CONSULTANTS

Unit 10, Level 1
1 Maitland Place
NORWEST NSW 2153

PO Box 7660
BAULKHAM HILLS NSW 1755

T 02 9634 6311

ENGINEERS
MANAGERS
INFRASTRUCTURE PLANNERS
DEVELOPMENT CONSULTANTS

ALBURY WODONGA REGIONAL HOSPITAL PROJECT

Operational, Construction Noise and Vibration Assessment – NEB (REF1)

Prepared for: Health Infrastructure NSW

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Revisions

Revision	Description	Date	Prepared by	Approved by	Signature
1	Operational, Construction Noise and Vibration assessment (CNVA)- REF1	22/04/2025	Mahbub Sheikh Rodrigo Vega	M. Sheikh	MSh

Review Panel

Division/ Office	Name
Acoustics and Vibration/Sydney	Dr. Mahbub Sheikh

Unless otherwise advised, the parties who have undertaken the Review and Endorsement confirm that the information contained in this document adequately describes the conditions of the site located at Nepean Hospital, NSW.

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1 Introduction

ACOR Consultants Pty Ltd (ACOR) have been engaged by Health Infrastructure NSW to provide an Operational Noise, and Construction Noise and Vibration Assessment report (CNVA) for the proposed development of the new 2-storey Northeast Building (NEB) and associated works at Albury Wodonga Regional Hospital, located at 201 Borella Road, East Albury. A project site plan is shown in Figure 1-1 below.

The purpose of this report is to provide a construction noise and vibration impact assessment (CNVA) report required for the Review of Environmental Factors (REF1).

Figure 1-1 Project Site Location (Source: Google Image)

2 Site Analysis and Project Description

The project site is located approximately 138m south of the Borella Road, which is considered a busy road. The noise environment at the site is dominated by road traffic noise from the surrounding areas including Borella Road to the north, East Street to the east and activities associated with typical hospital operations, including, traffic ingress and egress from the adjacent car park area, existing mechanical plant etc.

The proposed project activity comprises

- Construction of a new two-storey Northeast Building, including: Administration, Allied Health, Education Training and Research, Medical Lounge, Staff Amenities and Pharmacy with link bridge to L02 corridor, which is the existing public entry level, adjacent existing surgical wards and operating theatres
- Removal of hardstand of existing lower staff at-grade carpark
- Make good the interface and included pedestrian movement works and line marking
- Minor landscaping and paving works to building edge and interface to assist with accessibility and wayfinding
- Relocation of existing fire hydrant and some inground services diversions
- Tree removal, tree planting and landscaping works.
- Demolition of existing landscaping and hardstand, including walkways and associated pedestrian infrastructure.
- Relocation of two existing demountables to the eastern side of the existing Emergency Department

2.1 Temporary Carpark associated with Northeast Building

This will be reviewed in successive stages of the project upon receipt of finalised architectural drawings.

3 Regulations, Standards and Guidelines

The following regulations, standards, and guidelines have been referred to in relation to the noise and vibration assessment for this project:

- NSW Department of Environment & Climate Change - Interim Construction Noise Guidelines (ICNG) July 2009.
- Transport for NSW Construction Noise and Vibration Guideline – September 2023.
- Transport Roads & Maritime Services Construction Noise and Vibration Guideline 2016.
- NSW Department of Environment & Conversation - Assessing Vibration: A Technical Guideline 2006.
- NSW EPA Noise Policy for Industry 2017 (NPI).
- NSW EPA Approved Methods for the Measurement and Analysis of Environmental Noise in NSW.

- AS 1055:2018 – Acoustics – Description and measurement of environmental noise (AS 1055).
- Protection of the Environmental Operations (Noise Control) Regulations 2017 (POEO).
- Australian Standard AS 2670.2:1990 Evaluation of human exposure to whole-body vibration, Part 2: Continuous and shock-induced vibration in buildings (1 to 80 Hz). N.B. – Please note that this standard was superseded by Australian Standard ISO 2631.2:2014 Mechanical vibration and shock – Evaluation of human exposure to whole-body vibration, Part 2: Vibration in buildings (1 to 80 Hz); however, it is accepted practice within the Australian market to adopt the multiplying factors (R) as presented in Table 2 Appendix A (AS 2670.2:1990) for building vibration from human comfort.
- DIN Standard 4150-3 2016-12 – Vibration in Buildings – Part 3: Effects on Structures.
- BS 6472-1:2008 – Guide to evaluation of human exposure to vibration in buildings - Vibration sources other than blasting.
- ISO 8041:2017 Human response to vibration, ISO 5349 Human response for hand-transmitted vibration and ISO 2631 Human response for whole-body vibration exposure.
- Colin G. Gordon, *Generic Vibration Criteria for Vibration-Sensitive Equipment*, 411 Borel Avenue Suite 425, San Mateo, CA USA. SPIE, 1991.
- British Standard BS 7385-2:1993 “Evaluation and measurement for vibration in buildings. Guide to damage levels from ground borne vibration”.
- BS ISO 148371-1 Mechanical Vibration - Ground-borne Noise and Vibration arising from Rail Systems - Part 1: General Guidance.

4 Reference Documents

Table 4-1 below shows the documents referred to during the assessment.

Table 4-1 Reference documents

Document Name	Drawing/Report No.	Revision	Discipline	Prepared By	Project No.	Date
016713_DR_240410_B&S_Option3.3 _ReveE_Binder	A_0502	E	Architecture	Hassell	016713	09/04/2024
Albury Wodonga Regional Hospital Project – Concept Design Report	-	-	Architecture	Hassell	016713	July 2024

5 Current Noise and Vibration Environment

The current noise environment at the project site is dominated by road traffic noise from the surrounding areas including Borella Road and East Street and activities associated with typical hospital operations, including, traffic ingress and egress, existing mechanical plant etc.

5.1 On Site Noise Measurements

Attended measurements were conducted on the 23rd and 24th April 2024 at various locations around the project site to determine existing acoustic environment. Attended noise measurements were conducted over short durations recording in continuous with a logging interval of 1 second to capture passenger and traffic noise over different time intervals. Noise levels were measured in terms of L_{Amax}, L_{A10}, L_{A90}, L_{Aeq} and L_{Amin} sound pressure levels during peak hour in order to obtain a sample of the highest-noise exposure levels on the project site. Unattended background noise monitoring was conducted from 23rd to 30th April 2024 to establish existing background noise levels. The noise monitoring equipment was calibrated prior to commencement of the measuring period and at the completion of the monitoring. Location of the noise Logger (Location A) and attended noise monitoring locations (1 to 4) are shown in Figure 5-1.

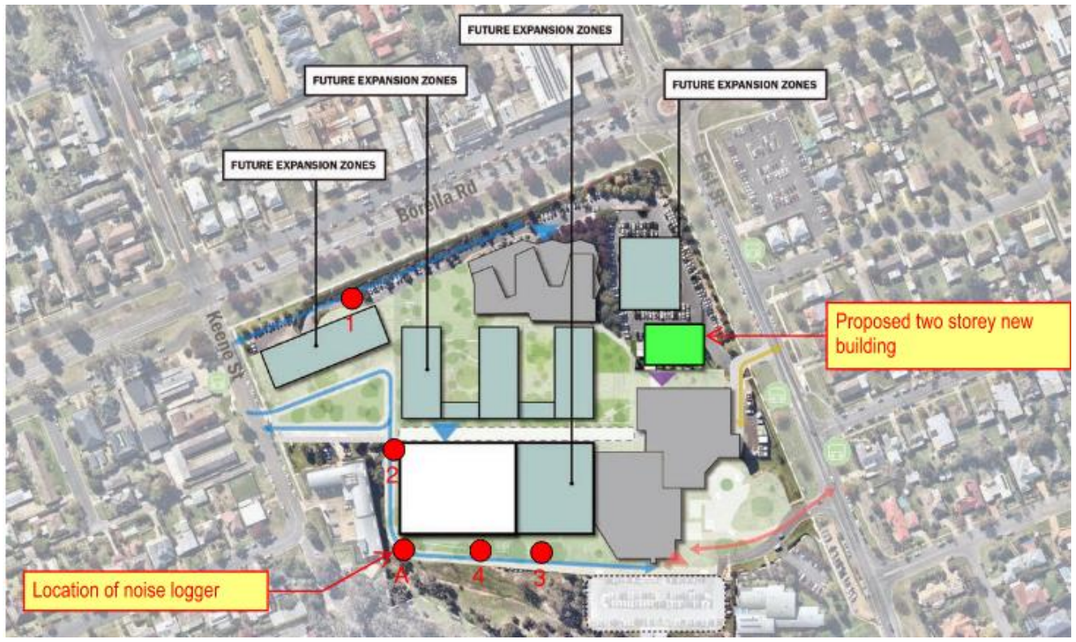


Figure 5-1 Noise measurement locations at the project site, Albury Hospital

The noise logger was configured to record continuous sound pressure levels over a recurring period of 15 minutes during the eight-day period. Measured data was stored for the measurement parameters L_{A10}, L_{A90}, L_{Aeq}, and L_{Amax} during each 15-minute period. Logging was done in A-weighted fast response mode.
The instruments used for attended and unattended measurements are listed in Table 5-1. The equipment was field calibrated before and after all measurements, with no significant drift (± 0.5 dB(A)) in calibration level. All instruments have been internally calibrated in NATA certified laboratories and hold current and traceable calibration certificates.

Table 5-1 Instrument Details

Instrument Name	Make/Model	Serial No.	Equipment Use
Sound Level Meter (Type 1)	NTi XL2	A2A-18927-E0	Attended measurements of mechanical plant and background measurement
Noise Logger (Type 1)	RION NL-53EX	00240811	Noise logging

Instrument Name	Make/Model	Serial No.	Equipment Use
Acoustic Calibrator	RION NC-74	34372753	Field calibration of equipment before use

Measurements were undertaken in general accordance with AS 1055:2018 – Acoustics - Description and Measurement of Environmental Noise and NSW EPA Approved Methods for the Measurement and Analysis of Environmental Noise in NSW.

Meteorological data during the measurement period was collected from the Weatherzone website for Albury area weather station and can be seen in Appendix D. NPI states that noise data affected by adverse meteorological conditions (wind speed >5m/s or rain) should be excluded from calculations. Wind speed adjustments corresponding to terrain type and weather balloon height have been calculated, with updated wind and rain affected noise data removed from the assessment, which occurred throughout the 23rd to 30th April time period.

5.2 Attended Noise Measurement Results

The results for the short-term measurements are shown in Table 5-2.

Table 5-2 Short term measurement results summary

Location	Comment	Time	Date	L_{eq}, dBA	$L_{max(f)}$, dBA	L_{90}, dBA
1	Dominant noise is from traffic along Borella Road and car movement at the carpark	14:44 – 15:19	23/04/2024	57	79	52
2	Traffic noise from Keene Street and Borella Road and pedestrian movement	07:50 – 08:20	24/04/2024	53	76	45
3	Distant traffic noise from East Street	08:23 – 08:54	24/04/2024	54	79	44
4	Dominant noise from Pool pump at the rehabilitation centre at the Allied Health Building	07:44 – 07:49	24/04/2024	62	67	60

5.3 Unattended Noise Logger Results

Measured noise data was processed in accordance with NSW EPA – Noise Policy for Industry (NPI) 2017 to establish the rating background noise level (RBL).

Table 5-3 below provides the noise levels. Detailed noise monitoring results are represented graphically in Appendix B . Note that in the NPI, time of the day is defined as follows:

- Day: 7am to 6pm
- Evening: 6pm to 10pm
- Night: 10pm to 7am

Table 5-3 Measured background and ambient noise levels at noise logging location (see figure 4-1)

Date	Day of the Week	Background Noise Level, L_{A90} dB(A)			Ambient Noise Level, L_{Aeq} dB(A)		
		Day	Evening	Night	Day	Evening	Night
23/04/24	Tuesday	-	40.1	39.3	42.7	44.8	42.3
24/04/24	Wednesday	39.9	38.0	37.8	48.3	41.2	49.7
25/04/24	Thursday	38.2	38.0	37.9	49.3	40.4	42.4
26/04/24	Friday	38.7	38.8	38.2	47.7	41.3	43.2
27/04/24	Saturday	38.7	38.7	38.1	45.0	43.0	42.3
28/04/24	Sunday	38.9	39.4	37.6	44.7	42.0	40.9
29/04/24	Monday	38.8	37.9	37.7	46.0	41.7	41.7
30/04/24	Tuesday	-	-	-	44.0	-	-
Rating Background Level (RBL)		**39**	**39**	**38**			
Average Ambient Noise Level					**47**	**42**	**44**

6 Acoustic and Vibration Criteria

6.1 Environmental Noise Emission Criteria - NSW EPA Noise Policy for Industry 2017

Industrial noise can have a significant effect on noise-sensitive receivers. Both the increase in noise level above background levels, as well as the absolute level of noise are important factors in how a community will respond to noise from industrial sources. The project "noise trigger level" established in the NPI addresses each of these components of noise impact.

6.1.1 Noise Sensitive Receivers

The project site is located within Albury Hospital. The nearest noise sensitive receivers are residential dwellings to the south-west and hospital buildings to the north and west. Figure 6-1 below shows the project site and the noise sensitive receivers.

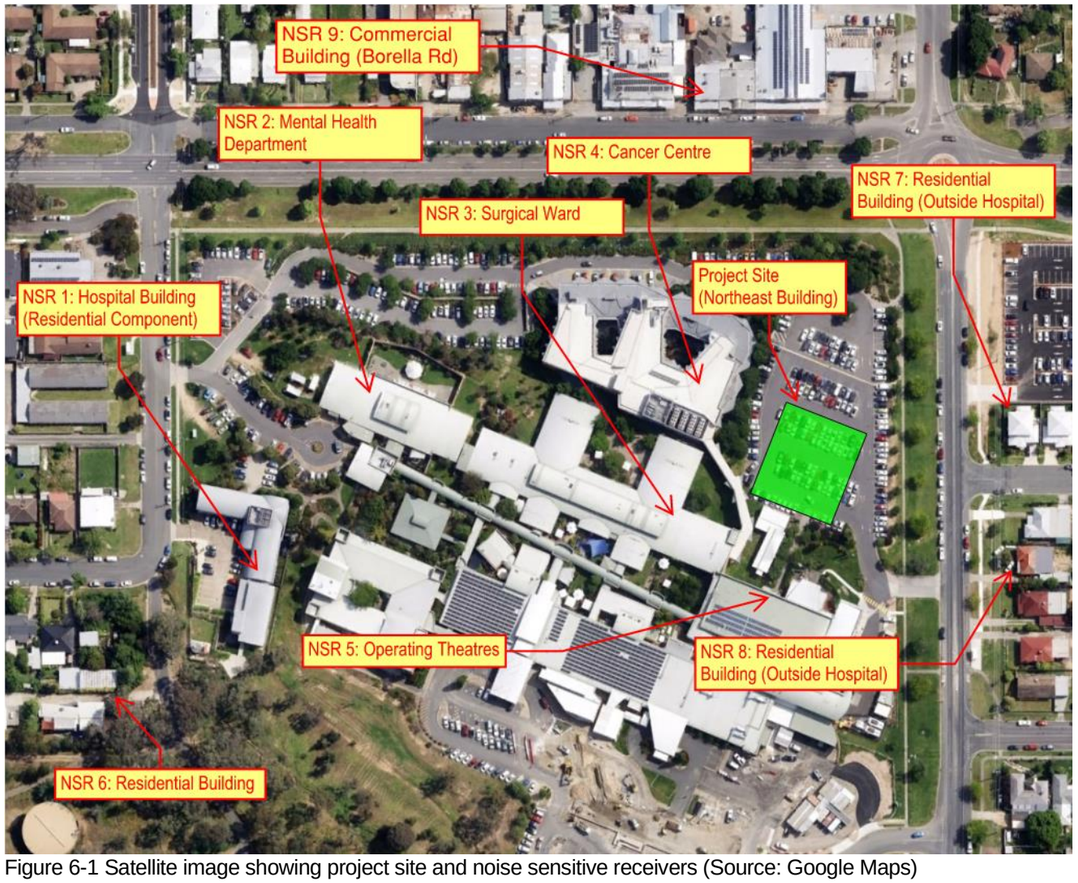


Figure 6-1 Satellite image showing project site and noise sensitive receivers (Source: Google Maps)

Noise sensitive receivers are listed below in Table 6-1

Table 6-1 Noise sensitive receivers

Noise Sensitive Receiver (NSR)	Description	Direction from Project Site	Distance from Project Site, m (approx.)
NSR 1	Hospital Building (Residential Component)	West	218
NSR 2	Hospital Building (Mental Health Department)	North	148
NSR 3	Hospital Building (Surgical Ward)	Northeast	50
NSR 4	Hospital Building (Cancer Centre)	North	42
NSR 5	Hospital Building (Operating Theatres)	East	51
NSR 6	Residential Building along Keene Street (243 Peechelba St)	West	300
NSR 7	Residential Building along East Street (172 Bilba St)	East	81
NSR 8	Residential Building along East Street (592 East St)	East	83
NSR 9	Commercial Building along Borella Rd (Ramsey Pharmacy)	North	132

A zoning map of the proposed development site is provided in Figure 6-2.

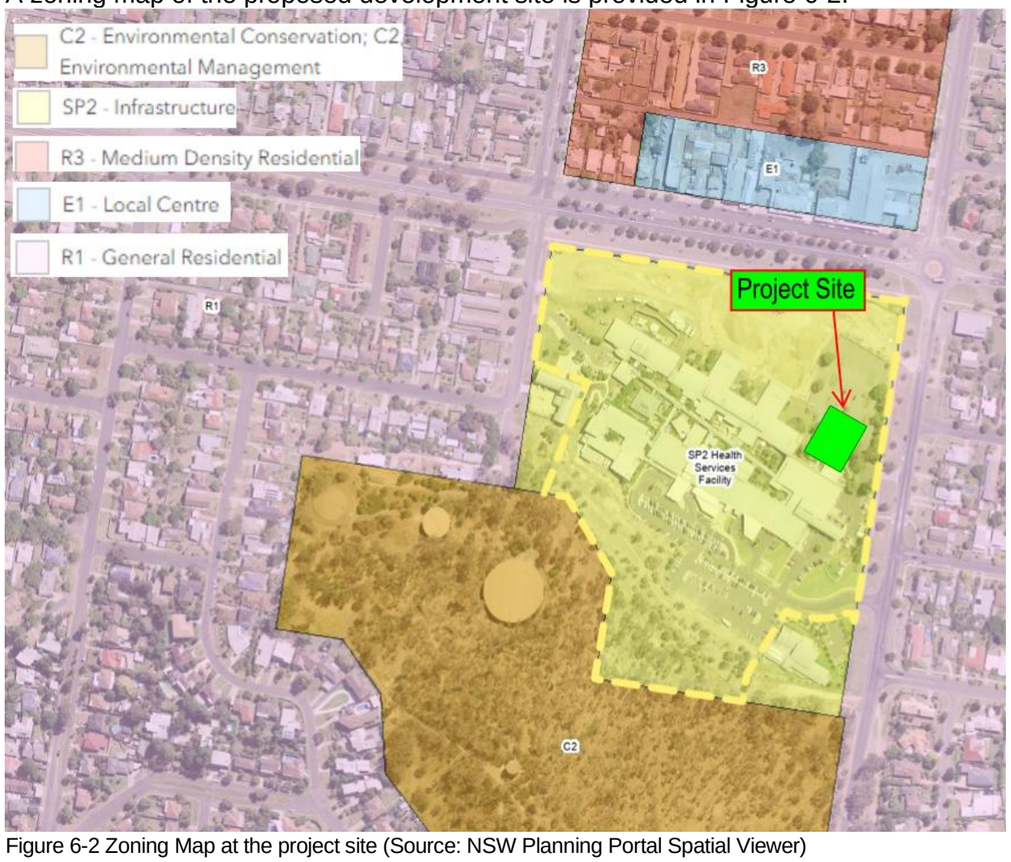


Figure 6-2 Zoning Map at the project site (Source: NSW Planning Portal Spatial Viewer)

6.1.2 Project Intrusiveness Noise Level

The intrusiveness of an industrial noise source may generally be considered acceptable if the level of noise from the source ($L_{Aeq,15min}$) does not exceed the RBL by more than 5 dB, when beyond a minimum threshold (35 dB(A) for the day, 30 dB(A) for the evening and night). This intrusiveness noise level seeks to limit the degree of change a new noise source introduces to an existing environment. The outcome of this approach aims to ensure that the intrusiveness noise level is being met for at least 90% of the time-periods over which annoyance reactions can occur (taken to be periods of 15 minutes). Project intrusiveness noise level is defined as follows:

- Project intrusiveness noise level ($L_{Aeq,15min}$) = RBL + 5 dB

The following table outlines established background and project intrusiveness levels as according to criteria outlined in the Noise Policy for Industry 2017.

Table 6-2 Project intrusiveness noise levels

	Rating Background Level RBL, dB(A)			**Project Intrusiveness Noise Levels, $L_{Aeq,15min}$ dB(A)**		
	Day	Evening	Night	Day	Evening	Night
At Residential Location outside Hospital Campus (NSR 6 to 8)	39	39	38	44	44	43
At Hospital Buildings (NSR 1 to 5)	39	39	38	-	-	-

6.1.3 Project Amenity Noise Level

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 remain below the recommended amenity noise levels specified in Table 2.2 of the NPI, where feasible and reasonable. The recommended amenity noise levels will protect against noise impacts such as speech interference, community annoyance and some sleep disturbance.
The recommended amenity noise levels (Table 2.2 of the NPI) represent the objective for 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 $L_{Aeq,15min}$ = Recommended amenity noise level – 5 dB(A) + 3 dB(A)

The recommended amenity noise level should be established from Table 2.2 of the NPI based on the noise sensitive receivers' category, determined based on Table 2.3 of the NPI.
As the NPI states, the approach of deriving the project amenity noise level from the recommended amenity noise level minus 5 dB is based on a receiver not being impacted by more than three to four individual industrial noise sources. To standardise the time periods for the intrusiveness and amenity noise levels, NPI assumes that the Amenity $L_{Aeq,15min}$ will be taken to be equal to the $L_{Aeq,period}$ + 3 decibels (dB).

