WOOD & GRIEVE ENGINEERS

Yagoona Public School

Acoustic Report for Development Application

Prepared for:

Kelsey Godwin-Smith
Conrad Gargett

Date:
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Prepared by:

Sean Matthews
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Level 6, Building B, 207 Pacific Highway, St Leonards NSW 2065
T: (02) 8484 7000 **F:** (02) 8484 7100 **E:** sydney@wge.com.au **W:** www.wge.com.au

Revision

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1. Introduction

As part of the DA documentation process, Wood & Grieve Engineers has been engaged by Conrad Gargett Pty Ltd to provide an acoustic assessment for the redevelopment/expansion of the Yagoona Public School.

The proposed work is to include:

- 16 new permanent teaching spaces (replacing 8 demountables)
- 184 additional students (future total 782)

This assessment has been prepared considering the following documents:

- Bankstown Development Control Plan 2015
- AS/NZS 2107:2016: Acoustics – Recommended design sound levels and reverberation times for building
- NSW Industrial Noise Policy (INP)
- State Environmental Planning Policy (SEPP) Infrastructure 2007
- Department of Planning (DoP) Development Near Rail Corridors and Busy Roads – Interim Guideline
- The Educational Facilities Standards & Guidelines (EFSG)

This assessment discusses the likely noise impact of the proposed development upon the nearest most-affected receivers.

This report provides:

- A statement of compliance with the Bankstown City Council requirements for the proposed educational development within the vicinity of the nearest potentially affected residential and commercial receivers.
- Recommendations for achieving the outlined criteria.

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. Background

2.1 Information sources

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.
- Architectural preliminary-drawings provided by Conrad Gargett dated 26.07.17
- Noise data collected on site through the use of a noise logger and a hand held type 1 spectrum analyser.

3. Project Overview

3.1 Site Description

Yagoona Public School is located along Hume Highway and is bound by residential properties to the East and South, commercial properties across the Hume Highway to the North, and residential properties across the railway to the West.

The site location, measurement positions and surrounding residential receivers are shown in Figure 1.

3.1.1 Acoustic Issues

The acoustic issues relating to the development are as follows:

- Noise emissions from the students to the surrounding residential receivers
- Noise emission from mechanical plant from the new and redevelopment buildings to the surrounding residential receivers
- Noise and vibration from the adjacent train line to the new facilities
- Carpark pick up and drop off noise from increased number of students and staff
- Traffic noise generation from increased number of students and staff

Figure 1: Overview of the site and measurement locations

Source: nearmap.com

3.2 Instrumentation

The following equipment was used for the noise surveys:

- Casella Sound Level Meter
- Hand-held sound spectrum analyzer B&K 2250, S/N 2709742
- Sound Calibrator B&K Type 4231, S/N 2709826
- SVAN 958 Sound and Vibration Analyser Type 1 S/N 15153
- SVANTEK SV207A Building Vibration Accelerometer S/N 22824

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.

3.3 Unattended Noise Survey Results

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

Day: is defined as 7:00am to 6:00pm, Monday to Saturday and 8:00am to 6:00pm Sundays & Public Holidays.
Evening: is defined as 6:00pm to 10:00pm, Monday to Sunday & Public Holidays.
Night: is defined as 10:00pm to 7:00am, Monday to Saturday and 10:00pm to 8:00am Sundays & Public Holidays**.**

3.3.1 Background and Ambient Noise Monitoring

A noise logger was placed at position L1 as shown in Figure 1 to measure the background and ambient noise that is representative of the surrounding residential receivers which are most affected by noise from the existing school and future re-development. Logger L1 was installed from the 21st to the 28th of July 2017.

