6 April 2018

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Dear Rachelle

Response to New Plymouth District Council request for further information on the Mt Messenger Bypass project resource consent application and notice of requirement

Thank you for your letter dated 22 March 2018, requesting further information under Section 92 of the Resource Management Act 1991 (RMA). The further information relates to the Mt Messenger Bypass project (Project) resource consent applications and a variation to the existing notice of requirement (NoR). We would also appreciate the opportunity to discuss the below responses with you in further detail. The paragraph numbers below match those in your letter of 22 March 2018.

Designation details

1. It is understood that the proposed new designation boundaries would include the existing Mt Messenger rest area, and the Requiring Authority would seek the proposed tunnel emergency water supply intended to be located within the rest area to be within the designated area. However access to this rest area would not be secured within the designation. Considering that the status of existing state highway to be revoked has not yet been determined, what consideration has been given to ensuring legal access continues, regardless of the future legal status of the existing road?

   __Response:__ The NZ Transport Agency (Transport Agency) is in ongoing discussions with the Council about the future of the section of SH3 that is being bypassed. As the Council is aware, State highway revocation issues are managed outside of the RMA. The revocation outcome is yet to be determined, but the Transport Agency will ensure ongoing legal access for all properties (or else acquire those properties). The potential for ongoing access to the Mt Messenger rest area will be considered as part of this process (and it may be that part of the existing designation is retained to ensure this access continues).

2. Please indicate which areas are anticipated to be removed from the designation once the construction is completed and the new route is operative. (This request is linked to the matter above regarding accessing properties and the state highway revocation, as well as consideration of effects on the Pascoe farm and buildings).

   Response: The NoR does not provide for revocation of any of the existing SH3 designation – it is to alter the existing designation by adding to it. Once construction of the Project is complete, the Transport Agency will consider what parts of the existing designation are no longer required. In relation to the areas covered by the altered designation again refinement (if any) after construction will be considered at that time.

3. The AEE explains that ongoing work continues and the "final design" is not yet completely developed. Please clarify when you think the design will be completed, and if not by the Hearing, to what extent can the drawings provided be relied upon?

   Response: The design provided, with the draft management plans, is intended to be a "consenting design" and provide worst case parameters for the Project. The drawings can be relied on to show these parameters. Assuming the consents and the altered designation are granted, final drawings will be developed which will incorporate changes required through the hearing process and any further refinement (within the parameters of the conditions).

Noise

4. A detailed assessment of the construction noise impacts on 2397 Mokau Road resulting from the use of the spoil area is requested. Please identify the possible location of haul road(s) and predict construction noise resulting from the use of the haul road(s) and the spoil area including earthworks activities, and identify what mitigation measures are appropriate and where these should be located. Include the separation distances between the dwelling and the haul roads and the spoil area. Identify the permitted hours of operation for the spoil area as night-time activity is of particular concern.

   Response: There is a possibility for exceedance of the daytime criteria of NZS6803:1999 near 2397 Mokau Road which is in close proximity to the southern spoil disposal area. The Construction Noise Management Plan (CNMP) (which the draft conditions require compliance with) includes the recommended mitigation of the Alliance's noise expert which is that if such exceedance occurs, the following measures are implemented:

   - the spoil site only operates Monday to Saturday 7:30am to 6:00pm (no Sunday or night works at this spoil site);
   - a solid site hoarding is constructed; and
   - there is appropriate on site management to avoid unnecessary noise.

   The CNMP includes proactive noise monitoring and reactive complaint procedures that must be followed.

Pascoe property

5. The noise report suggests that the dwelling at 3072 Mokau Rd (Pascoe) will be used for residential purposes following construction. This dwelling is located where the main construction yard is proposed to be located. Please outline the plan (or options for) how the dwelling would be used for living purposes again, given that the plans show the area to have provisional fill, potential permanent disposal area, mitigation planting and preferred yard site at this location.

   Response: While the noise report suggested that outcome at that time (and to provide a conservative assessment), it is subject to formal Public Works Act 1981 negotiations for land acquisition with the Pascoes. This will be updated at, or prior to, the hearing. The general processes for reinstatement is outlined in the Landscape and Environmental Design Framework (LEDF).

6. Section 5 of the Social Impact Assessment (SIA) considers construction dust from earthworks in relation to 3072 Mokau Rd (Pascoe) as if they would be living there during the construction period. Section 8 of the SIA considers local social impacts in terms of wellbeing and three other factors. It states that contractor's yards and other construction features will be located away from residences and fails to acknowledge that the preferred yard site and offices are proposed at the location of the existing Pascoe dwelling. Section 9 of the SIA rates the significance of social impacts and considers them to be minor or medium without mitigation, and reduced to minor with mitigation. Page 51 does identify the loss of social cohesion from land acquisition; rating this is a medium impact reduced to minor due to the compensation provided through the Public Works Act process. On page 47 of the SIA it states "Concern and anxiety cannot be fully avoided or mitigated as individuals have different reactions. However, the accelerated nature of the project has the potential to provide certainty to people that the project will go ahead as opposed to a long drawn out process." Whilst this may apply to the wider neighbourhood, I consider the SIA is deficient in its assessment of the social impact on the Pascoe's amenity, way of life and wellbeing. Please further assess the social impact on the Pascoes, who during the construction period will have a severely reduced ability to live on and farm their land. Please confirm you consider the impact on the Pascoes resulting from the land acquisition to be minor, and provide detail and justification for the medium/minor rating of the social impact.

   Response: The Social Impact Assessment provides a detailed assessment of the local social impacts of the Project (section 8). This captures the impacts on landowners whose property will be directly impacted by the construction of the Project, including the Pascoes. Section 9 of the Social Impact Assessment includes an expert assessment of the social effects of the Project once mitigation measures are in place.

   Issues associated with land acquisition and the disruption such acquisition may cause are addressed through the separate Public Works Act acquisition and compensation process. This process has commenced in respect of the Pascoes' property, and discussions between the Transport Agency and the Pascoes are ongoing. The Transport Agency intends to provide an update in respect of the treatment of the Pascoes' property at, or prior to, the hearing.

7. Concerns regarding the effects of the proposal on the Pascoes have been raised in submissions. Please comment on whether you consider the social impact and amenity effects on the Pascoes to be relevant to the decision on the Notice of Requirement. Please explain why this is not acknowledged in the application documentation or direct me to where in the application this is addressed.

   Response: See the response to question 6 above.

Consultation

8. The majority of public consultation carried out by NZTA related to alignments west of the existing state highway and along the existing state highway. Did consultation results help inform the decision to choose Option E (described as Option C in June 2017)? Please detail what feedback, if any, was received in relation to Option E.

   Response: Section 7.5.4 of the AEE summarises the Transport Agency's "Phase Four" consultation, carried out in June 2017. This consultation did help inform the decision to choose the Project alignment.

   The eastern option that became the Project alignment was one of the five options consulted on. The feedback received is summarised at section 7.5.4.2 of the AEE. While the weight of public feedback was in support of the western option (Option C in the consultation material), the main themes from the consultation exercise highlighted in section 7.5.4.2 were taken into account by the Transport Agency in choosing the Project alignment.

Alternatives assessment

9. With heavy commercial vehicles constituting approximately 20% of the vehicles on SH3 across Mt Messenger, has consideration been given to reducing road freight through increasing use of rail or shipping as an alternative method to alleviate identified problems with SH3 at Mt Messenger? I understand this may be outside this RMA process, but seek to understand the higher level transportation alternatives to undertaking the project.

   Response: The Transport Agency does not have requiring authority powers in respect of rail or shipping; the Project objectives relate specifically to the improvement of SH3. The application is for an alteration to the existing designation and the alternatives assessment must be viewed in light of this.

The Requiring Authority has taken significant steps to consider alternative routes, including rounds of consultation and the MCA process. However, I seek clarification and further detail on a number of matters to better understand the selection of Option E, and therefore be in a position to assess whether the designation and work are reasonably necessary for achieving the objectives of the Requiring Authority for which the designation is sought.

Comment: The Transport Agency acknowledges the statement as to the steps it has undertaken. The Transport Agency has completed a robust and transparent assessment using tested MCA approaches for alternative assessments. The answers to the questions below, particularly in relation to detail (and how much detail), are as set out in the MCA reports.

10. With reference to Sections 6 and 7, and Appendix N, of the Longlist Report, why was Option C1 not progressed to the shortlist investigations?

    Response: Figure 6.3 of the Longlist Report shows that there is a significant increase in cost for Option C1 in comparison to A1, D1, E1, Z2 and Z4, the other top ranked options. Hence Option C1 wasn't taken forward for further evaluation.

11. In Appendix M of the Shortlist Report (final MCA scoring results), Option Z is ranked 1st equal in the raw scores, 1st with the 'RMA' weighting, 1st with 'Environment' weighting, and 3rd with the 'Transport' weighting. Having read the Longlist and Shortlist Reports, there are questions regarding why Option Z scored lower with the Transport weighting, and it is unclear why Option Z was not selected (although section 6 of the AEE concludes by explaining that cost was a determining factor). More significant adverse effects are associated with Option E, there is a lack of an existing interest in the land required, and some submitters have stated that Option Z would be preferred. Z options scored extremely well through both stages of the MCA process (where it is understood cost was not a factor). Table 6.3 of the AEE presents Option Z as the most expensive option. Please explain:

    a. Why is Option Z so much more expensive than Option E?
       Response: In Appendix B: 3D views of options in Appendix B: Shortlist Briefing Pack, of the Shortlist Report, there are two sheets of drawings of Option Z (ref MMA-DES-GEM-Z7-FIG_0101/0102). A large amount of the difference in cost between option E and Z is due to:

       - the Option Z alignment on the northern side of Mt Messenger where the road crosses a large landslide (FIG-0101) and requires significant ground improvement; and
       - the long bridges on the southern approach with complex interaction with the existing road (FIG-0102).

    b. Was the costing of Option Z on the same basis as Option E as shown in Table 6.3 of the AEE, in terms of no passing lanes and other design standards such as shoulder widths?
       Response: Yes, in terms of no passing lanes on Option Z, noting that the roads would have a similar cross section. However Option Z has a lower expected operating speed due to the complexity of fitting the road predominantly within the existing designated area.
    c. Why does Figure 6.3 of the Longlist Report show options Z2 and Z4 costing at or below $250 million, but Table 6.3 of the AEE presents Option Z following the MCA2 as costing over $360 million?
       Response: Between the Longlist information preparation and the Table 6.3 of the AEE significant work was undertaken to establish geotechnical and other constraints to inform the design and costing refinement. As mentioned in a) above, the northern side of Option Z has a significant landslide feature and the design resolution of that was not as well defined at the early Longlist process.
    d. Did the costings include the costs associated with land acquisition?
       Response: Yes.

12. Please provide the following details for Options Z and E, to clearly show a comparison of the following factors:
    a. Land area required to be acquired – land that the Requiring Authority does not own
    b. Area of native vegetation clearance
    c. Number of significant trees to be felled
    d. Stream length affected
    e. Volume of earthworks
    f. Area of temporary works footprint

    <u>Response:</u> To the degree necessary this material appears in the specialist reports attached to the MCA Longlist and Shortlist Reports. Much of this information is too technical for the level of assessment required for a robust MCA process – see the technical expert reports for the level of information provided.

13. Please advise whether a tunnel beneath Mt Messenger was considered, and explain why this was not one of the options considered in the MCA process.

    <u>Response:</u> Tunnels closer to the summit of Mt Messenger were considered (see Option Z). In particular tunnels close to the maunga were not preferred by Ngati Tama on cultural grounds. A full tunnel alignment beneath Mt Messenger was not considered on cost grounds.

14. "Online options" is a term used in the AEE which implies that a route option exists which is wholly within the existing designation. Please confirm, in relation to shortlist Option Z:
    a. Would Option Z be wholly within the existing designation boundaries?
       <u>Response:</u> No. The intention behind the online option is to fit the road construction, particularly on the south side of Mt Messenger, within the existing designation, to avoid higher value ecological areas identified there. This also applies immediately north of the proposed tunnel, to a point where the proposed road would utilise existing farmland on the northern side.
    b. If not, what area of land would be required beyond the designation boundaries?
       <u>Response:</u> Full purchase of Beard property, possible purchases within other private properties and land from Ngati Tama (Scoring Table MCA Shortlist, property report).

15. Appendix A (Option Footprint Calculations (Ecology)) of the Longlist Report shows no affected stream length for Options Z2 and Z4. Please confirm whether adverse effects on streams would be avoided with Option Z?

    <u>Response:</u> No. See the Short-list Report, freshwater, table 5.1.

16. Is it correct to deduce that Option E was favoured over Option Z largely due to additional constructability challenges including it being very complex to construct while maintaining network capacity? Some difficulty in constructing offline Option E while maintaining network capacity would also be anticipated. Please provide an explanation of the constructability challenges of Option Z compared to E.

Response: A MCA process was completed. By its very nature, multiple matters are assessed. It is too simplistic to state that Option E was preferred over Option Z largely due to constructability (for example constructability was weighted low). The full range of factors in the MCA assessment must be considered (and costs were also factored in later). Aside from the relatively short period of interruption while the temporary intersections are formed, there will be very little impact on network capacity while constructing Option E.

17. I note (from Appendix A Option Footprint Calculations (Ecology) of Appendix L of the Longlist Report) that Z options would have the largest temporary works footprint. In investigating Z options:

    a. Where was it envisaged that temporary work areas would be located?
    Response: Adjacent to cuts and fills and below the proposed bridges
    b. Why would Z options have a larger temporary works footprint than other options?
    Response: The Temporary works footprint, that has an impact on Ecology, was large in this assessment due to the need to access large areas of bush for:

    - the piling and pier construction for the bridges;
    - immediately outside the tunnel portals; and
    - alongside where the existing and proposed roads overlap to the north of the tunnel.

    This is a specific outcome of the longer curved bridges required in this option.

18. Table 5.1 of the Longlist Report includes nine assessment criteria. Section 5.2.3 states that the options were not assessed against the project objectives as these were captured through the nine criteria. However the transport criterion contains three of the project objectives.

    a. Does this skew the scoring of the MCA in favour of transport over other criteria?
    Response: No. Transport was one of nine criteria involved in the MCA process. The scoring methodology is set out in the report at section 5.3.
    b. In relation to Table 5.1, please explain the rationale for having one criterion (transport) for three project objectives (safety, journey time reliability and reduced journey times) and a number of criteria for one project objective (managing the cultural, social, land use and other environmental effects).
    Response: Safety, journey time reliability and reduced journey times are all transport related and were combined within the transport assessment as explained in the transport reports. The other criteria related to a number of disparate disciplines, each with separate experts, and were separated and assessed individually, as important MCA issues.
    c. Why were the route options not assessed against individual project objectives, which could then be further subdivided into multiple criteria (as occurred in respect of Objective 4 with its wide range of environmental effects)? This is also relevant to Section 3.4 of the Shortlist Report.
    Response: As explained in the Longlist and Shortlist Reports, the Project objectives were one of the reference points in developing the assessment criteria, but there was no intention that there should be one criterion for each objective – the MCA process was not a direct assessment against the Project objectives. Mr Roan explains in those reports that he considers the nine criteria used to be an appropriate basis for an MCA assessment of

the Project route options. The reports include a breakdown explaining why each of the nine criteria were used.

19. Within Appendix F (transport) of the Longlist MCA Report, percentage weightings were assigned to the transport sub-criteria (40% for road safety, 10% for operational efficiency and travel time savings and 40% for operational resilience). These three criteria effectively align to three of the project objectives, which do not appear to be weighted.

  a. Please advise why and how these have been weighted?
  Response: The transport expert developed a system that she used consistently and transparently across all options. Operational efficiency and travel time savings were collectively considered to reflect the project objective of drivers' journey experience.
  b. Why was a consistent shoulder width not adopted, thereby having equal scoring in terms of safety for all options?
  Response: Generally shoulder widths are consistent at 1.5m, however, there is some difference in the shoulders in the "structures", i.e. the shoulders in the tunnels are 1.2m to allow for a 0.6m wide flush median in the centre.
  c. Are you confident in the road safety criteria for the options, when some options had narrower shoulders than others?
  Response: Yes. Refer to Section 3.1 of Appendix F, where assessment notes that those options with a reduced shoulder width were scored with a lesser (positive) score than those with the wider shoulders. This approach took into account the views of a road safety specialist.
  d. Why were no passing lanes considered for the Z options, when section 3.1 of Appendix F states that vertical grades greater than 8% would have passing lanes, and Z options included grades exceeding 8%?
  Response: In the Design Philosophy adopted for the Long List process passing lanes were not provided for the on-line options due to cost/available width within the constrained environment of the existing corridor.
  e. To what extent would the inclusion of a passing lane alter the scoring of operational efficiency for the Z options?
  Response: The operational efficiency has a comparably low weighting of 10%. Assuming passing lanes in each direction, this would alter the efficiency raw scoring from 0 to +3, a difference of (10% * 3) = +0.3 to the final weighted score. As noted in section 4, using the approach adopted, the 'raw score' (weighted) for the Z options was 0.9, rounded to 1. With passing lanes in each direction, the score would be (0.9+0.3) 1.2, rounded to 1. Passing lanes for the Z options would not affect either the ranking or final score for the Z options.
  f. With reference to Section 3.1, page 6 of Appendix F, why was option Z4 given a +1 rating when it has a design speed of 100 km/hr?
  Response: Ms Sutton acknowledges that this was an error in the calculations, but it has no effect on the outcome. Applying a +3 rating for travel time, and applying the 10% weighting, the overall total raw score (combined with for 0.4 for road safety, 0 for operational efficiency and 0.4 for operational resilience) is 1.1, which still rounds to 1 for Option Z4 (see table on pages 8-9 of Appendix F).

g. Has the scoring of the options been calculated correctly when correlating their ‘length’ as reported in Section 4.4 of the Longlist Report to the scoring criteria in Section 3.1, page 6 of Appendix F?
   <u>Response</u>: Section 4.4 of the Longlist Report outlines the Option parameters, including lengths. Appendix F, page 6, considers the travel time savings (as a function of both length and design speed). The lengths noted in Section 4.4 align with the lengths used in the assessment of the travel time savings.
h. Option L was the only option considered in the Longlist stage of the MCA to rejoin the existing SH3 as far north as Tongaporutu. All other options in the Longlist, and the Shortlist, are located between Uruti and Ahititi. Why then, in Table 2.1 of the Shortlist Report, is the route length considered between Uruti and Tongaporutu?
   <u>Response</u>: To provide consistency with Long List assessment.

20. Section 3.1 (operational resilience) of Appendix F (transport) of the Longlist MCA Report states “Off-line options would have greater ability to be established to a higher standard than the online options (which are restricted to the existing designation, which in some sections are relatively constrained).”

   a. How was the scoring of the sub-criteria for operational resilience determined and why are online options different from earthworks options?
      <u>Response</u>: As noted on page 7 of Appendix F “*It is considered that all options under consideration will represent an improved transport outcome when compared to the existing environment; the options are designed to a higher standard than existing, resulting in less likelihood of (particularly) unplanned events, and greater opportunity to re-open the road quickly. It is anticipated that the off-line options would have greater ability to be established to a higher standard than the online options (which are restricted to the existing designation, which in some sections are relatively constrained). In addition, discussions with the relevant specialist in the Alliance have confirmed that less routine maintenance would be expected for the tunnels, when compared to the earthworks options*.”
   b. How were ‘structures options’ with high positive scores determined over ‘earthworks options’ with a moderate score?
      <u>Response</u>: Scoring was developed in conjunction with an Alliance specialist with structures expected to have less routine maintenance requirements than earthworks options.
   c. How were the sub-criteria associated with online, earthworks and structures options derived and why are there significant differences in the range of scores (0 to positive 3) between options for ‘operational efficiency’, ‘travel time’, and ‘operational resilience’? Please explain and clarify this scoring, and provide the justification for the wide range of scores.
      <u>Response</u>: Refer page 4 - 5 of Appendix F: the potential for delays due to the presence of Heavy Vehicles (HVs) was used as a proxy for operational efficiency for the purpose of the assessment. Where passing lanes were provided, then improved efficiency (due to reduced risk of delay due to a slow moving HV ahead) was identified as a relative benefit. It is also noted that with a low weighting of 10% for this criteria means (at most) a total of (10% * 3)

0.3 to the final weights score. In fact, the operational efficiency scoring represents very little variability in the final score for each option.

21. Regarding constructability, raw scores for the Z options are negative 4 overall, which appears to result primarily from interactions with the existing state highway. One would assume that best endeavours would be applied to manage these conflicts and I question:

    a. Are adverse traffic effects able to be mitigated to result in a lesser score?

    Response: Not in the expert assessments based on the information available for the MCA process.

    b. What 'best endeavours' were considered to manage the conflicts between the existing state highway and construction areas?

    Response: It is unclear as to where the 'best endeavours' phrase has originated. A key requirement is to ensure the State Highway remains open as much as possible during construction as it is the key route north from New Plymouth. The creation of temporary lanes and building temporary structures over the existing road to reduce closures would be among the tools to reduce the impact on the existing traffic.

    c. It is noted from Table 4.1 of the Longlist Report that Option Z has relatively small areas of land affected by construction activities. Given potential mitigation measures, and when correlated to the quantum of land area affected by construction activities overall, is the negative 4 rating justified?

    Response: From a constructability point of view, yes.

    d. Please clarify why Z options were scored negative 4.
    Response: 13 options of the 24 scored -4, for the reasons set out in the Constructability Report. Given the steep bush clad slopes on which piles and piers are required to be constructed, and an inability to create a haul road of any consequence alongside the proposed alignment due to the existing road (particularly on the south side), and the challenging interaction between the existing and new road on very steep cross gradient north of the tunnel, the experts were of the opinion that a -4 was justified.

22. It is noted that the option put forward in the application (Option E) is different (in plan) to the E options in the longlist and short list reports. When comparing the alignment as presented in Volume 2 of the application documents with Appendix A of Appendix C in the longlist report and 3D views of options in Appendix B of Appendix B in the shortlist report, differences are noted, particularly on the north side of Mt Messenger.

    a. Is this the reason for the difference in overall plan area of 44.4 hectares in the application as opposed to the approximately 30 hectares considered in the Longlist and Shortlist reports?
    Response: No. As is normal in project development, the preferred option has been subject to further analysis and design following conclusion of the MCA process.

b. As the option in the application is quite different from the options that were part of the assessment of alternate routes, please analyse whether the scoring of constructability and other criteria in the MCA process would be different if Option E, being 44.4 hectares, was scored.
   <u>Response</u>: The 44.4ha is largely irrelevant to the constructability scoring and conservatively includes large areas of land for potential mitigation of slope stability, which is unlikely to be required. The 44.4ha is relevant to the designation boundary.

23. Section 3.2 of Appendix D of the Shortlist Report, notes that travel time savings less than 200 seconds represent a minor benefit. UK evaluation procedures (WebTAG Unit A3.1 (DfT 2014) identifies the following bands when appraising options: 0–2 minutes; 2–5 minutes; and greater than 5 minutes. Option Z would have a time saving of almost three minutes (179 seconds), which could be considered to represent a moderate benefit and accorded a rating of positive 4.

   a. Please present documentation that supports the criteria used that 200 seconds is the point at which travel time savings move from a minor to moderate benefit.
      <u>Response</u>: Engineering judgement of the expert applied in the New Zealand context of the Project. As noted for c) below, a travel time score of '4' for option Z would not change the overall weighted or ranked scores of the option.
   b. Has this rationale been used for other state highway projects in New Zealand?
      <u>Response</u>: Again, expert engineering judgement applied. There is no effect on the overall outcome with the UK example applied.
   c. How significant is the minor/moderate scoring of this factor to the overall transport weighted ranking?
      <u>Response</u>: As noted on page 4 of Appendix D, 20% weighting applied to travel time/efficiency scoring. If Option Z was to have a raw score of '4' (rather than 3), then the TT/efficiency weighted score would change from (0.2*3) 0.6 to (0.2*4) 0.8 – a change to the final score of 0.2. This would have the effect of changing the raw score of Option Z from 1.7 to 1.9 (with no change to the final score rounded to 2). In addition, Option Z with a raw score of 1.9 remains the lowest scored option, and this approach would not affect the overall score or ranking of Option Z.

Traffic and Transport Assessment

24. Section 3.1 of Technical Report 2 specifies 1.2m wide shoulders within the tunnel. Please confirm that this width is sufficient for safety purposes, given the correlation to near side shy line requirements adjacent to the barrier protection within the tunnel and the 100 km/hr design speed.

    <u>Response:</u> Whilst the width of the shoulders is proposed to be less within the tunnel when compared to the remainder of the corridor, the overall carriageway width does not change. As such the performance of the shoulders for such things as vehicle breakdown/manoeuvring space is not diminished when considered with the additional width being available within the formalised median.

The formalised median has been proposed as it is considered that this provides better delineation and separation of opposing traffic through the tunnel, while reduced shoulder widths also discourage motorists stopping unnecessarily within the tunnel and in combination with the LED studs along the median and edge lines creates a well-defined and channelised environment.

As the shoulder width is proposed to change, the rate of change for this and development of the median, is applied appropriately in relation to the shy line requirements described in Austroads Part 6 and the TCD Manual (namely MOTSAM Part 2). The proposed carriageway arrangement satisfies the Transport Agency functional requirements of operation, safety and maintenance.

25. Is the width of the access point into the escape tunnel, and the width of the escape tunnel, wide enough to provide mobility impaired access and egress?

    Response: The tunnel egress passage, including access into the egress passage, will be designed in accordance with the Building Code.

26. Please provide a haulage diagram to understand where earthwork activities will interface with the existing state highway. I note Appendix B of the Draft Construction Management Plan but seek greater detail in this with respect to locations of vehicle access points.

    Response: The anticipated haulage requirements are contained within the AEE, refer to Section 5 – Construction of the Project, for details. This describes the type of activities expected at the various construction zones, site access points (SAP) and construction material requirements.

    In relation to, "where earthwork activities will interface with the existing state highway", as noted in Table 5.3 – Bulk Fill:

    > "*Up to approximately 87,000m3 of cut material may be transported to the fill sites on the southern side of the Project, involving approximately 80 truck movements per day over six months.*"

    This could be spread between SAP 4, 5, 6 or 9 and travelling along SH.3 to SAP 8 and/or 10 as shown below in Figure 1.

    All site access points shown in Appendix B of the draft Construction and Environmental Management Plan (CEMP) are "locations of vehicle access points" for construction traffic, their form and function will be developed with consideration to all relevant management plans, regulatory requirement, road safety practices for temporary traffic management, and where required for semi-permanent or long-term installations developed and audited as if they were permanent works.

    Greater detail will not be available until later detailed design and construction programming works have been carried out.

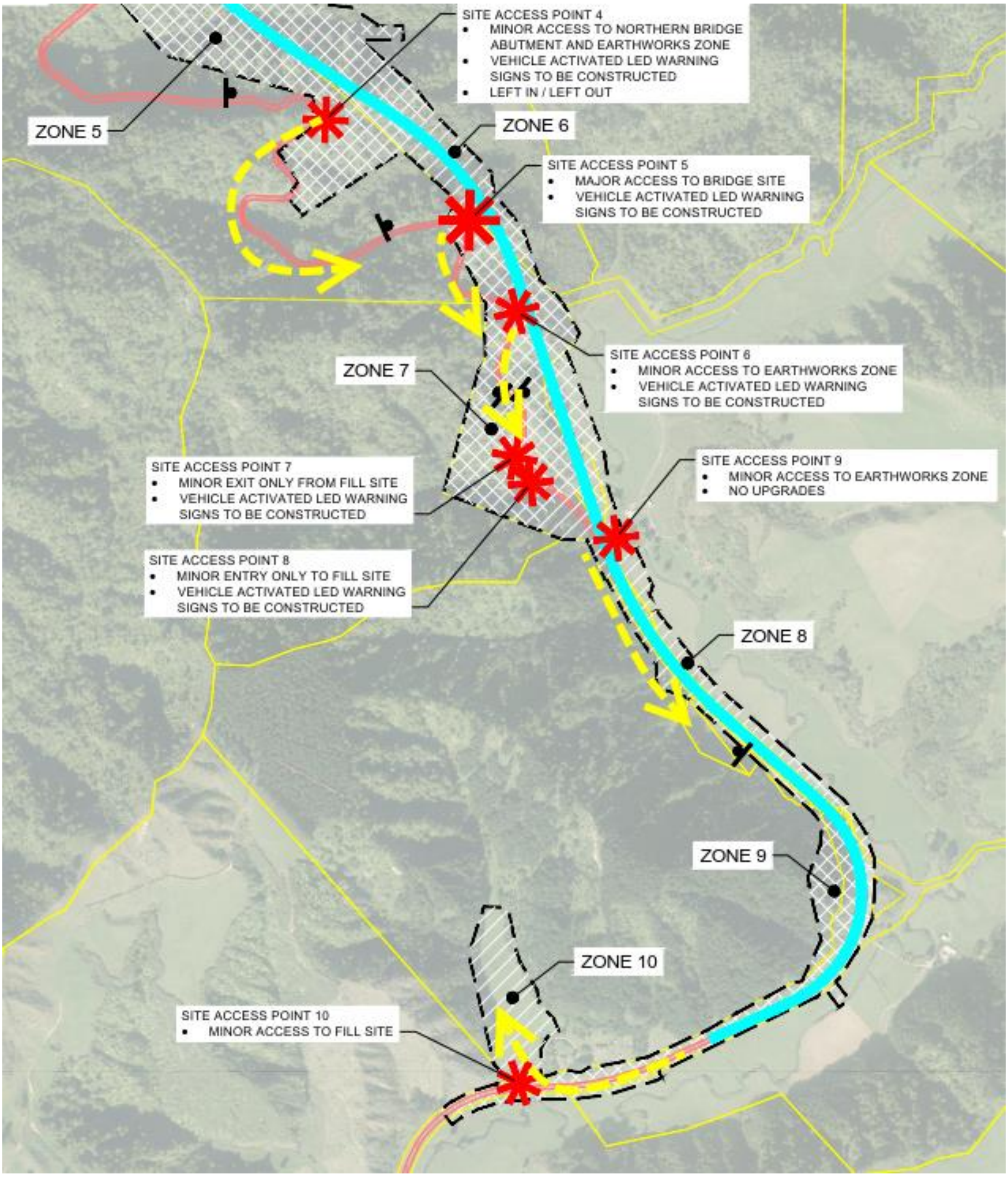

Figure 1: Draft haulage diagram

Geotechnical

The project alignment is within two separate river catchments, in topographically complex hill country, and the geology of the area includes soft sandstone and mudstone, volcanic ash, and alluvial deposits, resulting in geotechnical challenges for road construction and maintenance.

Submitter concerns include ongoing issues with road slumping and erosion in this terrain. To address concerns about land stability, please provide the following information in respect of the Geotechnical Appraisal Report ("GAR"):

27. Please provide the results of the site specific seismic hazard study undertaken by GNS Science (Section 3.3.1 of the GAR).

    Response: The final report from GNS is attached in Appendix A to this response. Note that the assessed background levels are low such that the minimum design requirements of the NZTA Bridge Manual govern the seismic design criteria.

28. In Section 3.2.2 of the GAR, it states that principal stress in the rock mass will be vertical in Wai-iti which has implications for cut slope and tunnel stability/support analyses. Please validate this assumption.

    Response: The assumption presented in the GAR regarding the principal stress likely to be in the vertical direction was based on the understanding that there has been relatively limited tectonic activity affecting the Wai-iti Group sediments (including the Mount Messenger Formation) post-deposition, as suggested by many authors.

    In-situ stress measurements have subsequently been obtained through the use of hydraulic fracturing tests conducted within one of the deep boreholes sunk to investigate the ground conditions at the proposed tunnel alignment. These confirm the vertical stress as the maximum with $k = \sigma h/\sigma v$ of approximately 0.8 to 0.9. The relatively high horizontal stress is believed to represent unloading of the Mount Messenger Formation as a result of uplift and erosion (some authors have suggested this may have been up to 1.5km of sediment). Analysis of triaxial compression tests to be completed on rock samples may provide an estimate of the preconsolidation stress (test completed to date have not loaded the samples sufficiently to reach the preconsolidation stress).

29. Please provide an assessment of the bridge in terms of meeting the performance requirement under the major earthquake (return period factor = 1.5* Ru) in accordance with NZTA Bridge Manual Table 5.1.

    Response: We confirm design of the bridge will include an assessment for the Maximum Credible Earthquake corresponding to a return period factor (Ru) x 1.5.

30. With reference to Section 4.2.1 of the GAR:

    a. Have the effects of rock dip on the design of proposed cut slopes, for example, slope batters, been considered and assessed?
       Response: To date we have completed engineering geological mapping of existing exposures of the Mount Messenger Formation in the vicinity of the project (including existing SH3 cuttings around Mt Messenger). These are consistent with the regional dip of sub-horizontal beds.
    b. As the interbedded sandstones, siltstones and mudstones are expected within the project limits, a build-up of pore water pressure between the interface of sandstones and siltstones/mudstones should be anticipated. Have these been assessed in the design of rock slopes?

Response: We agree with this assessment and allowance has been made for pore pressure relief drains, as required. Further detail on this aspect will be addressed during detailed design. This will confirm a range of potential mitigation measures to be instigated during construction, if such conditions arise.

c. Has the feasibility evaluation of soil nail walls in consideration of the prevailing ground conditions and the disadvantages of soil nail walls been assessed?

   Response: A range of options have been considered for treatment of the typically thin soils present overlying Mount Messenger Formation rocks, which are to be further developed during detailed design. Soil nails may be specified where simpler, lower maintenance solutions cannot be adopted due to the site topography or other constraints, but the general approach will be to cut the thin soil mantle at a stable angle, with inclusion of pinned erosion matting or similar, where necessary.

d. Has the rockfall assessment including the percentage of rockfall retained been undertaken for the proposed rock catchment?

   Response: Preliminary rockfall modelling has been completed for the proposed rock catchment and wider catchments. Based on further modelling, a combination of rockfall mitigation measures will be assessed during detailed design. This is likely to include a combination of rock drape, wider rock catchments and/or inclusion of passive rockfall barriers.

e. We note that for the rock slopes higher than 20m are likely to experience lateral movement on bedding – has this been considered?

   Response: We do not consider this to be a likely mode of failure for the Mount Messenger Formation due to the largely monotonous sequence with indistinct bedding surfaces and sub-horizontal dips. This assessment is supported by the observed stability of high existing road cuttings in the vicinity of Mt Messenger, as well as the very high and steep natural slopes present along the proposed route and the very high outcrops of Mount Messenger Formation rocks along the coast, particularly at White Cliffs. This mode of failure will, however, be included in the modelling during detailed design and closely monitored (and instrumented) by geologists during construction.

f. We note that typical slope batters within the catchment should be between 1V:4H and flat.

   Response: The majority of the road embankments have slopes of 1V:4H or less.

g. What is the design life of the drapery netting and how has its replacement been addressed in Safety in Design?

   Response: The proposed rock drape (TECCO G65/4) for the Project has been specified primarily because of its certified long design life (typically >100 years). We are waiting on confirmation from the manufacturer of the anticipated design life of the product at the specific site (taking into account the proximity to the coast), but is expected to be >80 years therefore requiring minimal maintenance. Further SID aspects will be taken into account in the detailing of the rock drape materials and installation to further minimise future maintenance requirements.

31. For the culvert at Ch4400 in the proximity of the proposed bridge (Section 4.3.4 GAR), please advise:

    a. Is upstream ponding expected in major floods?

Response: Preliminary design of the culvert has been completed for the 1 in 100 year Average Recurrence Interval (ARI) storm event. The predicted water depth at the culvert inlet will be marginally higher than the top of the culvert (approximately 1 metre). Due to the steep topography of the existing stream there will be minimal ponding. The model results will be refined during the detailed design.

b. Are there alternative overland flow paths that could affect the bridge and culvert?

   Response: The Hydrology and Flooding Modelling has been completed for the consent design. There was no significant impact on flood levels or extent on or near the road for the southern (Mimi River) catchment according to the results.

c. What assessment of scour (internal and external) has been undertaken? Have any measures been adopted to prevent scour?

   Response: Preliminary design scour calculations have been completed. Erosion protection such as rock riprap will be placed at the culvert inlet and outlet. Pipe materials of the culverts will need to comply with the design life of 100 years.

d. Have the potential seepage paths under the bridge or culvert been considered? How would it be controlled?

   Response: Control measures include culvert headwall toe and trench stops or bulkheads installed at regular intervals. Groundwater seepage beneath the bridge is expected to be negligible. Any necessary mitigation measures for seepage will be addressed during detailed design.

32. Please clarify, with respect to Table 4.3 GAR, are there four individual culverts (□□=1350mm) proposed at Ch 1850 (culvert ID No. 9)?

    Response: Correct, 4 x 1350mm diameter pipes are currently proposed.

33. Please clarify whether the dipping defects will have unfavourable effects on the design slope angle that is the key factor to the designation. Please show the extents and the locations where this effect might be anticipated (Section 4.4.2 GAR).

    Response: As per the response to 30a above, based on mapping completed to date and regional geological setting, we are not anticipating significant unfavourably orientated and persistent defects. A range of potential mitigation measures will be developed during detailed design so that if such defects are encountered during construction, a stabilisation strategy can be quickly and efficiently instigated.

34. Is it possible that the excavated materials to be a source of fill may not be viable depending on the nature of materials and construction programme? Please advise whether allowance has been made for the use of imported fill materials.

    Response: Testing of rock samples completed to date indicates that the rocks have in-situ water contents close to, and typically slightly dry, of optimum moisture content for placement and compaction, so earthworks control will focus on ensuring the excavated material does not become significantly wetter during handling and compaction (direct cut to fill with minimal stockpiling and suitable cross falls on working surface to prevent ponding of precipitation). Strength testing on rock samples broken down in the laboratory to a soil and then re-compacted (to represent field conditions), indicate these materials can be used as a good quality fill suitable for the proposed earth fill embankments on the project. Petrology tests have, however, indicated some strata may contain a relatively high proportion of smectite (or similarly reactive clay particles). These will need to be treated with care. The alignment includes a reasonable excess of cut to fill material, allowing less suitable materials to be placed in one of the proposed fill disposal areas (landscaped features). We are not anticipating importing (or disposing off-site) of bulk fill materials outside that indicated in the AEE (refer question 26), although some fill materials for specific functions will most likely need to be imported (such as sand/gravel for the embankment drainage blankets / pore pressure relief layers, hard fill for the temporary access road(s) etc., where required).

Cultural effects

35. The AEE states that Cultural Protocols are to be developed with Te Runanga o Ngati Tama. To avoid conditions relying on agreement from a third party it is imperative that these details are agreed prior to the Hearing. Please advise any progress on the development of these protocols.

    Response: The Transport Agency remains in active discussion with Ngati Tama representatives in respect of cultural protocols, and an update will be provided in due course. A proposed condition is being prepared as part of this process.

36. In the submission from Poutama Kaitiaki Charitable Trust, it states that the mitigation and biodiversity offset package does not provide for outcomes to Poutama. It also outlines consultation undertaken and states Poutama are now in a position to complete a cultural assessment. Please provide an assessment of the cultural effects of the proposal on Poutama.

