Northern Link

environmental impact statement
supplementary report

Appendix E:
Supplementary Technical Papers

Northern Link
Environmental Impact Statement

Supplementary Report

APPENDIX E

TECHNICAL REPORTS

■ June 2009

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HEGGIES

REPORT 20-1854-R5

Revision 0

Northern Link

Repeated Baseline Noise Monitoring

PREPARED FOR

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26 MAY 2009

HEGGIES PTY LTD
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Northern Link

Repeated Baseline Noise Monitoring

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DOCUMENT CONTROL

Reference	Status	Date	Prepared	Checked	Authorised
20-1854-R5	Revision 0	26 May 2009	Steve Henry	Shane Elkin	Shane Elkin

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1 INTRODUCTION

The Coordinator-General has requested that a new round of baseline monitoring be undertaken to confirm the results presented in the EIS. This report documents the monitoring methodology and results for the repeated baseline noise monitoring conducted by Heggies, with reference to the EIS measured baseline levels, for inclusion in the Supplementary Report for the Northern Link Project.

Acoustic terminology referred to throughout this report is defined in **Appendix A**.

2 REPEATED BASELINE NOISE MONITORING SITES

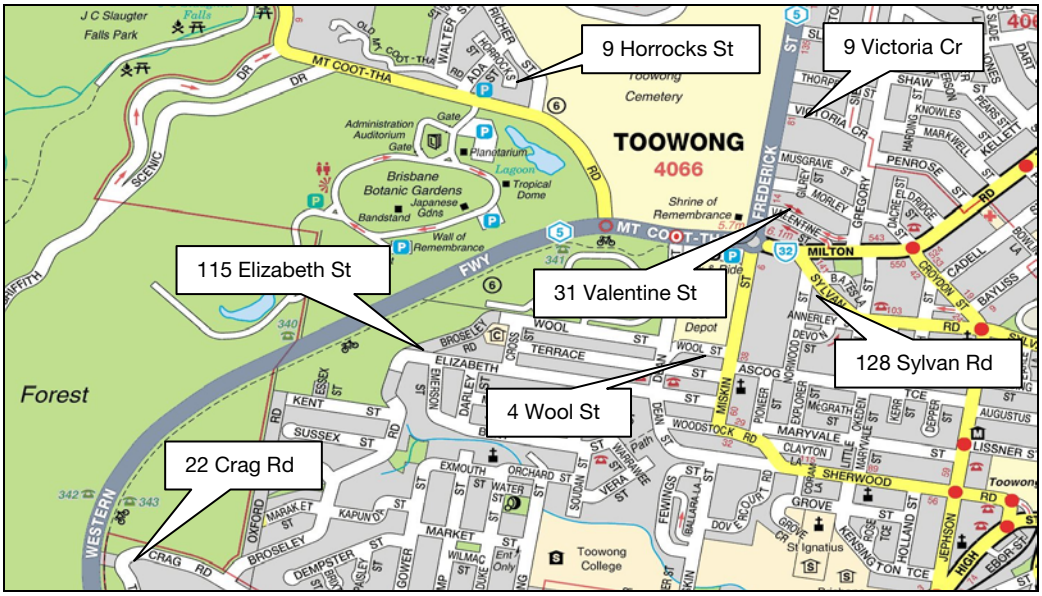
The repeated baseline noise monitoring study was confined to the western end of the project to address specific concerns raised in submissions regarding heavy vehicle movements through the Toowong precinct during the EIS noise monitoring.

Attempts were made to replicate the EIS noise monitoring locations and methodology however at two locations this was not achievable due to denied access to private property. Subsequently, alternative locations with comparable site characteristics were chosen. The street addresses of the repeated baseline noise monitoring locations are:

- 22 Crag Road, Taringa
- 9 Horrocks Street, Toowong
- 9 Victoria Crescent, Toowong
- 31 Valentine Street, Toowong (EIS site – 29 Valentine Street)
- 128 Sylvan Road, Toowong
- 4 Wool Street, Toowong (EIS site – 6 Wool Street)
- 115 Elizabeth Street, Toowong

Figure 1 illustrates the noise monitoring locations, and photographs showing the noise logger position at each monitoring site are presented in **Appendix B.**

Figure 1 Monitoring Locations



3 NOISE MONITORING METHODOLOGY AND INSTRUMENTATION

Noise monitoring was conducted in general accordance with Australian Standard AS1055-1997 *Acoustics – Description and Measurement of Environmental Noise* and the Queensland Environmental Protection Agency's *Noise Measurement Manual* (NMM) 2000.

For the unattended noise monitoring, the prevailing noise environment was measured in consecutive 15 minute periods for a minimum period of 7 days in accordance with the NMM.

The instrumentation that was used for the noise monitoring is listed in **Table 1.** The calibration of all instruments was checked before and after monitoring and the difference in noise level was within 1 dBA in all instances.

All instruments were programmed to continuously record A-weighted fast response noise levels over 15 minute sampling intervals.

Table 1 Noise Monitoring Instrumentation

Measurement Location	Instrumentation
All locations	RION NC-73 Sound Level Calibrator, RION NA-27 Sound Level Meter
1	Acoustic Research Laboratories Environmental Noise Logger EL316, SN 16-301-471
2	Acoustic Research Laboratories Environmental Noise Logger EL316, SN 16-299-426 and SN 16-203-524
3	Acoustic Research Laboratories Environmental Noise Logger EL316, SN 16-203-524
4	Acoustic Research Laboratories Environmental Noise Logger EL316, SN 16-203-529
5	Acoustic Research Laboratories Environmental Noise Logger EL316, SN 16-203-525
6	Acoustic Research Laboratories Environmental Noise Logger EL316, SN 16-203-505
7	Acoustic Research Laboratories Environmental Noise Logger EL316, SN 16-203-508

4 REPEATED BASELINE NOISE MONITORING RESULTS

Monitoring sites were inspected during peak traffic times, the evening period and also during the late night/early morning period when background noise is typically quietest. The dominant audible sounds at each location are summarised in **Table 2**. As can be seen in **Table 2**, traffic noise from nearby major roadways was a dominant source of noise at all times of the day.

Table 2 Description of Existing Noise Environment

Location ID	Monitoring Location	Dominant Daytime & Evening Noise Sources	Dominant Noise Sources Late at Night
1	22 Crag Road, Taringa	Western Freeway traffic	Western Freeway traffic
2	9 Horrocks Street, Toowong	Mt Coot-tha Road traffic	Mt Coot-tha Road and occasional Freeway traffic
3	9 Victoria Crescent, Toowong	Frederick Street traffic	Frederick Street traffic
4	31 Valentine Street, Toowong	Milton Road and Frederick Street traffic	Milton Road and Frederick Street traffic
5	128 Sylvan Road, Toowong	Milton Road and Sylvan Road traffic	Milton Road and Sylvan Road traffic
6	4 Wool Street, Toowong	Western Freeway and Miskin Street traffic	Western Freeway and Miskin Street traffic
7	115 Elizabeth Street, Toowong	Western Freeway traffic	Western Freeway traffic

Unattended noise monitoring was undertaken between Friday 27 March and Thursday 9 April 2009, providing at least 7 days of continuous noise monitoring for each site. Equipment malfunction at 9 Horrocks Street resulted in additional monitoring at this site between Monday 27 April and Friday 1 May 2009. Weather conditions during the monitoring periods were typically fine and mild with some periods of rainfall. Winds were generally light to moderate, with typically calm conditions, or light winds, occurring at night.

The results of the repeated baseline monitoring, presented in **Table 3** ($L_{A10(18hour)}$) and **Table 4** (Rating Background Levels), have been processed and are presented identically to the results presented in the EIS for direct comparison. Detailed monitoring charts, including the prevailing weather conditions, are provided in **Appendix B**. The results in **Table 3** and **Table 4** exclude noise monitoring results obtained during periods of wind speeds in excess of 5 m/s as recommended in AS 1055.1 and/or rain periods greater than 0.5 mm per 15 minute interval.

Table 3 Analysis of Baseline $L_{A10(18hour)}$ Noise Levels

Monitoring Location		Assessment of Average Day Evening Traffic Noise $L_{A10(18hour)}$ (dBA)	
		EIS Result	Repeated 2009 Result
1	22 Crag Road, Taringa	59	58
2	9 Horrocks Street, Toowong	58	58
3	9 Victoria Crescent, Toowong	55	54
4	31 Valentine Street, Toowong	59 (29 Valentine St)	58
5	128 Sylvan Road, Toowong	66	66
6	4 Wool Street, Toowong	55 (6 Wool Street)	54
7	115 Elizabeth Street, Toowong	52	50

Note – $L_{A10(18hour)}$ refers to the time period between 6 am and 12 midnight.

Table 4 Summary of (Unattended) Noise Logging Results

Monitoring Location		Rating Background Noise Levels minL_{A90} (dBA)					
		Day 7am – 6pm		Evening 6pm – 10pm		Night 10pm – 7am	
		EIS	Repeated	EIS	Repeated	EIS	Repeated
1	22 Crag Road, Taringa	48	48	46	45	39	38
2	9 Horrocks Street, Toowong	51	51	48	48	37	36
3	9 Victoria Crescent, Toowong	48	46	43	42	35	33
4	31 Valentine Street, Toowong	53	53	50	50	43	42
5	128 Sylvan Road, Toowong	49	49	44	45	35	35
6	4 Wool Street, Toowong	47	46	41	42	37	38
7	115 Elizabeth Street, Toowong	46	44	41	40	34	33

The operator-attended noise measurements are summarised in **Table 5**.

Table 5 Summary of Operator-Attended (Short-term) Noise Measurements

Monitoring Location		Period	Date & Time	L_{A10} (dBA)	L_{Aeq} (dBA)	L_{A90} (dBA)	Discernible Sources
1	22 Crag Road, Taringa	Day	01/04/09 09:44	61	57	48	Traffic on Crag Road, as well as Western Freeway. Birds.
		Evening	31/03/09 19:11	59	56	49	Traffic on Crag Road, as well as Western Freeway. Insects.
		Night	01/04/09 00:12	45	43	38	Traffic on Western Freeway. Insects.
2	9 Horrocks Street, Toowong	Day	01/04/09 10:13	60	57	52	Traffic on Mt Coot-tha Road. Birds, aircraft.
		Evening	31/03/09 20:44	55	52	46	Traffic on Mt Coot-tha Road. Insects.
		Night	31/03/09 22:45	53	50	41	Traffic on Mt Coot-tha Road. Insects, domestic noise.
3	9 Victoria Crescent, Toowong	Day	01/04/09 10:34	55	53	46	Mostly birds. Traffic on Frederick Street, some aircraft.
		Evening	31/03/09 21:14	51	48	45	Traffic on Frederick Street. Insects, wildlife.
		Night	31/03/09 23:14	49	40	41	Traffic on Frederick Street and Victoria Crescent. Insects.
4	31 Valentine Street, Toowong	Day	31/03/09 16:25	60	58	54	Milton Road, Frederick and Valentine Street traffic. Workshop noise, birds.
		Evening	31/03/09 20:18	55	53	49	Milton Road and Frederick Street traffic. Domestic noise, insects.
		Night	31/03/09 22:17	54	52	48	Milton Road, Frederick and Valentine Street traffic. Insects.

Monitoring Location		Period	Date & Time	LA10 (dBA)	LAeq (dBA)	LA90 (dBA)	Discernible Sources
5	128 Sylvan Road, Toowong	Day	31/03/09 16:53	64	60	49	Traffic on Sylvan Road and Milton Road. Domestic noise.
		Evening	31/03/09 21:46	63	57	43	Traffic on Sylvan Road mostly, as well as Milton Road. Insects.
		Night	31/03/09 01:43	46	48	36	Milton Road and Sylvan Road traffic. Train in background, wildlife, domestic noise.
6	4 Wool Street, Toowong	Day	31/03/09 17:14	52	53	46	Miskin Street and some Western Freeway/ roundabout traffic. Birds, dog barking.
		Evening	31/03/09 19:58	51	56	42	Western Freeway/ roundabout and Miskin Street traffic. Insects, dog barking.
		Night	31/03/09 23:42	48	47	43	Western Freeway/ roundabout and Miskin Street traffic. Bus depot hum, insects, aircraft.
7	115 Elizabeth Street, Toowong	Day	31/03/09 17:41	52	50	47	Western Freeway traffic. Birds, domestic noise.
		Evening	31/03/09 19:35	48	46	42	Western Freeway traffic. Insects, domestic noise.
		Night	31/03/09	41	39	32	Western Freeway traffic. Insects.

5 DISCUSSION OF NOISE MONITORING RESULTS

Comparison of the two data sets in **Table 3** and **Table 4** show a maximum variance of 2 dBA between the EIS monitoring and the repeated monitoring results. Regarding the $L_{A10(18hour)}$ parameter, all monitoring locations returned a lower result (average of 1 dBA and maximum difference of 2 dBA) with the exception of Sylvan Road and Horrocks Street which were the same as the EIS results.

Without significant change to the road network (eg surface type, signposted speed, barriers etc), the usual trend over time is for road traffic noise levels ($L_{A10(18hour)}$) to increase as a factor of traffic growth. Therefore, the resulting marginal reduction in road traffic noise level at some locations in the Toowong precinct may have resulted from a reduction in the number of heavy vehicle movements through the area during the 6 am and 12 midnight time period relevant to the $L_{A10(18hour)}$ parameter.

For the purpose of checking the repeated measurement results against the SoundPLAN modelled road traffic noise levels in the EIS used for verifying the noise model, these results are presented in **Table 6**.

Table 6 Analysis of Measured and Model Calculated $L_{A10(18hour)}$ Noise Levels

2009 Monitoring Locations	$L_{A10(18hour)}$ Road Traffic Noise Level (dBA)			
	EIS Measured	2009 Measured	EIS Noise Model Calculated	Difference
22 Crag Road	59	58	59	+1
9 Horrocks Street	58	58	61	+3
9 Victoria Crescent	55	54	55	+1
31 Valentine Street	59 (29 Valentine St)	58	N/A[1]	N/A[1]
128 Sylvan Road	66	66	67	+1
4 Wool Street	55 (6 Wool Street)	54	N/A[2]	N/A[2]
115 Elizabeth Street	52	50	54	+4

Note 1 – EIS Model verification carried out at a different location (ie 29 Valentine Street).

Note 2 – EIS Model verification carried out at a different location (ie 6 Wool Street)

In situations where the CoRTN model calculates higher $L_{A10(18hour)}$ road traffic noise levels than measured noise levels, it may be necessary to apply correction factors to the model calculated levels to account specifically for Australian road traffic conditions. According to data published by the Australian Road Research Board (ARRB), the values presented by CoRTN should be corrected by - 1.7 dB for a façade calculation and 0.7 dB for a free-field calculation to account for Australian road traffic conditions. ARRB corrections were not applied to the EIS calculated road traffic levels as they were within +2 dB of the measured noise levels which is considered acceptable for the purpose of model verification.

The CoRTN calculated road traffic noise levels in **Table 7** are based on the EIS calculated noise levels from **Table 6** with the recommended ARRB corrections to account for Australian road traffic conditions. The results of the analysis show that the ARRB corrected calculated noise levels are equal to or 2 dB higher than the 2009 (repeated) measured road traffic noise levels at all Northern Link monitoring locations at the western end of the Project. Therefore, the calculations are within the acceptable tolerance of ±2 dBA.

Table 7 Analysis of ARRB Corrected $L_{A10(18hour)}$ Road Traffic Noise Levels

2009 Monitoring Locations	$L_{A10(18hour)}$ Road Traffic Noise Level (dBA)			
	EIS Measured	2009 Measured	EIS Noise Model with ARRB Correction	Difference
22 Crag Road	59	58	59[1]	0
9 Horrocks Street	58	58	61[1]	+2
9 Victoria Crescent	55	54	55[1]	0
31 Valentine Street	59 (29 Valentine St)	58	N/A	N/A
128 Sylvan Road	66	66	67[1]	0
4 Wool Street	55 (6 Wool Street)	54	N/A	N/A
115 Elizabeth Street	52	50	54[2]	+2

Note 1 – CoRTN façade prediction correction of 1.7 dB.

Note 2 – CoRTN free-field prediction correction of 0.7 dB.

Regardless of whether the ARRB correction is applied or not, the Northern Link model calculated road traffic noise levels that were either equal to or higher than what was measured which means that the predicted future road traffic noise levels which are contained in the EIS are conservative. As the conservative future predictions do not result in any exceedances of Main Roads' Code of Practice 68 $L_{A10(18hour)}$ planning noise level, these additional measurements give further comfort that actual levels will also be below this planning level.

1 Sound Level or Noise Level

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

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

The symbols SPL, L or L_P are commonly used to represent Sound Pressure Level. The symbol L_A 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 4000 Hz), and less sensitive at lower and higher frequencies. Thus, the level of a sound in dBA is a good measure of the loudness of that sound. Different sources having the same dBA level generally sound about equally loud.

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

Sound Pressure Level (dBA)	Typical Source	Subjective Evaluation
140	Threshold of pain	Intolerable
130		
120	Heavy rock concert	Extremely noisy
110	Grinding on steel	
100	Loud car horn at 3 m	Very noisy
90	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	Rural house at night	Almost silent
10	Recording studio	

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

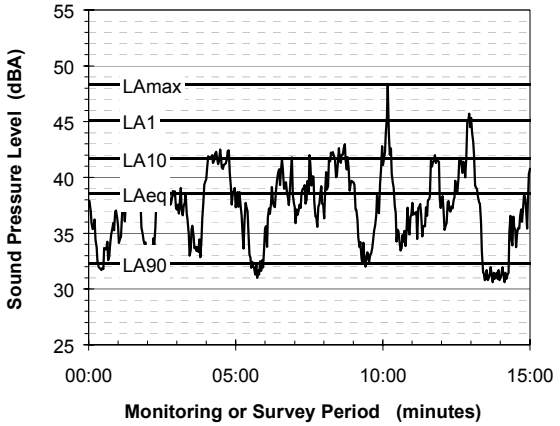
The Sound Power of a source is the rate at which it emits acoustic energy. As with Sound Pressure Levels, Sound Power Levels are expressed in decibel units (dB or dBA), but may be identified by the symbols SWL or L_W, or by the reference unit 10^{-12} W.

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

4 Statistical Noise Levels

Sounds that vary in level over time, such as road traffic noise and most community noise, are commonly described in terms of the statistical exceedance levels L_{AN}, where L_{AN} is the A-weighted sound pressure level exceeded for N% of a given measurement period. For example, the L_{A1} is the noise level exceeded for 1% of the time, L_{A10} 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:

L_{A1} The noise level exceeded for 1% of the 15 minute interval.

L_{A10} The noise level exceed for 10% of the 15 minute interval. This is commonly referred to as the average maximum noise level.

L_{A90} 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.

L_{Aeq} 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.

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

This method produces a level representing the "repeatable minimum" L_{A90} noise level over the daytime and night-time measurement periods, as required by the EPA. In addition the method produces mean or "average" levels representative of the other descriptors (L_{Aeq}, L_{A10}, etc).

5 Tonality

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

6 Impulsiveness

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

7 Frequency Analysis

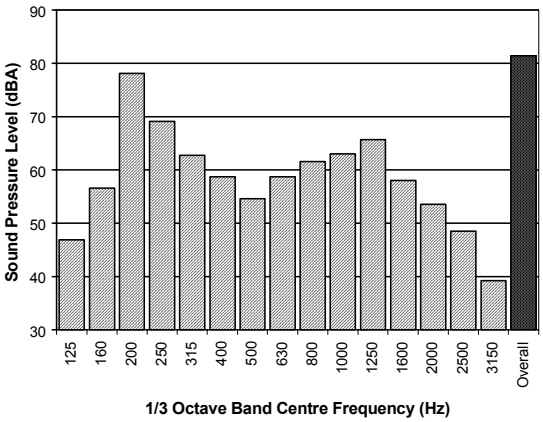
Frequency analysis is the process used to examine the tones (or frequency components) which make up the overall noise or vibration signal. This analysis was traditionally carried out using analogue electronic filters, but is now normally carried out using Fast Fourier Transform (FFT) analysers.

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

Frequency analysis can be in:

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

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



8 Vibration

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

The former is the maximum instantaneous velocity, without any averaging, and is sometimes referred to as "peak particle velocity", or PPV. The latter 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. Where triaxial measurements are used, the axes are commonly designated vertical, longitudinal (aligned toward the source) and transverse.

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

9 Human Perception of Vibration

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

10 Over-Pressure

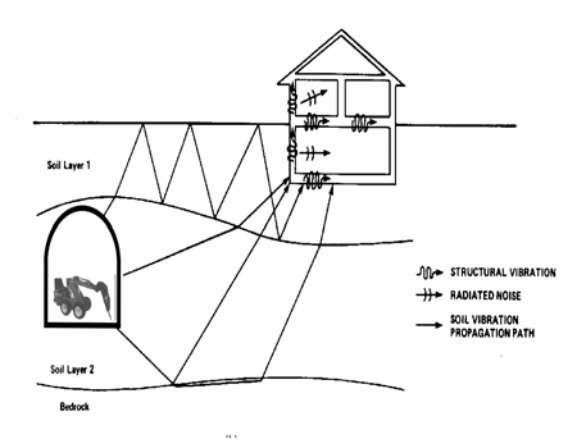
The term "over-pressure" is used to describe the air pressure pulse emitted during blasting or similar events. The peak level of an event is normally measured using a microphone in the same manner as linear noise (ie unweighted), at frequencies both in and below the audible range.

11 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.

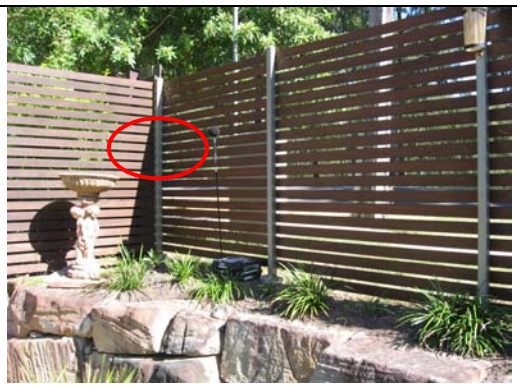
Typical sources of ground-borne or structure-borne noise include tunnelling works, underground railways, excavation plant (eg rockbreakers), and building services plant (eg fans, compressors and generators).

The following figure presents 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.

