

**BEFORE AN INDEPENDENT HEARING COMMISSIONERS APPOINTED BY
THE NELSON CITY COUNCIL**

IN THE MATTER OF

The Resource Management Act 1991
(**RMA or the Act**)

AND

IN THE MATTER OF

Hearing of Submissions and Further
Submissions on Plan Change 29 to the
NRMP

AND

IN THE MATTER OF

Submissions and Further Submissions
on Proposed Plan Change 29 by

BAYVIEW NELSON LIMITED

GP INVESTMENTS LIMITED

NELSON NORTH LIMITED

SUFFOLK HEIGHTS LIMITED

588 LIMITED

**SUPPLEMENTARY STATEMENT OF GEOTECHNICAL EVIDENCE OF
SALLY HARGRAVES**

Dated: 9 September 2024

INTRODUCTION

1. My full name is Sally Victoria Hargraves. I am the Director of GeoSolutions NZ Limited and a Professional Engineering Geologist.
2. My experience, qualifications, details of my engagement and agreement to comply with the Code of Conduct is set out in my primary Statement of Evidence dated 5 July 2024. Technical references given in that document are not repeated here. New references are listed at the end of this statement.
3. I attended expert conferencing on 31 July 2024. Details of the items agreed and still outstanding are given in the Joint Witness Statement (JWS) of 31 July 2024.
4. I have read the Rebuttal Statements and Summary Statements of Mr Dan Chamberose and Ms Janice Carter. I watched a recording of their presentations during the Hearing on 27 August 2024, along with their responses to queries raised by the Commissioners.

SCOPE OF MY EVIDENCE

5. In the additional evidence presented below I discuss each of the natural hazards in the following order – Liquefaction, Fault Rupture and Slope Instability. For each hazard, I present the position I have come to for each of the overlays (maps) and the rules. I then discuss further some of the questions raised by the commissioners in the Hearing on 27 August during their questioning of Mr Chamberose and Ms Carter.
6. I then finish with a summary of outstanding issues and my recommendations.

LIQUEFACTION HAZARD

7. In my opinion, the liquefaction overlay is fit for purpose.
8. The liquefaction rules were not discussed at the expert conferencing, however given the later discussion on rules with respect to slope instability, the following additional inputs are also considered relevant for liquefaction:

- 8.1 There needs to be pathway for sites where an existing geotechnical assessment is available.

- 8.2 Geotechnical report validity to be 7 years. There is further discussion on this later, under Slope Instability (Section 41.4 and 41.5).

FAULT RUPTURE HAZARD

9. Fault overlays

- 9.1 Revised mapping has been sought in areas where this was found to be inaccurate or where new information is available. Mr Chamberose has either already updated the maps or has agreed to update the maps to reflect the new information.
- 9.2 Since the expert conferencing, Mr Chamberose has confirmed that no areas were added to the Slope Instability Susceptibility overlays purely as a result of their being located within 100 m of a fault (per the Slope Instability Susceptibility methodology tree). There is therefore no need to continue discussion on this aspect of the Beca methodology (for slope instability mapping).
- 9.3 On the basis of the above, the updated Fault overlays are expected to be sufficiently accurate for their intended purpose.

10. Fault Rules

- 10.1 The discussion around the rules associated with the fault hazard is unresolved. I am strongly opposed to the stance taken in the current proposed regulations, on which both Mr Chamberose and Ms Carter have confirmed their position. Contrary to the recommendations given in the National Guidance on the subject, the current proposal has no regard for the activity level of any given fault, the proposed nature of the development, or whether that development is in a built environment or greenfield location. There is more discussion on this in Sections 11 to 32, below.

ADDITIONAL COMMENTS – FAULT HAZARD

11. Earthquakes occur when faults move. When the land on one side of a fault moves with respect to the other, this generates an earthquake. In some cases, if the fault movement continues to the ground surface, a rupture is observed at the surface. The movement can be horizontal, vertical or both. The movement of faults can have several different effects – ground shaking and fault rupture. Ground shaking is what can lead to liquefaction of the ground in some circumstances. Fault or surface rupture only happens if the fault movement propagates all the way to the ground surface. The majority of fault movement does not result in rupture of the land at the ground surface. Ground shaking, fault rupture and liquefaction are often termed ‘seismic effects’.

12. NZS 1170.0 2002 sets out requirements for building design. Table 3.3 of that document (attached below) sets out design requirements for various natural hazards – wind, snow and earthquake. As given in my primary evidence, each building has two design states it must consider – SLS (serviceability limit state), in which the building should be readily repairable such that the occupant can return reasonably quickly; and ULS (ultimate limit state), for which the building may be damaged beyond economic repair, but the occupiers must be able to safely get out of the building (life safety).

13. Table 3.3 states that for an Importance Level 2 (IL2) building (normal structure e.g. house) with a design life of 50 years, the ULS event is defined as a 1:500 year event and the SLS event is defined as a 1:25 year event, both for earthquake hazard – see highlighted box on Table 1 below.

