LOT 1 - BRINGELLY ROAD BUSINESS HUB

SSDA Noise Impact Assessment

Prepared for:

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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 ESR Australia (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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1 Introduction

SLR Consulting Australia Pty Ltd (SLR) has been engaged by ESR Australia to undertake a noise impact assessment in support of a State Significant Development (SSD) application (SSD 37558583) for a warehouse at Lot 1 of the Bringelly Road Business Hub.

SLR is suitably qualified and endorsed by the Planning Secretary to produce SSD noise impact assessments. SLR is a member of the Australian Acoustical Society (AAS) and a member firm of the Association of Australasian Acoustical Consultants (AAAC).

This report summarises the assessment of the potential construction and 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 proposal forms part of the 19 hectare Bringelly Road Business Hub which was granted development consent in January 2016 and allows for predominantly light industrial and retail development. SLR has been advised that the four lots to the northeast of Lot 1 are approved and operational.

The proposed facility would generally involve the delivery and storage of products along with office and support facilities. The proposal comprises the development of the site as summarised below:

- Construction, fit out and operation of a two-storey warehouse and distribution centre including:
  - 12,892 m^2 of total site area
  - 4,470 m^2 of warehouse GFA; and
  - 1,000 m^2 of office space GFA
- Provision of 41 car parking spaces at ground
- Provision of internal vehicle access route and loading dock
- Operation 24 hours per day seven days per week.

The site location is shown in **Figure 1** and the layout of the warehouse is shown in **Figure 2.**

The identified sources of noise from the proposed development include:

- Mechanical plant
- Operation of the loading dock
- Truck movements on internal access roads and the loading dock
- Light vehicle movements on internal access roads and parking areas.

Figure 1 Site Location, Surrounding Receivers and Noise Monitoring Locations

Figure 2 Proposed Development

1.2 Secretary's Environmental Assessment Requirements – SSD 37558583

The Secretary's Environmental Assessment Requirements (SEARs) for SSD 37558583 were issued by the Department of Planning and Environment (DPE) in March 2022. The requirements relevant to noise and vibration are shown in **Table 1**.

Table 1 Secretary's Environmental Assessment Requirements, SSD 31552370, 3 March 2022

Noise and Vibration	Where Addressed
Provide a noise and vibration assessment prepared in accordance with the relevant EPA guidelines. The assessment must detail construction and operational noise and vibration impacts on nearby sensitive receivers and structures and outline the proposed management and mitigation measures that would be implemented.	**Construction:** **Section 4.1** **Section 5.1** **Section 5.2** **Operation:** **Section 4.2** **Section 5.3** **Mitigation:** **Section 6**

1.3 Nearest Receivers

The nearest receivers are other commercial and industrial developments within the Bringelly Road Business Hub, located around 85 m to the northeast of the site. The nearest residential receiver is located around 150 m to northwest of the site. The nearest receivers are shown in **Figure 1** and detailed in **Table 2**.

The nearest sensitive receivers are residences on Stuart Road and Twenty Sixth Avenue. Additional residential receivers are also located more distantly to the north and east in West Hoxton and Horningsea Park, however, these receivers are generally shielded by the existing buildings on the adjoining lots.

The nearest sensitive receivers are residential dwellings to the north on Stuart Road and to the east on Twenty Sixth Avenue. The closest of these is around 150 m away from the proposal. Additional residential receivers are also located more distantly to the north and east in West Hoxton and Horningsea Park, however, are generally shielded by the existing buildings on the adjoining lots.

Table 2 Surrounding Sensitive Receivers

ID	Address	Type	Distance (m)	Direction
R01	12 Bringelly Road, Horningsea Park (abandoned condition)	Residential	650 m	Northeast
R02	12 Bringelly Road, Horningsea Park	Residential	700 m	Northeast
R03	Residences on Cowpasture Road	Residential	800 m	Northeast
R04	Residences on Stuart Road to the north	Residential	650 m	Northeast
R05	1088 Stuart Road, Horningsea Park	Residential	150 m	Northwest
R06	10 Sixth Avenue, West Hoxton	Residential	350 m	Northwest
R07	111 Twenty Sixth Avenue, West Hoxton	Residential	300 m	West
R08	MindChamps Early Learning Centre	Child Care Centre	650 m	Northeast
R09	Commercial / office buildings within Bringelly Road Business Hub	Commercial	85 m	Northeast

2 Existing Noise Environment

Unattended noise monitoring was completed in the study area in August 2018. 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, such as strong wind or rain (measured at the BOM weather station at Badgerys Creek), 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 3**. Details of the unattended monitoring together with graphs of the measured daily noise levels are provided in **Appendix B**.

Table 3 Summary of Unattended Noise Monitoring Results

ID	Location	Measured Noise Levels (dBA)					
		RBL[1]			$L_{Aeq(period)}$[2]		
		Daytime	Evening	Night-time	Daytime	Evening	Night-time
L01	18 Stuart Road, West Hoxton	39	36	31	53	51	48
L02	12 Bringelly Road, Horningsea Park	46	45	37	55	53	52
L03	Intersection of Stuart Road and Twenty Sixth Avenue, Horningsea Park	44	43	39	51	54	49

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.

Short-term attended noise monitoring was also completed. The attended measurements allow the contributions of the various noise sources at each location to be determined. Detailed observations from the attended measurements are provided in **Appendix B**.

The attended measurements were generally found to be consistent with the results of the unattended noise monitoring and show that existing ambient noise levels are typically dominated by industrial noise from existing industrial developments and road traffic noise from the surrounding road network.

With urban growth in the surrounding area it is possible that background noise levels have increased since the 2018 monitoring was undertaken, hence the data presented can be considered potentially conservative.

3 Assessment Criteria

3.1 Construction Noise Criteria

3.1.1 Interim Construction Noise Guideline

The NSW *Interim Construction Noise Guideline* (ICNG) is used to assess and manage impacts from construction noise on residences and other sensitive land uses in NSW.

The ICNG contains procedures for determining project specific Noise Management Levels (NMLs) for sensitive receivers based on the existing background noise in the area. The 'worst-case' noise levels from construction of a proposal are predicted and then compared to the NMLs in a 15-minute assessment period to determine the likely impact of the proposal.

The NMLs are not mandatory limits, however, where construction noise levels are predicted or measured to be above the NMLs, feasible and reasonable work practices to minimise noise emissions are to be investigated.

3.1.1.1 Residential Receivers

The ICNG approach for determining NMLs at residential receivers is shown in **Table 4**.

Table 4 ICNG NMLs for Residential Receivers

Time of Day	NML $L_{Aeq(15minute)}$	How to Apply
Standard Construction 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	Noise affected RBL[1] + 10 dB	• The noise affected level represents the point above which there may be some community reaction to noise • Where the predicted or measured $L_{Aeq(15minute)}$ is greater than the noise affected level, the proponent should apply all feasible and reasonable work practices to meet the noise affected level • The proponent should also inform all potentially impacted residents of the nature of works to be carried out, the expected noise levels and duration, as well as contact details.

	Highly Noise Affected 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.

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

Note 1: The RBL is the Rating Background Level and the ICNG refers to the calculation procedures in the NSW *Industrial Noise Policy* (INP). The INP has been superseded by the NSW EPA *Noise Policy for Industry* (NPfI).

Sleep Disturbance

Where construction work is planned to extend over more than two consecutive nights, the ICNG recommends that an assessment of sleep disturbance impacts should be completed.

The most current method for assessing sleep disturbance from NSW transport infrastructure projects is contained in the EPA's *Noise Policy for Industry* (NPfI). Although the NPfI sleep disturbance criteria relate to industrial noise, they are considered relevant for reviewing potential impacts from construction noise.

The NPfI defined sleep disturbance criteria is 52 dBA L_{AFmax} or the prevailing background level plus 15 dB, whichever is the greater.

3.1.1.2 'Other Sensitive' Land Uses and Commercial Receivers

The ICNG NMLs for 'other sensitive' non-residential land uses are shown in **Table 5**.

Table 5 Construction NMLs at 'Other Sensitive' Land Uses

Land Use	Noise Management Level $L_{Aeq(15minute)}$ (dBA) (applied when the property is in use)	
	Internal	External
Classrooms at schools and other educational institutions	45	55[1]
Hospital wards and operating theatres	45	65[2]
Places of worship	45	55[1]
Active recreation areas (characterised by sporting activities and activities which generate noise)	-	65
Passive recreation areas (characterised by contemplative activities that generate little noise)	-	60
Commercial	-	70
Industrial	-	75

Note 1: It is assumed that these receivers have windows partially open for ventilation which results in internal noise levels being around 10 dB lower than the external noise level.

Note 2: It is assumed that these receivers have fixed windows which conservatively results in internal noise levels being around 20 dB lower than the external noise level.

The ICNG references *AS2107:2016 Acoustics – Recommended design sound levels and reverberation times for building interiors* for criteria for 'other sensitive' receivers which are not listed in the guideline. Neither the ICNG nor AS2107 provide criteria for child care centres so the Association of Australian Acoustical Consultants *Guideline for Child Care Centre Acoustic Assessment* (GCCCAA) has been referenced. The NMLs for child care centres are shown in **Table 6**.

Table 6 NMLs for 'Other Sensitive' Receivers

Use	Period	NML Derived From	Noise Management Level $L_{Aeq(15minute)}$ (dBA)	
			Internal	External
Child care centres	Daytime	GCCCAA: Outdoor play areas	-	55
		GCCCAA: Sleeping areas	40	50[1]

Note 1: It is assumed that these receivers have windows partially open for ventilation which results in internal noise levels being around 10 dB lower than the external noise level.

3.1.1.3 NML Summary

The construction NMLs for the proposal have been determined using the results from the unattended noise monitoring and are shown in **Table 7**.

Table 7 Project Specific Noise Management Levels

Receiver ID	Representative Background Monitoring Location	Noise Management Level ($L_{Aeq(15minute)}$ – dBA)				Sleep Disturbance Screening Criteria (RBL +15 dB)
		Standard Construction (RBL +10 dB)[1]	Out of Hours (RBL +5 dB)[1]			
		Daytime	Daytime[2]	Evening	Night-time	
R01	L.02	56	51	50	42	52
R02	L.02	56	51	50	42	52
R03	L.02	56	51	50	42	52
R04	L.01	49	44	41	36	52
R05	L.03	54	49	47	44	54
R06	L.03	54	49	47	44	54
R07	L.03	54	49	47	44	54
R08	-	70 (play areas)	70	n/a	n/a	n/a
		50 (sleeping areas)	50	n/a	n/a	n/a
R09	-	70	70	n/a	n/a	n/a

Note 1: RBL = Rating Background Level.

Note 2: Daytime out of hours is 7 am to 8 am and 1 pm to 6 pm on Saturday, and 8 am to 6 pm on Sunday and public holidays.

3.2 Vibration Guidelines

The effects of vibration from construction works can be divided into three categories:

- Those in which the occupants of buildings are disturbed (human comfort)
- Those where building contents may be affected (building contents)
- Those where the integrity of the building may be compromised (structural or cosmetic damage).

3.2.1 Human Comfort Vibration

People can sometimes perceive vibration impacts when vibration generating construction works are located close to occupied buildings.

Vibration from construction works tends to be intermittent in nature and the EPA's *Assessing Vibration: a technical guideline* (2006) provides criteria for intermittent vibration based on the Vibration Dose Value (VDV). The 'preferred' and 'maximum' VDVs for human comfort impacts are shown in **Table 8**.

Table 8 Vibration Dose Values for Intermittent Vibration

Building Type	Assessment Period	Vibration Dose Value[1] ($m/s^{1.75}$)	
		Preferred	Maximum
Critical Working Areas (eg operating theatres or laboratories)	Day or night-time	0.10	0.20
Residential	Daytime	0.20	0.40
	Night-time	0.13	0.26
Offices, schools, educational institutions and places of worship	Day or night-time	0.40	0.80
Workshops	Day or night-time	0.80	1.60

Note 1: The VDV accumulates vibration energy over the daytime and night-time assessment periods, and is dependent on the level of vibration as well as the duration.

3.2.2 Effects on Building Contents

People perceive vibration at levels well below those likely to cause damage to building contents. For most receivers, the human comfort vibration criteria are the most stringent and it is generally not necessary to set separate criteria for vibration effects on typical building contents.

Exceptions to this can occur when vibration sensitive equipment, such as electron microscopes, are located in buildings near to construction works. No such items of equipment have been identified in the proposal area.

3.2.3 Structural and Cosmetic Damage Vibration

If vibration from construction works is sufficiently high it can cause damage to structural elements of affected buildings. The levels of vibration required to cause cosmetic damage tend to be at least an order of magnitude (10 times) higher than those at which people can perceive vibration.

Examples of damage that can occur includes cracks or loosening of drywall surfaces, cracks in supporting columns and loosening of joints. Structural damage vibration limits are contained in British Standard BS 7385 and German Standard DIN 4150.

BS 7385

British Standard BS 7385 recommends vibration limits for transient vibration judged to give a minimal risk of vibration induced damage to affected buildings. The limits for residential and industrial buildings are shown in **Table 9**.

Table 9 BS 7385 Transient Vibration Values for Minimal Risk of Damage

Group	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

Note 1: Where the dynamic loading caused by continuous vibration may give rise to dynamic magnification due to resonance, especially at the lower frequencies where lower guide values apply, then the guide values may need to be reduced by up to 50%.

For heritage buildings, the standard states that *"a building of historical value should not (unless it is structurally unsound) be assumed to be more sensitive"*.

DIN 4150

German Standard DIN 4150 also provides guideline vibration limits for different buildings. Damage is not expected to occur where the values are complied with and the values are generally recognised to be conservative. The DIN 4150 values for buildings and structures are shown in **Table 10**.

Table 10 DIN 4150 Guideline Values for Short-term Vibration on Structures

Group	Type of Structure	Guideline Values Vibration Velocity (mm/s)				
		Foundation, All Directions at a Frequency of			Topmost Floor, Horizontal	Floor Slabs, Vertical
		1 to 10 Hz	10 to 50 Hz	50 to 100 Hz	All frequencies	All frequencies
1	Buildings used for commercial purposes, industrial buildings and buildings of similar design	20	20 to 40	40 to 50	40	20
2	Residential buildings and buildings of similar design and/or occupancy	5	5 to 15	15 to 20	15	20
3	Structures that, because of their particular sensitivity to vibration, cannot be classified as Group 1 or 2 **and** are of great intrinsic value (eg heritage listed buildings)	3	3 to 8	8 to 10	8	20[1]

Note 1: It may be necessary to lower the relevant guideline value markedly to prevent minor damage.

3.2.4 Minimum Working Distances for Vibration Intensive Works

Minimum working distances for typical vibration intensive construction equipment are provided in the Roads and Maritime (now Transport for NSW) *Construction Noise and Vibration Guideline* (CNVG) and are shown in **Table 11**. The minimum working distances are for both cosmetic damage (from BS 7385 and DIN 4150) and human comfort (from the NSW EPA Vibration Guideline). They are based on empirical data which suggests that where works are further from receivers than the quoted minimum distances then impacts are not considered likely.

Table 11 Recommended Minimum Working Distances from Vibration Intensive Equipment

Plant Item	Rating/Description	Minimum Distance		
		Cosmetic Damage		Human Response (NSW EPA Guideline)
		Residential and Light Commercial (BS 7385)	Heritage Items (DIN 4150, Group 3)	
Vibratory Roller	<50 kN (1–2 tonne)	5 m	11 m	15 m to 20 m
	<100 kN (2–4 tonne)	6 m	13 m	20 m
	<200 kN (4–6 tonne)	12 m	25 m	40 m
	<300 kN (7–13 tonne)	15 m	31 m	100 m
	>300 kN (13–18 tonne)	20 m	40 m	100 m
	>300 kN (>18 tonne)	25 m	50 m	100 m
Small Hydraulic Hammer	300 kg (5 to 12 t excavator)	2 m	5 m	7 m
Medium Hydraulic Hammer	900 kg (12 to 18 t excavator)	7 m	15 m	23 m
Large Hydraulic Hammer	1,600 kg (18 to 34 t excavator)	22 m	44 m	73 m
Vibratory Pile Driver	Sheet piles	2 m to 20 m	5 m to 40 m	20 m
Piling Rig – Bored	≤ 800 mm	2 m (nominal)	5 m	4 m
Jackhammer	Hand held	1 m (nominal)	3 m	2 m

The minimum working distances are indicative and will vary depending on the particular item of equipment and local geotechnical conditions. The distances apply to cosmetic damage of typical buildings under typical geotechnical conditions.

3.3 Operational Noise Criteria

3.3.1 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.

3.3.1.1 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.

Intrusive and amenity noise levels are not used directly as regulatory limits. They are used to assess the potential impact of noise, assess feasible and reasonable mitigation options and subsequently determine achievable noise requirements.

The NPfI provides guidance on assigning residential receiver amenity noise categories based on the site-specific features shown in **Table 12**.

Table 12 Residential Receiver Amenity

Receiver Category	Typical Planning Land Use Zoning	Typical Existing Background Noise Levels (RBL)	Description
Rural	RU1 – primary production RU2 – rural landscape RU4 – primary production small lots R5 – large lot residential E4 – environmental living	Daytime <40 dBA Evening <35 dBA Night <30 dBA	Rural – an area with an acoustical environment that is dominated by natural sounds, having little or no road traffic noise and generally characterised by low background noise levels. Settlement patterns would be typically sparse. Note: Where background noise levels are higher than those presented due to existing industry or intensive agricultural activities, the selection of a higher noise amenity area should be considered.
Suburban residential	RU5 – village RU6 – transition R2 – low density residential R3 – medium density residential E2 – environmental conservation E3 – environmental management	Daytime <45 dBA Evening <40 dBA Night <35dBA	Suburban – an area that has local traffic with characteristically intermittent traffic flows or with some limited commerce or industry. This area often has the following characteristic: evening ambient noise levels defined by the natural environment and human activity.

Receiver Category	Typical Planning Land Use Zoning	Typical Existing Background Noise Levels (RBL)	Description
Urban residential	R1 – general residential R4 – high density residential B1 – neighbourhood centre (boarding houses and shop-top housing) B2 – local centre (boarding houses) B4 – mixed use	Daytime >45 dBA Evening >40 dBA Night >35 dBA	Urban – an area with an acoustical environment that: • Is dominated by 'urban hum' or industrial source noise, where urban hum means the aggregate sound of many unidentifiable, mostly traffic and/or industrial related sound sources • Has through-traffic with characteristically heavy and continuous traffic flows during peak periods • Is near commercial districts or industrial districts • Has any combination of the above.

Amenity noise categories for the surrounding receivers have been determined with reference to the NPFI. The assessment is shown in **Table 13**.

Table 13 Residential Receiver Amenity Category Assessment

Area	Land Use Zoning	Existing Background Noise Levels RBL (dBA)			Resulting Amenity Classification	Discussion
		Day	Eve	Night		
Residential to the north (R04)	R2 – low density residential	39	36	31	Suburban	The area is zoned as R2 – low density residential, therefore, the residences have been classified as suburban.
Residential to the east (R01 – R02)	-	46	45	37	Suburban	The nearby area is zoned as R2 – low density residential, therefore, the residences have been classified as suburban.
Residential to the east (R03)	R2 – low density residential	46	45	37	Suburban	The area is zoned as R2 – low density residential, therefore, the residences have been classified as suburban.
Residential to the west (R05 – R07)	-	44	43	39	Suburban	The nearby area is zoned as R2 – low density residential, therefore, the residences have been classified as suburban.

