New Shellharbour Hospital (NSH) – SSD-57064458

Construction Noise and Vibration Management Sub Plan (CNVMSP)

BESIX Watpac (NSW) Pty Ltd
Level 15, 210 George Street,
Sydney NSW 2000

Report Reference: 240296 – New Shellharbour Hospital (NSH) – CNVMSP – R2

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Revision: R2

Project Number: 240296

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0	DRAFT – For Review	240296 – New Shellharbour Hospital (NSH) – CNVMSP – R0	26/08/24	Matthew Furlong	Matthew Furlong	Ben White
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1 INTRODUCTION

Pulse White Noise Acoustics (PWNA) has been engaged by BESIX Watpac (NSW) Pty Ltd to prepare a site-specific Construction Noise and Vibration Management Sub-Plan (CNVMSP) for the construction of the new New Shellharbour Hospital (NSH) to be constructed at 86 Dunmore Road, Dunmore NSW (Lot 10 DP 1281639).

This CNVMSP has been prepared to satisfy the requirements of Conditions B16, C4, C5, C6, C7, C8, C13, C14, C15, C16, C17 and C18 of the consent conditions presented to this office given in the Notice of Determination – Approval issued for Development Application No. SSD-57064458, dated 12th August 2024.

Onsite unattended noise levels have previously been determined for the project by Stantec in the sites Noise and Vibration Impact Assessment submitted for as part of the SSD Application, report reference *New Shellharbour Hospital Acoustics Report* (Revision Final 006, dated 6th June 2023). These will be adopted for the purpose of establishing residential Noise Management Levels (NMLs).

A glossary of acoustic terminology used throughout this report is included in Appendix A.

1.1 Condition Satisfaction

In addressing the requirements of condition B16.

Table 1 Condition Satisfaction Table

CEMP Condition Satisfaction Table		
Condition	**Condition Requirements**	**Document/Sub-Plan Reference**
B16	*The Construction Noise and Vibration Management Sub-Plan must address, but not be limited to the following,*	-
	a) Be prepared by a suitably qualified and experienced noise expert;	Refer to Appendix D.
	b) Describe procedures for achieving the noise management levels in EPA's Interim Construction Noise Guideline (DECC, 2009);	Refer to section 4.2.
	c) Describe the measures to be implemented to manage high noise generating works such as piling, in close proximity to sensitive receivers;	Refer to section 5.2.
	d) Include strategies that have been developed with the community for managing high noise generating works;	Refer to section 5.7.
	e) Describe the community consultation undertaken to develop the strategies in condition B16(d);	Refer to section 5.7.
	f) Include a complaints management system that would be implemented for the duration of the construction; and	Refer to section 5.5.
	g) Include a program to monitor and report on the impacts and environmental performance of the development and the effectiveness of the management measures in accordance with Condition B16(d).	Refer to sections 5.3.2 (Vibration) and 5.2.3 (Noise).

1.2 Site Layout

In September 2020, the NSW Government committed to more than $700 million to deliver new and improved health facilities for the Illawarra Shoalhaven Local Health District (ISLHD) to meet the needs of the growing community.

The proposed development is for a new greenfield hospital for the Shellharbour region, known as the New Shellharbour Hospital (NSH). Health Administration Corporation (HAC) acquired land at 50 and 86 Dunmore Road, Dunmore (formally described as Lot 1 DP302910 and Lot 10 DP1281639) for a new health campus in June 2022. The NSH, the subject of this State Significant Development Application (SSDA), is proposed to occupy Lot 10 DP1281639.

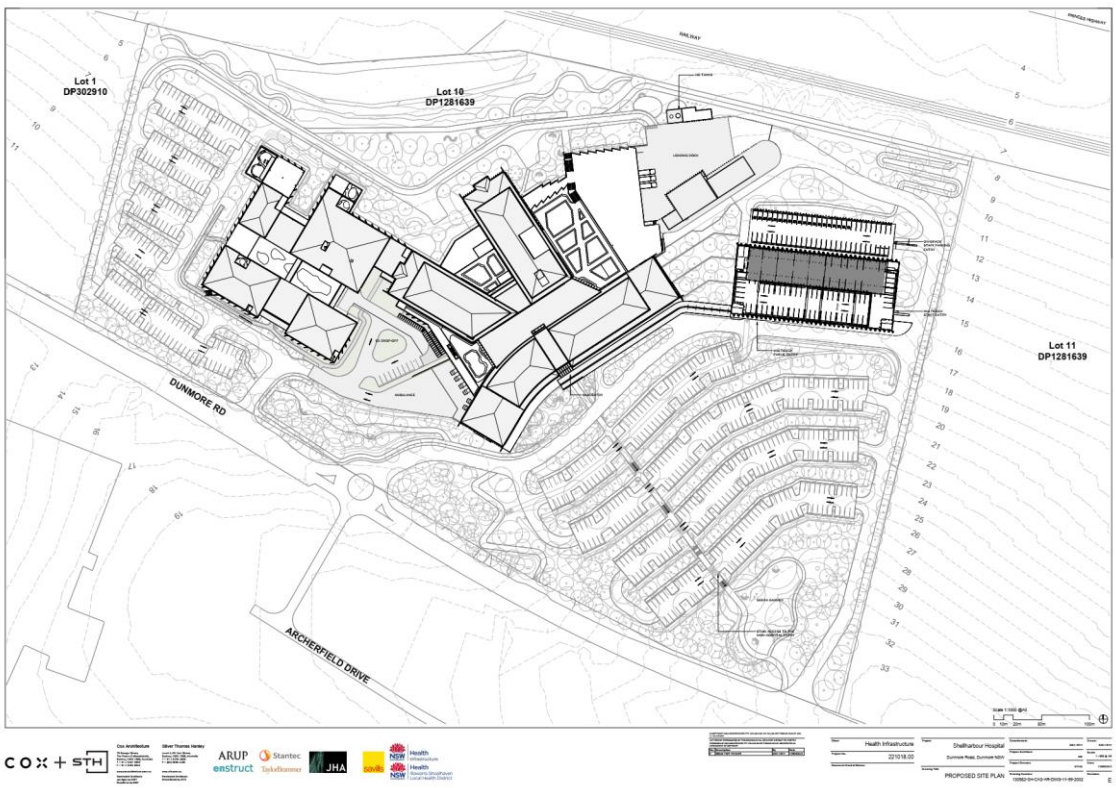
Lot 1 DP302910 does not form part of this application. It will be subject to stockpiling from earthworks as part of a separate scope of/consent for early works and is anticipated to be used for potential future expansion and complementary uses where suitable (subject to separate approval pathways, as required).

Broadly, the NSH Project and SSDA consist of:

- Construction and operation of a new (role delineation Level 4) hospital for Shellharbour to provide the health services required to meet the needs of the Shellharbour and Illawarra region (in conjunction with the other hospitals and community health facilities across the region).
- Construction of supporting infrastructure required for the NSH, including green space/ landscaping and other amenities, internal roads and access, at-grade and multi-deck car parking, external road upgrades and connections, utility/ services connections, and other supporting infrastructure.

A project site map is provided below.

Figure 1 - Site Plan (COX Architecture)



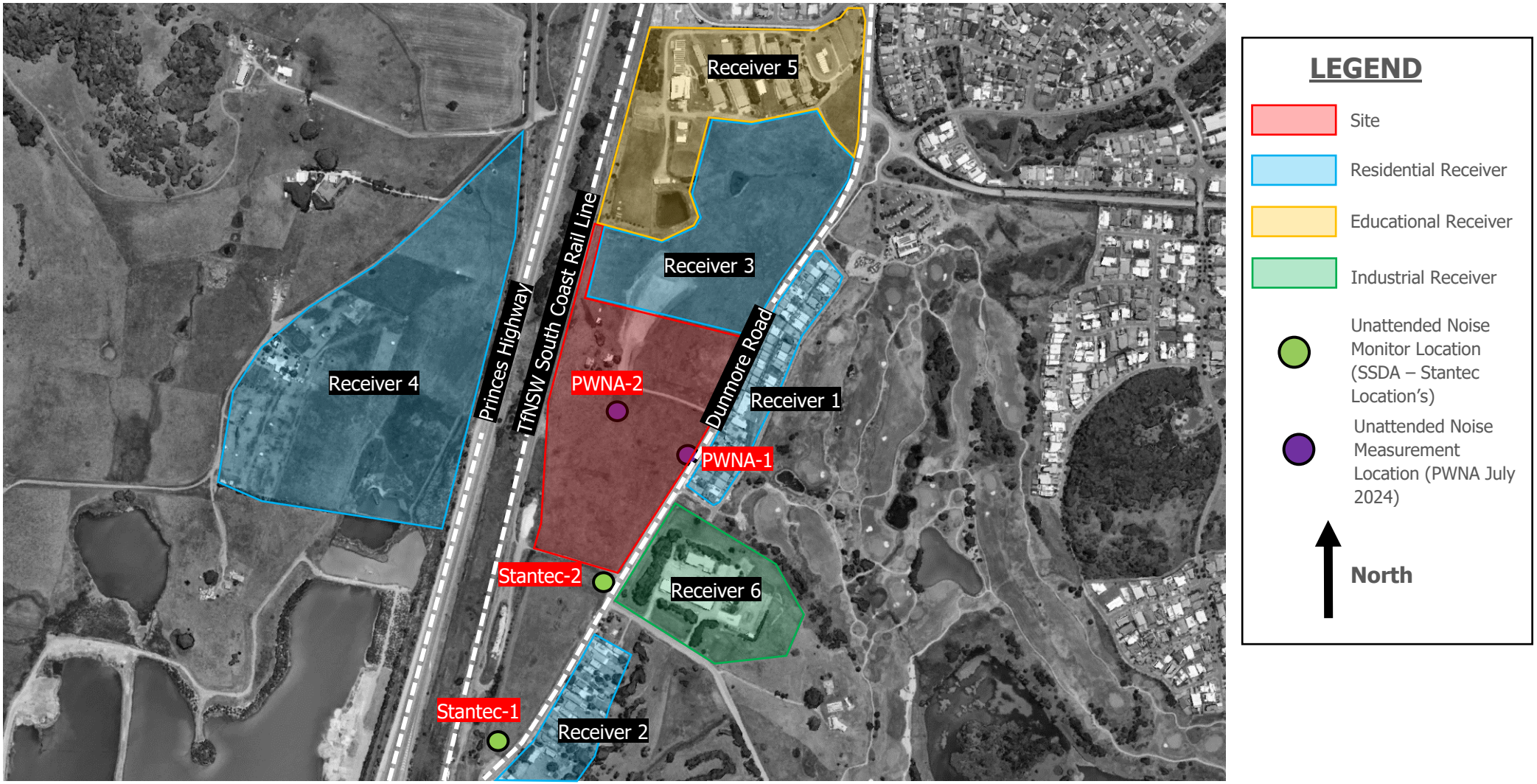
Surrounding the proposed project site are several sensitive receivers, these are summarised below for the project site.

Table 2 Surrounding Receiver Locations

Site	Receiver Number (See below)	Receiver Type	Address	Cardinal Direction (from site)
New Shellharbour Hospital	Receiver 1	Residential	61-111A Dunmore Road, Dunmore	East
	Receiver 2	Residential	23-51 Dunmore Road, Dunmore	South
	Receiver 3	Residential	90 Dunmore Road, Dunmore (Future Residential Subdivision)	North
	Receiver 4	Residential	183 James Road, Dunmore	West
	Receiver 5	Education	Shellharbour Anglican College	North
	Receiver 6	Industrial	Endeavour Energy – Shellharbour FSC	East

A map showing the site location, receiver locations and all measurement locations is provided in Figure 2below.

Figure 2 - Site Map and Nearest Sensitive Receivers (Sourced Google)



2 EXISTING ACOUSTIC ENVIRONMENT

2.1 Stantec Noise and Vibration Survey (SSD Measurements)

Onsite unattended noise levels have previously been determined for the project by Stantec in the sites Noise and Vibration Impact Assessment submitted for as part of the SSD Application, report reference *New Shellharbour Hospital Acoustics Report* (Revision Final 006, dated 6th June 2023). These will be adopted for the purpose of establishing residential Noise Management Levels (NMLs). Information regarding the monitoring conducted by Stantec is provided below:

Figure 3 - Extract from Stantec Noise & Vibration Impact Assessment

4. Acoustic Survey

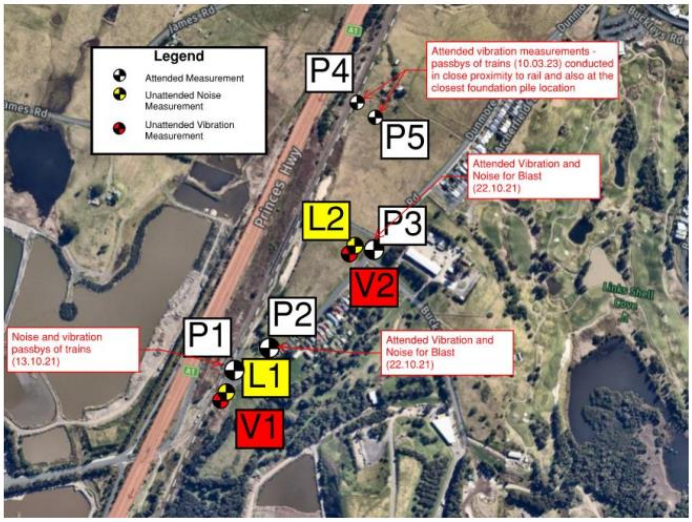


Figure 4: Attended and Unattended monitoring locations

4.1 Instrumentation

The equipment used for the noise survey was the following:

- Hand-held sound spectrum analyser Brüel & Kjær Type 2250, S/N 3027679
- Brüel & Kjær Sound Calibrator, S/N: 2709826
- SVAN 958 Vibration Analyser S/N 15153
- Svan SV30A Sound Calibrator, S/N 17556
- ARL Environmental Noise Logger, NL42EX, S/N 00810713
- ARL Environmental Noise Logger, NL42EX, S/N 00873125
- ARL Environmental vibration Logger, Vibra, S/N Vib00814
- ARL Environmental vibration Logger, Vibra, S/N Vib01711

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 Unattended Survey Results

Noise and Vibration monitors were placed at positions L1, L2, V1 & V2 as shown in Figure 4 to measure the background and ambient noise that is representative of the surrounding noise-sensitive residential receivers. All noise and vibration monitors were installed from the 13th to the 22nd of October 2021. The results of the unattended background and ambient noise surveys is shown in Table 2 below (for the day, evening and night time periods).

The Loggers installed at L2 & V2 was positioned towards the north-eastern boundary of Lot 1 DP302910 in the open field to understand the local noise environment and will be used to establish the project specific noise criteria for the noise sensitive receivers. The Logger was installed in the free field to minimise the influence of any potential reflections from any buildings or structures.

It is noted that the locations of the monitors are not installed within the bounds of the NSH site. The position of the logger at L2 was chosen as a practical location to be representative of the existing background environment (i.e. free from traffic and other intrusive noise sources). Due to the profile of the site being relatively flat, with minimal shielding provided from any buildings or structures, the general area located around the site is considered to be exposed to a similar noise environment, whilst simultaneously providing a secure tamper resistant location. The nearest residential receiver is noted to be at R1 (residential receivers along Dunmore Rd), directly west of the subject site (Lot 10). The background noise level at this location was expected to be slightly higher than that at logger location L2 as there was observed to be a higher volume of vehicle movements at the time of monitoring due to construction works for the residential developments along Dunmore Rd. By conducting long-term monitoring at the chosen locations, it is expected the results obtained are conservative in nature and are more reliable for determining the project specific criteria for the surrounding noise sensitive receivers.

The monitors placed at L1 & V1 have been used to characterise the noise generated by train pass-bys in addition to noise generated by vehicle movements along Princes Highway during the 15 hour and 9 hour periods established in the Department of Planning's Development near Rail Corridors and Busy Roads- Interim Guideline.

As the purpose of these monitors are to characterise the noise and vibration associated with movements along Princes Highway and the adjacent rail corridor. Locations were chosen near these sources, whilst being free from any potential interference from other sources. Particularly, the vibration monitor was needed to be installed by the rail to capture train pass-bys and ensure events exceeded the baseline (background) vibration associated with the local environment.

Table 2: Summary of unattended noise measurements

Location	Equivalent Continuous Noise Level $L_{Aeq,period}$ - dB(A)			Background Noise Level RBL - dB(A)		
	Day	Evening	Night	Day	Evening	Night
L1	62	60	61	51	46	34
L2	58	54	55	48	46	34

The local ambient noise environment is dominated by traffic noise from Princes Highway and occasional train noise from the adjacent rail corridor throughout the majority of the day, evening and night time periods. Note that any rain affected data during the period of logging has been excluded from the calculations. Refer to Figure 5 and below for the noise data.

