Before the Hearings Commissioners

Under	the Resource Management Act 1991 (the **RMA**)
In the matter of	a submission by KiwiRail Holdings Limited (**KiwiRail**) (submitter 233) on Hearing 3 Noise
and in the matter of	The Proposed Waitaki District Plan (**Proposed Plan**)

Primary statement of evidence of Catherine Lynda Heppelthwaite regarding Hearing Stream 3 of the Proposed Plan

Dated 8 October 2026

1 INTRODUCTION, QUALIFICATIONS AND EXPERIENCE

1.0 My full name is Catherine Lynda Heppelthwaite. I am a principal planner for Eclipse Group Limited. I am presenting this planning evidence on behalf of KiwiRail.

1.1 I hold a Bachelor's Degree in Resource Studies obtained from Lincoln University in 1993. I am a full member of the New Zealand Planning Institute, a member of the Resource Management Law Association and the Acoustical Society of New Zealand. I have more than 25 years' experience within the planning and resource management field, which has included work for local authorities, central government agencies, private companies and private individuals. Currently, I am practising as an independent consultant planner and have done so for the past 18 years.

1.2 I have extensive experience with preparing submissions and assessing district plan provisions in relation to noise and vibration, most recently in relation to the New Plymouth, Christchurch, Porirua, Far North and Whangarei District Plans where I assisted KiwiRail by providing specialist planning evidence on similar issues.

2 CODE OF CONDUCT

2.0 I have read the Environment Court's Code of Conduct for Expert Witnesses (2023) and I agree to comply with it. My qualifications as an expert are set out above. I confirm that the issues addressed in this brief of evidence are within my areas of expertise. I have not omitted to consider material facts known to me that might alter or detract from the opinions expressed.

3 SCOPE OF EVIDENCE

3.0 My evidence will address the following:

a. the statutory and higher order planning framework;

b. KiwiRail's submissions in relation to noise (including associated definitions) in the Proposed Plan;

c. the recommendations in the Section 42A Report for Noise prepared by Ms Belgrave;[1]

d. further amendments required to the Proposed Plan provisions.

3.1 In preparing my evidence on noise matters, I have also considered the Technical Memorandum of Marshall Day attached to the S42A Report: Noise.[2]

4 STATUTORY AND HIGHER ORDER PLANNING FRAMEWORK

4.0 In preparing this evidence I have specifically considered the following:

a. The purpose and principles of the RMA (sections 5-8);

b. Provisions of the RMA relevant to plan-making and consenting;

c. National Policy Statement Infrastructure 2025 (**NPS-I**);

d. National Policy Statement on Urban Development 2020 (**NPS-UD**);

e. National Planning Standards 2019;

f. Canterbury Regional Policy Statement 2013 (**CRPS**) and the Otago Regional Policy Statement 2021 (**ORPS**) with specific reference to:

i. Canterbury Regional Policy Statement

Objective 5.2.1 Location, Design and Function of Development (Entire Region) Development is located and designed so that it functions in a way that:
1. […]
2. enables people and communities, including future generations, to provide for their social, economic and cultural well-being and health and safety; and which:
[…]
f. is compatible with, and will result in the continued safe, efficient and effective use of regionally significant infrastructure;
g. avoids adverse effects on significant natural and physical resources including regionally significant infrastructure, and where avoidance is impracticable, remedies or mitigates those effects on those resources and infrastructure;
[…]

ii. Otago Regional Policy Statement

[1] Section 42A Report, dated 21 September 2026.
[2] Appendix 4, Memorandum prepared by Stuart Camp and Jon Farren, dated 18 September 2026.

EIT-INF-P7 – Protecting nationally significant infrastructure and regionally significant infrastructure
Protect the efficient and effective operation, maintenance, upgrading and development of nationally significant infrastructure and regionally significant infrastructure by:
(1) to the extent reasonably possible, managing activities, to ensure that of the operation, maintenance, upgrading and development of nationally significant infrastructure or regionally significant infrastructure, is not compromised,
(2) to the extent reasonably possible, managing activities to avoid reverse sensitivity effects on nationally significant infrastructure or regionally significant infrastructure, and
[…]

Anticipated environmental results
EIT-INF-AER3 Nationally significant infrastructure and regionally significant infrastructure is protected from adverse effects, including reverse sensitivity effects caused by incompatible activities.

EIT-TRAN-P23 – Operation of the transport system
The efficient and effective operation of the transport system is maintained by:
(1) […]
(2) avoiding the impacts of incompatible activities, to the extent reasonably practicable, including those that may result in reverse sensitivity effects,

UFD-O1 – Development of urban areas
The development and change of Otago's urban areas occurs in a strategic and coordinated way, which results in well-functioning urban environments, that:
(1) […]
(2) integrate effectively with infrastructure, development infrastructure and additional infrastructure, and surrounding urban areas and rural areas, including by managing reverse sensitivity effects and direct effects on electricity networks, […]

4.1 Ms Belgrave[3] has also identified other relevant statutory provisions in her Section 42A Report and s32 Report which I generally agree with and do not repeat here.

5 SUBMISSIONS

5.0 KiwiRail has a number of submission points allocated to Hearing Stream 3. I have set out below whether these submission points were accepted, accepted

[3] S42A Report: Noise Sections 5 and 6.

in part, or rejected by Ms Belgrave. Where KiwiRail's relief has not been accepted, I address this further in Section 6.

a. KiwiRail sought amendments to the Planning Maps to include a Rail Corridor Noise Control Overlay within 100m of the rail corridor (increased from 80m as notified). No changes to the planning maps are proposed[4] and I address this at section 6 of my evidence.

b. KiwiRail sought a range of amendments relating to the inclusion of a *Vibration Alert Area Overlay* 60m either side of the rail corridor boundary. These included:

    i. A new definition of *Rail Corridor Noise Control Overlay* to support management of rail noise and vibration effects near the rail corridor. Ms Belgrave does not support this relief.[5]

    ii. A new *Rail Vibration Alert Overlay* explanation in the Noise chapter introduction. This is not accepted by Ms Belgrave.[6]

    iii. Amendments to the Planning Maps, to include a *Vibration Alert Area Overlay* 60m either side of the rail corridor boundary. No changes to the planning maps are proposed.[7]

    I address the above at section 6 of my evidence.

c. KiwiRail supported the definition of *Transport Corridor* as notified. Some amendments to this definition are proposed by Ms Belgrave[8] and I address this in Section 6 along with KiwiRail's submission requesting a *Rail Corridor Noise Control Overlay.*

d. KiwiRail supported as notified NOISE-E1 which exempts trains and level crossing warning devices. Ms Belgrave recommends no changes to provisions relating to rail level crossings.[9]

4 S42A Report paragraph 319.
5 S42A Report, paragraph 64.
6 S42A Report, paragraph 64.
7 S42A Report paragraph 319.
8 S42A Report, paragraph 69.
9 S42A Report, paragraph 133.

e. KiwiRail sought to retain NOISE-O2, NOISE-P2, NOISE-P4 and NOISE-P6 as notified. No changes to NOISE-O2, NOISE-P2, NOISE-P3, NOISE-P4 or NOISE-P6 are proposed by Ms Belgrave.

f. KiwiRail sought to retain NOISE-P3 as notified, but Ms Belgrave has recommended an amendment to this provision. I address this at section 6 of my evidence.

g. KiwiRail sought amendments to NOISE-R2 to reflect 100m application of the standard from the rail corridor boundary. Ms Belgrave recommends alterations to the provision which I address at section 6 of my evidence.[10]

h. KiwiRail supported NOISE-S2 as notified and Ms Belgrave recommends no changes.[11]

i. KiwiRail sought to amend NOISE-S3 by ensuring the acoustic controls apply to the rail corridor for sensitive activities. Ms Belgrave recommends alterations to the provision which I address at section 6 of my evidence.[12]

5.1 Ms Belgrave notes that KiwiRail also proposed new objectives and policies to manage reverse sensitivity for the railway corridor.[13] I assume this point has been picked up from Appendix 1 of the S32 Report that was included with KiwiRail's submission.[14] I have conferred with Ms Grinlinton-Hancock and confirm that the provisions included in the S32 Report are not sought as specific relief.

6 ASSESSMENT: SECTION 42A REPORT: NOISE

Planning Maps Rail Corridor Noise Control Overlay

6.0 KiwiRail sought in its submission a mapped Rail Corridor Noise Control Overlay be included in the Proposed Plan, applying within 100m of the rail corridor designation boundary. Ms Belgrave does not support the Rail Corridor Noise Overlay being mapped and prefers the notified framework which uses an offset from the boundary of the rail corridor. She also considers the notified approach

[10] S42A Report, paragraph 217.
[11] S42A Report, paragraph 304.
[12] S42A Report, paragraph 217.
[13] S42A Report paragraph 93.
[14] Attachment A to KiwiRail submission *KiwiRail Holdings Limited Standard Railway Noise and Vibration Reverse Sensitivity Provisions and Section 32 Report 16 August 2023 Report Authors: Louise Taylor and Lisa Thorne.*

can accommodate changes to the rail designation without further amendment to the District Plan.[15]

6.1 I consider the application of a Rail Corridor Noise Control as a mapped overlay to be preferable from a planning perspective. Not only is a mapped overlay the predominant approach in District Plans (eg Waimakariri, Hamilton, Timaru and Selwyn District Plans), the National Planning Standards specifically provides for a mapped "Noise Control Boundary Overlay" symbol for use.[16]

6.2 In my view, use of a mapped overlay is an obvious and straightforward method to illustrate the overlay and is well suited to an e-plan. The maps are the starting point of any plan assessment. The alternative (to be defined in a plan rule) means the rule and standards are not readily accessible to Plan users, particularly those less experienced who may not know to look beyond the zone provisions and examine the district wide chapters just in case there are additional rules.

6.3 I also do not agree with Ms Belgrave's position that the noise overlay, if retained as a written rule, could move if there was an alteration to the designation boundary. This is inappropriate from a planning perspective as it could mean more properties are subject to a rule or planning restriction they did not know about.

6.4 Ms Grinlinton-Hancock has confirmed that KiwiRail can provide GIS maps of the Noise (and Vibration) overlays for inclusion in the Plan if that would be of assistance.

Rail Vibration Alert Overlay

6.5 KiwiRail in its submission also sought a range of changes which support a *Rail Vibration Alert Overlay* being included in the Plan. This includes:

a. a new definition Vibration Alert Area Overlay;

b. explanation of Rail Vibration Alert Overlay in the Noise chapter introduction; and

[15] S42A Report paragraph 318.
[16] National Planning Standards, Table 20 Symbol representation.

c. amendments to the Planning Maps, to include a Vibration Alert Area Overlay 60 metres either side of the rail corridor boundary.

6.6 Dr Chiles has described that noise and vibration effects that cannot be completely internalised are likely to arise from transport corridors even with management and mitigation.[17] Reverse sensitivity effects are a relevant consideration for both rail and road infrastructure, particularly where the infrastructure generates noise that cannot be fully internalised within the transport corridor. Development in close proximity to transport infrastructure can increase the potential for complaints about noise and other operational effects, which may in turn place pressure on the ongoing operation, maintenance and future use of the infrastructure. Planning for compatible development adjacent to established infrastructure is therefore important to avoid or minimise the potential for reverse sensitivity effects.

6.7 Ms Belgrave rejects the inclusion of the Rail Vibration Alert Area Overlay on the basis that it may create confusion with plan users and that occupants/purchasers know where the railway lines are so should be aware of effects.[18]

6.8 I do not agree that the Rail Vibration Alert Area Overlay will cause confusion if the text accompanying the maps is included as requested by KiwiRail. As explained by Ms Grinlinton-Hancock,[19] the proximity of a rail line does not equate to community understanding of vibration effects. In my opinion, the Rail Vibration Alert Area Overlay serves an important purpose, particularly for purchasers who may be new to an area or where the rail line is not visible but still within an area where vibration effects can occur (up to 100m as described by Dr Chiles).[20]

6.9 Further, provision of Rail Vibration Alert Area Overlays is an increasingly common feature of District Plans including Whangarei (60m),[21] Waimakariri District Plan (100m),[22] Timaru District Plan[23] (60m) and the Auckland Unitary Plan.[24] In addition, the need to consider effects <u>on</u> infrastructure has been

17 Evidence of Dr Chiles, Section 5.
18 S42A Report paragraph 92.
19 Evidence of Ms Grinlinton-Hancock, Section 5.
20 Evidence of Dr Chiles, Section 5.
21 Whangarei District Plan, NAV-R8.
22 Waimakariri District Plan, *How to Interpret and apply the rules* (3).
23 Timaru District Plan, last paragraph of NOISE Chapter Introduction.
24 Waihoehoe (I452) and Drury Centre (I450) Precincts.

further strengthened since these provisions were made operative by the NPS-I, Policy 10.

6.10 NPS-I, Policy 10 (Planning for and managing the interface and compatibility of infrastructure with other activities) subclause (2)(a)(ii) is very directive in relation to protecting existing and planned infrastructure (such as road and rail) from reverse sensitivity effects. It states (emphasis added):

> *2. Decision-makers on planning instruments must:*
> *a. engage with infrastructure providers to:*
> *i.* […]
> *ii. identify appropriate buffers and other methods to* ***protect existing and planned infrastructure*** *from the adverse effects of new or intensified sensitive and incompatible activities, including direct effects,* ***reverse sensitivity effects****, and risks to health and safety;*
> *iii. support the strategic integration of infrastructure with land use activities;*

6.11 The CRPS and ORPS also both address this matter; for example:

> *UFD-O1 – Development of urban areas*
> *The development and change of Otago's urban areas occurs in a strategic and coordinated way, which results in well-functioning urban environments, that:*
> *(1) […]*
> *(2) integrate effectively with infrastructure, development infrastructure and additional infrastructure, and surrounding urban areas and rural areas, including by managing reverse sensitivity effects and direct effects on electricity networks, […]*

6.12 Both Policy 10 of the NPS-I and UFD-O1 of the ORPS direct that reverse sensitivity must be managed (UFD-O1) and infrastructure must be protected (Policy 10) from adverse effects, including reverse sensitivity effects.

6.13 I acknowledge that there are other methods which could potentially alert purchasers/land owners to vibration effects, however I consider the Proposed Plan is the most effective as the Plan directly informs a LIM (for purchasers), and alerts developers of the site who may not obtain a LIM but would review Plan provisions.

6.14 I have also reviewed the section 32 assessment prepared by Louise Taylor and Lisa Thorne regarding Standard Railway Noise and Vibration Reverse Sensitivity Provisions[25] (included as **Attachment B** to my evidence). I agree

[25] Dated 16 August 2023.

with and adopt its conclusions in support of the Vibration Alert Layer sought by KiwiRail.

6.15 Overall, I consider the inclusion of the Rail Vibration Alert Overlay (applying to properties within 60m of the rail corridor designation boundary) and related amendments to be appropriate. These amendments are set out in **Attachment A** to my evidence.

Mapping

6.16 To support the changes above, I propose changes to the mapping to:

a. extend the Rail Noise Overlay to 100m from the rail designation boundary in all zones as this is a district wide matter; and

b. include a 60m Rail Vibration Alert Overlay from the rail designation boundary in all zones.

6.17 Below, I address other amendments required to the provisions, including consequential amendments if the above relief is accepted by the Panel.

Noise - Definitions

6.18 KiwiRail supported the definition of *Transport Corridor* as notified. Ms Belgrave, in conjunction with rejecting KiwiRail's submission requesting a new definition for *Rail Corridor Noise Control Overlay*, proposes to retain the definition and amend it to be *Transport Corridor Noise Control Area*.[26] Ms Belgrave proposes this relief as it supports her approach of not showing noise control 'areas' as an Overlay on the planning maps.[27]

6.19 NZTA also submitted on this definition and requested a – "Noise Corridor Boundary Overlay", and provided a GIS mapped layer to be included on the planning maps. [28]

6.20 I consider Ms Belgrave's definition of "Transport Corridor Noise Control Area" is fit for purpose to describe the locations where rail (and road) noise should be addressed however, consistent with my view that the noise control areas should be mapped, I consider that the definition should be "Transport Corridor Noise Control ~~Area~~ Overlay". For clarity, if this amendment is adopted, I do not

[26] S42A Report paragraph 64.
[27] S42A Report paragraph 64.
[28] NZTA submission 152.63.

consider KiwiRail's requested definition of *Rail Corridor Noise Control Overlay* would be necessary.

NOISE-R2 New buildings, change of use of existing buildings and additions to existing buildings, for use by a sensitive activity

Setback Distance

6.21 KiwiRail supported NOISE-R2 as notified and proposed minor amendments to NOISE-R2 PER-2 to extend the distance in which ventilation requirements apply from 80m to 100m as follows (amendments shown in red ~~strikethrough~~ and underline):

> *1. NOISE-S2 Mechanical ventilation requirements; and where within ~~80~~ 100 metres of a rail corridor:*

6.22 Ms Belgrave supports the amendment in principle and recommends alternative relief (being application of the control to all areas subject to the Transport Corridor Noise Control Area and consequential deletion of reference to setback distances) to achieve the same outcome. I agree with her response to this submission point as it achieves the same outcome as the submission.

6.23 However, I note that her recommended amendment to include reference to the "Transport Corridor Noise Control Area" appears to have been mistakenly left out of the recommended amendment at paragraph 217 of the Section 42A Report.

Removal of change in use / alterations to existing buildings

6.24 Ms Belgrave has proposed the following amendment to the heading of NOISE-R2 which would mean changes of use of existing buildings and additions to existing buildings would not need to comply with NOISE-S2 and NOISE-S3.

> NOISE-R2 New buildings, ~~change of use of existing buildings and additions to existing buildings,~~ for use by a sensitive activity

6.25 I understand but do not agree with the explanation Ms Belgrave has provided for removing *change of use of existing buildings* from the NOISE-R2 heading. In particular, Ms Belgrave[29] considers:

[29] S42A Report paragraph 215 in response to NZTA submission 152.64.

Given that not all internal alterations are subject to building consent, this will be difficult to monitor. From a pragmatic perspective, anyone who is undertaking internal alterations to an existing building within proximity to a noise generating activity such as a State Highway corridor should not be expected to include acoustic design for that part of the building they are now occupying, when the rest of the building remains the same.

6.26 The NZTA submission[30] (particularly Appendix 2, Rule 2(b) and (c)) which Ms Belgrave responds to has specific provisions which seek to permit internal alterations to noise sensitive activities (5m^2 within each 10 year period) without further acoustic mitigation. This appears to be conflated with a change in use which is a separate matter to an internal alteration to an existing use.

