**BEFORE INDEPENDENT COMMISSIONERS**

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| **IN THE MATTER** | of the Resource Management Act 1991 |
| **AND** | |
| **IN THE MATTER** | of submissions by Waka Kotahi New Zealand Transport Agency (**"Waka Kotahi"**) (submitter S370, further submitter FS103) and KiwiRail Holdings Ltd (**"KiwiRail"**) (submitter S408, further submitter FS72) on the Wellington City Proposed District Plan (**"PDP"**) |

**STATEMENT OF EVIDENCE OF STEPHEN CHILES ON BEHALF OF WAKA KOTAHI NZ TRANSPORT AGENCY AND KIWIRAIL HOLDINGS LIMITED**

**ROAD AND RAIL NOISE AND VIBRATION**

## 1. INTRODUCTION

1.1 My full name is Dr Stephen Gordon Chiles. I have the qualifications of Doctor of Philosophy in Acoustics from the University of Bath and Bachelor of Engineering in Electroacoustics from the University of Salford, UK. I am a Chartered Professional Engineer and Fellow of the UK Institute of Acoustics.

1.2 I am self-employed as an acoustician through my company Chiles Ltd. I have been employed in acoustics since 1996, as a research officer at the University of Bath, a principal environmental specialist for Waka Kotahi, and a consultant for Arup, WSP, and URS, Marshall Day Acoustics and Fleming & Barron. I am contracted as the principal advisor to provide the Environmental Noise Analysis and Advice Service to the Ministry of Health and Te Whatu Ora - Health New Zealand.

1.3 I have been involved in many situations relating to noise effects on new or altered sensitive activities around existing infrastructure. I was an Independent Commissioner for plan changes for Queenstown and Wanaka Airports and a plan variation for Port Nelson, which dealt particularly with noise effects. I have previously been engaged to advise Waka Kotahi and Auckland

Transport (roads), KiwiRail (railways), Christchurch City Council (airport) and Environment Canterbury (port) on reverse sensitivity noise issues. I have presented acoustics evidence for Waka Kotahi and KiwiRail on numerous plan changes and plan reviews. I previously drafted potential environmental noise provisions for Clause G6 of the New Zealand Building Code for the Ministry of Business, Innovation and Employment.

1.4 I am convenor of the New Zealand reference group for "ISO" acoustics standards and a member of the joint Australian and New Zealand committee responsible for acoustics standards. I was Chair of the 2012 New Zealand acoustics standards review, Chair for the 2010 wind farm noise standard, and a member for the 2008 general environmental noise standards.

## 2. CODE OF CONDUCT

2.1 I confirm that I have read the Code of Conduct for Expert Witnesses set out in the Environment Court's Practice Note 2023. I have complied with the Code of Conduct in preparing this evidence and will continue to comply with it while giving oral evidence at the hearing. Except where I state that I am relying on the evidence of another person, this written evidence is 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 in this evidence.

## 3. SCOPE OF EVIDENCE

3.1 My statement relates to the Noise chapter of the PDP. I have prepared this statement for KiwiRail and Waka Kotahi as the requiring authorities for the railway and state highway networks in Wellington City.

3.2 The KiwiRail and Waka Kotahi submissions seek that rules in the notified version of the PDP be amended so that they manage adverse effects caused by new and altered buildings containing noise sensitive activities establishing near existing railway and state highway corridors. The purpose of the provisions sought is to protect the health of occupants of new and altered buildings, and in turn to avoid or mitigate potential reverse sensitivity effects on the operations of KiwiRail and Waka Kotahi.

3.3 I attended meetings and have corresponded with the Council officers, Mark Ashby, Malcolm Hunt and Sean Syman, in relation to these submissions. There are some areas where we appear to be aligned on technical details, but there remain a number of areas where the Section 42A report recommends rejecting provisions that I consider necessary to provide protection from road and railway noise and vibration.

3.4 My evidence will address:

(a) noise and vibration effects arising from road and rail infrastructure;

(b) methods to manage adverse effects on new and altered buildings containing sensitive activities near existing infrastructure;

(c) controls that are included in the notified version of the PDP;

(d) the appropriateness of the relief sought by KiwiRail and Waka Kotahi from an acoustics and public health perspective; and

(e) the recommendations of the Council officers in the section 42A report in relation to the relief sought by KiwiRail and Waka Kotahi.

