Hurlstone Agricultural High School (Hawkesbury)

SEARs Noise and Vibration Assessment

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Glossary

A-weighting	A spectrum adaption that is applied to measured noise levels to represent human hearing. A-weighted levels are used as human hearing does not respond equally at all frequencies.
Daytime	Between 7 am and 6 pm as defined in the INP.
dB	Decibel—a unit of measurement used to express sound level. It is based on a logarithmic scale which means a sound that is 3 dB higher has twice as much energy. We typically perceive a 10 dB increase in sound as a doubling of that sound level.
dB(A)	'A' Weighted sound level in dB.
Evening	Between 6 pm and 10 pm as defined in the INP.
Frequency (Hz)	The number of times a vibrating object oscillates (moves back and forth) in one second. Fast movements produce high frequency sound (high pitch/tone), but slow movements mean the frequency (pitch/tone) is low. 1 Hz is equal to 1 cycle per second. The human ear responds to sound in the frequency range of 20 to 20,000 Hz.
INP	New South Wales *Industrial Noise Policy*, 2000.
Intrusive Noise	Noise emission that when assessed at a noise-sensitive receiver (principally the boundary of a residence) is greater than 5 dB(A) above the background noise level.
L_{10}	Noise level exceeded for 10% of the measurement time. The L_{10} level is commonly referred to as the average maximum noise level.
L_{90}	Noise level exceeded for 90% of the measurement time. The L90 level is commonly referred to as the background noise level.
L_{eq}	Equivalent Noise Level—Energy averaged noise level over the measurement time.
L_{max}	Maximum measured sound pressure level in the time period.
mm/s	Millimetres per second—units of vibration velocity.
$m/s^{1.75}$	Units of VDV.
Night-time	Between 10 pm on one day and 7 am on the following day as defined in the INP.
Noise Management Level (NML)	Construction noise management level. Where the construction noise levels are above the NML, additional consideration of feasible and reasonable noise mitigation is required.
Peak Particle Velocity (PPV)	The maximum speed of a particle in a particular component direction due to vibration during a measurement.

Rating Background Level (RBL)	Overall single-figure A-weighted background level representing an assessment period (Day/Evening/Night). For the short-term method, the RBL is simply the measured $L_{90,15min}$ noise level. For the long-term method, it is the median value of all measured background levels during the relevant assessment period.
Vibration	Refers to the oscillation of an object back and forth, normally the ground.
Vibration Dose Value (VDV)	A measure used to assess the level of vibration over a defined time period, such as a day, evening or night. Often used for the assessment of intermittent construction vibration that may rise and fall across a day.

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Executive Summary

The Department of Education are proposing to develop a state of the art STEMAg high school at the Western Sydney University Hawkesbury Campus. Hurlstone Agricultural High School (Hawkesbury) will run as an integrated school-university model providing specialised agricultural educational facilities for 1,500 students across NSW.

The Department of Planning and Environment has issued the project with the Secretary's Environmental Assessment Requirements (SEARs) for the preparation of an Environmental Impact Statement (EIS). SEAR 11 of SSD 8614 defines the requirement for a Noise and Vibration Assessment as part of the EIS to consider construction and operational noise and vibration from the development. This report has been prepared to address SEAR 11.

Construction phase

A preliminary construction noise and vibration assessment has been conducted against noise and vibration criteria determined from:

- Unattended noise monitoring data
- The *Interim Construction Noise Guideline*; and
- *Assessing Vibration – a technical guideline* (the Vibration Guideline).

Based on the preliminary assessment, it is anticipated that some noise and vibration impacts may occur during construction at a number of nearby noise and vibration sensitive receivers.

The construction noise and vibration impacts are considered to be manageable through

- the development and implementation of a Construction Noise and Vibration Management Plan
- carrying out works during standard daytime working hours wherever possible
- appropriate stakeholder consultation and complaint handling procedures for noise and vibration
- the implementation of all feasible and reasonable work practices to minimise noise and vibration from the site in accordance with the ICNG and Vibration Guideline.

Operational phase

Operational noise emission criteria for the development have been established in accordance with the NSW *Industrial Noise Policy* (INP). The noise emission criteria for the nearest noise-sensitive land uses are shown in Table 1.

Table 1 INP noise emission criteria for residential land uses

Land use	INP noise emission criteria, dB(A) $L_{eq,\ 15min}$		
	Day 7 am – 6 pm	Evening 6 pm – 10 pm	Night 10 pm – 7 am
Residential	42	39	34
Classroom	Internal 35 (when in use)		
Place of worship	Internal 40 (when in use)		
Active recreation	External 55 (when in use)		
Commercial	External 65 (when in use)		

Noise emissions from the development will predominantly be a result of student activities within the grounds with some impact from rooftop mechanical plant noise emission. Detailed information on the rooftop plant selection is not available at this stage but noise mitigation techniques will be investigated and determined during detailed design, and will include consideration of:

- Use of landscaping features as natural sound barriers/bunds.
- Selection of lower noise plant and equipment.
- Screening of external plant using solid barriers or acoustic louvres.
- Appropriate orientation and use of structures to shield potential noise sources.

The measures will be selected and designed to ensure that compliance is achieved with the INP noise emission criteria.

1 Introduction

The Department of Education are proposing to develop a state of the art STEMAg high school at the Western Sydney University Hawkesbury Campus. Hurlstone Agricultural High School (Hawkesbury) will run as an integrated school-university model providing specialised agricultural educational facilities for 1,500 students across NSW.

Stage 1 of the Hurlstone Agricultural High School (Hawkesbury) Project involves the construction of four multi-storey buildings that will provide a range of general learning, laboratory, sporting and agricultural facilities. The buildings part of Stage 1 will be constructed adjacent to the Western Sydney University Village and unoccupied farming land.

