BLESSED CARLO COLLEGE K-12

Noise & Vibration Impact Assessment

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0	08.12.2021	Issued to Client	RB	TE
1	01.04.2022	Amended title	RB	RB
2	12.07.2022	Added SEARs table	RB	RB

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1 Introduction

Octave Acoustics was engaged by Clarke Hopkins Clarke to carry out a noise and vibration impact assessment to addresses the requirements of Clause 10 of the Secretary's Environmental Assessment Requirements (SEARs) for the construction and operation of the Blessed Carlo College at the corner of Kiely and Lignum Roads, Moama.

Clause 10 of the SEARs states:

Provide a noise and vibration impact assessment that:

- *includes a quantitative assessment of the main noise and vibration generating sources during demolition, site preparation, bulk excavation and construction.*
- *details the proposed construction hours and provide details of, and justification for, instances where it is expected that works would be carried out outside standard construction hours.*
- *includes a quantitative assessment of the main sources of operational noise, including consideration of any public-address system, school bell, mechanical services (e.g. air conditioning plant), use of any school hall for concerts etc. (both during and outside school hours) and any out of hours community use of school facilities.*
- *outlines measures to minimise and mitigate the potential noise impacts on nearby sensitive receivers.*
- *considers sources of external noise intrusion in proximity to the site (including, road rail and aviation operations) and identifies building performance requirements for the proposed development to achieve appropriate internal amenity standards.*
- *demonstrates that the assessment has been prepared in accordance with polices and guidelines relevant to the context of the site and the nature of the proposed development.*

Relevant Policies and Guidelines:

- *NSW Noise Policy for Industry 2017 (NSW Environment Protection Authority (EPA)).*
- *Interim Construction Noise Guideline (Department of Environment and Climate Change, 2009).*
- *Assessing Vibration: A Technical Guideline (Department of Environment and Conservation, 2006).*
- *Development Near Rail Corridors and Busy Roads - Interim Guide line (Department of Planning, 2008).*

Table 1 Sets out where in this document each of the SEARs are addressed.

TABLE 1 – SECTION OF REPORT WHERE SEARS REQUIREMENTS ARE ADDRESSED

SEARs	Section of this Document
Provide a noise and vibration impact assessment that: includes a quantitative assessment of the main noise and vibration generating sources during demolition, site preparation, bulk excavation and construction.	Section 5.
Details the proposed construction hours and provide details of, and justification for, instances where it is expected that works would be carried out outside standard construction hours.	Section 6.
Includes a quantitative assessment of the main sources of operational noise, including consideration of any public-address system, school bell, mechanical services (e.g. air conditioning plant), use of any school hall for concerts etc. (both during and outside school hours) and any out of hours community use of school facilities.	Section 7.
Outlines measures to minimise and mitigate the potential noise impacts on nearby sensitive receivers.	Section 7.
Considers sources of external noise intrusion in proximity to the site (including, road rail and aviation operations) and identifies building performance requirements for the proposed development to achieve appropriate internal amenity standards.	Section 8.
Demonstrates that the assessment has been prepared in accordance with polices and guidelines relevant to the context of the site and the nature of the proposed development	Sections 3.1, 3.2 4.1, 4.4.

2 Site & Surrounds

Blessed Carlo College is to be a Kinder to Year 12 school consisting of five school buildings (A – D) and a chapel (refer to Figure 1). It is anticipated that construction will commence in August – September 2022.

- Building A includes the school reception, administration, and library facilities.
- Building B will contain the sports, performance, and music facilities.
- Building C will house the primary school.
- Building D will house the secondary school and workshops.

The school is to open in three stages with planned enrolments increasing as follows:

- Stage 1 – 120 Students [Kinder – Year 2 (90 students)] + Year 7 (30 Students)]
- Stage 2 – 330 Students [K -6 (210 Students) + Year 7 -10 (120 Students)]
- Stage 3 – 390 Students [K-6 (210 Students) + Year 7-12 (180 Students)]

School bell times will be 8.55am; 11.00am; 11.30am; 1.00pm; 1.55pm; 3.15pm. It is planned that a café will trade to the public from the communal forecourt, with a peak period at drop-off time prior to the first bell.

Out of hours use of the school facilities will mostly occur during weekends and consist of Mass, meetings and functions. Mass will occasionally be held on Sundays in the Chapel. However out of hours functions and meetings will be infrequent. Due to the limited size of the grounds, the school will not host major sporting events.

The school site is zoned R1 – General Residential and is abutted (refer to Figure 1):

- To the west by Lignum Road with existing dwellings zoned R5 – Large Lot Residential beyond.
- To the north by Kiely Road with a future residential subdivision zoned R1 beyond.
- To the east with a future residential subdivision zoned R1.
- To the south with a future residential subdivision zoned R1.

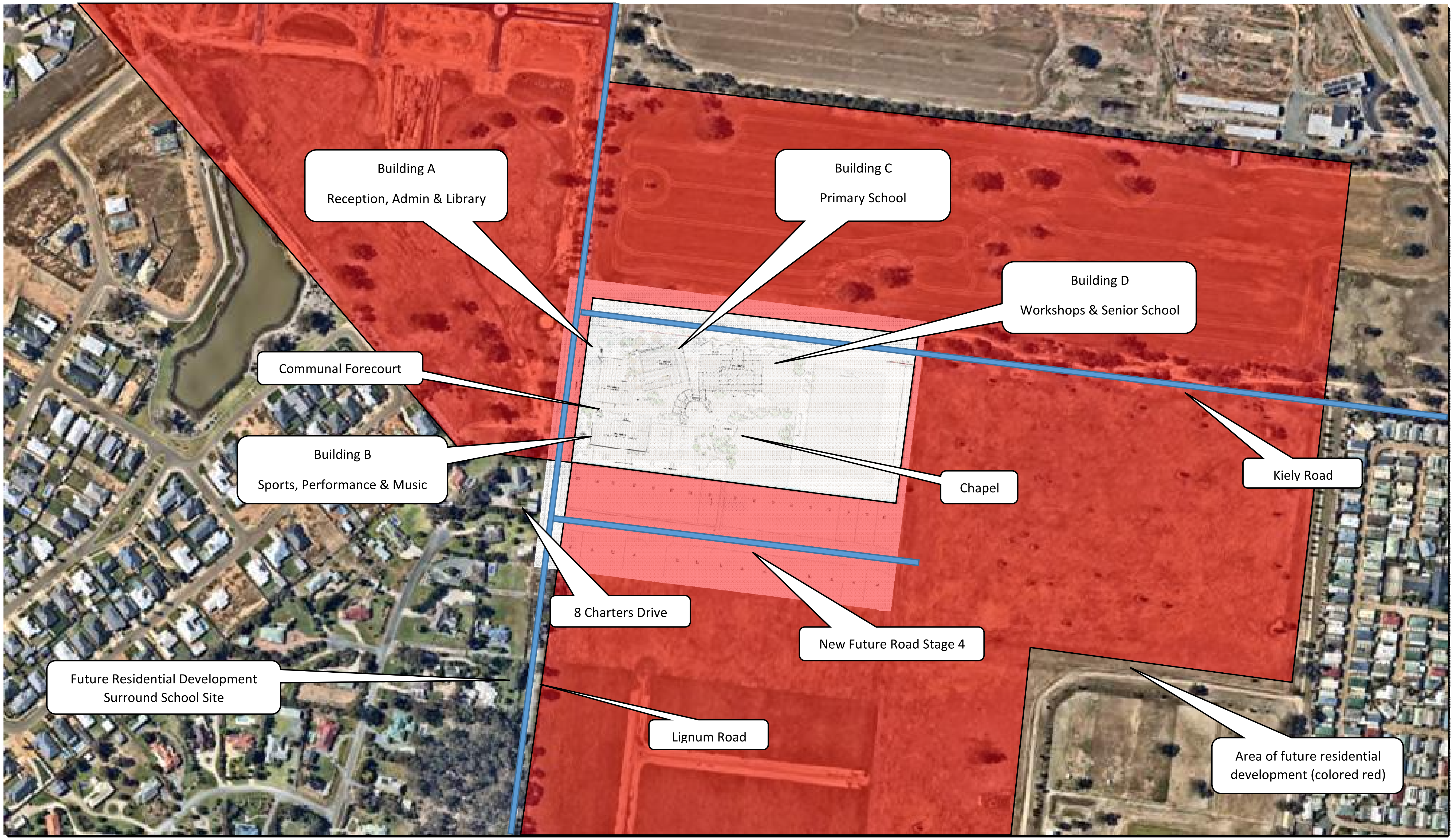

FIGURE 1 – SITE CONTEXT

3 Criteria for Demolition & Construction Impacts

3.1 Noise

3.1.1 Residences

The Department of Environment and Client Change *Interim Construction Noise Guideline* 2009 (ICNG) sets out management levels for noise at residences as presented in Table 2 below.

TABLE 2 – ICNG NOISE MANAGEMENT LEVELS

Time of Day	Management Level, $L_{Aeq\ 15min}$	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 + 10dB	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 affected noise 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 the works to be carried out, the expected noise levels and duration, as well as contact details.
	Highly noise affected 75dB(A)	The highly noise affected level represented 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: 1. 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. 2. If the community is prepared to accept a longer period of construction in exchange for restrictions on construction times.

Time of Day	Management Level, LAeq 15min	How to Apply
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 5dB(A) above the noise affected level, the proponent should negotiate with the community.

The applicable noise management levels for residential receivers adjacent the subject site have been calculated based on estimated background noise levels taken from Australian Standard 1055.3 1997 (AS1055) and are presented in Table 3 below. Noise monitoring was not carried out on site due to the distance from both Sydney and Melbourne and hence the cost to the project.

TABLE 3 – PROJECT NOISE MANAGEMENT LEVELS FOR RESIDENTIAL RECEIVERS

Time	RBL	Noise Affected Leq 15 min	Highly Noise Affected Leq 15 min
Monday to Friday 7am to 6pm Saturday 8am to 1pm	45 dB(A)	55 dB(A)	75 dB(A)
Out of hours 'evening'	35 dB(A)	40 dB(A)	-
Out of hours 'night'	30 dB(A)	35 dB(A)	-
Notes:	*1. AS1055.3 1997 Noise Area Category R2, 'Areas with low density transportation'.*		

3.1.2 Other Sensitive Land Uses

Other sensitive land uses, such as schools, typically consider noise from construction to be disruptive when the properties are being used (such as during school times). Table 4 presents management levels for noise at other sensitive land uses based on the principle that the characteristic activities for each of these land uses should not be unduly disturbed. The proponent should consult with noise sensitive land use occupants likely to be affected by noise from the works to schedule the project's work hours to achieve a reasonable noise outcome.

Internal noise levels are to be assessed at the centre of the occupied room. External noise levels are to be assessed at the most affected point within 50 m of the area boundary. Where internal noise levels cannot be measured, external noise levels may be used. The management levels in Table 4 are 5 dB above the corresponding road traffic noise levels in the Environmental Criteria for Road Traffic Noise (EPA 1999) (and the 'maximum' levels in the NSW Industrial Noise Policy (EPA 2000) for commercial and industrial uses) to account for the variable and short-term nature of construction noise.

TABLE 4 – PROJECT NOISE MANAGEMENT LEVELS FOR OTHER SENSITIVE LAND USES

Land Use	Management Level, Leq $_{15\ min}$ (applies when properties are being used)
Classrooms at schools and other educational institutions	Internal noise level 45 dB(A)
Hospital wards and operating theatres	Internal noise level 45 dB(A)
Places of worship	Internal noise level 45 dB(A)
Active recreation areas (characterised by sporting activities and activities which generate their own noise or focus for participants, making them less sensitive to external noise intrusion).	External noise level 65 dB(A)
Passive recreation areas (characterised by contemplative activities that generate little noise and where benefits are compromised by external noise intrusion, for example, reading, meditation).	External noise level 60 dB(A)
Community centres	Depends on the intended use of the centre. Refer to the recommended 'maximum' internal levels in AS2107 for specific uses.

3.1.3 Commercial & Industrial Premises

Due to the broad range of sensitivities that commercial or industrial land can have to noise from construction, the process of defining management levels is separated into three categories. The external noise levels should be assessed at the most-affected occupied point of the premises:

- Industrial premises: external LAeq (15 min) 75 dB(A)
- Offices, retail outlets: external LAeq (15 min) 70 dB(A)
- Other businesses that may be very sensitive to noise, where the noise level is project specific as discussed below.

Examples of other noise-sensitive businesses are theatres and childcare centres. The proponent should undertake a special investigation to determine suitable noise levels on a project-by-project basis; the recommended 'maximum' internal noise levels in *AS/NZS 2107 Acoustics – Recommended design sound levels and reverberation times for building interiors* may assist in determining relevant noise levels.

The proponent should assess construction noise levels for the project, and consult with occupants of commercial and industrial premises prior to lodging an application where required.