6.27 Further, the basis for removing "*additions to existing buildings"* is unclear as Ms Belgrave notes "additions to buildings containing sensitive activities within the Transport Corridor Noise Control Area are subject to the requirements of NOISE-R2".[31]

6.28 I do not support the removal of any text from the NOISE-R2 heading and the consequential narrowing of the application of NOISE-R2. I consider NOISE-R2 should apply to both a change of use and building additions and alterations where floor area is increased. In my experience, change of use (as with building alterations and additions) often triggers a building consent, particularly for consideration of fire and access so do not accept that there is a lack of potential for oversight by Council. Dr Chiles[32] also confirms that he considers alterations to noise sensitive activities should be retained.

6.29 For NOISE-R2, if KiwiRail's relief for a mapped overlay is accepted by the Panel, NOISE-R2 PER-2 should apply to sites within the *Transport Corridor Noise Control Overlay* (being the amended term I propose at paragraph 6.22).

NOISE-S3

6.30 KiwiRail seeks to amend NOISE-S3 to ensure NOISE-S3 applies to:

30 Submission 152.64.
31 S42A Report paragraph 215 in response to NZTA submission 152.64.
32 Evidence of Dr Chiles, paragraph 7.7.

[…] all zones within the Rail Corridor Noise Control Overlay.

6.31 Ms Belgrave agrees with the relief and as with NOISE-S2, supports amendments to ensure controls apply to 100m of the rail corridor. [33]

Other amendments to the noise controls

6.32 While KiwiRail supported the notified noise provisions above, I have read Dr Chiles' evidence which recommends some technical amendments to these provisions to ensure they are clearer and workable for NZTA and KiwiRail as operators of the state highway and rail network. I agree that the issues he raises should be addressed and would make the provisions clearer. In this regard, I have reviewed the evidence of:

a. Statement of Evidence of Dr Stephen Chiles dated 8 October 2026; and

b. Statement of Evidence of Michelle Grinlinton-Hancock dated 8 October 2026.

7 CONCLUSION

7.0 Overall, I support the amendments in my **Attachment A** as they will:

a. provide noise and vibration provisions which are proportionate to the potential effects;

b. be consistent with Policy 10 of the NPS-I;

c. give effect to the very directive ORPS and CRPS provisions; and

d. ensure the safe and efficient operation of KiwiRail's rail network in the Waitaki District.

7.1 I have included changes I consider necessary as **Attachment A**.

Catherine Heppelthwaite

8 October 2026

[33] S42A Report paragraph 309.

Attachment A: Revised Provisions

Base text:
Section 42A Officer's Report - Appendix 1 – Recommended Provisions with changes accepted.

Recommended changes:
Red underline / red ~~strike through~~

Definitions

Transport Corridor Noise Control ~~Area~~ Overlay
[…]

Vibration Alert Area Overlay
means the area potentially affected by vibration between a railway corridor designation boundary and a distance of 60m.

Noise

Introduction
[…]

This chapter focuses on managing the adverse effects of noise generating activities to ensure that they do not have unreasonable impacts on the amenity values and health and safety values of individuals and communities.

A Rail Vibration Alert Overlay has been applied which identifies the vibration-sensitive area within 60 metres each side of the railway designation boundary as properties within this area may experience rail vibration effects. No specific district plan provisions apply in relation to vibration controls as a result of this Rail Vibration Alert Area. The Rail Vibration Alert Overlay is to advise property owners of the potential vibration effects but leaves with the site owner to determine an appropriate response.

Other than where expressly provided for, noise levels arising from activities must be measured in accordance with NZS 6801:2008 Acoustics - Measurement of Environmental Sound and assessed in accordance with NZS 6802:2008 Acoustics - Environmental Noise.

[…]

NOISE-R2

NOISE-R2	**New buildings, change of use of existing buildings and additions to existing buildings, for use by a sensitive activity**	
Any site within 40m of a […]	[…]	[…]
Any site located within a Highway and	[…]	[…]

Transport Corridor Noise Control Overlay ~~a the Transport Corridor Noise Control Area~~		

Mapping

1. Amend District Plan Maps to apply a 100m *Highway and Transport Corridor Noise Control Overlay* from the rail designation boundary.

2. Amend Maps to apply a 60m *Rail Vibration Alert Overlay* from the rail designation boundary.

Taylor. Planning

KiwiRail Holdings Limited

Standard Railway Noise and Vibration Reverse Sensitivity Provisions and Section 32 Report

16 August 2023

Report Authors: Louise Taylor and Lisa Thorne



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KiwiRail Holdings Limited Section 32 Analysis of Rail Noise and Vibration Provisions

1. Introduction

KiwiRail Holdings Limited (**KiwiRail**) is the State-Owned Enterprise responsible for the construction, maintenance and operation of New Zealand's rail network. The rail network is critical to the safe and efficient movement of freight and passengers throughout New Zealand, and forms an essential part of the national transportation network and the wider supply chain.

KiwiRail is a network utility operator, and the Requiring Authority for railways throughout New Zealand. KiwiRail's rail network operates over 3500km of rail network and infrastructure, used by more than 900 freight trains every week, operating between Whangarei and Bluff. The rail network is utilised to carry imported and exported goods from New Zealand ports, timber and forestry products, bulk good such as dairy products and steel, domestic goods between cities, and domestic passengers, and demand for this service is expected to continue to grow. Passenger rail is also a growing source of traffic for the rail network. While passenger rail volumes are currently only located in New Zealand's main cities, expansion of passenger rail inter-regionally is a growing focus of national transport strategy.

This mix of freight and passenger rail traffic is critical to New Zealand's decarbonisation and public transport goals currently and into the future. For this reason, the rail network is recognised as nationally significant, and is often classified as regionally and/or nationally significant infrastructure in District Plans.

This report has been prepared in accordance with the requirements of s32 and Schedule 1 of the Resource Management Act 1991 (**Act**). It assesses and supports the inclusion of District Plan land use provisions to appropriately manage noise and vibration effects on sensitive activities in the vicinity of the rail network. In some cases, the provisions may require amendment to reflect the structure and style of the District Plan drafting (for example, utilising existing definitions, objectives or policies relating to the transport network or Activities Sensitive to Noise).

1.1 Value of Rail

The rail network is a significant contributor to the movement of freight within New Zealand, carrying 16% of total national freight, 25% of exports, and 18 million tonnes of freight every year. The 2021 Value of Rail in New Zealand report[1] found that the total value of rail in New Zealand was estimated to be between $1.70 billion - $2.14 billion each year, from:

- reduced greenhouse gas emissions and air pollution, by reducing 2.5 million tonnes of CO_2 emissions each year;
- time savings and reduced congestion; reducing cars and trucks on road, avoiding 26 million car trips a year in Auckland and Wellington alone, and removing 24,000 trucks from the road;
- improved road safety, including fewer injuries and fatalities, with 288 fewer injuries and fatalities each year; and
- lower road maintenance costs for taxpayers and greater fuel savings, saving between $310-$329 million each year.

Rail is an energy efficient mode of transport, and generates 70% fewer emissions than heavy road freight transport. KiwiRail is a leader in low emissions freight transport, supporting the national transition to net zero carbon by 2050. To achieve this, KiwiRail's Sustainability Strategy 2022-2025 contains specific carbon emission reduction objectives. With New Zealand's freight market projected to grow by 30% by 2030, rail will play an increasing part in handling the increase, providing greater resilience to the transport network, and reducing carbon emissions.

Acknowledging the benefits of rail (as outlined briefly above) and the role rail will play in decarbonising the freight network, the New Zealand Government has, to an extent not seen in a generation, chosen to fund, via the National Land Transport Fund, rail infrastructure, to ensure rail can scale effectively and efficiently to the needs of passengers and freight. Investment in rail (including new and improved infrastructure and rolling stock – locomotives, wagons and carriages) since 2019 now exceeds $8b.

Given the nationally significant benefits and savings to the New Zealand economy, the greenhouse gas emission reductions, and air pollution reductions associated with rail freight, the adverse effects of failing to protect the rail network from reverse sensitivity are significant. At a national

[1] Ernst and Young, The Value of Rail in New Zealand, Report for the Ministry of Transport, February 2021

scale, for illustrative purposes, every 1% reduction in rail traffic caused by reverse sensitivity may equate to costs in the range of approximately $17 to $21 million per annum.

1.2 Proposed Provisions

KiwiRail proposes to introduce a suite of provisions to the District Plan to appropriately protect the railway network from reverse sensitivity by avoiding and mitigating adverse health and amenity effects associated with railway noise and vibration where sensitive uses locate in proximity to the railway corridor[2]. As outlined in further detail below, similar provisions are already included in numerous operative plans throughout New Zealand.

These proposed provisions are provided in full in **Appendix 1** and are summarised below:

- Insert a new objective and two policies providing for the importance of the rail network and the potential for reverse sensitivity effects when activities sensitive to noise are in close proximity; [if needed, depending on nature of plan change or proposed district plan, including any existing policies which are in place regarding management of reverse sensitivity or activities sensitive to noise near infrastructure / industry]
- Insert a new definition for 'Activity Sensitive to Noise' In the Definitions Section (if required);
- Insert new vibration alert layer to District Plan maps;
- Insert new 100m rail corridor buffer to District Plan maps (called "Rail Noise Control and Vibration Alert Area") to which the rules below will apply:
- Insert new rules and standards for noise and vibration in the vicinity of the railway corridor:
    - Railway noise standards for Activities Sensitive to Noise within 100m of a rail network boundary (i.e. within the Rail Noise Control and Vibration Alert Area); and
    - Construction design standards for indoor noise control for Activities Sensitive to Noise within 100m of a rail network boundary (i.e. within the Rail Noise Control and Vibration Alert Area).
- Require resource consent for a Restricted Discretionary Activity where these standards are not met. Provide matters of discretion by which resource consent applications will be assessed against.

[2] "Railway Corridor" means the area captured within the KiwiRail designation.

- Include an advice note that applies within the Rail Noise Control and Vibration Alert Area, and which alerts the plan user that activities within this Area may be subject to vibration effects from rail activities. No standards or other rules apply in relation to vibration.

1.2 Supporting Information and Assessment

The development of these provisions and the assessment in this Section 32 Report is informed by:

- an expert Noise and Vibration Memorandum by Stephen Chiles, dated July 2023, and attached as **Appendix 2**; and
- an expert Economic Assessment of Options to Manage Rail Noise and Vibration Effects (Economic Assessment) by Insight Economics, dated July 2023, and attached as **Appendix 3**.

The Noise and Vibration Memorandum characterises the noise and vibration associated with the operation of the rail network, and analyses the adverse health effects associated with rail noise and vibration both internationally and in New Zealand. It includes an assessment of appropriate levels for exposure to railway sound and vibration in the New Zealand context to avoid or mitigate sensitivity to rail noise and vibration in proximity to the KiwiRail network. This has informed the preparation and analysis of the proposed provisions, and particularly the appropriateness of the proposed Rail Noise Control and Vibration Alert Area and associated setbacks, acoustic standards, and the consideration of vibration standards.

The Economic Assessment analyses the economic costs and benefits associated with the proposed provisions against a 'do nothing approach', and KiwiRail proposed provisions approach (being option G in this report), and a 100m setback approach (being Option E in this report). This includes the economic costs and benefits of health and amenity effects, building design/location, policy implementation, administration and compliance, opportunity costs of potentially forgoing noise sensitive development, and compromised rail operation and efficiency as a result of reverse sensitivity. The Economic Assessment quantifies an estimate of the net costs and benefits per kilometre of track, which confirms that the preferred option has the highest net economic benefit of the three options assessed.

1.3 Requirements of Section 32 of the Act

This report provides an evaluation of the proposed objective and options to achieve the objectives in accordance with section 32 of the Act. Under the Act, a section 32 evaluation must:

- Examine whether the proposed objectives of the proposal are the most appropriate way to achieve the purpose of the Act (s32(1)(a));

- Examine whether the proposed provisions are the most appropriate way to achieve the objectives by identifying other reasonably practicable options, assessing the efficiency and effectiveness of options and summarising the reasons for deciding on provisions (s32(1)(b));
- Relative to considering the efficiency and effectiveness of the provisions in achieving the objective, include an assessment of the benefits and costs of the effects anticipated from implementing the provisions (s32(2));
- Contain a level of detail that corresponds to the scale and significance of the environmental, economic, social, and cultural effects that are anticipated from implementing the proposal (s32(1)(c)); and
- Where amendments are sought to a plan change that is already proposed or a plan which already exists, evaluate the proposal against both the objectives of the proposal and the objectives of the existing plan or plan change (s32(3)). As this assessment applies to District Plans generally, additional evidence is likely to be required in terms of s32(3) for specific plans or plan changes.

Each of these matters is assessed in this report (other than s32(3)), and on that basis the proposed provisions are considered the most appropriate way to achieve the sustainable management purpose of the Act.

2. Resource Management Issue

2.1 Operational Rail Noise

Railway noise levels are dependent on the type and condition of train and traffic volumes, speeds, track geometry and condition, and terrain and other factors. When considering railway noise levels the assumed railway traffic volumes are also important. With full geospatial details and information on railway activity, various standard acoustics computer modelling packages can be used to predict railway noise levels, depending on the situation. However, there is currently no standardised approach to this modelling for railway sound in New Zealand, nor consistent use of a particular method.

In 2009 KiwiRail commissioned Marshall Day Acoustics to provide a recommended method for the prediction and control of rail noise. The recommendations of Marshall Day Acoustics have provided the basis for the methods developed and considered in this report. This is assessed and explained in greater detail in the Noise and Vibration Memorandum provided at Appendix 2 to this report.

The method proposed by Marshall Day Acoustics, and outlined in detail in the Noise and Vibration Memorandum uses a 1 hour averaging method, to appropriately capture the noise maximums likely from the rail network. Specifically, it utilises the following assumed noise levels from rail activities at certain distances:

> *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. More recent (unpublished) measurements for various New Zealand train types confirm these sound levels are in a realistic range.*

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 $L_{Aeq(1h)}$

Table 1: Typical rail sound levels (Noise and Vibration Memorandum)

The Noise and Vibration Memorandum sets out that internal sound levels with windows ajar for ventilation will typically be around 15 dB less than the above external levels.

2.2 Reverse Sensitivity

Reverse sensitivity is the susceptibility of lawfully established effects-generating activities (which cannot internalise all of their effects) to complaints or objections arising from the location of new sensitive activities nearby those lawfully established activities.

In the context of the railway corridor, this can adversely affect the 3500km of rail network throughout New Zealand, where activities that are sensitive to noise and vibration establish in close proximity to the rail corridor without suitable mitigation. The rail corridor is existing, fixed in place, and actively used for rail services (freight and/or passenger).

Without appropriate land use controls in place to manage health and amenity effects and the resulting reverse sensitivity effects associated with new or altered land uses in the vicinity of the railway corridor, sensitive activities can be adversely affected by rail noise and vibration, and this has adverse reverse sensitivity effects on the efficient operation of the rail network.

The rail network is usually identified as “regionally significant infrastructure” or similar definition in District Plans, which makes clear its importance to the District, Region and in some cases Country in terms of transportation of freight, passengers and associated resilience.

The Economic Assessment quantifies the net benefits and costs on rail operations under a ‘do nothing’ scenario (being Option A in this report). The net costs related to impacts on rail operation are estimated as $97,000 per kilometre of track. Conversely, the Economic Assessment confirms

there will be 0$ net costs to rail operation resulting from the proposed provisions.

2.3 Health Effects of Rail Noise

Where noise effects from the railway corridor are not appropriately managed by land use controls, health and amenity effects can arise for Activities Sensitive to Noise located on land near the railway network throughout New Zealand.

It is widely accepted nationally and internationally that sound and vibration from rail networks have the potential to cause adverse health effects on people living nearby. This has been documented by authoritative bodies such as the World Health Organisation[3] (**WHO**), including a publication by WHO Europe in October 2018 (**2018 WHO Guidelines**), which set out guidelines for managing environmental noise[4]. These WHO publications are underpinned by robust scientific research.

The 2018 WHO Guidelines are based on a critical review of academic literature and followed a rigorous protocol to determine the quality of evidence of adverse effects. With respect to noise from rail networks, the 2018 WHO Guidelines note the following adverse effects: ischaemic heart disease, hypertension, high annoyance and sleep disturbance. Based on the evidence of adverse effects, WHO makes recommendations to policymakers to reduce rail noise exposure to below a range of guideline values.

The Noise and Vibration Memorandum provides an analysis of the WHO Guidelines and applicability of those guidelines to New Zealand. Research published in 2019[5] specifically addresses the applicability of international data on noise annoyance to New Zealand. For rail noise, this research was based on a survey of 244 people living in the vicinity of the North Island Main Trunk in South Auckland, including the section through Drury. The survey was based on the questions and methods set out in the international technical specification ISO/TS 15666[6], which is the same approach used in most international studies. The research found that international noise response curves are generally applicable to the New Zealand context, although potentially New Zealanders may be slightly more noise sensitive.

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

[4] World Health Organisation, Environmental noise guidelines for the European region, 2018.

[5] 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/

[6] International Standards Organisation ISO/TS 15666:2003 Acoustics – assessment of noise annoyance by means of social and socio-acoustic surveys.

Although there is current New Zealand and international research that may further refine the understanding of health effects associated with exposure to railway noise, the memorandum sets out that the existing 2018 WHO Guidelines already establishes there are adverse health effects that warrant intervention.

KiwiRail employs various other mechanisms to reduce rail noise and vibration from the railway corridor. These include the installation of ballast mat, rail grinding and tamping, ballast cleaning and replacement, and automated monitoring of rolling stock wheel condition. In terms of track condition, KiwiRail has comprehensive procedures including measurement of track condition/ geometry with a specialist survey vehicle several times a year, and maintenance systems acting on that data.

As explained by Dr Chiles in the Noise and Vibration Memorandum, noise attenuation walls are rarely available for mitigation purposes as typically the rail corridor is elevated and therefore such a wall would need to be unreasonably high to provide benefit. Therefore, not all noise and vibration effects can be completely internalised within the KiwiRail designation boundaries. These effects are the result of normal rail operation and maintenance and cannot be solely attributed to defects in track or rolling stock, and form part of the existing environment.

For new buildings and alterations or additions to existing buildings near to the railway network, it is relatively straight-forward to control internal noise through building location, design and systems (such as using acoustic insulation and mechanical ventilation). In most cases, it is practical to achieve acceptable internal noise levels using such measures. Therefore, with careful design of building location, orientation and materials, and/or the use of new or existing barriers such as acoustic walls and/or bunds, or locating new dwellings behind existing dwellings or landforms on a site, the adverse effects of noise can be appropriately avoided and/or mitigated.

