WOOD & GRIEVE ENGINEERS

195-197 Sydney Road, Fairlight

Acoustic Report

Development Application

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Project No. 39921
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001	31/08/18	Initial issue	**Brandon Notaras**

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1. Introduction

As part of the Development Application (DA) documentation process, Wood & Grieve Engineers has been engaged by Modularium Pty Ltd to provide an acoustic assessment for the proposed residential development located at 195-197 Sydney Road, Fairlight NSW 2094.

The proposed work is to include:

- Five (5) levels of naturally ventilated residential apartments
- Basement car parking

This assessment has been prepared considering the following documents:

- Manly Development Control Plan (DCP) 2013 – Amendment 11 as part of Northern Beaches Councils.
- NSW Environment Protection Authority (EPA) Noise Policy for Industry, 2016 (NPI 2016)
- Department of Planning (DoP) – Development near Rail Corridors and Busy Roads – Interim Guideline.
- NSW Road Noise Policy, 2011 (RNP 2011)
- AS/NZS 2107:2016: "Acoustics – Recommended design sound levels and reverberation times for building interiors"
- Bureau of Meteorology, Daily rainfall report.
- NSW Environment Protection Authority (EPA) Interim Construction Noise Guideline (ICNG July 2009).
- Assessing Vibration – A Technical Guideline (NSW AV-TG), issued February 2006 by the Department of Environment and Conservation NSW, now part of the NSW EPA.
- British Standard BS5228: Part 1:1997 "Noise and Vibration Control on Construction and Open Sites."
- British Standard BS7358:1993 "Evaluation and Measurement for Vibration in Buildings" – Part 2: "Guide to Damage Levels from Groundborne Vibration"
- German Standard DIN4150-Part 3 "Structural vibration in buildings – Effects on structures

This assessment discusses the likely noise impact of the proposed development upon the nearest most-affected receivers, as well as outlining mitigation measures for noise intruding into the development.

This report provides:

- A statement of compliance with the Manly Council acoustic requirements for the proposed residential development within the vicinity of the nearest potentially affected receivers
- Recommendations for noise mitigation measures for the proposed development in order to meet the relevant criteria

The work documented in this report was carried out in accordance with the Wood & Grieve Engineers Quality Assurance system, which is based on Australian Standard / NZS ISO 9001.

This report is based on our understanding of the proposed project, application of the relevant state guidelines and professional experience within the acoustic field. Therefore, this report shall not be relied upon as providing any warranties or guarantees.

2. Acoustic Issues

The following documentation has been used for the preparation of this report:

- Site drawings presenting the location of the proposed development in relation to the nearest receivers.
- Noise data collected on site through the use of a noise logger and a hand held spectrum analyser.
- Architectural drawings issued by Modularium dated 17/07/18

3. Project Overview

3.1 Site description

The proposed development is located at 195-197 Sydney Road, Fairlight, and is bound by Sydney Road to the North, and residential properties to the East, South and West. Across Sydney Road are predominantly residential properties with two commercial facilities. The site, locations of measurements and the nearest sensitive receivers are shown in in Figure 1 below.

Figure 1: Overview of the Site

Source: nearmap.com

3.2 Acoustic Issues

The acoustic issues relating to the development are as follows:

- Noise intrusion from vehicle movements on Sydney Road into the habitable spaces of the development
- Noise emissions from mechanical plant servicing the proposed development to the surrounding receivers
- Increased traffic noise associated with the proposed development affecting the surrounding receivers

4. Noise Survey

4.1 Instrumentation

The equipment used for the noise survey was the following:

- Hand-held sound spectrum analyser Brüel & Kjær Type 2250, S/N 2709742
- Brüel & Kjær Sound Calibrator, S/N 2709826
- ARL Environmental Noise Logger, NL-42X, S/N 873125

All equipment was calibrated before and after the measurements and no significant drift was found. All equipment carries current traceable calibration certificates that can be provided upon request.

4.2 Attended Noise Survey Results

Attended noise measurements of 15-minute duration were conducted on site to characterise the acoustic environment for noise intruding into the development and to determine any noise impacts on the surrounding receivers. A summary of the attended noise measurements taken in the vicinity of the proposed development site are shown in Figure 1. Refer to Table 1 for measurement locations.

Table 1: Summary of attended noise measurements

Measurement Location	Measurement Time	L_{Aeq} dB(A)	L_{A90} dB(A)	L_{Amax} dB(A)	Comments
P1	21/08/18 10:57	72	55	94	Dominated by traffic noise on Sydney Road

4.3 Unattended Noise Survey Results

4.3.1 Background and Ambient Noise Monitoring

This assessment will consider the method for determining the RBL background for each period of the day in accordance with the NSW Noise Policy for Industry. The NPI defines background and ambient noise for the daytime, evening and night periods as follows:

Day: defined as 7:00am to 6:00pm, Monday to Saturday and 8:00am to 6:00pm Sundays & Public Holidays.

