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3 ELLIS STREET, CHATSWOOD

Acoustic Assessment for Planning Proposal - Proposed Mixed-Use Development

22 October 2021

MPG AU Pty Ltd

TL504-01F02 Acoustic Assessment (r2)

35 1982-2017 ACOUSTIC ENGINEERING EXCELLENCE

Sydney Melbourne Brisbane Gold Coast Kuwait Singapore
Renzo Tonin & Associates ABN 29 117 462 861
Level 1/418A Elizabeth St SURRY HILLS NSW 2010 | PO Box 877 STRAWBERRY HILLS NSW 2012
P (02) 8218 0500 F (02) 8218 0501 sydney@renzotonin.com.au www.renzotonin.com.au

aaac Association of Australian Acoustical Consultants

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Address:	PO Box R1639, Royal Exchange NSW 1225
Attention:	Wesley Chong

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1 Introduction

Renzo Tonin & Associates was engaged to undertake a preliminary acoustic assessment of a proposed mixed-use development at 3 Ellis Street, Chatswood to be submitted to Willoughby Council as part of a Planning Proposal. The purpose of the assessment is to assess noise and vibration impacts onto the subject site from the nearby T1/T9 North Shore, Northern & Western Line rail corridor; and potential noise emissions from the use of the mixed use development on neighbours (base building only – the assessment of noise emissions from use of the commercial space would be the responsibility of the tenant, for their DA for the use of the tenancy/tenancies).

Due to the impacts of COVID-19 restrictions, the current acoustic environment does not represent typical operations. This is particularly marked in Town Centres and areas adjoining (such as the subject site); and in the usage of public transport. Passenger volumes on the rail network are currently a fraction of the "normal" levels. As such, the current acoustic environment is not suitable for either long term unattended noise monitoring for background noise or rail noise; or for the measurement of rail induced vibration at the subject site.

As such, Renzo Tonin & Associates have reviewed file data from a previous project (monitoring conducted in May 2018) along the North Shore Rail Line to determine indicative noise levels at the subject site and associated controls to the building for compliance with the airborne internal noise goals of the State Environmental Planning Policy (Infrastructure) 2007 and associated Department of Planning *Developments Near Rail Corridors And Busy Roads: Interim Guideline*, 2008. The rail noise levels are indicative only, and on-site monitoring shall be undertaken on the site during the detailed design phase (between Development Application and Construction Certificate stage).

The nearest track is approximately 20m from the South East corner of the site. As such, rail vibration measurements shall be undertaken on the site during the detailed design phase (between Development Application and Construction Certificate stage), once the rail passenger volumes are more representative of "normal" operations. In terms of vibration, it is not appropriate to refer to the data previously obtained by Renzo Tonin & Associates due to the differences in typology between the two sites.

The following architectural drawing set issued by MGA Architects dated July 2021 were reviewed as part of this assessment.

The work documented in this report was carried out in accordance with the Renzo Tonin & Associates Quality Assurance System, which is based on Australian Standard / NZS ISO 9001. Appendix A contains a glossary of acoustic terms used in this report.

2 Site and surrounds

The site is located at 3 Ellis Street, Chatswood and is currently occupied by three-storeys of residential apartments with undercroft parking beneath. The proposed development consists of a mixed-use building comprised of 12-sotey residential apartments over a two level podium allocated for commercial tenancies and four basement levels for car parking and service vehicle access. Refer to Figure 1 overleaf.

The site is situated to the West of the T1 North Shore, Northern & Western Line rail corridor, being separated from that corridor by approximately 15-25m (that space comprising of the driveway for the adjacent residential flat building and Frank Channon Walk).

The site is bound by Ellis Street to the South and existing residential developments to the North, East and West. In the region of the site, a transparent noise wall has been installed along the edge of the rail corridor, which would provide some acoustic screening to the lower levels of the development.

Due to COVID-19, on site noise and vibration monitoring at this time is not appropriate. Long-term noise monitoring of rail noise from the T1 corridor was conducted for a previous study. Data from that study has been used to determine indicative levels at the subject site (for confirmation at DA/CC).

Figure 1: Aerial View of Subject Site and Surrounds

3 Rail noise survey

Renzo Tonin & Associates previously undertook an acoustic assessment for another site proximate to the T1/T9 rail corridor at Chatswood. As part of that study, long term unattended noise monitoring was undertaken in May 2018 along the T1/T9 stretch between Ashley Street and O'Brien Street at a location with direct line of site to all 4 above ground tracks and with a setback distance of approximately 9m to the nearest track.

The noise monitor recorded noise levels on a continuous basis and stored data every fifteen minutes. The monitors were calibrated before and after measurements and no significant deviation in calibration was noted. The noise monitoring equipment used here complies with Australian Standard 1259.2-1990 "Acoustics - Sound Level Meters" and is designated as Type 2 instruments suitable for field use.

Detailed results of the rail noise monitoring undertaken on the prior site are presented in Table 1. Indicative levels have been predicted to the façade of the proposed building, based on the additional distance from the nearside track (note: on site monitoring of rail noise impacts shall be undertaken for DA/CC, once the impacts of COVID-19 have normalised).

3.1 Results of unattended noise monitoring

3.1.1 Rail noise

The design rail noise levels are taken from the representative L_{Aeq} for the week for both the day time (7am to 10pm) and night time (10pm-7am) periods. The indicative predicted external rail noise levels are presented Table 1 below.

Table 1: Indicative Predicted Day and Night Rail Noise Levels

Monitoring Location	Survey Period	Predicted Noise Level $L_{eq,\,T}$ [1,2]
Eastern side of the site facing the rail corridor with direct line of sight.	Day time (7am to 10pm)	69
	Night time (10pm to 7am)	65
South-Eastern façade with 90 degrees angle of view to rail	Day time (7am to 10pm)	66
	Night time (10pm to 7am)	62
North-Western façade with less than 45 degrees angle of view	Day time (7am to 10pm)	63*
	Night time (10pm to 7am)	59*

Notes:

1. Noise levels presented are facade corrected values.
2. Representative external noise levels in measured L_{Aeq} over 15 hour and 9 hour day and night period respectively.

3.1.2 Background noise

Due to the proximity of the site to Chatswood Town Centre (being 150m from Chatswood Station, in a zoning permitting mixed use, with neighbours zoned R4 and in proximity to the railway corridor), it is not appropriate to undertake long term unattended background noise monitoring at this time due to

the impacts of COVID-19 restrictions (based on current NSW Roadmap to Recovery, this should be resolved from the 1st of December 2021). Traffic and rail movements are different from typical at this time as are the operations of retail and commercial premises, including restaurants, cafes and public houses. On site monitoring shall be undertaken, once the environment has returned to "normal", preferably for Development Application but by Construction Certificate stage at the latest.