During construction, the proponent should regularly update the occupants of the commercial and industrial premises regarding noise levels and hours of work.

3.1.4 Ground-borne Noise at Residences

Ground-borne noise is noise generated by vibration transmitted through the ground into a structure. Ground-borne noise caused, for example, by underground works such as tunnelling, can be more noticeable than airborne noise. The following ground-borne noise levels for residences indicate when management actions should be implemented. These levels recognise the temporary nature of construction and are only applicable when ground-borne noise levels are higher than airborne noise levels. The ground-borne noise levels are for evening and night-time periods only, as the objectives are to protect the amenity and sleep of people when they are at home.

- Evening (6 pm to 10 pm) - Internal: LAeq (15 min) 40 dB(A)
- Night-time (10 pm to 7 am) - Internal: LAeq (15 min) 35 dB(A)

The internal noise levels are to be assessed at the centre of the most affected habitable room.

Mitigation options to deal with ground-borne noise may include extensive community consultation to determine the acceptable level of disruption and the provision of respite accommodation in some circumstances, not just restriction of work hours. The level of mitigation of ground-borne noise would depend on the extent of impacts and also on the scale and duration of works. Any restriction that the relevant authority (consent, determining or regulatory) may impose on the days when construction work is allowed should take into account whether the community:

- Has identified times of day when they are more sensitive to noise (for example, Sundays or public holidays)
- Is prepared to accept a longer construction duration in exchange for days of respite.

3.1.5 Sleep Disturbance at Residences

Where construction works are planned to extend over more than two consecutive nights, and a quantitative assessment method is used, the analysis should cover the maximum noise level, and the extent and the number of times that the maximum noise level exceeds the RBL. Some guidance indicating the potential for sleep disturbance is in the NSW Environmental Criteria for Road Traffic Noise (EPA 1999).

Factors that may be important in assessing the extent of impact on sleep include how often high noise events occur at night, the predicted maximum noise levels at night, whether there are times when there is a clear change in the noise environment (such as during early morning shoulder periods), and the degree of maximum noise levels above the background noise level at night.

3.2 Vibration

3.2.1 Human Comfort

The ICNG states that human comfort vibration from construction works, including continuous, intermittent or impulsive vibration from construction, but excluding blasting, is to be assessed in accordance with section 2.5 'Short-term works' in *Assessing Vibration – a technical guideline* (DEC 2006), which states:

When short-term works such as piling, demolition and construction give rise to impulsive vibrations, undue restriction on vibration values may significantly prolong these operations and result in greater annoyance. Short-term works are works that occur for a duration of approximately one week.

In circumstances where work is short term, feasible and reasonable mitigation measures have been applied, and the project has a demonstrated high level of social worth and broad community benefits, then higher vibration values (above the maximum) may apply. In such cases, best management practices should be used to reduce values as far as practicable, and a comprehensive community consultation program should be instituted. An example of a possible management strategy would be to restrict the times during which high vibration values occur to the least sensitive times of the day. Typical issues covered in a consultation program include a public contact point for handling complaints, and early notification of proposed operations and any significant change to operations.

Assessing Vibration – a technical guideline provides criteria for exposure to continuous and impulsive vibration as set out in Table 5 below. Acceptable values for intermittent vibration as presented in Table 6 below.

TABLE 5 – CRITERIA FOR EXPOSURE TO CONTINUOUS AND IMPULSIVE VIBRATION

Place	Time	Assessment Criteria					
		[2]rms acceleration (m/s)[2]		[3]rms velocity (mm/s)		[3]Peak velocity (mm/s)	
		Preferred	Max	Preferred	Max	Preferred	Max
Continuous vibration							
Critical working areas[1]	Day or night-time	0.0050	0.010	0.10	0.20	0.14	0.28
Residences	Daytime[4]	0.010	0.020	0.2	0.4	0.28	0.56
	Night-time	0.0070	0.014	0.14	0.28	0.20	0.40
Offices	Day or night-time	0.020	0.040	0.40	0.80	0.56	1.1
Workshops	Day or night-time	0.040	0.080	0.80	1.6	1.1	2.2
Impulsive vibration							
Critical working areas[1]	Day or night-time	0.0050	0.010	0.10	0.20	0.14	0.28
Residences	Daytime[4]	0.30	0.60	6.0	12.0	8.6	17.0
	Night-time	0.10	0.20	2.0	4.0	2.8	5.6
Offices	Day or night-time	0.64	1.28	13.0	26.0	18.0	36.0
Workshops	Day or night-time	0.64	1.28	13.0	26.0	18.0	36.0

Notes:

1. *eg. hospital operating theatres, precision laboratories.*
2. *Values derived from z-axis critical frequency range 4–8 Hz. Where required, a more detailed analysis can be conducted as per BS 6472–1992.*
3. *Values given for the most critical frequency range >8 Hz assuming sinusoidal motion. Where required, a more detailed analysis can be conducted as per AS 2670.2–1990. Sufficient justification should accompany the use of a peak velocity approach if used in an assessment.*
4. *Specific values depend on social and cultural factors, psychological attitudes and expected degree of intrusion.*

TABLE 6 – ACCEPTABLE VIBRATION DOSE VALUES FOR INTERMITTENT VIBRATION ($m/s^{1.75}$)

Location	Daytime		Night-time	
	Preferred	Maximum	Preferred	Maximum
Critical areas	0.10	0.20	0.10	0.20
Residences	0.20	0.40	0.13	0.26
Offices, schools, educational institutions & places of worship	0.40	0.80	0.40	0.80
Workshops	0.80	1.60	0.80	1.60

Notes:

1. *Daytime is 7.00 am to 10.00 pm and night-time is 10.00 pm to 7.00 am.*
2. *Examples include hospital operating theatres and precision laboratories where sensitive operations are occurring. These criteria are only indicative, and there may be a need to assess intermittent values against the continuous or impulsive criteria for critical areas. Source: BS 6472–1992*

3.2.2 Building Damage

Assessing Vibration – A Technical Guideline does not address vibration induced damage to buildings and structures. Applicable criteria for vibration inducted building damage are typically taken from German Standard DIN 4150: Part 3 *Structural Vibration in Buildings – Effects on Structures* (German Institute for Standardisation, 1999). Trigger levels from the DIN4150 are given below in Table 7.

TABLE 7 – DIN 4150 STRUCTURAL DAMAGE CRITERIA

Line	Type of Structure	Peak Component Particle Velocity, mm/s			
		At Building Foundations			Plane of the Uppermost Floor
		4Hz to 15Hz	15Hz to 40Hz	40Hz and above	All frequencies
1	Buildings used for commercial purposes, industrial buildings and buildings of similar design	20	20 – 40	40 – 50	40
2	Dwellings and buildings of similar design and/or use	5	5 – 15	15 – 20	15
3	Structures that, because of the particular sensitivity of vibration, cannot be classified under lines 1 and 2 and are of great intrinsic value (e.g., Listed buildings under preservation order)	3	3 – 8	8 – 10	8

Table 7 gives guideline values for peak particle velocity at the foundation and in the plane of the highest floor of various types of buildings. Experience has shown that if these values are complied with, damage that reduces the serviceability of a building will not occur. If damage nonetheless occurs, it is assumed that other causes are responsible. Exceeding the values in Table 7 does not necessarily lead to damage, should they be significantly exceeded, however, further investigations are necessary.

These values relate to transient vibrations only. Continuous vibration can give rise to dynamic magnifications due to resonances and triggers may need to be reduced by up to 50%. It should be noted that DIN4150 does not provide criteria relating to vibration induced subsidence.

3.3 Blast Inducted Vibration

3.3.1 Human Comfort

AS2187 sets out assessment criteria for blast induced ground vibration effects on human comfort as shown in Table 8.

TABLE 8 – BLAST INDUCED GROUND VIBRATION CRITERIA FOR HUMAN COMFORT

Category	Type of Blasting Operation	Peak sound pressure level (dBL)
Sensitive Site*	Operations lasting for more than 12 months or more than 20 blasts	5 mm/s for 95% blasts per year, 10mm/s maximum unless agreement is reached with the occupier that a higher limit may apply
Sensitive Site*	Operations lasting for less than 12 months or less than 20 blasts	10mm/s maximum unless agreement is reached with occupier that a higher limit may apply.
Occupied non-sensitive sites, such as factories and commercial premises.	All blasting	25 mm/s maximum unless agreement is reached with occupier that a higher limit may apply. For sites containing equipment sensitive to vibration, the vibration should be kept below manufacturer's specification or levels that can be shown to adversely affect the equipment operation.
Note:	** A sensitive site includes houses and low-rise residential buildings, hospitals, theatres, schools, etc. occupied by people.*	

3.3.2 Building Damage

Recommended limits for ground vibration for control of damage to structures are provided in Table 9.

TABLE 9 – BLAST INDUCED GROUND VIBRATION CRITERIA FOR CONTROL OF BUILDING DAMAGE

Category	Type of Blasting Operation	Peak sound pressure level (dBL)
Other structures or architectural elements that include masonry, plaster, and plasterboard in their construction.	All Blasting	Frequency dependent damage limits criteria as per Table 7. Table 7.
Unoccupied structures of reinforced concrete or steel construction.	All Blasting	100mm/s maximum unless agreement is reached with the owner that a higher limit may apply.
Service structures pipelines, powerlines & cables located above ground.	All Blasting	Limit is to be determined by structural design methodology.

3.4 Air Blast Criteria

AS2187 provides criteria for air blast. Air blast can cause discomfort to persons and, at high levels, damage to structures and architectural elements, and at very high levels, injury to persons. The air blast levels at which people become annoyed are well below levels at which building damage has been proven to occur. The evaluation of the effects of blasting should separate human response and structural damage effects of air blast.

3.4.1 Human Comfort

Human comfort limits for air blast are linked to the annoyance produced. Several factors contribute to annoyance by impulsive sounds such as air blast. These include the loudness, duration and the nature of the disturbance. Air blast limits for human comfort chosen by some regulatory authorities are provided in Table 10. All the limits are expressed as peak linear sound pressure levels.

TABLE 10 – AIRBLAST LIMITS FOR HUMAN COMFORT

Category		Type of Blasting Operation	Peak sound pressure level (dBL)
Sensitive Site*		Operations lasting for more than 12 months or more than 20 blasts	115 dBL mm/s for 95% blasts. 125 dBL maximum unless agreement is reached with occupier that a higher limit may apply
Sensitive Site*		Operations lasting for less than 12 months or less than 20 blasts	120 dBL mm/s for 95% blasts. 125 dBL maximum unless agreement is reached with occupier that a higher limit may apply.
Occupied non-sensitive sites, such as factories and commercial premises.		All blasting	125dBL maximum unless agreement is reached with the occupier that a higher limit may apply. For sites containing equipment sensitive to vibration, the vibration should be kept below manufacturer's specifications or levels that can be shown to adversely affect the equipment operation.
Note:	** A sensitive site includes houses and low-rise residential buildings, hospitals, theatres, schools, etc., occupied by people.*		

3.4.2 Building Damage

From Australian and overseas research, damage (even of a cosmetic nature) has not been found to occur at air blast levels below 133dBL. The probability of damage increases as the air blast levels increases above this level. Windows are the building element currently regarded as most sensitive to air blast, and damage to windows is considered as improbable below 140 dBL.

A limit of 133 dBL is recommended as a safe level that will prevent structural/architectural damage from air blast. Recommended building damage criteria are given in Table 11. All the limits are expressed as peak linear sound pressure levels. The classification of type of structure may be difficult and, when in doubt, a more conservative limit from the nearest description in Table 11 shall be applied.

TABLE 11 – RECOMMENDED AIRBLAST LIMITS FOR DAMAGE CONTROL.

Category	Type of Blasting Operation	Peak sound pressure level (dBL)
Structures that include masonry, plaster and plasterboard in their construction and unoccupied structures of reinforced concrete or steel construction.	All Blasting	133 dBL maximum unless agreement is reached with the owner that a higher limit may apply.
Service structures, such as pipelines, powerlines and cables located above the ground.	All Blasting	Limit to be determined by structural design and methodology.

3.5 ANZEC Blast Guidelines

The Australia and New Zealand Environment Council publication *Technical Basis for Guidelines to Minimise Annoyance due to Blasting Overpressure and Ground Vibration* (1990) recommends the following with respect to times and frequency of blasting:

<u>Times and Frequency of Blasting</u>

- Blasting should generally only be permitted during the hours of 9am – 5pm Monday to Saturday. Blasting should not take place on Sundays or Public Holidays.
- Blasting should generally take place no more than once per day. (This requirement would not apply to minor blasts such as for clearing crushers, feed chutes, etc.)
- The restrictions on times and frequency of blasting referred to above do not apply to:
  - Those premises where the effects of the blasting are not perceived at noise sensitive sites; and
  - Major underground metalliferous mining operations.