Evening: defined as 6:00pm to 10:00pm, Monday to Sunday & Public Holidays.

Night: defined as 10:00pm to 7:00am, Monday to Saturday and 10:00pm to 8:00am Sundays & Public Holidays.

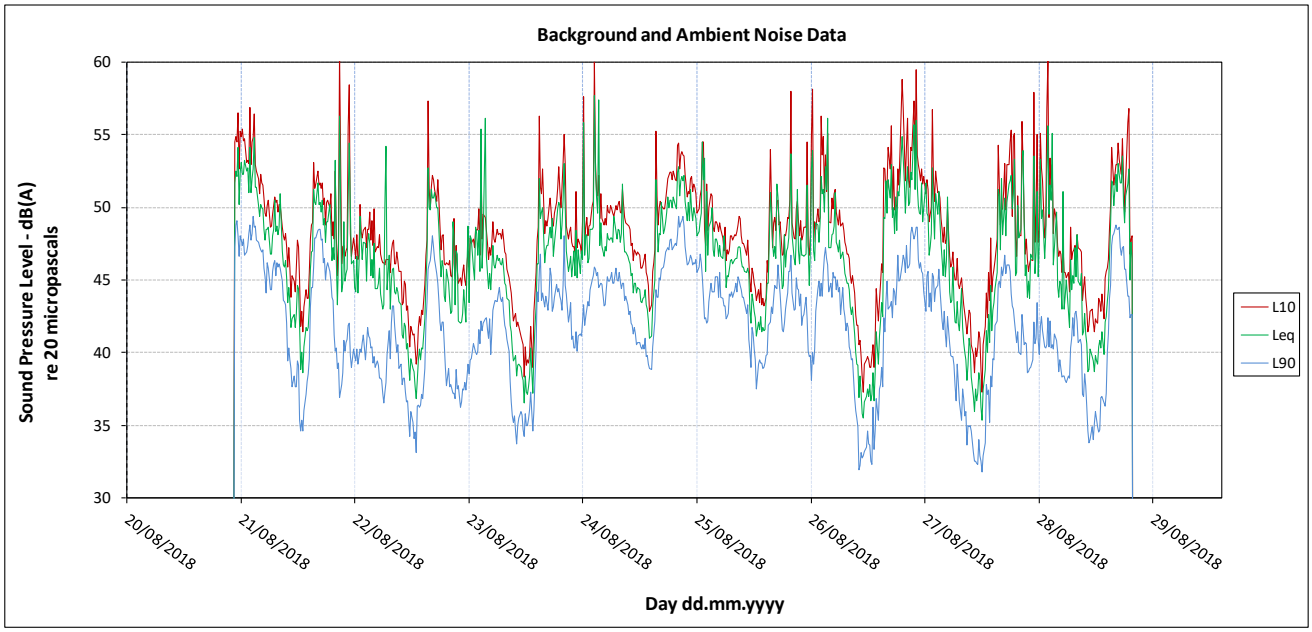
A noise logger was placed at position L1 as shown in Figure 2 to measure the background and ambient noise that is representative of the surrounding receivers. The noise logger was installed from the 21st of 29th of August 2018. Note that any extraneous data or rain-affected data has been excluded from the calculations.

Table 2: Unattended noise measurements - L1

Location	Equivalent Continuous Noise Level $L_{Aeq,period}$ - dB(A)			Background Noise Level RBL - dB(A)		
	Day	Evening	Night	Day	Evening	Night
L1	50	47	45	40	42	35

The local ambient noise environment is generally dominated by traffic noise throughout the majority of the day, evening and night periods. Refer to Figure 2 for the noise data.

Figure 2: Unattended background and ambient noise monitoring data



5. Noise Criteria

5.1 Internal Noise Levels

5.1.1 AS/NZS 2107:2016

In the absence of the internal noise criteria by Manly Development Control Plan (DCP) 2013, Australian Standard AS/NZS 2107:2016 – *'Acoustics- Recommended design sound levels and reverberation times for building interiors'* will be used to specify target noise levels for internal spaces to the development. Refer to Table 3 for the values corresponding to residential spaces near major roads.

Table 3: Recommended noise levels extracted from AS/NZS 2107:2016

Type of occupancy / activity	Design sound level L_{Aeq}, dB(A) range
Residential Buildings	
Apartment common areas (e.g. foyer, lift lobby)	45 to 50
Living areas	35 to 45
Sleeping areas (night time)	35 to 40
Work areas	35 to 45

5.2 External Noise Emissions

5.2.1 NSW Noise Policy for Industry (NPI)

In the absence of external noise emission criteria in Manly DCP 2013, the NPI sets out noise criteria to control the noise emission from industrial noise sources. The external noise due to mechanical services from the proposed development is also addressed following the guideline in the NSW EPA's NPI.

