ORICA BOTANY N&V SSDA

28 McPherson Street, Banksmeadow.
Noise and Vibration Impact Assessment

Prepared for:

Orica Australia Pty Ltd

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BASIS OF REPORT

This report has been prepared by SLR Consulting Australia Pty Ltd with all reasonable skill, care and diligence, and taking account of the timescale and resources allocated to it by agreement with Orica Australia 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

Reference	Date	Prepared	Checked	Authorised
610.18516-R01-v1.1	21 January 2019	Jason Rasquinha	Antony Williams	Antony Williams
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1 Introduction

SLR Consulting Australia Pty Ltd (SLR) has been engaged by Orica to prepare a Noise and Vibration Impact Assessment (NVIA) for the proposed warehouse development situated at 28 McPherson Street, Banksmeadow.

The assessment addresses the potential operational and construction noise and vibration impacts associated with the construction and use the site and forms part of the State Significant Development Application (SSDA) for the project.

This report addresses the Secretary's Environmental Assessment Requirements (SEARs) relevant to the Project (State Significant Development 9691) issued 14 December 2018.

The assessment uses specific acoustic terminology. An explanation of common terms used is included in **Appendix A**.

2 Description of the Development

The site is located at 28 McPherson Street, Banksmeadow in the Bayside LGA and is approximately 9 km south of the Sydney central business district, 4 km south east of the Sydney Airport and 400 m north of Port Botany. The site is legally described as Lot 9 in DP 1205673.

The location of the development along with the surrounding residential and commercial receivers is shown in **Figure 1**. The closest residential receivers are at Denison Street in Hillsdale to the east and Stephen Road in Botany to the west.

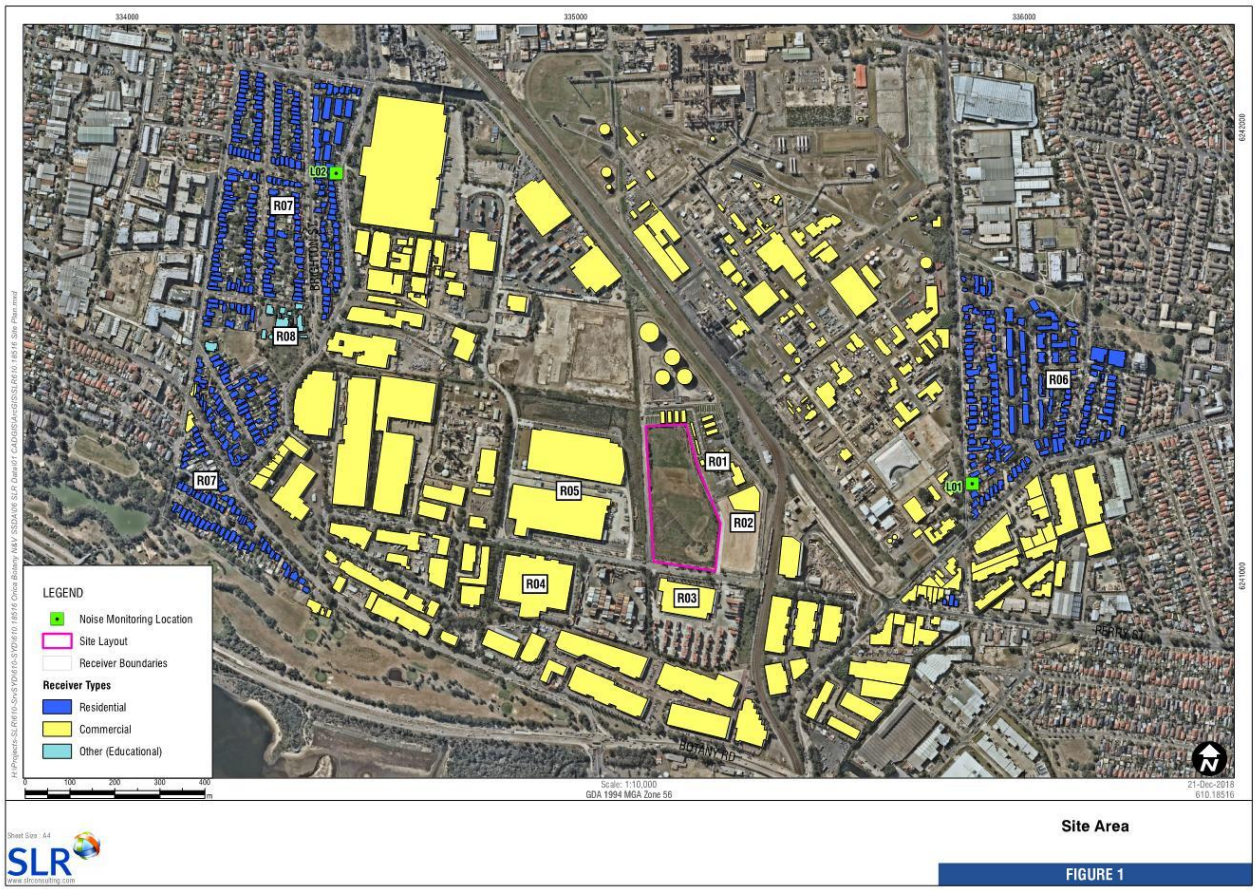
The development will involve the construction of two new warehouses on the project site over a suspended deck, bounded by Nant Street to the west and the Border protection facility for detector dogs to the north east, a warehousing development (currently under construction) to the east and McPherson Street to the south as shown in **Figure 2**.

The warehouses will be constructed in two stages:

- Stage 1 – Construction of the suspended deck
- Stage 2 – Construction of the warehouse/industrial buildings and associated activities on the deck.

The warehouses will be constructed on a concrete platform approximately 2.5 m above the existing ground level. The new facility will be used for warehousing and distribution uses, with associated offices, hardstands, parking and landscaping.

Figure 1 Development Location, Sensitive Receivers Areas and Modelled Buildings



Operating hours for the development are proposed to be 24 hours per day. Deliveries to and from the site could occur at any time during the opening hours, on any day of the week.

The identified sources of noise from the proposed facility include once operational is (noting that construction impacts are assessed later in this report):

- Mechanical plant
- Internal warehouse operations
- Operation of the loading docks (hardstands)
- Truck and light vehicle movements on hardstands and in parking areas

There is a shared hardstand situated between the two warehouses, along with light vehicle parking lots located along McPherson Street and Nant Street. Vehicle access to and from the site would be from McPherson Street and near the intersection with Nant Street.

Figure 2 Proposed Development Layout

2.1 Noise Sensitive Receivers

The project site is surrounded by various commercial warehouses and the border protection facility. The closest residential receivers to the east are located on Denison Street in Hillsdale, approximately 850 m from the site. The closest residential receivers to the west are located along Stephen Road in Botany, approximately 700 m from the site

Banksmeadow Public School is also located approximately 800m from the site on Stephen Road.

The nearest sensitive receivers to the development are shown in **Figure 1** and listed in **Table 1**.

Table 1 Nearest Noise Sensitive Receivers

Receiver	Description	Receiver Type
R1	Border protection facility for detection dogs	Outdoor Active
R2	8 Warehouse Units East of the project Site - (Under construction)	Commercial
R3	Warehouse South of the project site	Commercial
R4	Commercial building South West of the project site	Commercial
R5	Warehouse west of the project site	Commercial
R6	Residential receivers to the East	Residential
R7	Residential receivers to the West	Residential
R8	Banksmeadow Public School	Educational

Note 1: The border protect facility for detection dogs has been assumed to be classified as an outdoor active recreation area. No assessment has been undertaken regarding the potential impacts to the dogs at the facility.

3 Existing Environment

The acoustical environment at the site is generally controlled by existing industrial noise from the surrounding industrial and commercial uses including activities at Port Botany. The acoustical environment at the nearest residential receivers are also affected by existing road traffic noise along Denison Street in Hillsdale and Stephen Road in Botany.

3.1 Unattended Ambient Noise Monitoring

Unattended noise monitoring was completed at the site from 30 November to 10 December 2018 to measure the existing ambient noise environment of the area.

The noise monitoring locations were selected with consideration of other noise sources which may influence the measurements, security of noise monitoring equipment and gaining permission for access from residents and landowners. The unattended noise monitoring locations are considered representative of the background levels of the most potentially affected receivers.

Calibration of the loggers was checked prior to and following measurements, and drift in calibration did not exceed acceptable tolerances. All equipment carried appropriate and current NATA (or manufacturer) calibration certificates.

The measured data was processed with reference to the NSW EPA's *Noise Policy for Industry* (NPfI) and the data was filtered to remove periods affected by adverse weather conditions, based on Bureau of Meteorology weather station data. A summary of the background noise monitoring locations and results are provided in **Table 2** and **Table 3**, and are shown in **Figure 1**.

Table 2 Ambient Noise Monitoring Locations

ID	Location Address	Location Details	Representative Receiver Area
L.01	6 Denison St, Hillsdale	Noise logger deployed in front yard of residence	Residences to the east in Hillsdale
L.02	36 Stephen Rd, Botany	Noise logger deployed in rear yard of residence	Residences to the west in Botany

Table 3 Summary of Ambient Noise Levels

Location	Address	Measured Noise Levels (dBA)					
		Background Noise (RBL)			Average Noise (L_{Aeq})		
		Day	Evening	Night	Day	Evening	Night
L.01	6 Denison St, Hillsdale	54	46	42	68	66	64
L.02	36 Stephen Rd, Botany	49	49	47	60	62	54

Note 1: The Rating Background Levels (RBLs) and LAeq noise levels have been obtained from the measured data using the calculation procedures outlined in the NPfI.

Note 2: NPfI time periods – Day: 7:00 am to 6:00 pm Monday to Saturday, 8:00 am to 6:00 pm Sundays and public holidays; Evening: 6:00 pm to 10:00 pm; Night: the remaining periods.

Details of each monitoring location together with graphs of the measured daily noise levels are in **Appendix B**.

3.2 Attended Noise Monitoring

Short-term attended noise monitoring was completed during deployment of the equipment. The attended measurements allow the contributions of the various noise sources at each location to be determined.

The attended measurement was undertaken at both noise monitoring locations shown in **Figure 1**. Wind speeds were less than 5 m/s at all times, and the measurement was made at a height of 1.5 m above ground level.

Calibration of the sound level meter was checked before and after the measurement and the variation in calibration was found to be within acceptable limits at all times.

The noise environment at the attended monitoring location is described in **Table 4**.

Table 4 Attended Noise Monitoring Results

Measurement Details	Measured Noise Levels (dBA)			Description of Ambient Noise Source – Typical L_{Amax} Levels (dBA)
	L_{A90}	L_{Aeq}	L_{Amax}	
6 Denison St, Hillsdale	57	71	88	Cars- 71 - 74 Bus – 79 Passing trucks – 83 – 87
36 Stephen Rd, Botany	47	59	80	Cars – 62 – 65 Truck – 66 Speech/Laughter – 64

4 Assessment Criteria

4.1 Secretary's Environmental Assessment Requirements (SEARs)

The project SEARs require an Environmental Impact Statement to be prepared which addresses the following requirements in relation to noise:

- A quantitative noise and vibration impact assessment undertaken by a suitably qualified person in accordance with the relevant Environmental Protection Authority guidelines and included an assessment of nearby sensitive receivers.
- Cumulative impacts of other developments
- Details of proposed mitigation, management and monitoring measures.

4.2 Noise Policy for Industry

The *Noise Policy for Industry* (NPfI) was released in 2017 and sets out the NSW Environment Protection Authority's (EPA's) requirements for the assessment and management of noise from industry in NSW.

4.2.1 Trigger Levels

The NPfI describes 'trigger levels' which indicate the noise level at which feasible and reasonable noise management measures should be considered. Two forms of noise criteria are provided – 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 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'.

4.2.2 Project Specific Criteria

The noise emission trigger levels for industrial noise generated by the facility are provided in **Table 5**. The Project Noise Trigger Level (PNTL) is the lowest value of the intrusiveness or amenity noise level for each period and are shown below in bold.

Table 5 Project Trigger Noise Levels

Receiver	Period	Recommended Amenity Noise Level $L_{Aeq(period)}$ (dBA)	Measured Noise Level (dBA)		Project Noise Trigger Levels $L_{Aeq(15minute)}$ (dBA)	
			RBL[1]	$L_{Aeq(period)}$	Intrusiveness	Amenity[2,3]
R1 (Commercial)	When in use	55	n/a	n/a	n/a	**53**
R2 (Commercial)	When in use	65	n/a	n/a	n/a	**63**
R3 (Commercial)	When in use	65	n/a	n/a	n/a	**63**
R4 (Commercial)	When in use	65	n/a	n/a	n/a	**63**
R5 (Commercial)	When in use	65	n/a	n/a	n/a	**63**
Hillsdale Residential Receivers (R6)	Day	60	54	68	59	**56**[5]
	Evening	50	46	66	**51**	54[5]
	Night	45	42	64	**47**	52[5]
Botany Residential Receivers (R7)	Day	60	49	60	**54**	58
	Evening	50	49	62	54	**50**[5]
	Night	45	47	54	52	**47**[4]
School (R8)	When in use	50	n/a	n/a	n/a	**48**

Note 1: RBL = Rating Background Level.

Note 2: The recommended amenity noise levels have been reduced by 5 dB to give the project amenity noise levels, as outlined in the NPfI, due to other sources of industrial noise being present in the area, where appropriate.

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

Note 4: Amenity $L_{Aeq(period)}$ level was set at 10 dB below the existing industrial noise level, as outlined in the NPfI.

Note 5: The measured L_{Aeq} noise level was dominated by traffic noise and exceeds the recommended amenity noise level by 10 dB or more, therefore the 'high traffic project amenity noise level' is the existing $L_{Aeq(traffic)}$ noise level minus 15 dB.

