Before Independent Hearing Commissioners
At Lower Hutt

Under	the Resource Management Act 1991 (the Act)
In the matter of	a notice of requirement for a designation by Wellington Water Limited ('WWL'), on behalf of Hutt City Council ('HCC'), in accordance with section 168A of the Act, for the construction, operation and maintenance of a water supply reservoir at Summit Road, Fairfield, Lower Hutt.

Statement of evidence of Campbell Keepa for Wellington Water Limited (Geotechnical Matters)

Dated 14 November 2024

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Statement of Evidence of Campbell Keepa

1 Introduction

1.1 My full name is Campbell Keepa.

1.2 I am a Technical Principal (Geotechnical Engineering) at WSP, based in Wellington. I have been in this position since February 2021. I am responsible for the geotechnical aspects of the project including assessing the stability of the site and its vulnerability to earthquakes.

1.3 This evidence relates to a notice of requirement ('**NOR**') for a designation prepared by Hutt City Council ('**HCC**'), in accordance with section 168A of the Resource Management Act 1991 ('**RMA**'), for the construction, operation and maintenance of the proposed Eastern Hills Reservoir adjacent to the existing Naenae Reservoir at Summit Road, Fairfield, Lower Hutt ('**Project**'). In particular, my evidence relates to geotechnical matters.

1.4 I have been asked to provide evidence by Wellington Water Limited.

1.5 I have been involved in this project as the geotechnical lead since the initial site selection phase, through the preliminary site investigations and site assessment. My role includes scoping site investigations to better understand the ground conditions at the site, and review of the geotechnical assessment that considers the stability of the site and foundation conditions for the proposed reservoir.

2 Qualifications and experience

2.1 My qualifications include a Bachelor of Engineering (Civil) from Auckland University and a New Zealand Certificate in Engineering (Civil) from Waikato Polytechnic. I am a member of Engineering New Zealand, the New Zealand Geotechnical Society and the Structural Engineering Society New Zealand ('**SESOC'**).

2.2 I have worked in the infrastructure consultancy field for over 25 years in New Zealand and overseas, specialising in geotechnical engineering and particularly in earthquake geotechnical engineering. Currently I am the geotechnical lead for bridge design on the northern section of the Otaki to North Levin (O2NL) project. Previously I have led the geotechnical design for Melrose Reservoir in Wellington, the Eastern Lakes reservoir in Rotorua, Ohauiti Reservoir in Tauranga and Mt Te Aroha reservoir.

3 Code of Conduct

3.1 While the NOR is not before the Environment Court, I have read and am familiar with the Code of Conduct for Expert Witnesses in the current Environment Court Practice Note (2023). Accordingly, I have complied with the Code in the preparation of this evidence, and will follow it when presenting evidence at the hearing.

3.0 The data, information, facts and assumptions I have considered in forming my opinions are set out in my evidence to follow. The reasons for the opinions expressed are also set out in my evidence to follow.

3.1 Unless I state otherwise, my evidence is within my sphere of expertise, and I have not omitted to consider material facts known to me that might alter or detract from the opinions that I express.

4 Scope of evidence

4.1 My evidence addresses the following:

a Site investigations and ground conditions;

b Reservoir design requirements;

c Seismic resilience, site stability and hazard risk;

d Response to submissions; and

e Response to Section 42A Officer's Report ('**Officer's Report**').

5 Executive summary

5.1 Preliminary site investigations and assessment of the site's stability has been carried out to confirm the feasibility of the site for the proposed water reservoir tank. The site is underlain by Wellington Greywacke rock with surficial residually weathered soils that are not susceptible to liquefaction. There are no known active faults through the site, but the site is in an area of high seismicity.

5.2 The proposed reservoir will be constructed on a cut platform, mostly on rock at the top of the ridge. Stormwater will be disposed of in a controlled manner. While there is a risk of shallow instability of the natural slopes around the site, the risk of instability affecting properties below will, if anything, be reduced.

5.3 The reservoir is considered a high importance facility (importance level of 4 out of 5 based on New Zealand Seismic Loadings Standard, NZS1170.5:2004) and will

be designed and constructed to withstand very high seismic demands compared to most other structures in the Hutt Valley. This may require slope stabilisation measures. The reservoir foundations will be designed to tolerate or withstand any residual ground displacements near the edge of the reservoir.

5.4 The investigations and assessment to date show the site and tank foundations can be engineered so that there is a very low risk of major rupture of the reservoir in very severe storms or strong earthquakes. Further site investigations and design will be carried out in the next phase of design to complete the design of the reservoir foundations and any slope stabilisation measures required.

6 Site investigations and ground conditions

6.1 I provided oversight of the preliminary site investigations and analysis that were carried out at the site to assess site stability and foundation conditions for preliminary design of the reservoir. Additional site investigations are planned in the next phase of the project.

6.2 The preliminary site investigations included mapping of the geotechnical features exposed at the surface, geophysical surveys, drilling three boreholes (approx. 100 mm dia) to depths between 33.0 m to 45.2 m and 15 window sampler investigations (small bore holes) to depths between 1.1 m and 3.6 m.

6.3 The site investigations show the ground conditions at the tank site consist of highly fractured sandstone and siltstone, commonly referred to as ‘Wellington Greywacke’. The greywacke rock has weathered to a stiff soil near the ground surface but increases in strength with depth. The ground at the base of the ridge, around the Waiwhetū Stream are younger alluvial sands, silts and gravels that have been deposited across the Hutt Valley floor.

