

Memorandum

To: Greg Haldane, Waka Kotahi
From: Clare Dykes, Acoustic Engineering Services
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Project: Cost of traffic noise mitigation measures
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Meeting Telephone Memorandum File Note

Dear Greg,

In March 2020, Waka Kotahi NZ Transport Agency engaged Acoustic Engineering Services (AES) and O'Brien Quantity Surveying to undertake a study relating to the cost of traffic noise insulation measures. The project involved a review of a number of situations where traffic noise mitigation had been installed, including:

- Buildings which required upgrades to reduce traffic noise break-in as a result of their location in proximity to major roads, and;
- New residential neighbourhoods which were constructed near to major roads, where traffic noise barriers were integrated into the overall scheme design so that the upgrading of dwellings was no longer required (or was reduced) and noise in outdoor living areas was reduced.

This memorandum summarises the study, and the general trends visible in the results.

1.0 BUILDING UPGRADES

A common method of ensuring that noise from roads is not intrusive within buildings is to design the building envelope to provide a high level of sound insulation, and to provide a mechanical ventilation system so occupants do not need to open windows for cooling and fresh air.

The Christchurch District Plan contains a rule requiring the design of new noise sensitive buildings to be constructed in higher noise locations to include these sound insulation features. AES have previously completed a study related to the Christchurch District Plan sound insulation rule, which involved a review of the specific circumstances relating to a sample of building projects. The work described in this memo built on aspects of that previous study, and looked to quantify the cost of those building upgrades, to assist Waka Kotahi in understanding the potential financial implications of mandatory traffic noise insulation rules. A number of additional examples from various sources were added to the original sample, to increase the sample size and diversity.

We have also completed a review of the Proposed and Operative District Plans for the 67 New Zealand Districts. Two thirds of the District Plans throughout the country include requirements for sound insulation when dwellings are located in proximity to major roads. Of these, 10 % include a requirement which is very

similar to the Waka Kotahi Guidelines¹ centred around an internal noise level requirement of 40 dB L_{Aeq} (24 hour) in bedrooms and other habitable spaces, and the provision of mechanical ventilation. The remaining rules vary, with common variations including requiring different internal noise levels to be met, omitting any mechanical ventilation requirement (or a reduced mechanical ventilation requirement), and specifying a fixed level of sound insulation performance to be achieved by the building façade. As discussed below, all of these rule variations have a different cost impact.

1.1 The sample

A total of 58 buildings were considered for inclusion in the analysis. However, detailed costings were only completed on 23 of these, primarily because:

- A number of the building projects successfully obtained a Resource Consent to legitimise a partial or complete non-compliance with the relevant sound insulation rule, and so these results would not have assisted with understanding the cost of compliance.
- For a number of the building projects there was not sufficient publicly available information to complete an accurate costing.

The final 23 building projects included 11 detached residential dwellings, seven multi-residential units (such as terraced houses and duplexes), and five apartment buildings. These buildings were expected to experience worst-case traffic noise levels ranging from 55 dB L_{Aeq} (24 hours) to 71 dB L_{Aeq} (24 hours).

As discussed above, a variety of sound insulation rules are encountered throughout the country. The building projects in the sample had been assessed against the following rules:

- 12 of the sample has been assessed against a requirement which is similar to that described in the Waka Kotahi Guidelines, including an internal noise level requirement of 40 dB L_{Aeq} (24 hour) in bedrooms and other habitable spaces, and the provision of mechanical ventilation.
- Two of the sample were assessed using a rule which has a different internal noise level requirement with no mechanical ventilation required.
- Eight of the sample were assessed against rule with a façade reduction requirement or a provided set of constructions intended to provide a fixed façade reduction, and no mechanical ventilation required.
- One involved review against an internal noise level requirement of 40 dB L_{Aeq} (24 hours) for some spaces, and a façade reduction requirement for others.

Overall, the sample was relatively small – however a moderate number of examples could be assessed against a rule similar to that preferred by Waka Kotahi. Otherwise the variety within the sample is typical of the variety in sound insulation rules encountered in New Zealand.

Challenges of extending the sample included the lack of a centralised database to use for establishing a list of building projects of potential interest, and then the lack of availability of publicly available information for projects which provides sufficient detail for accurate costings.