The Noise and Vibration Memorandum sets out that in the New Zealand context:

> *…railway sound level criteria of 35 dB LAeq(1h) inside bedrooms and 40 dB LAeq(1h) inside other habitable spaces have previously been applied for protection from health effects. These values are slightly higher (more lenient) than the 2018 WHO Guidelines for regular sound events but would be more stringent for infrequent events. This comparison relates only to average sound levels, but corresponding relationships with health effects for different frequencies of railway events are uncertain/unknown. Therefore, currently there is not an evidence base available that would support significantly more or less stringent railway sound criteria than 35 dB LAeq(1h) inside bedrooms and 40 dB LAeq(1h) inside other habitable spaces for*

protection of health.

The provisions proposed by KiwiRail is consistent with this approach, and adapted for the New Zealand context as an integral part of KiwiRail's broader noise management activities. The internal noise levels are therefore adopted in the proposed provisions, which provide a suite of options for compliance including building location, orientation and materials, and/or the use of barriers such as acoustic walls and/or bunds.

2.4 Effects of Rail Vibration

Norwegian Standard NS 8176[7] provides a summary of annoyance and disturbance relationships associated with vibration from land-based transport. These relationships demonstrate that adverse effects occur at vibration exposures typically found around existing rail networks. The primary issue relates to people in buildings being disturbed due to feeling vibration. Furthermore, the same vibration can cause buildings to radiate noise inside. As for managing sound, routine track and rolling stock (wheel) maintenance can contribute to reducing vibration at source.

Vibration can vary significantly depending on ground conditions and localised features such as buried services and structures. Even with 'good' ground, track and rolling stock conditions there is still inherent vibration from railways that can cause disturbance.

The Noise and Vibration Memorandum sets out that:

> *Adverse effects of railway vibration can include annoyance and sleep disturbance for building occupants and damage to buildings. Damage to buildings (even cosmetic damage) occurs at greater vibration magnitudes than those which can cause annoyance.*
>
> *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 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.*

[7] Norwegian Standard NS 8176:2017 Vibration and shock - Measurement of vibration in buildings from land based transport. and guidance to evaluation of its effects on human beings.

In analysing the standards currently adopted nationally and internationally for assessing vibration effects, the Noise and Vibration Memorandum assesses vibration levels measured from different sources in New Zealand, and concludes that,

> *There is a knowledge gap as to the actual likelihood of cosmetic damage from railway vibration in New Zealand. However, all potential criteria for vibration effects on people are substantially more stringent, such that for buildings containing sensitive activities, cosmetic building damage might not require separate consideration.*

For new buildings and alterations or additions to existing buildings near to the railway network, as with railway noise, vibration can be controlled through building location, and design. Therefore, with careful design of building location, orientation and materials, the adverse effects of vibration can be appropriately avoided and/or mitigated.

However, the exact design requirements to ensure compliance with appropriate vibration levels depend significantly on site-specific factors, including ground condition / soil type, topography or other environmental features. The level of controls required and the associated cost of implementing such controls can therefore differ significantly on a site-to-site basis.

Without further research into the requirements and cost of implementing such controls on a district-wide basis, there is insufficient existing data to confirm appropriate district-wide provisions which require physical controls for vibration.

For this reason, KiwiRail has instead pursued a "Rail Vibration Alert Layer" be added to the District Plan maps. Such alert layers ensure landowners and occupiers are aware that vibration effects may be present in this location (100m from the rail corridor). They can then make their own design and location decisions should they wish to mitigate such effects. This enables behaviour change and appropriate notice to landowners, while avoiding uncertain costs of controls at this time.

2.4 Economic Effects

The Economic Assessment estimates the likely costs and benefits of 3 options: Option 1 to 'do nothing' (Option A in the s32 assessment below), Option 2 being the proposed provisions (Option G in the s32 assessment below), and Option 3 being a 100m setback option (per kilometre of rail track) (Option E in the s32 assessment below). The net costs and benefits of each option based on the assumptions set out in the Economic Assessment are summarised below.

Costs/Benefits per km of Track	Option 1	Option 2	Option 3
Amenity & health benefits	-$4,665,600	$0	$0
Impacts on rail operation	-$97,000	$0	$0
Policy compliance costs	$0	-$1,728,000	$0
Housing market impacts	$0	$0	-$28,800,000
Option Net Benefits/Costs	**-$4,762,600**	**-$1,728,000**	**-$28,800,000**

Table 2: Estimated net benefits and costs per kilometre of track (Economic Assessment)

The Economic Assessment notes there are different economic costs associated with the assessed options, and that when compared to a 'do nothing' or set back approach, the proposed approach has the lowest economic cost.

"Doing nothing" (Option 1/Option A) has a higher economic cost, primarily related to impacts on amenity and health, with some costs to rail operations. The Economic Assessment sets out that it is impossible to accurately assess the extent to which reverse sensitivity would disrupt the rail network and the consequential impacts on the economy. However the Economic Assessment sets out for illustrative purposes, at a national scale, "*every 1% reduction in rail traffic caused by reverse sensitivity from new Activities Sensitive to Noise establishing nearby would cost approximately $17 to $21 million per annum*".

A 100m setback (Option 3/Option E) while avoiding any economic impacts on rail and human health, "*will have the greatest impacts on housing supply because it sterilises the use of land for Activities Sensitive to Noise within 100 metres of the rail network*". The housing market costs associated with the loss of developable land are analysed in the Economic Assessment, and estimated net costs for a conservative typical mixed residential and non-noise sensitive activity scenario are approximately $28,800,000 per kilometre of track.

The proposed approach (Option 2/Option G) is assessed in the Economic Assessment as having no economic impacts associated with human health and rail operation effects. However there will be policy, administrative, and compliance costs estimated at approximately $1,728,000 per kilometre of track for a conservative typical mixed residential and non-noise sensitive activity scenario. These costs include the upfront costs to comply with the noise standards (acoustic assessment and the mitigation measures themselves), conservatively estimated as being $3000 (for an acoustic assessment), plus 3% of the building value for the associated mitigation to achieve compliance.

Although this places some cost burden on those establishing activities sensitive to noise in the vicinity of the rail network, these are largely one-off upfront costs which are a small proportion of

the total build cost. Additionally, these costs are significantly lower than the costs to health associated with no mitigation, and significantly lower still than the opportunity costs to the housing market of prohibiting the activity in the vicinity of the rail network.

2.5 Duty to Avoid Unreasonable Noise

Section 16 of the Act requires that:

> *"Every occupier of land… shall adopt the best practicable option to ensure that the emission of noise from that land or water does not exceed a reasonable level"*, and
>
> "*A national environmental standard, plan, or resource consent made or granted for the purposes of any of sections 9, 12, 13, 14, 15, 15A, and 15B may prescribe noise emission standards, and is not limited in its ability to do so by subsection*".

KiwiRail is a responsible infrastructure operator that endeavours to avoid, remedy or mitigate the adverse rail noise and vibration it produces, through its ongoing programme of upgrade, repairs and maintenance work to improve track conditions.

As discussed above, KiwiRail employs various mechanisms to reduce rail noise and vibration from the railway corridor. These include the installation of ballast mat, rail grinding and tamping, ballast cleaning and replacement, and automated monitoring of rolling stock wheel condition. KiwiRail has comprehensive procedures including measurement of track condition/geometry with a specialist survey vehicle several times a year, and maintenance systems acting on that data.

Not only is this important to KiwiRail as part of being a good neighbour, but it is also under a statutory obligation to use the best practicable option to avoid unreasonable noise (s16) and to avoid, remedy or mitigate adverse effects on the environment (s17).

The proposed provisions complement the above measures undertaken by KiwiRail in respect of its responsibilities under s 16 of the Act - to mitigate the remaining adverse effects that remain following the responsible management of noise and vibration by KiwiRail. They apply only to those developments which are bringing new or expanded sensitive activities to the existing activity operated by the KiwiRail – they do not impose new obligations on already established activities. As set out in the Economics Report, the provisions are also likely to result in a range of ancillary benefits to those dwellings where they are incorporated, including warmer, drier, and quieter homes that are also worth more.

Given the responsibility for the new activity lies with the neighbouring landowners, and the benefits

which come from the controls accrue to the new landowners, including in respect of overall property value, it is considered appropriate that the costs are assumed by those landowners. This is discussed further below in respect of Option H.

3. Approach to Issue

Mapping, land use rules and standards to avoid or mitigate adverse noise and vibration effects on sensitive activities are critical to protect sensitive activities from these effects. These standards are also fundamental to managing the potential for reverse sensitivity effects on the railway network as a result of this sensitivity. The location of incompatible sensitive activities in proximity to rail infrastructure can lead to noise and vibration effects on and complaints from sensitive users, affecting both the occupants in these areas, and affecting KiwiRail.

There are many examples in NZ district plans which seek to control the location and design of sensitive activities such as housing, healthcare and education facilities where such activities seek to locate near existing sources of noise and/or vibration. These include roads, railways, airports, ports, quarries, industrial sites, industrial and business zones, gun clubs and motorsport facilities. For sensitive activities near existing railways, examples of second-generation operative district plans containing controls include: Christchurch, Dunedin, Tauranga, Hamilton, Palmerston North and Hutt City. All these existing plans control land use standards to manage the adverse effects of noise and/or vibration.

The proposed provisions require that noise and vibration sensitive activities that may establish in proximity to the rail network are appropriately designed and sited to reduce the noise effect to an acceptable level. This will ensure that adverse effects on human health and amenity are appropriately managed, protects public health, provides certainty to those developing land adjacent to the rail corridor of the permitted standards, and protects nationally and regionally significant rail infrastructure from reverse sensitivity.

The proposed provisions are set out in full In **Appendix 1** and are summarised briefly below.

3.1 New Definitions

KiwiRail seeks the following definitions be added to the Definitions Section (if a suitably similar definition is not already in place in the District Plan):

Activity Sensitive to Noise: means any residential activity (including student or retirement accommodation), visitor accommodation, educational facility, child care facility, healthcare activity, and places of worship/marae.

3.2 New Objective and Policies

Insert a new objective and two policies providing for the importance of the rail network and the potential for reverse sensitivity effects when activities sensitive to noise are in close proximity:

- The Objective is to '*Ensure adverse reverse sensitivity, health and wellbeing effects arising from the development of Activities Sensitive to Noise adjacent to the railway network are appropriately avoided or mitigated'.*
- The policies are to:
    - '*Avoid reverse sensitivity effects on the ongoing and future operation and development of the railway network by ensuring new Activities Sensitive to Noise are designed or located to meet appropriate acoustic design standards'*; and
    - '*Manage effects on the health and wellbeing of communities through the design and location of Activities Sensitive to Noise adjacent to the railway network to meet appropriate acoustic design standards'*.

Where plans include existing objectives and/or policies which appropriately capture the matters above, or which could be amended or added to in order to integrate the objectives above, then this may be appropriate to ensure greater integration of the provisions into the particular plan.

3.3 New Rules and Standards

KiwiRail seeks the following rules and standards be added to the District Plan:

- For all zones at any point within 100 meters from the legal boundary of the KiwiRail Rail Corridor Designation (**Rail Noise Control and Vibration Alert Area**), all new buildings or alterations to existing buildings containing an Activity Sensitive to Noise, must meet:
    - Specified Internal noise standards ranging from:
        - 35 dB LAeq(1h) for sleeping spaces, lecture rooms/theatres, music studios, assembly halls, and places of worship and marae,
        - 40 dB LAeq(1h) for all other habitable rooms, and education teaching areas, conference rooms, drama studios and sleeping areas, and overnight medical care and wards, and

        - 45 dB LAeq(1h) for libraries, and health clinics, consulting rooms, theatres and nurses' stations; or

    - The nearest exterior façade of the building accommodating the activity is at least 50m from the railway network and is protected by a specified noise barrier, or

    - It can be demonstrated by way of prediction or measurement that the noise at all exterior façades of the listed activity is no more than 15 dB above the relevant noise levels; and

    - For buildings which require windows to be closed to achieve the noise standards, mechanical ventilation standards must be met; and

    - A report is submitted to the council demonstrating compliance with the above rules prior to the construction or alteration of any building containing an activity sensitive to noise using specified assumptions.

- Require resource consent for a Restricted Discretionary Activity where these standards are not met. Provide matters of discretion by which resource consent applications will be assessed against which limit the assessment of effects to the extent of non-compliance, effects on health and wellbeing, reverse sensitivity effects, and the outcome of any consultation with KiwiRail.

- Include an advice note that applies within the Rail Noise Control and Vibration Alert Area, and which alerts the plan user that activities within this Area may be subject to vibration effects from rail activities. No standards or other rules apply in relation to vibration.

4. Assessment of Objective

Section 32(1)(a) requires an assessment of whether the proposed objective is the most appropriate way to achieve the purpose of the Act. The purpose of the Act is set out in Section 5 as:

(1) The purpose of this Act is to promote the sustainable management of natural and physical resources.

(2) In this Act, sustainable management means managing the use, development, and protection of natural and physical resources in a way, or at a rate, which enables people and communities to provide for their social, economic, and cultural well-being and for their health and safety while—

(a) sustaining the potential of natural and physical resources (excluding minerals) to meet the reasonably foreseeable needs of future generations; and

(b) safeguarding the life-supporting capacity of air, water, soil, and ecosystems; and

(c) avoiding, remedying, or mitigating any adverse effects of activities on the environment.

An assessment of the provisions against the proposed Objective against section 5 is set out in the table, below.

Table 3: Assessment of Objective under Section 5 of the Act

Proposed KiwiRail Provisions	Reason for Objective
Objective Ensure adverse reverse sensitivity, health and wellbeing effects arising from the development of Activities Sensitive to Noise adjacent to the railway network are appropriately avoided or mitigated. Policy Avoid reverse sensitivity effects on the ongoing and future operation and	The objective and supporting policies enable communities to provide for their health and wellbeing, and protects the railway network from reverse sensitivity. Where located in close proximity to the railway corridor, activities sensitive to noise are appropriately designed and sited so that adverse effects on health and wellbeing are appropriately managed, and railway infrastructure is appropriately protected from reverse sensitivity.

development of the railway network by ensuring new Activities Sensitive to Noise are designed or located to meet appropriate acoustic design standards. Policy Manage effects on the health and wellbeing of communities through the design and location of Activities Sensitive to Noise adjacent to the railway network to meet appropriate acoustic design standards.	This enables people to provide for the economic and social use of sites adjacent to the railway corridor, and to meet the reasonably foreseeable needs of the activity, while ensuring that adverse noise and vibration effects are avoided and mitigated. It is therefore considered that the proposed objective is the most appropriate way to achieve the purpose of the Act.

5. Assessment of Proposed Noise and Vibration Provisions

Sections 32(1)(b) and 32(2) require an assessment of the proposed provisions to be undertaken to test their appropriateness and efficiency and effectiveness. This must include:

- whether the proposed provisions are the most appropriate way to achieve the objectives by identifying other reasonably practicable options, assessing their efficiency and effectiveness and summarising the reasons for deciding on provisions; and
- relative to considering the efficiency and effectiveness of the provisions in achieving the objective, include an assessment of the benefits and costs of the effects anticipated from implementing the provisions.

The cost and benefit assessment must identify and assess the costs and benefits associated with environmental, economic, social, and cultural effects including economic growth and employment that are anticipated to be provided or reduced. If practicable, the Act requires that these be quantified.

Section 32(2)(b) also requires an assessment of the risk of acting or not acting if there is uncertain or insufficient information. In this case, it is acknowledged that the costs of implementing the insultation measures will vary on a site by site basis, and the scale will depend on factors such as extent of area affected and density of housing. However, there is considered to be sufficient information about the effects of noise and vibration on health and amenity and reverse sensitivity to the rail corridor, to determine the range and nature of effects of the options. No assessment of the risk of acting or not acting is necessary.

5.1 Identification of Reasonably Practicable Options

KiwiRail have considered a range of potential options. This includes 'doing nothing', a number of existing approaches, the proposed provisions, and other regulatory methods and mechanisms available. These are summarised below:

Option A - Do nothing:
No or limited railway noise and vibration provisions in the District Plan. This may include no specific noise and vibration rules, standards or mapping overlays, but may include consideration of reverse sensitivity effects when assessing the adverse effects of any resource consent application, depending on the existing objectives, policies and rules in the District Plan.

This includes subdivision, use or development within the vicinity of the railway corridor if the District Plan provides sufficient direction to do so.

Option B – Rail operator reduces noise and vibration emissions:
The rail operator ensure that noise and vibration emissions are reduced to the extent that Activities Sensitive to Noise within 100m of the rail corridor achieve the recommended noise and vibration levels without needing to undertake any specific insulation, ventilation or construction design standards.

Option C - Noise barriers:
Acoustic walls or bunds installed by the applicant or the rail operator with no other noise or vibration management methods.

Option D - Construction design standards:
A table which specifies minimum construction materials and standards necessary to achieve internal acoustic levels within buildings, with no other noise or vibration management methods.

Option E - Setbacks:
Requiring Activities Sensitive to Noise to be set back 100m from the railway corridor with no other noise or vibration management methods.

Option F - Internal acoustic standards:
Require internal acoustic and ventilation rules and standards for noise-sensitive activities, but provide no other options to achieve compliance.

Option G – Combination of rules and standards (Proposed provisions):
Within 100m of the railway corridor, provide several options to achieve compliance with internal acoustic levels – within 50m of the rail corridor buildings are designed to meet specified Internal noise levels, or must meet a 50m setback, or where the noise at exterior façades is measured or predicted to be no more than 15 dB above the relevant noise level. Buildings must also meet mechanical ventilation standards and reporting standards. Includes an advice note to alert plan users that Activities Sensitive to Noise within the Rail Noise Control and Vibration Alert Area may be subject to vibration effects.

Option H – Proposed provisions funded by rail operator:
Within 100m of the railway corridor, via a mapped Rail Noise Control and Vibration Alert Area, the same options to achieve compliance would be available - buildings are designed to meet

specified Internal noise levels, or must meet a 50m setback, or noise at exterior façades is no more than 15 dB higher. Buildings must also meet mechanical ventilation standards and reporting standards, and there is an advice note regarding vibration effects. However, the difference is that KiwiRail would fund the achievement of these standards.

Option I - Landscaping:
Landscape planting to provide acoustic mitigation, with no other noise or vibration management methods.

Option J - National regulation:
This may include changes to the Building Act or Building Code or introduction of a National Planning Standard or National Environmental Standard. The Building Act and Code currently provides specifications to manage inter-tenancy noise (eg noise between residential apartments within the same building with shared tenancy walls). However, it does not require the management of internal noise where noise is generated from outside a building (e.g. rail noise from an adjacent rail corridor).

