[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

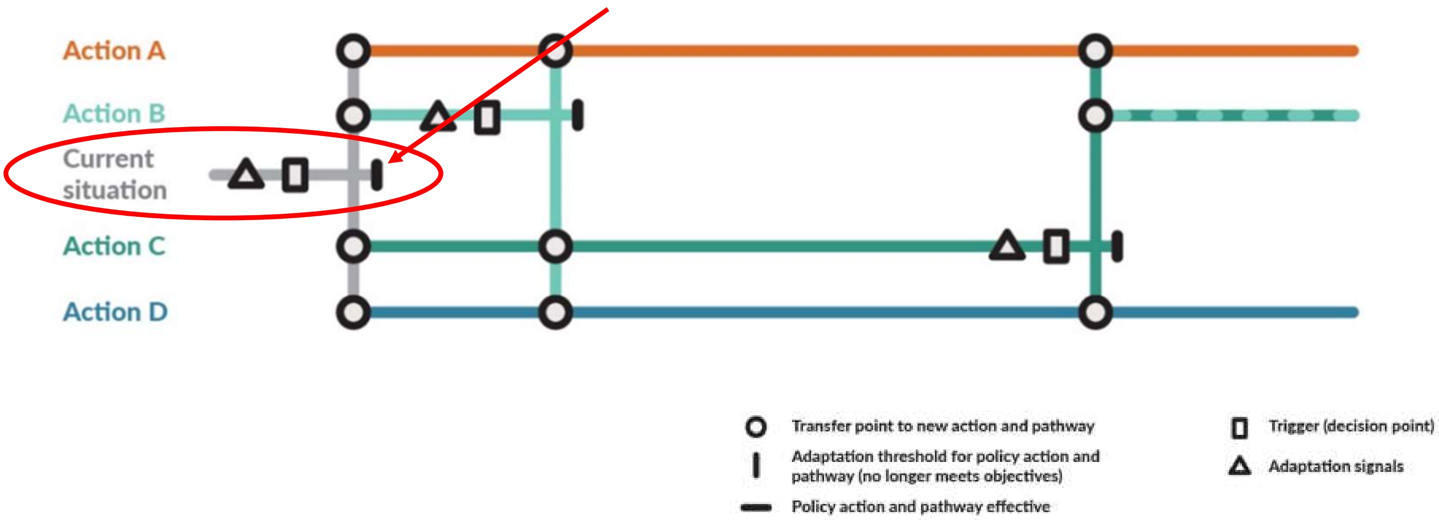
COASTAL CONVERSATIONS
The environment is changing, how will you?

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.

Phase three:
What can we do about it?



HURUNUI District Council

COASTAL CONVERSATIONS
The environment is changing, how will you?

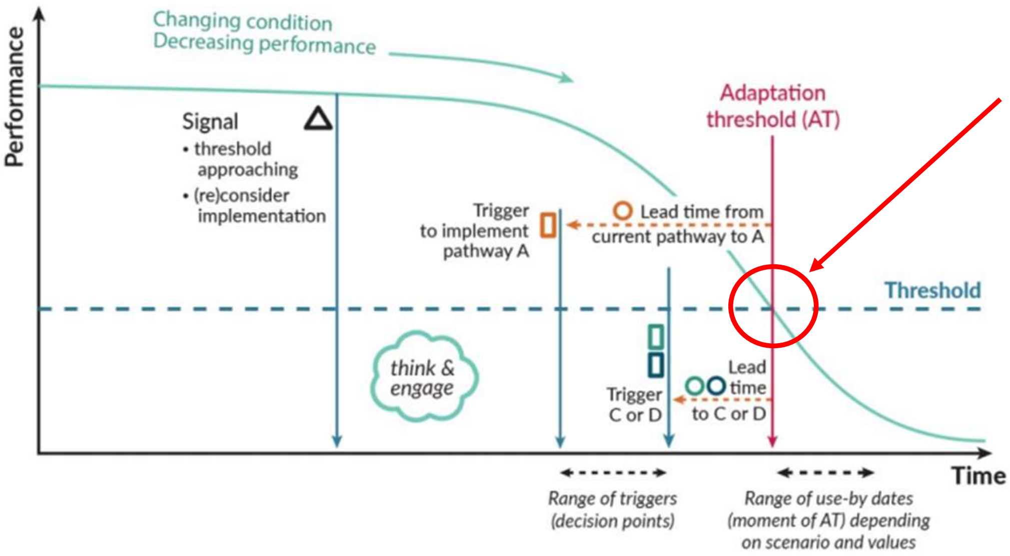
What can we do about it?

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?



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

Amberley 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.

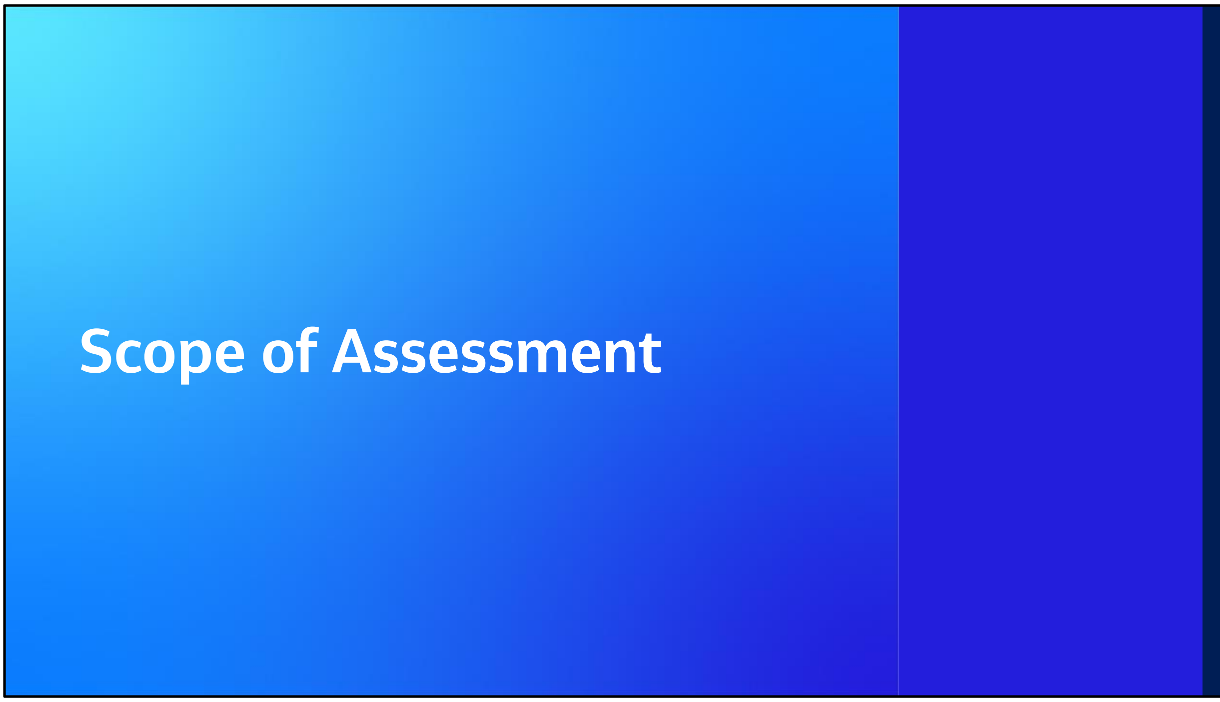
These notes will provide extra detail for the slides presented by Derek Todd of Jacobs at the "Coastal Conversations" talk held for Amberley Beach on the 16th September 2020.

