2 Fishburn Crescent (Lot 1 DP 1316896), Castle Hill

Noise and Vibration Impact Assessment

ARADA Development Management Pty Ltd

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TABLE OF CONTENTS

1 INTRODUCTION 6

1.1 Proposed Development 6

1.2 Relevant Guidelines 6

1.3 Site Layout 7

2 NOISE DESCRIPTORS & TERMINOLOGY 9

3 EXISTING NOISE ENVIRONMENT 10

3.1 Unattended Noise Monitoring 10

3.1.1 Results in accordance with the NSW *EPA Noise Policy for Industry (NPI) 2017* (RBL's) 10

3.1.2 Results in accordance with the NSW EPA *Road Noise Policy (RNP) 2011* 11

3.2 Attended Noise Measurements 11

4 ACOUSTIC CRITERIA 13

4.1 Noise Intrusion Criteria 13

4.1.1 The Hills Local Environmental Plan 2019 (LEP) 13

4.1.2 The Hills Development Control Plan (DCP) 2012 13

4.1.3 The Hills Development Control Plan (DCP) 2012 – Showground Precinct 13

4.1.4 NSW Government Legislation – State Environmental Planning Policy (Transport and Infrastructure) 2021 14

4.1.5 NSW Government Legislation – State Environmental Planning Policy (Transport and Infrastructure) 2021 14

4.1.6 NSW Department of Planning and Environments Development Near Rail Corridors and Busy Roads – Interim Guideline 2008 16

4.1.7 Australian / New Zealand Standard AS/NZS 2107:2016 Acoustics - Recommended design sound levels and reverberation times for building interiors - (AS/NZS 2107:2016) 17

4.1.8 Project Airborne Noise Requirements 18

4.2 Noise Emission Criteria (Operational Criteria) 18

4.2.1 The Hills Development Control Plan (DCP) 2012 18

4.2.2 NSW EPA Noise Policy for Industry (NPI) 2017 18

4.2.3 NSW DECCW – NSW Road Noise Policy (RNP) 2011 22

4.3 Ground Borne and Vibration Criteria 22

4.3.1 Ground-Borne Noise 22

4.3.2 Rail Tactile Vibration 23

5 TRAIN VIBRATION ASSESSMENT 25

5.1 Existing Rail Corridor – Sydney Northwest Metro 25

5.2 Existing Rail Corridor – Sydney Metro – Northwest – Tactile vibration levels 25

5.3 Existing Rail Corridor – Sydney Metro – Northwest – Ground-borne noise 26

6 BUILDING ACOUSTIC ASSESSMENT 28

6.1 Building Envelope Assessment 28

6.1.1 Glazing Recommendations 28

6.1.2 External Wall Construction 28

6.1.3 External Roof Construction 29

6.1.4 Open Windows Assessment 29

6.2 Noise from Engineering Services 30
6.3 Noise from Additional Vehicles on Surrounding Road Network 31
6.4 Noise Associated with Loading Dock 31
6.5 Noise Associated with Vehicle Basement Movements 31

7 CONSTRUCTION NOISE AND VIBRATION IMPACTS 32

7.1 Construction Noise Criteria 32
7.1.1 NSW EPA Interim Construction Noise Guideline (ICNG) – DECC 2009 32
7.1.2 Construction Traffic Noise Criteria 34
7.2 Vibration Criteria 35
7.2.1 Vibration Criteria – Human Comfort 35
7.2.2 Vibration Criteria – Building Contents and Structure 36
7.3 Ground-Borne Noise Criteria 38
7.4 Project Vibration Criteria 38
7.5 Noise and vibration assessment 39
7.6 Construction Noise Assessment 39
7.7 Construction Traffic Noise Assessment 51
7.8 Vibration Assessment 51
7.9 Noise Monitoring 51
7.9.1 Vibration Monitoring 53

8 CONCLUSION 54

APPENDIX A: ACOUSTIC GLOSSARY 55

APPENDIX B: UNATTENDED NOISE LOGGING – NOISE LOGGER 01 57

APPENDIX C: UNATTENDED NOISE LOGGING – NOISE LOGGER 02 58

TABLES

Table 1 Measured Ambient Noise Levels corresponding to the NPI's Assessment Time Periods. 11
Table 2 Measured Ambient Noise Levels corresponding to the EPA Road Noise Policy (RNP) 2011 Time Periods. 11
Table 3 Results of the Attended Noise Survey at the Site. 12
Table 4 Recommended design sound levels as per standard AS/NZS 2107:2016. 17
Table 5 Project Airborne Internal Noise Level Requirements 18
Table 6 NSW NPI – Recommended LAeq Noise Levels from Noise Sources. 20
Table 7 External noise level criteria in accordance with the NSW NPI (dB(A)). 21
Table 8 Building vibration z-axis curves from acceleration (R.M.S) 23
Table 9 Intermittent vibration impacts criteria (m/s1.75) 1 Hz-80 Hz, Vibration Dose Values (VDV) 24
Table 10 In-principle Glazing Recommendations. 28
Table 11 NMLs for quantitative assessment at residences. 33
Table 12 Construction noise management levels – other receivers. 34
Table 13 NMLs as basis for the acoustic assessment. 34
Table 14 Continuous vibration acceleration criteria (m/s^2) 1 Hz-80 Hz. 36
Table 15 Impulsive vibration acceleration criteria (m/s^2) 1 Hz-80 Hz. 36
Table 16 Intermittent vibration impacts criteria ($m/s^{1.75}$) 1 Hz-80 Hz. 36
Table 17 Transient vibration criteria as per standard BS 7385 Part 2 – 1993. 37
Table 18 Structural damage criteria as per standard DIN 4150 Part 3 – 1999. 38
Table 19 Summary of predicted sound power levels. 39
Table 20 Receiver – 01 – Residential – Summary of preliminary predicted construction noise levels. 40
Table 21 Receiver – 02 – Residential – Summary of preliminary predicted construction noise levels. 41

Table 22 Receiver – 03 – Residential – Summary of preliminary predicted construction noise levels. 42
Table 23 Receiver – 04 – Residential – Summary of preliminary predicted construction noise levels. 43
Table 24 Receiver – 05 – Residential – Summary of preliminary predicted construction noise levels. 44
Table 25 Receiver – 06 – Residential – Summary of preliminary predicted construction noise levels. 45
Table 26 Receiver – 07 – Residential – Summary of preliminary predicted construction noise levels. 46
Table 27 Receiver – 08 – Residential – Summary of preliminary predicted construction noise levels. 47
Table 28 Receiver – 09 – Residential – Summary of preliminary predicted construction noise levels. 48
Table 29 Receiver – 10 – Residential – Summary of preliminary predicted construction noise levels. 49
Table 30 Receiver – 11 – Residential – Summary of preliminary predicted construction noise levels. 50
Table 31 Recommended indicative safe working distances for vibration intensive plant. 51

FIGURES

Figure 1 Approximate location of Northwest Metro tunnels relative to project site – Sourced from OpenRailwayMap. 7
Figure 2 Site Map, Measurement Locations and Surrounding Receivers – Sourced from SixMaps. 8
Figure 3 RMS Traffic volume map – Extract. 15
Figure 4 Extract - DNRCBR - Table 3.1. 16
Figure 5 NSW Planning ePlanning Spatial Viewer Zoning Maps 20
Figure 6 Extract - DNRCBR - Table 3.1. 22
Figure 7 Vibration Assessment Zones based on Distance (m) of Sensitive Development from Operational Track (Not Corridor). 25
Figure 8 Predicted tactile vibration levels (weighted acceleration) – Extract. 26
Figure 9 Predicted ground-borne noise levels – Extract. 27
Figure 10 Location of Required Alterative Outside Air 29
Figure 11 BS 7385 Part 2 – 1993, graph of transient vibration values for cosmetic damage. 37

1 INTRODUCTION

Pulse White Noise Acoustics Pty Ltd (Pulse White Noise Acoustics) has been engaged to undertake an acoustic assessment for the proposed multi-storey residential development to be located at 2 Fishburn Cresent, Castle Hill NSW 2154 (Lot 1 DP 1316896).

This assessment will address the following:

- Potential surrounding environmental noise intrusion and vibration impacts on the development (i.e., traffic noise from Carrington Road, Middleton Avenue, and Sexton Avenue, and railway noise and vibration from the Hills Showground Metro Station / railway lines.
- Noise emissions to nearby receivers from the operation of the base building services (i.e., electrical, and mechanical services.) and noise of vehicles associated with the development.

This report will discuss the relevant acoustic criteria which has been adopted as well as the outcome of the noise and vibration assessment.

A glossary of acoustic terminology used in the acoustic assessment, is included in Appendix A.

1.1 Proposed Development

The proposed development site is located at 2 Fishburn Cresent, Castle Hill, which is located ~30 m south of the Hills Showground Metro Station / railway lines.

The site location is relation to the surrounding receivers, is shown in Figure 2 below. The project site is bounded by Carrington Road along the northern boundary, Middleton Avenue along the western boundary, and Sexton Avenue along the south-eastern boundary, with residential dwellings located along the eastern site boundary.

The proposed development includes the following:

- Two levels of basement carparking, with lift shafts, and mechanical services.
- Lower Ground – carparking, loading area, lift shafts, and multiple residential dwellings located along the north-western corner of the development.
- Ground Floor – Multiple residential dwellings, carparking, and communal use areas, indoor and outside pool, communal garden areas, and lobby areas.
- 18 story building including residential dwellings.
- Communal open areas are also included on levels 7, 10, 13, 14 and 18.

Architectural drawings for the proposed development, which have been used in our assessment, are prepared by *TURNER Studio Architects*, with job number 23104 and dated 21/08/2025.

1.2 Relevant Guidelines

Acoustic criteria which have been adopted in this assessment include requirements from the local and state authorities and in the absence of any applicable criteria from these bodies, Australian and International Standards will be utilised.

1.3 Site Layout

The project site is located at 2 Fishburn Cresent, Castle Hill, NSW 2154 and includes a location which is defined as High Density (RU4) areas as described in the NSW Planning ePlanning Spatial Viewer Zoning Maps.

The Hills Showground Metro railway line is located approximately 30 m to the north of the proposed project site across Carrington Road. The train line runs south-west and north-east through The Hills Showground station. The Northwest Sydney Metro lines are positioned approximately 30 m to the northern boundary of the project site. See Figure 1 below.

Figure 1 Approximate location of Northwest Metro tunnels relative to project site – Sourced from OpenRailwayMap.

The nearest sensitive receivers to the site and the measurement locations have been identified in Figure 2 below.

Receiver 1: Two storey residential receiver located at 1 Middleton Ave, Castle Hill NSW 2154.

Receiver 2: Two storey residential receiver located at 3M Middleton Ave, Castle Hill NSW 2154.

Receiver 3: Single storey residential receiver located 1 Partridge Ave, Castle Hill NSW 2154.

Receiver 4: Single storey residential receiver located at 7 Middleton Ave, Castle Hill NSW 2154.

Receiver 5: Single storey residential receiver located at 9 Middleton Ave, Castle Hill NSW 2154.

Receiver 6: Single storey residential receiver located at 11 Middleton Ave, Castle Hill NSW 2154.

Receiver 7: Single storey residential receiver located at 13 Middleton Ave, Castle Hill NSW 2154.

Receiver 8: Multi storey residential development (Chateau Showground) located at 16 Middleton Ave, Castle Hill NSW 2154.

Receiver 9: Multi storey residential development located at 24-35 Fishburn Crescent and 2-12 Sexton Avenue, Castle Hill.

Receiver 10: Single storey residential receiver located at 23 Sexton Avenue, Castle Hill NSW 2154.

Receiver 11: Single storey residential development located at 10 Carrington Road, Castle Hill NSW 2154.

Figure 2 Site Map, Measurement Locations and Surrounding Receivers – Sourced from SixMaps.

2 NOISE DESCRIPTORS & TERMINOLOGY

Environmental noise constantly varies in level with time. It is therefore necessary to measure environmental noise in terms of quantifiable time periods and statistical descriptors. Typically, environmental noise is measured over 15-minute periods and relevant statistical descriptors of the fluctuating noise are determined to quantify the measured level.

Noise (or sound) consists of minute fluctuations in atmospheric pressure capable of detection by human hearing. Noise levels are expressed in terms of decibels, abbreviated as dB or dB(A), the A indicating that the noise levels have been frequency weighted to approximate the characteristics of normal human hearing. Because noise is measured using a logarithmic scale, 'normal' arithmetic does not apply, e.g. adding two sources of sound of an equal value results in an increase of 3dB (i.e. 60 dBA + 60 dBA = 63 dBA). A change of 1 dB or 2 dB in the level of a sound is difficult for most people to detect, whilst a 3 dB – 5 dB change corresponds to a small but noticeable change in loudness. A 10 dB change roughly corresponds to a doubling or halving in loudness.

The most relevant environmental noise descriptors are the LAeq, LA01, LA10 and LA90 noise levels. The LAeq noise level represents the "equivalent energy average noise level". This parameter is derived by integrating the noise level measured over the measurement period and is equivalent to a level that would have been experienced had the fluctuating noise level remained constant during the measured time period.

The LA1, LA10 and LA90 levels are the levels exceeded for 1%, 10% and 90% of the sample period. These levels are sometimes thought of as the typical maximum noise level, the average repeatable maximum and average repeatable minimum noise levels, respectively.

Specific acoustic terminology is used in this assessment report. An explanation of common acoustic terms is included as Appendix A.

3 EXISTING NOISE ENVIRONMENT

This section of the report details the acoustic survey which has been undertaken at the site for the purpose of obtaining existing background noise levels, as well as noise levels incident on the future building façades.

3.1 Unattended Noise Monitoring

As part of this assessment an acoustic survey of the existing acoustic environment at two locations surrounding the site was undertaken. The survey included long-term unattended noise logging between the 2nd of July and the 10th of July 2024. Data affected by adverse meteorological conditions and by spurious and uncharacteristic events have been excluded from the results, and also excluded from the data used to determine the noise emission criteria. Meteorological information has been obtained from the Sydney Olympic Park AWS (Archery).

Noise logging was undertaken on the site using a Rion NL-42 (Noise Logger 01) type noise monitor with serial number 00396932, and a SVANTAK 971 (Noise Logger 02) type noise monitor with serial number 74365. Calibration of the logger was 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.

Noise Logger 01 was located along the western boundary of the project site, within the front yard of 6 Middleton Avenue, Castle Hill. Noise Logger 02 was located within the front yard of 29 Sexton Avenue, Castle Hill. The locations of the unattended noise loggers are illustrated in Figure 2 above. The purpose of noise monitoring at these locations was to characterise the existing background noise level at the proposed development. The monitors were also used to establish criteria for noise emissions (i.e., to determine the noise level representative of the nearest noise sensitive receiver locations to the proposed development). Note: Noise Logger 02 was located within close proximity to heavy construction works for the multi storey residential development (Chateau Showground) at 16 Middleton Avenue, Castle Hill. The presence of these works disrupted the measured daytime background and ambient noise levels. As such, noise levels within the daytime period of Noise Logger 02 have not been used to determine any criteria. In the absence of daytime data, Noise Logger 01 will be utilised.

Charts presenting summaries of the measured daily noise data are attached to this report in Appendix B and Appendix C for Noise Loggers 01 and 02 respectively. The charts present each 24-hour period and show the L_{A01}, L_{A10}, L_{Aeq} and L_{A90} noise levels for the corresponding 15-minute periods. This data has been filtered to remove periods affected by adverse weather conditions based on weather information.

3.1.1 Results in accordance with the NSW *EPA Noise Policy for Industry (NPI) 2017* (RBL's)

In order to assess the potential noise impacts of the development on nearby sensitive receivers the measured background noise data was processed in accordance with the Environmental Protection Authority (EPA) *Noise Policy for Industry* (NPI).

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 levels $L_{A90\ (15minute)}$ and L_{Aeq} noise levels are presented in Table 1.

Data affected by adverse meteorological conditions and by spurious and uncharacteristic events has been excluded from the results, and also excluded from the data used to determine the noise emission criteria. Meteorological information has been obtained from the Sydney Olympic Park AWS (Archery)

Table 1 Measured Ambient Noise Levels corresponding to the NPI's Assessment Time Periods.

Measurement Location	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] (dB(A))	L_{Aeq}[3] (dB(A))	L_{A90}[2] (dB(A))	L_{Aeq}[3] (dB(A))	L_{A90}[2] (dB(A))	L_{Aeq}[3] (dB(A))
Noise Logger 01- 6 Middleton Avenue (see Figure 2)	52	65	42	61	33	55
Noise Logger 02- 29 Sexton Avenue (see Figure 2)	43[4]	57[4]	39	47	30	48

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 L_{A90} 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 L_{Aeq} 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.

Note 4: The L_{Aeq} and L_{A90} levels from the daytime period have not been used to determine any noise level criteria due to the presence of construction noise occurring across the road. Levels have been provided for completeness only.

3.1.2 Results in accordance with the NSW EPA *Road Noise Policy (RNP) 2011*

The measured ambient noise level in accordance with the NSW EPA Road Noise Policy (RNP) 2011 are provided in Table 2.

Table 2 Measured Ambient Noise Levels corresponding to the EPA Road Noise Policy (RNP) 2011 Time Periods.

Measurement Location	Measured Noise Level	
	Daytime[1] – 9 hour 7:00 am to 6:00 pm	Night-time[1] – 15 hour 6:00 pm to 7:00 am
	L_{Aeq}[1] (dB(A))	L_{Aeq}[1] (dB(A))
Noise Logger 01- 6 Middleton Avenue (see Figure 2)	65	55
Noise Logger 02- 29 Sexton Avenue (see Figure 2)	56[2]	48

Note 1: The L_{Aeq} 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.

Note 2: The noise levels from the 9-hour period have not been used to determine any noise level criteria due to the presence of construction noise occurring across the road. Levels have been provided for completeness only.

3.2 Attended Noise Measurements

The survey included attended noise level measurements which were undertaken on the 2nd of July 2024. Testing was conducted during a period when there was no inclement weather. This allowed the existing noise levels around the site to be quantified.

The attended noise measurements were conducted using a SVANTEK 958A sound level meter (serial number 69812). Calibration of the sound level meter was checked prior to and following the measurements using a Brüel & Kjær Type 4231 sound calibrator (serial number 3009148). The calibrator emitted a calibration tone of 94 dB at 1 kHz. The drift in calibration did not exceed ±0.5 dB. All equipment carries appropriate and current NATA (or manufacturer) calibration certificates.

