WOOD & GRIEVE ENGINEERS

Parkes Hospital
Environmental Acoustic Assessment

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1. INTRODUCTION

The purpose of this report is to provide an environmental noise impact assessment as part of the Review of Environmental Factors for the proposed Parkes Hospital development, located in Parkes NSW 2870. The proposed work will involve the construction of a new public medical facility to serve the area.

The objectives of the Lachlan Health Services Project, which includes the new build of Parkes Hospital, is to provide contemporary healthcare facilities suited to the current and future needs of the catchment population, and to provide capacity to support the agreed scope of clinical care in an environment that facilitates the delivery of contemporary health services.
Facility function should allow efficient bed utilisation and staffing to better meet the current and future needs of Parkes and the surrounding community.

The scope of the Parkes Hospital project is summarised as follows:

- Early Works including site preparation and bulk earthworks
- Construction of a new two-storey approx 9,000 sqm hospital building, including:
  - 28-bed inpatient unit;
  - Birthing unit;
  - Emergency Department;
  - Community and Ambulatory Care zone, including 6 chemotherapy chairs and 3 dental chairs;
  - Clinical Support Services, including Pharmacy; Pathology Laboratory and Medical Imaging; and
  - Non-clinical support services, including a Linen Distribution Centre for the district.
- Construction of single storey (approx 120 sqm) short-stay staff accommodation building.
- Access roads and circulation.
- On-grade car-parking for approximately 140 vehicles.
- Landscaping.
- Associated site infrastructure works.

This assessment discusses the likely noise impact on the potentially nearest most-affected receivers of the proposed development.

This assessment has been prepared considering the documents listed in Section 2.2. The report provides:

- A statement of compliance with the Parkes Shire Council Development Control Plan (DCP) criteria for the proposed hospital development within the vicinity of the nearest potentially affected residential receivers.
- Recommendations for noise mitigation measures for the proposed development in order to meet the Parkes Shire Council criteria when compliance is not achieved.
- Traffic noise impact assessment associated with the proposed Hospital development.
- Construction noise and vibration criteria.

This noise assessment is based on noise data collected by three noise loggers located in representative locations close to the site over a period of 14 days in August/September 2013.

This report is based on our understanding of the proposed project, application of the relevant state guidelines and professional experience within the acoustic field. Therefore this report shall not be relied upon as providing any warranties or guarantees.

2. BACKGROUND

2.1 Information Sources

This assessment was based on the concept design architectural drawings provided by Rice Daubney (plan and elevations) and the following information:

- 4828-RD-AR-DWG-PM-1100 Rev 05
- 4828-RD-AR-DWG-PM-1101 Rev 05
- 4828-RD-AR-DWG-PM-1102 Rev 01
- 4828-RD-AR-DWG-PM-1103 Rev 01
- 4828-RD-AR-DWG-PM-3001 Rev 04
- 4828-RD-AR-DWG-PM-3002 Rev 06
- 4828-RD-AR-DWG-PM-3003 Rev 05
- 4828-RD-AR-DWG-PM-3004 Rev 05
- 4828-RD-AR-DWG-PM-3005 Rev 05
- 4828-RD-AR-DWG-PM-3006 Rev 05
- 4828-RD-AR-DWG-PM-3007 Rev 05
- 4828-RD-AR-DWG-PM-3008 Rev 03
- 4828-RD-AR-DWG-PM-3009 Rev 03
- 4828-RD-AR-DWG-PM-3010 Rev 03
- 4828-RD-AR-DWG-PM-3011 Rev 03
- 4828-RD-AR-DWG-PM-3012 Rev 03
- 4828-RD-AR-DWG-PM-3101 Rev 04
- 4828-RD-AR-DWG-PM-3102 Rev 04
- 4828-RD-AR-DWG-PM-3103 Rev 03
- 4828-RD-AR-DWG-PM-3104 Rev 04
- 4828-RD-AR-DWG-PM-3105 Rev 04
- 4828-RD-AR-DWG-PM-3106 Rev 01
- 4828-RD-AR-DWG-PM-3107 Rev 01
- Mechanical Sketches issued by WSP dated: 16/09/2013
- Master Plan & Concept Design Report dated 23rd August 2013
- Noise data collected on site through the use of 3 noise loggers and a Type 1 hand held sound level meter
- Generic noise data of mechanical plant based on manufacturers catalogues

2.2 Reference documents

- Parkes Shire Council Development Control Plan 2006
- New South Wales (NSW) Office of Environment and Heritage, Industrial Noise Policy (INP) January 2000.
- New South Wales (NSW) Environmental Protection Authority (EPA), Environmental Noise Control Manual (ENCM) 1994.
- New South Wales (NSW) Office of Environment and Heritage (DECCW) Interim Construction Noise Guideline July 2009.
- Australian Standard, AS 2436-1981, “Guide to Noise Control on Construction, Maintenance and Demolition Sites”.
- Australian Standard, AS 2021-2000 Acoustics - Aircraft noise intrusion - Building siting and construction.
- Air Services Australia, “Environmental principles and procedures for minimizing the impact of aircraft noise”.
- “Fly neighborly guide”, produced by the Helicopter Association International.

3. PROJECT OVERVIEW

3.1 Site description

The site of the Parkes Hospital is bounded by Newell Highway to the West and Henderson St to the South. The nearest sensitive receivers have been identified as follows and are displayed in Figure 1:

- Location C1: Commercial receivers along the Newell Highway approximately 220m form the site (displayed in Blue)
- Location R1:Residential receivers to the North approximately 250m from the site (displayed in Green)
- Location R2: Residential receivers to the East approximately 240m from the site (displayed in Green)

3.2 Existing noise environment

The existing background noise is typical for a suburban area that has local traffic with characteristically intermittent traffic flows with some limited commerce or industry. We can observe decreasing noise levels in the night period and the night ambient noise levels defined by the natural environment and infrequent human activity.
The lowest noise levels are generally recorded around 2am in the morning. With this scenario, the OEH Industrial Noise Policy (INP, Environment Protection Authority 2000) requires that the level of background and ambient noise be assessed separately for the daytime, evening and night time periods.

The INP defines these periods as follows:

- Day is defined as 7:00am to 6:00pm, Monday to Saturday and 8:00am to 6:00pm Sundays & Public Holidays.
- Evening is defined as 6:00pm to 10:00pm, Monday to Sunday & Public Holidays.
- Night is defined as 10:00pm to 7:00am, Monday to Saturday and 10:00pm to 8:00am Sundays & Public Holidays

The noise monitoring locations are illustrated in Figure 1.
The long term monitoring Locations LM1, LM2 and LM3 were selected away from any mechanical plant located in the vicinity that was likely to affect the noise monitoring results. These locations were selected as representative of the ambient noise level of the areas surrounding the site.

In addition to the unattended noise monitoring, attended noise monitoring was conducted at locations SM1 to SM5, which are also shown in Figure 1.

