BEFORE THE HEARING PANEL

IN THE MATTER of the Resource Management Act 1991

AND

IN THE MATTER of Proposed Plan Change 29 to the Nelson Resource Management Plan

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STATEMENT OF EVIDENCE OF DAN CHAMBEROSE

Dated 24 June 2024

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1. INTRODUCTION

1.1 My full name is Daniel Thomas Chamberose. I am employed as an Associate Engineering Geologist at Beca Limited. I have been engaged by the Nelson City Council (Council) to give evidence in respect of geotechnical related matters arising from the submissions and further submissions on the Plan Change 29 (PC29).

1.2 I hold the qualifications of BSc in Geology and Geography and MSc in Engineering Geology. I am a Chartered Member (PEngGeol) of Engineering New Zealand.

1.3 I have 10 years of experience in assessment and management of geological hazards. I have participated in a wide range of slope stability assessments, slope stabilisation works, and geological hazard management studies both in New Zealand and internationally. I have spent the last 5 years of my career in the Beca Nelson office, largely working on local projects in Nelson and the top of the South Island. In this time, I have undertaken slope stability assessments in the region and completed the fault deformation overlay work that Council commissioned Beca to conduct. I managed the slope instability susceptibility overlay assessment commissioned by Council and had some input to the Beca regional liquefaction assessment completed for Council.

2. CODE OF CONDUCT

2.1 Whilst this is not an Environment Court hearing, I have read the Code of Conduct for Expert Witnesses in the Environment Court Practice Note 2023. I have complied with it in preparing this evidence and I agree to comply with it in presenting evidence at this hearing. The evidence I give is within my area of expertise except where I state that my evidence is given in reliance on another person's evidence. I have considered all material facts that are known to me that might alter or detract from the opinions that I express in this evidence.

3. SCOPE OF EVIDENCE

3.1 I have prepared this statement of evidence for Council in respect of specialist geotechnical advice related to slope instability susceptibility, faults (deformation and awareness overlays) and liquefaction related to submissions and further submissions of Plan Change 29 (PC29) to the Nelson Resource Management Plan (NRMP). In preparing my evidence I have reviewed the submissions points related to these geotechnical items and this evidence summarises my conclusions.

4. EXPERT CONFERENCING

4.1 Expert conferencing has not been completed at this stage.

5. SLOPE INSTABILITY SUSCEPTIBILITY AND RUN-OUT OVERLAYS

Background and Methodology

5.1 Nelson has complex geology with a large number of rock types and ages, that have varying thickness of soil overlying them. Slope instability in the region is largely driven by these rock types, topography and certain trigger events (such as rainfall, earthquakes or human activities). In Nelson, there are various types of slope instability present on hill slopes which include soil creep, rock fall, shallow landslides of relatively superficial movement of soil over rock, earthflows and large deep-seated rotational landslides. The majority of Nelson is on sloping land with flatter areas around the valley bottoms. The presence of this sloping land and existing instabilities shows development on hillslopes needs consideration, given it can potentially trigger instabilities.

5.2 In 1996, the NRMP identified areas of known or potential erosion or slope risk through Slope Risk Overlays. This included:

(a) The Grampians Slope Risk Overlay

(b) The Tahunanui Core Slope Risk Overlay

(c) Tahunanui Fringe Slope Risk Overlay

5.3 In 2015, Council commissioned a re-evaluation of the 1996 zones and a broader assessment of slope instability hazard in the hillslopes of Nelson.

5.4 Council commissioned an update to the existing Slope Risk overlay layers in 2020. The update was intended to identify areas that could be potentially affected by slope instability, incorporating the above Slope Risk overlays and commentary around potential instability areas on the hillslopes. Beca was commissioned to complete this work[1]. A region wide assessment was completed which utilised desktop information to identify land potentially susceptible to slope instability and the run-out zones of the slope instability. The output of this assessment was called the slope instability susceptibility and run out overlay (collectively referred to now as the slope overlays). My role within Beca on this project was to develop a robust methodology in collaboration with my colleague, Sarah Barrett (née Bastin), and manage delivery of this to Council.

5.5 The work was peer reviewed by CGW Consulting Engineers[2]. The peer review largely agreed with the methodology, datasets used, the use of GIS for the exercise, and the intent of the slope overlays.

5.6 After the release of the 2020 assessment, Council established a slope instability technical advisory group (SI-TAG) of local engineering geologists and geotechnical engineers to address community feedback on the slope overlays. I was part of this advisory group to contribute my local knowledge, advise on how the slope overlays were developed and the intent of the slope overlays from a technical perspective. The SI-TAG recommended that the slope overlays be subdivided into three tiers/areas to reflect varied susceptibilities to slope instability based on local knowledge. No changes were proposed to the run-out zones. Beca completed these revisions to the slope overlays[3]. My role within Beca for this update was to manage the work and ensure matters raised by the SI-

[1] Beca, 2020. NCC Slope Instability Overlay Report, Report prepared for Nelson City Council by Beca Limited, Christchurch, New Zealand. Revision 1, dated 6 November 2020.
[2] CGW, 2020. Peer Review – NCC Slope Instability Overlay (Beca Limited). Report prepared for Nelson City Council by CGW Consulting Engineers, Nelson, New Zealand. 20480-RPTGEO-001-A, dated 10 November 2020.
[3] Beca, 2021a. NCC Slope Instability Overlay Report, Report prepared for Nelson City Council by Beca Limited, Christchurch, New Zealand. Revision 3, dated 9 December 2021.

TAG were incorporated into the update and delivered to Council. The revised tiers/areas are as follows:

(a) Tier I – Area of known active instability with previous slope failures impacting residential properties. This is limited to the previously documented Tahunanui core and part of the fringe slope risk overlay, within the headscarp of the slump from the 2015 report prepared for Council. The core area was not modified. This is known as Slope Instability Area 1 in PC29. The active Tahunanui landslide extents are well understood, and it has a documented history of several previous failure events so is known to be susceptible to slope instability. Therefore, activities that may trigger instability need to be well controlled.

(b) Tier II – Areas identified as having elevated susceptibility to slope instability including areas with existing deep seated or earthflow instabilities, over steepened sea cliffs and/or geologic units known to have an elevated susceptibility to instability. This includes the Grampians slope risk overlay presented in the 2015 report prepared for Council and was not modified. It is known as Slope Instability Area 2 in PC29. These areas show evidence of known past failure or have characteristics of potentially elevated susceptibility of slope instability. Therefore, activities that may trigger instability should be well controlled.

(c) Tier III – Areas identified as potentially susceptible to slope instability based on the geologic and geomorphic setting and/or with previous records of slope instability failure. Known as Slope Instability Area 3 in PC29. These areas have evidence of smaller scale or shallow instability within them or show characteristics of potential susceptibility to slope instability. Therefore, consideration of activities that may trigger instability should be considered and controlled.

(d) Run-out zones. Areas outside the overlay where debris run out from the potential instability above may occur.

5.7 Following the August 2022 severe weather event that hit the region, Council requested Beca complete a comparison that considered whether the observed types and distribution of slope instability following the event aligned with the assigned susceptibility and definitions of the tier/area subcategories of the slope overlays. This comparison was limited to areas where there was observable damage from the 2022 event in the datasets used and did not assess areas within the slope overlays where damage did not occur. This comparison found that landsliding occurred in all three of the slope overlay and run-out areas to varying degrees across the areas mapped. The observed extents and types of damage were found to be in general agreement with the boundaries and assigned tiers of the slope instability overlay, with some additional areas included. These descriptions of damage noted, and additional areas included are described in the Beca, 2023 report[4]. My role within Beca for this update was managing the technical work and also providing my knowledge of slope instability that I observed as part of the August 2022 Emergency Response. The Beca, 2023 report presents the slope overlays included in PC29.

