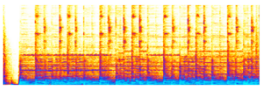
BROKEN HILL HOSPITAL REDEVELOPMENT

Noise and Vibration Impact Assessment for Review of Environmental Factors (REF)

Issued

18 October 2023



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Executive Summary

Acoustic Studio has been engaged by Health Infrastructure to prepare a Noise and Vibration Impact Assessment for the Review of Environmental Factors (REF) submission associated with the Broken Hill Hospital Redevelopment (BHHR).

A construction noise and vibration assessment has been carried out and is detailed in this report along with the findings and recommendations.

The objectives of this assessment are to:

- Identify noise sensitive receivers that will potentially be affected by the construction activities associated with the project.
- Determine existing ambient and background noise levels at the nearest noise sensitive receivers in the vicinity of the project.
- Establish the appropriate noise assessment criteria in accordance with the relevant standards and guidelines.
- Carry out an assessment to determine whether the relevant criteria can be achieved based on the proposed construction activities.
- Where applicable, provide recommendations are made for reasonable and feasible measures to be incorporated into the project in order to ensure compliance with the assessment criteria.

A summary of the critical outcomes and recommendations of this noise and vibration assessment are as follows:

Operational Noise Emission

Building Services

Building services noise is expected to meet noise limits with treatments proposed herein, including screening for external plant and acoustic treatment for fans and other equipment. Recommendations are provided for noise controls to key plant. During the detailed design and finalisation, the acoustic consultant shall provide advice to the architect and mechanical engineer to ensure that noise emissions from mechanical plant are effectively controlled to meet the relevant criteria at the nearest receiver boundaries.

The Use

Noise emissions have been considered from the following areas, and recommendations provided where necessary:

- Outdoor MHU Courtyard Areas
    - Noise emissions from outdoor courtyard areas are predicted to meet the applicable criteria at all sensitive receivers when in use.
- Car Park
    - Noise emissions from these areas are predicted to meet all relevant noise emission criteria at all sensitive receivers.
- Off-site Traffic
    - The impact to traffic volumes resulting from the development is negligible.

Noise Intrusion

Internal noise levels are expected to meet relevant targets for the proposed façade without any additional acoustic requirements. Noise to external open spaces is expected to meet the relevant criteria.

Construction Noise and Vibration

Noise

- Proposed construction hours are as follows:
    - Monday to Friday - 7:00am to 6:00pm
    - Saturday - 8:00am to 1:00pm
    - Sunday and Public Holidays – No works.
- There will be times / situations when works and activities are likely to be above Noise Management Levels and, in some cases, be above the Highly Affected Noise Levels, particularly from equipment including saws and excavators with hammers.
- Noise levels from operations of various plant and equipment are predicted to be 5-10 dB lower when location of activities within the site boundary are further away from a particular receiver, and in some cases, within the NMLs depending on the distance to the receiver.
- Where NMLs are exceeded, mitigation measures to be considered and incorporated where reasonable and feasible would include:
    - **Scheduling, Duration and Respite Periods** –
        - where practical and feasible, schedule noisier activities that cannot be shielded by acoustic curtains / hoarding to occur at less sensitive periods of the day and during standard hours (i.e. not early morning or late afternoon) .
        - Including Respite Periods where activities are found to exceed the 75 dB(A) Highly Affected Noise Level at receivers, such as 3 hours on and 1 hour off.
    - **Noise Barriers or Screening** – Incorporate shielding via site hoarding around the site and / or operate equipment behind localised hoarding or a noise curtain for up to 10 dB noise reduction (depending on how well the curtains block line of sight to the receiver). This is generally effective for all activities.
    - **Alternative construction methodology or equipment**
        - Use electric handheld tools where possible, rather than petrol or diesel tools.
        - Select the quietest available plant and equipment capable of carrying out the activity efficiently.
    - **Communication** - Inform affected residential receivers about the timing and duration of planned works.
    - **Complaints management** shall be addressed as noted in Section 7.7.3.
    - **Implementation of all reasonable and feasible mitigation measures** for all works will ensure that any adverse noise impacts to surrounding residential receivers are minimised when NMLs cannot be met due to safety or space constraints.

Vibration

- Based on the scope of works and typical equipment required, there is potential for human perception vibration impacts on nearby BHH buildings and there is requirement to review works processes during detailed works planning to ensure that minor cosmetic impacts to structures are avoided. The significance of these impacts will need to be determined as part of the CNVMP prepared by the Contractor.
- The Contractor shall determine whether the existence of significant vibration levels justifies a more detailed investigation.

Construction Noise and Vibration Management Plan

A CNVMP shall be prepared further to this assessment by the engaged Contractor. Project specific mitigation measures shall include:

- Scheduling, Duration and Respite Periods
- Noise Barriers or Screening
- Alternative construction methodology or equipment
- Communication
- Complaints management
- Construction Vibration

Glossary

Term	Definition
dB	Decibel is the unit used for expressing sound pressure level (SPL) or power level (SWL).
dB(A)	Decibel expressed as an 'A – weighted' sound pressure level, based on the frequency response of the human ear and has been found to correlate well with human subjective reactions to various sounds.
Frequency	The rate of repetition of a sound wave. Frequency is measured Hertz (Hz), or cycles per second. Human hearing ranges approximately from 20 Hz to 20 kHz (2000 Hz).
Ground-borne noise	The transmission of noise energy as vibration of the ground. The energy may then be re-radiated as airborne noise.
$L_{1(period)}$	The sound pressure level that is exceeded for 1% of a measurement period. This is commonly accepted as the maximum noise level.
$L_{10(period)}$	The sound pressure level that is exceeded for 10% of a measurement period. This is commonly accepted as the maximum noise levels.
$L_{90(period)}$	The sound pressure level that is exceeded for 90% of a measurement period. This is commonly accepted as the background noise level.
$L_{Aeq(period)}$	The equivalent continuous sound pressure level. The level of noise equivalent to the energy average of noise levels occurring over a measurement period.
L_{Amax}	The highest sound pressure level recorded over a measurement period.
Octave Band Centre Frequency	The most commonly used frequency bands are octave bands, in which the centre frequency of each band is twice that of the band below it.
Rating Background Level (RBL)	Rating background level is the overall single-figure background level representing each assessment period (day/evening/night) over a measurement period.
Sound Power Level (SWL)	Expressed in dB, it is the total acoustic energy radiated by a plant or equipment to the environment
Sound Pressure Level (SPL)	Expressed in dB, it is the level of noise measured by a standard sound level meter and requires a description of where the noise was measured relative to the source
Vibration	Vibration may be expressed in terms of displacement, velocity and acceleration. Velocity and acceleration are most commonly used when assessing structure-borne noise or human comfort issues respectively.

Initialisms

Initialism	Definition
BHH	Broken Hill Hospital
BHHR	Broken Hill Hospital Redevelopment
CNVMP	Construction Noise and Vibration Management Plan
ED	Emergency Department
ESG	Engineering Services Guidelines (NSW HI, 2016, Updated Section 13 Acoustics, 2017)
HI NSW	Health Infrastructure New South Wales
ICNG	Interim Construction Noise Guideline (NSW EPA, 2009)
MHU	Mental Health Unit
NML	Noise Management Level
NPI	Noise Policy for Industry (NSW EPA, 2017)
RBL	Rating Background Level
REF	Review of Environmental Factors

1 Introduction

Acoustic Studio has been engaged by Health Infrastructure NSW (HI NSW) to prepare a Noise and Vibration Impact Assessment (NVIA) to support the Review of Environmental Factors (REF) submission for the Broken Hill Hospital Redevelopment (BHHR).

The project site is located at the existing Broken Hill Hospital site, 176 Thomas St, Broken Hill, NSW.

The acoustic assessment detailed in this report is based on information provided by Acorn Project Advisory who oversee the project, plus drawings and information provided by the project architect (Silver Thomas Hanley (STH)), and various project consultants and engineers.

1.1 Scope

The NVIA assessment establishes the relevant noise and vibration criteria applicable to the project, assesses the predicted levels of noise and vibration impacts and provides recommendations for any mitigation required.

The assessment considers both construction and operational noise and vibration impacts to surrounding sensitive receivers in the vicinity of the project including areas within:

- the existing hospital building.
- external building receivers including commercial, medical, and residential properties.

The assessment has been carried out by:

- establishing the appropriate noise and vibration criteria in accordance with the relevant standards and guidelines.
- quantifying the existing ambient and background noise levels at noise sensitive receivers on and around the site.
- carrying out a quantitative assessment of:
    - the main noise and vibration generating sources associated with construction.
    - the main sources of operational noise including building services and traffic generation.
- assessing whether the relevant criteria can be achieved and, where applicable, recommending mitigation measures required.

The objectives of this assessment are to:

1. Identify Potential Noise and Vibration Impacts	• Construction Noise and Vibration • Operational Noise and Vibration
2. Determine Applicable Assessment Standards and Guidelines	• Interim Construction Noise Guideline (ICNG). • Noise Policy for Industry (NPI). • Road Noise Policy (RNP). • Etc.
3. Consider the existing site and surrounding environment	• Land use (zoning) and sensitivity. • Existing noise environment and surrounding noise sensitive receivers. • Target areas for determining representative background noise levels.
4. Establish assessment Criteria	• Informed by background monitoring, where applicable. • Select representative locations. • Carry out monitoring. • Remove extraneous and weather-affected data. • Determine Rating Background Levels.
5. Predict noise and Vibration Impacts	• Construction. • Operation.
6. Assess Noise and Vibration Impact	• Applying relevant standards and guidelines. • Recommend feasible and reasonable mitigation, where applicable.

1.2 REF Proposal

The proposed Broken Hill Hospital Redevelopment seeks approval for an upgrade to the Emergency Department as well as a new purpose-built Mental Health Inpatient Unit.

The activity comprises the development of the new 1-storey 8-bed Acute Mental Health Unit building and alterations and additions to the existing Emergency Department to reconfigure and expand upon its operations and reconfigure its ambulance bay.

The works further include associated tree removal and civil engineering works (involving internal roadworks and carpark reconfiguration, and earthworks and stormwater management works) in the lower campus as well as limited services relocation works in the upper and lower campuses. New landscaping and replacement tree planting is proposed in various locations.

The car park reconfiguration works have the potential to deliver up to a maximum additional 45 spaces within the lower campus

The project will include:

Stage 1

- Relocation of roads & accessways.
- New car parking to replace existing displaced car-parking.
- Relocation of services (above and in-ground) including communications, power and gas lines plus booster hydrant and stormwater diversion
- Staged services disconnections / reconnections as required.
- A new Mental Health Unit (MHU) followed by the relocation and decommissioning of existing MHU.
- Staged expansion and redevelopment of the Emergency Department (ED), including ambulance bay.

Stage 2

- Additional car parking spaces (up to 41 spaces).
- Rehabilitation unit walkway link.
- PV cells to the new MHU.
- Landscaping.

2 Key Acoustic Issues

The following acoustic issues are to be addressed as part of the assessment:

External Noise Emissions - Noise emissions from the Project will need to be managed to limit environmental noise impacts on nearby buildings resulting from the operation of the proposed development. In particular, this applies to:

- Building services and plant - the impact of mechanical noise generated by any new mechanical plant and services.
- Operational noise – new car park spaces, ambulance bay and internal roads.

External Noise Intrusion – From external noise sources including plant and equipment, road traffic and helicopter movements.

Noise and Vibration Emissions from demolition, site preparation, excavation, and construction - The impact of noise and vibration generated during the construction stages of the Project on surrounding noise and vibration sensitive premises.

The development will contribute to an increase in noise and vibration to the surrounding environment during Construction. Typically, this will result from a combination of intermittent and continuous noise from construction and excavation equipment, construction traffic and plant commonly used on construction sites.

Design noise and vibration targets have been set for the Project and construction noise impacts have been anticipated from standard construction procedures.

The noise and vibration targets and expected impacts are reported in Section 6.1 and Section 7 of this report. Where the noise and vibration impacts are predicted to be above the NMLs, then all reasonable and feasible noise and vibration mitigation measures must be considered as detailed in Section 7.5.

It is recommended that the Contractor prepares a comprehensive Construction Noise and Vibration Management Plan (CNVMP) based on their proposed plant, equipment, and construction methodology, prior to the commencement of any works.

3 Relevant Standards and Guidelines

The following acoustic standards and guidelines have been considered in establishing noise criteria and assessment for the proposed MHU and ED Works.

- [1] Broken Hill City Council, *Broken Hill Development Control Plan* (DCP), 2016
- [2] NSW EPA Noise Policy for Industry (NSW NPI) 2017.
- [3] NSW EPA Road Noise Policy (RNP) 2011.
- [4] NSW Department of Environment and Climate Change (DECC) "Interim Construction Noise Guideline" (ICNG) 2009.
- [5] NSW Department of Environment and Conservation (DEC) "Assessing Vibration: A Technical Guideline" (AVTG) 2006.
- [6] NSW Department of Planning "Development Near Rail Corridors and Busy Roads – Interim Guideline" 2008.
- [7] NSW Protection of the Environmental Operations (POEO) Act 1997.
- [8] Australian Standard AS 2107:2000 "Acoustics – Recommended design sound levels and reverberation times for building interiors".
- [9] Australian Standard AS 2021:2000 "Acoustics – Aircraft noise intrusion - building siting and construction".
- [10] Australian Standard "AS 2436 : Guide to Noise and Vibration Control on Construction, Demolition & Maintenance Sites" 2010.
- [11] Australian Standard "AS 1055 : Acoustics – Description and Measurement of Environment Noise" 1997.
- [12] Australian Standard "AS 2670.2 : Evaluation of human exposure to whole-body vibration – Part 2: Continuous and shock-induced vibration in buildings (1 to 80 Hz)" 1990.
- [13] British Standards Institution "BS 6472 – Evaluation of human exposure to vibration in buildings (1 Hz to 80 Hz)" 1992.
- [14] German Standard DIN 4150-3:1999 "Structural vibration Part 3: Effects of vibration on structures".
- [15] British Standard BS7385: Part 2: 1993 "Evaluation and measurement for vibration in buildings. Guide to damage levels from ground borne vibration".
- [16] NSW Health Infrastructure (HI) "Engineering Services Guidelines (ESG)", August 2022.
- [17] *"Australasian Health Facility Guidelines"* December 2012 Revision v.4.0.

3.1 Applicable Project Standards and Guidelines

Acoustic Consideration	Applicable Standard / Guideline	Relevant Section in Report
Construction Noise and Vibration		
Noise	Interim Construction Noise Guideline [4]	6.1 & 7
Vibration	Assessing Vibration, a Technical Guideline [5].	
Operational Noise Emissions		
General Operation	Noise Policy for Industry [2].	6.2 & 8
Sleep disturbance	Noise Policy for Industry [2]. Road Noise Policy [3].	
Plant and Equipment	Noise Policy for Industry [2].	
Traffic Noise generation (On site)	Noise Policy for Industry [2].	
Traffic Noise generation (Off site)	Road Noise Policy [3].	
External Noise Intrusion		
External Noise Intrusion	Engineering Services Guidelines [16]	6.3 & 9

Table 1: Applicable Project Standards and Guidelines

4 Site Details

4.1 Broken Hospital Site

The existing Broken Hill Hospital site is located at 176 Thomas St, Broken Hill, NSW. within an urban environment and is characterised by low to medium levels of general pedestrian and vehicle activity throughout the day / evening and low to very low noise levels in the night.

All project works will take place within this site boundary.

The following land uses immediately surround the Project site:

- R1 – Residential.

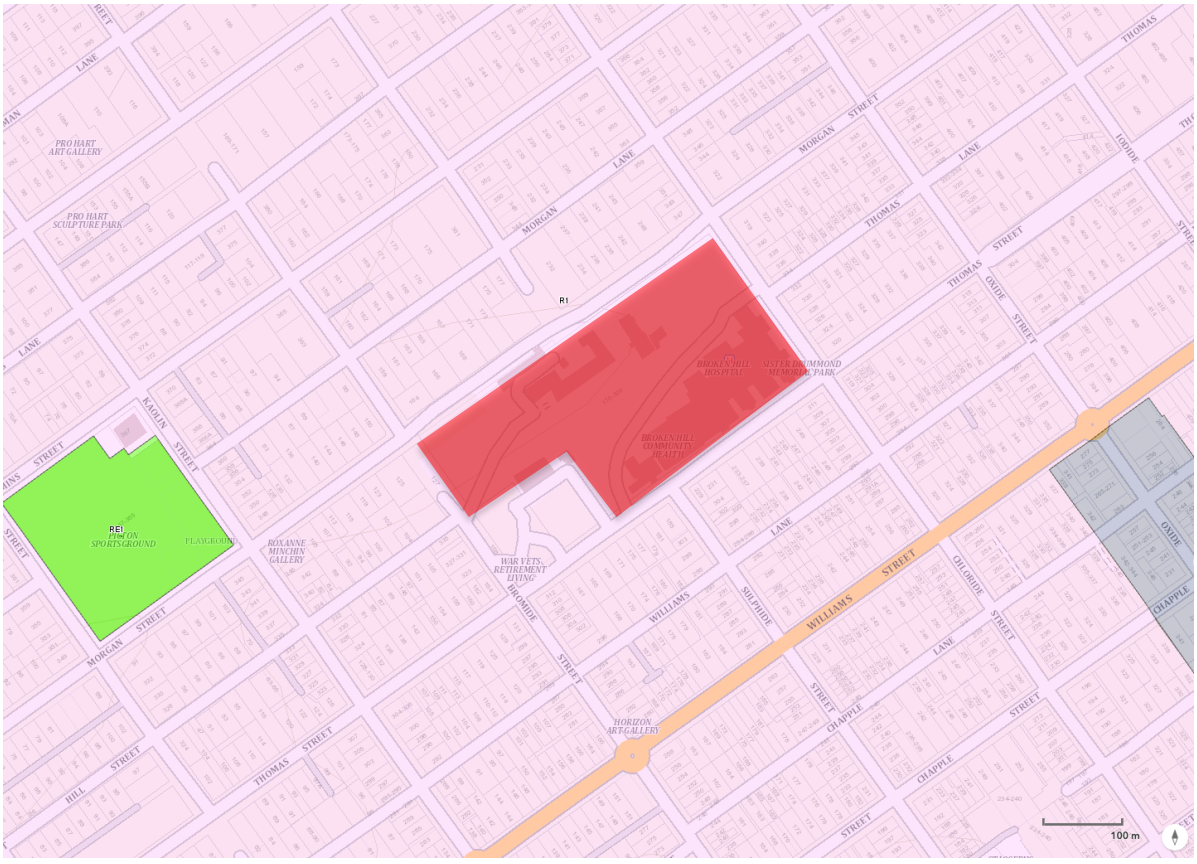


Figure 1: Broken Hill Hospital site (red shading) and surrounding land uses. Source NSW ePlanning Spatial viewer (https://www.planningportal.nsw.gov.au/spatialviewer/)

The project site is situated within an urban mixed-use residential zone characterised largely by residential buildings, plus commercial and medical facility land uses.

The following existing land uses surround the existing the project boundaries:

- To the North
    - Residential receivers across Morgan St
- To the North / North-East
    - Residential receivers across Chloride St
- To the East / Southeast / South
    - Residential receivers across Chloride and Thomas St
    - Private commercial businesses at 179 and 235 Thomas St
- To the South-west
    - Residential receivers at 168 Thomas St (retirement living)
- To the West
    - Residential receivers across Bromide and Morgan St.

A number of on-site receivers also exist, including:

- Staff accommodation quarters.
- Broken Hill University Department of Rural Health building.
- Far West Mental Health Café.
- Existing BHH buildings.

Figure 2 presents the project site in context of the surrounding land uses, as well as the long-term noise survey locations.

For the purposes of the assessment the residential areas have also been broken into two ‘catchment’ areas, which represent the approximate relative equal background noise environment within each catchment area.

