Nepean Creative and Performing Arts High School Hall – Acoustic Report

BKA Architecture
Suite 104/77 Dunning Avenue
Rosebery NSW 2018

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1 INTRODUCTION

Pulse White Noise Acoustics Consultancy Pty Ltd (Pulse White Noise Acoustics) has been engaged by BKA Architecture to undertake an Acoustic for the proposed Hall at the Nepean Creative and Performing Arts High School, 115-119 Great Western Highway Emu Plains. The hall is proposed to be include a basketball court, change rooms, equipment storage and a foyer.

This document assesses the potential operational noise impacts of the hall on the nearby residential receivers. In particular, operational impacts of the use of the hall as well as mechanical equipment are assessed at the nearest receptors.

Noise criteria in this report are taken from the Noise Policy for Industry and Interim Construction Noise Guideline, Assessing Vibration: A Technical Guideline, BS 7385-2 and BS 6472. Noise modelling of the potential operational impacts is conducted in iNoise 2021.

Relevant noise recommendations are given in this report. A list of acoustic terminology used in this report is included in Appendix A.

2 PROJECT DETAILS

2.1 Site Location

The hall is proposed to be located at the Nepean Creative and Performing Arts High School, 115-119 Great Western Highway, Emu Plains, formally known as Lot 12 in DP 1056135. The site is zoned R2 Low Density Residential and is located in the Penrith City Council local government area. The closest residential receptors are located along Gardenia Avenue to the south.

The proposed site is located 3km west of the Penrith CBD, on the western side of the Nepean River. The north side of the site borders the Western Railway line, the eastern edge of the site fronts the Great Western Highway with the southern edge of the site backing onto residential receivers off Gardenia Avenue. The site location is shown in Figure 2-1.

Figure 2-1 Site location

2.2 Project Description

The proposed hall is to be located at the Nepean Creative and Performing Arts High School, 115-119 Great Western Highway, Emu Plains. We understand the summary of works to be as follows

- New multipurpose performance hall to meet Stream 9 EFSG Standards and to be used for performances, events, indoor sports and as community resource.
- Large storage requirements to house performing arts apparatus and equipment as well as sporting equipment.
- Existing storage shed, gas tanks and garbage collection zone and stormwater services to be relocated.
- New hardscape and landscaping works between existing hall and new building.
- New hardscape and landscaping works between new building and block G.

The Hall is proposed to be available for use from 7am to 10pm, seven days a week (including use on the weekends). The site analysis plan is shown below in Figure 2-2. The proposed ground floor and first floor plans are shown in Figure 2-3 and Figure 2-4. The proposed elevations are shown in Figure 2-5 and Figure 2-6.

