WOOD & GRIEVE ENGINEERS

Bowral and District Hospital Redevelopment

Acoustic Report for
State Significant Development Application

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Revision

REVISION	DATE	COMMENT	APPROVED BY
04	30/04/2018	Final Report Issue	ATS
05	29/05/2018	Minor amendments after feedback	ATS
06	18/06/2018	Added clause justifying monitoring locations – Section 4.4	ATS
07	08/11/2018	Minor changes to NPI criteria	ORFG
08	26/11/2018	Logger data revised with weather data	MST
09	07/01/2019	New noise monitoring data	MST

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Contents

1. Introduction

The purpose of this report is to provide an environmental noise impact assessment as part of the State Significant Development Application (SSDA) works of the proposed Bowral and District Hospital redevelopment, located at 97-103 Bowral Street, Bowral. The proposed work will involve the construction of a new public medical facility and relocation of the Hospital Car Parking as part of the Bowral and District Hospital Redevelopment Program, which is referred to as the 'Main Works' component of the project.

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

This report has been prepared a part of the documentation package to be submitted to the public authority (Health Infrastructure) as part of the State Significant Development Application (SSDA) for the proposed Bowral and District Hospital redevelopment. Within this report the following is provided:

- Project overview which summarises extent of the redevelopment works and site layout
- Unattended acoustic survey conducted in order to obtain existing ambient noise levels and subsequently derived the external noise level criteria
- Operational acoustic criteria and construction noise and vibration criteria, which are based on regulatory requirements and guidelines typically used for acoustic assessments
- Operational acoustic assessment which includes, when required, conceptual treatment
- Acoustic assessment of construction activities
- Conclusions discussing the outcomes from the acoustic assessments; as well as the acoustic feasibility of the project.

This noise assessment is based on noise data collected by two noise loggers located at two representative locations close to the site from the 11 December 2018 to the 20 December 2018.

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 Information

2.1 Information Sources

This assessment was based on:

- The Concept design architectural drawings provided by MSJ:
    - 130443-MSJ-AR-DWG-EW03001 revision 12, dated 21/11/2017
    - 130443-MSJ-AR-DWG-EW03002 revision 12, dated 27/11/2017
    - 130443-MSJ-AR-DWG-EW03003 revision 14, dated 27/11/2017
    - 130443-MSJ-AR-DWG-EW03004 revision 12, dated 27/11/2017
    - 130443-MSJ-AR-DWG-EW03005 revision 01, dated 27/11/2017
- Noise data collected on site through the use of two noise loggers and a Type 1 hand held sound level meter.
- Generic noise data of mechanical plant based on manufacturers catalogues.
- Transport Impact Assessment by GTA Consultant, Issue A dated 24/04/2018.

2.2 Reference Documents

The acoustic assessment is also based on the following reference documents:

- Bowral Town Plan Development Control Plan (version 8, September 2015)
- NSW Noise Policy for Industry (NSW NPI), issued 2017 by the NSW Environment Protection Authority (NSW EPA)
- NSW Road Noise Policy (NSW RNP), issued March 2011 and published by the Department of Environment, Climate Change and Water NSW, now part of the NSW EPA
- NSW Environmental Noise Control Manual (NSW ENCM) dated 1994
- NSW Interim Construction Noise Guideline (NSW INCG), issued July 2009 and published by the Department of Environment, Climate Change and Water NSW, now part of the NSW EPA
- Australian Standard, AS 2436-1981, “Guide to Noise Control on Construction, Maintenance and Demolition Sites”
- Development Near Rail Corridors and Busy Roads – Interim Guideline (DNRCBR-IG), by the NSW Department of Planning which is now part of the NSW Department of Planning & Environment (issued December 2008)
- Assessing Vibration – A Technical Guideline (NSW AV-TG), issued February 2006 by the Department of Environment and Conservation NSW, now part of the NSW EPA
- 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 Bowral and District Hospital (SSD 8980) dated on 30th January 2018.
- Engineering Services Guideline (NSW HI ESG) issued by NSW Health Infrastructure, dated July 2017.
- Engineering Services and Sustainable Development Guidelines – Technical Series TS11 (NSW TS11), issued by NSW Health and dated December 2007, version 2.0.

3. Project Overview

3.1 Proposed Development

The proposed development for Bowral and District Hospital comprises of:

- A new main entry;
- New Inpatient building;
- New emergency department
- Linkways and connections back to existing buildings and supporting services in the retained buildings;
- A reconfigured public and ambulance entry to ED;
- On-grade car parking and drop off facilities, and overall improved access and wayfinding throughout the campus; and
- Upgrades to IT and engineering services infrastructure.

The redevelopment works will comprise some changes to the existing public carpark located along Bowral Street. This upgrade is designed to compensate for the loss of car parking spaces at the Bowral Street car park (due to the construction of the new building) and allocate additional 4 car parking slots.

3.2 Site Description

The existing hospital premises are located in Bowral, NSW; and bounded by the following streets:

- Bowral Street to the north
- Mona Road to the east
- Ascot Road to the south
- Sheffield Road to the west

The proposed new building, which is part of this redevelopment, will be located along Bowral Street, where the existing garden area is located currently. The existing emergency department is to be demolished to allow space for the new building.

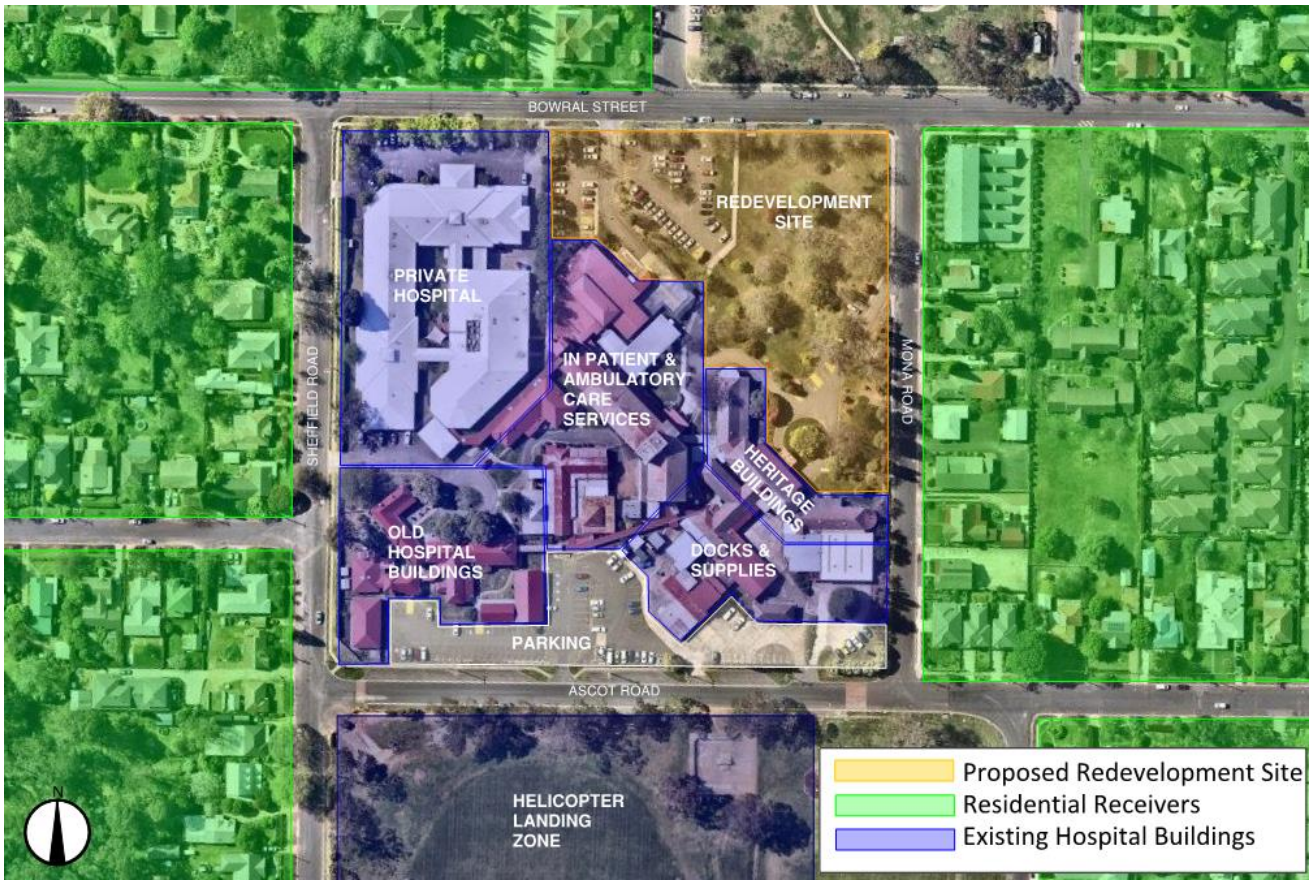
The existing hospital premises are currently surrounded by residential dwellings, which are primarily single-storey. A large portion of the Bowral Street front is opposite to a park. Consequently, the most noise sensitive receivers are located as follows (refer to Figure 1):

- Residential receivers directly across Bowral Street to the north
- Residential receivers directly across Mona Road to the east

It is noted on site that the existing ambient noise levels near these noise sensitive locations are mostly dominated by traffic noise from the local roads and influenced to a lesser extent by distant noise emissions from mechanical plant in the vicinity of these locations.