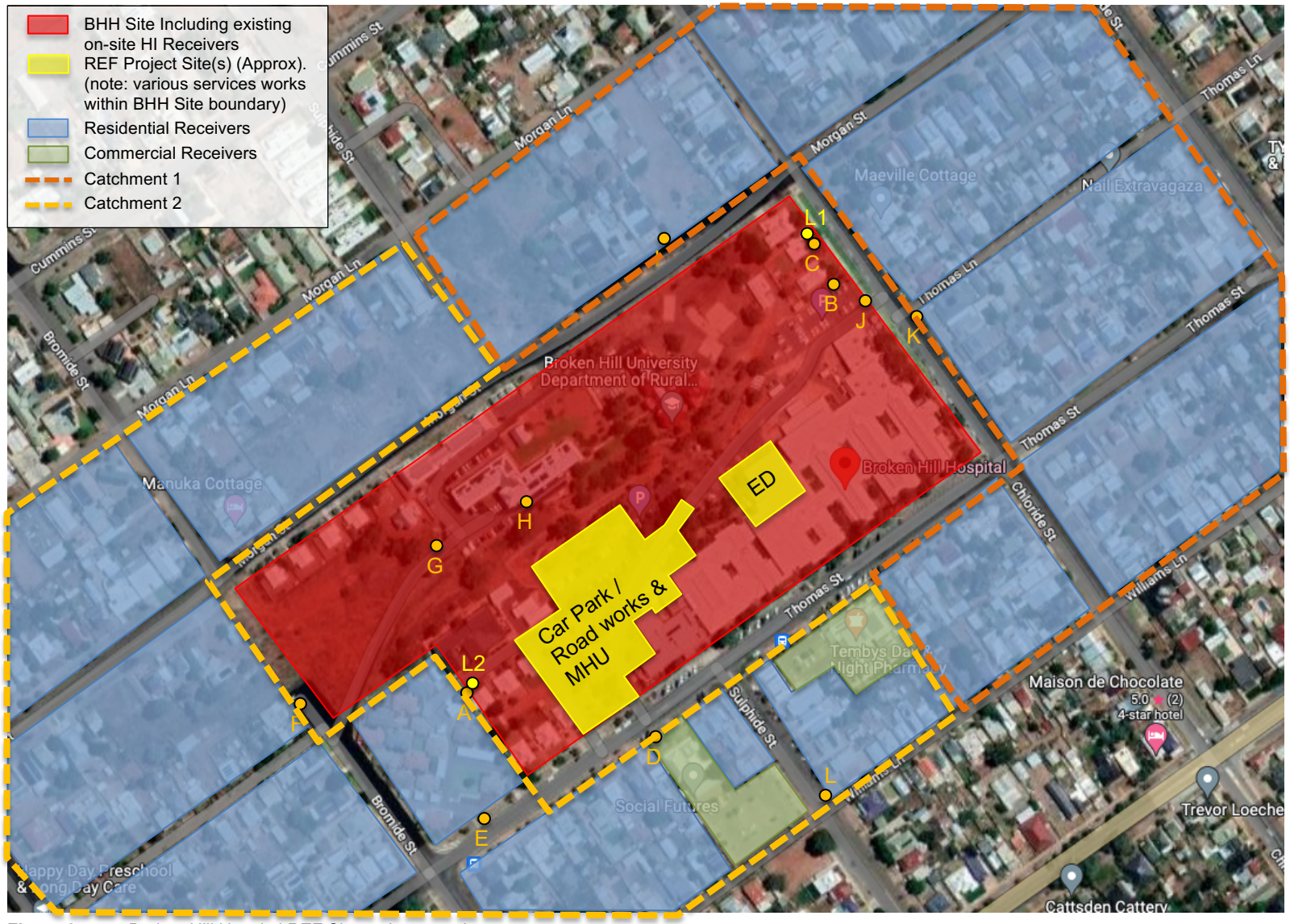


Figure 2: Broken Hill Hospital REF Site and surrounds

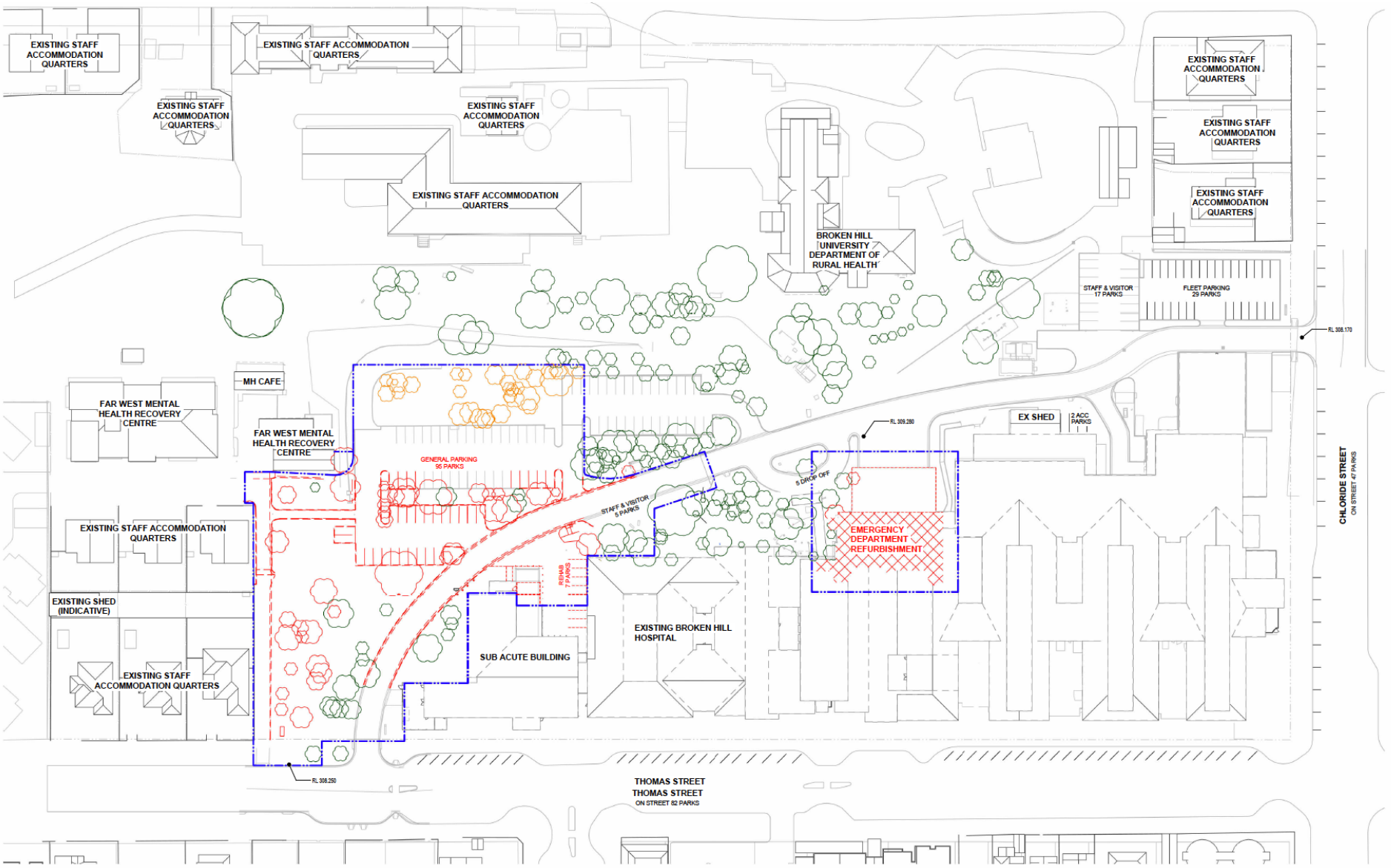


Figure 3: Broken Hill Hospital Existing Campus Buildings and Demolition Plan. Source STH Architects, 2023

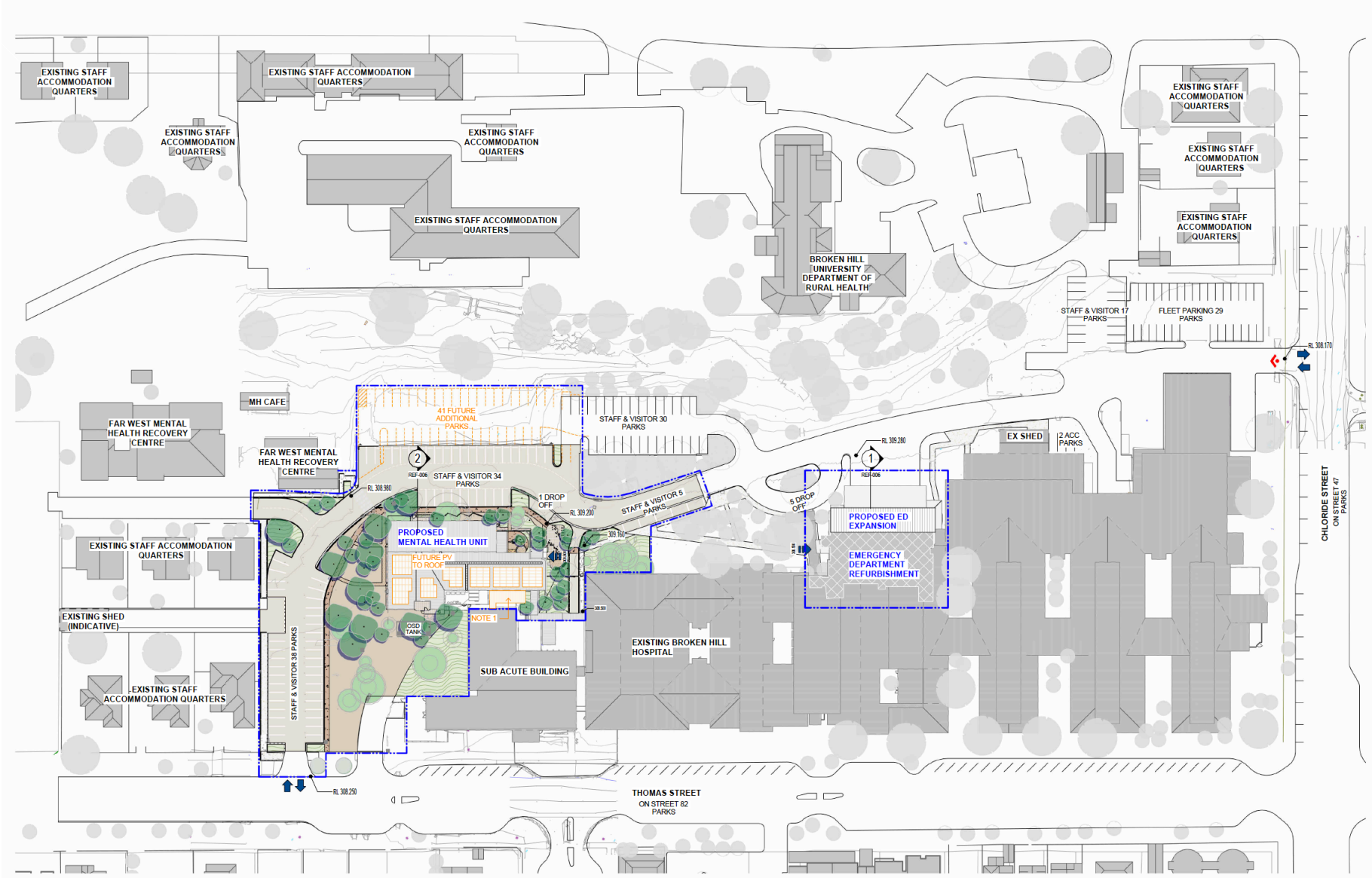


Figure 4: Broken Hill Hospital Site Plan and Proposed Works Area. Source: STH Architects 2023

4.2 Noise Sensitive Receivers and Proximity to Site

Table 2 outlines the most critical sensitive receivers surrounding the site(s) that will be potentially affected by noise (and vibration) from both construction and operation:

Receiver	Impact	Location/ Direction	Distance from site (m)		
			Car Park	MHU	ED
Residential	Airborne	N/NW (Catchment 1)	140	200	155
	Airborne	E/NE (Catchment 1)	130	240	170
	Airborne	S/SE (Catchment 2)	30	110	120
	Airborne	W/SW (Catchment 2)	50	140	250
Existing Hospital Campus Buildings	Airborne + Vibration	NW	10	60	50
	Airborne + Vibration	SE	10	10	10
	Airborne + Vibration	SW	10	60	140
Commercial	Airborne	S/SE	30	100	110

Table 2: Noise sensitive receivers and approximate distance to Project Site

5 Existing Noise Environment

5.1 General Survey Information

A survey of the existing noise environment at and around the site was conducted through unattended noise monitoring to continuously record the noise levels on the site.

Unattended long-term noise monitoring was carried out for the following periods:

- Thursday November 24 to Monday December 5, 2022.

The monitoring was undertaken at two locations, at the nearest most reasonably affected residential receivers surrounding the site to establish the typical range of ambient and background noise levels at receiver locations.

The monitoring was carried out with the following noise loggers:

- Logger L1: Svan 957 (Serial Number 27552)
- Logger L2: Svan 971 (Serial Number 82492).

The noise loggers recorded LA1, LA10, LA90, and LAeq noise parameters at 15-minute intervals continuously for the measurement period. The calibration of the loggers was checked before and after use and any variations noted were within tolerance.

Operator attended, short-term monitoring was also carried out as follows:

The short term monitoring was conducted in order to supplement the long-term outdoor data across the site and at key surrounding receivers, and to obtain spectral noise data for traffic noise at the proposed site. These short-term measurements included measurements at the property boundaries of the closest residential properties, which were used to confirm that the long-term monitoring at each location (on the opposite side of the street) is representative of the background and ambient noise levels at the nearest noise sensitive receivers.

Attended short-term measurements were made with a Brüel & Kjær Hand-held Analyser Type 2250 (Serial Number 3010734).

The calibration of the analyser was checked before and after the surveys and no variation in levels occurred.

Windshields were used to protect the microphones of all the loggers and analyser.

Weather conditions were generally calm and dry during the attended noise surveys, and therefore the data captured was not affected by weather.

Isaac Bradbury of Acoustic Studio Pty Ltd carried out the surveys.

5.2 Noise Monitoring Locations

Figure 2 displays the location of the noise monitoring. Appendix A provides further detailed information about logger locations.

These locations were chosen as they:

- were secure places to leave the noise loggers unattended, and
- were judged to provide representative of background and ambient noise levels at the nearest noise sensitive receivers.

For residential receivers, noise loggers L1 and L2 were installed at locations considered representative of the nearest, reasonably most - or potentially most - affected residences as detailed in the NPI:

- Logger L1 was installed in the front yard of 343 Chloride St, which was chosen as it was accessible by the BHH staff, being on-site accommodation, was shielded from any major existing plant and equipment, and was equidistant to the centre of the Chloride St, experiencing the same traffic noise levels as those residents on the opposite side of the road, providing a representative noise environment measurement.
- Logger L2 was installed at the rear entrance of 168 Thomas St, and was chosen as it represents the nearest, most affected residences within the same block as the project site (being at the border of the Southern Cross Care Retirement Living property).
- Residents to the north and south of the site were considered less effected, as they would generally be shielded from the project works or are exposed to higher background noise levels as follows:
    - Morgan St – shielded by the steep hill / embankment to the north
    - Thomas St - generally shielded by the existing BHH, and are exposed to traffic noise

5.3 Unattended Long-term Monitoring Results

5.3.1 Background and Ambient Noise

The detailed results of the unattended long-term noise monitoring at the two (2) logger locations are shown in Appendix B.

The logged data shows the background and ambient noise levels representative of the area. The recorded background noise levels have been used to establish noise targets for noise emitted from the Early Works construction.

The background sound level is defined as the sound level exceeded 90% of the time, and is designated as the L_{90}. The Rating Background Noise Level (RBL) provides a single figure that represents the background noise level over the entire monitoring period for assessment purposes. The ambient noise level impacting on the buildings is referred to as the equivalent continuous sound level (L_{eq}). This parameter is commonly used to describe a time varying noise such as traffic noise.

The background sound levels have been established in general accordance with the methodology described in the NSW Noise Policy for Industry (NPI), i.e. the 10th percentile background sound level for each period for each day of the ambient noise survey. The median of these levels is then presented as the background sound level for each assessment period.

These background noise levels are shown in Table 3 below, together with the L_{Aeq} ambient noise levels measured for each period.

Location	Ambient Noise Levels Leq, dB(A)			Rating Background Noise Levels (RBL), dB(A)		
	Day 7am-6pm	Evening 6pm-10pm	Night 10pm-7am	Day 7am-6pm	Evening 6pm-10pm	Night 10pm-7am
L1	57	51	45	38	36	31
L2	48	43	43	38	38	35

Table 3: NPI background noise levels

5.4 Short-term Monitoring Results

12 short-term noise monitoring locations were chosen as representative of the site and surrounds (as displayed in Figure 2), plus to supplement and validate the logger data. The results are as follows:

Location	Start Time and Duration	Descriptor	Measured sound level, dB re 20 µPa										Comments
			Overall dB(A)	Octave band centre frequency, Hz									
				31.5	63	125	250	500	1k	2k	4k	8k	
A	24/11/2022 10:46 00:30:46	Leq	42	52	49	43	39	36	36	34	35	28	Logger L2 position. Light wind in trees. Birds. No traffic noise. Calm weather.
		L90	49	48	42	38	36	32	31	27	23	15	
B	24/11/2022 11:44 00:22:29	Leq	52	63	60	58	51	48	47	43	38	32	Corner of BHH eastern carpark. Mech noise from BHH chillers audible. Intermittent slow moving traffic noise. Calm weather.
		L90	60	58	52	53	44	42	41	34	29	18	
C	24/11/2022 12:09 00:25:12	Leq	52	62	60	52	49	47	47	44	42	38	Logger L1 position. Light wind in trees. Birds. No traffic noise. Calm weather.
		L90	54	52	48	39	35	32	30	27	23	17	
D	24/11/2022 13:32 00:15:02	Leq	57	60	65	62	55	53	54	48	42	38	181 Thomas Street, near the Broken Hill Medical centre. Minimal noise from intermittent traffic, mechanical. Calm weather.
		L90	58	56	51	46	41	38	36	31	25	15	
E	24/11/2022 13:51 00:07:42	Leq	60	62	64	58	61	55	55	52	48	44	168 Thomas St, Southern Cross Care. Intermittent light traffic.
		L90	51	48	46	42	38	35	33	30	27	16	
F	24/11/2022 14:02 00:05:08	Leq	46	51	57	55	46	41	41	36	30	29	337 Bromide St. Quiet area. Calm Weather.
		L90	48	44	43	40	36	33	33	26	20	14	
G	24/11/2022 14:11 00:03:55	Leq	47	57	53	48	45	43	42	40	36	30	West of BHH, near staff accom / Broken Hill University. Higher background noise from distant urban hum and ac from BHH down below.
		L90	52	50	46	44	41	38	36	29	23	15	

Location	Start Time and Duration	Descriptor	Measured sound level, dB re 20 µPa										Comments
			Overall dB(A)	Octave band centre frequency, Hz									
				31.5	63	125	250	500	1k	2k	4k	8k	
H	24/11/2022 14:21 00:08:48	Leq	49	60	56	48	45	44	43	41	41	32	Near staff accommodation / Broken Hill University elevated location overlooking BHH. Light leaves in trees noise. Noise from BHH car park and light mechanical noise.
		L90	57	55	51	44	43	41	40	37	34	24	
I	24/11/2022 14:35 00:06:26	Leq	48	54	52	49	48	45	45	34	27	20	242 Morgan St. Quiet traffic noise. Calm weather. distant mech noise from hospital.
		L90	52	51	45	41	35	29	26	22	18	13	
J	24/11/2022 14:47 00:01:02	Leq	51	58	57	51	48	50	45	42	36	26	Mech noise from existing BHH building and chillers. Opposite eastern car park entrance.
		L90	59	55	53	48	45	49	43	40	34	24	
K	24/11/2022 14:51 00:05:13	Leq	57	61	63	60	55	53	52	49	44	36	332 Chloride St. Light intermittent traffic. BHH mech.
		L90	56	53	51	48	46	42	38	34	28	21	
L	24/11/2022 15:08 00:05:06	Leq	60	58	66	66	61	58	53	48	43	34	Cnr Sulphide St. and Williams Ln. Light intermittent traffic. Birds. Calm weather. Traffic from Williams St more constant.
		L90	53	49	50	43	39	35	35	29	28	16	

Table 4: Attended measurement results

5.5 Traffic Noise

Based on the unattended noise monitoring data and the attended measurements in Section 5, the Day and Night traffic periods are summarised in Table 5 below.

We consider this representative of the roads surrounding the BHH, as observed traffic volumes on both Chloride St and Thomas St were similar.

Location	Traffic Noise Levels[1], dB(A)			
	1 Hour Period		Period[2]	
	Day $L_{eq, (1\ hr)}$	Night $L_{eq, (1\ hr)}$	Day $L_{eq, (15\ hr)}$	Night $L_{eq, (9\ hr)}$
L1	53	46	54	45

Table 5: Summary of measured traffic noise levels

[1] Levels at 7m distance from centre of the closest lane

6 Project Specific Noise Criteria

6.1 Construction Noise and Vibration

6.1.1 Noise Management Levels

The relevant guideline applied for the assessment of construction noise is the ICNG. This guideline provides construction NMLs for Residential, Commercial and Industrial noise receivers as follows.

6.1.1.1 Residential Receivers

Section 4 of the ICNG provides recommendations for standard hours of work and suggests construction NMLs that aim to minimise the likelihood of annoyance caused to noise sensitive receivers. These consider both airborne and ground borne noise level impacts.

Table 6 outlines the methodology for determining construction NMLs at nearby residential receivers surrounding the development site based on existing background noise levels.

Time of Day	Management level $L_{Aeq\ (15\ min)}$	How to Apply
Recommended standard hours: Monday to Friday 7 am to 6 pm Saturday 8 am to 1 pm No work on Sundays or public holidays	Noise affected RBL + 10 dB	The noise affected level represents the point above which there may be some community reaction to noise. • Where the predicted or measured $L_{Aeq\ (15\ min)}$ 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 75dB(A)	The highly noise affected level represents the point above which there may be strong community reaction to noise. • Where noise is above this level, the relevant authority (consent, determining or regulatory) may require respite periods by restricting the hours that the very noisy activities can occur, taking into account: 1. Times identified by the community when they are less sensitive to noise (such as before and after school for works near schools, or mid-morning or mid-afternoon for works near residences 2. If the community is prepared to accept a longer period of construction in exchange for restrictions on construction times.
Outside recommended standard hours:	Noise affected RBL + 5 dB	• A strong justification would typically be required for works outside the recommended standard hours. • The proponent should apply all feasible and reasonable work practices to meet the noise affected level. • Where all feasible and reasonable practices have been applied and noise is more than 5 dB(A) above the noise affected level, the proponent should negotiate with the community. • For guidance on negotiating agreements see section 7.2.2.

