BEFORE INDEPENDENT COMMISSIONERS

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 S50) and KiwiRail Holdings Ltd (**"KiwiRail"**) (submitter S43) on an Intensification Planning Instrument (**"IPI"**) as a proposed plan change to the Operative Upper Hutt City District Plan (**"ODP"**)

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 IPI, and in particular to potential effects of road and railway noise and vibration on new and altered sensitive activities enabled by intensification provisions. I have prepared this statement for KiwiRail and Waka Kotahi as the requiring authorities for the Wairarapa Line and State Highway 2 (**"SH2"**) respectively that pass through Upper Hutt City.

3.2 KiwiRail and Waka Kotahi made submissions on the IPI to apply land use controls to new and altered sensitive activities within 100 metres of road and rail corridors. The submissions essentially seek the same framework of controls in terms of managing noise and vibration effects, with some variation in criteria and distances between road and rail. 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 Mr Muspratt discusses these aspects of the KiwiRail and Waka Kotahi submissions in Section 32 of the Council's Evidence Report. He recommends rejection of the relief sought in part citing lack of technical evidence. Mr Muspratt does not report having received any expert acoustics advice in reaching his position on these matters and no acoustics evidence has been filed by the Council.

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; and

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

3.5 Waka Kotahi is no longer pursuing controls for road vibration and therefore I will not address that matter in my evidence.

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]

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,

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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/

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 IPI 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.

Railway 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 railway vibration 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. Research is also investigating health effects arising from the combination of railway sound and vibration.

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 rail network. 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, railway vibration varies significantly depending on ground conditions and localised features such as buried services and structures.

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.

Even with "good" ground, track and rolling stock conditions there is still inherent vibration from railways that can cause disturbance to activities in proximity to the rail corridor.

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. RELIEF SOUGHT

Indoor noise and vibration criteria

6.1 Waka Kotahi and KiwiRail submissions seek rules to set maximum road and rail noise levels to be met in bedrooms of 40 dB $L_{Aeq(24h)}$ and 35 dB $L_{Aeq(1h)}$ respectively. The WHO 2018 Guidelines recommend criteria of 45/44 dB L_{night} but applied outside buildings and averaged over the night period for a year. These WHO values assume windows may be open, resulting in internal sound levels of around 30 dB. The respective averaging time periods for the $L_{Aeq(24h)}$, $L_{Aeq(1h)}$ and L_{night} need to be accounted for when comparing values. When adjusting to comparable time periods, the proposed road and rail noise criteria for bedrooms are slightly higher (more lenient) than the 45/44 dB L_{night} WHO recommendation. I consider this a pragmatic approach to address the most significant adverse health effects, without imposing significant constraints on development of

noise sensitive activities. Likewise, I consider the range of indoor noise criteria proposed in the submissions for other sensitive activities to be appropriate based on general consistency with guideline levels in AS/NZS 2107[6].

6.2 Both Waka Kotahi and KiwiRail submissions seek a requirement for ventilation systems to be installed if windows need to be closed to achieve internal noise criteria. Otherwise, if occupants need to open windows to achieve adequate thermal comfort, the windows cannot be relied on to be closed to reduce road and rail noise.

6.3 The KiwiRail submissions seek rules to require maximum road and rail vibration of 0.3 mm/s $v_{w,95}$ ("Class C") inside buildings for sensitive activities. This criterion comes from NS 8176, which defines four categories of vibration exposure in residential buildings, with Class A representing the best vibration conditions and Class D (or below) representing the worst. The Class C criterion has previously been applied in New Zealand for habitable spaces in new buildings. This corresponds to a vibration level at which 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 railways for reasonable protection from adverse health effects.

Distance for application of rail noise controls

6.4 KiwiRail's submission seeks to apply land use controls for noise within 100 metres of rail corridors. The indoor rail noise criteria of 35 dB $L_{Aeq(1h)}$ (bedrooms) and 40 dB $L_{Aeq(1h)}$ (other habitable spaces), typically correspond to outdoor rail noise levels of 50 to 55 dB $L_{Aeq(1h)}$, with windows ajar for ventilation. Therefore, controls are warranted in areas exposed to outdoor rail noise above 50 dB (bedrooms) or 55 dB (other spaces).