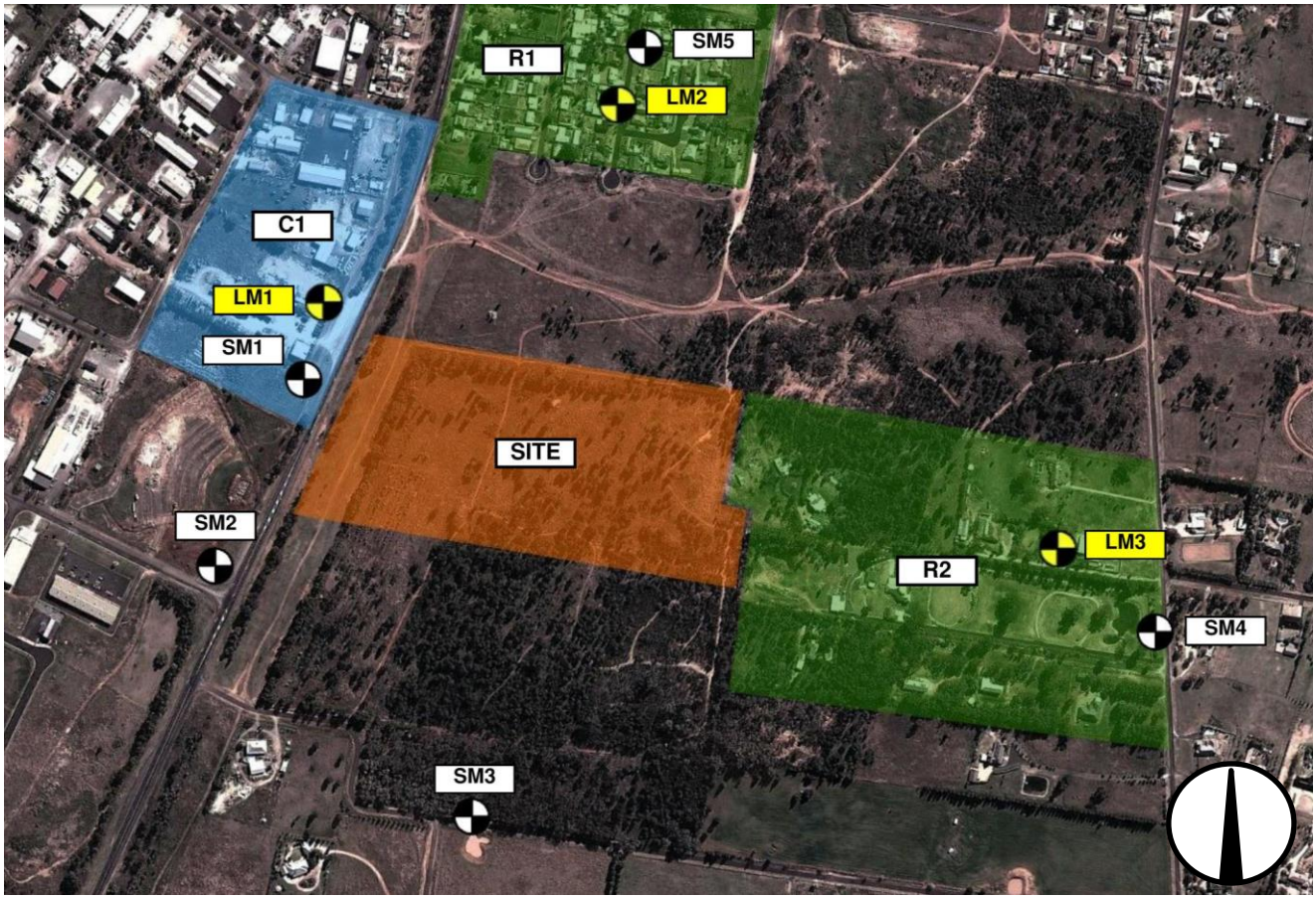
3.2.1 Instrumentation

The equipment used for the noise survey was the following:

- Hand-held sound spectrum analyzer Brüel & Kjær 2250 S/N 2709742.
- ARL Environmental Noise Logger EL-315 S/N 194535 (LM1 in Figure 1).
- ARL Environmental Noise Logger EL-315 S/N 194638 (LM2 in Figure 1).
- ARL Environmental Noise Logger EL-315 S/N 194528 (LM3 in Figure 1).
- Brüel & Kjær Calibrator, S/N: 2709826

All equipment was calibrated before and after the measurements and no significant drift was found. All equipment carries current traceable calibration certificates that can be provided upon request.

Figure 1: Site map illustrating nearest sensitive receivers and noise measurement locations



Source: Nearmap

Figure 2: Site location overview

Source: Near map

3.2.2 Short-term measurements

Table 1 below shows a summary of the attended measurements results.

Table 1: Summary of short-term measurements

Measurement Location	Date/Start Time	$L_{Aeq,15min}$ dB(A)	$L_{A90,15min}$ dB(A)	Background Noise Description
SM1	27/08/2013 21:45	62	39	Traffic noise with approx. 90% trucks and 10% cars
SM2	27/08/2013 22:05	67	38	Traffic noise with approx. 90% trucks and 10% cars
SM3	27/08/2013 22:25	52	38	Ambient noise, distant traffic
SM4	27/08/2013 22:46	57	37	Ambient noise, distant traffic
SM1	10/09/2013 18:16	67	46	Traffic noise from Newell Highway dominating ambient noise
SM2	10/09/2013 17:48	71	53	Traffic noise from Newell Highway dominating ambient noise
SM3	10/09/2013 17:26	57	45	Ambient noise with some distant traffic
SM4	10/09/2013 17:03	61	42	Ambient noise with some distant traffic
SM5	10/09/2013 18:52	50	37	Ambient noise with some distant traffic

3.2.3 Long-term measurements

The three noise loggers (LM1, LM2 and LM3) were set to record statistical noise levels and continuously logged from Tuesday 28th August until Tuesday 10th September 2013. The data collected by the three noise loggers is also presented graphically in Appendix 1. The equipment recorded the noise levels over a15-minute period and then determined the L_{A10}, L_{A90} and L_{Aeq} levels of the noise environment. Table 2 presents the results of the continuous averaged sound pressure levels (L_{Aeq}), and the rated background noise level (L_{A90}) see Appendix 2 for definitions.

Table 2: Summary of existing and background noise levels

Location	Rated background noise level RBL			$L_{Aeq,period}$		
	Day	Evening	Night	Day	Evening	Night
LM1	40	33	28	63	60	57
LM2	35	36	31	53	48	45
LM3	35	36	31	52	45	46

3.2.4 Traffic Noise

The noise environment at SM2 for the day period was consistently dominated by the traffic noise during our attended measurements; therefore the measurement was extrapolated to a one hour period.
We present the worst case scenario traffic noise level that is going to be used for the acoustic traffic assessment in Table 3 below.