## 4. NOISE AND VIBRATION EFFECTS FROM ROAD AND RAIL INFRASTRUCTURE

4.1 Sound and vibration from road and rail networks have the potential to cause adverse health effects on people living nearby.

*Noise effects*

4.2 In respect of noise, this has been documented by authoritative bodies such as the World Health Organisation (**"WHO"**),[1] including a 2018 publication by WHO Europe ("**2018 WHO Guidelines**"), which sets out guidelines for managing environmental noise.[2] These publications are underpinned by extensive research. I am not aware of any fundamental disagreement in the acoustics profession with the information published by WHO regarding road and rail noise effects.

4.3 Research published in 2019 specifically addressed the applicability of international data on road and rail noise annoyance to New Zealand.[3] This included a survey of people living in the vicinity of the North Island Main Trunk line and separately State Highway 1 in South Auckland, using the same general methodology as most international studies. The research found that international noise annoyance response curves are generally applicable for the New Zealand population. I am currently on the steering groups for two other research projects further investigating these issues: "Community response to noise" and "Social (health) cost of land transport noise exposure in New Zealand".[4]

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1 World Health Organisation, Guidelines for community noise, 1999; World Health Organisation, Burden of disease from environmental noise, 2011.

2 World Health Organisation, Environmental noise guidelines for the European region, 2018.

3 Humpheson D. and Wareing R., 2019. Evidential basis for community response to land transport noise, Waka Kotahi Research Report 656. https://nzta.govt.nz/resources/research/reports/656/.

4 https://www.nzta.govt.nz/planning-and-investment/research-programme/current-research-activity/active-research-projects/.

4.4 From preceding studies, the 2018 WHO Guidelines found evidence that road and railway sound cause adverse health effects in that they increase the risk of ischaemic heart disease, hypertension, annoyance and sleep disturbance in the population. Various other potential health effects were examined but evidence was not available to determine a relationship for them with road and railway sound. Based on the information available the 2018 WHO Guidelines made "strong" recommendations that external road and railway sound levels should be reduced below guideline values. The submissions on the PDP by KiwiRail and Waka Kotahi, to include land use controls for new and altered sensitive activities near road and rail corridors, are consistent with this direction, as an integral part of their broader noise management activities. I describe below some of the steps and actions that Waka Kotahi and KiwiRail implement as part of this management approach.

*Vibration effects*

4.5 Internationally, there has been less research into transportation vibration effects on people compared to research on transportation sound effects. However, the evidence that does exist on adverse health effects caused by vibration, such as annoyance and sleep disturbance, indicates they are material, and as such in my opinion the relative paucity of research is not an indicator of the degree of effects. There is international research ongoing in this area, including into the combination of noise and vibration given that both can cause the same adverse health effects.

4.6 With respect to vibration, Norwegian Standard NS 8176[5] provides a summary of annoyance and disturbance relationships associated with vibration from land-based transport. These relationships show that adverse effects occur at vibration exposures typically found around the existing road and rail networks. This primary issue relates to people in dwellings being disturbed due to feeling vibration, but there is also an interrelated issue that the same vibration can cause buildings to radiate noise inside.

## 5. METHODS TO MANAGE ADVERSE EFFECTS

5.1 I have been involved in different activities undertaken by KiwiRail and Waka Kotahi to manage and reduce sound and vibration where practicable. These include development of quieter road surfaces, installation of ballast mat, installation of noise barriers, rail grinding and tamping, investigation into engine braking noise, and automated monitoring of rolling stock wheel condition. However, even with practicable improvements implemented, the operation of the state highway and railway networks can result in adverse effects which cannot be completely internalised within its typical designation boundaries, such as noise and vibration. These effects commonly occur with the road and railway networks subject to normal maintenance and cannot be solely attributed to defects in road surface, track or rolling stock. In particular, vibration varies significantly

5 Norwegian Standard NS 8176:2017 Vibration and shock - Measurement of vibration in buildings from landbased transport and guidance to evaluation of its effects on human beings.

depending on ground conditions and localised features such as buried services and structures. Even with "good" ground, road/track and rolling stock conditions there is still inherent vibration that can cause disturbance to activities in proximity to the road and rail corridors.

5.2 As these effects cannot be completely internalised within the corridor, in my opinion there must be appropriate land use controls in place to manage sensitive development near these transport corridors. Land use controls to avoid or manage adverse noise and vibration effects on new sensitive activities or alterations to such activities are critical in protecting sensitive activities from adverse noise and vibration effects. Such controls, in turn, are fundamental to managing the potential for both health impacts on those located near the rail and road networks, and reverse sensitivity effects on those networks.