    Response: The Transport Agency has been discussing the Project with Poutama. Those discussions are ongoing, including in respect of the possible preparation of a cultural impact assessment. Ultimately it is for Poutama, as a submitter on the Project, to set out what it considers to be the cultural effects of the Project.

37. The submission from Te Korowai Tiaki o te Hauauru Inc, an incorporated society including members that whakapapa to Ngati Tama, considers that remedies to address adverse cultural effects should apply at the iwi and hapu level. Relief sought includes entering into cultural mitigation and offsetting agreements with relevant hapu including members of Te Korowai as representatives of affected hapu. I note the Ngati Tama submission seeks to protect the tribal interests of all members of Ngati Tama. Please detail what, if any, consultation has taken place at the hapu level and whether this outcome sought in the Te Korowai submission is being considered by the Requiring Authority.

    Response: The Transport Agency has engaged in detail with Te Runanga o Ngati Tama, as the mandated representative body for Ngati Tama. Te Runanga o Ngati Tama has been carrying out its own engagement and consultation with iwi members, including hui with iwi on the Project in December 2017.

38. There is a lack of clarity as to the nature of cultural mitigation or offsetting, or whether it is adequate to address relevant matters under Part 2 of the RMA (Sections 6(e), 7(a), and 8). Please provide details of any agreed measures and an update on what cultural mitigation or offsetting is being considered and what is likely.

Response: The mitigation measures necessary to address the cultural effects of the Project must properly be determined in consultation with Ngati Tama. That consultation is ongoing and includes the development of proposed conditions. The Transport Agency will provide an update on these matters in due course.

Historic Heritage

39. The Historic Heritage Assessment prepared by Clough and Associates (HHA) does not include reporting on visual inspection of the northern (Pascoe) property. The Pascoe property is an area of interest archaeologically due to the landscape being more suitable for early occupation than the surrounding rugged terrain. Please clarify whether an archaeological survey for the selected route been carried out, which may validate assumptions made in the HHA, and provide further information in this regard. If not, is it likely to be carried out prior to the Hearing?

    Response: Archaeological survey of the Pascoe land within the Project area has now been undertaken. No archaeological or other historic heritage sites were identified within the footprint of the Project route within the Pascoe land, either through historical information, previous investigations, or the field survey. As noted in Section 6.1 of the Historic Heritage Technical Report (December 2017), it is considered unlikely that there was significant Maori occupation of the Mangapepeke Valley because of its frequent flooding and steep inaccessible upper valley sides, although the valley may have been used by Māori to access inland areas.

40. The HHA suggests that the area was primarily a source of raw materials, and if this was the case then one would expect associated archaeological sites in the vicinity of the resource locations. Please provide examples of archaeological features that could be present in the project area, and greater detail on the archaeological potential, or "significance" of these features.

    Response: As noted in Section 6.1 of the Historic Heritage Technical Report, the steep inland bush country around Mount Messenger would generally have been unsuitable for intensive Māori occupation and use, which was focused along the coastal plains, but would have provided a source of raw materials.

    The reference to raw resources relates to the hunting and gathering of birds, rats, and plant materials – Mahinga kai. Activities such as these rarely leave archaeological traces that are likely to survive. Occasionally the archaeological remains of tracks, isolated camp sites, or refuge Pa may be found in less hospitable areas of settlement. The archaeological evidence of raw material gathering is usually found back in the settlement sites as bird bones, pollen and phytoliths contained in midden sites.

41. The project area is in proximity to the confiscation line created by the 1863 New Zealand Settlements Act, which resulted in land seizure having a devastating effect on iwi settlement patterns in the area. Please provide a discussion of this to help inform the archaeological potential of the area.

    Response: Information about the Treaty settlement process (including the 1863 Act) will be addressed in evidence. This is not relevant to the Historic Heritage assessment.

42. The existing Mt Messenger road is a piece of pre-1900 infrastructure and there are archaeological and historic heritage values associated with this section of the road. Please identify the historic heritage values and outline how these may be affected during the development of the bypass in terms of service and lay-down areas and possible modifications outside the main corridor identified in the HHA.

    Response: The proposed works will not affect the existing Mt Messenger road. Continuous road maintenance, widening and alteration over the Mt Messenger section of SH3 throughout the 20th century is likely to have removed any evidence of these kilns and quarries in the roadside banks.

43. Please address the possibility of encountering and disturbing remnants of papa kilns, original burnt papa roading surface or papa quarry sites within the wider project area, and your proposed response.

    Response: Our heritage expert has confirmed that no evidence was found along the SH3 Mt Messenger Road alignment of the roadside papa kilns or papa quarry sites that were dug away from the road banks for road metal from 1909. Continuous road maintenance, widening and alteration over the Mt Messenger section of SH3 throughout the 20th century is likely to have removed any evidence of these kilns and quarries in the roadside banks.

    See responses below for further information on this question.

44. Please advise whether the proposed works will impact on the Mount Messenger Tunnel, which has been identified as having a high contextual, historic and social value, moderate cultural and aesthetic value.

    Response: The proposed works will not affect the existing Mount Messenger tunnel.

45. The HHA historical background considers the historic formation of the road. Please provide an assessment of the heritage values and significance of the existing road, bearing in mind that infrastructure sites such as the papa kilns, tunnel, historic road and resource gathering locations have a relatively low representation in the archaeological record.

    Response: The heritage values and significance of the existing road are described in the Historic Heritage Technical Report. Continuous road maintenance, widening and alteration over the Mt Messenger section of SH3 throughout the 20th century is likely to have removed any evidence of the kilns and quarries in the roadside banks.

46. Presently, it is uncertain what will happen to the existing SH3 after development of the bypass. How might threats to existing historic heritage values be addressed into the future, should the existing corridor be revoked? What are the implications for heritage management, if any?

    Response: As above the revocation process is ongoing.

47. During the site visit on 19 September 2017, Geometria Archaeologist Daniel McCurdy noted an area of possible archaeological interest along the historic pack track from the rest area at the top of Mount Messenger, where the ridgeline above the modern access road (originally the pack track and possibly a Maori ara (pathway) before that) shows some evidence of anthropogenic modification – the ridgeline exhibits signs of terracing and two possible

transverse defensive ditches. This location is one of the highest points east of Mount Messenger, providing an exceptional viewshed down the Mangapepeke valley to the north and the Mimi valley to the south, across to Mount Taranaki, and is above (approximately) where the proposed tunnel would be constructed. The location would have been suitable for either a small pa or defended sentry post, with exceptional natural defences and sight lines. Please advise whether this area was examined during the HHA. If not, please carry out further investigation and advise on the findings. It is likely that this location is well enough removed from any works related to the proposed bypass route, but we request any potential implications for this potential site be addressed.

Response: The Historic Heritage Technical Report referred to survey plan SO 982 (1897), which shows a pack track heading east from the top of the Mount Messenger Road, in the vicinity of what is today the summit rest area. A remnant of this pack track was relocated during field survey in March 2018, and this feature was mistakenly identified by Daniel McCurdy (Geometria) as ‘terracing and two possible transverse ditches”. The Project will not affect this feature.

48. Please assess the archaeological effects with reference to the detailed plans of the proposed works, so that specific details such as the location of access roads and vehicle access points, storage areas, electrical and/or water infrastructure installation, fencing and vegetation removal can be considered in relation to historic heritage.

Response: These details have been assessed – see the historic heritage technical report. Please describe how earthworks should be managed to best mitigate damage to any previously unrecorded archaeological sites.

Conditions of consent are proposed to address accidental discovery and also the discovery of archaeological sites and koiwi tangata. The Accidental Discovery Protocol (Appendix M to the CEMP) also provides measures to mitigate damage to any previously unrecorded archaeological sites. This ADP is consistent with the Transport Agency’s Accidental Archaeological Discovery Specification (P45).

ECOLOGY

We note that at the time you were finalising the AEE and technical reports for lodgement, there remained information gaps due to seasonal constraints to survey work and the northern part of the Mangapepeke Valley being inaccessible due to access permissions. Between 22 February and 9 March 2018 supplementary reports for the vegetation, terrestrial invertebrates, avifauna, freshwater ecology, bats, ecological mitigation and offset, and biodiversity reports were received at the Council. These reports are currently under review and further information may be requested in the future. Unless the supplementary reports are referred to in relation to any particular question, the questions raised in this letter are based on the information contained in the ‘as lodged’ resource consent application and Notice of Requirement documents only.

Comment: As noted in the introduction above, the Ecology and Landscape Management Plan (ELMP) addresses a large number of the following queries. The northern Mangapepeke Valley has now been surveyed and the results from this are captured in the respective expert supplementary reports.

49. On Page 79 of the AEE, it states *"(A work programme of ecological monitoring and management will include) the salvage, recovery and translocation of high value flora and fauna from within the construction footprint, where practicable."* Please provide maps showing where the salvage, recovery and translocation of high value flora and fauna from within the construction footprint will be considered impracticable.

    Response: Work is underway to determine the areas where salvage, recovery and translocation of high value flora and fauna is practicable. This will be included within the ELMP. Determinants for this process will include topographical limitations (such as on cliff or very steep areas) and whether there are any health and safety issues in transporting flora and fauna from certain areas. This detail will be provided to the Council once it becomes available.

Vegetation

50. Please provide an assessment of the ecological values of the project area against all of the Significance Criteria listed in Appendix 21.1 of the New Plymouth District Plan. We wish to check there are not significant differences in assessments under the District Plan criteria to the assessment based on Davis *et al.* (2016) criteria that were relied upon in the application documents.

    Response: Mr Singers, author of the Vegetation Technical Report, assessed the potential effects of the Project by reference to the relevant significance criteria in the New Plymouth District Plan, and in accordance with the EcIA Guidelines. The two significance criteria in Appendix 21 considered to be relevant to the vegetation assessment are:

    - Criterion 1: Threatened species. For the purpose of assessing this criteria 'threatened species' includes:
        (a) any vascular plant listed as 'acutely or chronically threatened' by de Lange et al. (2013); and
        (b) 'regionally limited abundance' plants listed within the Taranaki regionally distinctive plant list. The presence of non-vascular threatened plants, lichens and fungi were not evaluated.
    - Criterion 3: Nationally rare ecosystems, habitat or sequences. For the purpose of assessing these criteria, nationally rare ecosystems, habitat or sequences are defined either by Williams et al. (2007) or occupying <20% of their original extent. This has been quantified through using Leathwick (2016) for the North Taranaki Ecological District and Taranaki regional scales. The national scale measures of extent remaining have been included where data exists as not all regions or districts have potential ecosystem maps.

    Regarding Criterion 2, Mr Singers noted that 'Areas of important habitat: for nationally vulnerable or rare species' was not triggered for vegetation and threatened plants, despite the Project impacting one 'At Risk' species and several regionally distinctive species. In this context 'Important' was defined as including one the following sub-criteria;

(i) being an important population or part of a larger population actively managed for the conservation of the species, or

(ii) being a large population (relative to other populations), or

(iii) being stable with no pressures or agents of decline present; iv or being on the margin of the species population range, or iv. containing important genetic diversity.

'Representativeness' is not included within the District Plan significance criteria. However Mr Singers considers that representativeness requires consideration with respect to specific vegetation communities affected. This is consistent with the criteria in Davis *et al.* (2016), which enable a broader assessment and consideration of values, and is consistent with what DOC considers best practice (particularly relevant given DOC's existing management interest in the wider Project area). Mr Singers will describe his approach to assessing these criteria in further detail in evidence.

51. With regard to the provision of quantitative vegetation information, please advise the rationale for using unbounded recce plots instead of other methods such as measurement of tree stem diameters in fixed size vegetation plots, which would provide good quality data for the biodiversity offsetting model.

<u>Response:</u> Quantitative data collection methods were used alongside qualitative methods. For example, see response to question 59 below. Application of the biodiversity offset model requires interpretation of data whether collected qualitatively or quantitatively. In this regard, Mr Singers has applied specialist knowledge based on data which were collected along the Project footprint.

52. The application documents refer to five metres wide edge effects, but other evidence considers edge effects as encroaching 50-100m into an area of vegetation (or more). The DOC submission states that five metres is insufficient. Please provide evidence to support your assertion that five metres is an appropriate measure for edge effects within each of the habitat types to be affected.

<u>Response:</u> The Project ecologists, including Mr Singers, have incorporated the 5m edge effects area for direct physical effects on vegetation from construction. The Vegetation Technical Report (at Section 2.3.2) acknowledges that edge effects can extend well beyond 5m from the Additional Works Area. The incorporation of a 'total loss' of 5m of vegetation provides for a conservative approach to calculating biodiversity offsets for the Project.

This is one of the most conservative approaches for addressing edge effects for any large infrastructure project in New Zealand. Indeed, for most large projects, while edge effects are acknowledged, they are not factored into mitigation measures.

53. The application omits many species from its list of significant tree species (e.g. tawa), and does not acknowledge that significant trees would also be lost in the future, due to ongoing windthrow and other edge effects. We would like to see additional plantings compensating for all significant trees within the project footprint regardless of species, and also include those within at least 50 metres of the maximum extent of clearance. If this is accepted by the Requiring Authority, please revise the calculations for mitigation plantings to include these.

Response: The surveys carried out to inform the Supplementary Vegetation Report included high quality drone imagery and visual surveys for any additional significant trees in the footprint. As stated in Section 2.3.3 of the Supplementary Vegetation Report, two additional significant trees were identified from drone imagery:

(1) A large pukatea (at NZTM 173106; 5694619); and

(2) A small miro growing on a ridge (at NZTM 1739041; 5694619).

As stated in Section 2.4 of the Supplementary Technical Report, these trees will be ground truthed to confirm their identification, size and ecological value.

Regarding the edge effects referenced above (such as windthrow), as noted in the response to question 53, the biodiversity offset calculation factors total loss of an additional 5m of vegetation beyond the Project footprint (which itself encompasses the road footprint and additional works area). This is a conservative approach.

Areas of tawa and rewarewa being affected by the Project have been assessed in the Vegetation Technical Report and Supplementary Technical Report. These have been input into the biodiversity offset model, and the Project ecologists have confidence that the mitigation package adequately addresses any potential adverse effects on these species.

54. Tawa, rewarewa and kamahi are not included as significant trees, irrespective of size. We are concerned this will create a shortcoming for mitigation planting and consider these species should be included with other significant trees. Please justify why such trees have not been identified as significant in your mitigation planting assessment. Alternatively, please revise the assessment to include these species.

    Response: Regionally and locally, tawa, rewarewa and kamahi are abundant. Given these species grow on very steep slopes, it is understood that there are few very large trees of these species. Mr Singers considers that the proposed integrated pest management programme, across a core area of 230ha and over a total area of 1085ha, will provide a major benefit to the species given how abundant they are in the Pest Management Area (PMA) and that their condition is being impacted by pests including widespread recruitment failure of kamahi and tawa.

55. Manuka has been ranked as 'low' ecological value in Table 3.1 of Technical Report 7a (Vegetation). Please advise whether this ranking reflects the value of Manuka as habitat for other species such as At Risk gecko species. Given the value of Manuka as habitat, please confirm whether you maintain the 'low' ranking.

    Response: The Herpetofauna Technical Report (December 2017) and Supplementary Herpetofauna Report (February 2018) addresses and acknowledges the loss of vegetation throughout the Project footprint which is suitable habitat for herpetofauna species. The potential adverse effects of the Project on those species are assessed in those reports, rather than the Vegetation Technical Report.

56. Please explain why Kahikatea-swamp forest, given its rarity and representativeness, is not ranked as one of the highest value forest types.

    Response: The Vegetation Technical Report gives Kahikatea swamp maire forest a 'High' rating for ecological value, based on the methodology set out in that report. It is noted that, following further investigations, the area of Kahikatea swamp maire forest in the Project footprint has decreased from 0.182ha to 0.159ha (refer Supplementary Vegetation Report).

57. Has the ranking of ‘moderate’ for dry-cliff taken into account that it could be habitat for uncommon species?

    Response: Yes this has been taken into account.

58. Kahikatea trees shown in photographs in Section 3.4.1 of Technical Report 7a (Vegetation) show large and older specimens, but the text describes them as ‘poles’. Diameters and heights are given that are estimates for ‘most’ of the trees present. Please advise what the diameters are of the largest individuals present for a transparent assessment of this species.

    Response: Trees on the margins of stands typically have larger diameters than within the centre of the stand. This observation is not surprising, however it does not represent the majority of trees, which are less than 30cm diameter at breast height (dbh).

    On 19 July 2017, a 200m^2 plot was placed within the centre of largest stand of pole kahikatea, of which approximately 2,540m^2 is proposed to be cleared (NZTM 1739238; 5694920). A tape was positioned approximately along the centre-line of the proposed road and all trees were recorded within 5m either side of this for a distance of 20m. In summary a total of 19 kahikatea trees were recorded, of which 15 were <30cm dbh, two were between 30-60cm dbh and two were >60cm dbh (but <70cm). Other trees recorded were all <30cm d.b.h and included six pukatea, 25 wheki and two putaputaweta. Very limited vegetation occurred in the 2-5m tier though ramarama, hoheria and kiekie were present along with climbing rata and hounds tongue fern. The understorey and ground cover tiers were heavily browsed with vegetation mostly <30cm height and was dominated by African clubmoss (approximately 50% cover).

59. In Section 3.4.2, should kahikatea/*Carex* spp. treeland be classed as a *Carex* sedgeland with emergent kahikatea, to reflect its wetland status? If so, please update your assessment to reflect this.

    Response: No, this classification should not be changed. Mr Singers considers that these areas are successional and will develop back into kahikatea forest, rather than being ‘semi-permanent non-forest wetland’.

60. In relation to Section 3.4.4, the wheki-ramarama vegetation type may be an ecologically interesting and important habitat. Please provide an explanation as to why this is not included for the ranking of ecological values in Table 3.1.

    Response: Like the non-forest wetland communities, this habitat is outside of the footprint so was not included in Table 3.1 of the Vegetation Technical Report.

61. Should the ranking assigned to all alluvial forest (primary or secondary) be assigned a ‘very high’ ranking, due to the significantly reduced extent of this forest type locally, regionally and nationally? Further, has the ecological sequences associated with alluvial forests in the project area, which may form intact sequences with hillslope forest, been considered? Please update your assessment with respect of alluvial forest rankings.

Response: No, the value ranking should not be changed. Mr Singers' rankings for particular vegetation types (rather than all alluvial forest) are set out in the Supplementary Vegetation Report (Table 2.3; pp15-16).

62. Please explain why all herbaceous freshwater wetlands dominated by indigenous species are not ranked as 'very high' or 'high', given that less than 0.1% of this vegetation type remains in North Taranaki Ecological District.

    Response: There are not any freshwater wetlands dominated by indigenous species within the footprint. Mangapepeke rushland sedgeland habitat is dominated by exotic vegetation. This was confirmed during further investigations in the northern Mangapepeke, captured in the Supplementary Technical Report. Despite this, a conservative approach has been taken to restore (1:1) areas of *Carex virgata* sedgeland mixed rushland.

63. Section 3.9 of Technical Report 7a (Vegetation) considers rare and threatened plants. *Astelia trinervia* is listed in the vegetation description for miro-rewarewa-kamahi forest and was identified in Section 2.11 as being regionally distinctive, but adverse effects on it have not been addressed. Please provide an assessment of adverse effects on this species.

    Response: *Astelia trinervia* was not found in the Project footprint, as noted in Section 4.3.4 of the Vegetation Technical Report and Section 2.3.3 of the Supplementary Vegetation Report. Section 4.3.4 of the Vegetation Technical Report notes that the abundance of *Astelia trinervia* is anticipated to increase in the PMA with goat control.

64. *Pittosporum cornifolium* may be the most widespread regionally significant plant throughout the route. Please provide an assessment of adverse effects on this species (Section 4.3.4).

    Response: Pittosporum cornifolium is light demanding and typically grows within large, typically Astelia spp. epiphyte clumps. At Mt Messenger these communities are mostly on the larger trees including many of the significant trees. Trees especially with large epiphyte communities were searched with binoculars and, as noted in Section 3.9 of the Vegetation Technical Report, *Pittosporum cornifolium* was found in the Project footprint, growing epiphytically on two large rimu and one matai. Others are expected on other host trees within the Project footprint and the possible number of plants affected was estimated at <20 individuals. The potential adverse effects of these plants will be mitigated by taking propagules (cuttings, seed or whole plants) of *Pittosporum cornifolium* when significant trees are felled (see Section 5.2.2 of the Report). The Report notes that *Pittosporum cornifolium* could potentially be cultivated on cut wheki tree-ferns and then be returned on site to suitable locations.

65. Section 4.2.6 of the Vegetation Report considers that roadside batters will be suitable for cliff specialist species and that this will address the loss of 0.4 hectares of mapped cliff habitat, and thus the project should have a positive effect on cliff communities in the long-term. Please provide evidence for this assertion.

    Response: Mr Singers is of the opinion that with management of weed threats, and planting some specialist cliff species, vegetation succession of road side batters will naturally develop especially on south facing slopes and where natural seepages occur. This is evident looking at roadside cuttings within the region and locally (along other sections of SH3), which include species include such as *Pseudopanax laetus* and *Olearia townsonii*.

66. Different vegetation units have been grouped into broad ecosystem categories, which has resulted in the significance of particular units being downgraded because of the inclusion of other vegetation types of lower value within the same ecosystem type. For example, a representative area of kahikatea-swamp maire forest was included within "kahikatea-pukatea forest" and subsequently ranked as "High", when if assessed separately, might qualify as "Very High". For accuracy and usefulness of the ecological assessment, please assess the significance of each vegetation unit separately. Please include wider biodiversity values, such as habitats and populations of indigenous fauna, in the ecological significance assessment.

Response: Mr Singers considers that the Vegetation Technical Report and Supplementary Vegetation Report have appropriately classified and assessed the value of and effects on vegetation units. Individual vegetation communities have been assessed within the Supplementary Vegetation report (Table 2.3; Pp15-16). The values of fauna species in areas of the Project footprint have been assessed in the relevant technical reports.

67. The grouping of vegetation types, and the assessment of their values in isolation from their fauna values, downplays the values of the certain habitats within the project footprint, e.g. mānuka scrub that may be habitat for At Risk gecko species. Please revise your assessment to reflect fauna values of habitat.

Response: As noted above, the assessment of effects on fauna species has been carried out in the relevant specialist fauna reports, rather than the vegetation assessment.

68. Section 4.3.2 of Technical Report 7a discusses the loss of large trees and considers that pest animal control can mitigate some of the loss. Effects of pest animal control on the health of large trees will differ from species to species, and have not been quantified. The extent to which pest animal control can mitigate the effects of loss of large trees is therefore uncertain. In general, it is very difficult to mitigate the adverse effects of loss of large trees which may be over 500 years old. They are not able to be replaced, except in extremely long timeframes, as the report notes. Please quantify the number and species of large, emergent trees within the area of proposed pest control, their vulnerability to browsing by introduced mammals, and the current health of their canopies.

Response: The Transport Agency has expanded the PMA to 1085ha in total. It is anticipated that a considerable number of large (or regionally distinctive) trees are included in this area including species which are vulnerable to the impacts of animal pests. The Project ecologists have selected the proposed PMA based on existing survey information for the area, and the potential improvement in vegetation condition (including for large trees) and recruitment is considered to be significant. There is widespread recruitment failure of several common trees including kamahi, tawa and pukatea which are expected to regenerate with integrated pest management.

69. In relation to Section 4.4, the overall unmitigated magnitude of effects on vegetation was assessed as only being 'high' despite the two most affected types being associated with 'very high' effects. Should this be reassessed as 'high'?

Response: We assume you are suggesting the unmitigated magnitude of effects be reassessed as 'very high'. Mr Singers considers the 'high' rating is appropriate, including following the additional data noted in the Supplementary Vegetation Report.

70. In relation to the ongoing control of introduced pest animals, and in light of Section 5.1 recognising that most gains would quickly be lost within 10-20 years if management stopped, please explain why you consider it could be appropriate to carry out pest control "until necessary", rather than "in perpetuity"?

    Response: As noted in the ELMP (Section 9.2) and draft conditions, the mitigation package includes "pest management in perpetuity (or until such time as pest management in the form we know of it today is no longer necessary to sustain the levels of biodiversity created)".

71. Please describe the financial and legal mechanisms that will enable the pest control to occur, and ensure it does occur.

    Response: The financial and legal mechanisms for pest control are still to be determined. However, the Transport Agency is in discussions with landowners, Ngati Tama and DoC. There are a variety of property law mechanisms that can enable pest control. The Council does not need to know the exact mechanism for the hearing - the Transport Agency must comply with the conditions.

72. Section 5.5 of Technical Report 7a (Vegetation) stated that up to eight hectares of swamp forest and wetland plantings will be undertaken to offset significant residual effects. This creates significant uncertainty as to the scale of mitigation planting proposed. Please state a minimum area of mitigation planting and explain why it is appropriate and effective.

    Response: As stated in Section 9.3 of the ELMP, 6ha of swamp forest restoration planting will occur, and will be pest managed. The key driver for this were the further investigations, documented in the Supplementary Vegetation Report. Other planting is proposed, including riparian planting and dryland mitigation planting in the Mangapepeke Valley.

73. Section 6 of Technical Report 7a (Vegetation) states that the areas of highest ecological value in the project footprint are 1.231 hectares of kahikatea forest (Table 4.4) and areas of hill-country forest, but it does not state the type or extent of hill-country forest to be lost, and that this comprises 19.852 hectares of tawa, kohekohe, rewarewa, hinau, podocarp forest. As this forest type is a national uncommon ecosystem type (Table 4.4), please advise the extent of hill country forest to be lost. Please also provide justification as to why plantings are not proposed to address the loss of this forest type.

    Response: Within the broader WF13 ecosystem type the Supplementary Vegetation report ascribes 'High ecological value' scores for 6.457ha of Tawa, rewarewa kamahi forest, 0.536ha of Miro, rewarewa kamahi forest and 1.347ha of Pukatea, nikau forest. Section 4.2.3 of the Vegetation Technical Report summarises this in more detail and why communities of higher ecological condition have been scored higher than communities of lower condition.

Bats

74. Please provide the following two reports which were relied upon in preparing Technical Report 7f (Bats):
    - Opus (2017a). Mount Messenger Bypass Investigation. Bat Baseline Survey and Preliminary Assessment of Effects, April 2017. New Zealand Transport Agency
    - Opus (2017b). Mount Messenger Bypass: Option MC23 – Bat Survey Addendum, Memo dated 25 July 2017.

    Response: Reports attached at Appendix B.
75. It was identified in Technical Report 7f (Bats) that the data used to assess the bat fauna within the project area was of limited use because the surveys occurred only within the winter and autumn periods, when bats are less likely to be active. Also, the report was prepared on the assumption that species present to the west of SH3 are also present in similar habitats to the east of SH3. A supplementary report based on the 2017-2018 field season for bats has been provided (9 March 2018) and whether this newly submitted information addresses this key information gap is currently being reviewed. Further questions may follow.

    Acknowledged.
76. The Department of Conservation bat database (as at 24 July 2017) includes records of both long-tailed bats and central lesser short-tailed bats approximately seven kilometres to the east of the project footprint in 1994 and 1995, as well as more recent records of central lesser short-tailed bats from Mt Damper, approximately 20 kilometres east of the project footprint in April 2016. This indicates a high likelihood that both species would be present within the project footprint. Therefore, please explain why the report considers that it is unlikely that short-tailed bats are present within the project footprint.

    Response: Though the presence of short-tailed bats cannot be confirmed absent, acoustic monitoring between January - December 2017 that has taken place across the alignment and former MC23 is providing accumulating evidence that this species is absent within this area. The Supplementary Bat Report concludes that no further evidence of short-tailed bats in the Project footprint was found. Regardless, the conservative effects assessment approach is still presuming both short-tailed and long-tailed bats could be encountered, and the effects conclusion and proposed mitigation remains the same following the additional investigation work.
77. A recent review of bat threat classifications found that long-tailed bats are now considered "Threatened-Nationally Critical" – that is, more threatened than previously described, whilst central lesser short-tailed bats ranking remains "At Risk-Declining". The old threat classifications suggest that long-tailed bats have a lesser threat classification. Please revise/comment.

    Acknowledged. In any case, the 'very high' value assigned to long-tailed bats remains the conclusion as stated in the Bat Technical Report and Supplementary Bat Report.
78. Based on research cited by Wildland Consultants, the five metre wide edge effects strip proposed may be too small given that the effects of roads on bats can extend over far greater distances. British bat studies showed that activity and diversity were affected as far as

1.6 kilometres from major roads. A New Zealand study found that long-tailed bat activity was reduced compared to edges 200 metres or more distant from roads used at night. Please confirm whether you maintain that a five metre strip is adequate with respect to edge effects on bats and provide evidence to support this.

Response: The purpose of the 5m allowance for edge effects was to allow for biodiversity offset calculations to take into account a total loss of the vegetation in that area. As noted in response to question 53 above, adding edge effects into the biodiversity calculation represents a conservative approach which has not (to the Project ecologists' knowledge) been used in any large scale infrastructure project in New Zealand.

Mr Chapman is comfortable that the measures proposed in the Bat Technical Report and Supplementary Bat Report will mitigate all potential adverse effects on bats from the Project as a whole, including edge effects.

79. With regard to roads being fragmenting features as discussed in Section 4.2.3 of Technical Report 7f (Bats), there is doubt that the project would "shift this potential fragmenting feature" because it is not yet known what will become of the existing road. Rather, consideration is likely that the new road could create a cumulative effect in terms of there being two fragmenting features. Please address the cumulative effects of two roads that potentially fragment the landscape for bats; two roads which are relatively close to each other.

Response: As stated in the Bat Technical Report, Mr Chapman's assessment is that both short-tailed and long-tailed bats can be adversely affected by roads. However as stated in Section 4.2.3 of the Bat Technical Report, the current presence of bats both east and west of existing SH3 demonstrate that fragmentation is probably not currently a significant issue for the existing bat population. This Report also notes that there will be a significant reduction of traffic volumes on the existing SH3, which will reduce its potential for fragmenting effect.

80. Please address the effect of the placement of the proposed road footprint in an ecologically significant wetland area, and along a watercourse, with its potential for increased effects on long-tailed bats in particular, as this species has been detected foraging along waterways at higher rates than in other locations.

Response: Mr Chapman states in section 5.2.2 of the Bat Technical Report that effects on bat foraging have been avoided and minimised by designing the road alignment to largely avoid wetland habitats. While the road will introduce a new potential obstacle where it crosses some tributary reaches used by bats as flight paths, Mr Chapman is of the view that bats are adapted to dynamic forest environments and are therefore likely to be able to fly over a new road much as they would avoid fallen large trees. Mr Chapman also states that effects associated with the removal of foraging habitat on long-tailed bats is likely to be low due to the abundance of alternative foraging habitats of similar or better quality within the wider Project area combined with the long-term benefits of the proposed revegetation and large-scale pest management.

81. Please provide an assessment of the impact on bats from lighting during road operation, from both road and tunnel lighting, and from vehicle headlights. Please further address this with respect to Technical Report 7h (ecological mitigation).

Response: The potential adverse effects of lighting (including during road operation) are assessed in Section 4.2.4 of the Bat Technical Report. These effects were factored into Mr Chapman's overall assessment of potential effects on bats.

82. Effects on the local bat population will be higher than the overall assessment ("negligible") in Technical Report 7f (Bats) if an occupied roost is felled. Section 4.4 of the report states that "The loss of any occupied roost tree(s) would constitute an adverse effect of 'Very High' magnitude for both bat species." How could the likelihood of this occurring be reduced?

Response: As stated in Section 5 of the ELMP, vegetation removal protocols will be implemented during works. These protocols will:

- locate bat colonial roost trees in the Project footprint prior to tree removal;
- require pre-felling procedures where potential roost trees are identified; and
- include protocols for bat injury and mortality.

83. Please outline the logistics involved in locating bat roosts and capturing/relocating bats, and likely success that would be expected.

Response: Please see Section 5 of the ELMP for the vegetation removal protocols.

84. Please provide a bat management plan, including the purpose and objectives of the plan, to avoid and mitigate adverse effects on bats.

Response: The bat management plan is included as Section 5 of the ELMP.

85. In sources cited by Wildland Consultants, research is presented relating to the extent of pest management areas required to be effective in protecting long-tailed bat populations. These studies suggest that the 560 hectare area proposed for pest control mitigation/offset would be insufficient to result in benefits to bats. The area of proposed pest control is approximately half the extent required, based on the lowest estimates available in the literature. Please confirm whether you consider the proposed 560 hectares is a sufficiently sized area in which pest control would benefit bats, and provide evidence to support this.

Response: The proposed PMA (core and buffer combined) has been increased to approximately 1085ha in size. This includes the core area of 230ha which was the area of biodiversity offset calculated to offset the Project, plus a surrounding buffer area which will lead to a net positive effect on biodiversity from the Project. Importantly, the PMA is located immediately to the east of Parininihi, a 1500ha area of pest managed forest which, combined with the PMA, forms a significant contiguous pest controlled area of habitat for bats.

86. The proposed 560 hectares for pest control consists of a core area of 220 hectares plus a 340 hectare buffer. Please provide a comparison of pest control measures envisaged within the core and buffer areas. Is there reduced certainty over the practicable likelihood that the buffer area will be maintained?

Response: Since the NOR was lodged, the Transport Agency has increased the size of the proposed PMA to a total of 1085ha. Detail about the pest control within the core and buffer areas in the PMA is included in Section 9 of the ELMP. The buffer area forms a key part of the PMA and will provide for significant benefits to the biodiversity in the core area.

87. Pest control may not benefit bat populations when undertaken at the scale proposed, and long-tailed bats are known to return to their natal social group to breed. Evidence is requested to support your assertion that pest control will result in a 'halo' effect, with species reaching carrying capacity within the pest controlled area, and subsequently dispersing to and increasing populations in adjacent habitats.

    Response: The reference to 'halo effect' was made in section 4.4.4 of the Mitigation and Offset Technical Report with birds and bats used as example species. The Bat Technical Report references a recent published paper (O'Donnell et al 2017) which provides evidence that managing mammalian predators such as mustelids and rats enhances the long-term survival of long-tailed bats.

88. Please detail the design of the early bat monitoring program, and clarify the basis for the locations selected for placing Automated Bat Monitoring units (ABMs), to allow review of the methodology followed.

    Response: This is set out in the Vegetation Removal Protocols in Section 5.7 of the ELMP. To determine roosting, 'High Risk' trees will be acoustically monitored with ABMs overnight (from one hour before official dusk to one hour after official dawn) for a minimum of three nights (with suitable weather conditions) immediately prior to removal. These nights may be non-consecutive depending on weather conditions.

89. Please confirm whether bat monitoring would occur post-construction, and advise whether this is in accordance with NZTA's Framework for bat monitoring. I note the Department of Conservation submission suggests bat monitoring for a period of at least 15 years following completion of the project works, and an adaptive management approach which responds with additional appropriate measures if the monitoring shows that the bat population is declining. Please provide draft conditions in this regard.

    Response: As stated in Section 5.3.6 of the Bat Technical Report, "*post-construction bat monitoring with ABMs is not considered necessary or appropriate because monitoring bats with ABMs does not provide any information on population size or trends*". This Report adds that given that the Project footprint represents only a relatively small proportion of the available habitat for bats in the wider Project area, and the benefits of large-scale long-term predator management for bats have been confirmed by a published study (O'Donnell et al 2017), a post-construction programme is not considered necessary.

90. Please provide an assessment of the areas of vegetation communities suitable for bat roosting within and around the project area/identify areas considered important to bats, with supporting evidence.

    Response: As stated in Section 5.7.2.1 of the ELMP, the Ecology Constraints Map, currently being produced (and to be appended to Appendix A), will include broad-scale areas of potential bat habitat within the Project footprint. This will guide bat ecologists in assessing whether trees in those areas are either 'High Risk' or 'Low Risk' in terms of providing potential bat roost habitat.

91. The Department of Conservation submission suggests an offsetting and compensation approach must be developed in relation to unavoided and unmitigated effects on bats. Is this an approach the Requiring Authority is exploring? If so, please provide details.

    Response: No. As stated in the Bat Technical Report and Supplementary Bat Report, Mr Chapman considers the proposed approach to avoiding and mitigating potential adverse effects on bats is appropriate and robust.

Avifauna

In December 2017 when the NoR was served, information had not been collected and the Requiring Authority was unable to provide baseline data for forest/farmland birds within the project footprint. Similarly surveys of wetland birds had not occurred. A supplementary avifauna report was provided in March 2018, which is currently being reviewed, and further information may be requested.

Note: The Supplementary Avifauna Report was provided to the councils on 22 February 2018, and is based on additional surveys which support the conclusions made in the Avifauna Technical Report. This is considered to provide robust baseline data, and kiwi radio tracking is soon to take place which will add further baseline data.

92. Ideally, the sedimentation controls proposed will be effective and any adverse effects on high quality wetland will be avoided. However, in a worse-case scenario in which sedimentation controls failed, potential effects on wetland birds may be 'High'. This includes mātātā/fernbird and pūweto/spotless crake which have been confirmed as being present in adjacent habitats, and matuku/Australasian bittern, which although not confirmed, may use adjacent habitats given the presence of suitable habitat. Please address how these effects would be mitigated if the worst case scenario was to eventuate.

    Response: Mr Graeme Ridley has confidence that the erosion and sediment control measures proposed in the CWMP are best practice and robust. In addition (and as noted in Section 8.3.2 of the ELMP) the raupo reedland also buffers the kahikatea swamp forest from sediment. However the CWMP also contains incident response measures in Section 10, including where erosion and sediment control measures fail, considered to be an unlikely scenario. A key element of the erosion and sediment control programme includes a comprehensive monitoring programme. This is detailed in the CWAR and CWMP and in the CWDMP. This includes qualitative and quantitative monitoring and has links to ensuring effects of sediment discharge are minimised throughout. The monitoring also has a significant emphasis on continuous improvement to ensure that the construction water management process improves throughout. Importantly the monitoring programme includes management thresholds with one of these related to sediment deposition in the Mimi Swamp Forest.

    The draft CWMP provides for corrective actions to rectify the situation should measures fail, including mitigation measures to be taken to minimise the adverse effects on the environment. These measures are considered to be sufficient to manage potential adverse effects on wetland bird species.

93. Please comment on the possible effects on local populations of the wetland species mentioned above if the worst case scenario were to eventuate.

    Response: As noted above, with the implementation of the erosion and sediment controls in the CWMP and the SCWMP's once developed, and the corrective actions that will be required should an incident (as defined in the CWMP) occur, effects on wetland bird species are appropriately managed. In addition, baseline sediment sampling undertaken to date indicates that high sediment loads appear to be a natural feature of the streams within the two catchments (see Section 4.2.2.2 of the Freshwater Ecology Report). This is considered to be due to the underlying papa mudstone geology, with small slips common across the wider Project area, even in bush catchments and the observed stream bank and bed erosion.