The results of the attended acoustic survey are detailed in Table 3.

Table 3 Results of the Attended Noise Survey at the Site.

Measurement Location	Time of Measurement [1]	Measured Noise Level $L_{Aeq, 15min}$ dB(A) [2]	Comments
Attended Location 1: North-eastern boundary of the project site. Adjacent to Carrington Road (refer to Figure 2)	15:45 – 16:00, 2 July 2024	69	Noise levels at the project site is dominated by road traffic along Carrington Road.
Attended Location 2: Norther-western corner of project site. Adjacent to Carrington Road (refer to Figure 2)	16:15 – 16:30, 2 July 2024	68	Noise levels at the project site is dominated by road traffic along Carrington Road and Middleton Avenue.
Attended Location 3: South-western boundary of project. Adjacent to Middleton Avenue (refer to Figure 2)	16:15 – 16:30, 2 July 2024	65	Nosie levels at the project site is dominated by road traffic along Middleton Avenue.

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 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.

4 ACOUSTIC CRITERIA

The acoustic criteria which have been adopted for this assessment are outlined below. All criteria have been separated into the relevant assessment type, these are: *Noise Intrusion Criteria* (Assessment of building envelope and ground borne noise), *Noise Emission Criteria* (Assessment of noise to surrounding receivers) and *Ground Borne and Vibration Criteria* (assessment of existing and future train corridor ground borne and vibration impacts).

4.1 Noise Intrusion Criteria

External noise intrusion into the building will generally be via the building envelope (External wall, glazing or external roof). The design of the building envelope should be such that the requirements listed below are achieved.

4.1.1 The Hills Local Environmental Plan 2019 (LEP)

A review of the current The Hills Local Environmental Plan 2019 (LEPs), the document does not contain any applicable numerical building envelope acoustic criteria for residential developments. As such in the absence of any applicable requirements, objectives listed in Australian/New Zealand 2107:2016 Acoustics - Recommended design sound levels and reverberation times for building interiors standard will be adopted.

4.1.2 The Hills Development Control Plan (DCP) 2012

A review of the current The Hills Development Control Plan (DCP) 2012 the document does not contain any applicable numerical building envelope acoustic criteria for residential developments. As such in the absence of any applicable requirements, the following will be adopted:

- NSW Government Legislation – State Environment Planning Policy (Transport and Infrastructure).
- NSW Government 'Development Near Rail Corridors and Busy Roads – Interim Guideline (DNRC &BR – IG).
- Australian/New Zealand 2107:2016 Acoustics - Recommended design sound levels and reverberation times for building interiors.

4.1.3 The Hills Development Control Plan (DCP) 2012 – Showground Precinct

A review of the current The Hills Development Control Plan (DCP) 2012 – Showground Precinct reveals that the document does contains the following applicable numerical building envelope acoustic criteria for residential developments criteria:

6.9 Noise

Objectives

a. To ensure the amenity of future residents and workers by appropriately responding to noise impacts.

Controls

5. The provisions of State Environmental Planning Policy (Infrastructure) 2007 and *Development near Rail Corridors and Busy Roads interim Guideline* must be taken into consideration to minimise impacts of busy roads and railway corridors on residential and other sensitive developments.

6. Development applications are to demonstrate how buildings comply with the noise criteria specified in Table 7 below.

Table 7 Noise Criteria

Internal Space	Recommended Noise Criteria	Maximum Noise Criteria
Living areas Working areas	40 dBA	45 dBA
Sleeping areas	35 dBA	40 dBA

4.1.4 NSW Government Legislation – State Environmental Planning Policy (Transport and Infrastructure) 2021

Section 2.100 Impact of rail noise or vibration on non-rail development states the following:

2.100 Impact of Rail Noise or Vibration on non-rail development

1. *This section applies to development for any of the following purposes that is on land in or adjacent to a rail corridor and that the consent authority considers is likely to be adversely affected by rail noise or vibration —*

    a) *Residential Accommodation*

    b) *A place of public worship*

    c) *A hospital*

    d) *An educational establishment or centre based childcare facility*

2. *Before determining a development application for development to which this clause applies, the consent authority must take into consideration any guidelines that are issued by the Secretary for the purposes of this clause and published in the Gazette.*

3. *If the development is for the purposes of residential accommodation, the consent authority must not grant consent to the development unless it is satisfied that appropriate measures will be taken to ensure that the following LAeq levels are not exceeded*

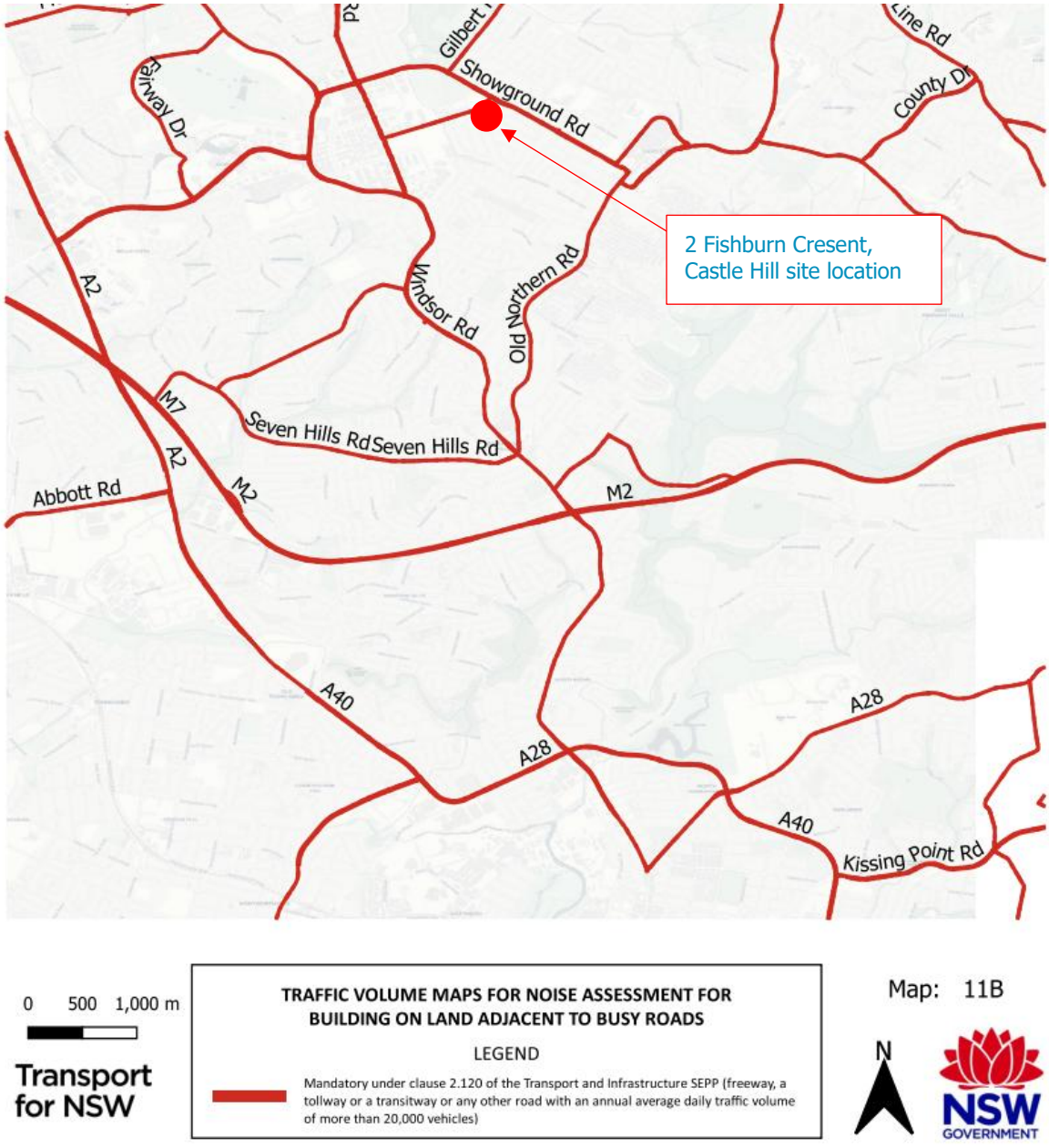
    a) *In any bedroom in the residential accommodation—35 dB(A) at any time between 10.00 pm and 7.00 am,*

    b) *Anywhere else in the residential accommodation (other than a garage, kitchen, bathroom or hallway)—40 dB(A) at any time.*

4.1.5 NSW Government Legislation – State Environmental Planning Policy (Transport and Infrastructure) 2021

Figure 3 shows the location of the proposed development relative to the nearest surrounding busy roads.

Figure 3 RMS Traffic volume map – Extract.



As evident in Figure 3 above, the project site is within close proximity to a busy road (featuring an AADT of >20,000 vehicles), as such, the SEPP defines the following criterial:

Section 2.120 Impact of road noise or vibration on non-road development states the following:

2.120 Impact of Road Noise or Vibration on non-road development

1. *This section applies to development for any of the following purposes that is on land in or adjacent to a road corridor and that the consent authority considers is likely to be adversely affected by road noise or vibration —*

    a) *Residential Accommodation*

    b) *A place of public worship*

    c) *A hospital*

    d) *An educational establishment or centre based childcare facility*

2. *Before determining a development application for development to which this clause applies, the consent authority must take into consideration any guidelines that are issued by the Secretary for the purposes of this clause and published in the Gazette.*

3. *If the development is for the purposes of residential accommodation, the consent authority must not grant consent to the development unless it is satisfied that appropriate measures will be taken to ensure that the following LAeq levels are not exceeded*

    a) *In any bedroom in the residential accommodation—35 dB(A) at any time between 10.00 pm and 7.00 am,*

    b) *Anywhere else in the residential accommodation (other than a garage, kitchen, bathroom or hallway)—40 dB(A) at any time.*

4.1.6 NSW Department of Planning and Environments Development Near Rail Corridors and Busy Roads – Interim Guideline 2008

NSW Department of Planning's document DNRCBR adopts the same internal noise criteria outlined in the SEPP infrastructure identified above. Table 3.1 from the DNRCBR requires the following airborne noise levels from the operation of the adjacent rail corridors and surrounding road network.

Figure 4 Extract - DNRCBR - Table 3.1.

Table 3.1: Noise criteria

Residential Buildings		
Type of occupancy	Noise Level dBA	Applicable time period
Sleeping areas (bedroom)	35	Night 10 pm to 7 am
Other habitable rooms (excl. garages, kitchens, bathrooms & hallways)	40	At any time
Non–Residential Buildings		
Type of occupancy		Recommended Max Level dBA
Educational Institutions including child care centres		40
Places of Worship		40
Hospitals	- Wards	35
	- Other noise sensitive areas	45

Note: airborne noise is calculated as L_{eq} (9h) (night) and L_{eq} (15h)(day). Groundborne noise is calculated as L_{max} (slow) for 95% of rail pass-by events.

4.1.7 Australian / New Zealand Standard AS/NZS 2107:2016 Acoustics - Recommended design sound levels and reverberation times for building interiors - (AS/NZS 2107:2016)

In relation to design internal noise levels, standard AS/NZS 2107:2016 recommends a range with lower and upper levels (rather than "satisfactory" and "maximum" internal noise levels) for building interiors based on room designation and location of the development relative to external noise sources. This change has occurred due to the fact that sound levels below 'satisfactory' could be interpreted as desirable, but the opposite may in fact be the case. Levels below those which were listed as 'satisfactory' can lead to inadequate acoustic masking resulting in loss of acoustic isolation and speech privacy.

The levels for areas relevant to this development are given in Table 4 below. In this report we will confine our recommendations to dBA levels, however, where the background noise appears to be unbalanced, standard AS/NZS 2107:2016 provides direction in terms of suitable diagnostic tools that can be used to assess the spectrum distribution of the background noise.

Section 6.18 of standard AS/NZ 2107:2016 notes that the presence of discrete frequencies or narrow band signals may cause the sound level to vary spatially within a particular area and be a source of distraction for occupants. Where this occurs, the sound level shall be determined as the highest level measured in the occupied location(s).

If tonal components are significant characteristics of the sound within a measurement time interval, an adjustment shall be applied for that time interval to the measured A-weighted sound pressure level to allow for the additional annoyance. If the background sounds include spectral imbalance, then the RC (Mark II) levels indicated in Table 4 should be referenced (see also Appendix D of AS/NZ 2107:2016 for additional guidance).

Table 4 Recommended design sound levels as per standard AS/NZS 2107:2016.

Type of Occupancy/Activity	Design sound level range ($L_{Aeq,t}$)
Residential Buildings – Houses and apartments in inner city areas or entertainment districts or near major roads	
Apartment common areas (e.g., foyer, lift lobby)	45 to 50
Living areas	35 to 45
Sleeping areas (night time)	35 to 40
Work areas	35 to 45

Generally, where the final noise levels are within +/- 2 dB of the specified level given above, the design criteria will be considered met. Both the upper and lower limits will need to be satisfied especially where privacy is important or where noise intrusion to be avoided.

4.1.8 Project Airborne Noise Requirements

Based on the details included in the section above, the project internal noise levels requirements are summarised in Table 5 below.

Table 5 Project Airborne Internal Noise Level Requirements

Room Type	Internal Environmental Noise Levels (Traffic and Airborne Train Noise) – dB(A) $L_{Aeq\ (period)}$
Residential Buildings	
Apartment common areas (e.g., foyer, lift lobby)	50 dB(A) $L_{Aeq\ (period)}$
Living areas	40 dB(A)$L_{Aeq\ (24\text{-}hour)}$
Sleeping areas (nighttime)	35 dB(A)$L_{Aeq\ (9\text{-}hour)}$
Work areas	40 dB(A)$L_{Aeq\ (period)}$

4.2 Noise Emission Criteria (Operational Criteria)

Noise emissions from the operation of the site impacting on the adjacent land users are outlined below.

4.2.1 The Hills Development Control Plan (DCP) 2012

Following a review of the current The Hills Development Control Plan (DCP) 2012, we note that the document does not contain any applicable numerical acoustic criteria for the assessment of noise emissions from mechanical plant for developments of this kind. As such, in the absence of any applicable requirements, objectives listed in the NSW EPA Noise Policy for Industry (NPfI) 2017 below will be adopted.

4.2.2 NSW EPA Noise Policy for Industry (NPI) 2017

In NSW, the control of noise emissions is the responsibility of Local Governments and the NSW Environment Protection Authority (NSW EPA).

The *Noise Policy for Industry* (NSW NPI) which provides a framework and process for determining external noise criteria for the assessment of noise emission from industrial developments. The NSW NPI criteria for industrial noise sources have two components:

- Controlling the intrusive noise impacts for residents and other sensitive receivers in the short term.
- Maintaining noise level amenity of particular land uses for residents and sensitive receivers in other land uses.

4.2.2.1 Intrusive Noise Impacts (Residential Receivers)

The NSW NPI states that the noise from any single source should not intrude greatly above the prevailing background noise level. Industrial noises are generally considered acceptable if the equivalent continuous (energy-average) A-weighted level of noise from the source (L_{Aeq}), measured over a 15-minute period, does not exceed the background noise level measured in the absence of the source by more than 5 dB(A). This is often termed the Intrusiveness Criterion.

The 'Rating Background Level' (RBL) is the background noise level to be used for assessment purposes and is determined by the methods given in the NSW NPI. Using the rating background noise level approach results in the intrusiveness criterion being met for 90% of the time. Adjustments are to be applied to the level of noise produced by the source that is received at the assessment point where the noise source contains annoying characteristics such as tonality or impulsiveness.

4.2.2.2 Protecting Noise Amenity (All Receivers)

To limit continuing increase in noise levels, the maximum ambient noise level within an area from industrial noise sources should not normally exceed the acceptable noise levels specified in Table 2.2 of the NSW NPI. That is, the ambient L_{Aeq} noise level should not exceed the level appropriate for the particular locality and land use. This is often termed the 'Background Creep' or Amenity Criterion.

The amenity assessment is based on noise criteria specified for a particular land use and corresponding sensitivity to noise. The cumulative effect of noise from industrial sources needs to be considered in assessing the impact. These criteria relate only to other continuous industrial-type noise and do not include road, rail or community noise. If the existing (measured) industrial-type noise level approaches the criterion value, then the NSW NPI sets maximum noise emission levels from new sources with the objective of ensuring that the cumulative levels do not significantly exceed the criterion.

Project amenity noise level for industrial developments is specified as the recommended amenity noise level (Table 2.2 of the NPI) minus 5 dB(A). To standardise the time periods for the intrusiveness and amenity noise levels, this policy assumes that the $L_{Aeq,15min}$ will be taken to be equal to the $L_{Aeq,period}$ + 3 decibels (dB).

Where the resultant project amenity noise level is 10 dB or more lower than the existing industrial noise level, the project amenity noise levels can be set at 10 dB below existing industrial noise levels.

4.2.2.3 Area Classification

The NSW NPI characterises the "Urban Residential" noise environment as an area that has the following characteristics:

- is dominated by 'urban hum' or industrial source noise, where urban hum means the aggregate sound of many unidentifiable, mostly traffic and/or industrial related sound sources

- has through-traffic with characteristically heavy and continuous traffic flows during peak periods

- is near commercial districts or industrial districts

- has any combination of the above

Figure 5 is obtained from the NSW Planning ePlanning Spatial Viewer Zoning Maps and shows the land zoning map of the proposed development and the nearest sensitive receivers.

Figure 5 NSW Planning ePlanning Spatial Viewer Zoning Maps

As shown above, the site and its nearest surrounding receivers are located in an area defined as R4 (High Density Residential). The most appropriate zoning for the site and its surrounding receivers is therefore *Urban Residential*.

For residential and commercial receivers in an urban residential area, the recommended amenity criteria are shown in Table 6 below.

When the existing noise level from industrial noise sources is close to the recommended "Amenity Noise Level" (ANL) given above, noise from the new source must be controlled to preserve the amenity of the area in line with the requirements of the NSW NPI.

Table 6 NSW NPI – Recommended L_{Aeq} Noise Levels from Noise Sources.

Type of Receiver	Indicative Noise Amenity Area	Time of Day[1]	Recommended Amenity Noise Level ($L_{Aeq, period}$)[2] (dBA)
Residence	Urban	Day	60
		Evening	50
		Night	45

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 L_{Aeq} 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.

