IN THE MATTER OF	Resource Management Act 1991, Subpart 6 concerning Intensification Streamlined Planning Process
AND	
IN THE MATTER	of Plan Change 2, a Council-led proposed plan change to the Kāpiti Coast District Plan under the Resource Management Act 1991, Schedule 1 Subpart 6.

STATEMENT OF EVIDENCE OF DEREK JOHN TODD

On COASTAL HAZARDS

On behalf of KAPITI COAST DISTRICT COUNCIL

February 2023

Introduction

1. My full name is Derek John Todd.

2. I am a coastal geomorphologist with the qualifications of B.Sc and M.Sc (Hons) from the University of Canterbury. My post-graduate studies were in physical geography including a thesis study on the interaction of coastal and fluvial processes. I am a member of the New Zealand Coastal Society, have lectured at Canterbury University on coastal management and am an adjunct of the Griffith Centre for Coastal Management, Griffith University on the Gold Coast, Australia.

3. I have 39 years of working experience in investigating coastal processes, assessing potential future changes in shoreline stability, and providing technical assessments and advice on coastal processes and hazards for Resource Consent applications, Regional Coastal Plans, and District Plans.

4. I currently hold the position of Principal Coastal and Hazards Scientist at Jacobs New Zealand Limited.

5. I was the Technical Lead of the Jacobs team that undertook the Kāpiti Coast Coastal Hazards Susceptibility and Vulnerability Assessment (**the assessment**) between November 2020 and February 2022. The results of this assessment were presented to the Kāpiti Coast District Council (**Council**) in the *Kāpiti Coast Coastal Hazards Susceptibility and Vulnerability Assessment Volume 2: Results* report (**the report**). The assessment is part of the Council Takutai Kāpiti Coastal Adaptation Project. Since February 2022 I have been assisting the Coastal Advisory Panel set up under the Takutai Kāpiti Project with the preparation of Dynamic Coastal Adaptation Pathways for the Kāpiti Coast District.

Code of Conduct

6. I have read the Code of Conduct for expert witnesses in the Environment Court Practice Note 2023 and I have complied with it when preparing this evidence. Except when I state that I am relying on the advice of another person, this evidence is within my area of expertise. I have not omitted to consider material facts known to me that might alter or detract from the opinions that I express.

Scope of Evidence

7. My evidence covers the following areas:

   i. An overview of the Kāpiti Coast Coastal Hazards Susceptibility and Vulnerability Assessment covering:
      - The purpose and intended use of the assessment
      - High level summary of the assessment methodology
      - The peer review process of the assessment

   ii. An overview of the Ministry for the Environment July 2022 *Interim guidance on the use of new sea-level rise projection* (MfE, 2022), in particular:
      - The sea-level rise scenarios recommended to be used for planning purposes; and
      - The relationship between these recommended scenarios and those used in the Kāpiti Coast Coastal Hazards Susceptibility and Vulnerability Assessment.

8. It is my understanding that this scope of evidence is to support the spatial extent of the "Coastal Qualifying Matter Precinct" proposed by Council under Proposed Plan Change 2 (Intensification) to the Operative Kāpiti Coast District Plan 2021. The spatial extent of the "Coastal Qualifying Matter Precinct" was informed by the results of the coastal erosion part of the Coastal Hazards Susceptibility and Vulnerability Assessment.

Kāpiti Coast Coastal Hazards Susceptibility and Vulnerability Assessment

Purpose

8. The purpose of the assessment was to update previous coastal hazard assessments undertaken along the KCDC shoreline including mapping the spatial extent of areas potentially susceptible to current and future coastal erosion and inundation hazards.

9. The assessment was presented in two volumes. The purpose of the first volume (June 2021) was to summarize the coastal process environment operating along the Kāpiti Coast District and to present a detailed description of the methodology to be used in the assessment to quantify the spatial extent of the susceptibility or exposure to coastal erosion and inundation over timeframes of 30, 50 and 100 years in the future, and to quantify the vulnerability of properties and council infrastructure (e.g roads, three waters) to these hazards.

10. The purpose of the second volume was to present the results of the coastal hazard susceptibility and vulnerability assessment for the various magnitudes of relative sea level rise (RSLR) projected to occur over the given future timeframes. Appended to the results report were the map overlays of the spatial extent of the areas susceptible to each of the coastal hazards within the three timeframes of 2050, 2070 and 2120 (e.g. 30, 50 and 100 years).