5.3 If it is not practicable to avoid sensitive activities near road and rail corridors, for new buildings being constructed, or existing buildings being altered, it is relatively straight-forward to control internal sound and vibration through the building location, design and systems (like acoustic insulation and mechanical ventilation). In most cases, it is practical to achieve acceptable internal sound and vibration levels using such measures. Thus, with careful design of building location, orientation and materials, future occupants of the building can be protected from the most significant adverse effects associated with road and railway sound and vibration.

5.4 Rules in district plans commonly control the location and design of sensitive activities such as housing, where such activities seek to locate near existing sound sources such as roads, railways, airports, ports, quarries, industrial sites, industrial and business zones, gun clubs and motorsport facilities. For new houses near existing roads and railways, examples of second-generation operative district plans containing controls include: Christchurch, Dunedin, Tauranga, Hamilton, Palmerston North, Whangarei and Hutt City. In all these example plans there are requirements to achieve reasonable internal noise levels in sensitive spaces near roads and railways. Other aspects of the controls vary between these plans.

## 6. NOTIFIED PDP

6.1 In the notified version of the PDP, NOISE-R3 and NOISE-S4/S5/S6 detail sound insulation and ventilation requirements for noise sensitive activities seeking to establish in a wide range of noisy environments, including near state highways and railways. These provisions partially address the effects I have discussed above, but there are significant gaps in the notified version that would leave people in new and altered buildings exposed to road and rail noise and vibration above guideline values. There are also gaps arising from what appear to be essentially drafting issues.

6.2 The PDP sets two categories of sound insulation for high noise areas (NOISE-S4) and moderate noise areas (NOISE-S5). Within each of these areas the same sound insulation is required for all parts of a building. Thus, the resulting internal levels will vary depending on the external noise exposure, such that within each type of noise area (moderate or high), buildings closer to a road or railway will generally have higher internal levels than those further away. Within individual buildings, spaces facing the road or railway will generally have higher levels than those facing the opposite direction. In my opinion this is an inefficient and partially ineffective approach to controlling road and railway noise because many parts of buildings are required to provide more sound insulation than needed to achieve appropriate internal levels, but the most exposed parts may not have sufficient sound insulation.

6.3 The PDP standard NOISE-S6 sets ventilation requirements where windows need to be closed to achieve indoor road and rail noise criteria. There appears to be a drafting error in that this standard is only applied under NOISE-R3 in moderate but not high noise areas. Furthermore, the ventilation required under NOISE-S6 does not include measures to provide thermal comfort for occupants when windows are closed. Therefore, windows might need to be opened, which would compromise the sound insulation and could result in excessive indoor noise.

6.4 The notified version of the PDP does not include any controls for new and altered buildings affected by road and railway vibration.

## 7. RELIEF SOUGHT

7.1 Waka Kotahi and KiwiRail submitted in support of the inclusion of land use controls for sensitive activities near road and rail corridors, but with amendments to address various gaps identified in the notified provisions.

*Extent of controls for road noise*

7.2 Waka Kotahi submitted that NOISE-R3.2 should be amended so that the moderate noise area extends to 100 metres from state highways rather than 80 metres in the notified version. Alternatively, Waka Kotahi submitted that the extent could be defined based on noise contours.

7.3 I have reviewed noise modelling of the national state highway network conducted by AECOM as part of a research project[6], based on input data reflecting 2020/21 conditions. In that modelling the 54 dB $L_{Aeq(24h)}$ noise contour extends beyond 100 metres along much of SH1 and SH2. Based on NZS 6806[7], a reasonable internal road noise level is 40 dB $L_{Aeq(24h)}$ and this typically corresponds to outdoor road noise levels of 57 dB $L_{Aeq(24h)}$, with windows ajar for ventilation. Allowing for a 3 dB tolerance in measurements or predictions, I consider the controls should extend to areas predicted to be exposed to outdoor road noise above 54 dB $L_{Aeq(24h)}$. In some

[6] Social (health) cost of land transport noise exposure in New Zealand, https://www.nzta.govt.nz/planning-and-investment/research-programme/current-research-activity/active-research-projects/.
[7] NZS 6806:2010 Acoustics – Road-traffic noise – New and altered roads.

areas, such as where there is screening by buildings or the terrain, the modelled distance is less than 100 metres and in some areas, the modelled distance is larger than 100m. Applying land use controls to all areas within 100 metres of state highways would cover the most affected areas. Technically, there could be scope to reduce the distance in some locations. The modelled noise contours provide clarity regarding the areas where that reduction would be appropriate.