3.3.1.2 Project Noise Trigger Levels

The trigger levels for industrial noise from the proposal are summarised in **Table 14**. They are based on the previously measured background noise levels, where appropriate. 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 14 Project Noise Trigger Levels

Receivers	Period	Recommended 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]
Residential to the north (R04)	Daytime	55	39	53	**44**	53
	Evening	45	36	51	**41**	43
	Night-time	40	31	48	**36**	38
Residential to the east (R01 – R03)	Daytime	55	46	55	**51**	53
	Evening	45	45	53	50	**43**
	Night-time	40	37	52	42	**40**[4]
Residential to the west (R05 – R07)	Daytime	55	44	51	**49**	53
	Evening	45	43	54	48	**43**
	Night-time	40	39	49	44	**38**
Child care centres (R08)	When in use	50[5]	n/a	n/a	n/a	**48**
Commercial receivers (R08)	When in use	65	n/a	n/a	n/a	**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 being present in the area, as outlined in the NPfI.

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: The measured L_{Aeq} noise level was dominated by road 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.

Note 5: The NPfI and AS2107 do not provide specific guideline noise levels for childcare centres, as such an internal criterion of 40 dBA has been used with a 10 dB external to internal, which is generally considered representative of windows being partially open for ventilation

3.3.1.3 Sleep Disturbance

The potential for sleep disturbance from maximum noise level events during the night-time period from the development is required to be considered.

The NPfI defines the sleep disturbance screening level as 52 dBA L_{AFmax} or the prevailing background level plus 15 dB, whichever is greater.

The sleep disturbance screening levels for the development are shown in **Table 15**.

Table 15 Sleep Disturbance Screening Levels

Location	Noise Level (dBA)	
	Measured Prevailing Night-time Background Level	Sleep Disturbance Screening Level[1]
Residential to the north (R04)	31	52
Residential to the east (R01 – R03)	37	52
Residential to the west (R05 – R07)	39	54

Note 1: The sleep disturbance screening level as 52 dBA L_{AFmax} or the prevailing background level plus 15 dB, whichever is greater

A detailed maximum noise level event assessment should be completed where the sleep disturbance screening level is exceeded. The detailed assessment should cover the maximum noise level, the extent to which the maximum noise level exceeds the RBL, and the number of times this happens during the night-time period.

The NPfI refers to the *Road Noise Policy* (RNP) for additional information regarding sleep disturbance. Health Council studies are referenced which indicate that for short-term or transient noise events, for good sleep over eight hours the indoor L_{AFmax} sound pressure level should ideally not exceed around 45 dBA more than 10 or 15 times per night.

The RNP goes on to conclude that from the research on sleep disturbance to date:

- Maximum internal noise levels below 50 dBA to 55 dBA are unlikely to awaken people from sleep
- One or two events per night with maximum internal noise levels of 65-70 dBA are not likely to affect health and wellbeing significantly.

3.3.2 Corrections for Annoying Noise Characteristics

Sources of industrial noise can cause greater annoyance where they contain certain characteristics, such as tonality, intermittency or dominant low-frequency content. The NPfI specifies the following modifying factor corrections, shown in **Table 16**, which are to be applied where annoying characteristics are present. The corrections are to be added to the noise level at the receiver before comparison with the Project Noise Trigger Levels.

Table 16 NPfI Modifying Factor Corrections

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 the 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 the thresholds defined in the NPfI are exceeded.	2 or 5 dB[2]

Factor	Assessment/Measurement	When to Apply	Correction[1]
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. The NPfI further defines intermittent noise as noise where the level suddenly drops/increases several times during the assessment period, with a noticeable change in source noise level of at least 5 dB, for example, equipment cycling on and off. The intermittency correction is not intended to be applied to changes in noise level due to meteorology.	5 dB[3]
Maximum adjustment	Refer to individual modifying factors	Where two or more modifying factors are indicated.	Maximum correction of 10 dB[2] (excluding duration correction)

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.

Note 3: Adjustment to be applied to night-time only.

Details of the modifying factor corrections applied in the assessment are provided in **Section 4.2**.

3.3.3 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).

An initial screening test is first applied to evaluate if existing road traffic noise levels are expected to increase by more than 2.0 dB. Where this is considered likely, further assessment is required using the RNP criteria shown in **Table 17**.

Table 17 RNP/NCG 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)
Local roads	Existing residences affected by additional traffic on existing local roads generated by land use developments	$L_{Aeq(1hour)}$ 55 (external)	$L_{Aeq(1hour)}$ 50 (external)

4 Methodology

4.1 Construction Noise and Vibration Assessment

A noise model of the study area has been used to predict noise levels from the proposed construction work to all surrounding receivers. The model uses ISO 9613 algorithms in SoundPLAN software.

Local terrain, receiver buildings and structures were digitised in the noise model to develop a three-dimensional representation of the construction sites and surrounding areas.

4.1.1 Construction Activities

Representative scenarios have been developed to assess the likely impacts from the various construction phases of the proposal. These scenarios are shown in **Table 18**.

The assessment uses 'realistic worst-case' scenarios to determine the impacts from the noisiest 15-minute period that are likely to occur for each work scenario, as required by the ICNG. The impacts represent construction noise levels without mitigation applied.

The sound power levels for the construction equipment used in each scenario is presented in **Appendix C.**

Table 18 Construction Equipment

Scenario	Equipment
Civil Work	Excavator (30t) with hammer, excavator (30t), articulated dump truck (30t), grader, roller (20t), watercart
Structural Steel	Mobile crane (30t), elevated working platform, hand tools, hiab truck, watercart
Cladding	Mobile crane (30t), franna crane, elevated working platform, hand tools, watercart
Fitout (Internal)	Concrete mixer truck and pump, concrete saw, elevated working platform, scissor lift, hand tools, freanna crane, forklift
Stormwater and Pavements	Excavator (30t) with hammer, excavator (15t), grader, roller (20t), roller (7t), tipper truck, truck and dog, water cart

4.1.2 Hours of Construction

Construction activities for the proposal would only be undertaken during the following hours:

- 7:00 am to 6:00 pm, Mondays to Fridays
- 8:00 am to 1:00 pm on Saturdays
- At no time on Sundays or Public Holidays.

4.2 Operational Noise Assessment

The project is in the early design stages and the future tenants are currently unknown. Several assumptions have been made regarding the future tenants and sources of noise, based on the likely warehouse and distribution uses. These assumptions have been used to develop representative worst-case noise modelling scenarios that reflect the highest noise emissions that the development would likely emit.

The potential operational noise levels from the proposal have been predicted to the surrounding receivers using the CONCAWE industrial noise algorithm in SoundPLAN. The model includes ground topography, ground type (ground absorption modelled as 0 for the development site, 0.5 for residential areas and 0.75 for open grass areas), buildings and representative worst-case noise sources from the proposal.

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

4.2.1 Operational Noise Sources

Lot 1 is a speculative development with no tenants committed. The facility has been designed to accommodate typical warehouse and distribution centre occupiers.

The main sources of operational noise at the development are expected to include:

- On-site light and heavy vehicle movements
- Loading dock activities
- Mechanical plant
- Off-site vehicle movements.

A summary of the expected noise sources and worst-case assessment scenarios associated with the operation of the development is provided below.

On-Site Traffic

On-site vehicles have been modelled using the data in **Table 19**. The volumes are representative of the worst-case 15-minute period for the daytime, evening and night-time. The volumes conservatively assume that light and heavy vehicles concurrently access the various warehouse tenancies during the worst-case 15-minute assessment period. In reality, vehicle access to each warehouse would be unlikely to occur concurrently, particularly during the night-time.

Heavy vehicle deliveries to the proposal may be via a range of freight vehicles up to large trucks (ie semi-trailers or b-doubles).

Table 19 Vehicle Traffic Data – Worst-case 15-Minute Period

Vehicle Type	Location	Sound Power Level (dBA)	Vehicle Speed (km/h)	Number of Vehicles in Worst-case 15-minute Period		
				Daytime (7am to 6pm)	Evening (6pm to 10pm)	Night-time (10pm to 7am)
Large trucks	Access	108[1,2]	15	6	1	1
Large trucks	Loading dock	108[1,2]	5	6	1	1
Light vehicles	Car park	96[3]	20	20	5	2

Note 1: Sound power level for large trucks based on 106 dBA for trucks at slow speed for 80% of the time and 111 dBA for trucks accelerating for 20% of the time. Sound power level for medium trucks based on 100 dBA for trucks at slow speed for 80% of the time and 106 dBA for trucks accelerating for 20% of the time.

Note 2: Sound power levels taken from the Federal Highway Administration's Traffic Noise Model.

Note 3: Sound power level taken from *Road Traffic Noise Prediction Model "ASJ RTN-Model 2013" Proposed by the Acoustical Society of Japan – Part 2: Study on Sound Emission of Road Vehicles*, OKADA et al, Internoise 2014, and accounts for vehicles accelerating.

Loading Dock

Details of the loading dock noise sources are shown in **Table 20**. The various sources have been modelled in the loading dock area based on the corresponding number of heavy vehicle movements in the worst-case 15-minute periods (see **Table 19**).

Table 20 Typical Breezeway and Loading Dock Noise Sources

Noise Source	Sound Power Level (dBA)	Typical Duration of Use in Worst-case 15-minute Period	Source Height (m)[1]
Truck reversing alarm	107[3]	30 seconds	1.0
Forklift reversing alarm[2]	102[3]	90 seconds	0.5
Truck air brakes	118	1 second	1.0
Roller door	94	15 seconds	6.0
Gas forklift	93	900 seconds	1.0

Note 1: Relative to local elevation at ground floor.

Note 2: SWL based on recommendation to use broadband reversing alarms, see **Section 6.2.**

Note 3: SWL includes a -3 dB reduction due to alarms being discrete events.

Internal Activities

The internal noise-generating activities are expected to generally be minimal. An internal reverberant noise level of 75 dBA has been included for the warehouse to represent breakout from general internal activities through roller shutter doors. Warehouse roller shutter doors are assumed to be open during loading dock activities.

Mechanical Plant

Mechanical plant associated with the proposal includes air-conditioning equipment serving the office buildings and roof mounted extraction fans for the warehouse. Mechanical plant associated with the proposal is shown in **Table 21**.

The office air-conditioning is assumed to be operational during the daytime period, with the extraction fans operational for the entire 24 hour period.

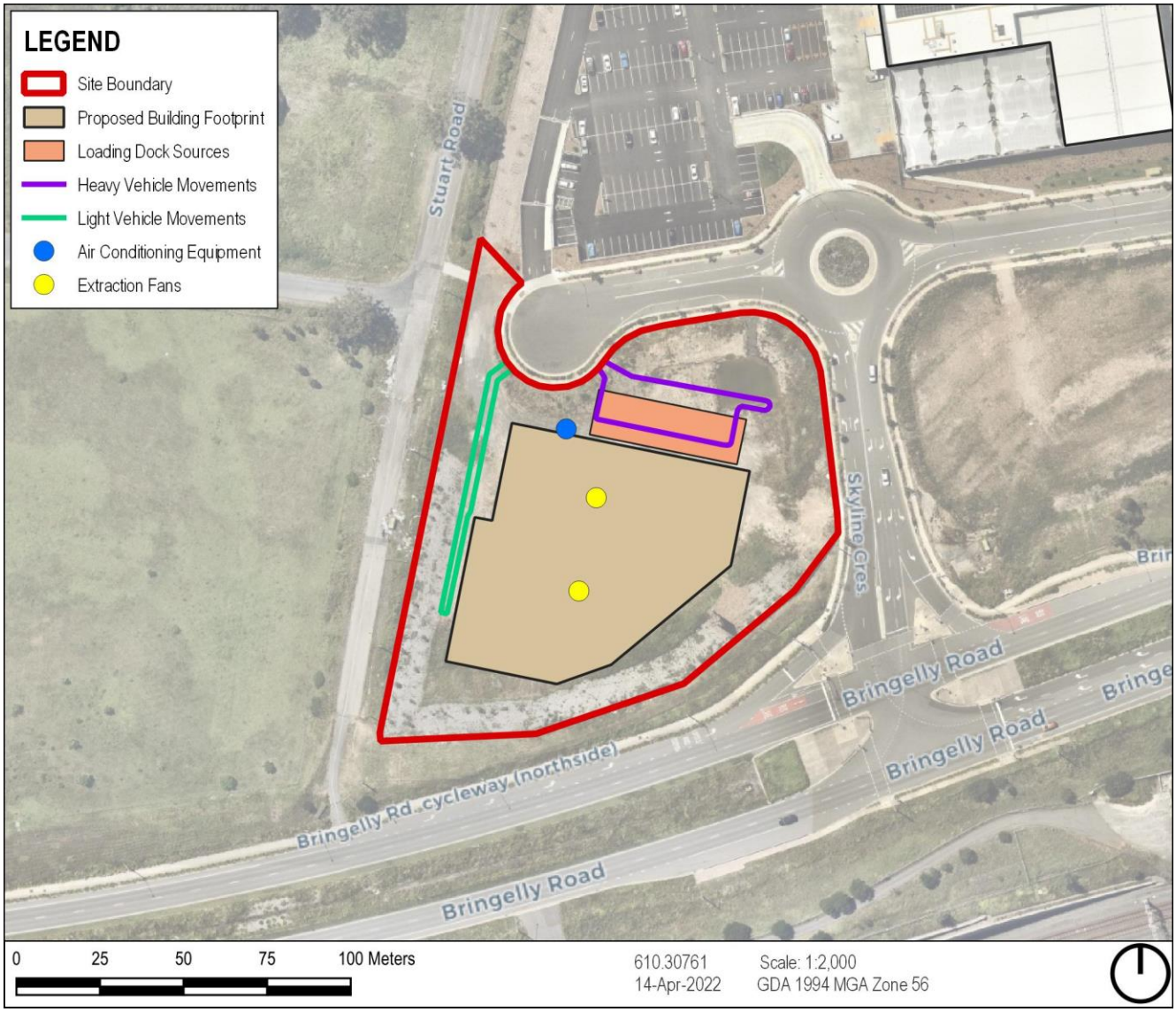
Table 21 Mechanical Plant

Noise Source	Sound Power Level (dBA)[1]	Location	Operational Time
Air-conditioning equipment	72 dBA	Ground level on north facade	8 am to 6 pm
Extraction fans	90 dBA	Two on warehouse roof	24 hours

Note 1: Specific details of the mechanical plant are not available at this stage. SWL data based on manufacturer data for equipment typical to a warehouse of this size.

The locations of the operational noise sources are shown in **Figure 3**.

Figure 3 Modelled Noise Source Locations



4.2.2 Corrections for Annoying Noise Characteristics

The potential annoying noise characteristics and modifying factor corrections relevant to the proposal are:

- **Tonality** – the only source identified with potential tonal characteristics is reversing alarms. However, broadband reversing alarms have been recommended as a noise mitigation measure (see **Section 6.2**), and it is unlikely that this noise source would result in tonal noise impacts. Therefore, no corrections for tonality noise have been applied.
- **Low frequency noise** – previous measurements of sources similar to those operating at the development indicate that no sources are expected to result in low frequency noise impacts.
- **Intermittent noise** – the NPfI defines intermittent noise as noise heard at the receiver where the level suddenly drops or increases several times during the assessment period, with a noticeable change of at least 5 dB. The audibility of noise would depend on several factors occurring at the time of potentially intermittent noise events, including the other noise sources operating at the development site and the existing background noise level at the receiver.

  The only source identified with potential intermittent characteristics is reversing alarms. However, when considering broadband reversing alarms have been recommended as a noise mitigation measure (see **Section 6.2**), and that the nearest residential receivers are around 150 m away, it is unlikely that this noise source would result in noise impacts at the receiver that change by at least 5 dB. Therefore, no corrections for intermittent noise have been applied.

4.2.3 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 22**.

Table 22 Sleep Disturbance Noise Events – L_{Amax} Sound Power Levels

Noise Source	Sound Power Level L_{Amax} (dBA)	Source Height (m)[1]
Large truck airbrake	118	1.0
Forklift reversing alarm	105	0.5
Roller door	94	6.0

Note 1: Relative to local elevation at ground floor.

4.2.4 Off-site Road Traffic

Traffic associated with the development is expected to enter and exit the directly on to Bringelly Road, with the traffic volumes shown in **Table 23**.

Table 23 Off-site Traffic Noise Assessment

Location	Vehicle Type	Number of Vehicle Movements		Predicted Increase in Road Traffic Noise
		Daytime (10pm – 7am)	Night-time (10pm – 7am)	
Bringelly Road	Light	254	5	No
	Heavy	62	5	

The potential noise impacts from development related traffic on public roads are predicted to be negligible given the high existing traffic volumes.

4.2.5 Weather Conditions

Certain weather conditions can increase noise levels by focusing noise towards receivers. Noise-enhancing weather conditions can occur where wind blows from the source to the receiver, or where temperature inversions occur.

The NPfI defines 'standard' and 'noise-enhancing' weather conditions as shown in **Table 24**. Noise-enhancing weather should be included in the assessment where it occurs for more than 30% of the daytime, evening or night-time period in any season.

Table 24 Standard and Noise-enhancing Weather Conditions

Weather Conditions	Meteorological Parameters
Standard	Daytime/evening/night-time: stability categories A–D with wind speed up to 0.5 m/s
Noise-enhancing	Daytime/evening: stability categories A–D with light winds up to 3 m/s Night-time: stability categories A–D with light winds up to 3 m/s and/or stability category F with winds up to 2 m/s

The NPfI contains guidance for determining noise enhancing weather conditions. Data measured between January 2017 and December 2021 at Badgerys Creek BOM weather station has been used to identify the occurrence of noise-enhancing weather conditions at the site, as summarised in **Table 25**.

Table 25 Occurrence of Noise-enhancing Weather Conditions

Period	Wind Speed from 0.5 to 3 m/s (Frequency of Occurrence > 30%)								Atmospheric Stability Class F or G[1]
	N	NE	E	SE	S	SW	W	NW	
Daytime	-	-	-	-	-	-	-	-	n/a
Evening	-	-	Yes	Yes	-	-	-	-	n/a
Night-time	-	-	-	-	Yes	Yes	-	-	Yes

Note 1: Noise-enhancing conditions for temperature inversions based on atmospheric stability class are only applied to the night-time assessment.

The weather analysis shows that noise-enhancing weather conditions are expected to be a feature of the site during the evening and night-time. Easterly and south easterly winds up to 3 m/s have been recorded for more than 30% of the evening periods in Spring and Autumn, respectively. South westerly and westerly winds up to 3 m/s have been recorded for more than 30% of the night-time periods in Winter. F or G class stability categories have been recorded for more than 30% of the night-time periods in Winter.

The weather conditions used in the assessment are shown in **Table 26**.

Table 26 Modelled Weather Conditions

Period	Weather Condition	Meteorological Parameters used in Assessment
Daytime	Standard	Stability category D with source to receiver wind up to 0.5 m/s
Evening	Noise-enhancing	Stability category D with source to receiver wind up to 3 m/s
Night-time	Noise-enhancing	Stability category D with source to receiver wind up to 3 m/s, and stability category F with source to receiver wind up to 2 m/s

5 Assessment of Impacts

5.1 Construction Noise Predictions

The predicted noise levels at the most-affected sensitive receivers surrounding the site are shown in **Table 27** and the exceedances of the NMLs are shown in **Table 28**.

The predictions represent a realistic worst-case scenario where the equipment in each scenario is working concurrently and the nearest location to each receiver. It is expected that noise levels would frequently be lower than the worst-case levels presented.

Table 27 Predicted Construction Noise Levels at Nearest Receivers

ID	Address	Type	NML	Predicted Noise Level – $L_{Aeq(15minute)}$ (dBA)				
				Civil Work	Structural Steel	Cladding	Fitout (Internal)	Stormwater and Pavements
R01	12 Bringelly Road, Horningsea Park (abandoned condition)[2]	Residential	56	44	36	40	40	39
R02	12 Bringelly Road, Horningsea Park	Residential	56	52	44	48	48	47
R03	Residences on Cowpasture Road	Residential	56	52	44	48	48	47
R04	Residences on Stuart Road to the north	Residential	49	52	44	48	48	47
R05	1088 Stuart Road, Horningsea Park	Residential	54	66	58	62	62	61
R06	10 Sixth Avenue, West Hoxton	Residential	54	59	51	55	55	54
R07	111 Twenty Sixth Avenue, West Hoxton	Residential	54	60	52	56	56	55

ID	Address	Type	NML	Predicted Noise Level – $L_{Aeq(15minute)}$ (dBA)				
				Civil Work	Structural Steel	Cladding	Fitout (Internal)	Stormwater and Pavements
R08	MindChamps Early Learning Centre	Child Care	50	55	47	51	51	50
R09	Commercial / office buildings within Bringelly Road Business Hub	Commercial	70	69	61	65	65	64

Note 1: Worst-case predicted noise levels are representative of the 'noisiest' construction periods during concurrent operation of equipment in the closest location to the various receivers.