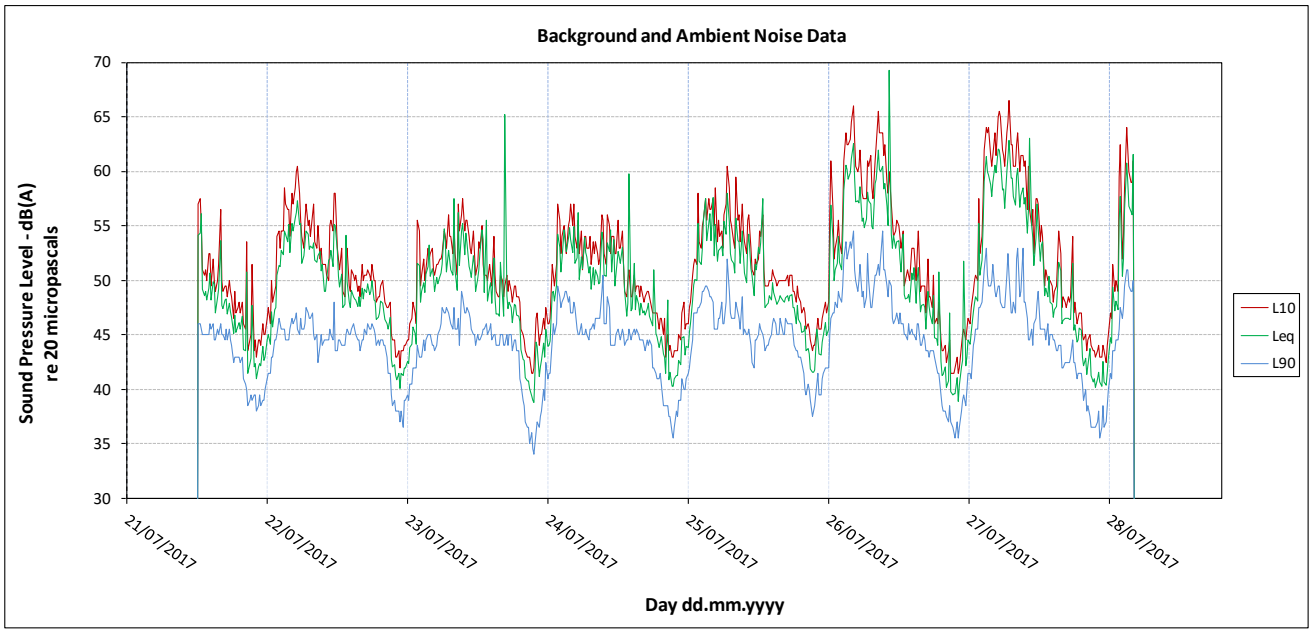
The results of the unattended background noise survey are shown in Table 1 below (for the day, evening and night periods). Note that any extraneous data or rain affected data has been excluded from the calculations.

Table 1: 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	56	51	47	45	44	38

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

Figure 2: Logger data L1



3.4 Attended Noise Survey Results

Attended noise measurements of 15-minute period were conducted on site in order to characterize the acoustic environment for the noise intrusion into the development and to determine any noise impact on the surrounding receivers. A summary of the attended noise measurements taken at the site are shown on Table 3 below. Refer to Figure 1 for the measurements location.

Table 2: Attended noise measurements

Measurement Location	Measurement Time	$L_{Aeq,\ 15mins}$, dB(A)	Comments
P1	21.07.17 – 3:15pm	57	Distant traffic noise
P2	28.07.17 – 9:00am	53	Distant traffic noise
P3	28.07.17 – 10:10am	80	Hume Highway noise

Attended noise measurements were also conducted of train pass-bys. The result of the noise measurements are shown in Table 3.

Table 3: Attended noise measurements of trains

Measurement Location	Measurement Time	$L_{Aeq,\ duration}$, dB(A)	L_{Amax}, dB(A)	Comments
P2	28/07/2017 7:15:01	53	56	Passenger train pass-by
P2	28/07/2017 7:16:20	50	60	Background
P2	28/07/2017 7:24:29	53	58	Passenger train pass-by
P2	28/07/2017 7:26:46	56	62	Passenger train pass-by
P2	28/07/2017 7:31:27	55	57	Passenger train pass-by
P2	28/07/2017 7:33:23	57	67	Background

4. Noise Criteria

4.1 Internal Noise Levels

4.1.1 The Educational Facilities Standards & Guidelines

In the absence of any specific requirements in the Bankstown City DCP, the Educational Facilities Standards & Guidelines (EFSG) has been used. The EFSG states internal noise levels for educational facilities when the development is impacted by traffic noise, and that the assessment shall be consistent with the requirements of the SEPP Infrastructure Clause 102. The internal noise levels from the EFSG as presented in Table 4 shall be met as the Hume Highway carries more than 20,000 vehicles AADT (which is the recommended volume for an assessment from the DoP Interim Guideline).

