PICTON INTERSECTION UPGRADES

Review of Environmental Factors
Operational Noise Impact Assessment

Prepared for:

Wollondilly Shire Council
62-64 Menangle St, Picton New South Wales 2571

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PREPARED BY

SLR Consulting Australia Pty Ltd

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 Wollondilly Shire Council (the Client). Information reported herein is based on the interpretation of data collected, which has been accepted in good faith as being accurate and valid.

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DOCUMENT CONTROL

Reference	Date	Prepared	Checked	Authorised
630.12706-R02-v0.1	25 September 2019			DRAFT

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1 Introduction

Wollondilly Shire Council proposes to upgrade two intersections south of the Picton Central Business District (CBD).

The Menangle and Prince Street intersection and the Argyle and Prince Street intersection are required to be upgraded in order to meet several council objectives including to maintain road safety, implement the Picton Town Centre Transport Plan 2026, support population growth, improve travel including wait times and traffic flows, as well as lower road maintenance costs. Prince Street currently carries a 7-day average of approximately 7,000 vehicles a day (combined directions) and is a popular route for vehicles travelling between Argyle and Menangle Streets.

1.1 Background

A Review of Environmental Factors (REF report) has been prepared by SLR Consulting Australia Pty Ltd (SLR) on behalf of Wollondilly Shire Council (SLR document reference: *630.12706 Picton Intersection Upgrade REF v1.0* dated March 2019) which summarises the construction noise and vibration impact assessment for the project.

The REF report recommended an operational noise assessment to be undertaken at a later stage using the finalised design to identify the potential for operational road traffic noise impacts at nearby residents.

1.2 Report Objectives

SLR has been engaged by Wollondilly Shire Council to prepare an operational noise assessment for the project.

The aims of this assessment are to:

- Summarise the operational noise assessment for the project
- Identify feasible and reasonable noise mitigation and management measures to be incorporated in the construction planning stage.

This assessment supplements the REF for the project.

1.3 Relevant Guidelines

The noise guidelines for assessment of operations are based on publications managed by the NSW Environment Protection Authority (EPA). The EPA guidelines applicable to this assessment include:

- NSW *Road Noise Policy* (RNP), NSW EPA 2011.

The following additional guidelines are also referenced in this study:

- *Noise Criteria Guideline* (NCG), Roads and Maritime Services, 2015
- *Noise Mitigation Guideline* (NMG), Roads and Maritime Services, 2015.

1.4 Terminology

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

2 The Project

A detailed description of the project is contained in the REF report. This section summarises the key variables which influence operational road noise, including the road design (ie location of the vehicles and surface type) and traffic conditions.

2.1 Road Design

2.1.1 Layout

The project is predominantly within the existing road footprint, with the exception of the left turn from Menangle Street onto Prince Street, the left turn from Princes Street onto Argyle Street and the western side of Argyle Street.

Table 1 Proposed Intersection Design

Intersection	Proposed Design
Argyle Street / Prince Street	The intersection consists of a channelised right turn movement for northbound traffic into Prince Street, a dedicated left turn movement for southbound traffic into Prince Street and a channelised left turn movement for westbound traffic into Argyle Street (Cardno, 2018). This intersection is not signalised. Limited pavement widening is required for the channelised left turn movement into Argyle St and for the northbound through lane on Argyle Street.
Menangle Street / Prince Street	The intersection consists of a channelised right turn movement for southbound traffic into Station Street and Prince Street, and a channelised left turn movement for northbound traffic into Prince Street and Station Street. This intersection will be signalised. The kerb returns on Prince Street are to be improved to allow for vehicles to manoeuvre safely through the turn movements which have resulted in the need for pavement widening and installation of new kerb and gutter. Further pavement widening and new kerb and gutter has occurred on the eastern side of Menangle Street to allow for a 3.5 m through lane for the southbound traffic.

Layout sketches of the proposed intersections are shown in **Figure 1** and **Figure 2**.

Figure 1 Argyle and Prince Street Intersection Design

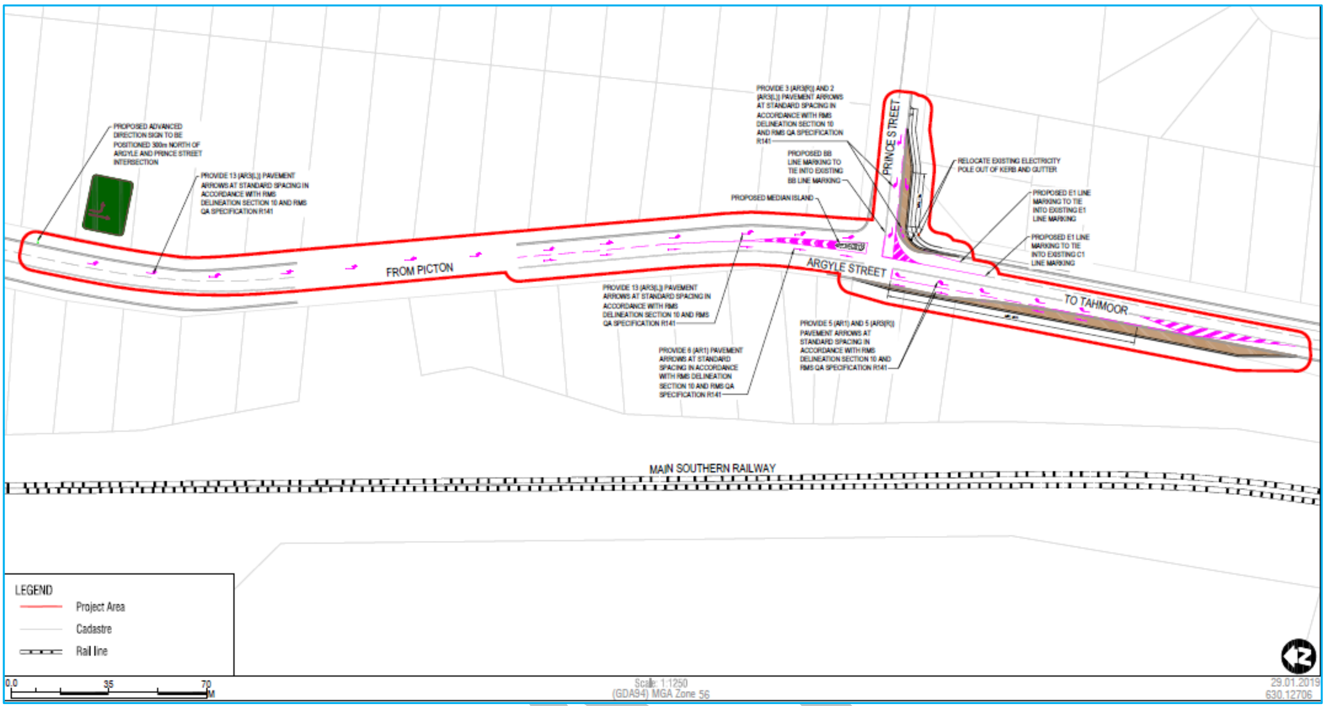
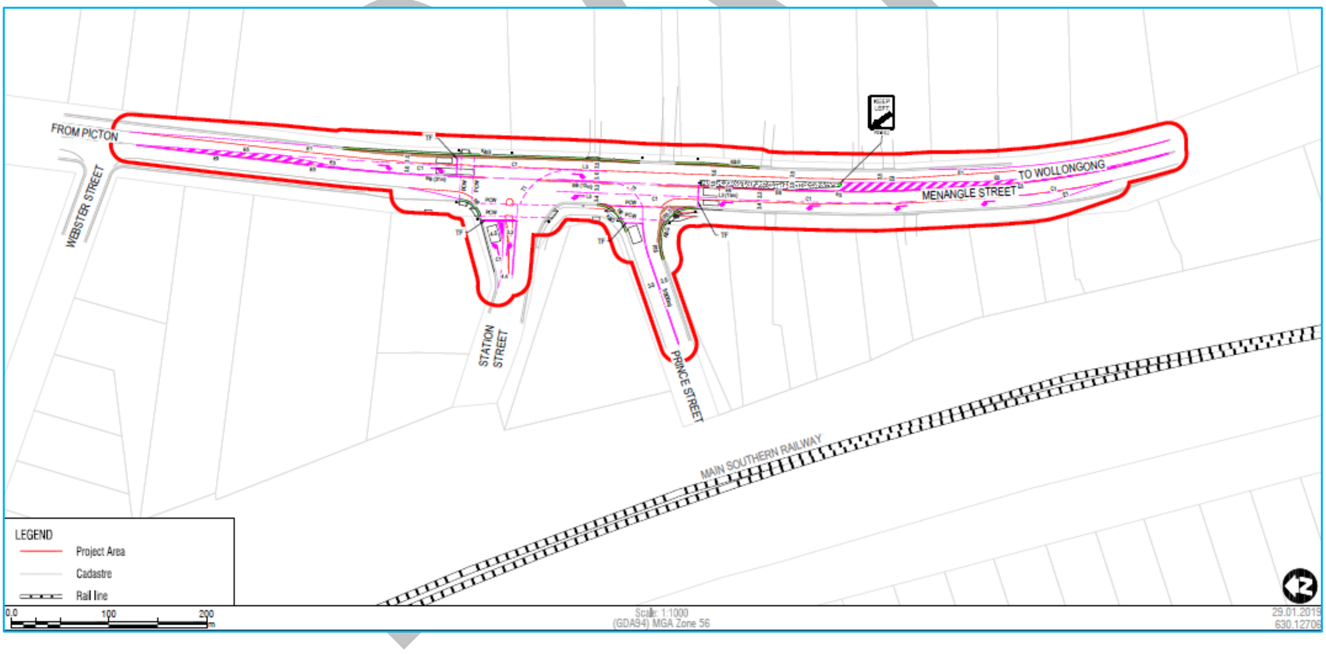


Figure 2 Menangle and Prince Street Intersection Design



2.1.2 Surface Type

No change to the road surface type is proposed as part of the project.

2.2 Traffic

2.2.1 Existing

Prince Street currently carries a 7-day average of around 7,000 vehicles a day (combined directions) and is a popular route for vehicles travelling between Argyle and Menangle Streets. Argyle Street (Old Hume Highway) is considered an approved route for 25 m B-double trucks but only as an emergency route if the Hume Highway is closed between the Yanderra Interchange and Picton Mt-Ousley (RMS, 2019). No heavy vehicles are permitted on Prince and Menangle Street (RMS, 2019).

2.2.2 With Project

The works are safety upgrades and not intended to increase the traffic carrying capacity of the overall road or accommodate a significant increase in heavy vehicle traffic and no changes to traffic volumes, vehicle mix (ie proportion of heavy vehicles) or posted speeds are proposed.

Once completed, the project will improve the traffic flows and wait times around the intersections.

3 Identification of Noise Sensitive Receivers

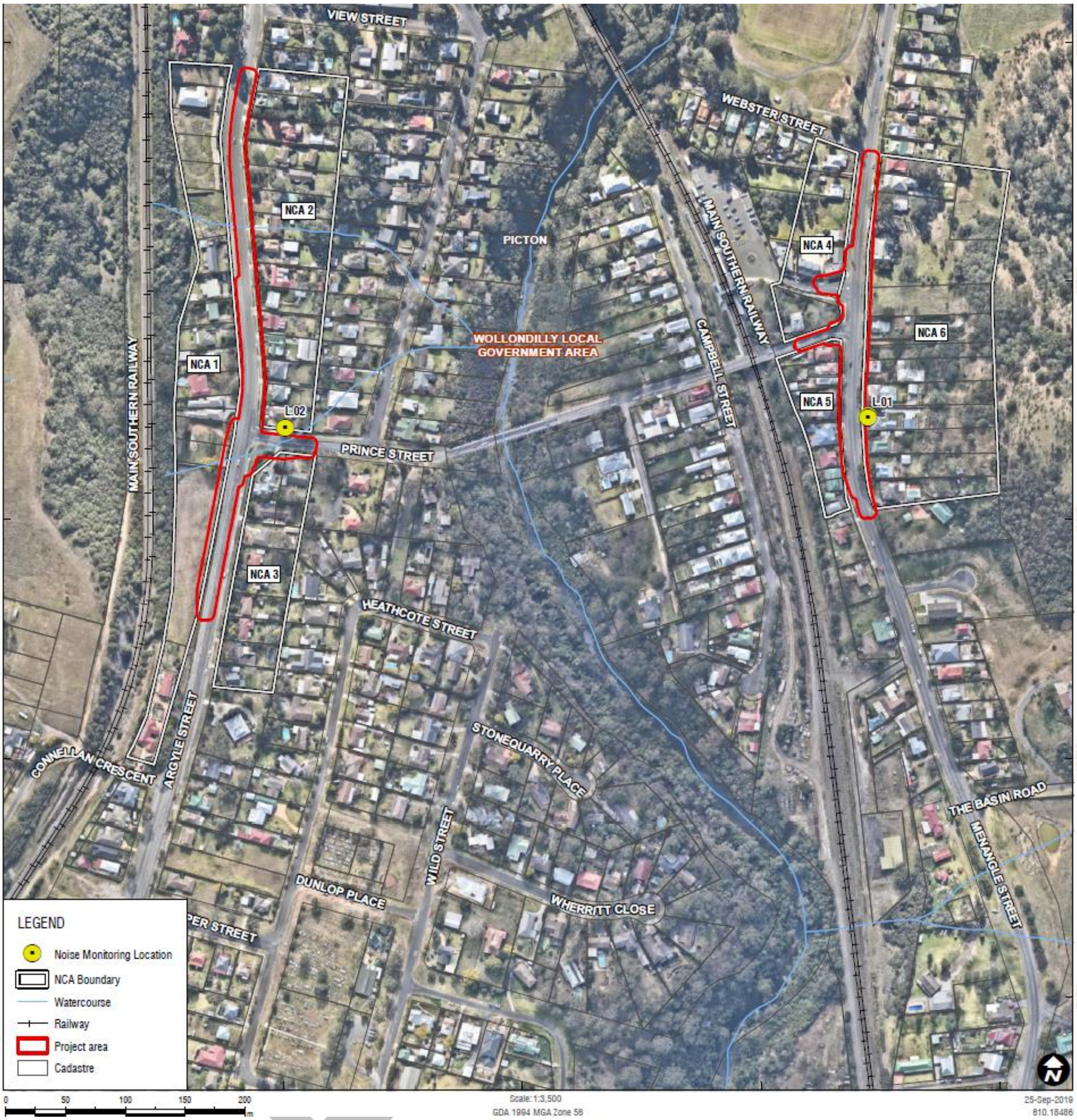
Table 2 provides a summary of the noise sensitive receivers adjacent to the project areas.

Table 2 Representative Noise Sensitive Receivers

NCA	Description	Approximate distance to nearest existing lane
Argyle Street / Prince Street Intersection		
NCA01	Residential receivers west of Argyle Street	10 m
NCA02	Residential receivers east of Argyle Street and north of Prince Street	12 m
NCA03	Residential receivers east of Argyle Street and south of Prince Street	19 m
Menangle Street / Prince Street Intersection		
NCA04	Residential receivers and veterinary centre west of Menangle Street and north of Prince Street.	8 m
NCA05	Residential receivers west of Menangle Street and south of Prince Street	8 m
NCA06	Residential receivers east of Menangle Street	8 m

The location of these noise catchment areas in relation to the project areas is shown in **Figure 3**.

Figure 3 Project Location



4 Existing Noise Environment

4.1 Continuous Unattended Monitoring

Unattended noise monitoring was completed in the study area in June and July 2019. The locations were selected based on an inspection of the potentially affected areas, within constraints such as accessibility, security and land owner permission.

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

The noise monitoring data has been processed to exclude noise from extraneous events and/or data affected by adverse weather conditions, such as strong wind or rain.

The noise monitoring locations are shown in **Figure 3** and the results are summarised in **Table 3**. Details of each monitoring location together with graphs of the measured daily noise levels are provided in **Appendix B**.

Table 3 Unattended Noise Logger Results

Location	Equipment used	Address	Date	Period	Measurement parameter (dBA)	
					LAeq	Typical Maximum Noise (LAmax)
L01	Svantek 957 (serial number 20668)	[redacted]	18/06/2019-5/07/2019	Daytime 7am-10pm	69	80-90
				Night-time 10pm-7am	66	70-85
L02	Svantek 957 (serial number 27580)	[redacted]	20/06/2019-5/07/2019	Daytime 7am-10pm	66	75-90
				Night-time 10pm-7am	62	70-85

The results of unattended noise monitoring show typical noise levels of a suburban noise environment where receivers are located close to an arterial road. Noise levels are typically dominated by road traffic on adjacent roads together with occasional rail traffic noise.

4.2 Operator Attended Measurements

Short-term attended noise monitoring was completed on 18 June 2019. 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**.

5 Minor Works Operational Noise Impact Assessment

5.1 Guidelines and Criteria

The assessment criteria in the NSW EPA *Road Noise Policy* (RNP) are not intended to be applied where projects are limited to minor road works designed to improve safety, such as straightening curves, installing traffic control devices or making minor road alignments.

Instead, assessment of potential noise impacts from projects involving minor works typically follow the minor works assessment process outlined in Roads and Maritime's *Noise Criteria Guideline* (NCG) Section 6.6 and *Noise Mitigation Guideline* (NMG) Section 6.3.

5.1.1 Minor Works Definition

The project is considered as minor works under the following (NCG) definition:

> *Some works may be primarily to improve safety. This may include minor straightening of curves, installing traffic control devices, intersection widening and turning bay extensions or making minor road realignments.*
>
> *These works are not considered redeveloped or new as they are not intended to increase the traffic carrying capacity of the overall road or accommodate a significant increase in heavy vehicle traffic.*

5.1.2 Assessment Procedure

For minor works, the assessment applies the RNP existing noise criteria, shown in **Table 4**, only if noise levels are predicted to increase by more than 2.0 dB at the most affected receivers.

