Appendix D – Road Traffic Noise Assessment

Project Number: 6-DHLHH.01 60026

Rangiora Eastern Link

Rangiora East Road Connection
Road Traffic Noise Assessment

15 April 2021

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150 YEARS IN AOTEAROA

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Version	Details
1	Draft for INCITE review
2	Include the northern addition to the designation, incorporate review comments
3	Removed northern addition to the designation

Contents

1 Introduction

1.1 Project Background

The Waimakariri District Council (WDC) is preparing a Notice of Requirement (NOR) for a new road designation on the eastern side of Rangiora.

The designation connects Lineside Road and Northbrook Road. The area to which the NOR applies is referred to as 'Rangiora East Road Connection' (RERC) and is shown in Figure 1 on the following page.

The proposed designation will form part of a roading link that will ultimately connect Lineside Road through to Coldstream Road (referred to as the 'Rangiora Eastern Link' (REL)). Those parts of the Rangiora Eastern Link that do not form part of the proposed designation are:

- MacPhail Avenue, which is an existing road that connects Northbrook Road and Kippenberger Avenue; and
- The connection from Kippenberger Avenue through to Coldstream Road.

The Rangiora Eastern Link (as well as southern and western routes) were originally proposed in the Rangiora Transport Study, Beca, September 2001 and a subsequent Scheme Assessment Report, Opus, February 2005, developed alignment options for study and provided preliminary details for the selected alignment.

WSP have been commissioned to prepare technical assessments to inform and support the proposed NOR. This Road Traffic Noise Technical Assessment is one of those technical assessments.

These technical assessments and reports are at a high-level and are intended to provide:

- an awareness of the types of effects and their magnitude that may occur as a result of the designation; and
- identify potential measures that would avoid, remedy or mitigate adverse effects

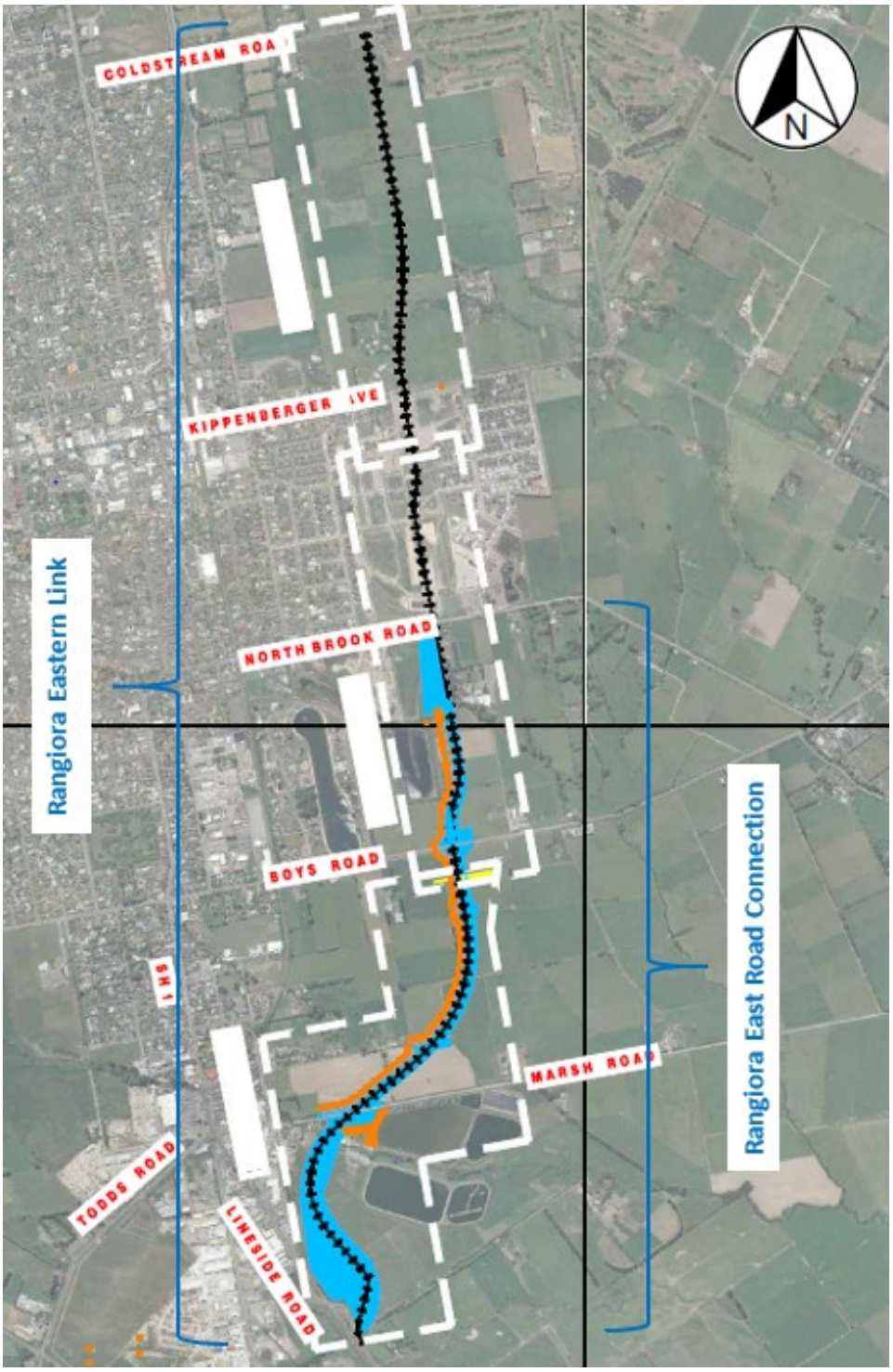


Figure 1: Layout Plan

1.2 Purpose of Noise Assessment

The purpose of this technical report is to assess the likely noise effects of the RERC ("the Project") as described in the NOR and demonstrate that any unreasonable adverse effects can likely be effectively mitigated.