The Department of Planning and Environment has issued the project with the Secretary's Environmental Assessment Requirements (SEARs) for the preparation of an Environmental Impact Statement (EIS). SSD 8614 defines the requirement for a noise and vibration assessment as part of the EIS:

> **11. Noise and Vibration**
>
> Identify and provide a quantitative assessment of the main noise and vibration generating sources during construction and operation, including consideration of any public address system, school bell and use of any school hall for concerts, etc. (both during and outside school hours, and outline measures to minimise and mitigate the potential noise impacts on surrounding occupiers of land.
>
> Relevant policies and guidelines:
>
> - *NSW Industrial Noise Policy* (EPA)
> - *Interim Construction Noise Guideline* (DECC)
> - *Assessing Vibration: A Technical Guideline* 2006
> - *Development Near Rail Corridors and Busy Roads – Interim Guideline* (Department of Planning 2008).

This report has been prepared to address the acoustic requirements of SSD 8614 and:

- Defines construction noise and vibration assessment criteria for the construction and operation of the Project.
- Identifies likely construction phase noise and vibration impacts and recommends management measures to be implemented during construction.
- Provides a preliminary assessment of operational noise from the development.

2 Project Description

2.1 Location

The Hurlstone Agricultural High School (Hawkesbury) will be constructed on a parcel of land located adjacent to Vines Drive within the Western Sydney University Hawkesbury campus. The proposed site location is presented in Figure 1.

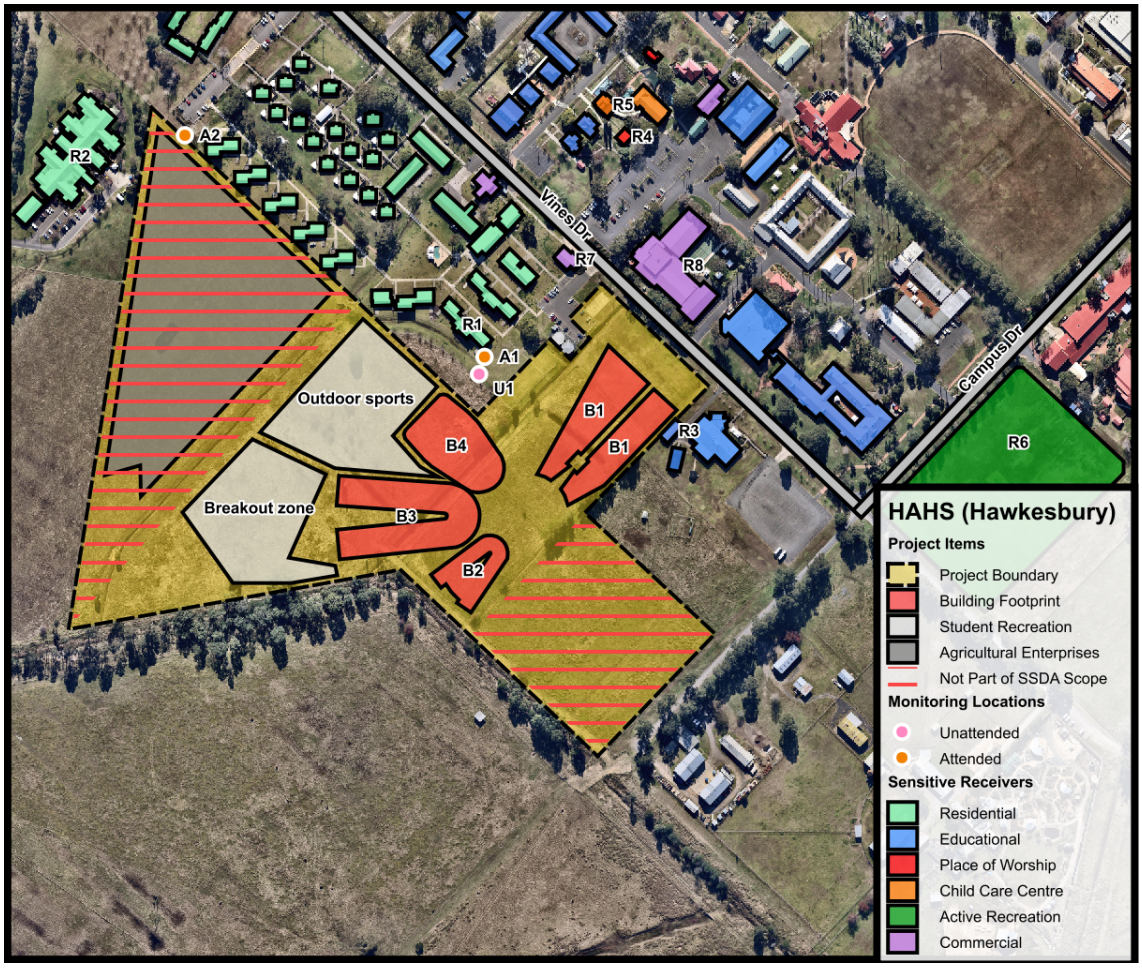

Figure 1 HAHS (Hawkesbury) site location

A number of noise and vibration sensitive land uses are located in the immediate vicinity of the project site, as shown in Figure 1. The nearest identified sensitive receiver is the Western Sydney University Village residences to the west of the proposed site location.

The most potentially affected sensitive land uses are summarised in Table 2 alongside a description.

Table 2 Noise and vibration sensitive land uses

Reference[1]	Description
Residential land uses	
R1 – Western Sydney University Village	Collection of campus accommodation for WSU students. Identified as nearest residential receiver.
R2 – Chesalon Nursing Home	Large nursing home located on Londonderry Rd to the west of the site
Other sensitive land uses	
R3 – WSU Microbiology	Nearest educational receiver to site location. Includes several buildings, including teaching, greenhouse and laboratory spaces.
R4 – Multi-Faith Centre	Chaplaincy and multi-faith centre.
R5 – Child Care Centre	WSU Early Learning Centre with multiple buildings and outdoor playground area.
R6 – Soccer field	Active recreation area to the east of the project site.
Commercial land uses	
R7 – WSU Gym	Indoor/outdoor gym facility located across Vines Dr from site location.
R8 – WSU Security Office	Nearest commercial premises to the project site consisting of small offices and reception area.

