Mitigating Natural Hazards *through* Land Use Planning and Building Control

Coastal Hazards Technical Report

1 December 2016

Department of Premier and Cabinet

Tasmanian Government

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Glossary of terms and acronyms

ABCB	Australian Building Codes Board
Actively Mobile Landform	Means as defined in the State Coastal Policy 1996.
AEP	Annual Exceedance Probability is the likelihood of a natural hazard event occurring in a calendar year, generally expressed as a percentage. For example, a 1% AEP event has a one per cent chance of occurring in a year, or once in every 100 years.
AHD	Australian Height Datum
AHO	Australian Hydrographic Office
ANTT	Australian National Tide Tables
AR	Assessment Report
ARI	Average recurrence interval
AS	Australian Standard
CFT	Climate Futures for Tasmania
COAG	Council of Australian Governments
Coastally-dependent use	Are uses which rely on a coastal location to fulfil its purpose.
Coastal erosion (CE)	The removal of coastal material by erosive agents such as waves and currents; for the purposes of this report, coastal erosion refers to both: – erosion occurring in a single erosion event or clusters of events (a 'storm bite') – recession due to the progressive, ongoing retreat of a shoreline due to multiple erosion events over a period of years or decades.
Coastal erosion hazard area	The coastal erosion hazard area is made up of the following bands: **Acceptable:** Based on current understanding of the hazard, coastal erosion is a rare event in this area but it may occur in some exceptional circumstances. **Low:** This area has been identified as vulnerable to a coastal recession by 2100 based on the elevation, soil, or rock type of the area and current SLR models. *Or* This area is protected by coastal defences for erosion. **Medium**: This area is vulnerable to coastal recession to 2050 based on the elevation, soil, or rock type of the area and current SLR models **High**: This area is vulnerable to storm-based erosion from two back to back one percent AEP storm events, this area is potentially an active mobile landform. **Investigation area:** an area adjacent to the coastline for which there is insufficient information to classify it into Acceptable, Low, Medium, or High hazard bands. The width of the area is the cumulative width of the Low, Medium, and High hazard bands. In this area a site specific investigation is required to classify the land into one of the hazard bands.

Coastal inundation (CI)	The temporary or permanent flooding of an area of land within the coastal zone, temporary inundation being a storm tide event influenced by regional storm surge, tides and the effects of climate change (including SLRPA and changes in the likelihood of storm events).
Coastal inundation hazard area	The coastal inundation hazard area is made up of the following bands: *Low*: areas vulnerable to a 1 % AEP storm event in 2100; these areas have a medium-term flooding issue *Medium*: areas vulnerable to a 1% AEP storm event in 2050; the medium band also contains all of the land that will be impacted by a 0.8 m SLR by 2100 *High*: areas that will be within a 0.2 m SLR from the mean high tide line by 2050; these areas are currently impacted by the Highest Astronomical Tide *Coastal Investigation*: areas that are not covered by LiDAR and are below the 10 m contour and within the coastal zone. In this area a site specific survey is required to identify the coastal inundation hazard band level for the locality.
Coastal zone	As defined by the SCP the coastal zone is all land within 1 km of the mean high tide line.
Critical use	Uses required to support a community in disaster response and recovery including hospital and emergency services.
DED	Department of Economic Development (now the Department of State Growth)
DEM	Digital Elevation Model
Development	Means as defined in the LUPAA.
DIER	Department of Infrastructure, Energy and Resources (now the Department of State Growth)
DPAC	Department of Premier and Cabinet
DPEM	Department of Police and Emergency Management (now the Department of Police, Fire and Emergency Management)
DPIW	Department of Primary Industries and Water (now DPIPWE)
DPIPWE	Department of Primary Industries, Parks, Water and Environment
Existing use or development	Established use or development within existing urban growth boundary, including buildings or dwellings located outside established communities. Over time, the redevelopment of existing developments may be considered, which maintains stability in the at-risk population while increasing the capital value of the site. Typically existing use or development can be considered as occurring on urban zoned land.
Fetch	The horizontal distance over which wind blows in generating waves
Greenfield use or development	Greenfield sites are typically located outside of the existing urban growth boundary and may involve the intensification of use. The implication is that greenfield sites may be developed in a way that minimises exposure to known hazards without unreasonable increase in public risk. Typically greenfield use or development can be considered as occurring on non- urban zoned land.
ha	hectare

Hazardous use	Uses involving management of hazardous substances of manifest quality as defined under the *Work Health and Safety Regulations 2012*.
HWM	High Water Mark, being the mean high tide line as defined by Land Information Tasmania.
ICSM	Intergovernmental Committee on Surveying and Mapping
Infill use or development	Development or redevelopment of a vacant or underutilised site situated within the urban growth boundary, with a focus on zone-compliant uses, including new builds, significant redevelopments or renovations and change of use. As with existing use or development, complexities may arise regarding the need to balance private rights with the responsibilities of state and local government. Typically infill use or development can be considered as occurring on urban zoned land.
IPCC	International Panel on Climate Change
km	kilometre
LGA	Local Government Authority
LiDAR	Light Detection and Ranging, a form of remotely sensed imagery and data acquisition that involves the use of laser reflections off the ground and other surfaces to enhance high resolution topographic mapping
LPS	Local Provision Schedule
LUPAA	*Land Use Planning and Approvals Act 1993*
m	metre
mm	millimetre
MHT	Mean High Tide
MHHW	Mean High High Water
MHW	Mean High Water
MHWS	Mean High Water Springs
MNHLUP	Mitigating Natural Hazards through Land Use Planning
Natural hazards	Naturally-occurring hazards include bushfire, flood, earthquake and tsunami, landslide, coastal inundation and erosion. Worldwide, natural hazards are commonly associated with extreme weather and climatic phenomena, with some regions more vulnerable than others to specific hazards. Natural hazards become natural disasters when people's lives and livelihoods are threatened and/or destroyed.
NCC	National Construction Code
NERAG	National Emergency Risk Assessment Guidelines
NSW	New South Wales
NT	Northern Territory
OSEM	Office of Security and Emergency Management, DPAC

Progradation	Seaward growth of the shoreline, resulting from prolonged accretion of sediment.
PWS	Parks and Wildlife Service, DPIPWE
Qld	Queensland
RCP	Representative Concentration Pathway
RMPS	Resource Management and Planning System
SCP	*State Coastal Policy 1996*
SD	Strategic Direction
SHT	Spring High Tide
SLR	sea level rise
SLRPA	Sea Level Rise Planning Allowance
SPIDC	State Planning Interdepartmental Committee
SPP Act	*State Policies and Projects Act 1993*
STCA	Southern Tasmanian Councils Authority
Storm bite	The area of sand 'cut' from a beach and dunes in a storm event.
Storm surge	The temporary piling-up of water at the coast due to onshore wind and/or low barometric pressure.
TCCO	Tasmanian Climate Change Office, DPAC
TEMP	Tasmanian Emergency Management Plan
TP	Tidal Port
TPS	Tasmanian Planning Scheme
TSNDRA	Tasmanian State Natural Disaster Risk Assessment
Wave runup	The vertical distance above mean water level reached by the uprush of water from waves across a beach or up a structure
Wave setup	The increase in water level within the surf zone above mean still water level caused by the breaking action of waves
Works	Means as defined in the LUPAA.
Urban Growth Boundary	Means the area identified for urban development in the regional land use strategies as required by the LUPPA.
Vulnerable use	A vulnerable use involves people who require additional assistance during an emergency including prisons, education centres, respite care, retirement or aged care and visitor accommodation.
WA	Western Australia

Executive Summary

Tasmania's coastal zone is particularly important to the Tasmanian community and the economy, with the majority of Tasmania's population centres and major industries located on or near the coast (ABS 2013). While the majority of these areas are not vulnerable to coastal hazards, those closest to the coast have a heightened vulnerability. This report outlines the assessment of the vulnerability.

Coastal hazards, including erosion and inundation, are the result of natural processes that have the potential to cause considerable damage to communities, industries and infrastructure. These hazards are expected to be magnified by climate change and sea level rise, presenting significant risk to Tasmanian communities and the economy if they are not appropriately managed.

In response to the risks presented by coastal inundation and erosion, the Department of Premier and Cabinet (DPAC) established the *Mitigating Natural Hazards through Land Use Planning (MNHLUP)* project in 2011. The project's objective is to provide a comprehensive framework to mitigate the risks to Tasmanian communities from natural hazards, by implementing a suite of recommended land use planning and building controls.

The *MNHLUP* framework comprises:

- ***a set of principles*** that describes the Tasmanian Government's role in managing natural hazards through land use planning and building controls
- ***a guide*** that outlines the method used to mitigate the risks presented by natural hazards through the land use planning system
- ***specific hazard reports*** that describes:
    - o the approach used to define hazard risk bands
    - o the proposed planning and building controls applicable to each of the hazard bands.

This report is the *Coastal Hazards Technical Report*. It defines hazard bands for erosion and inundation and provides guidance on appropriate mechanisms to mitigate the risks from erosion and inundation through land use planning and building controls.

Through the *MNHLUP* project, indicative mapping has been undertaken to assist in understanding Tasmania's vulnerability to erosion and inundation. This mapping was used to define four distinct hazard bands in order to establish the threshold of risk that coastal hazards present to the Tasmanian Government. The associated hazard matrices provide guidance on the appropriate level of structural intervention required for new developments (through land use planning and building controls), applicable to each hazard band. The mapping discussed in this report is indicative only and subject to a review of Tasmania's sea level rise planning allowances.

This report is available for download from the Department of Premier and Cabinet's Office of Security and Emergency Management at http://www.dpac.tas.gov.au/divisions/osem/coastal_hazards_in_tasmania

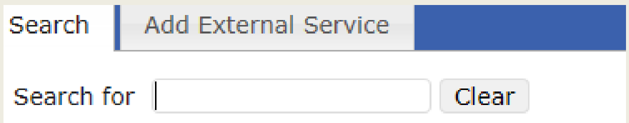
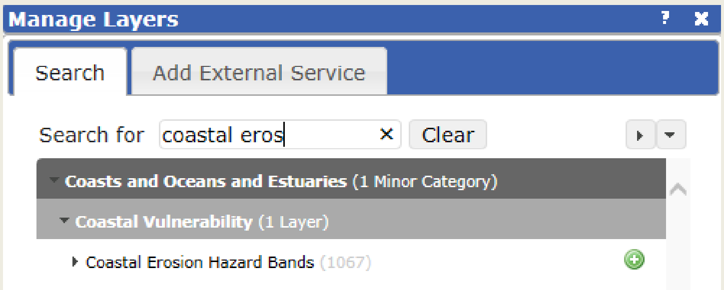
Access to the coastal inundation and erosion mapping

The inundation and erosion maps have been prepared through the *MNHLUP* project and are available through the LIST: www.thelist.tas.gov.au. or through the following bookmark http://bit.do/coastal_tasmania

Coastal hazard layers:

- *Coastal Erosion Hazard Bands 20161201*
- *Coastal Inundation Hazard Bands 20161201*

Instructions to add the coastal hazard layers to LISTmap:

Click on the LISTmap icon in the centre of the LIST home page www.thelist.tas.gov.au	
On the top RHS of the screen, click on 'Layers'	
Click on 'Add Layer'	
Search for the coastal hazard layers	
Add each layer to the map by clicking on the green button 	
Zoom into the area of interest	

1 Introduction

1.1 Background

In 2009, the Council of Australian Governments (COAG) agreed to adopt a nationwide resilience-based approach to disaster management to mitigate the risks that natural hazards present to Australian communities, businesses, infrastructure, economy and the environment. As part of this approach, the Tasmanian Government established the *Mitigating Natural Hazards through Land Use Planning (MNHLUP)* project in 2011.

Managed by the Office of Security and Emergency Management (OSEM) in the Department of Premier and Cabinet (DPAC), *MNHLUP* provides a comprehensive framework to mitigate the risks that natural hazards present to Tasmanian communities – including landslip, riverine flooding, storm events, and coastal erosion and inundation – through a range of land use planning and building control measures.

Through *MNHLUP*, indicative mapping has been developed to facilitate increased understanding of Tasmania's vulnerability to the abovementioned natural hazards. From this mapping, four hazard bands were defined to establish the Tasmanian Government's risk threshold to natural hazards and to guide appropriate land use planning and building controls that consider both present-day and projected future conditions.

The *MNHLUP* framework comprises:

- a set of principles that describes the Tasmanian Government's role in managing natural hazards through land use planning and building controls
- a guide that outlines the method used to mitigate the risks presented by natural hazards through land use planning and building controls
- reports for each of the abovementioned hazards that describe the methodology used to define hazard bands, and propose planning and building controls for managing development within those hazard bands.

This *Coastal Hazards Technical Report* is the final output of the coastal hazards component of the *MNHLUP* framework. More information about the framework and associated methodology is provided in Section 4.

1.2 Purpose and scope

The purpose of this *Coastal Hazards Technical Report* is to guide the development of Tasmanian land use planning codes and building regulations that will mitigate the risks to new development associated with coastal hazards, specifically inundation and erosion. While potentially impacted by coastal hazards, natural, social and historical values are out of scope for this work, however, they are addressed in the planning system through other codes, such as natural values or heritage codes.

This report outlines the methodology used, evidence collected and assumptions made through the project to support a position on Tasmania's risk tolerance to coastal hazards. This risk tolerance is expressed through the four hazard bands (*acceptable, low, medium* and *high*) and the hazard matrices, which provide guidance on the level of intervention for new developments (land use planning and building controls) that are appropriate to each hazard band.

This report will provide Tasmanian Government agencies and local government with greater confidence in the appropriate management of coastally located infrastructure and assets, and support coastal communities in appropriately responding to coastal hazards. It will also help environmentally focused agencies and emergency service providers to gain a greater understanding of the evolving threat that coastal hazards present in Tasmania, projected out until 2100.

The report includes:

- a statewide vulnerability assessment of communities[1] at risk from coastal hazards;
- an analysis of the management of public risk; and
- recommended controls to mitigate the risks of coastal hazards.

For the purposes of this report, *coastal zone* is defined as all land to a distance of 1 km inland from the high-water mark (HWM). This is consistent with the definition provided in the *State Coastal Policy 1996* (SCP).

This report is not intended as a review or commentary on existing policies, codes, regulations or legislation that relate to the management of the Tasmanian coastline.

The land use planning and building controls outlined in this report are proposed for new developments and, as such, should not be viewed as guidance for adaptation planning for existing settlements in coastal areas.

1.3 Report structure

This *Coastal Hazards Technical Report* is structured as follows:

Section 1 provides a summary of *MNHLUP* project background and the associated framework for the mitigation of natural hazards. It also outlines the purpose and scope of this report.

Section 2 defines coastal hazards for the purposes of this report and provides an overview of Tasmania's vulnerability to those hazards.

Section 3 reviews how coastal hazards are managed in Tasmania through land use planning and building controls and provides an overview of how coastal hazards are managed in other Australian jurisdictions.

Section 4 sets out the methodology of the framework for the mitigation of natural hazards through land use planning and building controls.

Section 5 outlines the approach to the management of public risk in the context of coastal hazards.

Section 6 applies the framework to **coastal erosion**, including the technical research that forms the basis of the indicative coastal erosion maps now available through the LIST. It explains the method used to define the *Coastal Erosion Hazard Bands* (Hazard Bands) that represent the levels of coastal erosion vulnerability (*acceptable, low, medium, high*) in different areas of Tasmania. The final part of the section provides guidance on how the impact of coastal erosion can be managed through the application of planning and development systems to new developments.

Section 7 applies the framework to **coastal inundation**, including the indicative mapping of inundation areas based on storm tide and the endorsed Sea Level Rise Planning Allowances (SLRPAs) for 2050 and 2100. Indicative maps of the Bands are available on the LIST. The Hazard Bands represent the levels of coastal inundation risk (*acceptable, low, medium, high*) in different areas. The final part of the section provides guidance on how the impact of coastal inundation can be managed through the planning and development systems to new development.

[1] Assessed through the number of residential buildings or private landholdings impacted

2 Coastal hazards in Tasmania

2.1 What are coastal hazards?

The coast is a dynamic system, shaped by wave, wind and tidal movements. Influenced by weather patterns, seasonal variations and climate change, these processes can have a temporary or permanent influence on the coastline. When natural processes lead to erosion and inundation that threaten to cause harm or damage to public and private assets, environmental and/or social values, the processes are described as hazards. Human modification to coastlines can also influence the way in which natural processes play out along the coast, adding to or reducing hazards within an area. This report considers the hazards of coastal erosion and inundation[2].

The relationship between coastal erosion and coastal inundation is complex and difficult to assess without a localised technical investigation. For this reason, the hazard assessments in this report address coastal erosion and coastal inundation separately. However, as the outcomes (treatments) of the hazard assessments are implemented through land use planning and building controls, the controls are integrated.

The hazard assessments and treatments are developed by assessing the public risk associated with the vulnerability of land to coastal hazards. Vulnerability is assessed by quantifying the potential frequency of an event or by defining areas that are susceptible to coastal hazards and assessing the potential consequences of the event. Once the vulnerability is understood, governments should only intervene to ensure that private investment minimises unacceptable public risk. Public risk is closely associated with the economic concept of 'externalities', which are the costs or benefits of a development that are experienced by the broader community.

2.1.1 What is coastal erosion?

Coastal erosion is the removal of coastal land by water, wind and general weather conditions. There are three aspects of coastal erosion: hazardous erosion, recession and landslide (Page and Thorp 2010).

- *Hazardous coastal erosion* is short-term (typically single-storm) erosion of sandy and other soft shorelines causing immediate hazards for people and infrastructure or other hazards. This are may contain the land can be considered the "Actively Mobile Landform" for the purpose of Clause 1.4.2 of the SCP.
- *Coastal recession* is the long-term retreat of a shoreline due to multiple erosion events in sandy or other soft shores. Coastal recession may occur for a variety of reasons, but is expected to become more prevalent in response to ongoing sea level rise (SLR).
- *Landslide* is the downslope movement of land. On the coast landslide is typically caused by the removal of material at the toe of the landslide due to wave or storm activity. Landslide within the coastal zone is addressed as part of the *MNHLUP* landslide hazard planning report (DPAC 2013).

Coastal erosion has many drivers and factors including tides, currents, sediment budgets, storm intensity and frequency, wave energy, fetch, SLR, land erodability, and human intervention. There is considerable variation in wave climates across the Tasmanian coastline, and rising sea levels can trigger a non-linear change to the sediment budget of beaches. Although the loss of sand naturally occurs on shores due to erosion, it may accelerate with changes in sea levels (Sharples 2006).

Due to the complexity of understanding and modelling all of the drivers and factors that contribute to coastal erosion, an assessment has been made based on the relative susceptibility of land to erosion and the likely rate of erosion. In some areas this assessment has not been able to be made, these areas have been identified as investigation areas and require site specific consideration.

2 Oil or chemical spills that impact the coastline are managed by Tasmania's Environment Protection Authority (EPA 2015)

2.1.2 What is coastal inundation?

Coastal inundation is the natural process of flooding of land by the sea. Coastal Inundation can be caused by storm surge, extreme storm events, floods, tides, tsunamis and changes in sea level.

For the purpose of this report, coastal inundation is classified as either temporary or permanent:

- *temporary inundation* is flooding due to storm surge, extreme storm events, floods or tides, typically measured as Annual Exceedance Probability (AEP)[3]
- *Permanent inundation* is usually the result of SLR, and is measured from the Mean High Tide (MHT) mark.

While riverine flooding and tsunami are significant contributors to coastal inundation, these phenomena are the focus of other work, including riverine flood assessments and emergency management plans for tsunami. It is important to note that the indicative coastal hazard mapping delivered through *MNHLUP* does not address the relationship between coastal inundation and riverine flooding in estuaries. This work, while critical to our understanding of flooding, is beyond the scope of the project. In some areas sufficiently accurate elevation data is not available to map the heights, these areas have been identified as investigation areas. In the investigation areas a site specific survey is required to define the hazard bands.

2.1.3 Sea level rise planning allowance

Climate change projections indicate that SLR is likely to increase the frequency and severity of coastal inundation in Tasmania. To allow for SLR in planning decisions, the Tasmanian Government implemented statewide SLRPAs in August 2012 to promote consistent decision-making concerning future land use and development, and reduce the level of uncertainty around the management of future SLR for coastal areas. The rationale for the 2012 SLRPAs is described in the Derivation of the Tasmanian Sea Level Rise Planning Allowance – Technical paper, released by the Department of Premier and Cabinet (DPAC)'s Tasmanian Climate Change Office (TCCO) in August 2012.

In March 2016, the Tasmanian Government engaged the Commonwealth Scientific and Industrial research Organisation (CSIRO) to develop SLRPAs Tasmania's coastal councils based on the International Panel on Climate Change (IPCC)'s Fifth Assessment Report (AR5). This has provided regional appropriate change to the SLRPAs from the previous level of 0.8 m by 2100 for all of Tasmania to between 0.92 m by 2100 in the North East of Tasmania to 0.82 m by 2100 in the Central North Coast. These projections are based on the IPCC AR5's high emissions, 'business-as-usual' scenario, known as Representative Concentration Pathway 8.5, or RCP 8.5 (McInnes et al 2016). Appendix 9 provides the LGA specific figures.

The SLRPA promotes consistent decision-making in future land use and development and strategic settlement planning by reducing the level of uncertainty around the management of future SLRs in coastal areas.

SLR and climate change are likely to increase the frequency and severity of coastal inundation (McInnes et al 2011). As such, the SLRPAs are applied at the level to which climate change is incorporated into adaption planning (for example, the height to which coastal defences are constructed). In addition, the SLRPAs have been incorporated into inundation and erosion modelling through the calculation of recession rates for erosion, the uplift in storm surge heights and the MHT level for inundation.

3 See *Glossary of terms and acronyms*

2.1.4 Coastal hazard exposure in Tasmania

Tasmania has 6 400 kms of coastline[4], emphasising the importance on coastal regions for their economic, social and environmental contributions to the State. No place in Tasmania is more than 115 km from the sea. The majority of the state's population centres and major industries are located on or near the coast (ABS 2013), which means there is significant exposure to risks from coastal hazards.

Of Tasmania's approximately 185 000 residential houses, almost half (~91000) are within 1 km of the mean HWM considered the 'coastal zone' under the SCP. The cost of losses due to coastal hazards is largely unknown, as most of it is borne by private landowners or built into the maintenance budget for state infrastructure, including roads, rail and utilities.

Projections on extreme tide and sea level events undertaken as part of the *Climate Futures for Tasmania* project show that SLR means that a 1% AEP event will occur between 15 and 100 times more often by the year 2100 (McInnes et al 2011).

The indicative mapping completed as part of the coastal hazards component of *MNHLUP* uses residential houses as an indicator of human settlement vulnerability to coastal erosion and inundation, both at present-day and to 2100. Impacts on other infrastructure, such as roads, have not been assessed as part of this work.

The coastal erosion mapping indicates that:

- In 2010, 734 houses were potentially vulnerable to storm bite (the area of land removed due to storm-based erosion), represented by the High hazard area.
- By 2050, an additional 1 334 houses (2 068 houses in total) are projected to be vulnerable to coastal recession, represented by the Medium hazard area.
- By 2100, an additional 1 720 houses (3 788 in total) are projected to be vulnerable to coastal recession, represented by the Low hazard area.
- A further 814 houses are within the investigation areas where there is insufficient information for a full classification.

The coastal inundation mapping indicates that inundation issues will worsen as this century progresses.

- In 2010, 85 houses were potentially vulnerable to a SLR to 2050 from the 2010 MHT represented by the High hazard area.
- By 2050, an additional 1 288 houses (1 373 houses in total) are projected to be vulnerable to a 1% AEP storm surge event or a 0.8 m SLR from the 2010 MHT, represented by the Medium hazard area.
- By 2100, an additional 1 779 houses (3 152 houses in total) are projected to be vulnerable to a 1% AEP storm surge event, represented by the Low hazard area.
- A further 357 houses are within the investigation areas where there is insufficient information for a full classification.

Based on the indicative mapping, the High hazard bands for inundation and erosion identify 779 houses as potentially vulnerable. Of those, 40 houses are identified as being in the High hazard bands for both erosion and inundation. Half of these houses are located in Ansons Bay (Break O'Day Council), with the remainder spread throughout the South.

4 Based on 1:25000 scale shoreline mapping including the Bass Strait islands

3 Regulatory and policy context

3.1 Resource management and planning system

Land use planning in Tasmania is guided by the Resource Management and Planning System (RMPS), which was established in 1993. The promotion of sustainable development is one of the key objectives of RMPS, which are included as schedules in each of the three pieces of legislation that comprise RMPS, namely:

- the *Land Use Planning and Approvals Act 1993 (LUPAA)*
- the *State Policies and Projects Act 1993 (SPP Act)*
- the *Tasmanian Planning Commission Act 1997.*

For the purpose of RMPS, 'sustainable' is defined as:

> … *managing the use, development and protection of natural and physical resources in a way, or at a rate, which enables people and communities to provide for their social, economic and cultural wellbeing, and for their health and safety, while:*
> - *sustaining the potential of natural and physical resources to meet the reasonable foreseeable needs of future generations;*
> - *safeguarding the life-supporting capacity of air, water, soil and ecosystems; and*
> - *avoiding, remedying or mitigating any adverse effects of activities on the environment.*

RMPS objectives inform land use planning instruments at the state, regional and local levels through state polices, regional land use strategies and planning schemes. The planning schemes include special area plans, local provisions (including zones and planning code overlays), regional provisions and state-based planning codes or zone requirements. The zoning of the land should ensure that the strategic capacity of the land is considered so that new use and development that is consistent with the zone requirements with minima

3.2 State Coastal Policy 1996

State policies are prepared in accordance with the SPP Act and represent the Tasmanian Government's policy position on sustainable development. They may contain matters relating to: sustainable development of natural and physical resources; land use planning; land management; environmental management; environment protection; or any other matter that may be prescribed.

The primary instrument guiding coastal planning in Tasmania is the SCP. The SCP is a statutory document, sitting between the provisions of legislation and the provisions of planning schemes and other mechanisms identified in the legislation that comprises the RMPS. The SCP applies to the whole of Tasmania and includes all islands except Macquarie Island, which is subject to a special management regime. The State Policy on Water Quality Management 1997 also applies to the coastal zone, providing a framework for the development of ambient water quality objectives and the management and regulation of point and diffuse sources of emissions to surface waters (including coastal waters) and groundwater5.

The SCP is guided by three principles:

1. The natural and cultural values of the coast shall be protected.
2. The coast shall be used and developed in a sustainable manner.
3. Integrated management and protection of the coastal zone is a shared responsibility.

[5] http://epa.tas.gov.au/policy/water-quality-policy

While the SCP addresses both management and statutory planning issues, it was developed before the implications of climate change and SLR were fully understood. Current SCP natural hazards provisions are detailed in *Table 1*.

Table 1 *Coastal hazards outcomes (State Coastal Policy, 1996)*

1.4.1	*Areas subject to significant risk from natural coastal process and hazards such as flooding, storms, erosion, landslip, littoral drift, dune mobility, and sea level rise will be identified and managed to minimise the need for engineering or remediation works to protect land, property and human life.*
1.4.2	*Development on actively mobile landforms such as frontal dunes will not be permitted except for works consistent with Outcome 1.4.1.*
1.4.3	*Policies will be developed to respond to the potential effects of climate change (including sea level rise) on use and development in the coastal zone.*

Application of SCP 1996 in the Coastal Hazards Report

In relation to the SCP's outcome 1.4.1 and 1.4.2, this Report applies a risk management methodology (Section 4) to identify the areas at significant risk from coastal processes and hazards. The Macquarie Dictionary definition of 'significant' as 'important or of consequence' has been applied. The concept of risk is discussed extensively in Sections 4 and 5. The identification of areas subject to significant risk is outlined in Sections 6 and 7 for coastal erosion and inundation respectively.

In relation to SCP's outcome 1.4.3, this Report spatially defines the high, medium and low hazard bands using projections in relation to SLR, regional storm surge and erosion.

The Coastal Erosion High Hazard band identifies areas that are 'actively mobile landforms' for the purpose of SCP clause 1.4.2.

This Report proposes controls to meet the outcomes of SCP clauses 1.4.1 by applying a risk methodology to define areas at a significant enough risk from natural coastal processes (Low, Medium and High hazard bands) to require treatment.

This Report also proposes outcomes in the Coastal Erosion High band that are not completely consistent with SCP Clause 1.4.2. The authors of the report have been advised that while the coastal erosion high hazard band could be considered to contain the 'actively mobile landforms' noting that this open to be tested as the SCP does not define what an actively mobile landform is. Furthermore, where the outcomes in this Report are not consistent with SCP clause 1.4.2 then the statutory instrument (such as a Coastal Erosion Hazard Code) must comply with the SCP over the outcomes of this Report. For example, in the coastal erosion high hazard band if a development is on a Actively Mobile Landforms it is not permitted unless it is for engineering or remediation works to protect land, property and human life.

More detail is provided in S*ections 4 to 7* of this Report.

3.3 Regional strategies and planning

The *Regional Planning Initiative*, a collaboration partnership between the Tasmanian Government and Local Government Authorities (LGA), is a significant element of the Tasmanian planning system. Since 2008, the *Initiative* has introduced regional strategic planning as the foundation of new planning schemes across the State.

The Initiative consists of three regional land use planning strategies, established through agreements between the Tasmanian Government, the three regional council authorities and the respective LGAs:

- ***Cradle Coast Framework*** sets out the principles that guide the development of the regional strategies and plans that include or are consistent with RMPS objectives, planning directives, state policies and projects of state significance. Under the framework, the strategies and regional plans seek to *"direct places where people live and work from areas where there is an unacceptable level of risk for the health and safety of people, property, and the environment from natural or man-made hazards."*

- *Northern Regional Land Use Planning Framework* sets out the principles that underpin policy development and focus on the desired outcomes of the Framework, including to "*provide outcomes which collectively reflect* … [and] … *ensure investors and decision-makers have a clearly defined framework within which to make decisions."* Principles are articulated into strategies and policies specifying that "*land designated for housing, industry, community and infrastructure services must not be located within or adjacent to areas which that are vulnerable to an unacceptable level of risk including coastal inundation, landslip, flooding or contaminated land*." Strategies to be promoted for the reduction of risk from natural hazards include:
    - ensuring that new areas zoned for residential, commercial and community purposes are not within areas identified as high risk
    - identifying hazard areas to include the likely impacts of climate change, such as SLR, storm surge, increased temperatures and intense/extreme rainfall events
    - reducing the risk of loss of life and property by avoiding development on land that has been identified as subject to a high risk of landslide, bushfire, sea inundation and flooding
    - where avoidance of hazards is not possible, or the level of risk is deemed acceptable, ensuring best practice construction and design techniques and management practices are implemented. If required, plan for retreat in vulnerable areas.
- *Southern Tasmanian Regional Land Use Strategy* sets strategic directions that are implemented through more detailed regional policies. As an example, the strategic directions (SD) that form part of the response to natural hazards include:
    - adopting a more integrated approach to planning and infrastructure (SD1)
    - holistically managing residential growth (SD2)
    - increasing responsiveness to our natural environment, including a risk approach to natural hazards, recognising that future developments and use will not be able to avoid hazards, and that spatial information is critical when developing settlement strategies (SD6)
    - creating liveable communities (SD10).

The regional land use strategies are statutory instruments, declared by Tasmania's then Minister for Planning on 27 October 2011. All new planning schemes, planning scheme amendments or projects of regional significance must accord with the initiatives and recommendations contained in the strategies.

3.4 Local government planning

Local government management of coastal hazards prior to implementation of the *Regional Planning Initiative* demonstrates a range of responses to coastal hazards: the planning schemes were developed and updated from 1979 to 2007. Since 2012, three regional model schemes and interim planning schemes have been progressively declared by the Minister responsible for planning.

3.4.1 Pre interim planning schemes

In the period prior to the development of interim planning schemes, planning schemes considered flooding (as applied to the coast) or erosion to different extents. The extents to which coastal hazards were considered were reflective of development pressures associated with the coastal zone and the level of concern that coastal hazards presented to each LGA. A review of each LGA's controls is provided at *Appendix 3.*

There are three types of triggers for assessment: the first is an arbitrary distance from the high-water mark or the spring high tides (SHTs); the second method uses a 1% AEP level; and the third does not provide guidance on where flooding can occur. The triggers act in two ways:

- to cause a development to become discretionary so that the impact of coastal hazard is assessed
- to define the minimum floor height in the areas vulnerable to coastal hazards.

The provisions and standards show two different approaches to coastal hazards. The first uses an arbitrary floor height as proxy for an acceptable standard to manage coastal hazards. The second approach uses a risk-based methodology that asks the proponent to demonstrate where a high, medium or low risk is located, and how an acceptable or tolerable risk can be achieved. In doing so, the application must demonstrate (typically through expert reports) how the development will be safe, be able to resist or recover from an event, and not have an unreasonable impact on neighbouring properties through increasing flooding or erosion.

The combination of the triggers, provisions and standards produces some overlap with the controls in the building regulations, with different minimum floor heights and requiring the developer to demonstrate that the development will not increase the risk of flood or erosion to neighbouring properties.

Figure 1 provides a summary of triggers, provisions and standards, and shows the duplication with building controls.

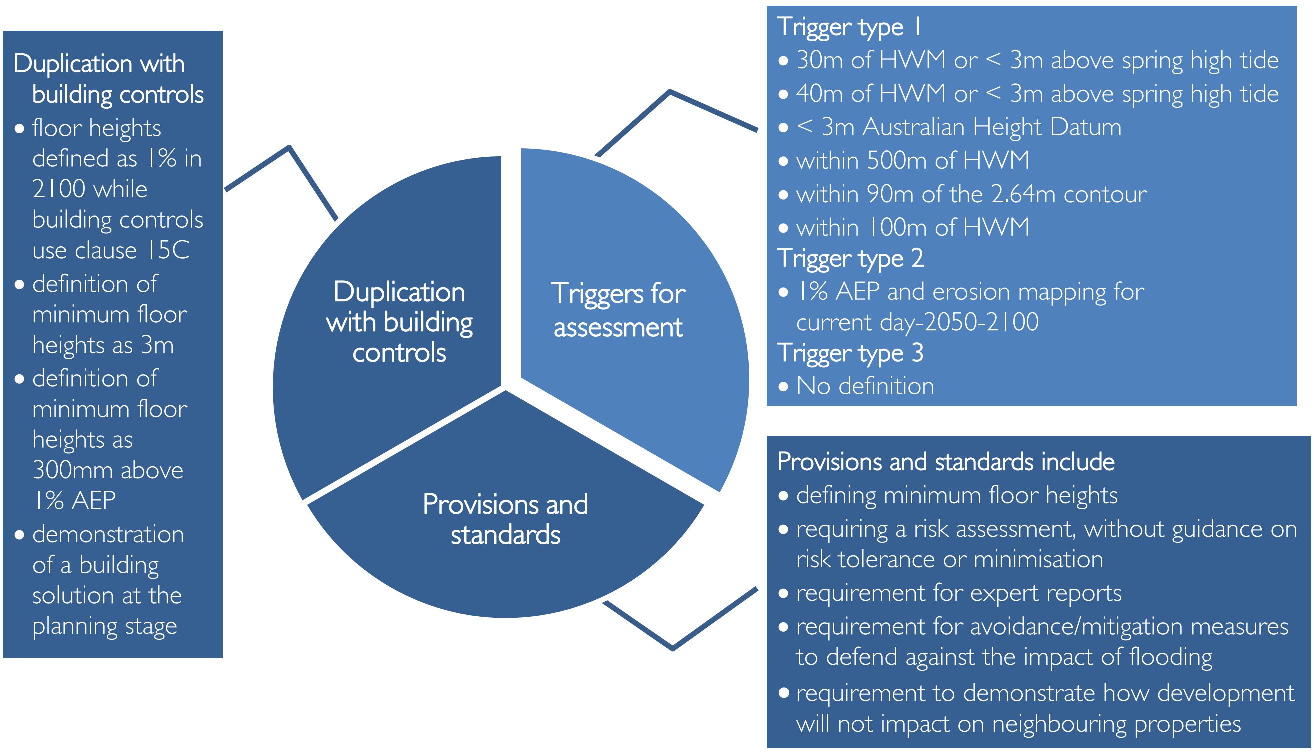


Figure 1 *Pre interim planning scheme response to coastal hazards*

3.4.2 Interim planning schemes

The interim planning schemes take three different approaches to the management of coastal hazards. All of the schemes were required to translate the pre interim planning scheme zones into the interim planning schemes. As a result, limited consideration has been given to whether the zones reflect the capacity of the land in the context of coastal hazards.

The schemes apply a risk-based approach, seeking acceptable or tolerable risk as an outcome, noting that:

- *Cradle Coast Interim Planning Schemes* have a 'Hazard Management Code' to address all hazards other than bushfire. This applies to all land identified on a map within the planning scheme as vulnerable to coastal erosion or coastal inundation. The Code requires a hazard management report (including risk assessment) to define the level of risk for the use or development and demonstrate how that risk will be mitigated.
- *Northern Interim Planning Schemes* have a 'Coastal Code' that responds to coastal inundation and the management of the coastal environment. The Code is activated through a spatial overlay, primarily seeking to regulate sensitive uses or modify the form of development for other development types if affected by inundation. Most development in this area is discretionary, unless it is a boatshed or for recreational purposes, and must demonstrate how impact on the coastal environment will be minimised, having regard for a range of factors.
- *Southern Interim Planning Schemes* have an 'Inundation Prone Areas Code' and a 'Coastal Erosion Hazard Code'. Codes are activated by coastal inundation and erosion mapping that define high, medium and low inundation areas.
    - The Inundation Prone Areas Code is provided to manage areas at risk from inundation. Typical controls require habitable floors to have a level above the 1% AEP in 2100, or a floor area of less than 40 m^2. New subdivisions can only be created if the access, building area and services are outside the high and medium hazard areas.
    - The Coastal Erosion Hazard Code is intended to reduce the risk to people, infrastructure or the environment in areas vulnerable to coastal erosion. Changes in use are required to demonstrate that such use can occur safely. Development controls address building and works, coastal-dependent development and subdivision. The controls seek a tolerable level of risk, no interference with coastal process, and no over-reliance on coastal defences.

