Cogent Acoustics

Bennett Road, Gisborne

Development Plan

Macedon Ranges Planning Scheme

Acoustic Engineering Report

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Development Plan

Macedon Ranges Planning Scheme

Acoustic Engineering Report

Prepared for:

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Revision History

Rev.	Date	Purpose	Prepared by:	Reviewed by:
0	24/01/2020	Draft for comment	Te-liang Chong	Irena Peoples
1	24/01/2020	Revised noise attenuation measures	Te-liang Chong	Irena Peoples
2	07/02/2020	Minor revisions	Te-liang Chong	Irena Peoples
3	07/02/2020	Updated Plans	Te-liang Chong	Irena Peoples
4	18/02/2020	For Issue	Te-liang Chong	Irena Peoples
5	3/08/2020	Amendment based on VicRoads response	Te-liang Chong	Irena Peoples
6	13/10/2021	Minor updates	Te-liang Chong	Irena Peoples

Executive Summary

G2 Urban Planning has instructed Cogent Acoustics Pty Ltd to provide acoustic engineering consulting services associated with the Development Plan for a proposed rural residential subdivision development at Bennett Road, Gisborne.

Advice in relation to the following acoustic engineering elements has been requested, and is presented in this report:

Table 1 Acoustic Engineering Elements and Reference Criteria

Acoustic Design Element	Reference Criteria
External noise ingress via building façade and roof	▪ Macedon Ranges Planning Scheme Clause 21.11-1 ▪ VicRoads Requirements of Developers – Noise Sensitive Uses ▪ AS/NZS 2107:2016 ▪ AS 3671:1989

A review of the above elements has been undertaken and it is considered that the residential development will satisfy the reference criteria with inclusion of the following acoustic engineering measure:

- Residential buildings constructed within the lots highlighted in Figure 4 should be constructed in accordance with Construction Category 3 as prescribed in AS 3671:1989; and
- Residential buildings constructed within the lots highlighted in Figure 4 should have building layouts where the service areas (laundry, bathroom, garage, etc.) face Calder Freeway whilst the noise sensitive uses (bedrooms, living areas, etc.) are located away from the Calder Freeway side of the building; and
- Residential buildings constructed within the lots fronting Bennett Road should be setback no less than 30 meters from the Bennett Road lot boundary (with the 30 meter setback, the highest Sound Pressure Level at the most affected residential buildings is calculated to be $L_{A10,18hr}$ 70 dB(A)); and
- Residential buildings constructed within all remaining lots (not highlighted in Figure 4) should be constructed in accordance with Construction Category 2 as prescribed in AS 3671:1989.
- Where Construction Category 3 is recommended, specialist acoustic advice should be obtained during planning permit stage.
- Refer to Section 6.4 for details of the AS 3671:1989 Construction Categories.
- Refer to Section 8 for full details of the acoustic engineering measure.

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1 Introduction

1.1 Purpose

G2 Urban Planning has instructed Cogent Acoustics Pty Ltd to conduct a road traffic noise assessment at the site of a proposed residential subdivision at 88-168 Bennett Road and 15-134 McGregor Road, Gisborne, and to provide advice on any noise attenuation measures necessary to protect the future occupants from external noise. This report shall form part of the Development Plan support reports for this area.

This report documents the investigations and advice provided in relation to the above services.

A glossary of the acoustic nomenclature used in this report is presented in Appendix A.

1.2 Reference Documentation

This report is based on information contained in the following documents and drawings:

Table 2 Reference Documentation

Document	Prepared by	Issue
Bennett Road Precinct Development Plan; Drawing No. 17085 Face Sheet V23, 17085 Site Context V23, 17085 Layout V23, 17085 Development V23	Terraco	22/09/2021
Bennett Road Precinct: Subdivision Concept Plan with Aerial; Drawing No. 17085 Concept V23 Sheet 1 to 6	Terraco	22/09/2021
Bennett Road Development Plan Report	G2 Urban Planning	08/2019
VicRoads Request for Information; Planning Application No. DP/2019/1; VicRoads Reference No. PPR 30959/19	VicRoads	10/11/2019
Email To: Te-liang Chong CC: Brian Hogan; Thomas Cybula Subject: RE: Bennett Road, Gisborne Development Plan VicRoads Ref: PPR 30959/19	Chris King, VicRoads	Fri 31/07/2020 3:20 PM

1.3 Report Limitations

The following limitations are applicable with respect to the acoustic advice presented in this report:

- Cogent Acoustics has prepared this document for the sole use of the Client and for the specific purpose expressly stated in the document. No other party should rely on this document without the prior written consent of Cogent Acoustics. Cogent Acoustics undertakes no duty, nor accepts any responsibility, to any third party who may rely upon or use this document.
- The information contained in this document provides advice in relation to acoustics and vibration only. No claims are made and no liability is accepted in respect of design and construction issues falling outside of the specialist field of acoustics and vibration engineering including and not limited to structural integrity, fire rating, architectural buildability and fitness-for-purpose, waterproofing and the like. Supplementary professional advice should be sought in respect of these issues.
- Reports marked 'Not for Construction' or 'Draft' may be subject to change and are not released as final reports. Cogent Acoustics accepts no liability pending release of the final version of the report.
- In preparing this document Cogent Acoustics may have relied upon information provided by the Client and other third parties, some of which may not have been verified. Cogent Acoustics accepts no responsibility or liability for any errors or omissions which may be incorporated into this document as a result.
- The recommendations, data and methodology documented in this assessment are based on the listed reference documentation. The recommendations apply specifically to the project under consideration, and must not be utilised for any other purpose. Any modifications or changes to the project from that described in the listed reference documentation may invalidate the advice provided in this document, necessitating a revision.
- Subject to the above conditions, this document may be transmitted, reproduced or disseminated only in its entirety.

2 Project Characteristics

2.1 Site Location

The project site is located at 88-168 Bennett Road and 15-134 McGregor Road, Gisborne, as shown in Figure 1.

The project comprises development of a Development Plan for a new rural residential subdivision located adjacent to Calder Freeway.

The topography in the area of the site is near flat with steep features along the drainage line or watercourse running through the southern and eastern sections of the site.