94. Despite the low probability of kōkako entering the project footprint from the west, please address the effect of the project if it does occur. The project footprint is well within the known post-release dispersal distances of kōkako at other reintroduction sites. A kōkako survey - using playback calls and experienced personnel - could be undertaken within the project footprint prior to the commencement of construction, to specifically determine if kōkako have dispersed into this area. A contingency plan could then be developed to guide decision-making in the event that kōkako are detected within the proposed project footprint. Please provide draft conditions allowing for the adaptive management of this species, to identify and avoid adverse effects on these birds in the project area.

    Response: Section 3 of the Ecology Supplementary Report notes that the additional investigations did not provide any additional information about the location of kokako and their potential to disperse from the release site. The Report notes that young kokako do not disperse far from natal areas, and that the natural rate of spread of a population from a source location is slow (about 9% per annum). Based on this, kōkako of Parininihi origin are unlikely to colonise the Project area and PMA for years, and possibly decades.

    With regard to post-translocation (rather than natal) dispersal: the staff member who will be monitoring kiwi during construction will also be trained in monitoring kokako. In the event of a kokako being found near the project footprint, DoC and the Kokako Recovery Group will be notified and their advice sought. The reasonable expectation is that nothing further will be done, because:

    (a) kokako may be transient and going to move away from the location without intervention; and

    (b) even if the kokako was establishing a territory in that area, the likely best option is to allow it to continue to do so (John Innes, Landcare Research, pers. comm.).

    Ongoing engagement with Ngati Tama and DOC about the kōkako will continue to inform whether any spread towards the Project area is likely.

95. The Department of Conservation submission includes a range of measures to manage adverse effects on kiwi. Please comment on these measures and whether/how they will be incorporated into proposed designation conditions.

Response: The proposed kiwi management measures are included in Section 6 of the ELMP. These measures include:

- Pre-construction kiwi catching and radio tracking;
- During-construction kiwi management, including relocation and managing nesting kiwis and eggs; and
- Post-construction outcome monitoring, which is detailed in Section 9.5.3.2 of the Pest Management Plan.

96. It is considered that post-construction monitoring for avifauna is required. Please propose details for monitoring.

Response: Post-construction outcome monitoring for avifauna is proposed, as set out in Section 9.5.3.2 of the ELMP.

Herpetofauna

97. In December 2017 when the NoR was served, a robust herpetofauna field survey had not been carried out within the project footprint by the Requiring Authority. A supplementary herpetofauna report was provided in March 2018, which is currently being reviewed, and further information may be requested. At this stage the following 2 clarifications are sought relating to the March 2018 supplementary report:

a. Please provide more detail on the duration of time that Artificial Cover Objects ("ACOs") and Closed Cell Foam Covers were left in situ prior to being checked. Please also clarify the times of day that ACOs were checked.

   Response: Section 2.2.1.1 of the Supplementary Herpetofauna Report contains this information.

b. Please provide justification for the limited duration that tracking tunnels and funnel traps were deployed, and why this duration is considered to be sufficient to detect highly cryptic species at very low densities.

   Response: The duration that tracking tunnels and funnel traps were set for is considered appropriate based on the methodology used for an absence / presence survey. Mr Chapman opinion is that the survey efforts were not 'limited', and were appropriate and sufficient to draw conclusions about the value of and potential effects on herpetofauna in the Project footprint. A conservative approach has been taken and a range of management options adopted within section 5 of the Herpetofauna Technical Report due to the limited information available regarding herpetofauna within the Project footprint.

98. Technical Report 7d (Herpetofauna) rates the overall species value assessment score at 'moderate-high'. Should this be 'high' given the number of At Risk species that are potentially present, and the abundance of suitable habitat for these species within the project footprint? If so, please provide an updated assessment.

Response: The overall species value assessment score of moderate to high for 'At Risk' species was determined due to the uncertainty and lack of information of these species being present within the Project footprint (section 4.1 of the Herpetofauna Technical Report). Even though the overall species value assessment score is moderate to high a conservative approach has been taken and the range of management options adopted assumes they are present.

99. Technical Report 7d (Herpetofauna) states that construction of a tunnel and bridge will provide "some level of connectivity for herpetofauna across the Project footprint." However, this would only be beneficial for the extremely limited proportion of lizards with home ranges within the immediate location of the tunnel and bridge. For all lizards that reside throughout the rest of the area, the barrier of the road will fragment the wider habitat that would otherwise be available to them. The report correctly identifies the fragmentation effects of creating a second road, however, then suggests that the effect of it will be minimised as road traffic will decrease along the existing road. This is contradictory to the report's statement about roads acting as "hard barriers that species or individuals within a population would not be able to traverse". There would therefore be cumulative effects of creating a secondary 'hard barrier' with its corresponding edge effects, which is unlikely to be offset by a reduction of traffic volume along the existing road. Please propose ways that fragmentation effects can be reduced.

<u>Response:</u> Mr Chapman assessed all potential adverse effects of the Project, including the potential fragmentation effects of the road. The overall conclusions about potential effects of the Project have taken this into account.

100. Construction of the new road will result in the creation of an 'island' of habitat between the existing and new roads which would isolate resident lizard populations. This could result in a reduction of gene flows and create an increased vulnerability of these populations to edge effects, i.e. degraded quality of edge vegetation and habitat, and increased exposure to predation. Please address this adverse effect, and the effects of habitat fragmentation on herpetofauna.

<u>Response:</u> The existing SH3, if it remains open, will be used by a significantly reduced number of cars. These potential effects of the existing road and proposed new road were considered in the Herpetofauna Technical Report and Supplementary Herpetofauna Report.

101. Whilst it is noted that there will be some permeability for herpetofauna to get across the road for some locations along the route (e.g. over the tunnel and under the bridge), please advise what measures could be put in place to reduce fragmentation effects caused by road construction, e.g. plantings and structures to restore linkages between habitats.

<u>Response:</u> As stated in the ELMP, significant planting is proposed as part of the mitigation package, including swamp forest restoration planting, dryland mitigation planting and riparian offset restoration planting. The mitigation package reflects all potential adverse effects on herpetofauna, including those noted above, and is considered to be appropriate to address these effects.

102. Areas to be impacted as a result of the project works include suitable habitat for lizards and such habitat often contains lizards which are not easily detected. The project effects upon an At Risk or Threatened species would be potentially significant if unmitigated (Section 4.3.2, Technical Report 7d (Herpetofauna)). Given that ten of the thirteen species identified as potentially present within the footprint are classified as At Risk, there is a considerable likelihood that at least one or more At Risk species will be encountered. Please propose

designation conditions with a precautionary approach to manage effects on low density populations of At Risk or Threatened lizard species present.

Response: The Herpetofauna Technical Report and Supplementary Herpetofauna Report have taken a precautionary approach in assuming these species are potentially present in the Project footprint. In addition, lizard management protocols are included in Section 7.4 of the ELMP. Protocol A of this is to identify lizard habitats. The Ecology Constraints Map (currently being prepared) will guide this process, informed by surveys by the Project lizard ecologists. This will enable 'Zero Risk', 'Low Risk', 'Medium Risk' and 'High Risk' lizard habitats to be identified. A precautionary approach will then be applied in salvaging lizards, as set out in Protocol B in the ELMP (Section 7.4.4).

103. The Department of Conservation submission suggests a compensation approach must be developed in relation to unavoided and unmitigated effects on lizards. Is this an approach the Requiring Authority is exploring? If so, please provide details.

Response: Mr Chapman considers that, with the implementation of the methods in the ELMP, all potential adverse effects on herpetofauna discussed in the technical reports can be adequately addressed.

104. It is proposed that 200 seedlings will be planted for every 'significant' tree felled, however, the habitats and micro-habitats that are being removed within the project footprint are likely to be of much greater diversity than will be provided by restoration plantings, which are often characterised by low compositional and structural diversity for many decades. Please explain how ecological restoration will address the potential adverse effects on herpetofauna (e.g. loss of forest epiphytes, loss of standing and fallen woody debris, loss of tree holes, loss of complex vegetation structure with trees/vines/ground tier vegetation).

Response: The measures to address adverse effects on herpetofauna specifically are set out in Section 7 of the ELMP. As noted above, Mr Chapman considers that these measures are considered to be appropriate to address the potential adverse effects on herpetofauna.

105. Mice are well-documented predators of indigenous lizards. Please discuss the likely build-up of mice populations in the periods between aerial 1080 drops, and the likely effects of these predator peaks on herpetofauna. Please consider if there is anywhere on the route where gentler terrain may allow ground-based control of mice over a smaller area (e.g. mature forest or scrub communities on valley floors).

Response: The ELMP states that targeted mouse control is not achievable - most notably the terrain is not suitable for ground based trapping that would effectively control mice. However, mice control is proposed in the small soft-release pen proposed to increase herpetofauna survival.

106. The supplementary report (February 2018) proposes to manage mouse densities within the soft-release pen and a 200 metre radial buffer. Please give a rationale for how this will provide protection for salvaged lizards outside of the construction period and immediate release term, with the potential for increased mouse densities to immediately invade and heavily predate upon lizards. Please consider if mouse control could continue longer term in the vicinity of the soft-release pen, as presumably this area is on accessible terrain.

Response: Detail about the soft-release pen is set out in Section 7 of the ELMP.

107. Technical Report 7h (Ecological Mitigation and Offset) initially suggests that the lizard management plan would include provisions for all of the usual and expected activities for a project of this scale, including the provision for post-release monitoring; but later in Section 3.6.3 it states that no post-construction herpetofauna monitoring is recommended, and that pest monitoring will serve as an indicator. Should post-release monitoring be a requirement, given the scale of the project, and the likelihood of At Risk and/or Threatened species being present? If so, please revise the monitoring approach or justify the rationale for not providing post-release monitoring.

Response: No post-release monitoring is considered to be required aside from observation and management of pest plants in the soft-release pen until one year after construction is complete (Section 7.4.7 of the ELMP). Other than that, the outcome monitoring set out in Section 9 of the ELMP is considered to be appropriate in determining how herpetofauna habitat is improving, and pest densities increasing, following the completion of construction.

108. Please add a detailed Herpetofauna Management Plan to the Ecology and Landscape Management Plan ("ELMP") and the Pest Management Plan ("PMP"), providing management options for all key vegetation types and lizard habitats within the project footprint, including the salvage of material from within the construction footprint for use at ecological restoration sites (e.g. logs, epiphytes, rocks). Please include management contingencies for the discovery of any unexpected herpetofauna 'hotspots'.

Response: The Lizard Management Plan is in Section 7 of the ELMP and addresses the potential adverse effects on lizards from the Project. This includes provisions for capturing, handling and releasing lizards, as well as steps to be implemented if any injured or dead lizards are found during salvage.

109. The supplementary report acknowledges that there is still a possibility of low density populations of multiple At Risk and Threatened species being scattered throughout the footprint, with extremely cryptic behaviours to avoid high predation pressures in the area. With this noted, if it is still considered that the herpetofauna population across the wider Project area is unlikely to be affected in any meaningful way by the Project, please justify this conclusion.

Response: The Project footprint occupies a small part of a significant area of potential herpetofauna habitat, including across the North Taranaki Ecological District. As such, even applying a conservative approach in assuming herpetofauna species are present in the Project footprint, the herpefotauna population in the wider Project area is unlikely to be affected by the Project (as stated in Section 4.2 of the Herpetofauna Technical Report). This conclusion was supported, after further data collection, in the Supplementary Herpetofauna Report.

Terrestrial invertebrates

In December 2017 when the NoR was served, an invertebrate survey had not been carried out within the project footprint by the Requiring Authority. A supplementary invertebrate report was provided in March 2018, which is currently being reviewed, and further information may be requested.

<u>Note:</u> The Supplementary Terrestrial Invertebrates Report and ELMP contain key information in regard to invertebrates, with the main development being in finding two species of Peripatus (*Peripatoides suteri* and *Peripatoides novaezealandiae*) on site, and therefore producing a Peripatus Management Plan (Section 10 of the ELMP).

110. We are concerned that seasonal constraints and the limited period of field survey does not allow for a full understanding of baseline entomology. Please advise whether, now that additional field surveys have been undertaken, you are satisfied that there is an adequate understanding of the range of terrestrial invertebrates present in the area, the presence/ density/importance of the populations present, the fauna in the areas of vegetation to be lost, and the fauna of the proposed pest management area.

<u>Response:</u> Yes – see Supplementary Terrestrial Invertebrates Report.

111. Lepidoptera (butterflies and moths) are closely associated with the vegetation of the different community types and they have significant biodiversity in the project area. Is there a baseline Lepidoptera survey of the project area across the seasons, including targeted surveys for forest ringlet butterfly, to inform the mitigation package?

<u>Response</u>: No Lepidopterists were available to carry out a targeted Lepidoptera survey within the timeframes. Further survey work using malaise traps has been completed, as discussed in the Supplementary Terrestrial Invertebrates Report. These surveys have informed the ELMP, which states at Section 4.4.3 that host species for the forest ringlet butterfly will be harvested, cultivated and returned to suitable restoration sites. This is considered to be an appropriate response to the potential adverse effects of the Project on the forest ringlet butterfly.

112. Please outline how the risk of potential invasions/accidental release of exotic invertebrates will be reduced during and post-construction.

<u>Response:</u> Sections 11.4-11.7 of the ELMP sets out pest animal management measures. This includes tools and actions to manage argentine ants from invading the Project area. Section 11.7 of the ELMP notes that an adaptive management approach will be essential in ensuring the Project does not facilitate the spread of pest animals. This approach will include keeping up-to-date on current best practice, adhering to MPI and Taranaki Regional Council updates, and adapting prevention and control behaviours throughout the construction programme. The author of the terrestrial invertebrates reports, Dr Corinne Watts, considers these approaches to be appropriate to manage the potential for exotic invertebrate invasions.

113. With regards to effects on invertebrates, a suite of introduced predators including small mammals and vespoid wasps are responsible for the Threatened status of many invertebrates. Please update the mitigation package to include additional introduced predators.

<u>Response</u>: The ELMP includes provisions to manage the potential for predatory species to invade the Project area (Sections 11.4-11.7). Dr Watts considers these provisions appropriate for managing the potential for introduced predators to affect terrestrial invertebrates.

Freshwater ecology

114. Please confirm whether works in streams will be timed to avoid peak migration of most fish species, and advise the fish recovery protocols proposed to be implemented at all affected waterways.

Response: Section 8.3.4.1 of the ELMP focuses on timing of works. This notes that "*priority will be given, where practicable, to avoiding works during peak migration period (August to December inclusive) within the larger streams e.g. the main stem Mangapepeke Stream and tributary located at monitoring site Ea10.*"

Mr Hamill also notes that the preferred approach is to avoid instream works and create diversion or culverts off line. The exceptions to this will be:

(a) extension of culverts under the existing farm access track, true left of the Mangapepeke Stream;

(b) short term culverts installed for access across the Mangapepeke Stream; and

(c) the fill leading to the tunnel portal at the head of the Mangapepeke Stream and Mimi River trib.

The short term culverts could be installed offline but this would create a larger foot print and in my view would be a worse outcome for the stream. The large fill area will likely take several months to complete. Need to balance a constraint on timing with the risk of it being only part completed during the winter. Standard procedures for managing effects of instream works by blocking stream and pumping around and timing to be in dry weather.

115. In Section 4 of the Application (Technical Report 7b) it states that the kahikatea swamp forest is "buffered from the Project area by a raupō reedland and rautahi swamp, and this reduces the potential effects". Based on Figure 3.4 in Technical Report 7a (Vegetation), the raupō reedland and rautahi swamp only provides a partial buffering to the northernmost margin of the swamp forest. Most of the northern margin of the kahikatea swamp forest is in fact contiguous with swamp maire forest, which is of equal (if not greater) ecological value to that of the kahikatea swamp forest. The proposed route footprint is very close to the swamp maire forest, and there is little in the way of buffering to be provided should sediment and erosion controls fail particularly given the steep terrain and unstable geology. The swamp forest provides suitable habitat for At Risk fish species such as giant kōkopu and longfin eel, and significant inputs of sediment have the potential to adversely affect local fish populations as well as alter the hydrology and morphology of the pools and watercourses present in the swamp forest. Please address the concern that the swamp maire component of the overall swamp forest system in the Mimi catchment is types that are vulnerable to a failure of sediment and erosion control and describe remedial measures should there be a failure of sediment and erosion control to the swamp forest.

Response: As noted in the Freshwater Ecology Technical Report and Supplementary Freshwater Ecology Report, due to the geology in the area, there is an abundance of sediment in freshwater systems throughout the Project area. The draft CWMP includes best practice erosion and sediment controls, and also contains incident response measures in Section 10, including where erosion and sediment control measures fail. The draft CWMP provides for corrective actions to rectify the situation should measures fail, including mitigation measures to be taken to minimise the adverse effects on the environment.

116. The supplementary freshwater report states that:

Sediment traps and sediment plates have been established in the raupō wetland near the end of the stream. These can be used to check the extent of any sediment deposition in the raupō wetland extending from the stream to the kahikatea wetland.

Please provide details of how often the traps and plates would be checked, and what actions would be taken if sediment thresholds were exceeded (note that this is not discussed in the Geotechnical Appraisal Report - Technical Report 14).

Response: Section 8.4.2.2 of the ELMP notes that the purpose of the sediment plates is to monitor any sediment deposition following heavy rain events during the baseline period, and weekly during construction.

117. The Department of Conservation submits that there will be significant effects due to the loss of habitat in headwater streams, and that sufficient weight has not been given to the biological importance of these headwater streams as source populations to maintain biodiversity for downstream reaches. Please revise the quantum and effects management approach to ensure no-net loss for these freshwater effects.

Response: The assessment of potential adverse effects on freshwater ecology, using the Stream Ecological Valuation method, has given weight to the effects on headwaters. Also as noted in Section 4.3.1.1 of the Freshwater Ecology Technical Report, the headwaters of both catchments are subject to natural barriers to non-climbing fish (such as inanga) in the form of waterfalls and cascades. However it is acknowledged that climbing fish and invertebrate species such as longfin eel, banded kōkopu, redfin bully and kōura can be found above waterfalls, so Mr Hamill has included these headwaters in the assessment of effects.

118. Forest & Bird submits that macroinvertebrate samples collected and scored consist of larval individuals (rather than adults), so provide only an indicator of water quality and taxa richness, and do not allow for the assessment of species richness or the presence/absence of rare species (as this would require adult individuals). It is possible that many notable and rare species of macroinvertebrate could be adversely affected by the proposal, but these would need to be surveyed for as part of a terrestrial invertebrate survey. Please advise whether further investigations are planned or possible to determine the actual biodiversity values of macroinvertebrate species present, to determine the level of diversity in the macroinvertebrate community, the presence of rare/threatened species, and any adverse effect on these species as a result of the project.

Response: Many (probably most) of the aquatic invertebrates that are used in standard methods to monitor stream health are larval stages of insects, which metamorphose into flying adults. In addition to the freshwater ecological assessments, the Transport Agency also carried out terrestrial invertebrate surveys using malaise traps which would have detected adult freshwater insects. These are reported in Technical Report 7e which accompanied the Assessment of Effects on the Environment, and the Supplementary Terrestrial Invertebrates Report.

Ecological Mitigation Review

119. It is noted that Section 5.2.3 of Technical Report 7a (Vegetation) states that greater than estimated loss could occur, for example if landslides that result from earthworks occur, and that the actual loss should be quantified at the end of the construction period. Please advise what additional mitigation or offsetting would be implemented, and how this would be calculated, if the extent of loss is greater than expected.

Response: Following the completion of construction, if vegetation removal exceeds the area currently anticipated, the Biodiversity Offset Calculation would be rerun based on the actual areas of vegetation removal from the Project. Based on this, appropriate measures would be put in place. It may be that the areas are less than currently anticipated and further recalculation will also then be required. This will be captured in a condition of consent.

120. Technical Report 7h (Ecological Mitigation and Offset) considers that many aspects of the indigenous flora and fauna present in the project area will benefit from the management of pest animals to permanently low densities. No quantitative data is presented to support this opinion (e.g. assessments of foliar browse index for canopy trees, or seedling ratio index for ground-tier vegetation). Please provide evidence to support the application's statements regarding current forest health, as this is required to then determine if forest condition can be improved, and by how much. Without knowing this, the quantum of pest control required to offset vegetation loss cannot be determined,

Response: The baseline quality of the vegetation in the PMA has been based on a number of surveys, and the expert judgement of Mr Singers. Section 4.1 of Technical Report 7h notes the significant body of evidence demonstrating the benefits of pest management on indigenous species, including indigenous vegetation. Please see, for example, Meads 1976; Timmins 2002; Gillies et al 2003; and Wilson et al 2003, which discuss the reduced mortality, increased seedling regeneration and increased foliage growth in forest vegetation resulting from animal pest control.

121. As not all species are likely to benefit from pest control (e.g. the area proposed being too small to benefit bats) should the mitigation package be reviewed to place greater emphasis on actions other than pest control? For example, can there be a goal to achieve no net loss of habitat area? If so, please provide an assessment of the effectiveness of the mitigation package to achieve this goal.

Response: Integrated pest management across the Pest Management Area is only part of what has been proposed in the mitigation package. As stated in the ELMP, other key measures include swamp forest restoration planting, dryland mitigation planting and riparian offset restoration planting, which will in combination with pest management produce a new benefit to biodiversity in the medium term. The mitigation package has been developed with the support of the Biodiversity Offset Calculation.

122. As already identified, five metres is considered an insufficient measure for assessing edge effects. In addition, we note some discrepancies regarding the area likely to be subject to habitat removal or modification, and consider there is under-reporting of vegetation loss. Therefore, please revise these calculations. As discussed, we are agreeable to further

discussions between specialist ecologists to work through concerns and seek the intended 'no net loss' of biodiversity values.

<u>**Response**</u>: As noted in the response to question 53 above, this 5m edge effects margin (on top of the Additional Works Area, which is considered to be conservatively applied) provides for total loss within this area for the purpose of the biodiversity offset calculation. While edge effects can extend beyond this area, they may only have a partial effect on biodiversity, so assuming total loss is considered to be a conservative way to calculate biodiversity loss.

This is one of the most conservative approaches for addressing edge effects for any large infrastructure project in New Zealand. Indeed, for most large projects, while edge effects are acknowledged, they are not factored into mitigation measures.

123. Actions proposed to be undertaken to mitigate the adverse effects of vegetation clearance include the planting of nine hectares of secondary scrub vegetation, mostly along the floor of the Mangapekepeke Valley. This vegetation to be cleared comprises mānuka scrub and mānuka-tree fern communities, and it is proposed to replace these on a 1:1 basis. This is certain to result in a net loss, as the affected mānuka forest associations in the Mangapekepeke Valley are 25-50 years old and some include pole-sized trees of rewarewa, kahikatea, and rimu. To acknowledge that plantings do not replace vegetation loss until similar maturity is reached, ratios for vegetation loss and planting extent usually consider the time lag between planting and when ecological equivalency is reached. For mānuka scrub with pole-sized rewarewa, kahikatea, and rimu, we consider a ratio of 1:2 would be more appropriate. If agreeable, please update the calculation for replacement vegetation.

<u>**Response**</u>: The dryland mitigation planting, including 1:1 planting of areas of mānuka scrub and mānuka-tree fern communities, will be carried out in addition to pest and livestock management, as well as weed management in the planting sites (see Section 4.6.3 of the ELMP). The experts are confident that these will, in the medium term, provide adequate mitigation for the removal of these communities for the Project.

124. In Section 3.3.2.2 of Technical Report 7h (Ecological Mitigation and Offset), it is proposed that 200 trees are planted as compensation for each significant tree felled. We are not convinced that 200 seedlings will compensate for the loss of a single significant large tree, because large trees are likely to be at least several centuries old, have large canopies that support epiphytes, have cavities suitable for hole-nesting birds, provide habitat for indigenous lizards, provide roosts for bats, and provide significant sources or fruit and nectar. None of these resources are available in seedlings or young trees. It is almost impossible to offset the loss of large trees through planting due to the very long period of time required for planted trees to grow large enough to provide similar habitat and resources. Furthermore, no details are provided regarding where the plantings to compensate for significant tree loss will occur. These planting areas will need to encompass a similar range of soils and landforms to the proposed project footprint, and should, as much as possible, replicate the composition of the existing vegetation to achieve similar ecological functions to the habitats to be lost, i.e. low density, emergent podocarps planted within a similar compositional mix to the vegetation within which the significant trees occur, e.g. a matrix of broadleaved species, not simply a dense single-species stand of the "significant' tree species. Please provide further information in this regard.

Response: Section 4.6.5 of the ELMP addresses the loss of significant trees. As noted in the ELMP, every endeavour will be made to avoid removing these trees and it is possible that fewer than 17 will ultimately be felled. Measures for relocating and propagating epiphyte clumps are proposed to reduce the effect on those species. The proposed PMA is also a response to the loss of significant trees with approximately 1085ha receiving ongoing pest control.

It is acknowledged in Section 4.6.5 of the ELMP that most of the trees for which seedlings will be planted have quite specific site preferences. The ELMP states:

> "*selection of suitable planting sites will be undertaken by an experienced field botanist or restoration ecologist and it may be necessary to plant some early successional species in advance, or with these to provide the necessary shelter.*
>
> *The deforested tributary valleys of the Mangapepeke, especially along the forest edges, offer the best planting sites for these seedlings including the margins and beneath areas of existing manuka and kanuka, especially on shallow sloping hillslopes, and in small gullies and sites with shelter and dappled light.*
>
> *Details of where and when these seedlings will be planted will be provided in the swamp forest and dryland mitigation design specifications.*"

125. For the proposed mitigation planting, please provide further details as to the suitability of the proposed planting site for swamp forest species, as these species have very specific soil and hydrology requirements. Furthermore, please provide information which supports a conclusion that the planting package will result in no net loss of forest area.

Response: The Project ecologists assessed a number of sites for suitability of site for swamp forest planting, with a preference for areas close to the Project footprint. The ecologists concluded that the proposed areas for planting are the most appropriate and will benefit from the proposed pest management as they are located within the PMA.

126. As the forest through which the road is to pass is largely continuous and intact, the project will result in a permanent new major road barrier through this forest, and no new areas of plantings are planned that will connect forest areas that are currently separated, it is difficult to see how connectivity benefits claimed in the application will occur. When considering connectivity, it is important to determine which specific biota would benefit from the claimed improved connectivity. For example, forest birds are unlikely to have any connectivity limitations in the project area, whereas herpetofauna and flightless invertebrates are likely to experience nearly complete severance of populations due to road construction. Therefore, please provide information which supports the assertion that the proposed mitigation will greatly improve the connectedness of the forest areas.

Response: The installation of a tunnel at the top of the proposed route, the sizeable reduction of traffic along the old SH 3 route, the removal of farm livestock and the effects of livestock from the Mangapapeke valley, and the restoration to indigenous vegetation of the full length of that valley down to the existing SH3 is, in Mr MacGibbon's opinion, very likely to improve connectivity.

127. In Section 3.3.3 of Technical Report 7h (Ecological Mitigation and Offset), the monitoring proposals are vague and do not include any detail on methods. Please provide further information on this.

<u>Response</u>: Please refer to Section 9 of the ELMP.

128. A key potential effect on lizards is mortality due to vegetation clearance and earthworks. The application lists habitat loss, habitat fragmentation and vehicle strikes as adverse effects on lizards, but mortality due to vegetation clearance and earthworks has not been addressed. Please address this.

<u>Response</u>: Please refer to Section 7 of the ELMP.

129. Approximately 3,825 metres of stream habitat in the Mangapepeke and Mimi catchments are proposed to be diverted, culverted, or substantially altered as a result of the Project. In order to offset the residual effects it is proposed to restore the margins of 8,724m^2 of stream channel equating to approximately nine kilometres of stream length. It is proposed to plant ten metre margins on each side of the stream. Although Technical Report 7b (Freshwater) outlines potential streams along which to undertake restoration planting, nothing has been confirmed. Please provide details on where the proposed stream restoration planting would take place if the areas mentioned in the report are not available. Please also describe the mechanisms proposed to ensure that the stream restoration plantings are permanently protected, both physically and legally.

<u>Response:</u> Please refer to the Supplementary Mitigation Report. In particular, refer to Section 2.2 of the Supplementary Mitigation Report, which notes that the offset requirement has reduced from 8,724m2 to 8,157m2 of stream surface area (a reduction of 8,932m to 8,627m of stream length). The Report notes that this reduction has occurred because of the replacement of a culvert with a stream diversion at one site and a revised assessment of impact on another section of stream. As for question 72, there are a number of property mechanisms that can provide for the permanent protection of these areas. The RMA focuses on the effect and the wording of the condition, not the type of mechanism ultimately used to achieve compliance with the condition.

130. The pest management strategy described in Section 4.4.2 of Technical Report 7h (Ecological Mitigation and Offset) indicates that monitoring of pest animal densities will be used as a surrogate for biodiversity outcomes. However, it would be more effective to verify the claimed positive benefits of pest control if quantitative information on biodiversity outcomes was collected as an element of the monitoring. Given that most of the mitigation package is dependent on the proposed pest control resulting in ecological benefits, we consider that post-construction monitoring is essential. Please reconsider your monitoring approach and provide more information on possible design or methods for monitoring, so that its effectiveness can be assessed.

<u>Response:</u> No – we are comfortable with the proposed monitoring approach set out in Section 9 of the ELMP.

131. Claims about the difficulties in monitoring of bats, herpetofauna, and invertebrates appear to be inconsistent with the claimed expectations of benefits to these taxa from pest control. Please explain the basis for your claims of expected benefits from pest control.

Response: Please refer to relevant technical reports for this information.

132. Construction and operation of the road has the potential to increase populations of mice, stoats, ship rats, and hares. Please outline the anticipated dispersal of alien species, and how this could be dealt with, by ensuring the potential increases in the abundance of mice, rats, stoats, and hares that could be caused by road construction are addressed in the pest management strategy.

Response: Please refer to Section 11.4 of the ELMP.

133. Please describe how goats will be controlled with regard to any mitigation plantings, particularly along the mitigation streams.

Response: The mitigation plantings will be fenced, and hunting will occur (please refer to Section 9.4.1.6 of the ELMP for more information).

134. The Department of Conservation submits that African clubmoss should be added to the weed species targeted for control and management, also appropriate measures should be followed throughout the duration of the construction works to avoid the spread of Myrtle Rust, both within the site, and from the site to other locations. Please confirm whether this is accepted by NZTA and, if so, what measures will be adopted.

Response: Measures are included in the ELMP to manage African clubmoss, including in Section 11.3.5. A Myrtle Rust Management Plan is being prepared to appropriately manage those potential effects.

135. The Mt Messenger site supports complex indigenous forest and wetland vegetation that contains old growth trees and provides habitat for indigenous bats, birds, lizards, fish, and invertebrates. Please provide examples of cases in New Zealand where a biodiversity offsetting approach has been used successfully to address significant adverse impacts on complex ecosystems such as this.

Response: As stated in the Mitigation Supplementary Report, pest management is the primary offsetting effort. Section 3.5.1 of the ELMP notes that based on evidence from other locations, particularly the adjacent Parininihi, the proposed pest management programme can be expected to generate biodiversity benefits for a wide range of plants and animal species. Plant biomass and diversity will increase as grazing and browsing pressure is reduced, the diversity and abundance of more palatable species will increase as seedling survival improves, and the health of old emergent forest giants especially rata and totara will improve as their foliage rebounds in the absence of possums in particular. The ecology experts are supportive of this approach.

136. It is likely that the health of the forest to the east of SH3 compared to west of SH3, if it is notably degraded, could be rapidly improved within 5-10 years if a pest control plan was implemented. We therefore question the considerable weight that is applied to differences in forest health either side of the state highway. Do the findings of the recent fauna surveys

(February 2018), with regards to kiwi and long-tailed bats, validate the degraded state of the forest to the east of SH3, as claimed in the AEE?

Response: Yes. Overall the investigations demonstrated that the vegetation to the east of SH3 is considerably more degraded than to the west of SH3.

137. Please advise/assess whether the offsetting proposed follows the Department of Conservation guidelines for biodiversity offsetting. If not, please explain why the offsetting methodology is appropriate.

Response: Yes, it does.

138. Please identify where the land is, which is intended to be used for mitigation and offsetting of ecological effects. Offset sites should be clarified and confirmed and the location of the offset site to allow an assessment of effectiveness of the proposed package, and must be reflected in the offset calculations so that quantified loss at the impact site can be compared with anticipated gains at a specific offset site. Please provide information which demonstrates that the offsetting sites are available for this purpose and about the legal mechanisms which will secure this.

Response: The Supplementary Mitigation Report and Supplementary Biodiversity Offset Calculation Report contains this detail.

139. The Department of Conservation submission identifies that in terms of the revegetation component of the effects management, there is no mitigation or other management measures proposed to address the loss of emergent trees which may be important as perches for falcon. Further, standing dead trees, and the time for revegetation to recover to be available for use by avifauna should be included for mitigation/offsetting. Please explain why such trees have not been identified in the mitigation/offsetting assessment. Alternatively, please revise the assessment to include them.

Response: The loss of emergent trees was factored into overall assessments of effects. In relation to falcons, none have been identified within the Project area. However, the proposed pest management could provide for their reintroduction.

140. If a restoration site can be found that is suitable for the restoration of hillslope forest, this would potentially create opportunities to address the loss of 19.85 hectares of tawa-kohekohe-rewarewa-hinau-podocarp forest, noted by the Applicant as a "nationally uncommon ecosystem, type". At present, the loss of this forest is to be solely mitigated for by pest control. Please consider opportunities to provide an area of hillslope forest restoration, within the goal suggested in No.122 above, to achieve no net loss of habitat area?

Response: No – the Project ecologists consider the proposed offset and mitigation approach is appropriate.

141. Please revise/strengthen the proposed designation conditions to reflect the level of action recommended by ecologists to adequately avoid, remedy, mitigate, offset or compensate (in that order) the adverse effects of this project, to provide greater confidence that the no-net loss approach that is proposed in Technical Report 7h (Ecological Mitigation and Offset) will be achieved, and to ensure the best ecological outcomes result. Can the proposed conditions be

framed in such a way that deferring such a high level of detail to a future (post-consenting) process is avoided?

__Response__: The proposed conditions require compliance with the ELMP. The intention is for the ELMP to be approved as final by the Hearing Panel, so no subsequent certification process is necessary.

Landscape effects

142. The application documents clearly acknowledge that significant work will have to be undertaken to create positive landscape outcomes and the application documents note that there are considerable opportunities for enhancement of natural character values. However the designation conditions do not reflect the proposed mitigation of landscape effects detailed in the application documents. There seems to be only one condition that refers explicitly to landscape, namely the requirement for an Ecology and Landscape Management Plan (ELMP). The draft ELMP is very brief and it is therefore considered that conditions do not adequately ensure that the Project's potential adverse landscape effects are addressed to create the outcomes suggested in Technical Reports 8a and 8b. Please propose suitably detailed conditions which specifically address the following 13 mitigation items listed in Technical Report 8a:

- Cut and fill batters to tie into natural landforms in the area – techniques should be employed to reflect natural rock faces as appropriate and treatments should be implemented to assist in the natural re-colonisation (revegetation);
  __Response:__ Refer to Sections 5.1 and 5.4 of the Landscape and Environmental Design Framework (LEDF).
- Options to further reduce the use of rock drapes will be investigated in detailed design;
  __Response__: Refer to Section 5.1.4 of the LEDF.
- Avoiding "engineered" landform modification and blending earthworks in with the immediate landform context including the form and contouring of permanent disposal areas;
  __Response__: Refer to Section 5.1 of the LEDF.
- Detailed design of highway furniture, barriers, lighting (if any) and signage – with particular emphasis on simplifying such elements and minimising visual clutter;
  __Response__: Refer to Section 5.1 of the LEDF.
- Consideration of rehabilitation and mitigation/offset planting that reflect the wider ecological conditions of the site including eco-sourcing of seed, coordination with the Project ecological restoration experts and participation with Ngāti Tama;
  __Response__: Refer to Section 5.4 of the LEDF.
- Maintenance of access to the conservation estate as appropriate;
  __Response:__ A matter for the CEMP.
- A planting programme including staging, integration with construction programme and wider maintenance programme;
  __Response:__ Refer to Chapter 4 of the ELMP (noting rehabilitation works is excluded).

- Design and finish of co-designed cultural expressions particularly for the tunnel portals and bridge areas and any other ancillary structures as appropriate;
  Response: Refer Section 5.2 LEDF (showing concepts/preliminary ideas for cultural expression on the tunnel portal, bridge and northern fill site). Other opportunities for cultural expression are to be addressed through the detailed design process and ongoing stakeholder engagement, as set out in Section 1.2 of the LEDF.
- Providing for views from the bridge, and for pedestrian and cycling access including through the tunnel;
  Response: Refer to Section 5.2 of the LEDF, although noting that for safety reasons there are no stopping places proposed on the bridge. Pedestrian access to the tunnel will be limited to the egress passage – for emergencies only. A 1.2m shoulder is continued through the tunnel which can be used by cyclists. Pedestrian use of the shoulder within the tunnel will not be permitted.
- Architectural form appropriate to nearby ecologically sensitive areas and the finish of the bridge appropriate to the rural landscape context;
  Response: Refer to Section 5.2 of the LEDF.
- Provision for cycling within the carriageway shoulder;
  Response: A typical 1.5m shoulder to the carriageway will be able to be used by cyclists.
- Consideration of stopping places as appropriate and where practical; and
  Response: Refer to Section 5.2.6 of the LEDF.
- Avoidance and retention of significant trees and areas of vegetation wherever possible.
  Response: Refer to Section 5.4 of the LEDF and Chapter 4 ELMP.

Natural Character

143. The proposal involves stream realignments, cut slopes and structures which would adversely affect the natural character of water bodies within the Mimi and Mangapepeke catchments. As with concerns relating to landscape effects above, proposed conditions do not adequately ensure that the project's potential effects on natural character are addressed to create the outcomes suggested in Technical Reports 8a and 8b. Please propose revised and suitably detailed conditions which specifically address the following 3 mitigation items listed in Technical Report 8a:

- Minimising construction effects on natural stream environments in the Mimi Valley and rehabilitating with riparian planting following construction;
  Response: A matter for the CEMP.
- Constructing stream diversions (where impacts are unavoidable), with naturalised elements reflecting the characteristics of the existing streams, within the Upper Mangapepeke Valley; and
  Response: Refer to Section 5.3 and 5.4 of the LEDF.
- Ecological restoration along the Mangapepeke Stream corridor within the designation.
  Response: Refer to Section 5.4 of the LEDF and Chapter 4 ELMP.

144. The proposal removes the ability to provide access along the Mangapepeke Stream. A portion of the upper stretch on Ngati Tama owned land will flow beneath the road. The

submissions by Mr and Mrs Pascoe describe many people enjoying the lower stretches that run through their farm. Please outline how the loss of stream values, in respect of public access, may be remedied or mitigated.

Response: There is no current public access along the Mangapepeke Stream (the Pascoe's may provide for this informally).

