WOOD & GRIEVE ENGINEERS

Goulburn Hospital Redevelopment

Acoustic Report
State Significant Development Application

Prepared for:

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TSA Management

Date:
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Project No. 28807
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Revision

REVISION	DATE	COMMENT	APPROVED BY
01	13/10/2017	For Comment	**ORFG**
02	03/11/2017	Traffic Update	**ORFG**
03	24/09/2018	Final	**ORFG**

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1. Introduction

The purpose of this report is to provide an environmental noise impact assessment as part of the State Significant Development Application (SSDA) for Phase 2D and 2E works of the proposed Goulburn Base Hospital redevelopment, located at 130 Goldsmith Street, Goulburn NSW 2580. The proposed work will involve the construction of a new public medical facility and relocation of some hospital car parks as part of Goulburn Base Hospital Redevelopment Program.

The scope of the Phase 2D and 2E development includes provision of the following new facilities;

- New acute building (4 storey), including building core and break-through links between the new and old building
- New emergency department ambulance entry and external works infrastructure and car-parking

This assessment discusses the likely noise impact on the potentially nearest most-affected receivers (residential) 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 Goulburn Mulwaree Development Control Plan (DCP) 2009 criteria for the proposed hospital re-development within the vicinity of the nearest potentially affected residential receivers.
- A compliance with Secretary's Environmental Assessment Requirements section 78A(8A) of the Environmental Planning and Assessment Act Schedule 2 of the Environmental Planning and Assessment Regulation 2000 for Redevelopment of Goulburn Base Hospital (SSD 8667) dated on 25th August 2017.
- Recommendations for noise mitigation measures for the proposed development in order to meet the Goulburn Mulwaree 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 four noise loggers located at four representative locations close to the site.

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 Peck von Hartel dated 23/08/18
- Noise data collected on site through the use of four noise loggers and a Type 1 hand held sound level meter.
- Generic noise data of mechanical plant based on manufacturers catalogues.
- Traffic and Parking Schematic Design Report by Taylor Thomson Whitting dated 31/10/2017.
- Existing and Post Completion Traffic Information by Taylor Thomson Whitting dated 02/11/2017.

2.2 Reference documents

- Goulburn Mulwaree Council Development Control Plan 2009.
- New South Wales Environment Protection Authority (NSW EPA), Noise Policy for Industry (NPI) 2017[1].
- New South Wales (NSW) Department of Environment Climate Change and Water (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.
- Australian Standard, AS 2822 – 1985 Acoustics – Methods for assessing and predicting speech privacy and speech intelligibility.
- Air Services Australia, "Environmental principles and procedures for minimizing the impact of aircraft noise".
- "Fly neighborly guide", produced by the Helicopter Association International.
- NSW Health Infrastructure - Engineering Services Guidelines (GL2016_020 dated 26 August 2016), including Design Guidance note no. 13 rev A July 2017 issued 19/07/2017 with Section 13 Acoustics July 2017 update
- Development Near Rail Corridors and Busy Roads – Interim Guideline (Department of Planning 2008)
- Secretary's Environmental Assessment Requirements section 78A(8A) of the Environmental Planning and Assessment Act Schedule 2 of the Environmental Planning and Assessment Regulation 2000 for Redevelopment of Goulburn Base Hospital (SSD 8667) dated on 25th August 2017

[1] The initial phases of this project used the NSW Industrial Noise Policy (INP) 2000, as they took place prior to 2017. This reference has been updated in this report to refer to the NSW Noise Policy for Industry (NPI) 2017 in response to HI comments. There are no significant changes to the details of this report as a result of this change.

3. PROJECT OVERVIEW

3.1 Site description

The proposed phase 2D and 2E redevelopment of Goulburn Base Hospital is to be located at located at 130 Goldsmith Street, Goulburn, NSW 2580. The site is bound by residential properties to the north; residential properties to the east; Goulburn Aquatic and Leisure Centre to the south; and Goulburn High School to the west.

The acoustic issues relating to the development are as follows:

- Noise intrusion from vehicle movements on Goldsmith, Faithful, Clifford, and Albert Street into the developments habitable areas.
- Noise emissions from mechanical plant from the development to the surrounding receivers.

The nearest potentially affected noise receivers (shown in Figure 1) have been identified as follows:

- Receiver North, Residential properties across Goldsmith Street.
- Receiver East, Residential properties across Faithful Street.
- Receiver West, School properties across Albert Street.
- Receiver South, Recreational area across Clifford Street.

Figure 1: Overview of the Site

Source: nearmap.com

3.2 Existing noise environment

The Environment Protection Authority Noise Policy for Industry (EPA NPI, 2017) requires that the level of background and ambient noise be assessed separately for the daytime, evening and night time periods.