3.4.3 Tasmanian Planning Scheme

The Tasmanian Planning Scheme (TPS) will replace the interim planning schemes outlined in Section 3.4.2. In addition to the 29 planning zones, the TPS has 15 codes that include coastal inundation and coastal erosion. the TPS is applied through the Local Provision Schedules (LPS). The TPS provides a consistent approach to coastal inundation and erosion across the State, while still providing the necessary flexibility to address local issues through the LPS.

Local planning authorities must use, at a minimum, the coastal inundation and erosion hazard mapping developed in this report as the statewide codes spatially in the overlay maps. The LPS provides Local Planning Authorities to seek amendment to the coastal inundation or erosion mapping by making an application for amendment to the Tasmanian Planning Commission. An amendment to the State mapping in the LPS should demonstrate amendment meets the intent and standards of the State mapping, while using locally specific information or an improved modelling method, and has been peer reviewed.

The development of the TPS codes has been coordinated with the development of new Building Regulations for Coastal Inundation and Erosion.

3.5 Building Act 2000

The *Building Act 2000* and *Building Regulations 2014* incorporate coastal inundation in provisions relating to land subject to flooding. Under the Regulations, the floor height of habitable rooms must be 300 mm above the designated flood level.

Under Regulation 15 of the *Building Regulations 2014*, the following is defined as the designated flood level:

> *(a) 600 mm above ground level or the highest known flood level, whichever is the highest, for land known to be subject to flooding other than as provided in paragraph (b), (c) or (d);*
>
> *(b) the level which has a one per cent probability of being exceeded in any year for 10 stipulated floodplains;*
>
> *(c) 600 mm above the ordinary high-water mark of the spring tide for land on which flooding is affected by the rise and fall of the tide; and*
>
> *(d) in respect of a watercourse floodplain not mentioned in paragraph (b), a level that, according to a report adopted by the relevant council, has a one per cent probability of being exceeded in any year.*

Clause C of the *Regulations* defines the designated flood area for the coast, noting that the *"ordinary high-water mark of the spring tide"* does not appear to have a legal or technical definition. In 2003, however, a working group of the Intergovernmental Committee on Surveying and Mapping (ICSM) compiled a compendium of tidal terms (ICSM 2003). When interpreted in conjunction with the *Australian Tides Manual Special Publication 9 Version 4.3*, ICSM (2003) suggests that the *"ordinary high-water mark of the spring tide"* is equivalent to the *"Mean High Water Springs"* (MHWS) or *"Mean High High Water"* (MHHW) (ICSM 2003: 31). The MHWS or MHHW are dependent upon location, due to variations in sea surface topography.

The Australian Hydrographic Office (AHO) maintains a series of summaries for Standard Ports and Secondary Ports[6] in the Australian National Tide Tables (ANTT). These summarise the relationship between chart datum, mean sea level, the Australian Height Datum (AHD) or applicable local height datum, and MHWS/MHHW. This information is subject to amendment as new measurements are performed.

Table 2 summarises the MHWS/MHHW derived from Tasmanian ANTT port records provided by the AHO (see *Appendix 3*). The Table shows the way in which final minimum floor levels are calculated to meet the requirements of Section 15(c) of the *Building Regulations 2014*. This calculation (including a review of the ANTT) must be undertaken for each development.

Table 2 *Minimum floor levels – Building Regulations 2014*

			Building Regulations 2014 – Clause 15(c) (heights in m AHD83-TAS*)		
Port	ANTT Tidal Port (TP) Number	Tidal Port Version	MHWS (MHHW) (rounded up to nearest 0.1m)	Designated Flood Height (+600mm)	Minimum Floor Level (+300mm)
Stanley	60900	28/11/2006	1.3	1.9	2.2
Burnie	60910	11/06/2009	1.3	1.9	2.2
Mersey River (Devonport)	60930	01/09/2006	1.3	1.9	2.2
Low Head	60948	04/04/2008	1.3	1.9	2.2
Spring Bay (Triabunna)	61170	12/06/2009	0.6	1.2	1.5
Hobart	61220	29/07/2009	0.7	1.3	1.6
Currie[7]	60827	22/09/2008	0.9	1.5	1.8

[6] http://www.bom.gov.au/oceanography/projects/ntc/NTC_glossary.pdf

[7] AHD is not available on the Bass Strait Islands: local height datums apply: http://dpipwe.tas.gov.au/land-tasmania/geospatial-infrastructure-surveying/geodetic-survey/coordinate-height-and-tide-datums-tasmania

3.6 How other states have responded to coastal hazards

Management of coastal hazards cuts across all Australian jurisdictions, with the exception of the Australian Capital Territory. A summary of jurisdictional coastal hazard responses is provided below.

Australian Government

The Australian Government has no direct legislative power over the coastal zone: this has traditionally resided with the states. The Australian Government does, however, have some influence over coastal management through funding, national plans and policies, and in the provision of supporting information, data and tools. Data and mapping initiatives delivered by the Australian Government include SLR mapping, the National Elevation Data Framework, Smartline Geomorphic mapping, and investment in climate change projections and information. The Australian Government has funded a *Coastal Adaptation Pathways* program and recently provided funding to the National Climate Change Adaptation Research Facility to develop a coastal climate risk decision support tool, which is due for release in 2017.

New South Wales

The New South Wales (NSW) Government is conducting a two-stage reform of its coastal legislation and policy. As part of this process, the *Coastal Protection Act 1979 (NSW)* has been amended to allow landowners to undertake temporary coastal protection works and lodge development applications for other protection works to reduce erosion impacts. NSW no longer has SLR planning benchmarks, but the Government does provide relevant data on climate projections that include SLR. The benchmarks were removed to allow councils greater flexibility around planning for coastal hazards. The NSW Government is preparing guidelines to assist local government to disclose SLR information on planning certificates. The second stage of the reform process will include the development of a simpler, more integrated legal and policy framework for coastal management. This will also identify potential funding options, particularly to implement coastal asset management strategies[8].

Northern Territory

The Northern Territory (NT) has a statewide planning scheme that restricts development in areas considered vulnerable to storm surge. Vulnerability is determined based on hazard mapping undertaken by the NT Government. The planning scheme notes two types of storm surge areas: primary areas, which are vulnerable to a 1% AEP event; and secondary areas, which are vulnerable to a 0.1% AEP event. In primary areas, development consent is required and is limited to open space, recreation, non-essential public works and short-stay tourist camping/caravan areas. In secondary areas, the scheme expands to include industrial and commercial uses. Avoiding residential uses, strategic and community services in both zones is recommended[9].

Queensland

The Queensland (Qld) Government is undertaking work to reintroduce coastal planning laws and hazard mapping that includes SLR projections. In 2014, a single *State Planning Policy* came into effect as the predominant policy under the *Sustainable Planning Act 2009 (Qld)*. The Policy requires local councils to identify coastal hazard areas and avoid or mitigate coastal hazard risks to communities. Under the *Coastal Protection and Management Act 1995 (Qld)*, areas subject to coastal hazards may be declared coastal management districts if the Minister considers there is a need for special protection or management. Areas within a coastal management district may be triggered for development assessment under the *Sustainable Planning Act 2009 (Qld)*[10].

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[8] NSW Office of Environment and Heritage http://www.environment.nsw.gov.au/coasts/stage1CoastRefQaA.htm
[9] NT Dept Lands Planning & the Environment http://lands.nt.gov.au/planning/system
[10] QLD Dept Infrastructure, Local Gov & Planning http://www.dsdip.qld.gov.au/about-planning/state-planning-policy.html

South Australia

South Australia's *Policy on Coast Protection and New Coastal Development*, developed in 1991, adopts an SLRA of 0.3 m by 2050 and 1.0 m by 2100. The Policy requires building sites for new development to be 0.3 m above the 1% AEP interval with a local adjustment, where appropriate, for land subsidence or uplift to the year 2050. For commercial or habitable buildings, floor levels should be at least 0.25 m above that minimum site level. In addition, development should not be approved unless it is capable of, by reasonably practical means, being protected or raised to withstand a further 0.7 m SLR.[11]

Victoria

The *Victorian State Planning Policy Framework (SPPF)* highlights the need to coordinate land use and planning with the requirements of the *Coastal Management Act 1995 (Vic)* and the *Victorian Coastal Strategy*. The *SPPF* includes a SLR planning allowance of 0.8 m by 2100. It also specifies that in planning for possible SLR, an increase of 0.2 m over current 1% AEP flood levels by 2040 may be used for new development in close proximity to existing development (urban infill). This policy applies to development proposals in existing settlements and urban-zoned areas. *Planning Practice Note 53: Managing Coastal Hazards and the Coastal Impacts of Climate Change* provides local government with guidance for the management of coastal hazards, the decision-making process for assessing coastal hazard risk, and planning for development in coastal areas.[12]

Western Australia

Western Australia (WA) has a SLR planning benchmark of 0.9 m by 2110, which is contained in the *State Coastal Planning Policy*. The WA Government of Western Australia developed *Coastal Hazard Risk Management and Adaptation Planning Guidelines* in September 2014 to assist statutory decision-makers to evaluate the risks from coastal hazards and identify pragmatic adaptation responses.[13]

[11] SA Department of Planning, Transport & Infrastructure, http://www.dpti.sa.gov.au/planning/home

[12] Victorian Government Department of Transport, Planning and Local Infrastructure, http://www.dtpli.vic.gov.au/planning/about-planning

[13] Western Australian Government Department of Planning, http://www.planning.wa.gov.au/publications/1168.asp

4 Methodology

The *National Strategy for Disaster Resilience* *(2011)* identifies the need for collective responsibility in the management of natural hazards:

> *Australian Governments have recognised that a national, coordinated and cooperative effort is required to enhance Australia's capacity to withstand and recover from emergencies and disasters. A disaster-resilient community is one that works together to understand and manage the risks that it confronts. Disaster resilience is the collective responsibility of all sectors of society, including all levels of government, business, the non-government sector and individuals. If all these sectors work together with a united focus and a shared sense of responsibility to improve disaster resilience, they will be far more effective than the individual efforts of any one sector*.

The *Strategy* outlines the role of government as:

- developing and implementing effective, risk-based land management and planning arrangements and other mitigation activities
- having effective arrangements in place to inform people about how to assess risks and reduce their exposure and vulnerability to hazards
- having clear and effective education systems so people understand what options are available and what the best course of action is in responding to a hazard as it approaches
- supporting individuals and communities to prepare for extreme events
- ensuring the most effective, well-coordinated response from our emergency services and volunteers when disaster hits
- working in a swift, compassionate and pragmatic way to help communities recover from devastation and to learn, innovate and adapt in the aftermath of disastrous events.

In setting out the risk assessment process for planning and building controls in Tasmania, *MNHLUP* applies the *Strategy* in a Tasmanian context, and is consistent with *AS/NZS ISO 31000:2009 Risk Management - Principles and guidelines*, and the *National Emergency Risk Assessment Guidelines (2014)*.

4.1 The MNHLUP Framework

The Framework includes:

- a set of **Principles** for the mitigation of natural hazards through land use planning and building controls (the Principles), and
- a **Guide** for the mitigation of natural hazards through planning and building controls (the Guide), which outlines how the Tasmanian Government translates RMPS objectives with the SCP in defining areas of significant risk.

The Principles establish the context for risk treatment representing an ideal outcome and are as follows:

- ❖ Private risks associated with natural hazards are the responsibility of individuals and businesses.
- ❖ Governments should encourage public and private risks to be factored into investment decisions.
- ❖ Governments can support individuals and businesses to understand and manage private risks through the collection of evidence, provision of information, and facilitation of collective action.
- ❖ Governments should ensure that private investment minimises unacceptable public risk.
- ❖ Governments should avoid investment, regulation or policy that gives rise to unacceptable public or private risks.
- ❖ Governments should have regard to, and support individuals and businesses to consider, how natural hazards may change in the future, including through climate change.

The Guide builds on the Principles by setting out a risk assessment process for translating evidence and policy on natural hazards into strategic land use planning decisions and building controls for defined hazard bands. It:

- Establishes a reasonable balance between the productive and sustainable use of land and the protection of the community from the costs associated with natural hazards
- Promotes the ownership of private risks by an individual or business
- Ensures that the potential impact of a hazard is identified early in the decision process when considering a development (and potentially in the transfer of land)
- Assists government at all levels to inform/educate the community, industry and officials about the nature of hazards
- Clarifies the approach to managing both public and private risks
- Assists the prioritisation of investment in research and mitigation of natural hazards by individuals, businesses and governments
- Facilitates collective action by landowners
- Enables governments to identify and avoid actions that give rise to unacceptable public and private risks to the community
- Assumes that the hazard will occur at any point in time in the landscape, with the process describing its relative likelihood
- Considers the treatment of the risk based on the new use or development, with the treatment being the level of intervention to reduce the potential consequence to tolerable levels.

The Guide outlines the **hazard treatment approach** to undertaking coastal hazard assessment. The hazard treatment approach is one of four methods of managing risks from natural hazards that arise from the development and use of land (*see Box 1*).

Box 1 *Approaches to mitigating natural hazards (Guide 2012)*

Risk-based

Government defines risk tolerance

Development considered on the basis of government risk assessments at regional or local levels

Emergency Management

Based on Planning, Preparation, Response and Recovery (PPRR) to help individuals and communities recover from an event

Precautionary

Government presumes that all properties within defined areas are at risk from a hazard

Assessment of development in defined areas is required to include an assessment of the risks at the cost of the developer

Hazard treatment approach

Draws on elements of the risk approach, precautionary approach and emergency response

Development controls based on agreed 'banding' of hazard likelihood based on best available knowledge

Process involves consultation and multi-agency participation in developing policy

Graduated imposition of assessment and control requirements

Figure 2 demonstrates the relationship between the Principles, the Guide and this Report in the Framework.

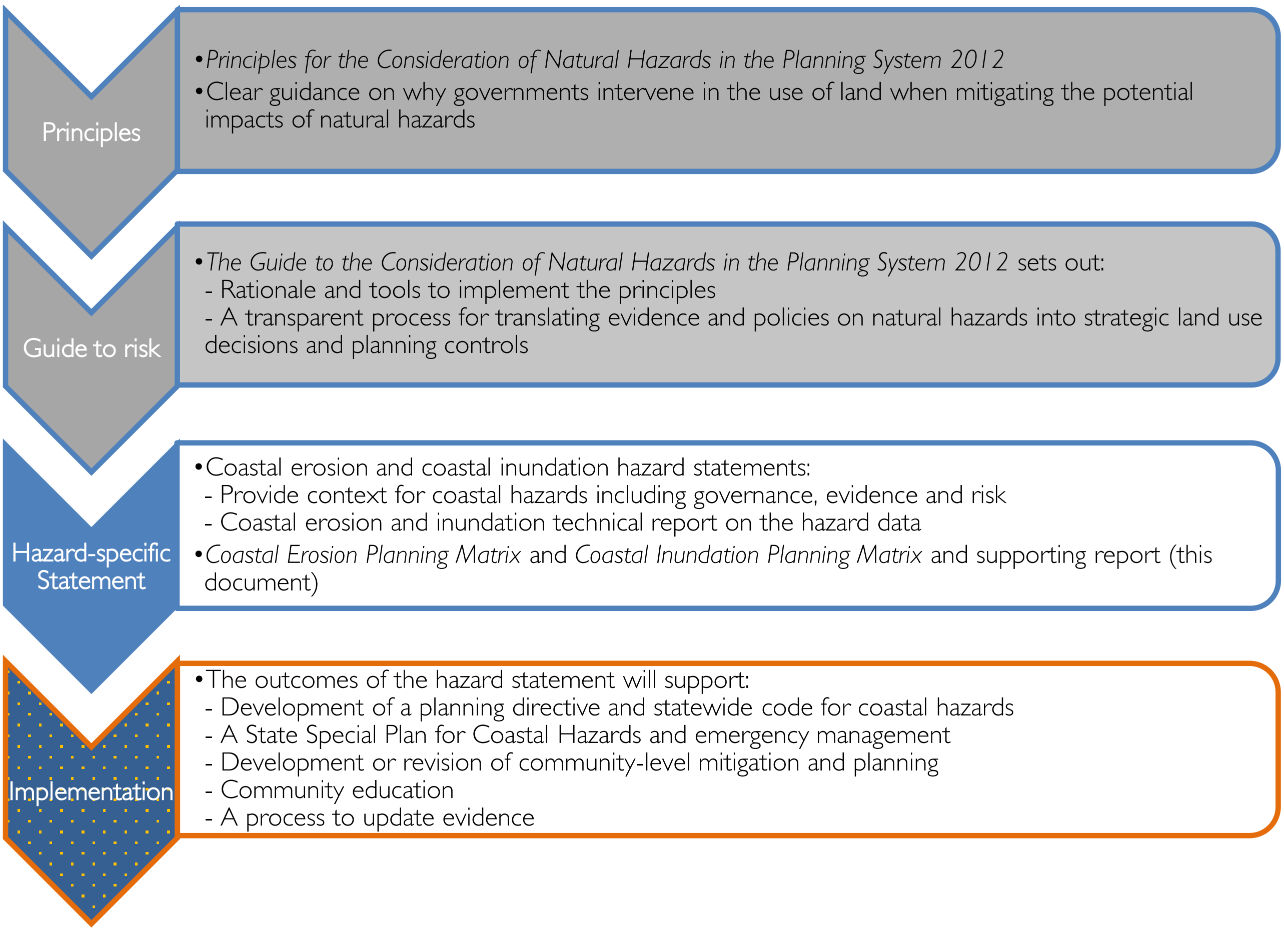


Figure 2 *State Framework for the mitigation of the impacts of natural hazards through land use planning*

4.2 *Hazard treatment approach*

The hazard treatment approach follows the same methodology as a risk management process (see *Figure 3*), where the regulatory and public risk context establish the context, is underpinned by a series of workshops held with hazard experts, land use planners, building surveyors and industry stakeholders as part of the adaptive process to the development and implementation of the risk assessment, in order to:

- define the hazard [Risk identification];
- consider available evidence and identify options for mapping areas that may be exposed to hazards throughout the State [Risk analysis];
- define the boundaries of the hazard bands [Risk evaluation]; and
- develop planning outcomes and controls to apply within each band of the hazard matrix [risk treatment].

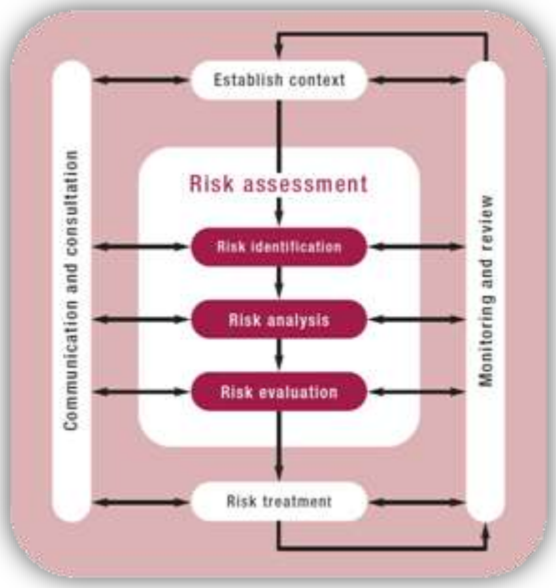


Figure 3 *The risk management process (adapted from Emergency Management Australia 2004)*

5 Assessment of public risk and coastal hazards

The coastal hazard assessment is:

- An assessment of the vulnerability of land to coastal hazards by assessing the potential frequency of an event occurring or by defining areas that are susceptible to coastal hazards.
- An assessment of the consequences of the occurrence of an event to development types.
- A proposal of treatments to mitigate the consequence (Hazard matrix).

Private risks associated with natural hazards are the responsibility of individuals and businesses. Governments should only intervene to ensure that private investment minimises unacceptable public risk.

Public risk is closely associated with the economic concept of 'externalities', being the costs/benefits of a development that are experienced by the broader community. This issue is addressed in more detail in *Section 5.3.*

5.1 Nature of public risk

Individuals, developers, communities and governments need to balance costs associated with managing the impacts of natural hazards with the benefits arising from development. Communities with low tolerance for risk will place significant controls in areas where communities with high tolerance for risk would impose few (if any) controls on development.

The proposed controls for coastal hazards are based on two premises. First, the premise that high-magnitude events have a very low frequency (such as a tsunami in Tasmania) and low-magnitude events have a high frequency (such as a daily high tide). This reflects the *National Emergency Risk Assessment Guidelines (NERAG)* (2009). Second, the premise that a hazard will affect all land susceptible to that hazard at some point in time (the 'precautionary principle').

The options for managing the impacts of natural hazards include:

- ***Emergency management:*** The *Emergency Management Act 2006* controls emergency management responses in Tasmania. Roles and responsibilities for emergency management are outlined in the *Tasmanian Emergency Management Plan (TEMP).* The *TEMP* sets out the management arrangements for each hazard, across Prevention, Preparedness, Response and Recovery.
- ***Building control:*** This provides the minimum standards required for safety and amenity of buildings for the

Acceptable: It is presumed that the risk in the area is acceptable, as either the natural hazard does not apply at all to the area, or occurs with such low frequency that it is not considered a matter that needs to be addressed. Normal building controls and emergency management responses are considered adequate to address any residual risk.

Low: The hazard occurs in the area but the frequency is low enough, or the magnitude when it does occur is low enough, that it might be experienced by a significant portion of the community without concern, or where there is reasonable expectation that a natural hazard may be present based on the characteristics of the land and our understanding of the hazard. Precautionary controls that are proportional to the importance of the use and development may be appropriate, including requirements for further site assessment or building standards.

Medium: Our knowledge of the hazard demonstrates that the likelihood is such that when it does occur the impact could be regarded as significant. Mitigation measures should be required to discourage vulnerable and hazardous uses from being located in these areas, or impose discretionary planning control on the form of a use or development through assessment against performance standards.

High: The hazard is frequent or severe, in that it creates conditions not normally considered manageable or tolerable without exceptional measures to respond to the natural hazard. It is to be presumed that most use and development is unacceptable in this area and any exceptional development needs to be considered on a case-by-case basis against rigorous tests and by demonstrating a need and community benefit for locating in the area.

occupants. This is achieved through the requirement to meet an Australian Standard (eg. building in bushfire prone areas), providing design guidance, or by requiring specialised investigations in sites identified as being susceptible to a hazard.

- *Land use planning: including strategic planning, use and development controls:* Strategic planning includes placement of defences (such as flood barriers) and avoidance of the hazard (such as not building on active landslides). Use controls include guidance on the zoning of land to highlight areas that are unsuitable for vulnerable, hazardous or critical development. Development controls focus on the form of the development (such as identifying a residential house envelope on a new parcel of land) or requiring a minimum level of services (such as access to water, sewage and stormwater services).

The relationship between emergency management, building control and land use planning (strategic settlement and statutory controls) is represented in *Figure 4*. The vertical axis represents the benefit represented by each type of control, while the horizontal axis represents the intervention as composite of the controls. The colouring on the graph represents the hazard changing from low likelihood-high magnitude events to high likelihood-low magnitude events.

In the context of the SCP the lower likelihood higher magnitude events while consequence for existing communities is potential significant the appropriate treatment is to restrict to through strategic planning for existing community and a reliance on the emergency management process. At the other end of the scale with high likelihood and low magnitude events the treatment is to avoid new development so as to minimise the potential to require defensive works to protect the new developments. The difficulty arises in locations, which are already developed; in these situations the preference is to develop adaption strategies so that the minimum level of intervention to achieve the most appropriate outcomes for the community.

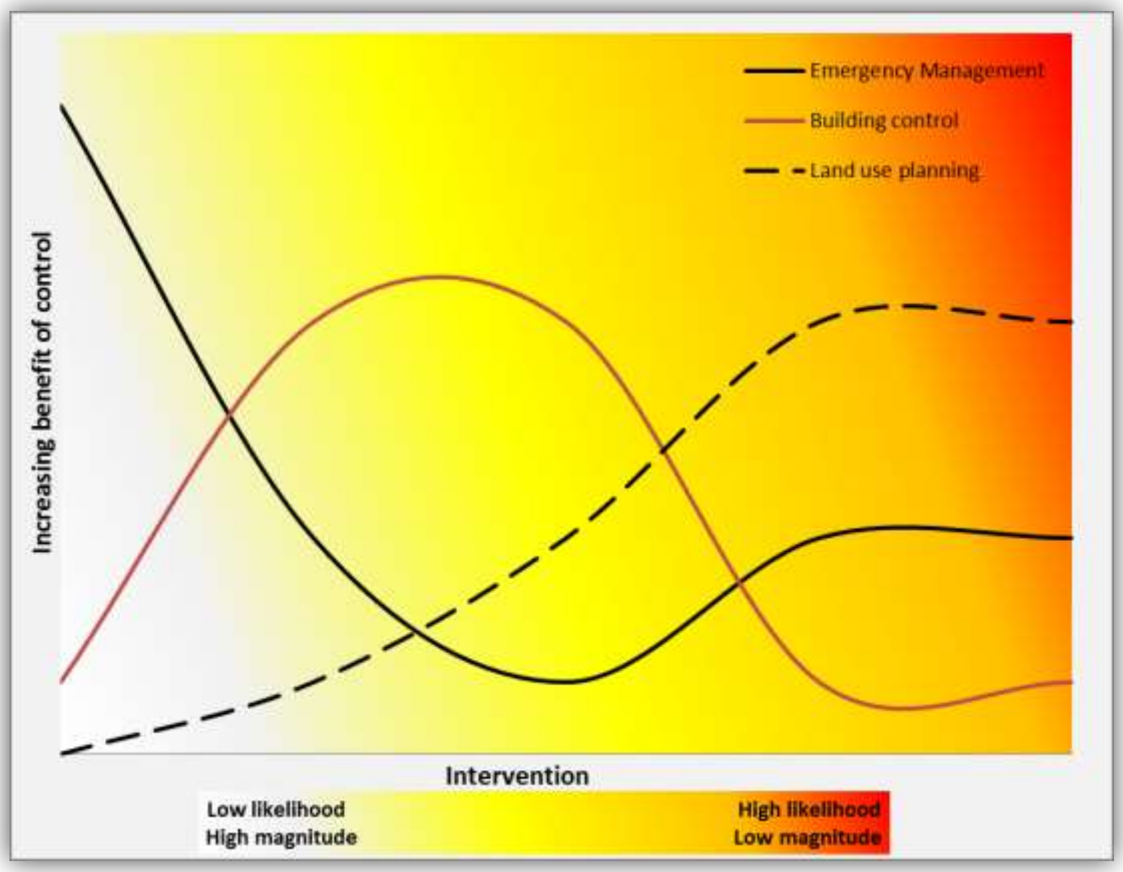


Figure 4 *Public policy instruments to manage risk from natural hazards*

The hazard treatment approach (see *Section 4.2*) provides the framework to evaluate the threat posed by a natural hazard and make judgements on the appropriate balance of controls. Hazard bands have been mapped according to exposure to the hazard. The composition of the land use planning and building controls in each hazard band defines the risk tolerance to the hazard and the responsible action to manage the hazard for human settlements (Bell 2014). In defining this balance through the hazard treatment approach, Tasmania provides a clear statement of tolerance to risk in any given location.

5.2 Public risk: development types

The assessment of tolerable risk considers whether risks can be (or should be) managed through planning controls (eg. siting and use controls), building controls (eg. floor heights and engineering works), emergency management related controls (eg. warnings and evacuations) or a combination thereof for each development type. The development types primarily inform strategic planning or zoning as they initially inform the assessment of public risk (see *Section 5.3*), then provide guidance on strategic and statutory planning of land (see *Sections 6* and *7*):

- *Outside the Urban Growth Boundary* relates to land that is outside the urban growth boundary defined in the regional land use strategies. New use or development will typically be located on the fringes of existing settlements and involve the intensification of agricultural land to urban or industrial uses. The implication is that this may be able to be developed in a way that minimises exposure to known hazards without an unreasonable increase in public risk.
- Inside the Urban Growth Boundary relates to land that has been identified for urban development that may include industrial, commercial or residential uses.
    - *Existing developments* are areas within existing [coastal] settlements but may also include buildings or dwellings located outside established communities. Existing developments are those already developed and may, over time, be considered for redevelopment, which keeps the at-risk population stable but increases the capital value of the location. In the context of existing development within a settlement, adaptation involves mitigation of the impact of the hazard balanced with the protection of public and private values. Mitigation can be more complex, especially where decisions made in relation to the protection, maintenance or ongoing depreciation of public land, infrastructure or services may affect the integrity of private property.

      A significant private right is afforded under *LUPAA,* in that existing development has the right to not only continue to be used for original purpose in perpetuity, but it also has the right to be rebuilt in the same location when destroyed due to a natural hazard, noting that such rebuilding would be in accordance with current building standards. Further intensification of use, or the change of use, should be in line with the strategic plan that considers coastal hazards and fulfils the responsibilities of both state and local governments to the coastal communities.
    - *Infill development* are areas within existing (coastal) settlements that involves the development or redevelopment of an unused or underused [coastal] site situated among other existing developed sites. The focus is on developing vacant parcels of land to uses that are compliant with the zoning. As with existing development, infill presents a complex issue with the requirement to balance private rights with the responsibilities of state and local governments. This can include new builds and significant redevelopments, renovations and change of uses.

5.3 Assessment of public risk

NERAG identifies ***six impact categories of consequence***:

1. People: impacts on physical health, deaths and injuries
   describes the potential consequence from deaths or injuries as a result of the emergency event
2. Environment: impacts on the ecosystem
   relates to the destruction and degradation of critical environmental assets (and their processes and structures) and/or species extinction and habitat range reduction
3. Economy: impacts economic activity
   includes financial and economic losses resulting from damage due to the emergency event
4. Public administration: impacts on the governing body's ability to govern
   relates to the impact of the emergency event on the delivery of core functions (including infrastructure service delivery) of the governing bodies for the community
5. Social Setting: impacts on society and its social fabric
   relates to the impact to communities from the emergency event, as distinct from the individual impacts assessed in the people criteria
6. Infrastructure: impacts on infrastructure
   relates to the impact on critical services and infrastructure as a result of the emergency event; this element is addressed as part of public administration.

Table 3 assesses public risk for these six impact categories against new, infill and existing development types. The assessment considers the *increase* in public risks associated with the hazard bands. It is a qualitative assessment to inform policy judgements. The assessment does not characterise the potential risk from flooding or erosion as the relative level of vulnerability in the area rises. The table assesses each category against each development type (greenfield, infill, existing) as it informs the hazard matrices for erosion (see *Section 6.3*) and inundation (see *Section 7.3*).

Table 3 *Assessment criteria (based on NERAG)*

PUBLIC RISK ASSESSMENT CRITERIA		
NERAG consequence category definitions		NERAG category assessment for each development type
People Relates to deaths and injuries directly from the emergency event	Risk to Life Risks to life are a core component of public risk. Governments retain a clear responsibility for maintaining a safe living and working environment. Tasmania has a duty of care not to allow ongoing development in areas vulnerable to risk without appropriate mitigation measures. The *Emergency Management Act 2006* provides for the protection of life, property and the environment during an emergency event.	Outside the urban growth boundary development in the hazard areas will increase the risk to life or injury resulting from the emergency event if appropriate mitigation strategies do not occur. Development within the hazard bands should generally be discouraged, while coastally-dependent development should demonstrate how the risk to life will be managed to within tolerable levels. Inside the urban growth boundary development in the hazard areas presents a greater role for government to support the residents in the mitigation of the hazard. This can be achieved by requiring the potential use, development or building controls to either not locate in hazardous areas (vulnerable, hazardous or critical uses) or requiring the development and building standards to accommodate the hazard, either through defensive structures or increased building standards. Vulnerable, Hazardous or Critical services should consider hardening, withdrawal or contingency plans to ensure that they can function in the event of an emergency.
Environment Relates to the destruction & degradation of critical environmental assets (and their processes & structures) and/or species extinction and habitat range reduction	Risk to the Environment Environmental risk relates to the potential environmental costs associated with mitigation measures that may be required to maintain tolerable levels of public and private risk. The *State Coastal Policy 1996* requires consideration of environmental impacts in the planning system, they have been addressed through the Natural Values Codes.	NA

<table>
<tr><th colspan="3">PUBLIC RISK ASSESSMENT CRITERIA</th></tr>
<tr><th colspan="2">NERAG consequence category definitions</th><th>NERAG category assessment for each development type</th></tr>
<tr><td>Economy

Relates to reduced economic activity and asset losses as a result of the emergency event</td><td>Risk to the Economy
Risk to the economic activity of the region or State associated with the loss of production or value due to the impacts of a natural disaster.
The statutory valuation of residential properties and unimproved land value are considered when they fall within a hazard area to indicate the scale of vulnerability to natural hazards.
Further consideration of potential loss due to individual events, the cost of response and recovery are not a factor in this work.</td><td>Outside the urban growth boundary use, development or building works should consider the increase in hazard from erosion and inundation.
The increase in hazard represents a progressive change from private risk to public risk as the importance of the use, development or building increases.
Further development in these areas should be minimised unless there is an increased public benefit such as a coastally-dependent development for which appropriate mitigation measures can be undertaken.

Inside the urban growth boundary use, development or building works should not unreasonably increase the economic risk without with consideration of mitigation strategies to reduce the economic burden when the erosion or inundation event occurs.
Coastal defences in these areas, designed to protect life, property and the environment, should be economically sustainable for the life of the structure and the assets they are protecting.

Vulnerable, Hazardous or Critical services should consider hardening, withdrawal or contingency plans to ensure that they can function in the event of an emergency.</td></tr>
<tr><td>Public administration
Concerned with the impact of the emergency event on the delivery of core functions (including infrastructure service delivery) of the governing bodies for the community</td><td>Risk to Emergency Management Operations and other critical services
Risk associated with the burden on emergency services to act to protect lives, as well as infrastructure, public and private property during an emergency.

Risk to access to Critical Services and Infrastructure
Risk to critical services and infrastructure (public or private) is a public risk due to the role critical services or infrastructure have in maintaining communities, and the role they play in assisting authorities to respond to an emergency.</td><td>Outside the urban growth boundary use, development or building works should consider the ability of the emergency's services to assist in the relief and recovery.

Inside the urban growth boundary use, development or building works must consider the level of hazard on the proposal so as to not increase the burden on emergency and critical services.

Vulnerable, Hazardous or Critical services should consider hardening, withdrawal or contingency plans to ensure that they can function in the event of an emergency.</td></tr>
</table>

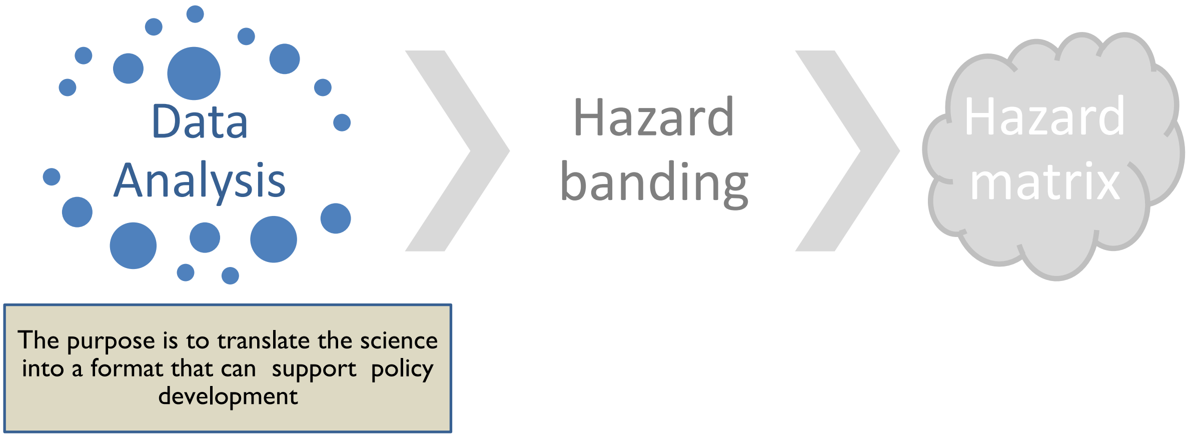
<table>
<tr><th colspan="3">PUBLIC RISK ASSESSMENT CRITERIA</th></tr>
<tr><th colspan="2">NERAG consequence category definitions</th><th>NERAG category assessment for each development type</th></tr>
<tr><td>Social setting
Concerned with the impact to communities from the emergency event, as distinct from the individual impacts assessed in the people criteria</td><td>Moral Hazard
In the context of natural hazards, moral hazard is the difference between the resources that individuals and families have to support their recovery, and the resources required to support recovery to a moderate standard of living.
These costs are borne by governments and charitable donations to public appeals and can reasonably be characterised as public risks.