Management Plan conditions

145. The proposed designation and resource consent conditions require the Requiring Authority to provide the Council with updated management plans, which the Council may comment on within 15 working days, and the Requiring Authority will take Council comments into account before finalising the plans. This is not in accordance with standard practice and Council as consent authority should hold the ultimate “certifying” responsibility for ensuring that management plans fulfil their intended functions. The Council would prefer that it retains a role as independent “certifier”. This is particularly important because the Requiring Authority seeks a waiver of the Outline Plan requirement. Please provide your view on whether the Council’s preferred approach is acceptable and, if so, amend proposed conditions accordingly. If you disagree, please provide your reasons for maintaining NZTA’s current approach.

146. Given that expert input will be required in certifying management plans, and the complexity of the project, a longer period than 15 working days to consider these plans is likely to be required. Council would endeavour to respond in a reasonable timeframe but would be a 15 working day turnaround would be unachievable in many instances. Please confirm whether Council’s preferred approach is acceptable and, if so, amend proposed conditions accordingly. If you disagree, please provide your reasons for maintaining NZTA’s current approach.

147. Please provide examples of cases in New Zealand, of large state highway projects through sensitive areas, where management plan conditions similar to the approach suggested in designation conditions 5 to 14 have been used, where the consent authority has no certifying role and where a 15 working day timeframe is stipulated.

Response: The Transport Agency has provided updated management plans, in particular the ELMP, to the Council (and other parties). Discussions on these management plans is continuing with the Council and submitters. The intention is that fulsome, complete management plans will be provided in evidence (if not before depending on the outcome of discussions). If consents are granted and the NoR is confirmed, that will be on the basis that the actions set out in those management plans will be carried out (as required by the proposed conditions). The management plans will be finalised based on the versions provided at the hearing – only substantive changes (that would lead to increased effects) will require certification. In finalising the management plans, the proposed conditions provide for the Transport Agency to take into account any comments made by the councils.

This is an appropriate resource management practice, allowing for decision making at the primary stage, rather than relying on delegation of a detailed certification power to the Council(s). 15 working days is a reasonable period of time for the councils to comment on the process of finalising management plans, in light of the intention that robust drafts will be considered at the hearing.

We would be happy to discuss the proposed approach to conditions and management plans with you in more detail.

Other matters

148. Computer Freehold Registers for the affected properties include the following notations: Ngati Tama Claims Settlement Act 2003; Conservation Covenants (Reserves Act); Crown Minerals Act; Mining Act and Coal Mines Act; NZ Walkways Act; Sustainable forest management permit; and Electricity easement. Table 2.4 of the AEE lists approvals required under other legislation (Public Works Act, Heritage New Zealand Pouhere Taonga Act, Wildlife Act, Freshwater Fisheries Regulations, Ngati Tama Claims Settlement Act). Please advise whether the remaining notations on Computer Freehold Registers are affected by the proposal.

Response: Notations on tiles of affected Properties are addressed through the Public Works Act processes.

149. Survey respondents request there be pull over areas and/or scenic spot for motorists. Section 5.1.7 of Technical Report 8a also notes possible opportunities in this regard. Please advise whether these have been considered for inclusion in the final roading layout and, if so, where they are proposed.

Response: Pull over areas and/or a scenic spot for motorists are still under consideration.

150. Please provide information which identifies the access to and location of the proposed parking area for accessing walking tracks on the southern side of Mt Messenger.

Response: This is under development with input from the Walking Access Commission, DOC and Ngati Tama. Further information will be provided prior to the hearing.

151. Some submitters consider that black ice and fog will be a problem along the new route. Please provide an assessment of this matter.

Response: Following feedback from the Alliance team, and black ice and fog is not considered to be an issue along the new route. This issue will be further addressed in evidence.

152. Some submitters have concerns about flooding downstream as a result of the significant earthworks associated with the project. Please address this concern.

Response: A hydrology assessment has been carried out to assess the potential for changes to flood patterns from the Project. This will be addressed in evidence.

Yours sincerely

Peter Roan

Planning and Consenting Manager

Mt Messenger Alliance

Appendix A: GNS Seismic Design Spectra for the Mt Messenger Bypass

Seismic Design Spectra for the Mount Messenger Bypass

R Buxton GH McVerry

GNS Science Consultancy Report 2017/193
December 2017

BIBLIOGRAPHIC REFERENCE

Buxton R, McVerry GH. 2017. Seismic design spectra for Mount Messenger Bypass. Lower Hutt (NZ): GNS Science. 36 p. (GNS Science consultancy report; 2017/193).

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FIGURES

TABLES

EXECUTIVE SUMMARY

GNS Science was approached by the Mount Messenger Alliance to perform a seismic hazard assessment for the proposed highway. In accordance with the client's requirements, horizontal peak ground accelerations (PGAs) and 5% damped magnitude weighted and unweighted acceleration response spectra were developed for return periods of 50, 100, 500, 1000 and 2500 years for the representative location 38.89° S, 174.59° E (specified by the client).

The results are for the larger horizontal component. The PGAs and spectra were calculated through a combination of the McVerry et al. (2006), Bradley (2013) crustal ground-motion prediction equations (GMPEs) and the McVerry et al. (2006), Zhao et al (2006) and Abrahamson et al (2015) subduction zone GMPEs, using the fault and distributed seismicity models of the 2010 National Seismic Hazard Model of Stirling et al. (2012). The results are provided for New Zealand Standard (NZS)1170.5 Site Classes B Rock, Class C Shallow Soil and Class D Deep/Soft Soil. For the Bradley, Zhao and Abrahamson GMPE(s) that characterise the site effects in terms of the average shear wave velocities to 30 m depth (Vs30), values of 800 m/s (Class B), 450m/s (Class C) and 250m/s were provided by the client. Spectra were produced for periods up to 5s. In line with NZS1170.5, the weighting for magnitude M by the factor $(M/7.5)^{1.285}$ applies only for periods up to 0.5s, with a transition to the unweighted spectra at 0.75s period.

The recommended spectra are the hazard spectra resulting from the modelling which is then modified according to the requirements of the Bridge Manual (NZTA Third Edition Amendment 2, 2016). In particular, for low seismicity regions, the lower bound of 70% of NZS1170 spectra and the minimum ZR=0.13 spectrum for ultimate limit state are overriding conditions.

In the case of the magnitude-weighted spectra, the Bridge Manual requirements mean that the 70% NZS1170 code spectra prevail except in the 500-year case where the ZR=0.13 spectra takes precedence. In the non-magnitude-weighted case, the hazard spectra prevail at short periods below about 0.5s and the recommended spectra use these values.

The results presented here are similar to those outlined in the GNS Science study for the Awakino Tunnel (Goded et al., 2017) but represent a slightly higher, but still low, level of hazard for the location chosen by the client.

Table ES 1 -Table ES **3** list the recommended magnitude-weighted spectra, with the unweighted values listed in brackets for the shorter spectral periods where they differ. Figure ES 1 to Figure ES **3** show the recommended magnitude-weighted and non magnitude-weighted spectra. Table ES 4 lists the non magnitude-weighted PGA values and corresponding average magnitudes for the Mount Messenger bypass site for each of the requested return periods. The average magnitudes shown in Table ES4 vary slightly with site class, because the Class C and Class D pgas are nonlinear functions of the Class B Rock pgas.

Table ES 1 The recommended magnitude-weighted, 5% damped larger horizontal component acceleration response spectra SA(T) for periods T up to 5s for the Mount Messenger Bypass site, corresponding to 50-, 100-, 500-, 1000- and 2500 year return period motions for site Class B Rock. Where different, the non magnitude-weighted values are included in brackets.

	Recommended Class B Weak Rock Spectra SA(T) (g)				
	Magnitude-weighted (non magnitude-weighted in brackets where different)				
T(s)	**50 year**	**100 year**	**500 year**	**1000 year**	**2500 year**
PGA	0.044(0.060)	0.063(0.084)	0.13(0.15)	0.16(0.20)	0.23(0.26)
0.075	0.089(0.11)	0.13(0.15)	0.26(0.34)	0.33(0.44)	0.46(0.60)
0.1	0.10(0.12)	0.15(0.19)	0.31(0.40)	0.38(0.52)	0.53(0.72)
0.15	0.10(0.13)	0.15(0.21)	0.31(0.42)	0.38(0.54)	0.53(0.73)
0.2	0.10(0.14)	0.15(0.22)	0.31(0.43)	0.38(0.55)	0.53(0.73)
0.25	0.10(0.12)	0.15(0.19)	0.31(0.36)	0.38(0.46)	0.53(0.60)
0.3	0.10(0.11)	0.15(0.16)	0.31	0.38(0.39)	0.53
0.35	0.092(0.10)	0.13(0.14)	0.27	0.34	0.47
0.4	0.083(0.095)	0.12	0.25	0.31	0.43
0.5	0.071(0.078)	0.10(0.11)	0.21	0.26	0.36
0.75	0.052	0.074	0.15	0.19	0.27
1	0.042	0.060	0.12	0.16	0.22
1.5	0.031	0.044	0.091	0.11	0.16
2	0.023	0.033	0.068	0.086	0.12
3	0.015	0.022	0.046	0.057	0.080
4	0.0087	0.012	0.026	0.032	0.045
5	0.0056	0.008	0.016	0.021	0.029

Table ES 2 The recommended magnitude-weighted, 5% damped larger horizontal component acceleration response spectra SA(T) for periods T up to 5s for the Mount Messenger Bypass site, corresponding to 50-, 100-, 500-, 1000- and 2500 year return period motions for site Class C Shallow Soil.

	Recommended Class C Shallow Soil Spectra SA(T) (g)				
	Magnitude-weighted (non magnitude-weighted in brackets where different)				
T(s)	**50 year**	**100 year**	**500 year**	**1000 year**	**2500 year**
PGA	0.059(0.077)	0.084(0.11)	0.17(0.21)	0.22(0.26)	0.30(0.34)
0.075	0.11(0.12)	0.16(0.19)	0.33(0.39)	0.42(0.51)	0.57(0.70)
0.1	0.13(0.14)	0.18(0.23)	0.38(0.47)	0.48(0.62)	0.67(0.85)
0.15	0.13(0.18)	0.18(0.26)	0.38(0.52)	0.48(0.67)	0.67(0.90)
0.2	0.13(0.20)	0.18(0.28)	0.38(0.55)	0.48(0.70)	0.67(0.93)
0.25	0.13(0.18)	0.18(0.26)	0.38(0.51)	0.48(0.63)	0.67(0.83)
0.3	0.13(0.17)	0.18(0.25)	0.38(0.47)	0.48(0.58)	0.67(0.75)
0.35	0.12(0.15)	0.16(0.23)	0.34(0.43)	0.43(0.53)	0.59(0.68)
0.4	0.10(0.14)	0.15(0.21)	0.31(0.39)	0.39(0.49)	0.54(0.63)
0.5	0.088(0.12)	0.13(0.16)	0.26(0.32)	0.33(0.39)	0.45(0.51)
0.75	0.065	0.093	0.19	0.24	0.33
1	0.052	0.075	0.15	0.19	0.27
1.5	0.039	0.055	0.11	0.14	0.20
2	0.029	0.041	0.086	0.11	0.15
3	0.019	0.028	0.057	0.072	0.099
4	0.011	0.016	0.032	0.040	0.056
5	0.007	0.010	0.021	0.026	0.036

Table ES 3 The recommended magnitude-weighted, 5% damped larger horizontal component acceleration response spectra SA(T) for periods T up to 5s for the Mount Messenger Bypass site, corresponding to 50-, 100-, 500-, 1000- and 2500 year return period motions for site Class D Deep/Soft Soil.

	Recommended Class D Deep/Soft Soil Spectra SA(T) (g)				
	Magnitude-weighted (non magnitude-weighted in brackets where different)				
T(s)	**50 year**	**100 year**	**500 year**	**1000 year**	**2500 year**
PGA	0.049(0.085)	0.071(0.11)	0.15(0.21)	0.18(0.26)	0.25(0.34)
0.075	0.11(0.13)	0.16(0.19)	0.33(0.36)	0.41(0.45)	0.57(0.59)
0.1	0.13(0.15)	0.19(0.23)	0.39(0.43)	0.49(0.54)	0.68(0.70)
0.15	0.13(0.19)	0.19(0.26)	0.39(0.49)	0.49(0.61)	0.68(0.78)
0.2	0.13(0.21)	0.19(0.29)	0.39(0.53)	0.49(0.65)	0.68(0.84)
0.25	0.13(0.21)	0.19(0.28)	0.39(0.50)	0.49(0.61)	0.68(0.79)
0.3	0.13(0.20)	0.19(0.26)	0.39(0.47)	0.49(0.59)	0.68(0.75)
0.35	0.13(0.19)	0.19(0.25)	0.39(0.45)	0.49(0.56)	0.68(0.73)
0.4	0.13(0.17)	0.19(0.24)	0.39(0.44)	0.49(0.54)	0.68(0.70)
0.5	0.13(0.15)	0.19(0.22)	0.39	0.49	0.68
0.75	0.11	0.15	0.31	0.39	0.54
1	0.085	0.12	0.25	0.32	0.44
1.5	0.063	0.090	0.19	0.23	0.32
2	0.047	0.067	0.14	0.18	0.24
3	0.031	0.045	0.093	0.12	0.16
4	0.018	0.025	0.052	0.066	0.091
5	0.011	0.016	0.033	0.042	0.058

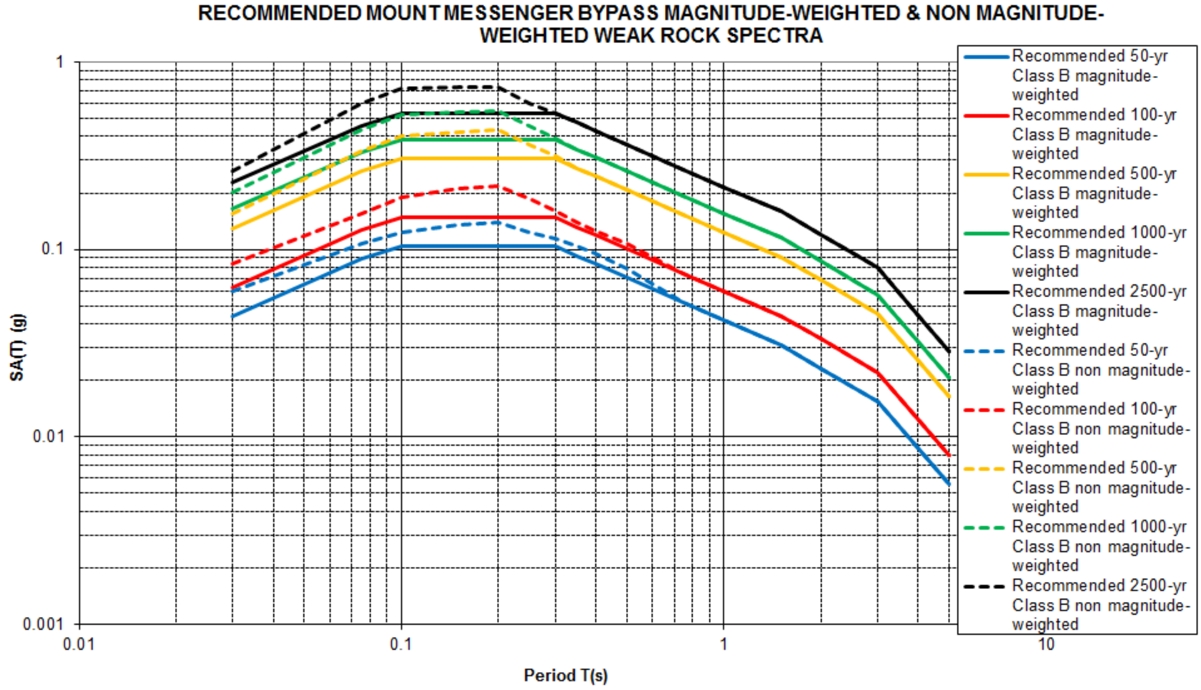

Figure ES 1 The magnitude-weighted (solid) and non magnitude-weighted (dashed), 5% damped larger horizontal component acceleration response spectra SA(T) for periods T up to 5s for the best estimate source model Mount Messenger Bypass, corresponding to 50-, 100-, 500-, 1000- and 2500-year return period motions for site Class B Rock.

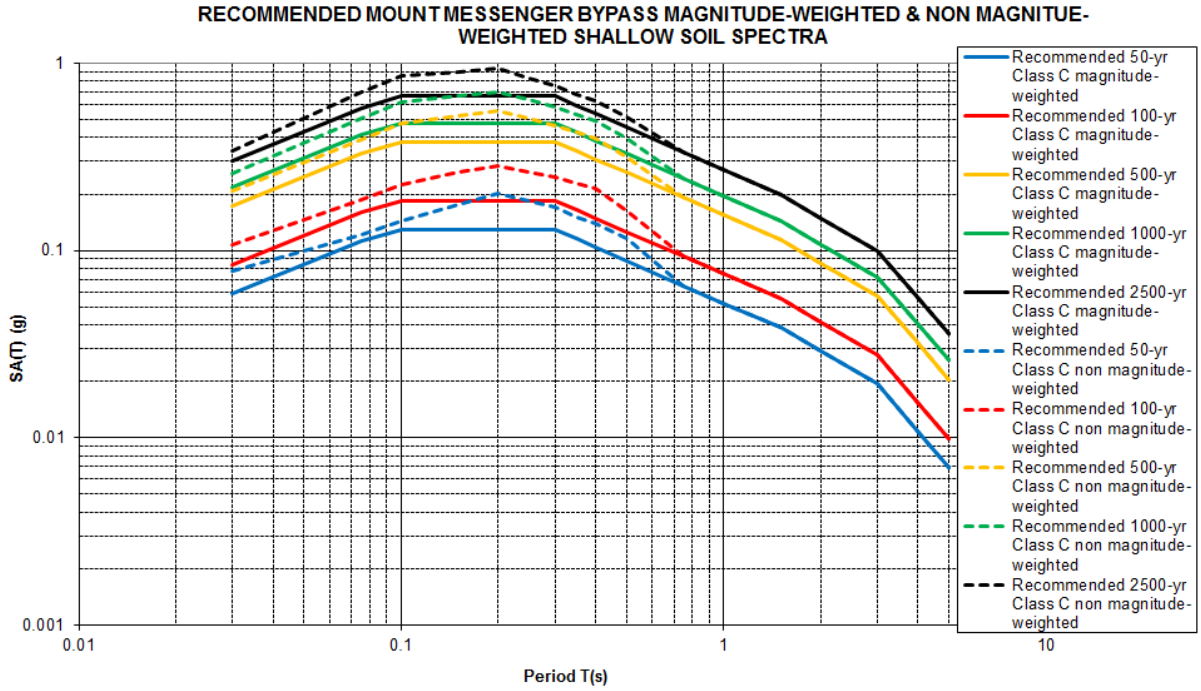

Figure ES 2 The magnitude-weighted (solid) and non magnitude-weighted (dashed), 5% damped larger horizontal component acceleration response spectra SA(T) for periods T up to 5s for the best estimate source model Mount Messenger Bypass, corresponding to 50-, 100-, 500-, 1000- and 2500-year return period motions for site Class C Shallow Soil.

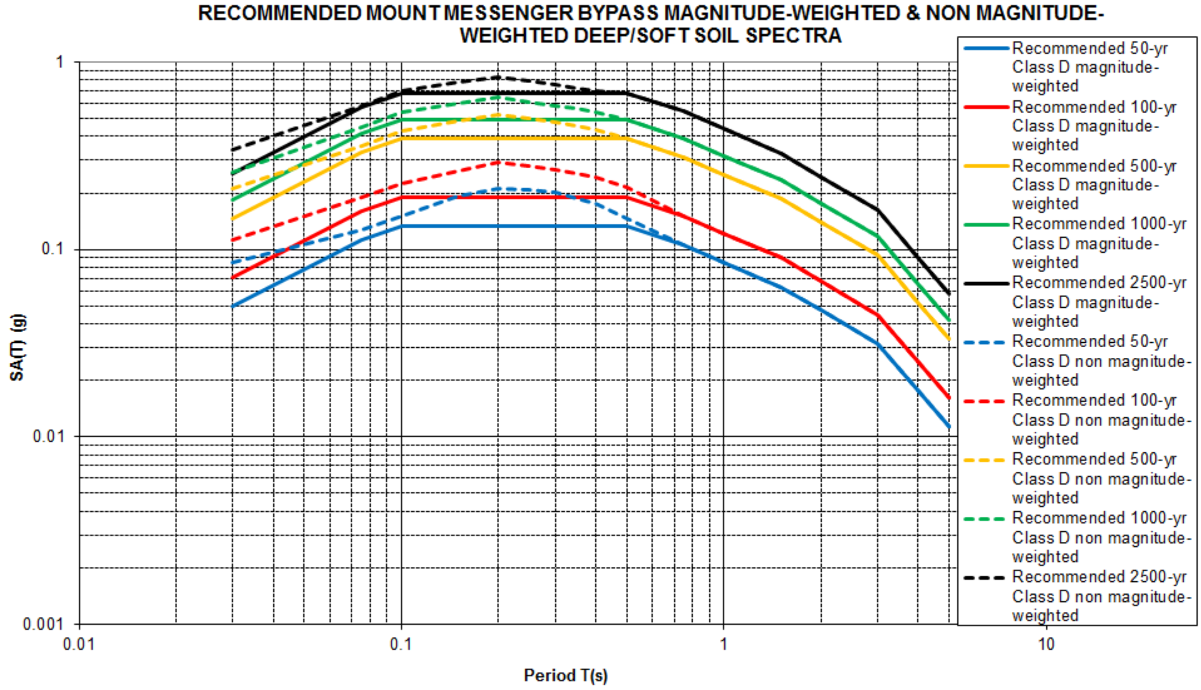

Figure ES 3 The magnitude-weighted (solid) and non magnitude-weighted (dashed), 5% damped larger horizontal component acceleration response spectra SA(T) for periods T up to 5s for the best estimate source model Mount Messenger Bypass, corresponding to 50-, 100-, 500-, 1000- and 2500-year return period motions for site Class D Deep/Soft Soil.

Table ES 4 Non magnitude-weighted PGA values and corresponding average magnitudes for the Mount Messenger Bypass site for each of the requested return periods.

		Return periods (years)				
		50	100	500	1000	2500
Class B Weak Rock	Non MW PGA(g)	0.060	0.084	0.15	0.20	0.26
	Average magnitude	6.1	6.1	6.2	6.3	6.3

		Return periods (years)				
		50	100	500	1000	2500
Class C Shallow Soil	Non MW PGA(g)	0.077	0.11	0.21	0.26	0.34
	Average magnitude	6.1	6.1	6.2	6.2	6.3

		Return periods (years)				
		50	100	500	1000	2500
Class D Deep/Soft Soil	Non MW PGA(g)	0.085	0.11	0.21	0.26	0.34
	Average magnitude	6.1	6.1	6.3	6.3	6.4

1.0 INTRODUCTION

GNS Science was approached by the Mount Messenger Alliance to perform a seismic hazard assessment for the proposed highway. In accordance with the client's requirements, horizontal peak ground accelerations (PGAs) and 5% damped magnitude weighted and unweighted acceleration response spectra were developed for return periods of 50, 100, 500, 1000 and 2500 years for the representative location 38.89° S, 174.59° E (specified by the client). This study has been completed in accordance with Section 5.2.3 'Site-Specific Hazard Studies' in the New Zealand Transport Agency (NZTA) Bridge Manual (NZTA Third Edition Amendment 2, 2016).

The results are for the larger horizontal component in line with New Zealand structural engineering design practice. Spectra were produced for periods up to 5s, and are provided with and without magnitude-weighting. Where magnitude weighting is present, it affects the spectra up to 0.5s period.

In order to address epistemic uncertainty, the use of multiple Ground Motion Prediction Equations (GMPEs) were requested by the client. The McVerry (2006), Bradley (2013), Zhao (2006) and Abrahamson et al. (2015) were used and results combined using a logic tree. The modelling procedure is explained in Section 4.

2.0 GEOLOGY AND SITE LOCATION

2.1 REGIONAL TECTONIC SETTING

New Zealand sits astride the boundary between the Australian Plate and the Pacific Plate, where relative plate motion is obliquely convergent across the plate boundary at rates of 48 – 40 mm/year from north to south (Wallace et al., 2007) (Fig. 2.1a). The plate boundary can be divided into three main components, namely: (i) the oblique westward subduction of the oceanic Pacific Plate beneath the continental Australian Plate east of the North Island (Hikurangi Margin, HkT in Figure 2.1a), where the Pacific plate is subducting beneath the Australian Plate (plates slip past each other with one of them located beneath the other); (ii) the oblique continent-continent collision in the South Island (South Island continental transpression zone) where the two plates collide and slip laterally (as both are too buoyant for either of them to subduct); and (iii) the northeastward subduction of the oceanic Australian Plate beneath the continental Pacific Plate southwest of the South Island (Puysegur Margin, Pt and PR in Figure 2.1a).

Within this overall tectonic framework, 12 tectonic domains of crustal faults have been recognised, based on geographic groupings of active faults that have similar geometries and kinematics (Fig. 2.1) (Litchfield et al, 2014; Stirling et al. 2012). Figure 2.1b below shows the 12 domains defined by Stirling et al. (2012) for the National Seismic Hazard Model (NSHM).

The site of the proposed Mount Messenger Bypass is located in Zone 1. “Extensional Western North Island Faults” near the eastern boundary of a region of low seismicity. Earthquakes occur to the southeast within the much more active Taupo Rift and deeper events occur within the subducting slab of the Hikurangi margin, with progressively deeper earthquakes as it dips north-eastwards from the upper edge of the Hikurangi Margin subduction thrust (HkT in Figure 2.1a) to extend at depth to the west of the highway.

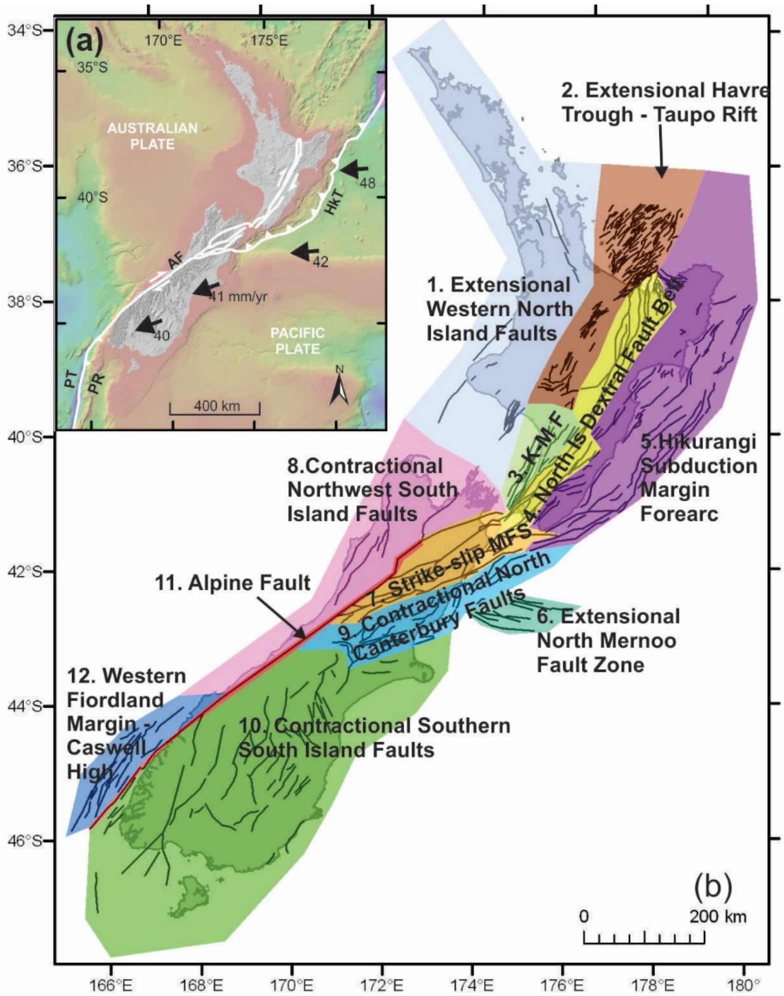

Figure 2.1 (a) New Zealand Plate boundary setting (black arrows are plate motion sense and rates from Wallace et al., 2007). (b) Groupings of active fault sources into domains or regions they occupy in New Zealand as per Stirling et al (2012). K-M F = Kapiti – Manawatu Faults, MFS = Marlborough Fault System. Only the upper plate (non-interface) active faults are shown on this figure. Note that this model has been updated with three more domains: the Hikurangi and Puysegur subduction thrusts and the Puysegur Ridge - Bank strike-slip fault zones in Litchfield et al (2013, 2014). Labelled in Figure 2.1a as HkT, Pt and PR, respectively.

3.0 THE NATIONAL SEISMIC HAZARD MODEL

3.1 GENERAL DESCRIPTION

To address the uncertainties in ground-motion predictions the hazard estimates were performed using a GMPE logic tree in the OpenQuake engine, an open source software developed by Global Earthquake Model (GEM) Foundation as a best-practice engine for hazard and risk calculation and modelling (GEM, 2017).

3.2 OPEN QUAKE PROBABILISTIC SEISMIC HAZARD ASSESSMENT SOFTWARE

The hazard calculations for this assessment were calculated using the March 2017 Version 2.3 of the OpenQuake Engine. OpenQuake (OQ) is a suite of open-source software developed by Global Earthquake Model (GEM) Foundation to promote consistent use of data and facilitate best practices in seismic hazard and risk calculation (GEM, 2017).

We utilise an updated version (GMPE logic tree) of the 2010 National Seismic Hazard Model (NSHM) (Stirling et al. 2012a). The OQ implementation of the GMPE logic tree (Section 3.3) is used to produce hazard curves and response spectra, one for each branch of the logic tree. The hazard curves for each of the logic tree branches are combined according to the associated weights to produce a single hazard curve and response spectrum.

In addition to the comprehensive treatment of epistemic uncertainty represented in the GMPE logic trees, the PSH calculations also consider the aleatory variability in ground motions from the GMPEs. All of the GMPEs have published standard deviations, and the PSH calculations consider the variability in predicted ground motions up to the 3-standard deviation level. This is frequently-used practice in PSHA globally.

The OQ software is also used to produce 50^{th}- and 84^{th}-percentile estimates of spectra for a deterministic fault-rupture scenario. This utilises the same weighted combinations of GMPEs used for the probabilistic calculations.

3.3 THE GMPE LOGIC TREE

The logic tree that controls the use of the different GMPEs is divided into four main sections. The first covers the GMPEs used for the crustal faults, the second controls those used for the volcanic sources, the third covers those used for the subduction interface and the last section controls the GMPEs used for the subduction intraslab sources. The Bradley (2013) and McVerry et al. (2006) GMPEs, with 60% and 40% weighting respectively, are used for the crustal and volcanic sources. This is consistent with the approach used in the study for the nearby Awakino Tunnel project (Goded et al., 2017).

For the subduction sources, McVerry et al. (2006), Zhao et al (2006) and Abrahamson et al (2015) are used with equal weightings.

4.0 PROBABILISTIC HAZARD SPECTRA

4.1 INTRODUCTION

In accordance with the client's requirements, magnitude-weighted and non-magnitude-weighted horizontal hazard spectra were developed for the Mount Messenger Bypass site for return periods of 50, 100, 500, 2500 and 10,000 years for periods up to 5s. Near-fault factors (NFFs) are not required for this location because it is located greater than 20 km distance from all of the 11 major faults designated by NZS 1170.5 as requiring the application of NFFs (Standards New Zealand, 2004, 2016).

The hazard studies conducted for the development of the NZS1170.5 spectra used magnitude-weighting of the spectra for periods up to 0.5s. The magnitude-weighting method scales the expected accelerations for any event according to earthquake magnitude M, by a factor $(M/7.5)^{1.285}$, while the non magnitude-weighted estimates have no scaling of the expected accelerations.

Magnitude-weighting recognises that for a given maximum acceleration, damage potential increases with the duration of shaking. Duration of shaking generally increases with magnitude. The magnitude-dependent scaling factor is intended to produce spectral acceleration estimates that are equivalent to magnitude 7.5 values in terms of damage potential, scaling down accelerations for magnitudes less than 7.5.

This procedure is the same as that used for peak ground accelerations by Idriss (1985) for assessing liquefaction potential, but is applied only to periods up to 0.5s. For longer spectral periods, small-to-moderate magnitude earthquakes produce significantly weaker motions than larger magnitude events, so that scaling is not necessary. At short spectral periods, magnitude-weighted spectral accelerations are usually less than those from uniform hazard analyses.

4.2 THE HORIZONTAL HAZARD SPECTRA AND MODIFICATION BY MINIMUM ALLOWABLE LIMITS

The Bridge Manual (NZTA, 2016), in its section 5.2.3a, requires site-specific spectra to be within ±30% of the NZS1170.5 (Standards New Zealand, 2004) spectra. In addition, the spectra shall not be less that those corresponding to ZR=0.13 for the ultimate limit state, where Z is the NZS1170.5 hazard factor and R is the Return Period factor. The horizontal spectra have been compared to the NZS1170 spectra for soil classes B Rock, C Shallow Soil and D Deep/Soft Soil, as well as the spectra corresponding to ZR=0.13. Figure 4.1 - Figure 4.3 show the magnitude-weighted spectra, and Figure 4.4 - Figure 4.6 the non magnitude-weighted spectra, for the three site classes together with ±30% of the NZS1170.5 spectra and the ZR=0.13 spectra. In reality, the NZS1170.5 spectra are only directly comparable to the magnitude-weighted hazard spectra as there are no spectra in NZS1170.5 or the Bridge Manual that are equivalent to the non magnitude-weighted spectra where they differ from the magnitude-weighted ones. For consistency with NZS1170.5, the magnitude-weighted and non-weighted spectra are the same for periods of 0.75s and greater, with full magnitude-weighting used only up to 0.5s. Consequently, the Bridge Manual requirement of a lower bound of 0.7 times the NZS1170.5 spectra applies for both the magnitude-weighted and non magnitude-weighted spectra for periods of 0.75s and longer.

Large parts of the magnitude-weighted spectra fall below and on the minimum requirements from the Bridge Manual. It was, therefore decided that for the magnitude-weighted cases the 70% NZS1170 spectra would be taken as the recommended spectra for all soil classes and return periods except the 500-year case where the ZR=0.13 spectra governs. The 70% NZS1170.5 lower bound spectra govern over the hazard spectra for both the magnitude-weighted and non magnitude-weighted spectra.

Spectral acceleration values less than 0.01g, which occur for some of the cases for periods longer than 3s, will be unreliable, because this is the minimum acceleration for which exceedance rates are calculated. Values less than 0.01g are obtained from extrapolation of the exceedance rates for 0.01g and 0.02g. Other values are determined through interpolation of acceleration and exceedance values. The extrapolation process required for the lower accelerations is inherently much less reliable than the interpolation.

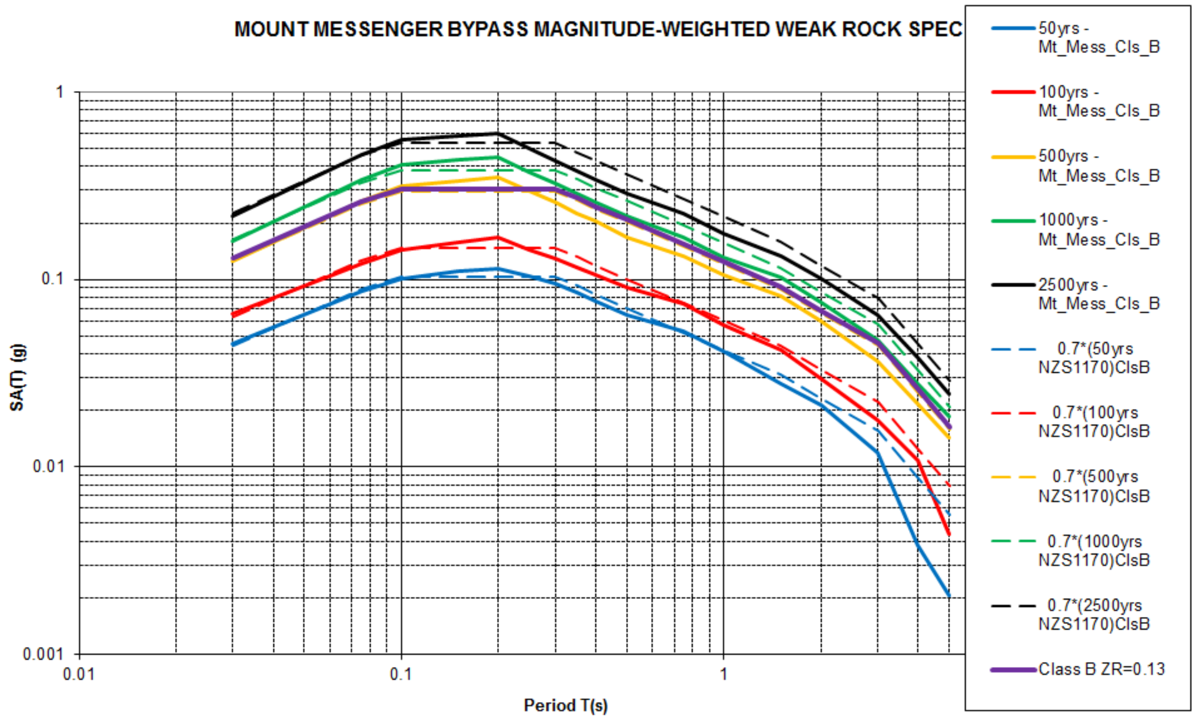

Figure 4.1 Mount Messenger Bypass magnitude-weighted Class B Weak Rock hazard spectra.

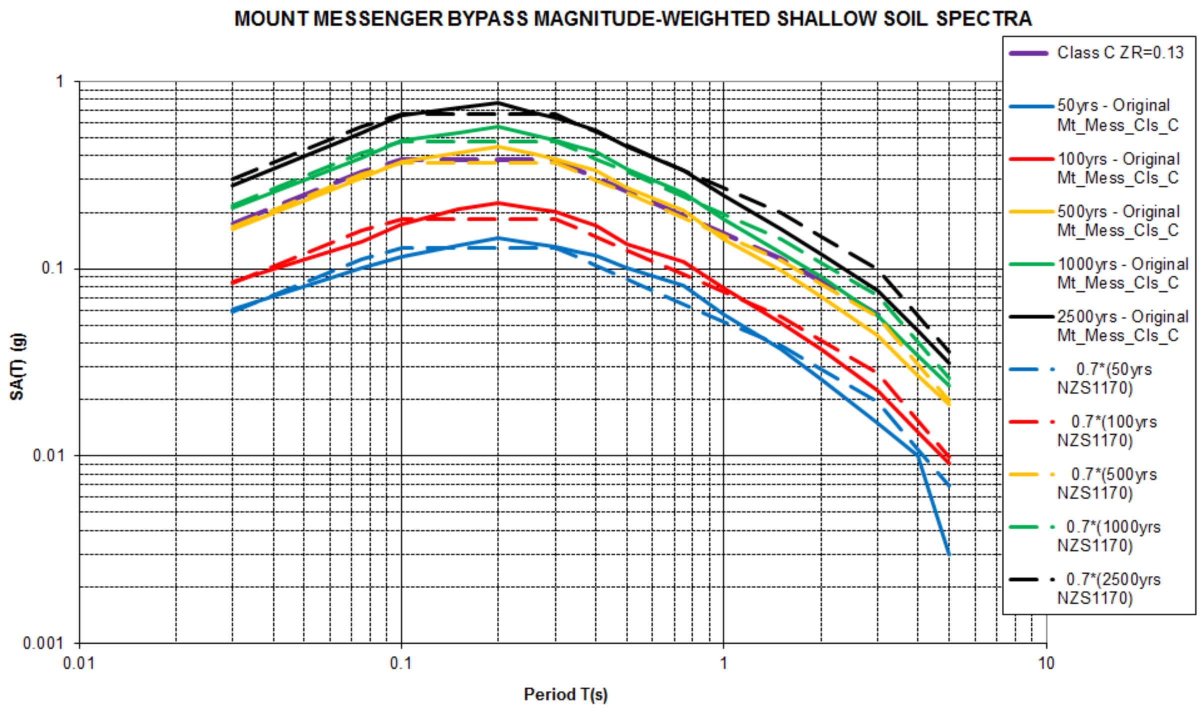

Figure 4.2 Mount Messenger Bypass magnitude-weighted Class C Shallow Soil hazard spectra.

