acoustic engineering services

www.aeservices.co.nz
office@aeservices.co.nz
Auckland +64 9 917 0369
Wellington +64 4 890 0122
Christchurch +64 3 377 8952

Report Number: AC22354 – 02 – F1

Dunedin City Second Generation District Plan – Variation 3

Review of Acoustic Insulation in commercial and mixed-use zones

Prepared for:
Mr J. Sule
Dunedin City Council
PO Box 5045
DUNEDIN 9054

Issued:
1 February 2023

ACENZ

Association of Australasian Acoustical Consultants

Revision History

Reference	Status	Date
AC22354 – 02 – R1	Revision 1	16 December 2022
AC22354 – 02 – R2	Revision 2	25 January 2023
AC22354 – 02 – F1	Final	1 February 2023

Document Acceptance

Author	Signature
Jonathan Prins *BE Hons, ME* Acoustic Engineer	
Author and Reviewer	**Signature**
Rewa Satory *B.E.(Mech.) MASNZ* Senior Acoustic Engineer	
Approver	**Signature**
Dr Jeremy Trevathan *Ph.D. B.E.(Hons.) Assoc. NZPI® MASNZ* Managing Director	

Table of Contents

This page has been left intentionally blank.

1.0 OVERVIEW & BACKGROUND

Acoustic Engineering Services (AES) has been engaged to review whether acoustic insulation requirements in the 2GP should be amended to better manage reverse sensitivity effects on entertainment and exhibition activity from residential activity in zones where both activities are permitted.

Section 8.1 of the report *Managing Compatibility Between Music Venues & Noise Sensitive Land Use (27 February 2022)* by Styles Group ('the Styles report') recommended the following changes to the Dunedin City Council Second Generation Plan (2GP):

1) *The insulation requirement of $D_{nT,w} + C_{tr} > 30$ should be increased to $D_{nT,w} + C_{tr} > 35$. This will increase the burden on the receiving environment somewhat but will increase the likelihood of compatibility overall.*

2) *Including a requirement for mechanical cooling so that the windows and doors of noise sensitive activities can remain closed, even in warm weather*

The current 2GP acoustic insulation requirements are set in Rule 9.3.1 and the associated compliance schedule in Appendix 9A. Rule 9.3.1 of the 2GP is currently as follows:

1. *In the locations specified below in clause 4, all rooms to be used for noise sensitive activities (other than those listed in clause 3 below) must have acoustic insulation that achieves a minimum design standard of $D_{nT,w} + C_{tr} > 30$.*
   …
5. *Rooms to which this acoustic insulation standard applies must be supplied with a positive supplementary source of ventilation that achieves a minimum of 7.5 litres per second per person, to enable adequate ventilation when windows are closed.*
   …

Rule 9.3.1.6 directs plan users to Appendix 9A, which describes the minimum requirements necessary to achieve the required external noise insulation level. The relevant part of Appendix 9A is as follows:

1) *Compliance with the acoustic insulation performance standard can be achieved by ensuring that rooms in which acoustic insulation is required by Rule 9.3.1 are designed and constructed in accordance with either:*

   a. *An acoustic design certificate signed by a suitably qualified acoustic engineer stating that the design as proposed will achieve compliance with the acoustic insulation performance standard; or*

   b. *In all areas other than the port noise control mapped area, the schedule of typical building construction in Table 9A. 1A.*

2) *Table 9A. 1A refers to common specifications for timber size. Nominal specifications may, in some cases, be slightly less than the common specifications stated in the schedule for timber size.*

3) *In determining the insulating performance of roof/ceiling arrangements, roof spaces are assumed to have no more than the casual ventilation typical of the jointing capping and guttering detail used in normal construction.*

In this report we have provided the following:

- An indication of the appropriateness of a 35 $D_{nT,w}$ + C_{tr} façade reduction requirement based on national and international guidance.
- Suggested additions to Appendix 9A to provide acceptable constructions to achieve a 35 $D_{nT,w}$ + C_{tr} façade reduction.
- Preliminary discussion with regard to a mechanical cooling requirement for bedrooms.
- Preliminary discussion of the financial implications of introducing an increased façade reduction requirement to bedrooms.