Table 6: Residential construction noise criteria for airborne noise as outlined in the ICNG

The project-specific construction Noise Management Levels are shown in Table 7 based on the measured background noise levels at the site.

Location	Period		Rating Background Level RBL, dB(A)	Resulting NML $L_{eq\ (15\ min)}$ dB(A)
Residential Catchment 1 + 2	Recommended Standard Hours	Monday to Friday 7am to 6pm	38	RBL + 10 / 48
		Saturday 8am to 1pm	38	RBL + 10 / 48
Residential Catchment 1	Outside Recommended Standard Hours	Monday to Friday 6am to 7am	31	RBL + 5 / 36
		Saturday 6am to 7am	31	RBL + 5 / 36
		Saturday 7am to 8am	31	RBL + 5 / 36
		Saturday 1pm to 6pm	37	RBL + 5 / 42
		Sunday 6am to 7am	32	RBL + 5 / 37
		Sunday 7am to 6pm	35	RBL + 5 / 40
Residential Catchment 2		Monday to Friday 6am to 7am	35	RBL + 5 / 40
		Saturday 6am to 7am	34	RBL + 5 / 39
		Saturday 7am to 8am	34	RBL + 5 / 39
		Saturday 1pm to 6pm	37	RBL + 5 / 42
		Sunday 6am to 7am	35	RBL + 5 / 40
		Sunday 7am to 6pm	37	RBL + 5 / 42

Table 7: Project Specific residential construction noise management levels for airborne noise

The ICNG also recommends *ground-borne* noise management levels at residences affected by nearby construction activities. Ground-borne noise is noise generated by vibration transmitted through the ground into a structure and can be more noticeable than airborne noise.

The ground-borne noise levels presented below are for evening and night-time periods only, as the objective is to protect the amenity and sleep of occupants during the more sensitive time periods.

Time of Day	Noise Management level L_{Aeq} (15 min)
Evening (6pm to 10pm)	40 dB(A) - Internal
Night (10pm to 7am)	35 dB(A) - Internal

Table 8: Residential construction noise criteria for ground-borne noise

6.1.1.2 Non-Residential Receivers: Commercial, Industrial and Educational Receivers

The ICNG also provides recommended construction noise management levels for commercial, industrial and educational facilities surrounding a construction site, which are as follows:

Occupancy	Management level L_{Aeq} (15 min)
Industrial premises	75 dB(A) - External
Offices, retail outlets	70 dB(A) - External
Classrooms at schools and other educational institutions	45 dB(A) - Internal / 55 dB(A) - External[3]
Hospital Wards and operating Theatres	45 dB(A) - Internal / 65 dB(A) - External[4]
Place of worship	45 dB(A) - Internal
Passive recreation areas	60 dB(A) - External

Table 9: Industrial, commercial, educational and hospital construction noise criteria for airborne noise

6.1.1.3 Construction Noise Impacts on Existing Broken Hill Hospital Campus

The ICNG does not provide specific guidance for hospitals, other than recommending an internal noise "management level" of 45 dB(A) for wards and operating theatres, above which the proponent is to consult with the health authority to determine ways to manage construction noise impacts.

There are a number existing hospital uses and activities that could be affected by construction noise, in addition to wards and operating theatres outlined in Table 9. For this project, it is recommended that the ICNG internal management level of 45 dB(A) is adopted for the existing Broken Hill Hospital buildings, including a corresponding external management level of 65 dB(A).

[3] Where internal noise levels are specified, the NSW NPI assessment methodology states that in cases where the gaining of internal access for monitoring is difficult, then external noise levels 10 dB above internal noise levels apply assuming a window opened sufficiently to provide ventilation.

[4] For hospitals, where windows are typically fixed (inoperable), it is assumed that the weakest building element (typically glazing) will provide a minimum of 20 dB(A) sound reduction. Therefore, external levels are based on an internal noise level plus 20 dB.

6.1.1.4 Construction Traffic Noise

The Road Noise Policy is applicable to traffic-generating developments including major road infrastructure developments. The emphasis is on achieving a reasonable balance between what is achievable on different road types and the sensitivity of different receiver types to road traffic noise. This is not directly relevant to the ED works.

In the absence of directly applicable guidelines, policies or standards for assessing road traffic noise impacts from the construction activities, Acoustic Studio's approach is to examine the increase in traffic noise events and levels for most-affected sensitive receivers. Section 3.4 of the RNP provides guidance on assessing the impact of increases in road traffic noise levels due to a project.

When considering land use redevelopment and the impact on sensitive land uses (residential / schools / hospitals / recreational) the RNP guideline Section 3.4 states that *"In assessing feasible and reasonable mitigation measures, an increase of up to 2 dB"... (in relation to existing noise levels)... "represents a minor impact that is considered barely perceptible to the average person".*

Acoustic Studio notes that a 2dB increase is associated with more than 60% increase in traffic numbers (all other factors being equal, such as speeds and type of vehicle).

The RNP provides criteria for traffic noise from new roads or additional traffic generated on roads from land use development. The criterion applies to additional traffic generated on public roads from construction vehicles / traffic.

Table 10 below provides the RNP criteria for additional traffic generated on local roads from land use development in relation to the applicable receiver types surrounding the site.

Receiver	Assessment Criteria (external[5])	
	Day (7am to 10pm) $L_{Aeq\ (period)}$	Night (10pm to 7am) $L_{Aeq\ (period)}$
Residential	60 (15 hour)	55 (9 hour)
Hospital Wards	55 (1 hour)	55 (1 hour)
School classrooms (Educational)	60 (1 hour)	-
	55 (1 hours) – Sleeping Rooms	-
Childcare Centres	60 (1 hours) – Indoor Play	-
	55 (1 hour) Outdoor Play	-

Table 10: RNP assessment criteria for additional traffic on local roads generated by land use development including construction vehicles / traffic

When considering land use redevelopment and the impact on sensitive land uses (residential / schools / hospitals / recreational) the RNP guideline states that *"In assessing feasible and reasonable mitigation measures, an increase of up to 2 dB"... (in relation to existing noise levels).. "represents a minor impact that is considered barely perceptible to the average person".*

[5] Non-residential external noise criteria are derived from internal noise criteria, assuming a transmission loss of 10dBA if windows are opened to provide natural ventilation (worst-case) and 20dBA if the windows are closed or external façade is glazing. This methodology is supported by the NPI.

6.1.2 Construction Vibration

Construction vibration is to be assessed in terms of:

- Human comfort
- Disruption to sensitive equipment (applicable to surrounding BHH buildings)
- Structural damage

Relevant criteria for each of these are detailed in the sections that follow.

6.1.2.1 Human Comfort

The Department of Environment and Conservation (DEC) "Assessing Vibration: A Technical Guideline", (2006) provides suitable criteria that can be applied to the assessment of vibration and human comfort. The guideline makes reference to the British Standard BS 6472: 1992, which shares many similarities to the Australian Standards AS 2670.2: 1990. This guideline presents preferred and maximum vibration values for use in assessing human responses to vibration plus limits for critical areas in hospital and educational buildings, and provides recommendations for measurement and evaluation techniques.

Vibration in buildings can be caused by many different external sources, including industrial, construction and transportation activities. The vibration may be continuous (with magnitudes varying or remaining constant with time), impulsive (such as in shocks) or intermittent (with the magnitude of each event being either constant or varying with time). Vibration in buildings may also occur from internal sources (within a building structure), such as building services and plant. As well as being sensitive to vibration, medical equipment can also be the source of vibration within the building.

Vibration and its associated effects are usually classified as continuous, impulsive or intermittent:

- **Continuous vibration** 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.
- **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.
- **Intermittent vibration** can be 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.

The criterion also considers the type of vibration being assessed, namely continuous, impulsive and intermittent vibration. Examples of these vibration types are provided in Table 11 below.

Continuous	Impulsive	Intermittent
Machinery, steady road traffic, continuous construction activity (such as tunnel boring machinery).	Infrequent: Activities that create up to 3 distinct vibration events in an assessment period, e.g. occasional dropping of heavy equipment, occasional loading and unloading.	Trains, nearby intermittent construction activity, passing heavy vehicles, forging machines, impact pile driving, jack hammers. Where the number of vibration events in an assessment period is three or fewer this would be assessed against impulsive vibration criteria.

Table 11: Examples of vibration types

The relevant criteria for human exposure to continuous and impulsive vibration are detailed in Table 12. Vibration levels are assessed through the consideration of the summation of effects for vibration levels at frequencies from 1 to 80 Hz for all axes.

Location	Assessment period	Preferred Values		Maximum Values	
		z-axis	x- and y-axes	z-axis	x- and y-axes
Continuous vibration					
Critical areas	Day or night time	0.10	0.072	0.20	0.14
Residences	Day time	0.20	0.14	0.40	0.28
	Night time	0.14	0.10	0.28	0.2
Offices, schools, educational institutions and places of worship	Day or night time	0.40	0.28	0.80	0.56
Workshops	Day or night time	0.80	0.58	1.6	1.16
Impulsive vibration					
Critical areas	Day or night time	0.10	0.072	0.20	0.14
Residences	Day time	6.0	4.2	12.0	8.4
	Night time	2.0	1.4	4.0	2.8
Offices, schools, educational institutions and places of worship	Day or night time	13.0	9.2	26.0	18.4
Workshops	Day or night time	13.0	9.2	26.0	18.4

Table 12: Preferred and maximum weighted rms values for continuous and impulsive vibration velocity (mm/s) 1-80 Hz

Human exposure to intermittent vibration is assessed using the Vibration Dose Value (VDV). The VDV accumulates the vibration energy experienced over an extended period (daytime and night-time periods) from intermittent events. Table 13 sets out the acceptable VDV values for intermittent vibration.

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

Table 13: Acceptable vibration dose values for intermittent vibration (m/s1.75)

6.1.2.2 Sensitive Equipment

Areas of the existing BHH campus (see Section 6.1.2.5) with sensitive equipment are likely to require a higher degree of vibration isolation than the values outlined in Table 12 and Table 13.

Vibration Criterion (VC) curves are used to provide the basis for the design and protection of highly vibration sensitive equipment. Table 14 details the VC curves applicable to a range of highly sensitive equipment that is to be referred to and considered in conjunction with manufacturer guidelines specific to each type of equipment.

Curve	Max Value 8-80Hz	Detail Size	Equipment Types / Requirements
	Microns / sec, rms	Microns	
VC-A	50	8	Bench Microscopes < 400 x Magnification, optical and other precision balances, coordinate measuring machines and optical comparators
VC-B	25	3	Bench Microscopes > 400 x Magnification, microsurgery and neurosurgery
VC-C	12.5	1	Electron Microscopes < 30,000 x magnification, magnetic resonance imagers and microelectronics manufacturing equipment
VC-D	6	0.3	Electron Microscopes > 30,000 x magnification, mass spectrometers and cell impact equipment
VC-E	3	0.1	Un Isolated laser and optical research systems

Table 14: VC Curves for Highly Sensitive Equipment

Figure 5 shows the relationship between criteria for highly sensitive equipment and human exposure criteria shown in Table 12.

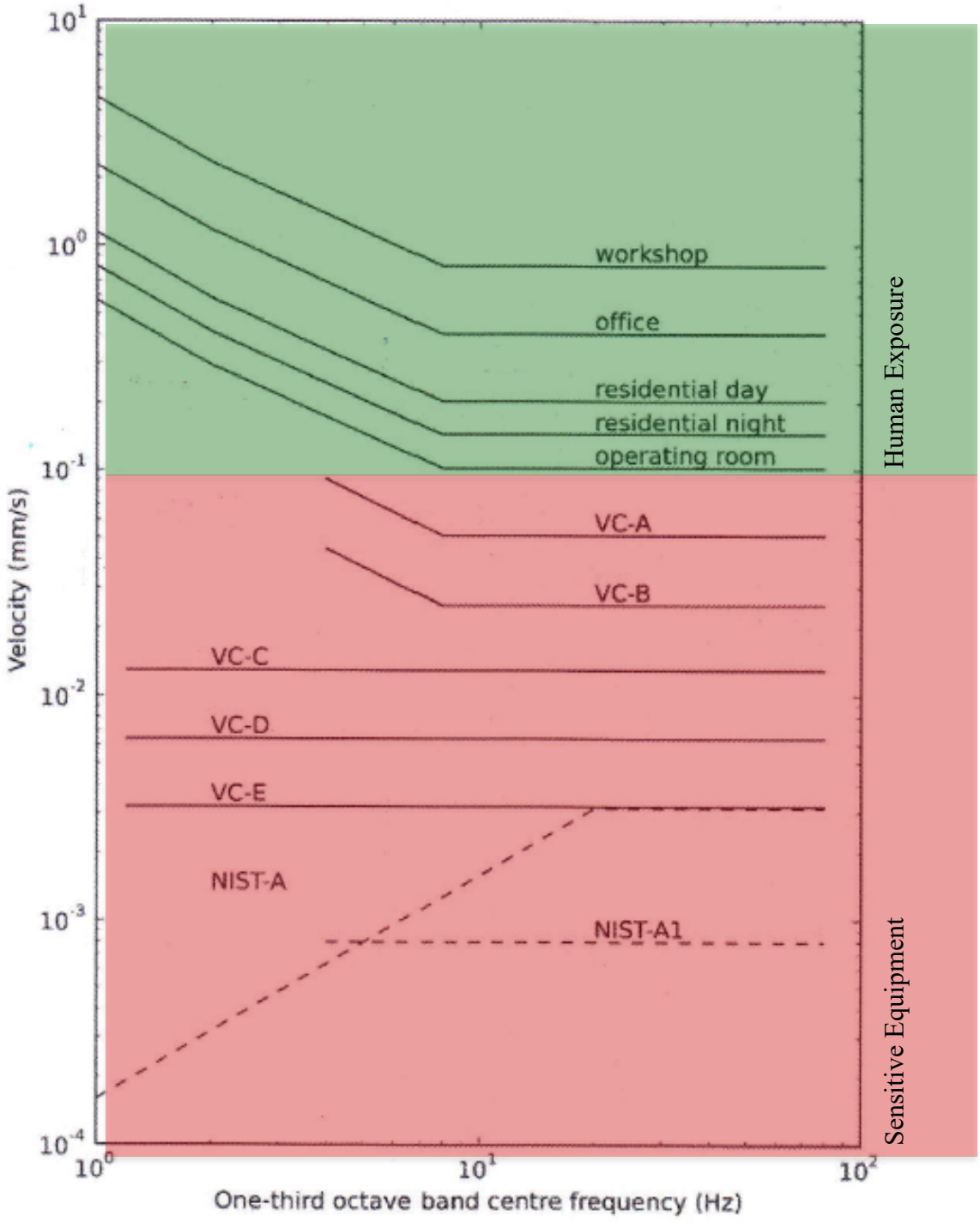


Figure 5: VC Curves - Source: ANC Guidelines – Measurement and Assessment of Ground-borne Noise & Vibration, Association of Noise Consultants (2012)

6.1.2.3 Structural Damage

Vibration-induced damage of buildings and structures is a common concern, but it is actually rare in practice. This explains why there is limited reliable data on the threshold of vibration-induced damage in buildings and there is no directly relevant Australian Standard. There are guidelines available in a number of international standards, although these vary significantly.

Table 15 gives a summary of vibration limits recommended in relevant standards and guidelines for minimising the risk of vibration-induced damage to buildings.

Standard	Type of building	Recommended vibration limit	Comments
DIN 4150	Structures of particular sensitivity or worthy of protection	3 mm/s to 20 mm/s @ < 10 Hz 3-40 mm/s @ 10-50 Hz 8-50 mm/s @ 50 Hz+ Also measurement at the top floor with limit of 8 mm/s to 40 mm/s across frequency range	Limit is for peak particle velocity in x,y, and z directions. Measurement on the top floor in x and y directions only
BS 7385	Un-reinforced or light framed	15 mm/s @ 4 Hz rising to 20 mm/s @ 15 Hz then rising to 50 mm/s @ 40 Hz and above[1]	Limit is for peak particle velocity in x, y, and z directions
AS 2187	Houses and low-rise residential, commercial buildings not of reinforced or steel construction	5 mm/s[1]	For buildings particularly susceptible to vibration. Limit is for peak *resultant* particle velocity, measured on the ground adjacent to the structure
SN 640 312	Structures of particular sensitivity	3 mm/s to 12 mm/s @ 10-30 Hz 3 mm/s to 18 mm/s @ 30-60 Hz	Limit is for peak particle velocity in x, y, and z directions

Table 15: Summary of vibration limits

6.1.2.4 Recommendations

It is clear from the above that relevant standards provide a wide range of suggested vibration limit values for structural damage, but the actual risk of vibration-induced damage is relatively low.

It is recommended that a precautionary approach for managing vibration-induced damage be taken for this project, whereby conservative vibration criteria are adopted in the first instance. It would be possible to relax these criteria if required, subject to review of specific buildings by a structural engineer and a regime of vibration monitoring.

The recommended precautionary criteria are:

- 3 mm/s (130 dB re 10^{-6} mm/s) for buildings surrounding the project site identified as "sensitive". At this stage no structures at or surrounding the site have been identified as particularly sensitive to vibration-induced damage.
- 5 mm/s (134 dB re 10^{-6} mm/s) for residential dwellings.
- 20 mm/s (146 dB re 10^{-6} mm/s) for classrooms, non-precision laboratories and commercial premises.

These limits apply across the full frequency range of relevance (i.e. typically 1 Hz – 100Hz encountered in building construction).

6.1.2.5 Additional Criteria

The following outlines areas that we understand to have specific sensitivity to vibration.

Objective requirements will need to be confirmed from relevant stakeholders prior to works commencing on site, and incorporated within the CNVMP.

- Medical Imaging

The Contractor will need to consider the relevant campus areas where sensitive equipment is located and the equipment-specific vibration criteria to be set and managed accordingly.

6.2 Operational Noise Emissions

6.2.1 General Noise

6.2.1.1 NSW Noise Policy for Industry

The NSW NPI provides guidance on methodology for determining project-specific noise trigger levels or targets for external noise emissions from plant associated with a development.

The criteria have two components:

- Intrusiveness Noise Level – controlling intrusive noise impacts in the short term for residences.
- Amenity Noise Level (ANL) – maintaining noise level amenity for particular land uses for residences and other land uses.

Applying the more stringent of the two criteria provides the Project Noise Trigger Level (PNTL).

The NSW NPI considers the following when establishing the criteria:

- The existing Ambient (L_{eq}) and Background noise levels (L_{90}) that surround the site.
- The time of day that the noise generating development will be in operation, defined by the following:
    - Day (7am to 6pm).
    - Evening (6pm to 10pm).
    - Night (10pm to 7am).
- The type of receivers.
- The type of area that the development site and its nearest receivers are located. The NSW NPI provides recommended noise levels for specific receiver types and the type of area they are located within.
- The type of noise source and its characteristics. The NSW NPI provides modifying factors for noise sources with certain characteristics that may potentially cause greater annoyance than other noise sources of the same level.

Further guidance on establishing the criteria can be found in the NSW NPI.

6.2.1.2 Noise Impacts on the Surrounding Community

Based on the measured noise levels detailed in Section 5 and in accordance with the methodology outlined in the NSW NPI (further described in Appendix C), Table 16 details the corresponding targets of allowable noise emission from external plant and equipment at the nearest receiver boundaries from the Hospital.

Receiver (External)	Period	Project Noise Trigger Level (PNTL) $L_{eq(15min)}$ dB(A)
Residential Catchment 1	Day	43
	Evening	41
	Night	36
Residential Catchment 2	Day	43
	Evening	43
	Night	40
Hospital Ward	When in use	48
Commercial Premises	When in use	63

Table 16: NSW NPI Project Noise Trigger Levels for external noise emissions from proposed development

6.2.1.3 Noise Impacts on the Existing BHH

Redevelopment of any site must consider all neighbouring receivers. When the redevelopment site is an extension of an existing campus, neighbouring receivers will include existing "on-campus" buildings. However, compliance with the NPI PTNL in Table 16 is discretionary.

A target noise level of 55 dB(A) is recommended at external occupied and trafficable areas surrounding existing BHH buildings. This is based on observations of pre-existing conditions made by Acoustic Studio during site inspections and noise surveys at the BHH.

This target also applies to external areas for the proposed MHU.

Applying these noise targets at the nearest BHH buildings will generally achieve the PTNLs at other receivers.

6.2.2 Sleep Disturbance (residential receivers)

Noise sources with the potential for sleep disturbance are likely to occur during night-time period operational (10pm to 7am) and construction works (6am to 7am) activities.
The NSW NPI provides guidance on the assessment of sleep disturbance based on the predicted event $L_{Aeq,15min}$ and/or L_{AFmax} noise levels at the receiver that are considered applicable to the SSDA. It suggests a Sleep Disturbance Screening Criteria of:

- *Event LAeq,15min 40 dB(A) or Night Time RBL+ 5 dB, whichever is the greater, and/or*
- *Event LAFmax 52 dB(A) or Night Time RBL + 15 dB, whichever is the greater.*

If the event $L_{Aeq,15min}$ noise level above background is less than 5 dB and/or maximum noise emergence above background is less than 15 dB, then the noise is considered unlikely to cause sleep disturbance. If the screening test level is exceeded, then further assessment of sleep disturbance effects is warranted.