Agenda

1. **Scope of the Assessment**
2. **Methodology**
3. **Results**
   - Coastal Inundation
   - Coastal Erosion
   - Groundwater

This presentation runs through the following items:

1. The scope of the Assessment
2. The methodology used to undertake the work
3. The results are broken into three main hazard areas of coastal inundation, coastal erosion and groundwater rise



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.

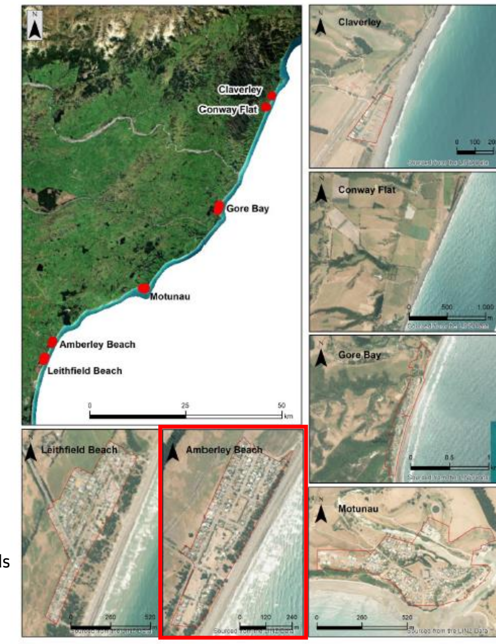
The three hazards covered in the assessment are:

- 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).

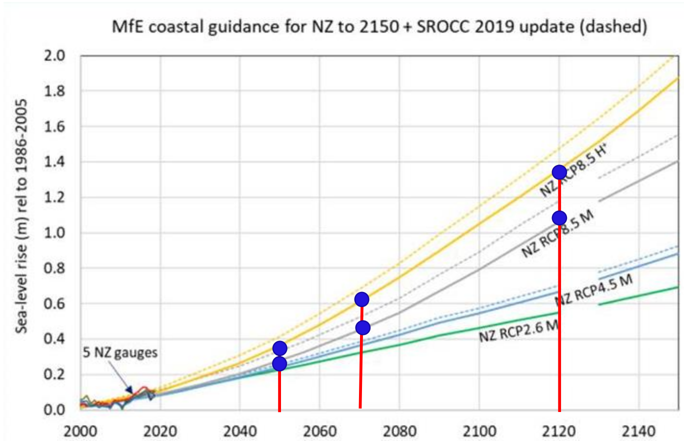
In the high-level risk assessment completed at each settlement, dwellings, properties and council infrastructure were assessed based on their intersection with the hazard footprint (e.g. whether the hazard overlays with a property). This was to give an indication of how many dwellings and properties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

Methodology

The following slides provide an overview of the methodology used. For further details refer to the Jacobs technical report that will be available through Hurunui District Council at www.hurunui.govt.nz/coastal

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 Erosion*

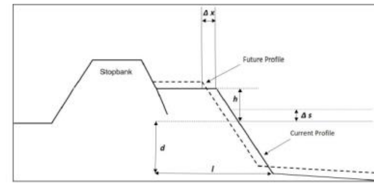
Projected Future Shoreline Position (PFSP) = (LT x T) + SL + ST

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



3. Short Term Storm Erosion

7

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:

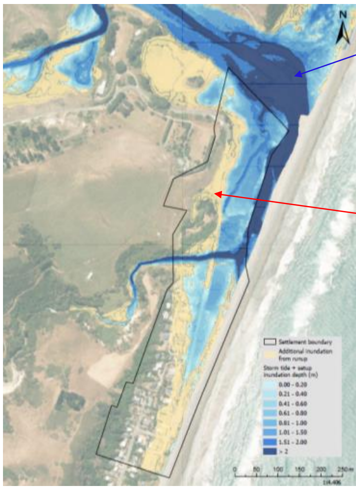
1. **Long term trend** – This is considered to ensure that the past trend at the site (e.g. accretion due to good sediment supply, or erosion due to sediment deficit) is taken into account when determining where the shoreline will be in the future. This is calculated using historical aerial imagery from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

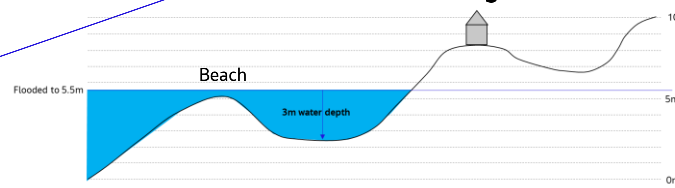
PFSP = (Long **T**erm **x T**imeframe**) + S**ea **L**evel **R**ise effect **+ S**hort **T**erm

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.

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

8

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.

