3	P	3	Mod	9	High	3	P	3	Mod	9	High	3	P	3	Mod	9	High	3	P	3	Mod	9	High	Undertake investigation into presence and impact of feral animals in the study area
Swan Lake	Coastal Environment	Ecological Environment	Altered ecology within lake	Climate change = more frequent extreme events (drought and bushfires)	Threat to estuary ecology (community perception of decline in charophytes and swans)	Entrance Management Policy	3	P	3	Mod	9	High	3	P	3	Mod	9	High	4	L	4	Maj	16	High	5	AC	4	Maj	20	Extreme	Research project potentially in conjunction with university to understand what if any changes to the ecology of the lake have occurred and the likely causes
Swan Lake	Coastal Environment	Ecological Environment	Changes to estuarine morphology	Past bridge construction	Community perception that bridge has led to reduced entrance opening and altered channel alignment	Entrance Management	3	P	3	Mod	9	High	3	P	3	Mod	9	High	3	P	3	Mod	9	High	3	P	3	Mod	9	High	Investigate impact on lake morphology when bridge is due for upgrade/replacement at the end of its design life. Consideration of old alignment within new bridge design while also protecting wetlands that have grown since construction.
Swan Lake	Coastal Environment	Ecological Environment	Artificial lake openings affecting fish populations, shorebirds and wetlands	Artificial lake openings primarily done illegally by the public outside of entrance management policy triggers	Threat to estuary ecology	Entrance Management	3	P	3	Mod	9	High	3	P	3	Mod	9	High	3	P	3	Mod	9	High	3	P	3	Mod	9	High	Review of Entrance Management Policy, targeted community education including for holidaymakers, signage, regular patrols, enforcement Provision of additional recreational facilities that can be utilised by the public during high lake water levels (e.g. pontoons for swimming).
Swan Lake	Coastal Vulnerability	Tidal Inundation and Sea Level Rise	Isolation during inundation or bushfires such as access to Princes Highway being cut.	Sea Level Rise and inundation	Damage to infrastructure, loss of community access, impact on tourists	Development controls, monitoring, flood warning system and flood evacuation procedures, Floodplain Risk Management Study and Plan	2	U	4	Maj	8	Mod	3	P	4	Maj	12	High	4	L	4	Maj	16	High	4	L	4	Maj	16	High	Update Shoalhaven Local Flood Plan, Community education on risk of not following evacuation orders, community education to enhance understanding of inundation risk, works to raise key evacuation routes above inundation levels. Complete a Flood Study and Floodplain Risk Management Study & Plan for Swan Lake
Swan Lake	Coastal Use	Navigation and Safety	Overcrowding at boat launching areas, safety issues with boat ramp	High demand for boating activities, inadequate facilities	Impact on recreational amenity at foreshore reserves	Upgrade existing boat launching facilities e.g. at The Springs Road Ski Beach Boat ramp	5	AC	2	Min	10	High	5	AC	2	Min	10	High	5	AC	2	Min	10	High	5	AC	2	Min	10	High	Additional or upgraded facilities, including upgraded boat ramp at Swan Lake Ski Beach Boat Ramp; Signage and enforcement to ensure powered craft not launched next to and are kept away from designated swimming areas

Table 4 – Identified High or Extreme Risks at Berrara Creek

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							Present Day						20 years						50 years						100 years						
Estuary	**Coastal Management Area**	**Risk Category**	**Risk Description**	**Root Cause**	**Consequence**	**Existing Controls**	**Lkihood (1-5)**		**Consq.(1-5)**		**Pre Treatment Rating**		**Lkihood (1-5)**		**Consq.(1-5)**		**Pre Treatment Rating**		**Lkihood (1-5)**		**Consq.(1-5)**		**Pre Treatment Rating**		**Lkihood (1-5)**		**Consq.(1-5)**		**Pre Treatment Rating**		**Potential Management Actions**
Berrara Creek	Coastal Wetlands and Littoral Rainforest	Water Quality	Pollution inputs into estuary from urban areas (turbidity and DO) including stakeholder concerns	Catchment inputs - erosion and urban runoff, climate change resulting in more frequent extreme events (drought and bushfires)	Threat to estuary ecology	Development controls, public education, stormwater treatment, Water quality monitoring program	3	P	3	Mod	9	High	3	P	3	Mod	9	High	4	L	3	Mod	12	High	5	AC	4	Maj	20	Extreme	NSW DP&E Estuary Health Program, Revised water quality program (including adoption of DP&E guidelines for lagoons) Urban runoff controls
Berrara Creek	Coastal Environment	Ecological Environment	Invasive weeds	Urban landuse and general spread of invasive species	Threat to estuary ecology	Development controls, public education, invasive weed management	3	P	3	Mod	9	High	3	P	3	Mod	9	High	3	P	3	Mod	9	High	3	P	3	Mod	9	High	Planting and invasive weed management, supplemented with native plantings where appropriate
Berrara Creek	Coastal Environment	Ecological Environment	Threats to shorebirds (pied oystercatcher) around foreshore and entrance area	Urban landuse and overcrowding due to peak holiday times	Disturbance to shorebirds during nesting season	Educational signage. South Coast Shorebird Recovery Program	3	P	3	Mod	9	High	3	P	3	Mod	9	High	3	P	3	Mod	9	High	3	P	3	Mod	9	High	Exclusion of public access from known nesting sites on southern side of lake entrance during breeding season. Continuation of South Coast Shorebird Recovery Program
Berrara Creek	Coastal Use	Navigation and Safety	Boating safety issues	Conflict between motorised and passive water craft	Amenity and safety impacts and environment	Vessel speed limits, signage	5	AC	3	Mod	15	High	5	AC	3	Mod	15	High	5	AC	3	Mod	15	High	5	AC	3	Mod	15	High	Stakeholders suggest to restrict access in Berrara Creek to non powered vessels

Table 5 – Identified High or Extreme Risks applying to all estuaries (St Georges Basin/Sussex Inlet, Swan Lake and Berrara Creek)

KEY: Likelihood: AC = Almost Certain, L = Likely. P = Possible, U = Unlikely, R = Rare
Consequence: C = Catastrophic, Maj = Major, Mod = Moderate, Min = Minor, I = Insignificant

							Present Day					20 years					50 years					100 years				
Estuary	Coastal Management Area	Risk Category	Risk Description	Root Cause	Consequence	Existing Controls	Lkihood (1-5)		Consq.(1-5)		Pre Treatment Rating	Lkihood (1-5)		Consq.(1-5)		Pre Treatment Rating	Lkihood (1-5)		Consq.(1-5)		Pre Treatment Rating	Lkihood (1-5)		Consq.(1-5)		Pre Treatment Rating	Potential Management Actions
Estuary-wide	Coastal Wetlands and Littoral Rainforest	Ecological Environment	Changes in balance between habitat types, landward migration or loss of macrophyte communities	Sea Level Rise and inundation	Loss or changes to biodiversity, landward migration of estuarine vegetation. The Sanctuary Point shoreline is particularly vulnerable	CMP including inundation mapping, development controls, state and federal legislation	4	L	4	Maj	16 High	4	L	4	Maj	16 High	5	AC	5	C	25 Extreme	5	AC	5	C	25 Extreme	Map migration pathways for Coastal wetlands via the MEMA Initiative 2 marine vegetation mapping strategy. Identify suitable areas where macrophytes can migrate, Continue NSW DPI macrophyte mapping to monitor variability and long-term trends. Community education on impacts from climate change resulting in increased tidal range, changes to entrance dynamics and changes in macrophyte composition and distribution. Development of management strategies e.g., rezoning of land to allow for future migration of estuarine vegetation communities
Estuary-wide	Coastal Vulnerability	Tidal Inundation and Sea Level Rise	Damage to public infrastructure and critical services due to increased frequency and duration of inundation	Sea Level Rise and inundation	Damage to infrastructure, loss of critical services to infrastructure	Measures developed in Climate change and inundation Adaptation Report	2	U	4	Maj	8 Mod	3	P	4	Maj	12 High	4	L	4	Maj	16 High	4	L	4	Maj	16 High	Investigate feasibility of moving infrastructure landward, e.g. sewage network and managing sewage overflows. Implementation of findings of the St Georges Basin Floodplain Risk Management Study and Plan (including emergency management aspects). Refer actions for individual assets identified as being at risk from coastal inundation
Estuary-wide	Coastal Vulnerability	Tidal Inundation and Sea Level Rise	Inundation of Crown Land with third party infrastructure e.g. caravan parks	Sea Level Rise and inundation	Damage to infrastructure, loss of critical services, injury or death	Measures developed in Climate change and inundation Adaptation Report	2	U	4	Maj	8 Mod	3	P	4	Maj	12 High	4	L	4	Maj	16 High	4	L	4	Maj	16 High	Investigate feasibility of moving infrastructure landward or feasibility of public works to raise low-lying land
Estuary-wide	Coastal Vulnerability	Tidal Inundation and Sea Level Rise	Increasing depth, duration and frequency of inundation of urban areas	Sea Level Rise and inundation	Damage to infrastructure, loss of critical services, injury or death, economic loss	Development controls, monitoring, flood warning system and flood evacuation procedures	2	U	4	Maj	8 Mod	3	P	4	Maj	12 High	4	L	4	Maj	16 High	4	L	4	Maj	16 High	Long term planning/strategies beyond CMP timeframe for adaption to sea level rise, integrating actions from Flood Risk Management Plan with CMP
Estuary-wide	Coastal Vulnerability	Tidal Inundation and Sea Level Rise	Rising water table and impact on existing and future development	Sea Level Rise and inundation	Damage to infrastructure, loss of critical services to infrastructure	none	2	U	4	Maj	8 Mod	3	P	4	Maj	12 High	4	L	4	Maj	16 High	4	L	4	Maj	16 High	Investigate engineering measures to mitigate against or prevent groundwater damage to building foundations and services and include these in development controls for new DAs
Estuary-wide	Coastal Vulnerability	Tidal Inundation and Sea Level Rise	Development approved in inappropriate locations	Inadequate or inappropriate sea level rise projections for planning purposes	Future increased risk to Infrastructure	Community education, planning controls, Council resolutions on sea level rise projections	3	P	4	Maj	12 High	3	P	4	Maj	12 High	4	L	4	Maj	16 High	5	AC	4	Maj	20 Extreme	Revise sea level rise projections for future planning purposes based on latest advice from IPCC. Develop a planning proposal to map the CVA. Review development controls within CVA mapped areas, and review planning controls in accordance with the Floodplain Risk Management Study and Plan (FRMS&P).
Estuary-wide	Coastal Use	Cultural and Social	Poor community understanding of coastal and estuary issues	Lack of easy-to-digest information	Lack of community ownership of issues, community misconceptions leading to poor environmental outcomes	Community education, dissemination of information to schools and community groups, provision of resources for community groups to empower them to undertake local projects and citizen science, effective coasts and estuaries committee, use of social media to communicate with community	4	L	3	Mod	12 High	4	L	3	Mod	12 High	4	L	3	Mod	12 High	4	L	3	Mod	12 High	Development of educational material including videos and fact sheets describing local coastal and estuary issues; Comprehensive community information program to accompany CMP implementation to explain key issues and actions

KEY: Likelihood: AC = Almost Certain, L = Likely. P = Possible, U = Unlikely, R = Rare
Consequence: C = Catastrophic, Maj = Major, Mod = Moderate, Min = Minor, I = Insignificant

							Present Day						20 years						50 years						100 years					
Estuary	Coastal Management Area	Risk Category	Risk Description	Root Cause	Consequence	Existing Controls	Lkihood (1-5)		Consq.(1-5)		Pre Treatment Rating		Lkihood (1-5)		Consq.(1-5)		Pre Treatment Rating		Lkihood (1-5)		Consq.(1-5)		Pre Treatment Rating		Lkihood (1-5)		Consq.(1-5)		Pre Treatment Rating		Potential Management Actions
Estuary-wide	Coastal Environment	Water Quality	Water quality and estuary health monitoring programs	Inconsistent monitoring of water quality and estuary health	Compromised ability to assess long term trends in water quality and estuary health	Water quality monitoring program, DP&E Estuary Health program, NSW DPI macrophyte mapping	5	AC	3	Mod	15	High	5	AC	3	Mod	15	High	5	AC	3	Mod	15	High	5	AC	3	Mod	15	High	Revised Council water quality monitoring program with continued estuary health monitoring program by DPE-EHG
Estuary-wide	Coastal Use	Navigation and Safety	Conflict between waterway users	High demand for waterway access	Amenity, safety	Signage and innovations in facility design	5	AC	3	Mod	15	High	5	AC	3	Mod	15	High	5	AC	3	Mod	15	High	5	AC	3	Mod	15	High	Assess effectiveness of signage and facility design in other areas and implement best practice for future facility upgrades
Estuary-wide	Coastal Environment	Cultural and Social	Poor communication between stakeholders, community and agencies leading to perceived lack of action on coastal management issues	Disagreements between stakeholders, responsible agencies for projects	Perceived lack of action or delays on urgent coastal and estuary rehabilitation projects	Effective communication between agencies, Council and stakeholders	5	AC	3	Mod	15	High	5	AC	3	Mod	15	High	5	AC	3	Mod	15	High	5	AC	3	Mod	15	High	Assess effectiveness of existing communication protocols between stakeholders, responsible agencies and community representatives via the Coastal and Estuary Management Committee, and update protocols if necessary
Estuary-wide	Coastal Environment	Water Quality	Overflows from sewage pumping network stations (all catchments)	Wet weather including more frequent inundations. Dry weather from blockages, power failures etc.	Recreational and human health impacts	STP EPLs, Pollution Incident Response Management Plan (PIRMP), Risk Assessment, Risk Minimisation and Incident Management Strategy, Water Quality Monitoring Program	4	L	3	Mod	12	High	4	L	3	Mod	12	High	4	L	3	Mod	12	High	4	L	3	Mod	12	High	Regular review of PIRMP, Incident Response Strategy and facility risk assessments.
Estuary-wide	Coastal Environment	Water Quality	Potential contaminants associated with urban area runoff and stormwater - litter/gross pollutants, hydrocarbons, metals, pesticides	Inundation and urban runoff	Estuary health and recreational impacts	Development controls	4	L	3	Mod	12	High	4	L	3	Mod	12	High	4	L	3	Mod	12	High	4	L	3	Mod	12	High	Collect maintenance data on existing GPTs to enable an internal assessment of the effectiveness of existing stormwater runoff treatment/GPTs. Install and maintain additional stormwater runoff and GPT controls where they have been recommended
Estuary-wide	Coastal Environment	Ecological Environment	Development resulting in a reduction in estuary health	Perceived incorrect LEP zoning of areas	Threats to estuary health	CMP, development controls, state and federal legislation	3	P	3	Mod	9	High	3	P	3	Mod	9	High	3	P	3	Mod	9	High	3	P	3	Mod	9	High	Review of LEP alongside the development of a Planning proposal to map a CVA. Review and where necessary update development controls
Estuary-wide	Coastal Use	Cultural and Social	Damage to or loss of non-Aboriginal and Aboriginal cultural heritage items (e.g. midden at Cudmirrah)	Inundation, erosion, lack of understanding from the community, malicious damage, vandalism	Loss of cultural heritage	Development controls, public education program, 4WD access management	3	P	4	Maj	12	High	3	P	4	Maj	12	High	3	P	4	Maj	12	High	3	P	4	Maj	12	High	More educational signage, better protection, enforcement of 4WD restrictions, better education, rezoning of areas to higher environmental protection. Mitigations are very dependent on the site and case by case basis. Some sites will benefit from fencing and restricted access, and in others may be more appropriate to have new access pathways to prevent access to sensitive sites, Jerrinja Tribe to assess and guide appropriate management options.
Estuary-wide	Coastal Use	Cultural and Social	Aboriginal loss of connection between land and sea	Inundation, erosion, lack of understanding from the community, malicious damage, vandalism	Loss of cultural heritage	Development controls, public education program, Aboriginal heritage mapping, statutory and non-statutory planning controls	3	P	3	Mod	9	High	3	P	3	Mod	9	High	3	P	3	Mod	9	High	3	P	3	Mod	9	High	Aboriginal access to the environment and 2.5km zone of coastline was recommended by Jerrinja Tribe. Access tracks between sites to maintain connection between the sea and rest of lands. NSW Government commitment for the future joint management of NSW National Parks .
Estuary-wide	Coastal Use	Cultural and Social	Lack of understanding of Aboriginal heritage	Inadequate education and communication	Compromised Aboriginal heritage values	Community education, Aboriginal Advisory Committee (Council), Council engagement strategy and supporting articles	3	P	3	Mod	9	High	3	P	3	Mod	9	High	3	P	3	Mod	9	High	3	P	3	Mod	9	High	Consultation with Jerrinja re. community suggestion to rename St Georges Basin using Indigenous language names, community education. Reinforcing that the region always has and always will be Jerrinja country
Estuary-wide	Coastal Use	Cultural and Social	Important loss of cultural significance	Lack of interpretive signage for educating the community about	Inadvertent damage to sites e.g. at Berrara Ck. Deterioration of heritage items,	Statutory and non-statutory planning controls, mapping tools.	3	P	3	Mod	9	High	3	P	3	Mod	9	High	3	P	3	Mod	9	High	3	P	3	Mod	9	High	Updating Aboriginal and non-Aboriginal heritage listings, including updating of mapping to ensure protection of any culturally significant heritage items

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Consequence: C = Catastrophic, Maj = Major, Mod = Moderate, Min = Minor, I = Insignificant

							Present Day					20 years					50 years					100 years					
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				heritage and environment	significant loss of historical authenticity for items that are listed or those items that may qualify for heritage listing																						
Estuary-wide	Coastal Use	Cultural and Social	Severe deterioration of natural beauty or heritage value of heritage listed items	Human damage to culturally significant sites and artefacts	Inadvertent damage to sites e.g. at Berrara Ck. Deterioration of heritage items, significant loss of historical authenticity for items that are listed or those items that may qualify for heritage listing	Statutory and non-statutory planning controls, mapping tools.	3	P	3	Mod	9 High	3	P	3	Mod	9 High	3	P	3	Mod	9 High	3	P	3	Mod	9 High	Work together with traditional owners to devise culturally appropriate protection measures. Updating Aboriginal and non-Aboriginal heritage listings, including updating of mapping to ensure protection of any culturally significant heritage items
Estuary-wide	Coastal Use	Cultural and Social	Deterioration of heritage items due to erosion	Foreshore erosion due to human impacts as well as coastal hazards	Inadvertent damage to sites e.g. at Berrara Ck. Deterioration of heritage items, significant loss of historical authenticity for items that are listed or those items that may qualify for heritage listing	CMP - erosion mapping in relation to heritage items	3	P	3	Mod	9 High	3	P	3	Mod	9 High	3	P	3	Mod	9 High	3	P	3	Mod	9 High	Preparation of CMP with targeted actions to prevent/minimise disturbances/deterioration/impacts to heritage items

Acronyms and abbreviations

Acronym/abbreviation	Definition
AEP	Annual Exceedance Probability
CEA	Coastal Environment Area
CEMC	Coastal Estuary Management Committee
CMP	Coastal Management Program
CWLRA	Coastal Wetland and Littoral Rainforest Area
CVA	Coastal Vulnerability Area
CZMP	Coastal Zone Management Plan
DCP	Development Control Plan
DPE - EHG	Department of Planning and Environment – Environment and Heritage Group
DPI Fisheries	Department of Regional NSW
KBA	Key Biodiversity Area
LEP	Local Environment Plan
LLS	Local Land Services
OEH	Office of Environment and Heritage
POEO	NSW *Protection of the Environment Operations Act* 1997
RA	Risk Assessment
SEPP	State Environmental Planning Policy
SLR	Sea Level Rise

1 Introduction

1.1 Background

The hierarchy of coastal management areas as referred to in the *State Environment Planning Policy (Resilience and Hazards) 2021* (the SEPP) are:

i) coastal wetland and littoral rainforest area

ii) coastal vulnerability area

iii) coastal environment area

iv) coastal use area.

The key issues for the estuaries in the Shoalhaven have been identified in previous Estuary Management Plans, Entrance Management Policies and Natural Resources Management Strategies as well as community consultation activities. Some of these issues remain relevant today, whereas others have been addressed or are in the process of being addressed.

This Risk Assessment categorises the main risks for the Sussex Inlet/St Georges Basin, Swan L:ake and Berrara Creek estuaries in terms of the above coastal management areas. It builds upon the first-pass risk assessment undertaken for the estuary as part of the Stage 1 Scoping Study (Advisian 2020), by identifying key issues and risks in greater detail.

The key issues and risks have been identified through the following supporting studies undertaken as part of the Coastal Management Program (CMP) for the Sussex Inlet and St Georges Basin, Swan Lake and Berrara Creek estuaries:

- **A Boating Study of the estuary -** this assessed whether there is sufficient capacity for vessels and whether there is a need to improve existing facilities or reduce the impact of boating on the environment. The Boating Study has been informed by observations and analysis by our coastal scientists and engineers, as well as a targeted community and stakeholder engagement program directly relating to boating and navigation issues within the St Georges Basin and Sussex Inlet areas. **Key risks addressed: Navigation and Safety within the Coastal Use Area.**

- **Field Based assessments** - of erosion and foreshore issues affecting estuary health have been undertaken. The shoreline was inspected in detail and features that indicate the coastal processes occurring at the various sites within the study area have been noted by the Study Team. The aim of this study was to understand areas that may be prone to bank erosion, inundation, and poor water quality, as well as provide a high-level visual inspection of foreshore assets, and ground-truthing of existing estuarine vegetation mapping. **Key risks addressed: Foreshore Erosion within the Coastal Environment Area and Coastal Vulnerability Area.**

- **Identification of opportunities for urban runoff treatment** – Poor water quality due to urban runoff was identified as a key risk in the Stage 1 Scoping Study for St Georges Basin and Sussex Inlet. Key locations where urban runoff may be causing water quality problems as well as locations where opportunities exist to provide urban runoff treatments have been identified as part of the Stage 2 studies for the CMP. **Key risks addressed: Water Quality within the Coastal Environment Area.**

- **Water Quality and Environmental Health Study** - The Scoping Study identified perceived poor water quality throughout the estuaries as an issue and threat by the community, resulting from industrial, agricultural, or urban runoff affecting the estuaries ecology and estuarine vegetation. Current controls include licensing of industrial discharges, urban stormwater treatment, provision of riparian zones and fencing of estuarine foreshores, and public education programs. The Water Quality and Environmental Health Study has involved assessment of existing water quality data for Sussex Inlet and St Georges Basin, Swan lake and Berrara Creek, determining the current estuary health condition, assessing water quality suitability for recreational activity, and assessing the adequacy of Council's existing monitoring and reporting program. **Key risks addressed: Water Quality, Environmental health, and risks to the ecological environment within the Coastal Environment Area and Coastal Use Area.**

- **Aboriginal and non-Aboriginal Heritage** – A review of background data / online mapping for the estuary has been undertaken to identify the cultural heritage attributes, including a desktop review of information contained in the Stage 1 Scoping Study and current legislative and regulatory provisions for cultural heritage matters. Desktop review of heritage registers (Australian Heritage Database, State Heritage Inventory and LEP), Aboriginal Heritage Information Management System (AHIMS), heritage studies and mapping of sites has been carried out. In addition, a site walkover at Berrara Creek with the Jerrinja Tribe was carried out to gain the perspectives of the local First Nations people. The Jerrinja people have a very strong connection to the land, local Aboriginal cultural heritage and land values are considered to be 'highly sensitive' and have 'high significance'. The Jerrinja Tribe are the key Aboriginal stakeholders that have governance of the area. Key requests from the Jerrinja Tribe are to ensure that for any works being carried out in these highly sensitive areas, a representative from the Jerrinja Tribe be present for all aspects and stages of works being carried out and that stakeholders are educated about the Aboriginal significance of the area. **Key risks addressed: Cultural and Social risks within the Coastal Environment Area.**

- **Synthesis of Current Knowledge on Estuary Processes and Health** – this has involved compilation of relevant information on the health of the estuary based on new studies, the Scoping Study, and any other prior plans/studies. **Key risks addressed: Water quality, coastal and tidal inundation, foreshore erosion, cultural and social, environmental health and water quality risks within the Coastal Wetlands and Littoral Rainforest, Coastal Environment, Coastal Vulnerability, Coastal Use Areas**.

- **Community and Stakeholder Engagement** – Through a series of community engagement activities including online surveys, targeted engagement with community groups and workshops, additional key issues and risks have been identified for key locations throughout the estuary. **Key risks addressed: Water quality, coastal and tidal inundation, foreshore erosion, cultural and social, environmental health and water quality risks within the Coastal Wetlands and Littoral Rainforest, Coastal Environment, Coastal Vulnerability, Coastal Use Areas.**

- **Tidal and Coastal Inundation Study** – A hydrodynamic modelling study has been carried out to help us understand the key risks to infrastructure and the coastal environment area from tidal inundation due to existing coastal processes as well as future changes to the estuary dynamics caused by sea level rise and climate change. **Key risks addressed: Tidal Inundation and Sea Level Rise within the Coastal Wetlands and Littoral Rainforest, Coastal Environment, Coastal Vulnerability, Coastal Use Areas.**

1.2 Study Area

The study area for the CMP includes the Sussex Inlet and St Georges Basin, Swan Lake and Berrara Creek estuaries and catchment areas. The study area is shown in Figure 1-1.

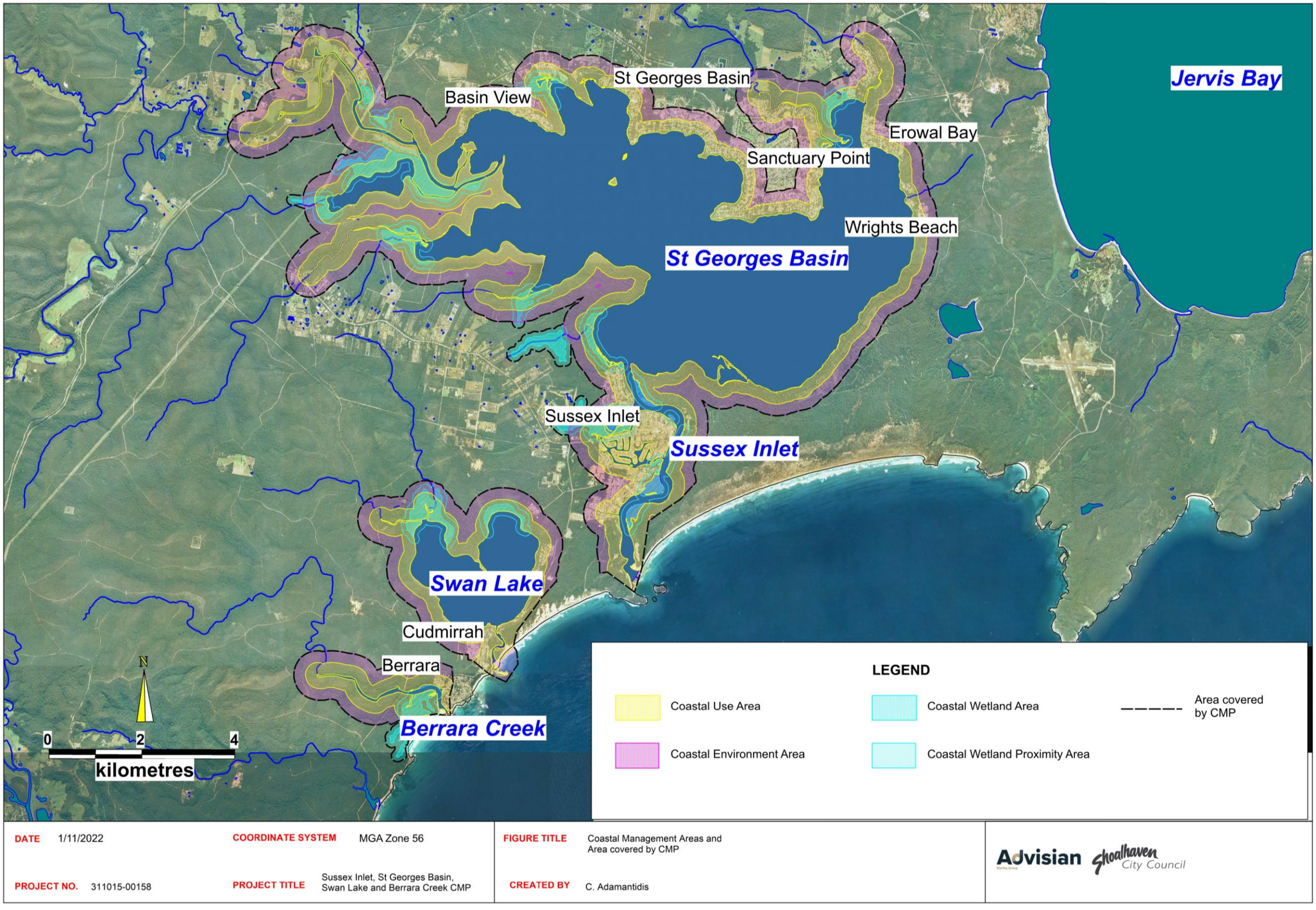

Figure 1-1 – Study Area

2 First Pass Risk Assessment – Key Issues

2.1 Introduction

The first-pass risk assessment undertaken for the Scoping Study highlights priorities for management actions while recognising the uncertainties associated with natural systems and future scenarios. High-level risks were identified for all of Council's estuaries including St Georges Basin and Sussex Inlet.

Risks were identified together with existing management measures, with the key risks for St Georges Basin and Sussex Inlet evaluated in accordance with Council's risk matrix, recorded in a risk register and defined below.

Key issues and existing controls identified from the First Pass Risk Assessment for St Georges Basin, Sussex Inlet, Swan Lake and Berrara Creek are provided in Table 2-1. These key issues have been updated as part of the Stage 2 of the CMP process to include more specific local issues and risks, with the risk register acting as a tool to monitor the effectiveness of management actions as well as the development of specific management actions to address each risk. This has resulted in the development of a detailed risk assessment to inform the CMP and inform potential management actions.

Key to a detailed assessment of risks and issues in the St Georges Basin and Sussex Inlet estuary is a detailed understanding of the estuarine processes, including estuary hydrodynamics, entrance processes and estuary ecology, as well as the key hazards and threats including inundation, erosion, and threats to estuary ecology through interference with the natural estuarine processes.

2.2 Key Risks

For the estuaries of the Shoalhaven, including St Georges Basin/Sussex Inlet, Swan Lake and Berrara Creek, the key risks and challenges identified from the first pass risk assessment carried out for the Shoalhaven CMP Scoping Study related to:

- Poor water quality from industrial, agricultural, or urban runoff affecting the estuary ecology and estuarine vegetation
- Coastal inundation, emergency management and the management of estuary entrances to reduce flood risk
- Tidal inundation of foreshore private and public assets from climate change and sea level rise
- Poor access or insufficient facilities for navigation and recreational boating
- Conflict between users of the waterways e.g., powered, and non-powered craft and swimmers
- Bank erosion and siltation caused by unrestricted access to foreshores by cattle, changes to estuary tidal regimes and boat wash
- Spread of weeds caused by agricultural and urban runoff
- Damage to estuarine vegetation leading to loss of habitat for fish and degradation of estuarine ecology, caused by changes to tidal regimes, clearing or boating activity, or deliberate damage of foreshore vegetation to improve views.
- Threat to threatened species including waders and shorebirds from feral animals, loss of habitat due to damage to marine vegetation, sea level rise and unrestricted access.

Table 2-1 – First Pass Risk Assessment – Key issues identified at St Georges Basin, Sussex Inlet, Swan Lake and Berrara Creek (Shoalhaven CMP Scoping Study, Advisian 2020)

Estuary	Coastal Management Area	Risk Category	Risk Description	Root Cause	Consequence	Existing Controls	Likelihood (1-5)		Consequence (1-5)		Risk Rating
St. Georges Basin	Coastal Wetlands and Littoral Rainforest	Environmental	Poor water quality	Urban runoff	Impact on estuary ecology	Zoning/development controls within catchment area, control of urban runoff, community education	3	Possible	4	Major	**12 HIGH**
St. Georges Basin	Coastal Wetlands and Littoral Rainforest	Environmental	Changes in balance between habitat types	Sea Level Rise	Loss of biodiversity, landward migration of estuarine vegetation	None	4	Likely	3	Moderate	**12 HIGH**
Sussex Inlet	Coastal Wetlands and Littoral Rainforest	Environmental	Changes in balance between habitat types	Sea Level Rise	Loss of biodiversity, landward migration of estuarine vegetation	None	4	Likely	3	Moderate	**12 HIGH**
Swan Lake	Coastal Wetlands and Littoral Rainforest	Environmental	Poor water quality	Urban runoff, sewage overflows	Threat to estuary ecology	Development controls, public education, stormwater treatment	3	Possible	3	Moderate	**9 HIGH**
Berrara Creek	Coastal Wetlands and Littoral Rainforest	Environmental	Poor water quality	Urban runoff, sewage overflows between Waterhaven Ave and Meadow Lake Avenue	Threat to estuary ecology	Development controls, public education, stormwater treatment	3	Possible	3	Moderate	**9 HIGH**
St. Georges Basin	Coastal Vulnerability	Safety	Flooding	Sea Level Rise, changes to estuary hydraulics	Impact on foreshore infrastructure, access	Development controls	4	Likely	4	Major	**16 HIGH**
St. Georges Basin	Coastal Vulnerability	Environmental	Foreshore Erosion	Vessel waves, wind waves, sea level rise	Damage to foreshore infrastructure and foreshore vegetation	Development controls, vessel speed limits	4	Likely	3	Moderate	**12 HIGH**
St. Georges Basin	Coastal Vulnerability	Financial	Foreshore Erosion	Vessel waves, wind waves, sea level rise	Damage to foreshore infrastructure and foreshore vegetation	Development controls, vessel speed limits, foreshore erosion protection structures	4	Likely	3	Moderate	**12 HIGH**

Estuary	Coastal Management Area	Risk Category	Risk Description	Root Cause	Consequence	Existing Controls	Likelihood (1-5)		Consequence (1-5)		Risk Rating
Sussex Inlet	Coastal Vulnerability	Safety	Flooding	Low lying development, lack of tourist awareness of flooding, no evacuation centre, lack of flood warning system and evacuation procedures	Damage to infrastructure, loss of community access, impact on tourists	Development controls, monitoring, development of flood warning system and flood evacuation procedures	4	Likely	4	Major	**16 HIGH**
Sussex Inlet	Coastal Vulnerability	Amenity	Erosion risk to cabins near estuary mouth	Coastal erosion due to wave action, proximity of cabins to beach	Amenity, safety	Consider risk to cabins and build landward	3	Possible	3	Moderate	**9 HIGH**
Swan Lake	Coastal Vulnerability	Safety	Flooding	Low lying development	Damage to infrastructure/loss of community access	Entrance Management, development controls	3	Possible	3	Moderate	**9 HIGH**
St. Georges Basin	Coastal Environment	Environmental	Damage to estuarine vegetation, seagrass beds	Propeller damage	Damage to seagrasses	Boating restrictions	4	Likely	3	Moderate	**12 HIGH**
St. Georges Basin	Coastal Environment	Environmental	Damage to foreshore vegetation, saltmarsh	Mowing, clearing	Loss of habitat and changes to estuary ecology	Education	4	Likely	3	Moderate	**12 HIGH**
St. Georges Basin	Coastal Environment	Amenity	Poor water quality	Urban runoff, sewage overflows, agricultural runoff	Reduced recreational amenity	Sewage treatment plant upgrade, sewerage infrastructure upgrade, community education, development controls	3	Possible	3	Moderate	**9 HIGH**
Sussex Inlet	Coastal Environment	Environmental	Foreshore Erosion	Erosion from boat wakes	Damage to foreshore infrastructure and foreshore vegetation	Foreshore protection structures, development controls for flood-prone areas, entrance management	4	Likely	3	Moderate	**12 HIGH**
Sussex Inlet	Coastal Environment	Environmental	Damage to seagrass beds at entrance to St Georges Basin	Dragging of boat anchors	Damage to seagrasses	Public education, provision of dedicated anchorage area	3	Possible	3	Moderate	**9 HIGH**

Estuary	Coastal Management Area	Risk Category	Risk Description	Root Cause	Consequence	Existing Controls	Likelihood (1-5)		Consequence (1-5)		Risk Rating
Sussex Inlet	Coastal Environment	Environmental	Poor water quality	Urban runoff, sewage overflows, poor tidal flushing in canal estate area	Impact on recreational amenity, health, ecology	Monitoring, estuary maintenance/dredging	4	Likely	3	Moderate	**12 HIGH**
Sussex Inlet	Coastal Environment	Environmental	Possible ballast rock contributing to sedimentation of channel	Legacy issue from past landuse practices	Increased channel sedimentation, impact on recreational amenity	Study/survey to locate ballast rock	3	Possible	3	Moderate	**9 HIGH**
Swan Lake	Coastal Environment	Environmental	Damage to dune vegetation	4WD vehicles	Damage to dune vegetation at eastern bend of estuary channel, risk of entrance breakthrough	4WD access management	3	Possible	3	Moderate	**9 HIGH**
Swan Lake	Coastal Environment	Environmental	Introduced species threatening native wildlife	Past landuse practices	Threat to estuary ecology	Feral animal control methods, fencing	3	Possible	3	Moderate	**9 HIGH**
Swan Lake	Coastal Environment	Environmental	Changes to estuarine morphology	Past bridge construction	Threat to estuary ecology	None	3	Possible	3	Moderate	**9 HIGH**
Swan Lake	Coastal Environment	Environmental	Artificial lake openings affecting fish populations and wetlands	Arbitrary lake opening	Threat to estuary ecology	Entrance Management	3	Possible	3	Moderate	**9 HIGH**
St. Georges Basin	Coastal Use	Amenity	Conflict between users of powered and non-powered craft	High demand for recreational use	Threat to recreational amenity	Provision of dedicated facilities for powered and non-powered vessel users	3	Possible	3	Moderate	**9 HIGH**
St. Georges Basin	Coastal Use	Amenity	Lack of public foreshore access	High private ownership of foreshore areas	Reduced foreshore access	Provision of additional foreshore recreation reserves	3	Possible	3	Moderate	**9 HIGH**
St. Georges Basin	Coastal Use	Amenity	Lack of public boating facilities	High demand for recreational use	Crowding at existing facilities	Provision of more boating facilities	3	Possible	3	Moderate	**9 HIGH**
Sussex Inlet	Coastal Use	Amenity	Foreshore Erosion	Erosion from meandering of channel, lack of riparian vegetation or	Sand entering estuary channel causing hazard to navigation	Foreshore protection structures, development controls	4	Likely	3	Moderate	**12 HIGH**

Estuary	Coastal Management Area	Risk Category	Risk Description	Root Cause	Consequence	Existing Controls	Likelihood (1-5)		Consequence (1-5)		Risk Rating
				failing bank protection		for flood-prone areas, entrance management					
Sussex Inlet	Coastal Use	Safety	Poor navigation conditions into the Basin and near the entrance, and at Chris Creek and Alamein	Shoaling of channel	Impact on navigation	Monitoring, estuary maintenance/dredging	5	Almost Certain	4	Major	**20 EXTREME**
Sussex Inlet	Coastal Use	Amenity	Conflict between users of powered and non-powered craft	High demand for recreational boating	Amenity, safety	Demand study and provision of additional boating facilities if needed	4	Likely	3	Moderate	**12 HIGH**
Sussex Inlet	Coastal Use	Infrastructure	Need for channel optimisation, sand nourishment/maintenance to revetment walls, review of the Canals Management Plan at Riviera Keys	Need for more maintenance	Damage to revetment walls, increased channel sedimentation, impact on navigation and recreational amenity	Review Riviera Keys Canals Management Plan	5	Almost Certain	3	Moderate	**15 HIGH**
Swan Lake	Coastal Use	Amenity	Overcrowding at boat launching areas	High demand for boating activities, inadequate facilities	Impact on recreational amenity at foreshore reserves	Upgrade existing boat launching facilities e.g., at The Springs Road	5	Almost Certain	2	Minor	**10 HIGH**
Berrara Creek	Coastal Use	Amenity	Poor water quality	Urban runoff, sewage overflows between Waterhaven Ave and Meadow Lake Avenue	Impact on recreational amenity at foreshore reserves	Development controls, public education, stormwater treatment	3	Possible	3	Moderate	**9 HIGH**

2.2.1 First Pass Discussion on Existing Controls for Key Risks

The existing controls for the key risks identified in the first pass assessment are provided in Table 2-1 above.

Key information gaps identified from Stage 1 to address the risks include:

- Regular water quality monitoring programs for all estuaries.
- GIS/aerial image analysis to identify estuarine areas where riparian zones can be established.
- Identification of opportunities for urban runoff treatment e.g., provision of swales, inline stormwater treatment.
- Comprehensive database of key stakeholders.
- Updated flood studies for key estuaries, estuary processes and entrance management policies for key estuaries to understand natural flow and sedimentation regimes.
- Demand studies, boating surveys, monitoring of recreational facilities, community/ stakeholder consultation to address demand for boating and recreation facilities.
- Bank erosion surveys from aerial imagery/drones to monitor bank erosion and regular visual inspections of key estuaries from vessels.
- Ecological surveys to identify occurrence of weeds in all estuaries, foreshore areas and beach dune areas and identification of mechanisms for spreading of weeds.
- Regular updates every few years to coastal hazard assessments and mapping for key areas where infrastructure is at risk.
- Regular review every few years of coverage and effectiveness of coastal development controls.
- Regular survey and monitoring of known key coastal erosion/inundation hotspots.
- Effective communication and provision of coastal and estuary information for Councillor decision makers, Terms of Reference for Coastal and Estuary Committees, social media and communications expertise.

The Stage 2 CMP studies have addressed some of these information gaps, to identify the risks in more detail. The existing risk controls have been further developed in Stage 2 and included in the updated Risk Register in Appendix A.

3 Risks, Issues and Opportunities identified by Stakeholders

3.1 Stage 1 Community and Stakeholder Engagement

The detailed risk assessment presented here for the Coastal Wetlands/Littoral Rainforest, Coastal Vulnerability, Coastal Environment and Coastal Use areas for Sussex Inlet/St Georges Basin, Swan Lake and Berrara Creek reviews and builds upon relevant information provided in the Shoalhaven Coastal Management Scoping Study (Advisian 2020). The public exhibition of the Scoping Study resulted in various submissions from the local community regarding specific issues, risks, and opportunities to be addressed for Sussex Inlet and St Georges Basin, some of which were included as Key Risks in the Stage 1 Scoping Study. Additional relevant issues and opportunities were identified by the community for inclusion in this Stage 2 detailed risk assessment during Stage 1.

3.2 Stage 2 Community Workshops

The local community has identified additional key issues to be included in the detailed risk assessment, through the community engagement held during Stage 2. These were identified through two community workshops that were held in March 2022, one in Erowal Bay focussing on St Georges Basin, and the other at Sussex Inlet focussing on Sussex Inlet, Swan Lake and Berrara Creek.

The key issues identified at the workshops, which have been included in the Stage 2 Risk Assessment, are presented in Table 3-1 and Table 3-2.

3.2.1 Community Online Place Tool Survey

An online survey using the "Place Tool" platform was undertaken during the period covering the workshops, between March and May 2022, where community members were able to pin locations of key management issues and provide suggested actions. The key management issues identified through this process related to the following six themes:

- Cultural and social issues
- Foreshore Erosion
- Ecological Environment
- Water Quality
- Inundation and Sea Level Rise
- Navigation and Safety.

Issues captured from the Place Tool survey included many of the same issues captured from the community workshops, but also included:

- unauthorised clearing and vandalism of vegetation and riparian corridors, specifically at Badgee Lagoon and Berrara Creek

- impact of dogs on wildlife, including shorebird breeding areas (e.g., pied oystercatchers), specifically at Berrara Creek, Swan Lake entrance and the islands within St Georges Basin
- difficulties navigating the entrance to Sussex Inlet
- the need for updated bathymetric survey at St Georges Basin.

Maps which illustrate the key issues as canvassed by the community in the workshops and online survey are provided in Appendix B.

Table 3-1 – Key Issues identified from Erowal Bay community workshop

Estuary	Coastal Management Area	Risk Category/Asset Type	Risk	Issue/Consequence	Opportunities / Comments	Stakeholder
St Georges Basin	Coastal Wetland and Littoral Rainforest Coastal Vulnerability Coastal Environment Coastal Use	Cultural and Social	There is a lack of knowledge or understanding by non-indigenous people about Aboriginal sites in the area	Damage/loss of Aboriginal cultural heritage places.	Education, by signage may help. Rename the St Georges Basin to acknowledge the traditional owners.	Traditional Owners, Council, Heritage NSW
St Georges Basin	Coastal Wetland and Littoral Rainforest Coastal Vulnerability Coastal Environment Coastal Use	Foreshore Erosion	A key area of erosion around Erowal Bay identified along Tomerong Creek.	Undermining of foreshore vegetation, sedimentation of estuary	Management of power boats within Tomerong Creek	TfNSW
St Georges Basin	Coastal Wetland and Littoral Rainforest Coastal Vulnerability Coastal Environment Coastal Use	Foreshore Erosion	Insufficient sediment and erosion controls at development sites within urban areas is leading to sediment being discharged into the estuary (e.g., near the Basin Road boat ramp) during rainfall events.	Impacts of sedimentation on water quality	Enforcement of erosion and sediment controls at development sites	Council
St Georges Basin	Coastal Vulnerability	Tidal Inundation and Sea Level Rise	The Sanctuary Point shoreline is affected by inundation or sea level rise.	Inundation of infrastructure	Planning controls, implementation of measures from the St Georges Basin Floodplain Risk Management Plan	Council

Estuary	Coastal Management Area	Risk Category/Asset Type	Risk	Issue/Consequence	Opportunities / Comments	Stakeholder
St Georges Basin	Coastal Use	Navigation and Safety	Safety for navigation on Tomerong Creek, conflict between users of powered and non-powered vessels	Impact on safety for recreational users, bank erosion	Feedback included suggestions to increase and provide clearer navigational aids to support safety on Tomerong Creek, with requests to ban power/motorboats and adding signage for speed limits.	TfNSW
St Georges Basin	Coastal Use	Navigation and Safety	Boat ramp damage and the impact on safety at St Georges Basin boat ramp and Basin View boat ramp.	Impact on safety of recreational users	Investigate need to upgrade ramps/implement improvements to infrastructure to improve safety	Council. TfNSW
St Georges Basin	Coastal Wetland and Littoral Rainforest Coastal Vulnerability Coastal Environment Coastal Use	Water Quality	Water quality issues are concentrated on siltation and sedimentation from upstream development and stormwater runoff.	Impact on recreational water quality and estuary health	Enforcement of erosion and sediment controls at development sites	Council
St Georges Basin	Coastal Wetland and Littoral Rainforest Coastal Vulnerability Coastal Environment	Water Quality	Siltation around Boathaven Boat Ramp due to storm runoff was also an issue and further management is required.	Impact on recreational water quality and estuary health	Identify areas for installation of gross pollutant traps	Council

Estuary	Coastal Management Area	Risk Category/Asset Type	Risk	Issue/Consequence	Opportunities / Comments	Stakeholder
	Coastal Use					
St Georges Basin	Coastal Wetland and Littoral Rainforest Coastal Environment	Ecological Environment	Stakeholders held concerns for the protection of significant ecological zones including wildlife corridors and habitat at numerous sites.	Fragmentation of wildlife corridors affecting habitat and estuary ecology	Identify potential wildlife corridors and implement planning controls/zoning to improve connectivity	Council, DPE-EHG, DPI Fisheries
St Georges Basin	Coastal Wetland and Littoral Rainforest Coastal Environment	Ecological Environment	Illegal removal of trees and other vegetation in the Tomerong Creek area	Damage to estuary ecology	Greater protections for the natural areas through signage and monitoring	Council
St Georges Basin	Coastal Wetland and Littoral Rainforest Coastal Environment	Ecological Environment	Inadequate mapping of important ecological areas as well as a loss of stingray environment was noted	Lack of understanding of estuary ecology leading to inadequate protection of habitat	Research project in conjunction with university to improve understanding of estuary ecology	DPE-EHG

Table 3-2 – Key issues identified from Sussex Inlet community workshop

Estuary	Coastal Management Area	Risk Category/Asset Type	Risk	Issue/Consequence	Opportunities / Comments	Stakeholder
Sussex Inlet, Swan Lake, Berrara Creek	Coastal Wetland and Littoral Rainforest Coastal Vulnerability Coastal Environment Coastal Use	Cultural and Social	Lack of knowledge or understanding around Aboriginal and cultural sites in the area. A site that was specified was the midden at Cudmirrah	Damage/loss of Aboriginal cultural heritage places	Signage and education, barriers to prevent people walking over middens e.g. at Cudmirrah	Traditional Owners, Council, Heritage NSW
Sussex Inlet, Swan Lake, Berrara Creek	Coastal Use Coastal Environment	Cultural and Social	Damage to sand dunes from 4WD	Damage to dunes	Enforcement of fines for 4WD in unauthorised areas, rezoning areas to protect dunes	Council, NPWS, DPE-EHG
Sussex Inlet, Swan Lake, Berrara Creek	Coastal Use Coastal Environment	Cultural and Social	Perceived overfishing	Reduction in fish stocks	Monitoring by DPI-Fisheries	DPI-Fisheries (outside remit of CMP)
Berrara Creek	Coastal Use Coastal Environment	Foreshore Erosion	Areas of notable erosion included the access stairs at Cudmirrah and Berrara Creek. In both cases the access stairs are eroded and in Cudmirrah people are taking alternative routes through the vegetation.	Damage to dune vegetation	Upgrade/repair coastal accessways in accordance with Council beach access management strategy	Council
Swan Lake	Coastal Environment	Foreshore Erosion	Damage to vegetation along Swan Lake leading to erosion.	Damage to dune vegetation, foreshore erosion	Improved monitoring and enforcement related to destruction and clearing of vegetation.	Council

Estuary	Coastal Management Area	Risk Category/Asset Type	Risk	Issue/Consequence	Opportunities / Comments	Stakeholder
Sussex Inlet	Coastal Vulnerability Coastal Environment Coastal Use	Foreshore Erosion	The retaining wall along Sussex Inlet that has fallen into disrepair was raised several times by stakeholders.	The damaged wall was seen as causing erosion in the Inlet and stakeholders requested for the wall to be reinstated.	Large scale erosion process occurring in Sussex Inlet, needs broad scale management	Council, Crown Lands, DPI Fisheries, DPE-EHG
Swan Lake, Berrara Creek	Coastal Environment Coastal Use	Foreshore Erosion	Ad-hoc storage of canoes and watercraft along the foreshore are also viewed to be causing erosion and damage to vegetation.	Foreshore erosion, damage to foreshore vegetation	To mitigate this, stakeholders suggested better storage of watercraft along the banks of the Inlet.	Council
Swan Lake Sussex Inlet	Coastal Vulnerability Coastal Use	Tidal Inundation and Sea Level Rise	Inadequate stormwater infrastructure to deal with runoff. High water levels of Swan Lake impacting recreational amenity and inundation of infrastructure.	Inundation of infrastructure, reduced recreational amenity when water levels are high	Improved stormwater infrastructure, provision of recreation facilities that can be used when water levels are high	Council
Swan Lake Berrara Creek	Coastal Environment Coastal Use	Water Quality	The main concerns raised were regarding the water quality in Berrara Creek and Swan Lake; the chlorine plant at Berrara Creek is also a concern for potential leakages.	Impacts on water quality and estuary ecology	NSW DP&E Estuary Health Program, Revised water quality program (including adoption of DP&E guidelines for lagoons) Urban runoff controls, review of emergency procedures for water pump station at Berrara Creek and where necessary upgrade to ensure a pollution event does not occur	Council, DPE-EHG

Estuary	Coastal Management Area	Risk Category/Asset Type	Risk	Issue/Consequence	Opportunities / Comments	Stakeholder
Berrara Creek	Coastal Environment Coastal Use	Water Quality	Sewerage and flooding during peak storm events are an issue; better infrastructure for storm runoff was requested.	Impact on recreational amenity at foreshore reserves	Revised Council water quality program - including sanitary inspections on an as-needs basis, event sampling, and continued publication of WQ results on Council web-site.	Council
Sussex Inlet	Coastal Use	Navigation and Safety	There were many stakeholder requests for an increase in clearer navigational aids, including addition of navigation lights.	Safety for waterway users	Provision of lighting on navigation aids	TfNSW
Berrara Creek	Coastal Use	Navigation and Safety	Concerns were raised regarding motorboats in Berrara Creek, particularly boats not keeping with speed limits and rules	Safety for waterway users, conflict between users of powered and non-powered craft	Stakeholders requested that only non-powered boats use this area.	TfNSW
Sussex Inlet Swan Lake	Coastal Use	Navigation and Safety	Boat ramps at Lions Park, and Swan Lake were mentioned as being unsafe, with some being very slippery	Safety for waterway users	Additional or upgraded facilities, including upgraded boat ramp at Swan Lake Ski Beach Boat Ramp and Lions Park	Council, TfNSW
Swan Lake, Berrara Creek	Coastal Environment	Ecological Environment	Environmental concerns include the damage to vegetation, dunes and habitats including shorebirds by 4-wheel driving, dogs and people unaware of	Impact on estuary ecology	Public education, Exclusion of public access from known nesting sites on southern side of lake	Council/NPWS

Estuary	Coastal Management Area	Risk Category/Asset Type	Risk	Issue/Consequence	Opportunities / Comments	Stakeholder
			sensitivities due to lack of signage and enforcement.		entrance during breeding season. Continuation of South Coast Shorebird Recovery Program	
Sussex Inlet, Swan Lake, Berrara Creek	Coastal Environment	Ecological Environment	Numerous stakeholders raised the illegal clearing of vegetation and trees as an issue.	Threat to estuary ecology	Signage to educate is seen as a tool to mitigation, in addition to enforcement through fines. Stakeholders requested replanting of vegetation in affected areas.	Council
Swan Lake	Coastal Environment	Ecological Environment	In Swan Lake stakeholders were concerned about overfishing and threats to endangered wildlife, particularly birds. Endangered birds were a specific concern with boating, habitat destruction and perceived decline in fish stocks thought to be the main influences.	Threat to estuary ecology	Greater protections to natural vegetation and nesting areas requested, and tighter controls on powered boats.	Council, TfNSW, DPI Fisheries, NPWS

3.3 Council Asset Management Workshop

A workshop was held with Council asset managers in June 2022, to assess the risks relating specifically to Council assets within the Study Area.

