



GEO-LOGIC
L I M I T E D

5022.12

19 November 2021

Nelson City Council
Team Leader Environmental Planning
PO Box 645
NELSON

Attention: Jacqui Hewson

Peer Review of Revised Nelson Fault Deformation Overlay Report

Scope

We were provided with a report and updated fault rupture corridor mapping for the Nelson urban area prepared by BECA (BECA, 2021) advised to have been “...commissioned as part of the ongoing hazard mapping for the Draft Nelson Plan.” In your email of 09 August 2021 you instructed “A peer review of this report and updated hazard maps needs to be carried out to ensure the methodology and reasonings for both the new and updated locations of fault rupture corridors are suitable for informing the draft Nelson Plan hazard overlay and subsequent planning provisions from a geotechnical engineering perspective.”

In that email the Scope of Services and Deliverables were set out as:

Scope of Services

Undertake the peer review, as per the following:

1. Paul Denton would review the general methodology covered in 14 pages of report text
2. Paul Denton to liaise with BECA, undertake necessary meetings at their office, accompanied with NCC staff to see first-hand how they analysed the datasets using their GIS system
3. No fieldwork will be undertaken
4. Deliver a draft brief review report of Paul Denton’s opinion on the methodology, the quality of the work undertaken and recommendations of how NCC should use the information in planning and how it may be refined, if needed.
5. Update the peer report with any requested changes by NCC staff and issue a ‘final’ peer report.

Deliverables

6. Deliver a draft brief review report of Paul Denton’s opinion on the methodology, the quality of the work undertaken and recommendations of how NCC should use the information in planning and how it may be refined, if needed
7. Attend a maximum of two meetings with BECA and/or NCC staff to discuss the report and findings
8. Deliver a ‘final’ peer report that incorporates any required changes by NCC staff

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We are familiar with the geology of the Nelson area and undertook a similar, albeit with a somewhat different peer review focus in our “*Nelson City Council Revised Fault Hazard Overlay; Fault Line Data Capture Maps*” providing GIS shapefiles (Geo-logic, 2010). The Brief in that report was:

The Fault Hazard Overlay (FHO) currently shown on maps in the Nelson Resource Management Plan has been in place for more than 10 years now. Nelson City and Tasman District Councils commissioned a review of the FHO as a considerable amount of new information has been collected on the faults in the districts since the Resource Management Plans were prepared. A draft Fault Hazard Rupture report has been prepared (Johnston and Nicol, 2007) which includes Fault Line Data Capture Maps at scales of 1:5000 and 1:25,000.

In addition, we have undertaken more than 20 site specific fault investigations in the Nelson/ Tasman/ Marlborough region as well as several in California, the latter prior to arriving in New Zealand in 1991.

Work undertaken for this report is, as per our instruction, a peer review of the general methodology and not a geotechnical review of the Fault Hazard Overlay Maps. No fieldwork has been undertaken (**Scope of Services item 3**).

Our work was undertaken as per NCC Services (Umbrella) Contract for Geotechnical Peer Review Services (Contract ID: A2733127) dated 14 September 2021 and email of 27 July and 16 August 2021.

Discussion

Review of General Methodology

Our evaluation of the general methodology covered in 14 pages of report text (**Scope of services item 1**) found the methodology presented in section 3.0 of the BECA report to be generally robust and geotechnically appropriate as applied to generate the *Updated Fault Deformation Corridor Maps* (Appendix A). In reviewing the methodology, we identified a number of items appropriate for further discussion/ clarification – all of which were raised with the authors of the report in a meeting at the offices of BECA on 20 October 2021 (**Scope of services item 2**). These items, and the responses, as well as other comments on the general methodology, are listed below:

Report Name: The BECA report provides terminology definitions and notes “*The term **fault deformation corridor** replaces the term’s fault hazard overlay, fault hazard corridor and fault rupture corridor used in previous NCC fault hazard studies.*” The term **fault deformation corridor** is considered to be “overly inclusive” in that it includes potentially several more specific geologic/ geotechnical features. We recommended a revision to the title of the report to include the term overlay and there was unanimous agreement that the name of the report be changed to **Revised Nelson Fault Deformation Overlay**.