AS1055.3-1997 Appendix A provides assumed background noise levels for residential receivers, in the absence of on-site noise monitoring. Whilst AS1055.3-1997 was superseded by AS1055-2018, the updated Standard did not include approximations for background noise levels (the intention being that they should be measured). Given that accurate background noise levels cannot be measured at this time, the AS1055.3-1997 Appendix A assumed backgrounds shall be used to undertake preliminary assessment until such time as on-site monitoring can be undertaken (for DA or CC as appropriate). In accordance with AS1055.3-1997 Appendix A, the residential receivers surrounding the subject site would be classified as R3 "Areas with medium density transportation or some commerce or industry".

Based on the AS1055.3-1997 Appendix A "R3" assumed background noise levels, the assumed background noise levels at the subject site are presented in Table 2 below.

Table 2: AS1055.3-1997 Assumed Background Noise Level

Location	Representative Background Noise Levels in dB(A) L_{A90}		
	Day[1]	Evening[2]	Night[3]
AS1055.3-1997 Residential Receiver Type "R3" - Areas with medium density transportation or some commerce or industry	50	45	40

Notes:

Day, Evening & Night assessment periods are defined in accordance NSW EPA's NPfI as follows.

1. Day is defined as 7:00am to 6:00pm, Monday to Saturday; 8:00am to 6:00pm Sundays & Public Holidays. As results were affected by construction noise weekend day and Saturday morning, Sunday results have been presented for the Day time period
2. Evening is defined as 6:00pm to 10:00pm, Monday to Sunday & Public Holidays
3. Night is defined as 10:00pm to 7:00am, Monday to Saturday; 10:00pm to 8:00am Sundays & Public Holidays

The representative background noise levels (L_{A90}) are used in defining external noise emission from the development such as mechanical ventilation and air-conditioning systems in accordance to the EPA Noise Policy for Industry.

4 Noise intrusion assessment

4.1 Criteria

The Standards, Government Policies, Guidelines and Council Development Control Plans (DCP) relevant to this development are as follows:

1. Willoughby City Council DCP 2006
2. State Environment Planning Policy (Infrastructure) 2007 (ISEPP)
3. Department of Planning (DoP) publication "Development Near Rail Corridors & Busy Roads – Interim Guideline" 2008 (DoP Guideline)
4. Australian Standard AS2107:2016 for commercial spaces (non-mandatory)

In accordance with the Willoughby Council DCP, design internal noise levels are required to be in accordance with the ISEPP and DoP Guideline. As such, the project internal noise goals for the residential portion of the development are outlined in Table 3 below.

Table 3: Recommended Internal Noise Criteria for Rail Noise

Type of Occupancy	Windows Condition	Design Noise Level	
		Day, $L_{Aeq\ (15hour)}$	Night, $L_{Aeq\ (9hour)}$
Bedrooms	Closed	-	35dB(A)
	Open*	-	45dB(A)
Open-plan Living/Dining/Kitchen	Closed	40dB(A)	40dB(A)
	Open*	50dB(A)	50dB(A)

*Window open to approximately 5% of the floor area of the room, to enable natural ventilation of the space.

In consideration of the comfort of future occupants, a design internal noise goal of 45dB(A) is set for the commercial portion, which would permit a range of general uses in accordance with AS2107:2016. Sensitive commercial uses would require a particular assessment, but that would typically be the responsibility of the future tenant.

Table 4 - Design internal noise goal for commercial space

Type of Occupancy	Windows Condition	Design Noise Level
		Day, $L_{Aeq\ (15hour)}$
Commercial	Closed	45dB(A) (when in use)

4.2 Calculated internal noise levels from rail traffic

Results from the previous long-term noise survey were used to predict indicative levels at the future facades on the subject site. Those predicted levels were used to calculate internal rail noise levels within the proposed development. Noise calculations and predications were conducted using the Outside-In

Glazing Spreadsheet developed in this office which takes into account external ambient noise levels, facade transmission loss and room sound absorption characteristics. Noise levels were calculated for each building facade to account for any variation in the external noise levels affecting different parts of the building.

External facade and glazing constructions required to comply with the project noise criteria outlined in Table 3 above are presented in Section 4.3 below. Note that these do not take into account traffic noise on Ellis Street or Albert Ave, which could add to the environmental noise at the façade. Treatments are indicative only and shall be reviewed for DA/CC based off site measured data.

4.3 Glazing design requirements

Table 5 below presents recommended glazing treatment for the building facades to achieve compliance with the maximum noise levels nominated in Table 3 above. For simplicity, the facades shall be referenced as follows: East is facing the railway line, South is facing Ellis Street, West is facing 7-13 Ellis Street and North is facing 88 Albert Ave.

Table 5: Recommended Glazing Treatment

Level	Facade	Occupancy Type	Recommended Minimum Sound Insulation Rating of Glazing Assembly	Typical Compliance Glazing Configuration	Laboratory Test Reference
Ground / Level 1	East, South	Commercial	R_w 32	Single laminated glass, indicatively 6.38mm laminated	ESTIMATE
	North, West	Commercial	R_w 30	Single laminated glass, indicatively 6mm Float	ESTIMATE
2 (assuming screening from noise wall)	East, South	Bedroom	R_w 32	Single laminated glass, indicatively 6.38mm laminated	ESTIMATE
		Living/Dining/Kitchen	R_w 32	Single laminated glass, indicatively 6.38mm laminated	ESTIMATE
	North, West	Living/Dining/Kitchen	R_w 30	Single laminated glass, indicatively 6mm Float	ESTIMATE
		Bedroom	R_w 30	Single laminated glass, indicatively 6mm Float	ESTIMATE
3 to 12 (including loft)	East, South	Bedroom	R_w 35	Single laminated glass indicatively 10.38mm laminated	ESTIMATE
		Living/Dining/Kitchen	R_w 35	Single laminated glass indicatively 10.38mm laminated	ESTIMATE
	North	Living/Dining/Kitchen	R_w 32	Single laminated glass, indicatively 6.38mm laminated	ESTIMATE
		Bedroom	R_w 32	Single laminated glass, indicatively 6.38mm laminated	ESTIMATE
	West	Living/Dining/Kitchen	R_w 32	Single laminated glass, indicatively 6.38mm laminated	ESTIMATE
		Bedroom	R_w 32	Single laminated glass, indicatively 6.38mm laminated	ESTIMATE

