1411 THE NORTHERN ROAD

Planning Proposal
Noise Impact Assessment

Prepared for:

EG Property Group Pty Ltd
Level 21, Governor Phillip Tower, 1 Farrer Place
Sydney, NSW 2000

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PREPARED BY

SLR Consulting Australia Pty Ltd
ABN 29 001 584 612
Tenancy 202 Submarine School, Sub Base Platypus, 120 High Street
North Sydney NSW 2060 Australia

T: +61 2 9427 8100
E: sydney@slrconsulting.com www.slrconsulting.com

BASIS OF REPORT

This report has been prepared by SLR Consulting Australia Pty Ltd (SLR) with all reasonable skill, care and diligence, and taking account of the timescale and resources allocated to it by agreement with EG Property Group Pty Ltd (the Client). Information reported herein is based on the interpretation of data collected, which has been accepted in good faith as being accurate and valid.

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DOCUMENT CONTROL

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CONTENTS

DOCUMENT REFERENCES

TABLES

CONTENTS

FIGURES

APPENDICES

1 Introduction

SLR Consulting Australia Pty Ltd (SLR) has been engaged by EG Property Group Pty Ltd to undertake a noise impact assessment of the proposed industrial/retail development at 1411 The Northern Road, Bringelly. This assessment has been prepared to accompany the Planning Proposal.

This report summarises the results of ambient noise measurements undertaken at the site and assesses the potential operational noise impacts associated with the proposal.

The following report uses specialist acoustic terminology. An explanation of common terms is provided in **Appendix A**.

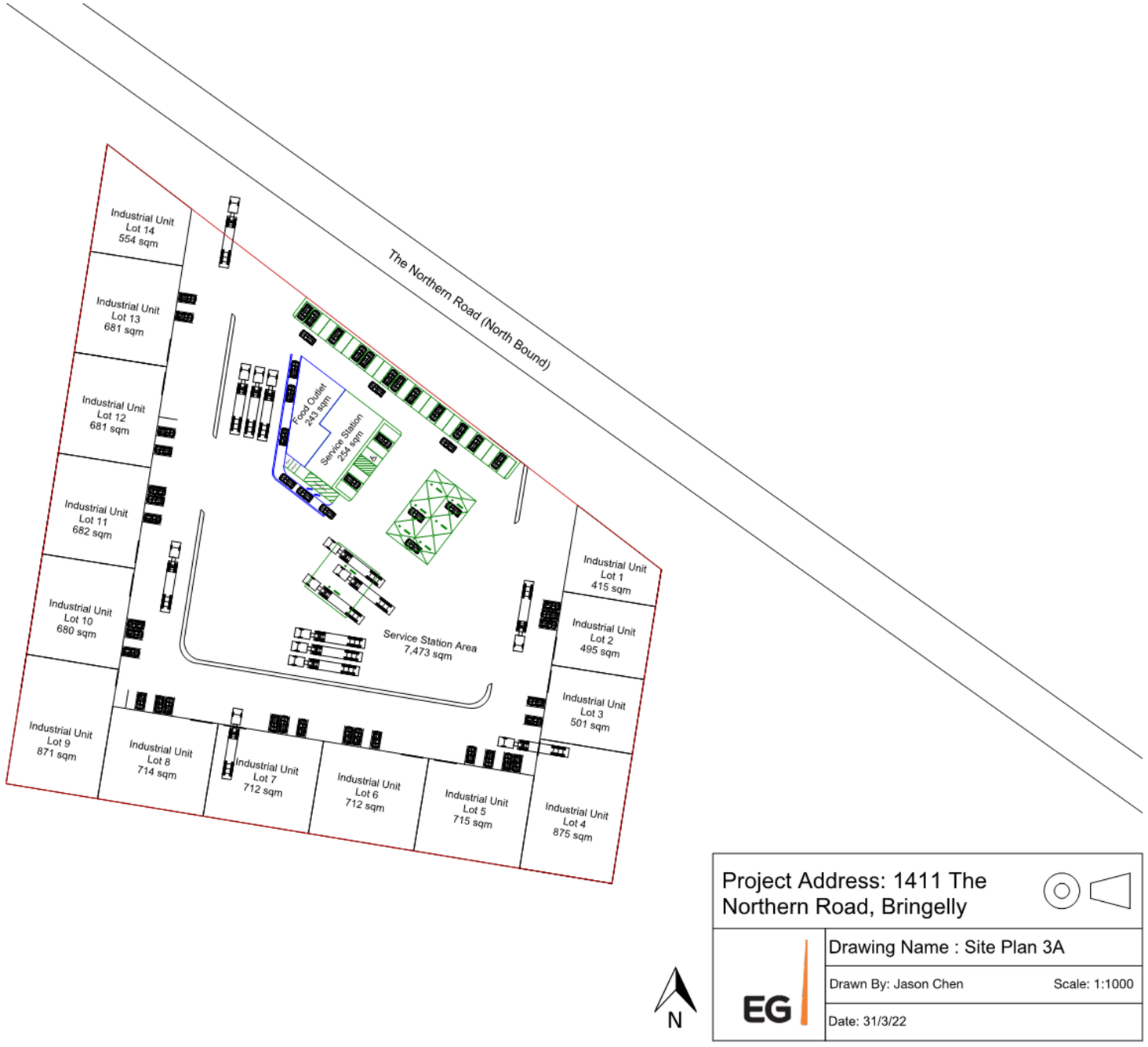
1.1 Proposal Description

The proposed development is located at 1411 The Northern Road, Bringelly. The site is adjacent to The Northern Road.

The site location is **Figure 1** and the proposed development layout is shown in **Figure 2**. SLR understands, from information provided from EG Property Group, that the industrial unit buildings will be a minimum of 12 meters in height.

Figure 1 Site Location, Surrounding Receivers and Noise Monitoring Locations

Figure 2 Proposed Development



Operating hours for the development would typically be 24/hrs 7 days a week for the service station, 7am to 6pm, Monday to Saturday for the Industrial lots. Deliveries to and from the development could occur at any time during the opening hours, on any day of the week.

The identified sources of noise from the proposed development include:

- Mechanical plant
- Truck and light vehicle movements on internal access roads and parking areas.

A minimum of 129 vehicle parking spaces are required for this development:

- Service station 27 vehicle parking spaces
- Food Outlet 40 vehicle parking spaces
- Industry 72 vehicle parking spaces

1.2 Nearest Receivers

The nearest sensitive receivers are residential properties located 40 m to the West and 50 m to the East. The area located to the east of the site is parkland. The nearest receivers are shown in **Figure 1** and **Table 1**

Table 1 Surrounding Sensitive Receivers

ID	Address	Type	Distance (m)	Direction
R01	1431 The Northern Road, Bringelly	Residential	40	West
R02	1445 The Northern Road, Bringelly	Residential	150	West
R03	1430 The Northern Road, Bringelly	Residential	240	North
R04	1412 The Northern Road, Bringelly	Residential	160	North
R05	1402 The Northern Road, Bringelly	Residential	170	North-East
R06	1375 The Northern Road, Bringelly	Residential	50	East
R07	1370 The Northern Road, Bringelly	Residential	300	East
R08	35 Dart Road, Bringelly	Residential	350	South
R09	45 Dart Road, Bringelly	Commercial	270	South
R10	65 Carr Road, Bringelly	Residential	440	South

2 Existing Noise Environment

The existing noise environment at the site is generally dominated by road traffic from the surrounding road network with the nearest major road being The Northern Road, which is located 15 m to the north.

2.1 Existing Noise Survey and Monitoring Locations

Unattended noise monitoring was completed in the study area during May 2022. The measured noise levels have been used to determine the existing noise environment and to set the criteria used to assess the potential impacts from the proposal.

The monitoring equipment was positioned to measure existing noise levels that are representative of receivers potentially most affected by the proposal, within constraints such as accessibility, security and landowner permission.

The noise monitoring equipment continuously measured existing noise levels in 15-minute periods during the daytime, evening and night-time. All equipment carried current National Association of Testing Authorities (NATA) or manufacturer calibration certificates and equipment calibration was confirmed before and after each measurement.

The measured data has been processed to exclude noise from extraneous events and periods affected by adverse weather conditions (measured at Badgerys Creek), such as strong wind or rain in accordance with NPfI procedures, to establish representative existing noise levels in the study area.

The noise monitoring locations are shown in **Figure 1** and the results are summarised in **Table 2**. Details of each monitoring location together with graphs of the measured daily noise levels are provided in **Appendix B.**

Table 2 Summary of Unattended Noise Logging Results

ID	Address	Measured Noise Levels (dBA)					
		Background Noise (RBL)			Average Noise (L_{Aeq})		
		Day	Evening	Night	Day	Evening	Night
L01	1411 The Northern Road, Bringelly	44	41	38	56	52	51

Note 1: The assessment periods are the daytime which is 7 am to 6 pm Monday to Saturday and 8 am to 6 pm on Sundays and public holidays, the evening which is 6 pm to 10 pm, and the night-time which is 10 pm to 7 am on Monday to Saturday and 10 pm to 8 am on Sunday and public holidays. See the NSW EPA *Noise Policy for Industry*.

2.2 Attended Noise Measurements

Short-term attended noise monitoring was also completed the monitoring location. The attended noise measurement was performed using a Bruel & Kjaer 2270 sound level meter (Serial Number 3004635).