<u>Acceptable variations</u>

It is recognised that under some circumstances or at certain mines blasting that cannot comply with the above criteria will have to be carried out. Environmental authorities should apply controls for such blasting with appropriate consideration to the circumstances applying.

4 Operational Criteria

4.1 Noise Policy for Industry

The EPA Noise Policy for Industry 2017 (NPI) sets criteria for noise emissions from industry under the Protection of the Environment Operations Act 1997 (POEO Act). The Blessed Carlo College school will not be a scheduled premises-based activity or otherwise and will therefore not be subject to the NPI under the POEO Act. Nonetheless, the noise criteria set out in the NPI are considered to provide useful guidance as to the acceptability of resultant noise impacts.

4.1.1 Intrusive Noise Assessment

The intrusiveness of a noise source may generally be considered acceptable if the level of noise from the source (L_{Aeq}), does not exceed the background noise level by more than 5dB when beyond a minimum threshold. The intrusiveness noise level seeks to limit the degree of change a new noise source introduces to an existing environment. The intrusiveness noise level is determined as follows:

$L_{Aeq,\ 15\ min}$ = Rating Background Noise Level +5dB

Where:

$L_{Aeq,\ 15\ min}$ represents the equivalent continuous (energy average) A-weighted sound pressure level of the source over 15 minutes.

And

Rating Background Noise Level (RBL) represents the background level to be used for assessment purposes, as determined by the methods outlined in the Noise Policy for Industry; typically being the median L_{A90} for each period, day, evening and night.

It should be noted that intrusiveness noise levels are not used directly as regulatory limits. They are used in combination with the amenity noise level to assess the potential impact of noise, assess reasonable and feasible mitigation options and subsequently determine achievable noise requirements. The applicable rating background noise levels and resulting Intrusiveness Noise Levels are set out in Table 12 below.

TABLE 12 – APPLICABLE INTRUSIVENESS NOISE LEVELS

Residences	Time of Day	RBL dB(A)	Intrusiveness Noise Levels ($L_{Aeq,\ 15\ min}$ dB(A))
All surrounding	Day	45	50
	Evening	35	40
	Night	30	35

Notes:
1. *Day is* *7am – 6pm Monday to Saturday*
   8am – 6pm Sundays and public holidays
2. *Evening is* *6pm – 10pm*
3. *Night is* *10pm – 7am Monday to Saturday*
   10pm – 8am Sundays and public holidays.

4.1.2 Amenity Noise Assessment

To limit continuing increases in noise levels from application of the intrusiveness level alone, the ambient noise level within an area from all industrial noise sources combined should not exceed the recommended amenity noise levels specified in Table 13 where feasible and reasonable.

TABLE 13 – AMENITY NOISE LEVELS

Receiver	Noise Amenity Area	Time of Day	$L_{Aeq,}$ dB(A)
Residential	Suburban	Day	55
		Evening	45
		Night	40
School classroom – internal	All	Noisiest 1-hour period when in use	35

Notes:
1. *Day is* *7am – 6pm Monday to Saturday*
   8am – 6pm Sundays and public holidays
2. *Evening is* *6pm – 10pm*
3. *Night is all remaining times.*
4. *'Suburban' is 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.*

The recommended amenity noise levels have been selected on the basis of studies that relate industrial noise to annoyance in communities (Miedema and Voss, 2004). They have been subjectively scaled to reflect the perceived differential expectations and ambient noise environments of rural, suburban and urban communities for residential receivers. They are based on protecting the majority of the community (90%) from being highly annoyed by industrial noise.

The recommended amenity noise levels represent the objective total industrial noise at a receiver location, whereas the project amenity noise level represents the objective for noise from a single industrial development at a receiver location.

To ensure that industrial noise levels (existing plus new) remain within the recommended amenity noise levels for an area, a project amenity noise level applies for each new source of industrial noise as follows:

Project amenity noise level for industrial developments = recommended amenity noise level minus 5dB(A) (refer to Table 14)

TABLE 14 – PROJECT AMENITY NOISE LEVELS (ANL)

Receiver	Noise Amenity Area	Time of Day	Project ANL	
			$L_{Aeq\ period}$, dB(A)	$L_{Aeq\ 15\text{-}minute}$, dB(A)
Residential	Suburban	Day	55	53[1]
		Evening	45	43[1]
		Night	40	38[1]
School classroom – internal	All	Noisiest 1-hour period when in use	35	35

Notes: 1. *Project ANL is that for the 'noise amenity area' minus 5dB(A) plus 3dB(A) to convert from a period level to a 15-minute level in accordance with the methodology set out in Fact Sheet E of the NPI.*

Amenity noise levels are not used directly as regulatory limits. They are used in combination with the project intrusiveness noise level to assess the potential impact of noise, and subsequently determine achievable noise requirements.

4.2 Outdoor Activity Noise

There are no mandatory policies or guidelines for the assessment and control of noise from school playgrounds. However, the Association of Australasian Acoustical Consultants (AAAC) *Guideline for Child Care Centre Acoustic Assessment Version 3.0* (AAAC Guideline) provides a framework for the assessment of noise impacts associated with noise from outdoor play areas at child-care centres.

Whilst outdoor areas at Blessed Caro College may produce differing noise levels than those at child-care centres, aspects of the AAAC Guideline remain appropriate for the assessment. The outdoor areas may not be in continuous use, resulting in reduced potential for annoyance. The AAAC Guideline provides graduated criteria depending on the degree to which the outdoor areas are used.

The AAAC Guideline recommends noise emission levels do not exceed:

- Greater than 5dB above background noise where outdoor play is greater than 4 hours per day; and

- Greater than 10dB above background noise where outdoor play is less than 4 hours per day.

Differences in noise levels emitted by school students compared with children in child-care centres can be taken into account by using appropriate sound power data in the noise model.

The resultant criteria for noise impacts associated with the use of the playgrounds area presented in Table 15 below.

TABLE 15 – NOISE CRITERIA FOR PLAYGROUND NOISE

Hours of Playground Use	Criteria $LAeq_{15\ minute}$
Up to 4[1] hours (total) per day	55 dB
More than 4[1] hours (total) per day	50 dB
Notes:	*1. 2 hours in the morning and 2 hours in the afternoon.*

4.3 Road Noise Policy

The NSW Road Noise Policy (RNP) provides noise criteria with the aim to provide protection inside and immediately around sensitive receivers. These noise criteria are consistent with current international practice for managing traffic noise impacts. The criteria applied in the RNP have been set approximately at the point where 90% of residents are not highly annoyed by noise. Table 16 sets out the Traffic Noise assessment criteria for residential land uses.

TABLE 16 - ROAD TRAFFIC NOISE ASSESSMENT CRITERIA FOR RESIDENTIAL LAND USES

Road Category	Type of Project/land use	Assessment Criteria – dB(A)	
		Day (7am – 10pm)	Night (10pm – 7am)
Freeway / arterial / sub arterial Roads	Existing residences affected by additional traffic on freeway / arterial / sub arterial Roads generated by land use developments.	$L_{Aeq,\ (15\ hour)}$ 60 (external)	$L_{Aeq,\ (9\ hour)}$ 55 (external)
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)

4.4 External Noise Intrusion

4.4.1 Development Near Rail Corridors & Busy Roads

The Department of Planning document *Development Near Rail Corridors and Busy Roads – Interim Guideline* states that an acoustic assessment for noise sensitive developments may be required where the site is located proximate to a busy road or rail corridor. A busy road is road carrying more than 20,000 – 40,000 vehicles a day. The site for Blessed Caro College is not proximate either a rail corridor or busy road. As such, assessment is not required under the guideline. However, the guideline does state that road traffic noise at sensitive uses does not exceed the recommended levels in the ECRTN. The ECRTN has subsequently been superseded by the NSW Road Noise Policy.

4.4.2 Road Noise Policy

The RNP provides guidance for non-residential developments (in this instance schools) potentially affected by noise from new land uses and roads or redeveloped roads as set out in Table 17 below. Whilst this definition may not strictly apply to the school, the criterion is nonetheless considered appropriate and adopted for this assessment.

Table 17 - Road Traffic Noise Assessment Criteria For non-residential Land uses Affected by Proposed Road Projects and Traffic Generating Developments

Existing Sensitive Land use	Assessment Criteria – dB(A)		Additional Considerations
	Day (7am – 10pm)	Night (10pm – 7am)	
School classrooms	$L_{Aeq, (1 hour)}$ 40 (internal) when in use	-	In the case of buildings used for education or health care, noise level criteria for spaces other than classrooms and wards may be obtained by interpolation from the 'maximum' levels shown in Australian Standard AS2107:2000 (Standards Australia 2000).

4.4.3 Educational Facilities Standards & Guidelines

The NSW Government Educational Facility Standards and Guidelines (EFSG) set criteria for noise intrusion to various school spaces. As a Catholic School, the EFSG do not apply to Blessed Carlo College. Nonetheless, the guidelines provide an appropriate benchmark for control of noise intrusion to the school.

Road Traffic Noise

The EFSG states:

Road Noise for general learning areas, music, drama, movement studios and halls shall be assessed consistent with the requirements of State Environmental Planning Policy (Infrastructure) 2007 - regulation 102. An assessment should be undertaken where directed for any site impacted by traffic noise. Generally, it is recommended for all sites impacted by noise from roads with greater than 20,000 vehicles AADT and required for all sites impacted by noise from roads with greater than 40,000 vehicles

AADT. The guideline internal noise levels presented in Acoustic Performance Guidelines (section 11.06) is to be used in the assessment.

The buildings Blessed Carlo College closet to Lignum Road and potentially most affected by traffic noise are the Reception and Administration building (include a future library) and the Share Facilities, incorporating the gymnasium. The relevant EFSG criteria from Section 11.06 are set out in Table 18 below.

TABLE 18 – EFSG CRITERIA FOR NOISE INTRUSION TO, & REVERBERATION WITHIN SCHOOL BUILDINGS

Room	Internal noise level (dB LAeq)	Reverberation time, s RT60 (Av 500Hz & 1000Hz)
Assembly halls over 250 seats	35	1.6
Gymnasiums	40	< 1.5
Staff common rooms	40	< 0.6
Professional & administrative offices	35	< 0.8
Libraries – general areas	40	< 0.6
Libraries – reading rooms	35	< 0.6
Libraries – stack areas	45	< 0.6

Aircraft Noise

Aircraft Noise for general learning areas, music, drama, movement studios and halls is to be assessed where the school site lies within Australian Noise Exposure Forecast (ANEF) 25 (or higher) as shown on airport planning instruments. The procedures in AS 2021 are to be followed in the assessment.

4.4.4 AS2107 – Road Traffic Noise

Australian Standard AS2107:2016 (AS2107) recommends design criteria for conditions affecting the acoustic environment within building interiors to ensure a healthy, comfortable and productive environment for the occupants and users. The background sound levels recommended take into account the function of the area(s) and apply to the sound level measured within the space unoccupied but ready for occupancy. The Standard is applicable to steady state or quasi steady state sounds. Relevant recommended design sound levels from AS2107 are presented in Table 19 below.

TABLE 19 – DESIGN SOUND LEVELS, LAEQ

Type of occupancy/activity	Design sound level range[1] (dB LAeq)	Design Reverberation Time, s
Assembly halls over 250 seats	30 - 35	1.6
Gymnasiums	< 50	1.6
Staff common rooms	40 – 45	< 0.6
Professional & administrative offices	35 – 40	0.6 – 0.8
Libraries – general areas	40 – 50	< 0.6
Libraries – reading rooms	40 – 45	< 0.6
Libraries – stack areas	-	-
Note	*1. Sound levels within the given ranges have been found to be acceptable by most people for the space under consideration. When the sound level is greater than the upper level of the range most people occupying the space will become dissatisfied with the level of the sound. When the sound level is below the lower level of the range, the inadequacy of background sound to provide masking sound can become problematic, for example, by allowing other intermittent noise sources to cause distraction, annoyance, or lack of privacy.*	

4.4.5 AS2021 – Aircraft Noise

Aircraft noise impacts to the schools should be assessed in accordance AS2021:2015 *Acoustics – Aircraft noise intrusion – Building Siting and Construction* (AS2021). AS2021 sets out a methodology to test whether buildings on a school site require treatment for aircraft noise. This involves determination as to whether the school site is classified 'Acceptable', 'Conditionally Acceptable' or 'Unacceptable' with respect to aircraft noise impacts using the following matrix (Table 20) with respect to the Aircraft Noise Exposure Forecast (ANEF) for the site.

TABLE 20 – BUILDING SITE ACCEPTABILITY BASED ON AIRCRAFT NOISE EXPOSURE

Building Type	ANEF Zone of Site		
	Acceptable	Conditionally Acceptable	Unacceptable
School, University	Less than 20 ANEF	20 – 25 ANEF	Greater than 25 ANEF

If the site is 'acceptable', then the school buildings do not require treatment to control aircraft noise intrusion. However, if the site in determined to be 'conditionally acceptable' then the buildings shall be designed to satisfy the aircraft noise intrusion levels set out in Table 21 below.