1.2 Assumptions

Key assumptions embodied in this part of the study are as follows:

¹ Waka Kotahi NZ Transport Agency, *Guide to the management of effects on noise sensitive land use near to the state highway network*, Version 1.0, September 2015

- The reported external noise levels are based on the available traffic numbers, road surface, and speed information for the road adjacent to the building project site at the time, and are for the most exposed building façade.
- The upgrades that were recommended by the acoustic engineers involved in each case were installed and alternative systems were not used.
- The systems where not specified were originally 10 mm Standard Gib plasterboard internal linings for walls, and 13 mm Standard Gib plasterboard linings for ceilings, and 4 mm float glass / 12 mm air space / 4 mm float glass for glazing.
- Where 7 mm Ecoply RAB board was specified for external walls it was assumed that this would have been included regardless of the acoustic upgrades, and so was not included in the upgrade costing.
- Where not specified, the mechanical ventilation system was assumed to be of similar or equal design and performance to those projects where this detail was provided.

1.3 Findings

We have summarised a number of key observations from the analysis below.

Table 1.1 outlines the increase in overall building cost associated with any upgrades to the building façade and/or the installation of mechanical ventilation system, to ensure compliance with the various sound insulation rules.

Table 1.1 – Summary of cost of traffic noise mitigation by building type

Building Type	Range of external noise levels (dB L _{Aeq} (24 hours))	Increase in overall cost of building (per residential unit)	Percentage increase in overall cost of building
Detached residential	55 – 68	\$0 – \$16,000	0 – 2 %
Residential units	58 – 69	\$500 – \$15,000	0 – 2 %
Apartment buildings	60 – 71	\$500 – \$16,000	0 – 1 %

These results illustrate that the overall percentage increase in building cost due to compliance with a sound insulation rule was 2 % or less (noting that none of the buildings in the sample were exposed to external traffic noise levels exceeding 71 dB L_{Aeq}(24 hour)).

For the residential units and apartment buildings, the figures in table 1.1 are based on the total cost of upgrades, divided by the total number of residential units in the development. However, some units did not require any upgrades, as they experience lower external noise levels. If the total cost of upgrades is only divided by the number of units in the development which required upgrading, the percentage increase changes to 1 – 4 %.

In table 1.2 the results are presented based on the type of sound insulation rule that the assessment was undertaken against.

Table 1.2 – Summary of cost of traffic noise mitigation by rule type

Rule	Range of external noise levels (dB L _{Aeq} (24 hours))	Increase in overall cost of building per residential unit	Percentage increase in overall cost of building
Internal noise level of 40 dB L _{Aeq} (24 hours) and mechanical ventilation	55 – 71	\$0 – \$16,000	0 – 2 %
Alternative internal noise level requirement, no mechanical ventilation	64 – 65	\$500 – \$1,500	0 – 1 %
Façade reduction requirement or defined constructions, and no mechanical ventilation	55 – 69	\$0 – \$16,000	0 – 2 %

This summary appears to indicate that the costs associated with both the internal noise level and façade reduction rules are similar (noting that the sample size for the ‘alternative internal noise level requirement, no mechanical ventilation’ rule was very small, and the external levels were moderate). However, we note the following:

- For the methods which used internal noise levels, the increase in costs is very dependent on the external noise level. The developments which resulted in upgrade costs of less than 1 % typically experienced external noise levels below 65 dB L_{Aeq} (24 hours). There are exceptions to this depending on the layout of the units.
- While the ‘façade reduction requirement or defined constructions’ rules appear to attract a similar cost to the ‘internal noise level’ rules, those particular rules did not require mechanical ventilation to be installed. Occupants in some situations would therefore have still had to choose between thermal comfort, and noise. Additional cost should have been involved with installing mechanical ventilation in those situations, as was the case for the ‘internal noise level of 40 dB L_{Aeq} (24 hours) and mechanical ventilation’ examples. To put it another way, the cost may be similar, but the benefit is likely to have been less in many cases.
- The required construction upgrades (and therefore the costs) of the ‘façade reduction requirement or a defined set constructions’ rules are not dependent on external noise levels. This means that while the range of cost increases is similar, in some situations the high costs lead to no benefit, as the external noise levels were low. For the ‘internal noise level of 40 dB L_{Aeq} (24 hours) and mechanical ventilation’ examples where the costs were high, that was at least in response to high external noise levels and so was justified.

For a small number of developments, no upgrades were required as either external traffic noise levels were very low, or the original design included high mass cladding with small window areas on key facades.

