REVERB ACOUSTICS
Noise and Vibration Consultants

Noise Impact Assessment
Muswellbrook Tertiary Education Centre
Lots 3 & 4 DP.11221
Hill Street
Muswellbrook NSW

September 2014

Prepared for Muswellbrook Shire Council
Report No. 14-1840-R1

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

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1 INTRODUCTION

Reverb Acoustics has been commissioned to conduct a noise impact assessment for the proposed Muswellbrook Tertiary Education Centre, Lots 2 and 3 DP.11221 Hill Street Muswellbrook. The purpose of this assessment is to theoretically determine the noise and vibration impact from passing rail traffic on the Great Northern Rail Line, and the noise impact from passing road traffic on Bridge Street, within habitable spaces of the development, and to ensure that noise levels comply with the requirements of AS/NZS2107-2000, Roads and Maritime Services (RMS), the Office of Environment and Heritage (OEH), Department of Planning & Infrastructure (DoPI), and Muswellbrook Shire Council (MSC).

Further assessment has also been undertaken to determine the noise impact activities and equipment associated with nearby commercial developments may have on the proposal (i.e. vehicles in carparks, mechanical plant, etc).

The assessment was requested by MSC to form part of and in support of a Development Application for the proposal and to ensure any noise control measures are incorporated into the design.

2 TECHNICAL REFERENCE / DOCUMENTS

AS 2107-2000 *“Acoustics-Recommended Design Sound Levels and Reverberation Times for Building Interiors”.*

AS 1276.1-1999 *“Acoustics – Rating of sound insulation in buildings and of building elements. Part 1: Airborne sound insulation”.*

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

NSW Environment Protection Authority (1999). *Environmental Criteria for Road Traffic Noise*

Department of Environment, Climate Change and Water (2010). *Draft Road Noise Policy.*

NSW Environment Protection Authority (2000). *Industrial Noise Policy*

Department of Environment and Climate Change NSW (2007). *Noise Guide for Local Government.*

NSW Environment Protection Authority (1992). *Environmental Noise Control Manual*