Risk to Ongoing Ownership
Public risk increases over time when risk information, including an understanding of the obligations to the landowner to maintain risk mitigation measures or the accepted risk-related costs are not clearly passed on to a new owner on the sale of the property.
The result can be that individuals may be unprepared to accept the consequences of natural hazards and, therefore, there is increased reliance on public assistance to support mitigation or recovery-related costs.
In considering the potential impacts of coastal hazards on a coastal community, the Government has a clear responsibility to ensure that the community is aware of the hazards and the Government takes a reasonable level of intervention as the vulnerability to the hazard increases.</td><td>Outside the urban growth boundary use, development or building works represent a new moral hazard to government if they occur in a known hazardous area without appropriate consideration of the hazard.

Inside the urban growth boundary government should support communities in the mitigation of coastal hazards.
This will help the community to continue as a whole, either in the aftermath of an event or as the hazard slowly becomes apparent, noting that the consideration of the hazard may cause some of the values in the community to be compromised and a transfer of private risk to the public.
Mitigation activities (including but not limited to defensive works) should consider if the activity is sustainable (socially and financially) for the foreseeable future.</td></tr>
</table>

6 Coastal erosion hazard assessment

6.1 Understanding coastal erosion planning bands evidence: identifying the hazard



MNHLUP indicative coastal erosion mapping is the result of a hazard assessment of the Tasmanian coastline for coastal landform behaviour. The scientific background to this report is set out in *Coastal erosion susceptibility zone mapping for hazard band definition in Tasmania*[14] (Sharples et al 2013). The policy decisions incorporated in the report and indicative mapping are outlined below.

Coastal landform behaviour includes storm erosion and longer-term shoreline recession in some circumstances, and shoreline accretion (growth) or progradation in others. It is driven by a complex range of processes and factors that may vary considerably from one coastal location to another. Factors include: the inherent resilience or mobility of the physical landforms (geology and geomorphology); local wave climate exposure; storm frequencies and magnitudes; local sediment sources and sinks; tidal and river discharge currents; and the effects of artificial changes to the coast. The interaction between many of these factors in driving coastal changes is complex to model due to the variation of the factors over short sections of the coast.

This means that statewide assessments must be based on generic assessments of susceptibility and be indicative, with the uncertainty built in to the response to each of the hazard areas. Tasmanian shorelines include not only swell-exposed, open coast beaches, but also sheltered (eg. estuarine) sandy shores, soft-rock (cohesive clay) shore, and hard rocky shores (including cliffs). Classifying shorelines in this way allows all shores to be considered in the context of their erodability and their potential hazard bands, ranging from *Acceptable* hazard (negligible) sloping hard-rock shores, through a range *of Low* and *Medium* hazard shores to *High* hazard exposed soft sediment shores (Sharples et al 2013).

Using these data, the composition of Tasmanian coastal landforms has been divided into three broad categories that reflect their fundamental differences in susceptibility to coastal erosion.

The three ***coastal substrate categories for susceptibility to coastal erosion*** will now be outlined.

14 Mapping projects include: Tasmanian first–pass coastal vulnerability assessment (Sharples 2006); several coastal landform mapping projects for the three Tasmanian Natural Resource Management (NRM) zones (Sharples & Mowling 2006); a first pass national coastal vulnerability assessment (DCC 2009) (Sharples, Mount & Pedersen, 2009) and a Coastal Hazards Assessment for Kingborough LGA (Sharples & Donaldson 2013). These datasets have been variously checked and edited or extended to the full Tasmanian coast. However, the use of these datasets to create ranked erosion susceptibility zone maps has not previously been undertaken for Tasmania (or Australia): this is a new contribution from this project.

6.1.1 Soft sediment category

This category includes typically muddy or sandy types, most readily eroded but also very mobile and capable of accretion (growth) as well as erosion.

The distribution of soft sediments at the coast around Tasmania is shown in *Figure 5*.

An assessment of the natural recession limit for the SLRPA of 0.8 m AHD has been undertaken for coastal soft sediment mapping. The natural recession limit is an assessment of where the underlying bedrock rises above the potential SLR and forms a physical barrier to further recession.

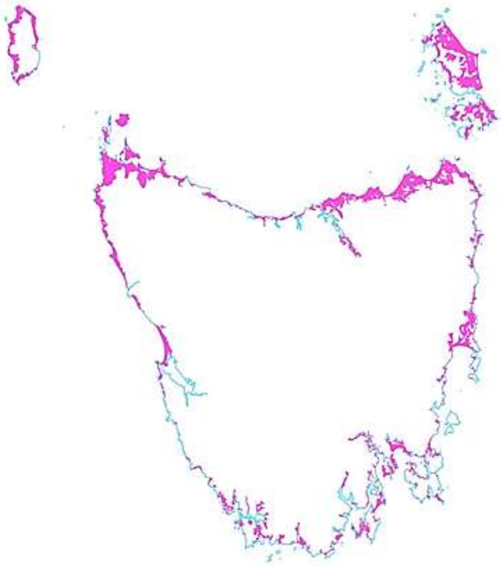


Figure 5 *Soft sediment bodies on the Tasmanian coast*

Figure 6 illustrates how generic erosion hazard bands are defined for soft sediment coasts, showing the storm bite, recession to 2050 and 2100, and the relationship to the natural recession limits.

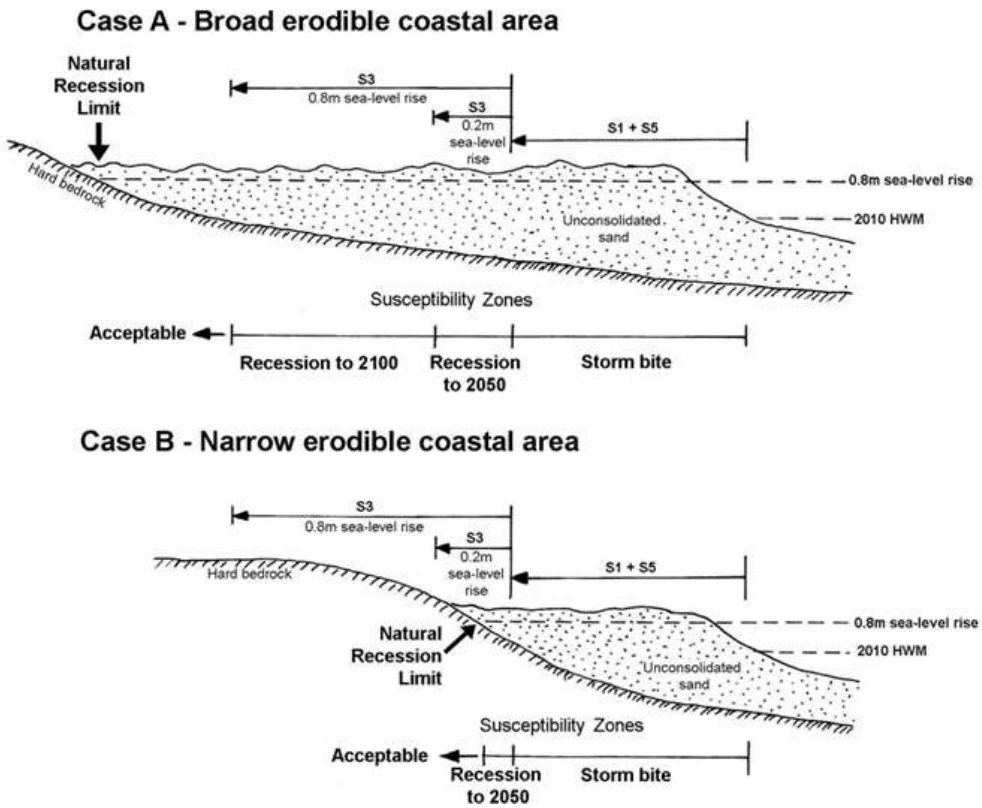


Figure 6 *Model to calculate erodible envelopes in soft sediments (from Sharples et al 2013)*

The Mariani et al (2012) method to calculate storm bite and recession is detailed in Sharples et al (2013). Of note, the (S1 + S5) and (S3 2050) and (S3 2100) susceptibility zones are described in Sharples et al (2013) following Mariani et al (2012). With (S1 + S5) representing storm bite from two back-to-back 1% AEP storms and associated slumping in soft sediments, this is, in effect, the immediate erosion hazard.

6.1.2 Soft-rock category

In Tasmania, soft rock bodies generally comprise cohesive clayey materials that are more resistant to erosion than soft sediment, but not as resistant as well-lithified rock.

These may erode slowly but significantly over time, and do not rebuild as soft sandy shores may.

The distribution of soft rocks on the Tasmanian coast is shown in *Figure 7*.

Figure 7 *Coastal 'soft-rock' bodies on the Tasmanian coast*

6.1.3 Hard-rock shoreline category

Hard-rock shoreline is mostly resistant to noticeable erosion on human timescales, although steeper hard-rock shores may be notably unstable with occasional landslides and rock-falls occurring. Artificial shorelines are also generally intended to resist erosion, although not all are designed with sufficient structural integrity as to achieve this.

Figures 8 and *9* show the distribution of hard-rock and artificial shorelines found on the Tasmanian coastline.

Figure 8 *Hard-rock shorelines defined for this coastal hazard assessment*

Figure 9 *Artificial shorelines incorporated into this coastal hazard assessment*

Each of the categories has been further subdivided according to key characteristics, which also play important roles in determining susceptibility to coastal erosion on a regional scale. These include: broad landform distinctions between (more stable) sloping rocky shores and (less stable) hard or soft-rock cliffs; exposure to or sheltering from open coast swell wave climates; and whether the area of coast has been armoured by artificial shorelines to resist erosion.

Several methods have been used to define potential erosion susceptibility zones (or 'setbacks') behind shores of each category as described in Sharples et al (2013). For open coast sandy beaches, a well-established and widely used erosion and recession hazard modelling technique described by Mariani et al (2012) was used, based on approaches previously used in NSW and Qld. However, similarly well-established and widely used modelling approaches for swell-sheltered soft sediment shores or soft-rock shores are not available. For these, empirical data was employed, taken from historic aerial photography and shoreline profiling surveys, in order to define erosion and recession setbacks based on actual measured erosion cuts and shoreline recession rates for Tasmanian shores. A precautionary factor was applied to allow for the limited scope of the available empirical data.

For hard-rock cliffs, an appropriate setback modelling technique was identified, but this cannot be employed until high-resolution topographic mapping is available for more of the Tasmanian coast. In lieu of this, a precautionary setback was defined, which is adequate to cover the scales of cliff instability considered likely for Tasmanian coasts. Moderately sloping hard-rock shores are considered to have *Acceptable* (negligible) erosion hazard based on the lack of significant historically-observed instability in this shoreline type. Resilient artificial shores are also considered to have negligible erosion hazard, while artificial shorelines judged to not be resilient are treated as if no artificial works were present.

6.1.4 Defining the Coastal Erosion Mapping Components

Using these approaches, coastal erosion and recession susceptibility zones were defined as shoreline buffers or setbacks of differing widths for each shoreline category. For each category, setbacks of four different types were generally defined, as depicted in *Figure 10*:

1. ***Storm bite erosion hazard***: the amount of erosion and consequent head scarp instability that could potentially occur at any time in response to two back-to-back 1% AEP storm events.
2. ***Shoreline recession to 2050***: the amount of shoreline recession that could potentially occur in response to projected SLR to 2050, in addition to the storm bite erosion hazard.
3. ***Shoreline recession to 2100***: the amount of shoreline recession that could potentially occur in response to projected SLR to 2100, in addition to the storm bite erosion hazard.
4. ***Shorelines beyond the limit of potential erosion or recession by 2100***.

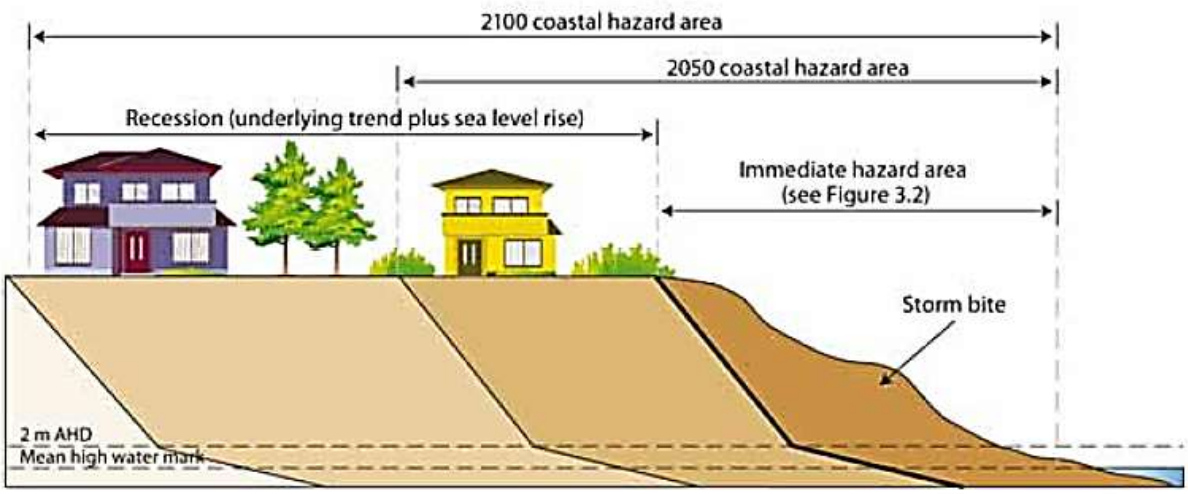


Figure 10 *Idealised schematic of a dune profile depicting the high hazard area, 2050 coastal hazard area and 2100 coastal hazard area (after Nielson et al (1992) and used by Mariani et al (2012) and Sharples et al (2013))*

Some exceptions to the relative rates of erosion or recession outlined in *Figure 10* were used, including the definition of a single precautionary hazard zone for hard-rock cliffs (in the absence of sufficient data or methods to apply more nuanced zones), and the definition of a short-term (to 2030) recession (rather than storm bite) zone for soft-rocks, due to the tendency of this shoreline type to recede slowly but steadily rather than in large storm bites. When combined, the three coastline types become 30 different components, as summarised in *Table 4*. In other areas with insufficient information a coastal erosion investigation area has been defined. In these areas a simple relationship based on the proximity to the MHW is defined to trigger site specific investigations to define the component or intent of the hazard band. The site specific assessment would need to classify the land into the closes component as listed in table 4 or demonstrate the areas relationship to the hazard band classifications in *Section 6.22*.

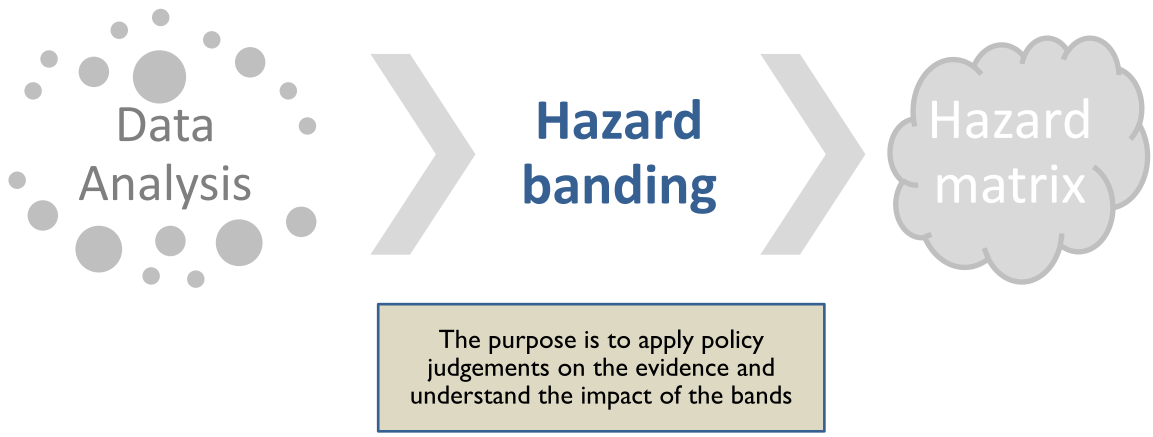
Each of the components has inherent susceptibility to erosion and forms the basis of the ranking process. A pairwise assessment was used to rank and combine the various erosion susceptibility zones defined for each shoreline category into four final overall erosion hazard bands ranked as *High, Medium, Low* or *Acceptable* hazards. This analysis is discussed in *Section 6.2*.

Table 4 Coastal Erosion Mapping Components (adapted from Sharples et al 2013)

Susceptible soft sediment shoreline zones – open (swell-exposed) shores (Differing-width zones for the four hydraulic zones cartographically combined in each component)
Storm bite (S1 + S5) High hazard zone (open coast soft sed. shore) – to likely natural recession limit
Storm bite (S1 + S5) High hazard zone (open coast soft sed. shore) – to possible natural recession limit
Recession (S3) to 2050 Med hazard zone (open coast soft sed. shore) – to likely natural recession limit
Recession (S3) to 2050 Med hazard zone (open coast soft sed. shore) – to possible natural recession limit
Recession (S3) to 2100 Low hazard zone (open coast soft sed. shore) – to likely natural recession limit
Recession (S3) to 2100 Low hazard zone (open coast soft sed. shore) – to possible natural recession limit
Susceptible soft sediment shoreline zones – swell-sheltered shores
Storm bite (S1 + S5) High hazard zone (sheltered soft sed. shore) – to likely natural recession limit
Storm bite (S1 + S5) High hazard zone (sheltered soft sed. shore) – to possible natural recession limit
Recession (S3) to 2050 Med hazard zone (sheltered soft sed. shore) – to likely natural recession limit
Recession (S3) to 2050 Med hazard zone (sheltered soft sed. shore) – to possible natural recession limit
Recession (S3) to 2100 Low hazard zone (sheltered soft sed. shore) – to likely natural recession limit
Recession (S3) to 2100 Low hazard zone (sheltered soft sed. shore) – to possible natural recession limit
Acceptable soft sediment shoreline zones – all (swell-exposed and sheltered) 'acceptable' zones
Acceptable zone (all soft sed. shores) – to likely natural recession limit
Acceptable zone (all soft sed. shores) – to possible natural recession limit
Acceptable zone (all soft sed. shores) – landwards of likely and possible natural recession limits
Soft-rock shorelines
Near-term potential recession hazard zone (normal soft rocks) – High hazard zone 14 m to 2030
Medium-term potential recession hazard zone (normal soft rocks) – Med hazard zone 28 m to 2050
Longer-term potential recession hazard zone (normal soft rocks) – Low hazard zone 63 m to 2100
Longer-term potential settling & slumping hazard (very coarse boulder clay soft rocks) – 20 m
Acceptable zone (normal soft rocks)
Acceptable zone (very coarse boulder clay soft rocks)
Hard-rock shorelines
Acceptable zone (all gently to moderately sloping 'pure' hard-rock shores)
Storm bite (S1 + S5) hazard zone for exposed sandy shores backed by moderately rising hard bedrock (Differing-width zones for the four hydraulic zones cartographically combined)
Storm bite (S1 + S5) hazard zone for sheltered sandy shores backed by moderately rising hard bedrock
(Acceptable zones landwards of storm bite (S1-S5) hazard zones for sandy shores backed by bedrock were assumed but not mapped as separate polygons)

Regression & slump hazard zone (steep to cliffed hard-rock shores) (standard precautionary 50 m buffer used in all cases)
(Acceptable zones landwards of hazard zone for steep to cliffed hard-rock shores were assumed but not mapped as separate polygons)
Artificial shorelines
Acceptable zone landwards of resilient artificial shores (defined as acceptable hazard to the landwards extent that any (non-acceptable) hazard zones would be defined for the shoreline type present in the absence of resilient artificial protection)
(Non-resilient artificial shores ignored; zoned according to the natural shoreline type in the absence of artificial protection)
Coastal Erosion Investigation Area(not included in the pairwise ranking)
Coastal Erosion Investigation Area: Coastal areas for which insufficient information is available to categorise their susceptibility to coastal erosion and recession.

6.2 *Defining coastal erosion hazard planning bands: analysing the hazard*



The previous section of this Report describes the erosion hazard zones adopted for the three broadly-defined coastal substrate categories (soft sediment, soft-rock and hard-rock), as well as artificial shorelines. To develop an indicative, integrated coastal erosion susceptibility map, each of the zoning schemes need to be merged into a single hazard susceptibility scheme, which incorporates an assessment of the relative hazards posed by the various hazard zones within each substrate type. This has been achieved by using a pairwise assessment.

6.2.1 Pairwise assessment

A pairwise assessment is a tool to support decision-making by helping non-technical experts to understand the relative susceptibility of each coastal erosion hazard component (Hansen & Ombler, 2009). The pairwise assessment delivers two outcomes:

- It translates the expert knowledge on coastal hazards for policymakers. The expert knowledge includes an understanding of the components that make up coastal erosion on the Tasmanian coastline, confidence in the spatial and attribute accuracy, and the expert opinion on the 'likelihood' that the erosion may occur in this area and its scale/magnitude.
- It provides an order of importance for merging the components into a single planning layer, ensuring that a less important component does not overwrite a more important feature.

During the data analysis stage (*Section 6.1*), the coastal erosion components were broadly divided into two groups: the first ranked based on a natural order[15], the second being un-dominated components for which there is no natural order of importance. The components with a natural order are identified in Table 5; the un-dominated components make up the remaining elements in Table 6.

Table 5 Coastal erosion components with a natural order

Storm bite (S1 + S5)	High hazard zone (open coast soft sed. shore) – to likely natural recession limit
Recession (S3) to 2050	Med hazard zone (open coast soft sed. shore) – to likely natural recession limit
Recession (S3) to 2100	Low hazard zone (open coast soft sed. shore) – to likely natural recession limit
Acceptable hazard zone	(All gently to moderately sloping 'pure' hard-rock shores)
Resilient artificial shores	(Low hazard storm bite zone landwards of resilient artificial shores)
Storm bite (S1 + S5)	High hazard zone (sheltered soft sed. shore) – to likely natural recession limit

A pairwise assessment completed by the authors of the technical report (Sharples et al 2013) ranked the components from must susceptible to least susceptible to coastal erosion. An extract of the assessment is provided in *Table 6*, with the full pairwise assessment in the technical report. Each component is listed on both the horizontal and vertical axes of the table.

Considering each column versus each row in turn, the following question was asked: *'Which (of each column vs row pair) is more susceptible to coastal erosion?'* Depending on the answer agreed, the intersecting column vs row cell was scored as follows: a value of (1000) was given to the component that was 'more susceptible', and a value of (1) was given to the component that was 'less susceptible'. A value of 100 was given to both components if they were considered equally susceptible.

Table 6 *Extract of the pairwise assessment*

N = Column category not as susceptible as row category(1)
Y= Column category more susceptible than row category (1000)
"=" Column category as susceptible as row category (100)

Basis for pairwise assessment decisions: Basic question is "Which (of a pair) is more susceptible to coastal erosion?" (assessment of column vs. row)	Storm bite (S1 + S5) High hazard zone (open coast soft sed. shore) – to likely natural recession limit	Storm bite (S1 + S5) High hazard zone (open coast soft sed. shore) – to possible natural recession limit	Recession (S3) to 2050 Med hazard zone (open coast soft sed. shore) – to likely natural recession limit	Recession (S3) to 2050 Med hazard zone (open coast soft sed. shore) – to possible natural recession limit	Recession (S3) to 2100 Low hazard zone (open coast soft sed. shore) – to likely natural recession limit	Recession (S3) to 2100 Low hazard zone (open coast soft sed. shore) – to possible natural recession limit	Storm bite (S1 + S5) High hazard zone (sheltered soft sed. shore) – to likely natural recession limit	Storm bite (S1 + S5) High hazard zone (sheltered soft sed. shore) – to possible natural recession limit
Storm bite (S1 + S5) High hazard zone (open coast soft sed. shore) – to likely natural recession limit		1	1	1	1	1	1	1
Storm bite (S1 + S5) High hazard zone (open coast soft sed. shore) – to possible natural recession limit	1000		1	1	1	1	1000	1
Recession (S3) to 2050 Med hazard zone (open coast soft sed. shore) – to likely natural recession limit	1000	1000		1	1	1	1000	1000
Recession (S3) to 2050 Med hazard zone (open coast soft sed. shore) – to possible natural recession limit	1000	1000	1000		1	1	1000	1000
Recession (S3) to 2100 Low hazard zone (open coast soft sed. shore) – to likely natural recession limit	1000	1000	1000	1000		1	1000	1000
Recession (S3) to 2100 Low hazard zone (open coast soft sed. shore) – to possible natural recession limit	1000	1000	1000	1000	1000		1000	1000
Storm bite (S1 + S5) High hazard zone (sheltered soft sed. shore) – to likely natural recession limit	1000	1	1	1	1	1		1
Storm bite (S1 + S5) High hazard zone (sheltered soft sed. shore) – to possible natural recession limit	1000	1000	1	1	1	1	1000	

[15] Components that can be ranked with a natural order are those in which there is a clear order of importance. For example, in the case of soft sediments shores, areas with a soft sediments swell-exposed storm bite classification have a 'natural order' that is higher than areas classified as soft sediment swell-sheltered coast recession areas to 2050.

Table 7 provides the relative rankings of the components by the consultant. Of note is the relationship between the components with a natural order (**bold**) and the un-dominated components, indicating the spread of values within the components.

Table 7 *Results of the pairwise assessment*

Coastal erosion hazard zone component	Pairwise assessment score
Acceptable hazard zone (all gently to moderately sloping 'pure' hard-rock shores)	24
Acceptable hazard zone (very coarse boulder clay soft rocks)	1023
Acceptable hazard zone (normal soft rocks)	2022
Acceptable hazard zone (all soft sed. shores) – landwards of likely and possible natural recession limits	3021
Acceptable hazard zone (all soft sed. shores) – to possible natural recession limit	4020
Acceptable hazard zone (all soft sed. shores) – to likely natural recession limit	5217
Resilient artificial shores (Acceptable recession zones landwards of resilient artificial shores)	5316
Resilient artificial shores (Low hazard storm bite zone landwards of resilient artificial shores)	5316
Longer-term potential settling & slumping hazard (very coarse boulder clay soft rocks) – 20 m	5514
Recession (S3) to 2100 Low hazard zone (sheltered soft sed. shore) – to possible natural recession limit	7215
Regression & slump hazard zone (steep to cliffed hard rocks)	7413
Longer-term potential recession hazard zone (normal soft rocks) – Low hazard zone 63 m to 2100	7512
Recession (S3) to 2100 Low hazard zone (open coast soft sed. shore) – to possible natural recession limit	9312
Recession (S3) to 2100 Low hazard zone (sheltered soft sed. shore) – to likely natural recession limit	10311
Recession (S3) to 2050 Med hazard zone (sheltered soft sed. shore) – to possible natural recession limit	12309
Recession (S3) to 2100 Low hazard zone (open coast soft sed. shore) – to likely natural recession limit	13110
Medium-term potential recession hazard zone (normal soft rocks) – Med hazard zone 28 m to 2050	14307
Recession (S3) to 2050 Med hazard zone (open coast soft sed. shore) – to possible natural recession limit	15207
Recession (S3) to 2050 Med hazard zone (sheltered soft sed. shore) – to likely natural recession limit	15306
Recession (S3) to 2050 Med hazard zone (open coast soft sed. shore) – to likely natural recession limit	17205
Near-term potential recession hazard zone (normal soft rocks) – High hazard zone 14 m to 2030	18105
Storm bite (S1 + S5) hazard zone for sheltered shores (sandy shores backed by moderately rising hard bedrock)	20202
Storm bite (S1 + S5) High hazard zone (sheltered soft sed. shore) – to possible natural recession limit	21003
Storm bite (S1 + S5) High hazard zone (open coast soft sed. shore) – to possible natural recession limit	21102

Storm bite (S1 + S5) High hazard zone (sheltered soft sed. shore) – to likely natural recession limit	22101
Storm bite (S1 + S5) hazard zone for exposed shores (sandy shores backed by moderately rising hard bedrock)	24000
Storm bite (S1 + S5) High hazard zone (open coast soft sed. shore) – to likely natural recession limit	24100

6.2.2 Coastal Erosion Hazard Bands

The boundaries represent both the areas vulnerable to coastal erosion and the relative risk within that vulnerability. The area vulnerable to erosion is defined as the land between the MHT and the landward edge of the area susceptible to coastal erosion, as discussed in the previous section. The relative risk is the area that will be managed to mitigate the impact of coastal erosion through emergency management, planning, development and building controls.

The boundaries are defined based on the ranking of the components, consultation with regulators, industry and policymakers (see *Appendix 1*), current regulatory practice, and consultation on the draft matrix and indicative mapping.

The principles that were agreed during the workshop process provided the following guidance to the development of the hazard bands:

- The *High* hazard band should be the most vulnerable to a hazardous erosion event that may occur at any time. It represents the area in which the State has the greatest duty of care to manage the risk to life and property, furthermore the *High* hazard band contains the area which may be considered to be actively mobile landforms, on which the SCP does not permit development unless for engineering or remediation works to protect land, property and human life .
- The *Medium* and *Low* bands should consider recession to 2050 and 2100 respectively. These represent the areas in which the State's duty of care is realised through a moral hazard created in part due to historic development patterns.
- The *Acceptable* band should be the area vulnerable to recession beyond 2100. It represents the area in which the State's duty of care is not in place as the level of impact is beyond what is able to be reasonably predicted or responded to at this point in time.
- The coastal erosion *Investigation* band will identify areas in which the underlying data is poorly understood and is within 1 km of the coast [16]and requires further investigation.

The proposed thresholds recognise that while the indicative coastal erosion mapping is based on relative susceptibility, its operation is different to hazards such as landslide as it is a highly dynamic hazard.

Boundary between *Acceptable* and *Low* hazards

The workshops agreed that the boundary between *Acceptable* and *Low* should include components that have been valued as more than the '*Resilient artificial shores (Low hazard storm bite zone landwards of resilient artificial shores)*': one of the natural order components. The implication of this is that areas that would normally be vulnerable to a storm bite event but are defended by artificial shore have a *Low* hazard banding instead of a *High* hazard banding.

If the defence is overwhelmed during a storm, the land behind it has a recognised vulnerability. However, other resilient shorelines with an underlying recession classification are recognised as presenting a vulnerability that does not require management.

[16] The SCP defines the coastal zone as within 1 km of HWM, this ensures that the investigation area is consistent with the SCP.

The implication of this threshold is that the *Low* band will be required to manage the long-term recession risk to 2100.

Other coastal erosion components such as slump hazards (steep to cliffed hard-rock) are included in the *Low* band due to both the potential impact of a failure in this area and the unpredictability of potential failures.

Boundary between *Low* and *Medium* hazards

The intention of the *Medium* band is to address medium-term recession to 2050. The workshops identified *'Recession (S3) to 2050 Medium hazard zone (sheltered soft sediment shore) – to possible natural recession limit'* as the appropriate threshold between the *Low* and *Medium* hazard bands.

Boundary between *Medium* and *High* hazards

The workshops agreed that the boundary between *Medium* and *High* is set at components most vulnerable to hazardous erosion events in 2010. This is limited to soft sandy shorelines, either in sheltered or open coast, which can be reasonably considered as potentially actively mobile landforms.

Composition of the coastal erosion hazard bands

Figure 11 and *Table 8* illustrate the outcomes of assessment of the relative importance of components in the indicative coastal erosion hazard maps, while *Figure 12* provides an example of the hazard banding at Lauderdale. The indicative coastal erosion hazard maps were endorsed by the Tasmanian Government in January 2014 to support the planning, development and building controls.

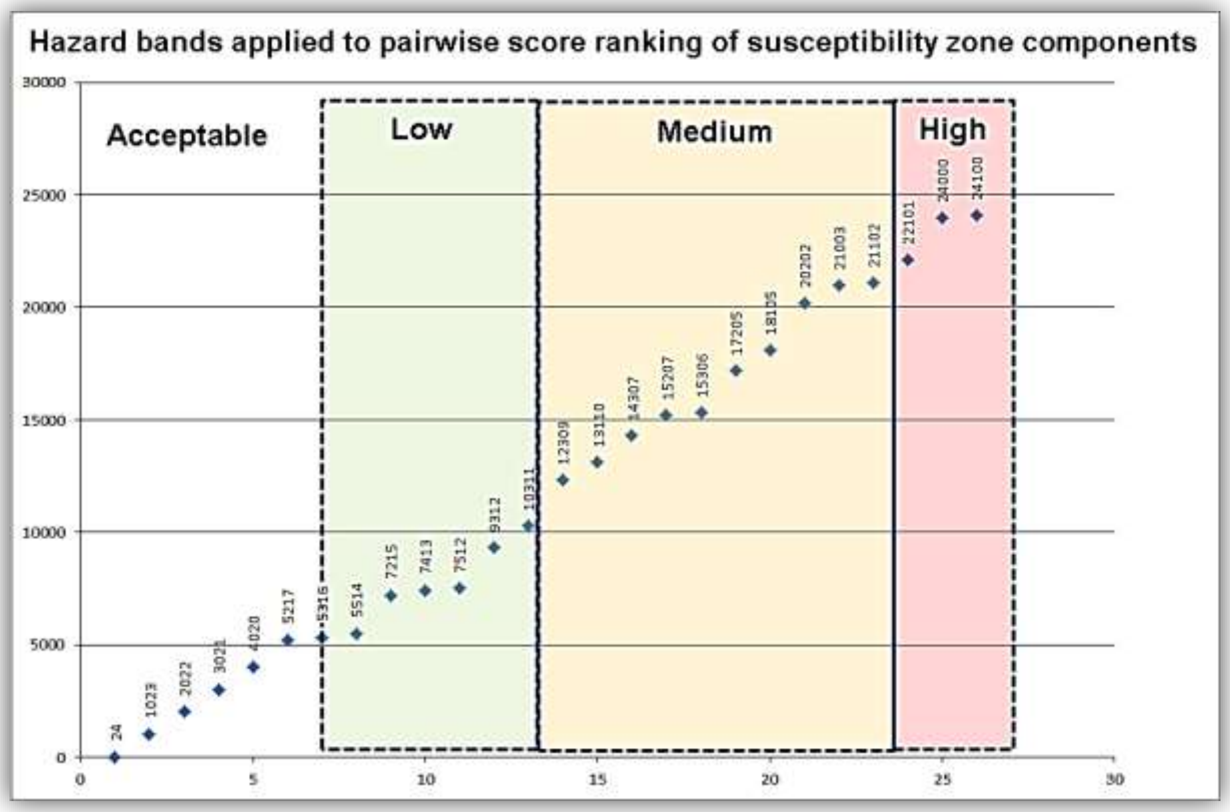


Figure 11 *Coastal erosion rankings and hazard bands*

Table 8 *Coastal erosion components and hazard bands*

Coastal erosion hazard zone component	Pairwise assessment score
Acceptable hazard zone (all gently to moderately sloping 'pure' hard-rock shores)	24
Acceptable hazard zone (very coarse boulder clay soft rocks)	1023
Acceptable hazard zone (normal soft rocks)	2022
Acceptable hazard zone (all soft sed. shores) – landwards of likely and possible natural recession limits	3021
Acceptable hazard zone (all soft sed. shores) – to possible natural recession limit	4020
Acceptable hazard zone (all soft sed. shores) – to likely natural recession limit	5217
Resilient artificial shores (Acceptable recession zones landwards of resilient artificial shores)	5316
Resilient artificial shores (Low hazard storm bite zone landwards of resilient artificial shores)	5316
Longer-term potential settling & slumping hazard (very coarse boulder clay soft rocks) – 20 m	5514
Recession (S3) to 2100 Low hazard zone (sheltered soft sed. shore) – to possible natural recession limit	7215
Regression & slump hazard zone (steep to cliffed hard rocks)	7413
Longer-term potential recession hazard zone (normal soft rocks) – Low hazard zone 63 m to 2100	7512
Recession (S3) to 2100 Low hazard zone (open coast soft sed. shore) – to possible natural recession limit	9312
Recession (S3) to 2100 Low hazard zone (sheltered soft sed. shore) – to likely natural recession limit	10311
Recession (S3) to 2050 Med hazard zone (sheltered soft sed. shore) – to possible natural recession limit	12309
Recession (S3) to 2100 Low hazard zone (open coast soft sed. shore) – to likely natural recession limit	13110
Medium-term potential recession hazard zone (normal soft rocks) – Med hazard zone 28 m to 2050	14307
Recession (S3) to 2050 Med hazard zone (open coast soft sed. shore) – to possible natural recession limit	15207
Recession (S3) to 2050 Med hazard zone (sheltered soft sed. shore) – to likely natural recession limit	15306
Recession (S3) to 2050 Med hazard zone (open coast soft sed. shore) – to likely natural recession limit	17205
Near-term potential recession hazard zone (normal soft rocks) – High hazard zone 14 m to 2030	18105
Storm bite (S1 + S5) hazard zone for sheltered shores (sandy shores backed by moderately rising hard bedrock)	20202
Storm bite (S1 + S5) High hazard zone (sheltered soft sed. shore) – to possible natural recession limit	21003
Storm bite (S1 + S5) High hazard zone (open coast soft sed. shore) – to possible natural recession limit	21102
Storm bite (S1 + S5) High hazard zone (sheltered soft sed. shore) – to likely natural recession limit	22101
Storm bite (S1 + S5) hazard zone for exposed shores (sandy shores backed by moderately rising hard bedrock)	24000
Storm bite (S1 + S5) High hazard zone (open coast soft sed. shore) – to likely natural recession limit	24100

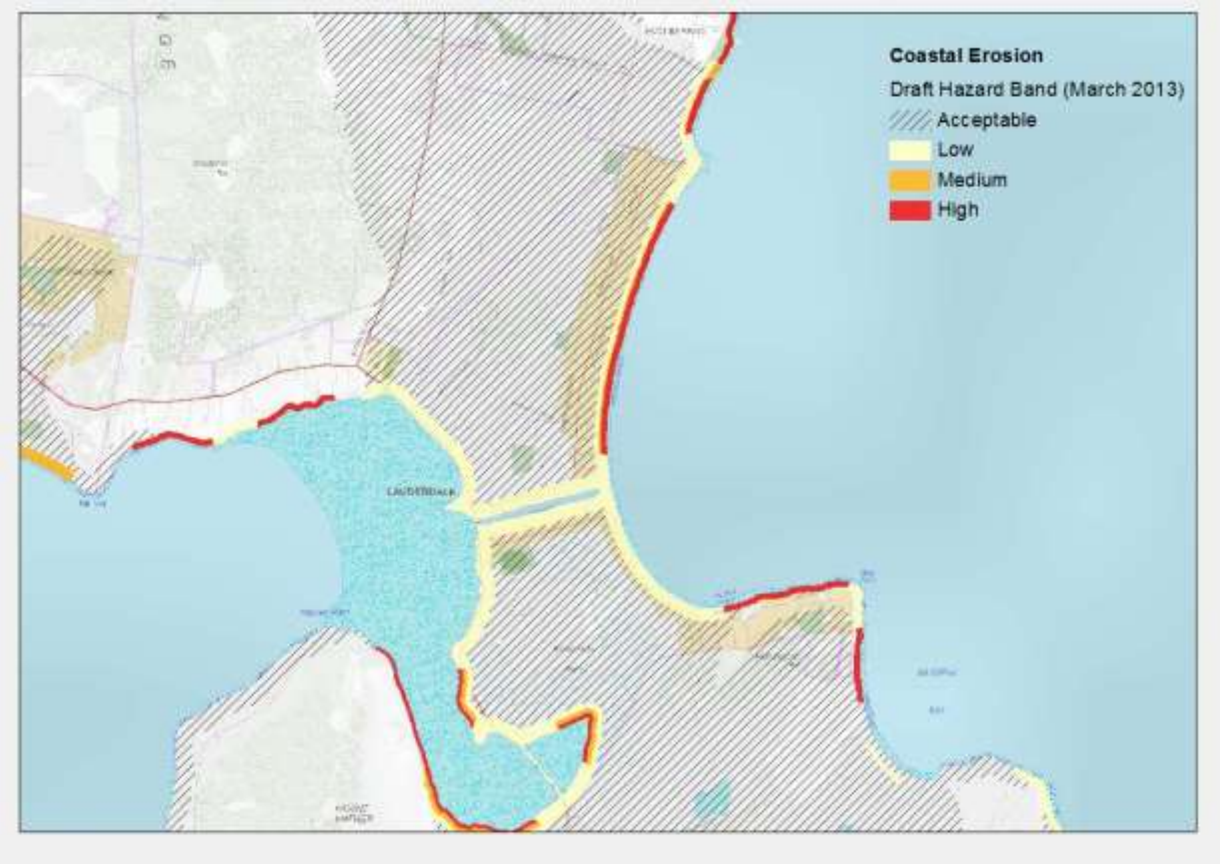


Figure 12 *Indicative coastal erosion hazard band mapping (Ralphs Bay – Lauderdale area)*

Considering the above the coastal erosion hazard bands are outlined in Table 9.

