10 October 2023

James Palmer
Secretary for the Environment and Chief Executive
Ministry for the Environment
Wellington

Tēnā koe James

I am writing to seek direction from you around the use of your Ministry's guidance documents relating to coastal hazards and climate change:

- Ministry for the Environment guidance for local government: *2017 Coastal Hazards and Climate Change*, and *2022 Interim Guidance on the Use of New Sea-level Rise Projections*; and
- It's relation to the Department of Conservations New Zealand Coastal Policy Statement 2010.

By way of introduction, the Kāpiti Coast District Council is in the progress of developing a district plan change for coastal matters. Following several years of litigation related to an attempt to introduce coastal hazards into our Proposed District Plan in 2012, the Council initiated a coastal adaptation project known as Takutai Kāpiti (circa 2020).[1] The project, which is led by an independent panel, supported by a technical advisory group, will provide Council with recommendations on coastal adaptation options in 2024. It is also expected to deliver recommendations that inform a future change to the District Plan dealing with coastal hazards.

As part of meeting legislative requirements around good community engagement via the Local Government Act 2002, we have been engaging the community in discussions around coastal hazards and coastal adaptation options to progress this work. Several interest groups in the community have raised concerns, as noted below, about the science that is being used to develop this advice, as they believe that the Ministry for the Environment and Department of Conservation advice is not consistent regarding requirements for completing this work.

[1] See https://takutaikapiti.nz/ for more information about the project.

I am writing to you as matter of urgency, as we are focused on meeting our requirements under relevant legislation (such as the Resource Management Act), to update the Coastal Environment chapter of the Operative Kāpiti Coast District Plan 2021 but face some challenges because of the points noted in this letter.

As some further brief background, the Takutai Kāpiti project is informed by modelling prepared by the consultancy firm Jacobs New Zealand ("the Jacobs Report").[2] The Jacobs Report identifies areas along the Kāpiti Coast susceptible to current and future coastal erosion and inundation under various potential magnitudes of sea-level rise over 30, 50, and 100 years. It identifies Council infrastructure, community services and private property vulnerable to those hazards. Other work is underway to assess risks to mana whenua (cultural) values, ecology, natural character and human domains.

We have received challenge from some parts of our community, including interest / advocacy groups, on the approach taken in the Jacobs Report as follows:

1. The Jacobs Report was published in February 2022, based on advice set by the Ministry for the Environment for local government. However, community concerns have been raised around the identification of coastal hazards in particular being set by inappropriate science and extremely conservative risk assessment.

2. Although independent peer reviewers from Beca and Greater Wellington Regional Council concluded that it was consistent at the time with national guidance relating to coastal hazard assessments, it was agreed that the modelling would be updated as new guidance and information is released.[3] Since publication of the Jacobs Report a number of updates have occurred to national and international guidance, including:
   - IPCC (2021) Climate Change 2021: The Physical Science Basis. Contribution of Working Group I to the Sixth Assessment Report of the Intergovernmental Panel on Climate Change.
   - NZ SeaRise Programme (2022) by Victoria University (In partnership with GNS, NIWA and Antarctic Science Platform) – we understand there is some concern that this is a draft, subject to final peer review.
   - Ministry for the Environment (2022a) Interim guidance on the use of new sea-level rise projections.
   - Ministry for the Environment (2022b) Aotearoa New Zealand's first national adaptation plan.

3. This new information prompted Council to commission Jacobs to prepare an addendum to its report responding to those changes ("Jacobs Addendum"). The draft Jacobs Addendum is provided as Attachment 1 to this letter. Council shared the draft Jacobs Addendum with Coastal Ratepayers United (CRU) for their review and comment, as a key interested party.[4] The critique from CRU, provided as Attachment 2, raises a number of issues regarding the use of national guidance in the Jacobs Report and the Jacobs Addendum including:

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[2] Background information about the Jacobs Report is available at https://www.kapiticoast.govt.nz/our-district/our-environment/coastal-adaptation/coastal-science/

[3] Jacobs Report, p.16, available at https://www.kapiticoast.govt.nz/media/pwynpxj1/coastal-hazard-technical-assessment-technical-report-volume-2-report.pdf

[4] Information about CRU can be found on its website at https://www.cru.org.nz/

- The adoption of the *NZ SeaRise Programme* work needs to be reconsidered while it remains unpublished awaiting final peer review. There are concerns around the validity of this evidence.
- Jacobs have over-relied on the Ministry for the Environment 2017 Guidance and 2022 Interim Update because they are wholly centred on IPCC pathways. This is not aligned to Department of Conservation guidance in the Coastal Policy 2010 guidance.
- There is belief that the Ministry for the Environment 2022 Interim Update is subservient to the Department of Conservation Guidance.

Council is considering what actions it might take in response to the issues raised. To inform this, we seek your feedback as the Ministry that is responsible for developing and administering national guidance that is referred to in the CRU critique. We are also seeking advice from the Department of Conservation.

Specifically, we seek advice on whether:

1. The Ministry for the Environment anticipates that local government utilise evidence from the *NZ Searise Programme*, acknowledging this may still be awaiting peer review.
2. In your view the Jacobs Report inclusive of the draft Jacobs Addendum have appropriately used national guidance.
3. There is confirmed hierarchy between the Ministry for the Environment and Department of Conservation guidance noted in this letter.

I appreciate that the nature of our inquiry is technical in nature. It is on that basis that we think it is vital to have a central government view on what is effectively a national approach. If your staff would like to discuss the detail attached to this letter, Kris Pervan (GM Strategy and Growth) is the best contact at the Council on this work. Kris can be contacted via Kris.pervan@kapiticoast.govt.nz

I look forward to your advice, at your earliest convenience.

Kind regards

Darren Edwards
Chief Executive
Kāpiti Coast District Council

Comparison of Relative Sea Level Rise projections presented in the Kāpiti Coast Coastal Hazards Susceptibility and Vulnerability Assessment Reports Volume 1 (2021) and Volume 2 (2022) with new information from more recent IPCC publications and MfE guidance.

Date:	7 June 2023
Project name:	Takutai Kāpiti
Project no:	IS355300
Attention:	Abbey Morris
Company:	Kāpiti Coast District Council
Prepared by:	Derek Todd
Document no:	IS355300-NM-MEM-0007
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1.1 Introduction

This addendum sets out the comparison of relative sea level rise projections presented in the ***Kāpiti Coast Coastal Hazards Susceptibility and Vulnerability Assessment Volume 1: Methodology (IS355300-NC-RPT-0003-1) (Section 3) and Volume 2: Results (IS355300-NC-RPT-0004-2) (Section 2.1)*** to the more recent information that has become available since modelling for the Volume 2 report was undertaken in 2021, and the Volume 2 report subsequently being released in February 2022. This information includes:

- IPCC (2021) Climate Change 2021: The Physical Science Basis. Contribution of Working Group I to the Sixth Assessment Report of the Intergovernmental Panel on Climate Change.
- NZ SeaRise Programme (2022) by Victoria University (In partnership with GNS, NIWA and Antarctic Science Platform).
- Ministry for the Environment (2022a) Interim guidance on the use of new sea-level rise projections. Wellington: Ministry for the Environment.
- Ministry for the Environment (2022b) Aotearoa New Zealand's first national adaptation plan. Wellington: Ministry for the Environment.

The IPCC (2021) report introduces the concept of Shared Socio-economic Pathways (SSP's) to replace Representative Concentration Pathways (RCP's) used in the previous IPCC (2014) SLR projections and adopted by the Ministry for the Environment (2017) *Coastal hazards and climate change: Guidance for local government*. Using the new SSP scenarios, IPCC (2021) provided updated global SLR projections, which had generally increased over a 100-year timeframe since the 2014 report. In addition to this, within New Zealand new information has been developed on local vertical land movement (VLM) around the coastline (NZ SeaRise, 2022), as well as national guidance for using the information in an adaptation planning context (MfE 2022a, 2022b). This new information therefore allows for an update of the RSLR projections for the Kāpiti Coast.

This addendum documents the new RSLR projections that have been developed for the Kāpiti Coast in light of the new information, and identifies that they are slightly different to that presented and used in the Volume 1 and Volume 2 reports. The range of RSLR used in the Volume 1 and 2 reports is still appropriate and the results are still relevant for identification of hazard susceptibility and adaptation planning purposes, however these new RSLR estimates will replace the data used to inform Table 3.2 of Volume 1 and Table 2.1 of Volume 2. This new information should be used in future coastal hazard assessment work (e.g. risk assessments for adaptation areas), and should be further updated as new information in regards to sea level

rise projections and vertical land movement becomes available. It is considered that changes to the existing work or reports are not required.

1.1.1 Addendum Structure

The structure of this addendum is as follows:

- Section 1.1 above presented an introduction and summary of this addendum.
- Section 1.2 provides a summary of the RSLR projections used in the Volume 1 and 2 reports to date for ease of understanding of the new data.
- Section 1.3 discusses the new SLR and VLM data that is available.
- Section1.4 compares the new data to that used in the Volume 1 and 2 reports, and identifies what needs to be changed or updated in future assessments.
- Section1.5 summarises the MfE (2022) *Interim guidance on the use of new sea-level rise projections* and the *National Adaptation Plan* (2022), and recommends how these may apply to future assessments as part of the Takutai Kāpiti adaptation process.
- Section 1.6 presents a summary of the above information.

