REVERB ACOUSTICS

Noise and Vibration Consultants

Rail Traffic Noise & Vibration Impact Assessment Multi-Unit Development Lot 6 DP.7538374 15 Raymond Terrace Road East Maitland NSW

May 2022

Prepared for Mr Pethers
Report No. 22-2748-R1

Building Acoustics-Council/EPA Submissions-Modelling-Compliance-Certification

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1 INTRODUCTION

Reverb Acoustics has been commissioned to conduct a rail traffic noise and vibration impact assessment for a proposed multi-unit residential development at Lot 6 DP.7538374, No.15 Raymond Terrace Road, East Maitland. The purpose of the assessment is to theoretically determine the noise and vibration impact within habitable spaces from passing rail traffic on the North Coast Rail Line and to recommend acoustic modifications that must be incorporated into the design. This noise and vibration impact assessment has been conducted with reference to NSW Department of Planning and Environment's (DPE's) Guideline, *Development near Rail Corridors and Busy Roads – Interim Guidelines.*

The Assessment was requested by Mr Pethers to form part of and to support a Development Application to Maitland City Council (MCC), and to ensure that noise levels comply with the requirements of the NSW Environment Protection Authority (EPA), DPE and MCC.

2 TECHNICAL REFERENCE / DOCUMENTS

AS/NZS 2107-2016 *"Acoustics-Recommended Design Sound Levels and Reverberation Times for Building Interiors"*.

Department of Planning (2008). *"Development near Rail Corridors and Busy Roads - Interim Guidelines".*

State Rail Authority of NSW (1995) *"Rail related noise and vibration issues to consider in local environmental planning – development applications and building applications".*

Rail Infrastructure Corporation. (2003). *Interim Guidelines for Councils – Consideration of rail noise and vibration in the planning process.*

Rail Infrastructure Corporation. (2003). *Interim Guidelines for Applicants – Consideration of rail noise and vibration in the planning process.*

Plans supplied by Agcad Pty Ltd, Issue 1, dated 24 May 2022. Note that variations from the design supplied to us, may affect the acoustic recommendations.

ARTC (2020). *2020 Hunter Valley Corridor Capacity Strategy.*

A Glossary of commonly used acoustical terms is presented in Appendix A to aid the reader in understanding the Report.

3 CRITERIA

3.1 Rail Traffic Noise (Internal Noise Levels)

3.1.1 Internal Noise Levels

State Environmental Planning Policy (Infrastructure) 2007 states the following:

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) residential accommodation,
(b) a place of public worship,
(c) a hospital,
(d) an educational establishment or centre-based child care facility.

(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 Secretary for the purposes of this clause and published in the Gazette.

(3) If the development is for the purposes of residential accommodation, 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 residential accommodation—35 dB(A) at any time between 10.00 pm and 7.00 am,
(b) anywhere else in the residential accommodation (other than a garage, kitchen, bathroom or hallway)—40 dB(A) at any time.

Cognate performance requirements for residential developments can be sourced from DPE's *"Development near Rail Corridors and Busy Roads - Interim Guidelines*" (released in December 2008). Limits specified within the Policy, which are identical to SEPP (Infrastructure) 2007, will be used for the purpose of this assessment, are shown below:

Type of Occupancy	*Noise Level in dB(A)*	*Applicable Time Period*
Sleeping areas (bedroom)	35	Night 10pm to 7am
Other habitable rooms (excluding garages, kitchens bathrooms & hallways)	40	At any time

If criteria are exceeded by more than 10dB(A) with windows open, mechanical ventilation should be incorporated into the design of affected rooms.

3.1.2 External Noise Levels

DPE's. *"Development near Rail Corridors and Busy Roads - Interim Guidelines"*, does not specify limits for outdoor recreational areas associated with a dwelling. However, their Guideline, *"Interim Guideline for the Assessment of Noise from Rail Infrastructure Projects"* suggests a limit of **60dB(A),Leq**. We have therefore adopted this limit for assessment purposes.

