Before the Hearings Panel
At Wellington City Council

Under Schedule 1 of the Resource Management Act 1991

In the matter of the Proposed Wellington City District Plan

Statement of evidence of Connon James Andrews on behalf of Wellington City Council (Coastal Inundation)

Date: 13 June 2023

INTRODUCTION:

1 My full name is Connon James Andrews. I am employed as a Manager – Coastal Climate Risk & Infrastructure at the National Institute of Water and Atmospheric Research (NIWA) – Taihoro Nukurangi.

2 I have prepared this statement of evidence on behalf of the Wellington City Council (the **Council**) in respect of technical related matters arising from the submissions and further submissions on the Proposed Wellington City District Plan (the **PDP**).

3 Specifically, this statement of evidence relates to the Coastal Hazard matters contained in the Coastal Environment Chapter of the PDP.

4 I am authorised to provide this evidence on behalf of the Council.

QUALIFICATIONS AND EXPERIENCE

5 I hold the qualifications of Master of Science (Hons) in Coastal Oceanography and Marine Geology and Batchelor of Science and Resource and Environmental Planning (BSc &REP) from the University of Waikato, obtained in 1997 and 1995 respectively.

6 I have been involved in consulting, science and research for over 25 years both nationally and internationally. My core skills include coastal processes, climate change, climate vulnerability, disaster risk and environmental assessment.

7 Since June 2022 I am the Manager of Coastal Climate Risk and Infrastructure for NIWA. In this role I lead and/or complete projects and research programmes focused on coastal hazards and future climate risk throughout New Zealand and the Pacific.

8 Relevant current projects include the quantification of the Hutt City inundation and climate change hazard using the same underlying

assessment used to define the inundation hazard for the Wellington City Council (WCC) District Plan, quantification of coastal inundation and climate change hazard for the Marlborough District, and refinement of a national inundation and sea level rise impact assessment for New Zealand.

9 Relevant recent research includes the MBIE funded Future Coasts Aotearoa programme whereby as the coastal adaptation research aim lead and specialist I am responsible for the development of science and tools to enable integrated adaption of New Zealand's coastal lowlands from the effects of sea level rise. I am also part of the specialist panel responsible for compiling guidelines to facilitate the implementation of dynamic adaptive planning as part of the New Zealand National Adaptation Plan.

10 My previous experience includes senior leadership and technical coastal and climate change specialist roles for organisations such as Beca Ltd (New Zealand), Worley (Australia, Canada and Chile) and Tonkin & Taylor Ltd (New Zealand).

11 I routinely provided national and international expertise in coastal processes, climate change, natural hazards, coastal management and adaption, coastal/marine engineering design and provision of specialist evidence support, either on half of an applicant or via Section 42A support to Councils. Examples include supporting Environment Canterbury for the Lyttelton Port Recovery Plan and the later capital dredging programme as coastal specialist.

12 I also act as specialist coastal, climate change and infrastructure advisor to the Asian Development Bank (ADB) and Pacific Regional Infrastructure Facility (PRIF) delivering specialist climate change projects throughout the Pacific. I was the lead author for the Guidance for Managing Sea Level Rise Infrastructure Risk in Pacific Island Countries (PRIF, 2021) that quantified inundation risk and developed sea level rise projections based on the IPCC 6th Assessment Report (AR6) for 13 Pacific Island countries.

13 I am a member and management committee member of the New Zealand Coastal Society, a technical group of Engineering New Zealand Te Ao Rangahau

CODE OF CONDUCT

14 I have read the Code of Conduct for Expert Witnesses set out in the Environment Court's Practice Note 2023. I have complied with the Code of Conduct in preparing my evidence and will continue to comply with it while giving oral evidence before the Environment Court. My qualifications as an expert are set out above. Except where I state I rely on the evidence of another person, I confirm that the issues addressed in this statement of evidence are within my area of expertise, and I have not omitted to consider material facts known to me that might alter or detract from my expressed opinions.

SUMMARY

15 My name is Connon James Andrews.

16 I have been asked by WCC to provide coastal inundation evidence in relation to the appeal on Chapter Natural Hazards and Risks.

17 My statement of evidence addresses:

a. The coastal inundation and future hazard mapping available to and used by WCC during the preparation of this Proposed Plan Change; and

b. My advice I provided to WCC in response to submissions received on this proposed Plan Change.