The Sleep Disturbance Screening Criteria are presented in Table 17.

Receiver Location	Period	Sleep Distrubance Screening Criteria	
		$L_{Aeq,15min}$ dBA	L_{AFmax}, dBA
Residential Catchment 1	Night (10pm to 7am)	41	52
Residential Catchment 2	Night (10pm to 7am)	45	55

Table 17: Sleep Disturbance Screening Criteria

The Sleep Disturbance Screening Criteria $L_{Aeq,15min}$ and L_{AFmax} not exceeding the $L_{A90,\ (15\ minute)}$ by more than 5 dB(A) and 15 dB(A) respectively are screening criteria for the purpose of assessing potential impacts from a project. It applies outside bedroom windows during the night-time period.

If the Sleep Disturbance Screening Criteria is exceeded, the detailed analysis is to cover the extent to which the noise level exceeds the background level and the number of times this happens during the night-time period. Some guidance on possible impact is contained in the review of research results in the RNP.

Other factors that may be important in assessing the extent of impacts on sleep include:

- How often high noise events will occur;
- Time of day (normally between 10pm and 7am);
- Whether there are times of day when there is a clear change in the noise environment (such as during early morning shoulder periods).

A further consideration for sleep awakening is whether the environmental noise has changed. Section 5.3 “Response to a Change in Noise Level” of the RNP states:

"While people may express a certain tolerance for their existing noise environment, they may feel strongly about increases in noise. […] The difference in reported awakenings from sleep was equivalent to a difference of 7 dB(A) in maximum noise levels."
Section 5.4 of the RNP, "Sleep Disturbance", states that:
"From the research on sleep disturbance to date it can be concluded that:

- *Maximum internal noise levels below 50–55 dB(A) are 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."*

The internal noise levels provided in the RNP are related to potential sleep awakening.

Typically noise impact assessments consider the worst-case scenario, including when residential receivers have windows open sufficiently to provide natural ventilation. This would result in approximately 10 dB(A) attenuation from outside to inside through the open window. This situation is considered likely during warmer seasons. When windows are closed, the likely sound attenuation through standard windows with poor seals (common in older houses) is approximately 20 dB(A).

Based on a minimum attenuation of 10 dB(A) with windows open, the first conclusion of the RNP suggests (extract from RNP Section 5.4 above) that short term external noises of 60 to 65 dB(A) are unlikely to cause awakening reactions. In addition, external levels of 75 to 80 dB(A) are unlikely to affect health and wellbeing significantly, provided that these events occur no more than twice in one night.

Receiver Location	Period	Sleep Awakening Level[6] L_{AFmax}, dB(A)
Residential (all)	Night (10pm to 7am)	60 to 65

Table 18: Sleep Awakening Level

6.2.3 Traffic Noise

6.2.3.1 NSW Road Noise Policy

The RNP provides criteria for traffic noise from new roads or additional traffic generated on roads from land use development. The relevant criteria is as per construction traffic noise criteria outlined in Section 6.1.1.4

[6] External noise criteria assuming minimum attenuation of 10 dB(A) with windows open.

6.3 External Noise Intrusion

The NSW HI Engineering Services Guidelines (ESG) aim to provide a performance based guide for the development of design and specification documentation for health care facilities. The ESGs recommend internal noise level design criteria within hospitals for helicopter noise intrusion. Table 19 provides recommended maximum internal design sound levels corresponding to the key spaces within hospital buildings.

Room Type	Recommended Design Sound Level			
	Continuous Internal Noise, dBL_{Aeq}		Intermittent Noise Levels, L_{Amax} dB	Emergency Generator Noise Level L_{Amax} dB above max continuous level
	Satisfactory	Maximum		
Clinical				
Patient Room / Single Bed Ward	35	40	55	+ 5
Multi Bed Ward	35	40	55	+ 5
Toilet / En-suite	50	55	-	+ 10
Patient Corridor	40	45*	-	+ 10
Counselling / Interview Room	40	45	60	+ 5
Consultation Room	40	45	60	+ 5
Treatment / Medication / Examination Room	40	45	60	+ 5
Emergency Areas	40	45	60	+ 5
Nurses Stations	40	45	60	+ 5
Patient lounge	40	45	60	+ 5
Public Areas				
Corridors and Lobby Spaces	40	45*	-	+ 10
Cafeterias / Dining	45	50	-	+ 10
Toilets	45	50*	-	+ 10
Waiting Rooms, Reception Areas	40	50	-	+ 10
Staff Back of House Areas				
Meeting Room	35	40	-	+ 5
Board / Conference Room (Large)	30	35	-	+ 5
Open Plan Offices	40	45	-	+ 5
Private Offices	35	40	-	+ 5
Multi Person Offices	40	45	-	+ 10
Locker Room	50	55	-	+ 5
Rest Room	40	45	-	+ 5
Plant Rooms	N/A	<85	-	-

* Limited to 5 dB(A) above the lower figure in Table 1 of AS107:2016 as per Greenstar 10.1 Requirements

Table 19: Engineering Services Guideline (2022) – Recommended Design Sound Levels

7 Construction Noise & Vibration Assessment

7.1 Proposed Hours

Proposed construction hours are as follows (which are consistent with the ICNG Standard Construction Hours):

- Monday to Friday - 7:00am to 6:00pm.
- Saturday - 8:00am to 1:00pm.
- Sunday and Public Holidays – No works.

7.2 Description of Proposed Works

Stage 1

- Site Establishment
    - Delivery and establishment of site office(s) and boundary fencing
- Services
    - Relocation of services (above and in-ground) including communications, power and gas lines plus
    - Booster hydrant and stormwater diversion
    - Staged services disconnections / reconnections as required.
- Road Works
    - Relocation of roads & accessways.
    - New car-parking to replace existing displaced car-parking.
- Mental Health Unit (MHU)
    - Site clearing and light earthworks
    - Construction of a new MHU building
    - Relocation and decommissioning of existing MHU.
- Emergency Department (ED)
    - Site clearing and light earthworks
    - Relocation of Ambulance Bay
    - Stage 1 Expansion of ED
    - Staged refurbishment of existing ED

Stage 2

- Additional car parking spaces (up to 41 spaces).
- Rehabilitation unit walkway link.
- PV cells to the new MHU.
- Landscaping.

Works	Main Tasks		Typical Plant
	STAGE 1		
Site Establishment	Delivery and establishment of site office(s) and boundary fencing		Mobile Crane / Forklift / Hand tools / Delivery trucks
Services diversion and relocation	Relocation of above and inground services		Excavators / demo saw / hand tools / mobile crane
	Services Trenching		
	Lighting installation		
Relocation of roads, accessways and car parking	Concreting of Kerbs and Gutters		Vibratory Roller / Compactor / Grader / Excavators / Bobcats / Skip Trucks / Concrete Trucks / Concrete Pumps / Asphalter / Line Marker
	Asphalting		
	Line Marking and Kerb Guttering		
Mental Health Unit	Site clearing and light earthworks		Excavators / bobcats / skip trucks
	Foundation		Forklift / demo saw / mobile crane / concrete mixer truck/ concrete vibrator
	Steel Structure		mobile crane / hand tools / drill
	Façade & Roof	Installation of façade and glazing	Drill / hand tools / mobile crane / tower crane
		Roofing	Hand tools / drills / mobile crane / angle grinders / circular saw
	Fit out		Hand tools / drills / angle grinders / circular saw / hammer drill
	Landscaping		Excavators / bobcats / skip trucks
	External works		Demo saw / excavators / hand tools / drills / angle grinders / hammer drill / mobile crane / tower crane

Works	Main Tasks		Typical Plant
Emergency Department	Site clearing and light earthworks		Excavators / bobcats / skip trucks
	Ambulance Bay Canopy Relocation		mobile crane / hand tools / drill
	Expansion Foundation		Forklift / demo saw / mobile crane / concrete mixer truck/ concrete vibrator
	Steel Structure		mobile crane / hand tools / drill
	Façade & Roof	Installation of façade and glazing	Drill / hand tools / mobile crane / tower crane
		Roofing	Hand tools / drills / mobile crane / angle grinders / circular saw
	Fit out		Hand tools / drills / angle grinders / circular saw / hammer drill
	Landscaping		Excavators / bobcats / skip trucks
	External works		Demo saw / excavators / hand tools / drills / angle grinders / hammer drill / mobile crane / tower crane
STAGE 2			
Additional Car Parking	Earthworks		Excavators, Piling
	Concreting of Kerbs and Gutters		Vibratory Roller / Compactor / Grader / Excavators / Bobcats / Skip Trucks / Concrete Trucks / Concrete Pumps / Asphalter / Line Marker
	Asphalting		
	Line Marking and Kerb Guttering		
Rehabilitation Walkway	Construction/installation		Hand tools / drills / mobile crane / angle grinders / circular saw
PV Cells to MHU	Construction/installation		hand tools / drill
Landscaping	Landscape works		Excavators / bobcats / skip trucks

Note: Items shaded in blue are works to be carried out internally within the building

Table 20: Proposed construction works stages and associated tasks and plant

7.3 Construction Noise

The following sections outline the preliminary assessment carried out for construction noise emissions.

7.3.1 Noise Sources

The key noise sources for the activities occurring during construction works and the associated equipment sound power levels are listed in Table 21. These values are based on Acoustic Studio's database and the relevant Australian and International Standards including AS2436:2010 and BS5228-1:2009.

Noise Source / Plant	Sound Power Level, $L_{eq,T}$ dB(A)	Sound Pressure Level, $L_{eq,T}$ dB(A), at 10m
Dump Truck (tipping material)	117	89 (+5dB penalty – tonal reversing alarm)
Truck, Forklift *(vibration source)*	107	79 (+5dB penalty – tonal reversing alarm)
Tipper / Bin lift Truck	111	83 (+5dB penalty – tonal reversing alarm)
Hiab (mobile crane) truck	113	85 (+5dB penalty – tonal reversing alarm)
Bobcat / Forklift	110	82 (+5dB penalty – tonal reversing alarm)
Front end / Wheeled loader	111	83 (+5dB penalty – tonal reversing alarm)
Skidsteer loader (½ tonne) *(vibration source)*	104	76 (+5dB penalty – tonal reversing alarm)
Excavator with rock breaker *(vibration source)*	116	88 (+5dB penalty)
Excavator, 8T with bucket *(vibration source)*	105	77
Vibratory roller *(vibration source)*	108	80
Asphalt Paver *(vibration source)*	108	80
Asphalt Rotomill (scabbler)	111	83
Concrete Pump	110	82
Cement Mixer	109	81
Concrete Placing Boom	105	77
Concrete Vibrator	104	76
Jump Form	102	74
Generator, 4 stroke portable petrol	103	75
Generator, diesel	113	85
Air compressor	107	79
Compactor *(vibration source)*	113	85
Angle grinder	101	73
Concrete Saw, handheld	115	87 (+5dB penalty)
Demolition saw	119	91 (+5dB penalty)
Circular saw	112	84 (+5dB penalty)
Jack Hammer *(vibration source)*	121	93 (+5dB penalty)

Hammer / percussive drill *(vibration source)*	112	84 (+5dB penalty)
Rattle gun	113	85 (+5dB penalty)
Electric drill	91	63
Electric hand tools	102	74
Welder	105	77
Tower crane	105	77
Mobile crane	106	78
Skip Fill	117	89
Bored Piling Rig	110	82
Scissor lift	98	70

Table 21: Anticipated airborne noise levels for equipment / plant during construction works

Potential sources of vibration and ground-borne noise during the Project works include:

- Excavation and rock hammering.
- Shoring / rotary piling.
- Vibratory Rollers.

Vibration and ground-borne noise impacts are likely to be highest during the excavation stages of the Project, when equipment such as rock breakers and jackhammers are used.

7.3.2 Sensitive receivers

Nearest sensitive receivers to the Project Site that will be potentially affected by noise and vibration are surrounding residential, commercial, and existing hospital premises as presented earlier in the report in Figure 2.

Table 2 outlines the most critical receivers surrounding the site and their typical distance to the works at each stage of the project (Site Establishment, Services, Road/Car Park, MHU and ED works).

The table has been repeated here for reference:

Receiver	Impact	Location /Direction	Distance from site (m)		
			Car Park	MHU	ED
Residential	Airborne	N/NW (Catchment 1)	140	200	155
	Airborne	E/NE (Catchment 1)	130	240	170
	Airborne	S/SE (Catchment 2)	30	110	120
	Airborne	W/SW (Catchment 2)	50	140	250
Existing Hospital Campus Buildings	Airborne + Vibration	NW	10	60	50
	Airborne + Vibration	SE	10	10	10
	Airborne + Vibration	SW	10	60	140
Commercial	Airborne	S/SE	30	100	110

Table 22: *'Table 2 Noise sensitive receivers and approximate distance to Project Site'* **(repeated for clarity)**

7.3.3 Construction Noise Assessment Methodology

An assessment of likely noise impacts from various construction activities has been carried out to identify where the relevant noise management levels may be exceeded during the works.

The assessment has considered the following:

- Typical activities considered in the noise impact assessment are as detailed in Section 7.2
- Project specific Noise Management Levels at each sensitive receiver location as outlined established in Section 6.1.1. The assessment considers the most sensitive (outside standard hours periods).
- Noise level predictions are calculated using the noise data provided in Table 21.
- Noise level predictions consider:
    - Distance attenuation
    - Ground and building reflections.
    - Sheilding
- Noise loss via the building façade (assumed a minimum 25dB to areas external from the building).
- The noise level predictions are based on assumptions that represent the worst-case scenario.
- LAeq noise levels are predicted for the operations of the nearest works area on the site to each of the nearest sensitive receiver location.
- The predictions consider individual tasks and associated equipment with a range from the nearest construction site boundary (for receivers on campus that are adjacent to the site) and the centre of construction site.
- The predictions assume continuous operation of equipment / plant over the 15-minute assessment period to provide a worst-case assessment, unless otherwise stated.

7.3.4 Assessment Results

Construction Noise

The construction noise assessment results presented below in Table 23 are based on the proposed activities and typical plant and equipment during both standard construction hours. The predicted levels assume no mitigation is in place.

The predicted activity noise levels are provided for each activity / task as a worst case and typical cumulative level which represents when several items of plant are operating concurrently. In most cases there is a wide variation in the noise emissions from each activity throughout the duration of the works, and typically would be lower than presented.

Notes:

- *Criteria for non-residential receivers are only applicable when those receivers are in use. 5dB penalties have been applied to predicted levels for the jackhammer and concrete saw in accordance with the ICNG.*

Location		Residential				Existing BHH Buildings			Commercial	Comments
		N/NW	E/NE	S/SE	W/SW	NW	SE	SW	S/SE	
NML		48	48	48	48	65	65	65	70	
Construction Activities		**Predicted equipment noise levels at surrounding community receivers, in $L_{eq,15min}$ dB(A)**								
Site Establishment	Delivery and establishment of site office(s) and boundary fencing	56	63	75	71	85	85	85	75	Primary noise contributors above NMLs are lifting machinery (i.e. crane) and delivery trucks
Services diversion and relocation	Relocation of above and inground services Services Trenching Lighting installation	62	69	81	77	91	91	91	81	Primary noise contributors above NMLs are excavators, noisy hand tools such as impact drills, and filling of skip trucks. Use the smallest excavator and hammer that is practical whilst remaining efficient (i.e. reduce noise level without significantly extending duration). Consider location of equipment and site hoarding / localised hoarding that can reduce noise up to 10 dB.
Relocation of roads, accessways and car parking	Concreting of Kerbs and Gutters Asphalting Line Marking and Kerb Guttering	59	67	79	75	89	89	89	79	Primary noise contributors above NMLs demo saw, concrete mixer and pumps. Consider location of equipment and site hoarding / localised hoarding that can reduce noise up to 10 dB.
Mental Health Unit	Site clearing and light earthworks	54	52	64	62	69	85	69	65	Primary noise contributors above NMLs are demo saw, cranes, noisy hand tools such as nail guns and circular saws, and filling of skip trucks.
	Foundation	61	58	70	68	75	91	75	71	
	Steel Structure	54	52	64	62	69	85	69	65	Impact from internal fit out works are expected to be minor due to the attenuation of building. Windows and doors of new building to be kept close, where possible.
	Façade & Roof Installation of façade and glazing	59	57	64	62	69	85	69	65	

Location		Residential				Existing BHH Buildings			Commercial	Comments
		N/NW	E/NE	S/SE	W/SW	NW	SE	SW	S/SE	
NML		48	48	48	48	65	65	65	70	
Construction Activities		**Predicted equipment noise levels at surrounding community receivers, in $L_{eq,15min}$ dB(A)**								
Emergency Department	Roofing	59	57	64	62	69	85	69	65	Consider minimising usage or alternative quieter methods and localised hoarding that can reduce noise up to 10 dB. Consider locations, loading / parking bays and lifting points to minimise noise impact on surrounding receivers. Use equipment without beepers where practical (i.e. with 'quacker' alarms)
	Fit out	38	36	43	41	48	64	48	44	
	Landscaping	63	61	68	66	73	89	73	69	
	External Works	65	63	70	68	75	91	75	71	
	Site clearing and light earthworks	61	60	58	52	71	85	62	59	Primary noise contributors above NMLs are demo saw, cranes, and filling of skip trucks. Impact from internal fit out works are expected to be minor due to the attenuation of building. Windows and doors of new building to be kept close, where possible. Consider minimising usage or alternative quieter methods and localised hoarding that can reduce noise up to 10 dB. Consider locations, loading / parking bays and lifting points to minimise noise impact on surrounding receivers. Use equipment without beepers where practical (i.e. with 'quacker' alarms)
	Ambulance Bay Canopy Relocation	55	54	52	46	65	79	56	53	
	Expansion Foundation	67	66	64	58	77	91	68	65	
	Steel Structure	61	60	58	52	71	85	62	59	
	Façade & Roof Installation of façade and glazing	61	60	58	52	71	85	62	59	
	Façade & Roof Roofing	61	60	58	52	71	85	62	59	
	Fit out	35	34	37	31	50	64	41	38	
	Landscaping	60	59	67	61	75	89	66	68	
	External Works	62	61	69	63	77	91	68	70	

Location		Residential				Existing BHH Buildings			Commercial	Comments
		N/NW	E/NE	S/SE	W/SW	NW	SE	SW	S/SE	
NML		48	48	48	48	65	65	65	70	
Construction Activities		**Predicted equipment noise levels at surrounding community receivers, in $L_{eq,15min}$ dB(A)**								
Additional Car Parking	Earthworks	60	61	78	74	88	88	88	78	Primary noise contributors above NMLs are piling rig and filling of skip trucks. Consider minimising usage or alternative quieter methods and localised hoarding that can reduce noise up to 10 dB.
	Concreting of Kerbs and Gutters	61	62	79	75	89	89	89	79	
	Asphalting									
	Line Marking and Kerb Guttering									
Rehabilitation Walkway	Construction/installation	50	51	68	64	78	78	78	68	Primary noise contributors above NMLs are cranes and noisy hand tools. Consider minimising usage or alternative quieter methods and localised hoarding that can reduce noise up to 10 dB.
PV Cells to MHU	Construction/installation	46	47	64	60	74	74	74	64	Primary noise contributors above NMLs are cranes and noisy hand tools. Consider minimising usage or alternative quieter methods and localised hoarding that can reduce noise up to 10 dB.
Landscaping	Landscape works	61	62	79	75	89	89	89	79	Primary noise contributors above NMLs are skip fill trucks and bobcat

Table 23: Predicted equipment/plant noise levels at the nearest surrounding community receiver locations. Levels predicted to exceed the NMLs are shown in orange, and those predicted to exceed the "Highly Noise Affected" threshold (>75dBA) are shown in red

The noise predictions in indicate that noise levels at locations external to the ED building may exceed the project specific NMLs (without mitigation).

Further refinement / more detailed calculations are likely to show lower actual noise levels.

Construction Traffic Noise

Based on information provided by the Traffic Consultant and Project Manager, we note the following:

- Construction workers will need to follow parking restrictions put in place for the project so as to not impact on the staff and patients accessing the hospital.
- The numbers of construction personnel onsite will fluctuate dependant on the stage of the works. At present the peak personnel per day is unknown. The Contractor will be required to undertake an analysis of the required workforce in accordance with the noise, traffic and physical distancing requirements at all stages of construction, this will be incorporated within the Construction Management Plan (CMP).
- The estimated generation of heavy vehicle traffic during the construction of the MHU and ED will be confirmed by the Contractor and detailed within their finalised CMP. These movements would likely be spread across the day and would include vehicles such as a concrete, articulated haul or delivery trucks.
- Light vehicle traffic generation would be largely generated by construction worker traffic movements to and from the site. Any construction worker traffic movements will generally be outside of peak periods. Volumes of light vehicle construction traffic are expected to be well below the allowable target of increase in traffic volumes outlined in 6.1.1.4
- Heavy vehicles will access the site for:
    - Drop off and materials.
    - Dump trucks collecting waste.
    - Concrete trucks and pumps.

