Somerset Coastal Adaptation Pathways

SGS Economics & Planning

Final Report

Waratah-Wynyard Council, Tasmanian Climate Change Office

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Independent insight.

Independent insight.

SGS Economics and Planning Pty Ltd
ACN 007 437 729
www.sgsep.com.au
Offices in Brisbane, Canberra, Hobart, Melbourne, Sydney

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1 INTRODUCTION AND AIM

1.1 This report

The aim of this report is to inform Council, residents and visitors of Somerset and the wider community about coastal risks in light of sea level rise resulting from climate change. It considers ways to respond to risks while also considering the values of living in Somerset and other benefits such as beach recreation, fishing and swimming.

A better understanding of the issues and possible responses will help the community to make informed decisions to respond to sea level rise and its potential impacts.

The report starts with an overview of the coastal hazards (inundation and erosion) at the present day and expected changes in the future as a result of expected sea level rise. The report then describes the potential damages that may occur as a result of sea level rise and extreme storm events. It also describes how likely it is that damages would occur, now and in the future.

While coastal risks may increase over time, the area also exhibits a range of specific values, such as access to the beach, which make it attractive to live and recreate there. In deciding how to respond to sea level rise it is important to not only consider the risks but also the values or benefits of using the land. The report therefore considers any values that may be foregone if new development is prohibited or lost if existing development is required to retreat.

The final part of the report provides an overview of potential responses or options to respond to sea level rise. It describes possible pathways for adaptation that are specific to the Somerset area. These pathways describe possible ways of adapting to future change, they are not predictions nor recommendations. These pathways have been used in the stakeholder workshop to explore how the future may look like with coastal adaptation. This section includes the views and preferences of the stakeholders. The last section offers a number of recommendations for Council as a way forward from here.

1.2 Project background

The Tasmanian Coastal Adaptation Decision Pathways (or TCAP) extension project is a project established with funding from the Department of Premier and Cabinet's Tasmanian Climate Change Office and the Australian Government's Natural Disaster Resilience Program (NDRP), administered in Tasmania by the State Emergency Services. The project is managed by the Tasmanian Climate Change Office (TCCO) working cooperatively with three local government areas: Waratah-Wynyard, West Tamar and Central Coast, each of which is contributing to TCAP through both financial and in-kind support.

The TCAP extension project will apply the earlier developed and applied TCAP methodology and develop coastal adaptation pathways for local communities. This will be done for the vulnerable coastal areas of Somerset, Kelso and Turners Beach. The pathways will be developed by progressing to Step 9 along a 15 step process for flexible community adaptation planning (refer to 1.3). The focus of the TCAP extension project will be on short term adaptation pathways (to 2050), while also considering the longer term impacts (to 2100).

1.3 Coastal Climate Change Adaptation Pathways

Based on previous and ongoing work, SGS developed guidelines for communities and states for coastal climate adaptation pathways. The adaptation pathways cover approximately 15 steps in total and presents a consultative approach involving the community, local and other government, land managers and other key stakeholders. The pathway approach does not prescribe a one-size-fits-all solution, but, as the word 'pathway' suggests, is a process to achieve adaptation responses.

It is anticipated that this study will progress Waratah-Wynyard Council to approximately step 9 of the 15 step pathway. The 15 steps are as follows:

1. Establish hazards and future sea level rise effects and map at the local/relevant scale
2. Review of Draft interim planning scheme for coastal hazard areas.
3. Assess assets at risk
4. Establish the expected cost of risk
5. Assess the value of occupation or use
6. First cut assessment of adaptation options and costs
7. Plan and implement necessary short term protection works in hazard areas
8. Establish preliminary policy and decision making framework
9. Strategic options assessment (Scenario Planning)
10. Detailed assessment of short listed options
11. Select preferred scenario
12. Establish financial framework
13. Revised 'final' planning scheme
14. Implementation
15. Review

Each section of this report relates to one of these 15 steps and this is identified at the start of each section. This report includes the results up to and including step 6.

1.4 Somerset – project site introduction

The study area of Somerset extends from east of the tennis club to the Cam River mouth and south to include part of the western river bank up to the corner of the Murchison Hwy and Wragg St. The study area consists mostly of a fairly narrow band along the coastline with the exception of the Cam estuary (Figure 1).

Along the foreshore, close to the river mouth is the Somerset Surf Life Saving Club which was built between 1960 and 1971.

FIGURE 1 SOMERSET STUDY AREA

1.5 Remainder of this report

The remainder of this report describes the findings for the Somerset study area. It covers:

- Current day and future coastal risks
- Current relevant planning scheme mechanisms
- Costs of risks in the study area
- Current property values, public benefit and other values in the project site
- Adaptation options with an introduction that explains what is likely to happen if nothing is done to manage current and future risks
- Possible adaptation pathways for the study area
- Results from the stakeholder workshop
- Recommendations on the way forward from here

2 COASTAL HAZARDS

Somerset is potentially subject to coastal erosion (periodic or progressive), flooding from the sea, flooding from peak river flows and erosion along the river banks. All these risks can occur under present day conditions, but with rising sea levels and more extreme weather (including storm and rainfall) the intensity and frequency of extreme coastal events is expected to increase over time.

This section provides site specific information regarding these coastal processes and relates to Step 1 of the project's coastal adaptation pathway process.

2.1 Somerset coastal erosion

The foreshores in the study area mostly consists of fine to medium grained sandy beaches. The foreshore from the river mouth to the tennis club is classified as an open sandy shore backed by soft sediment plain with potential erosion and shoreline recession vulnerability (Sharples, 2006[1]). The foreshore from the tennis club to the Headland is unclassified, requiring site-specific assessment of vulnerability. (Sharples, 2006).

Erosion issues have occurred in the past, particularly at the river mouth and the beach to 200 metres west of the Surf Life Saving Club (SLSC). A recent analysis of historic shoreline erosion on the basis of historic aerial photos suggests that the shoreline has experienced accretion alternated by years with significant storm events and related storm bite (Coastal Engineering, 2012). The SLSC has been built on a location that has been beach in the past (1956). Since 1960 there was mostly 12 metres of vegetation seaward of the building. The width of the foreshore between the river mouth and the SLSC can vary considerably by about 40metres (Coastal Engineering, 2012).

In 2011 a 50 metre rock revetment wall was built in the river mouth approximately 50 metres south of the bridge abutment. The sea wall acts as a last line of defence and is positioned at the most eroded position of the vegetated shoreline between 1956 and 2011. It is not expected to impact on sand drifting into the river mouth. In years of accretion, the shoreline may be located 10 to 15 metres seaward of the wall (Coastal Engineering, 2012). The sand spit of the river mouth accretes and recedes under the influence of river flood events, storm surge events and prevailing winds and waves from either the west or the east.

The foreshore from 200 metres west of the SLSC past the tennis club to the Headland, i.e. the western end of the study area, appears less susceptible to periodic erosion. The variation of shoreline vegetation has been around 10 metres over the 1956 to 2011 period, and west of the tennis club even less, approximately 5 metres. The foreshore west of the SLSC appears to consist more of gravel and rock outcropping, reducing its susceptibility to erosion.

[1] Sharples (2006) "Indicative Mapping of Tasmanian Coastal Vulnerability to Climate Change and Sea Level Rise, 2nd edition", DPIW, Tasmania,

Rock revetment and walkway onto beach within 200 m west of the SLSC

Erosion of foreshore vegetation Somerset Beach

Rock revetment wall west of SLSC at playground

In short, the foreshore area appears to accrete over time alternated by significant events of recession as a result of storm events.

2.2 Coastal inundation

Sea water height varies with tides, storms and regional wave effects. The combined effects can lead to extreme storm surges and consequently inundation. The more extreme heights occur with a lower probability. Present day storm sea level heights for different probability/frequency are shown in Table 1, below.

TABLE 1 STORM SEA LEVEL PROBABILITY, PRESENT DAY

Average Return Interval (ARI)[2]	Annual exceedance probability[3]	Sea storm level height* (m AHD[4])
20 year ARI	5%	2.33
50 year ARI	2%	2.38
100 year ARI	1%	2.42
200 year ARI	0.5%	2.45

*Includes 30 cm free board and round up to nearest ten centimetres

Source: M.J. Lacey, J.R. Hunter and R.E. Mount (2012), Coastal Inundation Mapping for Tasmania – Stage 2 Version 1; allowances for round-up and free board (June 2013)

The water height data includes a round-up of the estimate to the highest ten centimetres to reflect a reasonable level of accuracy that can be expected for surveyors. The storm surge data also includes a thirty centimetre free board on top of the water heights to identify the flood hazard area.

In addition to storm surge effects, there are local effects such as local wind setup, local wave setup and local wave runup. These local effects have not been allowed for in the modelling since reliable data was not available. These local effects may roughly add between 0.3 and 1.1 metres to water height levels depending on how exposed or sheltered the foreshores are to the sea.

Note that all values are 'best estimates' and subject to inaccuracies:

- Inundation depths may vary from estimates by ±0.2m
- Land levels based on Lidar (best available mapping surface) may vary by ±0.1m
- Actual floor heights may vary from the estimate by ±0.15m
- These errors may act to offset each other or may add together.

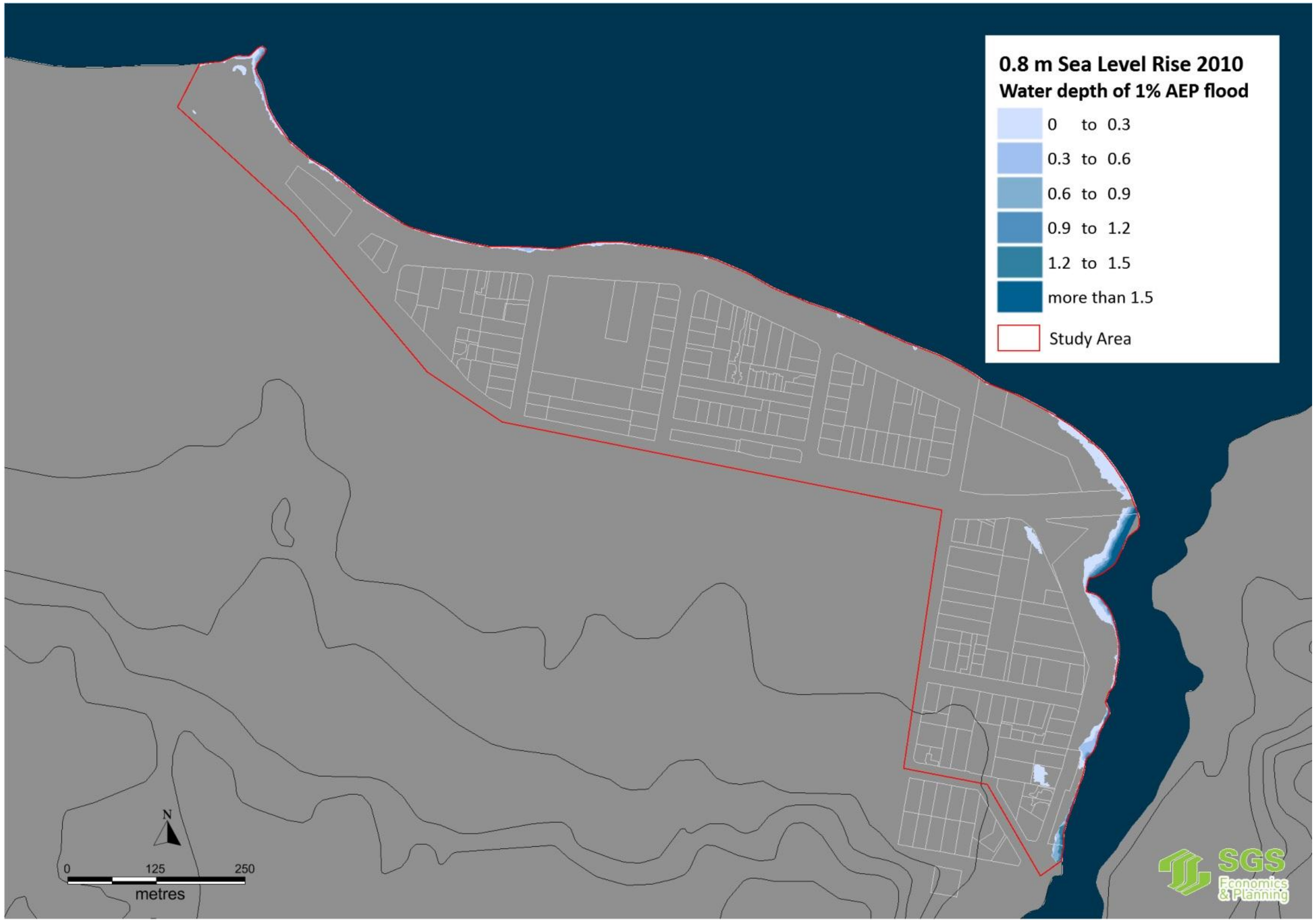
With a present day extreme storm event of a 1 in 100 year probability (1% AEP) no properties are at risk from inundation (Figure 2). The riverfront just south of the bridge is likely to be inundated possibly overtopping the revetment wall and flooding the Council footpath.

[2] The Average Return Interval expresses the likelihood for an event to occur as the average number of times an extreme event would occur in a given timeframe.

[3] The Annual Exceedance Probability is a way to express the likelihood for an extreme event to occur. It refers to the probability of an event occurring in any given year

[4] The Australian Height Datum (AHD) is a geodetic datum for altitude measurement in Australia. In 1971 the mean sea level for 1966-1968 was assigned the value of 0.000m on the Australian Height Datum at thirty tide gauges around the coast of the Australian continent. The resulting datum surface, has been termed the Australian Height Datum (AHD) and was adopted by the National Mapping Council as the datum to which all vertical control for mapping (and other surveying functions) is to be referred (Geoscience Australia)

FIGURE 2 LIKELY INUNDATION AT SOMERSET FOR AN EXTREME STORM EVENT (1% AEP), PRESENT DAY



Source: SGS (2013) based on M.J. Lacey, J.R. Hunter and R.E. Mount (2012), Coastal Inundation Mapping for Tasmania – Stage 2 Version 1; including round-up and free board (June 2013)

2.3 River Flooding and erosion

River flooding does not appear to be a major issue in Somerset with the last reported flooding of the Cam River being in July 1920 (FWCC, 2006[5]).