TABLE 3.3
ANNUAL PROBABILITY OF EXCEEDANCE

Design working life	Importance level	Annual probability of exceedance for ultimate limit states			Annual probability of exceedance for serviceability limit states	
		Wind	Snow	Earthquake	SLS1	SLS2 Importance level 4 only
Construction equipment, e.g., props, scaffolding, braces and similar	2	1/100	1/50	1/100	1/25	
Less than 6 months	1	1/25	1/25	1/25	—	
	2	1/100	1/50	1/100	1/25	
	3	1/250	1/100	1/250	1/25	
	4	1/1000	1/250	1/1000	1/25	
5 years	1	1/25	1/25	1/25	—	—
	2	1/250	1/50	1/250	1/25	—
	3	1/500	1/100	1/500	1/25	—
	4	1/1000	1/250	1/1000	1/25	1/250
25 years	1	1/50	1/25	1/50	—	—
	2	1/250	1/50	1/250	1/25	—
	3	1/500	1/100	1/500	1/25	—
	4	1/1000	1/250	1/1000	1/25	1/250
50 years	1	1/100	1/50	1/100	—	—
	2	1/500	1/150	1/500	1/25	—
	3	1/1000	1/250	1/1000	1/25	—
	4	1/2500	1/500	1/2500	1/25	1/500
100 years or more	1	1/250	1/150	1/250	—	—
	2	1/1000	1/250	1/1000	1/25	—
	3	1/2500	1/500	1/2500	1/25	—
	4	*	*	*	1/25	*

Table 1. SLS and ULS Design Requirements - Table 3.3 from NZS 1170.0 2002 Structural design actions.

14. To clarify, if the earthquake is a 1:75 year event, then there would be no requirement for the building to be designed for repairability, it only needs to ensure life safety. Similarly, if the earthquake is a 1:750 year event, there is actually no requirement in the Building Code to ensure life safety – the event would exceed the design requirement. Having said that, we will usually try to include some resilience in the design where possible, especially in regard to life safety.

15. Several faults have ruptured beneath buildings historically in NZ. In all known cases, the occupant was able to safely exit the building and no loss of life occurred. The buildings were usually heavily damaged, often beyond repair. These would all have met the design requirements of NZS 1170.0.

16. In Mr Chamberose’s presentation to the panel on 27 August, he stated that there was no way to prevent damage, we can only minimise damage in a fault rupture event. In discussing this, he started talking about how the buildings would need to be repaired or ‘relevelled’ following such an event. As given above, NZS 1170.0 does not require us to design buildings that can be repaired or lived in again following a fault rupture event. This is an important distinction – when designing for a large earthquake, we only need to target life safety; not repairability. NZS 1170.0 requires this for a 1:500 year event and the activity level of most Nelson faults is well over 1:5,000 years; a considerably lower likelihood.

17. As given in my primary evidence, the 2003 MfE and GNS Planning Guideline for Active Faults (MfE Guideline) refers to similar Building Importance Categories (BIC) and considers which buildings may be located across which faults (Table 9.2 of that Guideline, included below).

Table 9.2: Relationship between fault recurrence interval and Building Importance Category

Recurrence interval class	Fault recurrence interval	Building importance category (BIC) limitations* (allowable buildings)	
		Previously subdivided or developed sites	“Greenfield” sites
I	≤2000 years	BIC 1	BIC 1
II	>2000 years to ≤3500 years	BIC 1 and 2a	
III	>3500 years to ≤5000 years	BIC 1, 2a and 2b	BIC 1 and 2a
IV	>5000 years to ≤10,000 years	BIC 1, 2a, 2b and 3	BIC 1, 2a, and 2b
V	>10,000 years to ≤20,000 years		BIC 1, 2a, 2b and 3
VI	>20,000 years to ≤125,000 years	BI Category 1, 2a, 2b, 3 and 4	

Note: Faults with average recurrence intervals >125,000 years are not considered active.

Table 2. Extract from Table 9.2 of the 2003 MfE and GNS Planning Guideline for Active Faults

18. Despite all this, Mr Chamberose and Ms Carter have reverted to their original position, that all faults should be avoided at all cost, which is neither a pragmatic nor development-friendly approach. Nor does it respect the MfE Guidelines

19. In a more recent GNS report prepared for Wellington City Council (GNS Consultancy Report 2020/57 “Active Fault Mapping and Fault Avoidance Zones for Wellington City”), GNS agree (in part) that “*the surest and most successful way to mitigate*

the damage and loss that may results for ground-surface fault rupture is to avoid the hazard (i.e. to not build across the fault). However, we acknowledge that there has been significant urban development over the Wellington, Aotea and Evans Bay Faults ... In this instance it may be more practicable to mitigate the fault rupture hazard through engineered solutions rather than by fault avoidance, if it is feasible to reduce the risk to an acceptable level."

20. They go on to say that the aim of such foundation solutions should be to avoid collapse (i.e. preserve life safety). Appendix 2 of that report provides examples from NZ earthquakes showing the impact of fault surface rupture on residential structures. The plates below are copied from that report. The order of magnitude of movement shown in Plates 1C and D below is what might also be expected for the Waimea-Flaxmore system.