DESCRIPTION OF NOISE MONITORING LOCATIONS

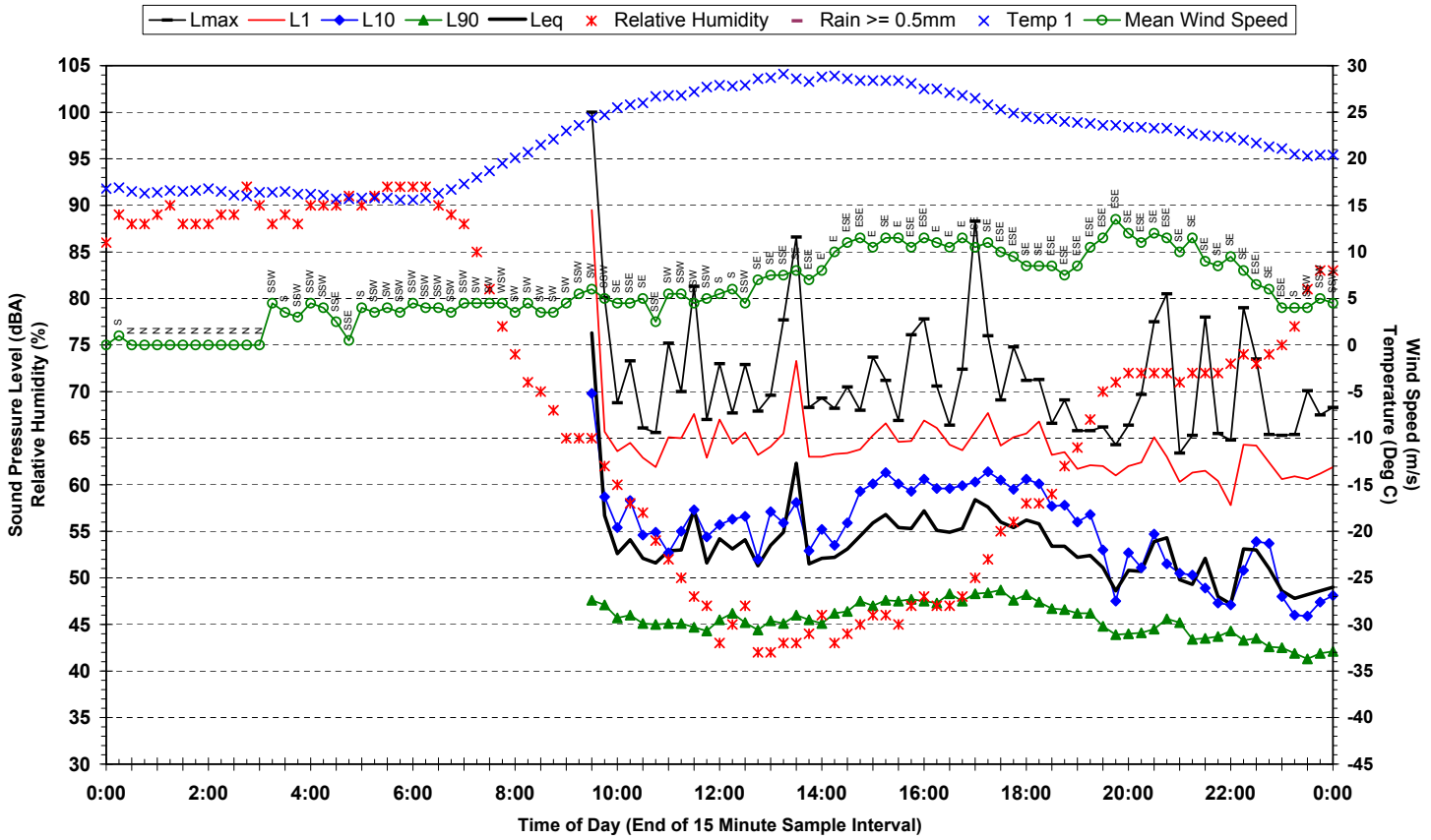
Monitoring Location	Description	Logger Location Image
Site 1 22 Crag Road Taringa	On retaining wall in front yard of single-storey house, facing Western Freeway	
Site 2 9 Horrocks Street Toowong	Low side of the yard near two-storey house, facing Mt Coot-tha Road	
Site 3 9 Victoria Crescent Toowong	Below stairs in front yard of double-storey house, Facing Victoria Crescent	
Site 4 31 Valentine Street Toowong	Front yard of two-storey house, facing towards Milton Road	

Site 5 128 Sylvan Road Toowong	Front yard of block of four (4) units facing Sylvan Road towards Milton Road	
Site 6 4 Wool Street Toowong	Front yard of single-storey house, overlooking Toowong roundabout	
Site 7 115 Elizabeth Street Toowong	High side of the yard near detached single-storey dwelling, facing Western Freeway	

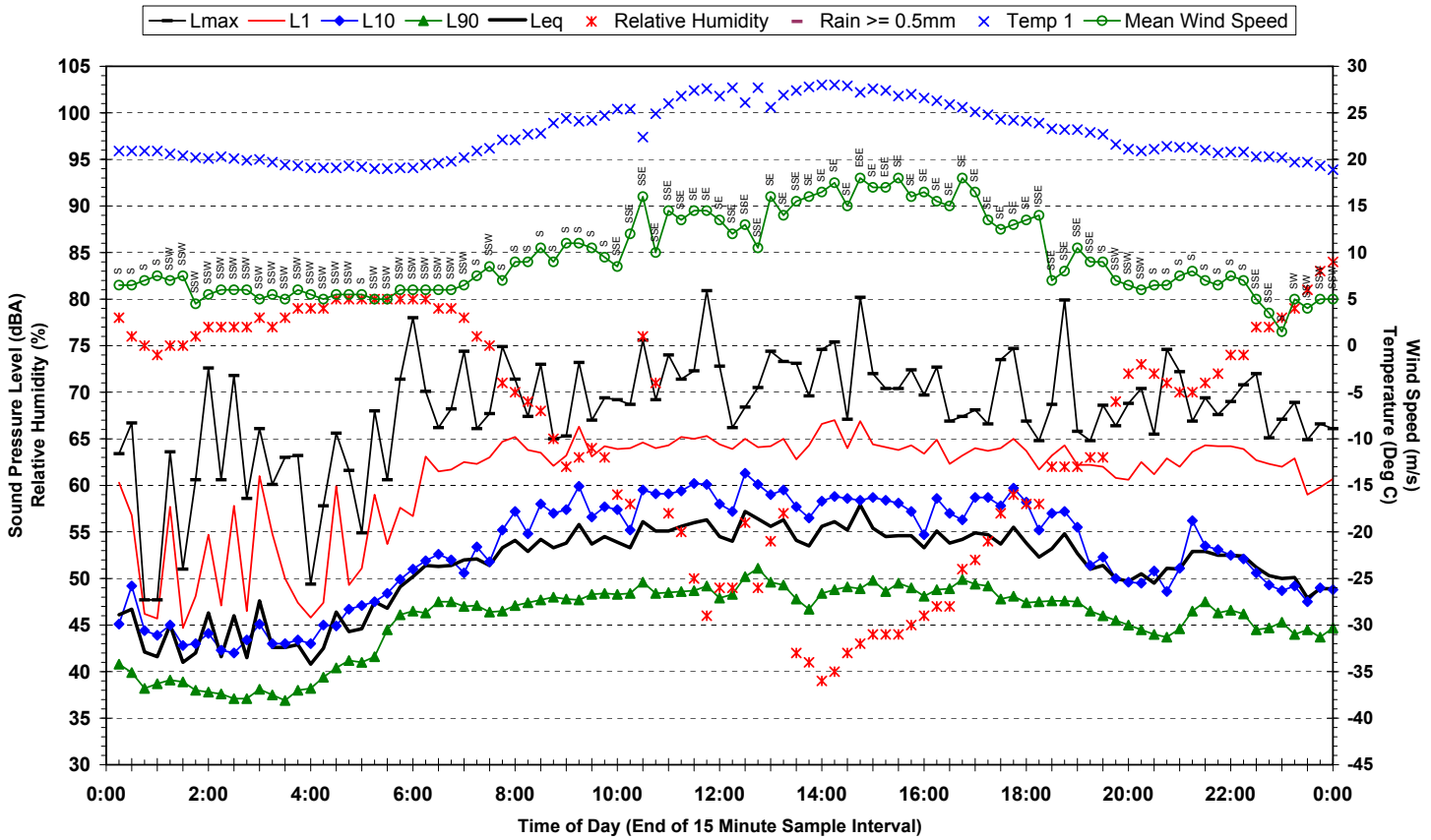
Appendix C
Report 20-1854-R5

NOISE MONITORING GRAPHS

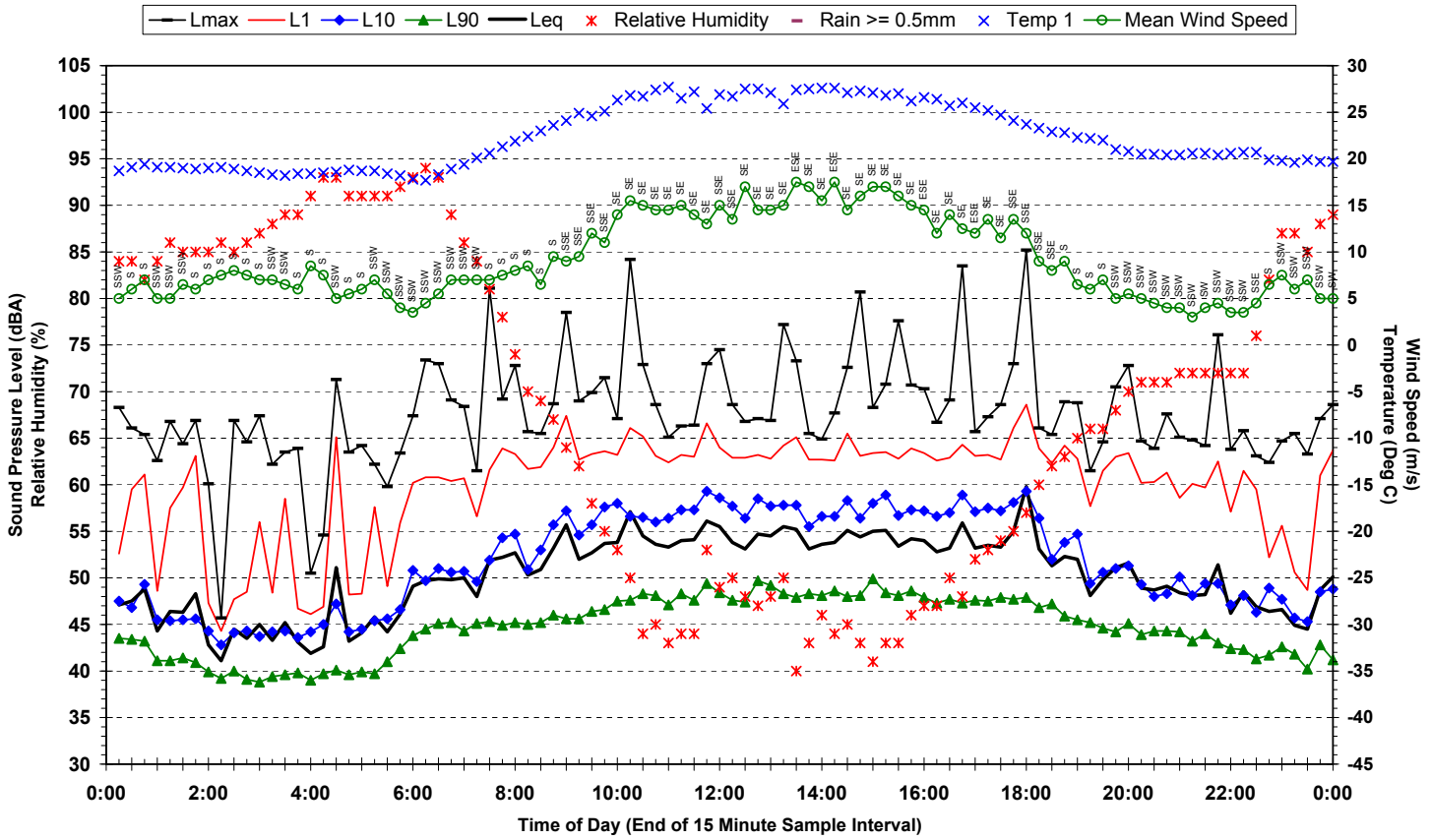
Statistical Ambient Noise Levels
20-1854 22 Crag Rd - Friday 27 March 2009



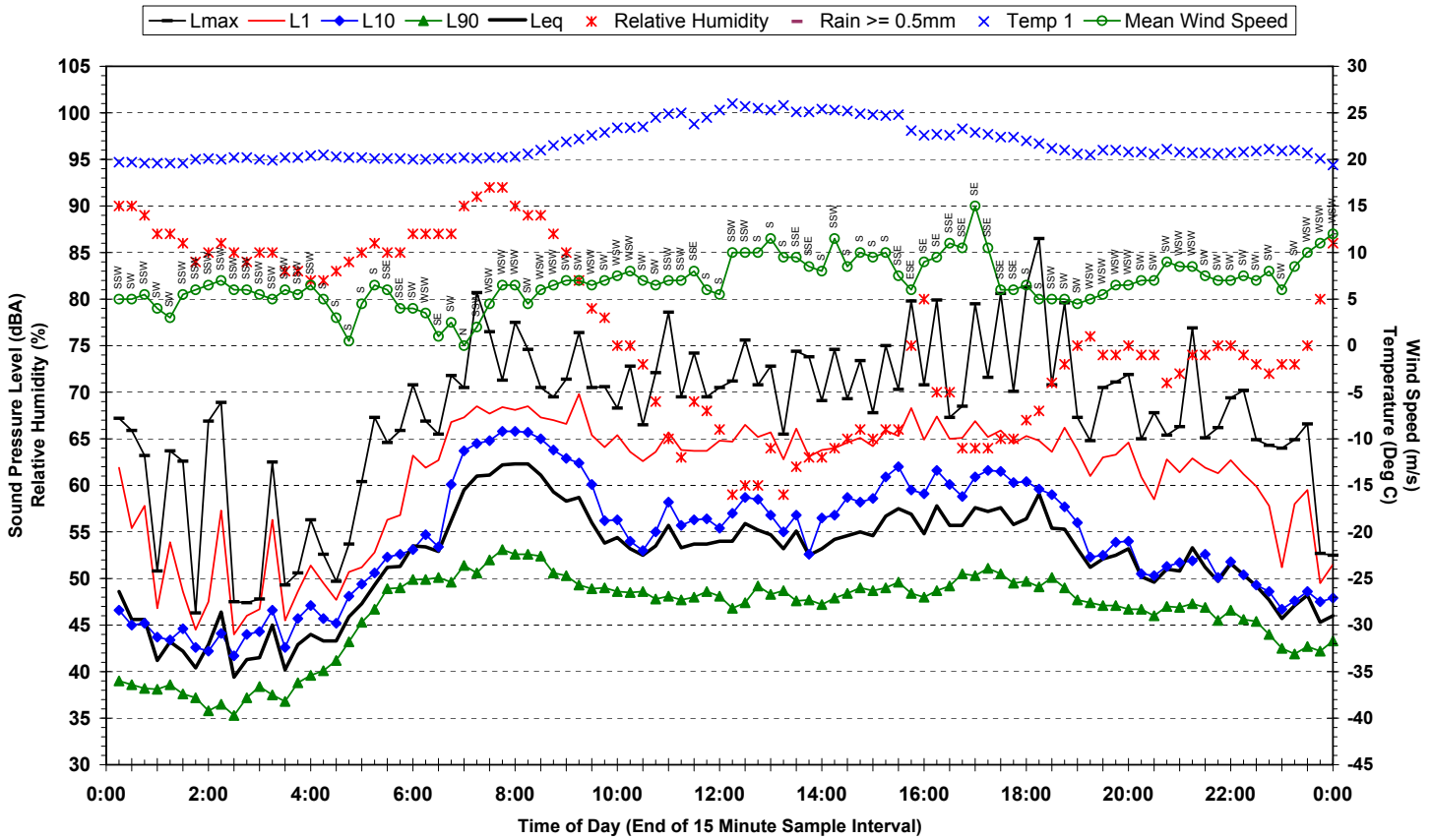
Statistical Ambient Noise Levels
20-1854 22 Crag Rd - Saturday 28 March 2009



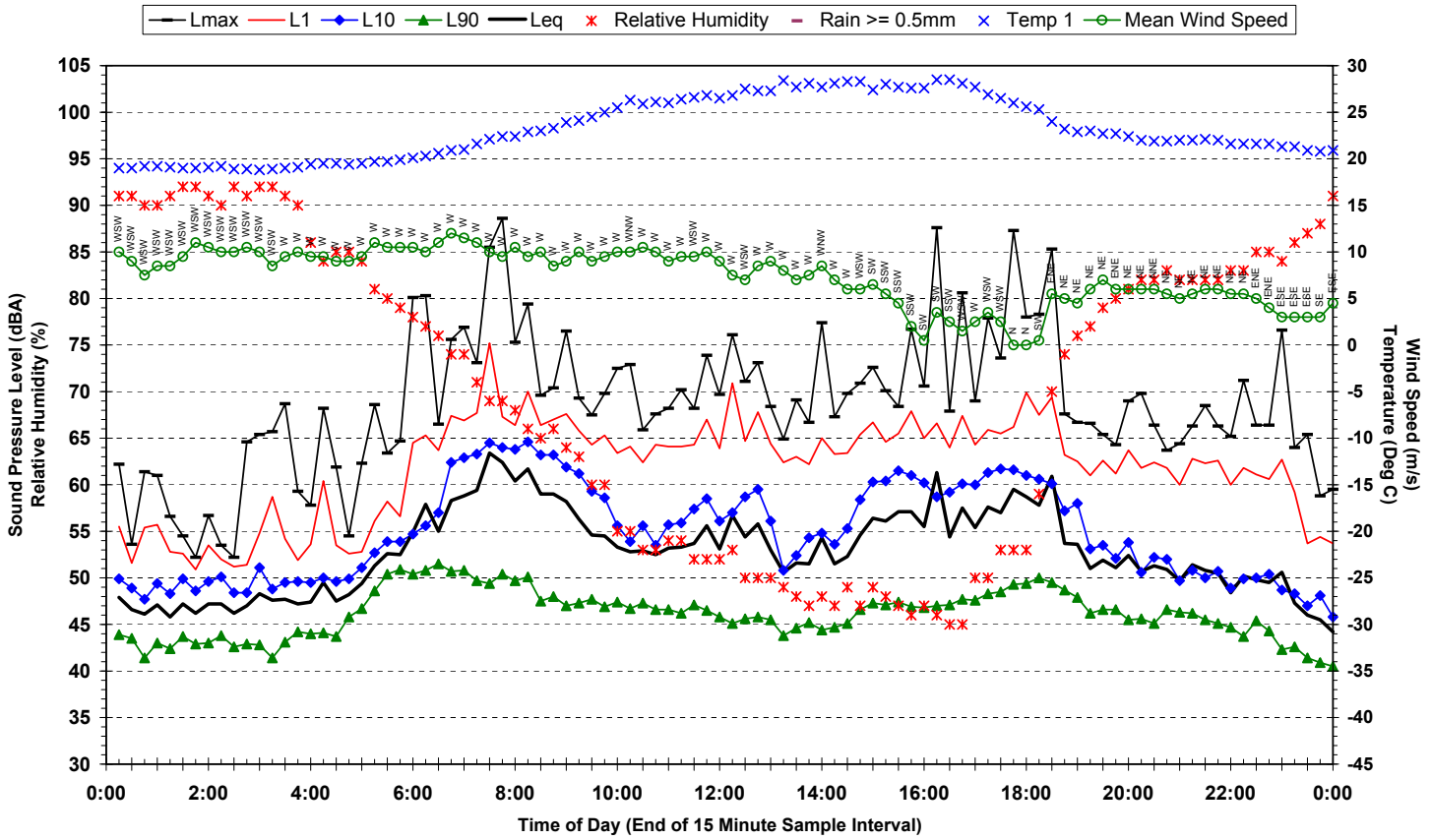
Statistical Ambient Noise Levels
20-1854 22 Crag Rd - Sunday 29 March 2009



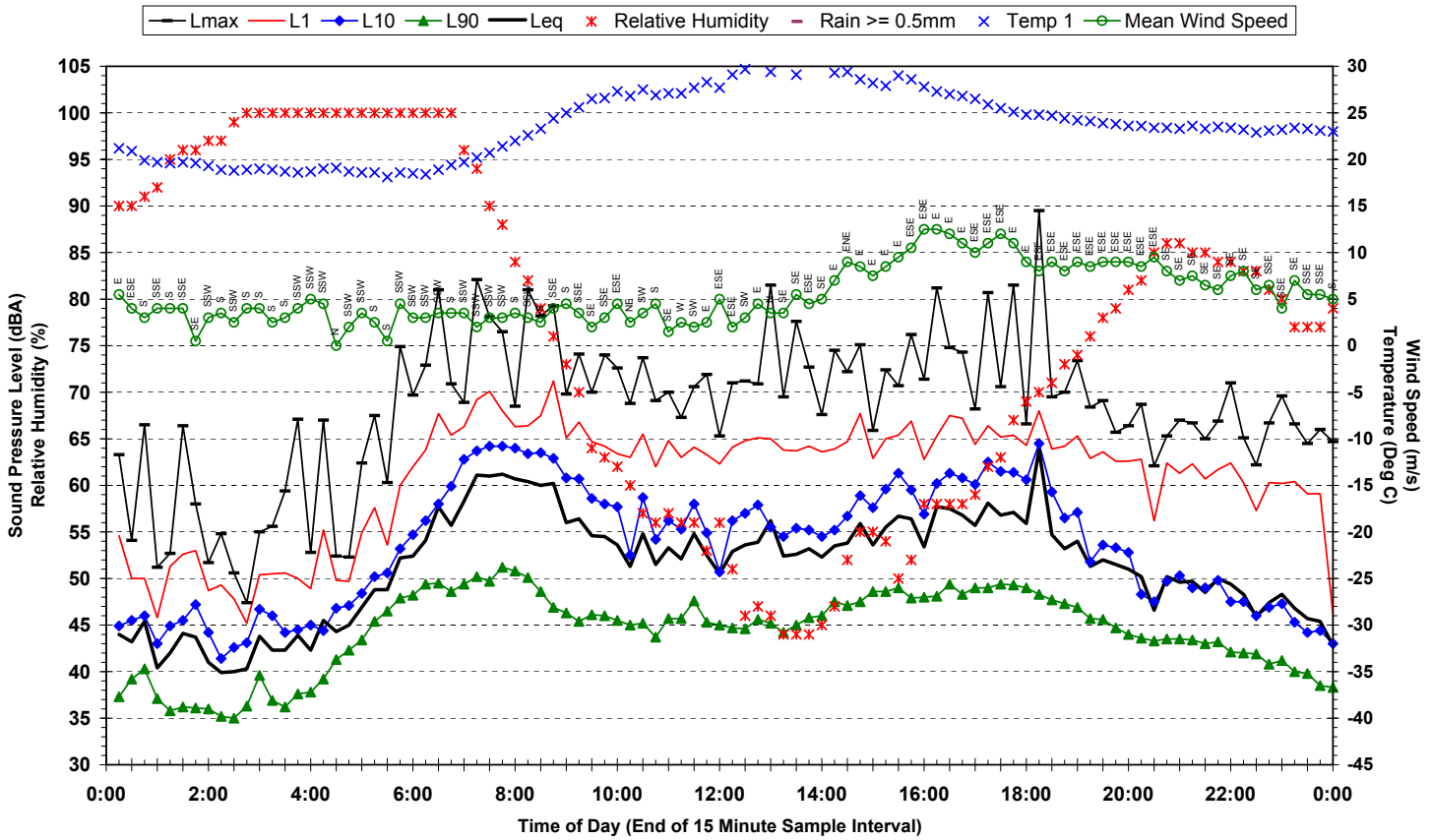
Statistical Ambient Noise Levels
20-1854 22 Crag Rd - Monday 30 March 2009



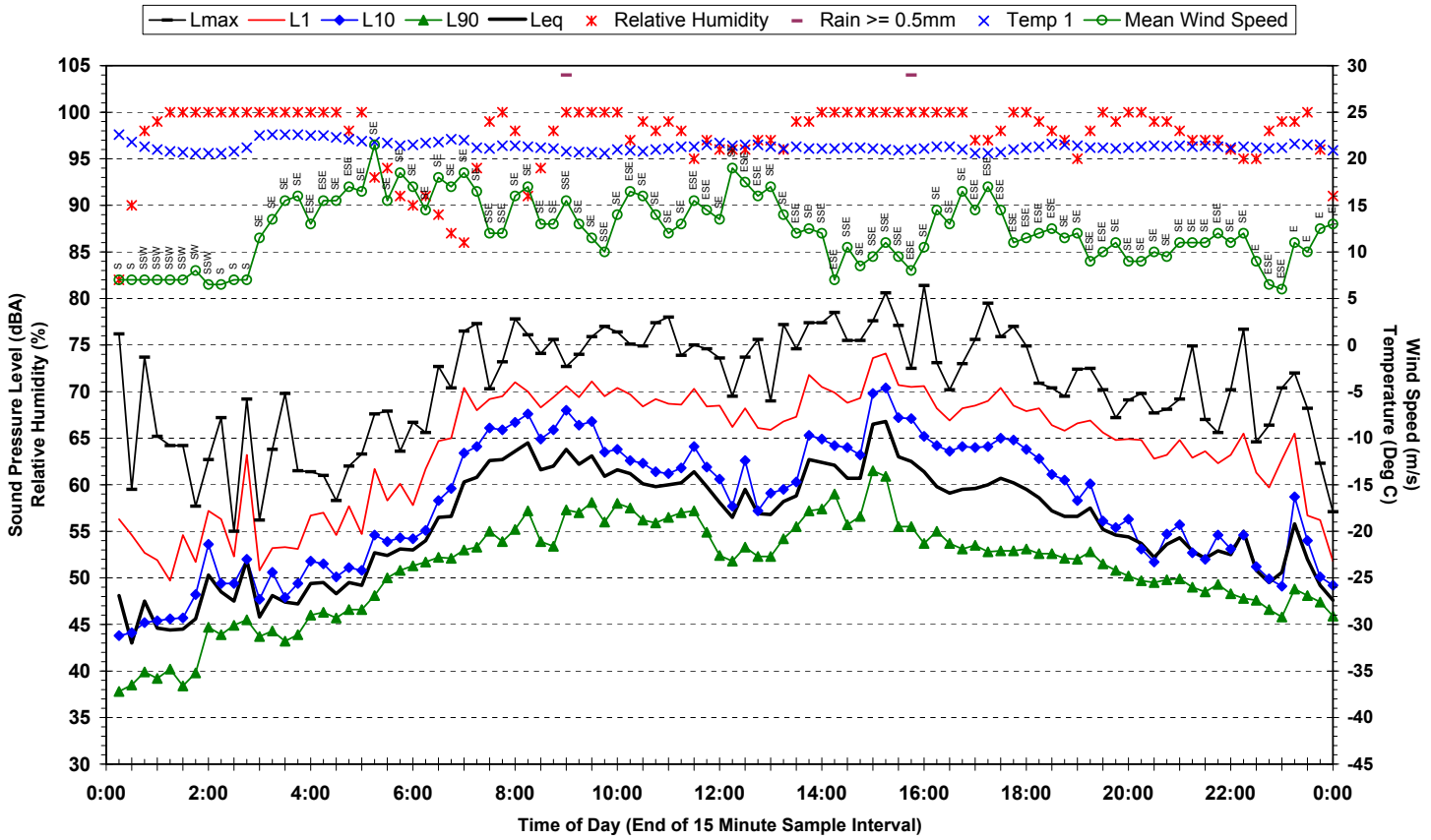
Statistical Ambient Noise Levels
20-1854 22 Crag Rd - Tuesday 31 March 2009