It has also been noted that ambient levels are relatively quiet and similar on all sides of the hospital. Residential receivers on all sides are subject to similar ambient conditions.

Figure 1: Overview of the Site



Source: nearmap.com

3.3 Acoustic Issues

The acoustic issues relating to the development are as follows:

- Noise intrusion from vehicle movements on Bowral Street, Mona Road, Ascot Road and Sheffield Road into the development habitable areas
- Noise emissions from mechanical plant and emergency electrical systems from the development to the surrounding receivers

4. Acoustic Survey

This revision of this acoustic report details the new unattended survey conducted in December 2018. For noise monitoring done in November 2017, refer to the previous revisions. Attended measurements from both site visits have been included.

4.1 Instrumentation

The equipment used for the noise survey was the following:

- Hand-held sound spectrum analyser Casella CEL 063X, S/N 4257387
- Rion NL-42EX noise logger, S/N 117375, presented as L1 in Figure 2
- Rion NL-42X noise logger, S/N 184110, presented as L2 in Figure 2
- Svan Calibrator SV 30A, S/N 17556

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.

4.2 Existing Noise Environment

The existing background noise is typical for a suburban area that has characteristically intermittent traffic flows with some recreational areas. It can be seen from the decreasing noise levels in the night period and the night ambient noise levels defined by the natural environment and infrequent human activity.

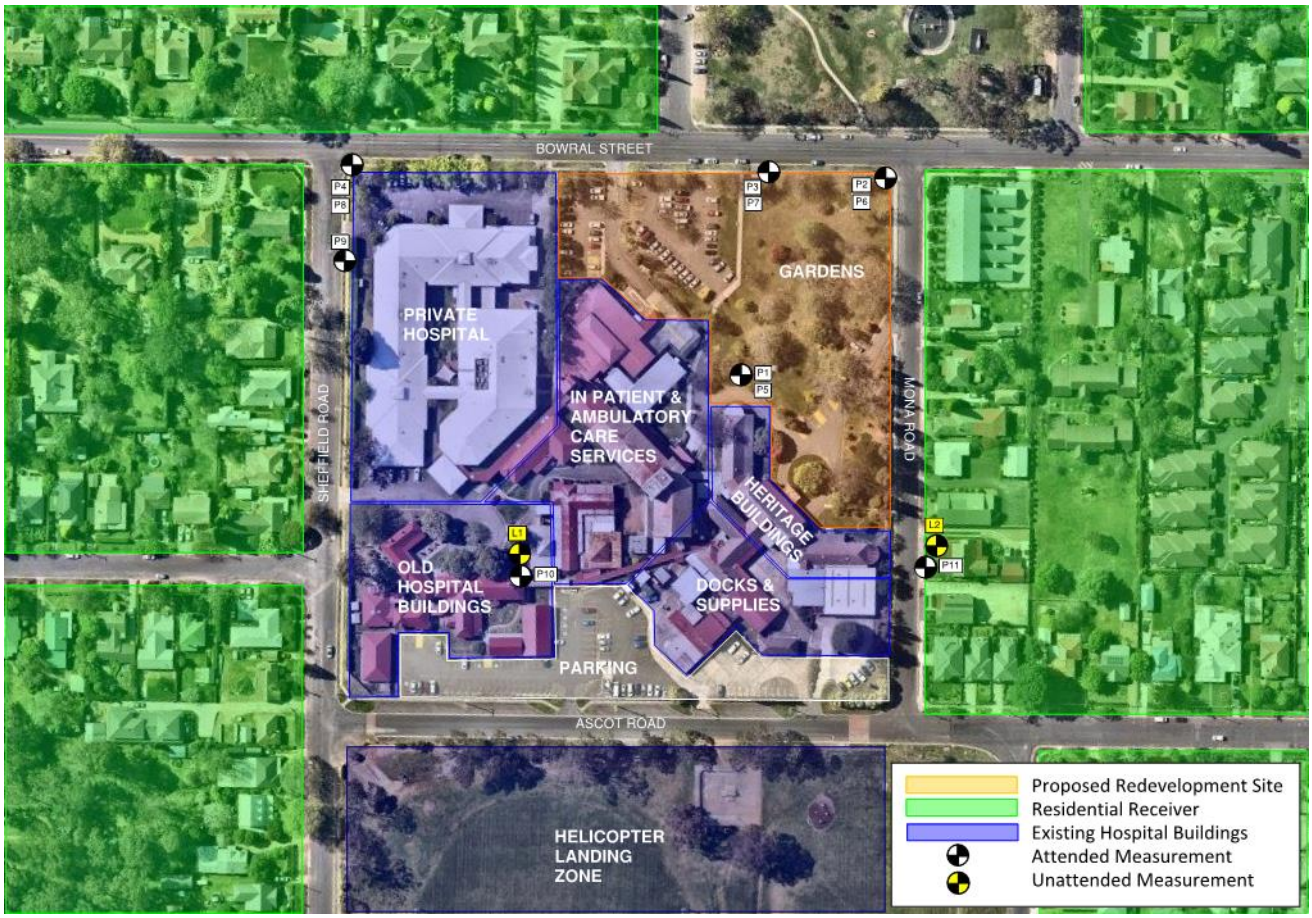
The EPA Noise Policy for Industry (NPI, Environment Protection Authority 2017) requires that the level of background and ambient noise be assessed separately for the daytime, evening and night time periods.

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

The noise monitoring and attended measurement locations are illustrated in Figure 2 below.

Figure 2: Measurement Locations



4.3 Attended Noise Survey Results

Attended noise measurements of approximately 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. The measurement results were used in conjunction with the unattended measurement data to calibrate and determine variations in different spots around the site. A summary of the attended noise measurements taken at the site are shown in Table 1, refer to Figure 2 for measurement locations. P1 – P9 were taken at the time of the initial noise logging in November 2017, while P10 and 11 were taken at the time of the most recent measurements in December 2018.

Table 1: Summary of Short-Term Measurements.

Measurement Location	Date/Start Time	$L_{Aeq,T}$, dB(A)	$L_{A90,T}$, dB(A)	Background Noise Description
P1	01 November 2017 / 19:52 PM	50	48	Existing Mechanical Noise Dominant
P2	01 November 2017 / 20:04 PM	61	40	Ambient noise with local traffic
P3	01 November 2017 / 20:20 PM	56	36	Ambient noise with local traffic
P4	01 November 2017 / 20:50 PM	58	35	Ambient noise with local traffic

P5	02 November 2017 / 06:50 AM	48	44	Existing Mechanical Noise Dominant
P6	02 November 2017 / 06:57 AM	63	42	Ambient noise with local traffic
P7	02 November 2017 / 07:13 AM	66	44	Ambient noise with local traffic
P8	02 November 2017 / 07:20 AM	66	45	Ambient noise with local traffic
P9	02 November 2017 / 07:31 AM	60	38	Ambient noise with local traffic
P10	11 December 2018 / 01:30 PM	47	44	Hospital background noise
P11	11 December 2018 / 01:50 PM	54	41	Ambient noise with local traffic

4.4 Unattended Noise Survey Results

Unattended noise measurements of existing ambient noise levels were conducted between 11 December 2018 and 20 December 2018. The measurements were undertaken using two Rion noise loggers as detailed in Section 4.1. The locations where the loggers were deployed on site are identified as *L1* and *L2* in Figure 2.

