Cogent Acoustics

18-20 Cottrell St, Werribee

Acoustic Engineering Report

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18-20 Cottrell St, Werribee

Acoustic Engineering Report

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Revision History

Rev.	Date	Purpose	Prepared by:	Reviewed by:
0	21/06/2019	Draft for comment	Te-liang Chong	Andrew Mitchell
1	11/07/2019	For Issue	Te-liang Chong	Andrew Mitchell
2	20/04/2020	Updated architectural drawings	Te-liang Chong	Andrew Mitchell

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Executive Summary

TM Design Group has appointed Cogent Acoustics Pty Ltd to provide acoustic engineering services associated with the proposed mixed-use development at 18-20 Cottrell St, Werribee. The purpose of this report is to present information for input to the town planning application.

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 due to traffic.	Victoria Planning Provision Clause 55.07-6 Standard B40; AS/NZS 2107:2016
Environmental noise emissions due to domestic air-conditioning condenser units and other domestic plant serving individual dwellings.	EPA Noise Control Guidelines
Environmental noise emissions due to building plant serving common and commercial areas of the building.	SEPP N-1
Sound transmission within the development.	NCC Volume 1 – Building Code of Australia – Class 2 to 9 Buildings

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

Table 2 Recommended Acoustic Engineering Measures

System	Acoustic Engineering Measure
External Façade	<u>External Walls</u> ▪ Design of building external walls should be as per the documented design details specified in Section 6.3; or ▪ Alternative wall construction achieving $R_w + C_{tr} \geq 49$. <u>External Glazing</u> ▪ Acoustic treatment is recommended to external glazing areas of certain bedrooms of Dwellings 1, 2, 3, 9, 10, 11, 12, 13, and 14. Refer to Section 6.6.1 for full details. ▪ Specification of remaining Dwelling external glazing should be as per the documented design details specified in Section 6.3 or alternative glazing specification achieving $R_w + C_{tr} \geq 27$. <u>Ceiling / Roof</u> ▪ Acoustic treatment is recommended to ceiling / roof construction above certain bedrooms of Dwellings 12, 13, and 14. Refer to Section 6.6.2 for full details.

	▪ Design of remaining Dwelling roof areas should be as per the documented design details specified in Section 6.3 or alternative roof construction achieving $R_w + C_{tr} \geq 32$.
Domestic Outdoor Air-Conditioning Condenser Units	The following noise control measures are recommended depending on the location where domestic AC condenser units are installed – refer to Section 7.2 for full details: <u>Installed on balconies of individual apartments:</u> ▪ AC condenser units should have individual sound power levels of no more than 70 dB(A); and ▪ Separating screens should be installed between adjoining balconies; and ▪ AC condenser units should not have direct line of sight to windows of habitable spaces of neighbouring dwellings. ▪ Separating screens between adjoining balconies should be no less than 1 m higher than the top of the tallest AC condenser unit. ▪ Separating screens between adjoining balconies should be constructed to the full depth of the balcony. ▪ Separating screen should be solid and provide minimum sound transmission loss of R_w 30. Acoustically suitable screening material include 1.6 mm thick steel, 9 mm thick fibre cement sheet, or another suitable sheeting material of at least 12 kg/m^2 mass. OR <u>Installed on rooftops:</u> ▪ AC condenser units should have individual sound power levels of no more than 70 dB(A); and ▪ AC condenser units should not have direct line of sight to windows of habitable spaces of neighbouring dwellings. ▪ Where six or more AC condenser units are installed at a mechanical plant zone, an acoustic screen will be required surrounding the mechanical plant zone.
Mechanical Plant Serving Common and Commercial Parts of the Building	Based on possible mechanical equipment selections, it is recommended that: ▪ Any mechanical plant serving commercial and common areas including AC condenser units, kitchen exhaust fans, and car park ventilation fans should be installed at, or ducted to a mechanical plant zone on the roof of the building; and ▪ An acoustic screen of the specifications presented in Section 7.3, should be installed surrounding the mechanical plant zone. ▪ Internal lining of the car park ventilation fan may also be required. ▪ Refer to Section 7.3 for further details.
Apartment Exhaust and Ventilation	▪ Toilet exhaust, kitchen exhaust, or other ventilation systems that have external air intakes / outlets should be designed so that the ventilation system achieves the following minimum noise reduction:

	– For external openings on south-east façade (facing Cottrell Street): 30 dB; – For openings on south-west and north-east facades: 15-30 dB (depending on distance from Cottrell Street); – For openings on north-west façade: 15 dB. ▪ Indicatively, it is recommended that: – Ventilation systems opening at the south-eastern facades should have at least 2 m length of acoustically insulated rigid ductwork and/or acoustic flexible ductwork. – Ventilation systems opening at all other facades should have minimum 1 m length of acoustically insulated rigid ductwork and/or acoustic flexible ductwork. ▪ Refer to Section 7.4 for further details.
Triggers for Further Acoustic Review of Mechanical Services Plant	Further acoustic review should be undertaken in the event that any of the following occurs: ▪ If apartment AC condenser units are installed at any location other than the apartment balconies or on the rooftop at a common mechanical plant zone. ▪ If apartment AC condenser units with individual sound power levels greater than 65 dB(A) are proposed. ▪ If the recommended specifications for separating screens between balconies cannot be accommodated. ▪ If more than two outdoor AC condenser units serving common or commercial areas are proposed; ▪ If more than two kitchen exhaust fans serving commercial areas are proposed; ▪ If more than one car park ventilation fan is proposed; ▪ If common or commercial AC condenser units with individual sound power levels greater than 70 dB(A) are proposed; ▪ If commercial areas kitchen exhaust fans have with individual sound power levels greater than 80 dB(A) are proposed; ▪ If the selected car park ventilation fan has individual sound power level greater than 88 dB(A); ▪ If the common or commercial AC condenser units, commercial kitchen exhaust fans, or car park ventilation fans are not located at, or ducted to a rooftop mechanical plant zone; ▪ If the car park ventilation fan duct internal acoustic lining specifications cannot be achieved; ▪ If any specifications for the rooftop mechanical plant zone acoustic screening cannot be achieved.

Noise Transmission within Development	▪ Noise transmission between apartments and between apartments and other types of spaces will be addressed by complying with the BCA Deemed-To-Satisfy Sound Insulation Performance Requirements. ▪ Refer to Section 8 for details on the relevant BCA requirements. ▪ The following external glazing specifications are recommended to external windows of Bedroom 1 and Bedroom 2 of Dwelling 8 (Level 1) and Bedroom 2 of Dwelling 9 (Level 1) to minimise the potential noise impacts of vehicles entering and exiting the site: – Double glazing units comprising 6 mm glass + 12 mm air gap + 6.38 mm laminated glass; or – Alternative glazing systems providing minimum sound insulation rating of $R_w + C_{tr}$ 29. – Framing selected to match the minimum sound insulation rating. – Refer to Section 8.5.3 for further details.
Car Park Main Entry Gate	The car park main entry gate should incorporate the following design features: ▪ A soft start motor; ▪ Rubber sealing strip / bump stop at base of gate and/or ends of travel, to prevent noise due to hard contact on closure of the gate; ▪ Guiderail systems specifically designed for smooth operation; ▪ Where the gate frame, guiderails, and motor are mounted to the building structure or floor slab, they should be isolated from the building structure using rubber vibration isolation mounts or pads with a static deflection of nominally 5 mm (e.g. Embelton NR series isolators) installed at all support points; ▪ Gate should be installed and adjusted so as not to impact rigid surfaces at the ends of its travel. ▪ If a drainage grate is included at the entry to the car park, it should be secured in place (e.g. bolted down) so that it cannot generate noise as vehicles drive over it on entry or exit from the car park.
Lift	▪ The lift motor, guiderails, and control equipment should be isolated from the building structure using rubber isolation mounts or pads. ▪ In accordance with the Building Code of Australia, the wall between the lift shaft and apartments should achieve a minimum airborne sound insulation rating of R_w 50 and be of discontinuous construction. ▪ Refer to Section 8.7 for further details.

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Contents

1 Introduction

1.1 Purpose

TM Design Group has appointed Cogent Acoustics Pty Ltd to undertake an acoustic assessment of the proposed mixed-use development at 18-20 Cottrell St, Werribee, for the purpose of informing a Planning Permit Application to Council.

The scope of the assessment includes:

- Review of external noise levels at the site and provision of advice on noise attenuation measures necessary to protect the future occupants from external noise.
- Prediction and assessment of noise emissions due to mechanical plant likely to be installed at the development in relation to statutory environmental noise requirements and EPA guidelines.
- Provision of advice on noise attenuation measures necessary to protect nearby noise sensitive areas from noise emissions due to the proposed development.
- Review of proposed floor plan layout and provision of advice where necessary to minimise noise transmission to noise sensitive areas within the development.

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 3 Reference Documentation

Document	Prepared by	Issue
Town Planning Issue architectural drawings; Drawing Nos. TP:01 – TP:04	TM Design Group	Dec 2019

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.
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- 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 Proposed Project

The project will comprise a 3-4 storey development incorporating 14 residential dwellings, ground floor commercial tenancies, and car parking.

2.2 Site Location

The project site is located at 18-20 Cottrell St, Werribee, as shown in Figure 1. The topography in the area of the site is near flat.

Figure 1 Aerial Image of Site (Image Source: Google Maps)

3 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
National Construction Code Volume 1 – Building Code of Australia – Class 2 to 9 Buildings (BCA) (ABCB, 2016)	Legislation	Prescribes the minimum performance requirements for sound insulation between spaces within the building.
State Environment Protection Policy (Control of Noise from Industry, Commerce and Trade) No. N-1 (SEPP N-1) (State of Victoria, 2001)	Legislation	Prescribes the methods for determining the statutory environmental noise limits that apply to noise emissions from industrial, commercial, and trade premises within metropolitan Melbourne, and the methods to be used for assessment. Mechanical plant noise emissions due to common and commercial parts of the development will be subject to the requirements of SEPP N-1.
Victoria Planning Provision Clause 55.07-6 Standard B40 (State of Victoria, 2018)	Legislation	Prescribe maximum internal noise levels for new apartments within prescribed distances of high traffic roads, railways and industrial areas.
Environment Protection (Residential Noise) Regulations 2018 (State of Victoria, 2018)	Legislation	Prescribes requirements in relation to noise emissions from domestic air-conditioning plant serving individual dwellings.
EPA Victoria, Noise Control Guidelines, Publication 1254 (EPA Victoria, 2008)	Guideline	Provides guidance on interpretation and application of the Environment Protection (Residential Noise) Regulations 2018. Provides guidance in relation to control of noise and vibration associated with construction of the development.
AS/NZS 2107:2016 Acoustics – Design Sound Levels and Reverberation Times for Building Interiors (Standards Australia, 2016)	Guideline	Provides guidance on internal noise levels and reverberation times for different types of spaces. The guidance provided is relevant to the development in respect of noise intrusion from external sources.

4 Noise Sensitive Areas

The site is bounded by residential premises to the north, south, and west, which are classified as Noise Sensitive Areas (NSAs) in accordance with the relevant environmental noise legislation.

The nearest and potentially most-affected NSAs in the vicinity of the project site are shown in Figure 2 and detailed in Table 5. Compliance with the environmental noise criteria at these locations will also result in compliance at all other nearby NSAs.