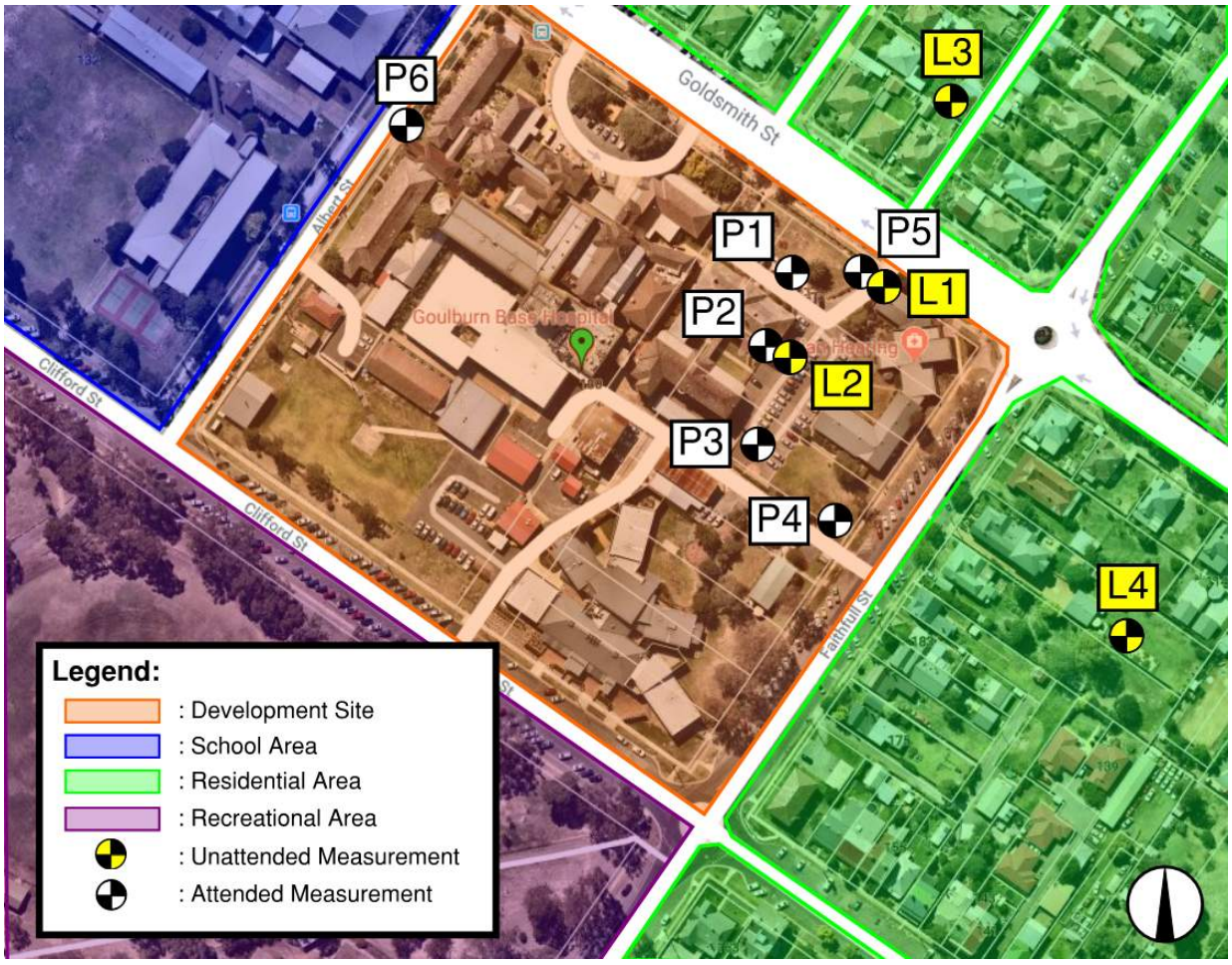
The NPI defines these periods as follows:

- 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

Noise monitoring was undertaken at locations illustrated in Figure 2 below. Measurements at locations L1 and L2 were taken prior to the commencement of construction work and measured the traffic noise and background noise level of the site respectively. These loggers had to be removed during the 6th day due to a severe storm which would have damaged equipment and compromised the measurements. Measurements at locations L3 and L4 were taken after the commencement of site construction work; the loggers were placed in residential dwellings adjacent to the site, rather than on site, so that a true representation of the area background noise could be recorded, without interference from site noise.

The existing background noise of the site is typical for a suburban area that has characteristically intermittent local traffic flows with some limited commerce or industry.

Figure 2: Overview of the Site and Measurement Locations



Source: nearmap.com

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-215 S/N 16707042 presented as L1 in Figure 2.
- ARL Environmental Noise Logger EL-215 S/N 16306037 presented as L2 in Figure 2.
- Casella Environmental Noise Logger CEL-63X S/N 4257389 presented as L3 in in Figure 2.
- Casella Environmental Noise Logger CEL-63X S/N 1488204 presented as L4 in in Figure 2.
- 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.

3.2.2 Attended Noise Survey Result

Attended noise measurements of 15-minute duration were conducted on site to characterise the acoustic environment for noise intrusion into the development and to determine any noise impact on the surrounding receivers. A summary of the attended noise measurements taken at the site are shown in Figure 2 refer to Table 1 for measurement locations.

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
P1	01:42 PM	49	45	Ambient traffic noise
P2	12:04 PM	52	45	Ambient noise
P2	12:20 PM	52	44	Ambient noise (steady)
P3	12:32 PM	52	51	Ambient noise (steady)
P4	12:41 PM	53	46	Ambient traffic noise
P5	11:43 AM	55	46	Ambient traffic noise
P6	01:07 PM	53	46	Ambient noise (steady)
P6	01:11 PM	53	47	Ambient noise (steady)