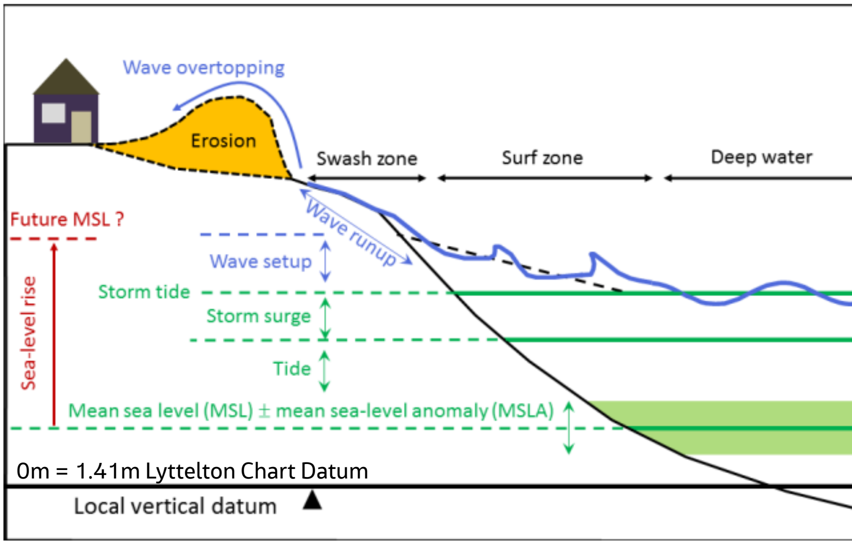
<u>Bathtub model</u>

- 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, mean high water spring tide level, 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.

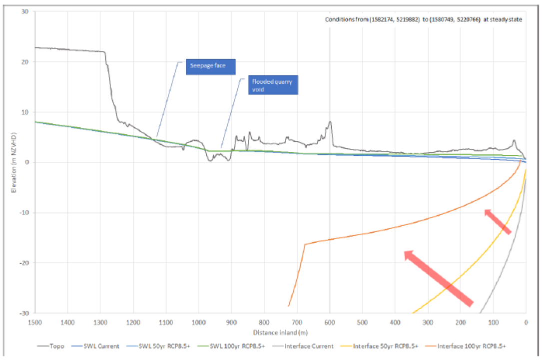
For this assessment, the combined water level used was a present day 1 in 100 year flood event combined with sea level rise for the 30, 50 and 100 year periods.

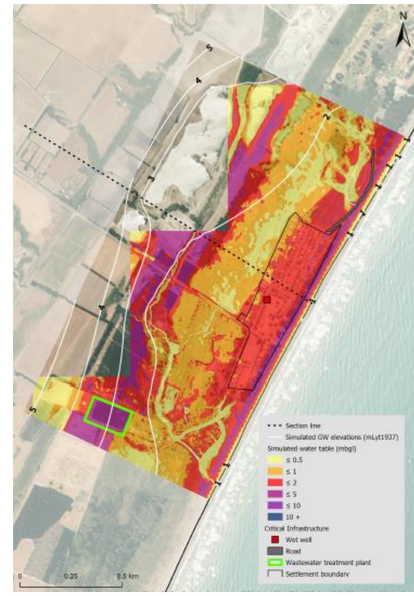


This slide shows the different components used to determine the 'static' water level – Astronomical tide, storm surge, wave setup and SLR.

Methodology – *Rising Groundwater*

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





10

This slide provides an overview of the approach used to assess the rising of shallow groundwater 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 graph on the left shows an example of the output for assessing the ingress of the saline interface, 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.

Methodology – *Risk Assessment*

Risk = Consequence x Likelihood

Consequence: The impact if the event occurs

Likelihood: 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

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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.

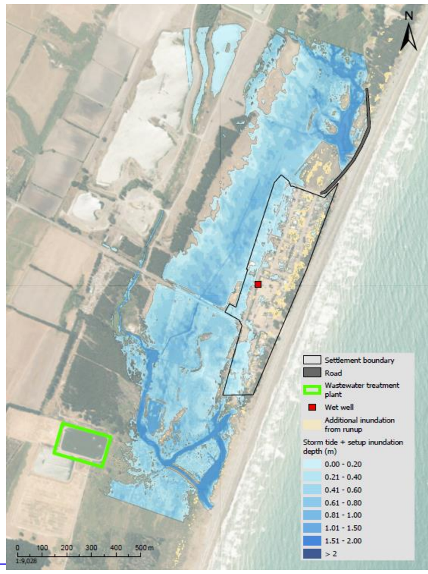
Key infrastructure at each settlement was identified by Hurunui District Council. These were different for each settlement, but included roads, wet wells and waste water treatment ponds.

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.

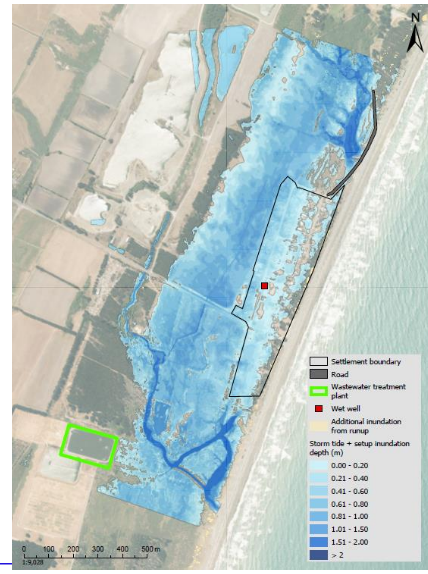
Results
Coastal Inundation

The following slides discuss the coastal inundation results.

Current Day 1 in 100 Year Storm



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



13

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 30 years (0.28m of SLR).