INVOLVEMENT WITH THE PROPOSED PLAN

18 I have been involved in the PDP since 2023 in a review capacity. The review has been limited to the report titled: *Allis M, Rautenbach C, Gorman R, Wadwha, S. 2021: Coastal hazards and sea level rise in*

Wellington City - supporting the 2020-2021 district plan process. National Institute of Water & Atmospheric Research Ltd (NIWA). 118pp. Client Report No. 2021250HN (the **Assessment**) completed by NIWA for WCC to inform their Urban Growth Plan review.

SCOPE OF EVIDENCE

19 My statement of evidence addresses the following matters:

Coastal Inundation

20 The Coastal Hazard Overlay in the PDP is based on the Assessment, which included the quantification of extreme coastal inundation levels and potential Relative Sea Level Rise (RSLR) to 2120 for the Wellington District. This included the shoreline within Wellington Harbour, South Coast and Makara Beach, but excludes the shoreline around Cape Terawhiti Head from Red Rocks to Makara Beach, and north of Makara Beach.

21 The Assessment considered the effects of astronomical tide, wind, waves, storm surge, RSLR and Vertical Land Movement (VLM).

22 Consistent with MfE (2017) *Coastal hazards and climate change: Guidance for local government,* the Assessment considered the following:

a. 1% Annual Exceedance Probability (AEP) extreme sea level (equivalent to a 1 in 100-year event).

b. RCP8.5M + VLM sea level rise of 1.43m with respect to the 1986-2006 Mean Sea Level (MSL) at 2120. The RSLR projection is defined as the 50th percentile of the RCP8.5 projection including subsidence of 3mm per year.

c. RCP8.5H^{+} + VLM sea level rise of 1.73m with respect to the 1986-2006 MSL at 2120. The RSLR projection is defined as the 83rd percentile of the RCP8.5 projection including subsidence of 3mm per year.

d. Increase in storminess due to climate change with a 10% increase in wind speed, offshore wave height and storm surge.

Coastal Inundation Methodology

23 The assessment utilised the 2020/2021 LIDAR ground surface for the district that excluded the presence of buildings and small footprint coastal defences not resolved in the LIDAR.

24 Coastal inundation was assessed using two methods tailored to the physical exposure of coastal processes. One method within Wellington Harbour and the other for the exposed open coast including Makara Beach.

25 Coastal inundation hazard for the Wellington Harbour shorelines was assessed via a multivariate extreme sea level analysis for storm tide and wave setup determined from numerical modelling of wind, waves and tides throughout the harbour, including swell from Cook Strait. The analysis was validated against historic observations and previous studies and quantified the future effects of climate change (RSLR and 10% increase in storminess).

26 The 1%AEP extreme sea level elevations including potential RSLR to 2120 and 10% increase in storminess was mapped onto land using static inundation (commonly termed “bathtub) mapping around the harbour shorelines. The static technique assumes that all land area lower than the inundation level and hydraulicly connected to the harbour is flooded at the same inundation level as observed at the shoreline.

27 The Southern open coast and Makara Beach coastal inundation hazard was assessed using a detailed hydrodynamic numerical model (XBeach-GPU). This dynamic modelling accounts for the complex interactions of waves, current, and water level with intricate bathymetric and topographic features in the surf zone, such as Tapu Te Rangi Island. To assess inundation the model resolves wave groups and determines how mean sea level is increased by wave setup in addition to extreme storm-tides. The model was calibrated to historical observations and subsequently used to simulate a suite of 1%AEP storms based on a joint probability multi variate analysis. The analysis further quantified the effect of RSLR and 10% increase in storminess.

28 The 1%AEP inundation extents for the Southern open coast and Makara Beach including potential RSLR to 2120 and 10% increase in storminess were mapped by integrating the maximum inland extents of the individual storms, providing the maximum extent of all modelled scenarios at the 1%AEP level.

29 The output of the mapping included GIS layers of spatial inundation extent and inundation depth which is the basis of the PDP Coastal Inundation Hazard Layer.

PDP Coastal Hazard Overlay

30 The PDP has utilised two of the Assessment scenarios in the Coastal Hazard Overlay as follows:

a. 1%AEP extreme sea level defined as High Hazard Ranking in the PDP; and

b. 1%AEP extreme sea level and RSLR of 1.43m (RCP8.5M + VLM) defined as Medium Hazard Ranking in the PDP.

