Before a Board of Inquiry
MacKays to Peka Peka Expressway Proposal

under: the Resource Management Act 1991

in the matter of: Notice of requirement for designation and resource consent applications by the NZ Transport Agency for the MacKays to Peka Peka Expressway Proposal

applicant: **NZ Transport Agency**
Requiring Authority

Statement of evidence of **James Whitlock** (Vibration assessment) for the NZ Transport Agency

Dated: 3 September 2012

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STATEMENT OF EVIDENCE OF JAMES WHITLOCK FOR THE NZ TRANSPORT AGENCY

QUALIFICATIONS AND EXPERIENCE

1 My full name is James Andrew Travis Whitlock.

2 I have 10 years' experience as an Acoustician with Marshall Day Acoustics (*MDA*), and have specialised in environmental vibration for the past 7 years. I have a Bachelor of Science in Physics, and a Master of Architectural Studies in Acoustics, both from the University of Auckland. I am a Member of the Acoustical Society of New Zealand (*MASNZ*), and hold positions on the Council of both the ASNZ and the National Foundation of the Deaf (*NFD*).

3 I have prepared vibration assessments for many infrastructure projects, including Waterview Connection, State Highway 18 Greenhithe, Auckland War Memorial Museum, Transpower North Island Grid Upgrade Project (*NIGUP*), Project DART and Tauranga Southern Pipeline.

4 My evidence is given in support of the Notice of Requirement (*NoR*) and applications for resource consent lodged with the Environmental Protection Authority (*EPA*) by the NZ Transport Agency for the construction, maintenance and operation of the MacKays to Peka Peka Expressway (*the Project)*.

5 I am familiar with the area that the Project covers and the State highway and local roading network in the vicinity of the Project.

6 I am the author of the Assessment of Vibration Effects (Technical Report 18),[1] and the Ambient Vibration Assessment Report (Technical Report 19),[2] and co-author of the Draft Construction Noise and Vibration Management Plan (CEMP, Appendix F).[3] These documents all formed part of the Assessment of Environmental Effects (*AEE)* lodged in support of the Project.

7 I have read the Code of Conduct for Expert Witnesses as contained in the Environment Court Consolidated Practice Note (2011), and I agree to comply with it as if this Inquiry were before the Environment Court. My qualifications as an expert are set out above. I confirm that the issues addressed in this brief of evidence are within my area of expertise. I have not omitted to consider material facts known to me that might alter or detract from the opinions expressed.

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[1] Assessment of Vibration Effects: Technical Report 18, Volume 3 of the AEE.

[2] Ambient Vibration Assessment: Technical Report 19, Volume 3 of the AEE.

[3] Construction Noise and Vibration Management Plan – CEMP Appendix F, Volume 4 of the AEE.

SCOPE OF EVIDENCE

8 My evidence will deal with the following:

8.1 Background and role;

8.2 Existing vibration environment;

8.3 Vibration standards;

8.4 Assessment of construction vibration effects;

8.5 Assessment of operation vibration effects;

8.6 Recommended mitigation (including the certified Construction Noise and Vibration Management Plan (*CNVMP*)) and proposed designation conditions;

8.7 Response to submissions;

8.8 Response to section 149G(3) key issues reports.

EXECUTIVE SUMMARY

9 I have assessed the Project's construction and operation vibration effects as they relate to potential building damage and human response to vibration. In the absence of applicable New Zealand standards, my assessment has adopted suitable assessment criteria from international standards.

10 My colleagues at MDA and I have measured heavy traffic, construction and ambient vibration levels in the vicinity of the Project.

11 I have identified dwellings and other buildings where there is a risk of exceeding the adopted construction vibration criteria. Those criteria are stringent, and exceeding them does not necessarily imply that damage will occur.

12 I consider that effects on identified receivers during construction can be adequately managed through implementation of the certified Construction Noise and Vibration Management Plan (*CNVMP*) which (amongst other things) requires building condition surveys, monitoring and continued liaison with affected parties.

13 I consider that operation vibration from the completed Expressway is unlikely to generate any adverse effects, provided the road surface is well maintained. Implementation of the NZTA's system

for monitoring and maintaining the condition of State Highway pavements and road surfaces[4] should ensure that this is achieved.

14 I have reviewed submissions lodged on the Project relevant to my area of expertise. Nothing raised in those submissions causes me to depart from the conclusions reached in my technical assessment of the Project.

BACKGROUND AND ROLE

15 My input to the Project has involved developing and supervising the ambient vibration monitoring regime, carrying out a literature review on relevant standards and technical papers on vibration in peat, undertaking all assessments and calculations of measured and predicted vibration levels from the construction and operation of the Project, assessing the effects on residents and other sensitive receivers in the area, and preparation of Technical Reports 18 and 19.

16 I also attended, and contributed to the Waikanae public open day (Expo 2)[5] where I held discussions on noise and vibration with individual residents and affected parties.

17 I have met with the NZTA and other vibration experts[6] to develop draft guidelines on construction vibration criteria for roading projects.[7] While this work was not part of the Project per se, it formed the basis for the construction vibration criteria I have adopted.[8]

18 My evidence includes reference to **Mr Gavin Alexander**'s technical report on ground settlement effects, **Mr Ian Bowman**'s evidence on built heritage, **Dr David Black**'s evidence on health effects, and personal communication with the Project Archaeological expert, **Ms Mary O'Keeffe**.

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4 Refer NZTA *State Highway Asset Management Plan* at Chapter 9 *[http://www.nzta.govt.nz/resources/state-highway-asset-management-plan/docs/state-highway-asset-mgmt-plan-2012-2015.pdf].*

5 Held on 17 May 2011.

6 During May – July 2011, and subsequent email correspondence.

7 NZTA *State highway construction and maintenance noise and vibration guide,* July 2012 / version 0.5 DRAFT at Section 2.2. Note this guide is a draft, with the finalised and approved version proposed for release in 2013. I reference the guide herein as a placeholder until the final version is released.