3.2.3 Long-term measurements

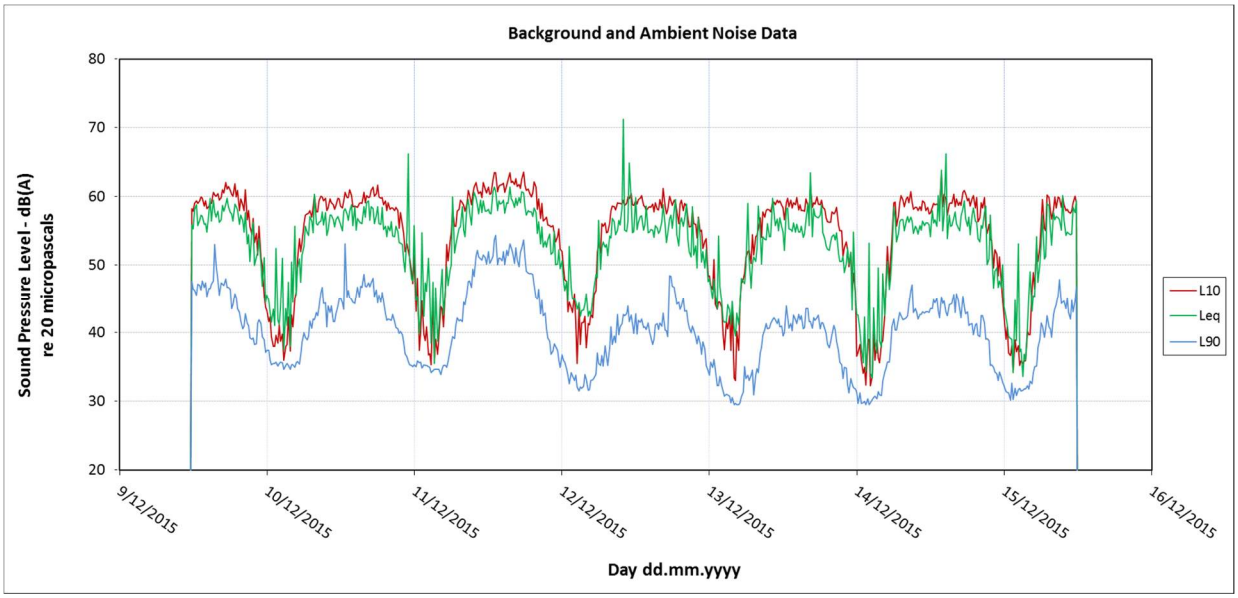
Traffic Noise Monitoring

A noise monitor was installed at location L1 as shown in Figure 2 to measure the traffic noise from Goldsmith Street, to facilitate design of the façade. The results of the traffic noise survey from L1 are shown in Table 2 for the day, evening and night time periods. Refer to Figure 3 for the noise data.

Table 2: Summary of existing noise levels, traffic

Location	Rated background noise level RBL			$L_{Aeq,period}$		
	Day	Evening	Night	Day	Evening	Night
L1	42	40	32	58	56	51

Figure 3: Long term noise monitoring results at location L4-background noise measurement



Background and Ambient Noise Monitoring

Noise loggers were positioned at locations L2, L3 and L4 as shown in Figure 2 to measure the ambient and background noise that is representative of the site and surrounding residential receivers. The results of the unattended noise survey are shown in Table 3.

Table 3: Summary of existing and background noise levels

Location	Rated background noise level (RBL)			$L_{Aeq,period}$		
	Day	Evening	Night	Day	Evening	Night
L2	43	40	33	56	54	48
L3	38	32	30	61	41	43
L4	40	35	30	51	42	43

The local ambient noise environment is dominated by traffic noise throughout the majority of the day, evening and night periods. Refer to Figure 4 through Figure 6 for the noise data.

Figure 4: Long term noise monitoring results at location L2-background noise measurement

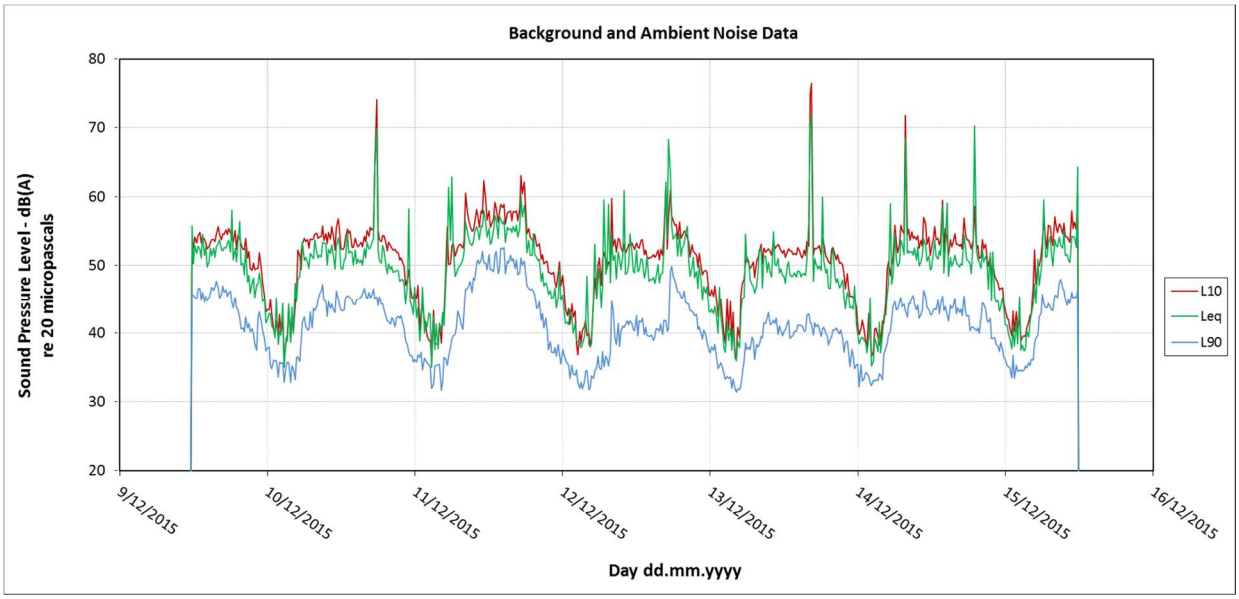


Figure 5: Long term noise monitoring results at location L3-background noise measurement