Plate 1B to D. B: Kekerengu Fault (2016); C & D Greendale Fault (2010) (Source: GNS Consultancy Report 2020/57)

21. Even at Kekerengu, where the fault moved 8m laterally and between 2 to 3m vertically (*i.e. greater than the average movement on the local fault systems*), the lightweight timber-framed building stayed relatively intact (no windows were broken), did not collapse and the occupant exited the building while it was shaking.

22. In Section A2.5 of the report, it refers to the MfE Guidance, recommending that a BIC2 structure, located in proximity or across a fault with a recurrence interval of $\leq 3,500$ years, be considered a Discretionary activity. It goes on however, to say that given the life-safety focus of the MfE document and the non-collapse performance requirement for BIC 2a structures, consideration could be given to adopting a more permissive resource consent category such as Controlled.

23. So, in 2021-2022, not only are GNS confirming that the guidance given in the 2003 MfE document is still appropriate and applicable to the faults of the Wellington Region,

they're saying that Councils could adopt more permissive settings than those given in the Guidance.

24. NCC's current approach is the opposite of this advice. They are pushing for complete avoidance for all faults, for nearly all new buildings and structures, regardless of consideration of recurrence interval – that is neither proper or practical.

25. I repeat my original recommendation that Council should adopt the Resource Consent Activity Status recommendations given in Tables 11.1 and 11.2 from the 2003 MfE Guidance, extract below, with full tables attached in Appendix A).

Table 11.1: Resource consent activity status for greenfield sites

Building importance category	1	2a	2b	3	4
Fault complexity	Activity status				
Fault recurrence interval class I less than or equal to 2000 years					
A – Well defined	Permitted	Non-complying	Non-complying	Non-complying	Prohibited
B – Distributed	Permitted	Discretionary	Non-complying	Non-complying	Non-complying
C – Uncertain [†]	Permitted	Discretionary	Non-complying	Non-complying	Non-complying
Fault recurrence interval class II greater than 2000 but less than or equal to 3500 years					
A – Well defined	Permitted	Non-complying	Non-complying	Non-complying	Prohibited
B – Distributed	Permitted	Discretionary	Non-complying	Non-complying	Non-complying
C – Uncertain [†]	Permitted	Discretionary	Non-complying	Non-complying	Non-complying
Fault recurrence interval class III greater than 3500 to but less than or equal to 5000 years					
A – Well defined	Permitted	Permitted*	Non-complying	Non-complying	Non-complying
B – Distributed	Permitted	Permitted	Discretionary	Discretionary	Non-complying
C – Uncertain [†]	Permitted	Permitted	Discretionary	Discretionary	Non-complying

Table 3: Extract from Table 11.1 (Source: Planning for Development of Land on or Close to Active Faults. MfE/GNS 2003)

26. The highlighted box above indicates where greenfield subdivision would sit for most of the faults in the Nelson region.

27. For comparison, the following tables indicate the data for Wellington City. Table 3.1 presents the estimated recurrence intervals for the active faults in Wellington City. As expected, the Wellington Fault, which is part of the Alpine Fault System and one of NZ's major fault lines, has a recurrence interval of RIC I i.e. expected to rupture more frequently than once every 2,000 years.

Table 3.1 Recurrence Interval Classes of known active faults within Wellington City. For more detail, see Kerr et al. (2003) and Van Dissen et al. (2003).

Fault Name	Recurrence Interval Class	Recurrence Interval Range of Respective Recurrence Interval Class	Confidence of Recurrence Interval Classification*
Wellington Fault	I	≤2000 years	High
Ohariu Fault	II	>2000 years to ≤3500 years	Medium–Low
Aotea Fault	III	>3500 years to ≤5000 years	Medium
Shepherds Gully Fault	III	>3500 years to ≤5000 years	Low
Evans Bay Fault	IV	>5000 years to ≤10,000 years	Medium
Moonshine Fault	IV	>5000 years to ≤10,000 years	Low
Terawhiti Fault	IV	>5000 years to ≤10,000 years	Low

Table A3.2 Example of relationships between Resource Consent Category, Building Importance Category, fault Recurrence Interval Class and Fault Complexity for Greenfield sites, based on the MFE Active Fault Guidelines (Kerr et al. 2003).