2.0 SUITABILITY OF INCREASED FAÇADE REDUCTION REQUIREMENT

The Styles report recommends increasing the 2GP sound insulation requirement from the existing $D_{nT,w} + C_{tr} > 30$ to $D_{nT,w} + C_{tr} > 35$. Guidance around the suitability of an increase in façade reduction requirements can be obtained from a number of sources, as reviewed below.

As requested, we have referred to the National Planning Standards; however, we note that Chapter 15 of the National Planning Standards gives directives on measurement methods and metrics only. They refer to several NZ Standards including NZS 6801:2008 *Acoustics – Measurement of environmental sound,* which uses the dB L_{Aeq} descriptor. The National Planning Standards do not provide any reference to acoustic insulation requirements and therefore we have based our review on other national and international guidance.

The acoustic parameter $D_{nT,w} + C_{tr}$ can be thought of as the number of decibels the noise is reduced by, as it passes from outside to inside the noise sensitive space. While there may be some situations where this is not strictly accurate, such as where there is a source spectrum that is markedly different to traffic noise or where the internal finishes in the sensitive spaces are unusually hard, in most situations (including for the purposes of this report) the assumption is likely to be a reasonable approximation.

2.1 World Health Organization

World Health Organization (WHO) *Guidelines for Community Noise*[1], advise in their guidelines on sleep disturbance effects, that continuous indoor noise should not exceed 30 dB L_{Aeq} for sleep. WHO also advises that when the noise source contains a large proportion of low-frequency noise, which is typical of music, that an even lower receiving room noise limit should be considered.

Assuming noise received at a sensitive location from a music venue is at the 2GP limit of 60 dB $L_{Aeq(15\ min)}$ for the Commercial and Mixed-use zones and the insulation requirement of $D_{nT,w} + C_{tr} > 30$ dB are met, the internal noise levels in the noise sensitive room due to the music would be in the order of 30 dB $L_{Aeq(15\ min)}$. This would just meet the recommendations of WHO. As WHO recommends a lower internal noise level where there is a large proportion of low-frequency noise such as for live music or DJ'S, an insulation rating higher than 30 $D_{nT,w} + C_{tr}$ would be required to protect sleep.

Noise from music venues will not be the only contributing source to noise sensitive activities in these areas. Other sources that are likely to be present are HVAC systems and traffic noise at uncontrolled levels. There may also be noise from other music venues, which could result in the overall noise level in any space exceeding 30 dB L_{Aeq}. For example, if another music venue on the other side of the property also operated at 60 dB L_{Aeq}, the overall sound levels inside the noise sensitive space would be increased by approximately 3 dB, and would be more likely to cause sleep disturbance for the occupants.

A façade reduction requirement of $D_{nT,w} + C_{tr} > 35$ dB would be more likely to ensure an internal noise level of 30 dB L_{Aeq} or less, even in the case of multiple external, or combined external and internal noise sources.

2.2 AS/NZS 2107:2016

The AS/NZS 2107:2016 *Recommended Design Sound Levels and Reverberation Times for Building Interiors* standard recommends that noise levels are between 35 to 45 dB L_{Aeq} for living areas and between 35 to 40 dB L_{Aeq} for sleeping areas in residential buildings in inner city areas or entertainment districts.

The standard allows higher sound levels for apartment common areas, which is consistent with the existing 2GP Rule, which specifically excludes corridors, hallways, lobbies, clothes drying rooms and the like from the requirement for sound insulation.

[1] Edited by Berglund, B et al. Guidelines for community noise. World Health Organization 1999

Even with multiple noise sources it is likely that the above recommendations would be satisfied with the original sound insulation requirement of $D_{nT,w} + C_{tr} > 30$ dB except in locations where traffic noise is particularly high.