*Internal noise limits for rail noise*

7.4 KiwiRail submitted that the notified provisions should be amended so that rather than specifying sound insulation of buildings affected by rail noise, resulting internal noise limits should be specified. I set out the technical details of this issue in Section 1 of Appendix A to my evidence. Using internal rail noise levels allows account to be taken of the specific external noise exposure of each building, room and façade, and allows for the most efficient design option to be adopted. In my opinion this approach is also preferable for road noise as it has similar characteristics in this respect.

*Basis for external noise assessment*

7.5 KiwiRail and Waka Kotahi submitted that the basis for determining external noise levels should be specified. Due to the potential variability of rail noise, KiwiRail sought fixed assumptions for rail source levels as set out in Section 2 of Appendix A to my evidence. Waka Kotahi sought for road noise to be based on measured or predicted levels, but with a 3 dB allowance applied for uncertainty and future changes to road or traffic conditions.

*Ventilation requirements*

7.6 Waka Kotahi and KiwiRail submissions seek for ventilation controls to be applied to all buildings affected by road and rail noise, and for the requirements to provide thermal comfort so that windows do not need to be opened. The submissions also seek inclusion of requirements for user controls and limitations on ventilation system self-noise.

*Vibration controls*

7.7 The Waka Kotahi and KiwiRail submissions seek rules to require maximum road and rail vibration of 0.3 mm/s $v_{w,95}$ inside buildings for sensitive activities. This criterion corresponds to exposure where about 20% of people would be expected to be highly or moderately annoyed by vibration. I consider 0.3 mm/s $v_{w,95}$ to be a minimum standard that should be achieved in new buildings near roads and railways for reasonable protection from adverse health effects.

7.8 Rail vibration is generally greater than road vibration. KiwiRail sought vibration controls within 60 metres of rail corridors and Waka Kotahi sought vibration controls within 20 metres of state highways.

7.9 Railway vibration is generally subject to greater variability between locations than noise, due to complex interactions between localised track/ground conditions and buildings. As an indication, the following table summarises various railway vibration measurements (and associated predictions) in New Zealand from a range of sources, generally ordered from lowest to greatest magnitude (other than the first row which uses the ppv metric rather than $v_{w,95}$). Where the data relates to a private development or complaint, a generic source reference is given. Not all measured values are directly comparable due to issues such as differences in measurement positions (ground/building) that would require adjustments.

| Data source | Vibration levels |
|---|---|
| Marshall Day Acoustics, *Ontrack rail noise criteria reverse sensitivity guidelines*, 22/10/09<br>*(secondary reporting of Marshall Day Acoustics 2006 assessment for Marsden Point)* | Based on measurements:<br>2 to 3 mm/s ppv at 30m<br>0.5 to 1 mm/s ppv at 60m |
| AECOM, *Bayfair to Bayview – Rail Relocation Post Construction Noise and Vibration Monitoring*, 6/3/17 | Measured:<br>0.56 mm/s $v_{w,95}$ at 7m<br>From measurement and distance correction:<br>0.19 mm/s $v_{w,95}$ at 100m<br>0.26 mm/s $v_{w,95}$ at 50m<br>0.37 mm/s $v_{w,95}$ at 25m |
| Marshall Day Acoustics, *Wiri to Quay Park third main rail line noise and vibration assessment*, 10/7/20 | Measured:<br>0.6 mm/s $v_{w,95}$ at 9.5m |
| URS, *Maunganui-Girven Road Intersection -Rail Vibration Assessment*, 14/4/14 | Measured:<br>26.5 mm/s$^2$ $a_{w,95}$ at 17m<br>*(this $a_{w,95}$ value has different units and is not directly comparable to a $v_{w,95}$ value)*<br>From measurement and distance correction:<br>0.34 mm/s $v_{w,95}$ at 100m<br>0.47 mm/s $v_{w,95}$ at 50m<br>0.67 mm/s $v_{w,95}$ at 25m |
| URS, *Operational noise and vibration assessment Peka Peka to North Ōtaki Expressway Project*, 12/2/13 | Measured:<br>0.58 mm/s $v_{w,95}$ at 60m |
| Marshall Day Acoustics, *assessment in relation to a complaint near Hamilton*, 28/11/12 | Measured (on a deck structure):<br>0.42 mm/s $v_{w,95}$ at 140m |
| Marshall Day Acoustics, *assessment for development in Napier*, 6/2/20 | Measured:<br>1.2 mm/s $v_{w,95}$ at 10m |
| URS, *Ground-borne vibration measurements at Hornby, Christchurch,* 12/9/14 | Measured before renewal:<br>2.2/2.9 mm/s $v_{w,95}$ at 8.4m<br>Measured after renewal:<br>0.5/0.4 mm/s $v_{w,95}$ at 8.4m |