TABLE 21 – INDOOR DESIGN SOUND LEVELS FOR DETERMINATION OF AIRCRAFT NOISE REDUCTION IN SCHOOLS

Building Type & Activity	Indoor Design Sound Level, dB LASmax
Library, study areas	50
Teaching areas, assembly areas	55
Workshops, gymnasia	75

5 Assessment of Demolition/Construction Impacts

5.1 Plant & Activity Source Levels

As the site is ‘green field’, the delivery of the school will involve two main phases of work, bulk earthworks and general construction.

5.1.1 Noise

Table A1 from Appendix A of Australian Standard AS2436 *Guide to Noise and Vibration Control on Construction, Demolition and Maintenance Sites* contains typical sound levels of construction plant. Selected equipment which it is expected may operate at the Subject Site during building works phase are as shown in Table 22 below.

TABLE 22 – TYPICAL SOUND LEVELS OF CONSTRUCTION PLANT AND EQUIPMENT

Plant description	Sound Power dB(A) ref 10^{-12} W		Sound pressure at 10m, dB(A)
	Typical or range	Typical mid-point	
Compactor	110-115	113	85
Compressor (silenced)	93-110	101	73
Concrete agitator truck	107-111	109	76
Concrete pencil vibrator	101-105	103	75
Concrete pump truck	103-113	108	80
Concrete saw	112-122	117	89
Excavator	97-117	107	79
Generator (diesel)	84-113	99	71
Hand tools (electric)	95-110	102	74
Hand tools (pneumatic)	114-117	116	88
Jack hammers	121	121	93
Loader (wheeled)	99-111	105	77
Machine mounted hydraulic drill	110-115	113	85
Machine mounted percussive drill	116	116	88
Machine mounted pneumatic drill	110-121	116	88
Piling (bored)	111	111	83
Rock breaker	118	118	90
Roller (vibratory)	103-112	108	80
Truck (>20 tonne)	107	107	79
Truck (dump)	117	117	89

Plant description	Sound Power dB(A) ref 10^{-12} W		Sound pressure at 10m, dB(A)
	Typical or range	Typical mid-point	
Vehicle (light commercial)	100-111	106	78
Welder	100-110	105	77

5.1.2 Vibration

Indicative data for vibration levels associated with construction equipment which may operate at the subject site during building works phase is presented in Table 23 below. Note that these data are subject to variability based upon the context within which the equipment is used. For example, resultant vibration levels may be higher for firm ground or rock conditions and lower for soft ground.

Where there is potential for either damage to structures or adverse amenity impacts, it is recommended that a protocol be included in the construction management plan requiring controlled testing and assessment of vibration associated with high-risk activities prior to commencement of the general activity.

TABLE 23 – INDICATIVE VIBRATION LEVELS ASSOCIATED WITH CONSTRUCTION & DEMOLITION EQUIPMENT

Plant description	Based on Typical Vibration Level at 7.6m (mm/s)
Loaded truck	1.9
Jackhammer	0.9
Concrete saw	0.6
Excavator (12-20 tonne)	2.1
Excavator (8-15 tonne)	1.0
Dump truck	0.5
Handheld compactor	1.8
Pile drilling	2.3
Rock breaker (12-15 tonne)	3.3
Rock breaker 32 tonne	6.9

5.2 Predicted Noise Levels

Resultant noise levels at any receiver will depend on many factors including, but not limited to the type of equipment being used, the distance of the receiver from the works, local topographical features, noise screening effects, ground absorption and atmospheric conditions. Resultant noise impacts for both the bulk excavation and general construction stages have been calculated using sound power levels set out in Table 22 at the potentially worst affected receivers. The potentially worst affected receivers would be the future dwellings located on subdivision land immediately adjacent the site (to the north, east, west and south). It should be noted that the potentially most affected existing sensitive receiver (8 Charters Drive) will be less affected that the future dwellings to the west of the school site.

5.2.1 Bulk Excavation

Resultant noise levels from bulk exaction works have been calculated and are presented in Table 24 and Table 25 below. The number of equipment /activities occurring for each type are shown in the first column of each table and has been considered in the sum total noise from all equipment.

The results in Table 24 assume significant rock breaking activities are occurring on site and indicate exceedance of the Noise Affected criterion irrespective of where the centre of activity is occurring on site. The results also indicate exceedance of the Highly Noise Affected criterion at receivers to the north and south of the works site where the centre of activity is located at an average distance from the receivers. Significant exceedance of the Highly Noise Affected criterion can be expected where high noise activities occur close, or at a minimum distance from a receiver.

Table 25 presents resultant noise impacts where rock breaking activities are not occurring. The effective outcome is a reduction of noise levels by 8dB(A), which is an approximate halving of the subjective noise level. This results in a situation where the High Noise Affected noise criterion is only exceeded at receivers to the north and south where activities are undertaken proximate the receiver.

TABLE 24 – CALCULATED NOISE LEVELS FOR BULK EXCAVATION WITH ROCK BREAKING OPERATIONS

Equipment	Equipment SWL (dBA)	Predicted Noise Level dB(A)											
		Kiely Road (future dwellings to the north of the school)			Lignum Road (future dwellings to the west of the school)			New Road Stage 4 (future dwellings to the south of the school)			New dwellings east boundary (future dwellings to the east of the school)		
		Min (30m)	Ave (120m)	Max (270m)	Min (30m)	Ave (200m)	Max (320m)	Min (10m)	Ave (100m)	Max (250m)	Min (10m)	Ave (180m)	Max (300m)
Compactor (x1)	113	75	63	56	75	59	55	85	65	57	85	60	55
Excavator (x3)	107	69	57	50	69	53	49	79	59	51	79	54	49
Loader (wheeled) (x2)	105	67	55	48	67	51	47	77	57	49	77	52	47
Machine mounted hydraulic drill (x1)	113	75	63	56	75	59	55	85	65	57	85	60	55
Machine mounted percussive drill (x1)	116	78	66	59	78	62	58	88	68	60	88	63	58
Machine mounted pneumatic drill (x2)	116	78	66	59	78	62	58	88	68	60	88	63	58
Rock breaker (x2)	118	80	68	61	80	64	60	90	70	62	90	65	60
Roller (vibratory) (x1)	108	70	58	51	70	54	50	80	60	52	80	55	50
Truck (dump) (x2)	107	69	57	50	69	53	49	79	59	51	79	54	49
Vehicle (light commercial) (x2)	106	68	56	49	68	52	48	78	58	50	78	53	48
Total all Equipment	-	-	75	68	-	71	67	-	77	69	-	72	68
Noise Affected Criterion	-	55			55			55			55		
Highly Noise Affected Criterion	-	75			75			75			75		

TABLE 25 – CALCULATED NOISE LEVELS FOR BULK EXCAVATION WITHOUT ROCK BREAKING OPERATIONS

Equipment	Equipment SWL (dBA)	Predicted Noise Level dB(A)											
		Kiely Road (future dwellings to the north of the school)			Lignum Road (future dwellings to the west of the school)			New Road Stage 4 (future dwellings to the south of the school)			New dwellings east boundary (future dwellings to the east of the school)		
		Min (30m)	Ave (120m)	Max (270m)	Min (30m)	Ave (200m)	Max (320m)	Min (10m)	Ave (100m)	Max (250m)	Min (10m)	Ave (180m)	Max (300m)
Compactor (x1)	113	75	63	56	75	59	55	85	65	57	85	60	55
Excavator (x3)	107	69	57	50	69	53	49	79	59	51	79	54	49
Loader (wheeled) (x2)	105	67	55	48	67	51	47	77	57	49	77	52	47
Roller (vibratory) (x1)	108	70	58	51	70	54	50	80	60	52	80	55	50
Truck (dump) (x2)	107	69	57	50	69	53	49	79	59	51	79	54	49
Vehicle (light commercial) (x2)	106	68	56	49	68	52	48	78	58	50	78	53	48
All Equipment	-	-	68	61	-	63	59	-	69	61	-	64	60
Noise Affected Criterion	-	55			55			55			55		
Highly Noise Affected Criterion	-	75			75			75			75		

5.2.2 General Construction

Resultant noise levels from general construction activities are presented in Table 26. The number of equipment /activities occurring for each type are shown in the first column of each table and has been considered in the sum total noise from all equipment.

The results indicate exceedance of the Noise Affected Criterion where the centre of construction activity is occurring at both an average and a maximum distance from the from the receiver. However, the Highly Noise Affected Criterion is only exceeded where high noise activities are caried out proximate (at a minimum distance from) a receiver.

TABLE 26 – CALCULATED NOISE LEVELS FOR GENERAL CONSTRUCTION

Equipment	Equipment SWL (dBA)	Predicted Noise Level dB(A)											
		Kiely Road (future dwellings to the north of the school)			Lignum Road (future dwellings to the west of the school)			New Road Stage 4 (future dwellings to the south of the school)			New dwellings east boundary (future dwellings to the east of the school)		
		Min (30m)	Ave (120m)	Max (270m)	Min (30m)	Ave (200m)	Max (320m)	Min (10m)	Ave (100m)	Max (250m)	Min (10m)	Ave (180m)	Max (300m)
Compactor (x1)	113	75	63	56	75	59	55	85	65	57	85	60	55
Compressor (silenced) (x1)	101	63	51	44	63	47	43	73	53	45	73	48	43
Concrete agitator truck (x1)	109	71	59	52	71	55	51	81	61	53	81	56	51
Concrete pencil vibrator (x1)	103	65	53	46	65	49	45	75	55	47	75	50	45
Concrete pump truck (x1)	108	70	58	51	70	54	50	80	60	52	80	55	50
Concrete saw (x1)	117	79	67	60	79	63	59	89	69	61	89	64	59
Generator (diesel) (x1)	99	61	49	42	61	45	41	71	51	43	71	46	41
Hand tools (electric) (x15)	102	64	52	45	64	48	44	74	54	46	74	49	44
Hand tools (pneumatic) (x2)	116	78	66	59	78	62	58	88	68	60	88	63	58
Piling (bored) (x1)	111	73	61	54	73	57	53	83	63	55	83	58	53
Vehicle (light commercial) (x2)	106	68	56	49	68	52	48	78	58	50	78	53	48
Welder (x2)	105	67	55	48	67	51	47	77	57	49	77	52	47
All Equipment	123	-	74	67	-	69	65	-	75	67	-	70	66
Noise Affected Criterion	-	55			55			55			55		
Highly Noise Affected Criterion	-	75			75			75			75		

5.3 Vibration

Vibration levels will vary depending on the equipment used as well as the soil type in the subject site and surrounding area. Construction activity vibration levels have been calculated at each adjacent noise sensitive location using the vibration data in Table 23. The results of this assessment are presented along with the relevant human comfort and building damage criteria in Table 27 below. The results indicate that building damage criteria may only be exceeded where impact piling or heavy rock breaking occur very close to dwellings or domestic structures. Onsite vibration monitoring would be required under these scenarios.

The results indicate that vibration from most construction activities will not adversely affect human comfort, unless moderate to high vibration inducing activities are carried out proximate / at a minimum distance from sensitive receivers.

TABLE 27 – PREDICTED VIBRATION LEVELS

Equipment	Vibration Velocity at 7.6m (mm/s)	Predicted Vibration Velocity Level (mm/s)											
		Kiely Road (future dwellings to the north of the school)			Lignum Road (future dwellings to the west of the school)			New Road Stage 4 (future dwellings to the south of the school)			New dwellings east boundary (future dwellings to the east of the school)		
		Min (6m)	Ave (120m)	Max (270m)	Min (30m)	Ave (200m)	Max (320m)	Min (10m)	Ave (100m)	Max (250m)	Min (10m)	Ave (180m)	Max (300m)
Loaded truck	1.9	1.0	0.5	0.3	1.0	0.4	0.3	1.7	0.5	0.3	1.7	0.4	0.3
Jackhammer	0.9	0.5	0.2	0.2	0.5	0.2	0.1	0.8	0.2	0.2	0.8	0.2	0.1
Concrete saw	0.6	0.3	0.2	0.1	0.3	0.1	0.1	0.5	0.2	0.1	0.5	0.1	0.1
Excavator (12-20 tonne)	2.1	1.1	0.5	0.4	1.1	0.4	0.3	1.8	0.6	0.4	1.8	0.4	0.3
Excavator (8-15 tonne)	1	0.5	0.3	0.2	0.5	0.2	0.2	0.9	0.3	0.2	0.9	0.2	0.2
Dump truck	0.5	0.3	0.1	0.1	0.3	0.1	0.1	0.4	0.1	0.1	0.4	0.1	0.1
Handheld compactor	1.8	0.9	0.5	0.3	0.9	0.4	0.3	1.6	0.5	0.3	1.6	0.4	0.3
Pile drilling	2.3	1.2	0.6	0.4	1.2	0.4	0.4	2.0	0.6	0.4	2.0	0.5	0.4
Rock breaker (12-15 tonne)	3.3	1.7	0.8	0.6	1.7	0.6	0.5	2.9	0.9	0.6	2.9	0.7	0.5
Rock breaker 32 tonne	6.9	3.5	1.7	1.2	3.5	1.3	1.1	6.0	1.9	1.2	6.0	1.4	1.1
Impact Pile Drivers	16.5	8.3	4.2	2.8	8.3	3.2	2.5	14.4	4.5	2.9	14.4	3.4	2.6
Vibratory Roller, speed 1.5 to 2.5km/h	5.3	2.7	1.3	0.9	2.7	1.0	0.8	4.6	1.5	0.9	4.6	1.1	0.8
Large Bulldozer	2.3	1.2	0.6	0.4	1.2	0.4	0.4	2.0	0.6	0.4	2.0	0.5	0.4
Criteria for Exposure to Continuous and Impulsive Vibration	-	0.28 – 0.56			0.28 – 0.56			0.28 – 0.56			0.28 – 0.56		
Structural Damage Criterion (4-15Hz)	-	5			5			5			5		

5.4 Assessment of Noise & Vibration Impacts

The analysis presented in Sections 5.2 and 5.3 above indicate that noise and vibration associated with construction activities at the school site will likely exceed the noise and vibration management levels established in Section 3 of this report. Therefore, it is recommended that construction noise and vibration management practices are adopted for the works.