4.3 Sleep Disturbance Noise Levels

Guidance for assessing the potential for sleep disturbance impacts on nearby residences is provided in Section 2.5 of the NPfI, which states:

> *Where the subject development/premises night-time noise levels at a residential location exceed:*
>
> - *$L_{Aeq,15min}$ 40 dB(A) or the prevailing RBL plus 5 dB, whichever is the greater, and/or*
> - *L_{AFmax} 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 night-time sleep disturbance noise levels for the development are presented in **Table 6**.

Table 6 Night-time L_{Amax} Sleep Disturbance Noise Levels

Receiver Area	Noise Level (dBA)	
	Measured Night-time RBL	Sleep Disturbance Noise Level
Hillsdale Residential Area	42	57
Botany Residential Area	47	62

4.3.1 Modifying Factors

Sources of industrial noise can cause greater annoyance where they contain certain characteristics, such as tonality, impulsiveness, intermittency, irregularity or dominant low-frequency content. The NPfI provides the following modifying factors, shown in **Table 7**, which are to be applied to the predicted receiver noise levels.

Table 7 NPfI Modifying Factors

Factor	Assessment/Measurement	When to Apply	Correction[1]
Tonal noise	One-third octave or narrow band analysis	Level of one-third octave band exceeds the level of the adjacent bands on both sides by levels defined in the NPfI.	5 dB[2]
Low-frequency noise	Measurement of source contribution C-weighted and A-weighted level and one-third octave measurements	Measure/assess source contribution C and A weighted $L_{eq,t}$ levels over same time period. Correction to be applied where the C minus A level is 15 dB or more and the level to which thresholds defined in the NPfI are exceeded.	2 or 5 dB[2]
Intermittent noise	Subjectively assessed but should be assisted with measurement to gauge the extent of change in noise level	The source noise heard at the receiver varies by more than 5 dB and the intermittent nature of the noise is clearly audible.	5 dB

Note 1: Corrections to be added to the measured or predicted levels.

Note 2: Where a source emits tonal and low-frequency noise, only one 5 dB correction should be applied if the tone is in the low-frequency range, that is, at or below 160 Hz.

4.3.2 NPfI Assessment of Prevailing Weather Conditions

The NPfI '*Fact Sheet D: Accounting for noise-enhancing weather conditions*' states:

Two options are available to a proponent to consider meteorological effects:

1. *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

2. *Determine the significance of noise enhancing conditions.*

Noise emissions from the proposed development have been assessed in accordance with NPfI Option 1 using 'noise enhancing' meteorological conditions. This ensures a conservative assessment and where compliance under 'worst-case' conditions are predicted then compliance during other scenarios is expected.

4.4 Construction Noise

4.4.1 NSW Interim Construction Noise Guideline (ICNG)

The NSW *Interim Construction Noise Guideline* (ICNG) sets out ways to assess and manage the impacts of construction noise on residences and other sensitive land uses. It does this by presenting assessment approaches that are tailored to the scale of the construction works.

The ICNG requires project specific Noise Management Levels (NMLs) to be established for noise affected receivers. The NMLs are not mandatory limits, however in the event construction noise levels are predicted to be above the NMLs, feasible and reasonable work practices are to be investigated to minimise noise emissions.

4.4.1.1 Residential Receivers

The ICNG provides an approach for determining NMLs at sensitive receivers based on the Rating Background levels (RBLs) for the area, as described in **Table 8**.

Table 8 Determination of NMLs for Residential Receivers

Time of Day	NML $L_{Aeq(15minute)}$	How to Apply
Standard hours Monday to Friday 7:00 am to 6:00 pm Saturday 8:00 am to 1:00 pm No work on Sundays or public holidays	RBL + 10 dBA	• The noise affected level represents the point above which there may be some community reaction to noise. • Where the predicted or measured LAeq(15minute) is greater than the noise affected level, the proponent should apply all feasible and reasonable work practises to meet the noise affected level. • The proponent should also inform all potentially impacted residents of the nature of works to be carried out, the expected noise levels and duration, as well as contact details.

	Highly Noise Affected
	75 dBA
		• The Highly Noise Affected (HNA) 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 restructuring the hours that the very noisy activities can occur, taking into account:
		  ◦ Times identified by the community when they are less sensitive to noise (such as before and after school for works near schools or mid-morning or mid-afternoon for works near residences.
		  ◦ If the community is prepared to accept a longer period of construction in exchange for restrictions on construction times.

Outside recommended standard hours	RBL + 5 dBA	• 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 practises have been applied and noise is more than 5 dBA above the noise affected level, the proponent should negotiate with the community.

Note 1 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*.

4.4.1.2 Commercial and Industrial Premises

The ICNG notes that due to the broad range of sensitivities that commercial or industrial land can have to noise from construction, the process of defining management levels is separated into three categories:

- Industrial premises: external $L_{Aeq(15minute)}$ 75 dBA
- Offices, retail outlets: external $L_{Aeq(15minute)}$ 70 dBA
- Other businesses that may be very sensitive to noise, where the noise level is project specific as discussed below.

The external noise levels should be assessed at the most-affected occupied point of the premises.

4.4.1.3 Other Sensitive Land Uses

The ICNG's quantitative assessment method provides NMLs for other sensitive land uses, such as educational institutes, hospitals, medical facilities and outdoor recreational areas. These land uses are considered potentially sensitive to construction noise only when the properties are in use.

The ICNG does not however provide an NML for all classifications of sensitive land use. Where sensitive land uses with no classification are identified within a construction noise catchment, the following guidance is given:

> *The proponent should undertake a special investigation to determine suitable noise levels on a project-by-project basis; the recommended 'maximum' internal noise levels in AS 2107 Acoustics – Recommended design sound levels and reverberation times for building interiors may assist in determining relevant noise levels (Standards Australia 2000).*

The project specific $L_{Aeq(15minute)}$ NMLs for other non-residential noise sensitive receivers from the ICNG are provided in **Table 9**.

Table 9 ICNG NMLs for Other Sensitive Receivers

Land Use	NML $L_{Aeq(15minute)}$ (Applied when the property is in use)
Classrooms at schools and other education institutions	Internal noise level 45 dBA
Hospital wards and operating theatres	Internal noise level 45 dBA
Places of Worship	Internal noise level 45 dBA
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 dBA
Passive recreation areas (characterised by contemplative activities that generate little noise and where benefits are compromised by external noise intrusion, eg reading, meditation)	External noise level 60 dBA
Community centres	Depends on the intended use of the centre. Refer to the recommended 'maximum' internal levels in AS 2107 for specific uses.

For sensitive receivers such as hospitals, schools and places of worship, the NMLs presented in **Table 9** are based on internal noise levels. For the purpose of this assessment, it is conservatively assumed that all schools and places of worship have openable windows. On the basis that external noise levels are typically 10 dB higher than internal noise levels when windows are open, an external NML of 55 dBA $L_{Aeq(15minute)}$ has been adopted.

4.4.2 Residential NML Summary

Using the background noise levels in **Table 3**, the residential NMLs derived for the project site are detailed in **Table 10**.

The noise monitoring locations used are considered to be the typically most affected residential locations surrounding the proposal area.

Table 10 Residential Receiver NMLs for Construction

Receiver Area	Standard Construction (RBL+10dB)	Out of Hours (RBL+5dB)			Sleep Disturbance Screening (RBL+15 dB)
	Daytime	Daytime	Evening	Night-time	
Hillsdale Residential Receivers (R6)	64	59	51	47	57
Botany Residential Receivers (R7	59	54	54	52	62

4.5 Construction Vibration Guidelines

The effects of vibration on buildings can be divided into three main categories:

- Those in which the occupants or users of the building are inconvenienced or possibly disturbed
- Those where the building contents may be affected
- Those in which the integrity of the building or the structure itself may be prejudiced.

4.5.1 Human Comfort Vibration

The Department of Environment and Conservation's (DEC) *Assessing Vibration: a technical guideline* (2006) provides guideline values for continuous, transient and intermittent events that are based on a Vibration Dose Value (VDV) rather than a continuous vibration level. The VDV is dependent upon the level and duration of the vibration event, as well as the number of events occurring during the daytime or night-time period.

The VDVs recommended in the guideline for vibration that is intermittent nature are presented in **Table 11**.

Table 11 Preferred and Maximum Vibration Dose Values for Intermittent Vibration

Building Type	Vibration Dose Value ($m/s^{1.75}$)	
	Preferred	**Maximum**
Critical Working Areas (eg hospital operating theatres, precision laboratories)	0.10	0.20
Residential Daytime	0.20	0.40
Residential Night-time	0.13	0.26
Offices, schools, educational institutions and places of worship	0.40	0.80
Workshops	0.80	1.60

Note: Daytime is 7:00 am to 10:00 pm and night-time is 10:00 pm to 7:00 am.

4.5.2 Effects on Building Contents

People can perceive floor vibration at levels well below those likely to cause damage to building contents or affect the operation of typical equipment found in most buildings that is not particularly vibration sensitive. For most receivers, the controlling vibration criterion is the human comfort criterion, and it is therefore not normally required to set separate criteria in relation to the effect of construction vibration on typical building contents.

Where appropriate, objectives for the satisfactory operation of vibration senstive critical instruments or manufacturing processes should be sourced from manufacturer's data and/or other published objectives.

4.5.3 Structural Damage Vibration

Structural damage vibration limits are based on Australian Standard AS 2187: Part 2-2006 *Explosives - Storage and Use - Part 2: Use of Explosives* and British Standard BS 7385 Part 2-1993 *Evaluation and measurement for vibration in buildings Part 2*. These standards provide frequency-dependent vibration limits related to cosmetic damage, noting that cosmetic damage is very minor in nature, is readily repairable and does not affect the structural integrity of the building.

The recommended vibration limits from BS 7385 for transient vibration for minimal risk of cosmetic damage to residential and industrial buildings are shown in **Table 12**.

Table 12 Transient Vibration Guide Values – Minimal Risk of Cosmetic Damage

Line	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

5 Operational Noise and Vibration Assessment

An end user for the warehouse development has not been identified at this stage of the project and therefore the exact uses that would be carried out within the warehousing structures is yet to be determined.

In undertaking an operational noise and vibration assessment for the development, certain assumptions are required regarding the type and location of equipment together with details regarding ongoing operational uses that will be carried out on the site. These assumptions are defined in the following sections.

5.1 Operational Noise Modelling

A noise model has been developed in SoundPLAN to predict the proposed operational noise impacts from the project. Calculations were undertaken based on the CONCAWE methodology, with meteorological conditions set to 'worst-case' in accordance with the NPfI guidance outlined in **Section 4.3.2**.

5.1.1 Daytime and Evening Periods

In order to assess the operational noise impacts from the development, worst-case peak light and heavy vehicle movements been modelled. Light vehicles have been modelled in the car parking areas and heavy vehicles in the hardstand areas. The modelled vehicle volumes are provided in **Table 13**.

Table 13 Peak Vehicle Volumes for the Development

Warehouse	Heavy Vehicles per Hour (Peak)	Light Vehicles per Hour (Peak)
Warehouse 1	10	52
Warehouse 2	10	52

Note 1: Vehicle volumes provided by the traffic consultants for the project (TRAFFIX).

The peak hour volumes outlined above were further broken down to peak 15 minute volumes in order to assess the noise emissions against the NPfI criteria. The peak hour volumes have been assumed to be spread evenly across each period.

External forklift movements (ie outside of the warehouses) have been modelled in the at-grade dock areas of the hardstands. It has been assumed that forklifts would operate continuously during any one 15-minute period. Two forklifts have been modelled operating externally in the hardstand areas for each warehouse.

Sound power levels and speed assumptions for the modelled vehicle movements are outlined in **Table 14**.

Table 14 Sound Power Levels for Onsite Vehicle Movements

Noise Source	Sound Power Level (SWL)	Average Speed
Heavy Vehicles	106 dBA[1]	25 km/h
Light Vehicles	96 dBA	40 km/h
Gas-powered Forklifts[2]	93 dBA	n/a

Note 1: Based on SLR's noise measurement database, this sound power level is typical of trucks travelling at low speeds, such as within industrial estates.

Note 2: If electric forklifts are proposed for the development, noise emissions from forklifts would be considerably lower than gas-powered forklifts.

5.1.2 Night-time Period

It has been conservatively assumed that as a worst case, the night-time operations will remain the same as during the daytime period.

In order to assess the possibility of sleep disturbance, in addition to the above noise sources, heavy vehicle brake releases and reverse alarms (non-tonal) have been modelled in the hardstand areas of the development with a sound power level (SWL) of 122 dBA.

5.1.3 Predicted Noise Levels

Operational noise levels have been predicted to all residential receivers surrounding the project site and are presented in **Table 15**.

Table 15 Predicted Operational Noise Level

Receiver ID	Noise Level (dBA)			Predicted Noise Level ($L_{Aeq(15minute)}$) (dBA)	Compliance
	PNTL Critieria ($L_{Aeq(15minute)}$)				
	Daytime	Evening	Night-time		
R1	**53 dBA** (when in use)			51	Yes
R2	**63 dBA** (when in use)			54	Yes
R3	**63 dBA**(when in use)			46	Yes
R4	**63 dBA**(when in use)			44	Yes
R5	**63 dBA** (when in use)			52	Yes
R6	56 dBA	51 dBA	47 dBA	30	Yes
R7	54 dBA	50 dBA	47 dBA	<30	Yes
R8	48 dBA (noisiest 1 hour period when in use)			<30	Yes

The above shows that the predicted noise levels are expected to comply with the PNTLs during all periods.

5.1.4 Sleep Disturbance

The predicted night-time L_{Amax} noise levels at the nearest receivers to the development are presented in **Table 16**.

Table 16 Summary of Predicted Sleep Disturbance Noise Levels (dBA)

Receiver Location	Source	L_{AFmax} Noise Level (dBA)			Compliance?
		Criteria	Predicted	Exceedance	
Hillsdale Residential Area	Truck Airbrake	57	53	-	Yes
Botany Residential Area	Truck Airbrake	62	54	-	Yes

The sleep disturbance noise levels are predicted to be comply with the criteria established for sleep disturbance in accordance with the NPfI.