  Traffic routes for heavy vehicles accessing the site are not available at this stage of the Project. However, it is anticipated that a traffic management plan will be prepared and the following recommendations are to be considered.
- Noise from construction traffic should be dealt with by appropriate management measures that minimise noise impact. This includes:
    - Staging and managing arrival of trucks to avoid queueing and idling on public streets;
    - Arriving at and departing from the site via designated routes that avoid or minimise the use of local roads;
    - Minimising reversing to minimise the use of movement alarms (“reversing beepers”) and / or incorporating quacker alarms;
    - Minimise the use of engine braking and to avoid noise actions such as slamming doors, loud radios, shouting or the use of truck horns for signalling.
- Further to the above, once the Contractor is engaged on this project, a detailed understanding of construction traffic vehicle generation plus noise feasible and reasonable mitigation strategies will be confirmed and included in the CNVMP. This will also include strategies and advice to heavy vehicle drivers to limit noise generation by avoiding heavy acceleration, plus limiting idling, engine braking and use of horns.

7.3.4.1 Cumulative Noise Impact

The Contractor will also need to consider cumulative noise impact as part of the CNVMP and collaboration will be required with other proponents and Contractors for other construction sites / activities in the vicinity are carried out at the same time.

The program and CNVMP prepared by the Contractor will need to consider the staging and other concurrent works on campus as part of the Project in order to minimise cumulative noise impacts on surrounding receivers.

7.3.5 Ground Borne Noise and Vibration

- The list of plant and activities provided to Acoustic Studio by Acorn are not expected to generate vibration levels exceeding relevant criteria at any external receiver.
- Ground borne noise from the likely construction activities is not anticipated to be audible above airborne noise inside residential receivers, and will not require specific controls.

7.3.6 Summary of Noise Assessment Findings and Discussion of Noise Controls During Construction

Based on the results from the high-level assessment of the indicative works, we make the following comments:

- Construction noise impacts will have the highest noise level impact at existing BHH buildings on the site, with noise levels predicted up to 26 dB above NMLs but generally within the "Highly Noise Affected" noise levels (i.e. < 75dBA).
- Residential construction noise impacts are highest at the residential receivers to the south of the site, on Thomas St, with noise levels predicted up to 31 dB above NMLs when works are nearest to the receiver during standard hours but generally within the "Highly Noise Affected" noise levels (i.e. < 75dBA).
- Considering the above typical worst case, it is noted that:
    - the predictions for noise levels above NMLs is not unusual given the plant and equipment that must be used, such as excavators and piling, and the proximity to sensitive receivers (some of which are within 30m).
    - Noise levels from operations of various plant and equipment are predicted to be up to 5-10 dB lower when location of activities within the site boundary are further away from a particular receiver, and in some cases, within the NMLs depending on the distance to the receiver.
    - Many of the high-noise works in close proximity to noise sensitive receivers will be of relatively short duration, which will lessen the impacts.
- Noise mitigation measures such as hoarding for certain activities can provide up to 10 dB reduction.

7.4 Adjacent areas to the ED Expansion and Refurbishment Works

Adjacent areas within the BHH Building are associated with the proponent (Health Infrastructure) and the proposed works.

The ED works are being carried out in close proximity to adjacent areas, noise levels are expected to be above the recommended Noise Management Levels applicable to Hospital environments.

- Airborne noise is expected to affect directly adjacent spaces to the works which will typically be horded off.
- Structure-borne noise will have the greatest impact from sources such as hammer drills, jackhammers and saws where there is contact with the structure. It is not possible to confirm the extent of impact without detailed assessment understanding of the structure (construction joints etc) and / or pilot testing.
- It will be critical to consult with users and stakeholders to practically schedule noisy and vibration intensive works around nearby areas (including concrete saws and jackhammers).
- Vibration is likely to have the greatest impact on adjacent medical imaging areas. Consultation should be carried out with the medical imaging department to confirm vibration sensitivity requirements and operational hours and avoid vibration-intensive activities during those hours if practicable.
- As the building will be in continuous operation during the works (including patient / sleeping areas) the works should implement all reasonable and feasible measures as described in Section 9 to limit noise and vibration impacts.

7.5 Project Specific Noise Controls During Construction

7.5.1.1 Project Noise Mitigation Measures

Based on the above the following noise control measures shall be incorporated and included in an updated Construction Site Management Plan.

The following mitigation controls shall be implemented:

- **Scheduling, Duration and Respite Periods**
  - Where practical and feasible, schedule noisier activities that cannot be shielded by acoustic curtains / hoarding to occur at less sensitive periods of the day (i.e. not early morning or late afternoon) .
  - Including Respite Periods where activities are found to exceed the 75 dB(A) Highly Affected Noise Level at receivers, such as 3 hours on and 1 hour off.
- **Noise Barriers or Screening** – Incorporate shielding via site hoarding around the site and / or operate equipment behind localised hoarding or a noise curtain for up to 10 dB noise reduction (depending on how well the curtains block line of sight to the receiver. This is generally effective for all activities.
- **Alternative construction methodology or equipment**
  - Use electric handheld tools where possible, rather than petrol or diesel tools.
  - Select the quietest available plant and equipment capable of carrying out the activity efficiently.
- **Communication -** Inform affected residential receivers about the timing and duration of planned works.
- **Complaints management** shall be addressed as noted in Section 7.7.3.
- Implementation of all reasonable and feasible mitigation measures for all works will ensure that any adverse noise impacts to surrounding residential receivers are minimised when NMLs cannot be met due to safety or space constraints.
- Further general noise controls are discussed in the following sections.

7.6 General Control elements

7.6.1 Noise

As a general rule, prevention is to be applied as universal work practice at any time of day, but especially for the occasional construction works to be undertaken at critical times outside normal daytime/weekday periods.

It is noted that the reduction of noise at the source and the control of the transmission path between the construction site and the receiver(s) are the preferred options for noise mitigation/minimisation. Providing treatments at the affected residences or other sensitive land uses is to be only considered as a last resort. Construction noise shall be managed by implementing the strategies listed below:

- Plant and equipment
  - Use quieter methods.
  - Use quieter equipment.
  - Operate plant in a quiet and effective manner.
  - Where appropriate, limit the operating noise of equipment.
  - Maintain equipment regularly.
  - Where appropriate, obtain acoustic test certificates for equipment.
- On-site noise management
  - Strategically locate equipment and plant.
  - Avoid the use of reversing alarms or provide for alternative systems.
  - Maximise shielding in the form of existing structures or temporary barriers.
  - Schedule the construction of barriers and structures so they can be used as early as possible.
  - Brief Project staff and workers on the noise sensitivity of the neighbours to the site, particularly the residents nearby. The staff and workers need to be mindful of the noise from their discussions and colour of the language, particularly in sensitive periods, for example, during the pre-start times or “toolbox talk” as they gather to commence for work in the morning.
- Consultation, notification and complaints handling
  - Provide information to neighbours before and during construction.
  - Maintain good communication between the community and Project staff.
  - Have a documented complaints process and keep register of any complaints.
  - Give complaints a fair hearing and provide for a quick response.
  - Implement all feasible and reasonable measures to address the source of complaint.
- Work scheduling
  - Schedule activities to minimise noise impacts.
  - Ensure periods of respite are provided in the case of unavoidable maximum noise levels events.
  - Keep truck drivers informed of designated routes, parking locations and delivery hours.

7.6.2 Vibration

At this stage, we anticipate that construction works will result in some structural and human perception vibration impacts at surrounding receivers – particularly from the use of excavators with hammers near the existing Broken Hill Hospital Campus buildings.

Vibration management controls required for the works would be determined when the Stage 2 Main Works CNVMP is prepared by the Contractor.

The Contractor shall carry out a vibration assessment at the commencement of operations for each vibration-generating-activity / equipment to determine whether the existence of significant vibration levels justifies a more detailed investigation.

A more detailed investigation will involve methods of constraining activities generating high vibration levels. A method of monitoring vibration levels will then need to be put in place. An additional review of vibration mitigation measures and vibration criteria may then be necessary.

All practical means are to be used to minimise impacts on the affected buildings and occupants from activities generating significant levels of vibration on-site.

The following considerations shall be taken into account:

- Modifications to excavation and construction equipment used.
- Modifications to methods of excavation and construction.
- Rescheduling of activities to less sensitive times.

If the measures given above cannot be implemented or have no effect on vibration levels or impact generated, a review of the vibration criteria is to be undertaken and the vibration management strategy amended.

7.6.3 Vibration surveys

Since the actual vibration levels experienced will be dependent upon the site characteristics and the specific equipment being used, early vibration level checks are to be carried out on site at the outset of each key vibration generating activity (if vibration is considered to be an issue).

Shortly before the commencement of each activity, the background vibration level is to be measured and again once the activity has begun. If the survey indicates levels of vibration exceeding those expected, the vibration management strategy for that process is to be re-assessed.

7.6.4 Additional Noise and Vibration Control Measures

All practical means should be used to minimise impacts on the affected buildings and occupants from activities generating significant levels of vibration on site.

If, during construction, an item of equipment exceeds ether the noise criteria at any location or the equipment noise level limits, the following noise control measures, together with construction best practices presented in Section 7.6.1, shall be considered to minimise the noise impacts on the neighbourhood.

- Modifications to construction equipment used:
    - Avoid the use of large excavators – use the smallest size practicable;
    - Avoid the use of vibratory rollers – switch off vibration mode, or use the smallest size practicable if vibration must be employed;
    - Avoid the use of tracked vehicles on site, where practicable, particularly large tracked excavators and cranes – use vehicles with tyres.
- Modifications to methods of construction:
    - Saw cutting can be considered for rock removal rather than conventional rock hammering techniques to limit vibration when closed to vibration sensitive locations.
- Schedule noisy activities to occur outside of the most sensitive times of the day for each nominated receiver. For example, residential receivers are likely to be more sensitive to noise before 9 am than the other receivers.
- Consider implementing equipment-specific screening or other noise control measures recommended in Appendix E of AS2436.
- Limit the number of trucks on site at the commencement of site activities to the minimum required by the loading facilities on site.
- When loading trucks, adopt best practice noise management strategies to avoid materials being dropped from height into dump trucks.
- Avoid unnecessary idling of trucks and equipment.
- Ensure that any miscellaneous equipment (extraction fans, hand tools, etc) not specifically identified in this assessment incorporates silencing/shielding equipment as required to meet the noise criteria.
- Minimise noise from workers as discussed in Section 7.6.1.

Implementation of all reasonable and feasible mitigation measures for all construction works will ensure that any adverse noise impacts to surrounding residential, commercial and recreational receivers are minimised when noise goals cannot be met due to safety or space constraints.

7.7 Noise and vibration monitoring

7.7.1 Noise monitoring

The Contractor is to consider implementing environmental noise monitoring at the locations described below.

- On campus Broken Hill Hospital Campus Receivers.
- The nearest noise sensitive residential receiver.

As per ICNG recommendations, where monitoring is carried out it should be carried out at the most noise-affected sensitive land use (where noise levels are likely to be the highest). It should also be considered where noise levels are predicted to be 20 dB above the NMLs or above the Highly Affected Noise Level.

7.7.2 Vibration monitoring

A vibration monitoring system is to be implemented if required. This system would monitor vibration levels when there is potential for them to change. This could happen in

various situations, such as, changes in equipment and activities or changes to work procedures that might affect existing vibration control measures. The monitoring procedure would be carried out with appropriate equipment so that results obtained are readily comparable with results obtained earlier. If results indicate vibration levels exceeding allowable limits appropriate action is to be taken.

7.7.3 Reporting

Where noise and vibration monitoring occurs as per Sections 7.7.1 and / or 0, the Contractor is to prepare a noise monitoring report each monitoring period for review by the Project Manager. The reports are to summarise and interpret the results of the noise and vibration monitoring carried out during that period.

Communication and complaints

The Contractor is to establish a communication register for recording incoming complaints. The registration of a particular item will remain open until the complaint has been appropriately dealt with.

In addition, the following procedures are an example of the procedures that are to be specifically adopted for complaints relating to noise.

Upon receipt of a complaint the Contractor is to:

- Try to ascertain from the complaint which appliance is causing the problem i.e. inside or outside the site and in what position.
- Establish from the monitoring equipment if the allowable noise levels have been complied with.
- Establish if the appliance positioning has previously been highlighted as a problem area. If not and the noise levels are above the allowable limit, then the equipment and its position shall be noted.
- Move machinery if the allowable levels have been exceeded or take other acoustic remedial action.

If the activity is occurring outside normal working hours, the activity is to be immediately stopped. Where stopping the activity would create a safety issue the activity may be permitted to continue only as long as is necessary to make the area safe. The activity is to then cease.

Any activity that is directed to cease due to excessive noise is not to recommence until the Project Manager is satisfied that the noise and vibration limits requirements can be met and has given permission to recommence the activity.

The Site Supervisor is to ensure that a report of any incident is provided to the Project Manager.

The Project Manager is to provide a report on the incident to the relevant stakeholders. The Contractor is to provide a 24-hour telephone contact number and this number is to be prominently displayed on the site.

7.8 Non-compliances

Non-compliance reports can be used as appropriate to deal with failures to meet the construction noise and vibration management and control requirements.

8 Operational Noise and Vibration Assessment

8.1 Operating Hours

Once the construction of the MHU and ED is completed, the premises will continue to operate 24 hours a day, seven days per week.

8.2 Building Services

It is recommended that allowances are made for the following external noise controls for buildings services proposed for MHU and ED Expansion.

8.2.1 Mechanical Plant and Equipment

Mechanical plant and equipment associated with the operation of the development is to be controlled to ensure external noise emissions are not intrusive and do not impact on the amenity of neighbouring receivers in accordance with the relevant criteria established in Section 6.2 of this report.

At this stage, final plant selections have not been made, therefore, a detailed assessment has not been carried out. Any plant selections will be reviewed in Detailed Design to ensure that noise emissions meet the applicable environmental noise criteria.

8.2.1.1 General

- Key plant is currently proposed to be located in the following areas:
    - MHU – an external plant room to the south of the proposed MHU building plus fans terminating at various locations around the façade at high level.
    - ED – New plant is being considered in the existing rooftop plant room plus fans to be located on the roof.
- The nearest potentially affected receivers are on campus adjacent hospital buildings. Achieving compliance at these receivers will also ensure compliance is achieved at all other noise sensitive receiver locations.
- The plant will operate 24 hours a day, 7 days a week.
- The most restrictive night time criterion for 24hrs plant operations is 48 dB(A) at hospital wards. Considering the distance to receivers in other catchments, achieving this criterion for each building will ensure compliance with the relevant criteria at all other receivers

During the Detailed Design phase, acoustic detailed design advice will provide to the architect and services engineers to ensure that noise emissions from plant and equipment are effectively controlled to meet the relevant criteria at the nearest receiver boundaries. General design considerations and controls that may need to be implemented typically include, but are not limited to:

- Strategic selection and location of plant to ensure the cumulative noise contribution at the receiver boundary is achieved, and/or
- Noise control measures to be put in place to minimise noise impacts such as:
    - Noise enclosures or barriers/screening as required.
    - Acoustic louvres as required.
    - In-duct attenuation.
    - Sound absorptive panels.

The following outlines allowances that have been included based on the current proposals. Actual treatments may change (and still achieve the relevant noise emissions targets) depending on final locations, orientation and equipment selections.

MHU External Condenser Units

The current condenser design considers 2 x domestic units plus 4 x large units with a combined sound pressure level of 70 dB(A) @ 1m.

Based on the selection and current location for external plant the following is recommended to control noise to external receivers, existing adjacent buildings and adjacent open areas:

- Option 1 – acoustic louvres.
- Option 2 – solid screening such as FC sheet or equivalent backed with sound absorptive lining.

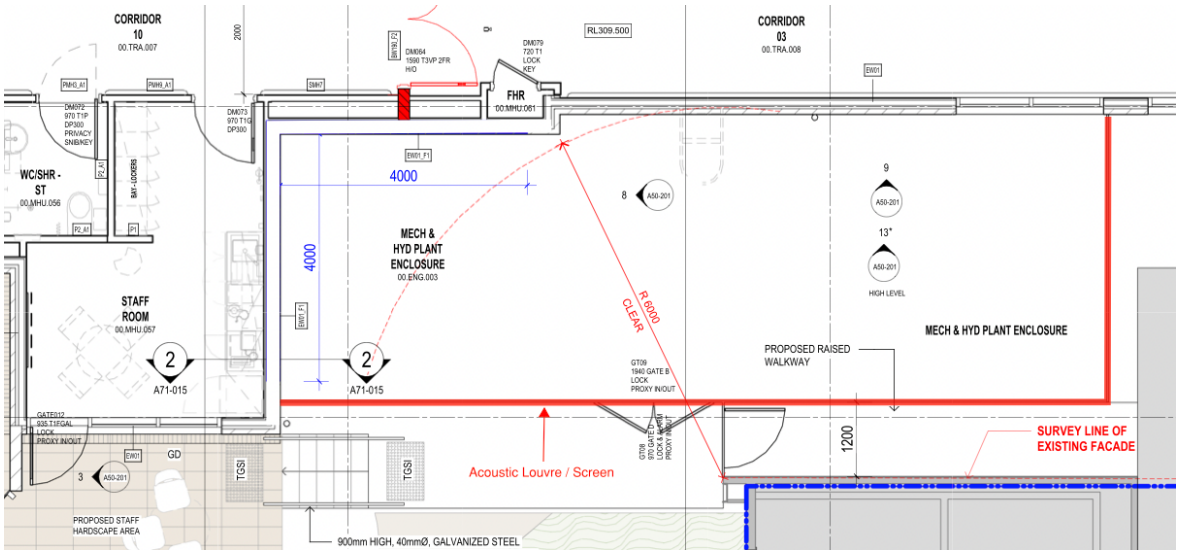


Figure 6: Plant Room Screening

ED AHU

Details are not yet finalised however the current design options are being considered:

- Option 1 – New AHU in Existing Plantroom.
- Option 2 – Localised New AHU

Internally lined ductwork for outside air will be allowed for to ensure the selected equipment is able to meet the noise criteria at the nearest noise sensitive receiver boundaries.

Cumulative Noise Impact

The assessment and design consider all existing plant and equipment that will be retained for existing buildings.

The recommendations provided (and detailed designs to be developed) will ensure that the noise emissions are achieved when considering the cumulative noise impact from existing and proposed plant.

During the design finalisation when final plant selections are made, acoustic detailed design advice will be provided to the architect and services engineers to ensure that noise emissions from all plant and equipment selections are effectively controls to meet the relevant criteria at the nearest receiver boundaries.

8.3 Operational Noise – The Use

The assessment has considered the following potential noise sources

- Noise from outdoor courtyards
- Traffic noise from:
    - New car park and access roads
    - Relocation of ED Ambulance Bay
    - Traffic generation on surrounding roads

8.3.1 Outdoor Courtyards

Noise from mental health patients using outdoor courtyards has been considered. No additional acoustic treatment is required based on the following:

- The new MHU locates courtyards central to the campus and further away from residential receivers than the existing MHU.
- Shielding of noise is provided by the proposed MHU building and courtyard security fencing.

8.3.2 Traffic Noise

Car Park and Access Road Reconfiguration (On-Site)

Current parking provisions on-site include 155 spaces, and peak parking demand is approximately 270 cars.

The project will see internal roadworks and car park reconfiguration, as shown in Figure 3 & Figure 4.

We understand from the traffic consultant (SCT Consulting) that the traffic impacts as a result of the development will be as follows compared to the existing arrangements on-site:

- **MHU**
    - **Network performance:** Increase in vehicle traffic accessing the site will be insignificant after the new MHU is operational, with minor increase in staff movements.
    - **Parking:** Parking demand is forecast to grow by three spaces as a result of the MHU expansion. Staff will continue to utilise on-street and off-street parking, and the impact of three additional staff members is negligible to the overall operation of car parking utilisation on site or within the surrounding street network.
- **ED**
    - **Network performance:** There will be a minor increase in vehicles accessing the site after development due to the increase in staffing levels and expanded capacity.
    - **Parking:** Approximately 12 additional staff cars are expected during the peak parking demand (i.e. the overlap of the morning and afternoon shift). This represents the maximum parking and vehicle demand by staff, as some of the FTE increase are allocated to the night shift. The additional staff members would not significantly impact the overall operation of car parking utilisation on site or within the surrounding street network.

The reconfigured parking spaces are proposed along the new circulation roadway are being provided as a replacement for the number demolished (not net loss or gain across the site), and while this reconfiguration moves some of the spaces closer to the existing staff accommodation quarters to the west, and residents to the south of Thomas St, the number of movements on the access road will remain very similar.

Therefore, the impacts of the car park and access road reconfiguration are predicted to have a negligible impact (i.e. <2dB) on the surrounding residential receivers, and no noise mitigation is required.

Future Additional Car Parks (On-Site)

The project will allow for an additional parking space to the north of the proposed MHU, which will provide 41 future additional car parks (as displayed in Figure 4).

We understand from the traffic consultant that the proposal for the car additional park extension is primarily to shift staff parking from on-street to on-site.