Assets and issues discussed under present day and future conditions at each estuary during the workshop included:

- Sewage pumping stations
- Sewage treatment works
- Critical wastewater mains (pressure/gravity)
- Water pumping stations
- Stormwater infrastructure (pipes/pits)
- Picnic shelters/park furniture
- Playgrounds
- Sporting Facilities
- Roads – minor local
- Roads – major arterial
- Implications of frequency of inundation – rare events vs. regular tidal inundation

The outcomes, issues and discussion from the workshop are provided in Table 3-3.

Table 3-3 – Outcomes, Issues and Discussion from Council Asset Workshop, June 2022

Estuary	Coastal Management Area	Risk Category/Asset Type	Risk	Issue/Consequence	Opportunities / Comments	Stakeholder
St Georges Basin	Coastal Wetland and Littoral Rainforest Coastal Environment Coastal Use	Tidal inundation and SLR – Critical Wastewater	Ingress of stormwater into sewer network	Inability for sewer network to cope with increased flows, water quality impacts due to sewer overflow	Increased funding to support post-emergency asset assessments and have a strategic plan of assessment based on priority	Shoalhaven Water/Council
St Georges Basin	Coastal Wetland and Littoral Rainforest Coastal Vulnerability Coastal Environment Coastal Use	Tidal inundation and SLR - Stormwater infrastructure	Insufficient capacity in stormwater network to deal with increased flows, tidal inundation and SLR	Flooding of properties/assets from reduced network capacity	Increase use of rainwater tanks	Shoalhaven Water/Council
St Georges Basin	Coastal Vulnerability Coastal Environment Coastal Use	Foreshore erosion - Stormwater infrastructure	Damage to stormwater assets caused by foreshore erosion	Overflow of stormwater, further erosion, water quality and inundation impacts	Protect, strengthen, or remove vulnerable stormwater assets	Shoalhaven Water/Council
St Georges Basin	Coastal Vulnerability Coastal Environment Coastal Use	Foreshore erosion - Stormwater infrastructure	Increased hazard to public and private assets from erosion caused by stormwater outflow	Foreshore erosion in the vicinity of stormwater outlets, damage to adjacent infrastructure	More environmentally focussed designs of stormwater outlets (e.g., focusing on energy dissipation) Strategically increase output of stormwater flows i.e., increase capacity of network but reduce number of outlet locations	Shoalhaven Water/Council

Estuary	Coastal Management Area	Risk Category/Asset Type	Risk	Issue/Consequence	Opportunities / Comments	Stakeholder
St Georges Basin	Coastal Vulnerability	Tidal inundation and SLR - Stormwater infrastructure	Community access/isolation due to inundation, communication blackout during inundation events	Tidal inflow infiltrating stormwater network causing overflow onto streets	Investigate installation of one-way valves for stormwater to exclude tidal inflow	Shoalhaven Water/Council
St Georges Basin	Coastal Vulnerability Coastal Use	Tidal inundation and SLR - Playgrounds/ Picnic Shelters/ Park furniture/ Sporting facilities	Damage to assets, impact to community safety/mental health	Financial loss, increased maintenance costs, loss of recreational amenity	Increased funding to support post-emergency asset assessments and have a strategic plan of assessment based on priority Upgrade of materials for park furniture/playgrounds to improve resilience against inundation Adapt equipment and facilities to enable them to be resilient against inundation	Council
St Georges Basin	Coastal Vulnerability Coastal Use	Tidal inundation and SLR - Roads - local	Community isolation due to inundation	Loss of access to essential services	Enact emergency management measures, share information with responsible agencies on inundation risk, locally upgrade infrastructure to allow continued access	Council, TfNSW, NSW SES
St Georges Basin	Coastal Vulnerability Coastal Use	Tidal inundation and SLR - Roads - local	Loss of first responder's access	Loss of life due to lack of emergency access in an inundation event	Enact emergency management measures, share information with responsible agencies on	Council, TfNSW, NSW SES

Estuary	Coastal Management Area	Risk Category/Asset Type	Risk	Issue/Consequence	Opportunities / Comments	Stakeholder
				Loss of welfare support to evacuation centres	inundation risk, locally upgrade infrastructure to allow continued access	
St Georges Basin	Coastal Vulnerability Coastal Use	Tidal inundation and SLR - Roads - local	Damage to roads caused by increased frequency of inundation events	Increased maintenance costs, potholes due to increased inundation frequency Closure of roads if roads damaged, Moderate-major severity if critical roads are closed, likely to be widespread and take a long time to resolve	Locally upgrade infrastructure to improve resilience to increased inundation, investigate upgraded pavement designs Implement learnings from program of pothole repairs implemented following the East Coast Low events of March and April 2022 to improve response and be adaptive/responsive as a workforce	Council, TfNSW
St Georges Basin	Coastal Wetland and Littoral Rainforest Coastal Vulnerability Coastal Environment Coastal Use	Tidal inundation and SLR - Sewage Pumping Station	Increased frequency and severity of sewage overflows leading to human health, water quality and ecology impacts	Inability for sewer pumping station to cope with increased water levels, water quality impacts due to sewer overflow	Investigate feasibility of upgrade of pumping stations to improve resilience against SLR	Shoalhaven Water/Council
St Georges Basin	Coastal Wetland and Littoral Rainforest Coastal Vulnerability	Tidal inundation and SLR - Sewage Pumping Station	Sewage overflows leading to impacts on recreational amenity, primary and secondary contact recreation, damage to tourism industry and Council reputation	Inability for sewer pumping station to cope with increased water levels, water	Investigate feasibility of upgrade of pumping stations to improve resilience against SLR	Shoalhaven Water/Council

Estuary	Coastal Management Area	Risk Category/Asset Type	Risk	Issue/Consequence	Opportunities / Comments	Stakeholder
	Coastal Environment Coastal Use			quality impacts due to sewer overflow		
St Georges Basin	Coastal Wetland and Littoral Rainforest Coastal Vulnerability Coastal Environment Coastal Use	Tidal inundation and SLR - Sewage Pumping Station	Damage to equipment - equipment failure leading to future overflows, major impact to environment and reputation	Severity of risk is site-specific for different sewage pumping stations Cost of repair of electronic components of sewage pumping stations is high.	Investigate feasibility of upgrade of pumping stations to improve resilience against SLR	Shoalhaven Water/Council
St Georges Basin	Coastal Vulnerability Coastal Use	Foreshore Erosion - Playgrounds/ Picnic Shelters/ Park furniture/ Sporting facilities	Damage to assets, impact to community safety/mental health	Financial loss, increased maintenance costs, temporary loss of recreational amenity Reputational risks if it takes too long to repair	Upgrade of park furniture/playgrounds to improve resilience against erosion Capacity to respond for repair of damaged assets is important. Revegetation of areas of moderate foreshore bank erosion. Investigate options for engineered erosion control where necessary	Council
St Georges Basin	Coastal Wetland and Littoral Rainforest Coastal Vulnerability Coastal Environment Coastal Use	Tidal inundation and SLR - Playgrounds/ Picnic Shelters/ Park furniture/ Sporting facilities	Inundation of open space areas/terrestrial vegetation communities	Minor impact if inundation is short duration, but major impact for longer inundation times and high frequency (relevant for increased frequency	Mapping of vegetation communities to assist in planning for migration of vegetation communities with sea level rise to offset other vegetation losses.	Council

Estuary	Coastal Management Area	Risk Category/Asset Type	Risk	Issue/Consequence	Opportunities / Comments	Stakeholder
				of tidal inundation with future sea level rise).		
St Georges Basin	Coastal Wetland and Littoral Rainforest Coastal Vulnerability Coastal Environment Coastal Use	Foreshore erosion - Critical Wastewater	Breakage of sewer infrastructure caused by erosion	Consequence is sewage overflow, with associated environmental, reputational, health and safety risks	Protect, strengthen, or remove vulnerable wastewater assets	Shoalhaven Water/Council`
Swan Lake/ Berrara Creek	Coastal Vulnerability Coastal Use	Tidal Inundation and SLR – Roads (local)	Damage to Swan Lake Bridge from increasing frequency of tidal inundation	Bridge includes major services e.g., water, major consequences if bridge is damaged, and is a key piece of infrastructure as it is the only access to Cudmirrah and Berrara.	Investigate design of The Springs Road and Swan Lake Bridge to be above regular tidal inundation levels considering SLR	Council
Swan Lake/ Berrara Creek	Coastal Vulnerability Coastal Use	Tidal Inundation and SLR – Roads (local)	Closure of The Springs Road at Cudmirrah due to inundation or flood damage	Major impact as road is only access to Cudmirrah and Berrara.	Investigate design of The Springs Road and Swan Lake Bridge to be above regular tidal inundation levels considering SLR	Council
Swan Lake/ Berrara Creek	Coastal Wetland and Littoral Rainforest Coastal Vulnerability	Tidal Inundation and SLR – Water mains/ critical water infrastructure	Inundation of water mains and/or water pumping station at Berrara	Sewer overflow from pumping station, ingress of polluted water into drinking water network, consequence to	Investigate feasibility of upgrade of pumping stations and water supply infrastructure to improve resilience against SLR	Shoalhaven Water/Council

Estuary	Coastal Management Area	Risk Category/Asset Type	Risk	Issue/Consequence	Opportunities / Comments	Stakeholder
	Coastal Environment Coastal Use			human health and water quality, damage to infrastructure, Major impact on water supply system if water supply network is inundated		
Swan Lake/ Berrara Creek	Coastal Wetland and Littoral Rainforest Coastal Vulnerability Coastal Environment Coastal Use	Foreshore Erosion - Playgrounds/ Picnic Shelters/ Park furniture/ Sporting facilities	Vegetation vandalism	Damage to riparian vegetation leading to increased risk of foreshore erosion	Education/awareness, revegetation	Council
Swan Lake/ Berrara Creek	Coastal Vulnerability Coastal Environment Coastal Use	Foreshore Erosion - Playgrounds/ Picnic Shelters/ Park furniture/ Sporting facilities	Environmental impact of watercraft usage and storage at Swan Lake	Damage to riparian vegetation leading to increased risk of foreshore erosion	Review watercraft usage and storage arrangements at Swan Lake and Berrara Creek	Council
Swan Lake/ Berrara Creek	Coastal Wetland and Littoral Rainforest Coastal Vulnerability Coastal Environment Coastal Use	Foreshore Erosion - Playgrounds/ Picnic Shelters/ Park furniture/ Sporting facilities	Loss of or damage to cultural heritage from foreshore erosion	Loss of cultural heritage	Map cultural heritage and plan/implement site specific protection plans	Council, LALC
Swan Lake/ Berrara Creek	Coastal Vulnerability Coastal Environment	Tidal inundation and SLR - Water mains/ critical water infrastructure	Increasing risk of damage to critical infrastructure from erosion or inundation due to sea level rise	Loss of services, impact on human health, impact on	Audit water and sewer infrastructure and upgrade water and sewage pumping	

Estuary	Coastal Management Area	Risk Category/Asset Type	Risk	Issue/Consequence	Opportunities / Comments	Stakeholder
	Coastal Use			water quality and ecology	stations, and pipes to improve resilience against foreshore erosion	
Sussex Inlet	Coastal Vulnerability Coastal Environment Coastal Use	Tidal inundation and SLR - Sewage Pumping Station	Damage to sewage pumping stations from short-term inundation (few hours), sewer overflows with associated water quality and human health impacts	Negligible consequence from short term inundation.	Need to know the height these are built to as raised above ground. Raise pump station elevation to protect electrical components, this would be financially viable if short-term inundation events are frequent. May not be possible for all pumping stations as the system is gravity-fed and house floor levels may need to be raised.	Shoalhaven Water/Council
Sussex Inlet	Coastal Vulnerability Coastal Environment Coastal Use	Tidal inundation and SLR - Sewage Pumping Station	Damage to sewage pumping stations from long-term inundation (two days or longer), sewer overflows with associated water quality and human health impacts	Moderate severity and moderate impact on environment,	Raise pump station elevation where possible to protect electrical components,	Shoalhaven Water/Council
Sussex Inlet	Coastal Vulnerability	Tidal inundation and SLR = Roads - local	Inadequate access to Badgee Lagoon area in an inundation event	Isolation of community and lack of first responder access	Road upgrade planned but with environmental consequences	Council
Sussex Inlet	Coastal Vulnerability	Tidal inundation and SLR = Roads - local	Displacement of people from inundated area for >24 hours	Major impact. Roads cannot be built up. Isolation of community and lack	Mitigation is to close roads and follow emergency management measures	Council, NSW SES

Estuary	Coastal Management Area	Risk Category/Asset Type	Risk	Issue/Consequence	Opportunities / Comments	Stakeholder
				of first responder access	such as signage. Education of community regarding level of risk from inundation	
Sussex Inlet	Coastal Vulnerability	Tidal inundation and SLR = Roads - local	Regular damage to roads with replacement required due to regular road inundation	Isolation of community and lack of first responder access	Investigate possibility of increasing road elevations and providing culverts below roads	Council, NSW SES, DPE-EHG
Sussex Inlet	Coastal Vulnerability	Tidal inundation and SLR = Roads - local	Residents trapped due to inundation,	Isolation of residents due to closure of access roads, injury, or death	Raise access roads and community education on inundation risks	Council, NSW SES, DPE EHG
Sussex Inlet	Coastal Vulnerability	Tidal inundation and SLR - Stormwater infrastructure	Inundation of stormwater infrastructure by tidal flows	Tidal inflow infiltrating stormwater network causing overflow onto streets	Investigate feasibility of installation of tide flaps beneath roads to reduce backflow through stormwater system, ingress of tidal flows into built-up areas.	Shoalhaven Water/Council
Sussex Inlet	Coastal Vulnerability	Tidal inundation and SLR - Water mains/ critical water infrastructure	Inundation of water mains	Not affected by inundation as these are gravity-fed	Assess vulnerability of watermains to ingress from tidal inundation	Shoalhaven Water/Council
Sussex Inlet	Coastal Vulnerability	Tidal inundation and SLR - Playgrounds/ Picnic Shelters/ Park furniture/ Sporting facilities	Inundation of park furniture/facilities/playground	Post-event clean-up, minor consequence.	Potential to build-up asset for protection against inundation to reduce need for cleaning and reduce damage to softfall of playgrounds.	Council

Estuary	Coastal Management Area	Risk Category/Asset Type	Risk	Issue/Consequence	Opportunities / Comments	Stakeholder
Sussex Inlet	Coastal Vulnerability	Foreshore erosion - Seawalls	Loss of land due to inadequate protection provided by seawalls	Damage to infrastructure	Currently built out of inadequate materials within the Sussex Inlet canals. Mitigation: rebuild these to a higher grade, enforce speed restrictions on wake boats, repair existing seawalls along public foreshores	Council
Sussex Inlet	Coastal Wetland and Littoral Rainforest Coastal Vulnerability Coastal Environment Coastal Use	Tidal inundation and SLR - Habitats	Lack of ability for migration of wetlands, saltmarsh, woodlands due to inundation and sea level rise	Loss of biodiversity	Allow this to occur, enact planning controls to ensure that areas where migration of habitats is expected are protected from future development.	Council
Sussex Inlet	Coastal Vulnerability	Tidal inundation and SLR - Private property	Inundation of private property and increasing risk with sea level rise	Damage to infrastructure	Relocate lowest properties, no location identified for relocation of Sussex Inlet CBD. Alternative is to consider new ways to design properties to be above flood levels, controls in place for future developments, enforce compliance with planning controls for new developments	Council, DPE-Planning

Estuary	Coastal Management Area	Risk Category/Asset Type	Risk	Issue/Consequence	Opportunities / Comments	Stakeholder
Sussex Inlet	Coastal vulnerability	Tidal inundation and SLR-Foreshore jetties	Inundation of fixed structures	Damage to foreshore infrastructure, loss of functionality and amenity	Replace fixed jetty structures with floating pontoon structures that can accommodate flooding, Implement MEMA Domestic waterfront structures strategy. Remove non-compliant jetties	Council
Sussex Inlet	Coastal Use	Tidal inundation and SLR - Boat ramps	Short-term inundation of boat ramps	Loss of boat ramp functionality, reduced recreational amenity	Extend boat ramps, redo design at the end of the asset life. Boat ramp is considered viable if able to be used 80% of the time.	Council, TfNSW
Sussex Inlet	Coastal Environment	Foreshore erosion - Natural areas	Erosion of sand dunes in Sussex Inlet	Ecological impact, infilling of navigation channels due to erosion, risk of injury/death	Restrict sand-boarding e.g., at The Haven and Little Manly by, installing signage and vegetating the area.	Council, TfNSW, Booderee National Park
Sussex Inlet	Coastal Vulnerability	Tidal inundation and SLR - Planning	Inundation of infrastructure	Damage to infrastructure, loss of services, isolation of community	Mapping of coastal vulnerability area, coastal hazards mapping update, already flood controls over many inundated properties - ensure the controls align with those in the Floodplain Management Program, inform new buyers of risk - education. Strategy in place of	Council/DPE-EHG

Estuary	Coastal Management Area	Risk Category/Asset Type	Risk	Issue/Consequence	Opportunities / Comments	Stakeholder
					where to relocate properties at risk of inundation elsewhere within the LGA	
Sussex Inlet	Coastal Vulnerability Coastal Environment Coastal Use	Tidal inundation and SLR - Emergency Response	Emergency management of inundation event	Loss of life due to lack of emergency access in an inundation event Loss of welfare support to evacuation centres	Closing of roads in an inundation event, water quality sampling during an inundation event to assess risk to public health and environment.	Council, DPE-EHG, NSW-SES

3.4 Agency Stakeholder Workshop

An additional workshop was held in July 2022 specifically for Government Agency stakeholders. The aim of this workshop was to understand the perspective of Agencies on the risks to the three estuaries, understand if there are any new risks that hadn't been covered from the previous discussions and engagement sessions and explore the most appropriate ways that the risks can be mitigated. The workshop included a short presentation and an interactive session to build on the list of risks in the Register, as well as discussion on risk ratings and management actions.

For this workshop, the main issues/threats were grouped under the same themes that were explored during the community workshops, namely:

- Tidal Inundation and Sea Level Rise
- Navigation and Safety
- Foreshore Erosion
- Cultural and Social
- Ecological Environment
- Water Quality

Representatives from the following Agencies attended the workshop:

- NSW State Emergency Service (NSW SES)
- NSW DPI Crown Lands
- NSW DPE Planning
- NSW DPI Fisheries
- NSW Local Land Services
- NSW EPA
- Transport for NSW Maritime
- NSW DPE Environment and Heritage Group (EHG)
- Shoalhaven City Council

The outcomes, issues and discussion from this workshop are presented in Table 3-4.

Table 3-4 – Outcomes, Issues and Discussion from Agency Workshop, July 2022

Estuary	Coastal Management Area	Risk Category	Risk	Issue/Consequence	Opportunities / Comments	Stakeholder
St Georges Basin/Sussex Inlet Swan Lake and Berrara Creek	Coastal Wetland and Littoral Rainforest Coastal Vulnerability Coastal Environment Coastal Use	Cultural and Social	Lack of community understanding of Indigenous Places and cultural significance	Damage/loss of Aboriginal cultural heritage places.	Mitigations are very dependent on the site and case by case basis. Some sites will benefit from fencing, signage, and restricted access, and in others may be more appropriate to have new access pathways to prevent access to sensitive sites. Community education on connection to country and understanding of intangible aspects and values	Council, DPE, Traditional Owners
St Georges Basin/Sussex Inlet Swan Lake and Berrara Creek	Coastal Wetland and Littoral Rainforest Coastal Vulnerability Coastal Environment Coastal Use	Cultural and Social	Protection of indigenous places from damage due to coastal hazards	Damage/loss of Aboriginal cultural heritage places.	Improved protocols around responding to new indigenous artefacts, such as along estuary foreshores that are becoming uncovered more frequently or to a greater extent.	Council, DPE, Traditional Owners
St Georges Basin/Sussex Inlet Swan Lake and Berrara Creek	Coastal Vulnerability Coastal Environment Coastal Use	Cultural and Social	Protection of indigenous places on private lands from damage due to coastal hazards or private development	Damage to/loss of cultural heritage on private lands due to lack of understanding about how to respond to new indigenous artefacts	Public education around protocols for dealing with discovery of new indigenous artefacts on private lands	Council, DPE, Traditional Owners
St Georges Basin	Coastal Wetland and Littoral Rainforest Coastal Vulnerability	Cultural and Social	Lack of public access to estuary foreshore	Coastal walk around St Georges Basin is disconnected by private land being owned to the water's edge in some locations.	Suggestions for controls - boardwalk above HWM or Strategic acquisition of waterfront corridor to provide access	Council, Crown Lands

Estuary	Coastal Management Area	Risk Category	Risk	Issue/Consequence	Opportunities / Comments	Stakeholder
	Coastal Environment Coastal Use					
St Georges Basin/Sussex Inlet Swan Lake and Berrara Creek	Coastal Wetland and Littoral Rainforest Coastal Vulnerability Coastal Environment Coastal Use	Estuary Health	Climate change – lack of community understanding	Lack of community understanding on impacts from climate change such as increased tidal range, changes to entrance dynamics and changes in macrophyte composition and distribution.	Community education through partnerships with local schools, signage, Council webpage, presentations at community group meetings	Council
St Georges Basin	Coastal Environment Coastal Use	Estuary Health	Seagrass wrack and impact on recreational amenity	Build-up of seagrass wrack along foreshores at St Georges Basin, can be unsightly and odorous. Lack of community understanding regarding role of seagrass wrack in maintaining estuary health,	Controls could be mitigations similar to what has been used in Central Coast. DPI Fisheries could issue permits to maintain on needs basis, such as around boat ramps Need to improve community education on seagrass wrack being a natural process and important habitat - removal with DPI permit only when there are health implications or aesthetics (e.g., Palm Beach for swimming).	DPI Fisheries, Council
St Georges Basin Swan Lake	Coastal Wetland and Littoral Rainforest Coastal Vulnerability Coastal Environment Coastal Use	Estuary Health	Damage to shorebird and Green and Golden Bell Frog habitat from unauthorised access or feral animals	Threats to shorebirds around estuary entrances, foreshores and islands in St Georges Basin as well as Green and Golden Bell Frogs (Swan Lake around STP and potentially within coastal wetlands).	Control may include additional signage to discourage public access to sensitive areas during breeding season, public education around shorebird breeding sites.	Traditional Owners. (St Georges Basin islands), Council

Estuary	Coastal Management Area	Risk Category	Risk	Issue/Consequence	Opportunities / Comments	Stakeholder
Swan Lake St Georges Basin	Coastal Wetland and Littoral Rainforest Coastal Environment Coastal Use	Estuary Health	Perceived risk of depletion of fish stocks by overfishing	Perception of decline in fish stocks e.g., in Swan Lake	Fishing is under regulation by DPI and perceived depletion of fish stock is not supported by data Baseline fish stock surveys in place to be able to monitor trends	DPI Fisheries
Swan Lake	Coastal Wetland and Littoral Rainforest Coastal Environment Coastal Use	Estuary Health	Perceived impact on estuarine ecology from human activities	Perceived decline in Swans & charophytes in Swan Lake due to unknown causes, maybe natural	Monitoring or confirming of existing data	DPE
St Georges Basin/Sussex Inlet Swan Lake and Berrara Creek	Coastal Wetland and Littoral Rainforest Coastal Vulnerability Coastal Environment	Estuary Health	Impact of Climate change/ inundation on coastal vegetation communities	Changes in macrophyte composition and distribution. Lack of suitable areas for these communities to migrate to.	Mapping of vegetation communities and areas where they can migrate to – Develop management strategies to increase resilience - could be weaved into these plans such as rezoning of areas for migration of vegetation communities.	
St Georges Basin/Sussex Inlet Swan Lake and Berrara Creek	Coastal Wetland and Littoral Rainforest Coastal Environment Coastal Use	Estuary Health	Threats to ecology from unauthorised trail bike riding	Trampling of vegetation from motorbikes not keeping to dedicated trails	Provide dedicated areas set aside for this activity where impact on estuarine ecology can be managed	
St Georges Basin/Sussex Inlet	Coastal Wetland and Littoral Rainforest	Estuary Health	Climate change – more frequent extreme events	Climate change resulting in more frequent extreme events (drought, bushfires, and flooding)	Plan for increased frequency of extreme events	

Estuary	Coastal Management Area	Risk Category	Risk	Issue/Consequence	Opportunities / Comments	Stakeholder
Swan Lake and Berrara Creek	Coastal Vulnerability Coastal Environment Coastal Use					
St Georges Basin/Sussex Inlet Swan Lake and Berrara Creek	Coastal Wetland and Littoral Rainforest Coastal Environment Coastal Use	Estuary Health	Ongoing suitability of water quality program	Suitability of water quality program as a tool to identify triggers for action and long-term changes due to climate change	Include controls within the water quality monitoring program to identify actions when issues are identified and revise the program as needed on a regular basis	
Swan Lake	Coastal Wetland and Littoral Rainforest Coastal Vulnerability Coastal Environment Coastal Use	Estuary Health	Entrance management	Key issues for Swan Lake are entrance management and illegal openings	Review of entrance management, Enforcement by Crown Lands and DPE under the NSW *Protection of the Environment Operations Act* (POEO Act) Signage and educational approach, Regular patrolling. Education including targeted of holidaymakers. Refer CMP Entrance Management Review report.	
St Georges Basin/Sussex Inlet Swan Lake and Berrara Creek	Coastal Vulnerability Coastal Use	Tidal inundation and SLR	Emergency management during coastal and tidal inundation events	Isolation during inundation or bushfires such as access to Princes Highway being cut. Challenge is being able to evacuate residents during previous events - evacuation order been released but residents do not want to follow advice.	Community education around emergency management for inundation– communicating risk mapping to communicate risk	SES, Council
St Georges Basin/Sussex Inlet	Coastal Vulnerability Coastal Use	Tidal inundation and SLR	Impact on coastal infrastructure e.g., caravan parks from tidal inundation	Impact of inundation on Crown Lands with third party infrastructure -	Investigate public works to raise land in low lying areas subject to inundation risk but be mindful of	Crown Lands, Council

Estuary	Coastal Management Area	Risk Category	Risk	Issue/Consequence	Opportunities / Comments	Stakeholder
Swan Lake and Berrara Creek					impact on other properties and environment. Investigate relocation of third-party infrastructure on Crown Land where the ongoing inundation risk cannot be managed	
St Georges Basin/Sussex Inlet Swan Lake and Berrara Creek	Coastal Vulnerability Coastal Use	Tidal inundation and SLR	Impact of inundation on services and essential infrastructure	Loss of services e.g., impact on sewer system, leading to increased occurrence of sewer overflows	Mitigation measures to move infrastructure landward, e.g., sewage network and managing sewage overflows Provide linkages in CMP with existing actions in Floodplain Risk Management Plan to avoid duplication Investigate long-term options to deal with increasing risk	Shoalhaven Water/Council
St Georges Basin/Sussex Inlet Swan Lake and Berrara Creek	Coastal Vulnerability Coastal Use	Tidal inundation and SLR	Impact of increases in groundwater elevations on building foundations	Higher water table with sea level rise can reduce capacity of building foundations	Investigate impact of higher water tables on existing and proposed structures e.g., roads, buildings	Council
St Georges Basin/Sussex Inlet Swan Lake and Berrara Creek	Coastal Wetland and Littoral Rainforest Coastal Vulnerability Coastal Environment Coastal Use	Tidal inundation and SLR	Uncertainty in sea level rise projections for future planning	Council's existing sea level rise projections are not in keeping with updated advice provided by the IPCC in the Sixth Assessment Report and may not provide sufficient protection to future development from sea level rise	General action - Council need to revise existing sea level rise projections for future planning based on latest available scientific information (e.g., IPCC AR6 report)	Council

Estuary	Coastal Management Area	Risk Category	Risk	Issue/Consequence	Opportunities / Comments	Stakeholder
St Georges Basin/Sussex Inlet Swan Lake	Coastal Wetland and Littoral Rainforest Coastal Vulnerability Coastal Environment Coastal Use	Navigation and safety	Impact on boating safety due to high demand for registered moorings	Lack of vessel storage and lack of suitable mooring options, long wait list for recreational vessels for new moorings = maintaining balance with access to waterways. Issues seen in all NSW estuarine waterways.	Investigate options for provision of boat storage and locations where moorings can be provided to cater for demand without impacting on the estuarine environment, and in keeping with the NSW MEMS Strategy	DPE, TfNSW (MIDO), NSW Fisheries
St Georges Basin/Sussex Inlet Swan Lake	Coastal Use	Navigation and safety	Boating safety due to increased demand for recreational users	Recent La Nina - changed waterways and access throughout NSW - also there has been a large increase in boating and vessel licences, use etc. following COVID Power boats, canoes and kayaks including = increase conflict between vessels and increased demand for facilities.	Implement improvements to boating infrastructure and safety as required, boating education measures for inexperienced users. Refer to CMP Boating Study for management options.	TfNSW (MIDO), Council
St Georges Basin/Sussex Inlet Swan Lake	Coastal Use	Navigation and safety	Impacts on boating safety due to conflict between users	Statewide focus on the issues raised for conflict between users.	Implementation of new designs and new signage templates that have been used in other places that are working. TfNSW to work with Council to facilitate upgrades or improve on existing boating safety measures	TfNSW (MIDO)
Sussex Inlet	Coastal Environment Coastal Use	Navigation and safety	Difficulty navigating through shallow areas within Sussex Inlet channel	Localised shoaling of navigation channel	Investigate feasibility of localised dredging to improve navigability in accordance with Australian Standards, refer CMP Boating Study report	TfNSW (MIDO)
Sussex Inlet	Coastal Use	Navigation and safety	Missing lights on navigation aids	Impact on boat user safety for night-time boating	Install lights on navigation aids	TfNSW (MIDO)
Sussex Inlet	Coastal Environment Coastal Use	Navigation and safety	Difficulty navigating through the entrance area at Sussex Inlet	Impact on boat user safety	Investigate feasibility of targeted dredging, scale and frequency to improve safety as per CMP Boating	Council, TfNSW

Estuary	Coastal Management Area	Risk Category	Risk	Issue/Consequence	Opportunities / Comments	Stakeholder
					Study report, including potential environmental impact and impacts on seagrass. In 2016, there was targeted dredging to improve navigability near The Haven which was combined with beach nourishment works to reduce the impact of erosion, this lasted for several years. Investigate feasibility of providing ocean access boat ramp as per CMP Boating Study report.	
St Georges Basin/Sussex Inlet Swan Lake	Coastal Use	Navigation and safety	Boating safety and provision of sufficient facilities for users	Lack of available resources and funding to upgrade all boating infrastructure, prioritisation needed	Strategic approach to upgrading boating assets, e.g., upgrade key boating infrastructure and retain other locations for local use only (refer CMP Boating Study for detailed management options)	Council/TfNSW (MIDO)
Sussex Inlet	Coastal Vulnerability Coastal Environment Coastal Use	Foreshore erosion	Erosion/landslips due to natural meandering of channel	Erosion of toe of slope due to meandering of channel, wind waves, lack of vegetation on upper slope	Community education/signage re sandboarding, investigation of erosion protection measures using DPE Decision Support Tool, stabilisation/revegetation of steep unstable slopes	Council, DPE
St Georges Basin/Sussex Inlet	Coastal Vulnerability Coastal Environment Coastal Use	Foreshore erosion	Increased foreshore erosion due to mowing of riparian vegetation	Lack of community awareness on importance of riparian vegetation, mowing and removal of trees within existing no-mow areas has increased since bushfires	Community education, implementation of no-mow areas	Council, DPE
Berrara Creek	Coastal Vulnerability	Foreshore erosion	Erosion/ land slipping and instability in front of cabins near Berrara Creek entrance	Lack of effective foreshore protection measures in this location	Investigate appropriate erosion protection/management measures using DPE Decision Support Tool	LLS, Council

Estuary	Coastal Management Area	Risk Category	Risk	Issue/Consequence	Opportunities / Comments	Stakeholder
St Georges Basin/Sussex Inlet Berrara Creek	Coastal Vulnerability	Foreshore erosion	Lack of effectiveness of foreshore protection structures Landslips from saturated soils in steep terrain	Foreshore protection structures not resilient against increasing severity and frequency of foreshore erosion events with climate change	Investigate appropriate erosion protection/management measures and feasibility of providing continued protection in severely impacted locations	Crown Lands, LLS, Council
St Georges Basin/Sussex Inlet Swan Lake and Berrara Creek	Coastal Vulnerability Coastal Environment Coastal Use	Foreshore erosion	Impact of foreshore protection structures on natural system	Loss of natural character of estuarine system due to installation of inappropriate or unnecessary erosion protection structures.	Want to encourage a natural system where we don't put structures in place unless absolutely necessary, need to understand natural processes and not work against them as intervention may not be appropriate (it will happen again). Understand if there is any consequence of allowing erosion to occur in natural areas	LLS
St Georges Basin/Sussex Inlet Swan Lake and Berrara Creek	Coastal Environment Coastal Use	Water Quality	Urban stormwater runoff	Impact to water quality, ecology from inadequate stormwater runoff treatment. St Georges Basin, Swan Lake and Berrara Creek are all listed as sensitive estuaries within the Illawarra Shoalhaven Regional Plan 2041-meaning more stringent stormwater controls are required.	Installation of Gross Pollutant Traps, water sensitive urban design for new developments, community education	Council
St Georges Basin/Sussex Inlet Swan Lake and Berrara Creek	Coastal Environment Coastal Use	Water Quality	Urban stormwater runoff	Misconceptions on water being treated but does not occur -	need community education programs on drains are for rain etc.	Council

Estuary	Coastal Management Area	Risk Category	Risk	Issue/Consequence	Opportunities / Comments	Stakeholder
St Georges Basin/Sussex Inlet Swan Lake and Berrara Creek	Coastal Environment Coastal Use	Water Quality	Gross pollutants/litter from urban runoff	Impact to water quality, ecology	Installation of Gross Pollutant Traps, community education	Council

4 Risk Assessment

4.1 Requirements under the Coastal Management Act 2016

Section 21 (3) (b) of the *Coastal Management Act* 2016 requires councils to follow a risk management process when preparing their Coastal Management Programs (CMPs) and identifying where management actions are required. This includes identifying and assessing risks and benefits to environmental, social and economic values and evaluating and selecting management actions to address those risks.

In Stage 1, councils prepare a first-pass risk assessment. This is a qualitative risk assessment using available information, to help inform the scope of the CMP.

In Stage 2, councils may refine the risk assessment through a detailed process that incorporates additional information from studies prepared in Stage 2. Additional studies are used to confirm and clarify the nature and significance of risks identified in Stage 1.

In Stage 3, councils identify and evaluate management actions to address the identified risks.

It is critical that stakeholders are engaged throughout this process.

The AS/NZS ISO 31000: Risk Management – Principles and Guidelines outlines a process for risk management and defines many of the common terms associated with risk management practice.

The Risk Assessment documented in this report has been undertaken in accordance with the above process, identified in Part B of the NSW Coastal Management Manual (OEH, 2018). The purpose of this Risk Assessment, as outlined in the Manual, is to highlight priorities for management actions while recognising the uncertainties associated with natural systems and future scenarios.

Risk can be quantified as the integration of probability (i.e., frequency analysis of the hazard) and consequences. The Risk Assessment documented herein has taken into account both the "likelihood" (or probability) of the hazard occurring and the "consequence" to define the level of risk.

The steps involved in the risk management process are outlined in Figure 4-1 and Figure 4-2.

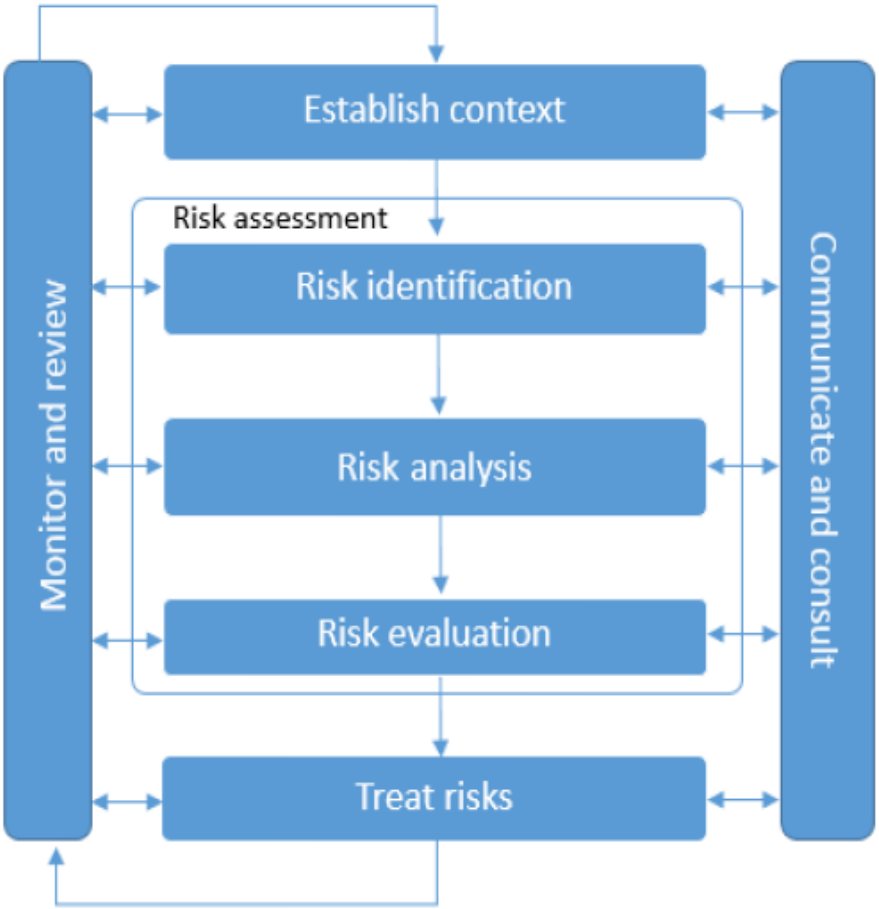

Figure 4-1 – Risk Management Process (AS/NZS ISO 31000: Risk Management – Principles and Guidelines, as documented in the NSW Coastal Management Manual 2018)

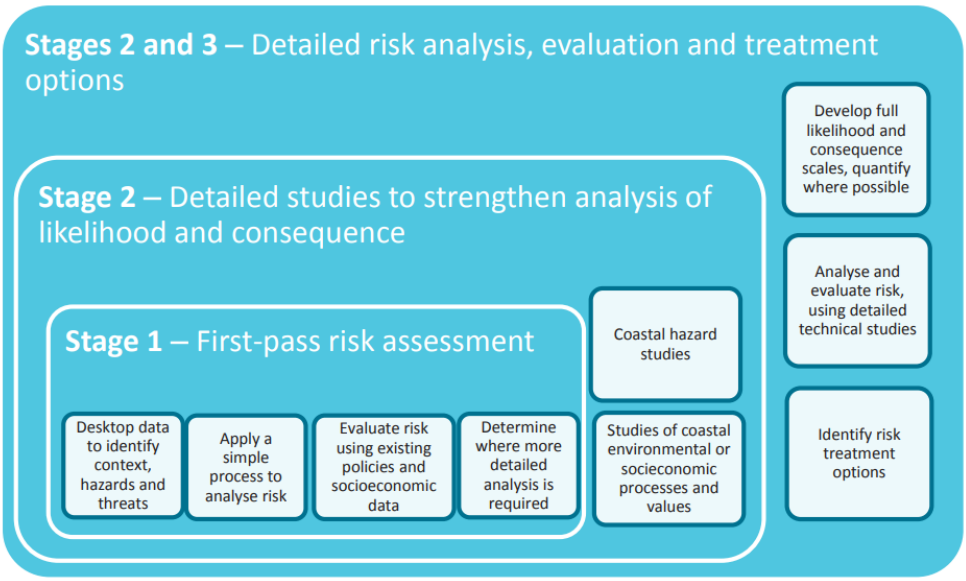

Figure 4-2 – Detailed Risk Assessment Process (from NSW Coastal Management Manual 2018)

4.2 Establish Context

The *State Environment Planning Policy (Resilience and Hazards) 2021 (*the SEPP), commenced on 1 March 2022. It supports implementation of the management objectives set out in the Coastal Management Act 2016. It consolidates three SEPPs into one planning policy: SEPP (Coastal Management 2018), SEPP 33 (Hazardous and Offensive Development) and SEPP 55 (Remediation of Land). There were no changes to Coastal Management Areas or provisions that were previously defined in the Coastal Management SEPP.

The hierarchy of coastal management areas as referred to in the SEPP (Resilience and Hazards) are identified below, from highest to lowest priority:

i) **coastal wetland and littoral rainforest area** (CWLRA) - areas which display the characteristics of coastal wetlands or littoral rainforests that were previously protected by SEPP 14 and SEPP 26. Development controls for the mapped CWLRA aim to continue existing protection for these important ecological communities.

ii) **coastal vulnerability area** (CVA) - areas subject to coastal hazards such as coastal erosion and tidal inundation. Development controls for the CVA are concerned with managing risk to human life, infrastructure, and public and private property that may be impacted by coastal hazards and ensuring that we do not create legacy issues for future generations to deal with.

iii) **coastal environment area** (CEA) - areas that are characterised by natural coastal features such as beaches, rock platforms, coastal lakes and lagoons and undeveloped headlands. Marine and estuarine waters are also included. Development controls for the CEA aim to protect and improve natural coastal features, coastal waters and environmental values for places such as beaches, dunes, surf zone and undeveloped headlands.

iv) **coastal use area** - land adjacent to coastal waters, estuaries and coastal lakes and lagoons where impacts of development on the use and enjoyment of the beaches, foreshores, dunes, estuaries, coastal lakes and lagoons, and the ocean, need to be considered. Development controls for CUA are concerned with ensuring appropriate urban development for coastal areas, considering urban design issues such as the bulk, scale and size of proposed development, water sensitive urban design, and preventing adverse impacts on scenic qualities, visual amenity and Aboriginal cultural heritage.

Each of the above areas has outcome-oriented management objectives so that councils can apply appropriate management tools and development controls.

4.2.1 Coastal Wetland and Littoral Rainforest Area

There are a number of coastal wetlands and littoral rainforest areas mapped throughout the Shoalhaven in the SEPP (Resilience and Hazards) – these are presented on the Department of Planning's website at https://www.planning.nsw.gov.au/Policy-and-Legislation/Coastal-management. A summary is also provided in the Synthesis of Knowledge report, also prepared as part of the CMP (Advisian 2022a).

The Coastal Management Act specifies that the management objectives for this area are:

- to protect coastal wetlands and littoral rainforests in their natural state, including their biological diversity and ecosystem integrity
- to promote the rehabilitation and restoration of degraded coastal wetlands and littoral rainforests
- to improve the resilience of coastal wetlands and littoral rainforests to the impacts of climate change, including opportunities for migration
- to support the social and cultural values of coastal wetlands and littoral rainforest
- to promote the objectives of State policies and programs for wetlands or littoral rainforest management.

Coastal wetlands include:

- Mangroves
- Saltmarshes
- Melaleuca forests
- Casuarina forests
- Sedgelands
- Brackish and freshwater swamps
- Wet meadows.

Littoral rainforests are mapped in the SEPP based on their dominant vegetation, from data created by the National Parks and Wildlife Service in 1986 that was validated with ground truthing.

Harming or removing native or marine vegetation, draining the land, constructing a levee, environmental protection works and all other development within a mapped coastal wetlands and littoral rainforests area requires consent, and is generally designated development, meaning that an environmental impact statement must be prepared to support any development application.

The detailed risk assessment for these areas has considered the overall objectives of the Coastal Wetland and Littoral Rainforest area, based on the following factors:

- Existing development and infrastructure in or within proximity of the coastal wetland or littoral rainforest area (defined as a 100 m buffer area)
- Zoning of land in or within proximity of this area as shown in Council's LEP
- Known issues and risks affecting the wetland or littoral rainforest from the outcomes of existing studies, community consultation and estuary management plans.

4.2.2 Coastal Vulnerability Area

The Coastal Vulnerability area has not been mapped within the SEPP (Resilience and Hazards). However, coastal hazard studies for foreshore erosion, coastal inundation and tidal inundation have been completed within each estuary as part of Stage 2. The results of these studies will be used to inform the development of a coastal vulnerability area map and a future planning proposal.

The Coastal Vulnerability Area is that area identified as being affected by one or more of the following coastal hazards:

- Beach erosion
- Shoreline recession
- Coastal lake or watercourse instability
- Coastal inundation
- Coastal cliff or slope instability
- Tidal inundation
- Erosion and inundation of foreshores caused by interactions of tidal waters, waves and catchment floodwaters.

The management objectives for this area are to:

- ensure public safety and prevent risk to human life
- mitigate current and future risks from coastal hazards, taking into account the effects of coastal processes and climate change
- maintain the presence of beaches, dunes and the natural features of foreshores, taking into account the beach system operating at the relevant place
- maintain public access, amenity and use of beaches and foreshores
- encourage land use that reduces exposure to risks from coastal hazards, including through siting, design, construction and operational decisions
- adopt coastal management strategies that reduce exposure to coastal hazards, in the first instance by restoring and enhancing natural defences such as coastal dunes, vegetation and wetlands; and, if that is not sufficient, by taking other action to:
    - avoid significant degradation of biological diversity and ecosystem integrity
    - avoid significant degradation or disruption of ecological, biophysical, geological and geomorphological coastal processes
    - avoid significant degradation of or disruption to beach and foreshore amenity and social and cultural values
    - avoid adverse impacts on adjoining land, resources or assets
    - provide for the restoration of the beach or adjacent land if any increased erosion is caused by actions to reduce exposure to coastal hazards
- prioritise actions that support the continued functionality of essential infrastructure during and immediately after a coastal hazard emergency
- improve the resilience of coastal development and communities by improving adaptive capacity and reducing reliance on emergency responses.

