SUMMARY STATEMENT

1. Tēnā koutou katoa, ko **Emily Margaret Lane** tōku ingoa. I am employed as Principal Scientist: Natural Hazards and Hydrodynamics at the National Institute of Water and Atmospheric Research (**NIWA**). My expertise is in tsunamis and tsunami modelling.

2. I have prepared evidence on behalf of the Christchurch City Council (the **Council**) in respect of Plan Change 14 to the Christchurch District Plan (the **District Plan**; **PC14**), and specifically in relation to matters arising from the submissions and further submissions on the proposed Tsunami Risk Management Area Qualifying Matter.

Documents

3. The documents relevant to the proposed Tsunami Qualifying matter that I have reviewed are:

   (a) Bosserelle et al., (2019), the tsunami hazard assessment work NIWA undertook for the Council.

   (b) Documents pertaining to national tsunami hazard, SLR, tsunami vulnerability functions and vertical evacuation.

   (c) Draft section 42A planning report, sub-section 6.16 of the section 32 report, rebuttal and submissions of Ms Oliver insofar as it relates to my evidence.

Tsunami modelling for Council

4. In 2018, tsunami inundation modelling was undertaken for Christchurch Council reported in Bosserelle et al. (2019). Two tsunami scenarios (a 1:500-year event and a 1:2,500-year event) were modelled assuming a baseline tide level of Mean High Water Spring (**MHWS**) for a range of sea level rise (**SLR**) scenarios. The modelled scenario for a 50th percentile 1:500-year tsunami in Christchurch is a Mw 9.28 earthquake on the Peru subduction zone (note that in my previous evidence I mistakenly said this was Mw 9.24 and that it was the 84th percentile). These scenarios are based on Power et al. (2014).

5. Since that modelling was undertaken, an updated tsunami review has been undertaken "The 2021 update to New Zealand's National Tsunami Hazard Model" (Power et al., 2022) which gives lower wave heights at coast than

Power et al. (2014) but gives the same scenario for the most-likely 1:500-year 50th percentile tsunami for Christchurch. As this scenario was modelled in Bosserelle et al. (2019), those results are still valid for that return period.

6. The wave heights at coast quoted in paragraph 31 of my evidence have been superseded by Power et al. (2022). This update estimates the wave height at coast for 50th percentile 1:500-year event in Christchurch to be 4.377m. Estimated wave heights at coast for 1:100-year and 1:200-year events are approximately 2.7m and 3.5m in this more recent work.

7. The maximum wave height at the coast taken from the scenario modelled in Bosserelle et al. (2019) is 4.9m (not including baseline water level or any sea level rise) which is slightly higher than the 4.4m estimated in Power 2022. Power 2022 uses more basic modelling for a national scale view and so the wave height at coast from the Bosserelle et al. (2019) modelled scenario (recommended by Power et al., 2022) takes precedence over the estimates given in Power et al. (2022).

8. The amended PC14 proposal adopts areas inundated by 30 cm or more in Bosserelle et al. (2019), for the Tsunami Risk Management Area. Inundation below that level is less likely to be damaging to property or harmful to life safety.

9. Environment Canterbury Regional Council (**ECan**) has also had tsunami modelling done for Christchurch including models of tsunamis with wave heights at the coast of 3 m and 5 m. The Coastal Hazard Management Area Parcels are based on the 5m wave height at coast modelling. This modelling assumed a baseline of MHWS but did not include SLR. Results for the ECan modelling for a 5 m wave height at the coast at MHWS are very similar to the 1:500-year scenario without SLR which is also modelled in Bosserelle et al. (2019).

10. The New Zealand Coastal Policy Statement recommends considering at least the next 100 years for intensification, for planning purposes. We are only 34.1% certain that the 1:100-year tsunami inundation zone will contain all tsunamis that occur between now and 2130, whereas we are 80.7% certain that the 1:500-year tsunami inundation zone will.

11. It is my opinion that the approach taken in defining the Tsunami Risk Management Area is appropriate.

SLR as it pertains to tsunami modelling

12. The modelling in Bosserelle et al. (2019) includes a scenario with 1.06 m of SLR (as projected for 2120 based on the 2017 Tonkin & Taylor report: Coastal Hazard Assessment – Stage Two, Report for the Council). More recent guidance came out on 29 February 2024. This also recommends using relative sea level rise (**RSLR**) for the SSP5-8.5 H+ scenario out to 2130 for intensification. This would be a RSLR of between 1.51 - 1.95 m around Christchurch. The SLR modelled in Bosserelle et al. (2019) is projected to occur in 2085 at the earliest, so up until that point the tsunami inundation will fully account for possible RSLR. After 2085, if the SSP5-8.5 H+ scenario occurs, the tsunami modelling will no longer fully account for RLSR.

Tsunami scenarios

13. New Zealand has been impacted by devastating tsunamis in the past and will be again at some point in the future. The scenario modelled in Bosserelle et al. (2019) is a subduction zone event in Peru, which is the most likely scenario for a 1:500-year tsunami event but is not the only possible scenario. Similar inundation could also be caused by a large rupture on the Hikurangi Subduction Zone which would reach Christchurch in around 80 minutes. In all these scenarios there would be substantial inundation along the east coast of New Zealand.

Vertical evacuation

14. Vertical evacuation is considered in some places around the world as an option of last resort for evacuation. Vertical evacuation buildings have additional building requirements as outlined in Tsunami Loads and Effects on Vertical Evacuation, Technical Information, May 2020.

15. People died in the 2011 Japan tsunami in vertical evacuation structures because the tsunami exceeded what the structure was designed for. It is far safer to be out of the inundation zone, which is why, in my opinion, it is better to avoid intensification in the tsunami hazard zone.

Conclusion

16. We know that SLR will occur over the next 100 years and continue after that. There will be future devastating tsunamis that affect New Zealand, but we don’t know whether one will occur in the next 100 years. Our decision as to whether to intensify in the proposed Tsunami Risk Management Area should

be based on the level of likelihood of an event happening that we are happy to accept.

Date: 8 April 2024

Dr Emily Margaret Lane