5.2 Continuous Mechanical Plant Noise Emissions

The noise emission of mechanical plant associated with the development should be controlled so that the operation of such plant does not adversely impact nearby residential properties. At this stage of the project the location and selection of mechanical plant has not been determined. Therefore appropriate assessment will need to be concluded at the detailed design stage of the project.

It is envisaged that the mechanical plant noise source will be controllable by common engineering methods that may consist of:

- Judicious location
- Barriers
- Silencers
- Acoustically lined ductwork

The selected mechanical equipment must be reviewed and assessed for conformance with established criteria as stipulated in **Section 4.2.2** at the detailed design stage of the project when specific plant selection and location is determined. Details demonstrating compliance with these criteria (refer to **Table 5**) must be provided at the Construction Certificate stage of the project.

5.3 Vibration

No vibration intensive activities are proposed to occur during the standard operation of the project site and therefore no impacts are anticipated.

5.4 Cumulative Impacts

Potential cumulative impacts from other developments in the area have been taken into consideration when deriving appropriate criteria for the proposed development as detailed in Section 2.4 of the NPfI.

6 Construction Noise and Vibration Assessment

Airborne noise modelling was undertaken using the ISO 9613 algorithms as implemented in SoundPLAN V8.0.

The three-dimensional model includes source noise levels, ground topography, location of sources and receivers, acoustic shielding provided by surrounding buildings, air absorption, ground effects and the duration of equipment usage within the assessment period.

Construction noise levels have been predicted the receivers surrounding the proposed project.

6.1 Working Hours

Where possible, the majority of construction works would be undertaken in accordance with the ICNG during the standard daytime working hours of:

- 7.00 am to 6.00 pm Monday to Friday
- 8.00 am to 1.00 pm on Saturdays.

Limited works may be conducted outside of these hours provided they are managed so as to generate noise levels below the relevant ICNG Noise Management Levels.

The construction of the proposed warehouses is anticipated to take 10-12 months to complete.

6.2 Construction Activity Source Noise Levels

Sound power levels for the typical operation of construction equipment used in the modelling are listed in **Table 17**. These noise levels have been taken from verified test data and global standards that form part of SLR's noise database.

Table 17 Sound Power Levels for Construction Equipment

ID	Construction Activity	Equipment	Operating minutes in 15-min period[1]	No of items in same location	Sound Power Level LWA (dB)	
					Item	Activity
W.0001	Early Works – Site Establishment	Hand Tools (5mins)	5	2	94	105
		Truck	5	2	107	
W.0002	Piling	Piling - Impact	7.5	1	116	114
		Truck	5	2	107	
W.0003	Concrete Works (including ramps)	Concrete Pump	7.5	1	106	107
		Concrete Mixer Truck	7.5	1	103	
		Concrete Vibrator	15	1	102	
		Hand Tools	15	1	94	

ID	Construction Activity	Equipment	Operating minutes in 15-min period[1]	No of items in same location	Sound Power Level LWA (dB)	
					Item	Activity
W.0004	Construction of Warehouse	Elevated Working Platform	15	2	97	107
		Flatbed Truck	15	1	100	
		Hand Tools (electric)	15	4	96	
		Mobile Crane (100 tonne)	15	1	100	
		Welding Equipment	15	1	97	
W.0005	Landscaping	Hydromulching Equipment	15	1	97	102
		Skidsteer Loaders (approx 1/2 tonne)	15	1	97	
		Ute	15	1	98	

Note 1: This refers to the amount of time in minutes that individual items of equipment would be in use for during the worst-case 15 minute assessment period, based on site observations. Some items of plant, such as Concrete Pumps, are not typically used in a continuous manner.

6.3 Predicted Worst-case Noise Levels – Proposal Overview

A summary of the predicted noise levels (without additional mitigation) for each of the closest residential receivers for the various work activities is presented in **Table 18**.

The following tables colour the predicted noise levels based on the exceedance of the NML during that period and for that receiver type. A qualitative description of the NML exceedance bands is given below, noting that the impact of these potential exceedances would depend on the period in which they were to occur (ie the night-time period is typically more sensitive than the daytime or evening for most people):

- Noise levels 1 to 10 dB above NML – impacts would typically be marginal to minor
- Noise levels 11 dB to 20 dB above NML – impacts would typically be moderate
- Noise levels >20 dB above NML – impacts would typically be high

For most construction activities, it is expected that the construction noise levels would frequently be lower than predicted at the most-exposed receiver, as the noise levels presented in this report are based on a realistic worst-case assessment.

Table 18 Predicted Worst-case Noise Levels from Proposal – All Works

Receiver ID	Receiver type	Noise Management Levels (NML)	Predicted $L_{Aeq(15minute)}$ Noise Level (dBA)[1]				
		Standard Daytime Hours	W.0001- Early Works – Site Establishment	W.0002- Piling	W.0003- Concrete works	W.0004- Construction of warehouse	W.0005- Landscaping
			Operating Period				
			DAY	DAY	DAY	DAY	DAY
R1	Outdoor Active	65	74	83	76	76	82
R2	Commercial	70	63	72	65	65	60
R3		70	65	74	67	67	62
R4		70	50	59	52	52	47
R5		70	63	72	65	65	60
R6	Residential	64	36	45	38	38	33
R7		59	35	44	37	37	32
R8	School	55	33	42	35	35	30

Note 1: Cell shading indicates highest predicted exceedance of NML for worst-case proposed operating period; yellow = minor (less than 10 dB), orange = moderate (11-20 dB), red = high (greater than 20dB)

Exceedances of the NML during standard construction hours are only predicted at the surrounding commercial receivers due to the proximity of the proposed works.

At R1 (the Border protection facility), the noise level is predicted to exceed the NML by up to 18 dB during piling works, which use highly noise intensive equipment at times, due to the proximity of the works to these buildings.

It is however noted that as works progress around the site the noise level would decrease. When the works are occurring approximately 100 m away from the boundary of the border force facility, the noise levels are predicted to comply with the NML of 65 dBA.

Construction noise is predicted to comply with the NMLs at all surrounding residential receivers during the works.

6.4 Construction Vibration

The major potential sources of vibration from the proposed construction activities are during the piling works proposed to be undertaken during construction of the suspended concrete platform.

6.4.1 Safe Working Distances

As a guide, safe working distances for various items of vibration intensive plant are provided in the TfNSW Construction Noise Strategy and are reproduced below in **Table 19**.

Table 19 Recommended Safe Working Distances for Vibration Intensive Plant

Plant Item	Rating/Description	Safe Working Distance	
		Cosmetic Damage (BS 7385)	Human Response (NSW EPA Vibration Guideline)
Vibratory Roller	< 50 kN (Typically 1-2t)	5 m	15 m to 20 m
	< 100 kN (Typically 2-4t)	6 m	20 m
	< 200 kN (Typically 4-6t)	12 m	40 m
	< 300 kN (Typically 7-13t)	15 m	100 m
	> 300 kN (Typically 13-18t)	20 m	100 m
	> 300 kN (Typically > 18t)	25 m	100 m
Small Hydraulic Hammer	300 kg - 5 to 12t excavator	2 m	7 m
Medium Hydraulic Hammer	900 kg - 12 to 18t excavator	7 m	23 m
Large Hydraulic Hammer	1600 kg - 18 to 34t excavator	22 m	73 m
Vibratory Pile Driver	Sheet Piles	2 m to 20 m	20 m
Pile Boring	800mm	2m (nominal	4 m
Jackhammer	Hand held	1 m (nominal)	2 m

Note: More stringent conditions may apply to heritage or other sensitive structures.

The safe working distances in **Table 19** are quoted for both cosmetic damage (refer to BS7385:2 *Evaluation and Measurement for Vibration in Buildings Part 2: Guide to Damage Levels from Ground-borne Vibration*, 1993) and human comfort (refer to NSW EPA *Assessing Vibration: a technical guideline*, 2006).

The safe working distances for building damage should be complied with at all times. The distances are noted as being indicative and would vary depending on the particular item of plant and local geotechnical conditions. They apply to addressing the risk of cosmetic (minor – easily reparable) damage of typical buildings under typical geotechnical conditions.

Where vibration intensive works are required to be undertaken within the specified safe working distances, vibration monitoring should be undertaken to ensure acceptable levels of vibration are satisfied.

In relation to human comfort, the safe working distances relate to continuous vibration. For most construction activities, vibration emissions are intermittent in nature and for this reason, higher vibration levels, occurring over shorter periods are allowed.

6.4.2 Impact Piling Predictions

To estimate the potential vibration values associated with the proposed impact piling, the empirical formula from British Standard BS 5228-2:2009 Code of Practice for noise and vibration control on construction and open sites – part 2: Vibration was used.

Table E.1 of BS528-2:2009 provides the following empirical formula to estimate the resultant Peak Particle Velocity (PPV) from Impact Piling:

$$Vres \leq Kp \left[\frac{\sqrt{W}}{r^{1.3}}\right]$$

Where:

Vres: Resulant PPV, in mm/s
Kp: Scaling factor
W: Nominal hammer energy, in Joules (J)
r: Slant distance from the pile toe to the receiver, in meters (m) and $r^2 = L^2 + x^2$
L: Pile toe depth, in metres (m)
X: Distance measured along the ground surface, in metres (m)

The following additional formulae were also solved for drop height and impact velocity:

$$v = \sqrt{2gh}$$

$$KE = \frac{1}{2}mv^2$$

yielding a hammer energy of $W = mgh$.

Where:

V: Impact velocity in m/s
G: acceleration of gravity = 9.8m/s^2
H: drop height, in metres
KE = Kenetic Energy in Joules
M = hammer mass

Based on the formulas, the maximum permissible kinetic energy and corresponding drop height based on a typical hammer mass of 16,000 kg has been calculated and is shown in **Table 20** for the heritage structures and residential/commercial buildings.

Table 20 Calculation of the maximum energy and drop height at the closest commercial structure

Parameter	Calculations			
	Option 1	**Option 2**	**Option 3**	**Option 4**
Criteria	7.5mm/s	7.5mm/s	7.5mm/s	7.5mm/s
Kp	5	3	1.5	1
r,m	14	14	14	14
L,M (start of piling)	0	0	0	0
x, (meters)	14	14	14	14
m, Kg	16,000	16,000	16,000	16,000
Energy giving 7.5mm/s at the receiver (KE, Joules)	2148.4	5967.8	23871.1	53710.0
Corresponding drop Height (h, m)	0.01	0.04	0.15	0.34

Table 20 provides the maximum drop height based on a hammer mass of 16,000 Kg under various ground conditions (Kp) as defined in Table E.2 of BS5228-2:2009, with respect to achieving the criteria for the nearby structures.

If the ground is stiff/very dense, the maximum drop height at 14 m from the nearest structure would decrease to around 1-5 centimetres, however, if the ground is soft/loose, the maximum drop height would increase up to around 35 centimetres.

Additionally, in order to increase the drop height and stay below the criteria of 7.5 mm/s, the mass of the hammer can be reduced to 8,000 Kg and therefore correspond to a maximum drop height of around 69 centimetres under soft/loose ground (Option 4).

Additionally the drop height can be increased for a smaller hammer mass. For example, with an 8,000 Kg hammer the maximum drop height increases to 69 centimeters under soft/loose ground (Option 4) while still complying with nominated 7.5 mm/s threshold.

It is recommended that vibration monitoring be undertaken during the piling to validate these predicted levels and to establish a site law (ie relationship of PPV vibration to hammer energy W).

6.4.3 Cosmetic Damage Assessment

For most sources of intermittent vibration during construction, such as impact piling, the predominant vibration energy occurs at frequencies usually in the 10 Hz to 100 Hz range. On this basis, and with reference to BS7385:2 and **Section 4.5**, a vibration damage screening level of 7.5 mm/s has been adopted for the purpose of assessing potential impacts from continuous vibration.

Calculations for the impact piling activities presented in **Table 20** to provide the maximum drop height based on various ground conditions with reference to the cosmetic damage criteria for the nearby border force dog kennel structures.

The assessment has also not taken into account the offset distance to unknown structures such as underground utilities (if any). The distance to these structures along with deriving an appropriate criterion will be required to be determined by the contractor prior to vibration intensive works being undertaken.

It is also recommended that the contractor undertake a site law to confirm the site specific vibration propagation and undertake dilapidation surveys where buildings are identified to be within the safe working distance or appear to be sensitive to vibration damage.

6.4.4 Human Response

In relation to human comfort (response), the safe working distances in **Table 19** relate to continuous vibration and apply to residential receivers. For most construction activities, vibration emissions are intermittent in nature and for this reason, higher vibration levels, occurring over shorter periods are permitted, as discussed in *Assessing Vibration – a technical guideline*.

The nearest residential receiver is located approximately 570 m away from the project site and as such is not anticipated to exceed the criteria applicable for human comfort.

The potential impact of vibration on the dogs has not been specifically assessed.

6.5 Construction Mitigation Measures

All feasible and reasonable mitigation measures will be implemented by the project. Impacts from the construction works will be minimised and managed in accordance with the procedures detailed below in **Table 21**.

Table 21 Environmental Management Controls for Construction Noise – Source Control

Item	Measure
Project Planning	Where possible, use alternative less noise and vibration intensive construction techniques to rock breaking and concrete sawing.
	Power tools to use mains power rather than using generators.
	Complete works during standard daytime construction hours.
	Truck routes to site should be limited to major roads.
Scheduling	Respite offers should be considered where high noise and vibration generating activities are near receivers (particularly the border protection facility). As a guide, work should be carried out in blocks that do not exceed three hours, with a minimum respite period of one hour between each block.
	Consult with the affected community to determine the need for respite periods.
Site Layout	Site entry and exit points to be located as far as possible from sensitive receivers, where possible.
	Compounds and worksites to be designed to promote one-way traffic and minimise the need for vehicle reversing.
	Position work compounds, parking areas, and equipment and material stockpiles away from noise-sensitive locations.
Training	Training to be provided to all personnel on noise and vibration requirements for the project. Inductions and toolbox talks to be used to inform personnel of the location and sensitivity of surrounding receivers.
Plant and Equipment Source Mitigation	Noise emissions from plant and equipment operated on the site shall be minimised by installing and maintaining, wherever practicable, efficient silencers, low noise mufflers (residential standard) and by replacing reversing alarms with alternative silent measures, such as flashing lights (subject to occupational health and safety requirements).
	Noisy plant or processes should be replaced by less noisy alternatives. This is particularly important for piling, for example. Bored piles generate less noise than impact-driven or percussive piling methods which should be avoided if possible.
	Operate plant and equipment in the quietest and most efficient way, including not idling vehicles or equipment unnecessarily.
	Siting noisy equipment behind structures that act as barriers, or at the greatest distance from the noise-sensitive area; or orienting the equipment so that noise emissions are directed away from any sensitive areas, to achieve the maximum attenuation of noise.
	Regular and effective maintenance of noise generating equipment, including checking of hatches/enclosures regularly to ensure that seals are in good condition and doors close properly against seals.
	Avoid dropping materials from a height.
	Avoiding noisy plant working simultaneously close together.
	Carrying out loading and unloading away from noise sensitive areas.