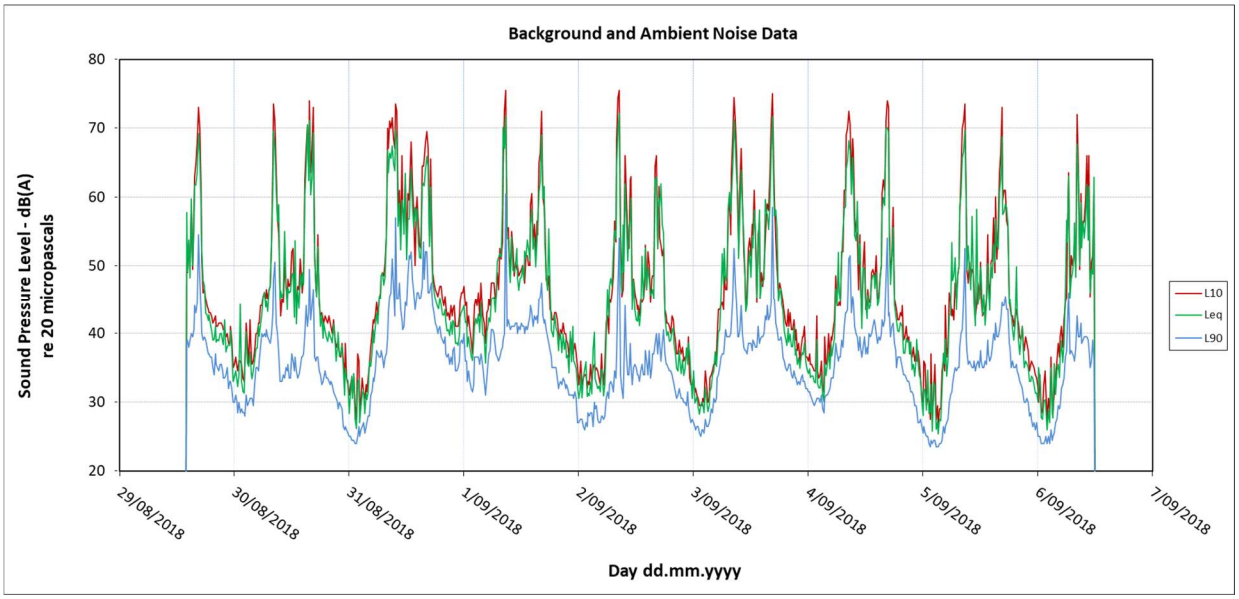
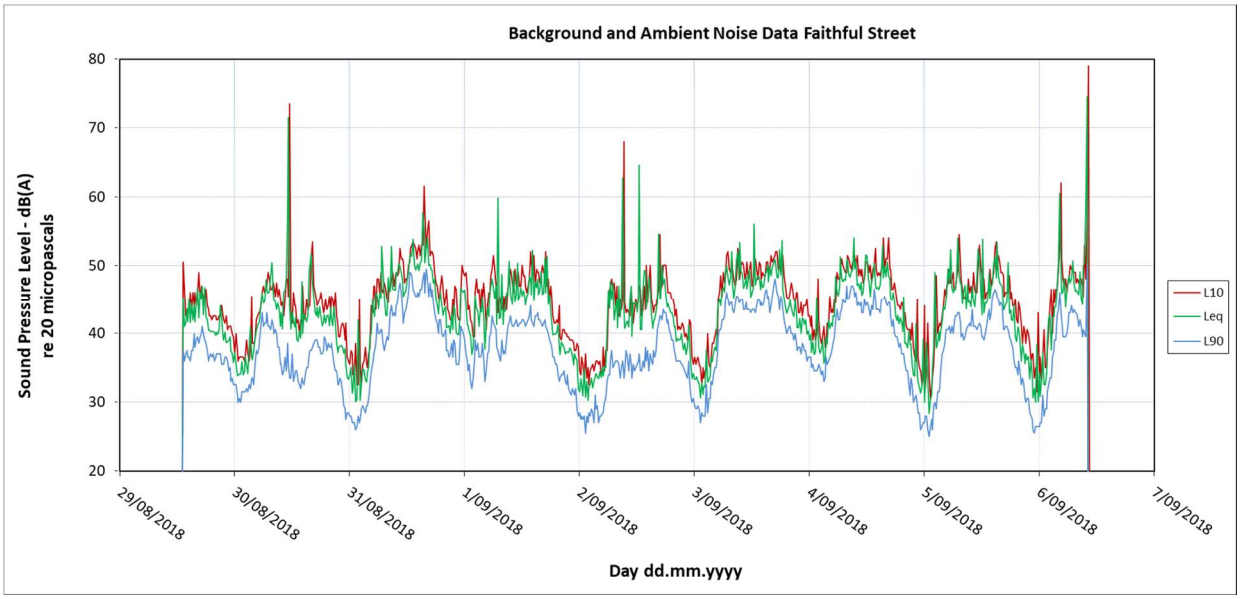


Figure 6: Long term noise monitoring results at location L4-background noise measurement



4. NOISE AND VIBRATION CRITERIA

4.1 Exterior Mechanical Plant and Equipment Noise Criteria

4.1.1 Goulburn Mulwaree Council Development Control Plan (DCP) 2009

In order to assess the impact of noise and vibration by proposed operations on proposed developments of existing and new buildings Goulburn Mulwaree Council recommends applicants utilise the following documents to assist them in making decisions relating to acceptable noise levels for noise generating and noise sensitive developments:

- NSW Noise Policy for Industry (NSW NPI)
- Environmental Criteria for Road Traffic Noise (ECRTN)
- Noise Guide for Local Government

4.1.2 New South Wales (NSW) Noise Policy for Industry (NPI)

Goulburn Mulwaree Shire Council recognizes and accepts the NSW EPA NPI as a guideline, therefore the state policy will be used to assess noise associated with the operation of the new mechanical plant installed for the proposed Hospital redevelopment.

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

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

- Controlling intrusive noise into nearby residences (Intrusiveness Criteria)
- Maintaining noise level amenity for particular land uses (Amenity Criteria)

Once both 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 EPA NPI 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 NPI)		Intrusiveness criteria at Goldsmith St	Intrusiveness criteria at Faithfull St	Intrusiveness criteria for project
Daytime 7am – 6pm	$L_{Aeq,\ 15\ min}$	43	45	**43**
Evening 6pm – 10pm	$L_{Aeq,\ 15\ min}$	37	40	**37**
Night 10pm – 7am	$L_{Aeq,\ 15\ min}$	35	35	**35**

NOISE AND VIBRATION CRITERIA

Amenity Criteria

The NSW EPA NPI states the following:

"To limit continuing increases in noise levels from application of the intrusiveness level alone, the ambient noise level within an area from all industrial noise sources combined should remain below the recommended amenity noise levels specified in Table 2.2 where feasible and reasonable. The recommended amenity noise levels will protect against noise impacts such as speech interference, community annoyance and some sleep disturbance.

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

The applicable parts of *Table 2.2: Amenity Noise Levels* which are relevant to the project are reproduced below:

Table 5: Recommended L_{Aeq} noise levels from industrial noise sources

Type of Receiver	Indicative Noise Amenity Area	Time of Day	Recommended $L_{Aeq,period}$ Noise Level, dB(A)	
			Acceptable	Maximum
Residence	Suburban	Day	55	60
		Evening	45	50
		Night	40	45
School Classroom - internal	All	When in use	-	35

Modifying Factor Adjustments

The NSW EPA NPI 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 C1 of the NSW EPA NPI (see Table 6 below) provides procedures for determining whether an adjustment should be applied for greater annoyance aspect.