The calculation is based on the results of the ambient and background noise unattended monitoring, addressing two components:

- Controlling intrusive noise into nearby residences (Intrusiveness Criteria)
- Maintaining noise level amenity for particular land uses (Amenity Criteria)

Once both criteria are established, the most stringent for each considered assessment period (day, evening, night) is adopted as the project-specific noise level (PSNL).

Intrusiveness Criteria

The NSW EPA NPI states the following:

> *"The intrusiveness of an industrial noise source may generally be considered acceptable if the equivalent continuous (energy-average) A-weighted level of noise from the source (represented by the L_{Aeq} descriptor), measured over a 15-minute period, does not exceed the background noise level measured in the absence of the source by more than 5 dB(A)."*

The intrusiveness criterion can be summarised as follows:

$L_{Aeq,\ 15\ minute} \leq$ RBL background noise level + 5 dB(A)

The intrusiveness criterion for the closest residential receivers is presented in Figure 1 below. Note the values from L2 have been used in this assessment as they are the most relevant to define the background and ambient noise level of the residential receivers.

Table 4: EPA NPI Intrusiveness Criteria

Period	Noise Descriptor – dB(A)	Noise Criteria – Residential Receivers $L_{Aeq,15mins}$
Daytime 7am – 6pm	$L_{Aeq,15min} \leq$ RBL + 5	45
Evening 6pm – 10pm	$L_{Aeq,15min} \leq$ RBL + 5	47
Night 10pm – 7am	$L_{Aeq,15min} \leq$ RBL + 5	40

Amenity Criteria

The NSW NPI states the following:

> *"To limit continuing increases in noise levels from application of the intrusiveness level alone, the ambient noise level within an area from all industrial noise sources combined should remain below the recommended amenity noise levels specified in Table 2.2 where feasible and reasonable. The recommended amenity noise levels will protect against noise impacts such as speech interference, community annoyance and some sleep disturbance. The recommended amenity noise levels have been selected on the basis of studies that relate industrial noise to annoyance in communities (Miedema and Voss, 2004).*
>
> To ensure that industrial noise levels (existing plus new) remain within the recommended amenity noise levels for an area, a project amenity noise level applies for each new source of industrial noise as follows "Project amenity noise level for industrial developments = recommended amenity noise level (Table 2.2) minus 5 dB(A)"

The applicable parts of Table 2.2: Amenity noise levels which are relevant to the project are reproduced below:

Table 5: NSW NPI Table 2.2 amenity criteria for external noise levels

Type of Receiver	Noise Amenity Area	Time of Day	L_{Aeq}, dB(A)	Project amenity noise level $L_{Aeq, period}$
			Recommended amenity noise level	
Residential	Urban	Day	60	55
		Evening	50	45
		Night	45	40
Commercial	All	When in use	65	65

Urban area as defined in EPA NSW NPI Table 2.3

'Modifying Factor' Adjustments

The NSW NPI also states:

> *"Where a noise source contains certain characteristics, such as tonality, intermittency, irregularity or dominant low-frequency content, there is evidence to suggest that it can cause greater annoyance than other noise at the same noise level."*

In order to take into account the potential annoying character of the noise an adjustment of 5 dB(A) for each annoying character aspect and cumulative of up to a total of 10 dB(A), is to be added to the measured value to penalise the noise for its potentially greater annoyance aspect.

Table C1 of Fact Sheet C of the NSW NPI (see Table 6 below) provides procedures for determining whether an adjustment should be applied for greater annoyance aspect.

