

# Coastal inundation

## Define the areas of concern

## Definition: Coastal inundation

the temporary and permanent flooding of a portion of land within the coastal zone.

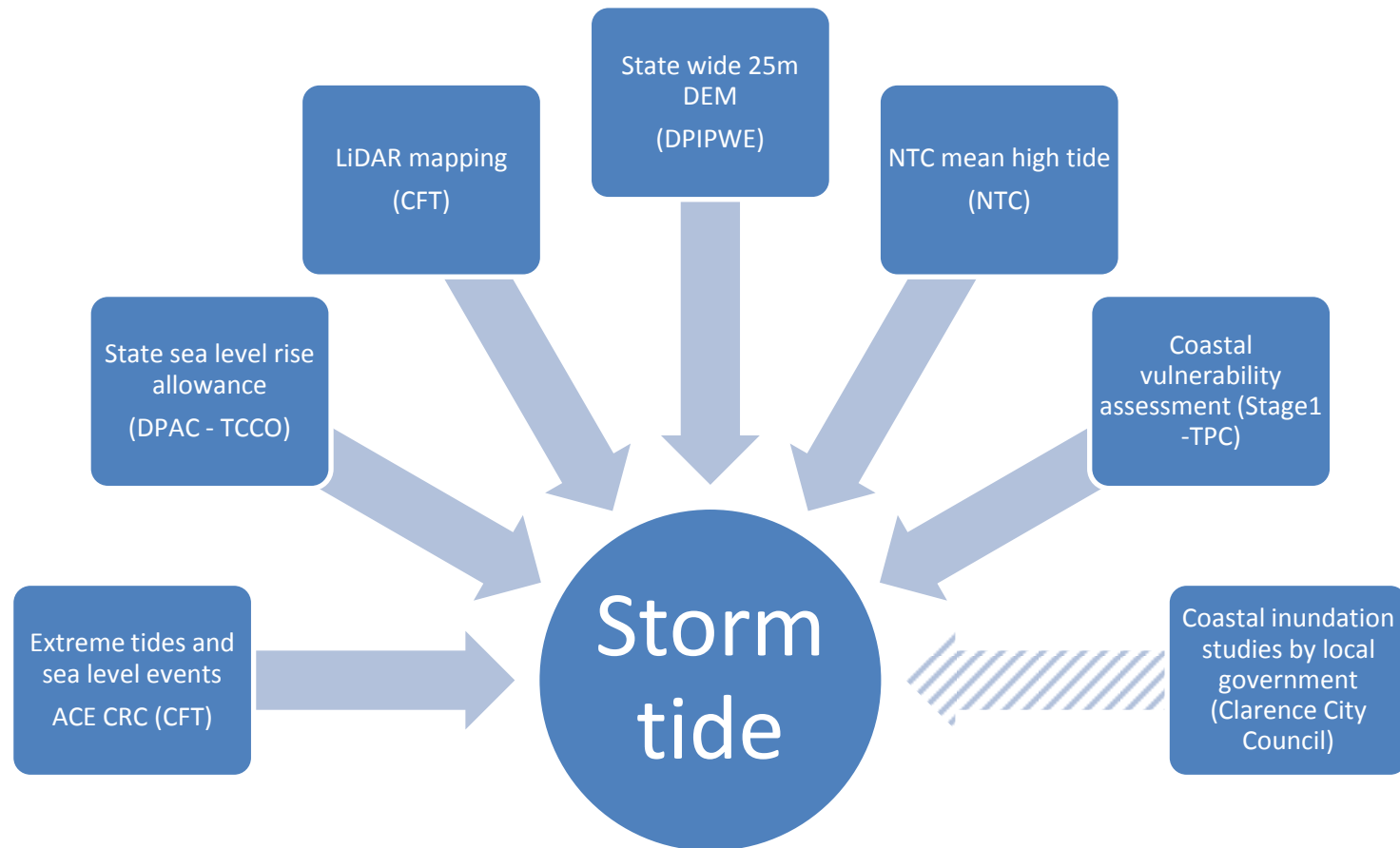
- Temporary inundation is a storm tide event that considers the following factors;
  - regional storm surge and tides,
  - climate change (including sea level rise allowance and changing likelihood of storm events),
  - local storm surge ,wave setup, wave runup - not modelled .
- Permanent inundation is the permanent loss of land to the sea, it considers the following factors:
  - National Tide Centre high water mark (tides),
  - climate change sea level rise planning allowance.
- Tsunami events are considered as part of the emergency management controls.