Intended Use of the Assessment Results

12. The outputs of the assessment were developed for use by KCDC to:

    i. Inform the *Takutai Kāpiti* project to assist in raising community awareness of the nature and extent of the hazards, and as input into decision making to identify the triggers and potential actions under dynamic adaptive planning pathways;
    ii. Develop future management strategies for council infrastructure and property located in areas susceptible to future coastal hazards; and
    iii. Provide base hazard data for future District Plan change processes.

Coastal Erosion Assessment Methodology

13. It is my view that the methodologies employed for the coastal erosion assessment are best practice and are similar to those used in a large number of other coastal erosion assessments undertaken in recent years in other parts of New Zealand.

14. The components considered in the assessment are consistent with the factors listed in NZCPS (2010) Policy 24 that must be had regard to in identifying areas potentially effected by coastal erosion over at least 100 years, being

    a) physical drivers and processes that cause coastal change including sea level rise;
    b) short-term and long-term natural dynamic fluctuations of erosion and accretion;

c) *geomorphological character;*
d) *the potential for inundation of the coastal environment, taking into account potential sources, inundation pathways and overland extent;*
e) *cumulative effects of sea level rise, storm surge and wave height under storm conditions;*
f) *influences that humans have had or are having on the coast;*
g) *the extent and permanence of built development; and*
h) *the effects of climate change on:*
   i. *matters (a) to (g) above;*
   ii. *storm frequency, intensity, and surges; and*
   iii. *coastal sediment dynamics.*

15. I consider that the methodology for calculating the above components and combining them to determine Projected Future Shoreline Positions **(PFSP**'s**)** is consistent with the methods given in *"Defining coastal hazard zones for setbacks lines: A guide to good practice*" (Ramsay et al, 2013) and "*Coastal hazards and climate change; Guidance for local government*" (Ministry for the Environment (**MfE**), 2017), including dealing with uncertainty in the future projections by employing a probabilistic approach to obtain a range of projections for multiple sea level rise scenarios.

16. As recommended by "*Coastal hazards and climate change; Guidance for local government*" (MfE, 2017), the magnitudes of sea level rise used in the assessment were relative sea level, being the combination of sea level rise due to global climate change and local vertical land movements (**VLM**).

17. The sea level rise projections due to climate change used in this assessment were the national projections provided by the MfE (2017) guidance, which were based on the Intergovernmental Panel for Climate Change (**IPCC**) 5th report (AR5, 2013) projections under three global greenhouse gas emissions scenarios known as Representative Concentration Pathway (**RCP**) scenarios, with a small adjustment for the findings of the IPCC (2019) *Special Report on the Ocean and Cryosphere in a Changing Climate* report.

18. The calculations and mapping of the PFSP's pre-dated the more recent IPCC AR6 report in August 2021, and therefore did not include the updated sea level rise projections since this time.

19. The IPCC do not assign likelihoods to any of the sea level rise scenarios in any of their reports, with the projections for each scenario being presented as median values within a likely range. The fourth MfE (2017) scenario is a more extreme scenario, known as RCP8.5H+, being the 83rd percentile of the IPCC RCP8.5 scenario. The MfE (2017) guidance recommends that all four sea level rise scenarios are presented in a coastal hazard assessment, with the function of RCP8.5H+ scenario being to "*stress test adaptation plans where the risk tolerance is low and/or future adaptation options are limited, and for setting an SLR for green-fields development where the foreseeable risk is to be avoided."*

20. Local VLM have had a significant influence on relative sea level rise for the Wellington region due to subsidence from slow slip activity and vertical uplift following recent large earthquake events. However, the certainty of future projections is limited due to high accuracy measurements of local past rates of VLM being restricted to a maximum of 20 years, being limited to only a small number of sites, and the inability to predict displacement from future earthquake events. VLM data for the three sites along or close to the Kāpiti Coast that covered a 20 year period (1998-2018) presented by

Bell et al (2018) *Update on relative sea-level rise and vertical land motion: Wellington region,* indicated an average net rate of land subsidence in the range of 1-3 mm/year.