On the other hand, considering that the maximum recommended noise levels for living areas are 5 dB greater than those for sleeping areas, there would be some logic to a requirement that is 5 dB greater for sleeping areas.

2.3 Noise insulation comparison with other District Plans

A review of other District Plans shows that a sound insulation requirement of $D_{nT,w} + C_{tr} > 30$ dB is common, but on the lower side for bedrooms in similar central city districts as shown below in table 2.1.

Table 2.1 – Acoustic requirements in other New Zealand cities

City	Wellington	Christchurch	Queenstown Lakes
Entertainment district or City Centre Noise Limits	60 dB L_{Aeq}	60 dB L_{Aeq}	65 dB L_{Aeq}
Acoustic insulation requirement	$D_{nT,w} + C_{tr} > 35$ dB: Courtenay Place Area $D_{nT,w} + C_{tr} > 30$ dB: All other areas	$D_{tr,2m,nT,w} + C_{tr} > 35$ for bedrooms $D_{tr,2m,nT,w} + C_{tr} > 30$ for other habitable spaces	40 dB $R_w + C_{tr}$

2.4 Discussion on suitability of increasing the acoustic insulation requirement

Based on the above we consider that for zones where entertainment and exhibition activity and residential activity are both permitted activities and the noise limit is 60 dB L_{Aeq}, an acoustic insulation requirement of $D_{nT,w} + C_{tr} > 35$ dB would be appropriate for bedrooms to protect the sleep of occupants and likely allow multiple music venues to operate at the District Plan noise limits without disturbing sleep.

3.0 UPDATES TO APPENDIX 9A

Rule 9.3.1 refers to Appendix 9A that provides acceptable construction solutions to meet the current acoustic insulation of $D_{nT,w} + C_{tr} > 30$. We have been asked to recommend amendments to Appendix 9A for acceptable solutions to meet acoustic insulation of $D_{nT,w} + C_{tr} > 35$.

Building acceptable solutions are specified for central city insulation in Christchurch, Kapiti Coast, Queenstown Lakes and Whanganui Districts[2] with acceptable solutions for other types of noise (such as road noise) in Auckland, Hutt City, Palmerston North and Upper Hutt. Some of these other Districts use a different descriptor for the amount of acoustic insulation required, however, each descriptor provides approximately the same reduction in noise level.

Upper Hutt City and Christchurch have construction upgrades for 35 dB reduction and 35 dB $D_{tr,2m,nT,w} + C_{tr}$ respectively. The upgrades are listed in Appendix A, and are similar.

Size and shape of rooms, areas of external building envelope and internal surface finishes of the room all influence the actual reductions achieved and a thorough analysis will be required to provide a robust review of the constructions required. We also note that in order to provide sufficient certainty that the constructions will be acceptable in most situations, the constructions listed in the Appendix are necessarily conservative.

An additional column is suggested to be added to Table 9A.1A as the existing $D_{nT,w} + C_{tr} > 30$ acceptable constructions will still be required for acoustic upgrades in zones other than those where entertainment and exhibition activity are permitted. We have shown below a proposed minimum construction requirement to achieve a $D_{nT,w} + C_{tr} > 35$ façade reduction with upgrades that are additional to the $D_{nT,w} + C_{tr} > 30$ requirement shown in red.