Definition:  
Annual Exceedance  
Probability

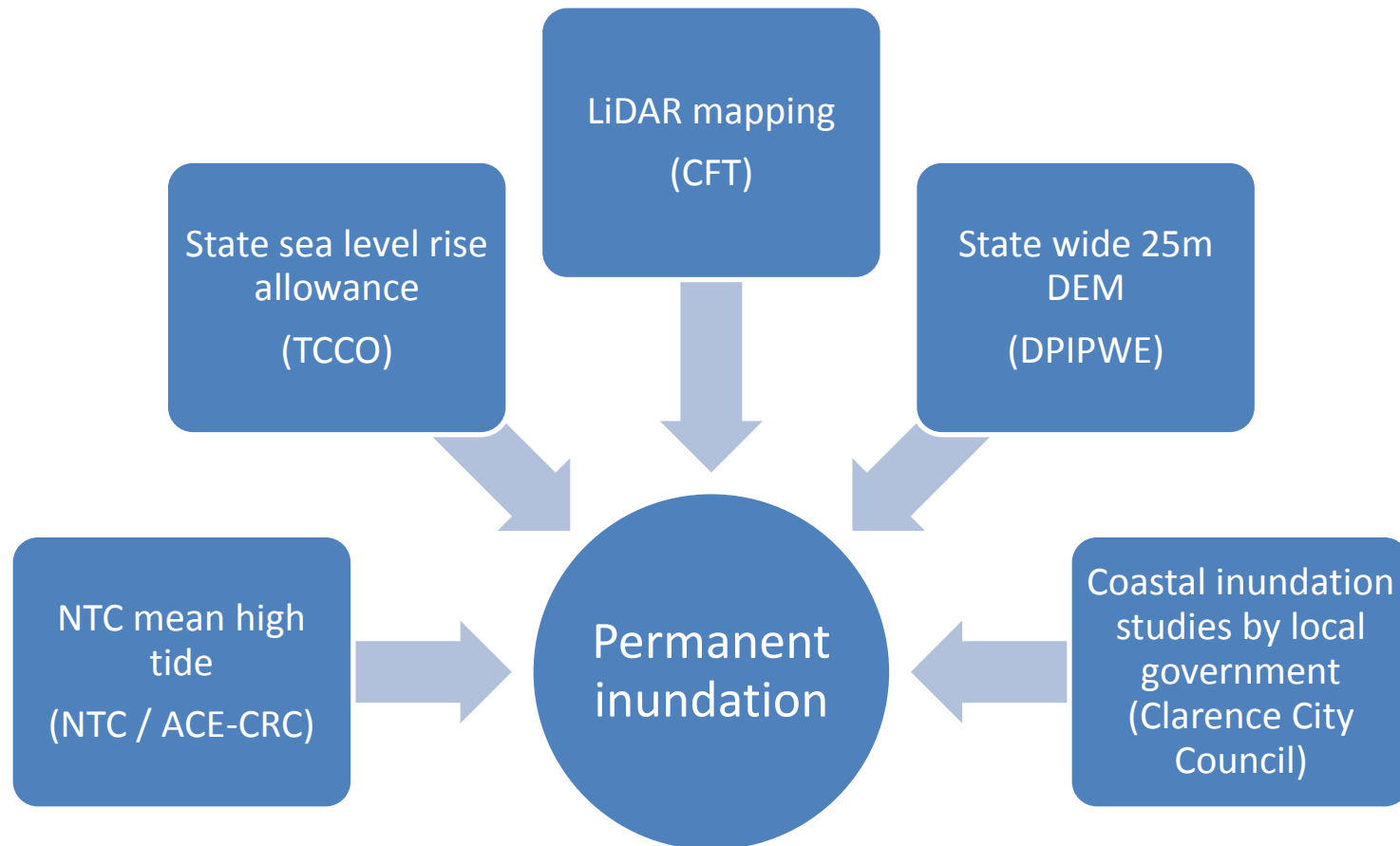
Annual Exceedance Probability	Average recurrence interval (years)	Percentage Probability of Experiencing in a 70 year period (%)	
		at least once	at least twice
10%	1 in 10 years	99.9	99.3
5%	1 in 20 years	97.0	86.4
2%	1 in 50 years	75.3	40.8
1%	1 in 100 years	50.3	15.6
0.5%	1 in 200 years	29.5	4.9

Likelihood of Occurrence in a 10-year Period	ARI	AEP	Qualitative indication of frequency at a particular location
Almost Certain	< 1 in 10 years	> 10%	Has occurred a number of times and is expected to occur within the decade
Likely	> 1-in-10 to < 1-in-50 years	> 2% and < 10%	Has occurred several times and is quite likely within the next decade
Possible	> 1-in-50 to < 1-in-100 years	> 1% and < 2%	Floods of a similar size have occurred in the past and will occur again
Unlikely	> 1-in-100 to < 1-in-1000 years	> 0.1% and < 1%	Conceivable it could occur; will occur on some rivers in the near future
Rare	> 1-in-1000 to < 1-in-10,000 years	> 0.01% and < 0.1%	Will occur in exceptional circumstances, though rarely
Very Rare	> 1-in-10,000 years	> 0.01%	Very unlikely to be seen by present residents but provides an upper limit of the potential scale of flooding
Almost Incredible	> 1-in-1,000,000 years	> 0.0001%	Almost incredible

