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

Phase one:
What is happening?

Sea level rise?

Coastal erosion?

Coastal inundation?

Rising groundwater?

HURUNUI District Council

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?

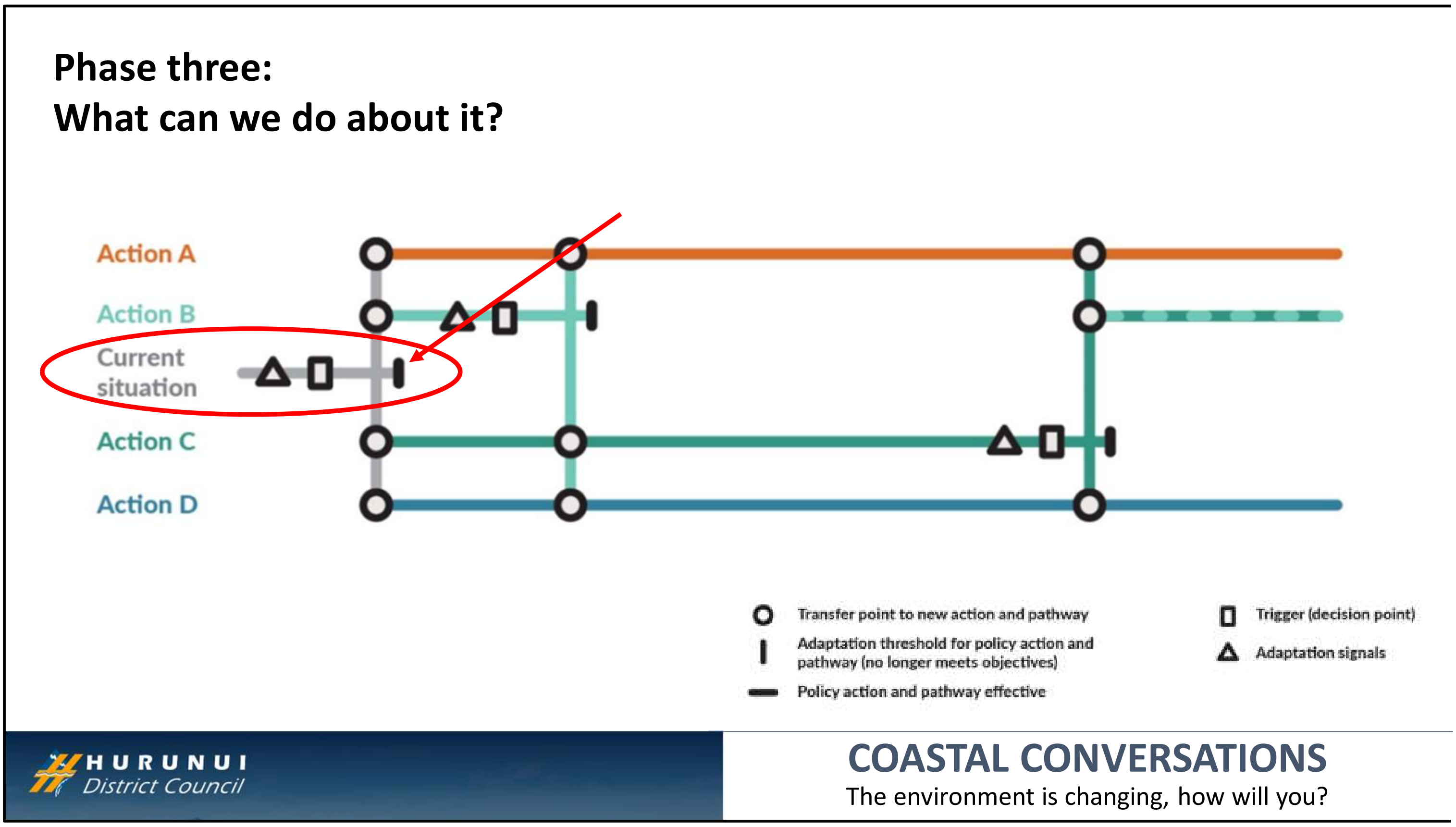
HURUNUI District Council

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.



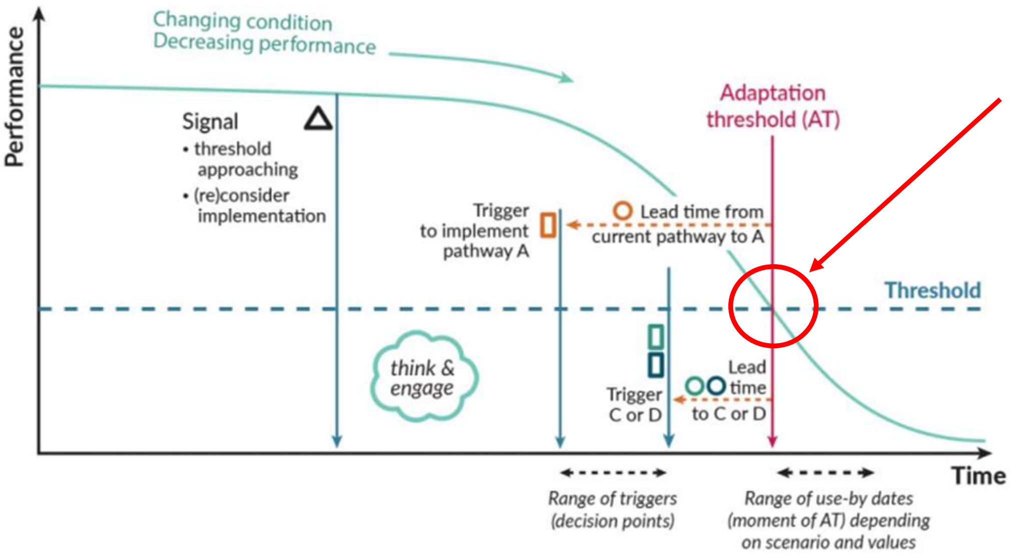
What can we do about it?

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?



HURUNUI District Council

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

Leithfield Beach

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.