4.2.2.4 Project Specific NPI Noise Emission Criteria

The intrusive and amenity criteria for industrial noise emissions, derived from the measured data at the logger location toward the western and eastern boundaries of the site, are presented in Table 7. These criteria are nominated for the purpose of determining the operational noise limits for mechanical plant associated with the development which can potentially affect noise sensitive receivers.

For each assessment period, the lower (i.e., the more stringent) of the amenity or intrusive criteria are adopted, which are shown in bold text in Table 7.

Table 7 External noise level criteria in accordance with the NSW NPI (dB(A)).

Location	Time of Day [1]	Project Amenity Noise Level, $L_{Aeq, period}$ [2]	Measured $L_{A90, 15\ min}$ (RBL) [3,4]	Measured $L_{Aeq, period}$ Noise Level	Intrusive $L_{Aeq, 15\ min}$ Criterion for New Sources	Amenity $L_{Aeq, 15\ min}$ Criterion for New Sources
Residential Receivers (Noise Logger 01)	Day	55	52	65	**57**	58
	Evening	45	42	61	**47**	48
	Night	40	33	55	**38**	43
Residential Receivers (Noise Logger 02 (excluding daytime period))	Day	55	-[6]	-[6]	-[6]	**58**
	Evening	45	39	47	**44**	48
	Night	40	30	48	**35**	43

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

Note 2: The L_{Aeq} 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.

Note 3: L_{A90} Background Noise or Rating Background Level.

Note 4: Project Noise Trigger Levels are shown in bold and underlined.

Note 5: As per section 2.3 of the Noise Policy for Industry, the evening and night-time RBL is set to be no greater than the daytime RBL.

Note 6: The L_{Aeq} and L_{A90} levels from the daytime period have not been used to determine any noise level criteria due to the presence of constriction noise occurring across the road. Instead, noise levels for the daytime period are determined from the amenity period only.

4.2.2.5 Maximum Noise Level Event Assessment

The EPA's *Noise Policy for Industry* (NPfI) includes suitable criteria for the assessment of potential sleep awakening events, which have been used as the basis of this report. The policy requires the following:

> ***2.5 Maximum noise level event assessment***
>
> *The potential for sleep disturbance from maximum noise level events from premises during the night-time period needs to be considered. Sleep disturbance is considered to be both awakenings and disturbance to sleep stages.*
>
> *Where the subject development/premises night-time noise levels at a residential location exceed:*
> - *LAeq,15min 40 dB(A) or the prevailing RBL plus 5 dB, whichever is the greater, and/or*
> - *LAFmax 52 dB(A) or the prevailing RBL plus 15 dB, whichever is the greater,*
>
> *A detailed maximum noise level event assessment should be undertaken.*

The detailed assessment should cover the maximum noise level, the extent to which the maximum noise level exceeds the rating background noise level, and the number of times this happens during the night-time period. Some guidance on possible impact is contained in the review of research results in the NSW Road Noise Policy.

Based on the measured noise levels outlined in Section 3.1 the resulting maximum noise level event requirements are:

Noise Logger 01:

- 33 dB(A) $L_{A90\ (10pm\text{-}7am)}$ + 5 dB(A) = 38 dB(A) $L_{Aeq(15\text{-}mins)}$, which is less than 40 dB(A) and therefore the 40 dB(A) will be adopted.
- 33 dB(A) $L_{A90\ (10pm\text{-}7am)}$ + 15 dB(A) = 48 dB(A) $L_{AFMax)}$, which is less than 52 dB(A) and therefore the 52 dB(A) L_{AFMax} will be adopted.

Noise Logger 02:

- 30 dB(A) $L_{A90\ (10pm\text{-}7am)}$ + 5 dB(A) = 35 dB(A) $L_{Aeq(15\text{-}mins)}$, which is less than 40 dB(A) and therefore the 40 dB(A) will be adopted.
- 30 dB(A) $L_{A90\ (10pm\text{-}7am)}$ + 15 dB(A) = 45 dB(A) $L_{AFMax)}$, which is less than 52 dB(A) and therefore the 52 dB(A) L_{AFMax} will be adopted.

4.2.3 NSW DECCW – NSW Road Noise Policy (RNP) 2011

For existing residences and other sensitive land uses affected by additional traffic on existing roads, the NSW Road Noise Policy 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.

4.3 Ground Borne and Vibration Criteria

4.3.1 Ground-Borne Noise

NSW Department of Planning's document DNRCBR adopts the same internal noise criteria outlined in the SEPP infrastructure identified above. Table 3.1 from the DNRCBR requires the following airborne noise levels from the operation of the adjacent rail corridors and surrounding road network.

Figure 6 Extract - DNRCBR - Table 3.1.

Table 3.1: Noise criteria

Residential Buildings		
Type of occupancy	Noise Level dBA	Applicable time period
Sleeping areas (bedroom)	35	Night 10 pm to 7 am
Other habitable rooms (excl. garages, kitchens, bathrooms & hallways)	40	At any time
Non–Residential Buildings		
Type of occupancy		Recommended Max Level dBA
Educational Institutions including child care centres		40
Places of Worship		40
Hospitals	- Wards	35
	- Other noise sensitive areas	45

Note: airborne noise is calculated as L_{eq} (9h) (night) and L_{eq} (15h)(day Groundborne noise is calculated as L_{max} (slow) for 95% of rail pass-by events.

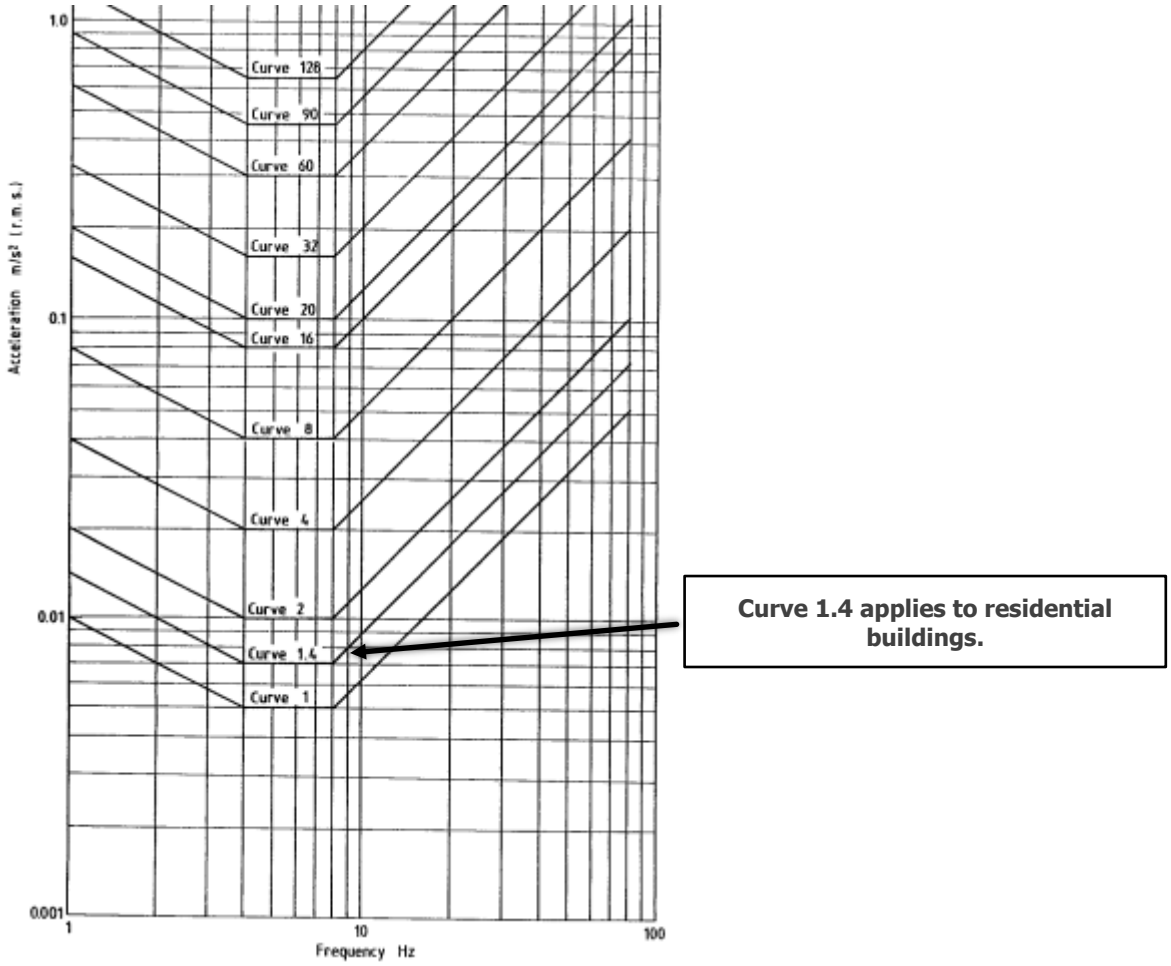
4.3.2 Rail Tactile Vibration

Section 3.6.3 of the DoP Guideline provides recommended vibration criteria in accordance with the German Standard DIN4150 Part 3 1999 and British Standards BS 7385 Part 2 1993. Human comfort is normally assessed with reference to the above British Standard or Australian Standard AS 2670.2 1990.

After reviewing the aforementioned documents, the standards for evaluating the impact of train passby, tactile vibration on the proposed development have been determined and measured according to the *Assessing Vibration: A technical guideline (Department of Environment and Conservation, 2006) and British Standard BS6472:1992 "Evaluation of Human Exposure to Vibration in Buildings (1 Hz to 80 Hz)*

Table 8 displays the standards outlined in the *British Standard BS6472:1992* for consistent vibration in residential areas, office spaces, and commercial workshops.

Table 8 Building vibration z-axis curves from acceleration (R.M.S)



The Department of Planning Development Near Rail Corridor and Busy Roads – Interim Guideline (DNRCBR) references to "Assessing Vibration – A Technical Guideline".

Vibration effects relating specifically to the human comfort aspects of the project are taken from the guideline titled *"Assessing Vibration – A Technical Guideline"*. (AVTG). The AVTG recommends that habitable rooms should comply with the criteria therein which is in line with the requirements of British Standard BS 6472:1992 "*Evaluation of Human Exposure to Vibration in Buildings (1 Hz to 80 Hz)*".

The British Standard details suitable criteria for the assessment of intermittent vibrations to prevent advise impacts on future residence.

Table 9 Intermittent vibration impacts criteria (m/s1.75) 1 Hz-80 Hz, Vibration Dose Values (VDV)

Measurement Location	Daytime		Night-Time	
	Preferred Values	Maximum Values	Preferred Values	Maximum Values
Residences	**0.20**	0.40	**0.13**	0.26

For the purpose of this assessment the *Preferred Values* detailed in the standard have been used as the criteria used in this assessment.

5 TRAIN VIBRATION ASSESSMENT

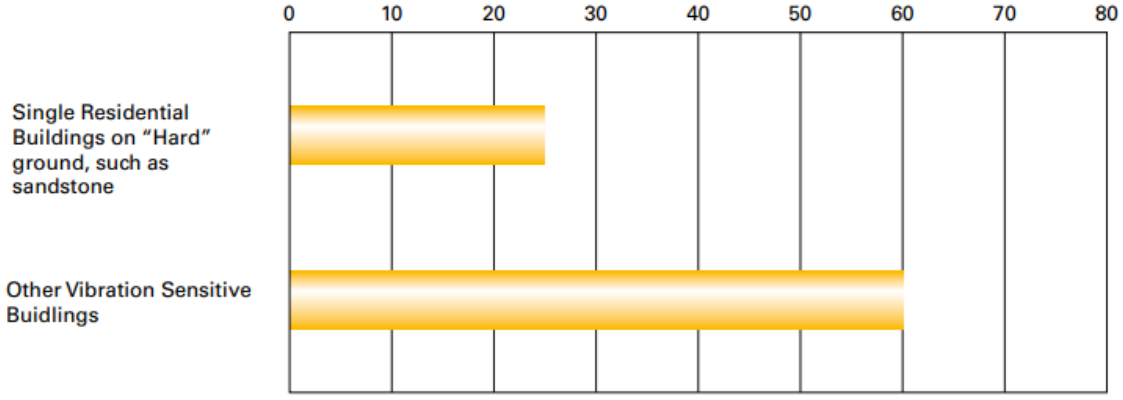
As outlined in the site description section above the site is adjacent to an existing below ground Sydney Metro rail tunnel, as such assessment of vibration from the Metro tunnel will be assessed.

5.1 Existing Rail Corridor – Sydney Northwest Metro

This section of the report details the consideration for possible impacts from the existing below ground Metro line located to the north of the proposed project site.

The distance from the proposed site boundary to the railway tunnel indicates that the site is within the distances required for a vibration assessment based on Section 3.5.1 of the *Development Near Rail Corridors and Busy Roads – Interim Guideline*. The distance requirement for a vibration assessment is shown in Figure 7.

Figure 7 Vibration Assessment Zones based on Distance (m) of Sensitive Development from Operational Track (Not Corridor).

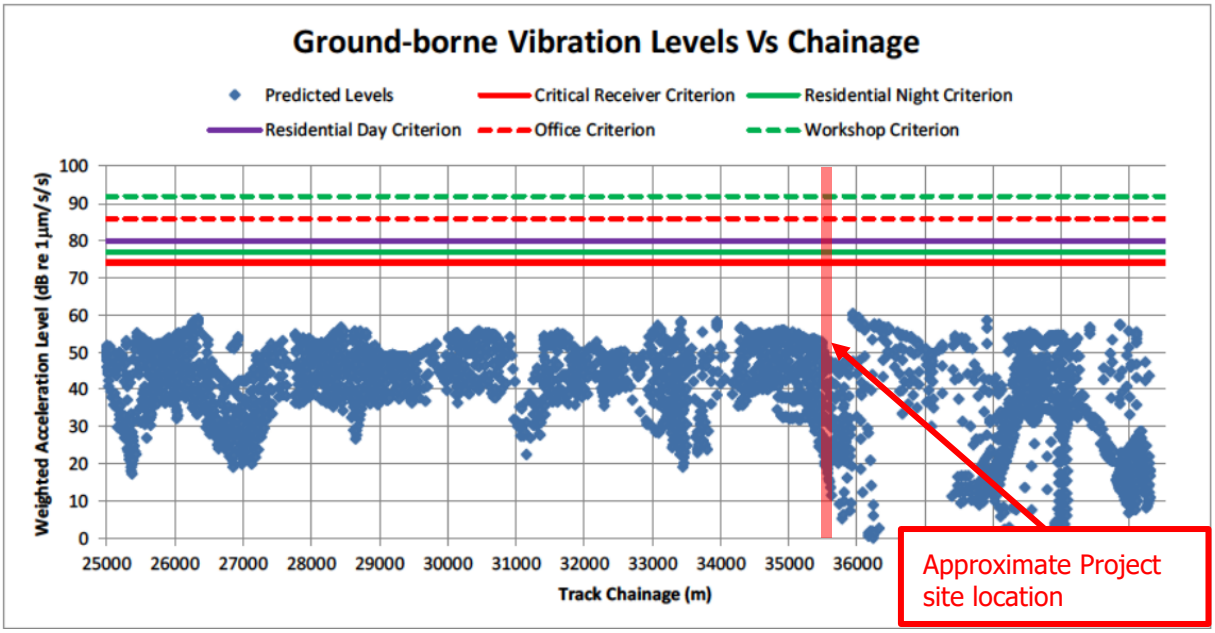


5.2 Existing Rail Corridor – Sydney Metro – Northwest – Tactile vibration levels

An existing Northwest Sydney Metro rail corridor is located approximately 30 m to the north of the property boundary. As such, reference to the submitted Operational Noise and Vibration Review (ONVR) submitted to the NSW Department of Planning (DoP) has been conducted. Report reference: NWRLOTS-NRT-SWD-AV-RPT-105008 Rev A, dated February 2017 prepared by Renzo Tonin & Associates Pty Ltd.

Extensive ground-borne vibration modelling has been conducted by Renzo Tonin & Associates with predicted ground-borne vibration levels for the project site depicted in Figure 8 below.

Figure 8 Predicted tactile vibration levels (weighted acceleration) – Extract.



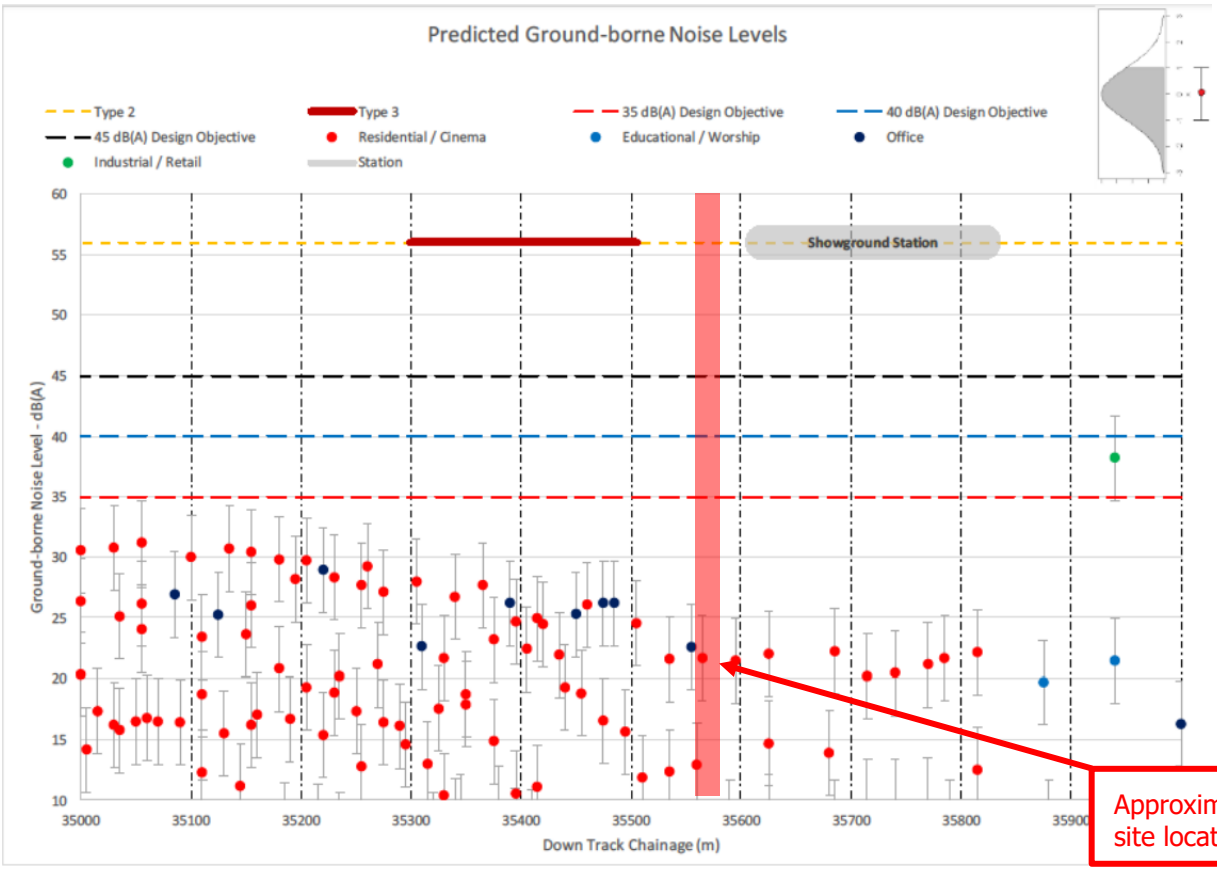
As illustrated within Figure 8 above, the ground-borne vibration predictions conducted by Renzo Tonin & Associates does not predict any exceedances of the tactile vibration criteria for the development site with the proposed track types proposed to be used. As such, no additional mitigation measures are required to reach the ground-borne vibration criteria for the proposed residential development.