The loggers were set to measure continuous measurements at 15-minute intervals. The instruments were calibrated prior to and after the survey. No significant drift was noted during the calibration procedure.

Please refer to Figure 3 and Figure 4 for a visual representation of the measured noise levels during the unattended noise survey. Logger 1 was positioned within the hospital complex near Southern Highland Private Hospital to determine the existing noise environment for use in designing the new building. Logger 2 was positioned at a residence along Mona Road to determine the existing ambient environment at sensitive receivers closest to the new building.

It should be noted that at L1, several impulsive noise events happened that were not associated with weather. This event has significantly increased the equivalent level for that 15-minute measurement. Likely causes of these impulsive noise events include delivery trucks, loud car horn, interference with the microphone from a bird, pedestrians etc.

Figure 3: Long-Term Noise Monitoring Results at Location L1 – Existing Noise Environment within Hospital Area.

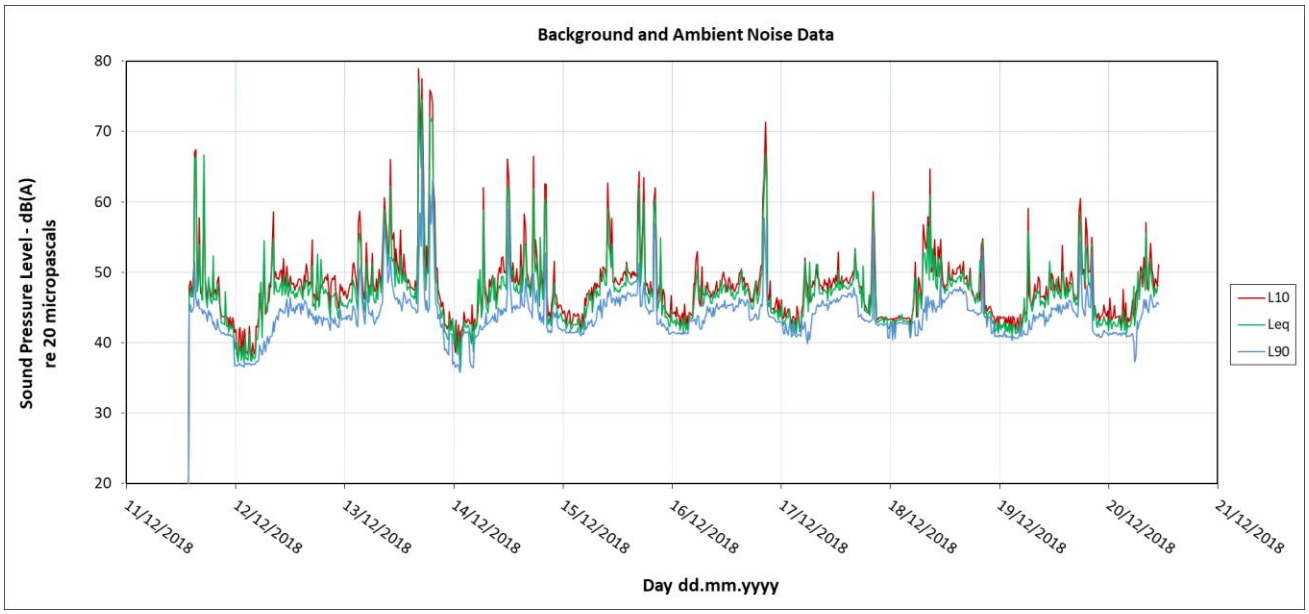
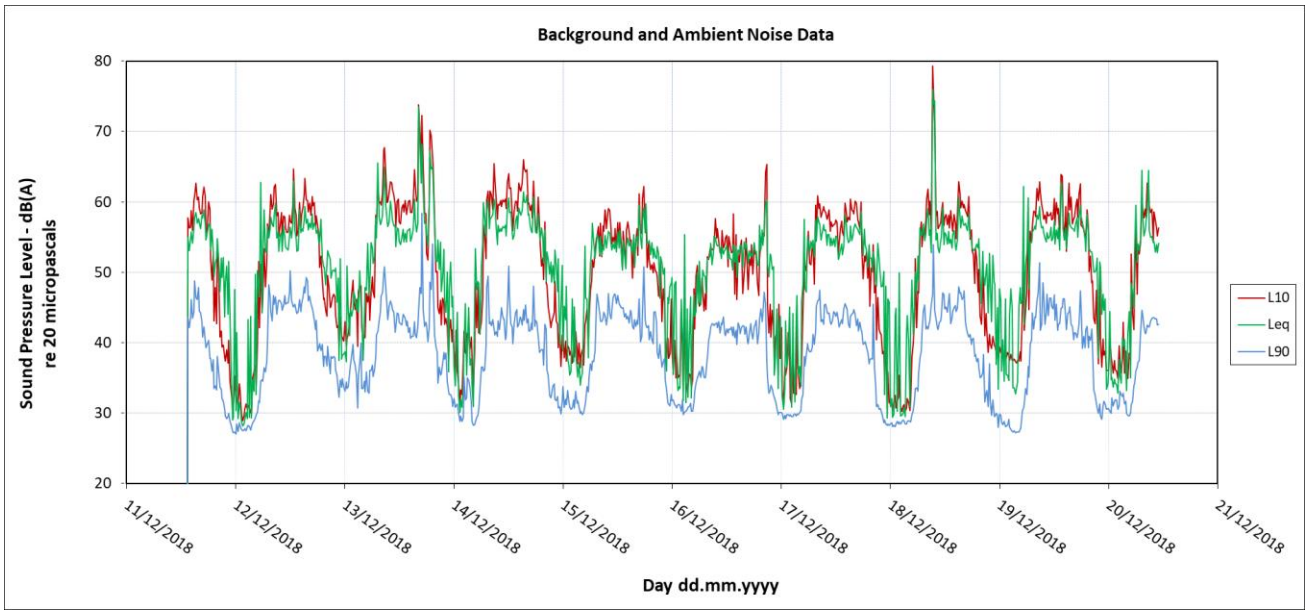


Figure 4: Long-Term Noise Monitoring Results at Location L2 – Existing Noise Environment at Nearest Residences.



Additionally, in order to confirm that the measurement data was obtained during favourable weather conditions, Bureau of Meteorology (BoM) weather data such as rainfall and wind speed were observed during the monitoring at the nearest meteorological stations, which are located at Bowral (Orchard St, rainfall, Station ID 68255) and at Moss Vale (wind speed, Station ID 068239). The BoM rain radar was also regularly checked to determine the timing and duration of rainfall. Consequently, measured noise information was excluded from the assessment if the weather conditions had affected the resulting noise levels. Where too many 15-minute measurements were affected within a period, this period was excluded as a whole, as advised by the NPI.

As the Moss Vale weather station is approximately 5 km from the site, WGE acknowledges there is some variance from the wind sock at the weather station to the actual wind speeds on site. Generally, there is considerably less wind speed on site at ground level than at the weather station. As a result, measurement data was only excluded where, based on Figure 3, Figure 4 and the calculations, the weather conditions were considered to have affected the measurements. This was assumed to have happened, when an increase in measured noise levels was observed, compared to other days with no recorded adverse weather conditions. Periods completely excluded based on poor weather were:

- Day:
  - 13/12
  - 14/12
- Evening:
  - 13/12
  - 14/12
  - 19/12
- Night:
  - 12-13/12

Wood & Grieve Engineers acknowledge that the day and evening times are only represented by six periods each. Despite being one day less than a 7-day week, the acquired data is considered to have identified the typical noise levels and possible patterns in the existing noise environment, and thus should be considered sufficient to describe the noise environment, as per Section B1.3 of the NPI.

Table 2 outlines the noise survey results for loggers L1 and L2. Please note the measured noise data is defined in terms of equivalent continuous (L_{Aeq}) noise levels and rating background noise levels. For definition of these noise parameters, please refer to the Glossary section at the end of this report.

Table 2: Summary of Unattended Noise Measurements.

Location	Rating Background Noise (RBL) Level, dB(A)			Equivalent Continuous Noise Level, L_{Aeq}, dB(A)		
	Day	Evening	Night	Day	Evening	Night
L1	44	43	41	49	50	45
L2	42	33	30*	58	53	49

* Adjusted from a level of 29 dB(A) to 30 dB(A) as per Section 2.3 of the NPI.