For the detailed risk assessment, the above issues are presented within a risk management framework, based on the outcomes of existing studies, additional studies undertaken as part of the CMP and known information from the existing Estuary Management Plans and CZMP.

4.2.3 Coastal Environment Area

The coastal environment area identifies the environmental features of the coastal zone, such as state waters, estuaries, coastal lakes and coastal lagoons. It also includes land adjoining those features including beaches, dunes, coastal headlands and rock platforms.

The Coastal Environment Area has been mapped within the SEPP – this area includes:

- Coastal Lakes plus a 500-metre landward component
- For coastal lakes defined as sensitive, the lake and its entire catchment area is included in this zone.
- Estuaries mapped to one kilometer beyond the Highest Astronomical Tide recorded in the estuary, plus a 500-metre landward component
- NSW Coastal Waters from the open ocean boundary of local government areas to the NSW state water boundary
- A 250-metre landward extent from the open ocean local government boundary to cover beaches, dunes, headlands, rock platforms and foreshores.

The objectives for this area under the Act are:

- to protect and enhance the coastal environmental values and natural processes of coastal waters, estuaries, coastal lakes and coastal lagoons
- enhance natural character, scenic value, biological diversity and ecosystem integrity
- to reduce threats to, and improve the resilience of, coastal waters, estuaries, coastal lakes and coastal lagoons, including in response to climate change
- to maintain and improve water quality and estuary health
- to support the social and cultural values of coastal waters, estuaries, coastal lakes and coastal lagoons
- to maintain the presence of beaches, dunes and the natural features of foreshores, taking into account the beach system
- to maintain and, where practicable, improve public access, amenity and use of beaches, foreshores, headlands and rock platforms.

Controls identify the need to minimise impacts on the environment, and the consent authority must be satisfied that any proposed development within this area avoids, minimises or manages impacts on:

- the integrity and resilience of the biophysical, hydrological and ecological environment.
- coastal environmental values and natural coastal processes
- the water quality of the marine estate, and has particular regard to cumulative impacts on sensitive coastal lakes
- marine vegetation, native vegetation and fauna and their habitats, undeveloped headlands and rock platforms
- existing public open space and safe access to and along the foreshore, beach, headland or rock platform for members of the public, including people with a disability

- Aboriginal cultural heritage, practices and places
- the use of the surf zone.

The detailed risk assessment for the Coastal Environment Area has considered the overall objectives above, based on the following factors:

- Existing development and infrastructure in the Coastal Environment Area
- Zoning of land in or within proximity of this area as shown in Council's LEP
- Known issues and risks affecting these areas from the outcomes of existing studies, community consultation and estuary management plans.

4.2.4 Coastal Use Area

The coastal use area is land adjacent to coastal waters, estuaries, coastal lakes and lagoons, where development is or may be carried out and impacts of development on the scenic and cultural values and use and enjoyment of the beaches, foreshores, dunes, headlands, rock platforms, estuaries, lakes and the ocean need to be considered.

The management objectives for this area within the Act are to accommodate both urbanised and natural stretches of coastline and to protect and enhance the scenic, social and cultural values of the coast by ensuring that:

- the type, bulk, scale and size of development is appropriate for the location and natural scenic quality of the coast
- adverse impacts on cultural and built environment heritage are avoided or mitigated
- urban design, including water sensitive urban design, is supported and incorporated into development activities
- adequate public open space is provided, including for recreational activities and associated infrastructure
- the use of the surf zone is considered.

In regional areas, the Coastal Use Area is mapped as a zone extending 500 m inland from the water-side boundary of a local government area.

Development proposals in this area must address the following:

- existing safe access to and along a foreshore, beach, headland or rock platform, including access for people with a disability
- overshadowing, wind funnelling and loss of views from public places to foreshores
- the visual amenity and scenic nature of the coast, including headlands
- Aboriginal cultural heritage, practices and places
- cultural and built environment heritage.

The detailed risk assessment for the Coastal Use Area has considered the management objectives above, based on the following factors:

- Existing development and infrastructure in the Coastal Environment Area

- Zoning of land in or within proximity of this area as shown in Council's LEP
- Known issues and risks affecting these areas from the outcomes of existing studies, community consultation and estuary management plans.

4.3 Likelihood Scale

The detailed risk assessment is being carried out to assess risks to natural and built assets for St. Georges Basin/Sussex Inlet, Swan Lake and Berrara Creek, to inform Stage 3 of the CMP process where management actions will be developed. The likelihood of risks occurring has been defined using a combined qualitative and quantitative approach, depending on the risk.

Foreshore inundation risks have been identified in a probabilistic sense and probabilities are ascribed to the risk, as described in the Tidal and Coastal Inundation Study (Advisian 2022b). Coastal Inundation mapping has been carried out for each estuary, for the 1% Annual Exceedance Probability (AEP) and 5% Annual Exceedance Probability events, and considering future sea level rise due to climate change. Tidal inundation modelling has been carried out also, which represents inundation that can occur at high frequencies, such as above Mean High Water Springs tidal levels at least twice per month, with the frequency of this inundation expected to increase in the future with sea level rise.

Other mapping, such as comparative estuarine vegetation mapping over time, has been used to make predictive informed assumptions on risks to estuarine and aquatic vegetation in relation to climate change or changes to water quality in the coastal environment as well as the coastal wetland/littoral rainforest management areas. Data on waterway usage and anecdotal information from community consultation and surveys was also used to identify the likelihood for risks that impact the coastal use area.

The likelihood scale adopted for this risk assessment is presented in Table 4-1. The likelihood descriptors are the same as those described in Shoalhaven City Council's Risk Assessment Procedure (PRD21/140) and accord with those presented in the NSW Coastal Management Manual (2018).

Table 4-1 - Likelihood Scale for Coastal Risk Assessment (Shoalhaven City Council, 2021)

Likelihood Descriptor
Almost certain The event is expected to occur in normal circumstances, several times a year
Likely This event may occur at sometime during the year, once or twice a year
Possible Might occur, a few recorded incidents in the locality and some anecdotal evidence in the community; some opportunity, reason or means to occur. The event may occur sometime. Some previous event history, once every 2 to 5 years.
Unlikely The event could occur in some circumstances, but would not be expected; could occur once every 6 to 9 years.
Rare The event may occur but only in exceptional circumstances, once every 10 or more years.

4.4 Consequence Scale

The consequence scale for the detailed risk assessment takes into account financial, governance, environmental, health and safety and beach amenity consequences. Some consequences in the coastal zone can be described quantitatively (*i.e.*, assigned a dollar value), but with the currently available information and methodologies, many consequences can only be described qualitatively.

For the risk assessment developed in this report, the risks have been categorised in terms of the six themes presented at the community engagement sessions:

- Tidal Inundation and Sea Level Rise
- Navigation and Safety
- Foreshore Erosion
- Cultural and Social
- Ecological Environment
- Water Quality

Consequence has been rated based on the definitions provided in Council's Risk Management Procedure (Shoalhaven City Council 2021), with consequence scale ranging from Insignificant to Severe. The definitions of consequence as it relates to Council's Consequence scale matrix is presented in Table 4-3.

For **infrastructure** related risks, the consequence scale takes into account also the vulnerability of the asset or landuse associated with the asset. The NSW Coastal Management Manual (2018) provides an example landuse vulnerability classification for areas within the coastal zone and is provided in Table 4-2 together with local examples. Based on Table 4-2 assets in the hazard areas

that are among the most vulnerable therefore would be assigned a higher risk rating (*e.g.*, housing, essential sewerage or road infrastructure) than those located in the same areas but are considered to be compatible (*e.g.*, coastal accessways, foreshore reserves).

Table 4-2 – Vulnerability of assets/landuse (after NSW Coastal Management Manual, 2018)

Classification	Land use
Most vulnerable uses	Hospitals, police stations, command centres, ambulance stations and telecommunications used for disaster response, isolated dwellings, housing (including group homes) and residential care facilities for seniors and disabled persons, prisons, childcare facilities and accommodation associated with an educational establishment, mobile homes used for permanent residential purposes.
Highly vulnerable uses	Multi-dwelling housing, dual occupancy, residential accommodation, residential flat building, backpackers' accommodation, boarding house, hostel, hotel accommodation, moveable dwelling, caravan park, serviced apartment, tourist and visitor accommodation
Less vulnerable uses	Commercial development, shops, financial and professional services, restaurants and cafes, hotels, offices, general industry, agriculture and forestry, waste treatment, short-term caravans and camping (subject to early warning and evacuation plans).
Essential Infrastructure	Essential transport and utility infrastructure, power stations, primary substations, sewage treatment plants and water treatment works.
Compatible uses	Coastal hazard and flood mitigation structures, water supply infrastructure and pumping stations, docks, marinas and wharves, shipbuilding, water-based recreation, surf clubs, amenity and open space, nature conservation and biodiversity, outdoor sports and recreation facilities and changing rooms.

For **Environmental** risks, the consequence relates to issues that have a potential to lead to an impact on the environment or a negative environmental outcome, or where this is known to be already occurring (for example, poor water quality affecting estuary ecology). For **Safety**, the risks relate to personal safety with the consequences of that risk being injury or death.

Table 4-3 – Consequence Scale Adopted for the Risk Assessment (adapted from Shoalhaven City Council 2021)

Category	Negligible 1	Minor 2	Moderate 3	Major 4	Severe 5
People (staff, contractors, volunteers, and the community)	• Minor injury with no treatment required • Isolated, internal or minimal impact on staff morale or performance • Little or no disruption to community	• Minor injury with first aid treatment required • Contained impact on staff morale or performance of short-term significance • Some displacement of people (<24hrs) or some minor disruption to community (<24 hrs.)	• Medical attendance, time off work • Significant impact on staff morale or performance of medium-term significance • Localised displacement of people; normal community functioning with some medium-term inconvenience; localised damage rectified by routine arrangements	• Serious illness or injury • Major impact on staff morale or performance with long term significance • Large number displaced for >24hrs; external resources required for personal support; significant damage that requires external resources	• Fatality or permanent disability • Extensive impact or organisational morale or performance • General and widespread displacement for extended duration; community unable to function without significant support
Environment	• Contained, localised • Reversible impact.	• Contained, small scale • Reversible impact.	• Contained, widespread • Reversible impact.	• Uncontained, widespread • Reversible impact.	• Uncontained • Irreversible impact.
Financial	• Negligible financial loss (up to 1% of Council's budget) • No impact on program or business operation	• Minor financial loss (up to 3% of Council's budget) • Minimal impact on business operation	• Significant financial loss (up to10% of Council's budget) • Considerable impact on business operation	• Major financial loss (up to 20% of Council's budget) • Severe impact on business operation	• Extensive financial loss (>20% of budget) • Long term consequences for operations.
Property & Infrastructure	• Isolated or minimal loss • short term impact • repairable through normal operations	• Minor loss with limited downtime • Short term impact • Mostly repairable through normal operations	• Significant loss with temporary disruption of services • Medium term impact on organisation	• Critical loss or event requiring replacement of property or infrastructure • Long term impact on organisation	• Disaster with extensive loss and long-term consequences • Threat to viability of service or operation
Reputation	• Public awareness may exist but there is little public concern • Resolved by day-to-day management process	• Attention from local media, and/or heightened local concern	• Significant and sustained adverse local media attention • Serious concerns expressed and large decrease in support from the public	• Significant adverse national media attention • Significant decrease in public support • Damage to reputation at a national level.	• Subject of sustained adverse publicity in multiple media. • Significant long-term detrimental effect on business areas.

4.5 Existing Risk Management Measures

Existing risk mitigation measures were included in determining the pre-treatment risk rating for each of the identified risks or issues. A root cause of each of the identified risks has been identified in the risk register also, to assist in defining potential management actions in subsequent phases of the CMP development.

The existing management or mitigation measures for the risks are identified in the risk register, and the estimated level of risk is that which currently exists based on the existing management regime.

The risk register allows for the development of additional management actions that can be implemented to reduce the level of residual risk and can be carried over to subsequent stages of the CMP. The Register is intended to be used as a living document that can act as a tool for the development of management actions for the CMP and a method for ongoing assessment of the effectiveness of the management actions.

Additional management measures have been developed in consultation with stakeholders in the Agency and Council risk workshops and included in the Register, together with a task owner. These measures are subject to further development as the CMP process progresses into Stage 3.

5 Risk Evaluation

5.1 Risk Methodology

The risk for each issue within the coastal zone was evaluated by applying a risk matrix combining the "likelihood" and "consequence" ratings discussed in Section 4.

This process has enabled a qualitative risk rating to be applied to each risk.

The risk matrix applied to quantify the risk to each asset is provided in Table 5-1.

Table 5-1 – Risk Matrix applied to evaluate risk

Risk Rating Matrix					
Likelihood	**Consequence**				
	Insignificant 1	Minor 2	Moderate 3	Major 4	Catastrophic 5
Almost Certain 5	MODERATE	HIGH	HIGH	EXTREME	EXTREME
Likely 4	LOW	MODERATE	HIGH	HIGH	EXTREME
Possible 3	LOW	MODERATE	HIGH	HIGH	HIGH
Unlikely 2	LOW	LOW	MODERATE	MODERATE	HIGH
Rare 1	LOW	LOW	LOW	LOW	MODERATE

5.2 Results

The results of the risk assessment for the St. Georges Basin/Sussex Inlet, Swan Lake and Berrara Creek estuaries are summarised below, with the risks identified as having a "HIGH" or "EXTREME" rating based on the existing controls listed in Table 5-2 to Table 5-5 for the St Georges Basin, Sussex Inlet, Swan Lake, Berrara Creek areas respectively, and in Table 5-6 for the risks that apply to all three estuaries.

The full risk register, which identifies all the issues including those with a "Moderate" and "Low" risk rating is provided in Appendix A, which also provides the Asset Risk Register for asset classes affected by coastal vulnerability, including foreshore erosion, coastal inundation and tidal inundation.

Many of the key risks are common across several areas and some are occurring at specific locations rather than throughout an entire estuary. These risks generally have existing management controls in place or management controls that can be readily implemented, but an assessment has been made of what further management actions could be implemented to reduce these risks and to monitor the effectiveness of the actions. Some of the identified risks have varying root causes – for example, poor water quality could be the result of agricultural or urban runoff, or poor water quality may be exacerbated by sedimentation from bank erosion.

Table 5-2 – Identified High or Extreme Risks and Root Causes at St Georges Basin

KEY: Likelihood: AC = Almost Certain, L = Likely. P = Possible, U = Unlikely, R = Rare
Consequence: C = Catastrophic, Maj = Major, Mod = Moderate, Min = Minor, I = Insignificant

							Present Day					20 years					50 years					100 years					
Estuary	Coastal Management Area	Risk Category	Risk Description	Root Cause	Consequence	Existing Controls	Lkihood (1-5)		Consq.(1-5)		Pre Treatment Rating		Lkihood (1-5)		Consq.(1-5)		Pre Treatment Rating		Lkihood (1-5)		Consq.(1-5)		Pre Treatment Rating		Lkihood (1-5)		Consq.(1-5)		Pre Treatment Rating		Potential Management Actions
St. Georges Basin	Coastal Wetlands and Littoral Rainforest	Water Quality	Poor water quality inputs from tributaries (nutrients and suspended solids, DO and turbidity).	Pollution inputs into tributaries, including sediment pollution into estuary from development activities	Impacts on estuary ecology	Zoning/development controls within catchment area, control of urban runoff, community education, water quality monitoring program	5	AC	2	Min	10	High	5	AC	2	Min	10	High	5	AC	2	Min	10	High	5	AC	2	Min	10	High	Revised Water Quality Monitoring Program (including event monitoring). Review and where necessary upgrade or retrofit erosion and sediment controls. Identification of key development sites as root cause and more stringent regulation. Continue to apply Neutral or Beneficial Effect (NorBE) on water quality for all greenfield development proposed in the catchments of the St Georges Basin, Swan Lake and Berrara Creek as a minimum standard. Application of the risk-based framework for stormwater management to be considered into the future, particularly where it demonstrates a higher level of water quality mitigation than NorBE, likely to be more relevant for infill development and development of already cleared land.
St. Georges Basin	Coastal Environment	Ecological Environment	Damage to estuarine vegetation, seagrass beds	Impact of jetties / waterfront structures on seagrass	Damage to seagrasses	Boating restrictions, NSW DPI mapping, vessel speed limits	5	AC	3	Mod	15	High	5	AC	3	Mod	15	High	5	AC	3	Mod	15	High	5	AC	3	Mod	15	High	Restricted vessel access to known/mapped seagrass areas, more stringent regulation on vessel speed limits, public education
St. Georges Basin	Coastal Environment	Ecological Environment	Threats to shorebirds around foreshore and islands in St Georges Basin	Disturbance of habitat and shorebird nesting due to public access and domestic/feral animals	Loss of shorebird habitat and changes to estuary ecology.	Access to islands managed by Jerrinja tribe. South Coast Shorebird Recovery Program	3	P	4	Maj	12	High	3	P	4	Maj	12	High	3	P	4	Maj	12	High	3	P	4	Maj	12	High	Community education, signage, restoration of disturbed habitat, feral animal control. Continuation of the South Coast Shorebird Recovery Program within St Georges Basin
St. Georges Basin	Coastal Environment	Water Quality	Impacts on estuary health	Climate change resulting in more frequent extreme events (drought, bushfires, flooding)	Impacts on water quality and estuary ecology	Water quality and estuary health monitoring program by Council DPE-EHG state-wide estuary health monitoring	3	P	4	Maj	12	High	3	P	4	Maj	12	High	4	L	4	Maj	16	High	5	AC	4	Maj	20	Extreme	Revised Council water quality monitoring program to include assessment of future impacts of drought, bushfires, flooding Report on the results of Councils WQ monitoring and any impacts on estuary health undertaken following the 2019-20 Bushfires. Continued monitoring of estuary health by DPE-EHG
St. Georges Basin	Coastal Environment	Ecological Environment	Damage to foreshore vegetation, saltmarsh	Illegal clearing, introduced animals (e.g. dogs). Illegal clearing is a problem especially in Tomerong Creek catchment. Mowing/damage to no-mow zones due to perceived risk following bushfires	Loss of habitat and changes to estuary ecology. Decreased buffering capacity.	Education	3	P	3	Mod	9	High	3	P	3	Mod	9	High	3	P	3	Mod	9	High	3	P	3	Mod	9	High	Stringent regulation on illegal clearing, replanting of targeted areas, better protection of significant ecological zones and maintaining no-mow zones, wildlife corridors and habitats. Specific surveys to map important ecological areas (e.g. Stingray habitat)
St. Georges Basin	Coastal Vulnerability	Tidal Inundation and Sea Level Rise	Flooding	Sea Level Rises and changes to estuary hydraulics	Impact on foreshore infrastructure, access	Development controls	4	L	3	Mod	12	High	4	L	4	Maj	16	High	4	L	5	C	20	Extreme	5	AC	5	C	25	Extreme	Improved stormwater infrastructure to account for increased runoff during inundation events. Adaptation planning and potential moving of at risk infrastructure / redesign and siting of access points
St. Georges Basin	Coastal Vulnerability	Foreshore Erosion	Foreshore Erosion	Vessel waves, wind waves, high water levels, sea level rise. Erosion from boat wakes around boat ramps, including specifically around Boathaven Boat Ramp.	Damage to foreshore infrastructure and foreshore vegetation	Foreshore protection structures, development controls, vessel speed limits	4	L	3	Mod	12	High	4	L	3	Mod	12	High	4	L	3	Mod	12	High	4	L	3	Mod	12	High	Maintenance of structures as required, more stringent regulation on vessel speed limits, apply recommended actions from foreshore erosion Decision Support Tool
St. Georges Basin	Coastal Use	Navigation and Safety	Conflict between users of powered and non-powered craft	High demand for recreational use, increased demand due to COVID	Threat to recreational amenity	Provision of dedicated facilities for powered and non-powered vessel users	3	P	3	Mod	9	High	3	P	3	Mod	9	High	4	L	3	Mod	12	High	4	L	3	Mod	12	High	Community education for boaters/kayakers regarding water safety
St. Georges Basin	Coastal Use	Cultural and Social	Lack of public foreshore access	High private ownership of foreshore areas	Reduced foreshore access	Provision of additional foreshore recreation reserves	3	P	3	Mod	9	High	3	P	3	Mod	9	High	3	P	3	Mod	9	High	3	P	3	Mod	9	High	Explore opportunities to connect missing links in foreshore walk around St Georges Basin by provision of boardwalk below HWM, strategic acquisition, need for access to easements for utilities etc.
St. Georges Basin	Coastal Use	Navigation and Safety	Lack of public boating facilities	High demand for recreational use	Crowding at existing facilities	Routine maintenance of existing boating facilities	3	P	3	Mod	9	High	4	L	3	Mod	12	High	4	L	3	Mod	12	High	4	L	3	Mod	12	High	Demand study and upgrade of existing boating facilities if needed

KEY: Likelihood: AC = Almost Certain, L = Likely. P = Possible, U = Unlikely, R = Rare
Consequence: C = Catastrophic, Maj = Major, Mod = Moderate, Min = Minor, I = Insignificant

							Present Day					20 years					50 years					100 years					
Estuary	Coastal Management Area	Risk Category	Risk Description	Root Cause	Consequence	Existing Controls	Lkihood (1-5)		Consq.(1-5)		Pre Treatment Rating		Lkihood (1-5)		Consq.(1-5)		Pre Treatment Rating		Lkihood (1-5)		Consq.(1-5)		Pre Treatment Rating		Lkihood (1-5)		Consq.(1-5)		Pre Treatment Rating		Potential Management Actions
St. Georges Basin	Coastal Vulnerability	Tidal Inundation and Sea Level Rise	Isolation during inundation or bushfires such as access to Princes Highway being cut.	Sea Level Rise and inundation	Damage to infrastructure, loss of community access, impact on tourists	Development controls, monitoring, flood warning system and flood evacuation procedures	2	U	4	Maj	8	Mod	3	P	4	Maj	12	High	4	L	4	Maj	16	High	4	L	4	Maj	16	High	Community education on risk of not following evacuation orders, community education to enhance understanding of inundation risk, works to raise key evacuation routes above inundation levels Implementation of findings of the St Georges Basin Floodplain Risk Management Study and Plan (including emergency management aspects) Update of the Shoalhaven City Local Floodplan with the results of most recent modelling and studies
St. Georges Basin	Coastal Vulnerability	Tidal Inundation and Sea Level Rise	Tidal and Coastal Inundation of caravan parks on Crown Land	Sea Level Rise and inundation	Damage to infrastructure, loss of critical services, injury or death	Measures developed in Climate change and inundation Adaptation Report	3	P	4	Maj	12	High	3	P	4	Maj	12	High	4	L	4	Maj	16	High	4	L	4	Maj	16	High	Investigate tidal and coastal inundation risk to two low-lying caravan parks on Crown Land in St Georges Basin and work with low-lying caravan parks to update their emergency response plans to prepare for and respond to coastal hazards in the short term, and adapt to changing tidal and coastal inundation in the longer term. Implementation of findings of the St Georges Basin Floodplain Risk Management Study and Plan (including emergency management aspects)
St. Georges Basin	Coastal Environment	Ecological Environment	Impacts on estuary health from unauthorised dirt-bike and 4WD access	Access by 4WD and dirt bikes to sensitive estuarine areas	Trampling of sensitive vegetation, erosion	4WD/motorbike access management	3	P	3	Mod	9	High	3	P	3	Mod	9	High	3	P	3	Mod	9	High	3	P	3	Mod	9	High	Community education/signage, enforcement in areas where access not permitted

Table 5-3 – Identified High or Extreme Risks and Root Causes at Sussex Inlet

KEY: Likelihood: AC = Almost Certain, L = Likely. P = Possible, U = Unlikely, R = Rare
Consequence: C = Catastrophic, Maj = Major, Mod = Moderate, Min = Minor, I = Insignificant

							Present Day						20 years						50 years						100 years					
Estuary	**Coastal Management Area**	**Risk Category**	**Risk Description**	**Root Cause**	**Consequence**	**Existing Controls**	**Lkihood (1-5)**		**Consq.(1-5)**		**Pre Treatment Rating**		**Lkihood (1-5)**		**Consq.(1-5)**		**Pre Treatment Rating**		**Lkihood (1-5)**		**Consq.(1-5)**		**Pre Treatment Rating**		**Lkihood (1-5)**		**Consq.(1-5)**		**Pre Treatment Rating**		**Potential Management Actions**
Sussex Inlet	Coastal Use	Navigation and Safety	Lack of vessel storage and no mooring options, long wait list for recreational vessels for new moorings	High demand for recreational boating	Reduced recreational amenity, economic opportunity cost	Mooring licences for registered moorings	4	L	3	Mod	12	High	4	L	3	Mod	12	High	4	L	3	Mod	12	High	4	L	3	Mod	12	High	Identify locations for vessel storage and potential to accommodate new registered moorings at alternative sites outside of the estuary. Support the implementation of the MEMS Domestic Foreshore Structure Strategy through the promotion of and reference to the strategy though the provision of planning advice and via Council's website
Sussex Inlet	Coastal Use	Foreshore Erosion	Foreshore Erosion	Erosion from tidal flows and natural meandering of channel, lack of riparian vegetation or failing bank protection ad hoc public access to waterway from foreshore	Sand entering/ moving within estuary channel causing hazard to navigation, damage to foreshore infrastructure and foreshore vegetation, loss of foreshore recreation area and loss of access to waterway	Ad-hoc foreshore protection structures, vessel speed limits, channel markers	4	L	4	Maj	16	High	4	L	4	Maj	16	High	4	L	4	Maj	16	High	4	L	4	Maj	16	High	Develop appropriate foreshore management actions or apply recommended actions from foreshore erosion Decision Support Tool. Maintenance of structures where these have been deemed to be effective, more stringent regulation on vessel speed limits. Altered location of channel markers as channel position changes
Sussex Inlet	Coastal Environment	Ecological Environment	Damage to seagrass beds at entrance to St Georges Basin	Damage to seagrass around some existing boating facilities (jetties, pontoons and boat ramps - boat moorings and damage caused by boats in shallow areas).	Damage to seagrasses	Public education, provision of dedicated anchorage area	3	P	3	Mod	9	High	3	P	3	Mod	9	High	3	P	3	Mod	9	High	3	P	3	Mod	9	High	Implementation of the Domestic Waterfront Structures Strategy for St Georges Basin and Sussex Inlet to reduce impacts to seagrass in the future
Sussex Inlet	Coastal Vulnerability	Tidal Inundation and Sea Level Rise	Isolation during inundation or bushfires such as access to Princes Highway being cut.	Sea Level Rise and inundation	Damage to infrastructure, loss of community access, impact on tourists	Development controls, monitoring, flood warning and flood evacuation procedures	3	P	4	Maj	12	High	3	P	4	Maj	12	High	4	L	4	Maj	16	High	5	AC	4	Maj	20	Extreme	Implementation of findings of the St Georges Basin Floodplain Risk Management Study and Plan (including emergency management aspects). Update Shoalhaven Local Flood Plan with the results of most recent modelling and studies. Community education on risk of not following evacuation orders, community education to enhance understanding of inundation risk, works to raise key evacuation routes above inundation levels
Sussex Inlet	Coastal Environment	Tidal Inundation and Sea Level Rise	Damage to estuarine vegetation	Sea Level Rise and inundation, conflict between maintenance of no-mow areas and public recreational uses	Loss or changes to biodiversity, landward migration of estuarine vegetation	Provision of no-mow areas	2	U	3	Mod	6	Mod	3	P	3	Mod	9	High	4	L	3	Mod	12	High	4	L	3	Mod	12	High	Community education on no-mow areas and enforcement, landward retreat of Council infrastructure e.g. playgrounds from vulnerable low-lying areas
Sussex Inlet	Coastal Vulnerability	Tidal Inundation and Sea Level Rise	Coastal and tidal inundation of infrastructure	Low lying development, lack of tourist awareness of flooding	Damage to infrastructure, loss of community access, impact on tourists	Development controls, monitoring, flood warning and flood evacuation procedures	4	L	4	Maj	16	High	4	L	4	Maj	16	High	5	AC	5	C	25	Extreme	5	AC	5	C	25	Extreme	Improved stormwater infrastructure to account for increased runoff during inundation events. Investigate feasibility of raising infrastructure and review development controls for floor elevations for residential dwellings, refer to and implement findings of the St Georges Basin Floodplain Risk Management Study and Plan (including emergency management aspects). Update Shoalhaven Local Flood Plan
Sussex Inlet	Coastal Use	Navigation and Safety	Poor navigation conditions into the Basin and near the entrance, and at Chris Creek and Alamein	Shoaling of channel	Impact on navigation	Monitoring, estuary maintenance/dredging	5	AC	4	Maj	20	Extreme	5	AC	4	Maj	20	Extreme	5	AC	4	Maj	20	Extreme	5	AC	4	Maj	20	Extreme	Undertake a detailed investigation into the feasibility of targeted dredging as per the Boating and Navigation Study. Such investigation would involve detailed seagrass mapping, sediment sampling, and sediment transport modelling. Undertake ongoing monitoring of sand movements via regular survey to assess long term sustainability of dredging.

KEY: Likelihood: AC = Almost Certain, L = Likely. P = Possible, U = Unlikely, R = Rare
Consequence: C = Catastrophic, Maj = Major, Mod = Moderate, Min = Minor, I = Insignificant

							Present Day					20 years					50 years					100 years					
Estuary	Coastal Management Area	Risk Category	Risk Description	Root Cause	Consequence	Existing Controls	Lkihood (1-5)		Consq.(1-5)		Pre Treatment Rating	Lkihood (1-5)		Consq.(1-5)		Pre Treatment Rating	Lkihood (1-5)		Consq.(1-5)		Pre Treatment Rating	Lkihood (1-5)		Consq.(1-5)		Pre Treatment Rating	Potential Management Actions
Sussex Inlet	Coastal Use	Navigation and Safety	Difficulty navigating over entrance bar at low tide	Shallow entrance channel	Reduced access to open ocean from Sussex Inlet	Safety warning signs	4	L	3	Mod	12 High	4	L	3	Mod	12 High	4	L	3	Mod	12 High	4	L	3	Mod	12 High	Community education, signage, improve navigation aids, investigate feasibility of providing a boat ramp on the ocean side of the entrance as per CMP Boating and Navigation Study. Undertake targeted consultation with LALC regarding this option
Sussex Inlet	Coastal Use	Navigation and Safety	Poor navigation safety at night	Lack of lighting on navigation aids	Impact on navigation and safety for night-time navigation	None	5	AC	3	Mod	15 High	5	AC	3	Mod	15 High	5	AC	3	Mod	15 High	5	AC	3	Mod	15 High	Provision of lighting on navigation aids
Sussex Inlet	Coastal Use	Navigation and Safety	Conflict between users of powered and non-powered craft	High demand for recreational boating	Amenity, safety	Routine maintenance of existing boating facilities	4	L	3	Mod	12 High	4	L	3	Mod	12 High	4	L	3	Mod	12 High	4	L	3	Mod	12 High	Demand study and upgrade of existing boating facilities where required
Sussex Inlet	Coastal Vulnerability	Foreshore Erosion	Accelerating erosion risk to cabins near estuary mouth	Foreshore erosion due to flood flows, rainfall/runoff over slope, slope stability, and ocean waves, proximity of cabins to beach	Amenity, safety	none	3	P	3	Mod	9 High	3	P	3	Mod	9 High	3	P	3	Mod	9 High	3	P	3	Mod	9 High	Consider risk to cabins and build landward. Review development controls within CVA mapped areas – Development of a Planning Proposal to map a CVA
Sussex Inlet	Coastal Use	Navigation and Safety	Reduced coastal amenity and compromised recreational use	Need for channel optimisation, sand nourishment/maintenance to revetment walls, review of the Canals Management Plan at Riviera Keys	Damage to revetment walls, increased channel sedimentation, impact on navigation and recreational amenity	Review Riviera Keys Canals Management Plan	5	AC	3	Mod	15 High	5	AC	3	Mod	15 High	5	AC	3	Mod	15 High	5	AC	3	Mod	15 High	Review Riviera Keys Canals Management Plan
Sussex Inlet	Coastal Environment	Ecological Environment	Impacts on estuary health from ad-hoc development and unapproved structures	Unchecked tourist development - caravans, ad-hoc jetties, caravan park, unapproved structures	Compromised estuary health	Development controls	5	AC	3	Mod	15 High	5	AC	3	Mod	15 High	5	AC	3	Mod	15 High	5	AC	3	Mod	15 High	Better monitoring and enforcement of illegal activities such as construction of unapproved structures

Table 5-4 – Identified High or Extreme Risks at Swan Lake

KEY: Likelihood: AC = Almost Certain, L = Likely. P = Possible, U = Unlikely, R = Rare
Consequence: C = Catastrophic, Maj = Major, Mod = Moderate, Min = Minor, I = Insignificant

							Present Day					20 years					50 years					100 years					
Estuary	Coastal Management Area	Risk Category	Risk Description	Root Cause	Consequence	Existing Controls	Lkihood (1-5)		Consq.(1-5)		Pre Treatment Rating	Lkihood (1-5)		Consq.(1-5)		Pre Treatment Rating	Lkihood (1-5)		Consq.(1-5)		Pre Treatment Rating	Lkihood (1-5)		Consq.(1-5)		Pre Treatment Rating	Potential Management Actions
Swan Lake	Coastal Environment	Ecological Environment	Impacts on estuary health	Boating, inadequate habitat protection, urban encroachment, invasive species	Compromised estuary health	Development controls	5	AC	3	Mod	15 High	5	AC	3	Mod	15 High	5	AC	3	Mod	15 High	5	AC	3	Mod	15 High	Greater protection to natural vegetation and nesting areas, tighter controls on powered boats, targeted ecological surveys to monitor communities, updated macrophyte mapping
Swan Lake	Coastal Environment	Ecological Environment	Erosion of dunes, damage to dune vegetation	Natural channel migration	Damage to dune vegetation at eastern bend of estuary channel, risk of entrance breakthrough	Entrance Management Plan, public education	4	L	3	Mod	12 High	4	L	3	Mod	12 High	4	L	3	Mod	12 High	4	L	3	Mod	12 High	Monitor and update Entrance Management Plan to reduce risk of opening at The Gap
Swan Lake	Coastal Vulnerability	Tidal Inundation and Sea Level Rise	Coastal inundation of infrastructure	Low lying development	Damage to infrastructure/loss of community access	Entrance Management, development controls	3	P	3	Mod	9 High	3	P	3	Mod	9 High	4	L	4	Maj	16 High	5	AC	4	Maj	20 Extreme	Improved stormwater infrastructure to account for increased backflows during coastal inundation events. Adaptation planning, raising/moving of at-risk infrastructure or access points e.g. access to The Springs Cabins. Updated development controls within CVA mapped areas. Updated entrance management policy
Swan Lake	Coastal Environment	Ecological Environment	Introduced species threatening native wildlife	Past landuse practices	Threat to estuary ecology	Feral animal control methods, fencing	3	P	3	Mod	9 High	3	P	3	Mod	9 High	3	P	3	Mod	9 High	3	P	3	Mod	9 High	Undertake investigation into presence and impact of feral animals in the study area
Swan Lake	Coastal Environment	Ecological Environment	Altered ecology within lake	Climate change = more frequent extreme events (drought and bushfires)	Threat to estuary ecology (community perception of decline in charophytes and swans)	Entrance Management Policy	3	P	3	Mod	9 High	3	P	3	Mod	9 High	4	L	4	Maj	16 High	5	AC	4	Maj	20 Extreme	Research project potentially in conjunction with university to understand what if any changes to the ecology of the lake have occurred and the likely causes
Swan Lake	Coastal Environment	Ecological Environment	Changes to estuarine morphology	Past bridge construction	Community perception that bridge has led to reduced entrance opening and altered channel alignment	Entrance Management	3	P	3	Mod	9 High	3	P	3	Mod	9 High	3	P	3	Mod	9 High	3	P	3	Mod	9 High	Investigate impact on lake morphology when bridge is due for upgrade/replacement at the end of its design life. Consideration of old alignment within new bridge design while also protecting wetlands that have grown since construction.
Swan Lake	Coastal Environment	Ecological Environment	Artificial lake openings affecting fish populations, shorebirds and wetlands	Artificial lake openings primarily done illegally by the public outside of entrance management policy triggers	Threat to estuary ecology	Entrance Management	3	P	3	Mod	9 High	3	P	3	Mod	9 High	3	P	3	Mod	9 High	3	P	3	Mod	9 High	Review of Entrance Management Policy, targeted community education including for holidaymakers, signage, regular patrols, enforcement Provision of additional recreational facilities that can be utilised by the public during high lake water levels (e.g. pontoons for swimming).
Swan Lake	Coastal Vulnerability	Tidal Inundation and Sea Level Rise	Isolation during inundation or bushfires such as access to Princes Highway being cut.	Sea Level Rise and inundation	Damage to infrastructure, loss of community access, impact on tourists	Development controls, monitoring, flood warning system and flood evacuation procedures, Floodplain Risk Management Study and Plan	2	U	4	Maj	8 Mod	3	P	4	Maj	12 High	4	L	4	Maj	16 High	4	L	4	Maj	16 High	Update Shoalhaven Local Flood Plan, Community education on risk of not following evacuation orders, community education to enhance understanding of inundation risk, works to raise key evacuation routes above inundation levels. Complete a Flood Study and Floodplain Risk Management Study & Plan for Swan Lake
Swan Lake	Coastal Use	Navigation and Safety	Overcrowding at boat launching areas, safety issues with boat ramp	High demand for boating activities, inadequate facilities	Impact on recreational amenity at foreshore reserves	Upgrade existing boat launching facilities e.g. at The Springs Road Ski Beach Boat ramp	5	AC	2	Min	10 High	5	AC	2	Min	10 High	5	AC	2	Min	10 High	5	AC	2	Min	10 High	Additional or upgraded facilities, including upgraded boat ramp at Swan Lake Ski Beach Boat Ramp; Signage and enforcement to ensure powered craft not launched next to and are kept away from designated swimming areas

Table 5-5 – Identified High or Extreme Risks at Berrara Creek

KEY: Likelihood: AC = Almost Certain, L = Likely. P = Possible, U = Unlikely, R = Rare
Consequence: C = Catastrophic, Maj = Major, Mod = Moderate, Min = Minor, I = Insignificant

							Present Day					20 years					50 years					100 years					
Estuary	Coastal Management Area	Risk Category	Risk Description	Root Cause	Consequence	Existing Controls	Lkihood (1-5)		Consq.(1-5)		Pre Treatment Rating	Lkihood (1-5)		Consq.(1-5)		Pre Treatment Rating	Lkihood (1-5)		Consq.(1-5)		Pre Treatment Rating	Lkihood (1-5)		Consq.(1-5)		Pre Treatment Rating	Potential Management Actions
Berrara Creek	Coastal Wetlands and Littoral Rainforest	Water Quality	Pollution inputs into estuary from urban areas (turbidity and DO) including stakeholder concerns	Catchment inputs - erosion and urban runoff, climate change resulting in more frequent extreme events (drought and bushfires)	Threat to estuary ecology	Development controls, public education, stormwater treatment, Water quality monitoring program	3	P	3	Mod	9 High	3	P	3	Mod	9 High	4	L	3	Mod	12 High	5	AC	4	Maj	20 Extreme	NSW DP&E Estuary Health Program, Revised water quality program (including adoption of DP&E guidelines for lagoons) Urban runoff controls
Berrara Creek	Coastal Environment	Ecological Environment	Invasive weeds	Urban landuse and general spread of invasive species	Threat to estuary ecology	Development controls, public education, invasive weed management	3	P	3	Mod	9 High	3	P	3	Mod	9 High	3	P	3	Mod	9 High	3	P	3	Mod	9 High	Planting and invasive weed management, supplemented with native plantings where appropriate
Berrara Creek	Coastal Environment	Ecological Environment	Threats to shorebirds (pied oystercatcher) around foreshore and entrance area	Urban landuse and overcrowding due to peak holiday times	Disturbance to shorebirds during nesting season	Educational signage. South Coast Shorebird Recovery Program	3	P	3	Mod	9 High	3	P	3	Mod	9 High	3	P	3	Mod	9 High	3	P	3	Mod	9 High	Exclusion of public access from known nesting sites on southern side of lake entrance during breeding season. Continuation of South Coast Shorebird Recovery Program
Berrara Creek	Coastal Use	Navigation and Safety	Boating safety issues	Conflict between motorised and passive water craft	Amenity and safety impacts and environment	Vessel speed limits, signage	5	AC	3	Mod	15 High	5	AC	3	Mod	15 High	5	AC	3	Mod	15 High	5	AC	3	Mod	15 High	Stakeholders suggest to restrict access in Berrara Creek to non powered vessels

Table 5-6 – Identified High or Extreme Risks applying to all estuaries (St Georges Basin/Sussex Inlet, Swan Lake and Berrara Creek)

KEY: Likelihood: AC = Almost Certain, L = Likely. P = Possible, U = Unlikely, R = Rare
Consequence: C = Catastrophic, Maj = Major, Mod = Moderate, Min = Minor, I = Insignificant

							Present Day						20 years						50 years						100 years					
Estuary	Coastal Management Area	Risk Category	Risk Description	Root Cause	Consequence	Existing Controls	Lkihood (1-5)		Consq.(1-5)		Pre Treatment Rating		Lkihood (1-5)		Consq.(1-5)		Pre Treatment Rating		Lkihood (1-5)		Consq.(1-5)		Pre Treatment Rating		Lkihood (1-5)		Consq.(1-5)		Pre Treatment Rating		Potential Management Actions
Estuary-wide	Coastal Wetlands and Littoral Rainforest	Ecological Environment	Changes in balance between habitat types, landward migration or loss of macrophyte communities	Sea Level Rise and inundation	Loss or changes to biodiversity, landward migration of estuarine vegetation. The Sanctuary Point shoreline is particularly vulnerable	CMP including inundation mapping, development controls, state and federal legislation	4	L	4	Maj	16	High	4	L	4	Maj	16	High	5	AC	5	C	25	Extreme	5	AC	5	C	25	Extreme	Map migration pathways for Coastal wetlands via the MEMA Initiative 2 marine vegetation mapping strategy. Identify suitable areas where macrophytes can migrate, Continue NSW DPI macrophyte mapping to monitor variability and long-term trends. Community education on impacts from climate change resulting in increased tidal range, changes to entrance dynamics and changes in macrophyte composition and distribution. Development of management strategies e.g., rezoning of land to allow for future migration of estuarine vegetation communities
Estuary-wide	Coastal Vulnerability	Tidal Inundation and Sea Level Rise	Damage to public infrastructure and critical services due to increased frequency and duration of inundation	Sea Level Rise and inundation	Damage to infrastructure, loss of critical services to infrastructure	Measures developed in Climate change and inundation Adaptation Report	2	U	4	Maj	8	Mod	3	P	4	Maj	12	High	4	L	4	Maj	16	High	4	L	4	Maj	16	High	Investigate feasibility of moving infrastructure landward, e.g. sewage network and managing sewage overflows. Implementation of findings of the St Georges Basin Floodplain Risk Management Study and Plan (including emergency management aspects). Refer actions for individual assets identified as being at risk from coastal inundation
Estuary-wide	Coastal Vulnerability	Tidal Inundation and Sea Level Rise	Inundation of Crown Land with third party infrastructure e.g. caravan parks	Sea Level Rise and inundation	Damage to infrastructure, loss of critical services, injury or death	Measures developed in Climate change and inundation Adaptation Report	2	U	4	Maj	8	Mod	3	P	4	Maj	12	High	4	L	4	Maj	16	High	4	L	4	Maj	16	High	Investigate feasibility of moving infrastructure landward or feasibility of public works to raise low-lying land
Estuary-wide	Coastal Vulnerability	Tidal Inundation and Sea Level Rise	Increasing depth, duration and frequency of inundation of urban areas	Sea Level Rise and inundation	Damage to infrastructure, loss of critical services, injury or death, economic loss	Development controls, monitoring, flood warning system and flood evacuation procedures	2	U	4	Maj	8	Mod	3	P	4	Maj	12	High	4	L	4	Maj	16	High	4	L	4	Maj	16	High	Long term planning/strategies beyond CMP timeframe for adaption to sea level rise, integrating actions from Flood Risk Management Plan with CMP
Estuary-wide	Coastal Vulnerability	Tidal Inundation and Sea Level Rise	Rising water table and impact on existing and future development	Sea Level Rise and inundation	Damage to infrastructure, loss of critical services to infrastructure	none	2	U	4	Maj	8	Mod	3	P	4	Maj	12	High	4	L	4	Maj	16	High	4	L	4	Maj	16	High	Investigate engineering measures to mitigate against or prevent groundwater damage to building foundations and services and include these in development controls for new DAs
Estuary-wide	Coastal Vulnerability	Tidal Inundation and Sea Level Rise	Development approved in inappropriate locations	Inadequate or inappropriate sea level rise projections for planning purposes	Future increased risk to Infrastructure	Community education, planning controls, Council resolutions on sea level rise projections	3	P	4	Maj	12	High	3	P	4	Maj	12	High	4	L	4	Maj	16	High	5	AC	4	Maj	20	Extreme	Revise sea level rise projections for future planning purposes based on latest advice from IPCC. Develop a planning proposal to map the CVA. Review development controls within CVA mapped areas, and review planning controls in accordance with the Floodplain Risk Management Study and Plan (FRMS&P).
Estuary-wide	Coastal Use	Cultural and Social	Poor community understanding of coastal and estuary issues	Lack of easy-to-digest information	Lack of community ownership of issues, community misconceptions leading to poor environmental outcomes	Community education, dissemination of information to schools and community groups, provision of resources for community groups to empower them to undertake local projects and citizen science, effective coasts and estuaries committee, use of social media to communicate with community	4	L	3	Mod	12	High	4	L	3	Mod	12	High	4	L	3	Mod	12	High	4	L	3	Mod	12	High	Development of educational material including videos and fact sheets describing local coastal and estuary issues; Comprehensive community information program to accompany CMP implementation to explain key issues and actions

KEY: Likelihood: AC = Almost Certain, L = Likely. P = Possible, U = Unlikely, R = Rare
Consequence: C = Catastrophic, Maj = Major, Mod = Moderate, Min = Minor, I = Insignificant

							Present Day						20 years						50 years						100 years					
Estuary	Coastal Management Area	Risk Category	Risk Description	Root Cause	Consequence	Existing Controls	Lkihood (1-5)		Consq.(1-5)		Pre Treatment Rating		Lkihood (1-5)		Consq.(1-5)		Pre Treatment Rating		Lkihood (1-5)		Consq.(1-5)		Pre Treatment Rating		Lkihood (1-5)		Consq.(1-5)		Pre Treatment Rating		Potential Management Actions
Estuary-wide	Coastal Environment	Water Quality	Water quality and estuary health monitoring programs	Inconsistent monitoring of water quality and estuary health	Compromised ability to assess long term trends in water quality and estuary health	Water quality monitoring program, DP&E Estuary Health program, NSW DPI macrophyte mapping	5	AC	3	Mod	15	High	5	AC	3	Mod	15	High	5	AC	3	Mod	15	High	5	AC	3	Mod	15	High	Revised Council water quality monitoring program with continued estuary health monitoring program by DPE-EHG
Estuary-wide	Coastal Use	Navigation and Safety	Conflict between waterway users	High demand for waterway access	Amenity, safety	Signage and innovations in facility design	5	AC	3	Mod	15	High	5	AC	3	Mod	15	High	5	AC	3	Mod	15	High	5	AC	3	Mod	15	High	Assess effectiveness of signage and facility design in other areas and implement best practice for future facility upgrades
Estuary-wide	Coastal Environment	Cultural and Social	Poor communication between stakeholders, community and agencies leading to perceived lack of action on coastal management issues	Disagreements between stakeholders, responsible agencies for projects	Perceived lack of action or delays on urgent coastal and estuary rehabilitation projects	Effective communication between agencies, Council and stakeholders	5	AC	3	Mod	15	High	5	AC	3	Mod	15	High	5	AC	3	Mod	15	High	5	AC	3	Mod	15	High	Assess effectiveness of existing communication protocols between stakeholders, responsible agencies and community representatives via the Coastal and Estuary Management Committee, and update protocols if necessary
Estuary-wide	Coastal Environment	Water Quality	Overflows from sewage pumping network stations (all catchments)	Wet weather including more frequent inundations. Dry weather from blockages, power failures etc.	Recreational and human health impacts	STP EPLs, Pollution Incident Response Management Plan (PIRMP), Risk Assessment, Risk Minimisation and Incident Management Strategy, Water Quality Monitoring Program	4	L	3	Mod	12	High	4	L	3	Mod	12	High	4	L	3	Mod	12	High	4	L	3	Mod	12	High	Regular review of PIRMP, Incident Response Strategy and facility risk assessments.
Estuary-wide	Coastal Environment	Water Quality	Potential contaminants associated with urban area runoff and stormwater - litter/gross pollutants, hydrocarbons, metals, pesticides	Inundation and urban runoff	Estuary health and recreational impacts	Development controls	4	L	3	Mod	12	High	4	L	3	Mod	12	High	4	L	3	Mod	12	High	4	L	3	Mod	12	High	Collect maintenance data on existing GPTs to enable an internal assessment of the effectiveness of existing stormwater runoff treatment/GPTs. Install and maintain additional stormwater runoff and GPT controls where they have been recommended
Estuary-wide	Coastal Environment	Ecological Environment	Development resulting in a reduction in estuary health	Perceived incorrect LEP zoning of areas	Threats to estuary health	CMP, development controls, state and federal legislation	3	P	3	Mod	9	High	3	P	3	Mod	9	High	3	P	3	Mod	9	High	3	P	3	Mod	9	High	Review of LEP alongside the development of a Planning proposal to map a CVA. Review and where necessary update development controls
Estuary-wide	Coastal Use	Cultural and Social	Damage to or loss of non-Aboriginal and Aboriginal cultural heritage items (e.g. midden at Cudmirrah)	Inundation, erosion, lack of understanding from the community, malicious damage, vandalism	Loss of cultural heritage	Development controls, public education program, 4WD access management	3	P	4	Maj	12	High	3	P	4	Maj	12	High	3	P	4	Maj	12	High	3	P	4	Maj	12	High	More educational signage, better protection, enforcement of 4WD restrictions, better education, rezoning of areas to higher environmental protection. Mitigations are very dependent on the site and case by case basis. Some sites will benefit from fencing and restricted access, and in others may be more appropriate to have new access pathways to prevent access to sensitive sites, Jerrinja Tribe to assess and guide appropriate management options.
Estuary-wide	Coastal Use	Cultural and Social	Aboriginal loss of connection between land and sea	Inundation, erosion, lack of understanding from the community, malicious damage, vandalism	Loss of cultural heritage	Development controls, public education program, Aboriginal heritage mapping, statutory and non-statutory planning controls	3	P	3	Mod	9	High	3	P	3	Mod	9	High	3	P	3	Mod	9	High	3	P	3	Mod	9	High	Aboriginal access to the environment and 2.5km zone of coastline was recommended by Jerrinja Tribe. Access tracks between sites to maintain connection between the sea and rest of lands. NSW Government commitment for the future joint management of NSW National Parks .
Estuary-wide	Coastal Use	Cultural and Social	Lack of understanding of Aboriginal heritage	Inadequate education and communication	Compromised Aboriginal heritage values	Community education, Aboriginal Advisory Committee (Council), Council engagement strategy and supporting articles	3	P	3	Mod	9	High	3	P	3	Mod	9	High	3	P	3	Mod	9	High	3	P	3	Mod	9	High	Consultation with Jerrinja re. community suggestion to rename St Georges Basin using Indigenous language names, community education. Reinforcing that the region always has and always will be Jerrinja country
Estuary-wide	Coastal Use	Cultural and Social	Important loss of cultural significance	Lack of interpretive signage for educating the community about	Inadvertent damage to sites e.g. at Berrara Ck. Deterioration of heritage items,	Statutory and non-statutory planning controls, mapping tools.	3	P	3	Mod	9	High	3	P	3	Mod	9	High	3	P	3	Mod	9	High	3	P	3	Mod	9	High	Updating Aboriginal and non-Aboriginal heritage listings, including updating of mapping to ensure protection of any culturally significant heritage items

KEY: Likelihood: AC = Almost Certain, L = Likely. P = Possible, U = Unlikely, R = Rare
Consequence: C = Catastrophic, Maj = Major, Mod = Moderate, Min = Minor, I = Insignificant

							Present Day						20 years						50 years						100 years					
Estuary	Coastal Management Area	Risk Category	Risk Description	Root Cause	Consequence	Existing Controls	Lkihood (1-5)		Consq.(1-5)		Pre Treatment Rating		Lkihood (1-5)		Consq.(1-5)		Pre Treatment Rating		Lkihood (1-5)		Consq.(1-5)		Pre Treatment Rating		Lkihood (1-5)		Consq.(1-5)		Pre Treatment Rating		Potential Management Actions
				heritage and environment	significant loss of historical authenticity for items that are listed or those items that may qualify for heritage listing																										
Estuary-wide	Coastal Use	Cultural and Social	Severe deterioration of natural beauty or heritage value of heritage listed items	Human damage to culturally significant sites and artefacts	Inadvertent damage to sites e.g. at Berrara Ck. Deterioration of heritage items, significant loss of historical authenticity for items that are listed or those items that may qualify for heritage listing	Statutory and non-statutory planning controls, mapping tools.	3	P	3	Mod	9	High	3	P	3	Mod	9	High	3	P	3	Mod	9	High	3	P	3	Mod	9	High	Work together with traditional owners to devise culturally appropriate protection measures. Updating Aboriginal and non-Aboriginal heritage listings, including updating of mapping to ensure protection of any culturally significant heritage items
Estuary-wide	Coastal Use	Cultural and Social	Deterioration of heritage items due to erosion	Foreshore erosion due to human impacts as well as coastal hazards	Inadvertent damage to sites e.g. at Berrara Ck. Deterioration of heritage items, significant loss of historical authenticity for items that are listed or those items that may qualify for heritage listing	CMP - erosion mapping in relation to heritage items	3	P	3	Mod	9	High	3	P	3	Mod	9	High	3	P	3	Mod	9	High	3	P	3	Mod	9	High	Preparation of CMP with targeted actions to prevent/minimise disturbances/deterioration/impacts to heritage items

6 Conclusions

This report has provided a Detailed Risk Assessment identifying key management issues and threats, based on stakeholder engagement and further studies undertaken during Stage 2 of the Coastal Management Program (CMP) for St Georges Basin/Sussex Inlet, Swan Lake and Berrara Creek. The report documents the risk assessment and provides commentary on the existing levels of risk, identifying the issues of highest risk for St Georges Basin and Sussex Inlet, Swan Lake and Berrara Creek.