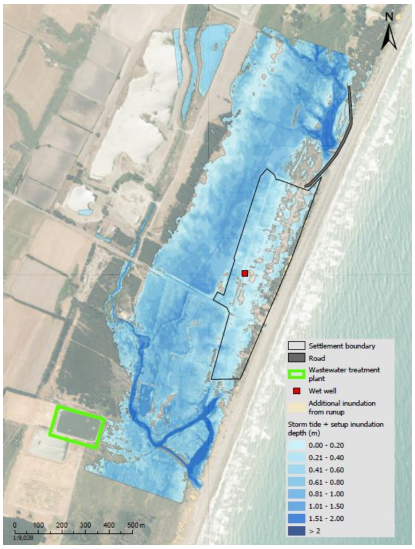
<u>Present Day 1 in 100 year storm</u>

- The map on the *left* shows the hazard footprint at the present day, with no sea level rise. This map shows that approximately 20% of the settlement could become inundated in a 1 in 100 year event. Potential inundation depths would be shallow, generally in the range 0.1-0.2m.
- Water levels are insufficient to overtop the protection bund along the settlement frontage, but can overtop the lowered beach ridge at the outlets of the coastal lagoons south and north of the settlement. These water bodies connect to the low-lying land to the west of the settlement.
- Wave run-up during this event in predicted to be able to reach elevations of 5.2 m LVD, which could overtop parts of the bund (which has an elevation of approx. 5m), which is consistent with current observations, but will only result in isolated additional shallow inundation along Chamberlain Ave.

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

- The map on the *right* shows the hazard footprint with 30 years, with 0.28m of SLR. This map shows that approximately one third of the settlement could become inundated in a 1 in 100 year event. Potential inundation depths in the order of 0.25 m and maximum depths up to 0.6 m in the north west corner of the settlement.
- Wave run-up, predicted to be able to reach elevations of 5.4 m LVD, will overtop the majority of the bund, however, the volume of water should not be sufficient to significantly increase the extent of inundation within the settlement, but could increase inundation depths.

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



Dwellings and Properties Affected:

Timeframe	Scenario	Dwellings	Properties
Total		108	138
Present Day		65	85
30-Year (2050)	RCP 8.5	88	110
50-Year (2070)	RCP 8.5	106	136
	RCP 8.5+	108	138
100-Year (2120)	RCP 8.5	108	138
	RCP 8.5+	108	138

Inundation Depth at Key Infrastructure:

Timeframe	Scenario	Wastewater Treatment Pond	Wet Well	Golf Links Road
Present Day		Not Inundated	Not inundated	0.02m
30-Year (2050)	RCP 8.5	Not Inundated	0.16m	0.21m
50-Year (2070)	RCP 8.5	Not Inundated	0.36m	0.3m
	RCP 8.5+	Not Inundated	0.49m	0.5m
100-Year(2120)	RCP 8.5	Not Inundated	0.92m	>0.6m
	RCP 8.5+	Not Inundated	1.2m	>1.2m

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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.

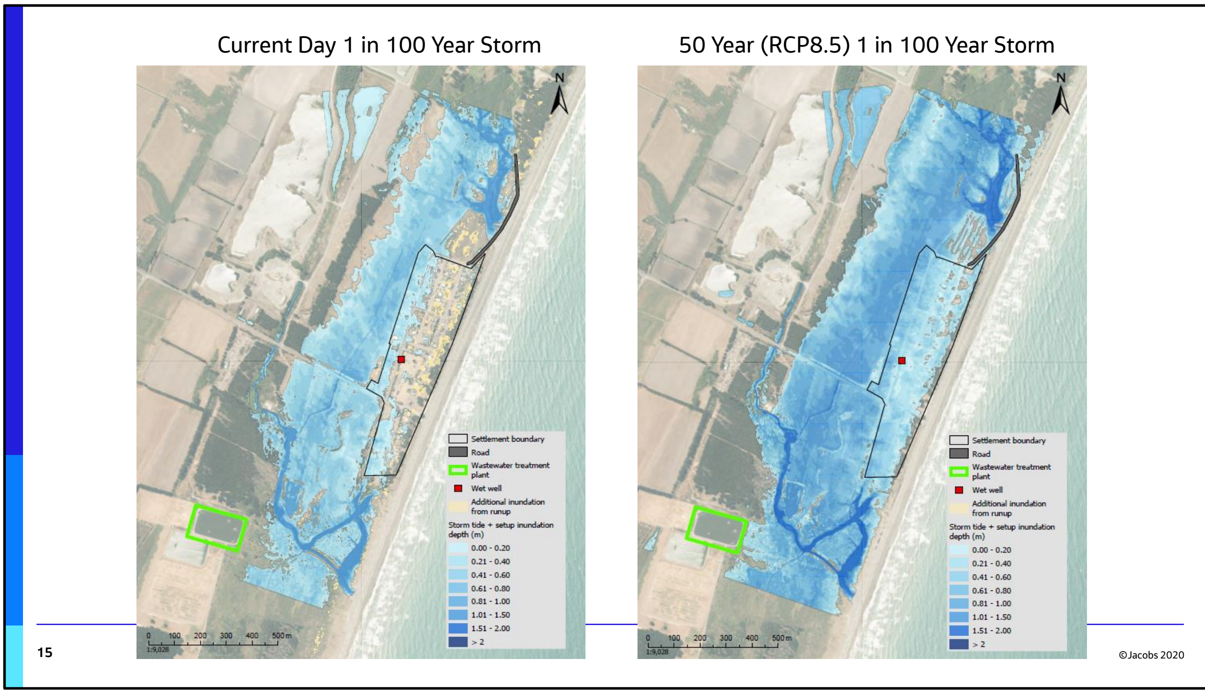
Key infrastructure at Amberley Beach that was assessed in the risk assessment was the waste water treatment pond, the wet well, and Golf Links Road.

Present Day

- As per the top right table, in a 1 in 100 year event at the present day, 65 dwellings (60%) out of 108 could be affected; and 85 properties (62%) out of the 138 could be affected.
- As per the bottom right table, Golf Links Road is the only assessed infrastructure that could be inundated, however the water depth would be very shallow (0.02m).

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

- In the 30-year scenario, 80% of property and dwellings are potentially affected. As per the top right table, in a 1 in 100 year event in 30 years, 88 dwellings out of 108 could be affected; and 110 properties out of the 138 could be affected.
- As per the bottom right table, Golf Links Road and the wet well could be inundated in this event. At the wet well, the water depth could be 0.16m. At Golf Links Road, the water depth could be in the order of 0.21m.