3.2 Rail Traffic Vibration

3.2.1 Personal comfort

Various authorities have set maximum limits on allowable ground and building vibration in different circumstances and situations, all directed at personal comfort rather than building damage. This usually leads in virtually every situation to people who interpret the effects of a vibration to ultimately determine its acceptability. The most recent criteria for assessment of rail traffic vibration impacts upon occupants of a building are those contained in DPIE's *"Development near Rail Corridors and Busy Roads - Interim Guidelines*". The Guideline recommends that the EPA's *Assessing Vibration: A Technical Guideline (2006)* should be used for the assessment of vibration. Limits set out in the Guideline are for vibration in buildings, and are directed at personal comfort for continuous, impulsive and intermittent vibrations. Table 1 shows the Vibration Dose Values for intermittent vibration activities such as train passbys, pile driving and use of vibrating rollers, taken from Table 2.4 of the Guideline, above which various degrees of adverse comment may be expected.

Table 1: Acceptable Vibration Dose Values ($m/s^{1.75}$)
Above which Degrees of Adverse Comment are Possible

Location	Day (7am-10pm)		Night (10pm-7am)	
	Preferred	Maximum	Preferred	Maximum
Critical areas #	0.10	0.20	0.10	0.20
Residences	0.20	0.40	0.13	0.26
Offices	0.40	0.80	0.40	0.80
Workshops	0.80	1.60	0.80	1.60

Hospital operating theatres, precision laboratories, etc.

3.2.2 Building Safety Criteria

Australian Standard AS2187.2-1993, dealing specifically with blasting vibration, specifies a maximum peak particle velocity of 10mm/sec for houses and a preferred limit of 5mm/sec where site specific studies have not been undertaken. German Standard DIN 4150 - 1986, Part 3 Page 2, specifies a maximum vibration velocity of 5 to 15 mm/sec in the foundations for dwellings and 3 to 8 mm/sec for historical and sensitive buildings, for the range 10 to 50Hz. British Standard BS 7385 Part 2, specifies a maximum vibration velocity of 15mm/sec at 4Hz increasing to 20mm/sec at 15Hz increasing to 50mm/sec at 40Hz and above, measured at the base of the building.

The above listed criteria vary from 3mm/sec up to 15mm/sec, therefore, the more conservative limit of **3mm/sec** will be adopted for the purposes of this assessment. It should be acknowledged, however, that intermittent ground vibration velocities at 5mm/sec are generally considered the threshold at which architectural (cosmetic) damage to normal dwellings may occur and velocities at 10mm/sec should not cause any significant structural damage, with the exception of the most fragile and brittle of buildings.

4 METHODOLOGY

4.1 Rail Traffic Noise

Reference to ARTC's Hunter Valley Corridor Capacity Strategy report 2013-2023 forecast that the frequency of coal trains using the rail line will be in the order of 149/day for the years 2014-2019. An additional 1-2 country ore/grain trains use the line each day, together with the occasional freight train. This equates to a maximum frequency of 155 trains per day, or up to 97 trains passing the site during the day (7am-10pm) and 58 trains during the night (10pm-7am).

Reference to Cityrail timetables indicates that up to 160 passenger trains may also pass the site each day. This equates to up to 100 passenger trains passing the site during the day (7am-10pm) and 60 passenger trains during the night (10pm-7am).

The predicted L(A)eq,1hr noise level for trains passing the site was calculated using the US EPA's Intermittent Traffic Noise calculation method. This method was adopted because train movements are not continuous, and have the same passby characteristic pattern as other vehicles. The mathematical formula used to calculate the Leq,T noise level for intermittent rail traffic noise is given in Equation 1 below:

$$L_{eq},T = L_b + 10\log\left[1+\frac{ND}{T}\left(\frac{10^{(L\max - Lb)/10}-1}{2.3}-\frac{(L_{\max}-L_b)}{10}\right)\right] \text{...... } \textit{Equation 1}$$

Where L_b is background noise level, dB(A)
T is the time (min)
D is duration of noise of each train (min)
L_{MAX} is train noise, dB(A)
N is number of trains

Due to the expected increase in future rail traffic movements, site measurements of train passbys does not give a true indication of the rail traffic impact, therefore, noise levels of train passbys are based on the maximum carrying capacity of the rail line and measurements of conducted by Reverb Acoustics at the site. Typical average maximum train and background noise levels were measured at a nearby site approximately 20 metres from the rail line. The Lmax train noise levels used in Equation 1 are the maximum predicted noise levels produced at the facade from trains passing the site.