1.2 Summary of projections of relative sea level rise used in the Jacobs Volume 2 report

The sea level rise projections due to climate change presented in the Jacobs Volume 1 (Table 3.2) and Volume 2 (Table 2.1) reports are based on the national projections provided by Ministry for the Environment (2017). These projections are from IPCC (2014) projections under four global greenhouse gas emissions scenarios (RCP scenarios) with a local New Zealand adjustment. These were then adjusted for an increase of 0.1 m by 2100 as a result of the interim IPCC (2019) report, which accounted for a better understanding of the contribution that the melting of the Antarctic Ice Sheet will have on global SLR.

Vertical land movement (VLM) was then added to the SLR projections to give a Relative Sea Level Rise (RSLR) projection for the Kāpiti Coast. Based on previous reports[1] which used cGPS[2] gauge records to identify VLM over the past 10-20 years for sites in Paekākāriki, Kāpiti, and Levin, an assumed range of -1 to -3 mm/yr VLM was then applied to the SLR projections to give the rates of RSLR along the Kāpiti Coast. VLM of -1 mm/yr was applied to the lower SLR scenario (RCP2.6), and -3 mm/yr was applied to the highest SLR projection (RCP8.5+) to cover the total range of RSLR possibilities.

By combining the SLR projections with the rate of VLM, the following RSLR projections reported in the Jacobs Volume 1 (Table 3.2) and Volume 2 (Table 2.1) reports are:

- For 2050 (e.g. 30 years): 0.2 m and 0.4 m
- For 2070 (e.g. 50 years): 0.3 m and 0.7 m
- For 2120 (e.g. 100 years): 0.6 m; 0.85 m; 1.25 m; and 1.65 m

[1] Beavan and Litchfield (2012); Bell and Hannah (2012); Bell et al (2018)

[2] cGPS: Continuous GPS (Global Positioning System) records provided by USA satellite system.

Figure 1 shows how the RSLR increments used in the Volume 2 assessment (black squares) relate to the RCP scenarios from MfE (2017) with VLM for the Kāpiti Coast.

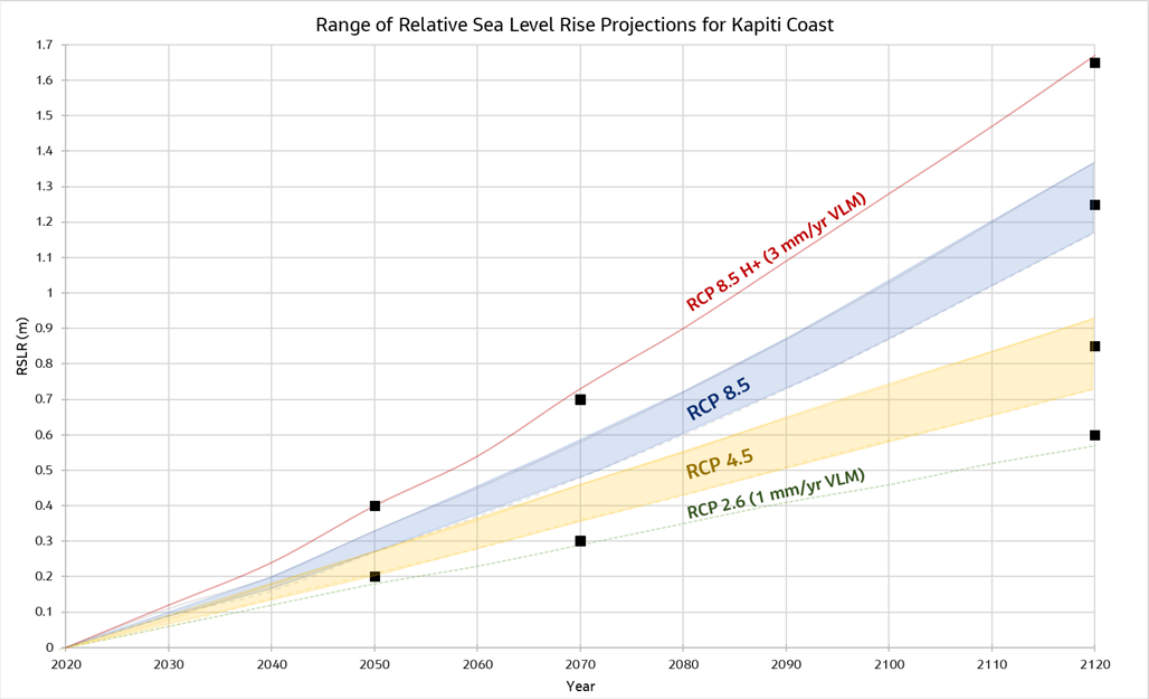


Figure 1: RSLR projections for the Kāpiti Coast from a 2020 baseline used in the Jacobs Volume 1 and 2 reports (black squares) against MfE (2017) projections with VLM component.

1.3 New information for sea level rise projections and vertical land movement

1.3.1 Updated Sea Level Rise Projections

In August 2021 the IPCC sixth assessment (AR6) was released, which moved away from the use of Representative Concentration Pathways (RCP[3]) referred to in the MfE (2017) guidance and the Jacobs Volume 1 and 2 report, to using RCP combined with Shared Socio-economic Pathways (SSP's[4]) to present projections of SLR.

IPCC (2021) presented updated global SLR projections from the previous assessments and interim reports, which supersede the projections presented in IPCC (2014); IPCC (2019) and MfE (2017). The direct comparison of the IPCC projections over the course of the most recent three reports is presented in Table 1.

[3] Representative Concentration Pathway (RCP) refers to the concentration of greenhouse gas under in the atmosphere under different emission scenarios, with the number label denoting the value of radiative forcing (W/m^2) in 2100 under each scenario

[4] Shared Scio-economic Pathways ((SSP) are scenarios of socioeconomic global change up to 2100 used to derive greenhouse gas emission scenarios under different global climate policies. As with the RCP's, the final number label denotes the value of radiative forcing (W/m^2) in 2100 under each scenario.

Table 1: Comparison of Global SLR projections from IPCC reports A5 (2014), SROCC (2019) and A6 ((2021) for the RCP-SSP 8.5 scenario from a 1995-2014 base level. Values are median values with the likely range given in brackets. Source: Table 9.8, IPCC (2021).

	RCP 8.5		SSP5-8.5
Source	**AR5 (IPCC, 2014) (m)**	**SROCC (IPCC, 2019) (m)**	**AR6 (IPCC, 2021) (m)**
Total projected SLR by 2100	0.71 (0.49-0.95)	0.81 (0.58-1.07)	0.77 (0.63-1.02)
Total projected SLR by 2150	(0.34-1.35)	1.27 (0.80-1.79)	1.35 (1.02-1.89)
Global Mean Sea Level rate 2080-2100 (mm/yr)	11.2 (7.5-15.7)	15 (10-20)	12.2 (8.8-17.7)

Following the release of IPCC (2021), the New Zealand Sea Rise "NZSeaRise" programme was released in April 2022. The projections in this online tool combine the IPCC (2021) SLR projections (downscaled to New Zealand), with localised rates of vertical land movement (VLM) at 2 km spacing along the total coastline of New Zealand to give projections of relative sea level rise (RSLR).

Figure 2 presents the difference in the updated nationally averaged SLR projections from the NZSeaRise dataset (excluding VLM) in comparison to the MfE (2017) projections, demonstrating an increase in magnitude of SLR projections since MfE (2017) across comparable climate future scenarios.

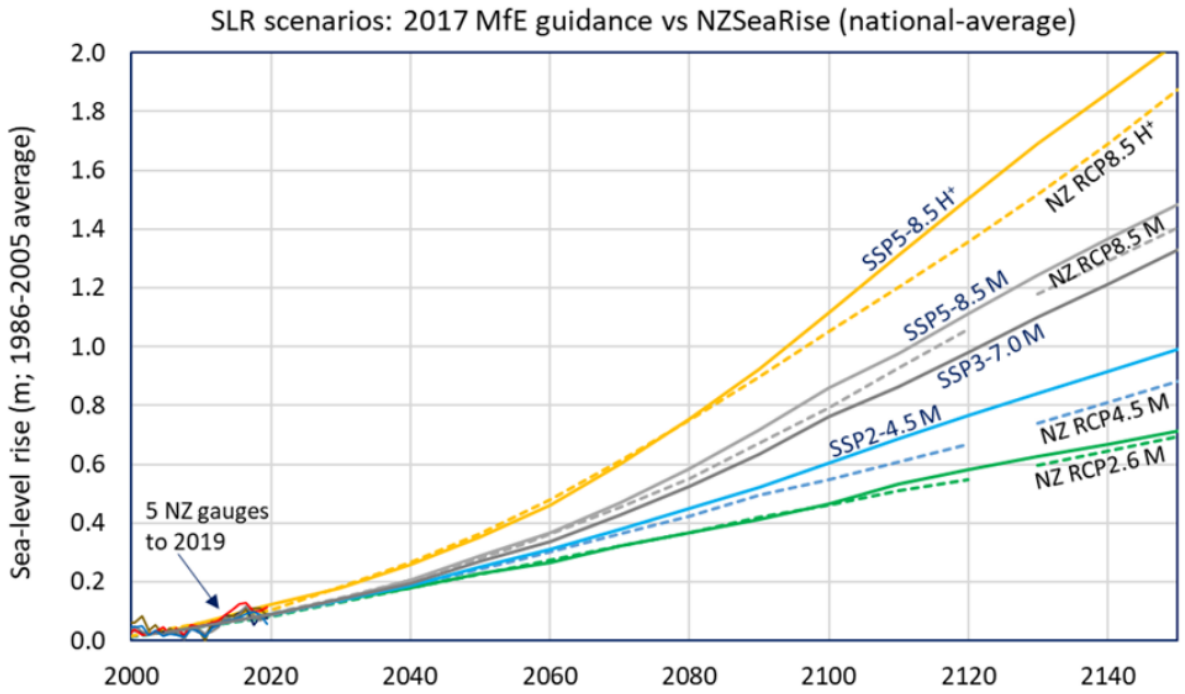


Figure 2: Comparison of the new nationally averaged NZSeaRise Projections (excluding VLM) (solid lines) with the matching equivalent suite of four sea-level rise (SLR)projections in the MfE (2017) guidance. SLR values are from a 1986-2005 zero baseline (Source: MfE, 2021).