Note that these levels are generally based on the satisfactory recommended levels by Australian Standard (AS) 2107:2016 – *'Acoustics- Recommended design sound levels and reverberation times for building interiors*.

Table 4: Internal noise levels according to EFSG

Room	Internal Noise Level, L_{Aeq}, dB(A)
Art/craft studios	40
Assembly halls up to 250 seats	35
Assembly halls over 250 seats	35
Audio-visual areas	35
Computer rooms – Teaching	40
Computer rooms – Laboratories	45
Conference room	35
Corridors and lobbies	45
Dance studios	40
Dining rooms	45
Drama Studios	30
Duplicating rooms/stores	50
Engineering workshops	50
Gymnasiums	40
Interview/counselling rooms	35
Kitchens	50
Laboratories – Teaching	40
Laboratories – Working	45
Lecture rooms – up to 50 seats	35
Lecture theatres – without speech reinforcement and >50 seats	30
Lecture theatres – with speech reinforcement	35
Libraries – General areas	40
Libraries – Reading areas	35
Libraries – Stack areas	45

Noise Criteria

Room	Internal Noise Level, L_{Aeq}, dB(A)
Manual arts workshops	40
Medical rooms (First aid)	40
Music practice rooms	35
Music studios	30
Office areas	40
Open plan teaching areas	40
Professional and Administrative offices	35
Staff common rooms	40
Study Rooms	35
Teaching spaces – Hearing impaired	30
Teaching spaces – Primary schools	35
Teaching spaces – Secondary schools	35
Toilet/change/showers	50

Note that for this assessment and based on the architectural drawings provided, the lowest internal noise level criteria from Table 4 for the spaces would be 35dB(A).

4.1.2 Department of Planning – Interim Guideline Developments Near Rail Corridors and Busy Roads

The DoP interim Guideline details the application of SEPP Infrastructure Clause 102 which is required to be used when an educational development is adjacent to a freeway, a tollway, or transitway or a road with an annual average daily traffic volume (AADTV) of more than 40,000 vehicles. Based on the RMS traffic volume maps, the Hume Highway carries over 20,000 vehicles, therefore the DoP Interim Guideline has been applied.

Based on the DoP Interim Guideline, the maximum recommended internal noise level to educational institutions is 40dB(A). As the internal noise levels from the EFSG have been derived to be consistent with the requirements of the SEPP Infrastructure, the levels from Table 4 have been used.

The DoP Interim Guideline also states the following in regards to open windows assessment:

> *"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."*

Note that this assessment has been conducted based on the room types and their proposed locations based on the architectural drawings provided. Changes to the layout would require re-assessing the natural ventilation as sensitive spaces may be placed in noisier locations.

4.2 Site Noise Emission

4.2.1 Bankstown DCP

Section 6 of the Bankstown City Council's DCP 2015 states the following:

(6.1) Air conditioning, mechanical ventilation or any other continuous noise source must not exceed the ambient level at any specified boundary by more than 5dB(A).

In regards to student related noise, clause 6.2 states that the following:
For the purpose of this clause, Council requires development applications to submit an Acoustic Report prepared by a suitable qualified acoustic consultant to determine:

(c) whether the development must apply measures to ensure the noise of students does not exceed 10dB(A) above the background noise level;

Clause 6.1 is consistent with the requirements of the NSW INP, as such mechanical services will be assessed as per the methodology of the INP. This will satisfy the Bankstown City Council requirement.
It is not stated whether Clause 6.2 is for new schools or redevelopments, however it is assumed this is for new schools, or significant increases in student numbers. As demonstrated in this report, the increase in noise level due to the additional students is negligible.