4.2 Rail Traffic Vibration

Typical vibration levels for train passbys were measured at nearby sites, at varying distances from the rail line and also sourced from our library of technical data for comparison purposes. Vibration levels of trains were measured with a Vibroch V801 Seismograph coupled to a triaxial geophone installed on hard packed earth. A sandbag was placed over the geophone during each measurement to ensure elevated readings were not recorded due to bouncing and movement, which may occur at higher vibration amplitudes. The unit is capable of measuring and storing peak Z-axis vibration velocities, as well as vibration in three directions simultaneously and gives peak velocity and acceleration on the x, y and z axes.

Figure 1: Location Plan

ANALYSIS

5.1 Rail Traffic Noise and Vibration

Measurements conducted by Reverb Acoustics at a nearby site reveal the following average maximum train noise passby levels at a distance of 20 metres from the rail line.

88dB(A),Lmax Coal/Freight 79dB(A),Lmax Passenger
81dB(A),Leq Coal/Freight 74dB(A),Leq Passenger

The following Table shows a sample calculation of the predicted rail traffic noise (LAeq,1hr) calculated to the theoretical facade of a proposed residence in an exposed location, with no allowance for topographical features or acoustic barriers.

Table 2: Received Train Noise Levels

	L(A)eq,15hr DAY	L(A)eq,9hr NIGHT
Rec Noise Level, Lmax.	88/79	88/79
Train frequency (coal/pass)	90/95	60/55
Average Bgd Noise, dB(A)	35	
Barrier loss #	6	6
Calculated train noise, Leq	**60.1**	**60.5**
Criteria (day/night)	**40 (internal)**	**35 (internal)**
Exceedance	**20.1**	**25.5**

1800mm high acoustic fence on south and west site boundaries

Theoretical results in the above table indicate that rail traffic noise impacting on the proposed residence may exceed DPE's limits. Therefore, in order to satisfy the requirements of their Guideline, acoustic modifications will need to be incorporated in the design of residence.

To put results into context, an L(A)eq,1hr impact of 26 implies that the facade of a residence must be capable of attenuating 26dB (i.e. 61dB(A),Leq(9hr) – 35 = 26). Windows are typically the acoustic weak spot and standard 3-4mm glass will only achieve 10-15dB attenuation, if the window frames are fully sealed into the parent wall. Facades with an Leq(1hr) impact greater than 15dB(A), must have acoustical modifications incorporated in the design.

Attended vibration monitoring revealed that no perceptible vibration was recorded from train passbys at a distance greater than 20 metres from the rail line. Under certain circumstances, say if a large vibrating track maintenance machine was to pass the site and the resonant frequency of the ground happened to be an exact multiple of the driving frequency of the source, then higher vibration levels could be expected. However, it is doubtful that levels would reach a magnitude capable of causing any adverse comment or structural damage.

Vibration can be felt at levels well below those considered to cause structural damage. Complaints from occupiers are usually due to the belief that if vibration can be felt then it is likely to cause damage. Slamming of doors or footfall within a building can produce vibration levels above those produced by passing rail traffic. Passing trains will only produce loads, and therefore vibration, when their mass is accelerated, for example when hitting joins or deformities in rails. This emphasises the importance of properly maintained rail lines.

Vibration levels caused by trains passing the site are unlikely to cause direct failure, and it is considered the main action is triggering cracks in materials already subjected to stress or natural forces, however, as previously mentioned, this may also arise from internal forces such as slamming of doors. In our experience, vibration will only begin to trigger "natural cracking" at levels above 1mm/sec.

6 RECOMMENDED NOISE CONTROL

6.1 Glazing – Windows/Sliding Doors

6.1.1 Glass installed in window assemblies must comply with AS1288-2006. Materials, construction and installation of all windows are to comply with the requirements of AS2047-2014. Similar calculations to those in Section 4 were performed for all building elements of the proposed development. From these calculations, a schedule of required glazing has been compiled, shown below. The glazing systems, sighted in the following Table, are presented as a guide for the supplier:

Glazing Systems:
Type A: Standard glazing. No acoustic requirement.
Type B: Single-glaze 5-8mm clear float glass.
Type C: Single glaze laminated or Vlam Hush glass.
Type D: Double-glaze or Insulating Glass Unit (IGU)

Note: The typical glazing shown in the following Table should be used as a guide only. The supplier of the window/door must be able to provide evidence that the complete system will achieve the specified Rw performance, i.e. do not simply install our recommended glass in a standard window frame.