Greenfield Sites					
WELLINGTON FAULT (based on fault Recurrence Interval Class I, ≤2000 years)					
Building Importance Category	1	2a	2b	3	4
Fault Complexity	Resource Consent Category				
Well-defined and well-defined extended	Permitted	<i>Non-Complying</i>	<i>Non-Complying</i>	<i>Non-Complying</i>	Prohibited
Distributed and uncertain constrained	Permitted	<i>Discretionary</i>	<i>Non-Complying</i>	<i>Non-Complying</i>	<i>Non-Complying</i>
Uncertain poorly-constrained	Permitted	<i>Discretionary</i>	<i>Non-Complying</i>	<i>Non-Complying</i>	<i>Non-Complying</i>

Greenfield Sites					
SHEPHERDS GULLY FAULT (based on fault Recurrence Interval Class III, >3500 years to ≤5000 years)					
Building Importance Category	1	2a	2b	3	4
Fault Complexity	Resource Consent Category				
Well-defined and well-defined extended	Permitted	<i>Permitted*</i>	<i>Non-Complying</i>	<i>Non-Complying</i>	<i>Non-Complying</i>
Distributed and uncertain constrained	Permitted	<i>Permitted</i>	<i>Discretionary</i>	<i>Discretionary</i>	<i>Non-Complying</i>
Uncertain poorly-constrained	Permitted	<i>Permitted</i>	<i>Discretionary</i>	<i>Discretionary</i>	<i>Non-Complying</i>

Table 4. Extracts from GNS Consultancy Report 2020/57 “Active Fault Mapping and Fault Avoidance Zones for Wellington City”

28. The first part of Table A3.2 shows the recommended resource consent categories for the RIC I Wellington Fault. The second part is for the RIC III Shepherds Gully Fault, which has a similar activity level (recurrence interval) to most of those in the Nelson Region.

29. Wellington City Council have clearly followed the guidance given in Table 11.1 and 11.2 in the MfE Guidance.

30. The same approach was used in West Coast, Central Hawkes Bay, Hastings and Palmerston North - all of which refer to these same recommendations and the same resource consent categories.

31. The main point of difference from Nelson's approach, is having the rules linked to the recurrence interval (activity level) of each fault and the type of structure proposed; which Nelson does not.

32. In my recent discussions with various people at Quake Core, GNS, MBIE and Canterbury University, any proposal to update the MBIE Guidance in the future would likely focus on including more pathways for construction within previously defined avoidance zones, with more advice around the most suitable construction practices for this purpose. To my knowledge, there is no current plan to change the resource management process or to adjust the recommendations currently given in Tables 11.1 and 11.2.

QUESTIONS ARISING (FROM THE HEARING – 27 AUGUST)

33. The Commissioner asked if *“the proposal was to have a 20 m wide offset and then have guidelines on what could be built within that restricted area?”*

33.1 Mr Chamberose responded saying that if you are located within the restricted area, the rules would require you to complete investigations to find the fault and then to offset the building from it.

33.2 I comment: The current rules make no differentiation between greenfield Vs urban setting; small addition Vs new house Vs new 5 storey building; or a fault with an occurrence interval of 3,500 years or 100,000 years. The proposed rules do not allow buildings to be designed for the anticipated movement, they allow only for offsets.

34. The Commissioner asked if *“it wasn't possible to achieve the required offset, what Mr Chamberose would consider to be the happy balance?”*

- 34.1 Mr Chamberose responded saying that if it was at subdivision stage, it would be easy to avoid. For buildings, he said there was no way to prevent damage, we can only minimise damage, and went on to talk about possible relevening after. Hence the focus on avoidance.
- 34.2 I comment: The Building Code and NZS 1170.0 does not require us to design houses that are not damaged in such a rare event. They do not need to be repairable, only to not collapse. As Mr Chamberose mentioned in his rebuttal, there are plenty of ways now to design buildings so that they would not be expected to collapse in a fault rupture event. Refer also Appendix A from the GNS report for Wellington City Council (GNS Consultancy Report 2020/57) which is discussed in more detail in Section 27.
- 34.3 Mr Chamberose also talked about the order of magnitude of movement on these faults being up to 5 m vertically.
- 34.4 In the abstract of the 2006 paper by Fraser, Nicol, Pettinga & Johnston “Paleoearthquake Investigation of the Waimea-Flaxmore Fault System, Nelson, New Zealand”, it states “*The Waimea-Flaxmore Fault System passes through Nelson City and Richmond and comprises active traces with mainly reverse displacements that formed during large magnitude surface-rupturing earthquakes. The size and timing of some of these prehistoric earthquakes has been constrained by geomorphological mapping and fault trenching at two sites... Three seismic events on the fault occurred ... Cumulative vertical displacement of about 3.5 m accrued during these events, with average slip/event and slip rates of approximately 1.0 m and 0.2 mm/yr respectively.*”
- 34.5 Clearly the 5m mentioned by Mr Chamberose was a substantial exaggeration, as the average movement on these faults is closer to a metre. Where buried under alluvial or colluvial deposits, the ground surface would be expected to deform rather than rupture, with the vertical movement component of that movement being considerably less than a metre.
35. The Commissioner asked if “*the approach to risk should be different for faulting and instability hazards?*”

35.1 Mr Chamberose responded saying that in both cases, the best option is to avoid, but if you can't avoid, then to design to mitigate the damage.

35.2 I comment as follows:

Firstly, I agree with the above, but note that is not how the current rules for either hazard have been written.

I would add that if we took the same approach to instability as NCC are taking to fault rupture, that we wouldn't be building on any slopes at all; which seems absurd. There are standard building techniques, earthworks and retaining methods, that allow for safely building on sloping ground, even very steeply sloping ground.