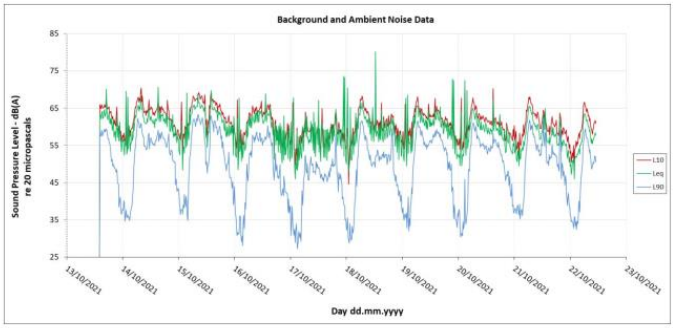


Figure . : Unattended bac. ground and ambient noise monitoring data – . 1

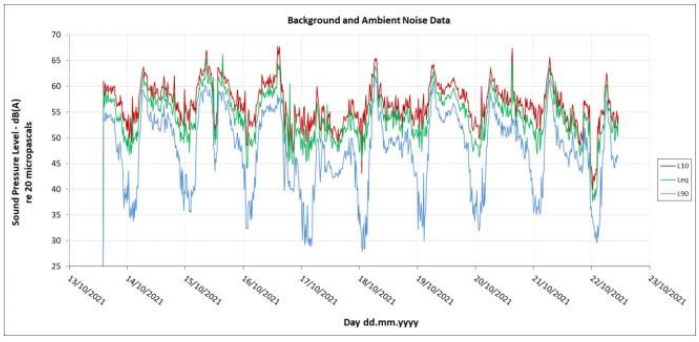


Figure . : Unattended bac. ground and ambient noise monitoring data – . 2

Unattended vibration monitors were installed to measure the vibration impact and propagation for train pass bys in the adjacent rail corridor. Weekly summary graphs for the Peak Velocity are presented in Figure 7 and Figure 8 below. The vibration monitor placed at V1 shows a considerable level of correlation with noise events. These peaks have been cross-referenced the South Coast Line Timetable to validate noise and vibration events to be used for the noise and vibration impact assessment.

It should be noted that the vibration monitor placed at V2 shows a smaller measure of correlation with the noise measurements, and is thought to be relatively unaffected by the impact of any vibration from the road and rail sources. There are a couple of notable peaks in the vibration measurements which do not correlate with noise measurements and is thought to be the result of animal interference or similar in the field.

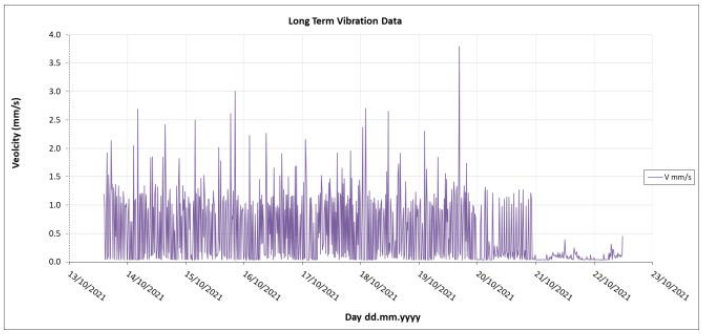


Figure . : Unattended vibration monitoring data – . 1

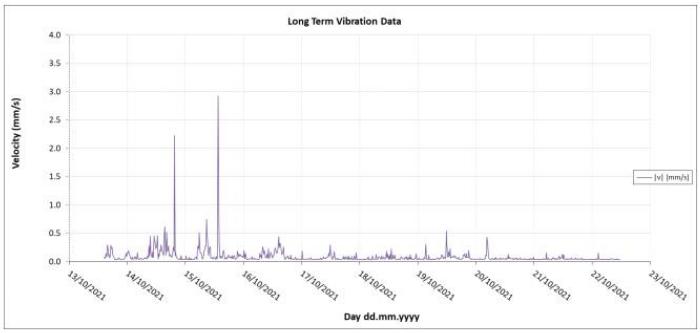


Figure . : Unattended vibration monitoring data – . 2

2.2 PWNA Acoustic Survey (August 2024)

In addition to the unattended and attended noise survey undertaken by Stantec previously, PWNA also conducted an additional acoustic survey to verify the adopted levels. These are detailed below.

Two unattended noise monitors were deployed to the site to survey existing background noise levels as well as ambient L_{Aeq} noise levels.

The monitoring location included the eastern boundary of the site along Dunmore Road, known as *PWNA-1* in Figure 2 above. This location was used for determining existing acoustic environment for the receivers across Dunmore Road.

The second location was in the centre of the project site at a similar distance from the existing Princes Highway/Rail Corridor as a similar representation of the likely ambient noise levels at the receiver across the Highway. As the receivers located across the Highway are exposed to similar noise sources/levels as the site this location is used a similar representation.

Onsite acoustic noise survey was conducted from Friday 9th August 2024 until Wednesday 14th August 2024. All data in the graphs presented in Appendix C and Appendix C have not been corrected (i.e., raw data is presented).

Instrumentation for the survey comprised two (2) Rion NL-42 sound level meter (serial number 001000231 and 00998081). Calibration of the monitors were checked prior to and following the measurements. Drift in calibration did not exceed ±0.5 dB. All equipment carried appropriate and current NATA (or manufacturer) calibration certificates.

Based on the unattended noise measurements, the results of the survey have been presented below.

To assess the acoustical implications of the development at nearby noise sensitive receivers, the measured background noise data of the logger was processed in accordance with the NSW EPA's Noise Policy for Industry (NPI, 2017).

The Rating Background Noise Level (RBL) is the background noise level used for assessment purposes at the nearest potentially affected receiver. It is the 90th percentile of the daily background noise levels during each assessment period, being day, evening and night. RBL $L_{A90\ (15minute)}$ and L_{Aeq} noise levels are presented in Table 3.

Table 3 PWNA Acoustic Survey

Measurement Location [4]	Daytime[1] 7:00 am to 6:00 pm		Evening[1] 6:00 pm to 10:00 pm		Night-time[1] 10:00 pm to 7:00 am	
	L_{A90}[2] (dBA)	L_{Aeq}[3] (dBA)	L_{A90}[2] (dBA)	L_{Aeq}[3] (dBA)	L_{A90}[2] (dBA)	L_{Aeq}[3] (dBA)
PWNA-1 – Eastern Boundary (see Figure 2)	49	63	52	58	36	57
PWNA-2 – Centre of Site (see Figure 2)	51	60	52	58	39	56

Note 1 *For Monday to Saturday, Daytime 7:00 am – 6:00 pm; Evening 6:00 pm – 10:00 pm; Night-time 10:00 pm – 7:00 am. On Sundays and Public Holidays, Daytime 8:00 am – 6:00 pm; Evening 6:00 pm – 10:00 pm; Night-time 10:00 pm – 8:00 am.*

Note 2 *The LA90 noise level is representative of the "average minimum background sound level" (in the absence of the source under consideration), or simply the background level.*

Note 3 *The LAeq is the energy average sound level. It is defined as the steady sound level that contains the same amount of acoustical energy as a given time-varying sound.*

2.3 Summary of Assumed Ambient Noise Levels

Based on the acoustic survey undertaken previously by Stantec and the updated survey by PWNA, the following ambient noise levels have been determined for each of the surrounding receivers.

Note: Noise Management Levels (NML's) for the surrounding education and industrial receivers are not based on a background + "X"dBA type assessment, they are set limits. As such the rating background noise levels at these locations are not relevant.

Table 4 Assumed ambient noise levels

Receiver Number (See Figure 2)	Receiver Type	Receiver Location (See Figure 2)	Adopted Measured Rating Background Level at Receiver Location (dBA L_{A90} [2])	
			Monday to Friday	Saturday
			7:00am to 6:00pm [1]	8:00am to 1:00pm [1]
Receiver 1	Residential	61-111A Dunmore Road, Dunmore	48	48
Receiver 2	Residential	23-51 Dunmore Road, Dunmore	48	48
Receiver 3	Residential	90 Dunmore Road, Dunmore (Future Residential Subdivision)	48	48
Receiver 4	Residential	183 James Road, Dunmore	51	51
Receiver 5	Education	Shellharbour Anglican College	N/A [3]	N/A [3]
Receiver 6	Industrial	Endeavour Energy – Shellharbour FSC	N/A [4]	N/A [4]

Note 1 As the approved construction hours as per the consent.

Note 2 The LA90 noise level is representative of the "average minimum background sound level" (in the absence of the source under consideration), or simply the background level.

Note 3 Construction noise objectives for the school are not based on a Background + type assessment, ICNG recommended 45dBA$L_{Aeq(15\text{-}minute)}$ for internal teaching spaces.

Note 4 Construction noise objectives for an industrial receiver are not based on a Background + type assessment, ICNG recommended 75 dBA$L_{Aeq(15\text{-}minute)}$ externally.

3 NOISE AND VIBRATION CRITERIA

Relevant noise and vibration criteria for construction activities are detailed below.

3.1 SSD Approval (SSD 41372302) Planning Conditions

Relevant conditions of the consent require the following in relation to construction noise and vibration impacts from the site.

Condition B16 – Construction Environmental Management Plan

The Construction Noise and Vibration Management Sub-Plan must address, but not be limited to, the following:

(a) be prepared by a suitably qualified and experienced noise expert;

(b) describe procedures for achieving the noise management levels in EPA's Interim Construction Noise Guideline (DECC, 2009);

(c) describe the measures to be implemented to manage high noise generating works such as piling, in close proximity to sensitive receivers;

(d) include strategies that have been developed with the community for managing high noise generating works;

(e) describe the community consultation undertaken to develop the strategies in condition B16(d);

(f) include a complaints management system that would be implemented for the duration of the construction; and

(g) include a program to monitor and report on the impacts and environmental performance of the development and the effectiveness of the implemented management measures in accordance with the requirements of condition B13.

Condition C4 – Construction Hours

C4. Construction, including the delivery of materials to and from the site, may only be carried out between the following hours:

a) between 7am and 6pm, Mondays to Fridays inclusive; and

b) between 8am and 1pm, Saturdays.

No work may be carried out on Sundays or public holidays.

Condition C5 – Construction Hours

C5. Notwithstanding condition C4, provided noise levels do not exceed the existing background noise level plus 5dB, works may also be undertaken during the following hours:

a) between 6pm and 7pm, Mondays to Fridays inclusive; and

b) between 1pm and 4pm, Saturdays.

Condition C6 – Construction Hours

C6. Construction activities may be undertaken outside of the hours in condition C4 and C5 if required:

a) by the Police or a public authority for the delivery of vehicles, plant or materials; or

b) in an emergency to avoid the loss of life, damage to property or to prevent environmental harm; or

c) where the works are inaudible at the nearest sensitive receivers; or

d) for the delivery, set-up and removal of construction cranes, where notice of the crane-related works is provided to the Planning Secretary and affected residents at least seven days prior to the works; or

e) where a variation is approved in advance in writing by the Planning Secretary if appropriate justification is provided for the works.

Condition C7 – Construction Hours

C7. Notification of such construction activities as referenced in condition C6 must be given to affected residents before undertaking the activities or as soon as is practical afterwards.

Condition C8 – Construction Hours

C8. Rock breaking, rock hammering, sheet piling, pile driving, and similar activities may only be carried out between the following hours:

a) 9am to 12pm, Monday to Friday;

b) 2pm to 5pm Monday to Friday; and

c) 9am to 12pm, Saturday.

Condition C13 – Construction Noise Limits

C13. The development must be constructed to achieve the construction noise management levels detailed in the Interim Construction Noise Guideline (DECC, 2009). All feasible and reasonable noise mitigation measures must be implemented and any activities that could exceed the construction noise management levels must be identified and managed in accordance with the management and mitigation measures identified in the approved Construction Noise and Vibration Management Plan.

Condition C14 – Construction Noise Limits

C14. The Applicant must ensure construction vehicles (including concrete agitator trucks) do not arrive at the site or surrounding residential precincts outside of the construction hours of work outlined under condition C4 and C5.

Condition C15 – Construction Noise Limits

C15. The Applicant must implement, where practicable and without compromising the safety of construction staff or members of the public, the use of 'quackers' to ensure noise impacts on surrounding noise sensitive receivers are minimised.

Condition C16 – Construction Vibration Limits

C16. Vibration caused by construction at any residence or structure outside the site must be limited to:

a) for structural damage, the latest version of DIN 4150-3 (1992-02) Structural vibration - Effects of vibration on structures (German Institute for Standardisation, 1999); and

b) for human exposure, the acceptable vibration values set out in the Environmental Noise Management Assessing Vibration: a technical guideline (DEC, 2006) (as may be updated or replaced from time to time).

Condition C17 – Construction Vibration Limits

C17. Vibratory compactors must not be used closer than 30 metres from residential buildings unless vibration monitoring confirms compliance with the vibration criteria specified in condition C15.

Condition C18 – Construction Vibration Limits

C18. The limits in conditions C16 and C17 apply unless otherwise outlined in a Construction Noise and Vibration Management Plan, approved as part of the CEMP required by condition B16 of this consent.

3.2 Construction Noise Criteria

3.2.1 NSW EPA Interim Construction Noise Guideline (ICNG) – DECC 2009

Noise criteria for construction and demolition activities are discussed in the Interim Construction Noise Guideline (ICNG). The ICNG also recommends procedures to address potential impacts of construction noise on residences and other sensitive land uses. The main objectives of the ICNG are summarised as follows:

- Promote a clear understanding of ways to identify and minimise noise from construction works.
- Focus on applying all "feasible" and "reasonable" work practices to minimise construction noise impacts.
- Encourage construction to be undertaken only during the recommended standard hours unless approval is given for works that cannot be undertaken during these hours.
- Streamline the assessment and approval stages and reduce time spent dealing with complaints at the project implementation stage; and
- Provide flexibility in selecting site-specific feasible and reasonable work practices to minimise noise impacts.

The ICNG contains a quantitative assessment method which is applicable to this project. Guidance levels are given for airborne noise at residences and other sensitive land uses.

The quantitative assessment method involves predicting noise levels at sensitive receivers and comparing them with the Noise Management Levels (NMLs). The NML affectation categories for residential receivers have been reproduced from the guideline and are listed in the table below.

Table 5 NMLs for quantitative assessment at residences

Time of Day [3]	Noise Management Level $L_{Aeq(15minute)}$ [1,2 & 4]	How to Apply
Recommended standard hours: Monday to Friday: 7 am to 6 pm **Saturday:** 8 am to 1 pm **No work on Sundays or public holidays**	"Noise Affected Level" RBL + 10 dB	The noise affected level represents the point above which there may be some community reaction to noise. • Where the predicted or measured $L_{Aeq(15minute)}$ is greater than the noise affected level, the proponent should apply all feasible and reasonable work practices to meet the noise affected level. • The proponent should also inform all potentially impacted residents of the nature of works to be carried out, the expected noise levels and duration, as well as contact details.
	"Highly Noise Affected Level" 75 dBA	The highly noise affected level represents the point above which there may be strong community reaction to noise. • Where noise is above this level, the relevant authority (consent, determining or regulatory) may require respite periods by restricting the hours that the very noisy activities can occur, taking into account: 1. Times identified by the community when they are less sensitive to noise (such as before and after school for works near schools, or mid-morning or mid-afternoon for works near residences. 2. If the community is prepared to accept a longer period of construction in exchange for restrictions on construction times.
Outside recommended standard hours (Any other times based on above)	Noise affected. RBL + 5 dB	• A strong justification would typically be required for works outside the recommended standard hours. • The proponent should apply all feasible and reasonable work practices to meet the noise affected level. • Where all feasible and reasonable practices have been applied and noise is more than 5 dB above the noise affected level, the proponent should negotiate with the community.

Note 1 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 30 m of the residence. Noise levels may be higher at upper floors of the noise affected residence.

Note 2 The RBL is the overall single-figure background noise level measured in each relevant assessment period (during or outside the recommended standard hours). The term RBL is described in detail in the NSW Noise Policy for Industry (EPA 2017).

Note 3 Requirements listed in the table above are in accordance with the Construction Hours listed in Condition C4 and C5.

Note 4 The LAeq is the energy average sound level. It is defined as the steady sound level that contains the same amount of acoustical energy as a given time-varying sound.

Construction noise levels at other noise receivers are outlined below:

- Construction noise levels within classrooms at schools and other educational institutions is not to exceed 45dB $L_{Aeq,15minute}$, when measured internally.
- Construction noise levels within places of worship is not to exceed 45dB $L_{Aeq,15minute}$, when measured internally.
- Construction noise levels at offices, retail outlets is not to exceed 70dB $L_{Aeq,15minute}$, when measured externally.

Based on the measured background noise levels summarised in section 2, and the NMLs outlined above the construction noise criteria to be used in this assessment are listed above.

Table 6 NMLs as basis for the acoustic assessment

Receiver Type	Receiver Number & Location	NML, dB $L_{Aeq(15minute)}$ [2] **Standard Hours [1]** **Monday to Friday: 7:00am to 6:00pm** **Saturday: 8:00am to 1:00pm**
Residences	**Receiver 1** – 61-111A Dunmore Road, Dunmore	NAFL: **58** (Externally) + HNAL: **75** (Externally)
	Receiver 2 – 23-51 Dunmore Road, Dunmore	NAFL: **58** (Externally) + HNAL: **75** (Externally)
	Receiver 3 – 90 Dunmore Road, Dunmore	NAFL: **58** (Externally) + HNAL: **75** (Externally)
	Receiver 4 – 183 James Road, Dunmore	NAFL: **61** (Externally) + HNAL: **75** (Externally)
Education	**Receiver 5** – Shellharbour Anglican College	**45** (Internal)
Industrial	**Receiver 6** – Endeavour Energy – Shellharbour FSC	**70** (Externally)

Note 1 Requirements listed in the table above are in accordance with the Construction Hours listed in Condition C4 and C5.

Note 2 The LAeq is the energy average sound level. It is defined as the steady sound level that contains the same amount of acoustical energy as a given time-varying sound.

3.2.2 Construction Traffic Noise Criteria

For existing residences and other sensitive land uses affected by additional traffic on existing roads, the NSW Road Noise Policy (RNP) states that for noise associated with increased road traffic generated by land use developments, any increase in the total traffic noise level should be limited to 2 dB during both day and night-time periods. An increase of 2 dB represents a minor impact that is considered barely perceptible to the average person.