4.2.2 NSW Industrial Noise Policy

The NSW Environment Protection Authority (EPA) sets out criteria in its Industrial Noise Policy (INP) to control the noise emission from industrial noise source or continuous steady state noise. The external noise due to the mechanical services from the proposed development will later be addressed in order to ensure the compliances with NSW EPA's INP guidelines.

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 INP 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 Laeq 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 L_{Aeq}, 15 minute $\leq$ RBL background noise level plus 5 dB(A).

Noise Criteria

Table 5: NSW INP intrusiveness criteria[1]

Period	Noise Descriptor – dB(A)	Noise Criteria – dB(A)
Day (7:00am to 6:00pm)	$L_{Aeq,15min} \leq$ RBL + 5	50
Evening (6:00pm to 10:00pm)	$L_{Aeq,15min} \leq$ RBL + 5	49
Night (10:00pm to 7:00am)	$L_{Aeq,15min} \leq$ RBL + 5	43

Amenity Criteria

The NSW INP states the following:

> *"To limit continuing increases in noise levels, the maximum ambient noise level within an area from industrial noise sources should not normally exceed the acceptable noise levels specified in Table 2.1 of the INP. Meeting the acceptable noise levels in table 2.1 will protect against noise impacts such as speech interference, community annoyance and to some extent sleep disturbance. These levels represent best practice for assessing industrial noise sources, based on research and a review of assessment practices used overseas and within Australia."*

The applicable parts of Table 2.1: Recommended L_{Aeq} Noise Levels from Industrial Noise Sources – dB(A) which are relevant to the project are reproduced below:

Table 6: NSW INP amenity criteria for external noise levels[2]

Type of Receiver	Indicative Noise Amenity Area	Time of Day	Recommended L_{Aeq} Noise Level, dB(A)		Adjusted Acceptable L_{Aeq} Levels
			Acceptable	Recommended Maximum	
Residential	All	Day	60	65	50
	All	Evening	50	55	42
	All	Night	45	50	37
Commercial	All	When in use	65	70	65

*Urban area as defined in EPA INP 2. 2.1.6.

'Modifying Factor' Adjustments

The NSW INP also states:

> *"Where a noise source contains certain characteristics, such as tonality, impulsiveness, 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.

[1] See Section 3.3 for noise survey results.
[2] See Section 3.3 for noise survey results.

Noise Criteria

Table 4.1 of Chapter 4 of the NSW DECCW INP (see Table 7 below) provides procedures for determining whether an adjustment should be applied for greater annoyance aspect.

Table 7: Table 4.1 from the NSW DECCW INP – Modifying factor corrections

Factor	Assessment / Measurement	When to Apply	Correction[1]	Comments
Tonal Noise	One-third octave or narrow band analysis	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 above 400 Hz - **8 dB** or more if the centre frequency band containing the tone is 160 to 400 Hz inclusive - **15 dB** or more if the centre frequency of the band containing the tone is below 160 Hz	5 dB[2]	Narrow-band frequency analysis may be required to precisely detect occurrence.
Low Frequency Noise	Measurement of C-weighted and A-weighted level	Measure / assesses C- and A-weighted levels over same time period. Correction to be applied if the difference between the two levels is 15 dB or more	5 dB[2]	C-weighting is designed to be more responsive to low-frequency noise, especially at higher overall levels
Impulsive Noise	A-weighted fast response and impulsive response	If difference in A-weighted maximum noise levels between fast response and impulse response is greater than 2 dB	Apply difference in measured levels as the correction, up to a maximum of 5 dB.	Characterised by a short rise time of 35 milliseconds (ms) and decay time of 1.5 s.
Intermittent Noise	Subjectively assessed	Level varies by more than 5 dB	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	On event in any 24-hour period	0 to – 20 dB(A)	The acceptable noise level may be increased by an adjustment depending on duration of noise.
Maximum Adjustment	Refer to individual modifying factors	Where two or more modifying factors are indicated	Maximum correction of 10dB(A)[2] (excluding duration correction)	