5. Operational Noise and Vibration Criteria

5.1 Secretary's Environmental Assessment Requirements (SEARs)

In accordance with the Secretary's Environmental Assessment Requirements, Clauses 6 and 7 of Schedule 2 of the Environmental Planning and Assessment Regulation 2000 for redevelopment of Bowral and District Hospital (SSD 8980) (dated 30th January 2018), the following documents are required to be used in order to identify and assess the noise and vibration impact from the development to the nearest receivers:

- Noise Policy for Industry 2017 (EPA), (Section 5.3);
- Interim Construction Noise Guideline (DECC), (Section 6);
- Assessing Vibration: A Technical Guideline 2006, (Section 5.7);
- Development Near Rail Corridors and Busy Roads – Interim Guideline (Department of Planning 2008) , (Section 5.3.2);

5.2 External Noise Criteria

5.2.1 Bowral Town Plan Development Control Plan 2010

The Bowral Town Plan Development Control Plan 2010 (Version 8 dated September 2015) does not state any particular criteria for the proposed hospital redevelopment or equivalent project category, in terms of acoustic impact to the surrounding environment.

5.2.2 The NSW Noise Policy for Industry (NSW NPI)

The external noise level criteria for steady state noise sources such as mechanical plant items have been derived in accordance to the guidelines discussed in the NSW NPI. The criteria are based on the results of the unattended noise monitoring at the nearest residences.

The criteria consider 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 noise trigger level (PNTL).

Intrusiveness Criteria

The NSW EPA NPI states the following:

> *"The intrusiveness of an industrial noise source may generally be considered acceptable if the 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 by more than 5 dB(A)."*

The intrusiveness criterion can be summarised as $L_{Aeq,15min} \leq$ RBL background noise level plus 5 dB.

Table 3: NSW NPI Intrusiveness Criteria.

Period	Noise Descriptor, dB(A)	Noise Criteria, dB(A)
Daytime 7am – 6pm	$L_{Aeq,15min} \leq$ RBL + 5	47
Evening 6pm – 10pm	$L_{Aeq,15min} \leq$ RBL + 5	38
Night 10pm – 7am	$L_{Aeq,15min} \leq$ RBL + 5	35

Logger 2 was chosen to represent background noise level as it was located away from any existing hospital mechanical equipment and represented a true background for the area.

Amenity Criteria

The NSW 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 applicable parts of Table 2.2: Amenity noise levels, which are relevant to the project, are reproduced below in Table 4 together with the project amenity noise levels.

Table 4: Recommended Amenity Noise Level L_{Aeq} from Industrial Noise Sources, dB(A).

Type of Receiver	Indicative Noise Amenity Area	Time of Day	Recommended Amenity Noise Level (ANL), dB(A)	Project Amenity Noise Levels[2], $L_{Aeq,15min}$, dB(A)
Residential	Suburban[1]	Day	55	53
		Evening	45	43
		Night	40	38
Internal hospital wards	All	Noisiest 1-hour	35	33
External hospital wards	All	Noisiest 1-hour	50	48

Notes:
1. Suburban area as defined in EPA NPI Section 2, Table 2.3.
2. Project Amenity Noise Level is ANL minus 5 dB, plus 3 dB to convert from period level to a 15-minutes level.

Modifying Factor Adjustments

The NSW NPI also states:

> *"Where a noise source contains certain characteristics, such as tonality, 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, a typical adjustment of 5 dB for each annoying character aspect and cumulative of up to a total of 10 dB is to be added to the measured value to penalise the noise for its potentially greater annoyance aspect.

Table C.1 of Fact Sheet C of the NSW NPI (see Table 5 below) provides procedures for determining whether an adjustment should be applied for greater annoyance aspect.

Table 5: Modifying Factor Corrections as per the NSW NPI.

Factor	Assessment / Measurement	When to Apply	Correction[1]	Comments
Tonal noise	One-third octave band analysis using the objective method for assessing the audibility of tones in noise – simplified method (ISO 1996.2-2007 – Annex D).	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 in the range 500-10,000 Hz - **8 dB** or more if the centre frequency of the band containing the tone is in the range 160 -400 Hz - **15 dB** or more if the centre frequency of the band containing the tone is in the range 25-125 Hz	5 dB[2,3]	Third octave measurements should be undertaken using unweighted measurements.
Low frequency noise	Measurement of source contribution to C-weighted and A-weighted level and one-third octave measurements in the range 10-160 Hz	Measure / assesses source contribution to C- and A-weighted equivalent sound pressure levels over the same time period. Correction to be applied if C level minus A level is 15 dB or more and: - where any of the one-third octave noise levels in Table C2 of the NSW NPI are exceeded by up to and including 5 dB and cannot be mitigated, add 2 dB to measured/predicted A-weighted levels for evening/night periods - where any of the third-octave noise levels in Table C2 of the NSW NPI are exceeded by more than 5 dB and cannot be mitigated, add 5 dB to measured/predicted A-weighted levels for evening/night and 2 dB for the daytime period	2 or 5 dB[2]	A difference of 15 dB or more between C-weighted and A-weighted measurements identifies the potential for an unbalance spectrum and potential increased annoyance. Refer to Table C2 of the NSW NPI.

Factor	Assessment / Measurement	When to Apply	Correction[1]	Comments
Intermittent noise	Subjectively assessed but should be assisted with measurement to gauge the extent of change in noise level.	The source noise heard at the receiver varies by more than 5 dB and the intermittent nature of the noise is clearly audible.	5 dB	Adjustment to be applied for **night-time only.**
Duration	Single-event noise duration may range from 1.5 min to 2.5 hours	On event in any assessment period	0 to 20 dB	The project noise trigger level may be increased by an adjustment depending on duration of noise. Refer to Table 6.
Maximum Adjustment	Refer to individual modifying factors.	Where two or more modifying factors are indicated	Maximum correction of 10 dB[2] (excluding duration correction).	

Notes:

1. Corrections to be added to the measured or predicted levels, except in the case of duration where the adjustment is to be made to the criterion.
2. Where a source emits tonal and low-frequency noise, only one 5 dB correction should be applied if the tone is in the low-frequency range, that is, at or below 160 Hz.
3. Where narrow-band analysis using the reference method is required, as outlined in column 5, the correction will be determined by the ISO 1996-2:2007 standard.

Please note that duration modifying factors can be applied to plant items which only operate occasionally for events such as maintenance operations. An example of such plant items are standby emergency generators. According to the NSW NPI, the modifying factors can be added to the project noise trigger levels for such plant items prior to comparison with the criteria. The duration modifying factors are listed in Table 6.

Table 6: Modifying Factors for Duration.

Allowable Duration of Noise (one event in any 24 hour period)	Allowable Exceedance of $L_{Aeq,15min}$ Equivalent Project Noise Trigger Level at Receptor for the Period of the Noise Event, dB	
	Daytime and Evening (7 am to 10 pm)	Night-time (10 pm to 7 am)
1 to 2.5 hours	2	0
15 minutes to 1 hour	5	0
6 minutes to 15 minutes	7	2
1.5 minutes to 6 minutes	15	5
Less than 1.5 minutes	20	10

Project Noise Trigger Levels (PNTLs)

Consequently, the project noise trigger levels (PNTLs) are defined from the most stringent criteria when comparing the intrusiveness and amenity criteria. The PNTLs are summarised in Table 7 below. As previously discussed these PNTLs are applicable for steady state noise sources such as mechanical plant items.

Table 7: Project Noise Trigger Levels, dB(A).

Period	Descriptor	PNTL
Residential Areas		
Day	$L_{Aeq,15min}$	**47**
Evening	$L_{Aeq,15\ min}$	**38**
Night	$L_{Aeq,15min}$	**35**
Hospital		
Internal	$L_{Aeq,15min}$	**33**
External	$L_{Aeq,15min}$	**48**

Given that the PNTLs are very low especially for the night-time period at residential receivers, the amenity criteria would be considered both suitable and more achievable in this application. Further discussion with the EPA is required.

5.3 Internal Noise Criteria

5.3.1 Engineering Health Services Guidelines

Environmental noise intrusion to the Bowral and District hospital is to comply with the satisfactory noise level targets listed in Table 8 below. This series of acoustic requirements include the following:

- Column A includes internal noise level criteria for steady state noise sources such as mechanical services. It is noted that these values are in general accordance with the recommended design noise levels as per standard AS/NZS 2107:2016.
- Column B lists internal noise level criteria for intermittent noise events caused by aircraft, road traffic and emergency vehicles.
- Column C shows criteria for noise intrusion of helicopter noise.
- Column D summarises the speech privacy requirements for each internal space listed in the table.
- Column E provides an indication of acoustic treatment for doors in each internal space.
- Column F list impact sound isolation requirements for floors.
- Column G includes mid frequency reverberation time criteria for internal spaces. Refer to Note 3 of Table 8 regarding the definition of mid frequency reverberation time.