Table 3: Road traffic noise levels from attended measurements

Measurement Location	Period	$L_{Aeq,60min}$ dB(A)	$L_{A10,60min}$ dB(A)
SM2	Day	71	75
SM2	Night	67	66

4. NOISE AND VIBRATION CRITERIA

4.1 Exterior Mechanical Plant and Equipment Noise Criteria

4.1.1 Parkes Shire Council Development Control Plan (DCP) 2013

The Parkes Shire Council Development Control Plan 2006 refers to the use of Environment & Heritage (OEH) Industrial Noise Policy (INP) as the guideline to follow in order to assess impact noise of new developments.

4.1.2 New South Wales (NSW) Office of Environment & Heritage (OEH) Industrial Noise Policy (INP)

The environmental noise criteria or project-specific noise level is calculated following the NSW OEH INP guidelines.

The calculation is based on the results of the ambient and background noise unattended monitoring, addressing the following component:

- Controlling intrusive noise into nearby residences (Intrusiveness Criteria)

Once the criteria are established the most stringent for each considered assessment period (day, evening, night) is adopted as the project-specific noise level (PSNL).

Intrusiveness Criteria

The NSW OEH INP states the following:

"The intrusiveness of an industrial noise source may generally be considered acceptable if the equivalent continuous (energy-average) A-weighted level of noise from the source (represented by the L_{Aeq} descriptor), measured over a 15-minute period, does not exceed the background noise level measured in the absence of the source by more than 5 dB(A)."

The intrusiveness criterion can be summarised as follows:

$L_{Aeq,\ 15\ minute} \leq$ RBL background noise level plus 5 dB(A)

The intrusiveness criteria for each assessment location are presented below in Table 4.

Table 4: Intrusiveness Criteria – dB(A)

Period (as defined in the INP)		Intrusiveness criteria at each assessment location		
		Location LM1	Location LM2	Location LM3
Day	$L_{Aeq,\ 15\ min}$	45	40	40
Evening	$L_{Aeq,\ 15\ min}$	38	41	41
Night	$L_{Aeq,\ 15\ min}$	33	36	36

The intrusiveness criteria in locations LM2 and LM3 (see Table 4) will be used as the criteria for the residential areas as they are seen as the most indicative of the background noise level for the areas.

Amenity Criteria

The amenity criterion was not incorporated into the criteria of this development due to the absence of industrial noise sources in the area.

Modifying Factor Adjustments

The NSW DECCW INP also states: "Where a noise source contains certain characteristics, such as tonality, impulsiveness, intermittency, irregularity or dominant low-frequency content, there is evidence to suggest that it can cause greater annoyance than other noise at the same noise level."

In order to take into account the potential annoying character of the noise an adjustment of 5 dB(A) for each annoying character aspect and cumulative of up to a total of 10 dB(A), is to be added to the measured value to penalise the noise for its potentially greater annoyance aspect.

Table 4.1 of Chapter 4 of the NSW DECCW INP (see Table 5 below) provides procedures for determining whether an adjustment should be applied for greater annoyance aspect.

Table 5: Table 4.1 NSW DECCW INP – Modifying factor corrections

Factor	Assessment / Measurement	When to Apply	Correction[1]	Comments
Tonal Noise	One-third octave or narrow band analysis	Level of one-third octave band exceeds the level of the adjacent bands on both sides by: - **5 dB** or more if the centre frequency of the band containing the tone is above 400 Hz - **8 dB** or more if the centre frequency band containing the tone is 160 to 400 Hz inclusive - **15 dB** or more if the centre frequency of the band containing the tone is below 160 Hz	5 dB[2]	Narrow-band frequency analysis may be required to precisely detect occurrence.
Low Frequency Noise	Measurement of C-weighted and A-weighted level	Measure / assesses C- and A-weighted levels over same time period. Correction to be applied if the difference between the two levels is 15 dB or more	5 dB[2]	C-weighting is designed to be more responsive to low-frequency noise, especially at higher overall levels
Impulsive Noise	A-weighted fast response and impulsive response	If difference in A-weighted maximum noise levels between fast response and impulse response is greater than 2 dB	Apply difference in measured levels as the correction, up to a maximum of 5 dB.	Characterised by a short rise time of 35 milliseconds (ms) and decay time of 1.5 s.
Intermittent Noise	Subjectively assessed	Level varies by more than 5 dB	5 dB	Adjustment to be applied for **night-time only.**
Duration	Single-event noise duration may range from 1.5 min to 2.5 h	On event in any 24-hour period	0 to – 20 dB(A)	The acceptable noise level may be increased by an adjustment depending on duration of noise.

Maximum Adjustment	Refer to individual modifying factors	Where two or more modifying factors are indicated	Maximum correction of 10dB(A)[2] (excluding duration correction)	

Notes:

1. Corrections to be added to the measured or predicted levels.
2. Where a source emits tonal and low-frequency noise, only one 5 dB correction should be applied if the tone is in the low-frequency range.

Project-Specific Noise Levels (PSNL)

Table 6 displays the PSNL based on the worst case scenario.

Table 6: Project Specific Noise Levels – dB(A)

Period	Descriptor	PNSL
Residential Areas		
Day	$L_{Aeq,Day}$	**40**
Evening	$L_{Aeq,Evening}$	**41**
Night	$L_{Aeq,Night}$	**36**
Commercial Areas		
When in use	$L_{Aeq,\ Period}$	**65**

The most stringent noise criterion to meet at the boundary of the nearest residence is the night time criterion of 36dB(A).

4.2 Sleep Disturbance Criteria

The NSW OEH's INP does not address the issue of sleep arousal. The NSW EPA's "Environmental Noise Control Manual" (ENCM) however, makes the general observation that a person's sleep can be significantly disrupted by noise. Scientific research has established that short duration or intermittent noise is more disturbing to sleep than continuous noise of similar acoustic energy.

Chapter 19 of the ENCM provides guidelines for assessing sleep disturbance resulting from short-duration high-level noises which occur at night (10:00pm to 7:00am according to the DECCW) as follows:

"Noise control should be applied with the general intent to protect people from sleep arousal. To achieve this, the L_1 level of any specific noise source should not exceed the background noise level (L_{90}) by more than 15 dB(A) when measured outside the bedroom window."

The following Table 7 summarises the sleep arousal criteria that are applied to the surrounding residential premises based on data from LM2.

These noise levels can be assessed (outdoor) at the facade of the residential premises.

Table 7: Sleep Arousal Criteria

Location	Night-time L_{A90}	L_{A1} Criteria – dB(A)
All	31	46

The Application notes regarding the INP published by the OEH suggest that the OEH recognises that the current sleep disturbance criterion of an $L_{A1,1min}$ not exceeding the $L_{A90,15min}$ by more than 15 dB(A) is not ideal. Nevertheless as there is insufficient evidence to determine what should replace it, the OEH will continue to use it as a guide to identify the likelihood of sleep disturbance. This means that where the criterion is met, sleep disturbance is not likely to occur, but where it is not met, a more detailed analysis is required.

