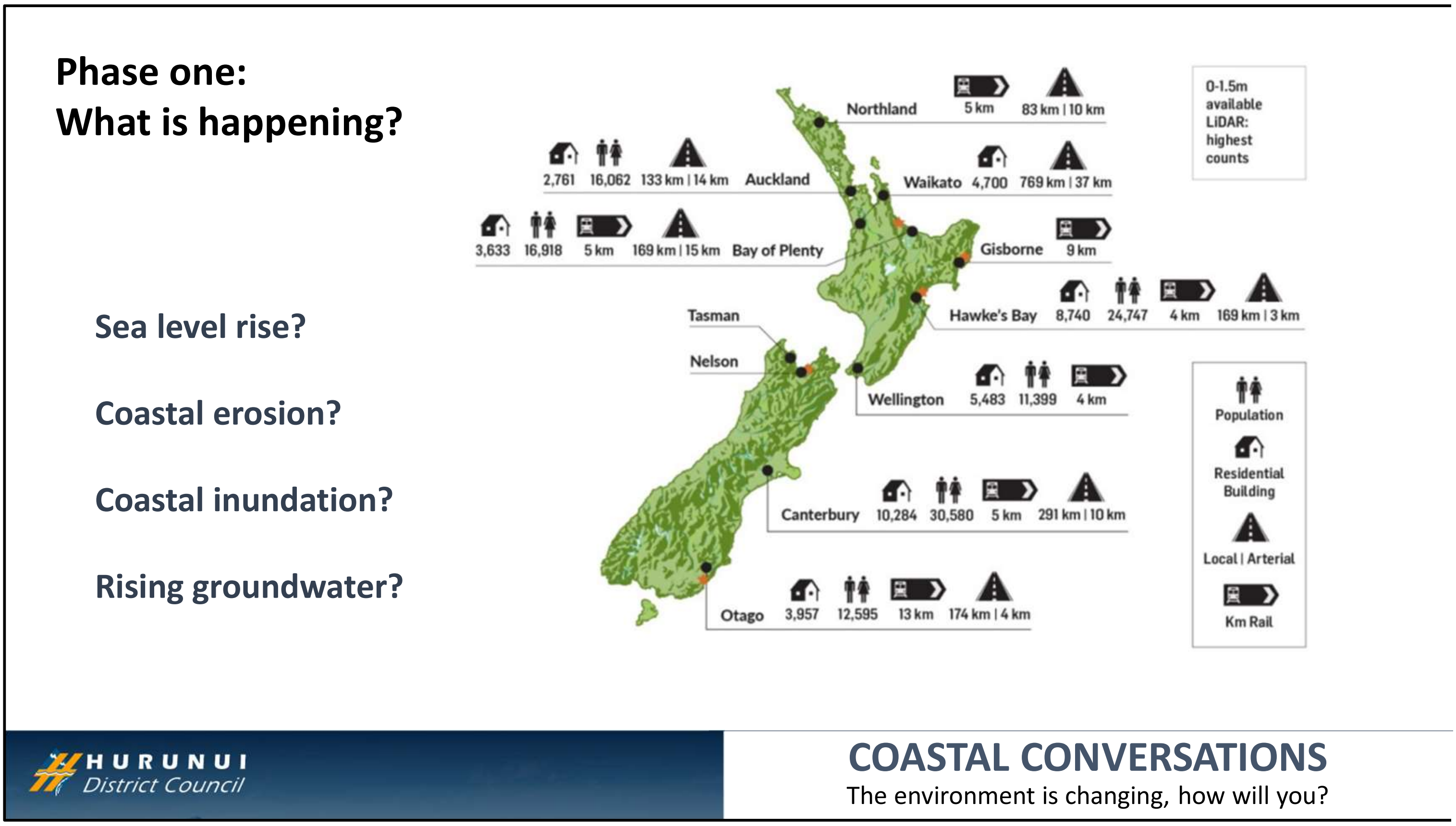
COASTAL CONVERSATIONS

The environment is changing, **how will you?**

[Intro from Mayor Marie Black]
[Intro from CEO Hamish Dobbie]



Phase one:
What is happening?

Sea level rise?

Coastal erosion?

Coastal inundation?

Rising groundwater?

COASTAL CONVERSATIONS

The environment is changing, how will you?

What is happening?

We live on a long narrow island with an abundant coastline. Coastal hazards are part of our reality. The map on the slide summarises national assets that are currently at risk from a changing coastline.

HDC is just starting on a project looking at the communities and assets we have that might need to adapt as the coastline changes. To kick this off we have asked Jacobs to provide some scenarios based on the most up to date science available – these look 30, 50 and 100 years into the future. This work is what we would like to share with you tonight.

But before we hear from Jacobs I would like to spend a few minutes outlining how the presentation tonight fits into the bigger project.

Phase one is about determining what is happening to the coastline now and what we can expect to happen in the future. Tonight's presentation is the first part of this.

Once we understand what is happening we can start to develop a plan.

Phase two:
What matters most?

HURUNUI
District Council

COASTAL CONVERSATIONS

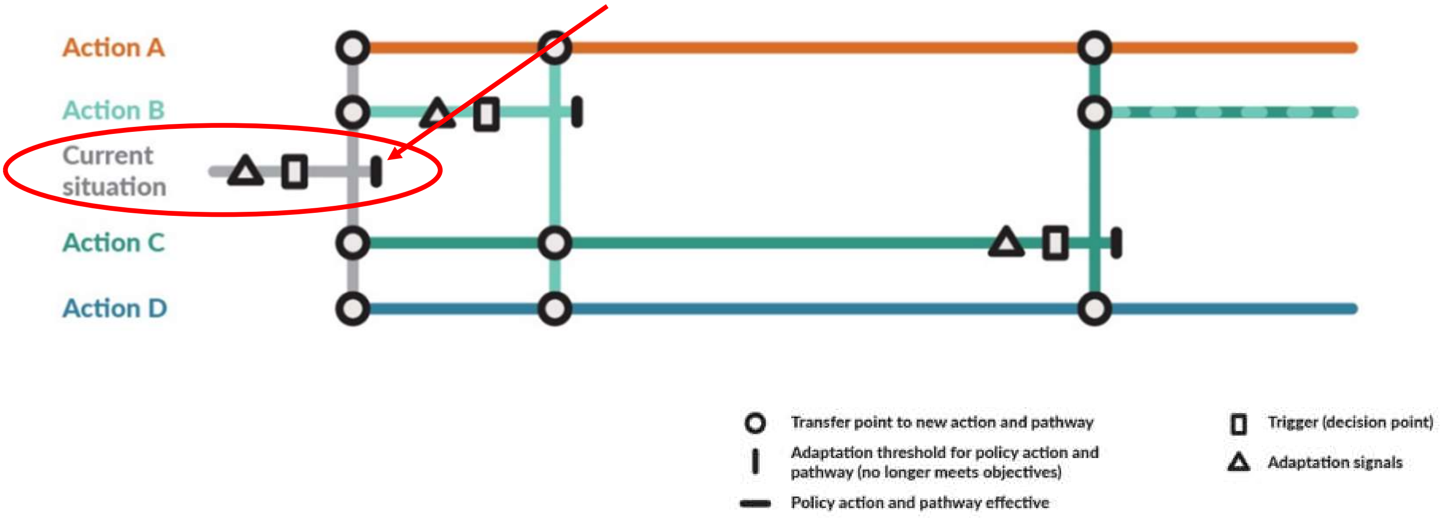
The environment is changing, how will you?

What matters most?

For a plan to be successful decisions need to be based on the right framework. This framework needs to be specific to the particular community. We know the coast is important to everyone for different reasons.

Any plan must recognise and prioritise these values. Once we understand what these values are we can use them to build a decision making framework – effectively those values become the lens in which we look through when assessing various options.

Phase three:
What can we do about it?



HURUNUI District Council

COASTAL CONVERSATIONS

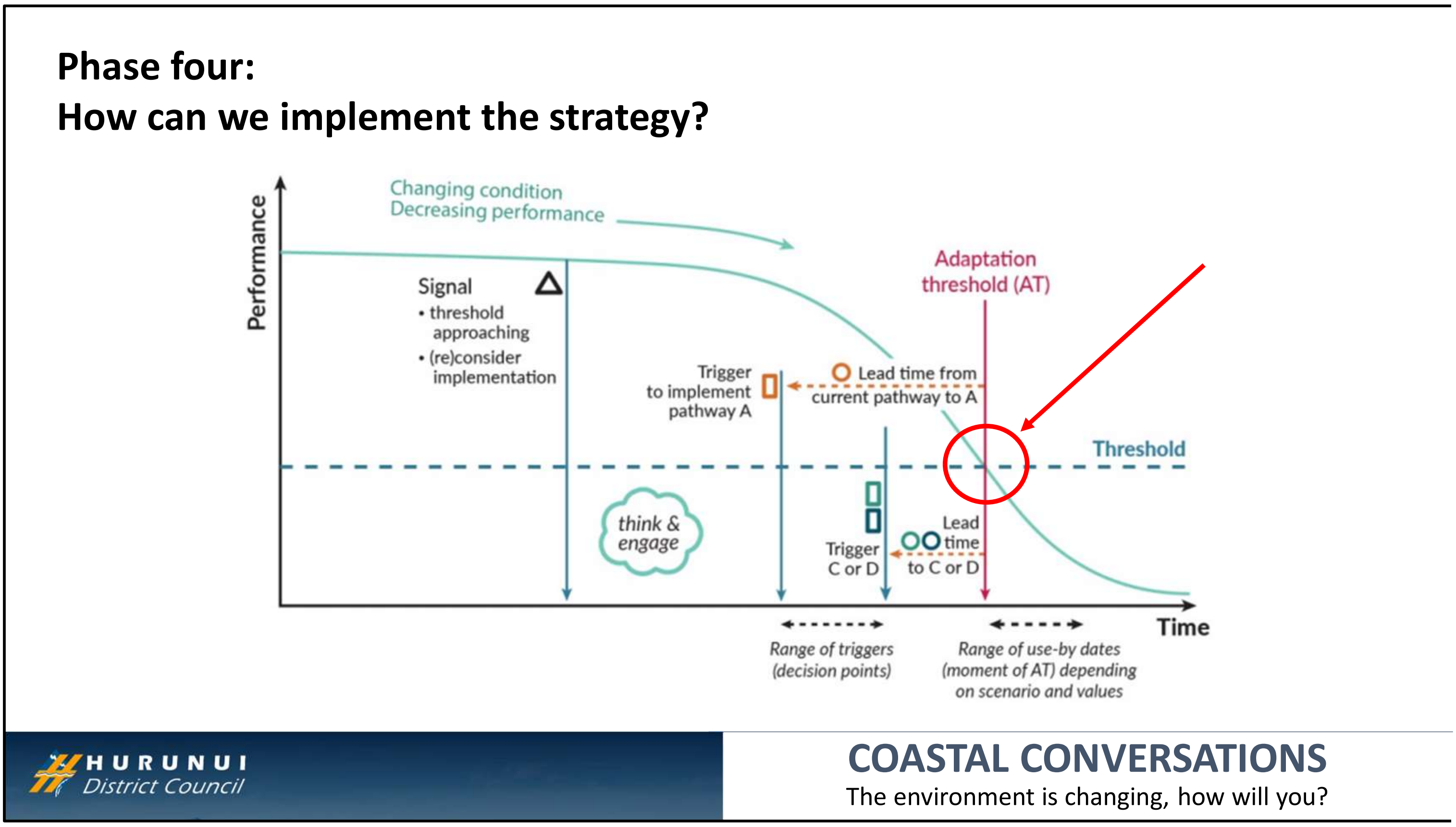
The environment is changing, how will you?

What can we do about it?

The image on the screen is an example of a dynamic adaptive pathway approach to planning. It shows that there is a time where the status quo will no longer protect the values identified in phase two. Before we reach this point we need to do something. This map shows that there are four possible options and there is the ability to move between various options. Each option has a different cost and a different life span.

Being an adaptive approach the end point of an option is based on a range of triggers. A trigger could be something visible like how often a piece of land is flooded in any given year or they could be more subtle but more constant like the depth to groundwater.

There is no timeframe associated with an action but there is an agreed point at which a particular situation is no longer acceptable. From this we can develop a plan to enable the preferred option or pathway when a change is required. An adaptive approach means no investment is required until necessary but it means we know what will happen if we get there.