Report Terminology: LiDAR: Further information on the extent (coverage) and use of LiDAR, referenced in the report “as flown between 2008-2015”, was requested and it was advised that LiDAR coverage was 100%. LiDAR coverage was either unavailable or only limited in extent at the time of preparation of the original Nelson Fault Hazard Overlay (FHO) - (Nelson Resource Management Plan, Volume 3 – Planning Maps. Revised December 1998) and subsequently updated FHO (Revised Fault Hazard Overlay. Fault Line Data Capture Maps, Peer Review, Nelson prepared for Nelson City Council dated December 2010).

BECA advised that full LiDAR coverage was found to be useful in preparation of the current revised review. LiDAR, is an acronym for “light detection and ranging” which is a remote sensing method that uses light in the form of a pulsed laser to measure ranges (variable distances). LiDAR is not listed in the definitions presented in the BECA report but could be.

General Methodology and References Cited: The BECA report notes “This update to the fault deformation corridor follows the MfE guidance as described in Step 1 and 2 presented in Kerr et al. 2003.” The report is extensively referenced, which includes appropriate updated geological reporting and mapping (reviewed and listed in the references in this peer review).

Fault Line vs Fault Zone: The Dataset Accuracy discussion in the report (section 3.3.3) discusses the “line delineating the interpreted location of a fault” and BECA advised that the Fault Deformation Overlays intentionally do not show the position of fault lines (unlike the TDC Fault Hazard Overlay). I concur with this approach including for the reasons set out in the report.

Fault Awareness Area (FAA) vs Fault Avoidance Zone: Consideration of the character of the overlay for poorly defined/ significant uncertainty of specific fault locations is presented (section 3.4). Two options are presented with Option 1 “Adopt the approach of having two separate areas of the fault deformation corridor” including a FAA and Option 2 “Continue with a single fault deformation corridor but have separate rules relating to the specific sections of the updated fault deformation corridors that are less defined”.

While no specific recommendation is presented in the report discussions at the meeting generally supported Option 2. Although not specifically a part of our brief in our opinion Option 2 is preferred and is recommended.

Historic Aerial Photo Review: The report notes “We reviewed aerial photography from 2020, 1940’s, 1970’s and 1980’s to constrain the location of some faults. It does not comment on whether or not stereo-scopic review of aerial photo has been undertaken. Stereo-scopic review of photos is a powerful and widely used tool to evaluate lineations which may be fault related. Aerial photo lineations may also be unrelated to faulting and indicate cultural features (i.e. old fences, pipelines, tracks etc). Limitations on the use of historic aerial imagery are presented however comment on whether or not stereo-scopic review has been undertaken should be provided.

Metadata: Details of the Metadata associated with the reporting were discussed and subsequently supplied and are considered appropriate for this level of reporting. Metadata descriptions developed for the drill hole locations presented in our Liquefaction Hazard Review, Drill Hole Data Compilation (Geo-Logic, 2013) are also attached for reference (refer attachments). Metadata is not listed in the definitions presented in the BECA report but could be.

It was discussed that the width of the FHO reflects in part the accuracy of the Metadata i.e., the narrower the zone the greater the accuracy.

Assumptions and Scale: The report notes “This update to the fault deformation corridor follows the MfE guidance as described in Step 1 and 2 presented in Kerr et al. 2003.” Importantly the report notes “The corridors are not a replacement for site-specific assessments”. Discussion of scale of the overlay mapping is appropriately presented as “1:5,000 to 1:10,000 where datasets allowed” which is considered appropriate for this level of reporting.

The BECA report appropriately points out that "...it is not appropriate to use features mapped at scales of 1:50,000 (or larger) to create fault deformation corridors, because the location of the actual fault is not considered accurate enough." *"A map should only be interpreted at the scale it is compiled at. Data should not be transferred from larger scale maps (1: 250,000) to typical district plan maps (1: 10,000), or used for detailed land use planning purposes"* (Kerr, 2003).