1.3.2 New Vertical Land Movement Estimates

The inclusion of local VLM to the new SLR projections give an estimate of relative sea-level rise (RSLR), or sea-level rise relative to the local landmass. The measurements of VLM in the NZ SeaRise tool were determined using Synthetic Aperture Radar Interferometry (InSAR) data, where changes in VLM are measured

by comparing radar images from satellites as the ground moves further away (subsidence) or closer to (uplift) the satellite. The accuracy of the results was then tested against nearby GPS readings.

The VLM presented in the NZSeaRise tool is the median VLM taken from a short record of satellite imagery (2003-2011), with the assumption that land movements which occurred over this timeframe will continue into the future. There are several limitations with the dataset which should be recognised:

- The period over which these observations were taken is short and excludes some major tectonic events which have affected land levels, such as the 2016 Kaikoura Earthquake. With it being such a short timeframe of information, there is some uncertainty in how this should be extrapolated into the future.
- The information accounts for VLM along the coastline, but does not consider how VLM will change inland where coastal hazards such as coastal flooding and groundwater rise will impact coastal communities. There can be large variability in the VLM within the 2 km radius alongshore, and it is unknown how the VLM translates inland.

It is likely that this information will change and be updated as the record of satellite imagery increases, just as SLR projections will be updated when the next IPCC report is released in its next cycle.

Figure 3 shows a screen capture of the NZSeaRise data across the Kāpiti Coast District, with a total of 21 sites within the district boundaries. As shown in the inset of Figure 3, the average of the median VLM across the 21 sites is -1.07 mm/yr. The total range of median VLM is between 0 mm/yr to -1.75 mm/yr; with 50% of sites having medium VLM within -0.8 to -1.4 mm/yr.

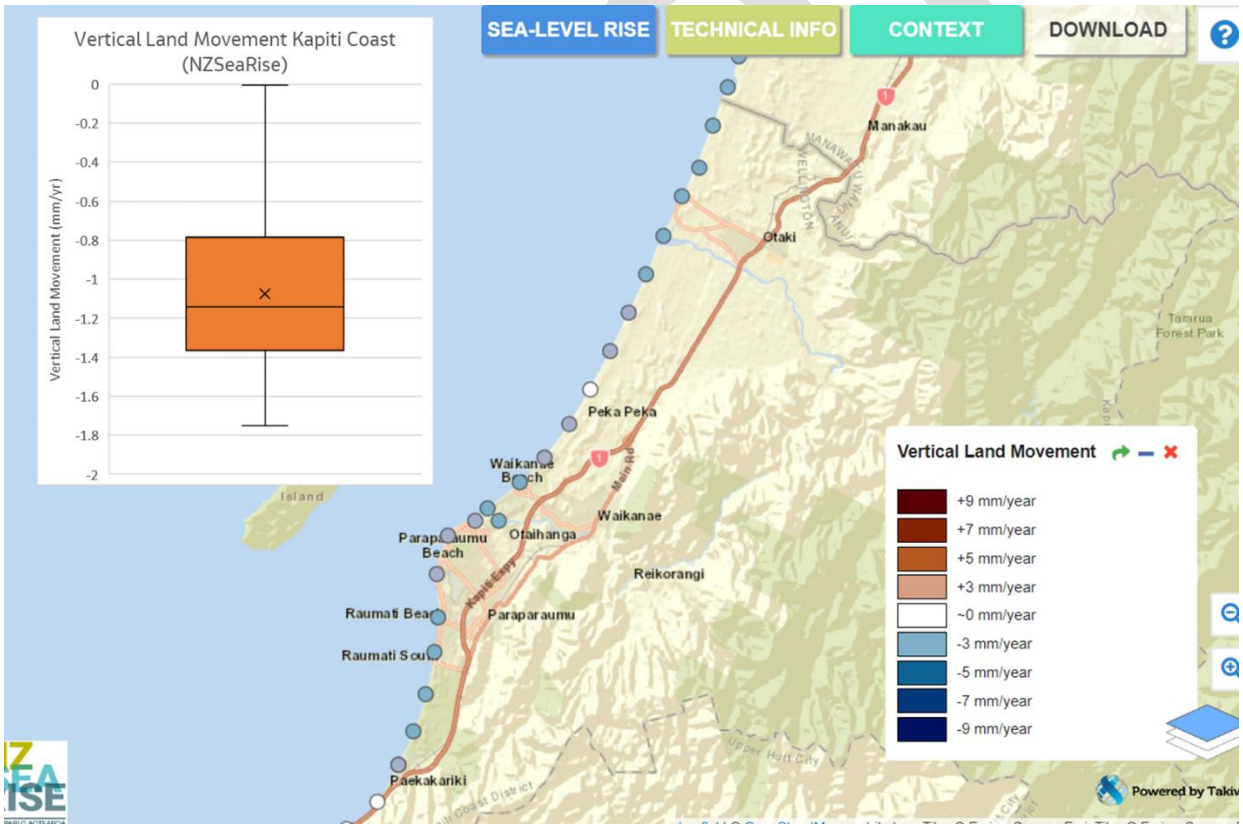


Figure 3: Screenshot of the NZ SeaRise sites on the Kāpiti Coast. Inset shows a box and whisker plot with the maximum and minimum median values being the extents of the whiskers, the central line being the median, and the 'X' being the mean value.

Additional data can be extracted from the NZ SeaRise tool to provide information at each site, including the maximum and minimum observations of VLM over the 2003-2011 record. As shown in Figure 4, minimum VLM observations (i.e. maximum subsidence) can be up to -3.6 mm/yr (site 2580), and maximum

observations (i.e. maximum uplift) can be up to +0.48 mm/yr (sites 2583, 2587-2590), with the maximum values showing low rates of uplift at most sites.

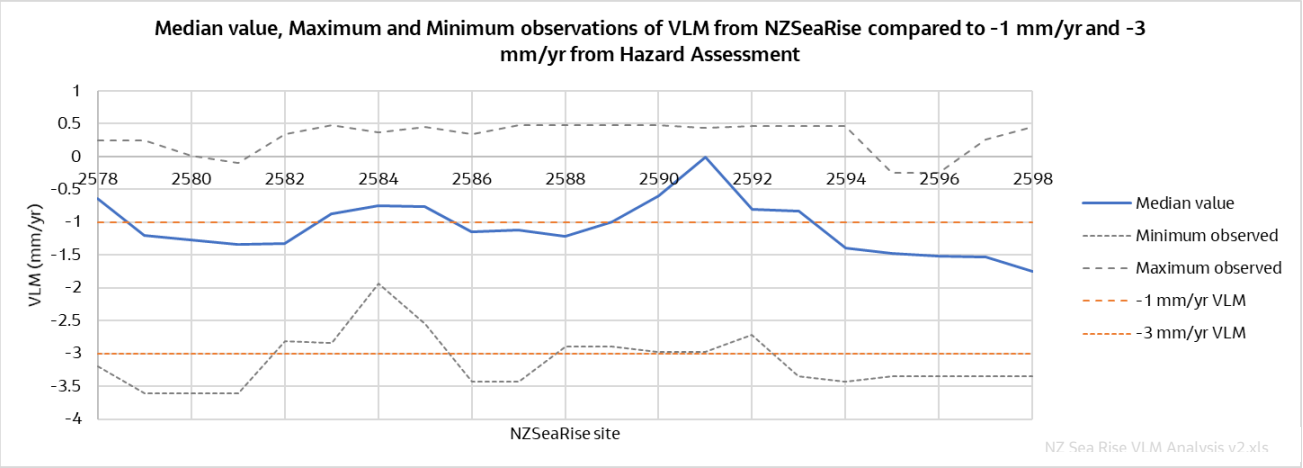


Figure 4: Median VLM compared to minimum and maximum observations at the sites.

The Jacobs Volume 1 and 2 reports used a range of -1 to -3 mm/yr of vertical land movement as a result of the available information at the time. As indicated in Figure 4, the lower VLM rate of -1 mm/yr used in the Jacobs assessment is closely aligned to the average of the median VLM rates measured across the district from the NZ SeaRise tool. The upper rate of VLM used in the Jacobs assessment could be considered to be conservative relative to the median dataset, however observations over the eight year period (2003-2011) have shown maximum subsidence rates can be in the order of -3 mm/yr and therefore it is not an unrealistic estimate of VLM to include in stress testing the impacts of the upper estimates of RSLR.

The MfE (2022a, page 14) states that in regions "*where the RSLR are broadly similar, rates can be averaged*". We consider the range of subsidence to across the Kāpiti Coast District be broadly similar (e.g. all sites are subsiding, within a 0.6 mm/yr range), and therefore it is appropriate to apply an averaged VLM for the district across all sites.

In light of this new information, we recommend that RSLR used in future assessments of coastal hazards on the Kāpiti Coast should use a rounded VLM of -1 mm/yr. However, the results of the Volume 2 report should still be utilised to stress test a high RSLR scenario for the possible -3 mm/yr VLM combined with sea level rise.