No modifying factor adjustments have been used in this analysis

Table 6: Table C1 NSW EPA NPI – 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 Noise Trigger Level

The project noise trigger level for the project is outlined in the NSW NPI as the more stringent of the intrusiveness criteria (Table 4) and the amenity criteria (Table 5). The amenity criteria is converted from an $L_{Aeq,period,}$ to an $L_{Aeq,15min}$ by adding 3dB to the acceptable level given in Table 5. The project noise trigger levels for each receiver and time of day are shown in Table 7.

Table 7: Project Noise Trigger Levels – dB(A)

Assessment	Period	Time	Intrusive Criteria $L_{Aeq,15min}$	Amenity Criteria $L_{Aeq,15min}$	Project Noise Trigger Level
Residential	Day	0700-1800 (0800-1800 Sundays, public holiday)	43	58	**43**
	Evening	1800-2200	37	48	**37**
	Night	2200-0700 (0800-1800 Sundays, public holiday)	35	43	**35**
School classroom (internal)	When in use		-	35	**35**

4.2 Internal Noise Level Criteria

4.2.1 Engineering Health Services Guidelines

Environmental noise intrusion to the Goulburn hospital is to comply with the satisfactory noise level targets listed in Table 8.

Table 8: Acoustic Requirements

Area Designation	A Continuous Internal Noise Levels, L_{Aeq} dB		B Intermittent Internal Noise Level L_{Amax} dB [9]	F Emergency Generator Noise Limit L_{Amax}, dB [11]
	Satisfactory	Maximum		
Clinical				
Operating Theatre	40	45	55	+5
Birthing Room or Delivery Suite	45	50	65	+5
Intensive Care	40	45	60	+5
Patient Room / Single Bed Ward	35	40	55[10]	+5
Multi Bed Ward	35	40	55[10]	+5
Toilet / Ensuite	50	55	-	+10
Patient Corridor	40	50	-	+10
Counselling/ Bereavement / Interview Room	40	45	60	+5
Consult Room	40	45	60	+5
Speech and Language Therapy	35	40	60[6]	+5
Treatment / Medication/ Examination Room	40	45	60[6]	+5
Public Areas				
Corridors and Lobby Space	40	50	-	+10
Cafeterias / Dinning	45	50	-	+10
Toilets	45	55		+10
Waiting Rooms, Reception Areas	40	50	-	+10
Multi Faith / Chapel	30	35	-	+5
Staff / Back of House Areas				
Meeting Room	35	40	-	+5

Area Designation	A Continuous Internal Noise Levels, L_{Aeq} dB		B Intermittent Internal Noise Level L_{Amax} dB [9]	F Emergency Generator Noise Limit L_{Amax}, dB [11]
	Satisfactory	Maximum		
Board / Conference Room (Large)	30	35	-	+5
Open Plan Offices	40	45	-	+5
Private Offices	35	40	-	+5
Multi Person Offices	40	45	-	+5
Locker Room	50	55	-	+10
Rest Room	40	45	-	+5
Classrooms, Training Rooms	35	40	-	+5
Lecture Theatre	30	35	-	+5
Library	40	45	-	+5
Workshops	45	50	-	+10
Plant Rooms	N/A	<85	-	-
Laboratory	45	50	-	+10

Notes:

1. All sound pressure levels referenced to 20 micro-Pascals (dB re 20 µPa).
2. For Column A, Leq noise levels should be measured over a repeatable, worst-case one hour period. A one hour averaging period has been selected to best represent impacts from continuous noise sources, and any frequently occurring intermittent noise sources.
9. The acceptability of any intrusive noise depends on the frequency of occurrence, the intrusive noise level and character, plus the sensitivity of the space. The intermittent internal noise levels shown are intended to apply to any frequently occurring intermittent noise sources including rail, internal and external driveways, loading docks, nearby industry, etc. and where the frequency of occurrence of the noise source is sufficiently high or low that adequate control of the intrusive noise level is not achieved via the Column A, Leq noise levels. The project acoustic engineer is required to apply professional judgement in assessing the frequency of occurrence of the intrusive noise, the intrusive noise level and character, plus the sensitivity of the space in order to apply the intrusive noise limits in Column B. Justification of the basis of the design needs to be reported for HI review. The intrusive noise limits in Column B do not apply to noise from commercial aircraft (which is to be assessed in accordance with AS2021).
10. Where a significant, intermittent and intrusive noise source is prevalent, a sleep disturbance assessment is required. The outcome of this assessment shall be included with the acoustic design.
11. Noise levels are set relative to the 'Maximum' continuous internal noise levels from Column A.

4.2.2 Development Near Rail Corridors and Busy Roads – Interim Guideline (Department of Planning)

The Development Near Rail Corridors and Busy Roads – Interim Guideline applies to developments that are either immediately adjacent to a rail corridor or any highly trafficked road with an AAWT greater than 40,000 vehicles the internal noise level criteria for the residential areas.

The Goulburn Hospital site is not within the vicinity of any rail corridors or major roads which exceeds the 40,000 AAWT limit therefore no further assessment is required.

4.3 Sleep Disturbance Criteria

The NSW EPA's NPI 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 L1 level of any specific noise source should not exceed the background noise level (L90) by more than 15 dB(A) when measured outside the bedroom window."

Table 9 summarises the internal sleep arousal criteria that are applied to the surrounding residential premises based on data from L2.

Table 9: Sleep Arousal Criteria

Location	Night-time L_{A90}	L_{A1} Criteria – dB(A)
All	35	50

The Application notes regarding the NPI published by the EPA suggest that the EPA 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 EPA 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. DECCW will accept analysis based on either $L_{A1,\ 1min}$ or L_{Amax}.

4.4 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 TTW.

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 10 below.

Table 10: 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)
Freeway/ arterial/ sub-arterial roads	Existing residences affected by additional traffic on existing freeways/arterial/sub-arterial roads generated by land use developments	$L_{Aeq\ (15\ hr)}$ 60 (external)	$L_{Aeq\ (9\ hr)}$ 55 (external)
Local roads	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 'no build option'.

