Noise and Sound Services

Road Traffic Noise Impact Statement

At:-

Orchard Hills North,
NSW 2748.

December 2019

Report No. nss23123 – Final

Prepared at the request of:-

Legacy Property
MLC Centre, Level 45
19 Martin Place
Sydney NSW 2000

Prepared by:-

NOISE AND SOUND SERVICES

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C O N T E N T S

EXECUTIVE SUMMARY

A road traffic noise assessment has been carried out for a greenfield site due to the proposed rezoning of approximately 120 hectares of rural land in Orchard Hills North. This is to assess noise impacts from the nearby M4 motorway and to propose preliminary noise mitigation measures for Orchard Hills North. The study also advises on the preliminary sound insulation requirements without a noise barrier from external noise in line with the NSW Road Noise Policy (2011) and the State Environmental Planning Policy (SEPP) Infrastructure, 2007 Clause 102 - Impact of road noise or vibration on non-road development and the Australian Standards AS 3671 and AS 2107 – 2000 *'Acoustic – Recommended Design Sound Levels and Reverberation Times for Building Interiors'*.

The proposed development site is bounded by Caddens Road to the north, Kingswood Road and a section north of Frogmore Road to the west, Hermitage Creasing to the east and the M4 motorway to the south.

Both attended and unattended road traffic noise measurements at the site have been carried out at the site. The attended at multiple distances from the M4 with frequency analysis and the unattended at two distances from the M4 recording long term (7 days) continuous (every 15 minute) logged data.

The data has been used to model the road traffic noise using the formulae as given in the Department of Transport, Welsh Office. Great Britain *'Calculation of Road Traffic Noise'* (CoRTN 88) and the International Standard ISO 9613-2 (1996(E)) '*Acoustic – Attenuation of sound during propagation outdoors Part 2 General method of calculation'*.

Land use developers must meet internal noise goals in the Infrastructure SEPP (Department of Planning NSW 2007) for sensitive developments near existing busy roads. Hence noise barriers are not mandatory. However, it is good practice to limit outdoor area noise level ($L_{Aeq,\ 15\ hour}$) to 60 dBA in line with that required for active recreation in the NSW Government's Road Noise Policy (2011). The results show that proposed dwellings at distances up to 62 metres from the M4 motorway will be over 60 dBA (day time) without noise barriers. Options for various heights of noise barriers and upgrades in the architectural treatments for sound insulation without a noise barrier of the future dwellings have been provided.

1. INTRODUCTION

Noise and Sound Services was requested by Legacy Property of MLC Centre, Level 45, 19 Martin Place, Sydney NSW 2000, in behalf of LegPro Orchard Hills Pty Ltd ATF LegPro Orchard Hills Unit Trust, to carry out a road traffic noise assessment. This is at a greenfield site due to the proposed rezoning of approximately 120 hectares of rural land in Orchard Hills North (OHN) to permit residential development comprising approximately 1,800 dwellings. Legacy's Planning Proposal achieved Gateway Determination in February 2019 with rezoning anticipated in the second half of 2020.

The purpose of the study is to assess noise impacts from the nearby M4 motorway and to propose preliminary noise mitigation measures for Orchard Hills North. The study also advises on the preliminary sound insulation requirements from external noise in line with the NSW Road Noise Policy (2011) and the State Environmental Planning Policy (Infrastructure) 2007 Clause 102 - Impact of road noise or vibration on non-road development and the Australian Standards AS 3671 and AS 2107 – 2000 *'Acoustic – Recommended Design Sound Levels and Reverberation Times for Building Interiors'*.

Summary Scope

- Evaluate the current noise environment from the M4 motorway on the Orchard Hills North site (data loggers, traffic volumes, etc).
- Model proposed indicative development scenario (two options) and discuss likely noise impacts against relevant guideline

This report considers:-

- An assessment using appropriate site-specific noise criteria based on NSW guidelines and Penrith City Council requirements;
- Acoustic modelling for one master plan to determine noise impacts on the site;
- Two options to evaluate alternate mitigation measures e.g. Noise Barriers and/or Architectural Treatments; and
- Recommendations to mitigate any noise impacts required to be implemented to achieve relevant statutory and policy standards to accompany the rezoning application;

2. SITE AND DEVELOPMENT DESCRIPTION

The proposed development site is bounded by Caddens Road to the north, Kingswood Road and a section north of Frogmore Road to the west, Hermitage Creasing to the east and the M4 motorway to the south. The area is shown bounded in red in Figure 1 below. Full details are given in the outline drawings provided by Legacy Property,

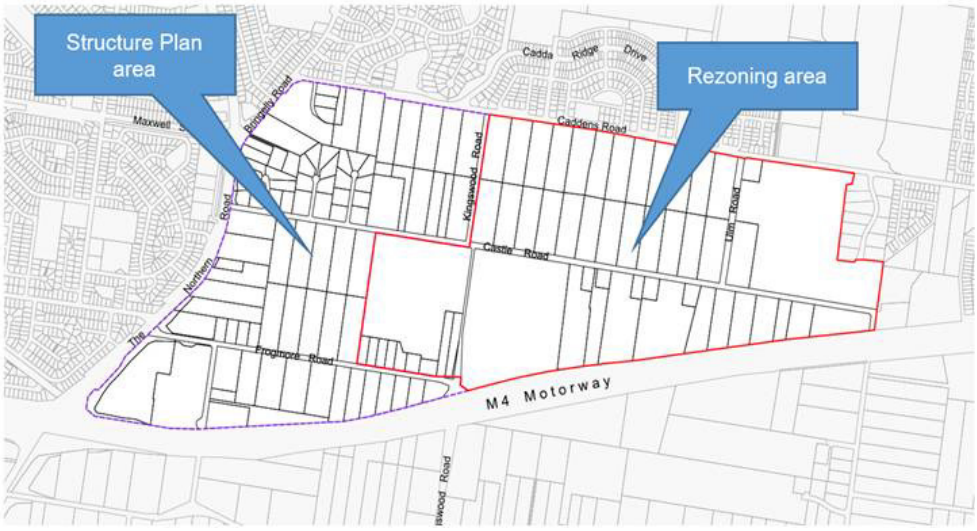


Figure 1. Outline Site Plan. Source: Legacy Property

The forecast population for the rezoning area is approximately 5,400 people. The balance of the Structure Plan area is 117 ha, forecast population of 3,900 people. The areas shown outside of the red boundaries in Figure 1 above are not part of this scope of works.

There are no significant purpose built noise barriers between the M4 and proposed site. However, there are existing earth mounds at varying heights to the north of the M4 and west of the proposed site. There are rows of trees and other foliage; however this offers negligible noise insulation.

3. CRITERIA

3.1 Penrith Development Control Plan 2014

Part C12 of Penrith Development Control Plan 2014 Noise and Vibration States:-

"12.1. Road Traffic Noise
A. Background currently; road traffic is the most widespread source of environmental noise. The controls below seek to minimise the impact of road

traffic noise. This Section of the DCP applies to all developments that generate a significant level of traffic noise (as determined by Council) that has potential to impact upon residential and other sensitive land uses. This Section is also applicable to any residential development, subdivision or other sensitive land uses, which propose to locate near existing areas of significant road traffic noise.
B. Objectives
a) To ensure that the amenity of all residential development and other sensitive land uses is not significantly affected by road traffic noise;
b) To ensure that the traffic associated with development does not significantly impact upon the amenity of surrounding land uses;
c) To ensure that the traffic associated with development does not have a significant noise impact on the existing road network; and
d) To ensure that any subdivisions are designed to minimise the impact of road traffic noise on any residential development or other sensitive land uses.

Penrith Development Control Plan 2014 C12 Noise and Vibration C12-4 C. Controls 1) Road traffic noise criteria including sensitive land uses

a) Council will not grant consent to development, particularly residential development, including subdivisions, unless the impact of traffic noise from freeway, arterial, designated or collector roads complies with the standards and guidelines for road traffic noise prepared by the relevant State Government authorities or agencies, as well as relevant Australian Standards.
b) Council will not grant consent to development for sensitive land uses unless it complies with the provisions and standards for road traffic noise prepared by the relevant State Government authorities or agencies, as well as relevant Australian Standards.
c) Sensitive land uses subject to road traffic noise criteria referred to in
b) above include educational establishments (including schools), places of public worship, hospitals, and passive and active recreation areas. Noise Impact Statements - Specific Requirements
a) Where a site is likely to be affected by unacceptable levels of road traffic noise, the applicant is required to provide a Noise Impact Statement prepared by a qualified acoustic consultant in accordance with the requirements set out in the DA Submission Requirements Appendix of this DCP.
b) The Noise Impact Statement should demonstrate acoustic protection measures necessary to achieve an indoor environment meeting residential standards, in accordance with EPA and Department of Planning Criteria, as well as relevant Australian Standards. NOTE: To determine whether your site is likely to be exposed to levels of road traffic noise that exceed residential standards:
a) Contact Council regarding main road frontages known to exceed residential noise standards; and
b) Obtain detailed advice from a qualified acoustic consultant regarding appropriate planning"

3.2 State Environmental Planning Policy (Infrastructure) 2007 Clause 102 - Impact of road noise or vibration on non-road development

The State Environmental Planning Policy (Infrastructure) 2007, Subdivision 2 Development in or adjacent to road corridors and road reservations, Clause 102, Impact of road noise or vibration on non-road development provides the following:-

1) This clause applies to development for any of the following purposes that is on land in or adjacent to the road corridor for a freeway, a tollway or a transitway or any other road with an annual average daily traffic volume of more than 40,000 vehicles (based on the traffic volume data published on the website of the RTA) and that the consent authority considers is likely to be adversely affected by road noise or vibration:

    (a) a building for residential use,
    (b) a place of public worship,
    (c) a hospital,
    (d) an educational establishment or child care centre.

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 Director-General for the purposes of this clause and published in the Gazette.

3) If the development is for the purposes of a building for residential use, 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 L_{Aeq} levels are not exceeded:

    (a) in any bedroom in the building — 35 dBA at any time between 10 pm and 7 am,
    (b) anywhere else in the building (other than a garage, kitchen, bathroom or hallway) — 40 dBA at any time.

4) In this clause, freeway, tollway and transitway have the same meanings as they have in the Roads Act 1993.

3.3 Australian Standards AS 3671 and AS 2107

The Australian Standard AS 3671-1989 *'Acoustics - Road traffic noise intrusion - building siting and construction'* refers to guideline limits in Australian Standard AS 2107. Australian Standard AS 2107 – 2016 *'Acoustic – Recommended Design Sound Levels and Reverberation Times for Building Interiors'* provides recommended design sound levels for different areas of occupancy in buildings.

This includes recommended internal design sound levels from continuous road traffic noise for houses near major roads as shown in Table 1 below.

TABLE 1 - RECOMMENDED DESIGN SOUND LEVEL FOR RESIDENTIAL BUILDINGS. FROM AS/NZS 2107 (2016).