1.4 Comparison to RSLR Estimates Used in the Volume 2 Report

Table 2 presents the 10 yearly projections of RSLR from a 2020 base date incorporating a -1mm/yr VLM for three of the IPCC (2021) scenarios (SSP1-2.6, SSP2-4.5, SSP5-8.5), and the most extreme upper New Zealand scenario termed SSP5-8.5(H+), which is the 83rd percentile of the SSP5-8.5 scenario.

Figure 5 below presents these RSLR scenarios against the RSLR increments presented in the Jacobs Volume 1 and 2 reports. This figure demonstrates that the upper RSLR estimates presented in these reports are slightly above the updated RSLR projections due to the following reasons:

- The SLR projections used in the Jacobs Reports comprised of MfE (2017) projections with an adjustment of 0.1 m SLR at 2100 in light of the IPCC (2019) interim report and were rounded to the nearest 0.05m;
    - The new projections use the IPCC (2021) projections for SSP-RCP scenarios, with a localised New Zealand adjustment.
- The VLM used for the upper RSLR projection (RCP8.5H+) in the Jacobs reports was -3 mm/yr;

- The new projections shown in Figure 5 use only the lower -1 mm/yr VLM, which is aligned with the average median VLM (1.07 mm/yr) across the 21 NZ SeaRise sites in the Kāpiti District.

Table 2: SLR Projections from NZSeaRise with -1 mm/yr VLM (from 2020 base).

	Relative Sea Level Rise from 2020 (m)			
Year	**SSP1-2.6 + VLM**	**SSP2-4.5 + VLM**	**SSP5-8.5 + VLM**	**SSP5-8.5 (H+) + VLM**
2020	0	0	0	0
2030	0.05	0.05	0.06	0.07
2040	0.11	0.11	0.13	0.16
2050	**0.16**	**0.19**	**0.22**	**0.27**
2060	0.22	0.26	0.31	0.39
2070	**0.28**	**0.34**	**0.43**	**0.54**
2080	0.34	0.42	0.55	0.71
2090	0.39	0.5	0.7	0.89
2100	0.45	0.59	0.85	1.1
2110	0.53	0.69	0.98	1.31
2120	**0.58**	**0.77**	**1.13**	**1.51**
2130	0.64	0.86	1.27	1.71

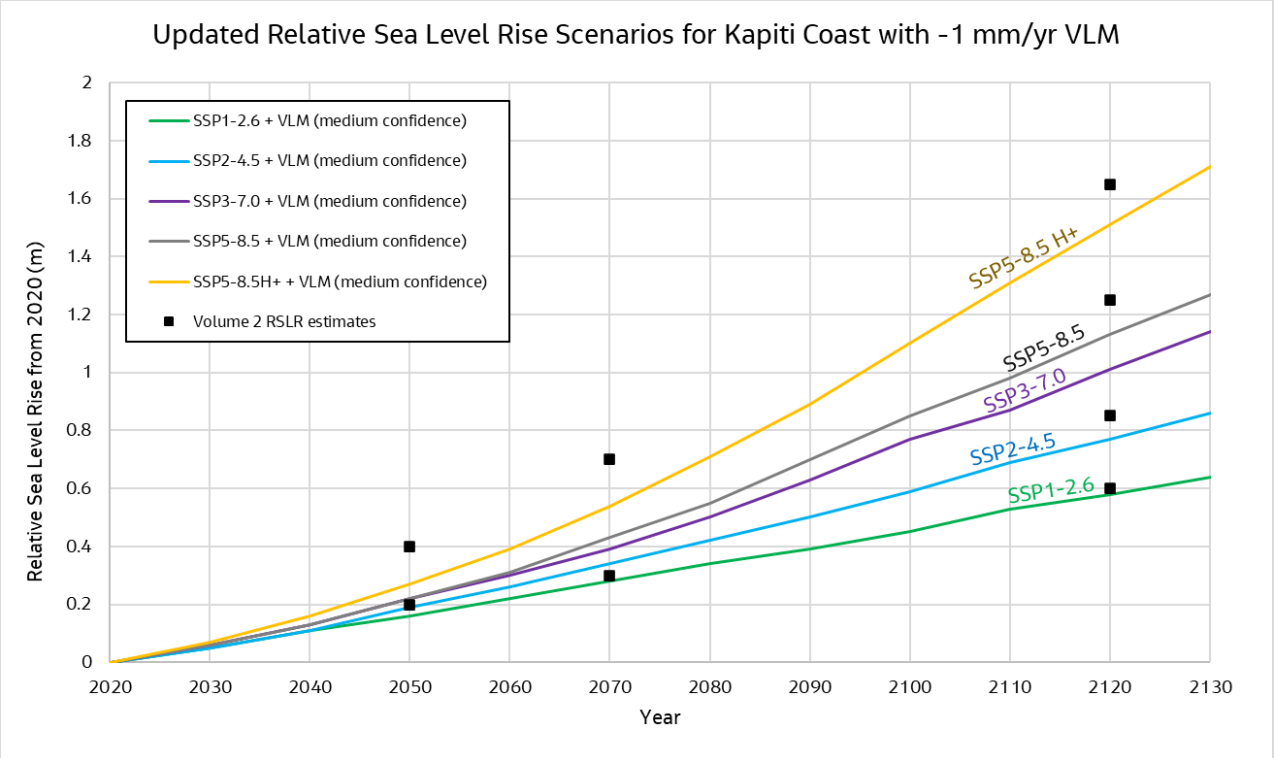


Figure 5: Updated RSLR projections from NZSeaRise tool with -1 mm/yr VLM, shown against RSLR estimates used in the Volume 2 report.

The Jacobs Volume 2 report used a -1 mm/yr VLM for the lower RCP2.6 scenario, hence the lower projections are still well aligned (green line in Figure 5). However, as can be seen in Figure 5, the upper RSLR increments from the Volume 2 report now sit above the SSP5-8.5 H+ projection with -1 mm/yr VLM by an average of 0.15 m across all three timeframes.

The increments of RSLR used in the Jacobs Volume 2 report encompass the full range of the SSP-RCP scenarios which are recommended in recent MfE publications to be considered in both land-use planning and adaptation planning (see following sections). It is recognised that the upper bound RSLR scenario from the Volume 2 report could be considered conservative in light of new information on VLM. However, we do not recommend updating the results of the Volume 2 report as the upper estimates are still considered to be representative of the total range of SSP scenarios that should be used to 'stress test' adaptation options.

1.5 Updates from Ministry for the Environment (2022a, 2022b)

Since the release of the Jacobs Volume 2 report, Ministry for the Environment (MfE) have produced two documents relevant to establishing the RSLR scenarios to be used in the Takutai Kāpiti project. These will be applied when completing further hazard assessment work (planning and adaptation) in the next phase of the project. These key information from these reports are summarised below.

1.5.1 MfE (July, 2022) Interim guidance on the use of new sea-level rise projections

The purpose of this document was to provide an update of the MfE (2017) guidance associated with the new SLR projections produced in the NZ SeaRise programme and supersedes Sections 5.3-5.7 of the 2017 guidance document.

Key recommendations from this document relevant to Takutai Kāpiti include:

- The use of the "medium confidence" SSP scenarios out to 2150, excluding the SSP1-1.9 scenario (e.g. SSP2-2.6, SSP2-4.5, SSP3-7.0, SSP5-8.5).
- The 83rd percentile of the SSP5-8.5 scenario (i.e. equivalent of the previous MfE (2017) RCP8.5H+ scenario) should be used to stress-test plans, policies and adaptation options, and for risk screening to determine coastal areas "potentially affected" [Policy 24, NZCPS].
- In areas where local subsidence is more accurately known or is being monitored, the SSP scenarios from NZSeaRise without VLM should be used, and the additional known VLM should then be added.
- Where VLM rates are broadly similar across a region, RSLR projections could be averaged across sites.
- For ongoing development of DAPP strategies to adapt existing development, this interim guidance should be used to determine which projections to apply. Adaptive pathways that emerge should use the range of future RSLR "medium confidence" projections provided from NZSeaRise to cross-check the realistic lifetime of adaptation options that make up the DAPP pathways.
- An update to the minimum transitional procedures of RSLR allowances (Table 3). This provides guidance for when the new information should be used in relation to project stage, where Takutai Kāpiti is considered to be an 'Ongoing DAPP project' (Table 3).

Table 3: Updates to the minimum translational procedures of RSLR allowances (source: MfE (2022a, Table 3)

Category	Description	RSLR allowances to use
A	Coastal subdivision, greenfield developments, and major new infrastructure	• Avoid new hazard risk by using "medium confidence" sea-level rise out to 2130 for the **SSP5-8.5 H+** (83rd percentile SSP5-8.5 or p83) scenario that includes the relevant VLM for the local/regional area. • Check the lifetime and utility of new developments using the median RSLR projections for the "low confidence" SSP scenarios out to 2150 and beyond.
B	Changes in land use and redevelopment (intensification)	• Adapt to hazards by conducting a risk assessment using the range of updated "medium confidence" RSLR scenarios (including VLM) out to 2130 with the dynamic adaptive pathways planning approach; or if a more immediate decision is needed: • Avoid new and increased hazard risk by using "medium confidence" sea-level rise out to 2130 and the **SSP5-8.5 H+** (83rd percentile SSP5-8.5 or p83) scenario that includes the relevant VLM for the local/regional area
C	Land-use planning controls for existing coastal development and assets planning. Use of single values at local/district scale transitional until dynamic adaptive pathways planning is undertaken	Use the **SSP5-8.5 M** scenario out to 2130, which includes the relevant VLM for the local/regional area
D	Non-habitable, shortlived assets with a functional need to be at the coast, and either low-consequences or readily adaptable (including services)	Use the **SSP5-8.5 M** scenario out to 2090 that includes the relevant VLM for the local/regional area.