Table 3.1 – Amended Table 9A.1A from Appendix 9A of the DCC 2GP

Building element			Minimum construction requirement	
			$D_{nT,w} + C_{tr} > 30$	$D_{nT,w} + C_{tr} > 35$
a.	External walls	i. Stud walls: Exterior cladding	20 mm timber or 9 mm compressed fibre cement sheet over timber frame (100 mm x 50 mm)	30 mm timber or minimum 15 mm compressed fibre cement sheet over timber frame (100 mm x 50 mm)
		ii. Cavity Infill	Fibrous acoustic blanket (batts or similar of a minimum mass of 9kg/m^3) required in cavity for all exterior walls. Minimum 90mm wall cavity.	Fibrous acoustic blanket (batts or similar of a minimum mass of 9kg/m^3) required in cavity for all exterior walls. Minimum 90mm wall cavity.
		iii. Interior lining	One layer of 12mm gypsum plasterboard. Where exterior walls have continuous cladding with a mass of greater than 25kg/m^2 (e.g. brick veneer or minimum 25mm stucco plaster), internal wall linings need to be no thicker than 10mm gypsum plasterboard.	One layer of 13 mm high density gypsum plasterboard (minimum 12 kg/m^2). Where exterior walls have continuous cladding with a mass of greater than 30 kg/m^2 (e.g. brick veneer or minimum 25mm stucco plaster), internal wall linings can be standard 13 mm gypsum plasterboard.

[2] As of May 2020

		iv. Combined superficial density	Minimum not less than 25kg/m² being the combined mass of external and internal linings excluding structural elements (e.g. window frames or wall studs) with no less than 10kg/m² on each side of structural elements.	Minimum not less than 35 kg/m² being the combined mass of external and internal linings excluding structural elements (e.g. window frames or wall studs) with no less than 12 kg/m² on each side of structural elements.
		v. Mass Walls	190mm concrete block, strapped and lined internally with 10mm gypsum plasterboard, or 150mm concrete wall.	190mm concrete block, strapped and lined internally with 10mm gypsum plasterboard, or 150mm concrete wall.
b.	Glazed areas	i. Glazed areas up to 10% of floor area	6mm glazing single float.	Double glazing: minimum 10 mm float glass /12 mm air gap / 6 mm float glass
		ii. Glazed areas between 10% and 35% of floor area	6mm laminated glazing.	Double window comprised of double glazed IGU: minimum 4 mm float glass /12 mm airgap / 4 mm float glass and a 6mm thick secondary pane at least 75 mm from the outer glazing
		iii. Glazed areas greater than 35% of floor area	Require a specialist acoustic report to show conformance with the insulation rule.	Require a specialist acoustic report to show conformance with the insulation rule.
		iv. Frames to be aluminium window frames with compression seals.		
c.	Skillion roof	i. Cladding	0.5mm profiled steel or 6mm corrugated fibre cement, or membrane over 15mm thick ply, or concrete or clay tiles.	0.5mm profiled steel or 6mm corrugated fibre cement, or membrane over 15mm thick ply, or concrete or clay tiles.
		ii. Sarking	17mm plywood (no gaps).	17mm plywood (no gaps).
		iii. Frame	Minimum 100mm gap with fibrous acoustic blanket (batts or similar of a mass of 9kg/m³).	Minimum 200 mm gap at minimum 600 mm centres with fibrous acoustic blanket (batts or similar of a mass of 9kg/m³).
d.	Ceiling		Two layers of 10mm gypsum plasterboard (no through-ceiling lighting penetrations unless correctly acoustically rated). Fibrous acoustic blanket (batts or similar of a minimum mass of 9kg/m³).	Two layers of 13 mm high density gypsum plasterboard (minimum 12 kg/m2) (no through-ceiling lighting penetrations unless correctly acoustically rated). Fibrous acoustic blanket (batts or similar of a minimum mass of 9kg/m³).