Notes:

1. Corrections to be added to the measured or predicted levels.
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.

4.2.3 Project-Specific Noise Levels (PSNL)

The following criteria is applicable for the external noise emissions from the development, as detailed below in Table 8. These project specific noise levels are in accordance with the requirements of the NSW INP, and shall be assessed to the most affected point on or within the residential boundary. Note that this is for mechanical services and operational noise emissions. Any noise emissions from students will be assessed against the intrusiveness criteria.

Table 8: Project specific noise levels

Period	Descriptor	PSNL dB(A)
Residential receivers		
Day (7:00am to 6:00pm)	$L_{Aeq,15min}$	**50**
Evening (6:00pm to 10:00pm)	$L_{Aeq,15min}$	**42**
Night (10:00pm to 7:00am)	$L_{Aeq,15min}$	**37**
Commercial receivers		
When in use	$L_{Aeq,duration}$	**65**

Where necessary, noise mitigation measures will be incorporated in the design to ensure that noise levels comply with the recommended noise emission criteria noted above.

4.3 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)
Local roads	Existing residences affected by additional traffic on existing local roads generated by land use developments	$L_{Aeq,1\ hour}$ 55 (external)	$L_{Aeq,1\ hour}$ 50 (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'.

4.4 Construction Noise Criteria

Noise criteria for construction sites are established in accordance with the Interim Construction Noise Guideline (*ICNG July 2009*) by the NSW Office of Environment & Heritage (NSW OE&H) currently under 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 noise limits are presented in Table 10, and are applicable to the development.

Table 10: NSW 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 EPA ICNG

4.5 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.

4.5.1 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: Preferred and maximum weighted RMS values for continuous and impulsive vibration acceleration (m/s2) 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/s1.75)

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

4.5.2 Structural Damage – Vibration Criteria

Ground vibration criteria are defined in terms of levels of vibration emission from 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

4.5.3 Vibration Objectives

Table 15 indicates the vibration criteria for the nearest residential and commercial properties to the development.

Table 15: Construction vibration criteria summary

Location	Period	Human Comfort Vibration Objectives			Building damage Objectives – Velocity (mm/s)
		Continuous mm/s^2 (RMS)		Intermittent $m/s^{1.75}$ (VDV)	
		z-axis	x- and y-axis		
Residential	Daytime	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

5. Noise Impact Assessment

5.1 Train Noise Impact

Based on the noise measurements conducted from train pass bys as shown in Table 3, and using the number of train movements for the respective periods as per the train timetables, the results of the train noise measurements at the façade of the development have been calculated. The levels have been calculated in accordance with the DoP Interim Guideline and are shown in Table 16.

Table 16: Train noise levels, $L_{Aeq,\ period}$ dB(A)

Location	Day time $L_{Aeq,\ 15hours}$ dB(A)	Night time $L_{Aeq,\ 9hours}$ dB(A)
Most affected facade	40	37

The noise levels as shown above are purely from train movements for the glazing design in accordance with the requirements of the DoP Interim Guideline.

5.2 External Façade

The general limiting factor of the performance of a building façade in term of noise attenuation is the glazing. The traffic noise along the Hume Highway and train noise provides the most acoustic demand on the facilities within the school.

In order to achieve the internal noise levels specified, the minimum recommended glazing selection for the façades of the proposed development is presented Table 17. The required Rw ratings have been provided which takes into account the performance when installed in a frame. This glazing as presented below has been designed to meet both the internal noise requirements.
The glazing thicknesses corresponding to the Rw ratings are presented below in Table 17, 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.

Table 17: Recommended acoustic performance of glazing system

Facade	Glazing configuration	Required Acoustic Rating of Glazing Assembly, Rw[3]
North, South, West	6mm float	31
East	6.38mm laminated	32
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.