Table 3: Glazing Schedule

Facade	Room	Description	Required Rw Must Achieve for Compliance	Typical Glazing System (Not for Specification)
		UNIT 4		
South	Bath	Window	**28**	Type B
	Ensuite	Window	**28**	Type B
West	Bed 1	Window	**33**	Type C
	Living	Window	**31**	Type C
	Living	Sl. Door	**29**	Type B or C
	Laundry	Window	**-**	No acoustic requirement
East	Entry	Door	**28**	Type B
	Bed 3	Window	**33**	Type C
	Bed 2	Window	**33**	Type C
		UNIT 3		
West	Bed 1	Window	**31**	Type C
	Living	Window	**29**	Type B or C
	Living	Sl. Door	**26**	Type B
	Laundry	Window	**-**	No acoustic requirement
East	Entry	Door	**-**	No acoustic requirement
	Bed 3	Window	**31**	Type C
	Bed 2	Window	**31**	Type C
		UNIT 2		
South	Bath	Window	**-**	No acoustic requirement
	Ensuite	Window	**-**	No acoustic requirement
West	Bed 1	Window	**27**	Type B
	Living	Window	**25**	Type B
	Living	Sl. Door	**-**	No acoustic requirement
	Laundry	Window	**-**	No acoustic requirement
East	Entry	Door	**-**	No acoustic requirement
	Bed 3	Window	**28**	Type B
	Bed 2	Window	**28**	Type B
		UNIT 1		
West	Bed 1	Window	**-**	No acoustic requirement
	Living	Window	**-**	No acoustic requirement
	Living	Sl. Door	**-**	No acoustic requirement
	Laundry	Window	**-**	No acoustic requirement
East	Entry	Door	**-**	No acoustic requirement
	Bed 3	Window	**-**	No acoustic requirement
	Bed 2	Window	**-**	No acoustic requirement

6.2 Walls

UNITS 4-3:
6.2.1 Masonry, brick veneer construction is acceptable, internally lined with 10mm plasterboard, plus R2/S2 cavity insulation.

6.2.2 Where light-weight cladding is installed, (Aluminium Composite Panel, Axon, Shadowclad, Weathertex, or similar) internal lining to rooms must be minimum 13mm plasterboard, plus R2/S2 cavity insulation.

UNITS 2-1:
6.2.3 No acoustic requirement.

6.3 Roof/Ceiling

UNITS 4-3:
6.3.1 Construction is to consist of Colorbond with a 30-40mm anticon foil faced building blanket hard under the roof sheeting (in situations where joists are at centres close enough to avoid excessive sagging of the blanket may be omitted). Close off eaves gaps with 2 layers S3/R3 insulation in ceiling void, tightly packed at the building perimeter at 600mm width, alternatively 1 layer R4.1 batts will suffice. All ceilings are to consist of 1 layer 13mm plasterboard.

6.3.2 To further assist in low frequency attenuation, all ceiling voids should contain a layer of fibreglass or rockwool insulation. The insulation is to be installed in addition to, not in lieu of the building blanket. Specialised acoustic insulation is preferred, however, dense thermal insulation (eg, R3 batts) will suffice and is much less expensive ($15/m^2$ for Rockwool 350 and $5/m^2$ for R3 batts).

UNITS 2-1:
6.3.3 No acoustic requirement.

6.4 Ventilation

6.4.1 DPE's Guideline states that if internal noise criteria cannot be met with windows open then they must be shut, if desired, while also meeting the ventilation requirements of the Building Code of Australia (BCA). This does not preclude the use of operable windows, although, the National Construction Code (NCC) states that when the minimum criteria cannot be met, mechanical ventilation is required (ref: Section 3.1.2 ABCB Indoor Air Quality, 2016). However. the DPIE's Apartment Design Guide Objective 4B-1 specifies all habitable rooms should be naturally ventilated in apartment complexes.