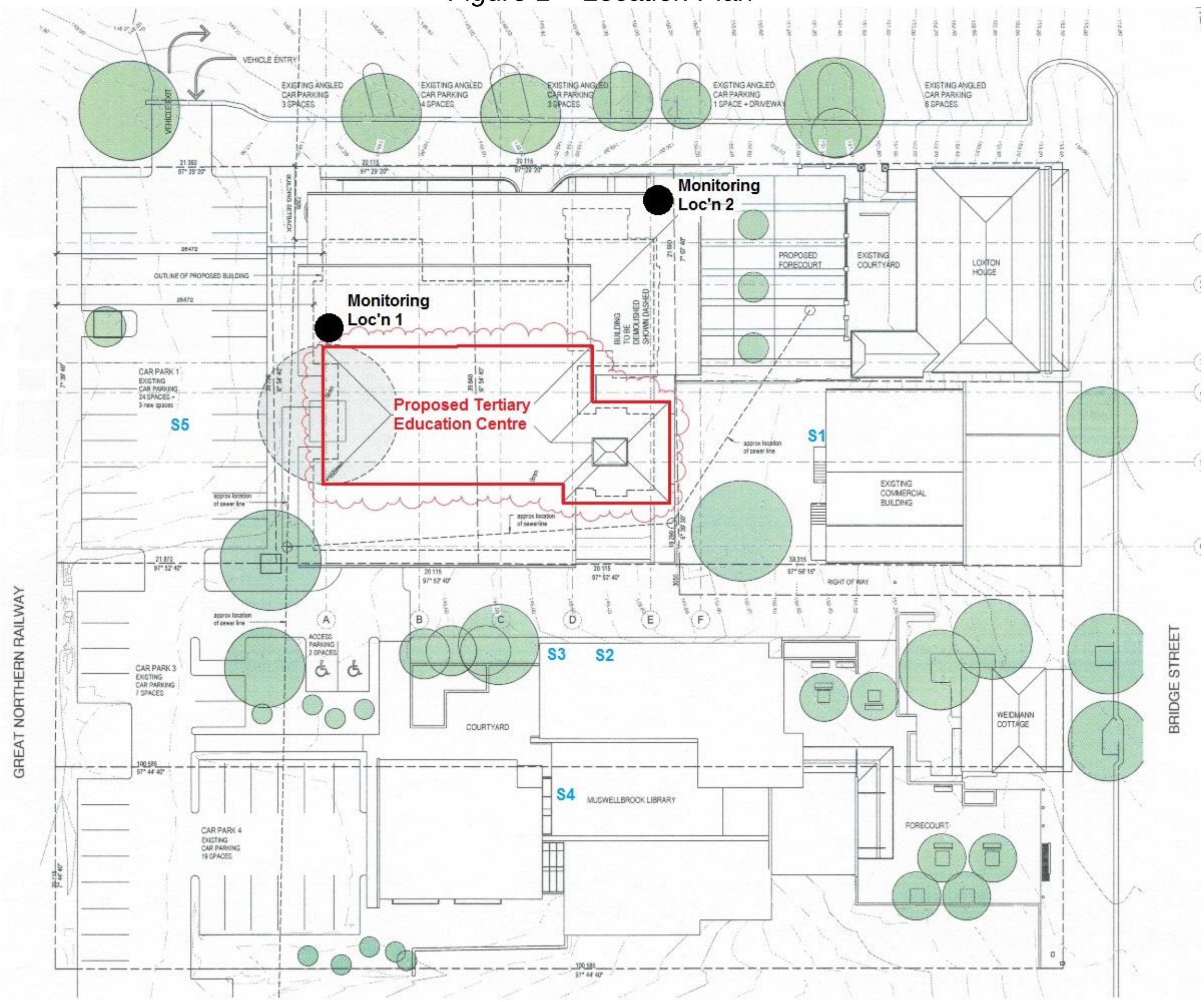
Plans supplied by Stephen Rose Architects. Note that variations from design, supplied to us, may affect our acoustic recommendations.

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

3 DESCRIPTION OF THE PROPOSAL

MSC seeks approval to construct the proposed Muswellbrook Tertiary Education Centre, Lots 2 and 3 DP.11221 Hill Street Muswellbrook. The site will consist of basement level plant room and Lobby and three levels of teaching spaces and office areas. The site is in the CBD near Bridge Street, the Great Northern Rail Line and commercial development, as such passing vehicles and rail traffic have the potential to create unacceptable noise and vibration levels for future occupants at the site. Proposed operating hours for the centre are 8.00am-9.30pm Monday to Thursday and 8.00am-4.30pm on Friday.

Figure 1 – Location Plan



LEGEND:

S1 Air con unit at GL
S2 Split-system air con GL
S3 Outside air fan side of blg
S4 Exhaust fan side of blg
S5 Vehicles in carpark

4 EXISTING ACOUSTIC ENVIRONMENT

Consideration must be given to the extent of the existing acoustic environment and whether such levels are appropriate for the land use of the receiver area. As such, attended noise level monitoring was conducted in the rear carpark at the approximate location of the NW corner of the proposed centre (Monitoring Location 1), and on the south side of Hill Street, approximately 50 metres from the Bridge Street intersection. Monitoring was conducted over 15 minute periods during peak and normal periods. All measurements were conducted using a Svan 949 Sound Level Meter. This instrument is Type 1 accuracy, in accordance with the requirements of AS1259, and has the capability to measure steady, fluctuating, intermittent and/or impulsive sound, and to compute and display percentile noise levels for the measuring period. The instrument was calibrated with a Brüel and Kjaer 4230 sound level calibrator producing 94dB at 1kHz before and after the monitoring period, as part of the instruments' programming and downloading procedure, and showed an error less than 0.5dB.