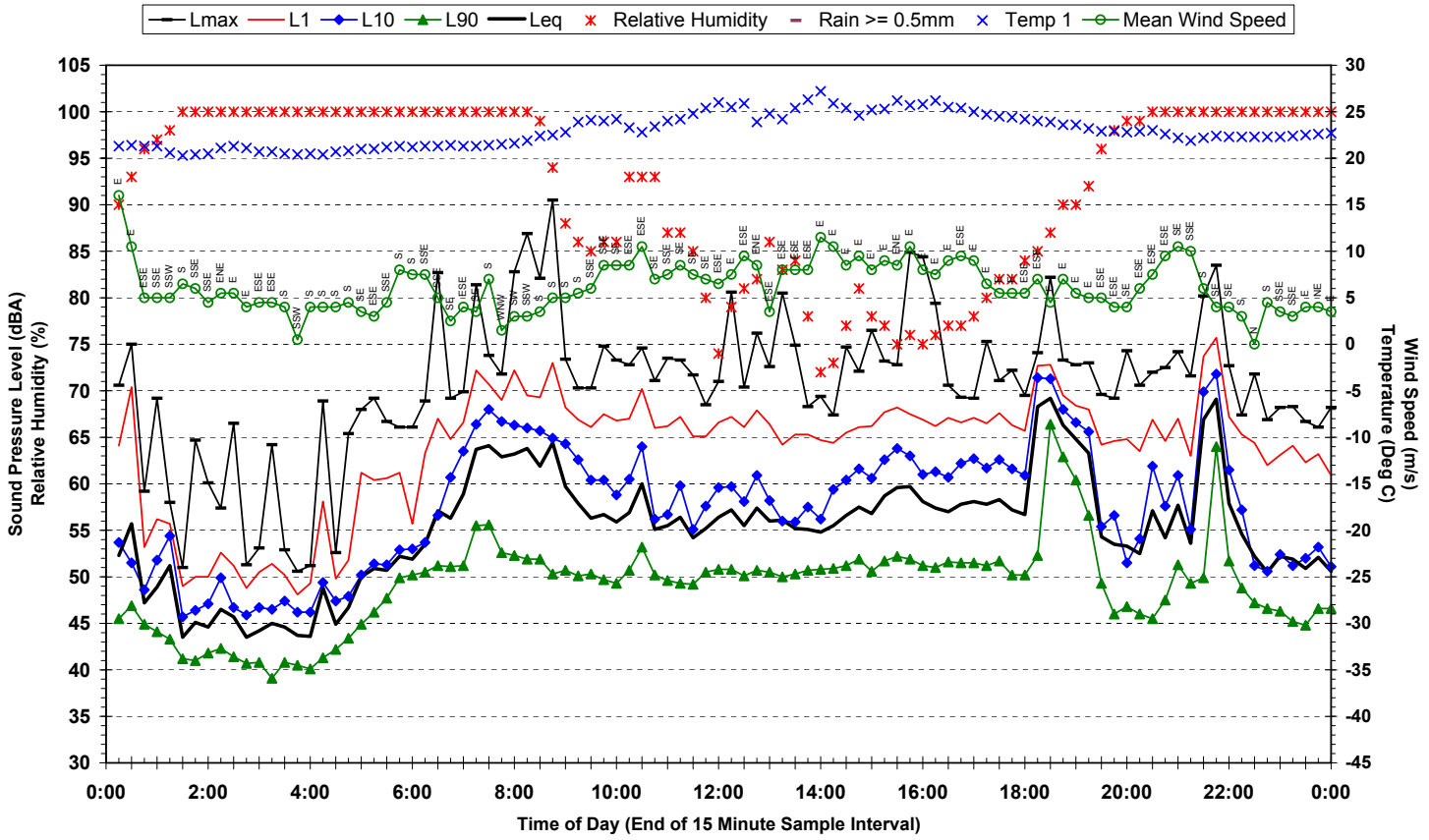
Statistical Ambient Noise Levels
20-1854 22 Crag Rd - Wednesday 1 April 2009



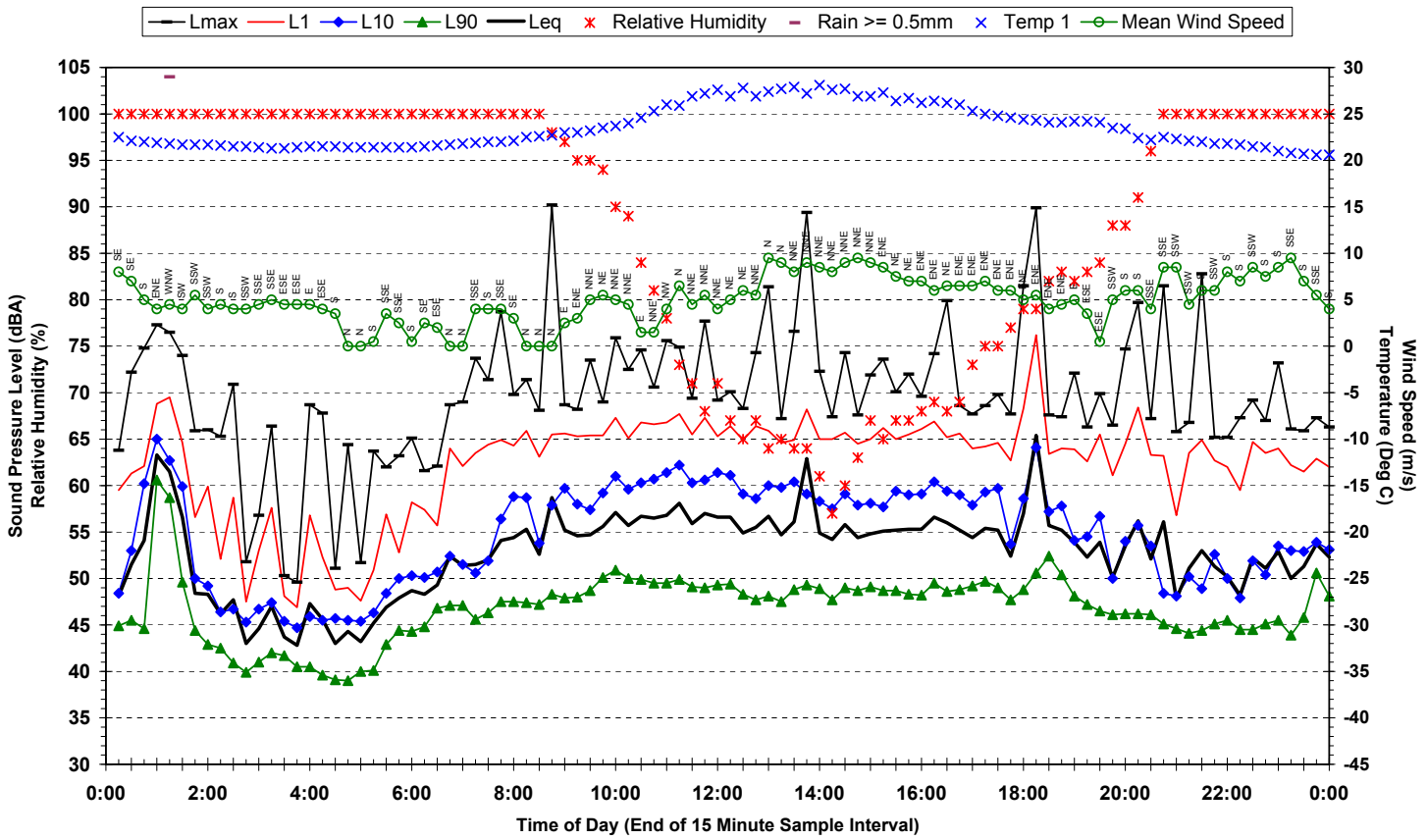
Statistical Ambient Noise Levels
20-1854 22 Crag Rd - Thursday 2 April 2009



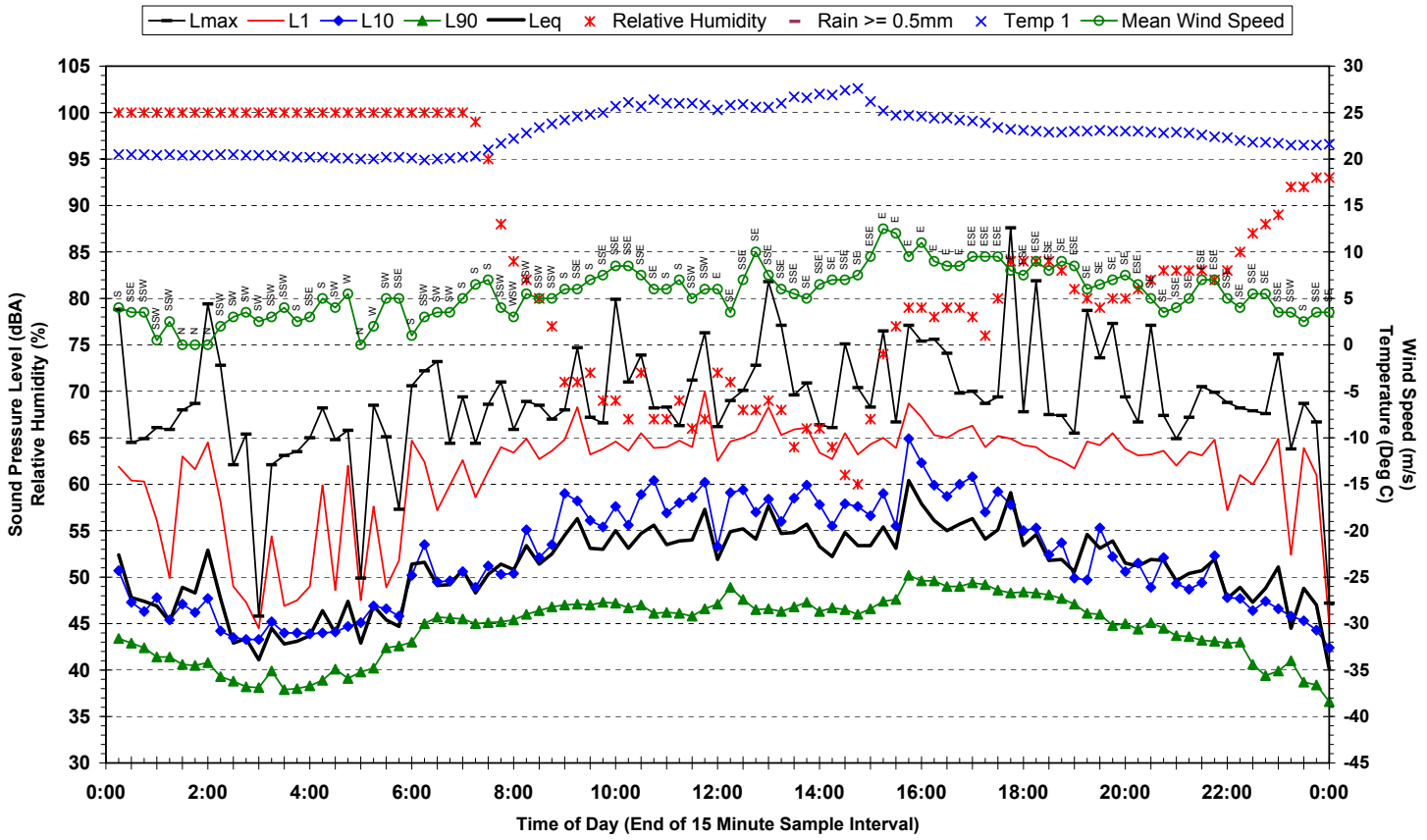
Statistical Ambient Noise Levels
20-1854 22 Crag Rd - Friday 3 April 2009



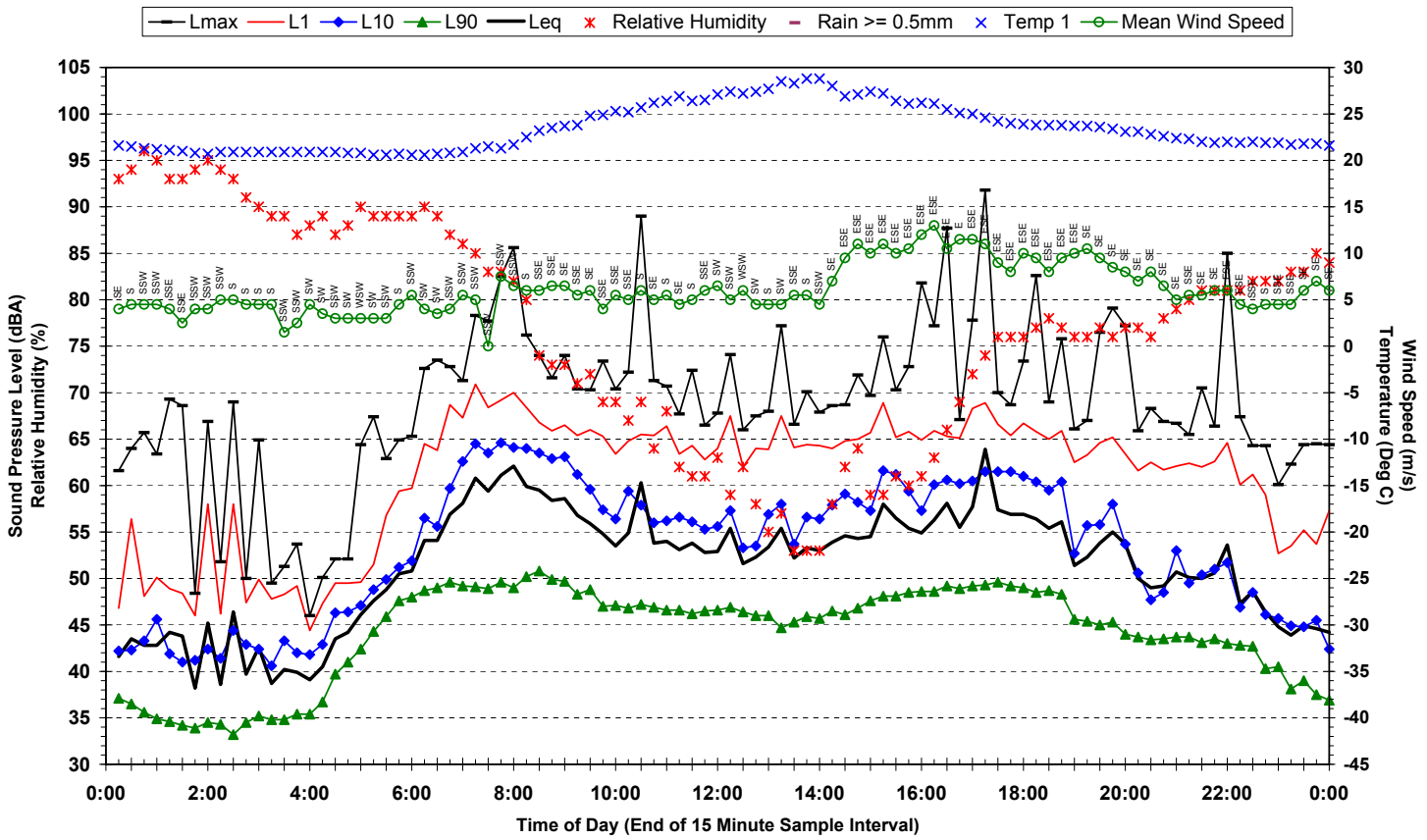
Statistical Ambient Noise Levels
20-1854 22 Crag Rd - Saturday 4 April 2009



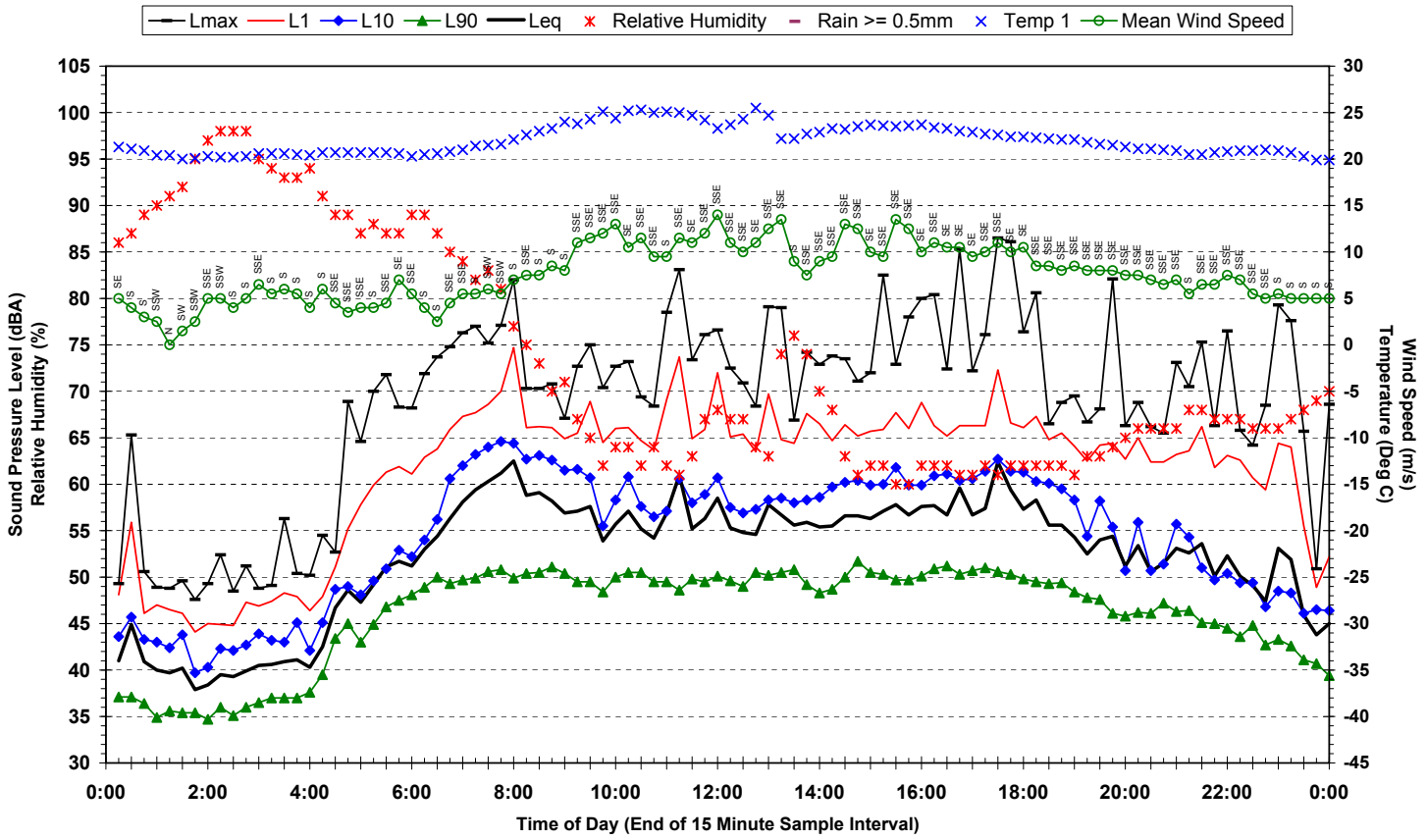
Statistical Ambient Noise Levels
20-1854 22 Crag Rd - Sunday 5 April 2009



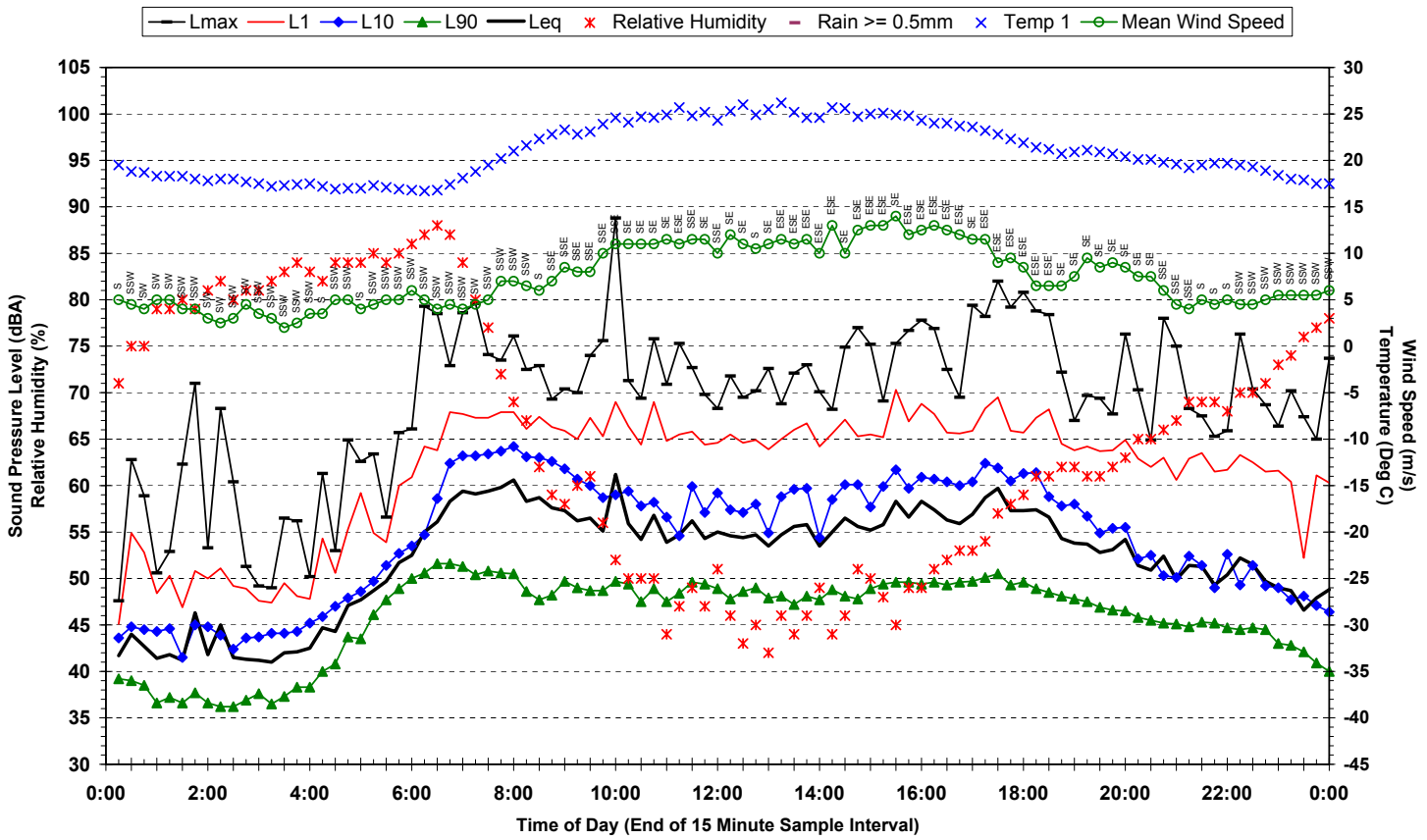
Statistical Ambient Noise Levels
20-1854 22 Crag Rd - Monday 6 April 2009



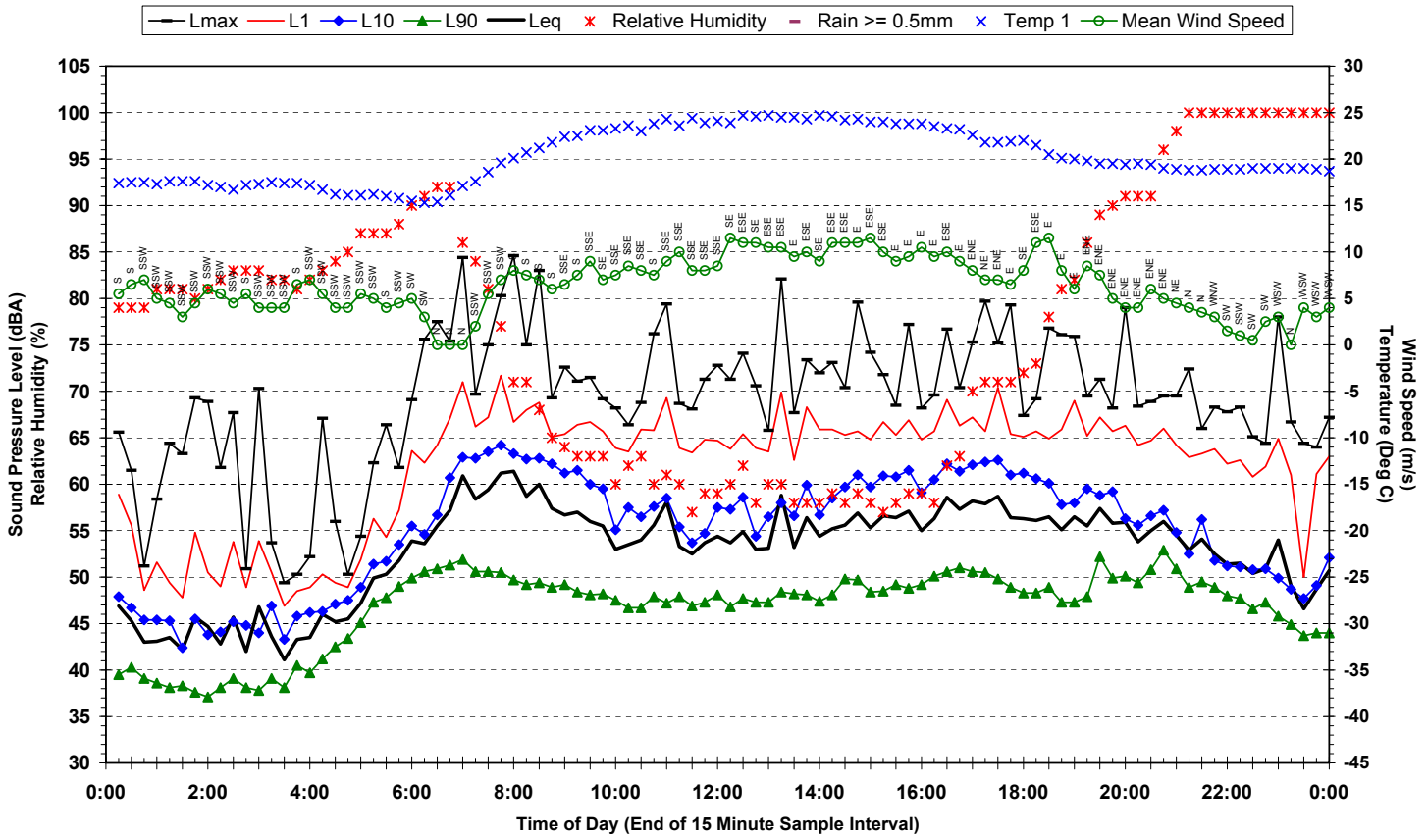
Statistical Ambient Noise Levels
20-1854 22 Crag Rd - Tuesday 7 April 2009