Item	Measure
Screening	Install purpose-built screening or enclosures around long-term fixed plant where possible.
	Site layout should take advantage of existing screening from local topography. Position site huts, maintenance sheds and/or shipping containers between noisy equipment and the affected receivers.
Community Consultation	Notifications should be provided to the neighbouring properties where high impacts are anticipated or where out of hours works are required. Notification should be a minimum of five working days.
	Where complaints are received, the work practices are to be reviewed and feasible and reasonable mitigation and management measures implemented to minimise any further impacts.
Monitoring	Noise and/or vibration monitoring may be required in response to any complaints received to verify that levels are not substantially above the predicted levels.
Vibration	Where works are required within the safe working distances, vibration monitoring should be undertaken to confirm that vibration is within acceptable levels.
	Where works are required within the cosmetic damage safe working distances, building condition surveys be completed before and after the works to ensure no cosmetic damage has occurred.
	Vibration monitoring should be undertaken during the piling to validate predicted vibration levels to minimise any potential cosmetic damage.

7 Conclusion

An assessment of the potential noise and vibration impacts associated with the proposed two warehouses located at 28 McPherson Street, Banksmeadow has been completed. This assessment has been carried out in accordance with NSW regulatory requirements.

An assessment has been undertaken using plant and equipment representative of the likely methodologies used to construct the project. The assessment identifies that various exceedances of the Noise Management Levels are predicted at the nearest commercial/industrial receivers surrounding the project site, notably the border protection facility. No exceedances are predicted at the nearest residential receivers in Hillsdale and Botany.

An assessment has been undertaken of the operational noise associated with the Project. The assessment has shown that noise emissions from the warehouse development are expected to comply with the relevant criteria.

The maximum drop height for the proposed impact piling has been established based on various ground conditions with reference to the cosmetic damage criteria for the nearby border force dog kennel structures. It is recommended that vibration monitoring be undertaken during the piling to validate these predicted levels and to establish a site law (ie relationship of PPV vibration to hammer energy W).

APPENDIX A

Acoustic Terminology

1 Sound Level or Noise Level

The terms “sound” and “noise” are almost interchangeable, except that in common usage “noise” is often used to refer to unwanted sound.

Sound (or noise) consists of minute fluctuations in atmospheric pressure capable of evoking the sense of hearing. The human ear responds to changes in sound pressure over a very wide range. The loudest sound pressure to which the human ear responds is 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 2E-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 4000 Hz), and less sensitive at lower and higher frequencies. Thus, the level of a sound in dBA is a good measure of the loudness of that sound. Different sources having the same dBA level generally sound about equally loud.

A change of 1 dBA or 2 dBA in the level of a sound is difficult for most people to detect, whilst a 3 dBA to 5 dBA change corresponds to a small but noticeable change in loudness. A 10 dBA 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
120 110	Heavy rock concert Grinding on steel	Extremely noisy
100 90	Loud car horn at 3 m Construction site with pneumatic hammering	Very noisy
80 70	Kerbside of busy street Loud radio or television	Loud
60 50	Department store General Office	Moderate to quiet
40 30	Inside private office Inside bedroom	Quiet to very quiet
20	Unoccupied 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

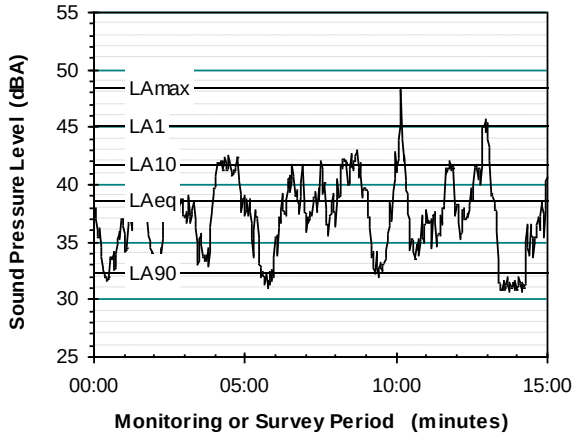
The Sound Power of a source is the rate at which it emits acoustic energy. As with Sound Pressure Levels, Sound Power Levels are expressed in decibel units (dB or dBA), but may be identified by the symbols SWL or LW, or by the reference unit 1E-12 W.

The relationship between Sound Power and Sound Pressure may be likened to 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 the statistical indices.



Of particular relevance, are:

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

LA10 The noise level exceed 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 Is the A-weighted equivalent continuous 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.

When dealing with numerous days of statistical noise data, it is sometimes necessary to define the typical noise levels at a given monitoring location for a particular time of day. A standardised method is available for determining these representative levels.

This method produces a level representing the “repeatable minimum” LA90 noise level over the daytime and night-time measurement periods, as required by the DECCW. In addition the method produces mean or “average” levels representative of the other descriptors (LAeq, LA10 etc).

5 Tonality

Tonal noise contains one or more prominent tones (ie distinct frequency components), and is normally regarded as more offensive than “broad band" noise.

6 Impulsiveness

An impulsive noise is characterised by one or more short sharp peaks in the time domain, such as occurs during hammering.

7 Frequency Analysis

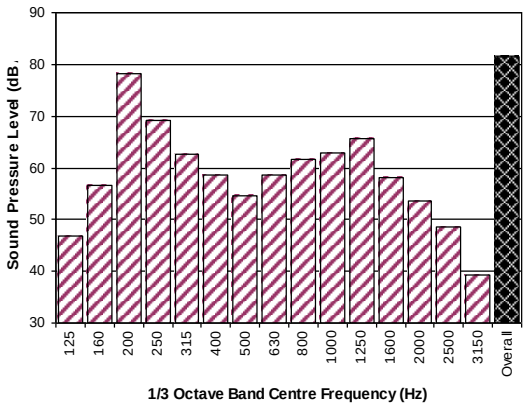
Frequency analysis is the process used to examine the tones (or frequency components) which make up the overall noise or vibration signal. This analysis was traditionally carried out using analogue electronic filters, but is now normally carried out using Fast Fourier Transform (FFT) analysers.

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 (3 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.



8 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 incorporate “root mean squared” averaging over some defined time period.

Vibration measurements may be carried out in a single axis or alternatively as triaxial measurements. Where triaxial measurements are used, the axes are commonly designated vertical, longitudinal (aligned toward the source) 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 (1E-6 mm/s). Care is required in this regard, as other reference levels are used by some organisations.

9 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.

10 Overpressure

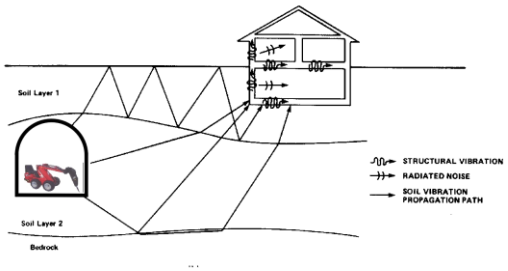
The term “over-pressure” is used to describe the air pressure pulse emitted during blasting or similar events. The peak level of an event is normally measured using a microphone in the same manner as linear noise (ie unweighted), at frequencies both in and below the audible range.

11 Regenerated Noise

Noise that propagates through a structure as vibration and is radiated by vibrating wall and floor surfaces is termed “regenerated noise”, “structure borne noise”, or sometimes “ground-borne noise”. Regenerated 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 regenerated noise include tunnelling works, underground railways, Demolition plant (eg rockbreakers), and building services plant (eg fans, compressors and generators).

The following figure presents the various paths by which vibration and regenerated noise may be transmitted between a source and receiver for construction activities occurring within a tunnel.



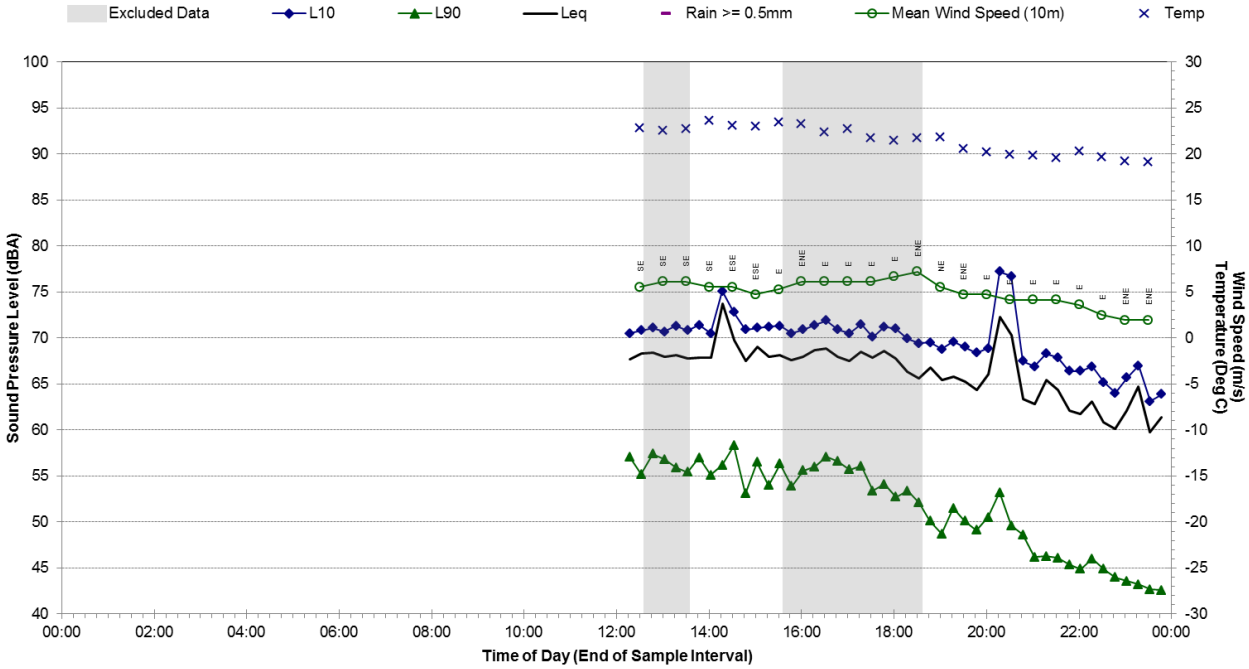
The term “regenerated noise” is also used to describe other types of noise that are emitted from the primary source as a different form of energy. One example would be a fan with a silencer, where the fan is the energy source and primary noise source. The silencer may effectively reduce the fan noise, but some additional noise may be created by the aerodynamic effect of the silencer in the airstream. This “secondary” noise may be referred to as regenerated noise.