Noise and Pollution, Apartment Design Guide Section 4J, provides solutions to provide natural ventilation when windows are open, while satisfying internal traffic noise criteria. These include operable facades, winter gardens, partially shielded and insulated balconies, apartment setbacks, judicious building design and selection of acoustic materials and products to be incorporated into the building design.

Recent studies have conclusively proven that a typical open window will reduce noise by 15dB(A) or more when contained within a masonry structure with no exposed flooring.

Table 4 shows road traffic design criteria at exposed facades and the predicted internal noise levels with windows open, to determine compliance.

Table 4: Internal Noise Assessment – Windows Open

Time Period	Predicted Traffic Noise level L(A)eq		Internal Criteria L(A)eq	Compliant YES/NO
	External	Internal		
Day	60	45	40	NO
Night	60	45	35	NO

In respect to the above, mechanical ventilation will be required for ventilation in habitable rooms of Units 3 and 4.

6.5 Acoustic Fence

6.5.1 An acoustic fence 1800mm above FGL is to be erected along the south and west site boundaries. Acceptable construction consists of Colorbond or lapped and capped timber. No significant gaps should remain in the fence to allow the passage of sound below the recommended height. Other construction options are available if desired, providing the fence is impervious and of equivalent or greater surface mass than the above construction options.

6.6 External Noise Levels

6.6.1 As can be seen by the results in Table 2, external noise levels at exposed facades will be in the order of 60dB(A), which will be <60dB(A) in a partially shielded locations used as recreational areas associated with the dwelling. This level is below the adopted criterion of 60dB(A),Leq.

6 CONCLUSION

A noise impact assessment of rail traffic noise and vibration impacting on a proposed residential development at Lot 6 DP.7538374, No.15 Raymond Terrace Road, East Maitland, has been completed. Results show that the site is satisfactory for the intended purpose, providing our modifications are incorporated into the design. Recommendations to reduce internal noise levels to achieve the desired noise reduction and satisfy the requirements of DPE, the EPA and MCC have been made regarding roof/ceiling and wall construction, sealing of voids, minimum glazing requirements, etc. The recommended glazing shown in Table 3 should be used as a guide only. The supplier of the window/door must be able to provide evidence that the complete system will achieve the specified Rw performance. Do not simply install our suggested glass type in a standard window frame.

The adopted train passby noise levels represent the average maximum noise level from train passbys. Therefore, individual train passbys may at times produce higher noise levels than those adopted. No significant increase in maximum received noise levels are expected in the future, as locomotive and rolling stock manufacturers are continuously developing noise reduction strategies addressing engine, exhaust and wheel noise. We conclude, with a high degree of confidence that vibration levels at the expected magnitudes will not cause direct structural damage or cause undue annoyance to the occupants. We suspect that one or more natural forces, as discussed in Section 5, will be the cause of any future damage. It should be noted, however, that vibration may be noticed on occasion while a person is standing or seated quietly. Other noticeable indicators may be rattling of window frames and ornaments, and possible visible movement of hanging pictures, etc.

In conclusion, providing the recommendations given in this report are implemented, rail traffic noise and vibration levels and industrial noise during typical operation will be compliant with DPE, EPA and MCC requirements. We therefore see no acoustic reason why the proposal should be denied.

Steve Brady M.A.S.A. A.A.A.S.
Principal Consultant

APPENDIX A
Definition of Acoustic Terms

Definition of Acoustic Terms

Term	Definition
dB(A)	A unit of measurement in decibels (A), of sound pressure level which has its frequency characteristics modified by a filter ("A-weighted") so as to more closely approximate the frequency response of the human ear.
Rw	Weighted Sound Reduction Index. The ability of a partition to attenuate sound, in dB. Given as a single number representation.
Leq	Equivalent Continuous Noise Level - which, lasting for as long as a given noise event has the same amount of acoustic energy as the given event.
L90	The noise level which is equalled or exceeded for 90% of the measurement period. An indicator of the mean minimum noise level, and is used in Australia as the descriptor for background or ambient noise (usually in dBA).
Lmax	The maximum level for the measurement period (usually in dBA)