Level	Facade	Occupancy Type	Recommended Minimum Sound Insulation Rating of Glazing Assembly	Typical Compliance Glazing Configuration	Laboratory Test Reference
By way of explanation, the Sound Insulation Rating Rw is a measure of the noise reduction property of the partition, a higher rating implying a higher sound reduction performance.					
Note that the Rw rating of systems measured as built on site (R'w Field Test) may be up to 5 points lower than the laboratory result.					
LEGEND where no appropriate test certificate exists:					
1. ESTIMATE: The client is advised not to commence detailing or otherwise commit to partition construction systems which have not been tested in an approved laboratory or for which an opinion only is available. Testing of partition construction systems is a component of the quality control of the design process and should be viewed as a priority because there is no guarantee the forecast results will be achieved thereby necessitating the use of an alternative which may affect the cost and timing of the project. No responsibility is taken for use of or reliance upon untested partition construction systems, estimates or opinions. The advice provided here is in respect of acoustics only.					
2. ESTIMATE – APPROVED FOR CONSTRUCTION: Use of the form of construction is approved prior to laboratory certification. To complete the quality control of the design process and confirm the acoustical performance of the construction, we recommend testing in a laboratory to confirm the Rw rating as soon as practicable. In the case of impact rating for floor systems, no particular impact rating is guaranteed to comply with either the Building Code of Australia or Strata Scheme Management Act and hence carpet runners may still be required.					
3. ESTIMATE – TEST NOT REQUIRED: Use of the form of construction is approved without laboratory certification. The STC/Rw of the form of construction exceeds the project requirements.					
4. The advice provided here is in respect of acoustics only. Supplementary professional advice may need to be sought in respect of fire ratings, structural design, buildability, fitness for purpose and the like.					
NOTES FOR GLAZING CONSTRUCTIONS:					
5. The information in this table is provided for the purpose of Council approvals process and cost planning and shall not be used for construction unless otherwise approved in writing by the acoustic consultant.					
6. The design in this table is preliminary and a comprehensive assessment shall be conducted prior to Construction Certification.					
7. Before committing to any form of construction or committing to any builder, advice should be sought from an acoustic consultant to ensure that adequate provisions are made for any variations which may occur as a result of changes to the form of construction where only an "estimate" is available for the sound insulation properties of recommended materials.					
8. The glazing supplier shall ensure that installation techniques will not diminish the Rw performance of the glazing when installed on site.					
9. All openable glass windows and doors shall incorporate full perimeter acoustic seals equivalent to Q-Lon, which enable the Rw rating performance of the glazing to not be reduced.					
10. The above glazing thicknesses should be considered the minimum thicknesses to achieve acoustical ratings. Greater glazing thicknesses may be required for structural loading, wind loading etc.					
GENERAL					
11. The sealing of all gaps in partitions is critical in a sound rated construction. Use only sealer approved by the acoustic consultant.					
12. Check design of all junction details with acoustic consultant prior to construction.					
13. Check the necessity for HOLD POINTS with the acoustic consultant to ensure that all building details have been correctly interpreted and constructed.					
14. The information provided in this table is subject to modification and review without notice.					
15. The advice provided here is in respect of acoustics only. Supplementary professional advice may need to be sought in respect of fire ratings, structural design, buildability, fitness for purpose and the like.					

4.4 Facade and roof sound insulation

In principle advice is provided below for the acoustic requirements of the roof and external walls for this proposed development.

4.4.1 External Walls

The dominant path of external noise ingress into building interior is via window and doors. Assessment and recommendations regarding external noise intrusion has accordingly been made with respect to the windows and doors. It is therefore recommended that the external walls have a sound isolation rating

(R_w) at least 15dB higher than that of the glazing specified in Table 5 above, to maintain the acoustic integrity of the overall facade system.

4.4.2 Roof and Ceiling

Similar to the external wall design, the roof/ceiling construction can generally provide acoustic performances well in excess of glazing or doors. The roof construction should have a sound isolation rating (R_w) at least 10dB higher than that of the glazing on its facade.

4.5 Ventilation

In accordance with the Department of Planning publication "Development Near Rail Corridors & Busy Roads – Interim Guideline" 2008:

If internal noise levels with windows or doors open exceed the criteria by more than 10dBA, the design of the ventilation for these rooms should be such that occupants can leave windows closed, if they so desire, and also to meet the ventilation requirements of the Building Code of Australia

Based on the preliminary study, external noise levels are such that on the east, north and western façades, suitable internal noise levels are achieved only when the windows are closed.

As required by the Dept Planning Guideline, supplementary ventilation to those apartments should be provided to meet BCA requirements subject to detailed design. Note: this is also pending the results of on site monitoring to be undertaken in future stages.

5 Rail vibration assessment

5.1 Criteria

5.1.1 Regenerated noise

The Department of Planning's "Development near Rail Corridors & Busy Roads – Interim Guideline" 2008 (DoP Guideline) provides recommended criteria for ground-borne or regenerated rail noise. Table 6 summaries these noise limits for sleeping and living spaces.

Table 6: Recommended Internal Noise Criteria for Regenerated Rail Noise

Occupancy	Period	L_{Amax} Noise Limit [1]
Sleeping areas (Bedrooms)	10pm – 7am	35 dB(A)
Other habitable rooms (excluding garages, kitchens, bathrooms and hallways)	At any time	40 dB(A)

Notes:

1. L_{Amax} – is the-weighted maximum sound pressure level measures using a "slow" response time

5.1.2 Rail tactile vibration

Section 3.6.3 of the DoP Guideline provides recommended vibration criteria in accordance with the following documents:

1. Department of Environment and Conservation 2006 publication "Assessing Vibration: a technical guideline" (DEC Guideline)
2. German Standard DIN 4150 Part 3 1992
3. British Standard BS 7385 Part 2 1993
4. Australian Standard AS 2670.2 1990

The above documents have been reviewed and the criteria for assessment tactile vibration from train pass-bys affecting the proposed development is quantified in accordance with:

- Assessing Vibration: A technical guideline (Department of Environment and Conservation, 2006)
- British Standard BS6472:1992 "Evaluation of Human Exposure to Vibration in Buildings (1Hz to 80Hz)"

The criteria curves presented in BS6472:1992 are identical to those in Australian Standard AS2670.2 1990 and the International Standard 2631-2:1989.

Criteria for continuous vibration from the British Standard BS6472:1992 for residential spaces, offices and commercial workshop environments are shown in Figure 2 below.