8 This is discussed later in my evidence.

EXISTING VIBRATION ENVIRONMENT

19 There are two predominant ground types in the vicinity of the proposed Expressway – peat and sand. Peaty soil is classed as soft ground and has some non-typical vibration propagation properties. Sandy soil can be classed as soft or 'competent' depending on its level of compaction.[9]

20 In order to establish the existing vibration environment for residential receivers along the proposed Expressway route, I oversaw the measurement of vibration at 13 sites. This ambient vibration assessment is contained in Technical Report 19.[10]

21 Nine of the ambient vibration level surveys were undertaken at dwellings adjacent to the proposed Expressway alignment to establish the level of vibration these residents are currently exposed to. The remaining four sites were chosen to determine vibration levels of heavy vehicles on the existing State Highway 1 in Raumati South, where the ground conditions are similar to that of the proposed Expressway (i.e. peaty soil). The road surface on the existing State Highway 1 is rougher and more dilapidated than that which would be laid for the proposed Expressway, so less vibration would be expected from the Project.[11]

22 The surveys were followed up by occupant questionnaires on whether the current level of vibration was noticeable, and if so whether it caused any annoyance.

23 Results from the nine sites near the proposed Expressway alignment showed that the ambient vibration environment due to existing traffic is low. The average vibration level did not exceed the threshold of perception[12] at any one site. Most occupants said they felt no traffic vibration in their homes, and those that did were not disturbed by it.[13]

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9 Competent soils are harder than 'soft' soils, but still soft enough to be dug with a shovel. Further detail is provided in Technical Report 18 at Section 2.

10 Survey locations and methodology are discussed in Sections 3 and 4 of Technical Report 19. Ambient vibration is the vibration at a given location that is due to any and all existing sources of vibration in the vicinity.

11 Refer Technical Report 19 at Section 3.1.

12 The perception threshold was set as 0.3mm/s PPV (peak particle velocity), based on the British Standard BS 5228-2:2009. The criteria in Table B.1 of the Standard states that 0.3mm/s PPV might just be perceptible in residential environments.

13 Refer Technical Report 19 at Section 5.3.

24 Results from the four sites adjacent to the existing SH1 showed vibration levels noticeably higher than at the other sites, with average levels close to or exceeding the threshold of perception and frequent peaks above it. This increase is attributed to traffic on existing SH1 and trains on the Kāpiti rail line that runs parallel to SH1 on the opposite side to the dwellings. The occupants said they regularly felt vibration from road traffic and/or trains, but were not disturbed by it, or had become used to it.[14]

VIBRATION STANDARDS[15]

25 There are no current New Zealand standards relating to construction or traffic vibration. Neither the Kāpiti Coast District Plan nor the Greater Wellington Regional Council Regional Plans contain any vibration criteria.

26 Because of this, I have looked to other relevant documents and international vibration standards in order to develop Project vibration criteria for the construction and operation phases. These include international standards which have been successfully implemented or applied to other large roading projects in New Zealand.

27 The vibration criteria adopted for this Project are detailed in Section 4.3 of Technical Report 18, which I will now summarise.

Construction phase

28 As noted earlier, I have been involved in an NZTA working group to develop a vibration guide for the construction of roading projects. The guide[16] is based on international vibration standards, most notably British Standard BS 5228-2:2009 Annex B and German Standard DIN 4150-3:1999.[17] I have adopted this guide (with minor modifications to ensure it is relevant to the Project) as the Project construction criteria.

29 The Project construction criteria are outlined in full in Technical Report 18 at Section 4.2, and in proposed designation conditions DC.31 and DC.33.[18] To summarise:

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14 Refer Technical Report 19 at Section 5.4.

15 These are discussed in detail in Technical Report 18 at Section 4 and Appendix B.

16 The vibration guide is in the NZTA *State highway construction and maintenance noise and vibration guide,* July 2012 / version 0.5 DRAFT at Section 2.2.

17 Refer Technical Report 18 at Section 4.3 and Appendix 18.B.

18 A copy of relevant conditions are contained in **Annexure A** attached to my evidence.

29.1 The criteria consider building occupants in the first instance, and specify vibration criteria which the referenced standards deem acceptable (Category A).

29.2 If these criteria are likely to be exceeded then a suitably qualified expert shall be engaged to assist in meeting them.

29.3 If they cannot be practicably met then Category B, which contains conservative building damage limits, shall be achieved – along with appropriate notification and liaison with affected parties.

29.4 If vibration levels are predicted to exceed Category B at any building, building condition surveys and monitoring of vibration levels must be undertaken while that building is at risk.

29.5 Where Category B criteria cannot be practicably met, the NZTA will prepare a Site Specific Construction Vibration Management Plan (SSCVMP) which shall describe site specific vibration risks and mitigation measures required. These shall be additional to the general mitigation measures noted in the certified CNVMP.

Operation phase

30 The standard adopted for operation vibration of this Project is the Norwegian Standard NS 8176.E:2005, Class C criterion.[19] This Standard addresses human response to transportation vibration and has been adopted in other large New Zealand roading projects (including Waterview Connection and Transmission Gully). It is referenced in the NZTA Environmental Plan.[20]

ASSESSMENT OF CONSTRUCTION VIBRATION EFFECTS

31 There is an important characteristic of vibration perception, the understanding of which gives context to the construction phase. This is the fact that humans can perceive vibration very much below levels that would damage a building. The limit of perception in residential environments is around 0.3 mm/s[21] PPV (peak particle velocity), whereas damage to a residential dwelling would not occur below 5 mm/s PPV.[22]

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19 Norwegian Standard NS 8176.E:2005 *"Vibration and Shock – Measurement of Vibration in Buildings from land based transport and guidance to evaluation of its effects on human beings."* Refer Technical Report 18 at Section 4.3.2 and Appendix B.5.