Type of Occupancy	Design Sound Level Range ($L_{Aeq, t}$) dBA
Houses and Apartments Near Major Roads	
Living Areas	35 to 45
Sleeping Areas (night time)	35 to 40
Work Areas	35 to 45

3.4 Site Specific Indoor Noise Goals

Site-specific indoor road traffic noise goals ($L_{Aeq, period}$) in line with the State Environmental Planning Policy (Infrastructure) 2007 and Australian Standard AS 2107 are set at 35 dBA for sleeping areas and 40 dBA for living/work areas.

3.5 Outdoor Noise Goals

Target outdoor noise levels for existing freeways, arterial and sub arterial roads as given in the NSW Government's Road Noise Policy (2011) are: day time (7:00 am to 10:00 pm) $L_{Aeq, (15\ hour)}$ **60 dBA** and night time (10:00 pm to 7:00 am) $L_{Aeq, (9\ hour)}$ **55 dBA.** This is for existing residences. Land use developers must meet internal noise goals in the Infrastructure SEPP (Department of Planning NSW 2007) for sensitive developments near busy roads (see Section 3.1 above). For active recreation use of open space the target outdoor noise level for existing freeways, arterial and sub arterial roads as given in the NSW Government's Road Noise Policy (2011) is day time (7:00 am to 10:00 pm) $L_{Aeq, (15\ hour)}$ **60 dBA** when the outdoor space is in use.

4. NOISE MEASUREMENT RESULTS

Both attended and unattended road traffic noise measurements have been carried out at the site. The attended measurements at multiple distances from the M4 motorway with frequency analysis and the unattended measurements at two distances from the M4 recording long term (7 days) continuous (every 15 minute) logged noise data.

4.1 Instrumentation – Attended

The instrumentation used during the attended noise source survey consisted of two Brüel and Kjær sound level meters model 2250 (serial numbers 3008564 and 3011239). These meters conform to Australian Standard AS IEC 61672.1-2004 : '*Electroacoustics - Sound level meters – Specifications*' as class 1 precision sound level meters and have an accuracy suitable for both field and laboratory use. The calibration of the meters was checked before and after the measurement period with a Brüel and Kjær acoustical calibrator model 4231 (serial no. 3011545). No significant system drift occurred over the measurement period.

The sound level meters were checked, adjusted and aligned to conform to the Brüel and Kjær factory specifications and issued with conformance certificates within the last 24 months as required by the regulations. The internal test equipment used is traceable to the National Measurement Laboratory at C.S.I.R.O., Lindfield, NSW, Australia.

The calibrator was checked, adjusted and aligned to conform to the Brüel and Kjær factory specifications and issued with conformance certificates within the last 12 months as required by the regulations. The internal test equipment used is traceable to the National Measurement Laboratory at C.S.I.R.O., Lindfield, NSW, Australia.

4.2 Instrumentation – Unattended

The instrumentation used for unattended measurements of the existing environment consisted of two 'ARL' - Type 2 Environmental Noise Logger serial numbers 194550 and 194569. These instruments conform to Australian Standard 1259 "Acoustics - Sound Level Meters", (1990) and have an accuracy suitable for both field and laboratory use.

The calibration of the loggers was checked before and after the measurement period with a Brüel and Kjær acoustical calibrator model 4230 (serial no. 3011545). No significant system drift occurred over the measurement periods.

The environmental noise loggers have been checked, adjusted and aligned to conform to the Brüel and Kjær or ARL factory specifications and issued with conformance certificates within the last 24 months as required by the regulations. The internal test equipment used is traceable to the National Measurement Laboratory at C.S.I.R.O., Lindfield, NSW, Australia.

4.3 Measurement Procedure – Attended

The acoustical measurements were carried out in accordance with Australian Standards AS 1055. '*Acoustics –Description and Measurement of Environmental*

Noise', (1997) and AS 2702 '*Acoustics –Methods for the Measurement of Road Traffic Noise'*, (1984) as required by Australian Standard AS 3671 '*Acoustics – Road Traffic Noise Intrusion – Building Siting and Construction'* (1989).

Free field noise measurements were carried out in the vicinity of the proposed residential site, at various distances from the M4 Motorway of approximately 13 metres to 225 metres. The measurements were carried out on Monday 28th October 2019 (see Figure 2 below for full results). The 'A' frequency weighting, 1/3 octave band frequency analysis and 'fast' time weighting were used exclusively. The weather was sunny, warm with negligible wind. The time of the measurements was selected as representing a time when the traffic flows are considered to be high whilst maintaining free flow, i.e. without congestion. As such, noise levels are considered to be a worst-case scenario. During this survey there were approximately 4000 vehicles per hour with 15% heavy vehicles.

4.4 Measurement Procedure – Unattended

Measured ambient road traffic noise levels were taken from Monday 28th October until Monday 4th November 2019. The loggers were located at the site approximately 25 metres and 225 metres from the closest road traffic lane of the M4. The full statistical noise measurement results are shown in graphical form in Appendix A.

4.5 Measurement Results – Attended

The 1/3 octave band road traffic noise results are shown in Figure 2 below.

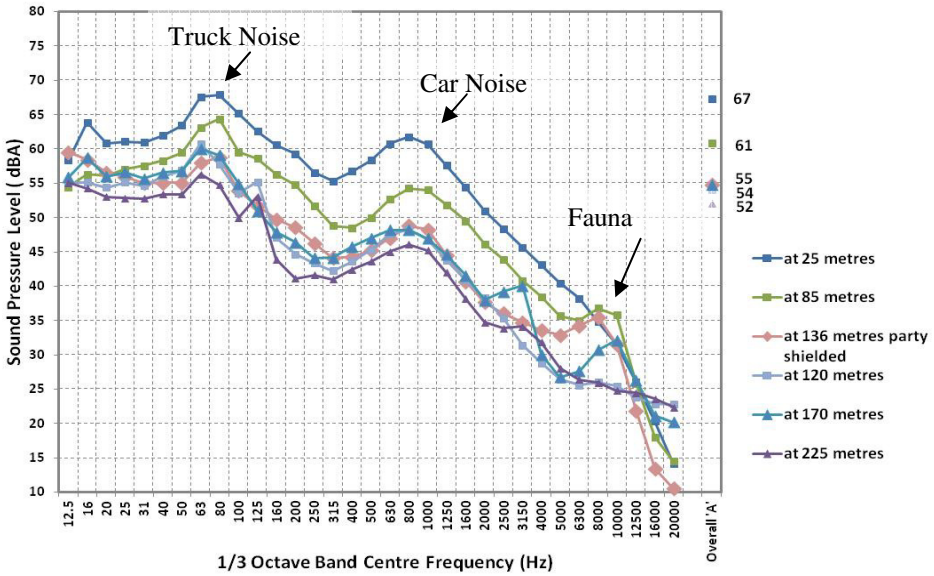


Figure 2. Attended Survey Road Traffic Noise Results Monday 28th October 2019.

4.6 Measurement Results – Unattended

The unattended (noise logger) results are shown in Table 2 below.

TABLE 2 - UNATTENDED ROAD TRAFFIC NOISE RESULTS

Date October/ November 2019	Sound Pressure Level $L_{Aeq, T}$ (dBA) at 25 Metres		Sound Pressure Level $L_{Aeq, T}$ (dBA) at 225 Metres	
	Day (T = 15 hour)	Night (T = 8 hour)	Day (T = 15 hour)	Night (T = 8 hour)
28	69	67	54	54
29	68	67	51	54
30	69	67	50	55
31	69	67	52	55
1	69	64	52	52
2	68	63	50	52
3	67	69	52	54
4	71	-	54	-

All results are rounded up to the nearest whole decibel.

5. DISCUSSION AND CALCULATIONS

This section of the report discusses the measurement results at the site of the proposed residential houses which are likely to be single storey or double storey homes with three or four bedrooms. Detailed formula is used to predict external and internal noise levels for various rooms of the proposed residences.

5.1 External Noise Levels

Noise models and calculations have been prepared for the occurrence of noise emissions from the M4 motorway. This section provides details of the models and calculations applicable to the development.

5.1.1 Noise Modelling Specifications

The sound pressure level from a line source noise has been modelled using the formulae as given in the Department of Transport, Welsh Office. Great Britain *'Calculation of Road Traffic Noise'* (CoRTN 88) and the International Standard ISO 9613-2 (1996(E)) '*Acoustic – Attenuation of sound during propagation outdoors Part 2 General method of calculation'*. This Standard specifies methods for the description of noise outdoors in community environments. The method described in the Standard is general in the sense that it may be applied to a wide

variety of noise sources, and covers the major mechanism of attenuation. The method allows for downwind propagation conditions within an angle of ± 45° of the direction connecting the centre of the dominant sound source and the centre of the specified receiver region with the wind blowing from source to receiver, and wind speed between approximately 1 m/s and 5 m/s measured at a height of 3 to 11 metres above the ground.

5.1.2 Basic Noise Modelling Equation

The equivalent continuous downwind sound pressure level (L_{Aeq}) at each receiver point can be calculated for each noise source using the equation below:-

$$\mathbf{L_{Aeq} = L_w + D_c - A}$$

Where:

L_w is the sound power level of the noise source;
D_c is directivity correction; and
A is the attenuation that occurs during the propagation from source to receiver.

The attenuation term A in the equation above is given by:-

$$\boldsymbol{A = A_{div} + A_{atm} + A_{gr} + A_{bar} + A_{misc}}$$

Where:

A_{div} is the attenuation due to geometric divergence;
A_{atm} is the attenuation due to atmospheric absorption;
A_{gr} is the attenuation due to the ground effects;
A_{bar} is the attenuation due to a barrier; and
A_{misc} is the attenuation due to miscellaneous other effects.

The last term (A_{misc}) generally refers to miscellaneous propagation through foliage, industrial sites and areas of houses. Due to the vicinity of the development to the neighbouring dwellings the attenuation due to atmospheric absorption, ground effects and other miscellaneous effects are of minor significance at this site.

5.2 Existing Road Traffic Flows

The free field external road traffic noise level ($L_{Aeq,\ 1\ hour}$) measurements have been used to model the road traffic noise with unobstructed line-of-sight for distances up to 300 metres at the subject site (see Figure 3 below). The best fit curve is –5.386 LN(D) + 81.67, where LN(D) is the natural logarithm of the distance. The results apply for both the 15 hour day time (7:00 am to 10:00 am) and the 9 hour night time (10:00 pm to 7:00 am). This is because of the large

traffic flows, with increased heavy traffic movements between 5:00 am and 7:00 am (see logger graphs in Appendix A below).