Table 6: Table C1 from the NSW NPI – Modifying factor corrections

Factor	Assessment / Measurement	When to Apply	Correction[1]	Comments
Tonal Noise	One-third octave band analysis using the objective method for assessing the audibility of tones in noise – simplified method *(ISO1996.2-2007 – Annex D)*.	Level of one-third octave band exceeds the level of the adjacent bands on both sides by: • 5 dB or more if the centre frequency of the band containing the tone is in the range 500–10,000 Hz • 8 dB or more if the centre frequency of the band containing the tone is in the range 160–400 Hz • 15 dB or more if the centre frequency of the band containing the tone is in the range 25–125 Hz.	5 dB[2,3]	Third octave measurements should be undertaken using unweighted or Z-weighted measurements. **Note**: Narrow-band analysis using the reference method in *ISO1996-2:2007, Annex C* may be required by the consent/regulatory authority where it appears that a tone is not being adequately identified, e.g. where it appears that the tonal energy is at or close to the third octave band limits of contiguous bands.
Low Frequency Noise	Measurement of source contribution C-weighted and A-weighted level and one-third octave measurements in the range 10–160 Hz	Measure/assess source contribution C- and A-weighted $L_{eq,T}$ levels over same time period. Correction to be applied where the C minus A level is 15dB or more and: • where any of the one-third octave noise levels in Table C2 are exceeded by up to and including 5 dB and cannot be mitigated, a 2dB(A) positive adjustment to measured/predicted A-weighted levels applies for the evening/night period • where any of the one-third octave noise levels in Table C2 are exceeded by more than 5 dB and cannot be mitigated, a 5-dB(A) positive adjustment to measured/predicted A-weighted levels applies for the evening/night period and a 2dB(A) positive adjustment applies for the daytime period.	2 or 5 dB[2]	A difference of 15 dB or more between C- and A-weighted measurements identifies the potential for an unbalance spectrum and potential increased annoyance. The values in Table C2 are derived from Moorhouse (2011) for DEFRA fluctuating low-frequency noise criteria with corrections to reflect external assessment locations.
Intermittent Noise	Subjectively assessed but should be assisted with measurement to gauge the extent of change in noise level.	The source noise heard at the receiver varies by more than 5 dB(A) and the intermittent nature of the noise is clearly audible.	5 dB	Adjustment to be applied for **night-time only.**
Duration	Single-event noise duration may range from 1.5 min to 2.5 h	One event in any assessment period.	0 to 20 dB(A)	The project noise trigger level may be increased by an adjustment depending on duration of noise (see Table C3).
Maximum Adjustment	Refer to individual modifying factors	Where two or more modifying factors are indicated	Maximum correction of 10dB(A)[2] (excluding duration correction)	

1. Corrections to be added to the measured or predicted levels, except in the case of duration where the adjustment is to be made to the criterion.

2. Where a source emits tonal and low-frequency noise, only one 5-dB correction should be applied if the tone is in the low-frequency range, that is, at or below 160 Hz.

3. Where narrow-band analysis using the reference method is required, as outlined in column 5, the correction will be determined by the ISO1996-2:2007 standard.

Sleep Disturbance

The NPI establishes sleep disturbance criteria for residential receivers in close proximity to industrial noise sources during the night-time period, such as vehicle movements and car door slams on private roads. The criteria for protecting the amenity of surrounding residential receivers in regards to sleep disturbance is:

- $L_{Aeq,15min}$ 40 dB(A) or prevailing RBL plus 5dB, whichever is greater, and/or
- L_{AFmax} 52 dB(A) or prevailing RBL plus 15dB, whichever is greater

Table 7 summarises the sleep disturbance criteria for the proposed development based on the LAmax assessment.

Table 7: Sleep Disturbance Criteria

Period	Sleep Disturbance Criteria (RBL + 15dB)
	L_{AFmax} dB(A)
Night (10:00pm to 7:00am)	50

5.2.2 Project Criteria

Refer to Table 8 for the NSW NPI criteria applicable to the mechanical and operational noise emissions from the proposed development. These project specific noise levels are in accordance with the requirements of the NSW NPI, and shall be assessed to the most affected point on or within the residential boundaries.

Table 8: Project noise trigger levels for industrial noise emissions

Period	Descriptor	PSNL dB(A)
Residential Receivers		
Day (7:00am to 6:00pm)	$L_{Aeq,15min}$	45
Evening (6:00pm to 10:00pm)	$L_{Aeq,15min}$	45
Night (10:00pm to 7:00am)	$L_{Aeq,15min}$	40
Commercial Receivers		
When in use	$L_{Aeq,15min}$	68

5.3 Traffic Noise Generation Criteria

The L_{Aeq} noise level or the "equivalent continuous noise level" correlates best with the human perception of annoyance associated with traffic noise.

Road traffic noise impact is assessed in accordance with the introduced NSW Road Noise Policy (Office of Environment and Heritage July 2011) which supersedes the *NSW Environmental Criteria for Road Traffic Noise* (ECRTN, Department of Environment Climate Change and Water 1999). The criterion (Table 3 – Road Traffic Noise Assessment Criteria for Residential Land Uses) divides land use developments into different categories and lists the respective criteria for each case. The category that is relevant to the proposed use of the site is shown below in Table 9.

Table 9: NSW Road Noise Policy – Traffic noise assessment criteria

Road Category	Type of project/land use	Assessment Criteria – dB(A)	
		Day (7am – 10pm)	Night (10pm – 7am)
Freeway/arterial/sub-arterial roads	Existing residences affected by additional traffic on existing freeways/arterial/sub-arterial roads generated by land use developments	$L_{Aeq,15\ hour}$ 60 (external)	$L_{Aeq,9\ hour}$ 55 (external)

In the event that the traffic noise at the site is already in excess of the criteria noted above, the NSW RNP states that the primary objective is to reduce the existing level through feasible and reasonable measures to meet the criteria above.

If this is not achievable, Section 3.4.1 Process for applying the criteria – Step 4 states that for existing residences affected by additional traffic on existing roads generated by land use developments, any increase in the total traffic noise should be limited to 2 dB above that of the corresponding 'no build option'.