(1) See Figure 1.

2.2 Development

Stage 1 of the development will involve the construction of the following:

- Building 1 – single-storey administrative building
- Building 2 – multi-storey teaching and library building
- Building 3 – multi-storey teaching building
- Building 4 – single-storey gymnasium and learning spaces
- Landscaping around the vicinity of the buildings, particularly on the western side of the project site.

Construction

It is anticipated that works construction works are to be complete by D1, T1 2020. At this stage of the design process a detailed construction methodology is not available. Therefore, a typical breakdown of construction phases for a building project has been used for the purposes of this assessment. The construction staging has been broadly summarised in Table 3. This assessment includes the consideration of standard hours and outside of standard hours works.

Table 3 Anticipated construction schedule

Stage	Description
Site establishment	Bulk excavation and services diversions
Substructure	Piling works, followed by creation of substructures
Superstructure and façades	Creation of building superstructures and installation of building façade progressively.
Internal works and fit out	Internal works and fit out. Will commence progressively as superstructures are completed.
External landscaping	Landscaping works around the site precinct.

Operation

Operational noise emission and vibration considerations for the project include:

- Mechanical services plant items (although minimised due to the use of natural ventilation).
- Other operational noise emission from the project, such as non-emergency alarms and public address systems.
- Use of the surrounding grounds by students and staff as sporting/breakout areas.
- Use of the gymnasium for sporting/performance events, particularly outside of regular operating hours.

Due to the requirement for natural ventilation throughout the facility, a limited number of external mechanical services plant items are required for the project. It is reasonable to expect that these items may have an impact on the development itself due to the use of operable windows. Whilst these impacts have not been addressed in this environmental noise emission assessment, careful attention will be paid during the design phase to mitigate these impacts.

3 Existing Environment

The existing environment is located in a rural area with minimal noise generated from road traffic and other industrial noise sources. Road traffic is intermittent along Londonderry Road and some aircraft traffic is present from the RAAF Base Richmond. Background noise levels are generally low with the majority driven by natural sources.

3.1 Unattended noise monitoring

The nearest residential land use is the Western Sydney University Village to the north-west of the project site. Unattended noise monitoring was conducted for the purpose of this report at a location representative of the nearest structure within the Village. Appendix A provides a detailed methodology for the noise survey. The resultant noise levels are summarised in Table 4.

Table 4 Unattended monitoring results

Location	Rating Background Level, dB(A) L_{90}[1]			Ambient noise level, dB(A) L_{eq}		
	Day 7 am—6 pm	Evening 6 pm—10 pm	Night 10 pm—7 am	Day 7 am—6 pm	Evening 6 pm—10 pm	Night 10 pm—7 am
U1 – WSU Village	37	37	32	47	44	44

(1) The Rating Background Level is a measure of the typical minimum steady background noise level for each time of day.

3.2 Attended noise monitoring

To supplement the unattended noise monitoring results, attended monitoring was conducted at locations around the site. The measured noise levels over 15-minute periods at each location are shown in Table 5, with the measurement locations shown in Figure 1.

Table 5 Attended noise monitoring results

Location	Measured noise level, dB(A)				Description
	L_{max}	L_{10}	L_{eq}	L_{90}	
A1 – WSU Village	63	45	42	35	Near the unattended logger site. Largely representative of ambient levels. Low levels of road traffic on Londonderry Rd and Vines Dr.
A2 – Chesalon Nursing Home	64	45	43	36	Located on the boundary of the nursing home and WSU Village. Largely representative of ambient levels. Slightly higher levels of road traffic on Londonderry Rd due to proximity but little impact on A-weighted overall level.

4 Assessment Criteria

4.1 Construction noise

Construction noise in New South Wales is assessed using the Department of Environment & Climate Change (now Environment Protection Authority) *Interim Construction Noise Guideline* (ICNG). The ICNG is also defined as the relevant guideline for construction noise by the SEARs issued by DPE.

The ICNG aims to manage noise from construction works regulated by the EPA. It is also intended to provide guidance to other interested parties in the management of construction noise, and has therefore been adopted for this construction noise assessment.

The ICNG prescribes $L_{eq,15min}$ Noise Management Levels (NML) for sensitive receivers as part of a quantitative construction noise assessment. Where the predicted or measured construction noise level exceeds these management levels, then all feasible and reasonable work practices should be implemented to reduce construction noise, and community consultation regarding construction noise is required to be undertaken.

Residential land uses

The NMLs prescribed for residential land uses by the ICNG are presented in Table 6. The levels apply at the most exposed property boundary of the noise sensitive receiver at a height of 1.5 metres above ground level.

Other sensitive land uses

The ICNG also prescribes NMLs for other sensitive land uses, including educational buildings. The NMLs for relevant land uses are summarised in Table 7 and apply only when those land uses are in use.

For those receivers where an internal NML applies, it is common to assume an outdoor-to-indoor noise reduction of 10 dB(A). This is based on a standard commercial building facade with windows kept open to allow sufficient natural ventilation. Therefore, for this assessment, an external NML of 55 dB(A) $L_{eq,15min}$ will be used for the educational and place of worship sensitive land uses surrounding the development site.

Commercial and industrial premises

The ICNG prescribes specific NMLs for commercial land uses for commercial and industrial premises in three categories:

- Industrial premises: external $L_{Aeq,15min}$ 75 dB(A)
- Offices, retail outlets: external $L_{Aeq,15min}$ 70 dB(A)
- Other businesses that may be very sensitive to noise, where the noise level is project specific should be assessed on a project-by-project basis.

These criteria apply when the buildings are in use.