3.3 Vibration Criteria

Effects of ground borne vibration on buildings may be segregated into the following three categories:

- Human comfort – vibration in which the occupants or users of the building are inconvenienced or possibly disturbed. Refer to further discussion in Section 3.3.1.
- Effects on building contents – where vibration can cause damage to fixtures, fittings and other non-building related objects. Refer to further discussion in Section 3.3.2.
- Effects on building structures – where vibration can compromise the integrity of the building or structure itself. Refer to further discussion in Section 3.3.2.

3.3.1 Vibration Criteria – Human Comfort

Vibration effects relating specifically to the human comfort aspects of the project are taken from the guideline titled "Assessing Vibration – A Technical Guideline". (AVTG) This type of impact can be further categorised and assessed using the appropriate criterion as follows:

- Continuous vibration – from uninterrupted sources (refer to Table 7).

- Impulsive vibration – up to three instances of sudden impact e.g. dropping heavy items, per monitoring period (refer to Table 8).
- Intermittent vibration – such as from drilling, compacting or activities that would result in continuous vibration if operated continuously (refer to Table 9)

Table 7 Continuous vibration acceleration criteria (m/s2) 1 Hz-80 Hz

Location	Assessment period	Preferred Values		Maximum Values	
		z-axis	x- and y-axis	z-axis	x- and y-axis
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 places of worship	Day or night-time	0.020	0.014	0.040	0.028
		0.04	0.029	0.080	0.058
Workshops	Day or night-time	0.04	0.029	0.080	0.058

Table 8 Impulsive vibration acceleration criteria (m/s2) 1 Hz-80 Hz

Location	Assessment period	Preferred Values		Maximum Values	
		z-axis	x- and y-axis	z-axis	x- and y-axis
Residences	Daytime	0.30	0.21	0.60	0.42
	Night-time	0.10	0.071	0.20	0.14
Offices, schools, educational institutions and places of worship	Day or night-time	0.64	0.46	1.28	0.92
Workshops	Day or night-time	0.64	0.46	1.28	0.92

Table 9 Intermittent vibration impacts criteria (m/s1.75) 1 Hz-80 Hz

Location	Daytime		Night-time	
	Preferred Values	Maximum Values	Preferred Values	Maximum Values
Residences	0.20	0.40	0.13	0.26
Offices, schools, educational institutions and places of worship	0.40	0.80	0.40	0.80
Workshops	0.80	1.60	0.8	1.60

3.3.2 Vibration Criteria – Building Contents and Structure

The vibration effects on the building itself are assessed against international standards as follows:

- For transient vibration: British Standard BS 7385: Part 2-1993 "Evaluation and measurement for vibration in buildings Part 2: Guide to damage levels from ground borne vibration" (BSI 1993); and
- For continuous or repetitive vibration: German DIN 4150: Part 3 – 1999 "Effects of Vibration on Structure" (DIN 1999).

3.3.2.1 Standard BS 7385 Part 2 - 1993

For transient vibration, as discussed in standard BS 7385 Part 2-1993, the criteria are based on peak particle velocity (mm/s) which is to be measured at the base of the building. These are summarised in Table 10 and illustrated in Figure 4.

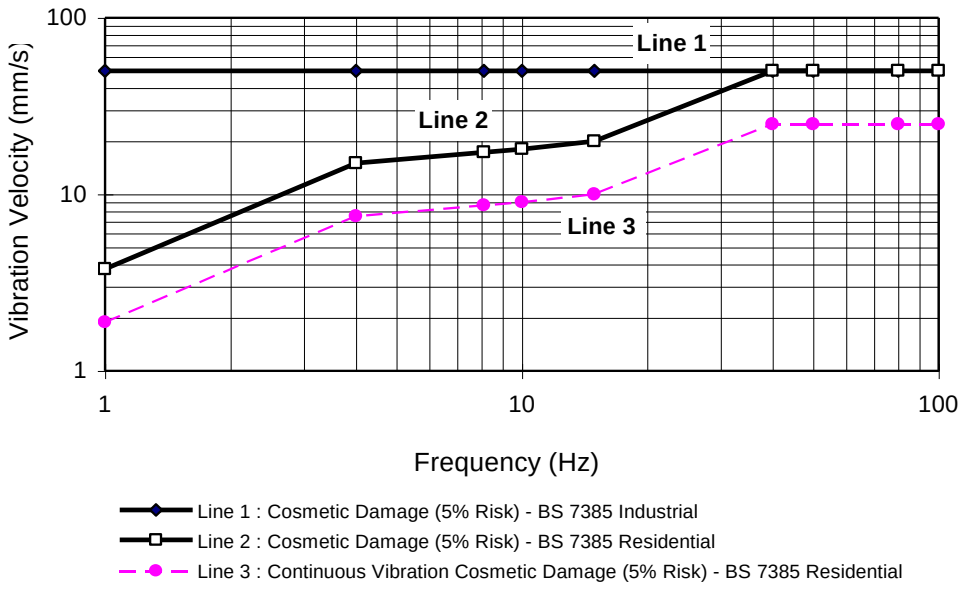
Table 10 Transient vibration criteria as per standard BS 7385 Part 2 - 1993

Line in Figure 4	Type of Building	Peak Component Particle Velocity in Frequency Range of Predominant Pulse	
		4 Hz to 15 Hz	15 Hz and Above
1	Reinforced or framed structures Industrial and heavy commercial buildings	50 mm/s at 4 Hz and above	
2	Unreinforced or light framed structures Residential or light commercial type buildings	15 mm/s at 4 Hz increasing to 20 mm/s at 15 Hz	20 mm/s at 15 Hz increasing to 50 mm/s at 40 Hz and above

Standard BS 7385 Part 2 – 1993 states that the values in Table 10 relate to transient vibration which does not cause resonant responses in buildings.

Where the dynamic loading caused by continuous vibration events is such as that results in dynamic magnification due to resonance (especially at the lower frequencies where lower guide values apply), then the values in Table 10 may need to be reduced by up to 50% (refer to Line 3 in Figure 4).

Figure 4 BS 7385 Part 2 – 1993, graph of transient vibration values for cosmetic damage



In the lower frequency region where strains associated with a given vibration velocity magnitude are higher, the recommended values corresponding to Line 2 are reduced. Below a frequency of 4 Hz where a high displacement is associated with the relatively low peak component particle velocity value, a maximum displacement of 0.6 mm (zero to peak) is recommended. This displacement is equivalent to a vibration velocity of 3.7 mm/s at 1 Hz.

The standard also states that minor damage is possible at vibration magnitudes which are greater than twice those given in Table 10, and major damage to a building structure may occur at values greater than four times the tabulated values.

Fatigue considerations are also addressed in the standard and it is concluded that unless calculation indicates that the magnitude and number of load reversals is significant (in respect of the fatigue life of building materials) then the values in Table 10 should not be reduced for fatigue considerations.

3.3.2.2 Standard DIN 4150 Part 3 - 1999

For continuous or repetitive vibration, standard DIN 4150 Part 3-1999 provides criteria based on values for peak particle velocity (mm/s) measured at the foundation of the building; these are summarised in Table 11. The criteria are frequency dependent and specific to particular categories of structures.

Table 11 Structural damage criteria as per standard DIN 4150 Part 3 - 1999

Type of Structure	Peak Component Particle Velocity, mm/s			
	Vibration at the foundation at a frequency of			Vibration of horizontal plane of highest floor at all frequencies
	1 Hz to 10 Hz	10 Hz to 50 Hz	50 Hz to 100 Hz1	
Buildings used for commercial purposes, industrial buildings and buildings of similar design	20	20 to 40	40 to 50	40
Dwellings and buildings of similar design and/or use	5	5 to 15	15 to 20	15
Structures that, because of their 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 to 8	8 to 10	8
Note 1 For frequencies above 100Hz, at least the values specified in this column shall be applied.				

3.4 Ground-Borne Noise Criteria

According to the NSW EPA Interim Construction Noise Guideline (ICNG) 2009, the criteria for ground-borne noise at residences is defined as follows:

- Maximum internal noise levels of 40 dB $L_{Aeq(15mins)}$ between 6:00pm and 10:00pm.

It is noted that the ground borne criteria will apply for construction works undertaken outside of standard hours.

4 NOISE AND VIBRATION ASSESSMENT

4.1 Construction Noise Assessment

Sound power levels have been predicted for the construction tasks identified in the project program. The equipment anticipated for use in each task is based on previous project experience. The sound power levels for the equipment likely to be used for each of the listed tasks are provided in Table 12 below.

Table 12 Summary of predicted sound power levels

Tasks	Equipment	Sound Power Levels (dBA re 1pW)	Aggregate Sound Power Level per Task (dBA re 1pW)
Site Establishment Works	Mobile crane	110	113
	Power hand tools	109	
	Semi Rigid Vehicle [1]	105	
Ground Works and Demolition	Excavator	112	120
	Hydraulic Hammer	118	
	Piling Rig	110	
	Handheld jack hammer [1]	111	
	Dump truck [1]	104	
	Concrete saw [1]	114	
	Skid steer	110	
	Power hand tools	109	
Structure	Handheld jack hammer [1]	106	117
	Concrete saw [1]	114	
	Power hand tools	109	
	Welder	101	
	Concrete pump truck	110	
	Concrete agitator truck	108	
Internal Works	Power hand tools	109	109
Common and External Works	Concrete agitator truck	108	114
	Saw cutter [1]	104	
	Dump truck [1]	104	
	Concrete saw [1]	114	
	Power hand tools	109	

Note 1 An assumed time correction has been applied, this being 5 minutes of operation in any 15-minute interval.

Note: Predictions to the Shellharbour Anglican College (Receiver 5) an external to internal noise reduction of 20dBA (assuming 6mm float glass installed).

Table 13 Receiver 1 – Summary of predicted construction noise levels

Phase	Activity	Aggregate Sound Power Level (dBA re 1pW)	Predicted Individual Noise Level at Receiver dBA $L_{Aeq\ 15\ minutes}$	Predicted Combined Noise Level at Receiver dBA $L_{Aeq\ 15\ minutes}$	Criteria dBA $L_{Aeq\text{-}15\ minutes}$	Summary of Result
Site Establishment Works	Mobile crane	113	52 to 71	54 to 72	**Standard Construction Hours (As Approved)** Monday to Friday: 7:00am to 6:00pm: • NAFL: **58 dB** • HNAL **75 dB** Saturday: 8:00am to 1:00pm: • NAFL: **58 dB** • HNAL **75 dB**	Works undertaken near the site boundary will exceed the BG +10dBA requirement and in some cases the Highly Noise Affected Level of 75dBA for noisy plant items are operating simultaneously or close to the site boundary. It is recommended that several acoustic mitigation measures are implemented. Refer to Table 20 and following sections below.
	Power hand tools		46 to 65			
	Semi Rigid Vehicle		38 to 56			
Ground Works	Excavator	120	49 to 68	58 to 77		
	Hydraulic Hammer		55 to 74			
	Piling Rig		47 to 66			
	Handheld jack hammer		44 to 62			
	Dump truck		37 to 55			
	Concrete saw		47 to 65			
	Skid steer		47 to 66			
	Power hand tools		46 to 65			
Structure	Handheld jack hammer	117	44 to 62	58 to 77		
	Concrete saw		52 to 70			
	Power hand tools		51 to 70			
	Welder		43 to 62			
	Concrete pump truck		52 to 71			
	Concrete agitator truck		50 to 69			
Internal Works	Power hand tools	109	51 to 70	51 to 70		
Common and External Works	Concrete agitator truck	114	50 to 69	56 to 75		
	Saw cutter		42 to 60			
	Dump truck		42 to 60			
	Concrete saw		52 to 70			
	Power hand tools		51 to 70			

Table 14 Receiver 2 – Summary of predicted construction noise levels

Phase	Activity	Aggregate Sound Power Level (dBA re 1pW)	Predicted Individual Noise Level at Receiver dBA $L_{Aeq\ 15\ minutes}$	Predicted Combined Noise Level at Receiver dBA $L_{Aeq\ 15\ minutes}$	Criteria dBA $L_{Aeq\text{-}15\ minutes}$	Summary of Result
Site Establishment Works	Mobile crane	113	46 to 60	49 to 63	**Standard Construction Hours (As Approved)** Monday to Friday: 7:00am to 6:00pm: • NAFL: **58 dB** • HNAL **75 dB** Saturday: 8:00am to 1:00pm: • NAFL: **58 dB** • HNAL **75 dB**	Works undertaken near the site boundary will exceed the BG +10dBA requirement, however not likely above the Highly Noise Affected Level of 75dBA. It is recommended that several acoustic mitigation measures are implemented. Refer to Table 20 and following sections below.
	Power hand tools		45 to 59			
	Semi Rigid Vehicle		37 to 51			
Ground Works	Excavator	120	48 to 62	57 to 71		
	Hydraulic Hammer		54 to 68			
	Piling Rig		46 to 60			
	Handheld jack hammer		43 to 57			
	Dump truck		36 to 50			
	Concrete saw		46 to 60			
	Skid steer		46 to 60			
	Power hand tools		45 to 59			
Structure	Handheld jack hammer	117	38 to 52	52 to 66		
	Concrete saw		46 to 60			
	Power hand tools		45 to 59			
	Welder		37 to 51			
	Concrete pump truck		46 to 60			
	Concrete agitator truck		44 to 58			
Internal Works	Power hand tools	109	45 to 59	45 to 59		
Common and External Works	Concrete agitator truck	114	44 to 58	50 to 64		
	Saw cutter		36 to 50			
	Dump truck		36 to 50			
	Concrete saw		46 to 60			
	Power hand tools		45 to 59			

Table 15 Receiver 3 – Summary of predicted construction noise levels

Phase	Activity	Aggregate Sound Power Level (dBA re 1pW)	Predicted Individual Noise Level at Receiver dBA $L_{Aeq\ 15\ minutes}$	Predicted Combined Noise Level at Receiver dBA $L_{Aeq\ 15\ minutes}$	Criteria dBA $L_{Aeq\text{-}15\ minutes}$	Summary of Result
Site Establishment Works	Mobile crane	113	44 to 49	47 to 52	**Standard Construction Hours (As Approved)** Monday to Friday: 7:00am to 6:00pm: • NAFL: **58 dB** • HNAL **75 dB** Saturday: 8:00am to 1:00pm: • NAFL: **58 dB** • HNAL **75 dB**	Works undertaken near the site boundary will exceed the BG +10dBA requirement, however not likely above the Highly Noise Affected Level of 75dBA. It is recommended that several acoustic mitigation measures are implemented. Refer to Table 20 and following sections below.
	Power hand tools		43 to 48			
	Semi Rigid Vehicle		35 to 39			
Ground Works	Excavator	120	46 to 51	55 to 6		
	Hydraulic Hammer		52 to 57			
	Piling Rig		44 to 49			
	Handheld jack hammer		41 to 45			
	Dump truck		34 to 38			
	Concrete saw		44 to 48			
	Skid steer		44 to 49			
	Power hand tools		43 to 48			
Structure	Handheld jack hammer	117	36 to 40	50 to 54		
	Concrete saw		44 to 48			
	Power hand tools		43 to 48			
	Welder		35 to 40			
	Concrete pump truck		44 to 49			
	Concrete agitator truck		42 to 47			
Internal Works	Power hand tools	109	43 to 48	43 to 48		
Common and External Works	Concrete agitator truck	114	42 to 47	48 to 53		
	Saw cutter		34 to 38			
	Dump truck		34 to 38			
	Concrete saw		44 to 48			
	Power hand tools		43 to 48			

Table 16 Receiver 4 – Summary of predicted construction noise levels

Phase	Activity	Aggregate Sound Power Level (dBA re 1pW)	Predicted Individual Noise Level at Receiver dBA $L_{Aeq\ 15\ minutes}$	Predicted Combined Noise Level at Receiver dBA $L_{Aeq\ 15\ minutes}$	Criteria dBA $L_{Aeq\text{-}15\ minutes}$	Summary of Result
Site Establishment Works	Mobile crane	113	49 to 72	52 to 75	**Standard Construction Hours (As Approved)** Monday to Friday: 7:00am to 6:00pm: • NAFL: **61 dB** • HNAL **75 dB** Saturday: 8:00am to 1:00pm: • NAFL: **61 dB** • HNAL **75 dB**	Works undertaken near the site boundary will exceed the BG +10dBA requirement and in some cases the Highly Noise Affected Level of 75dBA for noisy plant items are operating simultaneously or close to the site boundary. It is recommended that several acoustic mitigation measures are implemented. Refer to Table 20 and following sections below.
	Power hand tools		48 to 71			
	Semi Rigid Vehicle		39 to 63			
Ground Works	Excavator	120	51 to 74	60 to 83		
	Hydraulic Hammer		57 to 80			
	Piling Rig		49 to 72			
	Handheld jack hammer		45 to 69			
	Dump truck		38 to 62			
	Concrete saw		48 to 72			
	Skid steer		49 to 72			
	Power hand tools		48 to 71			
Structure	Handheld jack hammer	117	40 to 64	54 to 78		
	Concrete saw		48 to 72			
	Power hand tools		48 to 71			
	Welder		40 to 63			
	Concrete pump truck		49 to 72			
	Concrete agitator truck		47 to 70			
Internal Works	Power hand tools	109	48 to 71	48 to 71		
Common and External Works	Concrete agitator truck	114	47 to 70	53 to 76		
	Saw cutter		38 to 62			
	Dump truck		38 to 62			
	Concrete saw		48 to 72			
	Power hand tools		48 to 71			