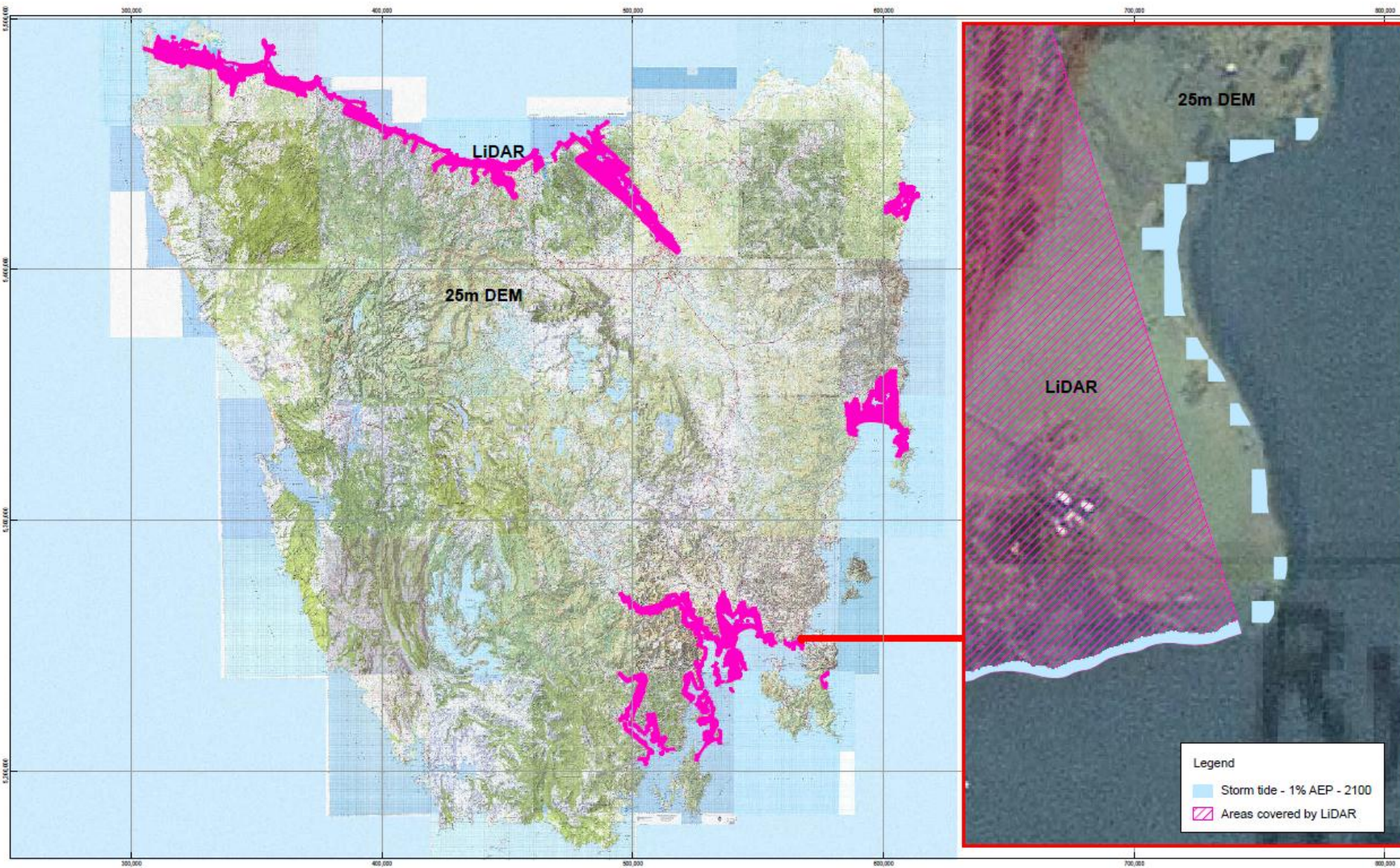
# Coastal inundation - inputs



## Coastal inundation - inputs

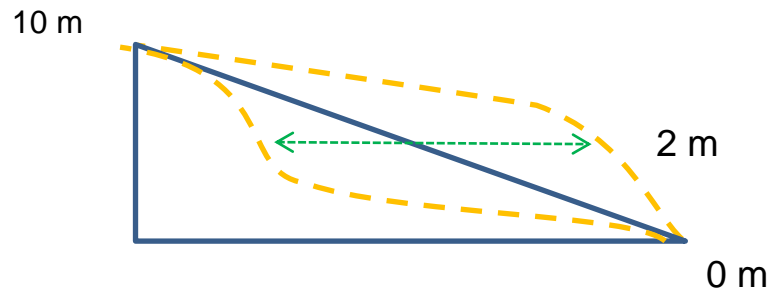






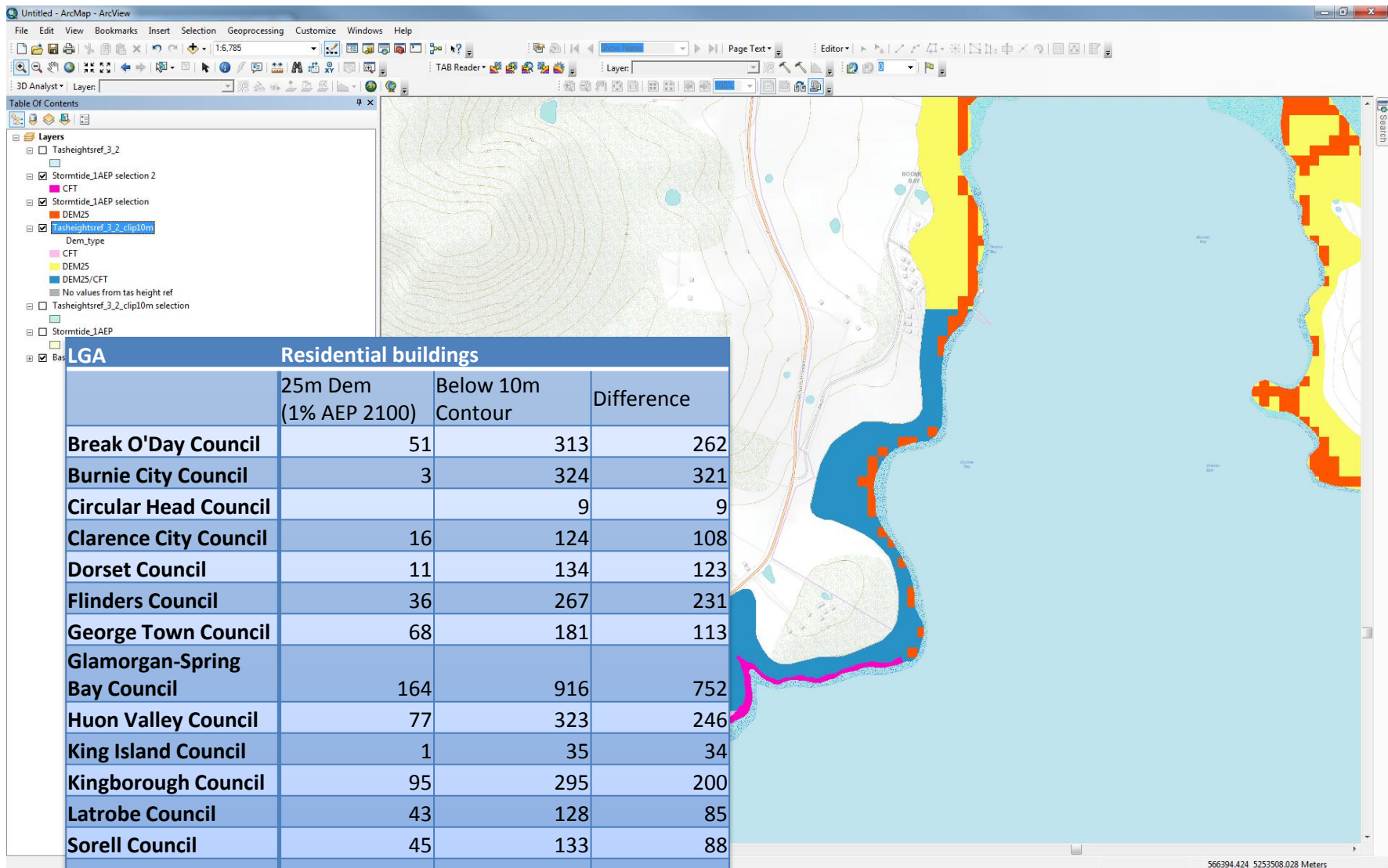
# Assumptions used in the non LiDAR areas

- When mapping the projected flood levels the figure has been rounded up to the nearest highest metre.
  - Eg - 0.9m SLR has been round up to 1 m
  - Eg – 1.2m SLR has been rounded up to 2m
- We have assumed a linear relationship between the 0m and 10m contour



- How do we use this for planning?
  - Accept the error
  - Buy more LiDAR mapping
  - Use the area below the 10m contour to trigger an investigation height