Table 9 Definition of coastal erosion hazard bands

Acceptable	This area is resilient to coastal erosion (hard rock shore), or is beyond the predicted recession of the coast to 2100.
Low	This area is vulnerable to coastal recession to 2100, or is protected by coastal defences that are considered resilient for planning purposes.
Medium	This area is vulnerable to coastal recession to 2050
High	This area is vulnerable to two back to back 1% AEP erosion events that result in a storm bite and associated slumping.
Coastal Erosion Investigation Area	This area does not have adequate information to judge if it is in a hazard band and requires a site specific assessment.

6.2.3 Coastal erosion investigation area

The coastal erosion investigation areas represent areas of the State which have insufficient information to classify into a hazard band. While the coastal erosion investigation areas represent identifiable errors within the underlying data, including incomplete data to classify into a component or has a logical inconsistency within the data set. However, such areas do not include areas with inaccurate underlying data that could only be identified with extensive fieldwork or local knowledge.

As a basis for the creation of the coastal erosion investigation area the following assumptions were used to testing the coastal erosion hazard areas for errors and inconsistencies:

- All parts of the coast have been classified into a hazard component and coastal erosion hazard band (hazard band) including high, medium, low, coastal erosion investigation area, or acceptable. The hazard bands have been supplied by DPAC as an output of the Coastal Hazards Planning Report (in draft).
- Not all hazard components will intersect with the coast line (some are present only landwards of the coast line).
- The coastline for the purposes of this hazard banding is the cartographic LIST HWM line, which is based on cartographic interpretation of air photos and may not be correct in all locations.
- Temporal and some spatial / attribute errors cannot be validated through this process and should be reviewed in a local context.
- Coastal erosion hazard banding is based on the project data set tascoasterosionhazardbands_v1_2013_MGA.shp.
- Higher hazard bands should not occur landwards of lower hazard bands (such situations may be validly based on accurate base data, for example where soft Tertiary clays overlie a hard rock shoreline just landwards of the shore; however in such cases the Tertiary clays are effectively protected from marine erosion and thus are not actually at higher risk of erosion than the hard shore).

6.2.4 Analysis of the coastal erosion planning boundaries

Understanding the impact of the coastal inundation planning boundaries is important when gauging the effect of policy on the Tasmanian community. The assessment focuses on the total area of private and public land, the number of residential properties, and the number of vacant parcels. The analysis is provided at both the State level (body of the report) and for each local government area (see *Appendix 6*) and includes:

- The area (hectares) of land in each band.

  The low-medium-high and coastal erosion investigation area contains approximately 0.49% of Tasmania's land mass. *Figure 13* shows the proportion of the land and the area in hectares within each band. Of note is the coastal erosion investigation area. The majority of this area is located on the southern and western coasts of Tasmania and the Furneaux Islands. *Appendix 6* provides a table of areas (ha) for each LGA.

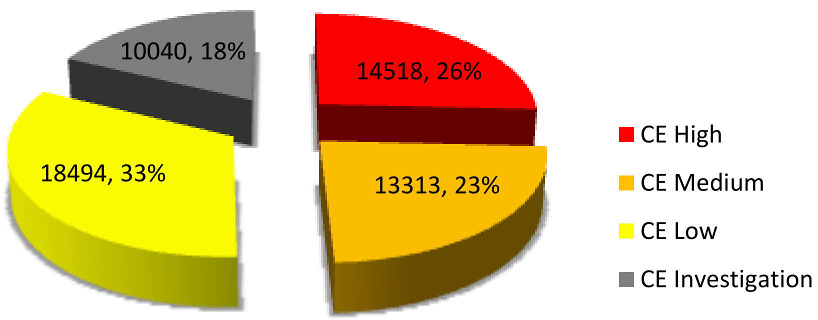


Figure 13 *Coastal erosion hazard band area (area hectares, and proportion of area within a hazard area)*

- The number of residential dwellings is based on a 10 m building envelope around the centre point of the building supplied by LIST data services and is correct at the time of publication for each 1:25 000 topographic map series.

  Calculation of the number of residential buildings is based on a simple intersect between the hazard band and the envelope of the building. In which the highest hazard band the envelope intersects is the hazard value assigned to it[17].

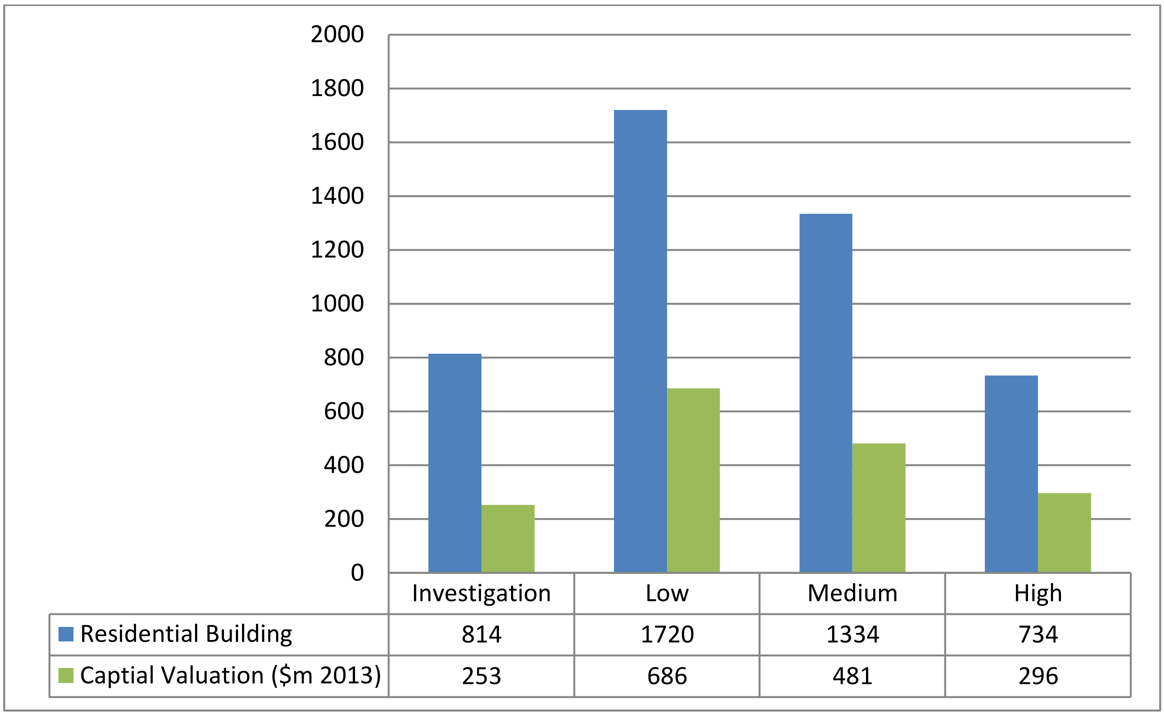
  This is shown in *Figure 14,* where adjacent houses may be in or out depending on the location of the centre point for the house.

Figure 14 *Calculating the number of houses impacted*

Approximately 2.8% of residential building envelopes are within the Investigation Area Low-Medium-High coastal erosion hazard bands. *Figure 15* provides an overview of the number of residential buildings in each band, their capital value and the area of developable land. Based on the modelling it is expected that:

- The number of residential building envelopes vulnerable to coastal erosion will grow from 769 present-day to between 4 001 and 5 188 by 2100, or with a 0.8 m SLR. That is a five-fold increase in vulnerability.
- The value of the residential building vulnerable to coastal erosion will grow from $307 million at present-day to between $1 526 and $2 002 million by 2100, or with a 0.8 m SLR.

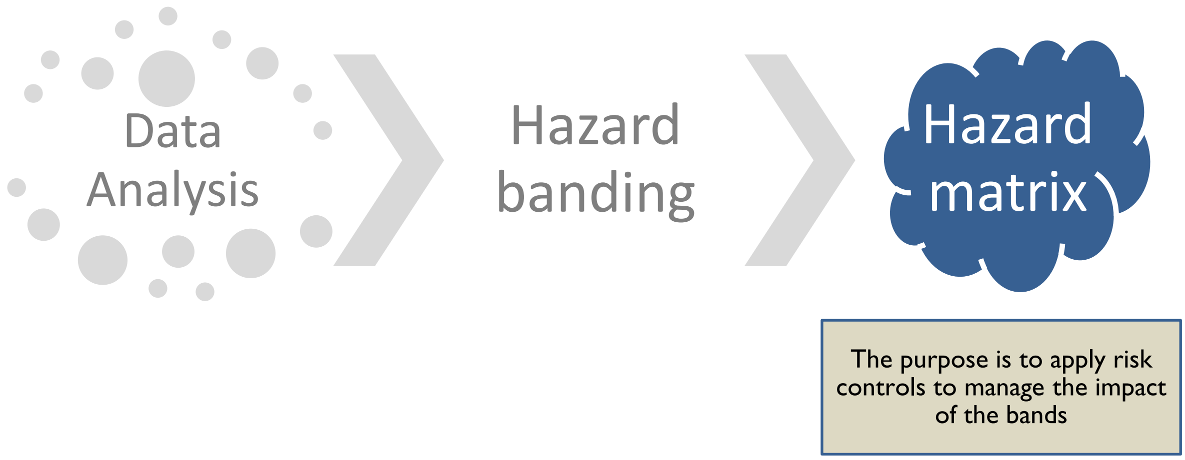
[17] Previous versions of this calculation were based on the house centroid: this was found to underestimate the potential impact.



	Investigation	Low	Medium	High
Residential Building	814	1720	1334	734
Captial Valuation ($m 2013)	253	686	481	296

Figure 15 *Summary plot of coastal erosion impacts: buildings and capital value*

6.3 Coastal erosion hazard planning matrix – evaluation and treatment of hazard



Based on the evidence and analysis of Tasmania's coastal erosion hazard risk described in the previous sections, and the outcomes of the workshop process, the recommended response to each coastal erosion hazard band for the development types *Greenfield, Infill* or *Existing* is outlined below. A summary of outcomes of the workshops is provided in *Appendix 1*.

The *Coastal Erosion Hazard Matrix* is divided into two sections: the first for strategic elements, while the second addresses the statutory guidance for the development of planning and building controls.

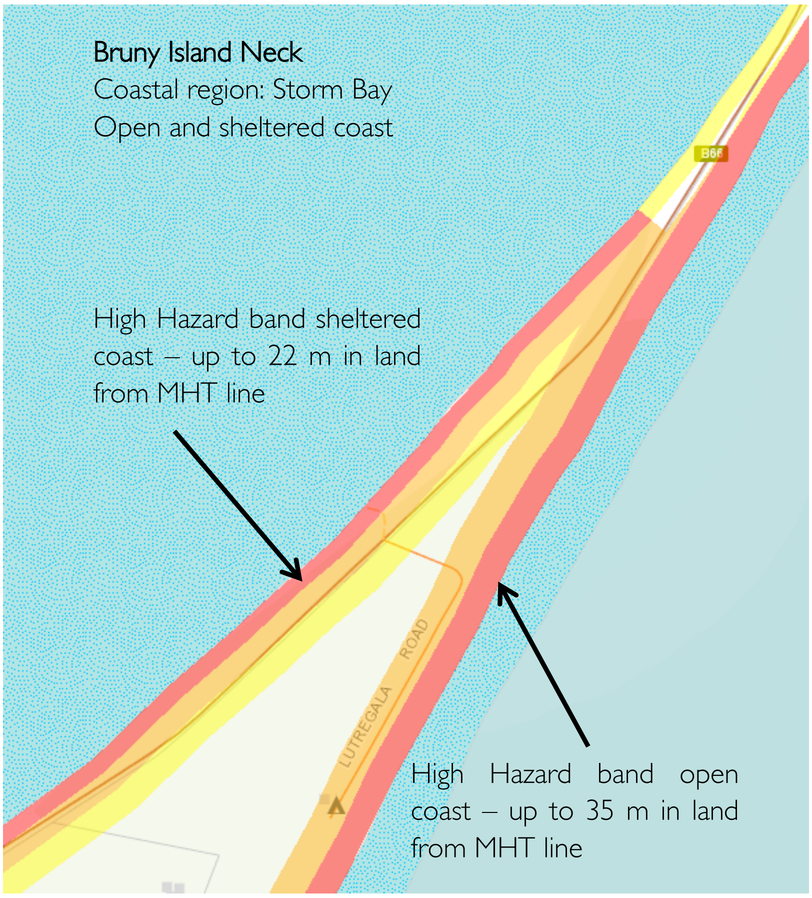
The *planning matrix (Sections 6.3.1 to 6.3.5)* includes the hazard banding, control levels, strategic planning level, and use and development controls. *Table 10* provides detail on vulnerable, hazardous, critical and coastal defences.

- *Planning bands (likelihood):* regions where it is presumed that the erosion hazard will exist at a relatively high, medium, low, or acceptable level

- ***Balance of controls:*** generalised statements regarding the presumed consequences associated with erosion hazard planning bands
- ***Strategic planning level:*** agreed measures that should be employed through strategic planning to determine if the benefits to the community of requiring consideration of whether development in certain areas is subject (or likely to be subject) to a natural hazard outweigh the costs to the community and individuals
- ***Planning and development controls:*** agreed measures that should be imposed on use to reduce risks from erosion. The measures consider rezoning, greenfield, infill, and existing use or development. Use and development controls are defined as:
  - ***Use controls:*** agreed measures that should be imposed on use to reduce risks from coastal hazards. *LUPAA* defines use as *"in relation to land, includes the manner of utilising land but does not include the undertaking of development".* For the purpose of coastal hazards, use types will be considered as *Greenfield, Infill, Existing* – and critical, vulnerable or hazardous.
  - ***Development controls:*** agreed measures that should be imposed on development to reduce risks in each hazard band. *LUPAA* defines development as:
    - the construction, exterior alteration or exterior decoration of a building
    - the demolition or removal of a building or works
    - the construction or carrying out of works
    - the subdivision or consolidation of land, including buildings or airspace
    - the placing or relocation of a building or works on land
    - the construction of, or putting up for display, signs or hoardings.
- ***Building controls:*** agreed measures that should be imposed on building to reduce risks in each hazard band to tolerable levels. The *Building Act 2000* provides for the control of the construction and maintenance of buildings and building or plumbing matters. Building work includes a proposed building, part of a building, a structure or a part of a structure. For the purpose of the hazard matrix it also includes works associated with the construction of the building.
-

6.3.1 Coastal erosion – high hazard band

Hazard Exposure	The High hazard band is vulnerable to erosion from two back-to-back 1% AEP storm events.
Description of area	The high hazard band represents the active coastal landforms areas extending from the mean high tide to between 22 m (East Coast) and 73 m (West and South West Coasts) inland depending on the coastal region and if the coast is, open or sheltered.

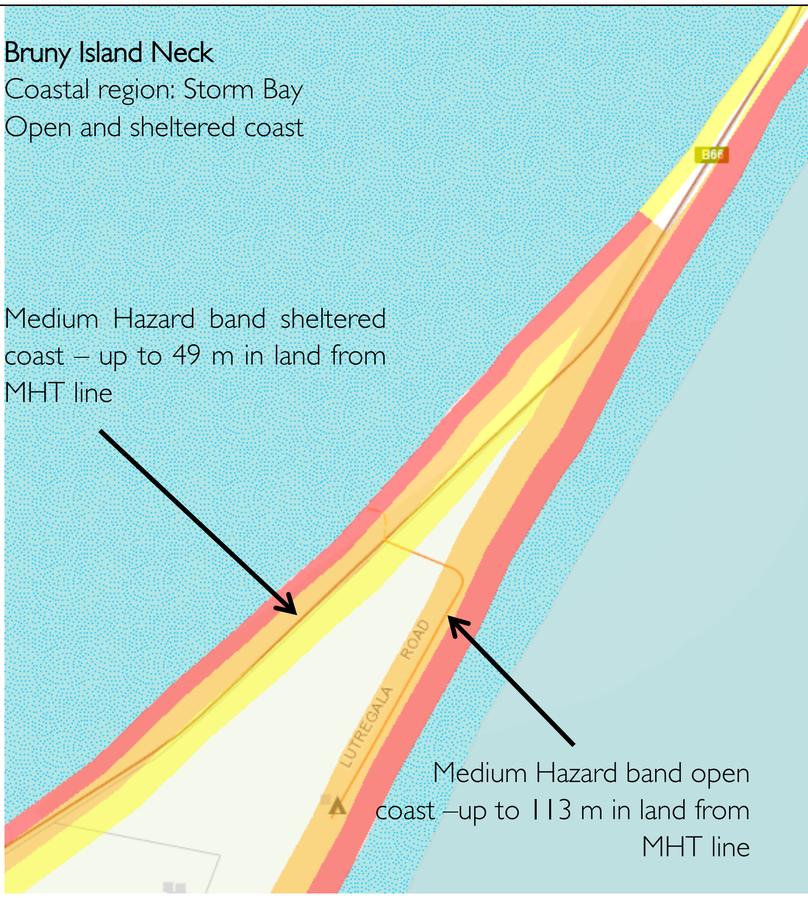
Example map of exposure	
Balance of controls	Planning and building controls are necessary for all use and development to ensure that risks are managed. If the area is an actively mobile landform then development is not permitted except for engineering or remediation works to protect land, property and human life. If the area is not an actively mobile landform then: • New use or development is not permitted unless it is coastally dependent or a development to an existing building; • Building controls apply for work to new and existing buildings and associated works requiring a building permit. The site should be considered problem site for coastal erosion. • Work must not increase the erosion or inundation risk to neighbouring properties.

Planning objectives

Strategic Objectives	This area should be zoned for non-residential or industrial use, and ensure new use or development on actively mobile landforms is not permitted with exception of works that minimise the areas need for engineering or remediation works to protect land property, and human life. Coastal defences, critical, hazardous, or vulnerable use and development are not permitted on actively mobile landforms unless they are part of works that minimise the area need for engineering or remediation works to protect land property, and human life.

Outside the Urban Growth Boundary	If the area is an actively mobile landform then development is not permitted except for engineering or remediation works to protect land, property and human life. If the area is not a actively mobile landform then: • Strategies should not permit zonings that allow new development. The exception being for utilities that cannot be reasonably located elsewhere or coastal-dependent uses that meet the objectives in Table 10 and minimise the need for engineering or remediation works. • Coastally-dependent or temporary use and development are allowed subject to demonstrating that they will meet the objectives in Table 10 and minimise the need for engineering or remediation works. • Other use or development, including and vulnerable, hazardous, critical uses or coastal defences not associated with an existing dwelling or a coastally-dependent use or development is not permitted.
Inside urban growth boundary	Infill use or development If the area is an actively mobile landform then development is not permitted except for engineering or remediation works to protect land, property and human life. If the area is not a actively mobile landform then: • New use or development, including and vulnerable, hazardous, critical uses not associated with a coastally-dependent use or development is prohibited. • Utilities that cannot be reasonably located elsewhere meet the objectives in Table 10 and minimise the need for engineering or remediation works. • Coastally-dependent (including coastal defences) or temporary use and development are allowed subject to demonstrating that they meet the objectives in Table 10 and minimise the need for engineering or remediation works.
	Existing use or development If the area is an actively mobile landform then development is not permitted except for engineering or remediation works to protect land, property and human life. If the area is not a actively mobile landform then: • Work to existing buildings will be managed through building control measures. • The substantial intensification of vulnerable, hazardous, critical uses or coastal defences are discretionary, subject to demonstrating that they achieve the relevant objectives in Table 10.
Building objectives	
Building and associated works.	Building design and associated works should consider the land as part of a coastal erosion area. In this area: • The design of the Building and Associated works should consider potential erosion through either hardening of the structures or by simplifying the relocation of the building to unaffected areas as the risk from erosion is realised. • A 'P' classification under AS2870 residential footing and foundations for erosion should be considered for the site classification. • Building and associated works must not increase the erosion or inundation risk to neighbouring properties and minimise the need for engineering or remediation works.

6.3.1 Coastal erosion – medium hazard band

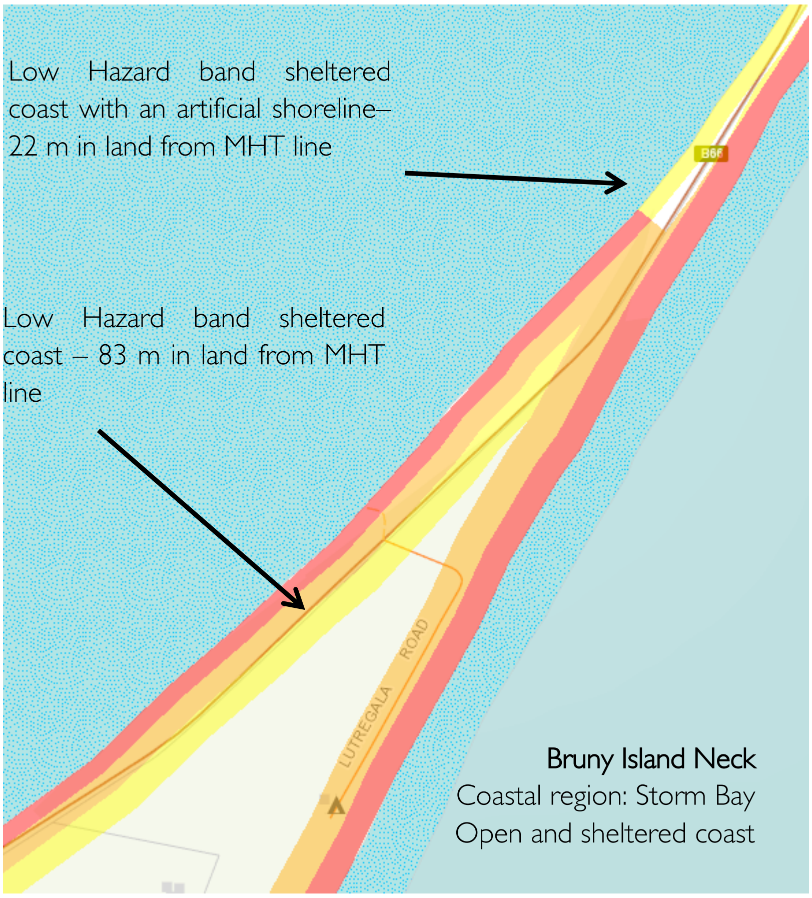
Hazard Exposure	The medium hazard band is the area vulnerable to coastal recession by 2050.
Description of area	The medium hazard band includes soft rock and soft sediment (sand) areas. This area extending from the MHT to between 28 m and 113 m inland depending on if the coast is made of soft rocks or sediments, the coastal region, and if the coast is, open or sheltered. While this area is vulnerable to coastal recession to 2050 due to SLR it is not an actively mobile land form system in the same vain as a frontal dune.
Example map of exposure	
Balance of controls	Planning and building controls are necessary for all use and development to ensure that risks are managed. Vulnerable, hazardous, or critical uses may be allowed if associated with a coastally dependent use. Building controls apply for all buildings and associated works requiring building permit. The site should be considered problem site for coastal erosion. Works must not increase the erosion risk for neighbouring properties.
Planning objectives	
Strategic Objectives	When broader planning considerations support the development of the area, the low and medium hazard band classification should not challenge the existing zoning in existing communities. However, if an area is to be rezoned to a more intensive use consideration of the hazard is required so that future development minimises the impact of the hazard.

Outside the Urban Growth Boundary	New use or development not requiring a building permit is allowed subject to demonstrating a tolerable risk to coastal erosion can be achieved while minimising the increase in risk to public asset or reliance on defensive structures. Vulnerable, hazardous, critical uses or coastal defences associated with an exisitng dwelling or a coastally-dependent use are allowed subject to demonstrating that they achieve the relevant objectives in Table 10.
Inside urban growth boundary	**Infill use or development** Infill use or development will be managed through building control measures. Vulnerable, hazardous, critical uses or coastal defences are discretionary, subject to demonstrating that they achieve the relevant objectives in Table 10.
	Existing use or development Work to existing buildings will be managed through building control measures. The substantial intensification of vulnerable, hazardous, critical uses or coastal defences are discretionary, subject to demonstrating that they achieve the relevant objectives in Table 10.
Building objectives	
Building and associated works.	Building design and associated works should consider the land as part of a coastal erosion area. In this area: • The design of the Building and Associated works should consider potential erosion through either hardening of the structures or by simplifying the relocation of the building to unaffected areas as the risk from erosion is realised. • A 'P' classification under AS2870 residential footing and foundations for erosion should be considered for the site classification. • Building and associated works must not increase the erosion or inundation risk to neighbouring properties and minimise the need for engineering or remediation works.

6.3.2 Coastal erosion – low hazard band

Hazard Exposure	This area has been identified as vulnerable to a coastal recession by 2100 based on the elevation, soil, or rock type of the area and current SLR models. Or This area is protected by a resilient defence for erosion.
Description of area	The low hazard band represents the coastal landforms that face long-term recession to 2100, including soft rocks and soft sediment areas. This area extending from the MHT to between 50 m and 83 m inland depending on if the coast is made up of soft rocks or sediments, the coastal region, and if the coast is, open or sheltered.

Example map of exposure



Balance of controls	While non-construction requirements are unnecessary for most use and development, the capacity for the use and development to adapt should be encouraged. Controls may be necessary to reduce the risks associated with vulnerable, hazardous or critical uses to ensure that residual tolerable risk is achieved. Building controls apply for all buildings and associated works requiring a building permit. The site should be considered problem site for coastal erosion. Works must not increase the erosion or inundation risk for neighbouring properties.

Planning objectives

Strategic Objectives	When broader planning considerations support the development of the area, the low and medium hazard band classification should not challenge the existing zoning. However, if an area is to be rezoned to a more intensive use consideration of the hazard is required so that future development minimises the impact of the hazard.
Outside the Urban Growth Boundary	New use or development not requiring a building permit is allowed subject to demonstrating a tolerable risk to coastal erosion can be achieved while minimising the increase in risk to public asset or reliance on defensive structures. Vulnerable, hazardous, critical uses or coastal defences associated with an existing dwelling or a coastally-dependent use are allowed subject to demonstrating that they achieve the relevant objectives in Table 10.

Inside urban growth boundary	**Infill use or development** Infill use or development will be managed through building control measures. Vulnerable, hazardous, critical uses or coastal defences are discretionary, subject to demonstrating that they achieve the relevant objectives in Table 10.
	Existing use or development Work to existing buildings will be managed through building control measures. The substantial intensification of vulnerable, hazardous, critical uses or coastal defences are discretionary, subject to demonstrating that they achieve the relevant objectives in Table 10.
Building objectives	
Building and associated works.	Building design and associated works should consider the land as part of a coastal erosion area. In this area: • The design of the Building and Associated works should consider potential erosion through either hardening of the structures or by simplifying the relocation of the building to unaffected areas as the risk from erosion is realised. • A 'P' classification under AS2870 residential footing and foundations for erosion should be considered for the site classification. • Building and associated works must not increase the erosion or inundation risk to neighbouring properties and minimise the need for engineering or remediation works.

6.3.3 Coastal erosion – acceptable hazard band

The acceptable hazard band is located outside of the high, medium, or low hazard bands and is within 1 km of the MHT mark. While this area may become vulnerable to erosion and recession beyond 2100 as the coastline and sea levels change or if a very rare or significant event does occur. Based on our current knowledge no planning, or building controls are considered necessary now.

6.3.2 Coastal erosion - investigation area

The classification of the coastal erosion investigation areas into a hazard band must be completed prior to the represent the areas the State does not have enough information to classify into a hazard band.

Consequently a localised technical investigation, that either applies the method used to compile the statewide coastal erosion hazard bands outlined in Sharples et al (2013)[18], can be used. Alternatively other methodologies may be used apply the definition associated with each of the Hazard Bands outlined in Table 9.

All methods should be applied at the site specific level and should be both peer reviewed and be completed by a suitably qualified person with appropriate skills, experience and qualifications in coastal engineering, geomorphology or geology.

The result of the assessment should be to map the land into the high, medium, low, or acceptable hazard banding for so as allow the appropriate application planning and building controls.

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18 http://www.dpac.tas.gov.au/divisions/climatechange/climate_change_in_tasmania/impacts_of_climate_change/coastal_impacts

Table 10 *Notes for vulnerable, hazardous or critical uses, coastal defences*

Coastal Erosion – notes for vulnerable, hazardous or critical uses, including coastal defences	
When allowed Use or development should demonstrate that they can meet the following objectives: a) the use or development is consistent with the *State Coastal Policy 1996*, a strategic plan for the community or a council policy relating to coastal defenses, or b) there is an insufficient increase in the level of risk to warrant any specific hazard reduction or protection measures, or c) a tolerable level of risk can be achieved and maintained for the type, form and duration of the use, **and** d) the appropriate clause(s) below:	
Critical use	A critical use must demonstrate that a coastal inundation event of 1% AEP in 2100 or coastal erosion to 2100 will not: a) impact on the ability of the use to function and maintain service during the event and recovery period b) interrupt business continuity in locations external to the immediate impact of the inundation event, and c) create a risk to the health or safety of a community from damage or disruption to a water supply or for the drainage and treatment of wastewater.
Hazardous use	A hazardous use must demonstrate that the release of a dangerous substance as a consequence of coastal inundation event of 1% AEP in 2100 or coastal erosion to 2100 will not impact on the health and safety of people, property, or the environment.
Vulnerable use	A hazardous use must demonstrate that a coastal inundation event of 1% AEP in 2100 or coastal erosion to 2100 that: a) the people who may live, work, or visit on the site have the capability to: i. protect themselves ii. evacuate in an emergency, and iii. understand and respond to instruction in the event of an emergency, and b) the level of risk to emergency personnel involved in evacuation and rescue is reasonable.
Coastal defences	When coastal defences are allowed, or part of a coastally-dependent industry, a report that considers the following must be ratified by the planning authority. The works: a) will not increase the risk of flooding or erosion to neighbouring properties b) will be both paid for by the proponent and have provision for the ongoing maintenance arrangements c) have the agreement of landowners d) mitigate the impacts of the hazard to 2100 (low hazard band), with the hazard band classification being changed from high or medium to low e) are able to be improved upon, and f) are designed by a suitably qualified person.

7 Coastal Inundation Hazard Assessment

7.1 Understanding coastal inundation planning bands evidence: identifying the hazard

The purpose is to translate the science into a format that can support policy development

MNHLUP indicative coastal inundation mapping is the result of a hazard assessment of the Tasmanian coastline for coastal flooding. The scientific background to this report is set out in *Coastal Inundation Mapping for Tasmania – Stage 2*[19] (Lacey et al 2012). The policy decisions incorporated in the report and indicative mapping are outlined below.

Coastal inundation is the natural process of land being flooded by the sea. Coastal inundation is driven by a complex range of processes and factors, including storm surge, tides, floods, tsunamis, changes in sea level, and the topography of the coastline. The influence of these processes and factors varies considerably across different coastal locations.

Work undertaken through the *MNHLUP* project focused on the relationship between storm surge, tides and changes in sea level. Other contributing factors, including floods (riverine and estuary) and tsunamis have not been considered.

7.1.1 Storm surge and tides

The assessment of storm surge and tide levels used the results and methods described in *Coastal Inundation Mapping for Tasmania – Stage* 2, work that built on the *Climate Futures for Tasmania (CFT) Extreme Tide and Sea Level Events Technical Report* (McInnes et al 2011). The assessment of storm surge was updated in May 2016 with a review of the methodology by McInnes and O'Grady (16 May 2016). The 2016 improved the sampling period to calculate the contributing factors to storm surge. *Figure 16* provides an overview of the contributing factors to storm surge and time that the CFT report summarises as:

> *Coastal sea levels vary on different timescales due to different physical forcing. Astronomical tides cause sea level variations on a range of time scales ranging from the (high and low tides), through fortnightly (spring and neap tides) to annual and longer timescales. Low pressure and strong winds associated with severe weather events can cause fluctuations in coastal sea levels, which are commonly called storm surge. Associated with storm surges are wind-driven waves, which can also contribute to elevated sea levels through wave set up. (McInnes et al 2011 p10).*

[19] The Coastal inundation stage 2 report was preceded by Mount et al 2010, *Tasmanian Coastal Inundation Mapping Project Report version 1.2*, Tasmanian Planning Commission (Consultant's Report); and Mount et al 2011, *Tasmanian Coastal Inundation Mapping Project Report version 2*, Tasmanian Planning Commission (Consultant's Report). A supplementary report is also available: Lacey et al 2015 *Coastal Inundation Mapping for Tasmania – Stage 3*. This report incorporates updated Light inferred Detection and Ranging elevation data for Tasmanian Coastal Communities.