APPENDIX B1

6 Denison St, Hillsdale

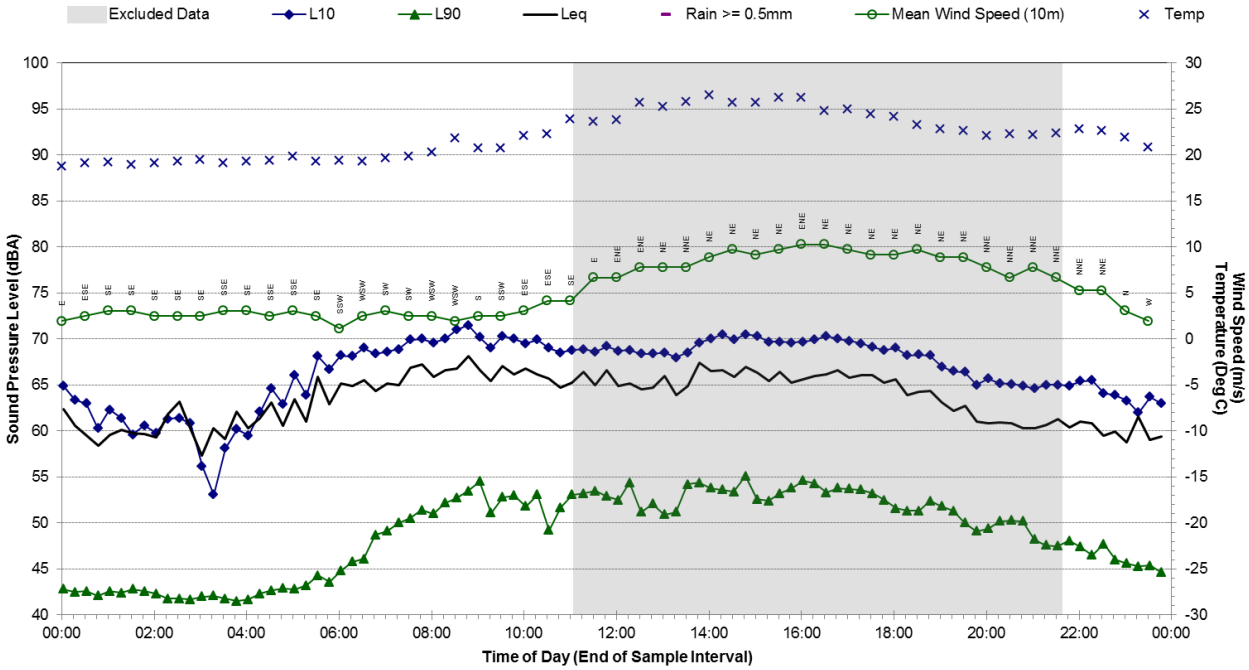
Statistical Ambient Noise Levels

6 Denison Street, Hillsdale - Friday, 30 November 2018



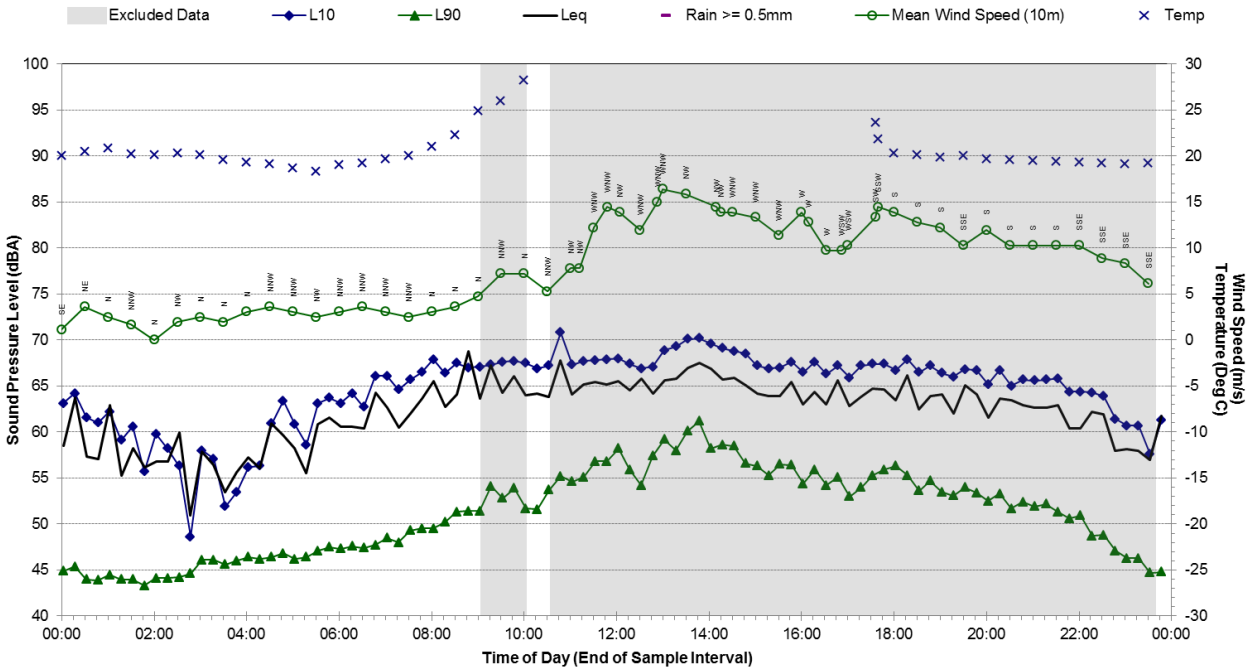
Statistical Ambient Noise Levels

6 Denison Street, Hillsdale - Saturday, 1 December 2018



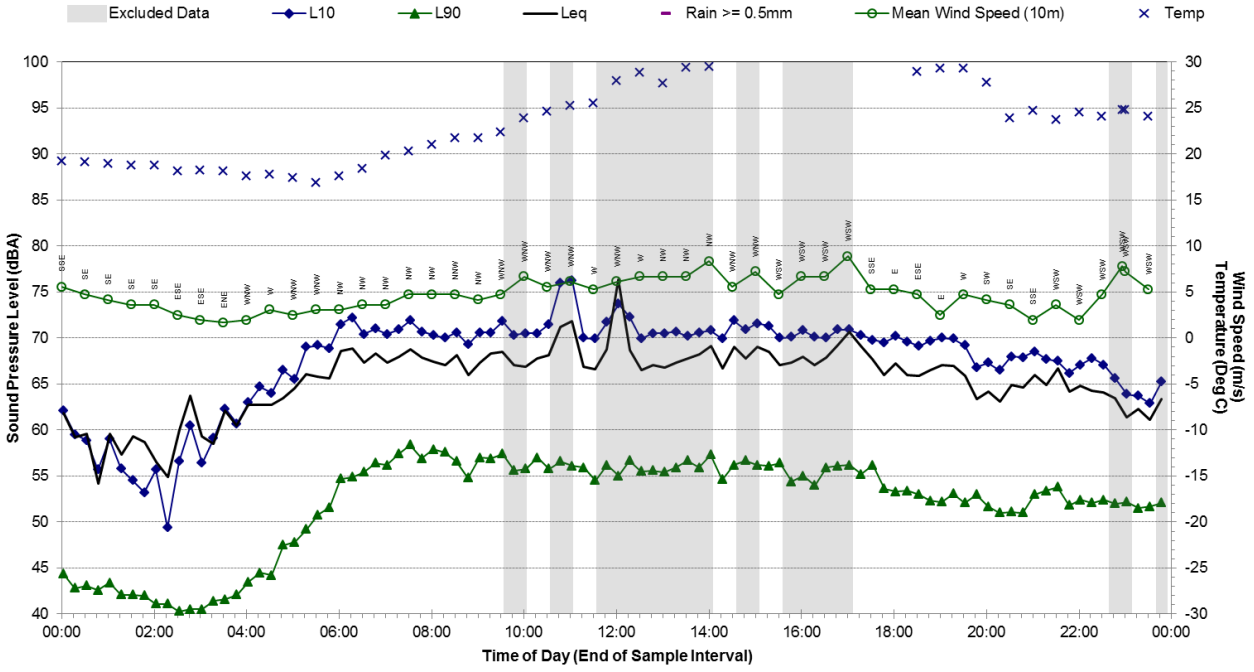
Statistical Ambient Noise Levels

6 Denison Street, Hillsdale - Sunday, 2 December 2018



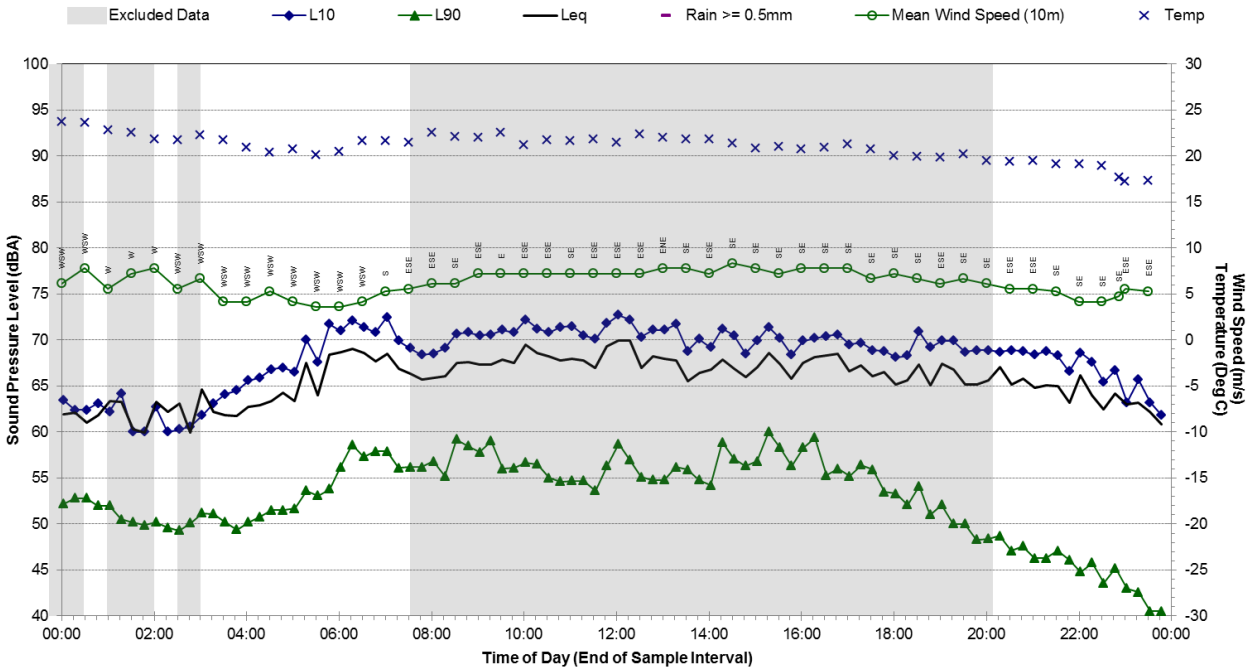
Statistical Ambient Noise Levels

6 Denison Street, Hillsdale - Monday, 3 December 2018



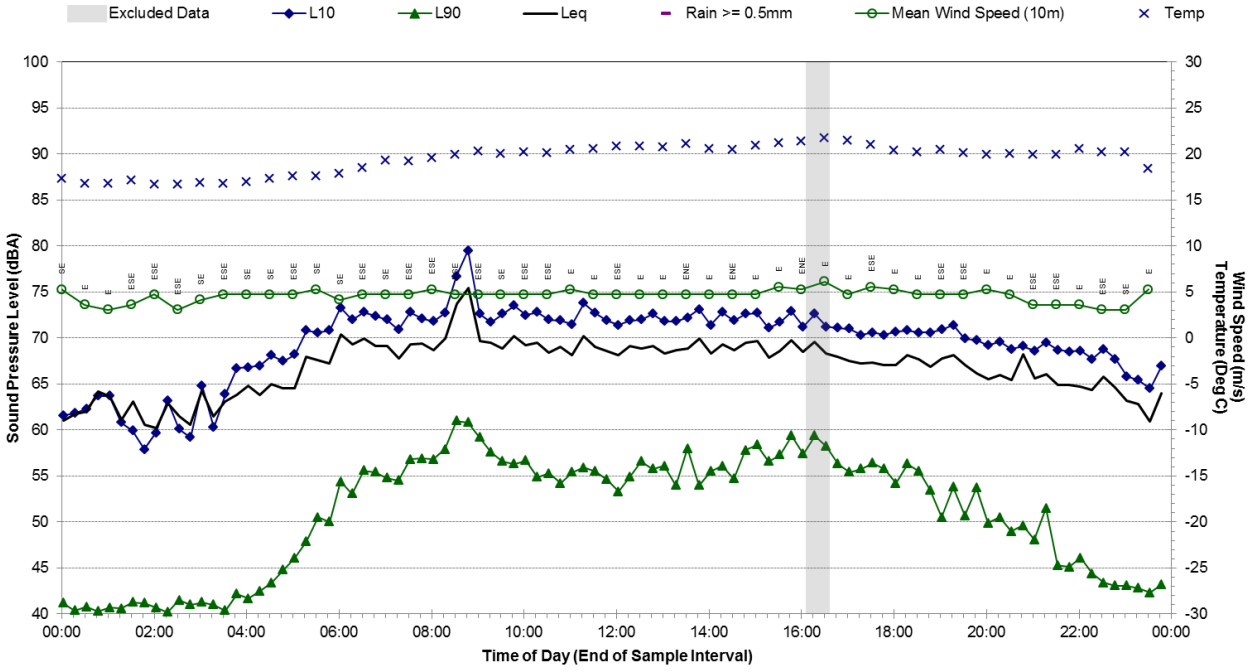
Statistical Ambient Noise Levels

6 Denison Street, Hillsdale - Tuesday, 4 December 2018



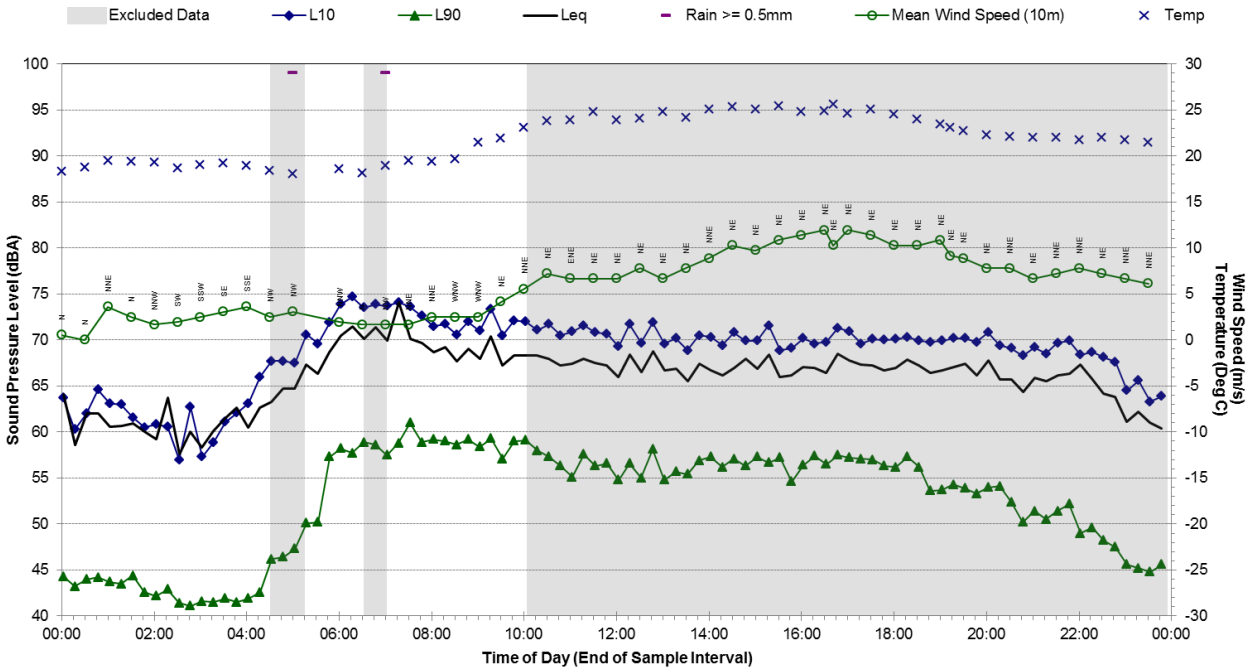