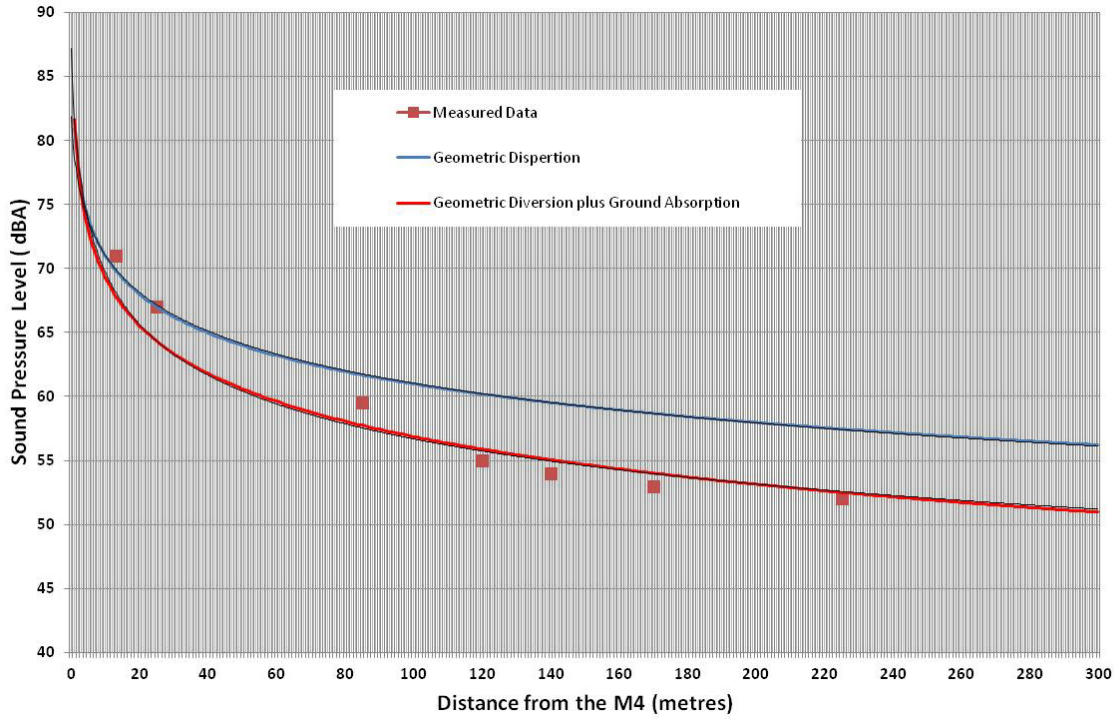


Figure 3. Measured and Modelled Road Traffic Noise Levels with Distance, Unobstructed Line of Sight.

The results show that proposed dwellings at distances up to 62 metres from the M4 motorway could be highly noise affected (i.e. over 60 dBA). The results also show that proposed dwellings at distances from 62 to 300 metres from the M4 motorway could be noise affected (i.e. over 50 dBA). The prediction for the residences at distances over 62 metres from the motorway allows for the noise reduction due to acoustic shielding from any proposed dwellings closer to the M4 motorway. Hence there is a need for a noise barrier as close to the M4 motorway as reasonably practicable to shield those residences within 62 metres from the motorway. Alternative to building a noise barrier would be to have large open spaces (i.e. 62 metres) between the motorway and the nearest residences. Example noise barrier designs are given below.

5.2 Noise Barrier Options

This section shows the options for three barrier heights for residences at a distance of 25 metres from the M4 motorway. These calculations are based on formulae as given in the *'Calculation of Road Traffic Noise'* (CoRTN 88) and the ISO 9613-2 (1996(E)) '*Acoustic – Attenuation of sound during propagation outdoors Part 2 General method of calculation'*.

TABLE 3 – BARRIER NOISE PREDICTION FOR RESIDENCES AT 25 METRES FROM THE M4 MOTORWAY – 2 METRE HIGH BARRIER.

	Octave Band Centre Frequency (Hz)								
	31	63	125	250	500	1k	2k	4k	8k
Overall 'A'	**Sound Pressure Level (dBA) No Barrier**								
69	31	49	53	55	63	67	60	51	42
Barrier Noise Reduction (dB)									
15	2	5	5	5	5	6	6	7	10
Overall 'A'	**Resultant Sound Pressure Level (dBA) 2 metre High Barrier**								
54	29	44	49	50	58	61	54	44	32

TABLE 4 – BARRIER NOISE PREDICTION FOR RESIDENCES AT 25 METRES FROM THE M4 MOTORWAY– 3 METRE HIGH BARRIER.

	Octave Band Centre Frequency (Hz)								
	31	63	125	250	500	1k	2k	4k	8k
Overall 'A'	**Sound Pressure Level (dBA) No Barrier**								
69	31	49	53	55	63	67	60	51	42
Barrier Noise Reduction (dB)									
21	4	5	6	7	8	10	12	15	19
Overall 'A'	**Resultant Sound Pressure Level (dBA) 3 metre High Barrier**								
48	27	44	48	49	55	57	48	36	23

TABLE 5 – BARRIER NOISE PREDICTION FOR RESIDENCES AT 25 METRES FROM THE M4 MOTORWAY– 4 METRE HIGH BARRIER.

	Octave Band Centre Frequency (Hz)								
	31	63	125	250	500	1k	2k	4k	8k
Overall 'A'	**Sound Pressure Level (dBA) No Barrier**								
69	31	49	53	55	63	67	60	51	42
Barrier Noise Reduction (dB)									
26	5	6	7	9	11	13	16	19	23
Overall 'A'	**Resultant Sound Pressure Level (dBA) 4 metre High Barrier**								
43	43	46	46	52	54	44	32	19	43

The barriers should be located as close to the motorway as reasonably practicable but not further than 15 metres. The exact distances will depend on the topography of the specific locations. The barriers can be earth mounds, concrete walls or timber fences. The noise barriers may be constructed of one or more of the following materials as shown in Table 6 below.

TABLE 6 – RECOMMENDED MATERIALS FOR CONSTRUCTION OF NOISE BARRIERS

Material	Typical Thickness (mm)	Surface Density (kg/m^2)
Polycarbonate	8 to 12	10-14
Acrylic	15	18
Timber	15 to 30	22
Aerated Concrete	100	161

For all constructions, the barrier must not contain any acoustically untreated holes or gaps. Occasional small gaps below the base of the fence to allow drainage may be necessary but should be kept to a minimum and not provide a line of sight from the noise source to the receiver. Timber fences should be constructed of not less than 15 mm thick lapped and capped timber provided such thickness can be maintained to prevent warping. The barriers must extend for a distance of at least 5 metres further than the edge of the proposed property line on each side to minimise sound diffraction. The barriers must be professionally constructed using a safe and secure method to ensure total stability in all predictable wind and weather conditions.

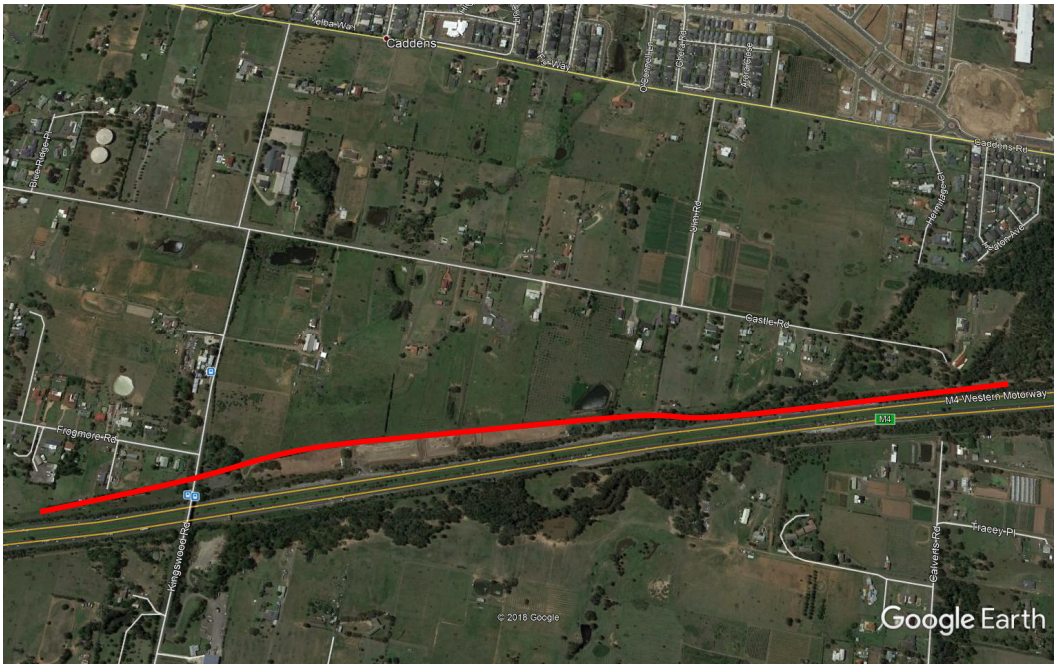


Figure 4. The Approximate Location of Proposed Noise Wall. Original Source: Google Earth.

The exact location of the barrier will be dependent upon the existing topography and will need to be decided upon on site. However, Figure 4 above gives an approximation of the location. Heights are discussed in Section 5.2 above. For earth bunds the base width is normally three times the height.

6. RECOMMENDATIONS - ARCHITECTURAL TREATMENTS FOR SOUND INSULATION

This section provides the minimum construction requirements to meet the noise goals without a noise barrier. If a noise barrier is built at the site, minor architectural treatments will still be required for sound insulation which will depend on the size and location of the noise barrier.

6.1 Planning of Dwellings.

Where reasonable and practicable, sleeping areas and other habitable areas should be placed on the side of the building furthest away from the M4 motorway. Rooms which are less sensitive to noise (i.e. laundries, bathrooms, storage rooms, corridors, stairwells, etc.) should be placed on the noisy side of the building to act as a noise buffer. An additional way of minimising the intrusion of noise is to minimise the number and the area of doors and windows (particularly windows that can be opened) on the noisy side of the dwelling.

6.2 Internal Noise Levels

In addition to distance attenuation, the internal noise level (L_{p2}) in various rooms for the proposed residences to be constructed in the development, is found from the formula:

$$\mathbf{L_{p2} = L_{p1} - R_w + 10\ Log_{10}\ (S/A) - K + 6\ dBA}$$

Where: L_{p1} is the external noise level;
R_w is the weighted sound reduction index of the partition;
S is the area of the partition (window or glazed door);
A is the room acoustic absorption; and
K is an angle of view correction.

By applying this formula the selection of the weighted sound reduction index (R_w) for the windows and glazed doors in the external façades for the proposed residential dwellings can be found. The glazed areas are normally the weakest acoustic partition in the room façades.

6.3 External Constructions for Residences at Distances between 62 metres and 100 metres from the Motorway.

The external walls must have a minimum R_w of approximately 55 dB, which is standard for:-

- brick veneer consisting of 110 mm thick exterior face brick, with 90 mm deep timber stud or 92 mm metal stud, at least 40 mm clearance between the masonry and stud frame and 13 mm thick sound rated plasterboard internal wall constructions; or

- double brick of 110 mm brickwork separated by at least a 40 mm gap.

6.3.1 Roof / Ceiling Construction

The roof/ceilings must have a minimum R_w of 52 dB, which is standard for a pitched sheet metal or concrete tiled roof with sarking and two layers of 13 mm thick sound rated plasterboard ceiling fixed to the ceiling joists and R2 (or greater) thermal insulation in the roof cavity. The plasterboard walls and ceiling should be well sealed. The joint between the wall and ceiling can be sealed, for example, with a resilient layer such as mastic and covered with a plasterboard cornice or the joint can be sealed with tape and cornice cement.