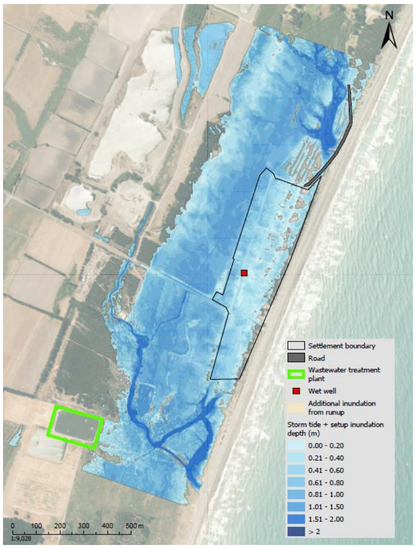


This slide shows a the results of the coastal inundation hazard at Amberley Beach for a 1 in 100 year storm for the present day (0m SLR), and in 50 years (0.45m of SLR).

<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 90% of the settlement could become inundated in a 1 in 100 year event. Potential inundation depths in the order of 0.3 m to 0.5 m , with maximum depths in the north-west corner being in the order of 1.0 m.
- The only part of the settlement footprint that is not below the 1 in 100 year static water level with this amount of SLR is a narrow strip of current backshore, however, this area will be subject to beach overtopping with wave run-up predicted to be able to reach elevations in the order of 5.7 m, and overtop the bund.

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



Dwellings and Properties Affected:

Timeframe	Scenario	Dwellings	Properties
Total		108	138
Present Day		65	85
30-Year (2050)	RCP 8.5	88	110
50-Year (2070)	RCP 8.5	106	136
	RCP 8.5+	108	138
100-Year (2120)	RCP 8.5	108	138
	RCP 8.5+	108	138

Inundation Depth at Key Infrastructure:

Timeframe	Scenario	Wastewater Treatment Pond	Wet Well	Golf Links Road
Present Day		Not Inundated	Not inundated	0.02m
30-Year (2050)	RCP 8.5	Not Inundated	0.16m	0.21m
50-Year (2070)	RCP 8.5	Not Inundated	0.36m	0.3m
	RCP 8.5+	Not Inundated	0.49m	0.5m
100-Year (2120)	RCP 8.5	Not Inundated	0.92m	>0.6m
	RCP 8.5+	Not Inundated	1.2m	>1.2m

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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.

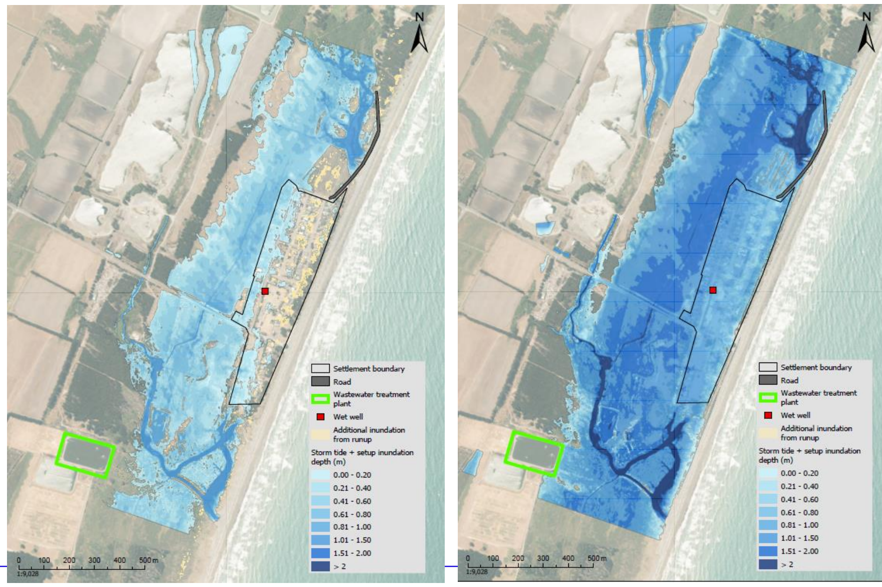
Key infrastructure at Amberley Beach that was assessed in the risk assessment was the waste water treatment pond, the wet well, and Golf Links Road.

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

- In the 50-year scenarios, all properties and dwellings are likely to be affected, with the exception of two properties and dwellings in the RCP8.5 scenario.
- As per the bottom right table, Golf Links Road and the wet well could be inundated in this event.
- At the wet well, the water depth could be 0.36m (RCP8.5) to 0.49m (RCP8.5+).
- At Golf Links Road, the water depth could be in the order of 0.3m (RCP8.5) to 0.5m (RCP8.5+).

Current Day 1 in 100 Year Storm

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



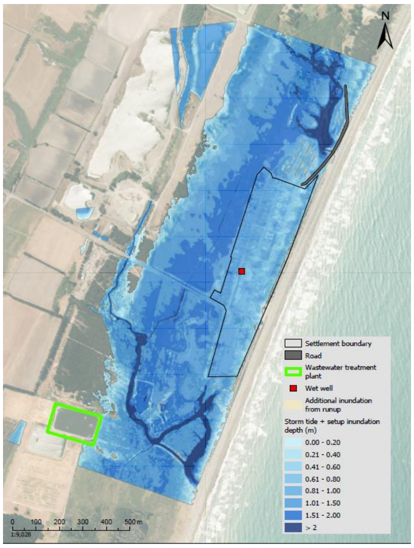
17

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 0.8 m to 1.2 m.
- While the extent of inundation within the settlement is similar to the 50-year scenarios, potential inundation depths are approximately doubled with water depths >0.7m across most of the settlement, and over 1m along the western edge (Grierson Ave).
- As these sea levels, the volume of water overtopping the beach during a high tide cycle could increase the inundation depths in the settlement by greater that 0.5 m

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



Dwellings and Properties Affected:

Timeframe	Scenario	Dwellings	Properties
Total		108	138
Present Day		65	85
30-Year (2050)	RCP 8.5	88	110
50-Year (2070)	RCP 8.5	106	136
	RCP 8.5+	108	138
100-Year (2120)	RCP 8.5	108	138
	RCP 8.5+	108	138

Inundation Depth at Key Infrastructure:

Timeframe	Scenario	Wastewater Treatment Pond	Wet Well	Golf Links Road
Present Day		Not Inundated	Not inundated	0.02m
30-Year (2050)	RCP 8.5	Not Inundated	0.16m	0.21m
50-Year (2070)	RCP 8.5	Not Inundated	0.36m	0.3m
	RCP 8.5+	Not Inundated	0.49m	0.5m
100-Year (2120)	RCP 8.5	Not Inundated	0.92m	>0.6m
	RCP 8.5+	Not Inundated	1.2m	>1.2m

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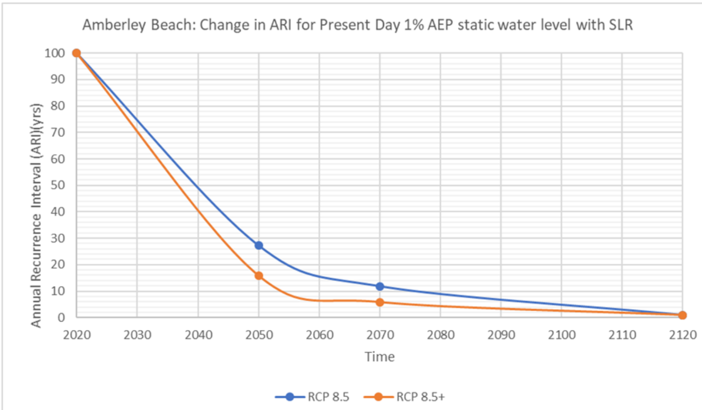
This slide shows the results of the risk assessment for the 100 year inundation hazard, the map on the right of this slide.

Key infrastructure at Amberley Beach that was assessed in the risk assessment was the waste water treatment pond, the wet well, and Golf Links Road.

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

- In the 100-year scenarios, all properties and dwellings are likely to be affected.
- As per the bottom right table, Golf Links Road and the wet well could be inundated in this event.
- At the wet well, the water depth could be 0.92m (RCP8.5) to 1.2m (RCP8.5+).
- At Golf Links Road, the water depth could be in the order of >0.6m (RCP8.5) to >1.2m (RCP8.5+).

Increase in Frequency of 1 in 100 Year Events with SLR



1 in 100 year event could occur every:

- 15-30 Years by 2050
- 6-12 Years by 2070
- Annually by 2120

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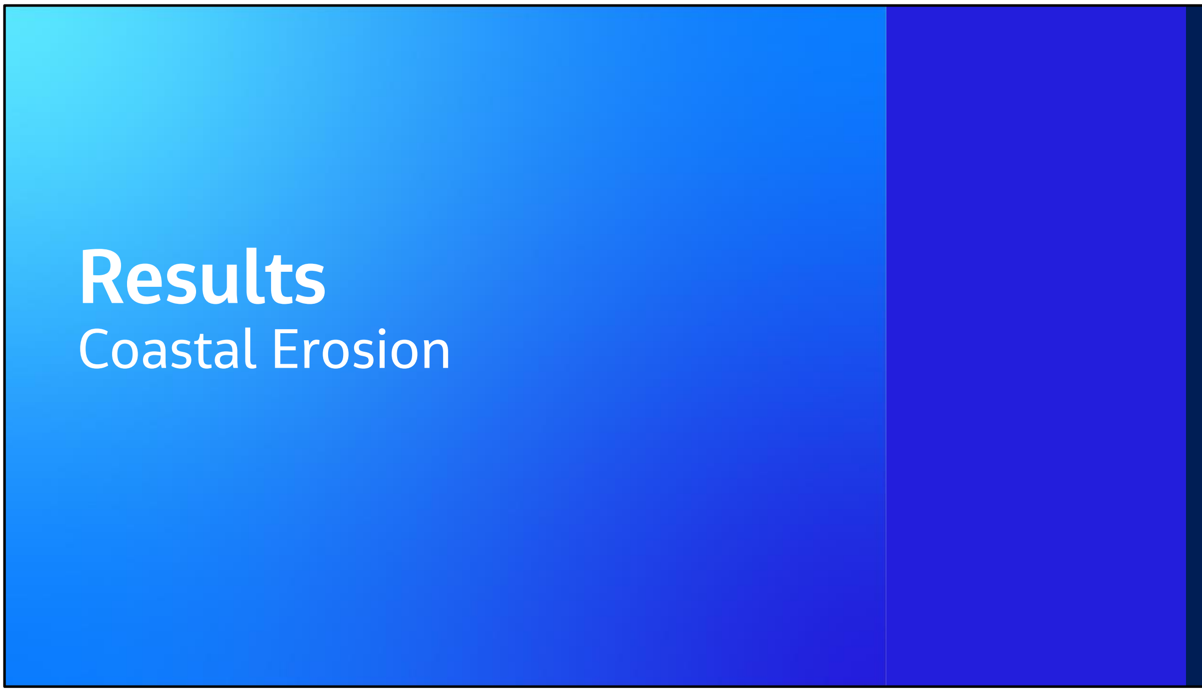
This slide shows the change in recurrence intervals of a 1 in 100 year event with sea level rise.

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.