Statistical Ambient Noise Levels

6 Denison Street, Hillsdale - Wednesday, 5 December 2018



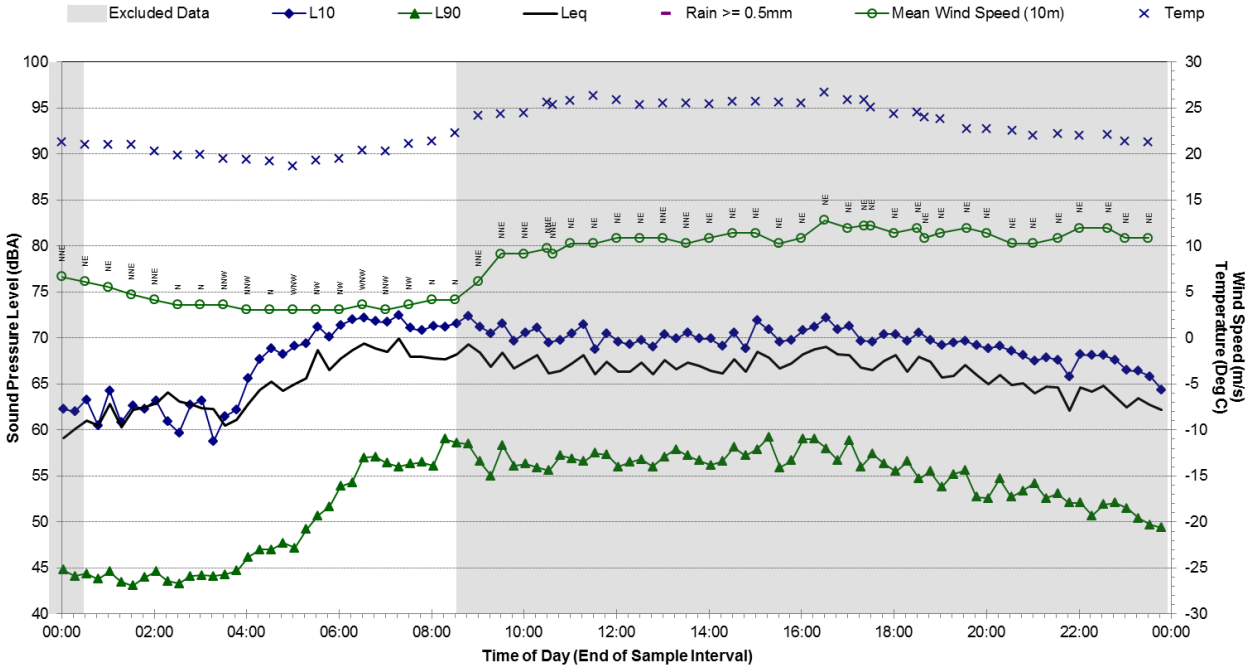
Statistical Ambient Noise Levels

6 Denison Street, Hillsdale - Thursday, 6 December 2018



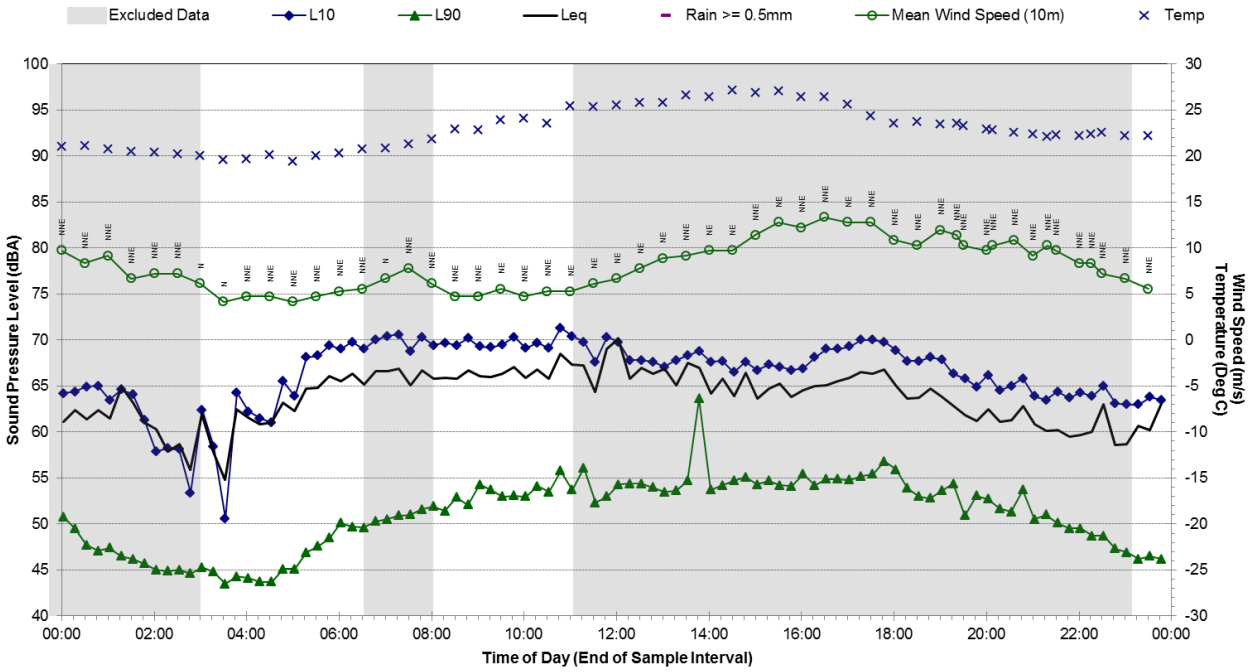
Statistical Ambient Noise Levels

6 Denison Street, Hillsdale - Friday, 7 December 2018



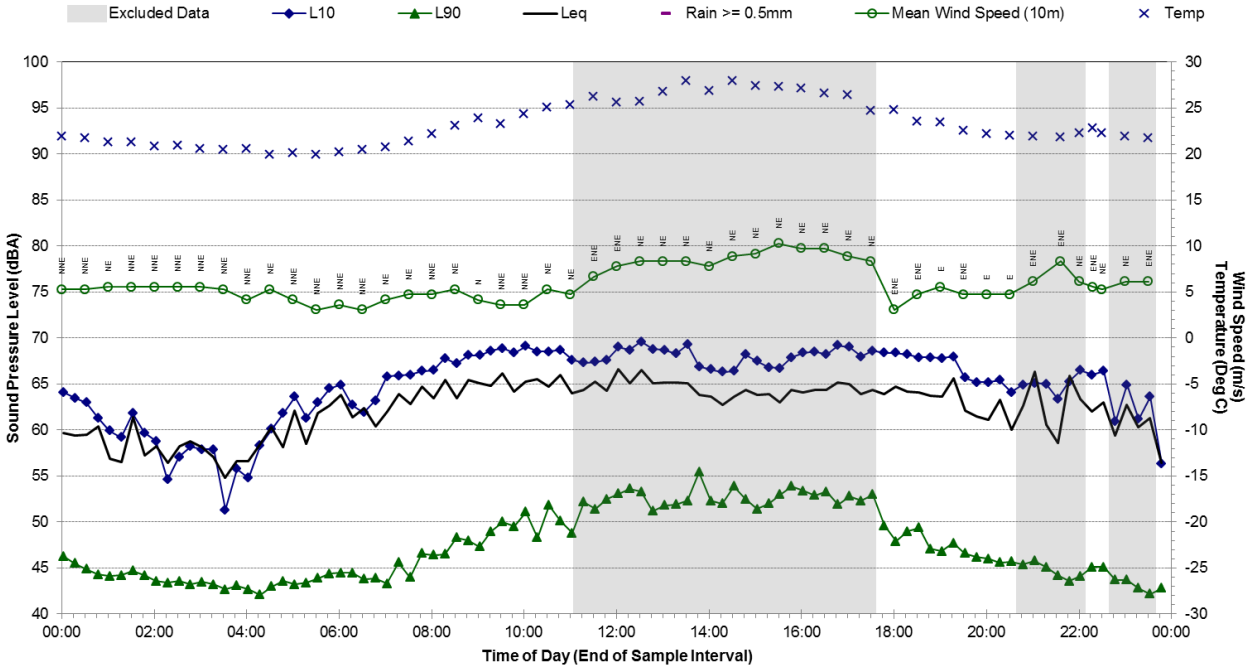
Statistical Ambient Noise Levels

6 Denison Street, Hillsdale - Saturday, 8 December 2018



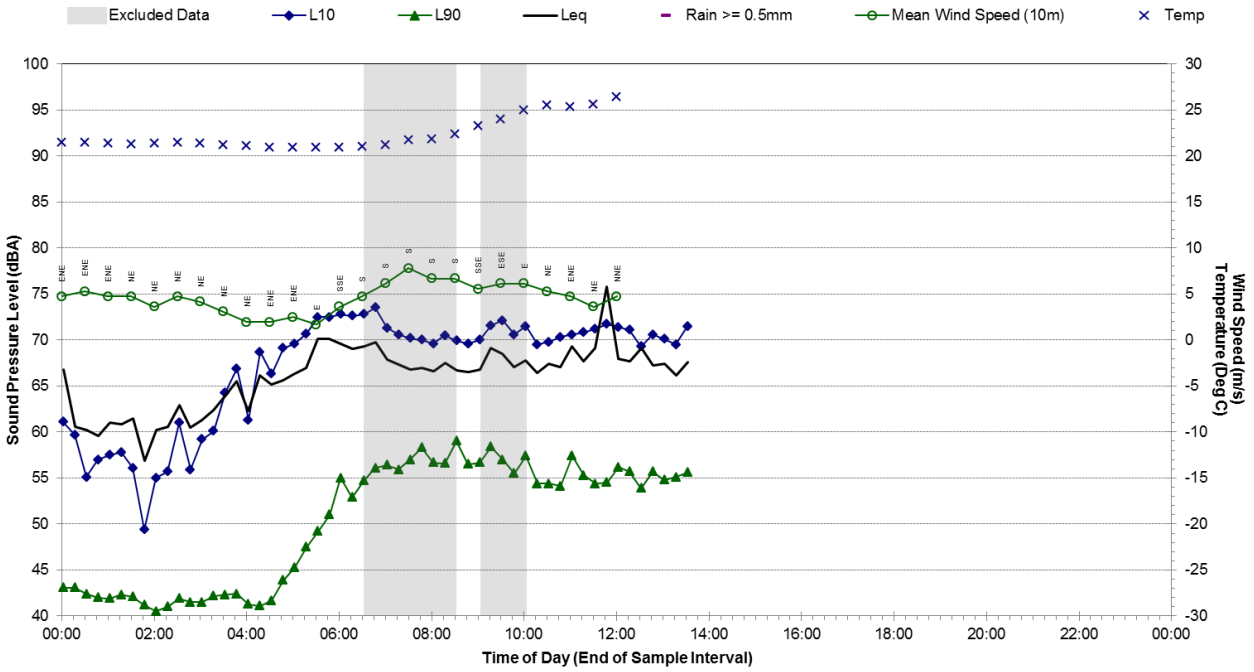
Statistical Ambient Noise Levels

6 Denison Street, Hillsdale - Sunday, 9 December 2018



Statistical Ambient Noise Levels

6 Denison Street, Hillsdale - Monday, 10 December 2018