e.	Combined superficial density		Combined mass of cladding and lining of not less than 25kg/m² with no less than 10kg/m² on each side of structural elements.	Combined mass of cladding and lining of not less than 35 kg/m² with no less than 12 kg/m² on each side of structural elements.
f.	Pitched Roof (all roofs other than skillion roofs)	i. Cladding	0.5mm profiled steel or tiles, or membrane over 15mm thick ply.	0.5mm profiled steel or tiles, or membrane over 15mm thick ply.
		ii. Frame	Timber truss with 100mm fibrous acoustic blanket (batts or similar of a minimum mass of 9kg/m³) required for all ceilings.	Timber truss at minimum 800 mm centres with 100mm fibrous acoustic blanket (batts or similar of a minimum mass of 9kg/m³) required for all ceilings.
		iii. Ceiling	12mm gypsum plasterboard.	13mm high density gypsum plasterboard (minimum 12 kg/m²)
		iv. Combined superficial density	Combined mass with cladding and lining of not less than 25kg/m².	Combined mass with cladding and lining of not less than 35 kg/m².
g.	Floor areas open to outside	i. Cladding	Under-floor areas of non-concrete slab type floors exposed to external sound will require a cladding layer lining the underside of floor joists of not less than 12mm ply.	Under-floor areas of non-concrete slab type floors exposed to external sound will require a cladding layer lining the underside of floor joists of not less than 20 mm ply.
		ii. Combined superficial density	Floors to attain a combined mass not less than 25kg/m² for the floor layer and any external cladding (excluding floor joists or bearers).	Floors to attain a combined mass not less than 35 kg/m² for the floor layer and any external cladding (excluding floor joists or bearers).
h.	External door		Solid core door (minimum 25kg/m²) with compression seals (where the door is exposed to exterior noise).	Hinged door minimum 45 kg/m² (likely to be solid timber with steel reinforcing) with compression seals tested to STC 35, OR, proprietary acoustic door rated STC 35, OR, second door located between external façade and habitable space to form a lobby.

4.0 MECHANICAL COOLING

The Styles report recommend including a requirement for mechanical cooling so that the windows and doors of noise sensitive activities can remain closed, even in warm weather. We have reviewed this recommendation noting that the 2GP already requires alternative ventilation for all spaces that have an acoustic insulation requirement in Rule 9.3.1.5, which states:

> *Rooms to which this acoustic insulation standard applies must be supplied with a positive supplementary source of ventilation that achieves a minimum of 7.5 litres per second per person, to enable adequate ventilation when windows are closed.*

People may also consider it necessary to open windows for cooling. As with ventilation, the opening of windows is likely to significantly reduce the performance of an acoustically insulated room and mechanical cooling would allow for room occupants to live comfortably in summer months without opening windows and compromising the acoustic insulation.

We note that the proposed Queenstown Lakes District Plan also has concessions for ventilation settings if air conditioning is available, however it does not require the use of mechanical cooling if a minimum airflow can be achieved.

In Dunedin the average daily high temperature in summer is 18°C, and rarely exceeds 22°C. The record high temperature in Dunedin is 35 °C. The humidity in these months is often in the order of 70%. Comfort levels are also dependent on wet bulb temperature, but for a humidity around 70%, comfortable indoor temperatures would be expected between 18°C and 24°C. While buildings may heat up slightly more than the surrounding environment, we expect it is possible that most living spaces in houses in Dunedin would not become excessively hot. We also note that the temperature at night is usually less than the temperature during the day and the 2GP also has a requirement for mechanical ventilation where acoustic insulation is required; therefore, build-up of heat in bedrooms will be reduced. We understand that the New Zealand Building Code does not require any form of cooling to be installed in habitable spaces.

Overall, while we are not experts in this field it is not expected that residents would frequently open windows to noise-sensitive areas during the night-time, even if mechanical cooling was not available; however, an HVAC engineer could be consulted to review and confirm.

5.0 FINANCIAL IMPLICATIONS

We have also been asked to provide comment on the financial implications of increasing acoustic insulation and while this is not our expertise we have previously been involved with a number of projects where financial implications of acoustic insulation requirements were considered. The most relevant findings are summarised below.

In March 2020, Waka Kotahi engaged AES and O'Brien Quantity Surveying to undertake a study relating to the cost of traffic noise insulation measures. The report sampled 58 buildings and found that construction upgrades increased the price of construction by 0 – 2 % for various façade reductions requirements, without the requirement for alternative ventilation. For apartment buildings where noise levels were up to 71 dB $L_{Aeq(24h)}$ (requiring a façade reductions in the order of 30 $D_{nT,w}$ + C_{tr}) construction costs increased by up to 1% over a standard construction.