The attended measurement allow the contributions of the various noise sources at each location to be determined. Detailed observations from the attended measurements are provided in **Table 3**.

Table 3 Operator Attended Noise Monitoring Results

Attended ID	Location	Date/ Start time/ Weather	Primary Noise Descriptor (dBA re 20 µPa)					Description of Noise Emissions and Typical Maximum Noise Levels (dBA)
			L_{Amax}	L_{A1}	L_{A10}	L_{A90}	L_{Aeq}	
A01	1411 The Northern Road, Bringelly	19/5/2022 13:02 18°C 2 m/s S	71	66	59	44	55	Aircraft 55-71 Traffic 44-67 Birds 54-61

The existing noise environment is generally influenced by road traffic from the surrounding road network with the nearest major road being The Northern Road.

3 Assessment Criteria

3.1 Noise Policy for Industry

The NSW *Noise Policy for Industry* (NPfI) was released in 2017 and sets out the requirements for the assessment and management of operational noise from industry in NSW.

3.1.1 Industrial Noise Trigger Levels

The NPfI defines how to determine 'trigger levels' for noise emissions from industrial developments. Where a development is likely to exceed the trigger levels at existing noise sensitive receivers, feasible and reasonable noise management measures are required to be considered to reduce the impacts.

There are two types of trigger levels – one to account for 'intrusive' noise impacts and one to protect the 'amenity' of particular land uses:

- The **intrusiveness** of an industrial noise source is generally considered acceptable if the L_{Aeq} noise level of the source, measured over a period of 15-minutes, does not exceed the representative background noise level by more than 5 dB. Intrusive noise levels are only applied to residential receivers. For other receiver types, only the amenity levels apply.
- To limit continual increases in noise levels from the use of the intrusiveness level alone, the ambient noise level within an area from all industrial sources should remain below the recommended **amenity** levels specified in the NPfI for that particular land use.

For this assessment, the area surrounding the proposal is considered to be 'urban' as per the NPfI definitions.

3.1.2 Project Noise Trigger Levels

The trigger levels for industrial noise from the proposal are summarised in **Table 4**. The Project Noise Trigger Levels (PNTL) are the most stringent of the intrusiveness and amenity trigger level for each period and are highlighted below.

Table 4 Project Noise Trigger Levels

ID	Receiver Type	Period	Amenity Noise Level L_{Aeq} (dBA)	Measured Noise Level (dBA)		Project Noise Trigger Levels $L_{Aeq(15minute)}$ (dBA)	
				RBL[1]	$L_{Aeq(period)}$	Intrusiveness	Amenity[2,3]
R1 -R8 & R10	Residential	Daytime	60	44	56	**49**	58
		Evening	50	41	52	**46**	48
		Night-time	45	38	51	**43**	43
R9	Commercial	When in use	65	-	-	-	63

Note 1: RBL = Rating Background Level.

Note 2: The recommended amenity noise levels have been reduced by 5 dB, where appropriate, to give the project amenity noise levels due to other sources of industrial noise likely to be built in the area in the future.

Note 3: The project amenity noise levels have been converted to a 15-minute level by adding 3 dB, as outlined in the NPfI.

3.2 Sleep Disturbance

In addition to the PNTLs, NPfI provides guidance in relation to the assessment of sleep disturbance. Specifically, the NPfI states:

Where the subject development/premises night-time noise levels at a residential location exceed:

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

a detailed maximum noise level assessment should be undertaken.

Where those trigger levels are not met, it is appropriate to consider any effect of the noise with regard to:

- The extent to which the maximum noise level exceeds the rating background noise level.
- How often high noise events will occur.
- The distribution of likely events across the night-time period and the existing ambient maximum events in the absence of the subject development.
- Whether there are times of day when there is a clear change in the noise environment (such as during early-morning shoulder periods).
- Current scientific literature available at the time of the assessment regarding the impact of maximum noise level events at night.

It may also be appropriate to consider other published research including the NSW *Road Noise Policy* which contains additional guidance relating to potential sleep disturbance impacts.

A review of research on sleep disturbance in the RNP indicates that in some circumstances, higher noise levels may occur without significant sleep disturbance. Based on studies into sleep disturbance, the RNP concludes that:

- Maximum internal noise levels below 50 dBA to 55 dBA are unlikely to cause awakening reactions; and that
- One or two noise events per night, with maximum internal noise levels of 65 dBA to 70 dBA, are not likely to affect health and wellbeing significantly.

Internal noise levels in a dwelling, with the windows open, are commonly 10 dB lower than external noise levels. Therefore, the first conclusion above suggests that short-term external noises of 60 dBA to 65 dBA are unlikely to cause awakening reactions. The second conclusion suggests that one or two noise events per night with maximum external noise levels of 75 dBA to 80 dBA are not likely to affect health and wellbeing significantly.

Sleep Disturbance criteria at each residential receiver is provided in **Table 5**.

Table 5 Sleep Disturbance Criteria

Receiver ID	Sleep Disturbance Criteria	
	L_{AFmax} dBA	LAeq(15minute) dBA
R1 -R8 & R10	53	43

3.3 Traffic on Surrounding Roads

The potential impacts from proposal related traffic on the surrounding public roads are assessed using the NSW EPA *Road Noise Policy* (RNP). **Table 6** presents the RNP criteria for residential land uses affected by additional traffic on public roads as a result of a development. Noise levels provided in **Table 6** are external noise levels and refer only to road traffic noise; they do not include ambient noise from other sources.

Table 6 RNP Criteria for Assessing Traffic on Public Roads

Road Category	Type of Project/Land Use	Assessment Criteria (dBA)	
		Daytime (7 am – 10 pm)	Night-time (10 pm – 7 am)
Freeway/ arterial/ sub-arterial roads	Existing residences affected by additional traffic on existing freeways/arterial/sub-arterial roads generated by land use developments	$L_{Aeq(15hour)}$ 60 (external)	$L_{Aeq(9hour)}$ 55 (external)

Section 3.4 of the RNP also states:

Where existing traffic noise levels are above the noise assessment criteria, the primary objective is to reduce these through feasible and reasonable measures to meet the assessment criteria. A secondary objective is to protect against excessive decreases in amenity as the result of a project by applying the relative increase criteria.

In assessing feasible and reasonable mitigation measures, an increase of up to 2 dB represents a minor impact that is considered barely perceptible to the average person.

For existing residences and other sensitive land uses affected by additional traffic on existing roads generated by land use developments, any increase in the total traffic noise level should be limited to 2 dB above that of the corresponding 'no build option'.

4 Methodology

The potential operational noise levels from the proposal have been predicted to the surrounding receivers using CONCAWE industrial noise algorithm in SoundPLAN V8.1. The model includes ground topography, buildings and representative noise sources from the proposal.

The potential impacts have been determined by comparing the predicted noise levels to the PNTLs in a 15-minute assessment period.

SLR understand that the industrial unit building heights are proposed to be a minimum of 12 meters in height and have been modelled as such.

4.1 Operational Noise Sources

A summary of operational noise sources associated with the existing operations and proposed operations for the development is provided below.

4.1.1 On-site Traffic

Details of the On-Site Traffic noise sources are shown in **Table 7**.

Table 7 Typical On-Site Noise Sources

Plant and Equipment	Sound Power Level dBA (each)	Number of Plant/Equipment Operational in 15 minute period		
		Day	Evening	Night
Truck	102 dBA	6	3	3
Car	85 dBA	140	30	30

4.1.2 Mechanical Plant

Details of the proposed mechanical plant and equipment noise sources are shown in **Table 8**.

Table 8 Typical Mechanical Plant Noise Sources

Plant and Equipment	Sound Power Level dBA (each)	Number of Plant/Equipment Operational in 15 minute period		
		Day	Evening	Night
Rooftop Fans	85 dBA	16	16	16
Condenser Units	90 dBA	16	16	16
Air Conditioner Equipment	85 dBA	16	16	16

Note 1: It has been assumed that the Project would be 100% utilised during the daytime period, 40% utilised during the evening and 5% utilised during the night-time period.

4.1.3 Noise Sources with Potential for Sleep Disturbance

As the development is proposed to operate 24-hours a day, noise emissions during the night-time require assessment for potential sleep disturbance at the nearest residential receivers. The details of typical activities with the potential to cause sleep disturbance are shown in

Table 9 Sleep Disturbance Noise Events – L_{Amax} Sound Power Levels

Source	L_{Amax}
Truck Manouvering	108 dBA
Truck – (air release)	115 dBA
Car	94 dBA

4.2 Weather Conditions

The meteorological environment has been assessed in accordance with the requirements of the NPfI Fact Sheet D, which sets out procedures for establishing noise enhancing weather conditions. There are two options available to consider meteorological effects, as follows.

*Adopt the **noise-enhancing meteorological conditions** for all assessment periods for noise impact assessment purposes without an assessment of how often these conditions occur - a conservative approach that considers source-to-receiver wind vectors for all receivers and F class temperature inversions with wind speeds up to 2 m/s at night.*

Or

*Determine the **significance** of noise-enhancing conditions. This involves assessing the significance of temperature inversions (F and G class stability categories) for the night-time period and the significance of light winds up to and including 3 m/s for all assessment periods during stability categories other than E, F or G. Significance is based on a threshold of occurrence of 30% determined in accordance with the provisions in this policy. Where noise-enhancing meteorological conditions occur for less than 30% of the time, standard meteorological conditions may be adopted for the assessment.*

NPfI Fact Sheet D also contains several important notes, and in particular states:

Noise limits derived for consents and licences will apply under the meteorological conditions used in the environmental assessment process, that is, standard or noise-enhancing meteorological conditions. For 'very noise-enhancing meteorological conditions' (see glossary) a limit is set based on the limit derived under standard or noise-enhancing conditions (whichever is adopted in the assessment) plus 5 dB. In this way a development is subject to noise limits under all meteorological conditions.