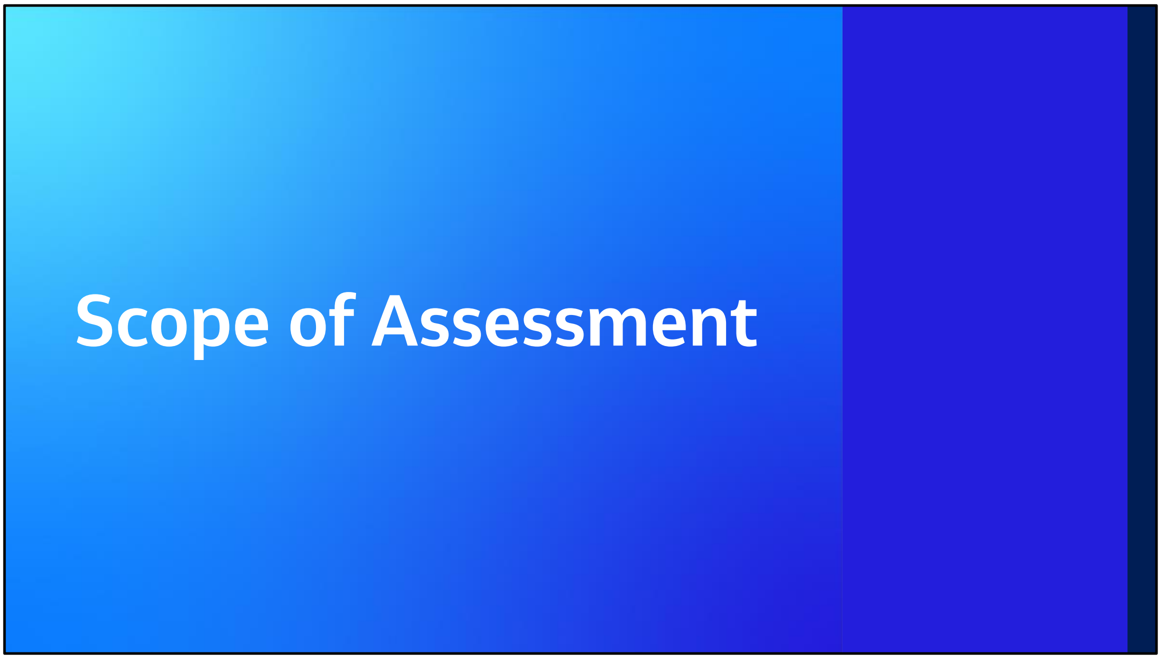
These notes will provide extra detail for the slides presented by Derek Todd of Jacobs at the "Coastal Conversations" talk held for Leithfield Beach on the 22nd September 2020.

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



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.

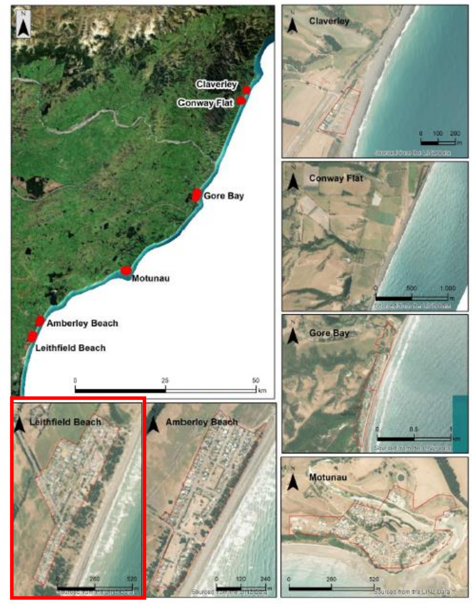
The three hazards covered in the assessment are:

- 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).

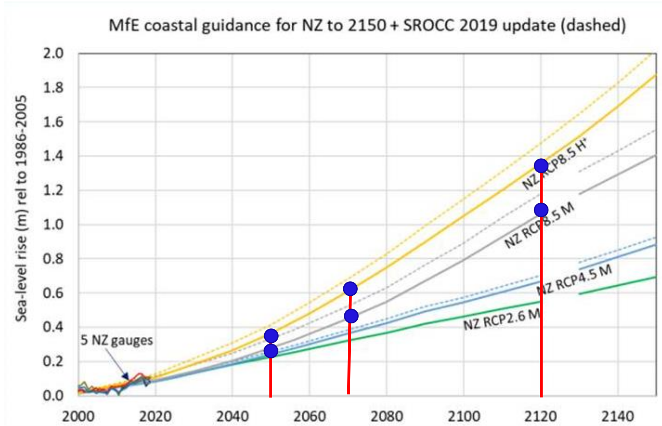
In the high-level risk assessment completed at each settlement, dwellings, properties and council infrastructure were assessed based on their intersection with the hazard footprint (e.g. whether the hazard overlays with a property). This was to give an indication of how many dwellings and properties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

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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.*

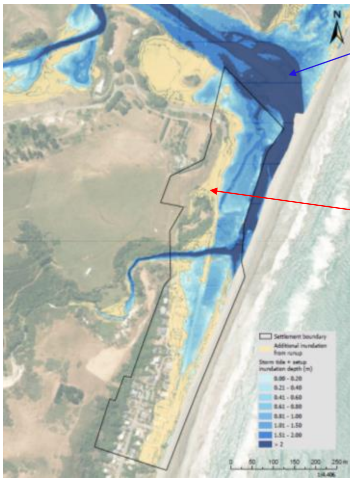
There are four commonly accepted sea level rise/climate change scenarios used both nationally and internationally, which are recognised by the New Zealand government. These scenarios are termed RCPs (Representative Concentration Pathways), and are based on the following global emissions scenarios:

- 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

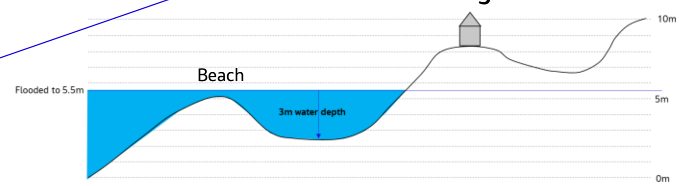
In this assessment, we looked at sea level rise over a 30, 50 and 100 year time frame (three red vertical lines) for a RCP8.5 and RCP8.5+ sea level rise scenario (blue dots) on the curved yellow and red lines), in which the sea level rise in metres in each of these scenarios is detailed in the table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