Table 4 Target Noise Abatement Levels for Existing Roads Not Subject to Redevelopment

Existing Road Category	Target Noise Level (dBA)	
	Day (7am–10pm)	Night (10pm–7am)
Freeway/arterial/sub-arterial road	$L_{Aeq(15hour)}$ 60 (external)	$L_{Aeq(9hour)}$ 55 (external)
Local road	$L_{Aeq(1hour)}$ 55 (external)	$L_{Aeq(1hour)}$ 50 (external)

Where an assessment is triggered, consideration of mitigation is required where the total noise level for the 'Build' scenario (with project) exceeds the criterion and there is an increase of more than 2.0 dB, relative to the 'No Build' scenario (without project).

5.1.3 Maximum Noise

The Roads and Maritime *Environmental Noise Management Manual* (ENMM) Practice Note iii is currently applied to evaluate potential sleep disturbance from maximum noise events.

A maximum noise assessment is used as a tool to help prioritise and rank mitigation strategies, rather than a decisive criterion in itself. The objective of the maximum noise level assessment is therefore to determine existing exposure to maximum noise events and indicate whether maximum noise levels are likely to increase or decrease as a result of the project.

A maximum noise level event is defined within the ENMM as being any passby where:

- The maximum noise level of the event is greater than 65 dBA L_{AFmax}; and
- The L_{AFmax} minus $L_{Aeq(1hour)}$ is greater than or equal to 15 dBA.

5.2 Traffic Noise at Intersections

The improved traffic flow through the project areas is due to both the refined lane configurations as well as introducing controlled interrupted flow conditions through the use of traffic lights to improve the existing ad-hoc start-stop traffic.

The flow conditions for interrupted flow due to the introduction of traffic lights may be characterised by periods of relatively low noise levels where traffic is free flowing, followed by periods of higher noise levels as vehicles accelerate away from the traffic lights. While, Roads and Maritime have reported noise complaints from residents in the vicinity of new intersections, roundabouts and traffic lights, research to quantify differences in noise level (free flow compared to interrupted flow) as they relate to the assessment criteria in NSW is not currently regarded as definitive. A Pacific Highway case study by Brown (*The Effect of Signalisation on Road Traffic Noise Levels – A Case Study, Australian Acoustical Society, 1996*) essentially found no difference in $L_{Aeq(18hour)}$ noise levels under signalisation compared to free flow conditions.

Notwithstanding, the interrupted flow conditions may result in changes to the character of the noise and L_{Amax} noise events (eg the maximum noise levels during vehicle acceleration/braking). It is likely that specific differences in noise level for one project could be markedly different from another project of similar scope and will depend on factors such as receiver distance, traffic mix, road layout and existing flow conditions. Where a location is currently congested but without traffic controls, the number of existing start-stop events may be significant compared to a scenario with managed interruptions (eg traffic lights).

Based on the above considerations, the preferred assessment approach for this project is to identify potential noise impacts without further correction for the presence of an intersection. Where the assessment is found to be sensitive to small changes in noise level, it is recommended to undertake compliance noise monitoring following completion of the works to confirm any site specific factors which may influence the noise levels adjacent to the intersections.

5.3 Average Noise Levels

5.3.1 Argyle Street / Prince Street Intersection

No significant change in road geometry is proposed at this location and therefore an increase in noise levels of more than 2.0 dB is not predicted. Consequently, no further assessment is required for the minor works (refer to **Section 5.1**).

5.3.2 Menangle Street / Prince Street Intersection

The nearest residential receivers in NCA06 are likely to be the most affected receivers as a result of the project and currently experience relatively high levels of road traffic noise that are above the nominated criteria (refer to **Section 5.1**).

The additional southbound through-lane at this location would create a new 3.5m wide lane to the east of the existing southbound lane to provide a dedicated right turn lane. This would likely result in increased noise levels at receivers to the east of the widening southbound lane (ie at 208 to 224 Menangle Street).

The potential increase in road traffic noise levels from the modification of the intersection has been estimated using the CoRTN algorithm and assumes the same mix of vehicles on both south and northbound carriageways.

The results indicate that the road traffic noise levels are predicted to increase by around 1.5 dB at the nearest residential receivers on Menangle Street located immediately to the east of the widened lane.

Negligible changes in the noise are anticipated at other locations where the design results in marginal refinements to the location of the trafficable lanes or moves traffic further away from the receivers.

The RNP notes that an increase of up to 2 dB represents a minor impact that is considered barely perceptible to the average person and therefore it is considered unlikely that mitigation would be required on the basis of the average (ie $L_{Aeq(period)}$) noise assessment for these minor works.

5.4 Maximum Noise Events

5.4.1 Existing Exposure

The maximum noise levels measured during the noise survey (refer to **Section 4.1**) are shown in **Appendix C**. A summary of the maximum noise level assessment is provided in **Table 5**.

Table 5 Maximum Noise Event Assessment

Monitoring location	Total night-time events within the monitoring period	Average number of events per night	Measured maximum noise level (dBA L_{AFmax})	
			Range	Median
L.01 - [redacted]	1,065	63	70-94	79
L.02 - [redacted]	624	42	66-89	73

The above results indicate that existing maximum noise events near the intersections from traffic are relatively high and exceed the nominated screening levels presented in **Section 5.1.3.** The existing flow environment is characterised as “interrupted” within the study area.

5.4.2 Predicted Maximum Noise Events with the Project

Traffic volumes and posted speeds are not proposed to change as a result of the project and therefore, no additional noise events are anticipated outside of the immediate intersection area.

The proposed modifications would introduce planned “interruptions” due to traffic signals as well as providing clearer free flow periods and refinements to the configuration to improve traffic flow. This may decrease L_{Amax} noise levels for individual vehicle pass-bys in cases where the existing L_{Amax} is due to noise from vehicle acceleration or deceleration (eg engine braking on trucks).

At the Menangle Street / Prince Street intersection, the south bound through-lane moves closer to the receivers compared to the existing alignment and this may result in an increase in L_{Amax} noise levels for these receivers (NCA06 to the east of Menangle Street).

It should also be noted that strategies are currently being implemented to reduce road traffic noise across the State road network which may reduce the number of maximum noise levels events over the longer term.

These strategies include metropolitan plans to increase the use of public transport, state wide plans for upgrades of major transport routes, and national initiatives to reduce heavy vehicle engine brake noise and road freight haulage.

In addition, state wide strategies for sharing freight with rail modes are expected to result in reduced noise from heavy vehicle freight on roads in many areas and a corresponding reduction in high noise level events from road traffic.

6 Recommendations

An increase in L_{Aeq} road traffic noise levels of around 1.5 dB is predicted for receivers to the east of the widened Menagle Street. Increases of less than 2.0 dB are generally considered not to be perceptible for most people. Maximum noise levels are also predicted to potentially increase for receivers to the east of Menangle Street.

It is recommended that post-construction noise monitoring is undertaken to confirm the predicted change in noise levels and resulting mitigation requirement for the project. If mitigation is required, it would likely consist of architectural at-property treatments for habitable rooms to improve the acoustic performance of the building with respect to road traffic noise. The extent of treatments depends on the existing construction of the building and magnitude of the noise impacts. Noise barriers are unlikely to be feasible for this project area due to access requirements for adjacent receivers.

The most affected receivers are likely to be those in NCA06 as a result of the road widening moving the nearest trafficable lane closer to these receivers.

APPENDIX A

Acoustic Terminology

1. Sound Level or Noise Level

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

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

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

2. 'A' Weighted Sound Pressure Level

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

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

A change of 1 dB or 2 dB in the level of a sound is difficult for most people to detect, whilst a 3 dB to 5 dB change corresponds to a small but noticeable change in loudness. A 10 dB change corresponds to an approximate doubling or halving in loudness. The table below lists examples of typical noise levels.

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

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

3. Sound Power Level

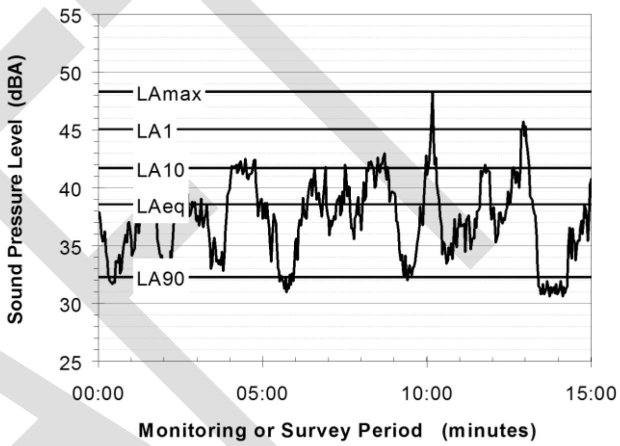
The Sound Power of a source is the rate at which it emits acoustic energy. As with Sound Pressure Levels, Sound Power Levels are expressed in decibel units (dB or dBA), but may be identified by the symbols SWL or LW, or by the reference unit 10^{-12} W.

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

4. Statistical Noise Levels

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

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



Of particular relevance, are:

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

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

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

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

5. Frequency Analysis

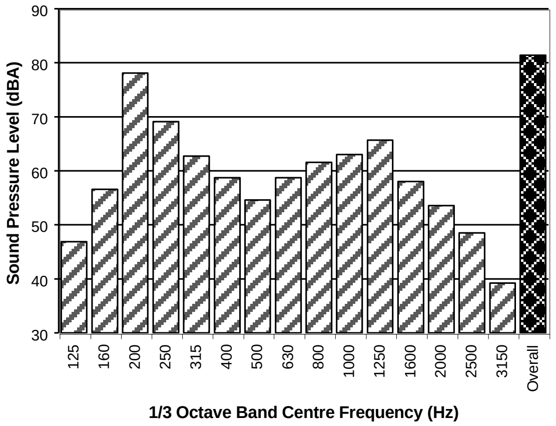
Frequency analysis is the process used to examine the tones (or frequency components) which make up the overall noise or vibration signal.

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

Frequency analysis can be in:

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

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



6. Annoying Noise (Special Audible Characteristics)

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

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

7. Vibration

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

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

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

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

8. Human Perception of Vibration

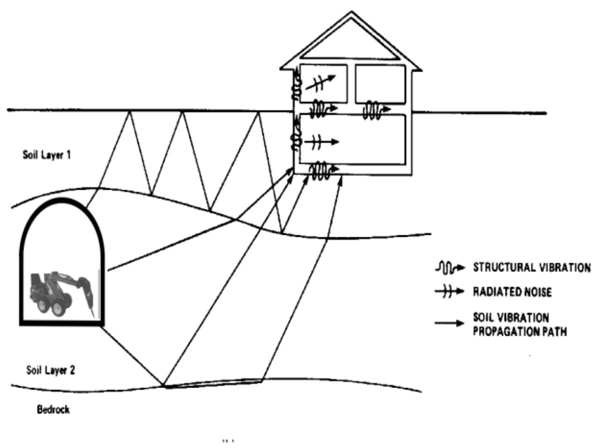
People are able to 'feel' vibration at levels lower than those required to cause even superficial damage to the most susceptible classes of building (even though they may not be disturbed by the motion). An individual's perception of motion or response to vibration depends very strongly on previous experience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

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

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

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

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



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

APPENDIX B

Noise Monitoring Results

Noise Monitoring Location	L.01
Noise Monitoring Address	[redacted]

Logger Device Type: Svantek 957, Logger Serial No: 20668
Sound Level Meter Device Type: Brüel and Kjær 2250L, Sound Level Meter Serial No: 3004636

Ambient noise logger deployed at [redacted] Logger located with view of Menangle Street and the Prince Street/Menangle Street intersection to the north.

Attended noise measurements indicate the ambient noise environment at this location is dominated by road traffic noise from Menangle Street. Frequent light and heavy-vehicle passbys on Menangle Street contribute to the LAeq at this location.

Recorded Noise Levels (LAmax):
18/06/2019: Light-vehicle traffic Menangle St: 65-78 dBA, Heavy-vehicle traffic Menangle St: 74-84 dBA, Aircraft: 50 dBA, Birds: 50-60 dBA, Distant traffic: 45-50 dBA

Map of Noise Monitoring Location

Ambient Noise Logging Results – ICNG Defined Time Periods

Monitoring Period	Noise Level (dBA)			
	RBL	**LAeq**	**L10**	**L1**
Daytime	47	70	73	79
Evening	41	67	71	76
Night-time	28	66	65	74

Ambient Noise Logging Results – RNP Defined Time Periods

Monitoring Period	Noise Level (dBA)	
	LAeq(period)	**LAeq(1hour)**
Daytime (7am-10pm)	69	71
Night-time (10pm-7am)	66	72

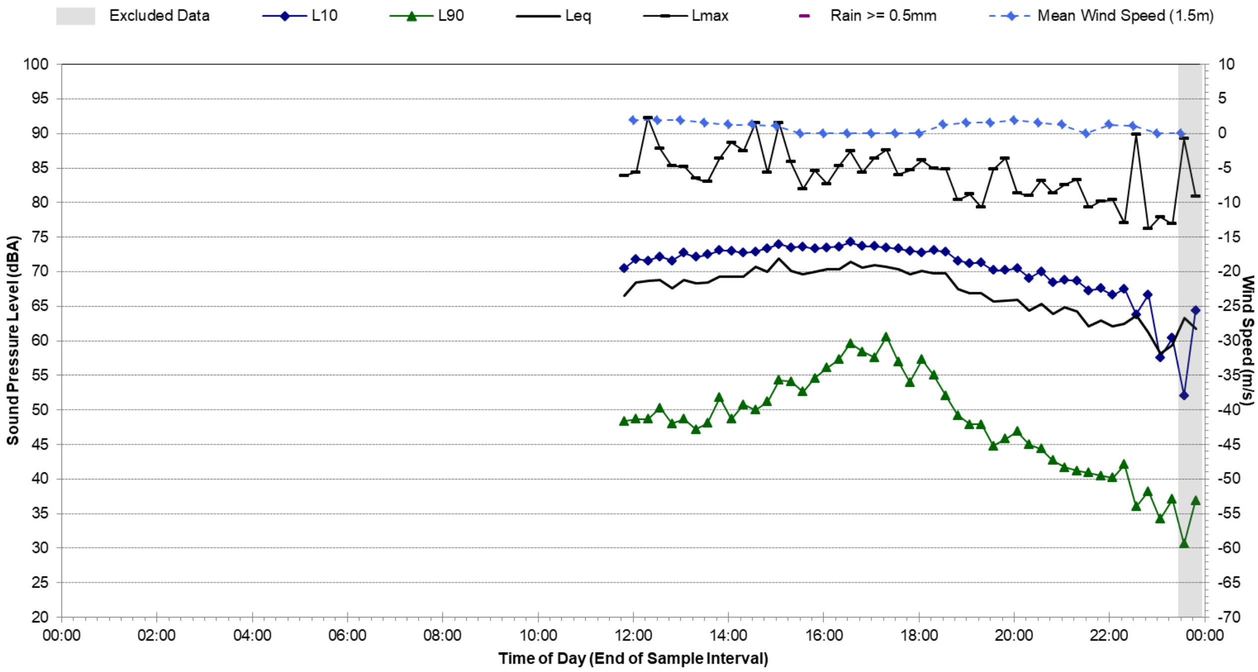
Attended Noise Measurement Results

Date	Start Time	Measured Noise Level (dBA)		
		LA90	**LAeq**	**LAmax**
18/06/2019	11:07	48	67	84