It should be noted that noise limit conditions will include the wind speed (scalar quantity without direction) under which noise limits will apply.

To provide a conservative approach and based on NPfI Table D1, the standard and noise enhancing meteorological conditions are presented in **Table 10**.

Table 10 NPfI Table D1 Standard and Noise Enhancing Meteorological Conditions

Meteorological Conditions	Meteorological Parameters
Standard	Day/evening/night: stability categories A-D with wind speed up to 0.5m/s at 10m AGL
Noise-enhancing	Day/evening: stability categories A-D with light winds (up to 3m/s at 10m AGL) Night-time: stability categories A-D with light winds (up to 3m/s at 10m AGL) and/or stability category F with winds up to 2m/s at 10m AGL

Notes: m/s = metres per second, m = metres, AGL = above ground level

where a range of conditions is nominated, the meteorological condition delivering the highest predicted noise level should be adopted for assessment purposes. However, feasible and reasonable noise limits in consents and licences derived from this process would apply under the full range of meteorological conditions nominated under standard or noise-enhancing conditions as relevant. All wind speeds are referenced to 10m AGL. Stability categories are based on the Pasquill-Gifford stability classification scheme.

The NPfI standard and noise enhancing meteorological conditions can be further defined for noise modelling purposes as presented in **Table 11.**

Table 11 Meteorological Parameters Considered for Noise Predictions

Period	Meteorological Conditions	Wind Speed (m/s) (Source to receiver)	Stability Category
Day	Standard	0.5	D Class
	Noise enhancing	3	
Evening	Standard	0.5	D Class
	Noise enhancing	3	
Night	Standard	0.5	D Class
	Noise enhancing	3	
		2	F Class

5 Noise Assessment

5.1 Predicted Noise Levels

A summary of the noise assessment at the receivers surrounding the proposal is shown in **Table 12** under standard weather conditions and **Table 13** under noise enhancing conditions. The predicted levels are compared to the PNTLs to determine the potential impact from the proposal.

Table 12 Industrial Noise Assessment –Standard Weather Conditions

Location	Receiver Type	Period	Noise Level $L_{Aeq\ (15\ minute)}$ dBA		Compliance? (Yes/No)
			PTNL (dBA)	Predicted Noise Level	
R1	Residential	Day	49	46	Yes
		Evening	46	42	Yes
		Night	43	35	Yes
R2	Residential	Day	49	45	Yes
		Evening	46	40	Yes
		Night	43	32	Yes
R3	Residential	Day	49	43	Yes
		Evening	46	40	Yes
		Night	43	37	Yes
R4	Residential	Day	49	47	Yes
		Evening	46	44	Yes
		Night	43	41	Yes
R5	Residential	Day	49	46	Yes
		Evening	46	42	Yes
		Night	43	39	Yes
R6	Residential	Day	49	44	Yes
		Evening	46	40	Yes
		Night	43	33	Yes
R7	Residential	Day	49	39	Yes
		Evening	46	35	Yes
		Night	43	30	Yes
R8	Residential	Day	49	37	Yes
		Evening	46	33	Yes
		Night	43	26	Yes
R9	Commercial	Day	63[1]	40	Yes
		Evening	63[1]	36	Yes
		Night	63[1]	28	Yes

Location	Receiver Type	Period	Noise Level $L_{Aeq\ (15\ minute)}$ dBA		Compliance? (Yes/No)
			PTNL (dBA)	Predicted Noise Level	
R10	Residential	Day	49	34	Yes
		Evening	46	30	Yes
		Night	43	24	Yes

Table 13 Industrial Noise Assessment – Noise Enhancing Weather Conditions

Location	Receiver Type	Period	Noise Level $L_{Aeq\ (15\ minute)}$ dBA		Compliance? (Yes/No)
			PTNL (dBA)	Predicted Noise Level	
R1	Residential	Day	49	46	Yes
		Evening	46	42	Yes
		Night	43	35	Yes
R2	Residential	Day	49	45	Yes
		Evening	46	41	Yes
		Night	43	33	Yes
R3	Residential	Day	49	45	Yes
		Evening	46	42	Yes
		Night	43	39	Yes
R4	Residential	Day	49	48	Yes
		Evening	46	45	Yes
		Night	43	42	Yes
R5	Residential	Day	49	46	Yes
		Evening	46	44	Yes
		Night	43	41	Yes
R6	Residential	Day	49	44	Yes
		Evening	46	40	Yes
		Night	43	33	Yes
R7	Residential	Day	49	40	Yes
		Evening	46	37	Yes
		Night	43	32	Yes
R8	Residential	Day	49	38	Yes
		Evening	46	34	Yes
		Night	43	28	Yes
R9	Commercial	Day	63	41	Yes
		Evening	63	37	Yes
		Night	63	29	Yes
R10	Residential	Day	49	36	Yes

Location	Receiver Type	Period	Noise Level $L_{Aeq\ (15\ minute)}$ dBA		Compliance? (Yes/No)
			PTNL (dBA)	Predicted Noise Level	
		Evening	46	32	Yes
		Night	43	26	Yes

Noise from the proposal is predicted to comply with the PNTLs at all receivers under standard and noise-enhancing weather conditions.

5.2 Sleep Disturbance

A review of **Table 12** and **Table 13** indicate that the $L_{Aeq(15minute)}$ sleep disturbance criterion of 43 dBA is predicted to be compliant at all nearest noise sensitive receivers. The predicted night-time L_{Amax} noise levels at the nearest residential receivers are shown in **Table 14** and **Table 15**. The predicted levels are compared to the PNTLs to determine the potential impact from the proposal.

Table 14 Sleep Disturbance Assessment – Standard Weather Conditions

Location	Receiver Type	Period	Noise Level L_{Amax} dBA		Compliance? (Yes/No)
			Sleep Disturbance Noise Level (dBA)	Predicted Noise Level	
R1	Residential	Night	53	50	Yes
R2	Residential	Night	53	42	Yes
R3	Residential	Night	53	51	Yes
R4	Residential	Night	53	**55**	No
R5	Residential	Night	53	**54**	No
R6	Residential	Night	53	49	Yes
R7	Residential	Night	53	39	Yes
R8	Residential	Night	53	40	Yes
R10	Residential	Night	53	36	Yes

Table 15 Sleep Disturbance Assessment – Noise Enhancing Weather Condition

Location	Receiver Type	Period	Noise Level L_{Amax} dBA		Compliance? (Yes/No)
			Sleep Disturbance Noise Level (dBA)	Predicted Noise Level	
R1	Residential	Night	53	51	Yes
R2	Residential	Night	53	44	Yes
R3	Residential	Night	53	54	No
R4	Residential	Night	53	57	No
R5	Residential	Night	53	56	No
R6	Residential	Night	53	50	Yes
R7	Residential	Night	53	41	Yes

Location	Receiver Type	Period	Noise Level L_{Amax} dBA		Compliance? (Yes/No)
			Sleep Disturbance Noise Level (dBA)	Predicted Noise Level	
R8	Residential	Night	53	43	Yes
R10	Residential	Night	53	38	Yes

Under standard and noise-enhancing weather conditions the sleep disturbance is expected to be compliant at all nearest noise sensitive receivers with the exception of R3, R4 and R5 where an exceedance of up to 4 dB is predicted.

It is noted that receivers R3, R4, R5 and R7 are all located withing the rezoned Aerotropolis Core Precinct pursuant of Western Sydney Aerotropolis (the Aerotropolis SEPP), which has been rezoned to an Enterprise Zone. A such it is likely that future land use at these reception locations is unlikely to be residential. Notwithstanding the land zoning change, given the current residential land use at these receptors it is appropriate to consider sleep disturbance impacts where predicted maximum noise levels exceed the sleep disturbance noise goal.

It should be noted that the external maximum noise levels at all receivers are at or below 60 dBA. This infers that internal noise levels (assuming a 10 dB reduction outside to inside with windows normally open) will be at or below 50 dBA and are therefore unlikely to cause awakening reactions.

5.3 Traffic increases on Surrounding Roads

All traffic would access the development directly from The Northern Road to the north of the site. Only northbound traffic would access the site. Existing traffic count and traffic generation for the site has been completed by Traffix Pty Ltd Traffic Impact Assessment Reference "21.471r01v01 Traffix 1411 The Northern Road, Bringelly TIA" dated 7 June 2022 (Traffic Report).

The Traffic Report data has been used to calculate the expected increase in noise levels on the Northern Road due to traffic associated with the development. The results are summarised in **Table 16:**

Table 16 Existing and predicted traffic flow volumes (7 Day AADT)

Location	Existing Vehicles Northbound	Predicted Increase	Noise Level Increase (dB)
Northern Road	7628	745	0.1

Based on the results of the assessment in **Table 16**, there is predicted to be less than a 1 dB increase in road traffic noise levels on the Northern Road. The corresponding increase in road traffic noise would therefore be expected to remain below 2 dB which, according to the RNP, is unlikely to be discernible and would not require consideration of mitigation.