31 The WCC s.42A reporting planner has also sought advice on whether coastal inundation depths of less than 5cm are material and implications should they be removed. For extreme coastal inundation events most of the flooding will be short lived (hours) except for depressions where flood waters are unable to drain or recede. In my opinion, the risk posed by localised coastal inundation with depths of less than 5cm is low and is unlikely to cause structural damage to infrastructure due to existing stormwater management requirements such as minimum kerb heights and floor levels. However, should large areas be affected the cumulative impact could impede access and some below ground infrastructure, such as basements could be inundated should existing stormwater controls not be sufficient.

32 Inundation of less than 5cm is likely to be controlled by small scale topographic features that are too small to be resolved in the LIDAR which has a vertical accuracy in the order of 10cm. Consequently, coupled with existing stormwater management controls, in my opinion removing areas with localised inundation depths of less than 5cm is reasonable but note inundation risk will remain in these areas.

Updated Science and Guidance

33 Since the preparation of the Assessment future sea level projections have been revised, which include a transition to Shared Socioeconomic Pathways (SSPs) an extension to the prior Representative Concentration Pathways (RCPs) and revisions to the contributions to sea level rise. The new approach is summarised in MfE (2022) *Interim guidance on the use of new sea-level rise projections.* Furthermore, MfE (2022) has revised the MfE (2017) transitional guidance for future SLR planning.

34 The MfE (2022) guidance recommends the use of the SSP scenarios, a timeframe out to 2130 (previously 2120) and the use of SSP5-8.5H^{+} + VLM scenario (previously RCP8.5H^{+}) for coastal subdivision, greenfield development and major new infrastructure. Additionally, MfE (2022) recommends the application of the SSP5-8.5H^{+} + VLM scenario for

changes in land use and development (intensification), where prior a dynamic pathways approach based on a range of SLR scenarios was recommended. A comparison of the RSLR projections used in the Assessment, adopted for the PDP and as per the MfE (2022) guidelines is presented in Table 1.

***Table 1. RSLR Projections relate to 1986-2006 MSL baseline**.*

Year	SLR Scenario	M (50%ile, m)	H+ (83%ile, m)
2120	RCP8.5 + VLM	1.43 [a b]	1.73 [a]
2120	SSP5-8.5 + VM	1.43	1.83
2130	SSP5-8.5 + VLM	1.58	2.04 [c]

a RSLR used in the Assessment
b RSLR used in the PDP
c RSLR recommended in MfE (2022)

35 Utilising the latest SSP5-8.5M + VLM projection which is most similar to RCP8.5M + VLM projection used in the PDP, the magnitude of RSLR to 2120 remains unchanged. However, to 2130 the magnitude of RSLR increases by 0.15m. Furthermore, the difference between SSP5-8.5H^{+} + VLM at 2130 as per MfE (2022) to RCP8.5M + VLM to 2120 used in the PDP is 0.61m.

36 RSLR of 1.43m, with respect to the 1986-2006 MSL baseline, is still within the "about as likely as not" band of 33% to 66% likelihood of RSLR at 2130 via SSP5-8.5, albeit at a much lower likelihood.

37 Best practice would be to revise inundation levels, so they are consistent with the latest guidance, noting the Assessment and PDP utilised the best available RSLR projection data and guidelines at the time of preparation.

RESPONSE TO SUBMISSIONS

38 Council officers have sought advice as to whether request in submission 309.3 by David, Karl to amend the coastal inundation overlay is appropriate from a technical perspective.

39 Submission 309.3 states "Considers that according to presentations from WCC staff and technical experts at a community climate adaptation meeting, modelling underpinning the current maps reflects some of the available, appropriate possible modelling, but does not account for wave dynamics. It is understood from these expert comments wave dynamics may have a significant bearing on the island". Submission 309.3 seeks that the coastal inundation overlay be amended to account for wave dynamics that include consideration of Tapu Te Rangi (the island in Island Bay).

40 I was not at the meeting in question so I cannot comment on what was stated in the presentation. However, the coastal inundation modelling completed for the project did take in account wave dynamics. The digital elevation model used in the numerical modelling assessment included Tapu Te Rangi and the hence wave dynamics are included in the mapped inundation extents. No amendments are therefore required.

Date: 13/06/2023

Connon Andrews