Figure 2: Tactile Vibration Criteria for Residential Buildings

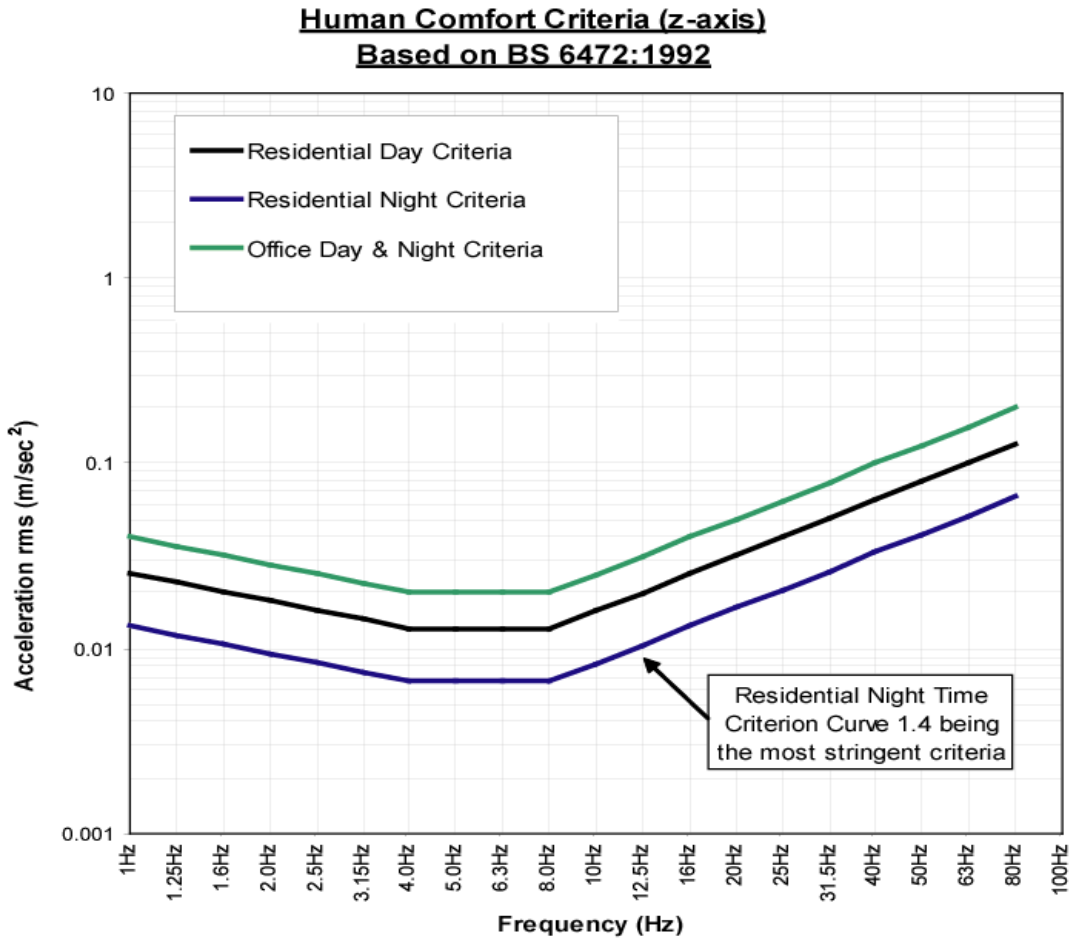

Table 2.4 of the DEC Guideline presents acceptable vibration dose values for intermittent vibration. Table 7 below outlines DEC's requirements.

Table 7: Acceptable VDVs for intermittent vibration in residential buildings m/s$^{1.75}$

Location	Period	Preferred VDV m/s$^{1.75}$
Residence	Day time (7am – 10pm)	0.20
	Night time (10pm – 7am)	0.13

5.2 Rail vibration monitoring locations

An operator attended rail vibration survey shall be undertaken on site post COVID-19 restrictions with the results and assessment presented for DA (preferred) or by CC at the very latest.

6 External noise emission from building services

6.1 EPA requirements

The NSW Environment Protection Authority (EPA) sets out noise criteria in its Noise Policy for Industry (NPfI) to control the noise emission from industrial sources.

The NPfI sets project noise trigger level to protect noise amenity for residential receivers. The project noise trigger level is set as the lower value of the following two assessment components:

- Controlling intrusive noise impacts in the short term for residences; and
- Maintaining noise level amenity for particular land uses for residences and other land uses.

Noise intrusiveness ensures that industrial noise does not exceed the background noise level by an excessive margin, preventing significant changes in the noise characteristic pertinent to the development site and surrounds. This is commonly referred to as the 'background plus 5' criterion. That is, the noise level from new industrial development, assessed in periods of 15 minutes, should not exceed the existing background noise level (measured in the absence of that development) by more than 5dB(A).

Noise amenity ensures that industrial noise levels do not increase without limit, for if a number of industrial noise sources are permitted to increase the background noise level by 5dB(A), in turn there would be a point where the ultimate noise level is unacceptable. A limit on the ultimate acceptable noise level is therefore included in the NPfI as a way of ensuring that cumulative noise impact from industrial growth is curtailed. This limit is referred to as the project amenity noise level. Amenity noise levels are not used directly as regulatory limits. They are used in combination with the project intrusiveness noise level to assess the potential impact of noise, assess reasonable and feasible mitigation options, and subsequently determine achievable noise requirements.

The table below presents the recommended amenity noise level relevant to the receivers surrounding the proposed development site. The project amenity noise level is defined as the recommended amenity noise level minus 5dB(A).

Table 8: NPfI Amenity Noise Levels - Recommended L_{Aeq} Amenity Noise Levels from Industrial Noise Sources [EPA NPfI Table 2.1]

Receiver	Noise amenity area	Time of day	L_{Aeq}, dB(A)
			Recommended Amenity noise level
Residential	Rural	Day	50
		Evening	45
		Night	40
	Suburban	Day	55
		Evening	45
		Night	40

Receiver	Noise amenity area	Time of day	L_{Aeq}, dB(A)
			Recommended Amenity noise level
	Urban	Day	60
		Evening	50
		Night	45
Hotels, motels, caretakers' quarters, holiday accommodation, permanent resident caravan parks	See column 4	See Column 4	5dB(A) above the recommended amenity noise level for a residence for the relevant noise amenity area and time of day
School classroom - internal	All	Noisiest 1-hour period when in use	35
Hospital ward - internal	All	Noisiest 1-hour	35
Hospital ward - external	All	Noisiest 1-hour	50
Place of worship - internal	All	When in use	40
Area specifically reserved for passive recreation (e.g. national park)	All	When in use	50
Active recreation area (e.g. school playground, golf course)	All	When in use	55
Commercial premises	All	When in use	65
Industrial premises	All	When in use	70
Industrial interface (applicable only to residential noise amenity areas)	All	All	Add 5dB(A) to recommended noise amenity

Notes:

- Daytime 7.00 am to 6.00 pm; Evening 6.00 pm to 10.00 pm; Night-time 10.00 pm to 7.00 am
- On Sundays and Public Holidays, Daytime 8.00 am - 6.00 pm; Evening 6.00 pm - 10.00 pm; Night-time 10.00 pm - 8.00 am.
- The LAeq index corresponds to the level of noise equivalent to the energy average of noise levels occurring over a measurement period.

In accordance with Section 2.4 of the NPfI, the following **exceptions** to the above method to derive the project amenity noise level apply:

1. In areas with high traffic noise levels (see Section 2.4.1 of the NPfI).
2. In proposed developments in major industrial clusters (see Section 2.4.2 of the NPfI).
3. Where the resultant project amenity noise level is 10dB, or more, lower than the existing industrial noise level. In this case the project amenity noise levels can be set at 10dB below existing industrial noise levels if it can be demonstrated that existing industrial noise levels are unlikely to reduce over time.