21. This range of VLM projections was added to the projected medium sea level rise from each of the climate change scenarios to obtain the projections of relative sea level rise (**RSLR**) for use in the coastal erosion assessment. The full range of RSLR projections across all scenarios is presented in Figure 1, with the lowest projection being for the RCP2.6 scenario combined with -1 mm/yr VLM, and the highest being the RCP8.5H+ scenario combined with -3 mm/yr VLM. The relative sea level rise elevations applied in the assessment to calculate coastal erosion distances to PFSP's by 2050, 2070, and 2120, are also shown in Figure 1, being the highest and lowest scenario at each timeframe, and additional intermediate elevations in 2120 associated with RCP4.5 and RCP8.5 scenarios. The highest projected sea level rise elevation was 1.65 m above the 2020 sea level by 2120 under the RCP8.5H+ scenario combined with -3 mm/yr VLM.

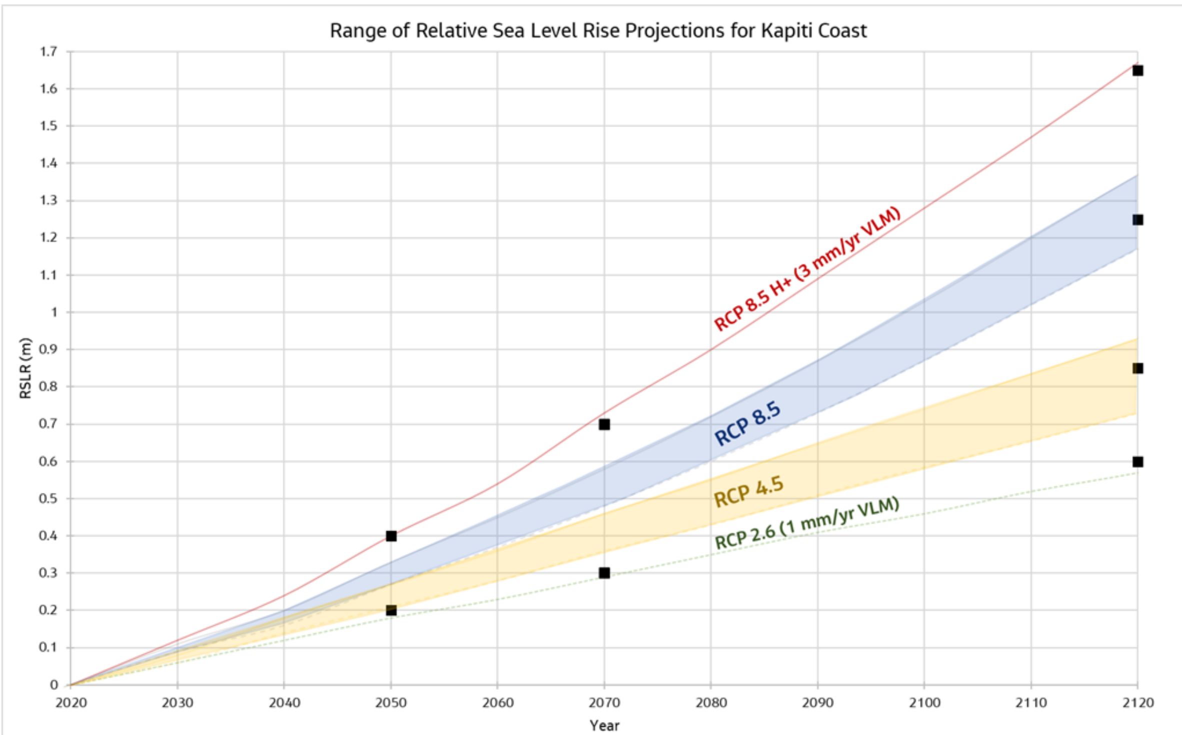

Figure 1: RSLR projections for the Kāpiti Coast from a 2020 base level incorporating climate change scenarios and local Vertical Land Movement (VLM). The projections applied in Coastal Hazards Susceptibility and Vulnerability Assessment for the timeframes of 2050, 2070, and 2120 are shown by the black squares. The range of projections under the RCP4.5 and RCP8.5 scenarios cover VLM of -1 to -3 mm/yr.