6 Conclusion

SLR has been engaged to assess the potential operational noise emissions from the proposed industrial/retail development at 1411 The Northern Road, Bringelly. The proposal includes the operation of light industrial warehouses used for distribution and storage of goods, and a service centre which would be operational 24/7.

Operational noise levels are predicted to comply with the relevant criteria at all receivers under standard and noise-enhancing weather conditions.

Night-time sleep disturbance noise levels are predicted to be met at all receivers with the exception of R3, R4 and R5; however noise levels are unlikely to cause awakening reactions.

There is predicted to be less than a 1 dB increase in traffic noise levels due to increased traffic accessing the site, which, according to the RNP, is unlikely to be discernible and would not require consideration of mitigation.

Appendix A:

Acoustic Terminology

1. Sound Level or Noise Level

The terms 'sound' and 'noise' are almost interchangeable, except that 'noise' often refers to unwanted sound.

Sound (or noise) consists of minute fluctuations in atmospheric pressure. The human ear responds to changes in sound pressure over a very wide range with the loudest sound pressure to which the human ear can respond being ten million times greater than the softest. The decibel (abbreviated as dB) scale reduces this ratio to a more manageable size by the use of logarithms.

The symbols SPL, L or LP are commonly used to represent Sound Pressure Level. The symbol LA represents A-weighted Sound Pressure Level. The standard reference unit for Sound Pressure Levels expressed in decibels is 2 x 10^{-5} Pa.

2. 'A' Weighted Sound Pressure Level

The overall level of a sound is usually expressed in terms of dBA, which is measured using a sound level meter with an 'A-weighting' filter. This is an electronic filter having a frequency response corresponding approximately to that of human hearing.

People's hearing is most sensitive to sounds at mid frequencies (500 Hz to 4,000 Hz), and less sensitive at lower and higher frequencies. Different sources having the same dBA level generally sound about equally loud.

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 to 5 dB change corresponds to a small but noticeable change in loudness. A 10 dB change corresponds to an approximate doubling or halving in loudness. The table below lists examples of typical noise levels.

Sound Pressure Level (dBA)	Typical Source	Subjective Evaluation
130	Threshold of pain	Intolerable
120	Heavy rock concert	Extremely noisy
110	Grinding on steel	
100	Loud car horn at 3 m	Very noisy
90	Construction site with pneumatic hammering	
80	Kerbside of busy street	Loud
70	Loud radio or television	
60	Department store	Moderate to quiet
50	General Office	
40	Inside private office	Quiet to very quiet
30	Inside bedroom	
20	Recording studio	Almost silent

Other weightings (eg B, C and D) are less commonly used than A-weighting. Sound Levels measured without any weighting are referred to as 'linear', and the units are expressed as dB(lin) or dB.

3. Sound Power Level

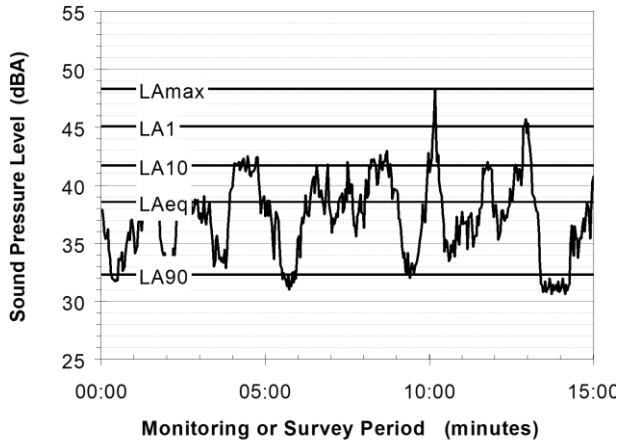
The Sound Power of a source is the rate at which it emits acoustic energy. As with Sound Pressure Levels, Sound Power Levels are expressed in decibel units (dB or dBA), but may be identified by the symbols SWL or LW, or by the reference unit 10^{-12} W.

The relationship between Sound Power and Sound Pressure is similar to the effect of an electric radiator, which is characterised by a power rating but has an effect on the surrounding environment that can be measured in terms of a different parameter, temperature.

4. Statistical Noise Levels

Sounds that vary in level over time, such as road traffic noise and most community noise, are commonly described in terms of the statistical exceedance levels LAN, where LAN is the A-weighted sound pressure level exceeded for N% of a given measurement period. For example, the LA1 is the noise level exceeded for 1% of the time, LA10 the noise exceeded for 10% of the time, and so on.

The following figure presents a hypothetical 15 minute noise survey, illustrating various common statistical indices of interest.



Of particular relevance, are:

LA1 The noise level exceeded for 1% of the 15 minute interval.

LA10 The noise level exceeded for 10% of the 15 minute interval. This is commonly referred to as the average maximum noise level.

LA90 The noise level exceeded for 90% of the sample period. This noise level is described as the average minimum background sound level (in the absence of the source under consideration), or simply the background level.

LAeq The A-weighted equivalent noise level (basically, the average noise level). It is defined as the steady sound level that contains the same amount of acoustical energy as the corresponding time-varying sound.

5. Frequency Analysis

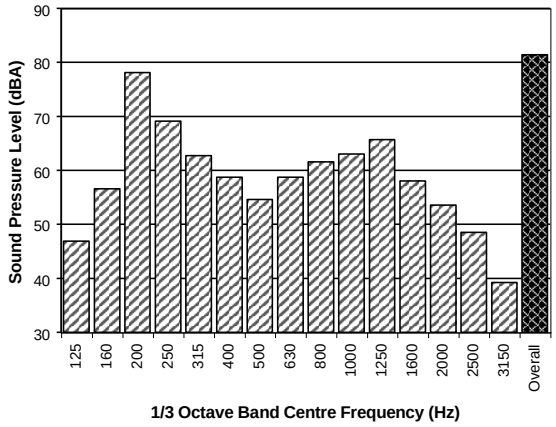
Frequency analysis is the process used to examine the tones (or frequency components) which make up the overall noise or vibration signal.

The units for frequency are Hertz (Hz), which represent the number of cycles per second.

Frequency analysis can be in:

- Octave bands (where the centre frequency and width of each band is double the previous band)
- 1/3 octave bands (three bands in each octave band)
- Narrow band (where the spectrum is divided into 400 or more bands of equal width)

The following figure shows a 1/3 octave band frequency analysis where the noise is dominated by the 200 Hz band. Note that the indicated level of each individual band is less than the overall level, which is the logarithmic sum of the bands.



6. Annoying Noise (Special Audible Characteristics)

A louder noise will generally be more annoying to nearby receivers than a quieter one. However, noise is often also found to be more annoying and result in larger impacts where the following characteristics are apparent:

- **Tonality** - tonal noise contains one or more prominent tones (ie differences in distinct frequency components between adjoining octave or 1/3 octave bands), and is normally regarded as more annoying than 'broad band' noise.
- **Impulsiveness** - an impulsive noise is characterised by one or more short sharp peaks in the time domain, such as occurs during hammering.
- **Intermittency** - intermittent noise varies in level with the change in level being clearly audible. An example would include mechanical plant cycling on and off.
- **Low Frequency Noise** - low frequency noise contains significant energy in the lower frequency bands, which are typically taken to be in the 10 to 160 Hz region.

7. Vibration

Vibration may be defined as cyclic or transient motion. This motion can be measured in terms of its displacement, velocity or acceleration. Most assessments of human response to vibration or the risk of damage to buildings use measurements of vibration velocity. These may be expressed in terms of 'peak' velocity or 'rms' velocity.

The former is the maximum instantaneous velocity, without any averaging, and is sometimes referred to as 'peak particle velocity', or PPV. The latter incorporates 'root mean squared' averaging over some defined time period.

Vibration measurements may be carried out in a single axis or alternatively as triaxial measurements (ie vertical, longitudinal and transverse).

The common units for velocity are millimetres per second (mm/s). As with noise, decibel units can also be used, in which case the reference level should always be stated. A vibration level V, expressed in mm/s can be converted to decibels by the formula 20 log (V/Vo), where Vo is the reference level (10^{-9} m/s). Care is required in this regard, as other reference levels may be used.

8. Human Perception of Vibration

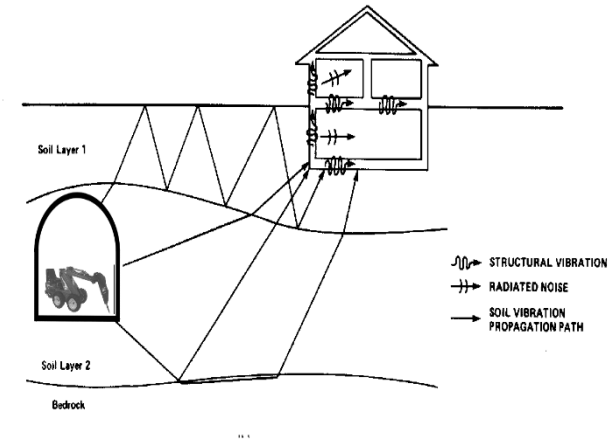
People are able to 'feel' vibration at levels lower than those required to cause even superficial damage to the most susceptible classes of building (even though they may not be disturbed by the motion). An individual's perception of motion or response to vibration depends very strongly on previous experience and expectations, and on other connotations associated with the perceived source of the vibration. For example, the vibration that a person responds to as 'normal' in a car, bus or train is considerably higher than what is perceived as 'normal' in a shop, office or dwelling.