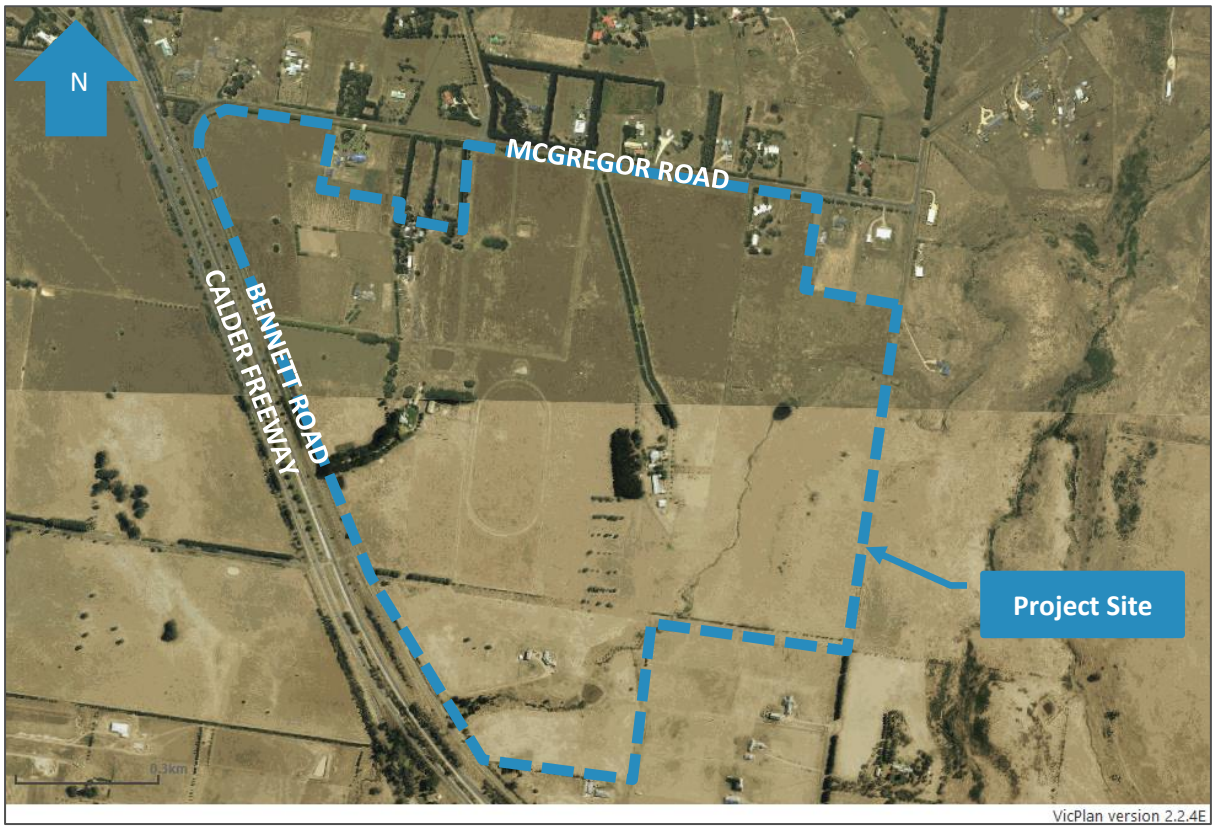


Figure 1 Aerial Image of Site (Image Source: VicPlan)

2.2 Subdivision Plan

Figure 2 shows the subdivision concept plan.

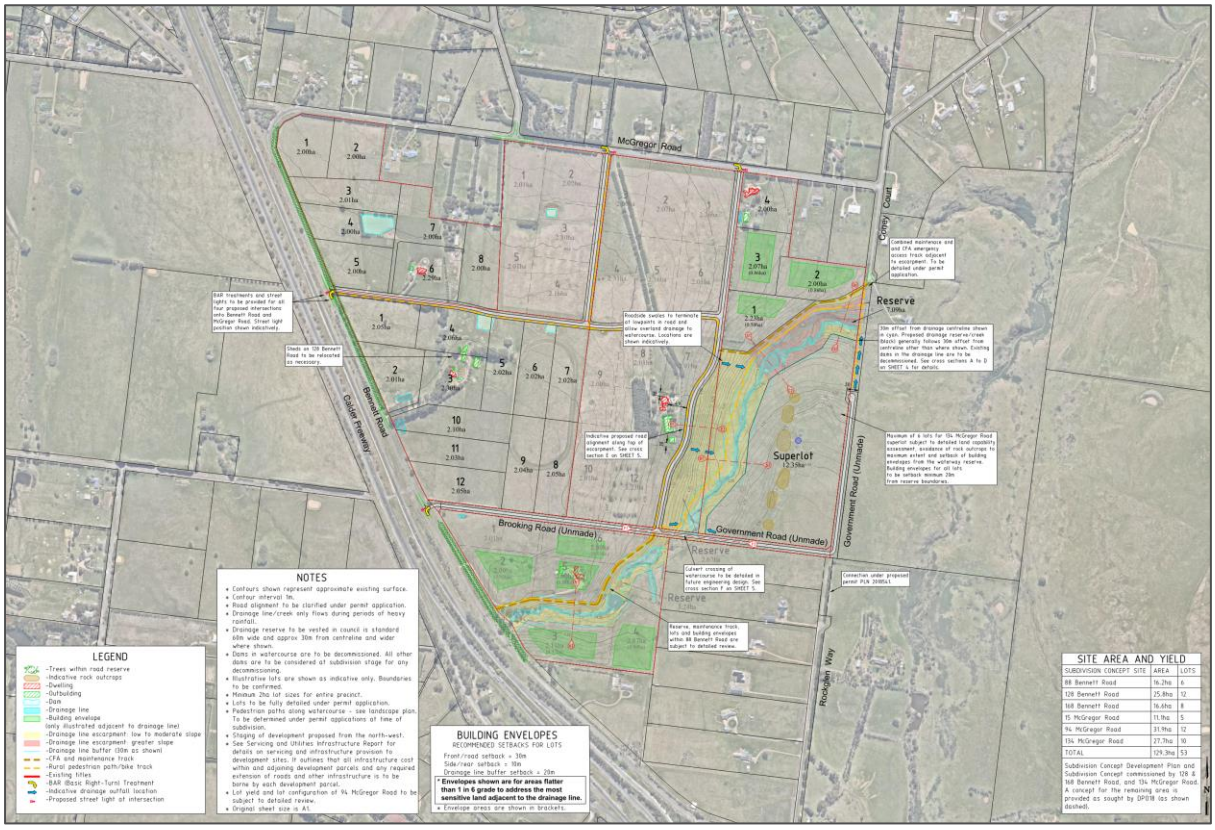


Figure 2 Subdivision Concept Plan (Image Source: Terraco)

3 Town Planning Requirements

VicRoads Request for Information in relation to the Development Plan Application No. DP/2019/1 issued on 10 November 2019 specifies items that need to be addressed in the planning permit application for the development. Table 3 presents the relevant acoustic items to be addressed.

Table 3 Relevant VicRoads Request for Information Acoustic Items

Item No.	Item Text
2	The application must review and address clause 21.11-1 of the Macedon Ranges Planning Scheme which states: ***Criteria*** *An application for land within 100 metres of the Calder Highway and Calder Freeway should meet the following criteria:* • *Dwellings should be designed and constructed to acoustic standards as set out in AS3671-1989 "Acoustics – Road Traffic Noise Intrusion – Building Siting and Construction" where the noise level is in excess of 60dB(A). (Note: Noise levels quoted are free field L10[18hr]).* • *Other buildings providing for noise sensitive uses, should be designed and constructed to acoustic standards with interior noise levels not greater than those set out in AS2107-1987 "Acoustics – Recommended Design Sound Levels and Reverberation Times for Building Interiors."* • *Subdivision of land that creates a lot for a dwelling should have sufficient space for a dwelling to be sited where noise does not exceed 70dB(A).*

4 Legislation and Guidelines

Table 4 presents a summary of the relevant legislation and guidelines applicable to the proposed development. The information contained in these documents forms the basis of the design criteria and advice presented in this report.