5.8 The outputs of the assessment were reviewed by the SI-TAG.

5.9 The slope overlays were developed to align with the landslide susceptibility zoning guidance provided in the Australian Geomechanics Society, 'Practice Notes Guidelines for Landslide Risk Management: Guideline for Landslide Susceptibility, Hazard and Risk Zoning for Land Use Planning' (AGS, 2007a) [5]. I consider the methodology used to develop the slope overlays aligns with the AGS guidance, and appropriately considers where slope instability might potentially occur in the Nelson region. Figure 1 and Figure 2 show the methodology tree used to

[4] Beca, 2023. NCC Slope Instability Overlay – Post-August 2022 Severe Weather Event Review, Report prepared for Nelson City Council by Beca Limited, Christchurch, New Zealand. Revision 2, dated 3 May 2023.

[5] Australian Geomechanics Society, 2007a. Guideline for Landslide Susceptibility, Hazard and Risk Zoning for Land Use Planning, Journal and News of the Australian Geomechanics Society, 42 (1): 13- 36.

determine the three tiers/areas of land potentially susceptible to slope instability and run out.

5.10 The slope overlays were developed in ArcGIS using datasets, including hill shade digital elevation models (DEM), developed using LiDAR (flown between 2008 to 2015), and slope angles, geological maps, previous slope instability reports and existing Slope Risk overlays produced for Council. Beca created a basic landslide inventory map (as per AGS guidance) to capture a representation of slope failure locations and types on the hills of Nelson. Beca used the locations of the mapped instabilities as the evidential basis to inform the assessment of potential slope instability and run-out zones. Beca drew the slope overlay area boundaries in a GIS system using the inventory along with the other datasets as shown in their methodology tree. AGS guidance recommends the use of GIS to complete this type of landslide zoning and I consider the datasets used and the use of GIS to be appropriate for this application. This is supported by the peer review that was completed[6].

5.11 The slope overlays were developed at a 1:5,000 scale which is considered a 'large' scale as per the AGS guidance[7]. Susceptibility zonation in AGS is recommended at a scale of 1:5,000 to 1:25,000. Large scale is reserved for a land area between 10-1,000 square kilometres. The area mapped in Nelson is approximately 10 square kilometres. I consider this scale of mapping is appropriate for the size of the Nelson region.

[6] CGW, 2020. Peer Review – NCC Slope Instability Overlay (Beca Limited). Report prepared for Nelson City Council by CGW Consulting Engineers, Nelson, New Zealand. 20480-RPTGEO-001-A, dated 10 November 2020.

[7] Australian Geomechanics Society, 2007a. Guideline for Landslide Susceptibility, Hazard and Risk Zoning for Land Use Planning, Journal and News of the Australian Geomechanics Society, 42 (1): 13- 36.

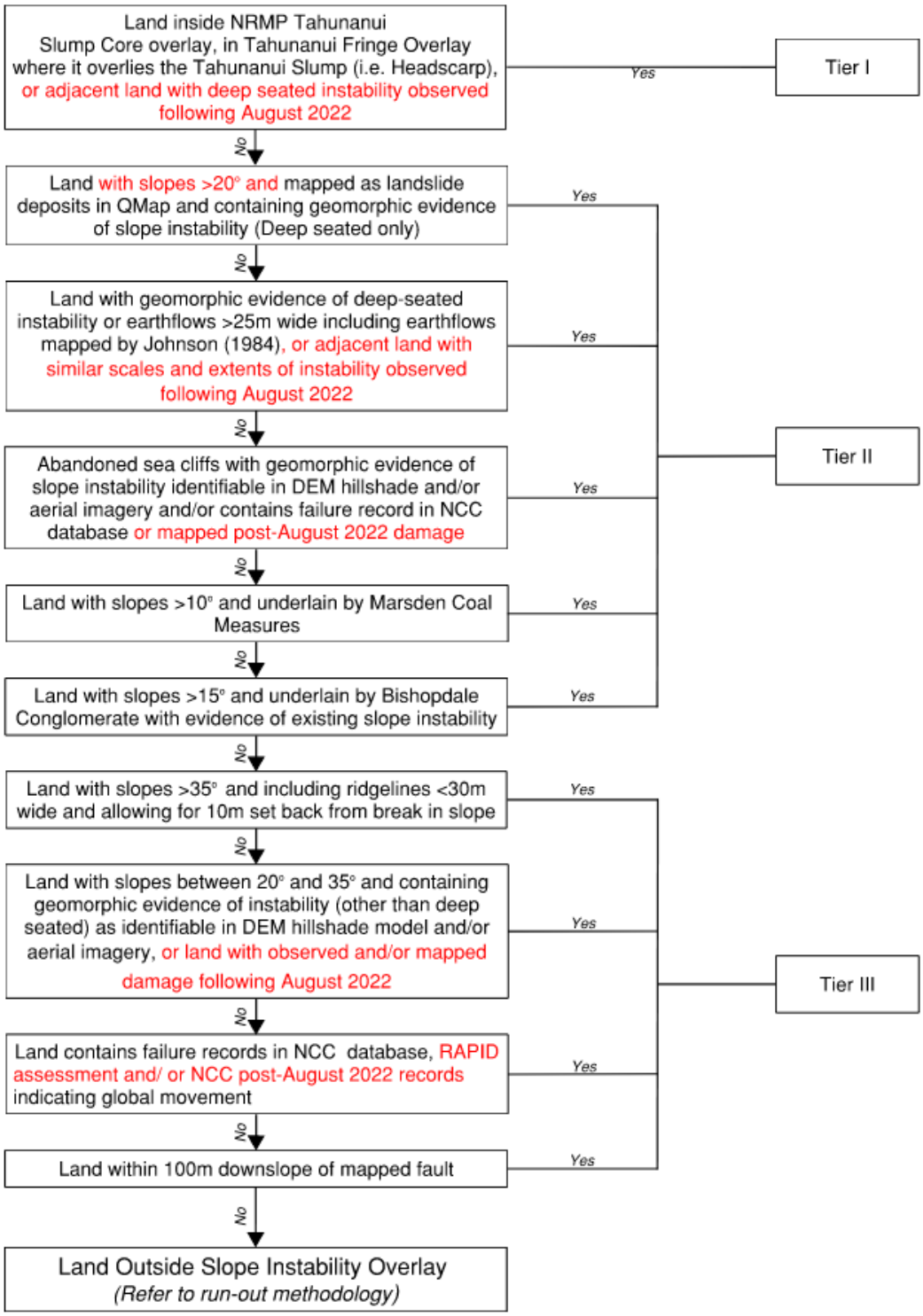


Figure 1: Revised methodology tree for identifying land potentially susceptible to slope instability[8]. Red text shows update to methodology tree from Beca, 2021a[9].

[8] Beca, 2023. NCC Slope Instability Overlay – Post-August 2022 Severe Weather Event Review, Report prepared for Nelson City Council by Beca Limited, Christchurch, New Zealand. Revision 2, dated 3 May 2023.

[9] Beca, 2021a. NCC Slope Instability Overlay Report, Report prepared for Nelson City Council by Beca Limited, Christchurch, New Zealand. Revision 3, dated 9 December 2021.