This noise assessment has been performed on a high-level design and based on broad parameters available at the NOR stage. Because the Project design and the receiving environment will continue to evolve over time, any designation conditions on noise arising from the NOR should allow for flexibility in future designs whilst still providing certainty to the community that noise effects will be reasonable.

Therefore, this assessment

- demonstrates that the noise effects of the Project (as built) can be made reasonable,
- recommends a process to ensure that the noise effects are reasonable,
- identifies the general nature and extent of structural noise mitigation that may be required, as this may introduce non-acoustic effects.

This assessment does not

- set out individual noise limits that must be met,
- define specific noise mitigation that must be implemented.

2 Assessment Criteria

2.1 Road Traffic Noise

The NZ Resource Management Act 1991 establishes the overarching legal requirement for management of road-traffic noise effects, requiring in section 16(1) that noise emission "does not exceed a reasonable level". Local authorities are then involved in determining what constitutes a reasonable level of road traffic noise for a given scenario. The Waimakariri District Plan states in Policy 12.1.1.12 that the noise effects from road traffic in the receiving environment should be avoided or mitigated but does not use rules to control the source (i.e. the road or the traffic). The Waimakariri District Plan predates the widespread adoption of the road traffic noise standard NZS 6806:2010[1], but this standard has been applied to local road projects in recent years, and is appropriate for assessment of noise effects that may arise from the Project.

This noise assessment therefore applies the methods and criteria of NZS 6806.

2.1.1 NZS 6806

NZS 6806 only applies to noise generated by limited types of roads, which the standard classifies as "new" and "altered". New roads are any road constructed where no previous road existed. The definition of an altered road is more complex, but essentially it requires a significant increase in noise emission of an existing road due to the project. Higher noise levels are allowed for sensitive receivers under the altered road classification than under the new road classification. The RERC will be considered a new road for most of its length, but there are receivers at either end for which the altered road criteria may be more appropriate.

Under NZS 6806, sensitive receivers are referred to as Protected Premises and Facilities (PPFs), and include dwellings, marae, educational facilities, and overnight medical facilities[2]. Table 2-1 shows the noise criteria for new and altered roads from NZS 6806. Category A noise limits of 57 dB $L_{Aeq(24h)}$ apply for PPFs adjacent to "new" roads, and 64 dB $L_{Aeq(24h)}$ for PPFs adjacent to "altered" roads. Where it is not consistent with the Best Practicable Option (BPO) to achieve Category A noise limits, the Category B limits should be achieved. Similarly, where the BPO mitigation cannot achieve Category B limits, the Category C limits should be achieved.

Only rural PPFs within 200-metres of the road alignment, and urban PPFs within 100-metres of the road alignment are considered.[3]

[1] NZS 6806:2010, Acoustics – Road-traffic noise – New and altered roads
[2] A building is typically only considered to be a PPF of a project if it already exists, or has an unlapsed building consent, at the time a designation is granted,
[3] NZS 6806 gives specific definitions for urban and rural. See Appendix A for more detail.

Table 2-1: Noise criteria for new and altered roads (Table 2 from NZS 6806)

Category	Altered Road [dB $L_{Aeq(24h)}$]	New roads with a predicted traffic volume >75 000 AADT at the design year [dB $L_{Aeq(24h)}$]	New roads with a predicted traffic volume of 2 000 to 75 000 AADT at the design year [dB $L_{Aeq(24h)}$]
A (free-field external noise)	64	64	57
B (free-field external noise)	67	67	64
C (internal noise)	40	40	40

2.2 Construction Noise

Waimakariri District Plan Rule 31.12.1.13 specifies that construction noise shall be assessed in accordance with NZS 6803:P1984. It will be appropriate for construction noise to be assessed in accordance with the most recent version of this standard, currently NZS 6803:1999[4].

3 Assessment Methodology

3.1 NZS 6806

Assessment under the NZS 6806 methodology relies on noise modelling to predict the noise environment with the REL in place in the design year, 2041, at least ten years after the completion of the project, expected in 2031. A second noise modelling scenario represents the environment as it would be in the design year without the REL having been built, and a third modelling scenario of the existing noise environment is used to generally validate the performance of the noise model through noise monitoring (see section 3.3).

The noise modelling software SoundPLAN has been used to model the first two of these scenarios, which are further described in Table 3-1. The noise modelling uses a high-level design, and is intended to achieve an accuracy suitable for assessment of noise effects at the NOR stage. It is not appropriate for detailed mitigation design, which will require the detailed design and PPF details that will only be known nearer to the time of construction.

The details of the specific inputs and modelling techniques used are given in Appendix A.

Table 3-1: Summary of NZS 6806's scenarios

Scenario name	Definition	Purpose
Existing	The Project area and traffic volumes as they are prior to construction work commencing.	To allow validation of the many aspects of the noise model using contemporary noise measurements.
Do-nothing	The Project area and traffic volumes as they would be in 2041 without the REL.	To establish a baseline level for assessing the impact of altered roads.