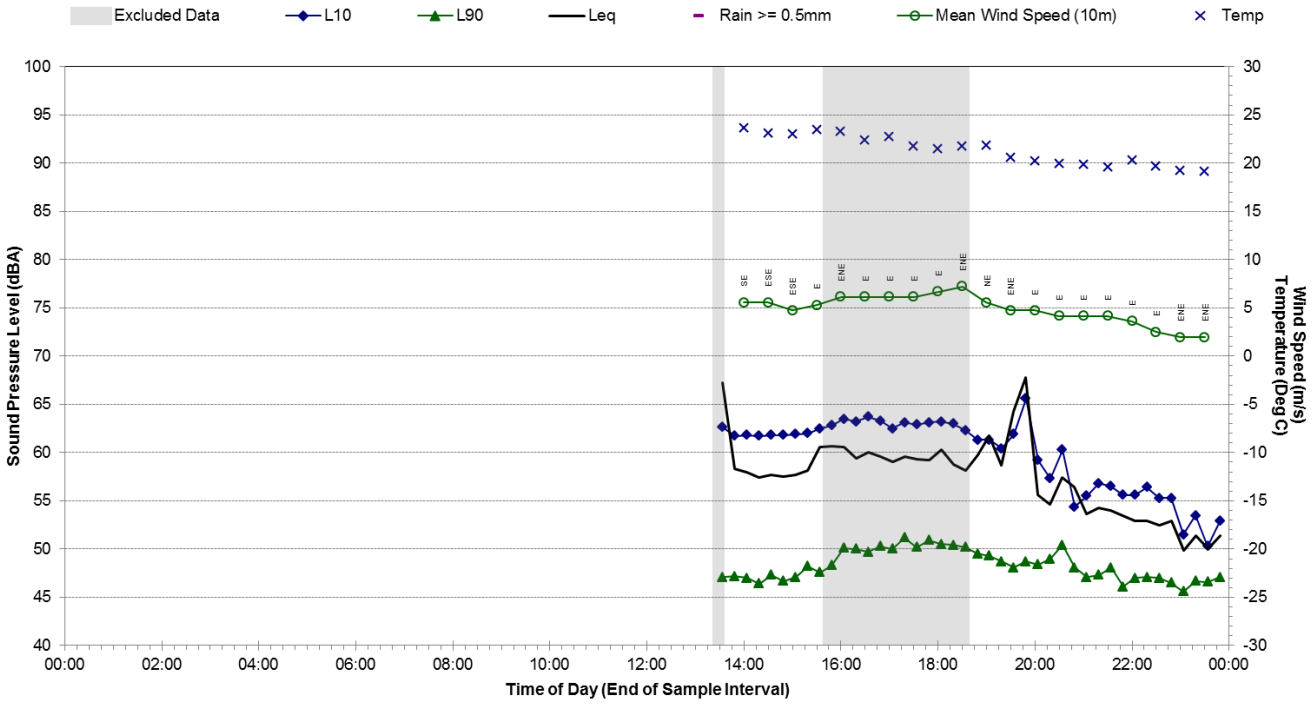


APPENDIX B2

36 Stephen Rd, Botany

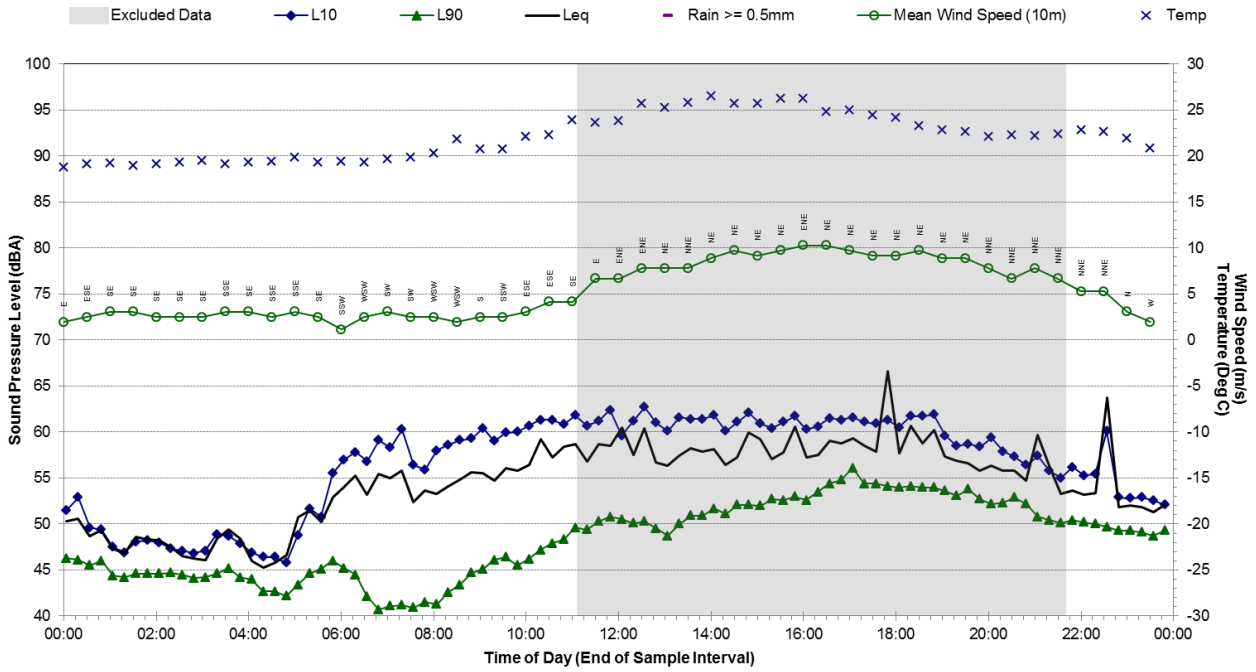
Statistical Ambient Noise Levels

36 Stephen Rd, Botany - Friday, 30 November 2018



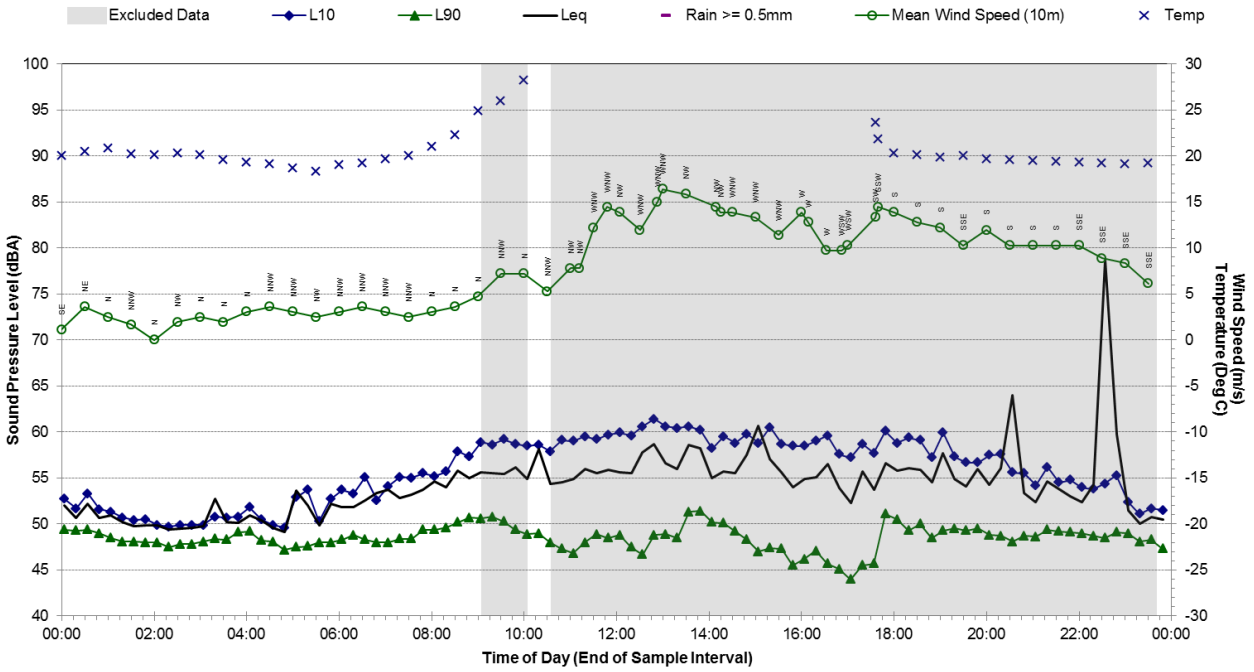
Statistical Ambient Noise Levels

36 Stephen Rd, Botany - Saturday, 1 December 2018



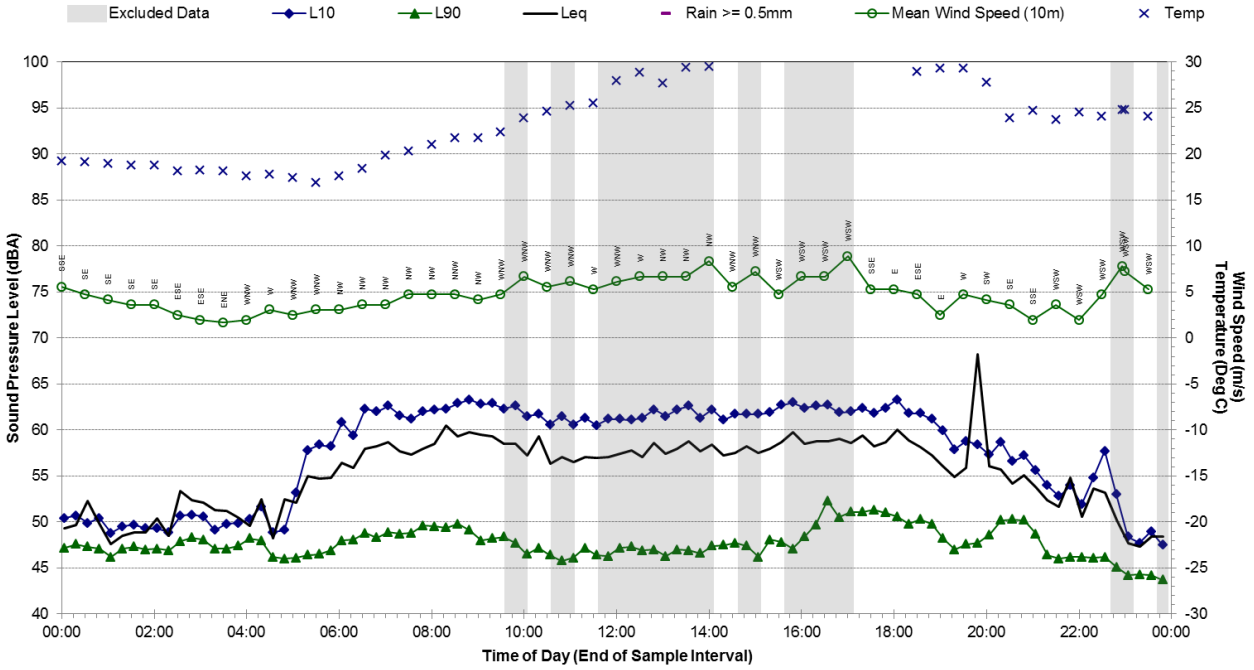
Statistical Ambient Noise Levels

36 Stephen Rd, Botany - Sunday, 2 December 2018



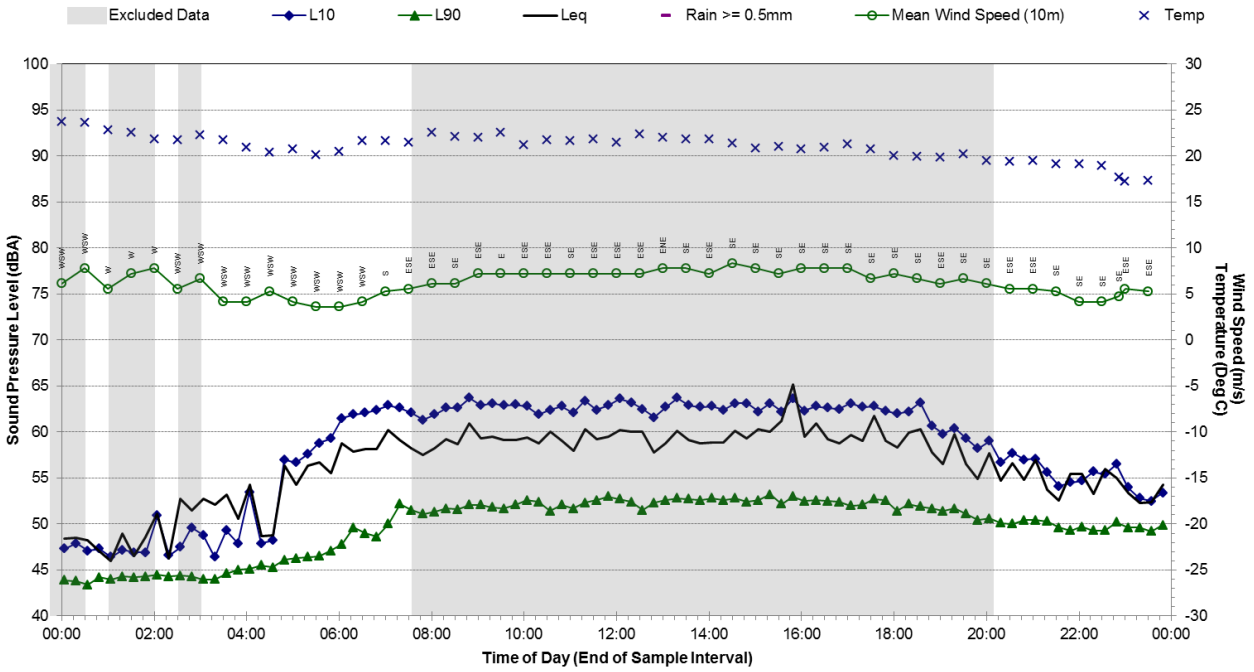
Statistical Ambient Noise Levels

36 Stephen Rd, Botany - Monday, 3 December 2018



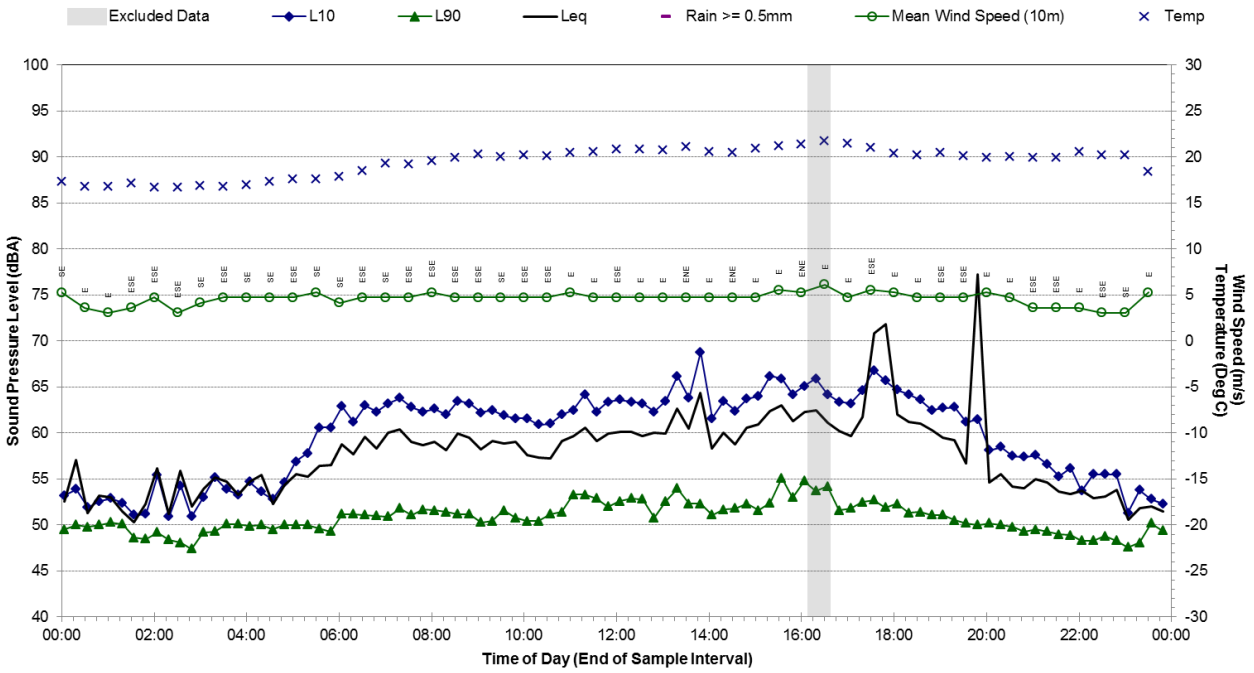
Statistical Ambient Noise Levels

36 Stephen Rd, Botany - Tuesday, 4 December 2018



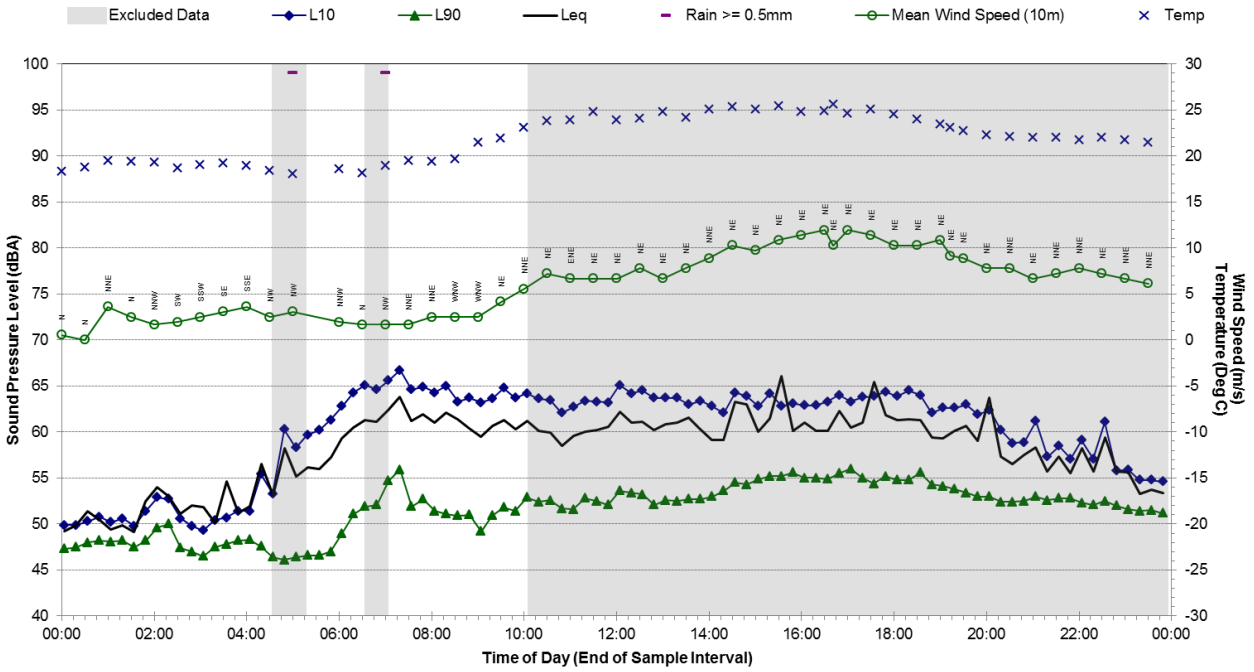