Table 1 shows a summary of our noise surveys, including the Assessment Background Level's (ABL's) for the day, which were determined according to the procedures described in the OEH's Industrial Noise Policy (INP) and with reference to guidelines detailed in Australian Standard AS1055-1997, "Acoustics - Description and Measurement of Environmental Noise, Part 1 General Procedures".

Table 1: Attended Monitoring Results, dB(A)

Time	Date	L1	L90	Leq
Monitoring Location 1				
08:15	3/09/14	66	44	57
10:30	3/09/14	61	43	53
Monitoring Location 2				
08:30	3/09/14	74	47	60
10:45	3/09/14	72	47	55

To provide a measure of conservatism background noise levels taken at Monitoring Location 1 have been adopted for assessment purposes.

The Sound Pressure Level's (SPL's) of additional noise sources identified during our site visits are listed below:

Item	*SPL dB(A)*	*Comments*
Mechanical plant (S1)	56	@ 4m
Mechanical plant (S2)	63	@ 1m
Exhaust (S3)	52	@ 2m
Exhaust (S4)	61	@ 2m
Cars in carpark (S5)	73	passby at 3m

5 CRITERIA

5.1 Road/Rail Traffic Noise

DOPI's *Development near rail corridors and busy roads-Interim Guidelines".* specifies limits for assessment of rail traffic noise in accordance with Clauses of SEPP (Infrastructure) 2007. Limits specified within the Policy are the same for both road and rail traffic noise. The Policy also recommends that in the absence of any codes, limits specified in AS/NZS2107-2000 *"Acoustics-Recommended Design Sound Levels and Reverberation Times for Building Interiors"* should be referenced, which is used for assessment of quasi-steady-state noise sources, such as continuous road traffic and mechanical services*",* and are detailed below.

Room Type	*dBA*
EDUCATIONAL BUILDINGS	
Computer rooms-teaching	40 – 45
Teaching spaces	35 – 45
Office areas	40 – 45
Corridors and lobbies	45 – 50
Office areas	40 – 45
Staff common rooms	40 – 45
Toilet/change/shower	45 – 55

DoPI's Guideline is a more recent document for assessment of road traffic noise impacts on educational institutions. Limits specified within the Policy, which are in agreement with those in AS/NZS2107-2000 are shown below:

Type of Occupancy	*Noise Level in dB(A),Lmax*	*Applicable Time Period*
Educational institutions		
Child care centres	40	When in use.

5.2 Rail Traffic Vibration – Personal Comfort

5.2.1 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. Arguably the most universally acceptable criteria of this type are the OEH's *Assessing Vibration: A Technical Guideline (2006).* Limits set out in the Guideline are for vibration in buildings, and are directed at personal comfort for continuous, impulsive and intermittent vibrations. Table 2 shows the Vibration Dose Values for intermittent vibration activities such as train and passbys, taken from Table 2.4 of the Guideline, above which various degrees of adverse comment may be expected.

Table 2: 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.

5.2.2 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.

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.

5.3 Site Noise/Mechanical Plant

Noise from industrial noise sources scheduled under the Protection of Environment Operations Act is assessed using the OEH's INP. However, local Councils may also apply the criteria for land use planning, compliance and complaints management. Table 2.1 of the INP specifies recommended noise levels for various types of receivers. The following Project Specific Noise Levels apply for the new Muswellbrook Tertiary Education Centre:

Commercial:
65-70dB(A),Leq when in use

School Classroom:
35-40dB(A) – internal noisiest 1-hour period

6 METHODOLOGY

6.1 Road Traffic Noise

Applicable noise level metrics, namely, Leq (day peak) are those calculated from our measurements at the site, following the methodology outlined in the OEH's Road Noise Policy. A +2.5dB(A) facade adjustment must be added to results as our measurements were conducted in the free-field.

received noise (free field) + facade correction = received noise

Applying the above formula gives:
Day 60.0dB(A) + 2.5dB(A) = **62.5dB(A) Leq** 7am – 10pm

Nearby RMS traffic stations indicate that approximately 20,000 vehicles pass the site each day for the year 2014. A figure of 10% heavy vehicles has also been adopted. The AADT for the year 2014 was applied to our computer programme, based on the OEH and RMS approved CORTN Method of Traffic Noise Prediction, and noise levels were calculated to the theoretical facades of the building. The CoRTN values are merely arbitrary, as calculated noise levels are adjusted to correlate with our measured peak external noise levels, with the intention is to provide a (theoretical) means of determining the degree of noise control required for a particular building component.