Table 4 Summary of Relevant Statutory Requirements and Guidelines

Document	Status	Relevance to this Project
Macedon Ranges Planning Scheme Clause 21.11-1 (Macedon Ranges Shire Council, 2019)	Policy	Provides acoustic criteria for an application of land within 100 metres of the Calder Highway and Calder Freeway.
AS/NZS 2107:2016 Acoustics – Design Sound Levels and Reverberation Times for Building Interiors (Standards Australia, 2016)	Guideline	Provides guidance on internal noise levels for different types of spaces. The guidance provided is relevant to the development in respect of noise intrusion from external sources.
AS 3671:1989 – Acoustics – Road Traffic Noise Intrusion – Building Siting and Construction (Standards Australia, 1989)	Guideline	Provides guidance on determining the required traffic noise reduction from outside to inside a building exposed to traffic noise, and the types of construction required to achieve acceptable internal noise levels.
VicRoads Requirements of Developers – Noise Sensitive Uses (VicRoads, 2004)	Guideline	Prescribes noise amelioration responsibility and standards of property developers of noise sensitive developments adjacent to freeways under VicRoads control.
VicRoads Requirements for Acoustic Consultants (VicRoads, 2005)	Guideline	Prescribes the method adopted by VicRoads for measurement of road traffic noise levels.

5 Road Traffic Noise Measurement

5.1 Soundscape

During the site visits on 11 and 18 December 2019, the soundscape was dominated by road traffic noise from Calder Freeway. Bird noise, insect noise, and wind-induced vegetation noise also contributed to the soundscape but were not dominant sources of noise.

5.2 Road Traffic Noise Levels

Environmental noise logging was performed at the site to establish the current levels of road traffic noise. The measurements were performed at a location near to the south-western boundary of the site between 11 and 18 December 2019. Details of the measurement location and measurement methodology are presented in Appendix B.

Table 5 presents a summary of the measured sound pressure levels. Hourly sound pressure levels and a graph showing the variation in noise level over the full measurement period are presented in Appendix C.

Table 5 Summary of Measured Road Traffic Noise Levels

Date	Measured Sound Pressure Level, dB(A)					
	Day Period			Night Period		
	$L_{A10,18hr}$ (6 am to 12 am)	$L_{Aeq,16hr}$ (6 am to 10 pm)	Max $L_{Aeq,1hr}$ (6 am to 10 pm)	$L_{A10,6hr}$ (12 am to 6 am)	$L_{Aeq,8hr}$ (10 pm to 6 am)	Max $L_{Aeq,1hr}$ (10 pm to 6 am)
Wednesday, 11 December 2019	64*	62*	64*	61	58	63
Thursday, 12 December 2019	66	64	67	62	59	64
Friday, 13 December 2019	66	64	66	61	58	61
Saturday, 14 December 2019	64	63	65	56	53	56
Sunday, 15 December 2019	62	62	66	61	58	63
Monday, 16 December 2019	62	61	65	63	59	65
Tuesday, 17 December 2019	61	60	66	64	61	66
Wednesday, 18 December 2019	66**	63**	66**	-	-	-
Adopted Design Sound Level	**66**	**64**	**67**	**64**	**61**	**66**

* Partial measurement period: 12 pm to 10 pm / 12 am only

** Partial measurement period: 6 am to 12 pm only.

6 Design Criteria

6.1 Macedon Ranges Planning Scheme Clause 21.11-1

Macedon Ranges Planning Scheme Clause 21.11-1 prescribes the following acoustic criteria for an application for land within 100 metres of the Calder Highway and Calder Freeway:

- Dwellings should be designed and constructed to acoustic standards as set out in AS 3671:1989 – Acoustics – Road Traffic Noise Intrusion – Building Siting and Construction (Standards Australia, 1989) where the noise level is in excess of 60 dB(A). (Note: Noise levels quoted are free field $L_{10[18hr]}$).
- Other buildings providing for noise sensitive uses, should be designed and constructed to acoustic standards with interior noise levels not greater than those set out in AS/NZS 2107:2016 Acoustics – Design Sound Levels and Reverberation Times for Building Interiors[1] (Standards Australia, 2016).
- Subdivision of land that creates a lot for a dwelling should have sufficient space for a dwelling to be sited where noise does not exceed 70 dB(A).

6.2 VicRoads Requirements of Developers – Noise Sensitive Uses

VicRoads Requirements of Developers – Noise Sensitive Uses (VicRoads, 2004) provides guidelines on methods to minimise road noise impacts to noise sensitive uses within developments near a freeway. It is noted that VicRoads Requirements of Developers prescribes similar, if slightly less stringent, acoustic criteria to Clause 21.11-1 of the Macedon Ranges Planning Scheme.

On this basis, the acoustic criteria in Macedon Ranges Planning Scheme Clause 21.11-1 will therefore be adopted for the purpose of this assessment. However, VicRoads Requirements of Developers does prescribe additional requirements relevant to the project, as follows:

- Two options for noise attenuation of traffic noise from a freeway may be considered:
  - Construction of a noise barrier between the freeway and noise sensitive uses; or
  - Where the developer decides, in consultation with VicRoads and Council, that it is not desirable to erect high noise barriers, then the noise sensitive buildings adjacent to the freeway must be designed and constructed with regards to the acoustic guidelines prescribed by AS/NZS 2107:2016 and AS 3671:1989.
- The adopted noise attenuation requirements will be met for 10 years after finalisation of the development. In consideration that the development has an estimated finalisation date in 2025, the noise attenuation target should be met up to the year 2035.

[1] Macedon Ranges Planning Scheme refers to AS 2107:1987 which has now been superseded.

- The noise barrier should have a design life of not less than 25 years.

6.3 Australian Standard AS/NZS 2107:2016

Australian Standard AS/NZS 2107:2016 (Standards Australia, 2016) provides recommended internal noise levels for various types of spaces. To achieve acceptable overall internal noise levels within the development, it is considered that:

- Buildings should be designed to achieve the middle to lower end of the range recommended by AS/NZS 2107:2016 for average internal noise levels during the daytime and night-time (i.e. $L_{Aeq,16hr}$ (6 am to 10 pm) and $L_{Aeq,8hr}$ (10 pm to 6 am) respectively).
- Buildings should be designed to achieve noise levels no greater than the upper end of the range recommended by AS/NZS 2107:2016 during the loudest hour that the rooms are typically occupied.