River bank erosion is likely to occur as a result of flow especially during events of peak river flow, mostly in winter/spring.

At the time of writing this report there were no other technical reports available on flooding and erosion for the Cam River.

2.4 Coastal hazards with climate change

This section considers expected coastal hazards as a result of climate induced sea level rise of 0.2 metres compared to 2010 levels, which is expected to occur around 2050, and of 0.8 metres, which is expected to occur around 2100.

The hazard assessment does not consider other climate change impacts such as more frequent and more severe extreme weather events and river flooding events.

Coastal erosion

Rising sea levels are likely to contribute to progressive erosion of sandy and soft sediment shorelines. As a rule of thumb, landward erosion for open sandy beaches with breaking waves is between 50 to 200 times the increase of sea level rise. This is based on a method known as the Bruun rule. That is, a rise of say 1 metre could lead to erosion of 50 to 200 metres inland. The coastal dynamics behind this rule, which is sometimes contested even for open sandy beaches, does not apply to more protected sandy shores, but observations have suggested the extent in these situations is not dissimilar in practice.

New erosion modelling and spatial data[6] enable properties that are susceptible to erosion at various levels of risk to be identified. The hazard bands high, medium and low identify areas of land that are susceptible to erosion:

- High hazard band: potential present day recession. Storm bite and consequent reduced foundation stability zone – 22 meters landwards from High Water Mark (HWM) or to natural recession limit
- Medium hazard band: potential shoreline recession to 2050 – 27 meters landwards of storm bite hazard zone or natural recession limit (i.e. 49 meters landwards of HWM or to natural recession limit)
- Low hazard band: potential shoreline recession to 2100 – 61 meters landwards of storm bite hazard zone or to natural recession limit (i.e. 83 meters landwards of (HWM)

The erosion susceptibility mapping takes into account the type of shoreline and the availability of any existing erosion protection works such as sea walls or groynes. It does not consider in detail the quality of these works and how effective they might be to protect against erosion over time.

The map below (Figure 3) displays the potential coastal erosion susceptibility hazard bands for Somerset.

[5] Tasmanian Flood Warning Consultative Committee (FWCC), Community Awareness Project 'Flood and You' final report, 2006

[6] C. Sharples, H. Waldorf & L. Roberts (July 2013) 'Coastal erosion susceptibility zone mapping for hazard band definition in Tasmania

FIGURE 3 POTENTIAL COASTAL EROSION SUSCEPTIBILITY AT SOMERSET

Source: SGS (2013), based on C. Sharples, H. Waldorf & L. Roberts 'Coastal erosion susceptibility zone mapping for hazard band definition in Tasmania

The mapping takes into account the potential effects of sea level rise, but does not consider the potential effects of a trend with increasingly more frequent and more severe extreme storm events. Storm events lead to temporary higher sea levels and wave attack on higher elevations of the beach and dunes, resulting in scarping and slumping of the dunes and erosion of the beach (Mowling, 2011). More frequent and more severe storm events are likely to result in increased scarping and slumping of the dune and erosion of the beach.

Coastal inundation

Future coastal inundation risks will increase as climate change causes sea levels to rise. The coastal sea level rise mapping undertaken for Tasmania has adopted sea level rise allowances compared to 2010 for 2050 and 2100. Sea levels are projected to rise by 0.2 metres by 2050 and 0.8 metres by 2100. The table below shows the projected water level heights for various types of events in 2010, 2050 and 2100.

While the impact of climate change is now fairly well understood within the scientific community, there is and will remain uncertainty in regards to the pace of climate change and related impacts such as sea level rise. Sea levels may rise slower or faster than projected.

TABLE 2 PROJECTED SEA HEIGHTS, 2010-2100

Annual Exceedance Probability (% AEP)	Present day / 2010	2050	2100
Sea Level Rise (m) compared to 2010	0.0	0.2	0.8
	(m AHD)	(m AHD)	(m AHD)
5%	2.33	2.53	3.13
2%	2.38	2.58	3.18
1%	2.42	2.62	3.22
0.5%	2.54	2.75	3.35

Source: SGS (2013) based on M.J. Lacey, J.R. Hunter and R.E. Mount (2012), Coastal Inundation Mapping for Tasmania – Stage 2 Version 1; allowances for round-up and free board (June 2013)

The estimates are based on the technique of Hunter (2012), observations of storm tides from the tide gauges at Hobart and Burnie, and regional projections of sea-level rise based on the IPCC A1FI emission scenario (Hunter et al., 2012). These allowances were added to the AEPs for 2010, to derive AEPs appropriate to 2050, 2075 and 2100. (Coastal Inundation Mapping Stage 2 V1, TPC, September 2012).

Climate change is also expected to result in more extreme weather events. This could mean that a 1% AEP (1 in 100 years) event at present day may become a 5% AEP (1 in 20 years) event by say 2050. The extent to which extreme events become more extreme and more frequent has not been taken into account in the coastal inundation mapping. As indicated earlier, the modelling does not consider local wave and wind conditions due to unavailability of data. The coastal inundation mapping must therefore be interpreted as conservative projections of future inundation hazards.

Figure 4 and Figure 5 show for a given sea level rise:

- The area flooded in a 1% AEP event
- The depth of inundation for a 1% AEP event

The maps have been produced using the coastal inundation data referenced above that assume a sea level rise of 0.2 metres and 0.8 metres. This is projected to occur by 2050 and 2100 respectively. The data includes the round-up to the next nearest ten centimetres and the freeboard allowance of 30 centimetres referenced earlier. The projected rate of sea level rise is approximately 0.5 centimetres per year to 2050, and 1.2 centimetres from 2050 to 2100.

The maps assume that the topography does not change with erosion and the movement of sand from wave action, which is likely to happen. Rising sea levels is likely to cause progressive erosion of sandy shores if no action is taken (previous section). If foreshore vegetation and dunes are unconstrained by development and other interference, they would generally be expected to move inland and be higher than existing dunes (where applicable). The dynamics of the estuary and mouth will also change, potentially leading to sand deposition, with water depths in the entrance not increased as much as sea level rise would suggest. The dynamics of the sediment budget have not been evaluated.

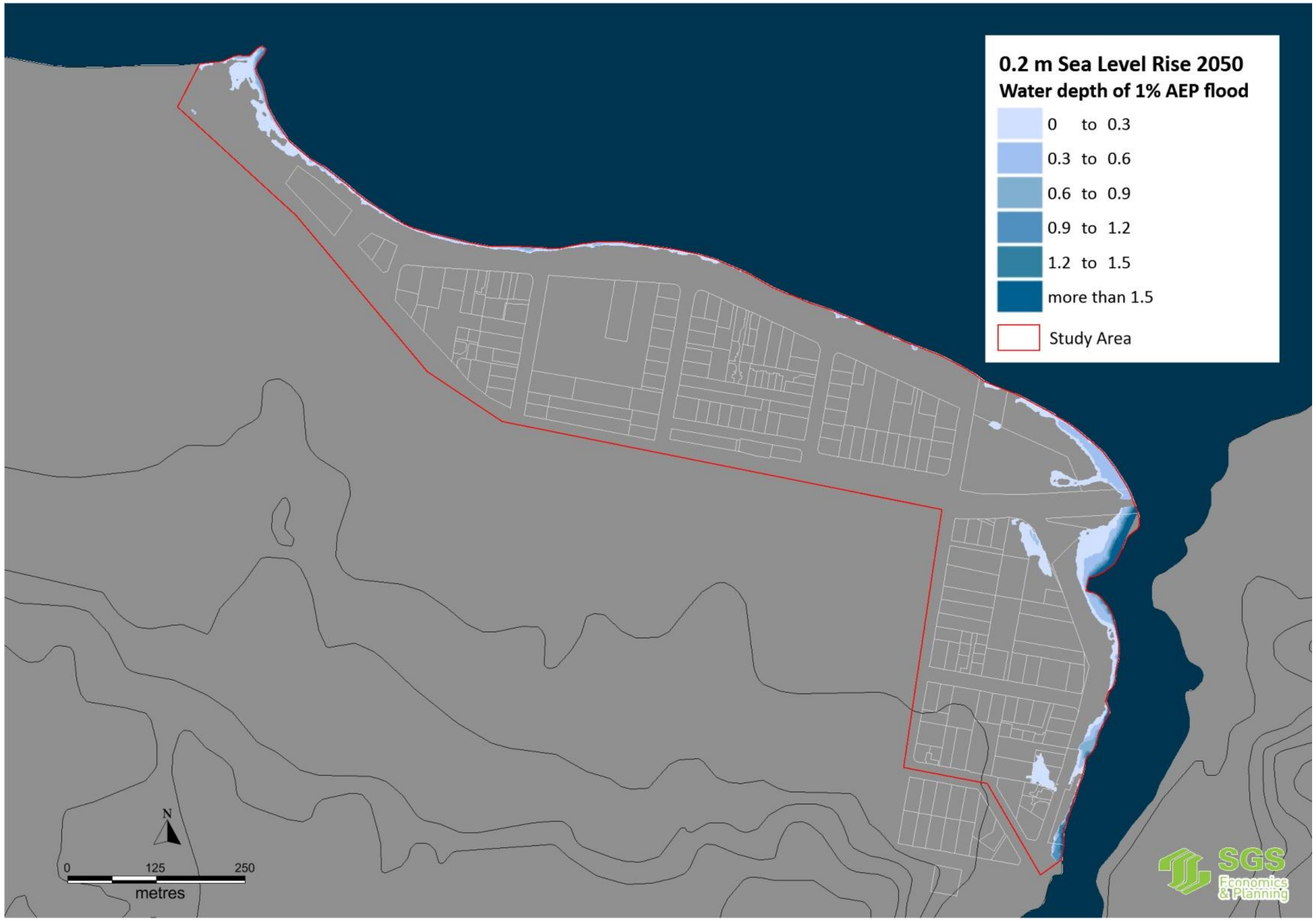
In regards to flooding a so-called ‘bathtub’ model was used, and low lying areas well back from the shore may not fill with the high tide associated with the storm event because the water cannot reach them (except through drainage pipes). Equally, if the extreme event is associated with rainfall, which is common, then these low lying areas are likely to flood from rainfall runoff that cannot escape because of high sea levels, and so therefore flooding is still likely. In fact, many of these areas are flood prone now due to limitations of drainage.

The maps show that with sea level rise of 0.2 metres (at around 2050) an extreme event is likely not to affect residential properties with inundation depths of more than 300 mm.

Over time, while the sea level rises, some properties are expected to be at risk from an extreme storm event. An extreme 1% AEP event with a sea level rise of 0.8 metres (at around 2100) is likely to affect approximately 11 residential properties with inundation depths of more than 300 mm. These properties are located at the river mouth. The Murchison Hwy is high enough to withstand flood levels even with 0.8 metres sea level rise. It is likely that the Highway will function as a barrier, thereby reducing the flood risk of the 11 residential properties at risk that are behind it.

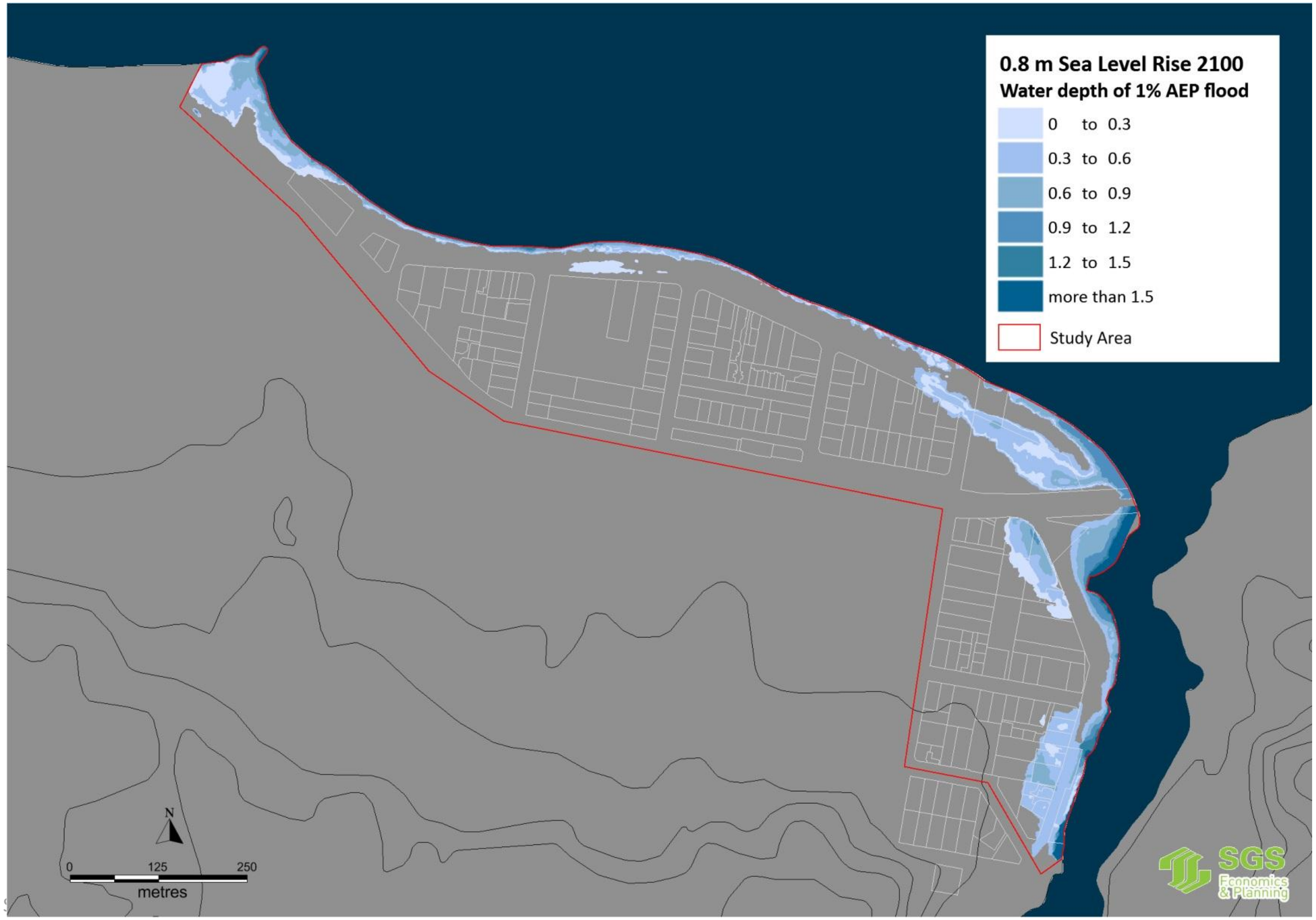
Some areas of public open space and Council assets are at risk of inundation, most notably river foreshore walkways and the Somerset Memorial Park between the river mouth and the SLSC.