Figure 2-2 Proposed Site Analysis Plan

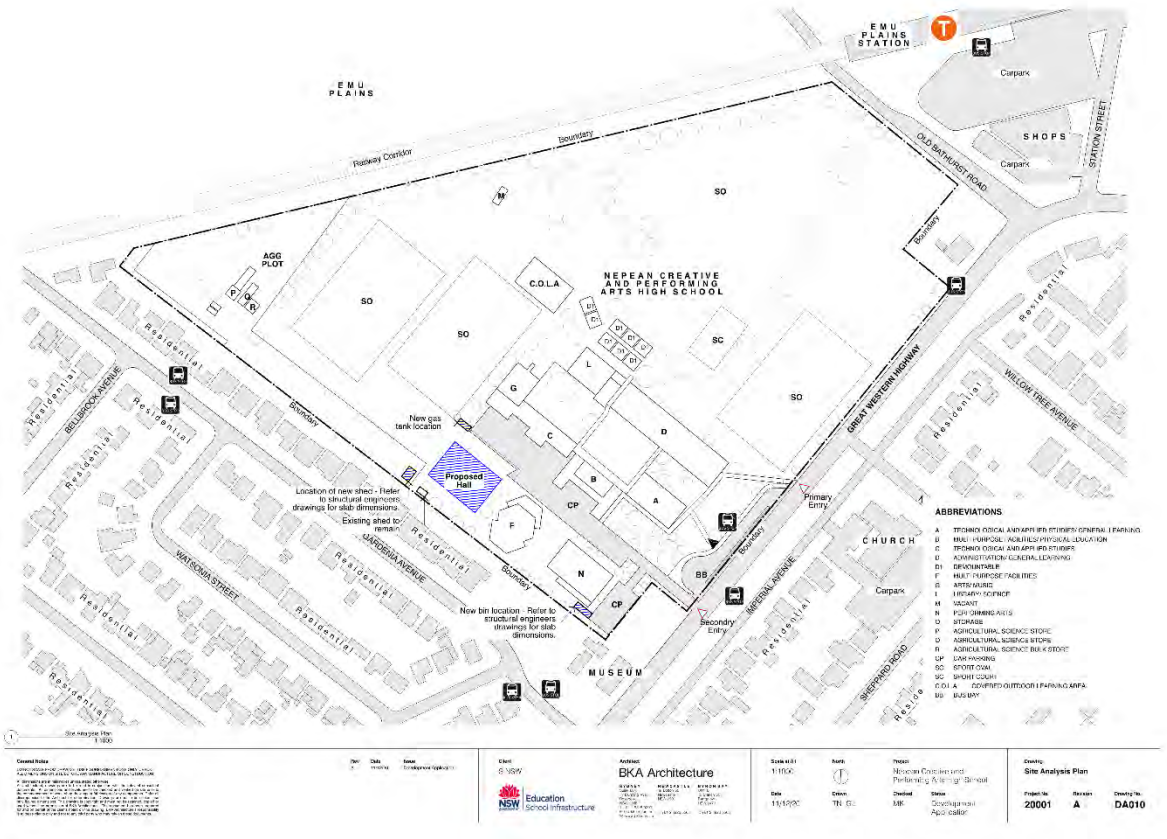


Figure 2-3 Proposed Ground Floor Plan

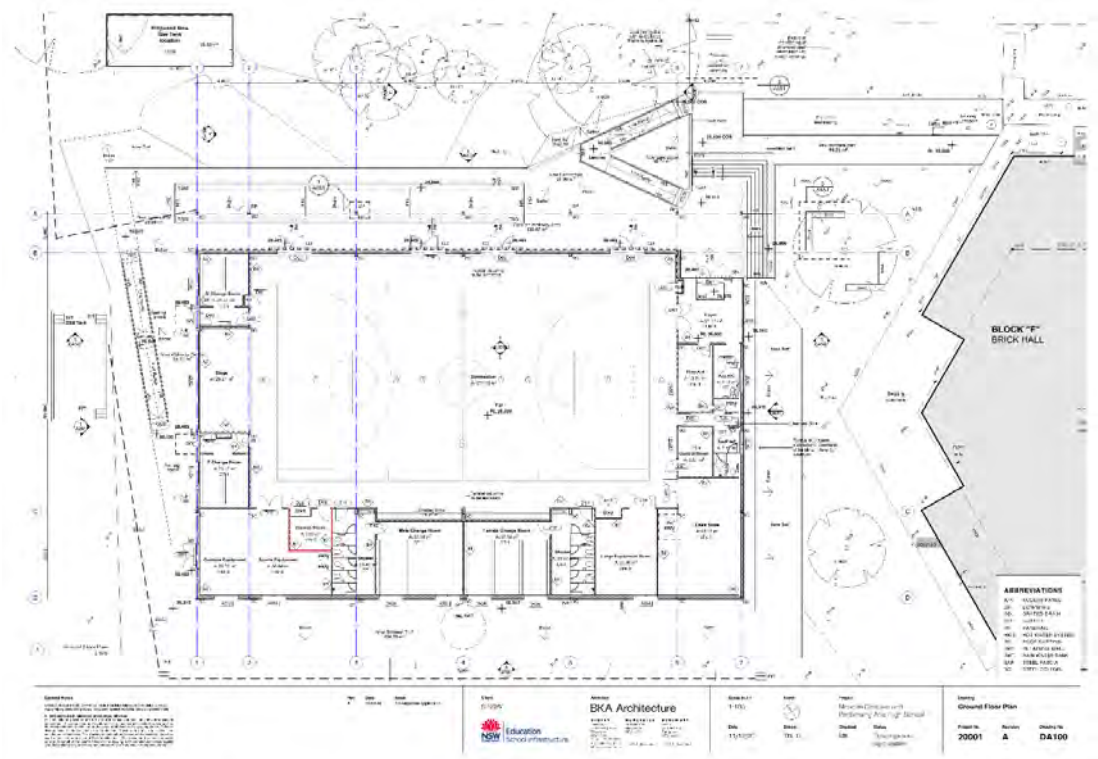


Figure 2-4 Proposed Roof Plan

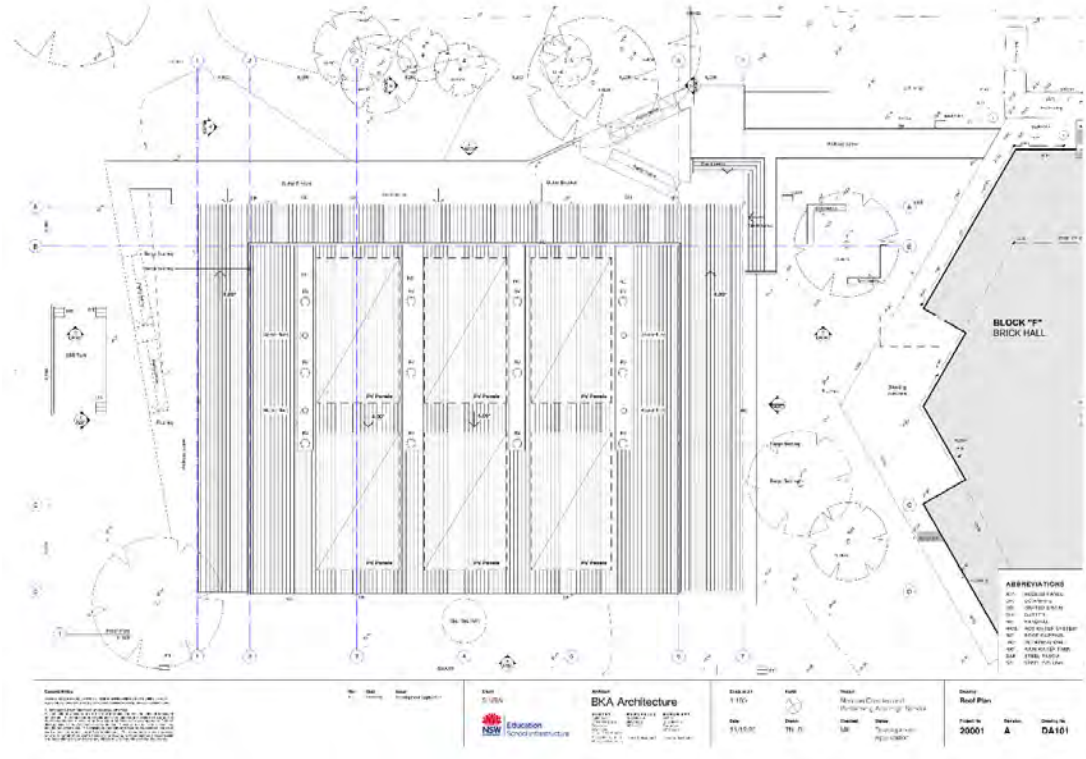


Figure 2-5 Proposed SE and NE Elevations

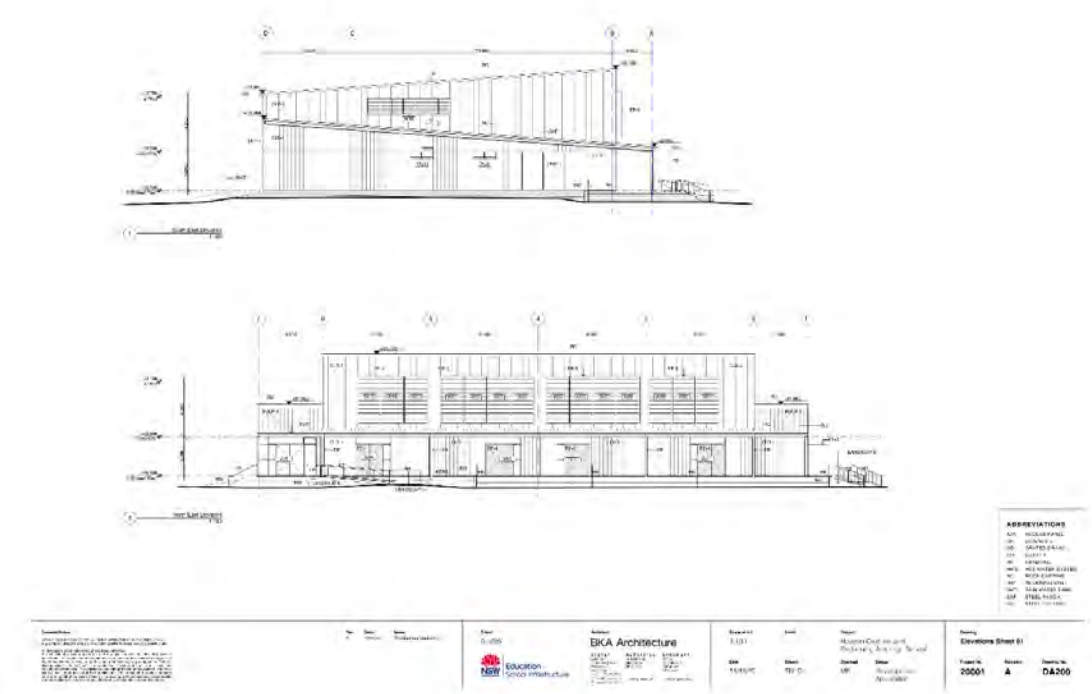
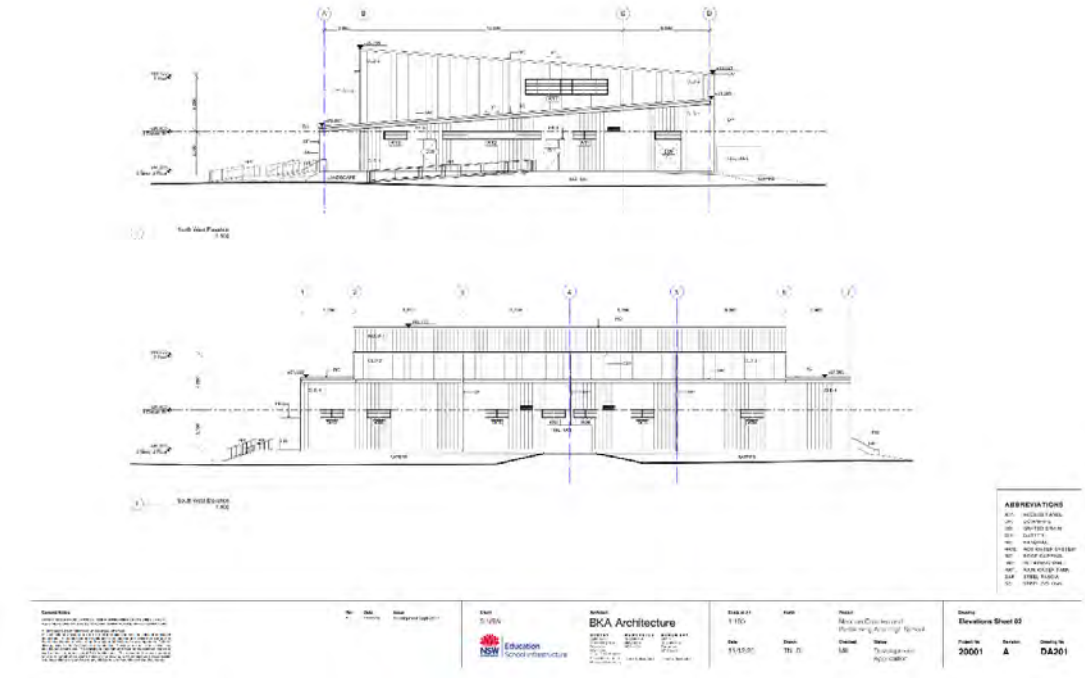


Figure 2-6 Proposed NW and SW Elevations



3 NEAREST SENSITIVE RECEPTORS

A number of sensitive receivers are located in the vicinity of the proposed hall. As shown in Figure 3-1, residential receivers are located to the south, along Gardenia Parade. The receptors utilised for noise predictions in this report are listed in Table 3-1 and presented in Figure 3-1.

Figure 3-1 Location of Considered Receivers

Table 3-1 Nearest Potentially Affected Receivers

Receptor ID	Address	Lot and DP	Type of Receiver
R1	1 Gardenia Avenue, Emu Plains	Lot 1 DP 242300	Residential
R2	3 Gardenia Avenue, Emu Plains	Lot 2 DP 242300	Residential
R3	5 Gardenia Avenue, Emu Plains	Lot 3 DP 242300	Residential
R4	7 Gardenia Avenue, Emu Plains	Lot 4 DP 242300	Residential
R5	9 Gardenia Avenue, Emu Plains	Lot 5 DP 242300	Residential
R6	11 Gardenia Avenue, Emu Plains	Lot 6 DP 242300	Residential
R7	13 Gardenia Avenue, Emu Plains	Lot 7 DP 242300	Residential
R8	15 Gardenia Avenue, Emu Plains	Lot 8 DP 242300	Residential

4 EXISTING ACOUSTIC ENVIRONMENT

4.1 Noise Descriptors and Terminology

Environmental noise constantly varies in level with time. Therefore, it is necessary to measure noise in terms of quantifiable time periods with statistical descriptors. Typically environmental noise is measured over 15 minute periods and relevant statistical descriptors of the fluctuating noise are determined to quantify the measured level.

Noise (or sound) consists of minute fluctuations in atmospheric pressure capable of detection by human hearing. Noise levels are expressed in terms of decibels, abbreviated as dB or dBA, the "A" indicating that the noise levels have been frequency weighted to approximate the characteristics of normal human hearing. Because noise is measured using a logarithmic scale, 'normal' linear arithmetic does not apply, e.g. adding two sound sources of equal values result in an increase of 3 dB (i.e. 60 dBA plus 60 dBA results in 63 dBA). A change of 1 dB or 2 dB in the sound level is difficult for most people to detect, whilst a 3 dB – 5 dB change corresponds to a small but noticeable change in loudness. A 10 dB change roughly corresponds to a doubling or halving in loudness.