Option K Reverse sensitivity covenant:
A plan provision which requires a covenant whereby property owners agree not to complain about noise and vibration effects on sensitive land uses. This is often referred to as a 'no complaints' covenant.

An assessment of these options in accordance with Sections 32(1)(b) and 32(2) of the Act is provided below.

5.2 Assessment of Reasonably Practicable Options

Table 4: Assessment of Reasonably Practicable Options

Option A - Do nothing

No or limited railway noise and vibration provisions, but this option may include consideration of reverse sensitivity effects when assessing a resource consent application for subdivision, use or development within the vicinity of the railway corridor.

Effectiveness and Efficiency	**Costs**	**Benefits**
Doing nothing requires no action from the territorial authority or applicant so could be considered efficient. It is considered to be the least effective option as it will place no limit on the establishment of Activities Sensitive to Noise in the vicinity of the railway corridor. This will result in an increase in exposure of sensitive activities to the adverse effects of rail noise and vibration.	Doing nothing will result in the establishment of Activities Sensitive to Noise in the vicinity of the railway corridor without being appropriately designed and sited. This will result in an increase in exposure of sensitive activities to the adverse effects of rail noise and vibration, resulting in adverse health and amenity effects for people, and adverse reverse sensitivity effects on rail activity. These costs are analysed in the Economic Assessment, and estimated net costs to health and amenity are approximately $4,665,600, estimated net costs to rail operation is approximately $97,000, with these costs totalling approximately $4,762,600 per kilometre of track.	There will be no additional regulatory cost or costs to landowners and occupiers in terms of compliance or building cost increases. There will be no administration and regulatory costs to the territorial authority as there will be no associated resource consenting or monitoring and compliance.
Is doing noting reasonably practicable? No - it will not achieve the objective and will result in adverse health and wellbeing effects, and adverse reverse sensitivity effects.		

Option B - Rail operator reduces noise and vibration emissions

The rail operator ensure that noise and vibration emissions are reduced to the extent that Activities Sensitive to Noise within 100m of the rail corridor achieve the recommended noise and vibration levels without needing to undertake any specific insulation, ventilation or construction design standards.

Effectiveness and Efficiency	**Costs**	**Benefits**
This option would not be efficient or effective as, given mitigation measures to minimise rail noise and vibration are unable to comprehensively control these effects, this would significantly curtail the reasonable operation of the existing rail network, and would eliminate the opportunity for any growth in rail traffic over time, resulting in an inefficient use of infrastructure. This would then have consequences for the delivery of freight and passenger transport, and may compromise the achievement of emissions reduction targets by increasing the reliance on road freight.	This option would likely be cost prohibitive to KiwiRail given the impacts on its operations. There may be an environmental cost associated with an increase in emissions associated with having to rely on alternative transport methods.	There are no potential benefits to KiwiRail associated with this option. There would be health and amenity benefits associated with the reduction of rail noise and vibration for Activities Sensitive to Noise within the vicinity of the rail corridor. There may be benefits to landowners to maximise development potential for Activities Sensitive to Noise within the vicinity of the rail corridor.
Is doing noting reasonably practicable? No – this option would places significantly curtail rail the efficient use and development of rail infrastructure.		

Option C - Noise barriers

Acoustic walls or bunds installed by the property owner or by the rail operator.

Effectiveness and Efficiency	Costs	Benefits
This option is effective and efficient when it integrated into the design of a new development in some instances. Acoustic walls may be able to be retrofitted in some instances. However it is not always practical because the height of the barrier required to achieve compliance would be very high (often in excess of 3.8m) and is therefore either impracticable or not consentable/difficult to consent. Most locations have practical limitations to install noise barriers. Limitations include the typical raised nature of rail lines (and train engines above these) above surrounding land, or from undesirable ground conditions and a lack of physical corridor which may necessitate property purchase due to the wider	There is a monetary cost of the installation of acoustic walls by KiwiRail. However this is not typically done by KiwiRail given the practical limitations set out in the efficiency and effectiveness review. Acoustic walls can be visually dominant and result in significant shading and shadowing, and can block view and outlook, given the heights required to achieve acoustic compliance. For these reasons the amenity and construction costs may in some circumstances be greater than the health and amenity effects they seek to mitigate. Walls and bunds also may reduce passive surveillance of surrounds and do not reduce vibration effects which would still need to be manged in a different way. If the permitted standards	Acoustic walls and bunds can provide noise reduction for single storied buildings. They also assist in visually screening development from the rail corridor, reducing the perception of noise, however they are often not practical or consentable, and can result in other health and amenity effects.

area of land required for the foundations of the noise barriers which require a wide base (which may result in the removal of adjacent activities) or for the physical space required for any bund. Whether bunds or acoustic walls are used, these may not often be effective for buildings of more than one storey.	are not met, then there will be costs borne by the applicant to prepare a resource consent application, costs to the territorial authority to assess the application, and costs to KiwiRail as a submitter to the application.	
Is the proposed approach reasonably practicable? In some circumstances acoustic walls and bunds can manage the adverse effects of noise on Activities Sensitive to Noise, and will protect KiwiRail railway infrastructure from reverse sensitivity. However, they are difficult to retrofit to existing situations, are often impractical for new situations, and can result on other adverse health and amenity effects.		

Option D - Construction design standards

A table which specifies minimum construction materials and standards necessary to achieve internal acoustic levels.

Effectiveness and Efficiency	**Costs**	**Benefits**
This option is somewhat effective and efficient. It is a relatively common approach	There will be additional compliance costs during building consent and building	Construction standards provide certainty as to outcome and design

to managing the adverse effects of noise in District Plan. However, it can have some limitations in terms of effectiveness as it essentially 'locks in' the standards to those at the time of writing the provisions. This means as construction standards improve and change over time, the standards in the plan remain static. This can result in future activities needing to obtain a resource consent where the standards are not met - even where the noise and vibration effects are appropriately managed. The Noise and Vibration Memorandum also sets out that in the Christchurch District Plan, although multiple compliance options were included for mitigating road and rail noise in buildings, including design standards, that on review of the controls the Council found that in most cases site-specific assessment associated with meeting internal acoustic standards was selected. This was presumably as despite any	construction when compared with Option A. Building and compliance design costs will be borne by the applicant and compliance confirmation costs will be borne by the territorial authority and/or the applicant. If the permitted standards are not met, then there will be costs borne by the applicant to prepare a resource consent application, costs to the territorial authority to assess the application, and costs to KiwiRail as a submitter to the application. Construction standards can often be complex, and typically require technical expertise on behalf of applicant and regulatory authority if there is any deviation from the standards in the schedule. This can Impose additional monetary and time costs. Construction standards often lack the flexibility to accommodate individual site circumstances. This may occur If the topography of the site removes or reduces the	specifications, and the associated costs can be estimated. Where compliance with the standards is demonstrated, an acoustics specialist does not need to be engaged by any party. Compliance can simply be demonstrated on building plans at the time a building consent is lodged.

specialist assessment costs the site-specific assessment provided a more efficient solution. This option is therefore considered to be less efficient than the preferred options.	need for all construction design standards to be met. As the standards are essentially 'locked in' to the plan, it requires a plan change to update them. The same requirements apply regardless of the level of external noise exposure. This means that some buildings will have more treatment and associated costs than is necessarily needed to achieve adequate indoor noise levels. Conversely, some buildings with the higher external noise exposure might not have adequate treatment.	
Is the proposed approach reasonably practicable? Somewhat - construction standards are a common regulatory approach to manage the adverse effects of noise and vibration for Activities Sensitive to Noise, and will protect KiwiRail railway infrastructure from reverse sensitivity. However, achieving compliance can be complex, and it is less preferred in practice than the acoustic standards in Option F, and there are limitations to this approach.		

Option E - Setbacks

Building or activity setback for Activities Sensitive to Noise of 100m from the railway corridor with no other noise or vibration management methods.

Effectiveness and Efficiency	Costs	Benefits
This option is effective as it is a simple method to minimise noise and vibration. However, it is not an efficient use of land. This approach is efficient for large rural sites where there is flexibility to locate Activities Sensitive to Noise away from the railway corridor.	The costs of requiring effective setbacks is the loss of developable land for Activities Sensitive to Noise within the vicinity of the railway corridor. The housing market costs associated with the loss of developable land are analysed in the Economic Assessment, and estimated net costs for a conservative typical mixed residential and non noise sensitive activity scenario are approximately $28,800,000 per kilometre of track. This also imposes a maintenance burden on the landowner as the person responsible for maintaining the large setback areas. If the permitted standards are not met, then there will be costs borne by the applicant to prepare a resource consent application, costs to	This is a simple approach that can work well for large rural sites where setback areas can continue to be used for agricultural purposes. However this approach remains open to rural sites as a method of management under other controls (including noise provisions). Setbacks effectively minimise noise, vibration and amenity effects.

	the territorial authority to assess the application, and costs to KiwiRail as a submitter to the application.	
Is the proposed approach reasonably practicable? Yes - it provides a tried and tested regulatory approach to effectively manage the adverse effects of noise and vibration on Activities Sensitive to Noise, and will protect KiwiRail railway infrastructure from reverse sensitivity. However, it is only efficient and effective for large rural sites, and there are high opportunity costs to the housing market.		

Option F – Acoustic Standards

Require internal acoustic rules and standards for noise-sensitive activities, but provide no other options to achieve compliance.

Effectiveness and Efficiency	**Costs**	**Benefits**
Acoustic standards are reasonably efficient and are common in a number of District Plans to manage noise effects of different activities including road, rail and aircraft noise. Territorial authorities typically require certification that the standard is met as part of the building consent application processing. Compliant buildings would not require a resource	There will be additional compliance costs during building consent and building construction when compared with Option A. Building and compliance design costs will be borne by the applicant and compliance confirmation costs will be borne by the territorial authority and/or the applicant. If the permitted standards are not met, then there will be	Acoustic standards which require Activities Sensitive to Noise to meet internal noise standards provide flexibility to the applicant to determine how they wish to meet the standards. This can be achieved using different options. Provides health and amenity benefits for new and expanded sensitive activities locating adjacent to the rail corridor, without unduly constraining development of

consent. Internal acoustic standards are not effective if there are opening windows. Any standards therefore require internal ventilation standards to be included alongside insulation controls.	costs borne by the applicant to prepare a resource consent application, costs to the territorial authority to assess the application, and potentially costs to KiwiRail as a submitter to the application depending on the potential level of reverse sensitivity effect. These policy, administrative and compliance costs for a conservative typical mixed residential and non noise sensitive activity scenario are analysed in the Economic Assessment, and estimated net costs are approximately $1,728,000 per kilometre of track.	Activities Sensitive to Noise near the rail corridor. Acoustic insulation also provides energy savings to occupiers and is likely to be capitalised in the value of the property. Avoids reverse sensitivity impacts on KiwiRail from increased numbers of sensitive activities locating adjacent to the rail corridor.
Is the proposed approach reasonably practicable? Yes – as addressed in full above it provides for a tried and tested regulatory approach to effectively manage the adverse effects of noise and vibration on Activities Sensitive to Noise, and will protect KiwiRail railway infrastructure from reverse sensitivity.		

Option G – Proposed Approach: Combination of new rules and standards for Activities Sensitive to Noise

Within 100m of the railway corridor, provide several options to achieve compliance with internal acoustic levels – within 50m of the rail corridor buildings are designed to meet specified Internal noise levels, or must meet a 50m setback, or where the noise at exterior façades is measured or predicted to be no more than 15 dB above the relevant noise level.

Buildings must also meet mechanical ventilation standards and reporting standards. Includes an advice note to alert plan users that Activities Sensitive to Noise within the Rail Noise Control and Vibration Alert Area may be subject to vibration effects.		
Effectiveness and Efficiency	**Costs**	**Benefits**
The provisions are effective as, depending on the activity and site circumstances, they provide several options for compliance. This option is efficient as it provides a range of options to achieve compliance. The standards are efficient as development meeting these standards will not require a require a consent and can be advanced as a permitted activity, which strikes an appropriate balance between enabling development and managing adverse effects. The standards are also efficient as they align with the rules in other District Plans - providing a nationally consistent approach and improving administration for KiwiRail and organisations operating nationally such as housing, healthcare and	There will be additional compliance costs during building consent and building construction when compared with Option A. Building and compliance design costs will be borne by the applicant and compliance confirmation costs will be borne by the territorial authority and/or the applicant. If the permitted standards are not met, then there will be costs borne by the applicant to prepare a resource consent application, costs to the territorial authority to assess the application, and costs to KiwiRail as a submitter to the application depending on the potential level of reverse sensitivity effect. These policy, administrative and compliance costs are analysed in the Economic Assessment, and for a	There will be an improvement in human health and amenity outcomes compared to Option A as there will be a reduction in the number of sensitive activities exposed to unacceptable levels of noise and vibration. It therefore enables Activities Sensitive to Noise to establish in the vicinity of the railway corridor where adverse effects can be effectively managed. This provides for the efficient use and development of land in accordance with section 7(b) of the Act. The range of permitted standards provides a flexible compliance pathway for applicants. It provides a range of potential responses to achieve compliance. This option also provides a comprehensive regulatory approach which recognises the actual spatial extent of railway corridor noise and vibration - and only limits

education providers. The noise and vibration provisions do not apply to existing activities so there are no additional constraints on developed sites where redevelopment is not anticipated. The provisions provide clear and specific matters of discretion which gives greater certainty to developers (and the Council) over the matters that will be assessed if resource consent is required.	conservative typical mixed residential and non noise sensitive activity scenario, the estimated net costs are approximately $1,728,000 per kilometre of track.	activities which are adversely affected by operating outside these parameters.
Is the proposed approach reasonably practicable? Yes - it provides for a range of tried and tested regulatory approaches to effectively manage the adverse effects of noise and vibration on Activities Sensitive to Noise, and will protect KiwiRail railway infrastructure from reverse sensitivity.		

Option H - Proposed provisions funded by rail operator

Within 100m of the railway corridor, via a mapped Rail Noise Control and Vibration Alert Area, the same options to achieve compliance would be available - buildings are designed to meet specified Internal noise levels, or must meet a 50m setback, or noise at exterior façades is no more than 15 dB higher. Buildings must also meet mechanical ventilation standards and

reporting standards, and other than an advice note, there are no vibration standards. However, the difference is that KiwiRail would fund compliance with these standards.		
Effectiveness and Efficiency	**Costs**	**Benefits**
This option is efficient as it provides a range of options to KiwiRail to achieve compliance. This option is not effective as putting the onus on KiwiRail to fund any compliance costs could perversely incentivise landowners to develop closer to the rail corridor than they would if the measures were self-funded. This could increase the costs of compliance as higher standards of insultation could be required, and it would result in more Activities Sensitive to Noise establishing in closer proximity to the rail corridor.	The policy, administrative and compliance costs are analysed in the Economic Assessment, and for a conservative typical mixed residential and non noise sensitive activity scenario, the estimated net costs are approximately $1,728,000 per kilometre of track. A large portion of these costs would be borne by KiwiRail.	The same benefit outlined in Option G apply, noting that benefits accrue to the landowner and occupier without any cost to them, despite their choice being to locate near a railway corridor.
Is the proposed approach reasonably practicable? No – this option could result in considerable cost to KiwiRail, of a level that would mean the implementation of the provisions is not feasible, and could perversely incentivise Activities Sensitive to Noise to establish in closer proximity to the rail corridor than they would otherwise.		

Option I - Landscaping Planted buffers to provide acoustic mitigation.		
Effectiveness and Efficiency	**Costs**	**Benefits**
This option is not effective or efficient, as dense landscaping in excess of tens of metres in width would be needed to provide noise reduction. Seasonal variations in terms of leaf density and weather induced variations may impact vegetation quality.	The costs of requiring effective landscape mitigation setbacks is the loss of developable land within the vicinity of the railway corridor. This also imposes a maintenance burden on the landowner as the person responsible for maintaining the large planted areas. If the permitted standards are not met, then there will be costs borne by the applicant to prepare a resource consent application, costs to the territorial authority to assess the application, and costs to KiwiRail as a submitter to the application.	Provides the benefit of added visual screening.
Is the proposed approach reasonably practicable? No – landscape planting is not an efficient or effective option.		

Option J - National Regulation

This may Include changes to the Building Act or Building Code or the introduction of a National Planning Standard or National Environmental Standard.

Effectiveness and Efficiency	Costs	Benefits
This option is likely to be the most efficient and effective compared to all other options. Unfortunately, although a nationally consistent approach would have a number of benefits, it is outside the Schedule 1 process of the Act and ultimately relies on political will.	Not applicable.	Not applicable.
Is the proposed approach reasonably practicable? No - not within scope.		

Option K - Reverse Sensitivity Covenant

A plan provision which requires a covenant requiring the property owners agree not to complain about noise and vibration effects on sensitive land uses.

Effectiveness and Efficiency	Costs	Benefits
This option is not effective and efficient, because it addresses the ability to complain about noise and vibration, rather than deal with those effects directly. Although this may avoid complaint regarding noise and vibration, Activities	There are legal costs associated with the covenant preparation and registration process. These costs will be borne by both the landowner and the territorial authority. This option provides for poor health and amenity outcomes as the actual	A covenant is a legally binding agreement between the property owner and the territorial authority, and is generally simple to understand. A covenant is likely to be a more cost effective approach compared to the other

Sensitive to Noise will still be affected by noise and vibration, resulting in adverse health and amenity effects for the occupants of these buildings and areas. A provision which requires a covenant is not efficient as it requires every individual site seeking to establish or add to a building to go through a covenant registration process against that individual parcel of land. In time, this can become difficult for a territorial authority to administer as it is not obvious whether or not a covenant applies to a record of title without searching that record of title individually.	effects of railway noise are not appropriately avoided or mitigated. If the permitted standards are not met, then there will be costs borne by the applicant to prepare a resource consent application, costs to the territorial authority to assess the application, and costs to KiwiRail as a submitter to the application.	options (excluding 'do nothing'), as It requires no additional building or design controls, or landscaping or noise barriers.
Is the proposed approach reasonably practicable? No - a reverse sensitivity covenant standard is not an efficient or effective option.		