6 Noise & Vibration Management Practices

Adverse comment from noise and vibration impacts may occur at some locations and consequently, noise and vibration generation should be appropriately managed. Noise level emissions and potential annoyance depend significantly on the condition of the equipment, the type of operation, its duration and the time of day it is conducted. Specific noise control measures to be adopted include the physical noise controls and management measures listed below.

6.1 Physical Noise Controls

6.1.1 Machinery Noise Attenuation Treatments

Australian Standard AS2436 sets out some example applications of noise attenuation treatments which have been adapted based on equipment which is expected may operate at the subject site during building works phase. To ensure a best practice approach to the minimisation of noise from construction machinery it is recommended that these noise attenuation treatments as shown below in Table 28 are adopted where possible.

TABLE 28 – TYPICAL NOISE SOURCES AND MITIGATION ADVICE ADAPTED FROM AS2436

Machine	Source of Noise	Possible Mitigation	Alternative Mitigation
Dump truck Excavator	Engine	Fit more efficient silencer or exhaust silencer. Enclosure panels, when fitted should be kept closed.	-
Compressor Generator	Engine	Fit more efficient exhaust silencer	Screen the compressor or generator. Use electric motor in preference to diesel or petrol engine for compressors. If there is no mains supply, a sound reduced compressor or generator can be used to supply several pieces of plant. Use centralized generator system.
	Compressor or generator	Acoustically dampen metal casing Enclosure panels should be kept closed.	

Machine	Source of Noise	Possible Mitigation	Alternative Mitigation
Pneumatic concrete Rock breaker and tools	Tool	Fit a muffler or silencer that reduce the noise without impairing efficiency.	Use rotary drill and burster. Hydraulic and electric tools are also available. A thermic lance can be used to burn holes in concrete and to cut through large sections of concrete; any reinforcement helps the burning process. For breaking large areas of concrete, equipment which breaks concrete by bending could be used.
	Bit	Use dampened bit to eliminate 'ringing'. Little noise once surface is broken.	
	Air-line	Leaks in air line should be sealed	-
	Motor	Fit muffler to pneumatic saws.	-
Power saws	Vibration of blade or material being cut	Keep saw sharp. Use a damped blade. Clamp material while cutting with packing if necessary.	-
Riveters	Impact on rivet	Enclose working area with an acoustic screen.	Design for high tensile steel bolts instead of rivets.
Explosive powered tools	Explosion of cartridge	Use a sound reduced gun	Drilled fixings.
Pumps	Engine pulsing	Enclose with an acoustic screen (allowing for engine cooling and exhaust)	-
Concrete mixer	Filling	Do not let aggregates fall from an excessive height.	
	Cleaning	Do not hammer the drum.	
Hammer	Impact on nail	-	Screws
Electric impact chisel	Impact	-	Rotary hand milling machine.
Materials handling	Impact of material	Do not drop materials from a height. Screen dropping zones especially on conveyor systems.	Cover surface with resilient material or unload elsewhere.

6.1.2 Noise Control Effectiveness

The relative effectiveness of different forms of noise control as listed in AS2436, is presented in Table 29 below.

TABLE 29 – RELATIVE EFFECTIVENESS OF VARIOUS FORMS OF NOISE CONTROL

Control by	Nominal noise reduction possible, in total A-weighted sound pressure level L_{pA} dB
Distance	Approximately 6dB for each doubling of distance
Screening	Normally 5 – 10, maximum 15
Enclosure	Normally 15 – 25, maximum 50
Silencing	Normally 5 – 10, maximum 20

6.2 General Work Practices

Some general construction activities can be carried out in the following ways:

Work practices at any time of day

- Regularly train workers and contractors (such as at toolbox talks) to use equipment in ways to minimise noise.
- Ensure site managers periodically check the site and nearby residences and other sensitive land uses for noise problems so that solutions can be quickly applied.
- Include in tenders, employment contracts, subcontractor agreements and work method statements clauses that require minimisation of noise and compliance with directions from management to minimise noise.
- Avoid the use of radios or stereos outdoors where neighbours can be affected.
- Avoid the overuse of public address systems.
- Avoid shouting, and minimise talking loudly and slamming vehicle doors.
- Keep truck drivers informed of designated vehicle routes, parking locations, acceptable delivery hours or other relevant practices (for example, minimising the use of engine brakes, and no extended periods of engine idling).
- Develop a one-page summary of approval or consent conditions that relate to relevant work practices, and pin it to a noticeboard so that all site operators can quickly reference noise information.
- Workers may at times need to discuss or negotiate practices with their managers.

Additional work practices at night

- Avoid the use of equipment which generates impulsive noise.
- Minimise the need for reversing or movement alarms.
- Avoid dropping materials from a height.
- Avoid metal-to-metal contact on equipment.
- Schedule truck movements to avoid residential streets if possible.
- Avoid mobile plant clustering near residences and other sensitive land uses.

- Ensure periods of respite are provided in the case of unavoidable maximum noise level events.

6.3 Plant & Equipment

In terms of both cost and results, controlling noise at the source is one of the most effective methods of minimising the noise impacts from any construction activities.

Use quieter methods

- Examine and implement, where feasible and reasonable, alternatives to rock-breaking work methods, such as hydraulic splitters for rock and concrete, hydraulic jaw crushers, chemical rock and concrete splitting, and controlled blasting such as penetrating cone fracture. The suitablility of alternative methods should be considered on a case-by-case basis.
- Use alternatives to diesel and petrol engines and pneumatic units, such as hydraulic or electric-controlled units where feasible and reasonable. Where there is no electricity supply, use an electrical generator located away from residences.
- Examine and implement, where feasible and reasonable, alternatives to transporting excavated material from underground tunnelling off site at night. For example, stockpile material in an acoustically treated shed at night and load out the following day.

Use quieter equipment

- Examine different types of machines that perform the same function and compare the noise level data to select the least noisy machine. For example, rubber wheeled tractors can be less noisy than steel tracked tractors.
- Noise labels are required by NSW legislation for pavement breakers, mobile compressors, chainsaws and mobile garbage compactors. These noise labels can be used to assist in selecting less noisy plant.
- Pneumatic equipment is traditionally a problem – select supersilenced compressors, silenced jackhammers and damped bits where possible.
- When renting, select quieter items of plant and equipment where feasible and reasonable.
- When purchasing, select, where feasible and reasonable, the most effective mufflers, enclosures and low-noise tool bits and blades. Always seek the manufacturer's advice before making modifications to plant to reduce noise.

Operate plant in a quiet and efficient manner

- Reduce throttle setting and turn off equipment when not being used.
- Examine and implement, where feasible and reasonable, the option of reducing noise from metal chutes and bins by placing damping material in the bin.

Maintain equipment

- Regularly inspect and maintain equipment to ensure it is in good working order. Also check the condition of mufflers.
- Equipment must not be operated until it is maintained or repaired, where maintenance or repair would address the annoying character of noise identified.

- For machines with enclosures, check that doors and door seals are in good working order and that the doors close properly against the seals.
- Return any hired equipment that is causing noise that is not typical for the equipment – the increased noise may indicate the need for repair.
- Ensure air lines on pneumatic equipment do not leak.

Location of plant

- Place as much distance as possible between the plant or equipment and residences and other sensitive land uses.
- Restrict areas in which mobile plant can operate so that it is away from residences and other sensitive land uses at particular times.
- Locate site vehicle entrances away from residences and other sensitive land uses.
- Carry out noisy fabrication work at another site (for example, within enclosed factory premises) and then transport to site.

Alternatives to reversing alarms

- Avoid use of reversing alarms by designing site layout to avoid reversing, such as by including drive-through for parking and deliveries.
- Install where feasible and reasonable less annoying alternatives to the typical 'beeper' alarms taking into account the requirements of the Occupational Health and Safety legislation; examples are smart alarms that adjust their volume depending on the ambient level of noise and multifrequency alarms that emit noise over a wide range of frequencies.
- In all circumstances, the requirements of the relevant Occupational Health and Safety legislation must be complied with.

Maximise shielding

- Reuse existing structures rather than demolish and reconstruct.
- Use full enclosures, such as large sheds, with good seals fitted to doors to control noise from night-time work.
- Use temporary site buildings and materials stockpiles as noise barriers.
- Schedule construction of permanent walls so that they can be used as early as possible as noise barriers.
- Use natural landform as a noise barrier – place fixed equipment in cuttings, or behind earth berms.
- Note large reflecting surfaces on and off site that might increase noise levels, and avoid placing noise-producing equipment in locations where reflected noise will increase noise exposure or reduce the effectiveness of mitigation measures.

6.4 Administrative Controls

6.4.1 Time Management

Scheduling noisy work during periods when people are least affected is an important way of reducing noise impact.

Provide respite periods

- Consult with affected schools to ensure that noise-generating construction works in the vicinity of affected school buildings are not scheduled to occur during examination periods, unless other arrangements (such as relocation to an alternative location) acceptable to the affected schools can be made.
- Where night work near residences cannot be feasibly or reasonably avoided, restrict the number of nights per week and/or the number of nights per calendar month that the works are undertaken, in consultation with residents who will be most affected.

Schedule activities to minimise noise impacts

- Organise work to be undertaken during the recommended standard hours where possible.
- Schedule work to avoid times when there are special events, such as international sporting competitions, if the construction site is in the vicinity of the venue. When works outside the recommended standard hours are planned, avoid scheduling on Sundays or public holidays.
- Schedule work when neighbours are not present (for example, commercial neighbours, colleges and schools may not be present outside business hours or on weekends).
- Schedule noisy activities around times of high background noise (local road traffic or when other local noise sources are active) where possible to provide masking or to reduce the amount that the construction noise intrudes above the background.
- For tunnelling works examine and implement, where feasible and reasonable, the possibility of stockpiling excavated material overnight in an enclosure and restrict load-out to the recommended standard hours only.
- Consult with affected neighbours about scheduling activities to minimise noise impacts. . Care should be taken to minimise noise from any refuelling at night.

Organise deliveries and access

- Nominate an off-site truck parking area, away from residences, for trucks arriving prior to gates opening.
- Amalgamated loads can lead to less noise and congestion in nearby streets.
- Optimise the number of vehicle trips to and from the site – movements can be organised to amalgamate loads rather than using a number of vehicles with smaller loads.
- Designate access routes to the site, through consultation with potentially noise-affected residences and other sensitive land uses, and make drivers aware of nominated vehicle routes.
- Provide on-site parking for staff and on-site truck waiting areas away from residences and other sensitive land uses. Truck waiting areas may require bunding or walls to minimise noise.

- Schedule deliveries to nominated hours only.

6.4.2 Site Management

All personnel working on site should be appropriately inducted. The site induction should address the requirements of the NVMP and their responsibilities with regard to noise and vibration management.

Contractors will need to ensure equipment is operated in the correct manner including replacement of engine covers, repair of defective silencing equipment, tightening of rattling components, repair of leakages in compressed air lines and shutting down equipment not in use.

Regular reinforcement of noise and vibration sensitivity should be raised at toolbox meetings.

6.4.3 Community Consultation

The community is more likely to be understanding and accepting of noise if the information provided is frank, does not attempt to understate the likely noise level, and if commitments are firmly adhered to.