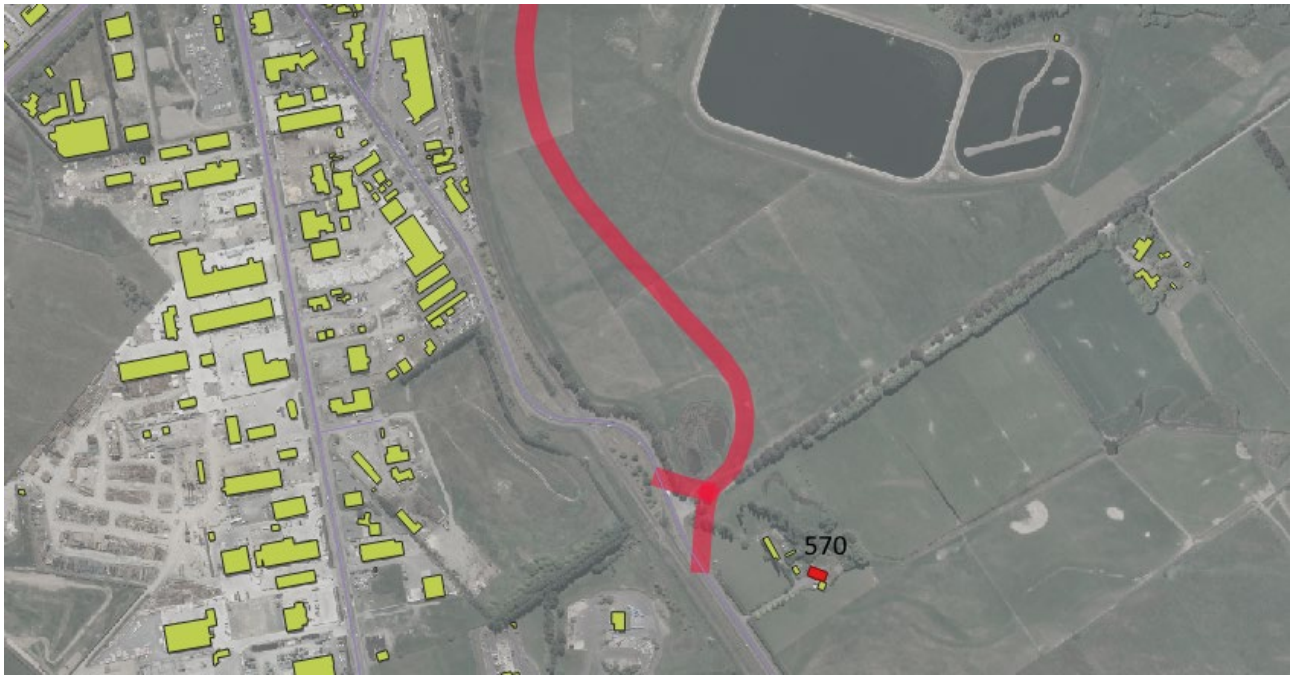
[4] NZS 6803:1999, Acoustics – Construction Noise

Scenario name	Definition	Purpose
Do-minimum	The Project area and traffic volumes in the year 2041, assuming that the REL is operational, but without specific noise mitigation measures implemented.	To establish the noise levels in 2041, determine noise effects, and act as a baseline for the effectiveness of any proposed noise mitigation measures.

3.2 Protected Premises and Facilities

In this assessment the Project will be discussed in four parts: the southern tie-in to Lineside Rd, the central section that forms the majority of the RERC, the northern tie-in to Northbrook Rd, and the short road section north of Kippenberger Ave. The Project is considered in these parts based on existing exposure to road-traffic noise. The central section has minimal existing exposure to road-traffic noise whereas the tie-in parts have some exposure to road-traffic noise from the existing roads.

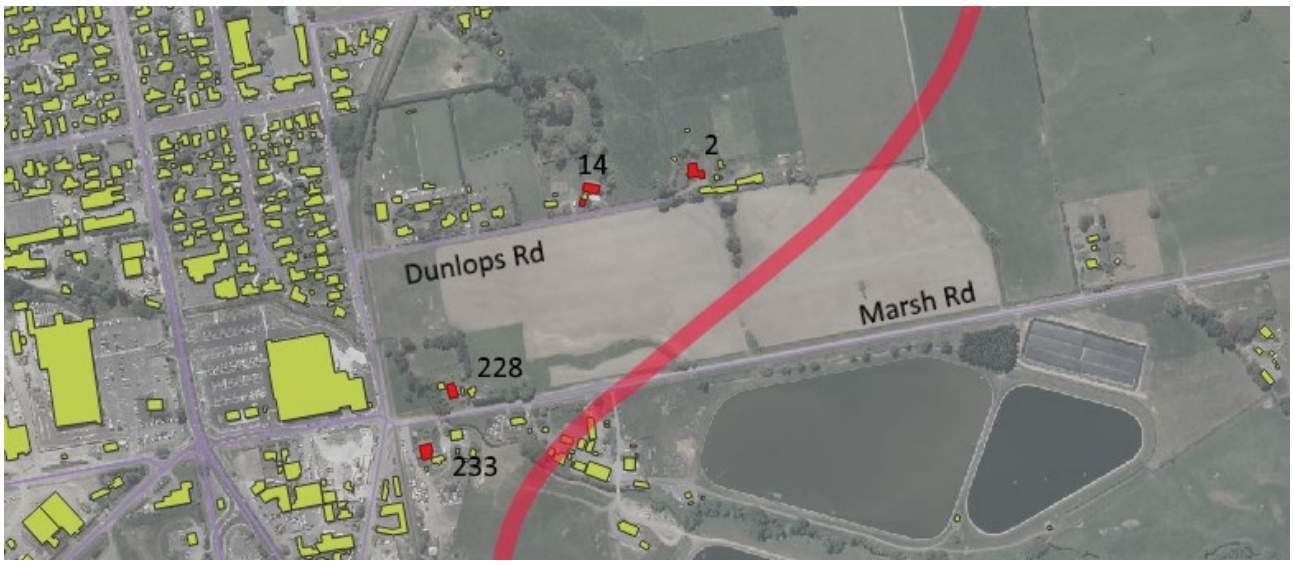
3.2.1 The Southern Tie-in to Lineside Rd



The intersection layout with Lineside Rd has not yet been confirmed, in terms of either form or location. This assessment conservatively assumes that it will be located somewhere in the large area south of the catchment ponds on Marsh Rd and northeast of the current Lineside Rd alignment.