6. Assessment Summary

Table 5: Assessment Summary

Reasonably Practicable Option	Assessment Summary
Option A - Do nothing: No or limited provisions.	Not reasonably practicable.
Option B – Rail operator reduces noise and vibration emissions: To the extent that no noise or vibration effect is generated on nearby Activities Sensitive to Noise.	Not reasonably practicable.
Option C – Noise barriers: Acoustic walls or bunds.	Not reasonably practicable.
Option D – Construction design standards: A table of minimum design requirements and construction materials to meet noise levels.	Somewhat reasonably practicable, but no favoured by plan users.
Option E - Setbacks: Building or activity setback of 100m with no other noise or vibration management methods.	Preferred methods - these methods can effectively manage the adverse effects of noise and vibration on Activities Sensitive to Noise and will protect KiwiRail railway infrastructure from reverse sensitivity. The most appropriate method to use is dependant on the site context.
Option F – Internal acoustic standards: Require internal acoustic rules and standards for noise-sensitive activities, but provide no other options to achieve compliance.	
Option G – Combination of rules and standards (Proposed provisions): New rules and standards for Activities Sensitive to Noise Within 100m of the railway corridor, provide several options to achieve compliance with internal acoustic levels – within 50m of the rail corridor buildings are designed to meet specified Internal noise levels, or must meet a 50m setback, or where	Most preferred method – Combines several of the methods above to provide options to effectively manage adverse noise effects and vibration and protect KiwiRail railway infrastructure from reverse sensitivity.

the noise at exterior façades is measured or predicted to be no more than 15 dB above the relevant noise level. Buildings must also meet mechanical ventilation standards and reporting standards. Includes an advice note to alert plan users that Activities Sensitive to Noise within the Rail Noise Control and Vibration Alert Area may be subject to vibration effects.	
Option H - Proposed provisions funded by rail operator: As above but funded by KiwiRail.	Not reasonably practicable.
Option I – Landscaping: Landscaping to provide acoustic mitigation.	Not reasonably practicable.
Option J - National Regulation: Changes to the Building Act or Code or new National Planning or Environmental Standards.	An out-of-scope potential long term solution.
Option K - Covenant: A 'no complaints' covenant provision.	Not reasonably practicable.

7. Conclusion

The operation, maintenance and development of the rail network is critical to the safe and efficient movement of freight and passengers throughout New Zealand, and forms an essential part of the national transportation network and the wider supply chain. KiwiRail's proposed provisions to the District Plan enable Activities Sensitive to Noise to be developed in the vicinity of the railway corridor where adverse noise and vibration effects can be effectively managed through a range of standards. The proposed provisions will mitigate health and amenity effects on new and altered Activities Sensitive to Noise that seek to establish within 100 metres of the railway corridor. This will ensure that the continued operation of nationally and regionally significant infrastructure of the rail corridor will be appropriately protected from reverse sensitivity, and neighbouring communities will experience positive health and amenity outcomes.

Consistent with section 32 of the Act, the proposed objective and policies have been developed and analysed against Part 2 and it is considered that the proposed objective is the most appropriate way to achieve the purpose of the Act.

The proposed provisions have been assessed against a number of alternative options in terms of their costs, benefits, and efficiency and effectiveness in accordance with the relevant clauses of section 32 of the Act.

The proposed provisions are considered to represent the most appropriate means of achieving the proposed objective. The provisions are also the most appropriate way of addressing the underlying resource management issues relating to managing the adverse effects of noise and vibration of surrounding land uses, and minimising reverse sensitivity effects to protect the railway network. Adopting the proposed provisions will maintain and enhance the continued use of Railway infrastructure while enabling the efficient subdivision, use and development of land in its vicinity, and providing for health and amenity outcomes.

Appendix 1: Proposed Provisions

Model District Plan Provisions

1. **Definitions**

Noise sensitive activity [if required]
Means any residential activity (including student or retirement accommodation), visitor accommodation, educational facility, child care facility, healthcare activity, and places of worship/marae.

The following provisions should be co-located together in a district -wide chapter (preferable noise and infrastructure) rather than applied on a zone by zone basis.

2. Objective

Ensure adverse reverse sensitivity, health and wellbeing effects arising from the development of noise sensitive activities adjacent to the railway network are appropriately avoided or mitigated.

3. Policies

Avoid reverse sensitivity effects on the ongoing and future operation and development of the railway network by ensuring new noise sensitive activities are designed or located to meet appropriate acoustic design standards.

Manage effects on the health and wellbeing of communities through the design and location of noise sensitive activities adjacent to the railway network to meet appropriate acoustic design standards.

4. Rules/Standards

4.1 Noise and vibration

E. Activities sensitive to noise within 100m of [KiwiRail Rail Corridor Designation]:

<table>
<tr><th></th><th colspan="3">Activity sensitive to noise near a railway network</th><th></th></tr>
<tr><td>All zones – at any point within 100 metres from the legal boundary of [KiwiRail Rail Corridor Designation] (Rail Noise Control and Vibration Alert Area)</td><td colspan="3">Activity status: Permitted

Indoor railway noise
1. Where any activity listed in Table 1 is located within the Rail Noise Control and Vibration Alert Area:
(a) the entire room or space shall be designed, constructed and maintained (including in any alterations) to achieve indoor design noise levels in Table 1; or

[RULEXX] Table 1
<table>
<tr><th>Building type</th><th>Occupancy/activity</th><th>Maximum railway noise level LAeq(1h)</th></tr>
<tr><td rowspan="2">Residential
[note definition in the plan must be broad enough to cover all types of residential activities – or other types of</td><td>Sleeping spaces</td><td>35 dB</td></tr>
<tr><td>All other habitable rooms
[note this may require the definition from the National</td><td>40 dB</td></tr>
</table></td><td>Activity status when compliance with standards 1, 2 or 3 not achieved: Restricted discretionary

Matters of discretion are restricted to:
1. The extent of non-compliance with the noise and vibration standards.
2. Effects on the health and wellbeing of people.
3. The reverse sensitivity effects on the rail network, including the extent to which the activity will unduly constrain the ongoing operation, maintenance and upgrade of the rail network.
4. The outcome of any consultation with KiwiRail.</td></tr>
</table>

residential activities not addressed within it will need to be added to this table]	*Planning Standards to be added if this is not already defined in the District Plan]*		Notification: Application for resource consent under this rule shall not be notified or limited notified unless KiwiRail is determined to be an affected person determined in accordance with section 95B of the Resource Management Act 1991 or the Council decides that special circumstances exist under s 94A(4) of the Resource Management Act 1991.
Visitor Accommodation	Sleeping spaces	35 dB	
	All other habitable rooms	40 dB	
Education Facility	Lecture rooms/theatres, music studios, assembly halls	35 dB	
	Teaching areas, conference rooms, drama studios, sleeping areas	40 dB	
	Libraries	45 dB	
Health	Overnight medical care, wards	40 dB	
	Clinics, consulting rooms, theatres, nurses' stations	45 dB	
Cultural	Places of worship, marae	35 dB	

(b) the nearest exterior façade of the building accommodating the activity listed in Table 1 is at least 50 metres from the legal boundary of the [KiwiRail Rail Corridor Designation], and there is a solid building, fence, wall or landform that completely blocks line-of-sight from all parts of doors and windows, to all points 3.8 metres above railway tracks; or

(c) it can be demonstrated by way of prediction or measurement that the noise at all exterior façades of the listed activity is no more than 15 dB above the relevant noise levels in Table 1.

Mechanical ventilation

2. If windows must be closed to achieve the design noise levels in clause 1(a), the building is designed, constructed and maintained with a mechanical ventilation system that:
   (a) For habitable rooms for a residential activity or visitor accommodation activity, achieves the following requirements:
      i. provides mechanical ventilation to satisfy clause G4 of the New Zealand Building Code; and
      ii. is adjustable by the occupant to control the ventilation rate in increments up to a high air flow setting that provides at least 1 air change per hour; and
      iii. provides relief for equivalent volumes of spill air;
      iv. provides cooling and heating that is controllable by the occupant and can maintain the inside temperature between 18°C and 25°C; and

	v. does not generate more than 35 dB $L_{Aeq(30s)}$ when measured 1 metre away from any grille or diffuser. (b) For other spaces, is as determined by a suitably qualified and experienced person. **Report required** 3. A report is submitted to the council demonstrating compliance with clauses (1) to (2) above (as relevant) prior to the construction or alteration of any building containing an activity sensitive to noise. Compliance with 1(a) and (c) must be confirmed by a Registered Acoustician and when doing so railway noise must be assumed to be 70 $L_{Aeq(1h)}$ at a distance of 12 metres from the track, and must be deemed to reduce at a rate of 3 dB per doubling of distance up to 40 metres and 6 dB per doubling of distance beyond 40 metres. Note: The Rail Noise Control and Vibration Alert Area identifies the vibration-sensitive area within 100metres each side of the [KiwiRail Rail Corridor Designation]. Properties within this area may experience rail vibration effects. No specific district plan rules or notification requirements apply in relation to vibration controls as a result of this Rail Noise Control and Vibration Alert Area.	

Insert mapping overlay which identifies a 100m buffer on each side of the [KiwiRail Rail Corridor Designation] called “Rail Noise Control and Vibration Alert Area” to which the above rules will apply.

Appendix 2: Acoustics Advice

Chiles Ltd

Project: **Land use controls for railway sound and vibration**

Report: **Acoustics advice**

Client: KiwiRail

Reference: 130418h

Date: 19 July 2023

Author: Stephen Chiles

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1. Introduction

1.1. KiwiRail is undertaking an analysis of potential controls for existing/permitted railway sound and vibration from its national network, affecting new and altered sensitive land uses nearby. Chiles Ltd has been engaged by KiwiRail to provide advice on associated acoustics details to inform that analysis. This report sets out: effects of sound and vibration on people and buildings, indicative sound and vibration levels at different distances from railway tracks, methods to reduce sound and vibration, and recommendations for land use controls.

1.2. In normal acoustics usage the term "noise" describes unwanted airborne "sound", although some people use the words interchangeably. However, under the Resource Management Act (RMA) "noise" is defined as including vibration; presumably ground-borne. Notwithstanding that in practice "noise limits" in rules and conditions under the RMA refer exclusively to airborne sound. The term sound has been used in this report to distinguish airborne sound from ground-borne vibration in an RMA context where both are defined as noise.

1.3. A fundamental input when assessing railway sound and vibration is the type, volume and timing of railway traffic to be assumed on a particular section of the network. For comparison, when considering roads in New Zealand, road traffic volumes often gradually increase or remain steady, such that acousticians can sometimes use existing measured road traffic volumes as a reasonable baseline for future design. However, for railways in New Zealand, railway traffic volumes and times can change significantly, such that existing railway traffic may not be a reliable baseline when considering effects associated with new neighbouring houses that will exist for many decades. Therefore, appropriate assumptions for railway traffic types, volumes and times are an essential input that should be considered alongside the following acoustics information in this report.

1.4. Both sound and vibration have complex varying characteristics which are only approximated by metrics representing levels as a single number. There are compromises with whichever metrics are used. In the case of railway sound and vibration in New Zealand the choice of metrics is particularly challenging because often there are a relatively small number of intense events. In this situation, use of average values might under-represent adverse effects and use of maximum values might over-represent effects. The extent of under or over representation varies depending on the rail traffic in any location, which in turn relates to the comment above on railway traffic volumes. Metrics and objective analysis can still be valuable to focus interventions in the most effective places, but the limitations of the metrics require consideration when evaluating potential land use controls. This issue is discussed further in section 4.

2. Effects of sound

2.1. The World Health Organisation ("WHO") has periodically reviewed and collated evidence of health effects caused by environmental sound including from railways.[1] The most recent publication was by WHO Europe ("2018 WHO Guidelines"),[2] which was based on systematic

[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.

reviews of a large number of published studies. There have been numerous other discrete studies of these issues, but the 2018 WHO Guidelines provides a robust synthesis of available information and its findings with respect to railway sound appear to be widely accepted.

2.2. From preceding studies, the 2018 WHO Guidelines found moderate quality evidence that railway sound causes adverse health effects in that it increases the risk of 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 railway sound. Based on the information available the 2018 WHO Guidelines made "strong" recommendations that external railway sound levels should be reduced below 54 dB L_{den} and 44 dB L_{night}. The 2018 WHO Guidelines found there was insufficient evidence to recommend one type of intervention over another to reduce levels.

2.3. The above 2018 WHO Guidelines recommendations are in terms of long-term (annual) average sound levels. One of the metrics relates just to the night period (L_{night}) and the other (L_{den}) is for a 24-hour average including penalties for sound occurring in the evening (+5dB) and at night (+10dB). By necessity, this use of long-term averages is a pragmatic approach given that potential health effects generally relate to exposure over extended periods and are determined from consideration of the community/population rather than specific individuals. Other research into health effects, such as relating to awakenings from sleep, has previously referenced maximum sound levels, but sleep disturbance as a health effect is only assessed in terms of average levels in the 2018 WHO Guidelines.

2.4. The 2018 WHO Guidelines were based on international research from a wide range of countries. There was no available data from New Zealand at that time. Subsequent research published in 2019 specifically addressed the applicability of international data on railway sound annoyance of the New Zealand population.[3] This included a survey of people living in the vicinity of the North Island Main Trunk line 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.

2.5. There is current New Zealand and international research that may further refine the understanding of health effects caused by railway sound. However, the existing 2018 WHO Guidelines already establishes there are adverse health effects that warrant intervention.

2.6. In New Zealand, railway sound criteria have commonly been defined in terms of one-hour average levels (see section 4). Values of 35 dB $L_{Aeq(1h)}$ inside bedrooms and 40 dB $L_{Aeq(1h)}$ inside other habitable spaces have previously been applied for protection from health effects. Accounting for the different metrics, these values are slightly higher (more lenient) than the 2018 WHO Guidelines for regular sound events but would be more stringent for infrequent events. This comparison relates only to average sound levels, but corresponding relationships with health effects for different frequencies of railway events are uncertain/unknown. Therefore, currently there is no evidence base available that would support significantly more or less

[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/

stringent railway sound criteria than 35 dB $L_{Aeq(1h)}$ inside bedrooms and 40 dB $L_{Aeq(1h)}$ inside other habitable spaces for protection of health.

2.7. There is a lack of information on the combination of indoor and outdoor living conditions in relation to health effects. Even if indoor conditions are controlled, there may still be residual health effects arising from outdoor conditions. In a New Zealand context, based on criteria applied for other sources, reasonable conditions in outdoor living spaces might be achieved with railway sound levels of 55 dB $L_{Aeq(1h)}$.

3. Effects of vibration

3.1. Adverse effects of railway vibration can include annoyance and sleep disturbance for building occupants and damage to buildings. Damage to buildings (even cosmetic damage) occurs at greater vibration magnitudes than those which can cause annoyance.

3.2. 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 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.

3.3. Norwegian Standard NS 8176[4] summarises research of human response to transportation vibration and provides exposure response curves in terms of the percentage of people who would perceive or experience degrees of annoyance from vibration. The current version of the standard (2017) discusses the inherent uncertainty in the data, including that it does not account for varying traffic volumes, although notes no other studies addressing that factor were found.

3.4. NS 8176 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. The Class C criterion is defined as a $v_{w,95}$ of 0.3 mm/s (vibration metrics are explained in section 4).

3.5. For vibration effects on buildings, a ppv criterion of 5 mm/s is often used in New Zealand as a threshold at which there is potential for cosmetic damage to new buildings. While the 5 mm/s ppv criterion has been taken from guidance in an overseas standard, it does not relate specifically to railway vibration and is generally regarded as a cautious value. There is a knowledge gap as to the actual likelihood of cosmetic damage from railway vibration in New Zealand. However, all potential criteria for vibration effects on people are substantially more stringent, such that for buildings containing sensitive activities, cosmetic building damage might not require separate consideration.

[4] Norwegian Standard NS 8176:2017 Vibration and shock - Measurement of vibration in buildings from land-based transport, vibration classification and guidance to evaluation of effects on human beings

4. Methods

Sound level metrics

4.1. As discussed in section 1, for railway lines with intermittent traffic in New Zealand, use of an average sound level over any time period can cause inconsistencies between the level and the corresponding human response or health effect.

4.2. The noise provisions which have been sought by KiwiRail in plan changes around New Zealand to date have adopted a one-hour average ($L_{Aeq(1h)}$) for railway sound in their standards. This approach was initially proposed by Marshall Day Acoustics in a review undertaken in 2009 of appropriate noise criteria for district planning rules.[5] This report considered the utilisation of one-hour averaging as against broadscale setbacks and average / maximum or day / night averages. The one-hour average allows for a degree of averaging compared to single events, but still represents periods of activity when disturbance from railway sound is occurring. In the New Zealand context an alternative metric with longer averaging times (e.g. L_{den}/L_{night}) would be likely to significantly under-represent adverse effects from maximum/event sound levels over much of the network.

4.3. Neither one-hour averages or maximum levels however have an established, researched relationship with the health effects correlated to the external long term average sound level criteria recommended by the 2018 WHO Guidelines. This represents a knowledge gap and currently necessitates a broad judgement to determine criteria using the one-hour average (or another metric like maximum levels).

4.4. As set out in section 2, the 2018 WHO Guidelines recommend annual average criteria of 54 dB L_{dn} and 44 dB L_{night} applying outside buildings. These values assume windows may be open, resulting in internal sound levels around 15 dB lower than the criteria (with windows ajar for ventilation): 39 dB L_{den} and 29 dB L_{night}. In a situation where there are regular railway sound events, it could be appropriate to directly take the long-term average L_{den} and L_{night} criteria to apply as one-hour criteria (the L_{den} would also need a -10dB adjustment if applying at night). However, for irregular or infrequent events a higher one-hour criterion could be appropriate. It might also be appropriate to adjust criteria if there are no events at night.

Vibration level metrics

4.5. Internationally there are a range of different metrics used to quantify vibration affecting humans, with no accepted standardisation for this application. The "statistical maximum value of weighted velocity" ($v_{w,95}$) metric has been used previously in New Zealand for both road and railway vibration affecting people, and has the advantage that is corresponds to the exposure response curves in Norwegian Standard NS 8176.

4.6. For vibration effects on buildings and structures, the "peak particle velocity" (ppv) metric is in widespread use in New Zealand. This metric is mandated by the Noise and Vibration Metrics National Planning Standard for construction vibration affecting structures.

[5] Marshall Day Acoustics, *Ontrack rail noise criteria reverse sensitivity guidelines*, 22/10/09

4.7. In this report, vibration is presented in terms of the $v_{w,95}$ with respect to effects on people, and in terms of the ppv with respect to effects on buildings/structures.

Railway traffic characteristics

4.8. The above railway sound levels and effects depend on the timing, type and frequency of train movements at a particular location. As discussed in section 2, the proposed one-hour average sound criteria are generally less stringent than international daily average values for lines with more frequent movements. This was acknowledged by the original Marshall Day Acoustics report, which noted the application of one-hour averages are likely insufficient for lines with greater than 20 train movements a day, and the use of day / night averages or maximum levels would be more protective.