Table 5 Details of Potentially Most-Affected Noise Sensitive Areas (NSAs)

Ref.	Address	Usage
NSA 1	18-20 Cottrell Street, Werribee	Dwellings in project building
NSA 2	11 Beasley Avenue, Werribee	1-storey residential dwellings
NSA 3	15 Beasley Avenue, Werribee	1-storey residential dwellings
NSA 4	22 Cottrell Street, Werribee	1-storey residential dwelling
NSA 5	16 Cottrell Street, Werribee	1-storey residential dwelling
NSA 6	15 Cottrell Street, Werribee	2-storey residential dwellings

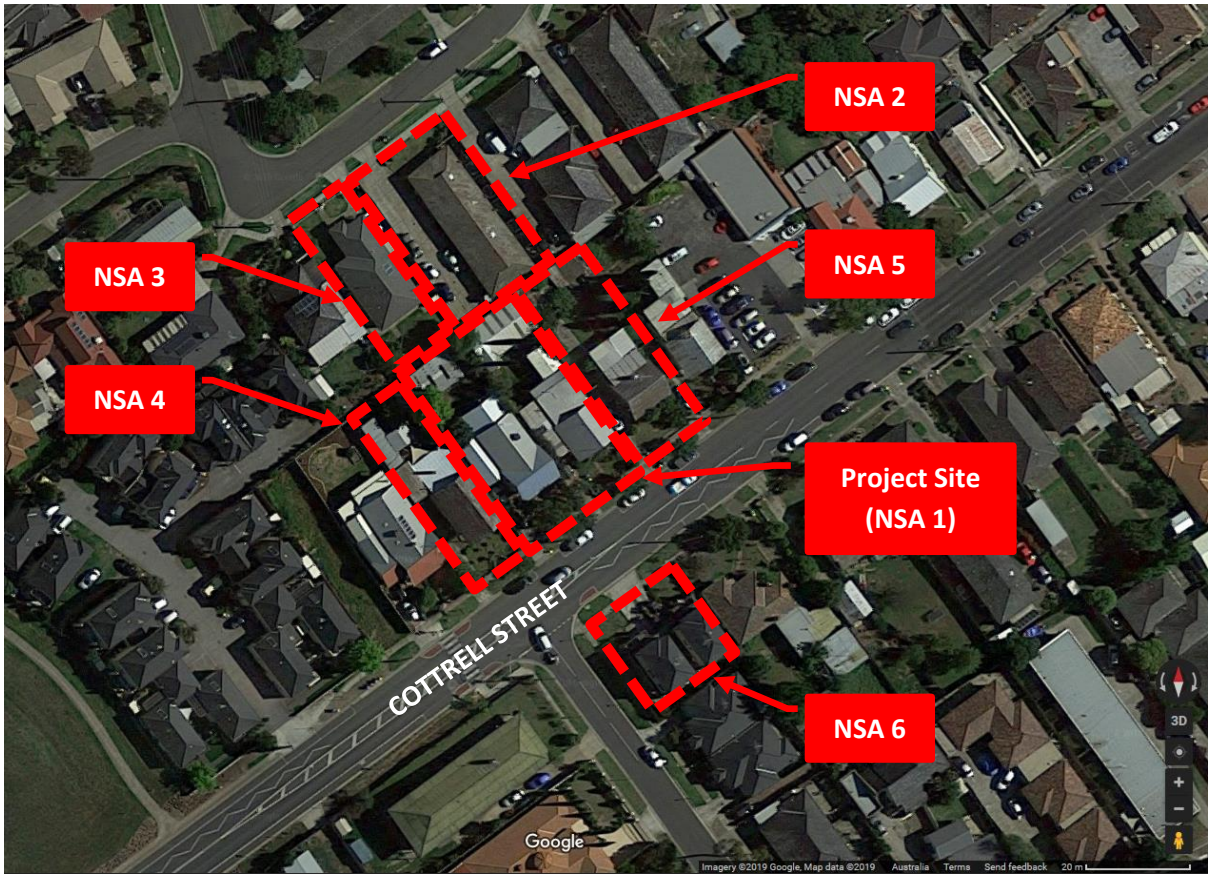


Figure 2 Locations of Potentially Most-Affected Noise Sensitive Areas (NSAs) (Image Source: Google Maps)

5 Existing Acoustic Environment

5.1 Soundscape

During our site visits on 7 and 12 June 2019, the soundscape was dominated by road traffic noise from Cottrell Street. Distant rail noise, from the Warrnambool railway line approximately 200 m to the south-east, can sometimes be heard during lulls in traffic movement along Cottrell Street, but is not a dominant feature of the soundscape.

5.2 Background Noise Levels

Environmental noise logging was performed at the site to establish the background noise levels. The measurements were performed at a location along the south-western boundary of the site between 7 and 12 June 2019. Details of the measurement location and measurement methodology are presented in Appendix B.

The background noise levels at the selected noise logging location are considered to be representative of the background noise levels at the potentially most-affected receptors.

Table 6 presents a summary of the measured background noise levels, as determined in accordance with the procedures given by SEPP N-1. Graphs showing the variation of background noise level over the full measurement period are presented in Appendix C.

Table 6 Background Noise Levels

Period	Applicable Times	L_{A90} Background Noise Level, dB(A)
Day	▪ 7 am to 6 pm Monday to Friday ▪ 7 am to 1 pm Saturday	39
Evening	▪ 6 pm to 10 pm Monday to Friday ▪ 1 pm to 10 pm Saturdays ▪ 7 am to 10 pm Sundays and Public Holidays	38
Night	▪ 10 pm to 7 am All Days	34

5.3 Road Traffic Noise Levels

5.3.1 Noise Logging

Data from the environmental noise logging described in Section 5.2 was also used to establish the road traffic noise levels at the site.

Table 7 presents a summary of the measured sound pressure levels. Graphs showing the variation of the sound pressure levels over the full measurement period are presented in Appendix C.

Table 7 Summary of Measured Environmental Noise Levels

Date	Day Period (6 am to 10 pm)		Night Period (10 pm to 6 am)	
	$L_{Aeq,16hr}$	Loudest $L_{Aeq,1hr}$	$L_{Aeq,8hr}$	Loudest $L_{Aeq,1hr}$
Friday, 7 June 2019	48[1]	50[1]	43	46
Saturday, 8 June 2019	48[3]	51[3]	43	45
Sunday, 9 June 2019	47[3]	51[3]	45[4]	45[4]
Monday, 10 June 2019	49	52	40	45
Tuesday, 11 June 2019	48	51	46	48
Wednesday, 12 June 2019	50[2]	51[2]	-	-

1 Partial measurement period: 7:45 am to 10 pm only.

2 Partial measurement period: 6 am to 7:30 am only.

3 The noise data summary presented in Table 7 has omitted two noise level peaks at 12 pm Saturday 8 June 2019 and at 4:15 pm Sunday 9 June 2019. The cause of the peaks is not known. Due to the rare occurrence of these peaks throughout the measurement period, it is considered that the cause of these peaks is not due to road traffic noise and have therefore been omitted for the purposes of the external noise intrusion assessment.

4 The tenant where the noise logger was installed (20 Cottrell St) indicated that an event involving motorcycles being driven close to the noise logger occurred on the night of Sunday 9 June 2019. The measurement results between 8 pm on 9 June 2019 and 6 am on 10 June 2019 have therefore been omitted for the purposes of the external noise intrusion assessment. The noise data summary presented in Table 7 presents the noise data with this period omitted.

5.3.2 Attended Noise Measurements

Attended noise measurements were performed along the south-eastern boundary of the development between 7:45 am and 8 am on 7 June 2019. Details of the measurement location and measurement methodology are presented in Appendix B.

Table 8 presents a summary of the measured road traffic noise levels.

Table 8 Measured Octave Band Sound Pressure Level

Measurement Location	Overall, L_{Aeq} dB(A)	Unweighted Octave Band Sound Pressure Level, L_{eq} (dB)						
		63 Hz	125 Hz	250 Hz	500 Hz	1 kHz	2 kHz	4 kHz
South-eastern boundary – Adjacent to Cottrell Street	68	72	69	64	62	64	61	54

6 External Noise Intrusion Assessment

6.1 Assessment Criteria

6.1.1 Victoria Planning Provisions Clause 55.07-6 Standard B40

Victoria Planning Provisions (VPP) Clause 55.07-6 (State of Victoria, 2018) prescribes noise impacts objectives for apartment developments near major roads, railways, and industry. This clause includes external noise intrusion criteria for apartment developments within defined 'Noise Influence Areas' near major roads, railways, and industry.

The proposed apartment development is not within a Noise Influence Area, and therefore compliance with internal noise criteria prescribed by the VPP is not mandatory. Nevertheless, the clause still specifies an overarching objective to protect residents from external noise sources.

To assess compliance with this external noise objective, consideration has been given to both the VPP noise criteria and the guidelines provided by Australian Standard AS/NZS 2107:2016 'Acoustics – Recommended Design Sound Levels and Reverberation Times for Building Interiors' (Standards Australia, 2016), as detailed in the following subsection.

6.1.2 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:

- The building 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); and
- The building should be designed to achieve noise levels no greater than the upper end of the range recommended by AS/NZS 2107:2016 (which is consistent with the noise criteria specified by the VPP for apartment developments within a 'Noise Influence Area') during the loudest hour that the rooms are typically occupied.

Table 9 presents the adopted internal noise level design criteria based on the above approach:

Table 9 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 suburban areas or near minor roads			
Living areas	30 to 40	$L_{Aeq,16hr} \leq 35$	$L_{Aeq,1hr} \leq 40$
Sleeping areas (night time)*	30 to 35	$L_{Aeq,8hr} \leq 30$	$L_{Aeq,1hr} \leq 35$

* 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 day time when occupants would generally not be sleeping, provided that the day time 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 day time.

6.2 Adopted External Noise Levels for Building Façade Design

Table 10 presents the design external noise levels adopted for the external noise intrusion assessment based on the highest measured L_{Aeq} sound pressure levels, as well as the setback of the proposed façades from Cottrell Street.

Table 10 Design External Sound Pressure Levels

Façade Direction	Day Period (6 am to 10 pm)		Night Period (10 pm to 6 am)	
	$L_{Aeq,16hr}$	Loudest $L_{Aeq,1hr}$	$L_{Aeq,8hr}$	Loudest $L_{Aeq,1hr}$
South	68	72	66	68
West*	66-53*	70-57*	64-51*	66-53*
East*	66-53*	70-57*	64-51*	66-53*
North	50	54	48	50

* Varies with distance from Cottrell Street.

6.3 Review of Documented Building Façade Design

Calculations of internal noise levels for the documented design (i.e. without noise mitigation) have been conducted based on the building being constructed as detailed in Table 11. Room dimensions and areas of each façade material have been taken to be as per the reference drawings.

Table 11 Documented Design Details

Façade Element	Documented Design Details
External Walls	▪ The reference documentation indicates that the building will feature precast concrete panels to the majority of the external walls. ▪ Certain external facades of Dwellings 4 to 8 will feature brick veneer. ▪ Noise ingress calculations for the documented design (i.e. without acoustic treatment) have been based on the following, depending on the indicated surface finish:

Façade Element	Documented Design Details
	Precast Concrete Panel: – 100 mm thick precast concrete panel; – 10 mm standard plasterboard (min. mass 6.5 kg/m^2) internal lining fixed to concrete via minimum 28 mm furring channels; – 30 mm thick, 11 kg/m^3, polyester, fibreglass or mineral wool insulation cavity infill. – This construction is calculated to achieve a sound insulation rating of $R_w + C_{tr} = 49$. Brick Facing: – 110 mm thick single layer brickwork; – 10 mm standard plasterboard (min. mass 6.5 kg/m^2) internal lining fixed to steel sheeting via 90 mm timber studs at 600 mm centres; – 90 mm thick, 9 kg/m^3 fibreglass or mineral wool insulation (equivalent to R2.0 wall batt) cavity infill. – This construction is calculated to achieve a sound insulation rating of $R_w + C_{tr} = 46$.
External Glazing	▪ Double glazing has been proposed throughout the building. ▪ Noise ingress calculations for the documented design (i.e. without acoustic treatment) have been based on: – Double glazing units comprising 4 mm glass + 12 mm air gap + 4 mm glass; or – Alternative glazing systems providing minimum sound insulation rating of $R_w + C_{tr} = 27$. – Framing selected to match the minimum sound insulation rating. ▪ Where openable glazing is proposed, rubber acoustic seals are installed to the full perimeter of the glazing frame.
Ceiling / Roof	▪ The reference documentation indicates that the roof will be metal sheet on steel framing. ▪ Noise ingress calculations for the documented design (i.e. without acoustic treatment) have been based on the following: – 0.42 mm BMT steel roof sheeting (Colorbond or similar); – 10 mm standard plasterboard (min. mass 6.5 kg/m^2) ceiling lining fixed to underside of roof framing; – 300 mm depth between roof sheeting and plasterboard lining; – 195 mm thick, 7.5 kg/m^3 glasswool insulation (equivalent to R4.0 ceiling batt) cavity infill. – This construction is calculated to achieve a sound insulation rating of $R_w + C_{tr} = 32$.

6.4 Calculated Internal Noise Levels with Documented Design

Table 12 presents the results of internal noise level calculations based on the adopted design traffic noise levels and the documented design details.

Only the rooms nearest to the south-eastern façade have been assessed as these rooms are considered to be the most affected by traffic noise. Rooms that have not been assessed are anticipated to have lower internal noise levels due to screening provided by the building and additional setback from the road. Rooms that have not been assessed are therefore expected to comply with the acoustic design criteria with the documented design provided the most affected rooms also comply.