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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

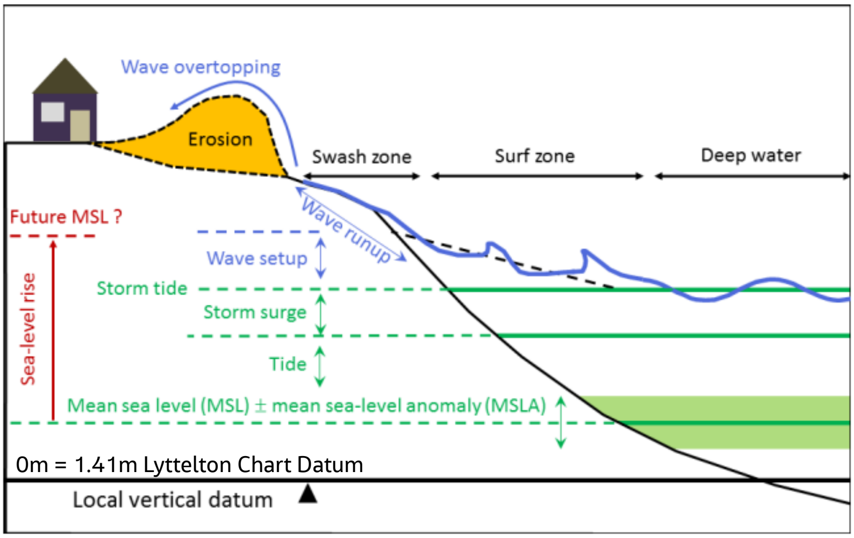
<u>Bathtub model</u>

- 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.



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This slide shows the different components used to determine the 'static' water level – Astronomical tide, storm surge, wave setup and SLR.

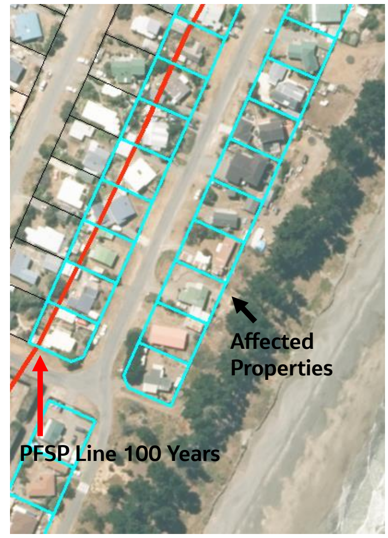
Methodology – *Risk Assessment*

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

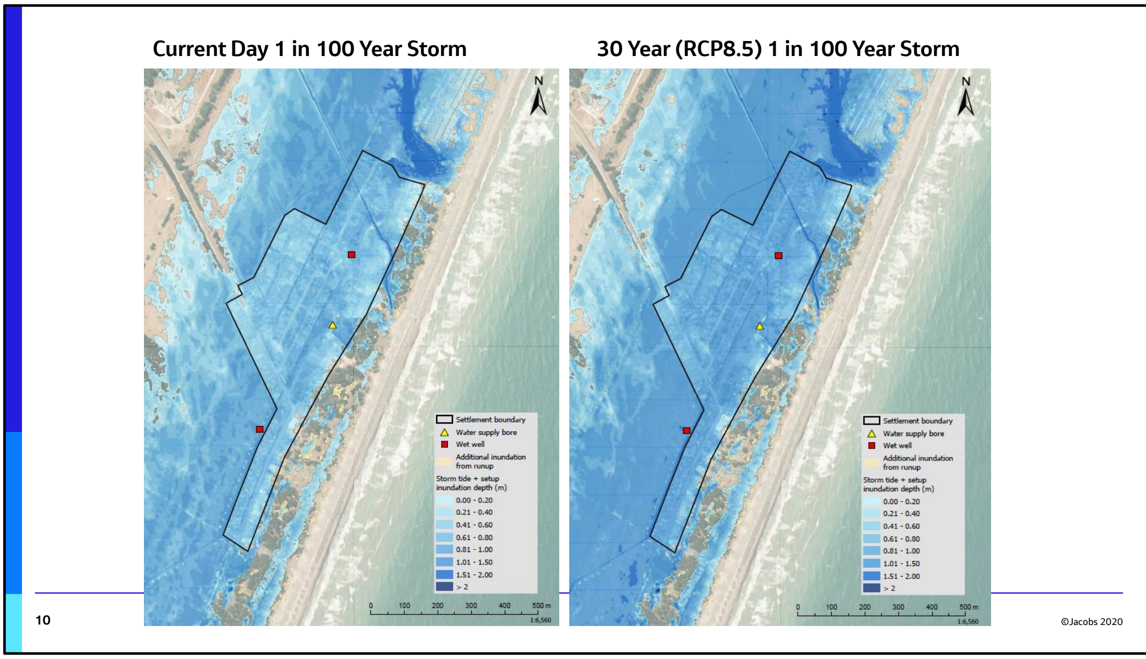
Risk is assessed as the consequence of the event, combined with the likelihood of that event occurring.

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. This is relevant for Leithfield Beach where the holiday park was included in the analysis.



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

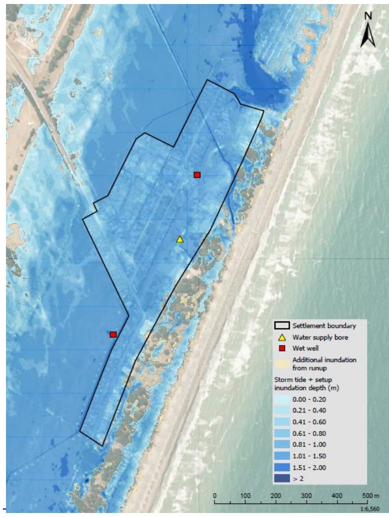
Present Day 1 in 100 year storm

- The map on the *left* shows the hazard footprint at the present day, with no sea level rise. This map shows that approximately 99% of the settlement could become inundated in a 1 in 100 year event. Potential inundation depths could be in the order of 0.5m.
- The mapping indicates that only isolated wave run-up overtopping of the double beach ridge system would occur within the settlement frontage, with the source of majority of the inundation being from overtopping of the lowered beach ridge at the coastal lagoon immediately to the north of the settlement footprint.
- Due to the entire settlement footprint being below the threshold for inundation by static water level, no additional inundation areas have been mapped for inundation by wave runup overtopping.