Operational noise car park extension proposal is expected to result in a negligible noise change from current car park usage, when considering the following:

- The increase in car park movements will increase by approximately 41 movements over a 1-hour period, and corresponds to a worst-case increase of < 2dB.
- The distance of the nearest residential receiver will mean noise emissions are well below the PTNLs and Sleep Disturbance Trigger Levels.
- Car park usage will remove cars parking on Thomas street and the surrounding streets, reducing impacts to the most affected residential receivers

Therefore, there will be minimal noise impact / change to existing conditions and no additional noise control measures are required.

Ambulance Bay

The ambulance bay area will be modified (reduced in size) to accommodate the Emergency Department Expansion. The number of ambulance parking bays will remain the same.

Based on this, there is negligible change to noise emissions associated with the ambulance bay relocation.

Traffic Generation (Off Campus)

The development is not expected to generate any additional traffic and therefore no change to traffic noise off campus is anticipated.

9 External Noise Intrusion

9.1 Traffic Noise Intrusion

Acoustic Studio has carried out a review of existing traffic noise as the main noise source affecting the site.

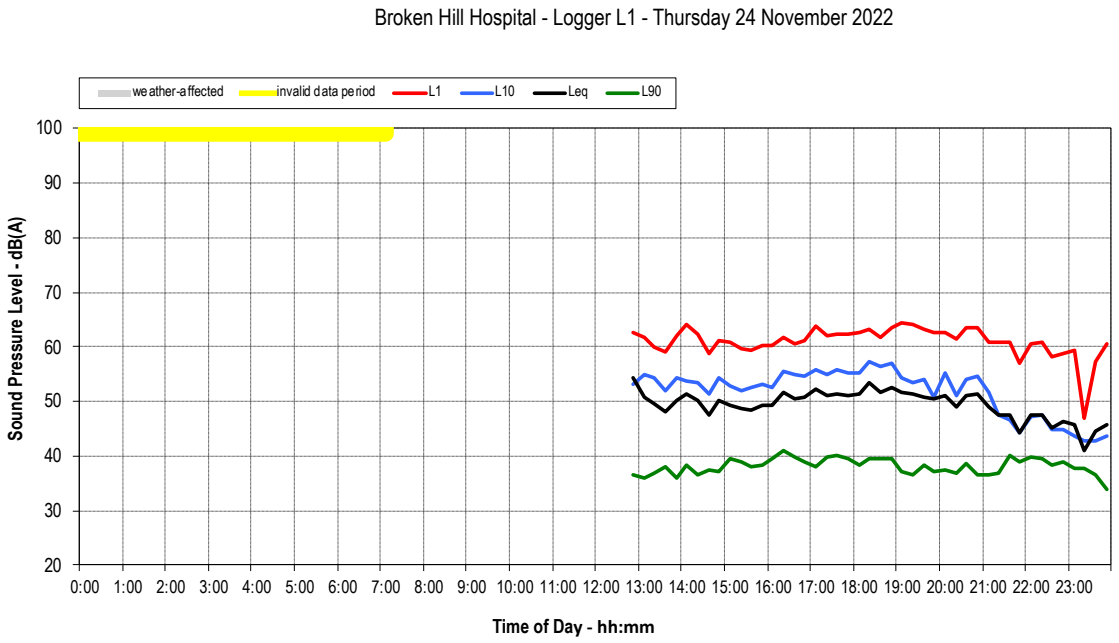
Traffic noise levels are as outlined in Table 5.

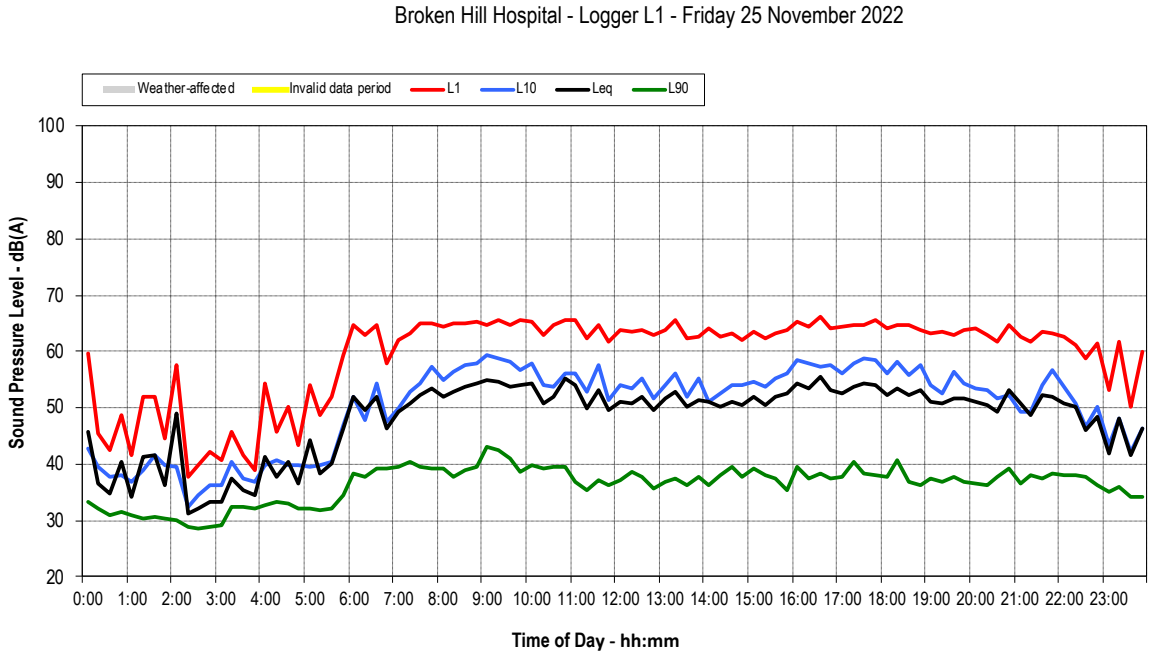
Based on the setback of the proposed buildings central to the Hospital Campus, a standard façade (including standard single glazing with a performance of Rw 30-32) is sufficient to achieve internal recommended noise levels from traffic noise intrusion.

Appendix A – Noise Logger Locations

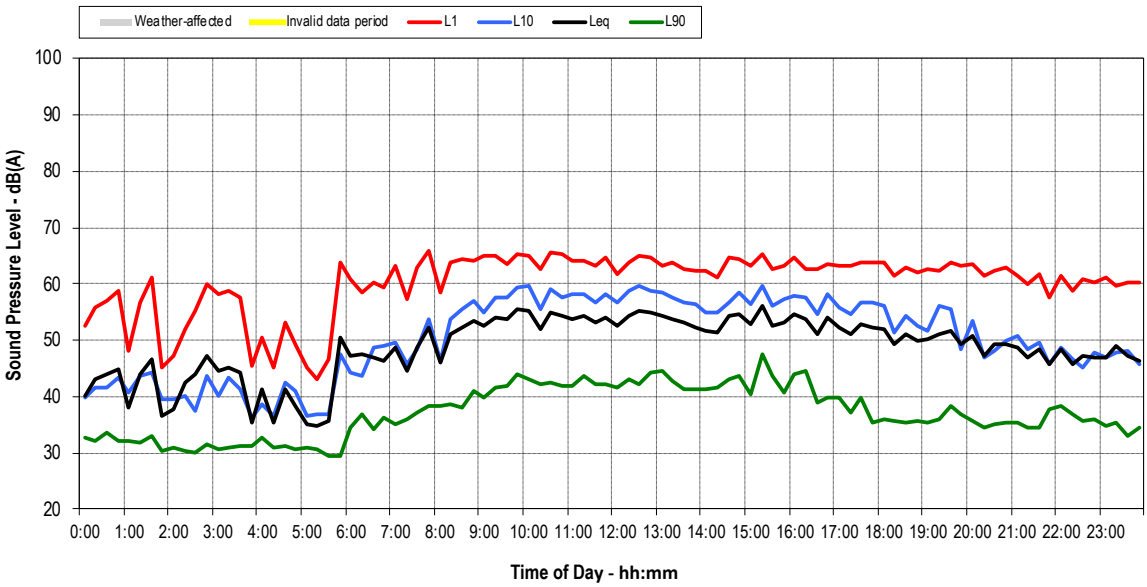
Appendix B – Ambient Noise Monitoring Data

Logger L1

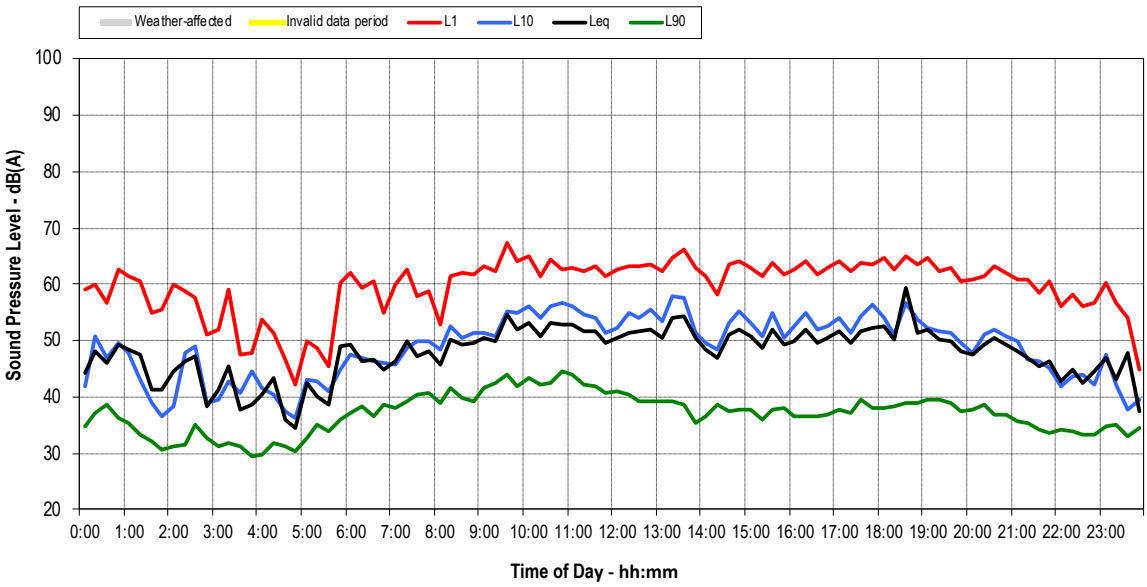




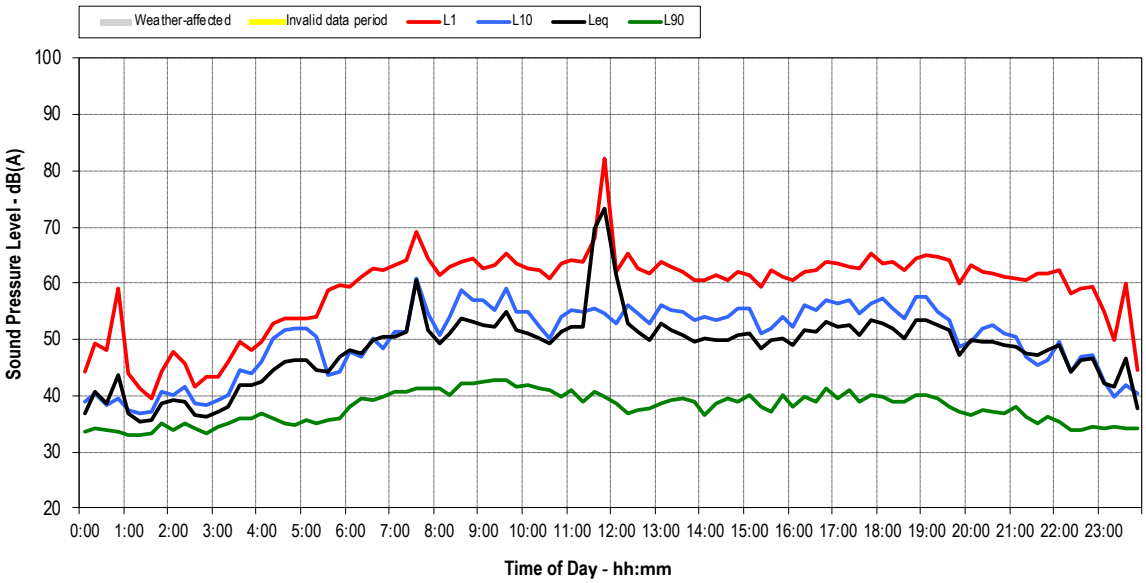
Broken Hill Hospital - Logger L1 - Saturday 26 November 2022



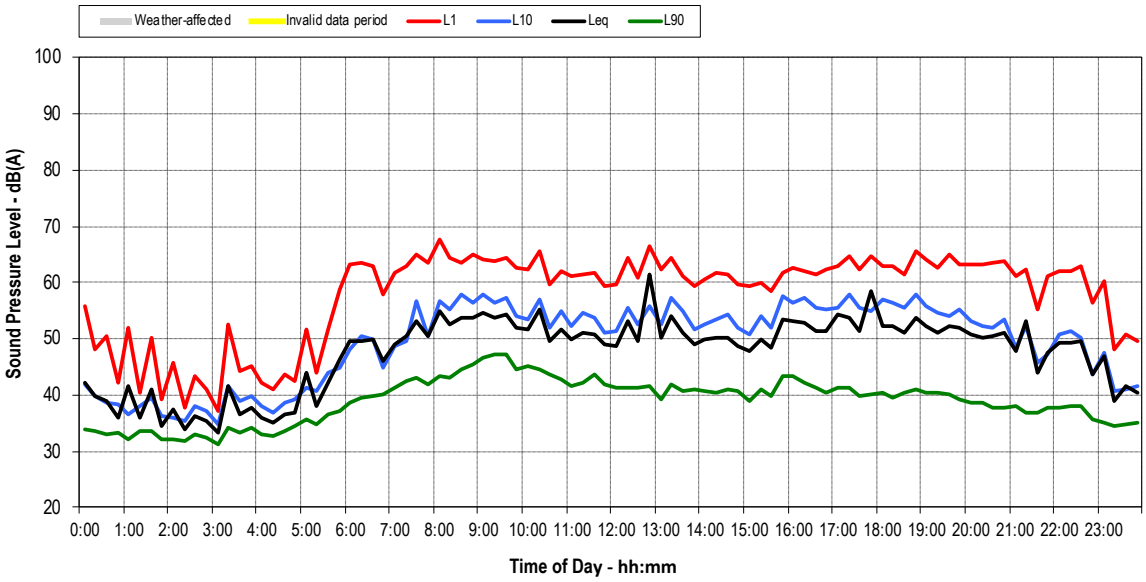
Broken Hill Hospital - Logger L1 - Sunday 27 November 2022



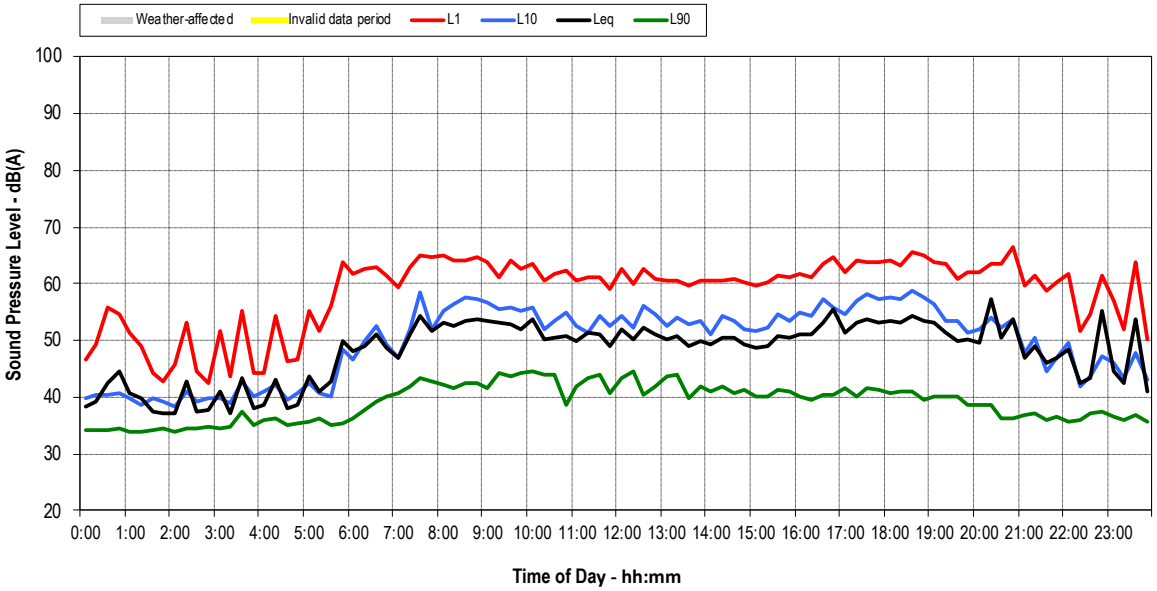
Broken Hill Hospital - Logger L1 - Monday 28 November 2022



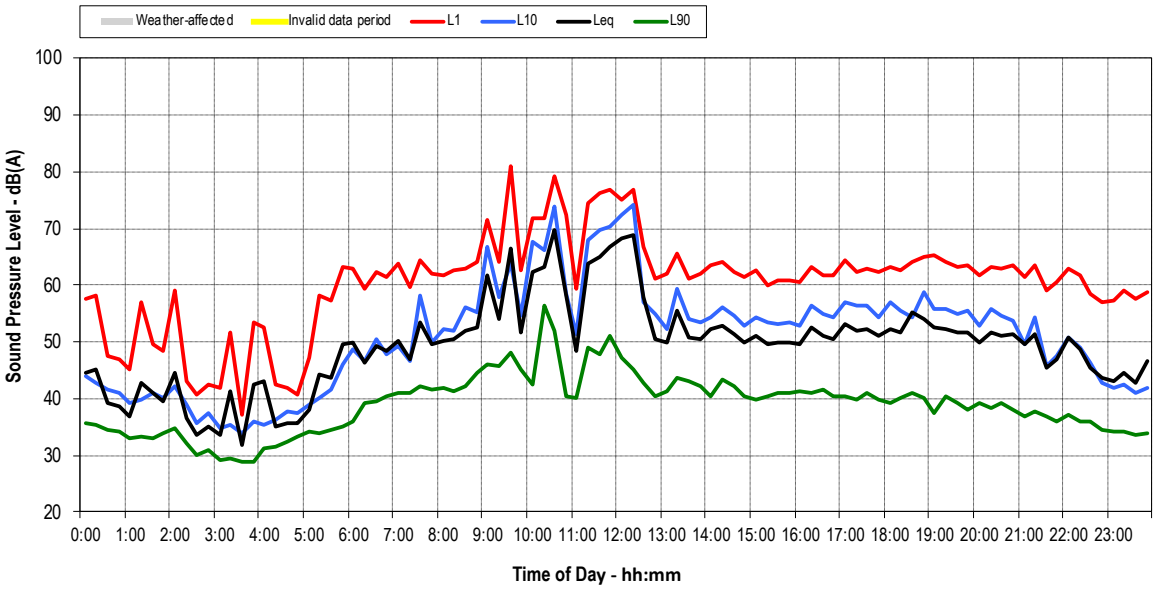
Broken Hill Hospital - Logger L1 - Tuesday 29 November 2022



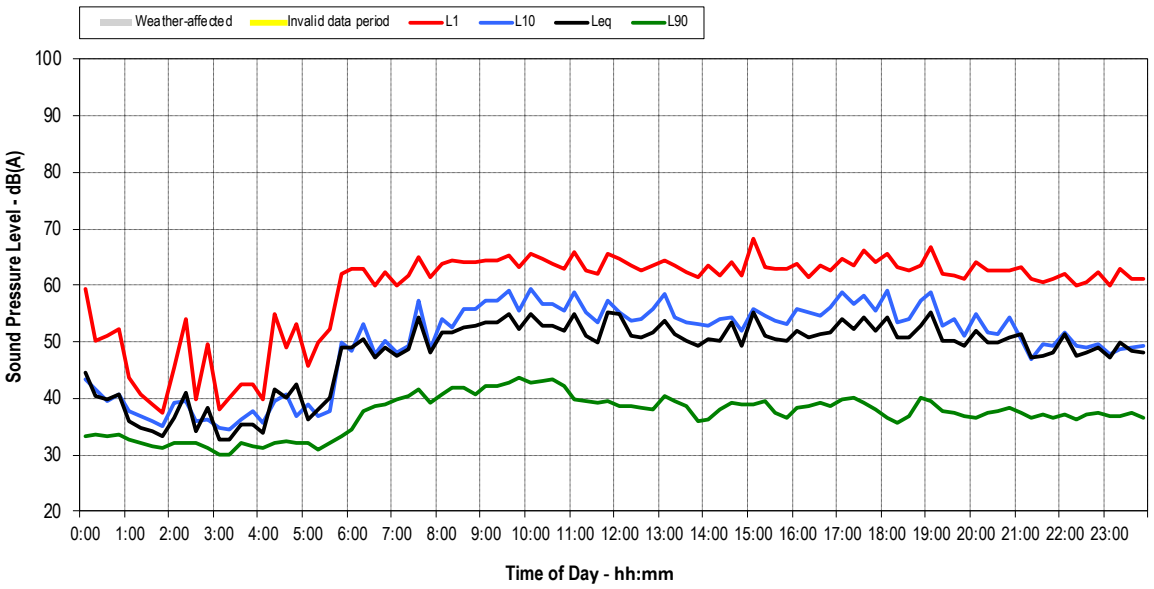
Broken Hill Hospital - Logger L1 - Wednesday 30 November 2022