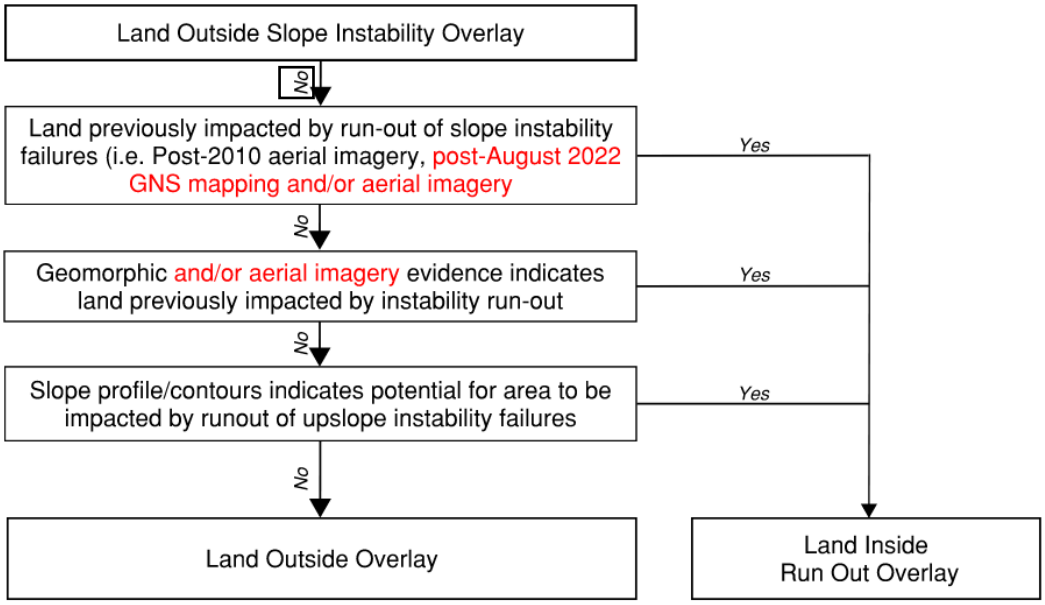


Figure 2: Revised methodology tree for identifying land potentially susceptible to run out of solid debris[10]. Red text shows the update to methodology tree from Beca, 2021a[11]. Note: the 'No' on the top arrow, shown in the black box is not required and should be ignored.

5.12 The intent of the slope overlays is to identify areas requiring geotechnical assessments during the early stages of land planning and development for the purpose of managing or mitigating natural hazards to help fulfil Council's obligations under Section 30 and 31 of the Resource Management Act 1991 (RMA 1991). In my opinion, the slope overlays achieve this as they flag land on a large scale (1:5,000 – refer to 5.11) where slope instability needs to be considered and allow Council to manage this potential hazard.

5.13 It is important to note that the slope overlays are largely developed using desktop information, which identifies land where landslides have occurred in the past or have certain characteristics that indicate its potentially susceptibility to slope instability in the future. They are not

[10] Beca, 2023. NCC Slope Instability Overlay – Post-August 2022 Severe Weather Event Review, Report prepared for Nelson City Council by Beca Limited, Christchurch, New Zealand. Revision 2, dated 3 May 2023.

[11] Beca, 2021a. NCC Slope Instability Overlay Report, Report prepared for Nelson City Council by Beca Limited, Christchurch, New Zealand. Revision 3, dated 9 December 2021.

risk zoning overlays as described in AGS guidance[12]. Risk zoning overlay assessments require additional considerations, including likelihood of slope failure and the potential consequences to a particular element at risk which was outside the scope of work and not the intent of the slope overlays.

5.14 I note that GNS science recently released 'The Landslide Planning Guidance: Reducing Landslide Risk through Land-Use Planning'[13] which details various types of assessments to reduce landslide risk through land-use planning. The slope overlays created for Nelson, align with a Level A assessment. A Level A assessment is described in this guidance as a susceptibility analysis that identifies areas that may be susceptible to landsliding (both source areas and landslide runout). It involves the classification, volume and spatial distribution of existing and potential landslides in a study area.

5.15 The slope overlays did not consider previously completed site specific hazard/risk assessments or engineered/certified land when they were developed. AGS guidance was followed to develop the basic landslide inventory map which doesn't involve analysis of previous land use or its influence on slope instability. For more sophisticated landslide inventories, AGS recommends this be completed but a sophisticated landslide inventory was not completed as part of these slope overlays. For the intent of the slope overlays, I believe the basic landslide inventory is appropriate. A sophisticated inventory is typically used for more advanced hazard and risk zoning.

Principal issues raised in submissions.

5.16 I have reviewed the submission points related to the slope overlays and have identified the principal issues raised. I have grouped common

[12] Australian Geomechanics Society, 2007a. Guideline for Landslide Susceptibility, Hazard and Risk Zoning for Land Use Planning, Journal and News of the Australian Geomechanics Society, 42 (1): 13- 36.

[13] de Vilder, S.J.; Kelly, S.D.; Buxton R.B., Allan, S.; Glassey, P.J. 2024 Landslide planning guidance : reducing landslide risk through land use planning. Lower Hutt, NZ: GNS Science. GNS Science miscellaneous series 144. 84 p.; doi: 10.21420/R2X8-FJ49

themes and issues together and presented responses and recommendations under the below sub-headings.

Principal Issue 1: Accuracy of the slope instability susceptibility overlays and site-specific requests to remove individual properties from the slope overlays (various submissions)

5.17 A number of submissions[14] were received that commented on the accuracy of the slope overlays when compared to site specific information. Examples of site-specific information mentioned include:

(a) A lack of damage observed during previous events (i.e., August 2022 storm event),

(b) On-site investigations and previous geotechnical assessment/certification.

5.18 Therefore, the submitters requested their properties be exempt from the provisions or removed from the slope overlays. I discuss (a) and (b) below.

a) A lack of observed damage during previous events (i.e., August 2022 storm event)

5.19 Whether a site has been affected by slope instability during past trigger events (such as the August 2022 storm) does not directly correlate with behaviour in future trigger events. Trigger events such as rainfall or earthquake will affect sites in different ways depending on a variety of factors. For rainfall events, this could include intensity and duration of rainfall, direction that the event comes from and the local site conditions that might contribute or mitigate its effect. For earthquakes, it could be magnitude of the event, distance of a site from the earthquake focus or how the earthquake waves travel through the geological units and affect the severity of shaking at any specific site. I note that site specific characteristics can change over time at a site (for example: vegetation cover, stormwater changes, hydrology, land use) that may alter a site's resilience to slope instability, therefore changing its susceptibility. The August 2022 storm was one type of trigger event and a lack of damage observed in that event does not mean the land no longer has

[14] Related submission points to this particular issue: S895.001, S411.002, S144.001, S840.001, S840.002, S358.001, S519.001, S321.001, S307.001, S529.001, S755.003, S768.004, S767.004, S766.004, S464.009, S594.001, S594.002

characteristics of potential slope instability susceptibility, which could potentially be triggered in a future event[15].

5.20 Therefore, in my opinion I do not believe it is appropriate to remove areas from the slope overlays just because they were not affected by recent events.

b) On-site investigations and previous geotechnical assessment/certification

5.21 As mentioned in item 5.12, the intent of the slope overlays is to identify where additional geotechnical assessment is required to better understand site specific instability risks. As mentioned in 5.15, the slope overlays do not consider previously completed site specific hazard/risk assessments or engineered/certified land and the slope overlays have been developed in alignment with AGS methodology which is appropriate for their intended purpose. The slope overlays cannot supersede site specific hazard/risk assessments that have previously been completed at a site and that is not the purpose of the overlays. Site specific instability issues/risks are identified at a site at the time the assessment was completed, and normally to address a specific building or activity proposal.[16]

5.22 A number of submitters[17] noted that their land has recently been assessed and certified by suitably qualified geotechnical professionals and that more recent subdivisions generally go through appropriate steps to consider natural hazards at a site. These submitters suggest this land should be exempt from the PC29 provisions or removed from the slope overlays. Where this is the case, in my opinion it is not appropriate for individual landowners to undertake a typical consent process in addition to what has already been completed at subdivision level, providing it was appropriately considered at that time.