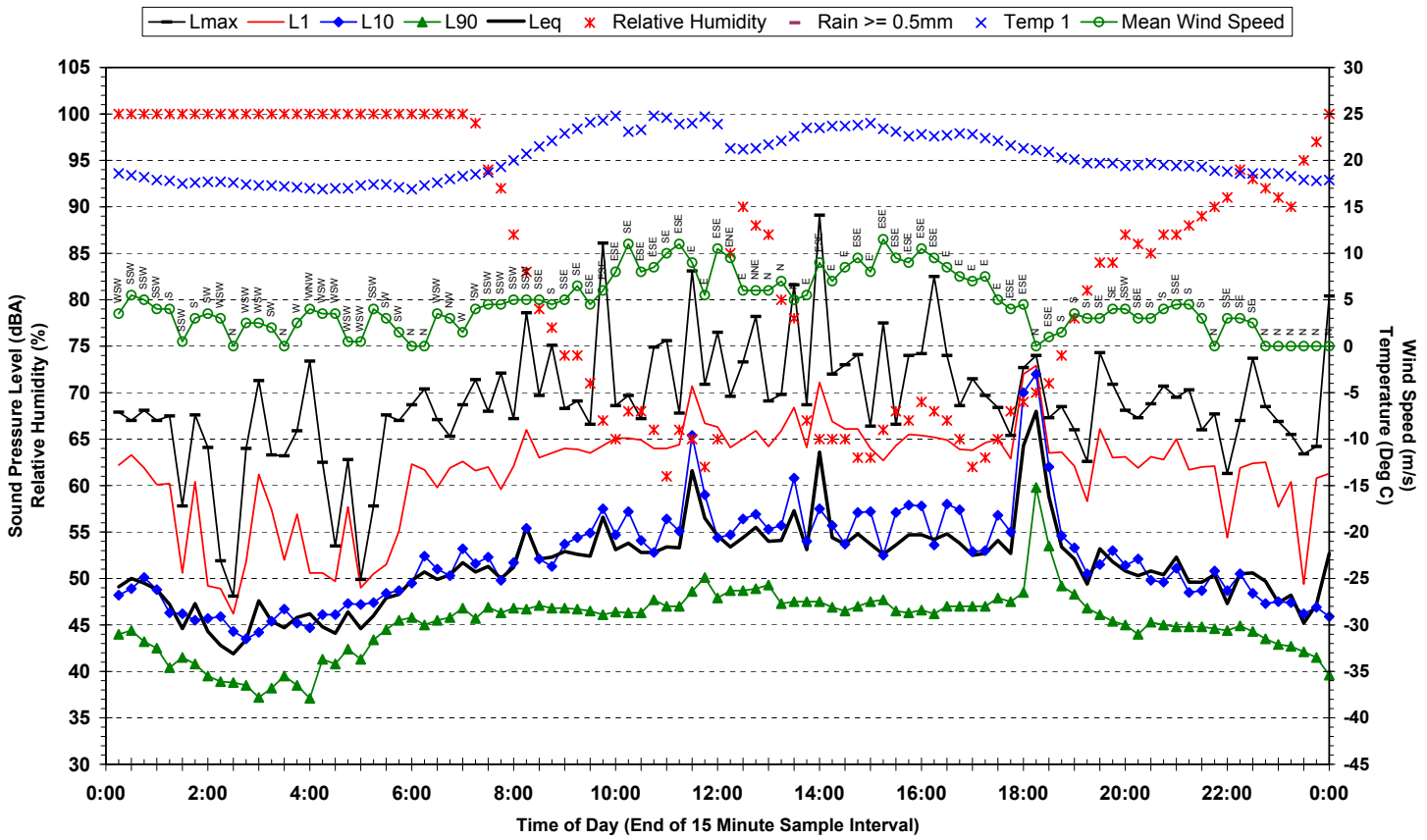
Statistical Ambient Noise Levels
20-1854 22 Crag Rd - Wednesday 8 April 2009



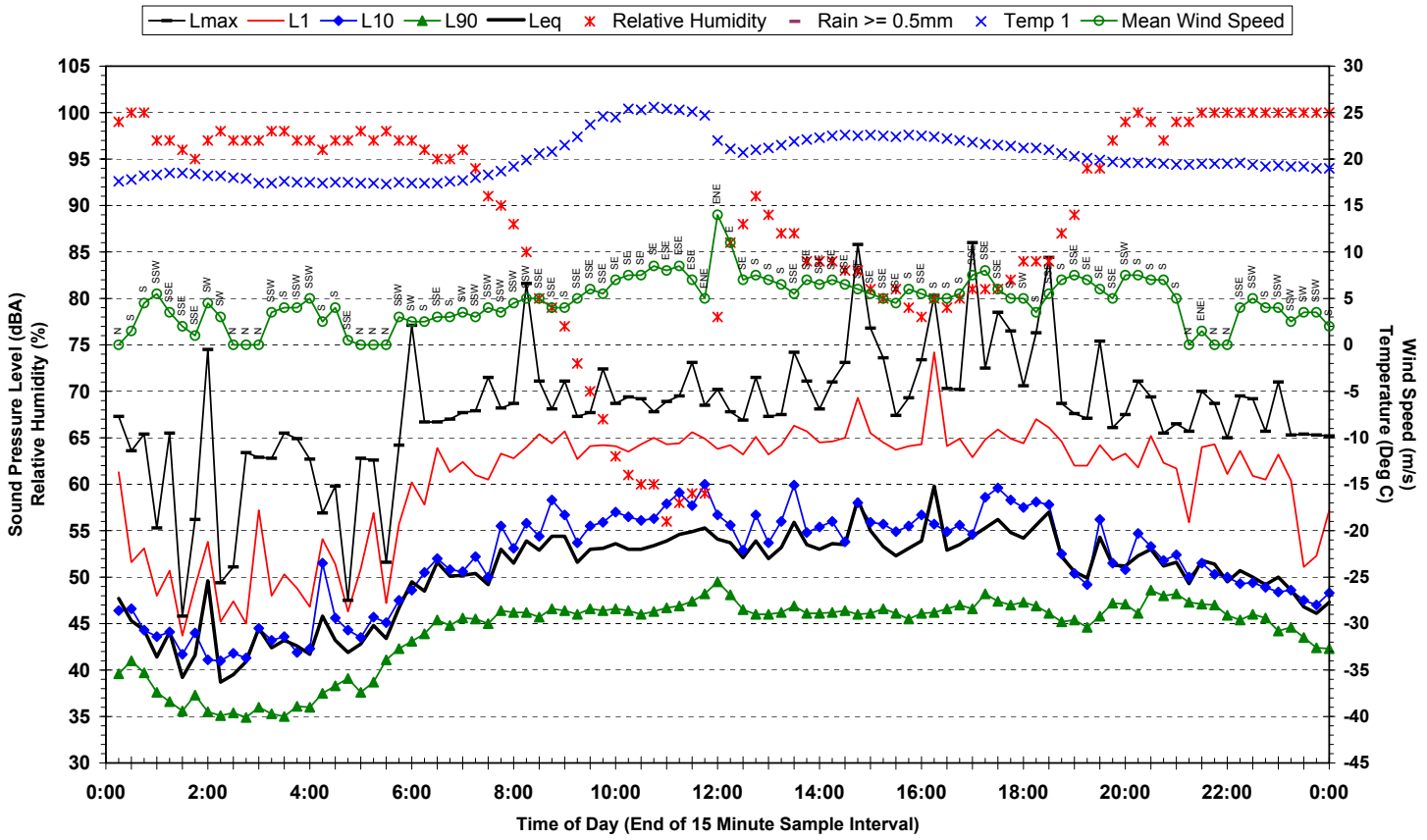
Statistical Ambient Noise Levels
20-1854 22 Crag Rd - Thursday 9 April 2009



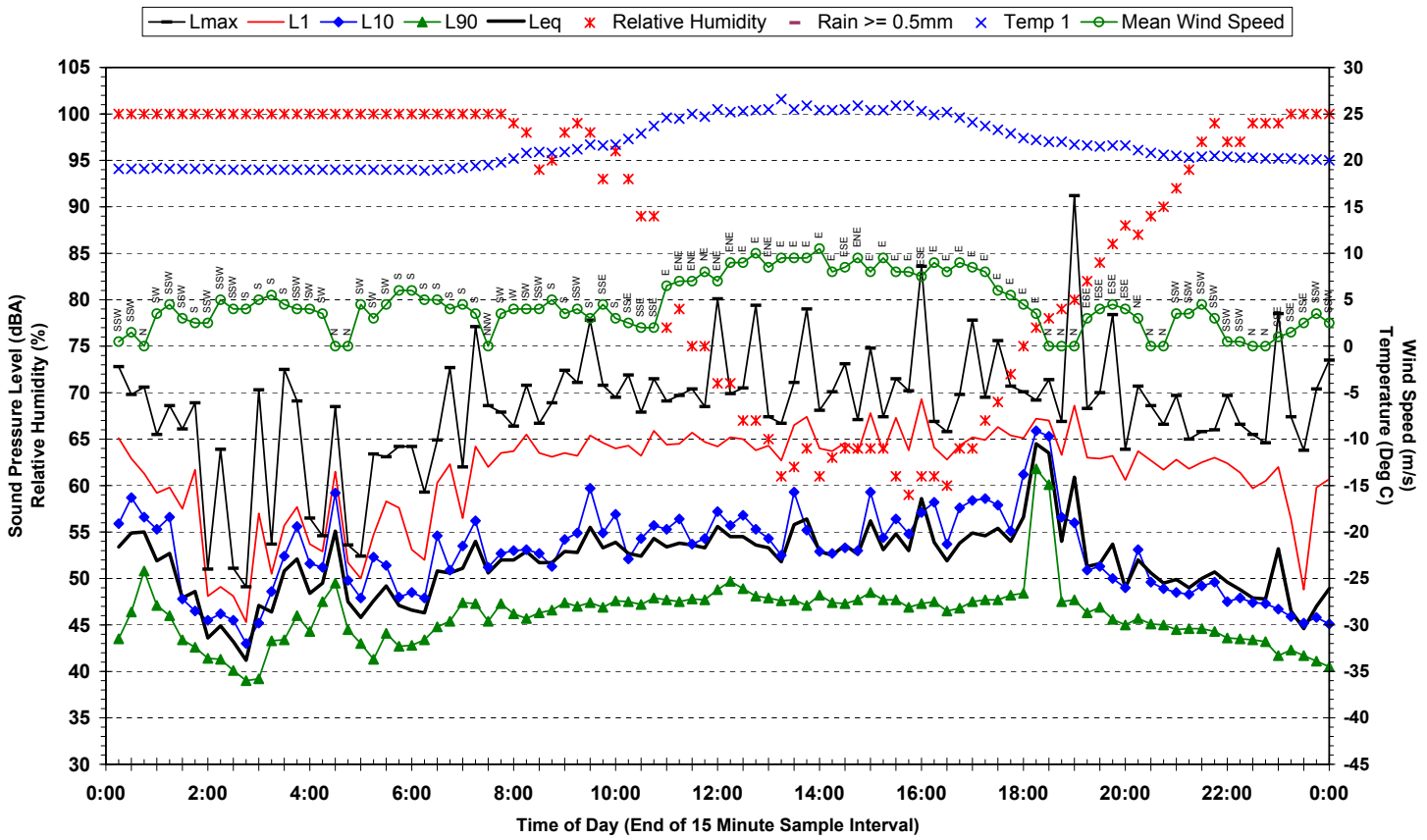
Statistical Ambient Noise Levels
20-1854 22 Crag Rd - Friday 10 April 2009



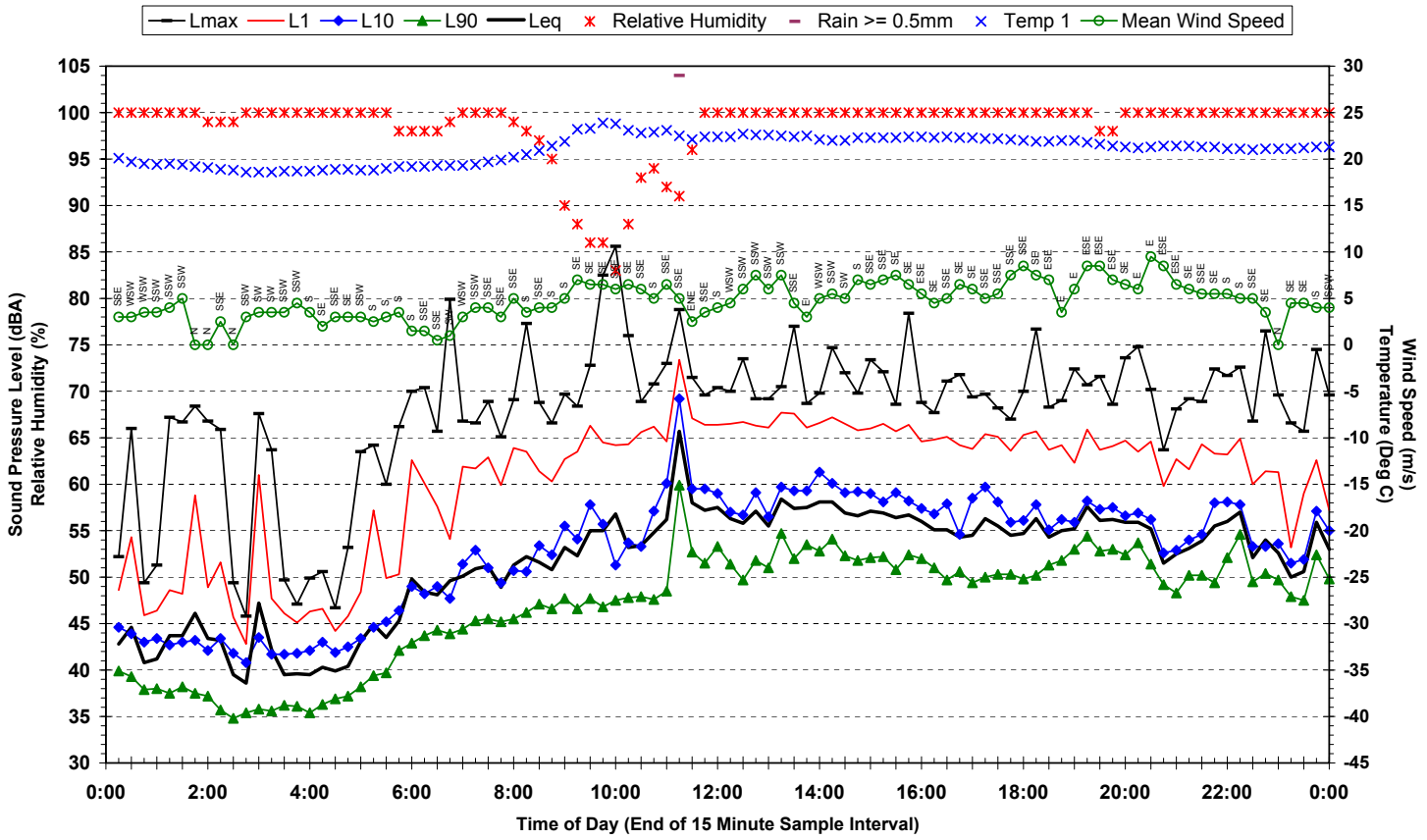
Statistical Ambient Noise Levels
20-1854 22 Crag Rd - Saturday 11 April 2009



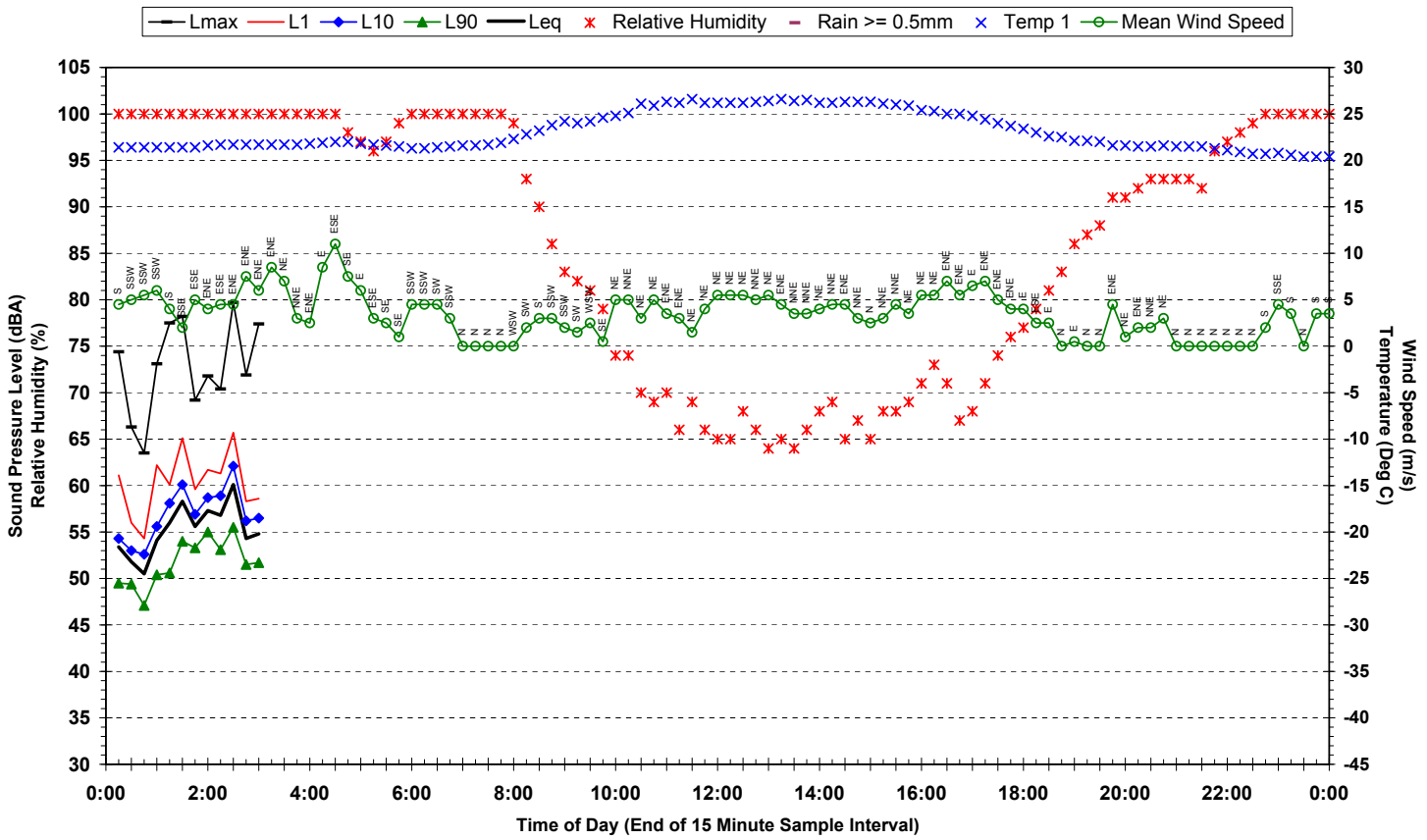
Statistical Ambient Noise Levels
20-1854 22 Crag Rd - Sunday 12 April 2009



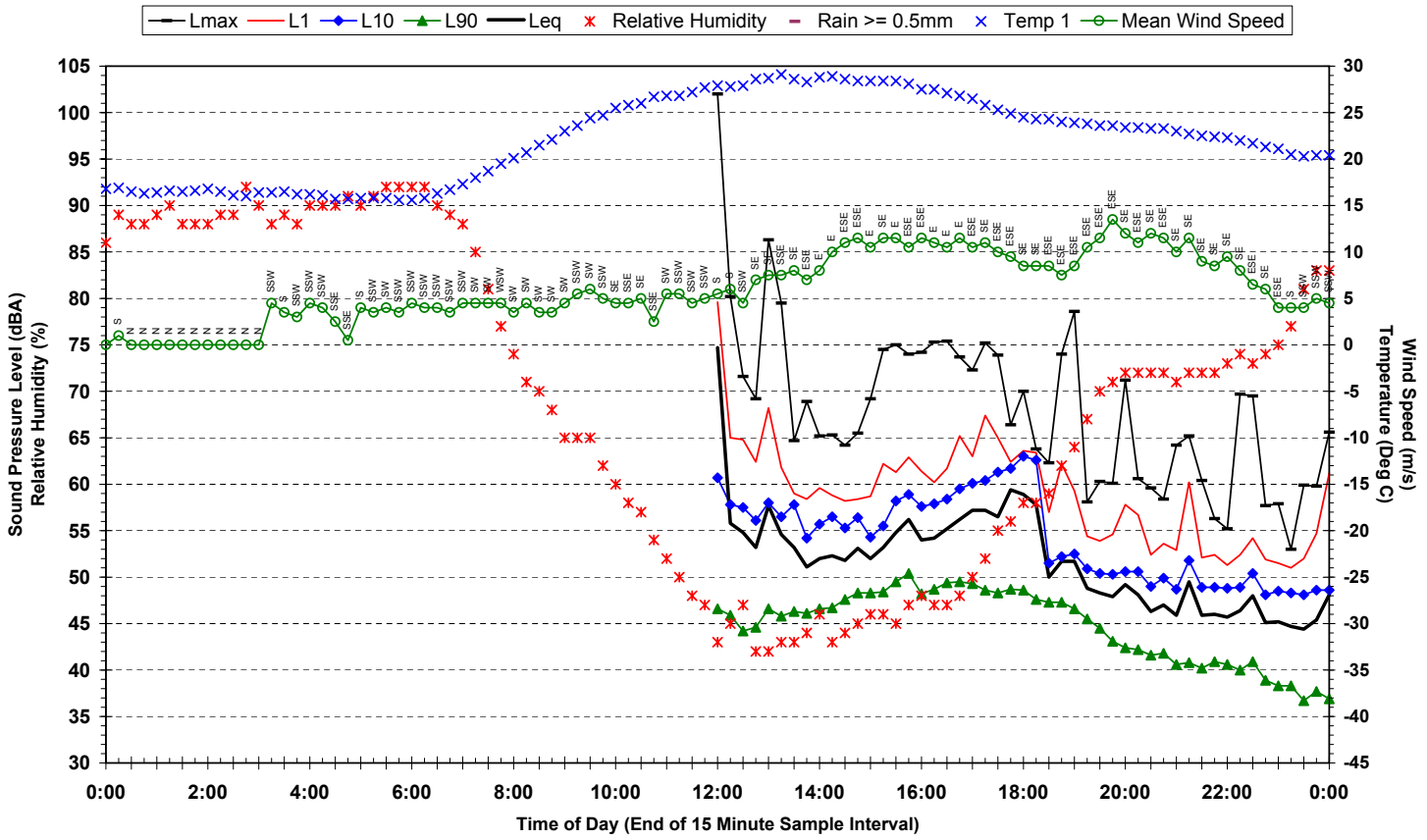
Statistical Ambient Noise Levels
20-1854 22 Crag Rd - Monday 13 April 2009



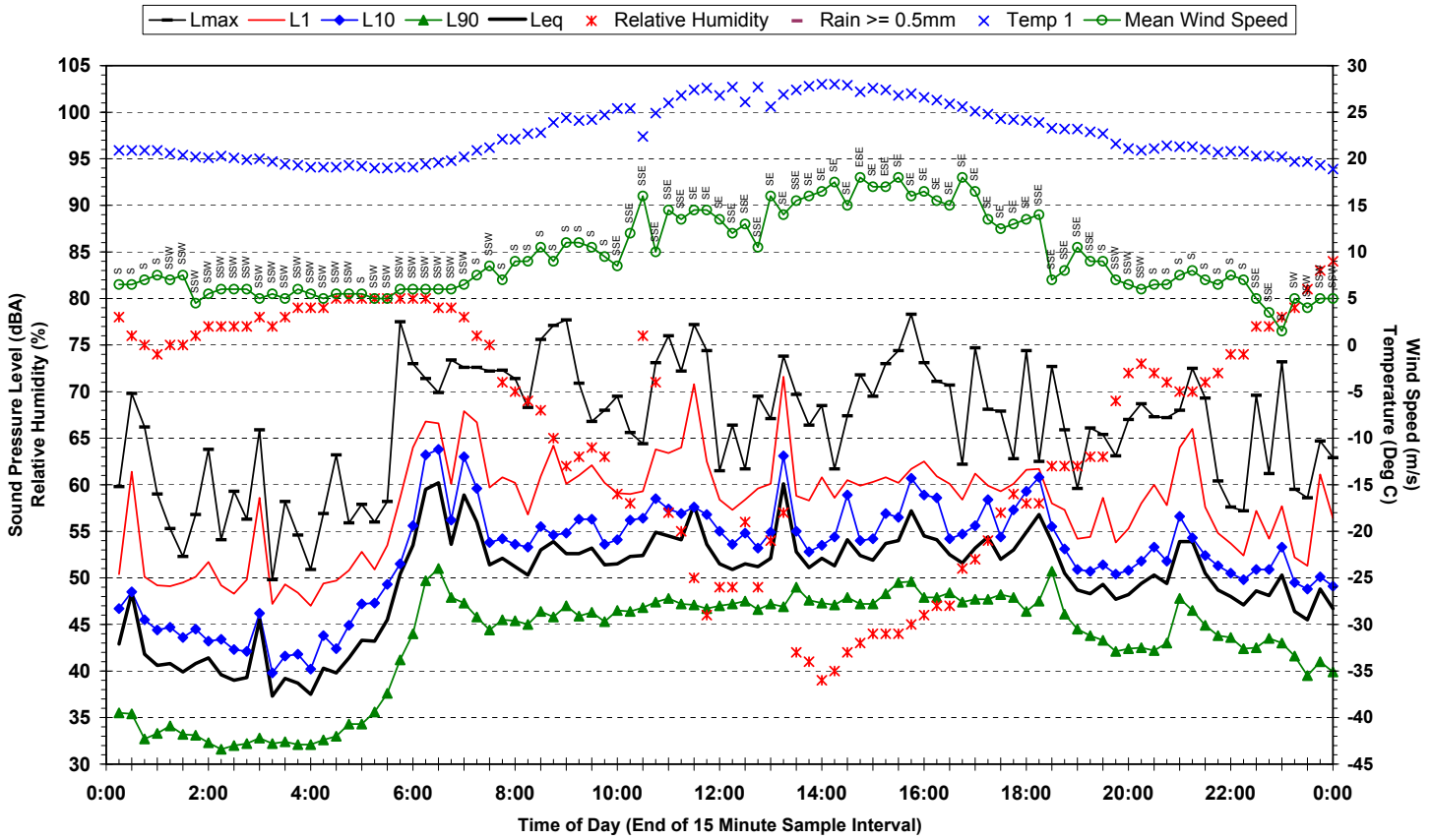
Statistical Ambient Noise Levels
20-1854 22 Crag Rd - Tuesday 14 April 2009