5.3 Existing Rail Corridor – Sydney Metro – Northwest – Ground-borne noise

An existing Northwest Sydney Metro rail corridor is located approximately 30 m to the north of the property boundary. As such, reference to the submitted Operational Noise and Vibration Review (ONVR) submitted to the NSW Department of Planning (DoP) has been conducted. Report reference: NWRLOTS-NRT-SWD-AV-RPT-105008 Rev A, dated February 2017 prepared by Renzo Tonin & Associates Pty Ltd.

Extensive ground borne noise modelling has been conducted by Renzo Tonin & Associates with predicted ground borne noise levels for the project site depicted in Figure 9 below.

Figure 9 Predicted ground-borne noise levels – Extract.



Based on the theoretical predictions provided within the Operational Noise and Vibration Review by Renzo Tonin & Associates, the ground-borne noise criteria is not expected to be exceeded by the nearby Northwest Metro development. Hence, no additional building treatments are required to achieve the internal ground-borne noise criteria.

6 BUILDING ACOUSTIC ASSESSMENT

In addressing all the criteria shown above, preliminary façade acoustic treatments based on the external levels from surrounding roads and other environmental noise sources as discussed in Section 2 above are provided below.

6.1 Building Envelope Assessment

6.1.1 Glazing Recommendations

The recommended sound transmission loss requirement required to satisfy the specified internal noise level criteria outlined above are summarised in the table below.

Table 10 In-principle Glazing Recommendations.

Level	Façade Orientation	Occupancy Type	Minimum Glazing System Rating Requirements	Indicative Construction
All levels featuring residential dwellings	North	Residential	Rw (C;Ctr): 35 (0;-3)	10.38 mm Laminated **OR** 6 mm float / 12 mm airgap / 10 mm float
	East	Residential	Rw (C;Ctr): 35 (0;-3)	10.38 mm Laminated **OR** 6 mm float / 12 mm airgap / 10 mm float
	South	Residential	Rw (C;Ctr): 31	6.38 mm Laminated
	West	Residential	Rw (C;Ctr): 35 (0;-3)	10.38 mm Laminated **OR** 6 mm float / 12 mm airgap / 10 mm float

Please note for windows, this performance is not only subject to the glazing selection but also to the construction of the window frame and the frame seal selection. Therefore, it is recommended that the window manufacturer should confirm that the required sound insulation can be achieved. It is anticipated that the window system should comprise Q-Lon (or equivalent) or fin seals with deep C channels as part of the window track **(i.e., Performance levels outlined above need to be achieved with glazed panels + frame + seals).**

A detailed review of the glazing assessment should be conducted during the design phase of the project.

6.1.2 External Wall Construction

If external wall constructions are to be constructed from a masonry construction, compliance with the internal noise criteria will be achieved. If penetrations through any external skin are required, all gaps remaining in the penetration are to be filled with an acoustic grade sealant which provides an equal or better performance to the system being penetrated.

Any light-weight external plasterboard walls should be constructed with a minimum acoustic performance of Rw 45.

A detailed review of the façade should be assessed during the design phase of the project.

6.1.3 External Roof Construction

External roofing system will be a concrete construction. As such, no further acoustic treatments are required. If penetrations through any external skin are required, all gaps remaining in the penetration are to be filled with an acoustic grade sealant which provides an equal or better performance to the system being penetrated.

A detailed review of the roof should be assessed during the design phase of the project.

6.1.4 Open Windows Assessment

The internal design sound levels detailed above are achieved with the external building openings closed to the façade elements of dwellings.

Based on the requirements of the Department of Planning *Development Near Rail Corridor and Busy Roads – Interim Guideline* (road traffic noise) the trigger for the requirement of an alternative outside air is required where internal noise levels with the windows open for ventilation are 10 dB(A) above design noise levels.

Based on the noise level survey of the site the trigger for an alternative outside air includes dwellings with a faced opening including those detailed in the figure below:

Figure 10 Location of Required Alterative Outside Air

The method of providing an alternative method of outside air ventilation is required to be provided in accordance with relevant regulations including the Building Code of Australia and AS1668.

As part of the proposed development the provision for an alternative outside air source to all residential dwellings is required. The options for the proposed alternative source of ventilation are discussed below:

1. The acoustic design of the building includes performance of glass and solid façade elements which will ensure internal noise levels with operable windows closed will achieve internal noise level requirements and ensure a suitable acoustic amenity for future residence.
    a. The use of the operable windows and doors could be used to provide ventilation/cross ventilation to the units. This can be undertaken by opening the operable elements of the façade at the discretion of the future occupants.
2. In the event occupants choose to keep the windows closed, an alternative source of outside air will be provided to the residential dwellings. The method of providing an alternative outside air will include a design which is in accordance with AS1668 and does not reduce the acoustic performance of the building's external façade. Possible methods of providing an alternative outside air source include one of the following:
    a. The use of a mechanical system to provide outside air such as a dedicated fan or the use of the fan within a units FCU including an outside air source (which would not be required to condition air to provide outside air to the unit).
    b. Provision of an outside air source to the intake air side of the Fan Coil Units (FCU) located in the ceiling space of each apartment. The outside air is mixed with the return air in the return air plenum and provided to the dwelling using the fan of the FCU which can operate with or without air conditioning being functional.
    c. Provision of outside air via a dedicated supply air fan which can be operated at the discretion of future occupants.
    d. Other methods of outside air supply which are compliant with the requirements of the Australian Standard AS1668.2.

6.2 Noise from Engineering Services

At this stage of the project, the exact locations of key plant items, and the selection of items to be installed, have not been selected. As such, a detailed assessment of noise associated with engineering services cannot be undertaken.

All future plant and equipment are to be acoustically treated to ensure the noise levels at all surrounding receivers and internal receivers comply with noise emission and intrusion criteria detailed within this report. Experience with similar projects indicates that it is both possible and practical to treat all mechanical equipment such that the relevant noise levels are achieved. Examples of the possible acoustic treatments to mechanical equipment includes the following:

- Supply and Exhaust Fans – location of fans within the building and treated using internally lined ductwork or acoustic silencers.
- General supply and exhaust fans – general exhaust and supply fans such as toilet, kitchen, lobby and other small mechanical fans can be acoustically treated using acoustic flex ducting or internally lined ducting.
- Residential Condensers – The project may include external residential condenser units which will likely be located on the roof-top or individually balconies. Providing condenser equipment is selected using suitable noise level data, then acoustic treatments can be implemented such as screening and treatment to exhaust to ensure that the relevant noise emission criteria will be achieved.

Details of the required mechanical services equipment and acoustic treatments to ensure the relevant noise level criteria is achieved will be provided as part of the CC submission of the project.

Experience with similar projects indicates that the acoustic treatment of whatever mechanical equipment is to be installed on the project is both possible and practical, in order to meet the relevant criteria at surrounding receivers, as well as the relevant noise intrusion criteria for internal receivers within the development.

6.3 Noise from Additional Vehicles on Surrounding Road Network

Noise impacts from the increase in vehicle movements along Carrington Road, Middleton Avenue, and Sexton Avenue are to be assessed in accordance with the NSW EPA Road Noise Policy (RNP) 2011.

A peak hour increase proposed for the number vehicles associated with the development will not exceed a 2 dB(A) increase at a residential receiver as summarised in the NSW EPA RNP to be barely perceptible to the average person and therefore considered acoustically acceptable.

6.4 Noise Associated with Loading Dock

A lower ground level loading dock is proposed within the southern half of the development. From our review the operation of the loading dock during daytime and evening times will not result in an adverse impact on the existing acoustic amenity. Additionally, the residential dwellings located within close proximity to the lading dock / ramp currently do not feature any windows / openings.

It is recommended that the loading dock is not used during the night period of 10:00 pm and 7:00 am.

6.5 Noise Associated with Vehicle Basement Movements

A review of the noise created by vehicles manoeuvring around the basement has been undertaken as part of the assessment. From our review we can confirm vehicle manoeuvring around the basement will comply with the requirements listed in the NSW EPA *Noise Policy for Industry (NPfI) 2017*.

7 CONSTRUCTION NOISE AND VIBRATION IMPACTS

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

7.1 Construction Noise Criteria

7.1.1 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 in order 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 11 NMLs for quantitative assessment at residences.

Time of Day	Noise Management Level $L_{Aeq(15minute)}$[1,2]	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.
Outside recommended standard hours	Noise affected RBL + 5 dB	• A strong justification would typically be required for works outside the recommended standard hours. • The proponent should apply all feasible and reasonable work practices to meet the noise affected level. • Where all feasible and reasonable practices have been applied and noise is more than 5 dB above the noise affected level, the proponent should negotiate with the community.
	"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.

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).*

The ICNG also provides NMLs for non-residential land uses. Unlike residential receivers, these criteria are fixed levels, independent of local background noise levels. Presented in Table 12 below are the NMLs for non-residential land uses.

Table 12 Construction noise management levels – other receivers.

Land use	Location applied	Noise management level, $L_{Aeq,15min}$
Classrooms at school and other educations institutions	Internal noise level	45 dB(A)
Hospital wards and operating theatres	Internal noise level	45 dB(A)
Places of worship	Internal noise level	45 dB(A)
Active recreation areas (characterised by sporting activities and activities which generate their own noise or focus for participants, making them less sensitive to external noise intrusion)	External noise level	65 dB(A)
Passive recreation areas (characterised by contemplative activities that generate little noise and where benefits are compromised by external noise intrusion, for example, reading, meditation)	External noise level	60 dB(A)
Community centres	Refer to the recommended "maximum" internal levels in AS2107 for specific uses	
Industrial premises	External noise level	75 dB(A)
Offices, retail outlets	External noise level	70 dB(A)

Based on the measured background noise levels summarised in Section 3, and the NMLs outlined above the construction noise criteria to be used in this assessment are listed in Table 13 below.

Table 13 NMLs as basis for the acoustic assessment.

Receiver Types	NML, dB $L_{Aeq(15minute)}$		
	Standard Hours Monday to Friday: 7:00am to 6:00pm Saturday: 8:00am to 1:00pm	Outside Standard Hours	
		6:00pm to 10:00pm	10:00pm to 7:00am
Receiver 01 – Residential	**62** / *HNAL* = 75	47	38
Receiver 02 – Residential	**62** / *HNAL* = 75	47	38
Receiver 03 – Residential	**62** / *HNAL* = 75	47	38
Receiver 04 – Residential	**62** / *HNAL* = 75	47	38
Receiver 05 – Residential	**62** / *HNAL* = 75	47	38
Receiver 06 – Residential	**62** / *HNAL* = 75	47	38
Receiver 07 – Residential	**62** / *HNAL* = 75	47	38
Receiver 08 – Residential	**62**[1] / *HNAL* = 75	44	35
Receiver 09 – Residential	**62**[1] / *HNAL* = 75	44	35
Receiver 10 – Residential	**62**[1] / *HNAL* = 75	44	35
Receiver 11 – Residential	**62**[1] / *HNAL* = 75	44	35

Note 1: The L_{Aeq} and L_{A90} levels from the daytime period have not been used to determine any noise level criteria due to the presence of construction noise occurring across the road.

7.1.2 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.

7.2 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 7.2.1.
- Effects on building contents – where vibration can cause damage to fixtures, fittings and other non-building related objects. Refer to further discussion in Section 7.2.2.
- Effects on building structures – where vibration can compromise the integrity of the building or structure itself. Refer to further discussion in Section 7.2.2.

7.2.1 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 14).
- Impulsive vibration – up to three instances of sudden impact e.g. dropping heavy items, per monitoring period (refer to Table 15).
- Intermittent vibration – such as from drilling, compacting or activities that would result in continuous vibration if operated continuously (refer to Table 16 below).

Table 14 Continuous vibration acceleration criteria (m/s^2) 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 15 Impulsive vibration acceleration criteria (m/s^2) 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 16 Intermittent vibration impacts criteria (m/s$^{1.75}$) 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	0.80	1.60

7.2.2 Vibration Criteria – Building Contents and Structure

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

- For continuous or repetitive vibration: German DIN 4150: Part 3 – 1999 *"Effects of Vibration on Structure"* (DIN 1999).

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 17 and illustrated in Figure 11.

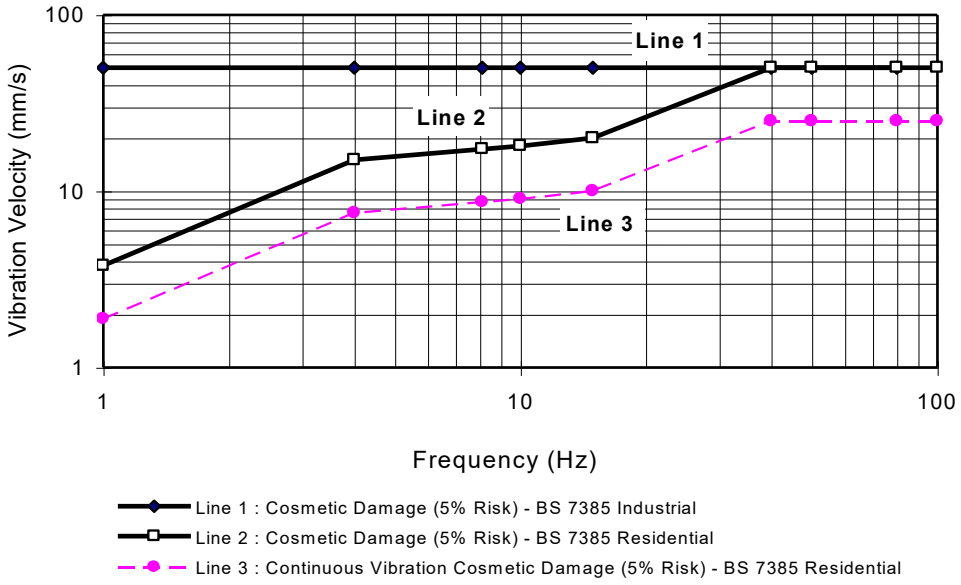
Table 17 Transient vibration criteria as per standard BS 7385 Part 2 – 1993.

Line in Figure 11	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 17 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 17 may need to be reduced by up to 50% (refer to Line 3 in Figure 11).

Figure 11 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 17, 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, including the impact of repetitive vibration impacts, (in respect of the fatigue life of building materials) then the values in Table 17 should not be reduced for fatigue considerations.

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 18. The criteria are frequency dependent and specific to particular categories of structures.

Table 18 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 Hz[1]	
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 100 Hz, at least the values specified in this column shall be applied.

7.3 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.

7.4 Project Vibration Criteria

Based on the details included in the points above, the project specific construction vibration criteria is recommended to include the following:

1. Neighbouring buildings – 7.5 mm/s.

7.5 Noise and vibration assessment

7.6 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 19 below.

Table 19 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	Excavator	112	119
	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.