[15] This specifically addresses property specific submissions: S840.001, S840.002, S464.009
[16] This specifically addresses property specific submissions or relevant submission: S895.001, S411.002
[17] Related submissions: S144.001, S358.001, S519.001, S321.001, S307.001, S529.001, S755.003, S768.004, S767.004, S766.004, S594.001, S594.002

5.23 However, I do not believe it is appropriate to amend the slope overlays to remove land previously certified.[18] This is because:

(a) land use/susceptibility can change over time which can cause changes to how slope instability might affect land in the future (previously discussed in 5.19)

(b) there will be variability in the quality of slope instability assessment/documentation of risks and how these risks should be managed over time by the landowner if certain further development activities occur within the subdivision in the future. i.e., generally captured by consent conditions at time of development for that specific development.

(c) the slope overlays were developed using the available datasets at the time (mentioned above, such as LiDAR data flown in 2008-2015) which identified land with characteristics that may potentially be susceptible to slope instability. If updated datasets were used to complete the same methodology of slope overlay creation across the region in the future, it may show characteristics of the land have changed (i.e., if land modifications have been completed), which potentially altered the characteristics of potential slope instability susceptibility. This could result in changes to slope overlay boundary extents. Therefore the boundaries are likely to change as land continues to be developed.

5.24 With regard to (b) above. When a resource consent is granted for a subdivision, typically specific consent conditions are applied which often capture and constrain specific activities at a site. These consent conditions cannot be used to provide exemption of land from the slope overlays, for two reasons. First, if future changes to the land and the activities on it are made, this might impact on slope instability. Second, time may have elapsed since conditions were applied to the development

[18] This specifically addresses property specific submissions: S144.001, S358.001, S519.001, S321.001, S307.001

and they might not be appropriate in the context of current or future development activities. Therefore, blanket exemption of all previously certified developments (or previous certification within a timeframe) from the slope overlays and accompanying proposed PC29 provisions may result in sub optimal outcomes.

5.25 With regard to (c) above. An appropriate timeframe on which to update the slope overlays in the future to capture updated datasets and changes to characteristics of potential slope instability when assessed against the methodology should be considered. Timing of this could be aligned with when new LiDAR information (most recent flown after August 2022 storm) which is available in the region and shows current landform, or to align with new guidance on planning around landslides[19].

5.26 I agree with submitters that an exemption or streamlined consent process may be appropriate and recommendations/amendments are further discussed in the natural hazards section 42A report.

5.27 I also note, the way the information is presented in the PC29 documents uses the term 'slope instability' and 'slope instability area' in a number of locations. For Area 1 and 2 the elevated susceptibility warrants the name but could be amended to include 'susceptibility' in the title to be clear what the intent is. In Area 3, small scale or shallow slope instability has occurred or may potentially occur because of the land characteristics. The current naming of this layer may be misleading and interpreted by the public as believing slope instability will happen there. Therefore, I recommend that the naming related to this layer be amended to reflect its slight difference to the Area 1 and 2 areas. This is further discussed in the natural hazards section 42A report.

Principal Issue 2: Scale of slope instability overlay at property level

5.28 Submission point S75.011 (Eliot Sinclair) raises that the locked limit of viewing on the website is 1:5,000 scale and requests that it be allowed to zoom in to property specific scale.

[19] de Vilder, S.J.; Kelly, S.D.; Buxton R.B., Allan, S.; Glassey, P.J. 2024 Landslide planning guidance : reducing landslide risk through land use planning. Lower Hutt, NZ: GNS Science. GNS Science miscellaneous series 144. 84 p.; doi: 10.21420/R2X8-FJ49

5.29 The assessment used to generate the slope overlays have been completed at a large scale and gives an indication of the scale and extent of potential exposure to slope instability across suburbs. These slope overlays are not intended to show specific details for each property (or provide geotechnical assessment of the property) and should not be relied on as the sole basis for making any decision in relation to potential risk. However, to allow the slope overlays to be easily viewed at individual property level, I recommend that the electronic map be modified to allow this level of integration, but make clear the scale the slope overlays were completed at and should only be used as a trigger for the provisions. This is also discussed in the natural hazards section 42A report.

Principal Issue 3: Removal of slope instability area 3 from overlay definition and as a natural hazard overlay (various submissions)

5.30 A number of submissions[20] have raised that slope instability Area 3 (referred to from now as Area 3) should be removed from the definition of natural hazard overlay because submitters believe risks related to Area 3 do not warrant it and also the basis on which the layer was formed are unreliable. Submissions have also requested that Area 3 should be removed as an overlay, amend its extent or reassess risks within it to ensure they are accurate.

5.31 Area 3 has been developed using a robust methodology aligned with the AGS guidance[21] and datasets available at the time of creation, which identifies land potentially susceptible to instability. The basic landslide inventory used to develop Area 3 boundaries highlights slope instability occurs within Area 3. This inventory was used to identify adjacent sections of land that exhibit similar characteristics to the land that already showed landslides. Therefore, land within Area 3 may be adversely affected by slope instability, consequently I recommend it is appropriate to maintain the slope overlay as it stands.

[20] Related submission points to this particular issue: S755.004, S768.006, S767.006, S766.006, S845.007, S768.005, S767.005, S766.005, S755.014, S845.006

[21] Australian Geomechanics Society, 2007a. Guideline for Landslide Susceptibility, Hazard and Risk Zoning for Land Use Planning, Journal and News of the Australian Geomechanics Society, 42 (1): 13- 36.

5.32 Susceptibility can change over time (refer 5.19) and the intent of the slope instability overlays is to identify areas requiring further geotechnical assessments, to help Council fulfil the obligations under Section 30 and 31 of the Resource Management Act to avoid or mitigate natural hazards. In my opinion, this layer provides the tool to do this. A robust methodology has been used, the outputs have been peer reviewed, reviewed by the SI-TAG and aligns with a Level A assessment described by current guidance[22]. Therefore, I do not believe it is appropriate to remove Area 3 from the slope instability overlays and natural hazard overlay definition.

Principal Issue 4: Delete or amend rules proposed for slope instability overlays (various submissions)

5.33 Submissions[23] have raised that the proposed rules related to Area 2 and 3 of the slope overlays should be deleted or amended. The rules associated with these Areas are expanded below where relevant.

5.34 Area 2 presents areas with potential elevated susceptibility of slope instability. Because of these characteristics, uncontrolled activities can more readily lead to instability within the overlay, which need to be managed to reduce the likelihood of instability occurring. The rules applied to this slope overlay were discussed with the SI-TAG and were largely agreed as appropriate within these elevated susceptibility areas. I have reviewed the rules, and, in my opinion, the rules will appropriately manage potential slope instability causing activities within Area 2.