20 NZTA Environmental Plan at Section 2.12 *[http://www.nzta.govt.nz/resources/environmental-policy-manual/docs/environmental-plan.pdf]*

21 British Standard BS 5228-2:2009. Refer Technical Report 18 at Appendix B.4.

22 German Standard DIN 4150-3:1999. Refer Technical Report 18 at Appendix B.1.

32 Furthermore, the 5 mm/s PPV limit for dwellings (and other limits contained in DIN 4150-3:1999) are designed to protect the building from *any* damage, even cracking in plaster or paint work. It is relevant to note that the vibration level required to cause structural damage and affect a building's serviceability would be significantly higher again. [23]

33 Hence, even if a building occupant can feel vibration in his/her building – even if the levels seem high – the risk of damage to the building is still low. In my opinion, it is important that this is conveyed to concerned building owners to give them reassurance on this matter.

34 This does not imply that annoyance from vibration is not an important issue. It can be, and will be managed through liaison, monitoring and the application of the Category A construction vibration criteria via the certified CNVMP.[24]

35 For assessment purposes, I have focussed on building damage risk and have applied the 5 mm/s PPV criterion as a threshold to identify those buildings that may be at risk of minor damage.

36 Applying that criterion, I have assessed the risk of building damage from construction vibration in each of the four Project sectors. I have identified 139 dwellings, 5 garages, 6 pools and one building at El Rancho which have a medium or high risk of receiving 5 mm/s PPV or higher.[25] The majority are located in Sector 2, between Kāpiti Road and Mazengarb Road.

37 I have reviewed **Mr Ian Bowman**'s evidence in respect of Built Heritage. I note that he identifies Greenaway Homestead, Stringer Wind Rain house and St Luke's Church as vibration sensitive receivers. I expect there to be no vibration effects from the Project on these buildings as they are sufficiently far away from the Expressway that ground attenuation will reduce levels to below risk levels. The Stringer Wind Rain House is inside the Project designation and I understand it is to be relocated sufficiently far from the Expressway so that vibration from construction and operation will be below risk levels.

38 Prior to construction commencing, detailed Building Condition Surveys should be undertaken by suitably qualified engineers at each of these identified receivers. This is required by proposed

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[23] Siskind, D.E., Stagg, M.S., Kopp, J.W., Dowding, C.H., "Structure Response and Damage Produced by Ground Vibration from Surface Mine Blasting", Report of Investigations 8507, United States Bureau of Mines, 1980.

[24] Construction Noise and Vibration Management Plan – CEMP Appendix F, Volume 4 of the AEE.

[25] These are listed in Technical Report 18 at Section 5.7.

designation condition DC.34. I note that the CNVMP recommends that the same buildings are surveyed within 6 months of completion of the Expressway, though this may not be necessary for all buildings and accordingly has not been required in a condition.

39 The main items of vibration-inducing construction equipment are anticipated to be vibratory rollers, excavators, wheeled loaders, motor scrapers, off-road trucks and, for the Raumati Road overbridge, vibro-hammer piling and vibroreplacement.[26] The CNVMP[27] recommends monitoring of vibration levels during critical phases of the Project and I anticipate this would include the first time that identified vibration-inducing activities take place. The measured levels would allow verification and or/modification of the risk contours[28] applied in my assessment.

40 I note that the draft CNVMP at Section 9.1 does not specifically address the need to measure high-vibration activities at their first occurrence. This is an omission and prior to final certification of the CNVMP, I recommend that the first bullet point of Section 9.1 is modified to read as follows (with additions shown as underlined):

> "as and when required during critical phases of construction i.e. <u>at the first use of high-noise or high-vibration machinery,</u> when possible exceedance of the Project criteria is anticipated, e.g. night works<u>, etc.</u>;"

41 A pertinent issue relating to peat is that the weight shift associated with movement of the construction machinery can be a significant vibration source. I noticed this whilst conducting vibration measurements of construction machinery (an excavator and a wheeled dozer) at the peat trial measurements at 155 Greenhill Road, Peka Peka,[29] particularly with the excavator where digging generated little or no ground vibration compared with vibration generated by its side-to-side movement.

42 Construction operators should be aware of this and when operating on peat close to vibration sensitive receivers, minimise the effects by using restrained and controlled movements of machines as far as practicable and/or installing low friction linings to excavator buckets

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[26] Note that this list of sources may change prior to finalising the construction methodology in the CNVMP.

[27] Refer Construction Noise and Vibration Management Plan – CEMP Appendix F, Volume 4 of the AEE at Section 9.1.

[28] Refer Technical Report 18 at Section 5.7.

[29] Refer Technical Report 18 at Section 5.5.1. Measurements of construction equipment were undertaken during trials in May/June 2011, the purpose being to measure actual machinery proposed to be used during construction in peaty soils.

so that the boom arm does not need to be shaken to remove soil clumps.[30]

43 Construction vibration can sometimes cause ground settlement which, in turn may cause damage to buildings or structures. This effect has been addressed in **Mr Gavin Alexander**'s evidence on ground settlement.[31] I understand that construction vibration is not expected to cause ground settlement, other than in extremely close proximity to the vibration source.

44 In summary, I expect that construction vibration will comply with the Project criteria at most buildings and structures along the proposed Expressway route. The risk of building damage is limited to a number of identified receivers and in my opinion can be adequately managed through the certified CNVMP.[32]

45 I anticipate that many building occupants will periodically feel vibrations in their buildings, but they can be assured that the risk of building damage is low, and their concerns will be heard and managed by the construction contractor, through the requirements of the certified CNVMP.