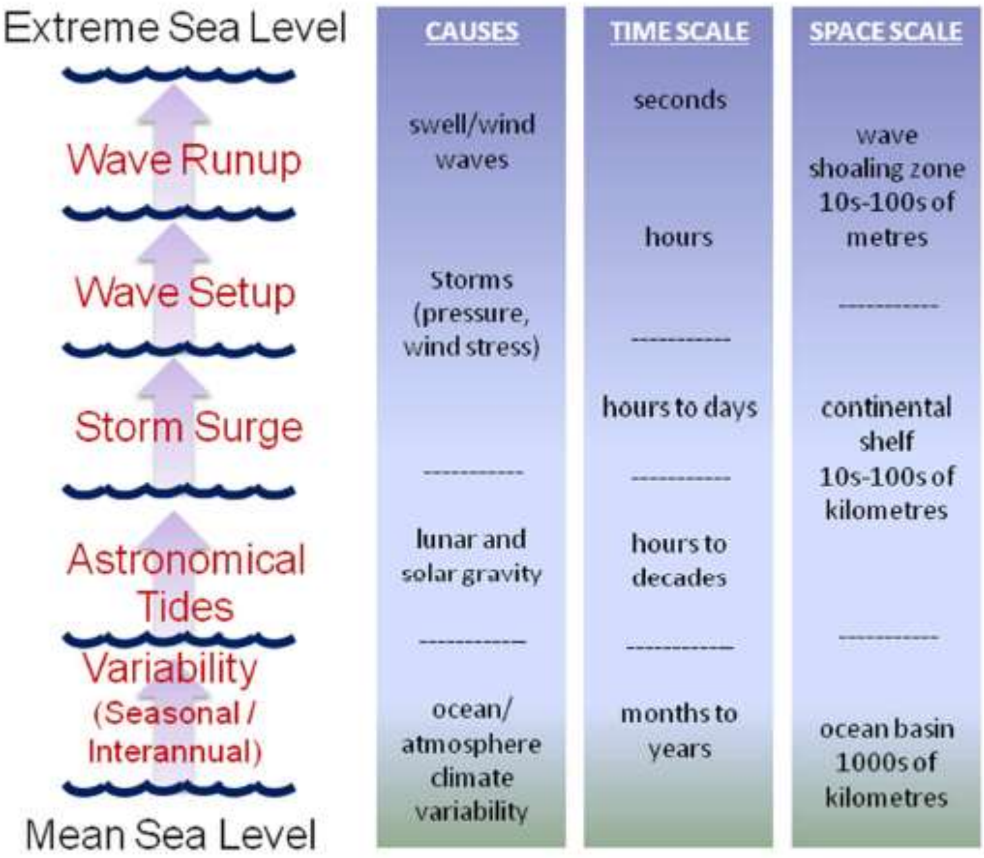

Figure 16 Oceanic phenomena that contribute to the total water levels at the coast during an extreme sea-level event, their causes and the time and space scales over which they operate (McInnes et al 2016)

Coastal Inundation Mapping for Tasmania – Stage 2 outlines the predictability of tides, based on current knowledge of past tides and the movement of the sun and moon, noting that this predictability cannot address changes in tidal level due to climate change. Conversely, storm surges and waves are only able to be described, in a statistical sense, as the average time between storm tide events (eg. AEP)).

As a result of the *MNHLUP* modelling work, 24 indicative flood maps were developed, which show the impact of inundation events between 0.005% AEP to 5% AEP for the years 2010, 2050 and 2075[20]. A height reference layer complements the indicative maps and provides the inundation levels around the Tasmanian coast in 1 km by 1 km grid squares. *Section 7.2* of this Report outlines the process used to refine the maps into the coastal inundation hazard bands.

[20] The maps show the impact of the following AEPs: 0.005%, 0.05%, 0.5%, 1.0%, 2.0% and 5.0%.

7.1.2 Sea level rise planning allowance

Tasmania's SLRPAs were implemented by the Tasmanian Government in August 2012 to promote consistent decision-making concerning future land use and development, and reduce the level of uncertainty around the management of future SLR for coastal areas. The rationale for the 2012 SLRPA[21] is described set out in the Derivation of the Tasmanian Sea Level Rise Planning Allowance – Technical paper, released by DPAC's TCCO in August 2012. The 2012 SLRPA is calculated using:

- the statistical distribution (95th percentile) of the IPCC's Fourth Assessment Report sea level projections for the 21st century under the A1FI emission scenario[22]; and
- the variability of present local tides, as outlined in Hunter (2011).

In May 2016 the Tasmanian Government engaged the CSIRO to develop SLRPAs for Tasmania based on IPCC AR5.

McInnes et al (2016) explains that RCP 8.5 most closely resembles the IPCC AR4 A1FI emissions scenario, which was adopted to derive the 2012 SLR PAs. McInnes et al (2016) derives SLR PAs for Tasmania based on the methodology outlined in Hunter (2012), using the statistical distribution of the 95 percentile for RCP 8.5 and the variability of present local tides.

This result is a regional appropriate change to the SLRPA from the previous level of 0.8 m by 2100 for all of Tasmania to between 0.92 m by 2100 in the North East of Tasmania to 0.82 m by 2100 in the Central North Coast.

7.1.3 Contributing factors *not* considered in this study

Work undertaken in this project focused on the relationship between storm surge, tides and changes in sea level. Other contributing factors, including wave set up and run up, riverine flooding and tsunamis, have not been included in this assessment.

Local wave set up and run up

The impact of local wave set up and run up were not included in the modelling undertaken by McInnes et al (2011) due to the complexity associated with modelling these impacts at the local level. Typically this work is only able to be undertaken at the local level, however future updates to the work may explore how wave set up and run up could be incorporated into the inundation models. In consideration of the current inability to account for this, minimum floor levels will consider the 1% AEP event in 2100. The rationale for this is discussed in *Section 7.2.1*.

Riverine flooding

In coastal areas, riverine flooding contributes to an increase in flood levels when combined with coastal inundation in the estuaries. Land use planning, building controls and emergency management processes are used to reduce Tasmania's vulnerability to riverine flooding. However, the current flood information base is insufficient time to produce flood levels for the estuaries, both in inundation models

[21] The August 2012 SLRPA included:

- Tasmania's SLRPA for 2050 - 0.2 m SLR above the 2010 MHT benchmark
- Tasmania's SLRPA for 2110 - 0.8 m SLR above the 2010 MHT benchmark

Mapping utilising the August 2012 SLRPA was released by the Government in in January 2014, and again in January 2016.

[22] The A1F1 emissions scenario is characterised by rapid economic growth, population growth and continued reliance on fossil fuels.

for the rivers and in understanding the statistical likelihood of tides, storm surge and riverine floods occurring at the same time. While studies have been undertaken in specific locations[23], this information has not been integrated into a statewide model due to differences in modelling parameters, the varying ages of the studies and methodologies used. The studies may be incorporated into the flood model on a case-by-case basis at LGA request.

To address this knowledge gap for flooding, the *MNHLUP* project is developing a methodology, in collaboration with the University of Tasmania and Entura, to inform consistent flood modelling for rivers and the cumulative impact of flooding in estuaries.

Tsunami

Tsunami is the generation of a wave by the sudden movement of the sea floor, typically earthquake. Tsunami differs from storm surges or tides as the wave extends from the sea floor to the surface. The *Tasmanian State Natural Disaster Risk Assessment 2012 (TSNDRA)* outlines the way in which parts of Tasmania (typically South-East Tasmania) have potentially been impacted by up to 16 events since 1852, with coastal water levels raised between 0.15 m and 2.4 m[24].

The *TSNDRA* risk assessment considered the risk of tsunami in the low to medium range and recommended further research to better understand potential impacts in vulnerable areas, the preparation and release of tsunami mapping, evacuation planning and the preparation of a 'State Special Plan for Tsunami'.

7.1.4 Digital Elevation Model

A Digital Elevation Model (DEM) is a digital representation of the land surface. For the purposes of this project, the DEM used a 'bare earth model', which means that no buildings or vegetation were included.

As coastal inundation has been mapped statewide, a combination of best-available information was used, including LiDAR and 10m contour data. The LiDAR dataset was supplied by Land Tasmania (DPIPWE) as a single DEM, with vertical accuracies of +/ 25 cm. LiDAR data was compiled from *Climate Futures for Tasmania LiDAR*[25] collected in 2010, GeoScience Australia data (collected 2014), Greater Hobart (2012), Launceston (2011), and *DPAC/Local Government Coastal Communities* (2014).

In areas where LiDAR data was not available, the area between the 10 m contour and the mean HWM was identified as the 'Coastal Inundation Investigation Area'. In this area, the height corresponding to the *High, Medium* and *Low* hazard bands is supplied in metres AHD.

Figure 17 shows the distribution of the DEMs used.

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[23] Studies undertaken in Huonville, Douglas River, Greens Beach, Launceston–Tamar River, Browns Rivulet and Georges River.

[24] Of the 16 events, only one has been above 0.9m. The 2.4 m 'freak wave' occurred on the Brid River in 1953 and resulted in the drowning of one child on a beach and damage to a jetty. The wave has no known trigger.

[25] Collected by Digital Mapping Australia (DiMAP) for the Antarctic Climate & Ecosystems Cooperative Research Centre (ACE CRC).

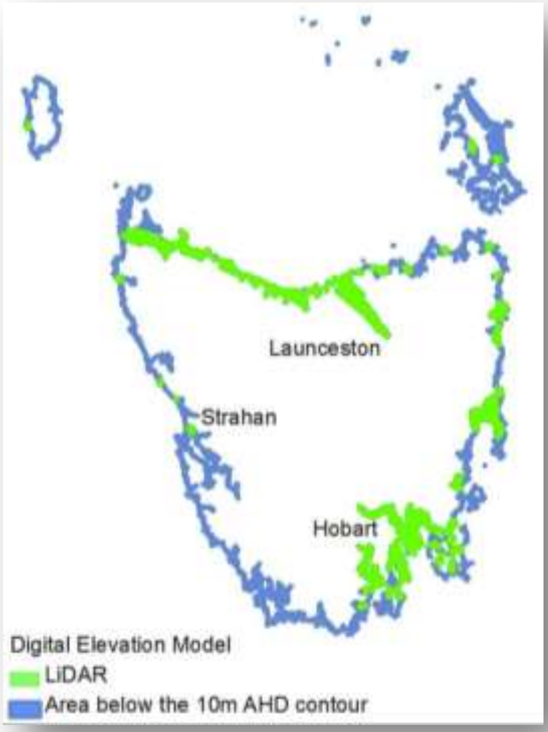


Figure 17 *DEM data used to map coastal inundation (LiDAR–10m contour)*

7.2 Defining coastal inundation hazard planning bands: analysing the hazard

The purpose is to apply policy judgements on the evidence and understand the impact of the bands

To develop the coastal inundation planning bands, ***six options** were developed*, based on current inundation standards and indicative mapping options. The six options were mapped and then assessed during a workshop with state and local government officers and industry groups. The six options are:

Inundation policy map options		*Rationale*
Option 1	Vulnerable to a: High = 1% AEP by 2100 Medium = 1% AEP 2050 and SLR 2050 Low = 1% AEP 2100 and SLR 2100	• Incremental increase in likelihood • Exposure increases over time • Includes storm tide hazard • SLR as it becomes an issue

Option 2	Vulnerable to a: High = 5% AEP events Medium = 1 % AEP events Low = 0.5% AEP events High, medium and low applies to each period (2010, 2050 and 2100) as a set of hazard bands	• Incremental increase in likelihood • Allows the full hazard to be understood
Option 3	Vulnerable to a: High = 5% AEP 2010 Medium = 1% AEP and SLR 2050 Low = 1% AEP and SLR 2100	• Incremental increase in likelihood • Identifies areas with an immediate hazard • SLR and storm tide as they become an issue
Option 4	Vulnerable to a: High = 5% AEP 2100 Medium = 1% 2100 AEP and SLR Low = 0.5% AEP 2100	• Focuses on the end of period • Incremental likelihood • Highly precautionary
Option 5	Vulnerable to a one % AEP in 2100	• Focuses on the end of the period • Equivalent to the 1% AEP river flood areas • Very simple
Option 6	Vulnerable to a: High = SLR 2050 (0.2 m) Medium = SLR 2100 (0.8 m) Low = 1% AEP 2100	• Identifies areas that will be lost due to SLR without defence • Incremental increase in risk • Differentiates between permanent inundation and temporary inundation • Most closely aligned to Clarence LGA

A workshop summary is included at *Appendix 1*. Each option was assessed for strengths and weaknesses by the workshop attendees. The preferred options from the workshops were Options 3 and 6.

7.2.1 Coastal Inundation Hazard Bands

Based on the preferred options identified at the workshops, a hybrid of Options 3 and 6 was used to progress development of the coastal inundation hazard bands. This hybrid allows for the progressive increase in vulnerability and separates the difference between permanent SLR inundation and temporary, storm-based inundation.

During subsequent consultation, the following ***coastal inundation hazard bands were agreed:***

Low	This area is vulnerable to a 1% AEP storm surge event in 2100. The elevation values used are provided in *Appendix 9 – Coastal inundation hazard band levels in metres AHD by LGA and Suburb.* This level will be considered the minimum floor level for the *Low*, *Medium* and *High* hazard bands. A 300 mm freeboard allowance for wave setup and runup has been added to the modelled storm surge elevations.
Medium	This area is vulnerable to a 1% AEP storm surge event in 2050. This area also contains all of the land that is vulnerable to a 0.8 m SLR by 2100 from the MHT in 2010. The elevation values used are provided in *Appendix 9 – Coastal inundation hazard band levels in metres AHD by LGA and Suburb.*

High	This area is vulnerable to a 0.2 m SLR by 2050 from the mean high tide in 2010. This area is currently vulnerable to the Highest Astronomical Tide. The elevation values used are provided in *Appendix 9 – Coastal inundation hazard band levels in metres AHD by LGA and Suburb.* A 300 mm freeboard allowance for wave setup and runup has been added to the modelled storm surge elevations.
Coastal Inundation Investigation Area	This area is not covered by LiDAR and is both below the 10 m contour[26] and within 1 km of the HWM[27]. In this area, elevations equivalent to the *High*, *Medium* and *Low* values are provided in *Appendix 9 – Coastal inundation hazard band levels in metres AHD by LGA and Suburb.*

The following additions to the hazard bands were also agreed during the consultation process:

- All elevations would be rounded up to the nearest highest 100 mm to allow for errors in the LiDAR-derived surface models.
- Inundation areas not contiguous with the coast would not be included in the hazard mapping. While these areas are artefacts in the data resulting from bathtub modelling undertaken, they may represent an area that is vulnerable to a rise in ground water as the sea level rises, requiring further investigation beyond this study.

Figure 18 describes the relationship between the *High-Medium-Low* bands with the tide ranges and storm surge events. *Table 11* shows the relationship between the current building regulations (which require a 300 mm increase from the designated flood height of MHWS, plus 600 mm) and the proposed minimum floor level of 300 mm above the 1% AEP in 2100.

This level will provide a precautionary level of protection for habitable rooms within the hazard bands until more methods are developed to model local wave set up and run up factors at regional or State levels. This level is consistent with the position applied by the Clarence City Council over and above the regulations in its planning scheme.

Coastal hazard bands

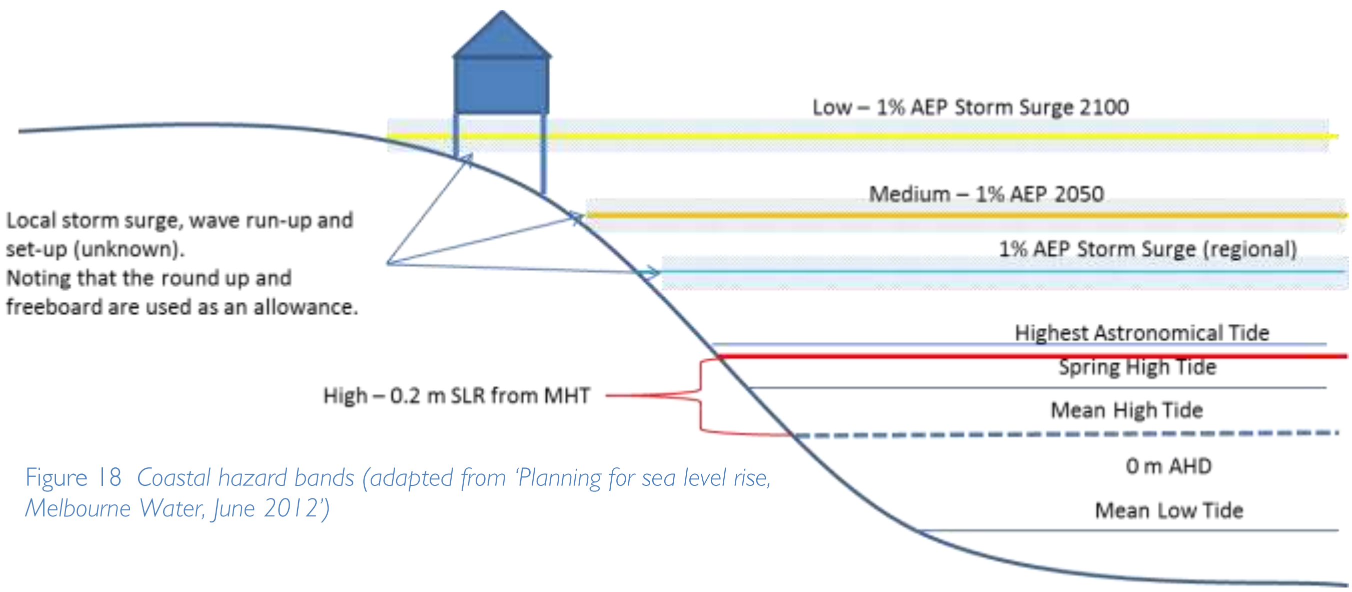


Figure 18 *Coastal hazard bands (adapted from 'Planning for sea level rise, Melbourne Water, June 2012')*

[26] The 10m contour was used in non-LiDAR areas as it is the only suitable, known elevation in these areas without further survey work.
[27] The SCP 1996 defines the coastal zone as being with 1km of the high water mark.

Table 11 *Comparison of building regulation floor levels and proposed floor levels*

			Building Regulations 2014, clause 15(c) (heights in m AHD83-TAS*)			Proposed coastal flood levels	
Port	ANTT Tidal Port (TP) Number	Tidal Port Version	MHWS (MHHW) (rounded up to nearest 0.1 m)	Designated Flood Level (+600 mm)	Minimum Floor Level (+300 mm)	1% AEP 2100 flood level rounded up to nearest 0.1 m	Minimum Floor Level (+300 mm)
Stanley	60900	28/11/2006	1.3	1.9	2.2	2.9	3.2
Burnie	60910	11/06/2009	1.3	1.9	2.2	3	3.3
Mersey River (Devonport)	60930	01/09/2006	1.3	1.9	2.2	3	3.3
Low Head	60948	04/04/2008	1.3	1.9	2.2	2.9	3.2
Spring Bay (Triabunna)	61170	12/06/2009	0.6	1.2	1.5	2.1	2.4
Hobart	61220	29/07/2009	0.7	1.3	1.6	2.2	2.5
Currie[28]	60827	22/09/2008	0.9	1.5	1.8	2.1	2.4

7.2.2 Analysis of the coastal inundation planning boundaries

Understanding the impact of the coastal inundation planning boundaries is important when gauging the effect of the hazard bands on the Tasmanian community. The indicators detailed in this Section provide the total area of private and public land, the number of residential properties and the number of vacant parcels. The methodology used to calculate values associated with each indicator value is provided at *Appendix 5*.

The analysis is provided at both state and LGA levels. State values are provided in the main body of the report and local government values are provided at *Appendix 7*. The assessment includes:

- area (hectares) of land in each band, of note is the investigation area with the majority being outside of the urban growth boundary and located on the South and West Coasts. Figure 19 provides the proportions each hazard band at the State level while Appendix 7 provides the breakdown for each LGA.

  The majority of the investigation area is outside current settlements, both in terms of proportion and area. *Appendix 7* provides a summary of the coastal investigation area for each LGA.

[28]AHD is not available on the Bass Strait Islands: local height datums apply: http://dpipwe.tas.gov.au/land-tasmania/geospatial-infrastructure-surveying/geodetic-survey/coordinate-height-and-tide-datums-tasmania

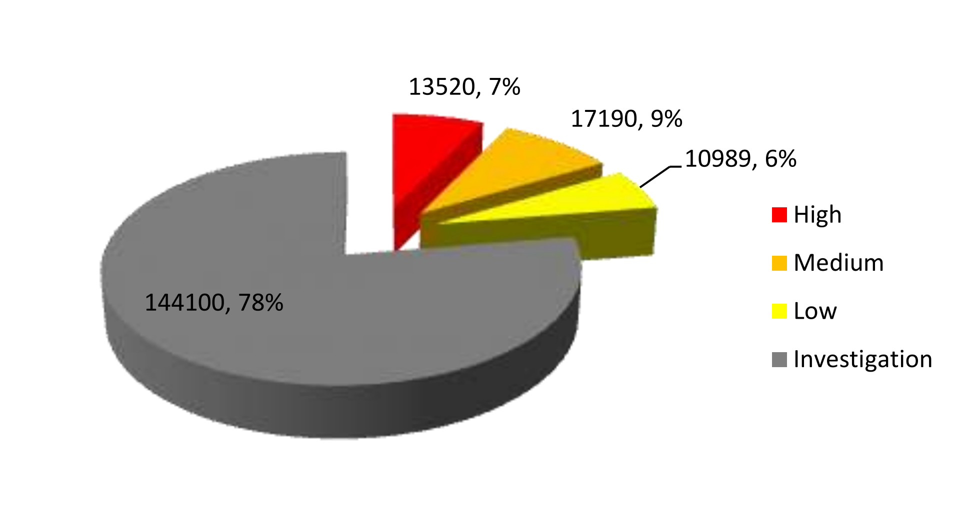


Figure 19 *Coastal inundation area (ha) state*

- the number of residential dwellings is based on a 10 m building envelope around the centre of the building supplied by LIST data services and is correct at the time of publication for each of the 1:25 000 topographic map series.

  Calculation of the number of residential buildings is based on a simple intersect between the hazard band and the envelope of the building. The highest hazard band the envelope intersects is the hazard value assigned to it.[29] This is shown in *Figure 20*, where near adjacent houses may be 'in' or 'out' depending on the location of the centre point for the house.

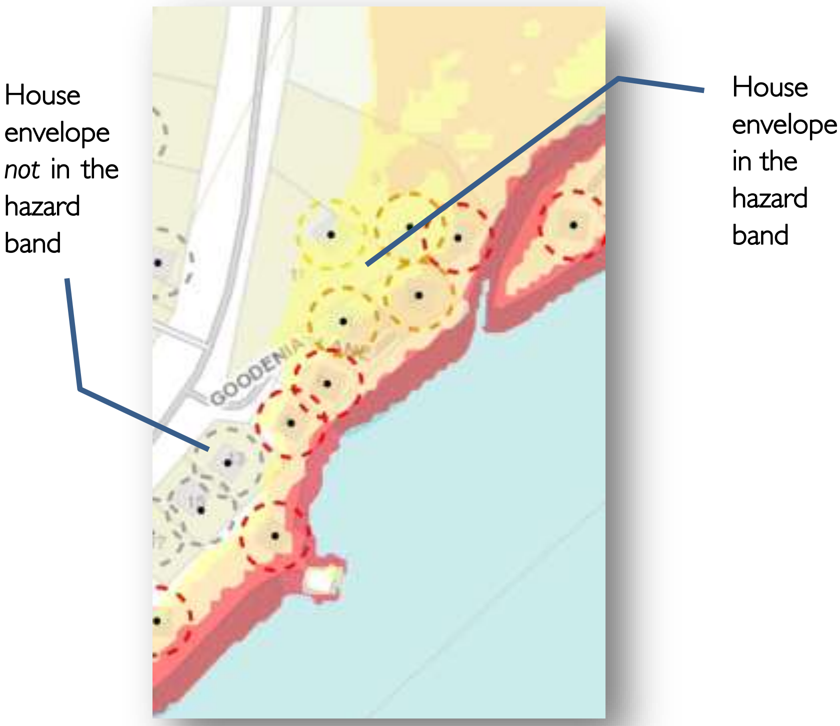
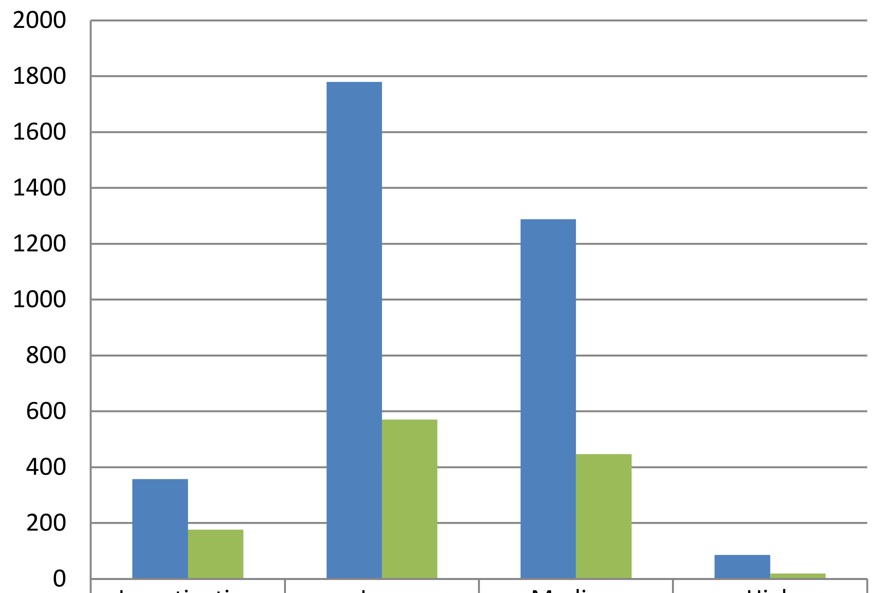


Figure 20 Calculating the number of houses impacted

[29] Previous versions of this calculation were based on the house centroid, this was found to underestimate the potential impact.

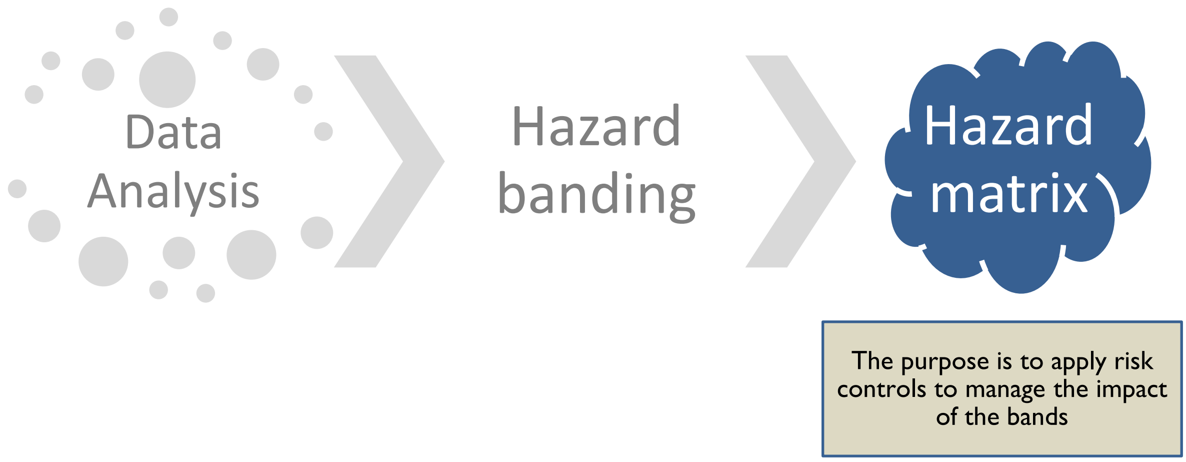
Approximately 1.2% of residential buildings will be vulnerable to coastal inundation by 2100. *Figure 21* provides a summary of the actual number of residential buildings, the associated capital value based on statutory valuations, and the amount of developable land in each of the hazard bands. *Appendix 7* breaks the graph into LGA and suburb for each of the hazard bands.



	Investigation	Low	Medium	High
Residential Buildings	357	1779	1288	85
Capital Valuation ($m/2013)	176	571	446	19

Figure 21 *Summary of coastal inundation impacts: buildings and capital value*

7.3 *Coastal inundation hazard planning matrix – evaluation and treatment of hazard*



Based on the evidence and analysis of Tasmania's coastal inundation hazard risk and the outcomes of the consultation process, the recommended responses to each coastal erosion hazard band for the development types *Greenfield, Infill* and *Existing* are outlined below.

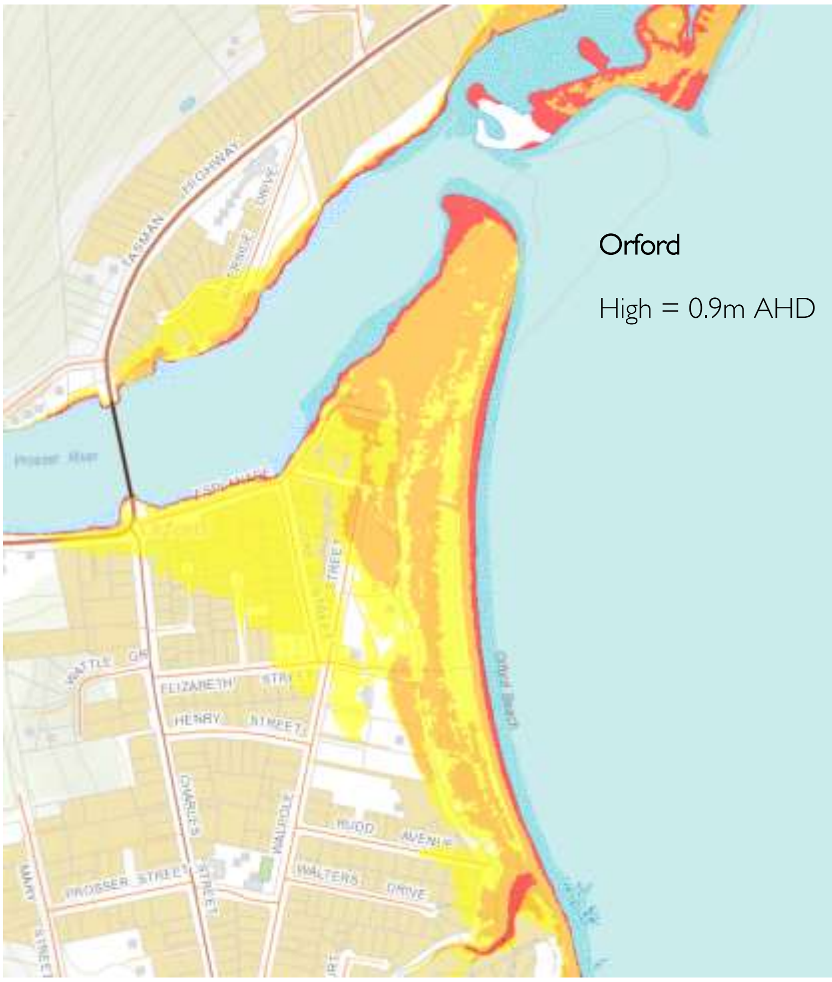
The ***Coastal Inundation Hazard Matrix*** is divided into two sections: the first is for strategic elements, and the second addresses the statutory guidance required to inform the development of planning and building controls.

The ***planning matrix (refer to Section 7.3.1** to **7.3.5)*** includes the hazard banding, control levels, strategic planning level, and use and development controls, while ***Table 13*** provides further detail on vulnerable, hazardous, critical and coastal defences.

- ***Planning bands (likelihood):*** regions in which it is presumed that an inundation hazard will exist at a relatively high, medium, low or acceptable level
- ***Balance of controls:*** generalised statements regarding the presumed consequences associated with inundation planning bands
- ***Strategic planning level:*** agreed measures that should be employed through strategic planning to determine if the benefits to the community of requiring consideration of whether development in certain areas is subject (or likely to be subject) to a natural hazard outweigh the costs to the community and individuals
- ***Planning and development controls:*** agreed measures that should be imposed on use to reduce risks from inundation. The measures consider rezoning, greenfield, infill, and existing use or development. Use and development controls are defined as:
    - ***Use controls:*** agreed measures that should be imposed on use to reduce risks from inundation. *LUPAA* defines use as *"in relation to land, includes the manner of utilising land but does not include the undertaking of development".* For the purpose of coastal hazards, use types will be considered as *Greenfield, Infill, Existing* – and critical, vulnerable or hazardous.
    - ***Development controls:*** agreed measures that should be imposed on development to reduce risks in each hazard band. *LUPAA* defines development as:
        - the construction, exterior alteration or exterior decoration of a building
        - the demolition or removal of a building or works
        - the construction or carrying out of works
        - the subdivision or consolidation of land, including buildings or airspace
        - the placing or relocation of a building or works on land
        - the construction of, or putting up for display, signs or hoardings.
- ***Building controls:*** agreed measures that should be imposed on building to reduce risks in each hazard band to tolerable levels. The *Building Act 2000* provides for the control of the construction and maintenance of buildings and building or plumbing matters. Building work includes a proposed building, part of a building, a structure or a part of a structure. For the purpose of the hazard matrix it also includes works associated with the construction of the building.

7.3.1 Coastal Inundation High hazard Band

Hazard Exposure	The High hazard band is vulnerable to SLR of by 2050 (Table 1) from the MHT. Note this area is also vulnerable to the Highest Astronomical Tide now.
Description of area	The area impacted is within the 20 year tide cycle, typically the North Coast of Tasmania has values around 1.8 m AHD while the East Coast has values around 0.9 m AHD.

Example map of exposure	
Balance of controls	New use or development is strongly discouraged unless it is coastally dependent as it would require significant mitigation measures to achieve, and maintain a tolerable level of risk. Mitigation measures may never achieve adequate levels of security and safety.

Planning objectives

Strategic Objectives	Strategies should indicate appropriate zoning outside the urban growth boundary includes open space, rural, agricultural or environmental purposes. The exception is for vital community infrastructure that cannot be reasonably located elsewhere or coastal-dependent developments. Existing use and development may be retained, maintained or redeveloped, but the opportunity to intensify development for infill develop these areas must be minimised so as not to increase public risk. Critical, hazardous, vulnerable or defensive works not associated with a coastal dependent use are prohibited.

Outside the Urban Growth Boundary	Coastally-dependent or temporary use and development are allowed. They must demonstrate a tolerable risk to coastal inundation is achievable for the duration of the proposed use and development. Other use or development, including and vulnerable, hazardous , critical uses or coastal defences not associated with an existing dwelling or coastally-dependent use or development are prohibited. The uses associated with coastal- dependent uses must demonstrate that they achieve the relevant objectives in Table 12.
Inside urban growth boundary	**Infill use or development** Coastally-dependent (including associated defensive works) or temporary use and development are allowed, subject to demonstrating that they achieve the relevant objectives in Table 12. Infill use or development is prohibited. Coastal defences are discretionary, subject to demonstrating that they achieve the relevant objectives in Table 12.
	Existing use or development Changes to existing use and development are allowed and will be managed through building control measures. Vulnerable, hazardous or critical use, including coastal defences, are discretionary subject to demonstrating that they achieve the relevant objectives in Table 12.
Building objectives	
Building and associated works.	Building and associated works should consider this area as part of the coastal inundation area. In this area: • Designs should consider how buildings may be relocated as inundation becomes a regular occurrence towards 2100. • Floor heights for habitable rooms should be 300 mm above the 1% AEP in 2100 (see *Appendix 9*). • Building and associated works must not increase flood or erosion risk to neighbouring properties or public infrastructure. • Minor extensions or internal modifications are not subject to control.

7.3.2 Coastal Inundation Medium Hazard Band

Hazard Exposure	The Medium hazard band is vulnerable to a 1% AEP storm tide event in 2050.
Description of area	This area is up to 35cm higher than the 1% AEP storm tide even now, with East and West Coasts having levels around 1.7 m, and North Coast around 2.7 m AHD.

Example map of exposure	
Balance of controls	Planning controls are necessary for all use and development to ensure that risks are managed. Any vulnerable or hazardous use will only be allowed in exceptional circumstances. Building controls should consider this area as part of the coastal inundation area and not increase the flooding risk to neighbouring properties. Also consider changes to natural drainage paths, wastewater or stormwater on and from the site as part of the building and associated works.

Planning objectives

Strategic Objectives	Strategies should indicate appropriate zoning outside the urban growth boundary includes open space, rural, agricultural or environmental purposes. The exception is for vital community infrastructure that cannot be reasonably located elsewhere or coastal-dependent developments. Existing use and development may be retained, maintained or redeveloped, but the opportunity to intensify development for infill develop these areas must be minimised so as not to increase public risk. Critical, hazardous, vulnerable or defensive works not associated with a coastal dependent use are prohibited.

Outside the Urban Growth Boundary	Coastally-dependent or temporary use and development are allowed. They must demonstrate a tolerable risk to coastal inundation is achievable for the duration of the proposed use and development. Other use or development, including and vulnerable, hazardous, critical uses or coastal defences not associated with an existing dwelling or a coastally-dependent use or development are prohibited. The uses associated with coastal-dependent uses must demonstrate that they achieve the relevant objectives in *Table 12*.
Inside urban growth boundary	Infill use or development Infill use or development requiring a building permit will be managed through building control measures. Coastally-dependent or temporary use and development, including associated coastal defences are allowed. They must demonstrate a tolerable risk to coastal inundation is achievable for the duration of the proposed use and development. Vulnerable, hazardous, critical uses or coastal defences are discretionary subject to demonstrating that they achieve the relevant objectives in Table 12.
	Existing use or development Changes to existing use and development are allowed and will be managed through building control measures. Vulnerable, hazardous or critical use, including coastal defences, are discretionary subject to demonstrating that they achieve the relevant objectives in *Table 12*.
Building objectives	
Building and associated works.	Building and associated works should consider this area as part of the coastal inundation area. In this area: • Designs should consider how buildings may be relocated as inundation becomes a regular occurrence towards 2100. • Floor heights for habitable rooms should be 300 mm above the 1% AEP in 2100 (see *Appendix 9*). • Building and associated works must not increase flood or erosion risk to neighbouring properties or public infrastructure. • Minor extensions or internal modifications are not subject to control.

7.3.3 Coastal Inundation Low Hazard Band

Hazard Exposure	This area is vulnerable to a 1% AEP storm tide event in 2100. .
Description of area	The area ranges in height from 3.3 m AHD in Base Strait to 2.4 m AHD on the South East Coast.

Example map of exposure	
Balance of controls	Non-construction requirements are not necessary for most uses. Controls may be necessary to reduce risks associated with vulnerable, hazardous or critical uses to ensure the residual risk is tolerable. Building controls should consider this area as part of the coastal inundation area and not increase the flooding risk to neighbouring properties. Also, consider changes to natural drainage paths, wastewater or stormwater on and from the site as part of the building and associated works.