5.35 Area 3 presents areas that are potentially susceptible to slope instability due to steepness of slopes, geological conditions and presence of previous small scale/shallow slope instability. For these reasons, I agree activities need to be managed appropriately to mitigate the effects of slope instability. However, from my geotechnical perspective the rules for

[22] de Vilder, S.J.; Kelly, S.D.; Buxton R.B., Allan, S.; Glassey, P.J. 2024 Landslide planning guidance : reducing landslide risk through land use planning. Lower Hutt, NZ: GNS Science. GNS Science miscellaneous series 144. 84 p.; doi: 10.21420/R2X8-FJ49

[23] Related submission points to this particular issue: S755.007, S768.011, S767.013, S766.012, S768.012, S767.014, S766.014, S755.023, S768.013, S767.015, S766.015, S755.024, S768.014, S767.016, S766.016, S755.025, S768.016, S767.018, S766.018, S755.033

Area 3 require some amendments to align with the level of potential susceptibility in these areas.

5.36 Stormwater rules REr.75M for Area 3 require all water from roofs and impermeable areas to be pipped to an approved stormwater system. Small amounts of concentrated flows from these surfaces pose a low risk of triggering slope instability. The rule would result in small garden shed roofs and small impermeable outdoor areas triggering resource consent. I recommend a maximum permitted square metreage area for roof and impermeable areas to this rule.

5.37 The earthworks rule REr.75N permits maximum allowable height of earthworks to 0.6m. Large cut heights over extended lengths of slope can increase the risk of triggering instability, however, localised increases in cut height have a low risk of triggering instability. The rule as it stands would result in consents being required for small landscaping works that are unlikely to significantly affect slope instability. I recommend the rule be split into two components in an either/or type approach. The first remaining as is currently shown, linking the 0.6m cut height to the 20m^2 volume. The second increasing the cut height to 1.2m but restricting its volume to 3m^2. The spread of earthworks material over the land area should remain the same as I believe it is appropriate from a geotechnical perspective.

5.38 I would support amendments to the rules related to new residential units, accessory buildings and additions to existing residential units for Area 3, as both the subdivision consent process and the building consent process can manage potential slope instability triggering activities in Area 3. This may have a subsequent change to the weight requirements of the structural rules.

Principal Issue 5: Slope instability and intensification around Tosswill Road/Tamaki Street area and Tahunanui hills area

5.39 Parts of the Tahunanui Hills have experienced instability in the past or have been identified as being potentially susceptible to slope instability. These have been identified through the methodology as described in the Beca reports.

5.40 A number of submitters[24] have raised concerns around high density housing in the Area 2 and 3 slope instability areas of the Tahunanui Hills.

5.41 For the purposes of this evidence, I define the Tahunanui Hills as the area from The Cliffs to the north, Tosswill Road/North part of Chamberlain Street to the south, Rocks Road/Tahunanui Drive to the west and Princes Drive to the east (refer Figure 3 below).

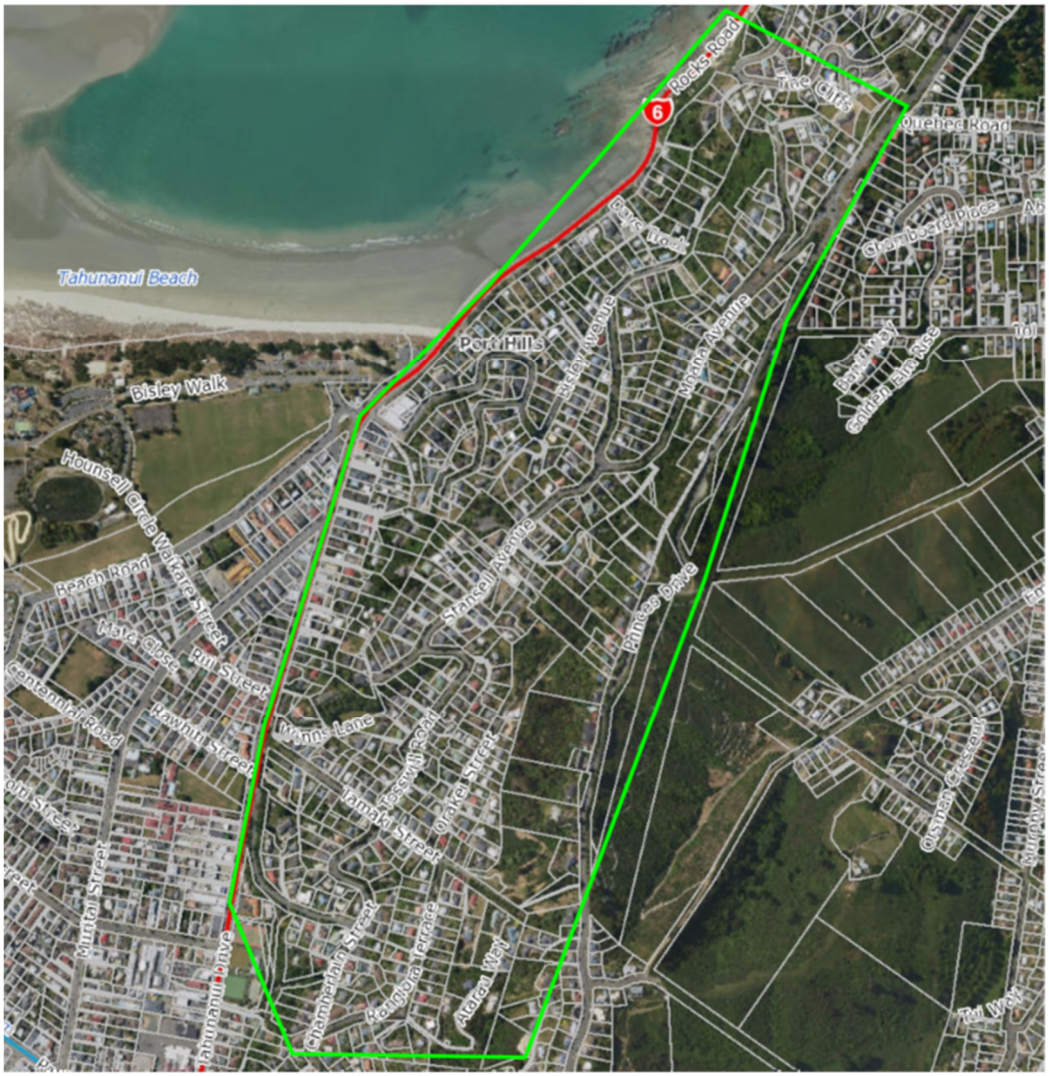


Figure 3: Tahunanui Hills Area.

5.42 The Tahunanui Hills are covered by all three slope instability susceptibility areas.

5.43 The main area of heightened slope instability susceptibility is the Tahunanui Slump which is a deep-seated landslide that is well studied and

[24] Related submission points to this particular issue: S546.022, S627.004, S190.001, S754.042, S312.013, S781.013, S893.013, S481.014, S546.029, S781.013

has moved at various times in the past. This is classified as Area 1 and is not subject to intensification as part of this plan change.

5.44 Area 2 of potential slope instability is identified throughout a number of areas in Nelson. In the Tahunanui Hills area specifically, it is located around the currently understood, inactive part of the Tahunanui Slump and the steep sea cliffs above Tahunanui Drive. Area 3 covers the steeper slopes below Princes Drive in this Tahunanui Hills area.

5.45 I completed a site visit to the Tosswill Road/Tamaki Street area on 8th May 2024 to look for signs of instability mentioned in the submissions. I identified minor shallow landslides that had occurred on the cut above Tosswill Road which was located within Area 2. There were no obvious signs of widespread water seepages or cracking resulting from instability.

5.46 I acknowledge that there are some geotechnical challenges around the presence of sea cliffs (Area 2), the steeper slopes below Princes Drive (Area 3) and also the presence of some weaker overlying shallow soils/historic landslide deposits above rock in the Tosswill Road/Tamaki Street area.