4.9. At the other end of the spectrum, for lines with very infrequent movements the proposed one-hour average criteria might be considered too stringent. With the numerous factors involved and the underlying knowledge gaps relating to sound effects, it is not possible to precisely define a lower railway traffic volume at which one-hour average sound criteria might become unwarranted. Any such consideration should not just include current rail volumes, but potential future rail volumes to which newly established activities may be subject to in the future.

4.10. Railway vibration levels and effects also depend on the traffic characteristics. However, the vibration criteria discussed in section 3 relate to levels from individual events rather than average levels. As such, the criteria are independent of the number of movements. Under the specified standard (NS 8176) the vibration criteria relate to the type of train at a particular location that generates the highest vibration levels, which will generally be freight trains. Therefore, the proposed criteria could be applied to all lines regardless of traffic characteristics.

5. Sound levels

5.1. Different options for sound level metrics are discussed in section 4 with respect to effects and criteria. In this section, example railway sound levels are presented in terms of average values over one hour ($L_{Aeq(1h)}$).

5.2. Railway sound levels are dependent on train types/condition, traffic volumes, speeds, track geometry/condition, terrain and various other factors. As discussed above, when considering average levels the assumed railway traffic volumes are a critical input.

5.3. 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.

5.4. 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.[6] More recent

[6] Marshall Day Acoustics, *Ontrack rail noise criteria reverse sensitivity guidelines*, 22/10/09

(unpublished) measurements for various New Zealand train types confirm these sound levels are in a realistic range.

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 $L_{Aeq(1h)}$

5.5. 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 (as noted in section 4 above, where there were more than 20 movements a day, a one-hour average was considered inadequate to address the likely effects). 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/maximum approach which was considered to add extra complication without significant benefits in effects management given the variability of single train pass-bys).

5.6. Based on this assumption the proposed sound criteria are likely to be appropriate for all urban lines with passenger trains and any lines with at least say six daily freight movements and/or freight movements at night (including where this level of activity may be required in future). This threshold of six freight movements is tentatively suggested based on a hypothesis that the one-hour average criteria would not be unduly stringent at this frequency of effect.

5.7. Internal sound levels with windows ajar for ventilation will typically be around 15 dB less than the external levels set out above. As such, at 100 metres from a track with 56 dB $L_{Aeq(1h)}$ outside, there is still potential to exceed internal criteria of 35 and 40 dB $L_{Aeq(1h)}$ (section 2). A 35 dB internal criterion in particular could be exceeded significantly beyond 100 metres from the track, potentially to around 200 metres. However, at progressively further distances from the track the actual sound level is more likely to be affected by topography and localised screening such that there will be greater variability in sound levels.

5.8. For land use controls, the appropriate method to determine railway sound levels for a particular site (specified values, modelled, measured) depends significantly on the approach to information on train types, volumes and times. This is discussed further in section 9 with respect to recommended controls.

6. Vibration levels (ground-borne)

6.1. 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

6.2. The data in the above table illustrates the significant variation that is inherent in railway vibration. Vibration levels often vary even within a localised area and cannot be reliably predicted, such as in the same manner as airborne sound. Hence, measurements are generally required to assess ground-borne vibration.

6.3. With respect to effects on people, a vibration criterion of 0.3 mm/s $v_{w,95}$ is discussed in section 3. 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 at least 50 metres from the track in most cases.

6.4. With respect to effects on buildings, a vibration criterion of 5 mm/s ppv is discussed in section 3. The vibration measurement data indicates that vibration levels might exceed this criterion within approximately 20 metres of the track. The implications of this are discussed further with respect to recommended controls in section 9.

7. Approaches to manage effects of railway sound

Source

7.1. Routine rolling stock and track maintenance undertaken by KiwiRail contributes to reducing sound at source. There might be incremental improvements if more stringent maintenance service standards were adopted.

7.2. Locomotives can be designed with sound reducing features, such as attenuators and silencers. Generally, these need to be integrated at the time of initial design/manufacture. Retrofitting measures to existing locomotives may be constrained and would be likely to constitute a major rebuilding. Locomotives with alternative power systems such as battery power can have reduced sound, although significant sound still arises from the track/wheel interface. Unpublished research[7] included measurements that show the sound levels set out in section 5 remain representative for the current locomotive fleet, including the newer DL class locomotives. It is understood that KiwiRail has existing workstreams to renew its rolling stock (including the locomotives) overtime. This workstream is focused on alternative power systems, and as a multi-year project to explore (and where supported) upgrades/renewals of its stock, as opposed to retrofitting of existing or old stock.

7.3. Specific sound sources such as wheel squeal, can sometimes be reduced through treatment of rolling stock.

7.4. If older track is not continuously welded, implementing this measure can reduce sound.

Pathway

7.5. Barriers such as formed by earth bunds or walls can reduce railway sound. A barrier providing effective screening could typically reduce railway sound levels by around 5 dB. However, this is often impracticable because any noise barrier would typically need to be in the order of 5 metres high to achieve effective screening of locomotive sound sources that are several metres above the tracks, which in turn are often raised above local ground level. Sound screening might also be provided by intervening buildings or the terrain. As barrier performance is limited by sound passing over the top, typical barriers generally do not provide sufficient sound reduction for receivers close to the railway (within around 50 metres).

[7] Waka Kotahi research programme. Social cost (health) of land transport noise exposure, https://www.nzta.govt.nz/planning-and-investment/research-programme/current-research-activity/active-research-projects/

7.6. Increasing the distance of the pathway reduces sound levels: i.e. separating the receiver from the source by a greater distance. As discussed previously, this measure in isolation may require separation of 100 to 200 metres.

Receiver

7.7. If habitable/sensitive spaces are orientated with no opening windows with exposure to railway sound then internal levels will be reduced. Hence the layout of a building can be used to manage railway sound. A practical approach can be to locate only ancillary, non-sensitive spaces such as garages and bathrooms on the side of the building facing the railway.

7.8. Where windows do have exposure to railway sound, closing those windows reduces internal sound levels. This typically provides a reduction in the order of 10 dB compared to when windows are open ajar for ventilation. However, if windows are required to be closed to reduce sound then an alternative (i.e. mechanical) ventilation and temperature control method is needed for occupants to maintain thermal comfort such that they have a genuine choice to leave the windows closed. For two older roading projects (SH20 Mt Roskill and SH1 Plimmerton) Waka Kotahi installed ventilation systems in 35 and 57 houses respectively with the intention that it would allow windows to be kept closed to reduce road-traffic noise.[8] However, those systems only provided ventilation and not temperature control (e.g. cooling) and for both projects residents reported the temperature being uncomfortable with windows closed. Therefore, if closed windows are to be considered as a noise reduction measure, temperature control should be included in any alternative ventilation system.

7.9. If greater reductions are required than can be achieved just by building layout or closing windows, then the building fabric can be upgraded. This typically requires thicker and/or laminated glazing of windows and in some cases additional/thicker layers of plasterboard wall/ceiling linings.

8. Approaches to manage effects of railway vibration

Source

8.1. As for managing sound, routine track and rolling stock (wheel) maintenance contributes to reducing vibration at source. Again, there might be incremental improvements if more stringent maintenance service standards were adopted. It is understood based on evidence previously provided by KiwiRail that it endeavours to undertake current maintenance best practice where practicable, and continues to invest in ongoing upgrades of its maintenance abilities. This includes the recent commissioning of a new wheel maintenance facility at its Hutt Workshops, which should contribute to improved wheel servicing and repair. In terms of track condition, KiwiRail has comprehensive procedures including measurement of track condition/geometry with a specialist survey vehicle several times a year, and maintenance systems acting on that data.

8.2. There are several different methods to treat railway track to reduce vibration. These include resilient clips fastening the rails to sleepers, resilient material under the sleepers or ballast, and

[8] Waka Kotahi, State highway guide to acoustic treatment of buildings, 2015

tracks directly or on ballast on concrete slabs, "floating" on resilient or spring vibration bearings. These vibration treatments are generally "built into" the overall track formation, particularly for the better performing options. Some treatments can increase the height of the track, having implications on clearances from bridges and overhead structures. As such, these measures are most commonly used for new tracks when the treatments can be integrated into and constructed as part of the overall design (e.g. on the Auckland City Rail Link). Retrofitting treatments over a wide area would require a major rebuilding of the tracks, beyond standard upgrading or maintenance.

Pathway

8.3. There are no standard pathway controls to reduce vibration. In some instances, depending on the dominant propagation route in the specific location, in-ground barriers can reduce vibration propagation. In addition to practical/space constraints (where the corridor is too narrow to construct an in-ground barrier), this is generally not something that could be applied broadly along a rail corridor as it would require analysis and design for specific locations.

8.4. Again, increasing the distance of the pathway reduces vibration levels: i.e. separating the receiver from the source by a greater distance.

Receiver

8.5. Depending on the specific propagation paths, use of different building foundation types (e.g. pile/pad) can result in reduced vibration entering a structure. Likewise, propagation through a structure will alter depending on its design (e.g. concrete/steel).

8.6. Buildings can be built on vibration bearings to reduce vibration from the foundations entering the building. (Some types of vibration bearing are similar to earthquake bearings.) Individual spaces within a building could be constructed as separate structures mounted on vibration isolators, but this is unlikely to be a practical solution in most cases compared to isolating the entire building.

9. Recommended land use controls

Form of controls

9.1. Extensive and widespread mitigation at source would generally only give relatively small incremental improvements and/or would require renewal/replacement of a substantial proportion of track and rolling stock. While (as set out at 7.2 above) there are programmes being undertaken by KiwiRail to renew its existing rolling stock, this confirms any improvements are likely to be incremental as fleets are gradually renewed. There are therefore unlikely to be practicable options for extensive mitigation at source to address sound and vibration effects on new and altered sensitive land uses seeking to establish near existing railways.

9.2. In terms of sound and vibration affecting people, the most robust control would be avoidance of effects by separating sensitive activities from railways. This could be achieved by defining an area around railways where new noise sensitive activities are not allowed. However, in addition to any non-acoustic impacts of such a control, if it contributed to larger and/or more dispersed urban areas then it might in itself cause increased transportation sound and vibration as the

overall population travels greater distances. The following recommendations are therefore made on the assumption that avoidance of effects by separation alone is not a practicable option.

9.3. 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.

9.4. 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.

9.5. 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.

9.6. The potential health effects discussed above have been shown to occur (or be more likely) above certain sound and vibration threshold levels inside buildings. As discussed previously, 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.

9.7. 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.

9.8. It is recommended that any land use controls should be based on achieving internal sound and vibration criteria and allowing for requirements for each site to be determined through individual assessment.

Sound and vibration criteria

9.9. For the reasons discussed previously, the following criteria are recommended to manage potential health effects. A range of sensitive activities have been included in this table, extending from the primary issue of residential units.

9.10. For all these building types the vibration criterion relating to health effects is more stringent than any separate control that might relate to building damage. For other building types a

[9] Christchurch District Plan, Plan Change 5E

separate vibration criterion is included in the table, which could be used to avoid potential building damage.

Building type	Occupancy/activity	Sound criterion $L_{Aeq(1h)}$	Vibration criterion
Residential	sleeping spaces	35 dB	0.3 mm/s $v_{w,95}$
	all other habitable rooms	40 dB	
Visitor accommodation	sleeping spaces	35 dB	
	all other habitable rooms	40 dB	
Education	lecture rooms/theatres, music studios, assembly halls	35 dB	
	teaching areas, conference rooms, drama studios, sleeping areas	40 dB	
	libraries	45 dB	
Health	overnight medical care, wards	40 dB	
	clinics, consulting rooms, theatres, nurses' stations	45 dB	
Cultural	places of worship, marae	35 dB	
All	All occupancies/activities not specified above	-	5 mm/s ppv

9.11. As discussed in section 2, reasonable conditions should be achieved in outdoor living spaces if they are subject to a sound criterion of 55 dB $L_{Aeq(1h)}$.

9.12. The sound level criteria are based on intermittent rail activity. For the assumed rail activity discussed in sections 4 and 5, controls should specify that criteria are to be achieved for external railway sound of 70 $L_{Aeq(1h)}$ at a distance of 12 metres from the track, reducing at a rate of 3 dB per doubling of distance up to 40 metres and 6 dB per doubling of distance beyond 40 metres.

Extent of controls

9.13. Setting a distance for application of controls that includes most land affected by railway sound and vibration would extend for say 200 metres from railways, and would include a substantial area towards the periphery where on closer examination of specific developments no building treatments would be required. Previously, a distance of 100 metres has been used for the application of controls for railway sound. Technically this represents a reasonable compromise if the aim is to capture the most affected sites without requiring assessment where building treatment is less likely to be required. This aligns with the assumed sound levels applied for the rail volumes and one-hour average discussed at section 5 above.

9.14. For vibration, a distance of 60 metres has been used for controls previously. On the basis of the measurement data presented above, I have recommended this be increased to 100 metres consistent with the distance used for sound.

Ventilation

9.15. Where windows are required to be closed it is recommended that a mechanical system be required to provide thermal comfort so there is a genuine choice to leave windows closed. Ventilation is outside the expertise of Chiles Ltd, but on the basis of work published by Waka Kotahi[10,11] the following system specification for residential and visitor accommodation habitable rooms may be appropriate:

i. provides mechanical ventilation to satisfy clause G4 of the New Zealand Building Code; and

ii. is adjustable by the occupant to control the ventilation rate in increments up to a high air flow setting that provides at least 6 air changes per hour; and

iii. provides relief for equivalent volumes of spill air;

iv. provides cooling and heating that is controllable by the occupant and can maintain the inside temperature between 18°C and 25°C; and

v. does not generate more than 35 dB $L_{Aeq(30s)}$ when measured 1 metre away from any grille or diffuser.

Alternative compliance pathways

9.16. Existing controls in district plans based on internal sound and vibration criteria, often include alternative compliance pathways that can be used in some cases to demonstrate that appropriate sound and vibration conditions will be achieved, without requiring specialist assessment or only requiring a reduced assessment. Essentially, these pathways allow for sites and buildings that are likely to have lower sound exposure, or that adopt conservative building designs, to face reduced assessment requirements. Alternative pathways have included:

a) Compliance with internal sound criteria demonstrated by external levels not exceeding the internal criteria by more than 15 dB (reduced assessment needed for external levels).

b) Compliance with internal sound criteria demonstrated by the building being at least 50 m from the railway and screened by a solid barrier, from all points up to 3.8 m above the tracks.

c) Compliance with internal sound criteria demonstrated by using prescribed building constructions.

d) Compliance with internal vibration criterion demonstrated by use of prescribed building base isolation system.

9.17. Technically, the alternative pathways are valid as they result in compliance with the sound and vibration criteria, albeit generally not in the most efficient manner. As discussed above, in the case of the Christchurch District Plan alternative pathways provided were generally not used and were found to make the plan more confusing for users and harder to administer for the Council.

[10] Acoustic Engineering Services, NZTA Ventilation specification review, 30 June 2020
[11] Beca, Ventilation systems installed for road-traffic noise mitigation, 26 June 2014

Appendix 3: Economic Assessment

INSIGHT | ECONOMICS



Final Report: 16 August 2023

Economic Assessment of Options to Manage Adverse Rail Noise Effects

Prepared for: **KiwiRail Holdings Limited**

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1. Executive Summary

Introduction

The rail network is an integral part of New Zealand's transport infrastructure and is estimated to generate nearly $2 billion of value annually (via reduced traffic). To ensure that it is free to grow and operate as needed, and to protect the health and amenity of people, KiwiRail promotes the inclusion of District Plan provisions that require new buildings and/or alterations to existing ones, for noise sensitive activities to mitigate the effects of rail noise. To assist decision-makers, this report assesses the likely high level economic costs and benefits of three options for managing such effects.

Options Analysed

The three options analysed are:

1. Do nothing – where the adverse effects of rail noise are not managed (Option A in the s32 report);

2. KiwiRail's proposed provisions – which apply within 100 metres of the rail network (Option G in the s32 report); and

3. No noise sensitive development within 100 metres of the rail network (Option E in the s32 report).

Option Costs and Benefits

The main costs and benefits of the options relate to:

1. Adverse health and amenity effects from prolonged exposure to rail noise.

2. Costs of changing building designs and/or locations to mitigate effects.

3. Policy implementation, administration, and compliance costs.

4. The opportunity cost of potentially foregoing noise sensitive development near the network.

5. Compromised rail operation and efficiency due to potential reverse sensitivity issues (complaints, changes in operating regime).

Worked Example

The likely costs and benefits of each option are area- and context-specific because they depend on a range of factors that are fluid through both time and space. To demonstrate how the approach can be applied in each territorial authority where Kiwirail's preferred provisions are sought, we derived a model that can be applied on a case-by-case-basis. It contains nearly 20 inputs and assumptions that can be populated with figures that match the circumstances of each district at that time to provide timely and reliable insights to the likely costs and benefits of the three options evaluated herein.

Table 1 below shows the various inputs and parameters in the model, which are populated here with a set of hypothetical values purely for illustration.

Table 1: Model Parameters for Assessing Option Costs and Benefits (Hypothetical Example)

Area of Land Affected & Likely Dwelling Yield	**Values**
Control Area (Buffer) start distance in metres from edge of rail network	10
Control Area (Buffer) end distance in metres from edge of rail network	100
Share of land within proposed buffer otherwise available for development	80%
Residential development density - dwellings/ha (gross)	10
Metres per kilometre	1,000
Square metres per hectare	10,000
Land Values for Noise Sensitive and Non-Sensitive Activities	**Values**
Value of land zoned for residential & other noise sensitive activities ($/m2)	$400
Value of land zoned for non-noise sensitive activities ($/m2)	$200
Health & Amenity Benefits	**Values**
Average dwelling price	$540,000
Mitigation Impact (dB of noise reduction)	5
Mitigation benefits (as a % of property value) per 1 dB improvement	1.20%
Policy Compliance Cost Parameters	**Values**
Average dwelling build cost	$300,000
Mitigation fixed costs per dwelling	$3,000
Mitigation variable cost (as a % of construction cost)	3%
Impacts on Rail Operation	**Values**
Annual value of rail to New Zealand (from Deloitte Study)	$1,900,000,000
Impact of new noise sensitive activities on value of rail (as a %)	2%
Total length of NZ railway track (km)	3,700
Financial Parameters	**Values**
Time Period of Analysis (years)	30
Discount Rate	10%

Finally, Table 2 shows the corresponding option costs and benefits for this specific example, where KiwiRail's proposed provisions generate the lowest net cost and hence are the preferred option.