Considering that the residential noise sensitive receivers are located in an R2 Low Density Residential Zone (Suburban Residential), the NPI recommended Amenity Noise Level and Project Amenity Noise Level for this project are presented in Table 6-3.

Table 6-3 Project amenity noise levels

Noise Sensitive Receiver	**Recommended Amenity Noise Level, L_{Aeq} dB(A)**			**Project Amenity Noise Levels, $L_{Aeq,15min}$ dB(A)**		
	Day	**Evening**	**Night**	**Day**	**Evening**	**Night**
At Residential Location outside Hospital Campus (NSR 6 to 8)	55	45	40	53	43	38
At Hospital Buildings (NSR 1 to 5)	50 (noisiest 1-hr) External			48 External		
	35 (noisiest 1-hr) Internal			33 Internal		
Commercial Property	65 When in use			65		

*Suburban: 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.

6.1.4 Project Noise Trigger Level

The project noise trigger level is the lower (that is, the more stringent) value of the project intrusiveness noise level and the project amenity noise level determined in accordance with the NPI. The project intrusiveness noise level aims to protect against significant changes in noise levels, whilst the project amenity noise level seeks to protect against cumulative noise impacts from industry and maintain amenity for particular land uses. Applying the most stringent requirement as the project noise trigger level ensures that both intrusive noise is limited, and amenity is protected and that no single industry can unacceptably change the noise level of an area. It is noted that Intrusive noise levels are only applied to residential receivers (residences). For other receiver types identified in Table 2.2 of the NPI, only the amenity levels apply.
The project noise trigger levels for this project are established in accordance with the NPI and are shown below in Table 6-4.

Table 6-4 Project noise trigger levels

Noise Sensitive Receiver	**Project Intrusiveness Noise Level, $L_{Aeq,15min}$ dB(A)**			**Project Amenity Noise Level, $L_{Aeq,15min}$ dB(A)**			**Project Noise Trigger Level, $L_{Aeq,15min}$ dB(A)**		
	Day	**Evening**	**Night**	**Day**	**Evening**	**Night**	**Day**	**Evening**	**Night**
At Hospital Buildings (NSR 1 to 5)	-			External 48 dB(A) Noisiest 1 Hour Internal 33 dB(A) Noisiest 1 Hour			External 48 dB(A) Noisiest 1 Hour		
At Residential Location outside Hospital Campus (NSR 6 to 8)	44	44	43	53	43	38	44	43	38
Commercial Premises				63 dB(A) when in use.			63 dB(A) when in use.		

6.1.5 Correction for Modifying Factors

Where a noise source contains certain characteristics, such as tonality, intermittency, irregularity or dominant low-frequency content, a correction should be applied as per the NPI, to the measured or predicted noise levels at the receiver before comparison with the project noise trigger levels. The maximum correction of 10 dB(A) to be applied to the predicted or the measured level where two or more modifying factors are present. NPI recommended correction factors (Table C1 of the NPI) are shown in Table 6-5.

Table 6-5 Modifying factor corrections for noise characteristics

Factors	Corrections[1]	Notes
Tonal Noise	5 dB[2,3]	[1.] Corrections to be added to the measured or predicted levels, except in the case of duration where the adjustment is to be made to the criterion. [2.] Where a source emits tonal and low-frequency noise, only one 5-dB correction should be applied if the tone is in the low-frequency range, that is, at or below 160 Hz. [3.] Where narrow-band analysis using the reference method is required, as outlined in column 5, the correction will be determined by the ISO1996-2:2007 standard
Low-Frequency Noise	2 or 5 dB[2]	
Intermittent Noise	5 dB	
Duration	0 to 20 dB(A)	
Maximum Adjustment	Maximum correction of 10 dB(A)[2] (excluding duration correction).	

As per the NPI, correction for duration is applied where a single-event noise is continuous for a period of less than two and a half hours in any assessment period. The allowable exceedance of the $L_{Aeq,15min}$ equivalent noise criterion is provided in Table C3 of the NPI for the duration of the event. This adjustment is designed to account for unusual and one-off events and does not apply to regular and/or routine high-noise level events. The adjustments for duration are to be applied to the criterion.

6.1.6 Sleep Disturbance Criteria

The potential for sleep disturbance from maximum noise level events from premises during the night-time period needs to be considered. NPI recommends, where the subject development/premises night-time noise levels at a residential location exceed:

- $L_{Aeq,15min}$ 40 dB(A) or the prevailing RBL plus 5 dB, whichever is the greater, and/or
- L_{AFmax} 52 dB(A) or the prevailing RBL plus 15 dB, whichever is the greater,

that a detailed maximum noise level event assessment should be undertaken. The detailed assessment should cover the maximum noise level, the extent to which the maximum noise level exceeds the rating background noise level, and the number of times this happens during the night-time period. Based on the NPI, the sleep disturbance criteria for the proposed development are determined as shown in Table 6-6.

Table 6-6 Sleep disturbance criteria

Noise Sensitive Receiver	Rating Background Level (RBL) at Night, L_{A90} dB(A)	NPI Recommended Sleep Disturbance Criteria, dB(A)	
		$L_{Aeq,15min}$ (40 dB(A) or the prevailing RBL plus 5 dB, whichever is the greater)	L_{AFmax} (52 dB(A) or the prevailing RBL plus 15 dB, whichever is the greater)
At Residential Location outside Hospital Campus (NSR 6 to 8)	38	43	53

In addition to the above, NSW Road Noise Policy (RNP) noted that the research on sleep disturbance to date concluded that:

- Maximum internal noise levels below 50–55 dB(A) is unlikely to awaken people from sleep.
- One or two noise events per night, with maximum internal noise levels of 65–70 dB(A), are not likely to affect health and wellbeing significantly.

6.2 Construction Noise Criteria - Interim Construction Noise Guideline (ICNG) (DECC, 2009)

The Interim Construction Noise Guideline (ICNG) (DECC, 2009) guideline recommends standard hours for construction activities as:

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

These hours are not mandatory and the ICNG acknowledges that the following activities have justification to be undertaken outside the recommended standard construction hours assuming that all reasonable and feasible mitigation measures are implemented to minimise the impacts to the surrounding sensitive land uses:

- the delivery of oversized plant or structures that police or other authorities determine require special arrangements to transport along public roads.
- emergency work to avoid the loss of life or damage to property, or to prevent environmental harm.
- maintenance and repair of public infrastructure where disruption to essential services and/or considerations of worker safety do not allow work within standard hours.
- public infrastructure works that shorten the length of the project and are supported by the affected community
- works where a proponent demonstrates and justifies a need to operate outside the recommended standard hours.

Construction noise management levels at sensitive residential receivers are provided in Table 6-7. The construction noise management levels during recommended standard hours represent a noise level that, if exceeded, would require management measures including:

- reasonable and feasible work practices
- contact with the residences to inform them of the nature or works to be carried out, the expected noise levels and durations and contact details.

The management measures are aimed at reducing noise impacts at the residential receivers. However, it may not be reasonable and feasible to reduce noise levels to below the noise affected management level. The noise affected construction noise management levels during recommended standard hours is not intended as a noise limit but rather a level where noise management is required and as such should not be included as a noise limit.

Table 6-7 Residential construction noise management levels, dBA

Time of day	Noise Management level, LAeq (15 min)	Application Notes
Recommended standard hours	Noise affected: RBL + 10 dBA	The noise affected level represents the point above which there may be some community reaction to noise. ▪ where the predicted or measured LAeq(15 min) is greater than the noise affected level, the proponent should apply all feasible and reasonable work practices to meet the noise affected level. ▪ the proponent should also inform all potentially impacted residents of the nature of works to be carried out, the expected noise levels and duration, as well as contact details.
	Highly noise affected: 75 dBA	The highly noise affected level represents the point above which there may be strong community reaction to noise. Where noise is above this level, the relevant authority (consent, determining or regulatory) may require respite periods by restricting the hours that the very noisy activities can occur, taking into account: ▪ times identified by the community when they are less sensitive to noise (such as before and after school, or mid-morning or mid-afternoon for works near residences) ▪ if the community is prepared to accept a longer period of construction in exchange for restrictions on construction times.
Outside recommended standard hours	Noise affected: RBL + 5 dBA	▪ 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 measures have been applied and noise is more than 5 dBA above the noise affected level, the proponent should negotiate with the community.

Noise management levels for other sensitive land uses are provided in Table 6-8 and only apply when the properties are in use.

Table 6-8 Noise management levels for other sensitive land uses

Land Use	Noise management, $L_{Aeq\ (15\ minutes)}$
Commercial premises - Offices	70 dBA (external)
Active recreational areas – characterised by sporting activities	65 dBA (external)
Passive recreational areas – characterised by quiet contemplative activities	60dBA (internal)
Hospital Wards and operating theatres	45 dBA (internal)*
Classrooms at schools and other educational institutions	45 dBA (internal)*
*External noise level can be adopted as 65 dB(A) considering a 20 dB sound transmission loss provided by the closed façade.	

A summary of the construction noise management levels for this project are provided in Table 6-9.

Table 6-9: Project construction noise management levels, dBA

Receiver type	Construction noise management levels, $L_{Aeq(15\ min)}$				
	Standard construction hours		Outside standard construction hours		
	Noise affected	Highly noise affected	Day	Evening	Night
At Hospital Buildings (NSR 1 to 5) Hospital Ward and Operating Theatres	45 dBA (internal)*		45 dBA (internal)*		
At Residential Location outside Hospital Campus (NSR 6 to 8)	49	75	44	44	43
Commercial premises - Offices					
*External noise level can be adopted as 65 dB(A) considering a 20 dB sound transmission loss provided by the closed façade.					

6.2.1 Ground-borne Noise Criteria

Ground-borne noise is generated by vibration transmitted through the ground into a structure. 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: L_{Aeq} (15 min) 40 dB(A).
- Night-time (10 pm to 7 am): Internal: L_{Aeq} (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.

6.3 Construction Road Traffic Noise Criteria

Traffic noise associated with construction vehicles movement is not covered by ICNG 2009. The application notes1 for the Road Noise Policy state that “for existing residences and other sensitive land uses affected by additional traffic on existing roads generated by land use developments, any increase in the total traffic noise level as a result of the development should be limited to 2 dB above that of the noise level without the development. This limit applies

wherever the noise level without the development is within 2 dB of, or exceeds, the relevant day or night noise assessment criterion." This is also considered to be applicable for construction noise therefore if road traffic noise increases from construction is within 2 dB(A) of current levels then the objectives on the Road Noise Policy are achieved.
A significant increase in traffic volumes would be needed in order to increase road traffic noise by 2 dB(A) (a doubling in traffic corresponds to an approximate 3 dB(A) increase). Construction work would generate light and heavy vehicle movements associated with employees, deliveries, transportation of machinery, materials and equipment to work sites.

6.4 Protection of the Environment Operations (POEO) Act 1997

The POEO Act 1997 aims to protect, restore and enhance the quality of the noise environment in New South Wales. 'Offensive noise' in the Act is defined as 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 is likely to be harmful to) a person who is outside the premises 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.

For control of noise from Air Conditioners, Pumps and Heat Pump Water Heaters, the Act defines the following in regard to its use on residential premises:

A person is guilty of an offence if -

(a) the person causes or permits an air conditioner / pump to be used on residential premises in such a manner that it emits noise that can be heard within any room in any other residential premises (that is not a garage, storage area, bathroom, laundry, toilet or pantry) whether or not any door or window to that room is open -

(i) before 8 am or after 10 pm on any Saturday, Sunday or public holiday, or

(ii) before 7 am or after 10 pm on any other day,

6.5 Vibration Criteria

6.5.1 Human Comfort - NSW DEC Assessing Vibration: A Technical Guideline (2006)

Vibration can potentially impact on the quality of life or working efficiency. Individuals can detect building vibration values that are well below those that can cause any risk of damage to the building or its contents. The level of vibration that affects amenity is lower than that associated with building damage. To protect the health and wellbeing of the community, NSW DEC has developed a guideline to aid in protecting people from values of vibration above preferred and maximum values felt inside buildings. The recommended vibration criteria for Human Comfort are based on the NSW DEC Assessing Vibration: A Technical Guideline (2006). The criteria for continuous and impulsive vibration are summarized in Table 6-10.

6.5.1.1 Human Comfort – Continuous and Impulsive Vibration (1 to 80 Hz)

Continuous vibration is defined as the vibration that continues uninterrupted for a defined period (usually throughout daytime and/or night-time). This type of vibration is assessed on the basis of weighted RMS acceleration values presented in Table 6-10.
Impulsive vibration is a rapid build up to a peak followed by a damped decay that may or may not involve several cycles of vibration (depending on frequency and damping). It can also consist of a sudden application of several cycles at approximately the same amplitude, providing that the duration is short, typically less than 2 seconds. Impulsive vibration (no more than three occurrences in an assessment period) is assessed on the basis of acceleration and the recommended criteria is provided in Table 6-10.

Table 6-10 Vibration criteria for Human Comfort – Continuous and Impulsive Vibration (1 to 80 Hz)

Location	**Assessment Period***	**Preferred weighted RMS values (m/s^2)**		**Maximum weighted RMS values (m/s^2)**	
Continuous Vibration					
		z-axis	x and y axes	z-axis	x and y axes
ical areas**	Day or Night-time	0.0050	0.0036	0.010	0.0072
sidences	Daytime (7am to 10pm)	0.010	0.0071	0.020	0.014
	Night-time (10pm to 7am)	0.007	0.005	0.014	0.010
Offices, Schools, Educational Institutions and Places of Worship	Day or Night-time	0.020	0.014	0.040	0.028
Impulsive Vibration					
Critical areas**	Day or Night-time	0.0050	0.0036	0.010	0.0072
Residences	Daytime (7am to 10pm)	0.30	0.21	0.60	0.42
	Night-time (10pm to 7am)	0.10	0.071	0.20	0.14
Offices, Schools, Educational Institutions and Places of Worship	Day or Night-time	0.64	0.46	1.28	0.92
aytime is 7.00 am to 10.00 pm and night-time is 10.00 pm to 7.00 am					
**Examples include hospital operating theatres and precision laboratories where sensitive operations are occurring. There may be cases where sensitive equipment or delicate tasks require more stringent criteria than the human comfort criteria specified above. Stipulation of such criteria is outside the scope of this policy, and other guidance documents (e.g. relevant standards) should be referred to. Source: BS 6472–1992.					

Guidelines for human comfort with respect to vibration within a building are also provided by NSW Environmental Noise Management – Assessing Vibration: a technical guide (February 2006). This technical guideline provides acceptable RMS acceleration and velocity for continuous, impulsive and intermittent vibration. Velocity and acceleration limits are presented in Table 6-11.

Table 6-11 Weighted vibration criteria for exposure to continuous and impulsive vibration – Human Comfort

Location	Assessment Period	RMS velocity (mm/s)		RMS acceleration (m/s^2)		Peak velocity (mm/s)	
Continuous Vibration							
		Preferred	Maximum	Preferred	Maximum	Preferred	Maximum
Workshop	Day – or Nighttime	0.80	1.6	0.040	0.080	1.1	2.2
Offices	Day – or Nighttime	0.40	0.80	0.020	0.040	0.56	1.1
Critical Areas, include hospital operating theatres and precision laboratories where sensitive operations are occurring	Day – or Nighttime	0.10	0.20	0.0050	0.010	0.14	0.28
Residences	Day	0.20	0.40	0.010	0.020	0.28	0.56
	Nighttime	0.14	0.28	0.007	0.014	0.20	0.40
Impulsive Vibration							
Workshop	Day – or Nighttime	13	26	0.64	1.28	18.0	36.0
Offices	Day – or Nighttime	13	26	0.64	1.28	18.0	36.0
Critical Areas, include hospital operating theatres and precision laboratories where sensitive operations are occurring	Day – or Nighttime	0.10	0.2	0.0050	0.010	0.14	0.28
Residences	Day	6.0	12.0	0.30	0.60	8.6	17.0
	Nighttime	2.0	4.0	0.10	0.20	2.8	5.6

6.5.1.2 Human Comfort – Intermittent Vibration (1 to 80 Hz)

Perception of vibration will depend on the vibration magnitude and its duration of exposure. In addition to the continuous and impulsive vibration, people can be subjected to intermittent vibration. It is defined as interrupted periods of continuous (e.g. a drill) or repeated periods of impulsive vibration (e.g. a pile driver), or continuous vibration that varies significantly in magnitude. It may originate from impulse sources (e.g. pile drivers and forging presses) or repetitive sources (e.g. pavement breakers), or sources which operate intermittently, but which would produce continuous vibration if operated continuously (for example, intermittent machinery, railway trains and traffic passing by). This type of vibration is assessed on the basis of Vibration Dose Values (VDV) which is used to evaluate the cumulative effects of intermittent vibration. As per the recommendations of the NSW DEC Assessing Vibration: A Technical Guideline (2006), the recommended criteria for intermittent vibration are summarized in Table 6-12.

Table 6-12 Acceptable vibration dose values for Intermittent Vibration

Location	Vibration Dose Values (m/s$^{1.75}$)			
	Daytime (7am – 10pm)		Night-time (10pm – 7am)	
	Preferred	Maximum	Preferred	Maximum
Critical Areas, hospital operating theatres and precision laboratories where operations are occurring**	0.10	0.20	0.10	0.20
Residences	0.20	0.40	0.13	0.26
Offices	0.40	0.80	0.40	0.80
AAAC Guideline for Healthcare Facilities: Theatres	Curve 0.10 from ASHRAE			
AAAC Guideline for Healthcare Facilities: Single bed ward (including Mental Health, Parent Accommodation), Multiple bed ward, General intensive care wards, Neonatal or paediatric ICUs, and the like	-	0.20	-	0.10
AAAC Guideline for Healthcare Facilities: Consulting, examination, treatment, procedures, interview, counselling etc.	-	0.40	-	0.40
AAAC Guideline for Healthcare Facilities: Boardroom/conference, open plan and private offices, etc.	-	0.80	-	0.80
* Daytime is 7.00 am to 10.00 pm and night-time is 10.00 pm to 7.00 am				
**Examples include hospital operating theatres and precision laboratories where sensitive operations are occurring. There may be cases where sensitive equipment or delicate tasks require more stringent criteria than the human comfort criteria specified above. Stipulation of such criteria is outside the scope of this policy, and other guidance documents (e.g. relevant standards) should be referred to. Source: BS 6472–1992.				

6.5.2 ASHRAE 2019 - Human Comfort Vibration Criteria

The concept of using base curves to assess human comfort has been adopted from Australian Standard 2670.2:1990. NB - Please note that this standard was superseded by AS ISO 2631.2:2014, however, it is accepted practice within the Australian market to adopt the multiplying factors as presented in Table 2 Appendix A (2670.2:1990) for building vibration from human comfort. A base curve marks the threshold of human perception and is defined in one-third octave bands from 1 Hz to 80 Hz. Vibration levels below the base curves typically do not result in adverse comments or complaints from occupants. The vibration criteria for different occupancy types are obtained by multiplying the base curve by a factor. Multiplying factors for different occupation types on the recommendations in AS 2670.2:1990 are listed in Table 6-13.

The vibration criteria for the sleeping areas in the building should be as follows: AS2670.2 Base Curve multiplied by 1.4 at night time and multiplied by 2 during day time.

Table 6-13 Multiplying factors for satisfactory magnitudes of building vibration with respect to human response

Room Type	Multiplying Factor (R)	
	Continuous or Intermittent Vibration	Transient Vibration excitation with several occurrences per day
Critical working areas (for example some hospital operating-theatres, some precision laboratories or similar)	1.0	1.0
Residential	2.0 to 4.0 (Day) 1.4 (Night)	30 to 90 (Day) 1.4 to 20 (Night)
Boardroom/conference, open plan and private offices	4.0	60 to 128
Engineering, Workshop, co-working and collaborative spaces, plant rooms	8.0	90 to 128

The American Society of Heating, Refrigerating and Air-Conditioning Engineers (ASHRAE) curves include residential velocity curves for vibration measured on building structure in areas containing occupants. Velocity vibration criteria curves (RMS) defined in one-third octave frequency bands range 1 to 80 Hz are shown Figure 6-3.

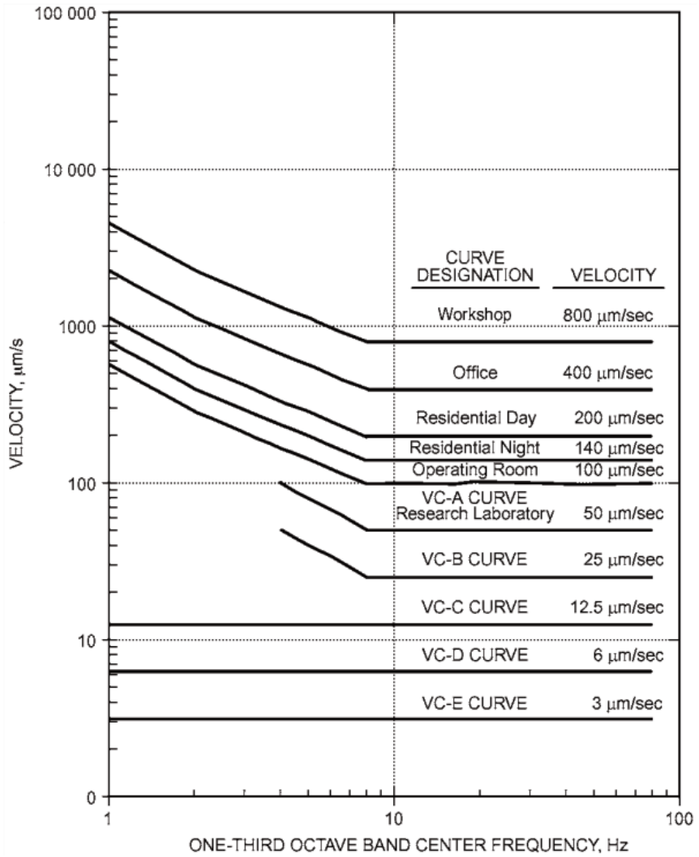


Figure 6-3 Vibration Criteria Curves (ASHRAE 2019)

The ASHRAE curves include workshop, office, residential, operating room and VC curves for sensitive equipment. Velocity vibration criteria curves (RMS) defined in one-third octave frequency bands (CPB) range 1 to 80 Hz are shown in Table 6-14.