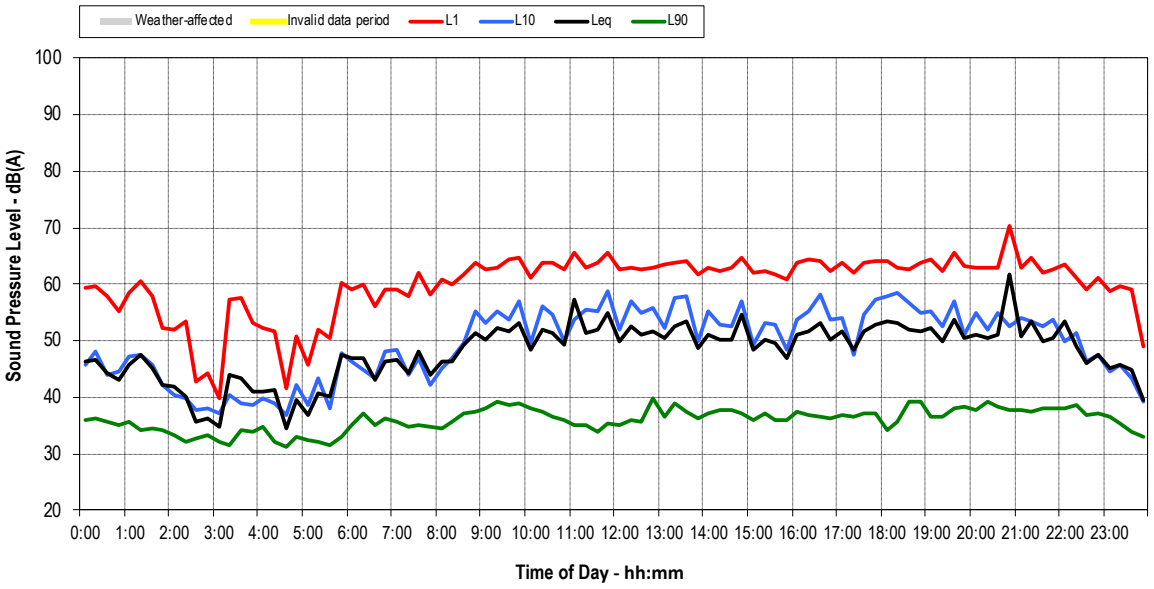
Broken Hill Hospital - Logger L1 - Thursday 01 December 2022



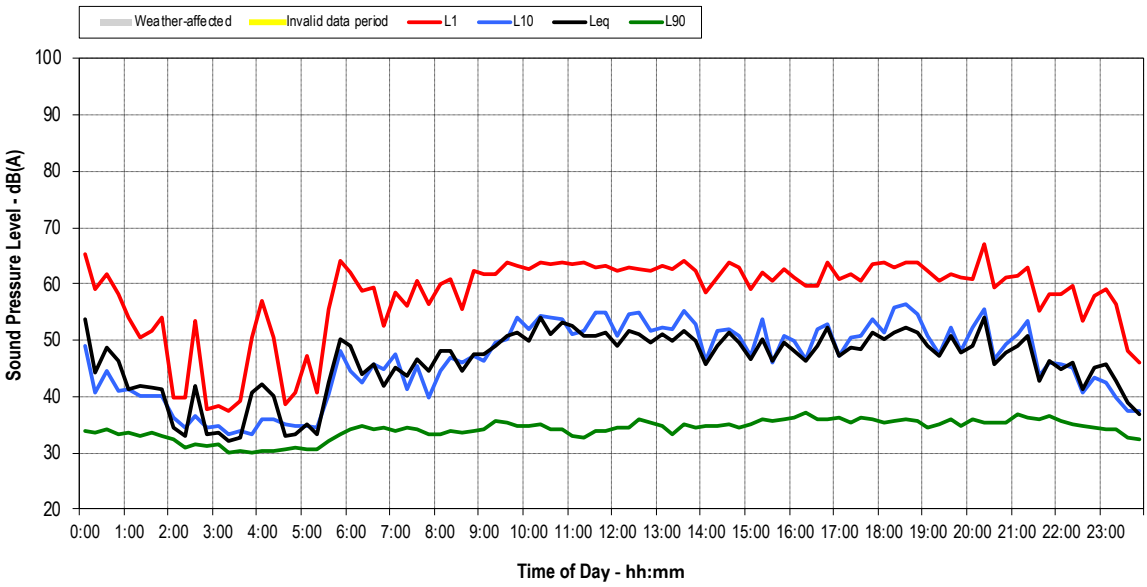
Broken Hill Hospital - Logger L1 - Friday 02 December 2022



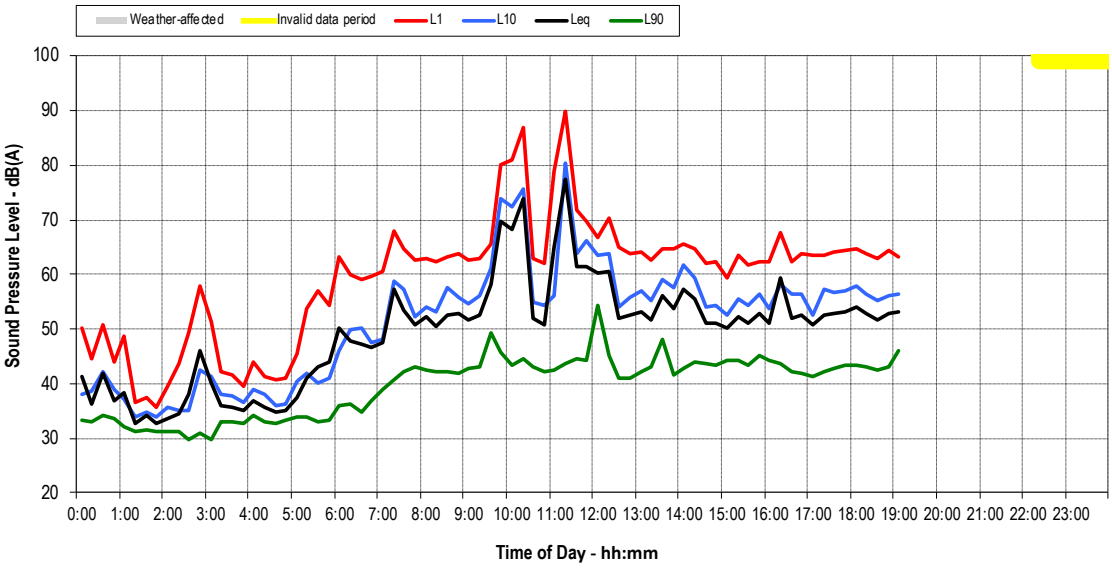
Broken Hill Hospital - Logger L1 - Saturday 03 December 2022



Broken Hill Hospital - Logger L1 - Sunday 04 December 2022

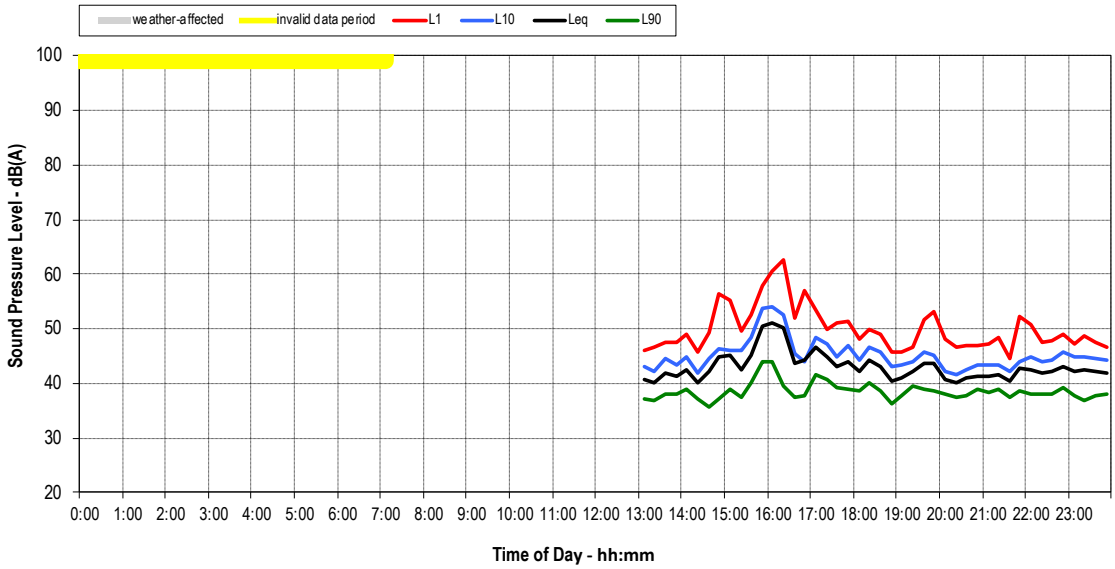


Broken Hill Hospital - Logger L1 - Monday 05 December 2022

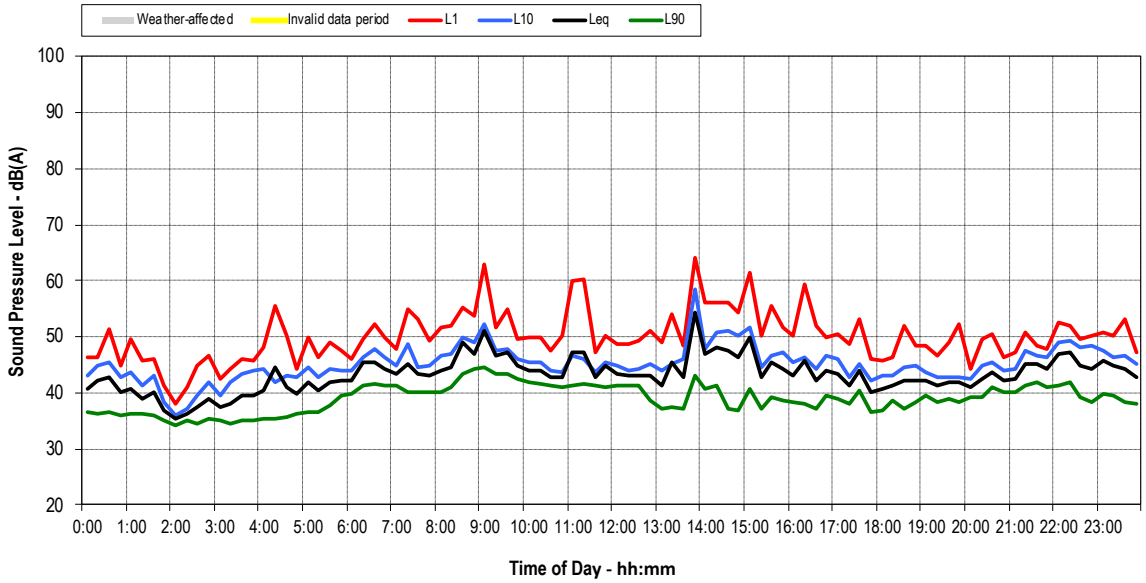


Logger L2

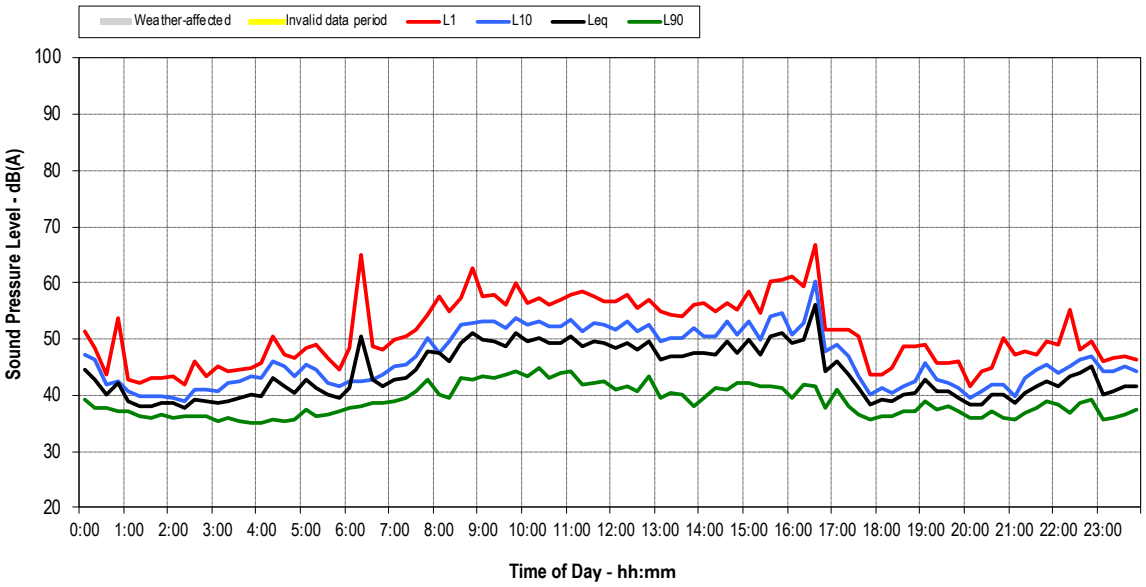
Broken Hill Hospital - Logger L2 - Thursday 24 November 2022



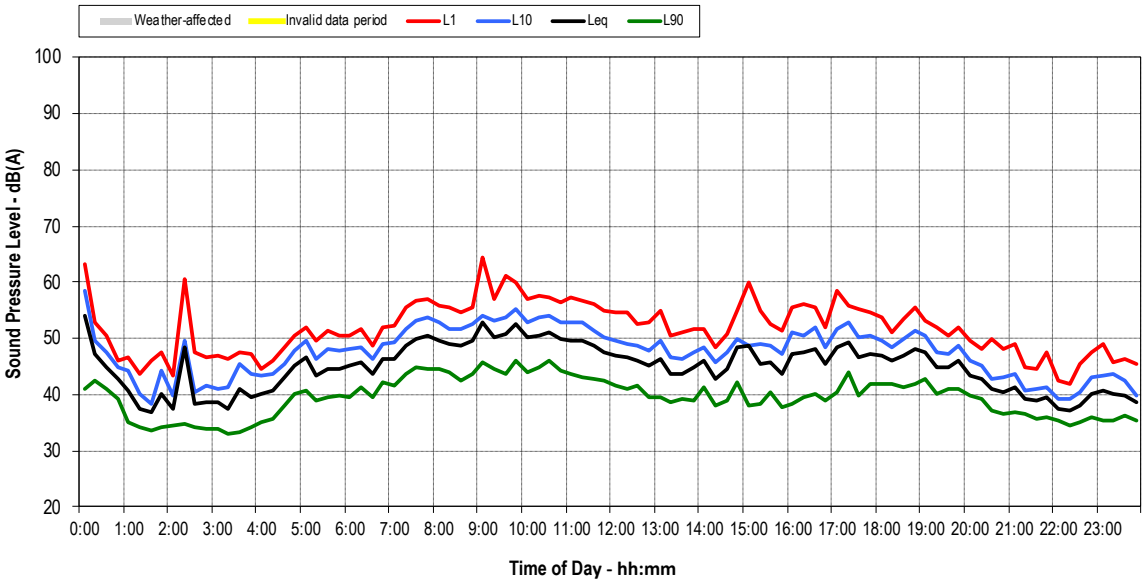
Broken Hill Hospital - Logger L2 - Friday 25 November 2022



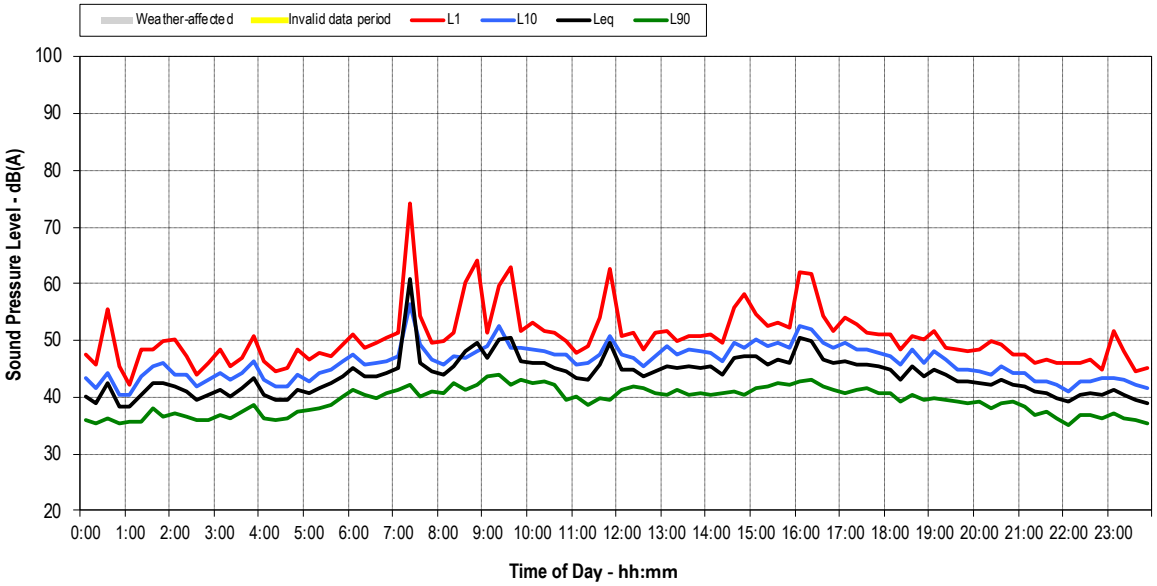
Broken Hill Hospital - Logger L2 - Saturday 26 November 2022



Broken Hill Hospital - Logger L2 - Sunday 27 November 2022



Broken Hill Hospital - Logger L2 - Monday 28 November 2022



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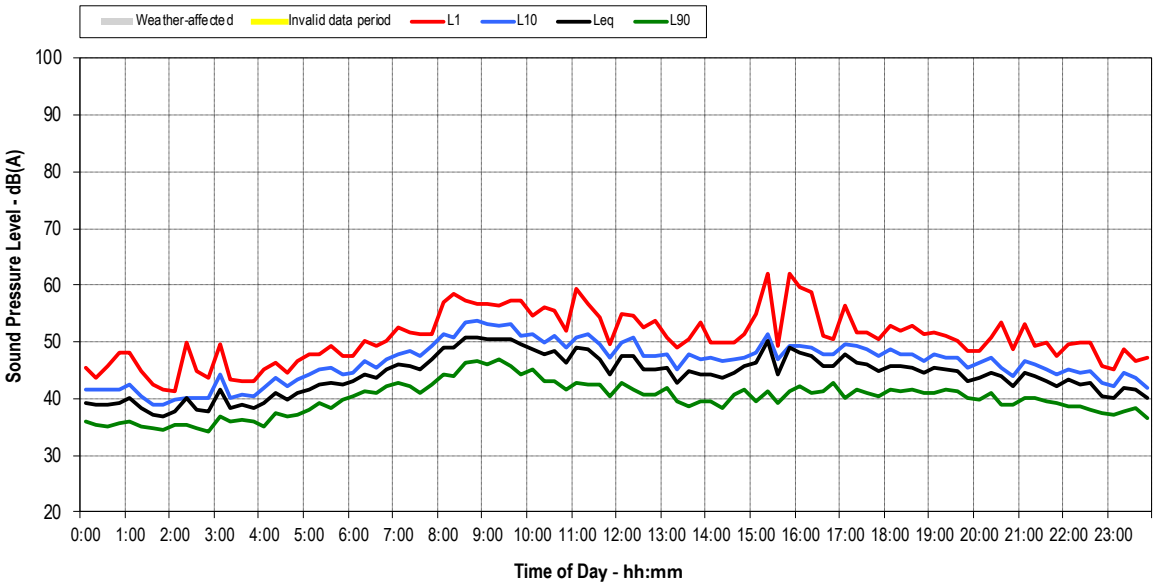
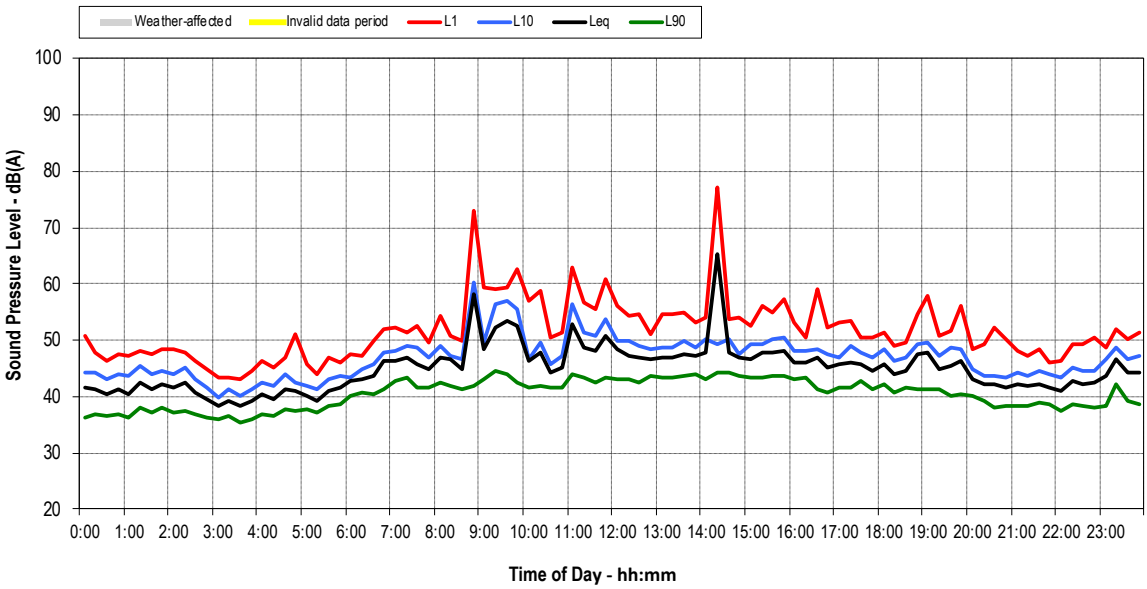
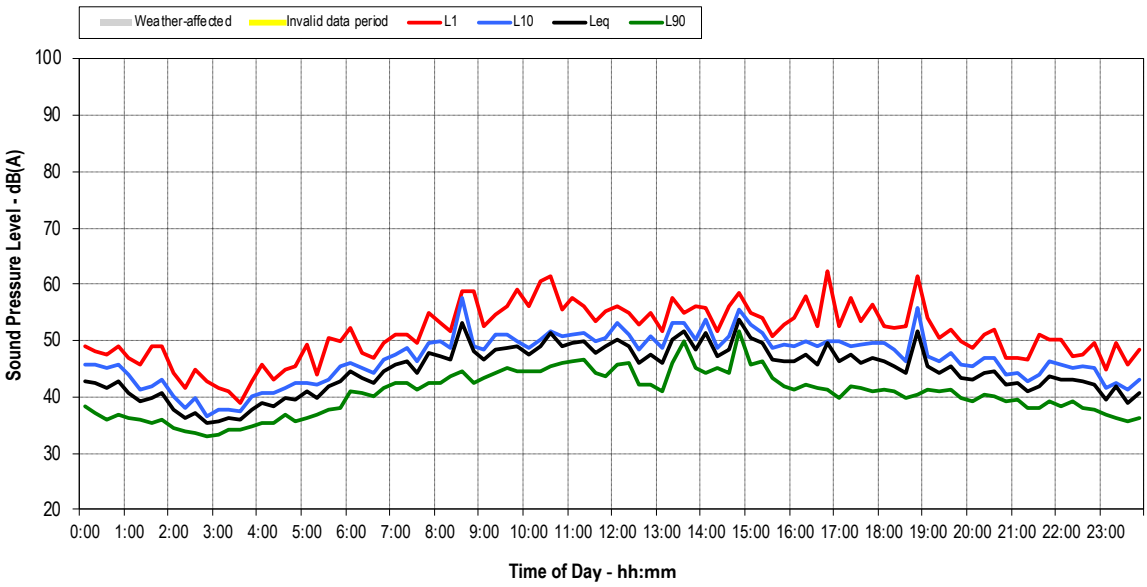