Table 2: Estimated Net Costs/Benefits per Kilometre of Track (Hypothetical Example)

Costs/Benefits per km of Track	**Option 1**	**Option 2**	**Option 3**
Amenity & health benefits	-$4,665,600	$0	$0
Impacts on rail operation	-$97,000	$0	$0
Policy compliance costs	$0	-$1,728,000	$0
Housing market impacts	$0	$0	-$28,800,000
Option Net Benefits/Costs	**-$4,762,600**	**-$1,728,000**	**-$28,800,000**

2. Introduction

2.1 Context & Purpose of Report

KiwiRail is responsible for the development and operation of New Zealand's rail network. To ensure that the rail network is free to grow and operate as needed to meet ever-evolving needs, KiwiRail promotes the inclusion of District Plan provisions that require new buildings, and/or alterations to existing ones, for noise sensitive activities to mitigate the effects of rail noise. To assist, this high-level report assesses the likely key economic costs and benefits of three options for managing such effects, including KiwiRail's proposed provisions.

2.2 Steps in Assessment & Report Structure

Below are the key steps in our assessment and the sections of this report where each is addressed.

1. Understand the strategic context (section **3**)
2. Identify options to manage rail noise effects (section **4**)
3. Identify option effects and key stakeholders (section **5**)
4. Assess the impacts of each option on stakeholders (sections **6 to 9**)
5. Identify the best/preferred option (section **10**)

The rest of this report works through each step.

3. Strategic Context

3.1 About the New Zealand Freight Task

New Zealand, like all developed nations, is highly dependent on domestic and international trade. This trade creates a massive freight task, with approximately 280 million tonnes moved around NZ annually.[1] While rail plays a key role in the freight sector, particularly for certain goods like timber, dairy, and meat[2], most of the national freight task is performed by diesel trucks. These generate harmful emissions, including CO_2, and are therefore the target of a concerted effort to decarbonise the transport fleet. For example, the New Zealand freight and supply chain strategy seeks to move 20% more freight by 2035 while generating 25% lower emissions, including via modal shifts to rail.

3.2 Rail for Passengers

Rail is not just a freight mode, either, and also plays an increasingly important role in keeping people moving in and around our largest metropolitan areas, particularly Auckland and Wellington. As those cities continue to intensify with more people living in and around centres serviced by the rail network, the share of passenger journeys taken by rail will also naturally increase too. The potential for to reconnect large metropolitan centres through inter-regional passenger rail is also an increasing focus, building on pilot programmes like the Te Huia connection between Auckland and Hamilton.

3.3 The Future Role of Rail

In parallel, the New Zealand Government has recognised the need to maximise the value of its existing investments in the rail network, including making rail a more attractive mode for freight and expanding the passenger rail network. Previously, investment in the rail network lacked a long-term view about its role in the transport system. This caused short-term thinking and investment decision-making, so a new approach was needed.[3]

The New Zealand Rail Plan[4] was developed in 2021 to articulate the Government's vision and priorities for rail to 2030, and to identify the investment needed to achieve it. In June 2021, the Rail Network Investment Programme (RNIP) was created to fund various planks of the Rail Plan that will help renew the network, restore it to a resilient and reliable state, and support freight and passenger rail growth and productivity.[5]

3.4 The Value of Rail to New Zealand

The New Zealand rail network delivers significant value to its freight and passenger customers, and also generates significant benefits for all New Zealanders. These wider benefits are far-reaching, but the most significant are lower road congestion, fewer road accidents, and lower carbon emissions that result from less road traffic.

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[1] https://www.transport.govt.nz/assets/Uploads/Freight-and-supply-chain-issues-paper-full-version.pdf

[2] https://www.kiwirail.co.nz/our-business/freight/

[3] https://www.transport.govt.nz/area-of-interest/infrastructure-and-investment/the-new-zealand-rail-plan/

[4] ibid

[5] ibid

In 2021, Ernst & Young were commissioned by the Ministry of Transport to evaluate the value of rail to New Zealand.[6] Their study built on an earlier analysis from 2016 and considered the benefits of (i) national freight rail, and (ii) passenger rail in Auckland and Wellington.[7] Two scenarios were modelled. The first assumed that all rail services were cancelled, with all rail freight and passengers shifted to the road network. The second scenario also assumed that all rail services were cancelled and shifted to the road network, but with 20% higher rail traffic to capture the impacts of projected future growth. For both scenarios, the value of rail equals the costs of road traffic avoided.

The table below summarises the study's estimates of rail's benefits for the first scenario, where rail volumes match today. In short, the value of rail is estimated to be $1.7 to $2.1 billion per annum.

Table 3: Estimated Annual Value of Rail to New Zealand

Benefit	**Low Estimate**	**High Estimate**
Time (congestion) savings	$939	$1,054
Reduced air pollution	$170	$474
- NOx emissions	$92	$394
- SOx emissions	**<$1**	<1
- Brake & tire (PM10)	$21	$22
- Exhaust (PM2.5)	$57	$58
Reduced fuel use	$211	$222
Reduced GHG emissions	$178	$182
Maintenance benefits	$104	$107
Safety	$94	$98
- Death	$63	$65
- Serious injuries	$25	$27
- Minor injuries	$5	$6
Totals	**$1,695**	**$2,137**

In the words of the Ernst & Young study, as demonstrated above, rail transportation provides the largest benefits to the road sector and society through:

- Time and congestion savings (49% - 55% of benefits)
- Reduced air pollution (10% - 22% of benefits)
- Reduced fuel use and maintenance costs (14% of benefits)
- Reduced greenhouse gas (GHG) emissions (9% to 10% of benefits).

The report also notes that the second scenario, where rail volumes are 20% higher, generates higher benefits than the scenario summarise above, but the difference is not linear with rail volumes. Specifically, the second scenario generates benefits that are about 10% higher than scenario one.

[6] Ernst & Young, the Value of Rail in New Zealand, 2021.

[7] i.e. it excluded inter-island ferries and long-distance passenger rail services, which are also operated by KiwiRail.

3.5 Need for Operational Freedom & Flexibility

To continue realising rail's substantial value to New Zealand, as per above, and to maximise its potential to limit growth in road traffic over time, the rail network must be available for operations 24/7 just like the road network. Reverse sensitivity from nearby sensitive receivers risks undermining that flexibility.

3.6 Summary and Conclusion

Rail is an important part of New Zealand's current transport mix. It provides significant value to New Zealand. It is necessary to protect that critical role to enable rail traffic to grow over time alongside population and economic growth. It is on this basis that KiwiRail seeks the inclusion of District Plan provisions which manage the risk to its operations and future growth that reverse sensitivity poses.

4. Policy Options

This section identifies three policy options to manage the adverse effects of rail noise. These were considered the most plausible/workable options from the long list shown in the appendix.

4.1 Option 1: Do Nothing (option A in the s32 report)

The first option is to "do nothing" with the adverse effects of rail noise not managed, either in the District Plan, or via other means. This forms the baseline (or counterfactual) against which the impacts of the other options are assessed.

4.2 Option 2: KiwiRail Proposed Provisions (option G in the s32 report)

The next option is KiwiRail's proposed provisions. These require new buildings for noise sensitive activities, or alterations to existing ones, within 100 metres of the railway network boundary to mitigate the effects of noise. Specifically, affected buildings must either:

(a) be designed, constructed and maintained to achieve indoor design noise levels resulting from the railway not exceeding the maximum values in the following table; or

Building Type	Occupancy or Activity	Max Railway Noise LAeq(1h)
Residential	Sleeping spaces	35 dB
	All other habitable rooms	40 dB
Visitor Accommodation	Sleeping spaces	35 dB
	All other habitable rooms	40 dB
Education Facility	Lecture rooms/theatres, music studios, assembly halls	35 dB
	Teaching & sleeping areas, conference rooms, drama studios	40 dB
	Libraries	45 dB
Health	Overnight medical care, wards	40 dB
	Clinics, consulting rooms, theatres, nurses' stations	45 dB
Cultural	Places of worship, marae	35 dB

(b) be located at least 50 metres from any railway network, and is designed so that a noise barrier completely blocks line-of-sight from all parts of doors and windows, to all points 3.8 metres above railway tracks, or

(c) it can be demonstrated by way of prediction or measurement that the noise at all exterior façades of the listed activity is no more than 15 dB above the relevant noise levels in Table 1 (above).

If windows must be closed to achieve the design noise levels in (a), mechanical ventilation must be designed, constructed, and maintained. Finally, a report must be submitted to the Council demonstrating compliance with the proposed provisions prior to the construction or alteration of any building containing a noise sensitive activity.

We note the assessment of the costs of Option 2 may also be helpful in assessing a scenario where KiwiRail adopts the funding of the various mitigation measures. This scenario is not assessed

separately below, but we note from an economics assessment, the feasibility of implementing these provisions drops rapidly should KiwiRail adopt both its internal (eg track maintenance and noise reduction costs) and the cost of implementing the provisions. Given the benefits of the provisions also attribute the benefits of the costs of implementation (via warmer, drier, and quieter homes that are also worth more) solely to the landowner, this further reduces the burden of the costs of those provisions sitting with the landowner, rather than KiwiRail.

4.3 Option 3: No Noise Sensitive Development within 100 Metres (option E in the s32 report)

The final option is to prevent new buildings for noise sensitive activities, or alterations to existing ones, occurring within 100 metres of the railway network to avoid adverse noise effects. For clarity, this option does not preclude activities that are not noise-sensitive (eg commercial, industrial or rural activities) from establishing there.

5. Option Impacts & Key Stakeholders

This section identifies likely option impacts and key stakeholders affected.

5.1 Option Costs

The main costs of the options are likely to be:

1. Adverse **health and amenity effects** from prolonged exposure to rail noise. These impacts will vary with several factors, including distance from the network, the design and orientation of buildings, the extent of outdoor activity, plus the health and resilience of affected people.

2. Costs of **changing building designs and/or locations** to mitigate effects. These costs result directly from the need to mitigate effects within the 100-metre buffer area (where deemed necessary by a suitably-qualified noise/acoustic expert).

3. Policy **implementation (ie construction), administration, and compliance** costs. While KiwiRail is seeking the inclusion of provisions only during District Plan review processes, rather than via its own plan change processes (which helps minimise implementation costs), the proposal will still have ongoing administration and compliance costs. These include costs borne by Councils as the administrators of District Plans, plus costs incurred by affected landowners, such as the engaging a noise/acoustic expert to assess the extent of mitigation required, if any.

4. Potential **impacts on housing supply**. If affected properties cannot mitigate the adverse effects of rail noise in a financially feasible manner, there may be a reduction in the quantity of new housing built. This, in turn, could affect the wider housing market and may affect the ability of some Councils to meet their obligations under the National Policy Statement on Urban Development 2020 (NPSUD).

5. **Compromised rail operation and efficiency** due to potential reverse sensitivity. Finally, for options that do not properly manage the adverse effects of rail noise on nearby noise sensitive activities, there may be potential risks to the ongoing operation and efficiency of the rail network.

5.2 Option Benefits

The main benefits of the options are likely to be:

- Improved **health and amenity effects** from properly managing exposure to rail noise. In many cases, these measures will also result in **warmer, drier, healthier homes** that are cheaper to run.

- For options that properly manage the adverse effects of noise, there will be **benefits from the ongoing, unconstrained operation of the rail network**. To the extent that rail can attract a larger share of the national freight task, as sought by several policy initiatives, all new Zealanders will benefit from **lower congestion, accidents, and harmful emissions**.

- Compared to options that effectively sterilise development (for noise sensitive activities) near the rail network, those that enable it will **allow affected land to be put to higher and better uses** than they likely would to otherwise.

- Finally, to the extent that options avoid investments that would otherwise be needed, there will be benefits in the form of **avoided costs saved**.

5.3 Key Stakeholder Groups

Our analysis considers the extent to which option costs and benefits affect the following key stakeholder groups:

- **Affected property owners** – this group will be directly affected in several ways. First, if they develop their land to accommodate noise sensitive activities near the railway line and no mitigation measures are adopted, future occupants may experience adverse effects from prolonged exposure to rail noise. Conversely, affected property owners may face provisions that either (i) limit their ability to develop their land for certain activities, and/or (ii) which impose additional costs to enable noise sensitive activities to establish there.

- **Rail network customers** – this group could be adversely affected if growth in noise sensitive activities near the rail network causes reverse sensitivity, which in turn reduces the frequency, reach, and/or availability of the rail services upon which they rely.

- **KiwiRail and the NZ Government** – As the rail network operator and funder, respectively, KiwiRail and the New Zealand Government will also be affected by the presence or absence of provisions to manage the adverse effects of rail noise. For example, if such effects are left unmanaged, these groups may be negatively impacted by potential constraints arising from reverse sensitivity, which would undermine the operation of – and investment in – the rail network.

- **Territorial authorities** – to the extent that provisions are included in District Plans, territorial authorities will bear the costs and responsibility of incorporating and administering them. While these costs are unlikely to be significant over and above those already associated with their day-to-day functions, they are still an important consideration.

- **NZ's people and its economy** – finally, we note that provisions to manage adverse rail noise, or the absence thereof, may have far reaching effects. For example, if such effects are not properly managed leading to reverse sensitivity that curtail rail operation or availability, any consequent increases in road freight traffic will have negative effects on all of New Zealand. In addition, New Zealanders will bear some of the costs of treating adverse health effects via the tax-funded public health system.

6. Health and Amenity Impacts

This section considers the health and amenity impacts of each option.

6.1 Option 1: Do Nothing[8]

Under this option, the District Plan does not contain provisions that manage the adverse health and amenity impacts of rail noise. Accordingly, it exposes proximate noise sensitive activities to potential adverse health and amenity effects from the rail network.

6.2 Option 2: KiwiRail Proposed Provisions[9]

By design, KiwiRail's proposed provisions directly manage the adverse effects of proximity to the rail network and therefore create ongoing benefits for affected landowners and their tenants (if any). In addition, this option will have wider benefits on the increased warmth, energy efficiency and dryness of homes due to the kinds of mitigation measures imposed (see further discussion re these benefits in the report of Dr Chiles).

However, the true impacts of this option on health and amenity depend fundamentally on the extent to which any proposed mitigation measures would be required anyway, for example to meet the New Zealand Building Code. As the code (likely) continues to strengthen over time, or as developers voluntarily include such measures anyway to keep pace with consumer preferences, the marginal benefits of complying with these provisions will decline. So too, however will the costs, which we return in section 8 below.

To the extent that KiwiRail's proposal does cause some buildings to install design features or elements that they would not have otherwise, there will be health and amenity benefits. First, and most foremost, the adverse effects of rail noise will be properly managed. While it is difficult to accurately quantify such benefits, a recent report for Christchurch City Council (CCC) estimated the health and amenity benefits of noise attenuation to be approximately 1.2% of property value per decibel of road noise reduction.[10]

We consider it unlikely that health and amenity effects accrue linearly with property value, as suggested by the CCC estimate. This would imply, for example, that a $1 million house receives double the benefits of a $500,000 one. Instead, there are likely to also be lump-sum (per-property) elements. That said, these estimates are the best currently available, so below we use them to show the potential benefits for different combinations of property values and noise level reductions.

Table 4: Health & Amenity Benefits by Property Value and Size of Noise Reduction in dB ($000s)

Property Value (000s)	**Noise Reduction dB**									
	1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**
$250	$3	$6	$9	$12	$15	$18	$21	$24	$27	$30
$500	$6	$12	$18	$24	$30	$36	$42	$48	$54	$60
$750	$9	$18	$27	$36	$45	$54	$63	$72	$81	$90

[8] Option A in the s32 report

[9] Option G in the s32 report

[10] Formative, Christchurch Plan Change 5E Noise Sensitive Activities Near Road and Rail Corridors, 30 September 2022.

$1,000	$12	$24	$36	$48	$60	$72	$84	$96	$108	$120
$1,250	$15	$30	$45	$60	$75	$90	$105	$120	$135	$150
$1,500	$18	$36	$54	$72	$90	$108	$126	$144	$162	$180
$1,750	$21	$42	$63	$84	$105	$126	$147	$168	$189	$210
$2,000	$24	$48	$72	$96	$120	$144	$168	$192	$216	$240

Table 4 shows that heath and amenity benefits could be substantial, especially if they accrue linearly with property value as assumed/modelled. For example, a 5dB reduction could translate to a $30,000 benefit for a $500,000 home, or $60,000 for a $1 million home.

In addition, measures adopted to comply with KiwiRail's proposed provisions, such as double glazing and/or mechanical ventilation, are likely to make homes warmer, healthier, and drier. For example, a 2022 interim report by EECA[11] found that 62% of families who were provided heat pumps reported being in very good or excellent health, compared to only 46% before installation. Further, EECA's final report from December 2022[12] noted that electricity use (through winter) falls in a house fitted with a heat pump by an estimated 16% relative to a house without a heat pump installed.

Thus, not only do heat pumps make homes warmer, drier, and healthier, but they also save on energy costs. Over time, these savings will add up and help offset the initial costs of purchase and installation.

6.3 Option 3: No Noise Sensitive Development within 100 Metres[13]

This option also (largely) avoids the adverse effects of rail noise but does not deliver the additional benefits resulting from building improvements associated with the KiwiRail proposal.

[11] Motu report for EECA, Warmer Kiwis Study: Interim Report: An impact evaluation of the Warmer Kiwi Homes programme

[12] Motu report for EECA, Warmer Kiwis Study: Final Report: An impact evaluation of the Warmer Kiwi Homes programme

[13] Option E in the s32 report

7. Impacts on Rail Uptake & Operation

This section considers impacts of each option on rail network uptake and operation.

7.1 Option 1: Do Nothing[14]

Because this option does not manage adverse rail noise effects, it can cause reverse sensitivity that gradually undermines the future uptake and operation of the rail network. This, in turn, would erode the value created by rail (as summarised above) and limit rail's ability to attract market share from the road freight sector. In addition, it can affect the ability of passenger rail services to shift people out of single occupancy vehicles during rush hour, which are a major contributor to congestion and delay on the road network as well as emissions.

Unfortunately, it is impossible to accurately assess the extent to which reverse sensitivity resulting from this option would disrupt the rail network and the consequential impacts on the economy. However, for the sake of illustration, we note that every 1% reduction in rail traffic caused by reverse sensitivity from new noise sensitive activities establishing nearby would cost the broader economy approximately $17 to $21 million per annum (based on the annual values shown in section 3.3 above).

7.2 Option 2: KiwiRail Proposed Provisions[15]

By design, KiwiRail's proposed provisions would directly manage the adverse effects of new noise sensitive activities establishing in proximity to the rail network which would help it become an increasingly credible alternative to road transport for freight and passenger movements. However, that said, we acknowledge that reverse sensitivity may still arise from existing proximate activities.