Table 6 ICNG noise management levels for residential land uses

Time of day	Noise Management Level, $L_{eq,15\ min}$	Application notes
Recommended standard hours: Monday to Friday 7 am to 6 pm Saturday 8 am to 1 pm No work on Sundays or public holidays	Noise affected RBL + 10 dB	May be some community reaction to noise. • Where the predicted or measured construction noise level exceeds the noise affected level, all feasible and reasonable work practices should be applied to meet the noise affected level. • All residents potentially impacted by the works should be informed of the nature of the works, the expected noise levels and duration, and provided with site contact details.
	Highly noise affected 75 dB(A)	May be strong community reaction to noise. • Where construction noise is predicted or measured to be above this level, the relevant authority may require respite periods that restrict the hours that the very noisy activities can occur. • Respite activities would be determined taking into account times identified by the community when they are less sensitive to noise, and if the community is prepared to accept a longer period of construction to accommodate respite periods.
Outside recommended standard hours	Noise affected RBL + 5 dB	• A strong justification would typically be required for works outside the recommended standard hours. • The proponent should apply all feasible and reasonable work practices to meet the affected noise level. • Where all feasible and reasonable practices have been applied and noise is more than 5 dB(A) above the affected noise level, the proponent should negotiate with the affected community.

Table 7 ICNG noise management levels for other sensitive land uses

Land use	Noise Management Level, $L_{eq,15\ min}$ [1]
Classrooms at schools and other educational institutions	Internal noise level 45 dB(A)
Places of worship	Internal noise level 45 dB(A)
Active recreation areas (characterised by sporting activities and activities that 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 65 dB(A)

(1) Applies when properties are being used.

Noise management levels

Table 8 summarises the NMLs applicable to sensitive land uses around the project site during the construction phase. The NMLs are based on the background levels measured for the purposes of this report.

Table 8 Project specific Noise Management Levels

Land use	Noise Management Level, dB(A)			
	Standard Working Hours	Outside of Standard Working Hours		
		Day	Evening	Night
Residential land uses	47	42	42	37
Educational buildings	55	55	55	55
Places of worship	55	55	55	55
Sporting ovals	65	65	65	65
Commercial buildings	70	70	70	70

4.2 Construction vibration

Ground vibration generated by construction can have a range of effects on buildings and building occupants. The main effects are generally classified as:

- human disturbance – disturbance to building occupants: vibration which inconveniences or interferes with the activities of the occupants or users of the building
- effects on building structures – vibration which may compromise the condition of the building structure itself.

In general, vibration criteria for human disturbance are more stringent than vibration criteria for effects on buildings. Building occupants will normally feel vibration readily at levels well below those which may cause a risk of cosmetic or structural damage to a structure. However, it may not always be practical to achieve the human comfort criteria. Furthermore, unnecessary restriction of construction activities can prolong construction works longer than necessary, potentially resulting in other undesirable effects for the local community.

Construction vibration criteria have been adopted from the following sources:

- Cosmetic and structural damage to buildings: German Standard DIN 4150-3[1]
- Human comfort: *Assessing Vibration – A Technical Guideline* (the Vibration Guideline)

Cosmetic and structural damage

DIN 4150-3 summarises structural and cosmetic damage assessment criteria for different types of buildings, which are presented in Table 9, which are widely used for the assessment of construction vibration effects on buildings in Australia. The criteria are specified as Peak Particle Velocity (PPV) levels measured in any direction at or adjacent to the building foundation.

Table 9 DIN 4150-3 vibration cosmetic and structural damage criteria

Structure type	Peak Particle Velocity (PPV), mm/s			
	Foundation of structure			Vibration at horizontal plane of highest floor at all frequencies
	< 10 Hz	10-50 Hz	50-100 Hz	
Buildings used for commercial, industrial purposes, industrial buildings and buildings of similar design	20	20 to 40	40 to 50	40
Dwelling and buildings of similar design and/or use	5	5 to 15	15 to 20	15
Structures that, because of their particular sensitivity to vibration, do not correspond to those listed in rows 1 and 2, and are of great intrinsic value (e.g. heritage-listed buildings)	3	3 to 8	8 to 10	8

With respect to the project site, there are no neighbouring State heritage sites on the NSW Office & Environment Heritage Register.

DIN 4150-3 states that exposing buildings to vibration levels higher than that recommended would not necessarily result in damage. Rather, it recommends these values as maximum levels of short-term construction vibration at which experience has shown damage reducing the serviceability of structures will not occur due to vibration effects.

[1] German Standard DIN 4150-3, 1999, *Structural Vibration – Part 3: Effects of vibration on structures.*

DIN 4150-3 is considered to be suitable for the assessment of both structural and cosmetic damage as it considers a reduction in serviceability of the structure is deemed to have occurred if:

- cracks form in plastered surfaces of walls
- existing cracks in the building are enlarged
- partitions become detached from loadbearing walls or floors.

Human comfort

The ICNG recommends that vibration from construction works be assessed under *Assessing Vibration – a technical guideline* (the Vibration Guideline), consistent with the SEARs issued by DPE.

The vibration assessment criteria defined in the Vibration Guideline are for human comfort and represent goals that, where predicted or measured to be exceeded, require the application of all feasible and reasonable mitigation measures. Where the maximum value cannot be feasibly and reasonably achieved, the operator would need to negotiate directly with the affected community.

The Vibration Guideline defines vibration assessment criteria for continuous, impulsive and intermittent vibration. Vibration can be classified according to the following definitions:

- Continuous vibration: continues uninterrupted for a defined period. Applies to continuous construction activity such as tunnel boring machinery.
- Impulsive vibration: rapid build-up to a vibration peak followed by a damped decay or the sudden application of several cycles of vibration at approximately the same magnitude providing that the duration is short. Applies to very occasional construction activities that create distinct events such as the occasional dropping of heavy equipment.
- Intermittent vibration: interrupted periods of continuous vibration (such as a drill) or repeated periods of impulsive vibration (such as a pile driver).