The most relevant environmental noise descriptors are the L_{Aeq}, L_{A1}, L_{A10} and L_{A90} noise levels. The L_{Aeq} noise level represents the "equivalent energy average noise level". This parameter is derived by integrating the noise level measured over the measurement period. It represents the level that the fluctuating noise with the same acoustic energy would be if it were constant over the measured time period.

The L_{A1}, L_{A10} and L_{A90} levels are the levels exceeded for 1%, 10% and 90% of the sample period. These levels can be considered as the maximum noise level, the average repeatable maximum and average repeatable minimum noise levels, respectively.

Specific acoustic terminology is used in this assessment report. An explanation of common acoustic terms is included in Appendix A.

4.2 Unattended Acoustic Monitoring

4.2.1 Monitoring Details

To determine the background noise levels at nearby receivers, long term unattended noise monitoring was conducted at the boundary of the school and 7 Gardenia Avenue Emu Plains. As per Table A1 of the Noise Policy for Industry, the noise logger was placed in the vicinity of the reasonably most or potentially most affected residence. The location of the noise is shown in Figure 3-1 and Figure 4-1. The logging was also conducted during school holidays, so that any local noise sources from the school would not be present to add to the existing local background noise levels.

Figure 4-1 Position of Unattended Noise Logger

4.2.2 Monitoring Instrumentation

Instrumentation used for the noise survey comprised a Rion NL-42 sound level meter / analysers (serial number 00409024 fitted with a microphone windshield. Calibration of the logger was checked prior to and following the measurements. Drift in calibration did not exceed ±0.5 dBA. All equipment carried appropriate and current NATA (or manufacturer) calibration certificates.