7.3 Option 3: No Noise Sensitive Development within 100 Metres[16]

This option also (largely) avoids the adverse effects of rail noise and therefore should result in the same outcomes for the rail network as KiwiRail's proposed provisions.

[14] Option A in the s32 report

[15] Option G in the s32 report

[16] Option E in the s32 report

8. Policy Administration/Compliance Costs

8.1 Option 1: Status Quo[17]

The status quo does not incur any administrative or compliance costs because it is (assumed to be) devoid of such provisions.

8.2 Option 2: KiwiRail Proposed Provisions[18]

KiwiRail's proposed provisions will have one-off costs to the Council of including them in the District Plan. However, because KiwiRail is proposing their introduction only during District Plan review or Plan Change processes, where changes to plans are occurring anyway, the marginal costs to Councils of including the proposed provisions is likely to be negligible. Further, while there will be ongoing costs from administering the provisions once operative, these are not expected to be material in the context of functions ordinarily carried out by Councils.

The greatest administrative and compliance costs associated with this option are those that fall on affected landowners. First, affected properties must commission a noise/acoustic expert to identify the need for, and optimal types of, mitigation to manage rail noise. We understand that these are likely to cost about a few thousand dollars.

Where buildings cannot be situated on a site or designed to locate sensitive activities away from the rail corridor, installing insulation, double glazing, mechanical ventilation, and other mitigation features will be the major cost felt by affected landowners. Again, unfortunately, it is difficult to provide reliable generalised estimates of these features because they are context-specific, and depend on the particular design choices of each landowner and their preferred use of their site. In addition, as noted earlier, the true cost of complying with these provisions will depend on the extent to which such measures would have been included in the building design anyway (either due to Building Code requirements and/or because the developer chose to adopt them).

Another complication is that the nature and cost of mitigation works will differ with several variables, including building height and distance from the rail network. For example, the following table from a recent report by Chiles Limited indicates the general relationship between distance from the rail network and the level of noise experienced.[19]

[17] Option A in the s32 report

[18] Option G in the s32 report

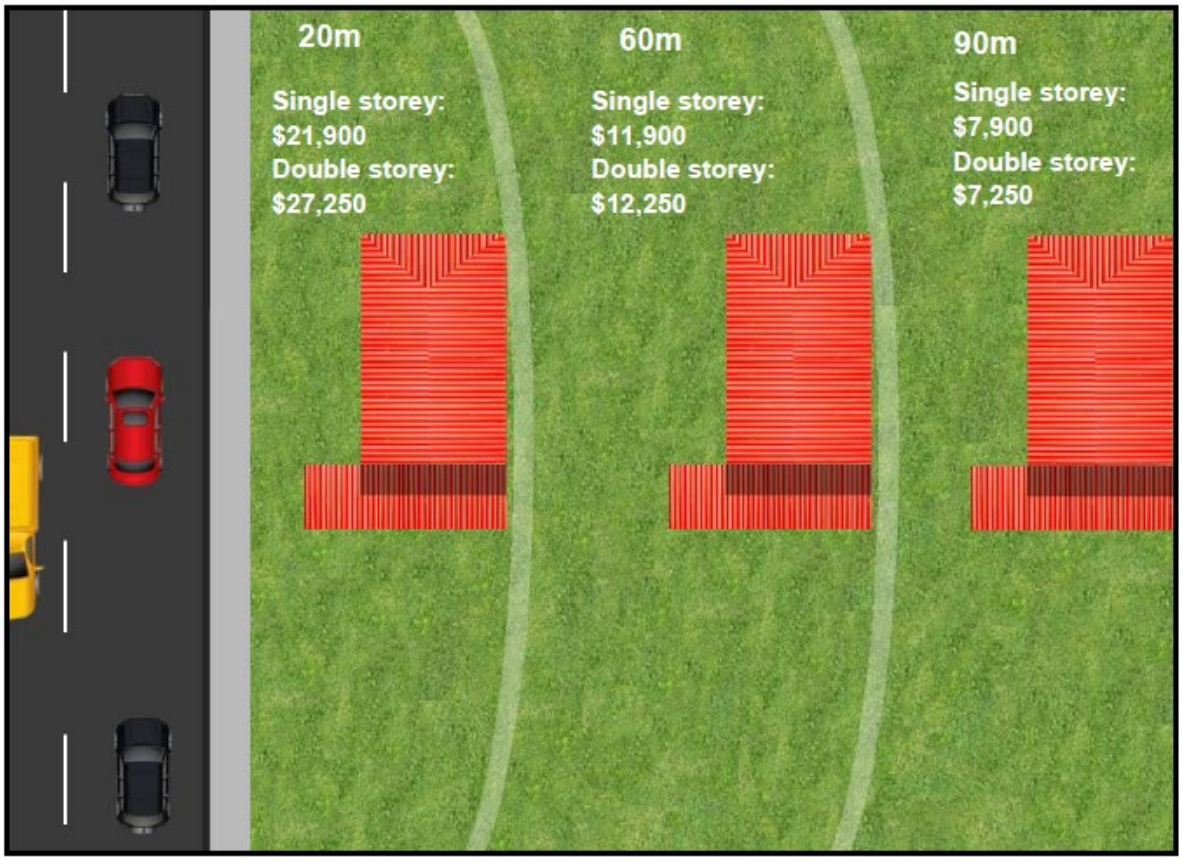
[19] Chiles Limited, Land use controls for railway sound and vibration, March 2023.

Table 5: Relationship Between Distance and Sound Levels

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

To advance the analysis, and for the sake of illustration, we draw on work completed by Beca for Waka Kotahi in 2013[20], which estimated the cost of mitigating road noise for dwellings located at different distances from the state highway network. The excerpt below summarises their key findings.

Figure 1: Beca Estimate of Mitigation Costs by Distance from Road Network (2013 $)



A more recent estimate of likely costs was provided by AES for Christchurch City Council, which suggested that they may be about 1 to 2% of construction costs. Thus, the expense for a dwelling that costs $300,000 to build may be $3,000 to $4,000, while the cost for a $500,000 dwelling would be around $5,000 to $10,000. Again, however, we emphasise that the true cost of complying with the

[20] New Zealand Transport Agency Building Acoustic Mitigation Case Study, prepared for NZTA, 2013

provisions depends fundamentally on the extent to which any of the design features or building elements required would have been provided anyway.

It is also important to acknowledge that these costs will be offset by potential energy savings over time, as noted in the previous section. Plus, as set out in the table at 6.2 above, more importantly, they will likely be capitalised in the value of the property. Even setting aside that direct research, houses with double glazing and/or heat pumps are generally worth more than those without. Thus, while this option imposes upfront costs on homeowners, these will not be lost and instead could be better described as investments in the quality and future marketability of properties.

8.3 Option 3: No Noise Sensitive Development within 100 Metres[21]

This option is unlikely to impose any notable administrative or compliance costs.

[21] Option E in the s32 report

9. Housing Market Impacts

9.1 Option 1: Status Quo[22]

The status quo will not affect the quantity of housing supplied in each district.

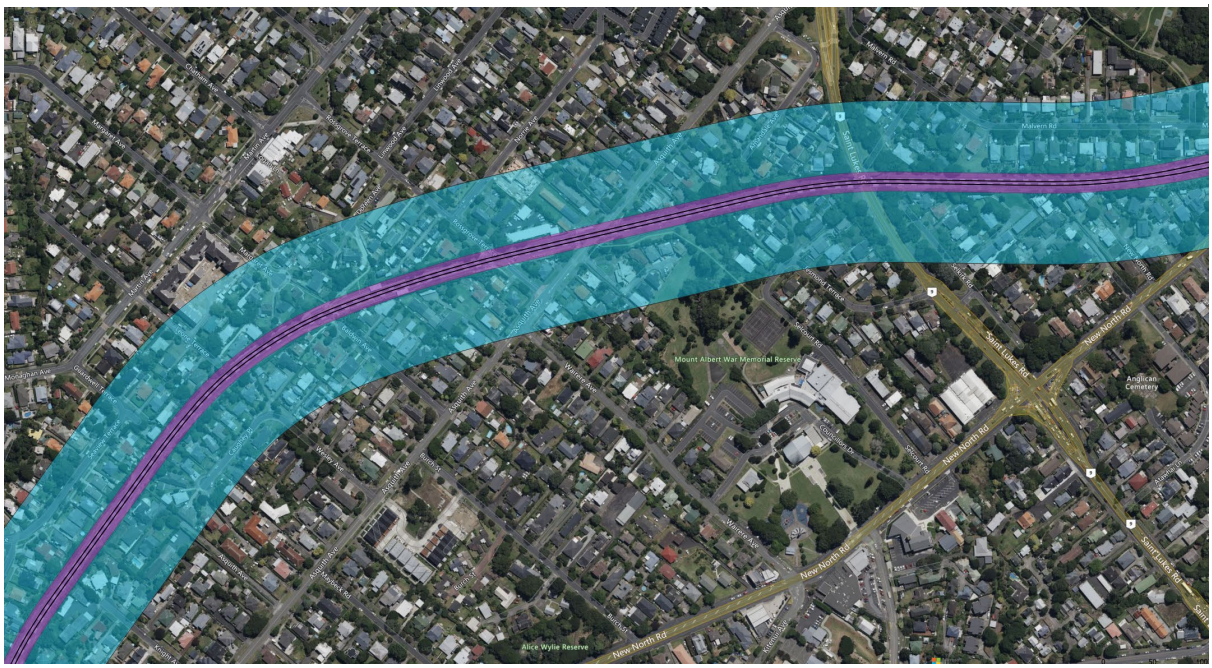
9.2 Option 2: KiwiRail Proposed Provisions[23]

KiwiRail's proposed provisions may have small impacts on housing supply at the margin if the costs of mitigation are considered prohibitively expensive. However, this seems unlikely given the quantum of costs estimated by AES for Christchurch City Council, as per the previous section.

9.3 Option 3: No Noise Sensitive Development within 100 Metres[24]

This option will have the greatest impacts on housing supply because it sterilises the use of land for noise sensitive activities within 100 metres of the rail network. To broadly quantify this impact, we used GIS to inspect the proximity of existing noise sensitive activities to the rail network in built-up areas, particularly Auckland. To that end, the figure below draws 10 and 100 metre buffers around the rail network in pink, and blue, respectively, to investigate how close existing homes are to the tracks.

Figure 2: Proximity of Noise Sensitive Activities to the Rail Network in Mt Albert, Auckland



This map shows there is very little development within 10 metres of the network, although the edges of some buildings are close. Conversely, there are large swathes of development within the 100-metre

[22] Option A in the s32 report

[23] Option G in the s32 report

[24] Option E in the s32 report

buffer. Accordingly, per kilometre of track, this option may prohibit noise sensitive development that would have otherwise likely occurred on approximately 180,000m^2 (or 18 hectares) of land.[25]

The cost of this prohibition will depend on several factors, including the zoning of affected land, the extent to which it is already developed or not, the presence or absence of other binding constraints on development, the underlying value of land, and the scope for accommodating non-noise sensitive activities instead.

Below, we estimate the value of land foregone for noise sensitive development per kilometre of track based on (i) the proportion of land that is developable for any purpose, and (ii) the incremental value of developing land for noise sensitive activities vs other activities. Table 5 presents the results.

Table 6: Value of Land Foregone for Noise Sensitive Activities by 100-Metre Setback per Kilometre of Track ($ millions)

Developable Land %	Incremental Value of Using Land for Noise Sensitive Activities per m^2							
	$50	**$100**	**$150**	**$200**	**$250**	**$300**	**$350**	**$400**
0%	$0	$0	$0	$0	$0	$0	$0	$0
10%	$1	$2	$3	$4	$5	$5	$6	$7
20%	$2	$4	$5	$7	$9	$11	$13	$14
30%	$3	$5	$8	$11	$14	$16	$19	$22
40%	$4	$7	$11	$14	$18	$22	$25	$29
50%	$5	$9	$14	$18	$23	$27	$32	$36
60%	$5	$11	$16	$22	$27	$32	$38	$43
70%	$6	$13	$19	$25	$32	$38	$44	$50
80%	$7	$14	$22	$29	$36	$43	$50	$58
90%	$8	$16	$24	$32	$41	$49	$57	$65
100%	$9	$18	$27	$36	$45	$54	$63	$72

To summarise: the opportunity cost of precluding noise sensitive development within the 100-metre buffer depends critically on the proportion of such land that is developable in the first place, and the difference in land value between noise sensitive activities and all others.

For example, suppose that the current value of residential land is $200 per square metre but (say) $100 for industrial, and that 50% of land within the buffer is available for some form of development. According to the table above, the cost per kilometre of track is $9 million.[26]

In more extreme cases, say where residential land values are $300 higher than industrial and the full buffer area is available for development, the opportunity cost per kilometre is $54 million.

[25] This equals one kilometre of track (1,000 metres) multiplied by 90 metres of developable land between the 10- and 100-meter buffers, which is then multiplied by two because the buffer extends in both directions on both sides of the tracks.

[26] This can be found by subtracting the value of land for industrial from the value for residential (which is $100 per m^2) and scanning down that column to the row labelled as 50% developable.

10. Calculating Option Net Benefits

10.1 Introduction

The likely costs and benefits of each option are area- and context-specific because they depend on a range of factors that are fluid through both time and space. To demonstrate how the approach can be applied in each territorial authority where Kiwirail's preferred provisions are sought, we derived a model that can be applied on a case-by-case-basis. It contains nearly 20 inputs and assumptions that can be populated with figures that match the circumstances of each district at that time to provide timely and reliable insights to the likely costs and benefits of the three options evaluated herein.

10.2 Worked (Hypothetical) Example

Table 7below shows the various inputs and parameters in the model, which are populated here with a set of hypothetical values purely for illustration.

Table 7: Model Parameters for Assessing Option Costs and Benefits (Hypothetical Example)

Area of Land Affected & Likely Dwelling Yield	**Values**
Control Area (Buffer) start distance in metres from edge of rail network	10
Control Area (Buffer) end distance in metres from edge of rail network	100
Share of land within proposed buffer otherwise available for development	80%
Residential development density - dwellings/ha (gross)	10
Metres per kilometre	1,000
Square metres per hectare	10,000
Land Values for Noise Sensitive and Non-Sensitive Activities	**Values**
Value of land zoned for residential & other noise sensitive activities ($/m2)	$400
Value of land zoned for non-noise sensitive activities ($/m2)	$200
Health & Amenity Benefits	**Values**
Average dwelling price	$540,000
Mitigation Impact (dB of noise reduction)	5
Mitigation benefits (as a % of property value) per 1 dB improvement	1.20%
Policy Compliance Cost Parameters	**Values**
Average dwelling build cost	$300,000
Mitigation fixed costs per dwelling	$3,000
Mitigation variable cost (as a % of construction cost)	3%
Impacts on Rail Operation	**Values**
Annual value of rail to New Zealand (from Deloitte Study)	$1,900,000,000
Impact of new noise sensitive activities on value of rail (as a %)	2%
Total length of NZ railway track (km)	3,700
Financial Parameters	**Values**
Time Period of Analysis (years)	30
Discount Rate	10%

Finally, Table 2 Table 8shows the corresponding option costs and benefits for this specific example, where KiwiRail's proposed provisions generate the lowest net cost and hence are the preferred option.

Table 8: Estimated Net Costs/Benefits per Kilometre of Track (Hypothetical Example)

Costs/Benefits per km of Track	**Option 1**	**Option 2**	**Option 3**
Amenity & health benefits	-$4,665,600	$0	$0
Impacts on rail operation	-$97,000	$0	$0
Policy compliance costs	$0	-$1,728,000	$0
Housing market impacts	$0	$0	-$28,800,000
Option Net Benefits/Costs	**-$4,762,600**	**-$1,728,000**	**-$28,800,000**

11. Appendix: Long List of Options

Below is the long list of options from which the three analysed in this report were drawn.

Option A - Do nothing:
No or limited railway noise and vibration provisions in the District Plan. This may include no specific noise and vibration rules, standards or mapping overlays, but may include consideration of reverse sensitivity effects when assessing the adverse effects of any resource consent application, depending on the existing objectives, policies and rules in the District Plan. This includes subdivision, use or development within the vicinity of the railway corridor if the District Plan provides sufficient direction to do so.

Option B – Rail operator reduces noise and vibration emissions:
The rail operator ensure that noise and vibration emissions are reduced to the extent that Activities Sensitive to Noise within 100m of the rail corridor achieve the recommended noise and vibration levels without needing to undertake any specific insulation, ventilation or construction design standards.

Option C - Noise barriers:
Acoustic walls or bunds installed by the applicant or the rail operator with no other noise or vibration management methods.

Option D - Construction design standards:
A table which specifies minimum construction materials and standards necessary to achieve internal acoustic levels within buildings, with no other noise or vibration management methods.

Option E - Setbacks:
Requiring Activities Sensitive to Noise to be set back 100m from the railway corridor with no other noise or vibration management methods.

Option F - Internal acoustic standards:
Require internal acoustic and ventilation rules and standards for noise-sensitive activities, but provide no other options to achieve compliance.

Option G – Combination of rules and standards (Proposed provisions):
Within 100m of the railway corridor, provide several options to achieve compliance with internal acoustic levels – within 50m of the rail corridor buildings are designed to meet specified Internal noise levels, or must meet a 50m setback, or where the noise at exterior façades is measured or predicted to be no more than 15 dB above the relevant noise level. Buildings must also meet mechanical ventilation standards and reporting standards. Includes an advice note to alert plan users that Activities Sensitive to Noise within the Rail Noise Control and Vibration Alert Area may be subject to vibration effects.

Option H – Proposed provisions funded by rail operator:
Within 100m of the railway corridor, via a mapped Rail Noise Control and Vibration Alert Area,

the same options to achieve compliance would be available - buildings are designed to meet specified Internal noise levels, or must meet a 50m setback, or noise at exterior façades is no more than 15 dB higher. Buildings must also meet mechanical ventilation standards and reporting standards, and there is an advice note regarding vibration effects. However, the difference is that KiwiRail would fund the achievement of these standards.

Option I - Landscaping:
Landscape planting to provide acoustic mitigation, with no other noise or vibration management methods.

Option J - National regulation:
This may include changes to the Building Act or Building Code or introduction of a National Planning Standard or National Environmental Standard. The Building Act and Code currently provides specifications to manage inter-tenancy noise (eg noise between residential apartments within the same building with shared tenancy walls). However, it does not require the management of internal noise where noise is generated from outside a building (e.g. rail noise from an adjacent rail corridor).

Option K Reverse sensitivity covenant:
A plan provision which requires a covenant whereby property owners agree not to complain about noise and vibration effects on sensitive land uses. This is often referred to as a 'no complaints' covenant.