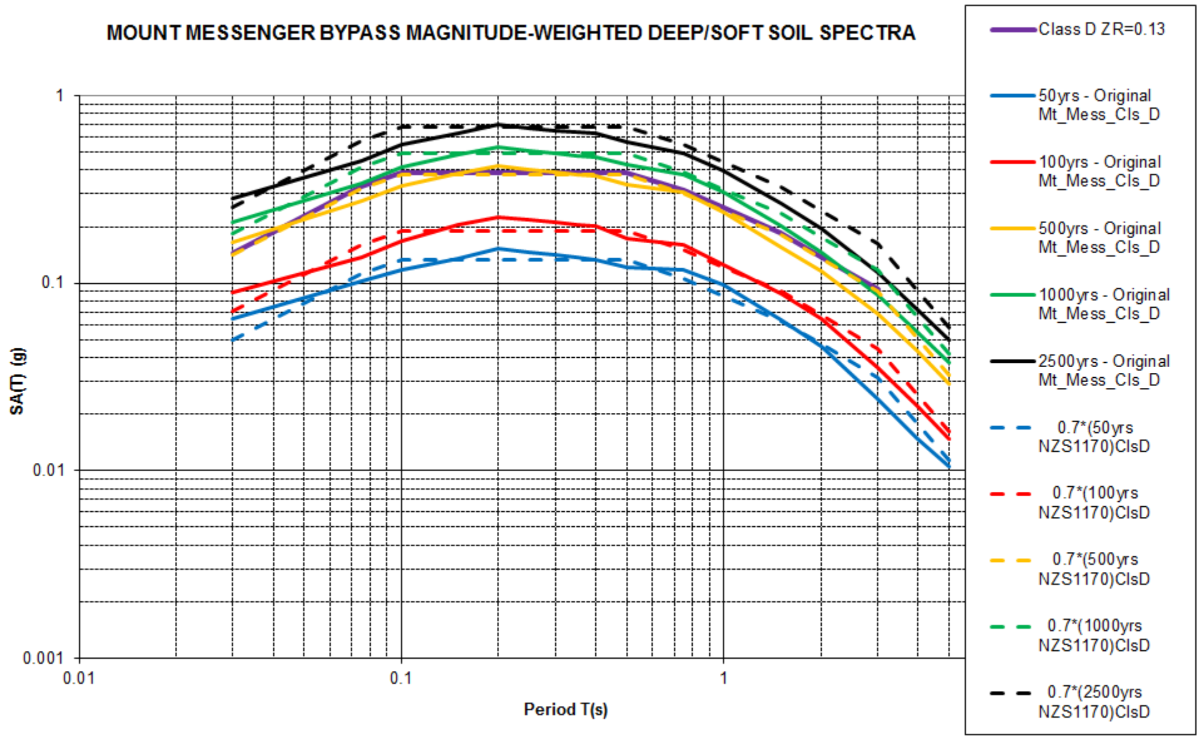

Figure 4.3 Mount Messenger Bypass magnitude-weighted Class D Deep/Soft Soil hazard spectra.

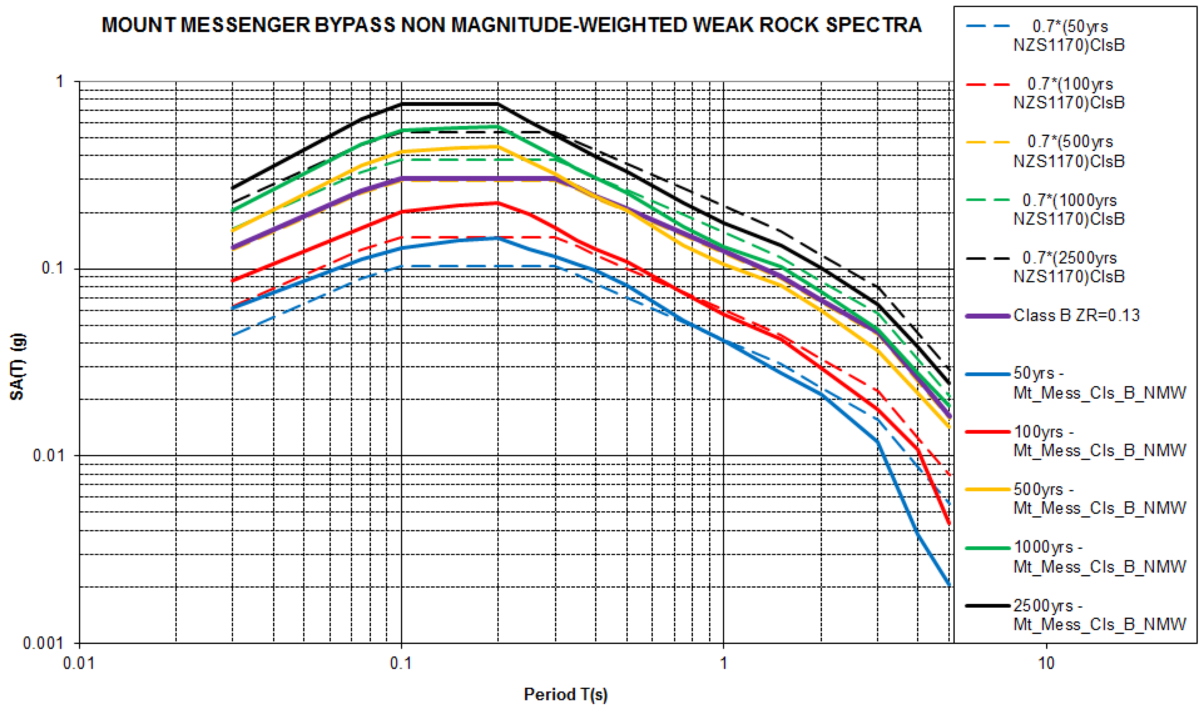

Figure 4.4 Mount Messenger Bypass non magnitude-weighted Class B Weak Rock hazard spectra.

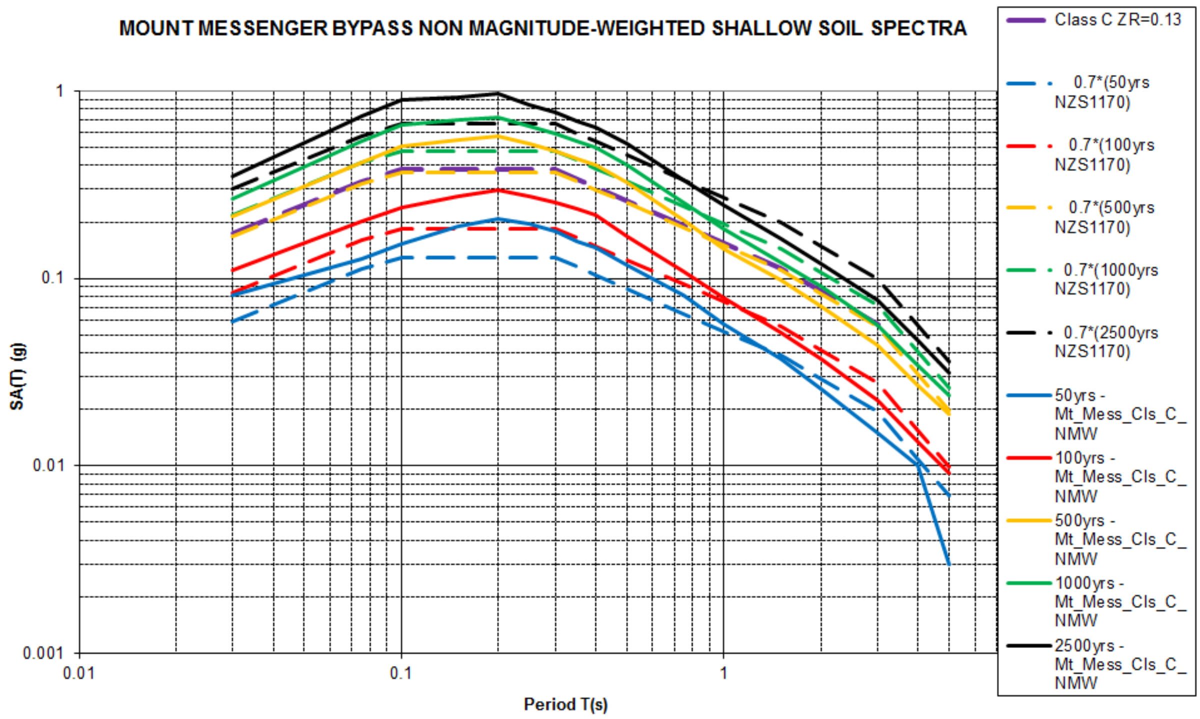

Figure 4.5 Mount Messenger Bypass non magnitude-weighted Class C Shallow Soil hazard spectra.

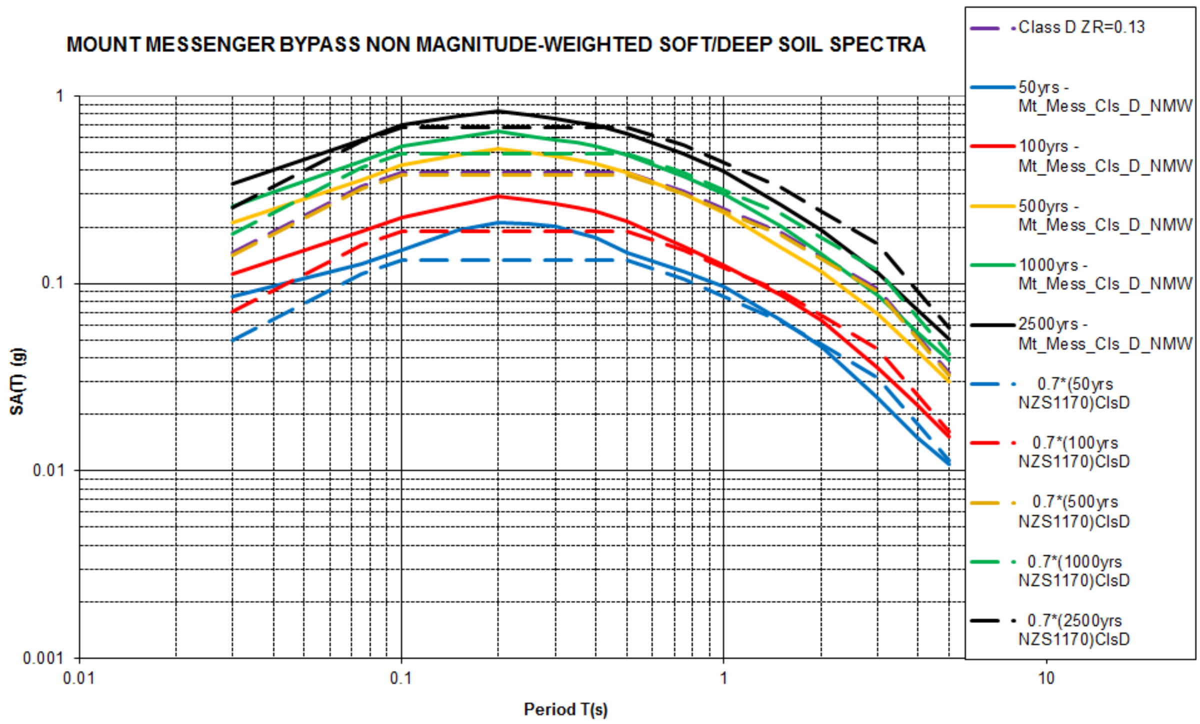

Figure 4.6 Mount Messenger Bypass non magnitude-weighted Class D Deep/Soft Soil hazard spectra.

4.3 THE RECOMMENDED HORIZONTAL HAZARD SPECTRA

The recommended horizontal spectra for site Class B Weak Rock, Class C Shallow Soil and Class D Deep/Soft soil are listed in Table 4.1 -Table 4.3 and shown in Figure 4.7-Figure 4.9 with and without magnitude-weighting. The corresponding magnitude-weighted and non magnitude-weighted spectra are identical from 0.75s onwards. The magnitude-weighted hazard spectra were taken as the 70% NZS1170 code spectra across all spectral periods, for purposes of satisfying the minimum requirements. Occasionally, the hazard spectra exceeded these minimum values. In the non magnitude-weighted case, the hazard spectra supersede the minimum code spectra by some margin, especially at short periods, so an envelope of the hazard and code values was taken.

Table 4.1 The recommended magnitude-weighted, 5% damped larger horizontal component acceleration response spectra SA(T) for periods T up to 5s for the Mount Messenger Bypass site, corresponding to 50-, 100-, 500-, 1000- and 2500 year return period motions for site Class B Rock. Where different, the non magnitude-weighted values are included in brackets.

	Recommended Class B Weak Rock Spectra SA(T) (g)				
	Magnitude-weighted (non magnitude-weighted in brackets where different)				
T(s)	**50 year**	**100 year**	**500 year**	**1000 year**	**2500 year**
PGA	0.044(0.06)	0.063(0.084)	0.13(0.15)	0.16(0.20)	0.23(0.26)
0.075	0.089(0.11)	0.13(0.15)	0.26(0.34)	0.33(0.44)	0.46(0.60)
0.1	0.10(0.12)	0.15(0.19)	0.31(0.40)	0.38(0.52)	0.53(0.72)
0.15	0.10(0.13)	0.15(0.21)	0.31(0.42)	0.38(0.54)	0.53(0.73)
0.2	0.10(0.14)	0.15(0.22)	0.31(0.43)	0.38(0.55)	0.53(0.73)
0.25	0.10(0.12)	0.15(0.19)	0.31(0.36)	0.38(0.46)	0.53(0.60)
0.3	0.10(0.11)	0.15(0.16)	0.31	0.38(0.39)	0.53
0.35	0.092(0.10)	0.13(0.14)	0.27	0.34	0.47
0.4	0.083(0.095)	0.12	0.25	0.31	0.43
0.5	0.071(0.078)	0.10(0.11)	0.21	0.26	0.36
0.75	0.052	0.074	0.15	0.19	0.27
1	0.042	0.060	0.12	0.16	0.22
1.5	0.031	0.044	0.091	0.11	0.16
2	0.023	0.033	0.068	0.086	0.12
3	0.015	0.022	0.046	0.057	0.080
4	0.0087	0.012	0.026	0.032	0.045
5	0.0056	0.008	0.016	0.021	0.029

Table 4.2 The recommended magnitude-weighted, 5% damped larger horizontal component acceleration response spectra SA(T) for periods T up to 5s for the Mount Messenger Bypass site, corresponding to 50-, 100-, 500-, 1000- and 2500 year return period motions for site Class C Shallow Soil.

	Recommended Class C Shallow Soil Spectra SA(T) (g)				
	Magnitude-weighted (non magnitude-weighted in brackets where different)				
T(s)	**50 year**	**100 year**	**500 year**	**1000 year**	**2500 year**
PGA	0.059(0.077)	0.084(0.11)	0.17(0.21)	0.22(0.26)	0.30(0.34)
0.075	0.11(0.12)	0.16(0.19)	0.33(0.39)	0.42(0.51)	0.57(0.70)
0.1	0.13(0.14)	0.18(0.23)	0.38(0.47)	0.48(0.62)	0.67(0.85)
0.15	0.13(0.18)	0.18(0.26)	0.38(0.52)	0.48(0.67)	0.67(0.90)
0.2	0.13(0.20)	0.18(0.28)	0.38(0.55)	0.48(0.70)	0.67(0.93)
0.25	0.13(0.18)	0.18(0.26)	0.38(0.51)	0.48(0.63)	0.67(0.83)
0.3	0.13(0.17)	0.18(0.25)	0.38(0.47)	0.48(0.58)	0.67(0.75)
0.35	0.12(0.15)	0.16(0.23)	0.34(0.43)	0.43(0.53)	0.59(0.68)
0.4	0.10(0.14)	0.15(0.21)	0.31(0.39)	0.39(0.49)	0.54(0.63)
0.5	0.088(0.12)	0.13(0.16)	0.26(0.32)	0.33(0.39)	0.45(0.51)
0.75	0.065	0.093	0.19	0.24	0.33
1	0.052	0.075	0.15	0.19	0.27
1.5	0.039	0.055	0.11	0.14	0.20
2	0.029	0.041	0.086	0.11	0.15
3	0.019	0.028	0.057	0.072	0.099
4	0.011	0.016	0.032	0.040	0.056
5	0.007	0.010	0.021	0.026	0.036

Table 4.3 The recommended magnitude-weighted, 5% damped larger horizontal component acceleration response spectra SA(T) for periods T up to 5s for the Mount Messenger Bypass site, corresponding to 50-, 100-, 500-, 1000- and 2500 year return period motions for site Class D Deep/Soft Soil.

	Recommended Class D Deep/Soft Soil Spectra SA(T) (g)				
	Magnitude-weighted (non magnitude-weighted in brackets where different)				
T(s)	**50 year**	**100 year**	**500 year**	**1000 year**	**2500 year**
PGA	0.049(0.085)	0.071(0.11)	0.15(0.21)	0.18(0.26)	0.25(0.34)
0.075	0.11(0.13)	0.16(0.19)	0.33(0.36)	0.41(0.45)	0.57(0.59)
0.1	0.13(0.15)	0.19(0.23)	0.39(0.43)	0.49(0.54)	0.68(0.70)
0.15	0.13(0.19)	0.19(0.26)	0.39(0.49)	0.49(0.61)	0.68(0.78)
0.2	0.13(0.21)	0.19(0.29)	0.39(0.53)	0.49(0.65)	0.68(0.84)
0.25	0.13(0.21)	0.19(0.28)	0.39(0.50)	0.49(0.61)	0.68(0.79)
0.3	0.13(0.20)	0.19(0.26)	0.39(0.47)	0.49(0.59)	0.68(0.75)
0.35	0.13(0.19)	0.19(0.25)	0.39(0.45)	0.49(0.56)	0.68(0.73)
0.4	0.13(0.17)	0.19(0.24)	0.39(0.44)	0.49(0.54)	0.68(0.70)
0.5	0.13(0.15)	0.19(0.22)	0.39	0.49	0.68
0.75	0.11	0.15	0.31	0.39	0.54
1	0.085	0.12	0.25	0.32	0.44
1.5	0.063	0.090	0.19	0.23	0.32
2	0.047	0.067	0.14	0.18	0.24
3	0.031	0.045	0.093	0.12	0.16
4	0.018	0.025	0.052	0.066	0.091
5	0.011	0.016	0.033	0.042	0.058

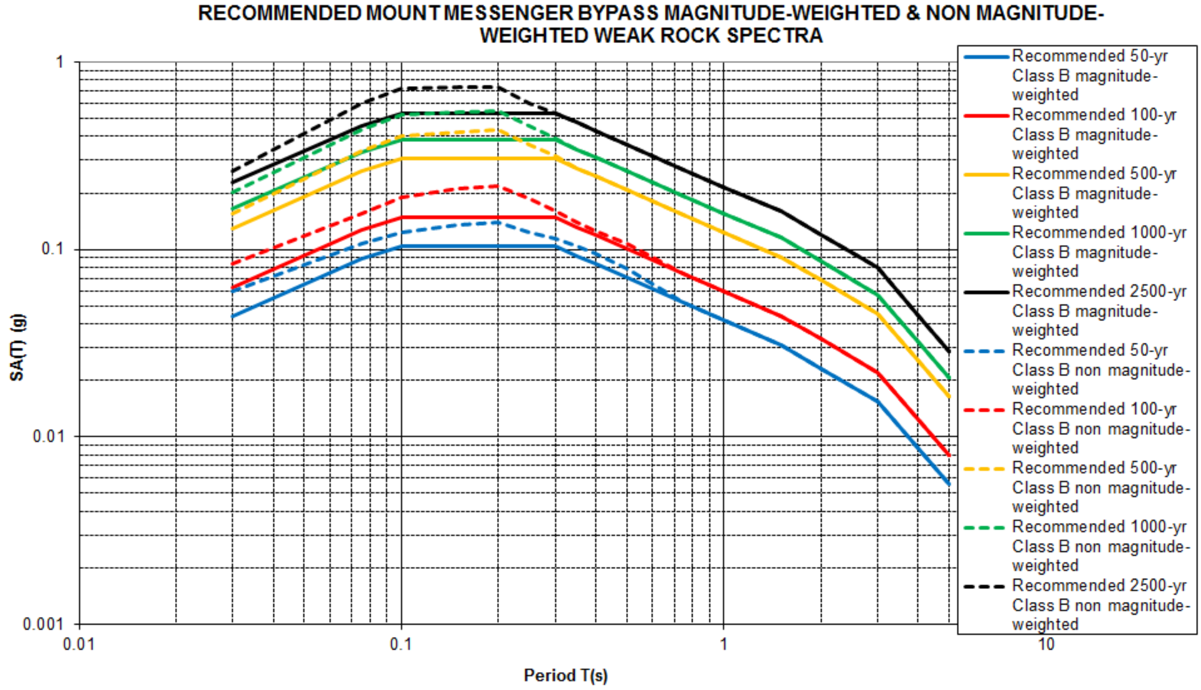

Figure 4.7 The magnitude-weighted (solid) and non magnitude-weighted (dashed), 5% damped larger horizontal component acceleration response spectra SA(T) for periods T up to 5s for the best estimate source model Mount Messenger Bypass, corresponding to 50-, 100-, 500-, 1000- and 2500-year return period motions for site Class B Rock.

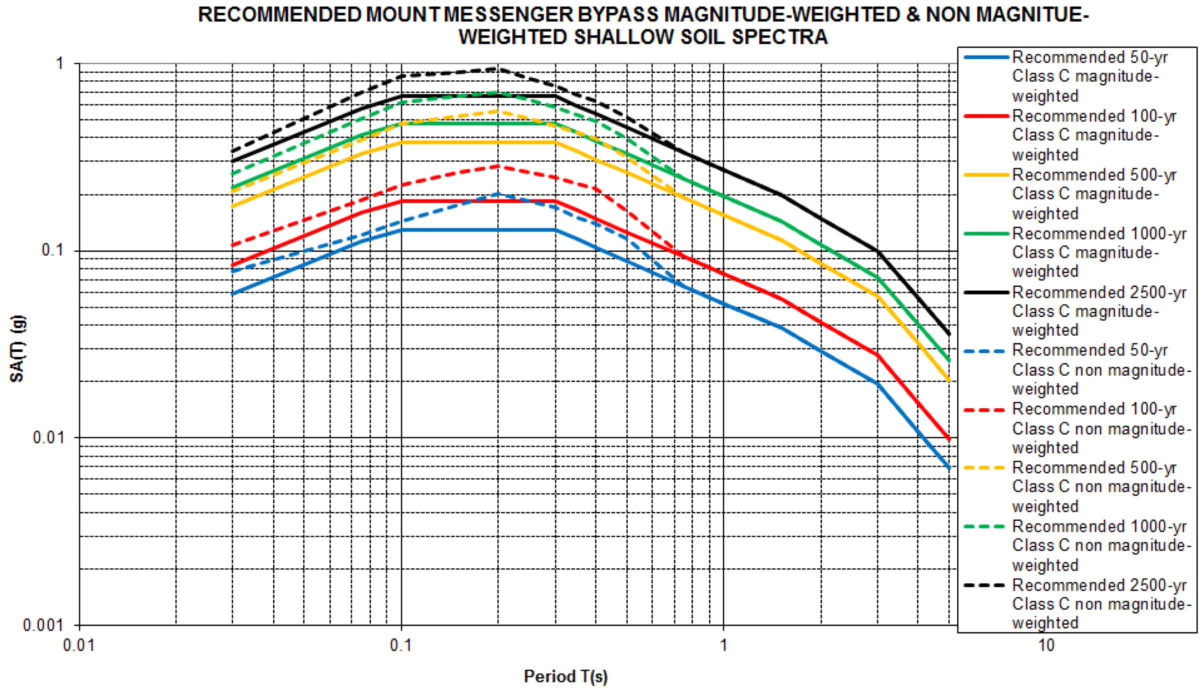

Figure 4.8 The magnitude-weighted (solid) and non magnitude-weighted (dashed), 5% damped larger horizontal component acceleration response spectra SA(T) for periods T up to 5s for the best estimate source model Mount Messenger Bypass, corresponding to 50-, 100-, 500-, 1000- and 2500-year return period motions for site Class C Shallow Soil.

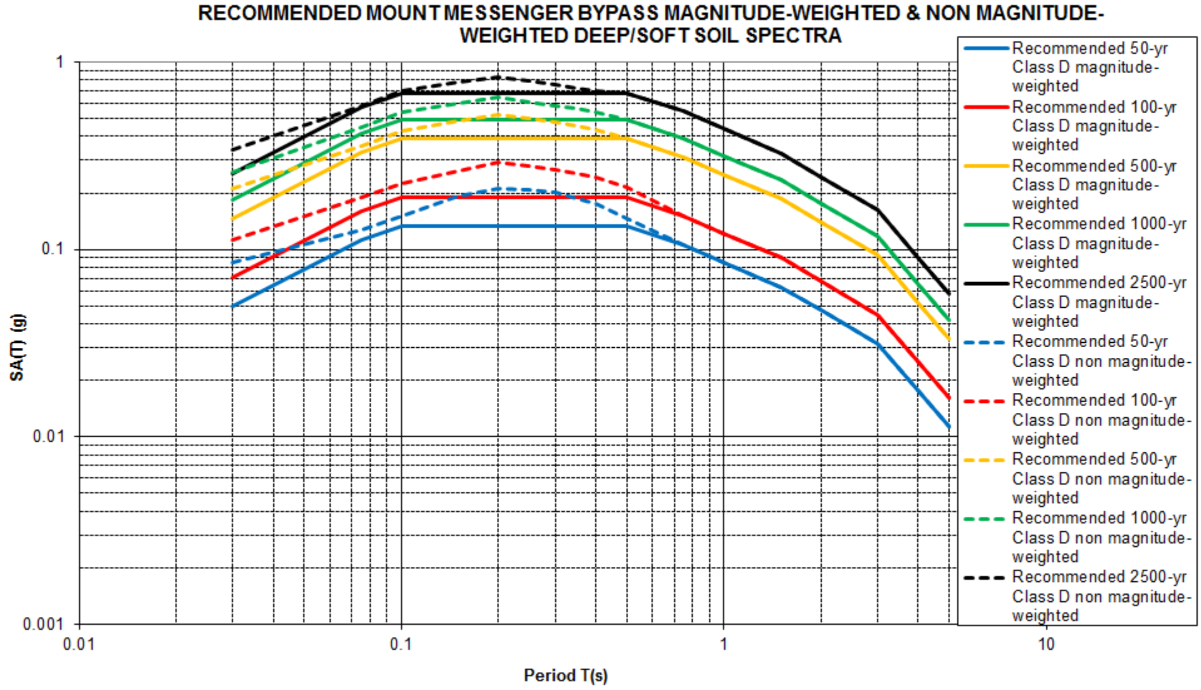

Figure 4.9 The magnitude-weighted (solid) and non magnitude-weighted (dashed), 5% damped larger horizontal component acceleration response spectra SA(T) for periods T up to 5s for the best estimate source model Mount Messenger Bypass, corresponding to 50-, 100-, 500-, 1000- and 2500-year return period motions for site Class D Deep/Soft Soil.

4.4 VERTICAL SPECTRA

The recommended 5% damped vertical acceleration response spectra for this study (Table 4.4 - Table 4.6 and Figure 4.7 - Figure 4.12) are based on expressions that have been incorporated in Amendment 1 of NZS1170.5 (Standards New Zealand, 2016) published on 30 September 2016. The new NZS1170.5 expressions are based on scaling of the horizontal PGA and the value at the plateau of the horizontal response spectrum. The parameters for constructing the new NZS1170.5 vertical spectra are the horizontal PGA and the peak horizontal spectral acceleration, with the vertical spectra falling away from the peak for periods longer than 0.15s. In NZS1170.5, the peak spectral acceleration is represented by the 0.1s value. In the current study, this is replaced by the 0.15s value, which is higher than that at 0.1s for the recommended non magnitude-weighted horizontal spectra. With this slight modification of the NZS1170.5 construction, the 5% damped vertical acceleration response spectrum, $SA_v(T)$, recommended for Mount Messenger Bypass for a given return period is given by Equations 1 to 4:

$SA_v(T) = \alpha\ [SA(0s) + (SA(0.15s)-SA(0s))(T/0.05)]$	for $T \le 0.05s$	(1)
$SA_v(T) = \alpha\ SA(0.15s)$	for $0.05s < T \le 0.15s$	(2)
$SA_v(T) = \alpha\ SA(0.15s)\ (0.15/T)^{0.75}$	for $0.15s < T \le 3s$	(3)
$SA_v(T) = SAv(3s)\ (3/T)^2$	for $T > 3s$	(4)

where α = 0.9 for site classes B and C, and 1.5 for Class D, and SA(T) is the horizontal spectrum for period T for the same return period.

The following explanation of the derivation of these vertical spectra is taken from Commentary Clause 3.2 of Amendment 1 of NZS1170.5, with minor editing.

Traditionally, the vertical to horizontal spectra ratio has been taken as about 2/3, based on the pioneering work on spectral shapes by Newmark and Hall (1982). However, in the near-source region, the high-frequency content of vertical motions is often very strong, leading to peak ground accelerations and spectra at short periods that may exceed the horizontal values (Niazi and Bozorgnia, 1992; Bozorgnia and Niazi, 1993; Ambraseys and Simpson, 1996). The formulation of the vertical spectra is appropriate for near-source locations, where the short-period part of the vertical spectrum may equal or exceed the horizontal spectrum, but may be conservative away from sources.

The expressions for constructing vertical spectra from horizontal spectra are based on Bozorgnia and Campbell (2004). The values of the parameter α correspond to the short-period vertical to horizontal (V/H) ratios shown in Figure 7 of Bozorgnia and Campbell, namely 0.9 at distances of less than 20 km from the rupture for Shallow Soil (NEHRP Class D, applied here at all distances to NZS1170.5 classes B Rock and C Shallow Soil).

Vertical to horizontal ratios approaching or exceeding 1.0 generally occur only at short spectral periods. The V/H ratio typically falls with increasing spectral period for periods longer than about 0.15s, which has been taken as the long-period corner of the plateau of the vertical spectra.

Bozorgnia and Campbell (2004) extend the plateau of the vertical spectrum back to 0s (PGA), with no rising branch from 0s to 0.05s. Equation (1) gives a rising branch from 0s up to the plateau starting at 0.05s. The range of 0.05s to 0.15s for the plateau of the vertical spectrum is as used in Eurocode 8 (European Standard, 2004). The rising branch from 0s to 0.05s has been introduced so that the vertical peak ground acceleration (0s period) is specified appropriately. Similarly, a branch proportional to $(3/T)^2$ *is introduced in equation (4) for periods longer than 3s, so that V/H remains comfortably less than 1 at long periods, although, in reality this period range is unlikely to be required for consideration of vertical motions in design.*

Vertical spectra have been generated from the recommended magnitude-weighted horizontal spectra given in section 4.3.

Table 4.3 Vertical spectra for Mount Messenger Bypass site for Class B Weak Rock.

	Magnitude-weighted Class B Weak Rock				
Period T(s)	**50-yrs**	**100-yrs**	**500-yrs**	**1000-yrs**	**2500-yrs**
PGA	0.040	0.057	0.117	0.147	0.204
0.03	0.072	0.103	0.212	0.267	0.369
0.05	0.093	0.133	0.275	0.346	0.479
0.075	0.093	0.133	0.275	0.346	0.479
0.1	0.093	0.133	0.275	0.346	0.479
0.15	0.093	0.133	0.275	0.346	0.479
0.2	0.075	0.107	0.221	0.279	0.386
0.25	0.064	0.091	0.187	0.236	0.327
0.3	0.055	0.079	0.163	0.206	0.285
0.35	0.049	0.070	0.145	0.183	0.254
0.4	0.045	0.064	0.132	0.166	0.230
0.5	0.038	0.054	0.111	0.140	0.194
0.75	0.028	0.040	0.082	0.103	0.143
1	0.022	0.032	0.066	0.083	0.115
1.5	0.017	0.024	0.049	0.062	0.085
2	0.013	0.019	0.039	0.050	0.069
3	0.010	0.014	0.029	0.037	0.051
4	0.0055	0.0079	0.016	0.021	0.028
5	0.0035	0.0051	0.0105	0.0132	0.0182

Table 4.4 Vertical spectra for Mount Messenger Bypass site for Class C Shallow Soil.

	Magnitude-weighted Class C Shallow Soil				
Period T(s)	**50-yrs**	**100-yrs**	**500-yrs**	**1000-yrs**	**2500-yrs**
PGA	0.053	0.076	0.156	0.197	0.272
0.03	0.091	0.130	0.268	0.338	0.468
0.05	0.116	0.166	0.343	0.432	0.599
0.075	0.116	0.166	0.343	0.432	0.599
0.1	0.116	0.166	0.343	0.432	0.599
0.15	0.116	0.166	0.343	0.432	0.599
0.2	0.094	0.134	0.277	0.349	0.483
0.25	0.079	0.113	0.234	0.295	0.408
0.3	0.069	0.099	0.204	0.257	0.356
0.35	0.062	0.088	0.182	0.229	0.317
0.4	0.056	0.080	0.164	0.207	0.287
0.5	0.047	0.067	0.139	0.175	0.243
0.75	0.035	0.050	0.103	0.129	0.179
1	0.028	0.040	0.083	0.104	0.144
1.5	0.021	0.030	0.061	0.077	0.106
2	0.017	0.024	0.049	0.062	0.086
3	0.012	0.018	0.036	0.046	0.063
4	0.0069	0.0099	0.020	0.026	0.036
5	0.0043	0.0065	0.013	0.0166	0.0227

Table 4.5 Vertical spectra for Mount Messenger Bypass site for Class D Deep/Soft Soil.

	Magnitude-weighted Class D Deep/Soft Soil				
Period T(s)	**50-yrs**	**100-yrs**	**500-yrs**	**1000-yrs**	**2500-yrs**
PGA	0.074	0.106	0.218	0.275	0.381
0.03	0.149	0.212	0.438	0.552	0.765
0.05	0.198	0.284	0.585	0.737	1.021
0.075	0.198	0.284	0.585	0.737	1.021
0.1	0.198	0.284	0.585	0.737	1.021
0.15	0.198	0.284	0.585	0.737	1.021
0.2	0.160	0.228	0.471	0.594	0.823
0.25	0.135	0.193	0.399	0.503	0.696
0.3	0.118	0.169	0.348	0.438	0.607
0.35	0.105	0.150	0.310	0.390	0.541
0.4	0.095	0.136	0.280	0.353	0.489
0.5	0.080	0.115	0.237	0.299	0.414
0.75	0.059	0.085	0.175	0.220	0.305
1	0.048	0.068	0.141	0.178	0.246
1.5	0.035	0.050	0.104	0.131	0.181
2	0.028	0.041	0.084	0.106	0.146
3	0.021	0.030	0.062	0.078	0.108
4	0.0118	0.0169	0.035	0.044	0.061
5	0.0076	0.0108	0.0223	0.0281	0.0389

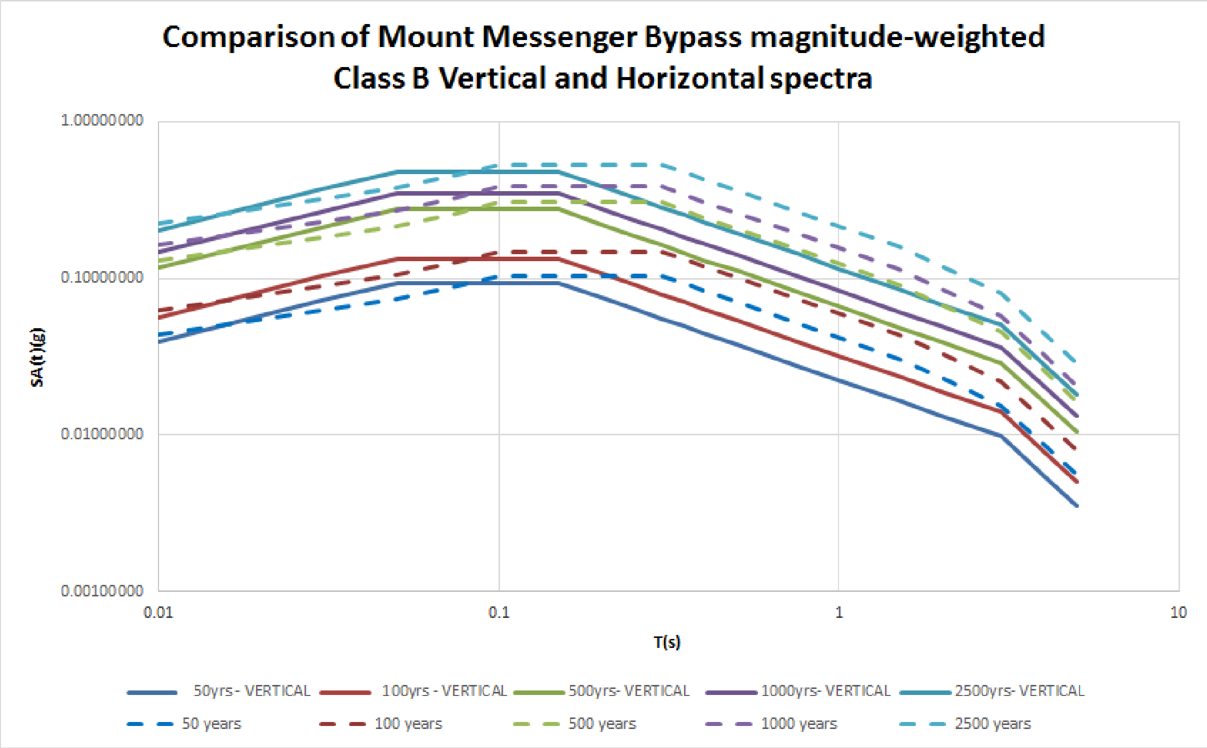

Figure 4.10 Vertical and magnitude-weighted horizontal spectra for Class B Weak Rock.