Note 2: Receiver not considered noise sensitive.

Table 28 Predicted Exceedance at Nearest Receivers

ID	Address	Type	NML	Exceedance (dB)				
				Civil Work	Structural Steel	Cladding	Fitout (Internal)	Stormwater and Pavements
R01	12 Bringelly Road, Horningsea Park (abandoned condition)[2]	Residential	56	-	-	-	-	-
R02	12 Bringelly Road, Horningsea Park	Residential	56	-	-	-	-	-
R03	Residences on Cowpasture Road	Residential	56	-	-	-	-	-
R04	Residences on Stuart Road to the north	Residential	49	3	-	-	-	-
R05	1088 Stuart Road, Horningsea Park	Residential	54	12	4	8	8	7
R06	10 Sixth Avenue, West Hoxton	Residential	54	5	-	1	1	-
R07	111 Twenty Sixth Avenue, West Hoxton	Residential	54	6	-	2	2	1
R08	MindChamps Early Learning Centre	Child Care	50	5	-	1	1	-
R09	Commercial / office buildings within Bringelly Road Business Hub	Commercial	70	-	-	-	-	-

Note 1: Worst-case predicted noise levels are representative of the 'noisiest' construction periods during concurrent operation of equipment in the closest location to the various receivers.

Note 2: Receiver not considered noise sensitive.

The above shows that noise levels from all construction activities are predicted to exceed the NMLs at the nearest sensitive receivers. No residential receivers are predicted to be Highly Affected during any of the works.

Worst-case exceedances of up to 12 dB are predicted at the nearest residential receiver (R05). Marginal exceedances of 1-5 dB are also predicted at MindChamps Early Learning Centre to the north of the proposal. However, the worst-case exceedances would only be expected to occur when noisy work is being completed close to the site boundaries. When work is in other areas of the site, or when less noise intensive equipment is being used, the noise levels are expected comply with the NMLs.

The noise levels are predicted to comply with the NMLs at the more distant residential receivers to the east during all construction activities.

5.2 Construction Vibration

The major potential sources of vibration from the proposed construction activities would likely be during Civil Work when excavators with rock hammers are being used.

Vibration offset distances have been determined from the CNVG minimum working distances for cosmetic damage and human response (see **Table 11**) and the assessment is summarised in **Figure 4** for a large hydraulic hammer. Buildings within the minimum working distances are shown in the figures.

Figure 4 Construction Vibration – Large Hydraulic Hammer

Figure 4 shows that the distance between the construction work and the nearest sensitive receivers is sufficient for all receiver buildings to be outside of the cosmetic damage and human comfort minimum working distances for vibration intensive equipment.

5.3 Operational Noise Assessment

5.3.1 Predicted Noise Levels

A summary of the worst-case operational noise assessment at the receivers surrounding the proposal is shown in **Table 29**. Impacts have been predicted at all floors of the nearest receivers. The predicted worst-case levels are compared to the Project Noise Trigger Levels to determine the potential impact from the proposal.

Noise contours of the predicted worst-case operational noise impacts are in **Appendix D.**

Table 29 Operational Noise Assessment

ID	Receiver Location	Period	Noise Level $L_{Aeq(15minute)}$ (dBA)					Compliance
			Noise Criteria	Standard Weather		Noise Enhancing Weather		
				Predicted	Exceedance	Predicted	Exceedance	
R01	12 Bringelly Road, Horningsea Park (abandoned condition)	Day	51	<30	-	<30	-	Yes
		Evening	43	<30	-	<30	-	Yes
		Night	40	<30	-	<30	-	Yes
R02	12 Bringelly Road, Horningsea Park	Day	51	42	-	42	-	Yes
		Evening	43	36	-	40	-	Yes
		Night	40	35	-	39	-	Yes
R03	Residences on Cowpasture Road	Day	51	42	-	42	-	Yes
		Evening	43	35	-	39	-	Yes
		Night	40	35	-	39	-	Yes
R04	Residences on Stuart Road to the north	Day	44	43	-	43	-	Yes
		Evening	41	36	-	40	-	Yes
		Night	36	35	-	39	3	**No**
R05	1088 Stuart Road, Horningsea Park	Day	49	49	-	49	-	Yes
		Evening	43	43	-	45	2	**No**
		Night	38	42	4	44	6	**No**
R06	10 Sixth Avenue, West Hoxton	Day	49	36	-	39	-	Yes
		Evening	43	36	-	39	-	Yes
		Night	38	36	-	39	1	**No**
R07	111 Twenty Sixth Avenue, West Hoxton	Day	49	35	-	37	-	Yes
		Evening	43	35	-	37	-	Yes
		Night	38	35	-	37	-	Yes

ID	Receiver Location	Period	Noise Level $L_{Aeq(15minute)}$ (dBA)					Compliance
			Noise Criteria	Standard Weather		Noise Enhancing Weather		
				Predicted	Exceedance	Predicted	Exceedance	
R08	MindChamps Early Learning Centre	When in use	48	43	-	43	-	Yes
R09	Commercial / office buildings within Bringelly Road Business Hub	When in use	63	56	-	56	-	Yes

The above assessment indicates that noise from the proposal is predicted to comply with the Project Noise Trigger Levels at most of the surrounding receivers.

Exceedances are predicted at the closest residential receivers R04, R05 and R06, primarily due to the on-site truck movements and loading dock activities that would occur at the north of the proposal. R04 and R06 are predicted to exceed during the night-time period, with a marginal exceedance of up to 3 dB and 1 dB, respectively, only during noise enhancing weather conditions.

R05 is predicted to have marginal exceedances of up to 2 dB during the evening period, only during noise enhancing weather conditions. During the night-time R05 is predicted to have an exceedance of up to 4 dB with standard weather conditions and up to 6 dB with noise enhancing weather conditions (ie class F inversion).

5.3.2 Sleep Disturbance

The predicted night-time maximum noise levels at the nearest residential receivers are shown in **Table 30**.

Table 30 Sleep Disturbance Assessment

ID	Receiver Location	Source	Maximum Noise Level L_{Amax} (dBA)			Compliance
			Sleep Dist. Screening Level	Predicted	Exceedance	
R01	12 Bringelly Road, Horningsea Park (abandoned condition)	Forklift reversing alarm	52	25	-	Yes
		Large truck airbrake		38	-	Yes
		Roller door		14	-	Yes
R02	12 Bringelly Road, Horningsea Park	Forklift reversing alarm	52	42	-	Yes
		Large truck airbrake		55	3	**No**
		Roller door		31	-	Yes
R03	Residences on Cowpasture Road	Forklift reversing alarm	52	41	-	Yes
		Large truck airbrake		54	2	**No**
		Roller door		30	-	Yes

ID	Receiver Location	Source	Maximum Noise Level L_{Amax} (dBA)			Compliance
			Sleep Dist. Screening Level	Predicted	Exceedance	
R04	Residences on Stuart Road to the north	Forklift reversing alarm	52	41	-	Yes
		Large truck airbrake		54	2	**No**
		Roller door		30	-	Yes
R05	1088 Stuart Road, Horningsea Park	Forklift reversing alarm	54	49	-	Yes
		Large truck airbrake		62	8	**No**
		Roller door		40	-	Yes
R06	10 Sixth Avenue, West Hoxton	Forklift reversing alarm	54	42	-	Yes
		Large truck airbrake		55	1	**No**
		Roller door		32	-	Yes
R07	111 Twenty Sixth Avenue, West Hoxton	Forklift reversing alarm	54	42	-	Yes
		Large truck airbrake		55	1	**No**
		Roller door		19	-	Yes

The above shows that maximum noise levels are generally expected to comply with the sleep disturbance screening level at the nearest residential receivers except when truck airbrakes are used. A worst-case exceedance of up to 8 dB is predicted at the nearest receiver (R05). Relatively minor exceedances, up to 3 dB, are predicted at more distant receivers

The NPfI requires a detailed maximum noise level assessment to be completed where night-time noise levels exceed the screening level.

5.3.2.1 Detailed Maximum Noise Level Assessment

The detailed maximum noise level assessment is summarised in **Table 31**.

Table 31 Detailed Maximum Noise Level Assessment

Receiver	Maximum Noise Level L_{Amax} (dBA)					Comments
	Sleep Disturbance Goals (dBA)		Development Related Maximum Noise Events		Existing Maximum Noise Levels	
	Awakening Response[1]	Good Sleep	Predicted	Frequency of Occurrence		
R02	65	Around 55 (10 to 15 times per night)	55	Infrequent, as large trucks are not expected to regularly use air brakes	60-65[3]	**Awakening Response:** maximum noise levels from airbrakes of large trucks are predicted to be below the 'awakening response' level at all receivers. **Good Sleep:** up to five trucks are expected to access the proposal during the night-time and are not expected to frequently use airbrakes. Maximum noise events from large truck airbrakes are, therefore, not expected adversely affect 'good sleep' (ie they not expected to occur more than 10-15 times per night). **Existing maximum noise levels:** The unattended noise monitoring completed at L03 (near to R05) showed that existing maximum noise levels were measured to frequently be in the order of 60 to 65 dBA. Development related maximum noise levels are likely to be similar in magnitude, or lower than, existing maximum noise levels.
R03	65	Around 55 (10 to 15 times per night)	54			
R04	65	Around 55 (10 to 15 times per night)	54			
R05	65	Around 55 (10 to 15 times per night)	62			
R06	65	Around 55 (10 to 15 times per night)	55			
R07	65	Around 55 (10 to 15 times per night)	55			

Note 1: Based on RNP guidance that maximum internal noise levels below 50 dBA to 55 dBA are unlikely to awaken people from sleep. This equates to an external noise level of 65 dBA when assuming a 10 dB loss for partially open windows for ventilation.

Note 2: Based on RNP guidance that for a good sleep over eight hours the indoor L_{Amax} sound pressure level should not exceed around 45 dBA more than 10 or 15 times per night. This equates to an external noise level of around 55 dBA when assuming a 10 dB loss for partially open windows for ventilation.

Note 3: Based on monitoring location L03.

The predicted maximum noise levels at all surrounding receivers are expected to be below the levels outlined in the RNP that would be considered to have the potential to cause sleep disturbance and are expected to be comparable to or lower than existing maximum noise levels from existing vehicles on the surrounding roads.

Based on the above, the predicted sleep disturbance exceedances are considered of low significance and do not warrant any specific mitigation measures.

5.3.3 Cumulative Noise from all Developments

Cumulative operational noise levels from Lot 1, Lot 4 (assessed in SLR report 610.17734-R10-v1.1), Steelforce (assessed in SLR report 610.17734-R03-v1.0), CFC (assessed in SLR report 610.17734-R02-v1.3) and Bunnings (assessed in Wilkinson Murray report 19268 Version A) have been considered at the surrounding residential receivers and the results are shown in **Table 32**.

Table 32 Cumulative Noise Levels – Lot 1, Lot 4, Steelforce, CFC and Bunnings

ID	Receiver Location	Period	$L_{Aeq(15\ minutes)}$ Noise Level (dBA)								Compliance
			Noise Trigger Level[1]	Steelforce[2]	CFC	Bunnings	Lot 4	Lot 1[4]	Cumulative Level	Exceedance	
R01	12 Bringelly Road, Horningsea Park (abandoned condition)	Daytime	58	51	34	-	<30	<30	51	-	Yes
		Evening	48	51	33	-	<30	<30	51	3	**No**
		Night-time	43	42	33	-	<30	<30	43	-	Yes
R02	12 Bringelly Road, Horningsea Park	Daytime	58	42	45	-	36	42	48	-	Yes
		Evening	48	42	34	-	30	36	44	-	Yes
		Night-time	43	33	34	-	<30	35	39	-	Yes
R03	Residences on Cowpasture Road	Daytime	58	35	34	-	40	42	45	-	Yes
		Evening	48	35	32	-	35	35	40	-	Yes
		Night-time	43	30	32	-	33	35	39	-	Yes
R04	Residences on Stuart Road to the north	Daytime	58	36	43	35	46	43	49	-	Yes
		Evening	48	36	35	35	40	36	44	-	Yes
		Night-time	43	30	35	n/a	38	35	41	-	Yes
R05	Residences on Stuart Road to the west	Daytime	58	-	38	44	38	49	51	-	Yes
		Evening	48	-	30	44	33	43	47	-	Yes
		Night-time	43	-	30	n/a	33	42	43	-	Yes

Note 1: The cumulative noise criteria is taken to be the amenity level plus 3 dB (to convert it to a 15-minute assessment level), as per the NPfI.

Note 2: Noise from Steelforce is not expected to significantly impact R05.

Note 3: Noise from Bunnings is not expected to significantly impact R01, R02 and R03.

Note 4: Standard weather conditions have been considered for the cumulative noise contribution from the proposal.

The above shows that cumulative noise levels are predicted to comply with the relevant noise trigger levels at all residential receivers except for R01.

R01 is predicted to exceed the evening noise trigger level. This receiver is to the immediate east of the business hub and noise levels at this receiver are predicted to be controlled by the Steelforce site alone (ie the cumulative noise level is the same as the noise level from Steelforce alone).

Cumulative noise levels are therefore not expected to introduce any additional adverse effects at any receivers surrounding the site.

6 Mitigation and Management Measures

6.1 Construction Impacts

The impacts during construction of the project are predicted to be relatively minor and no works outside of Standard Construction Hours are currently proposed. The use of standard mitigation measures to minimise the impacts is considered sufficient. Examples of measures which could be applied to the work are provided in the Roads and Maritime (now Transport for NSW) *Construction Noise and Vibration Guideline* (see **Appendix E**).

6.2 Operational Noise Impacts

Operational noise emissions from the proposal are generally predicted to be compliant with the Project Noise Trigger at the surrounding receivers. However, operational noise emissions are predicted to exceed the Project Noise Trigger Levels by up to 6 dB at the nearest residential receiver (R05), up to 3 dB at residences on Stuart Road to the north (R04) and up to 1 dB at another nearby receiver to the northwest (R06) with noise enhancing weather conditions.

It is noted that R04 and R06 are predicted to comply with the trigger levels during all periods with standard weather conditions. Therefore, the marginal exceedances are only expected for a minority of the time when weather is enhancing the noise propagation between the proposal and these receivers, and the significance of these impacts is considered minor. Noise contribution from the proposal are below the amenity criteria at these receivers and the closer sites within the Bringelly Road Business Hub are expected to dominate the industrial noise contribution in this area.

Where operational noise impacts are expected, noise mitigation measures are to be considered in the following order of preference:

- At-source mitigation:
  - Limited use of loading dock and truck movements
- Path mitigation:
  - Noise mounds
  - Noise barriers
- At-receiver mitigation:
  - At-property treatments.

A detailed assessment of all potential feasible and reasonable mitigation measures that can be applied to the development to minimise the impacts has been completed and is summarised in **Table 33**.

Table 33 Feasible and Reasonable Mitigation Options

Mitigation Option	Noise Benefit / Comment	Reasonable and Feasible to Apply
Source Control		
Limiting truck movement and loading dock activity to the daytime	In the absence of truck movements and loading dock activity, the mechanical plant would be the only operational noise source during the evening and night-time periods and is expected to comply at all surrounding receivers.	Dependant on tenant
Path Control		
Noise barriers	Not feasible to implement due to the location of the site entrance relative to the loading dock and the nearest receiver. A noise barrier may be feasible if the site layout is rearranged such that the site entrance is moved to the east. In this case, a barrier is expected to provide the required attenuation at R05, however, the barrier height would need to be optimised at a later stage when more detailed information is available.	No
Receiver Control		
At property mitigation	Typically can involve addition or improvement of property external fences and/or using architectural treatments to improve building elements such as doors, windows, vents, etc.	Yes

Based on the assessment, at property mitigation may be reasonable and feasible to apply at receiver R05. At this stage, ESR is undertaking ongoing consultation and engagement with the potentially impacted nearby landowners.

The project is a speculative development without any tenants committed and the exact operational procedures of the site are not known at this time. Several assumptions have been made regarding the likely future uses and sources of noise. The noise predictions in this report should be regarded as indicative for planning purposes and are required to be confirmed at a later stage when detailed information is available.

7 Conclusion

SLR has been engaged to assess the potential construction and operational noise emissions from the proposed development at Lot 1 of the Bringelly Road Business Hub. The proposal includes the operation of warehouse facility which would be in use 24/7.

Construction noise levels are predicted to exceed the management levels at the nearest sensitive receivers. Exceedances are predicted at the nearest receivers to the west and north of the proposal, however, this would only be expected to occur when noisy work is being completed close to the site boundary. Standard mitigation measures have been recommended to address the potential construction impacts.

Operational noise levels are generally expected to comply with the trigger levels at the nearest receivers. A notable exceedance was predicted at the nearest residential receiver to the northwest (R05). Potential feasible and reasonable mitigation measures have been recommended to control the impacts to meet the Project Noise Trigger Levels.

Based on the predicted levels and indicative mitigation measures, the proposal is considered appropriate from an acoustic standpoint.

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 2×10^{-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

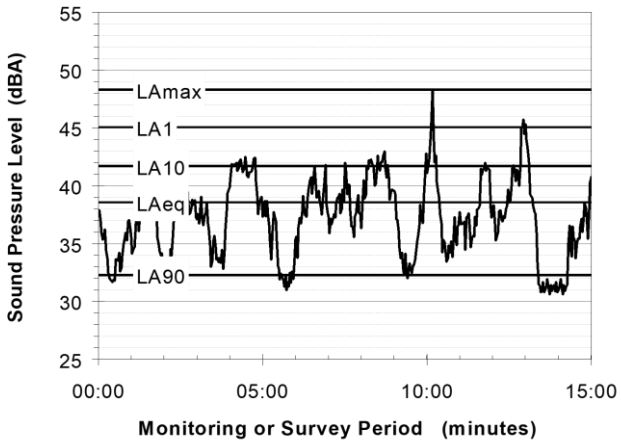
The Sound Power of a source is the rate at which it emits acoustic energy. As with Sound Pressure Levels, Sound Power Levels are expressed in decibel units (dB or dBA), but may be identified by the symbols SWL or LW, or by the reference unit 10^{-12} W.

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

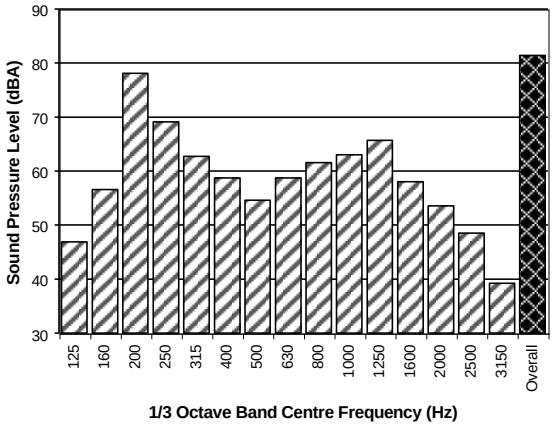
Frequency analysis is the process used to examine the tones (or frequency components) which make up the overall noise or vibration signal.