5.4 Construction Noise Criteria

Noise criteria for construction sites are established in accordance with the Interim Construction Noise Guideline (ICNG July 2009) by the NSW Environment Protection Authority (EPA). It is important to note that the recommended criteria are for planning purposes only. Numerous other factors need to be considered when assessing potential noise impacts from construction works.

However, in undertaking the assessment of potential noise intrusion associated with the proposed construction activities, Chapter 4 of the NSW EPA ICNG (July 2009) were specifically referenced. The limits presented in Table 10 apply.

Table 10: NSW EPA ICNG Construction Noise Criteria

Time of Day	Management Level $L_{Aeq,15min}$ *	How to Apply
Recommended Standard Hours: Mon – Fri (7am – 6pm) Sat (8am – 1pm) No work on Sunday & Public Holidays	Noise Affected RBL + 10dB	The noise affected level represents the point above which there may be some community reaction to noise. • Where the predicted or measured $L_{Aeq,15min}$ is greater than the noise affected level, the proponent should apply all feasible and reasonable work practices to meet the noise affected level. • The proponent should also inform all potentially impacted residences of the nature of works to be carried out, the expected noise levels and duration as well as contact details.
	Highly Noise Affected 75 dB(A)	The highly noise affected level represents the point above which there may be strong community reaction to noise. • Where noise is above this level, the relevant authority (consent, determining or regulatory) may require respite periods by restricting the hours that the very noisy activities can occur in, taking into account: • Times identified by the community when they are less sensitive to noise (such as before and after school, for works near schools, or mid-morning or mid-afternoon for works near residences) • If the community is prepared to accept a longer period of construction in exchange for restrictions on construction times.
Outside Recommended Standard Hours	Noise Affected RBL + 5dB	• A strong justification would typically be required for works outside the recommended standard hours. • The proponent should apply all feasible and reasonable work practices to meet the noise affected level. • Where all feasible and reasonable practices have been applied and noise is more than 5 dB(A) above the noise affected level, the proponent should negotiate with the community. • For guidance on negotiating agreements see section 7.2.2.

Note: Noise levels apply at the property boundary that is most exposed to construction noise, and at a height of 1.5 m above ground level. If the property boundary is more than 30 m from the residence, the location for measuring or predicting noise levels is at the most noise-affected point within 30m of the residence. Noise levels may be higher at upper floors of the noise affected residence.

Source: Chapter 4 (Table 2 Sec 4.1.1) of NSW DECCW ICNG

5.5 Construction Vibration Criteria

The NSW Environment Protection Authority (EPA) developed a document, "Assessing vibration: A technical Guideline" in February 2006 to assist in preventing people from exposure to excessive vibration levels within buildings. The guideline does not however address vibration induced damage to structures or structure-borne noise effects. Vibration and its associated effects are usually classified as continuous, impulsive or intermittent.

5.5.1 Human Comfort – Continuous and Impulsive Vibration Criteria

Structural vibration in buildings can be detected by occupants and can affect them in many ways including reducing their quality of life and also their working efficiency. Complaint levels from occupants of buildings subject to vibration depend upon their use of the building and the time of the day.

Maximum allowable magnitudes of building vibration with respect to human response are shown in Table 11. It should be noted that the human comfort for vibration are more stringent than the building damage criteria.

Table 11: RMS values for continuous and impulsive vibration acceleration (m/s^2) 1-80Hz

Location	Assessment period[1]	Preferred values		Maximum values	
		z-axis	x- and y-axis	z-axis	x- and y-axis
Continuous vibration					
Residences	Daytime	0.010	0.0071	0.020	0.014
	Night time	0.007	0.005	0.014	0.010
Offices, schools, educational institutions and place of worship	Day or night time	0.020	0.014	0.040	0.028
Impulsive vibration					
Residences	Daytime	0.30	0.21	0.60	0.42
	Night time	0.10	0.071	0.20	0.14
Offices, schools, educational institutions and place of worship	Day or night time	0.64	0.46	1.28	0.92

Human Comfort – Intermittent Vibration Criteria

Disturbance caused by vibration will depend on its duration and its magnitude. This methodology of assessing intermittent vibration levels involves the calculation of a parameter called the Vibration Dose Value (VDV) which is used to evaluate the cumulative effects of intermittent vibration. Various studies support the fact that VDV assessment methods are far more accurate in assessing the level of disturbance than methods which is only based on the vibration magnitude.

Table 12: Acceptable Vibration Dose Values for Intermittent Vibration ($m/s^{1.75}$)

Location	Daytime (7:00am to 10:00pm)		Night-time (10:00pm to 7:00am)	
	Preferred value	Maximum value	Preferred value	Maximum value
Residences	0.20	0.40	0.13	0.26
Offices, schools, educational institutions and place of worship	0.40	0.80	0.40	0.80

5.5.2 Structural Damage – Vibration Criteria

Ground vibration criteria are defined in terms of levels of vibration emission from the construction activities which will avoid the risk of damaging surrounding buildings or structures. It should be noted that human comfort criteria are normally expressed in terms of acceleration whereas structural damage criteria are normally expressed in terms of velocity.