Table 20 Receiver – 01 – Residential – Summary of preliminary 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 $L_{Aeq\ 15\ minutes}$	Summary of Result
Site Establishment Works	Mobile crane	113	57 to 72	60 to 75	**Standard Construction Hours:** **Monday to Friday** 07:00-18:00 = 62 **Outside Standard Hours:** 18:00-20:00 = 47 20:00-07:00 = 38 **Highly Noise Affected Level** Standard Construction Hours **75**	Works indicatively predicted to be non-compliant with the Noise Management Level (BG + 10 dB(A)), and above the Highly Noise Affected Level of 75 dB(A) during peak standard construction hours in accordance with the application of the EPA *Interim Construction Noise Guideline.*
	Power hand tools		56 to 71			
	Semi Rigid Vehicle		48 to 63			
Ground Works and Demolition	Excavator	119	59 to 74	64 to 79		
	Handheld jack hammer		65 to 80			
	Dump truck		57 to 72			
	Concrete saw		54 to 69			
	Skid steer		47 to 62			
	Power hand tools		57 to 72			
Structure	Handheld jack hammer	117	57 to 72	63 to 78		
	Concrete saw		56 to 71			
	Power hand tools		49 to 64			
	Welder		57 to 72			
	Concrete pump truck		56 to 71			
	Concrete agitator truck		48 to 63			
Internal Works	Power hand tools	109	57 to 72	51 to 66		
Common and External Works	Concrete agitator truck	117	55 to 70	61 to 76		
	Saw cutter		51 to 66			
	Dump truck		55 to 70			
	Concrete saw		47 to 62			
	Power hand tools		47 to 62			

Table 21 Receiver – 02 – Residential – Summary of preliminary 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 $L_{Aeq\ 15\ minutes}$	Summary of Result
Site Establishment Works	Mobile crane	113	58 to 72	61 to 75	**Standard Construction Hours:** **Monday to Friday** 07:00-18:00 = 62 **Outside Standard Hours:** 18:00-20:00 = 47 20:00-07:00 = 38 **Highly Noise Affected Level** Standard Construction Hours **75**	Works indicatively predicted to be non-compliant with the Noise Management Level (BG + 10 dB(A)), and above the Highly Noise Affected Level of 75 dB(A) during peak standard construction hours in accordance with the application of the EPA *Interim Construction Noise Guideline.*
	Power hand tools		57 to 71			
	Semi Rigid Vehicle		48 to 63			
Ground Works and Demolition	Excavator	119	60 to 74	65 to 79		
	Handheld jack hammer		66 to 80			
	Dump truck		58 to 72			
	Concrete saw		54 to 69			
	Skid steer		47 to 62			
	Power hand tools		57 to 72			
Structure	Handheld jack hammer	117	58 to 72	64 to 78		
	Concrete saw		57 to 71			
	Power hand tools		49 to 64			
	Welder		57 to 72			
	Concrete pump truck		57 to 71			
	Concrete agitator truck		49 to 63			
Internal Works	Power hand tools	109	58 to 72	52 to 66		
Common and External Works	Concrete agitator truck	117	56 to 70	62 to 76		
	Saw cutter		52 to 66			
	Dump truck		56 to 70			
	Concrete saw		47 to 62			
	Power hand tools		47 to 62			

Table 22 Receiver – 03 – Residential – Summary of preliminary 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 $L_{Aeq\ 15\ minutes}$	Summary of Result
Site Establishment Works	Mobile crane	113	59 to 72	62 to 75	**Standard Construction Hours:** **Monday to Friday** 07:00-18:00 = 62 **Outside Standard Hours:** 18:00-20:00 = 47 20:00-07:00 = 38 **Highly Noise Affected Level** Standard Construction Hours **75**	Works indicatively predicted to be non-compliant with the Noise Management Level (BG + 10 dB(A)), and above the Highly Noise Affected Level of 75 dB(A) during peak standard construction hours in accordance with the application of the EPA *Interim Construction Noise Guideline.*
	Power hand tools		58 to 71			
	Semi Rigid Vehicle		49 to 63			
Ground Works and Demolition	Excavator	119	61 to 74	66 to 79		
	Handheld jack hammer		67 to 80			
	Dump truck		59 to 72			
	Concrete saw		55 to 69			
	Skid steer		48 to 62			
	Power hand tools		58 to 72			
Structure	Handheld jack hammer	117	59 to 72	64 to 78		
	Concrete saw		58 to 71			
	Power hand tools		50 to 64			
	Welder		58 to 72			
	Concrete pump truck		58 to 71			
	Concrete agitator truck		50 to 63			
Internal Works	Power hand tools	109	59 to 72	53 to 66		
Common and External Works	Concrete agitator truck	117	57 to 70	63 to 76		
	Saw cutter		53 to 66			
	Dump truck		57 to 70			
	Concrete saw		48 to 62			
	Power hand tools		48 to 62			

Table 23 Receiver – 04 – Residential – Summary of preliminary 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 $L_{Aeq\ 15\ minutes}$	Summary of Result
Site Establishment Works	Mobile crane	113	58 to 72	60 to 75	**Standard Construction Hours:** **Monday to Friday** 07:00-18:00 = 62 **Outside Standard Hours:** 18:00-20:00 = 47 20:00-07:00 = 38 **Highly Noise Affected Level** Standard Construction Hours **75**	Works indicatively predicted to be non-compliant with the Noise Management Level (BG + 10 dB(A)), and above the Highly Noise Affected Level of 75 dB(A) during peak standard construction hours in accordance with the application of the EPA *Interim Construction Noise Guideline.*
	Power hand tools		57 to 71			
	Semi Rigid Vehicle		48 to 63			
Ground Works and Demolition	Excavator	119	60 to 74	64 to 79		
	Handheld jack hammer		66 to 80			
	Dump truck		58 to 72			
	Concrete saw		54 to 69			
	Skid steer		47 to 62			
	Power hand tools		57 to 72			
Structure	Handheld jack hammer	117	58 to 72	63 to 78		
	Concrete saw		57 to 71			
	Power hand tools		49 to 64			
	Welder		57 to 72			
	Concrete pump truck		57 to 71			
	Concrete agitator truck		49 to 63			
Internal Works	Power hand tools	109	58 to 72	52 to 66		
Common and External Works	Concrete agitator truck	117	56 to 70	62 to 76		
	Saw cutter		52 to 66			
	Dump truck		56 to 70			
	Concrete saw		47 to 62			
	Power hand tools		47 to 62			

Table 24 Receiver – 05 – Residential – Summary of preliminary 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 $L_{Aeq\ 15\ minutes}$	Summary of Result
Site Establishment Works	Mobile crane	113	57 to 72	60 to 75	**Standard Construction Hours:** **Monday to Friday** 07:00-18:00 = 62 **Outside Standard Hours:** 18:00-20:00 = 47 20:00-07:00 = 38 **Highly Noise Affected Level** Standard Construction Hours **75**	Works indicatively predicted to be non-compliant with the Noise Management Level (BG + 10 dB(A)), and above the Highly Noise Affected Level of 75 dB(A) during peak standard construction hours in accordance with the application of the EPA *Interim Construction Noise Guideline.*
	Power hand tools		56 to 71			
	Semi Rigid Vehicle		47 to 63			
Ground Works and Demolition	Excavator	119	59 to 74	64 to 79		
	Handheld jack hammer		65 to 80			
	Dump truck		57 to 72			
	Concrete saw		53 to 69			
	Skid steer		46 to 62			
	Power hand tools		56 to 72			
Structure	Handheld jack hammer	117	57 to 72	62 to 78		
	Concrete saw		56 to 71			
	Power hand tools		48 to 64			
	Welder		56 to 72			
	Concrete pump truck		56 to 71			
	Concrete agitator truck		48 to 63			
Internal Works	Power hand tools	109	57 to 72	51 to 66		
Common and External Works	Concrete agitator truck	117	55 to 70	61 to 76		
	Saw cutter		51 to 66			
	Dump truck		55 to 70			
	Concrete saw		46 to 62			
	Power hand tools		46 to 62			

Table 25 Receiver – 06 – Residential – Summary of preliminary 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 $L_{Aeq\ 15\ minutes}$	Summary of Result
Site Establishment Works	Mobile crane	113	56 to 72	59 to 75	**Standard Construction Hours:** **Monday to Friday** 07:00-18:00 = 62 **Outside Standard Hours:** 18:00-20:00 = 47 20:00-07:00 = 38 **Highly Noise Affected Level** Standard Construction Hours **75**	Works indicatively predicted to be non-compliant with the Noise Management Level (BG + 10 dB(A)), and above the Highly Noise Affected Level of 75 dB(A) during peak standard construction hours in accordance with the application of the EPA *Interim Construction Noise Guideline.*
	Power hand tools		55 to 71			
	Semi Rigid Vehicle		46 to 63			
Ground Works and Demolition	Excavator	119	58 to 74	63 to 79		
	Handheld jack hammer		64 to 80			
	Dump truck		56 to 72			
	Concrete saw		52 to 69			
	Skid steer		45 to 62			
	Power hand tools		55 to 72			
Structure	Handheld jack hammer	117	56 to 72	61 to 78		
	Concrete saw		55 to 71			
	Power hand tools		47 to 64			
	Welder		55 to 72			
	Concrete pump truck		55 to 71			
	Concrete agitator truck		47 to 63			
Internal Works	Power hand tools	109	56 to 72	50 to 66		
Common and External Works	Concrete agitator truck	117	54 to 70	60 to 76		
	Saw cutter		50 to 66			
	Dump truck		54 to 70			
	Concrete saw		45 to 62			
	Power hand tools		45 to 62			

Table 26 Receiver – 07 – Residential – Summary of preliminary 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 $L_{Aeq\ 15\ minutes}$	Summary of Result
Site Establishment Works	Mobile crane	113	55 to 72	58 to 75	**Standard Construction Hours:** **Monday to Friday** 07:00-18:00 = 62 **Outside Standard Hours:** 18:00-20:00 = 47 20:00-07:00 = 38 **Highly Noise Affected Level** Standard Construction Hours **75**	Works indicatively predicted to be non-compliant with the Noise Management Level (BG + 10 dB(A)), and above the Highly Noise Affected Level of 75 dB(A) during peak standard construction hours in accordance with the application of the EPA *Interim Construction Noise Guideline.*
	Power hand tools		54 to 71			
	Semi Rigid Vehicle		45 to 63			
Ground Works and Demolition	Excavator	119	57 to 74	62 to 79		
	Handheld jack hammer		63 to 80			
	Dump truck		55 to 72			
	Concrete saw		51 to 69			
	Skid steer		44 to 62			
	Power hand tools		54 to 72			
Structure	Handheld jack hammer	117	55 to 72	61 to 78		
	Concrete saw		54 to 71			
	Power hand tools		46 to 64			
	Welder		54 to 72			
	Concrete pump truck		54 to 71			
	Concrete agitator truck		46 to 63			
Internal Works	Power hand tools	109	55 to 72	49 to 66		
Common and External Works	Concrete agitator truck	117	53 to 70	59 to 76		
	Saw cutter		49 to 66			
	Dump truck		53 to 70			
	Concrete saw		44 to 62			
	Power hand tools		44 to 62			

Table 27 Receiver – 08 – Residential – Summary of preliminary 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 $L_{Aeq\ 15\ minutes}$	Summary of Result
Site Establishment Works	Mobile crane	113	56 to 76	59 to 79	**Standard Construction Hours:** **Monday to Friday** 07:00-18:00 = 62 **Outside Standard Hours:** 18:00-20:00 = 44 20:00-07:00 = 35 **Highly Noise Affected Level** Standard Construction Hours **75**	Works indicatively predicted to be non-compliant with the Noise Management Level (BG + 10 dB(A)), and above the Highly Noise Affected Level of 75 dB(A) during peak standard construction hours in accordance with the application of the EPA *Interim Construction Noise Guideline.*
	Power hand tools		55 to 75			
	Semi Rigid Vehicle		47 to 66			
Ground Works and Demolition	Excavator	119	58 to 78	63 to 83		
	Handheld jack hammer		64 to 84			
	Dump truck		56 to 76			
	Concrete saw		53 to 72			
	Skid steer		46 to 65			
	Power hand tools		56 to 75			
Structure	Handheld jack hammer	117	56 to 76	62 to 81		
	Concrete saw		55 to 75			
	Power hand tools		48 to 67			
	Welder		56 to 75			
	Concrete pump truck		55 to 75			
	Concrete agitator truck		47 to 67			
Internal Works	Power hand tools	109	56 to 76	50 to 70		
Common and External Works	Concrete agitator truck	117	54 to 74	60 to 80		
	Saw cutter		50 to 70			
	Dump truck		54 to 74			
	Concrete saw		46 to 65			
	Power hand tools		46 to 65			

Table 28 Receiver – 09 – Residential – Summary of preliminary 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 $L_{Aeq\ 15\ minutes}$	Summary of Result
Site Establishment Works	Mobile crane	113	59 to 76	62 to 79	**Standard Construction Hours:** **Monday to Friday** 07:00-18:00 = 62 **Outside Standard Hours:** 18:00-20:00 = 44 20:00-07:00 = 35 **Highly Noise Affected Level** Standard Construction Hours **75**	Works indicatively predicted to be non-compliant with the Noise Management Level (BG + 10 dB(A)), and above the Highly Noise Affected Level of 75 dB(A) during peak standard construction hours in accordance with the application of the EPA *Interim Construction Noise Guideline.*
	Power hand tools		58 to 75			
	Semi Rigid Vehicle		49 to 66			
Ground Works and Demolition	Excavator	119	61 to 78	66 to 83		
	Handheld jack hammer		67 to 84			
	Dump truck		59 to 76			
	Concrete saw		55 to 72			
	Skid steer		48 to 65			
	Power hand tools		58 to 75			
Structure	Handheld jack hammer	117	59 to 76	65 to 81		
	Concrete saw		58 to 75			
	Power hand tools		50 to 67			
	Welder		58 to 75			
	Concrete pump truck		58 to 75			
	Concrete agitator truck		50 to 67			
Internal Works	Power hand tools	109	59 to 76	53 to 70		
Common and External Works	Concrete agitator truck	117	57 to 74	63 to 80		
	Saw cutter		53 to 70			
	Dump truck		57 to 74			
	Concrete saw		48 to 65			
	Power hand tools		48 to 65			

Table 29 Receiver – 10 – Residential – Summary of preliminary 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 $L_{Aeq\ 15\ minutes}$	Summary of Result
Site Establishment Works	Mobile crane	113	58 to 88	61 to 91	**Standard Construction Hours:** **Monday to Friday** 07:00-18:00 = 62 **Outside Standard Hours:** 18:00-20:00 = 44 20:00-07:00 = 35 **Highly Noise Affected Level** Standard Construction Hours **75**	Works indicatively predicted to be non-compliant with the Noise Management Level (BG + 10 dB(A)), and above the Highly Noise Affected Level of 75 dB(A) during peak standard construction hours in accordance with the application of the EPA *Interim Construction Noise Guideline.*
	Power hand tools		57 to 87			
	Semi Rigid Vehicle		48 to 78			
Ground Works and Demolition	Excavator	119	60 to 90	65 to 95		
	Handheld jack hammer		66 to 96			
	Dump truck		58 to 88			
	Concrete saw		54 to 84			
	Skid steer		47 to 77			
	Power hand tools		57 to 87			
Structure	Handheld jack hammer	117	58 to 88	63 to 93		
	Concrete saw		57 to 87			
	Power hand tools		49 to 79			
	Welder		57 to 87			
	Concrete pump truck		57 to 87			
	Concrete agitator truck		49 to 79			
Internal Works	Power hand tools	109	58 to 88	52 to 82		
Common and External Works	Concrete agitator truck	117	56 to 86	62 to 92		
	Saw cutter		52 to 82			
	Dump truck		56 to 86			
	Concrete saw		47 to 77			
	Power hand tools		47 to 77			

Table 30 Receiver – 11 – Residential – Summary of preliminary 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 $L_{Aeq\ 15\ minutes}$	Summary of Result
Site Establishment Works	Mobile crane	113	58 to 88	61 to 91	**Standard Construction Hours:** **Monday to Friday** 07:00-18:00 = 62 **Outside Standard Hours:** 18:00-20:00 = 44 20:00-07:00 = 35 **Highly Noise Affected Level** Standard Construction Hours **75**	Works indicatively predicted to be non-compliant with the Noise Management Level (BG + 10 dB(A)), and above the Highly Noise Affected Level of 75 dB(A) during peak standard construction hours in accordance with the application of the EPA *Interim Construction Noise Guideline.*
	Power hand tools		57 to 87			
	Semi Rigid Vehicle		48 to 78			
Ground Works and Demolition	Excavator	119	60 to 90	65 to 95		
	Handheld jack hammer		66 to 96			
	Dump truck		58 to 88			
	Concrete saw		54 to 84			
	Skid steer		47 to 77			
	Power hand tools		57 to 87			
Structure	Handheld jack hammer	117	58 to 88	63 to 93		
	Concrete saw		57 to 87			
	Power hand tools		49 to 79			
	Welder		57 to 87			
	Concrete pump truck		57 to 87			
	Concrete agitator truck		49 to 79			
Internal Works	Power hand tools	109	58 to 88	52 to 82		
Common and External Works	Concrete agitator truck	117	56 to 86	62 to 92		
	Saw cutter		52 to 82			
	Dump truck		56 to 86			
	Concrete saw		47 to 77			
	Power hand tools		47 to 77			

7.7 Construction Traffic Noise Assessment

It is proposed that the construction traffic would access the site via Carrington Road, Middleton Avenue, and Sexton Avenue.

From the criteria discussed in Section 4, it is noted that vehicle numbers on surrounding roads would need to increase by around 60% from existing traffic flows, for a 2 dB increase in road traffic noise to occur. As noted previously, a 2 dB increase in road traffic noise is not considered to be noticeable.

Based on the likely number of vehicles projected over each of the phases, it is concluded that noise impacts from construction traffic is unlikely to have an impact at the nearest affected properties. As a result, no further assessment is required.

7.8 Vibration Assessment

In order to maintain compliance with the human comfort vibration criteria discussed in Section 7.2, it is recommended that the indicative safe distances listed in Table 31 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 required to be used within the distances detailed in the table below.

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 7.2. This information should also be included as part of the CNVMSP.

Table 31 Recommended indicative safe working distances for vibration intensive plant.

Plant	Rating / Description	Safe Working Distances (m)	
		Cosmetic Damage (BS 7385: Part 2 DIN 4150: Part 3)	Human Comfort (AVTG)
Vibratory roller[1]	< 50 kN (Typically 1 – 2 tonnes)	5[1]	15 – 20[1]
	< 100 kN (Typically 2 – 4 tonnes)	6[1]	20[1]
	< 200 kN (Typically 4 – 6 tonnes)	12[1]	40[1]
	< 300 kN (Typically 7 – 13 tonnes)	15[1]	100[1]
	> 300 kN (Typically more than 13 tonnes)	20[1]	100[1]
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

7.9 Noise Monitoring

Noise monitoring, if required, will be performed by an acoustical consultant directly engaged by the contractor in accordance with the Conditions of Consent.

Noise monitoring is recommended to be undertaken by attended noise measurements including the following periods:

1. at the start of any new phase of works (i.e. demolition, excavation or construction etc.).

2. In response to ongoing complaints from the neighbouring receivers.

The statistical parameters to be measured should include the following noise descriptors: L_{Amin}, L_{A90}, L_{A10}, L_{A01}, L_{Amax} and L_{Aeq}. Unattended noise measurements should be conducted over consecutive 15-minute periods.

This monitoring should also be complemented by undertaking attended noise measurements in order to:

- Differentiate between construction noise sources and other extraneous noise events (such as road traffic and aircraft noise)

- Note and identify any excessive noise emitting machinery or operation.

In addition to the above detailed measurements, should any complaints be received which have not been determined previously, it should be confirmed by conducting additional attended noise measurements.

The survey methodology and any equipment should comply with the requirements discussed in Standard AS 1055.1-1997.

7.9.1 Vibration Monitoring

Vibration monitoring, if required, should be undertaken continuously at the nearest most affected structures in accordance with the conditions of the consent.

The monitoring location 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.

The vibration monitoring system 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 7.4).

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 vibration monitoring equipment would be downloaded and analysed by the acoustical consultant.

Reports of the measured vibration levels and their likely impacts would be prepared by the acoustical consultant and issued to the contractor.