There is one potential PPF in this rural area, 570 Lineside Rd. Depending on the final intersection design, either new or altered road criteria (Table 2-1) could apply. The most likely scenario is that the existing Lineside Rd traffic will continue to dominate, and the altered road criteria would then be appropriate.

3.2.2 The Central Section



Most of the route is through what is currently a rural area.

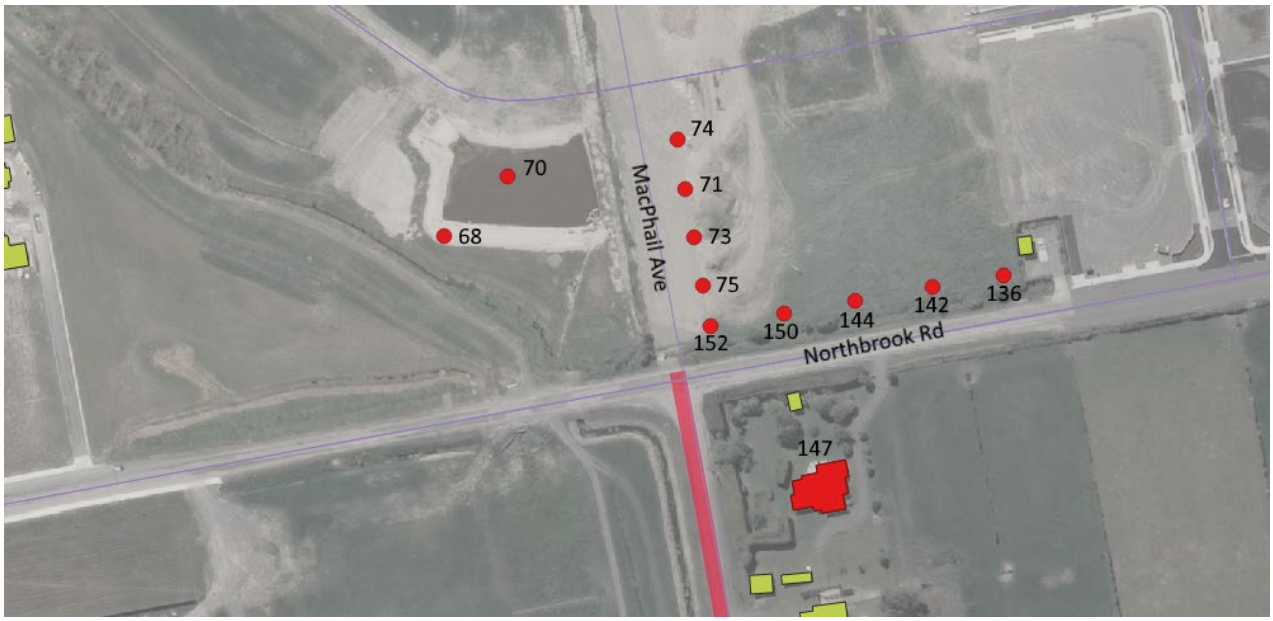
On Dunlops Road there are 3 potential PPFs within 200 metres of the proposed designation boundary at numbers 2 and 14.

On Marsh Rd there are at least 2 potential PPFs within 200 metres of the proposed designation boundary at numbers 233 and 228.

There is a collection of structures at 17 Spark Lane in an urban area that may include one or more PPFs within 100 metres of the designation. This property has been represented by a single PPF in the noise model (shown above in red), located in the most exposed western part of the property.

New road criteria would apply at all these dwellings if they are PPFs under the final design. Where there is a large increase in traffic on the local road it may be reasonable to apply the altered road criteria to noise exposure from that road only.

3.2.3 The Northern Tie-in to Northbrook Rd



Adjacent to Northbrook Rd are a number of potential PPFs in an urban area.

There is one dwelling on the south side of Northbrook Rd at number 147 which is within 100 metres of the RERC, and to which the new road criteria will apply.

Immediately to the north of Northbrook Rd are new residential developments, and about 20 lots are within 100 metres of the proposed RERC designation. The lots are currently in various stages of development, ranging from empty to completed dwellings, and many could be PPFs, depending on the timing of consents.

Because there is no building data (locations, outlines, etc) available, the first row of lots with 100 metres of RERC have been modelled as notional 'point receivers' in positions consistent with ground floor windows closest to the RERC. These are appropriate as placeholders for the NOR, but final mitigation design should be based on actual building data.

In general, the noise environment at many of these PPFs will be dominated by traffic on MacPhail Ave and/or Northbrook Rd rather than the new RERC road, so it may be most appropriate to apply the altered road criteria for these PPFs.