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

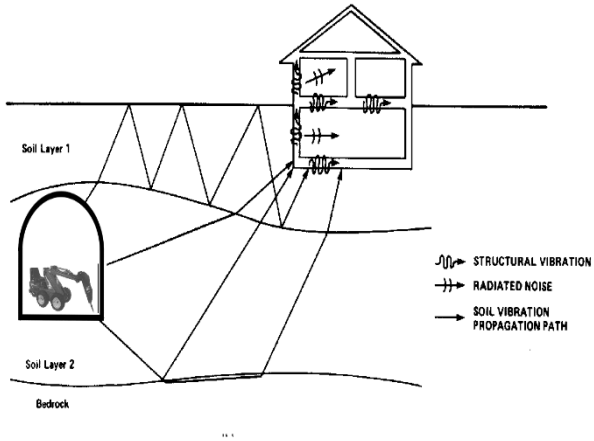
People are able to 'feel' vibration at levels lower than those required to cause even superficial damage to the most susceptible classes of building (even though they may not be disturbed by the motion). An individual's perception of motion or response to vibration depends very strongly on previous experience 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

Noise Monitoring

Statistical Ambient Noise Levels

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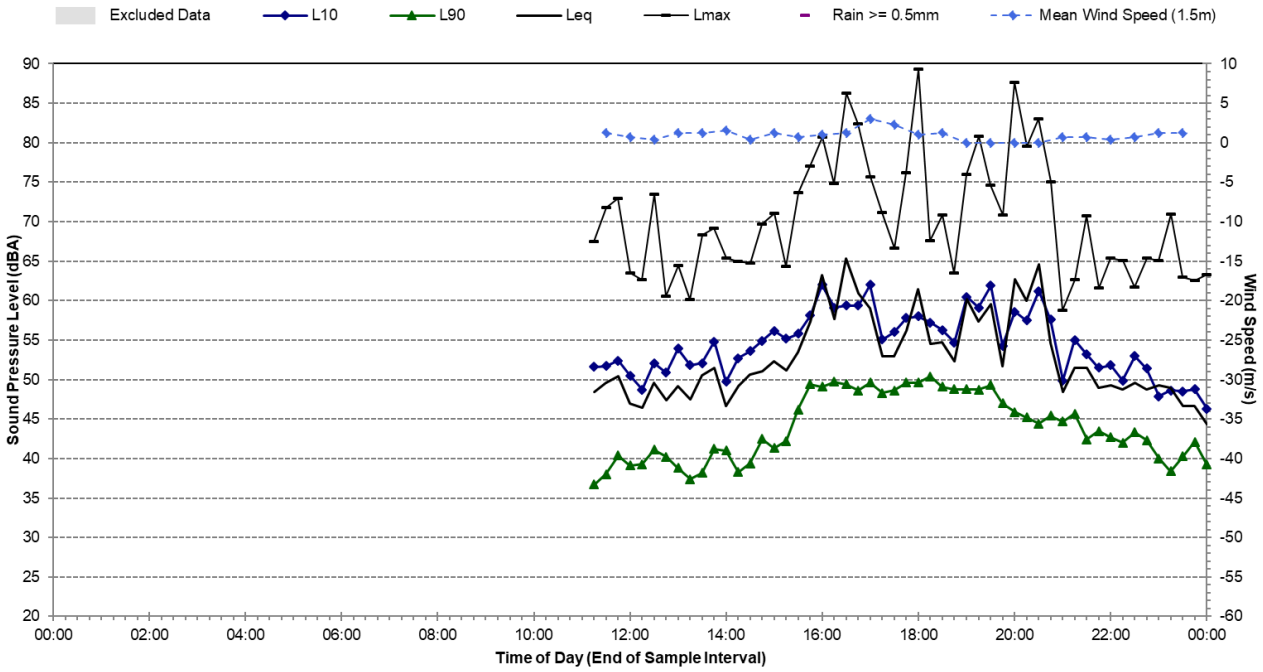

Statistical Ambient Noise Levels

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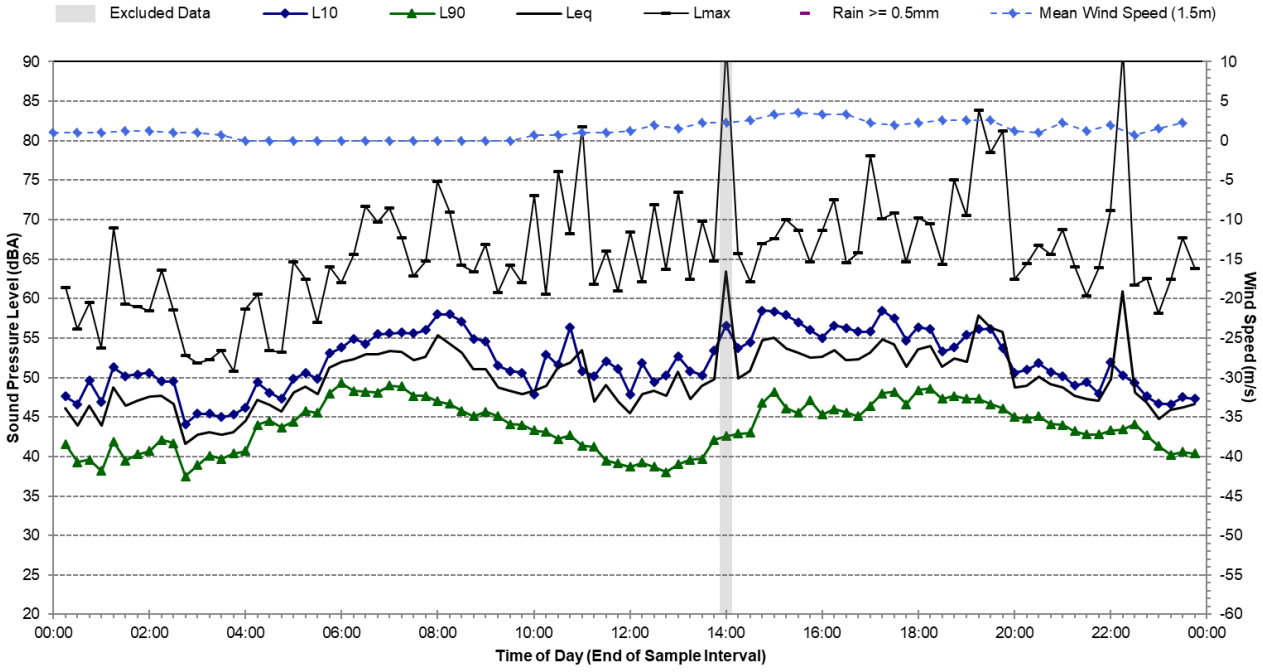

Statistical Ambient Noise Levels

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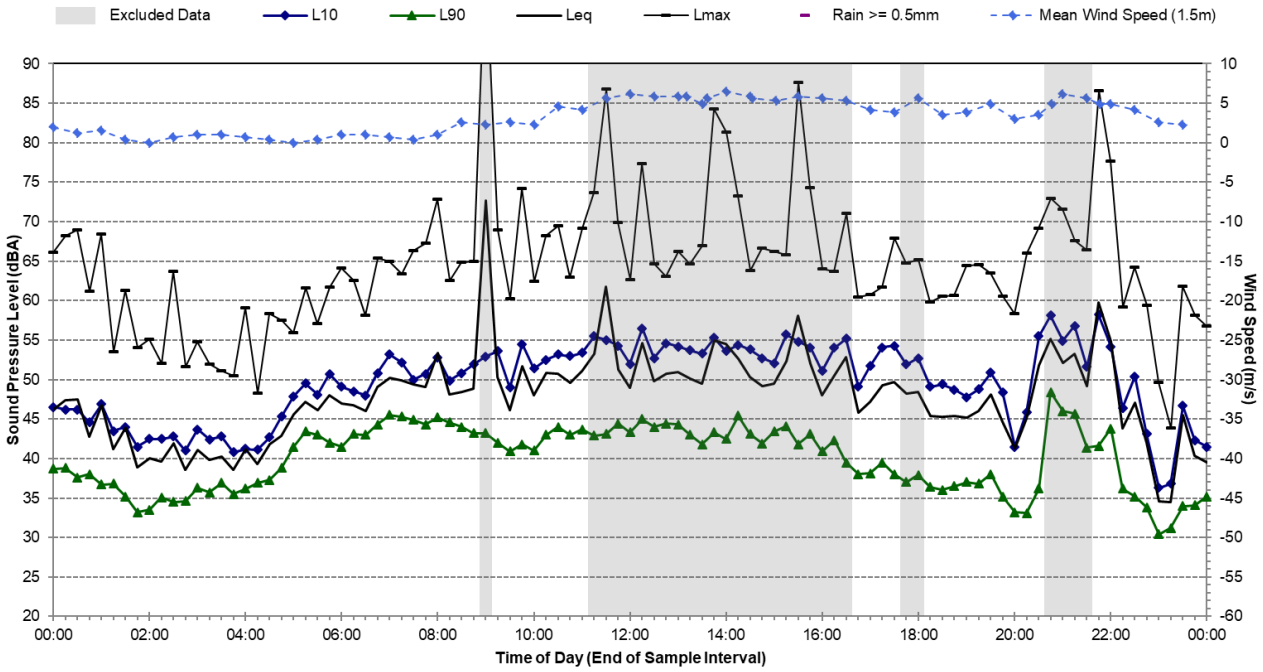

Statistical Ambient Noise Levels

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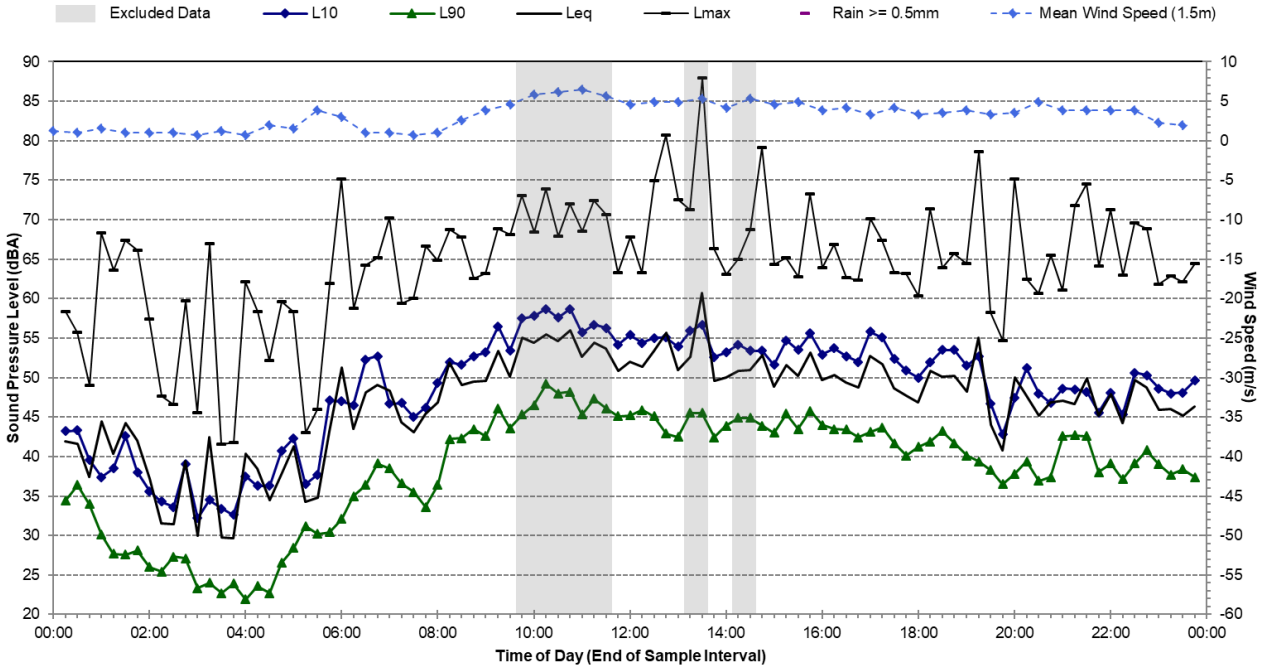

Statistical Ambient Noise Levels

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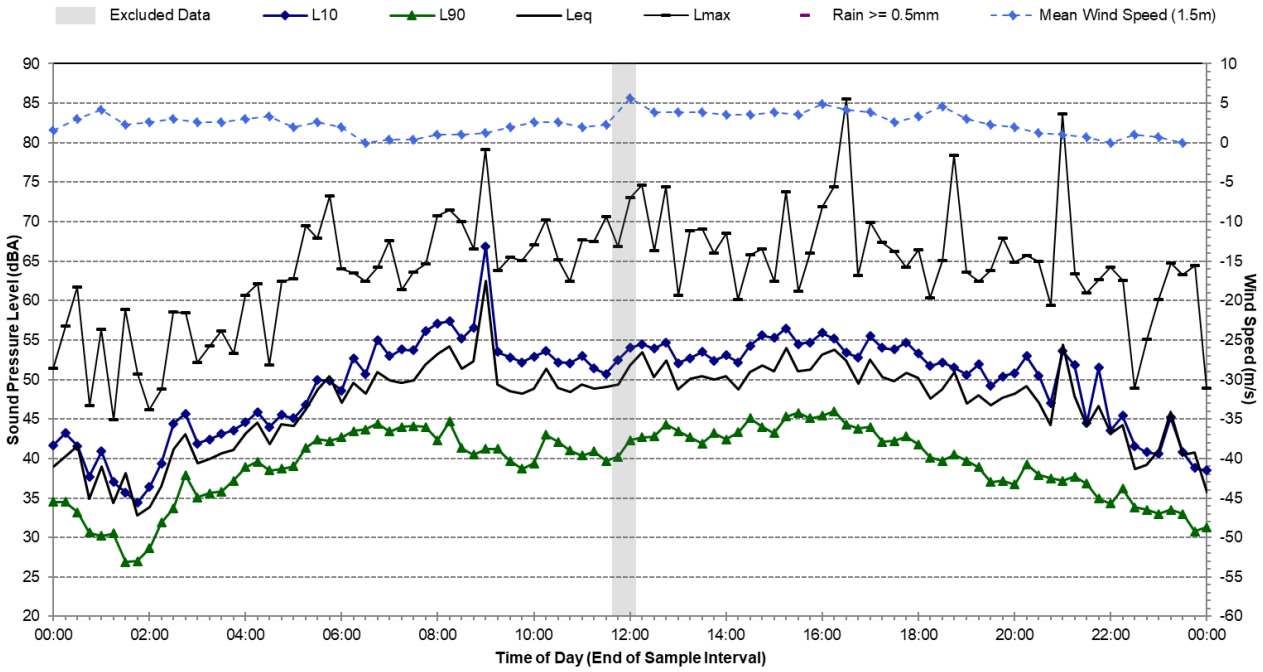

Statistical Ambient Noise Levels

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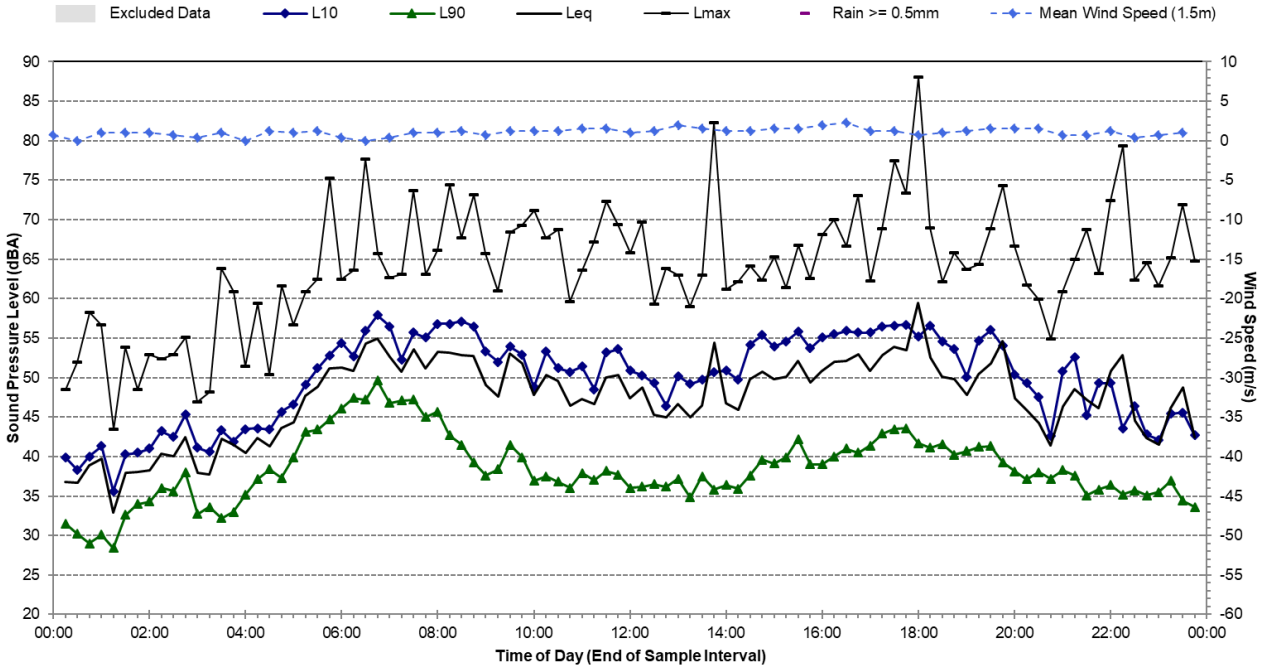

Statistical Ambient Noise Levels

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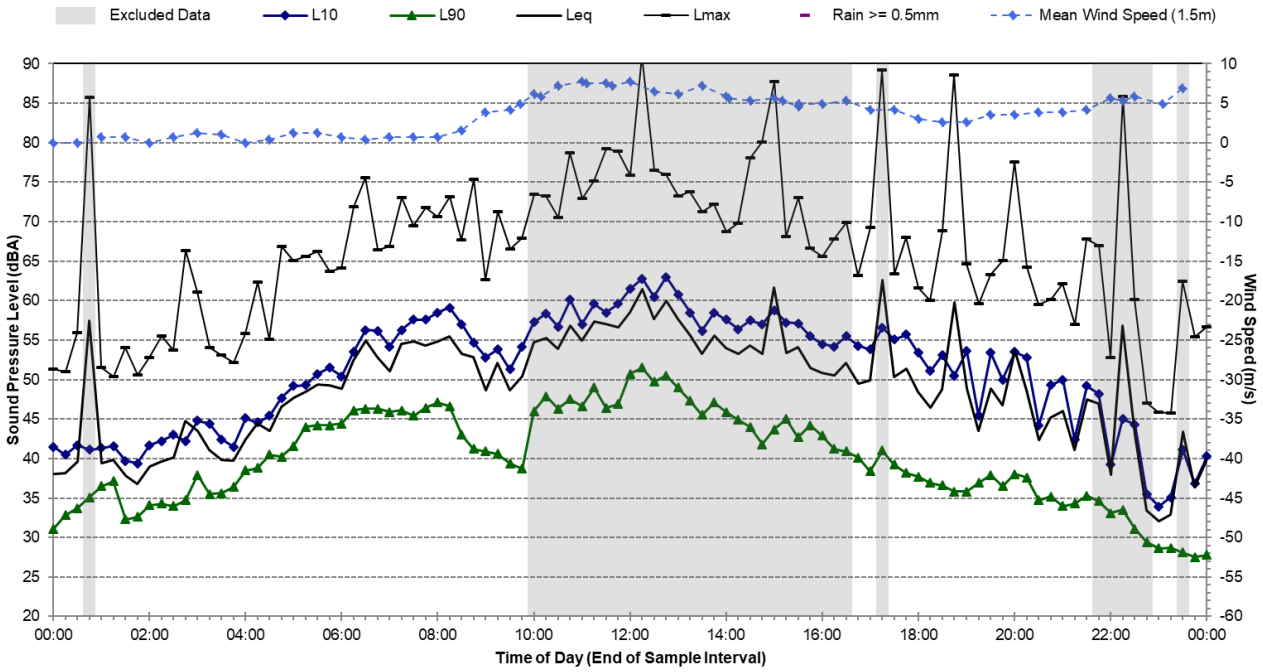