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

- The map on the *right* shows the hazard footprint with 30 years, with 0.28m of SLR. This map shows the entire settlement footprint would inundated in a 1 in 100 year event. Potential average inundation depths are in the order of 0.8m.

30 Year (RCP8.5) 1 in 100 Year Storm



Dwellings and Properties Affected:

Timeframe	Scenario	Dwellings	Properties
Total		265	197
Present Day		265	191
30-Year (2050)	RCP 8.5	265	191
50-Year (2070)	RCP 8.5	265	192
	RCP 8.5+	265	193
100-Year (2120)	RCP 8.5	265	195
	RCP 8.5+	265	196

Inundation Depth at Key Infrastructure:

Timeframe	Scenario	Wet Well North	Wet Well South	Water Supply Bore
Present Day		0.87m	0.93m	0.59m
30-Year (2050)	RCP 8.5	1.2m	1.2m	0.87m
50-Year (2070)	RCP 8.5	1.34m	1.38m	1.09m
	RCP 8.5+	1.5m	1.59m	1.2m
100-Year (2120)	RCP 8.5	1.95m	2.0m	1.8m
	RCP 8.5+	2.28m	2.29m	2.27m

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

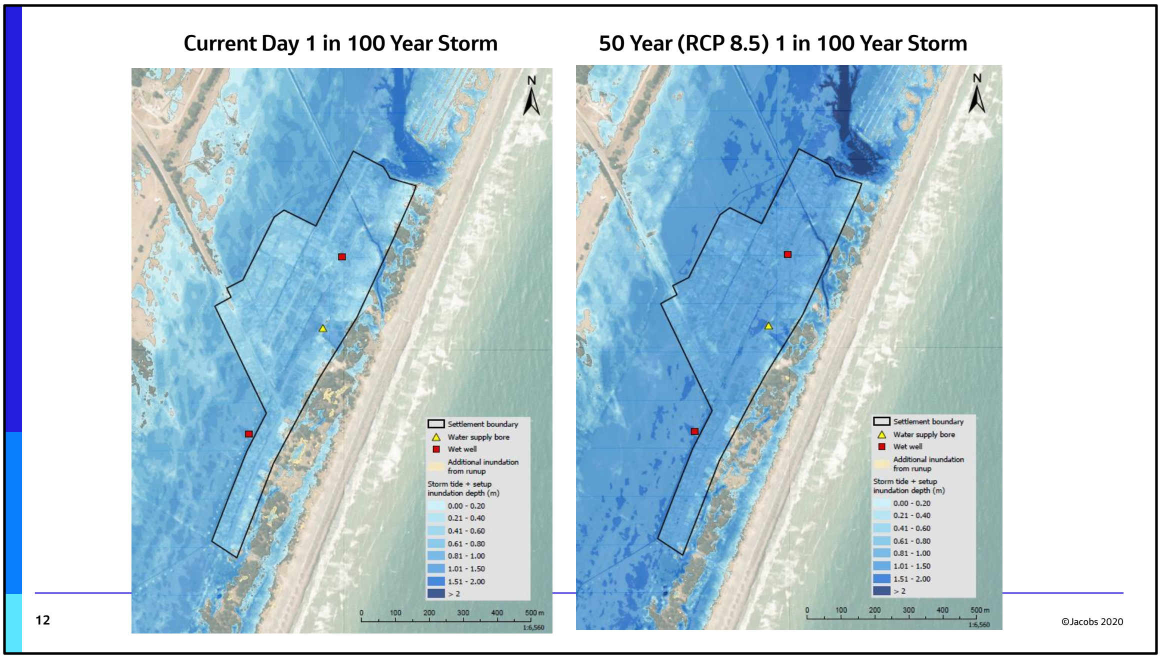
Key infrastructure at Leithfield Beach that was assessed in the risk assessment was the two wet wells (termed north and south), and the water supply bore.

<u>Present Day</u>

- As per the top right table, in a 1 in 100 year event at the present day all assessed dwellings would be affected, and 191 of the 197 properties would be affected.
- All three pieces of critical infrastructure assessed could become inundated in the order of 0.6m water depth at the water supply bore; 0.93m water depth at the south wet well, and 0.87m water depth at the north wet well.

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

- In the 30-year scenario, all assessed dwellings would be affected, and 191 of the 197 properties would be affected.
- All three pieces of critical infrastructure assessed could become inundated in the order of 0.87m water depth at the water supply bore; and in the order of 1.2m water depth at both wet wells.

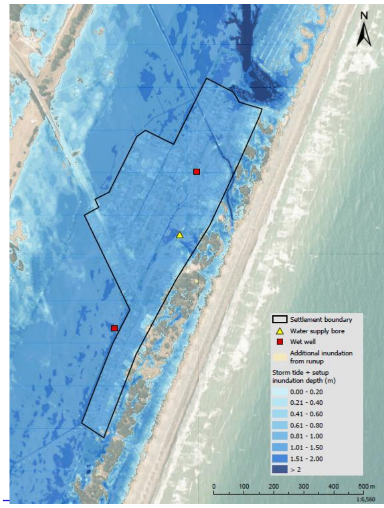


This slide shows a the results of the coastal inundation hazard at Leithfield Beach for a 1 in 100 year storm for the present day (0m SLR), and in 50 years (0.45m of SLR).

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

- The map on the *right* shows the hazard footprint with 50 years, with 0.45m of SLR. This map shows that approximately 99% of the settlement could become inundated in a 1 in 100 year event. Potential inundation depths are the order of 1.2 to 1.4 m.
- The source of majority of the inundation is from overtopping of the lowered beach ridge at the coastal lagoon immediately to the north of the settlement footprint.