Table 12 Calculated Internal Noise Levels with Documented Design

Dwelling; Room	Time Period	Noise Level Metric	Project Design Criteria, L_{Aeq}, dB(A)	Calculated Noise Levels and Compliance Status, L_{Aeq}, dB(A)
Dwelling 1 / 3 / 09 / 11; Bedroom 1	Day (6 am to 10 pm)	Average, L_{Aeq}	40	27 ✓
		Loudest Hour, L_{Aeq}	45	31 ✓
	Night (10 pm to 6 am)	Average, L_{Aeq}	35	25 ✓
		Loudest Hour, L_{Aeq}	40	27 ✓
Dwelling 1 / 3 / 09 / 11; Bedroom 2	Day (6 am to 10 pm)	Average, L_{Aeq}	40	38 ✓
		Loudest Hour, L_{Aeq}	45	42 ✓
	Night (10 pm to 6 am)	Average, L_{Aeq}	35	36 ×
		Loudest Hour, L_{Aeq}	40	38 ✓
Dwelling 1 / 3 / 09 / 11; Living	Day (6 am to 10 pm)	Average, L_{Aeq}	40	37 ✓
		Loudest Hour, L_{Aeq}	45	41 ✓
Dwelling 2 / 10; Bedroom 1	Day (6 am to 10 pm)	Average, L_{Aeq}	40	38 ✓
		Loudest Hour, L_{Aeq}	45	42 ✓
	Night (10 pm to 6 am)	Average, L_{Aeq}	35	36 ×
		Loudest Hour, L_{Aeq}	40	38 ✓
Dwelling 2 / 10; Bedroom 2	Day (6 am to 10 pm)	Average, L_{Aeq}	40	35 ✓
		Loudest Hour, L_{Aeq}	45	39 ✓
	Night (10 pm to 6 am)	Average, L_{Aeq}	35	33 ✓
		Loudest Hour, L_{Aeq}	40	35 ✓
Dwelling 2 / 10; Living Room	Day (6 am to 10 pm)	Average, L_{Aeq}	40	37 ✓
		Loudest Hour, L_{Aeq}	45	41 ✓

Dwelling; Room	Time Period	Noise Level Metric	Project Design Criteria, L_{Aeq}, dB(A)	Calculated Noise Levels and Compliance Status, L_{Aeq}, dB(A)
Dwelling 12 / 14; Bedroom 1	Day (6 am to 10 pm)	Average, L_{Aeq}	40	35 ✓
		Loudest Hour, L_{Aeq}	45	39 ✓
	Night (10 pm to 6 am)	Average, L_{Aeq}	35	33 ✓
		Loudest Hour, L_{Aeq}	40	35 ✓
Dwelling 12 / 14; Bedroom 2	Day (6 am to 10 pm)	Average, L_{Aeq}	40	41 ✗
		Loudest Hour, L_{Aeq}	45	45 ✓
	Night (10 pm to 6 am)	Average, L_{Aeq}	35	39 ✗
		Loudest Hour, L_{Aeq}	40	41 ✗
Dwelling 12 / 14; Living Room	Day (6 am to 10 pm)	Average, L_{Aeq}	40	37 ✓
		Loudest Hour, L_{Aeq}	45	41 ✓
Dwelling 13; Bedroom 1	Day (6 am to 10 pm)	Average, L_{Aeq}	40	41 ✗
		Loudest Hour, L_{Aeq}	45	45 ✓
	Night (10 pm to 6 am)	Average, L_{Aeq}	35	39 ✗
		Loudest Hour, L_{Aeq}	40	41 ✗
Dwelling 13; Bedroom 2	Day (6 am to 10 pm)	Average, L_{Aeq}	40	39 ✓
		Loudest Hour, L_{Aeq}	45	43 ✓
	Night (10 pm to 6 am)	Average, L_{Aeq}	35	37 ✗
		Loudest Hour, L_{Aeq}	40	39 ✓
Dwelling 13; Living Room	Day (6 am to 10 pm)	Average, L_{Aeq}	40	37 ✓
		Loudest Hour, L_{Aeq}	45	41 ✓
Dwelling 04 / 08; Bedroom 1	Day (6 am to 10 pm)	Average, L_{Aeq}	40	24 ✓
		Loudest Hour, L_{Aeq}	45	28 ✓
	Night (10 pm to 6 am)	Average, L_{Aeq}	35	22 ✓
		Loudest Hour, L_{Aeq}	40	24 ✓
Dwelling 04 / 08; Bedroom 3	Day (6 am to 10 pm)	Average, L_{Aeq}	40	26 ✓
		Loudest Hour, L_{Aeq}	45	30 ✓
	Night (10 pm to 6 am)	Average, L_{Aeq}	35	24 ✓
		Loudest Hour, L_{Aeq}	40	26 ✓

6.5 Assessment Summary

The results of the external noise intrusion assessment indicate that the external façades of Dwellings 1, 2, 3, 9, 10, 11, 12, 13, and 14, based on the documented design, will require acoustic treatment to comply with the assessment criteria. Analysis of the results indicate that the primary sound transmission paths are via the glazing and roof (for top floor Dwellings).

Recommended acoustic treatment to the glazing and roof are presented in the following subsection.

6.6 Recommended Acoustic Treatment

The following acoustic treatment measures are recommended to achieve compliant internal noise levels. For exterior facade elements not highlighted in the following subsections, construction according to the design details presented in Section 6.3 is acoustically acceptable.

6.6.1 Recommended Exterior Glazing Treatment

Table 13 presents recommended exterior glazing specifications to comply with the assessment criteria. Figure 3 to Figure 5 present exterior glazing demarcations indicating the coverage of each recommended exterior glazing type.

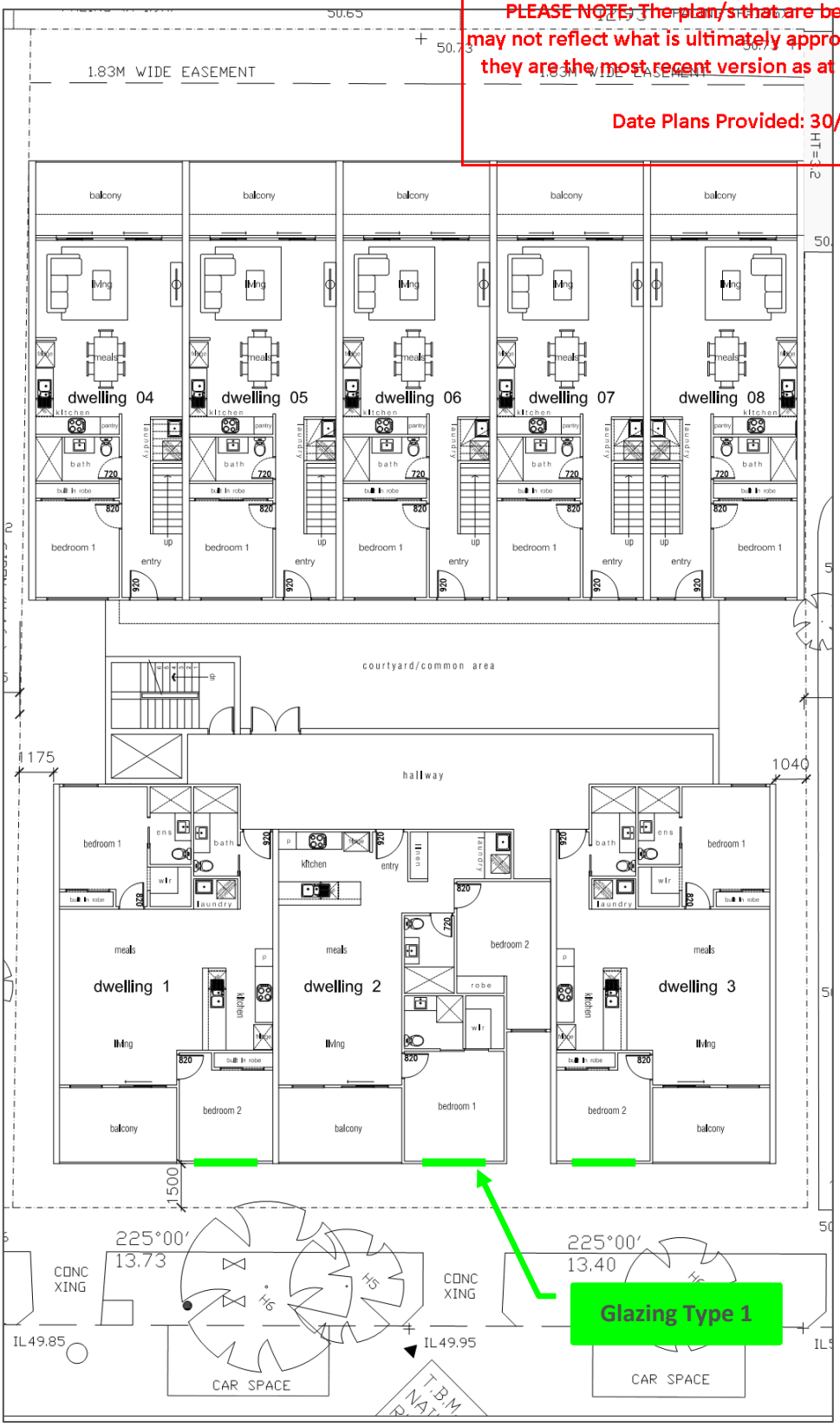


Figure 3 Exterior Glazing Demarcations – Level 1
(Image Source: TM Design Group)

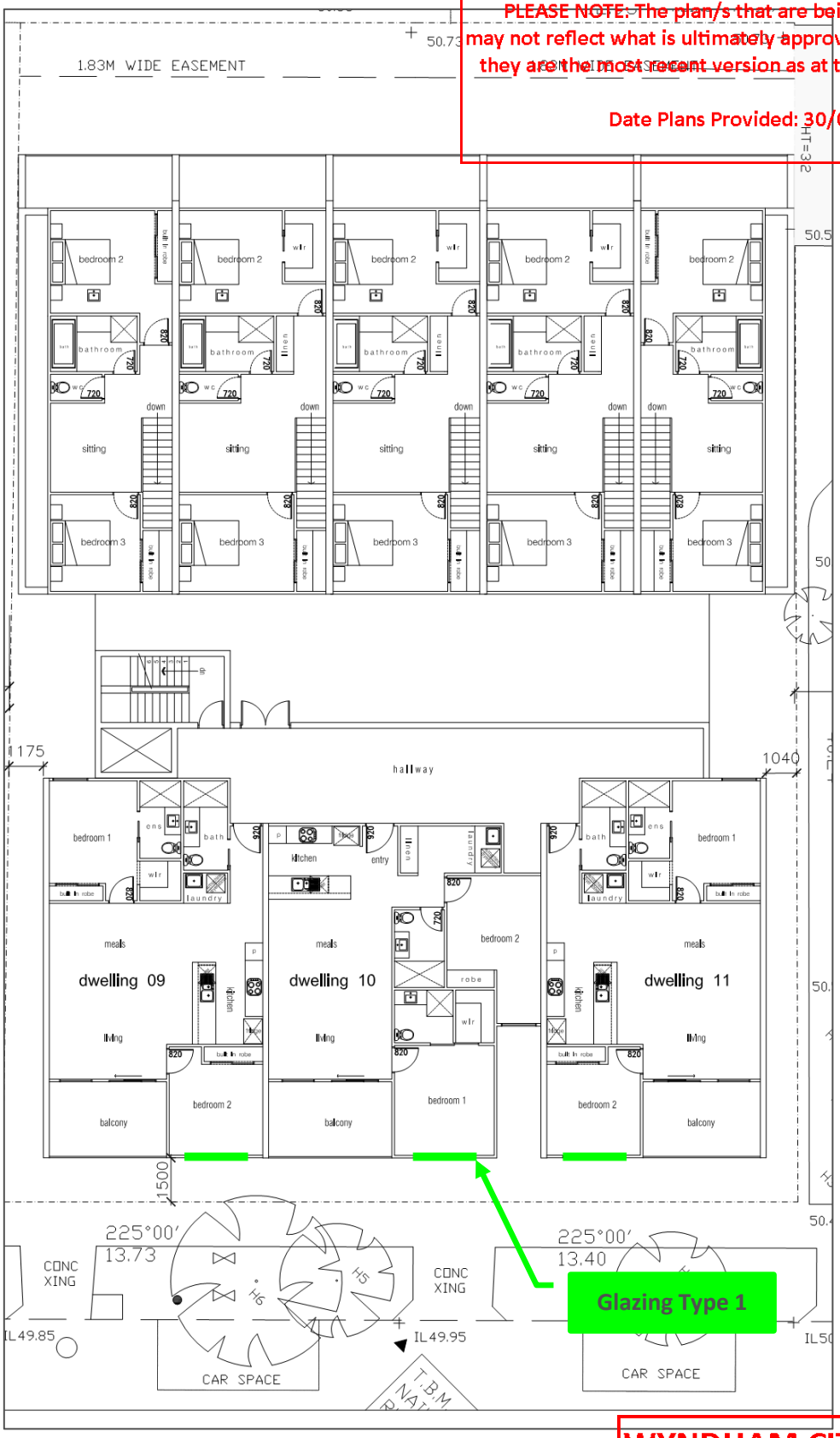


Figure 4 Exterior Glazing Demarcations – Level 2
(Image Source: TM Design Group)