Table 17 Receiver 5 – Summary of predicted construction noise levels

Phase	Activity	Aggregate Sound Power Level (dBA re 1pW)	Predicted Individual Noise Level at Receiver dBA $L_{Aeq\ 15\ minutes}$ (Note: Predictions Shown Below are Internal)	Predicted Combined Noise Level at Receiver dBA $L_{Aeq\ 15\ minutes}$	Criteria dBA $L_{Aeq\text{-}15\ minutes}$	Summary of Result
Site Establishment Works	Mobile crane	113	44 to 52	44 to 52	**Standard Construction Hours (As Approved)** When in Use: • **45 dB (internal)**	Works undertaken near the site boundary will exceed the NML requirement when working in the boundary closet to the receiver. It is recommended that several acoustic mitigation measures are implemented. Refer to Table 20 and following sections below.
	Power hand tools		23 to 31			
	Semi Rigid Vehicle		14 to 23			
Ground Works	Excavator	120	26 to 34	35 to 43		
	Hydraulic Hammer		32 to 40			
	Piling Rig		24 to 32			
	Handheld jack hammer		20 to 29			
	Dump truck		13 to 22			
	Concrete saw		23 to 32			
	Skid steer		24 to 32			
	Power hand tools		23 to 31			
Structure	Handheld jack hammer	117	15 to 24	29 to 38		
	Concrete saw		23 to 32			
	Power hand tools		23 to 31			
	Welder		15 to 23			
	Concrete pump truck		24 to 32			
	Concrete agitator truck		22 to 30			
Internal Works	Power hand tools	109	23 to 31	23 to 31		
Common and External Works	Concrete agitator truck	114	22 to 30	28 to 36		
	Saw cutter		13 to 22			
	Dump truck		13 to 22			
	Concrete saw		23 to 32			
	Power hand tools		23 to 31			

Table 18 Receiver 6 – Summary of predicted construction noise levels

Phase	Activity	Aggregate Sound Power Level (dBA re 1pW)	Predicted Individual Noise Level at Receiver dBA $L_{Aeq\ 15\ minutes}$	Predicted Combined Noise Level at Receiver dBA $L_{Aeq\ 15\ minutes}$	Criteria dBA $L_{Aeq\text{-}15\ minutes}$	Summary of Result
Site Establishment Works	Mobile crane	113	49 to 64	49 to 64	**Standard Construction Hours (As Approved)** When in Use: • **70 dB (internal)**	All works are predicted to be compliant with the receiver NML.
	Power hand tools		28 to 43			
	Semi Rigid Vehicle		19 to 34			
Ground Works	Excavator	120	31 to 46	40 to 55		
	Hydraulic Hammer		37 to 52			
	Piling Rig		29 to 44			
	Handheld jack hammer		25 to 40			
	Dump truck		18 to 33			
	Concrete saw		28 to 43			
	Skid steer		29 to 44			
	Power hand tools		28 to 43			
Structure	Handheld jack hammer	117	20 to 35	34 to 49		
	Concrete saw		28 to 43			
	Power hand tools		28 to 43			
	Welder		20 to 35			
	Concrete pump truck		29 to 44			
	Concrete agitator truck		27 to 42			
Internal Works	Power hand tools	109	28 to 43	28 to 43		
Common and External Works	Concrete agitator truck	114	27 to 42	33 to 48		
	Saw cutter		18 to 33			
	Dump truck		18 to 33			
	Concrete saw		28 to 43			
	Power hand tools		28 to 43			

4.2 Construction Traffic Noise Review

Direct vehicle access to and from the site is via Dunmore Road, which is subsequently accessed via Shellharbour Road and the Princes Highway.

It is recommended that all vehicle movements (light and heavy) are managed in accordance with the site-specific *Construction Traffic and Pedestrian Management Sub-Plan (CTPMSP)* which should encourage workers to undertake the following:

- Do access residential type streets earlier than required.
- Where possible, park onsite, not on Public Streets (Condition B23).
- Minimise all noise from vehicles when using Public Streets.

4.3 Vibration Assessment

In order to maintain compliance with the human comfort vibration criteria discussed in Section 3.3, it is recommended that the indicative safe distances listed in Table 19 should be maintained. These indicative safe distances should be validated at the start of construction works by undertaking measurements of vibration levels generated by construction and demolition equipment to be used on site.

If applicable, the criteria for scientific or medical equipment (should any of these exist close to the site) can be more stringent than those required for human comfort. Vibration validating measurements should be conducted at each site to determine the vibration level and potential impact to this sensitive equipment.

Additionally, any vibration levels should be assessed in accordance with the criteria discussed in Section 3.3. This information should also be included as part of the CNVMSP.

Table 19 Recommended Safe Working Distances

Plant	Rating / Description	Safe Working Distances (m)	
		Cosmetic Damage (BS 7385: Part 2 DIN 4150: Part 3)	Human Comfort (AVTG)
Vibratory roller	< 50 kN (Typically 1 – 2 tonnes)	5	15 – 20
	< 100 kN (Typically 2 – 4 tonnes)	6	20
	< 200 kN (Typically 4 – 6 tonnes)	12	40
	< 300 kN (Typically 7 – 13 tonnes)	15	100
	> 300 kN (Typically more than 13 tonnes)	20	100
Small hydraulic hammer	300 kg, typically 5 – 12 tonnes excavator	2	7
Medium hydraulic hammer	900 kg, typically 12 – 18 tonnes excavator	7	23
Large hydraulic hammer	1600 kg, typically 18 – 34 tonnes excavator	22	73
Vibratory pile driver	Sheet piles	2 – 20	20
Jackhammer	Hand held	1	Avoid contact with structure and steel reinforcements

5 NOISE AND VIBRATION MANAGEMENT PLAN

5.1 Acoustic Management Procedures

5.1.1 Summary of Management Procedures

Table 20 below summarises the management procedures recommended for airborne noise and vibration impacts. These procedures are also further discussed in the report. Hence, where applicable, links to further references are provided in Table 20.

Table 20 Summary of mitigation procedures

Procedure	Abbreviation	Description	Further Reference
General Management Measures	GMM	Introduce best-practice general mitigation measures in the workplace which are aimed at reducing the acoustic impact onto the nearest affected receivers.	Refer to Section 5.10 For noise impact, also refer to Section 5.2 For vibration impact, also refer to Section 5.3
Project Notification	PN	Issue project updates to stakeholders, discussing overviews of current and upcoming works. Advanced warning of potential disruptions can be included. Content and length to be determined on a project-by-project basis.	Refer to Section 5.4.
Verification Monitoring	V	Monitoring to comprise attended or unattended acoustic surveys. The purpose of the monitoring is to confirm measured levels are consistent with the predictions in the acoustic assessment, and to verify that the mitigation procedures are appropriate for the affected receivers. If the measured levels are higher than those predicted, then the measures will need to be reviewed and the management plan will need to be amended.	For noise impact, refer to Section 5.2.3. For vibration impact, refer to Section 5.3.2
Complaints Management System	CMS	Refer to Health Infrastructure NSW Complaint Management Procedures.	Refer to Section 5.5 and 5.6.
Specific Notification	SN	Refer to site specific notifications strategy.	Refer to Section 5.4.
Respite Offer	RO	Offer provided to stakeholders subjected to an ongoing impact.	Refer to Section 5.2.1
Alternative Construction Methodology	AC	Contractor to consider alternative construction options that achieve compliance with relevant criteria. Alternative option to be determined on a case-by-case basis. It is recommended that the selection of the alternative option should also be determined by considering the assessment of on-site measurements (refer to Verification Monitoring above).	Refer to Section 5.10.1 and 5.10.2

The application of these procedures is in relation to the exceedances over the relevant criteria. For airborne noise, the criteria are based on NMLs. The allocation of these procedures is discussed in Section 5.1.2

For vibration, the criteria either correspond to human comfort, building damage or scientific and medical equipment. The application of these procedures is discussed in Section 5.1.3.

5.1.2 Allocation of Noise Management Procedures

For residences, the management procedures have been allocated based on noise level exceedances at the affected properties, which occur over the designated NMLs (refer to Section 3). The allocation of these procedures is summarised in Table 21 below.

Table 21 Allocation of noise management procedures – residential receivers

Construction Hours	Exceedance over NML (dB)	Management Procedures (see definition above)
Standard Hours Mon – Fri: 7:00 am to 6:00 pm Sat: 8:00 am – 1:00 pm	0 - 3	GMM
	4 - 10	GMM, PN, V 1, CMS, AC
	> 10	GMM, PN, V, CMS, SN, AC
	≥ 75dBA	GMM, PN, V, CMS, SN, AC, RO
Note 1 Verification monitoring to be undertaken upon complaints received from affected receivers		

Please note the following regarding the allocation of these procedures:

- The exceedances have been estimated as part of the acoustic assessment, and these are summarised in Section 4.1
- The allocation of procedures is based on the assumptions used for noise level predictions (refer to Section 4.1). Consequently, these allocations can be further refined once onsite works are undertaken and further development of the construction program.

5.1.3 Allocation of Vibration Management Procedures

Table 22 below summarises the vibration management procedures to be adopted based on exceedance scenarios (i.e., whether the exceedance occurs over human comfort criteria, building damage criteria, or criteria for scientific and medical equipment). Please note these management procedures apply for any type of affected receiver (i.e., for residences as well as non-residential receivers).

Table 22 Allocation of vibration management procedures

Construction Hours	Exceedance Scenario	Management Procedures
Standard Hours Mon – Fri: 7:00 am to 6:00 pm Sat: 8:00 am – 1:00 pm	Over human comfort criteria (refer to Section 3)	GMM, PN, V, RO
	Over building damage criteria (refer to Section 3)	GMM, V, AC, RO

5.2 Site Specific Noise Mitigation Measures

5.2.1 Respite Periods

Predicted noise levels outlined in Section 4.1 indicate that in some cases when works are being undertaken within proximity of receiver boundaries, exceedances above the Noise Management Levels (NMLs) may occur. In addition, in accordance with Condition C8 respite periods are recommended for noisy activities. As such the following respite conditions are recommended in accordance with C8 or when works extended periods of noisy works are affecting a surrounding receiver above the HNAL of 75dBA. See below.

Table 23 Recommended Respite Periods

Monday to Friday	Saturday
7:00am to 9:00am – No rock breaking, rock hammering, sheet piling, pile driving and similar activities. (Respite Period)	**8:00am to 9:00am – No rock breaking, rock hammering, sheet piling, pile driving and similar activities. (Respite Period)**
9:30am to 12:00pm – Works	9:00am to 12:00pm – Works
12:00pm to 2:00pm – No rock breaking, rock hammering, sheet piling, pile driving and similar activities. (Respite Period)	**12:00pm to 1:00pm – No rock breaking, rock hammering, sheet piling, pile driving and similar activities. (Respite Period)**
2:00pm to 5:00pm – Works	
5:00pm to 6:00pm – No rock breaking, rock hammering, sheet piling, pile driving and similar activities. (Respite Period)	

Note: Recommended respite periods for noisy works has been formulated in accordance with Condition C8 from the Notice of Determination – Approval.

5.2.2 General Comments

The contractor will, where reasonable and feasible, apply best practice noise mitigation measures. These measures shall include the following:

- Maximising the offset distance between plant items and nearby noise sensitive receivers.
- Preventing noisy plant working simultaneously and adjacent to sensitive receivers.
- Minimising consecutive works in the same site area.
- Orienting equipment away from noise sensitive areas.
- Carrying out loading and unloading away from noise sensitive areas.

In order to minimise noise impacts during the works, the contractor will take all reasonable and feasible measures to mitigate noise effects.

The contractor will also take reasonable steps to control noise from all plant and equipment. Examples of appropriate noise control include efficient silencers and low noise mufflers.

The contractor should apply all feasible and reasonable work practices to meet the NMLs and inform all potentially impacted residents of the nature of works to be carried out, the expected noise levels, duration of noise generating construction works, and the contact details for the proposal.

5.2.3 Noise Monitoring

Unattended noise monitoring is proposed to be undertaken by the contractor as a process for providing regular feedback with regards to the management of construction noise levels. Unattended noise monitoring will be targeted for high noise generating works.

It is recommended that a combined four (4) sets of dust/vibration/acoustic monitors along the eastern Dunmore Road and northern Shellharbour Anglican College site frontages for the duration of the Works, to provide continuous real time monitoring and reporting of levels.

In addition, attended noise measurements may be undertaken from time to time to supplement the unattended monitoring.

The system which is proposed for the unattended noise monitoring results will be accessible by the project team via an online portal and monitored by the project acoustic consultant to provide real-time feedback with notifications and data analysis.

The survey methodology and equipment will comply with the monitoring requirements as discussed in Australian Standard AS 1055.1-1997.

All onsite measurements will be undertaken to investigate compliance against the noise management levels (NML's) which are formulated in section 3 above (i.e., Project Approval and NSW EPA ICNG).

The location of the monitors will be determined by the location and type of works being undertaken on each site, and will be reviewed monthly, or as work location and type progresses (whichever is first). Due to the extent of works area and the complex nature of the project sequencing, several monitors may be required throughout the duration of the project.

Monthly reporting is recommended to be undertaken which should include the following noise descriptors: LA90 and L_{Aeq}.

In the case of an exceedance, the unattended automated system will alert the project team, who will be able to begin an immediate investigation by use the project's "Noise and Vibration Investigation Checklist" (see Appendix A). This checklist will be used by the project team to determine the appropriate course of action which may or may not include involvement from the project's Acoustic Consultant. A summary of the available alternate mitigation measures will be provided as part of the monthly report. However, we do note in some cases alternate methodologies may not be available or cannot be implemented due to other project constraints.

5.2.4 Noise Mitigation Measures for Non-Residential Receivers

Where exceedances have been identified in Section 4, the following mitigation measures are recommended:

- Undertake general mitigation measures as discussed in Section 5.10.
- Issue project updates to tenants in affected premises. The updates can include overview of current and upcoming works, as well as advanced warning of potential disruptions.

- Signage to be posted in order to provide stakeholders information regarding project details, emergency contacts and enquiry contact information.

5.2.5 Alternate Equipment or Process

Exceedance of the site's NMLs should result in an investigation as to whether alternate equipment could be used, or a difference process could be undertaken.

In some cases, the investigation may conclude that the use of other equipment is not possible, however, a different process could be undertaken.

5.2.6 Acoustic Enclosures/Screening

Typically, on a construction site there are three different types of plant that will be used: mobile plant (i.e., excavators, skid steers, etc.), semi mobile plant (i.e., hand tools generally) or static plant (i.e., diesel generators).

For plant items which are static it is recommended that, in the event exceedances are being measured due to operation of the plant item, an acoustic enclosure/screen is constructed to reduce impacts. These systems can be constructed from Fibre Cement (FC) sheeting or, if airflow is required, acoustic attenuators or louvres.

For semi mobile plant, relocation of plant should be investigated to either be operated in an enclosed space or at locations away from a receiver.

With mobile plant it is generally not possible to treat these sources. However, investigations into the machine itself may result in a reduction of noise (i.e., mufflers/attenuators etc).

5.2.7 Tower Cranes

Three (3) permeant site cranes are proposed, all tower cranes will be diesel type tower cranes. Information for each of the three (3) cranes are provided below:

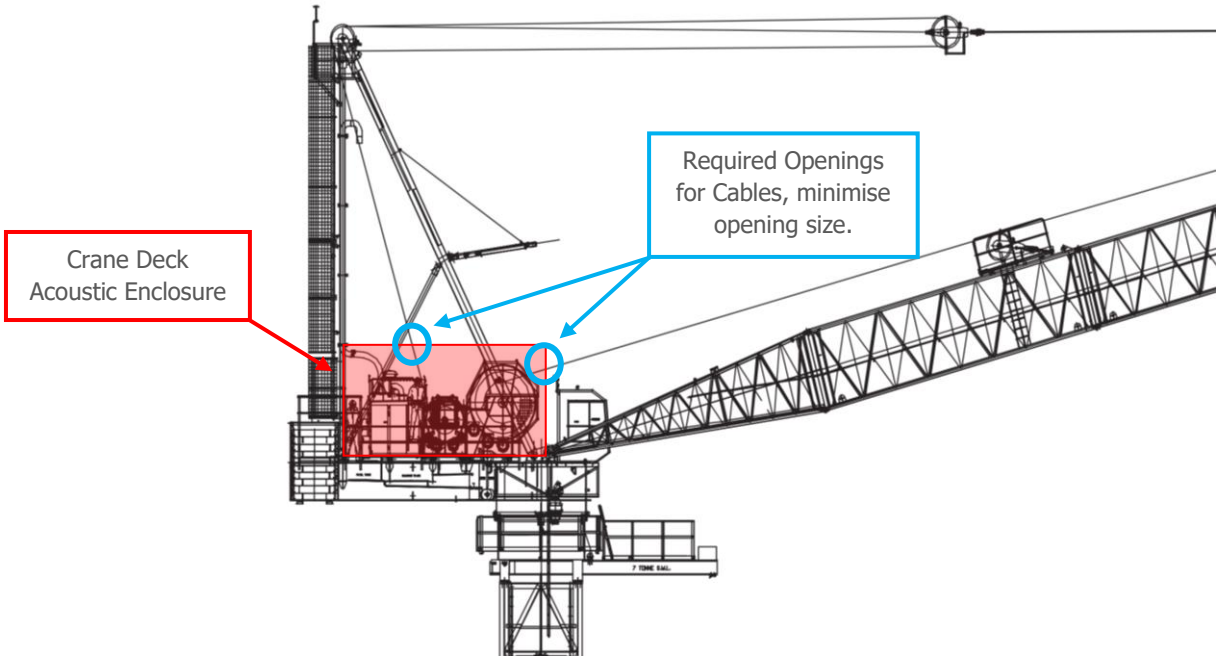
- TC1 (Tower Crane 1) – Favelle Favco M630D Tower Crane.
- TC2 (Tower Crane 2) – Favelle Favco M390D Tower Crane.
- TC3 (Tower Crane 3) – Exact details of this crane are not known at this stage. However, it is known that it will be an electric crane. For the purposes of this assessment a typical noise level for an electric crane has been assumed.