Statistical Ambient Noise Levels

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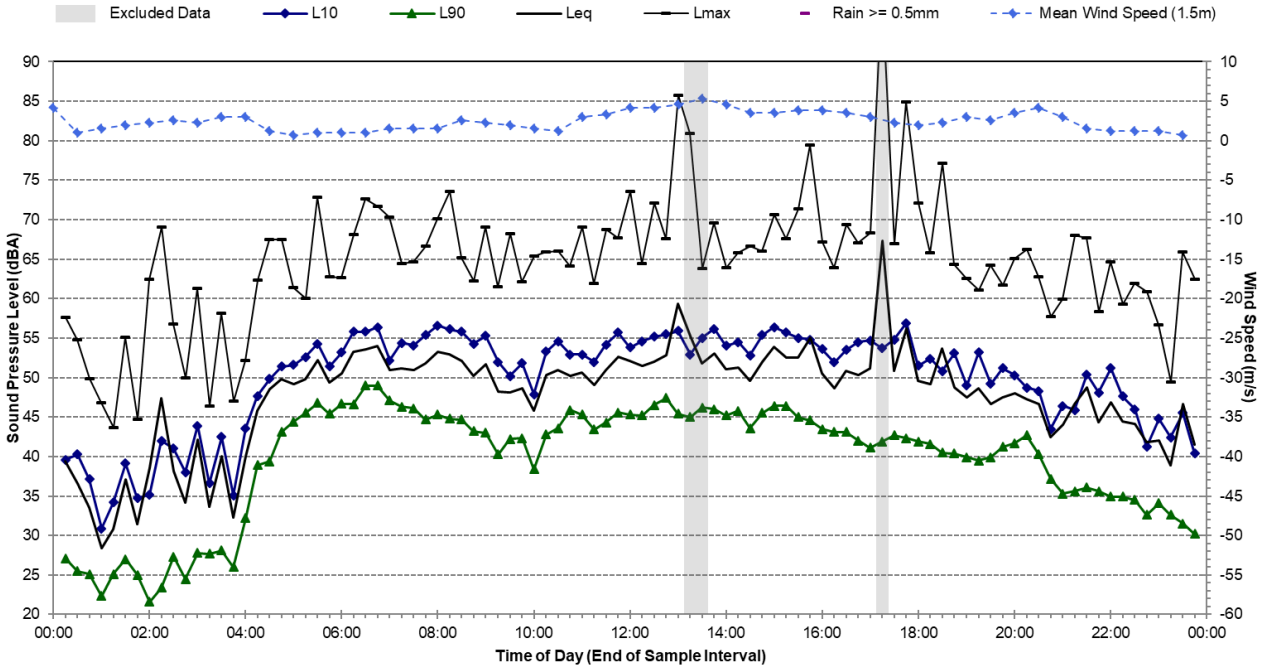

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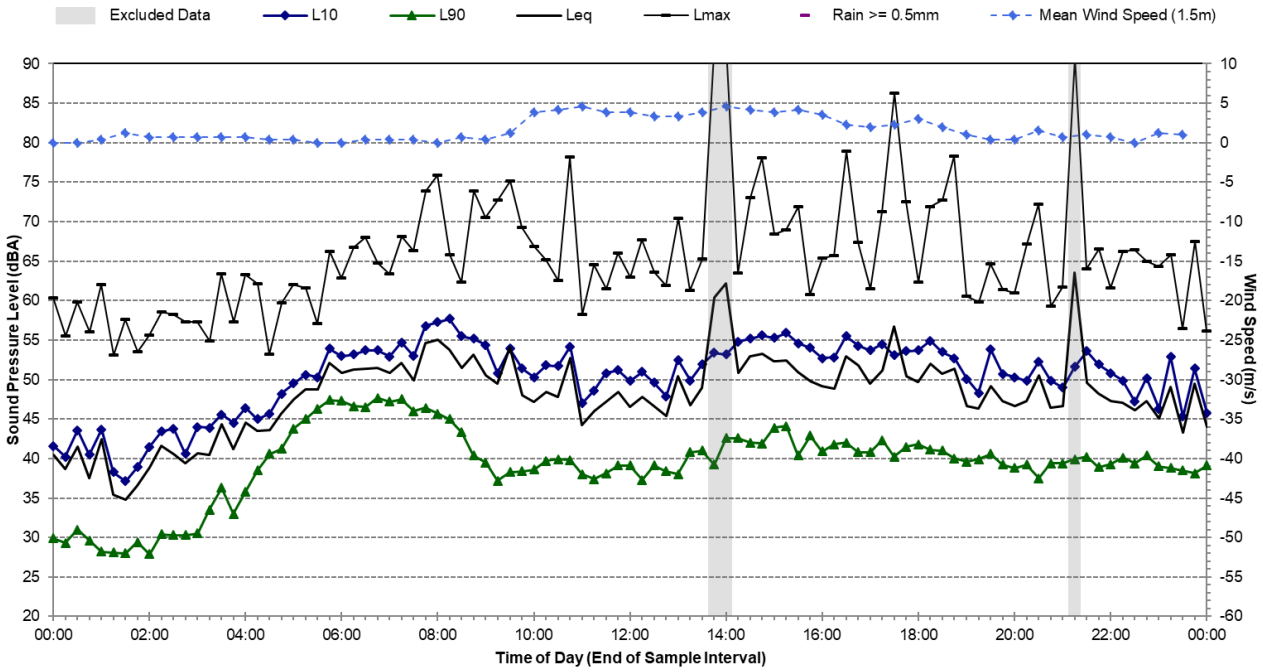

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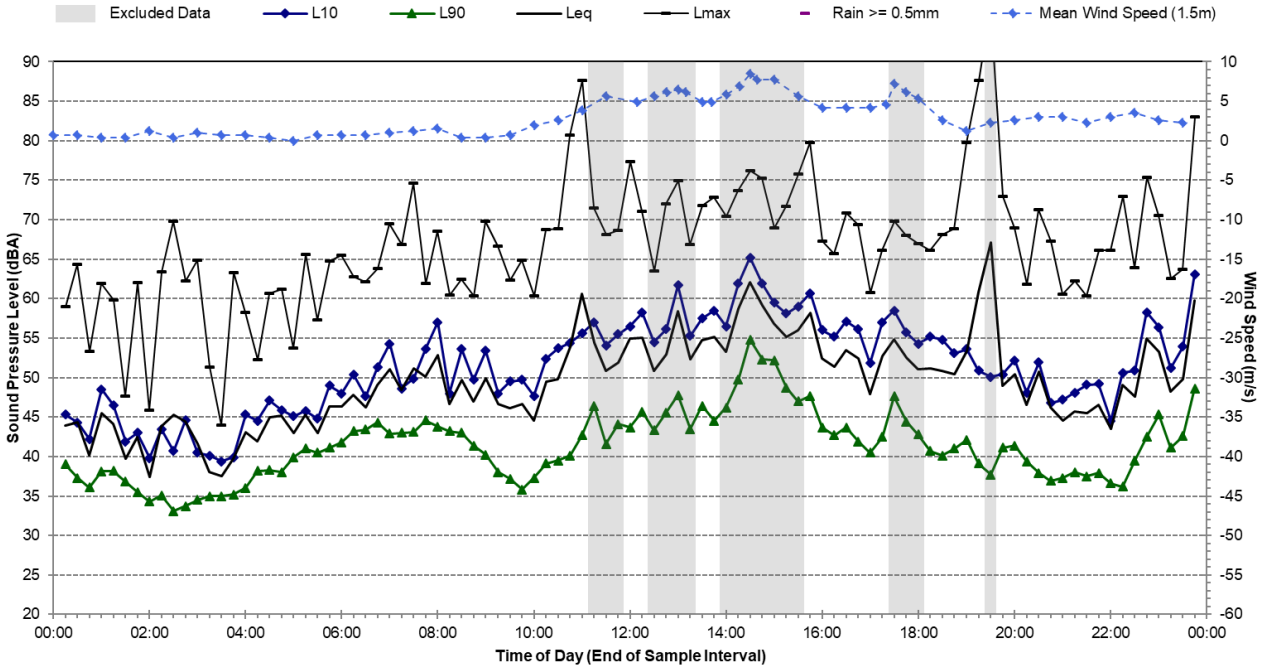

Statistical Ambient Noise Levels

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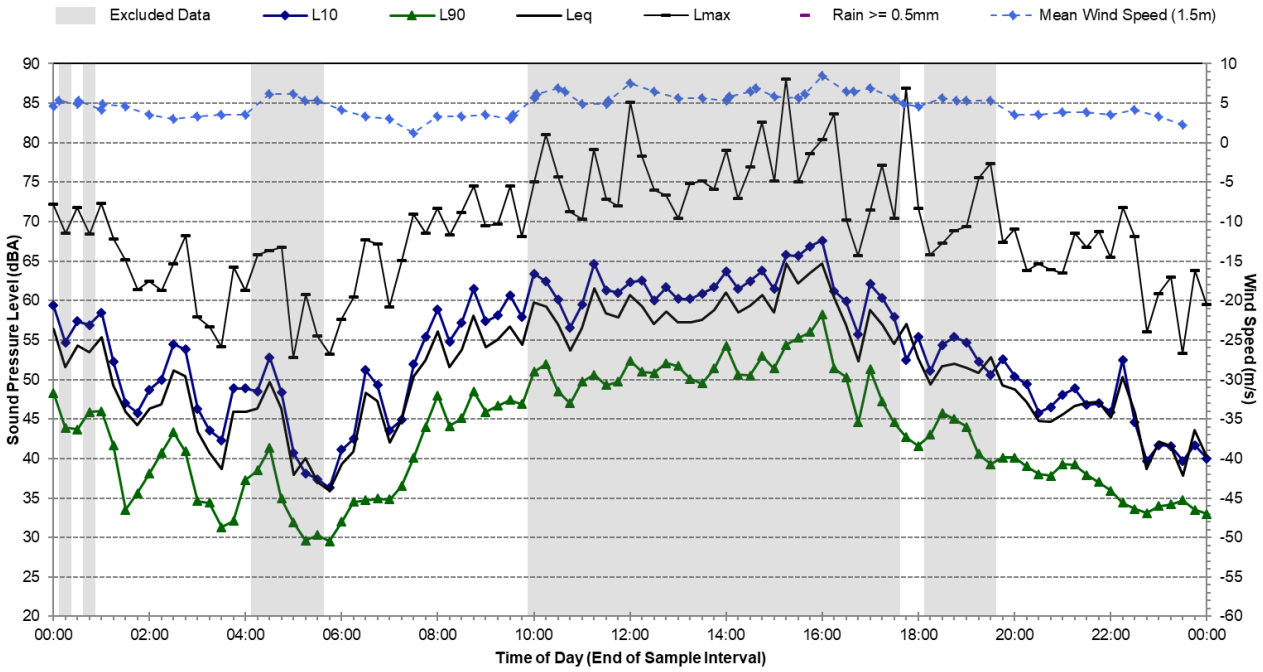

Statistical Ambient Noise Levels

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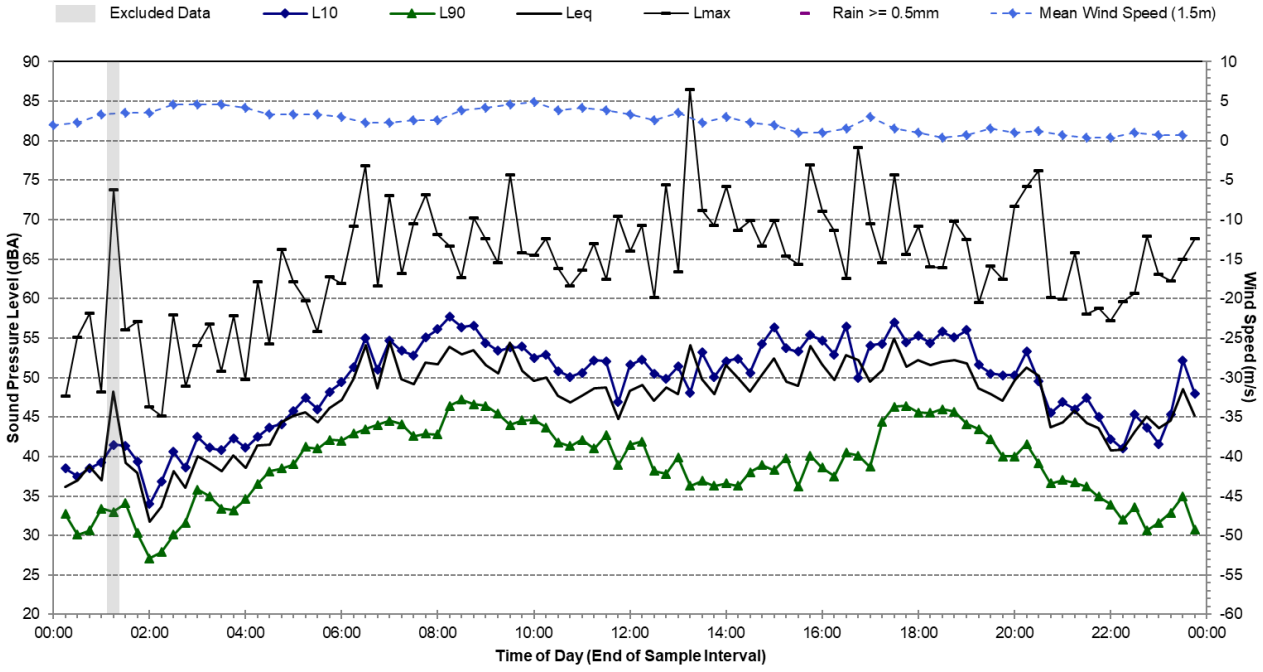

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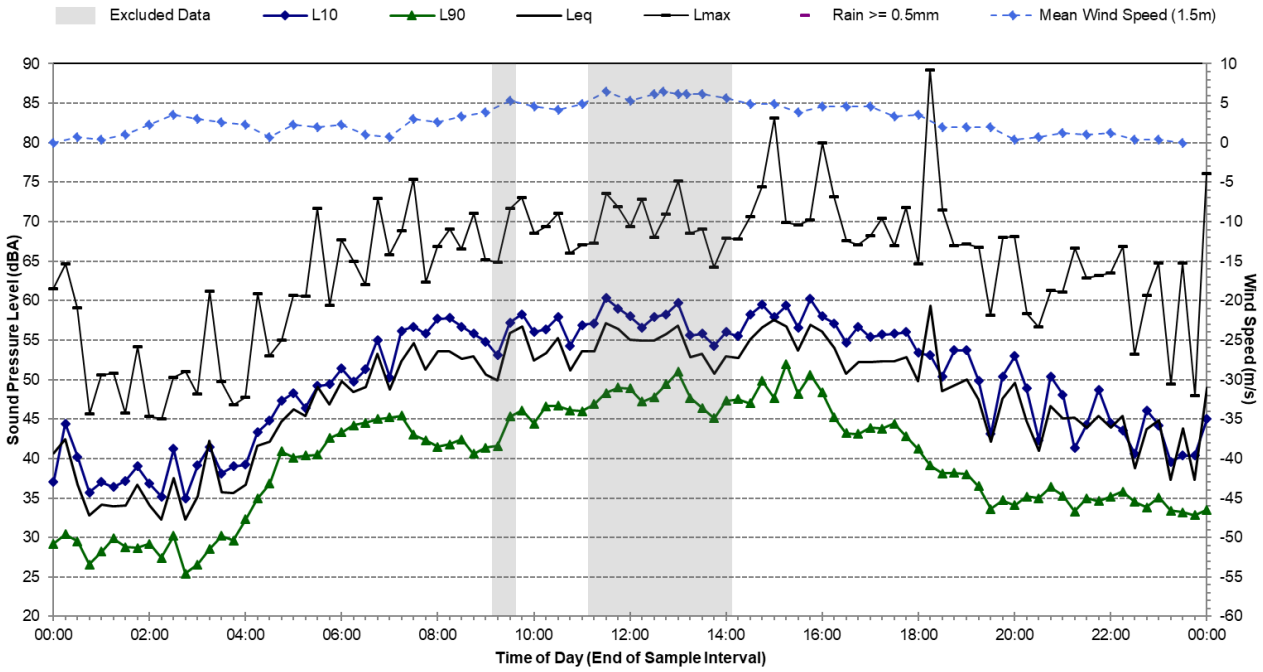

Statistical Ambient Noise Levels

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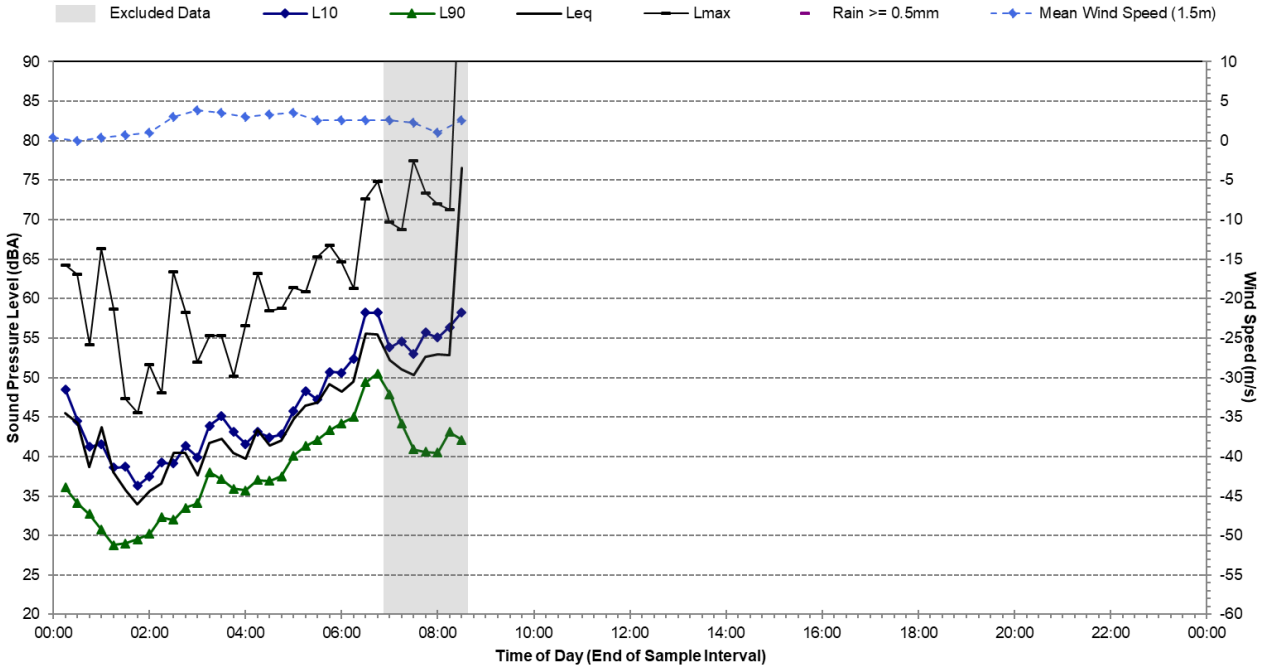