46 I have also considered the potential vibration effects on buried remains in the Waahi Tapu Area. Neither I nor the Project's Archaeological Expert, **Ms Mary O'Keeffe**, are aware of any suitable vibration standards or collected data to assess such effects.[33]

47 **Ms Mary O'Keefe** and I agree that soft ground in the area would serve to envelop and protect the buried remains, and that attempts to quantify or observe vibration effects on the remains would likely generate more disturbance than the vibration itself. I anticipate the issue can be sufficiently addressed through communication with the Takamore Trust and site-specific management, as required in the CNVMP. [34]

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30 Minimising vibration from excavator use is a vibration management and mitigation measure provided for in the CNVMP to be implemented throughout construction of the Project - refer Construction Noise and Vibration Management Plan – CEMP Appendix F, Volume 4 of the AEE at Section 10.11.

31 Statement of Evidence of **Mr Gavin Alexander**.

32 Refer Construction Noise and Vibration Management Plan – CEMP Appendix F, Volume 4 of the AEE at Sections 10 and 11.

33 Personal Communication with Mary O'Keeffe, December 2011.

34 Refer Construction Noise and Vibration Management Plan – CEMP Appendix F, Volume 4 of the AEE at Sections 10 and 11.

ASSESSMENT OF OPERATION VIBRATION EFFECTS

48 The only vibration effects I consider could result from the operation of the completed Expressway is from heavy traffic (i.e. trucks) passing over imperfections in the road surface.[35]

49 Whilst the type of road surface may have a slight effect on vibration levels (both OGPA[36] and chip seal are planned for the Project),[37] the primary risk comes from bumps and dips in the road, in particular poorly back-filled trenches. In my experience, those are the cause of practically all traffic vibration complaints.

50 I have measured vibration from heavy vehicles travelling along a 10 month old OGPA road surface, and the measured levels were insignificant (i.e. below the ambient vibration level).[38] This demonstrates that operation effects can be fully mitigated by the provision of a smooth road surface.

51 To quantify vibration levels from degraded road surfaces, I measured heavy truck passes at two of the ambient survey locations along State Highway 1, Raumati South, and adjacent to a very dilapidated road surface outside a quarry in Auckland.[39] All measurements were done in accordance with the NS 8176.E:2005 Standard contained in the Project criteria.

52 Translating these measurements to the Project (by correcting for distance and ground type) indicates that traffic vibration will comply with the Project criteria at 2 metres from a new OGPA road surface, and 15 metres from a very dilapidated road surface. There are no residences or other habitable buildings located this close to the proposed Expressway.

53 The NZTA has a system for monitoring and maintaining the condition of State Highway pavements and road surfaces[40] which, when applied to the Project, would avoid any operation vibration effects. As discussed earlier in my evidence, particular attention should be given to ensuring backfilled trenches do not result in bumps or dips in the road surface. This is addressed in proposed designation condition DC.49.

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35 Refer Technical Report 18 at Section 6.

36 Open Grade Porous Asphalt.

37 Assessment of Traffic Noise Effects – Technical Report 15.

38 Refer Technical Report 18 at Section 6.3.

39 Refer Technical Report 18 at Section 6.3.

40 Refer NZTA *State Highway Asset Management Plan* at Chapter 9 [http://www.nzta.govt.nz/resources/state-highway-asset-management-plan/docs/state-highway-asset-mgmt-plan-2012-2015.pdf]

54 This does not mean that no vibration from traffic will be felt at all; rather the vibration levels will be well controlled and are expected to readily comply with what I consider to be the most appropriate assessment criteria for building occupants.

55 There is negligible risk of heavy traffic causing building damage because the vibration levels from a well maintained road surface would be sufficiently low. There is also negligible risk to Built Heritage sites because of low vibration levels and sufficient distance from the Expressway.[41]

RECOMMENDED MITIGATION (INCLUDING THE CNVMP) AND PROPOSED DESIGNATION CONDITIONS

56 The certified CNVMP[42] will be the primary mitigation tool for vibration during the construction phase. It addresses the potential construction noise and vibration effects and identifies standards that must be complied with, as well as best practicable options for noise and vibration management, monitoring and liaison.

57 It contains general management procedures and mitigation measures such as consultation, training of personnel, selection of low noise and vibration plant, building condition surveys, vibration barriers and isolators and temporary resident relocation. All 'at-risk' buildings where vibration levels may exceed the Project construction vibration criteria are also listed and shown on a set of construction risk diagrams.[43]

58 The CNVMP is to be updated throughout the course of the Project[44] to reflect changes in construction techniques, and catalogue all noise and vibration management schedules, and site specific construction management plans (i.e. SSCNMPs and SSCVMPs) that are developed and submitted to KCDC.

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41 Refer also the evidence of **Mr Ian Bowman** regarding the Greenaway Homestead, Stringer Wind Rain house and St Luke's Church.

42 Refer Construction Noise and Vibration Management Plan – CEMP Appendix F, Volume 4 of the AEE.

43 Refer Construction Noise and Vibration Management Plan – CEMP Appendix F, Volume 4 of the AEE at Section 11.2.

44 Refer Construction Noise and Vibration Management Plan – CEMP Appendix F, Volume 4 of the AEE at Section 15.

59 The proposed designation conditions relating to my evidence[45] are:

59.1 DC.31 – This condition outlines the vibration criteria relating to construction which shall, as far as practicable, be met for the Project.[46] It states that vibration must be measured and assessed in accordance with DIN 4150-3:1999. This condition is essential to control the vibration levels produced during the construction phase.

59.2 DC.33 – This condition states that in the event DC.31 cannot be practicably met, special management in the form of a Site Specific Construction Vibration Management Plan (SSCVMP)[47] is required. This extra focus on a particular receiver will assist in reducing the vibration risk.