Charts presenting summaries of the measured daily noise data are attached in Appendix B. These charts, representing each 24 hour period, show the L_{A1}, L_{A10}, L_{Aeq} and L_{A90} noise levels measured over 15 minute time periods.

Logging was conducted from Thursday 14 January 2021 to Thursday 21 January 2021. The measurement results have been filtered to remove data affected by adverse weather conditions, such as excessively windy or rainy time periods, as recorded by the nearest Bureau of Meteorology weather station at Penrith Lakes (AWS 067113). Detailed noise logging results are shown in Appendix B.

The measured background noise data of the logger was processed in accordance with the recommendations contained in the NSW Environment Protection Authority's (EPA) *Noise Policy for Industry* (NPI).

The Rating Background Noise Level (RBL) is the background noise level used for assessment purposes at the nearest potentially affected receiver. It is the 90th percentile of the daily background noise levels during each assessment period, being day, evening and the night. The RBL $L_{A90\ (15minute)}$ and L_{Aeq} noise levels are presented in Table 4-1 for the unattended logging. The measured noise levels are considered to be representative of the levels to be expected at the nearest and most affected residence to the proposed development.

Table 4-1 Measured ambient noise levels in accordance with the NSW NPI

Measurement Location	Daytime[1] 7:00 am to 6:00 pm		Evening[1] 6:00 pm to 10:00 pm		Night-time[1] 10:00 pm to 7:00 am	
	L_{A90}[2]	L_{Aeq}[3]	L_{A90}[2]	L_{Aeq}[3]	L_{A90}[2]	L_{Aeq}[3]
Logger Location	39	58	37	53	31	46

Note 1: For Monday to Saturday, Daytime 7:00 am – 6:00 pm; Evening 6:00 pm – 10:00 pm; Night-time 10:00 pm – 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

Note 2: The L_{A90} noise level is representative of the "average minimum background sound level" (in the absence of the source under consideration), or simply the background level.

Note 3: The LAeq is the energy average sound level. It is defined as the steady sound level that contains the same amount of acoustical energy as a given time-varying sound.

5 APPLICABLE GUIDELINES AND RECOMMENDED CRITERIA

This section contains noise criteria on the operational criteria, construction criteria and vibration criteria.

The following criteria are relevant for the assessment of noise and vibration emissions from the proposed training centre:

- For the assessment of the predicted operational noise emissions by the training facility: The criteria have been derived in accordance with the *Noise Policy for Industry* (EPA, 2017). Refer to Section 5.2.
- The assessment of the noise impacts of the construction noise on the sensitive receivers: The criteria have been derived in accordance with the *Interim Construction Noise Guideline* (DECC, 2009). See Section 5.3.
- For the assessment of vibration impacts from the development: The criteria have been derived in accordance with Assessing Vibration: A Technical Guideline (DEC, 2006), BS 7385-2: 1993 and BS 6472: 1992. Refer to Section 5.4.

5.1 Penrith Council DCP

Penrith DCP Part C – City Wide Controls contains the following advice under section C12 Noise and Vibration.

12.4. Industrial and Commercial Development

C. Controls

1) General

a) Council will not grant consent to any noise generating industrial development, commercial development or licensed premises unless it can be demonstrated that:

i) The development complies with the relevant State Government authority or agency standards and guidelines for noise, as well as any relevant Australian Standards;

ii) The development is not intrusive (as defined in the EPA's Industrial Noise Policy);

Penrith DCP Part D – Land Use Controls contains the following advice under section D5 Other Land Uses.

5.4 Educational Establishments

A. Background

Given their scale, form and potential impact, there is a need to ensure educational establishments are located and designed in such a way as to minimise their impacts, particularly on surrounding areas. It is also important to ensure that nearby land uses do not have an adverse impact on children's health and learning.

B. Objectives

a) To ensure that the design and location of educational establishments does not adversely impact on the amenity of the area or neighbouring properties, including properties used for agriculture;

By complying with the criteria derived from the Noise Policy for Industry (section 5.2), compliance with the acoustic requirements within the Penrith DCP will also be met.

5.2 NSW Noise Policy for Industry

In NSW, the control of noise emissions is the responsibility of Local Government and the NSW Environment Protection Authority (NSW EPA). In October 2017, the NSW EPA released the *Noise Policy for Industry* (NSW NPI). The purpose of the policy is to ensure that noise impacts associated with particular industrial developments are evaluated and managed in a consistent and transparent manner. The policy aims to ensure that noise is kept to acceptable levels in balance with the social and economic value of industry in NSW.

The NSW NPI criteria for industrial noise sources have two components:

- Controlling the intrusive noise impacts for residential receivers in the short-term; and
- Maintaining noise level amenity of particular land uses for residents and sensitive receivers in other land uses.

The project noise trigger level is derived from the more stringent value out of the project intrusiveness noise level and the project amenity noise level.

5.2.1 Intrusive Noise Impacts (Residential Receivers)

The NSW NPI states that the noise from any single source should not intrude greatly above the prevailing background noise level. Industrial noises are generally considered acceptable if the equivalent continuous (energy-average) A-weighted level of noise from the source (L_{Aeq}), 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). This is often termed the Intrusiveness Criterion.

The 'Rating Background Level' (RBL) is the background noise level to be used for assessment purposes and is determined by the methods given in the NSW NPI. Using the rating background noise level approach results in the intrusiveness criterion being met for 90% of the time. Adjustments are to be applied to the level of noise produced by the source that is received at the assessment point where the noise source contains annoying characteristics such as tonality or impulsiveness.

5.2.2 Protecting Noise Amenity (All Receivers)

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 2.2 of the NSW NPI. That is, the ambient L_{Aeq} noise level should not exceed the level appropriate for the particular locality and land use. This is often termed the 'Background Creep' or Amenity Criterion.

The amenity assessment is based on noise criteria specified for a particular land use and corresponding sensitivity to noise. The cumulative effect of noise from industrial sources needs to be considered in assessing the impact. These criteria relate only to other continuous industrial-type noise and do not include road, rail or community noise. If the existing (measured) industrial-type noise level approaches the criterion value, then the NSW NPI sets maximum noise emission levels from new sources with the objective of ensuring that the cumulative levels do not significantly exceed the criterion.

5.2.3 Area Classification

The NSW NPI characterises the "Suburban Residential" as an area that has local traffic with characteristically intermittent traffic flows or with some limited commerce or industry. This area often has the following characteristic: evening ambient noise levels defined by the natural environment and human activity.

For the considered receptors in the rural area, the recommended amenity noise level is shown in Table 5-1 below. When the existing noise level from industrial noise sources is close to the recommended "Amenity Noise Level" (ANL) given above, noise from the new source must be controlled to preserve the amenity of the area in line with the requirements of the NSW NPI.