Note that all recommendations in this sections are based on acoustic requirements only, structural, thermal and other considerations should be accounted for when providing construction documentation.

[3] See Appendix 1 for Rw definition

5.3 Alternative Means of Ventilation

An open windows assessment has been conducted in order to assess whether the habitable spaces can meet the internal noise level requirements of the DoP Interim Guideline with windows open for natural ventilation (where open windows means in accordance with the natural ventilation requirements of the NCC). If there is an exceedance of the internal noise level criteria with the windows open, alternative means of ventilation is required in accordance with the requirements of the NCC (i.e. mechanical ventilation or air conditioning system complying with AS 1668.2 and AS/NZS 3666.1).

The assessment has been conducted using the typical estimation (and as recommended in the DoP Interim Guideline) that when the windows are open to 5% of the floor area of the room being ventilated, that the windows achieves 10dB reduction in noise level. Room loss has also been considered.

The DoP states that with windows open the criteria is to increase by 10dB internally. The lowest internal criteria is therefore 45dB(A) with windows open. Based on the location of the new facility, there is not expected to be an exceedance of 45dB(A) from either noise from the rail line or the Hume Highway with windows open for natural ventilation.

5.4 Students Noise Emissions

The school is proposed to have a total of 782 students after the addition of 184. The proposed modifications to the facilities and school do not result in any newly or more heavily affected receivers. Rather there will just be an increase in the overall noise level on top of what there currently is to existing impacted residences, therefore the increase in students can be assessed as an increase in noise level based on the relative increase in students to existing students. Refer to Table 18 for the results of the assessment.

Table 18: Predicted noise level increase

Current Student Capacity	Proposed Increase	Future Student Capacity	Relative increase in noise level (dB)
598	184	782	1.2

Based on the results of the assessment, the increase in total capacity at the school is not expected to result in any adverse impacts to surrounding residences, as the increase is marginally more than 1dB and considered negligible. This assessment is also worst case, and as such it is not expected that there will be any impact from the additional students provided operationally there are no changes to the school.

5.5 Mechanical Noise Emissions

The new facilities to the school are proposed to be naturally ventilated where possible. In the requirement for mechanical ventilation, the following assessment would be required. This assessment therefore considers external condenser units in order to predict the worst case scenario noise impact from the new works to the residential receivers.
The main mechanical sources associated with the development will include:

- Condenser units for the facilities

In order to assess the worst case scenario, it was assumed that the air conditioning units associated with the facilities are running at any time throughout the day time. The units have been calculated from all building façades to the most affected external residential receiver.

Refer to Table 19 for the proposed sound power levels for the mechanical plant associated with the proposed development. Acoustic mitigation measures such as utilising distance to receivers, and/or acoustic screening/enclosures of the units may be required based on the final selection and location.

Table 19: Sound power levels for mechanical plant

Item	SWL re 10^{-12} W dB								
	63 Hz	125 Hz	250 Hz	500 Hz	1 KHz	2 KHz	4 KHz	8 KHz	Overall dB(A)
Condenser unit	67	64	65	66	65	64	60	53	70

5.5.1 Road Traffic Noise Generation

For the road traffic noise assessment, existing traffic numbers and estimated generated vehicles from the proposed development was based on information provided Transport Planning. This data has been used to calculate the expected noise increase due to traffic associated with the development on Mulla Road. The results are summarized in Table 20.

Table 20: Existing and predicted traffic flow volumes (peak hour)

Traffic Volume	Existing vehicles	Predicted Increase	Noise Level Increase dB
	AM	AM	AM
Mulla Road	467	43	0.4

Based on the predicted increase in vehicles on Mulla Road during the peak hours, there is not expected to be an exceedance of the requirements of the NSW RNP in regards to the 2dB increase in noise levels.

6. Train Vibration

A vibration assessment has been conducted in accordance with the DoP Interm Guideline and referenced documents due to the proximity to the train line. The vibration levels of trains pass bys have been measured at the nearest point on the façade of the proposed development for all three axes. The measured values were processed and assessed in accordance with the criteria to determine whether there will be any adverse effect on occupants of the development from human perception, or potential structural damage to the building. Refer to Table 21 for the Vibration Dose Value results based on the Z axis of the measurements for human comfort.