The Risk Assessment was carried out in conjunction with stakeholders, including Council Asset Managers, Agency stakeholders and the community. Risks were assessed in terms of six key categories, including:

- Cultural and Social
- Water Quality
- Foreshore Erosion
- Ecological Environment
- Tidal Inundation and Sea Level Rise
- Navigation and Safety

Each risk was assigned a Likelihood and Consequence rating, based on the definitions provided in Council's Risk Assessment Procedure (Shoalhaven City Council 2021), which allowed the risk severity to be categorised. Risks were assessed under present day conditions, as well as for 20 year, 50 year and 100 year planning periods.

For each risk identified, the root cause and existing management measures were defined, with additional management actions identified that could reduce the level of residual risk and form the basis of management actions to take forward to Stage 3 of the CMP process. The risks, root causes, existing management measures and future management actions are all identified and provided in the Risk Registers for each estuary, given in Appendix A.

It is recommended that the potential management opportunities be developed and their feasibility examined further as part of Stage 3 of the CMP.

7 References

Advisian (2020). Shoalhaven CMP Scoping Study. Report 301015-04030 for Shoalhaven City Council.

Advisian (2022a) St Georges Basin, Sussex Inlet, Swan Lake and Berrara Creek Stage 2 Synthesis Report, Draft report being produced for Shoalhaven City Council by Advisian.

Advisian (2022b) St Georges Basin and Sussex Inlet Boating and Navigation Study (Draft).

Advisian (2022c) St Georges Basin and Sussex Inlet Water, Tidal and Coastal Inundation Study (Draft).

Advisian (2022d) St Georges Basin and Sussex Inlet CMP Community Consultation. Community consultation undertaken as part of the CMP for Shoalhaven City Council by Advisian.

Advisian (2022e) St Georges Basin and Sussex Inlet Water Quality and Estuary Health Study.

Campbell SJ, McKenzie LJ (2004) Flood related loss and recovery of intertidal seagrass meadows in southern Queensland, Australia. Estuarine, Coastal and Shelf Science 60: 477-490. http://dx.doi.org/10.1016/j.ecss.2004.02.007.

Davies, T., Harasti, D., Smith, S. and Kelahler B. 2016. Using modelling to predict impacts of sea level rise and increased turbidity on seagrass distributions in estuarine embayments. Estuarine and Coastal Shelf Science, 181, 10.1016/j.ecss.2016.09.005.

NSW DPI (2004) Swan Lake Macrophyte Mapping. Estuarine Habitat Dashboard and Change Analysis Tool. Available online: NSW Estuarine Mapping (shinyapps.io). NSW Department of Primary Industries (DPI). Date Accessed: March 2022.

NSW DPI (2004) Berrara Creek Macrophyte Mapping. Estuarine Habitat Dashboard and Change Analysis Tool. Available from: NSW Estuarine Mapping (shinyapps.io). NSW Department of Primary Industries (DPI). Date Accessed: March 2022.

NSW DPI (2007) Seagrasses Fact Sheet. Available from Seagrasses (nsw.gov.au). Accessed June 2022.

NSW DPI (2008) Mangroves Fact Sheet. Available from Mangroves (Primefact 746) (nsw.gov.au). Accessed June 2022.

NSW DPI (2013) Coastal Saltmarsh Fact Sheet. Available from: Coastal Saltmarsh - Primefact (nsw.gov.au). Accessed June 2022.

NSW DPI (2022) St Georges Basin and Sussex Inlet Macrophyte Mapping. Estuarine Habitat Dashboard and Change Analysis Tool. Available from: NSW Estuarine Mapping (shinyapps.io). NSW Department of Primary Industries (DPI). Date Accessed: March 2022.

OEH (2018) Coastal Management Manual. Available from: Coastal Management Manual Part B | NSW Environment and Heritage. Accessed: June 2022.

Shoalhaven City Council (2021) Shoalhaven City Council Risk Assessment Procedure, PRD21/140, Amended 03/2021.

Appendix A
Full Detailed Risk Register

- Overall Risk Register
- General Public Assets Risk Register
- Specific Public Assets Risk Register

KEY: Likelihood: AC = Almost Certain, L = Likely. P = Possible, U = Unlikely, R = Rare Consequence: C = Catastrophic, Maj = Major, Mod = Moderate, Min = Minor, I = Insignificant

								Present Day				20 years				50 years				100 years				
No.	Estuary	Coastal Management Area	Risk Category	Risk Description	Root Cause	Consequence	Existing Controls	Lkihood (1-5)		Consq.(1-5)	Pre Treatment Rating	Lkihood (1-5)		Consq.(1-5)	Pre Treatment Rating	Lkihood (1-5)		Consq.(1-5)	Pre Treatment Rating	Lkihood (1-5)		Consq.(1-5)	Pre Treatment Rating	Potential Management Actions
1	Berrara Creek	Coastal Wetlands and Littoral Rainforest	Water Quality	Pollution inputs into estuary from urban areas (turbidity and DO) including stakeholder concerns	Catchment inputs - erosion and urban runoff, climate change resulting in more frequent extreme events (drought and bushfires)	Threat to estuary ecology	Development controls, public education, stormwater treatment, Water quality monitoring program	3	P	3 Mod	9 High	3	P	3 Mod	9 High	4	L	3 Mod	12 High	5	AC	4 Maj	20 Extreme	NSW DP&E Estuary Health Program, Revised water quality program (including adoption of DP&E guidelines for lagoons) Urban runoff controls
2	Berrara Creek	Coastal Use	Water Quality	Pollution inputs into estuary from urban areas, poor water quality (faecal contamination/pathogens)	Urban runoff, stormwater pollution, sewage overflows between Lakehaven Ave and Meadow Lake Avenue OR environmental sources	Impact on recreational amenity at foreshore reserves	Upgraded sewage treatment and controls including containment ponds and monitoring, development controls, public education, stormwater treatment	2	U	3 Mod	6 Mod	2	U	3 Mod	6 Mod	2	U	3 Mod	6 Mod	2	U	3 Mod	6 Mod	Revised Council water quality program - including sanitary inspections on an as-needs basis, event sampling, and continued publication of WQ results on Council web-site.
3	Berrara Creek	Coastal Environment	Ecological Environment	Artificial lake openings affecting fish populations and wetlands	Unsanctioned lake openings	Threat to estuary ecology	Entrance Management	2	U	3 Mod	6 Mod	2	U	3 Mod	6 Mod	2	U	3 Mod	6 Mod	2	U	3 Mod	6 Mod	Monitoring of entrance openings and closures either via citizen science opportunities or remote sensing (e.g. Inlet Tracker). Community information and engagement regarding Berrara Creek natural opening and closure regimes and potential impacts of illegal openings. Updated water quality monitoring program. Publication of swimming suitability results and use of sanitary inspections / investigating source of pollutants if detected.
4	Berrara Creek	Coastal Environment	Foreshore Erosion	Bank erosion	Inappropriate foreshore development or inadequate maintenance. e.g. the erosion of access stairs where people are taking shortcuts through vegetation	Threat to estuary ecology	Education, development controls for adjacent lands, access management	2	U	3 Mod	6 Mod	2	U	3 Mod	6 Mod	2	U	3 Mod	6 Mod	2	U	3 Mod	6 Mod	Upgrade and ongoing maintenance of stair access. Restrictions on the use of powered watercraft within Berrara Creek
5	Berrara Creek	Coastal Environment	Ecological Environment	Invasive weeds	Urban landuse and general spread of invasive species	Threat to estuary ecology	Development controls, public education, invasive weed management	3	P	3 Mod	9 High	3	P	3 Mod	9 High	3	P	3 Mod	9 High	3	P	3 Mod	9 High	Planting and invasive weed management, supplemented with native plantings where appropriate
6	Berrara Creek	Coastal Use	Cultural and Social	Lack of public foreshore access	Limited available land adjacent to foreshore	Overcrowding during peak holiday times	Provision of additional foreshore recreation reserves, provide designated access	3	P	2 Min	6 Mod	3	P	2 Min	6 Mod	3	P	2 Min	6 Mod	3	P	2 Min	6 Mod	Explore opportunities to improve local access to foreshore
7	Berrara Creek	Coastal Environment	Ecological Environment	Threats to shorebirds (pied oystercatcher) around foreshore and entrance area	Urban landuse and overcrowding due to peak holiday times	Disturbance to shorebirds during nesting season	Educational signage. South Coast Shorebird Recovery Program	3	P	3 Mod	9 High	3	P	3 Mod	9 High	3	P	3 Mod	9 High	3	P	3 Mod	9 High	Exclusion of public access from known nesting sites on southern side of lake entrance during breeding season. Continuation of South Coast Shorebird Recovery Program
8	Berrara Creek	Coastal Use	Navigation and Safety	Boating safety issues	Conflict between motorised and passive water craft	Amenity and safety impacts and environment	Vessel speed limits, signage	5	AC	3 Mod	15 High	5	AC	3 Mod	15 High	5	AC	3 Mod	15 High	5	AC	3 Mod	15 High	Stakeholders suggest to restrict access in Berrara Creek to non powered vessels
9	Berrara Creek	Coastal Environment	Ecological Environment	Reduction in estuary health	Potential for environmental releases of chlorinated drinking water from water pump station at Berrara Ck	Acute toxicity of chlorine to aquatic ecology at concentrations in drinking water (new ANZG 2018 guideline for chlorine in freshwater)	Pollution Incident Response Management Plan (PIRMP), Risk Assessment, Risk Minimisation and Incident Management Strategy	2	U	3 Mod	6 Mod	2	U	3 Mod	6 Mod	2	U	3 Mod	6 Mod	2	U	3 Mod	6 Mod	Review of emergency procedures for this facility and where necessary upgrade to ensure a pollution event does not occur
10	Estuary-wide	Coastal Wetlands and Littoral Rainforest	Ecological Environment	Changes in balance between habitat types, landward migration or loss of macrophyte communities	Sea Level Rise and inundation	Loss or changes to biodiversity, landward migration of estuarine vegetation. The Sanctuary Point shoreline is particularly vulnerable	CMP including inundation mapping, development controls, state and federal legislation	4	L	4 Maj	16 High	4	L	4 Maj	16 High	5	AC	5 C	25 Extreme	5	AC	5 C	25 Extreme	Map migration pathways for Coastal wetlands via the MEMA Initiative 2 marine vegetation mapping strategy. Identify suitable areas where macrophytes can migrate, Continue DPI Fisheries macrophyte mapping to monitor variability and long-term trends. Community education on impacts from climate change resulting in increased tidal range, changes to entrance dynamics and changes in macrophyte composition and distribution. Development of management strategies e.g., rezoning of land to allow for future migration of estuarine vegetation communities. Develop a Planning proposal to map a CVA. Review and update development controls within CVA mapped areas
11	Estuary-wide	Coastal Environment	Foreshore Erosion	Bank erosion	Land slips in undeveloped areas due to saturated soils and heavy rainfall	Threat to estuary ecology	Foreshore erosion management/structures, provision of riparian zones	3	P	2 Min	6 Mod	3	P	2 Min	6 Mod	3	P	2 Min	6 Mod	3	P	2 Min	6 Mod	Assess whether intervention is necessary, allow erosion to occur if natural process and consequence is low

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12	Estuary-wide	Coastal Vulnerability	Tidal Inundation and Sea Level Rise	Damage to public infrastructure and critical services due to increased frequency and duration of inundation	Sea Level Rise and inundation	Damage to infrastructure, loss of critical services to infrastructure	Measures developed in Climate change and inundation Adaptation Report	2	U	4	Maj	8	Mod	3	P	4	Maj	12	High	4	L	4	Maj	16	High	Investigate feasibility of moving infrastructure landward, e.g. sewage network and managing sewage overflows. Implementation of findings of the St Georges Basin Floodplain Risk Management Study and Plan (including emergency management aspects). Refer actions for individual assets identified as being at risk from coastal inundation
13	Estuary-wide	Coastal Vulnerability	Tidal Inundation and Sea Level Rise	Inundation of Crown Land with third party infrastructure e.g. caravan parks	Sea Level Rise and inundation	Damage to infrastructure, loss of critical services, injury or death	Measures developed in Climate change and inundation Adaptation Report	2	U	4	Maj	8	Mod	3	P	4	Maj	12	High	4	L	4	Maj	16	High	Investigate feasibility of moving infrastructure landward or feasibility of public works to raise low-lying land
14	Estuary-wide	Coastal Vulnerability	Tidal Inundation and Sea Level Rise	Increasing depth, duration and frequency of inundation of urban areas	Sea Level Rise and inundation	Damage to infrastructure, loss of critical services, injury or death, economic loss	Development controls, monitoring, flood warning system and flood evacuation procedures	2	U	4	Maj	8	Mod	3	P	4	Maj	12	High	4	L	4	Maj	16	High	Long term planning/strategies beyond CMP timeframe for adaption to sea level rise, integrating actions from Flood Risk Management Plan with CMP
15	Estuary-wide	Coastal Vulnerability	Tidal Inundation and Sea Level Rise	Rising water table and impact on existing and future development	Sea Level Rise and inundation	Damage to infrastructure, loss of critical services to infrastructure	none	2	U	4	Maj	8	Mod	3	P	4	Maj	12	High	4	L	4	Maj	16	High	Investigate engineering measures to mitigate against or prevent groundwater damage to building foundations and services and include these in development controls for new DAs
16	Estuary-wide	Coastal Vulnerability	Tidal Inundation and Sea Level Rise	Development approved in inappropriate locations	Inadequate or inappropriate sea level rise projections for planning purposes	Future increased risk to Infrastructure	Community education, planning controls, Council resolutions on sea level rise projections	3	P	4	Maj	12	High	3	P	4	Maj	12	High	4	L	4	Maj	16	High	5	AC	4	Maj	20	Extreme	Revise sea level rise projections for future planning purposes based on latest advice from IPCC. Develop a planning proposal to map the CVA. Review development controls within CVA mapped areas, and review planning controls in accordance with the Floodplain Risk Management Study and Plan (FRMS&P).
17	Estuary-wide	Coastal Use	Cultural and Social	Poor community understanding of coastal and estuary issues	Lack of easy-to-digest information	Lack of community ownership of issues, community misconceptions leading to poor environmental outcomes	Community education, dissemination of information to schools and community groups, provision of resources for community groups to empower them to undertake local projects and citizen science, effective coasts and estuaries committee, use of social media to communicate with community	4	L	3	Mod	12	High	4	L	3	Mod	12	High	4	L	3	Mod	12	High	4	L	3	Mod	12	High	Development of educational material including videos and fact sheets describing local coastal and estuary issues; Comprehensive community information program to accompany CMP implementation to explain key issues and actions
18	Estuary-wide	Coastal Environment	Water Quality	Water quality and estuary health monitoring programs	Inconsistent monitoring of water quality and estuary health	Compromised ability to assess long term trends in water quality and estuary health	Water quality monitoring program, DP&E Estuary Health program, NSW DPI macrophyte mapping	5	AC	3	Mod	15	High	5	AC	3	Mod	15	High	5	AC	3	Mod	15	High	5	AC	3	Mod	15	High	Revised Council water quality monitoring program with continued estuary health monitoring program by DPE-EHG
19	Estuary-wide	Coastal Use	Navigation and Safety	Conflict between waterway users	High demand for waterway access	Amenity, safety	Signage and innovations in facility design	5	AC	3	Mod	15	High	5	AC	3	Mod	15	High	5	AC	3	Mod	15	High	5	AC	3	Mod	15	High	Assess effectiveness of signage and facility design in other areas and implement best practice for future facility upgrades
20	Estuary-wide	Coastal Environment	Cultural and Social	Poor communication between stakeholders, community and agencies leading to perceived lack of action on coastal management issues	Disagreements between stakeholders, responsible agencies for projects	Perceived lack of action or delays on urgent coastal and estuary rehabilitation projects	Effective communication between agencies, Council and stakeholders	5	AC	3	Mod	15	High	5	AC	3	Mod	15	High	5	AC	3	Mod	15	High	5	AC	3	Mod	15	High	Assess effectiveness of existing communication protocols between stakeholders, responsible agencies and community representatives via the Coastal and Estuary Management Committee, and update protocols if necessary
21	Estuary-wide	Coastal Environment	Water Quality	Overflows from sewage pumping network stations (all catchments)	Wet weather including more frequent inundations. Dry weather from blockages, power failures etc.	Recreational and human health impacts	STP EPLs, Pollution Incident Response Management Plan (PIRMP), Risk Assessment, Risk Minimisation and Incident Management Strategy, Water Quality Monitoring Program	4	L	3	Mod	12	High	4	L	3	Mod	12	High	4	L	3	Mod	12	High	4	L	3	Mod	12	High	Regular review of PIRMP, Incident Response Strategy and facility risk assessments.
22	Estuary-wide	Coastal Environment	Water Quality	Potential contaminants associated with urban area runoff and stormwater - litter/gross pollutants, hydrocarbons, metals, pesticides	Inundation and urban runoff	Estuary health and recreational impacts	Development controls	4	L	3	Mod	12	High	4	L	3	Mod	12	High	4	L	3	Mod	12	High	4	L	3	Mod	12	High	Collect maintenance data on existing GPTs to enable an internal assessment of the effectiveness of existing stormwater runoff treatment/GPTs. Install and maintain additional stormwater runoff and GPT controls where they have been recommended
23	Estuary-wide	Coastal Environment	Ecological Environment	Development resulting in a reduction in estuary health	Perceived incorrect LEP zoning of areas	Threats to estuary health	CMP, development controls, state and federal legislation	3	P	3	Mod	9	High	3	P	3	Mod	9	High	3	P	3	Mod	9	High	3	P	3	Mod	9	High	Review of LEP alongside the development of a Planning proposal to map a CVA. Review and where necessary update development controls

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24	Estuary-wide	Coastal Use	Cultural and Social	Damage to or loss of non-Aboriginal and Aboriginal cultural heritage items (e.g. midden at Cudmirrah)	Inundation, erosion, lack of understanding from the community, malicious damage, vandalism	Loss of cultural heritage	Development controls, public education program, 4WD access management	3	P	4	Maj 12 High	3	P	4	Maj 12 High	3	P	4	Maj 12 High	3	P	4	Maj 12 High	More educational signage, better protection, enforcement of 4WD restrictions, better education, rezoning of areas to higher environmental protection. Mitigations are very dependent on the site and case by case basis. Some sites will benefit from fencing and restricted access, and in others may be more appropriate to have new access pathways to prevent access to sensitive sites, Jerrinja Tribe to assess and guide appropriate management options.
25	Estuary-wide	Coastal Use	Cultural and Social	Aboriginal loss of connection between land and sea	Inundation, erosion, lack of understanding from the community, malicious damage, vandalism	Loss of cultural heritage	Development controls, public education program, Aboriginal heritage mapping, statutory and non-statutory planning controls	3	P	3	Mod 9 High	3	P	3	Mod 9 High	3	P	3	Mod 9 High	3	P	3	Mod 9 High	Aboriginal access to the environment and 2.5km zone of coastline was recommended by Jerrinja Tribe. Access tracks between sites to maintain connection between the sea and rest of lands. NSW Government commitment for the future joint management of NSW National Parks which may include Jervis Bay National Park.
26	Estuary-wide	Coastal Use	Cultural and Social	Lack of understanding of Aboriginal heritage	Inadequate education and communication	Compromised Aboriginal heritage values	Community education, Aboriginal Advisory Committee (Council), Council engagement strategy and supporting articles	3	P	3	Mod 9 High	3	P	3	Mod 9 High	3	P	3	Mod 9 High	3	P	3	Mod 9 High	Consultation with Jerrinja Tribe re. community suggestion to rename St Georges Basin using Indigenous language names, community education. Reinforcing that the region always has and always will be Jerrinja country
27	Estuary-wide	Coastal Use	Cultural and Social	Serious deterioration of known and undocumented heritage items, structures, artefacts	Lack of community understanding, education, maintenance of sites and surrounding infrastructure	Inadvertent damage to sites e.g. at Berrara Ck	Planning controls and Aboriginal heritage mapping	2	U	3	Mod 6 Mod	2	U	3	Mod 6 Mod	2	U	3	Mod 6 Mod	2	U	3	Mod 6 Mod	Erection of interpretative signage, explore more education initiatives for private landholders around Aboriginal heritage and enforcement of fines/penalties. Improved protocols around responding to new indigenous artefacts, such as in estuary foreshores that are becoming uncovered more frequently or to a greater extent.
28	Estuary-wide	Coastal Use	Cultural and Social	Impacts on heritage items	Lack of coherent heritage planning	Deterioration of heritage items, significant loss of historical authenticity for items that are listed or those items that may qualify for heritage listing	Statutory and non-statutory planning controls	2	U	3	Mod 6 Mod	2	U	3	Mod 6 Mod	2	U	3	Mod 6 Mod	2	U	3	Mod 6 Mod	Updating Aboriginal and non-Aboriginal heritage listings, including updating of mapping to ensure protection of any culturally significant heritage items
29	Estuary-wide	Coastal Use	Cultural and Social	Significant loss of historical authenticity for items that may qualify for heritage listing	Lack of forward planning, listing of items that may qualify for heritage listing and heritage status, lack of up-to-date mapping. Impacts from inundation, erosion and other natural and environmental impacts	Deterioration of heritage items, significant loss of historical authenticity for items that are listed or those items that may qualify for heritage listing	Statutory and non-statutory planning controls	2	U	3	Mod 6 Mod	2	U	3	Mod 6 Mod	2	U	3	Mod 6 Mod	2	U	3	Mod 6 Mod	Updating Aboriginal and non-Aboriginal heritage listings, including updating of mapping to ensure protection of any culturally significant heritage items
30	Estuary-wide	Coastal Use	Cultural and Social	Important loss of cultural significance	Lack of interpretive signage for educating the community about heritage and environment	Inadvertent damage to sites e.g. at Berrara Ck. Deterioration of heritage items, significant loss of historical authenticity for items that are listed or those items that may qualify for heritage listing	Statutory and non-statutory planning controls, mapping tools.	3	P	3	Mod 9 High	3	P	3	Mod 9 High	3	P	3	Mod 9 High	3	P	3	Mod 9 High	Updating Aboriginal and non-Aboriginal heritage listings, including updating of mapping to ensure protection of any culturally significant heritage items
31	Estuary-wide	Coastal Use	Cultural and Social	Severe deterioration of natural beauty or heritage value of heritage listed items	Human damage to culturally significant sites and artefacts	Inadvertent damage to sites e.g. at Berrara Ck. Deterioration of heritage items, significant loss of historical authenticity for items that are listed or those items that may qualify for heritage listing	Statutory and non-statutory planning controls, mapping tools.	3	P	3	Mod 9 High	3	P	3	Mod 9 High	3	P	3	Mod 9 High	3	P	3	Mod 9 High	Work together with traditional owners to devise culturally appropriate protection measures. Updating Aboriginal and non-Aboriginal heritage listings, including updating of mapping to ensure protection of any culturally significant heritage items
32	Estuary-wide	Coastal Use	Cultural and Social	Deterioration of heritage items due to erosion	Foreshore erosion due to human impacts as well as coastal hazards	Inadvertent damage to sites e.g. at Berrara Ck. Deterioration of heritage items, significant loss of historical authenticity for items that are listed or those items that may qualify for heritage listing	CMP - erosion mapping in relation to heritage items	3	P	3	Mod 9 High	3	P	3	Mod 9 High	3	P	3	Mod 9 High	3	P	3	Mod 9 High	Preparation of CMP with targeted actions to prevent/minimise disturbances/deterioration/impacts to heritage items
33	Estuary-wide	Coastal Use	Cultural and Social	Loss of protection of Aboriginal heritage items	Perceived conflict of interest/legislative loopholes between LALC and local tribe	Items that may qualify for heritage listing or status and existing Aboriginal cultural heritage may not be afforded quality of care or protection that they may require/deserve	Statutory and non-statutory planning controls, mapping tools.	2	U	3	Mod 6 Mod	2	U	3	Mod 6 Mod	2	U	3	Mod 6 Mod	2	U	3	Mod 6 Mod	Updating Aboriginal and non-Aboriginal heritage listings, including updating of mapping to ensure protection of any culturally significant heritage items
34	St. Georges Basin	Coastal Wetlands and Littoral Rainforest	Water Quality	Poor water quality inputs from tributaries (nutrients and suspended solids, DO and turbidity).	Pollution inputs into tributaries, including sediment pollution into estuary from development activities	Impacts on estuary ecology	Zoning/development controls within catchment area, control of urban runoff, community education, water quality monitoring program	5	AC	2	Min 10 High	5	AC	2	Min 10 High	5	AC	2	Min 10 High	5	AC	2	Min 10 High	Revised Water Quality Monitoring Program (including event monitoring). Review and where necessary upgrade or retrofit erosion and sediment controls. Identification of key development sites as root cause and more stringent regulation. Continue to apply Neutral or Beneficial Effect (NorBE) on water quality for all greenfield development proposed in the catchments of the St Georges Basin, Swan Lake and Berrara Creek as a minimum standard. Application of the risk-based framework for stormwater management to be considered into the future, particularly where it demonstrates a higher level of water quality mitigation than NorBE, likely to be more relevant for infill development and development of already cleared land.

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35	St. Georges Basin	Coastal Environment	Ecological Environment	Damage to estuarine vegetation, seagrass beds	Impact of jetties / waterfront structures on seagrass	Damage to seagrasses	Boating restrictions, NSW DPI mapping, vessel speed limits	5	AC	3	Mod	15	High	5	AC	3	Mod	15	High	5	AC	3	Mod	15	High	5	AC	3	Mod	15	High	Restricted vessel access to known/mapped seagrass areas, more stringent regulation on vessel speed limits, public education
36	St. Georges Basin	Coastal Environment	Ecological Environment	Threats to shorebirds around foreshore and islands in St Georges Basin	Disturbance of habitat and shorebird nesting due to public access and domestic/feral animals	Loss of shorebird habitat and changes to estuary ecology.	Access to islands managed by Jerrinja tribe. South Coast Shorebird Recovery Program	3	P	4	Maj	12	High	3	P	4	Maj	12	High	3	P	4	Maj	12	High	3	P	4	Maj	12	High	Community education, signage, restoration of disturbed habitat, feral animal control. Continuation of the South Coast Shorebird Recovery Program within St Georges Basin
37	St. Georges Basin	Coastal Environment	Water Quality	Impacts on estuary health	Climate change resulting in more frequent extreme events (drought, bushfires, flooding)	Impacts on water quality and estuary ecology	Water quality and estuary health monitoring program by Council DPE-EHG state-wide estuary health monitoring	3	P	4	Maj	12	High	3	P	4	Maj	12	High	4	L	4	Maj	16	High	5	AC	4	Maj	20	Extreme	Revised Council water quality monitoring program to include assessment of future impacts of drought, bushfires, flooding Report on the results of Councils WQ monitoring and any impacts on estuary health undertaken following the 2019-20 Bushfires. Continued monitoring of estuary health by DPE-EHG
38	St. Georges Basin	Coastal Environment	Ecological Environment	Damage to foreshore vegetation, saltmarsh	Illegal clearing, introduced animals (e.g. dogs). Illegal clearing is a problem especially in Tomerong Creek catchment. Mowing/damage to no-mow zones due to perceived risk following bushfires	Loss of habitat and changes to estuary ecology. Decreased buffering capacity.	Education	3	P	3	Mod	9	High	3	P	3	Mod	9	High	3	P	3	Mod	9	High	3	P	3	Mod	9	High	Stringent regulation on illegal clearing, replanting of targeted areas, better protection of significant ecological zones and maintaining no-mow zones, wildlife corridors and habitats. Specific surveys to map important ecological areas (e.g. Stingray habitat)
39	St. Georges Basin	Coastal Vulnerability	Tidal Inundation and Sea Level Rise	Coastal inundation of infrastructure	Sea Level Rises and changes to estuary hydraulics	Impact on foreshore infrastructure, access	Development controls	4	L	3	Mod	12	High	4	L	4	Maj	16	High	4	L	5	C	20	Extreme	5	AC	5	C	25	Extreme	Improved stormwater infrastructure to account for increased runoff during inundation events. Adaptation planning and potential moving of at risk infrastructure / redesign and siting of access points
40	St. Georges Basin	Coastal Vulnerability	Foreshore Erosion	Foreshore Erosion	Vessel waves, wind waves, high water levels, sea level rise. Erosion from boat wakes around boat ramps, including specifically around Boathaven Boat Ramp.	Damage to foreshore infrastructure and foreshore vegetation	Foreshore protection structures, development controls, vessel speed limits	4	L	3	Mod	12	High	4	L	3	Mod	12	High	4	L	3	Mod	12	High	4	L	3	Mod	12	High	Maintenance of structures as required, more stringent regulation on vessel speed limits, apply recommended actions from foreshore erosion Decision Support Tool
41	St. Georges Basin	Coastal Use	Navigation and Safety	Conflict between users of powered and non-powered craft	High demand for recreational use, increased demand due to COVID	Threat to recreational amenity	Provision of dedicated facilities for powered and non-powered vessel users	3	P	3	Mod	9	High	3	P	3	Mod	9	High	4	L	3	Mod	12	High	4	L	3	Mod	12	High	Community education for boaters/kayakers regarding water safety
42	St. Georges Basin	Coastal Use	Cultural and Social	Lack of public foreshore access	High private ownership of foreshore areas	Reduced foreshore access	Provision of additional foreshore recreation reserves	3	P	3	Mod	9	High	3	P	3	Mod	9	High	3	P	3	Mod	9	High	3	P	3	Mod	9	High	Explore opportunities to connect missing links in foreshore walk around St Georges Basin by provision of boardwalk below HWM, strategic acquisition, need for access to easements for utilities etc.
43	St. Georges Basin	Coastal Use	Navigation and Safety	Lack of public boating facilities	High demand for recreational use	Crowding at existing facilities	Routine maintenance of existing boating facilities	3	P	3	Mod	9	High	4	L	3	Mod	12	High	4	L	3	Mod	12	High	4	L	3	Mod	12	High	Demand study and upgrade of existing boating facilities if needed
44	St. Georges Basin	Coastal Use	Water Quality	Poor water quality inputs from tributaries (pathogens)	Poor water quality in tributaries - urban runoff, sewage overflows, agricultural runoff or environmental/natural sources	Reduced recreational amenity	Sewage treatment plant upgrade, sewerage infrastructure upgrade, community education, development controls	2	U	2	Min	4	Low	2	U	2	Min	4	Low	2	U	2	Min	4	Low	2	U	2	Min	4	Low	Review of sewage overflow, revised water quality program - including sanitary inspections, event sampling and could do additional faecal source tracking analysis (to identify source of faecal contamination), public education on suitable swimming times
45	St. Georges Basin	Coastal Use	Cultural and Social	Buildup of seagrass wrack at bathing area Blackett Park in front of Aloha Caravan Park	Natural part of system and provides habitat. Only an issue in front of seawalls	Reduced recreational amenity	Community education on wrack as habitat, Maintenance of seagrass wrack in front of seawalls	4	L	2	Min	6	Mod	4	L	2	Min	6	Mod	4	L	2	Min	6	Mod	4	L	2	Min	6	Mod	Community education on importance of seagrass wrack for estuary health. Removal of seagrass wrack only at locations where DPI issue permits e.g. at boat ramps or for aesthetic/health/recreational amenity at bathing areas only, refer Tuggerah Lakes seagrass management
46	St. Georges Basin	Coastal Use	Navigation and Safety	Navigational issues in Tomerong Creek	Insufficient navigation, powered vessels not suitable for creek	Reduced recreational amenity	Signage and vessel speed limits	5	AC	3	Mod	6	Mod	5	AC	3	Mod	6	Mod	5	AC	3	Mod	6	Mod	5	AC	3	Mod	6	Mod	Ban powerboats in Tomerong Creek, increase and provide more clear navigational aids to support safety

No.	Estuary	Coastal Management Area	Risk Category	Risk Description	Root Cause	Consequence	Existing Controls	Lkihood (1-5)		Consq.(1-5)		Pre Treatment Rating	Lkihood (1-5)		Consq.(1-5)		Pre Treatment Rating	Lkihood (1-5)		Consq.(1-5)		Pre Treatment Rating	Lkihood (1-5)		Consq.(1-5)		Pre Treatment Rating	Potential Management Actions
47	St. Georges Basin	Coastal Vulnerability	Tidal Inundation and Sea Level Rise	Isolation during inundation or bushfires such as access to Princes Highway being cut.	Sea Level Rise and inundation	Damage to infrastructure, loss of community access, impact on tourists	Development controls, monitoring, flood warning system and flood evacuation procedures	2	U	4	Maj	8 Mod	3	P	4	Maj	12 High	4	L	4	Maj	16 High	4	L	4	Maj	16 High	Community education on risk of not following evacuation orders, community education to enhance understanding of inundation risk, works to raise key evacuation routes above inundation levels Implementation of findings of the St Georges Basin Floodplain Risk Management Study and Plan (including emergency management aspects) Update of the Shoalhaven City Local Floodplan with the results of most recent modelling and studies
48	St. Georges Basin	Coastal Vulnerability	Tidal Inundation and Sea Level Rise	Tidal and Coastal Inundation of caravan parks on Crown Land	Sea Level Rise and inundation	Damage to infrastructure, loss of critical services, injury or death	Measures developed in Climate change and inundation Adaptation Report	3	P	4	Maj	12 High	3	P	4	Maj	12 High	4	L	4	Maj	16 High	4	L	4	Maj	16 High	Investigate tidal and coastal inundation risk to two low-lying caravan parks on Crown Land in St Georges Basin and work with low-lying caravan parks to update their emergency response plans to prepare for and respond to coastal hazards in the short term, and adapt to changing tidal and coastal inundation in the longer term. Implementation of findings of the St Georges Basin Floodplain Risk Management Study and Plan (including emergency management aspects)
49	St. Georges Basin	Coastal Environment	Ecological Environment	Impacts on estuary health from unauthorised dirt-bike and 4WD access	Access by 4WD and dirt bikes to sensitive estuarine areas	Trampling of sensitive vegetation, erosion	4WD/motorbike access management	3	P	3	Mod	9 High	3	P	3	Mod	9 High	3	P	3	Mod	9 High	3	P	3	Mod	9 High	Community education/signage, enforcement in areas where access not permitted
50	Sussex Inlet	Coastal Use	Navigation and Safety	Lack of vessel storage and no mooring options, long wait list for recreational vessels for new moorings	High demand for recreational boating	Reduced recreational amenity, economic opportunity cost	Mooring licences for registered moorings	4	L	3	Mod	12 High	4	L	3	Mod	12 High	4	L	3	Mod	12 High	4	L	3	Mod	12 High	Identify locations for vessel storage and potential to accommodate new registered moorings at alternative sites outside of the estuary. Support the implementation of the MEMS Domestic Foreshore Structure Strategy through the promotion of and reference to the strategy though the provision of planning advice and via Council's website
51	Sussex Inlet	Coastal Use	Foreshore Erosion	Foreshore Erosion	Erosion from tidal flows and natural meandering of channel, lack of riparian vegetation or failing bank protection ad hoc public access to waterway from foreshore	Sand entering/ moving within estuary channel causing hazard to navigation, damage to foreshore infrastructure and foreshore vegetation, loss of foreshore recreation area and loss of access to waterway	Ad-hoc foreshore protection structures, vessel speed limits, channel markers	4	L	4	Maj	16 High	4	L	4	Maj	16 High	4	L	4	Maj	16 High	4	L	4	Maj	16 High	Develop appropriate foreshore management actions or apply recommended actions from foreshore erosion Decision Support Tool. Maintenance of structures where these have been deemed to be effective, more stringent regulation on vessel speed limits. Altered location of channel markers as channel position changes
52	Sussex Inlet	Coastal Environment	Ecological Environment	Damage to seagrass beds at entrance to St Georges Basin	Damage to seagrass around some existing boating facilities (jetties, pontoons and boat ramps - boat moorings and damage caused by boats in shallow areas).	Damage to seagrasses	Public education, provision of dedicated anchorage area	3	P	3	Mod	9 High	3	P	3	Mod	9 High	3	P	3	Mod	9 High	3	P	3	Mod	9 High	Implementation of the Domestic Waterfront Structures Strategy for St Georges Basin and Sussex Inlet to reduce impacts to seagrass in the future
53	Sussex Inlet	Coastal Vulnerability	Tidal Inundation and Sea Level Rise	Isolation during inundation or bushfires such as access to Princes Highway being cut.	Sea Level Rise and inundation	Damage to infrastructure, loss of community access, impact on tourists	Development controls, monitoring, flood warning and flood evacuation procedures	3	P	4	Maj	12 High	3	P	4	Maj	12 High	4	L	4	Maj	16 High	5	AC	4	Maj	20 Extreme	Implementation of findings of the St Georges Basin Floodplain Risk Management Study and Plan (including emergency management aspects). Update Shoalhaven Local Flood Plan with the results of most recent modelling and studies. Community education on risk of not following evacuation orders, community education to enhance understanding of inundation risk, works to raise key evacuation routes above inundation levels
54	Sussex Inlet	Coastal Environment	Tidal Inundation and Sea Level Rise	Damage to estuarine vegetation	Sea Level Rise and inundation, conflict between maintenance of no-mow areas and public recreational uses	Loss or changes to biodiversity, landward migration of estuarine vegetation	Provision of no-mow areas	2	U	3	Mod	6 Mod	3	P	3	Mod	9 High	4	L	3	Mod	12 High	4	L	3	Mod	12 High	Community education on no-mow areas and enforcement, landward retreat of Council infrastructure e.g. playgrounds from vulnerable low-lying areas
55	Sussex Inlet	Coastal Vulnerability	Tidal Inundation and Sea Level Rise	Coastal and tidal inundation of infrastructure	Low lying development, lack of tourist awareness of flooding	Damage to infrastructure, loss of community access, impact on tourists	Development controls, monitoring, flood warning and flood evacuation procedures	4	L	4	Maj	16 High	4	L	4	Maj	16 High	5	AC	5	C	25 Extreme	5	AC	5	C	25 Extreme	Improved stormwater infrastructure to account for increased runoff during inundation events. Investigate feasibility of raising infrastructure and review development controls for floor elevations for residential dwellings, refer to and implement findings of the St Georges Basin Floodplain Risk Management Study and Plan (including emergency management aspects). Update Shoalhaven Local Flood Plan
56	Sussex Inlet	Coastal Use	Navigation and Safety	Poor navigation conditions into the Basin and near the entrance, and at Chris Creek and Alamein	Shoaling of channel	Impact on navigation	Monitoring, estuary maintenance/dredging	5	AC	4	Maj	20 Extreme	5	AC	4	Maj	20 Extreme	5	AC	4	Maj	20 Extreme	5	AC	4	Maj	20 Extreme	Undertake a detailed investigation into the feasibility of targeted dredging as per the Boating and Navigation Study. Such investigation would involve detailed seagrass mapping, sediment sampling, and sediment transport modelling. Undertake ongoing monitoring of sand movements via regular survey to assess long term sustainability of dredging.
57	Sussex Inlet	Coastal Use	Navigation and Safety	Difficulty navigating over entrance bar at low tide	Shallow entrance channel	Reduced access to open ocean from Sussex Inlet	Safety warning signs	4	L	3	Mod	12 High	4	L	3	Mod	12 High	4	L	3	Mod	12 High	4	L	3	Mod	12 High	Community education, signage, improve navigation aids, investigate feasibility of providing a boat ramp on the ocean side of the entrance as per CMP Boating and Navigation Study. Undertake targeted consultation with LALC regarding this option
58	Sussex Inlet	Coastal Use	Navigation and Safety	Poor navigation safety at night	Lack of lighting on navigation aids	Impact on navigation and safety for night-time navigation	None	5	AC	3	Mod	15 High	5	AC	3	Mod	15 High	5	AC	3	Mod	15 High	5	AC	3	Mod	15 High	Provision of lighting on navigation aids

No.	Estuary	Coastal Management Area	Risk Category	Risk Description	Root Cause	Consequence	Existing Controls	Lkihood (1-5)		Consq.(1-5)	Pre Treatment Rating	Lkihood (1-5)		Consq.(1-5)	Pre Treatment Rating	Lkihood (1-5)		Consq.(1-5)	Pre Treatment Rating	Lkihood (1-5)		Consq.(1-5)	Pre Treatment Rating	Potential Management Actions
59	Sussex Inlet	Coastal Use	Navigation and Safety	Conflict between users of powered and non-powered craft	High demand for recreational boating	Amenity, safety	Routine maintenance of existing boating facilities	4	L	3 Mod	12 High	4	L	3 Mod	12 High	4	L	3 Mod	12 High	4	L	3 Mod	12 High	Demand study and upgrade of existing boating facilities where required
60	Sussex Inlet	Coastal Vulnerability	Foreshore Erosion	Accelerating erosion risk to cabins near estuary mouth	Foreshore erosion due to flood flows, rainfall/runoff over slope, slope stability, and ocean waves, proximity of cabins to beach	Amenity, safety	none	3	P	3 Mod	9 High	3	P	3 Mod	9 High	3	P	3 Mod	9 High	3	P	3 Mod	9 High	Consider risk to cabins and build landward. Review development controls within CVA mapped areas – Development of a Planning Proposal to map a CVA
61	Sussex Inlet	Coastal Wetlands and Littoral Rainforest	Ecological Environment	Fragmentation of coastal wetland area	Urban encroachment	Threat to estuary ecology	Development controls. Zoning. Coastal Management Legislation	4	L	2 Min	8 Mod	4	L	2 Min	8 Mod	4	L	2 Min	8 Mod	4	L	2 Min	8 Mod	Review and where necessary update development controls (e.g. DCP) to ensure they are consistent with coastal legislation to ensure coastal wetlands are protected into the future.
62	Sussex Inlet	Coastal Environment	Ecological Environment	Possible ballast rock contributing to sedimentation of channel	Legacy issue from past landuse practices	Increased channel sedimentation, impact on recreational amenity	Study/survey to locate ballast rock	1	R	3 Mod	3 Low	1	R	3 Mod	3 Low	1	R	3 Mod	3 Low	1	R	3 Mod	3 Low	No further treatment action as studies did not find ballast rock to be present
63	Sussex Inlet	Coastal Use	Navigation and Safety	Reduced coastal amenity and compromised recreational use	Need for channel optimisation, sand nourishment/maintenance to revetment walls, review of the Canals Management Plan at Riviera Keys	Damage to revetment walls, increased channel sedimentation, impact on navigation and recreational amenity	Review Riviera Keys Canals Management Plan	5	AC	3 Mod	15 High	5	AC	3 Mod	15 High	5	AC	3 Mod	15 High	5	AC	3 Mod	15 High	Review Riviera Keys Canals Management Plan
64	Sussex Inlet	Coastal Environment	Ecological Environment	Impacts on estuary health from ad-hoc development and unapproved structures	Unchecked tourist development - caravans, ad-hoc jetties, caravan park, unapproved structures	Compromised estuary health	Development controls	5	AC	3 Mod	15 High	5	AC	3 Mod	15 High	5	AC	3 Mod	15 High	5	AC	3 Mod	15 High	Better monitoring and enforcement of illegal activities such as construction of unapproved structures
65	Sussex Inlet	Coastal Environment	Ecological Environment	Reduction in estuary health associated with sandmining impacts	Sandmining proposal (withdrawn in Jan 21)	Threats to estuary health	Environmental Approvals process, community submissions	2	U	4 Maj	8 Mod	2	U	4 Maj	8 Mod	2	U	4 Maj	8 Mod	2	U	4 Maj	8 Mod	No further treatment action required
66	Swan Lake	Coastal Environment	Ecological Environment	Impacts on estuary health	Boating, inadequate habitat protection, urban encroachment, invasive species	Compromised estuary health	Development controls	5	AC	3 Mod	15 High	5	AC	3 Mod	15 High	5	AC	3 Mod	15 High	5	AC	3 Mod	15 High	Greater protection to natural vegetation and nesting areas, tighter controls on powered boats, targeted ecological surveys to monitor communities, updated macrophyte mapping
67	Swan Lake	Coastal Environment	Ecological Environment	Invasive weeds	Urban landuse and general spread of invasive species	Threat to estuary ecology	Development controls, public education	3	P	2 Min	6 Mod	3	P	2 Min	6 Mod	3	P	2 Min	6 Mod	3	P	2 Min	6 Mod	Community planting and weeding programs, maintenance of reserves
68	Swan Lake	Coastal Environment	Ecological Environment	Risk to Green and Golden Bell Frog habitat at Swan Lake STP	Habitat loss due to surrounding landuse	Threat to estuary ecology	Ecological survey, monitoring	3	P	2 Min	6 Mod	3	P	2 Min	6 Mod	3	P	2 Min	6 Mod	3	P	2 Min	6 Mod	Ongoing monitoring to gauge health of population, educational signage
69	Swan Lake	Coastal Environment	Ecological Environment	Degradation of habitat for shorebirds and aquatic ecology (decline in Ruppia seagrasses in 2004 v 1980),	Pollution, entrance management practices	Threat to estuary ecology	Entrance Management, South Coast Shorebirds Recovery Program	3	P	2 Min	6 Mod	3	P	2 Min	6 Mod	3	P	2 Min	6 Mod	3	P	2 Min	6 Mod	Updated NSW DPI Macrophyte Mapping, signage and education on parking in camping and reserve areas
70	Swan Lake	Coastal Use	Water Quality	Poor water quality (pathogens) at inlet	Urban runoff, stormwater pollution, sewage overflows or environmental sources	Recreational amenity	Development controls, public education, publication of water quality results for swimming safety on Councils website, stormwater treatment	3	P	2 Min	6 Mod	3	P	2 Min	6 Mod	3	P	2 Min	6 Mod	3	P	2 Min	6 Mod	Revised Council water quality program - including sanitary inspections on an as-needs basis, event sampling, consideration of fish kills and continued publication of WQ results on Council web-site.