In addition, I note that the current rules for fault rupture target avoidance and do not allow for mitigation of damage using earthworks and building design, as is permitted in the GNS report for Wellington City Council.

FAULT HAZARD - CONCLUSION

36. In my opinion, there is no technical justification for Nelson City Council to adopt a hybrid approach, when there is sound guidance on the subject, that has been available for over twenty years and has been actively used and adopted elsewhere. If Nelson City Council continues as currently proposed, it would be an extreme outlier compared to other Territorial Authorities in New Zealand, with excessively conservative restrictions. Wellington, Palmerston North, West Coast, Hawkes Bay and Hastings, amongst others, all use the approach recommended in the 2003 MfE Guidance as set out in Tables 11.1 and 11.2 of that document.

37. In its current form, the proposed approach is not fit for purpose.

FAULT HAZARD - RECOMMENDATION

38. The maps can be left as they are, although annotating these with recurrence interval would be a useful additional step.

39. As given in my primary evidence, I strongly recommend Council adopt the regulatory approach set out in Tables 11.1 and 11.2 of the MfE Guidance (appended as Figures 1 and 2).

SLOPE INSTABILITY HAZARD

40. Slope Instability - Overlays

- 40.1 Methodology – the methodology tree presented in the Beca report was not discussed in much detail during the expert conferencing, as most of the issues were around the flawed application of that methodology. The inclusion of offsets from faults was briefly discussed, as was the identification of ‘geomorphic evidence of slope instability’ which is a key trigger for application of the overlay. I recommend a review of the methodology tree to confirm validity, application and extent of influence of each of the triggers.
- 40.2 At the Hearing Mr Chamberose alluded to the reasons for the combination of Tier 2 and Tier 3 being due to areas of land that may have been mapped as Tier 2 whilst being more likely Tier 3 and vice-versa. In effect, here he is agreeing with the argument that the application of the methodology to the maps is indeed flawed. However, the real reason for the proposed combination of Tier 2 and Tier 3 maps, was to remove any perception of increasing risk associated with the different levels or tiers, and to bring it back to an reflection of susceptibility only, per the original Beca report.
- 40.3 Several flaws have been identified where applying the Beca methodology to the maps (refer details given in Mr Lines primary evidence). In my opinion, the mapping flaws identified by Mr Lines are fundamental and not a difference in interpretation between GeoProfessionals or a result of availability of site-specific information. This issue has been masked by the proposal to combine Tier 2 with Tier 3, but was not a reason for the combination of tiers.
- 40.4 Debris run-out – in my primary evidence, I suggested that the debris run-out map could be separated out from the other maps to also include the hillsides above. My concerns mainly focussed on repeated evidence of poor identification of debris run-out risk from local practitioners in recent years,

resulting in numerous buildings damaged by landslips arising from properties above. During expert conferencing, this was discussed in more detail and it was agreed that the issue of poor practitioner performance was not one that should be solved by separating out the various maps. I have therefore withdrawn this request and now agree that there is no need to change the Debris Run-out overlay.

- 40.5 Naming – I strongly disagree with any proposed continuation of the current naming – “Slope Instability Susceptibility” and use of the word “Tiers”. Both of these aspects of the current proposed names have caused an issue with the insurers as well as in the housing sale and purchase market. Regardless of whether this was unintentional or not, it is vital that the name of this mapped area can be understood by those who are not experts in this field and will not just assume all land is unstable in the area. I recommend the term **“Slope Management Area”** be used for all land currently located within both Tiers 2 and 3 of the Slope Instability Susceptibility maps and the word “Tier” deleted from all overlays. The term “Management” clearly indicates that any property in this area will need some form of management or technical input to determine whether it is or is not currently unstable and whether the proposed works might destabilise the site or not; whilst not implying the whole area is unstable.
- 40.6 The Slope Instability Susceptibility Tier 1 area (Tahunanui Slump) – should be renamed to make it more pronounceable and to remove any reference to ‘tiers’. The new name could reflect the original NRMP naming, whilst removing the references to ‘core/fringe’ and ‘risk’ i.e. **Tahunanui Slump Slope Instability Area**. Tiers imply increasing risk and, as previously discussed, these maps do not consider risk, a matter that Council’s witnesses confirm.

41. Slope Instability - Rules

- 41.1 At expert conferencing, lengthy discussion was had with respect to whether the proposed rules needed to address buildings or not. I pointed out that the Building Act has robust rules on natural hazards and particularly slope instability, requiring geotechnical assessment to consider risks associated with

new buildings and ensuring the work does not instigate instability and that there are no offsite effects (refer Sections 71 to 74 of the Building Act). As a result, Ms Carter has agreed to drop the rules associated with building triggers, leaving that to the Building Act, focussing instead on earthworks and servicing triggers.