Table 6-14 Human Comfort and Equipment Vibration Criteria from Continuous Vibration

Location	Assessment Period	1 to 80Hz Curve mm/s
Workshops	Day – or Nighttime	0.813
Office Areas, Consulting, examination, treatment, procedures, interview, counselling	Day – or Nighttime	0.406
Residential	Day	0.203
	Nighttime	0.144
Hospital operating theatres rooms and critical work areas	Day – or Nighttime	0.102
Single bed ward, Multiple bed ward, General intensive care wards and the like	Day – or Nighttime	0.140

6.5.3 ASHRAE 2019 - Vibration Criteria for Sensitive Equipment

Vibration Criteria (VC) curves are used extensively in scientific and research environments. The VC curves were introduced by Gordon in 1991 in his publication by SPIE in 1991 and by IEST in 1993 and adopted in ASHRAE as widely accepted criteria for design of facilities accommodating vibration sensitive equipment.

The ASHRAE curves include workshop, office and VC curves for sensitive equipment.

Table 6-15 present recommended acceptable criteria for vibration in a building structure to assess vibration impacts on sensitive scientific laboratory equipment, if applicable. Velocity vibration criteria curves (RMS) defined in one-third octave frequency bands range 1 to 80 Hz are shown in Figure 6-3.

- It is recommended that the structural concrete slab comply with ASHRAE Vibration Criteria Curve VC-A where sensitive equipment will be located, including operating theatre rooms, X-ray or similar.
- Ground floor level, concrete slab supporting the imaging equipment must achieve the VC requirements to achieve the MRI manufacture specifications. Refer to
- Table 6-15 (i.e. note 2) and Figure 6-3.
- A comprehensive review of the proposed sensitive equipment (MRI) is required during design detail stage. A review of imaging equipment vibration criterion is also required to determine floor and/or equipment specific isolation requirements, and measures implemented to manage these accordingly. The criterion and treatments will be specific to the selected equipment and, where vibration controls are required, these will apply to the equipment floor area and equipment supports; through a dedicated isolation system such as floating concrete floor or as required.

Table 6-15 Building Vibration Criteria

Criterion Curve	Maximum RMS Velocity Level [µm/sec]	Detail Size (1) Microns	Description of Use
Workshop (ISO)	800	N/A	Distinctly perceptible vibration. Appropriate to workshops and non-sensitive areas
Office (ISO)	400	N/A	Perceptible vibration. Appropriate to offices and non-sensitive areas
Residential Day/Night (ISO)	200 to 140	75	Barely perceptible vibration. Appropriate to sleep areas in most instances. Probably adequate for computer equipment, probe test equipment and low-power (to 20X) microscopes
Operating Theatre (ISO)	100	25	Vibration not perception. Suitable for sensitive sleep areas. Suitable in most instances for microscopes to 100X and for other equipment of low sensitivity
VC-A	50 (0.05mm/s)	8	Adequate in most instances for optical microscopes to 400X, microbalances, optical balances, proximity and projection aligners, etc
VC-B	25	3	An appropriate standard for optical microscopes to 1000X, inspection and lithography equipment (including steppers) to 3-micron line widths
VC-C	12.5	1	A good standard for most lithography and inspection equipment to 1-micron detail size
VC-D	6.25	0.3	Suitable in most instances for the most demanding equipment including electron microscopes (TEMs and SEMs) and E-Beam systems, operating to the limits of their capability
VC-E	3.12	0.1	A difficult criterion to achieve in most instances. Assumed to be adequate for the most demanding of sensitive systems including long path, laser-based, small target systems and other systems requiring extraordinary dynamic stability

Note:

(1) The detail size refers to the line widths for microelectronics fabrication, the particle (cell) size for medical and pharmaceutical research, etc. The values given take into account the observation that the vibration requirements of many items depend upon the detail size of the process.

(2) Floor structure is expected to be dictated by vibration requirements for sensitive equipment required and operational/functional brief.

6.5.4 Vibration Criteria for Structural Damage

Currently there are no Australian Standards specifying the acceptable level of vibration limits for structural integrity due to ground vibration.

6.5.4.1 Building Structure - Cosmetic Damage - British Standard BS 7385-2:1993

The levels of vibration required to cause cosmetic damage to buildings tend to be at least an order of magnitude (10 times) higher than those at which people may consider the vibration to be intrusive. In terms of the most recent relevant vibration damage objectives, Australian Standard AS 2187: Part 2-2006 Explosives - Storage and Use - Part 2: Use of Explosives recommends the frequency dependent guideline values and assessment methods given in BS 7385 Part 2-1993 Evaluation and measurement for vibration in buildings Part 2 as they “are applicable to Australian conditions” BS7385.

The British Standard sets guide values for building vibration based on the lowest vibration levels above which damage has been credibly demonstrated. These levels are judged to give a minimum risk of vibration induced damage, where minimal risk for a named effect is usually taken as a 95% probability of no effect.

Recommended vibration criteria for cosmetic damage are based on the British Standard BS 7385-2:1993 “Evaluation and measurement for vibration in buildings. Guide to damage levels from ground borne vibration”. BS 7385-2:1993 recommends the lower value of vibration limits, above which cosmetic damage could occur, presented in Table 6-16.

Table 6-16 Recommended transient vibration values for cosmetic damage

Type of Building	Peak component particle velocity (PPV) in frequency range of predominant pulse	
	4 Hz to 15 Hz	15 Hz and above
Reinforced or framed structures Industrial and heavy commercial	50mm/s at 4 Hz and above	50mm/s at 4 Hz and above
Unreinforced or light framed structures Residential or light commercial type buildings	15mm/s at 4 Hz increasing to 20mm/sec at 15 Hz	20mm/s at 15 Hz increasing to 50mm/sec at 40 Hz and above.

The recommended values relate predominantly to transient vibration which does not give rise to resonant responses in structures, and to low-rise buildings. Where the dynamic loading caused by continuous vibration is such as to give rise to dynamic magnification due to resonance, especially at the lower frequencies where lower guide values apply, then the recommended values in Table 6-16 may need to be reduced by up to 50 %.

In the lower frequency region where strains associated with a given vibration velocity magnitude are higher, the guide values for building types corresponding to Line 2 are reduced. Below a frequency of 4 Hz where a high displacement is associated with the relatively low peak component particle velocity value, a maximum displacement of 0.6 mm (zero to peak) is recommended. This displacement is equivalent to a vibration velocity of 3.7 mm/s at 1 Hz.
The standard goes on to state that minor damage is possible at vibration magnitudes which are greater than twice those given in Table 16 and major damage to a building structure may occur at values greater than four times the tabulated values.

Where the dynamic loading caused by continuous vibration may give rise to dynamic magnification due to resonance, especially at the lower frequencies where lower guide values apply, then the guide values in Table 6-16 may need to be reduced by up to 50%. **Note: rock breaking/hammering and sheet piling activities are considered to have the potential to cause dynamic loading in some structures (e.g. residences) and it may therefore be appropriate to reduce the transient values by 50%.**

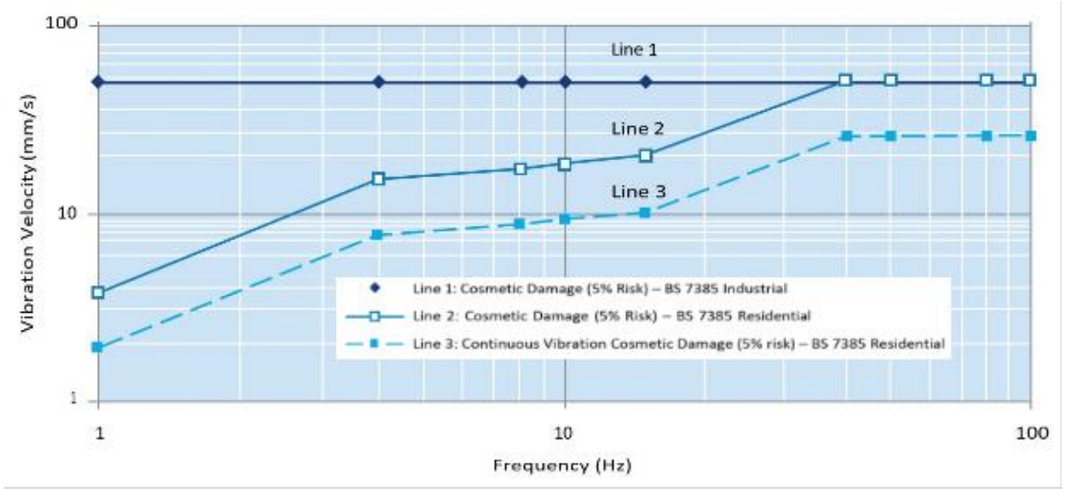


Figure 6-4 Graph of transient vibration guide values for cosmetic damage

Therefore, for most construction activities involving intermittent vibration sources such as rock breakers, piling rigs, vibratory rollers, excavators and the like, the predominant vibration energy occurs at frequencies greater than 4 Hz (and usually in the 10 Hz to 100 Hz range). On this basis, a conservative vibration damage screening level per receiver type is given below:

- Reinforced or framed structures: 25.0 mm/s
- Unreinforced or light framed structures: 7.5 mm/s

At locations where the predicted and/or measured vibration levels are greater than shown above (peak component particle velocity), a more detailed analysis of the building structure, vibration source, dominant frequencies and dynamic characteristics of the structure would be required to determine the applicable safe vibration level.

6.5.4.2 Building Structure - Structural Damage - German Standard DIN 4150-Part 3 (2016)

Vibration criteria for structural damage, as recommended in German Standard DIN 4150-Part 3 (2016) Effects on Structures, is adopted and recommended for vibration assessment for structural integrity. The DIN 4150 Part 3 prescribes maximum allowable vibration velocities measured at the foundation of the buildings, which do not affect the structural integrity of the buildings. Based on the Standard, the maximum allowable ground vibration velocity deemed acceptable for different types of buildings is shown in Table 6-17.

Table 6-17 Guideline values for vibration velocity for evaluating the effects of short-term vibration on structures (DIN 4150)

Type of Structure	Guideline values for $v_{i,max}$ in mm/s				
	Foundation, all directions (i=x,y,z) at a frequency of			Topmost floor, horizontal direction (i=x,y)	Floor Slabs, vertical direction (i=z)
	1 Hz to 10 Hz	10 to 50Hz	50 to 100Hz	All frequencies	All frequencies
Buildings used for commercial purposes, industrial buildings and buildings of similar design (Industrial)	20	20 to 40	40 to 50	40	20
Dwellings and buildings of similar design and/or occupancy (Residential)	5	5 to 15	15 to 20	15	20

6.5.4.3 Buried Pipe and Services - DIN 4150-3

The British Standard BS 7385-2:1993 Evaluation and measurement for vibration in buildings - Part 2: Guide to damage levels from ground-borne vibration notes that structures below ground are known to sustain higher levels of vibration and are very resistant to damage unless in very poor condition (British Standard BS 7385-2:1993, p5). Further guidance is taken from the German Standard DIN 4150: Part 3-1999.02 Structural vibration in buildings - Effects on Structures. Section 5.3 of DIN 4150: Part 3 sets out guideline values for vibration velocity to be used when evaluating the effects of vibration on buried pipework. These values are reproduced and presented in Table 6-18 below.

Table 6-18 DIN 4150-3 Guideline values for vibration velocity to be used when evaluating the effects of short-term vibration on buried pipework

Type of occupancy	Time Period	AAAC Structure - borne noise criteria, dB
Wards and Sleeping, Operating Theatres areas or similar	Day, 7am to 10pm	40 $L_{Amax,s}$
	Night, 10pm to 7am	35 $L_{Amax,s}$

Note: rock breaking/hammering and sheet piling activities are considered to have the potential to cause dynamic loading in some structures and it may therefore be appropriate to reduce the transient values by 50%.

6.5.5 Structure-Borne Noise

Structure-borne noise is noise generated by vibration transmitted through the structure into the new development. Structure-borne noise caused by existing building services can be more noticeable than airborne noise. Table 6-19 presents the structure-borne noise criteria for sensitive receivers such as sleeping areas.

Table 6-19 Structure-borne Noise Criteria for Sensitive Receivers

Type of occupancy	Time Period	AAAC Structure -borne noise criteria, dB
Wards and Sleeping, Operating Theatres areas or similar	Day, 7am to 10pm	40 $L_{Amax,s}$
	Night, 10pm to 7am	35 $L_{Amax,s}$

7 Operational Noise and Vibration Assessment

7.1 Operational Noise Assessment

7.1.1 Noise Emission from Mechanical Plant and Equipment to Environment

Noise emissions via the mechanical services from the proposed development are required to comply with the Noise Policy for Industry (NPI) criteria at all nearest sensitive receivers, including premises within the development.

It is understood that mechanical plant attached to Level 1 of the building will be externally installed to an open plant area on the western boundary of the building. Fan exhaust equipment would be located on the rooftop level, with the remainder of the HVAC mechanical plant installed internal to the structure.

The following project elements are known and given in preliminary mechanical/architectural drawings referenced in Section 7.3

- General site arrangement comprising of:
  - 1 two-storey structure, designated Northeast Building
  - Attached open-air mechanical plant enclosure with 8 floor-mounted air cooled VRF fan coil units
  - Roof area encompassing total building area with roof-mounted HVAC vents

The following elements were not known at the time of writing this report and are assumed (from previous experience) for this assessment, approximated in modelling.

- Rooftop fan sound power level.

In the following sections noise from the development is assessed against the noise requirements of the NSW EPA Noise Policy for Industry (2017). The detailed noise assessment methodology, findings of the noise assessments and relevant recommendations to achieve noise compliance are also included in this section.

7.2 Operational Activities adopted for Acoustic Modelling

The following operational activities associated with the proposed development are considered for the noise assessment of the project site development.

- The noise assessment is for a worst-case 15-minute period (at any time during the operation of then facility) for residential or commercial entities, or, for a worst-case 1-hour period as relevant to hospital project trigger criteria, as per the requirements of the NPI. Therefore, the following operational activities (noise sources) are considered during a typical exposure period to assess the worst-case noise level at the nearby noise sensitive receivers. It is noted that all these sources are considered to be operating simultaneously during the exposure period.

7.2.1 Sound Power Levels of Equipment adopted for Acoustic Modelling

Mechanical plant equipment for the project building has not been fully finalised at this stage of reporting and will be further reviewed in subsequent stages of the project.

The following mechanical equipment in Table 7-1 is located on the rooftop and L1 mechanical plant enclosure as documented in the mechanical design documentation.

Table 7-1 Proposed mechanical plant equipment sound power levels

Equipment	Brand	Model Number	Sound Power Level, L_{w}, dB(A) – per unit
8 x Air Handling Unit (AHU)	Daikin	REYQ20BYM9	77
9 x Fan (Vertical Discharge Unit)	Fantech	CE252V	76

7.3 Location of Noise Sources adopted for Acoustic Modelling

Location of the mechanical plant and equipment summarised in Table 7-1 are provided in Figure 7-1 & Figure 7-2.

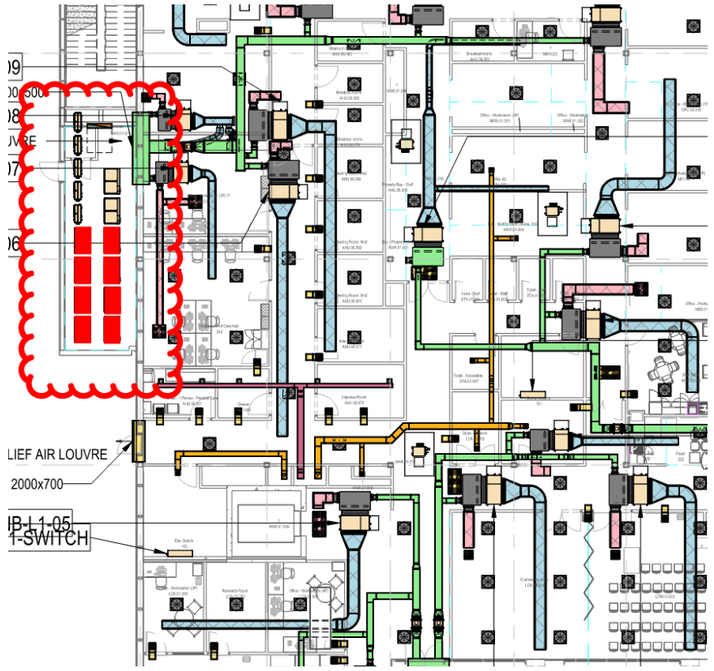


Figure 7-1 Proposed mechanical plant equipment location – L1 North-East Bldg.

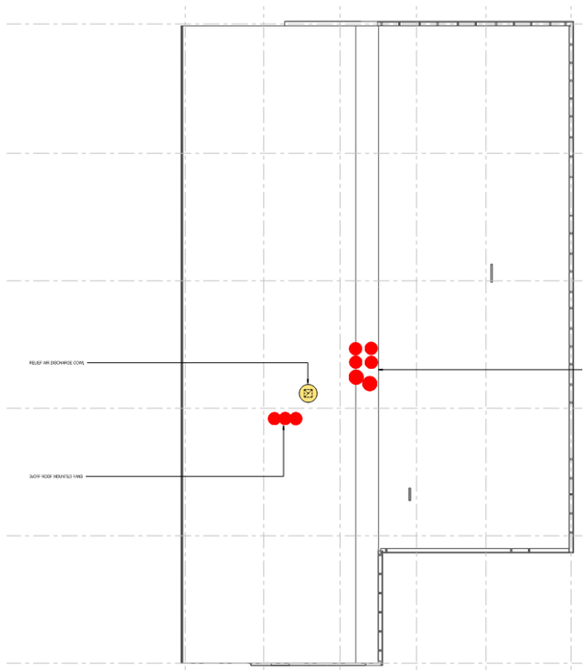


Figure 7-2 Proposed mechanical plant equipment location – Rooftop North-East Bldg.

7.4 Acoustic Modelling

An acoustic model was developed using SoundPLAN 9.1 noise modelling software to predict the mechanical equipment noise associated with the proposed development to the noise sensitive receivers. The CONCAWE noise propagation algorithm was used to perform the calculations, with the noise-enhancing meteorological conditions specified in Table D1 of the NPI. This is further discussed in the following section.

7.4.1 Meteorological Conditions

Certain meteorological/weather conditions may increase noise levels by focusing sound-wave propagation paths at a single point. Such refraction of sound waves will occur during temperature inversions (atmospheric conditions where temperatures increase with height above ground level), and where there is a wind gradient (that is, wind velocities increasing with height) with wind direction from the source to the receiver. Meteorological conditions need to be considered for both the impact assessment phase (pre-operation) and compliance assessment phase (post-operation) for an industrial activity.

The NPI specifies the following two options to consider meteorological effects:

Option 1:

"Adopt the noise-enhancing meteorological conditions for all assessment periods for noise impact assessment purposes without an assessment of how often these conditions occur – a conservative approach that considers source-to-receiver wind vectors for all receivers and F class temperature inversions with wind speeds up to 2 m/s at night", OR

Option 2:

"Determine the significance of noise-enhancing conditions. This involves assessing the significance of temperature inversions (F and G class stability categories) for the night-time period and the significance of light winds up to and including 3 m/s for all assessment periods during stability categories other than E, F or G. Significance is based on a threshold of occurrence of 30% determined in accordance with the provisions in this policy. Where noise-enhancing meteorological conditions occur for less than 30% of the time, standard meteorological conditions may be adopted for the assessment".

Acoustic modelling in this assessment adopted 'Option 1' of the NPI recommended meteorological conditions, which is provided in Table 7-2.

Table 7-2 Noise enhancing meteorological conditions

Meteorological Conditions	Meteorological Parameters
Noise-enhancing meteorological conditions	▪ Daytime/evening: stability categories A-D with light winds (up to 3m/s at 10m above ground level). ▪ Night-time: stability categories A-D with light winds (up to 3m/s at 10m above ground level) and/or stability category F with winds up to 2m/s at 10m above ground level.

7.4.2 Modelling Parameters

The below Table 7-3 outlines the modelling adopted for the operational noise assessment propagation model.

Table 7-3 Modelling parameters SoundPLAN 9.1 – North-East Bldg. Albury Hospital

Modelling Parameters	Modelling Details/Specifications
Ground Absorption	▪ 0.5
Elevation Data	▪ Elevation data imported into model
Meteorological Conditions	▪ Daytime/evening: stability categories A-D with light winds (up to 3m/s at 10m above ground level). ▪ Night-time: stability categories A-D with light winds (up to 3m/s at 10m above ground level) and/or stability category F with winds up to 2m/s at 10m above ground level.
Noise Sensitive Receivers	▪ As described in Section 6.1.1
Sound Power Level (L_w of the Noise Sources)	▪ As per Section 7.2.1
Operating Hours	▪ 24hrs – all applicable NPI noise levels
Height of Receiver	▪ 1.5m above ground level and storeys
Duration of Assessment	▪ 15 min

A snapshot of the 3D acoustic model is shown below in Figure 7-3.