4.5 Aircraft Noise Criteria

TSA has advised that historically an average of 40 helicopter movements occurs from the Goulburn Hospital site annually. There is no change proposed to the existing on-grade helicopter pad located on the south west of the hospital site.

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.*

On this basis there are no mandatory noise emission criteria resulting from helicopter noise operations from the Goulburn Hospital. In addition there are no current NSW EPA 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.

Airservices Australia Principles and Procedures for minimizing the impact of aircraft noise fly Neighbourly Guide are as follows

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 AGL,
5. Minimisation of noise impacts on residential areas by hovering/circling helicopters
6. Implement Fly Neighbourly procedures

4.5.1 Helicopter Noise Criteria

No further assessment is considered for the current Environmental Acoustic Assessment on the basis that there is no proposed change to the helicopter pad location or helicopter movements.

4.6 Construction Noise Criteria

Noise criteria for construction sites are established in accordance with the Interim Construction Noise Guideline (ICNG July 2009) by the Department of Environment and Climate Change NSW which now under NSW Environment Protection Authority (NSW EPA). 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 EPA ICNG (July 2009) were specifically referenced. The limits presented in Table 11 apply.

Table 11: NSW EPA ICNG Construction Noise Criteria

Time of Day	Management Level $L_{Aeq,15min}$ *	How to Apply
Recommended Standard Hours: Mon – Fri (7am – 6pm) Sat (7am – 4pm) No work on Sunday & Public Holidays	Noise Affected RBL + 10dB = 57	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 = 52	• 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 DECCW ICNG.

4.6.1 Construction Vibration Criteria

The EPA 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.

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 acceleration (m/s2) 1-80Hz

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
Offices, schools, educational institutions and place of worship	Day or night time	0.020	0.014	0.040	0.028
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

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
Offices, schools, educational institutions and place of worship	0.40	0.80	0.40	0.40
Critical areas	0.10	0.20	0.10	0.20

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

4.7 Construction Vibration Project Specific Levels

Table 16 indicates the construction vibration criteria applicable to residential properties and schools 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. OPERATIONAL 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 back-up electrical system such as emergency diesel generators
- 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
- Intermittent noise from operational filling of the bulk oxygen tank and associated enclosure
- 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.

5.2 Mechanical Plant

5.2.1 Noise Sources

The proposed phase 2D and 2E hospital redevelopment will include typical building services plant and equipment including chillers, boilers, compressors and cooling towers.

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 will operate in case of main power failure or for maintenance purposes. Hydraulic systems also require to be considered in this assessment such as pumps, booster pumps for fire system etc.

Major building services including mechanical, electrical and hydraulics noise sources associated with the development includes:

- 22x Air handling units
- 2x Cooling towers
- 3x Hot water boilers
- 3x Water pumps
- Rooftop VRF units
- Exhaust Fans
- 1x 550kVA Electrical Generator

The typical noise data (Sound Power Levels) of the proposed mechanical plant are presented in Table 17. As the assessment is of the overall noise level to receivers, assessment includes mechanical services plant associated with Phase 1A, 1B and 1C development of the site.

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

Plant Item	SWL – dB(A)
Air handling units	110
Cooling Tower	89
Variable Refrigerant Flow (outdoor)	80
Hot Water Boiler	80
Water Pumps	80
Emergency Diesel Generator	115

5.3 Assessment to the NSW EPA Noise Policy for Industry (NPI)

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 Figure 7.

5.3.1 Noise Model

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 (Residential units across Faithful and Goldsmith Street). 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 (show in Figure 7) considering the worst case scenario of all plant and equipment operating simultaneously.

Figure 7: Overview of the Plant Room and the Nearest Receivers

Source: nearmap.com

5.3.2 Building Services Plantroom and Roof-Top Plant

Assessment has been conducted of the noise emission to noise sensitive receivers for the Day, Evening and Night periods. From assessment, the Evening and Night periods have been confirmed as the most stringent condition to be achieved. For the purposes of the prediction, it been conservatively assumed that Cooling Towers will be reduced to 50% capacity and AHUs to 75% capacity for the Night period.

Project specific noise levels at the boundaries of the surrounding receivers can be achieved with the following acoustic controls;

- Acoustic barrier to the cooling towers
- Un-podded silencer attached to the discharge fan of the cooling towers

The predicted noise levels incorporating nominated acoustic controls are shown below in Table 18.

Table 18: Predicted noise levels for mechanical plant

Location (See Figure 7)	Period	NPI Criteria, $L_{Aeq,15min}$ dB(A)	Predicted Noise Levels, $L_{Aeq,15min}$ dB(A)	Compliance (Y/N)
R1	Evening	37	34	Yes
R1	Night	35	32	Yes
R2	Evening	37	34	Yes
R2	Night	35	32	Yes

Acoustic Barrier to Cooling Towers

The acoustic barrier will need to have a minimum surface density of 16kg/m^2 and transmission loss values similar or better in performance as those described in Table 19 below. 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 could 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 of the proposed acoustic barrier should be at least 0.5m higher than the Cooling Towers. The attenuation of the barrier has been predicted from a distance of 1.5m from the units.

Table 19: Acoustic barrier minimum transmission loss performance

Barrier Type	Octave band centred frequencies (Hz)							
	63	125	250	500	1k	2k	4k	8k
9mm Compressed Fibre Cement	17	21	26	31	35	36	34	35

Silencer attached to discharge fan

The cooling towers will need to have an un-podded silencer attached to the discharge fan, with insertion loss performance of a minimum as shown in Table 20. The length of the silencer will be equal to the diameter of the discharge fan.

Table 20: Discharge fan silencer minimum insertion loss performance

Silencer Type	Octave band centred frequencies (Hz)							
	63	125	250	500	1k	2k	4k	8k
Un-podded 1D	3	3	4	9	7	7	7	5

Further detailed assessment of all plant and equipment, including description of proposed noise mitigation measures will be provided during the detailed design stage of the project with confirmation of plant equipment selections.