6.4 Stability of the tank platform and preliminary design of the tank foundations was undertaken by WSP geotechnical engineers Mr. Rajashekhar Mekala and Dr. Zubair Nizamani under my supervision. The assessment is based on the investigations carried out to date and used a combination of dynamic finite element modelling and more conventional methods.

7 Reservoir design requirements

7.1 The reservoir will be designed for a very high level of resilience compared to most other infrastructure in the region. It will be relied upon to store water after storms and strong earthquakes when there may be substantial damage to other infrastructure and buildings in the area.

7.2 Buildings and infrastructure in New Zealand are classified under New Zealand Seismic Loadings Standard, NZS1170.5:2004 based on their importance, with higher importance structures designed to be more seismically resilient. The reservoir is classified as importance level 4 (out of 5). For comparison, houses and medium size office buildings are typically designated as importance level 2 and therefore designed for lower seismic performance.

7.3 Seismic demands used for design of new code compliant buildings are typically calculated using simplified methods in the New Zealand Seismic Loadings Standard, NZS1170.5:2004. The seismic hazard used to determine loads for design of the reservoir has been calculated in a special study by senior geotechnical engineer Mr Max Rossiter and reviewed by Dr Jeffrey Fraser using the 2022 revision of the New Zealand National Seismic Hazard Model. The loads in this special study are in the order of twice the loads calculated using the simplified method in NZS1170.5. Hence, the proposed reservoir will be designed for much larger seismic demands than most of the existing buildings in the Hutt Valley.

8 Seismic resilience, site stability and hazard risk

8.1 There are no known active faults nor evidence of previous deep seated slope instability at this site. The reservoir will be founded on rock and residual soils that are not susceptible to liquefaction. The sandy and silty alluvial soils at the base of the ridge and underlying the Hutt Valley are susceptible to liquefaction. However, I am not aware of any instances of liquefaction triggering in this area in recent history.

8.2 A shallow slip within the residual soils at the head of a small gully northeast of the reservoir was likely caused by a combination of erosion from water channelised into the gully and increased groundwater levels in a storm or period of prolonged wet weather.

8.3 To reduce the risk of damage and loss of service from slope instability in storms or earthquakes, the reservoir will be constructed entirely on a platform cut into the ridge so that reservoir is set-back from the surrounding natural slopes and predominantly founded on moderately weathered rock. Slope stabilisation measures such as soldier piles will be installed as necessary to meet the seismic design and slope stability requirements.

8.4 Surface water will be collected and disposed of in a controlled manner during the construction and life of the reservoir, thus reducing the risk of slope instability in

storms. Drainage will be installed beneath the tank to intercept leakage that could affect stability of the slopes and to aid in the detection of leaks.

8.5 Slope instability typically initiates at the top of slopes. By cutting the platform down and reducing the weight driving potential landslides at the top of the ridge, the risk of slope instability below the reservoir platform is reduced.

9 Response to submissions

9.1 I have reviewed the submissions lodged in relation to the resource consent applications for the Project. Where I am able to respond to the matters raised, I do this below. Mr Colin Holt is concerned about the projects of safety and potential property damage. The proposed reservoir will be designed to a very high seismic standard compared to other structures in the area and by reducing the amount of potentially unstable ground at the top of the slopes, safety is improved and the risk to property is reduced compared to the current situation. Mr Holt's observation of stream discolouration after earthquakes is unlikely to be liquefaction. If liquefaction near the base of the stream did occur there it would most likely be accompanied by lateral spreading of the stream banks and damage of the land in the near vicinity which there is no evidence of. The proposed reservoir will be founded on rock that is not susceptible to liquefaction.

9.2 Mr Richard Parry is concerned about the resilience of water supply where the proposed new reservoir is next to the current one and is exposed to similar site stability and seismic hazards.

9.3 While potentially exposed to similar slope hazards, the new tank will be constructed on a stable platform, engineered as necessary with structural elements such as piles or retaining structures if required to meet high standards ensuring a low probability of instability in storms or earthquakes.

10 Response to Section 42A Officer's Report

10.1 I have read the Officer's Report. The key discussion related to my evidence is contained in paragraphs 150 to 162. I agree with the planner's conclusion that with the appropriate technical analysis, investigation, and peer review of the ground conditions and applied engineering solutions, a reservoir can be appropriately designed for this site.

10.2 The intent is to do additional site investigations and analysis as part of next phase of the project. Further investigations and analysis are required in the proposed conditions.

10.3 Appendix 6 of the Officer's Report sets out Mr Adam Smith's geotechnical evidence, I agree with Mr Smith that additional deformation analysis should be undertaken as part of the reservoir design. This should occur once additional site investigations are complete to inform changes to the ground model used in the analysis. A geomorphological assessment of this site and other candidate sites was undertaken as part of the site selection process by Mr Dougal Mason. Mr Mason is currently completing a PhD with his thesis topic the seismic performance of slopes, and he previously carried out a slope failure susceptibility study of the Hutt City district. Mr Mason found no evidence of deep-seated instability at the site and noted that earthquake-induced landslide and other geohazard issues are significantly less than other sites that were considered as part of the site selection.

10.4 Peer review provides assurances to the quality of the engineering and is usually undertaken as part of the design phase for high importance structures. In my view, independent participatory peer review should be undertaken for this importance level 4 facility.

11 Conclusion

11.1 Considering the information currently available, my view is the site can be engineered to reduce any slope instability hazard and the tank foundations can be designed to meet the requirements of a resilient, high importance structure (importance level 4 as defined in the New Zealand Seismic Loadings Standard NZS1170.5)

Campbell Keepa

14 November 2024