6.4.3.1 Notification Before & During Construction

- Provide, reasonably ahead of time, information such as total building time, what works are expected to be noisy, their duration, what is being done to minimise noise and when respite periods will occur. For works outside standard hours, inform affected residents and other sensitive land use occupants between five and 14 days before commencement.
- Provide information to neighbours before and during construction through media such as letterbox drops, meetings or individual contact. In some areas, the proponent will need to provide notification in languages other than English. A website could also be established for the project to provide information.
- Use a site information board at the front of the site with the name of the organisation responsible for the site and their contact details, hours of operation and regular information updates. This signage should be clearly visible from the outside and include after hours emergency contact details.
- Maintain good communication between the community and project staff.
- Appoint a community liaison officer where required.
- For larger projects consider a regular newsletter with site news, significant project events and timing of different activities.
- Provide a toll-free contact phone number for enquiries during the works.
- Facilitate contact with people to ensure that everyone can see that the site manager understands potential issues, that a planned approach is in place and that there is an ongoing commitment to minimise noise.

6.4.3.2 Complaints Handling

- Provide a readily accessible contact point, for example, through a 24 hour toll-free information and complaints line.
- Give complaints a fair hearing.

- Have a documented complaints process, including an escalation procedure so that if a complainant is not satisfied there is a clear path to follow.
- Call back as soon as possible to keep people informed of action to be taken to address noise problems. Call back at night-time only if requested by the complainant to avoid further disturbance.
- Provide a quick response to complaints, with complaint handling staff having both a good knowledge of the project and ready access to information.
- Implement all feasible and reasonable measures to address the source of complaint.
- Keep a register of any complaints, including details of the complaint such as date, time, person receiving complaint, complainant's contact number, person referred to, description of the complaint, work area (for larger projects), time of verbal response and timeframe for written response where appropriate.

6.4.3.3 Complaint Resolution

If there are complaints concerning noise once the project has started, the steps below can be followed to address the noise. A copy of the complaints register should be kept on site.

Step 1: Noise sources should be identified, such as movement of material using a bobcat, cutting of wood using electric saws, short-term foundation works using a rock breaker, loader and truck, and deliveries of building materials with utilities and trucks.

Step 2: Answer the following questions regarding each noise source:

- Is the noise from the source loud either in an absolute sense or relative to other noise sources in the area?
- Does the noise include any tones or impulses?
- Does the noise occur at times when interference with sleep or comfort is likely – for example, at night?

Step 3: Implement feasible and reasonable work practices to minimise or avoid noise.

6.4.4 Compliance Auditing

Noise and vibration monitoring maybe required at locations which approximate the nearest noise sensitive receiver to the location where loud and high impact activities are expected to be conducted. The equipment should be set so that email or text alerts are sent to relevant staff if the trigger levels provided in Table 5, Table 6 and Table 7 are exceeded. Upon receiving the alert, the relevant staff member should investigate the nature or cause of the event and, if required, implement appropriate action in accordance with the processes outlined above.

The details of the monitoring program including the locations and duration of monitoring will be determined in consultation with the Contractor, Acoustic Engineer engaged on the project and Council (where applicable).

7 Operational Impacts

The primary noise sources associated with the operation of the school include; students playing in the outdoor areas, school bell, PA system, used of the school for activities including amplified speech and music and mechanical equipment and services. The following assessment is based on plans prepared by Clarke Hopkins Clarke (attached in Appendix B).

7.1 Noise Modelling

A 3-D computer noise model of the school and surrounds was built in CadnaA software and calculations run implementing the ISO9613 algorithms. The ISO9613 algorithms calculate the propagation of noise between source and receiver taking into account propagation effects associated with:

- Noise source sound power in octave bands;
- Geometrical spreading;
- Local topography;
- Atmospheric conditions, including wind;
- Barrier effects of fences, buildings and built form;
- Reflections from buildings and the environment; and
- Ground absorption.

7.2 Noise from Outdoor Areas

School bell times will be 8.55am; 11.00am; 11.30am; 1.00pm; 1.55pm; 3.15pm. Noise from play/use of outdoor areas can therefore be expected to be predominant for a total of approximately 120 minutes / 2 hours during the following times:

- 8:30am – 8:55am
- 11:00am – 11:30am
- 1:00pm – 1:55pm
- 3:15pm – 3:25pm

Noise from the use of the outdoor areas was added to the 3-D model as an area source evenly distributed over the outdoor space at the school at a height of 1m above the ground. Speech sound power levels used in the assessment (refer to Table 30) were adopted from Olsen[1]. The assessment assumed the school to be operating at ultimate capacity with 390 students playing outdoors,

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[1] *Olsen, WO (1998) Average Speech Levels and Spectra in Various Speaking/Listening Conditions: A Summary of the Pearson, Bennett & Fidell (1977) Report, American Journal of Audiology*

specifically with 95 percent of the students communicating in a raised voice and 5 percent of the students shouting.

TABLE 30 – SOUND POWER LEVELS FOR PLAYGROUND ASSESSMENT, RE 10^{-12} W

Condition	SWL dB(A)	Octave Band Centre Frequency, Hz							
		63	125	250	500	1k	2k	4k	8k
Single male, normal voice[1]	69	-	63	66	69	62	58	54	49
Single female, normal voice[1]	66	-	49	62	65	60	55	54	51
Single child shouting[1]	91	-	56	66	81	87	86	81	71
Single child raised voice[1]	75	-	43	67	72	71	67	63	59
Notes:	*1. Sound power levels for speech adopted from Olsen.*								

The noise model was the run to calculate resulting noise levels at the potentially worst affected noise sensitive receivers, including yet to be completed dwellings on the surrounding area slated for future residential development (refer to Figure 1). For the purpose of delivering a conservative assessment, it was assumed that all dwellings that are 'yet to be completed' have a height of two stories. The results of assessment are presented in Table 31 below.

The assessment is also likely to be conservate on the basis that usually there may be at least one listener for each person communicating (the net effect of which would reduce the results of the assessment by 3dB(A)). A further conservative aspect of the assessment is that older students (eg, years 10 – 12) may reasonably be expected spend time outdoors speaking in a 'normal' voice level, which would further reduce the results of the assessment below those set out in Table 31.

TABLE 31 – ASSESSMENT OF NOISE IMPACTS

Address	Receiver Level	Trigger Level, dB L_{Aeq}		Students Outside, dB L_{Aeq}
		> 4 hrs	< 4 hrs	
8 Charters Drive (existing)	LG	50	55	42
Kiely Road (future dwellings to the north of the school)	LG	50	55	55
	L1			55
Lignum Road (future dwellings to the west of the school)	LG	50	55	51
	L1			51
New Road Stage 4 (future dwellings to the south of the school)	LG	50	55	52
	L1			56
New dwellings east boundary (future dwellings to the east of the school)	LG	50	55	49
	L1			54

It is anticipated that predominant noise emissions from the outdoor areas at the school will occur for approximately two hours a day. The results of the assessment indicate that playground noise will comply with the relevant 'less than' four-hour trigger level at all noise sensitive receivers with the exception of the second storey of future dwellings on the north side of 'New Road Stage 4', where there is a 1dB(A) exceedance. A 1dB(A) exceedance is considered to be insignificant on the basis that it would not be subjectively distinguishable from the assessment level of 55dB(A).

The results indicate exceedances of up to 6dB(A) of the 'greater than' four-hour trigger level at the surrounding future dwellings. However, future dwellings immediately adjacent the school will experience increasingly reduced noise impacts with distance from the school. The 6dB(A) exceedance is not considered significant on the basis that the grounds will not typically be used for intensive play activity more than four hours a day.

Nonetheless, a 6dB(A) exceedance would also not be considered significant on the basis that sounds of children playing in the outdoor areas is expected and typical of noise emissions from school grounds. This concept is discussed in the Land and Environment Court decision in the matter Meriden School v Pedavoli [2009] NSWLEC 183.

7.3 School Bell & Public Address System

Blessed Carlo College will be provided with a PA system and school bell to signal the start and conclusion of classes. At this early stage of the project the location of the speakers has not yet been determined. However, assessment indicates that resultant noise will comply with both Intrusive and Amenity criteria with a tonality penalty applied and on the basis that:

- The PA / bell is used for a maximum of 30 seconds every half hour.
- The up to seven speakers are installed set to a maximum of 80dB(A) at 3m.

7.4 Mechanical Services

The schedule and location of proposed mechanical services as not yet been developed for the school. The following assessment has therefore been carried out on the basis that the school will be air-conditioned and otherwise fitted with typical exhaust fan systems as reflected in Table 32 below.

TABLE 32 – REPRESENTATIVE MECHANICAL INSTALLATION

Equipment Description	No.	SWL[1], dB(A)	Octave Band Centre Frequency (Hz)							
			63	125	250	500	1k	2k	4k	8k
Large (two fan) A/C fan	48	80	91	86	82	79	73	65	60	55
General exhaust fan	32	60	53	43	49	54	56	54	49	40
Kitchen/laboratory exhaust fan	32	71	64	54	60	65	67	65	60	51
Notes:	*1. SWL re 10^{-12} W.*									

The representative air-conditioning and exhaust fan systems were added to the 3-D model and resultant noise levels at the surrounding noise sensitive receivers calculated. The results of assessment are presented in Table 31 below.

TABLE 33 – ASSESSMENT OF NOISE IMPACTS

Address	Receiver Level	Trigger Level, dB L_{Aeq}		Plant Noise Level, dB L_{Aeq}
		Intrusive	Amenity	
8 Charters Drive (existing)	LG	50	53	36
Kiely Road (future dwellings to the north of the school)	LG	50	53	41
	L1			40
Lignum Road (future dwellings to the west of the school)	LG	50	53	44
	L1			45
New Road Stage 4 (future dwellings to the south of the school)	LG	50	53	36
	L1			38
New dwellings east boundary (future dwellings to the east of the school)	LG	50	53	29
	L1			33

The results of this assessment indicate that noise from mechanical systems typical of an air-conditioned school comfortably comply with both the adopted NPI Intrusive and Amenity noise trigger levels.

7.5 School Hall

The Shared Facilities (School Hall) includes a band practice room, gym and associated stage area. The stage area has external doors are the rear such that it may be used for external events. The gym includes five several large Renlita style doors which much of the southern façade be opened to the outdoors. It is anticipated that typical use of the School Hall will include:

- Physical education and sports.
- Band / music practice one to two days a week.
- Weekly school assemblies.
- School concerts (two to three per year)

Octave Acoustics has been advised that the School Hall will not typically be used by the community afterhours.

The 3-D model was further developed to include typical worst case noise sources associated with the operation of the School Hall, music / concerts and team ball sports (refer to Table 34).

TABLE 34 – SCHOOL HALL SOUND POWER LEVELS

Source	SWL[1], dB(A)	Octave Band Centre Frequency (Hz)							
		63	125	250	500	1k	2k	4k	8k
Ball sports in gym (netball)	99	95	89	87	87	94	94	90	95
Ball sports in gym (basketball)	97	95	91	89	89	92	90	92	95
Band practice / concert on stage	108	102	96	97	98	100	105	97	90
Notes:	*1. SWL re 10^{-12} W.*								

Noise modelling was carried out to consider scenarios with the Renlita and external stage doors both open and closed. The results of the assessment are presented in Table 35 and Table 36 below. Table 35 sets out results of the music noise modelling which indicate compliance with both Intrusive and Amenity criteria when the Renlita and external stage doors are closed.

However, when the doors are open the Intrusive criterion is exceeded by 8dB(A) at the existing house at 8 Charters Drive and by 18dB(A) at the upper level of potentially most affected future dwelling to the south of the School Hall. An 18dB(A) exceedance is relatively significant. Therefore, if noise complaints are received in relation to music noise emissions from the School Hall, it may be appropriate for the school to adopting a policy requiring that the Renlita and external stage doors are closed when band practices, concerts and the like are held within the main gymnasium space.

During the Evening period between 6pm and 10pm the noise criteria become 10dB(A) more onerous. When the Renlita and external stage doors are closed during the Evening period, results indicate an 8dB(A) exceedance of the Intrusive criterion at the future dwellings immediately to the south of the gym. Such exceedance may not be considered significant based on occasional use of gymnasium space for concerts during the evening. It is recommended that the Relita and external stage doors are kept closed during concerts (and similar) held during the Evening period.

TABLE 35 – ASSESSMENT OF SCHOOL HALL MUSIC NOISE IMPACTS

Address	Receiver Level	Trigger Level, dB L_{Aeq}		Music Noise Level, dB L_{Aeq}	
		Intrusive	Amenity	Doors Closed	Doors Open
8 Charters Drive (existing)	LG	50	53	40	58
Kiely Road (future dwellings to the north of the school)	LG	50	53	18	40
	L1			20	42
Lignum Road (future dwellings to the west of the school)	LG	50	53	44	50
	L1			44	52
New Road Stage 4 (future dwellings to the south)	LG	50	53	45	63
	L1			48	68
New dwellings east boundary (future dwellings to the east)	LG	50	53	20	43
	L1			23	47

Table 36 sets out modelling results of sports noise breakout from the School Hall. These results indicate compliance at all receivers with the exception of a 3 – 8dB(A) exceedance at the future dwellings to the south of the gym when the Relita doors are open. This exceedance may not be considered significant within the context of noise emissions reasonably expected from a school during the Day period. However, as the criteria become 10dB(A) more onerous during the Evening period, it may be appropriate for the school to consider a policy that the Relita doors be closed when sports practice or games are held within the gym space during the Evening period, after 6pm.