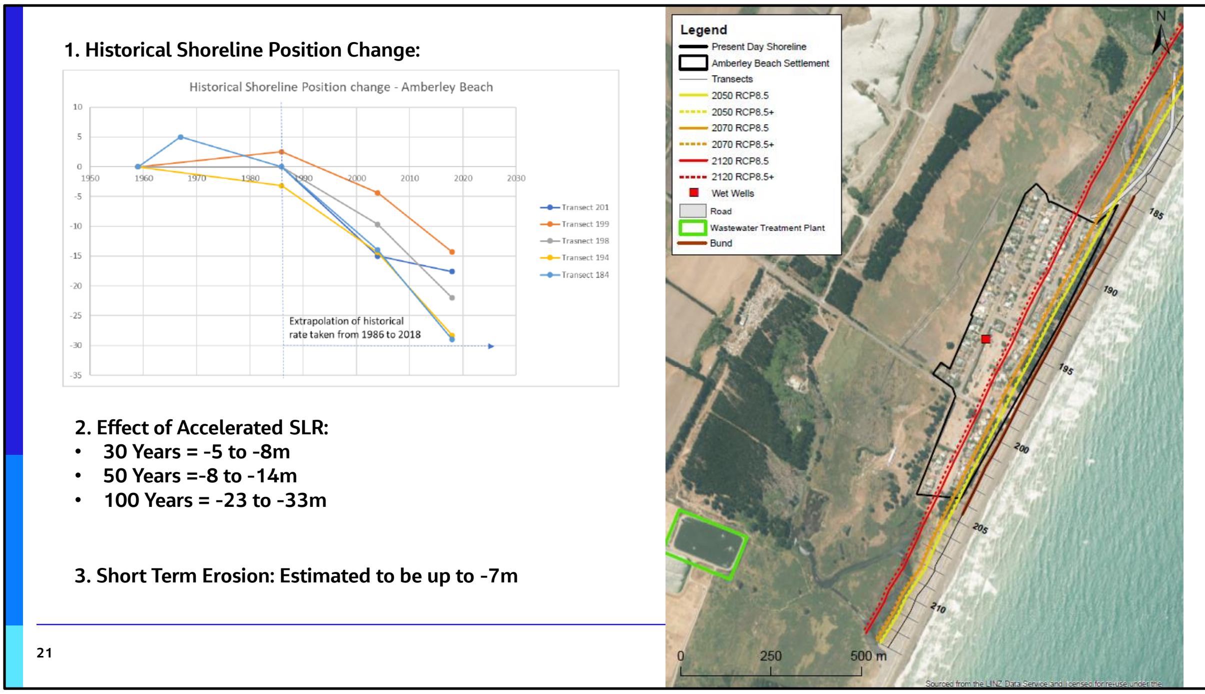
As shown in in the graph on this slide, the Annual Recurrence Interval (ARI) for the present day 1 in 100 year event with no sea level rise reduces from the current 100 years to:

- 15-30 years by 2050;
- 6-12 years by 2070; and
- Annually 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 more than three times as likely to occur in any one year by 2050, in the order of 10 times more likely to occur in any one year by 2070, and could become an annual occurrence by 2120.



The following slides discuss the coastal erosion results.



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 graph on the right shows the historical shoreline position at select locations along the Amberley Beach shoreline since the 1950s.

The long-term historical trend of shoreline movement found there was small scale accretion or stability up to 1986, followed by increasing erosion rates over time. Spatially erosion also increased to the north away from sand sediment supply from the Waimakariri and Ashley Rivers.

Shoreline retreat rates since 1986 were used for input into the Projected Future Shoreline Position.

<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 5 to 8m of erosion as a direct result of SLR;
- Over the next 50 years there could be 8 to 14m of erosion as a direct result of SLR; and
- Over the next 100 years there could be 23 to 33 m of erosion as a direct result of SLR.

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

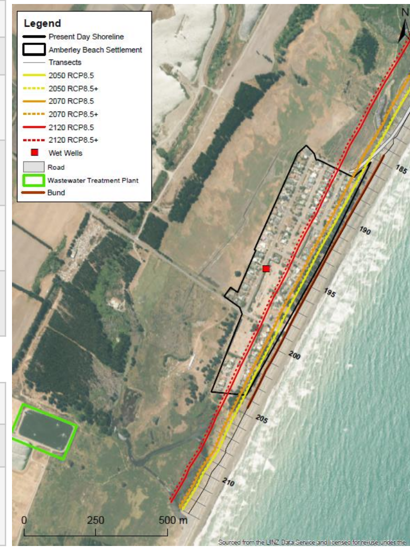
An assessment of Environment Canterbury beach profiles between 1991-2019 revealed that the maximum inter-survey erosion ranged from -6.3 to -6.6m.

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 201 (South Crescent)	-30	-32	-45	-50	-89	-98
Transect 199 (Amberley Beach Rd)	-30	-33	-46	-51	-92	-101
Transect 194 (Chamberlain Ave)	-33	-36	-51	-56	-101	-110
Transect 184 (Golf Links Rd)	-40	-43	-63	-68	-126	-135



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	138	0	0	15	15	45	45

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

<u>**Projected Future Shoreline Positions**</u>

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 -30 to -43m landward of its current position;
- In 2070, the shoreline could be in the order of -45 to -68m landward of its current position; and
- In 2120, the shoreline could be in the order of -89 to -135m landward of its current position.

At all timeframes, the extrapolation of long-term erosion will contribute the greatest percentage of the projected erosion, being responsible for 48 -72% over the next 30 years, increasing to 53-76% over a 100-year timeframe. In contrast, the contribution from accelerated SLR to the projected erosion will be 12-27% over the next 30 years, increasing to 18-38% over 100 years