5.47 However, I consider the slope overlay extents are appropriate in this area and both the subdivision consent process and the building consent process can manage potential slope instability triggering activities in Area 3 and areas not within the slope overlay.

6. FAULT DEFORMATION/AWARENESS OVERLAYS

Background and Methodology

6.1 Nelson has a number of faults that run through and around the city. The northeast trending Waimea-Flaxmore Fault System (comprising Flaxmore, Waimea, Eighty-Eight, Jenkins, Whangamoa, Bishopdale, Grampian and Hira Faults) is an active fault system with mainly reverse displacements. These faults are the main reason Nelson has so many hills around it. The Waimea fault has a recurrence interval of earthquake events of about 6 thousand years which is currently approximately equal to the elapsed time since its last rupture. Earthquake activity on the fault system is relatively low, but this highlights the importance of planning

development around these faults to accommodate ground surface deformation if one were to rupture.

6.2 In 1996 the Fault Hazard Overlay was created and presented in the NRMP. It had 150m wide corridors on potentially active faults in the region.

6.3 In 2013, Council commissioned an update to the fault hazard corridor. This report refined the existing corridors and resulted in a corridor over the Flaxmore, Waimea, Eighty-Eight, Jenkins, Whangamoa, Bishopdale, Grampian and Hira Faults. In 2019, the fault hazard corridor was updated using information received as part of building consent applications and presented in a report.

6.4 Beca was commissioned by Council in 2021 to update the 2019 Fault Hazard corridor. The update shows revised fault offset widths (i.e., revised corridor widths), where new information was known on faults and links up existing sections of non-continuous corridors (where appropriate to do so) in the region. The update shows active or potentially active faults that could potentially deform or rupture the ground surface and was renamed the 'fault deformation overlay'[25]. The overlay (referred to from now on as 'fault overlays') comprises:

(a) 'Existing section of fault rupture' overlay (i.e., areas that remain unchanged from the 2019 report). Known as Fault Deformation Overlay in PC29.

(b) 'Revised section of existing fault rupture corridor' (i.e., areas revised since the 2019 report). Known as Fault Deformation Overlay in PC29.

(c) 'Less defined section of the overlay' (i.e., where the location of the fault trace is less certain). Known as Fault Awareness Overlay in PC29.

6.5 The revisions were applied to the Flaxmore, Waimea, Eighty-Eight, Jenkins, Whangamoa, Bishopdale, Grampian and Hira Faults previously included in the existing Fault Hazard corridor and are now included in

[25] Beca, 2021b. Revised Nelson Fault Deformation Overlay, Report prepared for Nelson City Council by Beca Limited, Christchurch, New Zealand. Revision 3, dated 10 December 2021.

PC29. In my opinion, the faults included in the fault overlay are appropriate because they are currently active or are within the active fault system, meaning there could potentially be sympathetic movement along them if any of the local active fault's rupture.

6.6 The revisions followed Step 1 and 2 of the Ministry for the Environment (MfE) guidelines on 'Planning for Development of Land on or Close to Active Faults[26], a risk-based planning approach'. This was the available guidance at the time the revisions were completed and provides guidelines to help avoid or mitigate the risks associated with building on or close to active faults.

6.7 Beca completed the fault overlay revisions in ArcGIS using datasets including existing Council consent records (provided at the time of update), field mapping records of faults and geology, hill shade DEM, historic aerial imagery, New Zealand Geotechnical Database (NZGD) records and published geological maps. The fault locations were refined in light of the new information, and appropriate setbacks distances (i.e., revised corridor widths) were developed based on anticipated deformation widths, dataset accuracy and fault location confidence.

6.8 My role on the project within Beca was to revise the overlays, complete the reporting and manage the project for delivery to Council.

6.9 The field mapping records of faults and geology were provided by Mr Paul Wopereis as Mr Wopereis was a contributor to the Revised Geological Map of the Nelson-Richmond Urban Area[27] and has extensive knowledge of fault contacts in the region that he gained through involvement in this geological map update.

6.10 As part of this update, some less defined sections of faults were identified, where faults were deeply buried beneath overlying soil, thick

[26] Kerr, J., Nathan, S., Van Dissen, R., Webb, P., Brunsdon, D and King, A. 2003. Planning for Development of Land on or close to Active Faults. Report for the Ministry for the Environment by the Institute of Geological & Nuclear Sciences. Institute of Geological & Nuclear Sciences Client report 2002/124 440W103301, July 2003.

[27] Johnston M. R., Ghisetti, F. C. & Wopereis, P. 2021. Revised Geological Map of the Nelson-Richmond Urban Area. Accessed 15/02/2021 (https://nelson-richmond-geolmap.github.io/RGMap/).

alluvium, or landslides, where no surface expression of the fault was observable on the ground surface or where the small-scale geological maps are the only available evidence of the fault's location. Through review of previous reports around New Zealand[28], it was decided that a Fault Awareness Area (FAA) overlay was the most appropriate way to capture these areas. FAAs are a way of communicating that a fault is present but being less defined is not able to be identified accurately enough to determine the exact location. In my opinion, these FAAs (or 'less defined section of overlay' in PC29)[29] are appropriate in areas of this type of uncertainty. These types of awareness areas have been used by Kaikōura District Council, Manawatū District Council and Taupō District Council previously to similar effect.

6.11 The scale the fault overlays were updated at was typically 1:5,000 to 1:10,000. For planning purposes, MfE guidelines[30] recommend this scale. The accuracy of the fault overlays varies depending on the dataset used to update the overlay. I agree with the scale and accuracy bounds used to define the fault overlays.

6.12 The intent of the fault overlays is to identify where faults could potentially deform or rupture the ground surface, to inform the requirement for additional geotechnical assessment, to fulfil Council's obligations under Section 30 and 31 of the Resource Management Act. In my opinion, these fault overlays are appropriate for their intended use (with the exception of 'less defined sections of fault overlay' as discussed below). Such assessment (by suitably qualified geo-professionals) should define the fault's location within the Fault Deformation Overlay, provide expert

[28] Barrell D. J. A., Jack H., Gadsby M. 2015. Guidelines for using regional-scale earthquake fault information in Canterbury. Lower Hutt (NZ): GNS Science. 30 p. (GNS Science consultancy report; 2014/211).

[29] Beca, 2021b. Revised Nelson Fault Deformation Overlay, Report prepared for Nelson City Council by Beca Limited, Christchurch, New Zealand. Revision 3, dated 10 December 2021.

[30] Kerr, J., Nathan, S., Van Dissen, R., Webb, P., Brunsdon, D and King, A. 2003. Planning for Development of Land on or close to Active Faults. Report for the Ministry for the Environment by the Institute of Geological & Nuclear Sciences. Institute of Geological & Nuclear Sciences Client report 2002/124 440W103301, July 2003.

opinion on whether development of land close to the faults should occur, and advise any additional constraints or measures to be considered.

Principal issues raised in submissions.

6.13 I have reviewed the submission points related to the fault overlays and have identified the principal issues raised. I have grouped common themes together and presented responses and recommendations under the below sub-headings.

Principal Issue 1: Accuracy of fault deformation/awareness overlays and site-specific requests to remove properties from the fault deformation/awareness overlay (various submissions)

6.14 Several submissions[31] commented on the accuracy of the fault overlays when compared to site specific information or their broad coverage. As with slope instability susceptibility, the fault overlays are not intended to replace site specific hazard assessments that have previously been completed at a site. As land continues to be developed, new information will come to light that will further refine the fault overlays. The fault overlays captured information known on the faults and were based on datasets available at that point in time. New information on the locations of the faults will become available with time. This has eventuated, and as such, some submitters have requested their properties be exempt or removed from the overlay.