Photo of Noise Monitoring Location

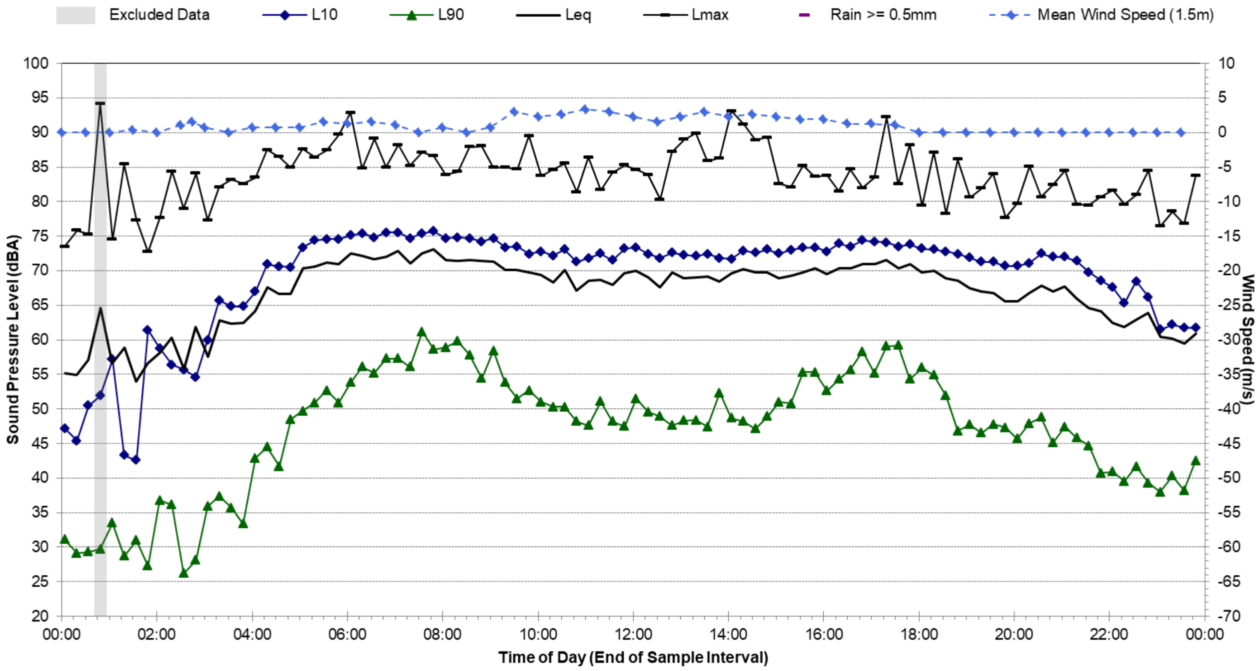
Statistical Ambient Noise Levels

L.01 - [redacted] - Tuesday, 18 June 2019



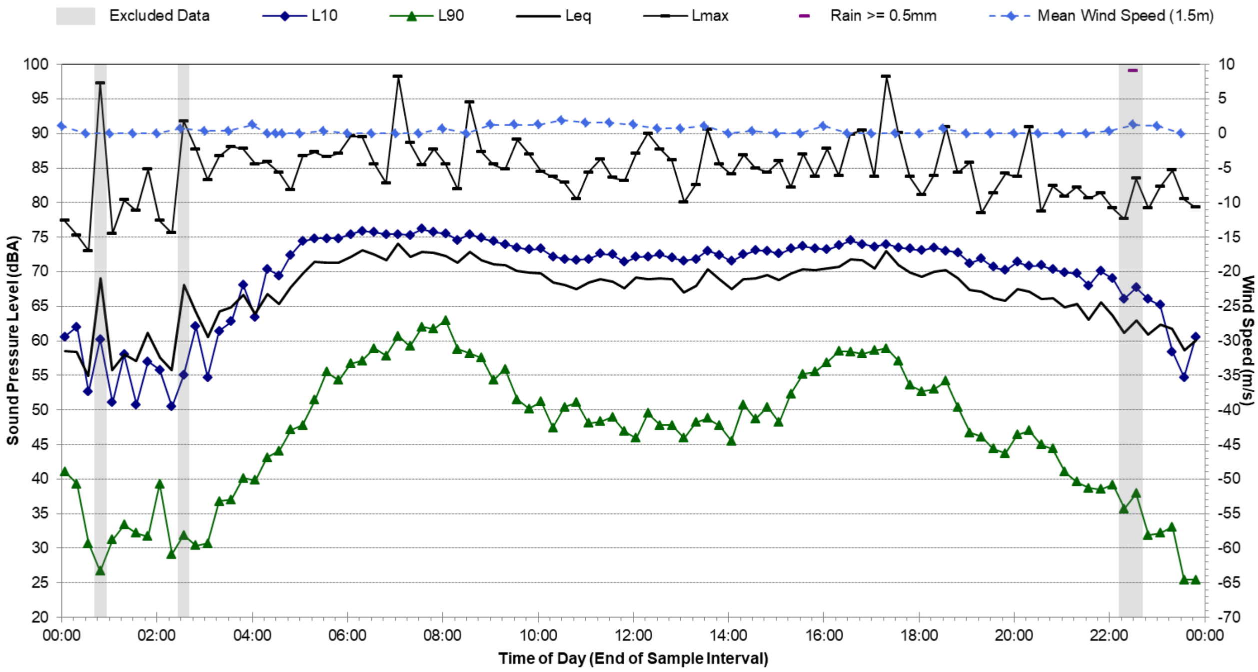
Statistical Ambient Noise Levels

L.01 - [redacted] - Wednesday, 19 June 2019



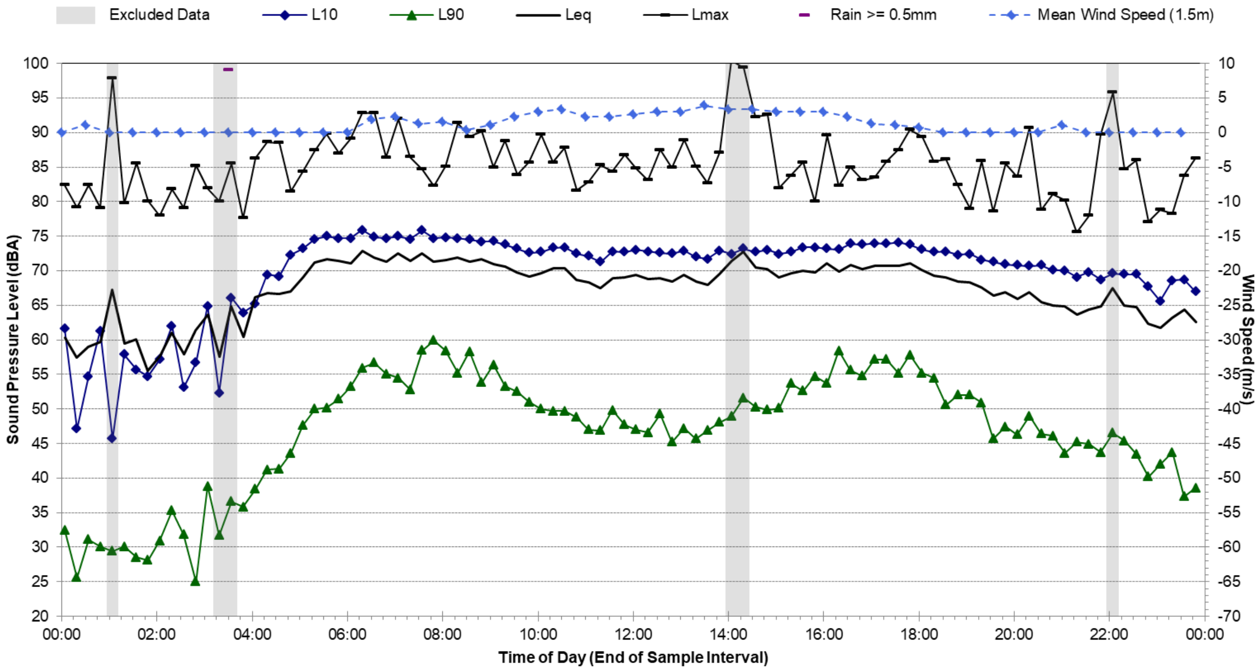
Statistical Ambient Noise Levels

L.01 - [redacted] - Thursday, 20 June 2019



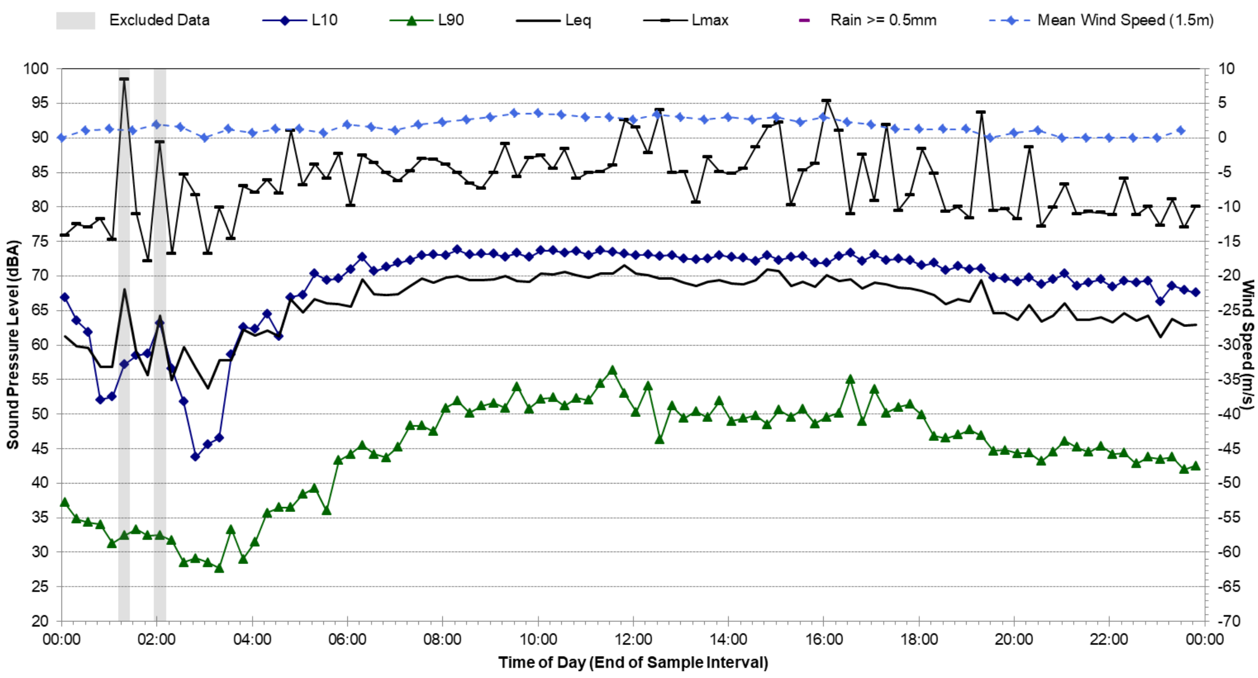
Statistical Ambient Noise Levels

L.01 - [redacted] - Friday, 21 June 2019



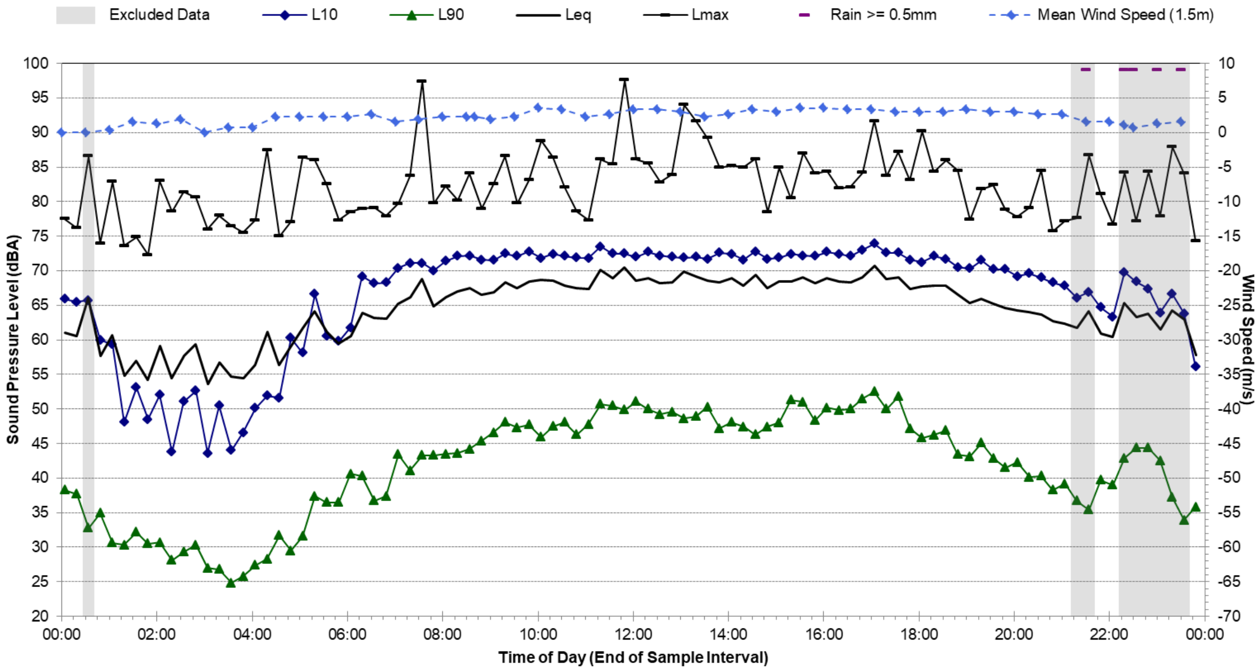
Statistical Ambient Noise Levels

L.01 - [redacted] - Saturday, 22 June 2019



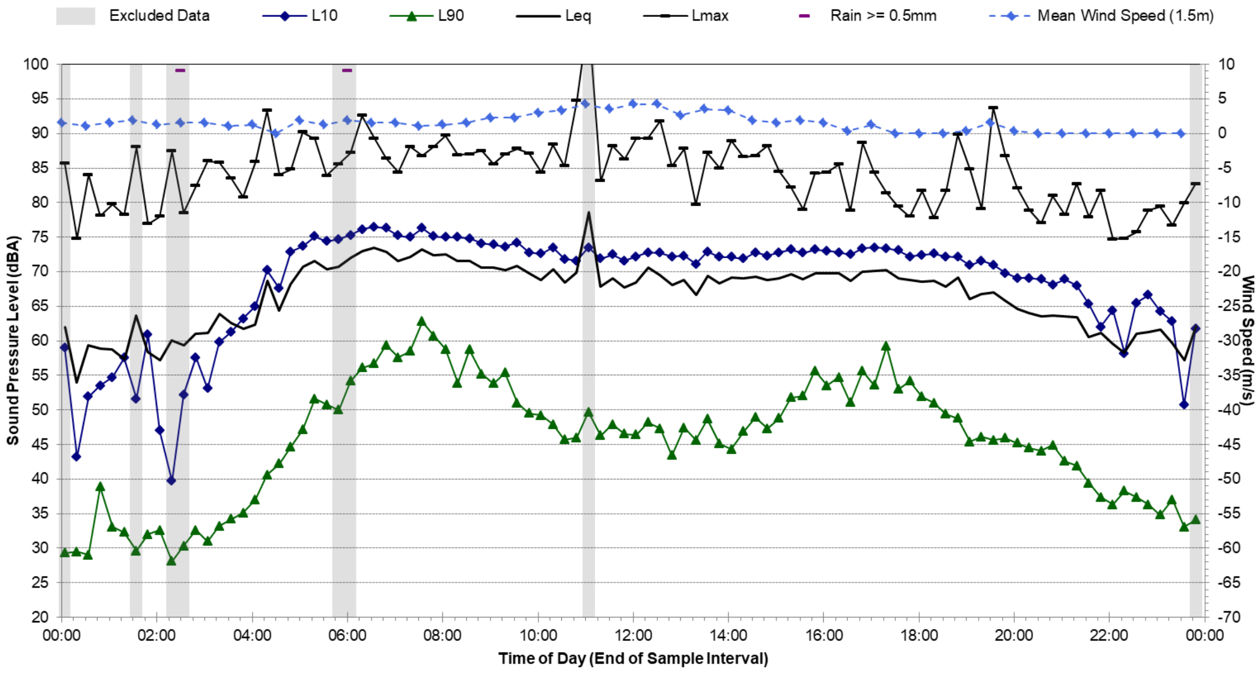
Statistical Ambient Noise Levels

L.01 - [redacted] - Sunday, 23 June 2019



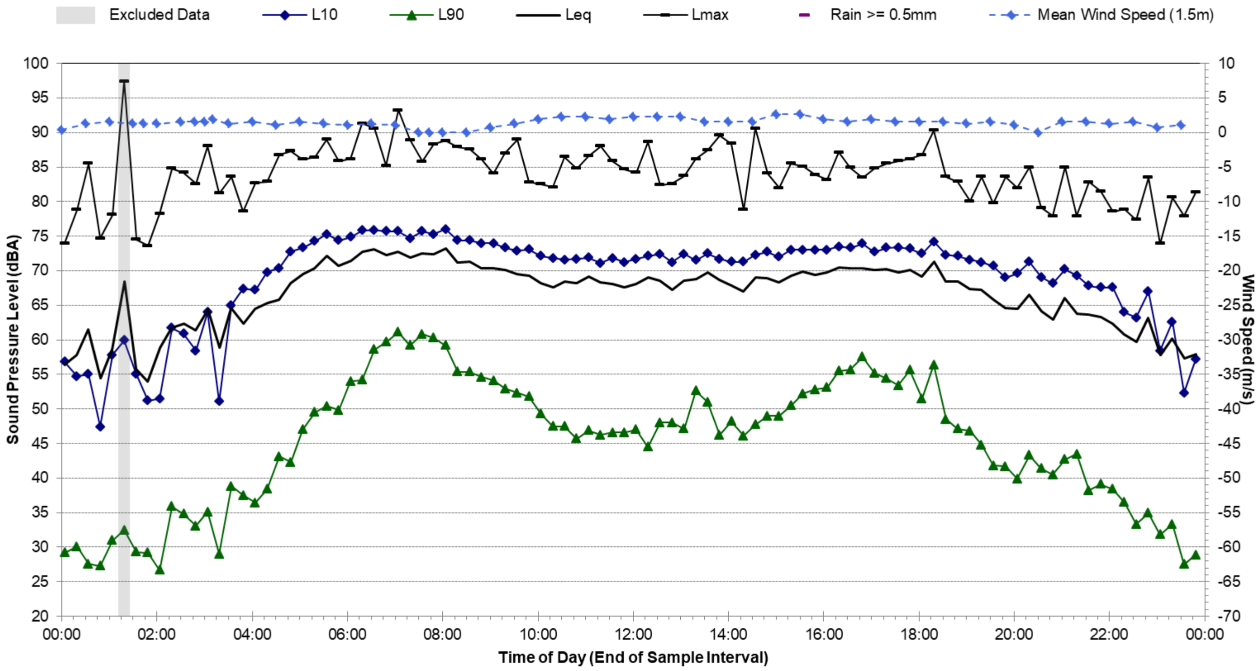
Statistical Ambient Noise Levels