As part of Christchurch District Plan Change 5E the Christchurch City Council have commissioned a financial report[3] reviewing the cost implications of acoustically insulating noise sensitive spaces from road traffic noise. While Plan Change 5E does not use the same acoustic insulation method, the report provides a cost per dwelling for up to 32 dB reduction of road noise of $27,757 and $11,600 for up to 29 dB reduction. The report also provides useful information on the wider societal cost implications when occupants are exposed to high levels of noise as a result of not including acoustic insulation as a requirement.

Both the AES and Formative reported costs include upgrades for living as well as sleeping areas and include costs for standalone dwellings and therefore likely overestimate the costs of upgrading apartment bedrooms only. While both reports consider increased costs up to a façade reduction of 32 dB, they do not discuss the *additional* cost of a change from a 30 $D_{nT,w}$ + C_{tr} to a 35 $D_{nT,w}$ + C_{tr} façade reduction requirement. Overall, it appears the additional cost will be low (less than 1 %).

Many heritage buildings may have poor existing acoustic insulation due to large gaps in the building envelope that are often found in older style windows, doors and façades. The increase in construction costs for retro fitting heritage buildings to comply with acoustic insulation are likely to be higher than for a new development and in some cases retro-fitting may not be practicable. Consideration of the costs of upgrading heritage buildings should be taken into account when applying the rule. We note that the Christchurch District Plan includes the following matter of discretion for acoustic insulation when upgrading Heritage buildings:

> *xii. The extent to which achieving the standard may give rise to adverse effects on the heritage values associated with a building listed in Appendix 9.3.7.2 (Schedule of Significant Historic Heritage) that outweigh the benefits of noise insulation*.

We consider that similar assessment guidance that includes consideration of the cost of upgrading a Heritage Building would be appropriate to include in the 2GP.

[3] *Christchurch Plan Change 5E. Noise sensitive activities near roads and rail corridors. Economic Assessment as* prepared by Formative Ltd and dated 30th of September 2022. Currently available at https://ccc.govt.nz/assets/Documents/The-Council/Plans-Strategies-Policies-Bylaws/Plans/district-plan/Proposed-changes/2020/PC5/PC5E-s42A-report-DRAFT-lex24432-20221206.pdf

6.0 CONCLUSIONS

Overall based on the above analysis we have the following conclusions:

- As outlined in section 2, insulation is particularly critical to sleeping. We agree with the Styles report that the acoustic insulation requirement should be increased to $D_{nT,w} + C_{tr} > 35$ dB for sleeping areas for zones where entertainment and exhibition activity and residential activity are both permitted activities and the noise limit is 60 dB L_{Aeq}.

- Rule 9.3.1 refers to Appendix 9A that provides acceptable construction solutions to meet the current acoustic insulation of $D_{nT,w} + C_{tr} > 30$. That table can be amended to also include acceptable solutions to provide acoustic insulation of $D_{nT,w} + C_{tr} > 35$, as outlined in section 3.0.

- Our preliminary review suggests that mechanical cooling is not likely to be required for bedrooms where mechanical ventilation is provided so that windows can be closed however, an HVAC engineer could be consulted to review and confirm.

- Our preliminary review suggests that the additional cost of an increased design requirement of 35 $D_{nT,w} + C_{tr}$ for bedrooms is likely to be low.

APPENDIX A

Table A.1 – Comparison of Christchurch and Upper Hutt constructions for nominal 35 reductions