6.15 It is now apparent that new information is available on the location of the fault related to submission S767. In light of this submission, Figure 4 below show the changes recommended to the fault overlay width.

[31] Related submission points to this particular issue: S895.001, S411.002, S766.002, S767.002, S845.002, S755.001, S768.002, S766.003, S767.003, S845.003, S755.002, S768.003, S358.002

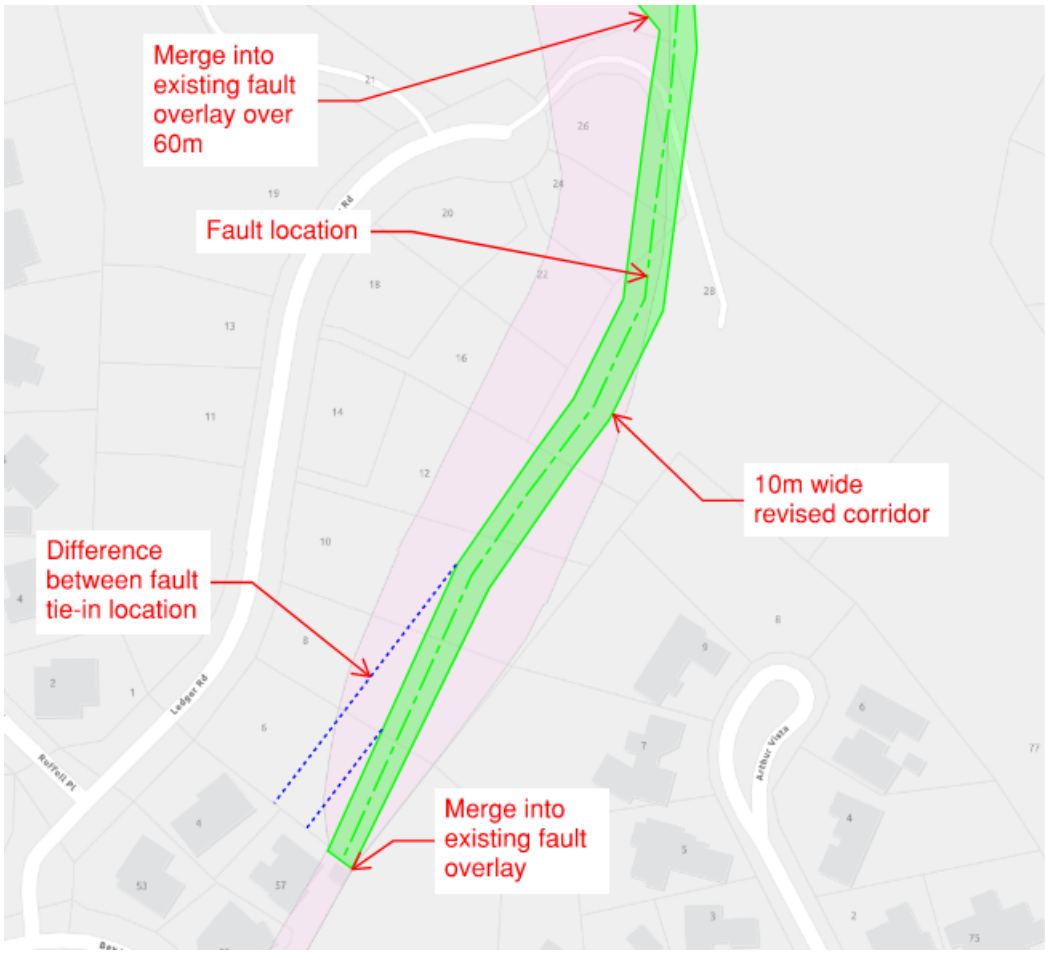


Figure 4: Recommended amendment to fault deformation overlay based on consent records related to S767. Note: There is a difference at the southern end between the submission and information held on the existing fault hazard corridor which was amended by Mike Johnston during the 2019 update. The existing tie-in point has been used.

6.16 Council should also consider an appropriate timeframe on which to update the overlays in the future to capture new information held on the faults in the region.

Principal Issue 2: Jenkins Fault in the Marsden Valley and appropriateness for it to be within the Fault Deformation Overlay

6.17 John Higginbotham [S948.001] describes in his submission on the Marsden Homestead Subdivision, where detailed geotechnical investigations have been completed around the Waimea Fault and the Jenkins Fault. The submission focuses on whether the Jenkins Fault is active and if there is enough information to support its inclusion in the Fault Deformation Overlay. It requests that the deformation overlay be removed from the fault.

6.18 The Jenkins Fault was originally shown on the Revised Geological Map of the Nelson-Richmond Urban Area[32]. Mr Paul Wopereis and I have discussed why the fault was originally included on the map. It was included as there was an observed fault contact between Port Hills Gravel Formation and Groom Creek Formation at a place locally known as Whalesback Hill, approximately 200m northeast of Plumtree Lane and located on the northeast side of the Marsden Valley. There were four other exposures of Groom Creek Formation in an alignment, and it was interpreted at that time as the southern continuation of the Jenkins Fault previously shown in the 1979 geology map "*Geology of the Nelson Urban Area*" published by NZ Geological Survey.

6.19 Although there is some uncertainty around whether this fault is active or not, it was included in the fault deformation overlay because it aligned to the tectonic regime of the region and was in close proximity to the Waimea Fault and was inferred to have the potential for sympathetic movement along it if a local fault rupture was to occur.

6.20 On 10th May 2024, Mr Paul Wopereis carried out a geological site visit to new earthworks exposures at Homestead Lane Subdivision in the inferred location of the Jenkins Fault.

6.21 Mr Wopereis observed that the earthworks had removed part of Whalebacks Hill and there were extensive new exposures of the geology on cut platforms and in vertical cut batters. Mr Wopereis noted that the geology is complex, but the exposures show that at the current site there was no evidence of the Jenkins Fault and the contact between the Port Hills Gravel Formation and Groom Creek Formation was observed to be a geological unconformity rather than the Jenkins Fault contact as originally interpreted. Mr Wopereis observed that there was a hard ridge of brownish weathered Groom Creek Formation with greyish cobbly Port Hills Gravel Formation unconformably deposited on top of this ridge. Mr Wopereis noted small offsets of the geology elsewhere in the Port Hills

[32] Johnston M. R., Ghisetti, F. C. & Wopereis, P. 2021. Revised Geological Map of the Nelson-Richmond Urban Area. Accessed 15/02/2021 (https://nelson-richmond-geolmap.github.io/RGMap/).

and Ngawhatu area and it appears likely the contact originally seen for the Jenkins Fault at the Whalesback could have simply been one of these small offsets and this has now been removed by the current earthworks. Therefore, Mr Wopereis considers there is not enough conclusive evidence to support the previous interpretation of the presence of the Jenkins Fault. I agree with the findings of these new field observations. Therefore, I recommend that the fault deformation overlay be removed from the Jenkins Fault between Marsden Valley Road to Enner Glynn Road and the fault overlay be updated to reflect this as shown in Figure 5 below.