L.01 - [redacted] - Monday, 24 June 2019



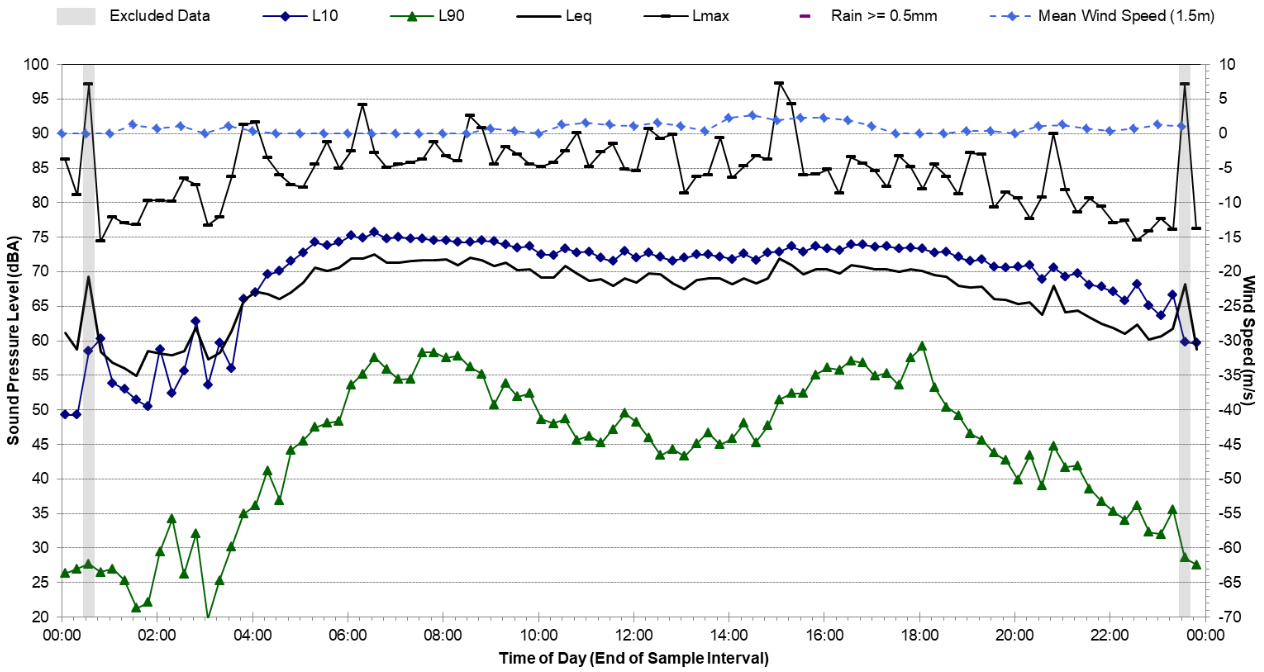
Statistical Ambient Noise Levels

L.01 - [redacted] - Tuesday, 25 June 2019



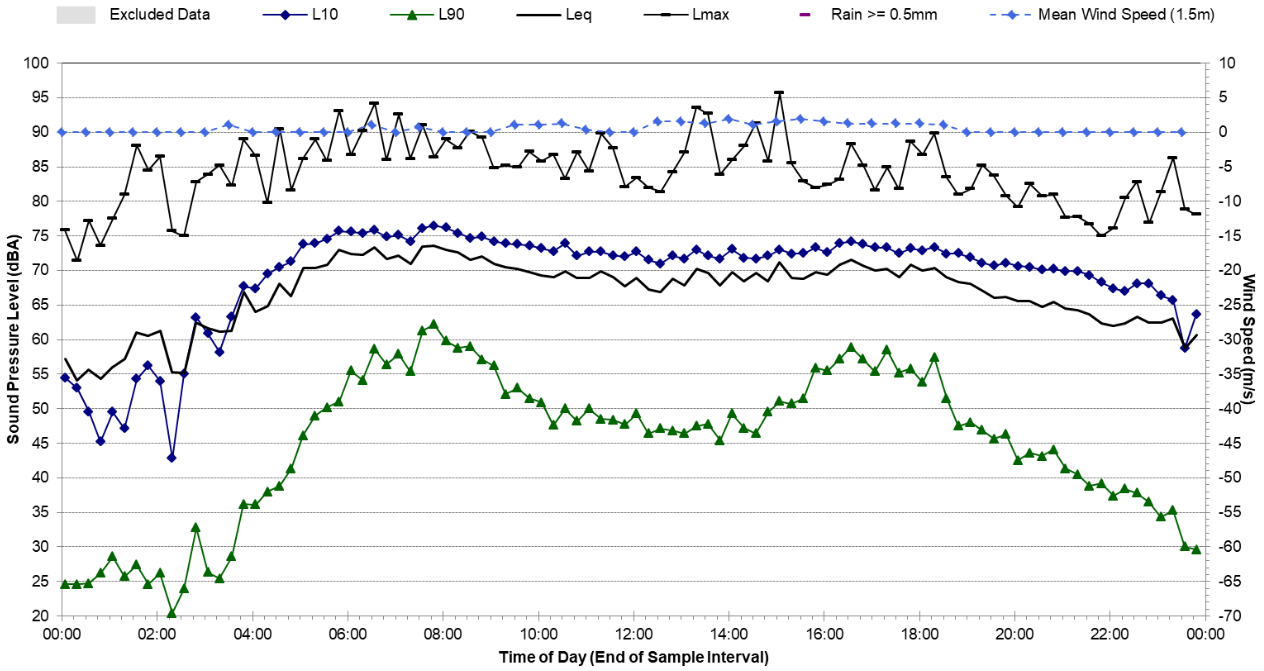
Statistical Ambient Noise Levels

L.01 - [redacted] - Wednesday, 26 June 2019



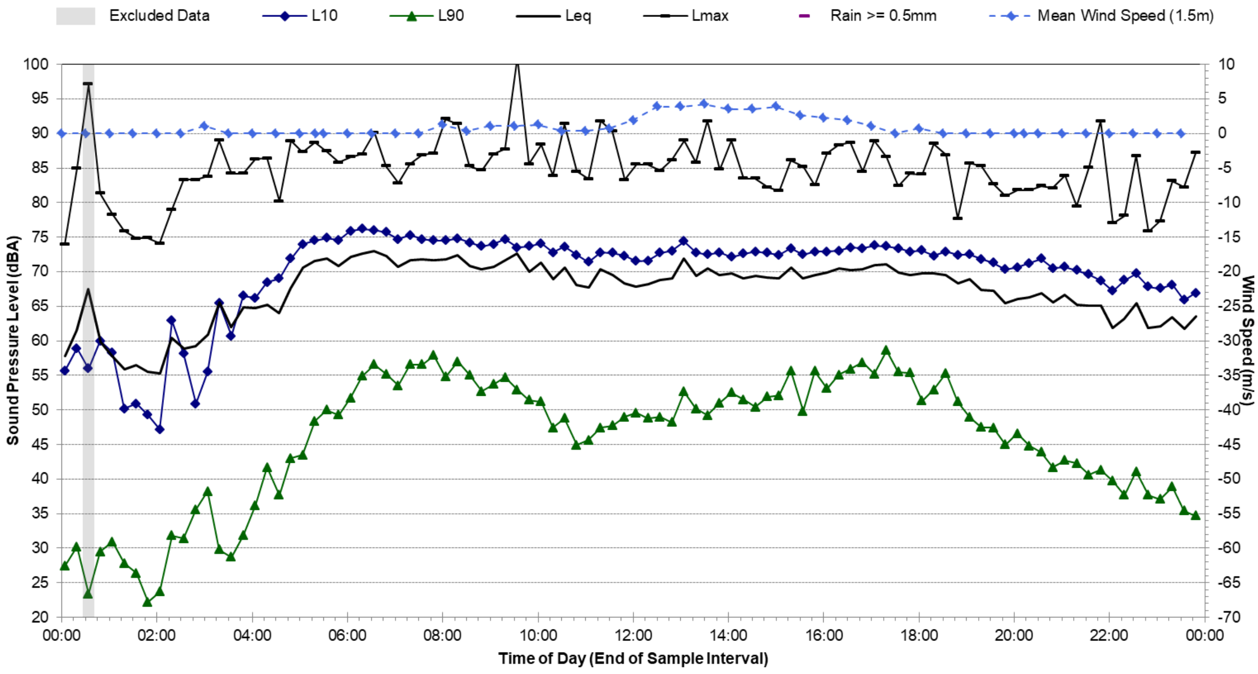
Statistical Ambient Noise Levels

L.01 - [redacted] - Thursday, 27 June 2019



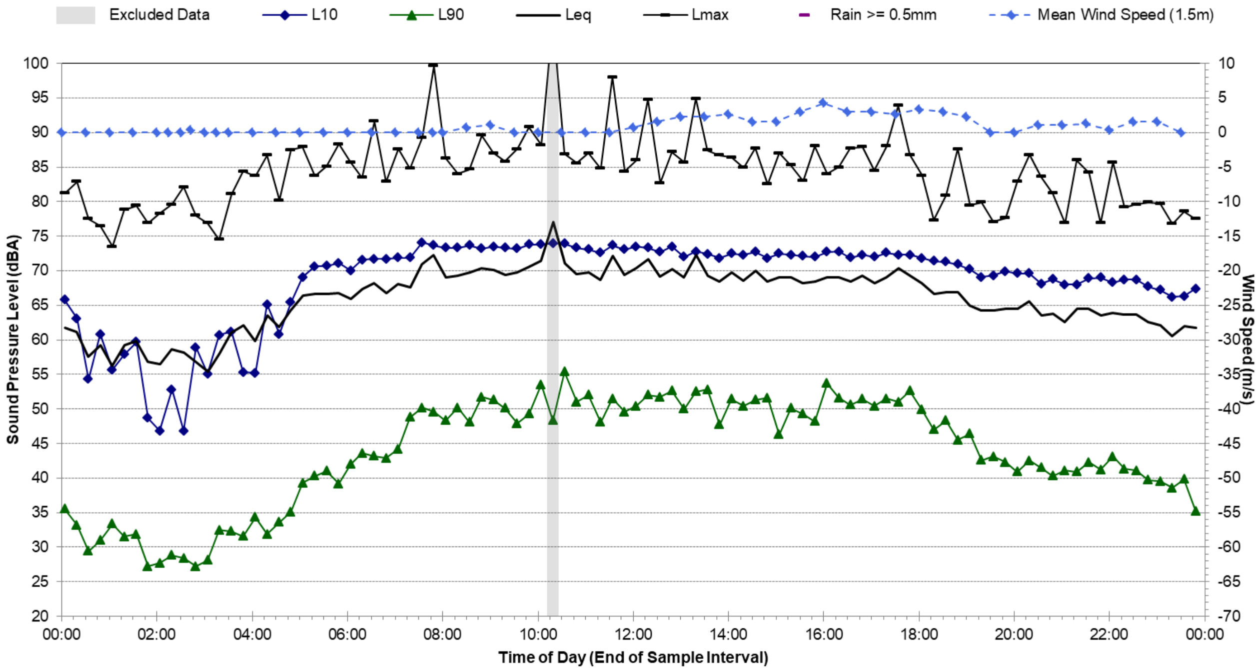
Statistical Ambient Noise Levels

L.01 - [redacted] - Friday, 28 June 2019



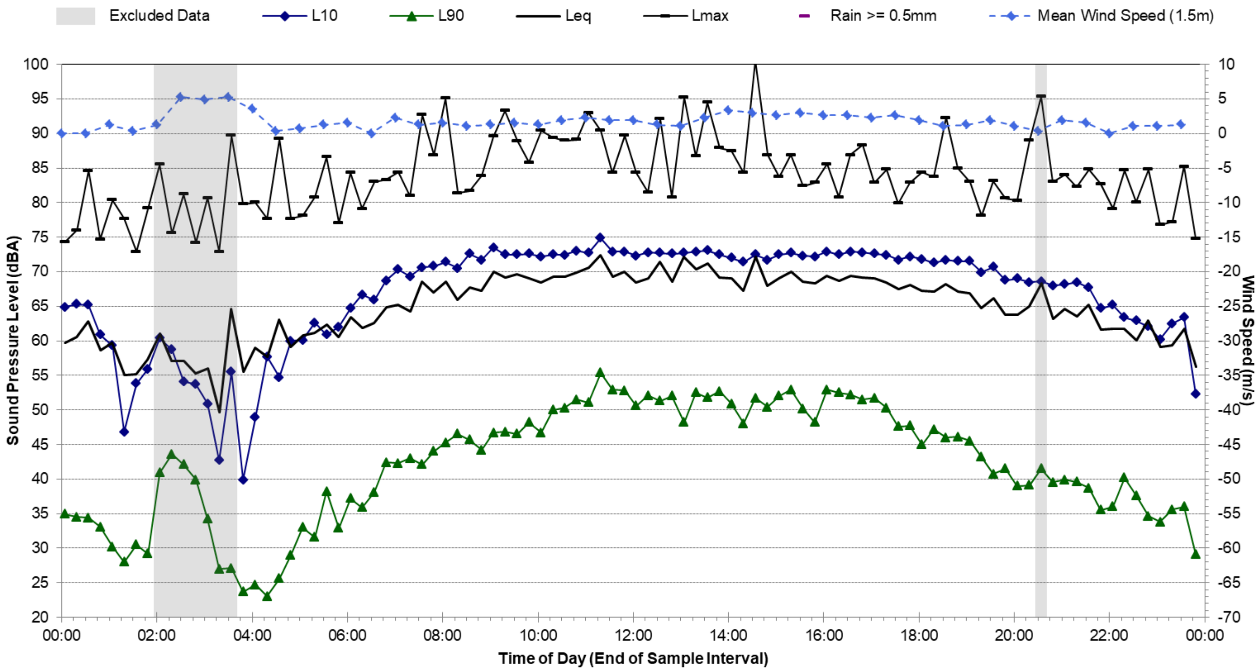
Statistical Ambient Noise Levels

L.01 - [redacted] - Saturday, 29 June 2019



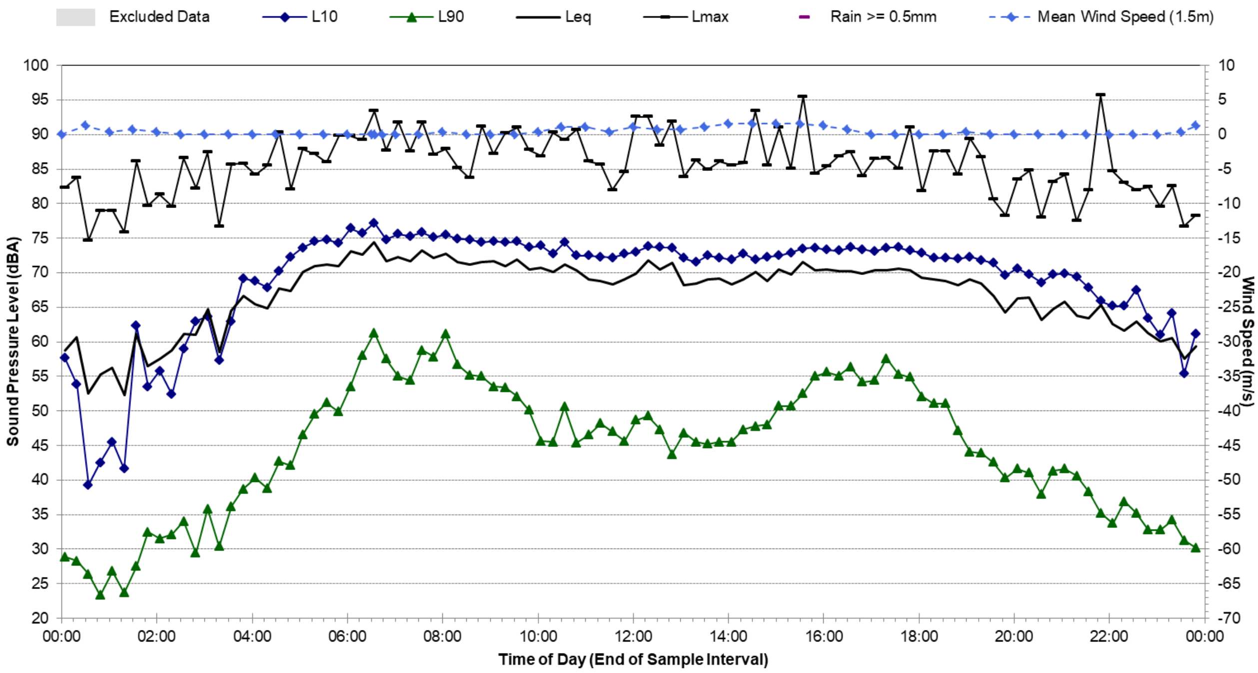
Statistical Ambient Noise Levels

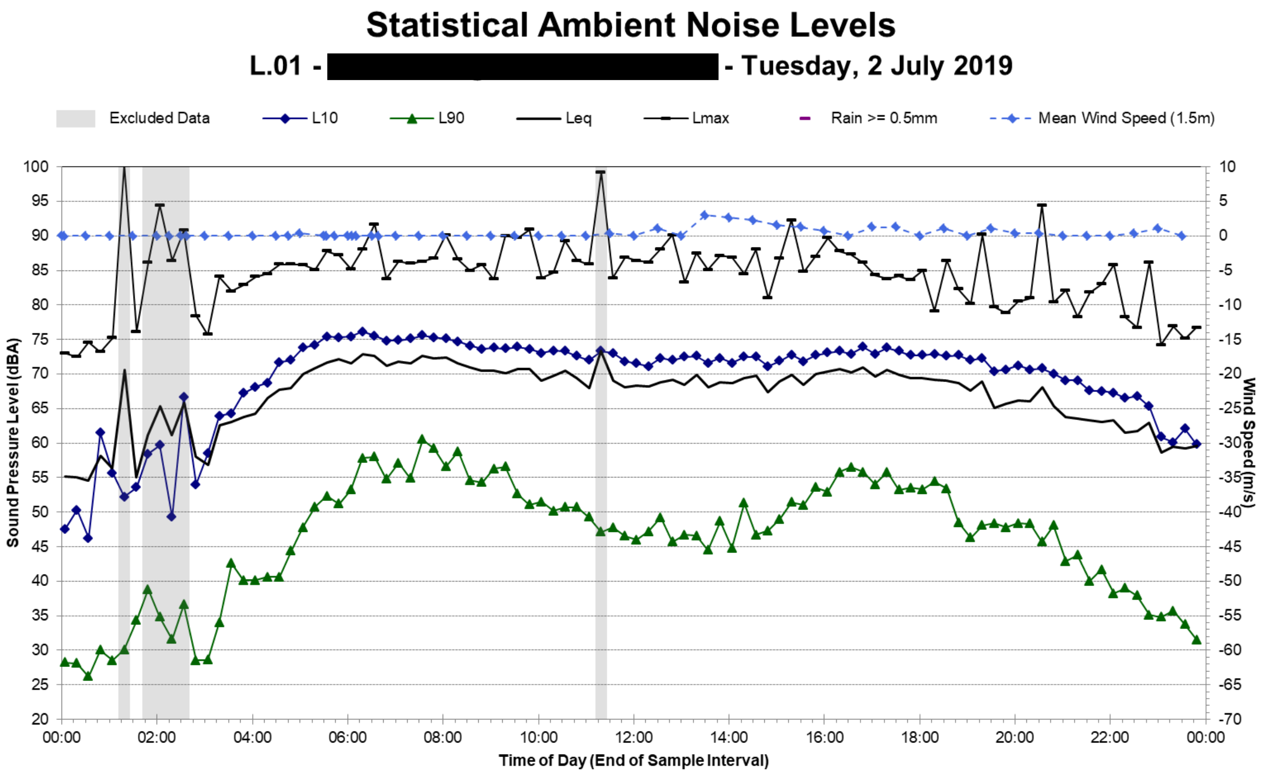
L.01 - [redacted] - Sunday, 30 June 2019