- 41.2 It is important to note however, that just because a site is located in a 'susceptibility overlay' or 'Slope Management Area', the widespread use of notifications per s73 of the Building Act, is not considered to be an acceptable approach and I would seek for Nelson City Council to publically confirm at this hearing, that this is not their intended approach. There are clear pathways for triggering of such notifications and they need to be applied with extreme caution as they have far-reaching repercussions.
- 41.3 It was agreed by all experts that there needs to be a pathway for land with existing geotechnical information. The wording suggested in Para 18 of Ms Carter's Addendum 1A to the Section 42A report is generally acceptable, although more clarification is required as given in Section 41.5 below.
- 41.4 The proposed 7 year timeframe for geotechnical report validity does not refer to the validity of the data, analysis or conclusions. It refers to the length of time that a professional indemnity insurer will provide cover for a geotechnical report.
- 41.5 Where the report is older than this, the conclusions and recommendations may still be as valid as the day it was written, but it would be appropriate for Council to request the original author to re-confirm this in writing, thus 'refreshing' the report and ensuring that the opinion is renewed in terms of indemnity insurance. There would not necessarily be any need for a whole new report, a simple plan review letter would likely suffice, where the original author reviews the latest proposals and confirms their original advice is still applicable for that proposal. The wording of the rule needs to reflect this, as there is the potential for costly and unnecessary additional geotechnical investigation and reporting to be requested without such clarification in the rules.

- 41.6 The rules suggested as triggers for resource consent being required in the 'Slope Management Area' are currently flawed and don't achieve the intended purpose. I here refer to the latest statement from Mr Lines.
- 41.7 In the expert conferencing session, we discussed the use of maximum cut and fill heights – which are certainly appropriate triggers; but the volumes suggested by Mr Chamberose and Ms Carter are not appropriate. As Mr Lines points out in his supplementary evidence, this wouldn't even allow for geotechnical investigations to be completed at the site without resource consent.
- 41.8 Mr Lines and I have discussed a number of different options, agreeing on the following proposed triggers. Where any of these is triggered, resource consent would be required to assess the geotechnical risk arising.

CUT HEIGHT
a) max cut height =1.2 <u>and</u> ,
b) the sum of cut height multiplied by cut length must not exceed 6.
CUT VOLUME
c) max cut volume 30 m ³
FILL
d) max fill height 0.6 m, or
e) max fill volume 10 m ³ , or
f) no fill to be placed on slopes steeper than 18 degrees

Table 5. Proposed triggers requiring resource consent for earthworks in the "Slope Management Area".

- 41.9 These were developed for the reasons given in the following sections.
- (a) There are two main types of instability to be prevented. The first is for sites including moderate to steep slopes. The risk here, is that of someone cutting out the toe of the slope at the top end of their site and potentially destabilising the hillside above. This would cover probably 90% of the sites in the current Slope Management Area. The other 10% might comprise slightly more gentle to moderate slopes, but in areas of previous instability or where the underlying geology is more prone to instability. In these areas, removal of bulk weight from the

lower part of the previous slip might instigate reactivation, affecting multiple properties. Similarly, the addition of excess additional weight at the top, might have the same effect.

- (b) Triggers a+b, d and f are intended to address the risk of localised instability for the majority of the sites, whilst the volume triggers (c and e) are intended to capture the risks associated with the larger-scale features.
- (c) I would expect the majority of proposed earthworks to be captured by the restrictions on height of cut or fill, with the volume triggers acting as a safety net for those larger-scale features.
- (d) The placement of any fill on slopes steeper than 18° (or one vertical to 3 horizontal) has the potential to not only become unstable in and of itself, but to also destabilise the surrounding slopes. For this reason, trigger (f) has also been added.

QUESTIONS ARISING (FROM HEARING – 27 AUG)

42. On the subject of updating the maps using 2022 LiDAR, the Commissioner asked *“notwithstanding the change in landform that gets detected by LiDAR, is it also an important element of assessment, the means by which that landform has changed? So, a resource consent is granted for earthworks [completed under the direction of a geoprofessional] which have resulted in a stable landform, versus a landform that may have been altered through less engineered means. Is that level of assessment and authorisation also critical in terms of determining the potential for instability of changed landforms?”*

42.1 I comment: in my opinion, Mr Chamberose did not answer the question that was asked.

42.2 My understanding of what was asked, is that when a new LiDAR data set is brought in, are any checks made as to whether the works completed to create that change in landform were completed under engineer guidance and/or certified as stable. My reading of the Beca report is that no, the new landform is taken at its face value and the methodology applied. So, if the land had

been reworked by earthworks so that it no longer meets any of the triggers in the methodology tree, it would fall off the susceptibility map, with no checks necessarily being completed to confirm these works were completed under engineer design. This is another flaw in the current methodology.

43. On the subject of why engineered landforms could not be allowed for in the mapping, Mr Chamberose responded that earthworks are often designed to a certain standard or to meet certain Codes, with maintenance requirements etc and it would be difficult to allow for all this. The Commissioner asked *“why should the maps add another layer of precaution on top of what Council already requires for resource consent certification?”*

43.1 Mr Chamberose said it was a good question. In essence, his preference would be for this issue to be dealt with in the rules rather than in the maps. His reasoning being that if land use changed in the future, there should still be some reflection of the original landform and its original susceptibility to instability.