Where cumulative industrial noise is not a necessary consideration because no other industries are present in the area, or likely to be introduced into the area in the future. In such cases the relevant amenity noise level is assigned as the project amenity noise level for the development.

The applicable noise limits, according to the policy, are determined as follows (based on the AS1055.3-1997 assumed background noise levels, TBC on site when possible):

Table 9: L_{Aeq} Design Criterion for Noise Production (EPA NPfI) ambient – receivers facing railway corridor or Ellis St

Time of Day	Column 1	Column 2	Column 3	Column 4	Column 5	Column 6	Column 7	Column 8	Column 9	Column 10
	Assumed Rating Background Level (RBL) L_{A90}	Intrusiveness Trigger Level (RBL+5)	Recommended Amenity Noise Level (RANL)	Project Amenity Noise Level (PANL)	Measured $L_{Aeq, period}$ existing noise levels	Traffic noise exceed the RANL by more than 10dB?	Existing noise level likely to decrease in future?	Exceptions to PANL?	Project Noise Trigger Level $L_{Aeq, period}$ dB	Project Noise Trigger Level $L_{Aeq, 15min}$ dB
Day (7am to 6pm)	50	55	55	50	TBC	TBC but unlikely (assume no)	No	No	50	53
Evening (6pm to 10pm)	45	50	45	40	TBC	TBC but likely (assume yes)	No	High rail noise area. Existing $L_{Aeq, period}$ minus 15 dB(A) = 54 dB(A) (refer Table 1	44	45
Night (10pm to 7am)	40	45	40	35	TBC	TBC but likely (assume yes)	No	High rail noise area. Existing $L_{Aeq, period}$ minus 15 dB(A) = 51 dB(A) (refer Table 1)	40	43

Explanatory notes:

Column 1 – RBL measured in accordance with the NPfI and outlined in the results of the long-term noise monitoring has been summarised in accordance with NPfI requirements and are presented in Table 2 above.

Column 4 – Project Amenity Noise Level determined based on 'Residential - suburban' area in Table 2.2 (Amenity noise levels) of the EPA's NPfI minus 5dB

Column 5 – Measured in accordance with the NPfI

Column 8 - Determined in accordance with Section 2.4 of the NPfI.

Column 9 – Project Noise Trigger Level is the lower value of project intrusiveness noise level and project amenity noise level.

Table 10: L_{Aeq} Design Criterion for Noise Production (EPA NPfI) ambient – receivers shielded from the railway

Time of Day	Column 1	Column 2	Column 3	Column 4	Column 5	Column 6
	Rating Background Level (RBL) $L_{A90, 15min}$	Project Intrusiveness Trigger Level (RBL+5) $L_{Aeq, 15min}$	Recommended Amenity Noise Level (RANL)	Project Amenity Noise Level (PANL)	Project Noise Trigger Level $L_{Aeq, period}$ dB(A)	Project Noise Trigger Level $L_{Aeq, 15min}$ dB
Day (7am to 6pm)	50	55	55	50	50	53
Evening (6pm to 10pm)	45	50	45	40	40	43
Night (10pm to 7am)	40	45	40	35	35	38

Time of Day	Column 1	Column 2	Column 3	Column 4	Column 5	Column 6
	Rating Background Level (RBL) $L_{A90,\ 15min}$	Project Intrusiveness Trigger Level (RBL+5) $L_{Aeq,\ 15min}$	Recommended Amenity Noise Level (RANL)	Project Amenity Noise Level (PANL)	Project Noise Trigger Level $L_{Aeq,\ period}$ dB(A)	Project Noise Trigger Level $L_{Aeq,\ 15min}$ dB

Explanatory notes:

Column 1 – RBL measured in accordance with the NPfI and outlined in the results of the long-term noise monitoring has been summarised in accordance with NPfI requirements and are presented in Table 2 above.

Column 4 – Project Amenity Noise Level determined based on 'Residential - suburban' area in Table 2.2 (Amenity noise levels) of the EPA's NPfI minus 5dB

Column 9 – Project Noise Trigger Level is the lower value of project intrusiveness noise level and project amenity noise level.

6.2 Maximum noise level event assessment

The potential for sleep disturbance from maximum noise level events, from the proposed development, needs to be considered. Section 2.5 of the NPfI provides sleep disturbance trigger levels, summarised as follows:

Table 11: Sleep disturbance noise trigger levels

Receiver	Sleep Disturbance Trigger Levels, 10:00pm to 7:00am	
	$L_{Aeq,\ 15\ minute}$	L_{AFmax}
All residential	Greater than 40dB(A) or RBL plus 5dB, whichever is the greater	52dB(A) or RBL plus 15dB, whichever is the greater

Where noise from the proposed development is predicted to exceed the sleep disturbance trigger levels above in Table 11, during the night time, a detailed noise level assessment is required. The detailed assessment is required to cover the maximum noise level, the extent to which the maximum noise level exceeds the RBL, and the frequency of events occurring during the night time.

6.3 Recommended noise control measures for mechanical plant

Where necessary, noise amelioration treatment will be incorporated in the design to ensure that noise levels comply with the recommended EPA's NPfI noise emission criteria noted above.

At this stage details of mechanical plant have not been finalised, the following in-principal recommendations are provided:

- Acoustic assessment of mechanical services equipment will need to be undertaken during the detail design phase of the development to ensure that they shall not either singularly or in total emit noise levels which exceed the noise limits in EPA's NPfI or Council's requirements;
- As noise control treatment can affect the performance of the mechanical services system, it is recommended that consultation with an acoustic consultant be made during the initial phase of mechanical services system design in order to reduce the need for revision of mechanical plant and noise control treatment;
- Mechanical plant noise emission can be controllable by appropriate mechanical system design and implementation of common engineering methods that may include any of the following:
    - procurement of 'quiet' plant,
    - strategic positioning of plant away from sensitive neighbouring premises, maximising the intervening shielding between the plant and sensitive neighbouring premises,
    - commercially available silencers or acoustic attenuators for air discharge and air intakes of plant;

- acoustically lined and lagged ductwork;
- acoustic screens and barriers between plant and sensitive neighbouring premises; and/or
- Partially-enclosed or fully-enclosed acoustic enclosures over plant.

- Mechanical plant shall have their noise specifications and their proposed locations checked prior to their installation on site; and
- Fans shall be mounted on vibration isolators and balanced in accordance with Australian Standard 2625 "Rotating and Reciprocating Machinery – Mechanical Vibration".

We recommend a full and detailed assessment with fully documented acoustic treatments be undertaken at the detailed design phase of the development, followed by construction/installation supervision of mechanical plant and equipment acoustic treatment. Compliance testing following the installation of the plant should also be undertaken.

6.4 Noise emission from use of the carpark driveway service bay for delivery/retrieval

Detailed analyses of noise emissions from use of the carpark would need to be assessed at DA stage, after on-site monitoring of existing typical noise levels has been undertaken. Acoustic review of traffic assessments has not been undertaken at this time.