6.3.2 Minimum Glazing Thickness and R_w Ratings

Detailed designs for the proposed dwellings have not yet been finalised, hence assumptions have been made for typical glazing sizes and locations for the residences. To meet the internal design goals and based on assumptions of typical constructions, the glazing for the rooms will require the glass thicknesses as given in Table 7 below. Once specific architectural plans have been produced a final specification for window thicknesses will need to be provided as this is dependent upon room sizes, room orientations, room uses and window areas.

TABLE 7 – MINIMUM GLAZING THICKNESS AND R_W RATINGS

Room	Assumed Size of Glazing (mm)	Recommended Glazing Minimum Thickness	Required Minimum R_w or STC (dB)
Typical Double Storey House			
Lounge / Family / Dining	2100 x 2700	10.38 mm Laminated sliding door with Fin Seals	33
	1000 x 1500 x 2	10.38 mm Laminated awning windows with Qlon Seals	32
Bedroom 1	2100 x 1800	10.38 mm Laminated awning window with Qlon Seals	36
Bedrooms 2, 3 and 4	1800 x 1200	10.38 mm Laminated awning window with Qlon Seals	34
Typical Single Storey House			
Lounge / Family / Dining	2100 x 2700	10.38 mm Laminated sliding door with Fin Seals	33
	1000 x 1500 x 2	10.38 mm Laminated awning windows with Qlon Seals	32
Bedroom 1	2100 x 1800	10.38 mm Laminated awning window with Qlon Seals	34
Bedrooms 2, 3 and 4	1800 x 1200	10.38 mm Laminated awning window with Qlon Seals	33

6.3.3 Entry Doors

All external entry doors (including from garages to habitable rooms) in residences should be at least 35 mm thick and of solid-core construction. The doors should also be fitted with acoustic seals (e.g. *'Lorient'* IS7025 and IS8011si or *'Raven' RP47* frame and *RP38* bottom seals) to give a certified R_w rating of at least 32 dB.

6.4 External Constructions for Residences at Distances between 100 metres and 200 metres from the Motorway.

The external walls must have a minimum R_w of approximately 45 dB, which is standard for:-

- brick veneer consisting of 110 mm thick exterior face brick, with 90 mm deep timber stud or 92 mm metal stud, at least 40 mm clearance between

the masonry and stud frame and 13 mm thick plasterboard internal wall constructions; or

- double brick of 110 mm brickwork separated by at least a 40 mm gap; or
- cladding construction with 6 mm fibre cement sheeting or weatherboards or plank cladding externally, 90 mm deep timber stud or 92 mm metal stud, 10 mm standard plasterboard internally with R1.5 insulation in wall cavity.

6.4.1 Roof / Ceiling Construction

The roof/ceilings must have a minimum R_w of 43 dB, which is standard for a pitched sheet metal or concrete tiled roof with sarking and one layers of 13 mm thick sound rated plasterboard ceiling fixed to the ceiling joists and R2 (or greater) thermal insulation in the roof cavity. The plasterboard walls and ceiling should be well sealed. The joint between the wall and ceiling can be sealed, for example, with a resilient layer such as mastic and covered with a plasterboard cornice or the joint can be sealed with tape and cornice cement.

6.4.2 Minimum Glazing Thickness and R_w Ratings

Detailed designs for the proposed dwellings have not yet been finalised, hence assumptions have been made for typical glazing sizes and locations for the residences. To meet the internal design goals and based on assumptions of typical constructions, the glazing for the rooms will require the glass thicknesses as given in Table 8 below. Once specific architectural plans have been produced a final specification for window thicknesses will need to be provided as this is dependent upon room sizes, room orientations, room uses and window areas.

TABLE 8 - TYPICAL CASE SCENARIO MINIMUM GLAZING THICKNESS AND R_W RATINGS –

Room	Assumed Size of Glazing (mm)	Recommended Glazing Minimum Thickness	Required Minimum R_w or STC (dB)
Typical Double Storey House			
Lounge / Family / Dining	2100 x 2700 1000 x 1500 x 2	6.38 mm Laminated sliding door with Fin Seals 4 mm Float awning windows	29 28
Bedroom 1	2100 x 1800	6.38 mm Laminated awning window with Qlon Seals	33
Bedrooms 2, 3 and 4	1800 x 1200	6.38 mm Laminated awning window with Qlon Seals	33
Typical Single Storey House			
Lounge / Family / Dining	2100 x 2700 1000 x 1500 x 2	6.38 mm Laminated sliding door with Fin Seals 4 mm Float awning windows	29 28
Bedroom 1	2100 x 1800	6.38 mm Laminated awning window with Qlon Seals	31
Bedrooms 2, 3 and 4	1800 x 1200	6.38 mm Laminated awning window with Qlon Seals	31

6.5 External Constructions for Residences at Distances between 200 metres and 300 metres from the Motorway.

The external walls must have a minimum R_w of approximately 38 dB, which is standard for:-

- brick veneer consisting of 110 mm thick exterior face brick, with 90 mm deep timber stud or 92 mm metal stud, at least 40 mm clearance between the masonry and stud frame and 10 mm thick plasterboard internal wall constructions; or

- double brick of 110 mm brickwork separated by at least a 40 mm gap; or

- cladding construction with 6 mm fibre cement sheeting or weatherboards or plank cladding externally, 90 mm deep timber stud or 92 mm metal stud, 10 mm standard plasterboard internally with R1.5 insulation in wall cavity.

6.5.1 Roof / Ceiling Construction

The roof/ceilings must have a minimum R_w of 40 dB, which is standard for a pitched sheet metal or concrete tiled roof with sarking and one layer of 10 mm thick sound rated plasterboard ceiling fixed to the ceiling joists and R2 (or greater) thermal insulation in the roof cavity. The plasterboard walls and ceiling should be well sealed. The joint between the wall and ceiling can be sealed, for example, with a resilient layer such as mastic and covered with a plasterboard cornice or the joint can be sealed with tape and cornice cement.

6.5.2 Minimum Glazing Thickness and R_w Ratings

Detailed designs for the proposed dwellings have not yet been finalised, hence assumptions have been made for typical glazing sizes and locations for the residences. To meet the internal design goals and based on assumptions of typical constructions, the glazing for the rooms will require the glass thicknesses as given in Table 9 below. Once specific architectural plans have been produced a final specification for window thicknesses will need to be provided as this is dependent upon room sizes, room orientations, room uses and window areas.

TABLE 9 - TYPICAL CASE SCENARIO MINIMUM GLAZING THICKNESS AND R_W RATINGS

Room	Assumed Size of Glazing (mm)	Recommended Glazing Minimum Thickness	Required Minimum R_w or STC (dB)
Typical Double Storey House			
Lounge / Family / Dining	2100 x 2700 1000 x 1500 x 2	6.38 mm Laminated sliding door with Fin Seals 4 mm Float awning windows	29 28
Bedroom 1	2100 x 1800	6.38 mm Laminated awning window with Qlon Seals	33
Bedrooms 2, 3 and 4	1800 x 1200	6.38 mm Laminated awning window with Qlon Seals	33
Typical Single Storey House			
Lounge / Family / Dining	2100 x 2700 1000 x 1500 x 2	6.38 mm Laminated sliding door with Fin Seals 4 mm Float awning windows	29 28
Bedroom 1	2100 x 1800	6.38 mm Laminated awning window with Qlon Seals	31
Bedrooms 2, 3 and 4	1800 x 1200	6.38 mm Laminated awning window with Qlon Seals	31

6.6 Ventilation

An acoustically insulated building must be kept virtually air tight to exclude external noise. Therefore any windows of the residences requiring laminated glazing must be kept closed to achieve the required R_w ratings. Hence there is a requirement for mechanical ventilation or air-conditioning to provide fresh air to control odours. Specific ventilation requirements are outside of our scope of expertise, however requirements for indoor-air quality are given in Australian Standard AS 1668.2 -2012, *"The use of ventilation and air-conditioning in buildings - Ventilation design for indoor air contaminant control"*. Internal noise levels from mechanical ventilation or air-conditioning should not exceed 35 dBA for bedroom areas and 40 dBA for all other habitable areas. External noise levels from mechanical ventilation or air-conditioning should not exceed 5 dB over the lowest existing background noise level (L_{A90}) when in day time use and when measured at the neighbouring boundary. Night time noise levels must meet the requirements of the Protection of the Environment Operations (Noise Control) Regulation 2017.

7. SUMMARY AND CONCLUSIONS

Noise and vibration from road traffic movements using the M4 Motorway have been measured in the vicinity of the green field site of approximately 120 hectares of rural land in Orchard Hills North (OHN). This is to permit residential development comprising of approximately 1,800 dwellings. The measurements have been used to predict internal noise levels for sample proposed residential dwellings in the development with or without the construction of a noise barrier. For no noise barrier recommendations for architectural treatments for sound insulation are shown in Section 6 above.

Status	**Date**	**Prepared by:**
Draft	14th November 2019	Ken Scannell MSc MAAS
Status	**Date**	**Checked by:**
Draft	14th November 2019	Mark Scannell *BA (Planning)* MAAS
Status	**Date**	**Issued by:**
Final	20th December 2019	Ken Scannell MSc MAAS

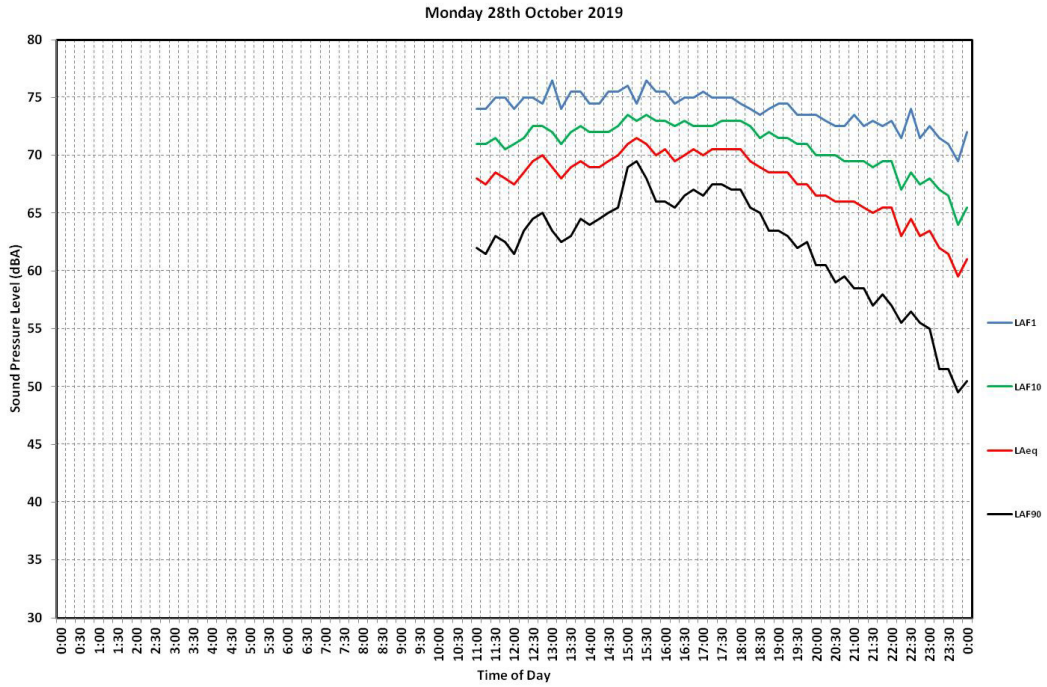
Important Note. *All products and materials suggested by 'Noise and Sound Services' are selected for their acoustical properties only. All other properties such as airflow, aesthetics, chemical, corrosion, combustion, construction details, decomposition, expansion, fire rating, grout or tile cracking, loading, shrinkage, ventilation, etc are outside of 'Noise and Sound Services' field of expertise and* ***must be*** *checked with the supplier or suitably qualified specialist before purchase.*