Statistical Ambient Noise Levels

36 Stephen Rd, Botany - Wednesday, 5 December 2018



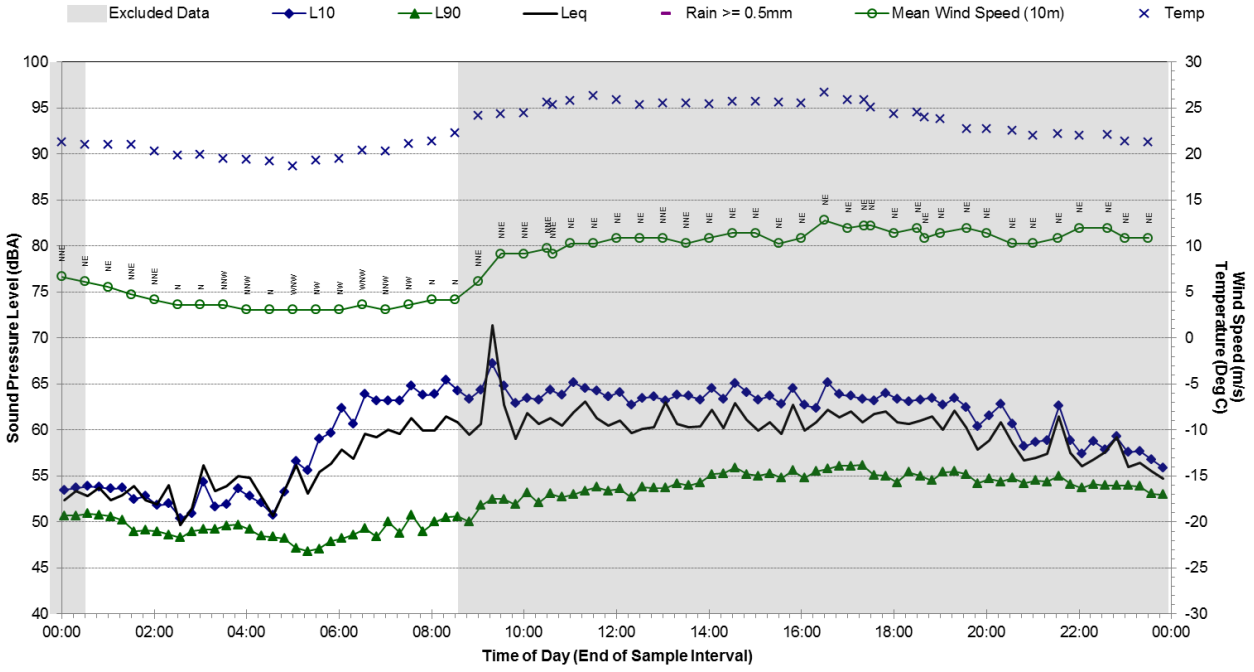
Statistical Ambient Noise Levels

36 Stephen Rd, Botany - Thursday, 6 December 2018



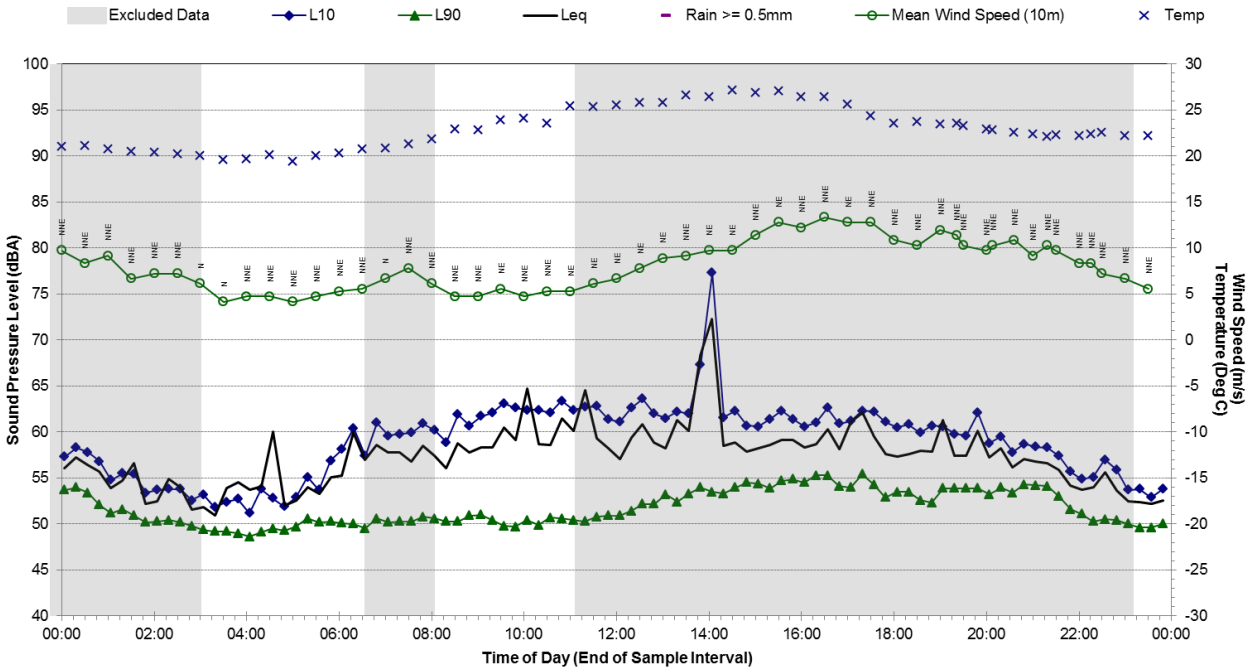
Statistical Ambient Noise Levels

36 Stephen Rd, Botany - Friday, 7 December 2018



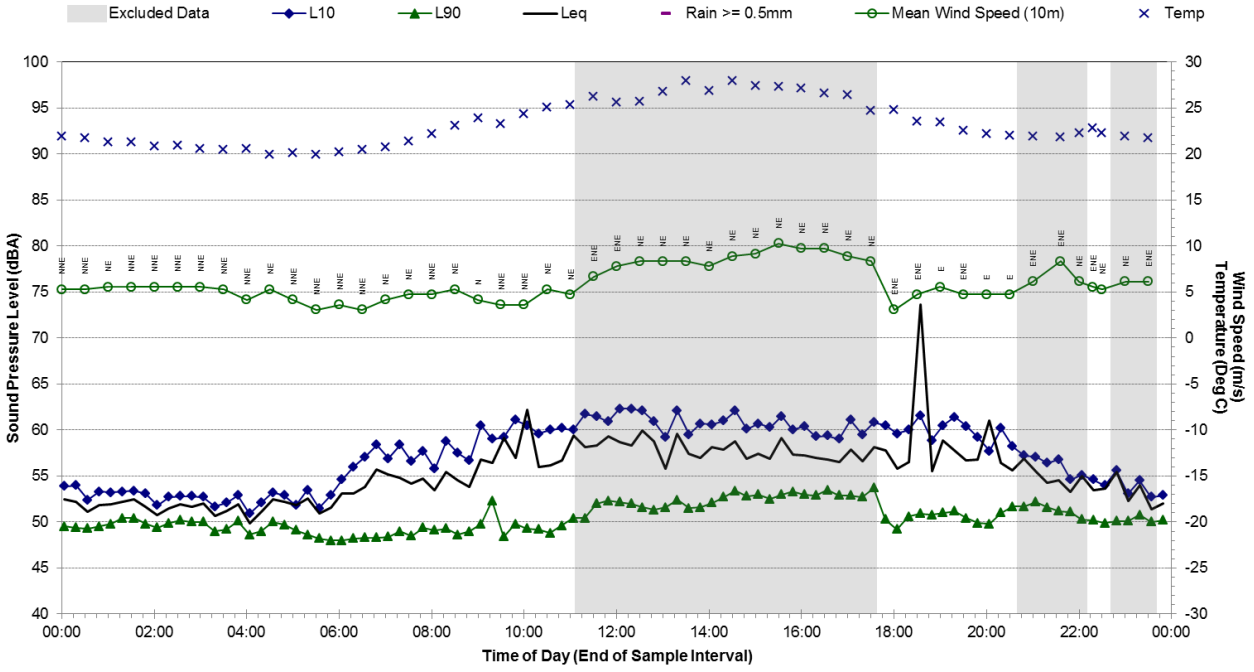
Statistical Ambient Noise Levels

36 Stephen Rd, Botany - Saturday, 8 December 2018



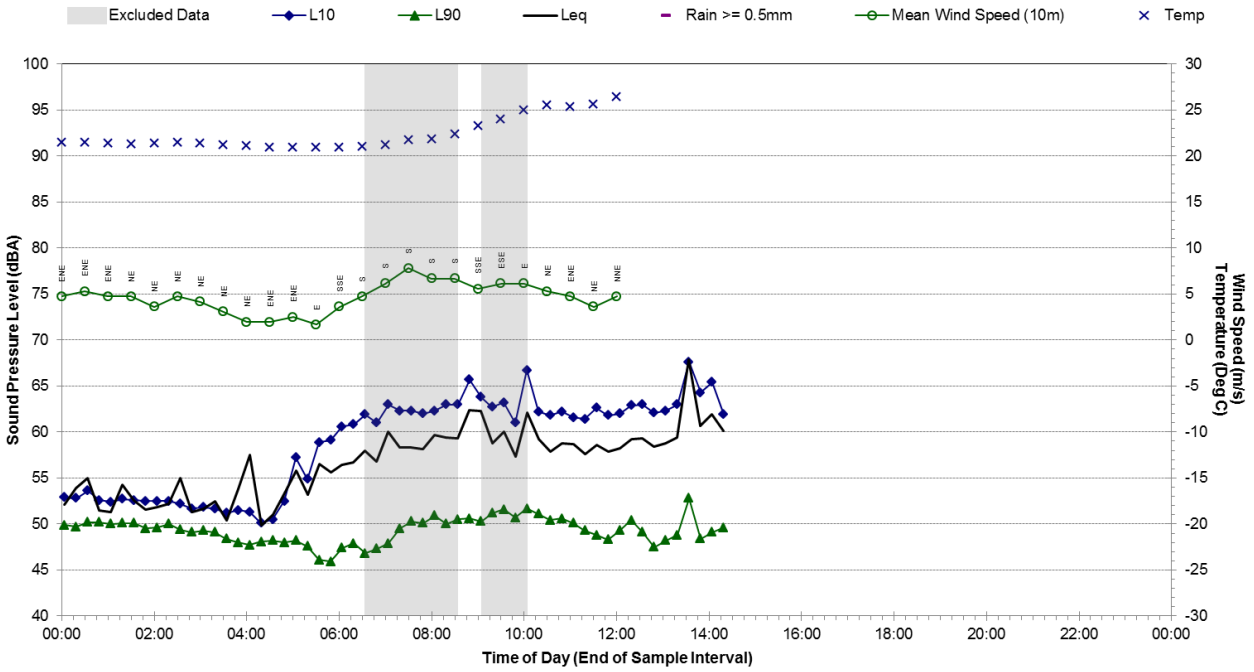
Statistical Ambient Noise Levels

36 Stephen Rd, Botany - Sunday, 9 December 2018



Statistical Ambient Noise Levels

36 Stephen Rd, Botany - Monday, 10 December 2018



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