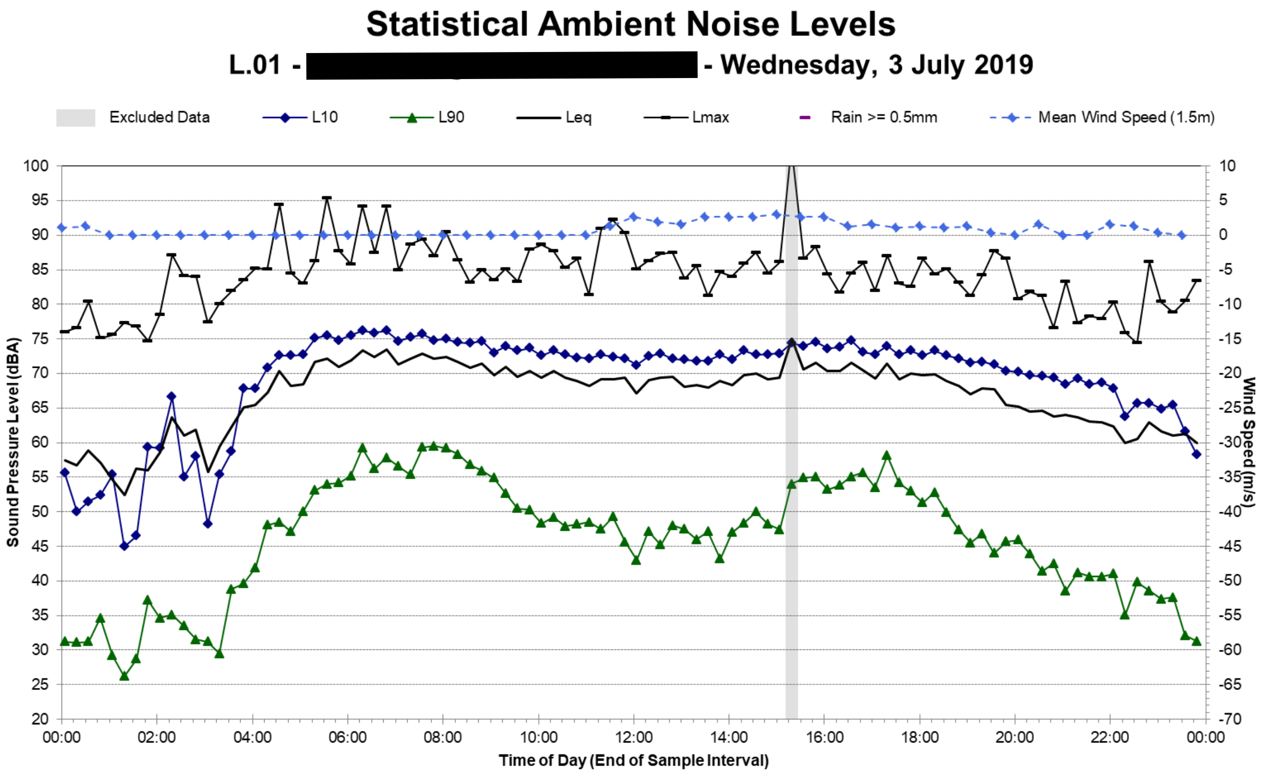
Statistical Ambient Noise Levels

L.01 - [redacted] - Monday, 1 July 2019





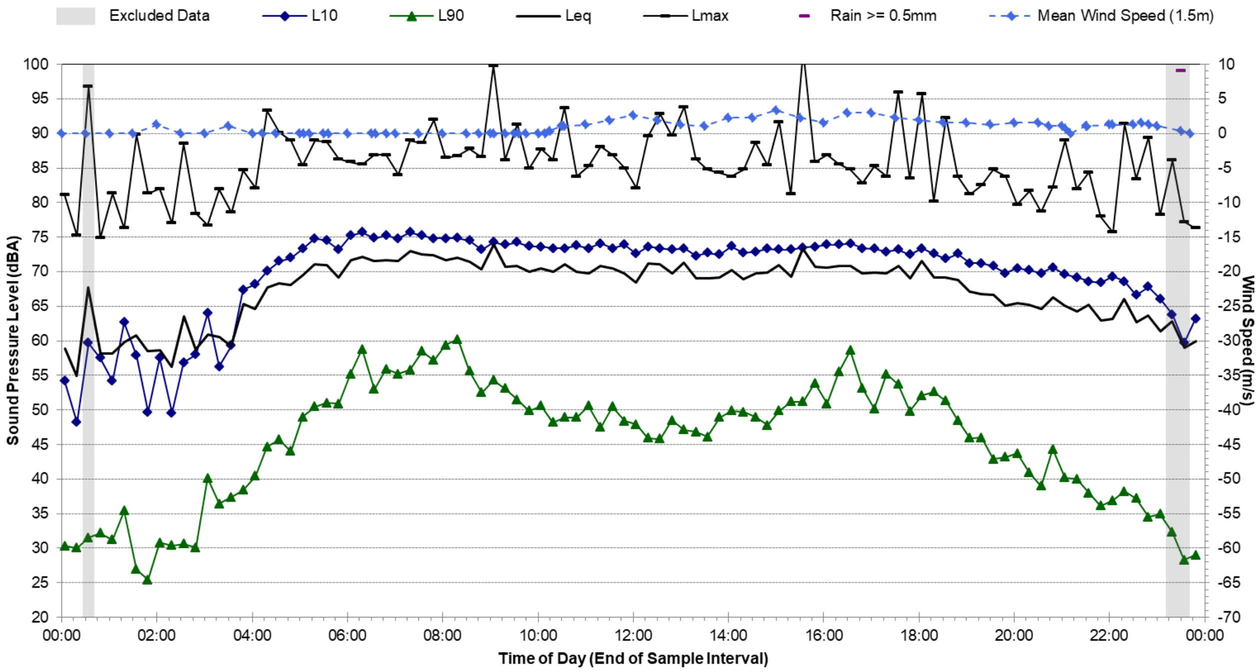
Statistical Ambient Noise Levels
L.01 - [redacted] - Tuesday, 2 July 2019
Excluded Data
L10
L90
Leq
Lmax
Rain >= 0.5mm
Mean Wind Speed (1.5m)
Sound Pressure Level (dBA)
Wind Speed (m/s)
Time of Day (End of Sample Interval)



Statistical Ambient Noise Levels
L.01 - [redacted] - Wednesday, 3 July 2019
Excluded Data
L10
L90
Leq
Lmax
Rain >= 0.5mm
Mean Wind Speed (1.5m)
Sound Pressure Level (dBA)
Wind Speed (m/s)
Time of Day (End of Sample Interval)

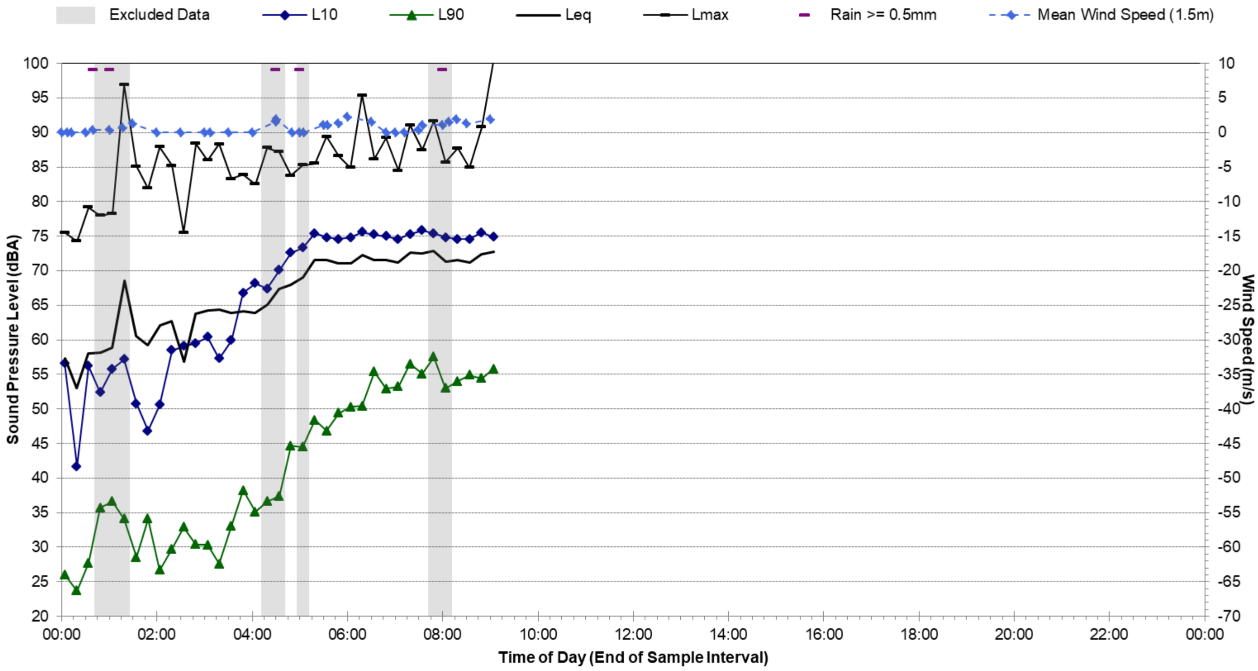
Statistical Ambient Noise Levels

L.01 - [redacted] - Thursday, 4 July 2019



Statistical Ambient Noise Levels

L.01 - [redacted] - Friday, 5 July 2019



Noise Monitoring Location	L.02
Noise Monitoring Address	[redacted]

Logger Device Type: Svantek 957, Logger Serial No: 27580
Sound Level Meter Device Type: Brüel and Kjær 2250L, Sound Level Meter Serial No: 3004636

Ambient noise logger deployed at [redacted] Logger located with view of Prince Street, Argyle Street, and the Prince Street/Argyle Street intersection.

Attended noise measurements indicate the ambient noise environment at this location is dominated by road traffic noise from Argyle Street. Frequent light and heavy-vehicle passbys on Argyle Street, less frequent vehicle passbys on Prince Street, and rail traffic contribute to the LAeq at this location.

Recorded Noise Levels (LAmax):
18/06/2019: Light-vehicle traffic Argyle St: 60-73 dBA, Heavy-vehicle traffic Argyle St: 73-73 dBA,
Light-vehicle traffic Prince St: 68-70 dBA, Motorbike Prince St: 85 dBA, Train: 65-70 dBA, Birds/dogs: 55-74 dBA,
Distant traffic: 50-55 dBA

Map of Noise Monitoring Location

Ambient Noise Logging Results – ICNG Defined Time Periods

Monitoring Period	Noise Level (dBA)			
	RBL	LAeq	L10	L1
Daytime	55	66	69	74
Evening	43	64	67	72
Night-time	29	62	62	71

Ambient Noise Logging Results – RNP Defined Time Periods

Monitoring Period	Noise Level (dBA)	
	LAeq(period)	LAeq(1hour)
Daytime (7am-10pm)	66	67
Night-time (10pm-7am)	62	66

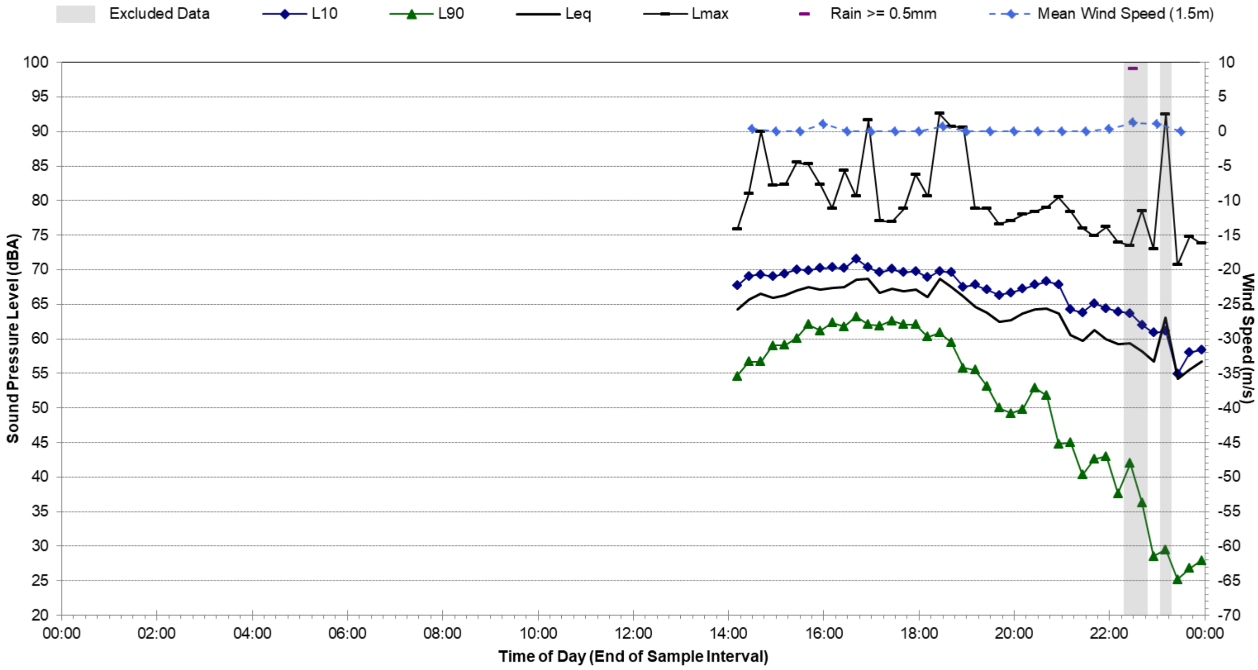
Attended Noise Measurement Results

Date	Start Time	Measured Noise Level (dBA)		
		LA90	LAeq	LAmax
18/06/209	10:20	53	64	85