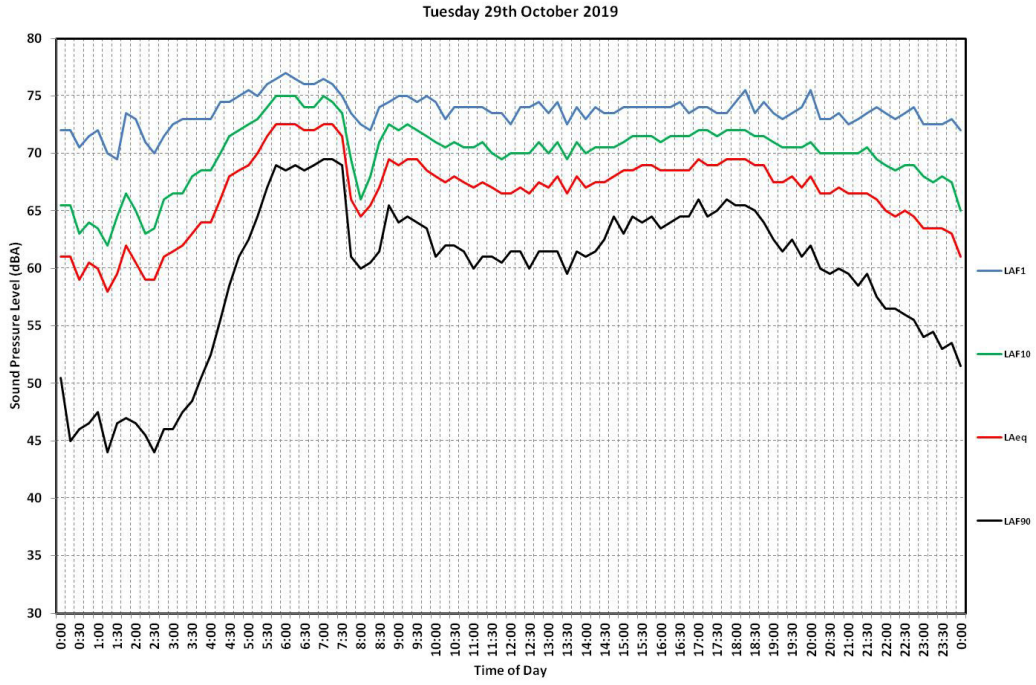
APPENDIX A – MEASURED SOUND PRESSURE LEVELS

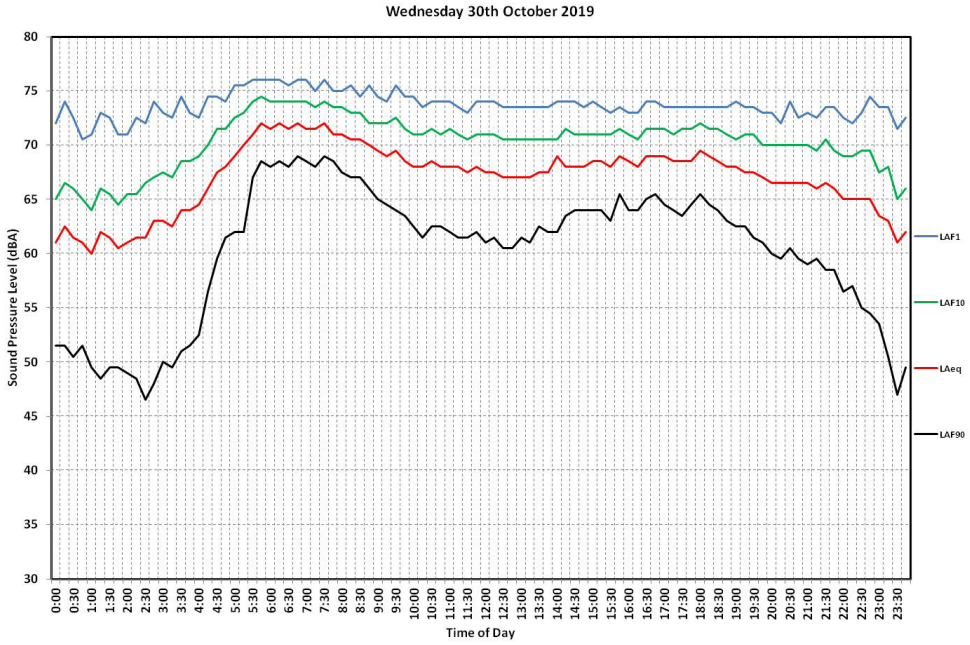
Environmental noise levels can vary considerably with time; therefore it is not adequate to use a single number to fully describe the acoustic environment. The preferred, and now generally accepted, method of recording and presenting noise measurements is based upon a statistical approach. For example, the L_{AF10} noise level is the level exceeded for 10% of the time, and is approximately the average maximum noise level. The L_{AF90} level is the level that is exceeded for 90% of the time, and is considered to be approximately the average of the minimum noise level recorded. This level is often referred to as the 'background' noise level. The L_{Aeq} level represents the average noise energy during the measurement period.

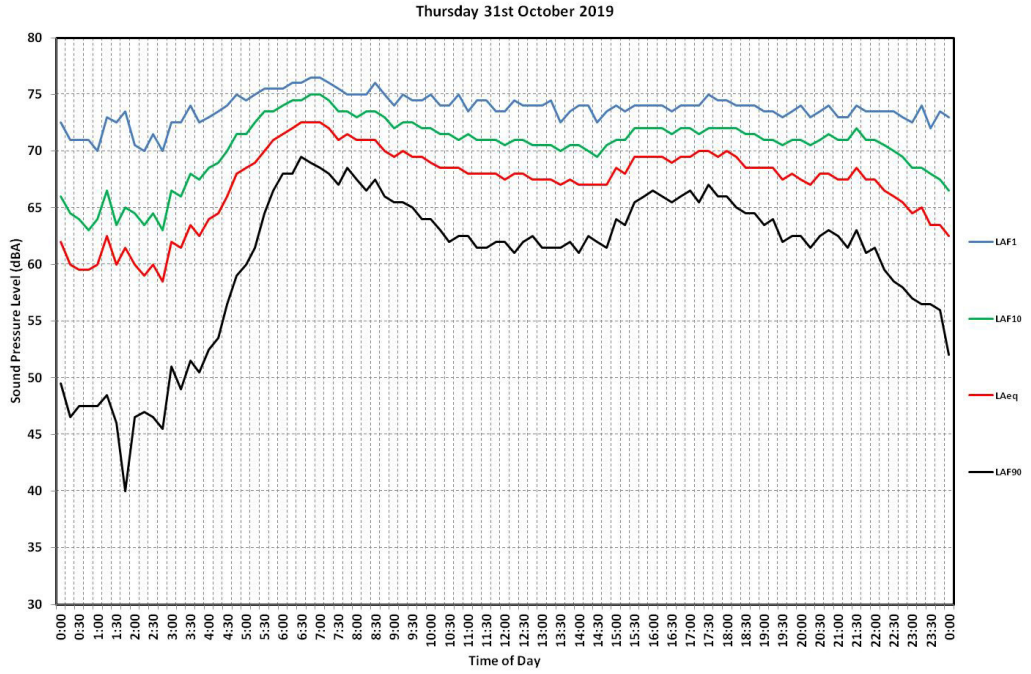
The measurement procedure and the equipment used for the unattended noise survey are given in Section 4 of this report. The measurement results are shown in the Figures below.

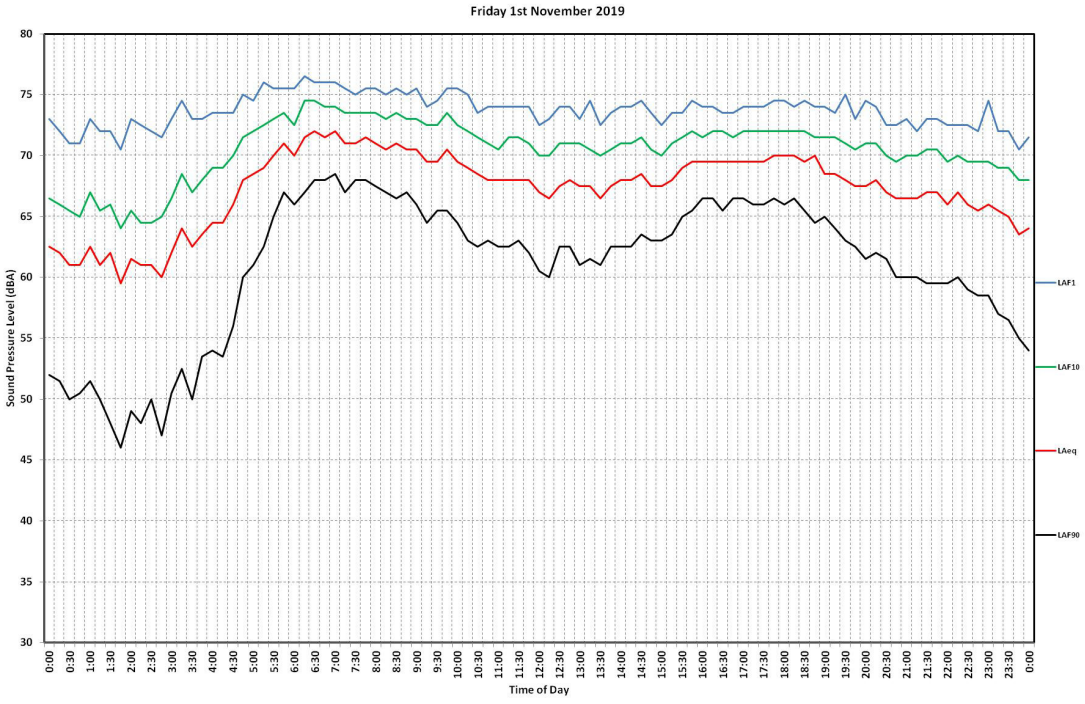
Logged Ambient Noise Levels
25 metres from M4, Orchard Hills, NSW 2748