Table 8: Internal Acoustic Requirements.

Area Designation	A Continuous Internal Noise Levels, L_{Aeq} dB		B Intermittent Internal Noise Level L_{Amax} dB	C Internal Noise Levels Helicopter L_{Amax} dB	D Floor Impact Sound Isolation L_{nw} dB	E Reverberation Time (s) (Fully finished)	F Emergency Generator Internal Noise Level L_{Amax} dB
	Satisfactory	Maximum					
Operating Theatre	40	45	50	55	55	0.4-0.7	+5
Birthing Room or Delivery Suite	45	50	65	65	60	0.4-0.6	+5
Intensive Care	40	45	50	55	50	0.4-0.7	+5
Patient Room / Single Bed Ward	35	40	50	55	50	0.4-0.7	+5
Multi Bed Ward	35	40	50	55	55	0.4-0.7	+5
Toilet / Ensuite	50	55	75	70	60	-	+10
Patient	40	50	65	70	60	0.4-0.6	+10

Operational Noise and Vibration Criteria

Area Designation	A Continuous Internal Noise Levels, L_{Aeq} dB		B Intermittent Internal Noise Level L_{Amax} dB	C Internal Noise Levels Helicopter L_{Amax} dB	D Floor Impact Sound Isolation L_{nw} dB	E Reverberation Time (s) (Fully finished)	F Emergency Generator Internal Noise Level L_{Amax} dB
	Satisfactory	Maximum					
Corridor							
Counselling / Bereavemet / Interview Room	40	45	50	55	55	0.4-0.6	+5
Consult Room	40	45	50	55	55	0.4-0.6	+5
Speech and Language Therapy	35	40	50	55	55	0.4-0.6	+5
Treatment / Medication / Examination Room	40	45	50	55	60	0.4-0.6	+5
Corridors and Lobby Space	40	50	65	70	60	0.4-0.6	+10
Cafeterias / Dinning	45	50	70	70	60	Practicable reduction	+10
Toilets	45	55	75	70	-	-	+10
Waiting Rooms, Reception Areas	40	50	65	70	60	0.4-0.6	+10
Multi Faith / Chapel	30	35	50	55	50	0.4-0.6	+5
Meeting Room	35	40	55	60	55	0.6-0.8	+5
Board / Conference Room (Large)	30	35	55	60	55	0.6-0.8	+5
Open Plan Offices	40	45	65	70	60	0.4-0.6	+5
Private Offices	35	40	55	60	55	0.6-0.8	+5
Multi Person Offices	40	45	65	70	55	0.6-0.8	+5
Locker Room	50	55	75	-	-	-	+10
Rest Room	40	45	65	70	-	0.4-0.6	+5
Classrooms, Training Rooms	35	40	55	60	55	0.5-0.6	+5
Lecture Theatre	30	35	55	60	55	Curve 1 of AS/NZS2107:2000	+5
Library	40	45	50	60	55	0.4-0.6	+5
Workshops	45	50	75	-	-	Practicable reduction	+10
Plant Rooms	N/A	<85	75	-	-	Practicable reduction	-
Laboratory	45	50	65	65	60	0.4-0.7	+10

Notes:

1. All sound pressure levels referenced to 20micro-Pascals (dB re 20 µPa).
2. Confidential privacy requirements can be difficult to achieve in practice with cost effective solutions. These spaces should be reviewed and agreed on a case-by-case basis.

3. Reverberation times are the spatial average in fully finished rooms, generally for full octave bands with centre frequencies of 500 Hz and 1 kHz;
4. The impact sound isolation requirements apply to the floor situated above the designated room type.
Please note the following regarding the internal acoustic requirements listed in Table 8:

It is noted that additional internal noise level criteria are discussed in Columns B, C and D in Table 8 of the NSW HI ESG. However, we understand these criteria apply to individual noise events. We also note that these events are intermittent or occasional, but not steady state (please note that standard AS/NZS 2107:2016 is only applicable for steady state or quasi-steady state noise levels)

Therefore, based on this discussion, it is recommended that the internal noise level criteria for the project, based on steady state noise levels (such as those generated by mechanical services) should be dictated by the recommended internal noise level criteria listed in Column A of Table 8 of the NSW HI ESG.

Also, the NSW HI ESG recommends that internal noise levels should be free of tonality and should not include annoying characteristics including tones and distinctive low or high frequency components described as rumbly or hissy. Nor should the noise contain amplitude or frequency modulation components referred to as hunting or beating.

Tonality will be deemed to apply where the noise in any 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 400Hz;
- 8 dB or more if the centre frequency of the band containing the tone is 160 to 400 Hz inclusive; and,
- 15 dB or more if the centre frequency of the band containing the tone is below 160 Hz.

The maximum noise level from mechanical services should be considered in aggregate with the environmental noise intrusion from external steady state noise sources in order to satisfy the maximum noise levels in Column A of Table 8.

5.3.2 Department of Planning – Interim Guideline – Developments Near Rail Corridors and Busy Roads

The DoP interim Guideline details the application of SEPP Infrastructure Clause 102 which is required to be used when an educational development is adjacent to a freeway, a tollway, or transit-way or a road with an annual average daily traffic volume (AADTV) of more than 40,000 vehicles. Based on the RMS traffic volume maps, the development is not located adjacent to or near a road carrying more than 20,000 vehicles AADTV or a rail line. As such the DoP Interim Guideline and the Infrastructure SEPP are not applicable. Note that the nearest road carrying more than 20,000 vehicles is a portion of Station Street which is located 950 metres away.

5.4 The State Environmental Planning Policy (Infrastructure) 2007

5.4.1 Noise and Vibration from Rail Corridors

The State Environmental Planning Policy (Infrastructure) 2007 (SEPP 2007) requires that the impact of noise and vibration from road and rail corridors should be considered for several types of development which includes hospital buildings.

Therefore, in order to provide guidelines for this type of assessment, the then NSW Department of Planning (now part of the NSW Department of Planning & Environment) has developed a document titled *"Development Near Rail Corridors and Busy Roads – Interim Guideline"*. Consequently, in Section 3.5.1 of the Guideline, a preliminary acoustic assessment is discussed based on distances from the rail corridor. These are illustrated in Figure 5 and Figure 6.

In relation to Figure 5, please note that for developments located within Zone A, a full acoustic assessment is required. For developments situated within Zone B, these should implement standard acoustic mitigation measures.

Figure 5: Preliminary Assessment for Rail Noise (Figure 3.1 of the DoP Guideline).

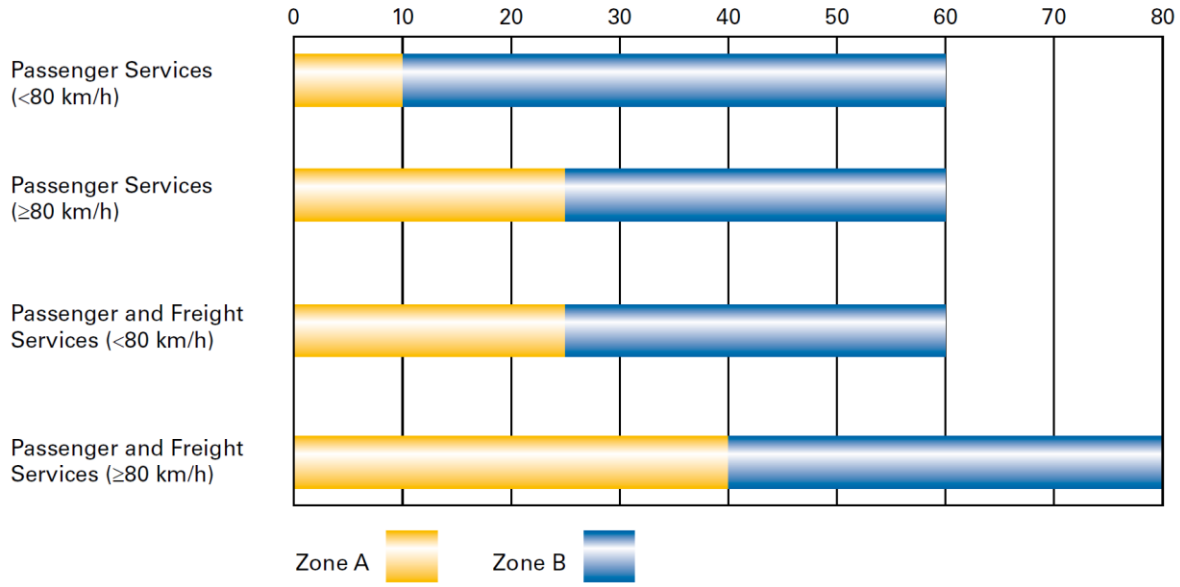


Figure 3.1: Acoustic Assessment Zones based on distance (m) of noise-sensitive development from operational track (not corridor)

Figure 6: Preliminary Assessment for Rail Vibration (Figure 3.2 of the DoP Guideline).