Most commonly specified structural vibration levels are defined to minimize the risk of cosmetic surface cracks and are set below the levels that have the potential to cause damage to the main structure. Structural damage criteria are presented in German Standard DIN4150-Part 3 "Structural vibration in buildings – Effects on structures" and British Standard BS7385-Part 2: 1993 "Evaluation and Measurement for Vibration in Buildings". Table 13 indicates the vibration limits presented in DIN4150-Part 3 to ensure structural damage doesn't occur.

Table 13: Guideline value of vibration velocity, vi, for evaluating the effects of short-term vibration

Line	Type of Structure	Vibration velocity, vi, in mm/s			
		Foundation			Plane of floor of uppermost full storey
		At a frequency of			
		Less than 10Hz	10 to 50Hz	50 to 100*Hz	All Frequencies
1	Buildings used for commercial purposes, industrial buildings and buildings of similar design	20	20 to 40	40 to 50	40
2	Dwellings and buildings of similar design and/or use	5	5 to 15	15 to 20	15
3	Structures that, because of their particular sensitivity to vibration, do not correspond to those listed in lines 1 and 2 and are of great intrinsic value (e.g. buildings that are under a preservation order)	3	3 to 8	8 to 10	8
*For frequencies above 100Hz, at least the values specified in this column shall be applied					

Table 14 presents guide values for building vibration, based on the lowest vibration levels above which cosmetic damage has been demonstrated as per BS7385-Part 2:1993.

Table 14: Transient vibration guide values for cosmetic damage

Type of Building	Peak Particle Velocity in frequency range of predominant pulse (PPV)	
Residential or light commercial type buildings	4 Hz to 15 Hz	15 Hz and above
	15mm/s at 4Hz increasing to 20mm/s at 15Hz	20mm/s at 15Hz increasing to 50mm/s at 40Hz and above

5.5.3 Construction Vibration Objectives

Table 15 indicates the construction vibration criteria applicable to the residential and commercial properties surrounding the site.

Table 15: Construction and train vibration criteria summary

Location	Period	Human Comfort Vibration Objectives			Building damage Objectives – Velocity (mm/s)
		Continuous mm/s^2 (RMS)		Intermittent mm/s$^{1.75}$ (VDV)	
		z-axis	x- and y-axis		
Residential	Day time	10 - 20	7 - 14	0.20 - 0.40	5
	Night time	7 - 14	5 - 10	0.13 - 0.26	5
Commercial	Any time	20 - 40	14 - 28	0.40 – 0.80	20

6. Noise Impact Assessment

6.1 External Glazing

The general limiting factor of the performance of a building façade in term of noise attenuation is the glazing. In this particular case of the proposed development, the traffic from Sydney Road places the greatest demand on the glazing for the development. Based on the measurements conducted, the glazing to the facades has been proposed in order to achieve the internal noise goals as recommended in AS2107.

The ratings presented are based on the worst case scenario of external noise obtained from the noise measurements. The glazing thicknesses corresponding to the Rw ratings are presented below in Table 16, and should be considered as the minimum thicknesses to achieve acoustical ratings. Greater glazing thicknesses may be required for structural loading, wind loading, thermal requirements etc. All

Table 16: Required acoustic performance of glazing systems

Level	Facade	Space	Fixed Single Glazed System	Fixed Double Glazed System	Required Acoustic Rating of Glazing Assembly, R_w
1-3	North, East, West (Northern Block)	All	12.38mm laminated glass	10mm float / 12mm air gap / 6mm float	37
4	North, East, West (Northern Block)	All	10.38mm laminated glass	10mm float / 12 air gap / 4mm float	35
All	South (Northern Block)	All	6.38mm laminated glass	6mm float / 12mm air gap /6.38mm laminated	32
All	All (Southern Block)	All	6.38mm laminated glass	6mm float / 12mm air gap /6.38mm laminated	32
Level 1	All	Communal space	6.38mm laminated glass	6mm float / 12mm air gap /6.38mm laminated	32
Note: The required acoustic rating of glazing assembly, refers to the acoustic performance of the glazing once installed on site (including the frame)					

During the detailed design stage of the project the acoustic performance of the glazing facade should be reviewed as the combined noise from external sources and mechanical services could result in the internal noise level exceeding the design sound level ($L_{Aeq,T}$ dBA).