	Building element	Christchurch 35 $D_{tr,2m,nT,w} + C_{tr}$ minimum construction requirement (Rule 6.11.4.2)	Upper Hutt 35 dBA minimum construction requirement (Rule DEV1-S7)
1.	External walls of habitable spaces	Either: External cladding with a surface mass not less than 23 kg/m^2; Ex 100 x 50 timber framing at 600 mm centres; Fibrous thermal insulation; Internal lining of one layer 13 mm thick high density gypsum board (minimum 12 kg/m^2) Or: Any wall construction utilising at least 50 mm thick concrete; Secondary timber strapping or wall framing not less than 50 mm thick lined with at least 10 mm thick gypsum board; and Fibrous thermal insulation.	External cladding with a surface mass of not less than 23 kg/m^2, ex 100 x 50 timber framing at 600 mm centres, Fibrous thermal insulation, Internal lining of one layer 13 mm thick high density gypsum board (minimum 12 kg/m^2). Or: Any wall construction utilising at least 50 mm thick concrete, Secondary timber strapping or wall framing not less than 50 mm thick lined with at least 10 mm thick gypsum board, and, Fibrous thermal insulation. Combined superficial density: Minimum not less than 35 kg/m^2 being the combined mass of external and internal linings excluding structural elements (e.g. window frames or wall studs) with no less than 12 kg/m^2 on each side of structural elements.

	Building element	Christchurch 35 $D_{tr,2m,nT,w} + C_{tr}$ minimum construction requirement (Rule 6.11.4.2)	Upper Hutt 35 dBA minimum construction requirement (Rule DEV1-S7)
2.	Windows of habitable spaces	4/12/4 thermal double glazing; with 6mm thick secondary pane at least 75mm from the outer glazing; and Windows to be new aluminium frames with fixed panes or opening sashes with full compression seals.	4/12/4 thermal double glazing, with 6 mm thick secondary pane at least 75 mm from the outer glazing. Windows to be new aluminium frames with fixed panes or opening sashes with full compression seals. Note: Rooms with glazed areas in external walls greater than 35% of floor area of the room will require a specialist acoustic report to show conformance with the insulation rule.
3.	Pitched roof	Profiled longrun steel or tiles, with minimum steel thickness of 0.4mm; Timber trusses at minimum 800mm centres; Fibrous thermal insulation; and Ceiling lining of one layer 13mm thick high density Gypsum board (minimum 12kg/m^2).	Profiled long-run steel or tiles, with minimum steel thickness of 0.4 mm, Timber trusses at minimum 800 mm centres, Fibrous thermal insulation, Ceiling lining of one layer 13 mm thick high density gypsum board (minimum 12 kg/m^2)
4.	Skillion roof	Profiled long-run steel or tiles, with minimum steel thickness of 0.4mm; Timber framing at minimum 600 centres; Fibrous thermal insulation; Ceiling lining of two layers 13mm thick high density Gypsum board (minimum 12kg/m^2 each layer); and Minimum cavity between roof and ceiling 200mm.	Profiled long-run steel or tiles, with minimum steel thickness of 0.4 mm, Timber framing at minimum 600 mm centres, Fibrous thermal insulation, Ceiling lining of two layers 13 mm thick high density Gypsum Board (minimum 12 kg/m^2 each)
5.	External Door to habitable spaces	Specific acoustic design required.	Solid core door (min 25 kg/m^2) with compression seals (where the door is exposed to exterior noise)

	Building element	Christchurch 35 $D_{tr,2m,nT,w} + C_{tr}$ minimum construction requirement (Rule 6.11.4.2)	Upper Hutt 35 dBA minimum construction requirement (Rule DEV1-S7)
		Advice note: 1. Where exterior wall cladding has a mass of greater than 25kg/m^2 (e.g. brick veneer or minimum 25mm stucco plaster), internal wall linings need to be no thicker than 10mm gypsum plasterboard. 2. Ventilation requirements shall be in compliance with 6.1.7.2.1 a.viii.. 3. In determining the insulation performance of roof/ceiling arrangements, roof spaces are assumed to have no more than the casual ventilation typical of the jointing, capping and guttering detail used in normal construction.	Notes: The table refers to common specifications for timber size. Nominal specifications may in some cases be slightly less than the common specification in the schedule for timber size. In determining the insulating performance of roof/ceiling arrangements, roof spaces are assumed to have no more than the casual ventilation typical of the jointing capping and guttering detail used in normal construction.