Equivalent continuous noise levels were calculated for each traffic lane separately on the basis that the noise source (i.e. the traffic) was located in approximately the centre of the respective lane. In particular, this gives an accurate estimation of the location of bus and truck exhausts which are generally located on the right hand side, being approximately at the same point for both traffic directions. Our calculations have been modified to compensate for the differing acoustic centres of cars and heavy vehicles, by modelling each separately and logarithmically adding received noise levels. The traffic noise level at the outer face of each building element was determined, the required Rw was calculated in accordance with the mathematical procedure given in AS3671-1989 *"Acoustics - Road traffic noise intrusion - Building siting and construction"*. This procedure is based on the required internal noise level shown in Section 5.

6.1.1 CoRTN Model Conversion

The OEH released their ECRTN in June 1999, which specifies modified assessment periods for day and night, namely, Leq,15hr (7am to 10pm) and Leq,9hr (10pm to 7am). These assessment periods have rendered the original Australian version of the CoRTN model invalid, which was designed to assess the impact over a single 24 or 18 hour period. Consequently, modification of the Model is required to adequately describe the new metrics. The CoRTN algorithm pertaining to traffic flow percentages has been modified by inserting all AADT figures for arterial roads, contained in RTA publications - Traffic Volume Data for Hunter and Northern Regions and establishing AADT figures for the applicable day and night periods. Our CoRTN model was then calibrated against long term measurements made at locations with reliable AADT figures.

6.2 Rail Traffic Noise and Vibration

The predicted L(A)eq,1hr and Lmax 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:

$$L_{eq},T = L_b + 10\log\left[1+\frac{ND}{T}\left(\frac{10^{(L\max - Lb)\,/\,10}-1}{2.3}-\frac{\left(L_{\max}-L_b\right)}{10}\right)\right]$$ ...... *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, calculations to predict the rail traffic noise impact on the development are based on the maximum carrying capacity of the line for the year 2018 and measurements of train passbys by Reverb Acoustics. Typical average maximum train and background noise levels were measured at the site (Monitoring Location 1). The Lmax train noise levels used in Equation 1 are the maximum predicted noise levels produced at the facade from trains passing the site.

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.

6.3 Site Noise/Mechanical Plant

Activities associated with nearby commercial developments, mechanical plant and vehicles movements in the public carpark all have the potential to impact on the amenity of occupants of the proposed centre. Noise levels of anticipated noise sources were measured during our site visit and sourced from manufacturers' data and/or our library of technical data. This library has been accumulated from measurements taken in many similar situations on other sites, and allows theoretical predictions of future noise impacts at each receiver and recommendations concerning noise control measures to be incorporated in the design of the site. The sound power level of each activity was determined according to the procedures described in AS2102 or AS1217 as appropriate, and theoretically propagated to occupied areas of the centre. Propagation calculations were carried out using the following in-house equation. Where noise impacts above the criteria are identified, suitable noise control measures are implemented and reassessed to demonstrate satisfactory received noise levels.

Equation 1:

$$L_{eq},T = Lw - 10 \log (2 \pi r^2) + 10 \log \frac{(D \times N)}{T}$$

Where Lw is sound power level of source (dB(A))
R distance to receiver (m)
D is duration of noise for each event (sec)
N is number of events
T is total assessment period (sec)

7 ANALYSIS AND DISCUSSION

7.1 Received Noise – Road Traffic

Sample Calculation

Shown below are sample calculations detailing the procedure followed in order to calculate required glazing for First Floor General Teaching 04, located on the north facade. The traffic noise level at the outer face of the glazing is calculated as follows:

Table 3: Road Traffic Noise Impact - First Floor General Teaching 04

		Octave band Sound Pressure Levels, dB(A)							
Propagation calculation	**dB(A)**	**63**	**125**	**250**	**500**	**1k**	**2k**	**4k**	**8k**
Facade traffic noise, Leq[1]	63	43	51	53	56	58	55	53	41
Architectural shielding[2]		3	3	3	3	3	3	3	3
Directivity[3]		0	0	0	0	0	0	0	0
Traffic noise at window	60	40	48	50	53	55	52	50	38

1. Traffic noise level 2014, distance correction applied. 2. Intervening structures. 3. Includes angle of incidence correction.

As the criterion for Office 4 is 40dB(A), see Section 5.1, the required traffic noise reduction is *TNR* = 60-40 = 20dB(A). The traffic noise attenuation, *TNA*, required for the glazing is calculated according to the equation given in Clause 3.4.2.6 of AS 3671,

$$TNA = TNR + 10\log_{10}[(S/S_f) \times 3/h \times 2T_{60} \times C] \qquad \textit{Equation 1}$$

where S = Surface area of glazing = 14m^2
S_f = Surface area of floor = 55m^2
h = Ceiling height, assumed to be 2.7m
T_{60} = Reverberation time, s
C = No. of components = 3 (glazing, wall, roof)

Assuming that the room is acoustically average (neither too 'live' nor too 'dead') equation 9.26 in <u>*Noise and Vibration Control*</u>, L.L. Beranek, 1971, gives a reverberation time of 0.76s. Consequently, the value of 0.8s was used in equation 1.

Using the values listed above gives

TNA = 21dB(A) for the glazing

Substituting this value into the equation given in Clause 3.4.3.1 of AS3671 gives

Rw = $TNA + 6 \approx 27$

As can be seen by the above results, the glazing system in First Floor General Teaching 04 must have an Rw27 rating to satisfy road traffic noise criteria. Based on typical laboratory performance data, a window glazed with laminated glass and acoustic seals at sliders would be required as a minimum. However, impacts from other external noise sources, in particular passing rail traffic, are higher than those from passing road traffic. Therefore, glazing requirements will be based on the most stringent requirements. See Section 8 for a schedule of required building construction.

7.2 Received Noise & Vibration – Rail Traffic

Table 4 shows results of noise measurements for train traffic passbys, taken at a distance of 30m from the track (see Figure 1).

Table 4: Train Noise & Vibration Levels – 30m from Rail Line

Train Passby	Type	Passby Lmax dB(A)	Measured Vibration Peak Velocity (mm/sec)
1	Diesel Passenger	76	No Trigger at 0.2
2	Coal	77	No Trigger at 0.2
3	Coal	71	No Trigger at 0.1

Results in the above Table indicate that average Lmax rail traffic noise levels impacting on the proposed centre are in the order of 76dB(A). To put results into context, an Lmax impact of 76dB(A) implies that the facade must be capable of attenuating 36dB, i.e. 76dB(A),max – 40 = 36. The OEH's Construction Noise Guideline suggests a conservative estimate of the difference between internal and external noise levels is 10dB with windows open to provide adequate ventilation and 15dB(A) with windows shut. Based on this assumption, facades with an Lmax impact greater than 15dB(A), must have acoustical modifications incorporated in the design. See Section 8 for required acoustic modifications for other areas within the development.

Attended vibration monitoring conducted at the site revealed that no perceptible vibration was recorded from train passbys at a distance greater than 30 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.

7.1 Received Noise – External Noise Sources

The following Table shows sample calculations to predict received noise levels from activities/equipment associated with commercial activities, nearby mechanical plant and vehicle movements in the carpark, propagated to General Teaching 05 on the First Floor. All calculations are based on distances scaled from plans supplied by Stephen Rose Architects and through measurement during our site visit.