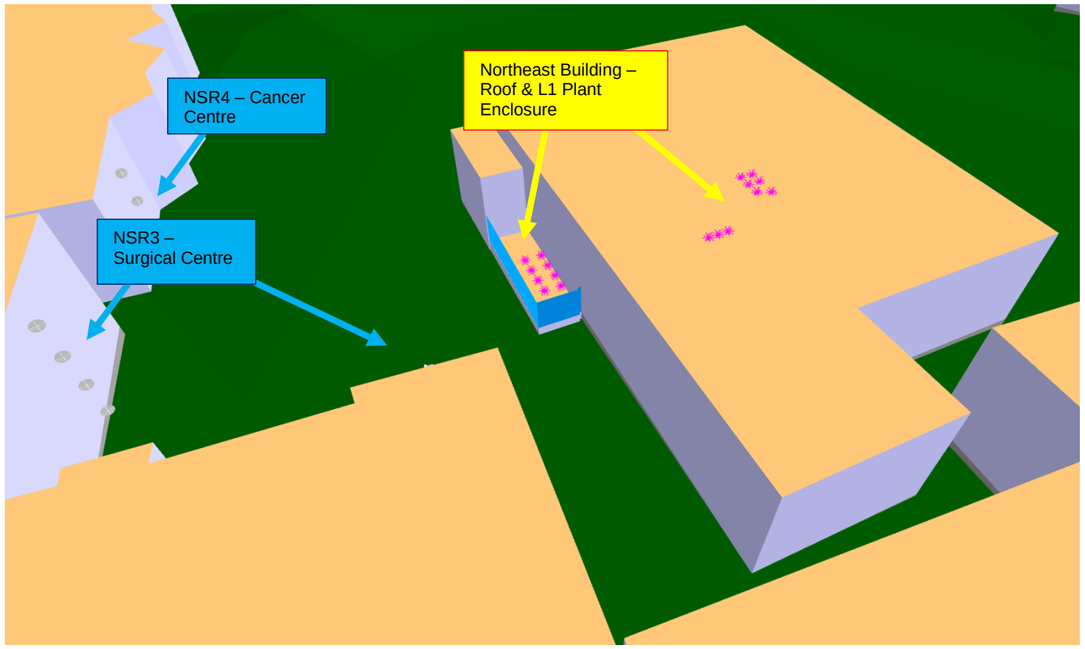


Figure 7-3 3D model used in SoundPLAN operational noise assessment – North-East Building & NSRs

7.4.3 Predicted Operational Noise Levels – NPI Project Noise Trigger Level Assessment

The operational activities associated with the proposed development, locations of noise sources, relevant sound power levels and key modelling parameters for the acoustic assessment are provided in Section 7.1 to Section 7.4.2. Based on this information provided, an acoustic modelling and assessment has been performed in SoundPLAN 9.1 to predict the cumulative noise levels at nearby noise sensitive receivers around the proposed development. It is noted that the acoustic modelling has considered simultaneous operation of all the operational activities to its maximum capacity, therefore considered a worst-case scenario. The acoustic modelling has incorporated the recommendations provided in Section 9

The predicted noise levels at nearby noise sensitive receivers are shown in Table 7-4. It is noted from Table 7-4 that predicted noise levels are within the project noise trigger levels at all receivers during day evening and night period. Providing that the recommendations detailed in Section 9.1 are implemented for this project, it is predicted that the proposed development will achieve the noise requirements of the NSW EPA Noise Policy for Industry.

Figure 6-1 highlights the locations of sensitive receiver points placed at nominated street frontages or business addresses surrounding the project site. Detailed receiver group names are detailed in Table 6-1.

Table 7-4 Predicted operational noise levels – North-East Building and NSRs

Noise Sensitive Receiver	Receiver Type	Floor	Predicted Noise Levels anytime during Day, Evening or Night, $L_{Aeq,15min}$ dB(A)	Project Noise Trigger Level, $L_{Aeq,15min}$ dB(A)	Criteria Satisfied?
NSR1 - Hospital Building (Residential Component)	Hospital	GF	28	48 – When in use	Yes
		L1	30		
		L2	31		
NSR2 - Hospital Building (Mental Health Department)	Hospital	GF	21	48 – When in use	Yes
		L1	24		
		L2	29		
		L3	33		
NSR3 - Hospital Building (Surgical Ward), Eastern Façade	Hospital	GF	43	48 – When in use	Yes*
		L1	46		
		L2	49*		
		L3	52*		
NSR3 #2 - Hospital Building (Surgical Ward), Northern Façade	Hospital	GF	39	48 – When in use	Yes
		L1	41		
		L2	44		
		L3	45		
NSR4 - Hospital Building (Cancer Centre)	Hospital	GF	37	48 – When in use	Yes
		L1	39		
		L2	41		
		L3	44		
NSR5 - Hospital Building (Operating Theatres)	Hospital	GF	32	48 – When in use	Yes
		L1	35		
		L2	42		
NSR6 - Residential Building along Keene Street (243 Peechelba St)	Residential	GF	<20	44 – Day 43 – Evening 38 – Night	Yes
		L1	<20		
NSR7 - Residential Building along East Street (172 Bilba St)	Residential	GF	31	44 – Day 43 – Evening 38 – Night	Yes

Noise Sensitive Receiver	Receiver Type	Floor	Predicted Noise Levels anytime during Day, Evening or Night, $L_{Aeq,15min}$ dB(A)	Project Noise Trigger Level, $L_{Aeq,15min}$ dB(A)	Criteria Satisfied?
NSR8 - Residential Building along East Street (592 East St)	Residential	GF	29	44 – Day 43 – Evening 38 – Night	Yes
NSR9 - Commercial Building along Borella Rd (Ramsey Pharmacy)	Commercial	GF	22	63 – When in use	Yes

*exceedance at L2 and L3 of receiver not likely to be impactful to inhabitants of the noise sensitive receiver for the following:

- Transmission loss after glazing/envelope will achieve indoor noise criteria
- Windows not likely to be operable due to sterilisation requirements of surgery ward

7.4.4 Predicted Operational Noise Levels – Sleep Disturbance Assessment

$L_{Aeq,15min}$ operational noise levels were predicted based on assumed operational activities outlined in the below table. It is not expected that the North-East Building will operate after NPI evening time of 10pm, though early morning operational activity may impact hospital and residential receivers before 7am. Dominant source of environmental noise during operational periods is likely to be continuous-type mechanical hum from external air-handling units and rooftop mounted fan exhaust vents.

Table 7-5 Summary of sleep-disturbance noise and impacts

Source	Receiver	Period	$L_{Aeq,15min}$ Noise Level (dBA)		Compliance
			Project Trigger	Predicted	
North-East Building	NSR6 - 243 Peechelba St	Night	43	<20	Yes
	NSR7 - 172 Bilba St		43	31	Yes
	NSR8 - 592 East St		43	29	Yes

Based on the above predicted noise levels, it is predicted that the operation of the proposed development is unlikely to cause any sleep disturbance at nearby noise sensitive receivers

7.4.5 Traffic Growth Assessment

The application notes for the Road Noise Policy state that “for existing residences and other sensitive land uses affected by additional traffic on existing roads generated by land use developments, any increase in the total traffic noise level as a result, the development should be limited to 2 dB above that of the noise level without the development. This limit applies wherever the noise level without the development is within 2 dB of, or exceeds, the relevant day or night noise assessment criterion.” This is also considered to be applicable for construction noise therefore if road traffic noise increases from construction is within 2 dB(A) of current levels then the objectives on the Road Noise Policy are achieved.

A significant increase in traffic volumes would be needed to increase road traffic noise by 2 dB(A) (a doubling in traffic corresponds to an approximate 3 dB(A) increase). Construction work would generate light and heavy vehicle movements associated with employees, deliveries, transportation of machinery, materials and equipment to work sites.

Preliminary traffic growth assessment on construction and project development traffic has not been provided by the client by time of reporting and will be assessed in successive stages of the project as data becomes available.

7.5 Operational Vibration Assessment

Refer to Section 9.1.1 for vibration isolation of mechanical plant and equipment

8 Construction Noise and Vibration Assessment

8.1 Construction Noise Assessment

It is understood that the project is currently at the concept/feasibility design stage and there is no contractor engaged, or any detailed construction plan developed. Therefore, assessment of construction noise and vibration would be based on typical construction method and equipment used for similar projects and information as provided by client and would predict the worst-case noise condition which may not occur to this project site. However, this assessment should be further reviewed when construction methodology is planned and detail information on the equipment type and locations are known.

The noise emissions from construction have been assessed at the surrounding potentially affected receivers during the standard construction hours. As shown in Figure 6-2, the noise sensitive receivers in the vicinity of the proposed development are mixed used development including residential and hospital buildings. A quantitative assessment has been undertaken with consideration to the Interim Construction Noise Guideline (ICNG).

The Interim Construction Noise Guideline (ICNG) (DECC, 2009) guideline recommends standard hours for construction activities as:

- Monday to Friday: 7am to 6pm,
- Saturday: 8am to 1pm, and
- no work on Sundays or public holidays.

These hours are not mandatory and the ICNG acknowledges that the following activities have justification to be undertaken outside the recommended standard construction hours assuming that all reasonable and feasible mitigation measures are implemented to minimise the impacts to the surrounding sensitive land uses:

- the delivery of oversized plant or structures that police or other authorities determine to require special arrangements to transport along public roads.
- emergency work to avoid the loss of life or damage to property, or to prevent environmental harm.

- works where a proponent demonstrates and justifies a need to operate outside the recommended standard construction hours.
- works which maintain noise levels at sensitive receivers to below the noise management levels outside of the recommended standard construction hours.

Construction activities would generally be carried out during the recommended standard construction working hours. Early morning oversized deliveries may be required on occasion for some of the construction works and may occur outside the recommended construction hours. No work would be intended on Sundays or public holidays.

Construction traffic movements would primarily be associated with the transportation of construction machinery and equipment to the proposal site and the transportation of material. Plant and equipment needed for the proposal would be determined during the construction planning phase. Other equipment may be used however it is anticipated that they would produce similar noise emissions.

The magnitude of off-site noise impact associated with construction will be dependent upon a number of factors:

- The intensity and location of construction activities.
- The type of equipment used.
- Existing background noise levels.
- Intervening terrain and structures.
- The prevailing weather conditions.

Construction machinery would likely move about the study area altering noise impacts with respect to individual receivers. During any given period, the machinery items to be used in the study area would operate at maximum sound power levels for only brief stages. At other times, the machinery may produce lower sound levels while carrying out activities not requiring full power. It is unlikely that all construction equipment would be operating at their maximum sound power levels at any one time and certain types of construction machinery would be present in the study area for only brief periods during construction. Therefore, noise predictions are considered conservative.

As noted earlier, the project is currently at the concept/feasibility design stage and there is no contractor engaged, or any construction plan developed. Therefore, construction equipment required for this project is not known at this stage. Based on the scope of construction works provided by the client, Table 8-1 below provides typical construction equipment associated with different stages of construction, some of which may be relevant to this project. The table also includes the equipment Sound Power Levels (SWL) and sound pressure level at 7m distance based on the data provided in NSW RMS Construction Noise and Vibration Guideline and Australian Standard AS2436-2010: Guide to noise and vibration control on construction, demolition and maintenance sites.

Table 8-1: Sound power levels of construction equipment

Activity	Description of Activity	Plant/Equipment	L_{Aeq} SWL	L_{Aeq} at 7m
Situation 1: Removal of hardstand of existing lower staff at-grade carpark	Demolition and Removal of hardstand	Excavator (tracked) 35t	110	85
		Dump truck	110	85
		Jackhammer	113	88
		Compactor	106	81
Situation 2: Making good of existing landscaping and pavement	Make good the interface and include pedestrian movement works and line marking. Minor landscaping and paving works to building edge and interface to assist with accessibility and wayfinding.	Grader	113	88
		Dump truck	110	85
		Compactor	106	81
		Roller (large pad foot)	109	84
		Pavement laying machine	114	89
Situation 3: Construction of a new two storey building		Pneumatic hammer	113	88
		Concrete Vibrator	113	88
		Concrete Truck	109	84
		Concrete Pump	109	84
		Front end loader	112	87
		Hand Tools (Electric)	102	77
		Excavator (tracked) 35t	110	85
		Angle Grinder	110	85
		Forklift	106	81
		Welding equipment	105	80
		Power generator	103	78
		Light vehicles (e.g. 4WD)	103	78
		Truck (medium rigid)	103	78
Situation 4: Relocation of existing fire hydrant and some inground services diversions	Relocation of services and demountable	Excavator (tracked) 35t	110	85
		Dump truck	110	85
		Franna crane 20t	98	73
		Pneumatic hammer	113	88

Activity	Description of Activity	Plant/Equipment	L_{Aeq} SWL	L_{Aeq} at 7m
Relocation of two existing demountable		Power generator	103	78
		Angle Grinder	110	85
		Welding equipment	105	80

Based on the construction equipment and the relevant sound power levels provided in Table 8-1, a high-level noise model was developed in SoundPLAN 9.1 to predict the construction noise at nearby noise sensitive receivers. The CONCAWE noise propagation algorithm was used to perform the calculations, with the noise-enhancing meteorological conditions specified in Table D1 of the NPI. The predicted noise levels for different construction stages (assumed) at nearby noise sensitive receivers are provided in Table 8-2.

Note the following in relation to this assessment:

- **The predicted noise level in Table 8-2 has considered a noise barrier of 4m high along the perimeter boundary of the project site. See Section 9.1 for full details.**
- Noise Management levels for residential building during standard construction period are as follows:
  - Noise Affected: 49 dB(A), $L_{Aeq,15min}$
  - Highly Noise Affected: 75 dB(A), $L_{Aeq,15min}$
- Noise Management levels for commercial building during standard construction period is 70 dB(A), $L_{Aeq,15min}$.
- Locations of the noise sources/construction equipment are adopted randomly, since they would be changing locations time to time depending on the construction.
- Construction equipment that are considered relevant for this project are adopted for this construction noise assessment. However, this is an assumption only and the exact equipment and type would be determined by the construction contractor.
- Predicted maximum noise levels indicated in "**Bold**" indicates that it exceeded the recommended "Highly Noise Affected" Noise Management Level and noise mitigation measures would be required.
- The plant and equipment used in the acoustic calculations are based on assumptions only and this should be finalised when a contractor is engaged for construction and relevant construction equipment are known. Therefore, the predicted results are an estimate only and is not a true scenario for the project.
- Acoustic calculation assumes that all the plant and equipment are operating at the same time, resulting in worst-case noise. This may not be the case in the reality as all construction equipment are likely not be operated at the same time.

Table 8-2: Predicted Construction Noise (with inclusion of a 4m high noise barrier)

Activity	Plant/Equipment	Predicted Maximum Noise Levels at Receivers, LAeq,15min							
		Hospital Building					Residential Dwelling (Outside Hospital)		
		NSR 1	NSR 2	NSR 3	NSR 4	NSR 5	NSR 6	NSR 7	NSR 8
Acoustic Criteria		External 65 dB(A) Noisiest 1 Hour*					Noise Affected Level: 49 dB(A) Highly Noise Affected Level: 75 dB(A) Standard Construction Hours		
Situation 1: Removal of hardstand of existing lower staff at-grade carpark	Excavator (tracked) 35t Dump truck Jackhammer Compactor	47	45	**78**	**72**	**77**	37	59	56
Situation 2: Making good of existing landscaping and pavement	Grader Dump truck Compactor Roller (large pad foot) Pavement laying machine	47	46	**81**	**73**	**80**	38	61	58
Situation 3: Construction of a new two storey building	Pneumatic hammer Fixed crane Front end loader Hand Tools (Electric) Excavator (tracked) 35t Angle Grinder Forklift Welding equipment Power generator Light vehicles (e.g. 4WD) Truck (medium rigid)	50	50	**83**	**77**	**81**	43	63	60

Activity	Plant/Equipment	Predicted Maximum Noise Levels at Receivers, LAeq,15min							
Situation 4: Relocation of existing fire hydrant and some inground services diversions	Excavator (tracked) 35t	47	48	**81**	**75**	**77**	39	58	56
	Dump truck								
	Franna crane 20t								
	Pneumatic hammer								
Relocation of two existing demountable	Power generator								
	Excavator (tracked) 35t								
	Dump truck								
	Angle Grinder								
	Welding equipment								

*External noise level can be adopted as 65 dB(A) considering a 20 dB sound transmission loss provided by the closed façade (Internal level 45 dB(A).

Note:

- NSR1: Hospital Building (Residential Component) – located to the West of project site.
- NSR2: Hospital Building (Mental Health Department) – located to the North of project site.
- NSR3: Hospital Building (Surgical Ward) - located to the Northeast of project site.
- NSR4: Hospital Building (Cancer Centre) – located to the North of project site.
- NSR 5: Hospital Building (Operating Theatres) - located to the East of project site.
- NSR 6: Residential Building along Keene Street (243 Peechelba St) – located to the West of project site
- NSR 7: Residential Building along East Street (172 Bilba St) - located to the East of project site.
- NSRT 8: Residential Building along East Street (592 East St) located to the East of project site.
- Based on the predicted constructions noise levels provided in Table 8-2, it is observed that the predicted construction noise levels would mostly exceed the ICNG recommended construction criteria at the Hospital receivers NSR3, NSR 4 and NSR 5. The exceedance ranges between 7 to 18 dB(A) even with the implementation of a 4m high noise barrier. Therefore, it is advised that noise management plan as provided in Section 9 should be considered and implemented during the period of construction at all hours to minimise the noise impact.
- Based on the predicted constructions noise levels provided in Table 8-2, it is observed that the predicted construction noise levels would exceed the ICNG recommended Noise Management Level (Noise Affected) at the residential receivers NSR 7 and NSR 8, although they would be within the ICNG recommended Highly Noise Affected Level of 75 dB(A). Therefore, it is expected that there would be minimal noise disturbance during the period of construction during standard hours, although it is advised that noise management plan as provided in Section 9 should be considered and implemented during the period of construction at all hours to minimise the noise impact at the residents.

Grid noise maps illustrating the noise contours at different stages of construction (at 1.5m height above ground level) are provided in Figure 8-1 to Figure 8-4. However, this should be noted that currently there is no constructions details available for this project, hence the predicted levels provide an estimation only of the worst-case scenarios for planning purpose. In reality, the construction noise is likely be lower as the number of equipment used on site at a time would differ (maybe a smaller number of noisy equipment and not operating all at the same time) from this worst-cast approximation scenario.

Where the predicted L_{Aeq} (15 minutes) noise level is greater than the noise affected level, all feasible and reasonable work practices should be applied. The magnitudes of construction noise levels are dependent on the duration of construction, the type of equipment, location of activities, the surrounding environment's background noise levels and the weather conditions during construction. The predicted noise levels are generally conservative as the construction noise model predicts the worse-case 15-minute scenario and these levels may not represent the actual noise emission experienced by the community throughout the entire construction period.