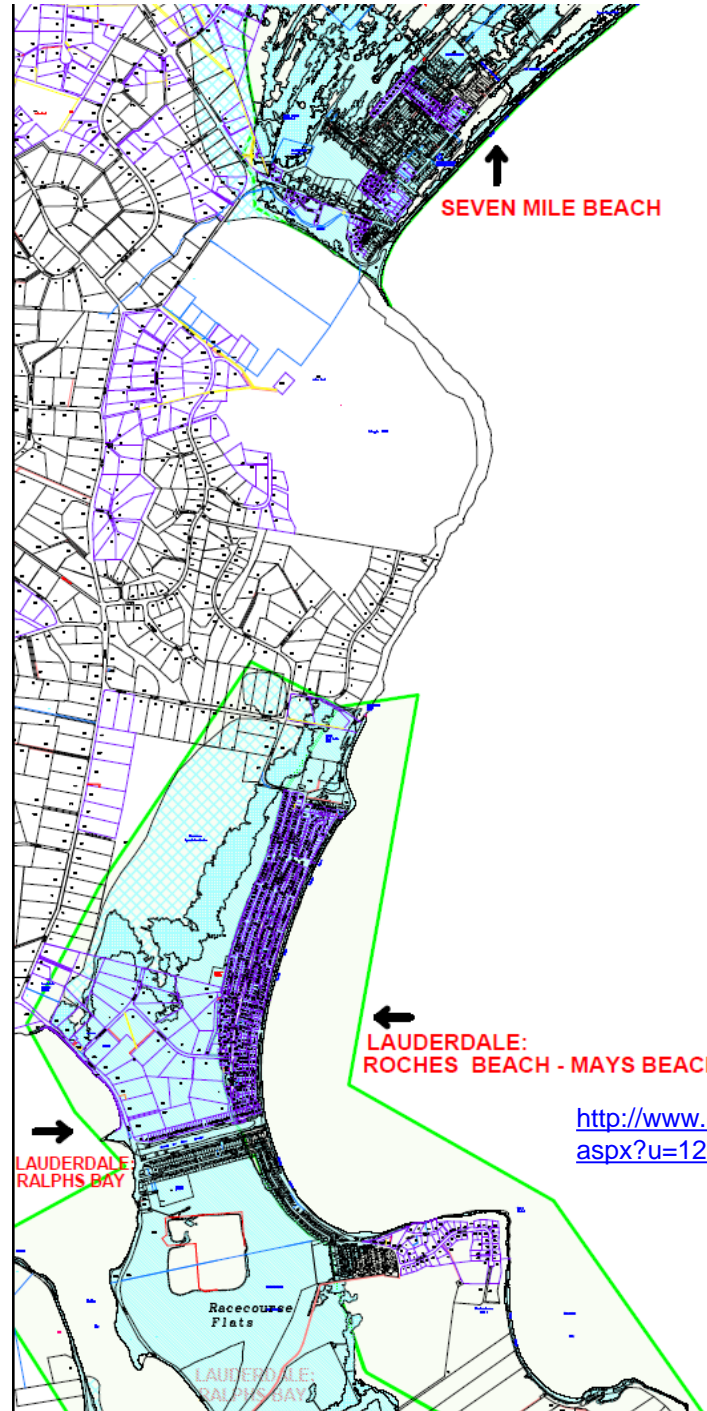






# Clarence City Council - Subject to Inundation Mapping

- Based on a 2009 report on coastal vulnerability:
  - Assumed a Sea level rise of 0.9m by 2100
  - Rounded all values up to the nearest 0.1m
  - Added 0.3m in precaution
  - Used the Sharples 2004 coastal vulnerability mapping in areas not modelled in detail
- Since the completion of the CCC work the State Government has taken delivery of:
  - *Climate Futures for Tasmania* report storm tide modelling
  - Defined a sea level rise allowance of 0.8m
  - Completed stage 1(TPC) and 2 (DPAC) of the coastal inundation mapping
  - In the process of finalising the mapping
- The State Government have made the following assumptions:
  - Storm tide inundation areas exclude non contiguous flooding areas
  - Permanent inundation includes areas which are not contiguous with the coast
  - Not rounded the inundation levels up to the nearest 0.1m in LiDAR areas
  - In non LiDAR areas we have rounded the level to nearest highest metre.



18 - SI

**CLARENCE PLANNING SCHEME 2007**

AMENDMENT A-2009/13

Scale 1:10000 @ A1

^  
N

2050/2100 Area  
SI(2050)  
SI(2100)  
SI(R)

AMENDMENT A-2009/13  
Amend Subject to Inundation Overlay by inserting the SI(2050) and SI(2100).

<http://www.ccc.tas.gov.au/page.aspx?u=1229>

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9





Paper Size A3  
 0 125 250 500 750 1,000  
 Metres

Map Projection: Transverse Mercator  
 Horizontal Datum: GDA 1994  
 GCR: MGA55



- | Sea Level Rise Planning Allowance |                            | CCC - Subject to Inundation Overlay |           |
|-----------------------------------|----------------------------|-------------------------------------|-----------|
|                                   | SLR 2100 (0.8 m)           |                                     | SI 2050   |
|                                   | Storm tide - 1% AEP - 2010 |                                     | SI (2100) |
|                                   | Storm tide - 1% AEP - 2100 |                                     | SI(R)     |

Project Name: Landslide planning matrix and map Revision A  
 Date: 09 Oct 2012

## Coastal Inundation Map Clarence City Council Inundation Mapping

X:\01058\1059\_1\HW\PCoastal\OPAC\_Coastal\_02.mxd  
 © 2011. Whilst every care has been taken to prepare this map, OPAC (and DATA CUSTODIAN) make no representations or warranties about its accuracy, reliability, completeness or suitability for any particular purpose and cannot accept liability or responsibility of any kind (whether in contract, tort or otherwise) for any expenses, losses, damages and/or costs (including indirect or consequential damage) which are or may be incurred by any party as a result of the map being inaccurate, incomplete or unsuitable in any way and for any reason.  
 Data source: DPPIWA, Coastal Vulnerability based on Stage 2008. Created by Luke Roberts

# Directions in finalising the mapping?

- For storm tide – only consider the parcels of water contiguous to the sea?
  - Used in the October 2012 data release.
  - These areas are unlikely to be impacted by a temporary inundation
- For permanent inundation - consider contiguous and non-contiguous areas?
  - Used in the October 2012 data release.
  - Highlights where ground water may rise to reflect the change in sea level
- In the non LiDAR areas should the 10m contour be used to trigger consideration of the mapping option?
- Should we round all values up to the nearest 10cm?
- Add 300mm to all flooding elevations
  - Identifies all land in the flood hazard area
  - Consistent with the river flooding in the building code

# Issues the mapping raises:

Issue	Project
Guidance on coastal inundation for a planning directive (future development)	OSEM
Impact on existing settlements	IDC
Impact on the environment	IDC
Impact on the infrastructure	IDC
Maintenance of lifelines to communities and settlements	IDC

# Options for preparing and changing the coastal inundation mapping



# Six options

## Option 1

High = 1% AEP 2010,  
Medium = 1 % AEP 2050 and SLR 2050  
High = 1 % AEP 2100 and SLR 2100

## Option 3

High = 5% AEP events in 2010  
Medium = 1% AEP events & SLR in 2050  
Low = 1% AEP events & SLR in 2100

## Option 5

1 % AEP in 2100

## Option 2

For 2010, 2050, and 2100 have a set of hazard bands.