Table 6 presents the adopted internal noise level design criteria based on the above approach:

Table 6 AS/NSZ 2107:2016 Recommended Internal Noise Levels

Type of Occupancy / Activity	AS/NZS 2107:2016 Recommended Design Noise Level Range, L_{Aeq}, dB(A)	Adopted Project Design Criteria, dB(A)	
		Day or Night Average	Loudest Hour
Houses and apartments in inner city areas or entertainment districts or near major roads			
Living areas	35 to 45	$L_{Aeq,16hr} \leq 40$	$L_{Aeq,1hr} \leq 45$
Sleeping areas (night-time)*	35 to 40	$L_{Aeq,8hr} \leq 35$	$L_{Aeq,1hr} \leq 40$

* The noise criteria for sleeping areas have been taken to apply during the night-time (10 pm to 6 am) only. Higher noise levels in sleeping areas are considered to be acceptable during the daytime when occupants would generally not be sleeping, provided that the daytime noise levels in sleeping areas do not exceed the adopted criteria for living areas. The noise criteria for living areas has therefore also been adopted for sleeping areas during the daytime.

6.4 Australian Standard AS 3671:1989

Australian Standard AS 3671:1989 (Standards Australia, 1989) provides recommended building construction to reduce road traffic noise intrusion.

AS 3671:1989 provides recommendations based on the required Traffic Noise Reduction (TNR) which is the difference between the external noise level and AS/NZS 2107:2016 design internal noise level. Depending on the required TNR, the recommended building construction will be categorised into one of four categories ranging from standard construction to where specialist acoustic advice should be sought.

Table 7 presents details of the AS 3671:1989 required Construction Categories.

Table 7 AS 3671:1989 Required Construction Categories for Residential Buildings

External Traffic Noise Level, $L_{Aeq,T}$, dB(A)	Traffic Noise Reduction, dB(A)	AS 3671:1989 Construction Category	AS 3671:1989 Construction Category Details
≤45	≤10	1	▪ Standard exterior façade construction acceptable. ▪ Openings including open windows and doors may comprise up to 10% of the exposed façade.
46 to 60	11 to 25	2	▪ Standard exterior façade construction acceptable, except for lightweight elements such as fibre cement, metal cladding or all glass façades. ▪ Windows, door, and other openings must be closed to achieve the required TNR.
61 to 75	25 to 35	3	▪ Special exterior façade construction. ▪ Specialist acoustic advice should be sought. ▪ Acoustic performance of façade must account for the type of room, number, type, and direction of the façade and any openings.
>75	>35	4	▪ As per Construction Category 3. ▪ Masonry construction, wide air gap double glazing, and fully insulated external facades are likely to be required to achieve this level of TNR.

7 Road Traffic Noise

7.1 Noise Modelling

SoundPLAN version 7.4 environmental noise modelling software was used to calculate the existing and future traffic noise levels at the development.

Full details of noise modelling input parameters and data sources are presented in Appendix D.

7.2 Noise Model Validation

To validate the noise model, a version of the model representing the existing scenario (year 2019) was generated and used to calculate the road traffic noise levels at the noise logging position. The traffic noise levels calculated by the model were then validated against the measured road traffic noise levels, as shown in Table 8.

Table 8 Traffic Noise Model Validation Results

Noise Logger Location	Sound Pressure Level Parameter	Measured Sound Pressure Level, dB(A)	Modelled Year 2019 Sound Pressure Level, dB(A)	Deviation, dB
1	$L_{A10,18hr}$	66	70	+4
	$L_{Aeq,16hr}$	64	68	+4
	$L_{Aeq,8hr}$	61	66	+5

The noise model validation results show that a deviation of between +4 and +5 dB(A) was calculated between the measured and modelled noise levels.

Therefore, a -4 dB(A) adjustment will be applied to all modelled noise levels.

7.3 Calculated Year 2035 Traffic Noise Levels

Year 2035 traffic noise levels were calculated by increasing the traffic volumes by the current (year 2019) annual growth rate. All other modelling parameters were unchanged. Full details of noise modelling input parameters and data sources are presented in Appendix D.

Figure 3 presents a noise contour map showing the calculated $L_{A10,18hr}$ traffic noise contours in year 2035 without noise attenuation measures. The presented Sound Pressure Levels include the -4 dB(A) adjustment.