Statistical Ambient Noise Levels

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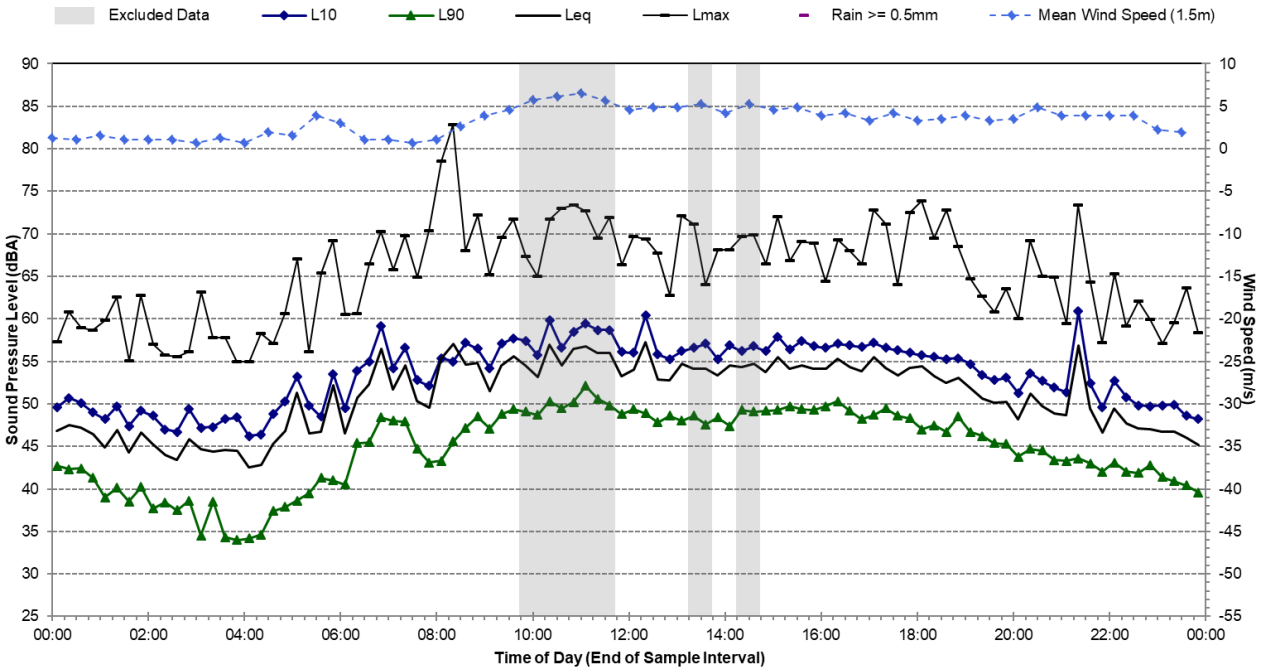

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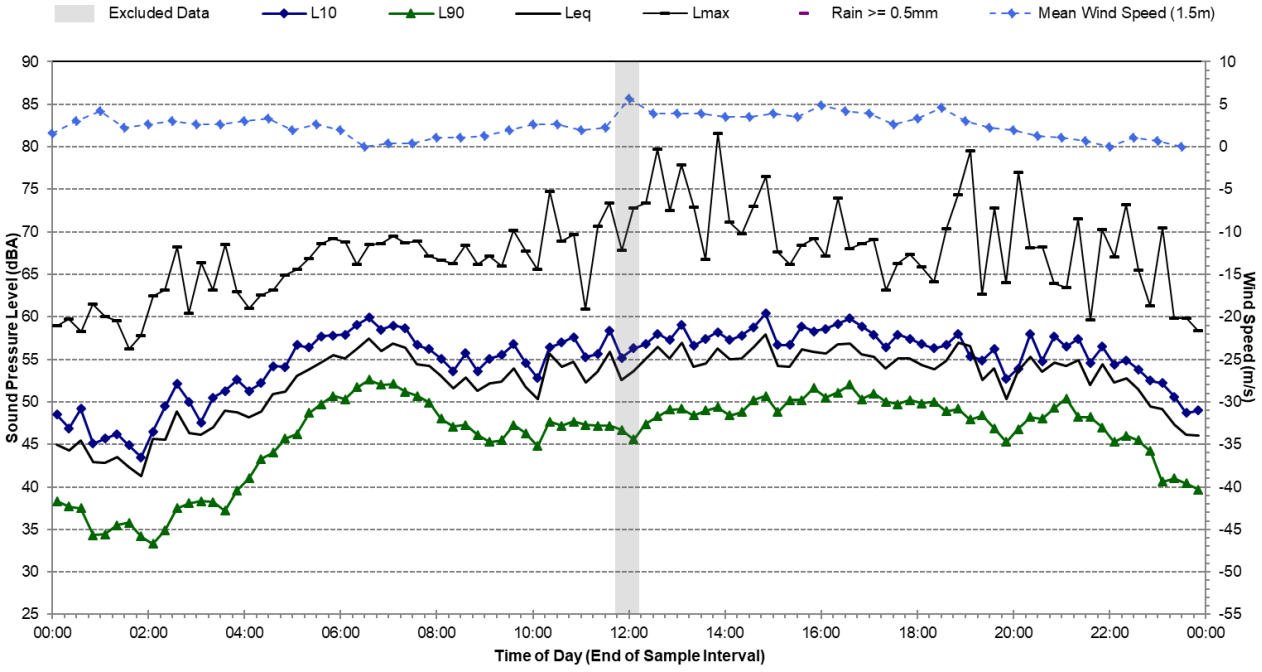

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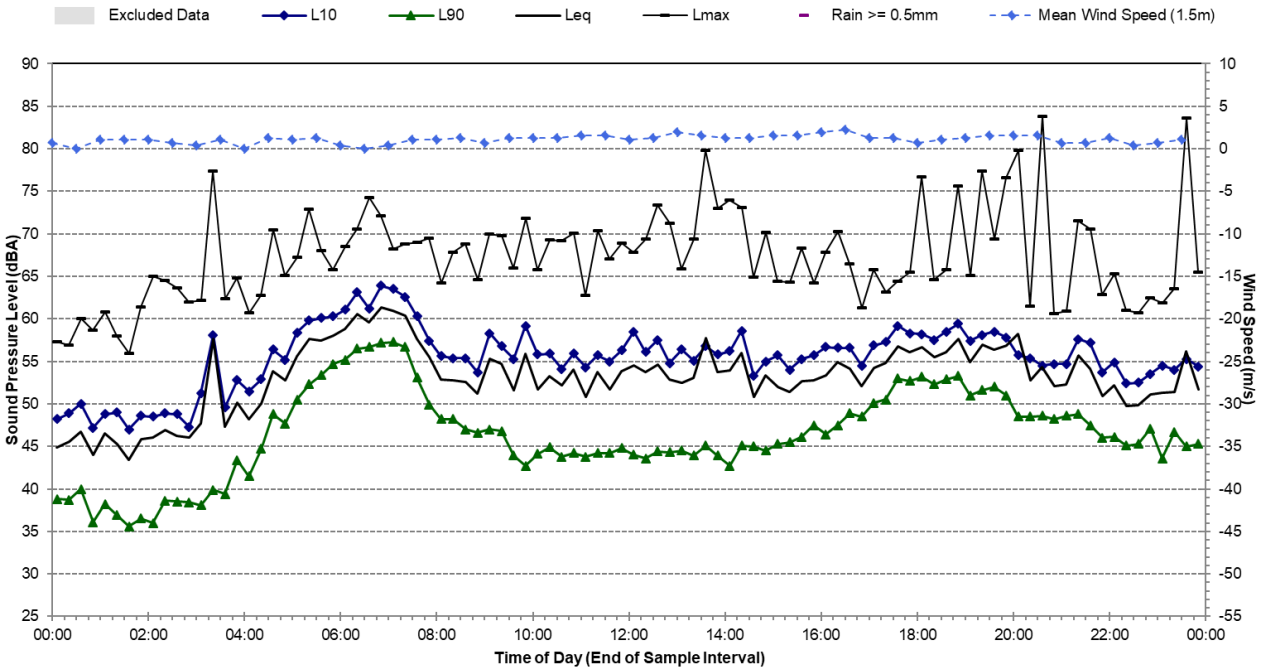

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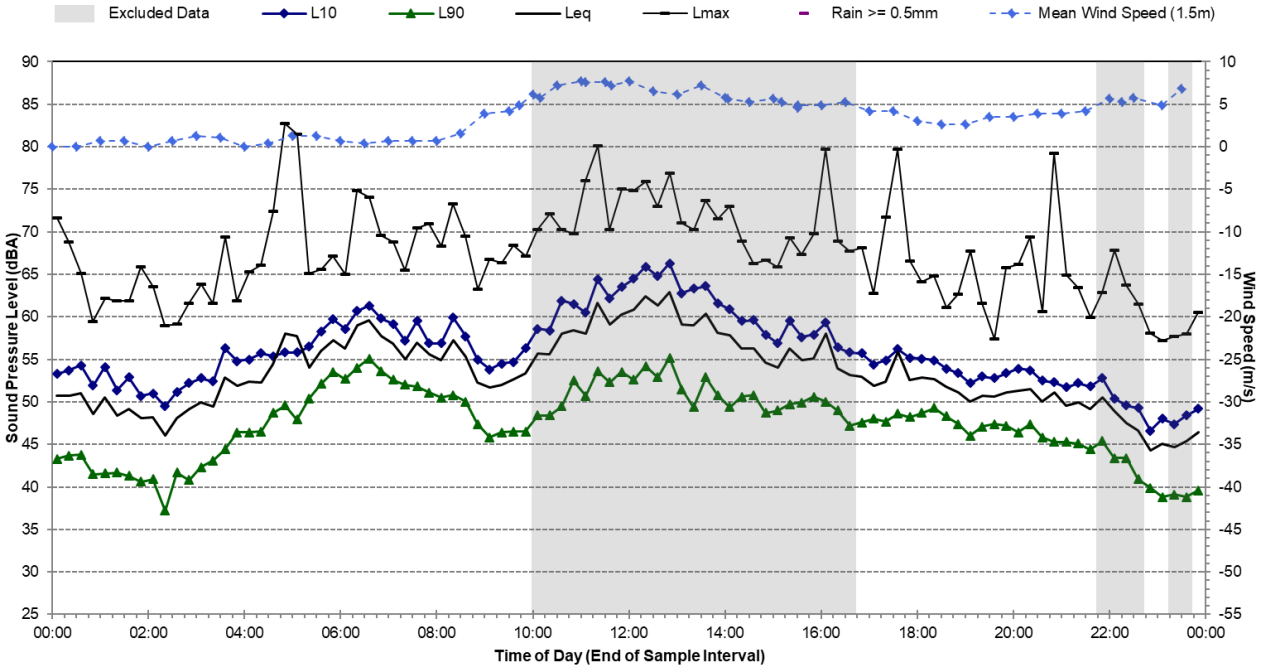

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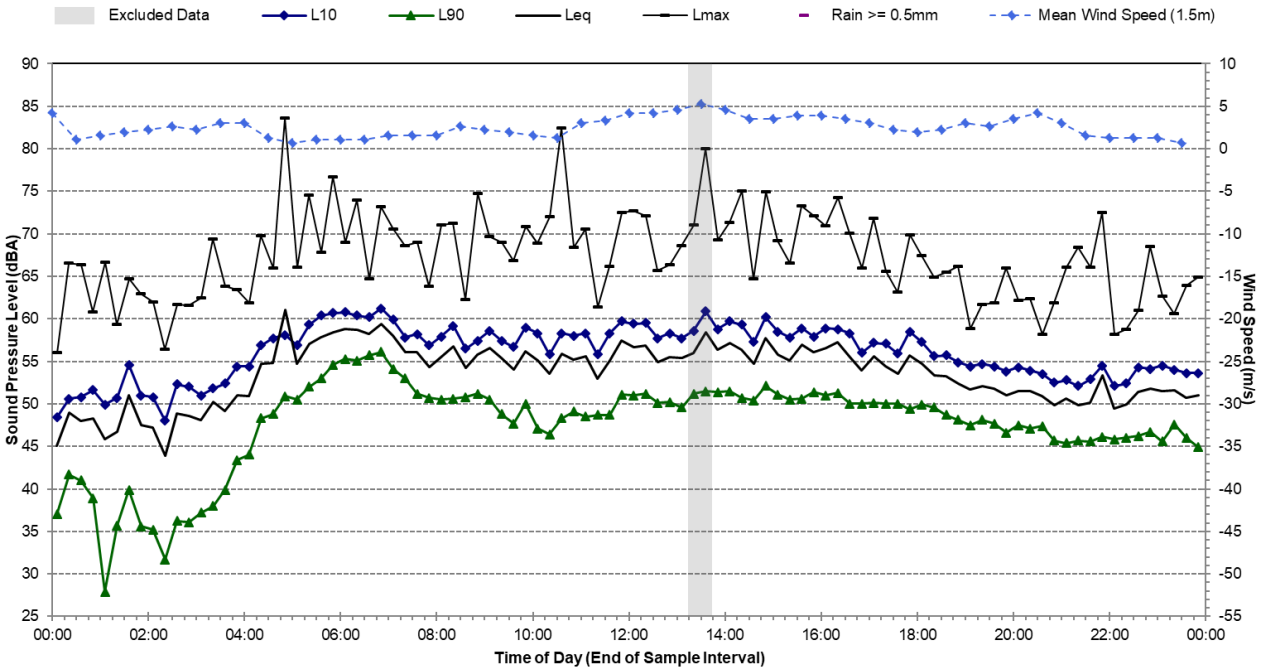

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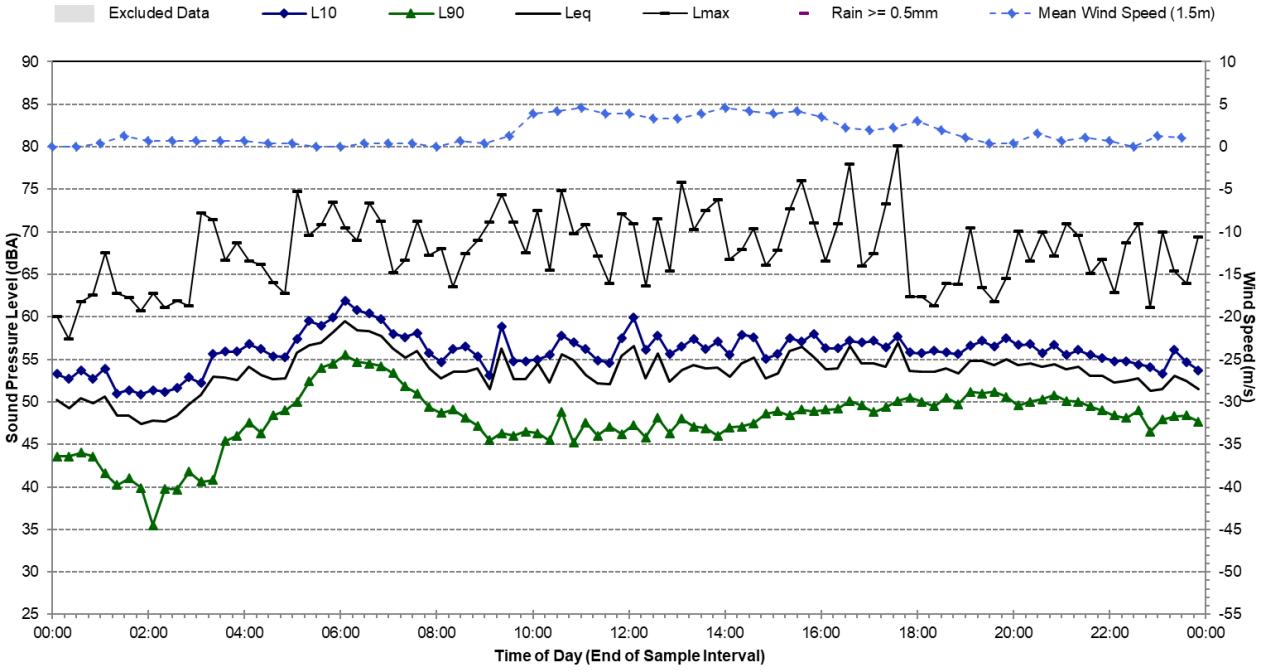

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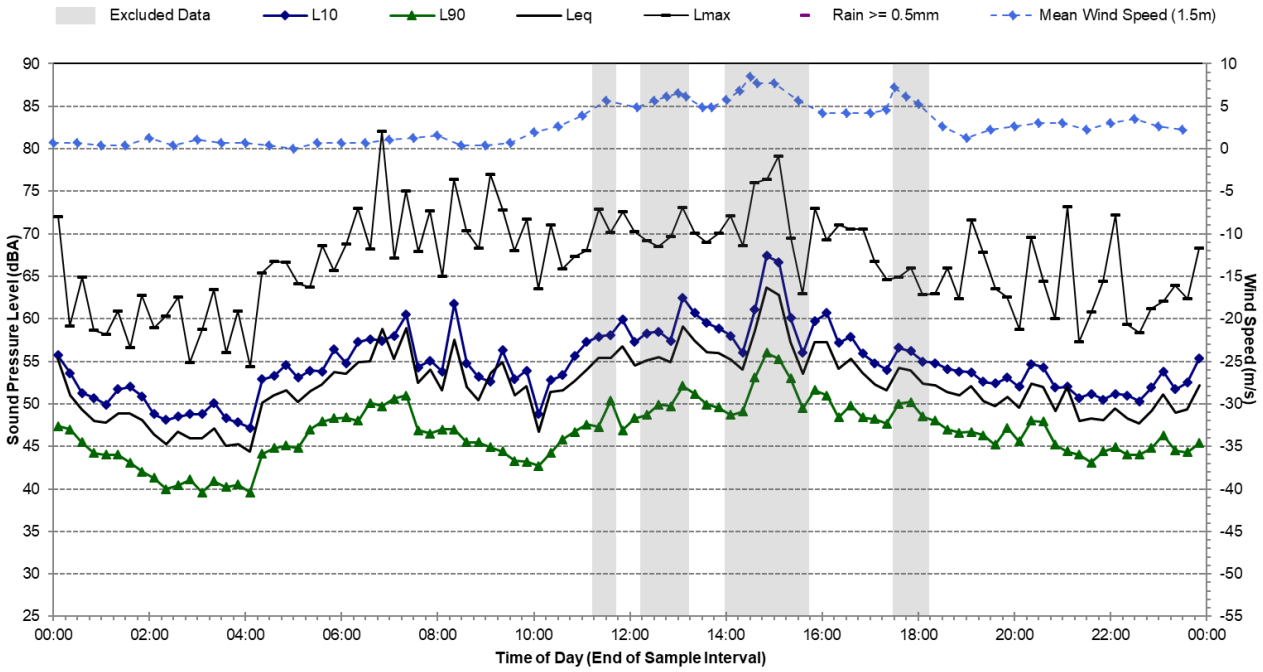

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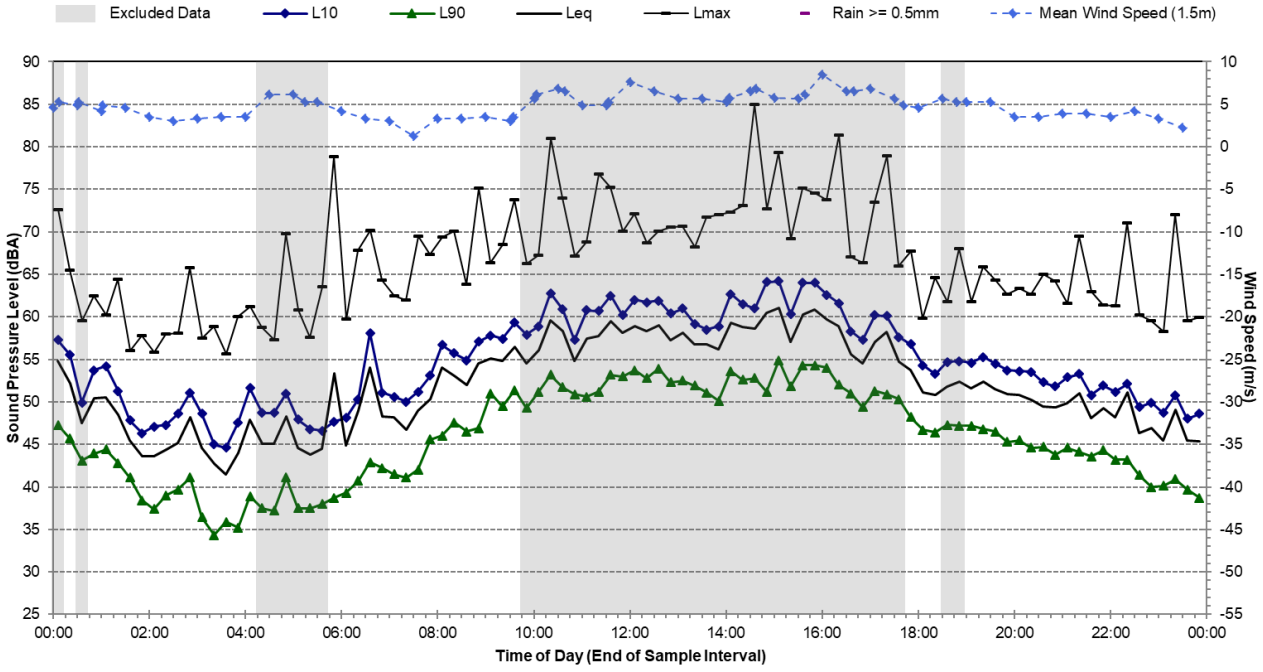