Based on the crane selections above the following the following is noted:

- Electric cranes are generally quieter than diesel-based cranes and wouldn't require any additional acoustic mitigations. Should these cranes require ground-based diesel generators for backup, acoustic enclosures/screens are to be provided. Refer to section 5.2.6 above.
- Crane Sound Power Levels (Lw) for electric cranes should not exceed:
    - TC1: 102 dBA.
    - TC2: 107 dBA.
    - TC3: 107 dBA.

- **Prior to the installation of all tower cranes, crane contractor to provide evidence the noise emitted from the use of the crane will not exceed a Sound Power Level (Lw) as per above.**
- In the event the noise levels from the cranes are greater than those presented above the following is recommended:
    - Acoustic treatment to the engine muffler is to include an acoustic silencer providing the required noise reduction to meet the nominated Sound Power Levels (Lw) as listed above.
    - An acoustic enclosure is to be constructed on the crane deck which encloses the engine and cable barrel is to be constructed from 1 x 9mm Fibre Cement Sheeting (or similar), as per the example detail below. If possible, internally line the inside of the acoustic enclosure with a 50mm thick acoustic absorbing material (equal to Megasorber FM panel). Noting there will be an opening required for the cable openings.
    - Ventilation openings shall be acoustically treated to ensure the acoustic enclosure is not compromised because of an untreated opening.

Figure 5 Crane Acoustic Enclosure (Example Treatment)



5.3 Vibration Mitigation Measures

5.3.1 General Comments

As part of the CNVMSP, the following vibration mitigation measures should be implemented:

- Any vibration generating plant and equipment is to be in areas within the site in order to lower the vibration impacts.
- Investigate the feasibility of rescheduling the hours of operation of major vibration generating plant and equipment.

- Use lower vibration generating items of construction plant and equipment; that is, smaller capacity plant, where feasible
- Minimise conducting vibration generating works consecutively in the same area (if applicable).
- Schedule a minimum respite period in accordance with Condition C8.

5.3.2 Vibration Monitoring

Like the methodology outlined for the noise monitoring above, unattended vibration monitoring is proposed to be undertaken by the contractor as a process for providing regular feedback with regards to the management levels. In addition, attended vibration measurements may be undertaken from time to time to supplement the unattended monitoring.

It is recommended that a combined four (4) sets of dust/vibration/acoustic monitors along the eastern Dunmore Road and northern Shellharbour Anglican College site frontages for the duration of the Works, to provide continuous real time monitoring and reporting of levels.

The vibration monitoring results will also be accessible by the project team via an online portal and monitored by the project acoustic consultant.

All vibration measurements are to be undertaken in accordance with the methodologies outlined in British Standard 7385-1:1990 Evaluation and measurement for vibration in buildings, DIN V 4150-1 Vibrations in Building; Influence On Persons In Buildings and DIN 4150-1 Effects On Structures.

The monitoring locations would be on a stiff part of the structure (at the foundation) on the side of the structure adjacent to the subject demolition and construction works, or in a suitable location at the site boundary.

Unattended monitoring systems will be configured to record the peak vibration levels and to trigger an alarm when predetermined vibration thresholds are exceeded. The thresholds correspond to an "Operator Warning Level" and an "Operator Halt Level", where the Warning Level is 75% of the Halt Level. The Halt Level should be determined based on the vibration criteria for building contents and structure (refer to Section 2).

Exceedance of the "Operator Warning Level" would not require excavation or demolition work to cease, but rather, alerts the site manager to proceed with caution at a reduced force or load.

An exceedance of the "Operator Halt Level" would require the contractor to implement an alternative excavation technique pending further analysis of the vibration frequency content in order to determine any potential exceedance of the criteria.

The location of the monitors will be determined by the location and type of works being undertaken on each site, and will be reviewed monthly, or as work location and type progresses (whichever is first). Due to the extent of works and the complex nature of the project sequence, several monitors will be required throughout the duration of the project.

If an exceedance above the management criteria is identified, an alert will be issued to the project team, who will assess whether it is at a 'Warning' or a 'Halt' level. If it is a 'Halt' level exceedance, the project team will complete a Noise and Vibration Investigation Checklist (see Appendix C) to determine the appropriate course of action. A summary of the available alternate mitigation measures is to be provided as part of the monthly report. However, we do note in some cases alternate methodologies may not be available or cannot be implemented due to other project constraints.

5.4 Community Consultation

Active community consultation and the maintenance of positive relations with local residents and businesses would assist in alleviating concerns and thereby minimising complaint. It is common for construction projects to provide community consultation if an exceedance of noise goals has been predicted. This communication is commonly conducted in the form of a letter box drop or more active engagement with more highly impacted receivers.

This form of notification should provide specific notification of the duration and timing of the construction activities so that residents are informed about the proposed works ahead of time. The letter should also provide the community with a hotline number for a community liaison officer available to adequately respond to all project related enquiries.

Ideally the hotline number should provide concerned locals an opportunity to raise any concerns with the project proponent and provide an opportunity to determine the best method to satisfy all requirements.

Prior to the works onsite being undertaken, it is recommended that community consultation with the neighbouring affected parties be undertaken.

The communication however should not be limited to the beginning of the onsite works but throughout providing the community with constant updates to the progress and upcoming works. In our experience these could include:

- Site noticeboard.
- Email notifications; and
- Letterbox drops.

5.5 Complaints Management System

Should complaints arise they must be delt with in a responsible and uniform manner, therefore a management system to deal with complaints is detailed above.

5.6 Contingency Plans

Contingency plans are required to address noise or vibration problems if excessive levels are measured at surrounding sensitive receivers and/or if justified complaints occur. Such plans include:

- Stop the onsite works.
- Identify the source of the main equipment within specific areas of the site which is producing the most construction noise and vibration at the sensitive receivers; and
- Review the identified equipment and determine if an alternate piece of equipment can be used or the process can be altered.
- In the event an alternate piece of equipment or process can be used, works can re-commence.
- In the event an alternate piece of equipment or process cannot be determined implement a construction assessment to be performed by a suitably qualified acoustic consultant.

The Superintendent shall have access to view the Contractor's noise measurement records on request. The Superintendent may undertake noise monitoring if and when required.

5.7 Community Engagement (Condition B16, (d) & (e))

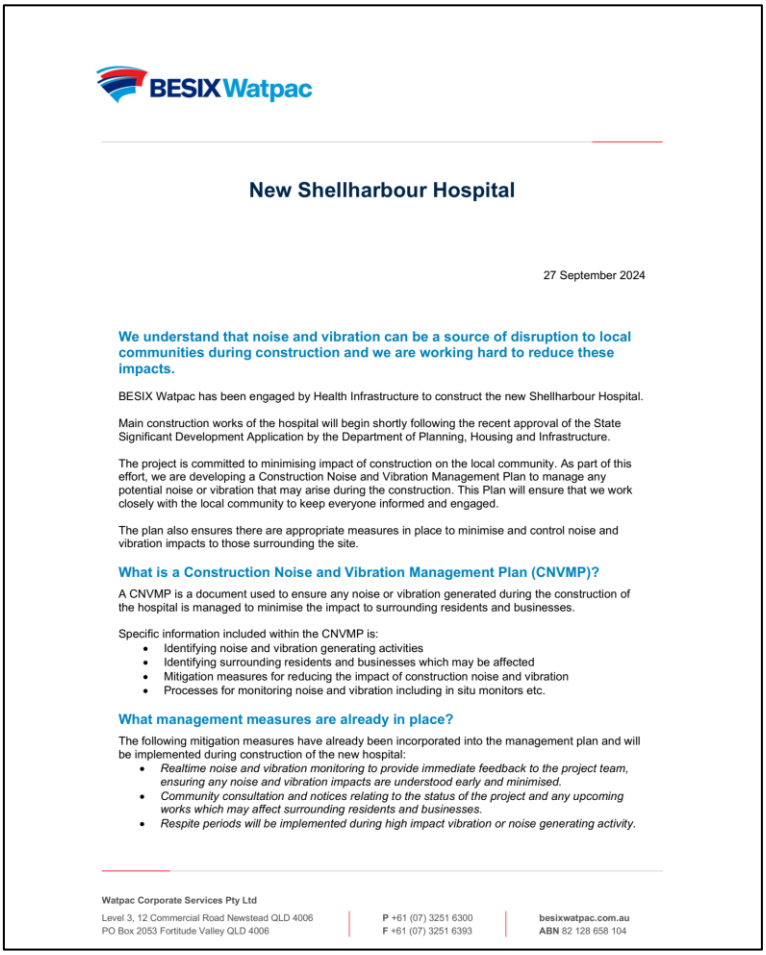
In addressing the requirement for the community consultation when formulating onsite noise and vibration mitigation measures in accordance with Condition B16(d) and (e) we note the following:

- Condition B16(d) reads:

  Condition B16(d) – "Strategies that have been developed with the community for managing high noise generating works."

- Health Infrastructure NSW prepared and issued the following letter which was distributed to nearby residential properties around the site via a letter box drop. This letter was distributed late 27th September 2024.

Figure 6 BESIX Watpac Community Letter – Construction Noise and Vibration Mitigation Input (Page 1)



BESIX Watpac

New Shellharbour Hospital

27 September 2024

We understand that noise and vibration can be a source of disruption to local communities during construction and we are working hard to reduce these impacts.

BESIX Watpac has been engaged by Health Infrastructure to construct the new Shellharbour Hospital.

Main construction works of the hospital will begin shortly following the recent approval of the State Significant Development Application by the Department of Planning, Housing and Infrastructure.

The project is committed to minimising impact of construction on the local community. As part of this effort, we are developing a Construction Noise and Vibration Management Plan to manage any potential noise or vibration that may arise during the construction. This Plan will ensure that we work closely with the local community to keep everyone informed and engaged.

The plan also ensures there are appropriate measures in place to minimise and control noise and vibration impacts to those surrounding the site.

What is a Construction Noise and Vibration Management Plan (CNVMP)?

A CNVMP is a document used to ensure any noise or vibration generated during the construction of the hospital is managed to minimise the impact to surrounding residents and businesses.

Specific information included within the CNVMP is:

- Identifying noise and vibration generating activities
- Identifying surrounding residents and businesses which may be affected
- Mitigation measures for reducing the impact of construction noise and vibration
- Processes for monitoring noise and vibration including in situ monitors etc.

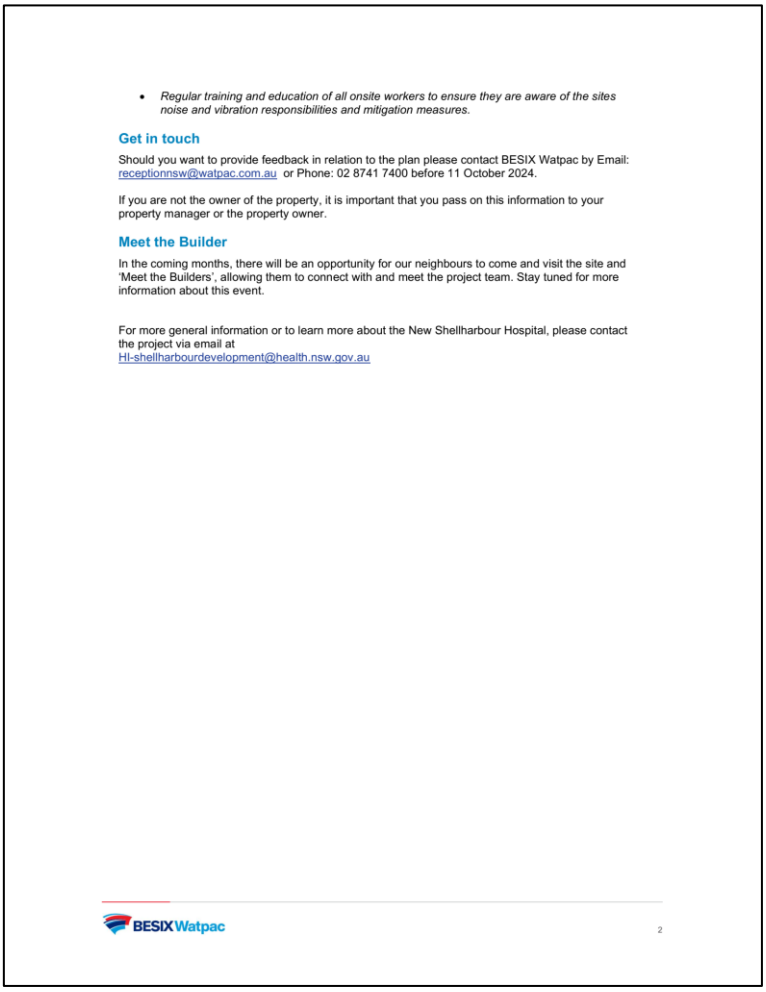
What management measures are already in place?

The following mitigation measures have already been incorporated into the management plan and will be implemented during construction of the new hospital:

- *Realtime noise and vibration monitoring to provide immediate feedback to the project team, ensuring any noise and vibration impacts are understood early and minimised.*
- *Community consultation and notices relating to the status of the project and any upcoming works which may affect surrounding residents and businesses.*
- *Respite periods will be implemented during high impact vibration or noise generating activity.*

Watpac Corporate Services Pty Ltd
Level 3, 12 Commercial Road Newstead QLD 4006
PO Box 2053 Fortitude Valley QLD 4006
P +61 (07) 3251 6300
F +61 (07) 3251 6393
besixwatpac.com.au
ABN 82 128 658 104

Figure 7 BESIX Watpac Community Letter – Construction Noise and Vibration Mitigation Input (Page 2)



- *Regular training and education of all onsite workers to ensure they are aware of the sites noise and vibration responsibilities and mitigation measures.*

Get in touch

Should you want to provide feedback in relation to the plan please contact BESIX Watpac by Email: receptionnsw@watpac.com.au or Phone: 02 8741 7400 before 11 October 2024.

If you are not the owner of the property, it is important that you pass on this information to your property manager or the property owner.

Meet the Builder

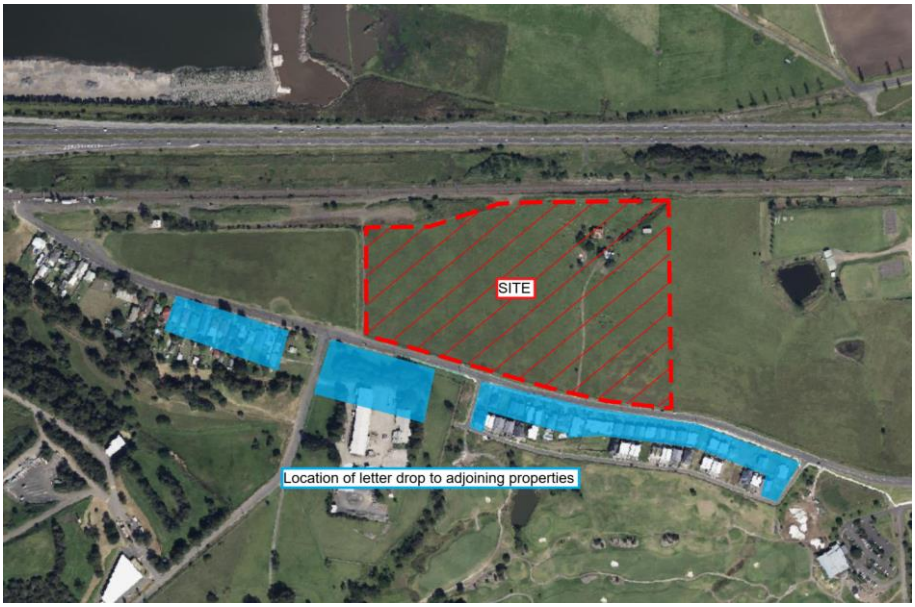
In the coming months, there will be an opportunity for our neighbours to come and visit the site and 'Meet the Builders', allowing them to connect with and meet the project team. Stay tuned for more information about this event.