No.	Estuary	Coastal Management Area	Risk Category	Risk Description	Root Cause	Consequence	Existing Controls	Lkihood (1-5)		Consq.(1-5)	Pre Treatment Rating	Lkihood (1-5)		Consq.(1-5)	Pre Treatment Rating	Lkihood (1-5)		Consq.(1-5)	Pre Treatment Rating	Lkihood (1-5)		Consq.(1-5)	Pre Treatment Rating	Potential Management Actions
71	Swan Lake	Coastal Use	Water Quality	Poor water quality in Swan Lake (Stakeholder perceptions)	Stakeholder concerns on water quality in Swan Lake. However, monitoring shows that apart from the inlet water quality is good and typical of back dune lagoon environments	Threat to estuary ecology	Development controls, public education, publication of water quality results for swimming safety on Councils web-site, stormwater treatment	3	P	2 Min	6 Mod	3	P	2 Min	6 Mod	3	P	2 Min	6 Mod	3	P	2 Min	6 Mod	Community education, revised water quality monitoring program (including adopting DP&E MER guidelines for back dune lagoons)
72	Swan Lake	Coastal Environment	Ecological Environment	Erosion of dunes, damage to dune vegetation	Natural channel migration	Damage to dune vegetation at eastern bend of estuary channel, risk of entrance breakthrough	Entrance Management Plan, public education	4	L	3 Mod	12 High	4	L	3 Mod	12 High	4	L	3 Mod	12 High	4	L	3 Mod	12 High	Monitor and update Entrance Management Plan to reduce risk of opening at The Gap
73	Swan Lake	Coastal Vulnerability	Tidal Inundation and Sea Level Rise	Coastal inundation of infrastructure	Low lying development	Damage to infrastructure/loss of community access	Entrance Management, development controls	3	P	3 Mod	9 High	3	P	3 Mod	9 High	4	L	4 Maj	16 High	5	AC	4 Maj	20 Extreme	Improved stormwater infrastructure to account for increased backflows during coastal inundation events. Adaptation planning, raising/moving of at-risk infrastructure or access points e.g. access to The Springs Cabins. Updated development controls within CVA mapped areas. Updated entrance management policy
74	Swan Lake	Coastal Environment	Ecological Environment	Introduced species threatening native wildlife	Past landuse practices	Threat to estuary ecology	Feral animal control methods, fencing	3	P	3 Mod	9 High	3	P	3 Mod	9 High	3	P	3 Mod	9 High	3	P	3 Mod	9 High	Undertake investigation into presence and impact of feral animals in the study area
75	Swan Lake	Coastal Environment	Ecological Environment	Altered ecology within lake	Climate change = more frequent extreme events (drought and bushfires)	Threat to estuary ecology (community perception of decline in charophytes and swans)	Entrance Management Policy	3	P	3 Mod	9 High	3	P	3 Mod	9 High	4	L	4 Maj	16 High	5	AC	4 Maj	20 Extreme	Research project potentially in conjunction with university to understand what if any changes to the ecology of the lake have occurred and the likely causes
76	Swan Lake	Coastal Environment	Ecological Environment	Changes to estuarine morphology	Past bridge construction	Community perception that bridge has led to reduced entrance opening and altered channel alignment	Entrance Management	3	P	3 Mod	9 High	3	P	3 Mod	9 High	3	P	3 Mod	9 High	3	P	3 Mod	9 High	Investigate impact on lake morphology when bridge is due for upgrade/replacement at the end of its design life. Consideration of old alignment within new bridge design while also protecting wetlands that have grown since construction.
77	Swan Lake	Coastal Environment	Ecological Environment	Artificial lake openings affecting fish populations, shorebirds and wetlands	Artificial lake openings primarily done illegally by the public outside of entrance management policy triggers	Threat to estuary ecology	Entrance Management	3	P	3 Mod	9 High	3	P	3 Mod	9 High	3	P	3 Mod	9 High	3	P	3 Mod	9 High	Review of Entrance Management Policy, targeted community education including for holidaymakers, signage, regular patrols, enforcement Provision of additional recreational facilities that can be utilised by the public during high lake water levels (e.g. pontoons for swimming).
78	Swan Lake	Coastal Vulnerability	Tidal Inundation and Sea Level Rise	Isolation during inundation or bushfires such as access to Princes Highway being cut.	Sea Level Rise and inundation	Damage to infrastructure, loss of community access, impact on tourists	Development controls, monitoring, flood warning system and flood evacuation procedures, Floodplain Risk Management Study and Plan	2	U	4 Maj	8 Mod	3	P	4 Maj	12 High	4	L	4 Maj	16 High	4	L	4 Maj	16 High	Update Shoalhaven Local Flood Plan, Community education on risk of not following evacuation orders, community education to enhance understanding of inundation risk, works to raise key evacuation routes above inundation levels. Complete a Flood Study and Floodplain Risk Management Study & Plan for Swan Lake
79	Swan Lake	Coastal Environment	Foreshore Erosion	Bank erosion	Boating activities, wind waves, high water levels	Threat to estuary ecology	Development controls for flood-prone areas, vessel speed limits, entrance management	2	U	3 Mod	6 Mod	2	U	3 Mod	6 Mod	2	U	3 Mod	6 Mod	2	U	3 Mod	6 Mod	More stringent regulation on vessel speed limits, revised entrance management policy, repair of access stairs in Cudmirrah to prevent people shortcutting through vegetation.
80	Swan Lake	Coastal Use	Navigation and Safety	Overcrowding at boat launching areas, safety issues with boat ramp	High demand for boating activities, inadequate facilities	Impact on recreational amenity at foreshore reserves	Upgrade existing boat launching facilities e.g. at The Springs Road Ski Beach Boat ramp	5	AC	2 Min	10 High	5	AC	2 Min	10 High	5	AC	2 Min	10 High	5	AC	2 Min	10 High	Additional or upgraded facilities, including upgraded boat ramp at Swan Lake Ski Beach Boat Ramp; Signage and enforcement to ensure powered craft not launched next to and are kept away from designated swimming areas

No.	Estuary or Beach	Coastal Management Area	Risk Category	Hazard	Risk Description	Root Cause	Consequence	Existing Controls	Present Day Likelihood (1-5)		Present Day Consequence (1-5)		Present Day Pre Treatment Rating		20 year Likelihood (1-5)		20 year Consequence (1-5)		20 year Pre Treatment Rating		50 year Likelihood (1-5)		50 year Consequence (1-5)		50 year Pre Treatment Rating		100 year Likelihood (1-5)		100 year Consequence (1-5)		100 year Pre Treatment Rating		Potential Management Actions
1	Estuary-wide	Coastal Vulnerability	Property & Infrastructure	Erosion	Erosion damage to sewage pumping stations	Lack of foreshore vegetation, boat wash, wind waves, privately managed foreshore	Sewage overflow, with major environmental, health and financial consequences	Repair and replace	3	Possible	4	Major	12	High	3	Possible	4	Major	12	High	3	Possible	4	Major	12	High	3	Possible	4	Major	12	High	Investigate landward relocation or protection of infrastructure
2	Estuary-wide	Coastal Vulnerability	Property & Infrastructure	Erosion	Erosion damage to sewage treatment works	Lack of foreshore vegetation, boat wash, wind waves, privately managed foreshore	Sewage overflow, with major environmental, health and financial consequences	Repair and replace	1	Rare	4	Major	4	Low	1	Rare	4	Major	4	Low	1	Rare	4	Major	4	Low	1	Rare	4	Major	4	Low	Investigate landward relocation or protection of infrastructure
3	St Georges Basin	Coastal Vulnerability	Property & Infrastructure	Erosion	Erosion damage to critical wastewater mains	Lack of foreshore vegetation, boat wash, wind waves, privately managed foreshore	Sewage overflow, with major environmental, health and financial consequences	Repair and replace	4	Likely	4	Major	16	High	4	Likely	4	Major	16	High	4	Likely	4	Major	16	High	4	Likely	4	Major	16	High	Investigate landward relocation or protection of infrastructure
4	Estuary-wide	Coastal Vulnerability	Property & Infrastructure	Erosion	Erosion damage to water pumping stations and critical water mains	Lack of foreshore vegetation, boat wash, wind waves, privately managed foreshore	Temporary shutdown of water distribution network	Repair and replace	1	Rare	4	Major	4	Low	1	Rare	4	Major	4	Low	1	Rare	4	Major	4	Low	1	Rare	4	Major	4	Low	Investigate landward relocation or protection of infrastructure
5	Estuary-wide	Coastal Vulnerability	Property & Infrastructure	Erosion	Erosion damage to stormwater infrastructure	Lack of foreshore vegetation, boat wash, wind waves, privately managed foreshore, stormwater outflow	Damage to foreshore and infrastructure from erosion	Repair and replace	4	Likely	2	Minor	8	Moderate	4	Likely	2	Minor	8	Moderate	4	Likely	2	Minor	8	Moderate	4	Likely	2	Minor	8	Moderate	More environmentally-focussed designs of stormwater outlets (e.g. focusing on energy dissipation), strategically increase output of stormwater flows. Protect, strengthen or remove vulnerable stormwater assets
6	Estuary-wide	Coastal Vulnerability	Property & Infrastructure	Erosion	Erosion damage to picnic shelters/park furniture	Lack of foreshore vegetation, boat wash, wind waves, privately managed foreshore	Impact on users	Repair and replace	4	Likely	2	Minor	8	Moderate	4	Likely	2	Minor	8	Moderate	4	Likely	2	Minor	8	Moderate	4	Likely	2	Minor	8	Moderate	Revegetation of areas of moderate foreshore bank erosion. Investigate options for engineered erosion control where necessary.
7	St Georges Basin, Sussex Inlet	Coastal Vulnerability	Property & Infrastructure	Erosion	Erosion damage to playgrounds	Lack of foreshore vegetation, boat wash, wind waves, privately managed foreshore	Impact on users	Repair and replace	4	Likely	2	Minor	8	Moderate	4	Likely	2	Minor	8	Moderate	4	Likely	2	Minor	8	Moderate	4	Likely	2	Minor	8	Moderate	Revegetation of areas of moderate foreshore bank erosion. Investigate options for engineered erosion control where necessary.
8	St Georges Basin	Coastal Vulnerability	Property & Infrastructure	Erosion	Erosion damage to sporting facilities	Lack of foreshore vegetation, boat wash, wind waves, privately managed foreshore	Impact on users	Repair and replace	3	Possible	2	Minor	6	Moderate	3	Possible	2	Minor	6	Moderate	3	Possible	2	Minor	6	Moderate	3	Possible	2	Minor	6	Moderate	Revegetation of areas of moderate foreshore bank erosion. Investigate options for engineered erosion control where necessary.
9	Estuary-wide	Coastal Vulnerability	Property & Infrastructure	Erosion	Erosion damage to local roads	Lack of foreshore vegetation, boat wash, wind waves, privately managed foreshore	Safety, loss of access	Repair/ replace/ temporary road closures	3	Possible	4	Major	12	High	3	Possible	4	Major	12	High	3	Possible	4	Major	12	High	3	Possible	4	Major	12	High	Investigate landward relocation or protection of infrastructure
10	Estuary-wide	Coastal Vulnerability	Property & Infrastructure	Erosion	Erosion damage to major/arterial roads	Lack of foreshore vegetation, boat wash, wind waves, privately managed foreshore	Safety, loss of access	Repair/ replace/ temporary road closures	2	Unlikely	5	Catastrophic	10	High	2	Unlikely	5	Catastrophic	10	High	2	Unlikely	5	Catastrophic	10	High	2	Unlikely	5	Catastrophic	10	High	Investigate landward relocation or protection of infrastructure
11	St Georges Basin, Sussex Inlet	Coastal Vulnerability	Property & Infrastructure	Erosion	Erosion damage to foreshore seawalls	Lack of foreshore vegetation, boat wash, wind waves, privately managed foreshore	Loss of land due to inadequate protection provided by seawalls	Assess, repair and replace	4	Likely	2	Minor	8	Moderate	4	Likely	2	Minor	8	Moderate	4	Likely	2	Minor	8	Moderate	4	Likely	2	Minor	8	Moderate	Rebuild these to a higher grade, control wake boats, repair existing seawalls along public foreshores, particularly opposite St Georges Basin
12	St Georges Basin, Sussex Inlet	Coastal Vulnerability	Property & Infrastructure	Erosion	Erosion damage to boat ramps/fishing platforms/access tracks	Lack of foreshore vegetation, boat wash, wind waves, privately managed foreshore	Impact on users	Repair/replace	4	Likely	4	Major	16	High	4	Likely	4	Major	16	High	4	Likely	4	Major	16	High	4	Likely	4	Major	16	High	Investigate landward relocation, redesign/reconstruction or protection of infrastructure
13	St Georges Basin, Sussex Inlet	Coastal Vulnerability	Property & Infrastructure	Coastal Inundation	Inundation of sewage pumping stations	High coastal water levels in estuary	Sewer overflows, risk to health, environment, financial cost to replace electronics	Repair/replace	3	Possible	5	Catastrophic	15	High	3	Possible	5	Catastrophic	15	High	4	Likely	5	Catastrophic	20	Extreme	5	Almost Certain	5	Catastrophic	25	Extreme	Investigate feasibility of raising pumping stations on a case-by-case basis
14	Estuary-wide	Coastal Vulnerability	Property & Infrastructure	Coastal Inundation	Inundation of sewage treatment works	High coastal water levels in estuary	Sewer overflows, risk to health, environment, financial cost to replace electronics	Repair/replace	1	Rare	5	Catastrophic	5	Moderate	1	Rare	5	Catastrophic	5	Moderate	1	Rare	5	Catastrophic	5	Moderate	2	Unlikely	5	Catastrophic	10	High	Protect works and components from future inundation, redesign
15	St Georges Basin, Sussex Inlet	Coastal Vulnerability	Property & Infrastructure	Coastal Inundation	Short term (several hours) Inundation of critical wastewater mains or sewage pumping stations	Tidal inundation from high coastal water levels in estuary	ingress of stormwater into sewer network leading to sewer overflows, risk to health, environment and Council reputation	Repair/replace	3	Possible	3	Moderate	9	High	3	Possible	3	Moderate	9	High	4	Likely	3	Moderate	12	High	5	Almost Certain	3	Moderate	15	High	Increased funding to support post-emergency asset assessments and have a strategic plan of assessment based on priority. Audit water and sewer infrastructure and upgrade where needed
16	St Georges Basin, Sussex Inlet	Coastal Vulnerability	Property & Infrastructure	Coastal Inundation	Long term (several days) Inundation of critical wastewater mains or sewage pumping stations	Coastal inundation from coastal storm event	ingress of stormwater into sewer network leading to sewer overflows, risk to health, environment and Council reputation	Repair/replace	2	Unlikely	4	Major	8	Moderate	3	Possible	4	Major	12	High	3	Possible	4	Major	12	High	4	Likely	4	Major	16	High	Increased funding to support post-emergency asset assessments and have a strategic plan of assessment based on priority. Audit water and sewer infrastructure and upgrade where needed
17	Swan Lake/ Berrara Creek	Coastal Vulnerability	Property & Infrastructure	Coastal Inundation	Inundation of water pumping stations and critical water mains	High coastal water levels in estuary	Sewer overflows, risk to health, environment, financial cost to replace electronics	Repair/replace	2	Unlikely	4	Major	8	Moderate	2	Unlikely	4	Major	8	Moderate	3	Possible	4	Major	12	High	3	Possible	4	Major	12	High	Protect pump station and components from future inundation, redesign
18	Estuary-wide	Coastal Vulnerability	Property & Infrastructure	Coastal Inundation	Inundation of stormwater infrastructure	High coastal water levels in estuary	Isolation of communities, loss of community access, flooding due to reduced network capacity	Repair/replace	4	Likely	4	Major	16	High	4	Likely	4	Major	16	High	5	Almost Certain	4	Major	20	Extreme	5	Almost Certain	4	Major	20	Extreme	One-way valves for stormwater, increase/encourage use of rainwater tanks
19	Estuary-wide	Coastal Vulnerability	Property & Infrastructure	Coastal Inundation	Inundation of picnic shelters/park furniture	High coastal water levels in estuary	Community safety/mental health, financial loss, increased maintenance costs	Repair/replace	4	Likely	2	Minor	8	Moderate	4	Likely	2	Minor	8	Moderate	5	Almost Certain	2	Minor	10	High	5	Almost Certain	2	Minor	10	High	Increased funding to support post-emergency asset assessments and have a strategic plan of assessment based on priority Upgrade of materials for park furniture/playgrounds to improve resilience against inundation
20	Estuary-wide	Coastal Vulnerability	Property & Infrastructure	Coastal Inundation	Inundation of playgrounds	High coastal water levels in estuary	Community safety/mental health, financial loss, increased maintenance costs	Repair/replace	4	Likely	2	Minor	8	Moderate	4	Likely	2	Minor	8	Moderate	5	Almost Certain	2	Minor	10	High	5	Almost Certain	2	Minor	10	High	Increased funding to support post-emergency asset assessments and have a strategic plan of assessment based on priority Upgrade of materials for park furniture/playgrounds to improve resilience against inundation
21	Estuary-wide	Coastal Vulnerability	Property & Infrastructure	Coastal Inundation	Inundation of sporting facilities	High coastal water levels in estuary	Community safety/mental health, financial loss, increased maintenance costs	Repair/replace	4	Likely	2	Minor	8	Moderate	4	Likely	2	Minor	8	Moderate	5	Almost Certain	2	Minor	10	High	5	Almost Certain	2	Minor	10	High	Increased funding to support post-emergency asset assessments and have a strategic plan of assessment based on priority Upgrade of materials for park furniture/playgrounds to improve resilience against inundation
22	Estuary-wide	Coastal Vulnerability	Safety	Coastal Inundation	Inundation of local roads	High coastal water levels in estuary	Isolation of communities, loss of community access	close roads and emergency management measures such as signage.	5	Almost Certain	4	Major	20	Extreme	5	Almost Certain	4	Major	20	Extreme	5	Almost Certain	4	Major	20	Extreme	5	Almost Certain	4	Major	20	Extreme	Education of community regarding level of risk from inundation, raise roads, investigate feasibility of providing additional culverts below raised roads

No.	Estuary or Beach	Coastal Management Area	Risk Category	Hazard	Risk Description	Root Cause	Consequence	Existing Controls	Present Day Likelihood (1-5)		Present Day Consequence (1-5)		Present Day Pre Treatment Rating		20 year Likelihood (1-5)		20 year Consequence (1-5)		20 year Pre Treatment Rating		50 year Likelihood (1-5)		50 year Consequence (1-5)		50 year Pre Treatment Rating		100 year Likelihood (1-5)		100 year Consequence (1-5)		100 year Pre Treatment Rating		Potential Management Actions
23	Estuary-wide	Coastal Vulnerability	Safety	Coastal Inundation	Inundation of major/arterial roads	High coastal water levels in estuary	Isolation of communities, loss of community access, injury or death, loss of first responders access	close roads and emergency management measures such as signage.	4	Likely	5	Catastrophic	20	Extreme	4	Likely	5	Catastrophic	20	Extreme	4	Likely	5	Catastrophic	20	Extreme	5	Almost Certain	5	Catastrophic	25	Extreme	Education of community regarding level of risk from inundation, raise upgrade roads
24	Swan Lake/ Berrara Creek	Coastal Vulnerability	Safety	Coastal Inundation	Inundation of tourism infrastructure e.g. council-owned caravan park	High coastal water levels in estuary	Temporary loss of access to infrastructire, damage	emegency mangement measures, repair infrastructure following inundation event	3	Possible	4	Major	12	High	3	Possible	4	Major	12	High	4	Likely	4	Major	16	High	4	Likely	4	Major	16	High	Ensure stormwater infrastructure outside of park boundary is regularly cleared to ensure adequate drainage
25	Swan Lake/ Berrara Creek	Coastal Vulnerability	Property & Infrastructure	Coastal Inundation	Closure of The Springs Road at Cudmirrah due to inundation or flood damage	High coastal water levels in estuary	Temporary loss of access to Cudmirrah and Berrara	close roads and emergency management measures such as signage.	3	Possible	4	Major	12	High	4	Likely	4	Major	16	High	4	Likely	4	Major	16	High	5	Almost Certain	4	Major	20	Extreme	Upgrade The Springs Road to be above flood level
26	Swan Lake/ Berrara Creek	Coastal Vulnerability	Property & Infrastructure	Coastal Inundation	Damage to Swan Lake Bridge from inundation	High coastal water levels in estuary, undermining of bridge due to outflow currents	Medium-long term loss of access to Cudmirrah and Berrara	Repair bridge	3	Possible	5	Catastrophic	15	High	3	Possible	5	Catastrophic	15	High	4	Likely	5	Catastrophic	20	Extreme	4	Likely	5	Catastrophic	20	Extreme	Upgrade bridge to accommodate inundation
27	Sussex Inlet	Coastal Vulnerability	Property & Infrastructure	Coastal Inundation	Inundation/Isolation of Badgee lagoon area	High coastal water levels in estuary	Isolation of communities, loss of community access, injury or death	close roads and emergency management measures such as signage.	4	Likely	4	Major	16	High	4	Likely	4	Major	16	High	4	Likely	4	Major	16	High	5	Almost Certain	4	Major	20	Extreme	future road upgrades
28	Estuary-wide	Coastal Vulnerability	Property & Infrastructure	Coastal Inundation	Inundation damage of local and major arterial roads, potholes	High coastal water levels in estuary	Damage to vehicles, loss of access, safety	Carry out repairs	5	Almost Certain	3	Moderate	15	High	5	Almost Certain	3	Moderate	15	High	5	Almost Certain	3	Moderate	15	High	5	Almost Certain	3	Moderate	15	High	Learn from program of pothole repairs implemented following the East Coast Low events of March and April 2022 to improve response and be adaptive/responsive as a workforce

No.	Estuary or Beach	Location	Coastal Management Area	Risk Category	Hazard	Risk Description	Root Cause	Consequence	Existing Controls	Present Day Likelihood (1-5)		Present Day Consequence (1-5)		Present Day Pre Treatment Rating		20 year Likelihood (1-5)		20 year Consequence (1-5)		20 year Pre Treatment Rating		50 year Likelihood (1-5)		50 year Consequence (1-5)		50 year Pre Treatment Rating		100 year Likelihood (1-5)		100 year Consequence (1-5)		100 year Pre Treatment Rating		Potential Management Actions
1	Berrara Creek	275906E, 6101279N	Coastal Vulnerability	Property & Infrastructure	Erosion	Risk of erosion damage to trunk water main ID 47522	Rainfall/runoff erosion	Damage to water main, loss of water supply to area	Repair water main	3	Possible	4	Major	12	High	3	Possible	4	Major	12	High	3	Possible	4	Major	12	High	3	Possible	4	Major	12	High	Redirect stormwater runoff to reduce erosion risk
2	Berrara Creek	276612E, 6101443N	Coastal Vulnerability	Property & Infrastructure	Erosion	Risk of erosion to stormwater headwall <450mm dia ID LAKEL12	Wind waves, swell when entrance open, rainfall/runoff, lake flows	Damage/undermining of headwall	Repair and replace	3	Possible	2	Minor	6	Moderate	3	Possible	2	Minor	6	Moderate	3	Possible	2	Minor	6	Moderate	3	Possible	2	Minor	6	Moderate	Provide scour protection at outlet
3	Berrara Creek	276612E, 6101443N	Coastal Vulnerability	Property & Infrastructure	Erosion	Risk of erosion to stormwater headwall 450 - 600 mm dia ID LAKEL10	Wind waves, swell when entrance open, rainfall/runoff, lake flows	Damage/undermining of headwall	Repair and replace	3	Possible	2	Minor	6	Moderate	3	Possible	2	Minor	6	Moderate	3	Possible	2	Minor	6	Moderate	3	Possible	2	Minor	6	Moderate	Provide scour protection at outlet
4	Berrara Creek	276782E, 6101014N	Coastal Vulnerability	Property & Infrastructure	Erosion	Erosion damage to coastal accessway ID155838	Swell when entrance open, lake flows, rainfall/runoff from top of slope	Damage to accessway, loss of access	Repair and replace	4	Likely	3	Moderate	12	High	4	Likely	3	Moderate	12	High	4	Likely	3	Moderate	12	High	4	Likely	3	Moderate	12	High	Redesign accessway to reduce risk of damage
5	Berrara Creek	276158E, 6101438N	Coastal Vulnerability	Property & Infrastructure	Tidal Inundation	Inundation of water pumping stations and critical water mains	Sea level rise	Temporary shutdown of water distribution network	Repair and replace	1	Rare	4	Major	4	Low	1	Rare	4	Major	4	Low	2	Unlikely	4	Major	8	Moderate	3	Possible	4	Major	12	High	Protect pump station and components from future inundation, redesign, investigate landward relocation of infrastructure
6	Swan Lake	277813E, 6101990N	Coastal Vulnerability	Property & Infrastructure	Erosion	Erosion damage to service vehicle access track	Lake outflow when entrance open, swell waves when entrance open	Lack of access for service vehicles to manage entrance	Repair as needed	3	Possible	2	Minor	6	Moderate	3	Possible	2	Minor	6	Moderate	3	Possible	2	Minor	6	Moderate	3	Possible	2	Minor	6	Moderate	Consider redesign to improve track resilience e.g. provide gravel surface or geogrid
7	Swan Lake	277881E, 6102257N	Coastal Vulnerability	Property & Infrastructure	Erosion	Erosion damage to open drain Koolyn Dr ID11422	Lake outflow when entrance open	Impact on drainage network upstream	Inspect and repair if required	3	Possible	1	Insignificant	3	Low	3	Possible	1	Insignificant	3	Low	3	Possible	1	Insignificant	3	Low	3	Possible	1	Insignificant	3	Low	Identify impact of damage to drainage network on inundation upstream
8	Swan Lake	277912E, 6102574N	Coastal Vulnerability	Property & Infrastructure	Erosion	Erosion damage to Swan Lake Bridge abutments, collapse of bridge, damage to trunk water main 450mm ID 33972, damage to critical wastewater main 300mm rising main ID173682	Lake outflow when entrance open, increase in outflow velocity/volume if lake opens at The Gap	Medium-long term loss of access to Cudmirrah and Berrara, damage to services (water, sewer)	Repair bridge and replace services	1	Rare	5	Catastrophic	5	Moderate	2	Unlikely	5	Catastrophic	10	High	3	Possible	5	Catastrophic	15	High	3	Possible	5	Catastrophic	15	High	Investigate future upgrade of bridge, beach scraping to reduce risk of opening at The Gap
9	Swan Lake	277331E, 6102606N	Coastal Vulnerability	Property & Infrastructure	Erosion	Erosion damage to open drain Goonawarra Dr ID11554	Wind waves at high water levels, rainfall/runoff	Impact on drainage network upstream	Inspect and repair if required	2	Unlikely	1	Insignificant	2	Low	2	Unlikely	1	Insignificant	2	Low	2	Unlikely	1	Insignificant	2	Low	2	Unlikely	1	Insignificant	2	Low	Inspect and provide scour protection at outlet if necessary
10	Swan Lake	277444E, 6102597N	Coastal Vulnerability	Property & Infrastructure	Erosion	Erosion damage to open drain Goonawarra Dr ID11555	Wind waves at high water levels, lake outflow when open	Impact on drainage network upstream	Inspect and repair if required	2	Unlikely	1	Insignificant	2	Low	2	Unlikely	1	Insignificant	2	Low	2	Unlikely	1	Insignificant	2	Low	2	Unlikely	1	Insignificant	2	Low	Inspect and provide scour protection at outlet if necessary
11	Swan Lake	277875E, 6102602N	Coastal Vulnerability	Property & Infrastructure	Erosion	Erosion risk to sewage pumping station Goonawarra Dr SPS No. 14	Lake outflow when open, higher outflow flows and velocities if lake were to open at The Gap	Sewage overflow, with major environmental, health and financial consequences	Inspect and repair if required	2	Unlikely	4	Major	8	Moderate	2	Unlikely	4	Major	8	Moderate	2	Unlikely	4	Major	8	Moderate	2	Unlikely	4	Major	8	Moderate	Investigate design of pumping station to improve resilience against future erosion event
12	Swan Lake	277875E, 6102602N	Coastal Vulnerability	Property & Infrastructure	Tidal Inundation	Short term (several hours) Inundation of critical wastewater mains or sewage pumping stations Goonawarra Dr SPS No. 14	Sea level rise	Sewer overflows, risk to health, environment, financial cost to replace electronics	Repair/replace	1	Rare	5	Catastrophic	5	Moderate	1	Rare	5	Catastrophic	5	Moderate	2	Unlikely	5	Catastrophic	10	High	2	Unlikely	5	Catastrophic	10	High	Investigate feasibility of raising pumping stations on a case-by-case basis
13	Swan Lake	278000E, 6102631N	Coastal Vulnerability	Property & Infrastructure	Coastal Inundation	Closure of The Springs Road at Cudmirrah due to inundation or flood damage	High coastal water levels in estuary, future sea level rise	Temporary loss of access to Cudmirrah and Berrara	close roads and emergency management measures such as signage.	2	Unlikely	4	Major	8	Moderate	3	Possible	4	Major	12	High	3	Possible	4	Major	12	High	4	Likely	4	Major	16	High	Upgrade The Springs Road to be above inundation level, i.e. above 2.5 m AHD plus freeboard
14	Swan Lake	277775E, 6102480N	Coastal Vulnerability	Property & Infrastructure	Coastal Inundation	Inundation of low-lying parts of Holiday Haven caravan Park., Cudmirrah	High coastal water levels in estuary, future sea level rise	Temporary loss of access to cabins, damage	Repair cabins following inundation event	1	Rare	3	Moderate	3	Low	2	Unlikely	3	Moderate	6	Moderate	2	Unlikely	3	Moderate	6	Moderate	3	Possible	3	Moderate	9	High	Investigate raising of affected cabins
15	Swan Lake	277850E, 6102700N	Coastal Vulnerability	Property & Infrastructure	Coastal Inundation	Inundation of picnic shelters/park furniture	Tidal inundation from high coastal water levels in estuary	Community safety/mental health, financial loss, increased maintenance costs	Repair if required following event	2	Unlikely	2	Minor	4	Low	2	Unlikely	2	Minor	4	Low	2	Unlikely	2	Minor	4	Low	3	Possible	2	Minor	6	Moderate	Investigate provision of resilient infrastructure if needed
16	Swan Lake	278315E, 6102868N	Coastal Vulnerability	Property & Infrastructure	Erosion	Erosion damage to Swan Lake boat ramp	Wind waves	Damage to boat ramp and impact on users	Repair if required following event	2	Unlikely	3	Moderate	6	Moderate	2	Unlikely	3	Moderate	6	Moderate	2	Unlikely	3	Moderate	6	Moderate	2	Unlikely	3	Moderate	6	Moderate	Upgrade ramp to provide improved resilience to erosion events
17	Sussex Inlet	280401E, 6105108N	Coastal Vulnerability	Property & Infrastructure	Erosion	Damage to 375mm dia RCP drainage pipe due to erosion, Drain line 7100	Erosion in canal due to outflow through channel causing undermining of outlet, stormwater outflow through pipe causing erosion	Damage to pipe, damage to bank due to stormwater flows	Repair if required following event	3	Possible	1	Insignificant	3	Low	3	Possible	1	Insignificant	3	Low	3	Possible	1	Insignificant	3	Low	3	Possible	1	Insignificant	3	Low	Consider providing energy dissipation at outlet, or headwall
18	Sussex Inlet	280344E, 6105120N	Coastal Vulnerability	Property & Infrastructure	Erosion	Damage to 375mm dia RCP drainage pipe due to erosion, Darin Line 7101	Erosion in canal due to outflow through channel causing undermining of outlet, stormwater outflow through pipe causing erosion	Damage to pipe, damage to bank due to stormwater flows	Repair if required following event	3	Possible	1	Insignificant	3	Low	3	Possible	1	Insignificant	3	Low	3	Possible	1	Insignificant	3	Low	3	Possible	1	Insignificant	3	Low	Consider providing energy dissipation at outlet, or headwall
19	Sussex Inlet	280404E, 6105141N	Coastal Vulnerability	Property & Infrastructure	Erosion	Damage to <450mm dia headwall and 375mm RCP drain at Edgewater Avenue	Erosion in canal due to outflow through channel causing undermining of outlet, stormwater outflow through pipe causing erosion	Damage to pipe, damage to bank due to stormwater flows	Repair if required following event	2	Unlikely	1	Insignificant	2	Low	2	Unlikely	1	Insignificant	2	Low	2	Unlikely	1	Insignificant	2	Low	2	Unlikely	1	Insignificant	2	Low	Consider energy dissipation at outlet if needed
20	Sussex Inlet	280550N, 6105190E	Coastal Vulnerability	Property & Infrastructure	Erosion	Damage to timber and rock retaining wall at Lions Park	Channel meandering, vessel waves, high water levels, wind waves	Loss of erosion protection to carpark, boat ramp, Council reserve	Repair if required following event	5	Almost Certain	3	Moderate	15	High	5	Almost Certain	3	Moderate	15	High	5	Almost Certain	3	Moderate	15	High	5	Almost Certain	3	Moderate	15	High	Design more resilient erosion protection for this foreshore in conjunction with boat ramp upgrade
21	Sussex Inlet	280574E, 6105268N	Coastal Vulnerability	Property & Infrastructure	Erosion	Undermining of fish cleaning table and damage to boat ramp	Channel meandering, vessel waves, high water levels, wind waves, stormwater outflow	Loss of fish-cleaning facility, damage to boat ramp	Repair if required following event	5	Almost Certain	3	Moderate	15	High	5	Almost Certain	3	Moderate	15	High	5	Almost Certain	3	Moderate	15	High	5	Almost Certain	3	Moderate	15	High	Design more resilient erosion protection for this foreshore in conjunction with boat ramp upgrade
22	Sussex Inlet	280492E, 6105210N	Coastal Vulnerability	Property & Infrastructure	Coastal Inundation	Short term (several hours) Inundation of critical wastewater mains and sewage pumping stations Edgewater Av SPS No. 11	High coastal water levels in estuary, future sea level rise	Sewage overflow, with major environmental, health and financial consequences	Inspect and repair if required	4	Likely	4	Major	16	High	4	Likely	4	Major	16	High	4	Likely	4	Major	16	High	4	Likely	4	Major	16	High	Investigate feasibility of raising pumping stations on a case-by-case basis
23	Sussex Inlet	280614E, 6105319N	Coastal Vulnerability	Property & Infrastructure	Erosion	Damage to six rock stub groynes at Sussex Inlet Bowling Club	Channel meandering, vessel waves, wind waves	Increased foreshore erosion	Inspect and repair if required	2	Unlikely	2	Minor	4	Low	2	Unlikely	2	Minor	4	Low	2	Unlikely	2	Minor	4	Low	2	Unlikely	2	Minor	4	Low	Monitor performance of groynes
24	Sussex Inlet	280668E, 6105390N	Coastal Vulnerability	Property & Infrastructure	Erosion	Damage to open drain at Christine Street	Rainfall/runoff erosion	Impact on drainage network upstream	Inspect and repair if required	3	Possible	1	Insignificant	3	Low	3	Possible	1	Insignificant	3	Low	3	Possible	1	Insignificant	3	Low	3	Possible	1	Insignificant	3	Low	Identify impact of damage to drainage network on inundation upstream
25	Sussex Inlet	280930E, 6105554N	Coastal Vulnerability	Property & Infrastructure	Erosion	Damage to headwall<450mm dia and 450mm dia RCP drainage pipe due to erosion	Stormwater outflow, vessel waves	Impact on drainage network upstream	Inspect and repair if required	4	Likely	2	Minor	8	Moderate	4	Likely	2	Minor	8	Moderate	4	Likely	2	Minor	8	Moderate	4	Likely	2	Minor	8	Moderate	Provide scour protection at outlet, upgrade foreshore protection to protect surrounding infrastructure
26	Sussex Inlet	280818E, 6105504N	Coastal Vulnerability	Property & Infrastructure	Erosion	Erosion damage to Seacrest caravan park double-row rock revetment	Channel meandering, vessel waves, wind waves	Increased foreshore erosion	Inspect and repair if required	2	Unlikely	2	Minor	4	Low	2	Unlikely	2	Minor	4	Low	2	Unlikely	2	Minor	4	Low	2	Unlikely	2	Minor	4	Low	Monitor performance of revetment and assess erosion damage due to edge effects
27	Sussex Inlet	280959E, 6105555N	Coastal Vulnerability	Property & Infrastructure	Coastal Inundation	Short term (several hours) Inundation of critical wastewater mains or wastewater pumping stations Private pumping station at	High coastal water levels in estuary	Sewage overflow, with major environmental, health and financial consequences	Repair/replace	4	Likely	4	Major	16	High	4	Likely	4	Major	16	High	4	Likely	4	Major	16	High	4	Likely	4	Major	16	High	Investigate feasibility of raising pumping stations on a case-by-case basis
28	Sussex Inlet	280896E, 6105622N	Coastal Vulnerability	Property & Infrastructure	Coastal Inundation	Inundation of critical wastewater main, gravity main, inflow into manholes	High coastal water levels in estuary	Sewage overflow, with major environmental, health and financial consequences	None	5	Almost Certain	3	Moderate	15	High	5	Almost Certain	3	Moderate	15	High	5	Almost Certain	3	Moderate	15	High	5	Almost Certain	3	Moderate	15	High	Identify locations where ingress into sewer system can occur and provide preventative measures to minimise risk of sewer overflows

No.	Estuary or Beach	Location	Coastal Management Area	Risk Category	Hazard	Risk Description	Root Cause	Consequence	Existing Controls	Present Day Likelihood (1-5)		Present Day Consequence (1-5)		Present Day Pre Treatment Rating		20 year Likelihood (1-5)		20 year Consequence (1-5)		20 year Pre Treatment Rating		50 year Likelihood (1-5)		50 year Consequence (1-5)		50 year Pre Treatment Rating		100 year Likelihood (1-5)		100 year Consequence (1-5)		100 year Pre Treatment Rating		Potential Management Actions
29	Sussex Inlet	280999E, 6105587N	Coastal Vulnerability	Property & Infrastructure	Erosion	Erosion damage to 900mm dia RCP stormwater pipe and outlet drain line 10346	Stormwater outflow, vessel waves	Undermining of pipe, worsening of bank erosion	None	3	Possible	2	Minor	6	Moderate	3	Possible	2	Minor	6	Moderate	3	Possible	2	Minor	6	Moderate	3	Possible	2	Minor	6	Moderate	Provide scour protection and energy dissipation at outlet
30	Sussex Inlet	280988E, 6105579N	Coastal Vulnerability	Property & Infrastructure	Erosion	Erosion damage to boat ramp, Sussex Road	Stormwater outflow, vessel waves	Loss of functionality of boat ramp	None	3	Possible	3	Moderate	9	High	3	Possible	3	Moderate	9	High	3	Possible	3	Moderate	9	High	3	Possible	3	Moderate	9	High	Provide scour protection around boat ramp
31	Sussex Inlet	280550E, 6104930N	Coastal Vulnerability	Property & Infrastructure	Erosion	Erosion damage to adhoc works at Alamein Caravan Park	Channel meandering, vessel waves, tidal flows, impact of ad-hoc structures	Safety, damage to caravan park infrastructure, additional foreshore erosion	None	4	Likely	4	Major	16	High	4	Likely	4	Major	16	High	4	Likely	4	Major	16	High	4	Likely	4	Major	16	High	Remove ad-hoc works and provide coordinated design of appropriate foreshore works to improve public access
32	Sussex Inlet	281553E, 6106555N	Coastal Vulnerability	Property & Infrastructure	Tidal Inundation	Short term (several hours) Inundation of critical wastewater mains or wastewater pumping stations River Road near Thora Street	High coastal water levels in estuary	Sewage overflow, with major environmental, health and financial consequences	Repair/replace	4	Likely	4	Major	16	High	5	Almost Certain	4	Major	20	Extreme	5	Almost Certain	4	Major	20	Extreme	5	Almost Certain	4	Major	20	Extreme	Investigate feasibility of raising pumping stations on a case-by-case basis
33	Sussex Inlet	281502E, 6106421N	Coastal Vulnerability	Property & Infrastructure	Coastal Inundation	Inundation of picnic shelters/park furniture, playground	Tidal inundation from high coastal water levels in estuary	Community safety/mental health, financial loss, increased maintenance costs	Repair if required following event	5	Almost Certain	2	Minor	10	High	5	Almost Certain	2	Minor	10	High	5	Almost Certain	2	Minor	10	High	5	Almost Certain	2	Minor	10	High	Increased funding to support post-emergency asset assessments and have a strategic plan of assessment based on priority Upgrade of materials for park furniture/playgrounds to improve resilience against inundation
34	Sussex Inlet	281549E, 6106436N	Coastal Vulnerability	Property & Infrastructure	Erosion	Erosion damage to <450mm headwall and 450mm RCP stormwater pipe, Thora St ID11193	Stormwater outflow, vessel waves	Undermining of pipe, worsening of bank erosion	Inspect and repair if required	3	Possible	1	Insignificant	3	Low	3	Possible	1	Insignificant	3	Low	3	Possible	1	Insignificant	3	Low	3	Possible	1	Insignificant	3	Low	Assess and provide scour protection and energy dissipation if warranted
35	Sussex Inlet	281628E, 6106592N	Coastal Vulnerability	Property & Infrastructure	Erosion	Erosion damage to <450mm headwall and 450mm RCP stormwater pipe, Gordon St ID11197	Stormwater outflow, vessel waves	Undermining of pipe, worsening of bank erosion	Inspect and repair if required	3	Possible	1	Insignificant	3	Low	3	Possible	1	Insignificant	3	Low	3	Possible	1	Insignificant	3	Low	3	Possible	1	Insignificant	3	Low	Assess and provide scour protection and energy dissipation if warranted
36	Sussex Inlet	281740E, 6106850N	Coastal Vulnerability	Property & Infrastructure	Erosion	Erosion damage to timber retaining wall at Sussex Inlet RSL	Wave overtopping, tidal flows, vessel waves	Erosion damage to public reserve	Inspect and repair if required	4	Likely	2	Minor	8	Moderate	4	Likely	2	Minor	8	Moderate	4	Likely	2	Minor	8	Moderate	4	Likely	2	Minor	8	Moderate	Assess and repair where needed, consider appropriateness of existing protection for this foreshore
37	Sussex Inlet	280915E, 6106797N	Coastal Vulnerability	Property & Infrastructure	Tidal Inundation	Short term (several hours) Inundation of critical wastewater mains or wastewater pumping stations Sandpiper Way SPS no. 6	High coastal water levels in estuary	Sewage overflow, with major environmental, health and financial consequences	Repair/replace	3	Possible	4	Major	12	High	3	Possible	4	Major	12	High	4	Likely	4	Major	16	High	4	Likely	4	Major	16	High	Investigate feasibility of raising pumping stations on a case-by-case basis
38	Sussex Inlet	280215E, 6106592N	Coastal Vulnerability	Property & Infrastructure	Tidal Inundation	Short term (several hours) Inundation of critical wastewater mains or wastewater pumping stations "The Moorings" private pump	High coastal water levels in estuary	Sewage overflow, with major environmental, health and financial consequences	Repair/replace	2	Unlikely	4	Major	8	Moderate	3	Possible	4	Major	12	High	4	Likely	4	Major	16	High	4	Likely	4	Major	16	High	Investigate feasibility of raising pumping stations on a case-by-case basis
39	Sussex Inlet	280373E, 6106358N	Coastal Vulnerability	Property & Infrastructure	Tidal Inundation	Short term (several hours) Inundation of critical wastewater mains or wastewater pumping station	High coastal water levels in estuary	Sewage overflow, with major environmental, health and financial consequences	Repair/replace	2	Unlikely	4	Major	8	Moderate	3	Possible	4	Major	12	High	4	Likely	4	Major	16	High	4	Likely	4	Major	16	High	Investigate feasibility of raising pumping stations on a case-by-case basis
40	Sussex Inlet	280483E, 6106729N	Coastal Vulnerability	Property & Infrastructure	Tidal Inundation	Short term (several hours) Inundation of critical wastewater mains or wastewater pumping station	High coastal water levels in estuary	Sewage overflow, with major environmental, health and financial consequences	Repair/replace	2	Unlikely	4	Major	8	Moderate	3	Possible	4	Major	12	High	4	Likely	4	Major	16	High	4	Likely	4	Major	16	High	Investigate feasibility of raising pumping stations on a case-by-case basis
41	Sussex Inlet	280104E, 6106794N	Coastal Vulnerability	Property & Infrastructure	Tidal Inundation	Short term (several hours) Inundation of critical wastewater mains or wastewater pumping station Private pump station Asset ID	High coastal water levels in estuary	Sewage overflow, with major environmental, health and financial consequences	Repair/replace	2	Unlikely	4	Major	8	Moderate	3	Possible	4	Major	12	High	4	Likely	4	Major	16	High	4	Likely	4	Major	16	High	Investigate feasibility of raising pumping stations on a case-by-case basis
42	Sussex Inlet	279255E, 6107007N	Coastal Vulnerability	Property & Infrastructure	Tidal Inundation	Inundation of local roads - Golfcourse Way	High coastal water levels in estuary	Temporary loss of access, damage to road surface	Repair/replace, local evacuation advice	4	Likely	2	Minor	8	Moderate	4	Likely	2	Minor	8	Moderate	4	Likely	2	Minor	8	Moderate	5	Almost Certain	2	Minor	10	High	Investigate feasibility of raising of road surface, improving drainage below road
43	Sussex Inlet	278967E, 6106830N	Coastal Vulnerability	Property & Infrastructure	Tidal Inundation	Inundation of Sussex Inlet Road	High coastal water levels in estuary	Temporary loss of access to village	Repair/replace, local evacuation advice	2	Unlikely	4	Major	8	Moderate	2	Unlikely	4	Major	8	Moderate	2	Unlikely	4	Major	8	Moderate	3	Possible	4	Major	12	High	Investigate feasibility of raising of road surface, improving drainage below road
44	Sussex Inlet	281074E, 6107185N	Coastal Vulnerability	Property & Infrastructure	Tidal Inundation	Inundation of local roads - River Road	High coastal water levels in estuary	Temporary loss of access to area west of Badgee Lagoon bridge, damage to road surface	Repair/replace, local evacuation advice	3	Possible	3	Moderate	9	High	3	Possible	3	Moderate	9	High	3	Possible	3	Moderate	9	High	4	Likely	3	Moderate	12	High	Investigate feasibility of raising of road surface, improving drainage below road
45	Sussex Inlet	281293E, 6107308N	Coastal Vulnerability	Property & Infrastructure	Tidal Inundation	Short term (several hours) Inundation of critical wastewater mains or wastewater pumping station	High coastal water levels in estuary	Sewage overflow, with major environmental, health and financial consequences	Repair/replace	3	Possible	4	Major	12	High	3	Possible	4	Major	12	High	4	Likely	4	Major	16	High	4	Likely	4	Major	16	High	Investigate feasibility of raising pumping stations on a case-by-case basis
46	Sussex Inlet	281240E, 6107320N	Coastal Vulnerability	Property & Infrastructure	Erosion	Loss of public recreation reserve area due to foreshore erosion Lot 7028 DP 1052695	Erosion in channel due to tidal flows	Loss of public access to foreshore, damage to mooring infrastructure	Ad hoc erosion control measures	4	Likely	4	Major	16	High	5	Almost Certain	4	Major	20	Extreme	5	Almost Certain	4	Major	20	Extreme	5	Almost Certain	4	Major	20	Extreme	Remove ad-hoc works and provide coordinated design of appropriate foreshore works to improve public access
47	Sussex Inlet	281367E, 6107309N	Coastal Vulnerability	Property & Infrastructure	Erosion	Undermining of fish cleaning table, erosion damage to Nielson Lane boat ramp	Erosion in channel due to tidal flows	Loss of access to waterway via boat ramp	None	2	Unlikely	4	Major	8	Moderate	3	Possible	4	Major	12	High	4	Likely	4	Major	16	High	4	Likely	4	Major	16	High	Repair and replace with design integrated with potential ramp upgrade
48	Sussex Inlet	281196E, 6107335N	Coastal Vulnerability	Property & Infrastructure	Erosion	Erosion damage to stormwater outlet pipe 375mm PVC Poole Avenue drain line 7370	Bank erosion and undermining of pipe, erosion due to stormwater flows	Further bank erosion at pipe outlet	None	4	Likely	2	Minor	8	Moderate	5	Almost Certain	2	Minor	10	High	5	Almost Certain	2	Minor	10	High	5	Almost Certain	2	Minor	10	High	Provide scour protection and energy dissipation at pipe outlet
49	Sussex Inlet	281777E, 6106949N	Coastal Vulnerability	Property & Infrastructure	Erosion	Erosion damage to public jetty at Jacobs Drive	Tidal flows in inlet, boat wakes	Reduced public access to waterway	Landward end of jetty currently protected by rock seawall	1	Rare	4	Major	4	Low	1	Rare	4	Major	4	Low	2	Unlikely	4	Major	8	Moderate	2	Unlikely	4	Major	8	Moderate	Monitor and repair as required
50	Sussex Inlet	280705E, 6107389N	Coastal Vulnerability	Property & Infrastructure	Tidal Inundation	Short term (several hours) Inundation of critical wastewater mains or wastewater pumping station SPS no. 2 River Road Badgee	High coastal water levels in estuary	Sewage overflow, with major environmental, health and financial consequences	Repair/replace	2	Unlikely	4	Major	8	Moderate	2	Unlikely	4	Major	8	Moderate	3	Possible	4	Major	12	High	4	Likely	4	Major	16	High	Investigate feasibility of raising pumping stations on a case-by-case basis
51	Sussex Inlet	280767E, 6107794N	Coastal Vulnerability	Property & Infrastructure	Tidal Inundation	Short term (several hours) Inundation of critical wastewater mains or wastewater pumping station	High coastal water levels in estuary	Sewage overflow, with major environmental, health and financial consequences	Repair/replace	3	Possible	4	Major	12	High	3	Possible	4	Major	12	High	3	Possible	4	Major	12	High	4	Likely	4	Major	16	High	Investigate feasibility of raising pumping stations on a case-by-case basis
52	Sussex Inlet	281459E, 6107277N	Coastal Vulnerability	Property & Infrastructure	Erosion	Erosion damage to stormwater outlet headwall 450 - 600mm and 600mm RCP pipe Nielson Lane Drain Line 10168	Bank erosion and undermining of pipe, erosion due to stormwater flows	Further bank erosion at pipe outlet	Headwall	3	Possible	2	Minor	6	Moderate	4	Likely	2	Minor	8	Moderate	4	Likely	2	Minor	8	Moderate	4	Likely	2	Minor	8	Moderate	Investigate need to provide scour protection and energy dissipation at outlet
53	Sussex Inlet	280397E, 6108294N	Coastal Vulnerability	Property & Infrastructure	Tidal Inundation	Short term (several hours) Inundation of critical wastewater mains or wastewater pumping station SPS no. 1 River Road (north)	High coastal water levels in estuary	Sewage overflow, with major environmental, health and financial consequences	Repair/replace	3	Possible	4	Major	12	High	3	Possible	4	Major	12	High	3	Possible	4	Major	12	High	4	Likely	4	Major	16	High	Investigate feasibility of raising pumping stations on a case-by-case basis