Table 5-1 NSW NPI – Recommended L_{Aeq} Noise Levels from Industrial Noise Sources

Type of Receiver	Indicative Noise Amenity Area	Time of Day[1]	Recommended Amenity Noise Level ($L_{Aeq, period}$)[2]
Residence	Suburban	Day	55
		Evening	45
		Night	40

Note 1: For Monday to Saturday, Daytime 7:00 am – 6:00 pm; Evening 6:00 pm – 10:00 pm; Night-time 10:00 pm – 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

Note 2: The L_{Aeq} is the energy average sound level. It is defined as the steady sound level that contains the same amount of acoustical energy as a given time-varying sound.

5.2.4 Project Trigger Noise Levels

The intrusive and amenity criteria for industrial noise emissions derived from the measured data are presented in Table 5-2. The amenity and intrusive criterion are nominated for the purpose of determining the operational noise limits for noise sources associated with the development which can potentially affect noise sensitive receivers.

For each assessment period, the project trigger noise levels are the lower (i.e. the more stringent) of the amenity or intrusive criteria. The project trigger noise levels are shown in bold text in Table 5-2.

Table 5-2 External noise level criteria in accordance with the NSW NPI

Location	Time of Day	Project Amenity Noise Level, $L_{Aeq, period}$ [1] (dBA)	Measured $L_{A90, 15\ min}$ (RBL) [2] (dBA)	Measured $L_{Aeq, period}$ Noise Level (dBA)	Intrusive $L_{Aeq, 15\ min}$ Criterion for New Sources (dBA) [3]	Amenity $L_{Aeq, 15\ min}$ Criterion for New Sources (dBA) [3, 4]
Residence (Suburban)	Day	50	39	58	44	53
	Evening	40	37	53	42	43
	Night	35	31	46	36	38

Note 1: Project Amenity Noise Levels corresponding to "suburban" areas, equivalent to the Recommended Amenity Noise Levels minus 5 dBA

Note 2: L_{A90} Background Noise or Rating Background Level

Note 3: Project Noise Trigger Levels are shown in bold

Note 4: According to Section 2.2 of the NSW NPI, the LAeq, 15 minutes is equal to the LAeq, period + 3 dB

5.2.5 Sleep Disturbance

As the facility is not proposed to operate during the night time period, sleep disturbance is not assessed in this report.

5.3 Interim Construction Noise Guideline

The DECC *Interim Construction Noise Guideline* (ICNG, July 2009) provides guidelines for the assessment and management of construction noise. The NSW EPAs Road Noise Policy (RNP) refers to the use of the ICNG for the assessment of construction noise impacts.

The ICNG focuses on applying a range of work practices and management strategies to minimise construction noise impacts rather than focusing on achieving numeric noise levels which is not always practical on large infrastructure projects.

The main objectives of the ICNG are to:

- Identify and minimise noise from construction works
- Focus on applying all 'feasible' and 'reasonable' work practices to minimise construction noise impacts
- Encourage construction during the recommended standard hours only, unless approval is given for works that cannot be undertaken during these hours
- Reduce time spent dealing with complaints at the project implementation stage
- Provide flexibility in selecting site-specific feasible and reasonable work practices to minimise noise impacts

5.3.1 Quantitative Noise Assessment Criteria

Construction noise assessment goals presented in the ICNG are referenced to Noise Management Levels (NMLs) for residential, sensitive land uses and commercial/industrial premises.

Residential premises

Table 5-3 sets out NMLs for noise at residences and how they are to be applied.

In Table 5-3 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). The term RBL is described in detail in the NSW *Noise Policy for Industry* (EPA, 2017).

As a guide, the difference between the internal noise level and the external noise level is typically 10 dB with windows open for adequate ventilation.

Table 5-3 Noise at Residents Using Quantitative Assessment

Time of day	Management Level $L_{Aeq\ (15\ min)}$[1]	How to apply
Recommended standard hours: Monday to Friday 7am to 6pm Saturday 8am to 1pm No work on Sundays or public holidays	Noise affected RBL + 10 dB	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.

Time of day	Management Level $L_{Aeq\ (15\ min)}$[1]	How to apply
	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, 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 + 5 dB	- 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.

Note 1: Noise levels apply at the property boundary that is most exposed to construction noise, and at a height of 1.5m above ground level. If the property boundary is more than 30m from the residence, the location for measuring or predicting noise levels is at the most noise-affected point within 30 m of the residence. Noise levels may be higher at upper floors of the noise affected residence.

Construction hours are understood to be as follows:

- Monday to Friday 7 am to 6 pm
- Saturday 8 am to 1 pm

Proposed construction hours only fall under the recommended standard hours outlined in the ICNG

Table 5-4 NMLs as basis for the acoustic assessment

Receiver Types	Noise management level ($L_{Aeq,15min}$) dB(A) Standard Hours Monday to Friday: 7 am to 6 pm Saturday: 8 am to 1 pm
Residences	49

As no construction is expected to occur outside of standard hours, a sleep disturbance assessment for construction noise is not required.

5.4 Vibration Criteria

Effects of ground borne vibration on buildings may be segregated into the following three categories:

- Human comfort – vibration in which the occupants or users of the building are inconvenienced or possibly disturbed
- Effects on building contents – where vibration can cause damage to fixtures, fittings and other non-building related objects
- Effects on building structures – where vibration can compromise the integrity of the building or structure itself

5.4.1 Vibration Criteria – Human Comfort

The first of these vibration effects relating specifically to the human comfort aspects of the project are taken from the *Assessing Vibration – A Technical Guideline*. This type of impact can be further categorised and assessed using the appropriate criterion as follows:

- Continuous vibration – from uninterrupted sources (see Table 5-5)
- Impulsive vibration – up to three instances of sudden impact e.g. dropping heavy items, per monitoring period (see Table 5-6)
- Intermittent vibration – such as from drilling, compacting or activities that would result in continuous vibration if operated continuously (see Table 5-7)

Table 5-5 Continuous Vibration Acceleration Criteria (m/s2) 1-80Hz

Location	Assessment period	Preferred Values		Maximum Values	
		z-axis	x- and y-axis	z-axis	x- and y-axis
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 places of worship	Day or night-time	0.020	0.014	0.040	0.028
		0.04	0.029	0.080	0.058
Workshops	Day or night-time	0.04	0.029	0.080	0.058

Note 1: From Assessing Vibration – A Technical Guideline DEC (2006)

Table 5-6 Impulsive Vibration Acceleration Criteria (m/s2) 1-80Hz

Location	Assessment period	Preferred Values		Maximum Values	
		z-axis	x- and y-axis	z-axis	x- and y-axis
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 places of worship	Day or night-time	0.64	0.46	1.28	0.92
Workshops	Day or night-time	0.64	0.46	1.28	0.92