9. Ground-borne Noise, Structure-borne Noise and Regenerated Noise

Noise that propagates through a structure as vibration and is radiated by vibrating wall and floor surfaces is termed 'structure-borne noise', 'ground-borne noise' or 'regenerated noise'. This noise originates as vibration and propagates between the source and receiver through the ground and/or building structural elements, rather than through the air.

Typical sources of ground-borne or structure-borne noise include tunnelling works, underground railways, excavation plant (eg rockbreakers), and building services plant (eg fans, compressors and generators).

The following figure presents an example of the various paths by which vibration and ground-borne noise may be transmitted between a source and receiver for construction activities occurring within a tunnel.



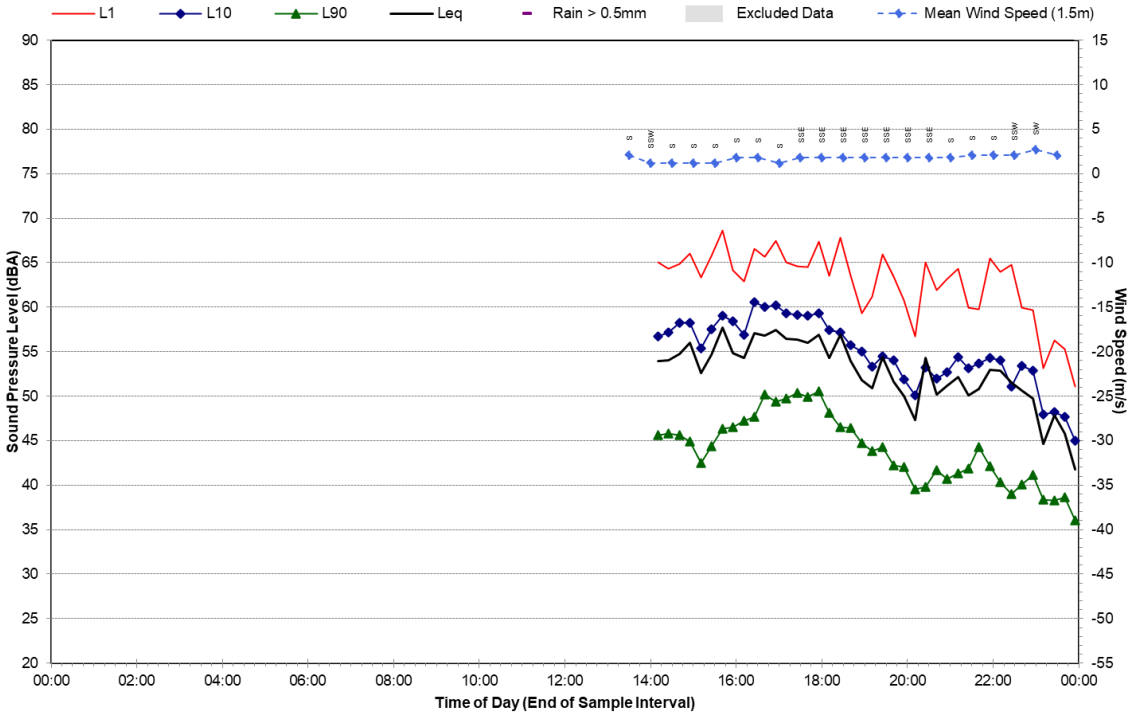
The term 'regenerated noise' is also used in other instances where energy is converted to noise away from the primary source. One example would be a fan blowing air through a discharge grill. The fan is the energy source and primary noise source. Additional noise may be created by the aerodynamic effect of the discharge grill in the airstream. This secondary noise is referred to as regenerated noise.

Appendix B:

Statistical Ambient Noise Levels

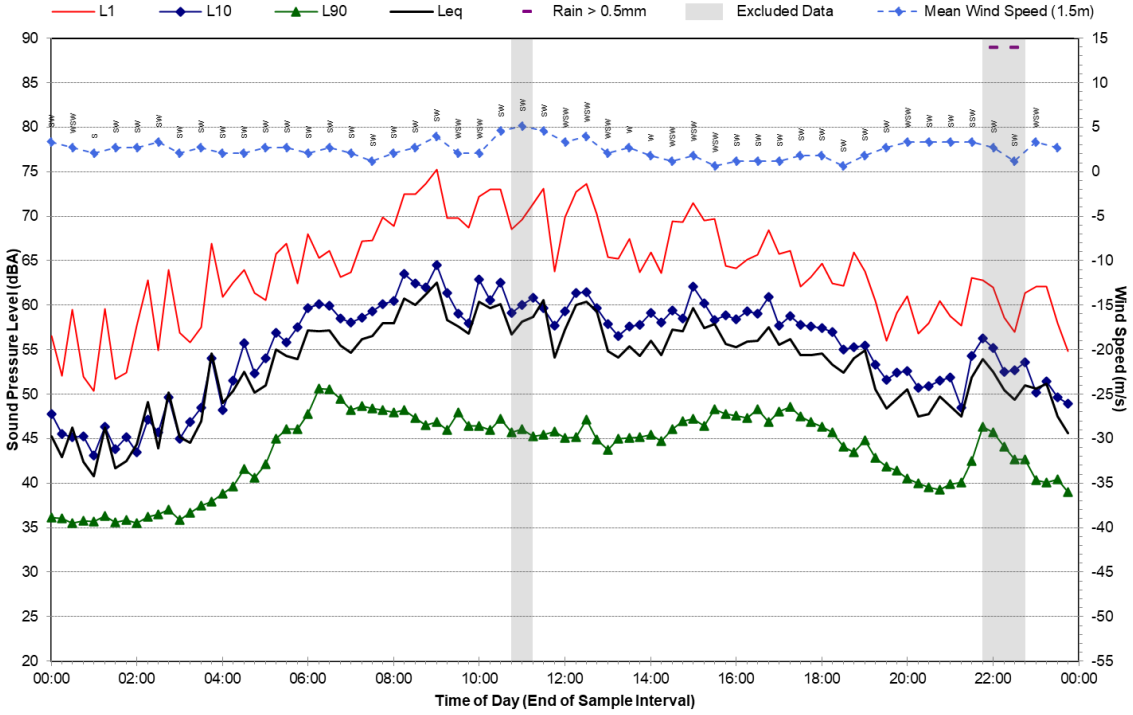
Statistical Ambient Noise Levels

L01 - 1411 The Northern Road - Thursday, 19 May 2022



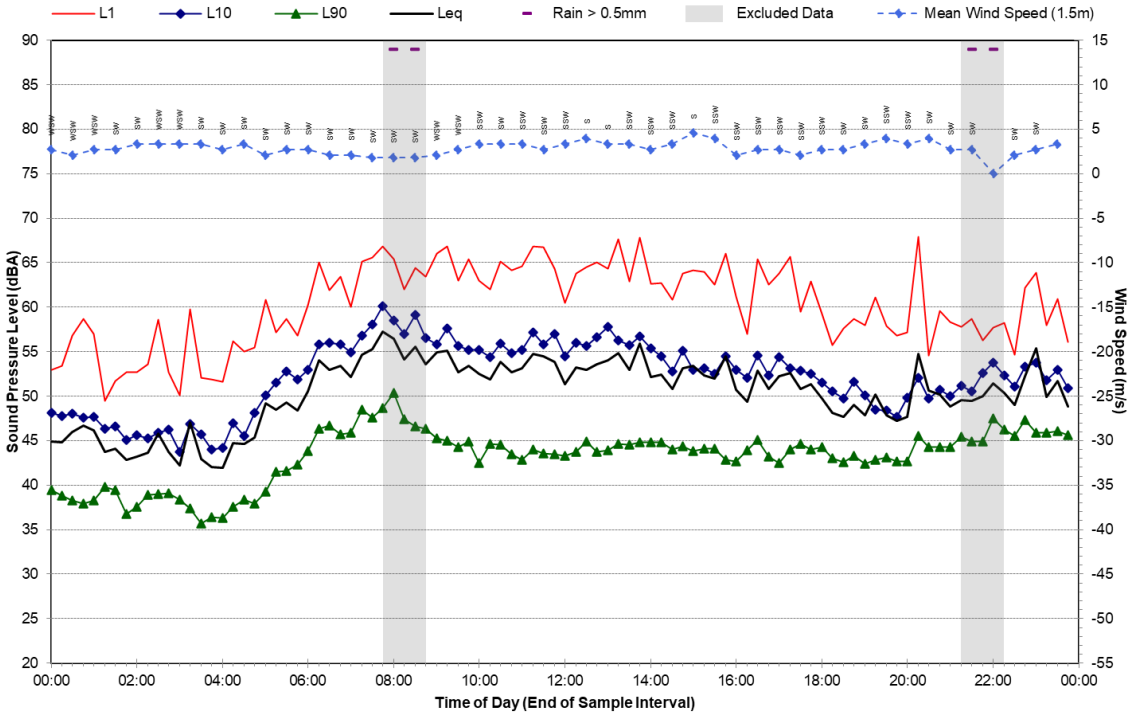
Statistical Ambient Noise Levels

L01 - 1411 The Northern Road - Friday, 20 May 2022



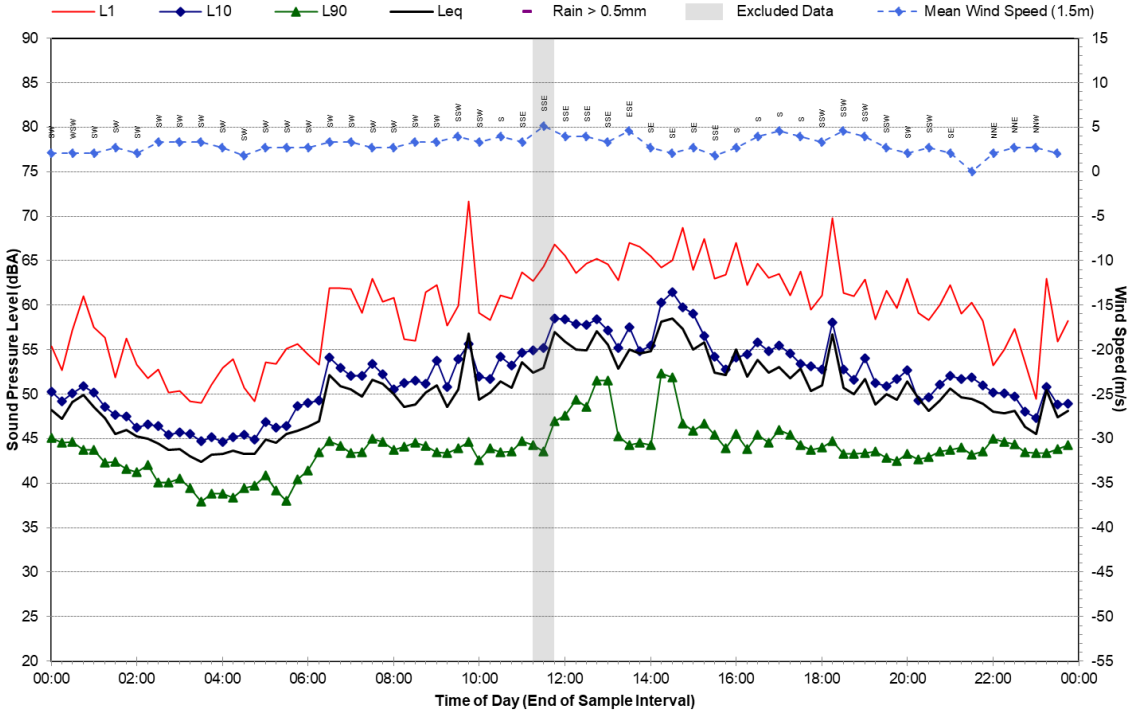
Statistical Ambient Noise Levels

L01 - 1411 The Northern Road - Saturday, 21 May 2022



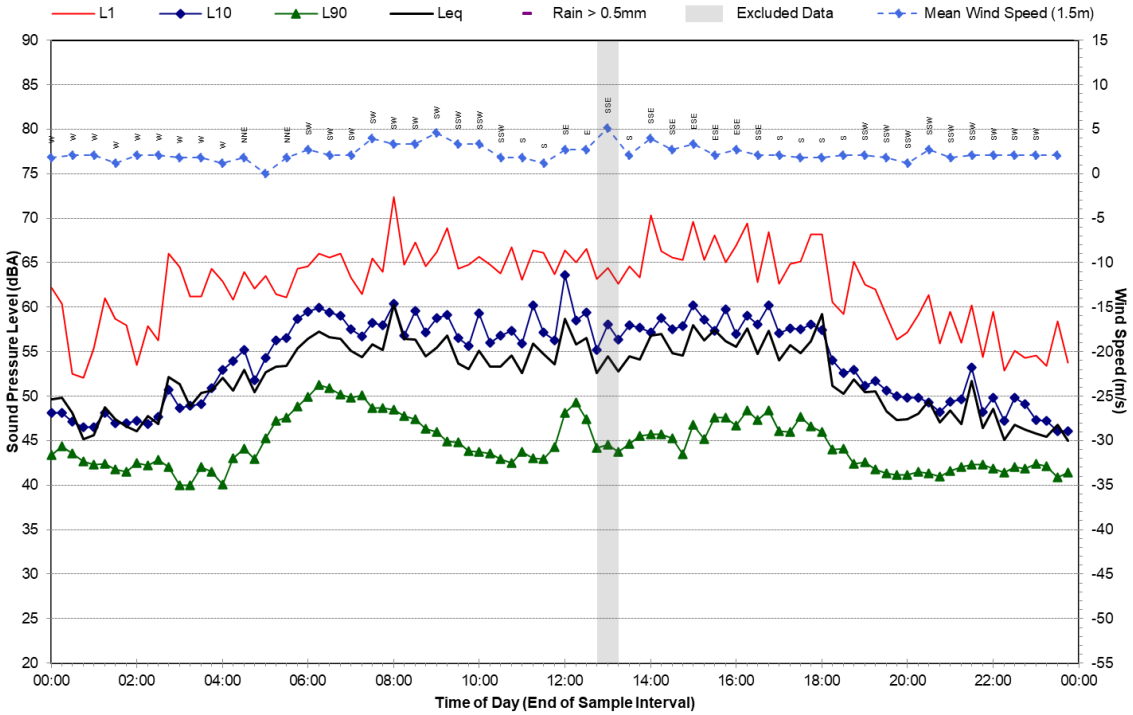
Statistical Ambient Noise Levels

L01 - 1411 The Northern Road - Sunday, 22 May 2022



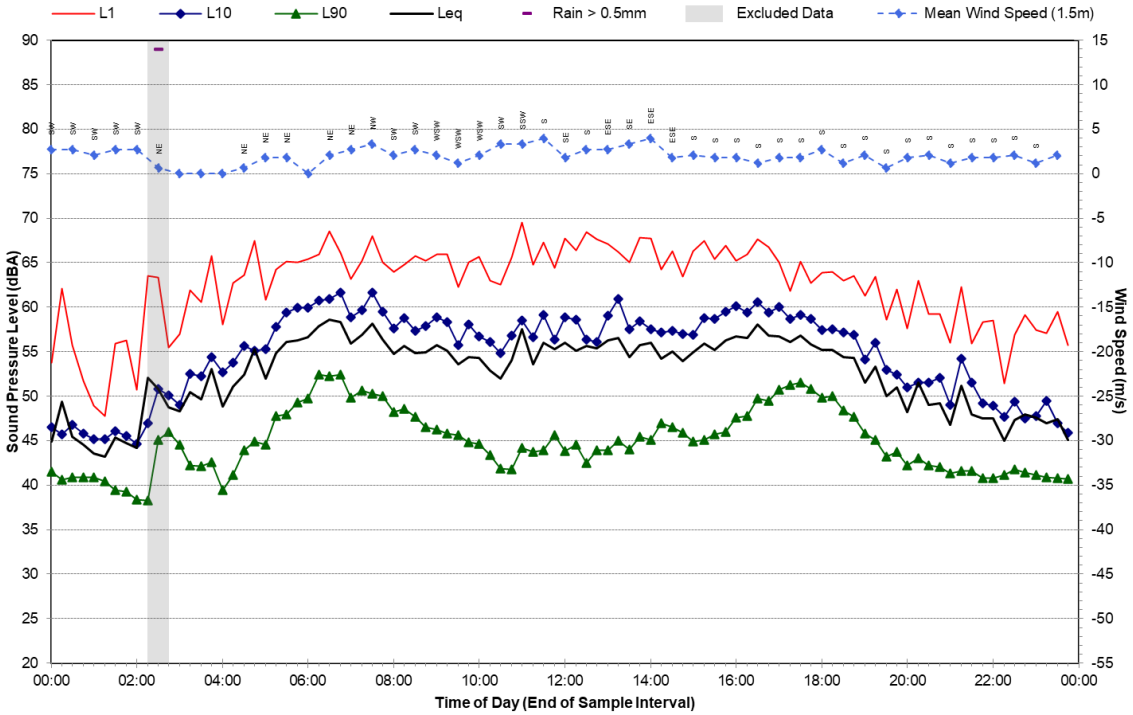
Statistical Ambient Noise Levels

L01 - 1411 The Northern Road - Monday, 23 May 2022



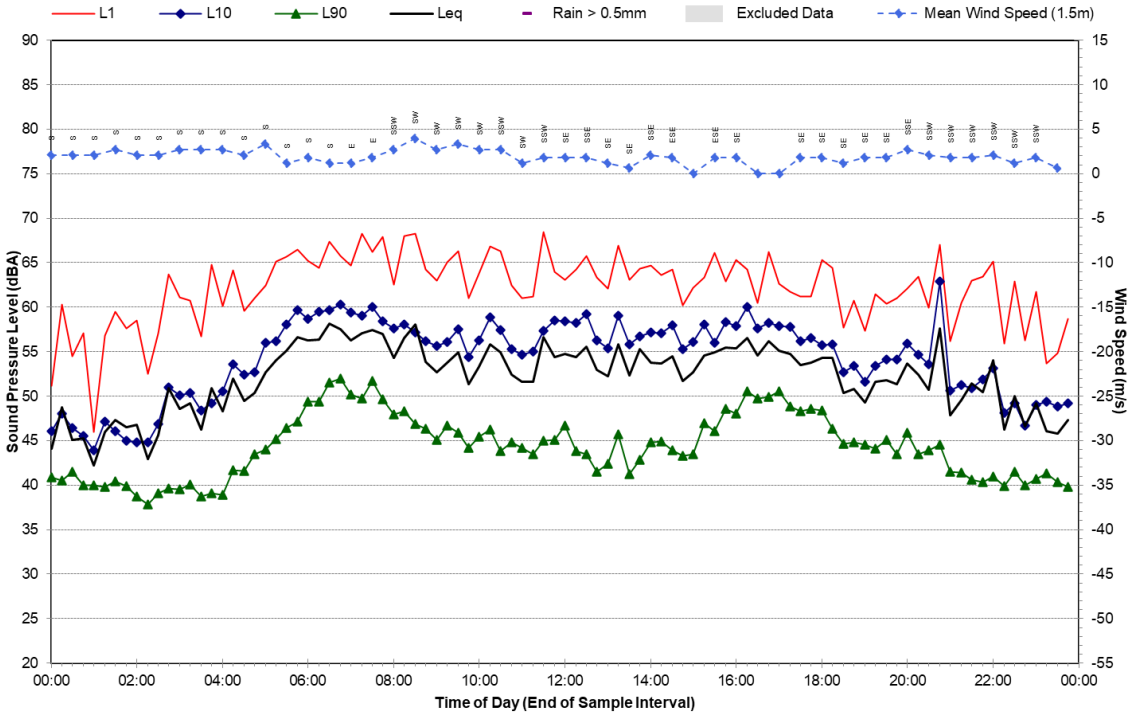
Statistical Ambient Noise Levels

L01 - 1411 The Northern Road - Tuesday, 24 May 2022



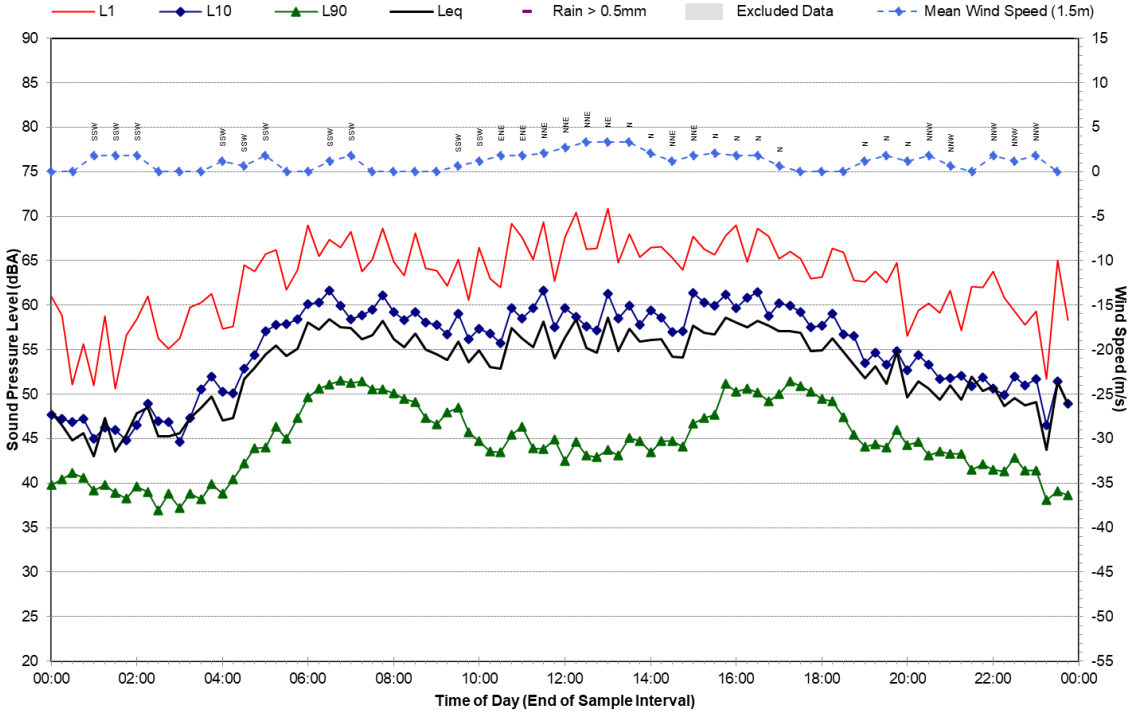
Statistical Ambient Noise Levels

L01 - 1411 The Northern Road - Wednesday, 25 May 2022



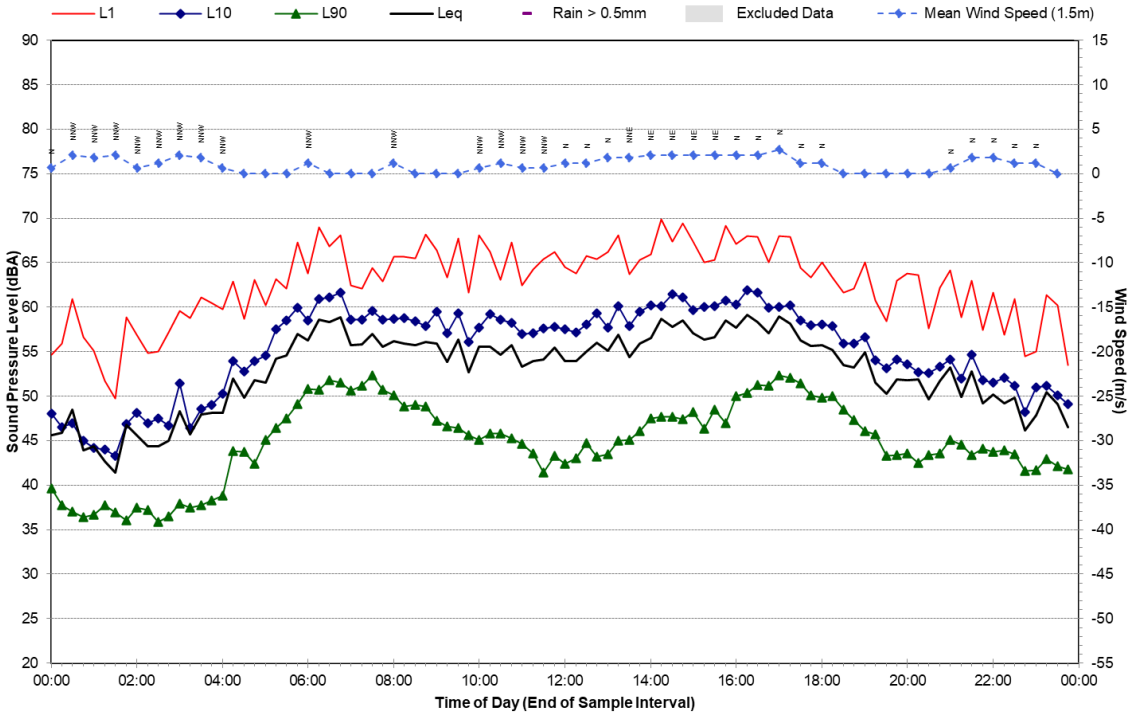
Statistical Ambient Noise Levels

L01 - 1411 The Northern Road - Thursday, 26 May 2022



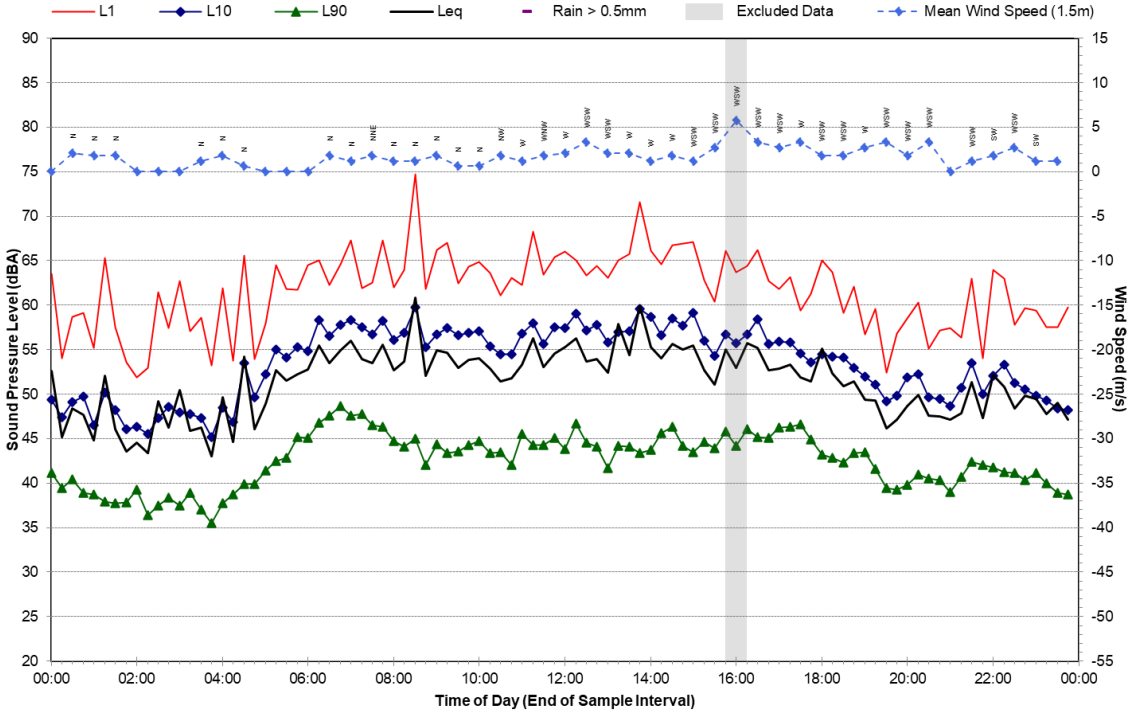
Statistical Ambient Noise Levels

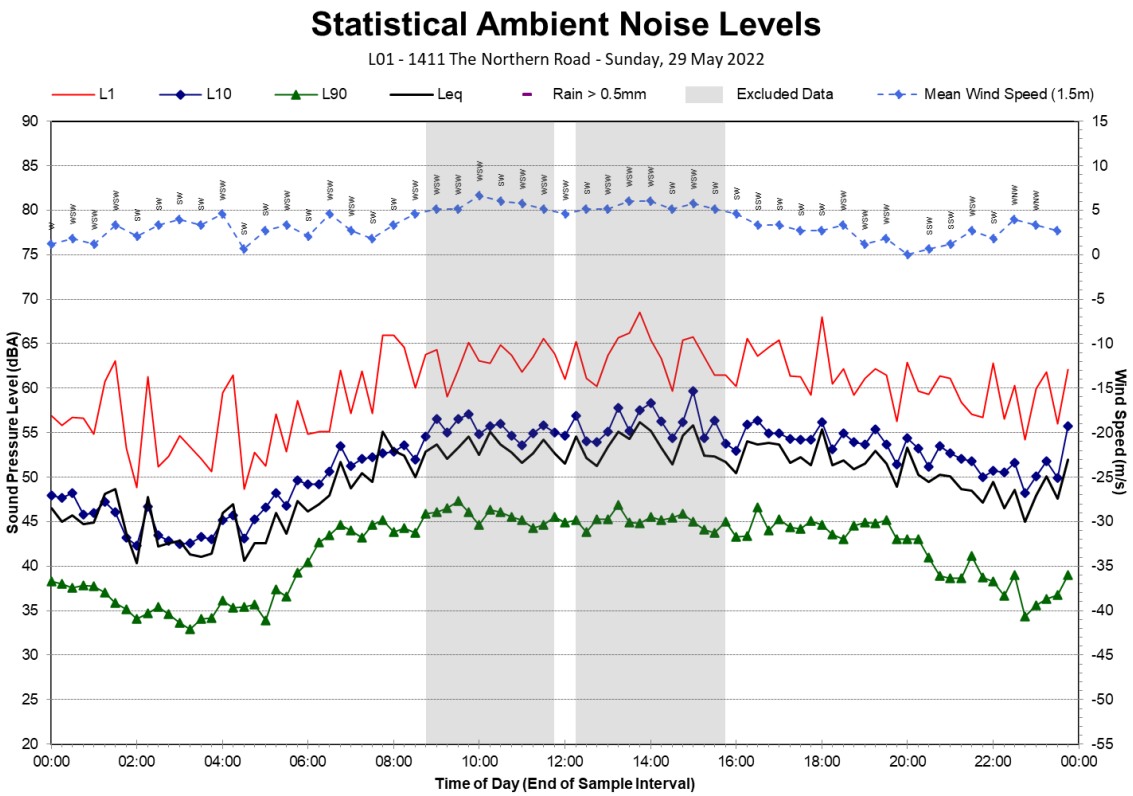