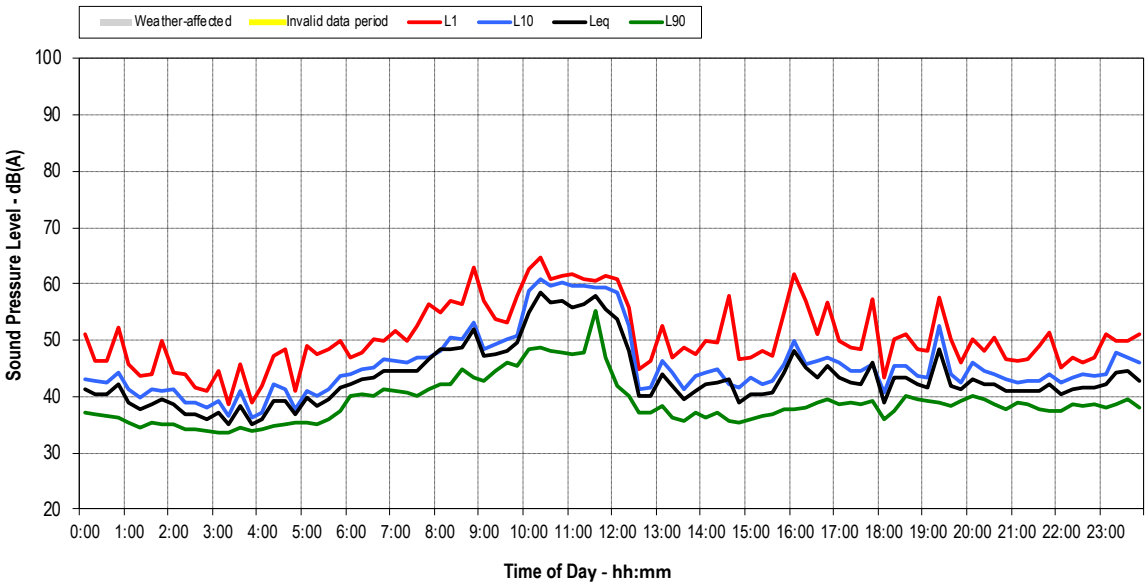
Broken Hill Hospital - Logger L2 - Wednesday 30 November 2022



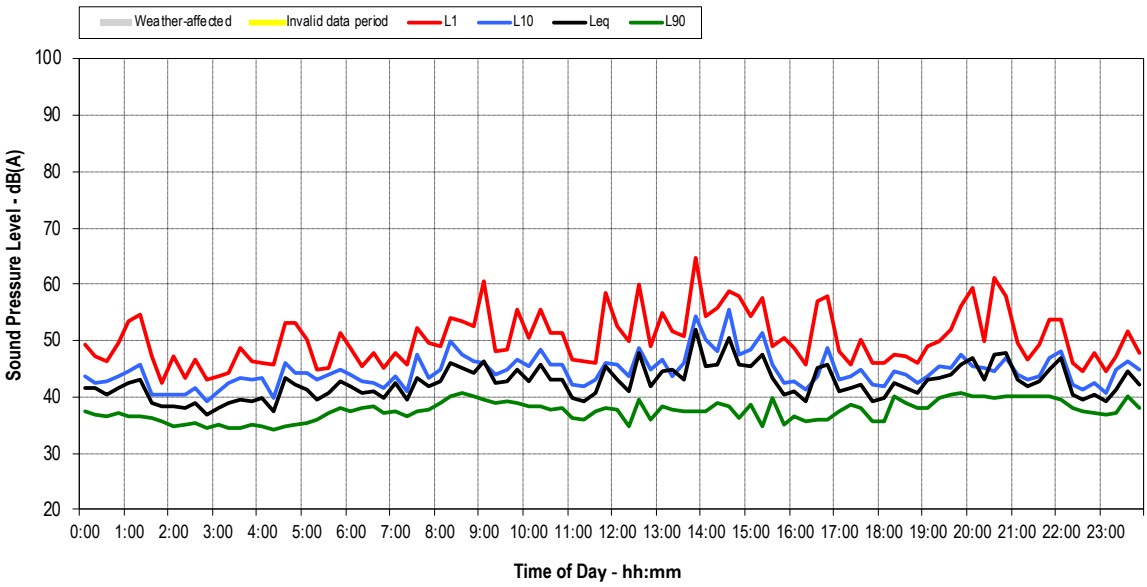
Broken Hill Hospital - Logger L2 - Thursday 01 December 2022



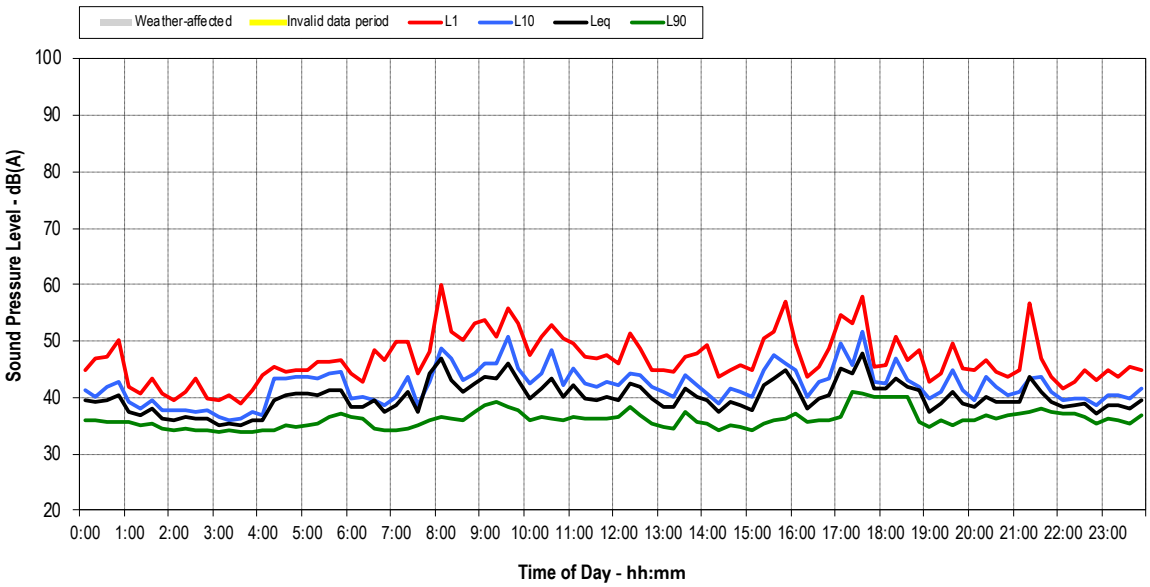
Broken Hill Hospital - Logger L2 - Friday 02 December 2022



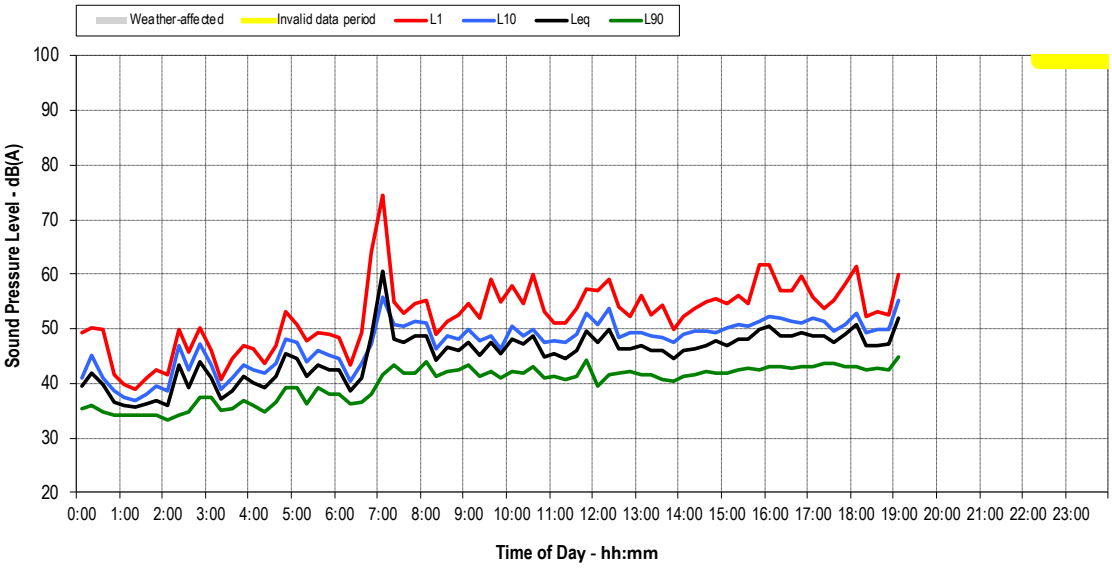
Broken Hill Hospital - Logger L2 - Saturday 03 December 2022



Broken Hill Hospital - Logger L2 - Sunday 04 December 2022



Broken Hill Hospital - Logger L2 - Monday 05 December 2022



Appendix C – Establishing NSW NPI Criteria

The main source of noise break-out from the proposed development to the environment will be activities noise from the premises and noise from the mechanical plant.

The environmental noise impact of the site has been assessed in accordance with the NSW EPA Noise Policy for Industry 2017 (NSW NPI).

The NSW NPI sets two separate noise criteria to meet environmental noise objectives: one to account for intrusive noise and the other to protect the amenity of particular land uses. Both are used to derive the Project Noise Trigger Level (PNTL).

Assessing intrusiveness

The intrusiveness criterion essentially means that the equivalent continuous noise level of the source is not to be more than 5 dB above the measured existing background noise level.

Assessing amenity

The amenity assessment is based on noise criteria specific to land use and associated activities. The criteria only relate to industrial-type noise, including plant. The existing noise level from industry (or plant) is measured – if it approaches the criterion value, then the noise levels from new plant need to be designed so that the cumulative effect does not produce noise levels that would significantly exceed the criterion.
The cumulative effect of noise from all industrial or plant sources is considered in assessing impact.

Project noise trigger level

For the new plant in BHHR premises, the more stringent of the intrusive and the amenity criteria sets the PNTL.

The derivation of the PNTL is provided below.

C.1 Existing Background and Ambient Noise Levels

The Rating Background Level (RBL) has been determined from $L_{A90,15min}$ measured during the long-term noise survey in accordance with the methodology prescribed in NSW NPI.

Three time periods are considered (consistent with the operating times and the time of day classifications in the NSW NPI):

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

The estimated RBLs and ambient noise levels are shown below in Table C1.

Location	L_{eq} Ambient Noise Levels, dB(A)			L_{90} RBL Background Noise Levels, dB(A)		
	Day 7am-6pm	Evening 6pm-10pm	Night 10pm-7am	Day 7am-6pm	Evening 6pm-10pm	Night 10pm-7am
Logger Location 1	57	51	45	38	36	31
Logger Location 2	48	43	43	38	38	35

Table C1 : Long-term background and ambient noise levels based on NSW NPI around the site

We make the following comments with regard to the summary above:

- Review of the data and weather observations during the monitoring period confirmed that the data was not affected by adverse weather conditions.
- With consideration of the above it was noted that 90% of the data captured was consistent daily and the data collected is considered representative of the existing conditions at site (i.e. additional monitoring will not change the long term background summary).
- Based on the unattended and attended noise monitoring, the data from the follow loggers is representative of the following locations and used to establish the respective criteria:
    - Logger 1 – Pre-existing ambient and background noise levels at residential receivers to the east of the site.
    - Logger 2 – Pre-existing ambient and background noise levels at residential receivers to the west and south of the hospital campus

C.2 Determination of project intrusiveness noise level

The intrusiveness noise level is defined as:

$$L_{Aeq,15minute} = RBL \text{ plus } 5 \text{ dB(A)} \qquad (Equation\ 1)$$

The intrusiveness noise level has been determined from the RBL's presented in table 1 for each period.

East (based on Logger Location 1)

- Day Intrusiveness criterion of - 38 + 5 = **43 dB(A)**
- Evening Intrusiveness criterion of - 36 + 5 = **41 dB(A)**
- Night Intrusiveness criterion of - 31 + 5 = **36 dB(A)**

West / South (based on Logger Location 2)

- Day Intrusiveness criterion of - 38 + 5 = **43 dB(A)**
- Evening Intrusiveness criterion of - 38 + 5 = **43 dB(A)**
- Night Intrusiveness criterion of - 35 + 5 = **40 dB(A)**

The Intrusiveness noise levels are only applied to residential receivers.

C.3 Determination of project amenity noise levels

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 is to remain below the recommended Amenity Noise Levels (ANL) specified in Table 2.2 of the NSW 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 ANL represents the objective for total industrial noise at a receiver location, whereas the project ANL 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 ANL for an area, a project ANL applies for each new source of industrial noise from an industrial development as follows:

Project ANL = Recommended ANL minus 5 dB(A) (Equation 2)

The nearest residential receivers to the project are considered to be – as per NSW NPI Table 2.3 and the land use zoning as per NSW Planning Portal (R1) – in a Noise Amenity Area characterised by the NSW NPI as urban.

The recommended ANLs relevant to this project are specified in Table C3.

Receiver[7]	Time of Day	LA_{eq}, dB(A)
		Recommended ANL
Residential (Urban)	Day	60
	Evening	50
	Night	45
Hospital Ward - External	When in Use	50
Commercial	When in use	65

Table C3 : Recommended L_{Aeq} noise levels from industrial noise sources at residential and non-residential receivers

The following exceptions to the above method to derive the project ANL apply:

- **Exception A – In areas with high traffic noise levels**

  The level of transport noise, road traffic noise in particular, may be high enough to make noise from an industrial source effectively inaudible, even though the LAeq noise level from that industrial noise source may exceed the project amenity noise level. In such cases the project amenity noise level may be derived from the $L_{Aeq, period(traffic)}$ minus 15 dB(A).

  This high traffic project amenity noise level may be applied only if all the following apply:

[7] The NSW NPI states, "Where internal noise levels are specified, they refer to the noise level at the centre of the habitable room that is most exposed to the noise and are to apply with the windows opened sufficiently to provide adequate ventilation, except where means of ventilation complying with the Building Code of Australia are provided. In cases where gaining internal access for monitoring is difficult, then external noise levels 10 dB(A) above internal levels apply".

- traffic noise is identified as the dominant noise source at the site,
- the existing traffic noise level (determined using the procedure outlined in Section A2, Fact Sheet A of NSW NPI, measuring traffic instead of industrial noise) is 10 dB or more above the recommended ANL for the area, and
- it is highly unlikely traffic noise levels will decrease in the future,

for each assessment period where these traffic noise provisions apply, the High Traffic Project ANL is to be used for industrial development, derived from the $L_{Aeq,period(traffic)}$ as:

High Traffic Project ANL = $L_{Aeq,period(traffic)}$ minus 15 dB(A) (Equation 3)

- **Exception B – In proposed developments in major industrial clusters**

The recommended amenity noise level from Table C3 represents the total industrial noise level from all sources (new and proposed) that is sought to be achieved using feasible and reasonable controls.
The approach of deriving the project amenity noise level resulting from a new development on the basis of 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.

Where an existing cluster of industry, for example, an industrial estate or port area, is undergoing redevelopment and/or expansion and the development constitutes a single premises addition or expansion, with no other redevelopment planned in the foreseeable future, the project amenity noise level approach procedure in Section B.3 can be applied.

However, where a greenfield or redevelopment of an existing cluster of industry consisting of multiple new noise-generating premises is proposed, the approach for determining the project amenity noise level in Section B.3 is not applicable and the approach below is to be applied.
For the new multiple premises or redevelopment of existing clusters of industry, for each individual premise,

Individual Project ANL = $10Log_{10}(10^{(L - 5\ dB/10)}/N)$ dB(A) (Equation 4)

where L is the relevant recommended ANL from Table C3 and N is the number of proposed additional premises.

Where a greenfield development is proposed and it can be demonstrated that existing L_{Aeq} industrial noise levels are more than 5 dB lower than the relevant recommended ANL, the above equation can be modified to reflect "L" in lieu of "L – 5 dB".

- **Exception C**

Where the resultant project ANL is 10 dB or more lower than the existing industrial noise level. In this case the project ANL can be set at 10 dB below existing industrial noise levels if it can be demonstrated that existing industrial noise levels are unlikely to reduce over time.

- **Exception D**

  Where cumulative industrial noise is not a necessary consideration because no other industries are present in the area, or likely to be introduced into the area in the future. In such cases the relevant ANL is assigned as the project ANL for the development.

Where the project ANL applies and it can be met, no additional consideration of cumulative industrial noise is required. However, in circumstances where this level cannot be feasibly and reasonably met, an assessment of existing industrial noise, and the combined resulting noise level from existing and the proposed industries, is required so the impact of the residual noise levels can be determined in accordance with Section 4.2 of the NSW NPI.

Receiver - External	Time of Day	Recommended ANL	Adjustment	Project ANL[8]
Residential (East)	Day	60	Equation 2	58
	Evening	50	Equation 2	48
	Night	45	Equation 2	43
Residential (West / South)	Day	60	Equation 2	58
	Evening	50	Equation 2	48
	Night	45	Equation 2	43
Hospital Ward (external)	When in use	50	Equation 2	48
Commercial Premises	When in use	65	Equation 2	63

Table C4: Determination of Project Amenity Noise Levels for residential and commercial receivers

C.4 Project noise trigger level

The PNTL is defined as the lower of the project intrusiveness and amenity noise levels. On this basis, the PNTL are shown in Table C5 below (PNTLs shown shaded).

Receiver - External	Period	Project Intrusiveness Noise Level	Project Amenity Noise Level
Residential (East)	Day	43	58
	Evening	41	48
	Night	36	43
Residential (West / North)	Day	43	58
	Evening	43	48
	Night	40	43
Hospital Ward (external)	When in use	-	48
Commercial Premises	When in use	-	63

Table C5 : Determination of Project Noise Trigger Levels for the site

[8] The L_{Aeq} is determined over a 15-minute period for the project intrusiveness noise level and over an assessment period (day, evening and night) for the Project ANL. This leads to the situation where, because of the different averaging periods, the same numerical value does not necessarily represent the same amount of noise heard by a person for different time periods. To standardize the time periods for the intrusiveness and amenity noise levels, the Policy assumes that the $L_{Aeq,15min}$ will be taken to be equal to the $L_{Aeq,period}$ + 3dB(A).