Table 5: Received Noise – External Noise Sources, dB(A),Leq Propagated to First Floor General Teaching 05

Activity	Plant S1	Plant S2	Exhaust S3	Exhaust S4	Cars C'park S5
Lw dB(A)	76	69	66	75	90
Ave Dist to rec (m)	10	15	20	35	35
Duration of event	continuous	continuous	continuous	continuous	10 sec
No. of events	1	1	1	1	60
Barrier loss/Directivity	24	0	0	4	0
Rec dB(A),Leq	**11**	**33**	**30**	**32**	**51**
Combined	**51**				
Loss through window	**15**				
Received in room	**36**				
Criteria (internal)	**35dB(A),Leq (1 hour)**				
Impact	**1**				

As can be seen by the above results, noise from nearby external activities/equipment is predicted to exceed the criteria by only 1dB(A) within General Teaching 05. The Centre will be air conditioned, therefore windows may be closed to reduce impacts from noise. However, the internal criterion of **35dB(A),Leq** will still be exceeded. Glazing will therefore need to be upgraded. Once again, noise impacts from passing rail traffic are much greater and glazing requirements will be based on the most stringent requirements. See Section 8 for a schedule of required building construction.

8 NOISE CONTROL RECOMMENDATIONS

8.1 Glazing Windows/Sliding Doors

Glass installed in window assemblies must comply with AS1288-1994. Materials, construction and installation of all windows are to comply with the requirements of AS2047-1999. Similar calculations to those in Section 7 were performed for all building elements of the proposed Centre. From these calculations, a schedule of required glazing has been compiled, shown below. ***Note that our calculations account for the cumulative noise impact from all significant noise sources***. The glazing systems, sighted in the following Tables, are presented as a guide for the supplier:

Glazing Systems: Type A: Standard glazing. No acoustic requirement.
Type B: Single-glaze 6-8mm clear float glass.
Type C: Single glaze 6.38-10.38mm laminated glass
Type D: Double-glaze 6.38mm lam x 25mm air space x 6mm cl. float.

<u>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 from a registered laboratory that the complete system will achieve the specified Rw performance, i.e. do not simply install our recommended glass in a standard window frame.</u>

Table 6: Glazing Schedule

Facade	Room Use	Required Rw Must Achieve for Compliance	Typical Glazing System (Not for Specification)
GROUND FLOOR			
South	North Corridor GF10	**34**	Type C
	Lift Lobby/Stair GF13	**33**	Type C
East	Lobby/Stair Glazing GF13	**28**	Type B
	Lobby/Stair Doors GF13	**28**	Type B
	Student Com Glazing GF05	**32**	Type C
	Student Com Doors GF05	**28**	Type B
North	Student Common GF05	**36**	Type D
	Foyer Doors GF14	**29**	Type B
	Administration GF03	**36**	Type D
	General Teaching GF02	**38**	Type D
	Gen Purpose Glazing GF01	**39**	Type D
	Gen Purpose Doors GF01	**30**	Type C
FIRST FLOOR			
South	Comp Lab FF07	**39**	Type D
	Comp Work Rm FF08	**39**	Type D
	General Teaching FF10	**38**	Type D
	Lobby/Stair FF14	**28**	Type B
East	Lobby/Stair FF14	**28**	Type B
North	General Teaching FF03	**38**	Type D
	General Teaching FF02	**38**	Type D
	General Teaching FF01	**39**	Type D
West	General Teaching FF01	**39**	Type D
	Comp Lab FF07	**39**	Type D
SECOND FLOOR			
South	Staff Common SF05	**34**	Type C
	Staff Office SF08	**38**	Type D
	Void	**33**	Type C
East	Stair	**28**	Type B
North	Staff Office SF08	**38**	Type D
	Copy SF06	**34**	Type C
	Store SF12	**31**	Type C
West	Lobby SF01	**34**	Type C
	WC SF02	**34**	Type C

Double glazed systems should be installed with the following principles in mind:

- The larger the airspace, the better the performance, i.e. not less than 25mm. (i.e.6.38mm lam x 25mm airspace x 6mm cl. float)
- Panes should be mounted in separate frames and held in rubber or neoprene mouldings.
- Panes <u>must</u> be different thickness to avoid coupled resonance.
- In this instance reveals do not have to be lined with acoustic tile, carpet, etc, typically required to reduce cavity resonance and increase acoustic performance.