Table 4: Table outlining when new information should be used in relation to a project stage (Soure: MfE, (2022a) Quick reference guide)

Project stage	Actions
New projects; or those at an early stage	Use updated NZSeaRise scenarios recommended in this interim guidance
Projects at a later stage	Continue to use scenarios recommended in the 2017 guidance, but stress test with VLM to understand how this impacts adaptation thresholds and timing.
Ongoing Dynamic Adaptive Planning Pathway (DAPP) projects	Use updated NZSeaRise scenarios recommended in this interim guidance from now and use all five "medium confidence" scenarios for adaptive pathways.

1.5.2 MfE (August, 2022) Aotearoa New Zealand's first national adaptation plan.

This document sets out Aotearoa New Zealand's long-term strategy and first National Adaptation Plan (NAP), which sets out the Government's approach to adaptation. This first national adaptation plan, and subsequent plans, will be prepared and implemented in accordance with this strategy. It is the first in a series of national adaptation plans that will be prepared every six years, where each plan will respond to a new national climate change risk assessment.

Two key recommendations from the NAP relevant to the Takutai Kāpiti project are:

- to screen for hazards and risks in coastal areas, use the Shared Socioeconomic Pathway scenario for fossil fuel intensive development (SSP5-8.5);
- for detailed hazard and risk assessments in coastal and non-coastal areas, use both the middle-of-the-road scenario (SSP2-4.5) and the fossil fuel intensive development scenario (SSP5-8.5) to 2130, for areas at high risk of being affected, adding the relevant rate of vertical land movement locally.

1.5.3 Summary of Guidance Updates

There are some differences between the two documents in relation to what is recommended for use in coastal planning, land use management, and adaptation planning; depending on the stage of the project.

In applying these documents in the context of the Takutai Kāpiti project, we have interpreted the guidance as follows:

- For a detailed hazard and risk assessment (e.g. the adaptation area risk assessments), the SSP2-4.5 and SSP5-8.5 scenarios should be assessed, as per the (MfE, 2022b) *Aotearoa New Zealand's first national adaptation plan.*
- For adaptation planning when DAPP's are being developed, pathways should be tested against the total range of RSLR scenarios to understand potential changes of timeframes and success in applied options, as per the MfE (2022a) *Interim guidance on the use of new sea-level rise projections.*

In line with the National Adaptation Plan, the SSP2-4.5 and SSP5-8.5 scenarios have been adopted for the risk assessments produced for each adaptation area. As with the previous assessments, the adopted projections for 2050, 2070, and 2130 are from a 2020 base date and have been rounded to the nearest 0.05 m. The resulting RSLR projections from a 2020 base date are presented in Table 5 below, along with the RSLR projections presented in the Jacobs Volume 2 assessment for comparison purposes.

Given the encapsulation of the SSP1-2.6 and SSP5-8.5 H+ scenarios in the results of the Volume 2 assessment, the Volume 2 results will be used to represent the total range of RSLR scenarios for stress testing DAPP developed by the CAP and potential land-use planning controls to be included in a future district plan change for coastal hazards.

Table 5: RSLR projections to be applied in Risk Assessments for each Adaptation Area, with comparison with projections presented in the Jacobs Volume 2 report. All projections are from a 2020 base data.

SSP-RCP Scenario	RSLR to be applied in Adaptation Area Risk Assessments			RSLR presented in Jacobs volume 2 Report		
	2050	2070	2130	2050	2070	2120
RCP2.6				0.2	0.3	0.6
SSP2-4.5	0.2	0.35	0.85			0.85
SSP5-8.5	0.2	0.45	1.25			1.25
SSP5-8.5H+				0.4	0.7	1.65

As can be seen from Table 5, the maximum timeframe projections have changed from 2120 in the Jacobs Volume 2 assessment to 2130 in the Risk Assessments. This is due to both MfE (2022a) and (2022b) pushing the longest time frame projections for coastal adaptation and land use planning out to 2130. However, as can also be seen from Table 5, this has not altered the absolute magnitude of RSLR projections applied over this 100+ year timeframe. This is due to the reduction in the VLM component of the RSLR, dropping from 2

mm/yr for these intermediate RSLR projections in the Jacobs Volume 2 assessment to 1mm/yr for the RSLR projections applied in the risk assessment.

As a result, the extent and depths modeled to be impacted by coastal inundation for the intermediate projections in the Volume 2 assessment and the projections over the maximum timeframe applied in the Risk Assessments are the same, since the time required to reach the RSLR projection has no bearing on the resulting inundation.

However, for coastal erosion, there are differences in the net Projected Future Shoreline Position (PFSP) with the difference in maximum timeframe, largely due to the 10-year difference in the time period of extrapolation of the historical long-term rate. These differences in PFSP are generally small, in the order of 10 m for the 1.25 m RSLR scenario, and less for the 0.85 m RSLR scenario. In some areas, such as the Northern Adaptation Area, the differences are positive, with less erosion projected to 2130, and in others such as in Paekākāriki, they are negative, with more erosion projected to occur to 2130.

1.6 Summary

In light of this new information and guidance, we recommend that future coastal assessments undertaken as part of Takutai Kāpiti project adopt the following RSLR and guidance measures:

- RSLR projections for the Kāpiti Coast District (including a rounded 1 mm/yr VLM) from the NZSeaRise tool presented in Table 2 will be used.
- In aligning with the National Adaptation Plan, SSP2-4.5 and SSP5-8.5 should be used for undertaking risk assessments for each adaptation area.
- Results presented in the Volume 2 represent the total range of SSP scenarios and VLM in the Kāpiti Coast, are still considered to be appropriate for use. The results from Volume 2 should be used to stress test DAPP developed by the CAP against the total range of RSLR scenarios, as per the MfE (2022a) Guidance.
- The intermediate values of RSLR for 2120 presented in the Jacobs Volume 2 report of 0.85 m and 1.25 m are the same magnitudes as RSLR by 2130 applied in the Risk Assessments. Therefore, there is no difference in the extent or depths of coastal inundation presented in the different reports for these maximum timeframes. However, for coastal erosion there are small differences to the PFSP, largely due to the extrapolation of the historical long-term rate being applied over slightly longer timeframes.

Any additional mapping of coastal erosion and coastal inundation that is undertaken using the projections in Table 5 will be uploaded to the web-viewer as it becomes available.

1.7 References

Beavan and Litchfield (2012) Vertical land movement around New Zealand coastline: implications for sea level rise. GNS Science.

Bell, R.G., Hannah, J. (2012). Sea-level variability and trends: Wellington Region. NIWA Report prepared for Greater Wellington Regional Council, June 2012.

Bell R.G., Denys P. Hannah J. (2018). Update on relative sea-level rise and vertical land motion: Wellington region. NIWA report prepared for Greater Wellington Regional Council, December 2018.

IPCC (2013). Climate Change 2013: The Physical Science Basis. Contribution of Working Group I to the Fifth Assessment Report of the Intergovernmental Panel on Climate Change.

IPCC (2019). Special Report on the Ocean and Cryosphere in a Changing Climate: Summary for Policymakers. Report of the Intergovernmental Panel on Climate Change.

IPCC (2021) Climate Change 2021: The Physical Science Basis. Contribution of Working Group I to the Sixth Assessment Report of the Intergovernmental Panel on Climate Change.

Ministry for the Environment (2017) Coastal Hazard and Climate Change Guidance to Local Government.

Ministry for the Environment (2022a) Interim guidance on the use of new sea-level rise projections. July 2022.

Ministry for the Environment (2022b) Urutau, ka taurikura: Kia tū pakari a Aotearoa i ngā huringa āhuarangi Adapt and thrive: Building climate-resilient New Zealand. Aotearoa New Zealand's First National Adaptation Plan. August 2022.

Critique of Jacobs' Draft Addendum – 7 June 2023

Jacobs' Document IS355300-NM-MEM-0007

Coastal Ratepayers United Inc.

29 June 2023

This critique will follow the same numbering and structure as the Addendum.

INTRODUCTION

The introduction sets out new information which is claimed triggers amendments to Volumes 1 and 2. But it must be recognised that there is a hierarchy of planning documents that must be applied, with others having optional applications. In this case, the New Zealand Coastal Policy Statement (2010) (NZCPS 2010) is a Statutory Document that must be given effect:

Regarding the documents listed, none of them are Statutory Documents. The following should be noted from the outset:

- The IPCC (2021) report indeed refers to shared socio-economic pathways (SSP's) to replace the RCPs. However, the most extreme pathway, known as SSP5-8.5 is now considered by the IPCC as 'implausible' so is arguably worthy to 'stress test' a scenario, but not for policy, given the requirement to adopt 'likely' scenarios.
- The work by the SeaRise Programme (2022) was submitted to the American Geophysical Union for peer review and publication in July 2022. The work has not passed the peer review and caution should be adopted when considering the findings.
- The Ministry for the Environment (2022a) Interim Guidance has similarly yet to be finalised. It is a non-statutory document and is subservient to statutory instruments such as the NZ Coastal Policy Statement 2020 (and associated guidance).

1.1 Summary of Projections of Relative Sea Level Rise used in the Jacobs Volume 2 report

The Addendum provides that sea level rise projections presented in Jacobs Volume 1 (Table 3.2) and Volume 2 (Table 2.1) were based on MfE (2017). It is important to note that both the MfE 2022a and the document upon which it updates (MfE 2017) have specific warnings as to the use of both documents.