The detailed analysis should cover the maximum noise level $L_{A1,\ 1min}$ that is, the extent to which the maximum 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 appendices to the *NSW Environmental Criteria for Road Traffic Noise* (ECRTN, Environment Protection Authority 1999). Other factors that may be important in assessing the extent of impacts on sleep include:

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

The $L_{A1,\ 1min}$ descriptor represents a maximum noise level measured under fast time response. OEH will accept analysis based on either $L_{A1,\ 1min}$ or L_{Amax}.

4.3 Traffic Noise Criteria

Road traffic noise impact in this report is assessed according to the NSW Road Noise Policy (2011) and the Traffic Report by GTA Consultants.

The traffic noise criteria for the proposed road (or residential land use developments) in NSW Road Noise Policy divides land use developments into different categories and lists the respective criteria for each case.

Table 3 Section 2.3.1 in the NSW Road Noise Policy sets out the assessment criteria for residences to be applied to particular types of projects, road category and land use. Relevant to this project is Category 6 under Local roads category, which is summarized in Table 8 below.

Table 8: NSW Road Noise Policy – Road Traffic Noise Assessment Criteria for Residential Land Uses

Road Category	Type of Project/Land Use	Day, dB(A) (7:00am to 10:00pm)	Night, dB(A) (10:00pm to 7:00am)
Local roads	6. Existing residences affected by additional traffic on existing local roads generated by land use developments	$L_{Aeq\ (1\ hr)}$ 55 (external)	$L_{Aeq\ (1\ hr)}$ 50 (external)

In the process for applying the criteria, for existing residences and other sensitive land uses affected by additional traffic on existing roads generated by land use developments, any increase in the total traffic noise level should be limited to 2dB above that of the corresponding existing noise levels.

4.4 Aircraft Noise Criteria

Schedule 1 of The Environment Operations Act 1997 reads as follows:

> ***20 Helicopter-related activities***
>
> *(1) This clause applies to a "helicopter-related activity" but not including an activity that is carried out exclusively for the purposes of emergency aeromedical evacuation, retrieval or rescue.*

Thus, although not strictly necessary we believe that certain criterion needs to be applied in regards to helicopter noise.

There is no current NSW OEH criteria for aircraft noise that are available to assess helicopter noise from a development. Previous assessments in the Land and Environmental Court NSW have applied noise criteria obtained from Airservices Australia.
Helicopter noise from the development will be assessed against the guidelines given in the Airservices Australia Principles and Procedures for minimizing the impact of aircraft noise fly Neighbourly Guide and AS2021-2000.

4.4.1 Airservices Australia

1. No overflight of residential areas, if this can't be achieved then;
2. No overflight of residential area below 1,500 ft AGL, if this can't be achieved then;
3. Minimisation of incidence of helicopters flying below 1,500 ft AGL, if this can't be achieved then;
4. Minimisation of noise impact on residential areas by helicopters below 1,500 ft AG;
5. Minimisation of noise impacts on residential areas by hovering/circling helicopters;
6. Implement Fly Neighbourly procedures.

4.4.2 AS2021-2000

Australian Standard, AS 2021-2000 Acoustics - Aircraft noise intrusion - Building siting and construction makes reference to the acceptable noise levels inside Hospital wards regarding aircraft noise intrusion.

Table 9 and Table 10 display the indoor design sound levels for determination of building noise reduction and the building site acceptability based on aircraft noise levels respectively.

Table 9: Indoor design sound levels for determination of building noise reduction

Building Type and activity	Aircraft noise levels at site Indoor Design Sound Level, dB(A)
Hospitals	
Wards, theatres, treatments and consulting rooms	50
Laboratories	65
Service Areas	75
Houses, home units, flats, caravan parks	
Sleeping Areas, dedicated lounges	50
Other habitable spaces	55
Bathrooms, toilets, laundry	60

Table 10: Building site acceptability based on aircraft noise levels for less than 20 movements per day

Building Site	Aircraft noise levels at site		
	Acceptable	Conditionally acceptable	Not acceptable
Hospitals	<80	80 to 90	>90

Due to the nature of the site we will discuss the proposed recommended levels.
The helipad will reside ~20m away from the Eastern side of the development.
The most important variable to take into account is how often helicopters will land and take off from the helipad per day.

4.5 Construction Noise Criteria

Noise criteria for construction sites are established in accordance with the Interim Construction Noise Guideline (ICNG July 2009) by the NSW Office of Environment and Heritage. It is important to note that the recommended criteria are for planning purposes only. Numerous other factors need to be considered when assessing potential noise impacts from construction works.

However, in undertaking the assessment of potential noise intrusion associated with the proposed construction activities, Chapter 4 of the NSW OEH ICNG (July 2009) were specifically referenced. The limits presented in Table 11 apply.

Table 11: NSW OEH ICNG Construction Noise Criteria

Time of Day	Management Level $L_{Aeq,15min}$ *	How to Apply
Recommended Standard Hours: Mon – Fri (7am – 6pm) Sat (8am – 1pm) No work on Sunday & Public Holidays	Noise Affected RBL + 10dB	The noise affected level represents the point above which there may be some community reaction to noise. • Where the predicted or measured $L_{Aeq,15min}$ 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 residences of the nature of works to be carried out, the expected noise levels and duration as well as contact details.
	Highly Noise Affected 75 dB(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 in, taking into account: • 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) • 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 + 5dB	• A strong justification would typically be required for works outside the recommended standard hours. • The proponent should apply all feasible and reasonable work practices to meet the noise affected level. • Where all feasible and reasonable practices have been applied and noise is more than 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.

Note: Noise levels apply at the property boundary that is most exposed to construction noise, and at a height of 1.5 m above ground level. If the property boundary is more than 30 m from the residence, the location for measuring or predicting noise levels is at the most noise-affected point within 30m of the residence. Noise levels may be higher at upper floors of the noise affected residence.

Source: Chapter 4 (Table 2 Sec 4.1.1) of NSW OEH ICNG.

4.5.1 Construction Vibration Criteria

The OEH has developed a document, "Assessing vibration: A technical Guideline" in February 2006 to assist in preventing people from excessive vibration levels within buildings. The guideline does not however address vibration induced damage to structures or structure-borne noise effects. Vibration and its associated effects are usually classified as continuous, impulsive or intermittent.

4.5.2 Human Comfort – Continuous and Impulsive Vibration Criteria

Structural vibration in buildings can be detected by occupants and can affect them in many ways including reducing their quality of life and also their working efficiency. Complaint levels from occupants of buildings subject to vibration depend upon their use of the building and the time of the day.