No.	Estuary or Beach	Location	Coastal Management Area	Risk Category	Hazard	Risk Description	Root Cause	Consequence	Existing Controls	Present Day Likelihood (1-5)		Present Day Consequence (1-5)		Present Day Pre Treatment Rating		20 year Likelihood (1-5)		20 year Consequence (1-5)		20 year Pre Treatment Rating		50 year Likelihood (1-5)		50 year Consequence (1-5)		50 year Pre Treatment Rating		100 year Likelihood (1-5)		100 year Consequence (1-5)		100 year Pre Treatment Rating		Potential Management Actions
54	St Georges Basin	277159E, 6113757N	Coastal Vulnerability	Property & Infrastructure	Tidal Inundation	Short term (several hours) inundation of Harriss Avenue, Basin View	High coastal water levels in estuary	Temporary loss of access to properties on Harriss Ave, Boathaven Ave, Harper Road	Evacuation	2	Unlikely	3	Moderate	6	Moderate	2	Unlikely	3	Moderate	6	Moderate	3	Possible	3	Moderate	9	High	4	Likely	3	Moderate	12	High	Investigate drainage below Harriss Ave, road levels
55	St Georges Basin	277300E, 6113776N	Coastal Vulnerability	Property & Infrastructure	Tidal Inundation	Short term (several hours) Inundation of critical wastewater mains or wastewater pumping station SPS no.3 Harriss Ave Basin	High coastal water levels in estuary	Sewage overflow, with major environmental, health and financial consequences	Repair/replace	2	Unlikely	4	Major	8	Moderate	2	Unlikely	4	Major	8	Moderate	3	Possible	4	Major	12	High	4	Likely	4	Major	16	High	Investigate feasibility of raising pumping stations on a case-by-case basis
56	St Georges Basin	277604E, 6113797N	Coastal Vulnerability	Property & Infrastructure	Erosion	Erosion of foreshore at Watersedge Avenue, Basin View, loss of public reserve at Lot 287 DP 28960	Wind waves, high water levels in estuary, boat waves	Loss of significant vegetation (EEC Swamp Oak Floodplain forest), loss of public access to foreshore	None	4	Likely	2	Minor	8	Moderate	4	Likely	2	Minor	8	Moderate	4	Likely	2	Minor	8	Moderate	4	Likely	2	Minor	8	Moderate	Investigate foreshore treatment to reduce erosion, speed limits for boats within set distance of Basin View boat ramp
57	St Georges Basin	277788E, 6113838N	Coastal Vulnerability	Property & Infrastructure	Tidal Inundation	Inundation of park furniture at Basin View Boat Ramp reserve	High coastal water levels in estuary	Community safety/mental health, financial loss, increased maintenance costs	Repair if required following event	3	Possible	1	Insignificant	3	Low	3	Possible	1	Insignificant	3	Low	4	Likely	1	Insignificant	4	Low	5	Almost Certain	1	Insignificant	5	Moderate	Investigate provision of resilient infrastructure if needed
58	St Georges Basin	278300E, 6113712N	Coastal Vulnerability	Property & Infrastructure	Erosion	Erosion of foreshore at Mathie Street causing damage to critical wastewater node manhole asset ID 191310 and 225mm gravity mains, Asset No. 171777	Rainfall/runoff, wind waves	Sewage overflow, with major environmental, health and financial consequences	Ad-hoc protection works, building rubble/rock revetment, repair if required	2	Unlikely	4	Major	8	Moderate	3	Possible	4	Major	12	High	3	Possible	4	Major	12	High	4	Likely	4	Major	16	High	Monitor, remove building rubble and install erosion protection, install stormwater pipe and energy dissipation/outlet scour protection
59	St Georges Basin	278550E, 6113613N	Coastal Vulnerability	Property & Infrastructure	Erosion	Erosion damage to critical wastewater main Asset ID 171998, Basin View Parade water frontage east of Mathie Street and west of Waterpark Road	Wind waves, Privately managed foreshore with difficult access	Sewage overflow, with major environmental, health and financial consequences	Isolate network and repair as required	2	Unlikely	4	Major	8	Moderate	2	Unlikely	4	Major	8	Moderate	3	Possible	4	Major	12	High	4	Likely	4	Major	16	High	Inspect, monitor, install erosion protection
60	St Georges Basin	279150E, 6113330N	Coastal Vulnerability	Property & Infrastructure	Erosion	Erosion of foreshore at Basin View Pde, Basin View, loss of public reserve at Lot 7300 DP 1130281	Wind waves	Loss of significant vegetation (EEC Swamp Oak Floodplain forest), loss of public access to foreshore	None	2	Unlikely	2	Minor	4	Low	2	Unlikely	2	Minor	4	Low	2	Unlikely	2	Minor	4	Low	2	Unlikely	2	Minor	4	Low	Monitor
61	St Georges Basin	278407E, 6114228N	Coastal Vulnerability	Property & Infrastructure	Tidal Inundation	Short term (several hours) Inundation of critical wastewater mains or wastewater pumping station SPS no.2 North East Mathie	High coastal water levels in estuary	Sewage overflow, with major environmental, health and financial consequences	Repair/replace	2	Unlikely	4	Major	8	Moderate	2	Unlikely	4	Major	8	Moderate	3	Possible	4	Major	12	High	4	Likely	4	Major	16	High	Investigate feasibility of raising pumping stations on a case-by-case basis
62	St Georges Basin	277810E, 6114420N	Coastal Vulnerability	Property & Infrastructure	Coastal Inundation	Inundation of The Wool Road, Basin View	High coastal water levels in estuary, future sea level rise	Loss of access to Basin View village	Evacuation, implement actions from Floodplain Management Plan	1	Rare	4	Major	4	Low	2	Unlikely	4	Major	8	Moderate	2	Unlikely	4	Major	8	Moderate	3	Possible	4	Major	12	High	Monitor, investigate culvert drainage at The Wool Road and road levels for resilience against future sea level rise
63	St Georges Basin	278600E, 6114800N	Coastal Vulnerability	Property & Infrastructure	Coastal Inundation	Inundation of The Wool Road, Basin View	High coastal water levels in estuary, future sea level rise	Loss of access to Basin View village	Evacuation, implement actions from Floodplain Management Plan	1	Rare	4	Major	4	Low	2	Unlikely	4	Major	8	Moderate	2	Unlikely	4	Major	8	Moderate	3	Possible	4	Major	12	High	Monitor, investigate culvert drainage at The Wool Road and road levels for resilience against future sea level rise
64	St Georges Basin	278824E, 6114542N	Coastal Vulnerability	Property & Infrastructure	Tidal Inundation	Short term (several hours) Inundation of critical wastewater mains or wastewater pumping station SPS no.4 Waterpark Road, Panorama Road St Georges	High coastal water levels in estuary	Sewage overflow, with major environmental, health and financial consequences	Repair/replace	2	Unlikely	4	Major	8	Moderate	3	Possible	4	Major	12	High	3	Possible	4	Major	12	High	4	Likely	4	Major	16	High	Investigate feasibility of raising pumping stations on a case-by-case basis
65	St Georges Basin	279335E, 6114713N	Coastal Vulnerability	Property & Infrastructure	Coastal Inundation	Inundation of The Wool Road, St Georges Basin	High coastal water levels in estuary, future sea level rise	Loss of access to Basin View village and western area of St Georges Basin	Evacuation, implement actions from Floodplain Management Plan	1	Rare	4	Major	4	Low	2	Unlikely	4	Major	8	Moderate	2	Unlikely	4	Major	8	Moderate	3	Possible	4	Major	12	High	Monitor and review The Wool Road levels for resilience against future sea level rise
66	St Georges Basin	279291E, 6114737N	Coastal Vulnerability	Property & Infrastructure	Tidal Inundation	Short term (several hours) Inundation of critical wastewater mains or wastewater pumping station SPS no.5 The Wool Road St Georges Basin opposite school	High coastal water levels in estuary	Sewage overflow, with major environmental, health and financial consequences	Repair/replace	1	Rare	4	Major	4	Low	2	Unlikely	4	Major	8	Moderate	2	Unlikely	4	Major	8	Moderate	3	Possible	4	Major	12	High	Investigate feasibility of raising pumping stations on a case-by-case basis
67	St Georges Basin	280230E, 61145207N	Coastal Vulnerability	Property & Infrastructure	Tidal Inundation	Short term (several hours) Inundation of critical wastewater mains or wastewater pumping station SPS no.6 Deane St St Georges	High coastal water levels in estuary	Sewage overflow, with major environmental, health and financial consequences	Repair/replace	1	Rare	4	Major	4	Low	1	Rare	4	Major	4	Low	1	Rare	4	Major	4	Low	2	Unlikely	4	Major	8	Moderate	Monitor
68	St Georges Basin	280308E. 6114281N	Coastal Vulnerability	Property & Infrastructure	Erosion	Erosion of foreshore at informal boat ramp and jetty	Wind waves, high water levels in estuary	Loss of foreshore access	Repair/replace	4	Likely	2	Minor	8	Moderate	4	Likely	2	Minor	8	Moderate	4	Likely	2	Minor	8	Moderate	4	Likely	2	Minor	8	Moderate	Monitor and repair as required, consider erosion protection
69	St Georges Basin	280308E. 6114281N	Coastal Vulnerability	Property & Infrastructure	Tidal Inundation	Inundation of jetty making it temporarily unsafe	Wind waves, high water levels in estuary	Loss of foreshore access, safety of users	None	4	Likely	2	Minor	8	Moderate	4	Likely	2	Minor	8	Moderate	4	Likely	2	Minor	8	Moderate	4	Likely	2	Minor	8	Moderate	Monitor and repair as required, signage to warn users of danger when water levels high
70	St Georges Basin	280764E, 6114101N	Coastal Vulnerability	Property & Infrastructure	Tidal Inundation	Inundation of park furniture at Blackett Park reserve	High coastal water levels in estuary	Community safety/mental health, financial loss, increased maintenance costs	Repair if required following event	3	Possible	1	Insignificant	3	Low	3	Possible	1	Insignificant	3	Low	4	Likely	1	Insignificant	4	Low	5	Almost Certain	1	Insignificant	5	Moderate	Monitor and repair, assess resilience against inundation
71	St Georges Basin	280230E, 6114059N	Coastal Vulnerability	Property & Infrastructure	Tidal Inundation	Short term (several hours) Inundation of critical wastewater mains or wastewater pumping station SPS no.7 Collett Pl St Georges	High coastal water levels in estuary	Sewage overflow, with major environmental, health and financial consequences	Repair/replace	1	Rare	4	Major	4	Low	2	Unlikely	4	Major	8	Moderate	3	Possible	4	Major	12	High	4	Likely	4	Major	16	High	Investigate feasibility of raising pumping stations on a case-by-case basis
72	St Georges Basin	280762E, 6113889N	Coastal Vulnerability	Property & Infrastructure	Erosion	Erosion damage to critical wastewater main Asset ID 170856, 300mm rising main and 150mm gravity main	Wind waves, vessel waves	Sewage overflow, with major environmental, health and financial consequences	Repair/replace	3	Possible	4	Major	8	Moderate	3	Possible	4	Major	8	Moderate	3	Possible	4	Major	12	High	4	Likely	4	Major	16	High	Inspect, monitor, plan for erosion protection, investigate landward relocation of infrastructure
73	St Georges Basin	280767E, 6113686N	Coastal Vulnerability	Property & Infrastructure	Erosion	Erosion damage to stormwater outlet headwall <450 and 300mm RCP pipe Rauch Cl Drain Line 8240	Wind waves, vessel waves, stormwater erosion	Undermining of pipe, worsening of bank erosion	Repair/replace	4	Likely	1	Insignificant	4	Low	5	Almost Certain	1	Insignificant	5	Moderate	5	Almost Certain	1	Insignificant	5	Moderate	5	Almost Certain	1	Insignificant	5	Moderate	Scour protection and energy dissipation at outlet
74	St Georges Basin	280790E, 6113582N	Coastal Vulnerability	Property & Infrastructure	Erosion	Erosion damage to stormwater outlet headwall <450 and 375mm RCP pipe Island Pt Rd Drain Line 6832	Wind waves, vessel waves, stormwater erosion	Undermining of pipe, worsening of bank erosion	Repair/replace	4	Likely	1	Insignificant	4	Low	5	Almost Certain	1	Insignificant	5	Moderate	5	Almost Certain	1	Insignificant	5	Moderate	5	Almost Certain	1	Insignificant	5	Moderate	Scour protection and energy dissipation at outlet
75	St Georges Basin	280793E, 6113641N	Coastal Vulnerability	Property & Infrastructure	Erosion	Damage to park furniture at Blackett Park reserve due to erosion	Wind waves, vessel waves, stormwater erosion	Community safety/mental health, financial loss, increased maintenance costs	Monitor and repair	4	Likely	1	Insignificant	4	Low	5	Almost Certain	1	Insignificant	5	Moderate	5	Almost Certain	1	Insignificant	5	Moderate	5	Almost Certain	1	Insignificant	5	Moderate	Consider relocating park furniture landward and softening bank, reduced vessel speed limits
76	St Georges Basin	280885E, 6113046N	Coastal Vulnerability	Property & Infrastructure	Erosion	Loss of public recreation reserve area at Kingfisher Reserve due to foreshore erosion Lot 6 DP 225886	Wind waves, vessel waves, stormwater erosion	Reduced foreshore access	Monitor and repair	3	Possible	1	Insignificant	3	Low	4	Likely	1	Insignificant	4	Low	5	Almost Certain	1	Insignificant	5	Moderate	5	Almost Certain	1	Insignificant	5	Moderate	Provide energy dissipation to dish drain, monitor and provide no-mow areas

No.	Estuary or Beach	Location	Coastal Management Area	Risk Category	Hazard	Risk Description	Root Cause	Consequence	Existing Controls	Present Day Likelihood (1-5)		Present Day Consequence (1-5)		Present Day Pre Treatment Rating		20 year Likelihood (1-5)		20 year Consequence (1-5)		20 year Pre Treatment Rating		50 year Likelihood (1-5)		50 year Consequence (1-5)		50 year Pre Treatment Rating		100 year Likelihood (1-5)		100 year Consequence (1-5)		100 year Pre Treatment Rating		Potential Management Actions
77	St Georges Basin	280826E, 6113061N	Coastal Vulnerability	Property & Infrastructure	Coastal Inundation	Damage to jetty and pontoon due to wind waves at Island Point Road	Wind waves	Reduced foreshore and waterway access, safety	Monitor and repair	5	Almost Certain	3	Moderate	15	High	5	Almost Certain	3	Moderate	15	High	5	Almost Certain	3	Moderate	15	High	5	Almost Certain	3	Moderate	15	High	Design new pontoon specific to conditions at Island Point
78	St Georges Basin	281215E, 6113330N	Coastal Vulnerability	Property & Infrastructure	Erosion	Erosion of foreshore at Loralyn Ave causing damage to critical wastewater asset ID 174850 450mm PVC Gravity Main	Wind waves, Privately managed foreshore with difficult access	Sewage overflow, with major environmental, health and financial consequences	Isolate network and repair as required	2	Unlikely	4	Major	8	Moderate	2	Unlikely	4	Major	8	Moderate	3	Possible	4	Major	12	High	3	Possible	4	Major	12	High	Inspect, monitor, plan for erosion protection, investigate landward relocation of infrastructure
79	St Georges Basin	281341E, 6113429N	Coastal Vulnerability	Property & Infrastructure	Coastal Inundation	Inundation of Loralyn Avenue, St Georges Basin, cutting off local access	High coastal water levels in estuary, future sea level rise	Local loss of access	Temporarily close road and monitor, post-event repair	3	Possible	2	Minor	6	Moderate	3	Possible	2	Minor	6	Moderate	4	Likely	2	Minor	8	Moderate	4	Likely	2	Minor	8	Moderate	Monitor and Investigate improved drainage, local raising of roadway if needed
80	St Georges Basin	281507E, 6113333N	Coastal Vulnerability	Property & Infrastructure	Tidal Inundation	Short term (several hours) Inundation of critical wastewater mains or wastewater pumping station SPS no.8 Loralyn Ave near Meriton St. St Georges Basin	High coastal water levels in estuary	Sewage overflow, with major environmental, health and financial consequences	Repair/replace	2	Unlikely	4	Major	8	Moderate	2	Unlikely	4	Major	8	Moderate	3	Possible	4	Major	12	High	4	Likely	4	Major	16	High	Investigate feasibility of raising pumping stations on a case-by-case basis
81	St Georges Basin	281709E, 6113374.N	Coastal Vulnerability	Property & Infrastructure	Erosion	Erosion of foreshore at Loralyn Ave Sanctuary Point causing damage to critical wastewater asset ID 174816 375mm PVC Gravity Main	Wind waves, Privately managed foreshore with difficult access	Sewage overflow, with major environmental, health and financial consequences	Isolate network and repair as required	2	Unlikely	4	Major	8	Moderate	2	Unlikely	4	Major	8	Moderate	3	Possible	4	Major	12	High	4	Likely	4	Major	16	High	Inspect, monitor, plan for erosion protection, investigate landward relocation of infrastructure
82	St Georges Basin	281915E, 6113426N	Coastal Vulnerability	Property & Infrastructure	Coastal Inundation	Inundation of Loralyn Avenue, Sanctuary Point, cutting off local access	High coastal water levels in estuary, future sea level rise	Local loss of access	Temporarily close road and monitor, post-event repair	2	Unlikely	2	Minor	4	Low	2	Unlikely	2	Minor	4	Low	3	Possible	2	Minor	6	Moderate	4	Likely	2	Minor	8	Moderate	Monitor and Investigate improved drainage, local raising of roadway if needed
83	St Georges Basin	282220E, 6113300N	Coastal Vulnerability	Property & Infrastructure	Coastal Inundation	Inundation of public reserve, Lot 7308 DP 1130873, Loralyn Ave Sanctuary Point	High coastal water levels in estuary	Loss of foreshore access, damage to The Basin walking track, damage to park furniture	Inspect and repair	4	Likely	2	Minor	8	Moderate	4	Likely	2	Minor	8	Moderate	5	Almost Certain	2	Minor	10	High	5	Almost Certain	2	Minor	10	High	Improve resilience of walking track and park furniture against inundation
84	St Georges Basin	282220E, 6113300N	Coastal Vulnerability	Property & Infrastructure	Erosion	Erosion of public reserve, Lot 7308 DP 1130873, Loralyn Ave Sanctuary Point	High coastal water levels in estuary	Loss of foreshore access, damage to The Basin walking track, loss of foreshore vegetation, damage to park furniture	Inspect and repair, no-mow zones	4	Likely	2	Minor	8	Moderate	4	Likely	2	Minor	8	Moderate	5	Almost Certain	2	Minor	10	High	5	Almost Certain	2	Minor	10	High	Monitor success of no-mow zones and provide additional zones if successful
85	St Georges Basin	282292E, 6113243N	Coastal Vulnerability	Property & Infrastructure	Water Quality	Urban runoff and sewer overflow at open drain Loralyn Ave near Anson Street	Sewer overflows, urban runoff	Public health impact, water quality impact to estuary	Trash rack installed	4	Likely	2	Minor	8	Moderate	4	Likely	2	Minor	8	Moderate	4	Likely	2	Minor	8	Moderate	4	Likely	2	Minor	8	Moderate	Install in-line stormwater treatment devices upstream, minimise sewer overflows, education
86	St Georges Basin	282404E, 6112961N	Coastal Vulnerability	Property & Infrastructure	Erosion	Erosion of foreshore at Loralyn Ave causing damage to critical wastewater asset ID 172558 150mm PVC Gravity Main	Wind waves	Sewage overflow, with major environmental, health and financial consequences	Isolate network and repair as required	2	Unlikely	4	Major	8	Moderate	2	Unlikely	4	Major	8	Moderate	3	Possible	4	Major	12	High	4	Likely	4	Major	16	High	Inspect, monitor, plan for erosion protection, investigate landward relocation of infrastructure, combine erosion protection with protection for The Basin
87	St Georges Basin	282404E, 6112961N	Coastal Vulnerability	Property & Infrastructure	Erosion	Erosion of The Basin Track at Loralyn Avenue	Tidal inundation, rainfall/runoff	Loss of foreshore access	Post-event repair, small drainage culverts and grating installed in some areas to prevent inundation damage to track	3	Possible	2	Minor	6	Moderate	3	Possible	2	Minor	6	Moderate	3	Possible	2	Minor	6	Moderate	4	Likely	2	Minor	8	Moderate	Provide better drainage below track to accommodate inundation
88	St Georges Basin	283230E, 6112460N	Coastal Vulnerability	Property & Infrastructure	Coastal Inundation	Inundation of public reserve, Lot 7300 DP 1152150, Walmer Ave Sanctuary Point	High coastal water levels in estuary	Loss of foreshore access, damage to The Basin walking track, damage to park furniture	Inspect and repair	5	Almost Certain	2	Minor	10	High	5	Almost Certain	2	Minor	10	High	5	Almost Certain	2	Minor	10	High	5	Almost Certain	2	Minor	10	High	Improve resilience of walking track and park furniture against inundation
89	St Georges Basin	282359E, 6113258N	Coastal Vulnerability	Property & Infrastructure	Tidal Inundation	Short term (several hours) Inundation of critical wastewater mains or wastewater pumping station SPS no.10 Loralyn Ave near	High coastal water levels in estuary	Sewage overflow, with major environmental, health and financial consequences	Repair/replace	3	Possible	4	Major	12	High	3	Possible	4	Major	12	High	3	Possible	4	Major	12	High	4	Likely	4	Major	16	High	Investigate feasibility of raising pumping stations on a case-by-case basis
90	St Georges Basin	282749E, 6112842N	Coastal Vulnerability	Property & Infrastructure	Tidal Inundation	Short term (several hours) Inundation of critical wastewater mains or wastewater pumping station SPS no.11 Walmer Av opposite Cross St Sanctuary	High coastal water levels in estuary	Sewage overflow, with major environmental, health and financial consequences	Repair/replace	3	Possible	4	Major	12	High	3	Possible	4	Major	12	High	3	Possible	4	Major	12	High	4	Likely	4	Major	16	High	Investigate feasibility of raising pumping stations on a case-by-case basis
91	St Georges Basin	283243E, 6112182N	Coastal Vulnerability	Property & Infrastructure	Tidal Inundation	Short term (several hours) Inundation of critical wastewater mains or wastewater pumping station SPS no.12 Walmer Av near Frederick St Sanctuary Point	High coastal water levels in estuary	Sewage overflow, with major environmental, health and financial consequences	Repair/replace	4	Likely	4	Major	16	High	5	Almost Certain	4	Major	20	Extreme	5	Almost Certain	4	Major	20	Extreme	5	Almost Certain	4	Major	20	Extreme	Investigate feasibility of raising pumping stations on a case-by-case basis
92	St Georges Basin	283380E, 6111400N	Coastal Vulnerability	Property & Infrastructure	Erosion	Erosion damage to 150mm PVC Critical Wastewater Gravity Main Asset No. 173149	Wind waves, rainfall/runoff	Sewage overflow, with major environmental, health and financial consequences	Isolate network and repair as required	4	Likely	4	Major	16	High	4	Likely	4	Major	16	High	4	Likely	4	Major	16	High	4	Likely	4	Major	16	High	Inspect, monitor, plan for erosion protection, investigate landward relocation of infrastructure
93	St Georges Basin	284528E, 6111567N	Coastal Vulnerability	Property & Infrastructure	Erosion	Erosion damage to The Basin Track, Macleans Point	Wind waves, rainfall/runoff, high water levels in estuary	Loss of access to foreshore, financial loss	Inspect and repair	5	Almost Certain	2	Minor	10	High	5	Almost Certain	2	Minor	10	High	5	Almost Certain	2	Minor	10	High	5	Almost Certain	2	Minor	10	High	Improve resilience of walking track against inundation, improve local drainage to provide drainage below track
94	St Georges Basin	283380E, 6111400N	Coastal Vulnerability	Property & Infrastructure	Coastal Inundation	Inundation of public reserve Lot 7311 DP 1152152 Greville Ave Sanctuary Point (Palm Beach Reserve and	High coastal water levels in estuary	Community safety/mental health, financial loss, increased maintenance costs	Repair if required following event	3	Possible	2	Minor	6	Moderate	3	Possible	2	Minor	6	Moderate	4	Likely	2	Minor	8	Moderate	5	Almost Certain	2	Minor	10	High	Investigate whether inundation-resistant park and playground furniture required
95	St Georges Basin	284818E, 6111541N	Coastal Vulnerability	Property & Infrastructure	Erosion	Erosion protection works, 3 x rock groynes, John Williams Reserve	Wave overtopping, tidal flows, vessel waves	Foreshore erosion if groynes fail	Design of groynes	1	Rare	3	Moderate	3	Low	2	Unlikely	2	Minor	4	Low	2	Unlikely	2	Minor	4	Low	3	Possible	2	Minor	6	Moderate	Inspect and monitor groynes for damage periodically
96	St Georges Basin	284905E, 6111712N	Coastal Vulnerability	Property & Infrastructure	Coastal Inundation	Inundation of public reserve Lot 7026 DP 1074334 Sanctuary Point John Williams Reserve, adjacent to boat	High coastal water levels in estuary	Community safety/mental health, financial loss, increased maintenance costs	Repair if required following event	5	Almost Certain	2	Minor	10	High	5	Almost Certain	2	Minor	10	High	5	Almost Certain	2	Minor	10	High	5	Almost Certain	2	Minor	10	High	Improve resilience of playground against inundation (e.g. raised pad)
97	St Georges Basin	284711E, 6112244N	Coastal Vulnerability	Property & Infrastructure	Tidal Inundation	Short term (several hours) Inundation of critical wastewater mains or wastewater pumping station SPS no.14 Sanctuary Pt Rd (Opp. Leumea) Sanctuary	High coastal water levels in estuary	Sewage overflow, with major environmental, health and financial consequences	Repair/replace	2	Unlikely	4	Major	8	Moderate	3	Possible	4	Major	12	High	4	Likely	4	Major	16	High	4	Likely	4	Major	16	High	Investigate feasibility of raising pumping stations on a case-by-case basis
98	St Georges Basin	284428E, 6113224N	Coastal Vulnerability	Property & Infrastructure	Tidal Inundation	Short term (several hours) Inundation of critical wastewater mains or wastewater pumping station SPS no.16 Sanctuary Pt Rd (Opp. Cessna) Sanctuary Point	High coastal water levels in estuary	Sewage overflow, with major environmental, health and financial consequences	Repair/replace	3	Possible	4	Major	12	High	4	Likely	4	Major	16	High	5	Almost Certain	4	Major	20	Extreme	5	Almost Certain	4	Major	20	Extreme	Investigate feasibility of raising pumping stations on a case-by-case basis

No.	Estuary or Beach	Location	Coastal Management Area	Risk Category	Hazard	Risk Description	Root Cause	Consequence	Existing Controls	Present Day Likelihood (1-5)		Present Day Consequence (1-5)		Present Day Pre Treatment Rating		20 year Likelihood (1-5)		20 year Consequence (1-5)		20 year Pre Treatment Rating		50 year Likelihood (1-5)		50 year Consequence (1-5)		50 year Pre Treatment Rating		100 year Likelihood (1-5)		100 year Consequence (1-5)		100 year Pre Treatment Rating		Potential Management Actions
99	St Georges Basin	284290E, 6113500N	Coastal Vulnerability	Property & Infrastructure	Tidal Inundation	Inundation of Walmer Avenue Sanctuary Point, cutting off local access	High coastal water levels in estuary, future sea level rise	Local loss of access	Temporarily close road and monitor, post-event repair	4	Likely	2	Minor	8	Moderate	4	Likely	2	Minor	8	Moderate	5	Almost Certain	2	Minor	10	High	5	Almost Certain	2	Minor	10	High	Monitor and Investigate improved drainage, local raising of roadway if needed
100	St Georges Basin	284660E, 6113780N	Coastal Vulnerability	Property & Infrastructure	Tidal Inundation	Inundation of The Park Drive Sanctuary Point, cutting off local access	High coastal water levels in estuary, future sea level rise	Local loss of access	Temporarily close road and monitor, post-event repair	4	Likely	2	Minor	8	Moderate	4	Likely	2	Minor	8	Moderate	5	Almost Certain	2	Minor	10	High	5	Almost Certain	2	Minor	10	High	Monitor and Investigate improved drainage, local raising of roadway if needed
101	St Georges Basin	284579E, 6113850N	Coastal Vulnerability	Property & Infrastructure	Tidal Inundation	Short term (several hours) Inundation of critical wastewater mains or wastewater pumping station SPS no.15 The Park Drive	High coastal water levels in estuary	Sewage overflow, with major environmental, health and financial consequences	Repair/replace	3	Possible	4	Major	12	High	4	Likely	4	Major	16	High	5	Almost Certain	4	Major	20	Extreme	5	Almost Certain	4	Major	20	Extreme	Investigate feasibility of raising pumping stations on a case-by-case basis
102	St Georges Basin	283771E, 6114004N	Coastal Vulnerability	Property & Infrastructure	Tidal Inundation	Short term (several hours) Inundation of critical wastewater mains or wastewater pumping station SPS no.17 The Wool Road near Shoreville Sanctuary	High coastal water levels in estuary	Sewage overflow, with major environmental, health and financial consequences	Repair/replace	3	Possible	4	Major	12	High	4	Likely	4	Major	16	High	5	Almost Certain	4	Major	20	Extreme	5	Almost Certain	4	Major	20	Extreme	Investigate feasibility of raising pumping stations on a case-by-case basis
103	St Georges Basin	285580E, 6114052N	Coastal Vulnerability	Property & Infrastructure	Erosion	Loss of public recreation reserve area at Prentice Reserve Old Erowal Bay due to foreshore erosion Lot 7026 DP 1074334	Wind waves	Reduced foreshore access	Monitor and repair	5	Almost Certain	2	Minor	10	High	5	Almost Certain	2	Minor	10	High	5	Almost Certain	2	Minor	10	High	5	Almost Certain	2	Minor	10	High	Active management of erosion in this reserve
104	St Georges Basin	283771E, 6114004N	Coastal Vulnerability	Property & Infrastructure	Tidal Inundation	Short term (several hours) Inundation of critical wastewater mains or wastewater pumping station SPS no.18 Prentice Avenue	High coastal water levels in estuary	Sewage overflow, with major environmental, health and financial consequences	Repair/replace	3	Possible	4	Major	12	High	4	Likely	4	Major	16	High	5	Almost Certain	4	Major	20	Extreme	5	Almost Certain	4	Major	20	Extreme	Investigate feasibility of raising pumping stations on a case-by-case basis
105	St Georges Basin	285781E, 6113994N	Coastal Vulnerability	Property & Infrastructure	Erosion	Erosion damage to 200mm PVC Critical Wastewater Rising Main Asset No. 170830	Wind waves	Sewage overflow, with major environmental, health and financial consequences	Isolate network and repair as required	3	Possible	4	Major	12	High	3	Possible	4	Major	12	High	3	Possible	4	Major	12	High	3	Possible	4	Major	12	High	Inspect, monitor, plan for erosion protection, investigate landward relocation of infrastructure
106	St Georges Basin	285833E, 6113758N	Coastal Vulnerability	Property & Infrastructure	Tidal Inundation	Short term (several hours) Inundation of critical wastewater mains or wastewater pumping station SPS no.20 Naval Parade nr Kallaroo Rd Erowal Bay	High coastal water levels in estuary	Sewage overflow, with major environmental, health and financial consequences	Repair/replace	3	Possible	4	Major	12	High	4	Likely	4	Major	16	High	5	Almost Certain	4	Major	20	Extreme	5	Almost Certain	4	Major	20	Extreme	Investigate feasibility of raising pumping stations on a case-by-case basis
107	St Georges Basin	285785E, 6113562N	Coastal Vulnerability	Property & Infrastructure	Erosion	Erosion damage to 300mm PVC Wastewater Gravity Main Asset No. 180562 Erowal Bay	Wind waves	Sewage overflow, with major environmental, health and financial consequences	Isolate network and repair as required	3	Possible	4	Major	12	High	3	Possible	4	Major	12	High	3	Possible	4	Major	12	High	3	Possible	4	Major	12	High	Inspect, monitor, plan for erosion protection, investigate landward relocation of infrastructure
108	St Georges Basin	286329E, 6112876N	Coastal Vulnerability	Property & Infrastructure	Erosion	Erosion damage to 225mm PVC Wastewater Gravity Main Asset No. 180072 Erowal Bay	Wind waves, rainfall/runoff, high water levels in estuary, privately managed foreshore with limited access	Sewage overflow, with major environmental, health and financial consequences	Isolate network and repair as required, foreshore erosion protection	4	Likely	4	Major	16	High	4	Likely	4	Major	16	High	4	Likely	4	Major	16	High	4	Likely	4	Major	16	High	Inspect, monitor, plan for erosion protection, investigate landward relocation of infrastructure
109	St Georges Basin	285833E, 6113758N	Coastal Vulnerability	Property & Infrastructure	Tidal Inundation	Short term (several hours) Inundation of critical wastewater mains or wastewater pumping station SPS no.21 Naval Parade nr Wharf Rd Erowal Bay	High coastal water levels in estuary	Sewage overflow, with major environmental, health and financial consequences	Repair/replace	3	Possible	4	Major	12	High	3	Possible	4	Major	12	High	4	Likely	4	Major	16	High	4	Likely	4	Major	16	High	Investigate feasibility of raising pumping stations on a case-by-case basis
110	St Georges Basin	286733E, 6111891N	Coastal Vulnerability	Property & Infrastructure	Tidal Inundation	Short term (several hours) Inundation of critical wastewater mains or wastewater pumping station SPS no.22 Fisher St Wrights	High coastal water levels in estuary	Sewage overflow, with major environmental, health and financial consequences	Repair/replace	3	Possible	4	Major	12	High	3	Possible	4	Major	12	High	4	Likely	4	Major	16	High	4	Likely	4	Major	16	High	Investigate feasibility of raising pumping stations on a case-by-case basis
111	St Georges Basin	286763E, 6111750N	Coastal Vulnerability	Property & Infrastructure	Erosion	Erosion damage to 150mm PVC Wastewater Gravity Main Asset No. 171016 Wrights Beach	Wind waves, rainfall/runoff, high water levels in estuary, privately managed foreshore with limited access	Sewage overflow, with major environmental, health and financial consequences	Isolate network and repair as required, foreshore erosion protection	3	Possible	4	Major	12	High	3	Possible	4	Major	12	High	3	Possible	4	Major	12	High	3	Possible	4	Major	12	High	Inspect, monitor, plan for erosion protection, investigate landward relocation of infrastructure

Appendix B
Key community management issues

DATE	26/11/22	**COORDINATE SYSTEM**	MGA Zone 56	**FIGURE TITLE**	St Georges Basin (west) Management Issues
PROJECT NO.	311015-00158	**PROJECT TITLE**	Sussex Inlet, St Georges Basin, Swan Lake and Berrara Creek CMP	**CREATED BY**	CA

Advisian Worley Group | Shoalhaven City Council | NSW Government Planning, Industry & Environment

Workshop Comment: Tomerong Creek safety issues power boats, no speed limit signs

Workshop Comment: Erosion along Tomerong Creek

Workshop Comment: Identification of National Park

Workshop Comment: One of the more affected areas by sea level rise

Workshop Comment: Erowal Bay highly sensitive to upstream development due to lack of flushing in area

Workshop Comment: Development site: erosion and deposition

Workshop Comment: Tomerong Creek illegal removal of trees/vegetation making urban areas more susceptible to erosion

Workshop Comment: Development site: erosion and deposition

Workshop Comment: Water Quality

Workshop Comment: Insufficient drainage planning and control of storm water throughout Sanctuary Point

Workshop Comment: Basin Walking Track (between Paradise Beach South and Palm Beach) erosion and land runoff

Workshop Comment: Foreshore damage around Sanctuary Point shoreline

Workshop Comment: Navigation and safety

N

0 0.5 1

kilometres

LEGEND

- Cultural and Social Issues
- Ecological Environment
- Inundation and Sea Level Rise
- Navigation and Safety
- Foreshore Erosion
- Water Quality

DATE	26/11/22	**COORDINATE SYSTEM**	MGA Zone 56	**FIGURE TITLE**	St Georges Basin (east) Management Issues
PROJECT NO.	311015-00158	**PROJECT TITLE**	Sussex Inlet, St Georges Basin, Swan Lake and Berrara Creek CMP	**CREATED BY**	CA

Advisian Worley Group | Shoalhaven City Council | NSW Government | Planning, Industry & Environment

DATE 22/11/22	**COORDINATE SYSTEM** MGA Zone 56	**FIGURE TITLE** Sussex Inlet (North) Management Issues	Advisian Shoalhaven City Council NSW Government Planning, Industry & Environment
PROJECT NO. 311015-00158	**PROJECT TITLE** St Georges Basin, Sussex Inlet, Swan Lake and Berrara Creek CMP	**CREATED BY** CA	

LEGEND

- Cultural and Social Issues
- Ecological Environment
- Inundation and Sea Level Rise
- Navigation and Safety
- Foreshore Erosion
- Water Quality

Workshop Comment: Seagrass amount has decreased in this area

N

Potential dog off leash area?

Tide flows fast here and makes boat entry & exit challenging.

Workshop Comment: Boat ramp facilities Lions Park and all ramps, public access from reserve to foreshore

Workshop Comment: Boat ramps in a poor state throughout

Workshop Comment: Erosion around Lyons Park retaining wall

Changes could be made to the boat ramp at this location.

Workshop Comment: More places for kids to fish, away from boats

Workshop Comment: Alamein Erosion/Dune

Workshop Comment: Bitou bush invading mangroves, widespread but particular issue in this area

Workshop Comment: People driving boats too fast at 6 knots

Workshop Comment: Insufficient lighting

0 100 200
metres

Workshop Comment: Overfishing at Sussex Inlet - shells

DATE	26/11/22	**COORDINATE SYSTEM**	MGA Zone 56	**FIGURE TITLE**	Sussex Inlet (south) Management Issues
PROJECT NO.	311015-00158	**PROJECT TITLE**	Sussex Inlet, St Georges Basin, Swan Lake and Berrara Creek CMP	**CREATED BY**	CA

Advisian Worley Group | Shoalhaven City Council | NSW Government Planning, Industry & Environment

LEGEND

- Cultural and Social Issues
- Ecological Environment
- Inundation and Sea Level Rise
- Navigation and Safety
- Foreshore Erosion
- Water Quality

Workshop Comment: People want to be able to walk along waterfront near entrance but cannot because of fallen trees

Workshop Comment: Pontoons in Sussex Inlet landing on the banks causing erosion and damaging aquatic vegetation

Workshop Comment: Bar too shallow, variable channel depth

Workshop Comment: General attitudinal issue around all areas, lack of regard to rules. Residents also parking illegally in visitor spots.

Workshop Comment: Retaining wall through Sussex Inlet is not being maintained, now leading to foreshore erosion. Hazards (e.g., fallen trees) are having to be removed by locals

Workshop Comment: Following recent events, erosion is even worse; Navigation marker sitting on sand; Sanc has moved with recent event

Workshop Comment: The Ralph Lucas sign is wrong it should say Chris Creek

Improvements could be made to the Bar to allow for safer navigation when exiting and entering via boat

Workshop Comment: Need to engage more with traditional owners

Workshop Comment: Excessive number of visitors blocking fire trails and access and parking for local residents

Surfers here frequently leave dogs off leash while they surf. It's confronting and potentially dangerous for other beach users as the dogs can be protective of the space. Also threatening to shorebird and natural habitats.

There's a creek running along track and a great deal of erosion developing on the track from carpark down to rock platform - as people move off the track when wet and create new tracks through the bush (track becomes the creek).

There's a lot of fireweed taking over on this hillside.

N

0 100 200
metres

DATE	26/11/22	**COORDINATE SYSTEM**	MGA Zone 56	**FIGURE TITLE**	Sussex Inlet (entrance area) Management Issues
PROJECT NO.	311015-00158	**PROJECT TITLE**	Sussex Inlet, St Georges Basin, Swan Lake and Berrara Creek CMP	**CREATED BY**	CA

Advisian Worley Group | Shoalhaven City Council | NSW Government Planning, Industry & Environment

LEGEND

- Cultural and Social Issues
- Ecological Environment
- Inundation and Sea Level Rise
- Navigation and Safety
- Foreshore Erosion
- Water Quality

Swan Lake

Workshop Comment: The Medlyn Entrance to Swan Lake is a safer swimming area, boats shouldn't be allowed to moor

Workshop Comment: Perception of a decline in bird life eg swans

Dogs frequently off leash in this area

Workshop Comment: Perceived pressure on fish stocks in Swan Lake due to professional fishing

Workshop Comment: Vandalism and destruction of vegetation, particularly in Swanhaven region. Erosion along Lake Drive, along Swan Lake.

Concerned that if we open access to the lake here people will bring dogs - negative impacts to wildlife - although it seems a small area, dogs are not leashed and may impact a large area

Workshop Comment: Dyball reserve boat ramp issue - illegal use of boat ramp. Rated for passive watercraft only, however, power boats/motorised vessels being operated (i.e. jet-skis).

Workshop Comment: Threat to local ecology and natural landscapes due to potential re-start of sand mine.

Workshop Comment: Impact of water skiing on Swan lake

Workshop Comment: Mining threat at the bed of Swan Lake.

Workshop Comment: Concern around water quality: Feel tress are dying, swans/cootes have disappeared, water plants are dying off, fisherman report that only small amounts of veg weed left

Workshop Comment: Commercial fishing in Swan Lake and illegal trawling offshore

Workshop Comment: Impact of professional fishing methods on birds

Buggy tracks through here - from the surf club?

Workshop Comment: Hemes has sea plane landing on Swan Lake - is this impacting the wildlife?

Workshop Comment: Destruction of vegetation along the foreshore areas of Swan Lake.

0 250 500 metres

Workshop Comment: Erosion of fire-trails resulting in sediment flowing into the lake/creek Goonawarra Drive

Workshop Comment: Swan Lake - is water quality improving or declining

Workshop Comment: Four-wheel drive vehicles threatening sand dunes. Illegal off-roading taking place from southern portion of Swan Lake towards Cudmirrah Beach.

Workshop Comment: Sand dunes are at risk of being eroded due to illegal activities taking place.

DATE	26/11/22	**COORDINATE SYSTEM**	MGA Zone 56	**FIGURE TITLE**	Swan Lake (north) Management Issues
PROJECT NO.	311015-00158	**PROJECT TITLE**	Sussex Inlet, St Georges Basin, Swan Lake and Berrara Creek CMP	**CREATED BY**	CA

Advisian Worley Group | Shoalhaven City Council | NSW Government | Planning, Industry & Environment

LEGEND

- Cultural and Social Issues
- Ecological Environment
- Inundation and Sea Level Rise
- Navigation and Safety
- Foreshore Erosion
- Water Quality

Workshop Comment: Boat ramp/facilities Swan Lake

Workshop Comment: Swan Lake Bridge structure not adequate

Workshop Comment: Sea levels are coming near the top of Swan Lake Bridge

No Dog off leash here please, protect the shore habitat for native animals

Workshop Comment: Monitoring of Conjola Regional Sewage System

Dog on leash signage & educational signage required here - dogs frequently off leash in the inlet area where there's a population of endangered shorebirds.

Workshop Comment: Illegal opening of Swan Lake

Workshop Comment: - Damage to midden at Cudmirrah

Workshop Comment: Fish netting across Swan Lake

Workshop Comment: Endangered and critically endangered spedes at threat around Swan Lake entrance.

Workshop Comment: Erosion of access stairs at Cudmirrah and people taking alternate routes (i.e., walking through vegetation)

0 100 200
metres

DATE	26/11/22	**COORDINATE SYSTEM**	MGA Zone 56	**FIGURE TITLE**	Swan Lake (south) Management Issues
PROJECT NO.	311015-00158	**PROJECT TITLE**	Sussex Inlet, St Georges Basin, Swan Lake and Berrara Creek CMP	**CREATED BY**	CA

Advisian Worley Group | Shoalhaven City Council | NSW Government Planning, Industry & Environment

Workshop Comment: Lack of access to Fishermans Rock due to fires and natural disasters

Workshop Comment: Erosion around ramp/foreshore

Workshop Comment: Water quality in Berrara Creek not as good as other water bodies?

Workshop Comment: Lack of knowledge of important cultural/indigenous sites

Workshop Comment: Damage to axe grooves

Workshop Comment: No risk mitigation for inundation of Berrara Creek Chlorine Treatment Plant

Workshop Comment: No Kayak facilities

Workshop Comment: Conflict between powered craft users & non-powered craft users eg. Jetskis

People are clearing plants and removing the understory of twigs and sticks along this shoreline, tidying up i think, to improve presentation of the foreshore for tourists? I'm concerned about loss of habitat. - all the way along this strip

Tree clearing - damage to local ecology - reduction of habitat

Tree clearing - damage to local ecology - reduction of habitat

Workshop Comment: Erosion of access stairs at Berrara Creek and erosion upstream leaving hazards (i.e., fallen trees) around

Workshop Comment: Erosion near houses/parking at Berrara Cove

Workshop Comment: Erosion along north foreshore of Berrara Creek canoes, watercraft on foreshore, damage to vegetation

Dogs consistently off leash in this area.

Workshop Comment: North Berrara Creek Headland Madeira Vine Biotubush infestation Banksias are smothered and in decline

dogs entering inlet from Berrara Cove Beach

Workshop Comment: Shellfish decline on coastal rock shelves

Trees being removed/not replaced all along this strip to the headland. Loss of habitat. Only a few years ago this was a cliff topped by trees and you could see the chalets behind the trees, now the chalets are front and centre

Workshop Comment: Impact on shorebird breeding area (summer); Decline in bird numbers in Swan Lake, need to find out why

Workshop Comment: Educate locals and issue heavy penalties and fines. Enforce compliance action for unauthorised entrance openings.

Workshop Comment: 4 WDriving and camping on beach (and at Berrara)

N

0 100 200

metres

LEGEND

- Cultural and Social Issues
- Ecological Environment
- Inundation and Sea Level Rise
- Navigation and Safety
- Foreshore Erosion
- Water Quality

DATE 26/11/22	**COORDINATE SYSTEM** MGA Zone 56	**FIGURE TITLE** Berrara Creek Management Issues	Advisian Worley Group; Shoalhaven City Council; NSW Government Planning, Industry & Environment
PROJECT NO. 311015-00158	**PROJECT TITLE** Sussex Inlet, St Georges Basin, Swan Lake and Berrara Creek CMP	**CREATED BY** CA	

Appendix C
Workshop Materials

Sussex Inlet, St Georges Basin, Swan Lake and Berrara Creek CMP – Risk Management Workshop

Workshop presentation

16 June 2022

This project is being supported with funding from the NSW Government's – Coastal and Estuary Grant Program.

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Acknowledgement of Country

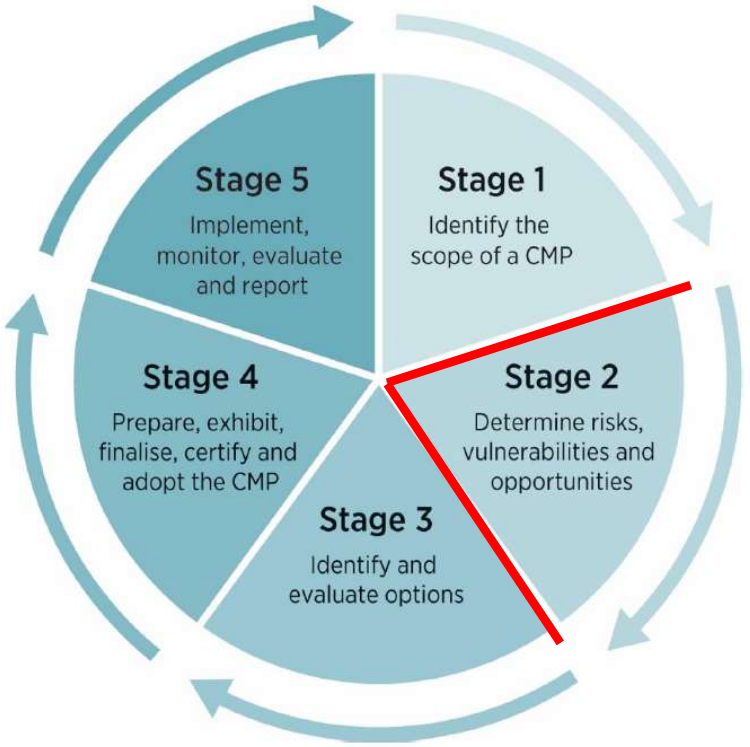
We would like to acknowledge the Traditional Custodians of the land in which we gather upon today. We acknowledge their continuing connections to the land, culture and community. We pay respect to Elders past, present and future.