The disclaimer in MfE 2017 says it: "*holds no official status".* The Interim Update states: "*The information does not alter the laws of New Zealand, other official guidelines, or requirements."*

Curiously, instead of surveying local scientific papers to assess the rate of Relative Sea Level Rise (RSLR) along the Kapiti Coast (e.g. Watson, 2011; Cole, 2011; Hannah and Bell 2012; Denys et al 2020), the Addendum records that IPCC projections were used with a local New Zealand adjustment, even though the projections, when hindcast, are inconsistent with such prior local scientific papers.

Vertical land movement (VLM) was then added based on local "reports" (Beaven and Litchfield (2012), Bell and Hannah (2012); Bell et al (2018) that used cGPS gauge records to "identify VLM." The Addendum records that a subsiding trend of -1 mm to -3mm/yr was applied with -1 mm/yr applied to the lowest SLR scenario and – 3mm/yr to the highest.

However, those citations don't support the VLM adjustments made. Taking each in turn:

Beaven and Litchfield 2012 (see Figure 3) note that over long-term scales (125,000 years) Kapiti is rising at 0-1 mm/yr. They also single out measurements made on the Kapiti Coast as not necessarily representative of the longer-term trends:

> "Along the west coast of the southern North Island from Wellington to Bulls, the cGPS rates show rapid subsidence while the geological rates show slow uplift. Some of these subsidence signals are biased negative because the time series do not sample through enough SSE [slow-slip-event] cycles (e.g. KAPT in Figure 5; see also Figure 8). The cGPS rates again show faster subsidence than the coupling model rates, by ~1.5 mm/yr."

This appears to have been born out now that in 2023 we can look at a longer date set (see in section 1.3.2 where Kapiti has lifted by 1 cm in this year alone).

Bell and Hannah (2012) provided advice on the projected sea-level rise using the tide gauges and VLM estimates from the relatively new cGPS measurements. They note VLM as important finding a subsidence of 1 mm/yr on the Kapiti Coast for the prior 6 years but going to make the following finding:

> "The fact that the cGPS trend estimates are derived from data collected between 2000-2009 i.e., between the two SSEs [slow-slip-events] is likely to result in regional ground motion that is quite different from the overall average for the 1891-2011 period of the tide gauge."

Regarding sea-level rise, they note:

> "At least two studies have been undertaken in the Australasian region (Watson, 2011; Cole 2011) where a search has been made for any evidence of an acceleration in relative sea-level rise. Both studies using different methodologies, have concluded that no statistically significant acceleration is able to be detected at this time."

This conclusion is consistent with several prior papers published by John Hannah (e.g. Hannah (2004)[1] concluded regarding New Zealand RSLR: "*There continues to be no evidence of any acceleration in relative sea levels over the record period.*")

In a seminal text "Sea Level Rise: History and Consequences", which was published as part of the international geophysics series (volume 75)[2], the authors made the following comment:

> "Has there been any acceleration of global sea level in the 20th century?*[…]*. Woodworth (1990), Gornitz and Solow (1991), and Douglas (1992) …examine[d] the issue of an acceleration of sea level during the last 100-150 years. No author found conclusive evidence of a global acceleration of sea level, especially compared to what is predicted to accompany future global warming. Douglas (1992) used the largest number of tide gauge records for his estimate of global sea level acceleration and found for the period of the latter half of the 19th century to 1980 the global acceleration of value -0.01 ± 0.01 mm/yr^2. He also concluded that 50 or more years would be needed to detect an increase in the rate of sea level rise (i.e., an acceleration) from ordinary tide gauge records."

Whilst this citation comes from a text dated 2001, the clear advice is that a longer period will be needed to detect an acceleration.

[1] Hannah J. 2004. An updated analysis of long-term sea level change in New Zealand. Geophysical Research Letters 31(3): L03307. https://agupubs.onlinelibrary.wiley.com/doi/full/10.1029/2003GL019166

[2] Douglas et al (2001).

Bell and Hannah 2012 caution that: "it is clear that a substantial acceleration is now required, possibly through an ice-sheet tipping-point response, to achieve any projected rise of more than 1.2 m by 2015. **The lack of such a signal in present-day tide gauge data suggests that a measure of caution be taken before higher-end sea level rise scenarios be adopted in statutory plans**." (emphasis added).

It would be helpful to have an opinion on whether such an acceleration has indeed occurred.

The prospect such an acceleration has not definitively emerged is in line with advice in MfE 2017[3] which concludes that:

> "Watson et al (2015)[4] determined a small acceleration from 1993 to mid-2014, comparable to the accelerated loss of ice from Greenland and larger than the 20th-century acceleration.
>
> To ensure the separation of decadal-scale variability from the regional trends, and definitively assess long-term climate shift, a longer time series from the satellite altimetry is still required.

Consequently, modelling an acceleration would be precautionary, and should avoid high-end scenarios for planning.

Bell et al (2018) went on to assess vertical land movement and the ameliorating slow slip events, concluding that:

> "Following the Kaikoura earthquake event, significant postseismic displacement has occurred up to present, mostly uplift. Some sites along the Kāpiti Coast, have uplifted by approximately 50 mm, negating much of subsidence caused by the coseismic deformation during the Kaikoura earthquake."

Accordingly, based on the cited literature, the proposed projected subsidence for VLM should be adjusted to reflect the longer-term uplifting trend.

1.2 New Information for Sea Level Rise Projections and Vertical Land Movement

1.2.1 Updated Sea Level Rise Projections

The Addendum introduces the analysis of sea level rise from the IPCC's AR6 but does not note that the most extreme scenario is regarded as 'implausible' and therefore not compliant with NZCPS 2010's 'likely' scenario requirement.

IPCC AR6 WG1 scientists clarified the status of the higher emissions scenarios (called 'SSP3-7.0' and 'SSP5-8.5'), making it clear that they are not likely:

> *"… However, the likelihood of high emission scenarios such as … SSP5-8.5 is considered low in light of recent developments in the energy sector …"* [IPCC AR6 WG1 Section 1.6.1.4]

[3] https://environment.govt.nz/assets/Publications/Files/coastal-hazards-guide-final.pdf page 78.

[4] Watson CS, White NJ, Church JA, King MA, Burgette RJ, Legresy B. 2015. Unabated global mean sea-level rise over the satellite altimeter era. Nature Climate Change 5(6): 565–568. Retrieved from http://dx.doi.org/10.1038/nclimate2635

> *"… SSP3-7.0 and SSP5-8.5 are explicit 'no-climate-policy' scenarios … , assuming a carbon price of zero. These future 'baseline' scenarios are hence counterfactuals that include less climate policies compared to 'business-as-usual' scenarios – given that 'business-as-usual' scenarios could be understood to imply a continuation of existing climate policies…."* [IPCC AR6 WG1 Section 1.6.1.4]

> *"The high-end scenarios RCP8.5 or SSP5-8.5 have recently been argued to be implausible to unfold …. However, where relevant we show results for SSP5-8.5, for example, to enable backwards compatibility with AR5, for comparison between emission-driven and concentration-driven simulations, and because there is greater data availability of daily output for SSP5-8.5."*
>
> [IPCC AR6 WG1 Section 4.2.2]

That RCP8.5 and SSP5-8.5 are no longer deemed plausible in IPCC (2021) is supported by recent literature including Hausfather and Peters (2020a[5]; 2020b[6]), Pielke and Ritchie (2021[7]), and Burgess *et al* (2021[8]). It is also important to note that medium scenarios (RCP4.5, RCP6.0 (discontinued) and SSP2-4.5) are more plausible and consistent with current global policies and emissions. Figure 4 illustrates the "low-likelihood, high impact" storyline that describes SSP5-8.5.

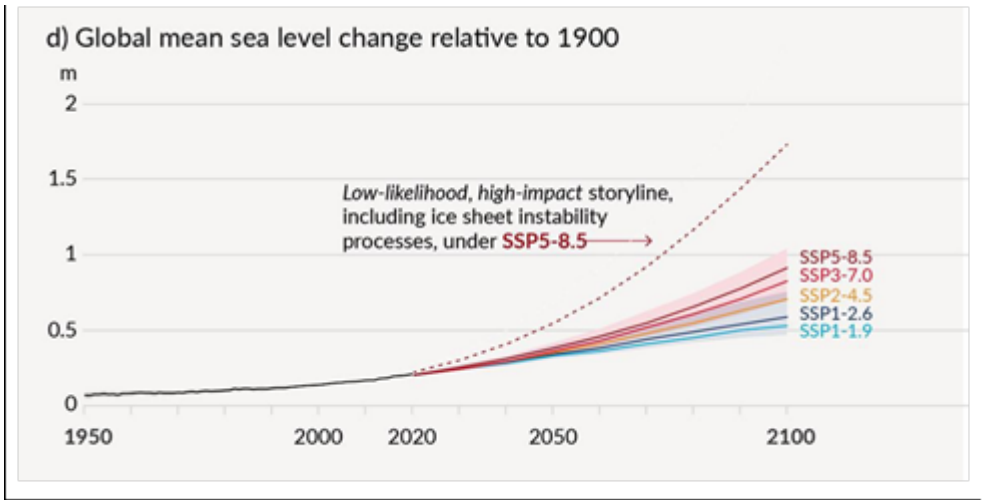


Figure 4: From IPCC AR6 WGI (SPM.8) projected eustatic sea level changes relative to AD 1900 for 5 scenarios (IPCC, 2021). The data for 1950-1992 are from tide gauges, satellite altimetry for 1992-2014, and CMIP6 models from 2014. Data are adjusted upwards to allow for a 0.158 m sea level rise from 1900 to the 1995- 2014 baseline used for simulations.