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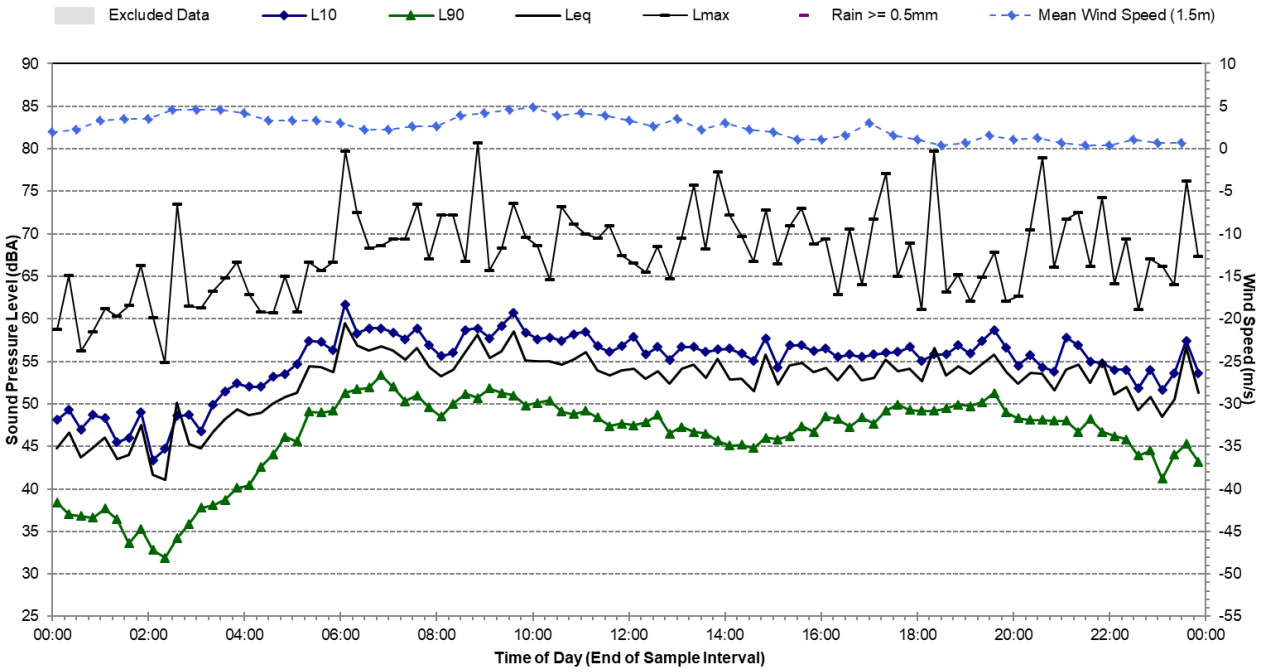

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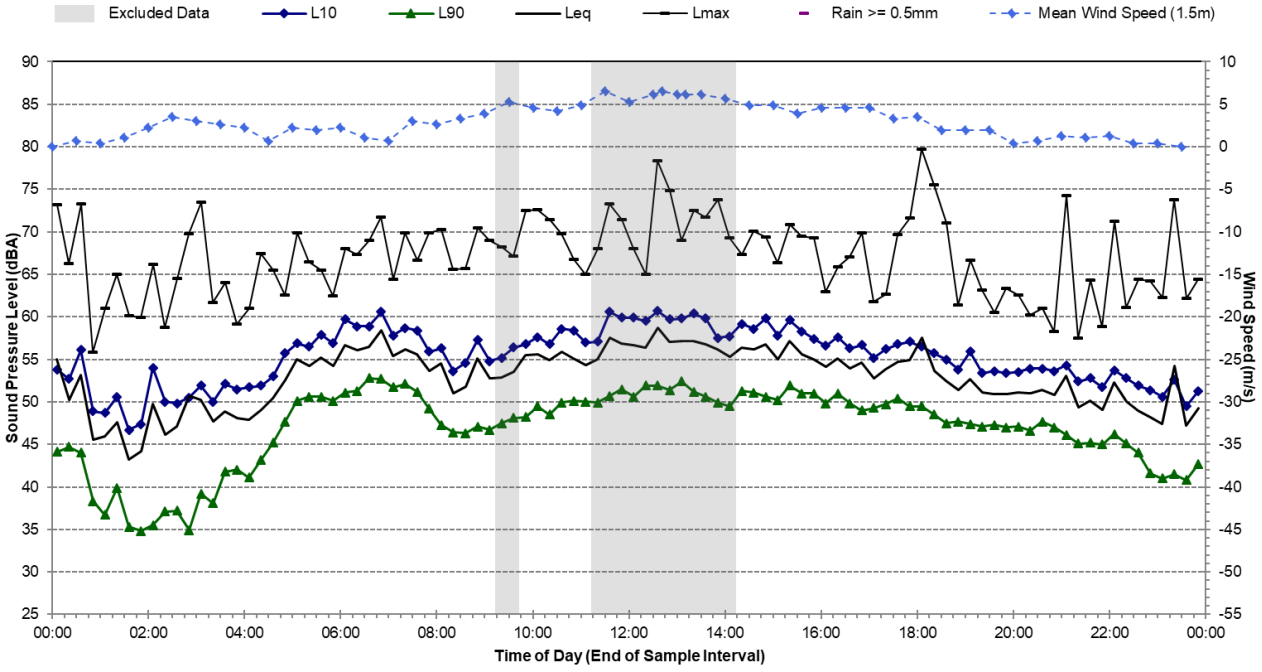

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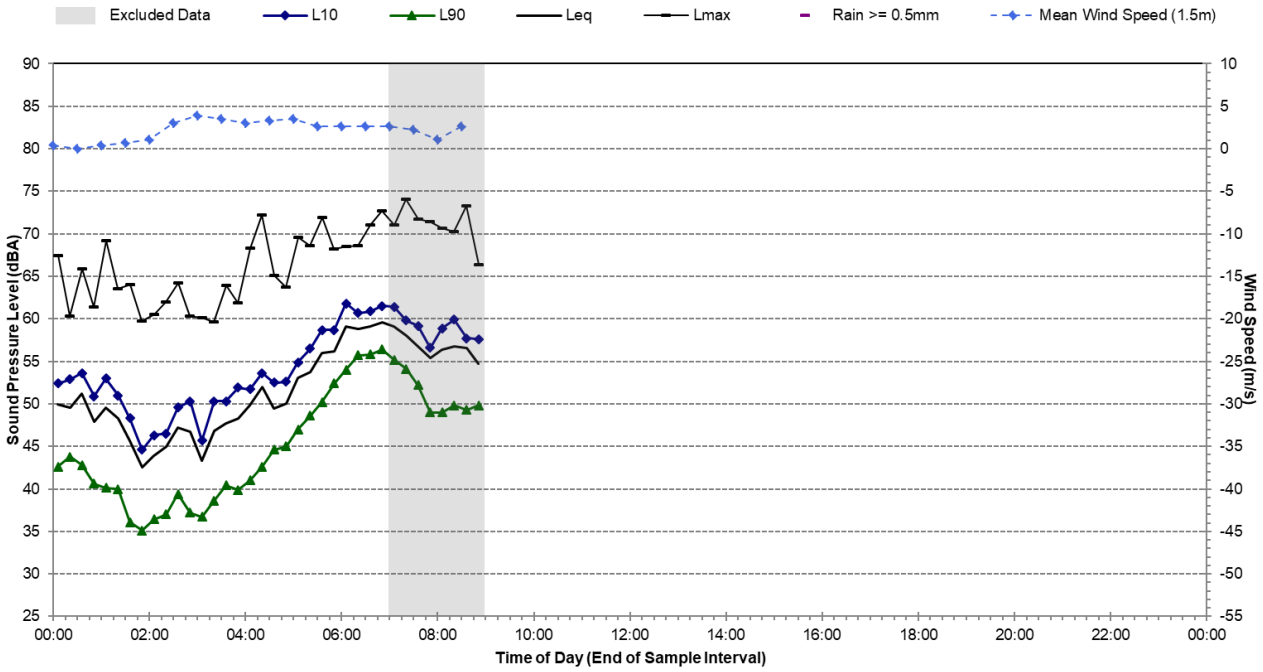

Statistical Ambient Noise Levels

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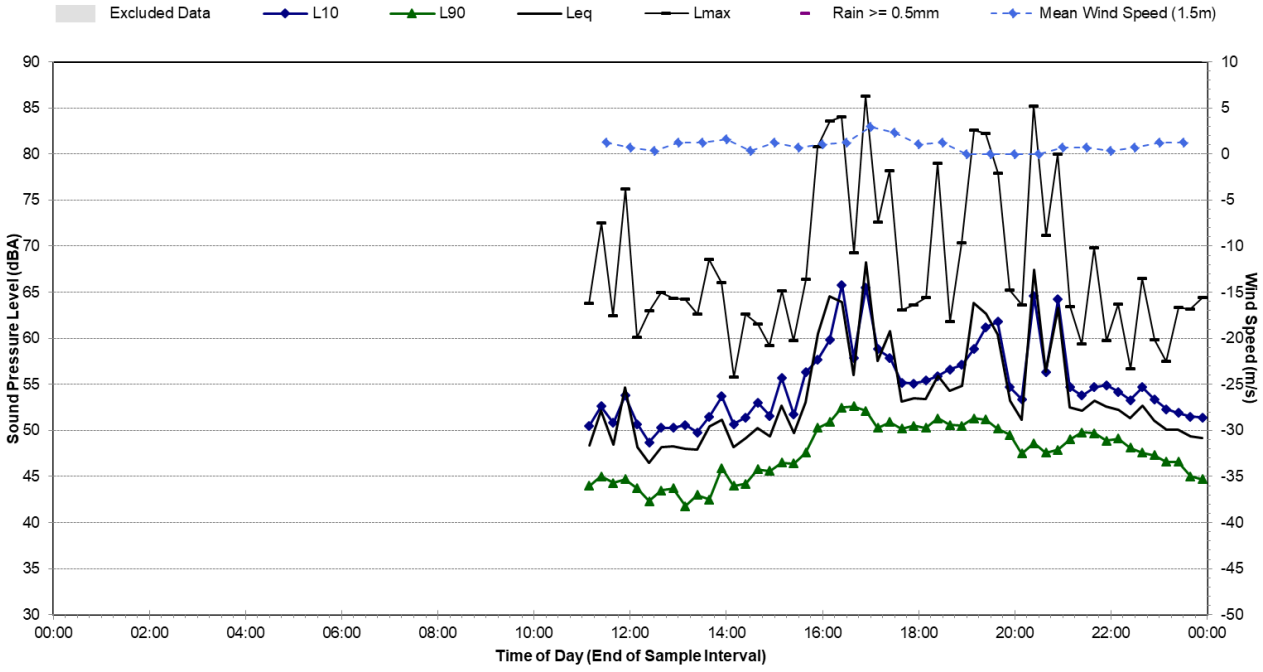

Statistical Ambient Noise Levels

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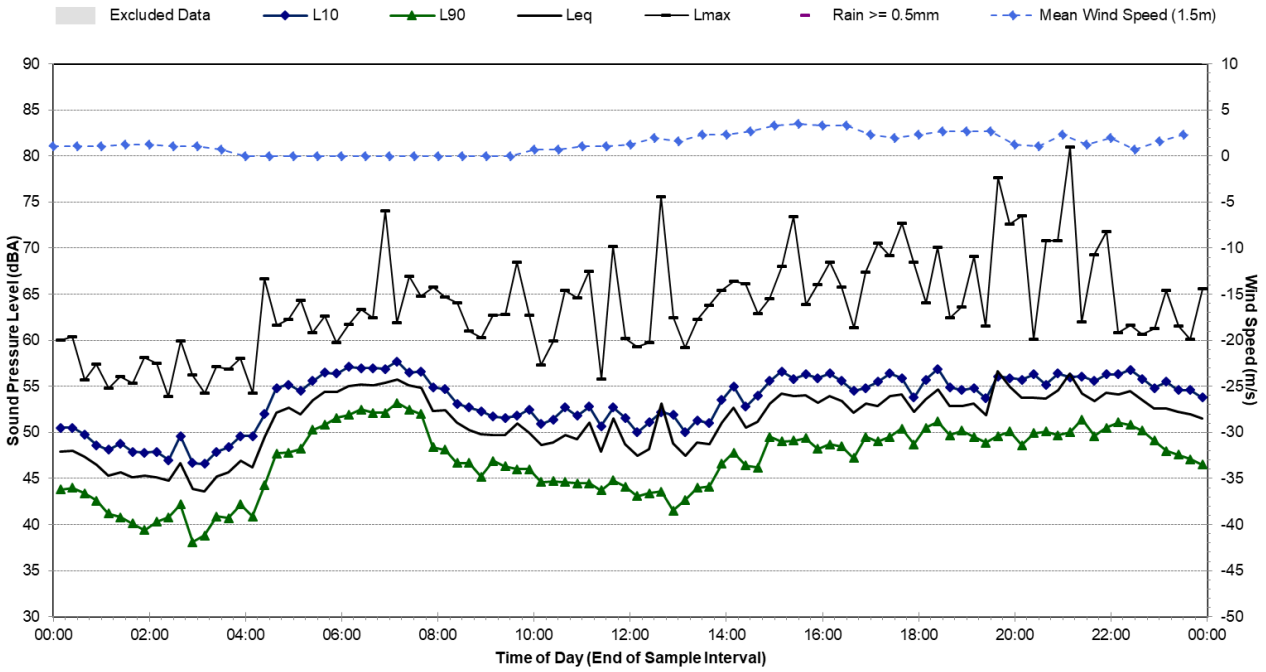

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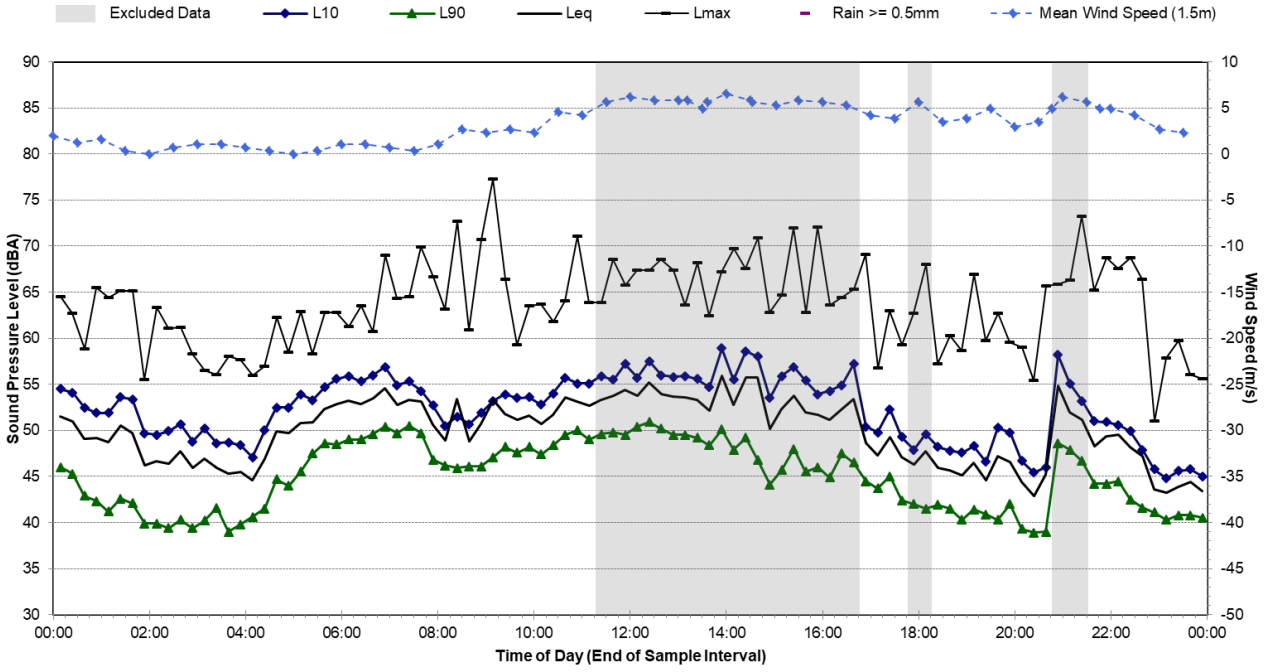

Statistical Ambient Noise Levels

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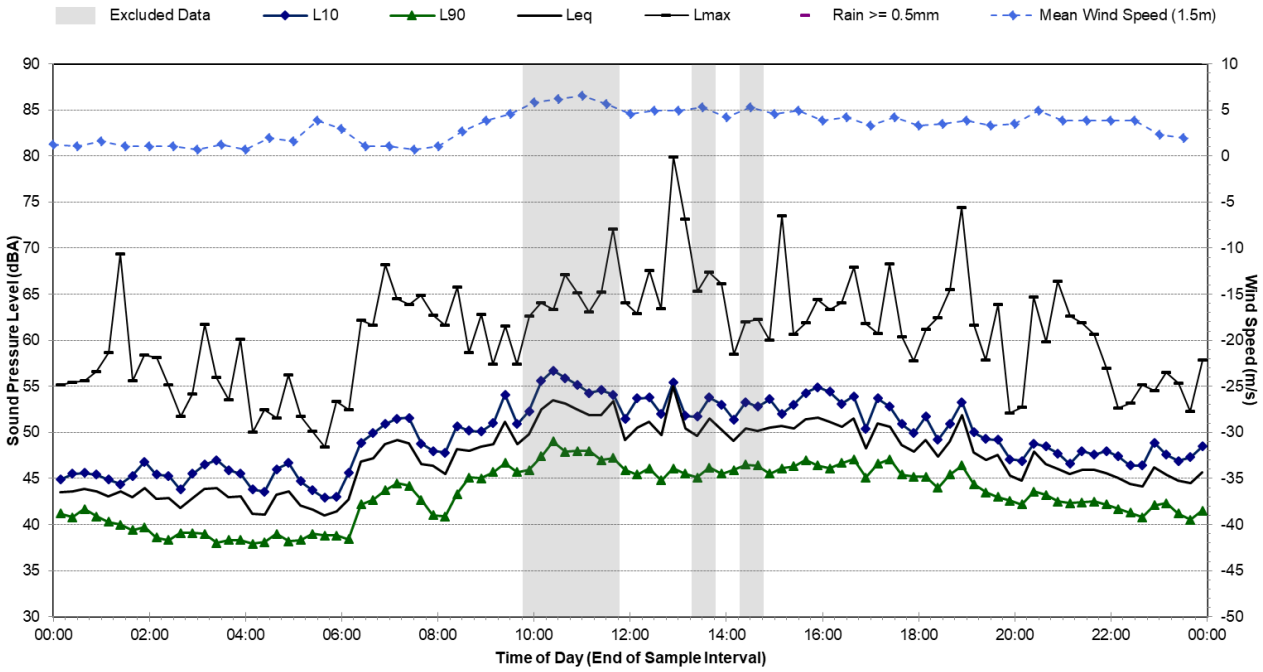