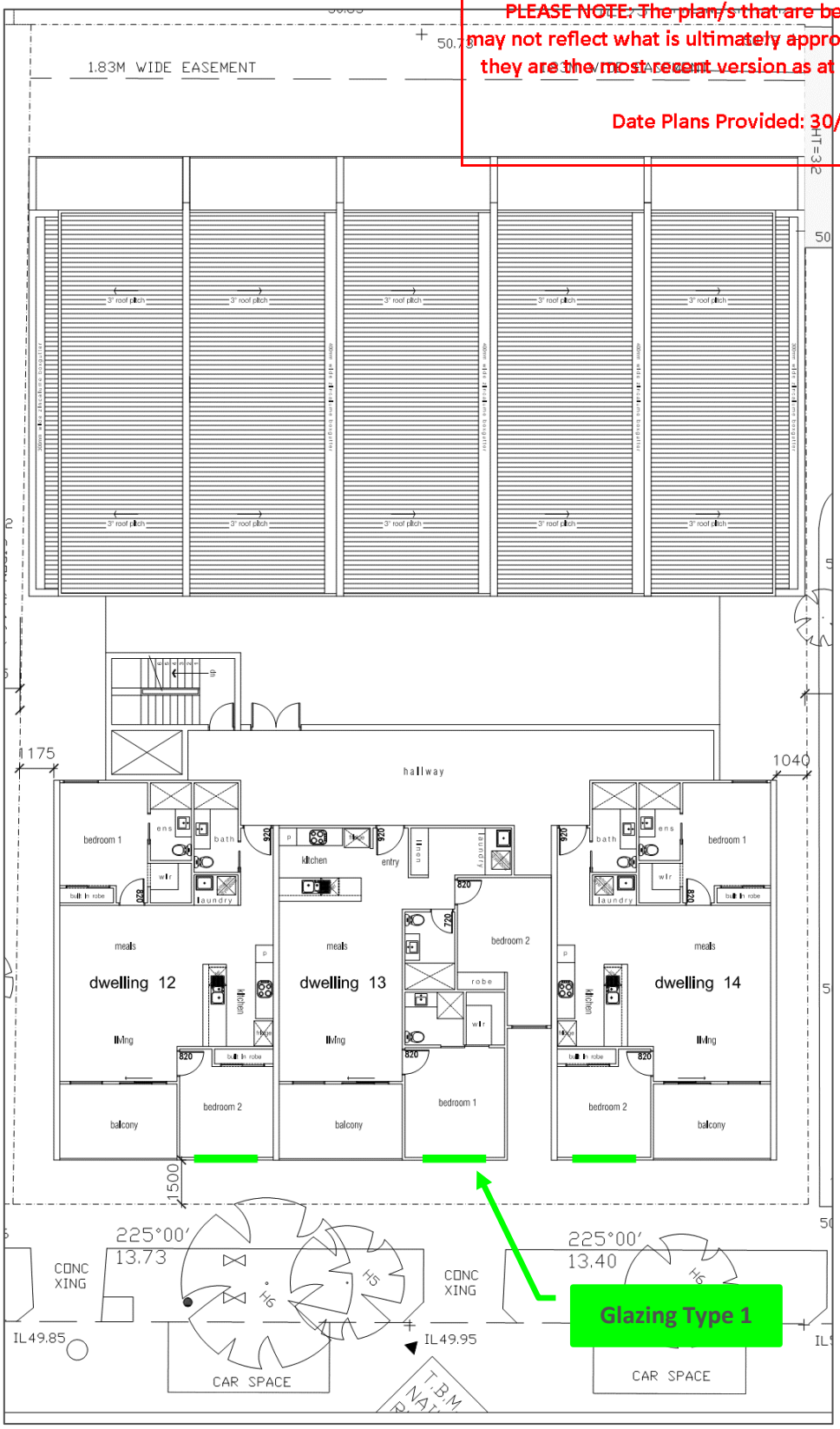


Figure 5 Exterior Glazing Demarcations – Level 3
(Image Source: TM Design Group)

Table 13 Recommended Exterior Glazing Specifications

Exterior Glazing Type		Recommended Exterior Glazing Specifications
	Unmarked exterior glazing areas in Figure 3 to Figure 5	▪ As per documented baseline design details in Table 11.
	Glazing Type 1	▪ Double glazing unit consisting of 6 mm glass + 12 mm air gap + 6.38 mm laminated glass; or ▪ Alternative equivalent glazing system rated to $R_w + C_{tr} \geq 29$. ▪ Framing must be specified to match the required acoustic rating of the glazing. ▪ Openable windows must include rubber or dense foam acoustic seals e.g. Schlegel Q-lon or equivalent.

6.6.2 Recommended Top Floor Ceiling / Roof Treatment

Table 14 presents recommended ceiling / roof design details to comply with the external noise intrusion criteria. Figure 6 presents ceiling / roof demarcations indicating the coverage of each recommended ceiling / roof type.

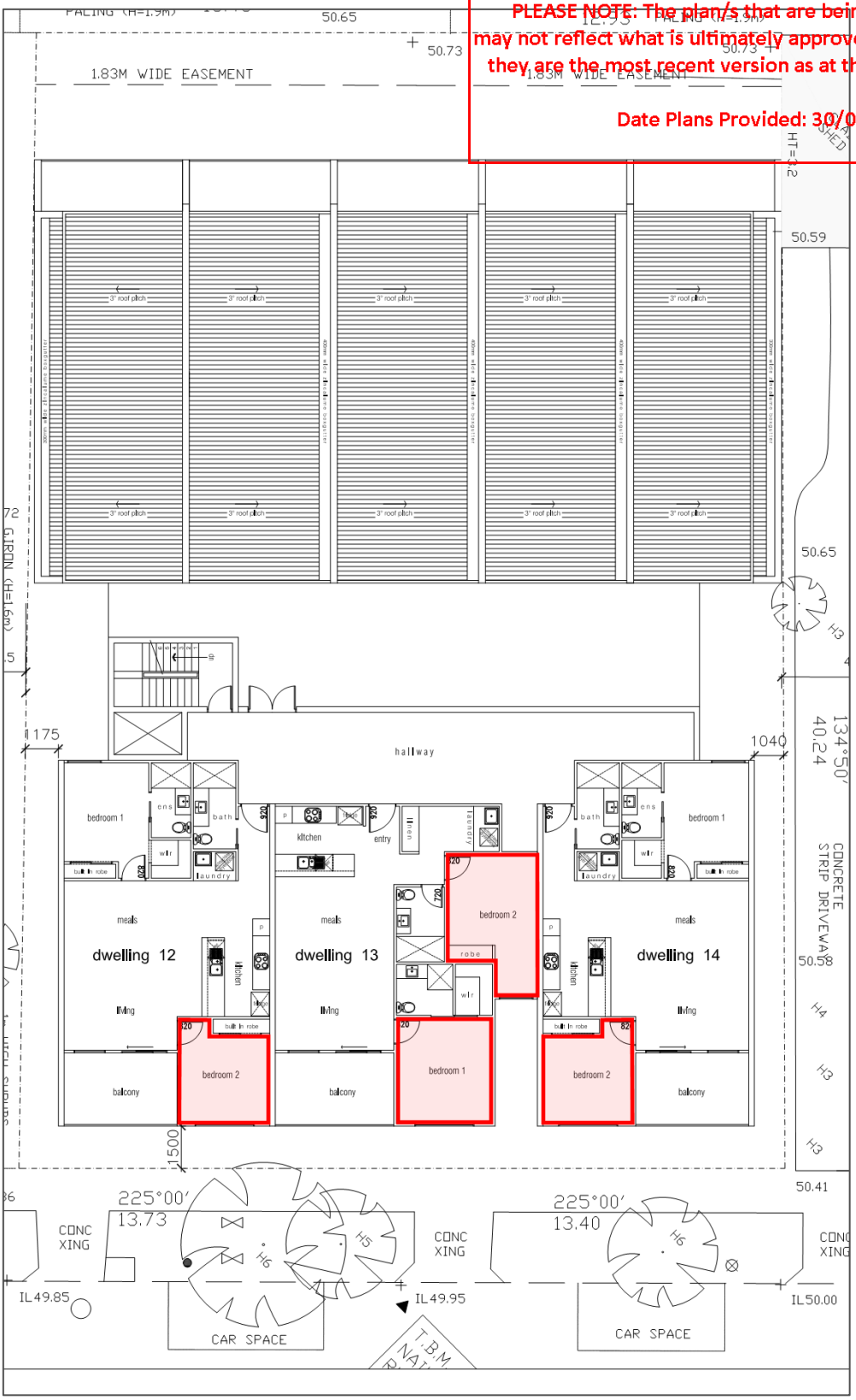


Figure 6 Ceiling / Roof Demarcations – Level 3
(Image Source: TM Design Group)

Table 14 Recommended Ceiling / Roof Design Details

Ceiling / Roof Type	Recommended Ceiling / Roof Design Details
Unmarked ceiling / roof areas in Figure 6.	▪ As per documented baseline design details in Table 11.
Ceiling / Roof Type 2a	▪ 0.42 mm BMT steel roof sheeting (Colorbond or similar). ▪ Two layers of minimum 10 mm standard plasterboard (min. mass 6.5 kg/m^2) or one layer of 13 mm acoustic plasterboard (min. mass 13.0 kg/m^2) as ceiling lining fixed to underside of roof framing. ▪ Minimum 300 mm depth between roof sheeting and plasterboard lining. ▪ Minimum 195 mm thick, 7.5 kg/m^3 glasswool insulation e.g. Knauf Earthwool R4.0 Ceiling Batt, Bradford Gold R4.1 Ceiling Batt, or similar. ▪ If recessed light fittings are included in the ceiling, it is recommended that acoustic-rated fittings or covers should be used. Such fittings or covers should be rated to achieve a minimum sound insulation rating of R_w 31. OR ▪ Alternative roof / ceiling configuration to achieve a minimum sound insulation rating of $R_w + C_{tr} \geq 38$.

6.7 Calculated Internal Noise Levels with Recommended Acoustic Treatment

Table 15 presents the results of internal noise level calculations with the recommended acoustic treatment measures implemented to the development.

Table 15 Calculated Internal Noise Levels with Documented Design

Dwelling; Room	Time Period	Noise Level Metric	Project Design Criteria, L_{Aeq}, dB(A)	Calculated Noise Levels and Compliance Status, L_{Aeq}, dB(A)
Dwelling 1 / 3 / 09 / 11; Bedroom 2	Day (6 am to 10 pm)	Average, L_{Aeq}	40	37 ✓
		Loudest Hour, L_{Aeq}	45	41 ✓
	Night (10 pm to 6 am)	Average, L_{Aeq}	35	35 ✓
		Loudest Hour, L_{Aeq}	40	37 ✓
Dwelling 2 / 10; Bedroom 1	Day (6 am to 10 pm)	Average, L_{Aeq}	40	37 ✓
		Loudest Hour, L_{Aeq}	45	41 ✓
	Night (10 pm to 6 am)	Average, L_{Aeq}	35	34 ✓
		Loudest Hour, L_{Aeq}	40	37 ✓

Dwelling; Room	Time Period	Noise Level Metric	Project Design Criteria, L_{Aeq}, dB(A)	Calculated Noise Levels and Compliance Status, L_{Aeq}, dB(A)
Dwelling 12 / 14; Bedroom 2	Day (6 am to 10 pm)	Average, L_{Aeq}	40	37 ✓
		Loudest Hour, L_{Aeq}	45	41 ✓
	Night (10 pm to 6 am)	Average, L_{Aeq}	35	35 ✓
		Loudest Hour, L_{Aeq}	40	37 ✓
Dwelling 13; Bedroom 1	Day (6 am to 10 pm)	Average, L_{Aeq}	40	37 ✓
		Loudest Hour, L_{Aeq}	45	41 ✓
	Night (10 pm to 6 am)	Average, L_{Aeq}	35	35 ✓
		Loudest Hour, L_{Aeq}	40	37 ✓
Dwelling 13; Bedroom 2	Day (6 am to 10 pm)	Average, L_{Aeq}	40	37 ✓
		Loudest Hour, L_{Aeq}	45	41 ✓
	Night (10 pm to 6 am)	Average, L_{Aeq}	35	35 ✓
		Loudest Hour, L_{Aeq}	40	37 ✓

7 Building Mechanical Plant Noise

7.1 Assessment Criteria

7.1.1 Environment Protection (Residential Noise) Regulations 2018

Noise emissions from residential premises must comply with the Environment Protection (Residential Noise) Regulations 2018 (Residential Noise Regulations) (State of Victoria, 2018).

The Residential Noise Regulations prescribe the times (termed "Prohibited Times") during which certain types of noise emission is deemed to be unreasonable noise for the purposes of Section 48A(5) of the Environment Protection Act 1970 (State of Victoria, 1970).

The EPA Noise Control Guidelines (EPA Victoria, 2008) provide guidance to assist with interpretation of the Residential Noise Regulations for noise from fixed domestic plant such as air conditioners, swimming pool and spa pumps, heating systems, internal vacuum systems, and the like.

Table 16 presents the guidance provided by the EPA Noise Control Guidelines, and the recommended design criteria for this project, based on the measured background noise levels.

Table 16 EPA Noise Control Guidelines and Design Criteria for Fixed Domestic Plant

Period	Applicable Times	EPA Noise Control Guidelines	Recommended Project Design Criterion (Outdoors), dB(A) L_{Aeq}
Day / Evening (Non-Prohibited Times)	7 am to 10 pm Monday to Friday. 9 am to 10 pm Weekends and Public Holidays.	Where noise from any fixed domestic plant is audible beyond the boundary of the residential premises on which the plant is situated, the intrusive noise shall not exceed the background noise level (L_{A90}) by more than 5 dB at the measurement position.	47
Night (Prohibited Times)	10 pm to 7 am Monday to Friday. 10 pm to 9 am Weekends and Public Holidays.	Noise from any fixed domestic plant must not be audible within a habitable room of any other residence (regardless of whether any door or window giving access to the room is open).	35

Note: The level of sound that would be audible or inaudible is difficult to define precisely, as audibility depends on a number of factors including the level of the sound, its temporal and spectral characteristics, the characteristics of the background acoustic environment, the hearing abilities of the listener, and environmental influences such as screening due to fences and noise reductions from outside to inside the receiving building.