8 CONCLUSION

Pulse White Noise Acoustics Pty Ltd (Pulse White Noise Acoustics) has been engaged to undertake an acoustic assessment for the proposed residential development to be located at 2 Fishburn Cresent, Castle Hill NSW 2154. The conclusions of this assessment are outlined in the following sections.

Minimum acoustic performances and associated indicative constructions for the building envelope have been provided in Section 6.1 of this report. The recommended treatments have been provided to ensure compliance with the objectives presented in 4.

To control noise impacts at external and internal receivers, recommended indicative treatments for major engineering services have been provided in Section 6.2. From our review we have formulated the following opinion:

- At this stage of the project the exact selections/locations of plant items are not known. A preliminary assessment, however, has been carried out using our experience with similar types of developments and the typical plant items installed. Experience with similar projects indicates that the acoustic treatment of the likely mechanical equipment to be installed on the project is both possible and practical, in order to meet the relevant criteria at surrounding receivers, as well as the relevant noise intrusion criteria for internal receivers within the development.

- It is recommended that, prior to the issue of a Construction Certificate (CC), a detailed acoustic assessment is undertaken to ensure all cumulative noise from engineering services comply with the requirements as listed in this report.

The existing Northwest Sydney Metro railway line is located approximately 30 m from the northern façade of the project site. The results of extensive numerical modelling conducted by Renzo Tonin & Associates and presented in the Operational Noise and Vibration Review, Report Ref: NWELOTS-NRT-SWD-AV-RPT-105008 Rev A, dated February 2017 has been referenced with the predictions used to assess the impact of the propose residential apartments within the development.

An assessment of the impacts associated with the number of vehicles on surrounding public roads around the site predicted the impact to be less than 2 dB and therefore is compliant with the NSW EPA RNP.

Regards,

Nikolaj Drydale-Cech

Acoustic Engineer

PULSE WHITE NOISE ACOUSTICS PTY LTD

APPENDIX A: ACOUSTIC GLOSSARY

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; 0 dB the faintest sound we can hear 30 dB a quiet library or in a quiet location in the country 45 dB typical office space. Ambience in the city at night 60 dB Martin Place at lunch time 70 dB the sound of a car passing on the street 80 dB loud music played at home 90 dB the sound of a truck passing on the street 100 dB the sound of a rock band 115 dB limit of sound permitted in industry 120 dB 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: UNATTENDED NOISE LOGGING – NOISE LOGGER 01

Weather Station: Sydney Olympic Park AWS (Archery Centre)

Weather Station ID: 066212

6 Middleton Avenue, Castle Hill NSW 2154

Ambient noise monitoring report

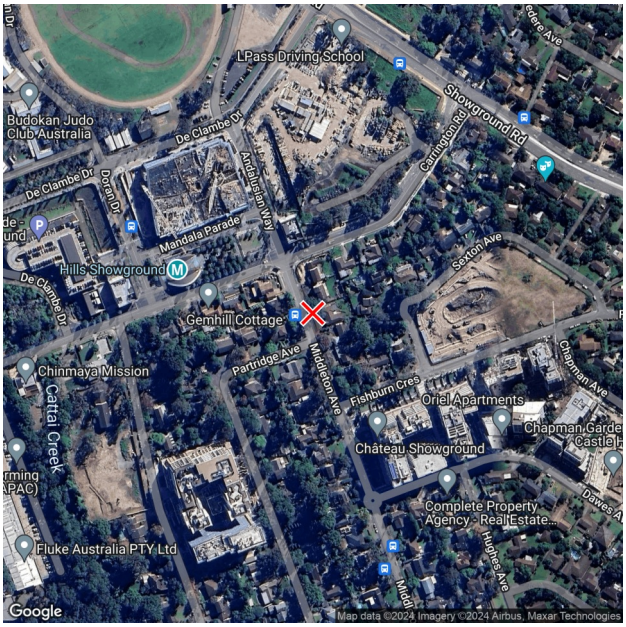
Item	Information
Logger Type	NL-42
Serial number	396932
Address	6 Middleton Avenue, Castle Hill NSW 2154
Location	6 Middleton Avenue, Castle Hill NSW 2154
Facade / free field	Free field
Environment	

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
Tue 02 Jul 2024	-	43	-	64	61	56
Wed 03 Jul 2024	53	45	34	66	62	56
Thu 04 Jul 2024	52	41	34	66	61	55
Fri 05 Jul 2024	52	42	33	65	63	57
Sat 06 Jul 2024	50	39	34	63	59	54
Sun 07 Jul 2024	45	36	31	61	58	52
Mon 08 Jul 2024	49	40	30	63	60	55
Tue 09 Jul 2024	52	45	31	67	60	56
Wed 10 Jul 2024	-	-	-	68	-	55
Summary	**52**	**42**	**33**	**65**	**61**	**55**

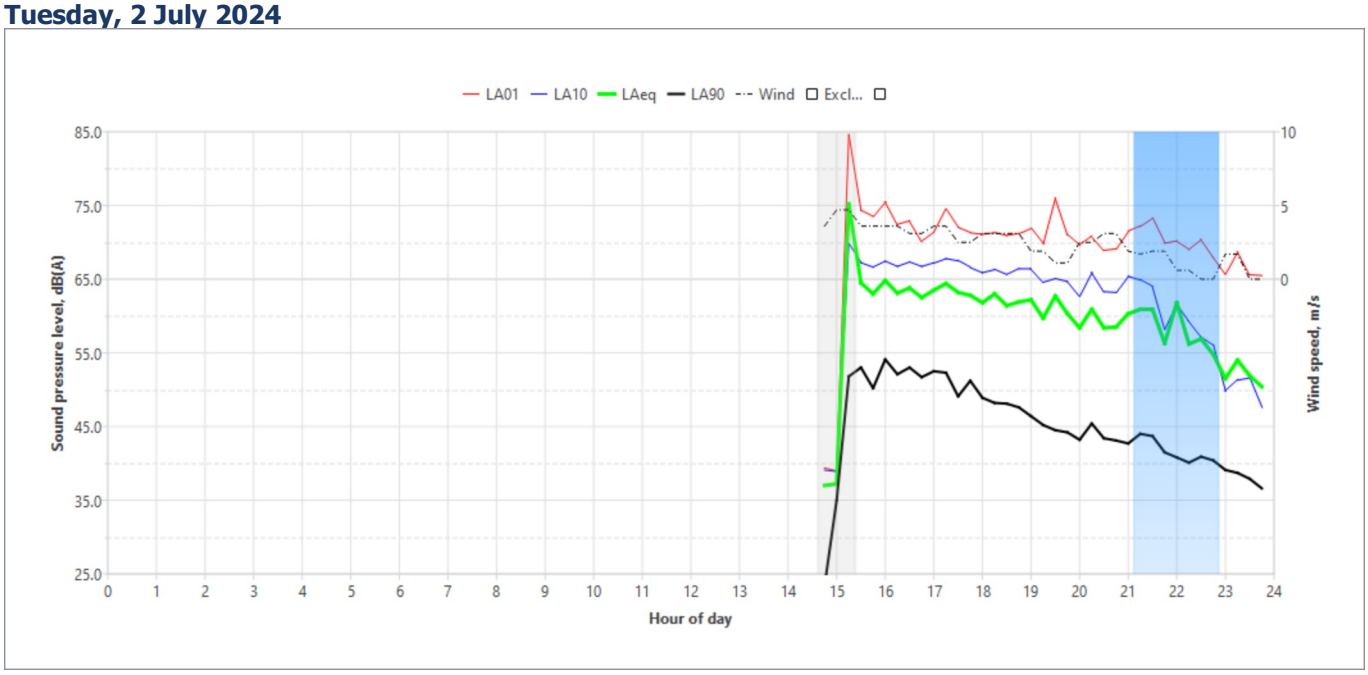
Note: Results with a '-' identify that there were not enough measurements available to correctly calculate the level, in accordance with the Noise Policy for Industry. The data has been excluded either from weather or manual exclusions. See the charts for more information

Logger location



Logger deployment photo

Tuesday, 2 July 2024



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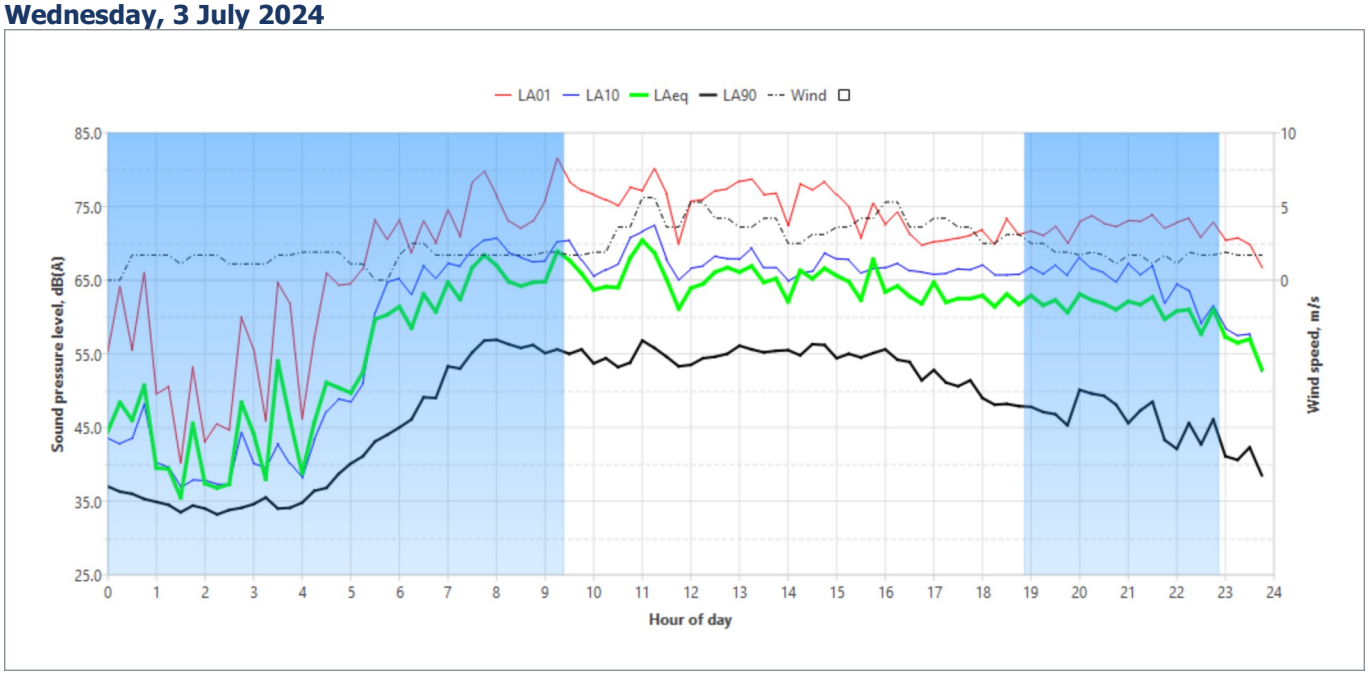

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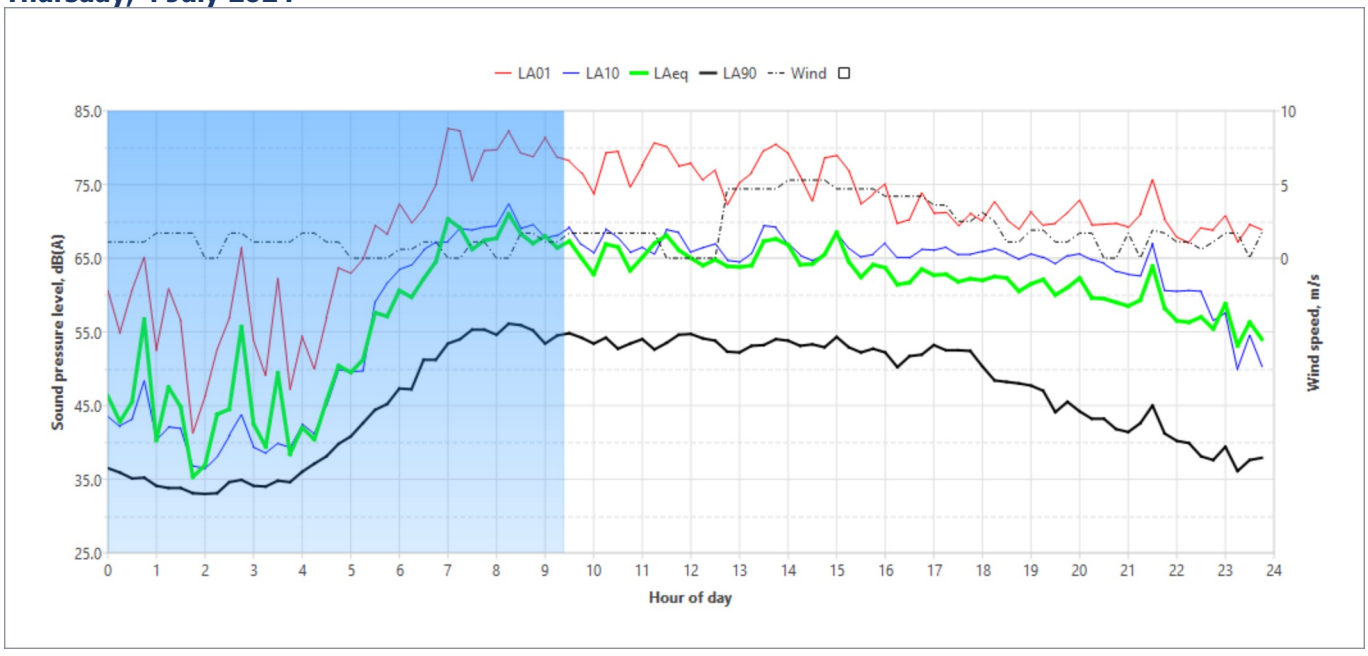

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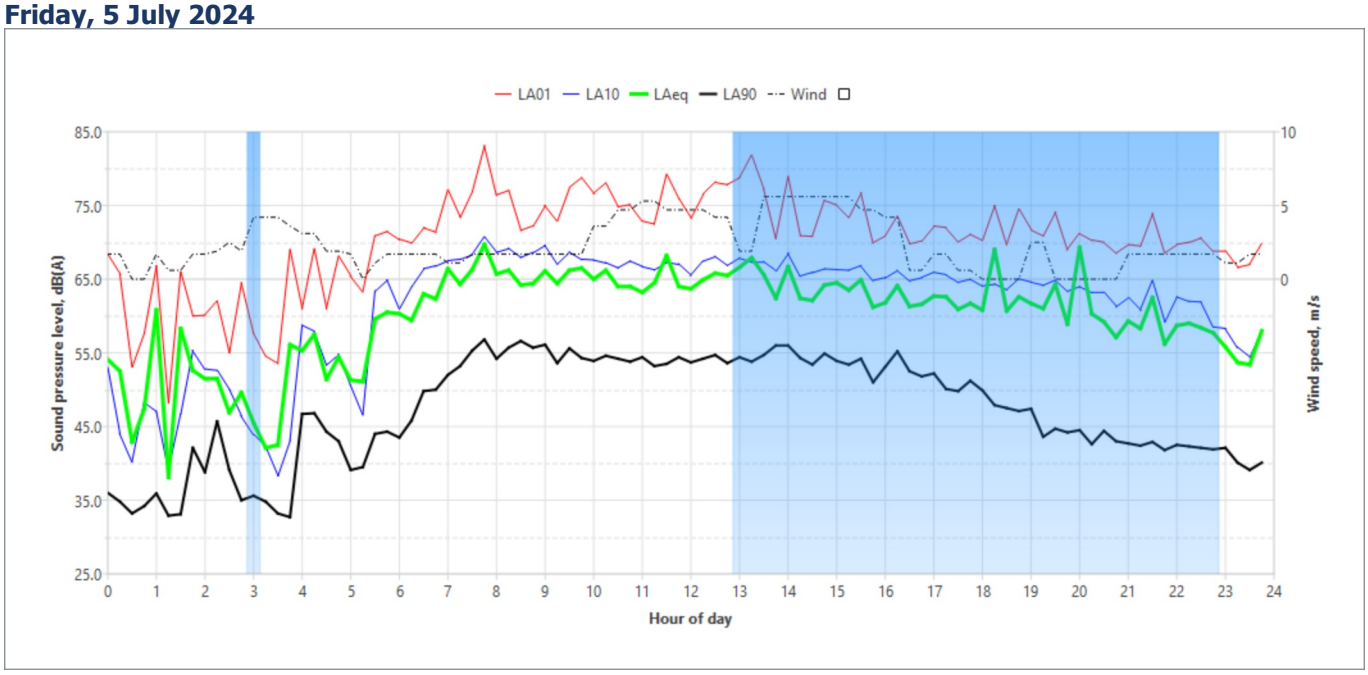

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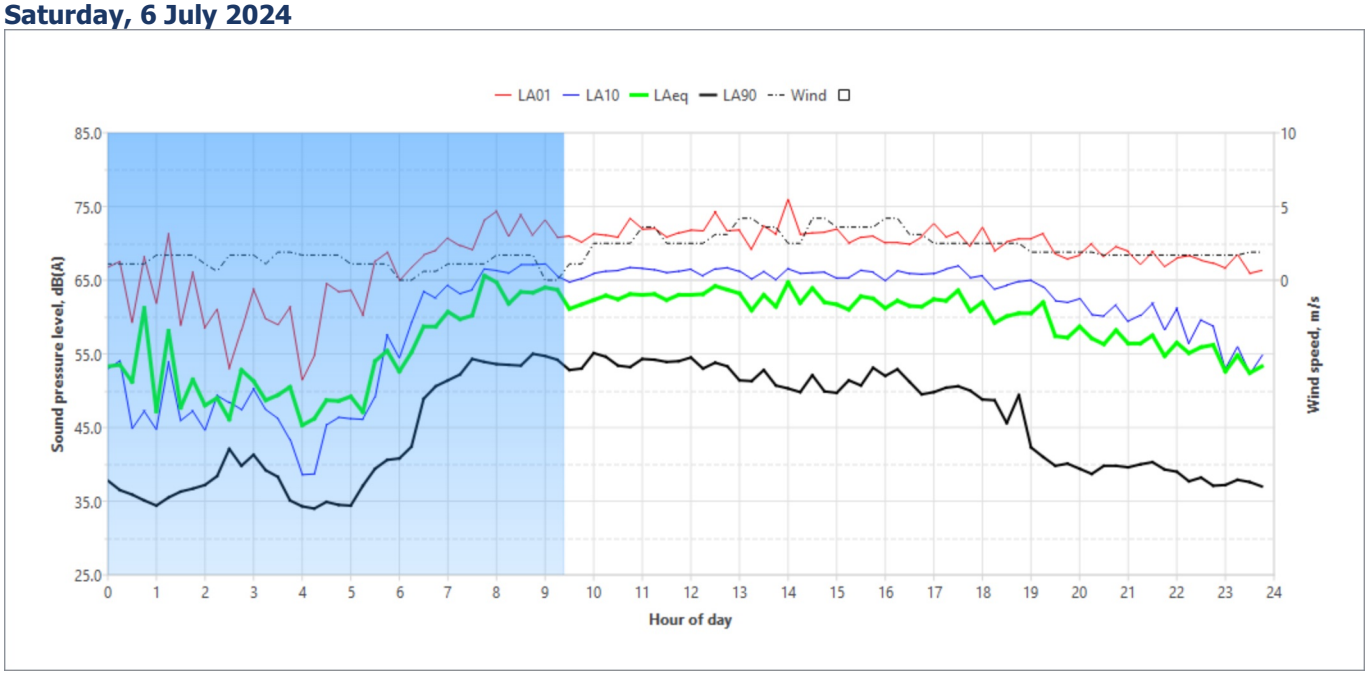