59.3 DC.34 – This condition requires that Building Condition Surveys of identified at-risk buildings, services and structures be carried out prior to construction. These surveys provide a baseline against which any subsequent claims of damage can be assessed, and should lead to fair and reasonable outcomes of such matters.

59.4 DC.36 – This condition requires that any vibration mitigation structures identified in the certified CNVMP should be suitably designed and implemented before construction takes place in that vicinity.

59.5 DC.49 – This condition identifies the NZTA system for monitoring and maintaining the condition of State Highway pavements and road surfaces[48] to ensure that the condition of the Expressway surface is maintained to a reasonable standard. Traffic vibration is anticipated to be an issue only if significant bumps and dips are present in the road surface and the NZTA policy controls this.

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45 Copies attached for ease of reference in **Annexure A** to my evidence.

46 I note that the proposed condition DC.31 refers to the 'draft NZTA vibration guide'. Referencing the draft guide is a placeholder until the final version is released in 2013. The draft condition has been updated in **Annexure A** to note this.

47 I note that proposed condition DC.33 incorrectly refers to SSVMPs, rather than SS**C**VMPs. That has now been corrected in **Annexure A**.

48 Note that in **Annexure A** this has been updated for specificity, so it now refers to the NZTA *State Highway Asset Management Plan* at Chapter 9 *[http://www.nzta.govt.nz/resources/state-highway-asset-management-plan/docs/state-highway-asset-mgmt-plan-2012-2015.pdf]*

59.6 Although the proposed conditions do not specify it, if any traffic vibration complaints were to arise, vibration levels should be measured and assessed in accordance with Norwegian Standard NS 8176.E:2005.d[49]

60 I agree with the proposed conditions as currently drafted, but recommend some minor amendments to conditions DC.31, DC.33(a) and DC.49 as shown in **Annexure A**.

RESPONSE TO SUBMISSIONS

61 I have reviewed all the submissions that relate to vibration and/or vibration-induced damage to houses and property. I have grouped these submissions according to the concerns raised, and address each concern in the sub-headings below. For groups that contain many submissions (i.e. more than a dozen), I have listed the 10 submissions whose properties are closest to the construction envelope.

62 In addition, there are eight submissions that I feel should be specifically addressed,[50] and have done so.

Construction Vibration

63 The most common issue raised is vibration from construction phase, with more than 50 submissions raising this as a concern.[51] Some specify the nature of their concern (e.g. health effects, building/property damage) which I have addressed separately, but others do not.

64 In response to these submissions, I emphasise that the CNVMP's sole purpose is to address the noise and vibration effects (with the exception of health) of the construction phase. It requires liaison with affected parties who have been identified, either through the safe distance method or by receiving a complaint from them, and provides an effective framework for management, monitoring and mitigation as required.

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49 Refer Project Criteria – Technical Report 18 at Section 4.3.2.

50 Submitters Transpower NZ (0178), Daniell (0417), El Rancho (0477), Paraparaumu Medical Centre (0521), Metlifecare Kāpiti (0608), KCDC (0682), Takamore Trust (0703) and Raumati South Residents Association (0707).

51 Including Submitters Cornick (0065), Ashford (0198), Harrison (0323), Baxter (0422), Paraparaumu Medical Centre (0521), Metlifecare Kāpiti (0608), Lindsay (0622), Anderson (0678), Takamore Trust (0703) and Farr (0727).

Operation Vibration

65 Nearly 50 submitters have expressed concern over vibration from the Expressway once operational.[52] In response to these submissions, I refer again to the NZTA's system for monitoring and maintaining the condition of State Highway pavements and road surfaces,[53] which contains provisions for maintaining the Expressway pavement to avoid vibration issues. Should a vibration issue arise, complaints can be made to the NZTA and an investigation over the cause of vibration can be undertaken. In my experience, the most common cause is a poorly back-filled trench or some other surface artefact, which can be remedied.

Health Effects

66 Concern over vibration-induced health effects has been raised in more than 30 submissions,[54] including two – Lenk (0329) and O'Sullivan (0675) – that mention vibro-acoustic disease. As I am not a health specialist, these submissions are addressed in the evidence of **Dr David Black**.[55]

Building Damage

67 The concern with potential building and/or property damage has been raised in over 20 submissions.[56] Most of these submissions associate damage risk with the construction phase, but others are non-specific.

68 In response to these submissions, I reiterate that the Project criteria are stringent and that even buildings inside the risk contours have a low risk of construction damage. The CNVMP will manage this risk by instigating building condition surveys of buildings inside risk contours, and monitoring as appropriate.

69 I note that submitters Sisarich (0328, 0331 and 0332) and Leonard-Taylor (0594) request building condition surveys prior, during and after construction. As Mrs Leonard Taylor's dwelling is inside the risk contours, the CNVMP requires that building condition surveys will be undertaken before and 6 months after construction. Mr and Mrs Sisarich's dwelling is not inside the risk contour, but could be

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52 Including Submitters Cornick (0065), Waterson (0267), Scrimshaw (0307), Pomare (0309), Schager (0312), Laing (0337), Paraparaumu Medical Centre (0521), Leonard-Taylor (0594), Metlifecare Kāpiti (0608) and Farr (0727).

53 Refer NZTA *State Highway Asset Management Plan* at Chapter 9 *[http://www.nzta.govt.nz/resources/state-highway-asset-management-plan/docs/state-highway-asset-mgmt-plan-2012-2015.pdf]*

54 Including Submitters Dearden (0261), Schager (0312), Anderson (0378/0678), Baxter (0422), Schwass (0531), Starke (0589/0690), Leonard-Taylor (0594), Metlifecare Kāpiti (0608), Lindsay (0622) and Farr (0727).