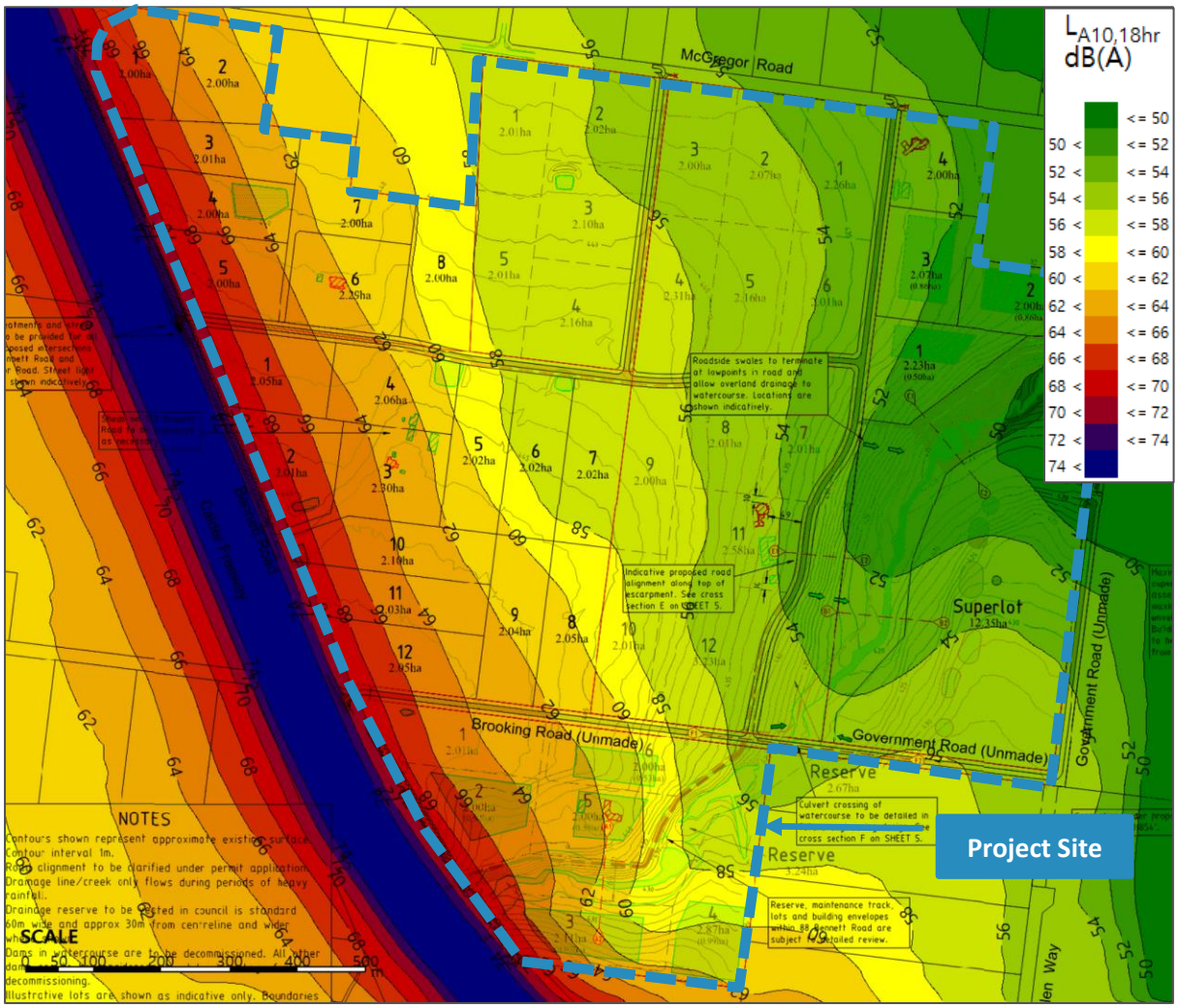


Figure 3 Calculated Year 2035 $L_{A10,18hr}$ Traffic Noise Contours

The noise modelling results indicate that noise levels at the lots adjacent to Bennett Road (and nearest to Calder Freeway) will be up to $L_{A10,18hr}$ 72 dB(A) in year 2035 without noise attenuation measures.

The minimum noise level at lots within the project site will be $L_{A10,18hr}$ 47 dB(A), which has been calculated to occur at the lots furthest from Calder Freeway.

On the above basis, noise attenuation measures will be required to satisfy the VicRoads Requirements of Developers.

8 Recommended Noise Attenuation Measures

The following noise attenuation measures are recommended:

- Residential buildings constructed within the lots highlighted in Figure 4 should be constructed in accordance with Construction Category 3 as prescribed in AS 3671:1989; and
- Residential buildings constructed within the lots highlighted in Figure 4 should have building layouts where the service areas (laundry, bathroom, garage, etc.) face Calder Freeway whilst the noise sensitive uses (bedrooms, living areas, etc.) are located away from the Calder Freeway side of the building; and
- Residential buildings constructed within the lots fronting Bennett Road should be setback no less than 30 meters from the Bennett Road lot boundary (with the 30 meter setback, the highest Sound Pressure Level at the most affected residential buildings is calculated to be $L_{A10,18hr}$ 70 dB(A)); and
- Residential buildings constructed within all remaining lots (not highlighted in Figure 4) should be constructed in accordance with Construction Category 2 as prescribed in AS 3671:1989.
- Where Construction Category 3 is recommended, specialist acoustic advice should be obtained during planning permit stage. The acoustic specialist should take into account the guidelines prescribed by AS/NZS 2107:2016 and AS 3671:1989. The sound insulation performance of each façade should account for the location of each room, their intended occupancy, and exposure to traffic noise.

  Indicatively, Construction Category 3 will require masonry external façade construction, double glazed window units, and walls and ceilings complete with bulk insulation. Openable windows and exterior doors should be fitted with rubber-type acoustic seals. Fresh air intake or exhaust systems should be ducted, and consideration should be given to fitting acoustic attenuators or internal acoustic lining to the ductwork.
- Where Construction Category 2 is recommended, specialist acoustic advice is not required. However, lightweight external façade elements such as fibre cement, metal cladding, or all glass façades will not provide sufficient sound insulation. External façades should be of masonry construction, such as brickwork, to provide sufficient sound insulation.
- These requirements and this report shall be referenced on future subdivision permits.

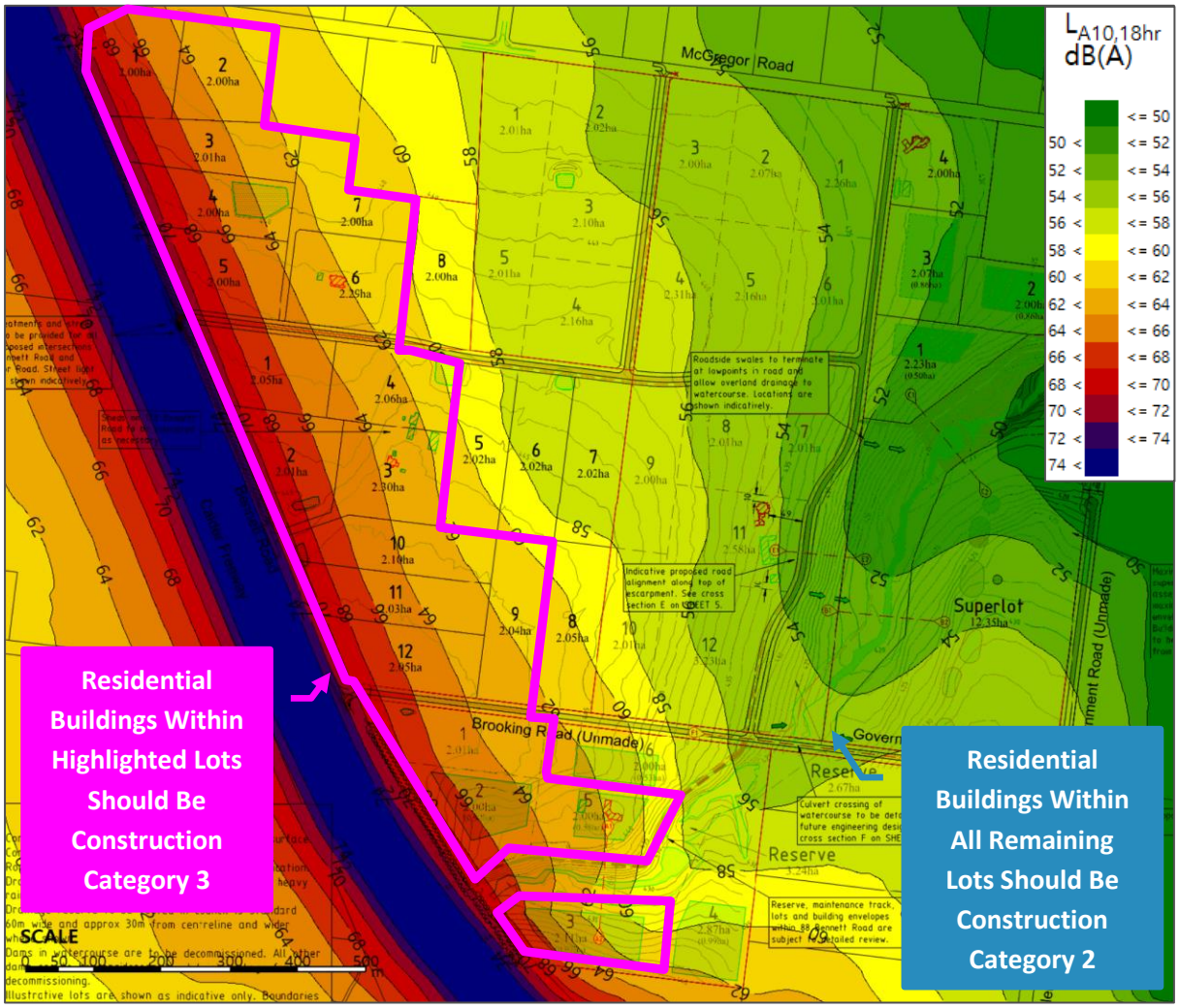


Figure 4 Recommended AS 3671:1989 Construction Categories for Residential Buildings

9 Conclusion

This report has presented a road traffic noise assessment for the proposed residential subdivision development at Bennett Road, Gisborne.