5.3.3 Emergency Generator

The emergency generator is to be located in a building adjacent to the new Faithfull Street carpark. The emergency generator will only operate during emergency operation or during planned maintenance. Compliance is predicted to the NSW NPI project specific noise limits for day time maintenance operation (0700-1800) with the following acoustic controls;

- Acoustic shielding via acoustic enclosure blocking line of sight to the Faithfull Street residential receivers and providing air intake and discharge attenuation
- Residential grade acoustic silencer to the generator exhaust
- Internal absorptive lining to the generator plant room soffit (e.g. weatherproof faced polyester / glasswool insulation)

The combined effect of these measures must be to achieve a level of 63dB(A) at 7 metres from the generator

The predicted noise levels incorporating the acoustic treatment as proposed above are shown below in Table 21. Assessment conservatively assumes no modifying factor for duration, noting in maintenance operation the period of operation is expected restricted.

Table 21: Predicted noise levels for emergency generator

Location (See Figure 7)	NPI Criteria dB(A)	Predicted Noise Level dB(A)	Compliance (Y/N)
R1	43	31	Yes
R2	43	43	Yes

Further detailed assessment of the emergency generator, including detailed description of proposed noise mitigation measures will be provided during the detailed design stage of the project with confirmation of plant equipment selections.

5.3.4 Vehicle Movements in the Carpark

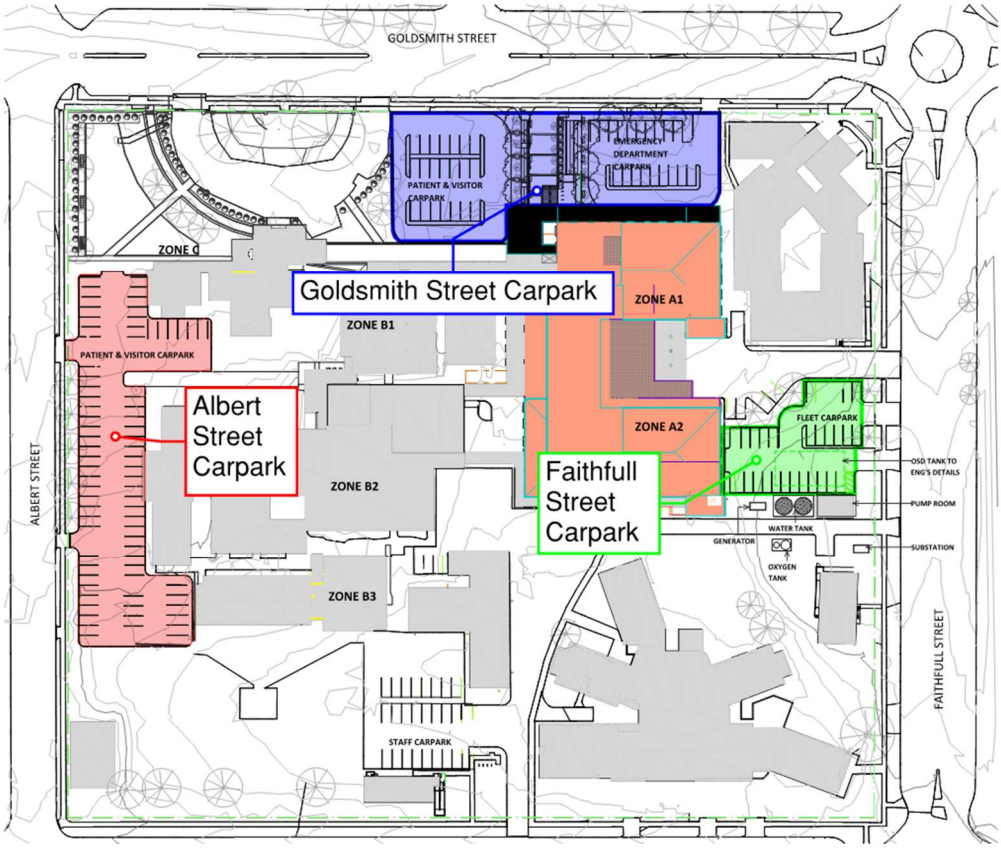
Proposed onsite vehicle carparks are shown in Figure 8. The loading dock is not proposed to be relocated and as is located within the Goulburn hospital site adjacent to the existing Ambulatory building.

Due to the different noise exposures, car park noise emission has been assessed separately against the Day-time and Night-time Criteria.

For each assessment, the operational car-park noise emission will be assessed on these assumptions:

- Average noise of LA_{eq} 84dB(A) from the cars manoeuvring and parking.
- The car manoeuvring with maximum of 20km/hour in the car park areas.

Figure 8: Proposed parking locations



Day Time Criteria

In the absence of peak traffic movements in carparks, for the purposes of the assessment the following conservative assumptions have been made;

- Assuming the car parks will be completely filled within one hour, and 25% of the car park capacities are moving within 15-minutes period. This is approximately a peak of 15, 11, and 9 vehicle movements in a 15-minute period within the Albert, Goldsmith, and Faithfull Street car-park respectively.

Table 22: Car Park Noise Assessment (Daytime)

Receiver Location	Noise Source	Predicted Noise Level – dB(A) $L_{eq(15mins)}$	Acoustic Day Criteria – dB(A) $L_{eq(15mins)}$	Complies
Goldsmith Street (Residential)	Car manoeuvring at Goldsmith Street car park	40	43	Yes
Faithful Street (Residential)	Car manoeuvring at Faithful Street car park	38	43	Yes
Albert Street (Goulburn High School)	Car manoeuvring at Albert Street car park	42	45[2]	Yes

[2] On the conservative basis of open windows to the school

As presented on Table 22 above, the predicted noise level from cars manoeuvring at car park areas are expected to complies with the day/evening time (7am-10pm) criteria at the nearest receivers.

Night Time Criteria

The operational car-park noise emission will be assessed on these assumptions:

- Given that the car park is primarily used for visitors, as a worst case there will be approximately 10 vehicle movements per hour within the car-park during night-time period (10pm-7am).