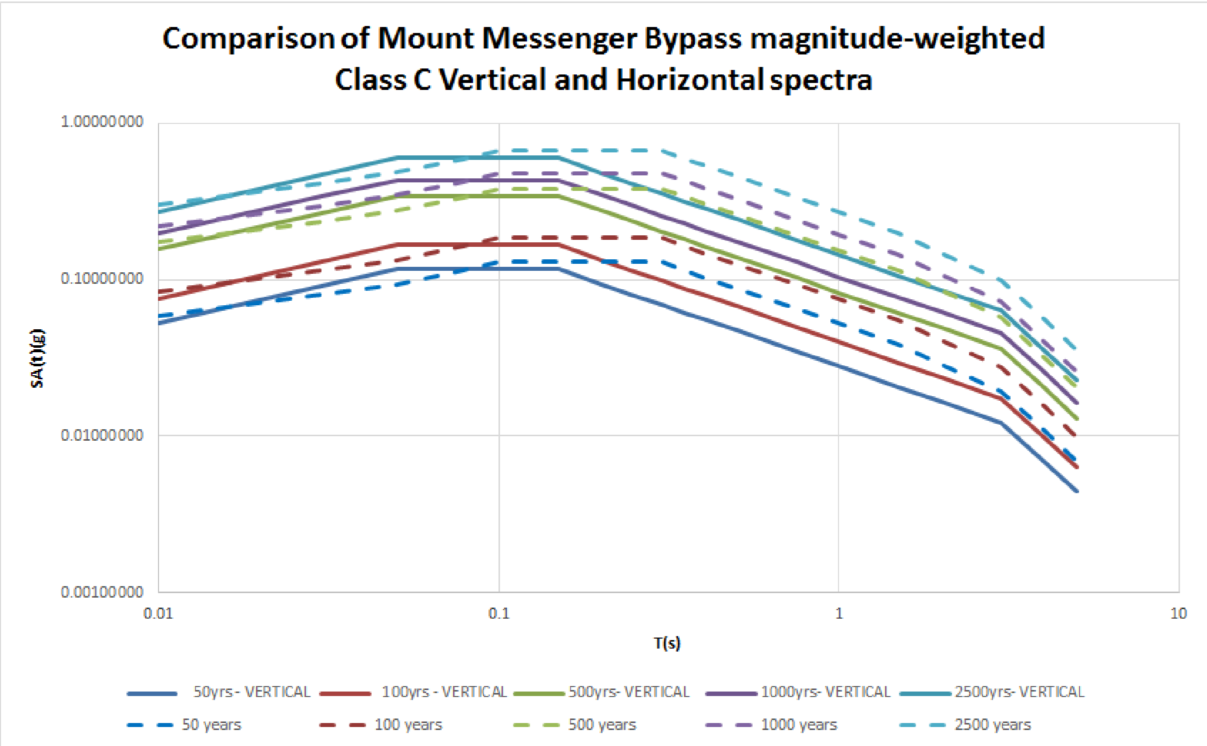

Figure 4.11 Vertical and magnitude-weighted horizontal spectra for Class C Shallow Soil.

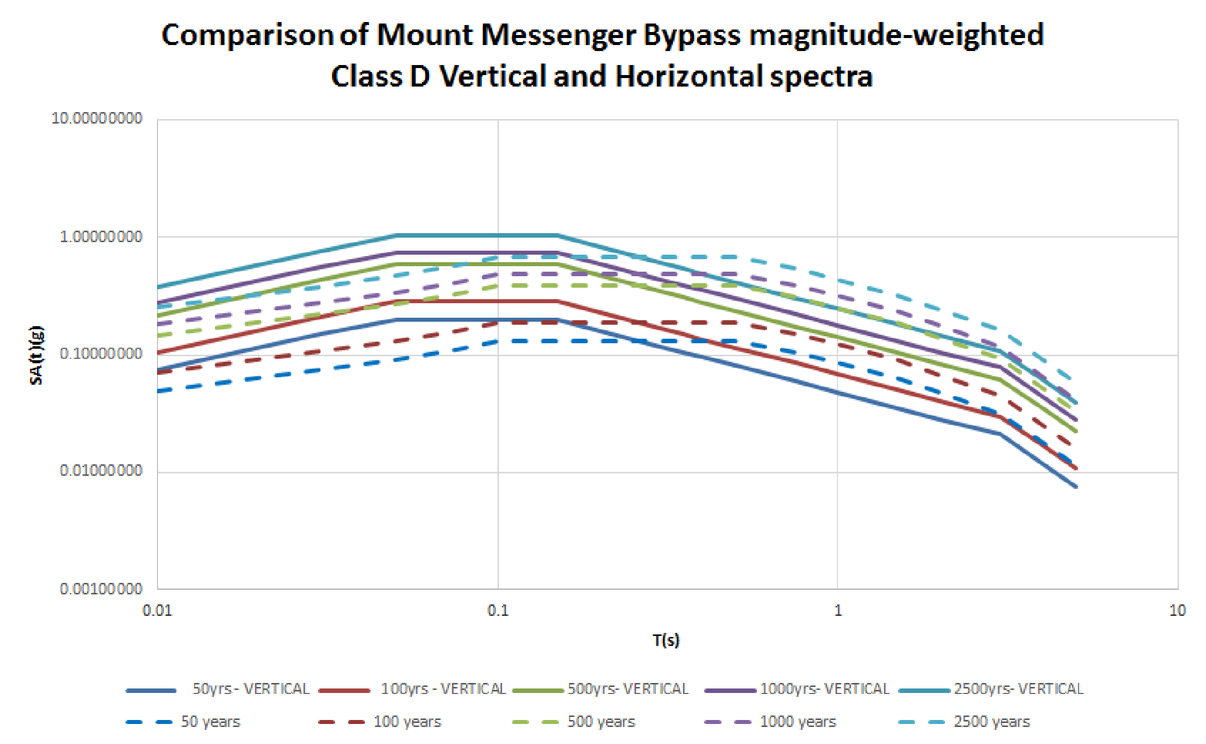

Figure 4.12 Vertical and magnitude-weighted horizontal spectra for Class D Deep/Soft Soil.

4.5 MAGNITUDES ASSOCIATED WITH THE NON-MAGNITUDE-WEIGHTED PGAS

The PGA values without magnitude-weighting, and their associated average magnitudes (described below) are listed by return period in

Table 4.6. The GMPEs used for Classes C and D have nonlinear site response modifications of the rock pgas (i.e., the Class C/Class B and Class D/Class B pga ratios depend on the Class B pga, rather than being a constant multiplier of it). If the soil pgas were simply proportional to the rock pgas, the deaggregations should be the same for all site classes, and the average magnitudes from the deaggregations would be identical. With the nonlinear site response terms, the average magnitudes vary slightly across the site classes. For the results shown in Table 4.6, the variation in average magnitude is no more than the resolution of 0.1 used to report the magnitudes.

Table 4.6 Non magnitude-weighted PGA values and corresponding average magnitudes for the Mount Messenger Bypass for each of the requested return periods.

		Return periods (years)				
		50	100	500	1000	2500
Class B Weak Rock	Non MW PGA(g)	0.060	0.084	0.15	0.20	0.26
	Average magnitude	6.1	6.1	6.2	6.3	6.3

		Return periods (years)				
		50	100	500	1000	2500
Class C Shallow Soil	Non MW PGA(g)	0.077	0.11	0.21	0.26	0.34
	Average magnitude	6.1	6.1	6.2	6.2	6.3

		Return periods (years)				
		50	100	500	1000	2500
Class D Deep/Soft Soil	Non MW PGA(g)	0.085	0.11	0.21	0.26	0.34
	Average magnitude	6.1	6.1	6.3	6.3	6.4

5.0 DEAGGREGATIONS

The non magnitude-weighted deaggregations (i.e. contributions by magnitude and distance groups to the exceedance rates of the spectral accelerations for various return periods) show that at PGA level background seismicity is the largest overall contributor to the hazard at the site. For all return periods, deaggregations at increased spectral periods result in enhanced contributions from the individual fault sources, especially the large magnitude subduction sources at around 200km distance from the site. In the interests of being as concise as possible only Class B (Rock) results are shown here.

Figure 5.1 shows the PGA deaggregation at the 50-year hazard level. Nearly 92% of the overall hazard is contained within the magnitude 5.1-7.1 range which is largely dominated by background seismicity. Active sources in this range include the offshore Turi Central, Turi North and Turi South, but their contributions are minor compared with the distributed seismicity component. Other peaks on the plot in the distant (200km) magnitude 8 range correspond to distant subduction sources, the main contributor being the Hikurangi Wellington Max source. Figure 5.2 shows the 1s SA deaggregation at the 50-year hazard level. A substantial amount of the total contribution to the hazard lies in the magnitude 5.1 to 7.1 range (70%), although this is less than the contribution in this range at PGA level. The contribution of the distant subduction sources is slightly increased to about 16%. Most of the remaining hazard is attributed to sources in the magnitude 7.1-7.5 range which includes the Wellington Pahiatua, the Mohaka South and the Mascarin faults. Figure 5.3 shows the 3s SA deaggregation at the 50-year hazard level. More than 62% of the contribution to the hazard comes from fault sources of magnitude greater than 7.1. More than 18% of the hazard comes from distant subduction sources including the Hikurangi Wellington Max source.

Figure 5.4 shows the PGA deaggregation for the 100-year hazard level. Just over 90% of the hazard is attributed to magnitude 5.1 to 7.1 sources. This includes small contributions from the Turi Central, Turi North and Turi South, however, this is mostly distributed background seismicity. Most of the remaining hazard comes from the distant magnitude 8+ subduction sources including the Hikurangi Wellington Max source. Figure 5.5 shows the 1s SA deaggregation for the 100-year hazard level. The magnitude 5.1 – 7.1 range accounts for 67% of the total hazard. A large proportion of this is accounted for by distributed seismicity. The offshore Turi North accounts for the small spike in the distribution at magnitude 6.8 and 30-50km. The Mohaka South and Wellington Pahiatua contribute to the hazard in the magnitude 7.1-7.5 range. A total of about 22% of the hazard occurs in the magnitude 8.1-8.9 range occupied by the distant subduction sources. Figure 5.6 shows the 3s SA deaggregation for the 100-year hazard level. A total of 41% of the hazard is attributed to sources in the magnitude 5.1 to 7.1 range. About 4% of this is attributed to the Turi North. The Mohaka South and Well Pahiatua contribute to about 8% of the hazard in the magnitude 7.5 bin at between 170-190km. About 27% of the hazard is attributed to sources in the magnitude 8.1 – 8.9 range.

Figure 5.7 shows the PGA deaggregation for the 500-year hazard level. Around 88% of the hazard is attributed to sources in the magnitude 5.1 to 7.1 range. This includes small contributions from the Turi Central, Turi North and Turi South faults. Just over 12% of the hazard is attributed to faults in the magnitude 8.1 to 8.9 range corresponding to the distant subduction sources. Figure 5.8 shows the 1s SA deaggregation. About 63% of the hazard is attributed to sources in the magnitude 5.1 to 7.1 range, the majority of this is due to distributed seismicity. About 34% of the hazard comes from distant sources in the magnitude 8.1 to 8.9 range. Figure 5.9 shows the 3s SA deggregation. About 45% of the hazard is attributed to large, distant sources in the magnitude 8.1 to 8.9 range.

Figure 5.10 shows the PGA deaggregation for the 1000-year hazard level. Around 86% of the total hazard is generated in the magnitude 5.1 to 7.1 range. Most of the remainder of the hazard occurs in the magnitude 8.1 to 8.9 range and is attributed to distant subduction sources. Figure 5.11 shows the 1s SA deaggregation. About 61% of the hazard is attributed to sources in the magnitude 5.1 to 7.1 range. Most of this hazard is generated by distributed seismicity. About 38% of the hazard is attributed to distant subduction sources in the magnitude 8.1 to 8.9 range. Figure 5.12 shows the 3s SA deaggregation. About 32% of the hazard is attributed to sources in the magnitude 5.1 to 7.1 range. Just over 50% of the hazard is attributed to distant subduction sources in the magnitude 8.1 to 8.9 range.

Figure 5.13 shows the PGA deaggregation for the 2500-year hazard level. Nearly 86% of the hazard is attributed to sources in the magnitude 5.1 to 7.1 range. Most of the rest of the hazard is attributed to distant subduction sources in the magnitude 8.1 to 8.9 range. Figure 5.14 shows the 1s SA deaggregation for the 2500-year level. Just over 60% of the hazard is attributed to sources in the magnitude 5.1 to 7.1 range. Most of the remaining hazard is attributed to sources in the magnitude 8.1 to 8.9 range. Figure 5.15 shows the 3s SA deaggregation. About 32% of the hazard is attributed to sources in the magnitude 5.1 to 7.1 range. About 58% of the hazard is attributed to distant subduction sources in the magnitude 8.1 to 8.9 range.

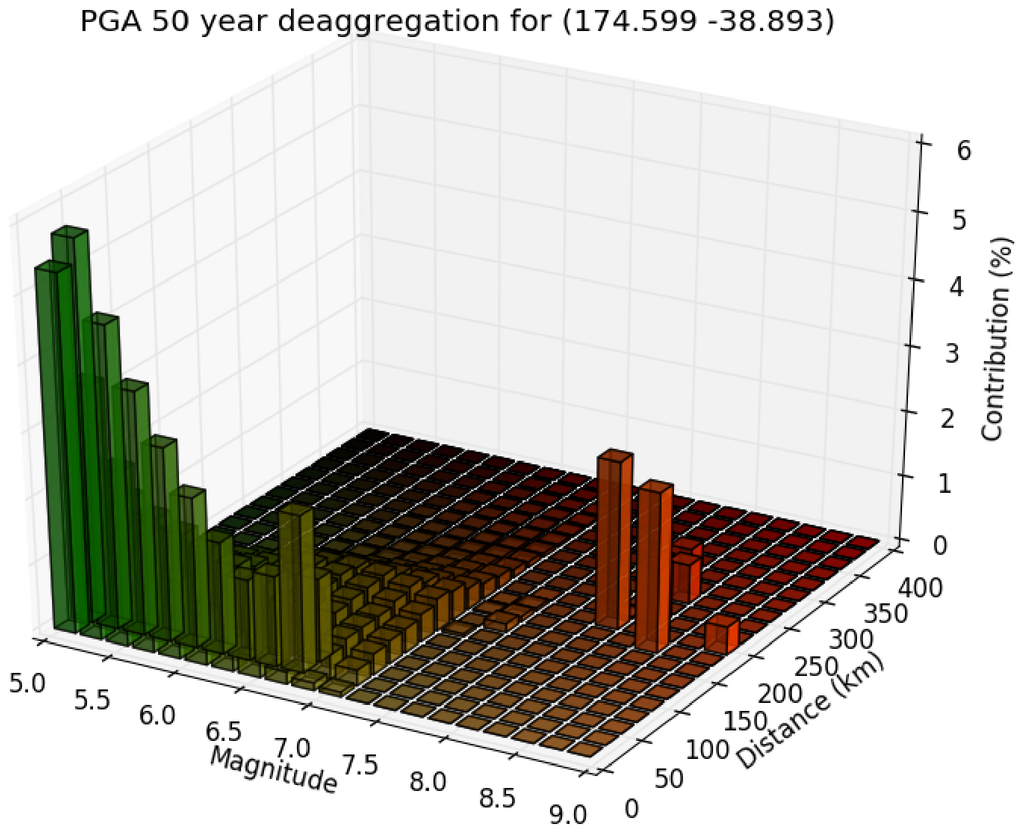

Figure 5.1 Non magnitude-weighted Class B (Weak rock) 50-year PGA deaggregation.

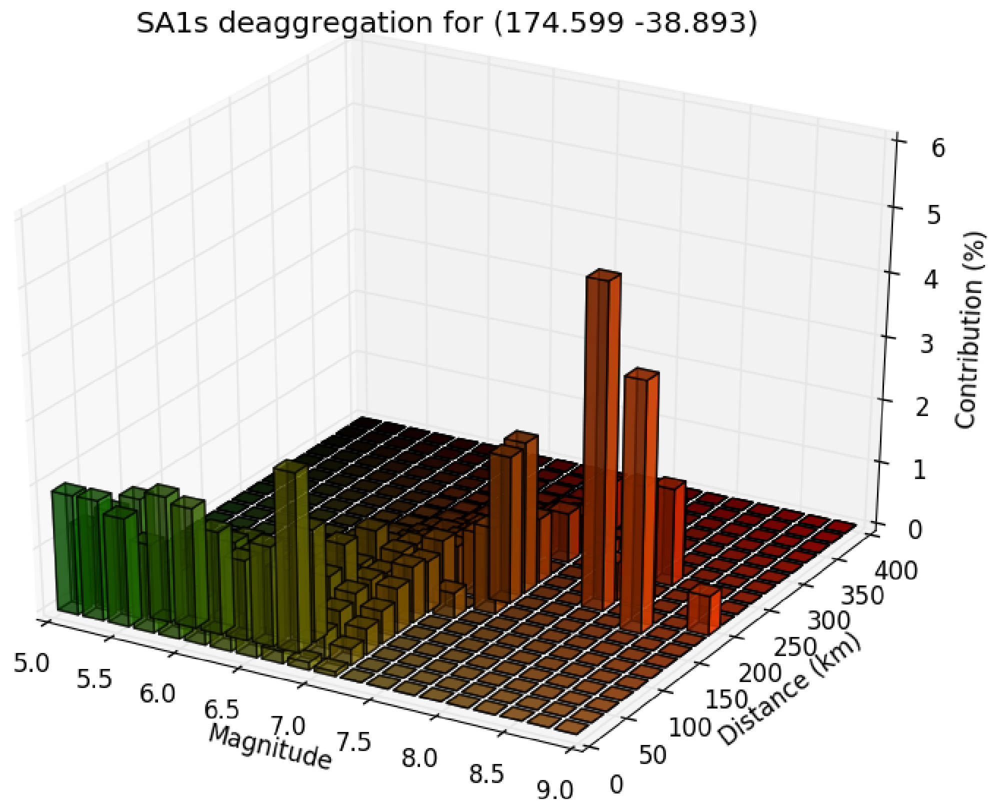

Figure 5.2 Non magnitude-weighted Class B (Weak rock) 50-year SA (1.0s) deaggregation.

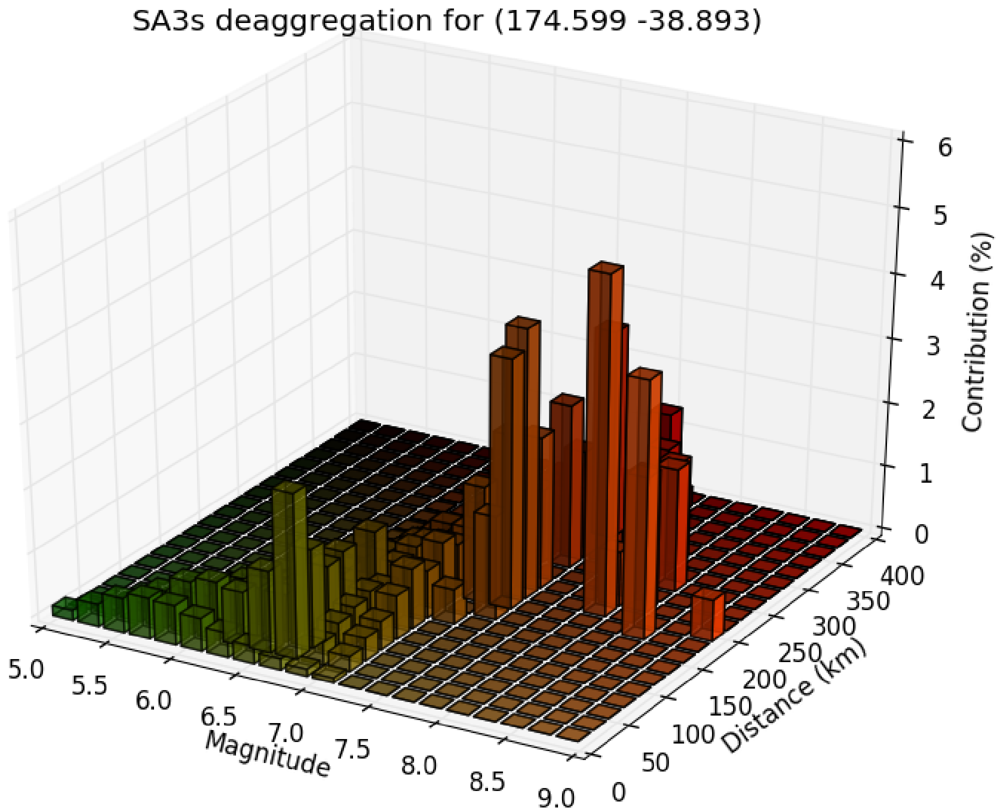

Figure 5.3 Non magnitude-weighted Class B (Weak rock) 50-year SA (3.0s) deaggregation.

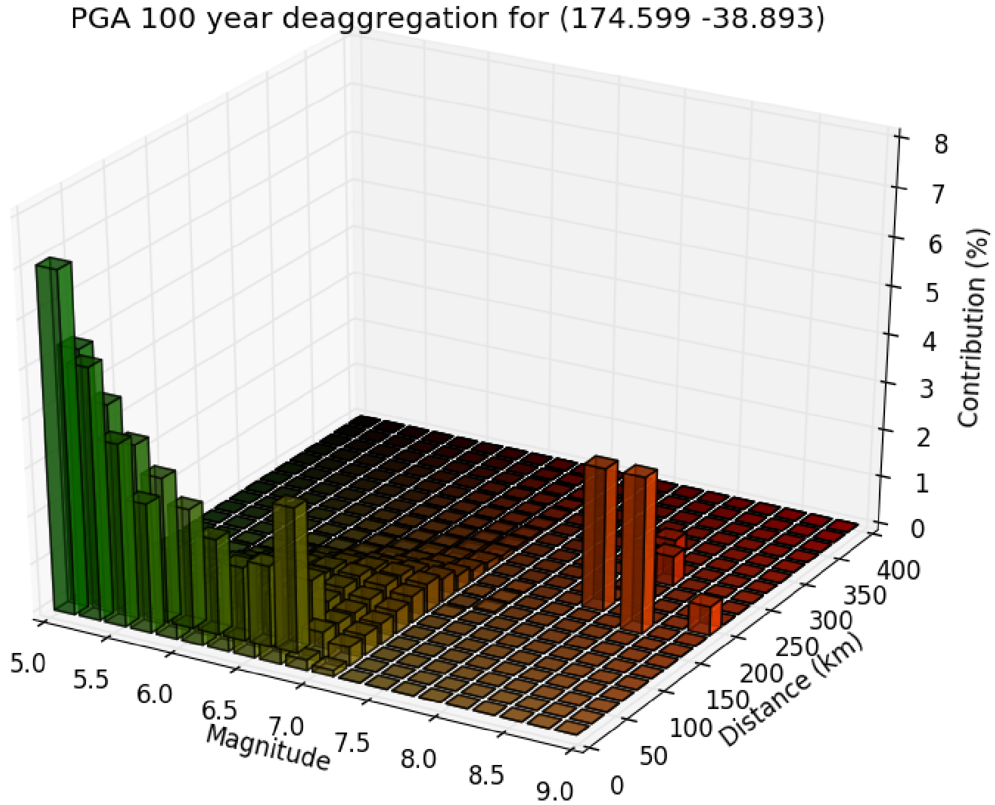

Figure 5.4 Non magnitude-weighted Class B (Weak rock) 100-year PGA deaggregation.

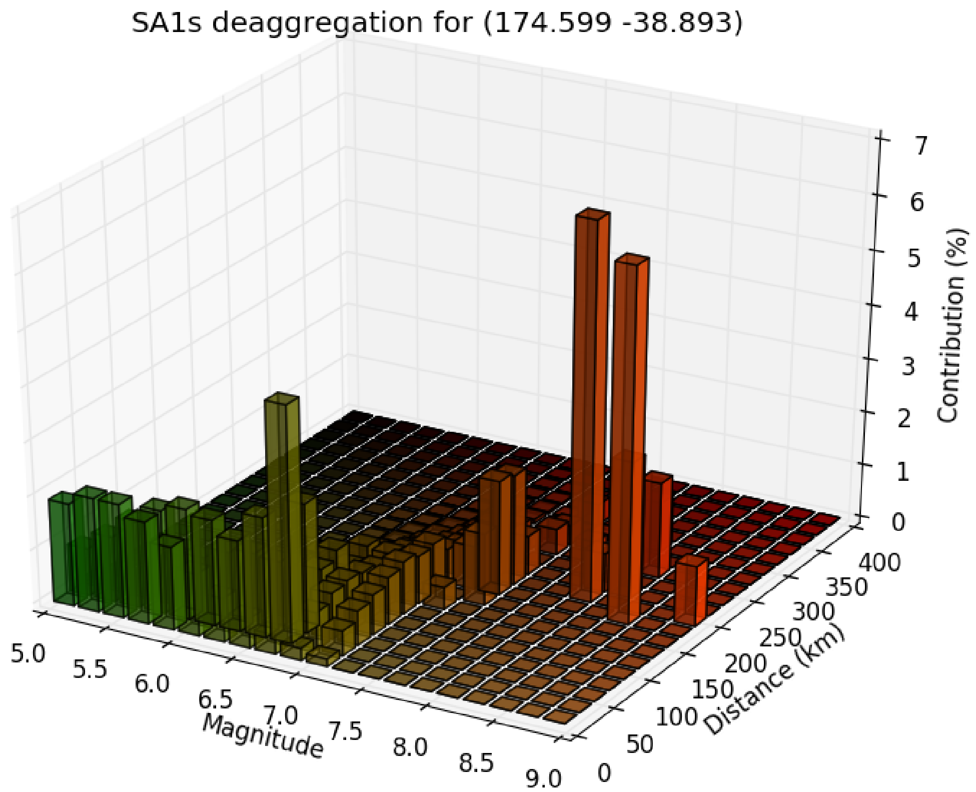

Figure 5.5 Non magnitude-weighted Class B (Weak rock) 100-year SA (1s) deaggregation.

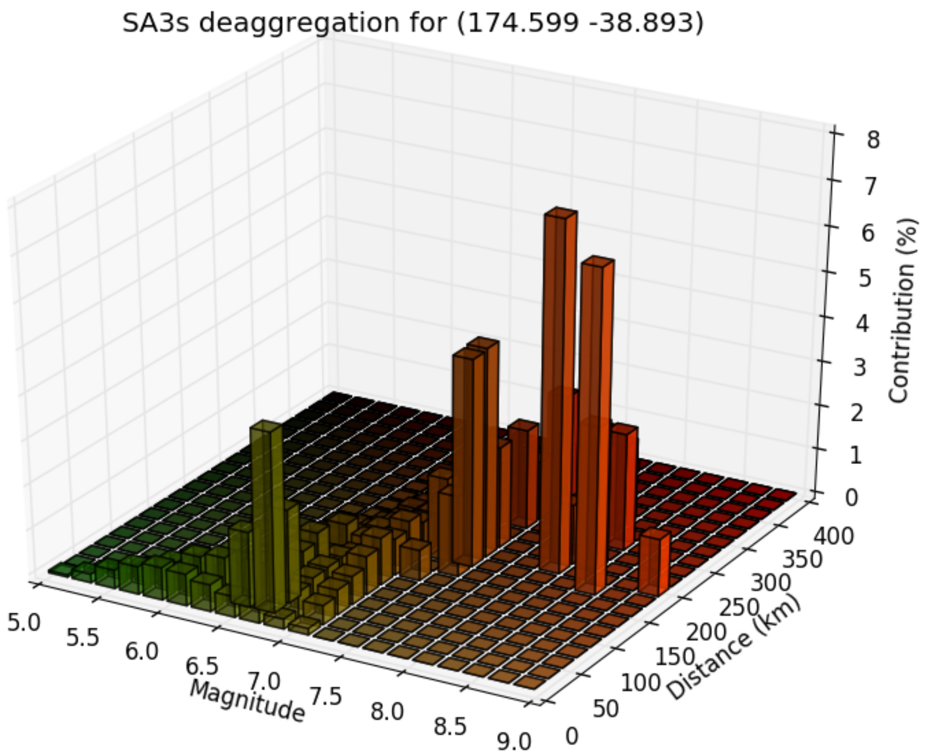

Figure 5.6 Non magnitude-weighted Class B (Weak rock) 100-year SA (3.0s) deaggregation.

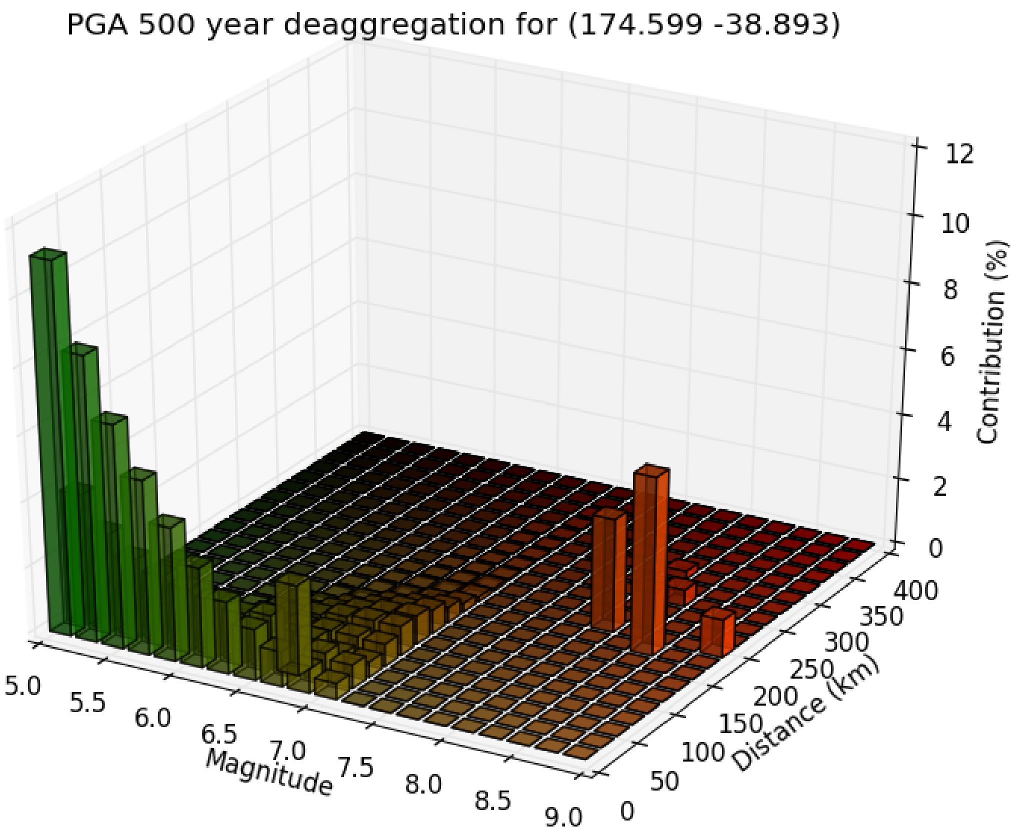

Figure 5.7 Non magnitude-weighted Class B (Weak rock) 500-year PGA deaggregation.

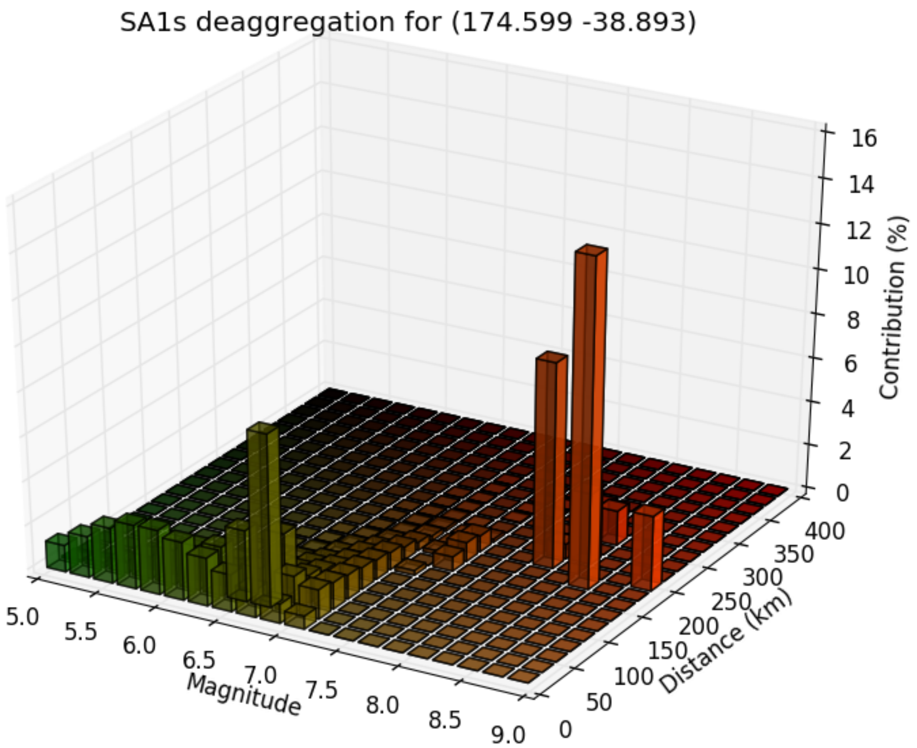

Figure 5.8 Non magnitude-weighted Class B (Weak rock) 500-year SA (1s) deaggregation.

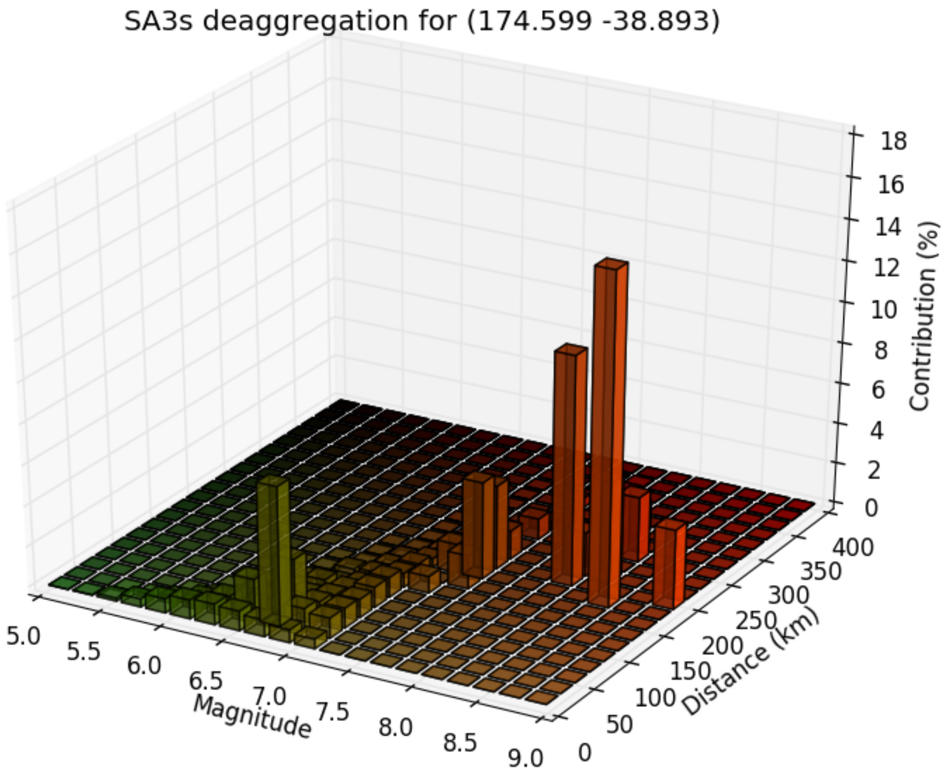

Figure 5.9 Non magnitude-weighted Class B (Weak rock) 500-year SA (3s) deaggregation.

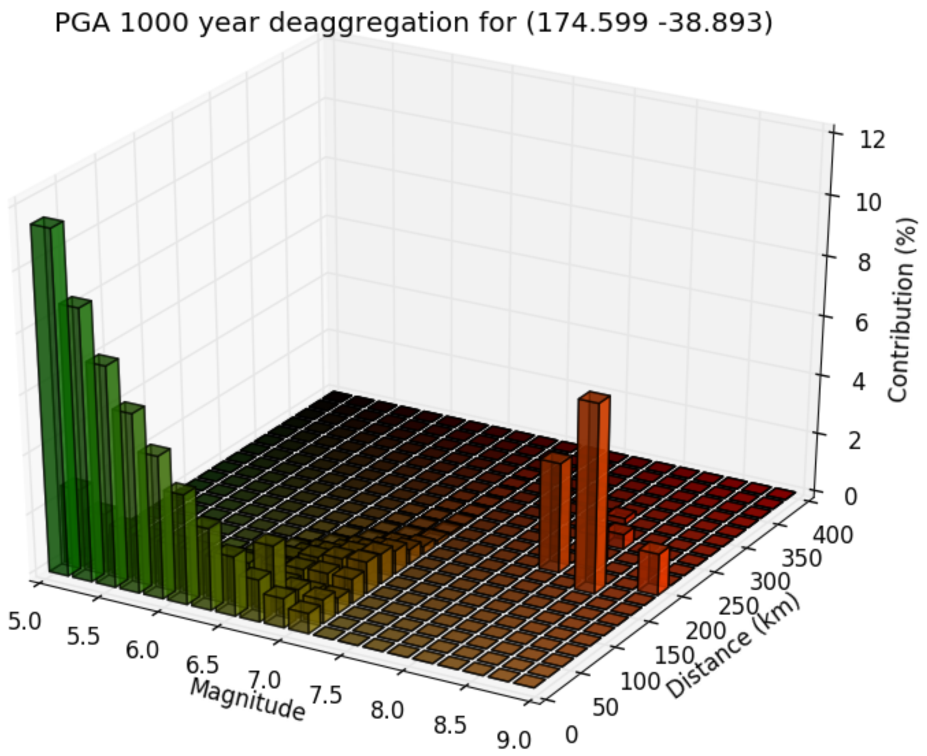

Figure 5.10 Non magnitude-weighted Class B (Weak rock) 1000-year PGA deaggregation.