Regarding policy, the IPCC concluded that "***High-end scenarios (like RCP8.5) can be very useful to explore high-end risks of climate change but are not typical 'business-as-usual' (BAU)***

[5] Hausfather Z, & Peters GP, 2020a. Emissions – the 'business as usual' story is misleading. Nature 577(7792): 618– 620.

[6] Hausfather Z, & Peters GP, 2020b. RCP8.5 is a problematic scenario for near-term emissions. Proceedings of the National Academy of Science 117(45): 27791-27792.

[7] Pielke Jr R, & Ritchie J, 2021. Distorting the view of our climate future: The misuse and abuse of climate pathways and scenarios. Energy Research and Social Science 72: 101890. https://www.sciencedirect.com/science/article/abs/pii/S2214629620304655

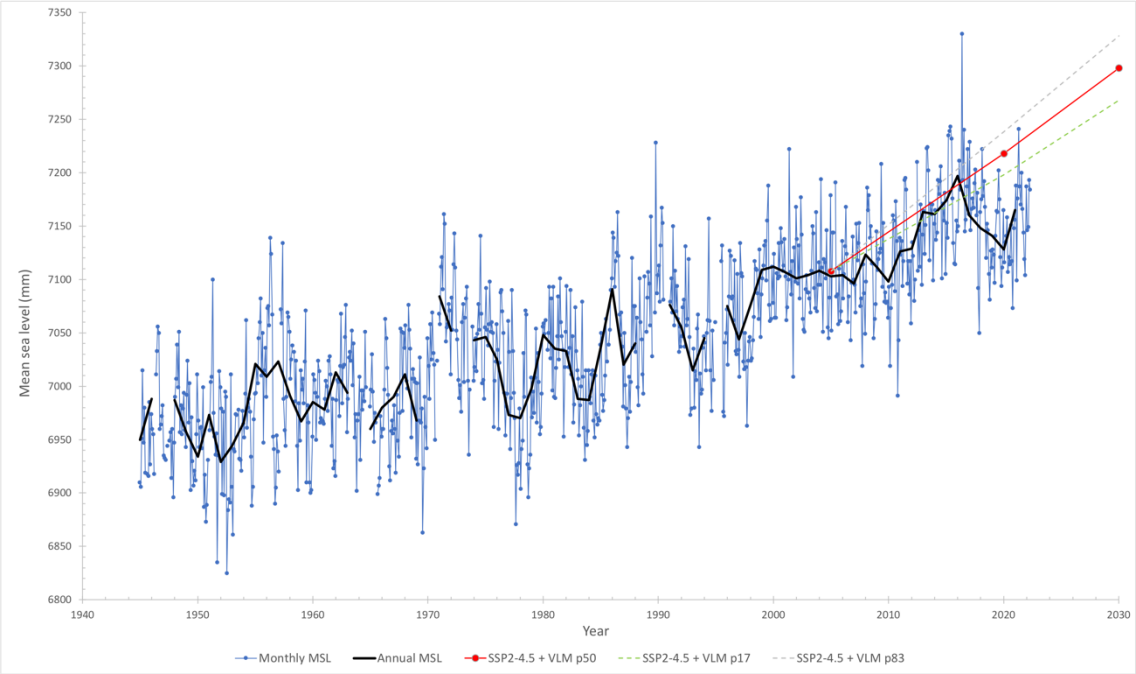
[8] Burgess MG, Ritchie J, Shapland J, & Pielke Jr R, 2021. IPSS baseline scenarios have over-projected emissions and economic growth. Environmental Research Letters 16: 014016. https://iopscience.iop.org/article/10.1088/1748-9326/abcdd2

projections and should therefore not be presented as such."[9] (emphasis added).

Consequently, whilst the MfE guidance recommends to 'stress test' scenarios using RCP 8.5 (and H+), policy should only be based on such scenarios where they are 'likely'.

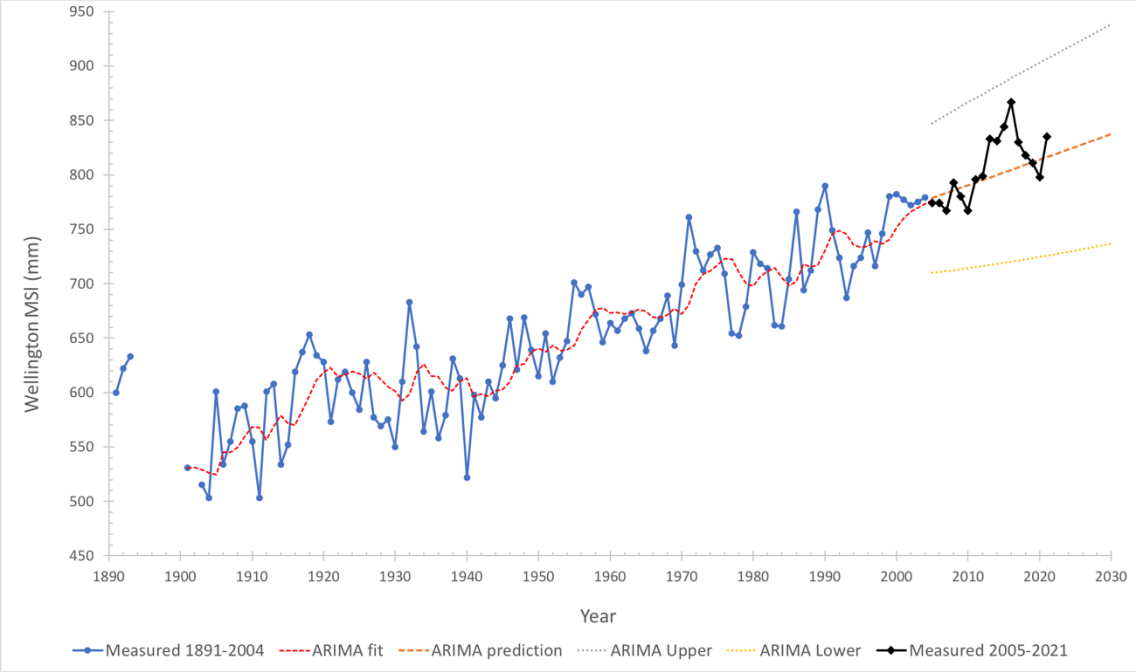
The authors go on to reference the work of the NZ Sea Rise Programme. Unbeknown to the MfE, this work was fast-tracked into policy before passing the peer review. It was submitted to an international journal for publication in July 2022. It has not been published because it omits addressing important ameliorating aspects, such as slow slip events, that have important effects on the medium to long-term estimates. Several of New Zealand's leading geoscientists have called for the online tool to be taken down until corrections can be undertaken.

The SeaRise model has had a poor record since it started in 2011. Below in red is the SeaRise model of sea level rise from 2011 (the end of their data set) plotted on the Wellington tide gauge measurements (black being the average). It clearly overestimates the trend.



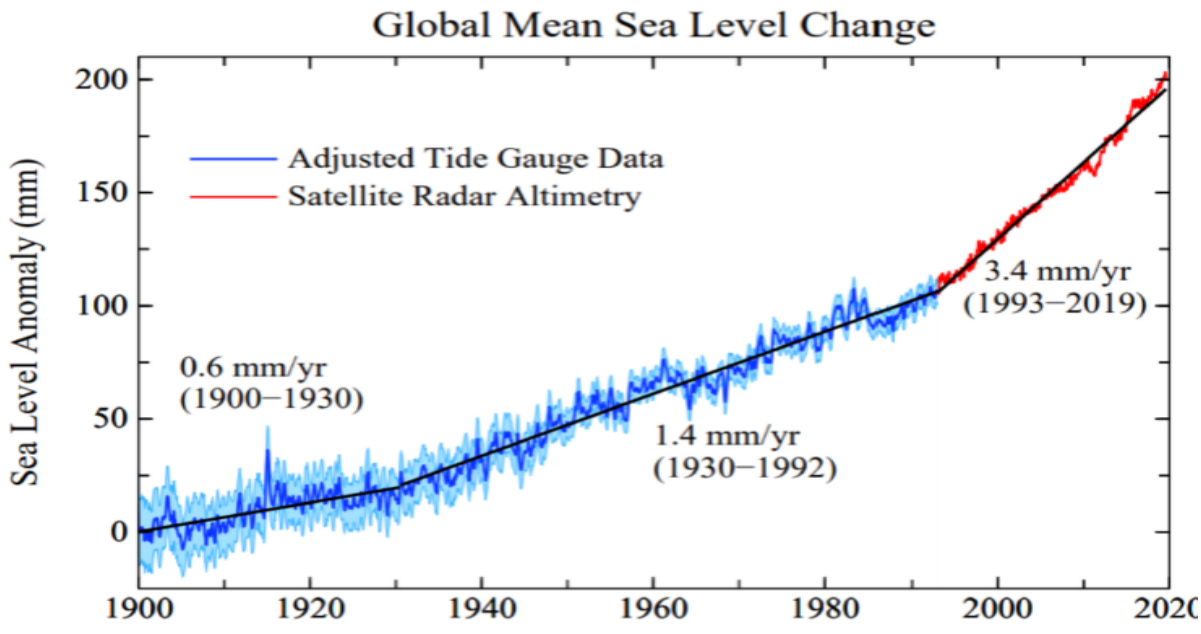
A better fit is to simply average the historic trend and project it forward from 2011. The average, in red again,(which accommodates periodic slow slip events and other earth movements) is a much better fit to what has happened:

[9] IPCC AR6 WGIII Chapter 3, FAQ 3.3, page 386.