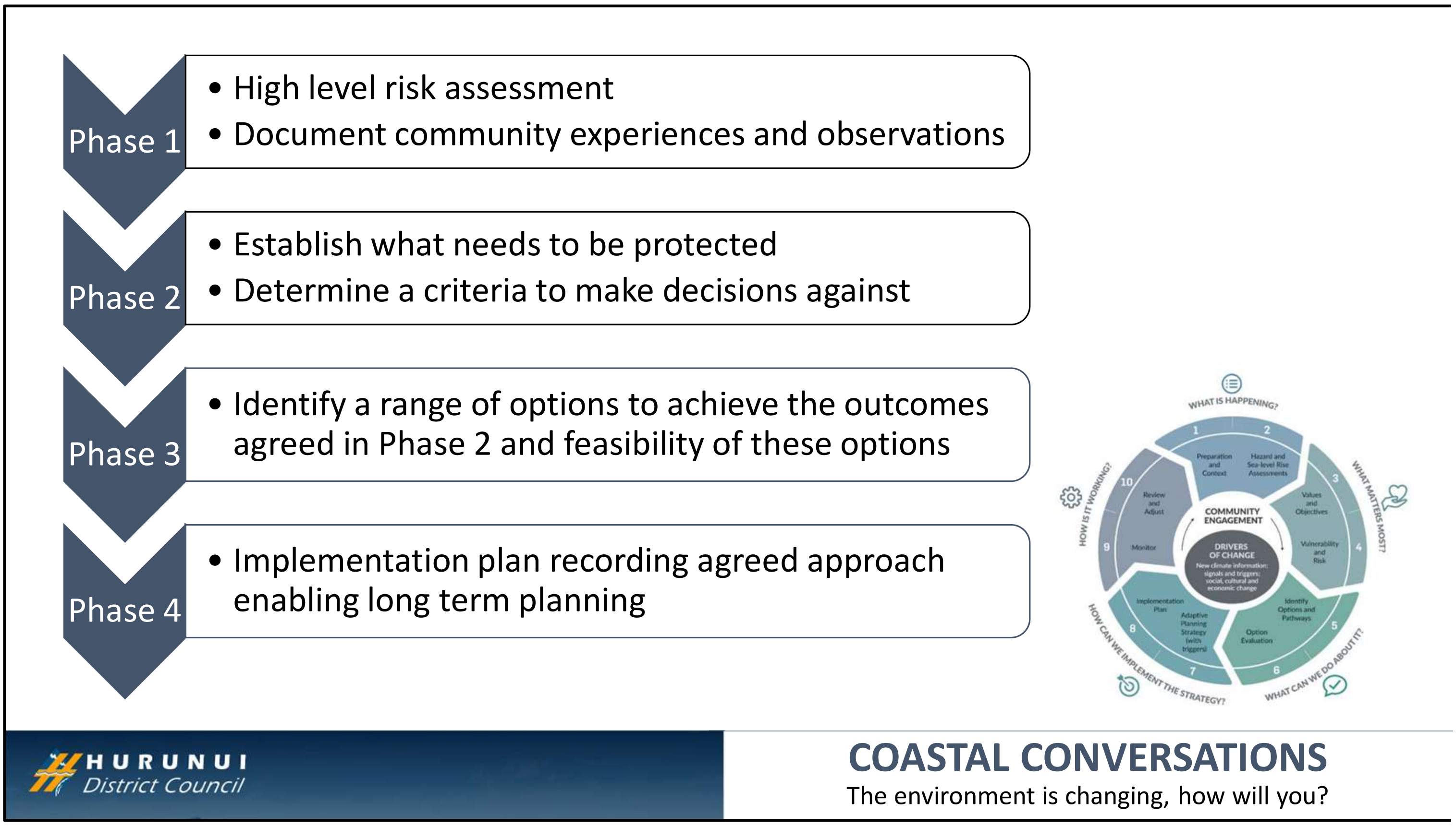
Phase four:
How can we implement the strategy?

COASTAL CONVERSATIONS

The environment is changing, how will you?

How can we implement the strategy?

This shows how it all comes together. The blue dotted line shows the agreed minimum level of service or rather the point we have agreed is no longer acceptable. When the performance of the status quo decreases to this point something needs to be done immediately. However change takes time. Through identifying early warning signs and agreed trigger points we can ensure that the necessary change is ready to go when or just before it is needed.



Phase 1
- High level risk assessment
- Document community experiences and observations

Phase 2
- Establish what needs to be protected
- Determine a criteria to make decisions against

Phase 3
- Identify a range of options to achieve the outcomes agreed in Phase 2 and feasibility of these options

Phase 4
- Implementation plan recording agreed approach enabling long term planning

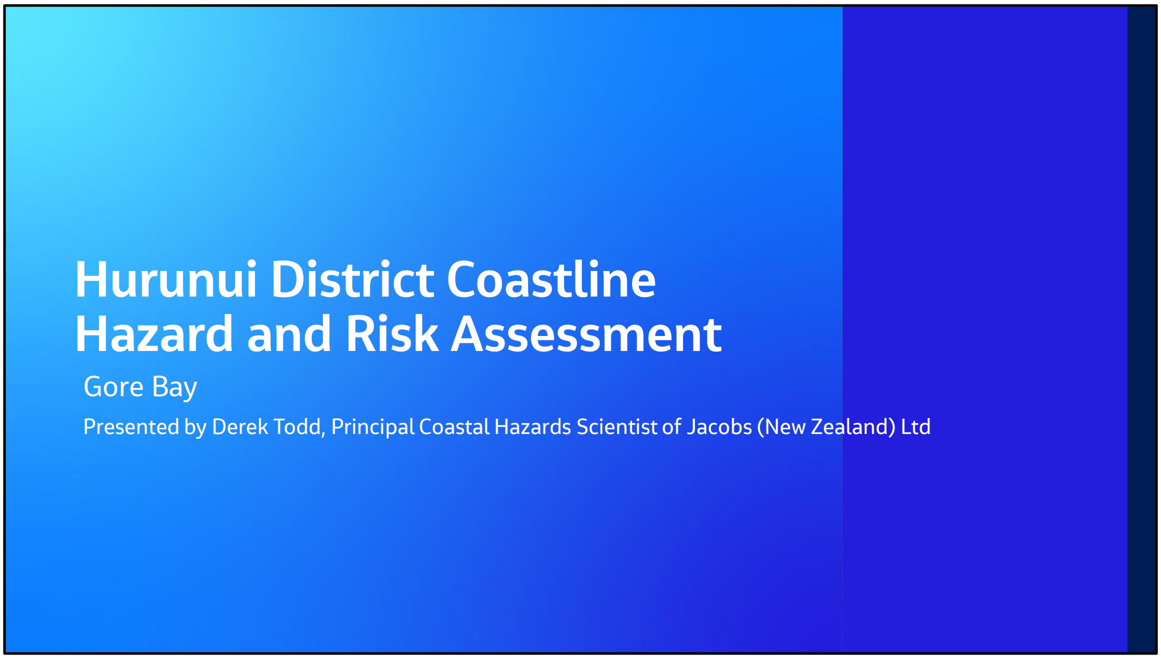
HURUNUI District Council

COASTAL CONVERSATIONS
The environment is changing, how will you?

In Summary

We can't do this alone. This is your future and this needs to be your plan. We would like today to be the start of a much longer conversation as we learn about the changing coastline together.

While we do need to do to have a plan we also need to make sure that this is the right plan and everyone has opportunity to design their future. This is your opportunity to look ahead.



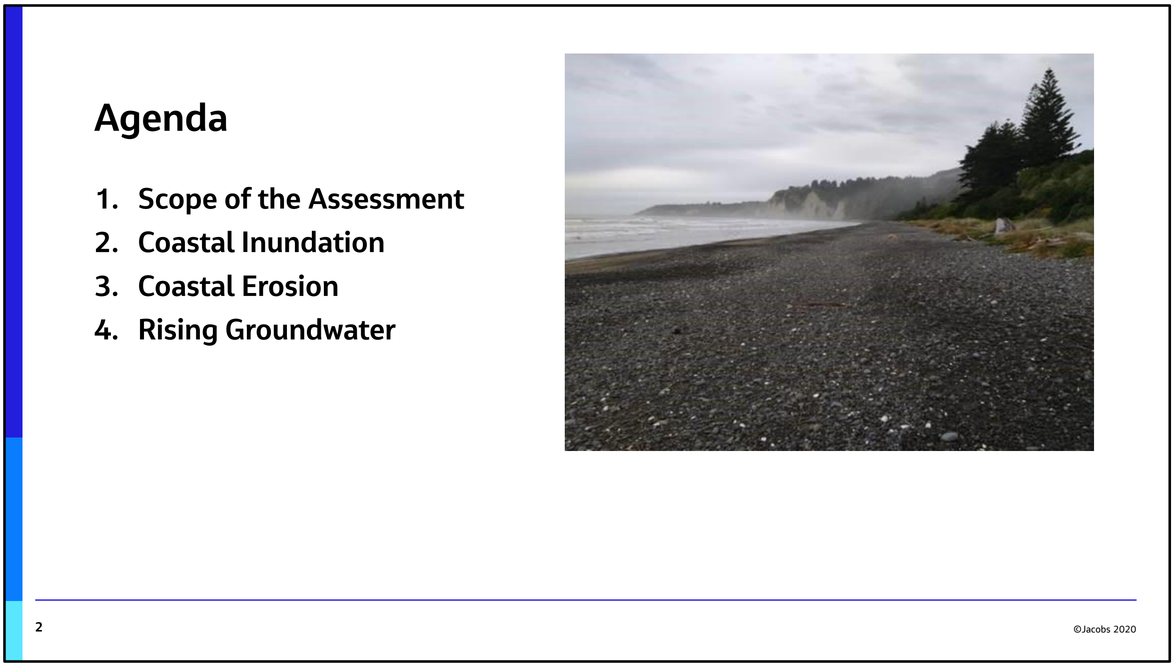
Hurunui District Coastline Hazard and Risk Assessment

Gore Bay

Presented by Derek Todd, Principal Coastal Hazards Scientist of Jacobs (New Zealand) Ltd

In 2019 Hurunui District Council (HDC) engaged with Jacobs NZ Ltd to undertake an assessment of how coastal hazards will change with projected climate change scenarios over the next 100 years at five settlements throughout the district, and what the risks to coastal settlements and critical council infrastructure could be.

These notes will provide extra detail for the slides presented by Derek Todd of Jacobs at the “Coastal Conversations” talk held for Gore Bay on the 24th September 2020.

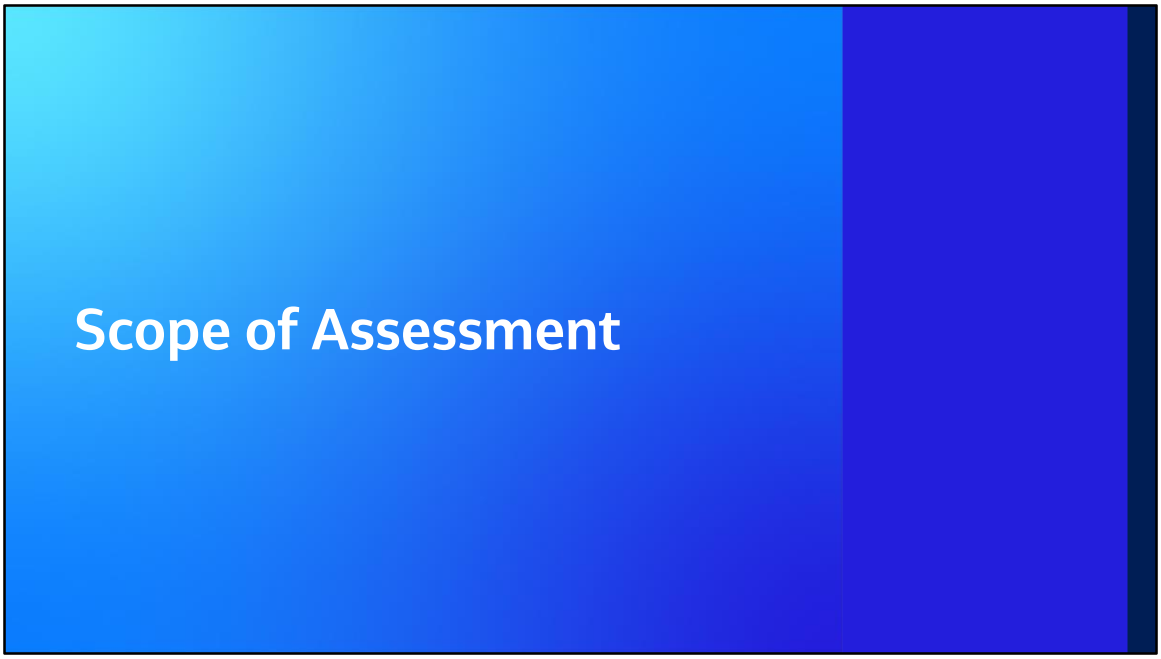


Agenda

1. Scope of the Assessment
2. Coastal Inundation
3. Coastal Erosion
4. Rising Groundwater

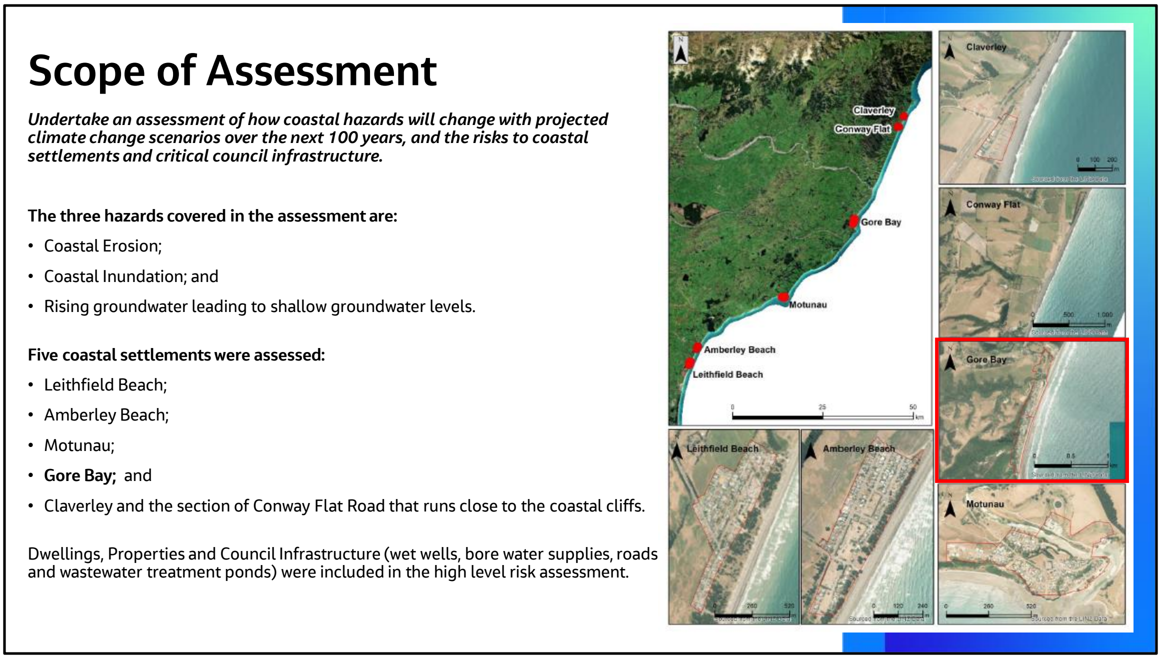
This presentation runs through the following items:

1. The scope of the assessment
2. The methods and the results of the coastal inundation assessment
3. The methods and results of the coastal erosion assessment
4. The methods and results of the rising groundwater assessment



Scope of Assessment

The following slide presents the scope of the assessment work.