50 Year (RCP 8.5) 1 in 100 Year Storm



Dwellings and Properties Affected:

Timeframe	Scenario	Dwellings	Properties
Total		**265**	**197**
Present Day		265	191
30-Year (2050)	RCP 8.5	265	191
50-Year (2070)	RCP 8.5	265	192
	RCP 8.5+	265	193
100-Year (2120)	RCP 8.5	265	195
	RCP 8.5+	265	196

Inundation Depth at Key Infrastructure:

Timeframe	Scenario	Wet Well North	Wet Well South	Water Supply Bore
Present Day		0.87m	0.93m	0.59m
30-Year (2050)	RCP 8.5	1.2m	1.2m	0.87m
50-Year (2070)	RCP 8.5	1.34m	1.38m	1.09m
	RCP 8.5+	1.5m	1.59m	1.2m
100-Year (2120)	RCP 8.5	1.95m	2.0m	1.8m
	RCP 8.5+	2.28m	2.29m	2.27m

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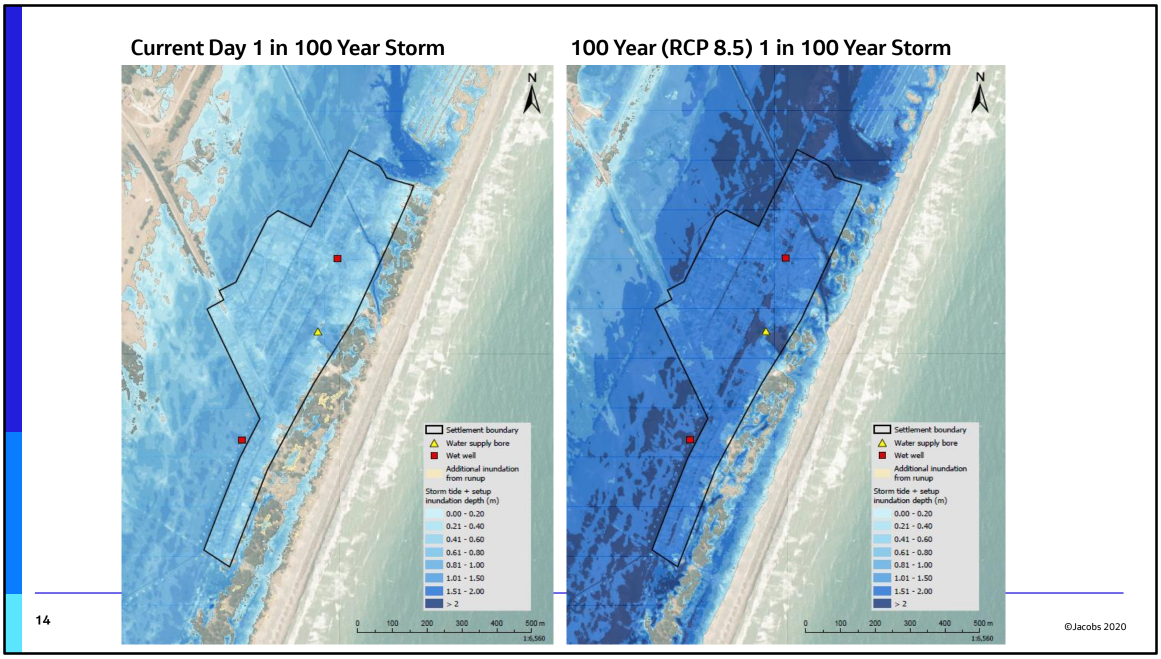
This slide shows the results of the risk assessment for the 50 year inundation hazard, the map on the right of this slide.

Key infrastructure at Leithfield Beach that was assessed in the risk assessment was the two wet wells (termed north and south), and the water supply bore.

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

- In the 50-year scenarios, all dwellings assessed are likely to be affected, and 192-193 of the 197 properties are likely to be affected.
- Water depth at the water supply bore in this event could be 1.1 to 1.2m deep.
- Water depth at the southern wet well could be in the order of 1.4 to 1.6m, and at the northern wet well could be in the order of 1.35 to 1.5m.

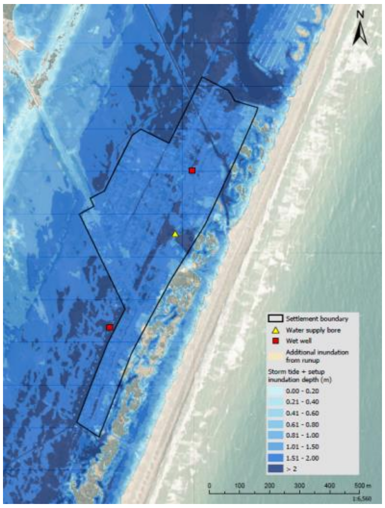


This slide shows a the results of the coastal inundation hazard at Amberley Beach for a 1 in 100 year storm for the present day (0m SLR), and in 100 years (1.06m of SLR).

<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 99% of the settlement could become inundated in a 1 in 100 year event. Potential inundation depths in the order of 1.8 to 2m deep.
- The source of majority of the inundation is from overtopping of the lowered beach ridge at the coastal lagoon immediately to the north of the settlement footprint.