FIGURE 4 LIKELY INUNDATION AT SOMERSET FOR AN EXTREME STORM EVENT (1% AEP), 0.2 M SEA LEVEL RISE



Source: SGS (2013)

FIGURE 5 LIKELY INUNDATION AT SOMERSET FOR AN EXTREME STORM EVENT (1% AEP), 0.8 M SEA LEVEL RISE



3 PLANNING SCHEME MECHANISMS

This section contributes to **Step 2 of the 15 Step Community Adaptation Pathway: Review of Draft interim planning scheme for coastal hazard areas.**

The section reviews the existing and proposed Waratah-Wynyard planning scheme provisions and relevant state and regional directions on coastal hazards and climate change impacts for the Council area.

Section 3.2 reviews relevant state and regional policies, projects or land use frameworks which address the effects of climate change on coastal areas. Section 3.3 reviews the interim draft Waratah-Wynyard Planning Scheme and details any planning provisions that relate to the mitigation of climate change effects on coastal areas, while section 3.4 briefly looks at the current Planning Scheme as a means of comparison. Section 3.5 provides considerations for Waratah-Wynyard Council on planning scheme amendments that could be made prior to detailed scenario planning to better address coastal hazards and climate change risks.

3.1 Regional Planning Initiative

The Regional Planning Initiative covers three regional planning partnership projects: the North West, Northern and Southern region. They have been established through agreements between the State Government, the respective councils and regional bodies. Waratah-Wynyard Council is located in the North West region.

Each region has prepared a regional land use strategy and all were declared in October 2011:

– Northern Region: Regional Land Use Strategy of Northern Tasmania
– Southern Region: Southern Tasmania Regional Land Use Strategy 2010-2035
– North West Region: Living on the Coast – The Cradle Coast Regional Land Use Planning Framework

These Strategies and Frameworks are statutory instruments meaning new planning schemes, planning scheme amendments or projects of regional significance must be in accordance with the frameworks. Each Council is now tasked with preparing new planning schemes that will be consistent with the regional land use strategies.

The regional planning initiative is supported by the State Government through Planning Directive 1 – The Format and Structure of Planning Schemes, released by the Tasmanian Planning Commission in May 2011. The directive incorporates a new 'Planning Scheme Template for Tasmania' which Councils are to use to achieve consistent layout, zones and terminology of planning schemes.

North West Region

Living on the Coast: Cradle Coast Regional Land Use Planning Framework 2010-2030 was declared on 27 October 2011. Part C of the Framework, 'Cradle Coast Regional Land Use Strategy 2010-2030', includes direction to address mitigation and adaptation to climate change impacts. Directions are included under three of the strategy themes:

- Wise Use of Resources
- Places for People
- Infrastructure Provision

Wise Use of Resources

Chapter 2 of Part C of the Framework, 'Wise Use of Resources – respect for what is valued', includes Clause 2.8 Land Use Policies for Coastal Management. This provides direction for land use planning in adapting to the impacts of climate change to coastal areas.

Clause 2.8 Land Use Policies for Coastal Management
Relevant policies under this Clause include:

c. Minimise or avoid use or development in areas subject to high levels of coastal hazard

Places for People

Chapter 4 of Part C of the Strategy, 'Places for People –liveable and sustainable communities', includes relevant policies under:

- Clause 4.3 Land Use Policies for Managing Growth and Development;
- Clause 4.4 Land Use Policies for Protecting People and Property; and
- Clause 4.7 Land Use Policies for Housing Land – places to live.

Clause 4.3 Land Use Policies for Managing Growth and Development
Policies under 4.3.1 Urban Settlement Areas include:

g. Implement structure plans and regulatory instruments for each centres which –
   vi. Minimise exposure of people and property to unacceptable levels of risk to health or safety

Clause 4.4 Land Use Policies for Protecting People and Property
Relevant policies under this Clause include:

a. Recognise land exposed to future or enhanced risk is a valuable and strategic resource that should not be sterilized by unnecessarily excluding use or development
b. Establish the priority for risk management is to protect the lives of people, the economic value of buildings, the functional capacity of infrastructure, and the integrity of natural systems
c. Avoid new essential service, sensitive or inappropriately located use or development on undeveloped land exposed to or affected by a high level of existing likely future or enhanced risk, including from inundation and erosion by the sea, flooding, bush fire or landslip
d. Limit opportunity for expansion of existing essential service, sensitive or inappropriately located use and development onto land exposed to or affected by an existing, likely future or enhanced level of risk
e. Limit opportunity for redevelopment and intensification of existing essential service, sensitive or inappropriately located use or development on land exposed to or affected by an existing,

likely future or enhanced level of risk unless the impact can be managed to be no greater or less than the existing situation

f. Promote guidelines and technical measures that which will assist to reduce impact of an existing, likely future or enhanced level of risk and make existing strategically significant places, uses, development and infrastructure assets less vulnerable, including provision for protection, accommodation and abatement, or retreat
g. Require a hazard risk assessment for new or intensified use or development on land exposed to an existing, likely future or enhanced risk, such assessment to address the nature and severity of the hazard, the specific risk factors for the proposed use or development, and the measures required to mitigate any risk having exceedance probability of greater than 1% at any time over the life of the development
h. Ensure current and future landowners and occupiers are put on notice of the likelihood for a further or enhanced level of risk

Clause 4.7 Land Use Policies for Housing Land – places to live
Relevant policies include:

e. Rationalise or remove opportunity for housing in locations where oversupply is identified, and in locations where access, servicing, safety or impact are unacceptable
h. Provide opportunity for housing in rural areas where –
   vi. There is an acceptable level of risk from exposure to natural or man-made hazard

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Infrastructure Provision

Chapter 5 of Part C of the Strategy, 'Infrastructure Provision – support for growth and development', includes Clause 5.3 Land Use Policies for Integrated Land Use and Infrastructure Planning.

Clause 5.3 Land Use Policies for Integrated Land Use and Infrastructure Planning
Relevant policies include:

c. Promote compact contained settlement areas to –
   i. Assist climate change adaptation and mitigation measures
l. Promote infrastructure corridors, sites and facilities that –
   iii. Minimise exposure to likely risk from natural hazards
   iv.

3.2 Waratah-Wynyard (Draft) Interim Planning Scheme 2013

Waratah- Wynyard Council has drafted a new planning scheme using the new state planning template to align with the Living on the Coast – Cradle Coast Regional Land Use Planning Framework.

The interim Planning Scheme is still in draft form. The draft was submitted to the Tasmanian Planning Commission in December 2012. It will be considered by both the Commission's Advisory Committee and the Minister for Planning regarding its suitability and compliance with the Land Use Planning and Approvals Act 1993. The interim Planning Scheme will then likely be publicly exhibited.

Two of the general objectives identified in the planning scheme relate to coastal vulnerability. These objectives are to:

- minimise likely risk to the community and the environment from use or development on land exposed to a natural hazard or environmental harm; and
- recognise the cumulative and likely escalating impacts of climate change.

The Draft Waratah-Wynyard Planning Scheme uses Zone and Code Provisions for addressing coastal vulnerability, with the codes being the primary mechanisms to address this risk.

Zoning

There are two zones available for use within the planning scheme which relate to coastal vulnerability; the Environmental Living Zone (Clause 14) and the Environmental Management Zone (Clause 29). Both zones have been used in this planning scheme, however relate more generally to 'environmental hazards' than coastal vulnerability specifically.

Three additional zones include development standards for identifying the presence of natural hazards in regards to subdivision applications. These are the General Residential Zone (Clause 10), Low Density Residential Zone (Clause 12), and the Rural Living Zone (Clause 13). These three zones all contain a local area objective that relates to coastal vulnerability, being that the type, scale, and intensity of use or development is appropriate for the level of permanent constraint on the use as a result of an unacceptable level of risk from exposure to a natural or environmental hazard.

The Codes, and especially the Hazard Management Code (next section), provide more detailed definitions and requirements in regards to coastal hazards.

Codes

Codes set out standards for use and development for matters that are not confined to one zone and apply over and above zone provisions.

There are four codes that include use and development standards that recognise coastal vulnerability. The codes are the Change in Existing or Natural Ground Level Code (E3), Clearing and Conversion of Vegetation Code (E4), Hazard Management Code (E6), and the Water and Waterways Code (E12).

More detailed information on the codes is provided in Appendix 1.

Within the Water and Waterways Code, development in a seashore area must often be consistent with desired future character statement for the zone, including exposure to or increased risk from a natural hazard including sea level rise, storm surge or inundation as a result of climate change.

The Hazard Management Code is quite comprehensive in detail, and separates out sea level rise and other coastal hazards for risk assessment. The risk assessment provided in the appendix also provides extra detail specific to coastal vulnerability. The code also points to two key external independent documents:

- Mapping of Tasmania Coastal Vulnerability to Climate Change and sea Level Rise (2006)
- Coastal Inundation Map prepared for the Tasmanian Planning Commission (2011)

Although this provides scope for decisions within the Hazard Management Code to be updated when these two documents are updated, this isn't explicitly stated. A phrase added to the clause that requires applicants / assessors to refer to the most recent version of these reports would solidify this. This will reduce the need to amend a planning scheme with the inclusion of new hazard information every time it is released.

The codes do not indicate how to deal with developing risks over time, and how this relates to the expected lifetime of a proposed use or development.

Hazard maps

The planning scheme maps (dated October 2012) identify areas of:

- Flood risk
- Landslip hazard
- Coastal Inundation
- High Water Mark

The Draft Interim Planning Scheme maps provide no indication of timeframe so it is not possible to tell whether this is flood vulnerability today, 2050, 2100, or beyond.

Comparison Waratah-Wynyard Planning Scheme 2000

When comparing the Draft Interim Waratah-Wynyard Planning Scheme to the Planning Scheme 2000, it is clear that there has been an increase in the inclusion of both wider environmental hazards and coastal issues relating to a changing climate throughout the new planning scheme. The 2000 Planning Scheme has detail relating to coastal issues in two schedules, yet the zones have little provisions for coastal erosion.

The 2000 Planning Scheme listed the prime objective as aiming to achieve sustainable use and development of resources. There are no local area objectives that relate to environmental issues or coastal vulnerability.

Coastal vulnerability is captured within the following schedules of the planning scheme, namely:

– Schedule 12.0: Siting of Development Schedule
– Schedule 16.0: Wetlands and Waterways Schedule

Considerations

– The Scheme refers to independent scientific sources in regards to identifying hazards. These sources tend to be reviewed and updated every few years, and as a result the planning scheme may need to be amended. The scheme could also include a statement that requires the most current revisions of these sources to be identified as the relevant source to consider in relation to a proposed use or development, thereby preventing the need for an amendment.
– More detailed specification of acceptable levels of risk including how risks may change over time is needed. This should then be related to the lifetime of the type of use or development. For example, the acceptable level of risk may differ between types of uses such as car ports compared to new dwellings and hospitals. The proposed use or development should be designed and built in such a way that it remains within an acceptable level of risk during the asset's lifetime.

4 COST OF RISK

This section assesses properties at risk of being affected by inundation or sea level rise to 2100. The total risk is expressed in net present value, which is the present day value (in $) of future costs and revenues (cash flows).

This section relates to **Step 3 and 4 of the adaptation pathway process**: **Assess assets at risk and establish the expected cost of risk.**

In reading this section it is important to define the term **risk**. Risk is the result of the **total damage** multiplied by the **probability** of an event happening. While the total damages of an event actually happening can be very substantial, the probability of it happening is often quite low. Therefore, the total risk (in $) may be substantially below the total damages of an extreme event.

The analysis on the costs of risks is presented here only for private dwellings. Infrastructure, public amenities, the caravan park and open space also may be damaged by coastal inundation. The same level of information about the cost of damage as a result of flooding is not readily available for infrastructure as it is for dwellings.

4.1 Inundation Risks

The key findings about inundation risks in Somerset are summarised below:

- No residential dwellings have present-day inundation risks[7].
- With a sea level rise of 0.2 metres from today's levels (expected by about 2050), one dwelling would be at potential inundation risk.
- With a sea level rise of 0.8 metre from today's levels (expected by about 2100), 16 properties would be at some inundation risk, with an average inundation probability of 14%.
- With 0.8 metre sea level rise 10 dwellings in Somerset would be flooded by a 1% AEP (100 year ARI) event with an average above-floor depth of 0.14 metres.
- With 0.8 metre sea level rise 1 parcel of land would be lost, falling permanently beneath the high tide level.

The table below shows the estimated number of properties in Somerset that would be flooded above floor level by an event with a 1% annual exceedance probability (100 year ARI) at present day sea levels, with 0.2 metre sea level rise and with 0.8 metre sea level rise.

[7] Risk, if not specified, refers to more than 0.01% chance of having an over floor flood.