7.10 The data in the above table illustrates the significant variation that is inherent in railway vibration. With respect to the criterion of 0.3 mm/s $v_{w,95}$, the measurement data shows that this criterion can routinely be exceeded at over 100 metres from railway tracks in New Zealand, but there is significant variation. Vibration levels exceeding this criterion occur beyond 60 metres from the track in most cases.

7.11 For application of land use controls, from a technical perspective it would be preferable to assess all sites within 100 metres or more of rail corridors. However, KiwiRail has limited proposed controls to 60 metres in its submission on a pragmatic basis, also in recognition of the significant variability in vibration levels.

7.12 The KiwiRail submission seeks an option in the proposed vibration provisions to use a construction specification for a vibration isolation bearing. This can be applied for simple buildings (i.e. single-storey framed residential buildings) as an alternative to conducting a site/building specific assessment. From a technical perspective, I recommend a site-specific assessment in all instances due to the variability of vibration and building designs. As such, I consider the construction specification part of the proposed rule could be omitted. However, if a compliance option is desired that does not require site-specific assessment, then the construction specification should provide reasonable vibration isolation such that vibration inside most buildings is likely to be less than 0.3 mm/s $v_{w,95}$.

## 8. SECTION 42A REPORT

8.1 Mr Ashby has relied on the technical evidence of Mr Hunt and Mr Syman, both dated 3 July 2023. I will address matters they raise in their individual statements relating to road and rail noise and vibration.

*Evidence of Mr Hunt*

8.2 In paragraphs 77 to 80 of his evidence, Mr Hunt discusses the distance for application of road noise controls. He supports amendment of NOISE-R3 to apply controls within 100 metres of state highways, but only where the speed limit is above 70 km/h. I agree with Mr Hunt that this distance is primarily warranted where the speed limit is above 70 km/h. However, there is a potential ambiguity with the term ‘posted’ speed limit in the wording recommended in the Section 42A report, in relation to the variable speed limits that apply on SH1 north from the Terrace Tunnel. I recommend that the wording should be adjusted to make clear that the 100 metre distance applies to all sections of state highway with a variable speed limit as well as where there is a fixed speed limit above 70 km/h.

8.3 Mr Hunt recommends reducing the extent of controls for road noise to 40 metres where the speed limit is less than 70 km/h. This would apply to SH1 between the Terrace Tunnel and the airport. I agree with Mr Hunt that in practice a 40 metre distance would be sufficient in most of these areas due to the screening by buildings. I note that this amendment wouldn’t actually have an effect between the Terrace Tunnel and the Basin Reserve because surrounding land in the City Centre Zone would remain in a moderate noise area regardless.

8.4 In paragraphs 81 to 83 Mr Hunt discusses the alternative option of using noise contours to define where controls apply, which he would prefer. Waka Kotahi has drafted a candidate overlay based on noise contours. At the time of preparing my evidence, GIS corrections to various modelling artefacts in the overlay have not yet been completed. Once completed I agree with Mr Hunt that the overlay based on noise contours could be an appropriate alternative to set distances.

8.5 In paragraphs 84 and 85 of his evidence Mr Hunt discusses the 3 dB allowance sought by Waka Kotahi to be applied to external road noise measurements or predictions. Mr Hunt considers that 3 dB is excessive to allow for traffic growth and that 2 dB would be appropriate. I agree with Mr Hunt that 3 dB would generally be excessive for traffic growth, but that is not the sole basis for Waka Kotahi seeking that value. The most significant factor is the inherent uncertainty in all sound level measurements and predictions. In reality, the uncertainty from all relevant factors exceeds 3 dB, but in my opinion this is a pragmatic compromise value that should be used to avoid erroneous exclusion of certain sites/buildings from the sound insulation controls.