The majority of construction activities as part of the proposed works would be expected to be continuous or intermittent in nature.

Table 10 presents the management levels for continuous and impulsive vibration at different land uses. The management levels specified are as overall unweighted RMS vibration velocity levels. The Vibration Guideline specifies the management levels as suitable for vibration sources predominantly in the frequency range 8-80 Hz as would be expected for construction vibration.

Table 10 RMS velocity management levels for continuous and impulsive vibration

Land use	Continuous vibration – RMS vibration velocity, mm/s		Impulsive vibration – RMS vibration velocity, mm/s	
	Preferred	Maximum	Preferred	Maximum
Critical areas[1]	0.1	0.2	0.1	0.2
Residences – daytime[2]	0.2	0.4	6.0	12.0
Residences – night time[3]	0.14	0.28	2.0	4.0
Offices, schools	0.4	0.8	13.0	26.0
Workshops	0.8	1.6	13.0	26.0

(1) Critical operating areas include hospital operating theatres and precision laboratories where sensitive operations are occurring.

(2) Daytime is defined by the Vibration Guideline to be 7 am to 10 pm.

(3) Night time is defined by the Vibration Guideline to be 10 pm to 7 am.

For intermittent vibration, the Vibration Dose Value (VDV) is used as the metric for assessment as it accounts for the duration of the source, which will occur intermittently over the assessment period. The VDV management levels at different land uses for intermittent vibration sources are presented in Table 11.

Table 11 VDV management levels for intermittent vibration

Land use	VDV – intermittent vibration, $m/s^{1.75}$	
	Preferred	Maximum
Critical areas[1]	0.1	0.2
Residences and hospital wards – daytime[2]	0.2	0.4
Residences and hospital wards – night time[3]	0.13	0.26
Offices, schools	0.4	0.8
Workshops	0.8	1.6

(1) Critical operating areas include hospital operating theatres and precision laboratories where sensitive operations are occurring.

(2) Daytime is defined by the Vibration Guideline to be 7 am to 10 pm.

(3) Night time is defined by the Vibration Guideline to be 10 pm to 7 am.

4.3 Operational noise criteria

Noise emissions from the project when operational should comply with the requirements of the NSW *Industrial Noise Policy* (INP). The INP applies to noise emissions from rooftop plant and the like at the development.

The INP sets two separate noise criteria to meet desirable environmental outcomes:

- Intrusiveness – steady-state noise from the site should be controlled to no more than 5 dB(A) above the background noise level in the area. In this case, the steady-state L_{eq} noise level should not exceed the RBL measured for different time periods in the environment.
- Amenity – amenity criteria are set based on the land use of an area. It requires noise levels from new industrial noise sources to consider the existing industrial noise level such that the cumulative effect of multiple sources does not produce noise levels that would significant exceed the amenity criteria.

Internal and external noise criteria are also set by the INP for non-residential land uses such as hospital wards, educational facilities and active recreation areas.

Normal operation

Table 12 presents the INP noise emission criteria for residential land uses for the Day, Evening and Night periods.

Table 12 INP noise emission criteria for residential land uses

Location	**INP noise emission criteria, dB(A) $L_{eq,15min}$ (dB re 20 µPa)**		
Residential land uses and Colleges	**Day 7 am–6 pm**	**Evening 6 pm–10 pm**	**Night 10 pm–7 am**
Rating Background Level (RBL)	*37*	*37*	*32*
Intrusive criterion (RBL + 5 dB)	42	42	37
Amenity criterion for all sources (Rural[1])	50	45	40
Amenity criterion for new sources	47	39	34
Project specific criterion for residential land uses	**42**	**39**	**34**

(1) A rural classification has been adopted for the site, described as an area with an acoustical environment that is dominated by natural sounds, having little or no road traffic.

(2) The project-specific criteria are the minimum of the Intrusive criterion and the Amenity criterion for new sources for each time period.

Table 13 presents the applicable INP criteria for other (non-residential) sensitive land uses.

Table 13 INP noise emission criteria for other sensitive land uses

Land use	**Time of day**	**Noise emission criteria, dB(A)**	
		Acceptable	**Recommended maximum**
Classroom	Noisiest one-hour period when in use	Internal 35[1]	Internal 40[1]
Place of worship	When in use	Internal 40[1]	Internal 45[1]
Active recreation area	When in use	External 55	External 60
Commercial premises	When in use	External 65	External 70

(1) Internal noise levels refer to the centre of a habitable room most exposed to the noise source and are to apply with windows open sufficiently to allow for natural ventilation. Where gaining access for monitoring purposes is difficult, external noise levels 10 dB above the internal levels apply.

5 Construction Assessment

5.1 Construction noise

Construction noise sources

Table 14 summarises the assumed sound power levels (L_w) for the major construction noise sources which would reasonably be expected to be on site during each phase. The sound power levels have been based on data obtained from previous measurements conducted by Resonate and those within the UK Department for Environment, Food and Rural Affairs (DEFRA) *Update of noise database for prediction of noise on construction and open sites*. An overall sound power level for each phase has also been assumed based on the loudest typical source(s) operating for each works phase.

Table 14 Construction noise source sound power levels

Stage	Typical plant items	Assumed sound power level, dB(A)
Site establishment	Large excavator	111
	Vibratory roller	107
	Concrete truck	109
	Concrete pump	107
	Large truck	108
	Typical overall sound power level	**112**
Substructure	Bored piling rig	111
	Crane	106
	Large excavator	111
	Pneumatic jackhammer	109
	Concrete truck	109
	Concrete pump	107
	Large truck	108
	Typical overall sound power level	**114**
Superstructure and facade	Concrete truck	109
	Concrete pump	107
	Crane	106
	General hand tools	98
	Large truck	108
	Typical overall sound power level	**111**

Stage	Typical plant items	Assumed sound power level, dB(A)
Internal works and fit out	General hand tools	98
	Compressor	94
	Portable generator	95
	Typical overall sound power level	**84**[1]
External landscaping	Large excavator	111
	Grader	112
	Large truck	108
	Typical overall sound power level	**113**

(1) Includes a 15 dB(A) indoor-to-outdoor reduction in noise levels for internal works.