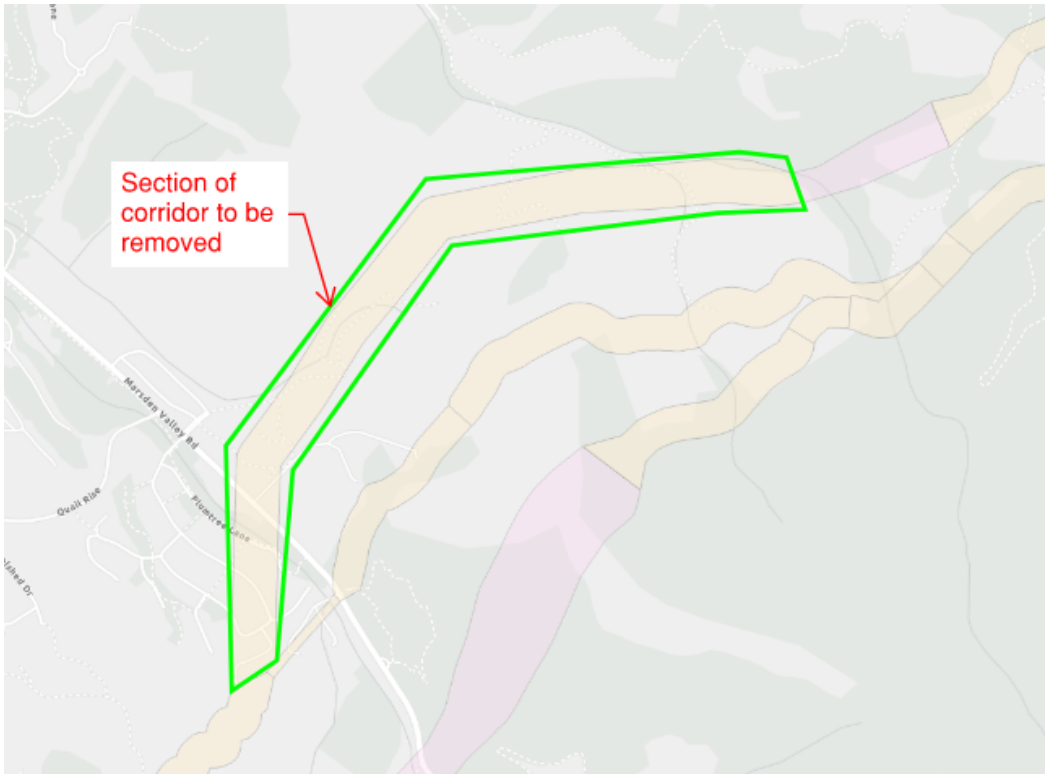


Figure 5: Section of the Jenkins Fault to be removed.

Principal Issue 3: Delete or amend rules proposed for fault deformation/awareness overlays (various submissions)

6.22 Submissions[33] raised that the proposed rules should be amended to exempt allotments that have already received engineering certification I discuss this in relation to slope instability in paragraph 5.22 to 5.26 of my

[33] Related submission points to this particular issue: S766.008, S767.009, S845.044, S755.006, S768.007, S766.009, S767.010, S845.045, S755.015, S768.008, S766.010, S767.011, S845.046, S755.016, S768.009, S766.011, S767.012, S845.047, S755.017, S768.010

evidence. I agree with submitters that an exemption or streamlined consent process may be appropriate and recommendations/amendments are further discussed in the natural hazards section 42A report.

6.23 In relation to the fault awareness overlay, the precise location of the fault is difficult to establish because of the thickness of overlying soils. Even if the location of the fault trace could be established, the surface effect of any fault movement would be difficult to accurately predict given the depth of the overlying soils. It would also be very difficult to complete a level of investigation and assessment within the bounds of a specific property boundary (in already developed areas) to give confidence on the location of a deeply buried fault or how it might propagate to the surface.

6.24 Residential property foundations can typically be designed in a way to accommodate some movement if a deeply buried fault was to rupture beneath it. Taller or larger structures are likely at higher risk of significant damage and potential collapse if they are located where a fault might deform the ground surface that it sits on. And it is also difficult to design buildings of these scales to resist surface deformation of a fault, therefore it is best to avoid the deeply buried faults beneath them.

6.25 For these reasons, I support the comments on the Fault Awareness Overlay rules outlined in the natural hazards section 42A report.

Principal Issue 4: Multi story developments erected on/near identified fault lines (various submissions)

6.26 A number of submissions[34] have raised concerns around high density residential zones in close proximity to faults (i.e., the fault awareness overlay) in the Nile/Domett/Hardy Street area.

6.27 In this particular area, there is a fault awareness area due to a deeply buried fault below. As mentioned in 6.23 and 6.24, there is uncertainty

[34] Related submission points to this particular issue: S719.018, S815.007, S456.010, S785.007, S579.009, S658.009, S664.009, S717.009, S726.009, S727.009, S740.021, S742.010, S743.009, S744.009, S745.009, S746.009, S787.009, S788.009, S789.009, S790.009, S792.009, S791.009, S793.009, S794.009, S795.009, S796.009, S797.009, S798.009, S799.009, S800.009, S801.009, S802.009, S804.009, S856.009, S857.009, S859.009, S387.008, S620.008, S763.008

around where the fault may propagate to the surface in the event of rupture in these types of locations.

6.28 Therefore, I would not support development of taller or larger structures in these areas and support the amendments proposed in the natural hazards section 42A report.

7. LIQUEFACTION OVERLAY

7.1 Liquefaction susceptible materials are present in many locations in the Nelson region. These areas have been identified in PC29 through the Liquefaction Hazard Overlay.

7.2 Council commissioned Beca to complete a regional liquefaction assessment in 2021 in accordance with a 'Level A – Basic Desktop Assessment' as per the joint MBIE/ MfE (2017)[35] guidance 'Planning and engineering guidance for potentially liquefication-prone land'. This is described in the Beca report[36]. I had little involvement in this Beca work but I have viewed the Beca report and in my opinion, the work completed is in alignment with this guidance and is appropriate for its intended use.

Principal issues raised in submissions.

Principal Issue 1: Multi story developments erected within liquefaction areas (various submissions)

7.3 Submitters[37] have raised concerns around high density residential zones in liquefaction zones in the Nile/Domett/Hardy Street area.

7.4 It is important that development in liquefaction prone areas is managed through appropriate planning rules and the building consent process, and that proposed developments are assessed and designed by suitably qualified professionals to accommodate or avoid liquefaction. This gives

[35] MBIE/MfE, 2017. Planning and engineering guidance for potentially liquefaction-prone land Resource Management Act and Building Act aspects; ISBN (online) 978-1-98-851770-4 Rev 0.1 Issue date September 2017, Wellington, New Zealand.

[36] Beca, 2021c. Nelson Regional Liquefaction Assessment, Report prepared for Nelson City Council by Beca Limited, Christchurch, New Zealand. Revision 2, dated 23 November 2021.

[37] Related submission points to this particular issue: S719.018, S815.007, S456.010, S785.007, S579.009, S658.009, S664.009, S717.009, S726.009, S727.009, S740.021, S742.010, S743.009, S744.009, S745.009, S746.009, S787.009, S788.009, S789.009, S790.009, S792.009, S791.009, S793.009, S794.009, S795.009, S796.009, S797.009, S798.009, S799.009, S800.009, S801.009, S802.009, S804.009, S856.009, S857.009, S859.009, S387.008, S620.008, S763.008

confidence that the proposed development when built within an area exposed to the liquefaction hazard is suitable for its intended purpose.

7.5 Foundations can generally be adequately designed on buildings to accommodate the effects of liquefaction.

7.6 Therefore, the proposed planning rules and building consent processes adequately address the potential hazards to multistorey developments within liquefaction zones.

Daniel Thomas Chamberose
24 June 2024