8.6 In paragraphs 101 to 117 of his evidence Mr Hunt discusses ventilation requirements. Mr Hunt recommends amendment of NOISE-S6 to include more comprehensive requirements than the notified PDP, but in some circumstances more lenient than those sought by Waka Kotahi and KiwiRail. The provisions sought by Waka Kotahi and KiwiRail are largely based on advice I previously commissioned for Waka Kotahi.[8] I do not have expertise in mechanical engineering so am unable to comment on the amendments recommended by Mr Hunt.

*Evidence of Mr Syman*

8.7 In paragraphs 18 to 28 of his evidence, Mr Syman discusses rail noise controls and recommends that building sound insulation should continue to be specified rather than internal noise levels. I disagree with Mr Syman for the reasons I have discussed above and set out in Appendix A, in that I consider specifying internal noise levels is a more efficient and effective approach.

8.8 In paragraph 21 Mr Syman states that using indoor noise limits would be inconsistent with the rest of the Noise chapter. I agree that consistent noise rules are preferable when addressing similar situations. However, in this instance there is a significant difference in the noise sources, and I consider that a different approach is required. The rules that Mr Syman is seeking consistency with are for sound insulation in general 'noisy' zones, where protection is being provided from noise coming from any other site/location. The actual existence, location and characteristics of current or future noise sources is unknown. Therefore, uniform sound insulation requirements for all façades of all buildings may be warranted. This is fundamentally different to rail noise (and also road noise) which comes from a known location, affects one side of buildings significantly more than the other, and affects nearer buildings more than those further away. In

[8] Beca, Ventilation systems installed for road-traffic noise mitigation, 26 June 2014

my opinion, the general preference for consistency should not apply to this situation addressing different issues.

8.9 In paragraphs 22 and 23 of his evidence Mr Syman comments on the need for known external rail noise levels. This matter is addressed by the noise source levels specified in the provisions proposed by KiwiRail.

8.10 In paragraph 27 of his evidence Mr Syman comments on the relative rail noise from passenger and freight lines. As set out in Appendix A, the rail noise source level in the provisions proposed by KiwiRail was originally derived as being approximately equivalent to the noise level from lines with regular passenger movements.

8.11 In paragraphs 29 to 37 of his evidence Mr Syman discusses rail vibration. While acknowledging that rail vibration is an issue, he raises various practical concerns. I have addressed some of these matters, such as indicative vibration levels in paragraph 7.9 above.

8.12 I agree with Mr Syman that vibration assessment and control can be complicated. However, based on the evidence of typical rail vibration exposures and potential adverse health effects, in my opinion controls are required if introducing new and altered sensitive activities to this environment.

8.13 In paragraph 34 of his evidence Mr Syman notes that he is unaware of any requirements for KiwiRail to maintain track condition. I am aware that KiwiRail has comprehensive procedures relating to track condition including measurement of track condition/geometry with a specialist survey vehicle, several times a year, and maintenance systems acting on that data.

8.14 In paragraphs 38 to 44 of his evidence Mr Syman discusses road vibration. He raises similar practical concerns as for rail vibration, and for the above reasons, I disagree that controls should be omitted on this basis.

8.15 In paragraph 41 of his evidence Mr Syman states that vibration from a well maintained road can generally meet the proposed vibration criterion 2 metres from the road. In 2010 I arranged comprehensive vibration measurements at four distances from SH1 in Linden. The measured road surface roughness showed this section of road to be in good condition at the time, and it did not have service covers and had not been excavated over time for service installations. At that location the vibration criterion was exceeded at 5 metres from the road but achieved at 7 metres from the road. In other areas, road pavements generally have numerous buried services, often service covers, and road surface features. For existing roads, these issues do not necessarily represent a degraded state or maintenance defects. In my experience, road vibration levels are generally higher in urban areas where there are intersections and turning movements and where the road corridor is the primary route for buried services. For roads subject to normal maintenance, in my experience the vibration criterion may be exceeded within 20 metres of a road and controls are warranted.

## 9. CONCLUSIONS

9.1 Noise and vibration from road and rail corridors can give rise to adverse health effects on sensitive land uses located nearby. The research and guidelines relating to these effects are widely accepted internationally and applied in New Zealand.