Fault Database Updates: There was discussion about the desirability and practicality of maintaining the Fault Database as a "live document". As a planning document this was soundly rejected as not viable given the effort (including public notification requirements) and expense of revisions to planning documents. A Council policy could, however, be developed to encourage/ require submission of geotechnical reporting with "geo-referenced" siteplans where faulting investigations are undertaken. The BECA report notes "...there were a number of records where no geotechnical reports were available." Having an appropriate Council policy in place could address this issue for future revisions of Council overlays.

The report appropriately references the New Zealand Geotechnical Database (NZGD), section 3.2.5, which is a "live document". Discussions with BECA clarified that data held in this publicly available database did not significantly add to the refinement of the overlays (see also Appendix C).

Discussions raised consideration of showing the TDC Fault Hazard Overlay at the southern limit of the Nelson Overlay area and the MDC (Marlborough District Council) Fault Buffer Zone at the northern limit. However this was discounted as unviable for similar reasons as per the above and to avoid inappropriate planning complexity between the adjacent districts. Map 6 of Appendix B does show continuity of some fault corridors between NCC and TDC across Champion Road. "Natural hazards do not stop at local authority boundaries." "It is important to consider how the plan will co-ordinate with the plans of territorial authorities that share the same hazards, to ensure that provisions are integrated across councils" (Kerr, 2003).

Other Discussion Items:

Geological Review of the Current Fault Hazard Overlay Maps: BECA confirmed consideration of the Revised Geological Map of the Nelson-Richmond Urban Area (Johnston M. R., Ghisetti, F. C. & Wopereis, P. 2021) in preparation of the overlays prepared for this report. Also discussed was the nature of the geological review of the Fault Hazard Overlay Maps. In addition to the report's Document Acceptance review, which is signed off by Paul Horrey, it was confirmed that an appropriately qualified geologist familiar with the geology of the Nelson Area, Paul Wopereis, participated in the review of the current Fault Hazard Overlay Maps. This is not mentioned in the report but could be.

Tahunanui Fault: It was clarified that the newly mapped Tahunanui Fault was considered for inclusion in the current reporting but ultimately excluded. A "Review of Fault Rupture Hazard Corridors, Nelson City notes "A fault, which is responsible for the western edge of the Port Hills has long been inferred as lying somewhere concealed beneath Tasman Bay and the low-lying ground extending from Tahunanui Beach southwards through Stoke. The fault, which has in recent years been broadly constrained by drilling for groundwater in the Stoke area, separates the rocks exposed in the Port Hills in the east from Moutere Gravel in the west. However, its characteristics and position are not known sufficiently to define a fault hazard corridor (Johnston, 2019). The BECA report sets out and identifies those faults which were considered for inclusion in preparation of the revised Fault Hazard Overlays. No comment on the basis/ reasoning for excluding consideration of the newly mapped Tahunanui Fault are presented in the reporting but could be.

Existing Fault Extensions: BECA confirmed that there was no removal (stripping out) of fault related overlays associated with previously designated faulting. The revised overlays reflect modifications and, in some cases, extensions of previously identified fault hazard overlay.

The impact, in terms of additional properties now included in the revised overlays, relative to the last revision (which significantly reduced the number of properties affected) was raised but considered a statistical GIS analysis exercise which has not been carried out, nor considered a part of the scope of work being addressed in this report. It appears that a significant number of additional properties will be “captured” in the revised overlays and I believe it would be a useful exercise for Council to carry out which could assist Council in future public discussions if these were to take place.

Summary

Following the meeting at the offices of BECA on 20 October 2021 this DRAFT report has been prepared to address **Scope of services item 4**. In summary I concur that the methodology undertaken for this report is robust and geotechnically appropriate as applied to generate the *Updated Fault Deformation Corridor Maps* (Appendix A). The work undertaken is of a high quality and assumptions clearly stated with regard to accuracy and limitations.