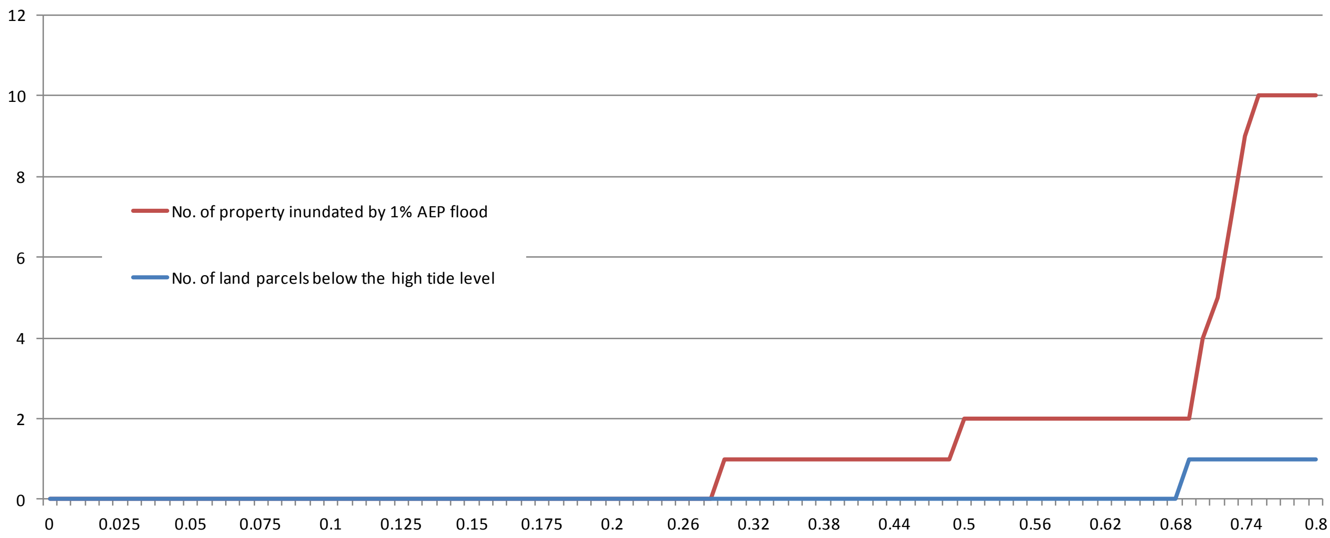
TABLE 3 NUMBER OF INUNDATED PROPERTIES[8] AND AVERAGE OVER-FLOOR DEPTH CAUSED BY 1% AEP FLOOD

		Estimated No. of inundated properties	Average over-floor depth (m)
0.0	**(2010)**	0	0
0.2	**(2050)**	0	0
0.8	**(2100)**	10	0.14

Source: SGS estimates (2013)

As sea levels rise, the numbers of properties at some risk of flooding increases steadily from about 0.29 metres. With a 1 metre sea level rise (projected post 2100), 20 properties are at risk, which is approximately 10% of the properties surveyed. This trend is shown in Figure 6.

FIGURE 6 NUMBER OF HOUSES AFFECTED BY 1% AEP FLOOD AND LAND BELOW HIGH TIDE LEVEL, WITH VARIOUS SEA LEVEL RISES, IN SOMERSET

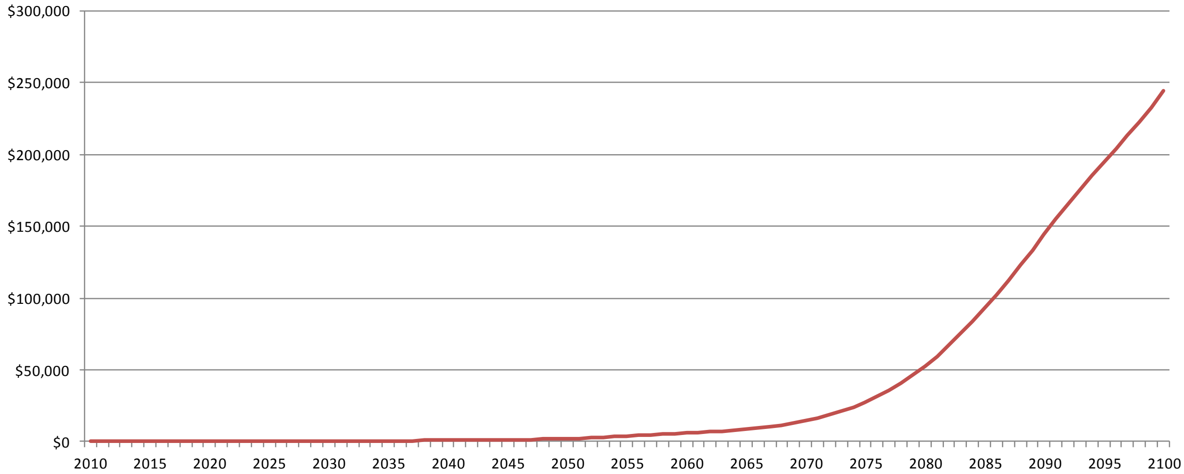


4.2 Property Risks

The charts below depict the expected risks (structure damages x probability) in dollar values over time. Expected risk is calculated for each property within the study area for each year by considering likelihood/probability of different flood depths occurring and associated structure damages (derived from the damage curve) as sea levels rise. The total risk at Somerset is a sum of the risk to all properties. The figure below shows the expected risk to structures assuming the properties are fully maintained over time with a minimum level of depreciation in structure value (Figure 7).

[8] Includes residential properties with above floor level inundation depths only

FIGURE 7 EXPECTED ANNUAL STRUCTURE DAMAGES (IN REAL DOLLARS) AT SOMERSET, WITHOUT DEPRECIATION

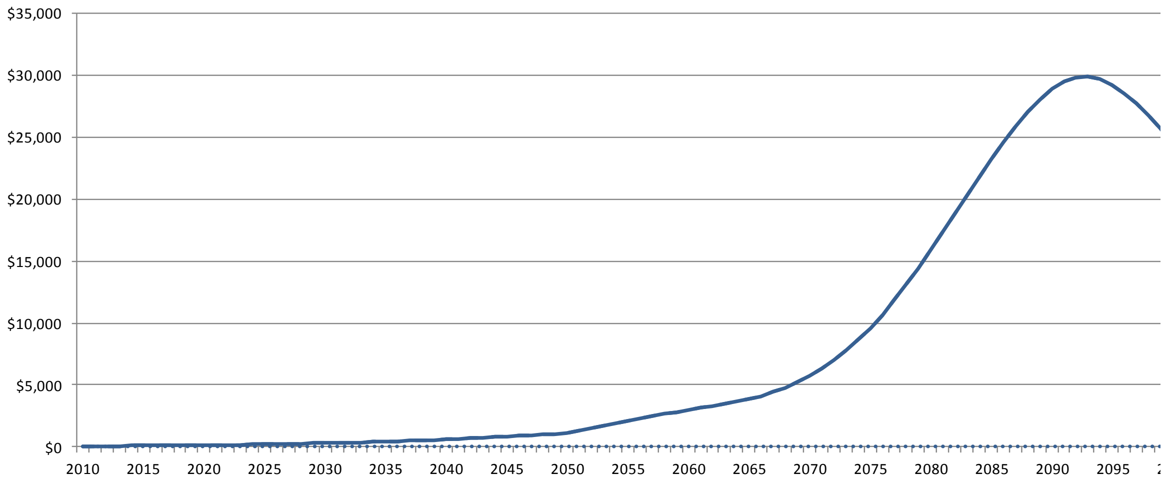


Source: SGS (2013)

The calculations assume that dwellings would be repaired to their previous condition after every flood until the expected annual damage reaches 10% of the replacement value in any one year. At that point the property is dropped from the calculation on the basis that it either would cease to be repaired (too much damage) or it would have been rebuilt in a non-flood vulnerable form (higher floors, flood proof construction).

If the properties are fully maintained and renewed over time, but not expanded or upgraded, with minimum level of depreciation in structure value, the expected structure damages at Somerset start at negligible values in 2010. They grow rapidly from 2070 onwards, peaking at approximately $30,000 in 2093 (figure 8).

FIGURE 8 EXPECTED ANNUAL STRUCTURE DAMAGES (IN REAL DOLLARS) AT SOMERSET, WITH DEPRECIATION



Source: SGS (2013)

The net present values (NPV) of these expected future coastal inundation structure risks are calculated using a real discount rate of 5% per annum and are provided in the table below (Table 4).

Without structure depreciation (i.e. assuming ongoing investment on maintenance and capital upgrade), the NPV of the future risks amounts to $85,000.

If the properties in Somerset are assumed to be fully depreciated in 100 years (i.e. not properly maintained and upgraded), the NPV of the structure risks is $25,000.

We have classified the residential dwellings[9] in the study area into three categories:

1. No dwellings had present-day inundation risks
2. The 16 dwellings with no present-day inundation risks but at risk with 0.8 m sea level rise
3. Those not at risk even with 0.8 m sea level rise.

The table below shows that the total risk to structures at long term risk is moderate to low compared to their value.

TABLE 4 NPVS OF TOTAL STRUCTURE DAMAGES, AND THEIR SHARE OF THE EXISTING STRUCTURE VALUES[10]

	Present day risk		Long term risk		All
Current value and count	**$0**	**0 dwellings**	**$3,460,000**	**20 dwellings**	**201**
	NPV of expected damages	**% of existing capital value**	**NPV of expected damages**	**% of existing capital value**	**NPV of expected damages**
Without structure depreciation	$0	N/A	$85,000	2.4%	$85,000
With structure depreciation	$0	N/A	$25,000	0.7%	$25,000

Source: SGS (2013)

It should be noted that the damage of an extreme storm event if it actually did occur could be much higher than the expected value.

Table 5 below shows that the potential damage caused by an extreme storm with a 1% annual probability could result in a total damage of $620,000 in 2100 if the dwellings are well maintained.

TABLE 5 TOTAL DAMAGES[11] CAUSED BY 1% PROBABILITY FLOOD

	Total damages caused by 1% AEP (100 yr ARI) flood		
	2010	**2050**	**2100**
Without structure depreciation	$0	$0	$620,000
With structure depreciation	$0	$0	$60,000

Source: SGS estimates (2013)

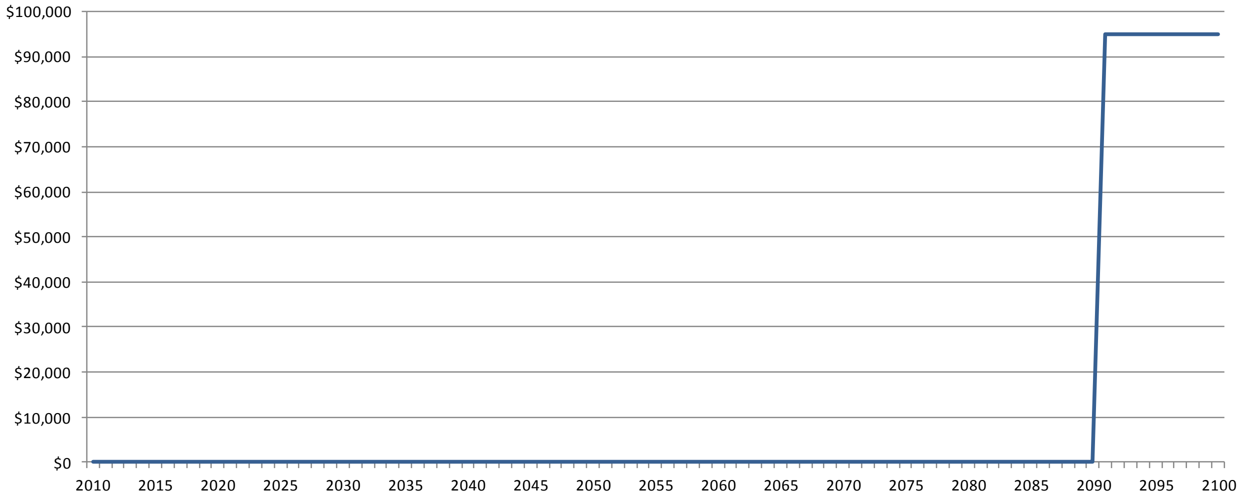
These flood estimates are based on the effects of sea level rise on coastal inundation (from the sea). These estimates do not include cost of damage:

[9] Includes residential properties with any depths of inundation (also below floor level flood depth)
[10] Amounts are rounded to the nearest $5,000
[11] Amounts are rounded to the nearest $5,000

- To public infrastructure (roads, street lighting, water supply, damage to the sea wall, or other public amenities)
- From erosion
- To other commercial infrastructure (telephone, electricity supply)
- From river flooding events for all assets, which may be as large as flooding from the sea.

In addition to the structure damages as a result of the over-floor flood, we have estimated the value (per Waratah-Wynyard Council) of land lost once it is lower than the average high tide level (Figure 9).

FIGURE 9 EXPECTED LAND LOSS AT SOMERSET



Source: SGS (2013)

If nothing is done, by 2100 the total land loss is expected to reach 1 parcel with a value of $95,000 based on present day valuation. The NPV of this loss is estimated to be around $1900.

Comparison with acceptable levels of risk with no sea level rise

For risks that do not change over time, potential damage from events with an annual probability at or below 1% is often considered an **acceptable level of risk**[12]. A property that has a floor just at the 1% AEP flood level has an expected damage in any given year of 1.13% of the value of the structure[13]. On a structure worth $100,000 this corresponds to an expected annual damage of about $1130 if exposed to this level of risk from inundation from the sea in Somerset.

Without sea level rise this value would remain the same each year. The lifetime NPV of risk would increase with the expected life of the structure to almost 23.5% of the structure value in the Somerset area. If it is assumed that the building depreciates over time, the value lost from a major flood would be less. The economic loss is only that of the depreciated value of the dwelling.

With sea level rise (about 0.8 m over the next 90 years) the risk of damaging floods increases every year. The risk rises particularly quickly in later years as the rate of sea level rise increases and many more flood events are expected to be damaging. In that case, the NPV rises continuously to 2052, after which

[12] Different acceptable levels of risk would be applied to different uses. A much lower level of risk would be used for a school or hospital compared to a boat shed or car port.

[13] It is normal to require a freeboard above the predicted flood level, usually of about 0.3 m. The expected damage for such a building could be even less, but the freeboard is often used to compensate for uncertainties in the estimate of actual flood levels.

buildings at risk of flooding are assumed to have been abandoned or rebuilt in flood-proof form. The lifetime NPV reaches about 37.6% of the structure value[14] in the Somerset area.

Conclusion

The estimated cost of risk (in present day values) of coastal inundation to private dwellings is between approximately **$24,000 and $84,000 to 2100** depending on whether owners continue to maintain their dwellings.

By 2100, an extreme storm event (1% AEP) is estimated to cause $621,000 worth of damage (without structure depreciation) if the existing buildings or comparable ones are still in their current locations and elevations.

In addition, some land parcels at present-day inundation risks would become permanently inundated if no protection work is undertaken to cope with the future coastal hazards. With a 0.8 m sea level rise (likely in 2100), one land parcel in the study area is likely to be lost, resulting in a total loss of $95,000 (current day value).