Note 1: From Assessing Vibration – A Technical Guideline DEC (2006)

Table 5-7 Intermittent Vibration Impacts Criteria (m/s1.75) 1-80Hz

Location	Daytime		Night-time	
	Preferred Values	Maximum Values	Preferred Values	Maximum Values
Residences	0.20	0.40	0.13	0.26
Offices, schools, educational institutions and places of worship	0.40	0.80	0.40	0.80
Workshops	0.80	1.60	0.80	1.60
Note 1: From Assessing Vibration – A Technical Guideline DEC (2006)				

5.4.2 Vibration Criteria – Building Contents and Structure

The vibration effects on the building itself are assessed against international standards as follows:

- For transient vibration: British Standard BS 7385: Part 2-1993 *"Evaluation and measurement for vibration in buildings Part 2: Guide to damage levels from ground borne vibration"* (BSI 1993); and
- For continuous or repetitive vibration: German DIN 4150: Part 3 – 1999 *"Effects of Vibration on Structure"* (DIN 1999).

5.4.2.1 Standard BS 7385 Part 2 - 1993

For transient vibration, as discussed in standard BS 7385 Part 2-1993, the criteria are based on peak particle velocity (mm/s) which is to be measured at the base of the building. These are summarised in Figure 5-1 and illustrated in Figure 5-1.

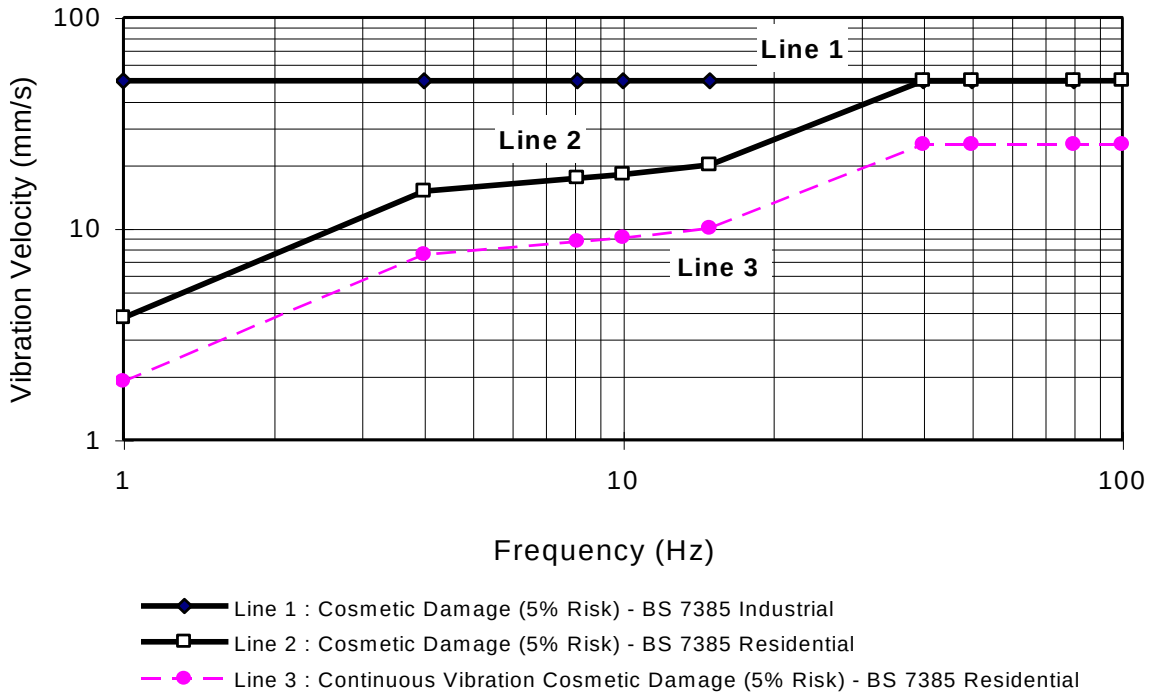
Table 5-8 Transient vibration criteria as per standard BS 7385 Part 2 - 1993

Line in Figure 9	Type of Building	Peak Component Particle Velocity in Frequency Range of Predominant Pulse	
		4 Hz to 15 Hz	15 Hz and above
1	Reinforced or framed structures Industrial and heavy commercial buildings	50 mm/s at 4 Hz and above	
2	Unreinforced or light framed structures Residential or light commercial type buildings	15 mm/s at 4 Hz increasing to 20 mm/s at 15 Hz	20 mm/s at 15 Hz increasing to 50 mm/s at 40 Hz and above

Standard BS 7385 Part 2 – 1993 states that the values in Table 5-8 relate to transient vibration which does not cause resonant responses in buildings.

Where the dynamic loading caused by continuous vibration events is such as that results in dynamic magnification due to resonance (especially at the lower frequencies where lower guide values apply), then the values in Table 5-8 need to be reduced by up to 50% (refer to Line 3 in Figure 5-1).

Figure 5-1 BS 7385 Part 2 – 1993, graph of transient vibration values for cosmetic damage



In the lower frequency region where strains associated with a given vibration velocity magnitude are higher, the recommended values corresponding to Line 2 are reduced. Below a frequency of 4 Hz where a high displacement is associated with the relatively low peak component particle velocity value, a maximum displacement of 0.6 mm (zero to peak) is recommended. This displacement is equivalent to a vibration velocity of 3.7 mm/s at 1 Hz.

The standard also states that minor damage is possible at vibration magnitudes which are greater than twice those given in Table 5-8. Major damage to a building structure may occur at values greater than four times the tabulated values.

Fatigue considerations are also addressed in the standard and it is concluded that unless calculation indicates that the magnitude and number of load reversals is significant (in respect of the fatigue life of building materials) then the values in Table 5-8 should not be reduced for fatigue considerations.

6 OPERATIONAL ACOUSTIC ASSESSMENT

Predictive noise modelling was carried out using the ISO 9613 algorithm within iNoise 2021. The iNoise software package allows a 3D computational model of the site and surrounding area to be created. Inputs into the noise model included terrain, ground absorption, surrounding buildings, fences, receiver locations and noise sources.

6.1 Noise Generating Scenario

This Noise Assessment includes assessment of the potential uses within the hall and mechanical plant. One noise generating scenario is presented with the gymnasium, change rooms and all rooms in the building occupied. The modelled internal noise levels within various spaces of the hall are listed in Table 6-1 below.

Table 6-1 Modelled internal noise levels within spaces

Room	63	125	250	500	1000	2000	4000	8000	Overall
Gymnasium	53	56	65	74	71	67	58	50	75
Change rooms, foyer	39	42	52	56	49	44	40	35	55
Storage rooms, stage, bathrooms	29	32	42	46	39	34	30	25	45

Noise sources are modelled as emitting facades and an emitting roof in the locations shown in Figure 6-1.