Typical construction noise levels

Typical worst-case predicted noise levels are shown in Table 15 for each sensitive-receiver location and each phase of works. Predicted noise levels that exceed the relevant Standard Work Hours NML are highlighted in **bold** type.

Based on the predictions, it can be seen that construction noise from the site is predicted to exceed the relevant NMLs at:

- WSU Village and Chesalon Nursing Home. The predicted exceedance is a maximum of 25 dB(A).
- Nearest WSU education buildings during major external works.
- WSU Early Learning Centre and Multi-faith Centre during major external works

It is our understanding that work outside of the recommended standard hours is proposed for the project. Based on the predictions shown in Table 15, exceedances for the identified residential receivers for the most stringent night-time NMLs range from 5 dB(A) to 35 dB(A).

It is important to note that these predictions are typical worst-case predictions as they assume that:

- The construction works are occurring at the nearest point to each receiver and that the receiver is located at the most exposed position.
- The noisiest construction sources are operating continuously for the entire 15-minute period. This will not occur at all times as equipment will regularly be stood down or idled while other activities are undertaken.

Any construction work that is proposed to occur outside of the recommended standard hours set out in Table 6 should undergo an approvals procedure in order to manage the potential noise impact on the nearby residential receivers through all feasible and reasonable mitigation measures.

Recommendations for construction noise management are provided in Section 5.3.

Table 15 Typical worst-case external construction noise levels for each phase

Receiver	Minimum distance (approx.)	Typical worst-case external construction noise level for phase, dB(A) $L_{eq(15minute)}$				
		Site establishment	Substructure	Superstructure and facade	Internal works and fit out	External landscaping
R1	50	**70**	**72**	**69**	42	**71**
R2	310	**54**	**56**	**53**	26	**55**
R3	10	**84**	**86**	**83**	**56**	**85**
R4	170	**59**	**61**	**58**	31	**60**
R5	190	**58**	**60**	**57**	30	**59**
R6	200	58	60	57	30	59
R7	60	68	**70**	67	40	69
R8	70	67	69	66	39	68

5.2 Construction vibration

Table 16 summarises recommended safe working distances for key vibration-generating activities that would be expected during the construction phase, based on prior measurements conducted by Resonate Acoustics.

Table 16 Recommended safe working distances for key vibration generating activities

Plant	Rating	Typical safe working distance for occupant comfort, m		Typical safe working distance for building damage, m	
		Preferred vibration target	Maximum vibration target	Heritage structure	Commercial building
Vibratory roller	< 7t	≥ 35	≥ 20	≥ 10	≥ 2
	7t – 12t	≥ 50	≥ 30	≥ 15	≥ 5
	≥ 13t	≥ 75	≥ 40	≥ 20	≥ 10
Excavator	Large excavator digging	≥ 25	≥ 15	≥ 5	≥ 1
Bored piling	≤ 800mm	≥ 20	≥ 10	≥ 2	≥ 1
Jackhammer	Handheld	–[(1)]	–[(1)]	≥ 3	≥ 1

Based on the safe working distances above, vibration impacts on buildings may be expected at the microbiology buildings (R3) whilst work is being conducted on Building 1. Recommendations are provided in Section 5.3 for the management of construction vibration from the works.

5.3 Recommendations

To manage the potential impact of noise and vibration during construction, feasible and reasonable management measures and work practices should be implemented as detailed below.

Construction Noise and Vibration Management Plan

Prior to the commencement of major construction works the contractor should develop a Construction Noise and Vibration Management Plan (CNVMP). The CNVMP should:

- identify relevant construction noise and vibration criteria as detailed in this report
- identify neighbouring sensitive land uses for noise and vibration
- summarise key noise and vibration generating construction activities and the associated predicted levels at neighbouring land uses
- identify reasonable and feasible work practices to be implemented during the works
- summarise stakeholder consultation and complaints handling procedures for noise and vibration.

Stakeholder consultation

Nearby stakeholders should be consulted prior to the works and kept regularly informed of potential noise and vibration impacts from the works. Specifically, this would involve:

- Consultation with Western Sydney University to determine the location of noise and vibration sensitive uses surrounding the site and to discuss noise and vibration mitigation options with them, such as appropriate programming of noisy works.
- Consultation with the residential land uses at the Chesalon Nursing Home and WSU Village to inform them of the works.

A noise and vibration complaints handling procedure and register should be developed and implemented during construction.

Work programming

Construction stage programming should be implemented such that works, and particularly noisy works, occur during standard working hours wherever feasible, namely:

- Monday to Friday 7 am to 6 pm
- Saturday 8 am to 1 pm
- No work on Sundays or public holidays.

If high noise works are to occur outside of these times, then the CNVMP should define an approval process for undertaking out of hours works that identifies feasible and reasonable mitigation measures to be implemented. Such measures might include, but not be limited to:

- taking delivery of loud plant and equipment during the Standard Hours periods
- undertaking high-impact noise generating construction works prior to 12 am
- implementing localised noise barriers or hoarding around work areas for the duration of the out of hours work
- stakeholder consultation, as above, to determine local sensitivity to out of hours works and implementation of feasible and reasonable measures based on community feedback.

Truck movements and site access

Truck movements during long term construction projects have the potential to cause annoyance for sensitive receivers, even where trucks may be travelling on sealed roads. The design and selection of site access routes shall consider the potential disturbance to residents. In particular:

- site access and delivery points shall be located as far away from residences as possible
- truck movements shall use arterial roads and be diverted away from residential streets where feasible
- deliveries to/from site shall not occur during the night time period where possible.