22. For each of the above increments of RSLR, the erosion distance from the current shoreline to the PFSP for the open coast was calculated by the following standard best practice formula:

CED = (LT x T) + SL + DS + ST

Where:

CED = Coastal Erosion Distance to the PFSP;

LT = Historic long-term rate of shoreline movement;

T = The timeframes over which the past long-term rates are extrapolated in the future. For this assessment these are set at 30, 50, and 100 years (taken as 2050, 2070, 2120 respectively);

SL = Erosion due to projected future accelerated rate of sea level rise over the above timeframes;

DS = Dune stability factor recognising the natural angle of repose of dune material; and

ST = Short-term storm erosion effect.

23. LT, SL, DS, and ST are termed erosion components, with each one being calculated from standard best practice equations involving a number of coastal process input parameters.

24. The input parameter data used to calculate the open coast erosion components were the most relevant and recent available at the time. However, there were still gaps in the data, and assumptions on the temporal and spatial coverage of some the data had to be made to complete the calculation of continuous PFSP's along the entire length of the Kāpiti Coast shoreline. These uncertainties in the data inputs are addressed by the probabilistic approach.

25. The probabilistic approach involved assigning a range of values from a triangular distribution (e.g. lower bound, mean, and upper bound) for each input parameter within the erosion component calculations, which is then applied to a 'Monte Carlo'[1] simulation to obtain 10,000 random values for each erosion component. The combination of the corresponding random values for each of the erosion component results in a distribution of 10,000 values of the possible CED from the current shoreline position to the PFSP, from which probabilities of occurrence are calculated. The resulting cumulative probabilities decrease with distance from the current shoreline position, as there is decreasing likelihood that erosion will reach or exceed this position with the specified magnitude of RSLR within the specified timeframe. Hence for the same RSLR magnitude and timeframe, it is my view that we can be more certain that erosion will reach the positions with higher probabilities, and less certain it will reach the positions with lower probabilities. The mapping presented with the assessment showed two probability scenarios for the PFSP:

    a) The 'most likely' scenario, being the range of positions that the PFSP has between 33-66% probability of being located in for the specified magnitude of relative sea level rise over the given timeframe (e.g. there is a 33% probability that the shoreline will be located further landward for the specified magnitude of relative sea level rise over the given timeframe), and

    b) A 'very unlikely' scenario, being the position that there is a 10% probability of the future shoreline being in this position or further landward for the specified magnitude of RSLR over the given timeframe. In this report this position is termed as P10. It is this PFSP under the 2120 RCP8.5H+ plus + 3 mm/yr VLM that has been proposed as the extent of the Coastal Qualifying Matter Precinct under Proposed Plan Change 2.

[1] A Monte Carlo simulation is a mathematical technique that **predicts possible outcomes of an event that has uncertainty**. This method predicts a range of future outcomes based on the probabilistic distributions of its inputs formed by analysing historical data and relevant geomorphic models.

26. The reference position or baseline for the open coast erosion calculations was the seaward dune toe or the seaward vegetation line. This is a standard commonly applied reference position for coastal erosion hazard calculations for beach environments. This position is seaward of the dune environment, and therefore the PFSP mapped does not include the foredune environment, the landward limit of which will also migrate to some degree with erosion of the seaward toe/ vegetation line if allowed to do so (e.g not constrained by infrastructure, buildings etc), but is most likely to be at slower rates.

27. A different methodology was required for determining PFSP's at the ten river and stream mouth environments (termed hydrosystems in the assessment) along the Kāpiti Coast as the open coast erosion components can not be applied due to different and complex processes occurring in these environments. Each hydrosystem was assessed subjectively using a 'decision tree approach' for each timeframe and relative sea level rise scenario that considered the following factors:

- The position of the mouth environment in relation to the adjacent open coast future shoreline position;
- The topography and elevation of the land surrounding the mouth environment;
- The conservation of area and volume of the available water ponding within the mouth environment;
- The relationship of the future width and depth of the mouth throat to its current position; and
- The occurrence of structures and assumptions around their future existence.

The resulting PFSP's indicate the extent of potential longshore migration of the river/stream mouth in the future, with the landward extent of the zone being the anticipated maximum landward position of the hydrosystem environment for the RSLR scenarios within each timeframe. However, due to the more subjective nature of defining these future migration areas, there is less confidence with the position of these shorelines than the PFSP calculated for the open coast.