For more general information or to learn more about the New Shellharbour Hospital, please contact the project via email at HI-shellharbourdevelopment@health.nsw.gov.au

BESIX Watpac

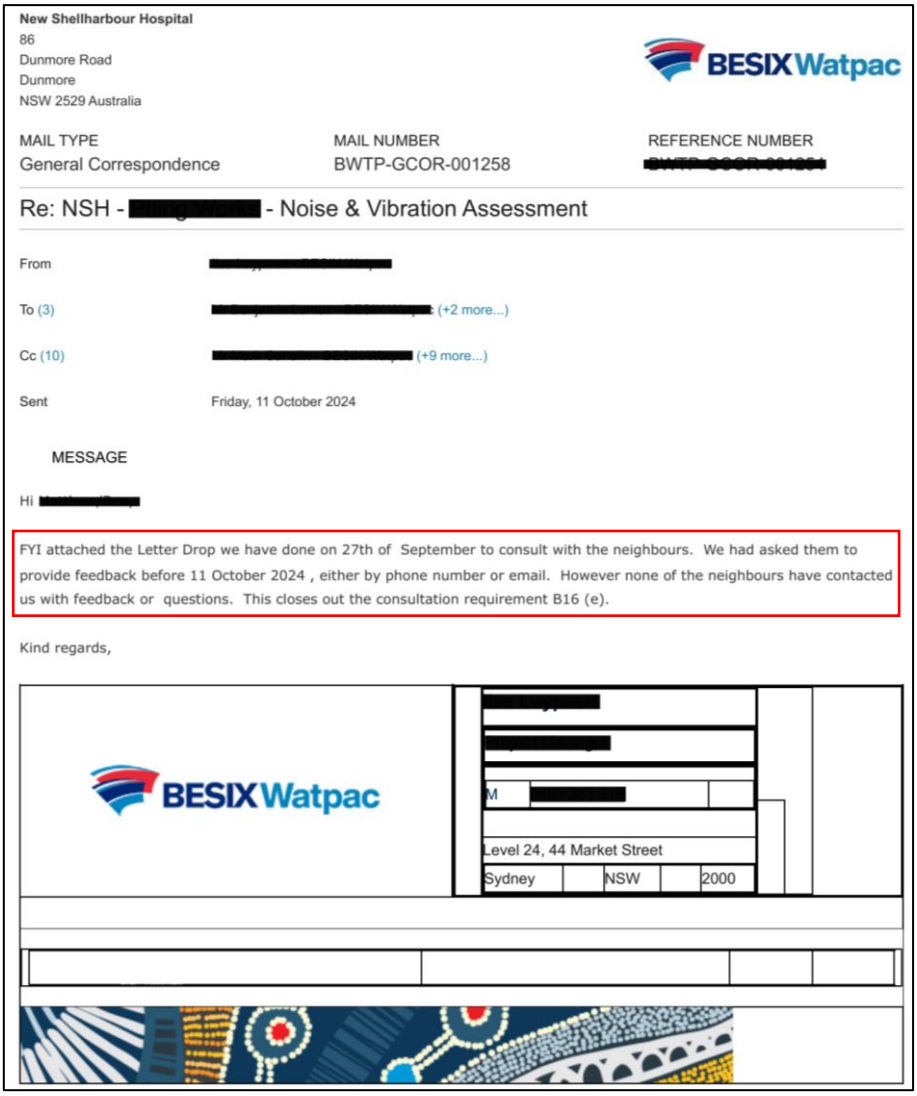
2

Figure 8 Location of Letter Drop



- No community responses were received in response to the letter box drop. See below.

Figure 9 Health Infrastructure Response Condition B16(d) & (e)



New Shellharbour Hospital
86
Dunmore Road
Dunmore
NSW 2529 Australia

BESIX Watpac

MAIL TYPE	MAIL NUMBER	REFERENCE NUMBER
General Correspondence	BWTP-GCOR-001258	[redacted]

Re: NSH - [redacted] - Noise & Vibration Assessment

From [redacted]

To (3) [redacted] (+2 more...)

Cc (10) [redacted] (+9 more...)

Sent Friday, 11 October 2024

MESSAGE

Hi [redacted]

FYI attached the Letter Drop we have done on 27th of September to consult with the neighbours. We had asked them to provide feedback before 11 October 2024 , either by phone number or email. However none of the neighbours have contacted us with feedback or questions. This closes out the consultation requirement B16 (e).

Kind regards,

BESIX Watpac

[redacted]
M [redacted]
Level 24, 44 Market Street
Sydney NSW 2000

- Based on no responses been received, no further additional mitigation measures were development with the Community.
- **Notwithstanding above, Condition B16(d) and (e) have been satisfied.**

5.8 Complaints Management System

Should complaints arise they must be dealt with in a responsible and uniform manner, therefore, a management system to deal with complaints is detailed above through Health Infrastructure NSW.

5.9 Contingency Plans

Contingency plans are required to address noise or vibration problems if excessive levels are measured at surrounding sensitive receivers and/or if justified complaints occur. Such plans include:

- Stop the onsite works.
- Identify the source of the main equipment within specific areas of the site which is producing the most construction noise and vibration at the sensitive receivers; and
- Review the identified equipment and determine if an alternate piece of equipment can be used or the process can be altered.
- In the event an alternate piece of equipment or process can be used, works can re-commence.
- In the event an alternate piece of equipment or process cannot be determined implement a construction assessment to be performed by a suitably qualified acoustic consultant.

The Superintendent shall have access to view the Contractor's noise measurement records on request. The Superintendent may undertake noise monitoring if and when required.

5.10 General Mitigation Measures (Australia Standard 2436-2010)

As well as the above project specific noise mitigation controls, AS 2436-2010 "Guide to Noise and Vibration Control on Construction, Demolition and Maintenance Sites" sets out numerous practical recommendations to assist in mitigating construction noise emissions. Examples of strategies that could be implemented on the subject project are listed below, including the typical noise reduction achieved, where applicable.

5.10.1 Adoption of Universal Work Practices

- Regular reinforcement (such as at toolbox talks) of the need to minimise noise and vibration.
- Regular identification of noisy activities and adoption of improvement techniques.
- Avoiding the use of portable radios, public address systems or other methods of site communication that may unnecessarily impact upon nearby sensitive receivers.
- Where possible, avoiding the use of equipment that generates impulsive noise.
- Minimising the need for vehicle reversing for example (particularly at night), by arranging for one-way site traffic routes.
- Use of broadband audible alarms on vehicles and elevating work platforms used on site.
- Minimising the movement of materials and plant and unnecessary metal-on-metal contact.
- Minimising truck movements.

5.10.2 Plant and Equipment

- Choosing quieter plant and equipment based on the optimal power and size to most efficiently perform the required tasks.
- Selecting plant and equipment with low vibration generation characteristics, where feasible.
- Operating plant and equipment in the quietest and most efficient manner.

5.10.3 On Site Noise Mitigation

- Maximising the distance between noise activities and noise sensitive land uses.
- Installing purpose-built noise barriers, acoustic sheds and enclosures around static plant.

5.10.4 Work Scheduling

- Providing respite periods which could include restricting very noisy activities to time periods that least affect the nearby noise sensitive locations, restricting the number of nights that after-hours work is conducted near residences or by determining any specific requirements.
- Scheduling work to coincide with non-sensitive periods.
- Planning deliveries and access to the site to occur quietly and efficiently and organising parking only within designated areas located away from the sensitive receivers.
- Optimising the number of deliveries to the site by amalgamating loads where possible and scheduling arrivals within designated hours.
- Including contract conditions that include penalties for non-compliance with reasonable instructions by the principal to minimise noise or arrange suitable scheduling.

5.10.5 Source Noise Control Strategies

Some ways of controlling noise at the source are:

- Where reasonably practical, noisy plant or processes should be replaced by less noisy alternatives.
- Modify existing equipment: Engines and exhausts are typically the dominant noise sources on mobile plant such as cranes, graders, excavators, trucks, etc. In order to minimise noise emissions, residential grade mufflers should be fitted on all mobile plant utilised on site.
- Siting of equipment: locating noisy equipment behind structures that act as barriers, or at the greatest distance from the noise-sensitive area; or orienting the equipment so that noise emissions are directed away from any sensitive areas, to achieve the maximum attenuation of noise.
- Regular and effective maintenance.

5.10.6 Miscellaneous Comments

- Deliveries should be undertaken, where possible, during standard construction hours.
- Maximise hammer penetration (and reduce blows) by using sharp hammer tips. Keep stocks of sharp profiles at site and monitor the profiles in use.
- "As per Consent Condition C15, where practicable, the use of "quackers" will be used to ensure noise impacts on surrounding noise sensitive receivers are minimised. This will not be implemented where it is deemed the use of quackers (as opposed to standard vehicle notification devices) would compromise the safety of construction staff or members of the public.
- No public address system should be used on site (except for emergency purposes).

6 CONCLUSION

Pulse White Noise Acoustics (PWNA) has been engaged by BESIX Watpac (NSW) Pty Ltd to prepare a site-specific Construction Noise and Vibration Management Sub-Plan (CNVMSP) for the construction of the new New Shellharbour Hospital (NSH) to be constructed at 86 Dunmore Road, Dunmore NSW (Lot 10 DP 1281639.

This CNVMSP has been prepared to satisfy the requirements of Conditions B16 of the consent conditions presented to this office given in the Notice of Determination – Approval issued for Development Application No. SSD-57064458, dated 12th August 2024.

An assessment of noise and vibration impacts from the required processes to be undertaken during the construction period of the project (including excavation and construction) has been undertaken and suitable treatments, management controls, perioding measurements and community engagement has been detailed in this report.

Providing the recommendations in this report are included in the construction of the site, compliance with the relevant EPA's Interim Construction Noise Guideline Objectives and condition B16 of the projects *Conditions of Consent* can be achieved.

For any additional information please do not hesitate to contact the person below.

Regards

Matthew Furlong
Principal Acoustic Engineer (MAAS & AAAC Members)
Pulse White Noise Acoustics

APPENDIX A. APPENDIX A. ACOUSTIC TERMINOLOGY

The following is a brief description of the acoustic terminology used in this report:

Ambient Sound	The totally encompassing sound in a given situation at a given time, usually composed of sound from all sources near and far.
Audible Range	The limits of frequency which are audible or heard as sound. The normal ear in young adults detects sound having frequencies in the region 20 Hz to 20 kHz, although it is possible for some people to detect frequencies outside these limits.
Character, acoustic	The total of the qualities making up the individuality of the noise. The pitch or shape of a sound's frequency content (spectrum) dictate a sound's character.
Decibel [dB]	The level of noise is measured objectively using a Sound Level Meter. The following are examples of the decibel readings of every day sounds; 0dB the faintest sound we can hear 30dB a quiet library or in a quiet location in the country 45dB typical office space. Ambience in the city at night 60dB Martin Place at lunch time 70dB the sound of a car passing on the street 80dB loud music played at home 90dB the sound of a truck passing on the street 100dB the sound of a rock band 115dB limit of sound permitted in industry 120dB deafening
dB(A)	*A-weighted decibels* The ear is not as effective in hearing low frequency sounds as it is hearing high frequency sounds. That is, low frequency sounds of the same dB level are not heard as loud as high frequency sounds. The sound level meter replicates the human response of the ear by using an electronic filter which is called the "A" filter. A sound level measured with this filter switched on is denoted as dB(A). Practically all noise is measured using the A filter. The sound pressure level in dB(A) gives a close indication of the subjective loudness of the noise.
Frequency	Frequency is synonymous to *pitch*. Sounds have a pitch which is peculiar to the nature of the sound generator. For example, the sound of a tiny bell has a high pitch and the sound of a bass drum has a low pitch. Frequency or pitch can be measured on a scale in units of Hertz or Hz.
Loudness	A rise of 10 dB in sound level corresponds approximately to a doubling of subjective loudness. That is, a sound of 85 dB is twice as loud as a sound of 75 dB which is twice as loud as a sound of 65 dB and so on
LMax	The maximum sound pressure level measured over a given period.
LMin	The minimum sound pressure level measured over a given period.
L1	The sound pressure level that is exceeded for 1% of the time for which the given sound is measured.
L10	The sound pressure level that is exceeded for 10% of the time for which the given sound is measured.
L90	The level of noise exceeded for 90% of the time. The bottom 10% of the sample is the L_{90} noise level expressed in units of dB(A).
Leq	The "equivalent noise level" is the summation of noise events and integrated over a selected period of time.
dB (A)	'A' Weighted overall sound pressure level
Sound Pressure Level, LP dB	A measurement obtained directly using a microphone and sound level meter. Sound pressure level varies with distance from a source and with changes to the measuring environment. Sound pressure level equals 20 times the logarithm to the base 10 of the ratio of the rms sound pressure to the reference sound pressure of 20 micro Pascals.

Sound Power Level, Lw dB	Sound power level is a measure of the sound energy emitted by a source, does not change with distance, and cannot be directly measured. Sound power level of a machine may vary depending on the actual operating load and is calculated from sound pressure level measurements with appropriate corrections for distance and/or environmental conditions. Sound power levels is equal to 10 times the logarithm to the base 10 of the ratio of the sound power of the source to the reference sound power of 1 picoWatt

APPENDIX B. PWNA UNATTENDED NOISE MONITORING – AUGUST 2024

86 Dunmore Road, Dunmore (Boundary)

Ambient noise monitoring report

Item	Information
Logger Type	NL-42
Serial number	998081
Address	86 Dunmore Road, Dunmore (Boundary)
Location	
Facade / free field	Free field
Environment	

Measured noise levels

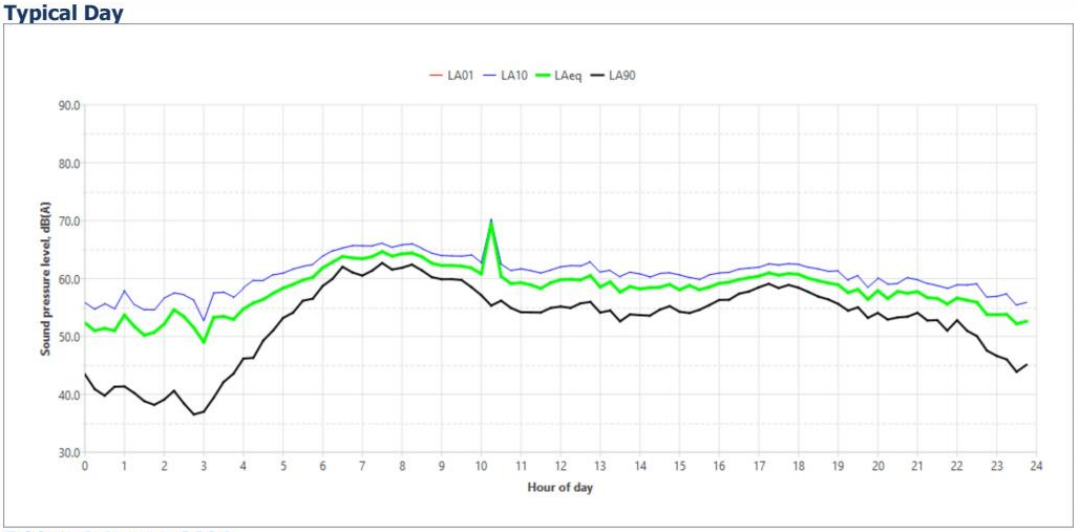
Logging date	Rating Background Level			$L_{Aeq,period}$		
	Daytime 7am-6pm	Evening 6pm-10pm	Night-time 10pm-7am	Daytime 7am-6pm	Evening 6pm-10pm	Night-time 10pm-7am
Fri 09 Aug 2024	-	54	-	59	59	56
Sat 10 Aug 2024	48	53	35	60	58	57
Sun 11 Aug 2024	47	52	36	57	58	54
Mon 12 Aug 2024	49	51	37	61	58	59
Tue 13 Aug 2024	58	52	36	62	58	57
Wed 14 Aug 2024	-	-	-	69	-	58
Summary	**49**	**52**	**36**	**63**	**58**	**57**

Note: Results with a '-' identify that there were not enough measurements available to correctly calculate the level, in accordance with the Noise Policy for Industry. The data has been excluded either from weather or manual exclusions. See the charts for more information