<u>**Coastal Erosion Risk Assessment**</u>

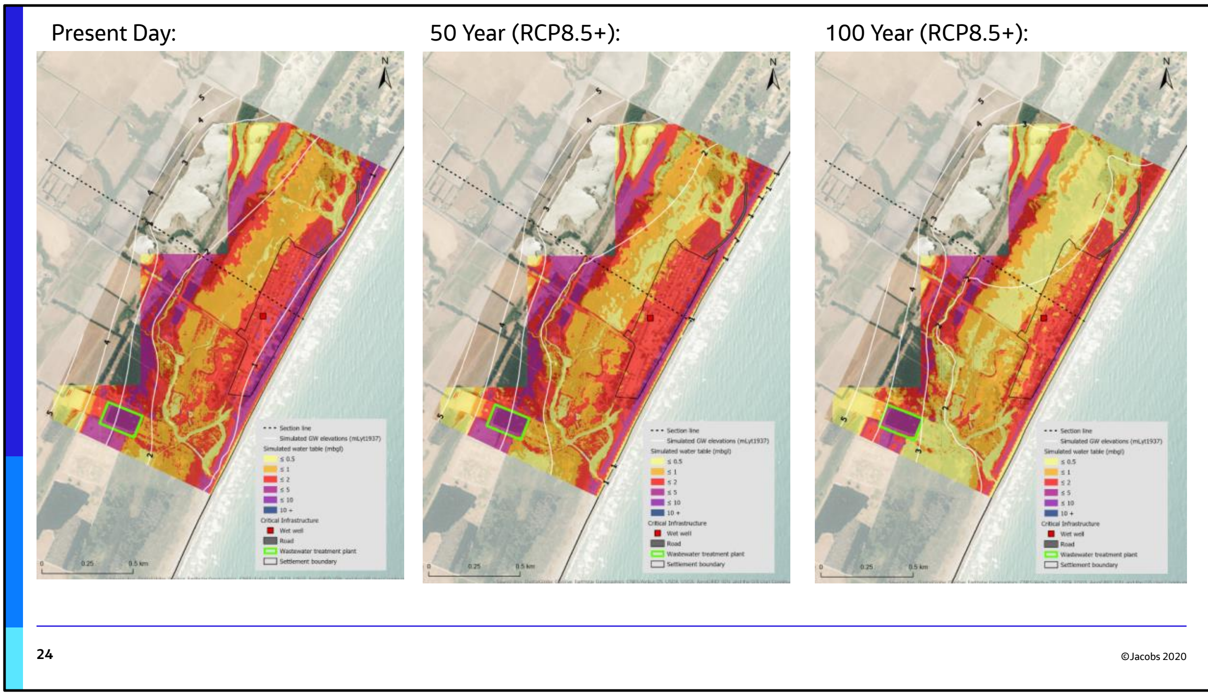
Bund: By 2050 the existing beach bund will be totally eroded and become ineffective as an inundation protection. The loss of this bund will occur even without accelerated SLR. Without maintenance, this could occur within 10-15 years with existing rates of shoreline retreat.

Properties: *A*ssuming the bund is not maintained, by 2070 there will be up to 15 properties along South Crescent and the eastern side of Chamberlain Ave affected by erosion under both SLR scenarios. By 2120, 45 properties (33% of settlement) could be affected by erosion.

Critical Infrastructure: The wastewater treatment pond and the wet well are not projected to be affected by erosion in any timeframe. The coastal section of Golf Links Road is projected to be eroded by 2050. As with the bund, this will occur even without accelerated SLR. Without maintenance of the existing erosion protection, the road could be totally lost within 10-15 years with existing rates of shoreline retreat.

Results
Rising Groundwater

The following slides discuss the groundwater results.



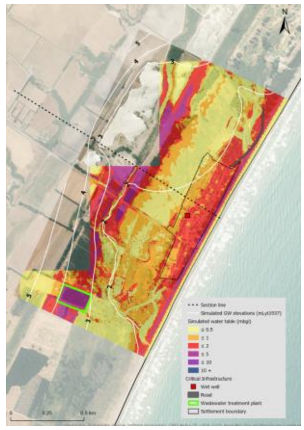
This slide shows the results of the shallow groundwater mapping in the present day, with 50 years SLR (RCP 8.5+), and with 100 years SLR (RCP 8.5+).

The map of depths to the indicative average shallow groundwater conditions at Amberley 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 there are only very limited areas in north west corner of the settlement with shallow groundwater (<1 m below ground level), and no areas within the settlement with depth to average groundwater being less than 0.5 m.
- In the 50 year scenario (SLR of 0.56 m) (centre), the results indicate that there only small increase in area along the western settlement boundary exposed to shallow average groundwater (<1m below ground level), and no areas with average groundwater < 0.5 m below ground level.
- Under the 100 year scenario (SLR of 1.3m) (right), the whole of the western margin of the settlement (e.g. west of Grierson Ave) is predicted to have average groundwater levels shallower than 1m below ground level, with some areas shallower than 0.5m below ground level in the northwest corner.

50 Year (RCP8.5+):

100 Year (RCP8.5+):



Indicative Average Groundwater Depths at Critical Infrastructure:

Infrastructure	Present day (2020)	100-year RCP 8.5+
Wet Well	1-2m	1-2m
Wastewater Treatment Plant	2-5m	2-5m

Number of Dwellings exposed to indicative average groundwater depths:

RCP 8.5+ SLR Scenario	SLR Scenario	Depth to Groundwater (m BGL)			
		≤ 0.5	0.5-1	1-2	> 2
Present Sea level (2020)	Current day	0	9	83	16
50 year (0.6 m SLR)	50 year/0.6m	1	30	77	0
100 year (1.3 m SLR)	100 year/1.3m	15	51	42	0

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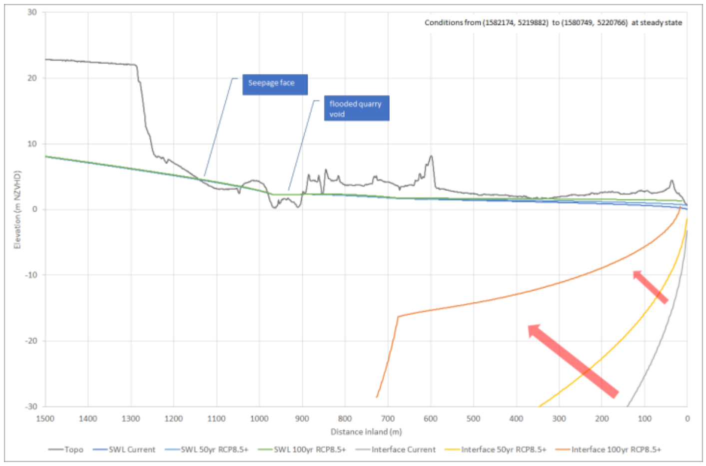
This slide presents the results of the rising shallow groundwater risk assessment.

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 dwelling predicted to be at risk from groundwater shallower than 0.5 m increases from zero to one over the next 50 years, and increases to 15 dwellings by 2120. Within this timeframe over 60% of dwellings will be subjected to average groundwater shallower than 1m below ground level, compared to 8% under the current scenario.

Predicted average groundwater depths at the critical infrastructure is presented in the table on the top right. The Amberley Wastewater Treatment Plant and wet well are not predicted to be impacted by rise a rise in shallow groundwater 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 potentially significant saline incursion in the unconfined aquifer, which propagates up to 700m inland under the 100 year (RCP 8.5+) SLR scenario.

Thank you

Jacobs

Challenging today.
Reinventing tomorrow.

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