Peer Review Process

28. The methodology and results of the coastal hazards susceptibility and vulnerability assessment were externally peer reviewed by appropriately qualified and experienced specialists from Beca and Greater Wellington Council. Brief statements from each of these reviewers are included in the appendices of both Volume 1 and Volume 2 of the assessment reports, which include the following statements:

From the Beca Reviewer (Connon Andrews - Technical Director, Coastal Science)):

"Based on my review, I can confirm that the coastal erosion hazard methodology as outlined in the aforementioned reports:

- *Is consistent with the assessment guideline intent outlined in MfE, 2017: Coastal Hazards and Climate Change – Guidance for Local Government.*
- *Adopts current assessment techniques that have been used to define coastal hazards for similar environs in New Zealand;*
- *Considers uncertainty of the individual parameters contributing to coastal erosion from future sea level rise; and*

- *Is considered appropriate considering the level of information and data available and is suitable to inform the development of potential adaptation options."*

From the Greater Wellington Council Reviewer (Dr. Iain Dawe, Senior Hazards Analyst, Environmental Policy):

"I am satisfied that the methodology to undertake the coastal vulnerability assessment and the results from this work are appropriate for the purposes of informing and guiding community based decision making for coastal adaptation in the short, medium and long term planning horizons and to provide direction for District Plan coastal hazard management approaches".

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

Interim guidance content and recommendations

29. Following the release of the IPCC AR6 report in August 2021, and the availability of new localised information on VLM around the New Zealand coast as part of the NZ SeaRise Programme (April 2022), the MfE released *Interim guidance on the use of new sea level rise projections (MfE, 2022).*

30. MfE (2022) *Interim guidance* states that '*the updated climate change sea level projections for New Zealand from IPCC (2021) remained close to the national scenarios presented in the MfE (2017) guidance until around 2070*" and "*by the end of the century* (e.g. 2100) *show an increase of 3 to 14 cm*", which is assumed to be across the four scenarios presented in MfE (2017). Due to the SLR projections in the Kāpiti Coast coastal hazard assessment already incorporating an adjustment for the findings of IPCC (2019) *Special Report on the Ocean and Cryosphere in a Changing Climate,* the increase in the projections in the assessment from the IPCC (2021) projections are a maximum of 3 cm by 2120 under the new SSP5-8.5H+ scenario. For context, the RCP scenarios of the IPCC (2013) 5th assessment have been replaced by SSP (shared Socio-economic pathways) scenarios in the IPCC (2021) 6th assessment, with the SSP5-8.5H+ scenario being equivalent to the former RCP8.5H+ scenario.

31. The NZ SeaRise programme used recent analysis of satellite radar and GNSS/GPS data to develop high-spatial resolution estimates of VLM rates (in mm/yr) for 2003–11 at 2 km spacings along the entire coast of New Zealand. These averaged local VLM rates are extrapolated into the future and added to the updated IPCC climate change SLR projections to produce the RSLR projections presented in the NZ SeaRise digital platform (https://www.searise.nz/maps-2) and discussed in the MfE (2022*) Interim guidance*. The interim guidance states that "*there are uncertainties in the VLM rates currently used in the relative sea level rise projections, arising from both the quality of the VLM data and the uncertainty of how VLM trends will track in the future*". Part of this uncertainty is due to the very short length of VLM record used in the projections, being limited to 9 years. This is a shorter period than the data used to determine VLM in the Jacobs (2022) coastal hazards assessment, but is restricted to less locations than the 2 km spaced sites of the NZ SeaRise data.

32. This uncertainty in the VLM is incorporated into the range of RSLR projections presented in the NZ SeaRise digital platform for each VLM assessment site, being larger than the previous range of projections in the 2017 guidance. The 2022 *Interim guidance* further states that "*the uncertainty in VLM rates this century is another reason to adopt an adaptive planning approach such as DAPP* (Dynamic Adaptation Pathways Planning), *where changes in VLM rates are monitored over time,*

along with other changes in risk, and responded to, if VLM continues to be a significant contributor to future RSLR".