TABLE 36 – ASSESSMENT OF SCHOOL HALL SPORTS NOISE IMPACTS

Address	Receiver Level	Trigger Level, dB L_{Aeq}		Sports Noise Level, dB L_{Aeq}	
		Intrusive	Amenity	Doors Closed	Doors Open
8 Charters Drive (existing)	LG	50	53	30	48
Kiely Road (future dwellings to the north of the school)	LG	50	53	8	25
	L1			10	27
Lignum Road (future dwellings to the west of the school)	LG	50	53	33	39
	L1			33	42
New Road Stage 4 (future dwellings to the south of the school)	LG	50	53	34	53
	L1			37	58
New dwellings east boundary (future dwellings to the east of the school)	LG	50	53	10	28
	L1			12	33

7.6 Traffic Generated by the School

Preliminary traffic engineering advice anticipates that with a full roll of 390 students the school will generate 321 vehicle movements per hour during the morning drop-off peak hour and 255 movements per hour during the afternoon pick-up peak hour. This peak hour traffic was added to the 3-D model using the vehicle sound power data presented in Table 37 below. The model assumed that school traffic approaches via Lignum Road at 40km/h, enters and proceeds around the full kiss and drop circuit at 5km/h before departing via Lignum Road at 40km/h.

TABLE 37 – VEHICLE SOUND POWER LEVELS, DB LEQ

Source	SWL[1], (A)	Octave Band Centre Frequency (Hz)							
		63	125	250	500	1k	2k	4k	8k
Car moving within carpark	77	84	81	76	73	71	69	69	64
Car at 50 km/h	87	94	91	86	83	81	79	79	74
Notes:	*1. SWL re 10^{-12} W.*								

The potentially most affected receiver is expected to be the future dwelling on the corner of the Lignum Road and the kiss and drop turn-off. Other receivers in this area may also be affected, with traffic noise levels diminishing with distance from both Lignum Road and the kiss and drop circuit. The results of this assessment are presented in Table 38 below and indicate compliance with the applicable RNP criterion for local roads.

TABLE 38 – ASSESSMENT OF TRAFFIC NOISE IMPACTS

<table>
<tr><th>Address</th><th>Receiver Level</th><th>RNP Assessment Criteria – dB(A) Day (7am – 10pm)</th><th>Traffic Noise Level, dB L_{Aeq}</th></tr>
<tr><td>8 Charters Drive (existing)</td><td>LG</td><td rowspan="5">$L_{Aeq,\ (1\ hour)}$ 55 (external)</td><td>49</td></tr>
<tr><td rowspan="2">Future dwelling cnr Lignum Road and kiss and drop circuit</td><td>LG</td><td>52</td></tr>
<tr><td>L1</td><td>53</td></tr>
<tr><td rowspan="2">Lignum Road (future dwellings to the west of the school)</td><td>LG</td><td>49</td></tr>
<tr><td>L1</td><td>49</td></tr>
</table>

8 External Noise Intrusion

8.1 Road Traffic Noise

As discussed in Section 4.4.3, the Educational Facilities Standards and Guidelines do not apply to catholic school development. However, the EFSG provide a useful benchmark with which to consider the acoustic performance of Blessed Carlo College. With respect to potential traffic noise intrusion, the EFSG only recommends formal assessment where traffic volumes on adjacent roads are expected to exceed 20,000 vehicles a day. Traffic engineering advice for the project indicates that traffic volumes will be less than 10,000 vehicles a day in the year 2030. A formal assessment of road traffic noise intrusion may not then be required. Nonetheless, Octave Acoustics has incorporated Lignum Road traffic into the 3-D model to assess noise intrusion with respect to the established criteria in Section 4.4.

The results of the noise model indicated a worst-case traffic noise of 48dB(A) incident on the facades of the two buildings closest to Lignum Road, the Reception and Administration Building and the Shared Facilities Building. With windows open, this would result in 38dB(A) within the associated spaces. It can then be concluded that resultant traffic noise intrusion will comply with the established criteria, noting that any spaces and rooms having indoor noise criteria of 35dB(A) or less are located such that their facades would be exposed to less than 45dB(A).

8.2 Aircraft Noise

At over 7km away, the Echuca Aerodrome is the closest airfield to the subject site. The Echuca Aerodrome Master Plan 2010, prepared for Campaspe Shire Council by Beca Pty Ltd states the following with respect to aircraft noise.

An Australian Noise Exposure Forecast (ANEF) is not being produced as part of this Master Plan. The ANEF system adopted in Australia is a planning tool used to forecast the level of noise generated by aircraft operations at an aerodrome. The level of noise is determined by the size and type of aircraft, the number of movements and whether the movements occur during the day or at night. Wind conditions and runway orientation are also factored into the model that is used to produce the ANEF.

Echuca Aerodrome is only used by light aircraft and due to the low number of aircraft movements these aircraft do not generate sufficient noise for an ANEF to be meaningful. The contours produced by the ANEF model, if one was produced for Echuca Aerodrome, would all likely fall within the aerodrome property, or marginally outside the property, and would be difficult to decipher.

It is therefore concluded that Blessed Carlo College falls comfortably outside the ANEF 20 contour. Under AS2021 the site would be classified as ‘acceptable’ for construction and no further consideration of potential aircraft noise impacts is required.

9 Conclusion

Octave Acoustics was engaged by Clarke Hopkins Clarke to carry out a noise and vibration impact assessment to addresses the requirements of Clause 10 of the Secretary's Environmental Assessment Requirements (SEARs) for the construction and operation of the Blessed Carlo College at the corner of Kiely and Lignum Roads, Moama.

The resulting work included a quantitative assessment of noise and vibration generating sources during bulk excavation and construction. Outcomes indicated that excavation and construction impacts will exceed the applicable Noise Affected criterion and may at times also exceed the Highly Noise Affected criterion. As such, it is recommended that construction noise management practices are adopted for the works.

High vibration generating activities such as pile driving and heavy rock breaking may exceed building damage criteria when carried out proximate to domestic structures. Vibration monitoring should be implemented in such circumstances.

Assessment of noise impacts associated with the operation of the school generally indicate that noise from the school is unlikely to be offensive or result in adverse amenity impacts. However, it is recommended that the school keep the large gym (Relita) and external doors closed when:

- Band practices, concerts and the like are held within the main gymnasium space.
- Sports practice or games are held within the gym space during the Evening period, after 6pm.

Assessment of potential noise impacts on the school considered both traffic and aircraft noise and determine that no special acoustic treatments are required to deal with the resulting noise intrusion.

Appendix A: Glossary of Acoustic Terms

'A' FREQUENCY WEIGHTING

The 'A' frequency weighting roughly approximates to the Fletcher-Munson 40 phon equal loudness contour. The human loudness perception at various frequencies and sound pressure levels is equated to the level of 40 dB at 1 kHz. The human ear is less sensitive to low frequency sound and very high frequency sound than midrange frequency sound (i.e. 500 Hz to 6 kHz). Humans are most sensitive to midrange frequency sounds, such as a child's scream. Sound level meters have inbuilt frequency weighting networks that very roughly approximates the human loudness response at low sound levels. It should be noted that the human loudness response is not the same as the human annoyance response to sound. Here low frequency sounds can be more annoying than midrange frequency sounds even at very low loudness levels. The 'A' weighting is the most commonly used frequency weighting for occupational and environmental noise assessments. However, for environmental noise assessments, adjustments for the character of the sound will often be required.

AMBIENT NOISE

The ambient noise level at a particular location is the overall environmental noise level caused by all noise sources in the area, both near and far, including all forms of traffic, industry, lawnmowers, wind in foliage, insects, animals, etc. Usually assessed as an energy average over a set time period 'T' ($L_{Aeq,T}$).

AUDIBLE

Audible refers to a sound that can be heard. There are a range of audibility grades, varying from "barely audible", "just audible" to "clearly audible" and "prominent".

BACKGROUND NOISE LEVEL

Total silence does not exist in the natural or built-environments, only varying degrees of noise. The Background Noise Level is the minimum repeatable level of noise measured in the absence of the noise under investigation and any other short-term noises such as those caused by all forms of traffic, industry, lawnmowers, wind in foliage, insects, animals, etc. It is quantified by the noise level that is exceeded for 90 % of the measurement period 'T' ($L_{A90,T}$). Background Noise Levels are often determined for the day, evening and night time periods where relevant. This is done by statistically analysing the range of time period (typically 15 minute) measurements over multiple days (often 7 days). For a 15-minute measurement period the Background Noise Level is set at the quietest level that occurs at 1.5 minutes.

'C' FREQUENCY WEIGHTING

The 'C' frequency weighting approximates the 100 phon equal loudness contour. The human ear frequency response is more linear at high sound levels and the 100 phon equal loudness contour attempts to represent this at various frequencies at sound levels of approximately 100 dB.

DECIBEL

The decibel (dB) is a logarithmic scale that allows a wide range of values to be compressed into a more comprehensible range, typically 0 dB to 120 dB. The decibel is ten times the logarithm of the ratio of any two quantities that relate to the flow of energy (i.e. power). When used in acoustics it is the ratio of the square of the sound pressure level to a reference sound pressure level, the ratio of the sound power level to a reference sound power level, or the ratio of the sound intensity level to a reference sound intensity level. See also Sound Pressure Level and Sound Power Level. Noise levels in decibels cannot be added arithmetically since they are logarithmic numbers. If one machine is generating a noise level of 50 dB, and another similar machine is placed beside it, the level will increase to 53 dB (from $10 \log_{10}(10^{(50/10)} + 10^{(50/10)})$ and not 100 dB. In theory, ten similar machines placed side by side will increase the sound level by 10 dB, and one hundred machines increase the sound level by 20 dB. The human ear has a vast sound-sensitivity range of over a thousand billion to one, so the logarithmic decibel scale is useful for acoustical assessments.

dBA – See ‘A’ frequency weighting

dBC – See ‘C’ frequency weighting

EQUIVALENT CONTINUOUS SOUND LEVEL, LAeq

Many sounds, such as road traffic noise or construction noise, vary repeatedly in level over a period of time. More sophisticated sound level meters have an integrating/averaging electronic device inbuilt, which will display the energy time-average (equivalent continuous sound level - L_{Aeq}) of the ‘A’ frequency weighted sound pressure level. Because the decibel scale is a logarithmic ratio, the higher noise levels have far more sound energy, and therefore the L_{Aeq} level tends to indicate an average which is strongly influenced by short-term, high level noise events. Many studies show that human reaction to level-varying sounds tends to relate closer to the L_{Aeq} noise level than any other descriptor.

‘F’(FAST) TIME WEIGHTING

Sound level meter design-goal time constant which is 0.125 seconds.

FREE FIELD

In acoustics a free field is a measurement area not subject to significant reflection of acoustical energy. A free field measurement is typically not closer than 3.5 metres to any large flat object (other than the ground) such as a fence or wall or inside an anechoic chamber.

FREQUENCY

The number of oscillations or cycles of a wave motion per unit time, the SI unit is the hertz (Hz). 1 Hz is equivalent to one cycle per second. 1000 Hz is 1 kHz.

LOUDNESS

The volume to which a sound is audible to a listener is a subjective term referred to as loudness. Humans generally perceive an approximate doubling of loudness when the sound level increases by about 10 dB and an approximate halving of loudness when the sound level decreases by about 10 dB.

MAXIMUM NOISE LEVEL, LAFmax

The root-mean-square (rms) maximum sound pressure level measured with sound level meter using the 'A' frequency weighting and the 'F' (Fast) time weighting. Often used for noise assessments other than aircraft.

MAXIMUM NOISE LEVEL, LASmax

The root-mean-square (rms) maximum sound pressure level measured with sound level meter using the 'A' frequency weighting and the 'S' (Slow) time weighting. Often used for aircraft noise assessments.

NOISE

Noise is unwanted, harmful or inharmonious (discordant) sound. Sound is wave motion within matter, be it gaseous, liquid or solid. Noise usually includes vibration as well as sound.

OFFENSIVE NOISE

Reference: Dictionary of the NSW Protection of the Environment Operations Act 1997).

"Offensive Noise means noise:

(a) that, by reason of its level, nature, character or quality, or the time at which it is made, or any other circumstances:

(i) is harmful to (or likely to be harmful to) a person who is outside the premise from which it is emitted, or

(ii) interferes unreasonably with (or is likely to interfere unreasonably with) the comfort or repose of a person who is outside the premises from which it is emitted, or

(b) that is of a level, nature, character or quality prescribed by the regulations or that is made at a time, or in other circumstances prescribed by the regulations."