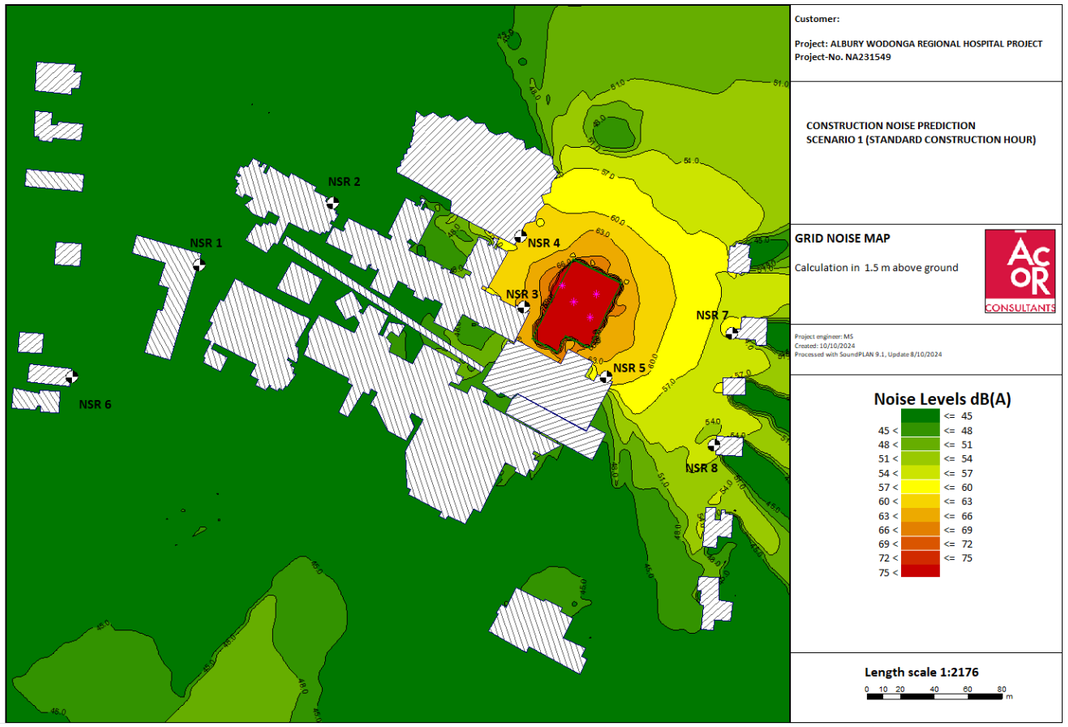


Figure 8-1 Grid noise map showing predicted construction noise – Scenario 1 (Removal of hardstand of existing lower staff at-grade carpark)

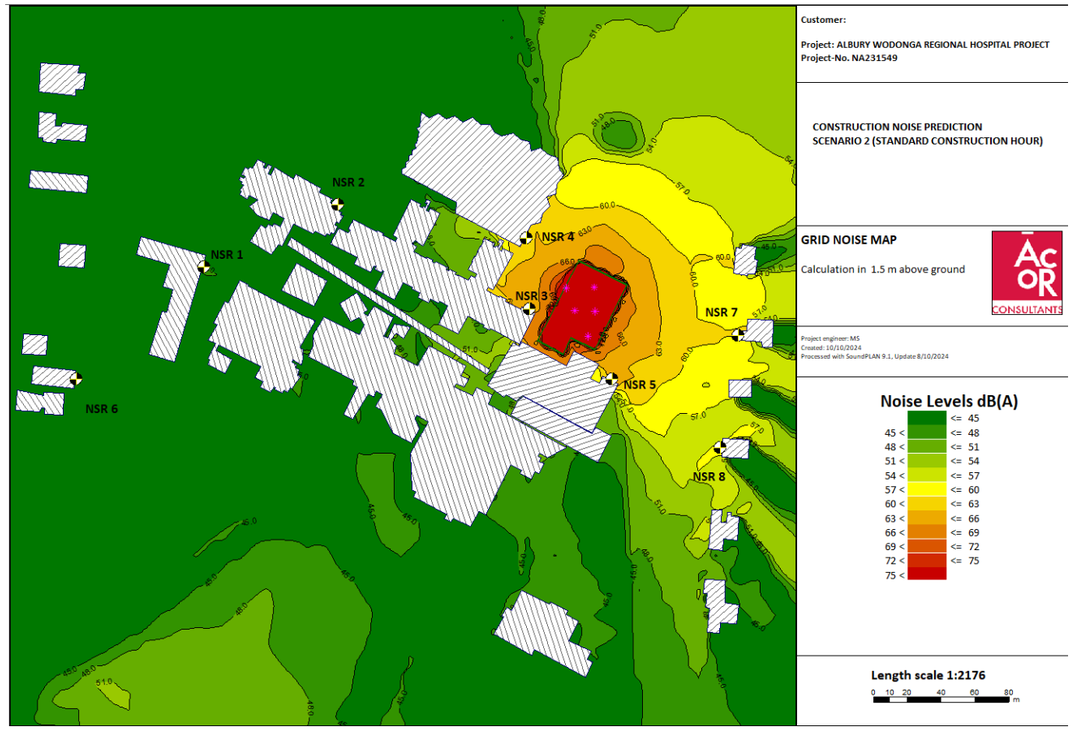


Figure 8-2 Grid noise map showing predicted construction noise — Scenario 2 (Making good of existing landscaping and pavement)

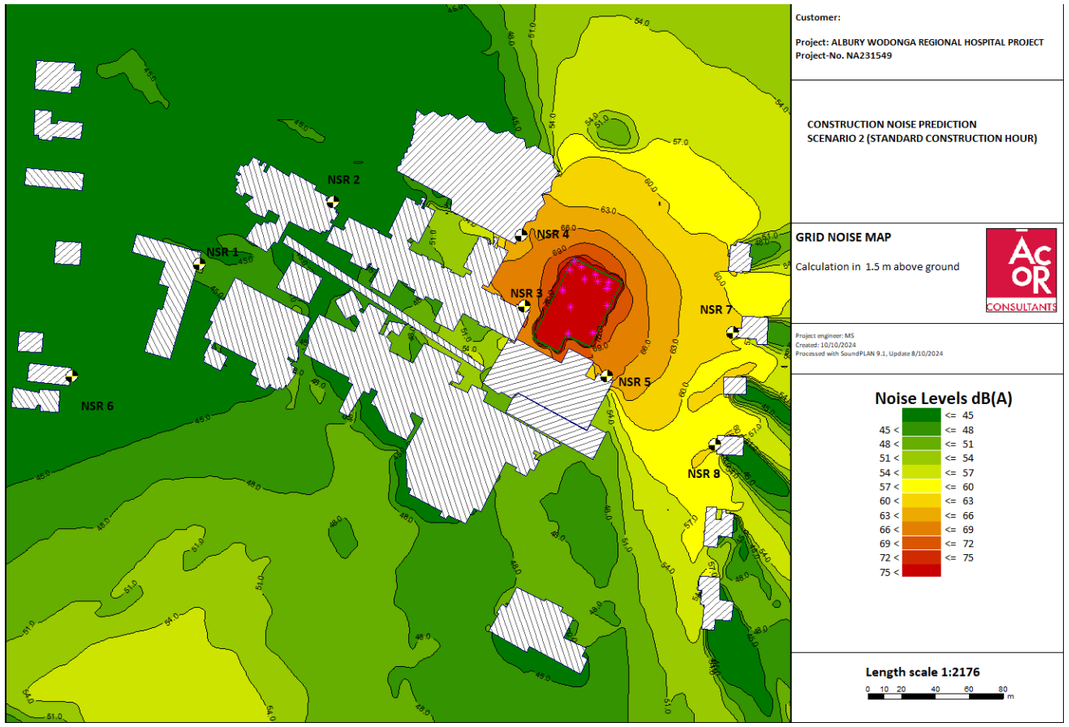


Figure 8-3 Grid noise map showing predicted construction noise — Scenario 3 (Construction of a new two storey building)

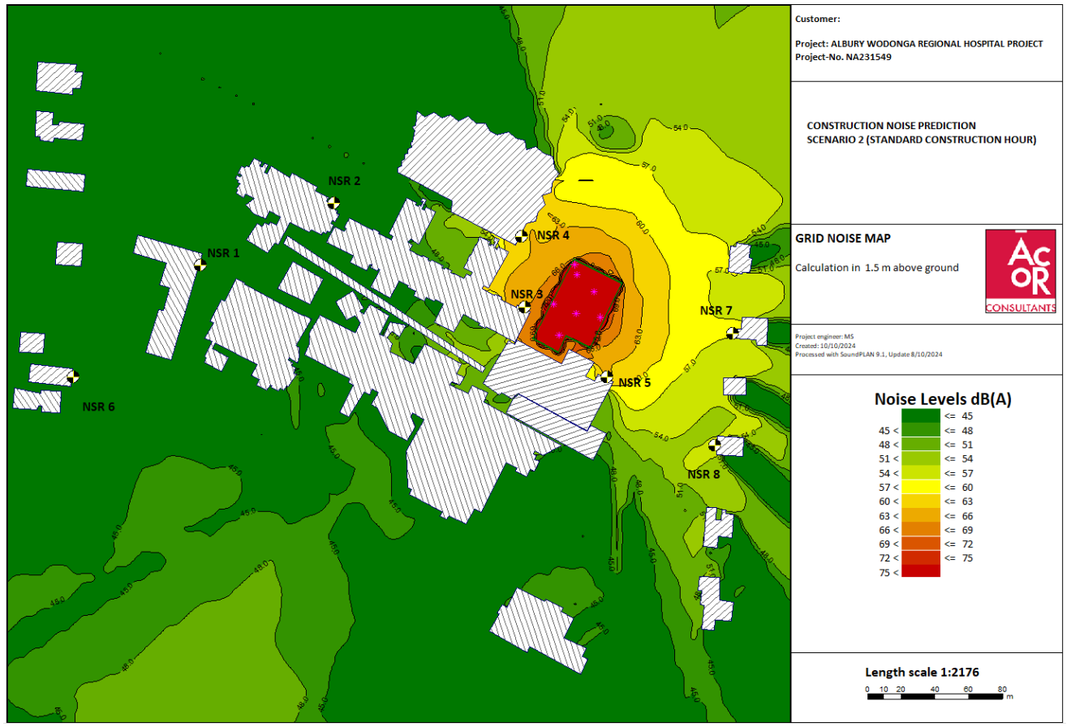


Figure 8-4 Grid noise map showing predicted construction noise – Scenario 4 (Relocation of existing fire hydrant and some inground services diversions, Relocation of two existing demountable)

8.2 Sleep Disturbance

All construction activity is expected to occur during recommended standard hours therefore sleep disturbance impacts are not expected.

8.3 Construction traffic impacts

The application notes1 for the Road Noise Policy state that “for existing residences and other sensitive land uses affected by additional traffic on existing roads generated by land use developments, any increase in the total traffic noise level as a result of the development should be limited to 2 dB above that of the noise level without the development. This limit applies wherever the noise level without the development is within 2 dB of, or exceeds, the relevant day or night noise assessment criterion.” This is also considered to be applicable for construction noise therefore if road traffic noise increases from construction is within 2 dB(A) of current levels then the objectives on the Road Noise Policy are achieved.

A significant increase in traffic volumes would be needed in order to increase road traffic noise by 2 dB(A) (a doubling in traffic corresponds to an approximate 3 dB(A) increase). Construction work would generate light and heavy vehicle movements associated with employees, deliveries, transportation of machinery, materials and equipment to work sites.

The increase in vehicle movements would be limited to the period of construction. Noise level increases due to construction traffic would not be significant when compared with the existing vehicle numbers in the study area.

8.4 Construction Vibration Assessment

The following construction equipment are likely to be used in the proposed development for construction and are considered to be a source of vibration:

- Jack hammer
- Excavator 12t/34t (rock breaker)
- Compactor

The minimum distances, as provided by Transport for NSW Construction Noise and Vibration Guideline (2023) are quoted for both “cosmetic” damage (refer BS 7385-2:1993) and human comfort (refer OH&E’s Assessing Vibration - a technical guideline). The minimum working distances for cosmetic damage must be complied with at all times, unless otherwise approved by the Roads and Maritime Services NSW as relevant. DIN 4150 has criteria of particular reference for heritage structures. The recommended buffer distance as provided in in Table 8-3 should be maintained during construction to avoid cosmetic damage to structure or uncomfortable level of vibration for human.

Table 8-3 Recommended buffer distance for control of construction vibration

Plant Item	Rating/ /Description	Minimum working distance	
		Cosmetic damage (BS 7385)	Human response (OH&E Vibration guideline)
Small Hydraulic Hammer	(300 kg - 5 to 12t excavator)	2m	7m
Medium Hydraulic Hammer	(900 kg – 12 to 18t excavator)	7m	23m
Large Hydraulic Hammer	(1600 kg – 18 to 34t excavator)	22m	73m
Jack hammer	Handheld	1m (nominal)	2m, avoid contact with Structure

- The minimum working distances are indicative and will vary depending on the particular item of plant and local geotechnical conditions. They apply to cosmetic damage of typical buildings under typical geotechnical conditions. Vibration monitoring is recommended to confirm the minimum working distances at specific sites.
- Operational aspects of some receivers may be highly sensitive to noise and vibration over, and above typical noise and vibration allowances based on annoyance and human comfort. For highly sensitive receivers (i.e., hospitals critical areas, precision laboratories high technology facilities with sensitive equipment, recording studios and cinemas), specific assessment is required to ensure satisfactory operation of the facility and determine if any mitigation or management measures are required to minimise the potential impacts.
- In relation to human comfort (response), the minimum working distances in Table 8-3 relate to continuous vibration. For most construction activities, vibration emissions are intermittent in nature and for this reason, higher vibration levels, occurring over shorter periods are allowed (see OEH’s Assessing Vibration: a technical guideline). Where the predicted vibration levels exceed the human comfort objectives, procedures are to be followed in order to mitigate the potential impacts at sensitive receivers.
- The recommended values for cosmetic damage relate predominantly to transient vibration which does not give rise to resonant responses in structures, and to low-rise buildings. Where the dynamic loading caused by continuous vibration is such as to give rise to dynamic magnification due to resonance, especially at the lower frequencies where lower guide values apply, then the recommended values in Table 6-16 may need to be reduced by up to 50 %.

Due to the proximity of the proposed construction site to the Operating Theatre Building, Surgical Wards and Cancer Centre, it is important that the vibration levels at these areas should be monitored during construction, especially during the use of Jack Hammer and Excavator. Minimum buffer working distance should be maintained as provided in Table 8-3 . Vibration measurement should be performed at these areas to ensure the compliance with vibration criteria in relation to Human Comfort, Cosmetic Damage, Structural Damage and Sensitive Equipment.

9 Recommendations - Noise & Vibration Control and Management Plan

9.1 Design Recommendations for Mechanical Plant and Equipment

Based on the acoustic assessment, it is predicted that the proposed development will achieve the NSW EPA NPI noise objectives using the minimum construction specifications presented below.

- The sound power levels of the proposed mechanical equipment should not be any higher than what is specified in Table 7-1.
- It is understood that an acoustic louvre barrier is proposed for the perimeter of the L1 mechanical plant enclosure. Figure 9-1 shows the span of the proposed acoustic barrier.
- The below Table 9-1 outlines minimum transmission loss performance ratings required for the proposed acoustic louvre barrier, outlined in the above Figure 9-1. Further details are provided in Appendix C

Table 9-1 Acoustic louvre minimum performance standard

Acoustic Control Element	Octave – Band Centre Frequencies (Hz) Transmission Loss, dB								Rw
	63	125	250	500	1000	2000	4000	8000	
ACRAN 200 (200mm deep)	3	8	7	11	21	24	16	16	17
IAC SL-300	6	7	10	12	18	18	14	13	17

The following acoustic louvre barrier specifications are to be implemented to ensure compliance with operational noise objectives.

- The acoustic louvre wall is to span the entire exposed perimeter of the mechanical plant enclosure, outlined in Figure 9-1.
- The acoustic louvre wall is to be constructed to a minimum height of 3.1m from the floor level of the enclosure slab.
- Any door assemblies proposed for the acoustic louvre barrier are to have a minimum construction performance equivalent to that specified in the above Table 9-1.

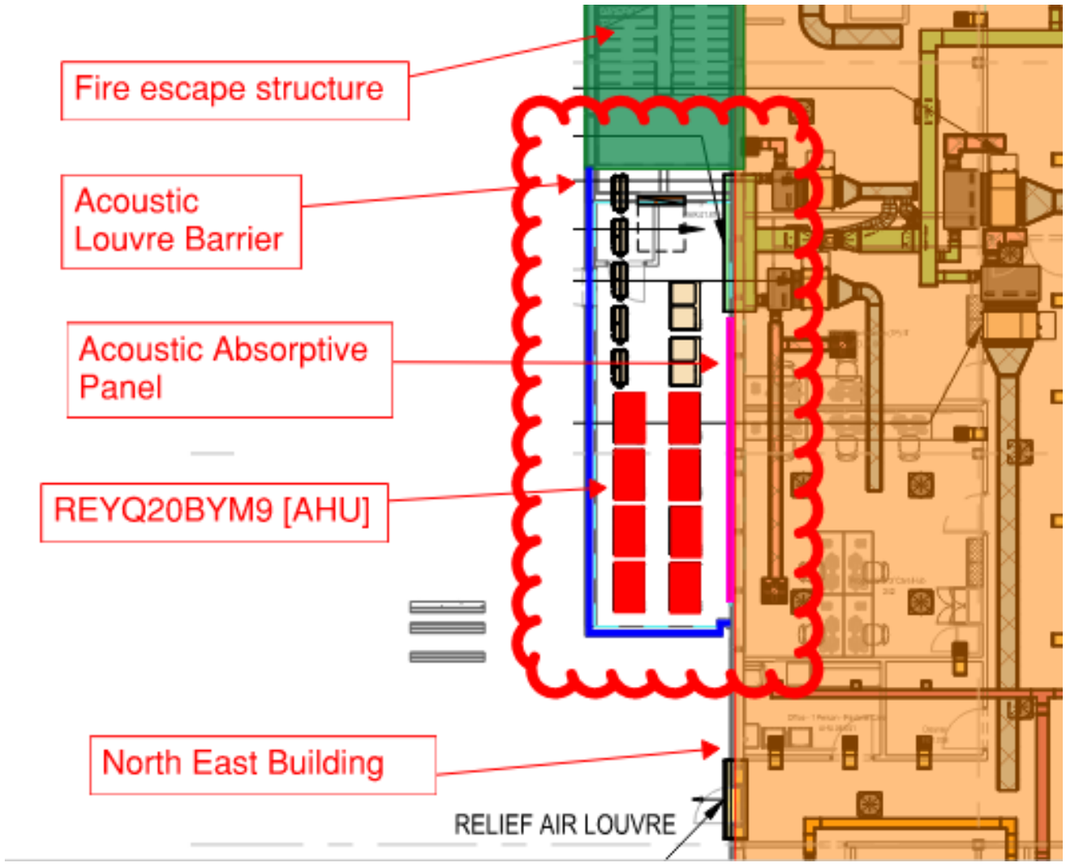


Figure 9-1 Proposed acoustic barrier location and mechanical plant equipment/enclosure

- It is also recommended that weather-proof acoustic absorptive panels be installed onto the internal lining of the enclosure and along the North-East Building envelope as shown in Figure 9-2 below. The below Figure 9-2 and Table 9-2 outline the proposed location and examples of acceptable acoustic panels designed to provide reverberation control.

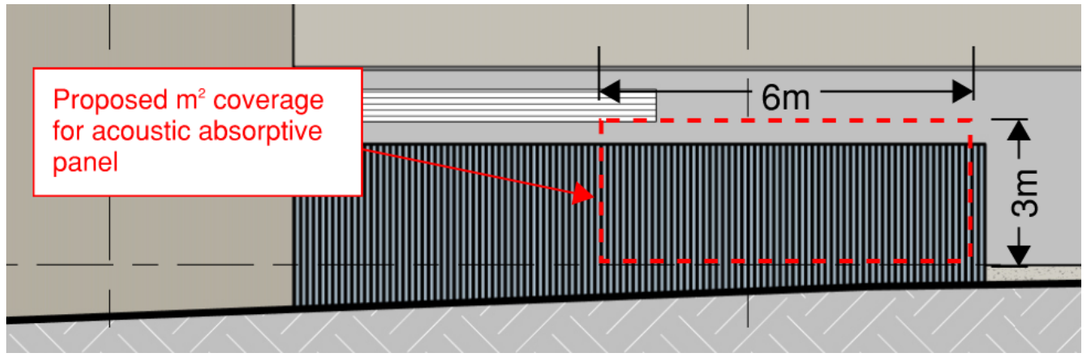


Figure 9-2 Proposed m² coverage of wall-mounted acoustic absorptive panels for mechanical plant enclosure

Table 9-2 Examples of acceptable weather-proof absorptive acoustic panels used for reverberation control

Absorptive Panel Brand	Brand Model	NRC	Thickness	Description	Dimensions
Pyrotek	Reapor,	NRC 0.90	50mm	Sintered glass	625mm x 625mm 1250mm x 625mm
Sealed Air	Whisper	NRC 0.9	50mm	Closed cell foam	1200mm x 2400mm

9.1.1 Mechanical Plant Vibration Isolation

The below points provide advice on controlling potential vibratory transmission impacts caused by operation of air-handling units installed in the L1 mechanical plant enclosure.

Air Handling Unit (AHU)

- The AHUs should be installed on a 100mm thick reinforced concrete plinth.
- Floor supports or wall supports for piping should use elastomeric pads (Sylomer or Natural Rubber) between the pipe and building structure.
- AHU should be installed away from the adjacent North-East Building envelope shared by ‘Pastoral Care’, ‘Progression of Care Hub’ and ‘Office/IT Workstation’ rooms, and the L1 mechanical plant enclosure.
- To reduce potential structure borne noise generated by the AHU it is imperative that vibration at the operational frequency be reduced. Steel spring isolators with static deflection of min. 25mm are required (e.g. Embelton XL Spring Mount). Flexible pipe connections between the AHU and all ductworks must be installed to prevent vibration transmission via connected services.

Fans

- Fans should be mounted/supported on rubber isolation hangers with minimum 12/20mm static deflection to avoid structure borne noise and excessive vibration experienced inside the building. The ductworks (SA and RA) should be connected to the associated unit via flexible connections.

9.2 Construction Noise Mitigation Measures

For control of construction noise and associated noise annoyance during the period of construction of the proposed development, following preliminary recommendations should be considered.

9.2.1 Acoustic Fence / Noise Barrier

As referred to in Section 8.1 the modelled results presented subsequently in Table 8-2 has considered the erection of a noise barrier for the control of construction operational noise predicted to exceed acoustic design criteria. For the purposes of assessment, it has been considered that a 4m high temporary noise barrier / hoarding is implemented on site, along the perimeter and to all sides, as shown in Figure 9-3. There should be no gap between the bottom of the noise barrier and the ground level.

It should be further reiterated that, as the project has not progressed to construction phase there is no schedule or construction details that can be provided to accurately review, and as such, presented acoustic control recommendations are solely prescriptive and should be reassessed during the construction phase, or when details become available to review.