Workshop Agenda

- Introductory Presentation (5min)
- Key Council Asset Risks
  - Tidal inundation and sea level rise
  - Foreshore Erosion
  - Safety and Emergency Management
- Key Assets at risk – maps at each area
  - St Georges Basin
  - Sussex Inlet
  - Swan Lake
  - Berrara Creek
- Summary and Wrap up (10min)

What does the CMP involve?

- Specialist studies to determine key risks and issues
- Based on outcomes of our studies we want to hear thoughts and ideas on how to best manage Council's assets and put some definition around the magnitude of the risks
- How can we best manage the estuaries into the future?



(WE ARE HERE)

What are the key CMP studies?

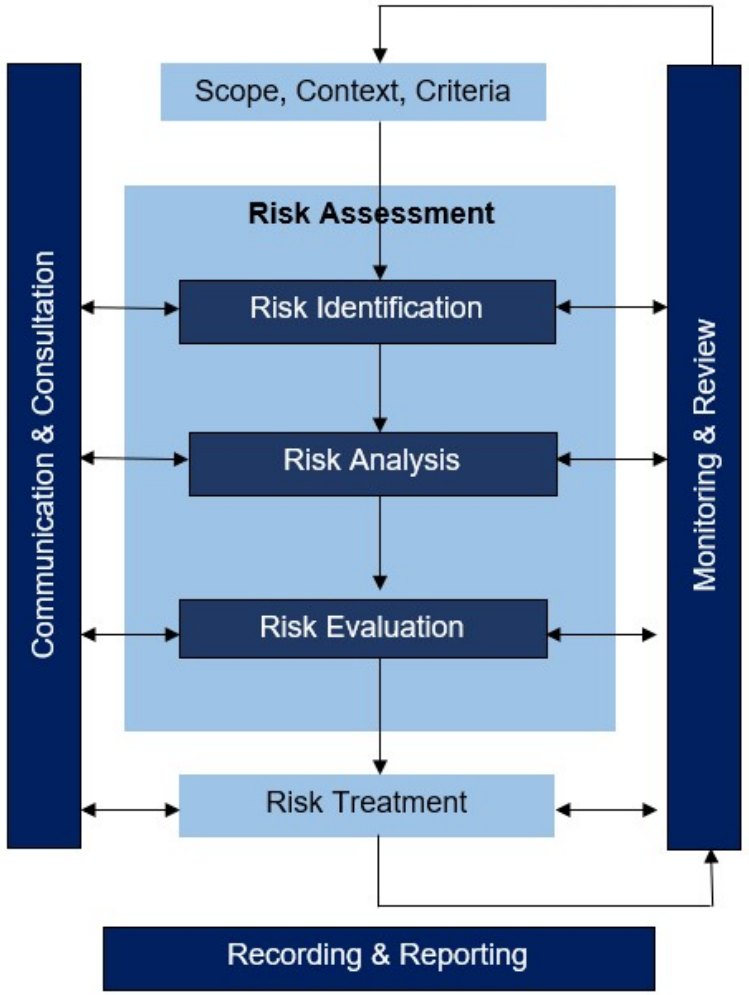
- Assets and Safety
  - Tidal Inundation and sea level rise
  - Navigation and safety
  - Erosion
- Intangible Assets
  - Cultural and social
  - Ecological environment
  - Water quality

What is Risk?

- Risk = Likelihood x Consequence

Risk Rating Matrix

Likelihood	Consequence				
	Insignificant 1	Minor 2	Moderate 3	Major 4	Catastrophic 5
Almost Certain 5	MODERATE	HIGH	HIGH	EXTREME	EXTREME
Likely 4	LOW	MODERATE	HIGH	HIGH	EXTREME
Possible 3	LOW	MODERATE	HIGH	HIGH	HIGH
Unlikely 2	LOW	LOW	MODERATE	MODERATE	HIGH
Rare 1	LOW	LOW	LOW	LOW	MODERATE

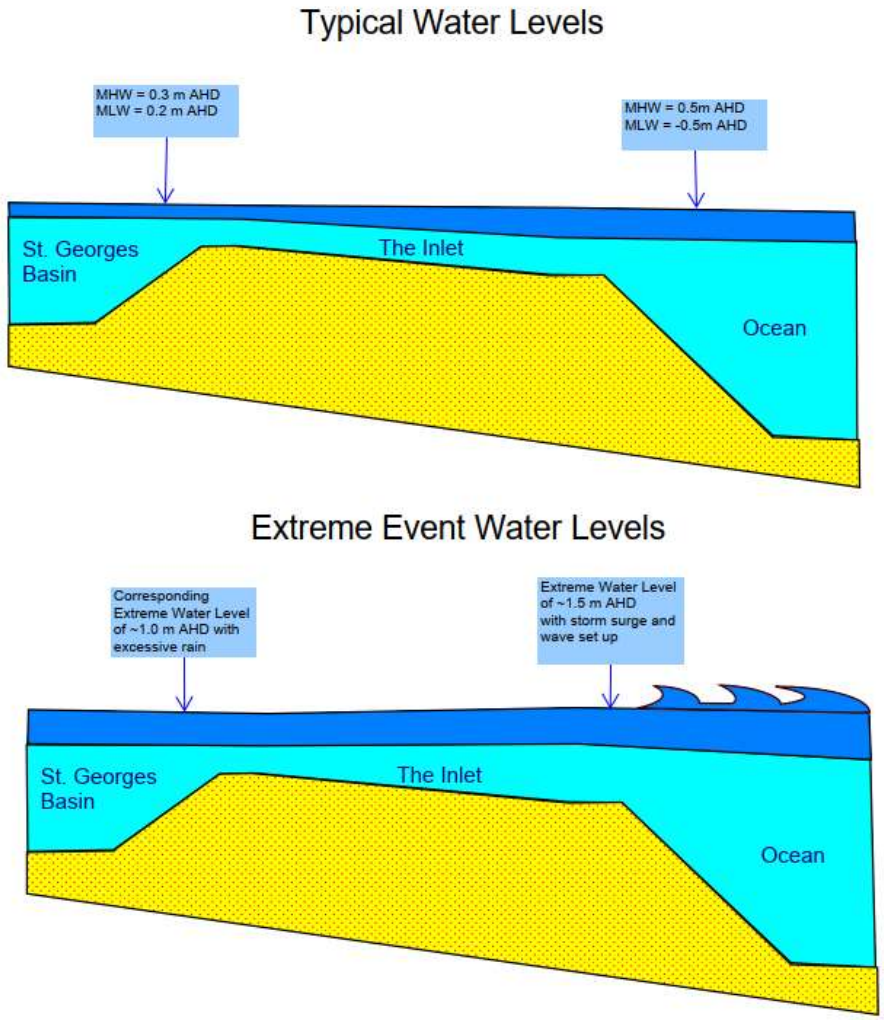


[*Source: AS 31000:2018 Risk management – Guidelines*)

Inundation and sea level rise

What Is Tidal Inundation?

- Tidal inundation refers to inundation of the low-lying land surrounding the waterways that occurs due to oceanic tides
- Can occur independently of rainfall events that cause catchment-based flooding.
- Ocean water levels can become elevated above normal tide levels due to storm surge caused by strong winds and the effects of coastal low pressure systems.
- The high ocean water levels at the entrances of the estuaries can prevent water from flowing out of the estuaries on a low tide, which can elevate water levels in the upstream parts of the estuaries causing inundation.
- A hydrodynamic model has been developed to quantify the risk



Inundation and sea level rise

Which areas are at risk?

- Sussex Inlet
- Risk expected to increase with future sea level rise.
- Northern foreshore of St Georges Basin also prone to tidal inundation, particularly when a southerly wind leads to “piling up” of the water against the shoreline.

What factors affect tidal inundation?

- High water levels on the ocean side of the estuary moving up the estuary from the ocean – occurs when estuary entrances are open to the sea.
- Channel bathymetry, wind speed and direction, wave action at the estuary mouth, astronomic tides.

Erosion

How are we assessing erosion?

- Bank inspections from the water and by foot, to identify areas that are suffering from foreshore erosion.
- Foreshore erosion is being mapped for each of the estuaries, with erosion being identified as minor, moderate or severe.
- A Decision Support Tool has been developed to assess foreshore erosion including:
  - the environmental impact of the erosion e.g. on foreshore vegetation
  - the impact of the erosion on infrastructure, safety and whether the erosion is likely to continue into the future
  - the severity of the erosion
  - the causes of erosion
  - any existing control on erosion and its effectiveness and the feasibility of providing foreshore protection against erosion.

Erosion

Which key areas are worst affected?

- St Georges Basin – northern foreshores
- Wandandian Creek
- Berrara Creek – northern foreshore
- Sussex Inlet - The Haven, Little Manly. Upstream of Christians Minde on the outside of a channel bend, at Alamein and within the Canals.

What are the causes of erosion?

- Wave action from ocean, wind or vessel waves
- Meandering of channels/tidal currents
- Slope instability
- Stock and public access to foreshore
- Lack of stabilising foreshore vegetation
- High water levels and winds

Key Assets at Risk – St Georges Basin

Rates of Erosion

Likelihood

1. Likelihood Rating Table		
Descriptor	**Description**	**Frequency**
Almost certain (5)	The event is expected to occur in normal circumstances	Several times a year
Likely (4)	This event may occur at some time during the year	Once or twice a year
Possible (3)	The event may occur sometime. Some previous event history.	Once every 2 to 5 years
Unlikely (2)	The event could occur in some circumstances, but would not be expected	Once every 6 to 9 years
Rare (1)	The event may occur but only in exceptional circumstances	Once every 10 or more years

Inundation Scenarios - Likelihood

Model run ID	Water Level Boundary Condition	Wind	Sea Level Rise (m)	Entrance Berm Level	Comment
01 – RARE – PRESENT DAY	1% AEP Group 4 Ocean Time series A3	Jervis Bay, 100y ARI, south (38.3 m/s)	0	Present day level	Present day
02/13	1% AEP Group 4 Ocean Time series	Jervis Bay, 100y ARI, south (38.3 m/s)	0.1	Raise by 0.1m	Council SLR projections
02a/13/16	1% AEP Group 4 Ocean Time series	Jervis Bay, 100y ARI, south (38.3 m/s)	0.23		Interpolated mapping
03/12	1% AEP Group 4 Ocean Time series	Jervis Bay, 100y ARI, south (38.3 m/s)	0.36	Raise by 0.36m	Council SLR projections
04/12	1% AEP Group 4 Ocean Time series	Jervis Bay, 100y ARI, south (38.3 m/s)	0.6	Raise by 0.6m	50 year planning period SLR
04a/12/16	1% AEP Group 4 Ocean Time series	Jervis Bay, 100y ARI, south (38.3 m/s)	0.9		Interpolated mapping for 2100
05/12	1% AEP Group 4 Ocean Time series	Jervis Bay, 100y ARI, south (38.3 m/s)	1.2	Raise by 1.2m	100 year planning period
05a - RARE – 100 years	1% AEP Group 4 Ocean Time series	Jervis Bay, 100y ARI, south (38.3 m/s)	1.2	As per 2021	100 year planning period
06/16	1% AEP Group 4 Ocean Time series	Jervis Bay, 100y ARI, west (38.3 m/s)	0	Present day level	Sensitivity run to test westerly wind
07/16	5% AEP Group 4 Ocean Time series A6	Jervis Bay, 20y ARI, south (32 m/s)	0	Present day level	Present day
08	5% AEP Group 4 Ocean Time series	Jervis Bay, 20y ARI, south (32 m/s)	0.1	Raise by 0.1m	Council SLR projections
08a/16	5% AEP Group 4 Ocean Time series	Jervis Bay, 20y ARI, south (32 m/s)	0.23		Interpolated mapping
09 – UNLIKELY – 50 years	5% AEP Group 4 Ocean Time series	Jervis Bay, 20y ARI, south (32 m/s)	0.36	Raise by 0.36m	Council SLR projections
10	5% AEP Group 4 Ocean Time series	Jervis Bay, 20y ARI, south (32 m/s)	0.6	Raise by 0.6m	50 year planning period SLR
10a	5% AEP Group 4 Ocean Time series	Jervis Bay, 20y ARI, south (32 m/s)	0.9		Interpolated mapping for 2100
11	5% AEP Group 4 Ocean Time series	Jervis Bay, 20y ARI, south (32 m/s)	1.2	Raise by 1.2m	100 year planning period
12 – UNLIKELY - PRESENT	5% AEP Group 4 Ocean Time series	Jervis Bay, 20y ARI, west (32 m/s)	0	Present day level	Sensitivity run to test westerly wind

Hydrodynamic Model – Sussex Inlet

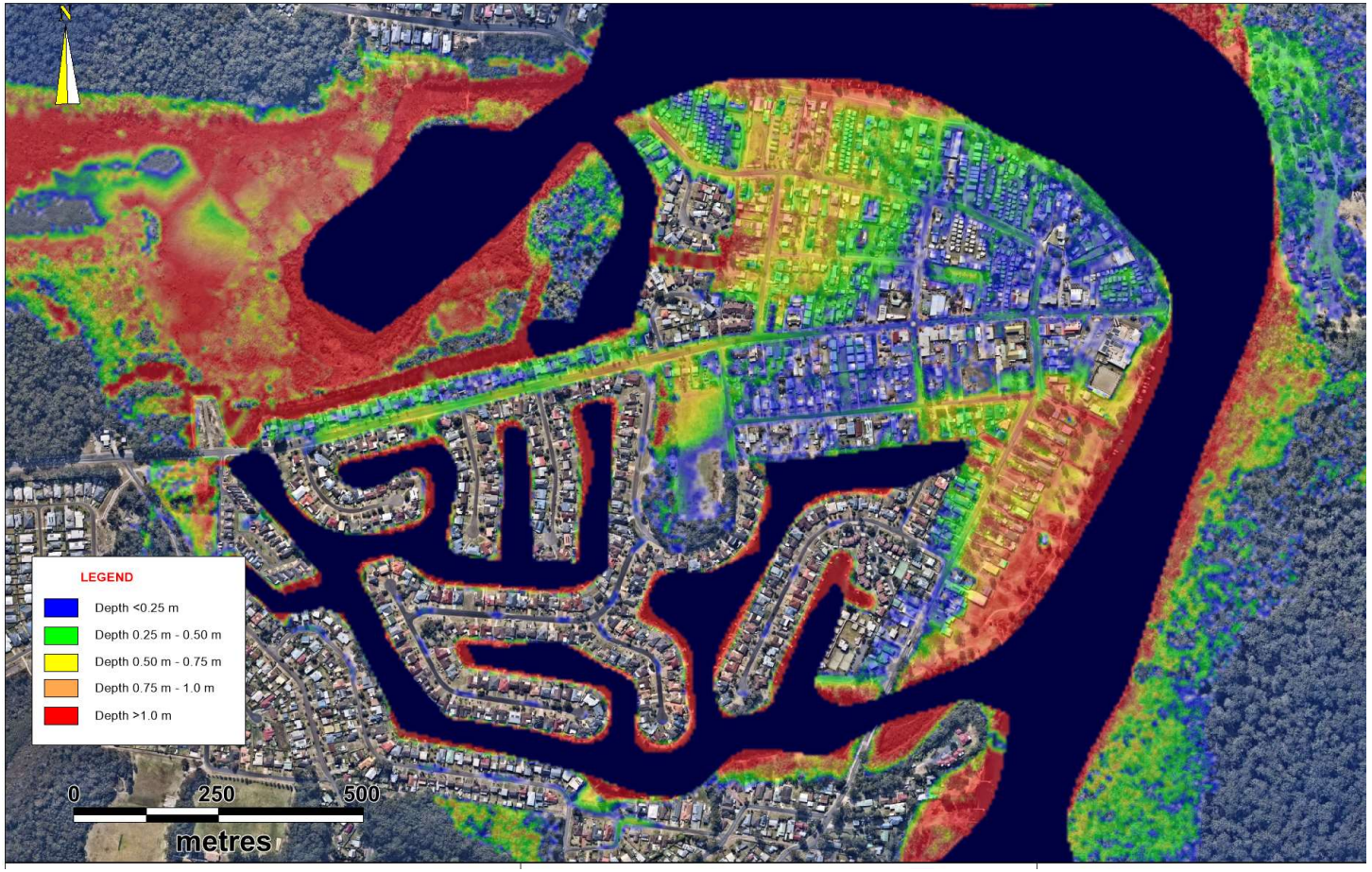
Considering different combinations of:

- Sea level rise
- Estuary entrance bathymetry
- Wind speeds/directions
- Ocean water levels

Present Day

(20 year Average Recurrence Interval ARI event)

- Southerly wind 32m/s

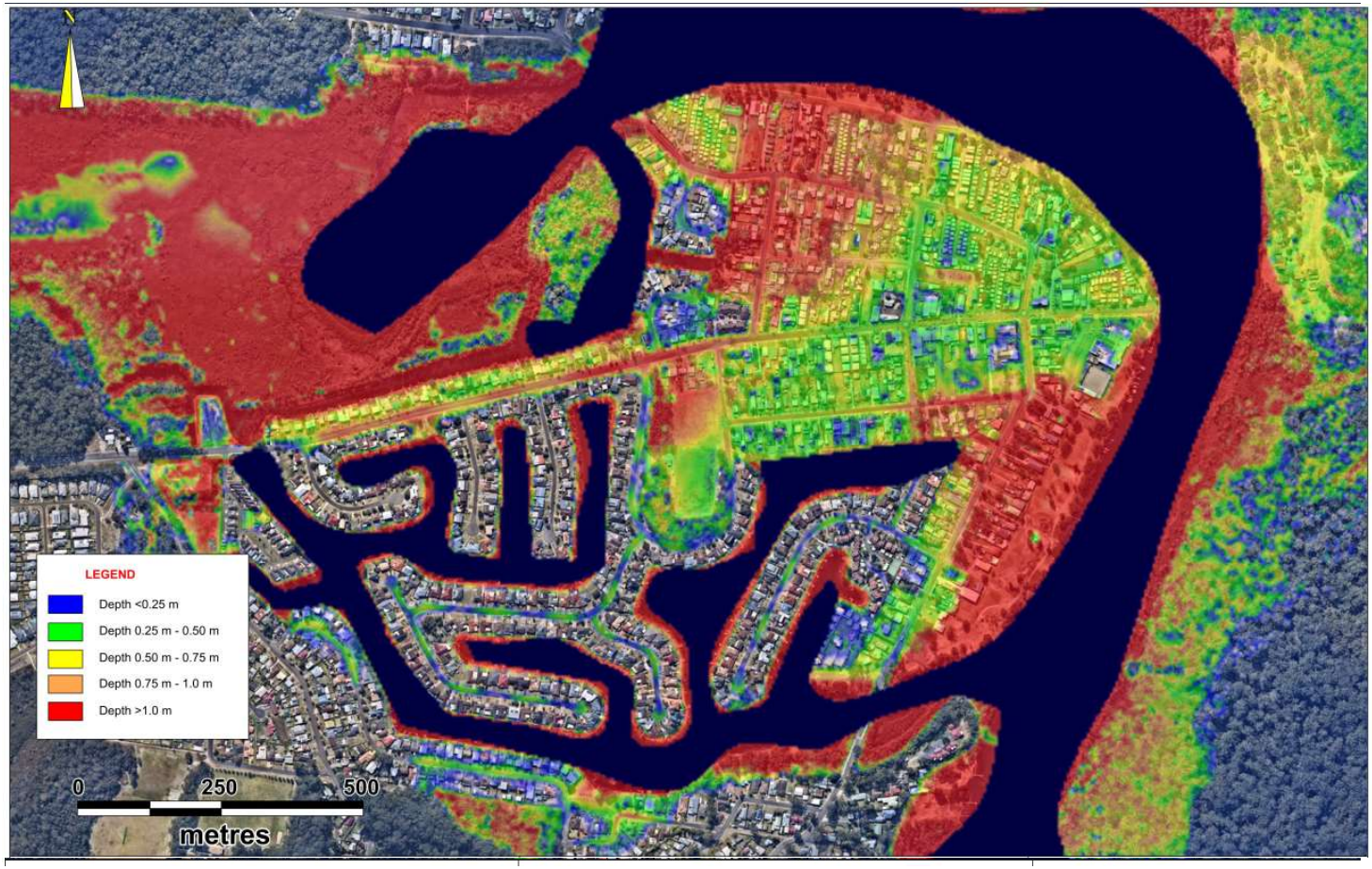


Hydrodynamic Model – Sussex Inlet

0.36m SLR

(20 year Average Recurrence Interval ARI event, 0.36m SLR)

- Southerly wind 32m/s

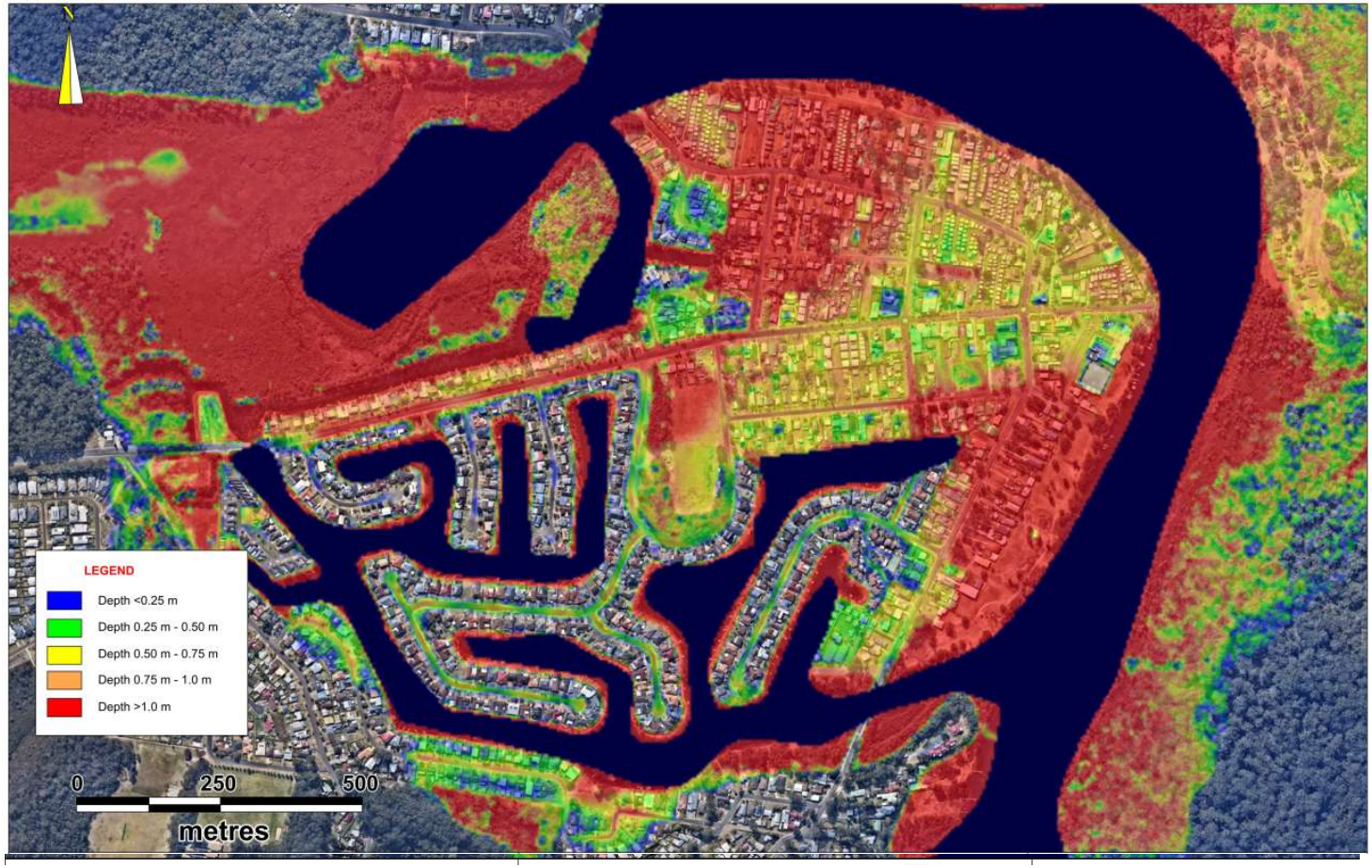


Hydrodynamic Model – Sussex Inlet

0.6m SLR

(20 year Average Recurrence Interval ARI event, 0.6m SLR)

- Southerly wind 32m/s

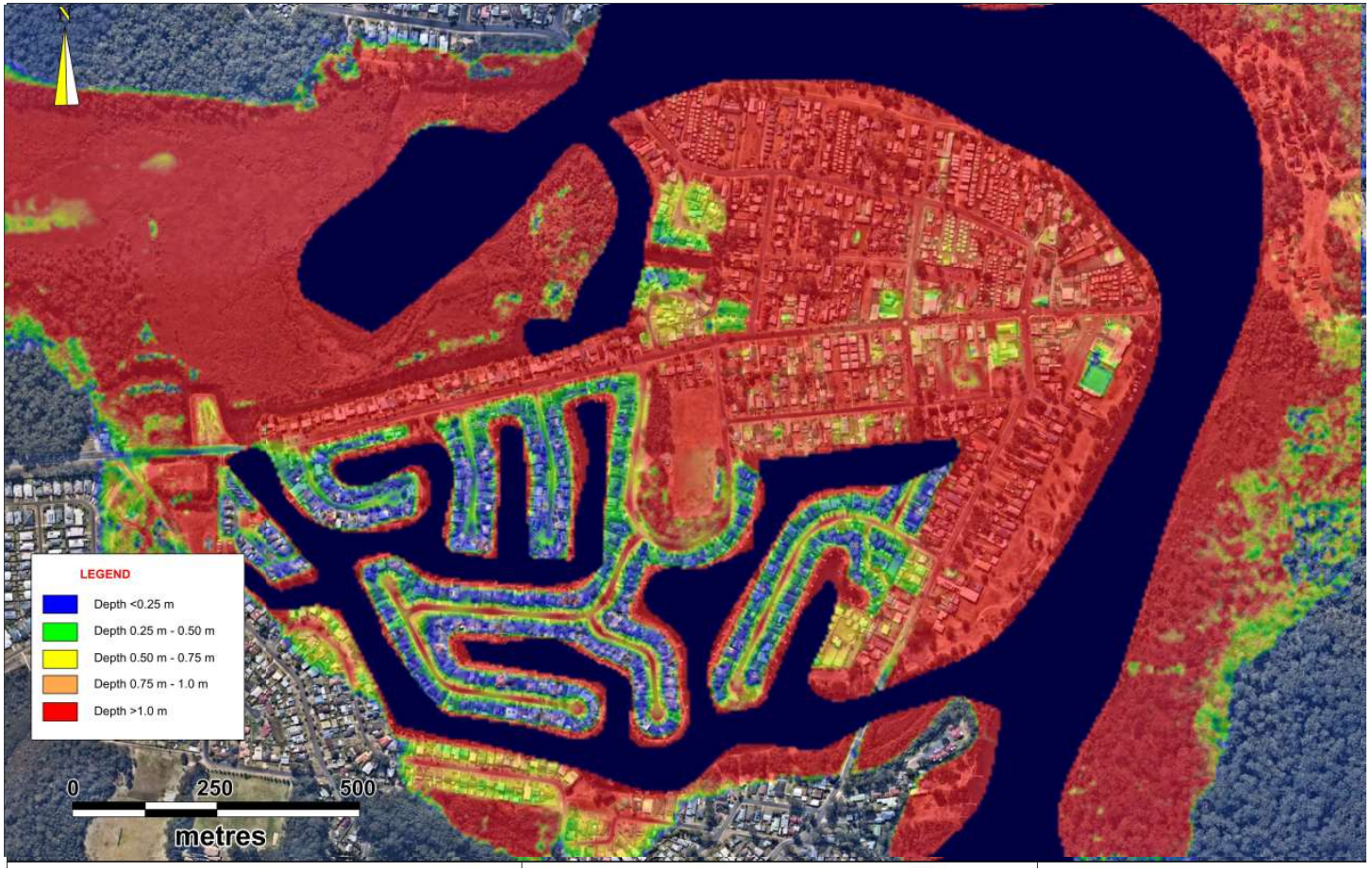


Hydrodynamic Model – Sussex Inlet

0.9m SLR

(20 year Average Recurrence Interval ARI event, 0.9m SLR)

- Southerly wind 32m/s

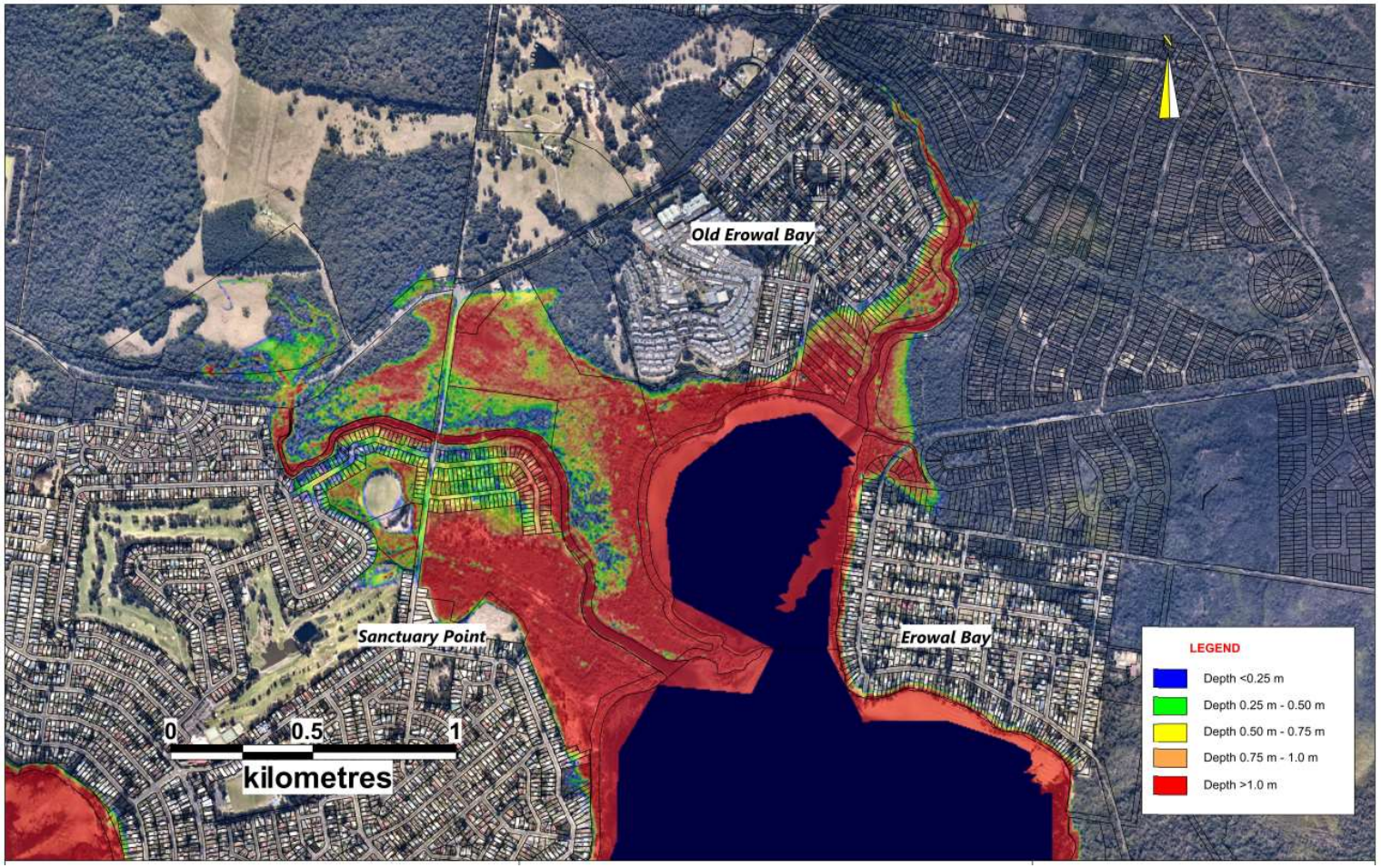


Hydrodynamic Model – St.Georges Basin

Present Day

(20 year ARI event)

- Southerly wind 32m/s

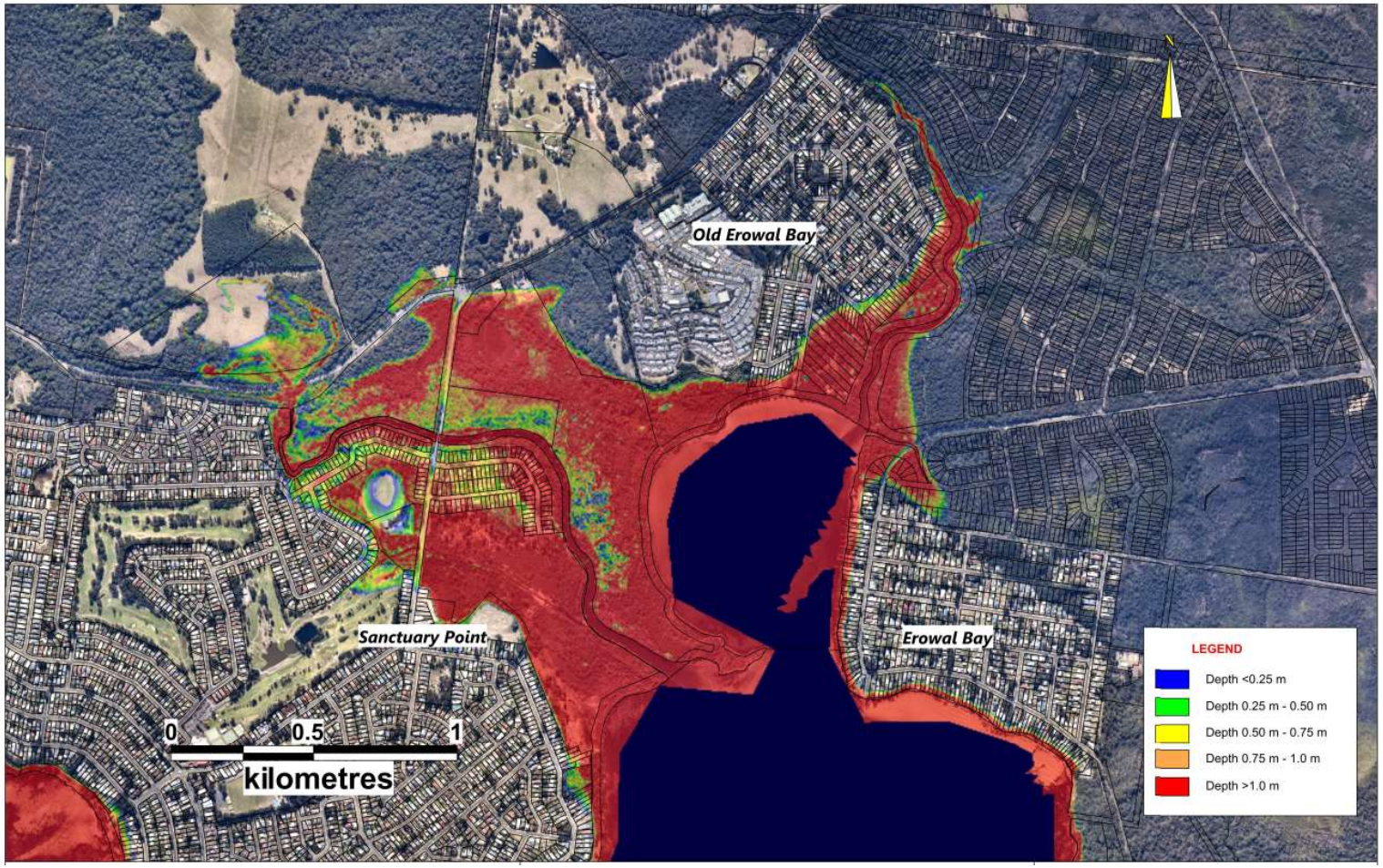


Hydrodynamic Model – St.Georges Basin

0.36m SLR

(20 year ARI event)

- Southerly wind 32m/s

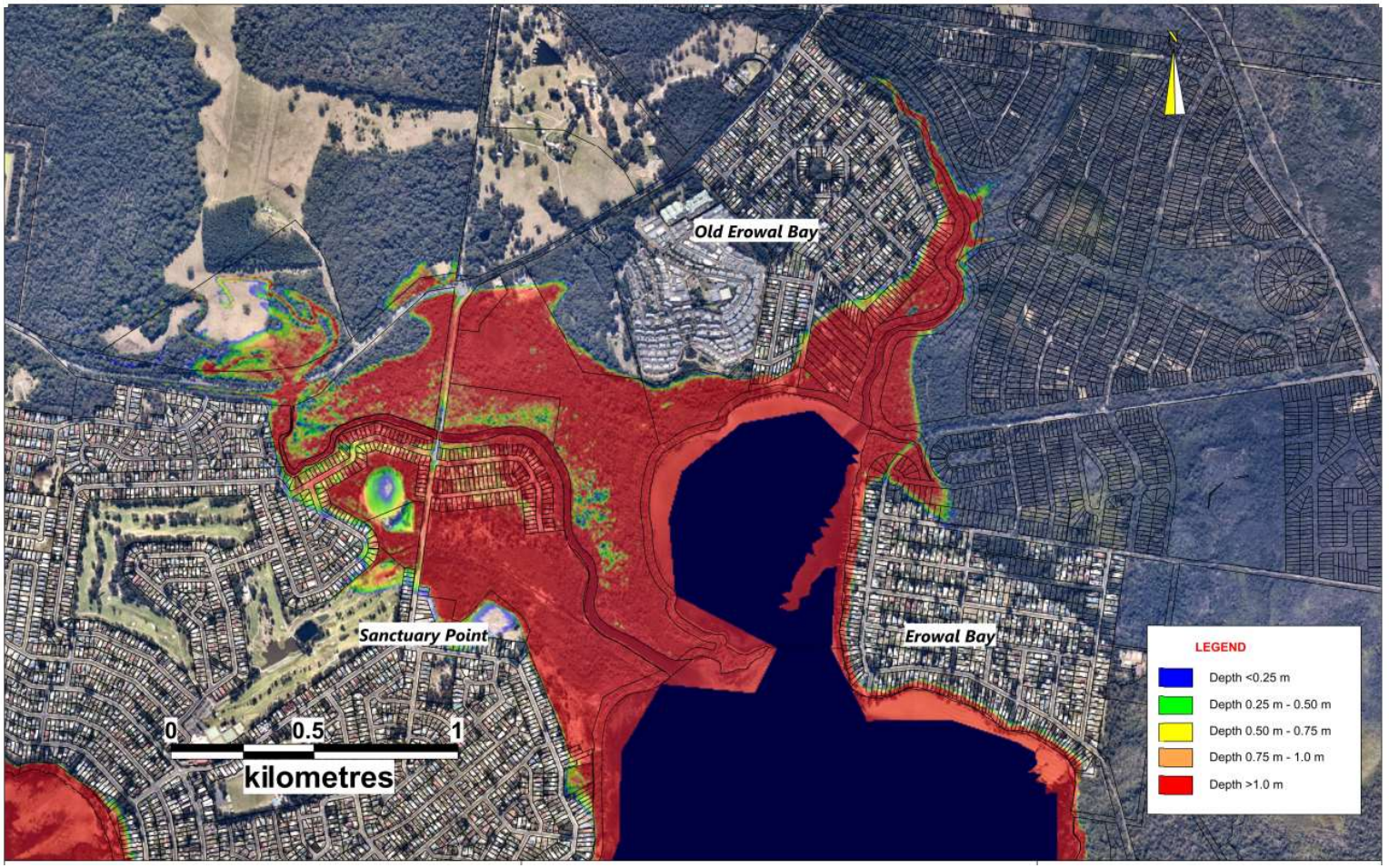


Hydrodynamic Model – St.Georges Basin

0.6m SLR

(20 year ARI event)

- Southerly wind 32m/s

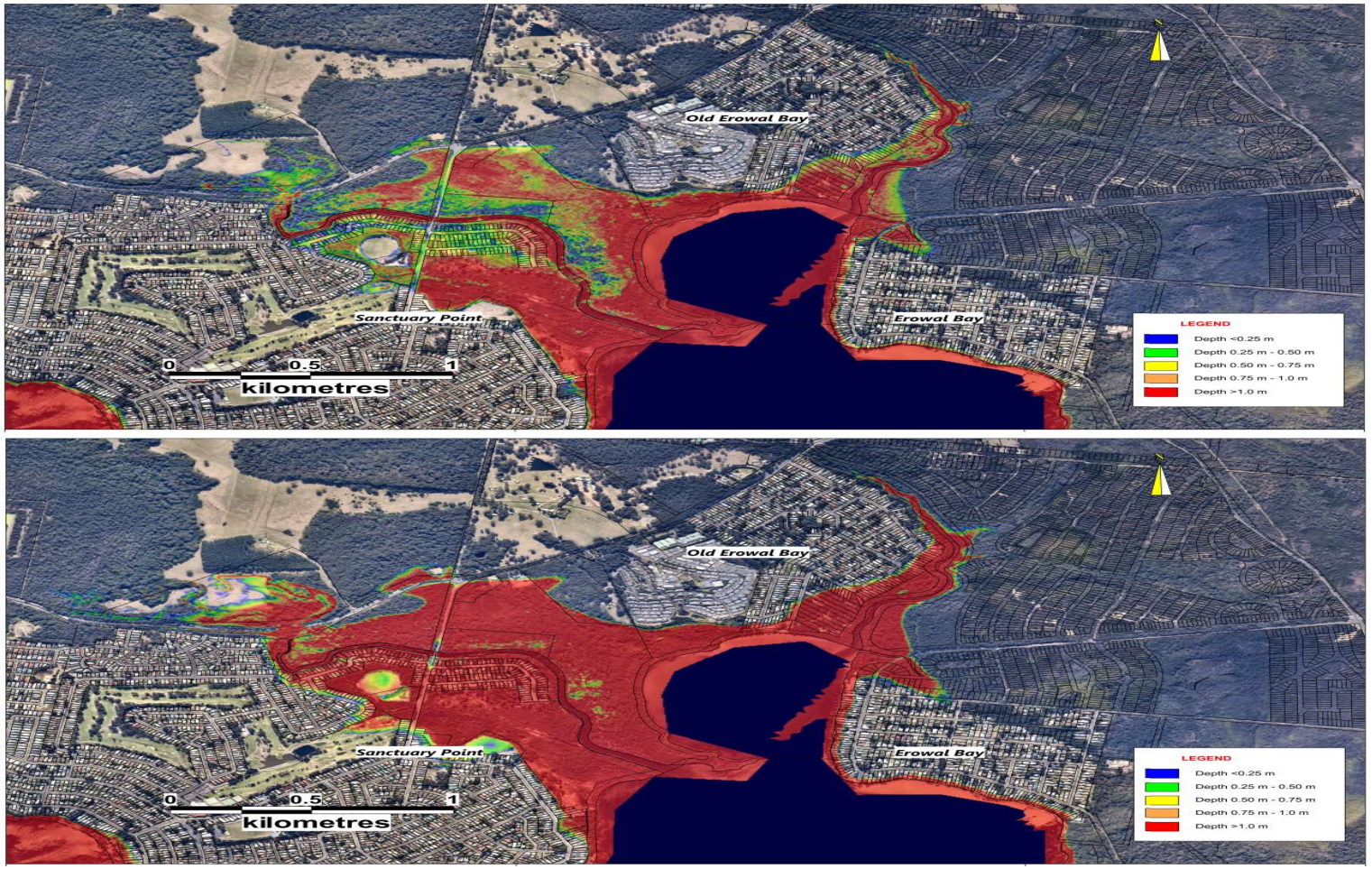


Hydrodynamic Model – St.Georges Basin

0.9m SLR

(20 year ARI event)

- Southerly wind 32m/s



APPENDIX A: LIKELIHOOD, CONSEQUENCE & RISK RATING TABLES

3. Risk Rating Table					
Likelihood	**Consequences**				
	Negligible (1)	**Minor (2)**	**Moderate (3)**	**Major (4)**	**Severe (5)**
Almost Certain 5	**M (5)**	**M (10)**	**H (15)**	**E (20)**	**E (25)**
Likely 4	**L (4)**	**M (8)**	**H (12)**	**H (16)**	**E (20)**
Possible 3	**L (3)**	**M (6)**	**H (9)**	**H (12)**	**H (15)**
Unlikely 2	**L (2)**	**L (4)**	**M (6)**	**M (8)**	**H (10)**
Rare 1	**L (1)**	**L (2)**	**L (3)**	**L (4)**	**M (5)**

Risk Rating	Explanation	Action	Review & Reporting
Low (1-4)	Risk treatment not likely to be required.	Managed in day to day operations at section/ local level	Biannual reassessment of risk.
Medium (5-10)	Residual risk tolerable only if no further risk treatment feasible or practical	Risk Owner appointed to monitor and manage. May require specific processes or procedures.	Annual reassessment of risk.
High (11-16)	Risk has significant impact on one or more departments.	Managed and monitored by Group Director(s). Implementation of treatments within 6 months. Controls reviewed annually and tested every three years.	Half yearly reassessment of risk and when changes occur. BAR quarterly report to EMT with overview of *high* risks.
Extreme (17-25)	Risk has serious implications to Council and cannot be justified except in extraordinary circumstances.	Risk must be approved by the General Manager. Immediate implementation of treatments. Controls audited annually as part of the internal audit process.	As stipulated by General Manager. BAR quarterly report to EMT with overview of *extreme* risks.

Consequence

2. Consequence Rating Table					
Category	**Negligible 1**	**Minor 2**	**Moderate 3**	**Major 4**	**Severe 5**
People (staff, contractors, volunteers, and the community)	• Minor injury with no treatment required • Isolated, internal or minimal impact on staff morale or performance • Little or no disruption to community	• Minor injury with first aid treatment required • Contained impact on staff morale or performance of short-term significance • Some displacement of people (<24hrs) or some minor disruption to community (<24 hrs)	• Medical attendance, time off work • Significant impact on staff morale or performance of medium-term significance • Localised displacement of people; normal community functioning with some medium-term inconvenience; localised damage rectified by routine arrangements	• Serious illness or injury • Major impact on staff morale or performance with long term significance • Large number displaced for >24hrs; external resources required for personal support; significant damage that requires external resources	• Fatality or permanent disability • Extensive impact or organisational morale or performance • General and widespread displacement for extended duration; community unable to function without significant support
Environment	• Contained, localised • Reversible impact.	• Contained, small scale • Reversible impact.	• Contained, widespread • Reversible impact.	• Uncontained, widespread • Reversible impact.	• Uncontained • Irreversible impact.
Financial	• Negligible financial loss (up to 1% of Council's budget) • No impact on program or business operation	• Minor financial loss (up to 3% of Council's budget) • Minimal impact on business operation	• Significant financial loss (up to10% of Council's budget) • Considerable impact on business operation	• Major financial loss (up to 20% of Council's budget) • Severe impact on business operation	• Extensive financial loss (>20% of budget) • Long term consequences for operations.
Corporate Governance	• Isolated non-compliance or breach • Negligible financial impact	• Contained non-compliance or breach with short term significance and minor financial impact	• Serious breach involving statutory authority or investigation • Prosecution possible with significant financial impact	• Major breach with fines and litigation • Long term significance and major financial impact	• Extensive fines and litigation with possible class action • Threat to viability of programs or services

Consequence

Shoalhaven City Council - Risk Assessment Procedure

2. Consequence Rating Table					
Category	**Negligible 1**	**Minor 2**	**Moderate 3**	**Major 4**	**Severe 5**
Information Technology	• No measurable operational impact to organisation	• Minor downtime or outage in single area of organisation • Address with local management and resources	• Significant downtime or outage in multiple areas of organisation • Substantial management required and local resources	• Loss of critical functions across multiple areas of organisation • Long term outage • Extensive management required and extensive resources	• Extensive and total loss of functions across organisation • Disaster management required
Property & Infrastructure	• Isolated or minimal loss • short term impact • repairable through normal operations	• Minor loss with limited downtime • Short term impact • Mostly repairable through normal operations	• Significant loss with temporary disruption of services • Medium term impact on organisation	• Critical loss or event requiring replacement of property or infrastructure • Long term impact on organisation	• Disaster with extensive loss and long-term consequences • Threat to viability of service or operation
Reputation	• Public awareness may exist but there is little public concern • Resolved by day-to-day management process	• Attention from local media, and/or heightened local concern	• Significant and sustained adverse local media attention • Serious concerns expressed and large decrease in support from the public	• Significant adverse national media attention • Significant decrease in public support • Damage to reputation at a national level.	• Subject of sustained adverse publicity in multiple media. • Significant long-term detrimental effect on business areas.

Consequences – Coastal Inundation of Infrastructure

What are the consequences of inundation of:

- Sewage pumping stations
- Sewage treatment works
- Critical wastewater mains (pressure/gravity)
- Water pumping stations
- Stormwater infrastructure (pipes/pits)
- Picnic shelters/park furniture
- Playgrounds
- Sporting Facilities
- Roads – minor local
- Roads – major arterial
- Implications of frequency of inundation – rare events vs. regular tidal inundation
- Any others?