100 Year (RCP 8.5) 1 in 100 Year Storm



Dwellings and Properties Affected:

Timeframe	Scenario	Dwellings	Properties
Total		265	197
Present Day		265	191
30-Year (2050)	RCP 8.5	265	191
50-Year (2070)	RCP 8.5	265	192
	RCP 8.5+	265	193
100-Year (2120)	RCP 8.5	265	195
	RCP 8.5+	265	196

Inundation Depth at Key Infrastructure:

Timeframe	Scenario	Wet Well North	Wet Well South	Water Supply Bore
Present Day		0.87m	0.93m	0.59m
30-Year (2050)	RCP 8.5	1.2m	1.2m	0.87m
50-Year (2070)	RCP 8.5	1.34m	1.38m	1.09m
	RCP 8.5+	1.5m	1.59m	1.2m
100-Year (2120)	RCP 8.5	1.95m	2.0m	1.8m
	RCP 8.5+	2.28m	2.29m	2.27m

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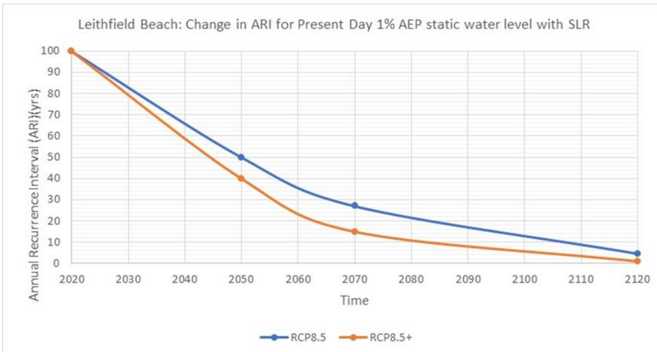
This slide shows the results of the risk assessment for the 100 year inundation hazard, the map on the right of this slide.

Key infrastructure at Leithfield Beach that was assessed in the risk assessment was the two wet wells (termed north and south), and the water supply bore.

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

- In the 100-year scenarios, all dwellings assessed are likely to be affected, and almost all (195-196) of the 197 properties are likely to be affected.
- Water depth at the water supply bore in this event could be 1.8-2.3m deep.
- Water depth at the southern wet well could be in the order of 2 to 2.3 m, and at the northern wet well could be in the order of 1.95 to 2.3m.

Increase in Frequency of 1 in 100 Year Events with SLR



1 in 100 year event could occur every:

- 40-50 Years by 2050
- 15-30 Years by 2070
- 1-5 Years by 2120

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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:

- 40-50 years by 2050;
- 15-30 years by 2070; and
- Every 1-5 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, it is twice as likely to occur in any one year by 2050, in the order of three to six times more likely to occur in any one year by 2070, and could become an annual occurrence by 2120.

Coastal Erosion Assessment

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

Methodology – *Coastal Erosion*

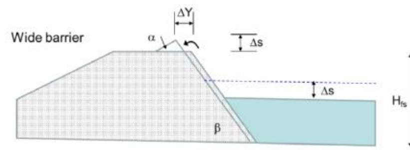
Projected Future Shoreline Position (PFSP) = (LT x T) + SL + ST

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

18 ©Jacobs 2019

This slides provides an overview of the approach used to assess the future <u>erosion hazard</u> 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:

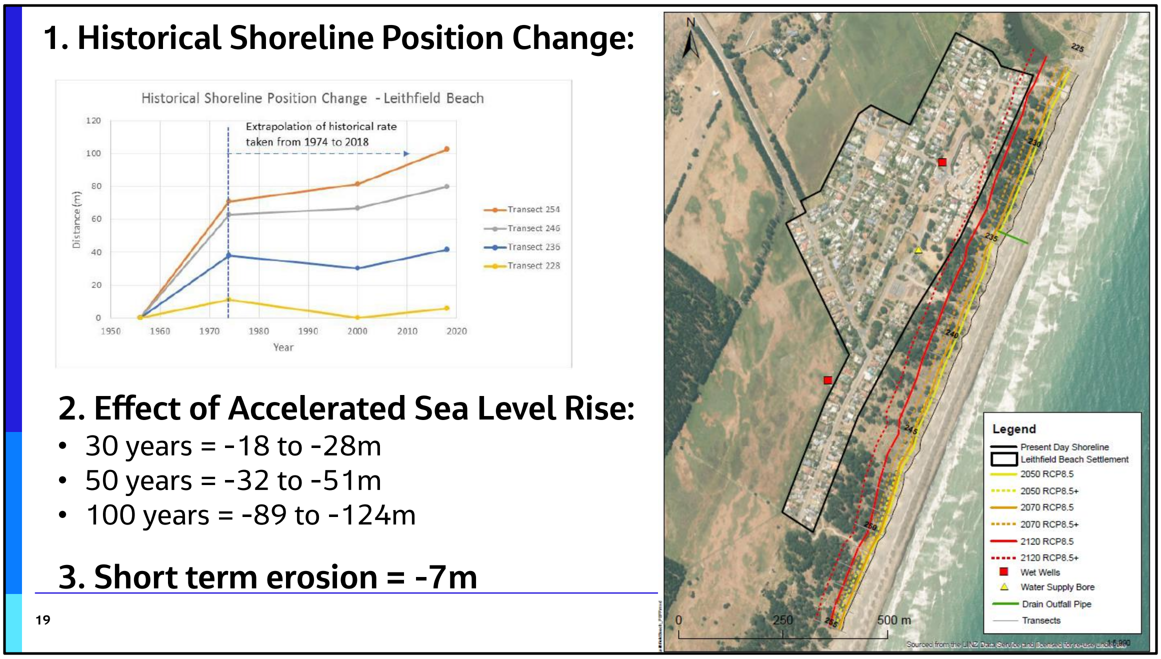
1. **Long term trend** – This is considered to ensure that the past trend at the site (e.g. accretion due to good sediment supply, or erosion due to sediment deficit) is taken into account when determining where the shoreline will be in the future. This is calculated using historical aerial imagery from 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.

References: 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.*



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

<u>1. Historical Shoreline Trend</u>

- The overall long-term historical trend along this section of coastline is for shoreline advance over the last 60 years. Accretion rates decrease in a northward direction along the settlement frontage, with the southern 500 m having average rates of +1.4 m/yr, decreasing in the central and northern parts of the settlement to average rates of +0.6 m/yr.
- This accretionary trend is considered to be due to the northward transport from sediment supplied by the Waimakariri River, supplemented by the supply from the Ashley River for the Leithfield area.
- Accretion rates have been decreasing over time. As a conservative approach to the extrapolation of historical rates for input into the determination of the PFSP position, only shoreline advance rates since 1974 have been used.

<u>2. Effects of Accelerated SLR</u>

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

- Over the next 30 years there could be -18 to -28m of erosion as a direct result of SLR;
- Over the next 50 years there could be -32 to -51m of erosion as a direct result of SLR; and
- Over the next 100 years there could be -89 to -124m of erosion as a direct result of SLR.