3.3 Validation of Road Traffic Noise Model

Assessment under NZS 6806 is based on modelling the noise of a future road layout, but aspects of the wider noise model can be validated by comparing the Existing scenario with contemporaneous measurements. The project-model developed for this NOR assessment uses the scenario existing now, in 2021, for validation. NZS 6806:2010 §5.3.4.2 suggests that the difference between measured and predicted/modelled levels should not exceed ± 2 dB, which is a reference to the required noise modelling accuracy of ± 2 dB at the 95% confidence interval for mitigation design. The project-model developed for this NOR assessment is not going to be used for detailed mitigation design so a lower level of accuracy would be acceptable, but ± 2 dB is a good guide.

Short-term noise measurements to validate the performance of the noise modelling process were undertaken on 15 January 2021 at three locations adjacent to existing roads (Table 3-2). Measurement sites 1 and 2 were close to busy roads and show good agreement against the modelled levels for the same locations after adjusting levels for the time of day (measurements were made between 9am and 4pm). Site 3 experienced no traffic passing on Dunlop Rd during the measurement period, and the noise environment was dominated by distant road and air traffic sources, as well as birds, wind, and industry noise. It is therefore expected (and observed) that this site would not agree well with the modelled results, which only account for traffic noise.

Table 3-2: Validation of noise model using measurements

Site ID	Location	Predicted $L_{Aeq(24h)}$ dB	Measured* $L_{Aeq(24h)}$ dB	Difference dB	Outcome
1	Northbrook Rd	52.8	51.7	-1.1	Good agreement
2	Boys Rd	64.4	65.2	+0.8	Good agreement
3	Dunlop Rd	44.6	41.1	-3.5	Reason for poor agreement is understood and acceptable

* Derived from $L_{Aeq(1h)}$ measurements by adjusting by -1.8 dB (c.f typical L_{Aday} vs $L_{Aeq(24h)}$ for road traffic noise)

Overall, the agreement between the Existing 2021 noise model and the short-term noise measurements is good, which provides confidence in the predictions of the 2041 noise levels.

4 Road Traffic Noise Assessment

4.1 NZS 6806

External free-field equivalent levels in dB $L_{Aeq(24h)}$ have been predicted (see section 3.1) for the PPFs identified in section 3.2 for the year 2041, with and without the Project in place. The upper limit of the 95% confidence interval for each PPF has been taken as its representative level in each case. These levels have been evaluated against the criteria for new and altered roads (Table 2-1) to provisionally place each PPF within an NZS 6806 noise category. From section 2.1.1, Category A is the lowest noise level or "best" category and generally requires no investigation of further mitigation, whereas Category B means that an investigation of further noise mitigation is required (with the typical aim of achieving Category A, if practicable).

Table 4-1 summarises the result of the noise assessment based on the NOR model, and provides a provisional noise category for each PPF. The implications for each PPF are discussed further below.

Table 4-1: Provisional assessment of RERC against NZS 6806 criteria for the year 2041

Zone	PPF	Road Classification	NZS 6806 Noise Category
Southern Tie-in	Lineside Rd 570	Altered	A
Central Section	Spark Ln 17	New	A
Central Section	Dunlops Rd 14 (flat)	New	A
Central Section	Dunlops Rd 14 (house)	New	A
Central Section	Dunlops Rd 2	New	A
Central Section	Marsh Rd 228	New	A
Central Section	Marsh Rd 233	New	A
Northern Tie-in	Northbrook Rd 147	New	B
Northern Tie-in	MacPhail Ave 71 *	Altered	A
Northern Tie-in	MacPhail Ave 73 *	Altered	A
Northern Tie-in	MacPhail Ave 75 *	Altered	A
Northern Tie-in	Northbrook Rd 136 *	Altered	A
Northern Tie-in	Northbrook Rd 142 *	Altered	A
Northern Tie-in	Northbrook Rd 144 *	Altered	A
Northern Tie-in	Northbrook Rd 150 *	Altered	A
Northern Tie-in	Northbrook Rd 152 *	Altered	B
Northern Tie-in	Watkins Dr 68 *	Altered	A
Northern Tie-in	Watkins Dr 70 *	Altered	A
Northern Tie-in	Watkins Dr 74 *	Altered	A

* these potential PPFs were modelled using point receivers (see section 3.2.3)

4.1.1 The Southern Tie-in to Lineside Rd

The noise environment at 570 Lineside Rd will be dependent on details of the location and design of the RERC tie-in with Lineside Rd. The scenario modelled here showed road traffic noise levels that were similar with and without the RERC in place, and comfortably within noise category A.

4.1.2 The Central Section

Any PPFs at 17 Spark Lane are likely to experience a large increase in road traffic noise from the west with the RERC in place, but are expected to remain in noise category A.

PPFs on Dunlops Road should remain comfortably within noise category A after the RERC opens.

PPFs on Marsh Rd will experience only a small increase in road traffic noise level from the RERC itself, and will fall in noise category A under the new road criteria. We note that greater noise exposure will come from the substantial increase in traffic volume along Marsh Rd by 2041, with or without the RERC. The additional increase coincident with the RERC opening is also substantial, but these PPFs would remain in category A if assessed under the altered road criteria (though it is not yet clear that this would be appropriate). The noise impact on these PPFs should be considered carefully in the future noise assessment of the detailed design, and in any other planning processes involving Marsh Rd.

4.1.3 The Northern Tie-in to Northbrook Rd

The existing PPF at 147 Northbrook Rd is at risk of falling within noise category B under the new road criteria in 2041 with the RERC open. Despite increased traffic on Northbrook Rd to the north, the façade facing west towards the RERC is expected to receive the highest noise level. The current modelling indicates that mitigation options such as a local speed reduction on the RERC or a low-noise road surface might be sufficient to return the PPF to category A, but that investigation should only be made once the detailed design is available, if it is still required.