Maximum allowable magnitudes of building vibration with respect to human response are shown in Table 12. It should be noted that the human comfort for vibration are more stringent than the building damage criteria.

Table 12: Preferred and maximum weighted RMS values for continuous and impulsive vibration (m/s^2)

Location	Assessment period[1]	Preferred values		Maximum values	
		z-axis	x- and y-axis	z-axis	x- and y-axis
Continuous vibration					
Residences	Daytime	0.010	0.0071	0.020	0.014
	Night time	0.007	0.005	0.014	0.010
Critical areas	Day or night time	0.0050	0.0036	0.010	0.0072
Impulsive vibration					
Residences	Daytime	0.30	0.21	0.60	0.42
	Night time	0.10	0.071	0.20	0.014
Critical areas	Day or night time	0.0050	0.0036	0.010	0.0072

4.5.3 Human Comfort – Intermittent Vibration Criteria

Disturbance caused by vibration will depend on its duration and its magnitude. This methodology of assessing intermittent vibration levels involves the calculation of a parameter called the Vibration Dose Value (VDV) which is used to evaluate the cumulative effects of intermittent vibration. Various studies support the fact that VDV assessment methods are far more accurate in assessing the level of disturbance than methods which is only based on the vibration magnitude.

Table 13: Acceptable Vibration Dose Values for Intermittent Vibration ($m/s^{1.75}$)

Location	**Daytime** (7:00am to 10:00pm)		**Night-time** (10:00pm to 7:00am)	
	Preferred value	Maximum value	Preferred value	Maximum value
Residences	0.20	0.40	0.13	0.26
Critical areas	0.10	0.20	0.10	0.20

4.5.4 Structural Damage – Vibration Criteria

Ground vibration criteria are defined in terms of levels of vibration emission from the construction activities which will avoid the risk of damaging surrounding buildings or structures. It should be noted that human comfort criteria are normally expressed in terms of acceleration whereas structural damage criteria are normally expressed in terms of velocity.

Most commonly specified structural vibration levels are defined to minimize the risk of cosmetic surface cracks and are set below the levels that have the potential to cause damage to the main structure.

Structural damage criteria are presented in German Standard DIN4150-Part 3 "Structural vibration in buildings – Effects on structures" and British Standard BS7385-Part 2: 1993 "Evaluation and Measurement for Vibration in Buildings".

Table 14 indicates the vibration limits presented in DIN4150-Part 3 to ensure structural damage doesn't occur.

Table 14: Guideline value of vibration velocity, vi for evaluating the effects of short term vibration

Line	Type of Structure	Vibration velocity, vi, in mm/s			
		Foundation			Plane of floor of uppermost full storey
		At a frequency of			
		< 10Hz	10 - 50Hz	50 -100*Hz	All Frequencies
1	Buildings used for commercial purposes, industrial buildings and buildings of similar design	20	20-40	40-50	40
2	Dwellings and buildings of similar design and/or use	5	5-15	15-20	15
3	Structures that, because of their particular sensitivity to vibration, do not correspond to those listed in lines 1 and 2 and are of great intrinsic value (e.g. buildings that are under a preservation order)	3	3-8	8-10	8
*For frequencies above 100Hz, at least the values specified in this column shall be applied					

Table 15 presents guide values for building vibration, based on the lowest vibration levels above which cosmetic damage has been demonstrated as per BS7385-Part 2:1993.

Table 15: Transient vibration guide values for cosmetic damage

Type of Building	Peak Particle Velocity in frequency range of predominant pulse (PPV)	
Residential or light commercial type buildings	4 Hz to 15 Hz	15 Hz and above
Residential or light commercial type buildings	15mm/s at 4Hz increasing to 20mm/s at 15Hz	20mm/s at 15Hz increasing to 50mm/s at 40Hz and above

4.6 Construction Vibration Project Specific Levels

Table 16 indicates the construction vibration criteria applicable to residential properties located adjacent to the development site.

Table 16: Construction vibration criteria summary

Location	Period	Human Comfort Vibration Objectives					Building damage Objectives – Velocity (mm/s)
		Continuous mm/s^2 (RMS)		Intermittent $m/s^{1.75}$ (VDV)	Impulsive vibration m/s^2 (RMS)		
		z-axis	x- and y-axis		z-axis	x- and y-axis	
Residential	Daytime	10-20	7.1-14	0.2-0.4	0.3-0.6	0.21-0.42	5
	Night time	7-14	5-10	0.13-0.26	0.1-0.2	0.071-0.14	5
Critical areas	Daytime or Night time	5-10	3.6-7.2	0.1-0.2	5-10 mm/s	3.6-7.2 mm/s	3

5. NOISE IMPACT ASSESSMENT

5.1 Noise Considerations

The following activities have been identified as being likely to generate noise with the potential to impact the surrounding environment.

These noise sources include:

- Continuous noise from mechanical plant such as cooling towers, air handler units (AHU), Chillers, condenser units and fans.
- Noise associated with electrical redundancy system such as emergency diesel generators Kohler KV410C2 (375 kVA Prime Power)
- Intermittent noise from typical site operation, such as maintenance activities and patron noise
- Intermittent traffic noise from light weight trucks entering the loading dock delivering various type of goods
- Intermittent traffic noise from car movement entering and exiting the carparks located on site
- Intermittent noise from ambulances accessing the emergency department unit (EDU)
- Intermittent noise from Helicopter movement landing on and taking off the on-site helipad

Equipment selections are yet to be finalised, therefore an indicative assessment has been conducted. This assessment will require to be updated as required once the final mechanical plant selection has been completed.

5.2 Mechanical Plant

5.2.1 Noise Sources

The proposed hospital development will include typical building services equipment, which will generate noise. Most of the spaces will be air-conditioned which will require mechanical system with items such as Chillers, compressors, cooling towers, air handling units, pumps to be located either externally or within plantrooms.

The main building services that are sources of noise are being located within plantrooms. Typically the noise of these plants will be controlled through the building fabric and the control of noise breakout through airways required for ventilation purposes with the use of attenuators or acoustic louvres.

As the site is an operational hospital with critical activities and equipment it will be supported by a redundancy system for power supply in order to avoid any issue in case of power outage. These redundancy systems when operating whether in case of main power failure or for maintenance purposes will generate a substantial amount of noise which is required to be assessed in detail.

Hydraulic systems also require to be considered in this assessment such as pumps, booster pumps for fire systems and the like.

The building services including mechanical, electrical and hydraulics noise sources associated with the development that has been assessed includes:

- 2 x Power Pax H08-2F Chillers
- 2 x Daikin RXYQ22PAY1E Outdoor VRF units
- 2 x Fantech CGD716 OA Fans*
- 3 x Fantech CD634VGL Fans*

*Fans were selected for indicative noise levels purposes only.

A further assessment will be conducted when more information becomes available.