Preliminary calculations of noise emissions from use of the service bay for deliveries or retrieval of waste indicate such use would comply with the NPfI project noise trigger levels during the Day Time, based on a Sound Power Level of 100dB(A) L_{eq} for the truck whilst entering and loading/unloading and 105dB(A) L_{eq} when coming back up the ramp.

Further analysis would be required to determine whether truck use of the service bay in the evening time (6pm to 10pm) would be appropriate.

Based on preliminary assessment, use of the loading bay for trucks at Night Time may not be appropriate. That may be subject of review at DA stage based on detailed analysis.

Given the bulk and scale of surrounding developments, and the placement of the site on Urban fringe, it is not anticipated that noise emissions from the use of the carpark would result in adverse impacts to the surrounding residential receivers. For noise emissions to the adjacent residential receivers, movement of the parking from undercroft to basement is likely of acoustic benefit, even if there is an increase in total number of vehicle movements each day.

7 Internal sound insulation between tenancies

Internal walls and floors shall comply with the National Construction Code of Australia 2019 (or relevant instrument at the time of the design). All services and doors shall comply with the requirements of the NCC 2019. APPENDIX C presents a summary of acoustic provisions outlined in Part F5 of the NCC 2019.

8 Conclusion

Renzo Tonin & Associates have completed a preliminary acoustic assessment of the proposed mixed use development at 3 Ellis Street, Chatswood including noise and vibration impacts on the site from rail and potential noise impacts from mechanical plant and equipment serving the site.

Acoustic review indicates that the site is capable of meeting typical acoustic requirements with respect to both external noise impacts on the site (and achieving suitable amenity for future occupants of the development) and noise generation by the site.

More detailed analysis of both rail noise and vibration impacts, and noise emission limits for future operational noise from the site should be conducted once COVID-19 social distancing restrictions are relaxed and ambient noise environments become typical of what is expected long term.

Whilst criteria for the assessment of floor induced vibration and ground-borne rail noise have been identified herein for compliance with the Department of Planning publication "*Development Near Rail Corridors & Busy Roads – Interim Guideline 2008*" and British Standard BS6472:1992 *"Evaluation of Human Exposure to Vibration in Buildings (1Hz to 80Hz)"*, on site measurements during typical operations are required to determine the particular impacts. Such measurements shall be undertaken prior to DA (preferred) or CC (at the latest), once rail movements return to more typical operations.

Based on measurements on similar sites it is likely that floor induced vibration within the proposed development due to train pass-bys will comply with the British Standard BS6472:1992 *"Evaluation of Human Exposure to Vibration in Buildings (1Hz to 80Hz)"* and day and night VDV values set by the DEC guideline as required by the Department of Planning.

Rail noise impacts from the T1/T9 corridor have been considered and in-principle treatments for the control of traffic noise intrusion have been presented for compliance with the SEPP (Infrastructure) 2007 and DoP Guideline 2008. On site measurements during typical operations are required to determine the particular impacts at the site, including the degree of impact from the rail noise wall. Such measurements shall be undertaken prior to DA (preferred) or CC (at the latest), once rail movements return to more typical operations with a subsequent review of noise intrusion to follow.

Noise emission goals for the operation of mechanical plant and equipment and noise from vehicles being driven on site have been set in accordance with the Noise Policy for Industry based on assumed background noise levels. On this basis, it is feasible that noise emissions from the subject site can comply with these criteria, subject to confirmation of background noise levels on site and subsequent detailed design for Construction Certificate.

APPENDIX A Glossary of terminology

The following is a brief description of the technical terms used to describe noise to assist in understanding the technical issues presented.

Adverse weather	Weather effects that enhance noise (that is, wind and temperature inversions) that occur at a site for a significant period of time (that is, wind occurring more than 30% of the time in any assessment period in any season and/or temperature inversions occurring more than 30% of the nights in winter).
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 point	A point at which noise measurements are taken or estimated. A point at which noise measurements are taken 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 (see below).
Decibel [dB]	The units that sound is measured in. The following are examples of the decibel readings of every day sounds: 0dB The faintest sound we can hear 30dB A quiet library or in a quiet location in the country 45dB Typical office space. Ambience in the city at night 60dB CBD mall at lunch time 70dB The sound of a car passing on the street 80dB Loud music played at home 90dB The sound of a truck passing on the street 100dB The sound of a rock band 115dB Limit of sound permitted in industry 120dB Deafening
dB(A)	A-weighted decibels. The A- weighting noise filter simulates the response of the human ear at relatively low levels, where the ear is not as effective in hearing low frequency sounds as it is in hearing high frequency sounds. That is, low frequency sounds of the same dB level are not heard as loud as high frequency sounds. The sound level meter replicates the human response of the ear by using an electronic filter which is called the "A" filter. A sound level measured with this filter switched on is denoted as dB(A). Practically all noise is measured using the A filter.
dB(C)	C-weighted decibels. The C-weighting noise filter simulates the response of the human ear at relatively high levels, where the human ear is nearly equally effective at hearing from mid-low frequency (63Hz) to mid-high frequency (4kHz), but is less effective outside these frequencies.
Frequency	Frequency is synonymous to pitch. Sounds have a pitch which is peculiar to the nature of the sound generator. For example, the sound of a tiny bell has a high pitch and the sound of a bass drum has a low pitch. Frequency or pitch can be measured on a scale in units of Hertz or Hz.
Impulsive 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	The level suddenly drops to that of the background noise several times during the period of observation. The time during which the noise remains at levels different from that of the ambient is one second or more.
L_{Max}	The maximum sound pressure level measured over a given period.
L_{Min}	The minimum sound pressure level measured over a given period.

L_1	The sound pressure level that is exceeded for 1% of the time for which the given sound is measured.
L_{10}	The sound pressure level that is exceeded for 10% of the time for which the given sound is measured.
L_{90}	The 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).
L_{eq}	The "equivalent noise level" is the summation of noise events and integrated over a selected period of time.
Reflection	Sound wave changed in direction of propagation due to a solid object obscuring its path.
SEL	Sound Exposure Level (SEL) 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	A fluctuation of air pressure which is propagated as a wave through air.
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.

APPENDIX B Assessment and design methodology

B.1 Willoughby City Council Development Control Plan

Willoughby City Council is the regulatory authority for the proposed development. Council's DCP 2006 refers to the State Environmental Planning Policy (Infrastructure) 2007 and Department of Planning publication "Development near rail corridors and busy roads – Interim Guidelines" as design guide for residential development near busy roads or rail corridor.

Relevant sections of Council's DCP are re-iterated below.