One of the eleven notional point receivers, 152 Northbrook Rd, is predicted to fall just within category B, and two more, 150 Northbrook Rd and 75 MacPhail Ave, are close to the category B threshold. The road traffic noise received by all eleven potential PPFs is dominated by traffic on MacPhail Avenue or Northbrook Road rather than the RERC. Mitigation should be investigated after the detailed design is available and it is established which of these lots contain PPFs and the location of the buildings. In urban areas, driveway access can mean that noise walls are not appropriate as mitigation, but there may be scope to provide a somewhat quieter road surface (though the existing asphalt AC-10 road surfacing is already a quiet surface). If mitigation is investigated and is practicable, most or all PPFs would fall under category A. Even if mitigation is not found to be practicable, very few PPFs would be expected in category B, and these would meet the NZS 6806 criteria.

Additionally, we recommend that WDC's intentions for MacPhail Ave (that it will form part of the future REL) be made clear so that developers of adjacent lots can consider the higher traffic volumes when determining setback distances and acoustic insulation of dwellings.

4.2 Other Receivers

There are additional receivers, outside of the scope of the current assessment, who may experience a change in noise environment coincident with the opening of RERC, and the REL.

Much of the change in traffic volume around Eastern Rangiora between now and 2041 appears to be driven by the expansion of the suburb itself, however, the REL will divert a substantial amount of traffic from its previous course (the 'do-nothing'), including to/from roads far from the RERC designation. After the REL opens some distant receivers will experience more noise and some less due to traffic volume shift. In general, this change in noise will be consistent with the evolving usage of the affected roads and will not cause more than a minor positive or negative effect. In most cases the traffic will be sufficiently distributed that the change in noise level will be less than 3 dB, and will not be audible to most people.

Two possible exceptions have been identified:

4.2.1 MacPhail Avenue

The recently completed MacPhail Ave is a north-south link across East Rangiora between Kippenberger Ave and Northbrook Rd. It makes up the middle of 3 sections of road that form the full Rangiora Eastern Link. It is not part of the RERC NOR.

The do-nothing scenario has very low traffic volume attributed to MacPhail Ave by the traffic modelling (see Appendix A). There is currently no road hierarchy available for MacPhail Ave[5], but the road has features[6] that indicate it may be intended to carry a higher volume of traffic than the surrounding roads: it is wider and has large setbacks to houses.

In the design year (as previously defined in Section 3.1), receivers along the length of MacPhail Ave, which may include dwellings and a school, will be exposed to significantly increased traffic

[5] Waimakariri District Plan, Road Hierarchy, Map 136.
[6] East Rangiora Outline Development Plan, Map 152

volumes, and a significant increase in road traffic noise compared to the current levels. Multiple factors will contribute to any noise effects experienced by these PPFs, one of which is the RERC.

4.2.2 Northbrook Road, west of RERC

Traffic modelling suggests that traffic volumes on Northbrook Rd west of MacPhail Ave will increase by a factor of 3 between now and 2041 without the REL, or by a factor of 8 with the REL. The former is probably attributable to the gradual expansion of Eastern Rangiora, but the latter is presumably driven by a more significant shift in traffic patterns through Rangiora due to the REL coming online.

Receivers on Northbrook Rd beyond the RERC's direct zone of influence (section 2.1.1) will experience a significant increase in road traffic noise coincident with the opening of the RERC (though potentially mitigated by factors such as road surface and traffic mix changes). Multiple factors will contribute to any noise effects experienced by these PPFs, one of which is the RERC.

4.3 Other Sources of Noise

There are no major bridges in the design, but if pre-cast sections are necessary (e.g. to span waterways or rail) then the seal joints should be designed to be smooth so they don't generate impact noise as tyres pass over them.

The very low road gradients expected do not suggest that truck engine braking will be prevalent, but this should be considered again against the detailed design.

Intersections will be introduced by the Project. Vehicles decelerating and accelerating influence both the absolute noise emission level and the qualitative nature of the traffic noise, and can contribute to annoyance. Intersections should be designed with their noise impact in mind and their impact considered in the noise assessment of the detailed design.

5 Construction Noise Assessment

The construction programme for the RERC has not yet been planned with any level of detail, but it is expected to be typical of road construction projects of similar magnitude undertaken elsewhere in the country. The construction period is expected to extend beyond one year but that total duration comprises different activities occurring at different locations. No single location will be subject to construction noise for the full construction period.

5.1 NZS 6803

Section 2.2 found it appropriate for construction noise to be assessed in accordance with the most recent version of NZS 6803, currently NZS 6803:1999. Table 2 of the standard sets out desirable noise limits for work of normal duration, and recommends that these limits be decreased for work of long duration, that is, more than 18 weeks. However, it is common for the noise limits for work of normal duration to be applied to road construction projects because that often more closely reflects the experience of individual sensitive receivers that are only exposed to noise for a few weeks at a time.

If the constructor considers night time work is required, the need for it and appropriate noise levels for that specific work would normally be negotiated with Council officers as the situation arises.

5.2 Construction Noise Management

It is clear that noise associated with the construction of the RERC will have the potential to cause annoyance and disruption to the community. The most effective method to control construction noise is through proactive management. To ensure this occurs, it should be a requirement on the

constructor to prepare a Construction Noise Management Plan as part of the Construction Management Plan. The Construction Noise Management Plan should detail constructor obligations during the construction, and will include details such as:

- Description of the works, anticipated equipment processes/durations;
- Identification of the most affected houses where noise limits apply;
- Applicable noise limits, including any consent/designation condition requirements;
- Assessment of construction noise levels;
- Appropriate noise mitigation measures to be implemented;
- Establishing a monitoring regime which targets both the more noisy activities and their potential occurrences near noise-sensitive locations;
- Staff training/awareness programme;
- Procedures for maintaining contact with stakeholders, including informing them when noisy activities may occur and providing summary reports of monitoring and investigations of any noise complaints;
- Process for managing noise complaints; and
- Contact telephone numbers for key construction staff, staff responsible for noise assessment and Council offices, plus a single point of contact to immediately advise of concerns about noisy activities.