8.2 Mechanical Ventilation

AS/NZS2107-2000 and DOPI's Guideline requires mechanical ventilation to be installed in habitable rooms where criteria are exceeded. This is generally in the form of air conditioning, although other methods such as Passive Acoustic Ventilators or Aeropac Wall Ventilators may be installed as alternatives. Note that alternate options while effective will not heat or cool a room.

We consider mechanical ventilation necessary for all areas of the Centre.

8.3 Roof/Ceiling Construction

Construction should consist of sisalation or wire mesh laid down on roof trusses. This is to be completely covered with a 30-40mm foil faced building blanket or similar (in situations where trusses are at centres close enough to avoid excessive sagging of the blanket, the sisalation/wire mesh may be omitted). Close off gaps between purlins and roof sheeting with Unisil Eaves Filler Strips or bituminous compound.

Ceilings to Office/Teaching Areas are to consist of 2 layers taped and set 10mm sound rated plasterboard or 2 layers taped and set 13mm fire rated plasterboard.

Ceilings to Transitory spaces are to consist of 1 layer taped and set 10mm sound rated plasterboard or 1 layer taped and set 13mm fire rated plasterboard.

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/S3 batts) will suffice and is much less expensive ($15/m^2 for Rockwool 350 and $6/m^2 for R3 batts).

8.4 Wall Construction

We understand that the majority of external walls will be concrete panels with internal lining 10mm plasterboard and cavity insulation R1.5/S1.5, which is acceptable.

Where lightweight cladding such as Alucobond is used for Office/Teaching Areas, internal lining of 2 layers taped and set 10mm sound rated plasterboard or 2 layers taped and set 13mm fire rated plasterboard is required, together with cavity insulation R1.5/S1.5.

Where lightweight cladding such as Alucobond is used for Transitory spaces, internal lining of 1 layer taped and set 10mm sound rated plasterboard or 1 layer taped and set 13mm fire rated plasterboard is required, together with cavity insulation R1.5/S1.5.

9 CONCLUSION

A noise impact assessment for Muswellbrook Tertiary Education Centre has been completed. The report has shown that the site is suitable for the intended purpose, providing our recommendations are implemented. An assessment of external noise impacting upon the development has resulted in the compilation of a schedule of minimum glazing thicknesses and types, roof/ceiling and wall construction, etc, to ensure the acoustic amenity of future occupants is ensured. **The typical glazing systems shown in Table 6 should be used as a guide only. The supplier of the window/door must be able to provide evidence from a registered laboratory that the complete system will achieve the specified Rw performance**. **Do not simply install our recommended glass in a standard window frame.**

The guidelines herein are preliminary in that the selection of building materials depends on user/client requirements, space limitations, budgetary constraints and practicalities that relate to the acoustic design of suites. Adequate building facade design may be achieved through many different combinations of materials, all of which may achieve the same result, subject to review by us.

In conclusion, providing the recommendations given in this report are implemented, noise from activities associated with nearby commercial developments, and passing road/rail traffic will comply with the requirements of the AS/NZS2107-2000, the OEH and DOPI within habitable spaces of the proposed centre. We therefore see no acoustic reason why the proposal should be denied.

REVERB ACOUSTICS

Steve Brady A.A.A.S. M.A.S.A.
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.
ABL	*Assessment Background Level* – A single figure representing each individual assessment period (day, evening, night). Determined as the L90 of the L90's for each separate period.
RBL	*Rating Background Level* – The overall single figure background level for each assessment period (day, evening, night) over the entire monitoring period.
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).
L10	The noise level which is equalled or exceeded for 10% of the measurement period. L_{10} is an indicator of the mean maximum noise level, and is generally used in Australia as the descriptor for intrusive noise (usually in dBA).