Statistical Ambient Noise Levels

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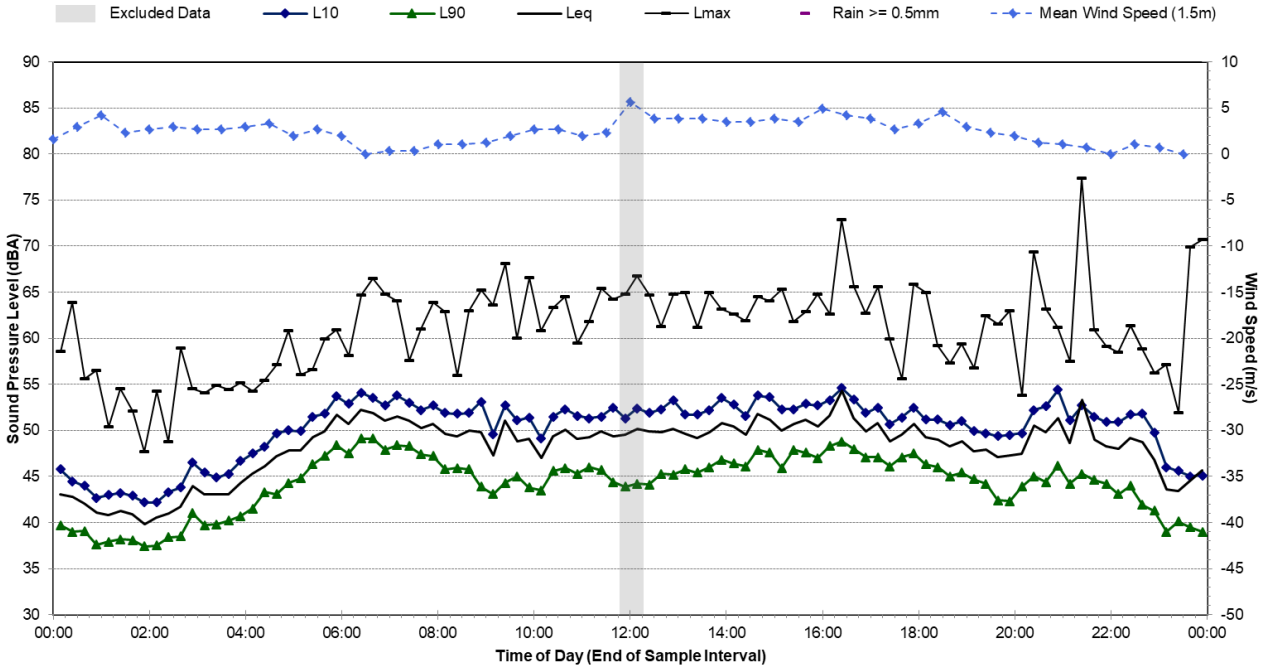
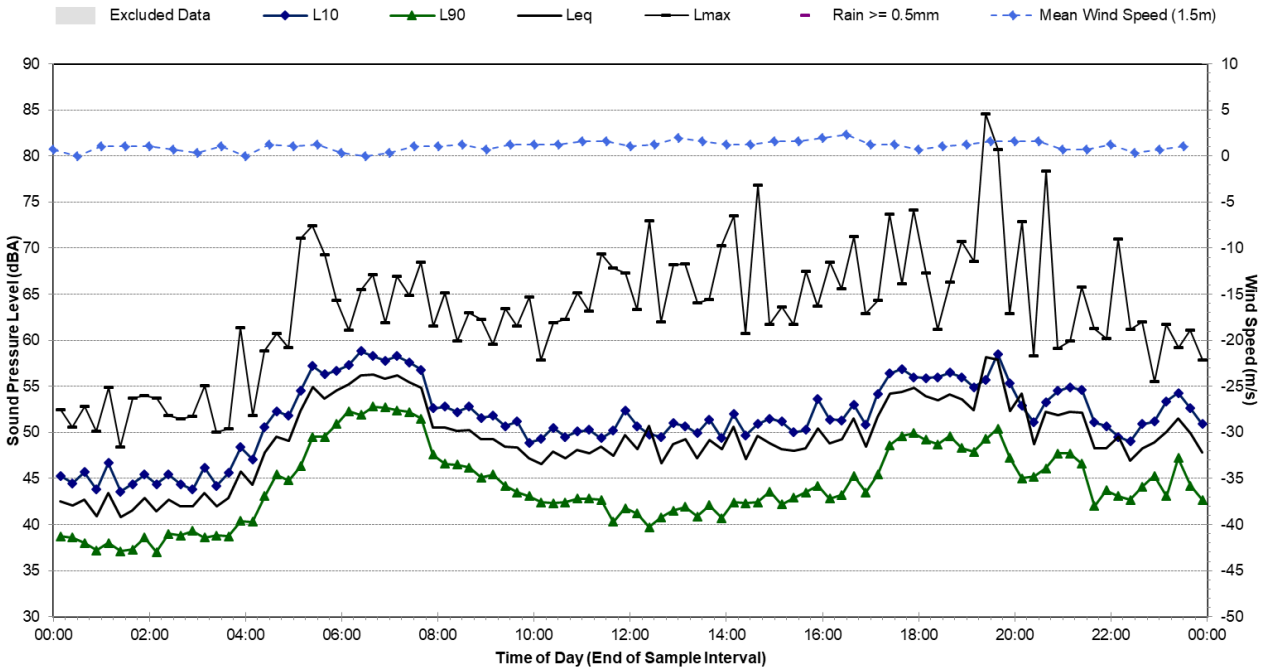


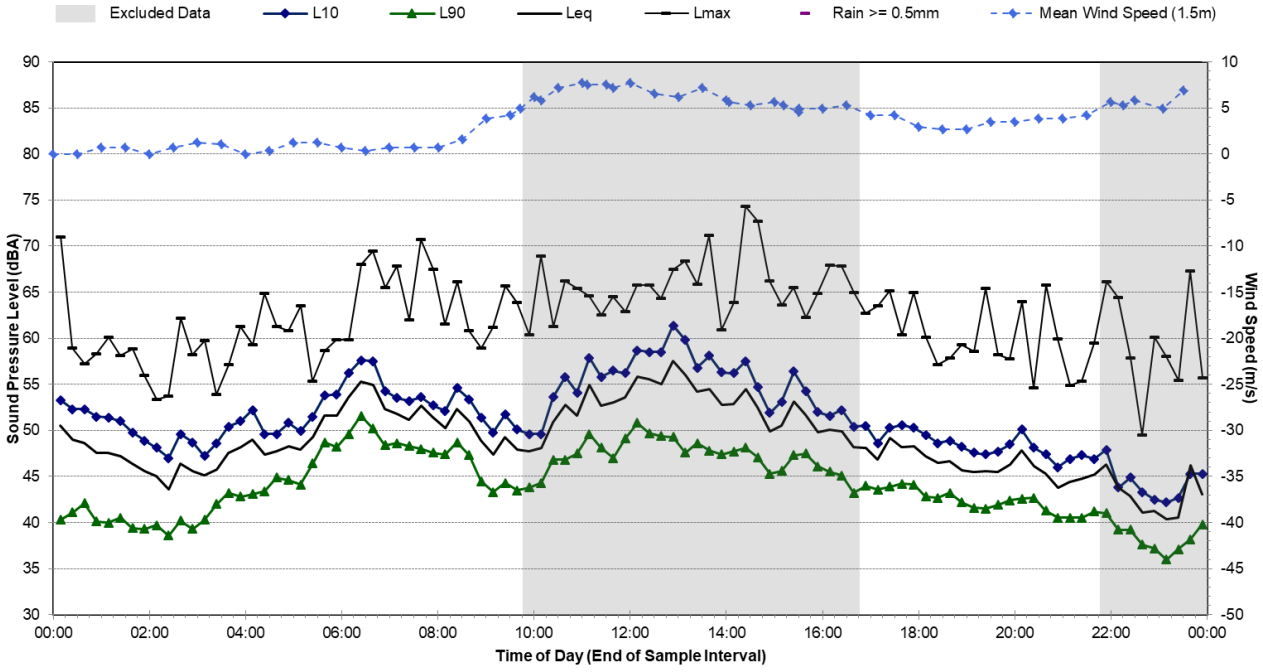
Statistical Ambient Noise Levels

L03 - Stuart Road, Horningsea Park - Tuesday, 14 August 2018



Statistical Ambient Noise Levels

L03 - Stuart Road, Horningsea Park - Wednesday, 15 August 2018



APPENDIX C

Construction Noise Sources

Equipment	Total SWL	Concrete Pump	Concrete Saw[1]	Concrete Truck	Crane - Mobile (30t)	Elevated Working Platform	Excavator (15t)	Excavator (30t)	Excavator (30t) with Breaker[1]	Forklift	Grader	Hand Tools	Roller – Smooth Drum	Scissor Lift	Truck - Dump	Truck - HIAB	Truck - Road Truck / Truck & Dog	Truck - Tipper	Water Cart
Sound Power Level[2]		109	123	109	113	97	105	110	127	106	113	104	107	98	110	108	108	108	107
Estimated on-time in any 15 minutes		10	5	15	15	15	15	15	5	5	15	15	15	15	10	10	15	15	10
Scenario																			
Civil Work	123							X			X		X		X				X
Structural Steel	115				X	X						X				X			X
Cladding	119	X	X	X		X				X		X		X					
Fitout (Internal)	119	X	X	X		X				X		X		X					
Stormwater and Pavements	118	X		X			X	X			X		X				X	X	X

Note 1: Equipment classed as 'annoying' in the ICNG and requires a 5 dB correction.

Note 2: Sound power level data is taken from the DEFRA Noise Database, RMS *Construction and Vibration Guideline* and TfNSW *Construction Noise and Vibration Strategy*.

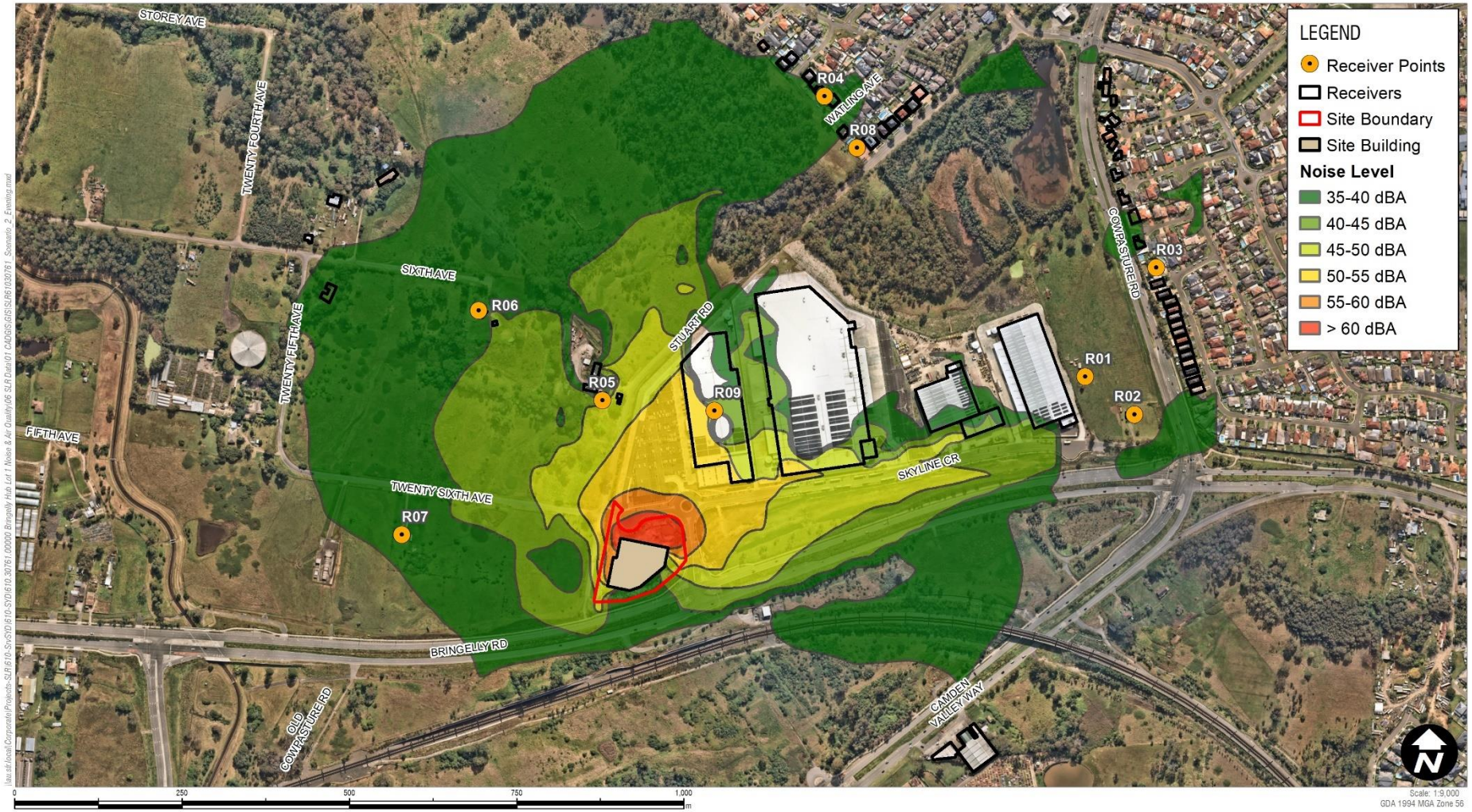
APPENDIX D

Operational Noise Contours

Site Operations - Day

Note: Noise contours are at a height of 1.5 m and are free field.

Site Operations – Evening (Noise Enhancing Weather)



Note: Noise contours are at a height of 1.5 m and are free field.

Site Operations – Night-time (Noise Enhancing Weather)

Note: Noise contours are at a height of 1.5 m and are free field.

APPENDIX E

CNVG Mitigation Measures

CNVG Standard Mitigation and Management Measures

Action Required	Applies To	Details
Management measures		
Implementation of any project specific mitigation measures required.	Airborne noise	Implementation of any project specific mitigation measures required.
Implement community consultation or notification measures.	Airborne noise Ground-borne noise & vibration	Notification detailing work activities, dates and hours, impacts and mitigation measures, indication of work schedule over the night-time period, any operational noise benefits from the works (where applicable) and contact telephone number. Notification should be a minimum of 7 calendar days prior to the start of works. For projects other than maintenance works more advanced consultation or notification may be required. Please contact Roads and Maritime Communication and Stakeholder Engagement for guidance. Website (If required) Contact telephone number for community Email distribution list (if required) Community drop-in session (if required by approval conditions).
Site inductions	Airborne noise Ground-borne noise & vibration	All employees, contractors and subcontractors are to receive an environmental induction. The induction must at least include: • all project specific and relevant standard noise and vibration mitigation measures • relevant licence and approval conditions • permissible hours of work • any limitations on high noise generating activities • location of nearest sensitive receivers • construction employee parking areas • designated loading/unloading areas and procedures • site opening/closing times (including deliveries) • environmental incident procedures.
Behavioral practices	Airborne noise	No swearing or unnecessary shouting or loud stereos/radios on site. No dropping of materials from height, throwing of metal items and slamming of doors.
Verification	Airborne noise Ground-borne noise & vibration	Where specified under Appendix C of the CNVG a noise verification program is to be carried out for the duration of the works in accordance with the Construction Noise and Vibration Management Plan and any approval and licence conditions.
Attended vibration measurements	Ground-borne vibration	Where required attended vibration measurements should be undertaken at the commencement of vibration generating activities to confirm that vibration levels are within the acceptable range to prevent cosmetic building damage.
Update Construction Environmental Management Plans	Airborne noise Ground-borne noise & vibration	The CEMP must be regularly updated to account for changes in noise and vibration management issues and strategies.

Action Required	Applies To	Details
Building condition surveys	Vibration Blasting	Undertake building dilapidation surveys on all buildings located within the buffer zone prior to commencement of activities with the potential to cause property damage
Source controls		
Construction hours and scheduling	Airborne noise Ground-borne noise & vibration	Where feasible and reasonable, construction should be carried out during the standard daytime working hours. Work generating high noise and/or vibration levels should be scheduled during less sensitive time periods.
Construction respite period during normal hours and out-of-hours work	Ground-borne noise & vibration Airborne noise	See Appendix C of the CNVG for more details on the following respite measures: • Respite Offers (RO) • Respite Period 1 (R1) • Respite Period 2 (R2) • Duration Respite (DR)
Equipment selection.	Airborne noise Ground-borne noise & vibration	Use quieter and less vibration emitting construction methods where feasible and reasonable. For example, when piling is required, bored piles rather than impact-driven piles will minimise noise and vibration impacts. Similarly, diaphragm wall construction techniques, in lieu of sheet piling, will have significant noise and vibration benefits. Ensure plant including the silencer is well maintained.
Plant noise levels.	Airborne-noise	The noise levels of plant and equipment must have operating Sound Power or Sound Pressure Levels compliant with the criteria in Appendix H of the CNVG. Implement a noise monitoring audit program to ensure equipment remains within the more stringent of the manufacturers specifications or Appendix H of the CNVG.
Rental plant and equipment.	Airborne-noise	The noise levels of plant and equipment items are to be considered in rental decisions and in any case cannot be used on site unless compliant with the criteria in Table 2 of the CNVG.
Use and siting of plant.	Airborne-noise	The offset distance between noisy plant and adjacent sensitive receivers is to be maximised. Plant used intermittently to be throttled down or shut down. Noise-emitting plant to be directed away from sensitive receivers. Only have necessary equipment on site.
Plan worksites and activities to minimise noise and vibration.	Airborne noise Ground-borne vibration	Locate compounds away from sensitive receivers and discourage access from local roads. Plan traffic flow, parking and loading/unloading areas to minimise reversing movements within the site. Where additional activities or plant may only result in a marginal noise increase and speed up works, consider limiting duration of impact by concentrating noisy activities at one location and move to another as quickly as possible. Very noise activities should be scheduled for normal working hours. If the work can not be undertaken during the day, it should be completed before 11:00pm. Where practicable, work should be scheduled to avoid major student examination periods when students are studying for examinations such as before or during Higher School Certificate and at the end of higher education semesters. If programmed night work is postponed the work should be re-programmed and the approaches in this guideline apply again.

Action Required	Applies To	Details
Reduced equipment power	Airborne noise Ground-borne vibration	Use only the necessary size and power.
Non-tonal and ambient sensitive reversing alarms	Airborne noise	Non-tonal reversing beepers (or an equivalent mechanism) must be fitted and used on all construction vehicles and mobile plant regularly used on site and for any out of hours work. Consider the use of ambient sensitive alarms that adjust output relative to the ambient noise level.
Minimise disturbance arising from delivery of goods to construction sites.	Airborne noise	Loading and unloading of materials/deliveries is to occur as far as possible from sensitive receivers. Select site access points and roads as far as possible away from sensitive receivers. Dedicated loading/unloading areas to be shielded if close to sensitive receivers. Delivery vehicles to be fitted with straps rather than chains for unloading, wherever possible. Avoid or minimise these out of hours movements where possible.
Engine compression brakes	Construction vehicles	Limit the use of engine compression brakes at night and in residential areas. Ensure vehicles are fitted with a maintained Original Equipment Manufacturer exhaust silencer or a silencer that complies with the National Transport Commission's 'In-service test procedure' and standard.
Path controls		
Shield stationary noise sources such as pumps, compressors, fans etc.	Airborne noise	Stationary noise sources should be enclosed or shielded where feasible and reasonable whilst ensuring that the occupational health and safety of workers is maintained. Appendix D of AS 2436:2010 lists materials suitable for shielding.
Shield sensitive receivers from noisy activities.	Airborne noise	Use structures to shield residential receivers from noise such as site shed placement; earth bunds; fencing; erection of operational stage noise barriers (where practicable) and consideration of site topography when situating plant.
Receptor control		
Structural surveys and vibration monitoring	Ground-borne vibration	Pre-construction surveys of the structural integrity of vibration sensitive buildings may be warranted. At locations where there are high-risk receptors, vibration monitoring should be conducted during the activities causing vibration.
See Appendix C of the CNVG for additional measures	Airborne noise Ground-borne vibration	In some instances, additional mitigation measures may be required.

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