<u>3. Short Term Erosion</u>

An assessment of Environment Canterbury beach profiles between 1991-2019 revealed that the maximum inter-survey erosion ranged from -5.7 to -6.8 m

Based on these survey changes and applying a conservative approach, an arbitrary value of -7m was adopted as the short-term erosion component of the PFSP.

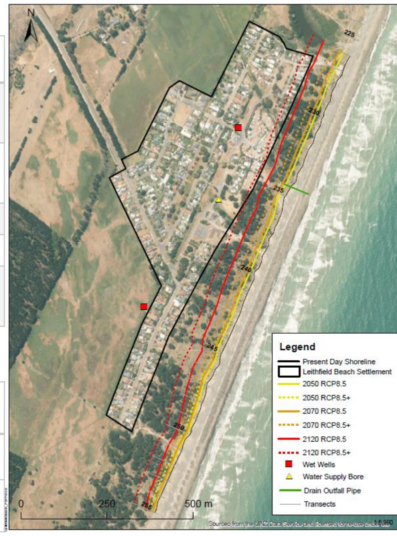
These three components are then combined to calculate the Projected Future Shoreline Positions seen on the map on the right.

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 254 (South end of settlement)	-6 m	-17 m	-8 m	-27 m	-34 m	-69 m
Transect 246	-16 m	-26 m	-23 m	-42 m	-64 m	-100 m
Transect 236	-19 m	-29 m	-28 m	-47 m	-74 m	-110 m
Transect 228 (north end of settlement)	-23 m	-33 m	-35 m	-54 m	-88 m	-124 m

Number of Properties Affected by Erosion:

Timeframe	Total	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+
Number of properties	197	0	0	0	0	0	14



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

Projected Future Shoreline Positions

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

These distances can be summarised as the following:

- In 2050, the shoreline could be in the order of -6 to -33m landward of its current position;
- In 2070, the shoreline could be in the order of -8 to -54m landward of its current position; and
- In 2120, the shoreline could be in the order of -34 to -124m landward of its current position.

The results of this assessment show that for all parts of the settlement coastal frontage, except the southern end under the RCP 8.5 scenario, within 30 years SLR will turn this beach into an erosional environment.

Coastal Erosion Risk Assessment

Properties: Coastal erosion with SLR is not projected to intersect any of the 197 properties until after 2070. By 2120 under the RCP 8.5 scenario (e.g. SLR≈1 m) the vegetation line is projected to be very close to property boundaries at the northern end of the settlement footprint, which will likely increase their exposure to coastal inundation due to reduced beach width and bulk (assuming the back of beach is fixed to the current position). Under the RCP 8.5+ scenario (e.g. SLR≈1 3 m) the shoreline is projected to intersect with 14 properties at this northern end of the settlement.

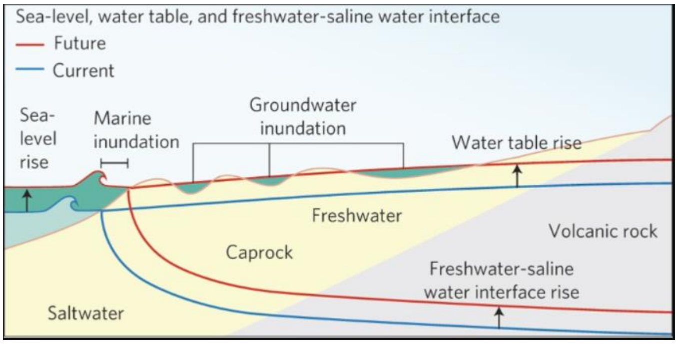
Critical Infrastructure: The water supply bore and both wet wells are not predicted to be affected directly by coastal erosion under any of the scenarios. However, it is considered likely that the drain outfall pipe structure at the beach would be affected to some degree by the projected erosion within the 30 to 50-year timeframes, by undermining of the ocean end with retreating beach profiles, and/or sediment blockage of landward pipe inlet from beach rollover.

Groundwater Assessment

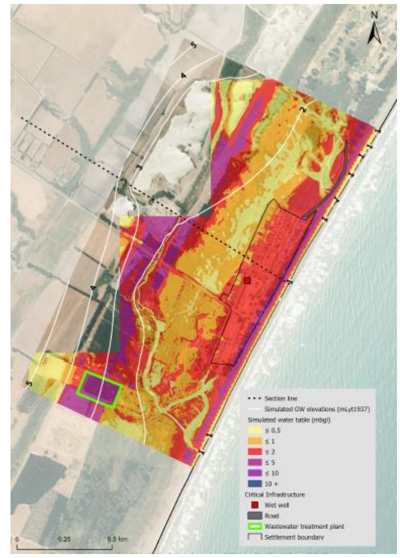
The following slides discuss the rising groundwater assessment methods and results.

Methodology – *Rising Groundwater*

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



Rotzall & Fletcher (2013)



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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.

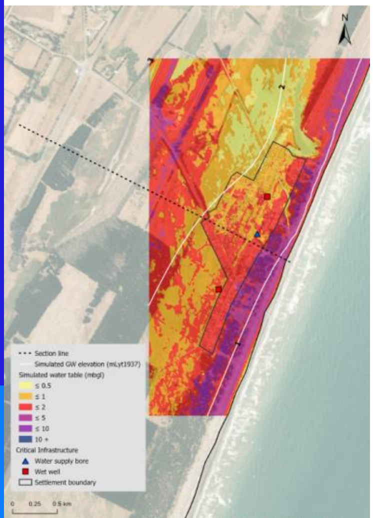
The figure on the left (from Rotzall & Fletcher, 2013) shows an example of the effect of SLR on the water table and the saline interface. It demonstrates how groundwater water quality can be effected as the freshwater-saline interface moves inland with SLR, as well as reducing the ability for land to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

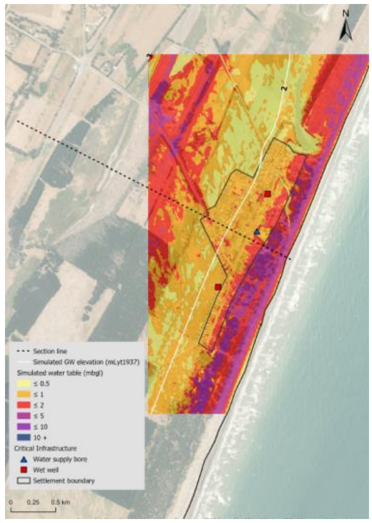
The map on the right shows an example of the output of the modelling assessing the rise in shallow groundwater, which shows the depth to ground water below 0m, which gives an indication of areas where the drainage capacity of the land could be reduced with sea level rise.