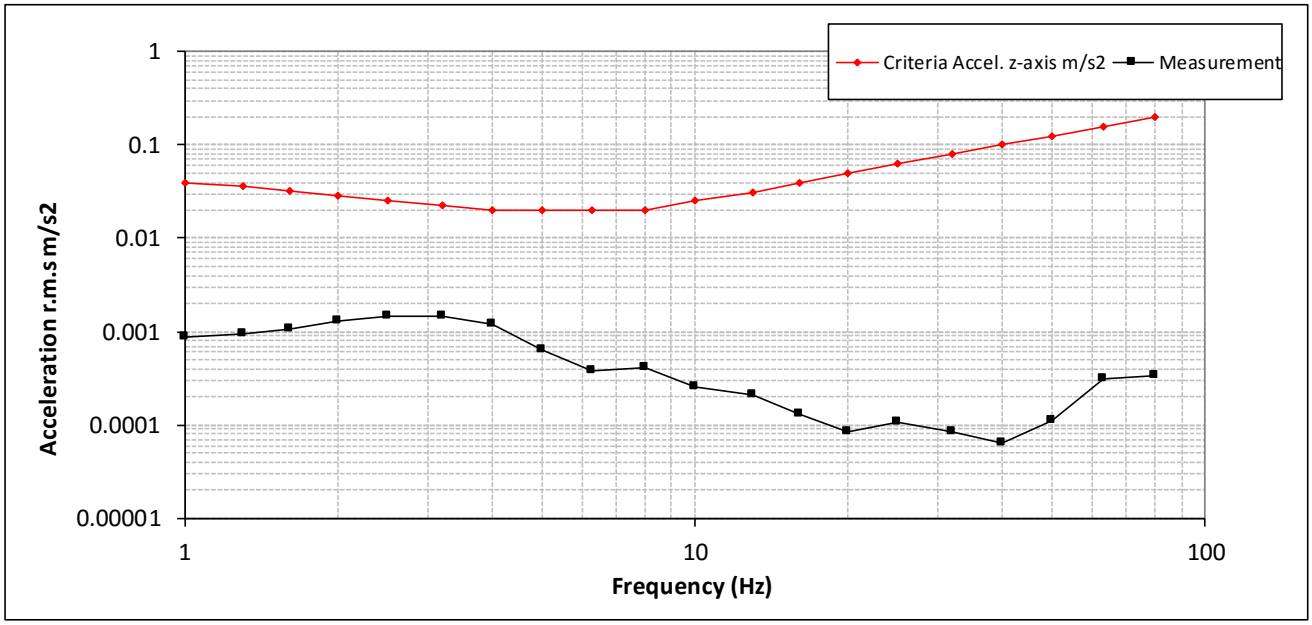
Table 21: Vibration Dose Values from train vibration

Period	eVDV ($m/s^{1.75}$)	Criteria	Complies (Yes/No)
Day (7am – 10pm)	0.033	0.40	Yes
Night (10pm – 7am)	0.024	0.40	Yes

Based on the vibration measurements, there is not predicted to be any human annoyance or disturbance to the occupants of the proposed development as determined in accordance with the "Assessing Vibration: A technical Guideline" document.