High = 5% AEP events  
Medium = 1% AEP events  
Low = 0.5% AEP events &  
Sea level rise thresholds

## Option 4

High = 5% 2100  
Medium = 1% 2100 and slr?  
Low = 0.5% 2100

## Option 6

High = SLR 2050 (0.2m)  
Medium = SLR 2100 (0.8m)  
Low = 1%AEP 2100

*Initial feedback suggests  
it is too complex*

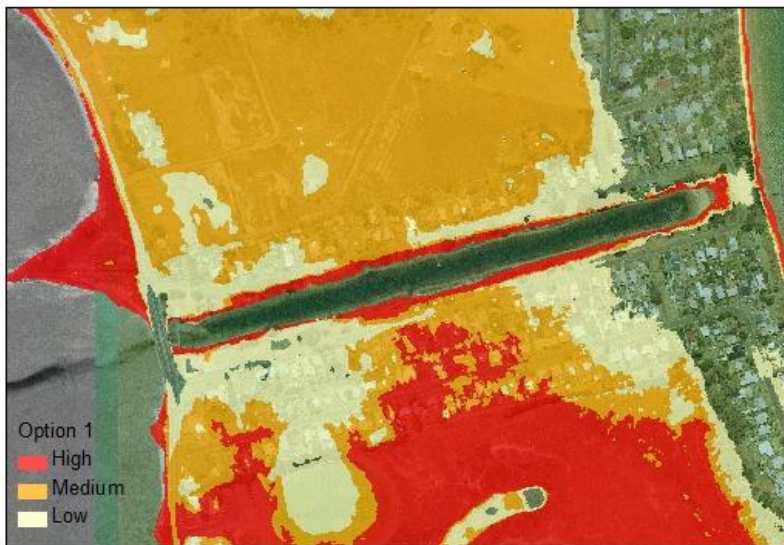
# Six options

## Option 1

High = 1% AEP 2010,  
 Medium = 1 % AEP 2050 and SLR 2050  
 Low = 1 % AEP 2100 and SLR 2100

### Rational

- Incremental increase in likelihood
- Exposure increases over time
- Includes storm tide hazard
- Sea level rise as it becomes a issue



Number of Residential Buildings		Hazard Bands			
Region	LGA	Low	Medium	High	Grand Total
<b>North West Region</b>					
	Burnie City Council	3			3
	Central Coast Council	147		2	149
	Circular Head Council	19	2		21
	Devonport City Council	7			7
	King Island Council	1			1
	Latrobe Council	106	10	42	158
	Waratah-Wynyard Council	8	1	2	11
	West Coast Council		1	22	23
<b>Northern Region</b>					
	Break O'Day Council	17		52	69
	Dorset Council	6	4	1	11
	Flinders Council	10	8	30	48
	George Town Council	15	17	49	81
	Glamorgan-Spring Bay Council	42	1	129	172
	<b>Launceston City Council (without levees)</b>	<b>159</b>	<b>539</b>		<b>698</b>
	West Tamar Council	74		3	77
<b>Southern Region</b>					
	Brighton Council	23	1		24
	Clarence City Council	269	95	63	427
	Derwent Valley Council	9	2		11
	Glenorchy City Council	6			6
	Hobart City Council	53	2		55
	Huon Valley Council	114	10	75	199
	Kingborough Council	107		53	160
	Sorell Council	29		46	75
	Tasman Council	21		26	47
<b>Grand Total</b>		<b>1086 (1245)</b>	<b>154 (693)</b>	<b>595</b>	<b>1835 (2533)</b>

# Six options

See GIS for the 4 sets of map

## Option 2

For 2010, 2050, and 2100 have a set of hazard bands.

High = 5% AEP events

Medium = 1% AEP events

Low = 0.5% AEP events &

Sea level rise thresholds

### Rational

- Incremental increase in likelihood
- Allows the full hazard to be understood

### Initial reactions

- To complex for land use planning or building
- This option has not been progressed

# Six options

## Option 3

High = 5% AEP events in 2010

Medium = 1% AEP events & SLR in 2050

Low = 1% AEP events & SLR in 2100

## Rational

- Incremental increase in likelihood
- Identifies areas with an immediate hazard
- Sea level rise and storm tide as it becomes a issue



Number of Residential Buildings		Option 3 Hazard Bands			
Region	LGA	Low	Medium	High	Grand Total
<b>North West Region</b>					
	Burnie City Council	3			3
	Central Coast Council	149			149
	Circular Head Council	19	2		21
	Devonport City Council	7			7
	Kentish Council				
	King Island Council	1			1
	Latrobe Council	107	25	26	158
	Waratah-Wynyard Council	8	2	1	11
	West Coast Council	3	12	8	23
<b>Northern Region</b>					
	Break O'Day Council	35	1	33	69
	Dorset Council	7	4		11
	Flinders Council	15	8	25	48
	George Town Council	16	20	45	81
	Glamorgan-Spring Bay Council	60	2	110	172
	<b>Launceston City Council (without levee banks)</b>	<b>159</b>	<b>539</b>		<b>698</b>
	Meander Valley Council				
	Northern Midlands Council				
	West Tamar Council	76	1		77
<b>Southern Region</b>					
	Brighton Council	23	1		24
	Central Highlands Council				
	Clarence City Council	277	135	15	427
	Derwent Valley Council	9	2		11
	Glenorchy City Council	6			6
	Hobart City Council	53	2		55
	Huon Valley Council	133	24	42	199
	Kingborough Council	123		37	160
	Sorell Council	34	4	37	75
	Southern Midlands Council				
	Tasman Council	28		19	47
<b>Grand Total</b>		<b>1192 (1351)</b>	<b>245 (784)</b>	<b>398</b>	<b>1835 (2533)</b>