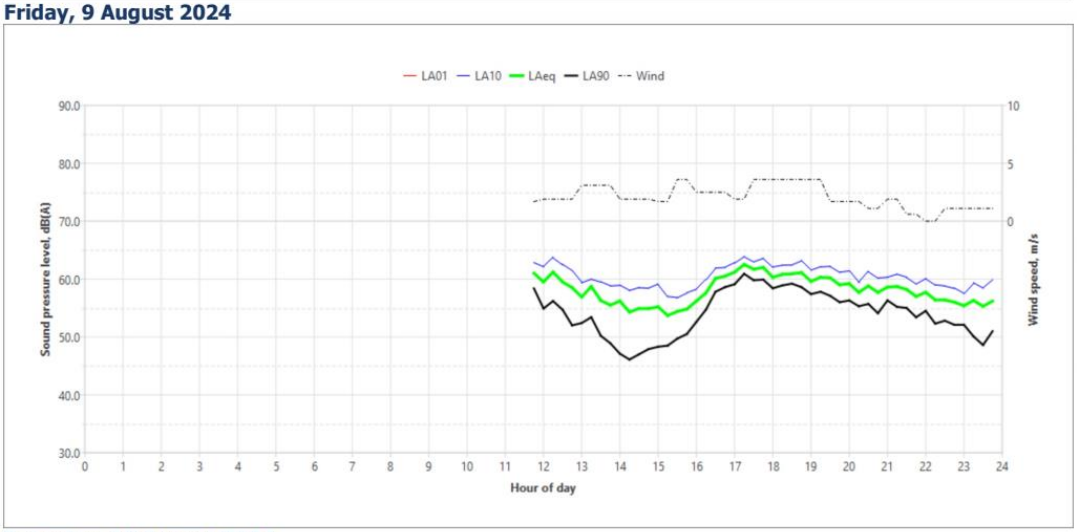
Logger location

Logger deployment photo

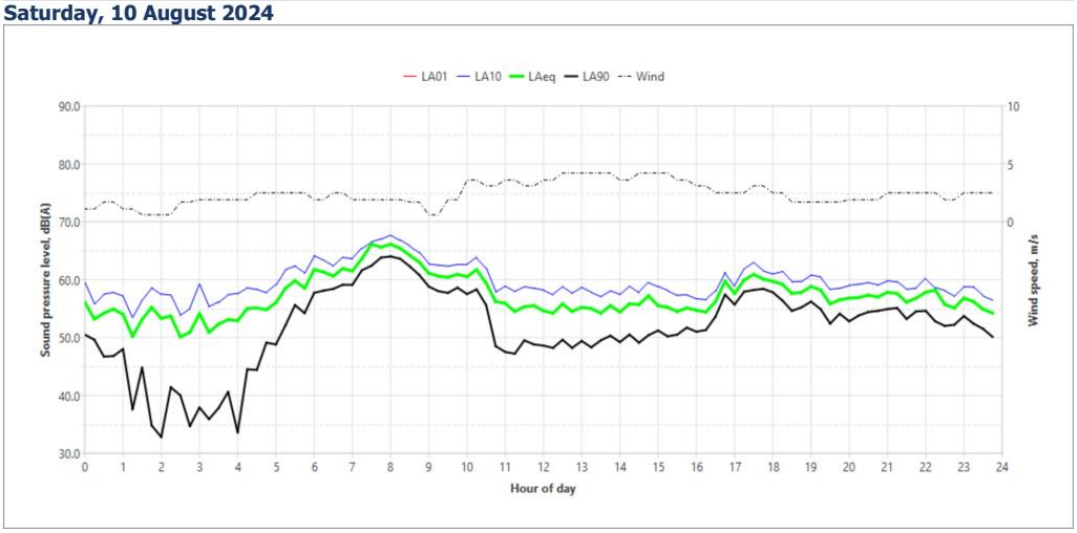
Typical Day



Friday, 9 August 2024

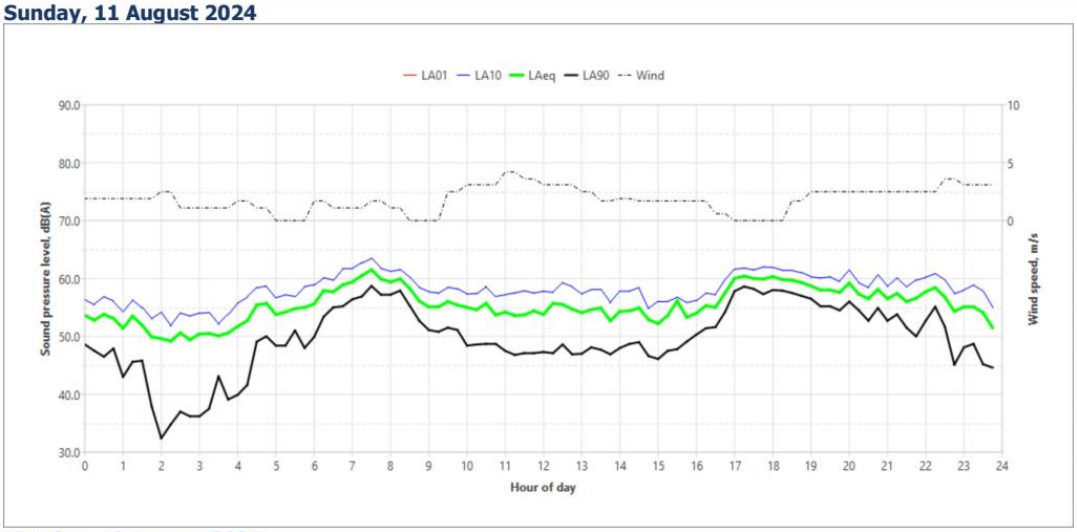


Saturday, 10 August 2024

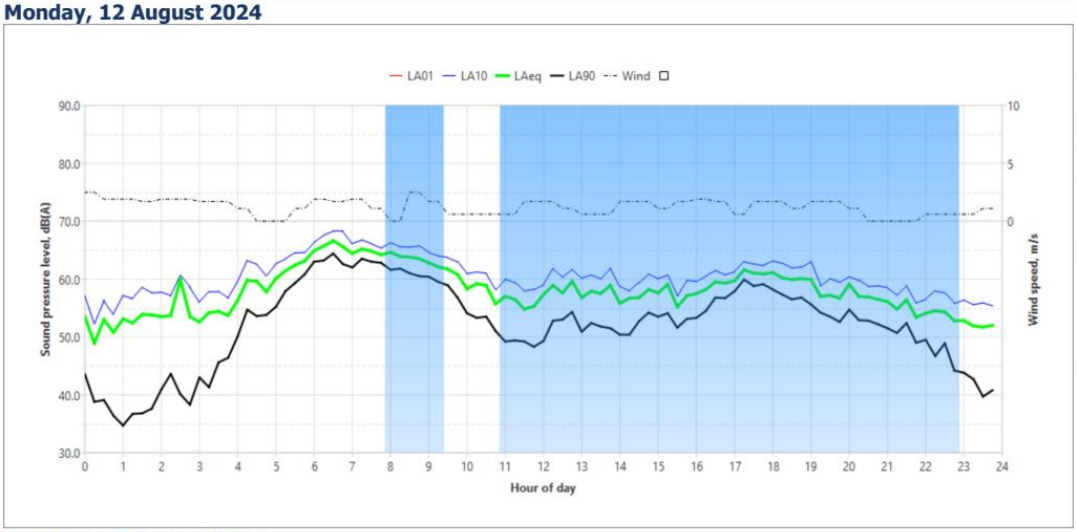


86 Dunmore Road, Dunmore (Boundary) Page 2

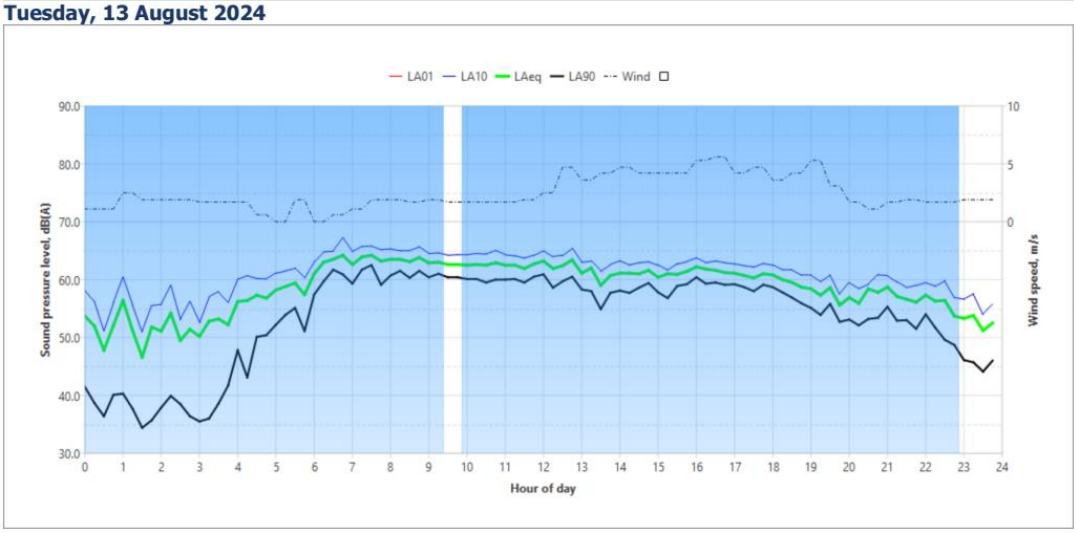
Sunday, 11 August 2024



Monday, 12 August 2024

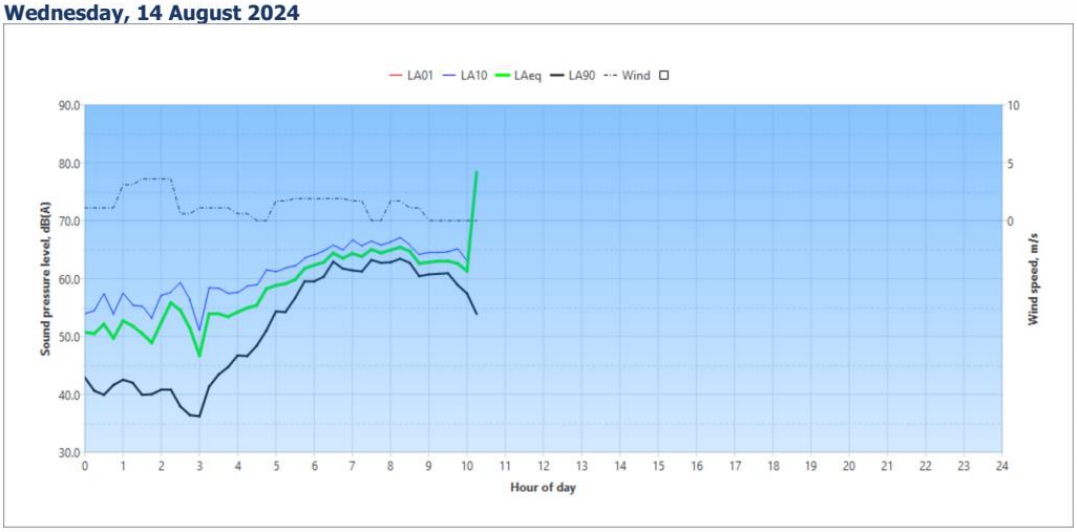


Tuesday, 13 August 2024



86 Dunmore Road, Dunmore (Boundary) Page 3

Wednesday, 14 August 2024



86 Dunmore Road, Dunmore (Boundary) Page 4

86 Dunmore Road, Dunmore (Centre)

Ambient noise monitoring report

Item	Information
Logger Type	NL-42
Serial number	1000231
Address	86 Dunmore Road, Dunmore (Centre)
Location	
Facade / free field	Free field
Environment	

Measured noise levels

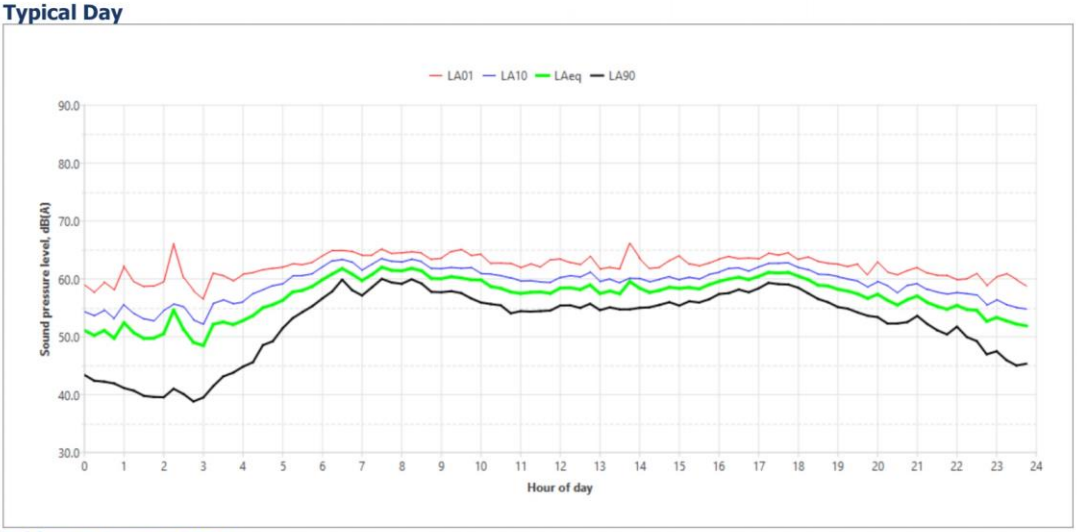
Logging date	Rating Background Level			$L_{Aeq,period}$		
	Daytime 7am-6pm	Evening 6pm-10pm	Night-time 10pm-7am	Daytime 7am-6pm	Evening 6pm-10pm	Night-time 10pm-7am
Fri 09 Aug 2024	-	54	-	60	60	56
Sat 10 Aug 2024	51	53	40	59	57	56
Sun 11 Aug 2024	49	52	39	58	58	53
Mon 12 Aug 2024	50	49	40	59	57	57
Tue 13 Aug 2024	57	52	39	61	58	55
Wed 14 Aug 2024	-	-	-	61	-	56
Summary	**51**	**52**	**39**	**60**	**58**	**56**

Note: Results with a '-' identify that there were not enough measurements available to correctly calculate the level, in accordance with the Noise Policy for Industry. The data has been excluded either from weather or manual exclusions. See the charts for more information