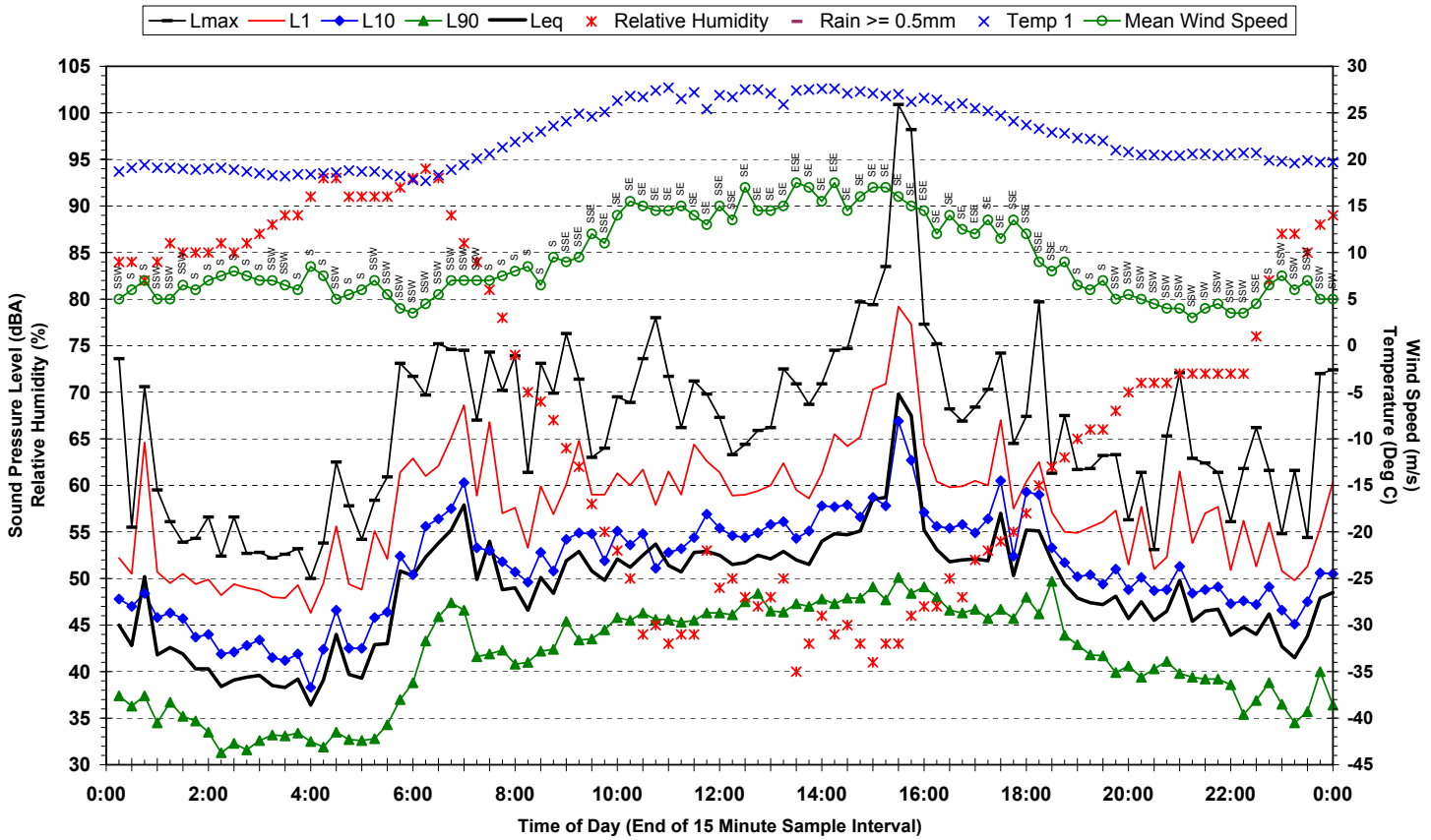
Statistical Ambient Noise Levels
20-1854 9 Victoria Cres - Friday 27 March 2009



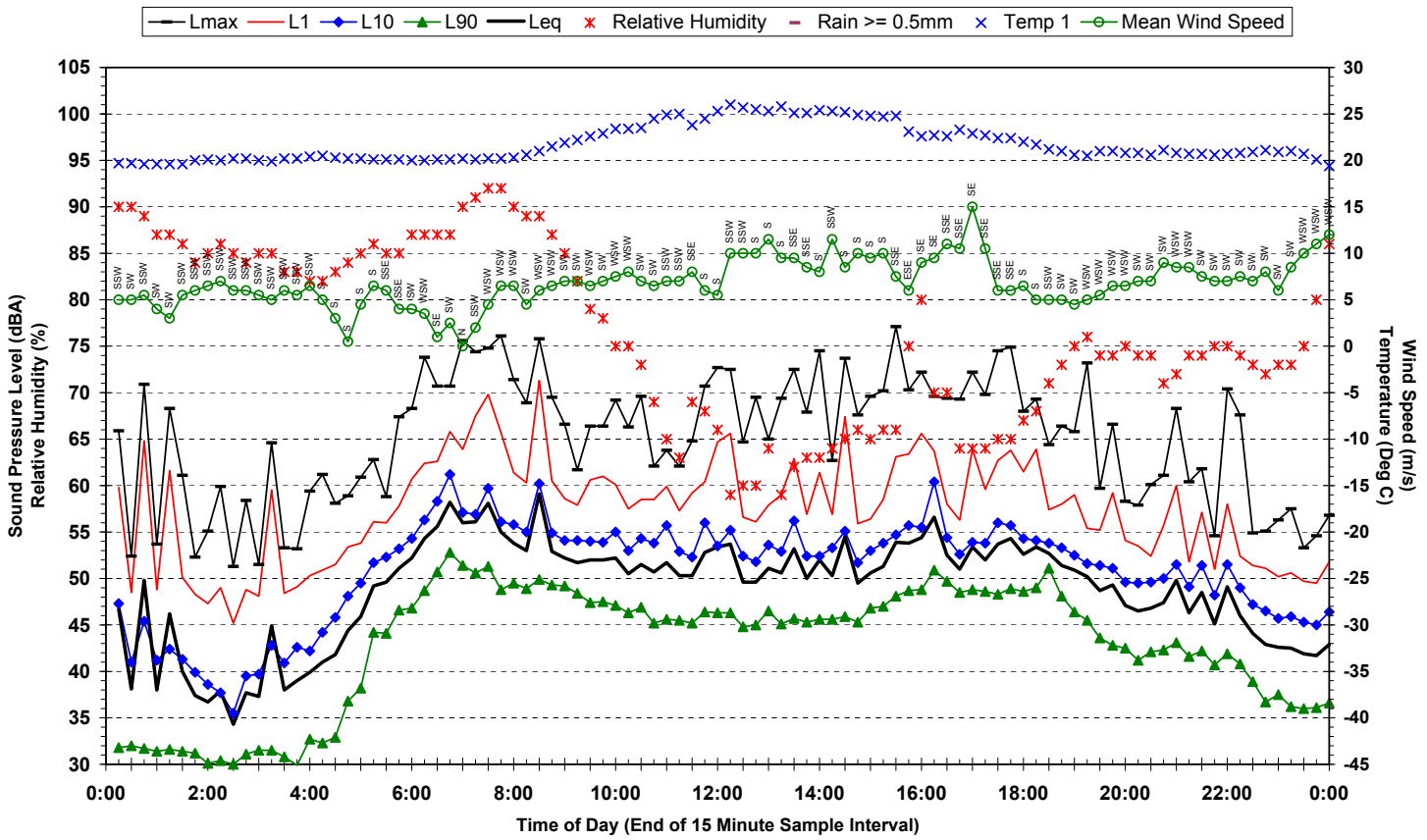
Statistical Ambient Noise Levels
20-1854 9 Victoria Cres - Saturday 28 March 2009



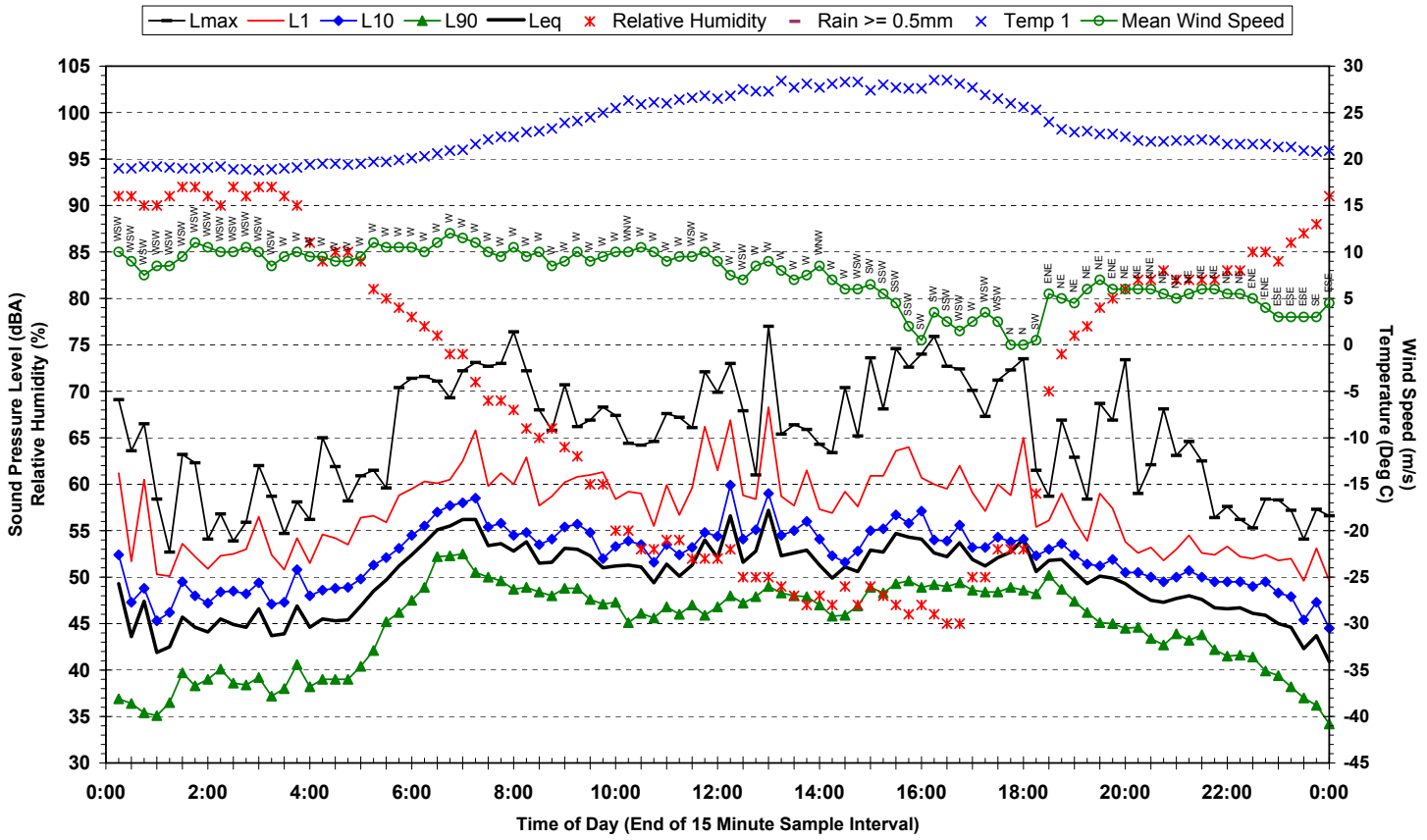
Statistical Ambient Noise Levels
20-1854 9 Victoria Cres - Sunday 29 March 2009



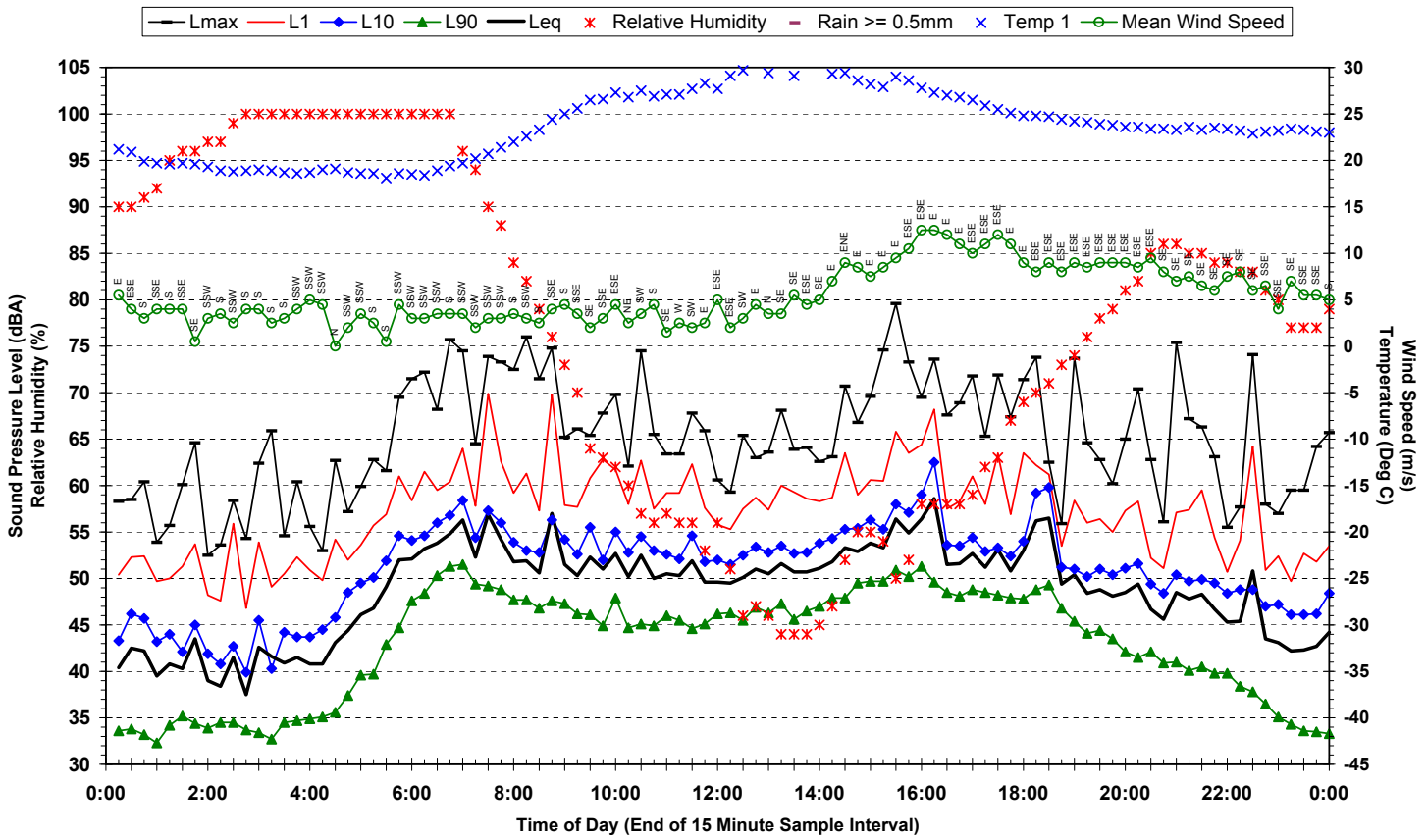
Statistical Ambient Noise Levels
20-1854 9 Victoria Cres - Monday 30 March 2009



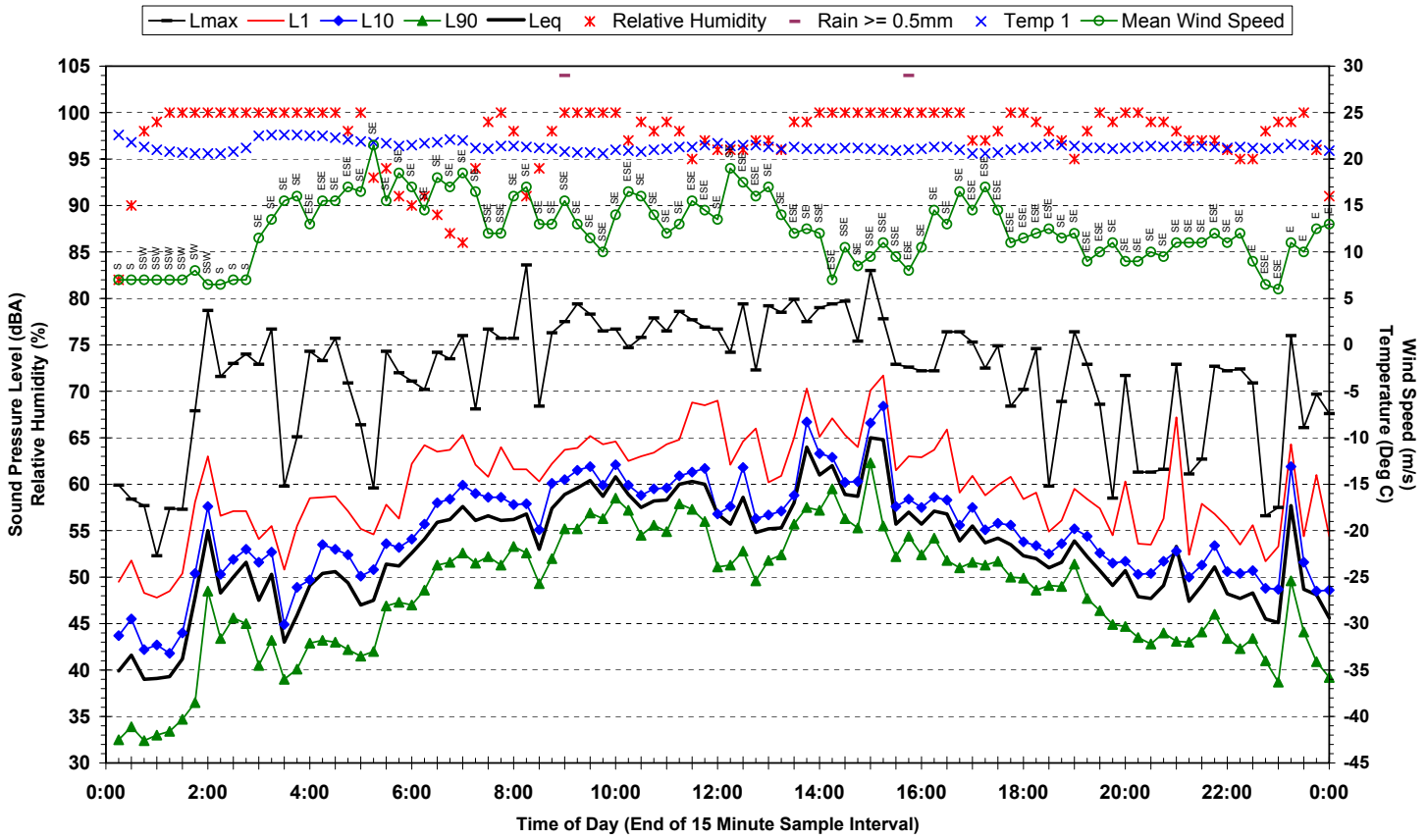
Statistical Ambient Noise Levels
20-1854 9 Victoria Cres - Tuesday 31 March 2009



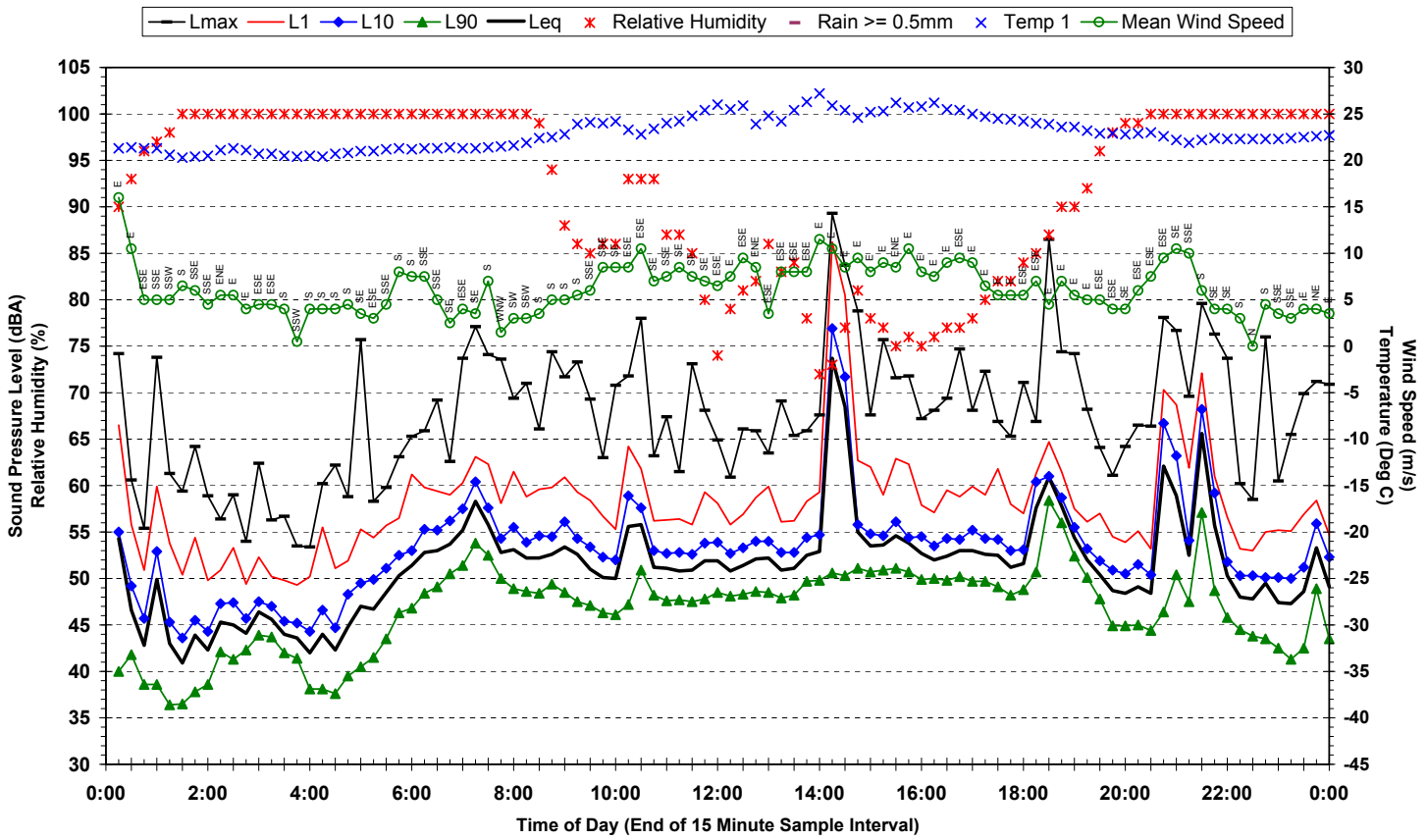
Statistical Ambient Noise Levels
20-1854 9 Victoria Cres - Wednesday 1 April 2009



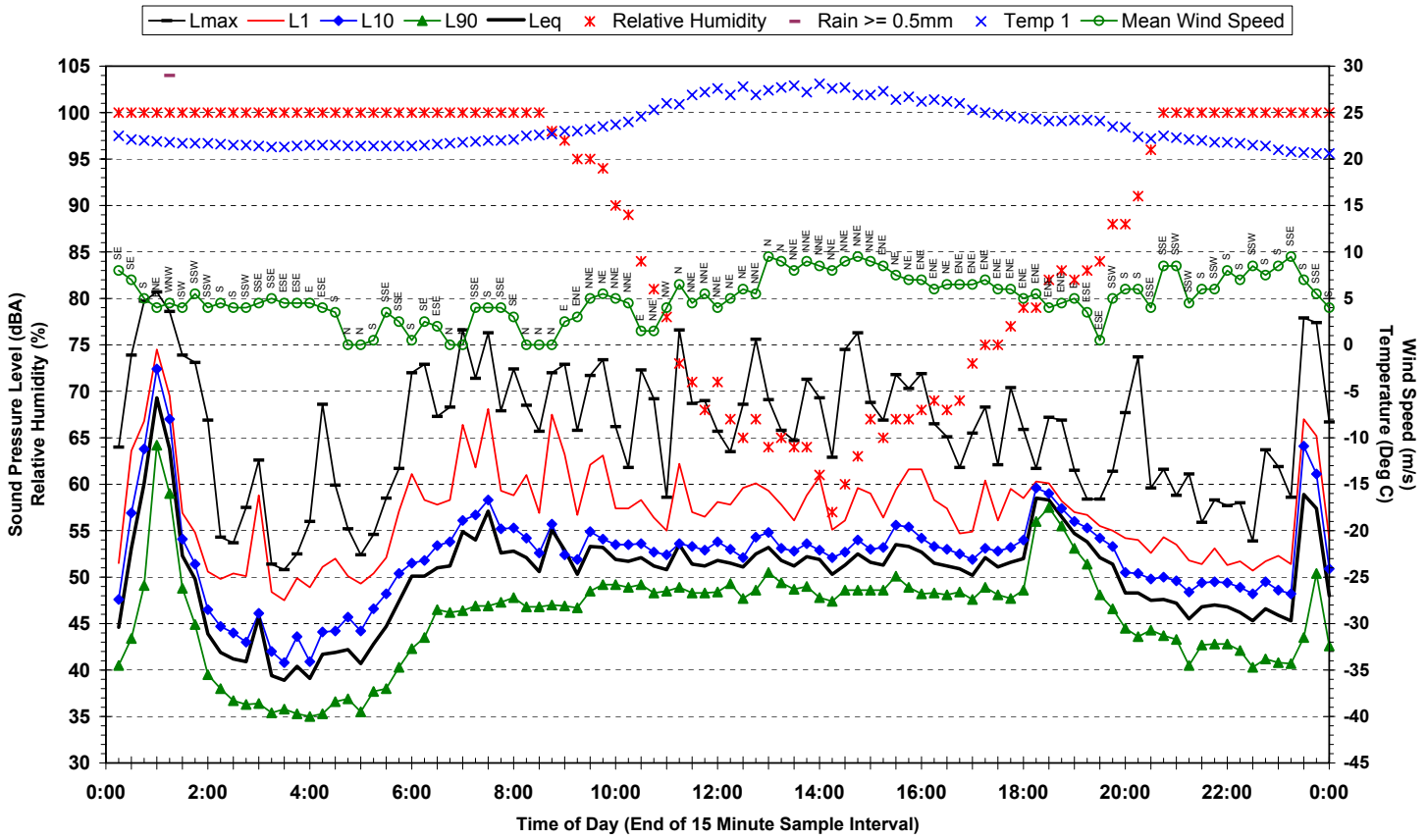
Statistical Ambient Noise Levels
20-1854 9 Victoria Cres - Thursday 2 April 2009