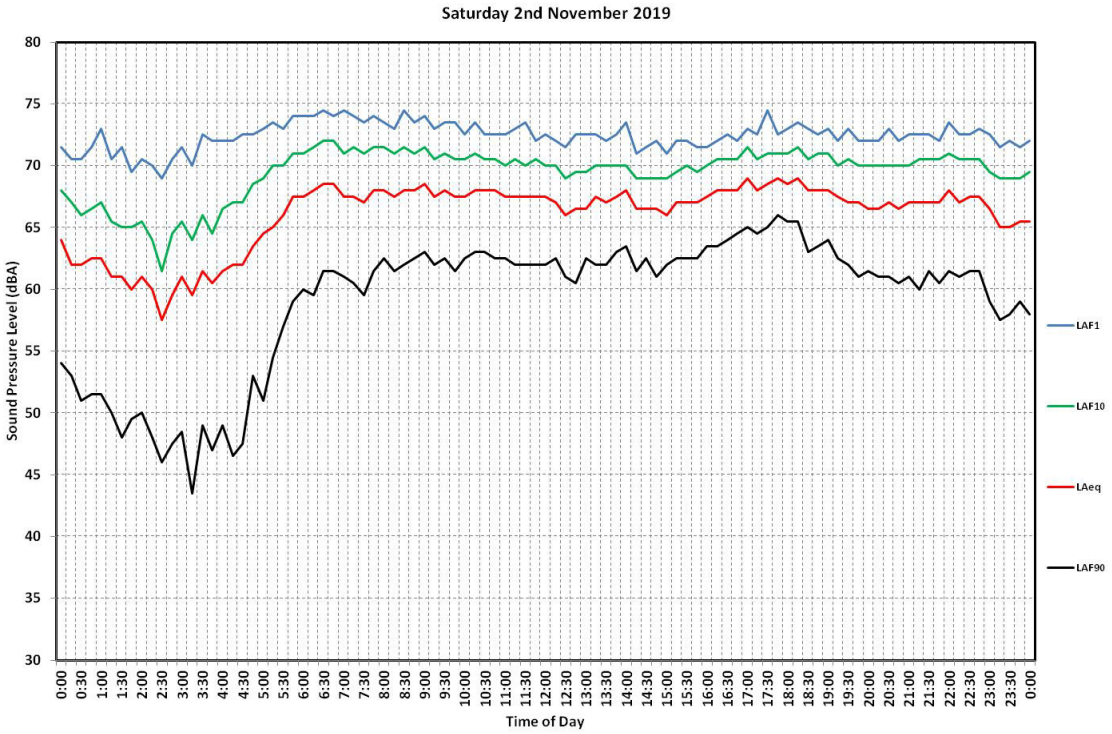


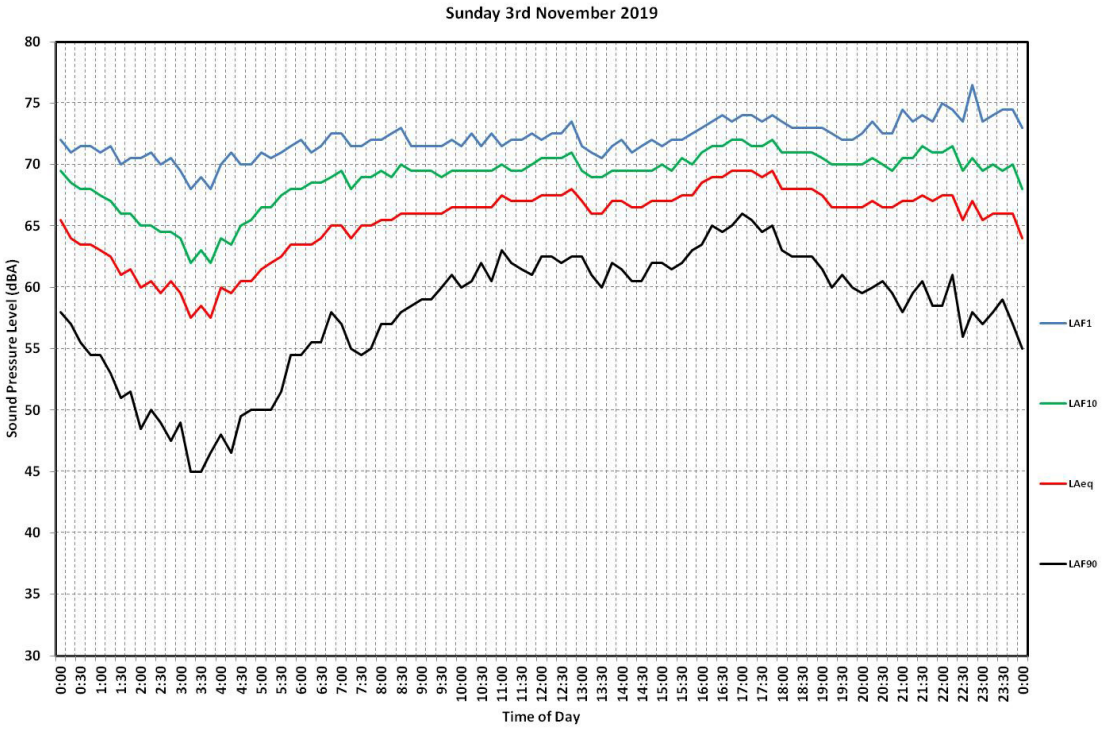

Tuesday 29th October 2019
Sound Pressure Level (dBA)
Time of Day
LAF1
LAF10
LAeq
LAF90

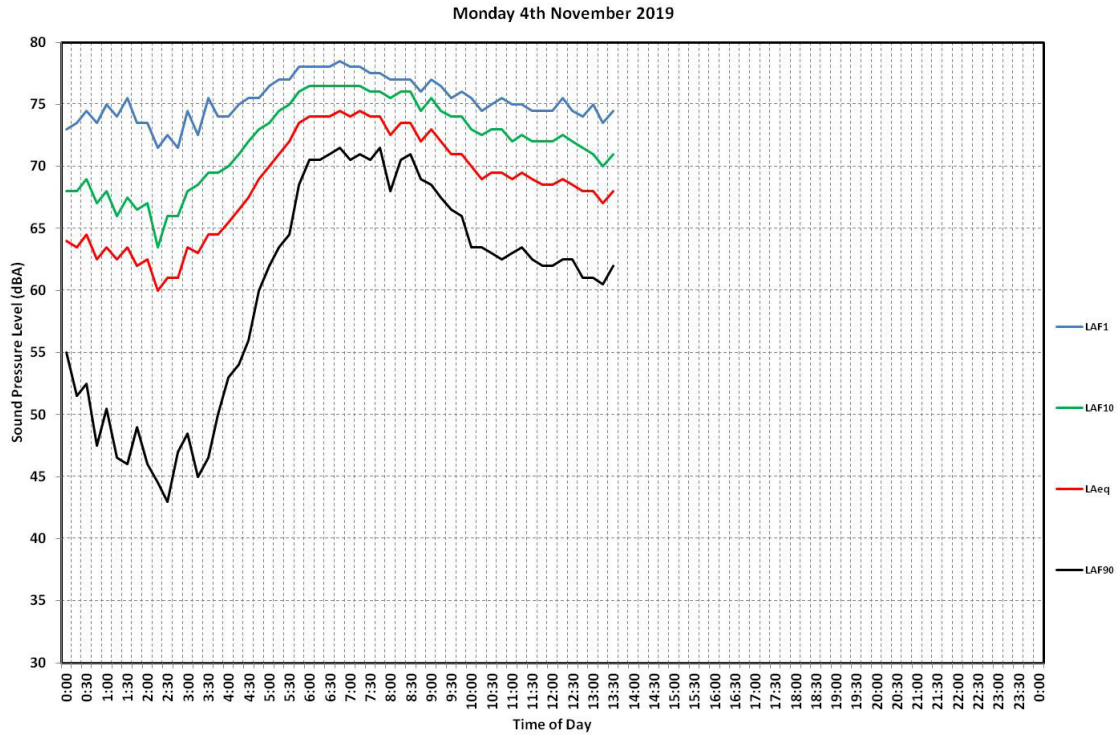

Wednesday 30th October 2019
Sound Pressure Level (dBA)
Time of Day
LAF1
LAF10
LAeq
LAF90


Thursday 31st October 2019
Sound Pressure Level (dBA)
Time of Day
LAF1
LAF10
LAeq
LAF90


Friday 1st November 2019
Sound Pressure Level (dBA)
Time of Day
LAF1
LAF10
LAeq
LAF90


Saturday 2nd November 2019
Sound Pressure Level (dBA)
Time of Day
LAF1
LAF10
LAeq
LAF90


Sunday 3rd November 2019
Sound Pressure Level (dBA)
Time of Day
LAF1
LAF10
LAeq
LAF90