L01 - 1411 The Northern Road - Friday, 27 May 2022

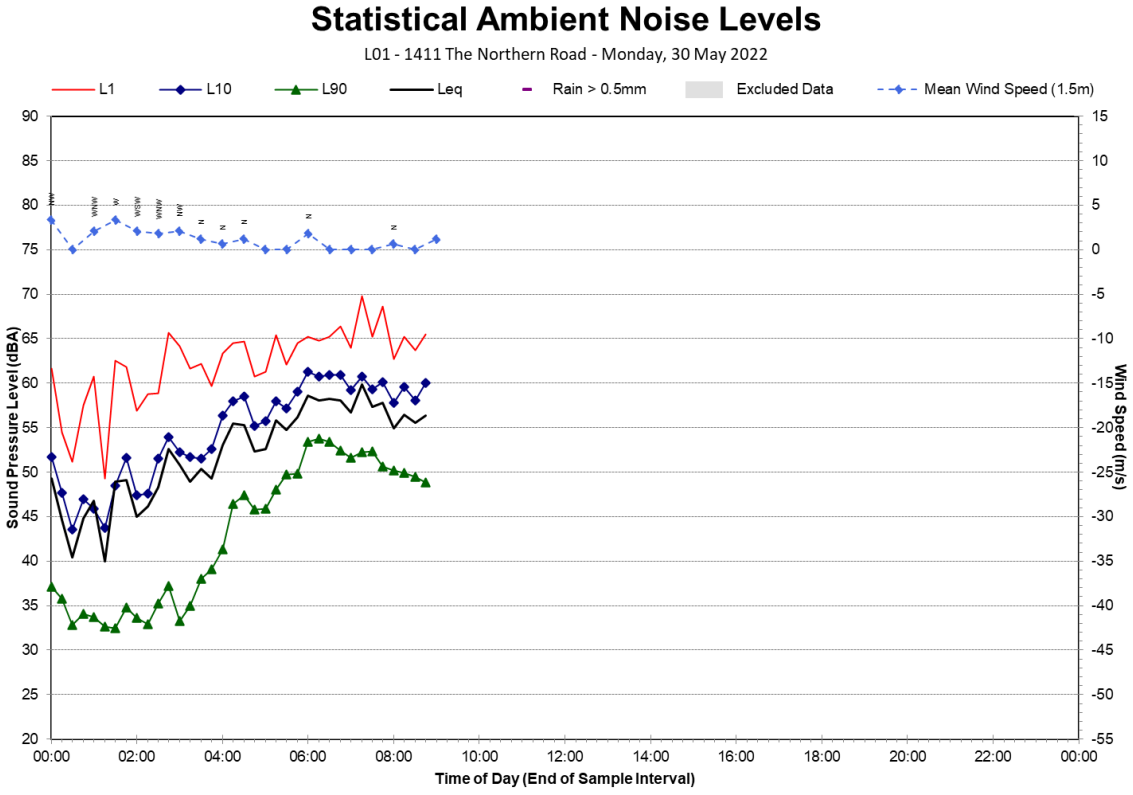


Statistical Ambient Noise Levels

L01 - 1411 The Northern Road - Saturday, 28 May 2022




Statistical Ambient Noise Levels
L01 - 1411 The Northern Road - Sunday, 29 May 2022
L1
L10
L90
Leq
Rain > 0.5mm
Excluded Data
Mean Wind Speed (1.5m)
Sound Pressure Level (dBA)
Wind Speed (m/s)
Time of Day (End of Sample Interval)


Statistical Ambient Noise Levels
L01 - 1411 The Northern Road - Monday, 30 May 2022
L1
L10
L90
Leq
Rain > 0.5mm
Excluded Data
Mean Wind Speed (1.5m)
Sound Pressure Level (dBA)
Wind Speed (m/s)
Time of Day (End of Sample Interval)

ASIA PACIFIC OFFICES

ADELAIDE
60 Halifax Street
Adelaide SA 5000
Australia
T: +61 431 516 449

BRISBANE
Level 16, 175 Eagle Street
Brisbane QLD 4000
Australia
T: +61 7 3858 4800
F: +61 7 3858 4801

CAIRNS
Level 1 Suite 1.06
Boland's Centre
14 Spence Street
Cairns QLD 4870
Australia
T: +61 7 4722 8090

CANBERRA
GPO 410
Canberra ACT 2600
Australia
T: +61 2 6287 0800
F: +61 2 9427 8200

DARWIN
Unit 5, 21 Parap Road
Parap NT 0820
Australia
T: +61 8 8998 0100
F: +61 8 9370 0101

GOLD COAST
Level 2, 194 Varsity Parade