Scope of Assessment

Undertake an assessment of how coastal hazards will change with projected climate change scenarios over the next 100 years, and the risks to coastal settlements and critical council infrastructure.

The three hazards covered in the assessment are:

- Coastal Erosion;
- Coastal Inundation; and
- Rising groundwater leading to shallow groundwater levels.

Five coastal settlements were assessed:

- Leithfield Beach;
- Amberley Beach;
- Motunau;
- **Gore Bay;** and
- Claverley and the section of Conway Flat Road that runs close to the coastal cliffs.

Dwellings, Properties and Council Infrastructure (wet wells, bore water supplies, roads and wastewater treatment ponds) were included in the high level risk assessment.

This slide outlines the scope of the *Hurunui District Coastline Hazard and Risk Assessment* report produced by Jacobs (2020).

The scope of this assessment was to:

- Create hazard maps of the likely extent of future coastal erosion, coastal inundation, and rising groundwater hazard, and increased salinity under a series of accepted sea level rise (SLR) scenarios.
- Undertake a high-level risk assessment on settlements and critical infrastructure to estimate the consequences of coastal erosion, inundation and groundwater rise associated with SLR on communities and council services.

There were three hazards covered within this assessment:

- Coastal erosion;
- Coastal inundation with sea water; and
- Rising groundwater leading to shallow groundwater levels

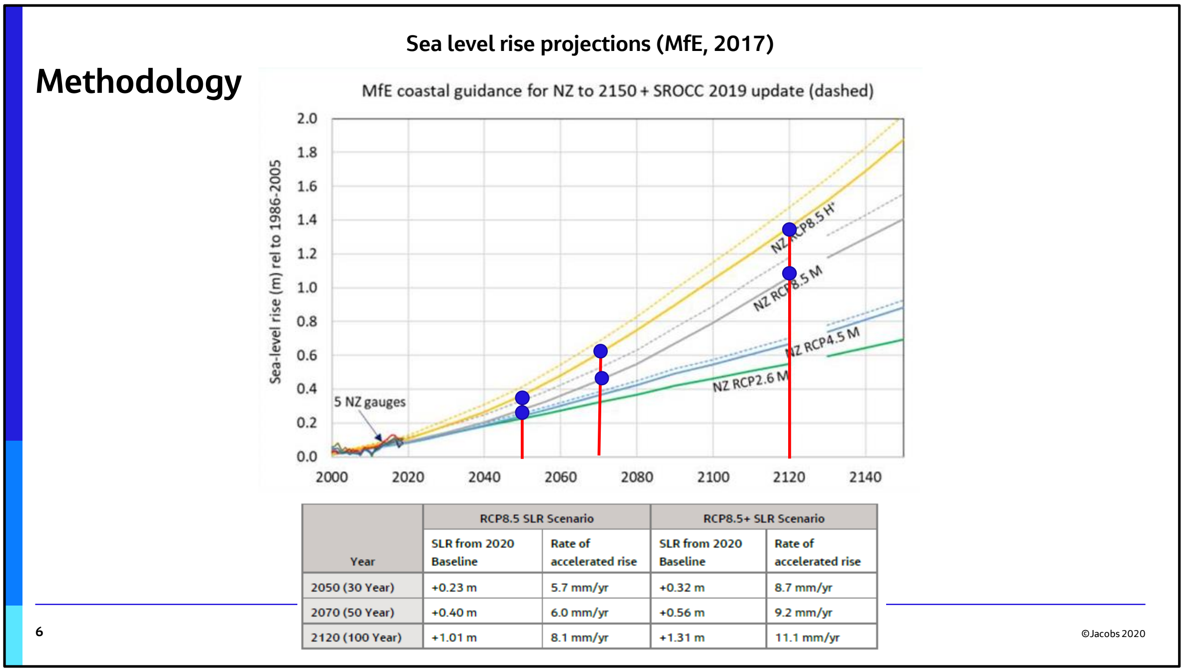
This assessment looked at the hazard footprint of these three hazards over a 30, 50, and 100 year timeframe.

Each of these hazards were assessed across five coastal settlements (as seen in the map on the right) which were assessed within the Hurunui District, and one area of shoreline where infrastructure was assessed (Conway Flat Road).

In the high-level risk assessment completed at each settlement, dwellings, properties and council infrastructure were assessed based on their intersection with the hazard footprint (e.g. whether the hazard overlays with a property). This was to give an indication of how many dwellings and properties could be affected in each timeframe as sea level rises.

Coastal Inundation Assessment

The following slides discuss the coastal inundation assessment methods and results.



Methodology

Sea level rise projections (MfE, 2017)

Year	RCP8.5 SLR Scenario		RCP8.5+ SLR Scenario	
	SLR from 2020 Baseline	Rate of accelerated rise	SLR from 2020 Baseline	Rate of accelerated rise
2050 (30 Year)	+0.23 m	5.7 mm/yr	+0.32 m	8.7 mm/yr
2070 (50 Year)	+0.40 m	6.0 mm/yr	+0.56 m	9.2 mm/yr
2120 (100 Year)	+1.01 m	8.1 mm/yr	+1.31 m	11.1 mm/yr

6

©Jacobs 2020

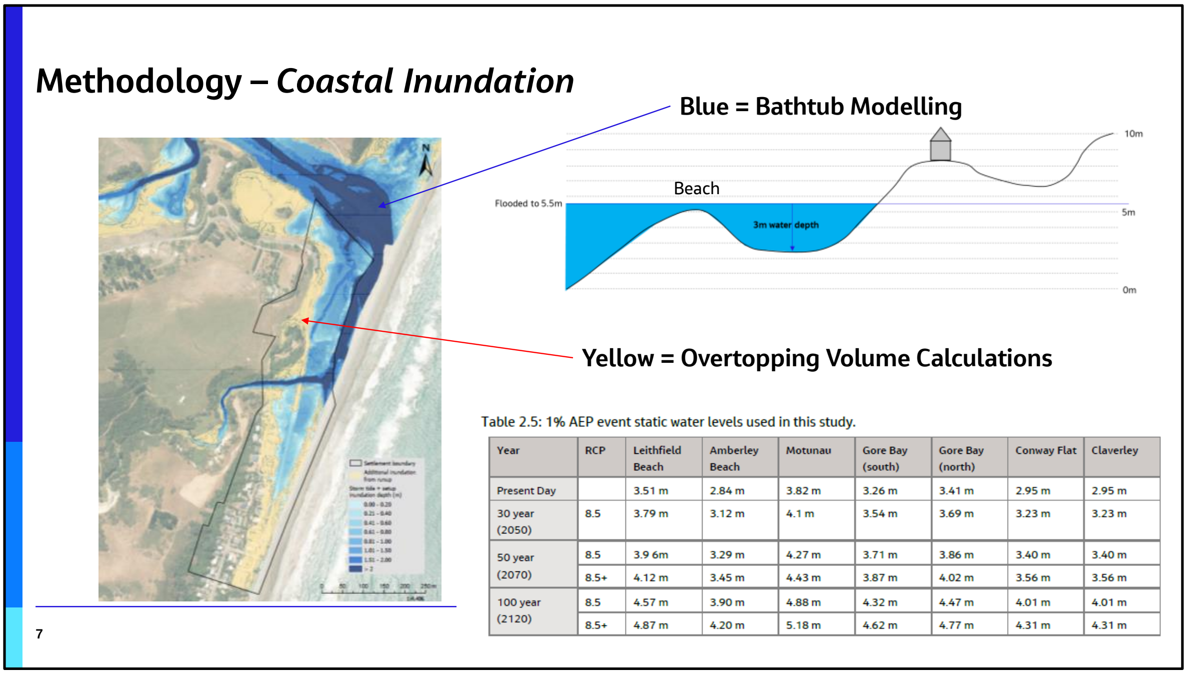
This slide shows the sea level rise projections used in this assessment, which are projections from the Ministry for the Environment (2017) *Coastal Hazards and Climate Change: Guidance for Local Government.*

There are four commonly accepted sea level rise/climate change scenarios used both nationally and internationally, which are recognised by the New Zealand government. These scenarios are termed RCPs (Representative Concentration Pathways), and are based on the following global emissions scenarios:

- RCP2.6 – low/reduced emission
- RCP4.5 – moderate then declining emissions
- RCP8.5 – continuing status quo high emissions
- RCP8.5+ - continuing status quo high emissions and possible instabilities in the polar ice sheets

In this assessment, we looked at sea level rise over a 30, 50 and 100 year time frame (three red vertical lines) for a RCP8.5 and RCP8.5+ sea level rise scenario (blue dots) on the curved yellow and red lines), in which the sea level rise in metres in each of these scenarios is detailed in the table at the bottom of the slide.

As can be seen in this graph, there is less certainty around sea level rise projections as time progresses. We can be fairly certain about sea level rise over the next 30 years, moderately certain about sea level rise over the next 50 years, and there is some uncertainty around the magnitude of sea level rise we could expect over the next 100 years.



Methodology – *Coastal Inundation*

Blue = Bathtub Modelling

Yellow = Overtopping Volume Calculations

Table 2.5: 1% AEP event static water levels used in this study.

Year	RCP	Leithfield Beach	Amberley Beach	Motunau	Gore Bay (south)	Gore Bay (north)	Conway Flat	Claverley
Present Day		3.51 m	2.84 m	3.82 m	3.26 m	3.41 m	2.95 m	2.95 m
30 year (2050)	8.5	3.79 m	3.12 m	4.1 m	3.54 m	3.69 m	3.23 m	3.23 m
50 year (2070)	8.5	3.9 6m	3.29 m	4.27 m	3.71 m	3.86 m	3.40 m	3.40 m
	8.5+	4.12 m	3.45 m	4.43 m	3.87 m	4.02 m	3.56 m	3.56 m
100 year (2120)	8.5	4.57 m	3.90 m	4.88 m	4.32 m	4.47 m	4.01 m	4.01 m
	8.5+	4.87 m	4.20 m	5.18 m	4.62 m	4.77 m	4.31 m	4.31 m

This slides provides an overview of the approach used to assess the future <u>coastal inundation hazard</u> at each settlement. Further detail and explanation of the methods can be found in the report at www.hurunui.govt.nz/coastal

Two methods were used to determine the future coastal inundation hazard at each settlement:

1) Bathtub modelling:
2) Volumetric calculation of water overtopping the beach

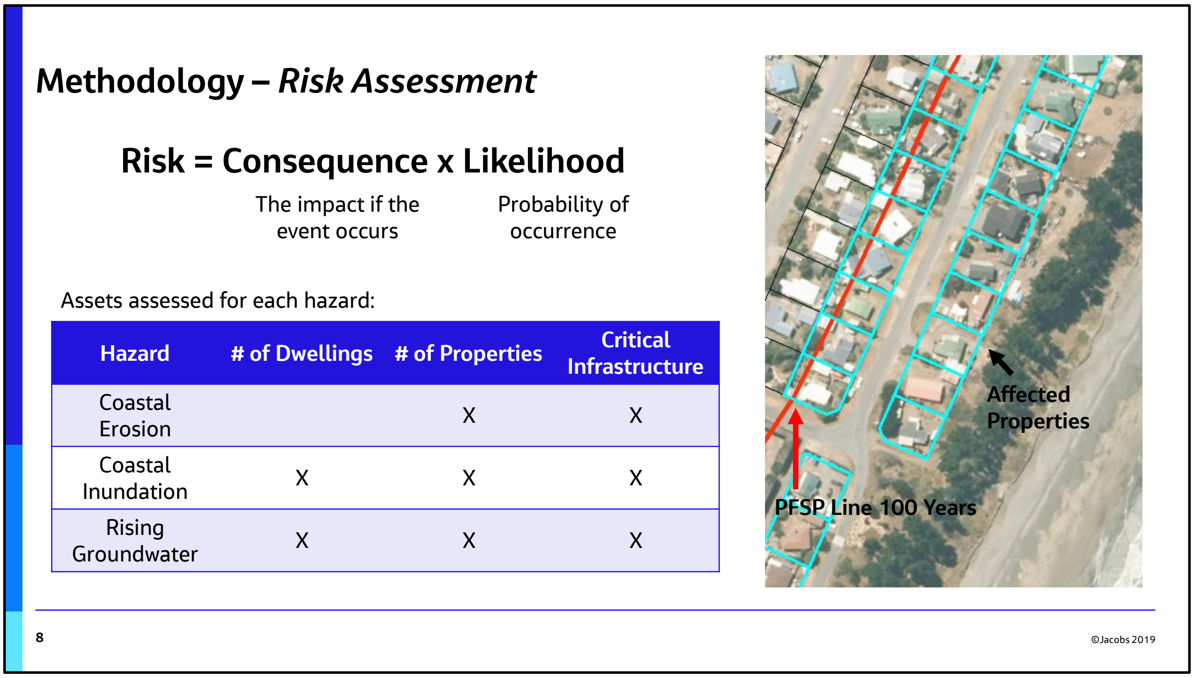
<u>Bathtub model</u>

- Bathtub modelling is a simplified flood model which floods land with elevations less than a set static water level, and has a connection to the sea. This is shown conceptually in the diagram on the top right of this slide, and is represented on the inundation hazard maps as the shaded blue area, which represent depth of water.
- The set 'static' water level used is a combination of wave set up, storm surge, astronomical tide, and sea level rise. The table on the bottom right of the slide shows the combined water levels used over each timeframe at each settlement.
- It is considered to be a conservative approach but it provides a basis for whether or not to proceed with more detailed and expensive hydrodynamic modelling.

<u>Volume overtopping calculations from run-up:</u>

- The yellow areas of the map shown on the left of this slide are the additional potential areas which could be inundated by wave overtopping caused by wave run-up on the beach. This is an additional component that is not input into the bathtub model.
- These areas were determined by calculating the likely volume of water that could overtop the beach in a 12 hour period with consideration of the tidal cycle.
- There is no depth associated with the areas shaded yellow, they are additional areas which could be effected by run-up, but it is unknown how deep the water would be there.

For this assessment, the combined water level used was a present day 1 in 100 year flood event combined with sea level rise for the 30, 50 and 100 year periods.



Methodology – *Risk Assessment*

Risk = Consequence x Likelihood

The impact if the event occurs

Probability of occurrence

Assets assessed for each hazard:

Hazard	# of Dwellings	# of Properties	Critical Infrastructure
Coastal Erosion		X	X
Coastal Inundation	X	X	X
Rising Groundwater	X	X	X

This slide outlines the approach used to conduct a high level risk assessment of each hazard in each settlement. Further details on the methods used can be found in the report at www.hurunui.govt.nz/coastal

Risk is assessed as the consequence of the event, combined with the likelihood of that event occurring.

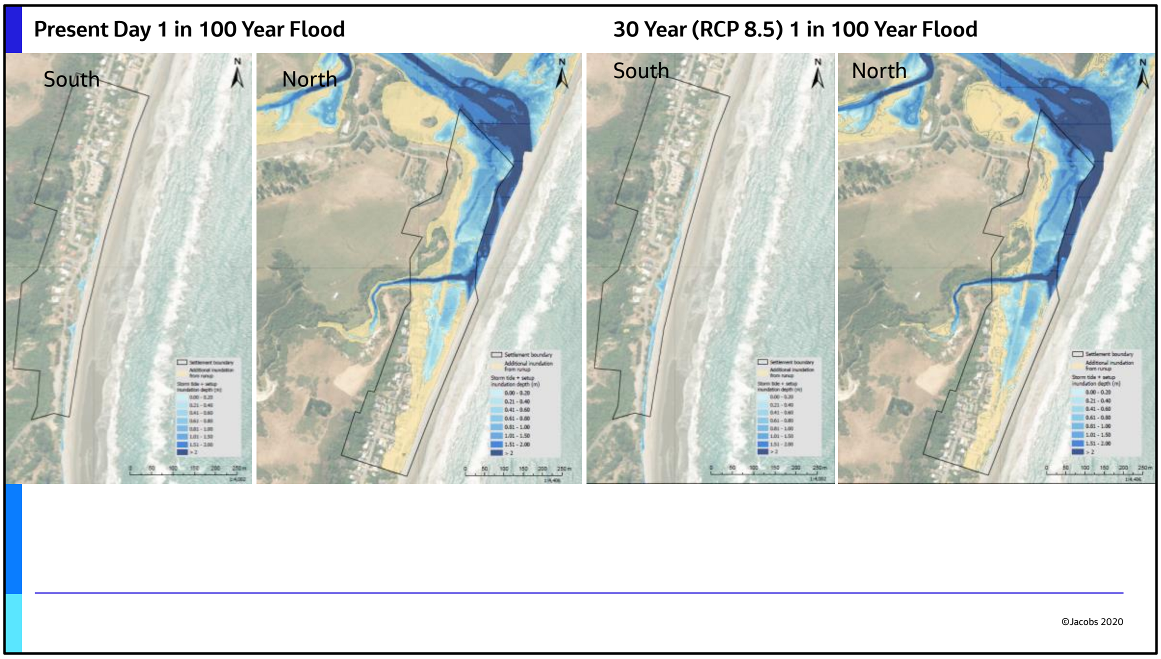
In this assessment, the consequence on the event was assessed by calculating the intersection of the hazard footprint with an asset (e.g. key critical infrastructure, dwellings, properties).

The table on the bottom left shows what assets were assessed for each hazard (e.g. dwellings, properties, key infrastructure), and the map on the right shows an example of how the number of properties effected were calculated for the erosion hazard.

Key infrastructure at each settlement was identified by Hurunui District Council. These were different for each settlement, but included roads, wet wells and waste water treatment ponds.

Properties and Dwellings were based on information from Land Information New Zealand (LINZ). Where possible, garages and sheds were removed from the building footprints provided by LINZ, however in some instances these could not be distinguished, and therefore some properties have more than one ‘dwelling’ on them, and are accounted for in the total numbers produced for each settlement.

At Gore Bay, only dwellings and properties were included in the risk assessment.



Present Day 1 in 100 Year Flood

30 Year (RCP 8.5) 1 in 100 Year Flood

©Jacobs 2020

This slide shows a the results of the coastal inundation hazard at Gore Bay for a 1 in 100 year storm for the present day (0m SLR), and in 30 years (0.28m of SLR).

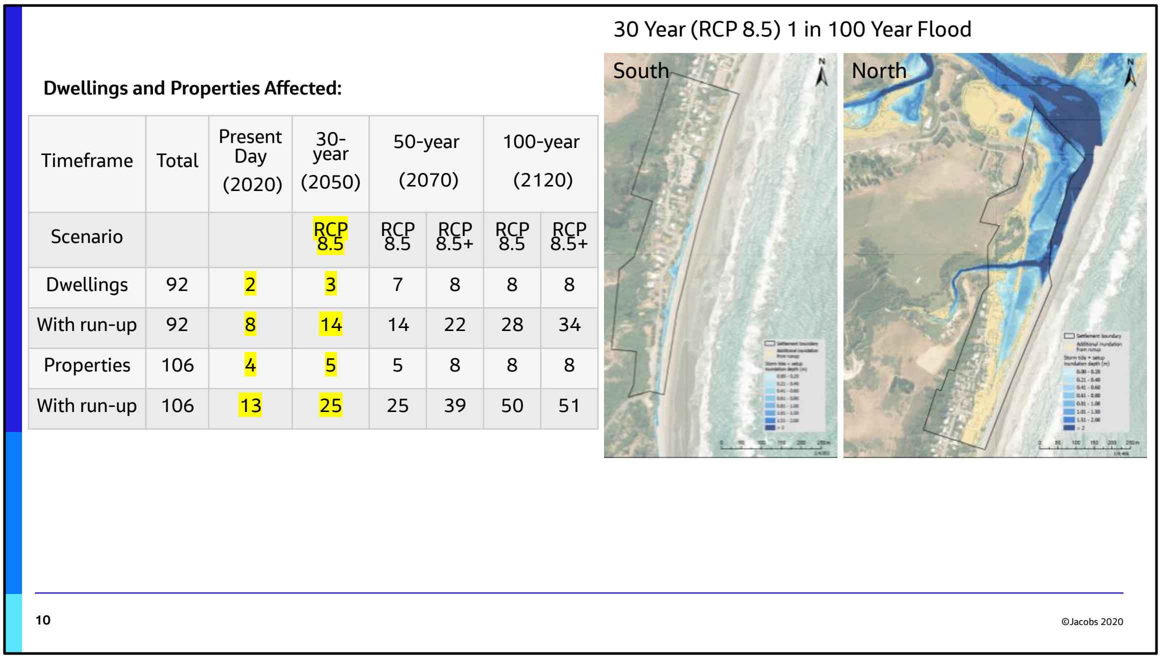
The blue areas on the map show the indicative depth of water in this event, and yellow areas show the additional area which could be effected due to runup.

<u>Present Day 1 in 100 year storm</u>

- The maps on the *left* shows the hazard footprint at the present day, with no sea level rise.
- This maps shows that approximately 10% of the settlement footprint is inundated with the static water level, and up to 35% of the settlement could be affected by additional runup.
- Average potential inundation depths are in the order of 0.3m.

<u>30 year (RCP8.5) 1 in 100 year storm</u>

- The maps on the *right* shows the hazard footprint with 30 years, with 0.28m of SLR.
- This maps shows a slight increase in the area inundated by static water level, where up to 15% of the total settlement is effected. Up to 35% of the settlement could be affected by additional runup.
- Average potential inundation depths are in the order of 0.6m.



30 Year (RCP 8.5) 1 in 100 Year Flood

South

North

Dwellings and Properties Affected:

Timeframe	Total	Present Day (2020)	30-year (2050)	50-year (2070)		100-year (2120)	
Scenario			RCP 8.5	RCP 8.5	RCP 8.5+	RCP 8.5	RCP 8.5+
Dwellings	92	2	3	7	8	8	8
With run-up	92	8	14	14	22	28	34
Properties	106	4	5	5	8	8	8
With run-up	106	13	25	25	39	50	51

This slide shows the results of the risk assessment for the 30 year inundation hazard, the map on the right of this slide.

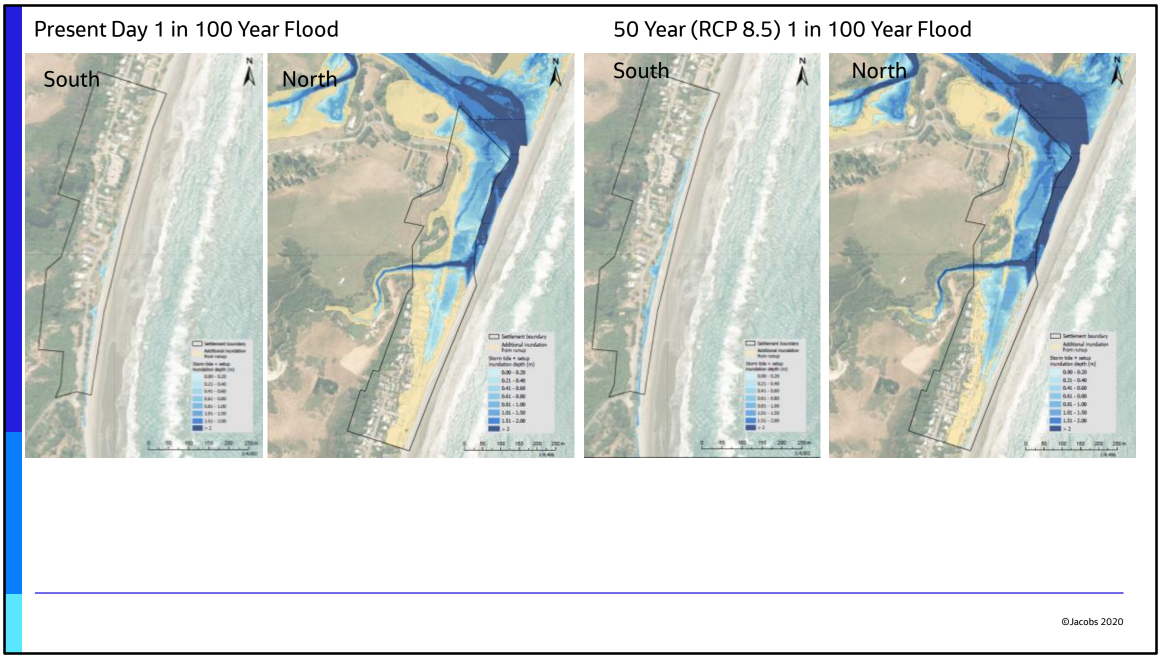
Only dwellings and properties were assessed for risk at Gore Bay.