Figure 6-1 Operational Scenario

6.2 Modelling Assumptions

The following modelling assumptions are utilised in this noise impact assessment:

- The noise generating scenario is modelled for a worst case 15 minute period;
- Off site terrain has been sourced from the NSW Land and Property Information database Sixmaps;
- On site terrain has been taken from the architectural drawings;
- Ground Absorption has been included in the model with the site and surrounding grass areas having an absorption factor of 0.5;
- All receptors are modelled 1.5m above the ground;
- Off-site structures such as buildings and fences have been included in the model where relevant;
- Noise sources have been modelled as emitting façades or an emitting roof on the exterior of the hall building as per Figure 6-1;
- The noise sources and sound power levels have been modelled with respect to the information presented in Table 6-1;
- Noise transmission through windows is assumed to be 3mm glass;
- Noise transmission through the roof is assumed to be 0.4mm colorbond or similar material;
- Noise transmission through the weather louvres has no transmission loss (Rw = 0); and
- Internal spaces of the hall are assumed to be operational from 7am to 10pm.

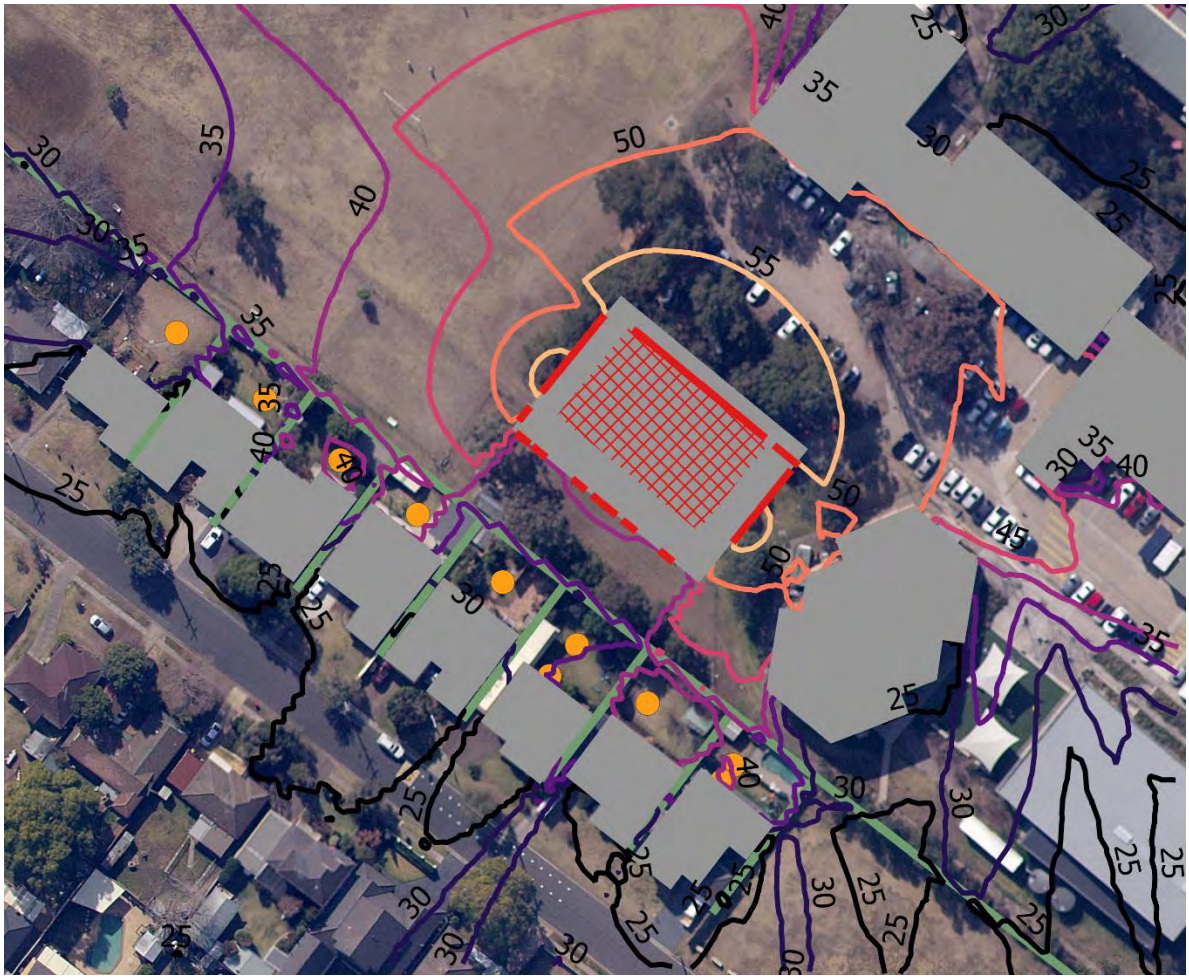
6.3 Predicted Noise Levels

The predicted L_{Aeq} results of the modelled operational scenario are presented below in Table 6-2. All receivers are located in the backyards, with additional receivers placed at 4.5m height at the façades of the two double storey buildings. Noise contours of the modelled operational scenario are shown in Figure 6-2. It is shown that noise levels are predicted to comply with the criteria at the considered receivers.

Table 6-2 Predicted Noise Levels, Operational Scenario, $L_{Aeq\ (15\ minute)}$

Receiver	Criteria		Predicted Noise Levels
	Day	Evening	Operational Scenario
R1 Backyard	44	42	38
R1 Upper Storey	44	42	39
R2 Backyard	44	42	42
R3 Backyard	44	42	35
R3 Upper Storey	44	42	35
R4 Backyard	44	42	34
R5 Backyard	44	42	40
R6 Backyard	44	42	39
R7 Backyard	44	42	36
R8 Backyard	44	42	32

Figure 6-2 Predicted Noise Contours – Operational Activities



6.4 Noise Control Measures

As this assessment is for the DA stage of the development, final selection of mechanical equipment has not occurred. Final selection of equipment is expected before at the Construction Certificate (CC) stage. It is therefore recommended that following the final selection of equipment, noise levels from mechanical equipment be predicted at the nearest receivers. Noise emissions from mechanical equipment are to be acoustically treated to achieve compliance with the external noise level criteria discussed in Section 5.2.