Photo of Noise Monitoring Location

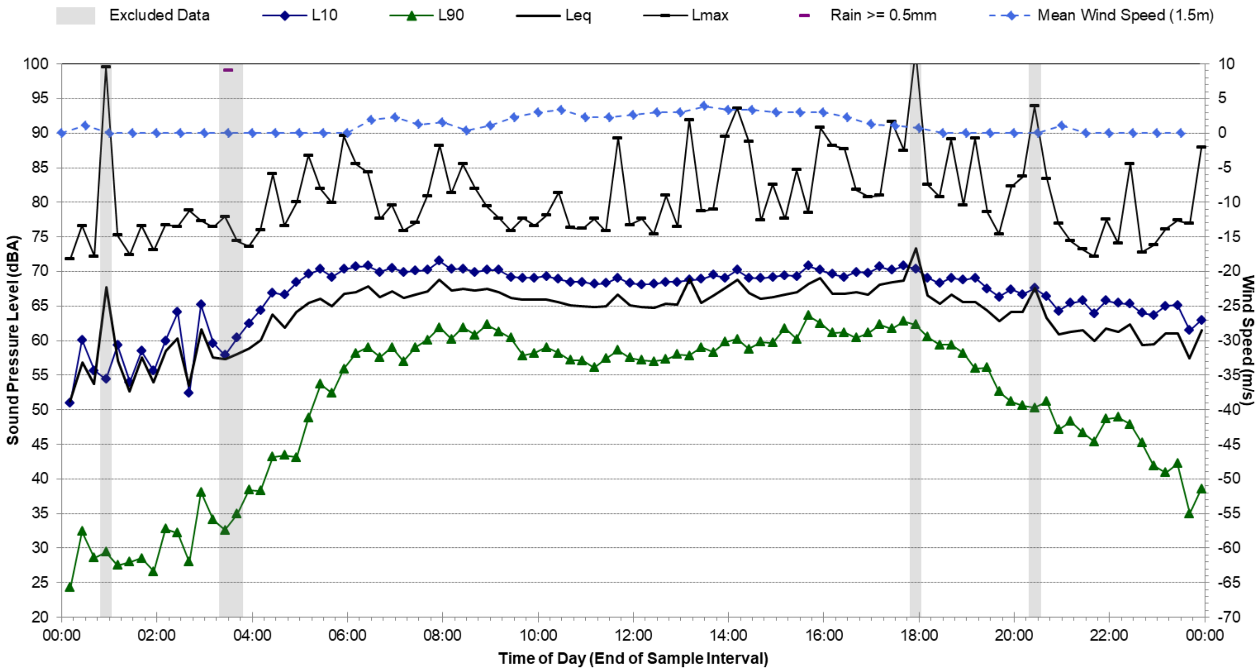
Statistical Ambient Noise Levels

L.02 - [redacted] - Thursday, 20 June 2019



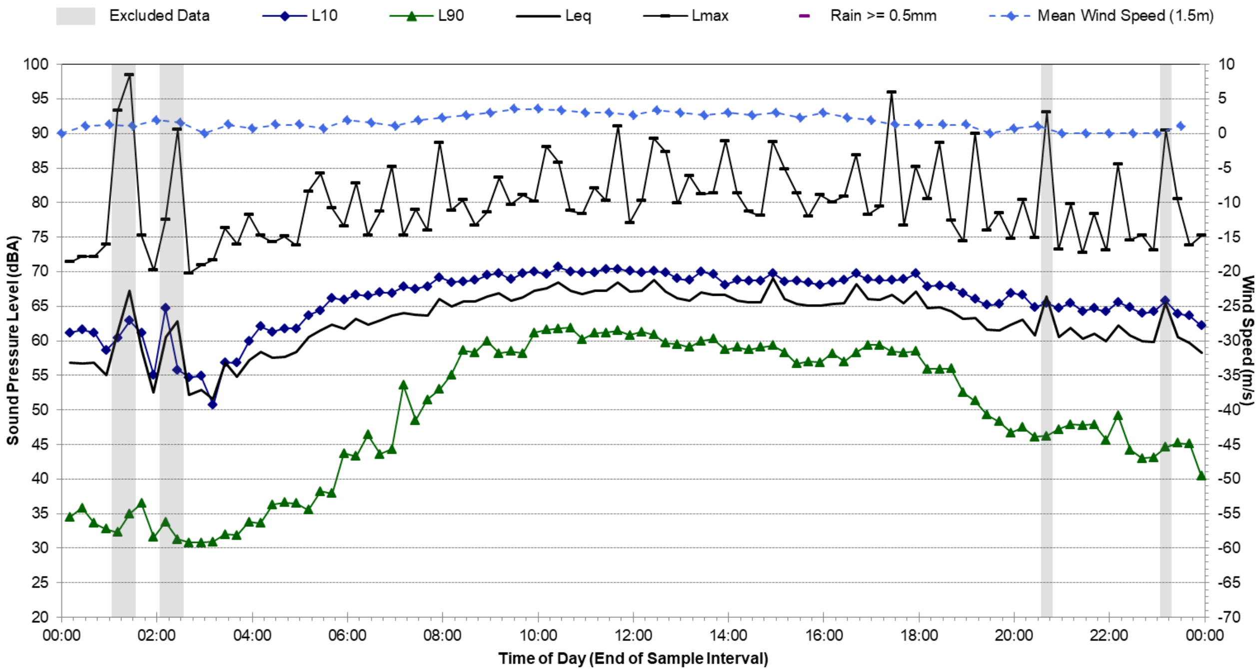
Statistical Ambient Noise Levels

L.02 - [redacted] - Friday, 21 June 2019



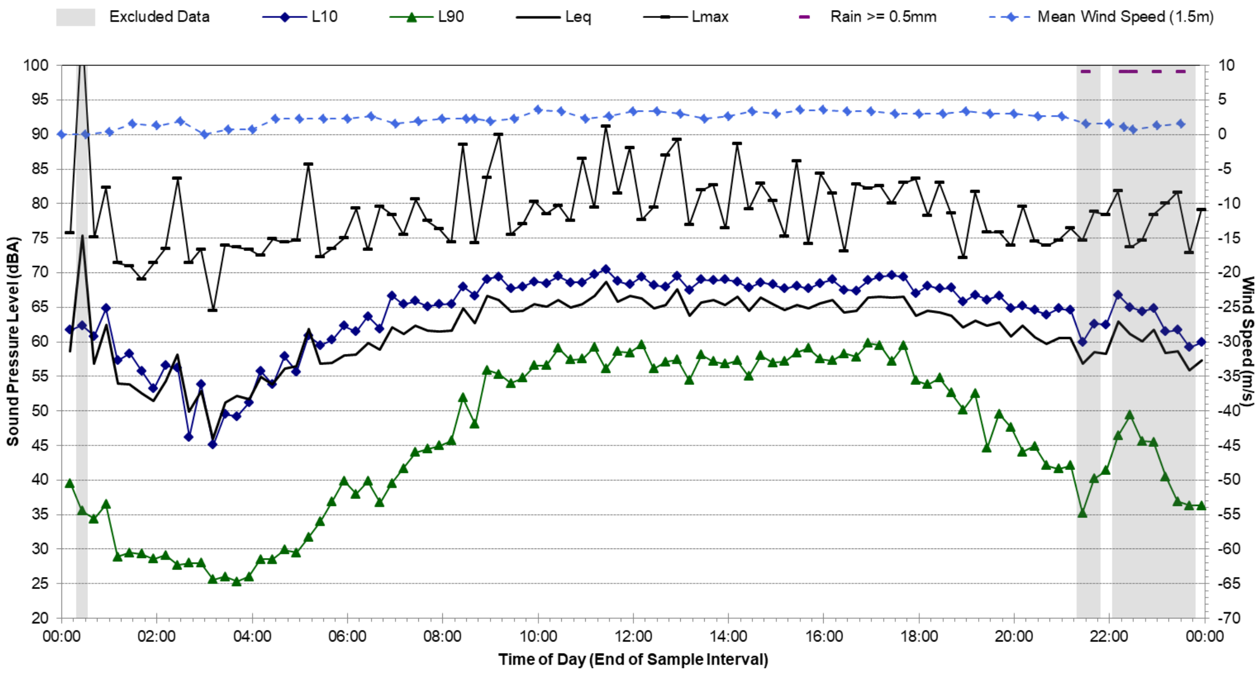
Statistical Ambient Noise Levels

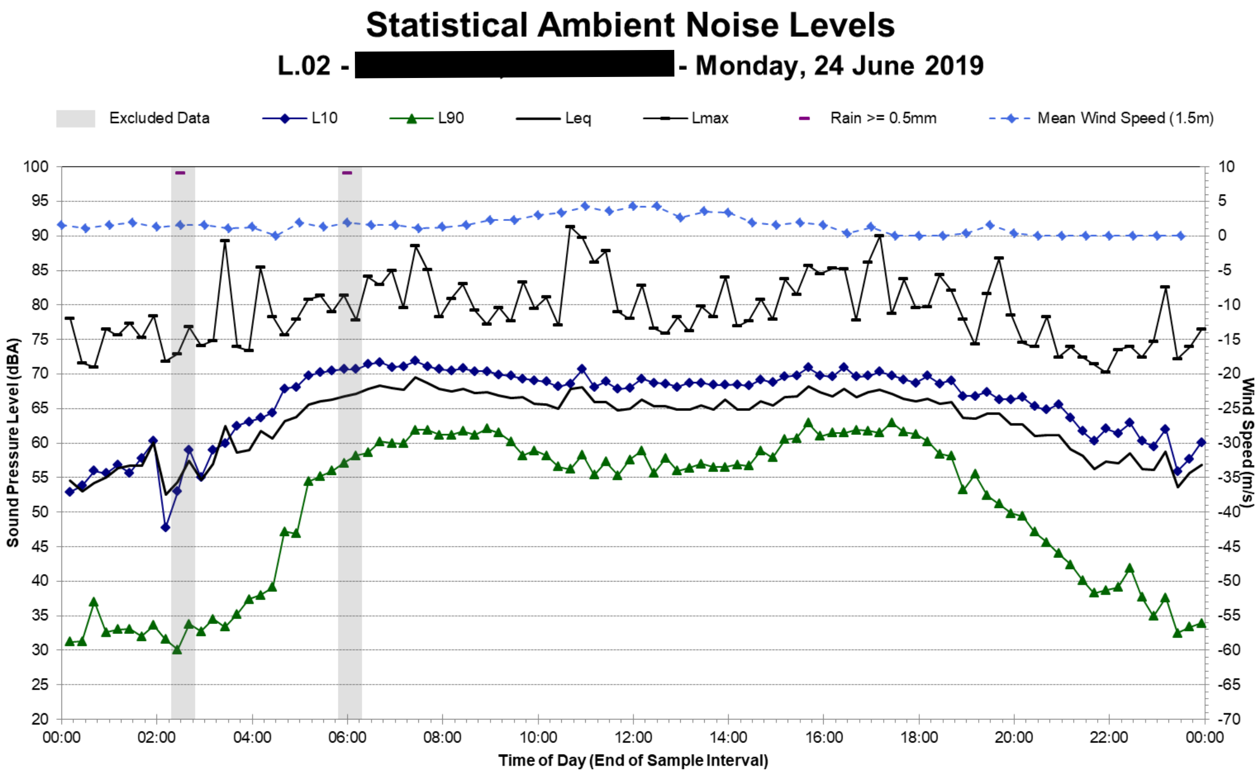
L.02 - [redacted] - Saturday, 22 June 2019

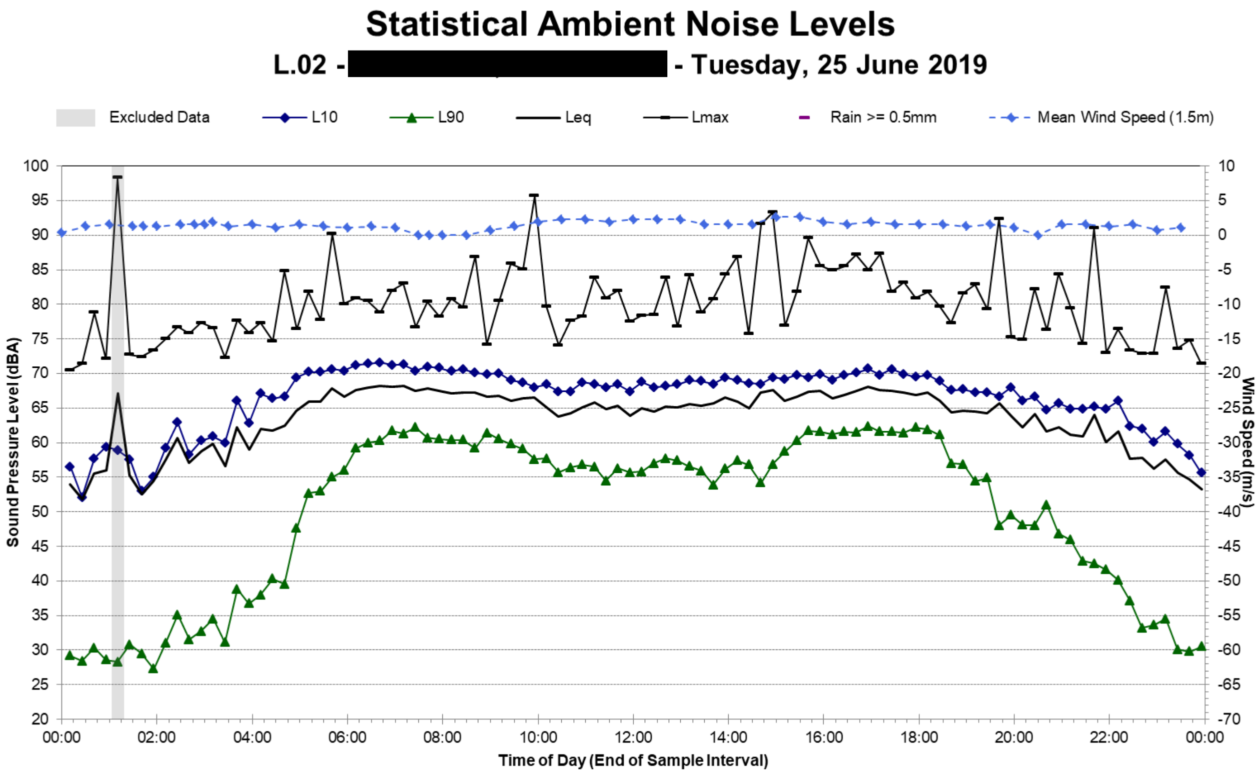


Statistical Ambient Noise Levels

L.02 - [redacted] - Sunday, 23 June 2019

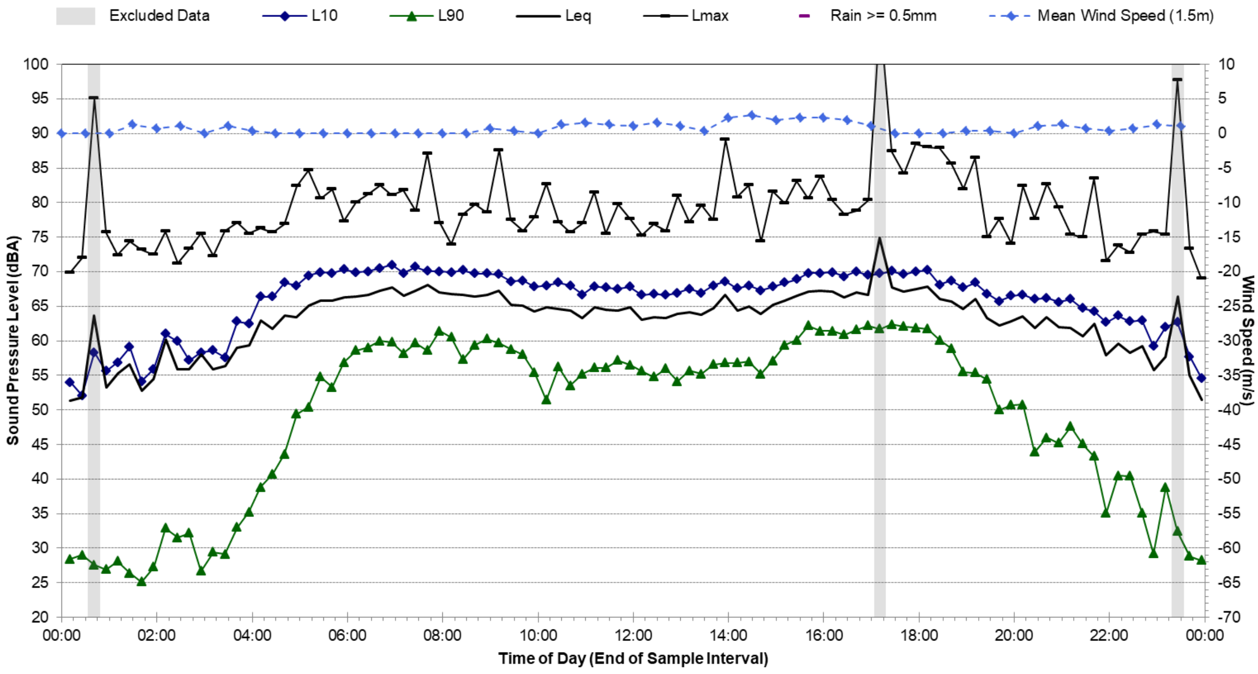



Statistical Ambient Noise Levels
L.02 - [redacted] - Monday, 24 June 2019
Excluded Data
L10
L90
Leq
Lmax
Rain >= 0.5mm
Mean Wind Speed (1.5m)
Sound Pressure Level (dBA)
Wind Speed (m/s)
Time of Day (End of Sample Interval)


Statistical Ambient Noise Levels
L.02 - [redacted] - Tuesday, 25 June 2019
Excluded Data
L10
L90
Leq
Lmax
Rain >= 0.5mm
Mean Wind Speed (1.5m)
Sound Pressure Level (dBA)
Wind Speed (m/s)
Time of Day (End of Sample Interval)