Present Day

- As shown in this table on the left, in a 1 in 100 year event at the present day, 2 (2%) out of the 92 dwellings in Gore Bay could be affected by static water level. 8 dwellings (9%) could be affected in this event when run-up is taken into account.
- 4 (4%) out of the 106 properties in Gore Bay could be affected by static water level. 13 properties (12%) could be affected in this event when run-up is taken into account.

30 year (RCP8.5) 1 in 100 year storm

- In the 30-year scenario, 3 (3%) out of the 92 dwellings in Gore Bay could be affected by static water level. 14 dwellings (15%) could be affected in this event when run-up is taken into account.
- 5 (5%) out of the 106 properties in Gore Bay could be affected by static water level. 25 properties (24%) could be affected in this event when run-up is taken into account.



Present Day 1 in 100 Year Flood

South

North

50 Year (RCP 8.5) 1 in 100 Year Flood

South

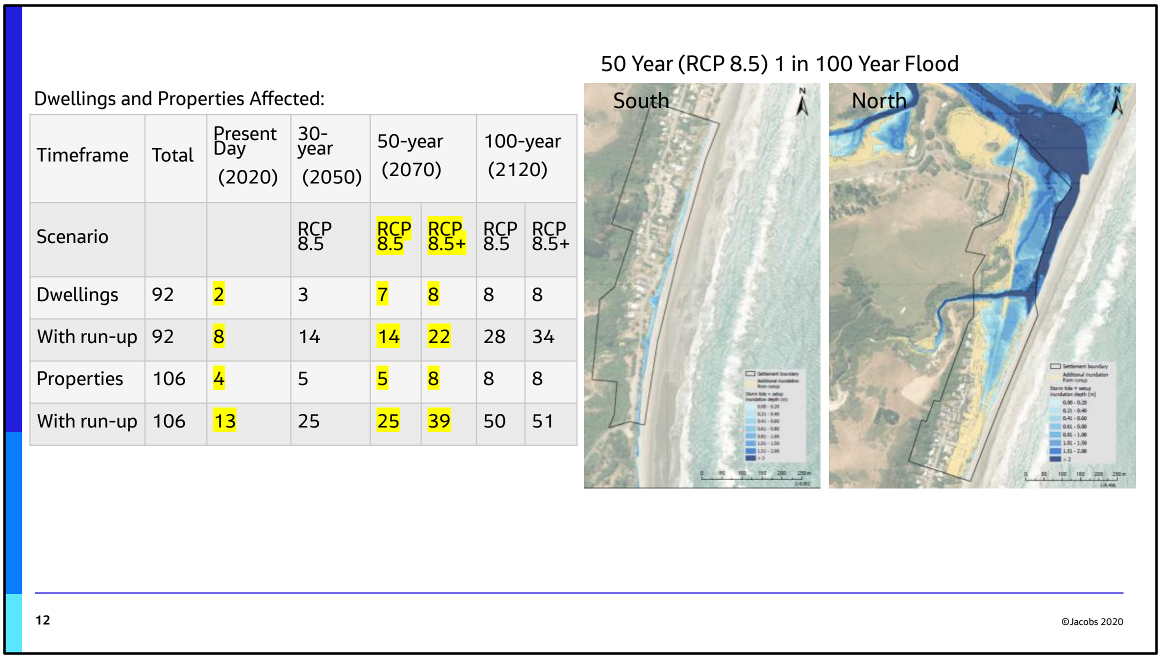
North

©Jacobs 2020

This slide shows a the results of the coastal inundation hazard at Gore Bay for a 1 in 100 year storm for the present day (0m SLR), and in 50 years (0.45m of SLR).

<u>50 year (RCP8.5) 1 in 100 year storm</u>

- The maps on the *right* show the hazard footprint with 50 years, with 0.45m of SLR.
- This map shows that approximately 15% of the settlement could become inundated in a 1 in 100 year event.
- The hazard footprint of static water level flooding has not increased significantly from the 30 year scenario. Average water depth across the flooded area has increased 0.7m to 1m.
- The hazard footprint of inundation including runup could effect 35-45% of the settlement.



Dwellings and Properties Affected:

Timeframe	Total	Present Day (2020)	30-year (2050)	50-year (2070)		100-year (2120)	
Scenario			RCP 8.5	RCP 8.5	RCP 8.5+	RCP 8.5	RCP 8.5+
Dwellings	92	2	3	7	8	8	8
With run-up	92	8	14	14	22	28	34
Properties	106	4	5	5	8	8	8
With run-up	106	13	25	25	39	50	51

50 Year (RCP 8.5) 1 in 100 Year Flood

12

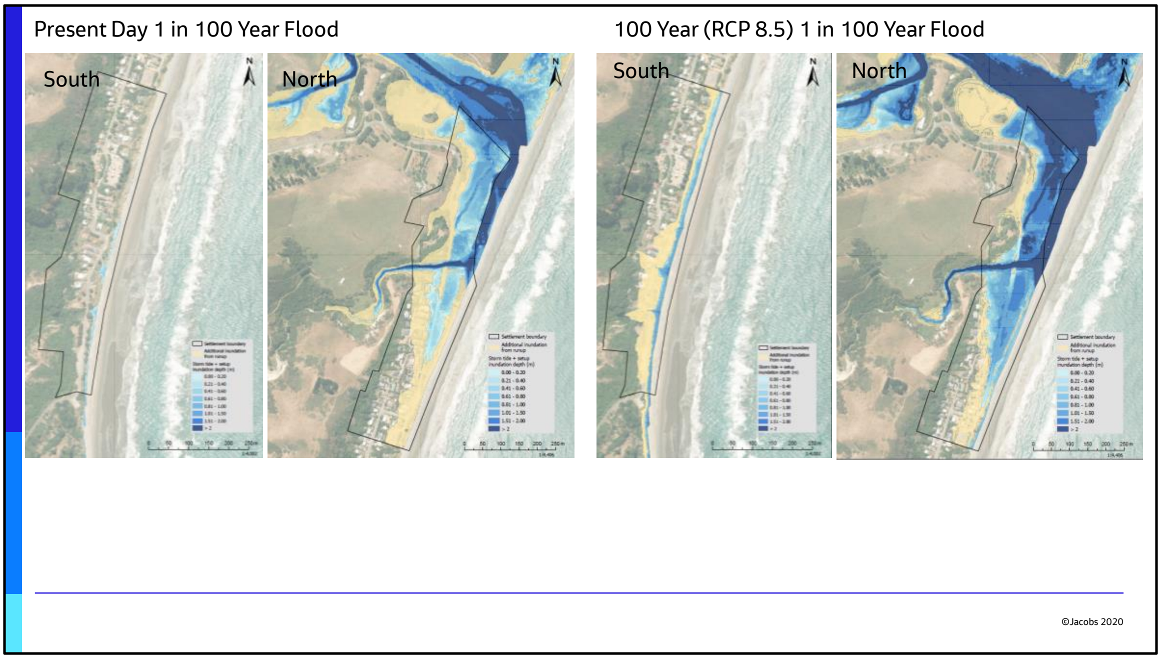
©Jacobs 2020

This slide shows the results of the risk assessment for the 50 year inundation hazard, the map on the right of this slide.

Only dwellings and properties were assessed for risk at Gore Bay.

<u>**50 Year (RCP 8.5 and 8.5+) Scenario**</u>

- As shown in this table on the left, in a 1 in 100 year event with 50 years of SLR, 7 to 8 (8%) out of the 92 dwellings in Gore Bay could be affected by static water level. 14 to 22 dwellings (15% to 24%) could be affected in this event when run-up is taken into account.
- In this scenario, 5 to 8 (5% to 7%) out of the 106 properties in Gore Bay could be affected by static water level; and 25 to 39 properties (24% to 37%) could be affected in this event when run-up is taken into account.



Present Day 1 in 100 Year Flood

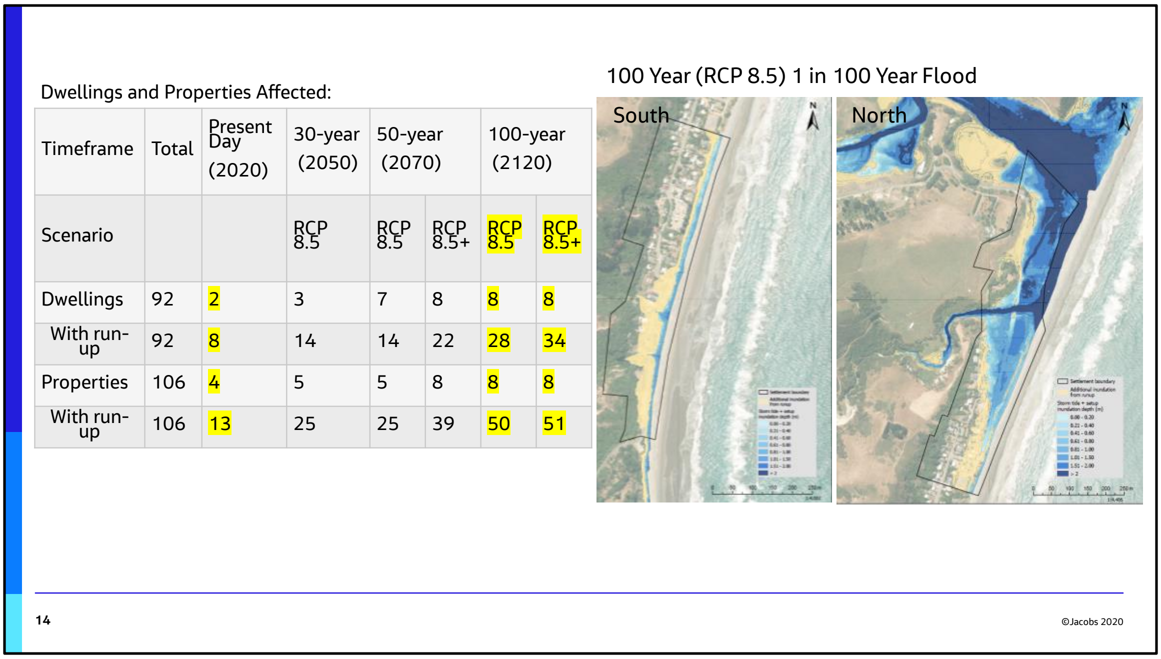
100 Year (RCP 8.5) 1 in 100 Year Flood

©Jacobs 2020

This slide shows a the results of the coastal inundation hazard at Gore Bay for a 1 in 100 year storm for the present day (0m SLR), and in 100 years (1.06m of SLR).

<u>100 year (RCP8.5) 1 in 100 year storm</u>

- The map on the *right* shows the hazard footprint with 100 years, with 1.06m of SLR.
- This map shows that approximately 20% of the settlement could become inundated in a 1 in 100 year event.
- Average water depth across the flooded area has increased 1.2-1.3m.
- The hazard footprint of inundation including runup could effect 45% of the settlement.



Dwellings and Properties Affected:

Timeframe	Total	Present Day (2020)	30-year (2050)	50-year (2070)		100-year (2120)	
Scenario			RCP 8.5	RCP 8.5	RCP 8.5+	RCP 8.5	RCP 8.5+
Dwellings	92	2	3	7	8	8	8
With run-up	92	8	14	14	22	28	34
Properties	106	4	5	5	8	8	8
With run-up	106	13	25	25	39	50	51

100 Year (RCP 8.5) 1 in 100 Year Flood

14

©Jacobs 2020

This slide shows the results of the risk assessment for the 100 year inundation hazard, the map on the right of this slide.

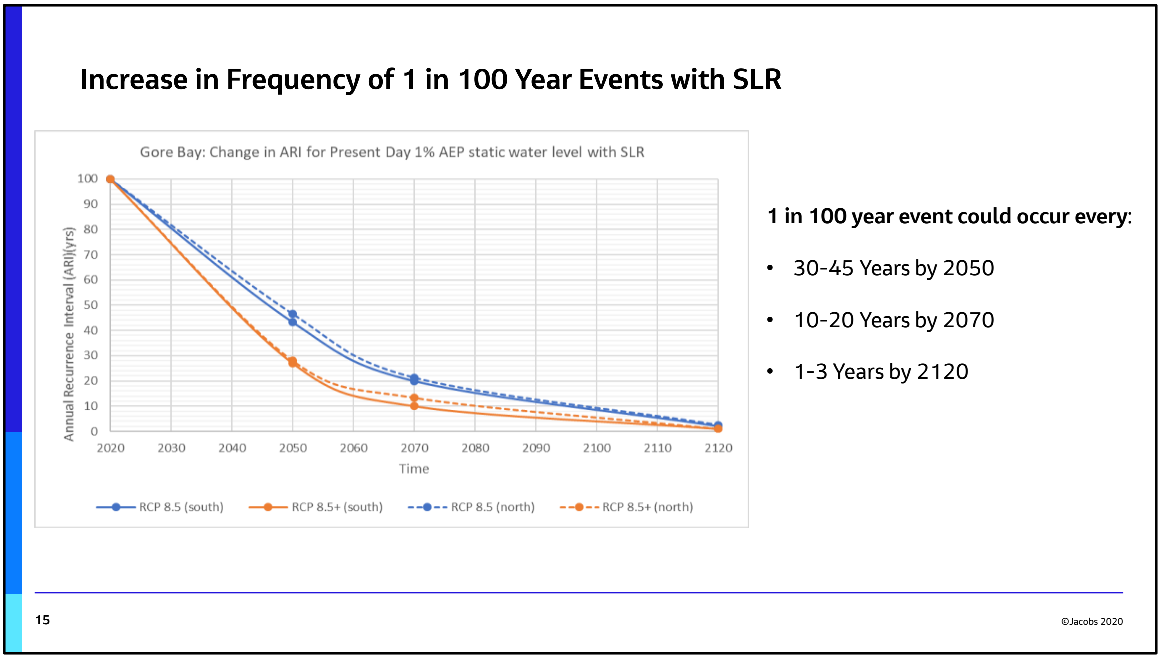
Only dwellings and properties were assessed for risk at Gore Bay.