6.2 Site Noise Emissions

6.2.1 Mechanical Noise Emissions

As the development is proposed to be naturally ventilated, the main mechanical noise emissions will be associated with the car park at the rear/south of the site and the ventilation scheme. The main mechanical sources associated with the development will include:

- Carpark exhaust and supply fan

In order to assess the worst case scenario, it was assumed that all mechanical plant is running at any time throughout a 24hr period. The noise emissions from the units have been calculated to the most affected residential receiver facades. With all, the night time is the most stringent period for the noise generated by the operation of mechanical plant; therefore, this criterion was used as the noise target at the boundary of the nearest sensitive receivers for the project.

Proposed Noise Levels

Table 17 presents the proposed sound power level for the carpark fans to achieve the noise criteria at the nearest receivers. Based on these levels and the acoustic mitigation measures as detailed in the following sections, the noise emissions from the development are expected to comply with the noise criteria.

Table 17: Proposed sound power levels dB(A)

Item	SWL re 1pW (dB)								
	63 Hz	125 Hz	250 Hz	500 Hz	1 kHz	2 kHz	4 kHz	8 kHz	Overall dB(A)
Carpark exhaust fan	81	79	80	81	80	79	75	68	85
Carpark supply fan	71	69	70	71	70	69	65	58	75

It is our opinion that the project specific noise levels at the boundaries of the surrounding receivers should be met if the requirements of Table 17 are satisfied and acoustic mitigation measures implemented. Note that this is a preliminary solution as the design is yet to be finalised; it is recommended that an updated acoustic report is conducted at a later juncture when more detailed information becomes available through further design.

Acoustic Mitigation Measures

The following acoustic mitigation measures are required to achieve compliance during the night time:

- Acoustic treatment will be required to the carpark exhaust fan such as an acoustic attenuator and/or 50mm internally lined straight duct and 90 degree elbow to the discharge side
- Acoustic treatment will be required to the carpark supply fan such as 50mm internally lined straight duct work and 90 degree elbow to the intake side

Further amelioration measures for the mechanical plant are to be considered during the design development stage so as to comply with the criteria outlined in Section 5. These amelioration measures could include but not limited to the following:

- Positioning and orientating mechanical plant away from nearby receivers
- Acoustic attenuators fitted to duct work
- Screening around mechanical plant
- Acoustic insulation within duct work

6.3 Service Vehicles Noise Assessment

An acoustic assessment for waste collection has been conducted to determine the noise levels to the nearest noise sensitive locations. The noise levels used within the assessment are shown below in Table 18. Note that the assessment was conducted at 1.5m above ground as per the NSW NPI.

Table 18: Typical sound power levels of service vehicles

Noise Source	Typical SWL, dB(A)
Garbage truck unloading bins	99

The noise emissions have been calculated to the nearest noise affected receiver Table 19. The following assumptions have been made:

- All service trucks including waste collection will be restricted to entering and exiting and operating during the day time period (7:00am – 6:00pm)
- Perforated roller door for natural ventilation
- No other openings in the basement

Table 19: Predicted noise levels

Receiver Location	Predicted Noise Level $L_{Aeq,15min}$ - dB(A)	Day time criteria $L_{Aeq,15min}$ - dB(A)	Compliance (Yes/No)
Nearest noise-affected premises	43	45	Yes

Based on this assessment, and provided the acoustic mitigation measures as detailed below are implemented, the noise emissions form the operation of waste collection on site is expected to meet the requirements of the NSW NPI.

6.3.1 Acoustic mitigation measures

The following acoustic mitigation measures are proposed to achieve compliance with the NSW NPI for garbage truck operation:

- The carpark roller door should be closed during waste collection activities. A perforated roller door may be used for ventilation with a maximum free area of 30%.

6.4 Traffic Noise Generation Assessment

For the road traffic noise assessment, as the development would provide approximately 75 apartments on total, the traffic generation would be considered to be negligible in comparison to the existing traffic flow on Sydney Road, as it is a state road with arterial function. As such, the development is not expected to result in a 2dB increase in noise levels due to traffic increase or an exceedance of the NSW Road Noise Policy criteria.

6.5 Communal Areas

The communal area within the development should be operated in a manner which does not cause any noise amenity impacts to the surrounding residences. General management measures should be applied in the form of the following:

- Restrictions on time of use particularly during the night time and early morning
- Restrictions on use of amplified music
- Limiting the number of people

7. Conclusion

An acoustic assessment for the proposed residential development located 195-197 Sydney Road, Fairlight, has been conducted. This document forms part of the documentation package to be submitted to local authorities as part of the Development Application process.

This report has provided criteria, in-principle treatment and design requirements which aim to achieve the statutory criteria discussed in Section 5. In terms of noise criteria, we have provided the following:

- Noise criteria for internal noise levels according to AS/NZS 2107:2016 in Section 5.1;
- Noise criteria for emissions from the development to receivers in accordance with the NSW NPI in Section 5.2;
- Traffic noise criteria for additional vehicle movements as per the NSW RNP in Section 5.3; and
- Construction noise and vibration criteria in Sections 5.4 and 5.5.