Monday 4th November 2019
Sound Pressure Level (dBA)
80
75
70
65
60
55
50
45
40
35
30
0:00
0:30
1:00
1:30
2:00
2:30
3:00
3:30
4:00
4:30
5:00
5:30
6:00
6:30
7:00
7:30
8:00
8:30
9:00
9:30
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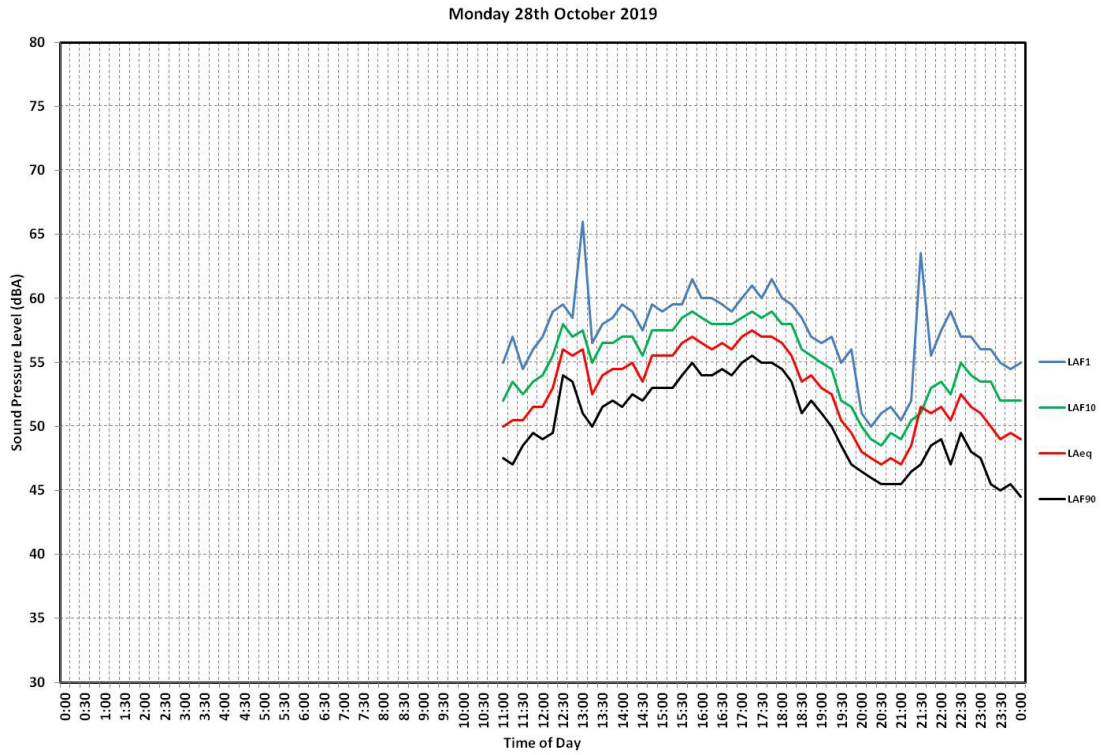
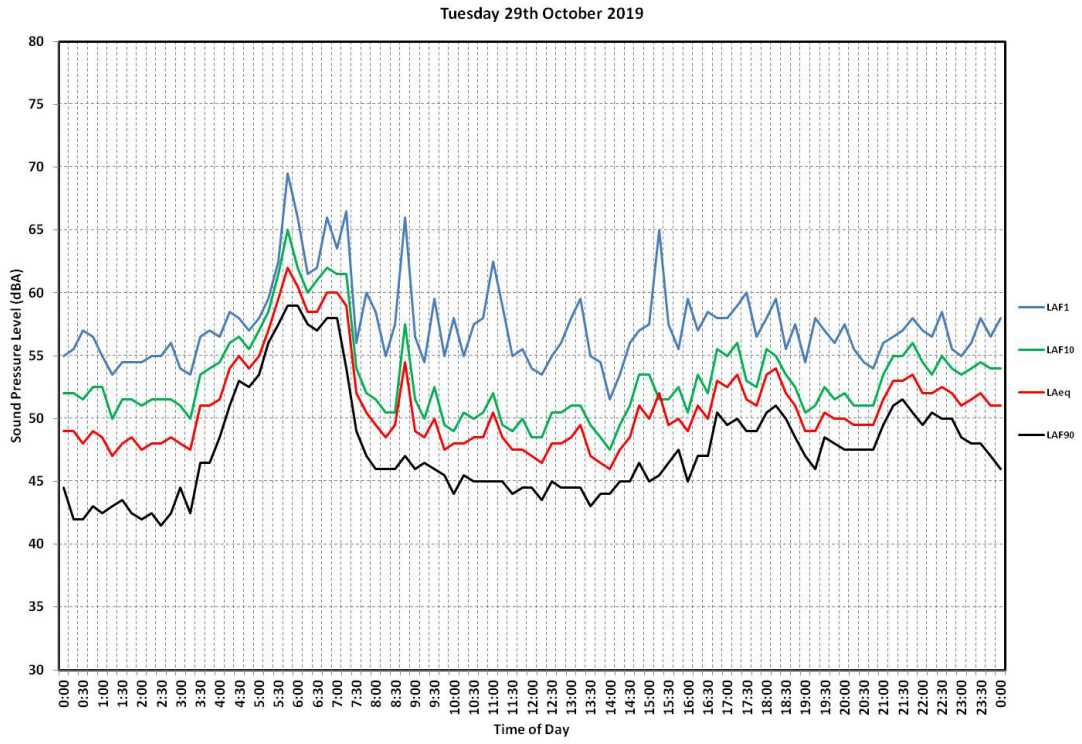
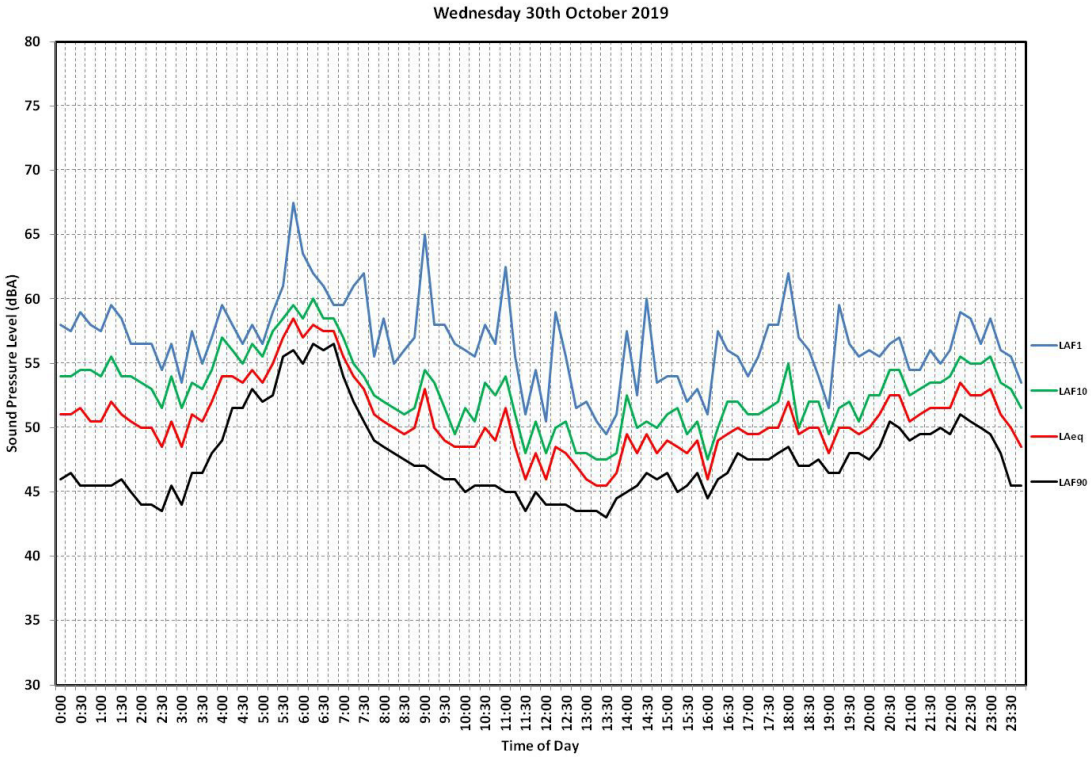
11:30
12:00
12:30
13:00
13:30
14:00
14:30
15:00
15:30
16:00
16:30
17:00
17:30
18:00
18:30
19:00
19:30
20:00
20:30
21:00
21:30
22:00
22:30
23:00
23:30
0:00
Time of Day
LAF1
LAF10
LAeq
LAF90

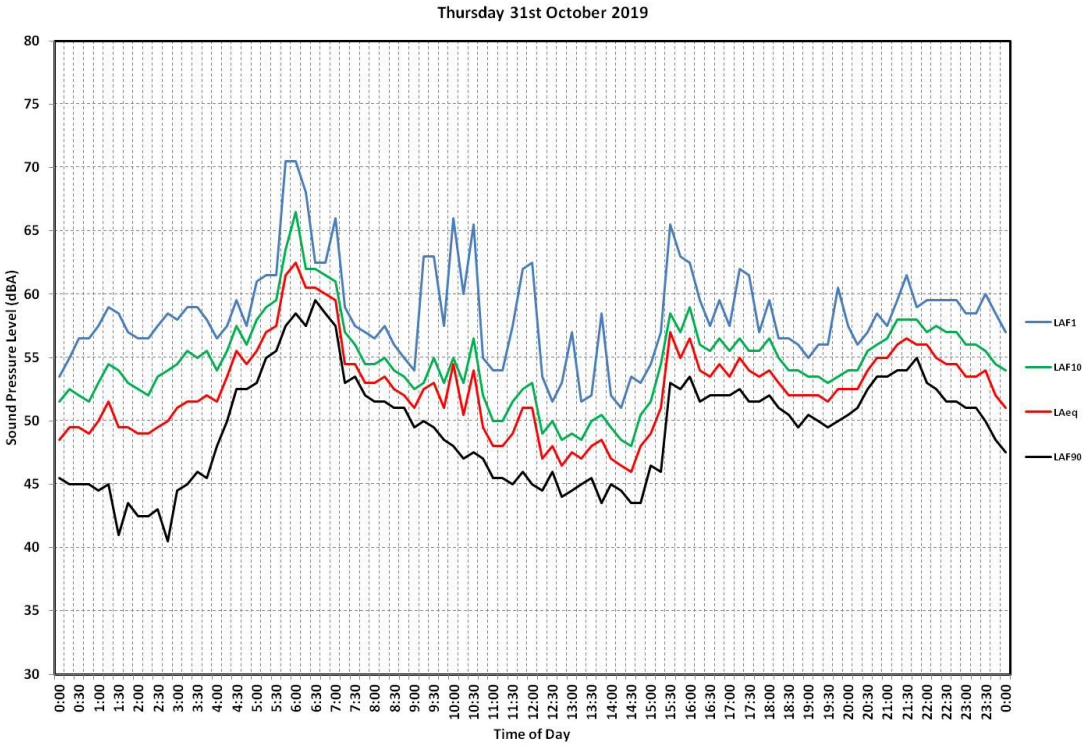
Logged Ambient Noise Levels

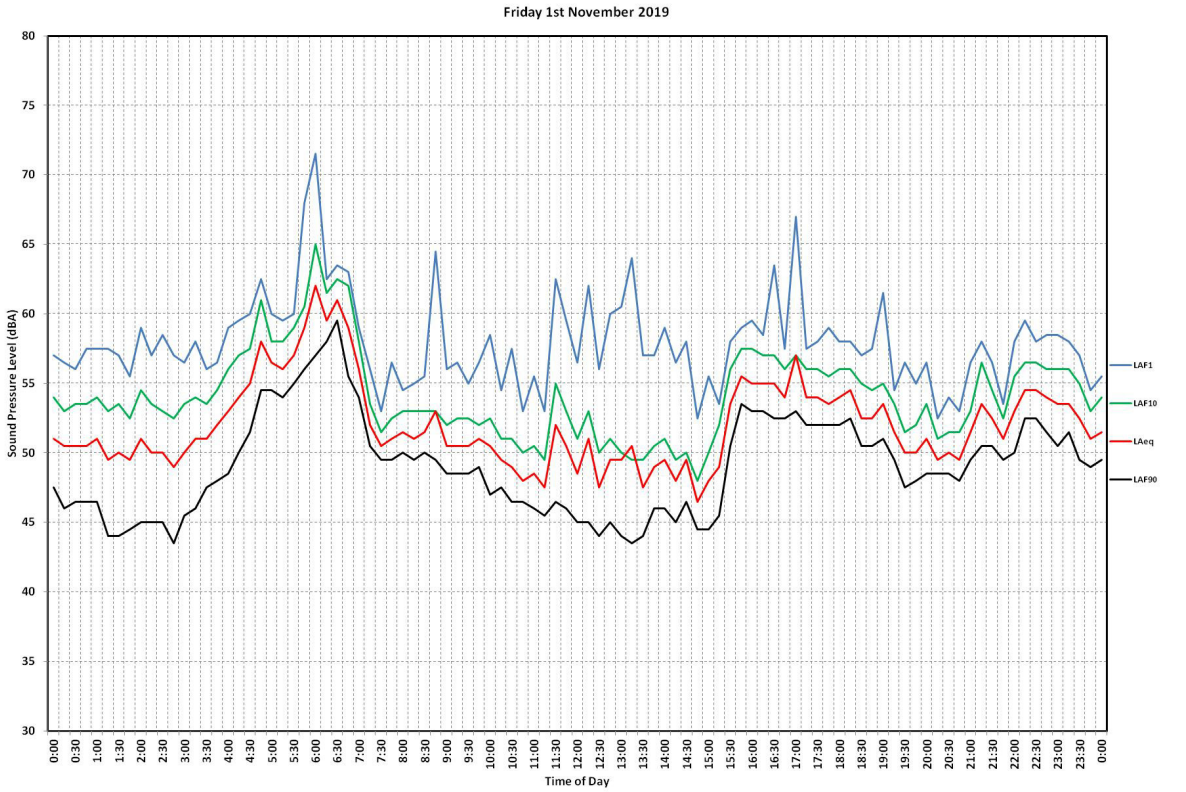
225 metres from M4, Orchard Hills, NSW 2748