Refinement recommendations have been presented, and are summarized below, for consideration which should assist NCC in developing planning documentation associated with the Revised Nelson Fault Deformation Overlays.

Recommendations

1. We recommended a revision to the title of the report to include the term overlay and there was unanimous agreement that the name of the report be changed to Revised Nelson Fault Deformation Overlay.
2. The term ***LiDAR*** is not listed in the definitions presented in the BECA report but could be.
3. The overlays intentionally do not show the position of fault lines (unlike the TDC Fault Hazard Overlays) and concur with this approach including for the reasons set out in the report.
4. While no specific recommendation is presented in the report with regard to Fault Awareness Area vs Fault Avoidance Zone Options 1 or 2, although not specifically a part of our brief in our opinion Option 2 is preferred and is recommended.
5. Limitations on the use of historic aerial imagery are presented however comment on whether or not stereo-scopic review has been undertaken should be provided.
6. The term ***Metadata*** is not listed in the definitions presented in the BECA report but could be.
7. Importantly the report notes the corridors are not a replacement for site-specific assessments.
8. Discussion of scale of the overlay mapping is presented as 1:5,000 to 1:10,000, where datasets allowed, which is considered appropriate for this level of reporting.
9. A Council policy could be developed to encourage/ require submission of geotechnical reporting with “geo-referenced” siteplans where faulting investigations are undertaken to improve future revisions of overlays.

10. No comment on the basis/ reasoning for excluding consideration of the newly mapped Tahunanui Fault are presented in the reporting but could be.
11. A geological review of the current Fault Hazard Overlay Maps by an appropriately qualified geologist familiar with the geology of the Nelson Area has, we understand, been carried out, as a part of the BECA internal review (Paul Wopereis/ Paul Horrey) and this could be mentioned in the report.
12. While no statistical GIS analysis has been carried out as a part of the reporting to evaluate changes in the number of properties impacted by the revised overlays it appears that a significant number of additional properties will be “captured” in the revised overlays and I believe it would be a useful exercise for Council to carry out internally which could assist Council in future public discussions if these were to take place.

Limitations

This report has been undertaken as per the agreed brief and has been prepared for the benefit of Nelson City Council. It is a peer review of the general methodology and not a geotechnical review of the Fault Hazard Overlay Maps. No fieldwork has been undertaken.

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References

Beca, 2021: Nelson Fault Deformation Corridor Update, prepared for Nelson City Council dated 6 August 2021 (3160262-472476811-30)

Geo-Logic Ltd, 2010: Revised Fault Hazard Overlay. Fault Line Data Capture Maps, Peer Review, Nelson prepared for Nelson City Council dated December 2010 (reference 5022.12)

Geo-Logic Ltd, 2013: Liquefaction Hazard Review, Drill Hole Data Compilation, Nelson prepared for Nelson City Council dated January 2013 (reference 5022.06)

Johnston, M.R. and Nicol A, 2010: *Assessment of the location and paleoearthquake history of the Waimea-Flaxmore Fault System in the Nelson-Richmond area with recommendations to mitigate the hazard arising from fault rupture of the ground surface.* GNS Science DRAFT Consultancy Report prepared for Nelson City Council and Tasman District dated December 2010 (ref 2007/64).

Johnston, M. R and Nicol, A. 2013: *Assessment of the location and paleoearthquake history of the Waimea-Flaxmore Fault System in the Nelson-Richmond area with recommendations to mitigate the hazard arising from fault rupture of the ground surface.* GNS Science Consultancy Report 2013/186.

Johnston, M. R. 2019. Review of Fault Rupture Hazard Corridors, Nelson City. Dated May 2019.

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/>).

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.

Yours faithfully
GEO-LOGIC LIMITED

A handwritten signature in black ink, appearing to read 'P. Denton', with a stylized flourish at the end.

Paul Denton
Engineering Geologist

Attachments:

Fault Deformation Corridor - Metadata, courtesy BECA

Drill holes accurate location - Metadata, example from Geo-Logic, 2017

Drill holes general location - Metadata, example from Geo-Logic, 2017