The flood estimates are based on the effects of sea level rise on coastal inundation (from the sea) and ignore rainfall runoff floods from the river, which may be more frequent and more severe than coastal flooding. The extent of the river flooding has not been quantified.

In practical terms:

- Well maintained high quality buildings close to or below the 1% AEP flood level with a long expected lifetime would be well advised to invest[15] in flood protection measures such as flood skirts that can be deployed when required **and** to pay attention to extreme weather forecasts.
- The owners of buildings close to or below the 1% AEP flood level that are in poor to modest condition or buildings damaged by flood events should consider whether it is worth reinvesting in the existing building or demolishing and rebuilding at a level above the flood or in a form that is resistant to flood damage.
- All occupants in hazard areas with properties at some risk, even if only for extreme events with a probability below 1% AEP, should have and rehearse an emergency response plan.
- Governments have an interest in restricting redevelopment that will be affected by a higher than acceptable risk of damage during its lifetime, including discouragement of reinvestment in existing properties that are or will be at higher than acceptable risk over their lifetime. However, such risks can be addressed by raising dwellings by relatively modest amounts even for quite long lifetimes.

[14] For properties with a life expectancy of maximum 100 years

[15] Up to20% of the structure's depreciated value assuming a 50 yr lifetime. Less if shorter lifetime expected.

5 COASTAL VALUES

People occupy and use areas near the coast, some of which are exposed to coastal hazards, because they derive value from doing so. Coastal property values are typically higher than similar sized properties inland, showing the premium placed on these areas. Other public, natural and economic values are major contributors of value from the 'use' of the coasts.

If the planning response to sea level rise prevents all (re)development in areas potentially at risk, many of the values from using and occupying these areas would be foregone, while other natural values may or may not gain from excluding development.

This section describes the private property values and other values of the study area.

The reporting in this section relates to the work undertaken and the findings so far in relation to **Step 5 of the adaptation pathway process: Assess the value of occupation or use.**

5.1 Private property and assets at risk

Residents in coastal areas derive a private property benefit from living in these areas. In order to assess the potential impacts of climate change and adaptation measures on coastal properties, one needs to understand how significant the premium is for living there.

The total value of all residential properties in the study area is $30 million, The study area comprises 68 residential properties, none of which are at risk from coastal hazards at present day. The average value of a property is $430,000.

Residential properties at risk of inundation

The previous section discussed in detail how properties in the study area are at risk of inundation with sea level rise. To 2100 there are likely to be 10 residential properties that will be at some risk of inundation. The total value of these properties is approximately $ 3 million (capital value).

Properties at risk of erosion

Based on the coastal erosion susceptibility data by Sharples et al it is possible to identify what properties may be at risk of erosion at present day, by 2050 with an expected sea level rise of 0.2 metre and by 2100 with an expected sea level rise of 0.8 metre.

Those properties, of which the majority of land area is within a hazard band, have been identified as susceptible to erosion. In total there are 26 residential and four non-residential properties identified as susceptible to erosion:

- It shows that in total 23 land titles including 22 residential properties and one commercial property are within the **low hazard** band. These properties are especially along the Esplanade and Murchison Hwy.
- There are 4 properties identified within the **medium hazard** band. In addition, the tennis club and the Memorial Park are within the medium band. Most properties are located along the Murchison Highway and the esplanade.

- There is one non-residential property that lies within the **high hazard** band: the Surf Life Saving Club.

It should be noted that the properties along Murchison Hwy especially are somewhat protected from erosion by the highway, lowering the potential risk. However if nothing is done to protect the highway, the potential erosion risks are not reduced.

The total value of the 26 residential, developed properties[16] being classified as medium and low risk is approximately $ 12 million or an average capital value of $475,000 per property. The average land value is approximately $160,000.

The total value of the 22 residential, developed properties being classified as low risk is approximately $ 11 million or an average capital value of $505,000 per property. The average land value for these properties is approximately $175,000. Many properties in this category are properties along the Esplanade, foreshore dwellings with an ocean view. The remainder is along Murchison Hwy along the river mouth.

The total value of the 4 residential properties at medium risk of erosion is $1.2 million or $300,000 per property on average. The average land value is $80,000. The dwellings at medium risk are along Murchison Hwy at the river mouth.

The total value of all residential, developed properties in the study area is $30 million or an average capital value of $430,000 per property. The average land value for these properties is $140,000.

Those properties closest to the coast are along the esplanade. Assuming other things being equal, the average capital value of properties closest to the beach is $75,000 above the average value of properties in the study area.

The average land value for properties closest to the beach is $15,000 above the average of properties in the study.

This suggests that on average people are willing to pay a significant premium to own a beachfront property.

Infrastructure and other assets

While some residential properties may be at risk of erosion or inundation by 2050 and 2100, the assets exposed to most risk, that is current day risk of erosion, are non-residential Council owned assets:

- The Surf Life Saving Club and
- Section of pedestrian foreshore walkways

Both are located in an area highly susceptible to erosion. Historic photographs from 1946 even show the location of the SLSC is where the beach used to be. With sea level rise, the risks will only increase, requiring shorter term decision making about future investment and protection.

The capital value of the SLSC is approximately $700,000 including land.

Both assets play an important role in the culture and recreation of the community of Somerset. The social value of these assets is therefore significant.

[16] Excluding vacant residential land, businesses, youth camp and caravan park

Other infrastructure at risk includes:

- possibly the bridge head where the Bass Hwy crosses Cam River
- the pedestrian walkways along the foreshore and along the river bank
- the Memorial Park
- the Esplanade
- the Murchison Hwy
- the tennis club

These assets play an important role in maintaining active lifestyles for people in the community, and providing accessibility for residents. The highway is an important connecting road to settlements on the west coast.

5.2 Other values at risk

Other values at risk are the beaches and foreshore vegetation.

The study area offers a range of recreational values, including enjoyment of natural values, beach recreation, swimming, surfing, fishing, walking and boating. There are several public toilets.

Fauna and flora

Threatened species data from the Natural Values Atlas identify the presence of threatened species in the study area (2009, Threatened Fauna Observations). These include:

- Little tern (Sternula albifron subsp.sinensis) which is endangered and has been observed in the foreshore waters in front of the tennis club
- Gunn's screw shell (Gazameda gunnii), which is classified as vulnerable and has been observed in foreshore waters just east of Langley park oval
- Grey-headed flying-fox (Pteropus poliocephalus), classified vulnerable and observed in a residential area between the tennis club and the oval
- Azure kingfisher (Alcedo azurea subsp. diemensis) which is endangered and observed in the Cam River just south of the bridge

Other species with a conservation value (non-threatened) are bower spinach (Tetragonia implexicoma) and native pigface (Carpobrotus rossii) which are both found in the foreshore waters just east of the oval.

Sea level rise and options to adapt to sea level rise may potentially impact on the habitat of some of these species.

5.3 Conclusions

Properties in the Somerset study area have significant value premiums due to their access and proximity to the beach and, to a lesser extent, access to the river front.

To 2100, 16 properties would at some level of risk from inundation due to sea level rise and extreme storm events with only 10 with expected above floor level inundation depths. To 2100, there are in total 26 residential properties and 4 non-residential properties at risk of erosion due to sea level rise and storm events.

Many of these properties are located at the foreshore with direct beach or river front access . The premiums of properties close to the waterfront are around $75,000 per property.

Refusing any (re)development in the area potentially affected by sea level rise, erosion and extreme storms by 2100 could result in significant property use and value being lost over time.

The natural and environmental values of the Somerset area include foreshore vegetation, beaches, flora and fauna. Sea level rise may result in the development of wetlands.

Social and economic values in the study area involve beach related recreation and amenity, recreational fishing and river amenity.

Potential loss of beaches due to possible protection works[17] would likely adversely affect some of the natural, recreational and economic values of the area.

[17] Such as a sea wall which would result in the beach being 'drowned'.

6 ADAPTATION OPTIONS

6.1 What if nothing is done?

What would happen if nothing is done? That is, what would the impacts be if nature takes its course and no measures are undertaken to manage the risks?

Inundation (from west to east)

With sea level rise, some of the public open space will become more susceptible to flooding. The Headland area in the west of the study area, would likely be inundated as a result of extreme storm events (1% AEP) by 2050. The flood depths and area inundated would increase significantly with a sea level rise of 0.8 metre, expected around 2100.

Most of the developed foreshore area will likely not be susceptible to flooding from a 1%AEP storm event, even with 0.8 metre sea level rise, expected around 2100. Foreshore vegetation will likely be flooded during extreme events, possibly washing out much of the vegetation. The existing revetment wall east of the SLSC will increasingly be overtopped by storm wave action, thereby possibly undermining and weakening the revetment wall.

The SLSC is likely built up high enough to prevent flooding from storm events, although wave action may undermine and weaken some of the existing concrete protection.

The low lying Memorial Park will be susceptible to flooding from extreme storm events, especially from 2050 onwards (expected sea level rise of 0.2m). With a sea level rise of 0.8 metre, expected around 2100, parts of the park would likely develop into wetlands (saltmarsh).

The public open space just south of the bridge along the Cam river foreshore will be at risk from inundation from a 1%AEP storm by 2050, possibly overtopping and weakening the existing revetment wall and possibly damaging the footpath. The Murchison Hwy will likely to function as a barrier to protect residential properties behind the road from an extreme 1%AEP storm event, at least to about 2050 .From 2050 onwards, flooding will occur more frequently and by 2100 parts of the highway would be overtopped by a 1%AEP storm, thereby exposing the residential properties behind the highway to flooding.

Erosion (from west to east)

Erosion risks are expected to increase as a result of sea level rise.

The Headland at the western tip of the study area is already at present day risk from erosion. The erosion risk may be reduced somewhat due to the presence of gravel and rock outcropping. The tennis club is potentially susceptible to erosion by 2050, or a sea level rise of 0.2m. The majority of the esplanade may also be affected by erosion from 2050 onwards, possibly affecting the accessibility to some residential properties along this road. If nothing is done to protect the road, most of the residential properties may become susceptible to erosion somewhere between 2050 and 2100. The road may act as a buffer, delaying and slowing the process of erosion somewhat. By 2100 (0.8 m slr) up to about 16 dwellings would have become uninhabitable due to erosion risk.

The foreshore from about 200 metres west of the SLSC to the river mouth appears most susceptible to erosion at present day. At present day important community infrastructure that is at risk from inundation is the SLSC. Over time, with a rising sea level, the land around the SLSC will recede increasingly landward, leaving the structure more exposed to wave and wind action. Over time, existing concrete protection works are likely to be weakened and undermined, thereby slowly exposing the building itself to erosion (between present day and 2050).

The bridge head of the Bass Hwy may in the medium term (by about 2050) be affected by erosion. Along the Cam River mouth south of the bridge, some of the Council footpaths are at risk of erosion at present day. Existing protection works (rock revetment wall) will over time be weakened, which is likely to occur during peak river flow events.

By 2050, the Murchison Hwy is potentially exposed to erosion, with peak river flow events possibly exacerbating the erosion process. Without any measures to address the risk, the highway will slowly deteriorate and be closed to traffic. Some residential properties may no longer be accessible, and an important connecting route to the west coast would be affected, requiring an alternative route to be used.

Residential properties behind the Murchison Hwy are potentially susceptible to erosion from 2050 onwards, with approximately 4 dwellings becoming uninhabitable in the medium term, and up to 8 dwellings becoming uninhabitable by 2100.

6.2 Options

This section reports on the work undertaken and preliminary findings relating to **Step 6 of the pathway process: First cut assessment of adaptation options and costs.**

There are many different options to adapt to the impacts of coastal impacts of climate change. The different options relate to different types of impacts resulting from erosion and inundation. The effectiveness of options varies considerably depending on characteristics of the coastal areas (such as sandy or rocky coast line) and the location-specific impacts of sea level rise.

In the case of Somerset, there are options that are potentially relevant to the impacts identified:

- Beach nourishment if a source of sand can be identified
- Groynes, reefs and structures to reduce erosion
- Construction of a hard revetment or sea wall
- Protecting individual structures
- Protecting properties prone to inundation with a levee
- Redevelopment of structures in less vulnerable form (higher floor levels)
- Raising low lying residential areas, roads and services for long term occupation
- Retreat.

Detailed descriptions of these options are provided in the Interim Local Area Report. Short descriptions are provided below.

Beach nourishment

Beach nourishment can build up the bulk and height of the beach, replacing sand lost should erosion become progressive and providing a larger volume to prevent storm cuts from reaching vulnerable assets.

Beach nourishment may be used to retain some useable beach as a public amenity, in contrast to a sea wall where the beach may be lost in front of the sea wall at high tide and eventually all of the time. Nourishment brings additional material into the local sediment budget for the beach. The availability of a suitable source for material would need to be investigated and is critically important for this to be practical.

Beach nourishment generally has the advantage of having limited adverse impacts on adjacent shorelines. Hard structures can often result in changes to coastal sediment dynamics and have impacts on adjacent areas, such as increasing erosion compared to the status quo. However, beach nourishment typically washes away after a period of time and requires replenishment.

Beach nourishment may impact on the habitat of threatened flora and fauna in foreshore waters.

With sea level rise, the frequency of beach re-nourishment will increase, thereby pushing up the annual costs for maintaining the beach.

Groynes, reefs and structures to reduce erosion

Groynes and offshore reefs are mostly applied to high value frontages influenced by strong long shore processes (wave induced or tidal currents) where nourishment or recycling are undertaken.

Groynes are best applied to shingle beaches or within estuaries, and also effective for sandy beaches. Groynes can be useful in estuaries to deflect flows. The structural life for rock groynes is significant.

Groynes are applicable in combination with beach nourishment. Groynes encourage upper beach stability and reduce maintenance commitment for recycling or nourishment.

Groynes may disrupt natural processes and public access along the upper beach. It is likely to cause downdrift erosion if the beach is not managed.

The costs for groynes are typically between $200,000 and $500,000 per structure, plus recycling (various sources, 2013[18]).

Sea wall or revetments

A seawall is a massive structure that is designed primarily to resist wave action along high value coastal property. A revetment is a facing of erosion resistant material, such as stone or concrete that is built to protect a scarp, embankment or other shoreline feature against erosion. Revetments are used to increase the stability of eroding foreshores.