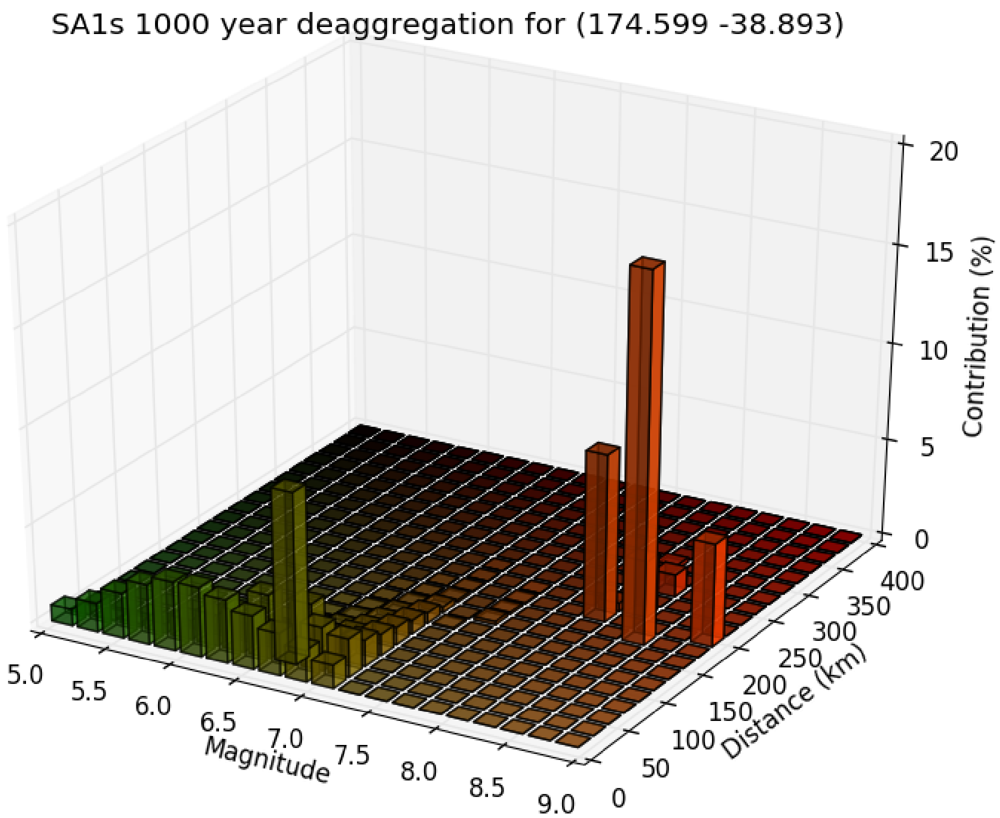

Figure 5.11 Non magnitude-weighted Class B (Weak rock) 1000-year 1s SA deaggregation.

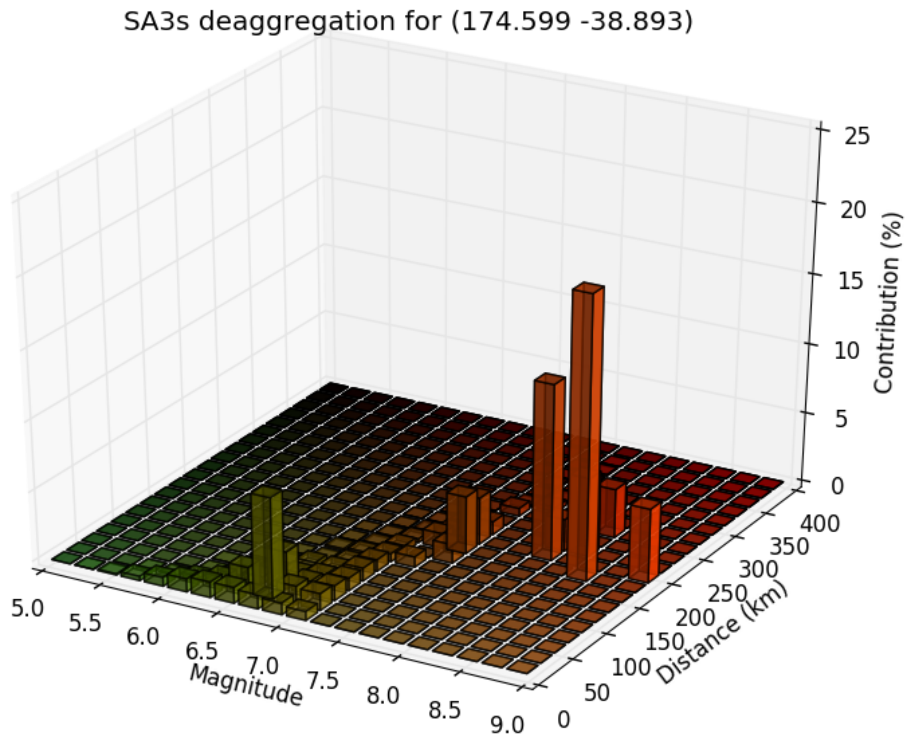

Figure 5.12 Non magnitude-weighted Class B (Weak rock) 1000-year 3s SA deaggregation.

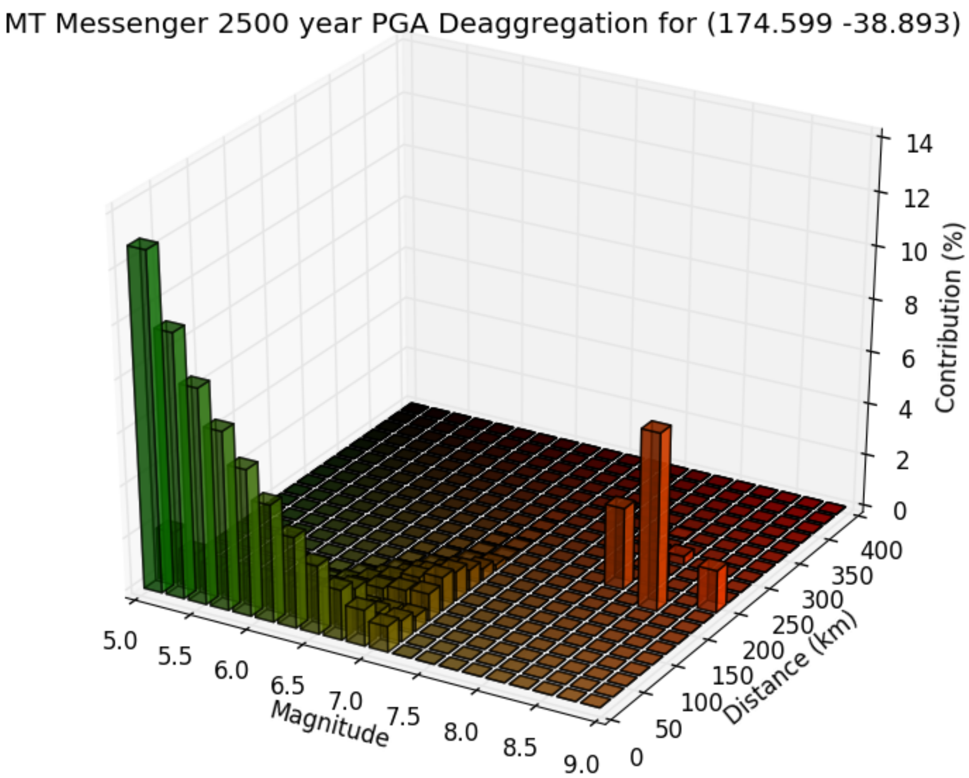

Figure 5.13 Non magnitude-weighted Class B (Weak rock) 2500-year PGA deaggregation.

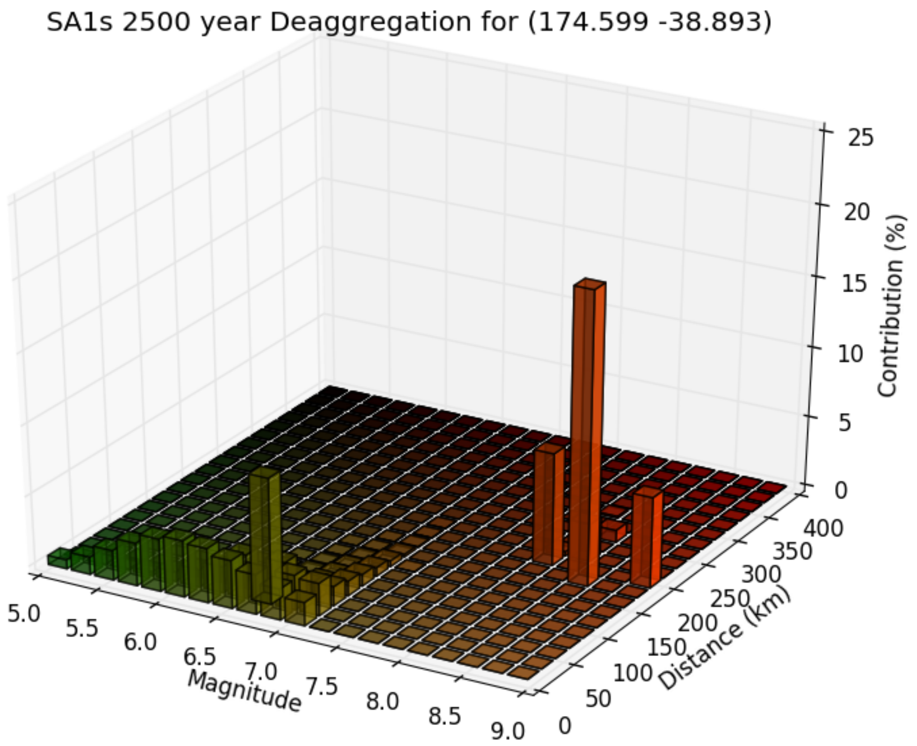

Figure 5.14 Non magnitude-weighted Class B (Weak rock) 2500-year 1s SA deaggregation.

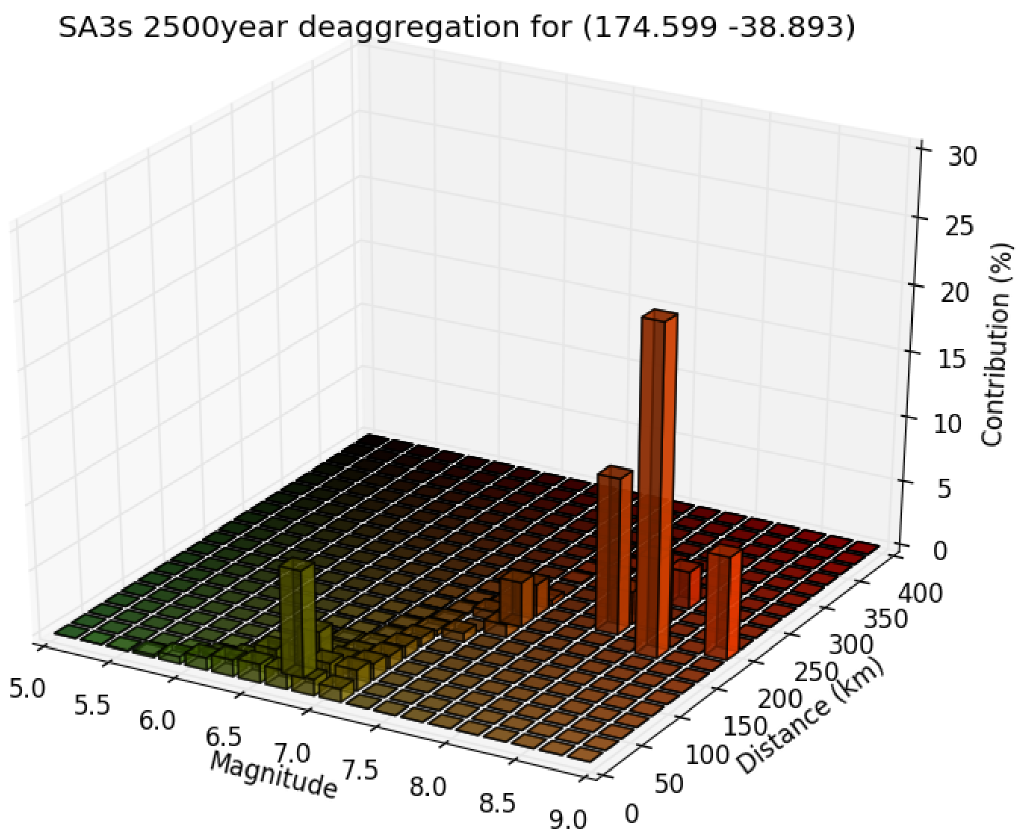

Figure 5.15 Non magnitude-weighted Class B (Weak rock) 2500-year 3s SA deaggregation.

5.1 DOMINANT EPSILON VALUE

The client requested that GNS provide information concerning the dominant epsilon values associated with the deaggregation information. Epsilon is a measure of how many standard deviations an acceleration value is from the median value expected at the site from a given event. The accelerations increase with return period, so the epsilons increase with return period for a given magnitude and distance. This increase of epsilon with return period is not very obvious from the values listed in Table 5.1, because epsilon has been reported in broad classes of 1.2 width. The probabilities of exceedance of the median acceleration value vary by a large amount across a single epsilon class. For example, the probabilities of exceedance of epsilon values of -0.6, 0.6, 1.8 and 3.0 are 73%, 27%, 3.6% and 0.13% respectively. Thus, large reductions in the probability of exceedance of the acceleration associated with the return period as the return period increase may still lie within the same epsilon class. For example, the probability of exceedance decreases by a factor of 7.5 within the 0.6 to 1.2 epsilon class. This factor is over 200 going from the 0.6 lower boundary of the 0.6-1.8 box to the upper bound of 3.0 for the next higher epsilon class of 1.8-3.0.

Table 5.1 lists the dominant epsilon values arising from the study.

Table 5.1 Dominant epsilon values arising from the study (non magnitude-weighted Class B Weak Rock).

	50-year		
	Magnitude (Mw)	**Distance(km)**	**Epsilon range**
PGA	5.1	30	0.6-1.8
1s SA	8.1	190	-0.6-0.6
3s SA	7.5	190	0.6-1.8
	100-year		
	Magnitude(Mw)	**Distance(km)**	**Epsilon range**
PGA	5.1	30	0.6-1.8
1s SA	8.1	190	0.6-1.8
3s SA	8.1	190	0.6-1.8
	500-year		
	Magnitude(Mw)	**Distance(km)**	**Epsilon range**
PGA	5.1	10	0.6-1.8
1s SA	8.5	170	0.6-1.8
3s SA	8.5	170	0.6-1.8
	1000-year		
	Magnitude(Mw)	**Distance(km)**	**Epsilon range**
PGA	5.1	10	0.6-1.8
1s SA	8.5	170	0.6-1.8
3s SA	8.5	170	0.6-1.8
	2500-year		
	Magnitude(Mw)	**Distance(km)**	**Epsilon range**
PGA	5.1	10	1.8-3.0
1s SA	8.5	170	1.8-3.0
3s SA	8.5	170	0.6-1.8

5.2 COMPARISON WITH SCENARIO SPECTRA

The deaggregation analysis confirms that this is a low seismicity site. At the PGA level, distributed seismicity dominates at all return periods. At longer periods the distant but large magnitude Hikurangi subduction zone sources provide significant contributions to the hazard. Median (50-percentile) and 84-percentile scenario spectra for the Hikurangi Wellington Max fault source has been modelled and shown in comparison to the hazard spectra in Figure 5.16.

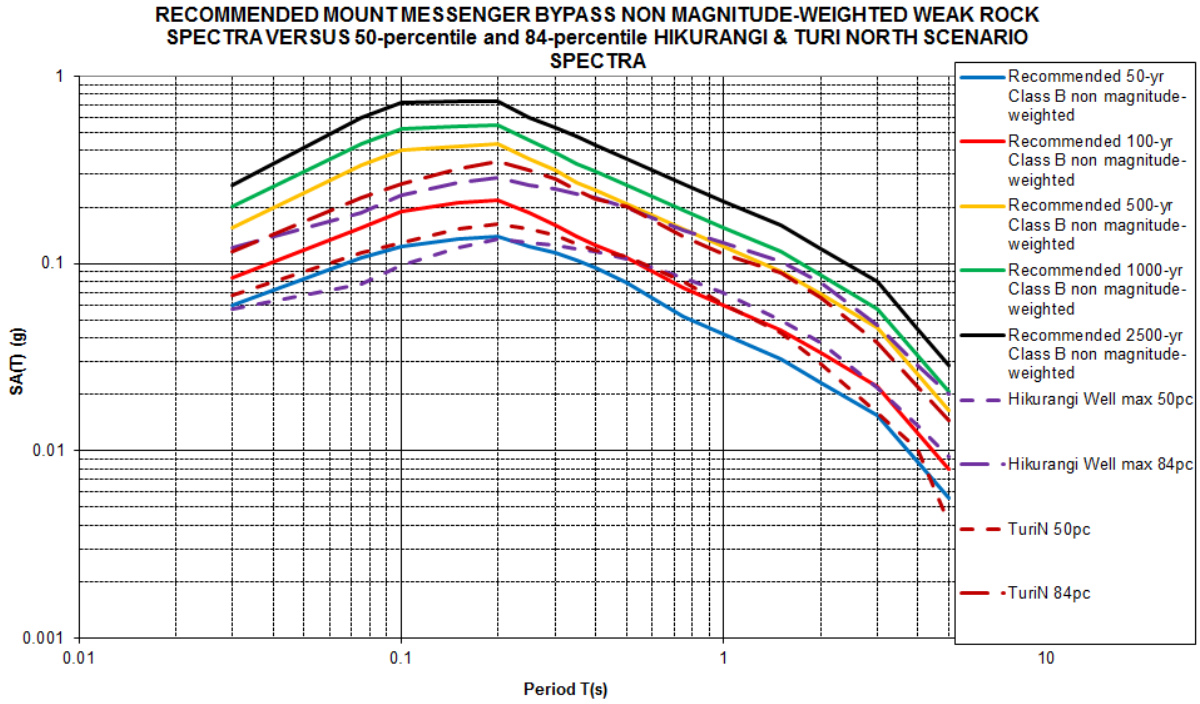

Figure 5.16 The recommended non magnitude-weighted, 5% damped larger horizontal component acceleration response spectra SA(T) for periods T up to 5s for the Mount Messenger Bypass compared to the scenario spectra for the Hikurangi Wellington max and the Turi North for site Class B Weak Rock.

Figure 5.16 shows that for the Hikurangi subduction source, the 50-percetile scenario spectrum is slightly below the 50-year hazard spectrum at short periods but at periods of 0.5s and longer it is similar to the 100-year hazard spectrum. The 84-percentile scenario spectrum is similar to the 500-year hazard spectrum at periods beyond 0.5s. The smaller, but closer, Turi North source produces larger short period accelerations than the Hikurangi but falls below the Hikurangi at longer periods.

6.0 COMPARISON WITH AWAKINO TUNNEL STUDY

GNS previously undertook a study on the Awakino Tunnel site (Goded et al, 2017) although this study used the Bradley and McVerry GMPEs only and only considered the 500-year, 1000-year and 2500-year return periods. The Mount Messenger Bypass site has a higher modelled seismicity although both locations are of low enough seismicity for them to be affected by the minimum bound levels arising from the NZ Bridge Manual (NZTA, 2016). Figure 6.1 shows the Weak Rock hazard spectra for both sites before the consideration of the Bridge Manual lower bounds on seismicity, with solid curves for the Mount Messenger spectra and dashed curves for the Awakino spectra. Only the 500-, 1000- and 2500-year spectra were provided for the Awakino study.

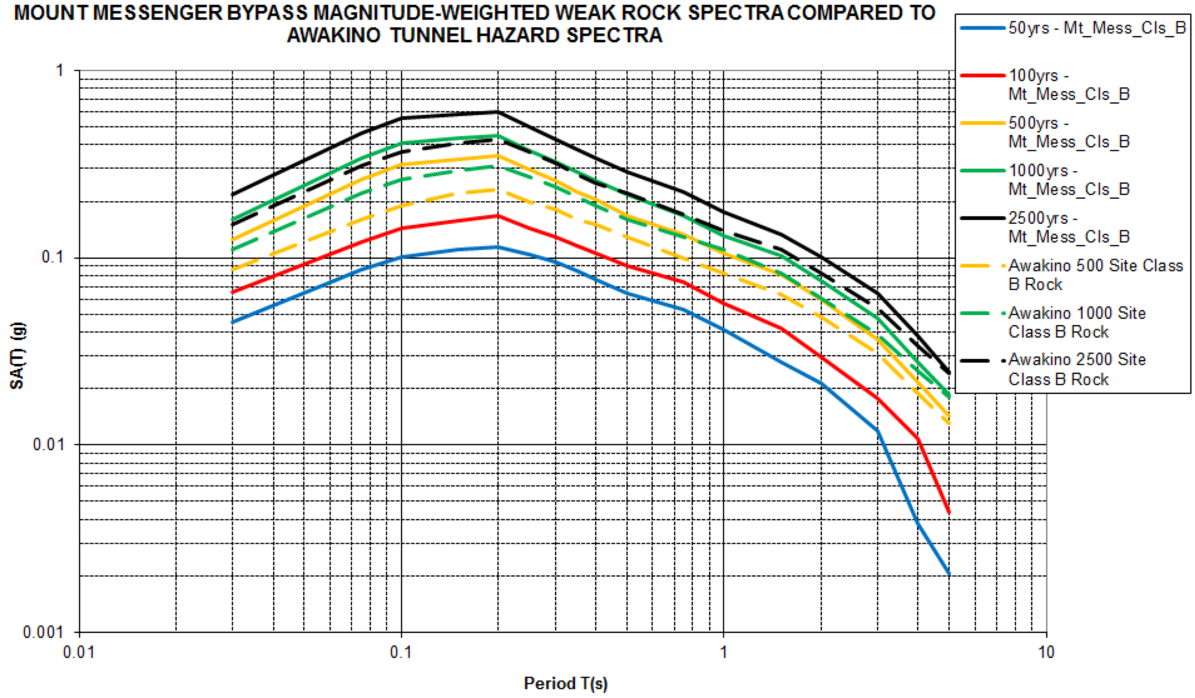

Figure 6.1 Comparison of the Mount Messenger Bypass site (solid) and the Awakino Tunnel site (dashed) hazard spectra before the consideration of the lower bound seismicity requirements of the Bridge Manual.

7.0 CONCLUSIONS

- A seismic hazard assessment has been carried out for the site of the proposed Mount Messenger Bypass site, for return periods of 50, 100, 500, 1000 and 2500 years, as requested by the client.
- The analysis has been carried out using a weighted combination of the McVerry et al. (2006), and Bradley (2014) GMPEs for crustal earthquakes, and the McVerry et al., Zhao et al (2006) and Abrahamson et al (2015) GMPEs for subduction zone earthquakes.
- Deaggregation analysis shows that the Mount Messenger Bypass site is in a low seismicity region with background seismicity accounting for much of the hazard at low spectral periods. At higher spectral periods, large magnitude earthquakes from distant subduction interface sources make a contribution to the overall hazard.
- Scenario spectra for the Hikurangi subduction interface and Turi North sources were compared in relation to the hazard spectra.
- The magnitude-weighted and non-magnitude-weighted horizontal PGAs and spectra for the return periods of interest have been produced up to 5s spectral period.
- The average magnitudes associated with the non-magnitude-weighted PGAs have been provided.
- The recommended horizontal spectra have been modified to take into account requirements of the NZTA Bridge Manual around the maximum allowed divergence from the NZS1170 code spectra and the maximum truncation allowed of the spectral peaks. In the magnitude-weighted cases, the 70% NZS1170 spectra supersede the modelled hazard spectra at all return periods. In the non-magnitude-weighted cases, the recommended spectra are a combination of the hazard spectra at short periods and the 70% NZS1170 code spectra at longer periods.
- Near-fault factors have not been evaluated as the site is not located within 20km of a fault requiring this analysis according to NZS1170.5 (Standards New Zealand, 2004).
- Vertical spectra developed from the recommended horizontal hazard spectra have been developed.
- An assessment of the dominant epsilon values for each return period has been undertaken.

8.0 ACKNOWLEDGEMENTS

The author would like to thank Elizabeth Abbott and Dr. Tatiana Goded for providing very useful comments during the review of this report.

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Appendix B: Opus bat reports

- Opus (2017a). Mount Messenger Bypass Investigation. Bat Baseline Survey and Preliminary Assessment of Effects, April 2017.
- Opus (2017b). Mount Messenger Bypass: Option MC23 - Bat Survey Addendum, Memo dated 25 July 2017.

NZ Transport Agency

Mt Messenger Bypass Investigation

Bat Baseline Survey and Preliminary Assessment of Effects

April 2017

NZ Transport Agency

Mt Messenger Bypass Investigation

Bat Baseline Survey and Preliminary Assessment of Effects

April 2017

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Date: 28/4/2017
Reference: 5-C3195.03
Status: Final

Contents

1 Introduction

The New Zealand Transport Agency (Transport Agency) is undertaking investigations into improvements to the Mount Messenger section of SH3, the key transport link between Taranaki and the Waikato regions. The existing alignment has been identified as substandard. Following the determination of MC23 as the preferred route alignment, Opus International Consultants Ltd has been commissioned to undertake comprehensive ecological surveys and assessments of effects on terrestrial and aquatic ecosystems. The work includes specialist investigations covering the following:

- Vegetation;
- Birds;
- Bats;
- Lizards;
- Terrestrial invertebrates; and,
- Aquatic ecology.

Each area of investigation is led by a recognised specialist in the field. This report details the results of long-tailed and short-tailed bat monitoring that has been undertaken along the MC23 alignment corridor. It provides:

- The results of the monitoring using ABM's (Automatic Bat Monitors) deployed along the MC23;
- An assessment of the value of the affected habitat for bats;
- An indication of the likely actual and potential effects of constructing and operating the road along the MC23 alignment;
- Preliminary recommendations on measures to avoid, remedy or mitigate adverse effects; and
- Preliminary comment on the expected values of the MC71 corridor for bats based on the survey results for MC23.

The alignment of MC23 is shown in Map 1.

There are two species of native bat in New Zealand, the long-tailed bat (*Chalinolobus tuberculatus*) and the lesser short-tailed bat (*Mystacina tuberculata*). There are two sub-species of long-tailed bats and three sub-species of short-tailed bats. The sub-species occurring in the Taranaki area are the Central lesser short-tailed bat (*Mystacina tuberculata rhyacobia*) and the North Island long-tailed bat (*Chalinolobus tuberculatus* "North Island"), although the latter is classified as taxonomically indeterminate. Both sub-species are classified as Nationally Vulnerable.

Lesser short-tailed bats are dependent on large tracts of old growth native forest and the Project area overlaps with the known national distribution of the short-tailed bat. Therefore, both short-tailed and long-tailed bats were a focus of this survey. Long-tailed bats are edge specialists and utilise both exotic and native tree stands. There are also records of long-tailed bats in the nearby forest, including two records (1988 and 1990) within 400m of the Project area. While those records were of 'unidentified' species, the habitats in which they were observed indicated that they were long-tailed bats. Despite the age of those records, bats are still likely to be present in the Project area. Given the very large home ranges of long-tailed bats (upwards of 100km^2, O'Donnell 2001), it

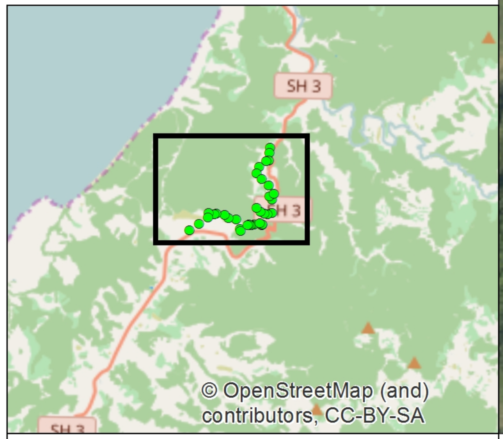
Legend

- Bat Monitors
- Road Design

Aerial Photography

0.1 m Hamilton City Aerial Imagery

0.5 m Waikato Regional Aerial Imagery



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Project No: 2-31695.00

Map 1
Location of bat ABMs within MC23 alignment

0 0.5 1
Kilometres

N

1:15,000 @A3

Projection:
NZGD 2000 New Zealand Transverse Mercator

| Date: 2/05/2017 | Revision: 1 |

is possible that long-tailed bats forage around the Project site and use native podocarps and exotic conifers and pines in the area as roosting habitat.

2 Methods

2.1 Survey method

A total of 35 Automated Bat Monitors (ABMs) were deployed throughout the designation in habitat which may be used by long-tailed and short-tailed bats, to determine if they are present (Map 1). At least thirteen of the 35 ABMs were placed within habitat suitable for short-tailed bats. ABMs operate remotely by recording and storing echolocation bat pass information with a date and time 'stamp' onto a 4GB SanDisk card for later processing and analysis. The ABMs were deployed for between 11 and 29 nights in January/February 2017, with minimum nightly temperatures above 10°C and with little or no precipitation during the first two hours after sunset. The ABMs were set to record from half an hour before sunset until half an hour after sunrise. A valid night of recording was defined as exhibiting a minimum temperature above 10°C and with little precipitation in the first two hours after sunset.

Data were analysed and summarised in terms of:

- Distribution of bat activity along the alignment; and
- Levels of bat activity at each site.

The monitors were secured onto mature exotic and native trees in open edge habitats and within the forest interior which may be used by roosting or foraging bats (if present in the Project area). They were positioned in trees at heights of between 1 to 5m where there is minimal obstruction from branches where possible. ABMs were separated by at least 40m to maximise the possibility that each detector will monitor bats independently. It was proposed that if short-tailed bats were confirmed as present within the alignment, all large diameter (>80 cm diameter at breast height) trees would be inspected for signs of roosting.

2.2 Site Selection

Long-tailed bats tend to use linear habitat features such as roads, forest edges, rivers and gullies when commuting between roosts and foraging sites, as such it was necessary to monitor for bats in areas with these habitat features as well as potential roosting areas. Sites offering the highest potential for bat habitat were approximately located remotely using high-resolution aerial imagery and then refined based on direct visual observations during a site walkover. Sites for the ABMs were chosen to ensure maximum coverage of the Project area in habitat edges, isolated trees in pasture areas, and potential 'flyway' (i.e., commuting route) and foraging areas. Long-tailed bat habitat preferences are such that they are likely to roost within old, large trees which are predominantly on higher ground (ridges and upper slopes) within the main forest. They are likely to emerge around dusk and fly above the main forest and down towards scrub, pasture and stream/wetland foraging areas further down the valleys either side of the main forest area of the alignment. ABM sites were generally located on or near the alignment and included upper areas near the main forest margin through to likely foraging sites lower down near the existing road.

Short-tailed bats inhabit the forest interior and detectors placed within sites of continuous indigenous forest were used to detect short-tailed bats as shown in Map 1. Difficult topography meant safest access was available via pest control tracks along ridges and transects were created along these tracks. Representative areas for short tailed bats were captured through two transects of detectors across the alignment within the forest interior. Transects included areas outside the alignment as a control for short-tailed bat detection.

2.3 Data Processing

Recorded sound files from the ABMs were processed using the latest version of BatSearch software (Department of Conservation, Wellington). Bat echolocation passes can be clearly distinguished from noise files (e.g. wind, rain, insect noise), which were disregarded. Total number of bat passes, along with time and date of recording was noted, as was any activity indicative of feeding or roosting.

2.4 Data Analysis

Data extracted from the BatSearch software processing was analysed, summarised and interpreted to provide assessments of:

- Presence/absence of long-tailed bats in the Project area;
- Distribution of bat activity in the Project area;
- Levels of activity at each site (if activity is detected); and
- Whether any activity is indicative of roosting.

3 Results

A total of 109,228 recordings were made by the ABMs during the survey period. However, the vast majority (>93%) of these recordings were not long-tailed bat passes (n=101,764), and none were short-tailed bats. 7464 recordings were assigned as long-tailed bat passes using the DOC BatSearch3 software.

Levels of long-tailed bat activity at sites along the alignment are shown in Table 1. Maps of ABM locations and recorded bat activity are shown in Appendix 1.

Table 1: Long-tailed bat activity at ABM sites along the alignment

Site	Valid Survey Nights	Survey nights with bat activity	Total Bat Passes	Mean bat passes/night*
1	28	24	433	15.46
2	27	21	92	3.41
3	25	20	1652	66.08
4	25	22	2907	116.28
5	11	5	9	0.82
6	26	5	5	0.19
7	23	13	85	3.70
8	25	3	6	0.24

9	26	1	2	0.08
10	26	13	37	1.42
11	22	6	12	0.55
12	23	2	3	0.13
13	17	1	3	0.18
14	23	4	6	0.26
15	18	6	17	0.94
16	25	10	53	2.12
17	20	8	12	0.60
18	18	6	6	0.33
19	24	7	12	0.50
20	23	17	138	6.00
21	23	1	1	0.04
22	26	13	43	1.65
23	28	19	80	2.86
24	26	15	31	1.19
25	13	4	12	0.92
26	27	21	214	7.93
27	28	20	120	4.29
28	28	18	156	5.57
29	24	19	665	27.71
30	24	0	0	0.00
31	23	4	5	0.22
32	25	2	3	0.12
33	25	13	36	1.44
34	25	4	6	0.24
35	23	12	17	0.74

*mean calculated from valid nights of activity.

Bat activity was generally concentrated around the southern ridge area within the main forest (sites 1, 26, 27, 28, and 29), and two sites within the pine forest adjacent to the main forest (sites 3 and 4) (Appendix 1). One other site further down in the southern farmland at a scrub margin recorded relatively moderate activity (site 20). All other sites recorded relatively low activity of below 4 mean passes per night.

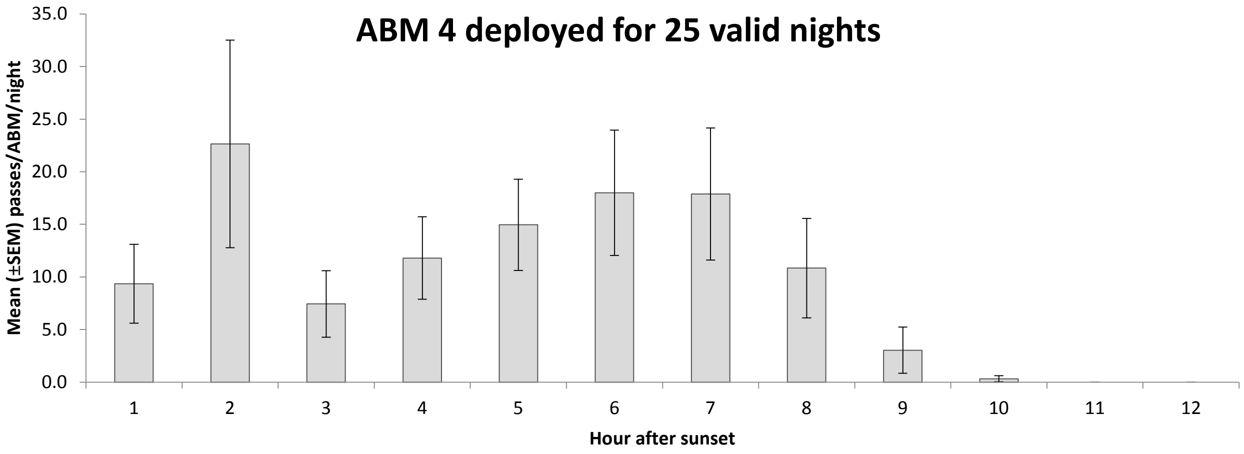

Figure 1. Mean bat activity at site 4 by hour after sunset.

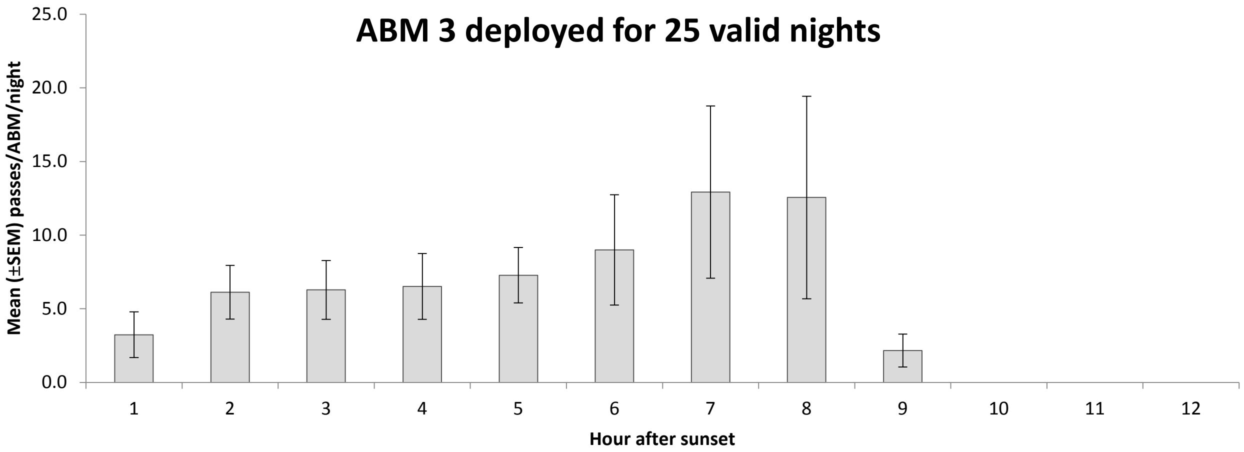

Figure 2. Mean bat activity at site 3 by hour after sunset.

The highest bat activity by far was recorded at site 4, followed by site 3, recording 116 and 66 passes/night respectively. Site 3 was located on the edge of the alignment where a row of large gum trees forms a canopy with an adjacent pine plantation, creating an open flyway beneath. Site 4 was located in a single gum tree located at the edge of the same pine plantation, overlooking a gully.

Figures 1 and 2 show bat activity for every hour after sunset was relatively consistent for both sites. Site 4 showed peak activity 2 hours after sunset, with a decline to 3 hours and a constant increase to 6-7 hours after sunset. Activity then drops off at 8-10 hours after sunset.

At site 3 (Figure 2), peak activity occurred between 7-8 hours after sunset, with lower levels of activity occurring before and after this window.

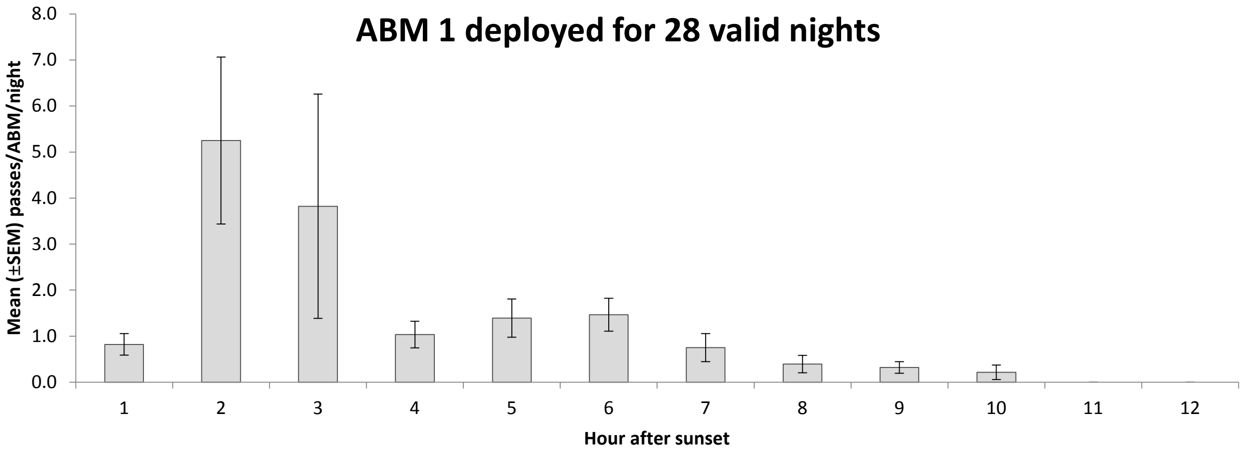

Figure 3. Mean bat activity at site 1 by hour after sunset.