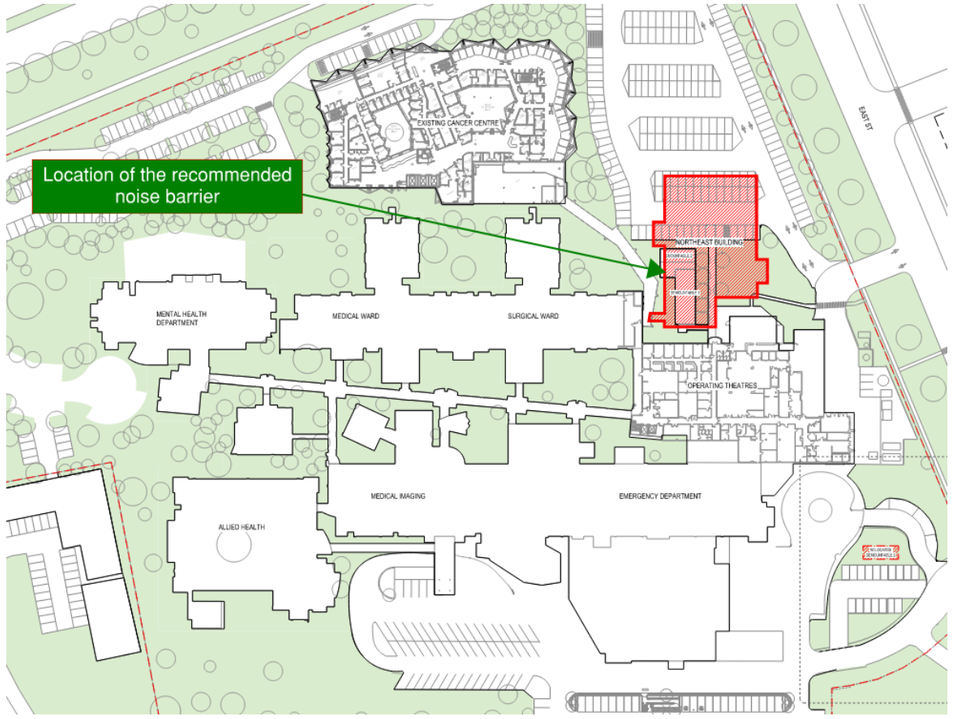


Figure 9-3 Location of recommended temporary noise barrier for control of construction noise

The temporary noise barrier could be construction with any of the following:

- Plywood (minimum 25mm thick)
- Fibre Cement Sheet (minimum 12mm thick)
- Flexible Noise Barrier/ Acoustic Curtains – Example: Hushtec Temporary Noise Barrier, Flexshield Acoustic Curtains, Echo Barrier (H10)
- Modular Acoustic Wall Panels, such as Dune Wall (Wallmark)
- Any other suitable material with a surface mass of approx. 15 kg/m^2

In addition to the above recommended noise barrier, the other recommended noise mitigation measures as presented in the following sections should be considered.

9.2.2 Standard Mitigation Measures

The following standard actions and mitigation measures should be implemented, where applicable.

Table 9-3 Standard Mitigation Measures (Source NSW RMS Construction Noise and Vibration Guideline)

Action Required	Applies to	Details
Management Control		
Implement community consultation or notification measures	Airborne noise. Ground-borne noise & vibration.	Notification detailing work activities, dates and hours, impacts and mitigation measures, indication of work schedule over the night-time period, any operational noise benefits from the works (where applicable) and contact telephone number Notification should be a minimum of 7 calendar days prior to the start of works. For projects other than maintenance works more advanced consultation or notification may be required Website (If required) Contact telephone number for community Email distribution list (if required) Community drop-in session (if required by approval conditions)
Site inductions	Airborne noise. Ground-borne noise & vibration.	All employees, contractors and subcontractors are to receive an environmental induction. The induction must at least include: all project specific and relevant standard noise and vibration mitigation measures relevant licence and approval conditions permissible hours of work any limitations on high noise generating activities. location of nearest sensitive receivers construction employee parking areas designated loading/unloading areas and procedures site opening/closing times (including deliveries) environmental incident procedures
Behavioural practices	Airborne noise	No swearing or unnecessary shouting or loud stereos/radios on site No dropping of materials from height, throwing of metal items and slamming of doors

Action Required	Applies to	Details
Attended/Unattended vibration measurements	Ground-borne vibration	Where required attended/unattended vibration measurements should be undertaken at the commencement of vibration generating activities such as rock breaking, compacting activities, digging, piling or similar to confirm that vibration levels are within the acceptable range to prevent cosmetic building damage
Source Control		
Construction hours and scheduling	Airborne noise. Ground-borne noise & vibration.	Where feasible and reasonable, construction should be carried out during the standard daytime working hours. Work generating high noise and/or vibration levels should be scheduled during less sensitive time periods.
Construction respite period during normal hours and out-of-hours work	Ground-borne noise & vibration. Airborne noise.	Respite offers should be considered made where there are high noise and vibration generating activities near receivers. As a guide, work should be carried out in continuous blocks that do not exceed 3 hours each with a minimum respite period of one hour between each block. The actual duration of each block of work and respite should be flexible to accommodate the usage of and amenity at nearby receivers. The purpose of such an offer is to provide residents with respite from an ongoing impact.
Equipment selection	Airborne noise. Ground-borne noise & vibration	Use quieter and less vibration emitting construction methods where feasible and reasonable. For example, when piling is required, bored piles rather than impact-driven piles will minimise noise and vibration impacts. Similarly, diaphragm wall construction techniques, in lieu of sheet piling, will have significant noise and vibration benefits. Ensure plant including the silencer is well maintained.
Plant noise levels	Airborne-noise.	The noise levels of plant and equipment must have lower sound power level and should be assessed by the acoustic consultant to ensure that the noise emission levels are within the criteria.
Use and siting of plant	Airborne-noise.	The offset distance between noisy plant and adjacent sensitive receivers is to be maximised. Plant used intermittently to be throttled down or shut down. Noise-emitting plant to be directed away from sensitive receivers. Only have necessary equipment on site.
Plan worksites and activities to minimise noise and vibration	Airborne noise. Ground-borne vibration.	Locate compounds away from sensitive receivers and discourage access from local roads. Plan traffic flow, parking and loading/unloading areas to minimise reversing movements within the site. Where additional activities or plant may only result in a marginal noise increase and speed up works, consider limiting duration of impact by concentrating noisy activities at one location and move to another as quickly as possible. Very noise activities should be scheduled for normal working hours.
Reduced equipment power	Airborne noise. Ground-borne vibration.	Use only the necessary size and power
Non-tonal and ambient sensitive reversing alarms	Airborne noise.	Non-tonal reversing beepers (or an equivalent mechanism) must be fitted and used on all construction vehicles and mobile plant regularly used on site and for any out of hours work. Broadband audible alarms include a wide range of sound frequencies (as opposed to the tonal frequency) are less intrusive when heard in the neighbourhood. Consider the use of ambient sensitive variable-level alarms that adjust output relative to the ambient noise level. Also, may consider the use of proximity alarms that use sensors to determine the distance from objects, such as people or structures, and generate an audible alarm in cabin for the driver.
Minimise disturbance arising from delivery of goods to construction sites.	Airborne noise.	Loading and unloading of materials/deliveries is to occur as far as possible from sensitive receivers. Select site access points and roads as far as possible away from sensitive receivers. Dedicated loading/unloading areas to be shielded if close to sensitive receivers. Delivery vehicles to be fitted with straps rather than chains for unloading, wherever possible. Avoid or minimise these out of hours movements where possible.
Use of localise noise control for construction equipment	Airborne noise.	Localised noise control of construction equipment can significantly reduce noise at the receivers. Some examples of such noise control are as follows: - Use of acoustic enclosure / noise barrier for power generator. - Use of noise control attachment for equipment such as rock breaker (example Hushtec product) - Use of pile driving shroud for control of noise from pile operation (example Hushtec product) - Use of localised temporary noise barrier to isolate noisy construction activities. For the early works construction phases, any cranage will be limited to mobile cranes where the engines are typically enclosed in an acoustically treated housing.
Path Control		
Shield stationary noise sources such as pumps, compressors, fans etc.	Airborne noise.	Stationary noise sources should be enclosed or shielded where feasible and reasonable whilst ensuring that the occupational health and safety of workers is maintained.

Action Required	Applies to	Details
Shield sensitive receivers from noisy activities.	Airborne noise.	Use structures to shield residential receivers from noise such as site shed placement; earth bunds; fencing; erection of operational stage noise barriers (where practicable) and consideration of site topography when situating plant.

The above standard mitigation measures should be considered during the planning stage, which should be further reviewed and updated when the appropriate construction methodology is known.

9.3 Construction Vibration Control and Management

As a guide, minimum working distances from sensitive receivers for typical items of vibration intensive plant are listed in Table 9-4. The minimum distances are quoted for both “cosmetic” damage (refer BS 7385-2:1993) and human comfort (refer OH&E’s Assessing Vibration - a technical guideline).

The minimum working distances for cosmetic damage must be complied with at all times, unless otherwise approved by Roads and Maritime or under the environmental license as relevant. DIN 4150 has criteria of particular reference for heritage structures.

Table 9-4 Recommended buffer distance for control of construction vibration

Plant Item	Rating/ /Description	Minimum working distance	
		Cosmetic damage (BS 7385)	Human response (OH&E Vibration guideline)
Small Hydraulic Hammer	(300 kg - 5 to 12t excavator)	2m	7m
Medium Hydraulic Hammer	(900 kg – 12 to 18t excavator)	7m	23m
Large Hydraulic Hammer	(1600 kg – 18 to 34t excavator)	22m	73m
Jack hammer	Handheld	1m (nominal)	2m

The minimum working distances are indicative and will vary depending on the particular item of plant and local geotechnical conditions. They apply to cosmetic damage of typical buildings under typical geotechnical conditions.

Operational aspects of some receivers may be highly sensitive to noise and vibration over, and above typical noise and vibration allowances based on annoyance and human comfort. For highly sensitive receivers (i.e., high technology facilities with sensitive equipment, recording studios and cinemas), specific assessment is required to ensure satisfactory operation of the facility and determine if any mitigation or management measures are required to minimise the potential impacts.

Some guidance where building contents contain sensitive equipment may be found in these additional references:

- Australian Standard 2834-1995 Computer Accommodation, Chapter 2.9 Vibration, p16.
- Gordon CG Generic Vibration Criteria for Vibration Sensitive Equipment Proceedings of International Society for Optical Engineering (SPIE), Vol. 1619, San Jose, CA, November 4-6, 1991, pp. 71-85.
- ASHRAE Applications Handbook, Sound and Vibration Control.
- NSW RMS Construction Noise and Vibration Guideline – August 2016.

The recommended values for cosmetic damage relate predominantly to transient vibration which does not give rise to resonant responses in structures, and to low-rise buildings. Where the dynamic loading caused by continuous vibration is such as to give rise to dynamic magnification due to resonance, especially at the lower frequencies where lower guide values apply, then the recommended values in Table 6-16 may need to be reduced by up to 50 %.

The following project specific recommendations should be adopted for the project:

- Rock breaking/hammering activities are considered to have the potential to cause dynamic loading in some structures (e.g. hospital buildings) and it may therefore be appropriate to reduce the transient values by 50%.
- Due to the proximity of the proposed construction site to the Operating Theatre Building, Surgical Wards and Cancer Centre, it is important that the vibration levels at these areas (south and western boundary) should be monitored prior to the use of Jack Hammer, Excavator and compactor during construction.
- During rock breaking, use of jack hammer, compactor or excavator near the south and western boundary of the construction site, attended structural vibration measurements at adjacent structures are recommended to confirm vibration levels and prevent damage to adjacent buildings, affecting human comfort or sensitive equipment.
- In relation to human comfort (response), the minimum working distances in Table 9-4 relate to continuous vibration. For most construction activities, vibration emissions are intermittent in nature and for this reason, higher vibration levels, occurring over shorter periods are allowed (see OEH’s Assessing Vibration: a technical guideline). Where the predicted vibration levels exceed the human comfort objectives, procedures are to be followed in order to mitigate the potential impacts at sensitive receivers.
- If the measured ground-borne vibration levels exceed the cosmetic damage objectives, a different construction method with lower source vibration levels must be used where feasible and reasonable otherwise construction works should not proceed unless attended vibration measurements are undertaken at the commencement of the works.
- If there is any risk of exceedance of the cosmetic damage objective, a permanent vibration monitoring system should be installed, to warn plant operators (via flashing light, audible alarm, SMS, etc) when vibration levels are approaching the cosmetic damage objective.

- As part of the vibration control measures, vibration monitoring is recommended during construction phase at strategic locations, mainly during rock breaking activities, excavation, drilling of the ground etc, construction of the basement and ground levels or other related construction activity that may affect adjacent receivers.
- Vibration levels should be continuously monitored throughout the construction activities, so that any exceedance could be swiftly identified, and the construction activities stopped and modified to comply with the relevant criteria. The real time measurements should be set up to provide live alerts via email or SMS to receivers as determined by the client where criterion was exceeded.
- Provision of monthly reports including results of the unattended noise and vibration monitoring undertaken.
- Upon receiving the exceedance alert the following actions are required by the head contractor:
  - Construction activity is immediately suspended.
  - Immediate investigation is carried out by head contractor into what might have caused the exceedance.
  - Noise and vibration controls are required to modify equipment or construction approach to ensure ongoing work remains below relevant criteria.
  - Provide details of location, type of work, expected duration of work and modifications taken.
  - Construction work is resumed.
  - Weekly meetings to discuss any alarm events for the week.
- Building foundations and piles should be located a safe distance from adjacent infrastructure to prevent structural damage and vibration transfer into the building.

9.4 Additional Mitigation Measures

Corresponding to noise mitigation periods outlined in the RMS Construction Noise and Vibration Guideline (2016) the results of this construction noise assessment characterise the proposed development as “Moderately Intrusive”, equivalent to up to 15dB above the NML, with the following additional mitigation measures required to be implemented during periods within and outside of standard hours. The below figure is taken from the RMS Construction Noise and Vibration Guideline (2016) and provides advice on “Additional Mitigation Measures” according to noise level exceedance.

Predicted airborne $L_{Aeq(15min)}$ noise level at receiver			Additional mitigation measures	
Perception	dB(A) above RBL	dB(A) above NML	Type[1]	Mitigations levels[2]
All hours				
75dBA or greater			N, V, PC, RO	HA
Standard hours: Mon–Fri (7am–6pm), Sat (8am–1pm), Sun/Public Holiday (Nil)				
Noticeable	5 to 10	0	-	NML
Clearly audible	10 to 20	< 10	-	NML
Moderately intrusive	20 to 30	10 to 20	N, V	NML+10
Highly intrusive	> 30	> 20	N, V	NML+20
OOHW Period 1: Mon–Fri (6pm–10pm), Sat (7am–8am & 1pm–10pm), Sun/Pub Holidays (8am–6pm)				
Noticeable	5 to 10	< 5	-	NML
Clearly audible	10 to 20	5 to 15	N, R1, DR	NML+5
Moderately intrusive	20 to 30	15 to 25	V, N, R1, DR	NML+15
Highly intrusive	> 30	> 25	V, IB, N, R1, DR, PC, SN	NML+25
OOHW Period 2: Mon–Fri (10pm–7am), Sat (10pm–8am), Sun/Public Holiday (6pm–7am)				
Noticeable	5 to 10	< 5	N	NML
Clearly Audible	10 to 20	5 to 15	V, N, R2, DR	NML+5
Moderately intrusive	20 to 30	15 to 25	V, IB, N, PC, SN, R2, DR	NML+15
Highly intrusive	> 30	> 25	AA, V, IB, N, PC, SN, R2, DR	NML+25

Notes [1](refer to detailed descriptions in Table C1 above):

1. AA = Alternative accommodation; V = Validation of predicted noise levels; IB = Individual briefings; N = Notification box drops; PC = Phone calls; SN = Specific notifications; R1 = Respite period 1; R2 = Respite period 2; DR = Duration respite
2. All affected receivers

Figure 9-4 Overview of mitigation measures required for normal case work periods and NML exceedance

The following times are established and represent standard hours and “Out of Hours Work” (OOHW) time periods:

Standard hours: Mon – Fri (7am-6pm), Sat (8am-1pm), Sun/Public Holiday (Nil)
OOHW Period 1: Mon-Fri (6pm-10pm), Sat (7am-8am & 1pm-10pm), Sun/Public Holiday (8am-6pm)
OOHW Period 2: Mon-Fri (10pm-7am), Sat (10pm-8am), Sun/Public Holiday (6pm-7am)

The below sections outline the additional mitigation measures to be implemented during the work periods described above if the works are predicted to exceed the NML. Work periods described in brackets denote the time period associated with the required control measures.

9.4.1 N: Community Notification

- Contact potentially noise affected neighbours at the earliest possible time before any site work begins.
- Inform potentially noise affected neighbours about the nature of the construction stages and the duration of noisier activities – for example, excavation and rock-breaking.
- Describe any noise controls, such as walls to be built first that will reduce noise, temporary noise walls, or use of silenced equipment.
- Keep potentially noise affected neighbours up to date on progress.
- Provide contact details on a site board at the front of the site, and maintain a complaints register suited to the scale of works.
- Ask about any concerns that potentially noise affected neighbours may have and discuss possible solutions.
- Provide a copy of the noise management plan, if available, to potentially noise affected neighbours.

9.4.2 V: Verification of Construction Noise and Vibration Levels

- During the earthworks and excavation phase, it is important to implement a vibration monitoring system at the following areas to assess the vibration for potential discomfort to humans, potential damage to nearby structures and sensitive equipment
  - Operating Theatre Building
  - Surgical Wards
  - Cancer Centre
- . The system will continuously monitor vibration levels and will be particularly sensitive to any potential changes in these levels. These changes may occur due to various factors, such as modifications in equipment and activities, or adjustments to work procedures that could impact existing vibration control measures. The monitoring process will utilize suitable equipment to ensure that the obtained results can be easily compared with previous findings. If the results indicate that vibration levels exceed permissible limits, appropriate steps must be taken.
- Attended measurements must be undertaken, when required, at the potentially most impacted receivers as per the NSW Environment and Heritage Interim Construction Noise Guidelines (ICNG) July 2009, NSW DEC Assessing Vibration: A Technical Guideline (2006) and NSW EPA Noise Policy for Industry 2017 (NPI).
- For projects with a duration greater than three months, the attended measurements are to be repeated on a three-monthly basis, where reasonable and feasible, to ensure that noise and vibration levels in the receiver locations remain consistent with the predicted levels, approval. Where out-of-hours works are required, the attended measurements must be undertaken at the time intervals described in the CNVA report.
- This will involve the measurement of noise and vibration at the nearest sensitive receivers.
- The attended measurements shall be carried out by a suitably qualified acoustic consultant, familiar with applicable standards and procedures and noise and vibration measurement methods.

9.4.3 R1/R2: Respite Offer

Respite offers should be considered where there are high noise and vibration generating activities near receivers. The purpose of such an offer is to provide residents with respite from an ongoing impact. This measure is evaluated on a project-by-project basis, and may not be applicable to all projects, or when Duration Respite has been agreed. As a guide,

- Work should be carried out in continuous blocks that do not exceed 3 hours each, with a minimum period of one hour between each block.
- The actual duration of each block of work and respite should be flexible to accommodate the usage of and amenity at nearby receivers.

9.4.3.1 R1: Respite Period 1

Out of hours construction noise in out of hours period 1 shall be limited to no more than three consecutive evenings per week, except where there is a Duration Respite. For night work, these periods of work should be separated by not less than one week, and no more than 6 evenings per month

9.4.4 DR: Duration Respite

Respite offers and respite periods 1 & 2 (not listed) may be counterproductive in reducing vthe impact on the community for longer duration projects. In this instance, and where it can be strongly justified, it may be beneficial to increase the work duration, number of evening or nights worked through Duration Respite so that the project can be completed more quickly.

- Project staff should engage with the community where noise levels are expected to exceed the NML (Noise Management Level) to demonstrate support for Duration Respite

9.5 Complaints Management

A complaint handling and management procedure should be developed and documented. Following items should be considered while developing a complaint management document:

- 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.

- As a standard response, complaints regarding construction noise or vibration shall be responded to by verifying noise or vibration levels are within noise/vibration predictions as soon as reasonably practical.
- Provide a readily accessible contact point, for example, through a 24-hour toll-free information and complaints line.
- Have a documented complaints process, including an escalation procedure so that if a complainant is not satisfied there is a clear path to follow.
- Implement all feasible and reasonable measures to address the source of complaint.
- 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.
- Keep staff who receive telephone complaints informed regarding current and upcoming works and the relevant contacts for these works.
- Handle complaints in a prompt and responsive manner.
- Where there are complaints about noise or vibration from an identified work activity, review and implement, where feasible and reasonable, actions additional to those described above to minimise noise/vibration output.

9.6 Compliance to WHS Noise and Vibration Requirements

- Exposure to workplace hazardous noise can cause permanent hearing loss in workers, which destroys their ability to hear clearly. It makes it more difficult for them to hear sounds, including those that are necessary to work safely, such as verbal instructions – even warning signals.
- There is strong evidence indicating that exposure to noise, vibration and ototoxins can exacerbate the effects of noise on hearing. Workers who are exposed to noise and vibration or ototoxins together may be more likely to suffer from hearing loss.
- Ensure noise levels do not exceed:
  - a total (continuous) noise level that exceeds 85 dB(A) when averaged over an 8-hour period (known as $L_{Aeq,8h}$ or 8-hour equivalent noise level).
  - an instantaneous sound that exceeds a peak noise level of 140 dB(C) at any time during the day.
- The WHS requirements for noise and vibrations should be complied as per the requirement of:
  - SafeWork NSW Code of Practice on managing noise and preventing hearing loss.
  - Work Health and Safety Act (the WHS Act).
  - AS/NZS 1269.1:2005 Occupational noise management, Part 1: Measurement and assessment of noise inmission and exposure.
  - NSW Department of Environment & Conversation - Assessing Vibration: A Technical Guideline 2006.

10 Conclusion

ACOR Consultants Pty Ltd has undertaken a Construction and Operational Noise and Vibration Assessment for the proposed development of the new 2 storey Northeast Building, Albury Wodonga Regional Hospital, located at 201 Borella Road, East Albury. A summary of the assessment and recommendations is provided below:

Construction Noise Assessment:

- Based on the predicted constructions noise levels provided in Table 8-2, it is observed that the predicted construction noise levels would mostly exceed the ICNG recommended construction criteria at the Hospital receivers NSR3, NSR 4 and NSR 5. The exceedance ranges between 7 to 18 dB(A) even with the implementation of a 4m high noise barrier. Therefore, it is advised that noise management plan as provided in Section 9 should be considered and implemented during the period of construction to minimise the noise impact on the nearby Hospital Buildings.
- The assessment also shows that the predicted constructions noise levels (provided in Table 8-2) would exceed the ICNG recommended Noise Management Level (Noise Affected) at the residential receivers NSR 7 and NSR 8, although they would be within the ICNG recommended Highly Noise Affected Level of 75 dB(A). Therefore, it is expected that there would be minimal noise disturbance during the period of construction during standard hours. It is advised that the noise management plan as provided in Section 9 should be considered and implemented during the period of construction to minimise the noise impact at dwellings on East Street.

