

**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 Angela Georgina Griffin behalf of Wellington City
Council (Liquefaction)**

Date: 13 June 2023

INTRODUCTION:

- 1 My full name is Angela Georgina Griffin. I am employed as a Geologist.
- 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 matters in the Natural Hazards Chapter.
- 4 I am authorised to provide this evidence on behalf of the Council.

QUALIFICATIONS AND EXPERIENCE

- 5 I hold the academic qualifications of a Master of Science (Second Class Honours, First Division – 2001) from the University of Waikato and a Bachelor of Science (1999) also from the University of Waikato.
- 6 I currently hold the position of Geologist at the Institute of Geological and Nuclear Sciences Limited (GNS Science). I have worked at GNS Science since 2007, including four years as the GNS Carbonreduce Programme leader. I have recently taken on the role of Acting Team Leader for the Basin Analysis Team.
- 7 My previous work experience prior to coming to GNS Science comprises technical positions at Solid Energy and Plant and Food Research, and five years working at two of Work and Income New Zealand's call centres.
- 8 During my time at GNS Science, I have led two liquefaction analysis projects for Wellington City Council.
- 9 I contribute to a research project within GNS Science that aims to assess the hazard and risk posed by earthquakes on the Hikurangi Subduction

Zone and all their cascading effects. This includes analysing the liquefaction potential of the area, but also includes other cascading effects from earthquakes such as tsunamis and earthquake induced landslides. The project aims to look not only on the direct effect of earthquakes on infrastructure, but also the cascading effect of that damage on lifeline network effectiveness and the economy.

- 10 I am a member of the Geoscience Society of New Zealand, and also an elected member on the National Committee of the Geoscience Society of New Zealand.

Code of conduct

- 11 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

- 12 My name is Angela Georgina Griffin.
- 13 I have been asked by the Council to provide Liquefaction evidence in relation to the appeal on Chapter Natural Hazards and Risk.
- 14 My statement of evidence addresses
- a. The liquefaction hazard mapping provided to and used by WCC during the preparation of the Proposed District Plan; and

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

INVOLVEMENT WITH THE PROPOSED PLAN

- 15 I have been involved since 2020 when WCC contracted GNS Science to confirm the reliability of and refine existing liquefaction susceptibility maps held in their existing corporate spatial database.

SCOPE OF EVIDENCE

- 16 My statement of evidence addresses the following matters:

Liquefaction

- 16 I prepared two reports entitled:

Griffin AG, Pradel GJ, Abbott ER, Hill MP. 2020. Liquefaction susceptibility verification for Wellington City Council. Lower Hutt (NZ) GNS Science 67 p. Consultancy Report 2020/109.

Griffin AG, Dellow S. 2020 Wellington City liquefaction data: review and recommendations. Lower Hutt (NZ): GNS Science. 27 p. Consultancy Report 2020/08.

- 17 In the Griffin and Dellow (2020) report we summarise the existing liquefaction information (provided by Dellow et al. 2018¹) currently held in the Wellington City Council's corporate spatial database and provide advice on the soundness and limitations of the data used. We suggest that the existing binary maps detailing the liquefaction susceptibility in Wellington City are not robust enough to be included in formal documents such as a district plan. We recommended that confirmation of the reliability of the binary maps be undertaken using publicly available data that had since become available since 2011. I led the project and

¹ References contained in Appendix 1

provided the summary and advice. Both authors contributed to the final report.

18. In the Griffin et al. (2020) report we test the accuracy and reliability of the existing liquefaction maps currently in the District Plan using publicly available cone penetration test (CPT) data, groundwater, LiDAR and peak ground acceleration (PGA) data for two likely earthquake (fault source) scenarios and one probabilistic seismic hazard scenario that could affect Wellington City. The resulting maps are more site-specific than the existing maps and are based on specific CPT locations, showing the probability of liquefaction occurring at those specific CPT locations around Wellington City, along with the Liquefaction Severity Number (LSN), and an expression of liquefaction-induced damage that may occur. To produce these maps, we used representative CPTs from most CPT clusters around Wellington City, including five from the large cluster located at the Wellington Airport carpark building and groundwater levels recorded at the time the CPTs were taken. The mean peak ground acceleration and earthquake magnitude values are derived in accordance with the third edition of the NZTA Bridge Manual (NZTA 2018). A mean probabilistic seismic hazard for PGA for 10% probability of exceedance in 50 years is produced using the corrected version of the 2010 National Seismic Hazard Model (NSHM; Stirling et al. 2012) and a logic tree of ground motion characterisation models using specific site conditions. LiDAR data was used to precisely obtain the ground level elevation at each CPT site. These data were then run through liquefaction analysis software using the Boulanger and Idriss (2014) liquefaction-triggering method in conjunction with amendments as per the Canterbury MBIE guidance (October 2014), to obtain the overall probability of liquefaction occurring, LSN, and expression of liquefaction damage, for each of the three scenarios. The results were displayed on maps that were provided to WCC in digital form along with an accompanying methodology report. I led the project, selected the CPT sites and performed the liquefaction-triggering analysis, ER Abbott provided the PGA and earthquake magnitude scenarios data, and MP Hill and GJ Pradel provided assistance