As noted, there is already a section of the foreshore where a rock revetment wall has been placed. The rock revetment wall was put in in 2011.

[18] Clarence City Council, Old Bar Council, Scottish Natural Heritage (2013), http://www.snh.org.uk/publications/on-line/heritagemanagement/erosion/appendix_1.12.shtml

A properly designed and constructed sea wall can reduce the risks to properties and areas of the foreshore from the impacts of beach erosion and coastline recession hazards. Essentially, the structure withstands erosive forces of waves and prevents further loss of shingle and sand from behind the structure.

They may be located at the top of the shore, out of reach of the water at low tide. Sometimes they may be partly or even fully covered with sand if there has been a period of accumulation since the wall was built. This may also be assisted by beach nourishment/shingle recharging.

Revetments can sustain considerable damage without totally failing, but take up more foreshore space than more vertical seawalls. Rock revetments can be suitable for high wave energy environments, but the potential for scouring in the upper reaches should be considered carefully. Revetments may provide more opportunities to create habitat for marine and coastal wildlife and vegetation than vertical sea walls. They cause less wave reflection than seawalls and survive storms for longer, but generally require regular maintenance to keep their structural integrity.

Very high water levels will cause waves to overtop a revetment or seawall. Having significant water flow or trapped water behind the sea wall may cause drainage problems or water logging resulting in erosion and structural instability. With sea level rise, coastal sea walls will need to be periodically increased in height. Revetments of large rocks may need maintenance after heavy storms. It will be possible to extend an existing sea wall if the foundations and sound are capable of withstanding additional loads. Otherwise, the existing wall will need to be demolished and a new, larger structure built.

As noted with other coastal structures, sea walls and revetments ultimately restrict sediment transport and may have impacts further along the coast. A particular problem with these hard structures can be terminal scouring at the end point. This can be minimised if they continue along a soft coast all the way along to a rocky shoreline.

Protection of Individual Properties

Protecting individual properties from erosion and inundation can be done in different ways:

- Flood barriers to protect existing dwellings from short term extreme events (not practical if water levels are permanently high)
- Piles or massive foundations to resist loss of foundation stability by erosion
- Elevated substructures (raised slab or floor, poles, non-inhabited ground floor) above flood levels
- Moveable dwellings
- Water proof or resistant construction not affected by temporary flooding
- Floatable dwellings.

Flood barriers either placed directly against the structures wall or free standing barriers can be used to protect existing dwellings. Most of the other options apply for new construction but could be used on extensions or where a building undergoes extensive renovation.

Protecting properties prone to inundation with a levee

Only a few properties are at risk of inundation from extreme events. Such events occur infrequently and the peak water level usually lasts for only a few hours. River flooding events may last longer, up to several days. Levee banks can provide protection against such flood peaks.

Levees are generally expensive, around $6,000 to $9,000 per metre. With a limited number of properties at risk of inundation, this measure is likely beyond the capacity to pay for those protected by such a structure.

A disadvantage of levees is that they may prevent rainwater from draining as freely and the drainage system may need adequate retention capacity or pumping to assist during peak storm events where local rainfall is also significant. A high levee can also block views and affect access to properties. A levee that is insufficiently high may fail if the storm surge overtops it and causes a breach, losing much of the protective value expected.

Raising low lying residential areas, roads and services for long term occupation

Raising the land level of developed low lying land, either with existing development or land planned for development, above the expected sea storm surge level is one of the most secure and sustainable responses to rising sea levels/inundation. Raising land also reduces the risks to structures and roads from high water tables that can reduce load bearing capacity and, if saline, affect services and structural integrity.

Typically the edge of the raised land would need some protection from erosion. For any new development or major re-development in inundation hazard affected areas, raising land level could be a requirement controlled by the planning scheme. Roads and services for the affected area would also have to be raised and hardened.

While raising land above the storm surge height can avoid inundation, it represents an obliteration of the existing flora and fauna in the filled area and may also have significant impacts at the source of the fill material.

If the filling is done in stages there may be issues where filled land could increase the flooding of adjacent unfilled land. Such a patchwork filling approach may create problems with drainage unless some considerable thought and planning is put in place to anticipate and manage this issue. An overall filling and drainage plan would be required to avoid the worst foreseeable problems.

Planned retreat

Progressive retreat means the loss of private and other property. In spite of this, it may prove to be the lowest cost long term alternative available, especially if the cumulative cost of protection into the future is high (higher than the enjoyed benefits or values). This is more likely to be the case if the rate of sea level rise is high and even adapted assets have a relatively short lifetime before becoming under threat.

The cost of planned retreat can be diminished to the cost of land if a process of planned disinvestment occurs, such as not redeveloping and/or extending existing properties.

7 ADAPTATION PATHWAYS

In preparation for the Council and community consultation in November 2013, the following three adaptation pathways were developed to explore the future for Somerset. Often adaptation is interpreted as retreat or protect. Also, adaptation may be incorrectly seen as a one-off task with the result being 'we have adapted'.

Adaptation however is a long term process that can follow various pathways. The pathways consist of various adaptation options that are mutually reinforcing and/or complementary to each other, and implemented as required over time. Some adaptation options may be implemented simultaneously, while other options may be implemented sequentially. The pathways primarily consider the timeframe to 2050 with only some reference to the longer term to 2100.

For Somerset three main pathways were identified in preparation for the consultation:

1. **Let nature take its course and retreat early.** This pathway allows maximum freedom for natural coastal processes to unfold, with a minimum of intervention or resistance from future development or coastal and flood protection works. Where erosion threatens structures, they would be removed. Where property is regularly inundated, it would eventually not be worth repairing and redevelopment in affected areas would not be permitted.

2. **Protect existing development as long as practical while protecting natural values.** This pathway protects property but only where that protection has a minimal impact on the values of the area important to the community. There is balance between protecting natural and shared community assets, and private property. There is also consideration of promoting and sustaining natural ecosystems in the face of climate change. In general, intensification of development in hazard areas would be discouraged unless it and the protection measures required clearly did not have any negative impact on natural and community values or were likely to have a positive effect.

3. **Protect existing development and permit new development to the maximum possible extent for as long as possible.** This pathway concentrates on protecting the existing and future community and property using any available options. Intensification of development provides more contributors to any protection works, so some intensification is permitted where it does not compromise community values for the suburb. While natural areas may be affected, they may adapt in their own way or become modified in ways that the community accepts.

The pathways are not predictions or recommendations, but ways of imagining different futures based on a range of choices about how to respond to climate change impacts. Many other variations are possible but these cover a wide scope of possibilities. All pathways are based on two principles:

- developing risk will be actively managed;
- people cannot be subsidised to occupy or use hazardous locations.

This means firstly that properties and assets must be managed in a way that they are exposed to acceptable levels of risk over the asset's lifetime. For dwellings, infrastructure and services, it is generally accepted that these must be built and designed to withstand a once in a hundred year extreme (1% AEP) event.

Secondly, this means that those who benefit from adaptation works should also contribute to the costs in an equitable way. It also means that those who pay should have a say about adaptation options and pathways.

With climate change, it will be unsustainable to continue to subsidise people who choose to occupy or use hazardous locations in the medium to short term with hazards projected to increase in many ways in all parts of the country. Arguably, current property owners were not fully aware of the potential risks at the time they invested in the area, and some short term works may be provided to enable property owners, residents and operators to consider their future plans.

7.1 Pathway 1 Let nature take its course and retreat early

This pathway allows maximum freedom for natural coastal processes to unfold with a minimum of intervention or resistance from existing or new development or erosion and flood protection works. Where erosion or severe flooding threatens structures with failure in the short term, they would be removed if they cannot resist the hazard. Where property is regularly inundated, it would eventually not be worth repairing and be abandoned. Redevelopment in affected areas would not be permitted. Little if any new development would be allowed in hazard areas, and certainly no intensification of existing areas (subdividing existing residential blocks or intensifying rural residential areas).

Property owners would be allowed to take action that extends the life of their existing structures by making it resistant to erosion or flooding (flood skirts, other waterproofing, underpin foundations), but only within their own property boundary, as long as it has no impact on adjacent areas. Filling and raising land would generally not be allowed, nor would hardening shorelines with rocks or concrete or even dune or beach nourishment.

How might things proceed with this pathway?

With nature taking its course, Somerset foreshore erosion is expected to proceed, with some cycles of rebuilding but a long term recession of perhaps 23 to 49 metres from the current High Water Mark by 2050 and 50 to 83 metres by 2100. About 4 residential properties might be at risk of loss by erosion from an extreme storm by 2050, currently valued at $1.2 million. Most dwellings are along the Murchison Hwy.

Over time multiple Council assets would need to be removed or relocated landward. The SLSC would require relocation before 2050, or if allowed to be redeveloped to be built on piles extending its lifetime (but not indefinitely), and depending on the frequency of storms over the next decade and related damages, potentially within the next ten years. Other Council assets at risk in the medium term (to 2050) are the tennis club, foreshore walkways and the Esplanade.

The Memorial Park would slowly erode away, with significant parts having eroded by 2050. With progressive erosion due to sea level rise, the river edge would edge towards the Murchison Hwy, potentially requiring the highway to be rerouted and over time exposing the properties behind the road to erosion as well. With the road working as a barrier and slowing erosion four properties would need to be abandoned and removed somewhere after 2050 and up to 22 properties around 2100. Properties may need to be abandoned earlier in case the road access to the property has been eroded and no alternative access is available.

Private property protection works are more effective to protection against flooding, but it would generally not be allowed to put in rock walls to prevent against erosion.

While this scenario presumes 'nature takes its course', in practical terms there are already some existing coastal protection works. These would be allowed to deteriorate, or any hazardous remnants removed if necessary.

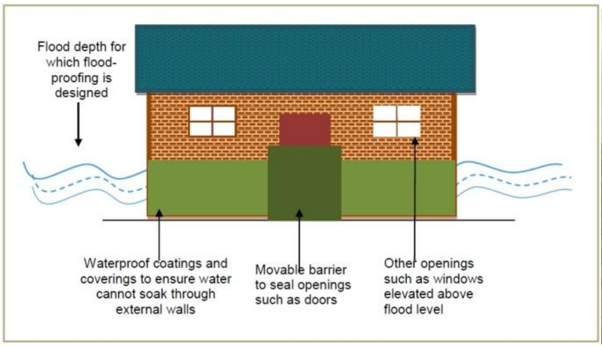
Increasingly, saline ground water would lead to a change in vegetation. Non-salt tolerant terrestrial plants, including many trees and shrubs, would become stressed and would die off and be replaced by more salt tolerant species.

The Bass Hwy bridge over the Cam River would need to be lengthened to accommodate riverbank erosion and maintain road stability and safety.

This plan would likely see most of the study area still occupied to 2100, with some areas required to commence retreating from about 2050 onwards. The SLSC is earliest affected, requiring it to be built on piles, removed or relocated landward before 2050, and possibly within the next decade.

Likely options within this pathway

Major works and modifications to the landscape would not be permitted under this scenario. Most work would be involved in 'clearing away' and reconfiguring infrastructure to remain serviceable.



Flood proofing for existing buildings **Dune vegetation management**
http://climatetechwiki.org/sites/default/files/images/extra/media%20image%202_10.jpg

A piled coastal structure (source: WRL)

Action plan and indicative costing

Actions: 0-10 Year Timeframe (indicative cost $ 200,000 per year excl. infrastructure upgrades and removal)

No	Option	Responsibility	Cost
1	Monitor rate of erosion and storm bite events	C	$10,000
2	Planning scheme amendment to restrict development, filling and subdivision	C/State	Nominal
3	'Soft' foreshore protection works (vegetation and access restriction)	C/residents	$20,000
4	Emergency management plans	State/C	Nominal
5	Advice to property owners on individual risk management measures	State/C	Nominal
6	Redevelop SLSC on piles or move landward	C/SLSC	$100k - $300k
	Repair and modification of infrastructure after any flood, erosion event as required to maintain agreed service levels	State/C	Increasing over time

Actions: 10-40 Year Timeframe (indicative cost $ 400,000 per year excl. infrastructure upgrades and removal)

No	Option	Responsibility	Cost
1	Monitor rate of erosion and storm bite events	C	$30,000
2	Emergency management plans update and review	State/C	Nominal
3	Advice to property owners on individual risk management measures	State/C	Nominal
4	Repair and modification of infrastructure after any flood, ersion event as required to maintain agreed service levels	State/C	Increasing over time
5	Disaster relief after major flood/erosion event and assistance to re-establish elsewhere	Federal/State	Increasing over time
6	Private, individual action to reduce erosion damage risks	Property owners	~ $8-$16m
7	Requirements to remove uninhabitable dwellings; rehabilitation of abandoned blocks	C/property owners	$40,000
8	Clearing away inaccessible roads	CS	Increasing over time

7.2 Pathway 2 Protect existing development as long as practical while protecting natural values

This pathway protects property but only where that protection has a minimal impact on the values of the area important to the community, such as the beach and the dunes. There is balance between protecting natural and shared community assets, and private property. There is also consideration of promoting and sustaining natural ecosystems in the face of climate change. In general, intensification of development in hazard areas would be discouraged unless it, and the protection measures required, clearly did not have any negative impact on natural and community values or potentially have a positive effect.

Some modifications to the environment may be permitted. For example, part of a wetland might be excavated to provide fill to raise flood prone property but provision would be made elsewhere for wetlands to migrate inland. However, protection and adaptation options that result in changes to the character of the area that reduce its attractiveness and property value would not be pursued (eg generally sea walls that threaten beaches).

How might things proceed with this pathway?

Beach nourishment could offset the impacts of erosion at least to 2050. The introduction of sediment management structures, such as groynes or offshore reefs, is likely to be necessary to retain sand and reduce recurrent re-nourishment costs. The frequency of recharging or renourishment depends on the effectiveness of the structures and the storm conditions experienced. Groynes would be more visually intrusive than an underwater offshore reef. An underwater offshore reef may have the effect of building a bar between the current shoreline and the reef, either permanent or transient, and may affect swimming and other beach activities. These structures may also offer additional or varied recreational opportunities, depending on the design objectives and costs.