The assessment has been undertaken with regard to the acoustic criteria prescribed in Macedon Ranges Planning Scheme Clause 21.11-1 (Macedon Ranges Shire Council, 2019), VicRoads Requirements of Developers – Noise Sensitive Uses (VicRoads, 2004), AS/NZS 2107:2016 Acoustics – Design Sound Levels and Reverberation Times for Building Interiors (Standards Australia, 2016), and AS 3671:1989 – Acoustics – Road Traffic Noise Intrusion – Building Siting and Construction (Standards Australia, 1989).

Acoustic engineering advice for the proposed development has been presented in Section 8.

Subject to the advice presented in this report, it is considered that the Development Plan and future rural residential development will satisfy the applicable acoustic criteria.

10 References

Macedon Ranges Shire Council. (2019). Macedon Ranges Planning Scheme.

Standards Australia. (1989). AS 3671:1989 Acoustics – Road Traffic Noise Intrusion – Building Siting and Construction.

Standards Australia. (2016). AS/NZS 2107:2016 Acoustics - Recommended Design Sound Levels and Reverberation Times for Building Interiors.

UK DoT. (1988). Calculation of Road Traffic Noise (CoRTN). Department of Transport, Welsh Office.

VicRoads. (2004). VicRoads Requirements of Developers - Noise Sensitive Uses. Roads Corporation of Victoria, Kew.

VicRoads. (2005). VicRoads Requirements for Acoustic Consultants. Roads Corporation of Victoria, Kew.

VicRoads. (2010, July). Road Design Note (RDN 06-01). *Interpretation and Application of VicRoads Traffic Noise Reduction Policy 2005*. Roads Corporation of Victoria, Kew.

Appendix A Glossary of Acoustic Terms

dB / dB(A) Decibels or 'A'-weighted Decibels, the units of Sound Pressure Level and Sound Power Level. 'A'-weighting adjusts the levels of frequencies within the sound spectrum to better reflect the sensitivity of the human ear to different frequencies at sound pressure levels typical of everyday sounds. [Unit: dB / dB(A)]

The following are examples of the decibel readings of every day sounds;

- 0 dB The faintest sound we can hear
- 30 dB A quiet library or in a quiet location in the country
- 45 dB Typical office space. Ambience in the city at night
- 60 dB The sound of a vacuum cleaner in a typical lounge room
- 70 dB The sound of a car passing on the street
- 80 dB Loud music played at home
- 90 dB The sound of a truck passing on the street
- 100 dB The sound of a rock band
- 120 dB Deafening

$L_{A10,T}$ The value of A-weighted Sound Pressure Level which is exceeded for 10 percent of the time during given measurement period T. This is commonly used to provide an indication of the upper limit of fluctuating noise, such as characteristic of music or moderately busy traffic. [Unit: dB / dB(A)]

$L_{Aeq,T}$ The Equivalent Continuous A-weighted Sound Pressure Level measured over the period T (also known as Time-Average Sound Pressure Level). The Equivalent Continuous A-weighted Sound Pressure Level is the constant value of A-weighted Sound Pressure Level for a given period that would be equivalent in sound energy to the time-varying A-Weighted Sound Pressure Level measured over the same period. In simple terms, this can be thought of as the average sound pressure level. [Unit: dB / dB(A)]

Sound Pressure Level A measure of the magnitude of a sound wave. Mathematically, it is twenty times the logarithm to the base ten of the ratio of the root mean square sound pressure at a point in a sound field, to the reference sound pressure; where sound pressure is defined as the alternating component of the pressure (Pa) at the point, and the reference sound pressure is $2x10^{-5}$ Pa. [Unit: dB]

Appendix B Noise Measurement Methodology

Measurement Location

Table 9 presents details of the noise measurement location. Figure 5 and Figure 6 present a map and a photograph of the noise measurement location.

Table 9 Noise Measurement Location Details

Location Reference	Measurement Description	Microphone Height Above Ground Level
1	Traffic noise logging	1.5 m

Figure 5 Noise Measurement Locations (Image Source: VicPlan)

Figure 6 Noise Measurement Location 1 – Photo Facing South-West

Measurement Procedure

Unattended environmental noise logging was performed at the site to establish the environmental noise levels. Table 10 presents details of the measurement:

Table 10 Details of Measurement Period

Location Ref.	Measurement Type		Start Time	Start Date	End Time	End Date
	Attended	Unattended				
1	☐	☒	11:20 AM	Wednesday 11/12/2019	12:00 PM	Wednesday 18/12/2019

The equipment was configured to provide the measurement results as a continuous series of 1 second A- and Z-weighted sound pressure levels. Metrics used for the assessment were then post-processed from this data.

A 60 mm diameter foam windscreen was installed on the microphone to minimise the effect of wind-induced pressure fluctuations on the measurements.

Instrumentation

All acoustic instrumentation used for the measurements held a current certificate of calibration from a National Association of Testing Authorities (NATA) accredited laboratory or from the manufacturer at the time of the measurements.

A field check to confirm correct calibration of the instrumentation was performed at the beginning and end of the measurement period using a laboratory calibrated portable Sound Level Calibrator. At the time of each check the instrumentation was found to be reading correctly and the deviation between consecutive checks was found to be less than 1 dB.

Details of the acoustic instrumentation used for measurements are presented in Table 11.

Table 11 Acoustic Instrumentation Details

Location Reference	Instrument Description	Serial No.	Date of Last Laboratory Calibration*
1	Convergence Instruments NSRT_mk3 Type 1 Sound Level Meter	Cnp0DtU4cVUfChtCQ6hxlD	14/05/2019
-	Svantek SV35 Portable Sound Level Calibrator	58054	13/05/2019

* In accordance with AS 1055.1-1997 and National Association of Testing Authorities Guidelines, Sound Level Meters and Environmental Noise Loggers are required to have comprehensive laboratory calibration checks carried out at intervals not exceeding two years. Sound Level Calibrators require calibration annually.

Meteorological Data

Weather observations during the monitoring period were taken from the Bureau of Meteorology Weather Station at Melbourne Airport, approximately 25 km away.

A maximum of 0.2 mm of rainfall was recorded on Wednesday 11 December 2019. No rainfall was recorded on any other day during the measurement period. The noise measurements are therefore not considered to have been affected by rain noise.

It is noted that for most of the measurement period, the wind speed at the Melbourne Airport Weather Station exceeded the 3 m/s limit as prescribed by the VicRoads Requirements for Acoustic Consultants (VicRoads, 2005). Local wind speed measurements were conducted near to the noise measurement location using a Kestrel 5500 Weather Meter. Table 12 presents the measured wind speed.