33. The MfE (2022) *Interim guidance* recommends that when planning for SLR in coastal areas, the four 'medium confidence' SSP scenarios from IPCC (2021) (SSP2-2.6, SSP 2-4.5, SSP3-7.0, SSP5-8.5) should be used, along with the additional higher SSP8.5H+ (the 83rd percentile of the SSP5-8.5 scenario). The interim guidance notes that "*the upper range SSP5-8.5 and 8.5H+ scenarios should continue to be used given that we are currently on a similar emissions trajectory, combined with the prospect of runaway polar-ice sheet instabilities and very long response time-lags (multi-decadal to centuries) in sea-level rise. This means impacts from sea-level rise will be distinctly different compared with other climate impacts that are more directly tied to global heating, will be more responsive to cuts in global emissions, and involve relatively short response times (decades), unlike sea-level rise".* The uses of the highest SSP5-8.5H+ scenario are listed in the Interim guidance as being "*to stress-test plans, policies and adaptation options, as previously recommended in the 2017 coastal hazards guidance, and for risk screening to determine coastal areas 'potentially affected' as required under NZCPS Policy 24"*.

34. Of relevance to Proposed Plan Change 2 is the recommendation in Table 3 of the *Interim guidance* that the minimum transitional allowance for SLR for coastal subdivisions, greenfield developments, major infrastructure and changes in land use and redevelopment such as intensification, until a DAPP strategy is in place, should be the magnitude of RSLR out to 2130 under the SSP5-8.5H+ scenario that includes the relevant VLM for the local/regional area.

35. It is noted in the *Interim guidance* that the extent to which councils can utilize the updated scenarios will depend on the stage of the project, with provision for projects that have been developed under scenarios from the 2017 guidance to continue to use those scenarios, but to stress test with the VLM from the 2022 interim guidance. In my view this is the appropriate status for the Kāpiti Coastal Hazards Assessment, which was completed prior to the release of the NZ SeaRise Programme and applied local Kāpiti VLM rates that pre-dated those presented for Kāpiti in the NZ SeaRise Programme.

Relationship between Interim guidance recommended scenarios and those used in the Kāpiti Coastal Hazards assessment

36. As stated earlier in my evidence, the RSLR projections in the Jacobs (2022) assessment are the combination of the IPCC (2013) *5th Assessment* rise due to climate change with a small adjustment for the IPCC (2019) *Special Report* and VLM in the range of -1 to -3 mm/yr. The highest projected sea level rise elevation was 1.65 m above the 2020 sea level by 2120 under the RCP8.5H+ scenario (1.35 m SLR) combined with -3 mm/yr VLM (0.3 m SLR over 100 years).

37. Applying the same SLR projections due to climate change under the new SSP5-8.5H+ scenario to 2120 yields a 1.40 m SLR, before the appropriate local VLM component is added. This is a very similar (e.g. only 0.05 m higher) projection than for climate change effects from the Jacobs (2022) assessment. However, the recommendation from Table 3 of the MfE (2022) *Interim guidance* is to apply the SSP8.5H+ scenario out to 2130, which results in a higher SLR projection due to climate change of 1.58 m above a 2020 baseline.

38. Data on VLM in the NZ SeaRise digital database is presented for 21 sites within the Kāpiti Coast District. Across these sites the median VLM rate ranges from 0 mm/yr to -1.75 mm/yr, with observations of maximum VLM over the 9 year record (2003-2011) ranging from subsidence at -3.6 mm/yr to uplift of +0.48 mm/yr. These rates indicate that the upper VLM rate used in the Jacobs (2022) assessment is conservative, but is a possible rate of VLM based on the short period of observations. However, a more appropriate rate of VLM to apply to RSLR on a district wide level is the district average medium VLM of -1.07 mm/yr, which would add an additional 0.12 m to the projected sea level by 2130, giving a total average district wide RSLR of 1.70 m from a 2020 base. This is only 0.05 m higher that the projected maximum RSLR applied in the Jacobs (2022) assessment.

39. This 0.05m difference in RSLR converts to less than 1 m horizontal difference in predicted shoreline erosion distance as a direct effect of sea level rise for the shoreline topography and nearshore bathymetry found along the Kāpiti Coast. Overall, therefore, it is my opinion that the differences in using the RSLR projections from the Jacobs coastal hazard assessment and those recommended in the MfE *Interim guidance* are insignificant in determining the PFSP's within the Kāpiti Coast District.