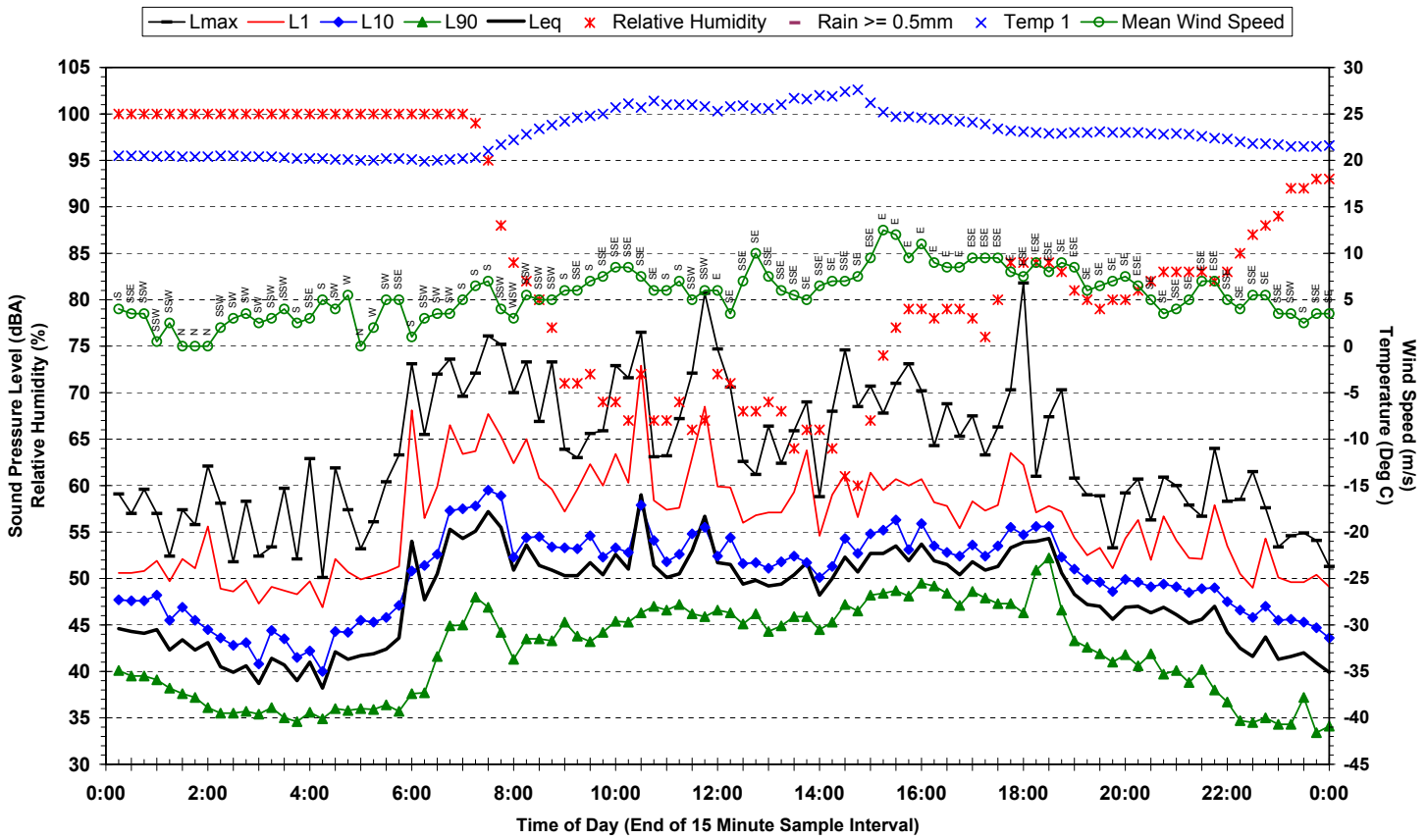
Statistical Ambient Noise Levels
20-1854 9 Victoria Cres - Friday 3 April 2009



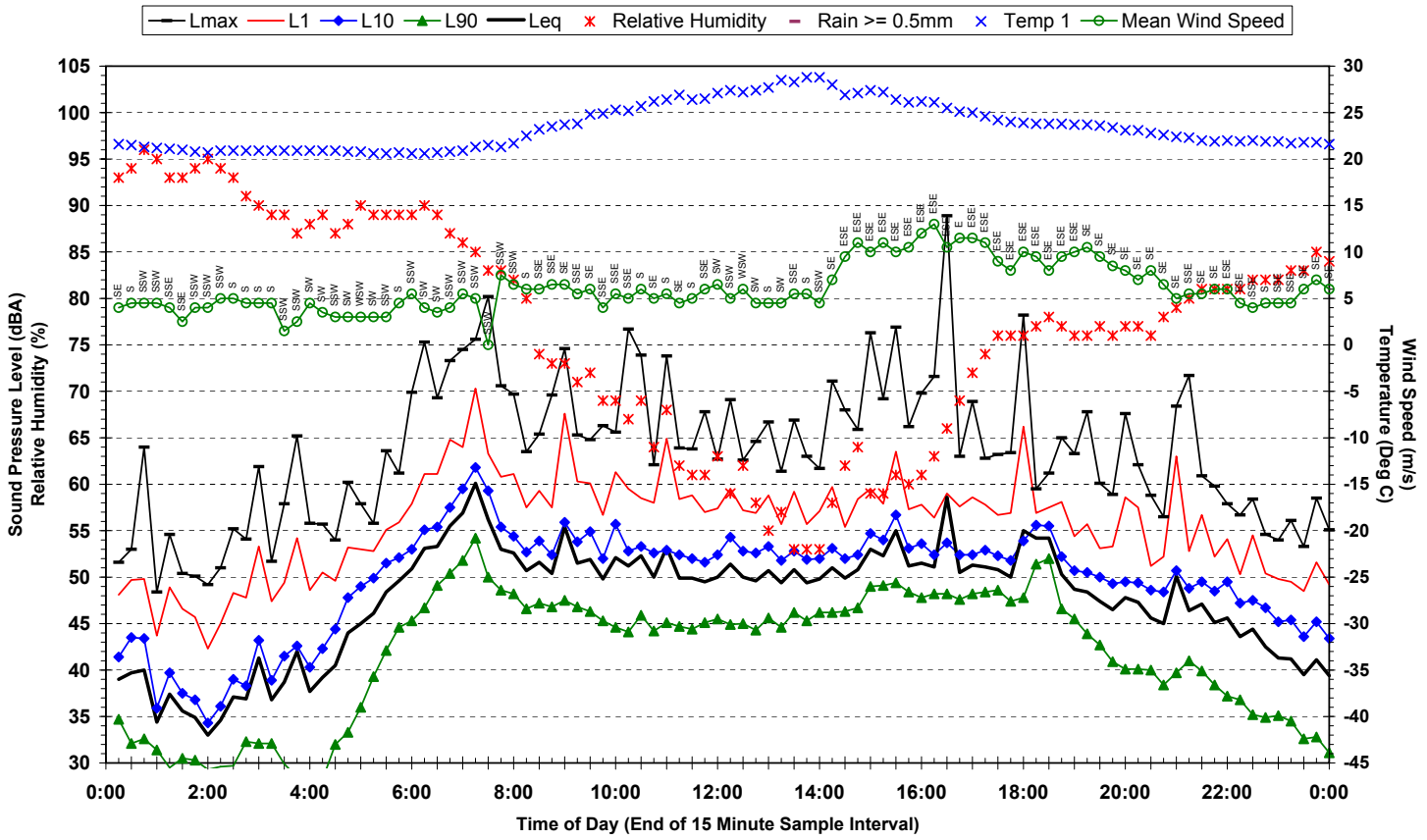
Statistical Ambient Noise Levels
20-1854 9 Victoria Cres - Saturday 4 April 2009



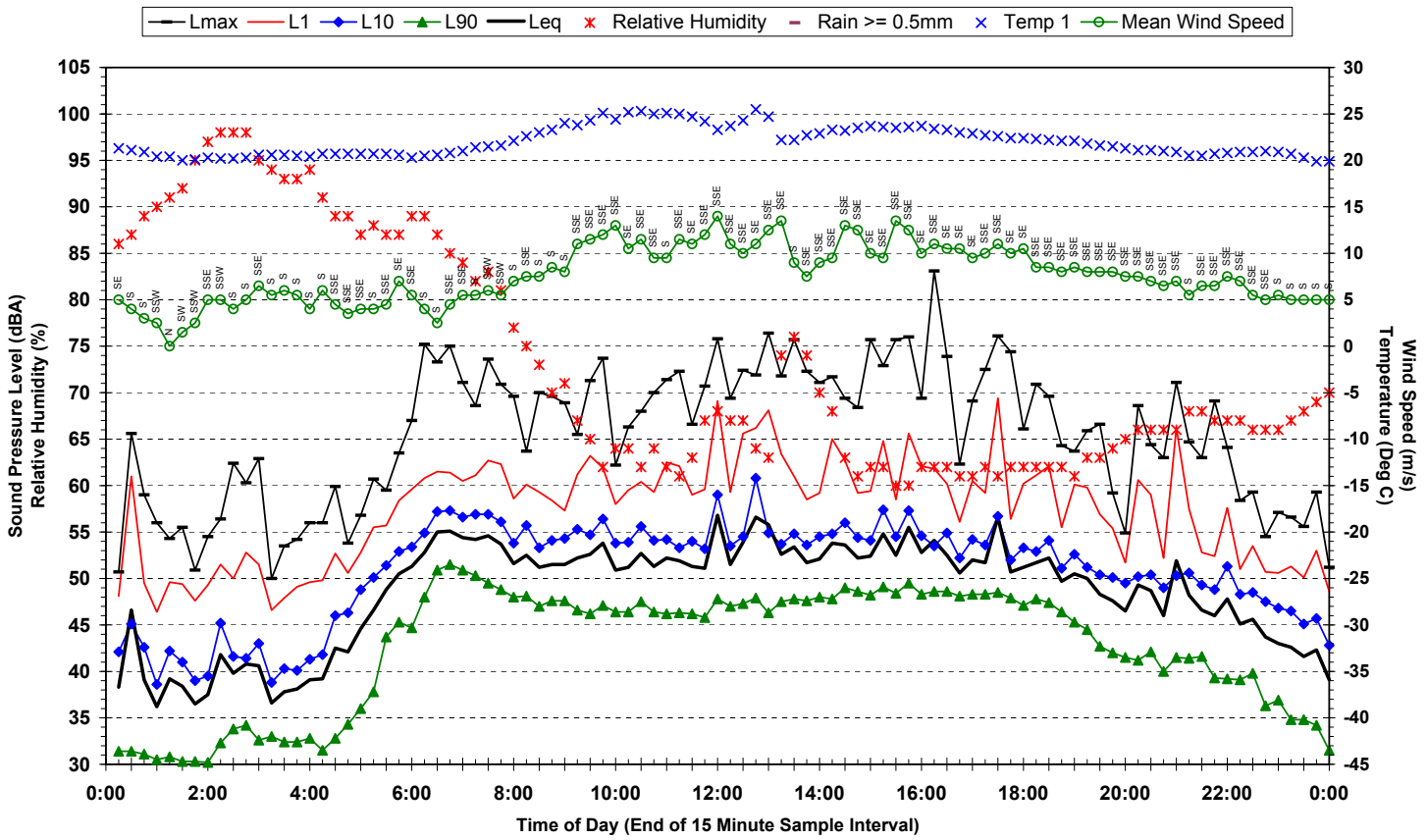
Statistical Ambient Noise Levels
20-1854 9 Victoria Cres - Sunday 5 April 2009



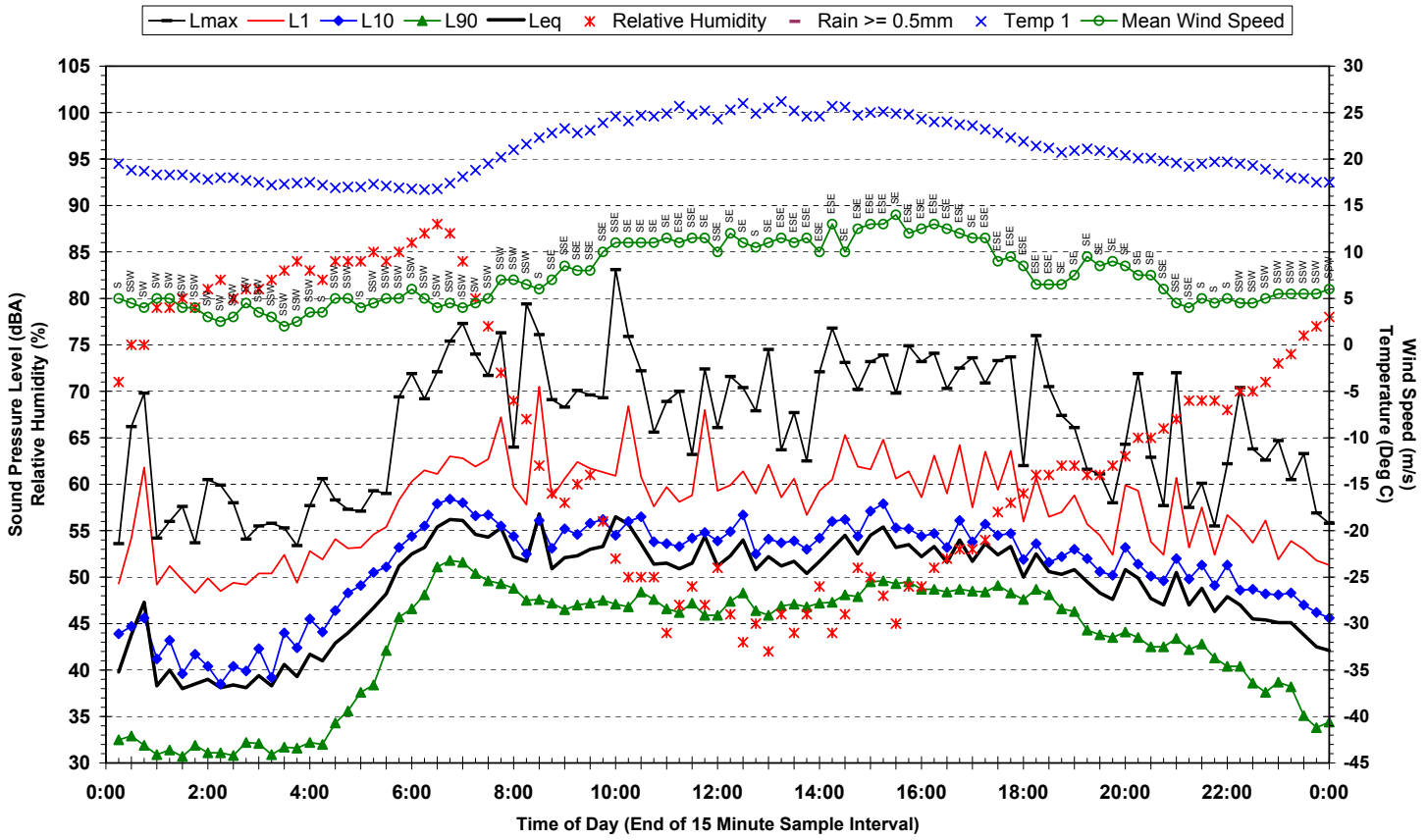
Statistical Ambient Noise Levels
20-1854 9 Victoria Cres - Monday 6 April 2009



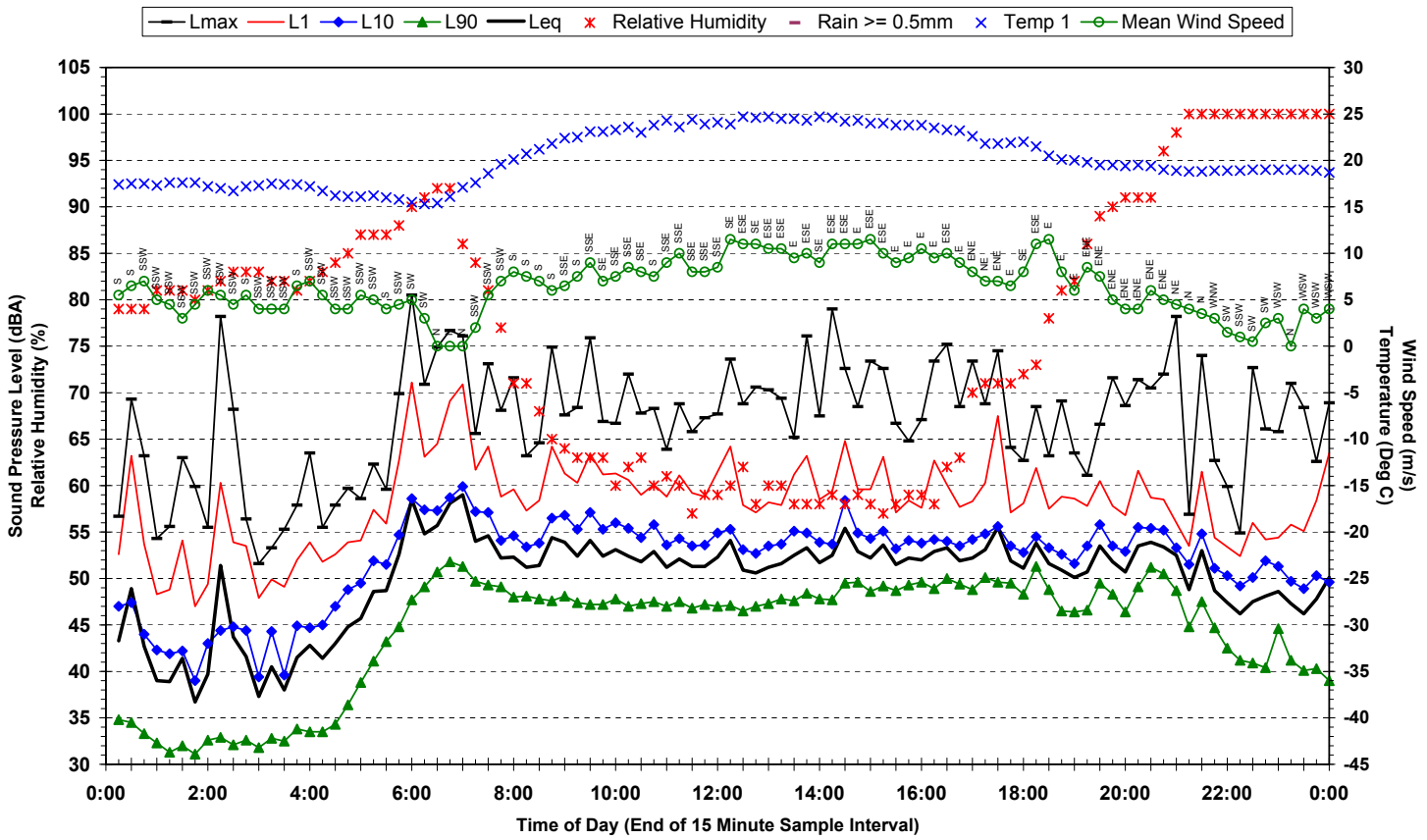
Statistical Ambient Noise Levels
20-1854 9 Victoria Cres - Tuesday 7 April 2009



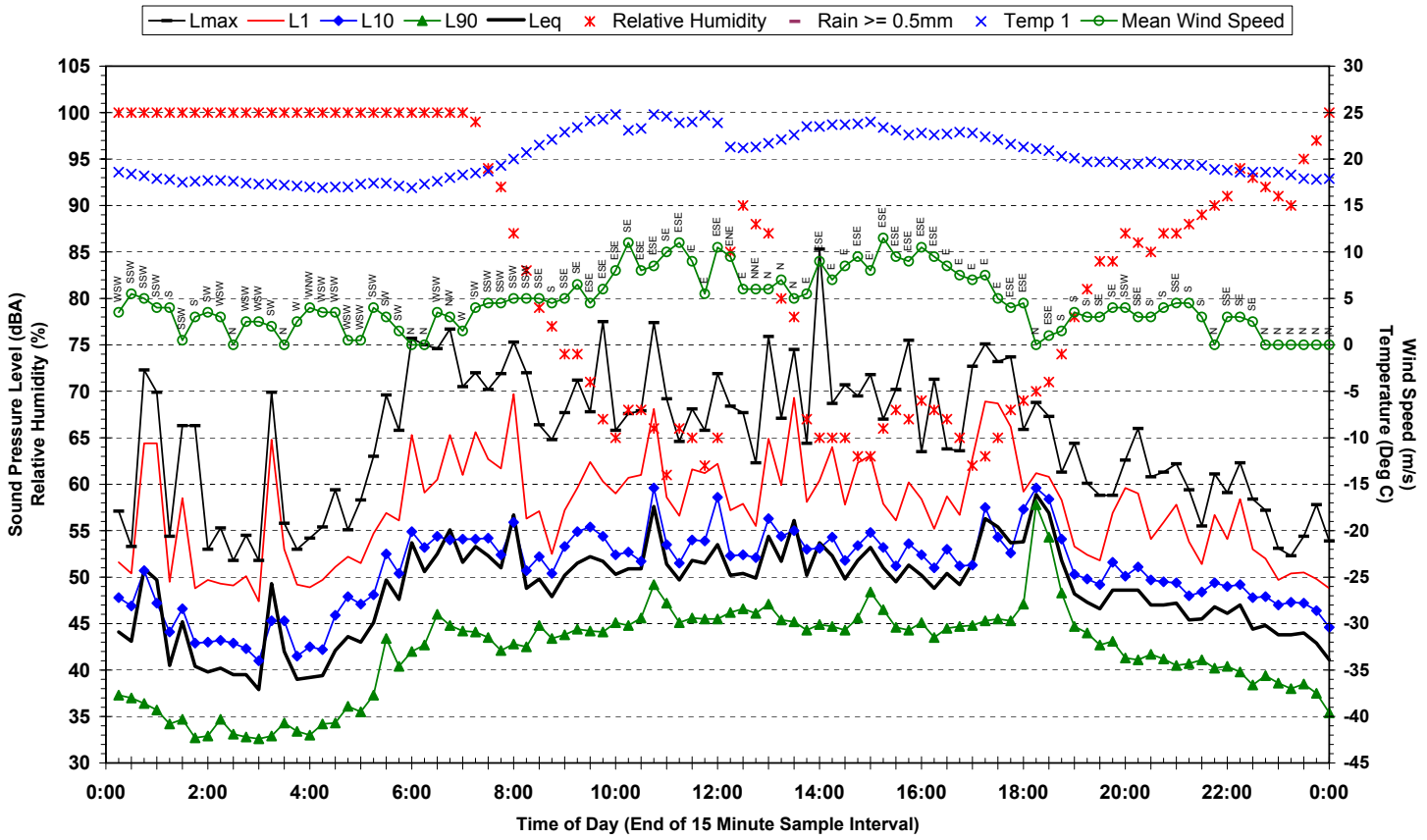
Statistical Ambient Noise Levels
20-1854 9 Victoria Cres - Wednesday 8 April 2009