Number of Residential Buildings		Option 4 Hazard Bands			
Region	LGA	Low	Medium	High	Grand Total
<b>North West Region</b>					
	Burnie City Council		1	1	2
	Central Coast Council	10	23	119	152
	Circular Head Council	5	3	18	26
	Devonport City Council	4	5	9	18
	Kentish Council				
	King Island Council				
	Latrobe Council	4	15	136	155
	Waratah-Wynyard Council	2	2	8	12
	West Coast Council			20	20
<b>Northern Region</b>					
	Break O'Day Council			50	50
	Dorset Council			4	4
	Flinders Council		1	39	40
	George Town Council		3	70	73
	Glamorgan-Spring Bay Council	3	3	134	140
	<b>Launceston City Council (without levee bank)</b>	<b>3</b>	<b>12</b>	<b>665</b>	<b>680</b>
	Meander Valley Council				
	Northern Midlands Council				
	West Tamar Council	1	10	44	55
<b>Southern Region</b>					
	Brighton Council	1	6	9	16
	Central Highlands Council				
	Clarence City Council	10	45	342	397
	Derwent Valley Council			6	6
	Glenorchy City Council	1	5	6	12
	Hobart City Council	4	10	35	49
	Huon Valley Council	3	30	139	172
	Kingborough Council	2	13	120	135
	Sorell Council	5	8	57	70
	Southern Midlands Council				
	Tasman Council		14	21	35
<b>Grand Total</b>		<b>55 (58)</b>	<b>197 (209)</b>	<b>1387 (2052)</b>	<b>1639 (2319)</b>

## Option 4

High = 5% 2100

Medium = 1% 2100 and SLR?

Low = 0.5% 2100

## Rational

- Focuses on the end of period
- Incremental likelihood
- Highly Precautionary





# Six options

## Option 5

1 % AEP in 2100

### Rational

- End of period
- Equivalent to the 1% AEP river flood areas
- Very simple



Region	LGA	1 % AEP 2100
<b>North West Region</b>		
	Burnie City Council	3
	Central Coast Council	133
	Circular Head Council	21
	Devonport City Council	4
	Kentish Council	
	King Island Council	1
	Latrobe Council	158
	Waratah-Wynyard Council	10
	West Coast Council	23
<b>Northern Region</b>		
	Break O'Day Council	69
	Dorset Council	11
	Flinders Council	42
	George Town Council	81
	Glamorgan-Spring Bay Council	166
	<b>Launceston City Council</b>	<b>679</b>
	Meander Valley Council	
	Northern Midlands Council	
	West Tamar Council	77
<b>Southern Region</b>		
	Brighton Council	24
	Central Highlands Council	
	Clarence City Council	420
	Derwent Valley Council	11
	Glenorchy City Council	5
	Hobart City Council	55
	Huon Valley Council	190
	Kingborough Council	160
	Sorell Council	75
	Southern Midlands Council	
	Tasman Council	47
<b>Grand Total</b>		<b>1786</b> <b>20(2465)</b>

Number of residential buildings		Option 6 Hazard Bands			Grand Total
Region	LGA	Low	Medium	High	
<b>North West Region</b>					
	Burnie City Council	2	1		3
	Central Coast Council	95	54		149
	Circular Head Council	21			21
	Devonport City Council	4	3		7
	Kentish Council				
	King Island Council	1			1
	Latrobe Council	68	64	26	158
	Waratah-Wynyard Council	5	5	1	11
	West Coast Council		15	8	23
<b>Northern Region</b>					
	Break O'Day Council	6	52	11	69
	Dorset Council		11		11
	Flinders Council		22	26	48
	George Town Council	9	27	45	81
	Glamorgan-Spring Bay Council	27	89	56	172
	<b>Launceston City Council (without levee banks)</b>	<b>41</b>	<b>118</b>	<b>539</b>	<b>698</b>
	Meander Valley Council				
	Northern Midlands Council				
	West Tamar Council	60	17		77
<b>Southern Region</b>					
	Brighton Council	21	3		24
	Central Highlands Council				
	Clarence City Council	250	175	2	427
	Derwent Valley Council	9	2		11
	Glenorchy City Council	4	2		6
	Hobart City Council	50	5		55
	Huon Valley Council	100	81	18	199
	Kingborough Council	102	48	10	160
	Sorell Council	27	30	18	75
	Southern Midlands Council				
	Tasman Council	21	11	15	47
<b>Grand Total</b>		<b>882 (923)</b>	<b>717 (835)</b>	<b>236 (775)</b>	<b>1835 (2533)</b>

## Option 6

High = SLR 2050 (0.2m)

Medium = SLR 2100 (0.8m)

Low = 1%AEP 2100

### Rational

- Identifies areas that will be lost due to sea level rise without defence
- Incremental increase in risk
- Differentiates between permanent inundation and temporary inundation



Option		Strengths	Weakness	Preference
1	High = 1% AEP 2010, Medium = 1 % AEP 2050 and SLR 2050, High = 1 % AEP 2100 and SLR 2100,	Allows the incremental implementation of controls		3
2	For each period 2010, 2050, and 2100 have a set of hazard bands. High = 5% AEP events Medium = 1% AEP events Low = 0.5% AEP events Sea level rise thresholds	Allows for a range or responses depending on the likelihood  Comprehensive	Complex Hard to manage  Difficult to communicate	
3	High = 5% AEP events in 2010 Medium = 1% AEP events & SLR in 2050 Low = 1% AEP events & SLR in 2100	Shows incremental risk Allows us to give a clear signal on risk tolerance for coastal hazards	Becoming complex	2
4	High = 5% 2100 Medium = 1% 2100 and slr? Low = 0.5% 2100	Based on the asset life of a house? Establishes the use in that period Talk about the presumed use life Don't focus on development = focus on the purpose of the use	Focuses on the end of period Conservative option	
5	1 % AEP in 2100	Simple binary control Triggers an intervention Type of an intervention? Focuses on the purpose of the use - not the development	Conservative option Does not send a signal about where avoidance of the hazard is required	
6	High = SLR 2050 (0.2m) Medium = SLR 2100 (0.8m) Low = 1%AEP 2100	separates recession and storm tide	?	1

- **Workshop 1 - Develop the hazard matrix**
- **Develop - Control Level**
  - See example consequence statements, what is the balance between emergency management, land use planning, and building control
- **Develop - Strategic Planning Level**
  - Should the area be avoided through settlement planning, zoning or regional strategies
- **Consider - Use or Development Controls**
  - Direct guidance for acceptable solutions or performance criteria in a code
  - Life controls on use and developments?