The typical noise data (Sound Power Levels) of the proposed mechanical plant are presented in Table 17.

Table 17: Sound Power Levels of Mechanical Plant dB(A) re 1 pW

Plant Item	SWL – dB(A)
Power Pax H08-2F	102
Daikin RXYQ22PAY1E	83
Fantech CGD716	81
Fantech CD634VGL	91

5.3 Road Traffic Noise

The traffic noise measurements results presented in Section 3.2.4 indicate that the noise levels at the façade of the existing residences are compliant with the relevant noise criteria. The SSD report for the Parkes Hospital state that an additional 80 vehicles per hour is expected during the day period which represents a total of 1200 vehicles within a 15 hours period. The existing situation based on our noise monitoring corresponds to 21,055 vehicles per day on Newel Highway. The increase of vehicle movements on Newel Highway will be 1200 per day which corresponds to a 6% increase in traffic volume which is equivalent to 0.3dB(A) noise increase. The NSW Road Noise Policy criteria will be met as the increase in road traffic noise doesn't exceed 2dB.
The proposed rind road to be located north of the site has been considered and no significant impact was found on the surrounding environment.

5.4 Ambulance Noise

The Ambulance Services of NSW has informed Wood and Grieve Engineers that sirens are not used within hospital sites, the only exception being a "short burst" alerting potential motorists of the ambulance's presence when absolutely necessary.
Whilst driving in response to an emergency call out ambulance drivers may use the siren continuously or use it periodically to alert motorists as deem necessary. Whilst returning to the hospital after attending an emergency the siren will only be used in an extreme emergency such as occurs when attempts are being made to resuscitate a "clinically dead" patient. No operational changes are proposed for the Parkes Hospital project with the exception of the relocation of the ambulance bay. Noise levels generated by ambulance activities will be similar to those currently experienced in the area; with residential properties located along Berkeley Street likely to remain in a similar situation as they are now.

5.5 Helicopter Noise

The helipad is proposed to be located 20m east of the emergency department unit located in the proposed new building. The estimated number of helicopter movements was estimated to be approximately 20 per year.
A Helicopter feasibility study was completed by Rehbein Airport Consulting for the Parkes Hospital development. The report focuses on assessing the best site for helicopter operations out of the four proposed site for the development. The report also provides information in regards to noise emission associated with the operation of Helicopter. The site we are focusing on is Crown-2.
The report provides the results of a noise modelling using the US Federal Aviation Administration (FAA) Integrated Noise Model (INM) version 7.0c.

The Augusta Westland AW139 helicopter type is the design helicopter used in the NSW guidelines.However, INM noise data for the AW139 type is unavailable. The Eurocopter EC130 has a similar noise profile to the AW139 and has been for the noise assessment purposes.

It is states in the report that: *"noise levels of between 110 dB(A) and 140dB(A) can be expected on the HLS"*. Based on this sound pressure level and the noise contours presented in Figure 13 of the report the noise level associated with helicopter operations at the two nearest residential boundaries were calculated.

The predicted external noise level at residential location 1 and 2 (R1 & R2) is 70dB(A), this means that if we assume that a typical noise reduction of the residential building we can expect that an internal maximum noise level of 45dB(A). This noise level will typically comply with recommended internal noise levels within bedrooms following AS2021:1985 as presented in section 4.4.2.

The noise impact associated with helicopters movement on the hospital itself has been discussed with Health Infrastructure (HI) and it was agreed that because of the small number of annual movement no particular façade treatment will be considered. Therefore the assessment of the noise impact of helicopter on the hospital is not presented in this document.

5.6 Noise Model

Noise emissions from the proposed operations of the site were modelled. Noise emissions from the proposed development associated with noise sources identified in Table 17, were calculated for the two nearest potentially affected residential receiver locations (R1 and R2 shown in Figure 1). Noise emissions were determined by modelling the noise sources, receiver locations, and topographical features of the intervening area using an acoustic model. The program calculates the contribution of each noise source at each specified receptor point and allows for the prediction of the total noise from a site.

Noise levels were calculated at the nearest affected residential locations considering the worst case scenario of all plant and equipment operating simultaneously.
Table 18 presents calculated noise levels at each receiver. The predicted noise levels were simulated assuming no noise control treatment. In undertaking the predictive noise modelling, single-point calculations were undertaken for the two (2) nearest potentially affected receiver locations.

5.7 Assessment to the NSW OEH Industrial Noise Policy (INP)

Calculation of noise from the site operations was based on the typical worst case scenario during the assessment periods including day, evening and night time. The location of noise sources and description are presented in the mechanical sketch as provided by WSP dated 16/09/2013.

5.7.1 Predicted noise levels

Table 18 presents the predicted noise levels associated with the Parkes Hospital development at the boundary of the most sensitive receivers as identified in Figure 1.

Table 18: Predicted noise levels for mechanical plant

Location (See Figure 1)	INP Night time Criteria dB(A)	Predicted Noise Levels dB(A)	Compliance (Y/N)
R1	36	29	Yes
R2	36	40	No
C1	65	43	Yes

5.7.2 Comments

The results as shown in Table 18 indicate that the noise resulting from the mechanical plant shown in Table 19 is not complying for residential receiver location R2. Therefore it is recommended that acoustic mitigation measures are implemented. The recommended mitigation measures are shown in the subsequent section.

6. RECOMMENDATIONS

6.1 Mechanical Plant

Details of the proposed noise mitigation measures for building services plant for environmental noise will be provided during the detailed design stage of the project.

Nevertheless, for planning purposes, it should be noted that the installation of an acoustic barrier located on the Eastern side of the plant area is required in order to achieve compliance with the relevant criteria (outlined in Section 4). The predicted noise levels incorporating the acoustic barrier are shown below in Table 19.

Table 19: Predicted noise levels of mechanical plant with proposed acoustic mitigation

Receiver Location (See Figure 1)	Predicted Noise Level dB(A)	Night Time Criterion dB(A)	Compliance (Yes/No)
R1	29	36	Yes
R2	33	36	Yes
C1	43	65	Yes

The acoustic barrier should possess a minimum surface density of 16kg/m^2 and transmission loss values similar or better in performance as those described in Table 20. The presented values are characteristic of typical barriers nevertheless any other product with comparable or better performance could be used.

The acoustic barrier should be continuous and solid over the length and height specified. Any holes and gaps would compromise the barriers performance and therefore should be avoided. It is also recommended that a structural engineer provides additional input on the feasibility of the proposed acoustic solutions. The nominal height for the proposed acoustic barrier is 3000mm. The attenuation of the barrier has been predicted from a distance of 1.5m from the units.