6.5 Railway sound levels are dependent on train types/condition, traffic volumes, speeds, track geometry/condition, terrain and various other factors. There will be variation in noise exposure along the length of the Wairarapa Line in Upper Hutt City. However, the following table 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. [7] I am familiar with more recent (unpublished) measurements for various New Zealand train types, which confirm these sound levels are in a realistic range.

[6] Standards New Zealand AS/NZS 2107:2016 Acoustics – Recommended design sound levels and reverberation times for building interiors
[7] 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 $L_{Aeq(1h)}$

6.6 I understand from KiwiRail that the Wairarapa Line through Upper Hutt City has scheduled freight movements, including at night, in addition to passenger services. Considering the combination of freight and passenger services I consider that the indicative levels in the table above provide a reasonable basis to evaluate where land use controls should apply in this instance. It can be seen from the table that application of the rule to all areas within 100 metres of the rail corridor would cover most areas likely to be exposed above 55 dB $L_{Aeq(1h)}$. In my opinion this is necessary to manage potential adverse health effects on people in new and altered buildings.

Distance for application rail vibration controls

6.7 KiwiRail's submission seeks to apply land use controls for vibration within 60 metres of rail corridors. 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 *(secondary reporting of Marshall Day Acoustics 2006 assessment for Marsden Point)*	Based on measurements: 2 to 3 mm/s ppv at 30m 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: 0.56 mm/s $v_{w,95}$ at 7m From measurement and distance correction: 0.19 mm/s $v_{w,95}$ at 100m 0.26 mm/s $v_{w,95}$ at 50m 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: 0.6 mm/s $v_{w,95}$ at 9.5m
URS, *Maunganui-Girven Road Intersection -Rail Vibration Assessment*, 14/4/14	Measured: 26.5 mm/s^2 $a_{w,95}$ at 17m *(this $a_{w,95}$ value has different units and is not directly comparable to a $v_{w,95}$ value)* From measurement and distance correction: 0.34 mm/s $v_{w,95}$ at 100m 0.47 mm/s $v_{w,95}$ at 50m 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: 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): 0.42 mm/s $v_{w,95}$ at 140m
Marshall Day Acoustics, *assessment for development in Napier*, 6/2/20	Measured: 1.2 mm/s $v_{w,95}$ at 10m
URS, *Ground-borne vibration measurements at Hornby, Christchurch,* 12/9/14	Measured before renewal: 2.2/2.9 mm/s $v_{w,95}$ at 8.4m Measured after renewal: 0.5/0.4 mm/s $v_{w,95}$ at 8.4m

6.8 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.

6.9 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.

Distance for application of road noise controls

6.10 Waka Kotahi's submission seeks to apply land use controls for road noise within 100 metres of the SH2 corridor, potentially with the distance reducing depending on traffic volume, composition, speed and road surface type. The main indoor road noise criterion of 40 dB $L_{Aeq(24h)}$, typically corresponds to outdoor road noise levels of 57 dB $L_{Aeq(24h)}$, with windows ajar for ventilation. Unlike for rail noise where the source level is specified, as road noise could be based on measurements or predictions a tolerance of 3 dB is required and therefore, controls are warranted in areas predicted to be exposed to outdoor road noise above 54 dB $L_{Aeq(24h)}$.

6.11 I have reviewed noise modelling of the national state highway network conducted by AECOM as part of a research project, 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 SH2. In some areas where there is screening by buildings the distance is less than 100 metres. Applying land use

controls to all areas within 100 metres of SH2 would cover the most affected areas. Technically, there could be scope to reduce the distance in some locations.

7. CONCLUSIONS

7.1 Sound 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.

7.2 Waka Kotahi and KiwiRail continuously work to reduce existing sound 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.

7.3 Adverse effects on new and altered to buildings for sensitive activities can be avoided and managed through well understood controls in district plans. Waka Kotahi and KiwiRail made submissions on the IPI seeking such controls within 100 metres of the Wairarapa Line and SH2 in Upper Hutt City. 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
19 April 2023