# Coastal inundation planning matrix

<b>Acceptable Band</b>	White or clear on the hazard map.
<b>Hazard exposure</b>	A coastal inundation event is an unlikely event in 2100 based on current understanding of the hazard, but it may if a storm event of greater than 1% AEP occurs.
<b>Control Level</b>	Development and use is not subject to control
<b>Strategic Planning</b>	No impacts on land use strategies or change to zoning required.
<b>Guidance on Use Standards</b>	No hazard specific controls.
<b>Guidance on Development Standards</b>	No controls are required to bring the use into an acceptable risk level.



<b>Low Band</b>	Yellow on the hazard map.
<b>Hazard exposure</b>	This area has been modelling as identified that the area is vulnerable to a 1% AEP storm tide event in 2100 or to permanent inundation from the sea based on the predicted sea level rise of 0.8m .
<b>Control Level</b>	<i>Whilst non-construction requirements are not necessary for most use and development, controls may be necessary to reduce the risks associated with vulnerable and hazardous uses or post –disaster and catastrophic risk-based use to ensure that risks are tolerable.</i>
<b>Strategic Planning</b>	<i>Where broader planning considerations support the development of the area, the low band should not inhibit use or development.</i>
<b>Guidance on Use Standards</b>	<p><b>Residential and other use and occasional or temporary use ...</b></p> <ul style="list-style-type: none"> <li>• Existing urban areas</li> <li>• Greenfield / brownfield development</li> </ul> <p><b>Vulnerable and hazardous uses ...</b></p> <p><b>Post–disaster and catastrophic risk based use ...</b></p>
<b>Guidance on Development Standards</b>	<p><b>Ancillary structures ...</b></p> <p><b>Minor extensions ...</b></p> <p><b>Infill/ new buildings, habitable buildings and large extensions, and minor utilities ...</b></p> <p><b>Major subdivision and major works ...</b></p>

	Orange on the landslide hazard map.
<b>Medium Band</b>	
<b>Hazard exposure</b>	The area is exposed to 1% AEP storm tide or permanent inundation from a sea level rise of 0.2 m in 2050
<b>Control Level</b>	<i>Planning controls are necessary for all use and development to ensure that risks are tolerable (as recommended by AGS 2007a). Any vulnerable or hazardous use will only be allowed in exceptional circumstances.</i>
<b>Strategic Planning</b>	<i>Where there is no compelling reason to include land identified in this band for development, it should be zoned for open space, rural, or environmental purposes.</i>  <i>Compelling reasons may include that it is an existing residential area, and further development will be infill. Alternatively, a risk assessment may be required to demonstrate that a proposed zoning is reasonable and avoids areas of high or very high risk.</i>
<b>Guidance on Use Standards</b>	<b>Residential and other use and occasional or temporary use ...</b> <ul style="list-style-type: none"> <li>• Existing urban areas</li> <li>• Greenfield / brownfield development</li> </ul> <b>Vulnerable and hazardous uses ...</b> <b>Post-disaster and catastrophic risk based use ...</b>
<b>Guidance on Development standards</b>	<b>Ancillary structures ...</b> <b>Minor extensions...</b> <b>Infill/ new buildings, habitable buildings and large extensions, and minor utilities ...</b> <b>Major subdivision and major works ...</b>

High Band	Red on the hazard map.
Hazard exposure	The site is likely to be flooded under current day circumstances [1% or 5% or other?]
Control Level	All use and development would require significant investigation and an engineered solution to mitigate the natural hazard and enable the development to achieve and maintain a tolerable level of risk, however, the mitigation measures may never achieve comprehensive levels of security and safety.
Strategic Planning	Strategies should discourage all development except vital community infrastructure that cannot be reasonably located elsewhere. Strategies must indicate appropriate zoning and overlays to provide a clear message to the public and the drafters of local government planning schemes to ensure use and development is generally prohibited except under special circumstances.
Guidance on Use Standards	Residential and other use and occasional or temporary use ... <ul style="list-style-type: none"> <li>Existing urban areas</li> <li>Greenfield / brownfield development</li> </ul> Vulnerable and hazardous uses ... Post-disaster and catastrophic risk based use ...
Guidance on Development Standards	Ancillary structures ... Minor extensions... Infill/ new buildings, habitable buildings and large extensions, and minor utilities ... Major subdivision and major works

- **Workshop 2 - Develop the hazard matrix**
- **Review - Control Level**
  - See example consequence statements, what is the balance between emergency management, land use planning, and building control
- **Review - Strategic Planning Level**
  - Should the area be avoided through settlement planning, zoning or regional strategies
- **Develop - Use or Development Controls**
  - Direct guidance for acceptable solutions or performance criteria in a code
  - Life controls on use and developments?