Site 1 was located within the forest interior, overlooking a steep gully to the north. The data shows a spike in activity 2-3 hours after sunset, with a decline until 10 hours after sunset (Figure 3). The pattern of activity exhibited at Sites 1 is considered to be relatively normal for edge-adapted species such as long-tailed bats (O'Donnell 2010). However, it does not specifically indicate that bat roosts are present in the area. Patterns of activity around roosts are not yet fully characterised for New Zealand, however detection of bat calls within this landscape indicates that roosts may be present in the vicinity.

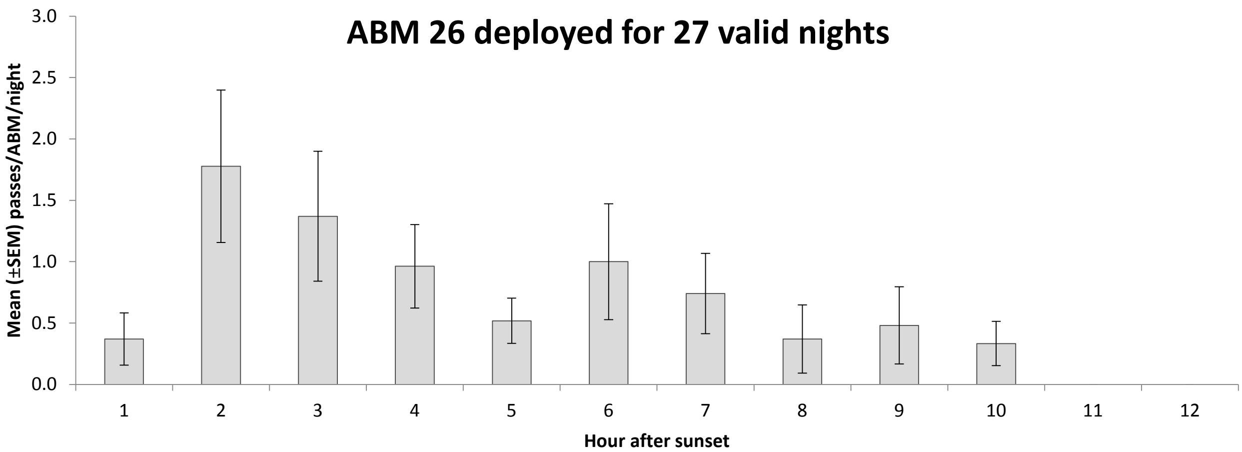

Figure 4. Mean bat activity at site 26 by hour after sunset.

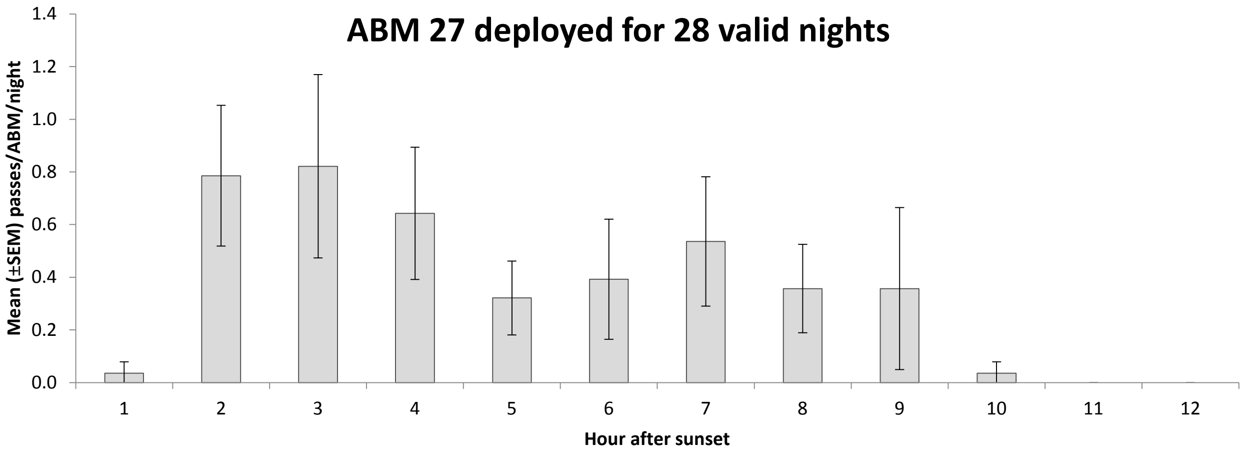

Figure 5. Mean bat activity at site 27 by hour after sunset.

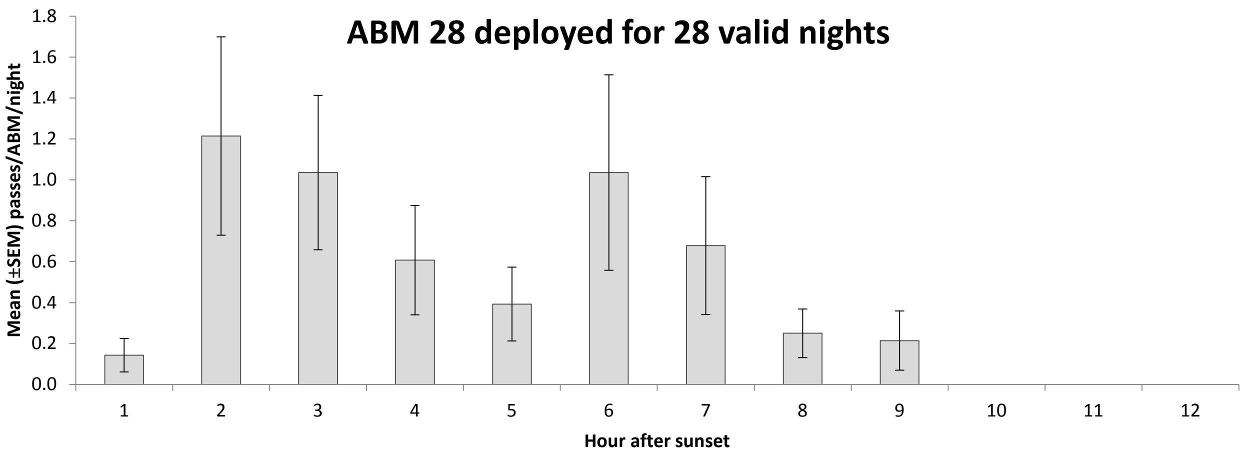

Figure 6. Mean bat activity at site 28 by hour after sunset.

Sites 26, 27, and 28 (Figures 4, 5, and 6) show similar levels of peak activity 2 and 3 hours after sunset, followed by smaller peaks 6-7 hours after sunset (Figures 4 and 5). These sites were also located within the forest interior on a ridge overlooking a steep gully to the north. It is possible the top of the gully is a natural flyway for bats as they forage through the night. Roost trees may be present in the area, however activity at these sites do not indicate this.

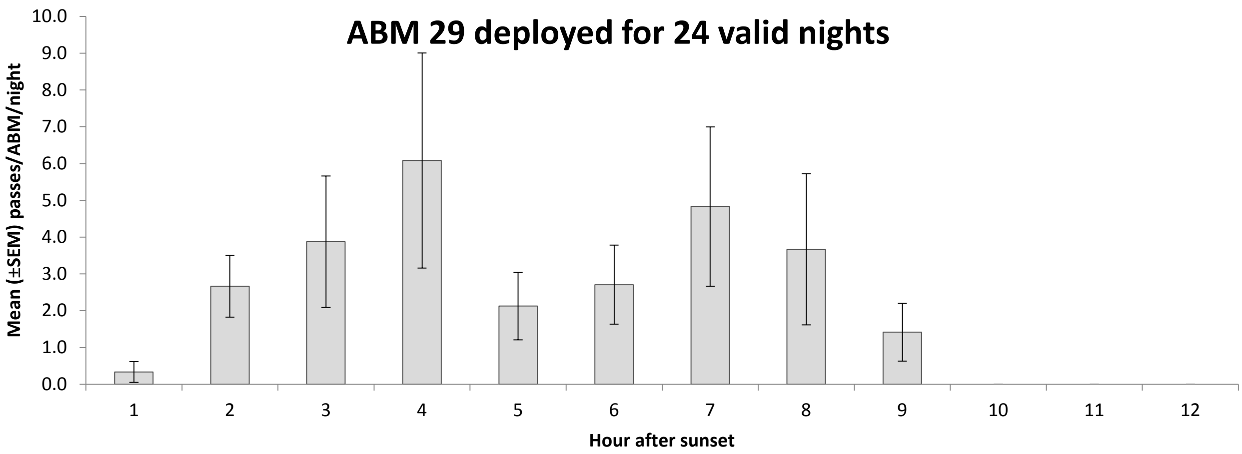

Figure 7. Mean bat activity at site 29 by hour after sunset.

Site 29 shows peak activity at 4 hours after sunset, with smaller peaks at 7 and 8 hours after sunset (Figure 7). Site 29 was located along the same ridge as sites 26-28, however the location was at the native/pine forest margin. Activity levels at site 29 are higher than the other five sites located along the ridge. Mean passes/night at site 29 were 27 compared to 15 for site 1, and less than 10 for sites 26-28 (Table 1). Again, this level of activity does not indicate a roost tree is present at that location, however it appears the pine forest is favourable foraging habitat and roost trees may be in the vicinity.

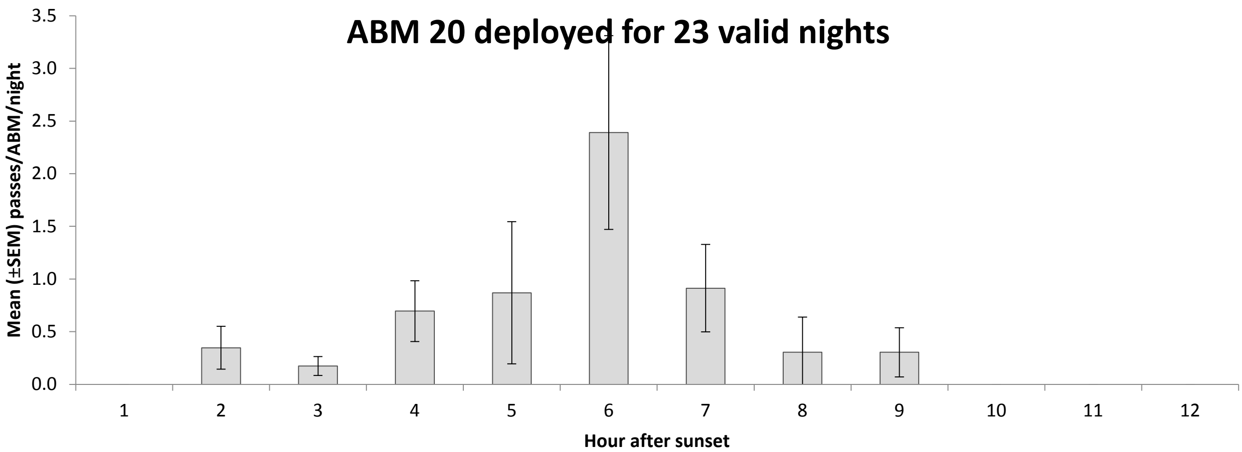

Figure 8. Mean bat activity at site 20 by hour after sunset.

Site 20 was located down in farmland of the southern section of the alignment, at a margin with manuka scrub. Activity was different than areas further up in the forest environment. There was an increase from 2 hours after sunset, with a peak at 6 hours and then a decrease to 9 hours after sunset (Figure 8).

4 Discussion

4.1 MC23

The overall bat activity level was relatively low, except for the three sites surrounding the pine plantation. As a comparison, the 2015-2016 Waikato Expressway Hamilton Section long-tailed bat surveys consistently returned a much larger number of mean bat passes/night above 10-20 around the gullies surveyed, with the highest at 244 passes/night. However, the Hamilton gullies provide the most favourable habitat within the Hamilton peri-urban landscape and therefore it is likely that bat activity is concentrated within this high value habitat that is of relatively limited spacial extent in the local landscape. The large forested area of Mt Messenger provides thousands of hectares of roosting and foraging habitat. Bat activity may therefore be spread throughout the landscape, with pockets of higher activity at particularly favourable sites such as the three sites surrounding the pine forest within the alignment.

The pattern of activity at site 4 is considered to be relatively normal for edge-adapted species such as long-tailed bats (O'Donnell, 2010). It does not specifically indicate that there are bat roosts present at that exact location, however detection of bat calls here indicates that roosts are likely to be present in the vicinity. The high activity levels recorded may also be indicative of important commuter routes and/or foraging. The trend of activity throughout the night with a peak at 6 hours after sunset at site 20 may also indicate the area is used for foraging.

A consideration with using ABMs to detect bat activity is that they may under represent the true levels of activity at a given site. Roost trees are detectable if an ABM is in close proximity to the tree. However, surveys from the Waikato Expressway have shown that a detector located even 100m from a roost tree will not show activity to indicate its presence in the vicinity. This lack of detection may be because bats rapidly depart roost sites very quickly at sunset, probably to avoid predators. Therefore, the results from this survey cannot discount the fact that roost trees are present within the alignment. A further consideration is that long-tailed bats often fly high above the canopy while foraging, or traveling to foraging areas. The low levels of activity recorded in the farmland/margin habitat may be a result of bats flying beyond the range of ABMs.

Detectors were placed within the most favourable habitat for short-tailed bats within the forest interior. Natural flyways along ridge tops and open areas underneath the canopy (e.g. tracks through more mature areas of forest) were targeted. The lack of detection of short-tailed bats does not completely confirm their absence within the alignment and construction management is recommended as described in the following sections.

4.2 MC71

Based on the results of the bat monitoring conducted along the MC23 corridor it is expected that long-tailed bats will also be present along the MC71 corridor, although activity levels may be different. While the lack of predator control might be expected to result in reduced activity, it is also possible that activity may be higher due to the greater amount of edge habitat and presence of wetlands, which are favoured feeding areas. While it is also possible short-tailed bats are present, it is considered less likely than along the MC23 corridor given the more modified nature of the MC71 corridor i.e. greater amount of forest edge and greater levels of vegetation fragmentation.

5 Effects

5.1 Construction Phase

5.1.1 Loss of roosts

It is likely the largest potential effect on the resident long-tailed bat population would be during construction within the main forest interior. Some roost trees may be removed for road construction and there is the potential for individual injury or mortality if occupied roost trees are felled. Long-tailed bats are known to utilise a large 'pool' of roost trees across the landscape, switching roost trees often (< 2 two days on average), with low rates of reuse in the short to medium term (O'Donnell 2010). Given that there are many large emergent trees within the Mt Messenger landscape it is highly unlikely that roost availability will be a limiting factor for long-tailed bats in this area. Consequently, loss of roost trees as a result of road construction is likely to be have limited impact on the bat population.

However, there is a possibility some of the older, emergent trees within the alignment such as rimu or northern rata could be occupied by bats during tree felling. Native bats are 'Absolutely Protected' species under the Wildlife Act 1953 and there is a legal requirement to ensure mortality and injury are reduced or avoided. There is the potential that bats may be killed during tree felling and a Wildlife Permit will be required prior to construction. The Permit is likely to require implementation of tree removal protocols in order minimise the risk of killing or injuring bats during tree felling.

Short-tailed bats are less mobile with their roosting behaviour, with large maternal roosting colonies occupying the same tree or small pool of trees for many years. If short-tailed bats are present within the alignment and a maternal roost is impacted during vegetation removal, effects on the population will likely be higher than for long-tailed bats. There is the potential for significant adverse effects on short-tailed bats if appropriate tree felling protocols are not adopted.

5.1.2 Loss of foraging habitat

Any long-tailed bat foraging habitat, predominantly manuka scrub and pasture located down the valleys near the existing road, will likely be impacted during construction. These foraging areas are not considered to be critical bat habitat as there is an abundance of similar vegetation throughout the wider landscape. Replacement planting of construction areas throughout the alignment, including within the main forest, will likely provide adequate mitigation. Provided that these new plantings have a large regenerating shrubland component to attract the invertebrates bats prey on, they will provide new foraging habitat. Effects of foraging habitat removal on long-tailed bats are likely to be minor.

Short-tailed bats forage predominantly within the forest interior. There will be a loss of foraging habitat for short-tailed bats if they are present, and individuals will be required to seek out new sites. The potential effects of foraging habitat removal on lesser short-tailed bats (were they to be present) are likely to be greater than minor. However, the losses are unlikely to significantly compromise the long-term viability of the population as the amount of foraging habitat lost (c.21ha) represents <3% of the Parininihi Protection area (c.2000ha).

5.1.3 Habitat Fragmentation

Long-tailed bats tend to use linear features and contiguous woody habitat to navigate across the landscape, avoiding open areas of low vegetation such as pasture. While bats will cross open country, habitat fragmentation may adversely affect native bat populations in landscapes that are already fragmented with small forest remnants. Further vehicle movement along roads may also produce a fragmentation effect. Results from the Waikato Expressway indicate bats are active close to major rural highways. However, a study by Borkin et al, (2016) concluded that long-tailed bats activity next to roads appears to decline rapidly as traffic volume approaches 1000 vehicles per night. These contrasting findings suggest that effects are site and context specific. In this case, the alignment will produce a relatively small area of cut compared to a much larger area of foraging and roosting habitat. Both species should be able to fly across the new road in the main forest area. It is unlikely habitat fragmentation will be a major problem for the bat population within the vicinity of the Project and effects are predicted be no more than minor.

5.1.4 Night Works

There is the potential for minor adverse effects from disturbance and noise produced by machinery and construction during night works. However, it is unknown at this stage if works will be conducted at night, therefore this effect cannot be assessed yet. If night works are necessary, appropriate mitigation can be implemented to minimise potential effects on the bat population from excessive vibration or noise, and lighting (see 5.2.3 below).

5.1.5 MC71

Construction of the Bypass along the MC71 corridor is likely to result in similar types of effects to those expected to occur along the MC23 corridor. The severity of effects could differ depending upon the relative importance of the alignment for bats. Measures to avoid and mitigate effects are also likely to be similar to those required for MC23 but may need some modification to reflect difference in the severity of effects. If the MC71 were to be considered further, then bat monitoring would be required to more clearly determine effects and necessary mitigation.

5.2 Operational Phase

5.2.1 Vehicle Strikes

Little is currently known about the effects of roads on long-tailed bats as few studies have been conducted. From overseas experience, it has been found that bat species can be impacted in species-specific and site-specific ways. A direct effect could be mortality through vehicle strike. The number of expected vehicles on the road at night will likely be relatively low (<3000/day) on the new two-lane road. The likelihood of vehicle strike is relatively low and would not likely impact the population noting that populations of long-tailed bats exist in close proximity to roads with much higher traffic volumes e.g. SH1 to the south of Hamilton. Effects of vehicle strike are likely to be less than minor.

5.2.2 Behaviour Disruption

There is uncertainty about whether roads impact native bats, and to what extent in New Zealand. Evidence from Waikato Expressway studies have shown no effect, or more activity in gullies closer to roads than further away. By contrast, Borkin et al, (2016) concluded that long-tailed bats activity next to roads appears to decline rapidly as traffic volume approaches 1000 vehicles per night. These contrasting findings suggest that effects are site and context specific. There is already a road present at Mt Messenger, thus the effects would likely move from the existing alignment to the new one. In addition, it is possible the old road, once retired, would make good foraging habitat as the existing edge would have little or no traffic moving along it. Overall, it is considered likely any potential adverse effects of avoidance behaviour for foraging will be minor, as there is an abundance of habitat in the landscape. Furthermore, when individuals leave roost trees in the main forest area they will likely be higher than the road as they move quickly to foraging areas and behaviour disruption effects will be minimal.

Little is known about the effects of roads on short-tailed bat behaviour but given their preference for mature native forest habitats, it is reasonable to assume that if they are present, they are likely to avoid the alignment both during and after construction.

5.2.3 Lighting

It is assumed at this stage that lighting will not be used on the new route, similar to the existing alignment. Therefore there will be no effects from lighting after the road is constructed. If lighting is used, mitigation could be employed to minimise the effects of light spill such as use of directional LED lighting.

6 Management of Effects

6.1 Construction

6.1.1 Tree Removal Protocols

A bat management plan and tree felling protocols would need to be produced and implemented to reduce the risk of injury or mortality to bats during construction. Potential bat roost trees should be classified as high risk above a certain diameter at breast height (DBH) and if they have one or more features:

- Cracks, crevices, cavities and/or fractured limbs large enough to support roosting bat(s)
- Sections of loose flaking bark large enough to support roosting bat(s)
- A hollow trunk, stem or branches
- Deadwood in canopy or stem of sufficient size to support roost cavities or hollows
- Bat droppings, grease marks and/or urine staining around cavities

Other large roading projects, such as the various sections of the Waikato Expressway and the Puhoi to Warkworth section of Ara Tuhono have developed and adopted tree removal protocols that minimise the risk of removing a tree during a period when it is occupied by bats and similar protocols should be adopted for this Project. Separate protocols for 1. Identification of potential bat roost habitat, 2. Pre-felling procedures, including requirements for acoustic monitoring and protocols if bats are found, and 3. Bat injury or mortality will need to be produced and implemented.

All pre-felling tree assessments, assessment of acoustic monitoring data and assessment of behavioural observations will need to be made by an appropriately qualified and experienced bat ecologist who has undergone DOC-endorsed training to a competency level of 'Class D' or higher.

6.1.2 Revegetation

Revegetation next to the alignment will likely be undertaken as part of landscape mitigation. Ideally this should include regenerating shrubland as a large component of the plantings as these plant species attract abundant flying invertebrate communities which bats prey on, and because it is similar to the regenerating native vegetation communities in the farmland areas. Appropriate canopy species could be included in the mitigation planting (or follow-up enrichment planting) to increase roosting habitat in the long term.

6.2 Avoidance and mitigation

6.2.1 Reducing habitat fragmentation

While habitat fragmentation and vehicle strikes are unlikely to be major issues for long-tailed bats as a result of this project (fragmentation of habitat is likely to be a greater issue for short-tailed bats). Any measures through the road design process that help maintain habitat connectivity, and particularly forest connectivity, such as use of tunnels and bridges, would help to further reduce the effects and risk of adverse effects on bats. While bats can cross open ground maintenance of linear features of tall woody vegetation assist in helping bats to navigate across the landscape more effectively.

6.2.2 Pest Control

The most beneficial long term form of mitigation for adverse effects of this Project on bats would be to undertake pest control in an area close to the alignment. Ngati Tama are currently undertaking pest control for mustelids, rats, cats, and possums across a 1500 ha area, that includes the alignment footprint. If pest control could be expanded into surrounding areas targeting at least the same species as mitigation for impacts on the native bat population, this is likely to have significant benefits for the bat population. Noting that pest control is only effective as long as it is being implemented, with predators reinvading once it ceases, careful consideration needs to be given to its duration, which needs to be regarded as long-term mitigation.

7 Conclusions

- Monitoring has confirmed that long-tailed bats are present along the MC23 corridor. Based on the results of this survey they are expected to occur widely in the surrounding landscape, including along the MC71 corridor.
- The monitoring made no recordings of short-tailed bats and the likelihood of their presence is considered low, although their occurrence cannot be entirely discounted.
- The main adverse effects of the Project on long-tailed bats are loss of roost trees and foraging habitat, and habitat fragmentation resulting in less favourable conditions for bats to commute across the landscape.
- Overall, while there are likely to be adverse effects on long-tailed bats, it is unlikely that the severity of these effects will have a significant long-term effect on the population. Furthermore, refinement of the design to reduce fragmentation effects and implementation of measures to compensate for the loss of roosting and feeding habitat (such as additional predator control in the surrounding landscape) should result in minimal long term effects on the population.
- Construction of the Bypass along the MC71 corridor is likely to result in similar types of effects to those expected to occur along the MC23 corridor although the severity of effects could differ depending upon the relative importance of the alignment for bats.

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Appendix 1

Legend

Mean Long-tailed Bat Passes per night

- 0.0
- 0.1 - 1.0
- 1.1 - 5.0
- 5.1 - 10.0
- 10.1 - 50.0
- 50.1 - 116.3
- Road Design

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Project No: 2-31695.00

SH3 Mt Messenger Bypass: Route Option MC23
Bat Survey Results (Jan-Feb 2017) Mean Passes per Night

0 50 100 150 200 m

1:6,000 @A3

N

Projection:
NZGD 2000 New Zealand Transverse Mercator

| Date: 30/03/2017 | Revision: 1 |

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SH3 Mt Messenger Bypass: Route Option MC23
Bat Survey Results (Jan-Feb 2017) Mean Passes per Night

0 50 100 150 200 m

N

1:3,000 @A3

Projection:
NZGD 2000 New Zealand Transverse Mercator

| Date: 30/03/2017 | Revision: 1 |

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Bat Survey Results (Jan-Feb 2017) Mean Passes per Night

0 50 100 150 200 m

1:6,000 @A3

N

Projection:
NZGD 2000 New Zealand Transverse Mercator

| Date: 30/03/2017 | Revision: 1 |

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Memorandum

To	Matt Baber
Copy	Simon Chapman
From	Paul Battersby, John Turner
Office	Auckland Environmental Office
Date	25th July 2017
File	5-C3195.03
Subject	Mt Messenger Bypass: Option MC23 - Bat Survey Addendum

1.1. Introduction

This memorandum provides an addendum to the earlier report *Mt Messenger Bypass Investigation- Bat Baseline Survey, (April 2017, Opus International Consultants),* that detailed the results of bat surveys undertaken along the MC23 route option during January/February 2017. It details methods and results from a second bat survey undertaken at Mt Messenger as part of the Mt Messenger Bypass investigations and should be read in conjunction with the primary report.

The first bat survey detected long-tailed bat (*Chalinolobus tuberculatus*) activity at various locations along the alignment. No lesser short-tailed bat (*Mystacina tuberculata*) activity was detected in the targeted surveys along ridges within the mature native forest of the alignment. While surveys along the ridges were over an extended period (where monitoring occurred for up to 29 valid nights), given the absence of any short-tailed bat recordings, it was considered prudent to survey in the base of the main gully crossed by MC23. The riparian margin of stream in the base of the gully was considered to provide suitable alternative potential habitat for short-tailed bats and was surveyed before the end of the survey season in May.

1.2. Methods

1.2.1. Field survey

A total of six Automated Bat Monitors (ABMs) were deployed along the gully floor in habitat considered suitable for roosting and foraging by short-tailed bats, to determine if they are present (see Figure 1 for ABM locations). ABMs operate remotely by recording and storing echolocation bat pass information with a date and time ‘stamp’ onto a 4GB SanDisk card for later processing and analysis. The ABMs were set to record from half an hour before sunset until half an hour after sunrise. A minimum temperature threshold of above 10°C, with little precipitation in the first two hours after sunset, were considered the ideal weather conditions for defining a valid recording night. However, because of the survey was undertaken late in the season and the primary purpose of the survey was to provide further confirmation of the likely presence of short-tailed bats, all nights with bat activity were considered valid for the purposes of this survey.

The ABMs were deployed for 28 nights in April/May 2017. During this time, there were varying nightly temperatures with some precipitation during the first two hours after sunset.

The monitors were secured onto mature exotic and native trees within the forest interior which may be used by roosting or foraging bats (if present). Where possible, they were positioned in trees at heights of between 1 and 5m, where there was minimal obstruction from branches. ABMs were separated by at least 40m to maximise the possibility that each detector would monitor bats independently.

It was proposed that if short-tailed bats were confirmed as present within the alignment, all large diameter (>80 cm diameter at breast height) trees would be inspected for signs of roosting. However, as no short-tailed bats were recorded this was unnecessary.

1.2.2. Data Processing

Recorded sound files from the ABMs were processed using the latest version of BatSearch3 software (Department of Conservation, Wellington). Bat echolocation passes can be clearly distinguished from noise files (e.g. wind, rain, insect noise), which were disregarded. Total number of bat passes, along with time and date of recording was noted, as was any activity indicative of feeding or roosting.

1.2.3. Data Analysis

Data extracted from the BatSearch software processing was analysed, summarised and interpreted to provide assessments of:

- Presence/absence of bats in the Project area;
- Distribution of bat activity in the Project area;
- Levels of activity at each site (if activity was detected); and
- Whether any activity was indicative of roosting.

1.3. Results

All nights were below the minimum threshold of 10 °C during deployment but because bat activity was recorded during the survey period all 28 nights were deemed to be valid survey nights.

No short-tailed bats were recorded during the survey period. A total of 29,319 recordings were made during the survey period; however, more than 93% (*n* = 27,542) of these recordings were not bat passes. There were 1,777 recordings assigned as long-tailed bat passes.

Levels of long-tailed bat activity at sites along the alignment are shown in Table 1. Figure 1 gives mean bat passes per night at each ABM location.

Bat activity was generally concentrated near the stream channel within the gully, notably sites 37 and 40. Figures 2 and 3 give the mean passes per night for each hour after sunset for these nights. The other four sites recorded relatively low activity of six or less passes per night.

Table 1: Long-tailed bat activity at ABM sites during the second survey, April/May 2017.

Site	Valid Survey Nights	Total Bat Passes	Mean bat passes/night*
36	28	163	5.82
37	28	1113	39.75
38	28	22	0.79
39	28	176	6.29
40	28	286	10.21
41	28	17	0.61

*mean calculated from valid nights of activity

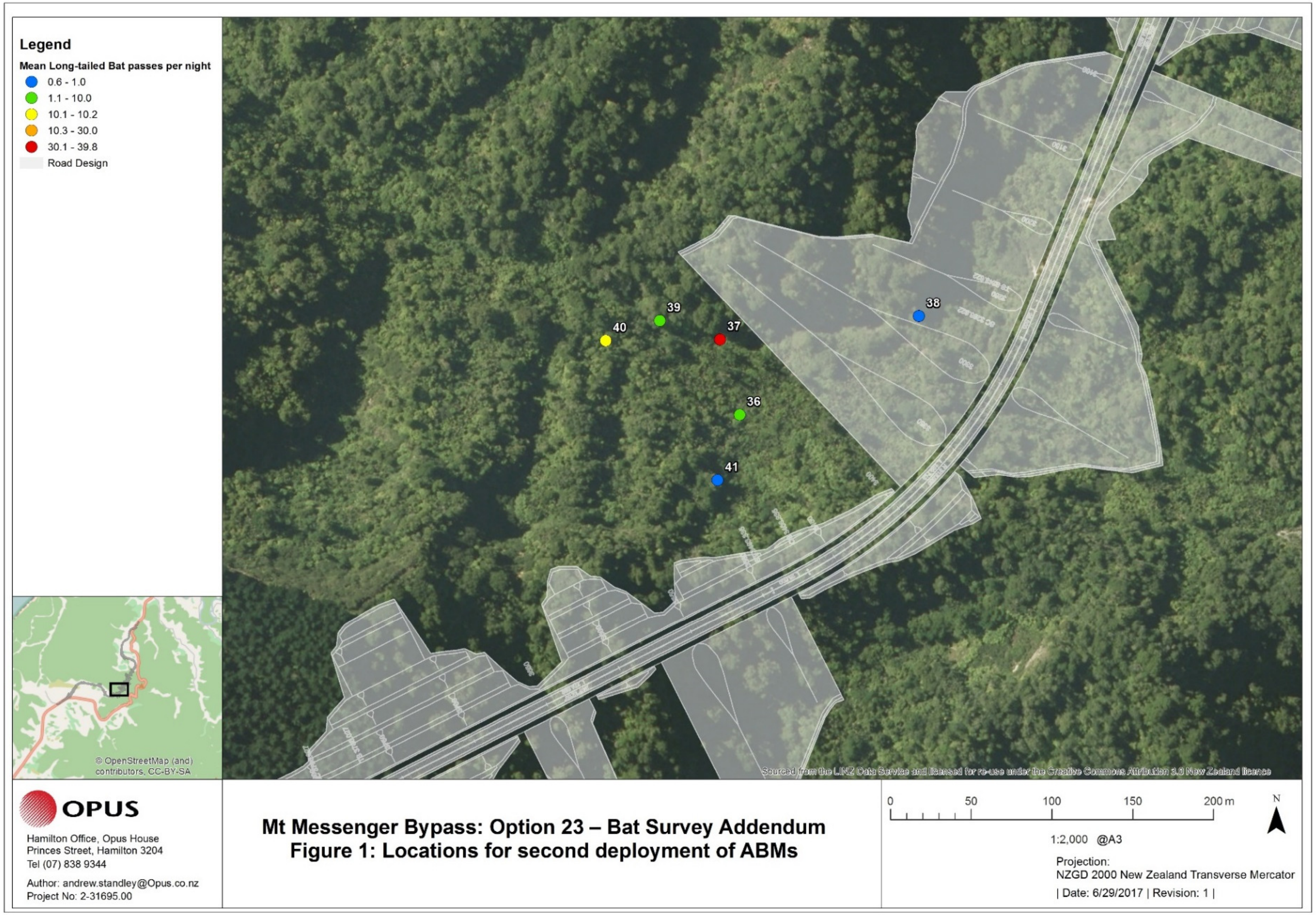

Figure 1. Map of ABM locations and bat activity for the second bat survey in April/May 2017.

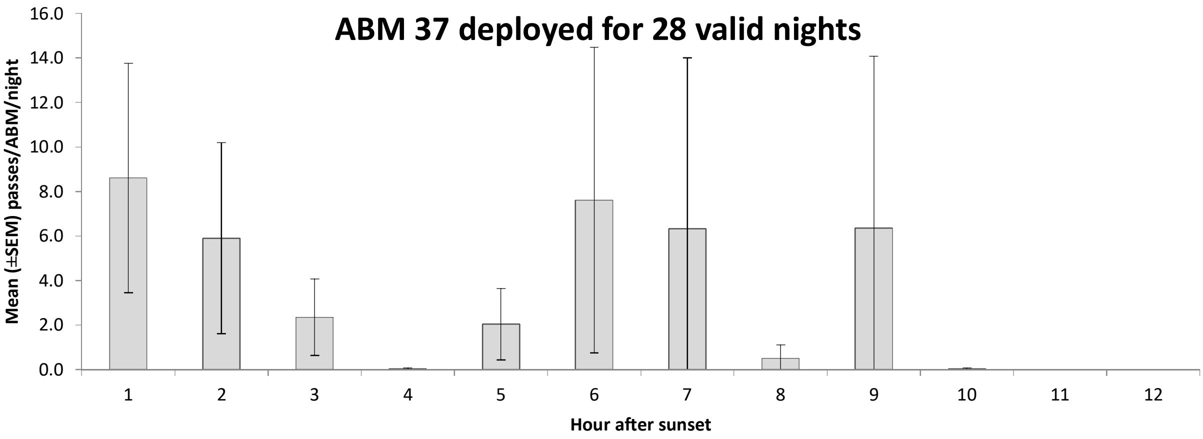

Figure 2. Mean bat activity at site 37 by hour after sunset, April/May 2017.

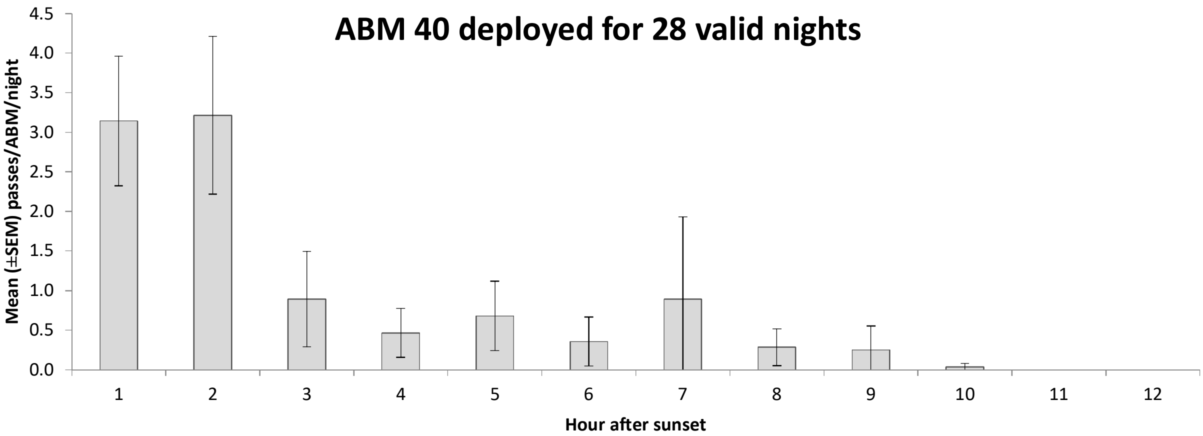

Figure 3. Mean bat activity at site 40 by hour after sunset, April/May 2017.

The highest bat activity was recorded at site 37, followed by site 40, recording 39 and 10 passes/night respectively. Both sites were located near the stream channel at the bottom of the gully.

Figure 2 shows bat activity peaked within the first hour after sunset at site 37, followed by smaller peaks at 6-7 and 9 hours after sunset. Figure 3 shows bat activity peaked within the two hours after sunset at site 40, with low activity throughout the remainder of the night.

It is possible the bottom of the gully is a natural flyway for bats as they forage through the night. Roost trees may be present in the area, however activity at the sites monitored does not generally indicate this, except at site 40, where activity peaks at sunset and sunrise may indicate close proximity to a roost.

1.4. Discussion

Detectors were placed within the most favourable habitat for short-tailed bats within the forest interior. Natural flyways along the gully bottom and open areas underneath the canopy were targeted. The lack of detection of short-tailed bats does not completely confirm their absence within the alignment and mitigation measures will need to be implemented during construction management to account for this e.g. implementation of bat tree roost removal protocols.

The results from the second survey complement those of the first, more comprehensive survey conducted throughout the alignment. Based on the results of this survey, the assessment of effects described in the primary report (Opus, 2017) remains unchanged and the management recommendations continue to apply.

1.5. Conclusions

The following conclusions are drawn from both bat surveys for the Mt Messenger project:

- Surveys have confirmed that long-tailed bats are present along the MC23 corridor. Based on the results of both surveys they are expected to occur widely in the surrounding landscape.

- The survey made no recordings of short-tailed bats and the likelihood of their presence is considered low, although their occurrence cannot be entirely discounted.

- The main adverse effects of the Project on long-tailed bats are loss of roost trees and foraging habitat, and habitat fragmentation resulting in less favourable conditions for bats to commute across the landscape.

- While the risk is considered low. It needs to be recognised that if short-tailed bats are present within the alignment and any maternity roosts are impacted during vegetation removal, effects on the population will likely be much higher than for long-tailed bats. This risk will need to be factored into the implementation of tree removal protocols during vegetation clearance in advance of road construction.

- Overall, while there are likely to be adverse effects on long-tailed bats, it is unlikely that the severity of these effects will have a significant long-term effect on the population. Typically long-tailed bats utilise a large pool of roosts over a wide area and, as they switch roosts often, standard tree removal protocols will minimise the likelihood of an occupied tree being removed during construction. Furthermore, refinement of the design to reduce fragmentation effects and implementation of measures to compensate for the loss of roosting and feeding habitat (such as additional predator control in the surrounding landscape) should result in minimal long-term effects on the population.