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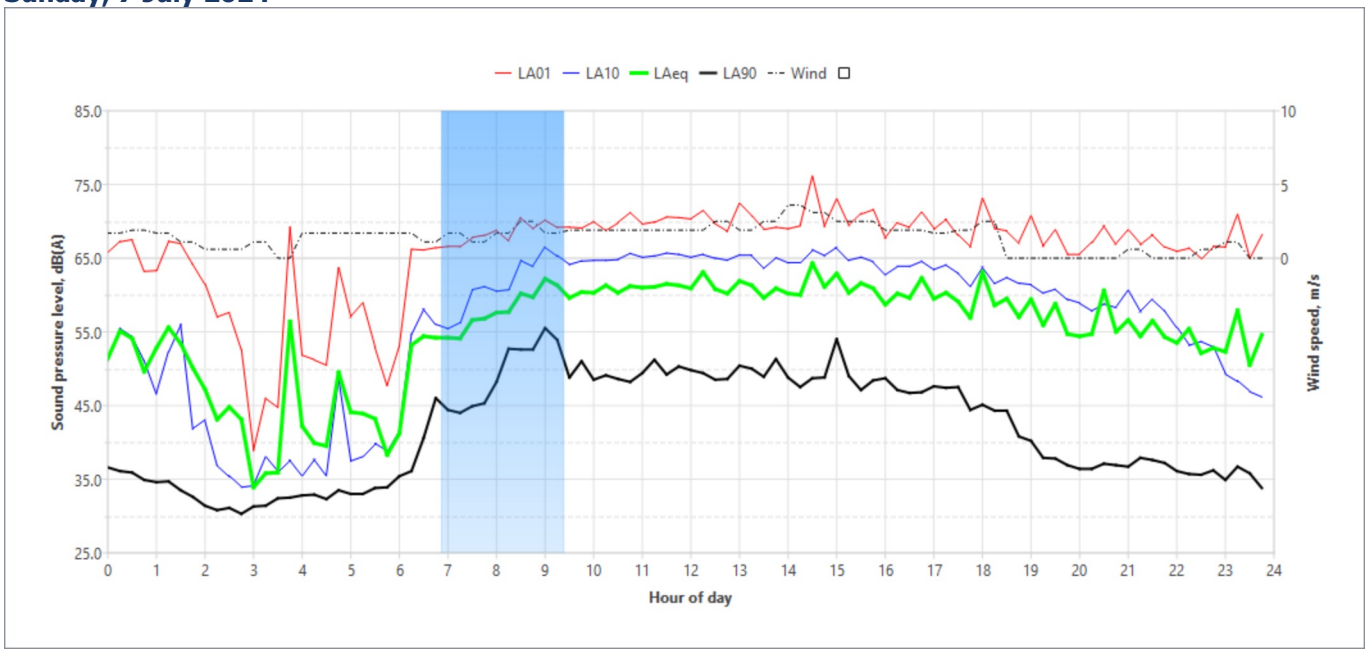

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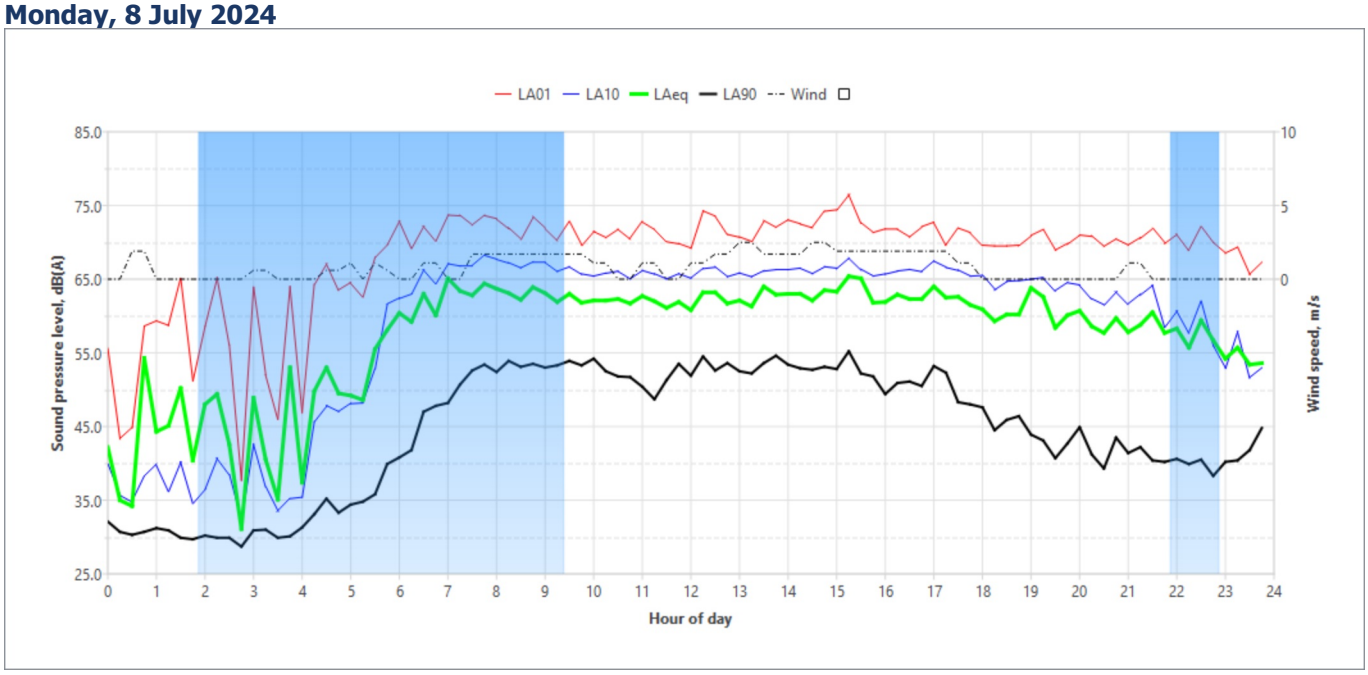

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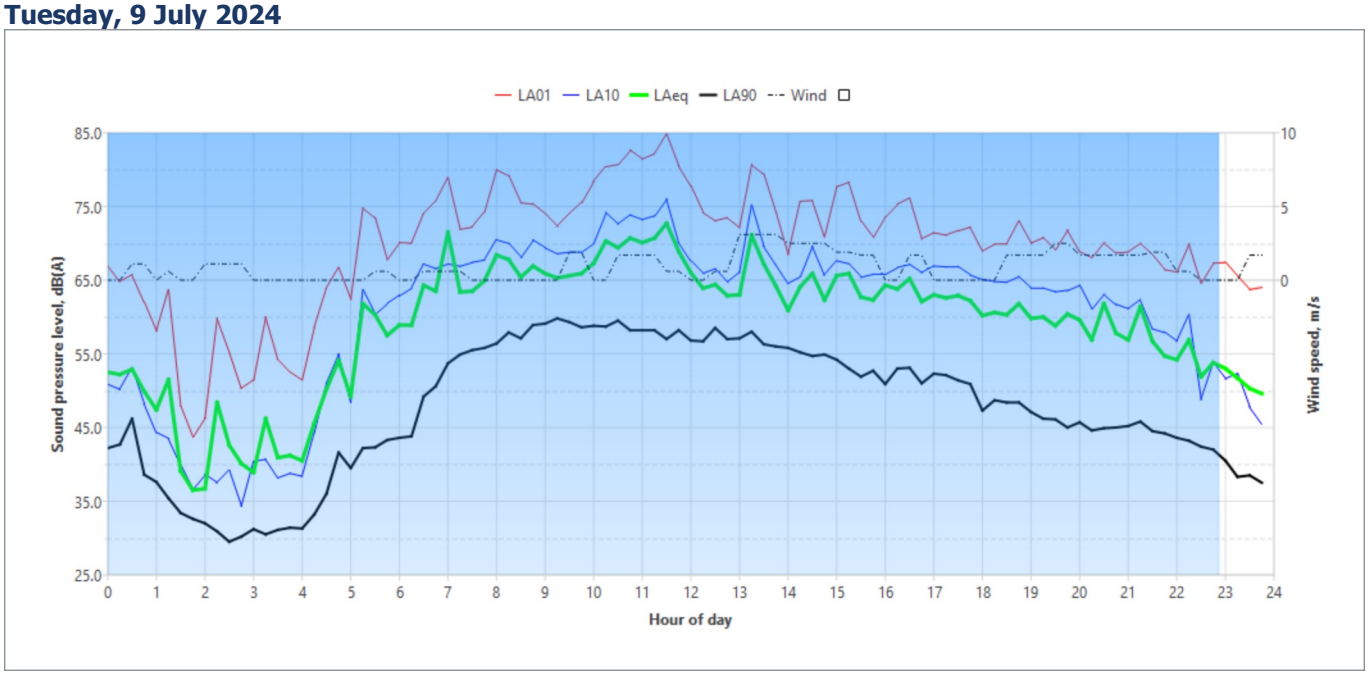

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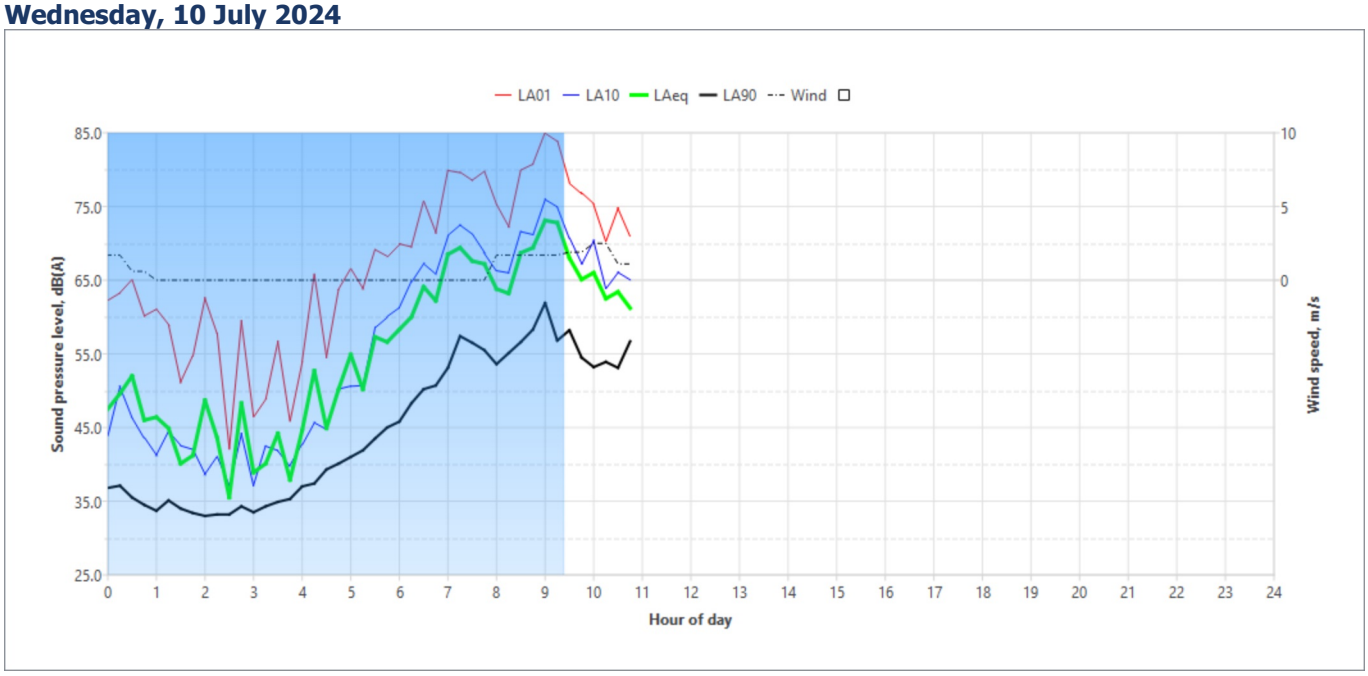


APPENDIX C: UNATTENDED NOISE LOGGING – NOISE LOGGER 02

Weather Station: Sydney Olympic Park AWS (Archery Centre)

Weather Station ID: 066212

27 Sexton Avenue, Castle Hill NSW 2154

Ambient noise monitoring report

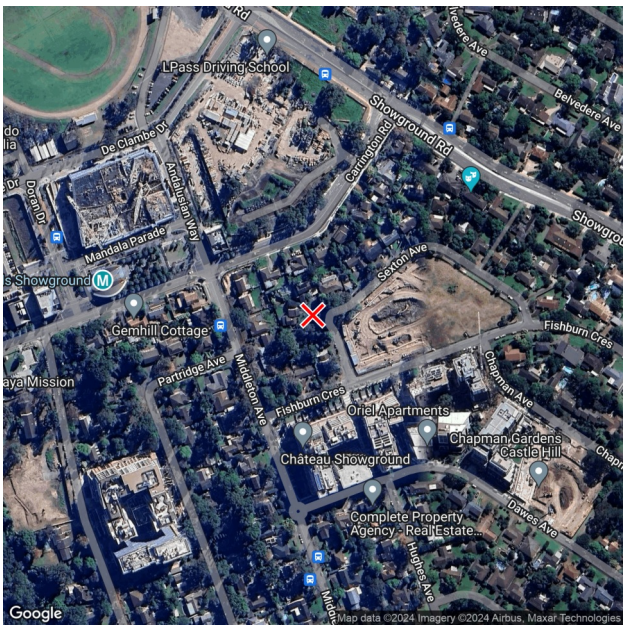
Item	Information
Logger Type	SVAN 971
Serial number	74365
Address	27 Sexton Avenue, Castle Hill NSW 2154
Location	27 Sexton Avenue, Castle Hill NSW 2154
Facade / free field	Free field
Environment	

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
Tue 02 Jul 2024	-	39	-	56	48	42
Wed 03 Jul 2024	44	41	30	57	47	44
Thu 04 Jul 2024	44	39	31	57	47	44
Fri 05 Jul 2024	44	40	32	58	49	48
Sat 06 Jul 2024	43	37	31	60	47	43
Sun 07 Jul 2024	38	35	28	50	44	39
Mon 08 Jul 2024	42	37	27	56	46	41
Tue 09 Jul 2024	-	-	-	-	-	55
Wed 10 Jul 2024	-	-	-	-	-	-
Summary	**43**	**39**	**30**	**57**	**47**	**48**

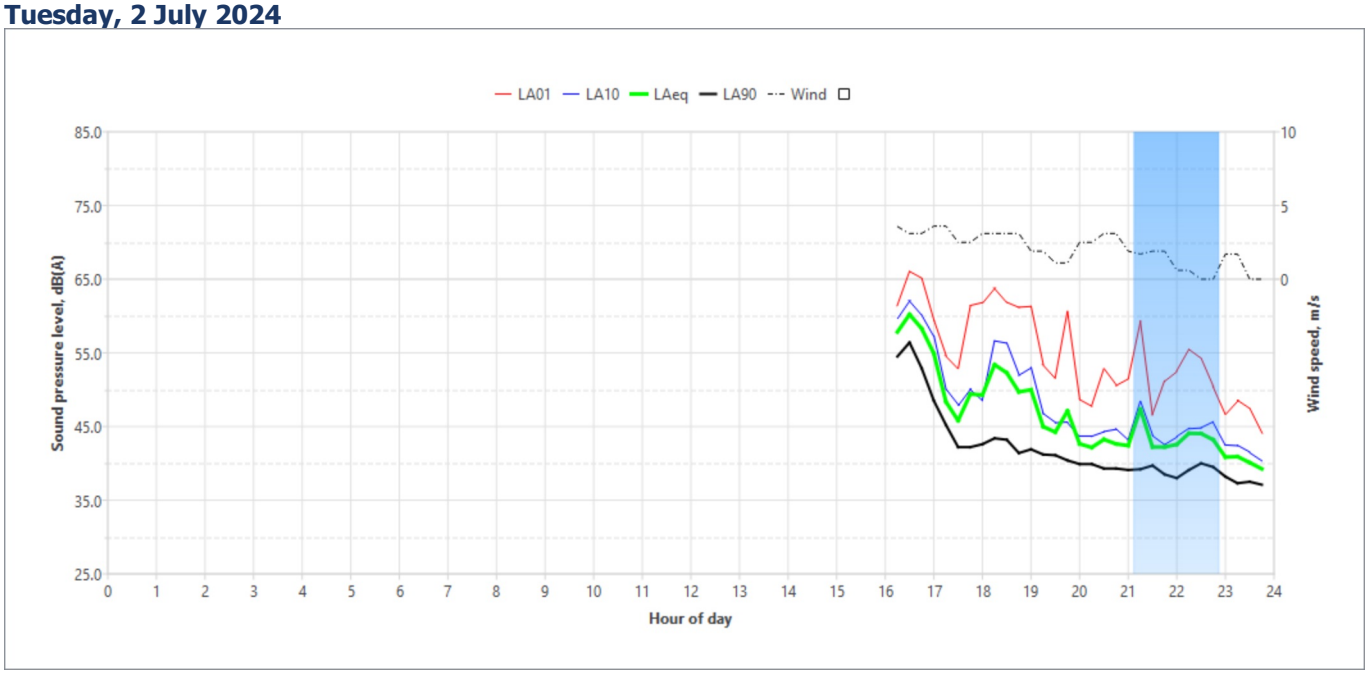
Note: Results with a '-' identify that there were not enough measurements available to correctly calculate the level, in accordance with the Noise Policy for Industry. The data has been excluded either from weather or manual exclusions. See the charts for more information