APPENDIX A: LIKELIHOOD, CONSEQUENCE & RISK RATING TABLES

3. Risk Rating Table

Likelihood	Consequences				
	Negligible (1)	Minor (2)	Moderate (3)	Major (4)	Severe (5)
Almost Certain 5	M (5)	M (10)	H (15)	E (20)	E (25)
Likely 4	L (4)	M (8)	H (12)	H (16)	E (20)
Possible 3	L (3)	M (6)	H (9)	H (12)	H (15)
Unlikely 2	L (2)	L (4)	M (6)	M (8)	H (10)
Rare 1	L (1)	L (2)	L (3)	L (4)	M (5)

Risk Rating	Explanation	Action	Review & Reporting
Low (1-4)	Risk treatment not likely to be required.	Managed in day to day operations at section/ local level	Biannual reassessment of risk.
Medium (5-10)	Residual risk tolerable only if no further risk treatment feasible or practical	Risk Owner appointed to monitor and manage. May require specific processes or procedures.	Annual reassessment of risk.
High (11-16)	Risk has significant impact on one or more departments.	Managed and monitored by Group Director(s). Implementation of treatments within 6 months. Controls reviewed annually and tested every three years.	Half yearly reassessment of risk and when changes occur. BAR quarterly report to EMT with overview of *high* risks.
Extreme (17-25)	Risk has serious implications to Council and cannot be justified except in extraordinary circumstances.	Risk must be approved by the General Manager. Immediate implementation of treatments. Controls audited annually as part of the internal audit process.	As stipulated by General Manager. BAR quarterly report to EMT with overview of *extreme* risks.

Consequences – Foreshore Erosion of Infrastructure

What are the consequences of erosion of:

- Sewage pumping stations
- Sewage treatment works
- Critical wastewater mains (pressure/gravity)
- Water pumping stations
- Stormwater infrastructure (pipes/pits)
- Picnic shelters/park furniture
- Playgrounds
- Sporting Facilities
- Roads – minor local
- Roads – major arterial
- Foreshore assets – access tracks, fishing platforms, seawalls, boat ramps etc.

APPENDIX A: LIKELIHOOD, CONSEQUENCE & RISK RATING TABLES

3. Risk Rating Table

Likelihood	Consequences				
	Negligible (1)	Minor (2)	Moderate (3)	Major (4)	Severe (5)
Almost Certain 5	M (5)	M (10)	H (15)	E (20)	E (25)
Likely 4	L (4)	M (8)	H (12)	H (16)	E (20)
Possible 3	L (3)	M (6)	H (9)	H (12)	H (15)
Unlikely 2	L (2)	L (4)	M (6)	M (8)	H (10)
Rare 1	L (1)	L (2)	L (3)	L (4)	M (5)

Risk Rating	Explanation	Action	Review & Reporting
Low (1-4)	Risk treatment not likely to be required.	Managed in day to day operations at section/ local level	Biannual reassessment of risk.
Medium (5-10)	Residual risk tolerable only if no further risk treatment feasible or practical	Risk Owner appointed to monitor and manage. May require specific processes or procedures.	Annual reassessment of risk.
High (11-16)	Risk has significant impact on one or more departments.	Managed and monitored by Group Director(s). Implementation of treatments within 6 months. Controls reviewed annually and tested every three years.	Half yearly reassessment of risk and when changes occur. BAR quarterly report to EMT with overview of *high* risks.
Extreme (17-25)	Risk has serious implications to Council and cannot be justified except in extraordinary circumstances.	Risk must be approved by the General Manager. Immediate implementation of treatments. Controls audited annually as part of the internal audit process.	As stipulated by General Manager. BAR quarterly report to EMT with overview of *extreme* risks.

Erosion – example Basin View

Figure 3-8 – Basin View foreshore looking west from boat ramp. Note lack of riparian vegetation and undercutting of casuarinas in the background (28 November 2

Figure 3-9 – Basin View – Mathie Street foreshore. Top – building rubble at top of bank; bottom – rock revetment protecting foreshore infrastructure.

Sussex Inlet, St Georges Basin, Swan Lake and Berrara Creek CMP – Agency Risk Management Workshop

Workshop presentation

28 July 2022

This project is being supported with funding from the NSW Government's – Coastal and Estuary Grant Program.

advisian.com

Acknowledgement of Country

We would like to acknowledge the Traditional Custodians of the land in which we gather upon today. We acknowledge their continuing connections to the land, culture and community. We pay respect to Elders past, present and future.

Workshop Agenda

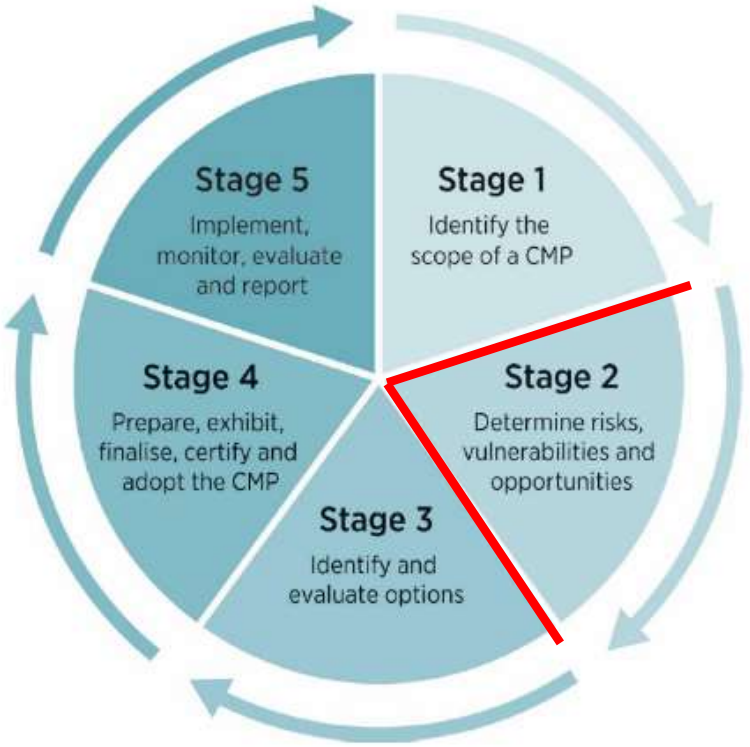
- Introductory Presentation (10min)
- Introductions
- Interactive Discussion on key risks identified
- Interactive Discussion on mitigation measures – realistic, affordable, practical, achievable
- Wrap-up

Study Area


St Georges Basin
Sussex Inlet
Swan Lake
Berrara Creek
N
0
2.5
5
kilometres

What does the CMP involve?

- Specialist studies to determine key risks and issues
- We want to use our collective experience to understand if there are any risks we may have missed
- We want to hear thoughts and ideas on how to best manage the estuaries to mitigate risks



(WE ARE HERE)

Issues Map
https://getinvolved.shoalhaven.nsw.gov.au/sussexinlet-stgeorgesbasin-berrara-swanlake-cmp/maps/what-are-your-values-issues-and-ideas-for-the-sussex-inlet-st-georges-basin-swan-lake-and-berrara-creek-area

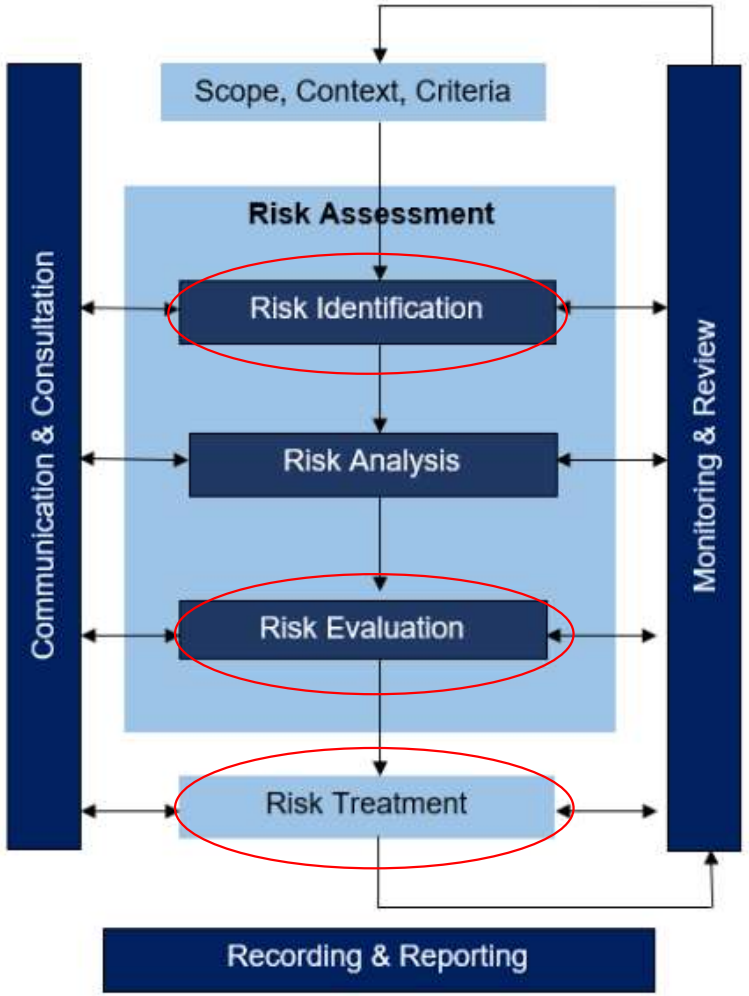
CMP Information
https://getinvolved.shoalhaven.nsw.gov.au/sussexinlet-stgeorgesbasin-berrara-swanlake-cmp

What is Risk?

- Risk = Likelihood x Consequence

Risk Rating Matrix

Likelihood	Consequence				
	Insignificant 1	Minor 2	Moderate 3	Major 4	Catastrophic 5
Almost Certain 5	MODERATE	HIGH	HIGH	EXTREME	EXTREME
Likely 4	LOW	MODERATE	HIGH	HIGH	EXTREME
Possible 3	LOW	MODERATE	HIGH	HIGH	HIGH
Unlikely 2	LOW	LOW	MODERATE	MODERATE	HIGH
Rare 1	LOW	LOW	LOW	LOW	MODERATE



[Source: AS 31000:2018 Risk management – Guidelines)

What are the key CMP risks?

- Four CMA's
  - Coastal Wetlands Littoral Rainforest Area
  - Coastal Vulnerability Area
  - Coastal Environment Area
  - Coastal Use Area
- Timeframes – Present day, 20y, 50y, 100y
- Assets and Safety
  - Tidal Inundation and sea level rise
  - Navigation and safety
  - Erosion
- Intangible Assets
  - Cultural and social
  - Ecological environment
  - Water quality

Risk Register

- Risk
- Category
- CMA
- Root Cause
- Consequence
- Existing Management Controls
- Likelihood, Consequence Rating (present, 20y, 50y, 100y) → Risk Rating
- Additional Management Measures, responsible party → Residual Risk Rating

Cultural and Social Risks (10 min)

Estuary or Beach	Coastal Management Area	Risk Description	Root Cause	Consequence
St. Georges Basin	Coastal Use	Lack of public foreshore access	High private ownership of foreshore areas	Reduced foreshore access
St. Georges Basin	Coastal Use	Buildup of seagrass wrack at bathing area Blackett Park in front of Ahola Caravan Park	Natural part of system and provides habitat. Only an issue in front of seawalls	Reduced recreational amenity
Swan Lake	Coastal Use	Overcrowding at boat launching areas, safety issues with boat ramp	High demand for boating activities, inadequate facilities	Impact on recreational amenity at foreshore reserves
Berrara Creek	Coastal Use	Lack of public foreshore access	Limited available land adjacent to foreshore	Overcrowding during peak holiday times

Cultural and Social Risks (10 min)

Estuary	Risk Description	Root Cause	Consequence
City Wide	Poor community understanding of coastal and estuary issues	Lack of easy-to-digest information	Lack of community ownership of issues, community misconceptions leading to poor environmental outcomes
City Wide	Damage to or loss of non-Aboriginal and Aboriginal cultural heritage items (e.g. midden at Cudmirrah)	Inundation, erosion, lack of understanding from the community, malicious damage, vandalism	Loss of cultural heritage
City Wide	Aboriginal loss of connection between land and sea	Inundation, erosion, lack of understanding from the community, malicious damage, vandalism	Loss of cultural heritage
City Wide	Lack of understanding of Aboriginal heritage	Inadequate education and communication	Compromised Aboriginal heritage values
City Wide	Serious deterioration of heritage items, structures, artefacts	Lack of community understanding, education, maintenance of sites and surrounding infrastructure	Inadvertent damage to sites e.g. at Berrara Ck
City Wide	Impacts on heritage items	Lack of coherent heritage planning	Deterioration of heritage items, signfiicant loss of historical authenticity for items that are listed or those items that may qualify for heritage listing
City Wide	Signfiicant loss of historical authenticity for items that may qualify for heritage listing	Lack of forward planning, listing of items that may qualify for heritage listing and heritage status, lack of up-to-date mapping. Impacts from inundation, erosion and other natural and environmental impacts	Deterioration of heritage items, signfiicant loss of historical authenticity for items that are listed or those items that may qualify for heritage listing
City Wide	Important loss of cultural significance	Lack of interpretive signage for educating the community about heritage and environment	Inadvertent damage to sites e.g. at Berrara Ck. Deterioration of heritage items, signfiicant loss of historical authenticity for items that are listed or those items that may qualify for heritage listing
City Wide	Severe deterioration of natural beauty or heritage value of heritage listed items	Human settlement, unchecked tourist activities, legal/illegal construction activities, industrial and agricultural development including use of pesticides and fertilisers, major public works, pollution, logging etc	Inadvertent damage to sites e.g. at Berrara Ck. Deterioration of heritage items, signfiicant loss of historical authenticity for items that are listed or those items that may qualify for heritage listing
City Wide	Deterioriation of heritage items due to erosion	Human encroachment on boundaries or in upstream areas	Inadvertent damage to sites e.g. at Berrara Ck. Deterioration of heritage items, signfiicant loss of historical authenticity for items that are listed or those items that may qualify for heritage listing
City Wide	Loss of protection of Aboriginal heritage items	Perceived conflict of interest/legislative loopholes between LALC and local tribe	Items that may qualify for heritage listing or status and existing Aboriginal cultural heritage may not be afforded quality of care or protection that they may require/deserve

Cultural and Social Risks – Mitigation (10 min)

Estuary	Risk Description	Existing Controls	Additional Treatment/Action
St. Georges Basin	Lack of public foreshore access	Provision of additional foreshore recreation reserves	
St. Georges Basin	Buildup of seagrass wrack at bathing area Blackett Park in front of Ahola Caravan Park	Community education on wrack as habitat, Maintenance of seagrass wrack in front of seawalls	
Swan Lake	Overcrowding at boat launching areas, safety issues with boat ramp	Upgrade existing boat launching facilities e.g. at The Springs Road	Additional or upgraded facilities, upgraded boat ramp at Swan Lake Bridge
Berrara Creek	Lack of public foreshore access	Provision of additional foreshore recreation reserves, provide designated access	

Cultural and Social Risks – Mitigation (10 min)

Estuary	Risk Description	Existing Controls	Additional Treatment/Action
City Wide	Poor community understanding of coastal and estuary issues	Community education, dissemination of information to schools and community groups, provision of resources for community groups to empower them to undertake local projects and citizen science, effective coasts and estuaries committee, use of social media to communicate with community	
City Wide	Damage to or loss of non-Aboriginal and Aboriginal cultural heritage items (e.g. midden at Cudmirrah)	Development controls, public education program, 4WD access management	More signage, better protection, enforcement of 4WD restrictions, better education, rezoning of areas to higher environmental protection.
City Wide	Aboriginal loss of connection between land and sea	Development controls, public education program, Aboriginal heritage mapping, statutory and non-statutory planning controls	Aboriginal access to the environment and 2.5km zone of coastline was recommended by Jerringja Tribe. Access tracks between sites to maintain connection between the sea and rest of lands.
City Wide	Lack of understanding of Aboriginal heritage	Community education, Aboriginal Advisory Committee (Council), Council engagement strategy and supporting articles	Community suggestion to rename St Georges Basin using Indigenous language names, community education. Reinforcing that the region always has and always will be Jerrinja country
City Wide	Serious deterioration of heritage items, structures, artefacts	Planning controls and Aboriginal heritage mapping	Erection of interpretative signage, explore more education initiatives and enforecement of fines/penalities
City Wide	Impacts on heritage items	Statutory and non-statutory planning controls	Updating Aboriginal and non-Aboriginal heritage listings, including updating of mapping to ensure protection of any culturally significant heritage items
City Wide	Signfiicant loss of historical authenticity for items that may qualify for heritage listing	Statutory and non-statutory planning controls	Updating Aboriginal and non-Aboriginal heritage listings, including updating of mapping to ensure protection of any culturally significant heritage items
City Wide	Important loss of cultural significance	Statutory and non-statutory planning controls, mapping tools.	Updating Aboriginal and non-Aboriginal heritage listings, including updating of mapping to ensure protection of any culturally significant heritage items
City Wide	Severe deterioration of natural beauty or heritage value of heritage listed items	Statutory and non-statutory planning controls, mapping tools.	Updating Aboriginal and non-Aboriginal heritage listings, including updating of mapping to ensure protection of any culturally significant heritage items
City Wide	Deterioriation of heritage items due to erosion	CMP - inundation mapping in relation to heritage items	Preparation of CMP with targetted actions to prevent/minimise disturbances/deterioration/impacts to heritage items
City Wide	Loss of protection of Aboriginal heritage items	Statutory and non-statutory planning controls, mapping tools.	Updating Aboriginal and non-Aboriginal heritage listings, including updating of mapping to ensure protection of any culturally significant heritage items

Ecological Environment Risks

MHWS with 1.2m SLR

Ecological Environment Risks (20 min)

Estuary	Risk Description	Root Cause	Consequence
St. Georges Basin	Changes in balance between habitat types, landward migration or loss of macrophyte communities	Sea Level Rise and inundation	Loss or changes to biodiversity, landward migration of estuarine vegetation. The Sanctuary Point shoreline is particularly vulnerable
St. Georges Basin	Damage to estuarine vegetation, seagrass beds	Propeller damage	Damage to seagrasses
St. Georges Basin	Impacts on estuary health	Climate change resulting in more frequent extreme events (drought and bushfires)	Impacts on water quality and estuary ecology
St. Georges Basin	Damage to foreshore vegetation, saltmarsh	Illegal clearing,introduced animals (eg. dogs). Illegal clearing is a problem especially in Tomerong Creek catchment.	Loss of habitat and changes to estuary ecology. Decreased buffering capacity.
Sussex Inlet	Damage to seagrass beds at entrance to St Georges Basin	Dragging of boat anchors	Damage to seagrasses
Sussex Inlet	Fragmentation of coastal wetland area	Urban encroachment	Threat to estuary ecology
Sussex Inlet	Changes in balance between habitat types, landward migration or loss of macrophyte communities	Sea Level Rise and inundation	Loss of biodiversity, landward migration of estuarine vegetation
Sussex Inlet	Possible ballast rock contributing to sedimentation of channel	Legacy issue from past landuse practices	Increased channel sedimentation, impact on recreational amenity
Sussex Inlet	Impacts on estuary health	Unchecked tourist development - caravans, ad-hoc jetties, caravan park, unapproved structures	Compromised estuary heatlth
Sussex Inlet	Reduction in estuary health associated with sandmining impacts	Sandmining proposal (withdrawn in Jan 21)	Threats to estuary health
Sussex Inlet	Impacts on estuary health	Unchecked tourist development - caravans, ad-hoc jetties, caravan park, unapproved structures	Compromised estuary heatlth

Ecological Environment Risks (20 min)

Estuary	Risk Description	Root Cause	Consequence
Swan Lake	Impacts on estuary health	Boating, inadequate habitat proteciton, urban encroachment, invasive species	Compromised estuary heatlth
Swan Lake	Invasive weeds	Urban landuse and general spread of invasive species	Threat to estuary ecology
Swan Lake	Degradation of habitat for birds and aquatic ecology (decline in Ruppia seagrasses in 2004 v 1980)	Pollution, entrance management practices	Threat to estuary ecology
Swan Lake	Erosion of dunes	Inappropriate estuary entrance management	Threat to estuary ecology
Swan Lake	Damage to dune vegetation	4WD vehicles	Damage to dune vegetation at eastern bend of estuary channel, risk of entrance breakthrough
Swan Lake	Introduced species threatening native wildlife	Past landuse practices	Threat to estuary ecology
Swan Lake	Low water levels	Climate change = more frequent extreme events (drought and bushfires)	Threat to estuary ecology (reported decline in charophytes and swans)
Swan Lake	Changes to estuarine morphology	Past bridge construction	Threat to estuary ecology
Swan Lake	Artificial lake openings affecting fish populations and wetlands	Arbitrary lake opening	Threat to estuary ecology
Swan Lake	Threat to fish stocks from overfishing	Overfishing	Threat to fish stocks

Ecological Environment Risks (20 min)

Estuary	Risk Description	Root Cause	Consequence
Berrara Creek	Artificial lake openings affecting fish populations and wetlands	Unsanctioned lake openings	Threat to estuary ecology
Berrara Creek	Invasive weeds	Urban landuse and general spread of invasive species	Threat to estuary ecology
Berrara Creek	Decline in fisheries	Overfishing	Reduced recreational and commerical fisheries value
Berrara Creek	Decline in estuary health	Climate change causing more frequent extreme events (drought and bushfires)	Reduced biodiversity (i.e. andecotal reports of decline in swans and charophyte food source)
Berrara Creek	Reduction in estuary health	Potential for environmental releases of chlorinated drinking water from water pump station at Berrara Ck	Acute toxicity of chlorine to aquatic ecology at concentrations in drinking water (new ANZG 2018 guideline for chlorine in freshwater)
City Wide	Lack of conservation policy, including risk assessment factoring in climate change, erosion/sedimentation, geological or other environmental factors.	Legislation	Threats to estuary health
City Wide	Reduction in estuary health	Percieved incorrect zoning of areas	Threats to estuary health

Ecological Environment – Mitigation (20 min)

Estuary	Risk Description	Root Cause	Existing Controls	Additional Treatment/Action
St. Georges Basin	Changes in balance between habitat types, landward migration or loss of macrophyte communities	Sea Level Rise and inundation	CMP including inundation mapping, development controls, state and federal legislation	Identify suitable areas where macrrophytes can migrate, continue NSW DPI macrophyte mapping to monitor variability and long term trends
St. Georges Basin	Damage to estuarine vegetation, seagrass beds	Propeller damage	Boating restrictions, NSW DPI mapping, vessel speed limits	Restricted vessel access to known/mapped seagrass areas, more stringent regulation on vessel speed limits, public education
St. Georges Basin	Impacts on estuary health	Climate change resulting in more frequent extreme events (drought and bushfires)	Water quality monitoring program	Revised water quality monitoring program
St. Georges Basin	Damage to foreshore vegetation, saltmarsh	Illegal clearing,introduced animals (eg. dogs). Illegal clearing is a problem especially in Tomerong Creek catchment.	Education	Stringent regulation on illegal clearing, replanting of targeted areas, better protection of significant ecological zones and maintaining wildlife corridors and habitats. Specific surveys to map important ecological areas (eg. Stringray habitat)
Sussex Inlet	Damage to seagrass beds at entrance to St Georges Basin	Dragging of boat anchors	Public education, provision of dedicated anchorage area	
Sussex Inlet	Fragmentation of coastal wetland area	Urban encroachment	Development controls. Zoning	
Sussex Inlet	Changes in balance between habitat types, landward migration or loss of macrophyte communities	Sea Level Rise and inundation	CMP, development controls, state and federal legislation	Identify suitable areas where macrrophytes can migrate, continue NSW DPI macrophyte mapping to monitor variability and long term trends
Sussex Inlet	Possible ballast rock contributing to sedimentation of channel	Legacy issue from past landuse practices	Study/survey to locate ballast rock	
Sussex Inlet	Impacts on estuary health	Unchecked tourist development - caravans, ad-hoc jetties, caravan park, unapproved structures	Development controls	Better monitoring and enforcement of illegal activites such as 4WD and fishing
Sussex Inlet	Reduction in estuary health associated with sandmining impacts	Sandmining proposal (withdrawn in Jan 21)	Environmental Approvals process, community submissions	
Sussex Inlet	Impacts on estuary health	Unchecked tourist development - caravans, ad-hoc jetties, caravan park, unapproved structures	Development controls	

Ecological Environment – Mitigation (20 min)

Estuary	Risk Description	Root Cause	Existing Controls	Additional Treatment/Action
Swan Lake	Impacts on estuary health	Boating, inadequate habitat proteciton, urban encroachment, invasive species	Development controls	Greater protection to natural vegetation and nesting areas, tighter controls on powered boats, targeted ecological surveys to monitor communities, updated macrophyte mapping
Swan Lake	Invasive weeds	Urban landuse and general spread of invasive species	Development controls, public education	Community planting and weeding programs, maintainance of reserves
Swan Lake	Degradation of habitat for birds and aquatic ecology (decline in Ruppia seagrasses in 2004 v 1980)	Pollution, entrance management practices	Entrance Management	Updated NSW DPI Macrophyte Mapping, consistent entrance management, signage and education on parking in camping and reserve areas
Swan Lake	Erosion of dunes	Inappropriate estuary entrance management	Entrance Management, public education	More stringent regulation on 4WD
Swan Lake	Damage to dune vegetation	4WD vehicles	4WD access management	
Swan Lake	Introduced species threatening native wildlife	Past landuse practices	Feral animal control methods, fencing	
Swan Lake	Low water levels	Climate change = more frequent extreme events (drought and bushfires)	Entrance Management Policy	Entrance Management to consider lake levels during droughts, water level triggers and migitation measures needed
Swan Lake	Changes to estuarine morphology	Past bridge construction	Entrance Management	
Swan Lake	Artificial lake openings affecting fish populations and wetlands	Arbitrary lake opening	Entrance Management	Review of Entrance Management Policy, community education, signage
Swan Lake	Threat to fish stocks from overfishing	Overfishing	Bag limits for fishing	A review of fishing and impacts on stock, targeted fish surveys, more stringent regulation on bag limits and penalties for illegal fishing,

Ecological Environment – Mitigation (20 min)

Estuary	Risk Description	Root Cause	Existing Controls	Additional Treatment/Action
Berrara Creek	Artificial lake openings affecting fish populations and wetlands	Unsanctioned lake openings	Entrance Management	Review of Entrance Management Policy and triggers to artifically open (such as following the bushfire events where there was a build up of debris and ash in waters), community education, signage
Berrara Creek	Invasive weeds	Urban landuse and general spread of invasive species	Development controls, public education, invasive weed management	Planting and invasive weed management
Berrara Creek	Decline in fisheries	Overfishing	Bag limits for fishing, NSW DPI enforcement	More signage, better communication on consequences, stricter regulation
Berrara Creek	Decline in estuary health	Climate change causing more frequent extreme events (drought and bushfires)	None	Targeted ecological surveys to be able to monitor long term trends
Berrara Creek	Reduction in estuary health	Potential for environmental releases of chlorinated drinking water from water pump station at Berrara Ck	Pollution Incident Response Management Plan (PIRMP), Risk Assessment, Risk Minimisation and Incident Management Strategy	Dechlorination of drinking water (using vitamin C or other suitable methods) prior to environmental releases, if they occur.
City Wide	Lack of conservation policy, including risk assessment factoring in climate change, erosion/sedimentation, geological or other environmental factors.	Legislation	CMP, development controls, state and federal legislation	
City Wide	Reduction in estuary health	Perceived incorrect zoning of areas	CMP, development controls, state and federal legislation	

Water Quality Risks (10 min)

Estuary	Risk Description	Root Cause	Consequence
St. Georges Basin	Poor water quality inputs from tributaries (nutrients and suspended solids, DO and turbidity), however does not impact on water quality significantly within the lake	Urban stormwater runoff and erosion including from key identifed development sites	Impacts on estuary ecology
St. Georges Basin	Erosion in tributaries	Development sites and stormwater management	Impact on water quality
St. Georges Basin	Poor water quality inputs from tributaries (pathogens)	Poor water quality in tributaries - urban runoff, sewage overflows, agricultural runoff or environmental/natural sources	Reduced recreational amenity
Sussex Inlet	Poor water quality (turbidity) in canals	Urban runoff, poor tidal flushing in canal estate area	Impact on ecology
Swan Lake	Poor water quality (pathogens) at inlet	Urban runoff, sewage overflows or environmental sources	Recreational amenity
Swan Lake	Poor water quality in Swan Lake (Stakeholder perceptions)	Stakeholder concerns on water quality in Swan Lake. However, montioring shows that apart from the inlet water quality is good and typical of back dune lagoon environments	Threat to estuary ecology
Berrara Creek	Poor water quality (turbidity and DO) including stakeholder concerns	Catchment inputs - erosion and urban runoff, climate change resulting in more frequent extreme events (drought and bushfires)	Threat to estuary ecology
Berrara Creek	Poor water quality (faecal contamination/pathogens)	Urban runoff, sewage overflows between Waterhaven Ave and Meadow Lake Avenue OR environmental sources	Impact on recreational amenity at foreshore reserves
City Wide	Water quality and estuary health monitoring programs	Inconsistent monitoring of water quality and estuary health	Compromised ability to assess long term trends in water quality and estuary health
City Wide	Overflows from sewage pumping network stations (all catchments)	Wet weather including more frequent inundations. Dry weather from blockages, power failures etc.	Recreational and human health impacts
City Wide	Potential contaminants associated with urban area runoff - hydrocarbons, metals, pesticides	Inundation and urban runoff	Estuary health and recreational impacts

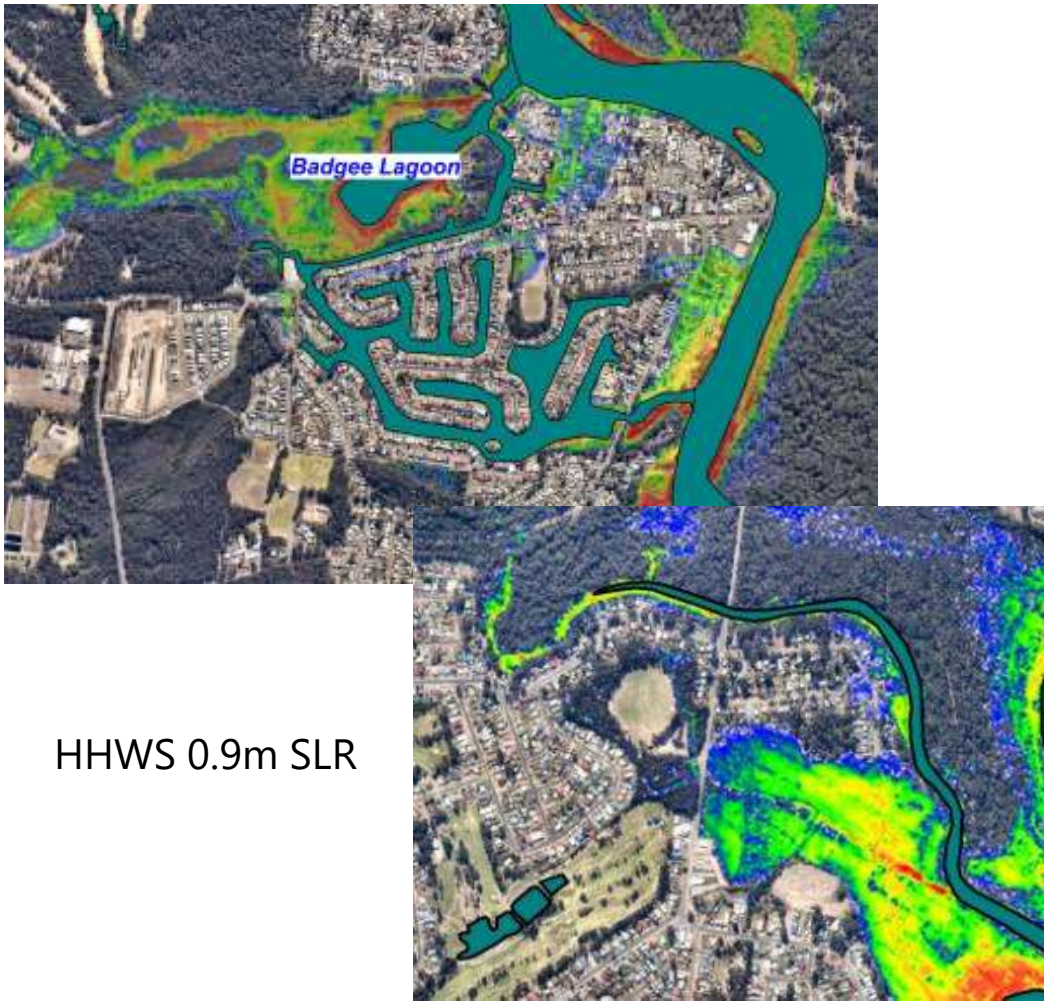
Water Quality Mitigation (10 min)

Estuary	Risk Description	Existing Controls	Additional Treatment/Action
St. Georges Basin	Poor water quality inputs from tributaries (nutrients and suspended solids, DO and turbidity), however does not impact on water quality significantly within the lake	Zoning/development controls within catchment area, control of urban runoff, community education, water quality monitoring program	Revised Water Quality Montioring Program (including event monitoring)
St. Georges Basin	Erosion in tributaries	Development controls	Identification of key development sites as root cause and more stringent regulation
St. Georges Basin	Poor water quality inputs from tributaries (pathogens)	Sewage treatment plant upgrade, sewerage infrastructure upgrade, community education, development controls	Review of sewage overflow, revised water quality program - including sanitary inspections, event sampling and could do additional faecal source tracking analysis (to identify source of faecal contamination), public education on suitable swimming times
Sussex Inlet	Poor water quality (turbidity) in canals	Monitoring,Riviera Keys Canals Management Plan, estuary maintenance/dredging	
Swan Lake	Poor water quality (pathogens) at inlet	Entrance Management, development controls, public education, stormwater treatment	Review of sewage overflow, revised water quality program - including sanitary inspections, event sampling and could do additional faecal source tracking analysis (to identify source of faecal contamination), public education on suitable swimming times
Swan Lake	Poor water quality in Swan Lake (Stakeholder perceptions)	Entrance Management, development controls, public education, stormwater treatment	Community education, revised water quality monitoring program (including adopting DP&E MER guidelines for back dune lagoons)
Berrara Creek	Poor water quality (turbidity and DO) including stakeholder concerns	Development controls, public education, stormwater treatment, Water quality monitoring program	NSW DP&E Estuary Health Program, Revised water quality program (including adoption of DP&E guidelines for lagoons)
Berrara Creek	Poor water quality (faecal contamination/pathogens)	Entrance Management, development controls, public education, stormwater treatment	Review of sewage overflows, revised water quality program - including sanitary inspections, event sampling and could do additional faecal source tracking analysis (to identify source of faecal contamination), public education on suitable swimming times
City Wide	Water quality and estuary health monitoring programs	Water quality monitoring program, DP&E Estuary Health program, NSW DPI macrophyte mapping	
City Wide	Overflows from sewage pumping network stations (all catchments)	STP EPLs, Pollution Incident Response Management Plan (PIRMP), Risk Assessment, Risk Minimisation and Incident Management Strategy, Water Quality Monitoring Program	
City Wide	Potential contaminants associated with urban area runoff - hydrocarbons, metals, pesticides	Development controls	

Break

Tidal Inundation and Sea Level Rise

1% AEP Coastal Inundation



HHWS 0.9m SLR

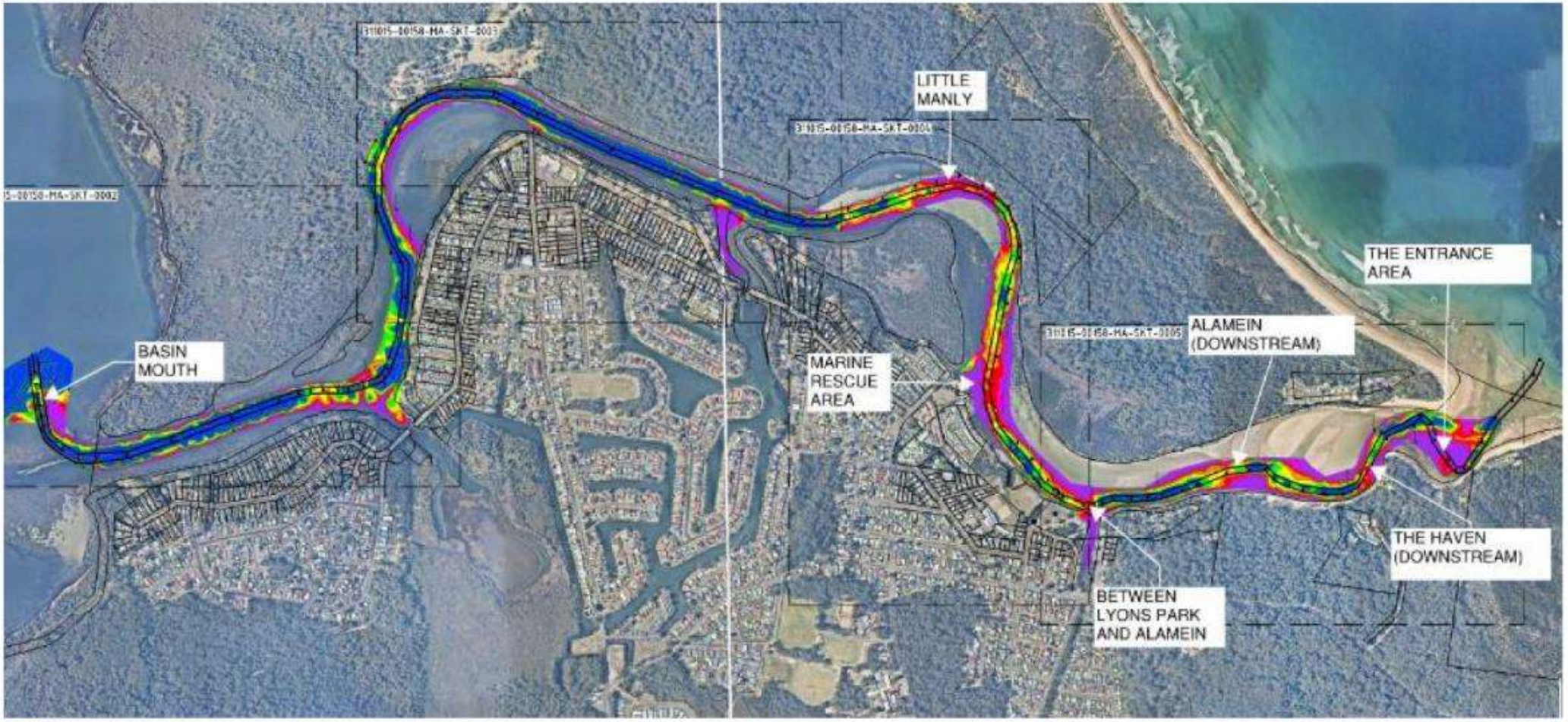
Tidal Inundation and Sea Level Rise (10 min)

Estuary	Coastal Management Area	Risk Description	Root Cause	Consequence
St. Georges Basin	Coastal Vulnerability	Flooding	Sea Level Rises and changes to estuary hydraulics	Impact on foreshore infrastructure, access
Sussex Inlet	Coastal Vulnerability	Flooding	Low lying development, lack of tourist awareness of flooding, no evacuation centre, lack of flood warning system and evacuation procedures	Damage to infrastructure, loss of community access, impact on tourists
Swan Lake	Coastal Vulnerability	Flooding	Low lying development	Damage to infrastructure/loss of community access
Swan Lake	Coastal Wetlands and Littoral Rainforest	Changes in balance between habitat types, landward migration or loss of macrophyte communities	Sea Level Rise and inundation	Loss or changes to biodiversity, landward migration of estuarine vegetation
Berrara Creek	Coastal Wetlands and Littoral Rainforest	Changes in balance between habitat types, landward migration or loss of macrophyte communities	Sea Level Rise and inundation	Loss or changes to biodiversity, landward migration of estuarine vegetation
City Wide	Coastal Vulnerability	Development approved in inappropriate locations	Inadequate or inappropriate sea level rise projections for planning purposes	Future increased risk to Infrastructure

Tidal Inundation and Sea Level Rise (10 min)

Estuary	Risk Description	Existing Controls	Additional Treatment/Action
St. Georges Basin	Flooding	Development controls	Improved stormwater infrastructure to account for increased runoff during innundation events.
Sussex Inlet	Flooding	Development controls, monitoring, development of flood warning system and flood evacuation procedures	Improved stormwater infrastructure to account for increased runoff during innundation events.
Swan Lake	Flooding	Entrance Management, development controls	Improved stormwater infrastructure to account for increased runoff during inundation events.
Swan Lake	Changes in balance between habitat types, landward migration or loss of macrophyte communities	CMP including inundation mapping, development controls, state and federal legislation	Identify suitable areas where macrrophytes can migrate, continue NSW DPI macrophyte mapping to monitor variability and long term trends
Berrara Creek	Changes in balance between habitat types, landward migration or loss of macrophyte communities	CMP including inundation mapping, development controls, state and federal legislation	Identify suitable areas where macrrophytes can migrate, continue NSW DPI macrophyte mapping to monitor variability and long term trends
City Wide	Development approved in inappropriate locations	Community education, planning controls, Council resolutions on sea level rise projections	

Navigation and Safety



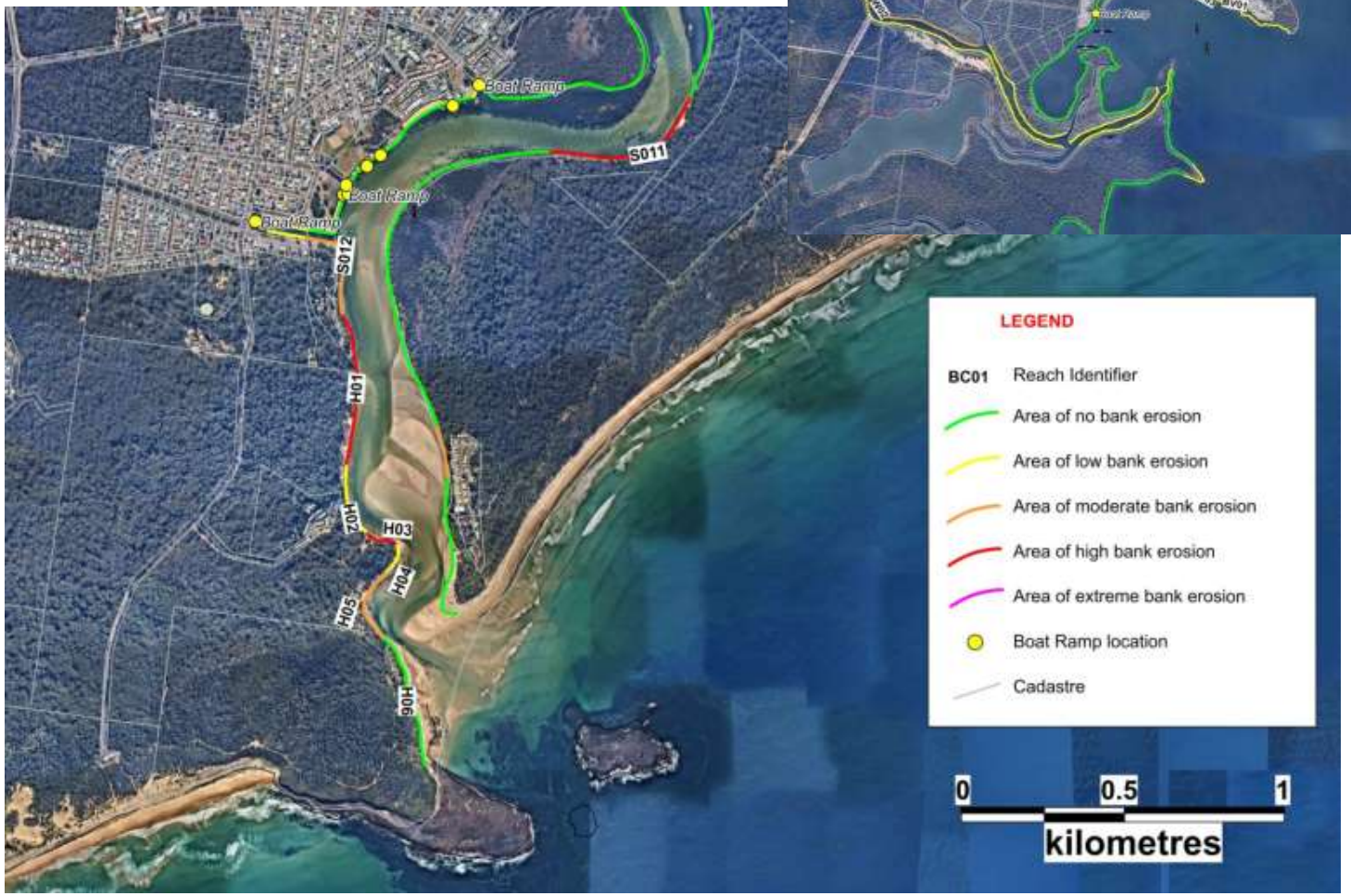
Navigation and Safety (10 min)

Estuary	Risk Description	Root Cause	Consequence
St. Georges Basin	Conflict between users of powered and non-powered craft	High demand for recreational use	Threat to recreational amenity
St. Georges Basin	Lack of public boating facilities	High demand for recreational use	Crowding at existing facilities
St. Georges Basin	Navigational issues in Tomerong Creek	Insufficent navigation, powered vessels not suitable for creek	Reduced recreational amenity
Sussex Inlet	Poor navigation conditions into the Basin and near the entrance, and at Chris Creek and Alamein	Shoaling of channel	Impact on navigation
Sussex Inlet	Conflict between users of powered and non-powered craft	High demand for recreational boating	Amenity, safety
Sussex Inlet	Reduced coastal amenity and compromised recreational use	Need for channel optimisation, sand nourishment/maintenance to revetment walls, review of the Canals Management Plan at Riviera Keys	Damage to revetment walls, increased channel sedimentation, impact on navigation and recreational amenity
Berrara Creek	Boating safety issues	Vessels not sticking to speed limits	Amenity and safety impacts and environment
City Wide	Conflict between users of powered and non-powered craft	Disagreements between stakeholders, responsible agencies for projects	Perceived lack of action or delays on urgent coastal and estuary rehabilitation projects

Navigation and Safety – mitigation (10 min)

Estuary	Risk Description	Existing Controls	Additional Treatment/Action
St. Georges Basin	Conflict between users of powered and non-powered craft	Provision of dedicated facilities for powered and non-powered vessel users	
St. Georges Basin	Lack of maintenance to public boating facilities	Maintenance of boating facilities	
St. Georges Basin	Navigational issues in Tomerong Creek	Signage and vessel speed limits	Ban powerboats in Tomerong Creek, increase and provide more clear navigational aids to support safety
Sussex Inlet	Poor navigation conditions into the Basin and near the entrance, and at Chris Creek and Alamein	Monitoring, estuary maintenance/dredging	
Sussex Inlet	Conflict between users of powered and non-powered craft	Demand study and provision of additional boating facilities if needed	
Sussex Inlet	Reduced coastal amenity and compromised recreational use	Review Riviera Keys Canals Management Plan	
Berrara Creek	Boating safety issues	Vessel speed limits, signage	Stakeholders suggest to restrict access in Berrara Creek to non powered vessels
City Wide	Conflict between users of powered and non-powered craft	Effective communication between agencies, Council and stakeholders	

Foreshore Erosion



Foreshore Erosion (10 min)

Estuary	Root Cause	Consequence
St. Georges Basin	Vessel waves, wind waves, sea level rise	Damage to foreshore infrastructure and foreshore vegetation
Sussex Inlet	Erosion from meandering of channel, lack of riparian vegetation or failing bank protection	Sand entering estuary channel causing hazard to navigation
Sussex Inlet	Erosion from boat and jetski wakes, storage of boats and canoes, 4WD.	Damage to foreshore infrastructure and foreshore vegetation
Sussex Inlet	Foreshore erosion due to flood flows and ocean waves, proximity of cabins to beach	Amenity, safety
Swan Lake	Boating activities	Threat to estuary ecology
Berrara Creek	Inappropriate foreshore development or inadequate Maintenance. Example the erosion of access stairs where people are taking shortcuts through vegetation	Threat to estuary ecology

Foreshore Erosion – Mitigation (10 min)

Estuary	Root Cause	Existing Controls	Additional Treatment/Action
St. Georges Basin	Vessel waves, wind waves, sea level rise	Foreshore protection structures, development controls, vessel speed limits	Maintenance of structures as required, more stringent regulation on vessel speed limits
Sussex Inlet	Erosion from meandering of channel, lack of riparian vegetation or failing bank protection	Foreshore protection structures, development controls for flood-prone areas, vessel speed limits, entrance management	Maintenance of structures as required, more stringent regulation on vessel speed limits
Sussex Inlet	Erosion from boat and jetski wakes, storage of boats and canoes, 4WD.	Foreshore protection structures, development controls for flood-prone areas, vessel speed limits, entrance management	Maintenance of structures as required, more stringent regulation on vessel speed limits
Sussex Inlet	Foreshore erosion due to flood flows and ocean waves, proximity of cabins to beach	none	Consider risk to cabins and build landward
Swan Lake	Boating activities	Development controls for flood-prone areas, vessel speed limits, entrance management	More stringent regulation on vessel speed limits, revised entrance management policy, repair of access stairs in Cudmirrah to prevent people shortcuting through vegetation.
Berrara Creek	Inappropriate foreshore development or inadequate Maintenance. Example the erosion of access stairs where people are taking shortcuts through vegetation	Education, development controls for adjacent lands, access management	More stringent regulation on vessel speed limits, maintenance of damaged access stairs

Where to from here?

- Update CMP Stage 2 Risk Register with additional risks and mitigation measures
- Finalise Stage 2 CMP
- Formulate mitigation measures into formal management actions for Stage 3 CMP