For design purposes, the recommended Night period noise limit has been set based on the State Environment Protection Policy (Control of Noise from Industry, Commerce and Trade) No. N-1 Night period base noise limit of 35 dB(A).

7.1.2 State Environment Protection Policy (Control of Noise from Commerce, Industry and Trade) No. N-1

Noise emissions from mechanical plant serving common and commercial areas of the building such as the car park and commercial tenancies must be designed to comply with the requirements of State Environment Protection Policy (Control of Noise from Industry, Commerce and Trade) No. N-1 (SEPP N-1) (State of Victoria, 2001).

State Environment Protection Policy (Control of Noise from Commerce, Industry and Trade) No. N-1 (SEPP N-1) (State of Victoria, 2001) prescribes the procedures used to determine limits for, and assess, environmental noise emissions from sources such as mechanical equipment and activities associated with commercial, industrial or trade operations. Compliance with SEPP N-1 is a statutory requirement within the Melbourne Metropolitan Region.

The limits prescribed by SEPP N-1 apply at or within Noise Sensitive Areas, such as residential dwellings, as defined in Appendix A. The limits are dependent on a number of factors including:

- The time of day at which the noise emissions occur;
- The planning zone types in the area of the Noise Sensitive Area; and
- The background noise levels at the Noise Sensitive Area.

Table 17 presents the noise limits that have been determined to apply at the potentially most-affected Noise Sensitive Areas (see Section 4). Details of the SEPP N-1 Zoning Level and noise limit calculations are presented in Appendix D.

Table 17 SEPP N-1 Noise Limits

Period	Applicable Times	L_{eff} Noise Limit, dB(A)
Day	▪ 7 am to 6 pm Monday to Friday ▪ 7 am to 1 pm Saturday	50
Evening	▪ 6 pm to 10 pm Monday to Friday ▪ 1 pm to 10 pm Saturdays ▪ 7 am to 10 pm Sundays and Public Holidays	44
Night	▪ 10 pm to 7 am All Days	39

In accordance with SEPP N-1, noise emissions from the source under consideration are measured so as to obtain an L_{Aeq} sound pressure level that is representative of the audible noise at the Noise Sensitive Area over a continuous 30-minute period. Adjustments to the measured level are applied where necessary to account for characteristics such as duration, intermittency, reflections, impulsiveness, tonality, and measurement location. The adjusted noise level is termed the Effective Noise Level, and it is the Effective Noise Level that is assessed in relation to the noise limits.

As the commercial and common mechanical plant could potentially operate at any time, the controlling noise limit for design purposes will be the SEPP N-1 Night period noise limit of 39 dB(A).

7.2 Domestic Outdoor Air-Conditioning Condenser Units

Table 18 presents indicative noise control advice to comply with the EPA Noise Control Guidelines depending on the location where domestic outdoor air-conditioning condenser units may be installed.

Table 18 Indicative Noise Control Recommendations for Domestic Outdoor AC Condenser Units

Install Location	Indicative Noise Control Recommendations
On balconies of individual apartments	▪ AC condenser units should have individual sound power levels of no more than 65 dB(A); and ▪ Separating screens should be installed between adjoining balconies; and ▪ AC condenser units should be installed at locations that do not have direct line of sight to windows of habitable spaces of neighbouring dwellings. ▪ Separating screens between adjoining balconies should be no less than 1 m higher than the top of the tallest AC condenser unit. ▪ Separating screens between adjoining balconies should be constructed to the full depth of the balcony. ▪ Separating screen should be solid and provide minimum R_w 30. Acceptable sheeting materials include 9 mm thick fibre cement sheet or another suitable sheeting material of at least 12 kg/m^2 mass.

On rooftops (either at a mechanical plant zone or individually)	▪ AC condenser units should have individual sound power levels of no more than 65 dB(A); and ▪ AC condenser units should be installed at locations that do not have direct line of sight to windows of habitable spaces of neighbouring dwellings. ▪ Where six or more AC condenser units are installed at a mechanical plant zone, an acoustic screen will be required surrounding the mechanical plant zone. ▪ Indicative design parameters for the acoustic screen are presented in Section 7.3.

7.3 Mechanical Plant Serving Common and Commercial Parts of Building

The future tenant and operating hours of the ground level commercial tenancies are unknown at this stage. As a conservative assumption, it is considered that the common and commercial mechanical plant could potentially operate during the SEPP N-1 Night period. The SEPP N-1 Night period noise limit of 39 dB(A) is therefore the controlling noise limit for the mechanical plant.

Based on the SEPP N-1 Night period noise limit and distance to nearby NSAs, it is recommended that any mechanical plant serving commercial and common areas including AC condenser units, kitchen exhaust fans, and car park ventilation fans should be installed at, or ducted to a mechanical plant zone on the roof of the building.

The following noise control measures are recommended to the mechanical plant equipment to comply with the SEPP N-1 noise limit:

- Each commercial tenancy should have no more than one outdoor AC condenser unit and kitchen exhaust fan;
- AC condenser units should have individual sound power levels of no more than 70 dB(A);
- If kitchen exhaust fans are installed on the rooftop to serve the commercial tenancies they should have individual sound power levels of no more than 80 dB(A);
- Note: If air-conditioning to the tenancies are proposed to be part of tenant fit-out rather than base build, it is recommended that the lease agreement for any future tenant includes a requirement for the tenant to ensure compliance with SEPP N-1 for any mechanical plant installed or operated for their use.
- No more than one car park ventilation fans should be installed;
- The car park ventilation fan should be of the in-line type and should be installed within the car park space;
- The car park ventilation fan should have an individual sound power level of no more than 80 dB(A);

- Inlet and outlet ductwork to the car park ventilation fan should be internally lined with 50 mm thick, 32 kg/m^3 insulation for a minimum 2.5 m from the fan.
- An acoustic screen should be installed surrounding the mechanical plant zone.
- The acoustic screen should be no less than 500 mm higher than the top of the tallest mechanical plant equipment.
- The acoustic screen should be solid and provide minimum R_w 30. Acceptable sheeting materials include 1.6 mm thick steel, 9 mm thick fibre cement sheet, or another suitable sheeting material of at least 12 kg/m^2 mass. Open screening is not recommended.
- The screen should be lined on the plant side with 50 mm thick, 32 kg/m^3, non-hygroscopic mineral wool or an approved alternative acoustic insulation suitable for outdoor environments.
- If required for moisture resistance, the insulation may be encapsulated in a thin foil or plastic membrane, having a maximum thickness of 50 microns.
- A perforated steel sheet may optionally be included over the insulation to protect it from mechanical damage. If included, the perforated steel sheet should have a minimum open area of 20%.
- The mechanical plant platform should also be constructed from minimum 1.6 mm thick steel, 9 mm thick fibre cement sheet, or another suitable sheeting material of at least 12 kg/m^2 mass. An open plant platform is not advised.

The acoustic screen design requirements are presented schematically in Figure 7.

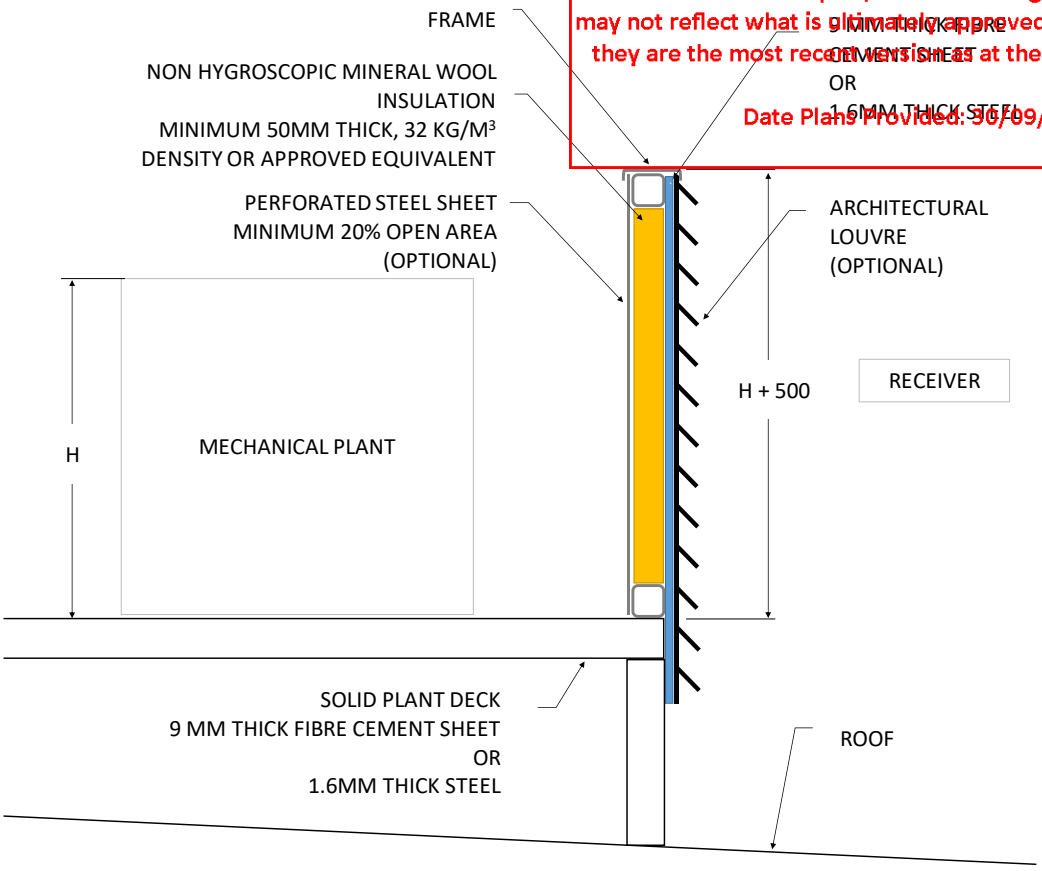


Figure 7 Mechanical Plant Zone Acoustic Screen Schematic (Not to Scale)

7.4 Apartment Exhaust and Ventilation

It is expected that apartment toilet exhaust and kitchen exhaust fans will be domestic-type in-line fans located in the ceiling space within each apartment and ducted to an external wall or roof. Noise emissions from these fans are not expected to require acoustic treatment to control noise impacts to nearby Noise Sensitive Areas.

However, toilet exhaust, kitchen exhaust, or other ventilation systems that have external air intakes / outlets should be designed so that the ventilation system achieves the following minimum noise reduction between the external ventilation opening and the room:

- For external openings on south-east façade (facing Cottrell Street): 30 dB;
- For openings on south-west and north-east facades: 15-30 dB (depending on distance from Cottrell Street);
- For openings on north-west façade: 15 dB.

Indicatively, it is recommended that:

- Ventilation systems opening at the south-eastern facades should have at least 2 m length of acoustically insulated rigid ductwork and/or acoustic flexible ductwork.
- Ventilation systems opening at all other facades should have minimum 1 m length of acoustically insulated rigid ductwork and/or acoustic flexible ductwork.

The required acoustic treatment measures should be determined as part of the mechanical services design for the building.

7.5 Triggers for Further Acoustic Review

Further acoustic review should be undertaken to confirm compliance with the EPA Noise Control Guidelines or SEPP N-1 noise limits in the event that any of the following occurs:

- If apartment AC condenser units are installed at any location other than the apartment balconies or on the rooftop at a common mechanical plant zone.
- If apartment AC condenser units with individual sound power levels greater than 65 dB(A) are proposed.
- If the recommended specifications for separating screens between balconies cannot be accommodated.
- If more than two outdoor AC condenser units serving common or commercial areas are proposed;
- If more than two kitchen exhaust fans serving commercial areas are proposed;
- If more than one car park ventilation fan is proposed;
- If common or commercial AC condenser units with individual sound power levels greater than 70 dB(A) are proposed;
- If commercial areas kitchen exhaust fans have with individual sound power levels greater than 80 dB(A) are proposed;
- If the selected car park ventilation fan has individual sound power level greater than 88 dB(A);
- If the common or commercial AC condenser units, commercial kitchen exhaust fans, or car park ventilation fans are not located at, or ducted to a rooftop mechanical plant zone;
- If the car park ventilation fan duct internal acoustic lining specifications cannot be achieved;
- If any specifications for the rooftop mechanical plant zone acoustic screening cannot be achieved.

8 Noise Transmission within the Development

Noise transmission between apartments and between apartments and other types of spaces will be addressed by complying with the BCA Deemed-To-Satisfy Sound Insulation Performance Requirements. The following sections present the BCA DTS Provisions.