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

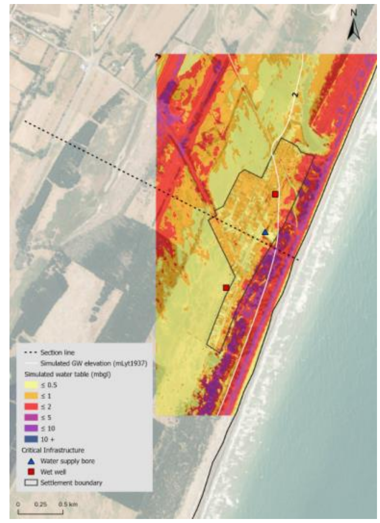
Present Day:



50 Year (RCP8.5+):



100 Year (RCP8.5+):



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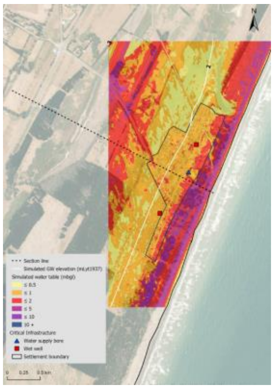
This slide shows the results of the shallow groundwater mapping in the present day, with 50 years SLR (RCP 8.5+), and with 100 years SLR (RCP 8.5+).

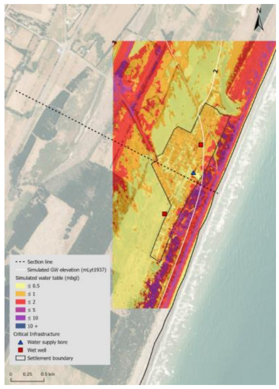
The map of depths to the indicative average shallow groundwater conditions at Leithfield Beach under present day and future sea levels is presented in the three maps in this slide. The results can be summarised as follows:

- In the present day, the map on the left indicates that significant areas of existing development and infrastructure at Leithfield Beach are located in areas of shallow groundwater (<1 m below ground level);
- In the 50 year scenario (SLR of 0.56 m) (centre), the results indicate that the majority of the settlement is predicted to have average groundwater levels shallower than 1 m BGL; and
- Under the 100 year scenario (SLR of 1.3m) (right), the majority of the settlement is predicted to have average groundwater levels shallower than 1 m BGL, with areas shallower than 0.5 m BGL encroaching on the settlement under the RCP 8.5+ scenario.

50 Year (RCP8.5+):



100 Year (RCP8.5+):



Indicative Average Groundwater Depths at Critical Infrastructure:

Infrastructure	Present day (2020)	100-year RCP 8.5+(SLR=1.3 m)
Wet Well North	1-2 m	0.5-1m
Wet Well South	1-2 m	<0.5m
Water Supply Bore	1-2 m	0.5-1m

Number of Dwellings exposed to indicative average groundwater depths:

RCP 8.5+ SLR Scenario	**Depth to Groundwater (m BGL)**			
	≤ 0.5 m	**0.5-1 m**	**1-2 m**	**> 2 m**
Present Sea level (2020)	5	132	128	0
50 year (0.6 m SLR)	16	193	56	0
100 year (1.3 m SLR)	112	130	23	0

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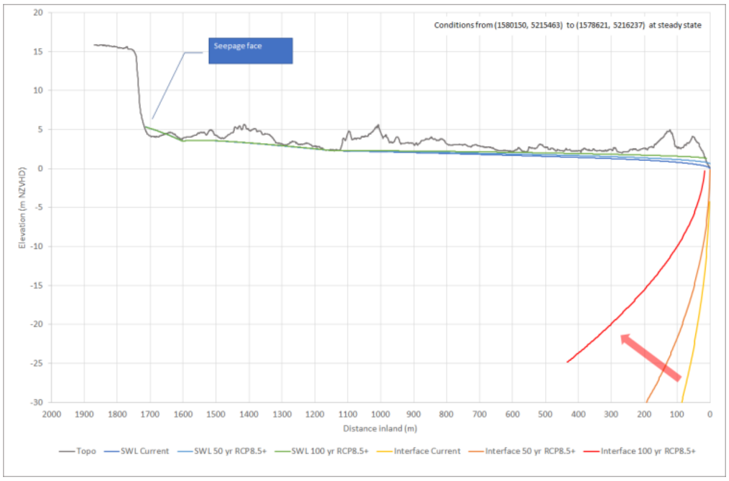
This slide presents the results of the rising shallow groundwater risk assessment.

The number of dwellings exposed to different groundwater depths with present and future sea levels is presented in the bottom left table on this slide. The number of dwellings predicted to be at risk from groundwater shallower than 0.5 m increases significantly with SLR particularly for SLR beyond 50 years. At present, only 2% of the total number of dwellings in the settlement are in this high-risk category, increasing only slightly to 6% in 50 years, but increasing to over 40% within 100 years.

As shown on the top right table, depths to groundwater levels are predicted to decrease from 1 to 2 m BGL with present sea levels, to 0.5 to 1 m BGL and shallower than 0.5 m BGL at the southern wet well under predicted 100-year sea levels.

Change in the Saline Interface



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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 this figure, and indicates potentially significant saline incursion in the unconfined aquifer under the RCP 8.5+ 100yr SLR scenario.

Under the future SLR scenarios, the saline interface is predicted to migrate inland by up to 100 m, however remains over 400 m from the Leithfield water supply well under pumping conditions. Under these scenarios, no deterioration of water quality is anticipated resulting from SLR and inland migration of the saline interface.

Thank you

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