Planning objectives

Strategic Objectives	When broader planning considerations support the development of the area, the low band should not change existing zoning. However, if an area is outside the urban growth boundary and is to be rezoned to a more intensive use, or is within a urban growth boundary undergo substantial infill development through intensification or redevelopment, consideration of the hazard is required so that future development minimises the impact of the hazard. Critical, hazardous, vulnerable or defensive works are allowed (ie. permitted or discretionary)

Outside the Urban Growth Boundary	New use or development not requiring a building permit is allowed subject to demonstrating a tolerable risk to coastal inundation can be achieved while minimising the increase in risk to public asset or reliance on defensive structures. Vulnerable, hazardous, critical uses or coastal defences not associated with a coastally-dependent use or development are prohibited. Vulnerable, hazardous, critical uses or coastal defences associated with an existing dwelling or a coastally-dependent use are allowed subject to demonstrating that they achieve the relevant objectives in Table 12.
Inside urban growth boundary	Infill use or development Infill use or development requiring a building permit will be managed through building control measures. Coastally-dependent or temporary use and development, including associated coastal defences are allowed. They must demonstrate a tolerable risk to coastal inundation is achievable for the duration of the proposed use and development. Vulnerable, hazardous, critical uses or coastal defences are discretionary subject to demonstrating that they achieve the relevant objectives in Table 12.
	Existing use or development Changes to existing use and development are allowed and will be managed through building control measures. Vulnerable, hazardous or critical use, including coastal defences, are discretionary subject to demonstrating that they achieve the relevant objectives in Table 12.
Building objectives	
Building and associated works.	Building and associated works should consider this area as part of the coastal inundation area. In this area: • Designs should consider how buildings may be relocated as inundation becomes a regular occurrence towards 2100. • Floor heights for habitable rooms should be 300 mm above the 1%AEP in 2100 (see *Appendix 9*). • Building and associated works must not increase flood or erosion risk to neighbouring properties or public infrastructure. • Minor extensions or internal modifications are not subject to control.

7.3.4 Coastal inundation – acceptable hazard band

The acceptable hazard band is located outside of the high, medium, or low hazard bands and is within 1km of the mean HWM. While this area may become vulnerable to erosion and recession beyond 2100 as the coastline and sea levels change or if a very rare or significant event does occur. Based on our current knowledge no planning, or building controls are considered necessary at this point in time.

7.3.5 Coastal inundation - investigation area

The classification of the coastal erosion investigation areas into a hazard band must be completed prior to the represent the areas the State does not have enough information to classify into a hazard band.

Consequently a localised technical investigation, that either applies the method used to compile the statewide coastal erosion hazard bands outlined in Sharples et at 2013 [30], can be used. Alternatively another methodologies may be used apply the definition associated with each of the Hazard Bands outlined in Table 9.

All methods should be applied at the site specific level and should be both peer reviewed and be completed by a suitably qualified person with appropriate skills, experience and qualifications in coastal engineering, geomorphology, or geology.

The result of the assessment should be to map the land into the high, medium, low, or acceptable hazard banding so as to apply appropriate planning and building controls.

30
http://www.dpac.tas.gov.au/divisions/climatechange/climate_change_in_tasmania/impacts_of_climate_change/coastal_impacts

Table 12 *Notes for vulnerable, hazardous or critical uses, coastal defences*

Coastal Inundation – notes for vulnerable, hazardous or critical uses, including coastal defences	
When allowed Use or development should demonstrate that they can meet the following objectives: a) the use or development is consistent with the State Coastal Policy 1996, a strategic plan for the community or a council policy relating to coastal defenses, or b) there is an insufficient increase in the level of risk to warrant any specific hazard reduction or protection measures, or c) a tolerable level of risk can be achieved and maintained for the type, form and duration of the use, **and** d) the appropriate clause(s) below:	
Critical use	A critical use must demonstrate that a coastal inundation event of 1% AEP in 2100 or coastal erosion to 2100 will not: a) impact on the ability of the use to function and maintain service during the event and recovery period b) interrupt business continuity in locations external to the immediate impact of the inundation event, and c) create a risk to the health or safety of a community from damage or disruption to a water supply or for the drainage and treatment of waste water.
Hazardous use	A hazardous use must demonstrate that the release of a dangerous substances as a consequence of coastal inundation event of 1% AEP in 2100 or coastal erosion to 2100 will not impact on the health and safety of people, property or the environment.
Vulnerable use	A vulnerable use must demonstrate that a coastal inundation event of 1% AEP in 2100 or coastal erosion to 2100 that: a) the people who may live, work, or visit on the site have the capability to: i. protect themselves ii. evacuate in an emergency, and iii. understand and respond to instruction in the event of an emergency, and b) the level of risk to emergency personnel involved in evacuation and rescue is reasonable.
Coastal defences	When coastal defences are allowed, or part of a coastally-dependent industry, a report that considers the following must be ratified by the planning authority. The works: a) will not increase the risk of flooding or erosion to neighbouring properties b) will be paid for by the proponent and ongoing maintenance arrangements c) have the agreement of landowners d) mitigate the impacts of the hazard to 2100 (low hazard band), with the hazard band classification being changed from high or medium to low e) are able to be improved upon, and f) are designed by a suitably qualified person.

8 List of Appendices

- Appendix 1: Summary of workshops and consultations
- Appendix 2: Australian Hydrological Office port summaries
- Appendix 3: Summary of pre-reform planning controls
- Appendix 4: Coastal erosion pairwise assessment
- Appendix 5: Method to calculate indicator values
- Appendix 6: State & LGA indicators – coastal erosion
- Appendix 7: State & LGA indicators – coastal inundation
- Appendix 8: High hazard hotspots – inundation & erosion
- Appendix 9: Coastal inundation hazard band levels
- Appendix 10: Summary of Consultation

Appendix 1: Summary of workshops and consultations

The coastal hazards planning report was developed through a series of workshops held with local government, industry groups and state agencies. The process involved three sets of workshops, including:

Workshop Series One

The purpose of Workshop Series One was to review and agree on a definition for the hazard, including the scope of application for the definition, and an approach to mapping the hazard and draft consequence statements. Three workshops were held for landslip in Burnie, Launceston and Hobart during March 2013.

Participants

Name	Position	Organisation
Devonport Entertainment & Convention Centre – 13 March 2013		
Barry Magnus	Executive Manager Development Services	Waratah-Wynyard Council
Brian Edwards	SNR Engineer	Cradle Mountain Water
David Atkins	Manager Asset Strategy	Cradle Mountain Water
George Walker	Planning Officer	Circular Head Council
Sharon Holland	Strategic Planning Officer	Latrobe Council
Ian Newman	Consultant Planner to West Coast Council	West Coast Council
Patrick Earle	Regional Planner/Manager Planning Services	Burnie Council
Samantha Seaton	Planning Officer	Burnie Council
Carolyn Harris	Planning Officer	Burnie Council
Hobart Baha'i Centre – 22 March 2013		
Peter Meloy	Senior Statutory Planner	Glenorchy City Council
Stewart Johnson	Director, Strategy, Policy & Business Services	Tasmanian Planning Commission
Rowan Moore	Environmental Developmental Planner	Hobart City Council
Helen Ayers	Planner	Clarence City Council
Benj Krom	Planner	Clarence City Council
Dan Ford	Planner	Clarence City Council
Jon Doole	Manager Environmental Services	Kingborough Council

Participants

Name	Position	Organisation
Bridget Dwyer	Project Officer, Environmental Strategy	Glenorchy City Council
Hannah Sadler	Environmental Officer	Glenorchy City Council
Amanda Beyer	Planning Officer	Huon Valley Council
Shane Wells		Huon Valley Council
Grietje van Randen		Glenorchy City Council
Michael Comfort	Sectional Leader, Geoconservation Section	DPIPWE
Tony McMullan	Manager - City Strategy	Glenorchy City Council
Graham Green		STCA
Tim Turner	Manager Operations, Leases, Licences & Sales	Crown Land Services
Jess Feehely	Principal Lawyer	Environmental Defenders Office (Tas) Inc
Glen Wooley		TASPOL
Damian Mackey		STCA
Lance Stapleton		Southern Water Tasmania
Brett Chandler		Glenorchy City Council
Launceston Clarion Hotel City Park Grand – 20 March 2013		
Justine Brooks	Municipal Planner	George Town Council
Rohan Willis	Town Planner	Dorset Council
Jo Oliver		Flinders Council
Michael Purves	Municipal Planner	West Tamar Council
Karin van Straten		West Tamar Council
Michael Johnston	Inspector	DPEM
Maria Chledowska	Council Planning Officer	Launceston City Council
Peter Voller		DPIPWE
Kathy Noble	Coastal Planning Officer, Land Conservation	DPIPWE
Chris Colley	Regional Manager, Northern Region	Parks & Wildlife
Jos Phillips		

Outcomes

The following outcomes relate to the application of hazard treatment to coastal inundation:

1. Strength and weakness assessment of the six approaches to coastal inundation mapping as outlined in the presentation:

Inundation policy map options (attachment 10 provides the analysis for each option)	Strengths	Weaknesses	Rationale
Option 1 High = 1% AEP 2100 Medium = 1% AEP 2050 and SLR 2050 Low = 1% AEP 2100 and SLR 2100	Allows incremental controls. Sets a risk tolerance to flooding.	Confuses SLR with storm tide. Difficult to communicate the risk tolerance.	•Incremental increase in likelihood. •Exposure increases over time. •Includes storm tide hazard. •SLR as it becomes an issue.

Inundation policy map options (attachment 10 provides the analysis for each option)	Strengths	Weaknesses	Rationale
Option 2 For each period 2010, 2050 and 2100 have a set of hazard bands that: High = 5% AEP events Medium = 1% AEP events Low = 0.5% AEP events SLR	Allows for a range of responses depending on the likelihood. Comprehensive. Separates SLR from storm tide events. Allows a response to inundation hazard based on the project life of the use.	Complex. Hard to manage in a planning scheme. Difficult to communicate.	•Incremental increase in likelihood. •Allows the full hazard to be understood Initial reactions. •Too complex for land use planning or building. •This option has not been progressed.
Option 3 High = 5% AEP 2010 Medium = 1% AEP and SLR 2050 Low = 1% AEP and SLR 2100	Shows incremental risk. Allows incremental controls. Clear focus on what is at risk from coastal inundation.	Becoming complex. Difficult to communicate the risk tolerance in 2050 and 2100. Does not separate SLR from storm events.	•Incremental increase in likelihood. •Identifies areas with an immediate hazard. • SLR and storm tide as it becomes an issue.
Option 4 High = 5% AEP 2100 Medium = 1% 2100 AEP Low = 0.5% AEP 2100	Based on the asset life of a house. Focus on the end of period. Establishes the use in that period. Talk about the presumed use life. Don't focus on development – focus on the purpose of the use. Only considers storm events.	Focus on the end of period. Conservative option. 0.5% is outside of normal planning ranges for temporary inundation. Does not identify what is at risk from SLR. Only considers storm events.	•Focuses on the end of period. •Incremental likelihood. •Highly precautionary.
Option 5 1% AEP in 2100	Simple binary control. Triggers an intervention. Equivalent to what is used in river flooding.	Conservative. Does not identify the risk from SLR.	•End of period. •Equivalent to the 1% AEP river flood areas. •Very simple.
Option 6 High = SLR 2050 (0.2 m) Medium = SLR 2100 (0.8 m) Low = 1% AEP 2100	Separates recession and storm-based events. Storm tide is considered at the end of the period. The low band the equivalent flooding. Directly implements the SLRPAs in planning controls. Allows the treatment of permanent inundation in a different way to flooding.	Does not consider the incremental increase in storm events. The high and medium bands are still water	•Identifies areas that will be lost due to SLR without defence. •Incremental increase in risk. •Differentiates between permanent inundation and temporary inundation.

2. Based on the workshops there is a preference to further Options 3 and 6.

3. In progressing the coastal inundation mapping into a planning scheme overlay the following changes are to be considered:

- In non-LiDAR areas, use the 10 m contours as the basis for a coastal inundation investigation area. The investigation would look at a proposed use or development relationship to height in metres AHD.
    - It was noted that while the 25 m DEM areas identified areas that were vulnerable, it was not a

good tool for regulation.

    - Concern was raised that the 10 m contour will bring too great an area and an alternate level such as 5m contours should be considered.

- Round all values up to the nearest 100 mm, eg 1.62 m will be rounded to 1.7 m.
- Add 300 mm to the final values in order to translate the inundation areas to hazard areas that are equivalent to river flooding.
- Questions were raised for further investigation as to whether this should apply to both SLR and storm tide.

4. The strategic planning levels for high, medium, low and acceptable were considered appropriate to continue development of the matrix.
5. Concern was raised during the workshops that the current method to update the mapping for overlays in the planning system.

The following outcomes relate to the application of hazard treatment to coastal erosion:

1. During the presentation on coastal erosion by Chris Sharples the following matters were discussed:
    - Hazard buffers on sea cliffs have three options for mapping susceptibility:
        - Modelled cliff recession based on a 45-degree regression angle from the MHT mark.
            - It was discussed that the weakness of this is that the full cliff height from the seabed is poorly understood.
            - Further weakness was also noted that the 25m DEM does not identify cliffs or cliff heights very well.
        - Identify all land over 45-degree steepness that is adjacent to the sea, noting that:
            - It is a simple measure.
            - There is potential for overlap with landslide hazard.
            - It relies on the smartline to identify the location of sea cliffs.
        - Apply a simple buffer from MHT mark to signify that a cliff is present.
            - This relies on the smartline to identify the location of sea cliffs.
            - The draft erosion susceptible mapping used a 50m buffer from the base of the cliff.
    - Artificial shores will be identified through the smartline and set out basic criteria to assess the longevity of the erosion defence and a process to update the mapping.
2. The draft hazard banding for erosion susceptibility outlined during the workshops was broadly endorsed as a good starting point to continue the development of the hazard matrix for coastal erosion.

    The pairwise assessment will be repeated once the layers are refined based on the outcomes of the workshops.

Workshop Two

The second workshop, held in Launceston (October 2013) was a more focused consultation that applied the boundaries for the hazard bands, reviewed the consequence statements and considered the controls.

Participants

Graeme Hunt (Workplace Standards – Building Control), Kathy Noble (DPIPWE), Patrick Earle (BCC), Michael Purves (WTC), Leigh Stevens (BOD), Damian Mackey (STCA), Mathew Clark (PIA), Jessica Feehely (EDO), Dan Ford (CCC), Ross Lovell (CCC), Rowan Moore (HCC), Luke Roberts (DPAC-OSEM), Mat Healey (DPAC-OSEM), Jo Oliver (NMC), Phillip (DPIPWE), Gary (DPIPWE), Ashley (WWC).

Outcomes

Participants discussed the indicative mapping of coastal inundation and coastal erosion, along with the development of the policy. The following items reflect the key points from the workshop:

- The hazard banding for coastal hazards (erosion and inundation) reflect our current understanding of coastal processes and Government policy on climate change (SLR, change in storm frequency). The broad definitions of each hazard band are:
  - The high hazard band is the area most at risk from permanent inundation or a hazardous erosion event.
  - The medium hazard band is temporary inundation and coastal recession in 2050.
  - The low hazard band is temporary inundation and coastal recession in 2100.

Application of the hazard banding is slightly different from other hazard areas (landslide) in that the hazard is dynamic. The low band, in effect, covers the combined low-medium-high area. *Figure 1* below shows the relationship between the different hazard bands and MHT (blue line), land surface (brown) and each hazard band.

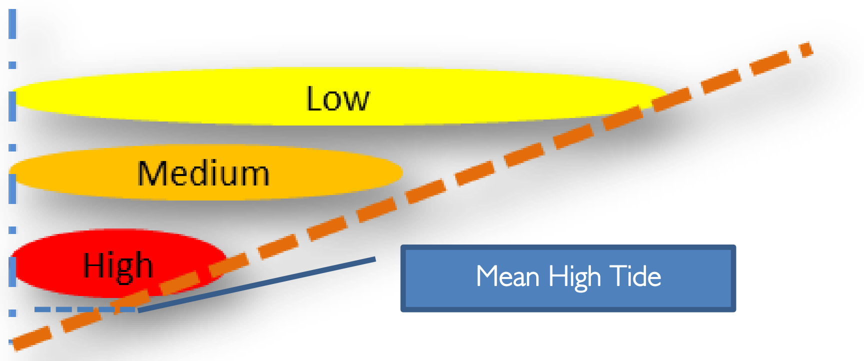


Figure 1 *Coastal Hazards Banding*

This overlap recognises that by 2050, the area affected by the high band will have either been submerged (inundation) or moved to impact further inland. The extent of this change is unknown beyond our current modelling. *Figure 2* bellow illustrates how the hazard bands for erosion and inundation may change by 2050.

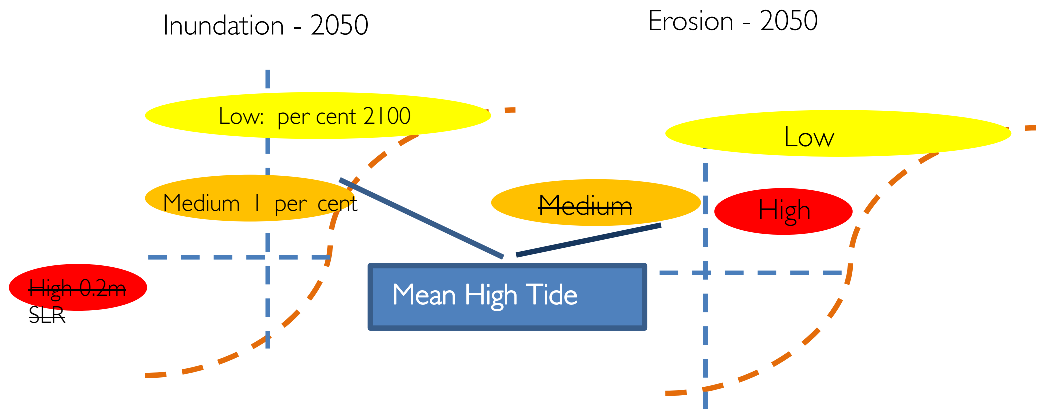


Figure 2 *Change in coastal hazard banding by 2050*

Figure 3 illustrates how the hazard bands for erosion and inundation may change by 2100:

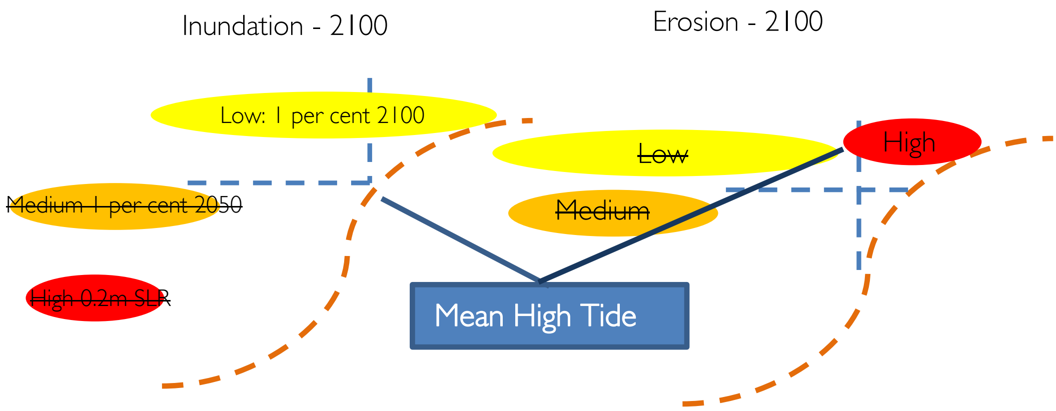


Figure 3 *Change in coastal hazard banding by 2100*

Given the change in how the hazard bands will be considered for inundation and erosion, the proposed hazard banding is outlined below:

Hazard banding – coastal inundation

The coastal inundation hazard bands are:

- Storm Surge in 2100 (1% AEP) is the low hazard area (spatial extent and height AHD)
- Storm Surge in 2050 (1% AEP) is the medium hazard area (spatial extent and height AHD)
- SLR in 2050 (0.2 m from 2010 MHT) is the high hazard area (spatial extent and height AHD)
- Coastal inundation investigation area is the area without a suitably accurate digital elevation model that requires further investigation on elevation (spatial extent and height AHD).

Each hazard band has three components including a spatial extent, a vertical elevation in metres AHD, and the hazard matrix.

The discussion noted that in areas with more detailed studies (typically estuaries) this work can be adopted over the state modelling. Some examples include:

- tidal – river flow models, such as the Upper Tamar river or Georges River, or
- coastal inundation modelling.

This modelling should take precedence over the state modelling in these areas.

Hazard banding – coastal erosion

The coastal erosion hazard bands are:

- Acceptable = the area beyond coastal recession by 2100 and not subject to controls.
- Low = the area vulnerable to coastal recession by 2100.
- Medium = the area vulnerable to recession to 2050.
- High = the area vulnerable to hazardous erosion in 2010.
- Coastal erosion investigation area = the area in which the underlying base data is poorly understood and requires further investigation.

Each hazard band is made up of the spatial extent and a geomorphic description for each component.

Outcomes for the hazard banding

- Support for a change in the way hazard bands for inundation and erosion are discussed
- Support for the revised coastal inundation hazard banding
- Support to use the 10 m contour and elevations in non-LiDAR areas
- Noted that estuaries such as Georges or Tamar River to use more detailed river flooding mapping where it exists
- Change the names of the hazard bands to reflect the temporal nature of the hazard, eg. the high band will become the SLR from MHT to 2050 (0.2 m AHD)
- Support the coastal erosion hazard banding
- Support the general investigation areas as a way to identify areas where the underlying data is not adequate
- Note that in the general investigation areas the development proponent would be required to demonstrate the erosion potential for storm or recession to 2050 and 2100

Broad outcomes relating to the hazard matrix

- The need for a better definition/explanation of compelling reasons
- In general, avoid the hazard unless there are compelling reasons
- The balancing of environmental (values and hazards), economic and social values with coastal hazard mitigation is part of the planning system as a whole through the coastal framework and coastal policy

Comment on the draft report (March 2016)

This is the summary of consultation undertaken on the draft report released March 2016.

- Coastal hazards, including inundation and erosion, are the result of natural processes that have the potential to cause considerable damage to communities, industries and infrastructure. These hazards are expected to be magnified by climate change and SLR, presenting significant risk to Tasmanian communities and the economy if they are not appropriately managed.

- In response to the risks presented by coastal inundation and erosion a Draft Coastal Hazards Package (the Draft Package) has been prepared. The Draft Package provides guidance for managing coastal hazards in the land use planning system. It adopts a risk-based approach based on the best available evidence to inform appropriate planning and building controls, including the coastal inundation and erosion codes in the draft State Planning Provisions.

- The Draft Package comprises the draft Coastal Hazards Summary Report, the draft Coastal Hazards Technical Report and draft coastal inundation and erosion mapping.

- On the 18 March 2016 the Minster of Planning and Local Government, Peter Gutwein MP, forwarded the Draft Package to industry bodies and the Local Government Association of Tasmania (LGAT) for comment. He also provided the Draft Package to the Tasmanian Planning Commission (TPC) for information. The Draft Package was also available on the Department of DPAC's website. The consultation period closed on 22 April 2016.

- LGAT ran information secessions for local government.

- DPAC's Office of Security and Emergency Management (OSEM) provided briefings to the West Tamar Council, the Launceston City Council, the Glenorchy City Council, TasNetworks, the Master Builders Association (Tas) and the Property Council of Australia (Tas).

- Submissions were received from the Property Council, the Housing Industry Association, Tas Water, Engineers Australia, Climate Tasmania, the Tasmanian Coastal Association (Environmental Defenders Office and BirdLife Tasmania), LGAT, the Kingborough Council, and the Hobart City Council.

Purpose of the consultation

- The consultation sought feedback on:
  - whether the Draft Package achieves the right balance between planning, building control and emergency management;
  - how the risk assessment and mapping could be improved;
  - information and resources that may assist organisations implementing the Package into their core business, including asset management, emergency management, and community or member awareness, as we planning and building controls; and
  - any other matters that may be considered relevant to the Package.

Consultation Outcomes and responses

- The comments universally supported the Draft Package highlighting it as a 'comprehensive response', 'pragmatic' and 'practical and sensible'. No negative comments on the broad subject matter or intent of the package were received.

- The current SLRPA based on the Intergovernmental Panel on Climate Change – Fourth Assessment Report: Climate Change (IPCC - AR4) was raised as an issue requiring further consideration.

  Response / recommended action: A review of the current SLRPA has been undertaken by DPAC's TCCO and the CSIRO. OSEM will update the Draft Package based on the outcomes of the review. The finalisation of the Package will be coordinated with the review of the SLRPA, expected to be completed in July 2016.

- The relevance of continuing to use Actively Mobile Landforms, as defined by the SCP, was questioned in light of the risk assessment methodology and improved coastal science that the Package presents.

Response / recommended action: A separate Minute will be prepared for the Minister for Planning and Local Government, in consultation with the Department of Justice, outlining a proposed response to this issue.

- The absence of a coincident flooding model in the estuaries was raised as potentially underestimating the inundation hazard in estuaries.

  Response / recommended action: This is significant scientific challenge for Tasmania. It requires a riverine flood model for all estuaries, a better understanding of the level of dependence between coastal inundation and riverine flooding, and a hazard assessment that takes into account how riverine flooding models interface with the coastal inundation hazard model.

  OSEM will, in the short term, amend the terminology in the mapping to highlight that coincident flooding has not been assessed. OSEM will develop a policy on how to include assessments of coincident flooding in to statutory tools.

  OSEM is developing a methodology to undertake a riverine flood assessment for Tasmania. The pre-feasibility assessment completed in May 2016 indicates that the proposed methodology is considered mature enough to undertake a feasibility assessment as a precursor to the development of a flood model. A funding application for the feasibility assessment under the National Partnership Agreement for the National Disaster and Resilience Grants Program is being developed with local government and the Department of Police, Fire, and Emergency Management. This application, if successful, will enable the project to be run across several phases - the first phase is a feasibility study, the second phase is refining the outputs and the third phase is undertaking a hazard assessment.

- Feedback was received that planning and building professionals and the community will need support to implement the Draft Package.

  Response/ recommended action: OSEM will write a project plan to support the development of appropriate support and guidance materials planning and building professionals and the public in consultation with key stakeholders.

- A number of editorial comments have been made.

  Response / recommended action: Editorial comments will be applied to the Package.

- Comments from the Building industry have raised the need to track the effectiveness of the reporting requirements and to adjust as appropriate.

  Response / recommended action: OSEM will liaise regularly with stakeholders to monitor how the changes are progressing.

State Planning Provisions

- No changes to the State Planning Provisions are required as a result of the consultation feedback on the Draft Package although, in the longer-term, resolving issues surrounding Actively Mobile Landforms and coincident flooding may mean some changes are necessary to the Coastal Erosion and Inundation Codes.

  Response / recommended action: The Minister for Planning and Local Government refers the consultation feedback to the State Planning Interdepartmental Committee (SPIDC).

Draft Building Regulations

- The consultation feedback on the Draft Package will inform the preparation of the Draft Building Regulations.

  Response / recommended action: OSEM to refer the consultation feedback to the Director of Building Control.

Appendix 2: Australian Hydrological Office port summaries

Port	ANTT Tidal Port (TP) Number	Tidal Port Version
Stanley	60900	28/11/2006
Burnie	60910	11/6/2009
Mersey River (Devonport)	60930	1/9/2006
Low Head	60948	4/4/2008
Spring Bay (Triabunna)	61170	12/6/2009
Hobart	61220	29/7/2009
Currie[31]	60827	22/9/2008

BM connections to datum

Station – Curry	Height (m)
BM "NW CNR Marine Board Building"	3.978
BM "170/2"	2.516
BM "Concrete deck level of jetty"	2.243 ± 0.005
BM "3.5 m mark of old tide board"	2.068
HAT	1.10
MHHW	0.94
HWM	0.793
MLHW	0.61
MSL	0.51
MHLW	0.42
AHD (King Island topographic datum)	0.118
MLLW	0.09
LAT (3d mm data, 2007)	0.00
ISLW	-0.02
170/2 summary Tide Board zero	-0.148
Adopted 3DMM LAT	-0.148
LWM	-0.307
SD (AHS Pty Ltd 1969/1970)	- 0.307
SD (1999)	-0.682
CD AUS 178 (NC 2002)	-0.707
Zero of old tide board (Cleeland 1999)	-1.432
TP Zero 3DMM long term gauge	-1.970

(Data levels are based on calculation of 3DMM dataset collected from 09 March 2007 to 10 July 2007.)

Other benchmarks in area but connection to LAT is unknown: nil

Station – Grassy Harbour	Height (m)
BM "F488"	4.156
BM "Station A Stern Ramp"	2.925
BM "F489" (1.426 +/-0.001m above F494 in 1998)	2.809 ± 0.001
HAT	1.90
MHHW	1.64
BM "F494 = Station B"	1.383
MLHW	0.98
MSL	0.92

[31] AHD is not available on the Bass Strait Islands – local height datums apply. See http://dpipwe.tas.gov.au/land-tasmania/geospatial-infrastructure-surveying/geodetic-survey/coordinate-height-and-tide-datums-tasmania

MHLW	0.86
MLLW	0.21
ISLW	0.07
LAT	0.00
Zero tide board PLA	-0.422
TGZ 3DMM long term gauge	-1.190

(Data levels are based on analysis results from 3DMM dataset collected from 08 March 2007 to 31 May 2007.)

CD (plans on AUS 178 NC June 2002)	Not yet assessed
CD (AUS 789 NC May 2003)	Not yet assessed

Other Benchmarks and sounding datum in area but connection to LAT is unknown:

SD (HI 271 Flinders 1998) to LAT: requires further consideration because of problems experienced and poor results that came out of tide gauges and pole versus gauge comparisons.

BM coping on south side of eastward end of old jetty at southern end of bay: do not use BM is 3.525m above MSL unless source documents (other than handwritten notes headed "Grassy Bay–King I Aus 789" and Mark Rayner email) can be located.

STN No 1 SH Nail in concrete at rear of ramp structure (not for use after 1999).

TBM (Temp BM) top of old bolt head on wooden wharf adjacent to temporary tide board (accuracy of any level +/- 0.01 – refer Cleeland letter dated 19 Feb 1999).

Station – Stanley	Height (m)
BM SPM 6235 RM 1 (being 4.917 m above AHD)	6.980
BM SPM 6235	5.493
PWD BM "seaward side concrete footing Fisherman's Co-op Preparation and Storage Building"	5.485
BM No 1	5.232
HAT	3.66
MHWS	3.28
MHWN	2.99
AHD	2.063
MSL	1.99
MLWN	0.99
MLWS	0.71
ISLW	0.44
LAT and ANTT Pred Datum 2007 – onward	0.00
CD (plan on AUS 178 NC June 2002)	~0.00
TG Zero 7 March 1966 to unknown and ANTT Pred Datum 1997 to 2006	-0.20
TG Zero prior to 7 March 1966	

(Data levels are based on calculation from NTC constituents for ANTT 2007.)

Other benchmarks in area but connection to LAT is unknown: nil

Station – Burnie		Height (m)

There are numerous other benchmarks in the area and relationship to LAT is shown on the following page.

SPM 9089	Note 2	16.603
SPM 9336 (5.802m above AHD)	Note 2	7.76
ST 1164 (5.361m above AHD)	Note 2	7.319
SPM 9337	Note 2	6.567
SPM 9338	Note 2	5.733
SPM 6554	**Damaged**	**5.733**
SPM 11090 (3.317 m above AHD)	Note 2	5.275
SPM 9087 (3.062 m above AHD)	Note 2	5.02
HAT		3.60
MHWS		3.24
MHWN		2.95
MSL		1.95
AHD	Note 2	1.958
MLWN		0.94
MLWS		0.65
Ellipsoid separation [SPM 9089 above Ellipsoid = 13.145 ITRF92 1994.0]		0.442
ISLW		0.38
TGZero 1 Jan 1985 – onward = ANTT Pred Datum 2001 (at least) – onward		0.02

LAT		0.00
CD (AUS 163 NE 1993)		+0.05 to -0.14

(Data levels are based on calculation from ANTT 2007 harmonic constituents.)

OTHER BENCHMARKS

SPM 6556	Note 1	10.944 +/-0.002
SPM 9076	Note 1	8.812 +/-0.002
SPM 6555	Destroyed Note 1	7.153 +/-0.002
SPM 9075	Note 1	6.864 +/-0.001
BM 3 = ANTT BM 1968 to 1989 (destroyed 1987)	Note 2	6.520
BM at gates to McGaw Pier (1946 – 1951)	Note 3	6.063m
SPM 8857	Note 1	5.511 +/-0.005
LAT		0.00

Note 1: Based on levels calculated to SPM 6554 from past Tide Gauge Details reports between 1973 and 1989. Accuracy associated with SPM 6554 included plus any difference observed in levels between benchmarks and SPM 6554.

Note 2: Connection to AHD. AHD value used by NTC and DPIPWE, Tasmania.

Note 3: Based on 1955 connection to AHD (TAS) supplied by DPIPWE, Tasmania.

Other benchmarks in area but connection to LAT is unknown: nil

Station – Devonport	Height (m)
BM SPM 6553	6.144
BM SPM 6552	6.013
BM L38A	5.784
BM SPM 6551	5.558
BM MB1 (cut on concrete wall)	4.115
HAT	3.66
MHWS	3.25
MHWN	2.97
MSL	1.95
MLWN	0.93
MLWS	0.65
ISLW	0.36
SD (Year 1950 &1951)	0.302
LAT	0.00
CD (AUS 164 NE 1999)	unknown

(Data levels are based on NTC LAT from 1994-2004 HC.)

CD is unknown due to different shifts applied for the same datum.

Other Benchmarks in area but connection to LAT is unknown: nil

Station – Low Head		Height (m)
BM SPM 9214 RM1 (2.287m above AHD)	Note 1	4.302
BM SPM 9214 RM2 (2.245m above AHD)	Note 1	4.260
BM SPM 9214 (1.863m above AHD)	Note 1	3.878
HAT		3.63
MHWS		3.26
MHWN		2.98
AHD		2.015
MSL		1.985
MLWN		0.99
MLWS		0.71
ISLW		0.42
TG Zero (Dec 2004 – 01 Jan 2005) = Pred Datum (ANTT 2007 – onward)		0.163
SD (HMAS Moresby Oct 1988)		0.163
TG Zero (intension to lower gauge by 0.1 m, 2008)		0.063
CD (AUS 167 NC 1997) – assumed 1.998 m below AHD Note 1		0.017
LAT		0.00

(Data levels are based on calculation by NTC for ANTT 2007.)

NOTE 1 USE WITH CAUTION: Levels determined via AHD. Heights of mark above AHD obtain from TASPORTS supplied Station Marks details and cross checked with TAS Survey Marks website (31 Mar 2006).

Other Benchmarks in area but connection to LAT is unknown:

BM "concrete step of disused lighthouse at Low Head"

Station – Spring Bay		Height (m)
BM SPM 8521 (7.236 m above AHD)		7.999
BM SPM 8522		7.682
BM MBH BM (orange day glow BM on conveyor foundation)		7.596
BM SPM 5758 (Destroyed) CAUTION connected by MSL only		6.655
BM SPM 9257 (5.844 m above AHD)	Note 1	6.607
BM AU 074 (4.567 m above AHD)	Note 1	5.330
BM 1968 (Destroyed)		~5.2
BM 362.1		4.362
BM SPM 9404 (2.522 m above AHD)		3.285
BM SPM 8523		2.967
HAT		1.45
MHHW		1.27
MLHW		0.81
AHD		0.763
MSL		0.74
MHLW		0.67
MLLW		0.20
ISLW		0.17
CD (AUS 175 NC 28 March 2008)		0.00
CD (AUS 170 NC October 2006)		0.00
CD (AUS 797 NC 6 June 2008)		0.00
CD (AUS 766 NC 27 April 2007		0.00
LAT		0.00
TGZ Seaframe Gauge (1991-)		-0.39
= Quasi Standard Seafarer 1993 – onward (local time zone)		-0.39

(Data levels are based on NTC Seaframe Data 1991-2004.)

Note 1: Connection to LAT via AHD

Other Benchmarks in area but connection to LAT is unknown:

BM Installed in rock by Gutteridge, Haskins and Davey April 1970 — 5.049 CAUTION

Station – Hobart		Height (m)
BM SPM 9217		7.670
BM SPM 1371		4.454
SPM 7444 (2.543m above AHD)	Note 1	3.373
BM SPM 9163 (2.153m above AHD)	Note 1	2.983
BM SPM 192 (2.039 m above AHD)	Note 1	2.869
BM SPM 193		2.857
BM SPM 194 (MBH No. 17) (1.859m above AHD) Note 1		**2.689**
HAT		1.69
MHHW		1.51
MLHW		1.00
MSL		0.88
AHD 1983 (MSL 1972)		0.83
MHLW		0.76
Tas State datum (MSL determined 20 years to 1905)		0.665
MLLW		0.26
ISLW		0.25
CD (AUS 172 NC Sept 2005)		0.03
CD (AUS 796 NC 29 Aug 2008)		~0.0
LAT and ANTT Pred Datum 2006 – onward		0.00
ANTT Pred Datum 2000 – 2005		-0.37

(Data levels are based on calculation from NTC constituents for ANTT 2006.)