<u>100 Year (RCP 8.5 and 8.5+) Scenario</u>

- As shown in this table on the left, in a 1 in 100 year event with 50 years of SLR, 8 (8%) out of the 92 dwellings in Gore Bay could be affected by static water level. 28 to 34 dwellings (29% to 37%) could be affected in this event when run-up is taken into account.
- In this scenario, 8 (7%) out of the 106 properties in Gore Bay could be affected by static water level; and 50 to 51 properties (47%) could be affected in this event when run-up is taken into account.

The northern entrance to the settlement via Gore Bay Rd is potentially at risk from inundation in current day 1% AEP storm conditions with inundation depths up to 0.2 m and increasing to 1 m with 100 years of SLR.

At the southern entrance to the settlement, parts of Cathedral Rd are shown to be at risk from inundation by 1% AEP storm wave run-up overtopping under the 50-year RCP8.5+ scenario, and under both 100-year SLR scenarios.



Increase in Frequency of 1 in 100 Year Events with SLR

1 in 100 year event could occur every:

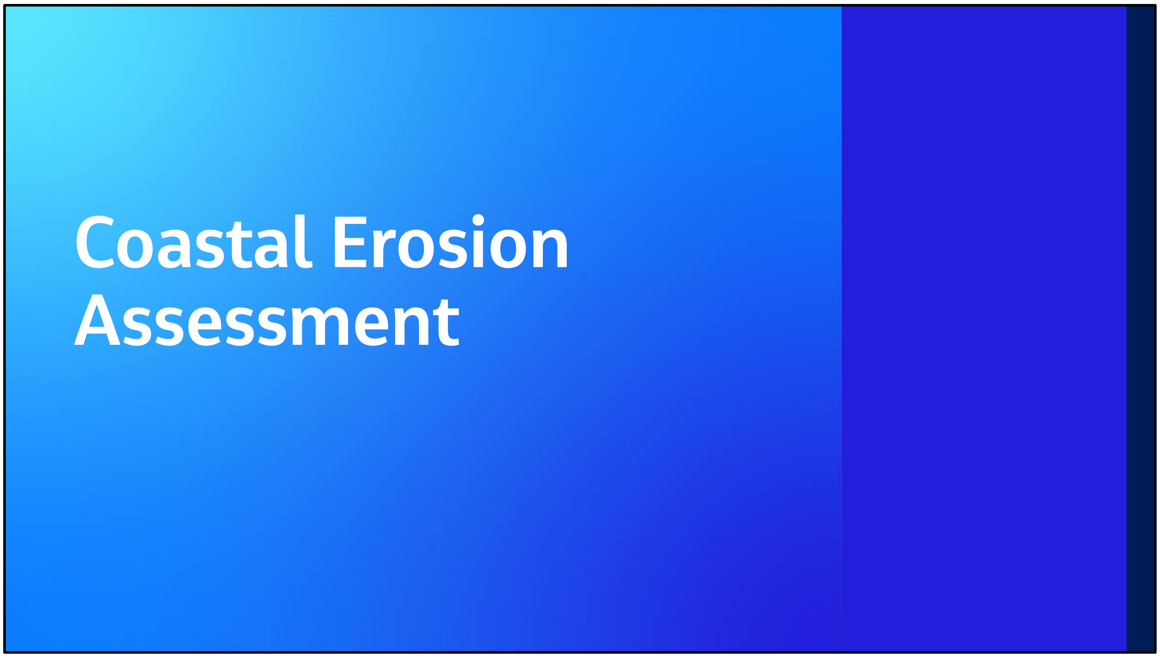
- 30-45 Years by 2050
- 10-20 Years by 2070
- 1-3 Years by 2120

This slide shows the change in recurrence intervals of a 1 in 100 year event with sea level rise.

As well as water levels, future SLR will also increase the annual probability (e.g. frequency) that the present day 1 in 100 year event will occur.

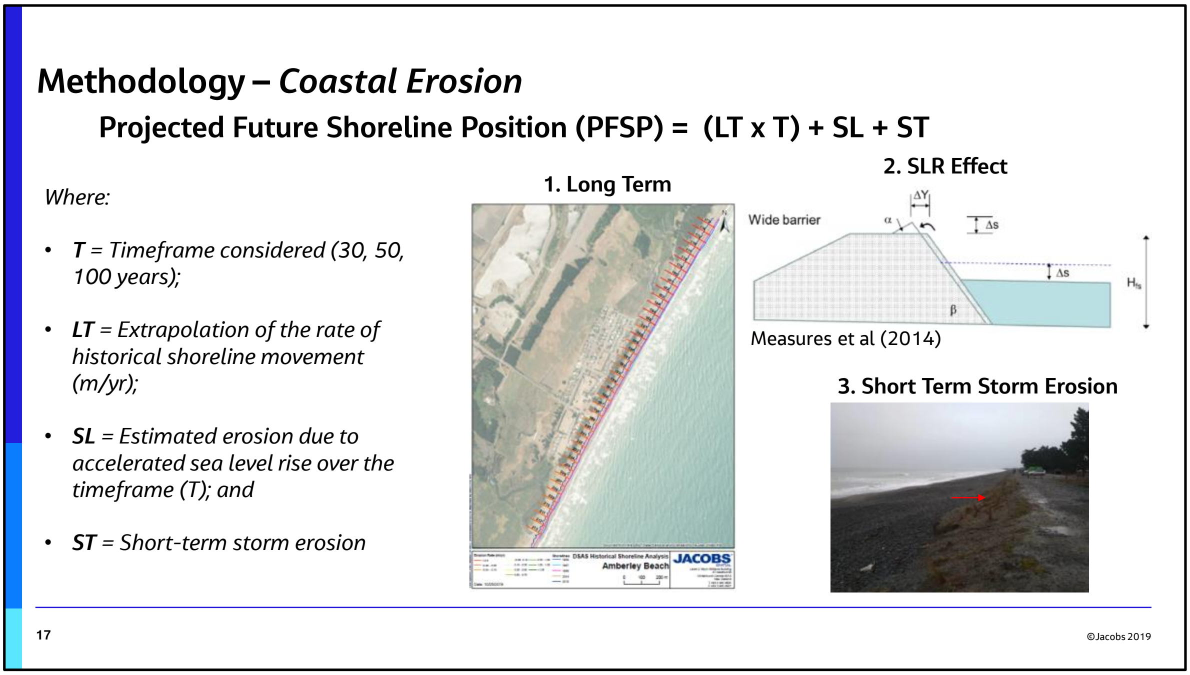
As shown in in the graph on this slide, the Annual Recurrence Interval (ARI) for the present day 1 in 100 year event with no sea level rise reduces from the current 100 years to:
- 30-45 years by 2050;
- 10-20 years by 2070; and
- 1-3 years by 2120.

Expressed another way, experiencing this area and depth of flooding, you would currently only expect it to occur once in 100 years at present. With SLR over 30, 50 and 100 years, more than twice as likely to occur in any one year by 2050, in the order of five to ten times more likely to occur in any one year by 2070, and could occur every year by 2120.



Coastal Erosion Assessment

The following slides discuss the coastal erosion assessment methods and results.



Methodology – *Coastal Erosion*

Projected Future Shoreline Position (PFSP) = (LT x T) + SL + ST

Where:

- ***T*** *= Timeframe considered (30, 50, 100 years);*
- ***LT*** *= Extrapolation of the rate of historical shoreline movement (m/yr);*
- ***SL*** *= Estimated erosion due to accelerated sea level rise over the timeframe (T); and*
- ***ST*** *= Short-term storm erosion*

1. Long Term

2. SLR Effect

Measures et al (2014)

3. Short Term Storm Erosion

This slides provides an overview of the approach used to assess the future erosion hazard at each settlement. Further detail and explanation of the methods can be found in the report at www.hurunui.govt.nz/coastal

When assessing coastal erosion hazard into the future, there are three key components to consider:

1. **Long term trend** – This is considered to ensure that the past trend at the site (e.g. accretion due to good sediment supply, or erosion due to sediment deficit) is taken into account when determining where the shoreline will be in the future. This is calculated using historical aerial imagery from the site;
2. **Effect of sea level rise** – The inclusion of the effect of accelerated sea level rise in the future shoreline position is to account for the erosional response on the beach to rising sea levels. This is calculated using two- dimensional geometric models which are adjusted depending on the morphology of the beach.
3. **Short term erosion** – The inclusion of short-term erosion as a component in the PFSP calculation is to account for an extreme storm event or series of events resulting in significant erosion occurring close to or soon after the end of the planning timeframe. This is calculated using ECan beach profiles and calculating year-to-year changes between profiles.

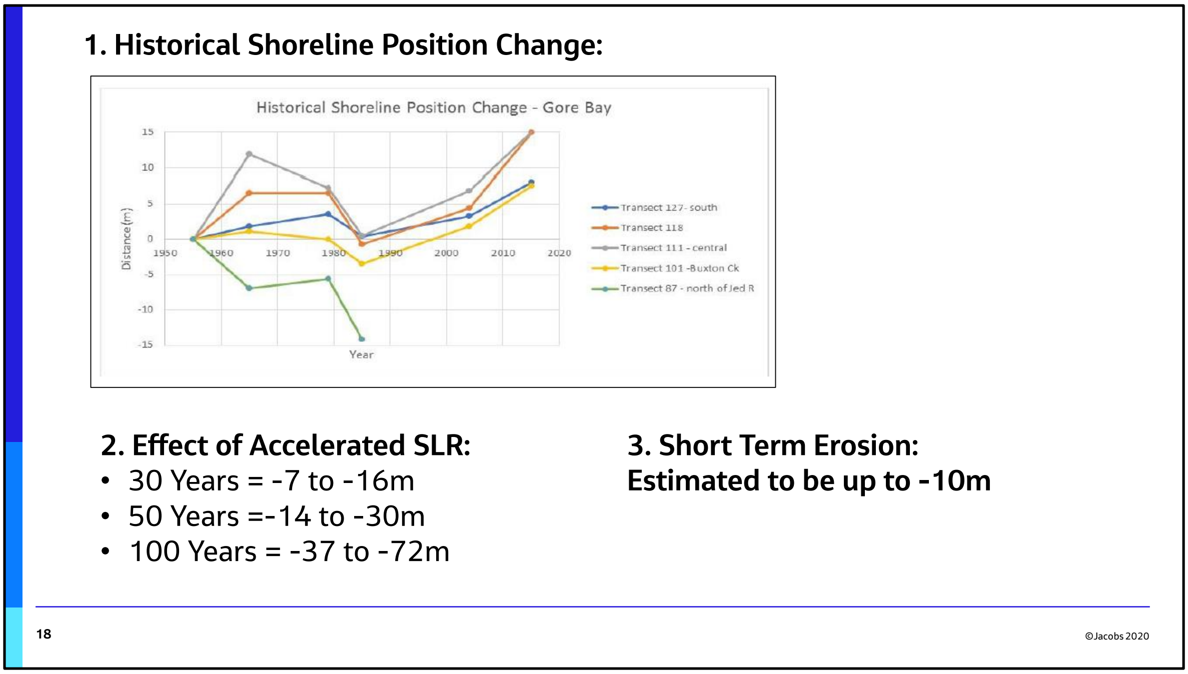
These components are combined in the following formula to calculate the position of the Projected Future Shoreline Position (PFSP), in which this approach meets the requirements of NZCPS Policy 24 for the identification of coastal hazards:

PFSP = (Long **T**erm **x T**imeframe**) + S**ea **L**evel **R**ise effect **+ S**hort **T**erm

.

The PFSP lines seen on the maps in each settlement and at Conway Flat Road are a combination of all three components, and represent where the back of the beach (e.g. the vegetation line or cliff line) could be in 30, 50 and 100 years under two different sea level rise scenarios.

Reference: Measures et al., (2014). Analysis of Te Waihora lake level control options: A Whakaora Te Waihora science project. *Prepared for Ngai Tahu and Environment Canterbury.*



1. Historical Shoreline Position Change:

2. Effect of Accelerated SLR:

- 30 Years = -7 to -16m
- 50 Years =-14 to -30m
- 100 Years = -37 to -72m

3. Short Term Erosion:

Estimated to be up to -10m

This slide presents the results of the Coastal Erosion hazard assessment for 30, 50 and 100 year timeframes.