Construction Vibration Assessment:

- Due to the proximity of the proposed construction site (south and western boundary) to the Operating Theatre Building, Surgical Wards and Cancer Centre, it is important that the attended structural vibration measurements at adjacent structures are monitored prior to the use of Jack Hammer, Excavator or compactor prior/during construction to confirm vibration levels and prevent damage to adjacent buildings, affecting human comfort or sensitive equipment.
- In relation to human comfort (response), the minimum working distances in Table 9-4 relate to continuous vibration. For most construction activities, vibration emissions are intermittent in nature and for this reason, higher vibration levels, occurring over shorter periods are allowed (see OEH's Assessing Vibration: a technical guideline). Where the predicted vibration levels exceed the human comfort objectives, procedures are to be followed in order to mitigate the potential impacts at sensitive receivers.
- If the measured ground-borne vibration levels exceed the cosmetic damage objectives, a different construction method with lower source vibration levels must be used where feasible and reasonable otherwise construction works should not proceed unless attended vibration measurements are undertaken at the commencement of the works.
- If there is any risk of exceedance for cosmetic damage or affecting the sensitive areas (operating theatre, surgical wards etc) and equipment, a permanent vibration monitoring system should be installed, to warn plant operators (via flashing light, audible alarm, SMS, etc) when vibration levels are approaching the vibration objective.
- Recommendations provided in Section 9 should be considered and implemented during the period of construction to mitigate the vibration impact on the nearby Hospital Buildings.

Noted that this assessment is conducted based on the preliminary information provided for different construction stages, without detail information on the type of construction equipment used for the project. It is, therefore, important that this assessment be further reviewed if the construction equipment selected differ (noisier and vibration active) from those preliminarily selected and used in this assessment.

Operational Noise and Vibration Assessment:

- Based on predicted operational noise level impacts at nominated NSRs provided in Table 7-4 it expected that operational noise generated from mechanical plant equipment will achieve project acoustic criteria outlined in the NSW EPA Noise Policy for Industry (2017), presented in Section 6.1, except for two points at NSR3 (L2,L3), which is not expected to be impactful and likely to achieve recommended noise levels internal to the building.
- Operational noise desktop assessment and 3D noise propagation model used in the calculation of noise impacts are presented in Section 7.
- Recommendations have been made in engineering acoustic control for proposed mechanical plant equipment installed on L1 mechanical plant enclosure and rooftop mounted fan equipment, presented in Section 9.1.

Based on this assessment, it is concluded that operational noise, construction noise and vibration associated with the project could suitably be managed to achieve the requirements of NSW Department of Environment & Climate Change - Interim Construction Noise Guidelines (ICNG) July 2009 and NSW Department of Environment & Conversation - Assessing Vibration: A Technical Guideline 2006, and Noise Policy for Industry (NPI 2017) provided the recommendations given in Section 9 are implemented.

We trust that the information provided is satisfactory. However, if you have any queries or require further information, please do not hesitate to contact us.

Yours sincerely

ACOR Consultants Pty Limited

Prepared by,

Rodrigo Vega

Acoustic Engineer – Graduate

AAAS

Reviewed/Approved by,

Dr. Mahbub Sheikh

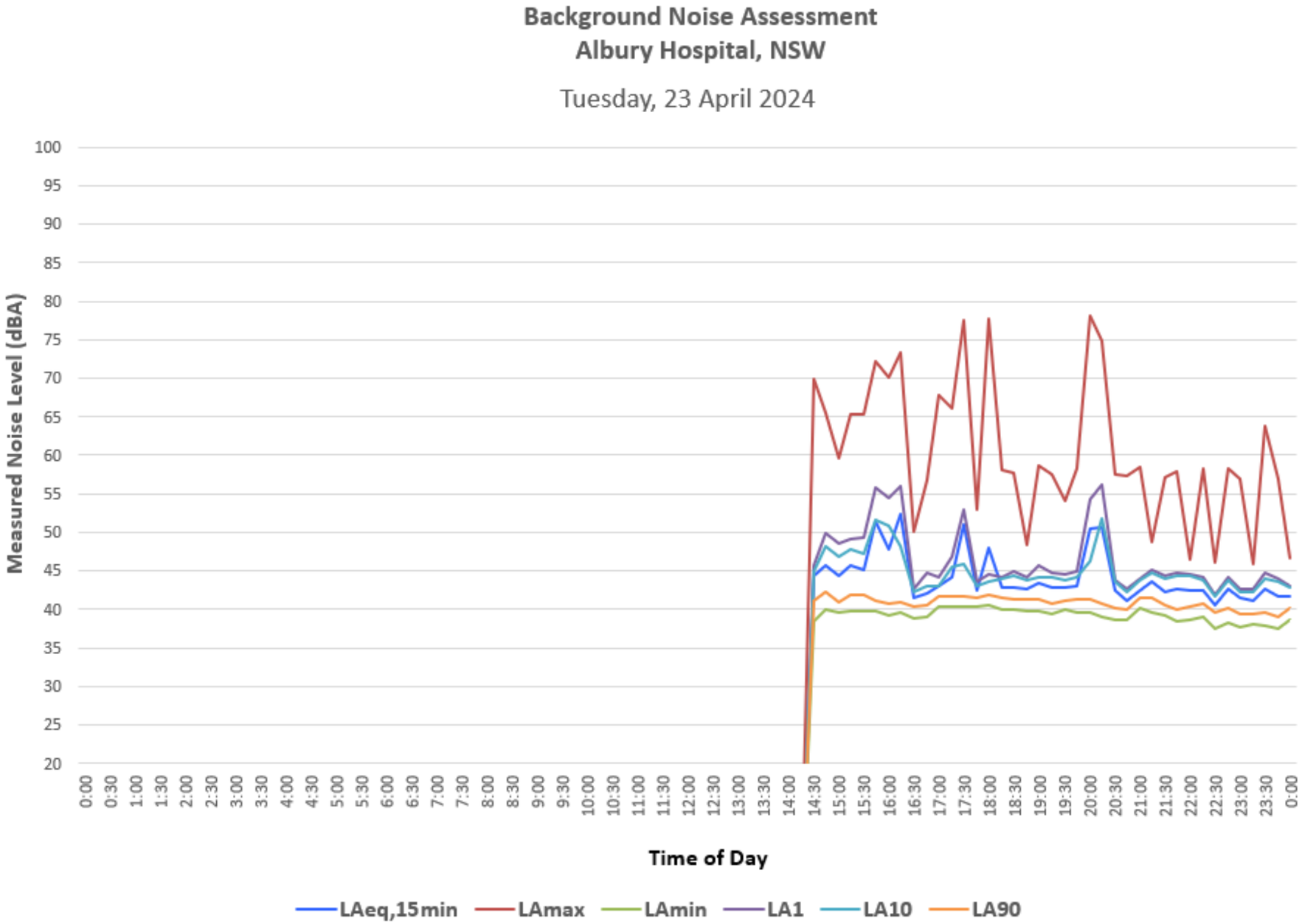
Acoustics Team Leader | Senior Engineer

M.A.A.S., FIEAust, CPEng, NER

Appendix A Glossary of Acoustic Terms

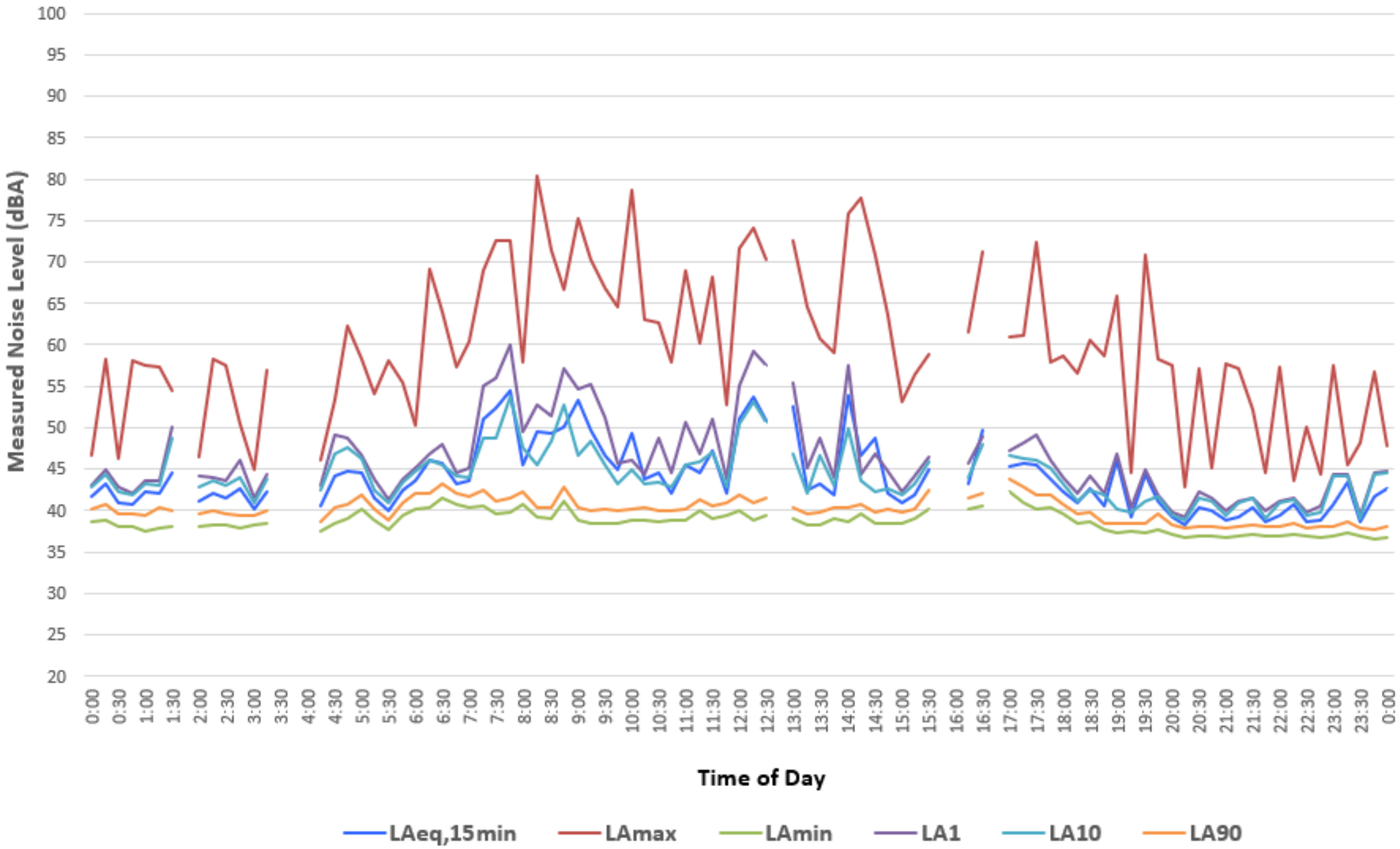
A-weighting	Frequency weighting applied to the level in each stated octave band by a specified amount, in order to better represent the response of the human ear. The letter 'A' will follow a descriptor, indicating the value has been 'A' weighted. An 'A' weighted noise level may also be written as dB(A).
C_{tr}	The spectrum adaptation term C_{tr} adjustment factor takes account of low frequency noise.
CAC	Ceiling Attenuation Class. The CAC determines how much cross-talk will occur between one room and another through the ceiling cavity where both rooms have the tested ceiling tile. This is an ideal situation, with no wall head leaks and no services penetrations in the ceiling. Therefore, it defines the ideal, best possible result as tested in a laboratory
dB	Decibel. This is the unit measurement of sound.
dBA	A weighted decibel is the most commonly used descriptor. The A weighting is an adjustment to the raw sound level to approximate what the average human ear can hear, which is less sensitive at very low and very high frequencies.
D_w	The Weighted Level Difference as defined in AS/NZS ISO 717.1:2004. This is the single number rating describing the ability of a partition to reduce noise as measured in the field with no standardisation or normalisation.
D_nT_w	The Weighted standardised level difference as defined in AS/NZS ISO 717.1:2004. This is the single number rating describing the ability of a partition to reduce noise as measured in the field. The higher the D_nT_w rating, the better is the acoustic performance of the wall or floor.
$D_nT_w + C_{tr}$	$D_nT_w + C_{tr}$ is D_nT_w with the addition of a low frequency sound correction factor Ctr (always a negative number remember). Rw + Ctr is used because of the increase in low frequency sound sources such as surround sound systems, drums or bass guitars, and of course traffic or aircraft noise. Two walls can have the same D_nT_w rating, but have different resistance to low frequency sound, thus a different $D_nT_w + C_{tr}$.
L_w or SWL	Sound power level. This is the total radiated sound energy.
L_p or SPL	Sound pressure level. This is the measurable sound level at a given distance from an item.
L_{max}	The RMS maximum noise level of a measurement
L_{10}	90^{th} percentile sound level of a measurement. Often called the average maximum noise level
L_{eq}	The energy average noise level of a measurement.
L_{90}	10^{th} percentile sound level of a measurement. Often called the average background noise level
L_{min}	The minimum noise level of a measurement
$L_{eq(T)}$	The time (T) equivalent energy noise level. The time interval is often in blocks of 10 or 15 minutes for short term measurements, or hours for long-term measurements. Common increments for long term measurements are 1 hour, day, night, 18 hours and 24 hours.
$L_{eq(8h)}$	The 8 hour equivalent energy noise level. Primarily used for occupational noise assessments
LC_{peak}	The C weighted peak noise level. Primarily used for occupational noise assessments
$L_{n,w}$	The Weighted Normalized Impact Sound Pressure Level. This is a single number rating describing the impact sound performance of a floor ceiling assembly as measured in a laboratory. Assessed in accordance with AS/NZS ISO 717.2. The lower the $L_{n,w}$ rating, the better is the impact sound isolation performance of a floor-ceiling assembly
$L'_{n}Tw$	The weighted standardized impact sound pressure level. This is a single number rating describing the impact sound performance of a floor ceiling assembly as measured in a filed. Assessed in accordance with AS/NZS ISO 717.2. The lower the $L'_{nT,w}$ rating, the better is the impact sound isolation performance of a floor-ceiling assembly
NRC	Noise Reduction Coefficient. The NRC defines how much sound is absorbed by a surface. An NRC of 0 means it absorbs no sound while an NRC of 1 means it will absorb most sound.
R_w	The Weighted Sound Reduction Index. This is the single number rating describing the ability of a building element to reduce noise as measured in a laboratory. Assessed in accordance with AS/NZS ISO 717.1. The higher the R_w rating, the better is the acoustic performance of the wall or floor.
$R_w + C_{tr}$	$R_w + C_{tr}$ is R_w with the addition of a low frequency sound correction factor Ctr (always a negative number remember). Rw + Ctr is used because of the increase in low frequency sound sources such as surround sound systems, drums or bass guitars, and of course traffic or aircraft noise. Two walls can have the same Rw rating, but have different resistance to low frequency sound, thus a different Rw + Ctr.

Appendix B Noise Logging Daily Summaries



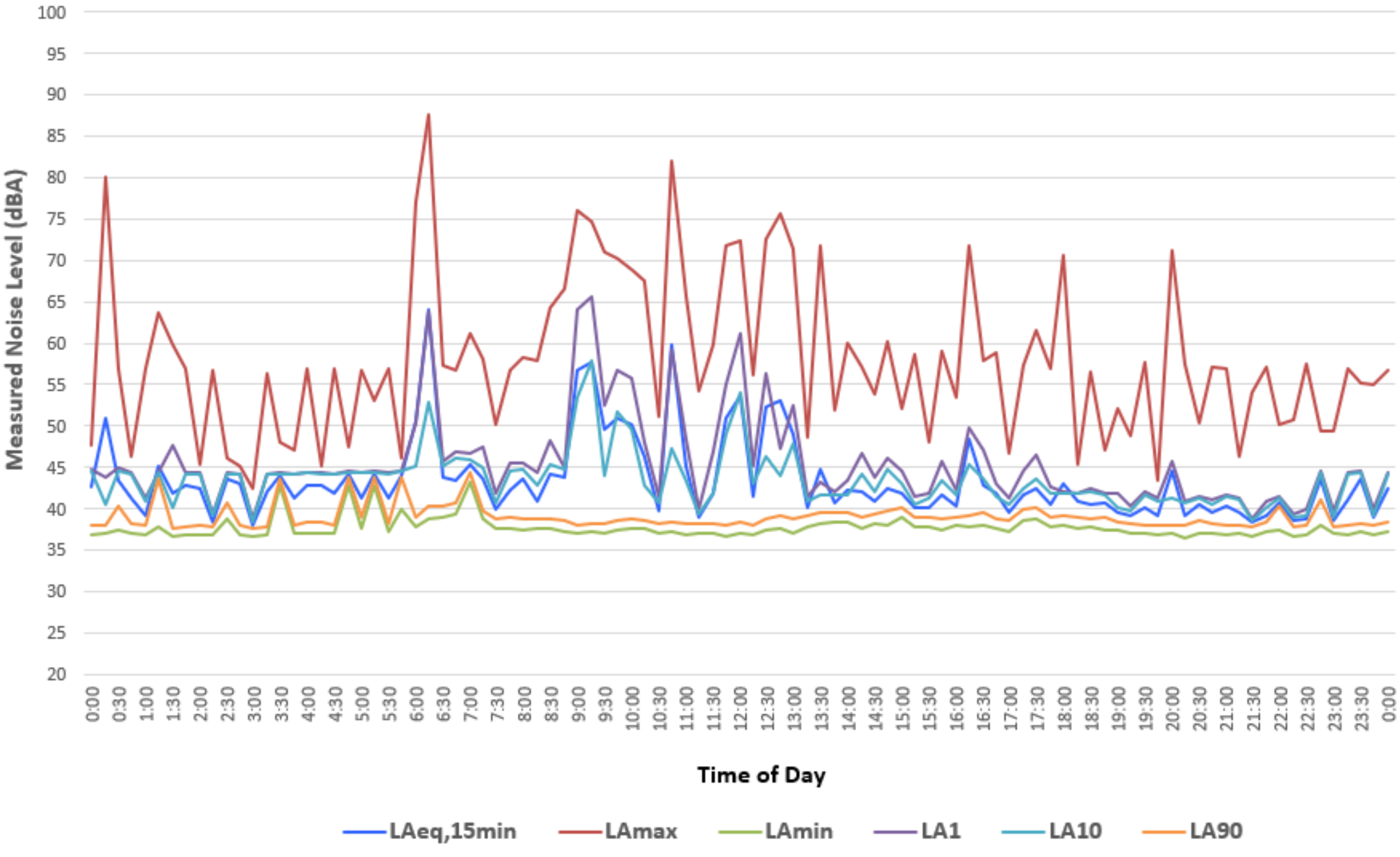
Background Noise Assessment
Albury Hospital, NSW

Wednesday, 24 April 2024



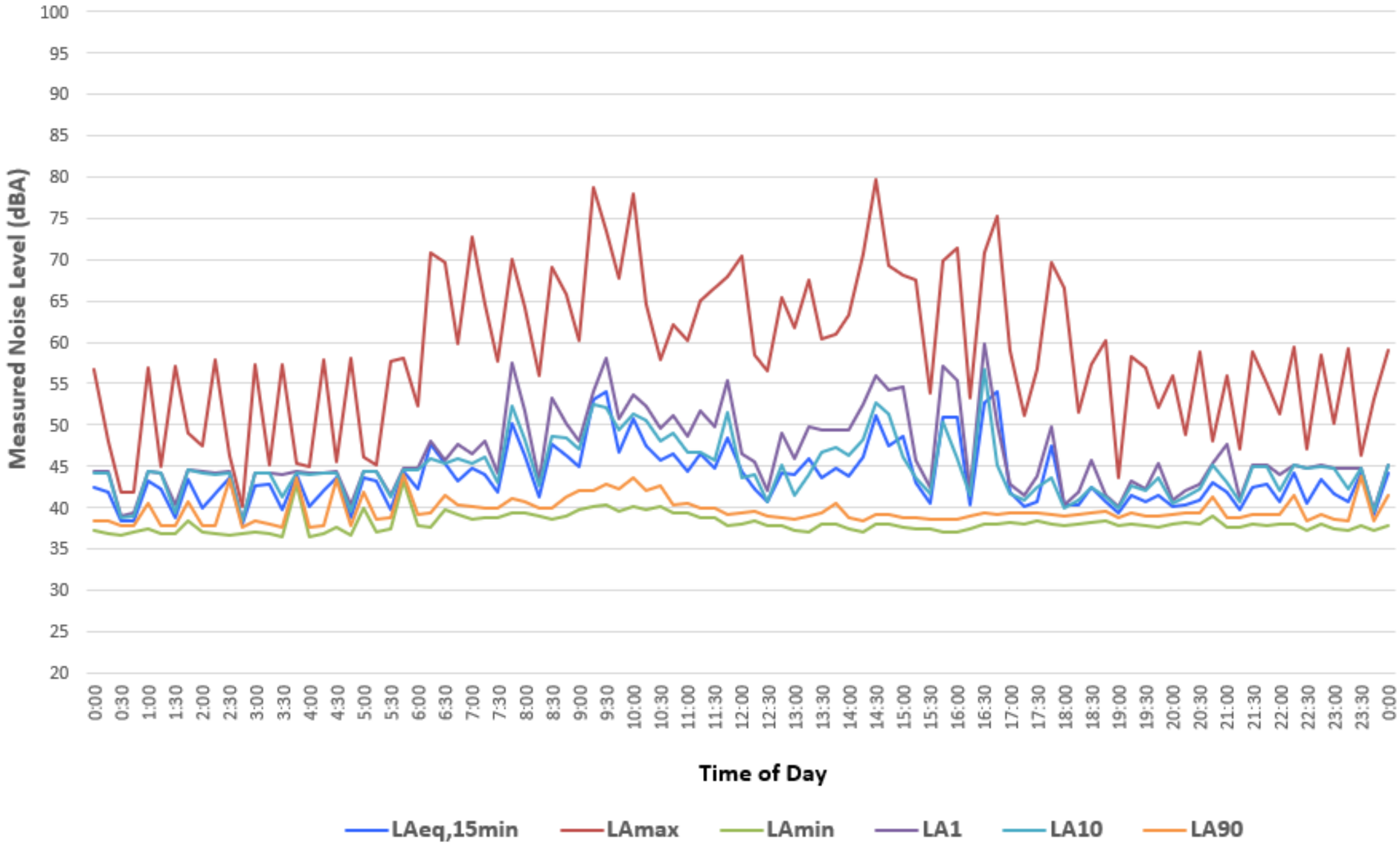
Background Noise Assessment
Albury Hospital, NSW