Table 20: Barrier construction and associated insertion loss

Barrier Type	Octave band centred frequencies							
	63 Hz	125 Hz	250 Hz	500 Hz	1 kHz	2 kHz	4 kHz	8 kHz
9mm thick Compressed fibre cement	17	21	26	31	35	36	34	35

6.2 Construction Noise and Vibration

As the Parkes hospital development is a green field site it means that the noise and vibration associated with construction equipment will only require to be considered for surrounding receivers including residential and industrial properties. IA detailed Construction Noise and Vibration Management Plan (CNVMP) was developed for the planning process application to ensure the noise and vibration criteria outlined in section 4.1.8 of this report are complied with when the construction work will commence.
The report has been provided by Wood and Grieve Engineers, Ref. Parkes Hospital – Construction Noise and Vibration Management Plan dated from 17/01/2014.

7. CONCLUSION

This report presents the results of a study of operational noise emission from the proposed development of the Parkes Hospital located on Newell Highway Parkes, NSW. This report forms a part of the documentation package to be submitted to the public authority (Health Infrastructure) as part of the Review of Environmental Factors.

The environmental noise and vibration intrusion criteria for the operation and construction of the proposed development have been established based on Parkes Shire Council requirements and state policy guidelines. The establishment of the noise criteria was based on our noise survey which monitored ambient and background noise levels using both hand held sound level meters and long-term noise loggers at the boundary of the potentially most-affected receivers.

Road traffic noise criteria intrusion was also established based on the requirements of Parkes Shire Council and state policy guidelines.

The predicted noise levels presented in this report show that the most stringent noise criterion (night time criterion) will be met with the implementation of the proposed mitigation measures for external mechanical plant. The report also discussed potential noise impact associated with additional traffic generated by the new development and construction noise. No noise impact associated with additional traffic is expected.

Following our investigation it was found that no significant noise impacts will occur as a result of the proposed development should the proposed noise mitigation measures be implemented during the construction stage.

Even though no assessment can be considered as being thorough enough to preclude all potential environmental impacts, having given regard to the above listed conclusions, it is the finding of this assessment that the proposed development should not be refused on the grounds of excessive noise generation.