1. Historical Shoreline Trend

The graph on the top of this slide shows the historical shoreline position at select locations along the Gore Bay shoreline since the 1950s. Key summary of the findings are as follows:

- There are similar trends of shoreline movements along the main part of the settlement to the south of Buxton Creek with fluctuating periods of accretion and erosion to the mid 1980's followed by steady accretion through to 2015.
- Over the 60 years analysed, the whole of the coastal frontage to the south of Buxton Creek accreted, with net rates ranging from +0.10 m/yr south of the settlement, increasing to +0.15 m/yr in the centre of the settlement, and decreasing back to +0.05 m/yr at Buxton Creek.
- North of Buxton Creek there is predominantly erosion being displayed to 1985, which is unfortunately where the aerial imagery ceases. Average net rates of retreat over the 30 years of measurements for this section of coast progressively increase to the north from -0.05 m/yr north of Buxton Creek to -0.5 m/yr north of the Jed River.

2. Effects of Accelerated SLR

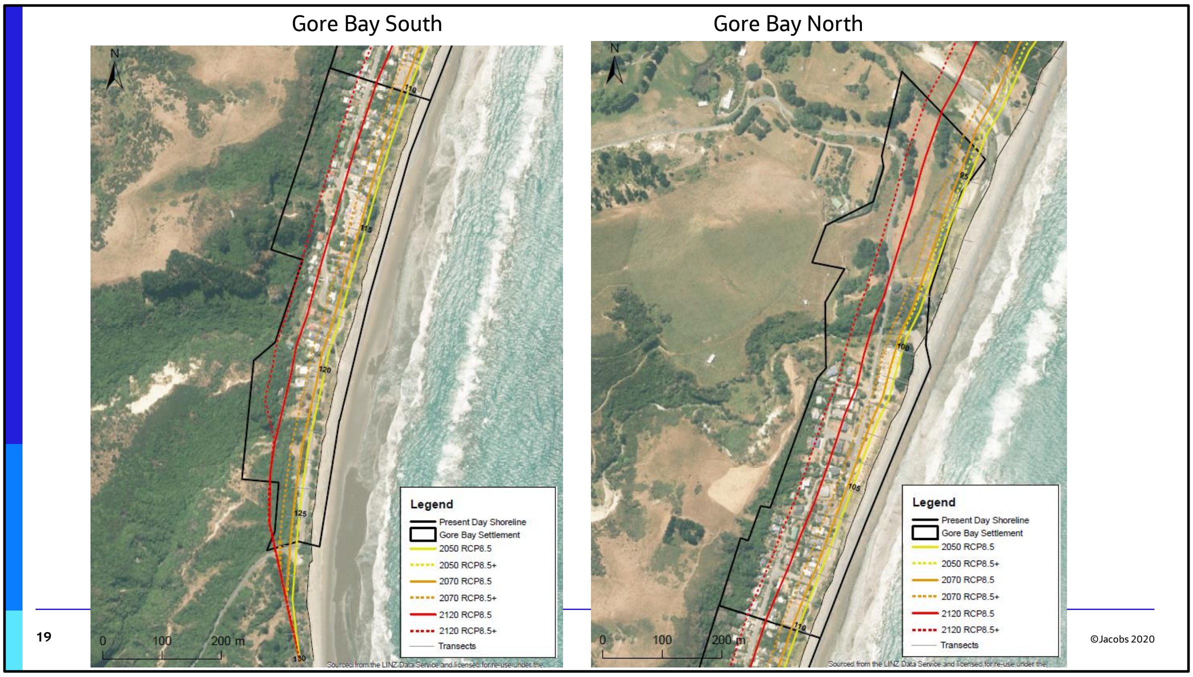
The effects of accelerated SLR at Motunau are calculated as the following:

- Over the next 30 years there could be 16 to 27m of erosion as a direct result of SLR;
- Over the next 50 years there could be 28 to 49m of erosion as a direct result of SLR; and
- Over the next 100 years there could be 80 to 120m of erosion as a direct result of SLR.

3. Short Term Erosion

An assessment of Environment Canterbury beach profiles between 1993-2019 revealed that the maximum inter-survey erosion ranged from -2.4 to -9.3m. Adopting this upper limit, an arbitrary value of 10m was used as the short-term erosion component for the PFSP for the Gore Bay settlement.

These three components are then combined to calculate the Projected Future Shoreline Positions seen on the map on the next slide.



Gore Bay South

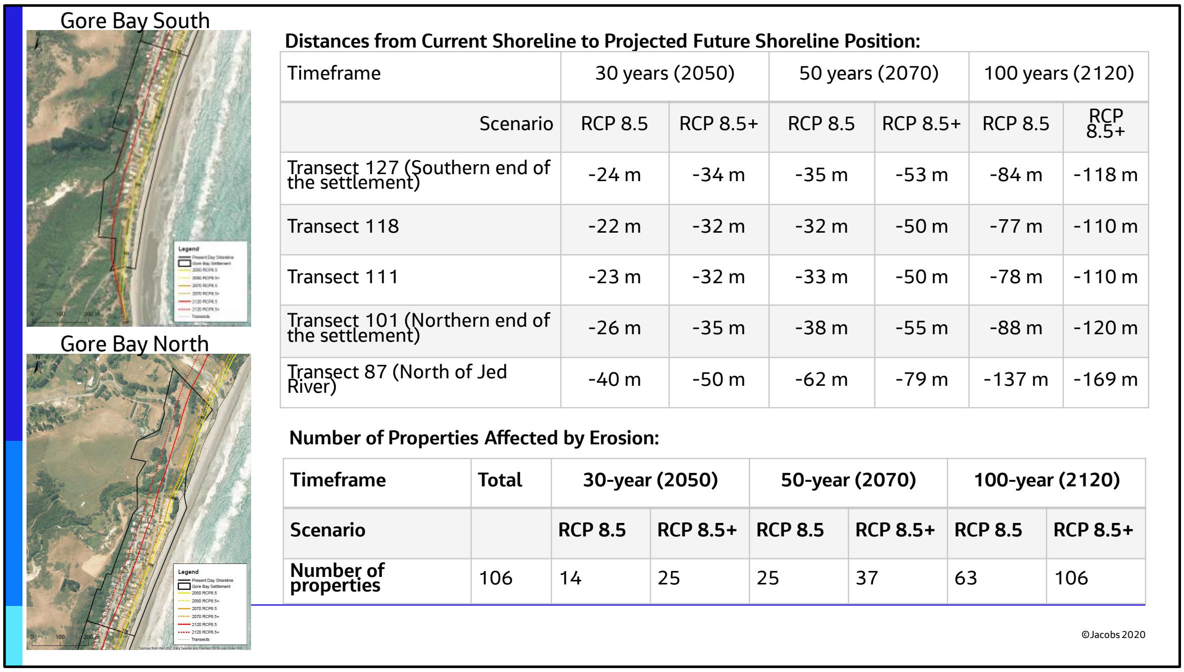
Gore Bay North

19

©Jacobs 2020

This slide presents the projected future shoreline positions from the coastal erosion hazard assessment for 30, 50 and 100 year timeframes.

Due to the confined nature of the settlement between the coastline and steep cliffs, the PFPS distance for the 100 year RCP8.5+ scenario it has been truncated to the base cliff where required as different erosional process would occur when the shoreline approached this location, that have not been accounted for in this assessment.



Gore Bay South

Gore Bay North

Distances from Current Shoreline to Projected Future Shoreline Position:

Timeframe	30 years (2050)		50 years (2070)		100 years (2120)	
Scenario	RCP 8.5	RCP 8.5+	RCP 8.5	RCP 8.5+	RCP 8.5	RCP 8.5+
Transect 127 (Southern end of the settlement)	-24 m	-34 m	-35 m	-53 m	-84 m	-118 m
Transect 118	-22 m	-32 m	-32 m	-50 m	-77 m	-110 m
Transect 111	-23 m	-32 m	-33 m	-50 m	-78 m	-110 m
Transect 101 (Northern end of the settlement)	-26 m	-35 m	-38 m	-55 m	-88 m	-120 m
Transect 87 (North of Jed River)	-40 m	-50 m	-62 m	-79 m	-137 m	-169 m

Number of Properties Affected by Erosion:

Timeframe	**Total**	**30-year (2050)**		**50-year (2070)**		**100-year (2120)**	
Scenario		**RCP 8.5**	**RCP 8.5+**	**RCP 8.5**	**RCP 8.5+**	**RCP 8.5**	**RCP 8.5+**
Number of properties	106	14	25	25	37	63	106

Projected Future Shoreline Positions

The table on the top right of this slide shows the distance of the projected future shoreline position from the present day shoreline (cliff edge and vegetation line) for each scenario. These distances are shown spatially on the maps on the left (and on the previous slide).

These distances can be summarised as the following:

- In 2050, the shoreline could be in the order of -22 to -50m landward of its current position;
- In 2070, the shoreline could be in the order of -32 to -79m landward of its current position; and
- In 2120, the shoreline could be in the order of -77 to -169m landward of its current position.

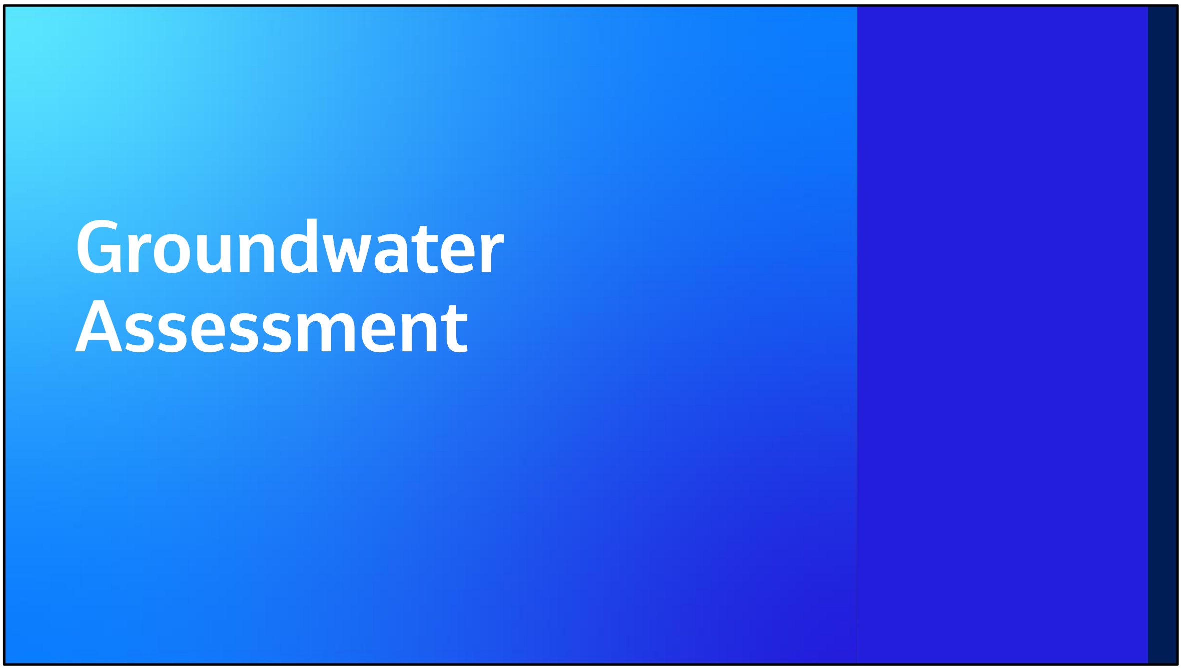
It is noticeable from these results that for all parts of the settlement coastal frontage south of the Buxton River that within 30 years the erosion due to accelerated SLR is predicted to overturn any accretion due to sediment supply, resulting in net erosion occurring. For these sites SLR contributes 65-85% of the distance to the PFSP over the next 30 years, and 75 to 95% over the next 50 years.

For the transects north of the Buxton River, predicted erosion distances are greater due to the added contribution of the current erosional long-term erosion rate. However, even within 30 years the effects of accelerated SLR will contribute more to the position of the PFSP than the extrapolation of current rates, and by 50 years will be contributing up to 85% of the predicted erosion.