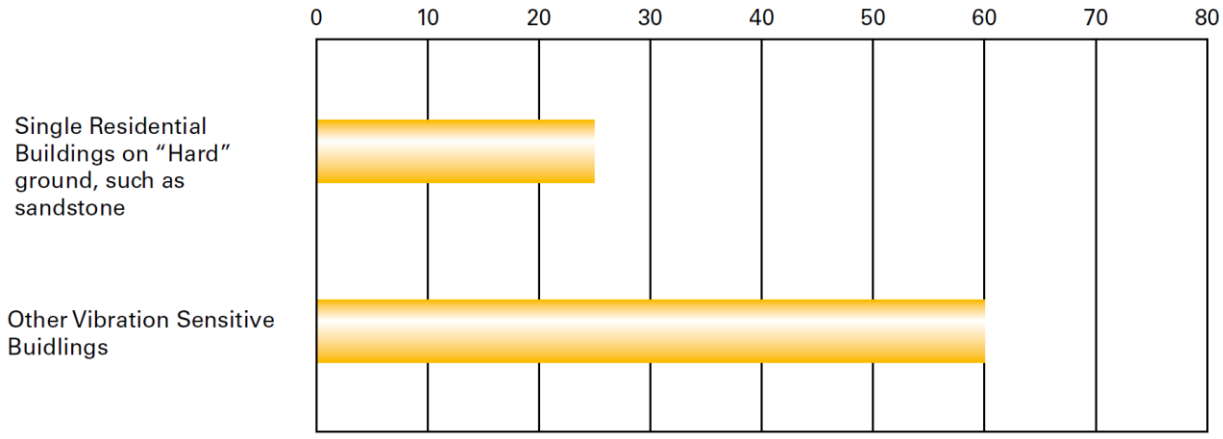


Figure 3.2: Distance from the nearest operational track (m)

5.4.2 Noise and Vibration from Road Corridor

According to the SEPP 2007, an acoustic assessment is required if a development is located near a freeway, tollway or a transit way or any other road that has an annual average daily traffic volume (AADT) of more than 40,000 vehicles (based on the traffic volume data available from the RMS website).

Based on the traffic volume data available it is determined that local roads in Bowral do not have such AADT which would trigger a preliminary acoustic assessment. The Hospital is also 1.0km from the nearest train line between Bowral and Burradoo Stations on the Southern Highland Line. Therefore, no assessment for road, rail noise and vibration is required.

Operational Noise and Vibration Criteria

5.5 Traffic Noise Criteria

Road traffic noise impact in this report is assessed according to the NSW Road Noise Policy (2011). 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 9.

Table 9: 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	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'.

5.6 Sleep Disturbance Criteria

The EPA NPI establishes sleep disturbance criteria for residential receivers in close proximity to industrial noise sources during the night-time period, such as vehicle movements and car door slams on private roads. The criteria for protecting the amenity of surrounding residential receivers in regards to sleep disturbance is:

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

Table 10 summarises the sleep disturbance criteria for the proposed development.

Table 10: Sleep Disturbance Criteria.

Period	Sleep Disturbance Criteria	
	$L_{Amax,RBL+15\ dB}$, dB(A)	$L_{Aeq,15min}$, dB(A)
Night (10:00pm to 7:00am)	**52**	**40**

The detailed analysis should cover the maximum noise level, 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. The detailed assessment should consider all feasible and reasonable mitigation measures with a goal of achieving the above trigger levels.

5.7 Vibration Criteria

The NSW EPA has issued a document titled *"Assessing vibration: A technical Guideline"* which is dated February 2006. This document has been produced in order to assist on the assessment of vibration levels. The guideline does not however address vibration induced damage to structures or structure-borne noise effects.

For human comfort, vibration and its associated effects are usually classified as continuous, impulsive or intermittent.

5.7.1 Human Comfort – Continuous and Impulsive Vibration Criteria

Structural vibration in buildings can be detected by occupants and can potentially have an impact on human comfort. This impact is influenced by the activity conducted by those affected (i.e. use of the building) and the time when the vibration levels occur.

Maximum allowable magnitudes of vibration levels with respect to human response are shown in Table 11. Please note that the assessment period is defined as follows:

- Daytime extends from 7 am to 10 pm.
- Night-time is from 10 pm to 7 am.

Table 11: Preferred and Max Weighted RMS Values for Continuous and Impulsive Vibration Acceleration (m/s^2) 1-80 Hz.

Location	Assessment Period	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
Offices, schools, educational institutions and place of worship	Day or night time	0.64	0.46	1.28	0.92
Critical areas	Day or night time	0.0050	0.0036	0.010	0.0072

5.7.2 Human Comfort – Intermittent Vibration Criteria

For intermittent events, the vibration assessment is based on Vibration Dose Values (VDVs). VDVs are used in order 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 12: 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	0.80
Critical areas	0.10	0.20	0.10	0.20

6. Construction Noise and Vibration Criteria

6.1 Secretary's Environmental Assessment Requirements (SEARs)

In accordance with the Secretary's Environmental Assessment Requirements, clauses 6 and 7 of Schedule 2 of the Environmental Planning and Assessment Regulation 2000 for redevelopment of Bowral and District Hospital (SSD 8980) (dated 30th January 2018), the following documents are required to be used in order to identify and assess the noise and vibration impact from the development to the nearest receivers:

- Noise Policy for Industry 2017 (EPA), (Section 5.3);
- Interim Construction Noise Guideline (DECC), (Section 6);
- Assessing Vibration: A Technical Guideline 2006, (Section 5.7);
- Development Near Rail Corridors and Busy Roads – Interim Guideline (Department of Planning 2008) , (Section 5.3.2);

6.2 Interim Construction Noise Guideline (ICNG July 2009)

The noise criteria for construction sites are established in accordance with the Interim Construction Noise Guideline (ICNG July 2009) by the Office of Environment and Heritage (OEH) and the City of Sydney Standard Conditions of Consent. This document is referred to as OEH's standard policy for assessing construction noise on new projects.

The key components of the ICNG 2009 incorporated into this assessment include:

1. **Use of LAeq as the noise metric for measuring and assessing construction noise**
   In recent years, NSW noise policies including OEH NPI and the NSW Environmental Criteria for Road Traffic Noise (ECRTN) have selected the LAeq to be the primary noise metric when measuring and assessing construction noise. Consistent with ICNG 2009, the use of the LAeq as a key descriptor for measuring and assessing construction noise may follow a 'best practice' approach.

2. **Application of feasible and reasonable noise mitigation measures**
   As stated in the ICNG 2009, a noise mitigation measure is feasible if it is capable of being put into practice, and is practical to build given the project constraints. Selecting reasonable mitigation measures from those that are feasible requires one to determine whether the overall noise benefit of applying the measure outweighs the overall social, economic and environmental effects, including the cost of the measure.

3. **Quantitative and qualitative assessment**
   The ICNG 2009 provides two methods for assessment of construction noise, being either a quantitative or a qualitative assessment.

   A quantitative assessment is recommended for major construction projects of significant duration, and involves the measurement and prediction of noise levels, and assessment against set criteria.

   A qualitative assessment is recommended for small projects with a short-term duration where works are not likely to affect an individual or sensitive land use for more than three weeks in total. It focuses on minimising noise disturbance through the implementation of feasible and reasonable work practice, and community notification.

   Given the significant scale of the construction works proposed for this Project, a quantitative assessment is carried out herein, consistent with the ICNG 2009 requirements.