55 Refer Statement of Evidence of **Dr David Black**.

56 Including Submitters Dearden (0261), Pomare (0309), Schager (0312), Harrison (0323), Kelly (0339), El Rancho (0477), Leonard-Taylor (0594), Metlifecare Kāpiti (0608), Neilson (0619) and Baray Holdings Ltd (0635).

included in the condition survey schedule upon request, through the CNVMP complaints provisions.[57] Mid-construction surveys are not proposed for any location, except where a complaint is received or exceedance of the Project criteria requires this.[58]

70 The submissions by Harrison (0323), Aregger (0382), Leonard Taylor (0594) and O'Sullivan (0675) raise the issue of compensation/remediation damage. In response to these, I note that the purpose of building condition surveys is to be able to reliably assess whether damage was caused by construction vibration. If proven, it is the NZTA's responsibility to repair or compensate for the damage.

Peat and Sand

71 Eleven submissions[59] mention the prevalence of peat and sand along the Expressway route and adjacent areas, and express concern over their vibration propagation properties.

72 In response to these submissions, I refer to the peat trial measurements that I conducted specifically to measure the transfer of vibration in peat and sand embedded in peat.[60] These measurements showed that peat and sand display vibration transfer properties that are generally consistent with soft soil i.e. vibration reduces with distance more than it does in hard soils or rock.

73 As discussed in paragraphs 41 and 42 of my evidence, the peat trials also showed that construction machinery, especially excavators, can generate noticeable horizontal ground movement in close proximity to the source. I do not consider that this movement poses a damage risk to buildings, but I have recommended management techniques to mitigate the human response aspect in those paragraphs.

74 Related to this were two submissions that raised the issue of settlement.[61] As noted earlier, **Mr Gavin Alexander**'s evidence is that vibration-induced settlement is not expected to occur.

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57 Refer Construction Noise and Vibration Management Plan – CEMP Appendix F, Volume 4 of the AEE at Section 12.

58 Refer Construction Noise and Vibration Management Plan – CEMP Appendix F, Volume 4 of the AEE at Section 10.4.

59 Submitters Pears (0004), Cairncross (0180), Hipkins (0385), Inge (0429), Whibley (0482), Allan (0502), Arnold (0567), O'Sullivan (0675), KCDC (0682), Raumati South Residents Association (0707), Scott (0735).

60 Refer Technical Report 18 at Section 5.1.

61 Submitters Harrison (0323) and Laing (0337).

Construction Traffic on Local Roads

75 Nine submissions[62] express concern over increased heavy vehicle movement on local roads as construction traffic accesses the Expressway site.

76 In response to these submissions, I note that the bridges and interchanges are to be established early in the construction period and thereafter the alignment will be used as the main haul road.[63] I refer also to the Assessment of Construction Noise Effects which addresses the noise effects of construction traffic on local roads.[64] It concludes that construction traffic is predicted to result in insignificant noise effects, due to the relatively minor increases in heavy vehicle numbers compared with the existing flow characteristics. I anticipate this will be the same for vibration.

Communication

77 Eight submissions[65] raise the issue of communication, to ensure their concerns are heard and responded to during and after construction.

78 In response to these submissions, I note that stakeholder liaison is one of the key areas addressed by the CNVMP. Receivers inside risk contours will be contacted and kept informed of construction operations that may affect them, and any vibration monitoring and/or building condition surveys will be carried out as required by the CNVMP. Additionally, there is a complaints procedure to address the concerns of any other parties whose properties have not been identified as being at risk.[66]

79 Mrs Pivac's submission (0536) notes that mitigation measures do not cover the entire length of the Expressway. I am not sure which mitigation measures are in question. Construction mitigation required by the CNVMP can be applied at any location, and I have recommended no operation mitigation other than road maintenance which also applies to the whole route. I presume that this comment was made in relation to noise concerns, but applied to vibration also.

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62 Submitters Pears (0004), Mackay (0402/0404), Waterhouse (0432), Paraparaumu Medical Centre (0521), Pivac (0536), Kāpiti Coast Grey Power Association (0624), Baray Holdings Ltd (0635) and Starke (0690).

63 Refer Technical Report 4 at Section 1.2.2.

64 Refer Technical Report 16 at Section 8.5.

65 Submitters Cornick (0065), Ashford (0198), Sisarich (0328/0331/0332), Laing (0337), Daniell (0417) and Leonard-Taylor (0594).

66 Refer Construction Noise and Vibration Management Plan – CEMP Appendix F, Volume 4 of the AEE at Section 12.

Construction Timeframe

80 Seven submissions are concerned about the length of the construction period, and the ongoing vibration effects for this duration.

81 In response to these submissions, I note that vibration associated with construction activities along the alignment will not occur continuously in any one location. Periods of high activity will only occur at certain times and stakeholders will be notified of these periods ahead of time.[67]

82 I note also that the risk contours are based on the worst-case activities i.e. high-vibration activities occurring at their closest point to receivers, and the vibration levels for the majority of the construction period will be very much less than this.

Buried Remains

83 Six submissions[68] have raised the issue of vibration effects on buried remains. I note that Takamore Trust (0703) is not one of these, but I include them in this response because of their overt interest in this issue.

84 In response to these submissions, I refer to my earlier evidence where I reference my communication with **Ms Mary O'Keeffe.** We consider that buried remains are not at risk of vibration disturbance from the Expressway construction, and that attempts to quantify or observe any effects may itself generate a disturbance. Liaison with the Takamore Trust over this issue is supported by the CNVMP.

Proposed Conditions

85 Six submissions[69] have noted that designation conditions must be put in place to address vibration effects. In response I consider that the proposed conditions[70] currently address most of the concerns raised by these submitters, with the exception of post-construction monitoring of operation vibration levels.