Note 1: Connections to LAT via AHD (DRMS AA409156)

Other Benchmarks in area but connection to LAT is unknown: SPM 195

Appendix 3: Summary of pre-reform planning controls

This assessment is based on a keyword search of each planning scheme. Keywords included 'coastal', 'inundation', 'erosion', 'storm', 'high-water mark'.

Break O'Day Council

Break O'Day Council Planning Scheme 1996 addressed both inundation and erosion through a risk assessment methodology. The intent of the scheme was to avoid development in areas considered to have a high risk of flooding (including from storm tide or SLR). Development in areas outside the high risk must demonstrate that they would not be at risk and will not increase the risk to neighbouring properties.

Brighton Council

Brighton Council Planning Scheme 2000 requires all land within 30m of HWM to demonstrate that the proposal will satisfy the SCP and will not be inundated by a one-in-100 year average recurrence interval (ARI) flood event, that is, the habitable floors are above 3 m AHD.

Burnie City Council

Burnie City Council Planning Scheme 1989 specifies that flooding should be considered as part of the application, while the 'West Park Precinct' clause of the scheme requires a climate change management plan to address coastal hazards under the IPCC A1FI scenario and the 1% AEP.

Central Coast Council

Central Coast Planning Scheme 2005 requires all development within 90 m of the 2.64 m AHD contour to have a coastal vulnerability assessment, demonstrating that the siting and design of the development will minimise the risk to life and property.

Circular Head Council

Circular Head Planning Scheme 1995 requires applications to demonstrate the relationship between the development and coastal dunes, wetlands and beach systems. The controls seek to minimise coastal erosion to protect the environment, but do not to appear to directly relate to coastal inundation as an issue.

Clarence City Council

Clarence Planning Scheme 2007 requires consideration of both coastal inundation and erosion in areas that have been mapped as vulnerable. Areas identified as vulnerable include the 1% AEP in 2050 and 2100 and recession areas. The controls require a range of responses, including the raising of floor levels and demonstration that risk to life and neighbouring properties is minimised.

Derwent Valley Council

New Norfolk Council Planning Scheme 1993 does not address coastal hazards as such as only a small portion of the Council area is estuarine on the lower reaches of the River Derwent. The Scheme does require floor levels to be inundation free, broadly, this is considered to be the 1% AEP level.

Devonport Council

Devonport and Environs Planning Scheme 1984 requires the council to apply the precautionary principle as defined in the SCP to all applications when considering coastal flooding and land stability.

Dorset Council

Dorset Planning Scheme 1996 requires development to consider flooding (among other issues) and to submit an Environmental Management Plan as part of the application.

Flinders Council

Flinders Planning Scheme 1994 provides for areas affected by coastal waters defined as within 100 m of the coast. The controls seek to restrict subdivision and require a setback from the coast of 100 m from HWM unless council is satisfied that it is reasonable to do so.

George Town Council

Municipality of George Town Planning Scheme 1991 requires council to assess the capability of the land regarding flood and land stability when considering a planning permit. The level to which it is considered and the outcomes of the consideration are not defined as part of the scheme.

Glenmorgan Spring Bay Council

Glenmorgan Spring Bay Planning Scheme 1994 requires setbacks from HWM.

Glenorchy City Council

Glenorchy Planning Scheme 1992 considers coastal inundation and erosion. It requires that all buildings (unless marine in purpose) are set back 10m from HWM. All development potentially impacted by SLR or storm surge must demonstrate ways to minimise structural damage, risk to life, reduction of the need for engineered solutions, and how they will not unreasonably impact on neighbouring properties.

Hobart City Council

Hobart City Council had three planning schemes (1979, 1992, 1997) prior to the release of the *Interim Planning Scheme* in 2015. *City of Hobart Planning Scheme 1982* and *Battery Point Planning Scheme 1979* identify land below 3m AHD as being vulnerable to coastal inundation from a 1% AEP storm surge. Applications must be designed and constructed to resist the hydrostatic and hydrodynamic forces, minimise the hazard to neighbouring properties and have a finished floor level of 300mm above the 1% AEP storm surge. *Sullivan's Cove Planning Scheme 1997* does not directly address coastal inundation.

Huon Valley Council

Until the release of the interim planning schemes, the Huon Valley Council had three schemes (1979, 1988, 1989) which address coastal hazards as follows:

- *Huon Valley Planning Scheme 1979* applies to the estuary area of the Huon River and primarily addresses the issue of riverine flooding (including coastal inundation) in an "*area designated as flood prone*", in which an engineer's report is required to demonstrate that the building will not be at risk of movement or instability and will not significantly impact on the downstream flows for a one-in-100-year flood event.
- *Port Cygnet Planning Scheme 1988* identifies all land under 3 m AHD to be discretionary development subject to conditions including a minimum floor height of 3 m AHD, and that the council is satisfied that it can be sited to minimise the risk, that waste water can be treated and the works will not increase the risk elsewhere.
- *Esperance Coast Planning Scheme 1989* requires that all development vulnerable to coastal inundation or erosion must be designed to provide reasonable protections from storm surge (including wave action and SLR from climate change) and have habitable rooms at 3.0 m AHD.

King Island Council

King Island Planning Scheme 1995 considers coastal hazards through a requirement for development potentially impacted by coastal hazards to consider them through the siting, design and construction of the development.

Kingborough Council

Kingborough Planning Scheme 2000 considers coastal areas to be all land within 500 m of HWM that has not been modified by roads or buildings. Within this area, council seeks to mitigate the impact of coastal hazards for all land with a moderate or higher risk. The mitigations must demonstrate how the risk will be mitigated through design and protection measures that are certified by a suitably qualified person.

Latrobe Council

Latrobe Planning Scheme 1994 requires consideration of flooding as part of the assessment of an application. The application is discretionary and must consider the 1% AEP flood level as part of the design response.

Launceston City Council

Launceston Planning Scheme 1994 primarily considers riverine flooding, with the tidal influence in the estuary considered in the flood modelling for the Tamar River. Of relevance to coastal inundation is the consideration of the 1% AEP flood level for floor heights. It is not known if SLR is considered as part of the modelling undertaken by council.

Sorell Council

Sorell Planning Scheme 1993 identifies all land below 3 m AHD as being vulnerable to a 1% AEP flood event. In these areas, a suitably qualified person must demonstrate that habitable floors will be free of flood and that the building can withstand a 1% AEP flood event.

Tasman Council

Tasman Planning Scheme 1979 requires consideration of if any part of the land is subject to flooding for the purpose of subdivision.

Waratah Wynyard Council

Waratah Wynyard Planning Scheme 2000 defines the coastal flood area as within 30 m of HWM, or less than 3 m above the ordinary HWM of the spring high tide in areas subject to storm surge. If the development is within these areas then it must demonstrate how the hazard can be mitigated, that it will not increase the risk to life, it will not unreasonably impact on neighbouring properties, that there is not another available site and that the development will not interfere with natural coastal processes or pollute the environment.

West Coast Council

West Coast Planning Scheme 2000 considers all natural hazards as a single issue. The scheme requires development that may be impacted by erosion, coastal inundation or SLR to demonstrate (using a suitably qualified person) that the development will avoid being impacted or demonstrate how the impact will be minimised and prevent the impact of the hazard being increased.

West Tamar Council

West Tamar Planning Scheme 2006 considers flood hazard and storm surge as a single issue. Land is considered vulnerable to storm surge if it is within 40 m landwards of HWM or less than 3 m AHD. In these areas, the development must demonstrate that it can avoid or lessen the impact, and does not interfere with the natural coastal processes.

Appendix 4: Coastal erosion pairwise assessment

Coastal erosion hazard components are ordered from most acceptable (lowest susceptibility, lowest pairwise scores) to most susceptible to erosion (highest pairwise scores). Note resilient artificial shores (score 5316) fall into the low hazard band for storm bite erosion and the acceptable band for all other recession.

Coastal erosion hazard zone component	Pairwise assessment score
Acceptable hazard zone (all gently to moderately sloping 'pure' hard-rock shores)	24
Acceptable hazard zone (very coarse boulder clay soft rocks)	1023
Acceptable hazard zone (normal soft rocks)	2022
Acceptable hazard zone (all soft sed. shores) – landwards of likely and possible natural recession limits	3021
Acceptable hazard zone (all soft sed. shores) – to possible natural recession limit	4020
Acceptable hazard zone (all soft sed. shores) – to likely natural recession limit	5217
Resilient artificial shores (acceptable recession zones landwards of resilient artificial shores)	5316
Resilient artificial shores (Low hazard storm bite zone landwards of resilient artificial shores)	5316
Longer-term potential settling & slumping hazard (very coarse boulder clay soft rocks) – 20 m	5514
Recession (S3) to 2100 Low hazard zone (sheltered soft sed. shore) – to possible natural recession limit	7215
Regression & slump hazard zone (steep to cliffed hard rocks)	7413
Longer-term potential recession hazard zone (normal soft rocks) – Low hazard zone 63 m to 2100	7512
Recession (S3) to 2100 Low hazard zone (open coast soft sed. shore) – to possible natural recession limit	9312
Recession (S3) to 2100 Low hazard zone (sheltered soft sed. shore) – to likely natural recession limit	10311
Recession (S3) to 2050 Med hazard zone (sheltered soft sed. shore) – to possible natural recession limit	12309
Recession (S3) to 2100 Low hazard zone (open coast soft sed. shore) – to likely natural recession limit	13110
Medium-term potential recession hazard zone (normal soft rocks) – Med hazard zone 28 m to 2050	14307
Recession (S3) to 2050 Med hazard zone (open coast soft sed. shore) – to possible natural recession limit	15207
Recession (S3) to 2050 Med hazard zone (sheltered soft sed. shore) – to likely natural recession limit	15306
Recession (S3) to 2050 Med hazard zone (open coast soft sed. shore) – to likely natural recession limit	17205
Near-term potential recession hazard zone (normal soft rocks) – High hazard zone 14 m to 2030	18105
Storm bite (S1 + S5) hazard zone for sheltered shores (sandy shores backed by moderately rising hard bedrock)	20202
Storm bite (S1 + S5) High hazard zone (sheltered soft sed. shore) – to possible natural recession limit	21003
Storm bite (S1 + S5) High hazard zone (open coast soft sed. shore) – to possible natural recession limit	21102
Storm bite (S1 + S5) High hazard zone (sheltered soft sed. shore) – to likely natural recession limit	22101
Storm bite (S1 + S5) hazard zone for exposed shores (sandy shores backed by moderately rising hard bedrock)	24000
Storm bite (S1 + S5) High hazard zone (open coast soft sed. shore) – to likely natural recession limit	24100
Non-resilient artificial shores (ignored)	

Appendix 5: Method to calculate indicator values

Introduction

This document summarises the data inputs and processes used to evaluate some descriptive statistics about Tasmania's exposure to coastal erosion hazard. It uses three datasets made available through an export from ArcGIS. The data is used to evaluate a number of statistics that describe Tasmania's overall exposure, as discussed in the next sections.

Plots of exposure statistics

The methods described in this document were used to calculate a number of statistics for plotting purposes contained within the 'Coastal Inundation Summary Plots' presentation. It is suggested that the presentation be read in conjunction with this document to understand the output objective for each calculation.

Calculation files are available from OSEM.

Underlying data accuracy

Elevation data surrounding the coast has been obtained using two methods. The first incorporates detailed LiDAR data obtained from 'flyover' surveys. This method produces highly detailed and accurate elevation data and provides an accurate measure of the land likely to be inundated by projected SLR and storm surge. The second method utilises an interpolation between the 10 m contour lines and the coastline to determine the elevation for areas around Tasmania where there is no LiDAR data available. This second method is a less accurate assessment of the coastal inundation hazard and should be treated with more caution.

Note that since the LiDAR data was obtained for the Launceston area, a levee system was constructed to reduce the inundation hazard. This means that any inundation hazard identified using the LiDAR data is overstated and should be removed from the calculations.

A note on data organisation

The data exported from the GIS are large and require some special management. The procedure adopted was to summarise large datasets in Excel using Pivot tables and then to copy 'values only' to new excel files for interrogation and plotting purposes. This allowed the data to be linked to presentation plots for easy updating without having to navigate large files.

The export of cadastre data was extremely large and necessitated some sub-setting using the statistical program R, a free open source statistical package. Full code used to subset the data is provided in *Appendix 1*.

Evaluating which buildings are exposed to coastal hazards: general notes

Property Identification, PID, is sometimes duplicated. This is because there may be multiple buildings on the same 'property', or PID. When evaluating the building's exposure, do not sort first based on PID. Note that where individual properties need to be tallied a unique property identifier of PID + FOLIO + VOLUME needs to be first created (this is discussed in the vacant land summaries).

Overall number of residential buildings and capital valuation impacted

This calculation predicts the number of buildings and the capital valuation impacted by the coastal inundation hazard (including the *High, Medium* and *Low* bands).

The Buildings Database (CI_op6a_buildings.xlsx) should be summarised by pivot table, incorporating the following elements:

Database: CI_op6a_buildings.xlsx (28 MB)

Descriptor	GIS attribute	Summarised in Pivot table by
Local Government Area	Name	Filter, and remove Launceston
Property Identification	PID	Filter, ensure 0's and Blanks are kept.
Residential Buildings	Build_type	Filter for "Residence"
Elevation data: LiDAR or non-LiDAR	Type	Rows: Type
Hazard bands	HB_V6a	Values: Count of HB_V6a Column: HB_V6a

To calculate the capital valuation impacted by coastal inundation, include the Current Capital Valuation as shown below.

Descriptor	GIS field name	Summarised in Pivot table by
Current Capital Valuation	Current CV	Sum of Current CV

Number of residential buildings impacted by LGA and suburb

The calculation for the number of residential buildings impacted in each LGA and suburb involves the creation of two more pivot tables summarising the above, with the inclusion of LGA and suburb as additional data fields:

Database: CI_op6a_buildings.xlsx (28 MB)

Descriptor	GIS field name	Summarised in Pivot table by
Local Government Area	Name	Filter and remove Launceston Row: Name
Suburbs	SUBURB_LOC	Filter and remove Launceston Row: SUBURBED_LOC

Evaluating what land is exposed to coastal hazards

Area of vacant land less than 2 000 m^2 impacted

Vacant land sized less than 2 000 m^2 is used as an approximate descriptor for land that could be readily developed. Hence vacant land less than 2 000 m^2 and subject to coastal inundation hazards describes potential future exposure if this land was developed, or land that may be prevented from development due to coastal hazards.

Area data is sourced from a collection of cadastre or land boundary data. Because the cadastre export from GIS is so large (2GB) GIS was used to isolate all vacant land under 2 000 m^2.

The GIS fields used to subset the data into the file 'CI_Cad_vg_address_V_lt2k_v6a_7_lt10m.xlsx' included:

GIS Descriptor	GIS field name	Attributes to select
Landuse status: Vacant?	LANDUSECODE	V1-V9
Landuse status: Privately owned?	Cadtype1	Private Parcel
Size of land parcel	COMP_AREA	Less than 2 000 m^2
Elevation data source	Type	LiDAR and Non-LiDAR

The area of vacant land less than 2000m^2 impacted by coastal hazards can be summarised by pivot table and incorporating the following elements.

Database: CI_Cad_vg_address_V_lt2k_v6a_7_lt10m.xlsx

Descriptor	GIS attribute	Summarised in pivot table by
Local Government Area	MUNICIPALITYCODE	Filter for all but Launceston (Code 120)
Elevation data source	Type	Row Labels: LiDAR and non-LiDAR
Hazard band	HB_V6a	Row labels: High, Medium and Low
Area of land in each hazard band	Shape_Area	Value: Sum Shape_Area

The summary then allows the land area within each hazard band, identified by elevation data type (LiDAR or non-LiDAR to be identified).

Proportion of vacant land less than 2 000m^2 impacted

The above calculation determines the absolute area of land impacted by each of the hazard bands (*High, Medium* and *Low*). The proportion of vacant properties affected, from the total, rather than an absolute figure should also be calculated. Additionally, properties will also be affected to varying degrees. For instance, the number of properties impacted by more than 10% or 50% for a particular hazard band would also be of interest.

The first step is to identify each unique property. This involves a combination of the attributes PID, FOLIO and VOLUME. A simple 'concatenate' function in Excel can be used to combine these attributes to create a unique property identifier that can then be later interrogated. Note that a simple comparison using PID cannot be utilised, as there can be multiple properties with the same PID, for instance where properties have been subdivided.

The second step is to sum the area of land impacted by each hazard band for each unique property (PID + FOLIO + VOLUME). This is because the GIS database assigns properties impacted by multiple hazard bands into a new row with the same PID, FOLIO and VOLUME. For example, a single property impacted by all three hazard bands *High, Medium* and *Low*, would be triple counted and the total number of properties would be overstated. (The true *proportion* under such a scenario would be understated.)

In order to calculate the proportion of vacant land less than 2 000 m^2 impacted for each property and, subsequently, the proportion of all vacant properties impacted, the database should again be summarised by pivot table incorporating the following elements:

Database: CI_Cad_vg_address_V_lt2k_v6a_7_lt10m.xlsx

Descriptor	GIS attribute	Summarised in pivot table by
Local Government Area	MUNICIPALITYCODE	Filter: All except Launceston (Code 120)
Elevation data source	Type	Both LiDAR and Non-LiDAR
Property Identification* (NEW VARIABLE)	Create new attribute based on: PID + FOLIO + VOLUME	Row labels: PID+Folio+Vol Values: Count of PID*
Hazard band	HB_V6a	Column labels: High, Medium and Low and Non-LiDAR
Parcel land size (m^2)	COMP_AREA	Values: Average of COMP_AREA***
Area of land in each hazard band	Shape_Area	Values: Sum Shape_Area

Notes

* Where properties have been subdivided, there may be multiple lots on a single PID. In order to attribute hazard areas to each individual property, a new variable that incorporates all of a land parcel's description is required. This includes the PID, FOLIO, and VOLUME attributes. A simple 'concatenate' function in Excel can combine these attributes into a new unique property descriptor.

** To check if duplication has occurred (it should not have)

*** COMP_AREA is averaged, not summed; this keeps the total land area associated with each parcel the same for easy manipulation later

The summary then allows the land area within each hazard band to be allocated to a single property (PID) and compared to the land area for that property. By calculating a percentage of land impacted for each property, the total number of properties can be determined that, say, are impacted more than 10 per cent or 50 per cent for each type of hazard band. Note that distinction can also be made for elevation data type (LiDAR or non-LiDAR).

Area of land exposed to coastal hazards by tenure: *'Who owns the problem?'*

Finally, the tenure of all land impacted by coastal hazards should be determined, and the total area attributable to various local and State Government agencies calculated. Because the ownership of all land is required, the entire cadastre database needs to be analysed. The database is large (2 GB) and so R (a statistical program) was utilised to subset and summarise the data with the following characteristics:

Database: CI_op6a_cadastre.txt (note that this is a .csv file (comma separated) exported direct from GIS)

Descriptor	GIS attribute	Sub-set in R by
Local Government Area	MUNICIPALITYCODE	Filter for All but Launceston (Code 120)
Tenure (land ownership)	CAD_TYPE1 and CAD_TYPE2	All attributes kept (see grouping of land ownership in table below
Elevation data source	Type	Identify as LiDAR and non-LiDAR
Hazard band	HB_V6a	High, Medium and Low
Area of land in each hazard band	Shape_Area	Value: Sum Shape_Area

The areas of land in each hazard band were then summed for each combination of ownership combination (CAD_TYPE1 and CAD_TYPE2) using the aggregate command in R (see *Appendix 1* for the complete command code in R). The data was then copied into Excel and a pivot table used to group the land ownership/tenure data into the following categories:

Ownership groups and their makeup

Ownership Group	CAD_TYPE1	CAD_TYPE2 attributes
State	Authority Land	Aboriginal Land, Department of Education, Department of State Growth, Department of Health and Human Services, Department of Police, Fire and Emergency Management (DPFEM), Department of Primary Industries, Parks, Water and Environment (DPIPWE), Housing Tasmania, Marine and Safety Tasmania, PWS, State Fire Commission, University of Tasmania
Private	Private Parcel	Private Parcel
Local Government	Authority Land	LGA
Casement	Casement	All, including: Reserved Road, Road (type unknown), Subdivision Road, User Road, Acquired Road, Casement Unknown, LGA Subdivision Road, Footway, Forestry Road, Walkway, Tramway.
Government Business	Authority Land	ABT Railway Corp, Aurora Energy Pty Ltd, Cradle Mountain Water, Forestry Tasmania, Hydro Electric Corporation, Port Arthur Historic Site Management Authority, Southern Water, Tasmanian Ports Corporation Pty Ltd.
Commonwealth of Australia	Authority Land	Commonwealth of Australia
Not included	'Other Category'	Marine Nature Reserve, Survey Inconsistency, Onshore Water Body

Excel was utilised to plot the information in a consistent manner and to further attribute land impacted to various departments for information.

Watch-its

A number of watch-its for revision of, and calculation of, new hazard banding statistics are included below:

- The GIS attribute 'name' with attribute values of 'Less than 10 m AHD' is meaningless for the purposes described in this document.
- PID is not a unique property identifier. PID plus FOLIO plus VOLUME is unique for each property.

R Code

% Read the 2GB file into R for subsequent analysis

- CI_Cad_op6a <- read.table("CI_op6a_cadastre.txt", header = TRUE, sep = ",")

% Isolate LiDAR obtained data into a separate dataframe in R for later query

- CI_Cad_op6a_exclLaun_LiDAR <- subset(CI_Cad_op6a, Type == "LiDAR < 10m" & MUNICIPALITYCODE %in% c(0,101,102,103,104,105,106,107,108,109,110,111,112,113,114,115,116,117,118,119,121,122,123,124,125,126,127,128,129),
- select = c(MUNICIPALITYCODE, Type, CAD_TYPE1, CAD_TYPE2, TENURE_TY, HB_V6A, Shape_Area))
- % Summarise LiDAR data with respect to tenure, hazard band and land area in each hazard band, copy output to Excel
- aggregate(Shape_Area ~ CAD_TYPE1 + CAD_TYPE2 + HB_V6A, data=CI_Cad_op6a_exclLaun_LiDAR, FUN=sum)

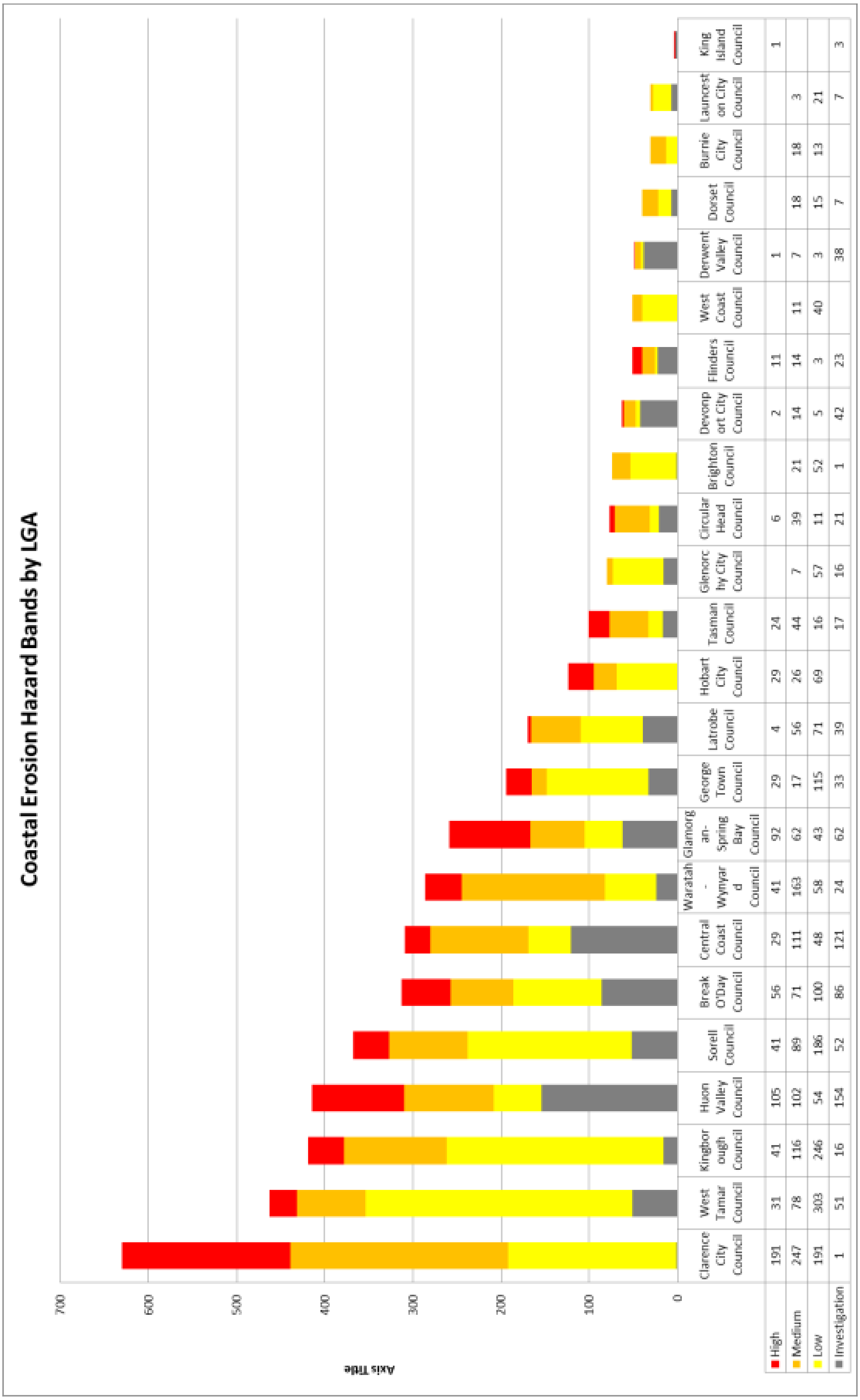
% Isolate Non LiDAR obtained data into a separate dataframe in R for later query

- CI_Cad_op6a_exclLaun_NonLiDAR <- subset(CI_Cad_op6a, Type == "Non LiDAR < 10m" & MUNICIPALITYCODE %in% c(0,101,102,103,104,105,106,107,108,109,110,111,112,113,114,115,116,117,118,119,121,122,123,124,125,126,127,128,129),
- select = c(MUNICIPALITYCODE, Type, CAD_TYPE1, CAD_TYPE2, TENURE_TY, HB_V6A, Shape_Area))

% Summarise Non-LiDAR data with respect to tenure, hazard band and land area in each hazard band, copy output to Excel

- aggregate(Shape_Area ~ CAD_TYPE1 + CAD_TYPE2 + HB_V6A, data=CI_Cad_op6a_exclLaun_NonLiDAR, FUN=sum)

Appendix 6: State & LGA indicators – coastal erosion



	High	Medium	Low	Investigation
Clarence City Council	191	247	191	1
West Tamar Council	31	78	303	51
Kingborough Council	41	116	246	16
Huon Valley Council	105	102	54	154
Sorell Council	41	89	186	52
Break O'Day Council	56	71	100	86
Central Coast Council	29	111	48	121
Waratah - Wynyard Council	41	163	58	24
Glamorgan-Spring Bay Council	92	62	43	62
George Town Council	29	17	115	33
Latrobe Council	4	56	71	39
Hobart City Council	29	26	69	
Tasman Council	24	44	16	17
Glenorchy City Council		7	57	16
Circular Head Council	6	39	11	21
Brighton Council		21	52	1
Devonport City Council	2	14	5	42
Flinders Council	11	14	3	23
West Coast Council		11	40	
Derwent Valley Council	1	7	3	38
Dorset Council		18	15	7
Burnie City Council		18	13	
Launceston City Council		3	21	7
King Island Council	1			3

Number of residential building envelopes by coastal erosion hazard band, LGA and locality

		Coastal Erosion Hazard Band				
LGA	Suburb	Investigation	Low	Medium	High	Total
Break O'Day Council	AKAROA		15	9	2	26
	ANSONS BAY	6	24	34	35	99
	BINALONG BAY	14		4		18
	SCAMANDER		15	1		16
	ST HELENS	18	30	20	7	75
	STIEGLITZ	47	12			59
	(blank)	1	4	3	12	20
Break O'Day Council Total		**86**	**100**	**71**	**56**	**313**
Brighton Council	BRIDGEWATER		7	18		25
	OLD BEACH		45	3		48
	(blank)	1				1
Brighton Council Total		**1**	**52**	**21**		**74**
Burnie City Council	CAMDALE		3	2		5
	COOEE		10	9		19
	OCEAN VISTA			7		7
Burnie City Council Total			**13**	**18**		**31**
Central Coast Council	GAWLER	3				3
	HEYBRIDGE				18	18
	LEITH	4	4			8
	PENGUIN		2	1	2	5
	PRESERVATION BAY	18				18
	SULPHUR CREEK	30				30
	TURNERS BEACH		6	34	1	41
	ULVERSTONE	39		13	2	54
	WEST ULVERSTONE	25	32	59	6	122
	(blank)	2	4	4		10
Central Coast Council Total		**121**	**48**	**111**	**29**	**309**
Circular Head Council	HELLYER		6	38	2	46
	SMITHTON		2		1	3
	STANLEY	19	3	1	2	25
	(blank)	2			1	3
Circular Head Council Total		**21**	**11**	**39**	**6**	**77**

Clarence City Council	BELLERIVE		5	5		10
	CAMBRIDGE		1	1		2
	CLIFTON BEACH		6	15		21
	CREMORNE		34	47	51	132
	GEILSTON BAY		3			3
	HOWRAH		9	1	1	11
	LAUDERDALE	1	23	125	22	171
	LINDISFARNE		20	1	18	39
	OPOSSUM BAY		33		71	104
	OTAGO		14			14
	ROCHES BEACH			3		3
	ROKEBY		2		1	3
	ROSE BAY		2	7	4	13
	SANDFORD		6	5		11
	SEVEN MILE BEACH			10	1	11
	SOUTH ARM		20	21	22	63
	TRANMERE		9			9
	(blank)		4	6		10
Clarence City Council Total		**1**	**191**	**247**	**191**	**630**
Derwent Valley Council	BOYER		1			1
	GRANTON	4				4
	NEW NORFOLK	29	1	4	1	35
	SORELL CREEK	1	1	3		5
	(blank)	4				4
Derwent Valley Council Total		**38**	**3**	**7**	**1**	**49**
Devonport City Council	DEVONPORT		1			1
	DON	1				1
	EAST DEVONPORT	8	2	12	2	24
	QUOIBA	20				20
	(blank)	13	2	2		17
Devonport City Council Total		**42**	**5**	**14**	**2**	**63**
Dorset Council	BRIDPORT	7	15	5		27
	TOMAHAWK			13		13
Dorset Council Total		**7**	**15**	**18**		**40**
Flinders Council	BASS STRAIT ISLANDS				7	7
	BLUE ROCKS			2		2
	CAPE BARREN ISLAND	1				1
	KILLIECRANKIE	1				1

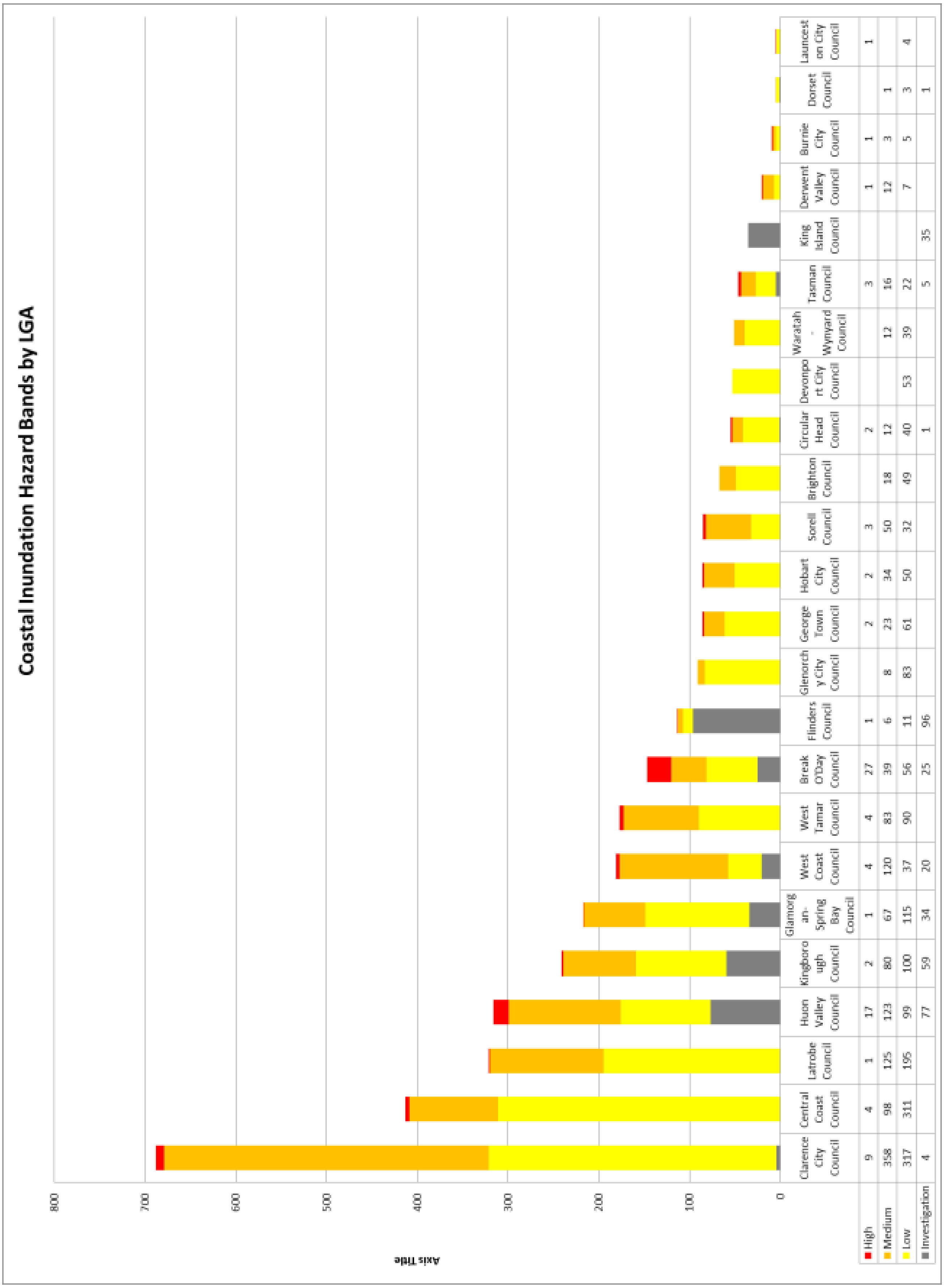
	LADY BARRON	11		1		12
	LEEKA				1	1
	WHITEMARK	2	3	8		13
	(blank)	8		3	3	14
Flinders Council Total		**23**	**3**	**14**	**11**	**51**
George Town Council	BELLINGHAM	10		1		11
	GEORGE TOWN	2	94	7	12	115
	HILLWOOD		6			6
	LOW HEAD	13	13		13	39
	LULWORTH	6	1	7		14
	WEYMOUTH	2			1	3
	(blank)		1	2	3	6
George Town Council Total		**33**	**115**	**17**	**29**	**194**
Glamorgan-Spring Bay Council	BICHENO			1	1	2
	COLES BAY		11	29	23	63
	DOLPHIN SANDS		5	8		13
	DOUGLAS RIVER		2	1		3
	ORFORD	39	10	22	56	127
	RHEBAN		7			7
	SPRING BEACH		5		6	11
	SWANSEA	14	1		3	18
	TRIABUNNA	4	2	1		7
	(blank)	5			3	8
Glamorgan-Spring Bay Council Total		**62**	**43**	**62**	**92**	**259**
Glenorchy City Council	BERRIEDALE		13	2		15
	CLAREMONT		39	2		41
	GLENORCHY	6				6
	GRANTON	10	2	2		14
	(blank)		3	1		4
Glenorchy City Council Total		**16**	**57**	**7**		**80**
Hobart City Council	BATTERY POINT		1		4	5
	SANDY BAY		63	22	20	105
	(blank)		5	4	5	14
Hobart City Council Total			**69**	**26**	**29**	**124**
Huon Valley Council	ABELS BAY		4		2	6
	BROOKS BAY		2			2

	CASTLE FORBES BAY		1			1
	CRADOC	1				1
	CYGNET	13		1	1	15
	DEEP BAY	1			10	11
	DOVER	1	15	44	17	77
	EGGS AND BACON BAY	2	8		1	11
	FRANKLIN	7	1	2		10
	GARDEN ISLAND CREEK	27			2	29
	GARDNERS BAY		1			1
	HUONVILLE	8	1	12		21
	LYMINGTON		1		1	2
	NICHOLLS RIVULET	2				2
	POLICE POINT		1		2	3
	RAMINEA	1				1
	RANDALLS BAY		1	4		5
	RECHERCHE	4		1	4	9
	SOUTHPORT	1	10	30	15	56
	SURGES BAY	2	3			5
	SURVEYORS BAY	19			14	33
	VERONA SANDS	64		3	1	68
	WATERLOO		1			1
	WATTLE GROVE		3			3
	WOODSTOCK			2		2
	(blank)	1	1	3	35	40
Huon Valley Council Total		**154**	**54**	**102**	**105**	**415**
King Island Council	CURRIE	1			1	2
	NARACOOPA	2				2
King Island Council Total		**3**			**1**	**4**
Kingborough Council	ADVENTURE BAY		13	49	7	69
	ALONNAH	1	5	1		7
	BARRETTA		3	5		8
	BIRCHS BAY		1			1
	BLACKMANS BAY		29		3	32
	CONINGHAM		9			9
	DENNES POINT	3	6	7	22	38
	ELECTRONA		1	1		2
	FLOWERPOT		1			1
	GORDON		3	3		6
	GREAT BAY		6	3		9
	HOWDEN		18		2	20
	KILLORA		3			3
	KINGSTON				2	2