Glazing for the residential spaces within the proposed development has been designed to achieve internal noise levels in accordance with the recommended levels from AS 2107:2016. The glazing recommendations are presented in Section 6.1.

Maximum sound power levels for the carpark exhaust and supply fans has been provided including acoustic mitigation measures in order to meet the requirements of the NSW NPI at the most affected residential receivers.

Due to the relatively low number of vehicles that will be generated by the development, and the existing capacity on Sydney Road, there is not expected to be any noise amenity issues associated with traffic generation and the development should comply with the NSW RNP in regards to traffic noise increase.

The noise emissions from waste collection within the basement have been assessed. Acoustic mitigation measures have been provided for compliance with day time noise criteria.

Even though no assessment can be considered as being thorough enough to preclude all potential environmental impacts, having given regard to the above listed conclusions, it is the finding of this assessment that the development application should not be refused on the grounds of excessive noise generation, as it can comply with all applicable regulations.

The information presented in this report shall be reviewed if any modifications to the features of the development specified in this report occur, including and not restricted to selection of air-conditioning units, layout of equipment, modifications to the building and introduction of any additional noise sources.

APPENDIX A Glossary of Acoustic Terms

NOISE	
Acceptable Noise Level:	The acceptable LAeq noise level from industrial sources, recommended by the EPA (Table 2.1, INP). Note that this noise level refers to all industrial sources at the receiver location, and not only noise due to a specific project under consideration.
Adverse Weather:	Weather conditions that affect noise (wind and temperature inversions) that occur at a particular site for a significant period of time. The previous conditions are for wind occurring more than 30% of the time in any assessment period in any season and/or for temperature inversions occurring more than 30% of the nights in winter).
Acoustic Barrier:	Solid walls or partitions, solid fences, earth mounds, earth berms, buildings, etc. used to reduce noise.
Ambient Noise:	The all-encompassing noise associated within a given environment at a given time, usually composed of sound from all sources near and far.
Assessment Period:	The period in a day over which assessments are made.
Assessment Location	The position at which noise measurements are undertaken or estimated.
Background Noise:	Background noise is the term used to describe the underlying level of noise present in the ambient noise, measured in the absence of the noise under investigation, when extraneous noise is removed. It is described as the average of the minimum noise levels measured on a sound level meter and is measured statistically as the A-weighted noise level exceeded for ninety percent of a sample period. This is represented as the L90 noise level.
Decibel [dB]:	The units of sound pressure level.
dB(A):	A-weighted decibels. Noise measured using the A filter.
Extraneous Noise:	Noise resulting from activities that are not typical of the area. Atypical activities include construction, and traffic generated by holidays period and by special events such as concert or sporting events. Normal daily traffic is not considered to be extraneous.
Free Field:	An environment in which there are no acoustic reflective surfaces. Free field noise measurements are carried out outdoors at least 3.5m from any acoustic reflecting structures other than the ground
Frequency:	Frequency is synonymous to pitch. Frequency or pitch can be measured on a scale in units of Hertz (Hz).
Impulsive Noise:	Noise having a high peak of short duration or a sequence of such peaks. A sequence of impulses in rapid succession is termed repetitive impulsive noise.
Intermittent Noise:	Level that drops to the background noise level several times during the period of

	observation.
LAmax	The maximum A-weighted sound pressure level measured over a period.
LAmin	The minimum A-weighted sound pressure level measured over a period.
LA1	The A-weighted sound pressure level that is exceeded for 1% of the time for which the sound is measured.
LA10	The A-weighted sound pressure level that is exceeded for 10% of the time for which the sound is measured.
LA90	The A-weighted level of noise exceeded for 90% of the time. The bottom 10% of the sample is the L90 noise level expressed in units of dB(A).
LAeq	The A-weighted "equivalent noise level" is the summation of noise events and integrated over a selected period of time.
LAeqT	The constant A-weighted sound which has the same energy as the fluctuating sound of the traffic, averaged over time T.
Reflection:	Sound wave changed in direction of propagation due to a solid object met on its path.
R-w:	The Sound Insulation Rating R-w is a measure of the noise reduction performance of the partition.
SEL:	Sound Exposure Level is the constant sound level which, if maintained for a period of 1 second would have the same acoustic energy as the measured noise event. SEL noise measurements are useful as they can be converted to obtain Leq sound levels over any period of time and can be used for predicting noise at various locations.
Sound Absorption:	The ability of a material to absorb sound energy through its conversion into thermal energy.
Sound Level Meter:	An instrument consisting of a microphone, amplifier and indicating device, having a declared performance and designed to measure sound pressure levels.
Sound Pressure Level:	The level of noise, usually expressed in decibels, as measured by a standard sound level meter with a microphone.
Sound Power Level:	Ten times the logarithm to the base 10 of the ratio of the sound power of the source to the reference sound power.
Tonal noise:	Containing a prominent frequency and characterised by a definite pitch.