Provided that an appropriate Construction Noise Management Plan is produced and adhered to, and good practice is followed, the construction of the RERC should be achieved without significant construction noise effects.

6 Findings and Recommendations

6.1 Road Traffic Noise

NZS 6806 provides an appropriate assessment method and criteria for the road traffic noise effects of the RERC.

The high-level RERC design and indicative traffic and receiver information has been used to construct a computer noise model, which has been successfully validated through field measurements. This model is appropriate for the level of assessment required by the NOR, that is, to determine whether the Project can be designed such that its road traffic noise effects are reasonable, and to identify the process by which that result will be ensured.

The assessment finds that the majority of PPFs will fall within NZS 6806 noise category A, which is commonly taken as an 'acceptable' level of noise. An existing PPF at 147 Northbrook Rd and one or more potential PPFs (not currently constructed) north of Northbrook Rd are at risk of falling within category B, which would require investigation of mitigation. Mitigation cannot currently be investigated based on the high-level NOR design and the uncertainty surrounding which receivers qualify as PPFs, so an additional noise assessment must be performed once the detailed design is available and PPFs have been identified. However, the magnitude of noise reduction required to restore all or most PPFs to category A appears to be achievable through traditional mitigation measures, which may include noise barriers, low noise surfaces, and potentially traffic speed reduction.

We conclude the RERC can be designed such that the road traffic noise effects are reasonable, and designation conditions to ensure this outcome are proposed in section 6.3.

6.2 Construction Noise

NZS 6803 provides an appropriate assessment methodology and noise limits for construction noise.

The construction programme for the RERC has not yet been planned with any level of detail, but it is expected to be typical of road construction projects of similar magnitude. It is likely that the NZS 6803 noise limits for work of 'normal duration' will be appropriate for many receivers, but this should be revisited once a construction schedule is in development.

We find that, provided an appropriate Construction Noise Management Plan is produced and adhered to, the construction of the RERC should be achieved without significant construction noise effects. A designation condition to ensure this outcome is proposed in section 6.3.

6.3 Proposed Designation Conditions

We recommend that the following designation conditions are applied for road traffic noise and construction noise, which are consistent with best practice and will ensure that noise effects will remain reasonable:

6.3.1 Road Traffic Noise

6.3.1.1 A list will be produced of the PPFs that exist, or that hold building consent, on the decision date of the designation. This will occur within 6 months of the granting of the designation.

6.3.1.2 A noise assessment of the final design will be undertaken following NZS 6806 (the current version at the time of the assessment).

6.3.1.3 Structural mitigation found by the NZS 6806 assessment to be the best practicable option will be implemented.

6.3.2 Construction Noise:

6.3.2.1 Construction noise will be managed and assessed against NZS 6803 (the current version at the time of construction).

6.3.2.2 A Construction Noise Management Plan will be prepared prior to construction and implemented throughout the construction process.

Appendix A : Noise modelling details

General	
Modelling and assessment	Richard Jackett, January 2021
Design year	2041
Noise model	NZS 6806:2010 provides guidance on the process and particulars expected of road-traffic noise assessments and noise modelling. All road-traffic noise modelling for this assessment has been in line with NZS 6806:2010. The modelling techniques used are well established in New Zealand. The model used is based on the Calculation of Road Traffic Noise (CRTN) model. The CRTN model was developed in the United Kingdom more than thirty years ago. Research in New Zealand has validated the model as appropriate in New Zealand so long as some New Zealand-specific adjustments are applied. Adjustments to suit New Zealand conditions are made in accordance with *Dravitzki, V. and Kvatch, I. (2007) Road surface effects of traffic noise: Stage 3 selected bituminous mixes, Land Transport NZ Research Report No. 326*. As recommended in *Barnes, J., Ensor, M., Beca Carter Hollings and Ferner Ltd and Hegley Acoustic Consultants Ltd (1994) Traffic noise from uninterrupted traffic flows, Transit New Zealand Research Report No. 28*, a road surface correction of -2 dB was used as the base correction for asphaltic concrete. Extensive validation has established the reliability of noise modelling for assessing changes in noise levels, including New Zealand-specific calibration and validation, as reported in *Barnes, J., Ensor, M., Beca Carter Hollings and Ferner Ltd and Hegley Acoustic Consultants Ltd (1994) Traffic noise from uninterrupted traffic flows, Transit New Zealand Research Report No. 28*; and *Dravitzki, V. and Wood, C. (1999) Validation of Leq models for road noise assessment in New Zealand, Transfund Research Report No. 121*.
Noise modelling software	The noise modelling software used is SoundPLAN version 8.2 (the most recent version). SoundPLAN takes into account the effects of terrain and buildings on the propagation of noise from the road-traffic into the surrounding environment and assumes neutral propagation conditions (i.e. does not account for day to day variations in environmental conditions). Noise can be predicted for identified assessment locations (such as building façades) or over a grid for transformation into noise contour maps.
Uncertainty	NZS 6806:2010 C5.3.4.2 states that “CRTN is known to predict noise levels to within 2 dB of the measured levels [and] this is considered to be the appropriate degree of accuracy to apply to prediction methods”. We have taken ± 2 dB as an indicative 95% uncertainty interval around each CRTN modelled noise level, and in this report our predicted noise levels represent the upper bound of this uncertainty interval.
Traffic and layout	
In the modelling of the project, the NZS 6806:2010 definition of the do-minimum design is used. This is “the project implemented including safety barriers and other structures (which may have an incidental noise mitigating effect)” but without “any measures undertaken for the sole purpose of	