Varsity Lakes QLD 4227
Australia
M: +61 438 763 516

MACKAY
21 River Street
Mackay QLD 4740
Australia
T: +61 7 3181 3300

MELBOURNE
Level 11, 176 Wellington Parade
East Melbourne VIC 3002
Australia
T: +61 3 9249 9400
F: +61 3 9249 9499

NEWCASTLE CBD
Suite 2B, 125 Bull Street
Newcastle West NSW 2302
Australia
T: +61 2 4940 0442

NEWCASTLE
10 Kings Road
New Lambton NSW 2305
Australia
T: +61 2 4037 3200
F: +61 2 4037 3201

PERTH
Grd Floor, 503 Murray Street
Perth WA 6000
Australia
T: +61 8 9422 5900
F: +61 8 9422 5901

SYDNEY
Tenancy 202 Submarine School
Sub Base Platypus
120 High Street
North Sydney NSW 2060
Australia
T: +61 2 9427 8100
F: +61 2 9427 8200

TOWNSVILLE
12 Cannan Street
South Townsville QLD 4810
Australia
T: +61 7 4722 8000
F: +61 7 4722 8001

WOLLONGONG
Level 1, The Central Building
UoW Innovation Campus
North Wollongong NSW 2500
Australia
T: +61 2 4249 1000

AUCKLAND
Level 4, 12 O'Connell Street
Auckland 1010
New Zealand
T: 0800 757 695

NELSON
6/A Cambridge Street
Richmond, Nelson 7020
New Zealand
T: +64 274 898 628

WELLINGTON
12A Waterloo Quay
Wellington 6011
New Zealand
T: +64 2181 7186

SINGAPORE
39b Craig Road
Singapore 089677
T: +65 6822 2203