Table 12 Measured Wind Speed at Noise Logging Location

Location Reference	Measurement Time	Measurement Date	Measured Wind Speed, m/s
1	11:30 AM to 11:45 AM	Wednesday 11/12/2019	3.1
1	11:45 AM to 12:00 PM	Wednesday 18/12/2019	1.8

An average wind speed of 3.1 m/s was measured at the noise logging location between 11:30 am and 11:45 am on Wednesday 11 December 2019. On the same day, the Melbourne Airport Weather Station measured an average wind speed of between 4.7 m/s and 6.1 m/s (reported at 9 am and 3 pm).

An average wind speed of 1.8 m/s was measured between 11:30 am and 11:45 am on Wednesday 18 December 2019. On the same day, the Melbourne Airport Weather Station measured an average wind speed of between 2.5 m/s and 7.2 m/s (reported at 9 am and 3 pm).

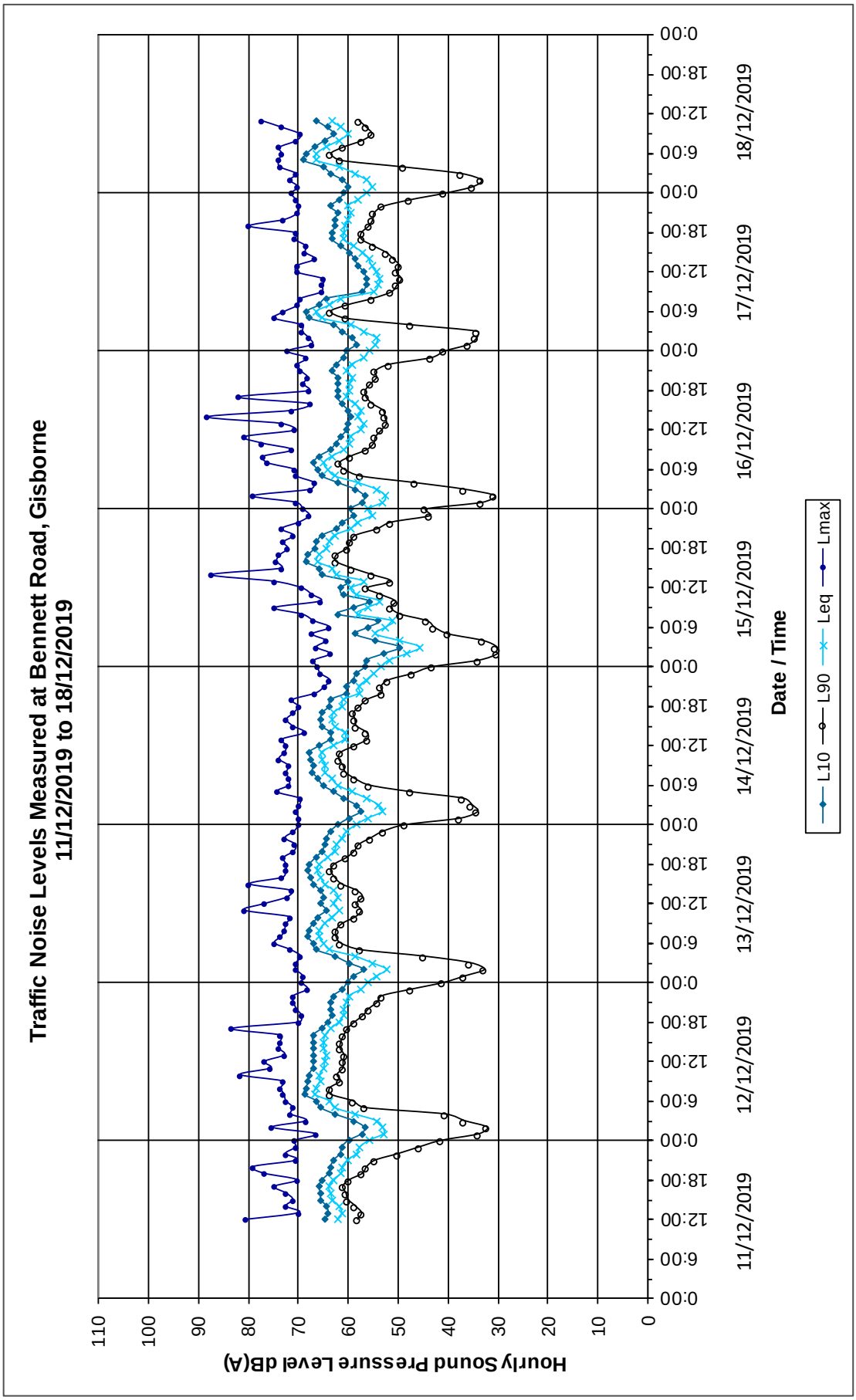
On the above basis, it is considered that the wind speed measured at the Bureau of Meteorology Weather Station at Melbourne Airport is higher than the wind speed at the noise logging location. However, it is likely that the wind speed will have still exceeded 3 m/s at the measurement position for a prolonged period on one or more occasions. As such, the measurement results may have been affected by wind noise, but the impact is not considered to be significant.

Appendix C Noise Measurement Results

Hourly Measurement Results

Location:	Bennett Road, Gisborne	**Microphone Location:**	South-Western Boundary	**Calibration Start:**	114	dB(A)
Measurement Period:	Wednesday 11/12/2019 to Wednesday 18/12/2019	**Instrument:**	Convergence Instruments NSRT_mk3	**Calibration End:**	114	dB(A)