reducing noise." The do-minimum project design is the project without any noise-specific mitigation.	
Road gradient	Road gradient was calculated by the SoundPLAN software for each road segment, which in this model is zero in all cases (see Terrain Data below).
Road layout, horizontal and vertical alignment	The Project road horizontal alignment was taken from two 2D pdf files provided by the Project team: LAND-PLAN-EAST-E1-(B)_23-12-2020.pdf and LAND-PLAN-EAST-E2-(B)_23-12-2020.pdf. The horizontal alignment of existing roads was taken from Open Street Map.
Terrain data	Topography for the area surrounding the REL was initially imported the LINZ layer "Canterbury – Rangiora LiDAR 1m DEM (2014)" but was found to include terrain features that no longer exist. Given that the area surrounding the Project is predominantly flat (there is only a 3 m fall over nearly 3 km of Project road) the risk of significant error is lower by assuming flat ground across the project, and this has been done.
Buildings	Building outlines and locations have been taken from the LINZ "NZ Building Outlines" layer. PPFs were identified from aerial photographs which were cross-referenced with the latest Google Earth and Google Streetview images where possible. All rural PPFs within 200 m of the new alignment and all urban PPFs within 100 m of the alignment have been modelled (consistent with NZS 6806). Note that in application of NZS 6806, "urban" and "rural" have specific definitions that follow *"New Zealand: An urban/rural profile", Statistics NZ, 2004* and are determined from the current Statistics NZ urban/rural profile data. Properties immediately north of Northbrook Rd are at various stages of development, and it is not appropriate to model these potential PPFs as completed buildings. Instead we have modelled the first row of lots (within 100 m of RERC) using 'point receivers' in positions consistent with ground floor windows closest to the RERC. Identified PPFs have also been reviewed by the Christchurch-based Project team for accuracy and completeness.
Assessment positions	NZS 6806 1.7.2 states the assessment position should be 1.2 to 1.5 metres above each *floor* level of interest in the building of the Protected Premise or Facility. Receivers have been modelled on all external building walls at a height of approximately 2.5 metres above *ground* level for one storey buildings and about 5 metres above ground level for two storey buildings, which reflects a conservative approach. The sound level is a free-field level, excluding any reflections from a building façade (using a correction of -2.5 dB if necessary).

Traffic volumes	Projected traffic volumes with and without the REL in the year 2038 were provided by the Project team. An annual growth rate of 1.5% was also provided, and this has been used to estimate the REL AADT three years later in the design year 2041. Other local roads derive existing 2021 volumes from the most recent estimates in mobileroad.org, and 2041 volumes via the growth rate of 1.5%. The AADT estimates are provided in Table A-1 below.
Road surfaces	The Project team advises that the surface of the RERC is nominally 'asphalt', which we have assumed will have acoustic properties comparable to the AC-10 asphalt specification. Surfaces of existing roads have been taken from the most recent surface recorded in mobileroads.org unless a visual inspection indicated a different specification. The modelled surface types and the corresponding road surface corrections, in decibels, are detailed in Table A-1 below.
Traffic speeds	The RERC could have a speed limit of either 50 km/h or 60 km/h, so noise modelling has used the more conservative estimate of 60 km/h. For existing roads the current speed limits have been used. The modelled vehicle speeds are detailed in Table A-1 below.

Table A-1: Road traffic and surface data used for noise model

Road Section	AADT			%HCV	Surface	Surface Correction (dB)	Speed (km/h)
	Existing 2021	Do Nothing 2041	REL 2041				
RERC - Lineside to Marsh	--	--	14312	3.0	Asphalt AC-10	-2.0	60
RERC - Marsh to Boys	--	--	15313	2.8	Asphalt AC-10	-2.0	60
RERC - Boys to Northbrook	--	--	12326	2.7	Asphalt AC-10	-2.0	60
RERC slip road N	--	--	4312	3.0	Asphalt AC-10	-2.0	60
RERC slip road S	--	--	10000	3.0	Asphalt AC-10	-2.0	60
Lineside Rd 50 km/h	15516	18058	8524	3.8	Grade 3	1.3	50
Lineside Rd 100 km/h	15516	18058	22417	3.8	Grade 3	1.6	100
Marsh Rd	299	1808	6461	10.0	Grade 3/5	2.0	50
Boys Rd*	2251	3106	4101	4.0	Grade 4/6	2.1	50
Railway Rd	959	1261	1261	16.0	Grade 4	-1.7	50
Dunlops Rd	80	105	105	1.0	Grade 4	0.7	50
Northbrook Rd (W)	1118	3117	9051	6.1	Grade 3/5	2.5	50
Northbrook Rd (E)	1118	2981	3141	6.1	Grade 3/5	2.5	50
MacPhail Ave	--	555	6316	4.0	Asphalt AC-10	-2.0	50
Kippenberger Ave	--	11648	10000	3.8	Grade 3	1.3	50
REL – Nth of Kippenberger	--	--	3429	1.0	Asphalt AC-10	-2.0	50
Low Volume Roads	500	500	500	4.0	Grade 4/6	2.1	50

* Boys Rd is currently 80 km/h with high %HCV and coarse chipseal but is assumed to be a 50 km/h suburban road in 2041

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