The SeaRise approach is a significant departure from prior methodologies (e.g. Bell and Hannah 2012) that centred on local tide gauges as the key planning tool. The use of satellite data instead of tide gauges needs to be thoroughly explored because of the significant variance in satellite measurements from those from the global tide gauges.

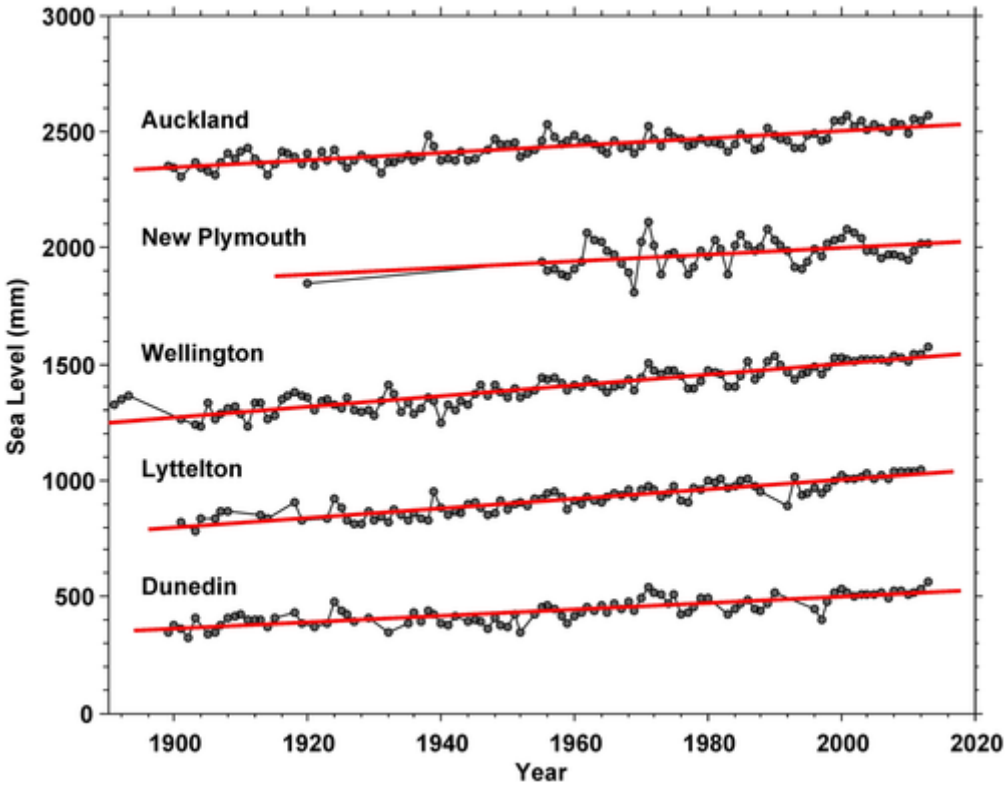
Below is the global mean sea level chart – blue is the tide gauges and red is the new satellite record.



Source: http://www.columbia.edu/~mhs119/SeaLevel/

Clearly, the change in measurement technique in 1993 has influenced the trend as no tide gauges

measure the step change in 1993 that the satellites show. See below the NZ long-term relative sea level data sets that show a fairly linear trend (from Denys et al 2020).



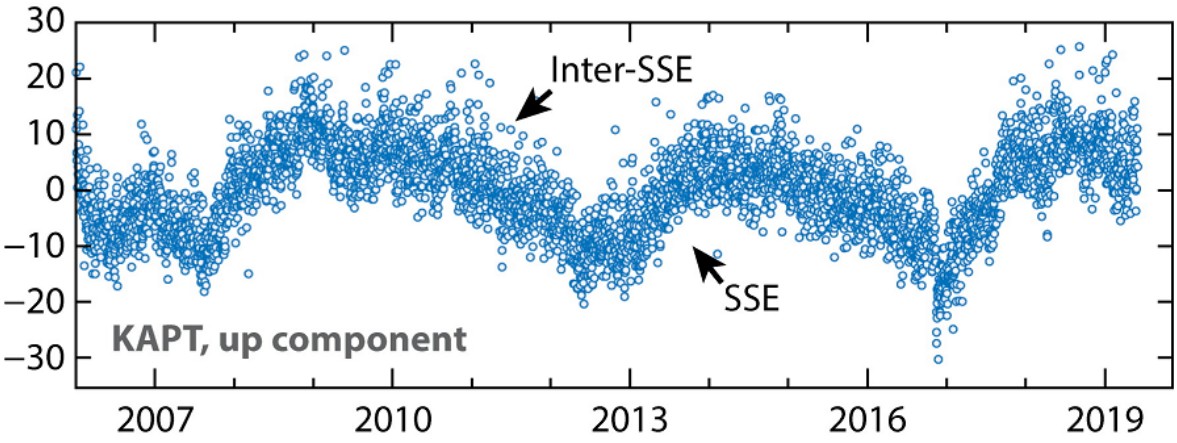
Looking at these fairly linear trends, that are shared by tide gauges around the world, there appears to be little justification in the short to medium term to projecting anything other than the linear trend.

1.2.2 New Vertical Land Movement Estimates

The Addendum correctly summarises the Sea Rise VLM estimates and notes its weakness as being a short data set from an 'inter-seismic' period. This biases the data with a subsiding trend and means that uplifting slow slip events are not likely to feature. Slow slip events have a significant impact on the VLM trend and likely are responsible for the long-term uplift trend on the Kapiti coast.

Missing from the literature reviewed in the Addendum is Wallace L., 2020[10] which gives the latest peer-reviewed analysis with specific mention of the Kapiti Coast. The below chart from Wallace LM. 2020, shows the uplift over time and the importance of using longer-term data sets for forward projections:

[10] Wallace LM, 2020. Annu. Rev. Earth Planet. Sci. 48: 175-203.



In May 2023 Dr Wallace reported that the Kapiti Coast has been subject to an uplift of up to 1 cm this year alone. She says: "*Some of the GNSS sites closest to the Manawatū and Kapiti SSEs have undergone as much as 1.5 cm of horizontal displacement and 1 cm of upward displacement since the beginning of 2023.*"[11]

And yet the SeaRise 'tool' shows subsidence along the Kapiti coast.

1.3 Comparison to RSLR Estimates Used in the Volume 2 Report

Based on the above, the VLM estimate should be revised to match the longer-term trend of ~1 mm/yr. Rather than adopt novel satellite estimates of global sea level, with a local adjustment, a more standard approach would be to use local VLM measurements as described and add the RSL trend as average from the 4 long tide gauges.

Denys et al 2020[12] separated out the VLM trend from the secular trend in sea level rise finding a sea level rate of +1.45 ± 0.36 mm/year (1891−2013). A defensible approach would be to add the long-term VLM estimate of ~1 mm/yr to find a sea level rise of +0.45 ± 0.36 mm/year (1891−2013).

To this, a precautionary value might be added to address an acceleration based on the 'likely' SSP2-4.5 scenario set out in Table 2, column 2 in the Addendum. A 5-year review is recommended.

1.4 Updates from Ministry for the Environment (2022a, 2022b)

1.4.1 MfE (July 2022) Interim guidance on the use of new sea-level rise projections

This document was actually published in August 2022. It is under review due to the uncertainties surrounding the SeaRise work around VLM and its inability to secure publication. This document is guidance only and is subservient to the DoC Guidance.

The third bullet mentioned suggests that the SSP5-8.5 scenario should be 'used to stress test plans, policies and adaptation options, and for risk screening to determine coastal areas "potentially affected. [Policy 24, NZCPS]."

[11] https://www.geonet.org.nz/news/6vAA6FVHI9ojGmkONfsoOi last visited 6 June 2023.
[12] Denys et al (2020) *"Sea Level Rise in New Zealand: The Effect of Vertical Land Motion on Century-Long Tide Gauge Records in a Tectonically Active Region."*

But this would be an incorrect application of Policy 24. The areas 'potentially affected" must be determined by "likely' scenarios, not outlier ones that are implausible.

1.4.2 MfE (August 2022) Aotearoa New Zealand's first national adaptation plan.

The use of SSP5-8.5 in this document is similarly described as per the MfE Interim Guidance. It's worth 'stress' testing but will not represent a 'likely' scenario for decision-makers.

1.5 Summary

Overall, the Addendum repeats or amplifies the mistakes of Volumes 1 and 2:

1. It fails to focus and properly analyse the application of Policy 24 (and guidance) when considering what amounts to a 'likely' scenario.

2. Does not recognise that the IPCC has determined SSR5-8.5 as 'implausible' and so fails to consider how presenting the outcomes of that scenario as a 'stress test' should be conducted to differentiate between a 'likely' scenario;

3. Over-relies on the MfE 2017 Guidance and 2022 Interim Update that are wholly centred on IPCC pathways. These documents are secondary to NZCPS 2010 and encourage an intellectually lazy approach where the legwork around the science is considered done by the IPCC who have little knowledge of the Kapiti Coast's unique regional conditions;

4. The adoption of the SeaRise work needs to be reconsidered while it remains unpublished in the peer review. Clearly, VLM on the Kapiti Coast varies in time and slow-slip-events and periodic uplifting earthquakes should be modelled. Whilst it was correct to include a caveat in regard to the inter-seismic data, the longer-term signal would appear to be more appropriate for planning.

5. Given that it is questionable whether an acceleration in sea level rise has been detected, consideration should be given to some analysis around what a precautionary approach might consider for the short – to -medium-term.

6. Advice on when the Council should review and update this work would be welcome.