> *"C.14 Development near Railway Corridors or Busy Roads*
>
> *Controls*
> *Development located in the vicinity of a rail corridor or busy road needs to take into consideration the provisions of the State Environmental Planning Policy (Infrastructure) 2007 and the NSW Department of Planning "Development Near Rail Corridors and Busy Roads- Interim Guideline"*
>
> *Performance Criteria*
> *Development should be designed and constructed so as to:*
>
> - *Protect the safety and integrity of key transport infrastructure; and*
> - *Ensure that the development achieves an appropriate acoustic amenity by meeting the internal noise criteria as specified in the State Environmental Planning Policy (Infrastructure) 2007."*

B.2 State Environmental Planning Policy (Infrastructure) 2007

The NSW State Environmental Planning Policy (Infrastructure) 2007 (known as 'ISEPP') came into force in NSW on 1 January 2008 to facilitate the effective delivery of infrastructure across the State. The aim of the policy includes identifying the environmental assessment category into which different types of infrastructure and services development fall and identifying matters to be considered in the assessment of development adjacent to particular types of infrastructure.

Pertinent to noise assessment, the ISEPP includes the following clauses:

> *87 Impact of rail noise or vibration on non-rail development*
>
> *1. This clause applies to development for any of the following purposes that is on land in or adjacent to a rail corridor and that the consent authority considers is likely to be adversely affected by rail noise or vibration:*
>
> *a. a building for residential use,*
>
> *b. a place of public worship,*
>
> *c. a hospital,*

d. an educational establishment or child care centre.

2. Before determining a development application for development to which this clause applies, the consent authority must take into consideration any guidelines that are issued by the Director-General for the purposes of this clause and published in the Gazette.

3. If the development is for the purposes of a building for residential use, the consent authority must not grant consent to the development unless it is satisfied that appropriate measures will be taken to ensure that the following LAeq levels are not exceeded:

a. in any bedroom in the building - 35 dB(A) at any time between 10 pm and 7am,

e. anywhere else in the building (other than a garage, kitchen, bathroom or hallway) - 40 dB(A) at any time.

102 Impact of road noise or vibration on non-road development

2. This clause applies to development for any of the following purposes that is on land in or adjacent to the road corridor for a freeway, a tollway or a transitway or any other road with an annual average daily traffic volume of more than 40,000 vehicles (based on the traffic volume data published on the website of the RTA) and that the consent authority considers is likely to be adversely affected by road noise or vibration:

f. a building for residential use,

g. a place of public worship,

h. a hospital,

i. an educational establishment or child care centre.

4. Before determining a development application for development to which this clause applies, the consent authority must take into consideration any guidelines that are issued by the Director-General for the purposes of this clause and published in the Gazette.

5. If the development is for the purposes of a building for residential use, the consent authority must not grant consent to the development unless it is satisfied that appropriate measures will be taken to ensure that the following LAeq levels are not exceeded:

b. in any bedroom in the building - 35 dB(A) at any time between 10 pm and 7am,

j. anywhere else in the building (other than a garage, kitchen, bathroom or hallway) - 40 dB(A) at any time.

6. In this clause, "freeway", "tollway" and "transitway" have the same meanings as they have in the Roads Act 1993

B.2.1 Department of Planning publication 'Development near rail corridors and busy roads – Interim guideline'

To support the Infrastructure SEPP, the NSW Department of Planning released the *Development in Rail Corridors and Busy Roads – Interim Guideline* (December 2008). The Guideline assists in the planning, design and assessment of developments in, or adjacent to, major transport corridors in terms of noise, vibration and air quality. While the ISEPP applies only to roads with an AADT greater than 40,000 vehicles, the guideline is also recommended for other road traffic noise affected sites.

B.2.2 Clarification of ISEPP noise limits

The Guideline clarifies the time period of measurement and assessment. Section 3.4 '*What Noise and Vibration Concepts are Relevant*' and Table 3.1 of Section 3.6.1 confirms that noise assessment is based over the following time periods:

- Daytime 7:00am - 10:00pm $L_{Aeq(15hr)}$
- Night-time 10:00pm - 7:00am $L_{Aeq(9hr)}$

The noise criteria nominated in the ISEPP apply to internal noise levels with windows and doors closed. However, as the preliminary noise assessment is based on measurements/predictions at external locations, equivalent external noise criteria has been established. The equivalent external noise criterion is used to determine which areas of the development may require acoustic treatment in order to meet the internal noise requirements of the ISEPP. The equivalent external goals have been determined on the following basis:

- The ISEPP states: "*If internal noise levels with windows or doors open exceed the criteria by more than 10dBA, the design of the ventilation for these rooms should be such that occupants can leave windows closed, if they so desire, and also to meet the ventilation requirements of the Building Code of Australia*." The internal criteria with windows open is therefore 10dB(A) above the criteria explicitly outlined in the ISEPP.
- The generally accepted noise reduction through an open window from a free-field external position is 10dB(A). Windows/doors are assumed to be open no more than 5% of room floor area, in accordance with the Building Code of Australia (BCA) ventilation requirements.

Table 12 presents the ISEPP internal noise criteria along with the equivalent external noise criteria for residential premises.

Table 12: ISEPP noise criteria for new residential development

Room	Location	$L_{Aeq, 15hr}$ Day 7am – 10pm	$L_{Aeq\ 9hr}$ Night 10pm – 7am
Living rooms*	Internal, windows closed	40	40
	Internal, windows open	50	50
	External free-field (allowing windows to remain open)^	60	60
Bedrooms*	Internal, windows closed	40	35

Room	Location	$L_{Aeq,\ 15hr}$ Day 7am – 10pm	$L_{Aeq\ 9hr}$ Night 10pm – 7am
	Internal, windows open	50	45
	External free-field (allowing windows to remain open)^	60	55

Notes: * Requisite for 40,000AADT Roads only under ISEPP 2007.

^ ISEPP Guideline states that where internal noise criteria are exceeded by more than 10dB(A) with windows open mechanical ventilation is required. External goals have been calculated on the basis of nominal 10dB(A) reduction through an open window to a free-field position. Windows open to 5% of floor area in accordance with the BCA requirements.

APPENDIX C Internal sound insulation

C.1 National Construction Code of Australia 2019

The National Construction Code of Australia (NCC) outlines minimum requirements for inter-tenancy (party) walls and ceiling/ floors to maintain privacy. This includes the incorporation of penetration of a service through a floor or through more than one sole-occupancy unit.

NCC nominates required Weighted Sound Reduction Indexes (R_w) and spectrum adaptation factor (C_{tr}) for partition constructions, of different space/ activity types in adjoining units. The R_w and $R_w + C_{tr}$ are single number descriptors for quantifying the attenuating performance of partitions for typical intrusive noises produced inside residences. The higher the rating, the greater the isolation provided by the partition.

Spectrum adaptation factors are commonly used to compensate for the fact that certain kinds of sounds are more readily transmitted through insulating materials than others insulate.

The adaptation factor C_{tr} has now been introduced for most building elements which require an airborne sound insulation rating. The only exception is a wall which separates a dwelling from a plant room, lift shaft, stairway, public corridor, public lobby or the like, or parts of a different classification. Therefore, both the C_{tr} factor and the R_w of the building element will need to be considered in most cases.