8.1 BCA DTS Provisions for Internal Walls

Table 19 presents the BCA DTS Sound Insulation Performance Requirements for the internal walls of Class 2 buildings separating Sole Occupancy Units (SOUs) from other parts of the building or other SOUs.

Table 19 BCA DTS Sound Insulation Requirements for Walls in Class 2 Buildings

Space Type 1	Space Type 2	BCA DTS Sound Insulation Requirement	
		Airborne	Impact
Habitable room of a sole occupancy unit	Habitable room of adjoining sole occupancy unit	$R_w + C_{tr} \geq 50$	-
Bathroom, sanitary compartment, laundry or kitchen of a sole occupancy unit	Bathroom, sanitary compartment, laundry or kitchen of adjoining sole occupancy unit	$R_w + C_{tr} \geq 50$	-
Habitable room of a sole occupancy unit	Bathroom, sanitary compartment, laundry or kitchen of adjoining sole occupancy unit	$R_w + C_{tr} \geq 50$	Discontinuous construction*
Sole occupancy unit (any room)	Stairway, public corridor, public lobby or the like, or parts of a different classification	$R_w \geq 50$	-
Sole occupancy unit (any room)	Plant room or lift shaft	$R_w \geq 50$	Discontinuous construction*

* Discontinuous construction means a wall having a minimum 20 mm cavity between 2 separate leaves, and

- For masonry, where wall ties are required to connect leaves, the ties are of the resilient type; and
- For other than masonry, there is no mechanical linkage between leaves except at the periphery.

8.2 BCA DTS Provisions for Floor / Ceiling Assemblies

Table 20 presents the BCA DTS Sound Insulation Performance Requirements for floor / ceiling assemblies within Class 2 buildings.

Table 20 BCA DTS Requirements for Floor / Ceiling Assemblies in Class 2 Buildings

Space Type 1	Space Type 2	BCA DTS Sound Insulation Requirement	
		Airborne	Impact
Sole occupancy unit (any room)	Adjoining sole occupancy unit (any room)	$R_w + C_{tr} \geq 50$	$L_{n,w} \leq 62$
Sole occupancy unit (any room)	Plant room, lift shaft, stairway, public corridor, public lobby or the like, or parts of a different classification	$R_w + C_{tr} \geq 50$	$L_{n,w} \leq 62$

8.3 BCA DTS Provisions for Services

If a duct, soil, waste or water supply pipe, including a duct or pipe that is located in a wall or floor cavity, serves or passes through more than one SOU, the duct or pipe must be separated from the rooms of any SOU by construction with an $R_w + C_{tr}$ (airborne) not less than —

- 40 if the adjacent room is a habitable room (other than a kitchen); or
- 25 if the adjacent room is a kitchen or non-habitable room.

8.4 BCA DTS Provisions for Apartment Entry Doors

A door incorporated in a wall in a Class 2 or 3 building that separates a sole-occupancy unit from a stairway, public corridor, public lobby or the like, must have an R_w not less than 30.

8.5 Acoustic Review of General Building Layout

8.5.1 Lift

The lift is not located adjacent to habitable rooms of any dwellings. This is an acoustically desirable configuration.

8.5.2 Apartment Entry Doors from Common Corridor

Apartment entry doors into common corridors are generally spaced well apart. Entries to apartments 8 and 9 on Level 1, 7 and 8 on Level 2, and 10 and 11 on Level 3, which have entry doors closer together incorporate dog-leg entry corridors to the apartment, which will reduce any noise transmission spaces due to noise received through the entry door. Overall, the layout of apartment entry doors is considered to be in an acoustically satisfactory configuration.

8.5.3 Bedroom Windows Above Site Entry

The external windows of Bedroom 1 and Bedroom 2 of Dwelling 8 (Level 1) and Bedroom 2 of Dwelling 9 (Level 1) are located directly above the vehicle Site Entry. It is recommended that the external glazing to these bedrooms should be upgraded to minimise the potential noise impacts of vehicles entering and exiting the site. The following external glazing specifications are recommended:

- Double glazing units comprising 6 mm glass + 12 mm air gap + 6.38 mm laminated glass; or
- Alternative glazing systems providing minimum sound insulation rating of $R_w + C_{tr}$ 29.
- Framing selected to match the minimum sound insulation rating.

8.6 Car Park Entry Gate

To minimise structure-borne noise transmission to the building, it is recommended that the car park main entry gate should incorporate the following design features:

- A soft start motor;
- Rubber sealing strip / bump stop at base of gate and/or ends of travel, to prevent noise due to hard contact on closure of the gate;
- Guiderail systems specifically designed for smooth operation;
- Where the gate frame, guiderails, and motor are mounted to the building structure or floor slab, they should be isolated from the building structure using rubber vibration isolation mounts or pads with a static deflection of nominally 5 mm (e.g. Embelton NR series isolators) installed at all support points;
- Gate should be installed and adjusted so as not to impact rigid surfaces at the ends of its travel.
- If a drainage grate is included at the entry to the car park, it should be secured in place (e.g. bolted down) so that it cannot generate noise as vehicles drive over it on entry or exit from the car park.

8.7 Lift Vibration Isolation

To minimise the risk of vibration and structure-borne noise impacting apartments, it is recommended that the lift motor, guiderails, and control equipment should be vibration isolated from the building structure. This should be achieved using rubber isolation mounts or pads at the points where the lift equipment mounts to the structure.

In accordance with the Building Code of Australia, the construction of the wall between the lift shaft and apartments should be of discontinuous construction and should be constructed to achieve an airborne sound insulation rating of $R_w \geq 50$.

Note: In accordance with the Building Code of Australia, discontinuous construction is defined as a wall having a minimum 20 mm cavity between 2 separate wall leaves with no mechanical linkage between leaves except at the periphery e.g. a double timber stud wall with a 20 mm cavity between the studs.

9 Conclusion

A town planning acoustic assessment has been performed for the proposed mixed-use development at 18-20 Cottrell Street, Werribee.

Assessment of noise intrusion via the building façade and environmental noise emissions due to mechanical services plant has been undertaken with regard to the acoustic requirements prescribed by the Planning Permit issued for the development, Victoria Planning Provisions Clause 58.04-3 (State of Victoria, 2018), State Environment Protection Policy (Control of Noise from Industry, Commerce and Trade) No. N-1 (SEPP N-1) (State of Victoria, 2001), and the Environment Protection (Residential Noise) Regulations 2018 (State of Victoria, 2018).

Acoustic engineering advice for the proposed development has been presented in Sections 6 to 8.

Subject to the advice presented in this report, it is considered that the proposed development will satisfy the adopted internal acoustic design criteria and environmental noise legislation applicable to the development.

10 References

ABCB. (2016). *National Construction Code Series Volume 1 - Building Code of Australia 2016 - Class 2 to 9 Buildings.* Canberra: Australian Building Codes Board.

EPA Victoria. (2008). Noise Control Guidelines, Publication 1254. Melbourne.

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

State of Victoria. (1970). *Environment Protection Act 1970.*

State of Victoria. (2001). State Environment Protection Policy (Control of Noise from Industry, Commerce and Trade) No. N-1. *No. S31, 16/5/1992, Gazette 15/6/1989, As varied 15/9/1992, No. G37, Gazette 23/9/1992, As varied 31/10/2001, No. S183, Gazette 31/10/2001*.

State of Victoria. (2018). Environment Protection (Residential Noise) Regulations 2018. *SR No. 121 of 2008*.

State of Victoria. (2018). *Victoria Planning Provisions.* Victoria.

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

C_{tr} A spectrum adaptation term, commonly used with R_w and D_{nTw}. C_{tr} adjusts the sound insulation ratings to better describe the performance of the particular construction under consideration when subject to low frequency noise, such as noise from heavy vehicle traffic or subwoofers. [Unit: dB]

Effective Noise Level "Effective noise level" means the level of noise emitted from the commercial, industrial or trade premises and adjusted if appropriate for character and duration.

$L_{A90,T}$ The value of A-weighted Sound Pressure Level which is exceeded for 90 percent of the time during given measurement period T. This is commonly used to represent the background noise level. [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)]

L_{eff} See 'Effective Noise Level'.

$L_{n,w}$	$L_{n,w}$ is the Weighted Normalized Impact Sound Pressure Level. It is a single number rating of the impact sound insulation of a floor/ceiling assembly determined using a standard a standard 'tapping' machine. A lower value of $L_{n,w}$ indicates better impact sound insulation. [Unit: dB]
Noise Sensitive Area	For the purposes of assessment of noise levels in relation to *State Environment Protection Policy (Control of Noise from Commerce Industry and Trade) No. N-1*, *State Environment Protection Policy (Control of Music Noise from Public Premises) No. N-2*, or the I*nterim Guidelines for Control of Noise from Industry in Country Victoria*, a Noise Sensitive Area is defined as: a) That part of the land within the apparent boundaries of any piece of land which is within 10 metres outside the external walls of any of the following buildings: ▪ A dwelling (except Caretaker's House) ▪ Residential Building b) That part of the land within the apparent boundaries of any piece of land on which is situated any of the following buildings which is within a distance of 10 metres outside the external walls of any dormitory, ward or bedroom of such buildings: ▪ Caretakers house ▪ Hospital ▪ Hotel ▪ Institutional home ▪ Motel ▪ Reformative institution ▪ Tourist establishment ▪ Work release hostel
R_w	Weighted Sound Reduction Index. A single number rating of the airborne sound insulation performance of a specific building element in the absence of flanking transmission. A higher R_w value indicates better airborne sound insulation. [Unit: dB]
Sound Power Level	A measure of the total sound energy radiated by a source, per unit time. Mathematically, it is ten times the logarithm to the base ten of the ratio of the sound power (W) of the source to the reference sound power; where the reference sound power is $1x10^{-12}$ W. [Unit: dB]

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 21 presents details of the noise measurement locations. Figure 8 to Figure 10 present a map and photographs of the noise measurement locations.

Table 21 Noise Measurement Location Details

Location Reference	Measurement Description	Microphone Height Above Ground Level, m
1	Environmental noise logging	1.3 m
2	Traffic noise measurement – Cottrell Street	1.5 m

Figure 8 Noise Measurement Locations (Image Source: Google Maps)

Figure 9 Noise Measurement Location 1 – Photo Facing South-West

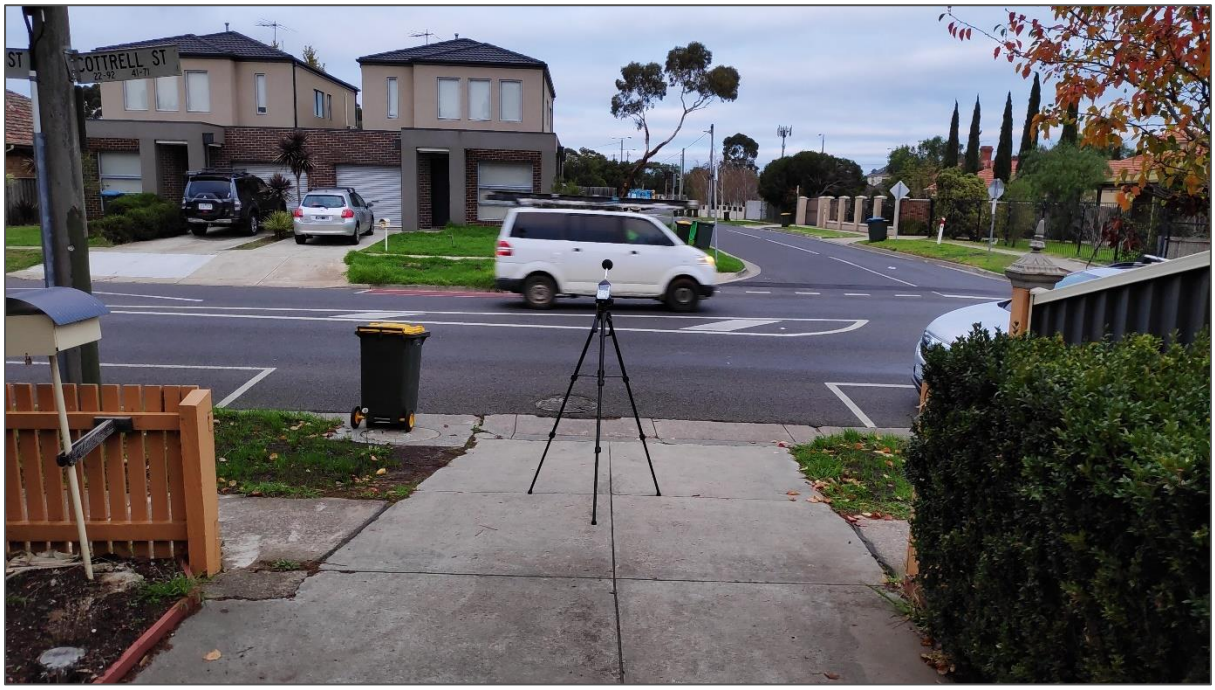


Figure 10 Noise Measurement Location 2 – Photo Facing South-East

Measurement Procedure

Unattended environmental noise logging and attended noise measurements were performed at the site to establish the environmental noise levels. Table 22 presents details of each measurement:

Table 22 Details of Measurement Period

Location Ref.	Measurement Type		Start Time	Start Date	End Time	End Date
	Attended	Unattended				
1	☐	☒	7:45 AM	Friday 7/06/2019	7:30 AM	Wednesday 12/06/2019
2	☒	☐	7:45 AM	Friday 7/06/2019	8:00 AM	Friday 7/06/2019

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.