43.2 I comment: It would not be a complicated or onerous process for Council to keep track of engineered landforms and to collate these into a separate **Engineered Landforms Overlay**. GeoProfessionals would simply create a plan in their subdivision certification reports showing the area of engineered / stabilised land as an extra plan to be supplied digitally to Council upon application for 224 certificate. These would then be collated at Council and added to the Engineered Landforms Overlay as a map outside the plan. The rules would then be changed to allow exemption from Slope Management Overlay rules for sites within this overlay.

SLOPE INSTABILITY - SUMMARY

44. Methodology – not entirely agreed upon, but individual elements not in dispute at present.

45. Issues with flawed application of methodology to overlays, mostly addressed by the merging of these two tiers.

46. I have withdrawn my request for a separate Debris Run-Out overlay.
47. Tiers 2 and 3 to be combined to remove any association with risk.
48. I disagree with the proposed name for the combined overlay and instead propose **Slope Management Area** which will cause less confusion and hopefully reduce issues with insurance. It also aligns much better with the existing planning regulations around instability which use a Land Management Overlay.
49. Change “Slope Instability Susceptibility Tier 1 area (Tahunanui Slump)” to **Tahunanui Slump Slope Instability Area**.
50. The proposed rules for the “Slope Management Area” need to allow for a pathway not requiring resource consent where existing geotechnical information exists. In Section 41.5 I have suggested some areas where additional clarification is needed to the wording suggested by Ms Carter.
51. Create a separate **Engineered Landforms Overlay** to sit outside the Plan. This can be updated with new information as subdivision certification reports provide the information to Council. New rules would allow exemption from resource consent triggers where development is proposed in this area.
52. In conjunction with Mr Lines, I have suggested alternative triggers for resource consent being needed with respect to earthworks. These are presented and discussed in Sections 41.8 and 41.9.
53. Clarification is required around wording to ensure the new rules will not trigger bulk application for notifications per s73 of the Building Act, simply because a site is located within a ‘Slope Management Area’. This is not an appropriate use of Sections 71 to 74 of the Building Act and we would seek confirmation that this is not Council’s intent.

OVERALL CONCLUSION

54. The liquefaction overlays are fit for purpose.
55. The fault overlays are fit for purpose.
56. The slope instability overlays are not fit for purpose.

57. The rules associated with liquefaction hazard are generally appropriate. Some additional minor clarification required with respect to a pathway for sites with previous geotechnical reporting and validity of that reporting.

58. The rules associated with fault hazard are not fit for purpose and are excessively conservative. They do not follow the MfE Guidance and are out of step with how the other Territorial Authorities in New Zealand are operating.

59. The rules associated with slope instability hazard are not fit for purpose and require considerable change to reflect the issue with the maps. Some suggestions have been made with respect to naming of the various overlays, triggers for earthworks and ways to deal with engineered landforms, amongst others.

Dated 9 July 2024

A handwritten signature in black ink, appearing to read 'S Hargraves', with a long horizontal flourish extending to the right.

Sally Hargraves

Professional Engineering Geologist

Principal and Director, GeoSolutions NZ Limited

ADDITIONAL REFERENCES

- 2006 Fraser JG, Nicol A, Pettinga JR & Johnston MR, 2006, "Paleoearthquake Investigation of the Waimea-Flaxmore Fault System, Nelson, New Zealand"
- GNS Consultancy Report 2020/57 "Active Fault Mapping and Fault Avoidance Zones for Wellington City"
- GNS Consultancy report 2018/75: Active Fault Mapping and Fault Avoidance Zones for Horowhenua District and Palmerston North City
- GNS Consultancy Report 2015/112: active Fault mapping and Fault Avoidance Zones for Hastings District and environs
- GNS Consultancy Report 2013/151: Active Fault Mapping and Fault Avoidance Zones for Central Hawkes Bay District: 2013 update
- GNS Consultancy report 2009/18: Mapping and fault rupture avoidance zonation for the Alpine Fault in the West Coast Region