Logger location



Logger deployment photo

Tuesday, 2 July 2024



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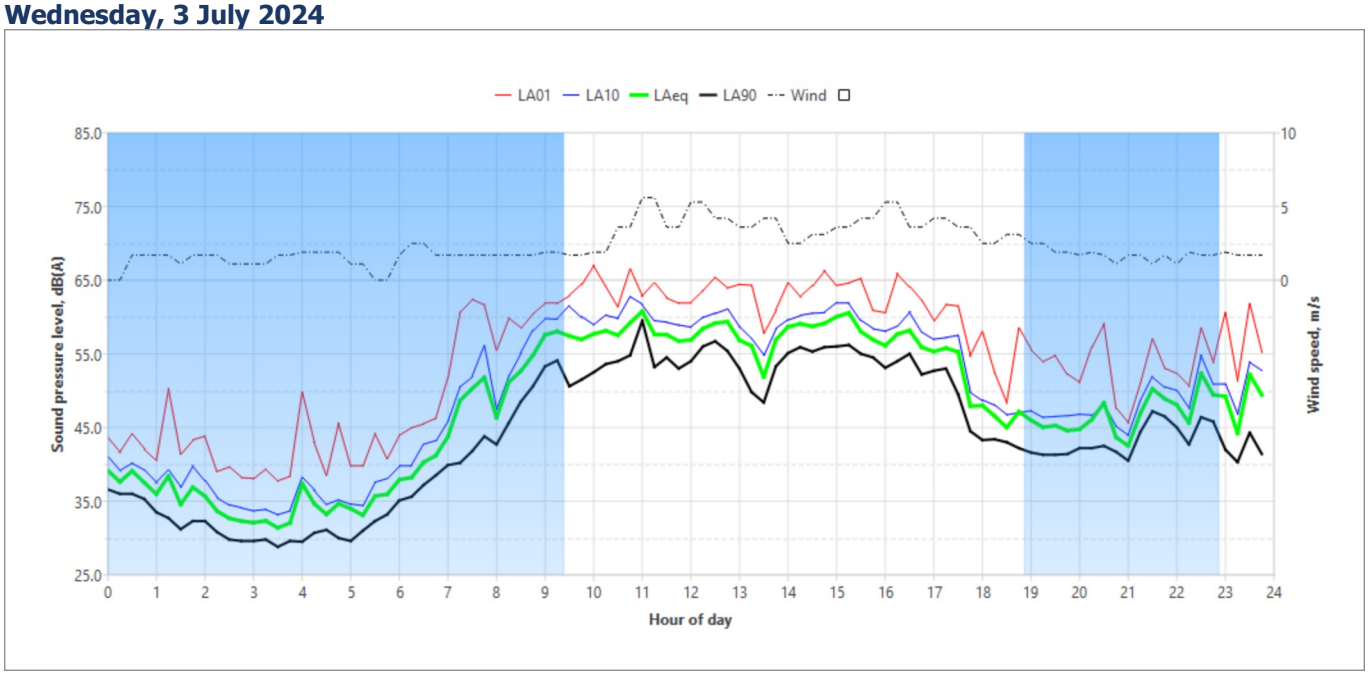

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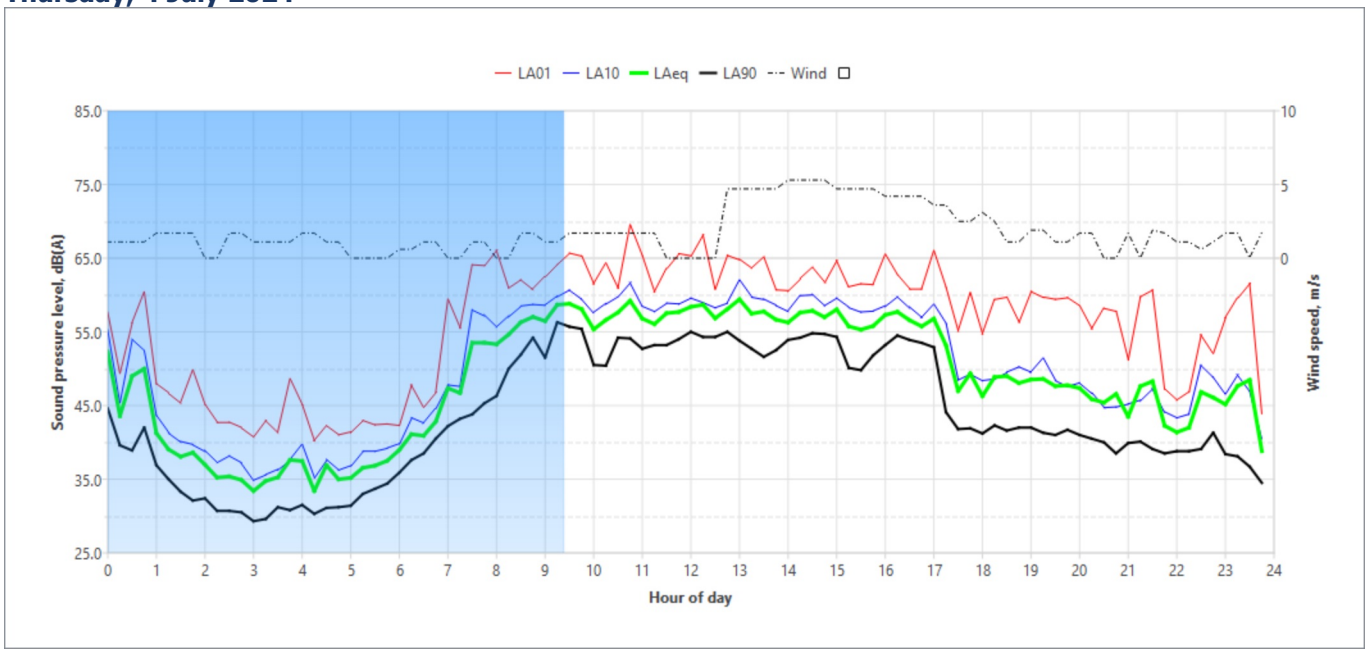

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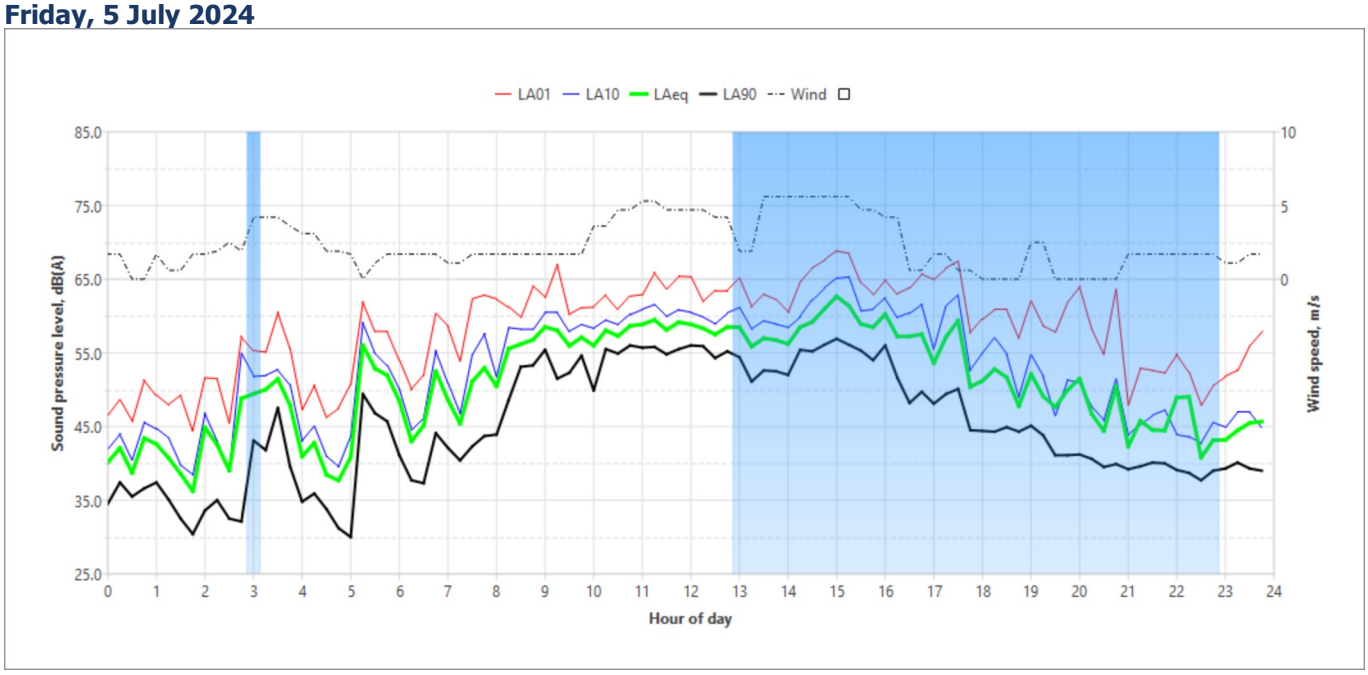

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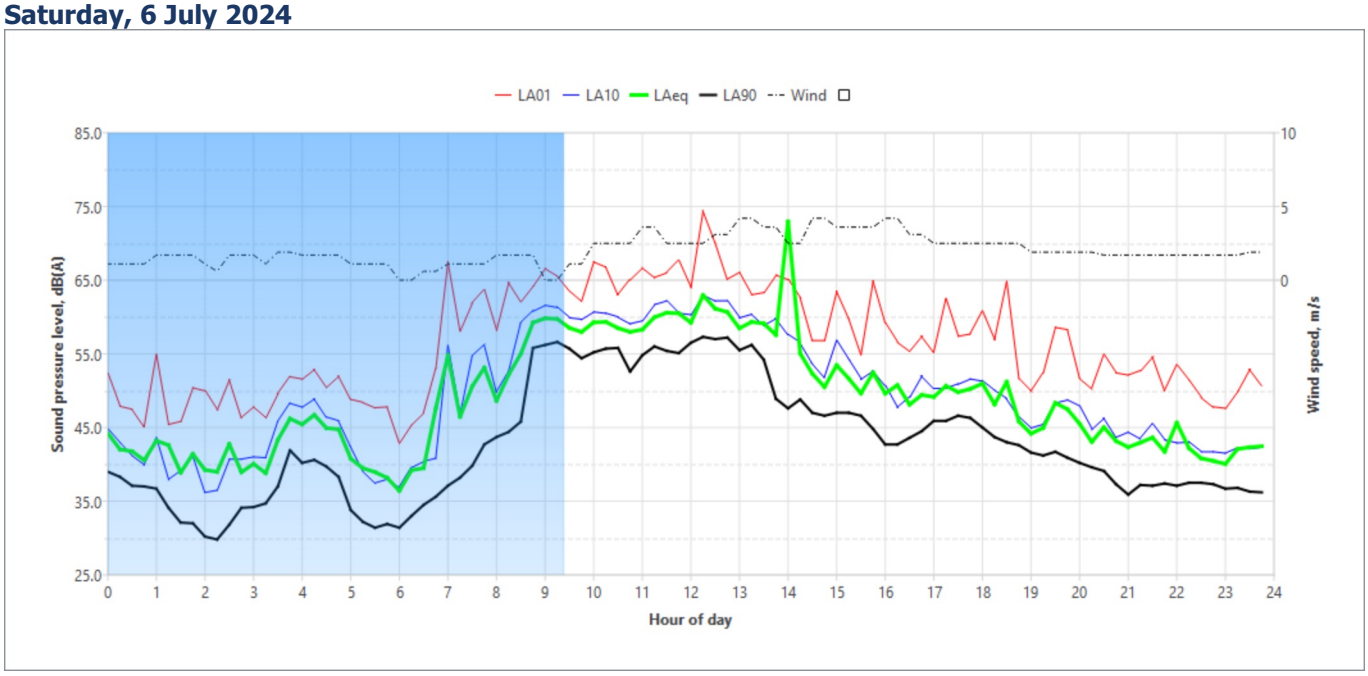

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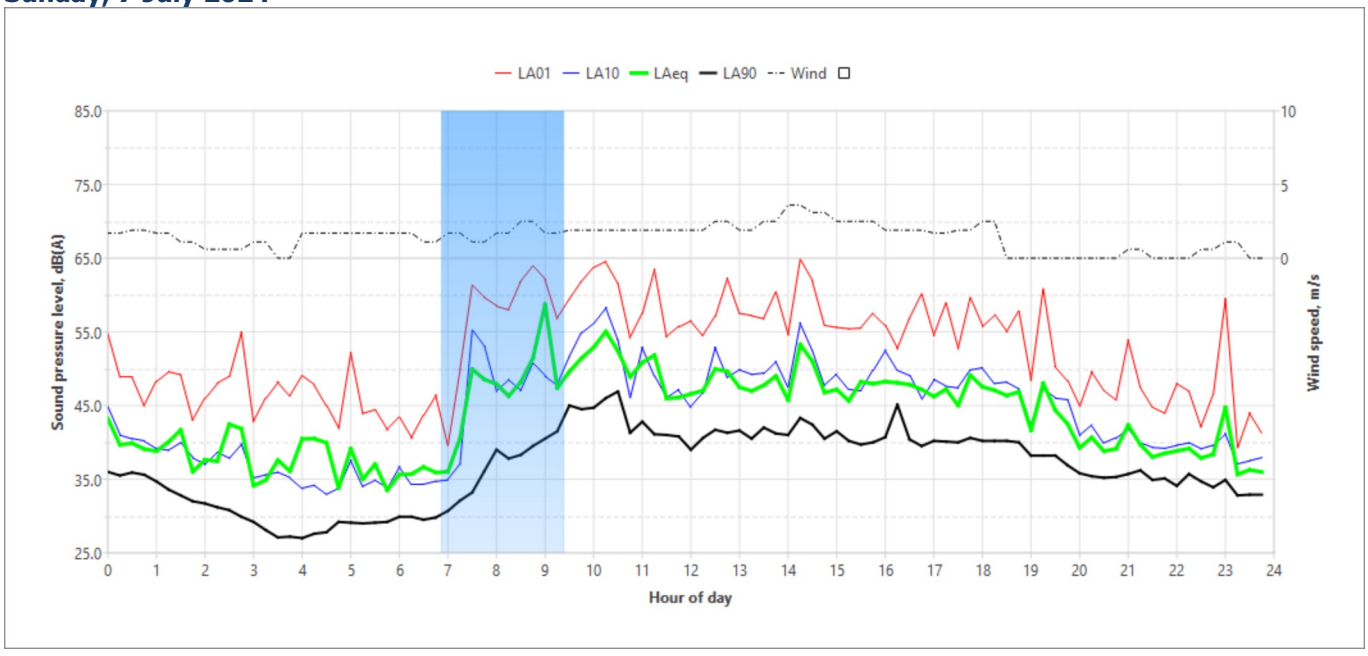

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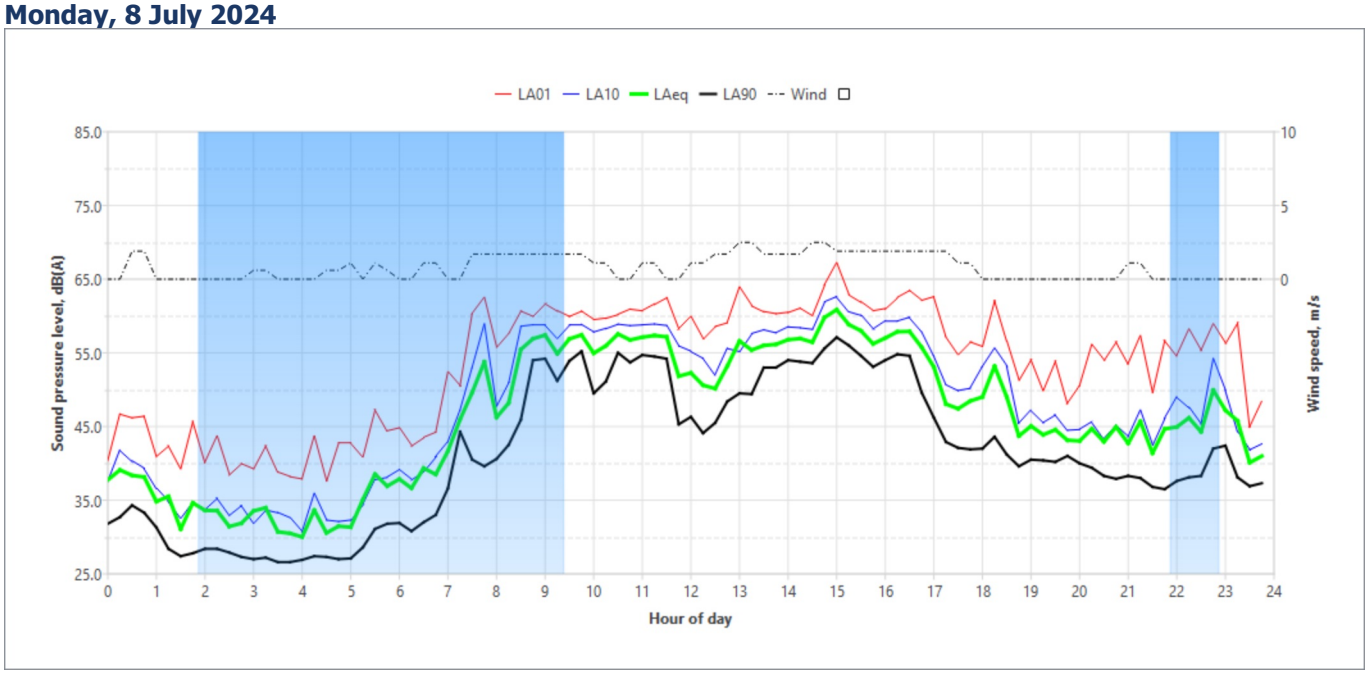

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