Foam windscreens were installed on the microphones 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 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 23.

Table 23 Acoustic Instrumentation Details

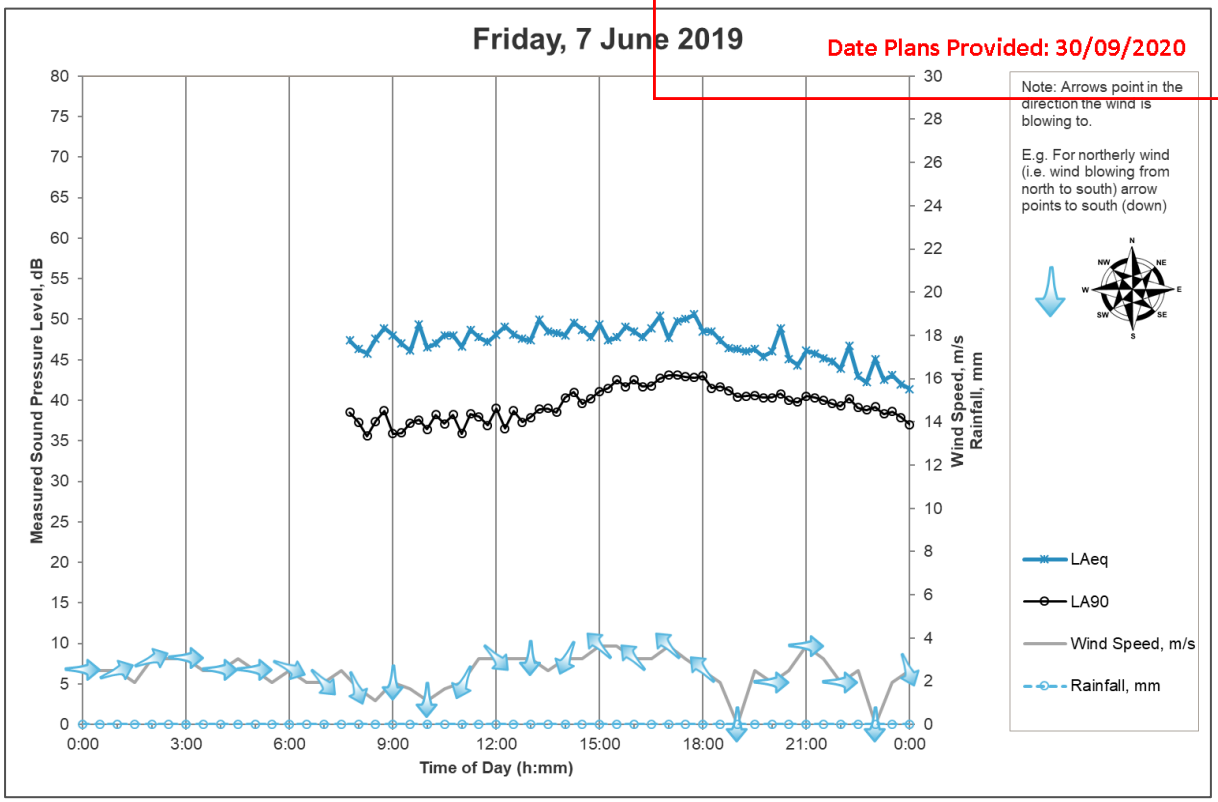
Location Reference	Instrument Description	Serial No.	Date of Last Laboratory Calibration*
1	Svantek 977 Class 1 Sound Level Meter	45758	13/09/2018
2	Svantek 977 Class 1 Sound Level Meter	45763	10/01/2019
-	Svantek SV33 Portable Sound Level Calibrator	57427	6/05/2019
-	Svantek SV35 Portable Sound Level Calibrator	58054	13/05/2019

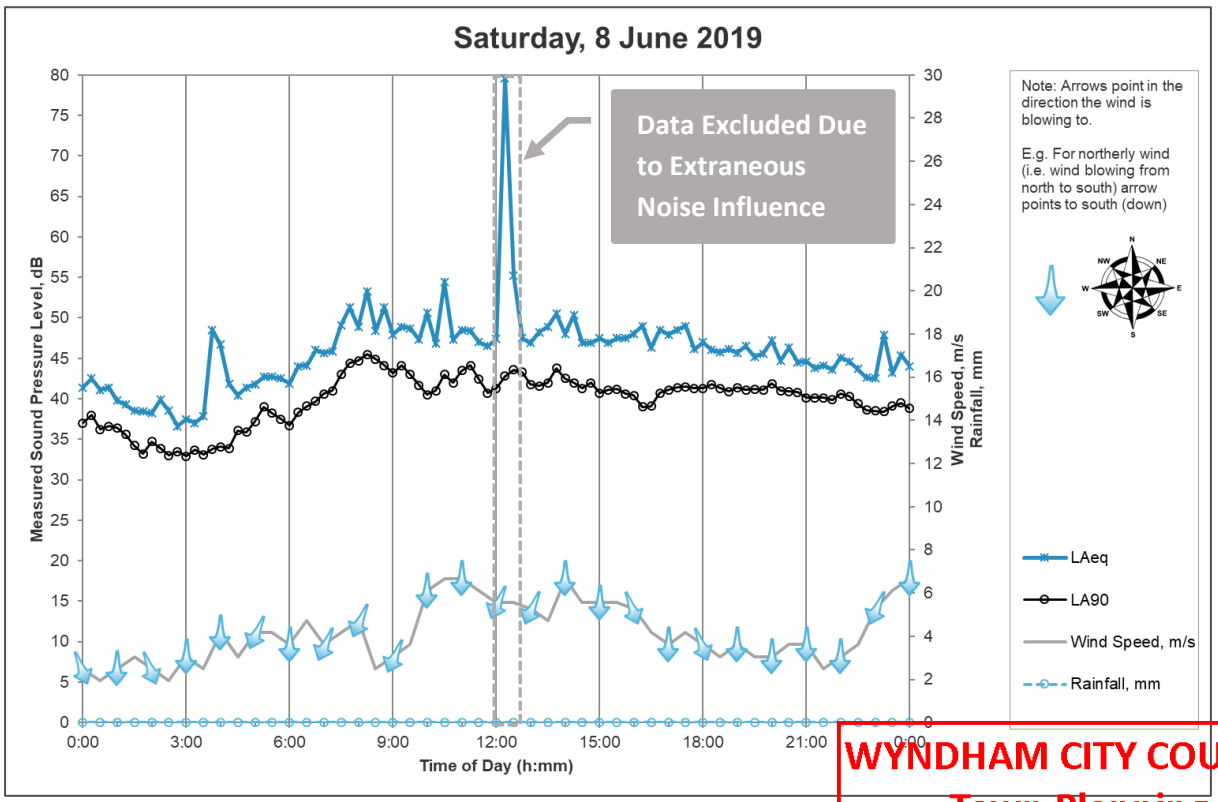
* In accordance with AS 1055.1-1997 and National Association of Testing Authorities Guidelines, Sound Level Meters and Environmental Noise Loggers are required to have comprehensive laboratory calibration checks carried out at intervals not exceeding two years. Sound Level Calibrators require calibration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

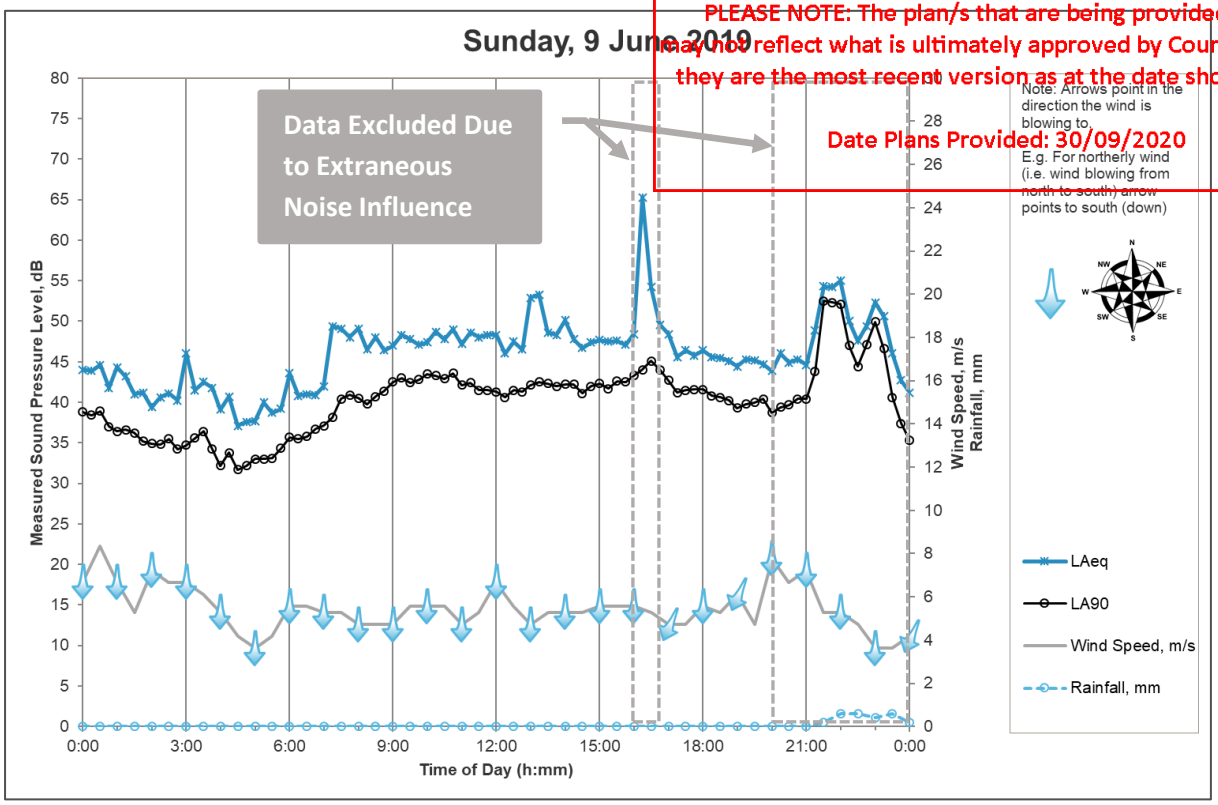
Meteorological Data

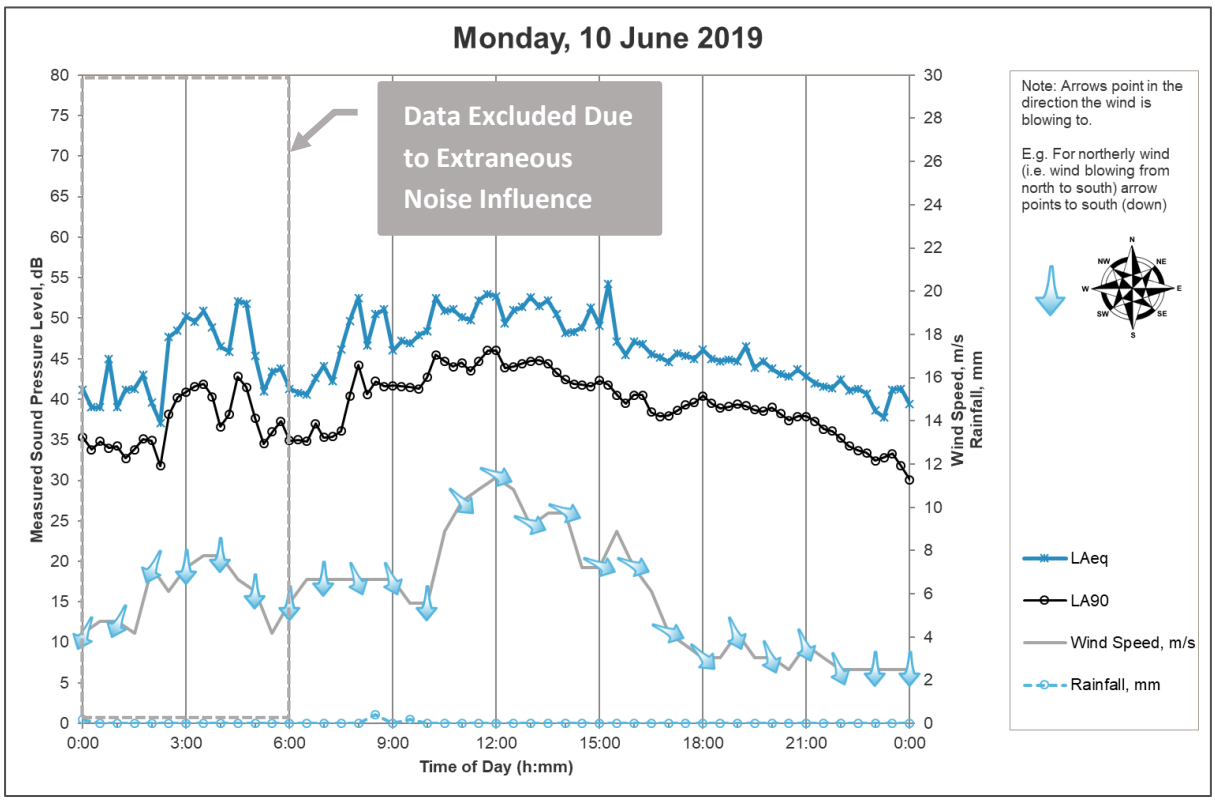
Weather observations during the monitoring period were taken from the Bureau of Meteorology Weather Station at Laverton, approximately 10 km away. Appendix C shows the meteorological observations plotted against the measured L_{Aeq} and L_{A90} sound pressure levels for the duration of the measurement period.