If nourishment were to use sand from outside the coastal system (that is, well offshore or land based sources), the added sand may reduce the rate and extent of erosion due to sea level rise. The ability to do this will depend on the availability, suitability, cost and environmental impact of taking sand from the source.

Eventually, recharging and maintenance of sediment management structures may become impractical due to cost and frequency, inadequate supplies of material, environmental or other impacts of supplying sand or the cost of maintaining or renewing the structures. At this point there would be some further progressive erosion and a shift toward retreat (between 2050 and 2100). However, some level of protection short of a sea wall may still be practical to limit 'catastrophic' damage. The beach and dunes would be retained as they migrate landwards.

Rock revetments as currently in place west from the SLSC and in the mouth of the Cam River south of the bridge will be maintained until the frequency of works and related costs become impractical.

The individual protection of the SLSC will be maintained as long as practical. This is likely to remain feasible as long as beach nourishment and sediment management structures remain effective. After that, 10 or more years from now, the SLSC would need to be moved landward. The relocation would be undertaken when the costs of recurrent protection works outweigh the costs of relocation. The relocation would need to occur sooner or later, and sooner may be the more cost-effective option. There is substantial space within the Memorial Park to allow for relocation of the SLSC. This would however reduce the size and amenity of the park, which is also reduced in size by erosion.

New development and redevelopments/major extensions would be required to be built with the floor above the expected maximum annual high tide for the lifetime of the structure plus a freeboard allowance.

Low lying land behind the Murchison Hwy would be allowed to be filled under certain conditions and as long it does not adversely affect nearby properties.

The Murchison Hwy would be protected as an important community asset. The river bank would be hardened to withstand erosion. In case of significant maintenance the highway would be raised to withstand sea level rise to 2100 and to protect properties behind the highways from flooding, with the highway acting as buffer.

Riverbank protection through revetments would enable the foreshore and the walkways to be used for longer, at least to 2050.

The bridge head of the Bass Hwy bridge over Cam River would need to be protected against erosion.

In the longer term, foreshore infrastructure would need to be adjusted to enable most properties to remain serviceable. Over time, towards 2100, the beach would move landward and Council infrastructure (including Esplanade, walkways and tennis club) would need to retreat as well as foreshore private properties (approximately 16 to 18 dwellings).

Likely options within this pathway

Beach nourishment

Groynes

Riverbank hardening

Action plan and indicative costing

Actions: 0-10 Year Timeframe (indicative cost $ 100,000 per year excl. infrastructure upgrades)

No	Option	Responsibility	Cost
1	Monitor rate of erosion and storm bite events	C	$10,000
2	Planning scheme amendment controlling filling so it does not adversely affect drainage or adjacent properties	C/State	Nominal
3	Emergency management plans	State/C	Nominal
4	Advice to property owners on individual risk management measures	State/C	Nominal
5	Repair and modification of infrastructure after any flood, erosion event as required to maintain agreed service levels	State/C	Increasing over time
6	Beach nourishment (1km, 50m, 0.3m)	C/property owners	$375,000
7	Groynes or other sediment management structures	C/property owners	$400,000
8	Protect SLSC	SLSC/C	$100k-$300k
9	Private, individual flood and erosion protection works	property owners	$40,000

Actions: 10-40 Year Timeframe (indicative cost $ 110,000 per year excl. infrastructure upgrades)

No	Option	Responsibility	Cost
1	Monitor rate of erosion and storm bite events	C	$30,000
2	Emergency management plans - update and review	State/C	Nominal
3	Advice to property owners on individual risk management measures	State/C	Nominal
4	Repair and modification of infrastructure after any flood, ersion event as required to maintain agreed service levels	State/C	Increasing over time
5	Maintenance of existing protection works	C/property owners	$150,000
6	Beach re-nourishment (increasingly frequent)	S/C/property owners	$1,875,000
7	Maintenance of sediment management structures	property owners	$800,000
8	Hardening and raising of Murchison Hwy and protection of Bass Hwy bridge	S	Increasing over time
9	Filling of residential properties (re- and new development)	property owners	$40,000
10	Relocate landward or protect SLSC	SLSC/C	$200k - $600k

7.3 Pathway 3 Protect existing development and permit new development to the maximum possible extent for as long as possible

This pathway concentrates on protecting the existing and future community and property. It assumes that the rate and extent of change will be manageable using available options and that any necessary protection and adaptation options will be acceptable. Intensification of development provides more contributors to any protection works, so some intensification is permitted where it does not compromise community values for the suburb. For example, low lying rural residential areas may be permitted to subdivide, making it more cost effective to fill lots as a way of combating inundation, while allowing sufficient floodways to control runoff. While natural areas may be affected, they will adapt in their own way or become modified in ways that the community accepts.

How might things proceed with this pathway?

Sediment trapping structures (eg groynes, artificial reef) combined with beach nourishment can manage erosion risks in Somerset potentially for decades. Assisting structures with re-nourishment may eventually become impractical due to cost, inadequate supplies of sand, environmental impacts or the cost of maintaining or renewing the structures. At this point, somewhere between 2050 and 2100, the shoreline would be hardened to prevent ongoing erosion, with a sea wall or revetments. Some level of sand re-nourishment may still be practical to maintain a beach for a while, but in the long run, hardening an eroding coast with rising seas would lead to the loss of the beach and dunes entirely.

Hardening of the shore would protect the community from shoreline erosion and recession for a long time (but not indefinitely). A sea wall would reduce the need for individual properties to address erosion hazards. Some may value security with a promenade and a view as highly, or more highly, than a beach. Often however, the beach is the main reason for people to live near the foreshore. The costs of a sea wall, to be borne by those who benefit from it, are substantial and may be beyond the carrying capacity of the existing community. Significant intensification of development would be a means to generate sufficient ability to pay.

Hardening of the foreshore is likely to be required between the river mouth and the SLSC around 2050. More extensive hardening along the foreshore would be required from around 2050 and 2100. Individual protection works, in combination with beach nourishment and sediment management structures, would allow the SLSC to remain at its current location until approximately 2050. Once the sea wall or revetment wall is built along the foreshore, the SLSC may need to be moved to be in or on top of the sea wall. Over time, with sea level rise to 0.8 m, the beach would gradually drown, largely taking away the reason of existence of the SLSC.

The riverbank in the mouth of the river would be hardened, the bridge head protected and the Murchison Hwy would over time be raised to withstand flooding and protect properties behind the road from inundation. Low lying land would be allowed to be filled to prevent flooding.

New development and redevelopment/major extensions would be required to be built with the floor above the expected maximum annual high tide for the lifetime of the structure plus a freeboard allowance. Land filling would be encouraged in all areas behind road barriers and levees except identified drainage lines and retention basins. For smaller blocks, filling would be mandatory at the time of any building redevelopment.

This approach should permit most of the existing residential areas and some other intensified areas to continue to be occupied for this century or longer. In the longer term, if sea levels rise by 2, 3 or more metres, the protection works along the foreshores may need to become larger and more sophisticated.

Protection works such as a sea wall may only be supportable with more intensive development of the area. Given the time from now until when this need arises (potentially of the order of 40 years or more) it is not realistic to predict the priorities and values of the community at that time. Quite high densities may be seen as appropriate as well as being better able to support more expensive protection works.

The costs of this pathway are likely to increase significantly from 2050 onwards, requiring foreshores to be hardened along the entire ocean and river foreshore.

Most of these significant costs will only occur after 2050. The projected costs are therefore very similar to pathway 2. The direction towards pathway 3 is practically a choice that will take effect after 2050. This project focusses on adaptation pathways to 2050 primarily, and therefore there is no real distinction between pathway2 and 3 until 2050. After 2050, the implications in terms of how the area will look and develop and in terms of costs will be significant.

Likely options within this pathway

Dyke with coastal road, Holland

Sea wall (Sandy Bay)

Houses elevated and designed for water levels

Fill to raise land levels

Action plan and broad costing

The action plan up to 2050 is very similar to pathway 2 to 2050, please refer to Pathway 2.

7.4 The workshop

Two adaptation pathways were investigated by stakeholders from the Somerset community at workshops held on Tuesday November 26 2013 with sessions held in the morning and early afternoon. The participating stakeholders involved representatives from the Somerset Surf Life Saving Club (SLSC), the tennis club, Council Elected Members (3) and Council staff (3). Also attending was one observer from State Government. The two pathways were:

1. **Let nature take its course and retreat early.** This pathway allows maximum freedom for natural coastal processes to unfold, with a minimum of intervention or resistance from future development or coastal and flood protection works. Where erosion threatens structures, they would be removed. Where property is regularly inundated, it would eventually not be worth repairing and redevelopment in affected areas would not be permitted.

2. **Protect existing development as long as practical while protecting natural values.** This pathway protects property but only where that protection has a minimal impact on the values of the area important to the community. There is balance between protecting natural and shared community assets, and private property. There is also consideration of promoting and sustaining natural ecosystems in the face of climate change. In general, intensification of development in hazard areas would be discouraged unless it and the protection measures required clearly did not have any negative impact on natural and community values or were likely to have a positive effect.

   This pathway protects property but only where that protection has a minimal impact on the values of the area important to the community. There is a balance between protecting natural and community assets, and private property.

Note: The workshops were used to explore the application of the pathways to 2050. Pathways 2 and 3 are very similar to 2050, and are only expected to deviate from each other thereafter.

The two pathways were explored in two sessions with each session lasting up to two hours, enabling an in depth investigation of the pathway. Prior to the interactive part of the workshops, SGS presented the findings of the hazard assessment, planning scheme review, cost of risk and values at risk analysis.

At the start of each session the participants were asked to read the flyer explaining the pathway, the types of adaptation options likely to be adopted and how things may be different with that pathway. After that the workshop moderator summarised the pathway and answered any questions before starting to explore the pathway.

Over the two hours participants examined the following for the scenario they were investigating:

- The pros and cons and desirability of the scenario
- Whether they believed the scenario was plausible
- What if conditions change (eg. sea level rises faster or slower than anticipated, there are technological advances, or property prices rise or fall)
- Who decides
- Who pays

After exploring these questions participants were asked what pathway they think is a realistic option for the Somerset study area.

7.5 Workshop summary and preferred pathway

The participants of the workshop tended to move most towards Pathway 2 which would buy the community some time to adapt and to use the assets at risk until the end of their economic lifetime. Quite typical for the Somerset study area is that community and council infrastructure are expected to be affected prior to any private properties being affected.

The most urgently at risk (at present day) asset from erosion is the SLSC. The tennis club is projected to be at risk in the medium term. The SLSC has received $350k funding to extend its assets. With the new information available about sea level rise and erosion risks, the club needs to reconsider the best way forward and to possibly extend the timeframe for spending the funding.

The participants agreed there is a fine balance between pathways 1 and 2, and there is more planning, research and community engagement required to determine what would be the optimum moment to relocate the SLSC landward. Retreat for the SLSC could be accommodated in a gradual way, with new extensions being built in locations landward but still in very close proximity.

While there was agreement between the participants at the workshop, everyone acknowledge that the private property owners who at some stage would be at risk of erosion and inundation were not present to express their views, and that their views may gravitate to a pathway 2 and 3 approach with as much protection as possible.

There was some level of agreement that the small community base of Somerset would not be able to afford expensive adaptation options and that retreat, sooner or later, would be a realistic strategy.

The workshop involved community stakeholders only and did not engage with the wider community directly. It was widely agreed during the workshop that the wider community and all Elected Members would need to be involved via a workshop approach as was undertaken with the participants that day.

Key benefits of pathway 2:

- Buys time and enables to use community facilities to be used to the end of their economic live, and allows for the community to develop a coordinated strategy to adapt (gradually retreat) over time
- More proactive approach than pathway 1 and likely to gain more community support
- Continue to use and retain the beach for as long as possible, with some sacrifice of aesthetical values (i.e. the view of groynes would change the areas character)

Key disadvantages of pathway 2:

- Possible spending of money on protection works that can be prevented by retreating earlier
- Property prices at foreshore may be negatively affected if the strategy would be to retreat at some stage (compared to hard protection)

7.6 How to make it work? Stakeholders perspective

The stakeholders expressed concerns about present day risks. It was acknowledge that the foreshore/beach area especially between the Cam River and past the SLSC has always been a very mobile landform. In fact, the SLSC club is built on a location that WAS beach only about twenty years before it was built. In recent years some erosion protection works have been undertaken, including right in front of the SLSC. This was undertaken without any proper consultation of the SLSC and the community. The discussions about future risks need to include the community and specific stakeholders involved.

One of the participants of the workshop indicated THAT significant sewage infrastructure and pump stations would likely be at risk within the short to medium term based on the information presented.

Engagement of the wider community

One of the main findings of the workshop was that it is crucial to engage the community in respect to the findings of this study as soon as possible. Both Elected Members and the community need to be informed about the projected impacts and be engaged in discussions about how to best plan for the future. Importantly, property owners at risk at some point in the future should be engaged.

The way forward for the Somerset Surf Life Saving Club

The SLSC representatives agreed that the information presented as well as the discussions during the workshop are of such an importance that the SLSC needs to reconsider its strategy in regard to the capital grant it has received for the extension of the facilities. Council is the owner of the existing assets. It was suggested that Council would be best suited to coordinate the adaptation of the SLSC.

The SLSC could adapt gradually by gradually relocating new investments/extensions landward and to higher ground. There is a possible opportunity to develop a multipurpose SLSC and community centre on the new site.

Funding, coordination and decision making

It was mentioned that there is a need to build partnerships between stakeholders to ensure there is cooperation and collaboration. Council was seen as the logical party to coordinate and make decisions.

It was suggested that more detailed planning needs to be undertaken to determine what the community can afford in terms of adaptation, to explore possible sources of external funding and to monitor data on sea level rise, storm surge, erosion but also the costs of maintenance and repair after events and the costs of adaptation options.

This planning should also include the preparation of a long term strategy with clear pathways and milestones for decision making and implementation of strategies and measures.

8 WHERE TO FROM HERE?

This section provides overall conclusions on the project, the assessments, and the stakeholder consultation findings. In broad terms it provides direction to the way forward. Many lessons have been learned, but also, it is clear many gaps in terms of knowledge, decisions making and funding still exist. The following conclusions will illustrate this and also suggest possible ways to address issues. Interestingly enough, the findings are largely true for other case study areas too (both the first TCAP and the TCAP Extension project of which Somerset is part of).