Site management

Site management procedures should include the following:

- processes that generate lower noise levels should be selected where feasible
- noisy plant should be located as far away from residences as is practical to allow efficient and safe completion of the task
- the potential shielding provided by site topography and intervening buildings should be taken into account in locating equipment
- site compounds should be located as far away as possible from residences
- equipment that is used intermittently should be shut down or throttled down to a minimum during periods where it is not in use
- works should be planned to minimise the reduce the noise from reversing signals
- warning horns should not be used as signalling devices
- two way radios should be set to the minimum effective volume
- noise associated with packing up plant and equipment at the end of works should be minimised.

Equipment management

Equipment management should include the following:

- selection of low-noise plant and equipment where possible
- equipment should be well maintained
- equipment should have quality mufflers and silencers installed where relevant
- equipment not in use on site should be shut down
- tasks should be completed using the minimum feasible power and equipment.

6 Operational Assessment

6.1 Mechanical services plant

A preliminary assessment of indicative mechanical services plant and equipment has been undertaken. It is understood that the school will be predominantly naturally ventilated with the requirement for a limited number of internal plant rooms and some rooftop critical exhaust fans. These are likely to include:

- Rooftop kitchen exhaust and fume cupboard extraction fan units for Building 3.
- Rooftop extraction fan units for Building 4.

Due to the proposed location of plant items and the proximity to adjacent classrooms with operable windows, classroom buildings forming part of the development would be considered the nearest sensitive receivers. Based on an external criterion of 45 dB (see Table 13(1)) when in use, it is reasonable to expect compliance with the amenity criteria for the nearest potentially affected noise sensitive receivers.

Noise mitigation techniques that will need to be considered for rooftop plant include as the design progresses include:

- Selection of lower noise plant and equipment.
- Screening of rooftop external plant using solid barriers or acoustic louvres.
- Appropriate construction of a rooftop plant room to reduce noise emissions to neighbouring land uses.

The noise levels from mechanical plant will be assessed as the design progresses to ensure that compliance with the INP noise emission criteria can be achieved.

6.2 Day-to-day operation

Children at play

It is proposed that an outdoor sporting area be located to the west of Building 4 and directly adjacent to the nearest sensitive receivers at the WSU Village.

Specific operational details relating to when and how the outdoor sporting areas may be used are not currently available. However, it is acknowledged that exceedances of the INP criteria during the daytime period may occur at the WSU Village due to the low RBL during the daytime period.

Therefore, noise emissions from children at play will be further assessed as the design progresses.

If required, potential acoustic mitigation measures could include:

- Maximise the separation between the outdoor sporting area and WSU Village.
- Provide landscaping features that act as natural noise barriers/bunds.
- Use of a boundary fence breaking line of sight between nearest noise sensitive receivers.
- Implementation of a Noise Management Plan that would identify operational measures to manage potential impacts.

Non-emergency period alarm system

It is understood that a school bell or non-emergency period alarm system will be implemented within the school grounds. Such systems, particularly in areas with low prevailing ambient noise levels, may potentially be perceived as a tonal and annoying sound source.

Assuming a minimum distance of 50 m to the nearest residential receiver the maximum allowable sound power level of a single source located to the west of the site servicing the sporting and breakout areas would be 85 dB(A). Based on a requirement for a notification level 10-15 dB above the prevailing background noise levels, this system would have an effective distance of 15-30 m.

Whilst no current system specification is currently available, it is understood that a notification system via a wireless network transmitted to mobile devices such as smartphones and tablets will be implemented in tandem with a lower sound power level period alarm system.

Methods for minimising potential noise impacts from a non-emergency alarm system would typically include:

- Utilising a lower sound power level system with evenly distributed speakers.
- Orienting loudspeakers so they are not facing directly towards sensitive receivers.
- Limiting the duration of the alarm.
- Locating loudspeakers in areas that utilise shielding from buildings, boundary fences, landscaping features and the like.

A further detailed analysis of the period alarm system would be undertaken during the detailed design phase when more details are available.

Sporting/concert events

Information in relation to the proposed hours of operation and use of Building 4 for sporting/performance events is not currently available. It is anticipated that sporting and performance activities would occur within Building 4 incorporating the use of an internal amplified public address audio-visual system.

Specifications of such systems are not yet available at the current stage of design; however, a high-level assessment of maximum allowable levels has been conducted based on the following assumptions:

- Gymnasium operating during the evening period (6 pm to 10 pm)
- Minimum distance of 50 m to nearest noise sensitive receiver.
- Evening noise criterion of L_{eq} 39 dB(A).

Based on the assumptions stated above, the maximum allowable radiated sound power level from Building 4 operating during the evening period would be 81 dB(A).

A more detailed assessment of the operation of Building 4 for sporting and concert events will be conducted during the detailed design phase. It is expected that an appropriately designed audio-visual system and internal acoustic finish would achieve compliance with the relevant operational noise criteria.

7 Conclusion

This report presents a construction and operational noise and vibration assessment for the proposed Hurlstone Agricultural High School (Hawkesbury). The proposal involves the construction of four separate buildings that will provide a range of teaching and administrative spaces. The project will be constructed within the surrounds of the Western Sydney University Hawkesbury Campus.

Construction noise and vibration criteria have been determined in accordance with relevant guidelines such as the ICNG and Vibration Guideline. It is likely that construction works may have some noise and vibration impact on the WSU Village and WSU microbiology buildings and some construction noise impact at the Chesalon Nursing Home and other WSU buildings. It is anticipated that these impacts will be able to be managed through works being carried out during standard working hours and with the implementation of reasonable and feasible work practices. Where works are proposed to occur outside of the standard hours set out in the *Interim Construction Noise Guideline*, a Construction Noise and Vibration Management plan should incorporate an approvals procedure for such works outlining feasible and reasonable mitigation measures that minimise the potential noise impact at surrounding sensitive receivers.