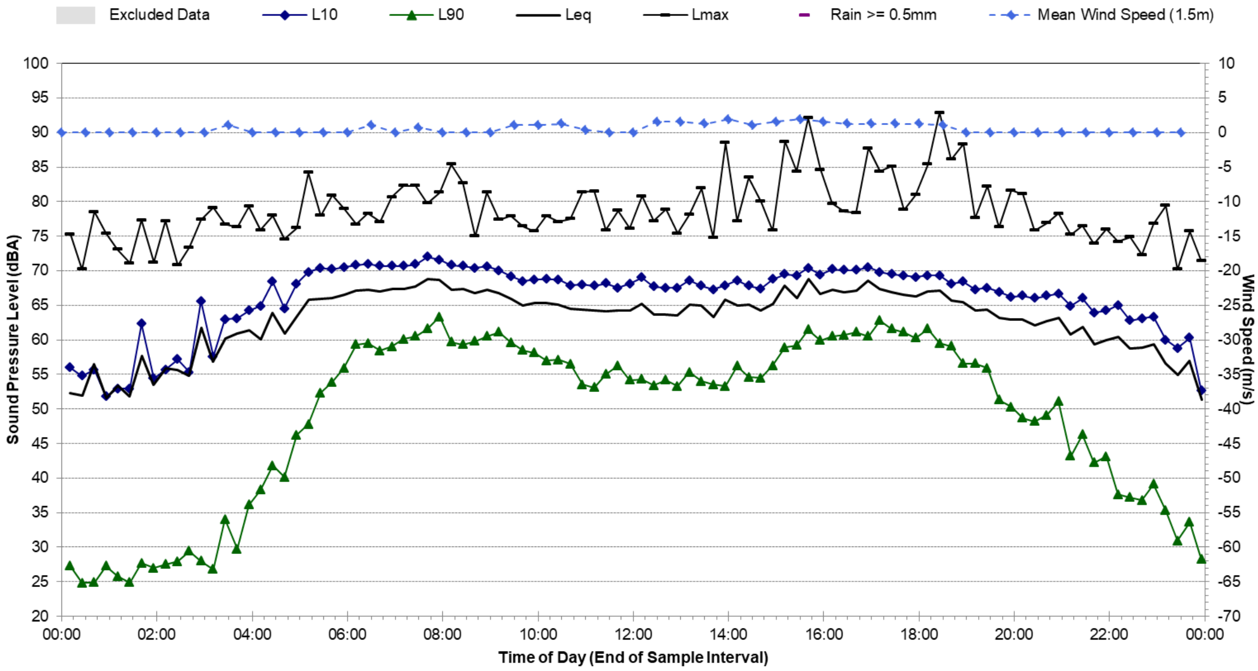
Statistical Ambient Noise Levels

L.02 - [redacted] - Wednesday, 26 June 2019



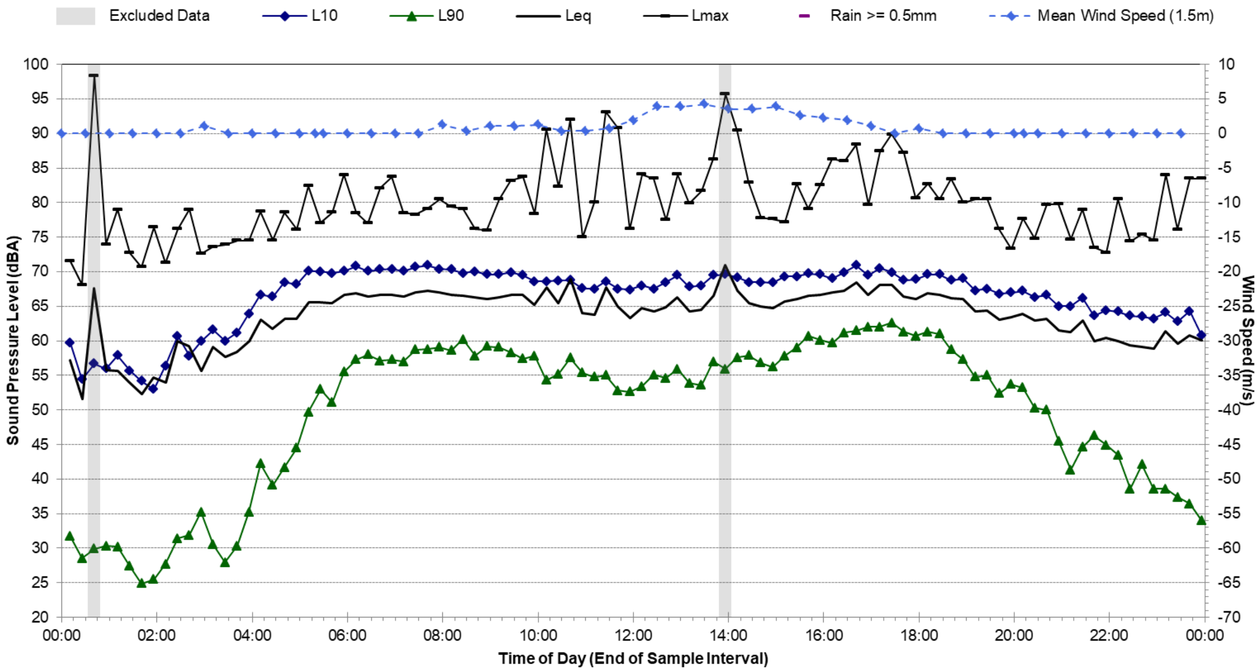
Statistical Ambient Noise Levels

L.02 - [redacted] - Thursday, 27 June 2019



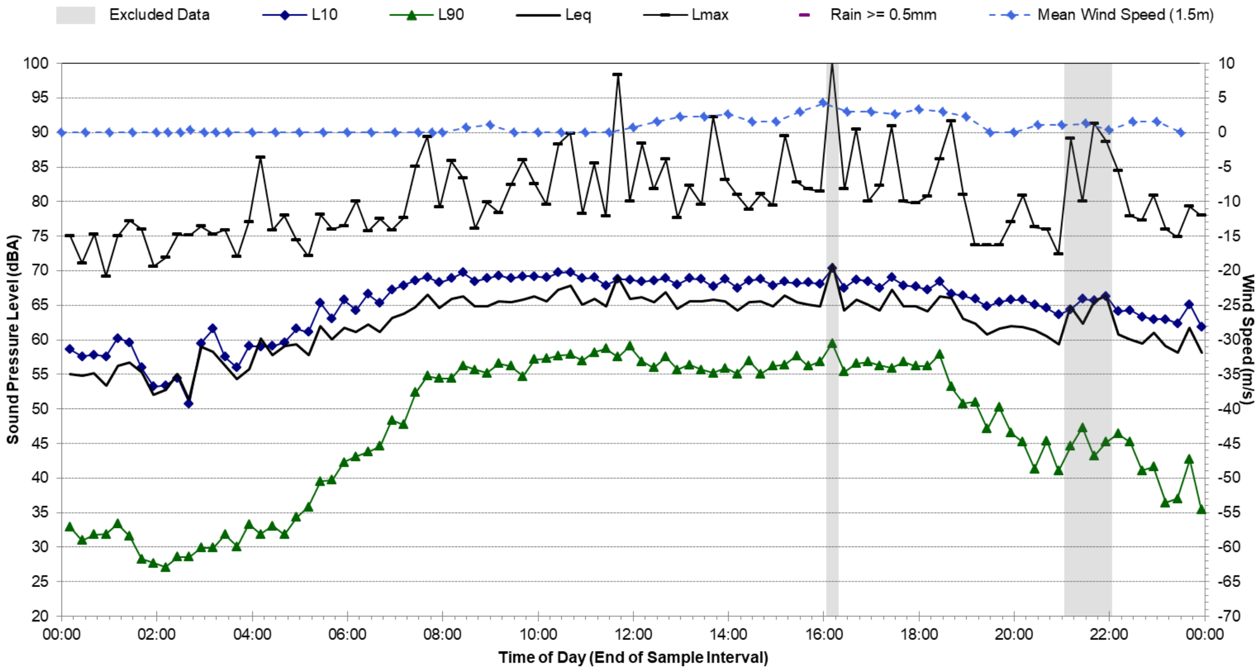
Statistical Ambient Noise Levels

L.02 - [redacted] - Friday, 28 June 2019



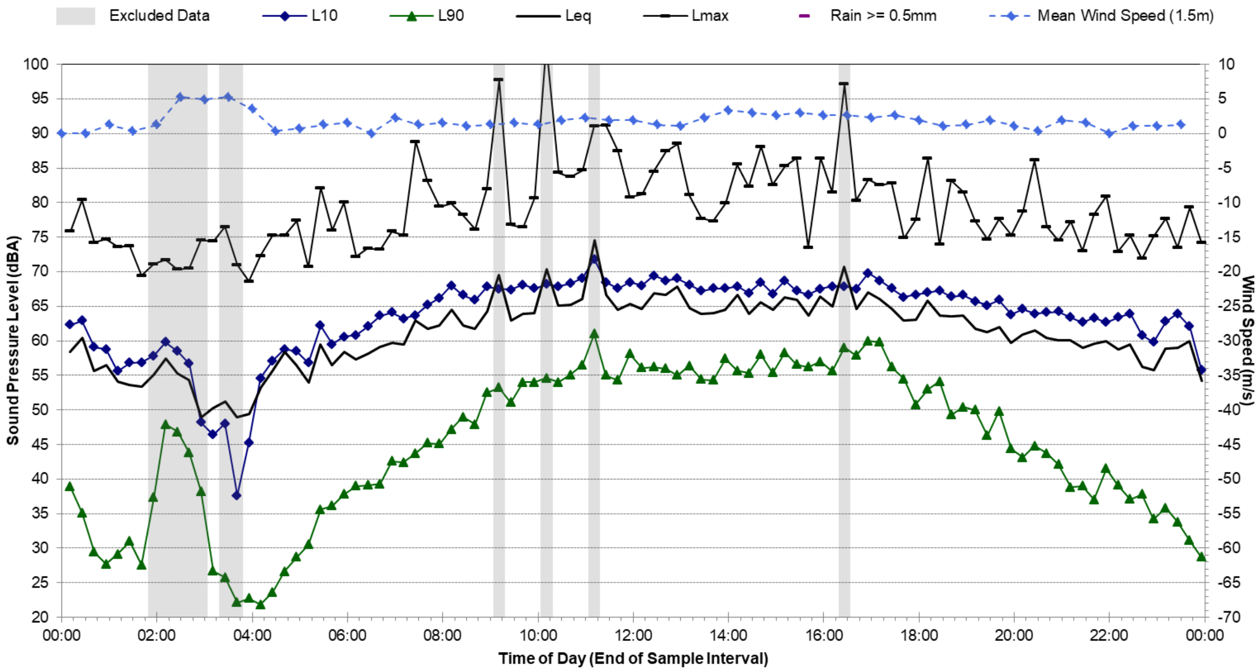
Statistical Ambient Noise Levels

L.02 - [redacted] - Saturday, 29 June 2019



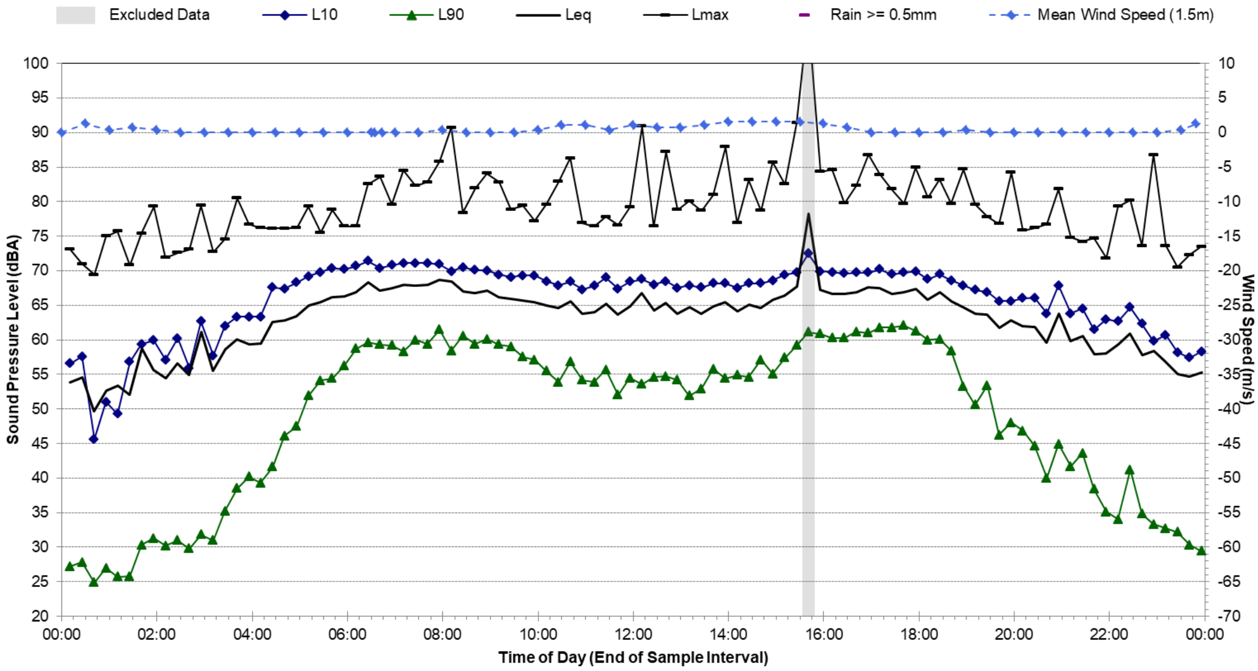
Statistical Ambient Noise Levels

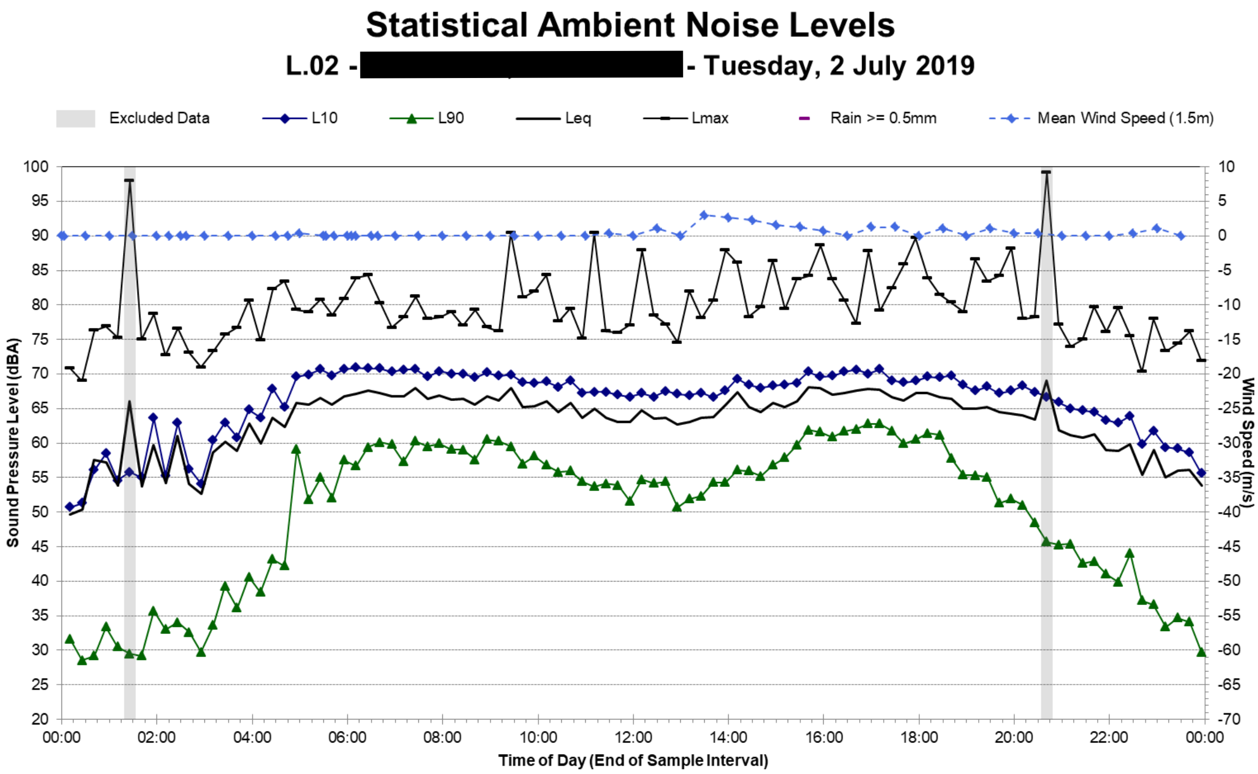
L.02 - [redacted] - Sunday, 30 June 2019



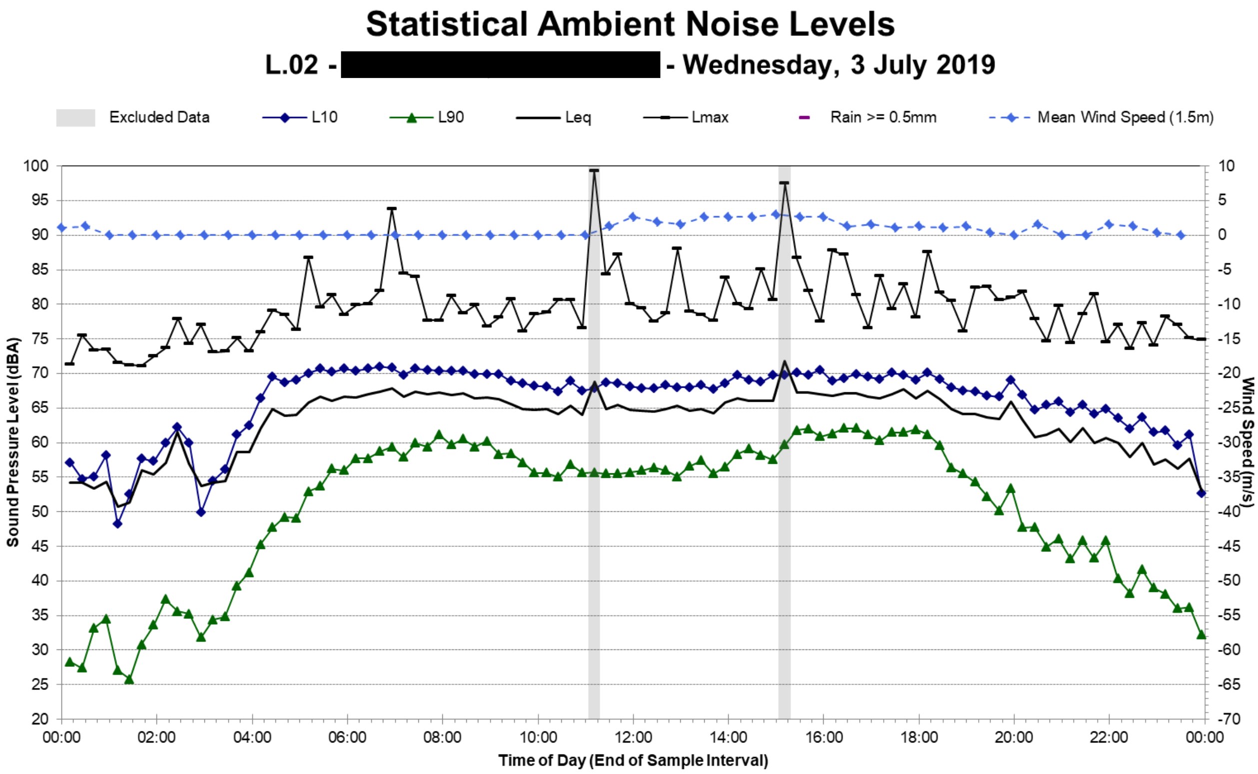
Statistical Ambient Noise Levels

L.02 - [redacted] - Monday, 1 July 2019





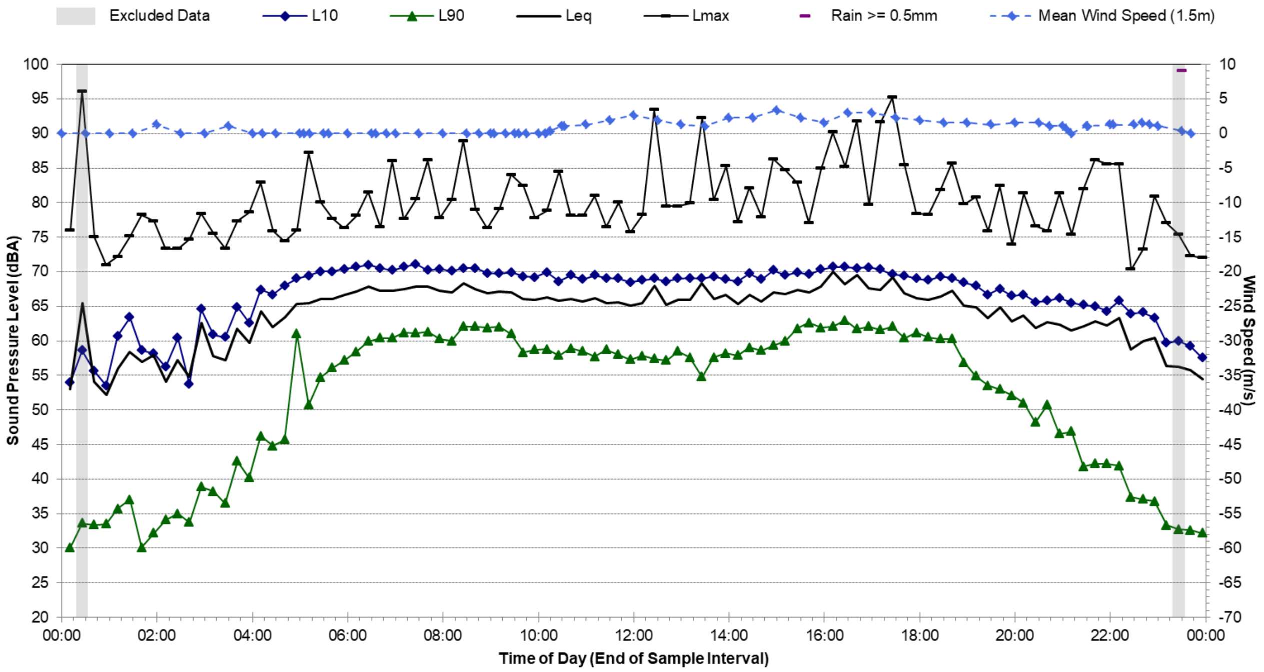
Statistical Ambient Noise Levels
L.02 - [redacted] - Tuesday, 2 July 2019
Excluded Data
L10
L90
Leq
Lmax
Rain >= 0.5mm
Mean Wind Speed (1.5m)
Sound Pressure Level (dBA)
Wind Speed (m/s)
Time of Day (End of Sample Interval)