The study area involves significant community facilities and infrastructure, including the Somerset surf lifesaving club (SLSC), the Memorial Park, the tennis club, foreshore walk ways, and Council and State roads. These assets are most at risk before private properties are likely to become at risk in the future, if nothing is done to address the risks. Consultation as part of this project has focussed on engaging with these community facilities and some of Council's Elected Members.

Community and Council engagement

The stakeholders[19] consulted indicated for them Council would be the most appropriate body to coordinate planning and decision making for adaptation in the study area. The stakeholders expressed their view that in taking up its local leadership role, as a matter of priority would be to engage all Elected Members and to engage the property owners and community members in the study area.

A process for agreeing a plan and reconciling different interests has been proposed in a paper prepared to 'reality check' the proposed pathway for Lauderdale in Clarence: *Decision Making and Funding for Coastal Adaptation*. This proposes that an adaptation management plan would be developed and formally adopted under a State government framework. The process would have parallels with the development of a planning scheme with opportunities to make representations and appeals, and input from state agencies and review by an authority to confirm compliance with relevant legislation. By having State backing, it would reduce the burden on Local Government for any impacts arising from implementing the plan. The content of this paper would equally apply to Somerset, or any other community in Tasmania facing similar issues.

At present the State does not provide a framework to enable such a plan to be prepared and recognised.

Recommendation: To work with the state government to develop a framework for the development of coastal adaptation plans that have state backing and recognition, and balance the priorities of both the local and wider community.

Local leadership and a coordinated approach

Council is probably best positioned to take a leadership role in driving a coordinated approach to adaptation. This means Council would be best positioned to set up and drive a local adaptation management plan. In taking such a role, it is important that Council adheres to and clearly communicates two core principles for sustainable adaptation:

1. Developing risks will be actively managed

[19] This view was clearly expressed by the stakeholders not part of Council (as staff or Elected Member)

2. People/parties cannot be subsidised to occupy or use hazardous locations

Thus, there is a clear distinction between taking on responsibility for coordinating, implementing and administering an adaptation management plan (Council's role) and responsibility to protect private property and pay for adaptation (not Council's role). Council should work together with the community and support them so they can adapt over time.

It is further important for Council to engage, in addition to the community and local stakeholders, with regional and State agencies and other relevant stakeholders. The Somerset study area includes State roads and sewage infrastructure owned and managed by TasWater.

Recommendation: For Council to take a local leadership role in coordinating and administering adaptation management in the study area, and to consistently communicate and consult with the community and relevant stakeholders.

Longer term strategic planning and monitoring

The hazards from inundation and potential erosion have been documented by the project for present day and for sea level rise of 0.2 and 0.8m. However, the projected impacts of erosion are still fairly uncertain and depend on detailed (geomorphological) studies of specific locations (especially around the SLSC) and impacts of the Cam River.

This work would also inform decision making on the feasibility of any adaptation options such as beach nourishment and groynes or other sediment trapping options. The stakeholders consulted expressed a strong desire to retain the beach and natural amenities in the area. Both this and the stakeholders' expectations that the community would not be able to afford some hard protection works (such as a sea wall) suggest the investigations would need to consider soft adaptation measures primarily.

To minimise future exposure to risk, especially if pathway 1 or even 2 is adopted, future new development in areas at considerable risk would need to be minimised and be allowed only if certain criteria are met.

Recommendation: Ensure a framework is in place to ensure appropriate research is done to make decisions on the basis of evidence.

Adaptation requires funding

Both the recommended investigations above and the works required for adaptation will require significant funds. Clarence City Council has spent close to $500,000 to date and the most recent investigations further changed the recommended response significantly from that suggested by earlier, less detailed work. It appears that there are few shortcuts to achieving a good understanding of the local issues that need to be addressed to adapt to climate change in a responsible way.

Under the principle put forward in the TCAP project that there will be no subsidy to assist people to occupy hazardous locations, and consistent with the recommendation of the report on funding and decision making, it is expected that the funds would be raised substantially by a special rate levies on property within the identified hazard areas. Some transition assistance may be available from national or state programs to support climate change adaptation, emergency planning or other relevant programs.

Recommendation: That an approach be formulated to identify the budget required and the sources of funds to raise the money required. It is considered that this should be done on a staged basis over a period of about 5 years, with priority given to identification of and responding to erosion risks and sediment transport.

Appendix 1 Planning Codes

There are four codes which that include use and development standards that recognise coastal vulnerability. The codes are the Change in Existing or Natural Ground Level Code (E3), Clearing and Conversion of Vegetation Code (E4), Hazard Management Code (E6), and the Water and Waterways Code (E12)

E3 Change in Existing or Natural Ground Level Code

The Purpose of the Change in Ground Level Code is to minimise impact of change in existing or natural ground level. This Code applies if use or development creates a change in existing ground level or natural ground level by cut or fill of more than 1.0m.

Development Standards for the Change in Existing or Natural Ground Level Code are contained within E3.5.

Change in existing ground level or natural ground level

Objective: Change in the existing ground level or the natural ground level by cut or fill are to minimise likely adverse impact on the physical, environmental, cultural, and amenity features of land or for inconvenience or risk to adjacent land.	
Acceptable Solution	Performance Criteria
A1 Cut or fill must – a) not be on land within an area of likely risk from a landslide hazard; and c) not create a change in existing ground level or natural ground level by more than 1.0m; e) not occur within a natural or constructed drainage channel; l) minimise erosion and movement of sediment and other contaminants from the site	P1 Cut or fill must - b) be assessed in accordance with Code E6 as being unlikely to trigger, spread, or intensify risk of landslide; c) be required to - iii. mitigate exposure to a natural or environmental hazard; g) safeguard the quality of receiving waters through measures to minimise erosion and release of sediments and other contaminants during each of the site preparation, construction and rehabilitation phase in accordance with Soil and Water Management on Building and Construction Sites 2009

E4 Clearing and Conversion of Vegetation Code

The purpose of the Clearing and Conversion of Vegetation Code is to assist protection and conservation of –

d) vegetation on land susceptible to landslide in accordance with Code E6 –Hazard Management under this planning scheme; and

e) vegetation within 30m of a water body, watercourse, wetland, or coastal shoreline

Development Standards for the Clearing and Conversion of Vegetation Code are contained within E4.5.

Clearing of vegetation on land susceptible to landslide

Objective The harvesting of timber or the clearing of vegetation is to minimise risk for activation of landslide	
Acceptable Solution	Performance Criteria
A1 a) The site must be within an area i. exposed to an acceptable level of likely risk from landslide; or ii. exposed to a low level of likely risk from landslide; and a. a landslide hazard risk assessment must indicate	P1 If site is exposed to a medium or high level of likely risk from landslide a hazard risk assessment must indicate – i. the use or development is unlikely to cause or contribute to occurrence of landslide on the site or on adjacent land; and

clearing of native vegetation – i. can achieve and maintain a tolerable level of risk; or ii. there is an insufficient increase in the level of risk to warrant any specific hazard reduction or protection measures; or iii. any condition or requirement for specific hazard reduction or protection measures; or b. there must be an approved Forest Practices Plan	ii. any condition or requirement for specific hazard reduction or protection measures

E6 Hazard Management Code

The purpose of the Hazard Management Code is to:
a) identify likely areas of risk for use or development on land exposed to natural or environmental hazard;
b) minimise likely social, economic, and environmental costs associated with exposure of use or development to an unacceptable level of risk from a natural or environmental hazard;
c) minimise likelihood for use or development to trigger, spread, or intensify a natural or environmental hazard;
d) apply controls to manage likely risk that are proportional to the type, intensity, and anticipated life of use or development

This Code applies for use or development on land in an area exposed to likely risk from a natural or environmental hazard because of –
a) coastal inundation and erosion by sea level rise or storm surge if –
  i. shown on the planning scheme maP;
  ii. (if no area is shown on the planning scheme map) land within landforms defined as vulnerable to erosion or regression in Indicative Mapping of Tasmania Coastal Vulnerability to Climate Change and sea Level Rise (Sharples 2006);
  iii. below 5.0m AHD; or iv. shown on the Coastal Inundation Map prepared for the Tasmanian Planning Commission 2011
c) flooding from a watercourse, wetland or stormwater disposal system if –
  i. shown on the planning scheme map; or
  ii. (if no area is shown on the planning scheme map) land within the overland flow path for the 1% annual exceedance probability flood in a watercourse, wetland or stormwater disposal system
d) landslide shown on the Landslide Hazard Map prepared by the Department of Premier and Cabinet

E6.3 contains a definition of terms that includes definitions that are used during a hazard risk assessment. The definition of terms is detailed in the appendix of this document.

Use Standards for the Clearing and Conversion of Vegetation Code are contained within E6.5.

Hazard Management

Objective: The level of likely risk from exposure to a natural or environmental hazard is to be tolerable for the type, scale, and intensity of each use or development	
Acceptable Solution	Performance Criteria
A1 a) The site must be within an area for which there is an acceptable level of risk; or b) If the site is within an area exposed to a low level of likely risk a use or development must – i. be an alteration or addition to an existing building or a minor building, structure, or work; ii. be infill or redevelopment for a purpose permitted within an area of established use;	P1 a) There must be a hazard risk assessment if - i. a critical use on a site within an area exposed to a low level of likely risk; ii. a vulnerable use or hazardous use on a site within an area exposed to a medium level of likely risk; or iii. subdivision within an area exposed to a medium level of likely risk to – a. create 3 or more lots; or b. extend an existing highway

iii. not be a vulnerable use, a hazardous use, or a critical use; or c) There must be a hazard risk assessment if the site is within - i. an area exposed to a low level of likely risk and use or development is – a. a vulnerable use or a hazardous use; or b. subdivision to create 3 or more new lots; or c. subdivision to extend an existing highway; or ii. an area exposed to a medium level of likely risk and use or development is for - a. alteration or addition to an existing building or a minor building, structure, or work; b. infill or redevelopment for a purpose permitted within an area of established use; or c. subdivision to create not more than 3 new lots by infill within an area of established use; and iii. the hazard risk assessment must indicate – a. there is an insufficient increase in the level of risk to warrant any specific hazard reduction or protection measures; or b. a hazard management plan to demonstrate a tolerable level of risk can be achieved and maintained for the type, scale and intensity of the use or development; and c. if the hazard management plan involves land external to the site, the consent in writing of the owner of that land to enter into a Part 5 agreement to be registered on the title of the land and providing for the affected land to be managed in accordance with the hazard management plan	b) There must be – i. an overriding community benefit; or ii. an exceptional circumstance; and iii. a hazard risk assessment if – a. a critical use on a site within an area exposed to a medium level of likely risk or a high level of likely risk; b. a vulnerable use or a hazardous use on a site within an area exposed to a high level of likely risk; c) if the hazard management plan involves land external to the site, the consent in writing of the owner of that land to enter into a Part 5 agreement to be registered on the title of the land and providing for the affected land to be managed in accordance with the hazard management plan; and d) There must be - i. an overriding community benefit; or . ii. an exceptional circumstance; and iii. a hazard risk assessment if – i. a critical use on a site within an area exposed to a medium level of likely risk; or ii. a vulnerable use, a hazardous use or a critical use on a site within an area exposed to a high level of likely risk

E12 Water and Waterways Code

The purpose of the Water and Waterways Code is to assist protection and conservation of a water body, watercourse, wetland or coastal shoreline area for –

a) ecosystem diversity and habitat value of native flora and fauna;

b) hydraulic capacity for water quality, yield, water table retention, flood flow, and waste water assimilation;

c) economic and utility importance to primary industry, settlement, industrial, irrigation and energy generation purposes;

d) aesthetic and recreational use

Development Standards for the Water and Waterways Code are contained within E12.5.

Proximity to a water body, watercourse or wetland

Objective: Use and development is to have minimum impact on – a) the ecological, economic, recreational, cultural significance, water quality, and physical characteristic of a water body, watercourse or wetland; b) the hydraulic capacity and quality of a water body, watercourse or wetland for ecological viability, water supply, flood mitigation, and filtration of pollutants, nutrients and sediments; c) function and capacity of a water body, watercourse or wetland for recreation activity; and d) aesthetic features of a water body, watercourse or wetland in the landscape	
Acceptable Solution	Performance Criteria
A1 Use or development must – a) not occur within 30m of the shoreline of a water body, watercourse or wetland; or	P1 Use and development minimise likely impact on a water body, watercourse or wetland having regard to –

b) involve any use or development partly or wholly in, over, on or under the water body, watercourse or wetland	e) requirement for access to the water body, watercourse, or wetland in terms of – f) level of disturbance and change in natural ground level, including by cut or fill and modification of a natural drainage channel a i) level of likely risk from exposure to natural hazards of flooding and inundation; viii. community risk and public safety;

Development in a seashore area

Objective: The sea-shore147and coastal environment are protected against likely adverse impact on economic, ecological, scenic, cultural, and recreation values and processes of the coast while facilitating use dependent for operational efficiency on a coastal location.	
Acceptable Solution	Performance Criteria
A1 Development must be – a) development to which section 20(7)(c) and (d) Land Use Planning and Approvals Act 1993 apply; alterations or additions to b) an existing building or work wholly or partly in the sea-shore area; c) risk management, emergency or rescue purposes; or	P1 Use or development must – c) be consistent with any applicable desired future character statement for the zone; i. tidal, wave, current, or sediment movement processes; viii. exposure to or increased risk from a natural hazard, including sea level rise, storm surge, or inundation as a result of climate change; ix. coastal protection and rehabilitation works required to address erosion, instability, regression, or inundation; x. collection, treatment, and disposal of waste, including bilge waters and excavated or dredged sediment;

Contact us

CANBERRA

Level 1, 55 Woolley Street
Dickson ACT 2602

+61 2 6262 7603
sgsact@sgsep.com.au

HOBART

Unit 2, 5 King Street
Bellerive TAS 7018

+61 (0)439 941 934
sgstas@sgsep.com.au

MELBOURNE

Level 5, 171 La Trobe Street
Melbourne VIC 3000

+61 3 8616 0331
sgsvic@sgsep.com.au

SYDNEY

Suite 12, 50 Reservoir Street
Surry Hills NSW 2010

+61 2 8307 0121
sgsnsw@sgsep.com.au

SGS Economics & Planning