9.2 Waka Kotahi and KiwiRail continuously work to reduce existing noise and vibration exposure and to manage the effects of their operations on existing sensitive activities. However, due to the nature of their operations, Waka Kotahi and KiwiRail (as with many large infrastructure providers) are unable to internalise all noise and vibration effects associated with their activities.

9.3 Adverse effects on new and altered buildings for sensitive activities can be avoided and managed through well understood controls in district plans. Waka Kotahi and KiwiRail made submissions on the PDP seeking amendments to address gaps in controls included in the notified provisions. I consider that the relief sought by Waka Kotahi and KiwiRail as refined in Appendix A to the evidence of Catherine Heppelthwaite appropriately address these issues.

**Stephen Chiles**
**18 July 2023**

## Appendix A

### 1. Internal noise limits for rail noise

If new and altered sensitive activities are allowed near railways, then to manage potential health effects, controls are needed to result in appropriate design of buildings or effective screening and separation of those buildings from the railway.

Several different methods have previously been used in RMA plans. Two common approaches are:
a) setting internal sound and vibration limits; or
b) specifying building constructions directly or in terms of sound reduction performance.

The first approach requires a site-by-site assessment and tailored mitigation for each development, whereas the second approach requires the same mitigation for all developments. The first requires specialist acoustics expertise whereas the second does not if specifying building constructions directly.

Potential health effects have been shown to occur (or be more likely) above certain sound and vibration threshold levels inside buildings. There are a large number of variables that determine external railway sound and vibration exposure and there are nuances with building siting/layout and design that affect the internal levels. Controls that require the same mitigation for all developments result in excess treatment in many cases and inadequate treatment for those developments most exposed (nearest to the railway). Technically, setting internal sound and vibration criteria and requiring a site-by-site assessment should be the most efficient and effective approach.

In the Christchurch District Plan, multiple compliance options were included for mitigating road and rail noise in buildings for new sensitive activities. On review of the controls the Council found that in most cases site-specific assessment was selected by developers rather than fixed mitigation (i.e. following a standard building design schedule or fixed sound reduction performance).[9] This was presumably as despite any specialist assessment costs the site-specific assessment provided a more efficient solution.

### 2. Basis for external noise assessment

Railway sound levels are dependent on train types/condition, traffic volumes, speeds, track geometry/condition, terrain and various other factors. With full geospatial details and information on railway activity, various standard acoustics computer modelling packages are available to predict railway sound levels for a specific situation. There is currently no standardised approach to this modelling for railway sound in New Zealand or consistent use of a particular calculation algorithm. Consequently, even with the same input data, predictions are likely to vary when made by different practitioners.

The following provides an illustration of typical railway sound levels based on an assumption of approximately two freight train movements in a one-hour period, in a flat area without screening. This is based on data summarised by Marshall Day Acoustics.[10] More recent (unpublished) measurements for various New Zealand train types confirm these sound levels are in a realistic range.

[9] Christchurch District Plan, Plan Change 5E
[10] Marshall Day Acoustics, *Ontrack rail noise criteria reverse sensitivity guidelines*, 22/10/09

| Distance from track | Sound level |
|---|---|
| 10 metres | 71 dB $L_{Aeq(1h)}$ |
| 20 metres | 68 dB $L_{Aeq(1h)}$ |
| 30 metres | 66 dB $L_{Aeq(1h)}$ |
| 40 metres | 64 dB $L_{Aeq(1h)}$ |
| 50 metres | 62 dB $L_{Aeq(1h)}$ |
| 60 metres | 60 dB $L_{Aeq(1h)}$ |
| 70 metres | 59 dB $L_{Aeq(1h)}$ |
| 80 metres | 58 dB $L_{Aeq(1h)}$ |
| 90 metres | 56 dB $L_{Aeq(1h)}$ |
| 100 metres | 56 dB $L_{Aeq(1h)}$ |

In the Marshall Day Acoustics report which generated the above levels, this sound level assumption of 2 freight train movements in a one-hour period was originally proposed as being approximately equivalent to the sound level from lines with regular passenger trains. It was not intended to apply in settings which actually experienced two freight train movements per hour across a day. Instead the intention of the average is to provide an approximation of both the effects of a single event, and a generalised average of noise from the corridor. The report considered a single measurement would enable simpler application of the rule framework by landowners (compared to an average and maximum approach which was considered to add extra complication without significant benefits in effects management given the variability of single train pass-bys).