Attachment A – Figures

Figure 1 – Table 11.1 from the 2003 MfE Guidance

Table 11.1: Resource consent activity status for greenfield sites

Building importance category	1	2a	2b	3	4
Fault complexity	Activity status				
Fault recurrence interval class I less than or equal to 2000 years					
A – Well defined	Permitted	Non-complying	Non-complying	Non-complying	Prohibited
B – Distributed	Permitted	Discretionary	Non-complying	Non-complying	Non-complying
C – Uncertain [†]	Permitted	Discretionary	Non-complying	Non-complying	Non-complying
Fault recurrence interval class II greater than 2000 but less than or equal to 3500 years					
A – Well defined	Permitted	Non-complying	Non-complying	Non-complying	Prohibited
B – Distributed	Permitted	Discretionary	Non-complying	Non-complying	Non-complying
C – Uncertain [†]	Permitted	Discretionary	Non-complying	Non-complying	Non-complying
Fault recurrence interval class III greater than 3500 to but less than or equal to 5000 years					
A – Well defined	Permitted	Permitted*	Non-complying	Non-complying	Non-complying
B – Distributed	Permitted	Permitted	Discretionary	Discretionary	Non-complying
C – Uncertain [†]	Permitted	Permitted	Discretionary	Discretionary	Non-complying
Fault recurrence interval class IV greater than 5000 but less than or equal to 10,000 years					
A – Well defined	Permitted	Permitted*	Permitted*	Non-complying	Non-complying
B – Distributed	Permitted	Permitted	Permitted	Discretionary	Non-complying
C – Uncertain [†]	Permitted	Permitted	Permitted	Discretionary	Non-complying
Fault recurrence interval class V greater than 10,000 but less than or equal to 20,000 years					
A – Well defined	Permitted	Permitted*	Permitted*	Permitted*	Non-complying
B – Distributed	Permitted	Permitted	Permitted	Permitted	Non-complying
C – Uncertain [†]	Permitted	Permitted	Permitted	Permitted	Non-complying
Fault recurrence interval class VI greater than 20,000 but less than or equal to 125,000 years					
A – Well defined	Permitted	Permitted*	Permitted*	Permitted*	Permitted*
B – Distributed	Permitted	Permitted	Permitted	Permitted	Permitted**
C – Uncertain [†]	Permitted	Permitted	Permitted	Permitted	Permitted**

Note: Faults with a recurrence interval of greater than 125,000 years are not considered active.

* The activity status is permitted, but could be controlled or discretionary because the fault location is well defined.

** Although the activity status is permitted, care should be taken in locating BIC 4 structures on or near known active faults. Controlled or discretionary activity status may be more suitable.

† Where the fault trace is uncertain, specific fault studies may provide more certainty on the location of the fault. Moving the fault into the distributed or well defined category would allow a reclassification of the activity status and fewer assessment criteria.

Italics show that the activity status is more flexible. For example, where *discretionary* is indicated, controlled activity status may be considered more suitable.

Figure 2 – Table 11.2 from the 2003 MfE Guidance

Table 11.2: Resource consent activity status for developed and already subdivided sites

Building importance category	1	2a	2b	3	4
Fault complexity	Activity status				
Recurrence interval class I less than or equal to 2000 years					
A – Well defined	Permitted	<i>Non-complying</i>	<i>Non-complying</i>	<i>Non-complying</i>	Non-complying
B – Distributed	Permitted	<i>Discretionary</i>	<i>Non-complying</i>	<i>Non-complying</i>	Non-complying
C – Uncertain [†]	Permitted	<i>Discretionary</i>	<i>Non-complying</i>	<i>Non-complying</i>	Non-complying
Recurrence interval class II greater 2000 but less than or equal to 3500 years					
A – Well defined	Permitted	Permitted*	<i>Non-complying</i>	<i>Non-complying</i>	Non-complying
B – Distributed	Permitted	Permitted	<i>Discretionary</i>	<i>Non-complying</i>	Non-complying
C – Uncertain [†]	Permitted	Permitted	<i>Discretionary</i>	<i>Non-complying</i>	Non-complying
Recurrence interval class III greater than 3500 but less than or equal to 5000 years					
A – Well defined	Permitted	Permitted*	Permitted*	<i>Non-complying</i>	Non-complying
B – Distributed	Permitted	Permitted	Permitted	<i>Discretionary</i>	Non-complying
C – Uncertain [†]	Permitted	Permitted	Permitted	<i>Discretionary</i>	Non-complying
Recurrence interval class IV greater than 5000 but less than or equal to 10,000 years					
A – Well defined	Permitted	Permitted*	Permitted*	Permitted*	Non-complying
B – Distributed	Permitted	Permitted	Permitted	Permitted	Non-complying
C – Uncertain [†]	Permitted	Permitted	Permitted	Permitted	Non-complying
Recurrence interval class V greater than 10,000 but less than or equal to 20,000 years					
A – Well defined	Permitted	Permitted*	Permitted*	Permitted*	Non-complying
B – Distributed	Permitted	Permitted	Permitted	Permitted	Non-complying
C – Uncertain [†]	Permitted	Permitted	Permitted	Permitted	Non-complying
Fault recurrence interval class VI greater than 20,000 but less than or equal to 125,000 years					
A – Well defined	Permitted	Permitted*	Permitted*	Permitted*	Permitted*
B – Distributed	Permitted	Permitted	Permitted	Permitted	Permitted**
C – Uncertain [†]	Permitted	Permitted	Permitted	Permitted	Permitted**

Note: Faults with a recurrence interval of greater than 125,000 years are not considered active.

* The activity status is permitted, but could be controlled or discretionary because the fault location is well defined.

** Although the activity status is permitted, care should be taken in locating BIC 4 structures on or near known active faults. Controlled or discretionary activity status may be more suitable.

† Where the fault trace is Uncertain, specific fault studies may provide more certainty on the location of the fault. Moving the fault into the Distributed or Well Defined category would allow a reclassification of the activity status and fewer assessment criteria.

Italics – show that the activity status is more flexible. For example, where *discretionary* is indicated, controlled activity status may be considered more suitable.