Statistical Ambient Noise Levels
L.02 - [redacted] - Wednesday, 3 July 2019
Excluded Data
L10
L90
Leq
Lmax
Rain >= 0.5mm
Mean Wind Speed (1.5m)
Sound Pressure Level (dBA)
Wind Speed (m/s)
Time of Day (End of Sample Interval)

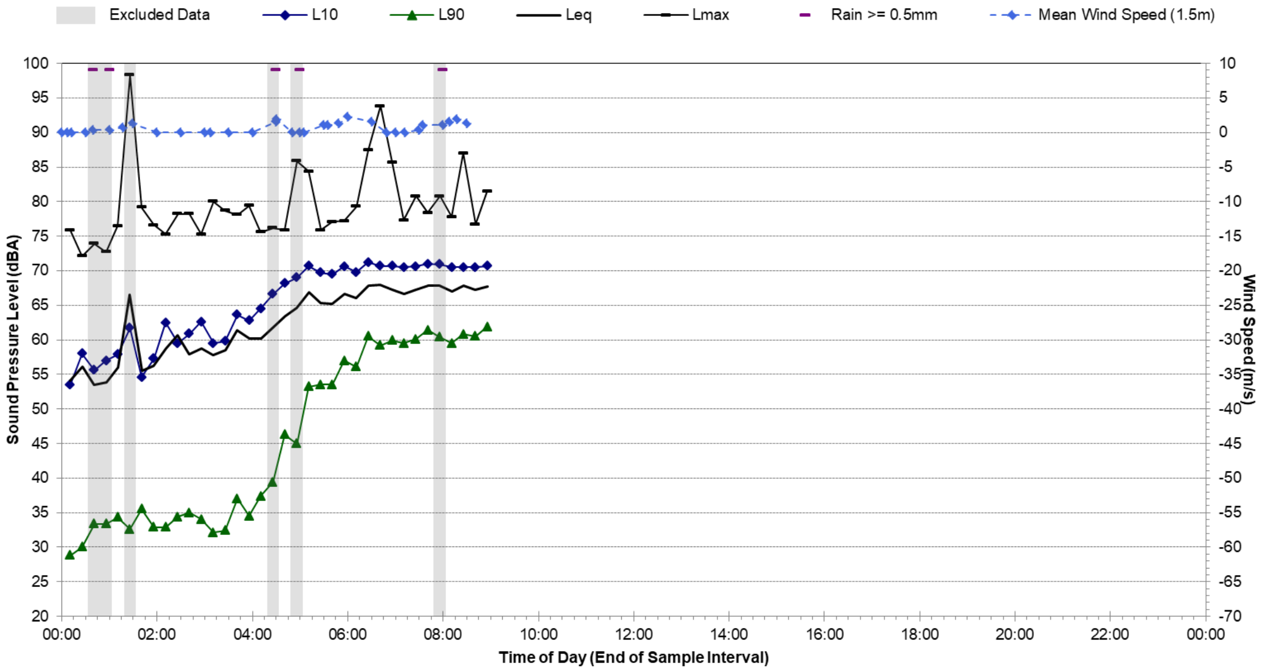
Statistical Ambient Noise Levels

L.02 - [redacted] - Thursday, 4 July 2019



Statistical Ambient Noise Levels

L.02 - [redacted] - Friday, 5 July 2019



APPENDIX C

Maximum Noise Level Assessment

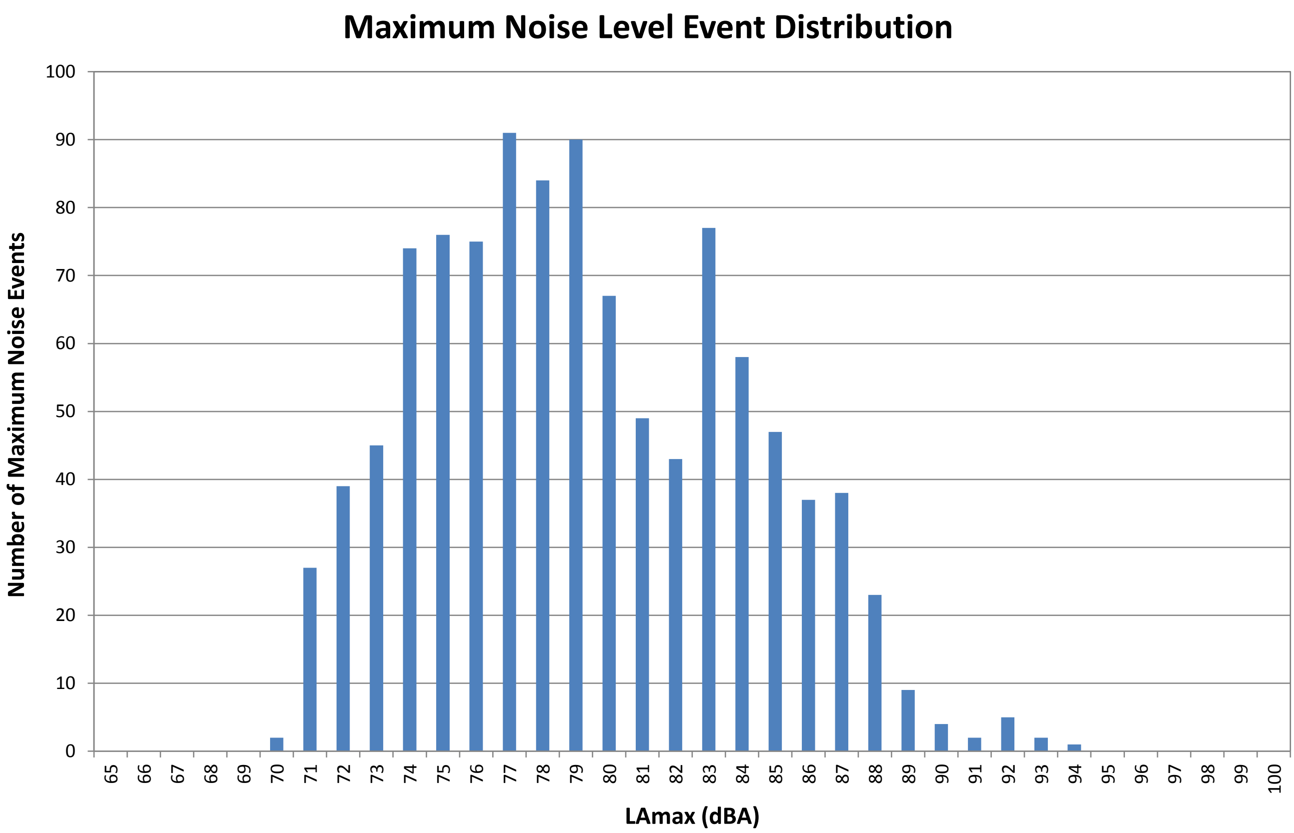
L.01 - [redacted]

Table 1 L.01 Maximum Noise Level Events

Monitoring Date	Number of Maximum Noise Events per Hour (LAmax Noise Levels, dBA)									
	00:00-01:00	01:00-02:00	02:00-03:00	03:00-04:00	04:00-05:00	05:00-06:00	06:00-07:00	22:00-23:00	23:00-00:00	Total/ (Range)
18-Jun-19	n/a[1]	n/a[1]	n/a[1]	n/a[1]	n/a[1]	n/a[1]	n/a[1]	3 (77-86)	3 (76-78)	6 (76-86)
19-Jun-19	2 (75-76)	11 (73-78)	9 (76-84)	11 (78-83)	12 (83-87)	3 (87-93)	1 (88)	7 (78-85)	8 (75-84)	64 (73-93)
20-Jun-19	-	10 (74-85)	5 (80-83)	10 (80-88)	6 (83-87)	4 (87)	-	3 (79-82)	11 (76-85)	49 (74-88)
21-Jun-19	5 (79-82)	16 (74-83)	10 (77-84)	5 (78-85)	6 (83-89)	8 (87-89)	2 (90-92)	3 (80-86)	7 (78-83)	62 (74-92)
22-Jun-19	9 (74-78)	-	7 (73-83)	14 (75-83)	10 (80-91)	8 (81-86)	10 (83-88)	6 (79-80)	4 (78-81)	68 (73-91)
23-Jun-19	2 (80-83)	18 (71-83)	14 (72-80)	18 (71-78)	9 (75-88)	13 (77-80)	3 (79)	-	-	77 (71-88)
24-Jun-19	12 (74-84)	6 (75-78)	6 (76-86)	13 (78-86)	10 (83-90)	1 (89)	2 (89-93)	6 (76-79)	7 (75-77)	63 (74-93)
25-Jun-19	9 (74-85)	1 (78)	11 (78-88)	10 (78-84)	7 (83-85)	3 (86-89)	2 (88-91)	9 (76-81)	8 (75-84)	60 (74-91)
26-Jun-19	1 (81)	13 (72-80)	10 (75-84)	8 (80-92)	6 (83-86)	1 (87)	1 (87)	4 (77-78)	-	44 (72-92)
27-Jun-19	17 (70-77)	5 (77-88)	15 (75-84)	7 (80-89)	7 (83-86)	2 (87-92)	1 (90)	5 (77-83)	8 (76-86)	67 (70-92)
28-Jun-19	3 (78-84)	22 (71-76)	11 (75-84)	11 (79-89)	10 (83-86)	4 (87-88)	1 (88)	1 (87)	7 (78-87)	70 (71-89)
29-Jun-19	10 (74-83)	15 (74-79)	13 (72-82)	13 (76-84)	12 (79-86)	9 (82-88)	3 (83-92)	5 (79-80)	6 (77-79)	86 (72-92)
30-Jun-19	5 (76-79)	10 (73-80)	-	5 (77-80)	11 (76-79)	10 (77-83)	6 (79-83)	6 (76-85)	7 (75-85)	60 (73-85)
1-Jul-19	11 (73-84)	9 (74-81)	10 (76-87)	13 (80-87)	7 (83-88)	2 (88-90)	1 (89)	7 (77-83)	11 (74-83)	71 (73-90)
2-Jul-19	15 (71-73)	-	1 (78)	9 (79-84)	11 (84-86)	4 (87-88)	2 (88-92)	5 (77-82)	15 (74-77)	62 (71-92)
3-Jul-19	14 (72-80)	18 (71-79)	8 (77-87)	15 (79-83)	4 (85-88)	1 (88)	1 (94)	4 (77-80)	7 (76-83)	72 (71-94)
4-Jul-19	2 (81)	5 (76-82)	10 (76-86)	14 (78-85)	10 (84-88)	3 (86)	2 (87)	2 (80-83)	2 (76)	50 (76-88)
5-Jul-19	7 (73-79)	3 (81-88)	9 (77-88)	11 (80-88)	2 (82-83)	2 (87-89)	-	n/a[1]	n/a[1]	34 (73-89)

Note 1: This period was outside of the period of unattended noise logging.

Figure 1 L.01 Maximum Noise Level Event Distribution of Monitoring Period



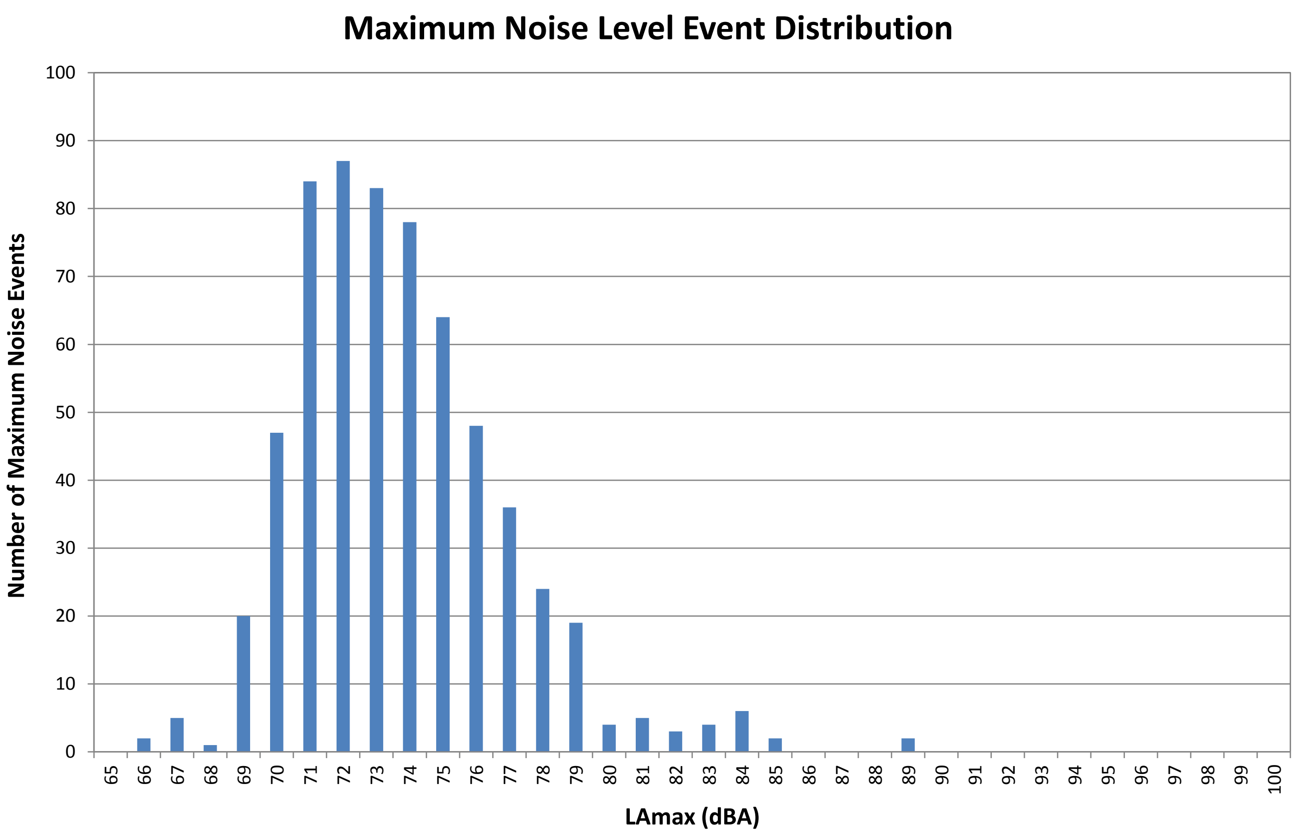
L.02 – [redacted]

Table 2 L.02 Maximum Noise Level Events

Monitoring Date	Number of Maximum Noise Events per Hour (LAmax Noise Levels, dBA)									
	00:00-01:00	01:00-02:00	02:00-03:00	03:00-04:00	04:00-05:00	05:00-06:00	06:00-07:00	22:00-23:00	23:00-00:00	Total/ (Range)
20-Jun-19	n/a[1]	n/a[1]	n/a[1]	n/a[1]	n/a[1]	n/a[1]	n/a[1]	-	1 (75)	1 (75)
21-Jun-19	-	11 (72-74)	8 (74-77)	2 (73-76)	2 (78-84)	-	1 (83)	3 (78-84)	2 (76-77)	29 (72-84)
22-Jun-19	4 (71-72)	-	-	13 (71-77)	9 (73-75)	2 (77-79)	1 (79)	1 (77)	1 (81)	31 (71-81)
23-Jun-19	-	8 (69-73)	8 (69-78)	13 (67-74)	14 (70-75)	5 (74-78)	1 (76)	-	3 (73-74)	52 (67-78)
24-Jun-19	12 (70-76)	8 (73-77)	8 (70-73)	1 (89)	3 (78-85)	-	2 (84-85)	3 (72-74)	9 (71-74)	46 (70-89)
25-Jun-19	9 (70-73)	-	10 (75-76)	5 (75-78)	1 (78)	2 (82-89)	-	4 (73-74)	6 (71-74)	37 (70-89)
26-Jun-19	1 (74)	10 (72-76)	10 (72-75)	9 (74-77)	-	1 (81)	1 (83)	2 (74-75)	-	34 (72-83)
27-Jun-19	8 (70-75)	14 (70-72)	9 (73-77)	6 (75-79)	2 (78)	-	-	2 (75)	8 (71-74)	49 (70-79)
28-Jun-19	1 (79)	14 (69-76)	9 (74-77)	6 (74-75)	2 (79)	1 (84)	-	1 (75)	5 (76-82)	39 (69-84)
29-Jun-19	5 (70-75)	11 (70-73)	15 (71-75)	12 (72-77)	6 (74-78)	3 (76-77)	3 (78)	5 (76-81)	6 (74-79)	66 (70-81)
30-Jun-19	8 (73-77)	5 (69-71)	1 (74)	4 (66-67)	12 (72-77)	6 (73-80)	-	4 (73-75)	5 (73-79)	45 (66-80)
1-Jul-19	11 (69-74)	8 (70-75)	6 (73-79)	4 (75-77)	1 (79)	-	-	3 (75-79)	7 (70-73)	40 (69-79)
2-Jul-19	9 (70-75)	1 (79)	11 (73-76)	5 (76-79)	3 (79-83)	-	1 (84)	4 (74-80)	7 (71-74)	41 (70-84)
3-Jul-19	10 (69-74)	15 (70-73)	9 (73-78)	8 (72-75)	1 (79)	1 (82)	2 (83-84)	6 (74-77)	8 (71-77)	60 (69-84)
4-Jul-19	-	5 (73-78)	6 (74-77)	5 (75-76)	2 (79-80)	-	-	3 (76-81)	8 (71-72)	29 (71-81)
5-Jul-19	5 (70-72)	3 (77-79)	9 (74-80)	8 (75-79)	-	-	-	n/a[1]	n/a[1]	25 (70-80)

Note 1: This period was outside of the period of unattended noise logging.

Figure 2 L.02 Maximum Noise Level Event Distribution of Monitoring Period



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