2.0 BARRIERS

An alternative method for reducing the levels of road traffic noise experienced by the occupants of new dwellings is for a barrier to be installed to screen a new residential neighbourhood from the road. This means that individual dwellings are less likely to need to be upgraded, and noise levels in outdoor living areas are also reduced. However, the developer of the new neighbourhood is likely to primarily bear the cost of the barrier, compared to the building upgrades discussed in section 1.0 above, which are paid for by the individual building owners.

2.1 The sample

10 new residential neighbourhoods were included in the analysis. All of these adjoined State Highways and were likely to have been designed with some regard to the Waka Kotahi Guidelines. Each of the neighbourhoods had been screened from the State Highway with a traffic noise barrier, including:

- Seven examples with 'acoustic' fences ranging in height from 2 – 3 metres
- Two examples where earth bunds had been constructed – these were 2 – 3 metres in height, and 8 – 9 metres wide
- One example with a combination of acoustic fencing and earth bund

For each example, we determined the number of dwellings which would have experienced traffic noise levels of greater than 57 dB L_{Aeq} (24 hours) without a barrier. These dwellings would have been the most likely to have required upgrading had the barrier not been constructed, in order to satisfy a traffic noise insulation rule of the type discussed in section 1.0 above. We note that it is possible that some dwellings still required upgrading even with the barrier – for example the upper level of two-storey houses. As above, the barrier also reduces the noise levels in outdoor living areas associated with dwellings – which is a benefit compared to the sound insulation rules discussed in section 1.0, which only modifies the environment within a dwelling.

The number of dwellings which would have experienced traffic noise levels of greater than 57 dB L_{Aeq} (24 hours) without a barrier ranged from 1 through to 120. The number of affected lots was dependent on the overall layout of the subdivision relative to the road, as well as the traffic numbers, road surface, and speed.

2.2 Assumptions

Key assumptions were as follows:

- The acoustic fences were constructed of 125 x 75 mm H4 posts, 75 x 50 mm H3 railings, 150 x 25 mm H3 palings with 50 x 25 mm H3 battens over joins and 150 x 50 mm H3 capping.
- In some cases, the effective height of fences was increased, because they were constructed on top of a retaining wall. It was assumed that the retaining walls would have been required for general site levelling and not specifically to enhance the acoustic effectiveness of the barrier. This was therefore not included within the upgrade cost.
- It was assumed that the subdivision layout without the barrier would have been exactly the same. In reality larger setback distances or other rearrangement of the layout may have been included if the traffic noise had not been largely mitigated by the barrier.
- The earth bund was assumed to be constructed with surplus excavated soil from the site, with a layer of imported topsoil 150 mm thick spread on top for grass.

2.3 Findings

We have summarised a number of key observations from the analysis below.

Table 2.1 shows the cost of each barrier, divided by the number of dwellings which would have experienced a noise level of greater than 57 dB L_{Aeq} (24 hours) without a barrier. We have grouped the results together for different barrier types, and have also shown the situations where are large and small number of dwellings benefited from the barrier separately.

Table 2.1 – Summary of cost of traffic noise mitigation by barrier type

Barrier Type	Approximate number of dwellings which benefited from barrier	Cost of barrier per dwelling
Acoustic fence	1 – 10	\$15,000 – \$30,000
	30	\$10,000
	80 – 110	\$3,000 - \$5,000
Earth bund	10	\$60,000
	50	\$6,000
Combination	120	\$4,000

Overall, this analysis shows that when the number of affected dwellings is low (i.e. the layout results in few lots near the road, or the volume of traffic is low etc.) the overall cost per dwelling is high. When these absolute costs are viewed as a percentage of the likely final value of each of the affected sections, the range is from 2 % (acoustic fence, benefiting a large number of sections) to 30 % (earth bund, benefiting a few sections). As above, in all of these examples for dwellings constructed on these sections, additional costs in the order of those presented in tables 1.1 and 1.2 above would be largely avoided, and traffic noise levels in outdoor living areas would also be reduced.

We note that a key decision in the above analysis is whether the loss of the land under the footprint of any earth bund is included as a 'cost'. In all of the examples the bund fell within an area which was ultimately sold to a homeowner as part of a site, or was within an area close to the State Highway which was unlikely to have been developed for residential use regardless – so the loss of the land under the bund has not been included as a cost. As an example, for the development with approximately 50 affected dwellings, if the cost of the land under the bund was included in the analysis, the total cost as a percentage of the likely final value of each of the affected sections would increase from 3 % to 16 %.

We trust this is of assistance. If you have any queries, please do not hesitate to contact us.

Kind Regards



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