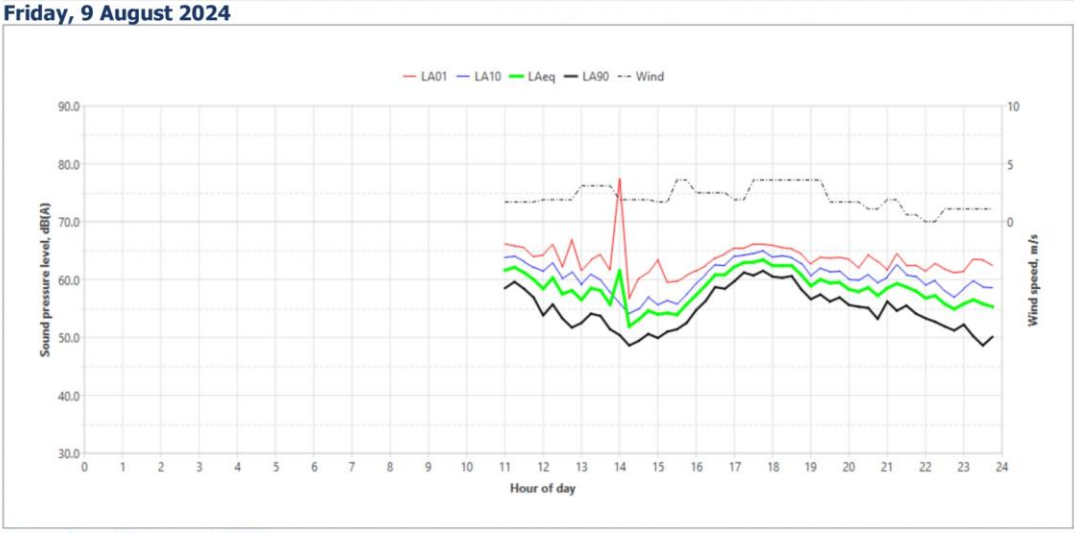
Logger location

Logger deployment photo

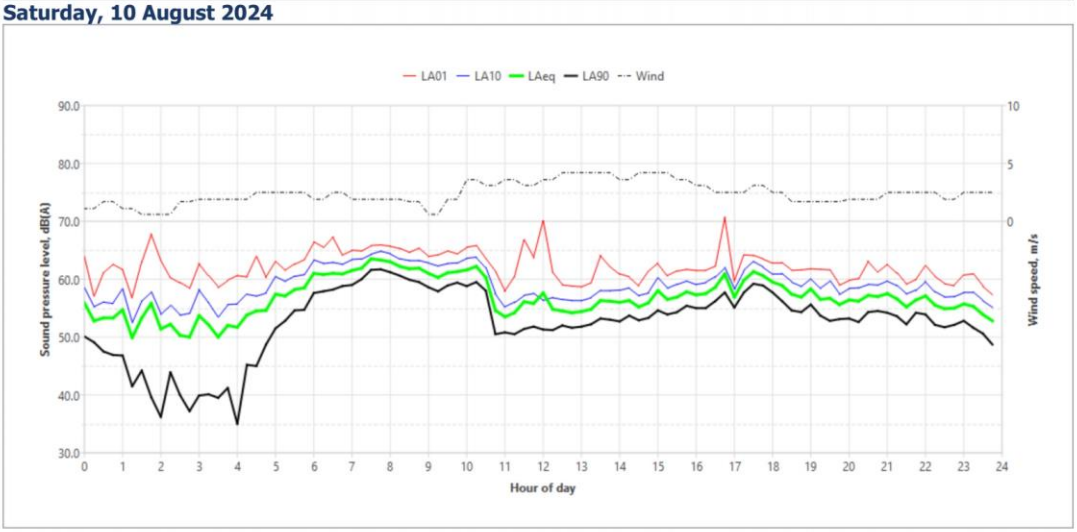
Typical Day



Friday, 9 August 2024



Saturday, 10 August 2024



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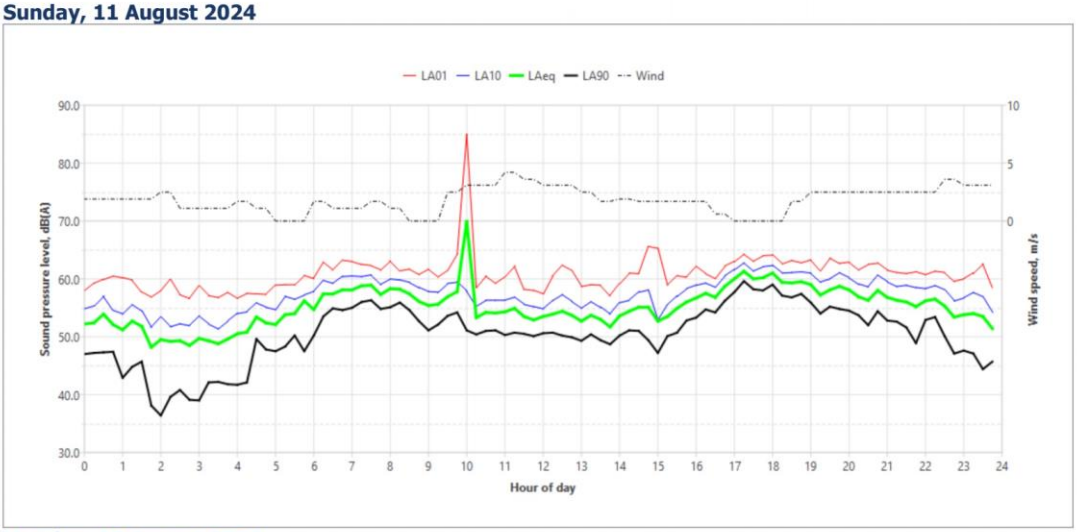
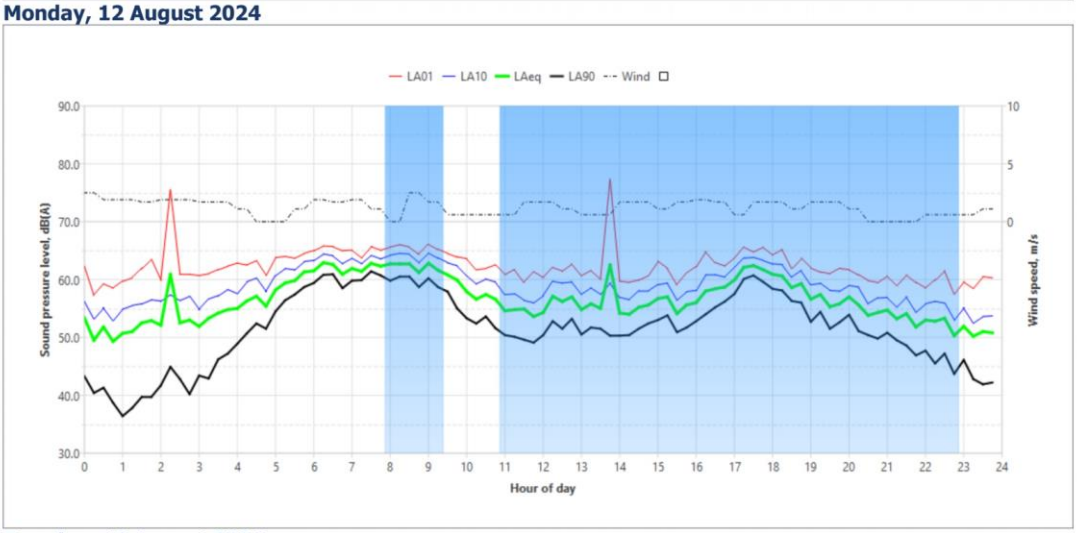
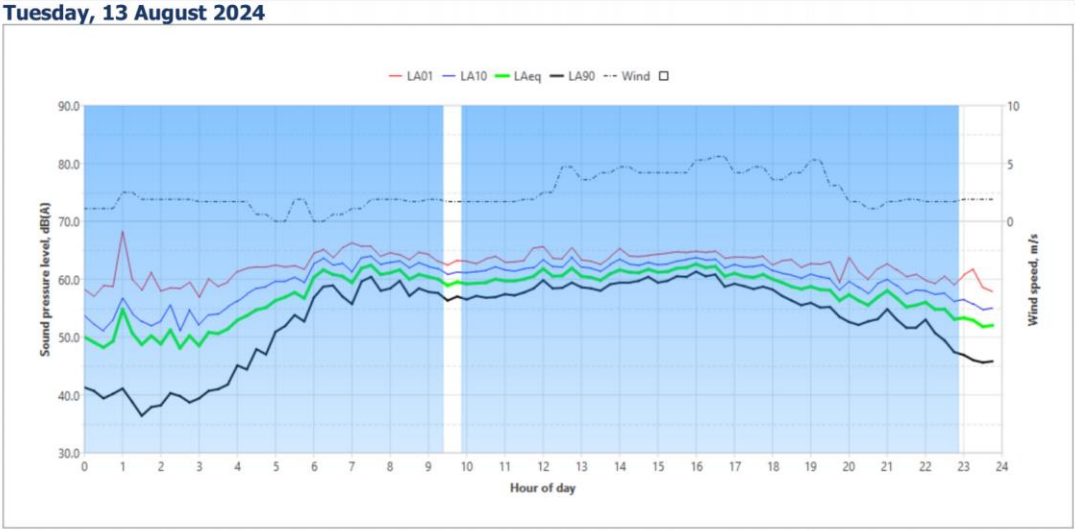
Sunday, 11 August 2024



Monday, 12 August 2024



Tuesday, 13 August 2024



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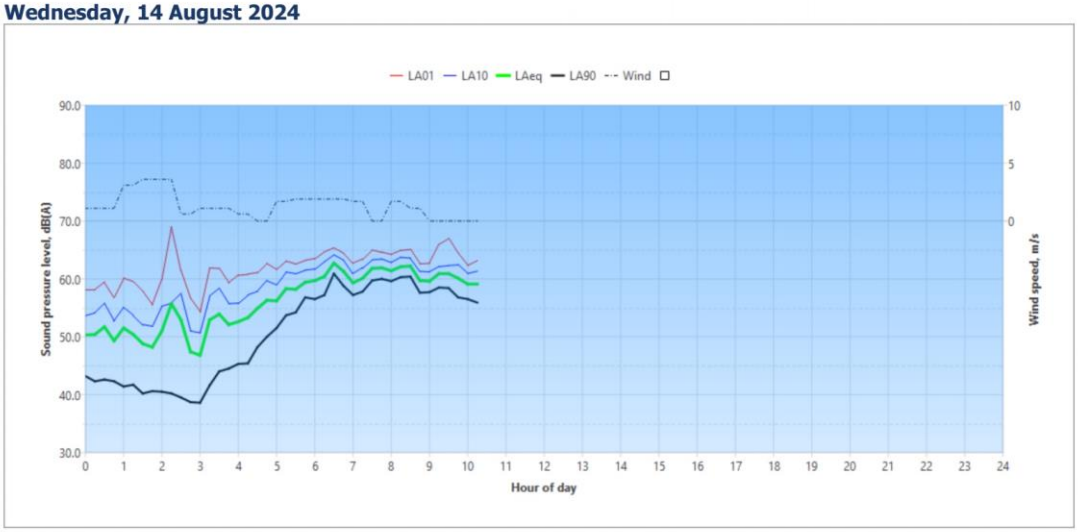
Wednesday, 14 August 2024



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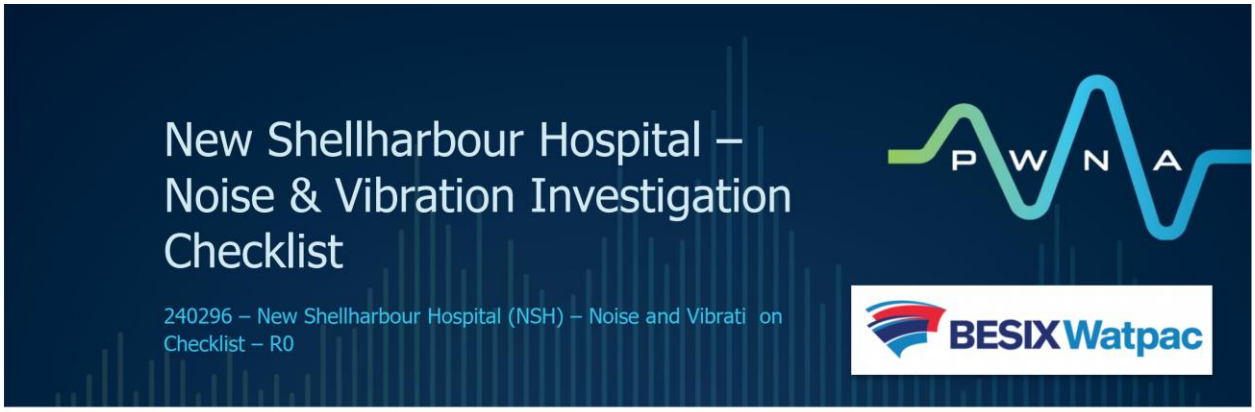
APPENDIX C. NOISE AND VIBRATION INVESTIGATION CHECKLIST



Pulse White Noise Acoustics (PWNA) and BESIX Watpac (NSW) Pty Ltd (BESIX Watpac) have prepared the following noise and vibration investigation checklist to assist the onsite construction team in investigation any received noise and vibration complaint or identifying an exceedance over the management levels. This checklist should be completed in conjunction with the *New Shellharbour Hospital (NSH) – SSD-57064458 - Construction Noise and Vibration Management Sub Plan (CNVMSP)* prepared by PWNA.

Should any noise and vibration complaint be received, Watpac must complete the following steps:

Exceedance/Complaint Information

Complaint reference number:..... .....

Date Received: .....

Location of Complaint: .....

Complainant Contact Details:.....

Step	Task	Completed Response
1	Pause onsite works	
2	Identify the main source(s) construction noise and/or vibration within specific areas of the site which is impacting the most at the sensitive receiver.	
3	Review the identified equipment and determine if an alternate piece of equipment can be used or the process can be altered. ***(If no, skip to step 5)***	
4	In the event an alternate piece of equipment or process can be used, works can re-commence incorporating possible and practical mitigation measures.	
5	In the event an alternate piece of equipment or process cannot be determined implement a construction assessment to be performed by a suitably qualified acoustic consultant. This may include additional respite periods.	

APPENDIX D. AUTHOR CURRICLULUM VITAE (CV)

MATTHEW FURLONG

PRINCIPAL ACOUSTIC ENGINEER

Bachelor of Creative Technology (Audio Engineering and Sound Production), JMC Academy

Member of Australian Acoustical Society (MAAS)

UTS Certification Short Course - Acoustics (NSW Fair Trading Approved)

Matthew is an acoustic consultant with over 10 years' experience in acoustic design for various architectural, environmental and infrastructure projects. He has provided services during the conceptual, planning approval, detailed design, design finalisation and IFC, construction, commissioning, and post-construction stages for a range of different projects.

Matthew's key strength is large scale acoustic design and delivery across the residential, commercial, education and healthcare sectors. As an acoustic consultant, he has also contributed his expertise to other development types including cultural and performance art spaces, licensed premises office fitouts, and industrial developments.

0452 414 785
MatthewF@pwna.com.au

SKILL SET:

- Architectural acoustic design
- Building services acoustic design
- Construction and commissioning
- Expert witness & court works
- Environment impact assessments (SSI & SSD)
- Façade acoustic design
- NCC/BCA design and compliance
- New business development
- Team management
- Project management

MAJOR PROJECTS:

Sydney Children's Hospital Stage 1 and Minderoo Children's Comprehensive Cancer Centre (SCH1 & MCCCC)
Client: LCI/NSW HI/John Holland

Western Sydney Airport (WSA)
Client: LCI

Chatswood Education Precinct (Chatswood HS & PS)
Client: Richard Crookes Constructions

Macquarie Park Village (MPV)
Client: Frasers

Crown Casino Sydney
Client: Crown Sydney/Lendlease

PULSE WHITE NOISE ACOUSTICS
Suite 601, L6, 32 Walker St, North Sydney NSW 2060 P 1800 478 573 pwna.com.au

MATTHEW FURLONG
PRINCIPAL ACOUSTIC ENGINEER, PWNA

EXPERIENCE

EDUCATION

- **Schematic, SSDA, Detailed Design, IFC, Construction Carlingford West Public School**
- **Detailed Design, IFC, Construction Cumberland High School**
- Masterplan, Concept, Schematic, SSDA, Design Development Tallawong Station Public School.
- Masterplan, Concept, Schematic and SSDA Tallawong Public School.
- Schematic and SSDA Macquarie Park Public School.
- Detailed Design, IFC and Construction Neutral Bay Public School.
- SSDA and Acoustic Design Meadowbank Education Precinct
- Schematic, SSDA, Detailed Design, IFC, Construction and Commissioning New Primary School in Murrumbateman
- Schematic, SSDA, Detailed Design, IFC, Construction and Commissioning New Primary School in Googong.
- Detailed Design, IFC, Construction and Commissioning at Epping South
- Detailed Design, IFC, Construction and Commissioning at Epping West.
- **Design Finalisation, IFC, Construction and Commissioning Chatswood High School.**
- **Design Finalisation, IFC, Construction and Commissioning Chatswood Public School.**
- Schematic, Planning Pathway Hurlstone Agricultural High School
- Schematic, Planning Pathway Yanco Agricultural High School
- SSDA, Construction (Mech) and Commissioning (Mech) Meadowbank School.
- Construction and Commissioning Meadowbank TAFE Building.
- CNVMP and Construction Services Anzac Park Public School
- CNVMP and Construction Services Alexandria Park Public School (Stage 1)
- **Design Finalisation, IFC, Construction Melonba High School**
- **Design Finalisation, IFC, Construction Melonba Public School**

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MATTHEW FURLONG
PRINCIPAL ACOUSTIC ENGINEER, PWNA

RESIDENTIAL

- **Acoustic Design for Crown Casino Sydney.**
- Acoustic Design and Construction Services 130 Elizabeth Street, Sydney (One30Hyde).
- Acoustic Design and Construction Services Trinity Terraces Rosebery.
- Construction Services 1a Coulson Street, Erskinville.
- Construction Services for the Erko Apartments Erskinville.
- Construction Services for the Eve Apartments Erskinville.
- Acoustic Design 54-56 Riley Street and 1 Crown Lane, Darlinghurst.
- Development Application, Acoustic Design and Construction Services New Life Darling Harbour, 495 Harris Street, Ultimo.
- **Development Application, Acoustic Design and Construction Services Meriton Developments (Mascot, Rosebery, Epping, Parramatta, Pagewood, Bondi, Dee Why, Zetland, Waterloo, North Sydney, Sydney, Macquarie Park).**
- Development Application, Acoustic Design and Construction Services Summer Hill Flourmill Stages 1, 2, 3 and 4.
- **Acoustic Design and Construction Services Macquarie Park Village.**
- **Acoustic Design and Construction Services Ryde Gardens.**
- Acoustic Design and Construction Services Tempo Apartments Victoria Road Drummoyne.
- Development Application, Acoustic Design and Construction Services Winston Hills Mall Residential.
- Construction Services Presbyterian Aged Care Paddington.
- Acoustic Design and Construction Services Wahroonga Nursing Home.
- Acoustic Design and Construction Anglicare Castle Hill (ARV).
- Acoustic Design and Construction Cardinal Freeman Village, Ashfield.

MATTHEW FURLONG
PRINCIPAL ACOUSTIC ENGINEER, PWNA

COMMERCIAL

- **Development Application, Acoustic Design and Construction Services Winston Hills Mall Enabling Works.**
- Development Application and Acoustic Design 210-220 George Street Sydney.
- **Acoustic Design and Construction Services 151 Clarence Street, Sydney.**
- Development Application for 390-396 Pitt Street, Haymarket.
- **Acoustic Design and Construction Services Chifley Plaza Internal Works.**
- Development Application 371-375 Pitt Street, Sydney.
- Construction Services Fitout of the Department of Premier and Cabinets.
- Noise Investigations for Transport NSW (Chatswood and Burwood).
- **Schematic Design for Western Sydney Airport – Nancy Warbird (WSA).**
- Schematic Design, Detailed Design, Tender, IFC, Construction Johnson Winter Slattery (JWS) Sydney Office Fitout.
- Schematic Design, Detailed Design, Tender, IFC, Construction UHY Haines Norton Sydney Office Fitout.

CULTURAL AND PERFORMING ART SPACES

- **Acoustic Design and demonstration for the Wintjiri Wiru drone, light and sound show (Uluru).**
- **Acoustic Design for Powerhouse Parramatta.**
- Acoustic Design and construction services for Manning Entertainment Centre.
- Acoustic Design and construction services for Brickworks Sydney Broadcast and Podcast Spaces.
- Acoustic Design and construction services for Channel 9 Sydney Headquarters and Studio Spaces.
- Acoustic Design for Maclean Community Precinct.
- **Commissioning services for Sydney Modern.**
- Acoustic Design for School Infrastructure NSW School Hall and Performing Arts Spaces (including Chatswood Public School, Chatswood High School, Googong Public School, Murrumbateman Public School, Tallawong Station Public School, Tallawong Public School, Melonba Public School, Marsden Park High School, Cumberland High School, Carlingford West Public School, New Primary, Nharala Public School etc).

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MATTHEW FURLONG
PRINCIPAL ACOUSTIC ENGINEER, PWNA

- Acoustic Design and Construction for Scientia Project, Monte Sant' Angelo Mercy College.

HEALTH FACILITIES

- **Master Planning, Feasibility, Schematic, SSDA, Detailed Design and IFC for Sydney Children's Hospital Stage 1 & Minderoo Children's Comprehensive Cancer Centre (SCH1/MCCCC), Randwick.**
- Formulation of the new Victorian Health Engineering Guidelines (Acoustics).
- Construction Services for Wagga Wagga Base Hospital Stage 2.
- SSDA and Acoustic Design for Concord Repatriation General Hospital.
- SSDA and Acoustic Design Nepean Public Hospital.
- **CNVMP, Design Finalisation, IFC, Construction Campbelltown Hospital Redevelopment Works.**
- Acoustic Design for Eurobodalla Regional Hospital.

LICENSED PREMISES

- Development Application for The Cauliflower Hotel, Waterloo
- Development Application for Christopher Hanna Salon and Bar, 13-15a Bridge Street, Sydney
- Development Application for the Tilbury Hotel Woolloomooloo.
- Development Application for the Exchange Hotel, Balmain.
- Development Application for the Town Hall Hotel, Balmain.
- Development Application for the Exchange Hotel, Darlinghurst.
- Development Application for 388 George Street, Sydney.
- Development Application for 88 Pitt Street, Sydney.
- Development Application for 92 Pitt Street, Sydney.
- Development Application for Pilu Freshwater.
- **Development Applications for the Redevelopment of Ibis Hotels:**
    - Enfield NSW.
    - Liverpool NSW.
    - Wentworthville NSW.

MATTHEW FURLONG
PRINCIPAL ACOUSTIC ENGINEER, PWNA

- Sydney Airport NSW.
- St Peters NSW.
- Olympic Park NSW.
- Thornleigh NSW.

INDUSTRIAL

- Acoustic design Erskine Park Industrial Area.
- CNVMP, Acoustic Design, IFC and Construction Snackbrands Orchard Hills.
- **CNVMP, Acoustic Design, IFC and Construction Logos Moorebank (Warehouse 6 & 7).**