86 Such monitoring is requested by KCDC (0682) and the Raumati South Residents Association (0707). As I have stated earlier in my evidence, I feel this is best addressed on a case-by-case basis by responding to complaints, rather than prescribing a monitoring

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67 Refer Stakeholder Communication Management Plan – CEMP Appendix S, Volume 4 of the AEE.

68 Submitters Dearden (0261), Lepionka (0416), Baxter (0422), Allen (0524), Peters (0693) and Svedsen (0733).

69 Submitters Transpower NZ (0178), Sisarich (0331), Leonard-Taylor (0594), KCDC (0682), Donaldson (0683) and Raumati South Residents Association (0707).

70 Refer Proposed Designation Conditions – Part H: Management of environmental effects, Volume 4 of the AEE at Section 32.

regime in conditions before the effects are known. Note that I anticipate no effects provided the road surface is well maintained.[71]

Transpower NZ Ltd (0178)

87 This submission expresses a neutral stance with respect to the Project and requests conditions "to ensure that ground vibration and/or ground instability does not cause material damage to transmission lines, including support structures."

88 In response to this submission, I note that my assessment references the National Environmental Standard (NES) for Electricity Transmission Activities, clause 37.3 which in turn requires compliance with DIN 4150-3:1999. This is the same Standard I have adopted into the Project criteria, which I consider adequately addresses this issue.

T. Daniell (0417)

89 Mr Daniell's submission raises the valid point that "the general public, especially the elderly do not have access to standards and do not understand the tables and definitions used".

90 In terms of access to vibration standards, my assessment contains the parts of those standards that relate to the vibration assessment.[72] It is difficult to know whether any definitions therein may be confusing, or not clearly defined from a layperson's point of view. I am confident the NZTA would forward any queries about the standards as appropriate, and I would be happy to answer those relating to vibration.

El Rancho (0477)

91 The concerns of El Rancho are of a general nature relating to the construction and operation vibration effects of the Expressway, and the potential for building damage. These concerns are addressed in paragraphs 63-65 and 67-68 of my evidence, and I have addressed the closest building – St Luke's Church specifically in paragraphs 37 and 55.

92 I note that this submission includes a Traffic Noise Assessment by Malcolm Hunt Associates, but this assessment does not mention vibration.

93 The submission also states that El Rancho has been meeting with NZTA's design team to discuss mitigation measures, but that the AEE contains different measures to those discussed. In response, I note that I have held no discussions with El Rancho about vibration mitigation and I presume that this comment relates to noise, and not vibration.

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[71] Refer paragraphs 52 – 54 of my evidence.

[72] Refer Technical Report 18 at Appendix B.

Paraparaumu Medical Centre (0521)

94 This submitter raises the issues of vibration from construction and operation of the Expressway, and construction traffic on local roads which I have addressed in paragraphs 63 – 65 and 75 – 76 respectively. However, their primary concern is vibration from construction and operation of the Expressway affecting medical and computer equipment in the centre, especially Electrocardiograph (ECG) machines.

95 Computer equipment is not particularly sensitive, and vibration limits similar to that of human response in dwellings can be applied.[73] Therefore I consider the Category A night-time value of 0.3 mm/s PPV in the Project Criteria[74] to be a suitable criterion to address these concerns. ECG machines may be more sensitive to vibration, but not significantly so as they can accommodate small patient movements and footsteps adjacent to the machine.

96 The Medical Centre is located inside the risk contours, so vibration monitoring is proposed for this receiver. I anticipate managing the effects on ECG machines by sourcing vibration limits of the submitter's machines (if available) and including these limits in the monitoring regime. The management and mitigation provisions of the CNVMP can then be implemented as and when required, according to that vibration criterion. **Dr David Black** also discusses the effects on the Paraparaumu Medical Centre in his evidence.[75]

Metlifecare Kāpiti Ltd (0608)

97 The concerns of Metlifecare Kāpiti Ltd are vibration from construction and operation of the Expressway, health effects and building damage. These concerns are addressed in paragraphs 63-68 of my evidence.

98 I note that because it is a village for elderly persons, communication from a representative of the NZTA in the form of personal visits may be appreciated.

Kāpiti Coast District Council (0682)

99 In its submission, KCDC specifically raises vibration issues, but first "acknowledges that the overall approach to minimising noise and vibration effects of new and altered roads on the environment appears to be appropriate…"[76]

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[73] Refer American Society of Heating, Refrigerating and Air-conditioning (ASHRAE) Handbook 2011 HVAC Applications – Chapter 48 at Table 45.

[74] Refer DC.31 in **Annexure A**.

[75] Refer Statement of Evidence of **Dr David Black**.

[76] Submission by Kāpiti Coast District Council (0682), clause 98.

100 Clauses 103 and 106 of the submission state that appropriate conditions are needed to ensure appropriate monitoring of vibration and minimum setbacks to avoid high levels of vibration. I consider that the CNVMP adequately addresses these aspects through its monitoring provisions, and safe distance tables,[77] and that additional conditions are not necessary.

101 Clauses 107 - 109 of the submission refer to the peat trial measurements and, in addition to minimum setbacks, raise the issues of equipment operator precautions and monitoring of additional construction machinery in peat.

102 In response I note that Section 8 of the CNVMP addresses staff training, and whilst it does not specifically mention the operator precautions relating to peat, I expect this issue would be raised under 'responsibilities for management of Project noise and vibration issues'. I note that the CNVMP is a living document which requires updating to include changes in methodology, so I consider that this adequately addresses the issue.

103 In terms of additional machinery measurements, my assessment recommends refining safe distances by measuring the first use of high-vibration equipment. I anticipate measurements of motor scrapers, off road trucks and piling would be undertaken at this stage.