Coastal Erosion Risk Assessment

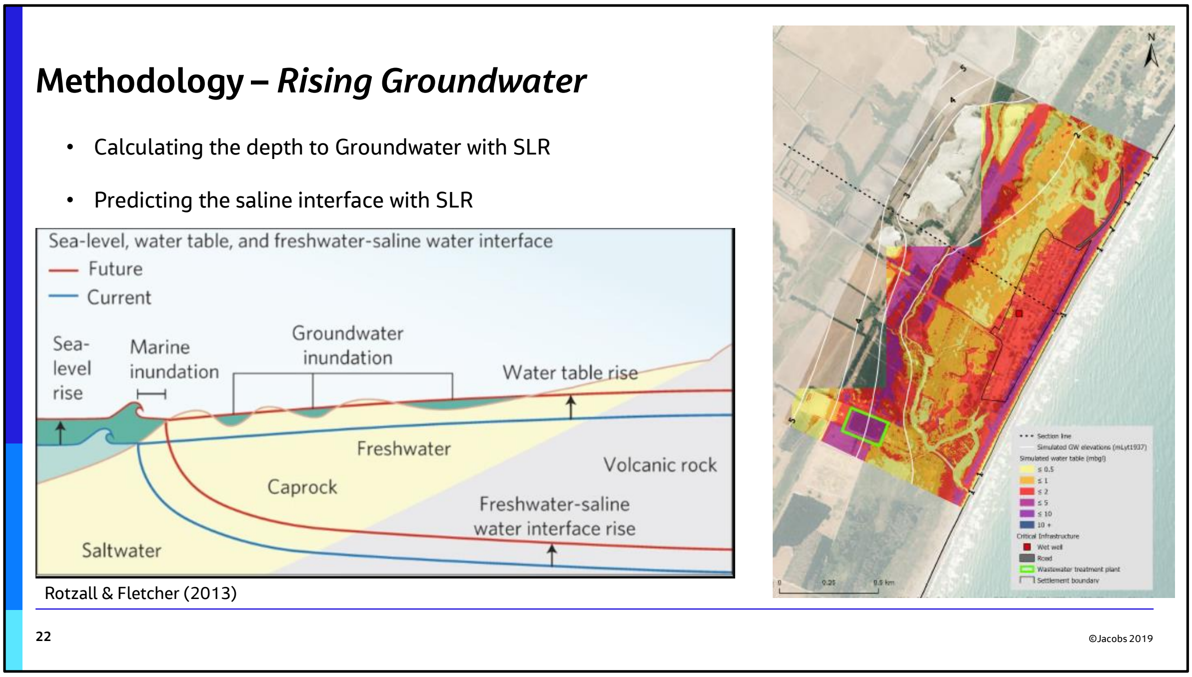
The number of properties effected by erosion over the next 100 years is presented in the bottom table. Of the 106 properties within the Gore Bay settlement footprint, 14 to 25 are projected to be at risk from erosion over the next 30 years, 25 to 37 over the next 50 years, and 63 to 106 over the next 100 years.

No critical infrastructure at Gore Bay was required to be assessed. However, around 300 m of Cathedral Rd at the southern entrance to the settlement and around 170 m of the southern section of Gore Bay Rd are mapped as be at risk from coastal erosion by 2050, with almost all the roading network through the settlement affected by 2120.



Groundwater Assessment

The following slides discuss the rising groundwater assessment methods and results.



Methodology – *Rising Groundwater*

- Calculating the depth to Groundwater with SLR
- Predicting the saline interface with SLR

Rotzall & Fletcher (2013)

This slide provides an overview of the approach used to assess the <u>rising of shallow groundwater</u> at each settlement. Further detail and explanation of the methods can be found in the report at www.hurunui.govt.nz/coastal

Two components of groundwater hazards were assessed in the Hurunui District:
1) Rising shallow groundwater with sea level rise; and
2) Ingress of the saline interface with sea level rise as seawater encroaches into the groundwater table

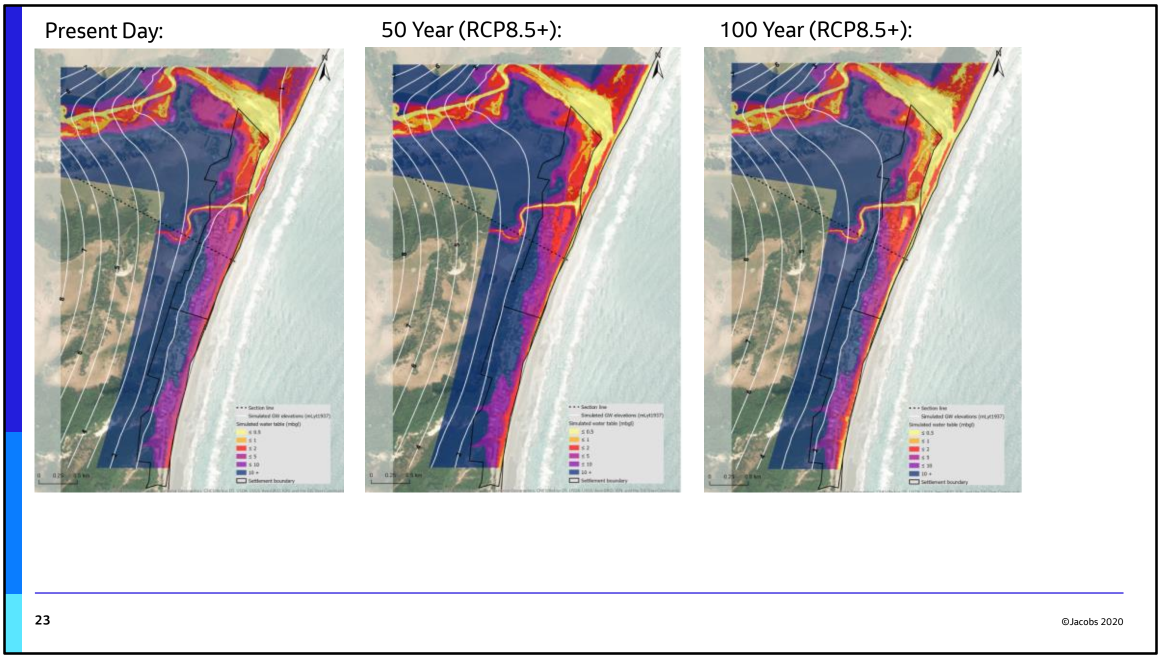
There were several limitations to calculating the rising groundwater hazard in the Hurunui District due to the lack of data available, and therefore only 50 year and 100 year scenarios were assessed.

The figure on the left (from Rotzall & Fletcher, 2013) shows an example of the effect of SLR on the water table and the saline interface. It demonstrates how groundwater water quality can be effected as the freshwater-saline interface moves inland with SLR, as well as reducing the ability for land to drain as the water table rises.

In this assessment, the change in the saline interface was assessed, which could have an effect on the water quality at a site where there is saltwater intrusion into water supplies or water treatment areas.

The map on the right shows an example of the output of the modelling assessing the rise in shallow groundwater, which shows the depth to ground water below 0m, which gives an indication of areas where the drainage capacity of the land could be reduced with sea level rise.

Rotzoll, K., Fletcher, C. Assessment of groundwater inundation as a consequence of sea-level rise. *Nature Clim Change* 3**,** 477–481 (2013)



Present Day:

50 Year (RCP8.5+):

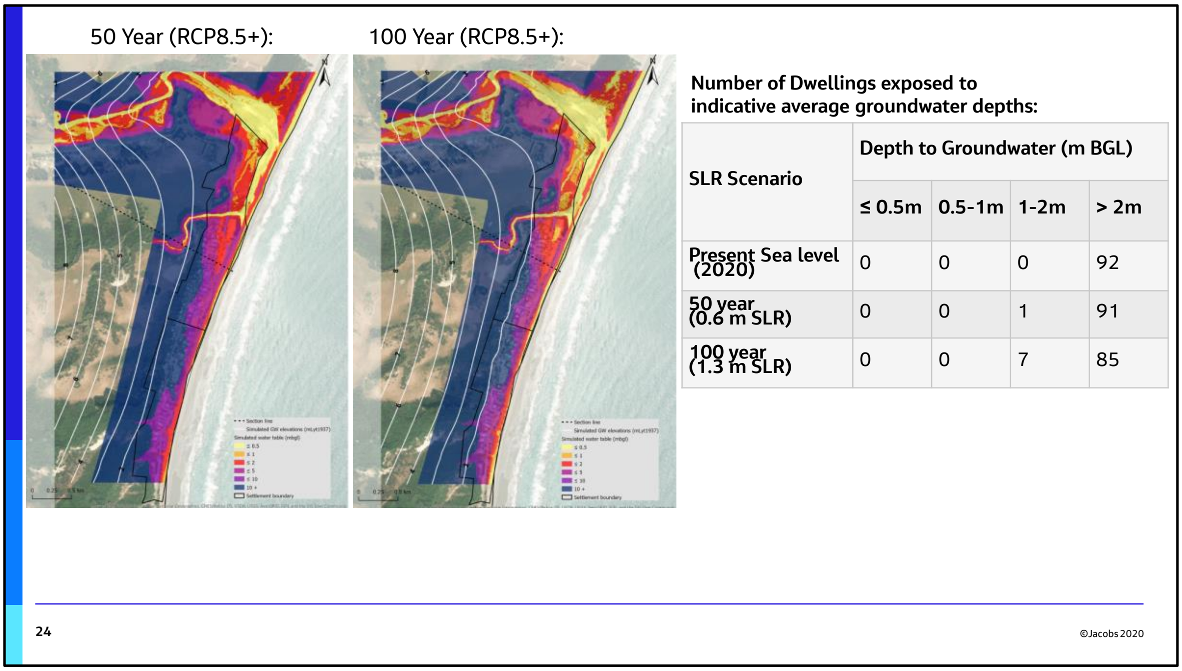
100 Year (RCP8.5+):

©Jacobs 2020

This slide shows the results of the shallow groundwater mapping in the present day, with 50 years SLR (RCP 8.5+), and with 100 years SLR (RCP 8.5+).

The map of depths to the indicative average shallow groundwater conditions at Gore Bay under present day and future sea levels is presented in the three maps in this slide.

The majority of the Gore Bay settlement is relatively elevated apart from around the combined mouth of the Buxton Creek and the Jed River. Depth to groundwater is greater than 1 m under all SLR scenarios over the whole settlement except for a small area at Buxton Campground under the 100-year RCP8.5+ scenario.



50 Year (RCP8.5+):

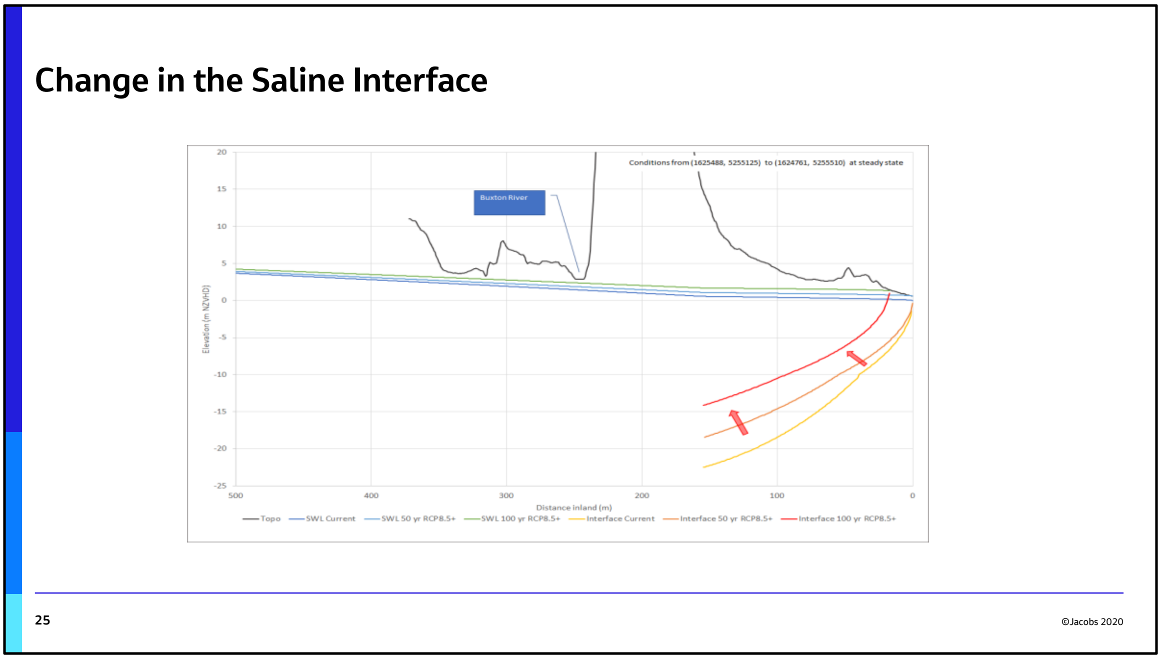
100 Year (RCP8.5+):

Number of Dwellings exposed to indicative average groundwater depths:

SLR Scenario	Depth to Groundwater (m BGL)			
	≤ 0.5m	0.5-1m	1-2m	> 2m
Present Sea level (2020)	0	0	0	92
50 year (0.6 m SLR)	0	0	1	91
100 year (1.3 m SLR)	0	0	7	85

This slide shows the results of the shallow groundwater mapping risk assessment with 50 years SLR (RCP 8.5+), and with 100 years SLR (RCP 8.5+).

The number of dwellings exposed to different groundwater depths with present and future sea levels is presented in Table on the right. No dwellings are predicted to be impacted by groundwater shallower than 1m BGL. The number of dwelling predicted to have groundwater in the range 1 to 2m BGL increases from zero to 7 with SLR over the next 100 years.



Change in the Saline Interface

This slide shows the results of the assessment of the change in the saline interface with SLR.

The predicted saline interface with SLR is shown in the graph on this slide. It indicates a small saline incursion in the unconfined aquifer, which is not predicted to have any impacts on the water quality in Gore Bay.

Thank you

Jacobs

Challenging today.
Reinventing tomorrow.

Copyright Notice