Table 23: Car Park Noise Assessment (Night time)

Receiver Location	Noise Source	Predicted Noise Level – dB(A) $L_{eq(15mins)}$	Acoustic Night Criteria – dB(A) $L_{eq(15mins)}$	Complies
Goldsmith Street (Residential)	Car manoeuvring at Goldsmith Street car park	35	35	Yes
	Car manoeuvring at Albert Street[1] car park	33	35	Yes
Faithful Street (Residential)	Car manoeuvring at Faithful Street car park	34	35	Yes

Note: 1. During night-criteria, Albert Street Car Park will be assessed towards the nearest residential receivers which are located on Goldsmith Street.

As presented in Table 23 above, the predicted noise level from cars manoeuvring at car park areas are expected to comply with the night time criteria (10pm-7am) at the nearest receivers.

5.3.5 Ambulance Operations

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 Goulburn Base 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 local roads likely to remain in a similar situation as they are now.

5.3.6 Medical Gas Storage

The current Goulburn hospital site includes a bulk oxygen storage tank and storage site for medical gas bottles. The proposal is to relocate the gas storage to the Faithfull Street site boundary adjacent to the Faithfull Street carpark. Relocation from the existing central site to the site boundary is on the basis of mitigating the need for large truck maneuvering areas on the Goulburn Hospital site.

Gas Storage Plant

Based on attended measurements conducted of the existing medical gas storage installation, compliance is expected without further acoustic controls to the project specific noise level criteria. Measured levels of the existing installation are shown in Table 24.

Table 24: Attended measurement, existing medical gas storage

Location	Existing Noise Level, L_{Aeq}, dB	Predicted level at the receiver	Acoustic Night Criteria – dB(A) $L_{eq(15mins)}$	Complies
3m from the bulk oxygen storage and medical gas bottle storage	52	<30	37	Yes

5.4 Road Traffic Noise

The proposed development will have its on-site car parking increased from 142 car parks to 206 car parking spaces. As per outlined in the traffic report, the shortfall of the on-site car parking to the total carpark demand is expected to be absorbed within the local streets (as currently provided). It is estimated there are over 1,000 vehicles within 300m walking distance from the premises.

Based on the traffic information given to WGE by TTW on Thursday, 2nd November 2017, it is expected that the development will result in the traffic increase during the AM and PM peak hours from the development site.

This data has been used to calculate the expected noise increase due to traffic associated with the development. The relevant information regarding peak hour vehicle movements on the surrounding roads has been summarized in Table 25.

Table 25: Existing and predicted traffic flow volumes through the nearest intersections(peak hour)

Traffic Volume	Existing vehicles		Predicted post-completion traffic		Noise Level Increase (dB)	
	AM	PM	AM	PM	AM	PM
Goldsmith St and Faithfull St	1136	910	1191(+55)	953(+43)	0.21	0.20
Clifford St and Faithfull St	639	546	669(+30)	575(+29)	0.20	0.22
Clifford St and Albert St	215	164	224(+9)	173(+9)	0.17	0.23
Goldsmith St and Albert St	810	642	840(+30)	674(+32)	0.16	0.21

As shown in Table 25 the relative increase in noise is at most 0.23dB during the peak hours, which is less than the 2dB increase criteria, therefore the proposed development is expected comply with the requirements of the NSW RNP for traffic generated noise.

5.5 Helicopter Noise

As the helipad will remain in its current location, the helicopter noise impact onto the surrounding residential receivers will not change as a result of the proposed refurbishment and new development. On this basis, no further assessment has been conducted for this Environmental Acoustic Assessment.

6. Construction Noise and Vibration

As the Goulburn Base hospital redevelopment will include for construction work to be undertaken while the Hospital is still operating it is recommended that a detailed Construction Noise and Vibration Management Plan (CNVMP) be developed prior to commencement of construction to ensure the noise and vibration criteria outlined in section 4.1.8 of this report are complied with.

The CNVMP should assess the likely noise and vibration emissions from construction activities occurring on site and recommend reasonable and feasible mitigation measures in order to comply with construction noise and vibration criteria and in doing so, minimizing the impact of construction activities on nearby residents but also on the hospital itself.

The CNVMP will include strategy to manage noise and vibration impact depending on the programmed construction activities such as noise and vibration monitoring and programming of activities generating high noise levels during particular non-sensitive period of the day.

7. CONCLUSION

This report presents the results of a study of operational noise emission from the proposed redevelopment of the Goulburn Base Hospital located in 130 Goldsmith Street, Goulburn, 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 for the proposed Hospital redevelopment.

The environmental noise and vibration intrusion criteria for the operation and construction of the proposed development have been established based on Goulburn Mulwaree 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 Goulburn Mulwaree 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.

Exceedance of the project specific noise level criteria at most affected residences is expected for gas filling operations. According to the NSW NPI, all reasonable and feasible noise control measures will need to be identified and applied for the non-compliance to be considered. Once considered and non-compliance is still predicted then the residual level of impact needs to be balanced against any social and economic benefits derived from the noise source in negotiation between Goulburn Hospital and the regulation consent authority.

Following our investigation, except where explicitly noted, 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. Further acoustic treatments may be required once the mechanical units have been confirmed.

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 - Glossary of Acoustic Terms

NOISE	
Acceptable Noise Level:	The acceptable LAeq noise level from industrial sources, recommended by the EPA (Table 2.2, NPI). 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.
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 L90 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.

Appendix 1 - Glossary of Acoustic Terms

Intermittent Noise:	Level that drops to the background noise level several times during the period of observation.
LAmax	The maximum A-weighted sound pressure level measured over a period.
LAmin	The minimum A-weighted sound pressure level measured over a period.
LA1	The A-weighted sound pressure level that is exceeded for 1% of the time for which the sound is measured.
LA10	The A-weighted sound pressure level that is exceeded for 10% of the time for which the sound is measured.
LA90	The A-weighted level of noise exceeded for 90% of the time. The bottom 10% of the sample is the L90 noise level expressed in units of dB(A).
LAeq	The A-weighted "equivalent noise level" is the summation of noise events and integrated over a selected period of time.
LAeqT	The constant A-weighted sound which has the same energy as the fluctuating sound of the traffic, averaged over time T.
Reflection:	Sound wave changed in direction of propagation due to a solid object met 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.