The following noise control measures are therefore recommended for the Nepean High School Hall

- The hall is recommended to be utilised from 7am to 10pm on any day of the week, including use on the weekends.
- Sound pressure levels within the hall from a PA system, music or likewise are recommended not to exceed 75 dBA
- Façade openings such as for the weather louvres, glass windows and doors are recommended to be constructed in the locations shown in these plans
- Noise emissions from mechanical equipment are to be predicted at the CC stage to achieve compliance with the external noise level criteria discussed in Section 5.2

7 CONSTRUCTION NOISE AND VIBRATION

This Acoustic Report is to be submitted for the DA stage of the proposed development. As such, details on the methods of construction are not yet available. A Construction Noise and Vibration Management Plan (CNVMP) is recommended to be carried out during the Construction Certificate stage of the development.

As part of this CNVMP, construction noise impacts are recommended to meet the criteria outlined in section 5.3, while construction vibration impacts are recommended to meet the criteria presented in section 5.4.

8 CONCLUSIONS

Pulse White Noise Acoustics Consultancy Pty Ltd (Pulse White Noise Acoustics) has been engaged by BKA Architecture to undertake an Acoustic for the proposed Hall at the Nepean Creative and Performing Arts High School, 115-119 Great Western Highway Emu Plains. The hall is proposed to be include a basketball court, change rooms, equipment storage and a foyer.

This document assesses the potential operational noise impacts of the proposed hall on the neighbouring receptors. In particular, operational impacts of the use of the hall as well as mechanical equipment are assessed at the nearest receptors.

This document assesses the potential operational noise impacts of the hall on the nearby residential receivers. The following noise control recommendations are contained within this report.

The following noise control measures are therefore recommended for the Nepean High School Hall

- The hall is recommended to be utilised from 7am to 10pm on any day of the week including use on the weekends.
- Sound pressure levels within the hall from a PA system, music or likewise are recommended not to exceed 75 dBA.
- Façade openings such as for the weather louvres, glass windows and doors are recommended to be constructed in the locations shown in these plans.
- Following the final selection of equipment at the Construction Certificate stage, noise levels from mechanical equipment are recommended to be predicted at the nearest receivers. Noise emissions from mechanical equipment are to be acoustically treated to achieve compliance with the external noise level criteria discussed in Section 5.2.
- A Construction Noise and Vibration Management Plan (CNVMP) is recommended to be carried out during the Construction Certificate stage of the development. As part of this CNVMP, construction noise impacts are recommended to meet the criteria outlined in section 5.3, while construction vibration impacts are recommended to meet the criteria presented in section 5.4.

Based on the findings from this Noise Impact Assessment, should the assumptions in this report be carried out, the proposed hall is predicted to comply with the recommended noise criteria at the surrounding receivers.

APPENDIX A: ACOUSTIC TERMINOLOGY

The following is a brief description of the acoustic terminology used in this report.

Sound power level	The total sound emitted by a source
Sound pressure level	The amount of sound at a specified point
Decibel [dB]	The measurement unit of sound
A Weighted decibels [dB(A])	The A weighting is a frequency filter applied to measured noise levels to represent how humans hear sounds. The A-weighting filter emphasises frequencies in the speech range (between 1kHz and 4 kHz) which the human ear is most sensitive to, and places less emphasis on low frequencies at which the human ear is not so sensitive. When an overall sound level is A-weighted it is expressed in units of dB(A).
Decibel scale	The decibel scale is logarithmic in order to produce a better representation of the response of the human ear. A 3 dB increase in the sound pressure level corresponds to a doubling in the sound energy. A 10 dB increase in the sound pressure level corresponds to a perceived doubling in volume. Examples of decibel levels of common sounds are as follows:

0dB(A)	Threshold of human hearing
30dB(A)	A quiet country park
40dB(A)	Whisper in a library
50dB(A)	Open office space
70dB(A)	Inside a car on a freeway
80dB(A)	Outboard motor
90dB(A)	Heavy truck pass-by
100dB(A)	Jackhammer/Subway train
110 dB(A)	Rock Concert
115dB(A)	Limit of sound permitted in industry
120dB(A)	747 take off at 250 metres

Frequency [f]	The repetition rate of the cycle measured in Hertz (Hz). The frequency corresponds to the pitch of the sound. A high frequency corresponds to a high pitched sound and a low frequency to a low pitched sound.
Ambient sound	The all-encompassing sound at a point composed of sound from all sources near and far.
Equivalent continuous sound level [L_{eq}]	The constant sound level which, when occurring over the same period of time, would result in the receiver experiencing the same amount of sound energy.
Reverberation	The persistence of sound in a space after the source of that sound has been stopped (the reverberation time is the time taken for a reverberant sound field to decrease by 60 dB)
Air-borne sound	The sound emitted directly from a source into the surrounding air, such as speech, television or music
Impact sound	The sound emitted from force of one object hitting another such as footfalls and slamming cupboards.
Air-borne sound isolation	The reduction of airborne sound between two rooms.
Sound Reduction Index [R] (Sound Transmission Loss)	The ratio the sound incident on a partition to the sound transmitted by the partition.
Weighted sound reduction index [R_w]	A single figure representation of the air-borne sound insulation of a partition based upon the R values for each frequency measured in a laboratory environment.
Level difference [D]	The difference in sound pressure level between two rooms.

Normalised level difference [D_n]	The difference in sound pressure level between two rooms normalised for the absorption area of the receiving room.
Standardised level difference [D_{nT}]	The difference in sound pressure level between two rooms normalised for the reverberation time of the receiving room.
Weighted standardised level difference [$D_{nT,w}$]	A single figure representation of the air-borne sound insulation of a partition based upon the level difference. Generally used to present the performance of a partition when measured in situ on site.
C_{tr}	A value added to an R_w or $D_{nT,w}$ value to account for variations in the spectrum.
Impact sound isolation	The resistance of a floor or wall to transmit impact sound.
Impact sound pressure level [L_i]	The sound pressure level in the receiving room produced by impacts subjected to the adjacent floor or wall by a tapping machine.
Normalised impact sound pressure level [L_n]	The impact sound pressure level normalised for the absorption area of the receiving room.
Weighted normalised impact sound pressure level [$L_{n,w}$]	A single figure representation of the impact sound insulation of a floor or wall based upon the impact sound pressure level measured in a laboratory.
Weighted standardised impact sound pressure level [$L'_{nT,w}$]	A single figure representation of the impact sound insulation of a floor or wall based upon the impact sound pressure level measured in situ on site.
C_I	A value added to an L_{nW} or $L'_{nT,w}$ value to account for variations in the spectrum.
Energy Equivalent Sound Pressure Level [$L_{A,eq,T}$]	'A' weighted, energy averaged sound pressure level over the measurement period T.
Percentile Sound Pressure Level [$L_{Ax,T}$]	'A' weighted, sound pressure that is exceeded for percentile x of the measurement period T.

*Definitions of a number of terms have been adapted from Australian Standard AS1633:1985 *"Acoustics – Glossary of terms and related symbols"*

APPENDIX B: UNATTENDED NOISE LOGGING