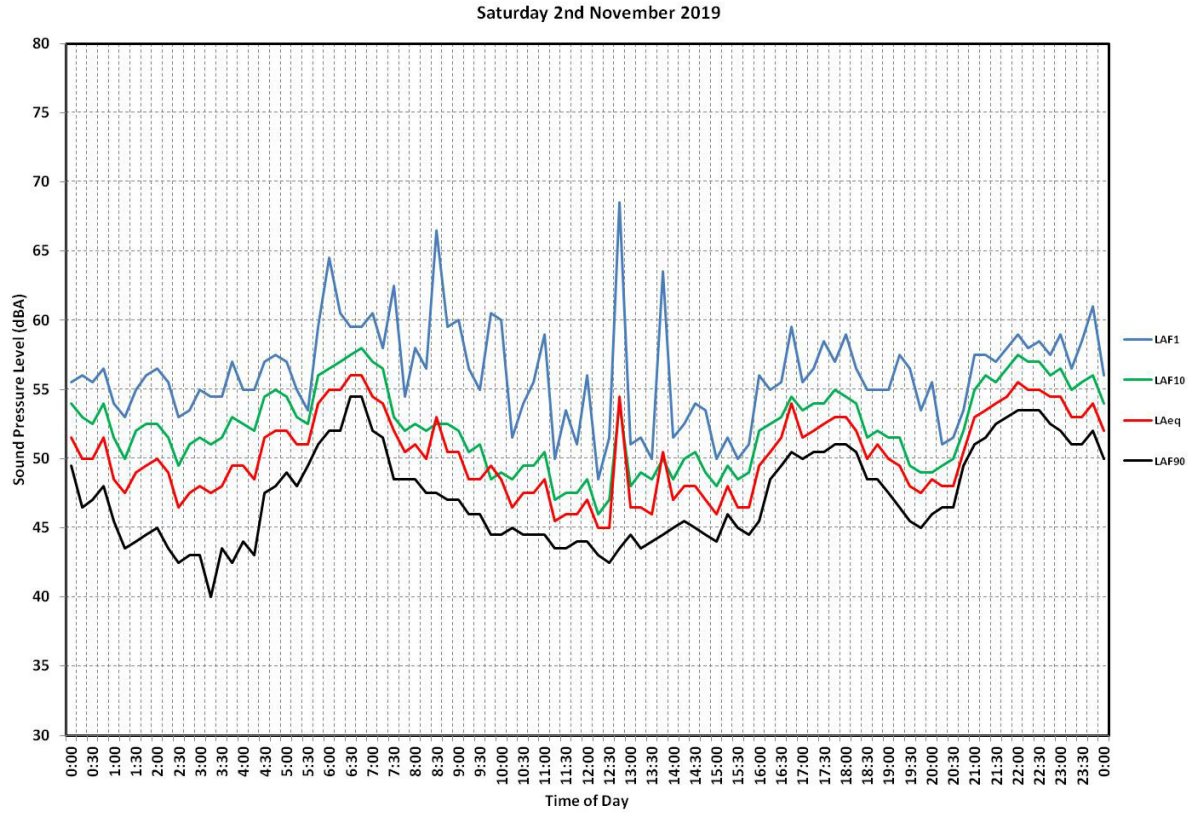


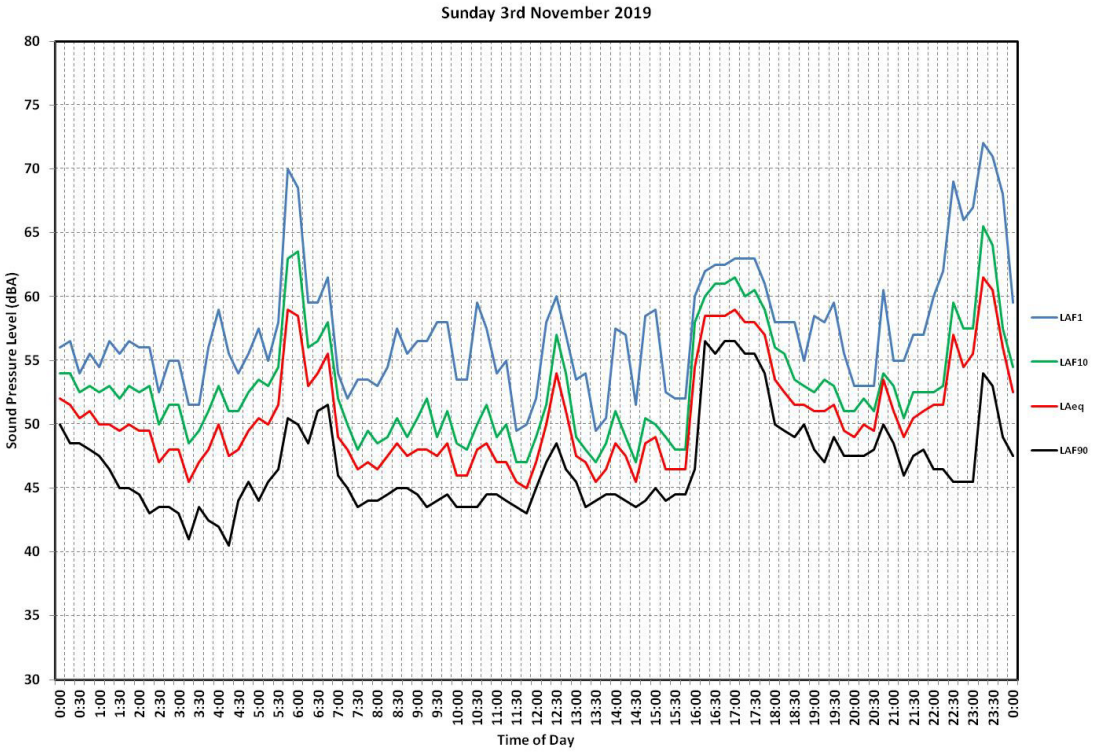


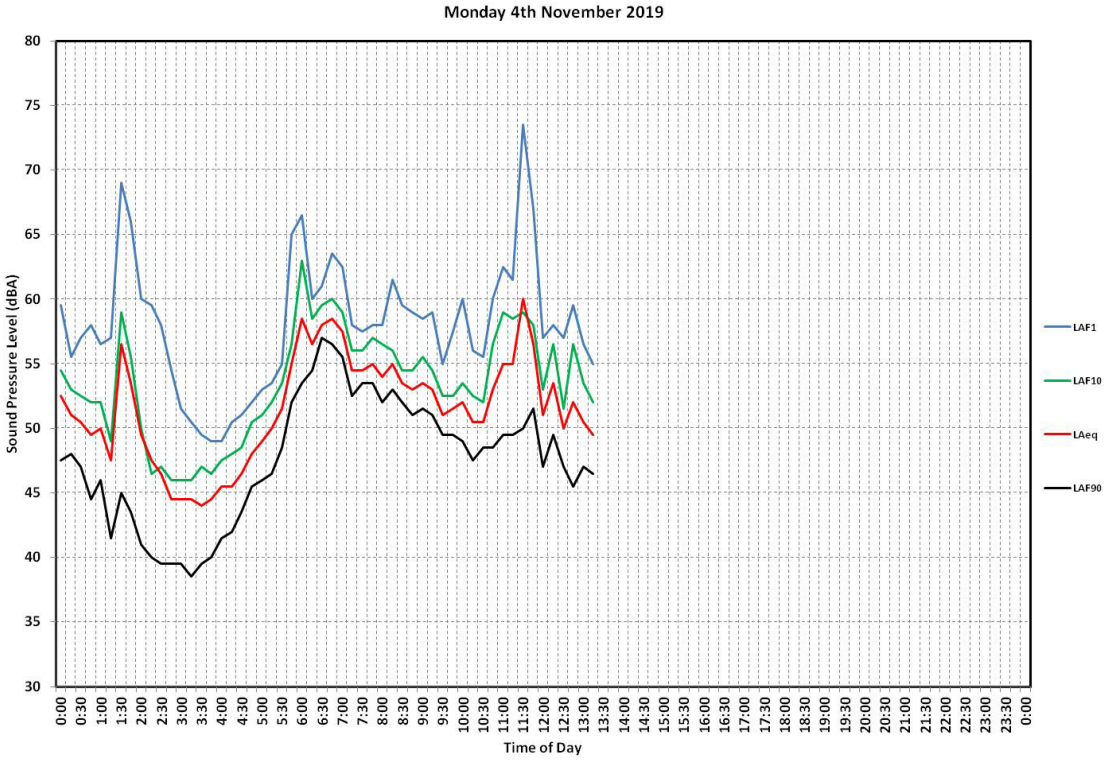

Wednesday 30th October 2019
Sound Pressure Level (dBA)
Time of Day
LAF1
LAF10
LAeq
LAF90


Thursday 31st October 2019
Sound Pressure Level (dBA)
Time of Day
LAF1
LAF10
LAeq
LAF90


Friday 1st November 2019
Sound Pressure Level (dBA)
Time of Day
LAF1
LAF10
LAeq
LAF90


Saturday 2nd November 2019
Sound Pressure Level (dBA)
Time of Day
LAF1
LAF10
LAeq
LAF90


Sunday 3rd November 2019
Sound Pressure Level (dBA)
Time of Day
LAF1
LAF10
LAeq
LAF90


Monday 4th November 2019
Sound Pressure Level (dBA)
Time of Day
LAF1
LAF10
LAeq
LAF90

APPENDIX B - EXAMPLE MATERIAL SUPPLIERS

Acoustic Glazing Suppliers

'Vantage Windows' telephone: 1300 026 189
http://www.awsaustralia.com.au
'Wideline Pty Ltd' telephone: (02) 8304 6400.
www.wideline.com.au
'Trend Windows & Doors Pty Ltd' telephone: (02) 9840 2000.
www.trendwindows.com.au
'Thermoglaze Windows' telephone: 1300 166 571
www.thermaglazewindows.com.au
'Christoffel Pty Ltd' telephone: (02) 9627 4811
www.christoffel.com.au/contact.htm
'Sound Barrier Systems Pty. Ltd' telephone: (02) 9540 4333, or email tony.angel@soundbarrier.com.au
'Velux' telephone: (02) 1300 859 856
http://www.velux.com.au/
'*Safetyline Jalouise'* telephone: 1300 86 3350
http://www.safetylinejalousie.com.au/

Internal Wall-Mounted Air Ventilators

Active:
Acoustica – telephone 1300 722 825 www.acoustica.com.au
Sonair – telephone 1300 858 674 www.edmonds.com.au
Passive:
Silenceair® – telephone **02 9555 7215 www.silenceair.com**

Acoustic Door Seals

Kilargo, telephone 1300 858 011. www.kilargo.com.au

Raven – telephone 1800 888 123, www.raven.com.au