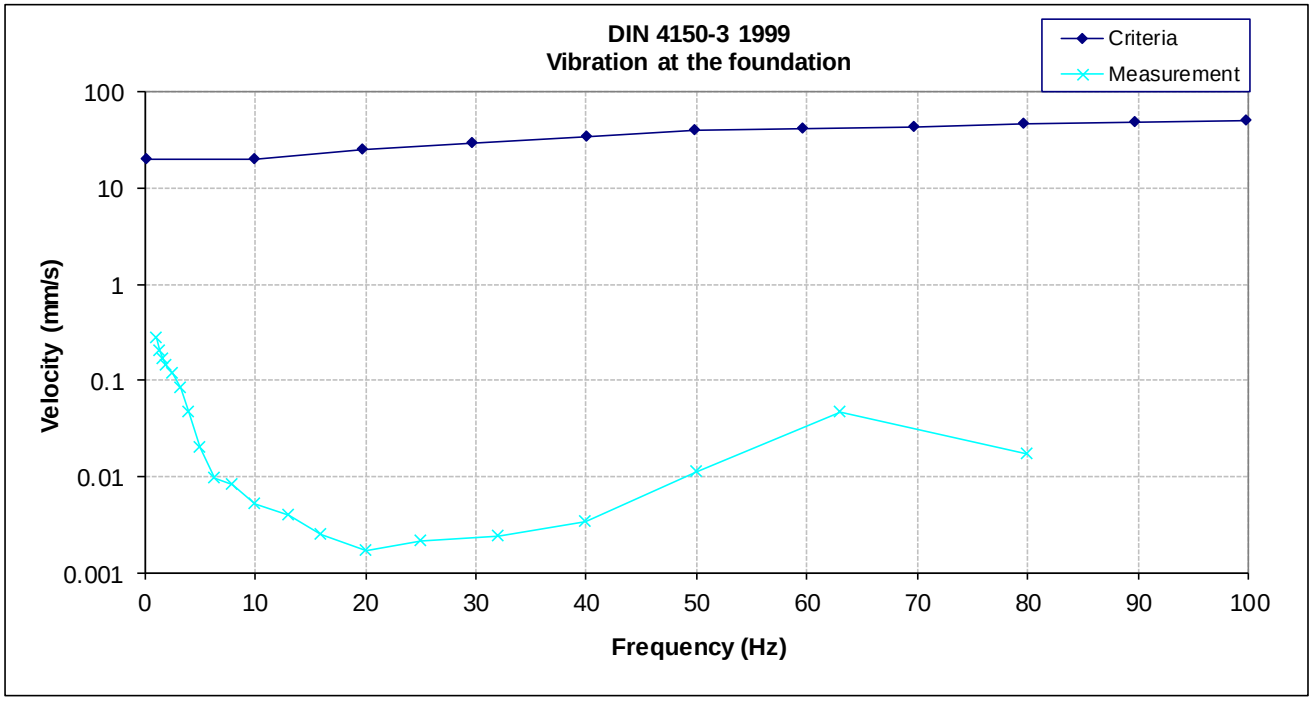
Refer to Figure 3 for the Z axis vibration acceleration against the BS6472 criteria.

Figure 3: Train vibration for human comfort (BS 6472)



Refer to Figure 4 for the results of the vibration velocity levels for comparison with the structural damage criteria from DIN4150 – 3.

Figure 4: Train vibration for structural damage (DIN 4150)



Based on the measured vibration levels, there is not expected to be any exceedance of the criteria in regards to human comfort or structural damage.

7. Conclusion

An acoustic assessment for the proposed redevelopment/expansion to the Yagoona Public School has been conducted. This document forms part of the documentation package to be submitted to local authorities as part of the DA process.

This report has provided criteria, in-principle treatment and design requirements which aim to achieve the statutory criteria as discussed in Section 3. In terms of noise criteria, the following has been provided:

- Internal noise levels in accordance with Bankstown Council, and the Educational Facilities Standards & Guidelines
- Noise criteria for emissions from the development
- Construction noise criteria
- Construction vibration criteria

Glazing for any new educational facilities has been designed in accordance with the EFS&G and the SEPP Infrastructure. The glazing is presented in section 5.2.

An assessment as to whether windows can be open to achieve natural ventilation in accordance with the DoP Interim Guideline has been conducted. Windows can be left open whilst achieving the internal noise level criteria from the DoP Interim Guideline.

A maximum sound power level has been proposed for condenser units in the event that they are required. This level should be reviewed when more information is known regarding proposed location, in order to determine if any acoustic treatment is required.

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.

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

Appendix 1 - 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.

Appendix

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.