with selecting suitable CPT locations to analyse and ground level elevation data.

19. The resulting maps from Griffin et al. (2020) are site-specific and fulfil the requirements for 'Level B – Calibrated Desktop Assessment' as specified in the 2017 MBIE document 'Planning and engineering guidance for potentially liquefaction-prone land Resource Management Act and Building Act aspects'.
20. I understand the Liquefaction Hazard Overlay layer shown in Proposed District Plan are based on the maps in Griffin et al. (2020) and Dellow et al. (2018). I have visually inspected the layer on the website ([Map - Wellington City Proposed District Plan](#)) and the maps in Griffin et al. (2020) report (Figures 7.1, 7.2 and 7.3).
21. The Overlays are clearly based on the data we produced for WCC, with the Low and Moderate liquefaction susceptibility zones of Dellow et al. (2018) not displayed. Dellow et al. (2018) and Griffin et al. (2020) do not specifically discuss which susceptibility zones should be included in the proposed District Plan. I agree with their exclusion due to the level of risk represented and the appropriateness of that risk being managed through district plan provisions.

Response to Submissions

22. Council officers have sought advice as to whether the below requested changes are appropriate from a technical perspective, particularly in terms of the location of liquefaction.

Submitter Name	Submission Point No.	Submission Point Text
Wellington International Airport Ltd	406.19	Opposes Liquefaction Hazard Overlay to the extent that they cover the Airport Zone. Considers that the engineering and design requirements of airport infrastructure, including the requirements under the CDEM to remain operational following a

		<p>natural hazard event, mean that liquefaction and flood hazard inundation cannot occur on site for operational reasons.</p> <p>Amend the extent of the Liquefaction Hazard Overlay to remove it from the extent of the Airport Zone.</p> <p>[Inferred Decision Requested]</p>
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23. The CDEM requirements for Wellington International Airport Limited are understood. However, while engineering and design may be to a level that mitigates liquefaction hazard for the airport infrastructure, the land itself has not been changed, and therefore the hazard itself exists.

Date: 13/06/2023



Angela Georgina Griffin

Appendix 1 – References

Boulanger RW, Idriss IM. 2014. CPT and SPT based liquefaction triggering procedures. Davis (CA): University of California Davis; Center for Geotechnical Modeling. 134 p. Report UCD/CGM-14/01.

Dellow GD, Perrin ND, Ries WF. 2018. Liquefaction hazard in the Wellington Region. Lower Hutt (NZ): GNS Science. 71 p. (GNS Science report; 2014/16).

[MBIE] Ministry of Business, Innovation and Employment. 2014. Wellington (NZ): MBIE. Updates and clarifications to the residential guidance. Issue 7 – October 2014; [accessed 2020 Oct].
<https://www.building.govt.nz/building-code-compliance/canterbury-rebuild/updates-clarifications-residential-guidance/canterbury-residential-guidance-update-issue-7/>

[NZTA] New Zealand Transport Agency. 2018. Bridge Manual. 3rd ed (amendment 3). Wellington (NZ): New Zealand Transport Agency. 342 p. (SP/M/022).

Stirling MW, McVerry GH, Gerstenberger MC, Litchfield NJ, Van Dissen RJ, Berryman KR, Barnes P, Wallace LM, Villamor P, Langridge RM, et al. 2012. National seismic hazard model for New Zealand: 2010 update. *Bulletin of the Seismological Society of America*. 102(4):1514–1542. doi:10.1785/0120110170.