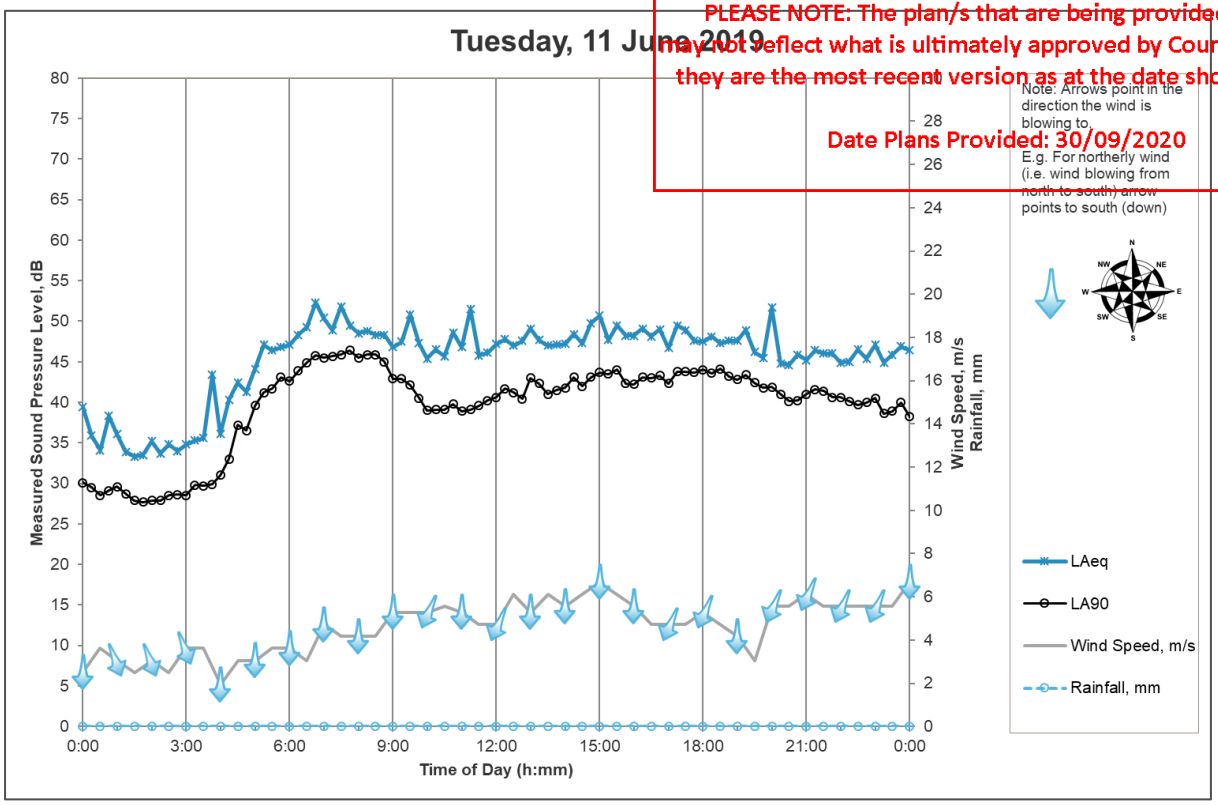
Appendix C Graphed Noise Measurement Results

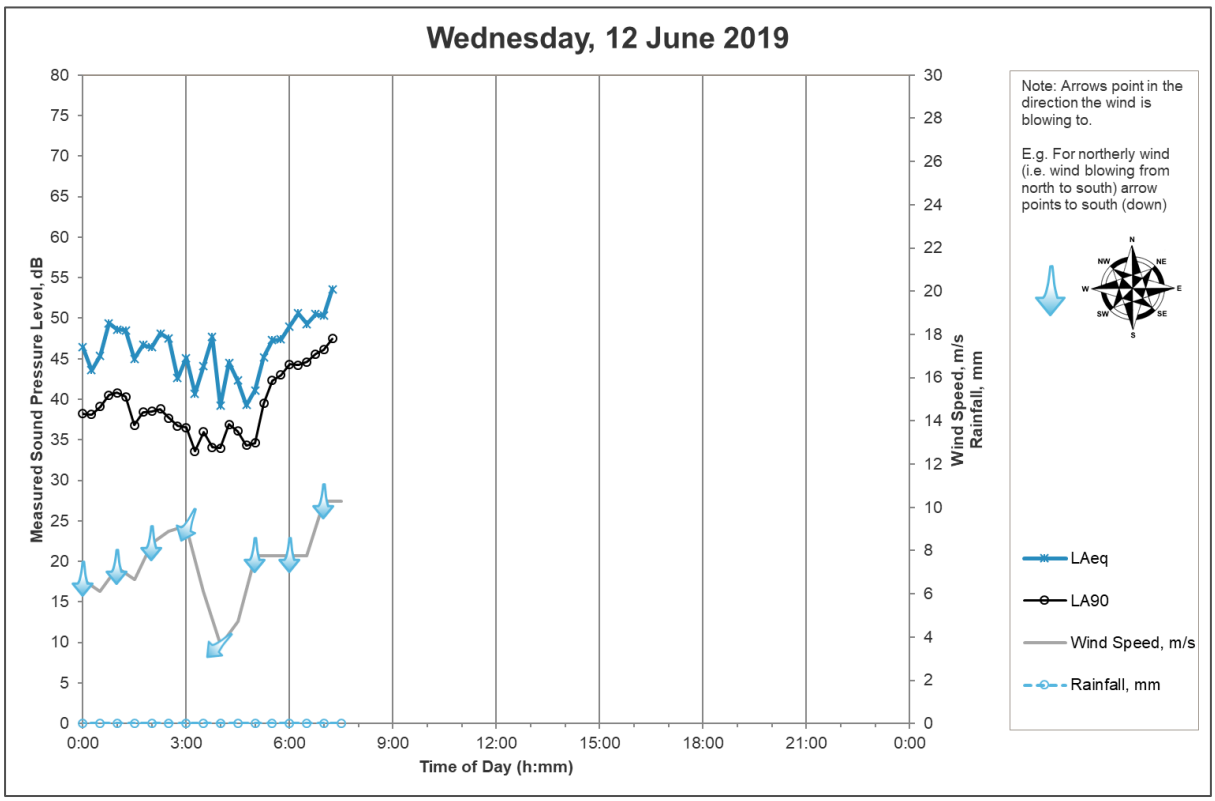












Appendix D SEPP N-1 Zoning Level and Noise Limit Calculations

18-20 Cottrell Street, Werribee

Zoning Map

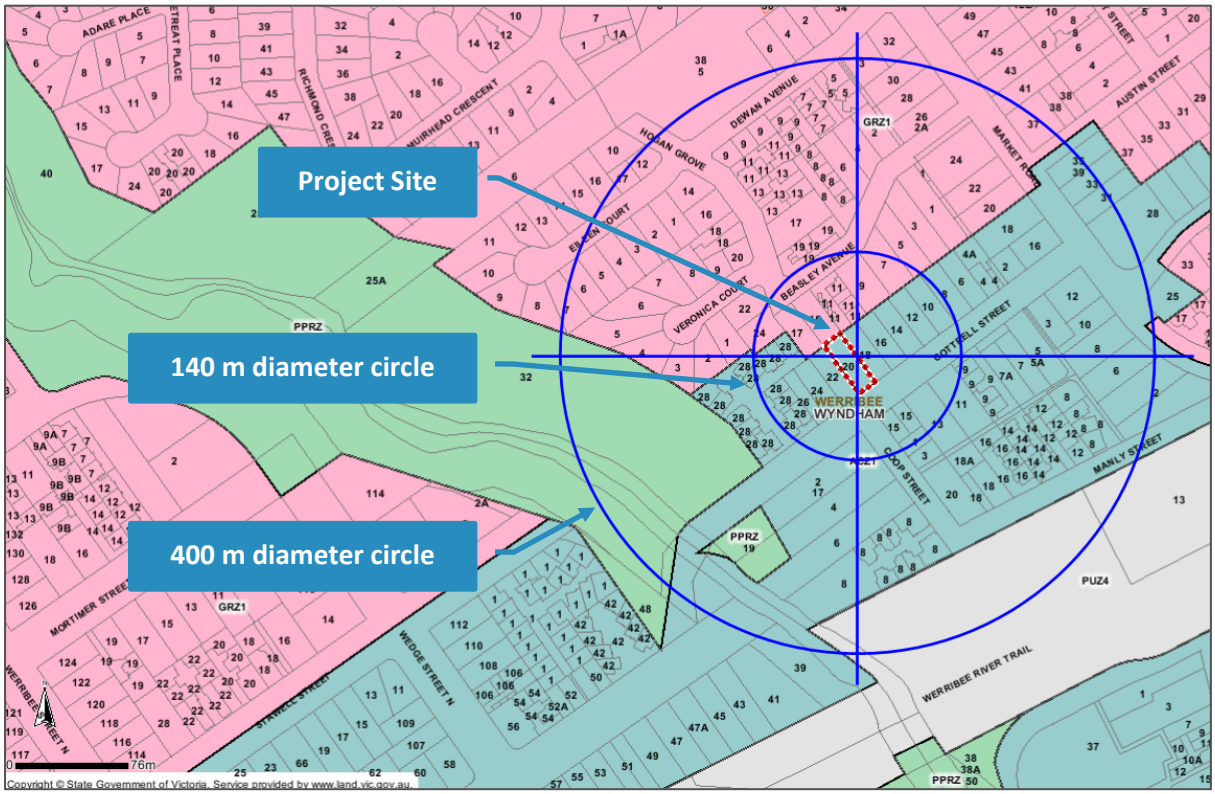


Figure 11 Zoning Circles (Image Source: http://services.land.vic.gov.au/maps/pmo.jsp)

Zone Areas

Zone Type Designation	Applicable Zones	% Area of 140m Circle	% Area of 400m Circle
Type 1	GRZ1, ACZ1, PPRZ	100%	93%
Type 2	PUZ4	0%	7%
Type 3	-	0%	0%

Influencing Factor: 0.02

Zoning Levels and Noise Limits

Period	Zoning Level, dB(A)	L_{A90} Background Noise Level, dB(A)	Background Noise Classification	SEPP N-1 Noise Limits, dB(A)
Day	50	39	Neutral	50
Evening	44	38	Neutral	44
Night	39	34	Neutral	39

Explanatory Notes to SEPP N-1 Noise Limit Derivation

In accordance with SEPP N-1 the Influencing Factor (IF) for an assessment location is calculated as follows:

$$IF = 0.25(Sum\ of\ Type\ 2\ fractions\ for\ both\ cicles) + 0.5(Sum\ of\ Type\ 3\ fractions\ for\ both\ circles)$$

The Zoning Levels are calculated according to the following equations:

$$Day\ Period\ Zoning\ Level = 18 \times IF + 50$$
$$Evening\ Period\ Zoning\ Level = 17 \times IF + 44$$
$$Night\ Period\ Zoning\ Level = 17 \times IF + 39$$

The Background Noise Levels are classified as follows:

Period	Classification Criteria	Background Noise Classification
Day	Background Noise Level > Zoning Level - 6 dB(A)	High
	Background Noise Level < Zoning Level - 12 dB(A)	Low
	Otherwise	Neutral
Evening and Night	Background Noise Level > Zoning Level - 3 dB(A)	High
	Background Noise Level < Zoning Level - 9 dB(A)	Low
	Otherwise	Neutral

The noise limits are determined based on the background noise classification, according to the following equations:

Period	Classification	Noise Limit
Day	High	Background Noise Level + 6 dB(A)
	Neutral	Zoning Level
	Low	0.5 x (Zoning Level + Background Noise Level) + 4.5 dB(A)
Evening and Night	High	Background Noise Level + 3 dB(A)
	Neutral	Zoning Level
	Low	0.5 x (Zoning Level + Background Noise Level) + 3 dB(A)

SEPP N-1 specifies that the noise limits may not be less than 45 dB(A) for the Day period, 40 dB(A) for the Evening period, and 35 dB(A) for the Night period.