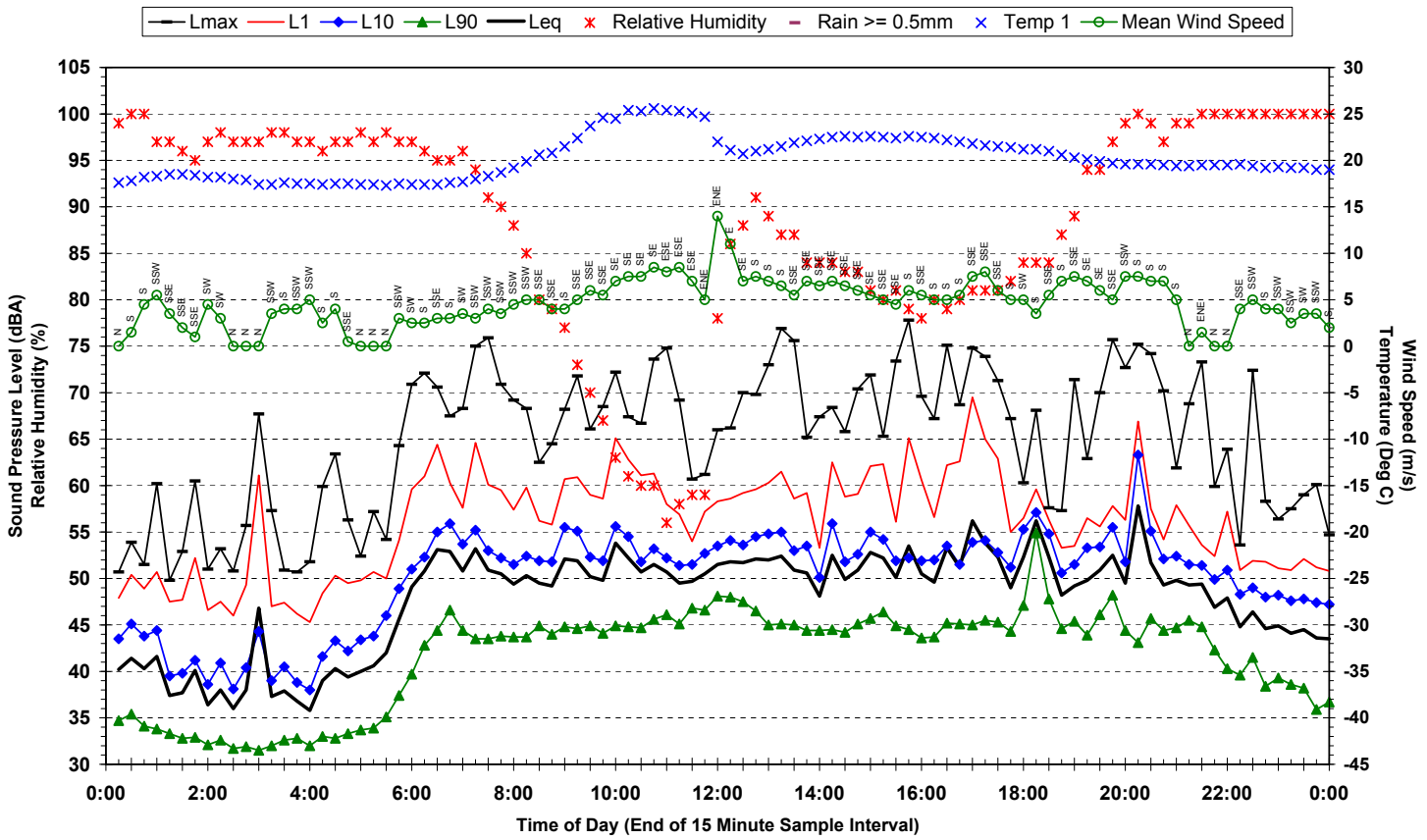
Statistical Ambient Noise Levels
20-1854 9 Victoria Cres - Thursday 9 April 2009



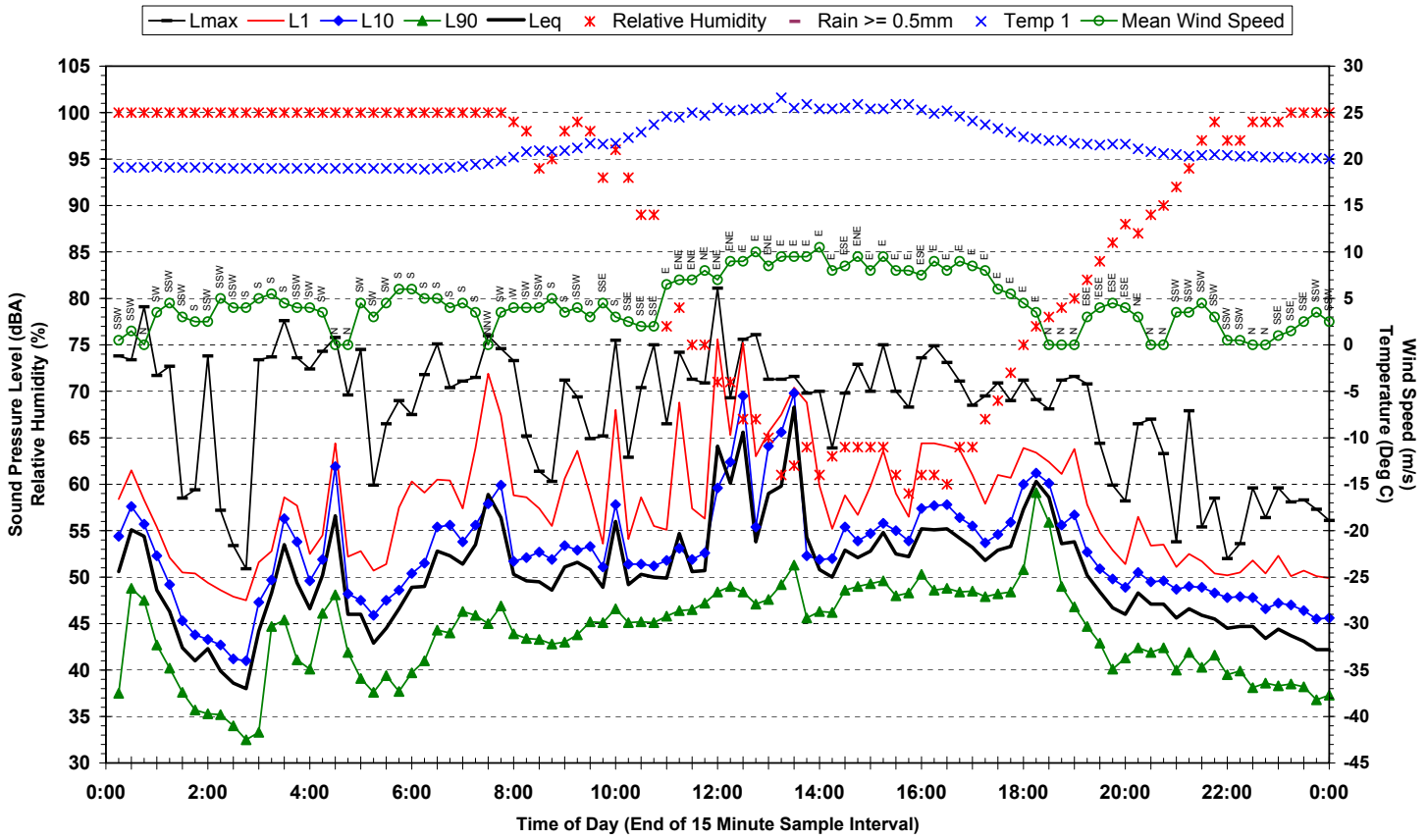
Statistical Ambient Noise Levels
20-1854 9 Victoria Cres - Friday 10 April 2009



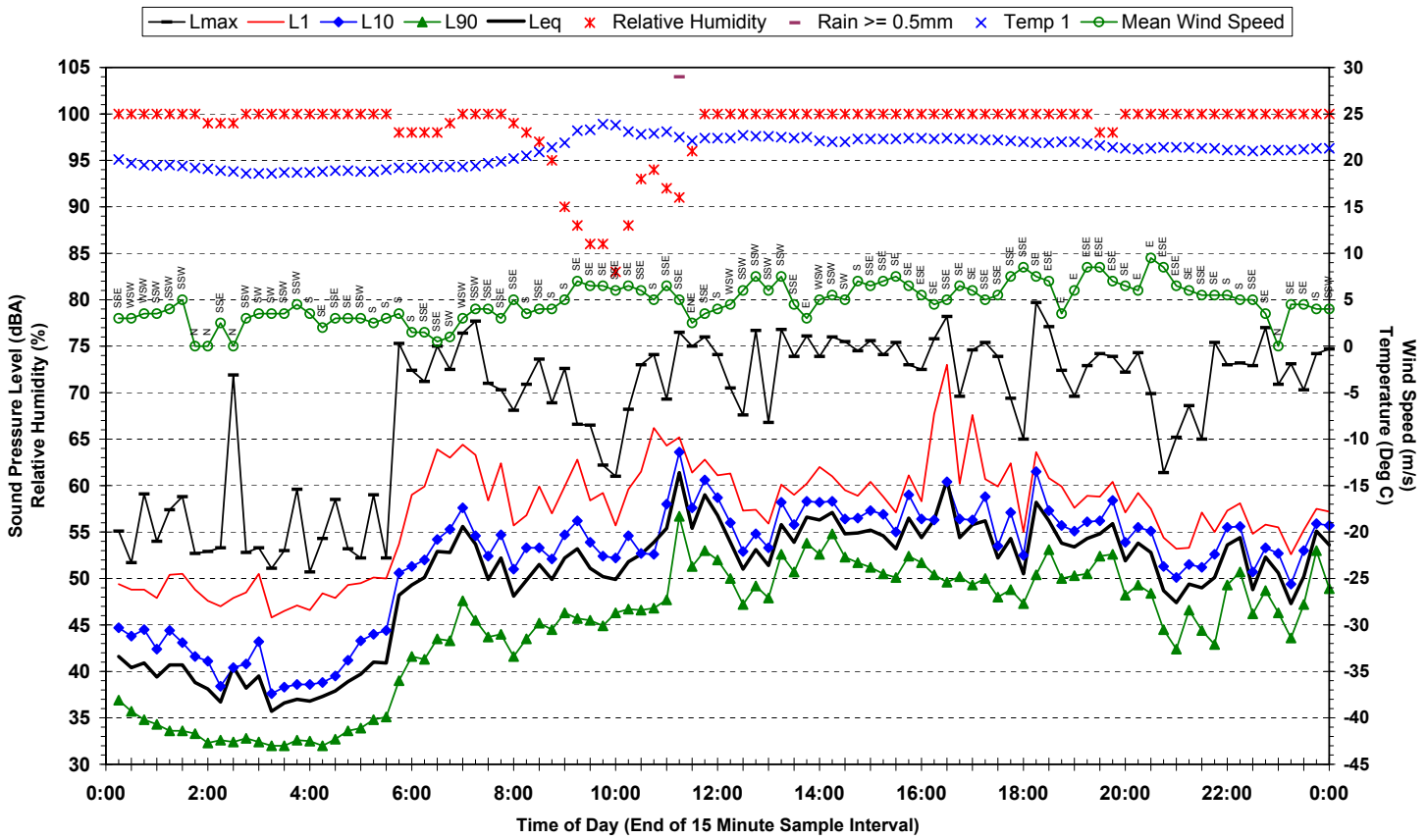
Statistical Ambient Noise Levels
20-1854 9 Victoria Cres - Saturday 11 April 2009



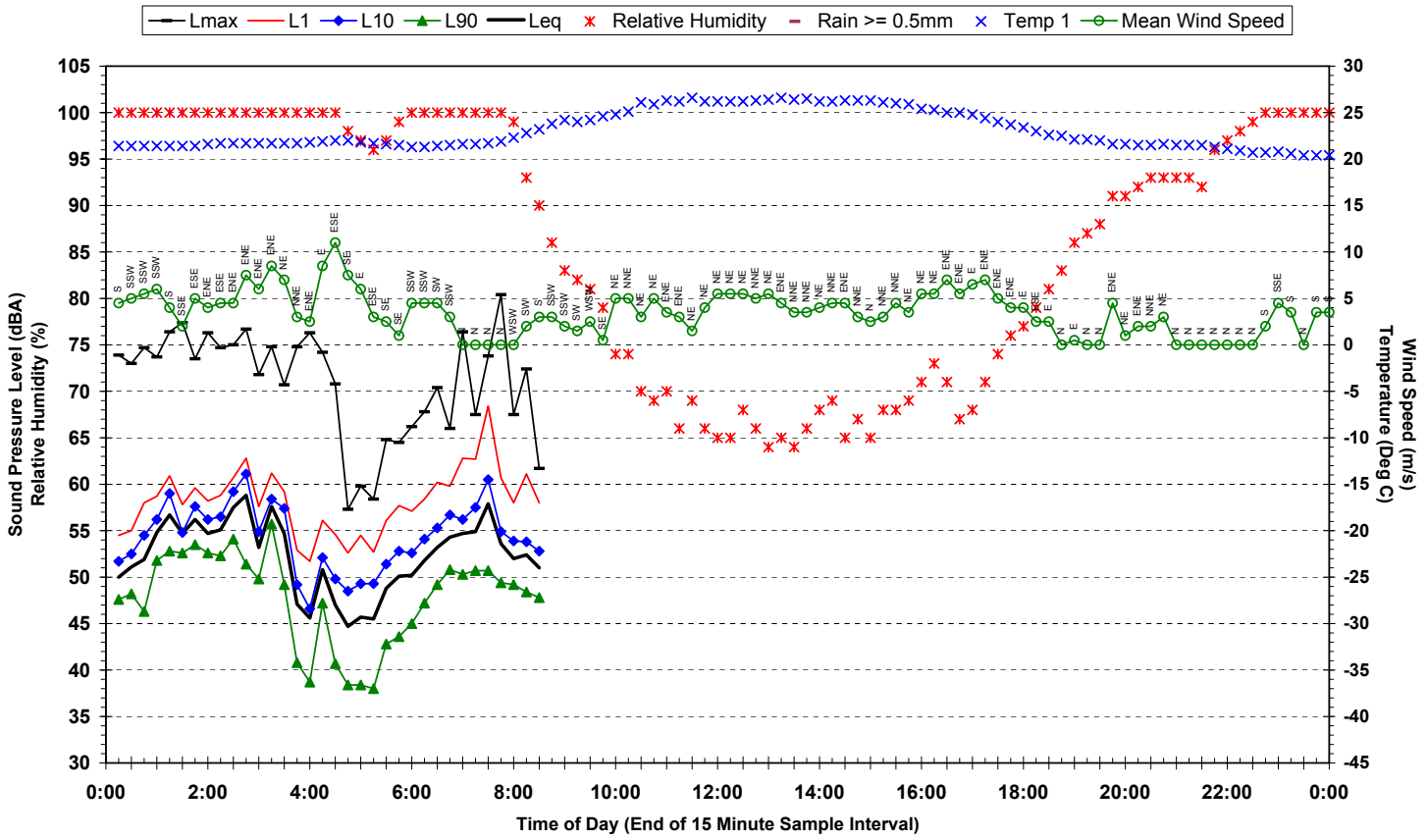
Statistical Ambient Noise Levels
20-1854 9 Victoria Cres - Sunday 12 April 2009



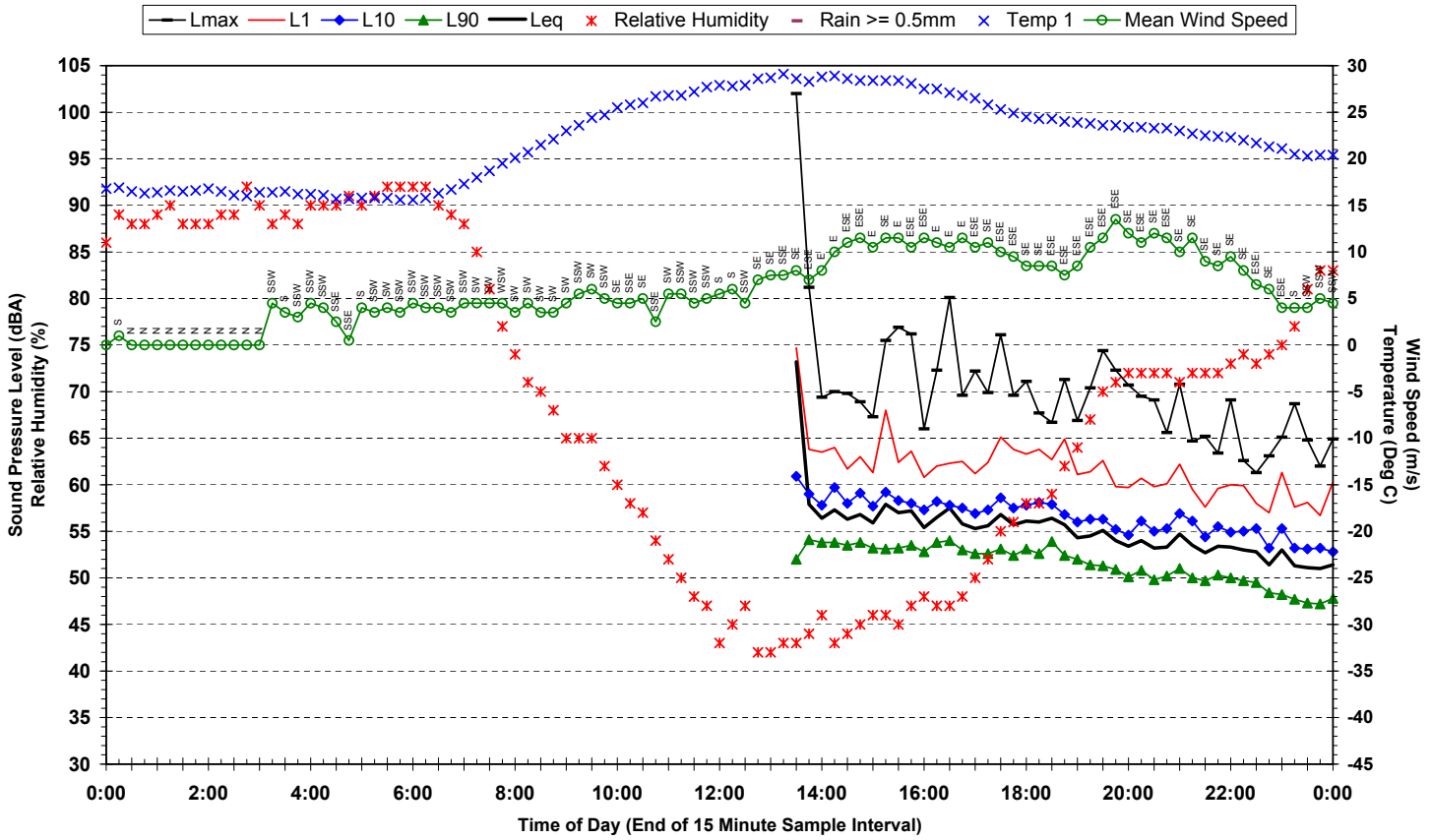
Statistical Ambient Noise Levels
20-1854 9 Victoria Cres - Monday 13 April 2009



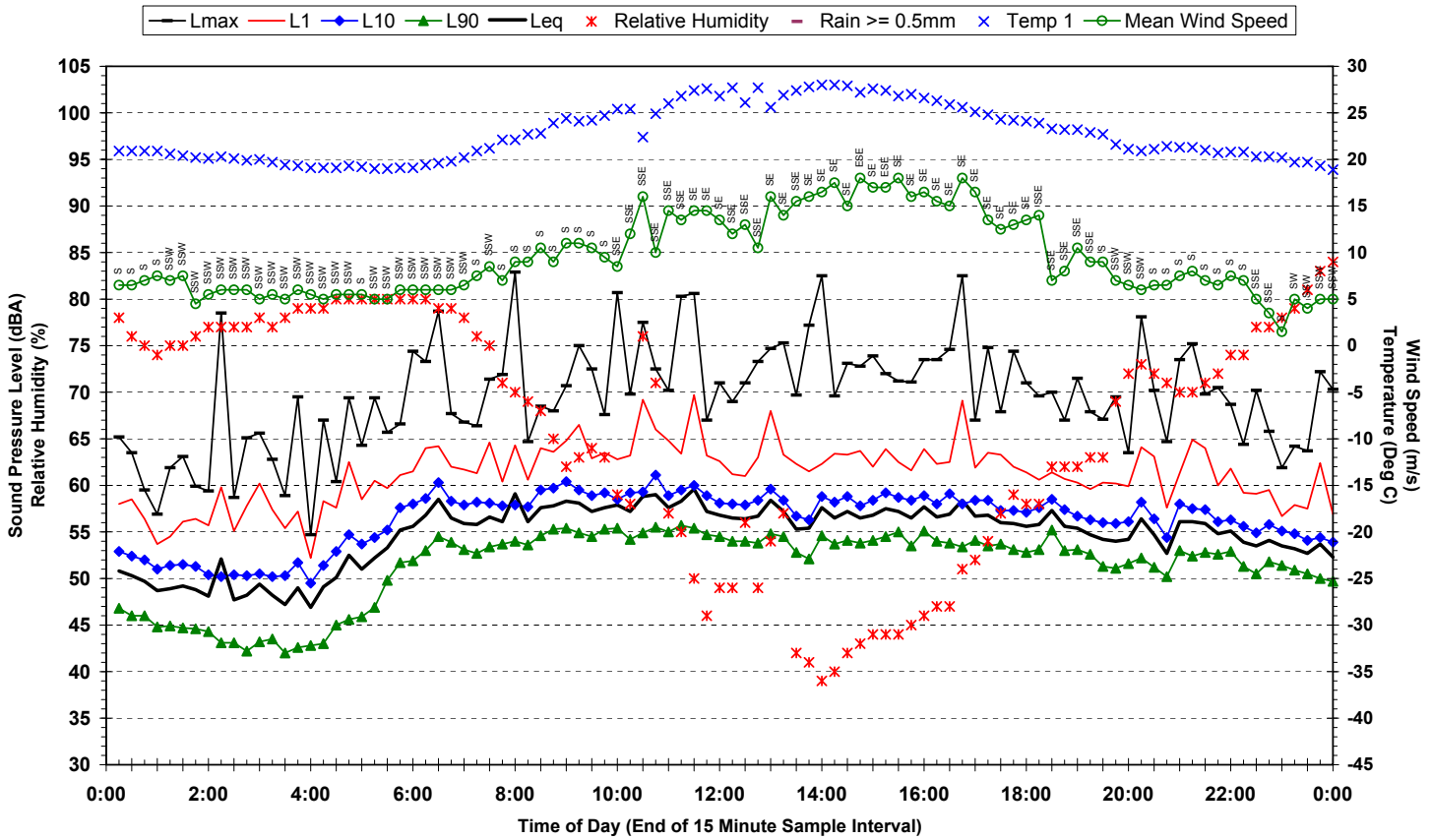
Statistical Ambient Noise Levels
20-1854 9 Victoria Cres - Tuesday 14 April 2009



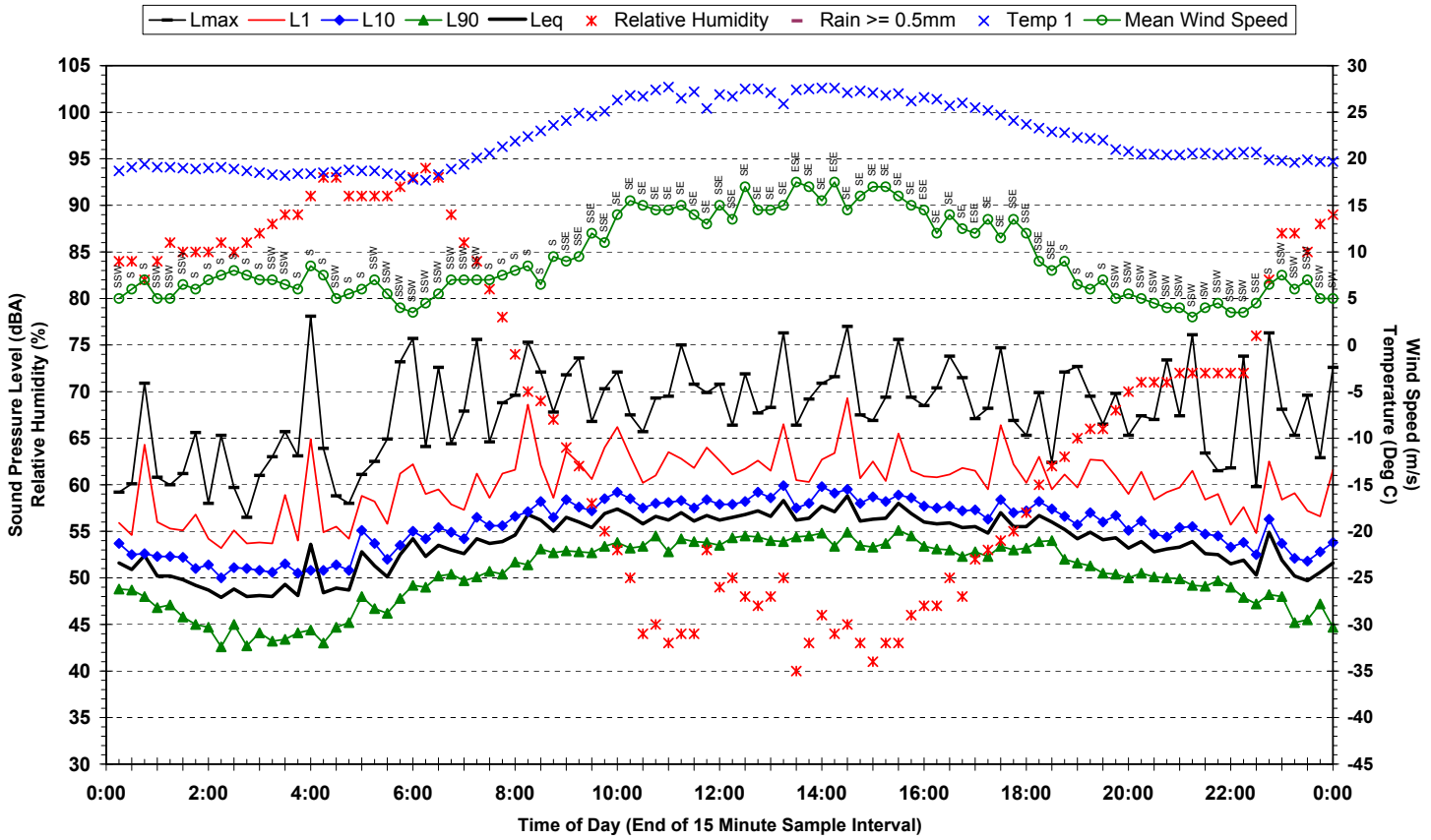
Statistical Ambient Noise Levels
20-1854 31 Valentine St - Friday 27 March 2009