The C_{tr} factor takes into account lower frequency level sounds, and has been chosen in large part, in recognition of the problem of the high bass frequency outputs of modern home theatre systems and music reproduction equipment.

The Deemed-to-Satisfy Provisions also have impact sound insulation requirements for floors. The terms to describe the impact sound insulation of the floor is the weighted normalised impact sound pressure level ($L_{n,w}$). The lower the $L_{n,w}$ of the floor, the better the performance of the floor in terms of impact sound insulation.

The following section represents a summary of acoustic provisions outlined in the Part F5 of the NCC.

C.2 Sound insultion provision of NCC of Australia

The acoustic provisions for inter-tenancy walls in Class 2 and 3 buildings are outlined in the National Construction Code of Australia and the following is an extract from the NCC:

F5.2 Determination of airborne sound insulation ratings

A form of construction required to have an airborne sound insulation rating must –

k. have the required value for weighted sound reduction index (Rw) or weighted sound reduction index with spectrum adaptation term (Rw + Ctr) determined in accordance with AS/NZS 1276.1 or ISO 717.1 using results from laboratory measurements; or

l. comply with Specification F5.2.

F5.3 Determination of impact sound insulation ratings

m. A floor in a building required to have an impact sound insulation rating must –

i. have the required value for weighted normalised impact sound pressure level (Ln,w) determined in accordance with AS/ISO 717.2 using results from laboratory measurements; or

ii. comply with Specification F5.2.

n. A wall in a building required to have an impact sound insulation rating must –

iii. for a Class 2 or 3 building be of discontinuous construction;

o. For the purposes of this part, discontinuous construction means a wall having a minimum 20 mm cavity between 2 separate leaves, and

iv. for masonry, where wall ties are required to connect leaves, the ties are of the resilient type; and

v. for other than masonry, there is no mechanical linkage between leaves except at the periphery.

F5.4 Sound insulation rating of floors

p. A floor in a Class 2 or 3 building must have an Rw + Ctr (airborne) not less than 50 and an Ln,w (impact) not more than 62 if it separates –

vi. sole-occupancy units; or

vii. a sole-occupancy unit from a plant room, lift shaft, stairway, public corridor, public lobby or the like, or parts of a different classification.

F5.5 Sound insulation rating of floors

q. A wall in a Class 2 or 3 building must –

viii. have an Rw + Ctr (airborne) not less than 50, if it separates sole-occupancy units; and

ix. have an Rw (airborne) not less than 50, if it separates a sole-occupancy unit from a plant room, lift shaft, stairway, public corridor, public lobby or the like, or parts of a different classification; and

x. comply with F5.3(b) if it separates:

a bathroom, sanitary compartment, laundry or kitchen in one sole-occupancy unit from a habitable room (other than a kitchen) in an adjoining unit; or

xi. *a sole-occupancy unit from a plant room or lift shaft.*

r. A door may be 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, provided the door assembly has an Rw not less than 30.

s. Where a wall required to have sound insulation has a floor above, the wall must continue to –

xii. *the underside of the floor above; or*

xiii. *a ceiling that provides the sound insulation required for the wall.*

F5.6 Sound insulation rating of services

t. 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 sole-occupancy unit, the duct or pipe must be separated from the rooms of any sole-occupancy unit by construction with an Rw + Ctr (airborne) not less than –

xiv. *40 if the adjacent room is a habitable room (other than a kitchen); or*

xv. *25 if the adjacent room is a kitchen or non-habitable room.*

u. If a storm water pipe passes through a sole-occupancy unit it must be separated in accordance with (a).

APPENDIX D Construction noise

The NSW *Interim Construction Noise Guideline* (ICNG, 2009) provides guidelines for assessing noise generated during the construction phase of developments.

The key components of the guideline that are incorporated into this assessment include:

- Use of L_{Aeq} as the descriptor for measuring and assessing construction noise.

  NSW noise policies, including the INP, RNP and RING have moved to the primary use of L_{Aeq} over any other descriptor. As an energy average, L_{Aeq} provides ease of use when measuring or calculating noise levels since a full statistical analysis is not required as when using, for example, the L_{A10} descriptor.

- Application of reasonable and feasible noise mitigation measures
- As stated in the ICNG, a noise mitigation measure is feasible if it is capable of being put into practice, and is practical to build given the project constraints.
- Selecting reasonable mitigation measures from those that are feasible involves making a judgement to determine whether the overall noise benefit outweighs the overall social, economic and environmental effects.

The ICNG provides two methods for assessment of construction noise, being either a quantitative or a qualitative assessment. A quantitative assessment is recommended for major construction projects of significant duration, and involves the measurement and prediction of noise levels, and assessment against set criteria. A qualitative assessment is recommended for small projects with a duration of less than three weeks and focuses on minimising noise disturbance through the implementation of reasonable and feasible work practices, and community notification.

Table 13 below (reproduced from Table 2 of the ICNG) sets out the noise management levels and how they are to be applied for residential receivers. The guideline intends to provide respite for residents exposed to excessive construction noise outside the recommended standard hours whilst allowing construction during the recommended standard hours without undue constraints.

The rating background level (RBL) is used when determining the management level. The RBL is the overall single-figure background noise level measured in each relevant assessment period (during or outside the recommended standard hours).

Table 13: Noise management levels at residential receivers

Time of day	Management level $L_{Aeq\ (15\ min)}$	How to apply
Recommended standard hours: Monday to Friday 7 am to 6 pm Saturday 8 am to 1 pm No work on Sundays or public holidays	Noise affected RBL + 10dB(A)	The noise affected level represents the point above which there may be some community reaction to noise. Where the predicted or measured LAeq (15 min) 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 residents of the nature of works to be carried out, the expected noise levels and duration, as well as contact details.
	Highly noise affected 75dB(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, 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)	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 5dB(A) above the noise affected level, the proponent should negotiate with the community. For guidance on negotiating agreements see section 7.2.2 of the ICNG.

Sensitive Land Use

Table 14 below (reproduced from Table 3 of the ICNG) sets out the noise management levels for various sensitive land use developments.

Table 14: Noise management levels at other noise sensitive land uses

Land use	Where objective applies	Management level $L_{Aeq\ (15\ min)}$
Classrooms at schools and other educational institutions	Internal noise level	45 dB(A)
Hospital wards and operating theatres	Internal noise level	45 dB(A)
Places of worship	Internal noise level	45 dB(A)
Active recreation areas	External noise level	65 dB(A)
Passive recreation areas	External noise level	60 dB(A)
Community centres	Depends on the intended use of the centre.	Refer to the 'maximum' internal levels in AS2107 for specific uses.
Commercial premises	External noise level	70 dB(A)
Industrial premises	External noise level	75 dB(A)

Notes: Noise management levels apply when receiver areas are in use only.