Operational noise emission criteria have been set in accordance with the NSW INP and apply predominantly to the proposed non-emergency period alarm, children at play and limited mechanical services noise emissions from the site. As the design progresses, noise mitigation measures will need to be incorporated into the design of the buildings and the surrounding landscape to ensure that noise from the operation of the school can comply with the INP noise emission criteria at neighbouring noise-sensitive land uses.

Appendix A

Unattended noise logging

Unattended noise measurements were conducted during the period Wednesday, 30 August to Wednesday, 06 September 2017. The logging equipment was located between the boundary of the project site and the nearest potentially affected sensitive receiver at the WSU Village, as shown in Figure 1.

Equipment

The equipment used was a Rion NL-42 sound level meter, serial number 00946976. Field calibration was conducted at the commencement and conclusion of the logging period and no significant calibration drift was observed.

The noise logger was configured to record all relevant noise indices, including background noise (L_{A90}) and equivalent continuous noise levels (L_{Aeq}). Samples were accumulated at 15-minute intervals. The time response of the logger was set to 'fast'.

Weather conditions

In order to provide an indication that noise data was obtained during suitable meteorological conditions, half-hourly weather data was obtained from the Bureau of Meteorology (BOM) Automatic Weather Station (AWS) 067105 at Richmond RAAF.

Noise data has been excluded from the processed results if:

- Rain was observed during a measurement period, and/or
- Wind speed exceeded 5 m/s (18 km/h) at the measurement height of 1.5 m above ground. Wind data obtained from the BOM is presented as the value at 10 m above ground. These values are halved for the purpose of estimating wind speed at 1.5 m above ground.

Measured noise levels

For reference, a weekly chart showing the graphed noise logging results is shown in Figure 2.

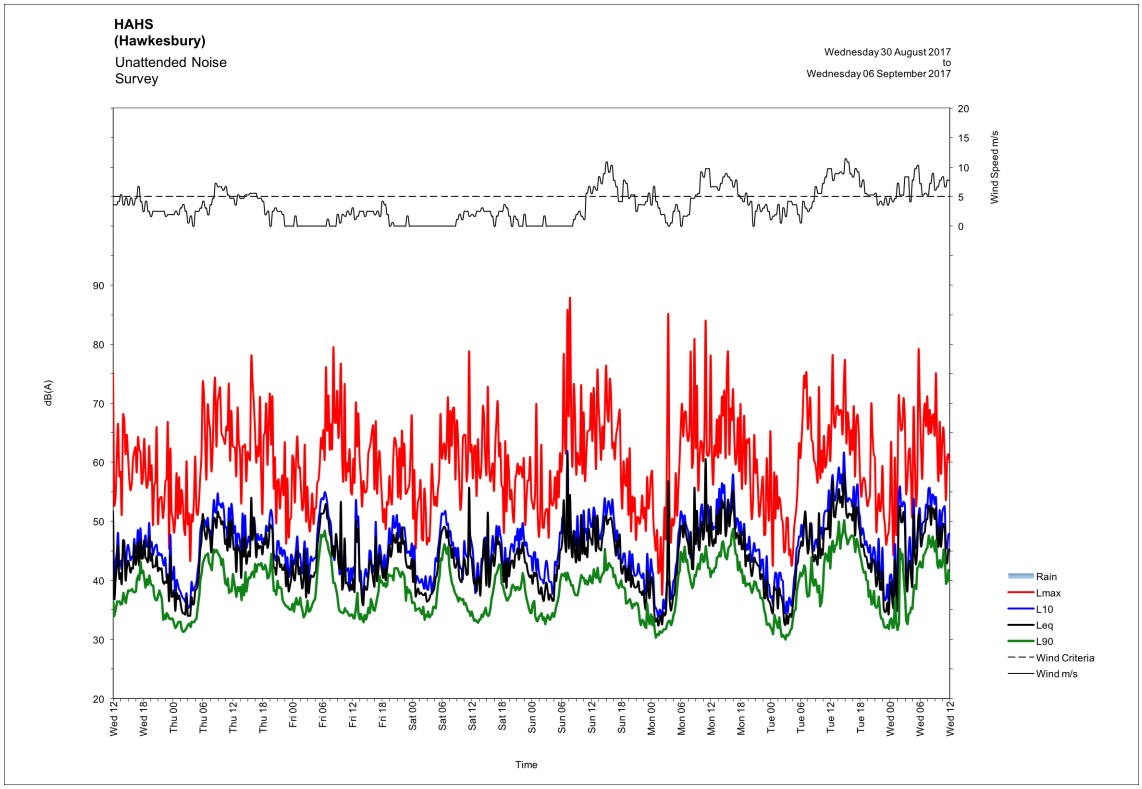

Figure 2 Graphed noise logging data

Data processing for noise emission criteria

In order to determine mechanical services noise emission criteria, data from the 'background' logger was processed according to the procedures and time periods in the NSW Industrial Noise Policy (INP) time periods as follows:

- INP Daytime: 07:00 to 18:00
- INP Evening: 18:00 to 22:00
- INP Night-time: 22:00 to 07:00

It is necessary to establish a representative noise level for each of these time periods. We have used the procedures in the NSW INP to derive a representative background noise level (a Rating Background Level or RBL) for the daytime, evening and night-time periods. An RBL is the median of the lowest 10th percentile of the background L_{A90} samples in each daytime, evening and night-time measurement period.

Derivation of noise emission criteria

Project specific criteria have been established in accordance with the INP. In determining existing levels for amenity criteria it is appropriate to exclude any noise source other than the contribution from industrial sources. Analysis of attended and unattended noise measurements has revealed that the prevailing background noise levels are dominated by natural sounds with a limited impact from road traffic and industrial noise sources.