4. **Management levels**
   Table 1 below (based on the ICNG criteria and the Conditions of Consent construction hours) sets out the noise management levels and how they should be applied. The guidelines intend to provide respite for residents exposed to excessive construction noise outside the recommended standard hours whilst allowing construction during the recommended standard hours without undue constraints.

The rating background level (RBL) is used when determining the management level. The RBL is the overall single-figure background noise level measured in each relevant assessment period (during or outside the recommended standard hours).

The noise criteria associated with construction and its related activities are shown below in Table 13.

Table 13: 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 (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. of the NSW ICNG

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 30m 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.

Table 14 (reproduced from Table 2 Sec 4.1.1 (Chapter 4) of the ICNG 2009) sets out the noise management levels for various sensitive land use developments.

Construction Noise and Vibration Criteria

Table 14: OEH ICNG Construction Noise Criteria at Other Sensitive Land Uses.

Land Use	Management Level, $L_{Aeq,15min}$ – Applies when Land Use is being Utilized
Classrooms at schools and other educational institutions	Internal noise level 45 dB(A)
Hospital wards and operating theatres	Internal noise level 45 dB(A)
Places of worship	Internal noise level 45 dB(A)
Active recreation areas	External noise level 65 dB(A)
Passive recreation areas	External noise level 60 dB(A)
Community centres	Depending on the intended use of the centre. Refer to the 'maximum' internal levels in AS/NZS 2107:2000 for specific uses.

Table 15 below (reproduced from Sec 4.1.3 (Chapter 4) of the ICNG 2009) sets out the noise management levels for commercial and industrial use developments. The external noise levels should be assessed at the most-affected occupied point.

Table 15: OEH ICNG Construction Noise Criteria at Commercial and Industrial Premises.

Land Use	Management Level, $L_{Aeq,15min}$ – Applies when Land Use is being Utilized
Industrial premises	External noise level 75 dB(A)
Offices, retail outlets	External noise level 70 dB(A)
Other business that may be sensitive to noise, where the noise levels are project specific as discussed below	Recommended 'maximum' internal noise levels in AS/NZS 2107:2000

Please note the following in regard to the NMLs:

- The NMLs are based on the quantitative assessment method as discussed in the NSW ICNG. This has been assumed in this manner since we consider the hospital redevelopment works not as short term activities (i.e. duration of more than three weeks).
- It is recommended that the working hours to undertake the redevelopment works should be as per the normal construction hours discussed in the NSW ICNG; these are:
    - Monday to Friday: 7 am to 6 pm
    - Saturday: 8 am to 1 pm
    - No work on Sundays or public holidays
- Feasible measures, as discussed in the NSW ICNG, is defined as follows: *"A work practice or abatement measure is feasible if it is capable of being put into practice or of being engineered and is practical to build given project constraints such as safety and maintenance requirements"*.
- Reasonable measures, as discussed in the NSW ICNG, is defined as follows: *"Selecting reasonable measures from those that are feasible involves making a judgment to determine whether the overall noise benefits outweigh the overall adverse social, economic and environmental effects, including the cost of the measure. The regulatory authority may review the information on feasible and reasonable work practices provided by the proponent, and compare the practices against those applied on similar projects. The regulatory authority may negotiate additional work practices that it considers may also be feasible and reasonable".*
- For non-residential premises, the NSW ICNG recommends the following NMLs:
    - For commercial premises: 70 dB(A) $L_{Aeq\ (15\ minutes)}$ external noise level
    - For places of worship, hospital wards and operating theatres: 45 dB(A) $L_{Aeq\ (15\ minutes)}$ internal noise level. Based on the assumption that the existing hospital façade provides a 15 dB noise reduction (which corresponds to typical 10.38 mm thick laminated commercial glazing), then the external NML is estimated as 60 dB(A) $L_{Aeq\ (15\ minutes)}$.

6.3 Construction Vibration Criteria

For human comfort, the NSW ICNG recommends the use of the vibration criteria as discussed in the NSW EPA *"Assessing vibration: A technical Guideline"*. Hence, please refer to Section 5.7 for detailed discussion regarding these criteria.

In addition to these human comfort criteria, we also recommend considering the following vibration criteria which address structural damage.

6.3.1 Structural Damage – Vibration Criteria

Generally, structural vibration criteria are defined in order to minimize the risk of cosmetic superficial damage (such as surface cracks). These criteria 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 16 indicates the vibration limits presented in DIN4150-Part 3 to ensure structural damage does not occur.

Table 17 presents guide values for building vibration, based on the lowest vibration levels above which cosmetic damage has been demonstrated as per BS 7385-Part 2:1993.

Table 16: Guideline Value of Vibration Velocity (v_i) for Evaluating the Effects of Short-Term Vibration.

Line	Type of Structure	Vibration Velocity, v_i, 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 17: Transient Vibration Guide Values for Cosmetic Damage.

Type of Building	Peak Particle Velocity in Frequency Range of Predominant Pulse (PPV)	
	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

6.3.2 Criteria for Vibration Sensitive Equipment

Vibration criteria for vibration sensitive equipment has been compiled by the American Society of Heating and Refrigeration Engineers (ASHRAE) and published in the *ASHRAE Handbook - HVAC Applications*. Figure 7 below summarises these criteria.

Certain hospital equipment has been identified as such vibration sensitive equipment. Hence, in general terms, the applicable criteria for this equipment correspond to the following curves:

- Operating room, for equipment in operating theatres.
- Curves VC-A, VC-B and VC-C for vibration sensitive equipment such as MRIs, CT scanners, etc.

Also please refer to vibration criteria discussed in Section 5.7 which are classified under *Critical Areas.*

Please note that specific criteria for this equipment are likely to be within the margins of the general criteria provided above. Hence, it is recommended that hospital staff or the equipment manufacturer should provide specific vibration criteria for each vibration sensitive instrument.

Figure 7: Building Vibration Criteria for Vibration Measured on Building Structure (from ASHRAE Handbook).

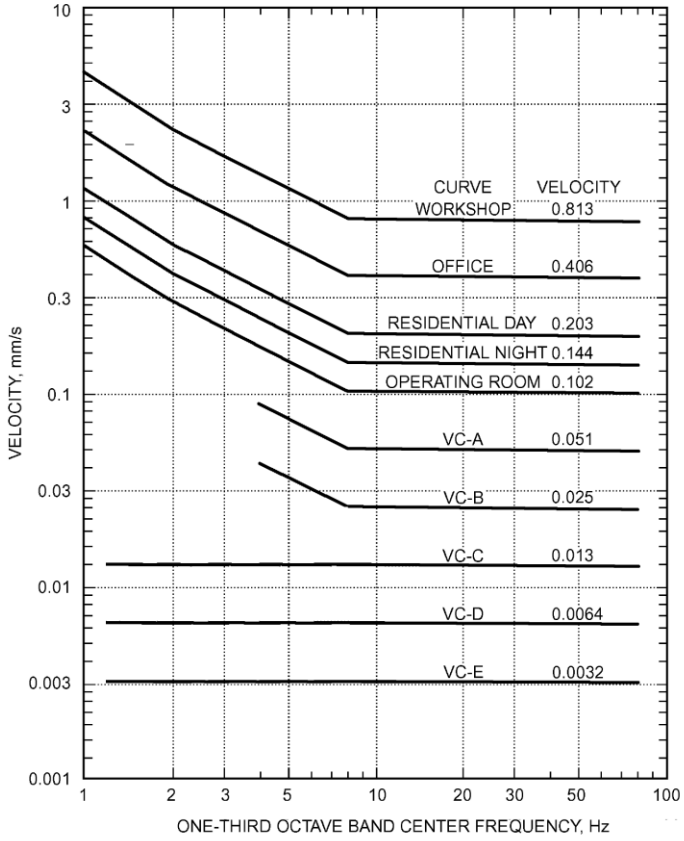


Table 46 Human Comfort and Equipment Vibration Criteria

Human Comfort	Time of Day	8 to 80 Hz Curve,[a] mm/s
Workshops	All	0.813
Office areas	All[b]	0.406
Residential (good environmental standards)	0700-2200[b]	0.203
	2200-0700[b]	0.144
Hospital operating rooms and critical work areas	All	0.102
Equipment Requirements		**Curve[a]**
Adequate for computer equipment, probe test equipment, and microscopes less than 40×		0.203
Bench microscopes up to 100× magnification; laboratory robots		0.102
Bench microscopes up to 400× magnification; optical and other precision balances; coordinate measuring machines; metrology laboratories; optical comparators; microelectronics manufacturing equipment; proximity and projection aligners, etc.		0.051
Microsurgery, eye surgery, neurosurgery; bench microscopes at magnification greater than 400×; optical equipment on isolation tables; microelectronic manufacturing equipment, such as inspection and lithography equipment (including steppers) to 3 mm line widths[c]		0.025
Electron microscopes up to 30 000× magnification; microtomes; magnetic resonance imagers; microelectronics manufacturing equipment, such as lithography and inspection equipment to 1 mm detail size[c]		0.013
Electron microscopes at magnification greater than 30 000×; mass spectrometers; cell implant equipment; microelectronics manufacturing equipment, such as aligners, steppers, and other critical equipment for photolithography with line widths of 1/2 µm; includes electron beam systems[c]		0.0054
Unisolated laser and optical research systems; microelectronics manufacturing equipment, such as aligners, steppers, and other critical equipment for photolithography with line widths of 1/4 µm; includes electron beam systems[c]		0.0032