	KINGSTON BEACH		34	17	3	54
	LOWER SNUG		4			4
	LUNAWANNA	3				3
	MARGATE	3	34	12		49
	MIDDLETON		4			4
	NORTH BRUNY		1	1	1	3
	OYSTER COVE		3	2	1	6
	SNUG		14	8		22
	SOUTH BRUNY		4	1		5
	TAROONA		36	6		42
	TINDERBOX		10			10
	WOODBRIDGE	5	2			7
	(blank)	1	2			3
Kingborough Council Total		**16**	**246**	**116**	**41**	**419**
Latrobe Council	BAKERS BEACH	4	18	2		24
	HAWLEY BEACH		11			11
	PORT SORELL	12	41	16	4	73
	SHEARWATER			37		37
	SQUEAKING POINT	22				22
	TARLETON	1	1			2
	(blank)			1		1
Latrobe Council Total		**39**	**71**	**56**	**4**	**170**
Launceston City Council	DILSTON	7	7			14
	TREVALLYN		5			5
	WINDERMERE		9	3		12
Launceston City Council Total		**7**	**21**	**3**		**31**
Sorell Council	BOOMER BAY			3		3
	BREAM CREEK	1				1
	CARLTON			28		28
	CARLTON RIVER	1				1
	CONNELLYS MARSH			17	8	25
	DODGES FERRY	46	21	3	9	79
	DUNALLEY		29	8	1	38
	LEWISHAM		17	3	7	27
	MARION BAY	3	7	1		11
	MIDWAY POINT	1	45	12		58
	PENNA		18	3		21
	PRIMROSE SANDS		46	9	14	69
	(blank)		3	2	2	7
Sorell Council Total		**52**	**186**	**89**	**41**	**368**

Tasman Council	EAGLEHAWK NECK		1	3	7	11
	KOONYA	1				1
	MURDUNNA	8		1	3	12
	NUBEENA		3		3	6
	PORT ARTHUR	3	11	20	1	35
	PREMAYDENA	2				2
	WHITE BEACH		1	19	9	29
	(blank)	3		1	1	5
Tasman Council Total		**17**	**16**	**44**	**24**	**101**
Waratah-Wynyard Council	BOAT HARBOUR		1			1
	BOAT HARBOUR BEACH		4		27	31
	DOCTORS ROCKS			9		9
	SISTERS BEACH		3	61	3	67
	SOMERSET		10	16		26
	WYNYARD	23	39	74	10	146
	(blank)	1	1	3	1	6
Waratah-Wynyard Council Total		**24**	**58**	**163**	**41**	**286**
West Coast Council	STRAHAN		36	9		45
	(blank)		4	2		6
West Coast Council Total			**40**	**11**		**51**
West Tamar Council	BAKERS BEACH		1			1
	BEAUTY POINT	1	34	20		55
	BLACKWALL	35				35
	CLARENCE POINT		4	3	1	8
	DEVIOT	5	24	16		45
	EXETER	1				1
	GRAVELLY BEACH		27	4		31
	GREENS BEACH		62	4		66
	KAYENA		16	2		18
	KELSO	8	26	19	30	83
	LEGANA		20	4		24
	ROBIGANA		3			3
	ROSEVEARS		34	2		36
	SWAN POINT		49	2		51
	(blank)	1	3	2		6
West Tamar Council Total		**51**	**303**	**78**	**31**	**463**
Grand Total		**814**	**1720**	**1334**	**734**	**4602**

Appendix 7: State & LGA indicators – coastal inundation



	High	Medium	Low	Investigation
Clarence City Council	9	358	317	4
Central Coast Council	4	98	311	
Latrobe Council	1	125	195	
Huon Valley Council	17	123	99	77
Kingborough Council	2	80	100	59
Glamorgan-Spring Bay Council	1	67	115	34
West Coast Council	4	120	37	20
West Tamar Council	4	83	90	
Break O'Day Council	27	39	56	25
Flinders Council	1	6	11	96
Glenorchy City Council		8	83	
George Town Council	2	23	61	
Hobart City Council	2	34	50	
Sorell Council	3	50	32	
Brighton Council		18	49	
Circular Head Council	2	12	40	1
Devonport City Council			53	
Waratah-Wynyard Council		12	39	
Tasman Council	3	16	22	5
King Island Council				35
Derwent Valley Council	1	12	7	
Burnie City Council	1	3	5	
Dorset Council		1	3	1
Launceston City Council	1		4	

Number of residential buildings by hazard band, LGA and suburb/town

LGA	Suburb	Investigation	Low	Medium	High	Grand Total
Break O'Day Council	AKAROA		8	6		14
	ANSONS BAY	2	18	15	21	56
	CHAIN OF LAGOONS	10				10
	DOUGLAS RIVER	2				2
	SCAMANDER	3	7	2		12
	SEYMOUR	7				7
	ST HELENS		17	8	1	26
	STIEGLITZ		4	4		8
	(blank)	1	2	4	5	12
Break O'Day Council Total		**25**	**56**	**39**	**27**	**147**
Brighton Council	BRIDGEWATER		4	6		10
	OLD BEACH		44	12		56
	(blank)		1			1
Brighton Council Total			**49**	**18**		**67**
Burnie City Council	CHASM CREEK			1		1
	HEYBRIDGE				1	1
	WIVENHOE		5	2		7
Burnie City Council Total			**5**	**3**	**1**	**9**
Central Coast Council	FORTH		2	1		3
	HEYBRIDGE		15	3	3	21
	PENGUIN		2	2		4
	TURNERS BEACH		65	5		70
	ULVERSTONE		6	2		8
	WEST ULVERSTONE		209	75		284
	(blank)		12	10	1	23
Central Coast Council Total			**311**	**98**	**4**	**413**
Circular Head Council	DETENTION		1			1
	HELLYER		10			10
	SMITHTON		21	10	2	33
	STANLEY		7	1		8
	(blank)	1	1	1		3
Circular Head Council Total		**1**	**40**	**12**	**2**	**55**
Clarence City Council	BELLERIVE		49			49
	CAMBRIDGE		1	1	1	3
	CLIFTON BEACH		12	16	1	29
	CREMORNE		14	130		144

	HOWRAH		9	4	1	14
	LAUDERDALE		159	166	1	326
	LINDISFARNE	2	4	5		11
	OPOSSUM BAY		1	13	2	16
	ROCHES BEACH		1			1
	ROKEBY			2	2	4
	ROSE BAY		2			2
	SANDFORD		3	14		17
	SEVEN MILE BEACH		23	6		29
	SOUTH ARM		13			13
	(blank)	2	26	1	1	30
Clarence City Council Total		**4**	**317**	**358**	**9**	**688**
Derwent Valley Council	NEW NORFOLK		4	10		14
	SORELL CREEK		1	2		3
	(blank)		2		1	3
Derwent Valley Council Total			**7**	**12**	**1**	**20**
Devonport City Council	DON		1			1
	EAST DEVONPORT		49			49
	(blank)		3			3
Devonport City Council Total			**53**			**53**
Dorset Council	BRIDPORT		3	1		4
	TOMAHAWK	1				1
Dorset Council Total		**1**	**3**	**1**		**5**
Flinders Council	BASS STRAIT ISLANDS	19				19
	BLUE ROCKS	5				5
	CAPE BARREN ISLAND	5				5
	EMITA	1				1
	KILLIECRANKIE	9				9
	LADY BARRON	13			1	14
	LEEKA	6				6
	LOCCOTA	2				2
	LUGHRATA	3				3
	MEMANA	1				1
	PALANA	7				7
	WHITEMARK	4	11	6		21
	(blank)	21				21
Flinders Council Total		**96**	**11**	**6**	**1**	**114**
George Town Council	BELLINGHAM		11	2		13
	GEORGE TOWN		15	7		22

	LOW HEAD		28	7		35
	WEYMOUTH		7	4		11
	(blank)			3	2	5
George Town Council Total			**61**	**23**	**2**	**86**
Glamorgan-Spring Bay Council	BICHENO	1				1
	COLES BAY		31	28		59
	DOLPHIN SANDS		3	5		8
	DOUGLAS RIVER	14				14
	ORFORD		53	29		82
	RHEBAN	18				18
	SWANSEA		10			10
	TRIABUNNA		1	5		6
	(blank)	1	17		1	19
Glamorgan-Spring Bay Council Total		**34**	**115**	**67**	**1**	**217**
Glenorchy City Council	BERRIEDALE		7	2		9
	CLAREMONT		5	5		10
	DERWENT PARK		2			2
	GLENORCHY		48			48
	GOODWOOD		1	1		2
	GRANTON		1			1
	LUTANA		5			5
	MONTROSE		8			8
	(blank)		6			6
Glenorchy City Council Total			**83**	**8**		**91**
Hobart City Council	BATTERY POINT		1	2	1	4
	SANDY BAY		29	30	1	60
	(blank)		20	2		22
Hobart City Council Total			**50**	**34**	**2**	**86**
Huon Valley Council	CRADOC			1		1
	CYGNET		3	6		9
	DEEP BAY		1			1
	DOVER	4	18	17	1	40
	EGGS AND BACON BAY		2	3	2	7
	FRANKLIN		2	11		13
	GARDEN ISLAND CREEK		22	18	2	42
	HASTINGS	11				11
	HUONVILLE		6	2		8
	LUNE RIVER	10				10
	POLICE POINT			2	2	4
	PORT HUON			1	1	2

	RAMINEA	5				5
	RANDALLS BAY			5		5
	RECHERCHE	36				36
	SOUTHPORT		7	10	2	19
	STRATHBLANE	6				6
	SURVEYORS BAY		6	9		15
	VERONA SANDS		26	16	1	43
	(blank)	5	6	22	6	39
Huon Valley Council Total		**77**	**99**	**123**	**17**	**316**
King Island Council	NARACOOPA	32				32
	SURPRISE BAY	1				1
	YAMBACOONA	2				2
King Island Council Total		**35**				**35**
Kingborough Council	ADVENTURE BAY		20	21		41
	ALONNAH	12				12
	BARNES BAY		1	1		2
	BARRETTA		1			1
	BIRCHS BAY	2				2
	DENNES POINT		2	1		3
	FLOWERPOT	1				1
	GORDON	9				9
	GREAT BAY		1			1
	KETTERING			1		1
	KINGSTON		3	2		5
	KINGSTON BEACH		55	20	1	76
	MARGATE		2	2	1	5
	MIDDLETON	9				9
	NORTH BRUNY			1		1
	SNUG		6	27		33
	SOUTH BRUNY	25		1		26
	WOODBRIDGE			1		1
	(blank)	1	9	2		12
Kingborough Council Total		**59**	**100**	**80**	**2**	**241**
Latrobe Council	LATROBE		2			2
	PORT SORELL		92	98	1	191
	SHEARWATER		95	20		115
	SQUEAKING POINT		1	1		2
	TARLETON			1		1
	(blank)		5	5		10
Latrobe Council Total			**195**	**125**	**1**	**321**

Launceston City Council	MOWBRAY		3			3
	TREVALLYN				1	1
	(blank)		1			1
Launceston City Council Total			**4**		**1**	**5**
Sorell Council	CARLTON		11	9		20
	CARLTON RIVER			1	1	2
	CONNELLYS MARSH		6	5		11
	DODGES FERRY		1	11		12
	DUNALLEY		1	8		9
	LEWISHAM		1	3		4
	MARION BAY		7	11		18
	PENNA		5			5
	PRIMROSE SANDS			1		1
	(blank)			1	2	3
Sorell Council Total			**32**	**50**	**3**	**85**
Tasman Council	KOONYA			1		1
	MURDUNNA			2		2
	NUBEENA	2				2
	PORT ARTHUR		14	4		18
	PREMAYDENA	2				2
	TARANNA		3			3
	WHITE BEACH	1	5	7		13
	(blank)			2	3	5
Tasman Council Total		**5**	**22**	**16**	**3**	**46**
Waratah-Wynyard Council	BOAT HARBOUR BEACH		7	7		14
	DOCTORS ROCKS			1		1
	SISTERS BEACH		16	4		20
	SOMERSET		15			15
	WYNYARD		1			1
Waratah-Wynyard Council Total			**39**	**12**		**51**
West Coast Council	STRAHAN		36	114	3	153
	WEST COAST	11				11
	(blank)	9	1	6	1	17
West Coast Council Total		**20**	**37**	**120**	**4**	**181**
West Tamar Council	BADGER HEAD		1			1
	BEAUTY POINT		5	4	1	10
	BLACKWALL		2	3		5
	CLARENCE POINT		2			2

	GRAVELLY BEACH		4	9		13
	GREENS BEACH		2			2
	KELSO		64	48	1	113
	RIVERSIDE		3			3
	ROBIGANA		1			1
	ROSEVEARS			1	1	2
	SWAN POINT		2	10		12
	TREVALLYN		3	4		7
	(blank)		1	4	1	6
West Tamar Council Total			**90**	**83**	**4**	**177**
Grand Total		**357**	**1779**	**1288**	**85**	**3509**

Appendix 8: High hazard hotspots – inundation & erosion

Coastal inundation and erosion high hazard hotspots are comprised of the number of residential houses that are vulnerable to at least a *High* hazard area for either coastal inundation (CI) or coastal erosions (CE) and another hazard band (*Low, Medium, Investigation Area*).

NAME	Suburb	CE=/CI=High	CE=Acceptable/CI=High	CE=High/CI=	CE=High/CI=High	CE=High/CI=Investigation	CE=High/CI=Low	CE=High/CI=Medium	CE=Investigation/CI=High	CE=Low/CI=High	CE=Medium/CI=High	Grand Total
Break O'Day Council	AKAROA			2								2
	ANSONS BAY			6	**17**		3	9		3	1	39
	ST HELENS			4			1	2			1	8
	(blank)			5	**5**		1	1				12
Break O'Day Council Total				**17**	**22**		**5**	**12**		**3**	**2**	**61**
Burnie City Council	HEYBRIDGE	1										1
Burnie City Council Total		**1**										**1**
Central Coast Council	HEYBRIDGE	3		7			11					21
	PENGUIN			2								2
	TURNERS BEACH			1								1
	ULVERSTONE			1			1					2
	WEST ULVERSTONE			2			4					6
	(blank)	1										1
Central Coast Council Total		**4**		**13**			**16**					**33**
Circular Head Council	HELLYER			2								2
	SMITHTON		1		**1**							2
	STANLEY						2					2
	(blank)							1				1
Circular Head Council Total			**1**	**2**	**1**		**2**	**1**				**7**
Clarence City Council	CAMBRIDGE										1	1
	CLIFTON BEACH		1									1
	CREMORNE			39			1	11				51
	HOWRAH						1			1		2
	LAUDERDALE		1	13			6	3				23
	LINDISFARNE			16			2					18
	OPOSSUM BAY			55	**2**		1	13				71
	ROKEBY		2	1								3
	ROSE BAY			3			1					4

	SEVEN MILE BEACH			1								1
	SOUTH ARM			18			4					22
	(blank)		1									1
Clarence City Council Total			**5**	**146**	**2**		**16**	**27**		**1**	**1**	**198**
Derwent Valley Council	NEW NORFOLK							1				1
	(blank)								1			1
Derwent Valley Council Total								**1**	**1**			**2**
Devonport City Council	EAST DEVONPORT						2					2
Devonport City Council Total							**2**					**2**
Flinders Council	BASS STRAIT ISLANDS					7						7
	LADY BARRON		1									1
	LEEKA					1						1
	(blank)					3						3
Flinders Council Total			**1**			**11**						**12**
George Town Council	GEORGE TOWN			3			8	1				12
	LOW HEAD			9			4					13
	WEYMOUTH			1								1
	(blank)	1						3			1	5
George Town Council Total		**1**		**13**			**12**	**4**			**1**	**31**
Glamorgan-Spring Bay Council	BICHENO			1								1
	COLES BAY			23								23
	ORFORD			51			1	4				56
	SPRING BEACH			6								6
	SWANSEA			3								3
	(blank)			2	1							3
Glamorgan-Spring Bay Council Total				**86**	**1**		**1**	**4**				**92**
Hobart City Council	BATTERY POINT			2	1			1				4
	SANDY BAY			16			4			1		21
	(blank)			3			2					5
Hobart City Council Total				**21**	**1**		**6**	**1**		**1**		**30**
Huon Valley Council	ABELS BAY			2								2
	CYGNET							1				1
	DEEP BAY			10								10
	DOVER			9			2	6			1	18
	EGGS AND BACON BAY		1					1	1			3
	GARDEN ISLAND				2							2

	CREEK										
	LYMINGTON		1								1
	POLICE POINT	1	1	**1**							3
	PORT HUON	1									1
	RECHERCHE				4						4
	SOUTHPORT	1	10	**1**			4				16
	SURVEYORS BAY		2			4	8				14
	VERONA SANDS		1					1			2
	(blank)		5	**6**	2	3	19				35
Huon Valley Council Total		**4**	**41**	**10**	**6**	**9**	**39**	**2**		**1**	**112**
King Island Council	CURRIE		1								1
King Island Council Total			**1**								**1**
Kingborough Council	ADVENTURE BAY		3			2	2				7
	BLACKMANS BAY		3								3
	DENNES POINT		21				1				22
	HOWDEN		2								2
	KINGSTON					1	1				2
	KINGSTON BEACH	1	1				2				4
	MARGATE									1	1
	NORTH BRUNY						1				1
	OYSTER COVE		1								1
Kingborough Council Total		**1**	**31**			**3**	**7**			**1**	**43**
Latrobe Council	PORT SORELL		1			1	2			1	5
Latrobe Council Total			**1**			**1**	**2**			**1**	**5**
Launceston City Council	TREVALLYN								1		1
Launceston City Council Total									**1**		**1**
Sorell Council	CARLTON RIVER	1									1
	CONNELLYS MARSH		5			1	2				8
	DODGES FERRY		7				2				9
	DUNALLEY		1								1
	LEWISHAM		6				1				7
	PRIMROSE SANDS		14								14
	(blank)			**2**							2
Sorell Council Total		**1**	**33**	**2**		**1**	**5**				**42**
Tasman Council	EAGLEHAWK NECK		7								7
	MURDUNNA		3								3
	NUBEENA		3								3
	PORT ARTHUR		1								1

	WHITE BEACH			9								9
	(blank)				1				2			3
Tasman Council Total				**23**	**1**				**2**			**26**
Waratah-Wynyard Council	BOAT HARBOUR BEACH			13			7	7				27
	SISTERS BEACH			2				1				3
	WYNYARD			10								10
	(blank)			1								1
Waratah-Wynyard Council Total				**26**			**7**	**8**				**41**
West Coast Council	STRAHAN									1	2	3
	(blank)										1	1
West Coast Council Total										**1**	**3**	**4**
West Tamar Council	BEAUTY POINT										1	1
	CLARENCE POINT			1								1
	KELSO						3	27			1	31
	ROSEVEARS										1	1
	(blank)										1	1
West Tamar Council Total				**1**			**3**	**27**			**4**	**35**
Grand Total		**6**	**13**	**455**	**40**	**17**	**84**	**138**	**5**	**7**	**14**	**779**

Appendix 9: Coastal inundation hazard band levels*

*(*In metres AHD by LGA and suburb)*

Notes and modelled scenarios	
RU	Rounded up to the nearest highest 100 mm to reflect a reasonable survey accuracy.
FB	Freeboard of 300 mm to quantify the acceptable floor height for a development in a flood-prone area.
Base Ht	Base MHT as supplied by the National Tidal Centre except for Macquarie Harbour and Tamar region, where published mean high tide data was used (as noted in the Stage 2 and Stage 3 reports)
AEP1pct_2050	Modelled 1% AEP for the year 2050 this is between 0.22 m and 0.24 m higher than the current day 1% AEP storm surge event.
AEP1pct_2100	Modelled 1% AEP for the year 2100
	The results include the effects of tides, storm surges and SLR only. They do not account for other factors such as wave sets or run up. To account for this, 300 mm FB has been added to the data.
	1 % AEP 2100 (Designated Flood Level) - is the modelled flood level with out the freeboard for building control purposes.
High, Medium, Low	The acceptable floor height in metres from the 0 m AHD.

- The actual inundation heights are shown in the *'DPAC Projected Sea Level Rise Ref Grid'* available through the LIST for viewing or download.
- The heights in estuaries do not consider coincident flooding in estuaries, councils may have other requirements in estuaries.

Sea Level Rise Planning Allowance for 2050 and 2100 for each council

LGA	**2050**	**2100**
Break O'day	0.24	0.92
Brighton	0.23	0.85
Burnie	0.22	0.82
Central Coast	0.22	0.82
Circular Head	0.22	0.84
Clarence	0.23	0.85
Derwent Valley	0.24	0.86
Devonport	0.22	0.81
Dorset	0.22	0.84
Flinders	0.23	0.92
George Town	0.22	0.82
Glamorgan Spring Bay	0.24	0.92
Glenorchy	0.23	0.85
Hobart	0.23	0.85
Huon Valley	0.23	0.86
King Island	0.22	0.86
Kingborough	0.24	0.87
Latrobe	0.22	0.82
Launceston	0.22	0.83
Sorell	0.23	0.84
Tasman	0.24	0.86
Waratah-Wynyard	0.22	0.83
West Coast	0.23	0.85
West Tamar	0.22	0.82
Average Of All Councils	**0.23**	**0.85**

Local Government Area	Suburb	High	Medium		Low
		Sea Level Rise 2050	1 % AEP 2050 with Freeboard	1 % AEP 2100 (Designated Flood Level)	1 % AEP 2100 with Freeboard
		RU	RU and 300mm FB	RU	RU and 300mm FB
Break O'Day	Ansons Bay	1	1.8	2.2	2.5
	Beaumaris	1	1.8	2.2	2.5
	Binalong Bay	1	1.8	2.2	2.5
	Douglas River	0.9	1.8	2.2	2.5
	Falmouth	1	1.8	2.2	2.5
	Four Mile Creek	0.9	1.8	2.2	2.5
	Scamander	1	1.8	2.2	2.5
	Seymour	1	1.8	2.2	2.5
	St Helens	1	1.8	2.2	2.5
	Stieglitz	1	1.8	2.2	2.5
	The Gardens	1	1.8	2.2	2.5
	Upper Scamander	1	1.8	2.2	2.5
Break O'Day Average		1	1.8	2.2	2.5
Brighton	Bridgewater	0.9	2	2.3	2.6
	Dromedary	0.9	1.9	2.3	2.6
	Gagebrook	0.9	2	2.3	2.6
	Old Beach	0.9	2	2.3	2.6
Brighton Average		0.9	2	2.3	2.6
Burnie	Burnie	1.8	2.7	3	3.3
	Chasm Creek	1.8	2.7	2.9	3.2
	Cooee	1.8	2.7	3	3.3
	Park Grove	1.8	2.7	3	3.3
	Round Hill	1.8	2.7	2.9	3.2
	South Burnie	1.8	2.7	3	3.3
	Wivenhoe	1.8	2.7	3	3.3
Burnie Average		1.8	2.7	3	3.3
Central Coast	Forth	1.8	2.7	2.9	3.2
	Gawler	1.8	2.7	3	3.3
	Heybridge	1.8	2.7	3	3.3
	Leith	1.8	2.7	2.9	3.2
	Penguin	1.8	2.7	3	3.3
	Sulphur Creek	1.8	2.7	3	3.3

	Turners Beach	1.8	2.7	3	3.3
	Ulverstone	1.8	2.7	3	3.3
	West Ulverstone	1.8	2.7	3	3.3
Central Coast Average		1.8	2.7	3	3.3
Circular Head	Arthur River	0.8	1.8	2.1	2.4
	Cowrie Point	1.8	2.6	2.9	3.2
	Edgcumbe Beach	1.8	2.6	2.9	3.2
	Hellyer	1.8	2.6	2.9	3.2
	Marrawah	0.8	1.8	2.1	2.4
	Nelson Bay	0.8	1.8	2.1	2.4
	Rocky Cape	1.8	2.6	2.9	3.2
	Smithton	1.8	2.6	2.9	3.2
	Stanley	1.8	2.6	2.9	3.2
	Temma	0.8	1.8	2.1	2.4
Circular Head Average		1.8	2.6	2.9	3.2
Clarence	Acton Park	0.9	2	2.3	2.6
	Bellerive	0.9	2	2.3	2.6
	Cambridge	0.9	2	2.3	2.6
	Clifton Beach	0.9	1.9	2.2	2.5
	Cremorne	0.9	1.9	2.2	2.5
	Geilston Bay	0.9	2	2.3	2.6
	Howrah	0.9	2	2.3	2.6
	Lauderdale	0.9	2	2.3	2.6
	Lindisfarne	0.9	2	2.3	2.6
	Montagu Bay	0.9	2	2.3	2.6
	Opossum Bay	0.9	1.9	2.2	2.5
	Otago	0.9	2	2.3	2.6
	Richmond	0.9	2	2.3	2.6
	Risdon	0.9	2	2.3	2.6
	Roches Beach	0.9	2	2.3	2.6
	Rokeby	0.9	2	2.3	2.6
	Sandford	0.9	2	2.3	2.6
	Seven Mile Beach	0.9	2	2.3	2.6
	South Arm	0.9	1.9	2.2	2.5
	Tranmere	0.9	2	2.3	2.6
Clarence Average		0.9	2	2.3	2.6
Derwent Valley	Boyer	0.9	1.9	2.3	2.6
	Lawitta	0.9	1.9	2.3	2.6
	Molesworth	0.9	1.9	2.3	2.6
	New Norfolk	0.9	1.9	2.3	2.6
Derwent Valley Average		0.9	1.9	2.3	2.6

Devonport	Ambleside	1.8	2.7	2.9	3.2
	Devonport	1.8	2.7	3	3.3
	Don	1.8	2.7	2.9	3.2
	East Devonport	1.8	2.7	2.9	3.2
	Miandetta	1.8	2.7	2.9	3.2
	Quoiba	1.8	2.7	2.9	3.2
	Spreyton	1.8	2.7	2.9	3.2
	Stony Rise	1.8	2.7	2.9	3.2
Devonport Average		1.8	2.7	3	3.3
Dorset	Bridport	1.8	2.5	2.8	3.1
	Musselroe Bay	1	1.9	2.3	2.6
	Tomahawk	1.7	2.4	2.7	3
Dorset Average		1.8	2.5	2.8	3.1
Flinders	Cape Barren Island	1.8	2.4	2.7	3
	Emita	1.7	2.4	2.7	3
	Killiecrankie	1.5	2.4	2.7	3
	Lady Barron	1.3	1.8	2.2	2.5
	Palana	1.4	2.4	2.7	3
	Whitemark	1.8	2.4	2.7	3
Flinders Average		1.8	2.4	2.7	3
George Town	Beechford	1.9	2.6	2.9	3.2
	Bell Bay	1.5	2.6	2.9	3.2
	Bellingham	1.8	2.5	2.8	3.1
	George Town	1.8	2.6	2.9	3.2
	Hillwood	1.4	2.6	2.9	3.2
	Long Reach	1.5	2.6	2.9	3.2
	Low Head	1.8	2.6	2.9	3.2
	Lulworth	1.8	2.5	2.8	3.1
	Weymouth	1.8	2.5	2.8	3.1
George Town Average		1.9	2.6	2.9	3.2
Glamorgan-Spring Bay	Bicheno	0.9	1.8	2.2	2.5
	Coles Bay	0.9	1.8	2.2	2.5
	Dolphin Sands	0.9	1.8	2.2	2.5
	Douglas River	0.9	1.8	2.2	2.5
	Freycinet	0.9	1.8	2.2	2.5
	Friendly Beaches	0.9	1.8	2.2	2.5
	Little Swanport	0.9	1.7	2.1	2.4
	Orford	0.9	1.7	2.1	2.4

	Pontypool	0.9	1.7	2.1	2.4
	Rheban	0.9	1.7	2.1	2.4
	Spring Beach	0.9	1.7	2.1	2.4
	Swansea	0.9	1.8	2.1	2.4
	Triabunna	0.9	1.8	2.1	2.4
Glamorgan-Spring Bay Average		0.9	1.8	2.2	2.5
Glenorchy	Austins Ferry	0.9	2	2.3	2.6
	Berriedale	0.9	1.9	2.3	2.6
	Claremont	0.9	2	2.3	2.6
	Derwent Park	0.9	1.9	2.3	2.6
	Glenorchy	0.9	1.9	2.3	2.6
	Granton	0.9	2	2.3	2.6
	Lutana	0.9	2	2.3	2.6
	Montrose	0.9	1.9	2.3	2.6
	Moonah	0.9	1.9	2.3	2.6
	Rosetta	0.9	1.9	2.3	2.6
Glenorchy Average		0.9	2	2.3	2.6
Hobart	Hobart	0.9	1.9	2.2	2.5
	New Town	0.9	1.9	2.3	2.6
	Queens Domain	0.9	1.9	2.2	2.5
	Sandy Bay	0.9	1.9	2.2	2.5
Hobart Average		0.9	1.9	2.3	2.6
Huon Valley	Abels Bay	0.9	1.8	2.2	2.5
	Cairns Bay	0.9	1.8	2.2	2.5
	Castle Forbes Bay	0.9	1.8	2.2	2.5
	Charlotte Cove	0.9	1.8	2.2	2.5
	Cradoc	0.9	1.8	2.2	2.5
	Cygnet	0.9	1.8	2.2	2.5
	Deep Bay	0.9	1.8	2.2	2.5
	Dover	0.9	1.8	2.2	2.5
	Eggs and Bacon Bay	0.9	1.8	2.2	2.5
	Franklin	0.9	1.8	2.2	2.5
	Garden Island Creek	0.9	1.8	2.2	2.5
	Gardners Bay	0.9	1.8	2.2	2.5
	Geeveston	0.9	1.8	2.2	2.5
	Glaziers Bay	0.9	1.8	2.2	2.5
	Glen Huon	0.9	1.8	2.2	2.5
	Hastings	0.9	1.8	2.1	2.4
	Huonville	0.9	1.8	2.2	2.5
	Lune River	0.9	1.8	2.1	2.4
	Lymington	0.9	1.8	2.2	2.5

	Police Point	0.9	1.8	2.2	2.5
	Port Huon	0.9	1.8	2.2	2.5
	Randalls Bay	0.9	1.8	2.2	2.5
	Ranelagh	0.9	1.8	2.1	2.4
	Recherche	0.9	1.8	2.1	2.4
	Southport	0.9	1.8	2.1	2.4
	Strathblane	0.9	1.8	2.2	2.5
	Surges Bay	0.9	1.8	2.2	2.5
	Surveyors Bay	0.9	1.8	2.2	2.5
	Waterloo	0.9	1.8	2.2	2.5
	Wattle Grove	0.9	1.8	2.2	2.5
Huon Valley Average		0.9	1.8	2.2	2.5
King Island	Currie	0.8	1.8	2.1	2.4
	Grassy	1.2	2.2	2.6	2.9
	Loorana	0.8	1.8	2.1	2.4
	Naracoopa	1.3	2.2	2.5	2.8
King Island Average		1.3	2.2	2.6	2.9
Kingborough	Adventure Bay	0.9	1.8	2.2	2.5
	Alonnah	0.9	1.8	2.2	2.5
	Apollo Bay	0.9	1.8	2.1	2.4
	Barnes Bay	0.9	1.8	2.1	2.4
	Blackmans Bay	0.9	1.9	2.2	2.5
	Bonnet Hill	0.9	1.9	2.2	2.5
	Coningham	0.9	1.8	2.1	2.4
	Dennes Point	0.9	1.8	2.1	2.4
	Electrona	0.9	1.8	2.1	2.4
	Gordon	0.9	1.8	2.2	2.5
	Great Bay	0.9	1.8	2.1	2.4
	Howden	0.9	1.8	2.1	2.4
	Kettering	0.9	1.8	2.1	2.4
	Killora	0.9	1.8	2.1	2.4
	Kingston	0.9	1.9	2.2	2.5
	Kingston Beach	0.9	1.9	2.2	2.5
	Lower Snug	0.9	1.8	2.1	2.4
	Lunawanna	0.9	1.8	2.2	2.5
	Margate	0.9	1.8	2.1	2.4
	Middleton	0.9	1.8	2.1	2.4
	North Bruny	0.9	1.8	2.1	2.4
	Oyster Cove	0.9	1.8	2.1	2.4
	Simpsons Bay	0.9	1.8	2.1	2.4
	Snug	0.9	1.8	2.1	2.4
	Taroona	0.9	1.9	2.2	2.5
	Tinderbox	0.9	1.8	2.2	2.5

	Woodbridge	0.9	1.8	2.1	2.4
Kingborough Average		0.9	1.9	2.2	2.5
Latrobe	Bakers Beach	1.8	2.6	2.9	3.2
	Hawley Beach	1.8	2.6	2.9	3.2
	Latrobe	1.8	2.7	2.9	3.2
	Port Sorell	1.8	2.6	2.9	3.2
	Shearwater	1.8	2.6	2.9	3.2
	Squeaking Point	1.8	2.6	2.9	3.2
	Tarleton	1.8	2.7	2.9	3.2
Latrobe Average		1.8	2.7	2.9	3.2
Launceston	Dilston	1.7	2.6	2.9	3.2
	Invermay	1.8	2.6	2.9	3.2
	Launceston	1.8	2.6	2.9	3.2
	Mowbray	1.8	2.6	2.9	3.2
	Newnham	1.8	2.6	2.9	3.2
	Newstead	1.8	2.6	2.9	3.2
	Norwood	1.8	2.6	2.9	3.2
	Ravenswood	1.8	2.6	2.9	3.2
	St Leonards	1.8	2.6	2.9	3.2
	Swan Bay	1.4	2.6	2.9	3.2
	West Launceston	1.8	2.6	2.9	3.2
	Windermere	1.6	2.6	2.9	3.2
Launceston Average		1.8	2.6	2.9	3.2
Sorell	Boomer Bay	0.9	2.2	2.5	2.8
	Carlton	0.9	2.1	2.4	2.7
	Carlton River	1	2.1	2.4	2.7
	Dodges Ferry	0.9	2.1	2.4	2.7
	Dunalley	0.9	2.2	2.5	2.8
	Forcett	0.9	2	2.3	2.6
	Lewisham	0.9	2	2.3	2.6
	Marion Bay	0.9	1.7	2.1	2.4
	Midway Point	0.9	2	2.3	2.6
	Penna	0.9	2	2.3	2.6
	Primrose Sands	0.9	2.1	2.4	2.7
	Sorell	0.9	2	2.3	2.6
Sorell Average		1	2.2	2.5	2.8
Tasman	Dunalley	0.9	1.7	2.1	2.4
	Eaglehawk Neck	1	2.4	2.7	3
	Koonya	1	2.4	2.7	3
	Murdunna	1	2.4	2.6	2.9

	Nubeena	0.9	1.9	2.2	2.5
	Port Arthur	0.9	1.7	2	2.3
	Premaydena	1	2.4	2.6	2.9
	Saltwater River	1	2.3	2.6	2.9
	Sloping Main	0.9	2	2.3	2.6
	Taranna	1	2.4	2.7	3
	White Beach	0.9	1.9	2.2	2.5
Tasman Average		1	2.4	2.7	3
Waratah-Wynyard	Boat Harbour	1.8	2.6	2.9	3.2
	Doctors Rocks	1.8	2.6	2.9	3.2
	Flowerdale	1.8	2.6	2.9	3.2
	Sisters Beach	1.8	2.6	2.9	3.2
	Somerset	1.8	2.6	2.9	3.2
	Wynyard	1.8	2.6	2.9	3.2
Waratah-Wynyard Average		1.8	2.6	2.9	3.2
West Coast	Granville Harbour	0.8	1.8	2.1	2.4
	Strahan	0.7	1.9	2.2	2.5
	Trial Harbour	0.8	1.8	2.1	2.4
	West Coast	0.8	1.8	2.1	2.4
West Coast Average		0.8	1.9	2.2	2.5
West Tamar	Badger Head	1.8	2.6	2.9	3.2
	Beauty Point	1.5	2.6	2.9	3.2
	Clarence Point	1.7	2.6	2.9	3.2
	Deviot	1.4	2.6	2.9	3.2
	Exeter	1.5	2.6	2.9	3.2
	Gravelly Beach	1.5	2.6	2.9	3.2
	Greens Beach	1.8	2.6	2.9	3.2
	Kayena	1.4	2.6	2.9	3.2
	Kelso	1.8	2.6	2.9	3.2
	Lanena	1.5	2.6	2.9	3.2
	Legana	1.8	2.6	2.9	3.2
	Riverside	1.8	2.6	2.9	3.2
	Robigana	1.4	2.6	2.9	3.2
	Rosevears	1.6	2.6	2.9	3.2
	Rowella	1.5	2.6	2.9	3.2
	Sidmouth	1.4	2.6	2.9	3.2
	Swan Point	1.4	2.6	2.9	3.2
	Trevallyn	1.8	2.6	2.9	3.2
West Tamar Average		1.8	2.6	2.9	3.2

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