'S' (SLOW) TIME WEIGHTING

Sound level meter design-goal time constant which is 1 second.

SOUND ATTENUATION

A reduction of sound due to distance, enclosure or some other devise. If an enclosure is placed around a machine, or an attenuator (muffler or silencer) is fitted to a duct, the noise emission is reduced or attenuated. An enclosure that attenuates the noise level by 20 dB reduces the sound energy by one hundred times.

SOUND EXPOSURE LEVEL (LAE)

Integration (summation) rather than an average of the sound energy over a set time period. Use to assess single noise events such as truck or train pass by or aircraft flyovers. The sound exposure level is related to the energy average ($L_{Aeq,T}$) by the formula $L_{Aeq,T}$ = LAE – 10 $\log_{10}$ T. The abbreviation (SEL) is sometimes inconsistently used in place of the symbol (LAE).

SOUND PRESSURE

The rms sound pressure measured in pascals (Pa). A pascal is a unit equivalent to a newton per square metre (N/m^2).

SOUND PRESSURE LEVEL, L_p

The level of sound measured on a sound level meter and expressed in decibels (dB). Where L_P = 10 $\log_{10}(P_a/P_o)^2$ dB (or 20 $\log_{10}$ (P_a/ P_o) dB) where Pa is the rms sound pressure in Pascal and Po is a reference sound pressure conventionally chosen is 20 µPa (20 x 10^{-6} Pa) for airborne sound. L_p varies with distance from a noise source.

SOUND POWER

The rms sound power measured in watts (W). The watt is a unit defined as one joule per second. A measures the rate of energy flow, conversion or transfer.

SOUND POWER LEVEL, L_w

The sound power level of a noise source is the inherent noise of the device. Therefore, sound power level does not vary with distance from the noise source or with a different acoustic environment. L_w = L_p + 10 $\log_{10}$ 'a' dB,

re: 1pW, (10^{-12} watts) where 'a' is the measurement noise-emission area (m^2) in a free field.

SOUND TRANSMISSION LOSS

The amount in decibels by which a random sound is reduced as it passes through a sound barrier. A method for the measurement of airborne Sound Transmission Loss of a building partition is given in Australian Standard AS1191 - 2002.

STATISTICAL NOISE LEVELS, L_n

Noise which varies in level over a specific period of time 'T' (standard measurement times are often 15-minute periods) may be quantified in terms of various statistical descriptors with some common examples:

The noise level, in decibels, exceeded for 1% of the measurement time period, when 'A' frequency weighted and 'F' time weighted is reference to as $L_{AF1,T}$. This may be used for describing short-term noise levels such as could cause sleep arousal during the night.

The noise level, in decibels, exceeded for 10% of the measurement time period, when 'A' frequency weighted and 'F' time weighted is reference to as $L_{AF10,T}$. In most countries the $L_{AF10,T}$ is measured over periods of 15 minutes, and is used to describe the average maximum noise level.

The noise level, in decibels, exceeded for 90% of the measurement time period, when 'A' frequency weighted and 'F' time weighted is reference to as $L_{AF90,T}$. In most countries the $L_{AF90,T}$ is measured over periods of 15 minutes, and is used to describe the average minimum or background noise level.

WEIGHTED SOUND REDUCTION INDEX, R_w

This is a single number rating of the airborne sound insulation of a wall, partition or ceiling. The sound reduction is normally measured over a frequency range of 100 Hz to 3.150 kHz and averaged in accordance with ISO standard weighting curves (Refer AS/NZS 1276.1:1999). Internal partition wall R_w+C ratings are frequency weighted to simulate insulation from human voice noise. The R_w+C is similar in value to the STC rating value. External walls, doors and windows may be R_w+C_{tr} rated to simulate insulation from road traffic noise. The spectrum adaptation term C_{tr} adjustment factor takes account of low frequency noise. The weighted sound reduction index is normally similar or slightly lower number than the STC rating value.

'Z' FREQUENCY WEIGHTING

The 'Z' (Zero) frequency weighting is 0 dB within the nominal 1/3 octave band frequency range centred on 10 Hz to 20 kHz. This is within the tolerance limits given in AS IEC 61672.1-2004: 'Electroacoustics - Sound level meters – Specifications'.

Appendix B: Architectural Plans

PRELIMINARY

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NSW Nominated Architect: Jordan Curran (10259)

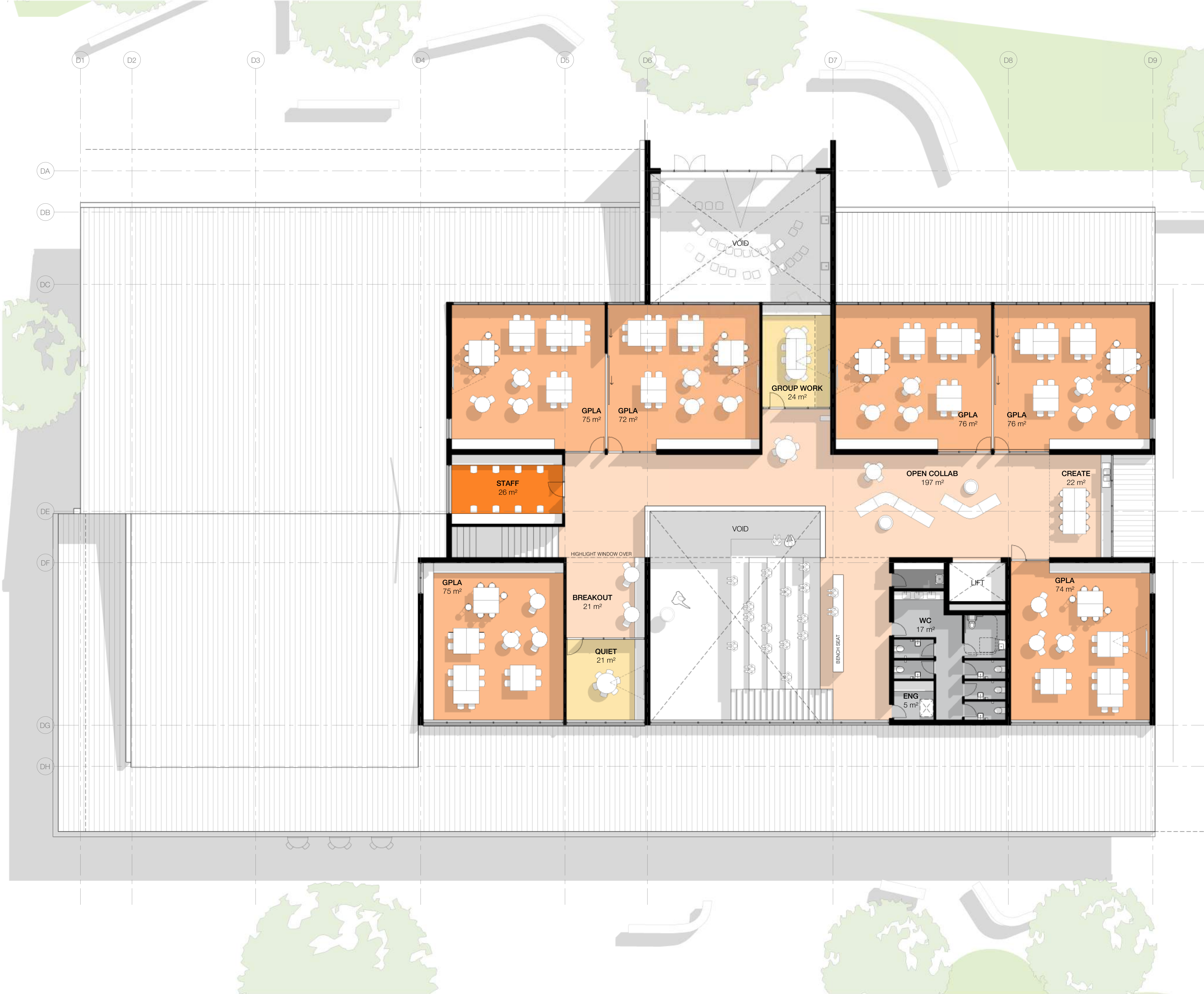
1 : 100 @ A1

Blessed Carlo Acutis College
<Project Address>

SECONDARY
SCHOOL
GROUND
LEVEL A

21026/A100D

A1



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1 : 100 @ A1

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SECONDARY SCHOOL LEVEL 01 A

21026/A101D

A1

Revision

Date

DEVELOPMENT APPLICATION ONLY
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Moama, NSW

SITE PLAN

210026/A001

Revision | Date

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0 5

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Moama, NSW

PRECINCT MASTERPLAN - GROUND LEVEL

210026/A010

TOTAL FUNCTIONAL AREA (UFA): 911M2

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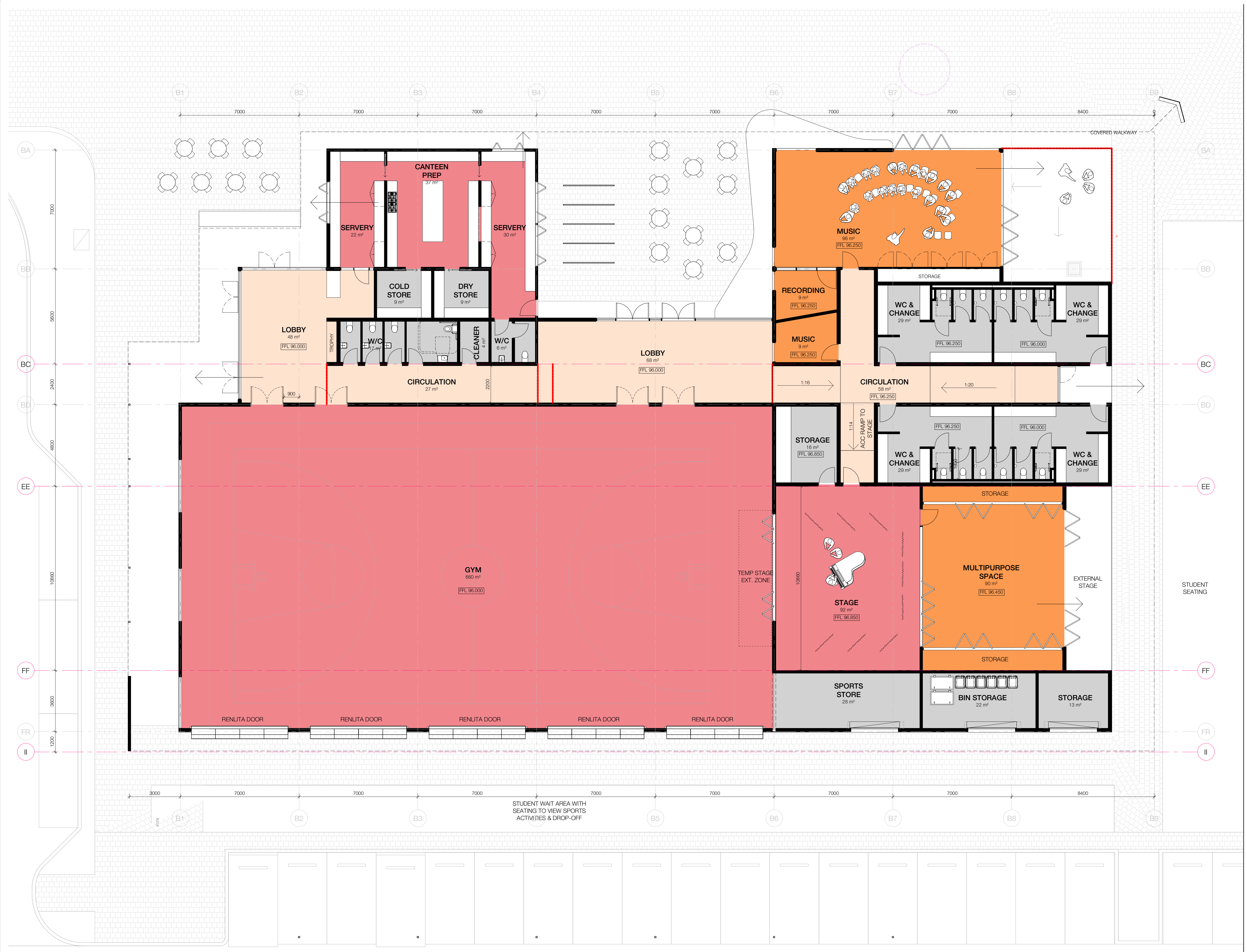
RECEPTION AND ADMIN GROUND LEVEL PLAN

21026/A100A1



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SHARED FACILITIES GROUND FLOOR PLAN

21026/A100B

A1

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PRIMARY SCHOOL GROUND LEVEL PLAN

21026/A100C