Thursday, 25 April 2024



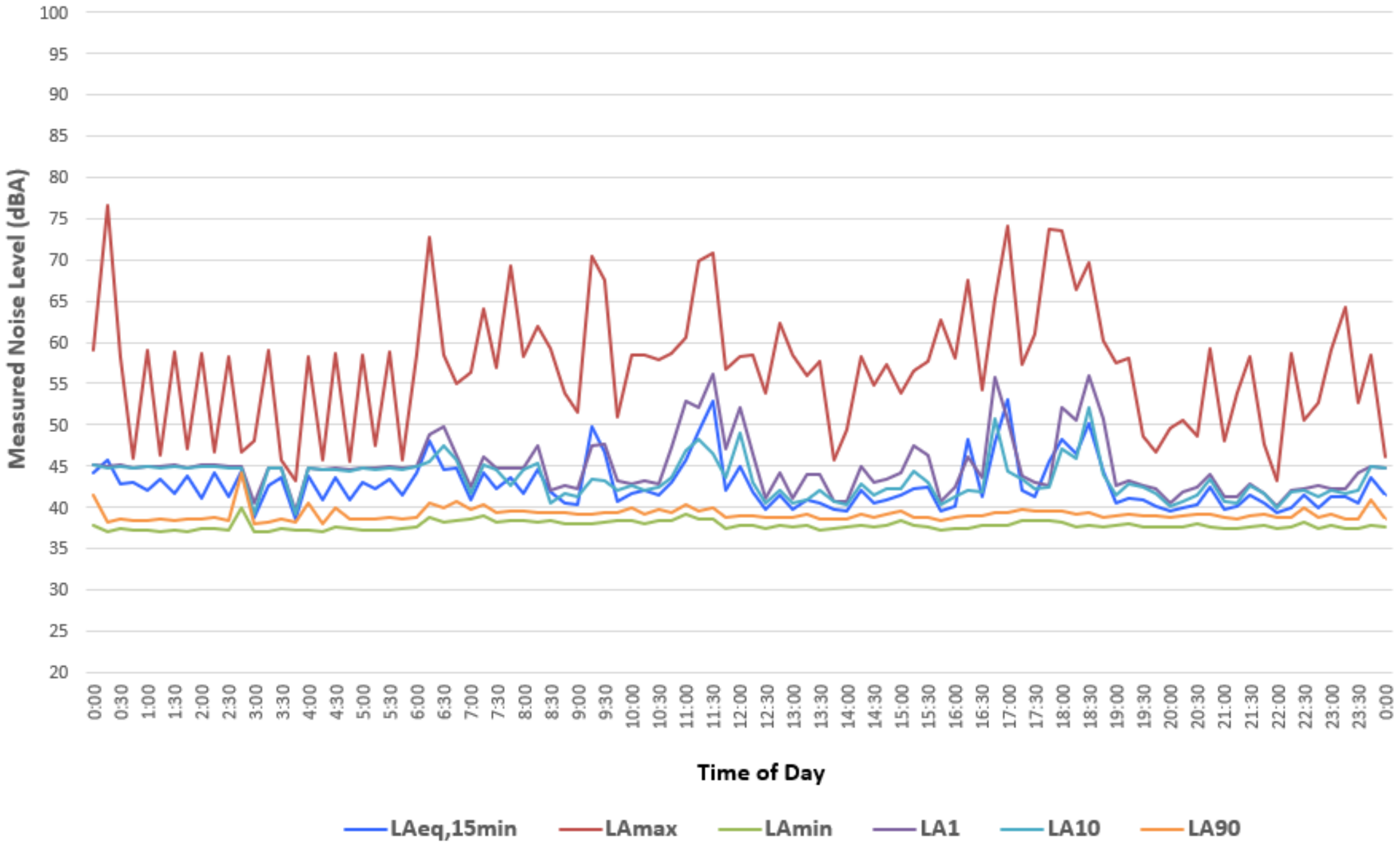
Background Noise Assessment
Albury Hospital, NSW

Friday, 26 April 2024



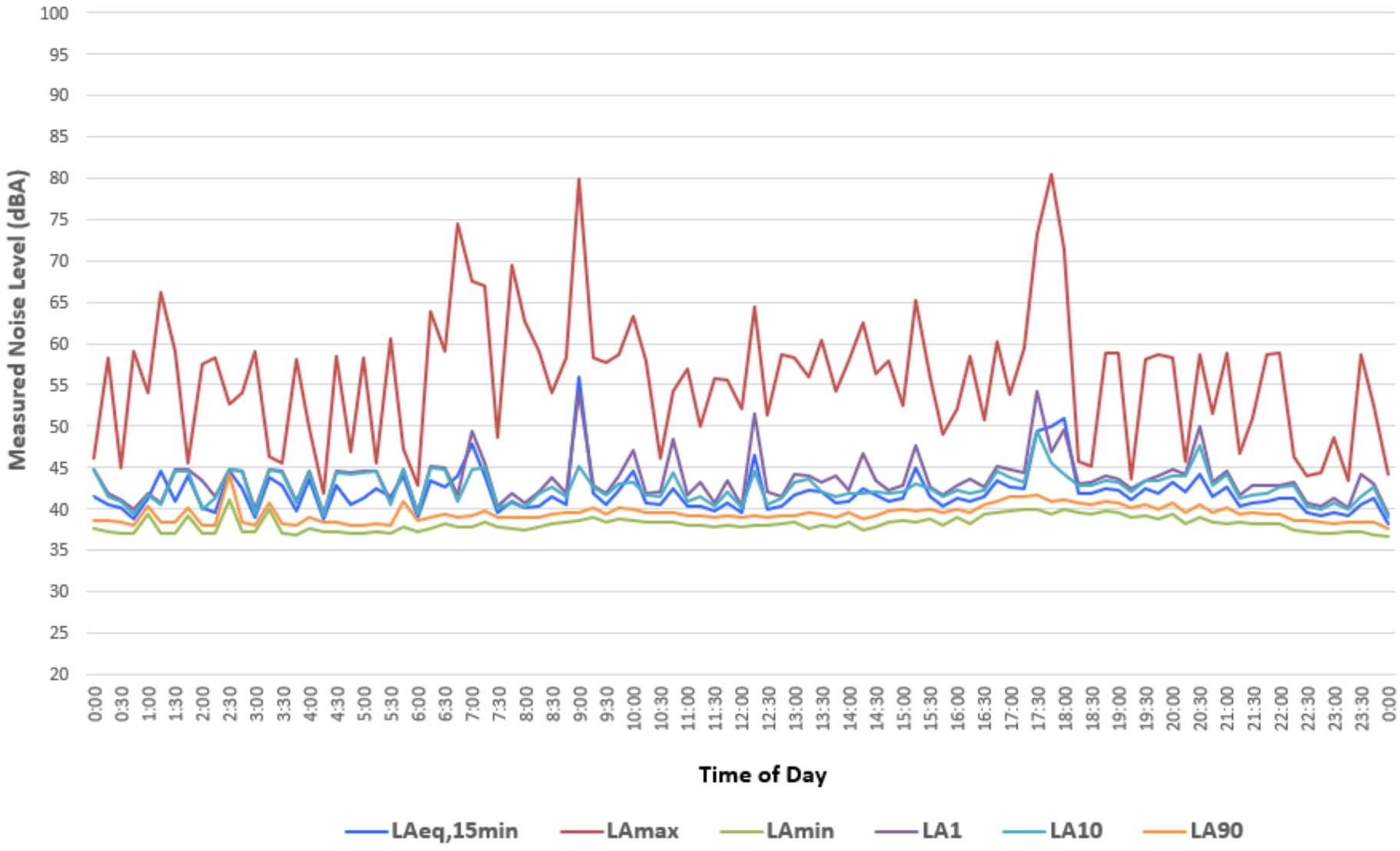
Background Noise Assessment
Albury Hospital, NSW

Saturday, 27 April 2024



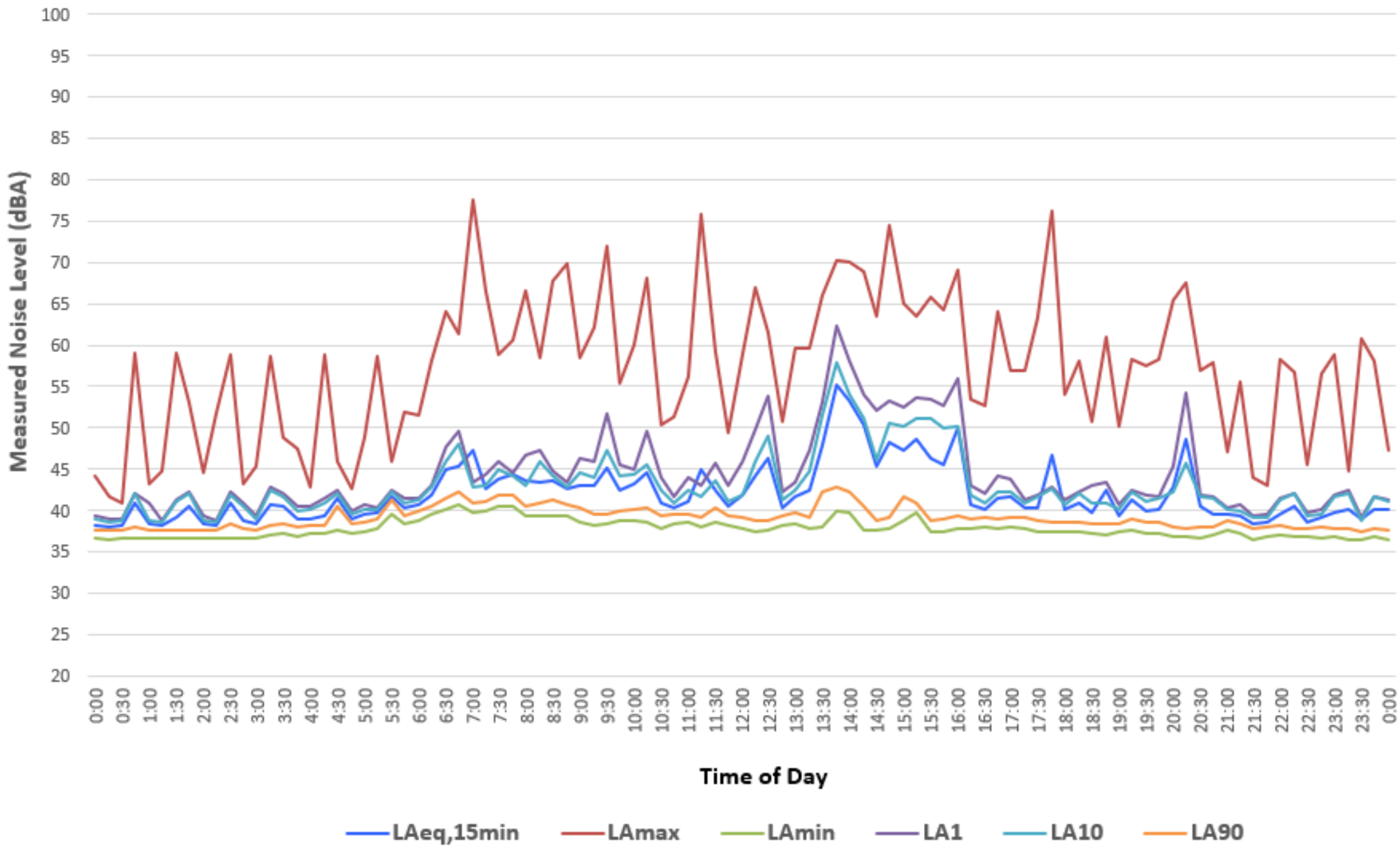
Background Noise Assessment
Albury Hospital, NSW

Sunday, 28 April 2024



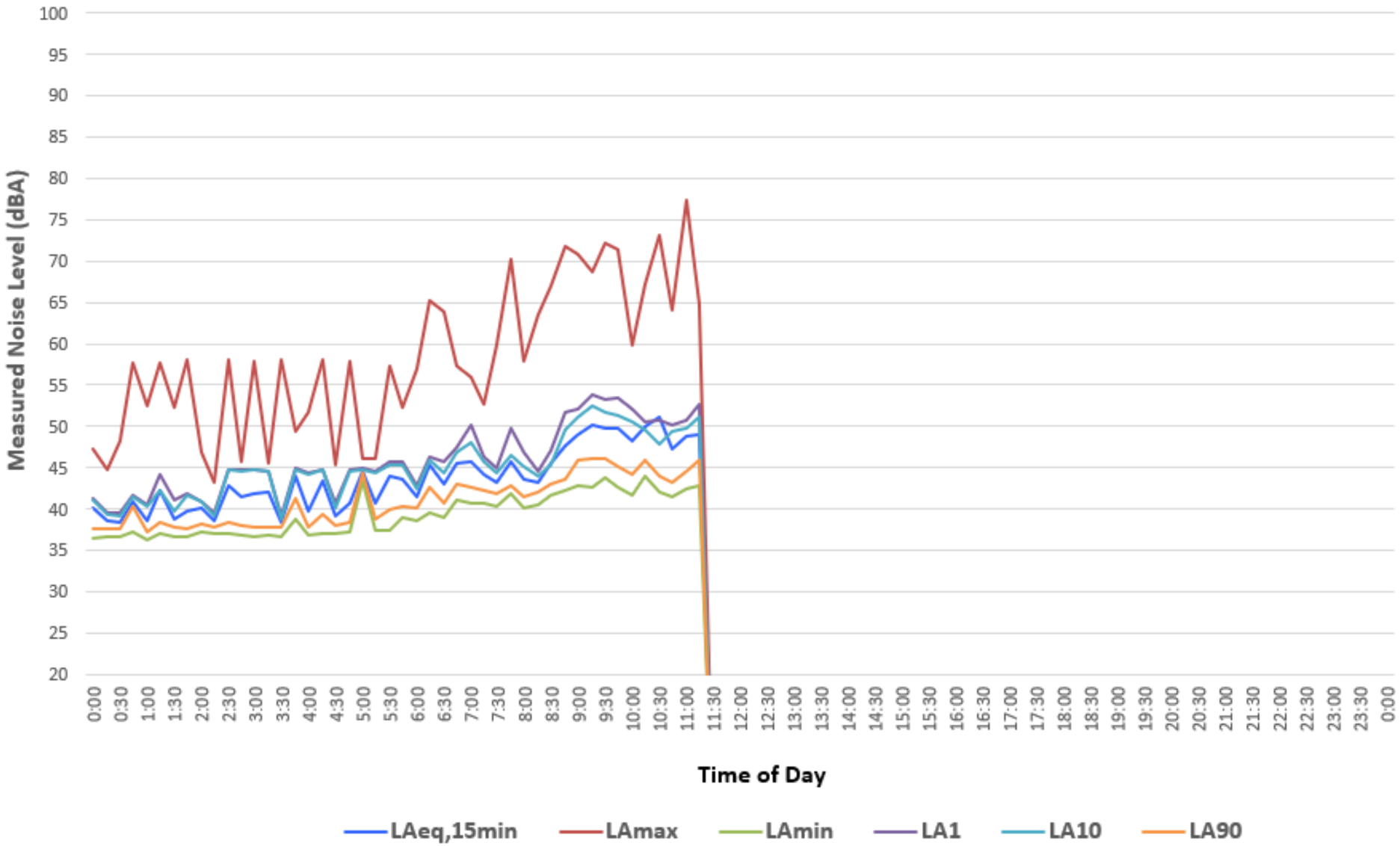
Background Noise Assessment
Albury Hospital, NSW

Monday, 29 April 2024



Background Noise Assessment
Albury Hospital, NSW

Tuesday, 30 April 2024

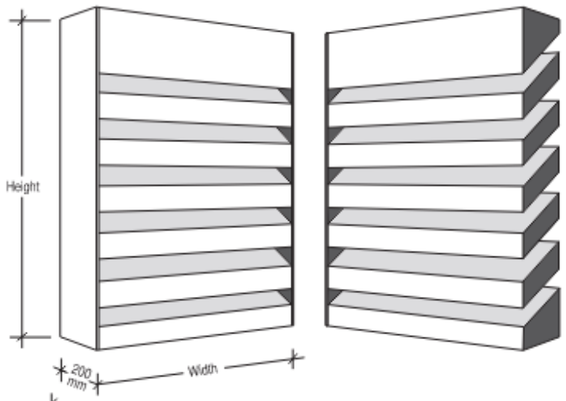


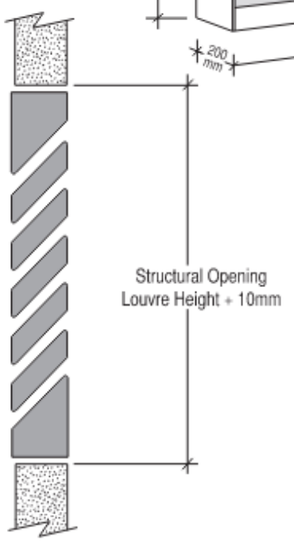
Appendix C Acoustic Louvre (examples)

ACRAN ACRAFLOW SERIES 200 ACOUSTIC LOUVRE

Model	NOISE REDUCTION (dB) Noise Reduction = Transmission Loss + 6dB across all frequencies						
	Octave Band Centre Frequencies (Hz)						
	125	250	500	1000	2000	4000	
Series 200	**14**	**13**	**17**	**27**	**30**	**22**	dB
Series 200S	**14**	**12**	**16**	**23**	**23**	**18**	dB

ACRAN louvres are tested in accordance with AS 1191-2002.
Please refer to ACRAN for detailed Performance Data.





TYPICAL SECTIONAL ELEVATION

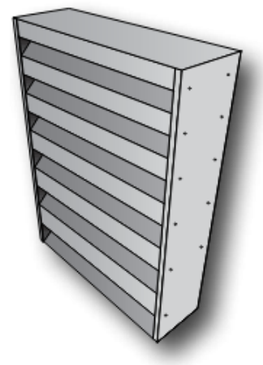
TYPICAL SECTIONAL PLAN

Individual Acran Louvre Segment Limitations

- Minimum Height - 440 mm
- Maximum Height - 4500 mm
- Maximum Width - 3600 mm

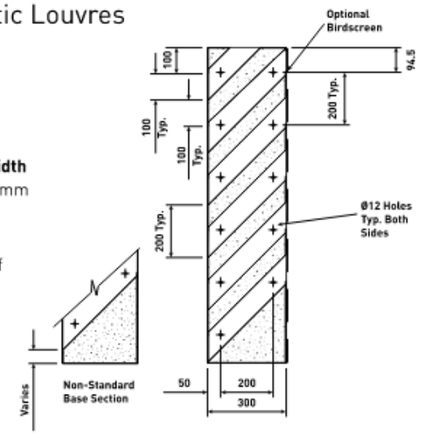
ACRAN Series 200

SL-300 Slimshield™ Acoustic Louvres



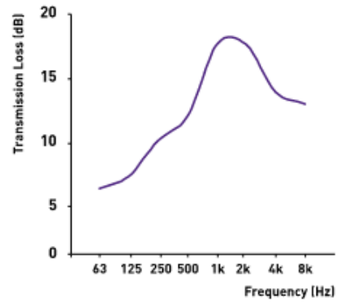
Weight 50kg/m²
Module Width 300 - 1800mm

Standard Module Height
600mm minimum,
(increasing increments of 200mm)
Intermediate heights are available



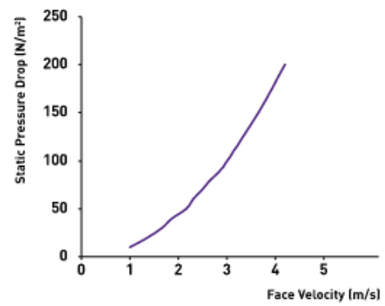
Acoustic Performance

Octave Band Centre Frequency (Hz)	63	125	250	500	1k	2k	4k	8k
Transmission Loss (dB)	6	7	10	12	18	18	14	13
Acoustic Rating	R_w17dB / D_{new}23dB							



Aerodynamic Performance

Static Pressure Drop (N/m²)	10	20	30	40	50	60	70	80	90	100
Face Velocity (m/s)	0.94	1.31	1.61	1.83	2.13	2.27	2.46	2.63	2.84	2.99
Nominal Free Area	45%*									* Average over louvre depth
Aerodynamic Coefficient	18.38k									



IAC SL-300