Appendix 1: Noise logger results

Table 21: Long term measurement location LM1

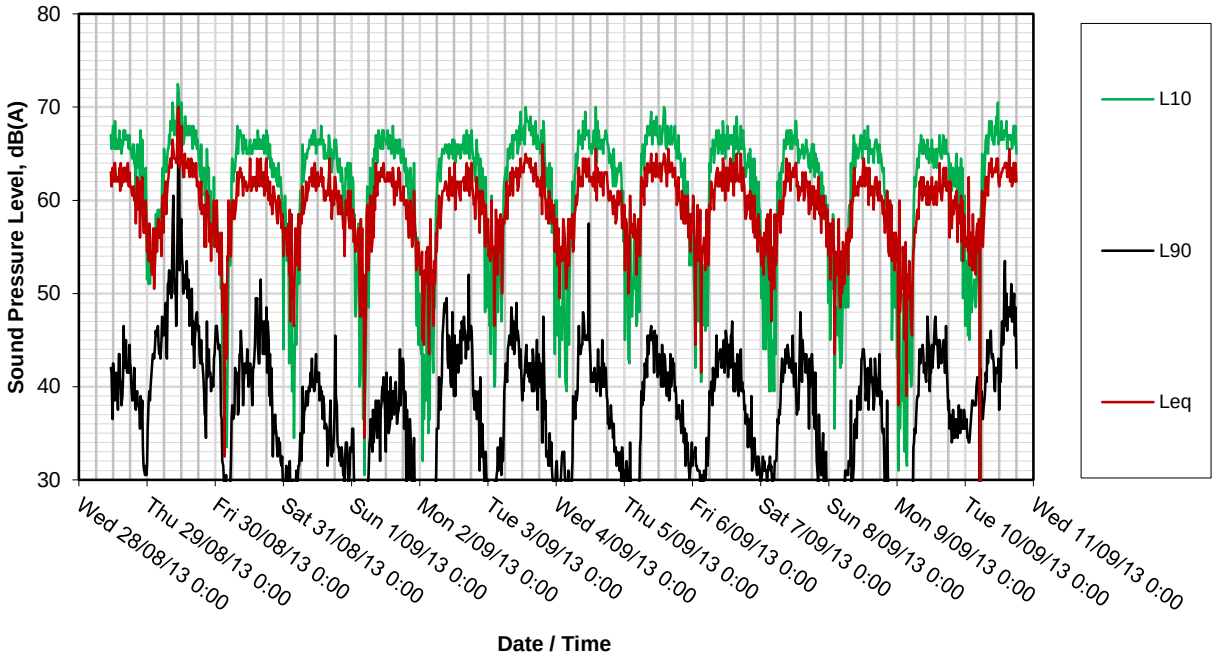


Table 22: Long term measurement location LM2

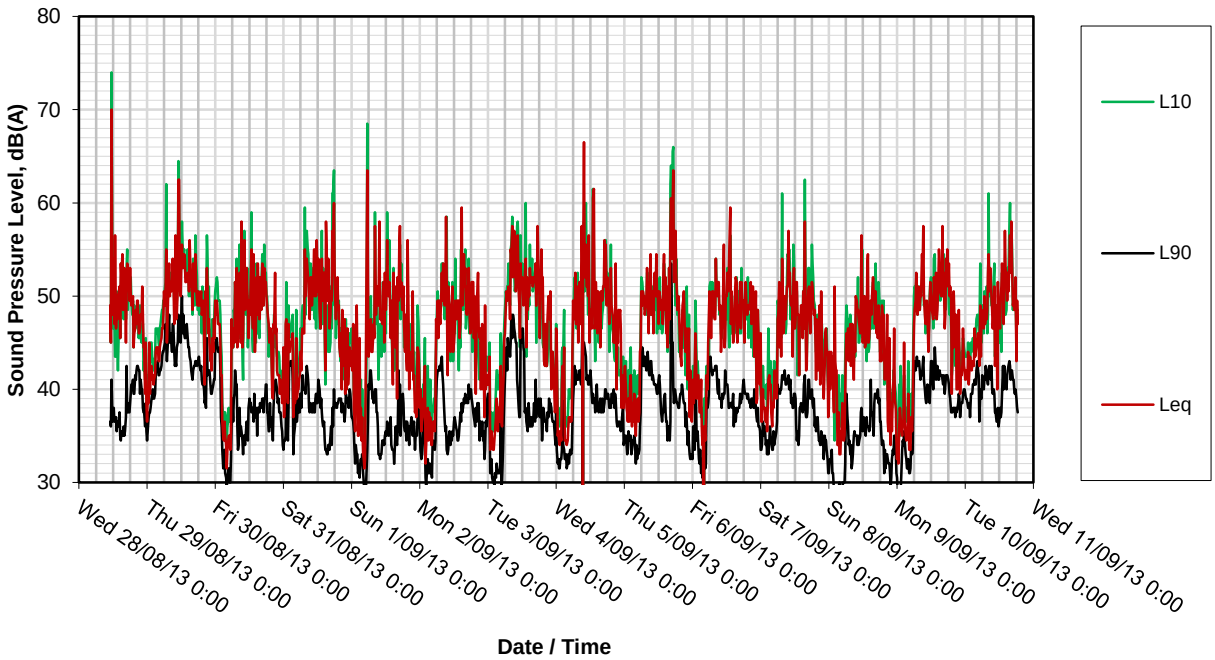
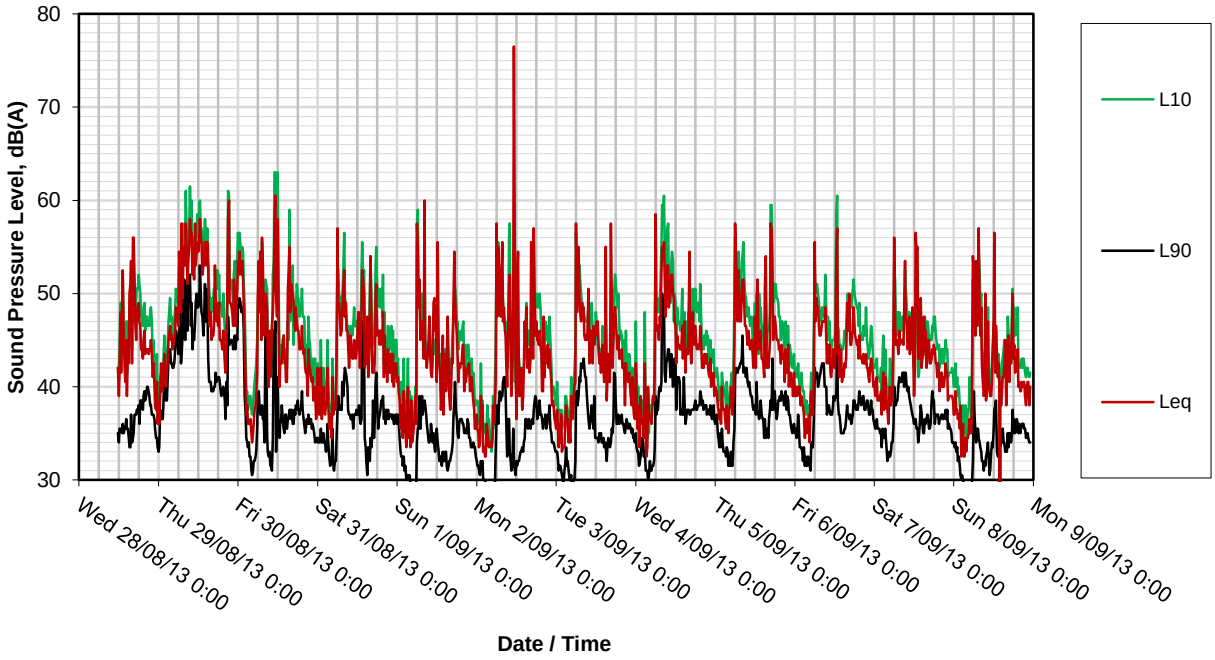


Table 23: Long term measurement location LM3



Appendix 2: Glossary of Acoustic Terms

Acceptable Noise Level: The acceptable L_{Aeq} noise level from industrial sources, recommended by the EPA (Table 2.1, INP). Note that this noise level refers to all industrial sources at the receiver location, and not only noise due to a specific project under consideration.

Adverse Weather: Weather conditions that affect noise (wind and temperature inversions) that occur at a particular site for a significant period of time. The previous conditions are for wind occurring more than 30% of the time in any assessment period in any season and/or for temperature inversions occurring more than 30% of the nights in winter).

Acoustic Barrier: Solid walls or partitions, solid fences, earth mounds, earth berms, buildings, etc used to reduce noise, without eliminating it.

Ambient Noise: The all-encompassing noise associated within a given environment at a given time, usually composed of sound from all sources near and far.

Assessment Period: The period in a day over which assessments are made.

Assessment Location: The position at which noise measurements are undertaken or estimated.

Background Noise: Background noise is the term used to describe the underlying level of noise present in the ambient noise, measured in the absence of the noise under investigation, when extraneous noise is removed. It is described as the average of the minimum noise levels measured on a sound level meter and is measured statistically as the A-weighted noise level exceeded for ninety percent of a sample period. This is represented as the $\mathbf{L_{90}}$ noise level.

Decibel [dB]: The units of sound pressure level.

dB(A): A-weighted decibels. Noise measured using the A filter.

Extraneous Noise: Noise resulting from activities that are not typical of the area. Atypical activities include construction, and traffic generated by holidays period and by special events such as concert or sporting events. Normal daily traffic is not considered to be extraneous.

Free Field: An environment in which there are no acoustic reflective surfaces. Free field noise measurements are carried out outdoors at least 3.5m from any acoustic reflecting structures other than the ground.

Frequency: Frequency is synonymous to pitch. Frequency or pitch can be measured on a scale in units of Hertz (Hz).

Impulsive Noise: Noise having a high peak of short duration or a sequence of such peaks. A sequence of impulses in rapid succession is termed repetitive impulsive noise.

Intermittent Noise: Level that drops to the background noise level several times during the period of observation.

$\mathbf{L_{Amax}}$ The maximum sound pressure level measured over a period.

$\mathbf{L_{Amin}}$ The minimum sound pressure level measured over a period.

$\mathbf{L_{A1}}$ The sound pressure level that is exceeded for 1% of the time for which the sound is measured.

L_{A10}	The sound pressure level that is exceeded for 10% of the time for which the sound is measured.
L_{A90}	The level of noise exceeded for 90% of the time. The bottom 10% of the sample is the L_{90} noise level expressed in units of dB(A).
L_{Aeq}	The "equivalent noise level" is the summation of noise events and integrated over a selected period of time.
Reflection:	Sound wave changed in direction of propagation due to a solid object meets on its path.
R-w:	The Sound Insulation Rating R-w is a measure of the noise reduction performance of the partition.
SEL:	Sound Exposure Level is the constant sound level which, if maintained for a period of 1 second would have the same acoustic energy as the measured noise event. SEL noise measurements are useful as they can be converted to obtain Leq sound levels over any period of time and can be used for predicting noise at various locations.
Sound Absorption:	The ability of a material to absorb sound energy through its conversion into thermal energy.
Sound Level Meter:	An instrument consisting of a microphone, amplifier and indicating device, having a declared performance and designed to measure sound pressure levels.
Sound Pressure Level:	The level of noise, usually expressed in decibels, as measured by a standard sound level meter with a microphone.
Sound Power Level:	Ten times the logarithm to the base 10 of the ratio of the sound power of the source to the reference sound power.
Tonal noise:	Containing a prominent frequency and characterised by a definite pitch.