[a]See Figure 37 for corresponding curves.
[b]In areas where individuals are sensitive to vibration, use Residential Day curve.
[c]Classes of microelectronics manufacturing equipment:

7. Operational Noise Impact Assessment

7.1 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 from Loseby Park to the South of the hospital

7.2 Mechanical Plant

7.2.1 Noise Sources

The proposed hospital redevelopment will include typical building services plant and equipment. The current proposal is to utilise a centralized roof top plant air-conditioning strategy. The proposal details that air handling units (AHUs) will be located in dedicated plant rooms on the roof along with centralised chillers, boilers and associated pumps and plant. Cooling towers will be located externally on the roof in the south-eastern corner of the plant area.

An assessment has been conducted during the detailed design phase to ensure noise levels from the plant do not exceed limits outside the plant room and at the nearby sensitive receivers. In order to meet the required sound levels at the receivers, the cooling tower platform must be surrounded by a noise barrier, and all the surfaces facing the tower should be lined with highly absorptive acoustic material. Further coordination is required with the mechanical engineers. Additionally, attenuators, duct lining and acoustic louvres are needed to reduce noise from air intake and exhaust openings. Internal acoustic lining will also be required on the plant room roof and/or walls.

An emergency diesel generator is proposed to be positioned next to the existing medical records building. Equipment has not been finalised, but a typical product and sizing have been proposed. A 400kVA generator has been sized, and typical Kohler and Cummins generator noise levels were used for an assessment. All generators come with an optional sound enclosure. Based on typical sound levels of the generator, it is confirmed that the optional sound enclosure will be necessary. Additionally, a barrier may be required, facing the nearest residential receiver. Confirmation of this will require a further assessment once a specific generator has been selected. We do not expect any further sound mitigation to be required for this item of plant.

7.2.2 General Mechanical Services Mitigation Measures

Mitigation measures for the mechanical plant should be considered during the design development stage so as to comply with the outlined criteria at the nearest sensitive receivers. These amelioration measures could include but not be limited to the following:

- Positioning mechanical plant away from nearby receivers
- Acoustic attenuators fitted to duct work
- Screening around mechanical plant
- Acoustic insulation within duct work

7.3 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. Once mechanical equipment has been finalised, an assessment will be conducted to deem required treatment.

7.3.1 Vehicle Movements in the Carpark

The carpark layouts will be changed as part of the Main Works stage of the redevelopment. There are approximately 4 additional parking spaces proposed, as well as a new crossover at Bowral Street. A section of the existing carpark will be used for a new Ambulance ramp and platform. The new carpark spots are all on ground level and positioned to the northeastern corner of the site. These parking spaces are not anticipated to cause any additional noise for nearby receivers. Two existing driveways are retained, with an additional driveway being positioned in the northeast corner opposed by the park.

7.3.2 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 Bowral 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.

7.3.3 Medical Gas Storage and associated Infrastructure/Plant

Based on the proposed medical gas infrastructure report by BOC dated Friday 4th August we can gain a good understanding of what changes there will be. The gas and plant equipment is largely retained, although there are a few small changes resulting from increased capacity requirements. BOC has recommended that a new suction plant be installed, as well as two gas manifolds that are potentially required. These items will be assessed when details have been confirmed.

7.4 External Car Park Noise

In accordance with the Traffic Report prepared by GTA Consultants dated 24/04/2018, currently there are 196 car spaces allocated within the Bowral and District Hospital Precinct. At the completion of the redevelopment program, the Bowral and District Hospital will have 200 car spaces allocated within the precinct.

As there are only minimal changes (4 additional car parks) to the number of onsite vehicle parking spots resulting from the redevelopment program, we expect this to have negligible effect based on the new parking locations and carpark entry changes. We do not anticipate any further impact on residents resulting from traffic changes post development. Therefore, the proposed development is expected to comply with the requirements of the NSW RNP.

7.5 Helicopter Noise

Loseby Park to the south of the hospital has been used for emergency helicopter take-offs and landings and will continue to be used as such. 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.

7.6 Loading Dock & Waste Collection

Observations of the site showed three existing zones for loading and garbage collection. Two of these are accessed from Ascot Road, while one is accessed from Sheffield Road. We do not expect any new loading areas adjacent to the new building that is large enough to entail a noise assessment. It is assumed that noise from existing loading dock and waste collection areas will not be worse than previously, and as such a noise assessment has not been conducted.

8. External Traffic Noise Intrusion

Acoustic modelling for external noise intrusion from the surrounding roads was conducted. Noise levels from the road were calculated in accordance with the Calculation of Road Traffic Noise (CRTN) methodology, and calibrated to measurements and logger data from around the site. This model is recognised by regulatory authorities around Australia and is endorsed by the NSW OEH for the use in projects of this scale. The acoustic modelling was undertaken considering no specific meteorological characteristics such as dominant wind direction and speed or temperature therefore it was considered under neutral conditions.

The traffic noise from Bowral Street has been considered as the main source affecting the new building for this assessment. In order to achieve the internal noise levels specified in the DoP Guideline and NSW Health Infrastructure Guidelines, the minimum recommended glazing selection for the façades of the proposed development is presented below in provided.

The ratings presented are based on the worst case scenario of external noise obtained from the attended noise measurement together with noise data from the unattended logger. The glazing thicknesses corresponding to the R_W ratings are presented below in Table 18, and should be considered as the minimum thicknesses to achieve acoustical ratings. Greater glazing thicknesses may be required for structural loading, wind loading, thermal requirements etc.

Table 18: Recommended Acoustic Performance of Glazing System – Traffic Noise.

Location	Required Acoustic Rating of Glazing Assembly, R_w[1]	Fixed Single Glazed System
All Areas	32	6.38mm laminate glass

Note:
The required acoustic rating of glazing assembly, refers to the acoustic performance of the glazing once installed on site (including the frame).

[1] See Appendix 1 for Rw definition

9. Conclusion

This report presents the results of a study of operational noise emission from the proposed redevelopment of the Bowral and District Hospital located at 97-103 Bowral Street, Bowral, NSW. This report forms a part of the documentation package to be submitted to the public authority (Health Infrastructure) as part of the State Significant Development Application (SSDA) 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 Bowral Town 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 both the boundary of the potentially most-affected receivers, and within the existing Hospital vicinity.

Road noise intrusion criteria was also established based on the requirements of Bowral Town 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. Noise control measures will have to be refined as plant equipment is selected. The report also discussed potential noise impact associated with additional traffic generated by the new development and construction noise.

Following our investigation, except where explicitly noted, it was found that no significant noise impacts will occur as a result of the proposed Main Works stage of the development should the proposed noise mitigation measures be implemented.

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 L_{Aeq} noise level from industrial sources, recommended by the EPA (Table 2.1, 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 3.5 m 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.
L_{Amax}:	The maximum A-weighted sound pressure level measured over a period.
L_{Amin}:	The minimum A-weighted sound pressure level measured over a period.

Appendix 1 – Glossary of Acoustic Terms

L_{A1}:	The A-weighted sound pressure level that is exceeded for 1% of the time for which the sound is measured.
L_{A10}:	The A-weighted sound pressure level that is exceeded for 10% of the time for which the sound is measured.
L_{A90}:	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).
L_{Aeq}:	The A-weighted "equivalent noise level" is the summation of noise events and integrated over a selected period of time.
L_{AeqT}:	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 L_{eq} 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.