Start Time	Sound Pressure Level, dB(A)																													
	11/12/2019				12/12/2019				13/12/2019				14/12/2019				15/12/2019				16/12/2019				17/12/2019				18/12/2019			
	L_{10}	L_{90}	L_{eq}	L_{max}	L_{10}	L_{90}	L_{eq}	L_{max}	L_{10}	L_{90}	L_{eq}	L_{max}	L_{10}	L_{90}	L_{eq}	L_{max}	L_{10}	L_{90}	L_{eq}	L_{max}	L_{10}	L_{90}	L_{eq}	L_{max}	L_{10}	L_{90}	L_{eq}	L_{max}	L_{10}	L_{90}	L_{eq}	L_{max}
0:00					60	41	56	71	60	41	56	69	62	49	58	70	57	43	53	66	60	44	56	69	60	41	56	72	61	41	56	71
1:00					57	34	53	66	59	37	54	69	60	38	56	70	56	34	52	67	57	33	53	70	58	36	55	67	60	35	55	70
2:00					57	32	53	75	57	33	52	70	57	34	53	70	53	30	48	64	57	31	53	79	59	34	54	68	61	33	56	72
3:00					59	37	54	68	60	36	55	70	58	35	54	70	50	30	46	66	59	37	54	68	61	34	57	69	63	37	59	70
4:00					63	41	59	71	63	45	59	69	61	37	56	70	55	33	50	64	62	47	58	67	63	47	59	69	65	49	62	74
5:00					66	57	63	71	66	58	64	72	63	47	59	74	59	40	55	67	65	57	63	70	68	60	65	75	69	61	66	74
6:00					66	59	64	72	67	61	65	75	65	56	62	72	56	43	53	64	66	61	64	71	68	63	66	73	68	63	66	73
7:00					69	63	67	73	68	62	66	73	66	59	63	72	54	44	51	67	67	62	65	76	66	60	64	70	67	61	65	74
8:00					68	64	66	74	68	62	66	73	67	61	65	72	62	50	58	69	66	60	63	77	64	55	61	70	65	57	62	70
9:00					68	62	66	73	67	61	65	72	67	61	65	72	59	51	56	75	64	56	61	71	57	51	55	65	63	55	60	70
10:00					68	62	66	82	66	59	63	72	67	62	65	74	56	51	54	66	62	55	60	77	56	50	54	65	64	56	61	73
11:00					67	61	65	76	64	57	62	81	68	61	65	73	61	53	58	67	61	55	60	81	56	49	54	65	66	58	63	77
12:00	65	58	62	80	67	61	65	77	65	58	63	77	66	59	63	72	62	56	59	69	60	53	58	71	57	50	54	70				
13:00	64	57	61	70	67	61	64	73	65	57	62	72	64	56	61	73	60	51	57	75	60	52	57	73	58	50	55	70				
14:00	64	59	62	72	67	62	65	74	66	58	63	71	64	56	61	69	65	55	62	87	59	53	58	88	59	51	56	67				
15:00	65	60	63	71	67	61	65	74	67	61	65	80	65	58	63	71	66	59	63	73	60	53	57	71	60	52	57	69				
16:00	66	60	64	72	67	61	65	73	68	63	66	73	65	59	63	72	69	62	66	74	61	55	59	68	61	55	59	68				
17:00	66	61	64	75	65	60	63	83	68	63	66	72	65	59	63	71	68	62	66	74	62	56	60	82	63	57	61	71				
18:00	65	60	63	70	64	59	62	70	68	63	66	72	64	58	61	70	67	60	64	72	62	57	60	68	63	57	61	70				
19:00	64	57	61	77	63	57	61	69	67	60	64	73	64	56	61	71	66	60	64	73	62	56	60	69	63	56	61	80				
20:00	64	56	61	79	64	56	61	70	65	59	63	71	60	53	58	67	65	59	63	71	62	54	59	68	63	55	60	73				
21:00	63	55	60	70	63	54	60	71	65	58	62	71	60	53	58	65	62	54	60	73	63	55	60	69	62	55	59	70				
22:00	62	50	58	73	63	53	60	71	64	55	61	73	59	52	56	64	61	51	58	70	62	52	59	70	64	53	60	70				
23:00	61	46	58	70	61	47	57	68	64	53	60	71	58	47	55	66	59	44	55	68	61	43	57	68	62	48	58	70				
$L_{10,18hr,\ Arith\ Av,\ 6\text{-}24h}$	64				66				66				64				62				62				61				66			
$L_{eq,15hr,\ Log\ Av,\ 7\text{-}22h}$			62				64				64				63				62				60				59				58	
$L_{eq,16hr,\ Log\ Av,\ 6\text{-}22h}$			62				64				64				63				62				61				60				59	
$L_{eq,8hr,\ Log\ Av,\ 22\text{-}6h}$			58				59				58				53				58				59				59				0	
$L_{eq,9hr,\ Log\ Av,\ 22\text{-}7h}$			59				60				59				53				59				61				60				0	
Wind @0900h	4.7 m/s, S				5.6 m/s, SSW				5.6 m/s, SSW				5.3 m/s, SW				4.2 m/s, SW				3.1 m/s, SW				1.9 m/s, SW				2.5 m/s, E			
Wind @1500h	6.1 m/s, S				7.2 m/s, SSE				6.7 m/s, SSW				5.3 m/s, SW				4.7 m/s, SSW				5.3 m/s, SE				4.7 m/s, S				7.2 m/s, W			


Traffic Noise Levels Measured at Bennett Road, Gisborne
11/12/2019 to 18/12/2019
Hourly Sound Pressure Level dB(A)
110
100
90
80
70
60
50
40
30
20
10
0
0:00
6:00
12:00
18:00
11/12/2019
12/12/2019
13/12/2019
14/12/2019
15/12/2019
16/12/2019
17/12/2019
18/12/2019
Date / Time
L10
L90
Leq
Lmax

Appendix D Modelling Parameters

General

Parameter	Description
Software	SoundPLAN Version 7.4
Calculation Method	CoRTN methodology (UK DoT, 1988)

Geometrical Parameters

Parameter	Description
Site Layout	▪ Modelled according to the documented site plan; and ▪ As per the latest VicPlan satellite image for the area in the vicinity of site.
Terrain	Digital ground map was constructed according to topographical data from the SRTM-derived Hydrological 1 Second Digital Elevation Model from the Geoscience Australia Elevation Information System (ELVIS).
Ground absorption	All surfaces have been modelled as soft ground using a ground factor of 0.5.
Buildings	No buildings were included in the modelling.
Receptor / Noise Contour Height	1.5 m above ground level.

Road Parameters

Parameter	Description
Road Geometry	▪ Calder Freeway was modelled as two double-lane carriageways separated by a grass median strip. Each lane has been modelled as 3.5 m wide. ▪ The freeway was modelled according to the elevation data from ELVIS. ▪ No other roads were included in the model.

<table>
<tr><th>Parameter</th><th>Description</th></tr>
<tr><td>Traffic Volumes</td><td>

VicRoads Open Data provided the data used to model traffic volume along Calder Freeway. Forecast year 2035 AADT was derived based on the current annual traffic growth rate. The AADTs used in the traffic noise modelling were therefore as follows:

<table>
<tr><th>Calder Freeway</th><th>2019 All Vehicles AADT</th><th>2019 %HV</th><th>Annual Growth Rate</th><th>2035 All Vehicles AADT</th><th>2035 %HV</th></tr>
<tr><td>South-East Bound</td><td>16,000</td><td>11%</td><td>2.5%</td><td>23,752</td><td>11%</td></tr>
<tr><td>North-West Bound</td><td>16,000</td><td>8%</td><td>2.7%</td><td>24,505</td><td>8%</td></tr>
</table>

The CoRTN modelling methodology uses 18-hour traffic volumes (6 am to midnight) rather than AADT volumes. To account for this difference the 18-hour road traffic volume used in the modelling was based on 95% of AADT volume.

</td></tr>
<tr><td>Vehicle Speeds</td><td>Modelling of Calder Freeway traffic flow has been based on a posted speed limit of 110 km/h.</td></tr>
<tr><td>Road Surfaces</td><td>The road surface of the section of Calder Freeway adjacent to the project site is understood to be a 14/7 double/double seal.
This section of Freeway has therefore been modelled with a +4 dB correction in accordance with Road Design Note 06-01 (VicRoads, 2010).</td></tr>
</table>