104 Clauses 118 – 120 and 126 of KCDC's submission raise the issue of operation vibration and seek monitoring conditions to address this. I have addressed this earlier in my evidence (paragraphs 85 and 86) and consider that additional conditions are not required.

105 Clauses 186 and 187 highlight the potential effects of the Expressway on Makarini Street, but do not specify any particular vibration concerns, referring to "significant cumulative impacts". I consider that these general concerns have been addressed earlier in my evidence (paragraphs 63 – 65). I also note that submissions were received from only 3 Makarini Street residents.

106 Clauses 192, 194 and 196 raise health effects, which I have commented on earlier in my evidence (to be addressed by **Dr David Black**).

107 Clauses 197, 199 and 200 raise concerns over the Paraparaumu Medical Centre's ability to operate during and after construction of the Expressway. I have addressed the Medical Centre's submission earlier in my evidence.

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[77] Refer Construction Noise and Vibration Management Plan – CEMP Appendix F, Volume 4 of the AEE at Sections 9 and 11.2 respectively.

Takamore Trust (0703)

108 The Takamore Trust submission notes that it requires procedural and mitigation considerations in relation to noise, dust and vibration and sediment management plans. I consider that this issue would be addressed through the Stakeholder and Communication Management Plan.[78]

Raumati South Residents Association (0707)

109 The Raumati South Residents Association is very similar, and appears to draw from the KCDC submission (0682). I consider that my responses to that submission address also the concerns of the RSRA.

RESPONSE TO SECTION 149G(3) KEY ISSUES REPORTS

110 The Key Issues Report prepared by GWRC[79] does not raise any issues relating to vibration.

111 The Key Issues Report prepared by KCDC[80] mentions the term vibration in several places, but does not raise any issues relating specifically to vibration.

James Whitlock
3 September 2012

[78] Refer Stakeholder Communication Management Plan – CEMP Appendix S, Volume 4 of the AEE.

[79] Greater Wellington Regional Council dated 11 June 2012.

[80] Kāpiti Coast District Council dated 8 June 2012.

ANNEXURE A: PROPOSED DESIGNATION CONDITIONS[81]

<table>
<tr><th>Ref</th><th>Draft condition</th></tr>
<tr><td>DC.31</td><td>
The Requiring Authority shall implement the vibration management and mitigation measures identified in the certified CVNMP. Construction vibrations shall, as far as practicable, be made to comply with the following criteria in accordance with the draft NZTA <u>State highway construction and maintenance noise and vibration guide,</u> <u>July 2012 / version 0.5 DRAFT</u> ~~vibration guide~~ <u>(or any subsequent revision of this document)</u>:
<table>
<tr><th>Receiver</th><th>Details</th><th>Category A</th><th>Category B</th></tr>
<tr><td rowspan="2">Occupied dwellings</td><td>Night time 2000h – 0630h</td><td>0.3 mm/s PPV</td><td>1 mm/s PPV</td></tr>
<tr><td>Daytime 0630h – 2000h</td><td>1 mm/s PV</td><td>5 mm/s PPV</td></tr>
<tr><td>Other occupied buildings*</td><td>Daytime 0630h – 2000h</td><td>2 mm/s PPV</td><td>5 mm/s PPV</td></tr>
<tr><td>All other buildings</td><td>Vibration – continuous**</td><td>5 mm/s PPV</td><td>50% of Line 2 values in Table B.2 of BS 5228-2:2009</td></tr>
</table>
* ‘Other occupied buildings’ is intended to include daytime workplaces such as offices, community centres etc, and not industrial buildings. Schools, hospitals, rest homes etc would fall under the occupied dwellings category.
** This line addresses ‘continuous’ or ‘long-term’ vibration as there are no construction machinery proposed which produces transient vibration.
(a) Measurements of construction vibration shall be undertaken in accordance with German Standard DIN 4150-3:1999 “Structural Vibration Part 3: Effects of vibration on structures”.
(b) If measured or predicted vibration levels exceed the Category A criteria then a suitably qualified expert shall be engaged to assess and manage construction vibration and to comply with the Category A criteria. If the Category A criteria cannot be practicably achieved, the Category B criteria shall be applied.
</td></tr>
</table>

[81] As contained in the lodged application, but with proposed amendments with additions shown as underlined and deletions shown as strike through.

	(c) If measured or predicted vibration levels exceed Category B criteria, then construction activity shall only proceed if there is continuous monitoring of vibration levels and effects on buildings at risk of exceeding the Category B criteria, by suitably qualified experts. (d) Where the Category B criteria set out above cannot be met, the process of Condition DC.33 shall be followed.
DC.33	(a) Where the Category B criteria of Condition DC.31 cannot practicably be met, the Requiring Authority shall prepare Site Specific Construction Vibration Management Plans (SSCVMPs) in accordance with the certified CNVMP. The SSCVMP shall describe site specific vibration risks and mitigation measures required, which shall be in addition to the general mitigation measures notes in the certified CVNMP. (b) Each SSCVMP shall be submitted to the Manager for certification at least 5 working days prior to the relevant construction activity commencing.
DC.34	Prior to the commencement of Project construction operations, a detailed pre-construction building survey of at-risk buildings, services and structures (as identified in the certified CNVMP) shall be conducted by a suitably qualified engineer. A report of each survey shall be forwarded to the Manager within one week of the assessment.
DC.36	The detailed design of any structural construction noise or vibration mitigation measures (e.g. temporary construction noise barriers) as identified in the certified CVNMP shall be undertaken by a suitably qualified acoustics specialist, and shall be implemented prior to commencement of construction within 100m of such miutigation.
DC.49	The NZTA system for monitoring and maintaining the condition of State Highway pavements and road surfaces~~policy for road roughness~~ shall be applied in order to minimise the risk of operation vibration issues.