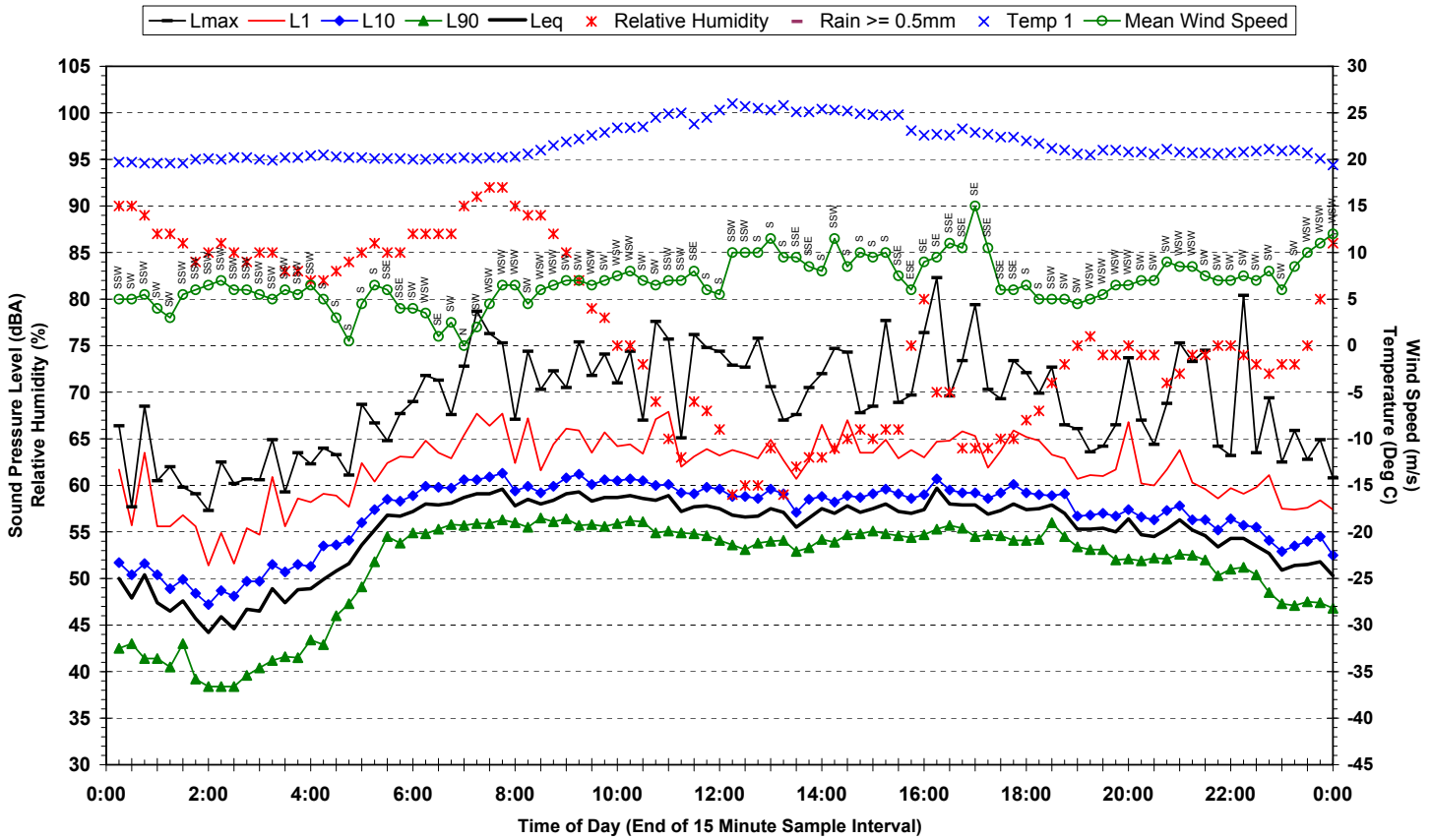
Statistical Ambient Noise Levels
20-1854 31 Valentine St - Saturday 28 March 2009



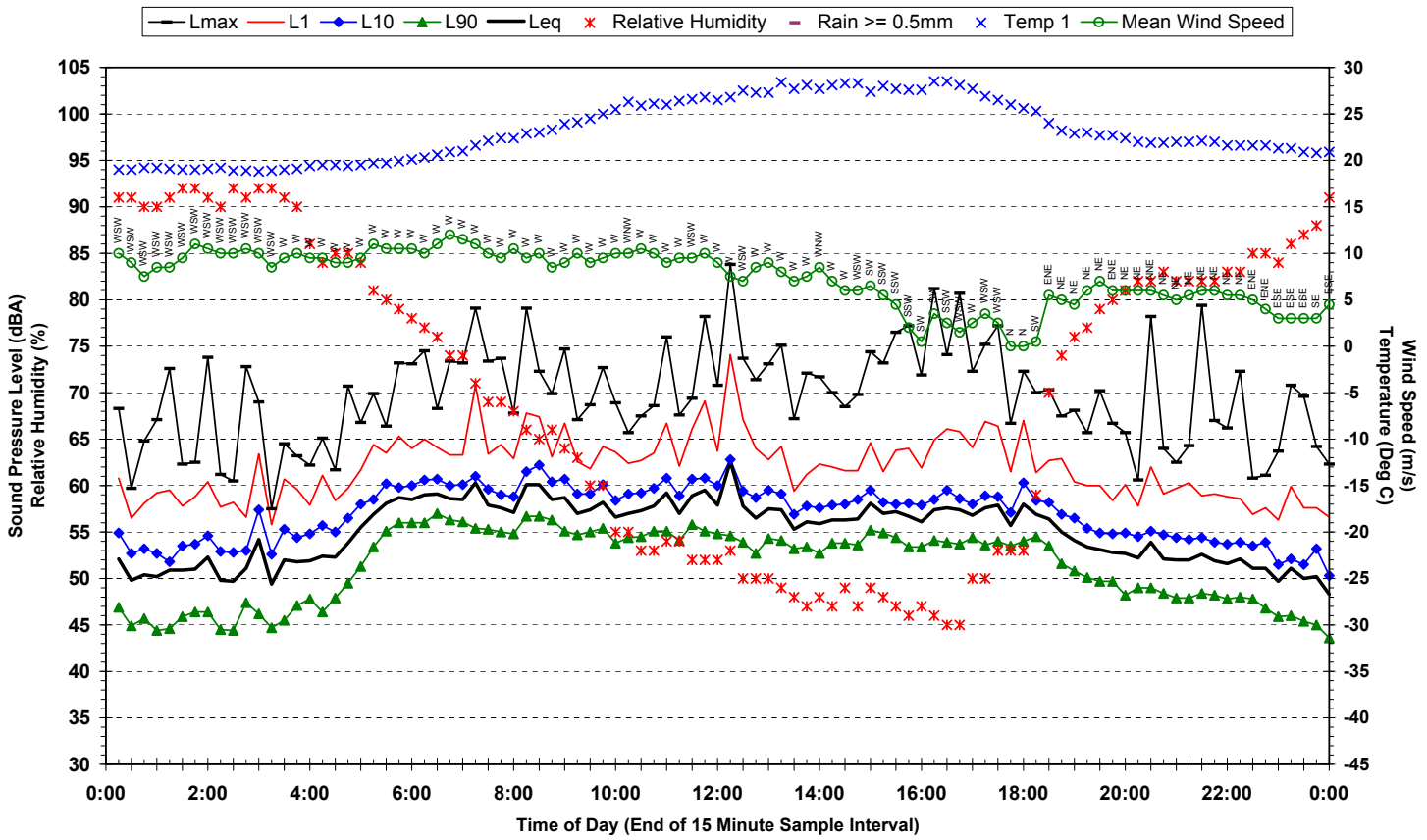
Statistical Ambient Noise Levels
20-1854 31 Valentine St - Sunday 29 March 2009



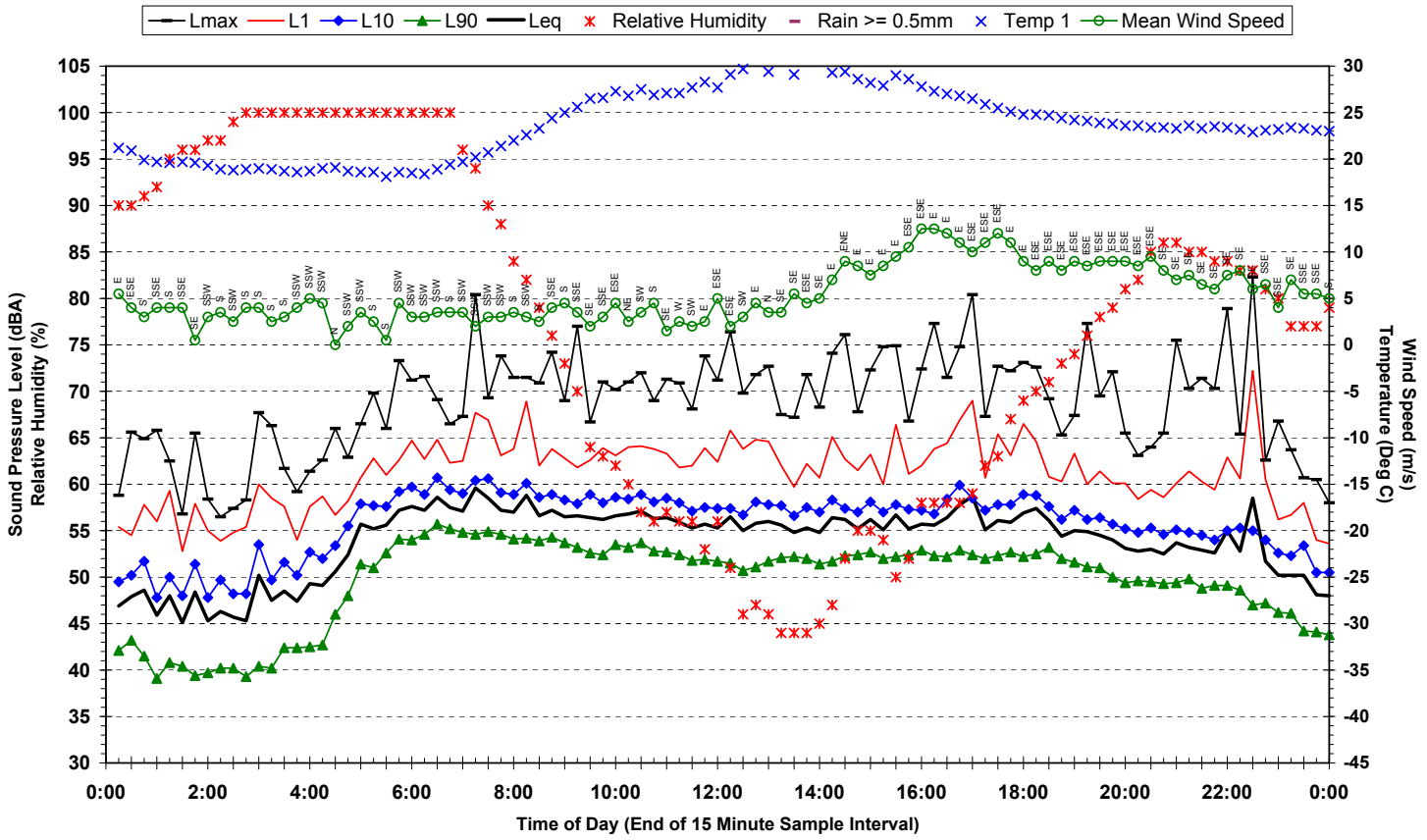
Statistical Ambient Noise Levels
20-1854 31 Valentine St - Monday 30 March 2009



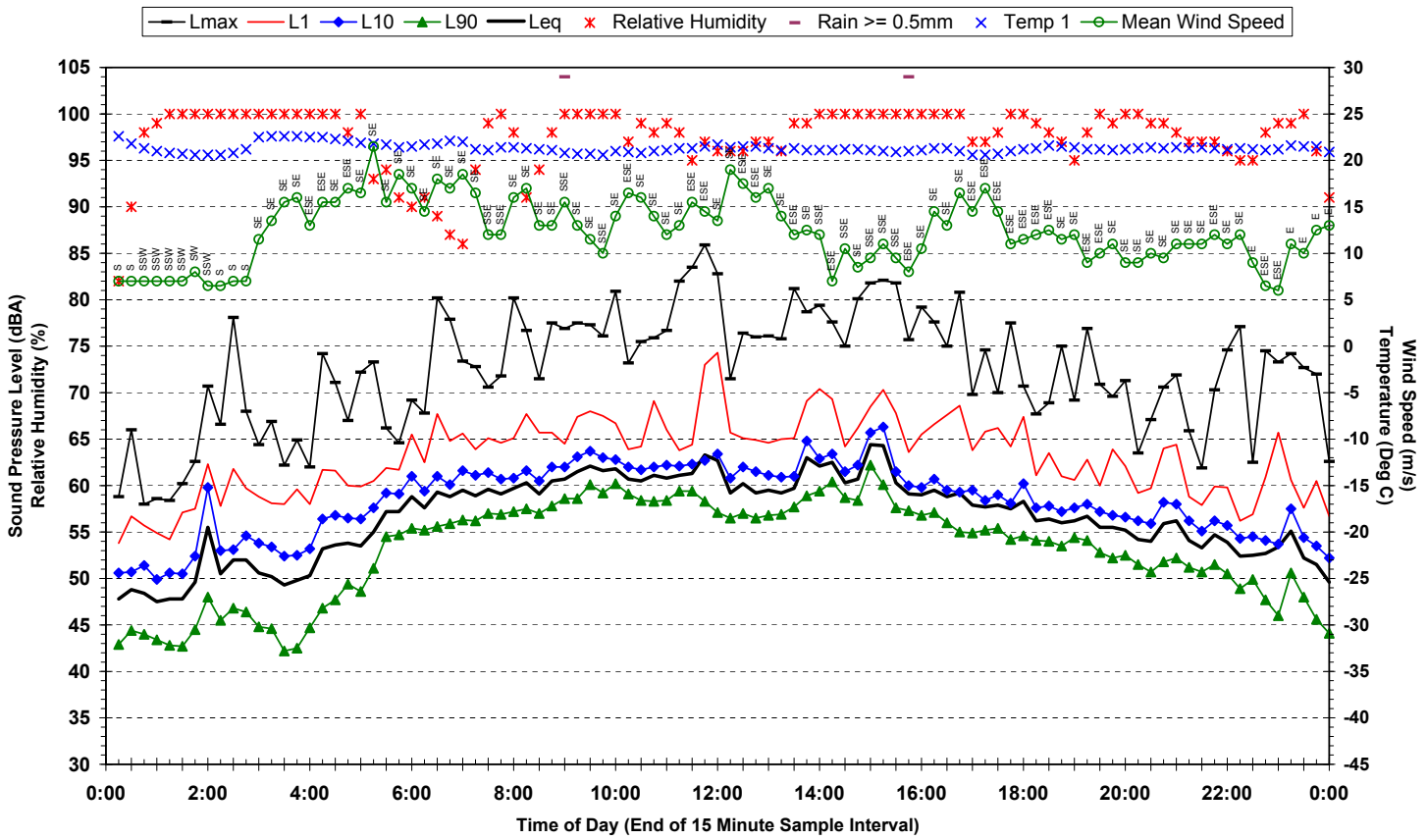
Statistical Ambient Noise Levels
20-1854 31 Valentine St - Tuesday 31 March 2009



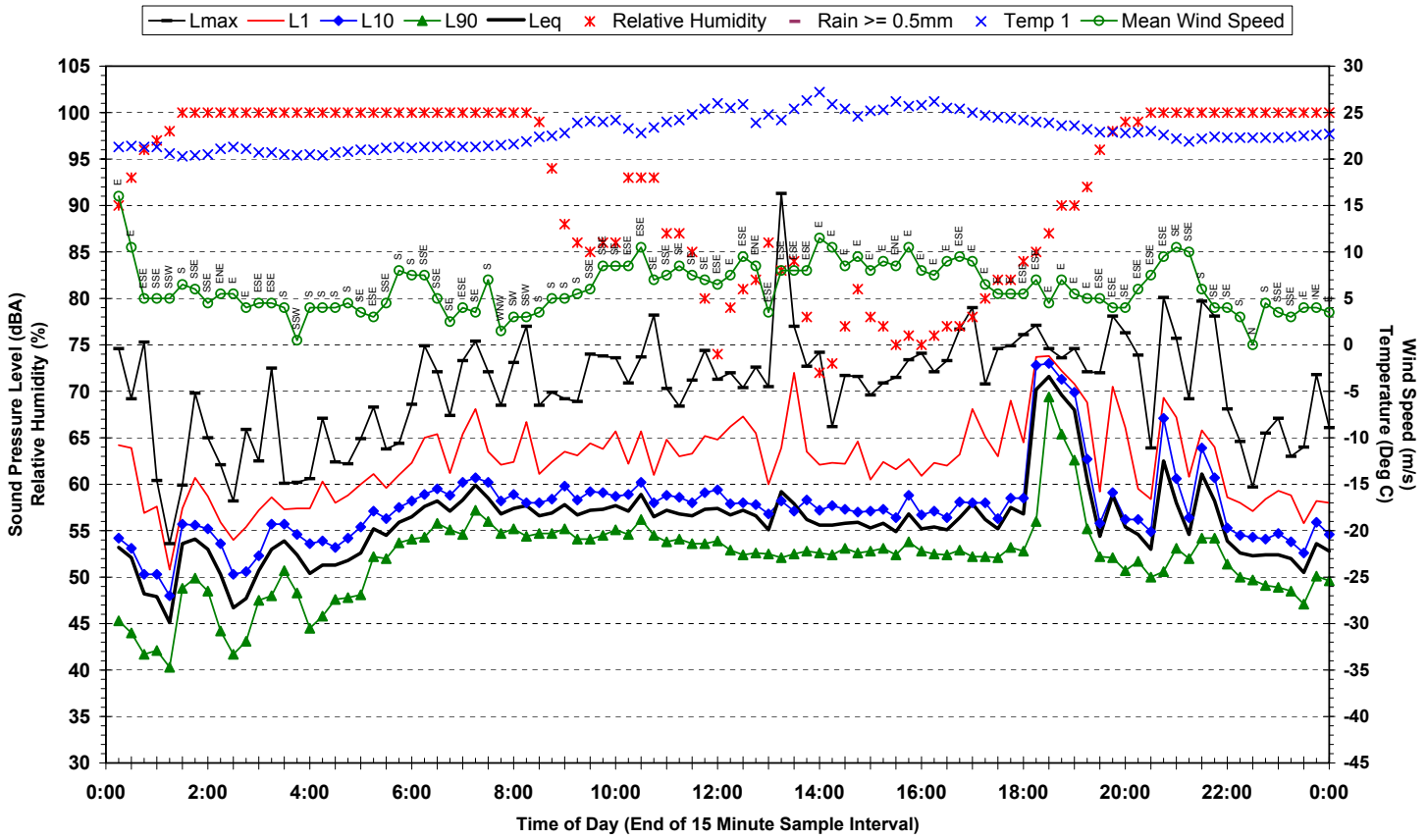
Statistical Ambient Noise Levels
20-1854 31 Valentine St - Wednesday 1 April 2009



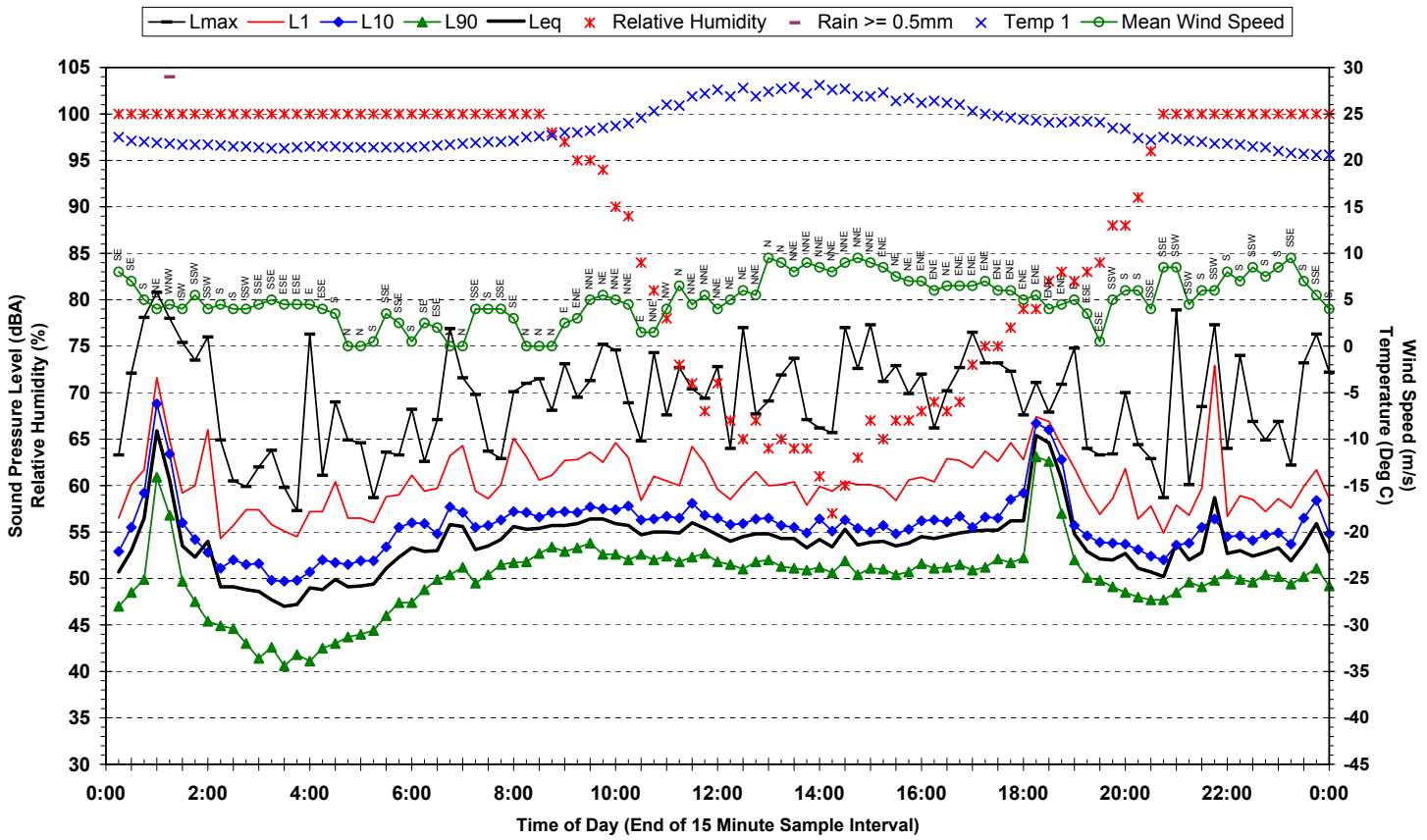
Statistical Ambient Noise Levels
20-1854 31 Valentine St - Thursday 2 April 2009



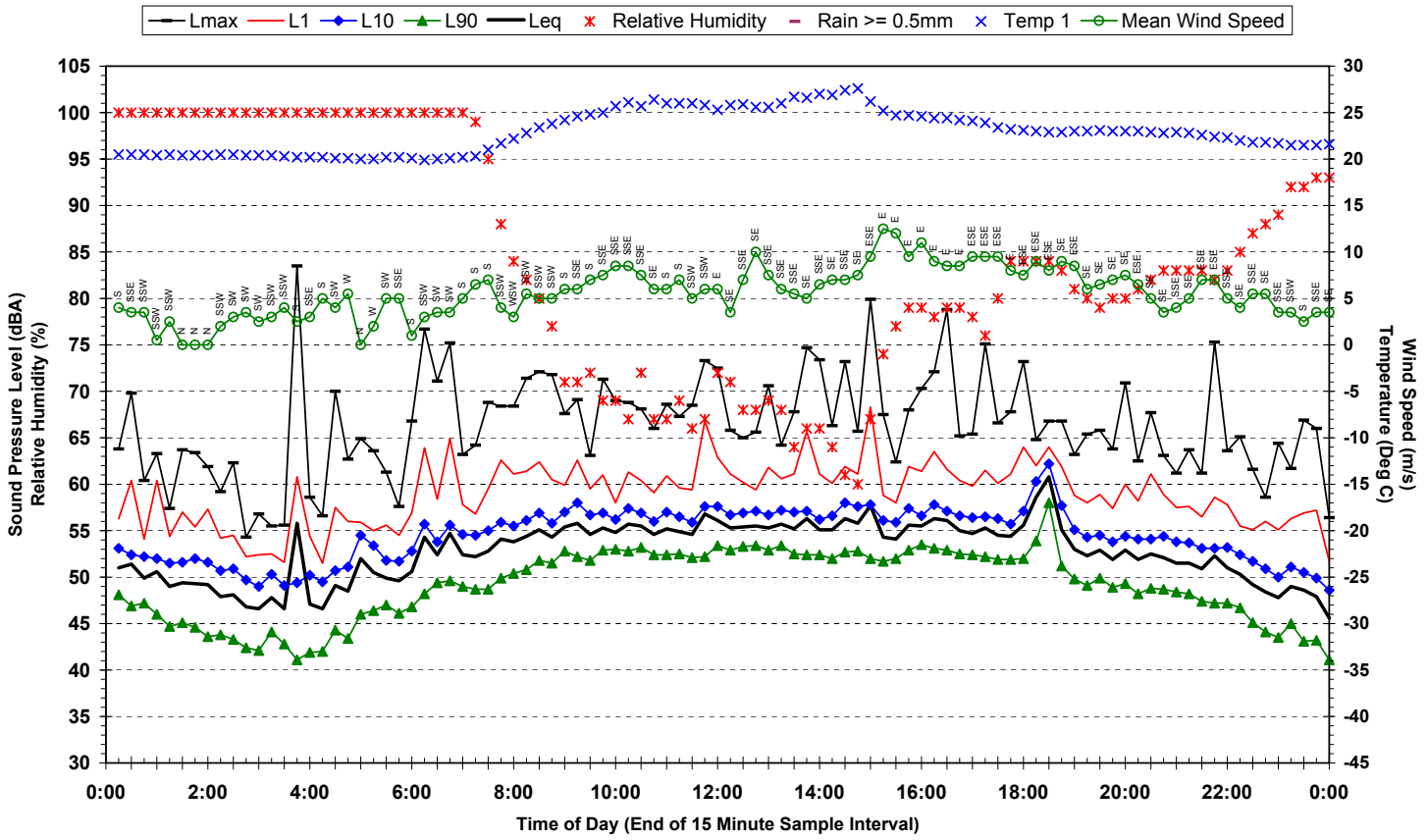
Statistical Ambient Noise Levels
20-1854 31 Valentine St - Friday 3 April 2009



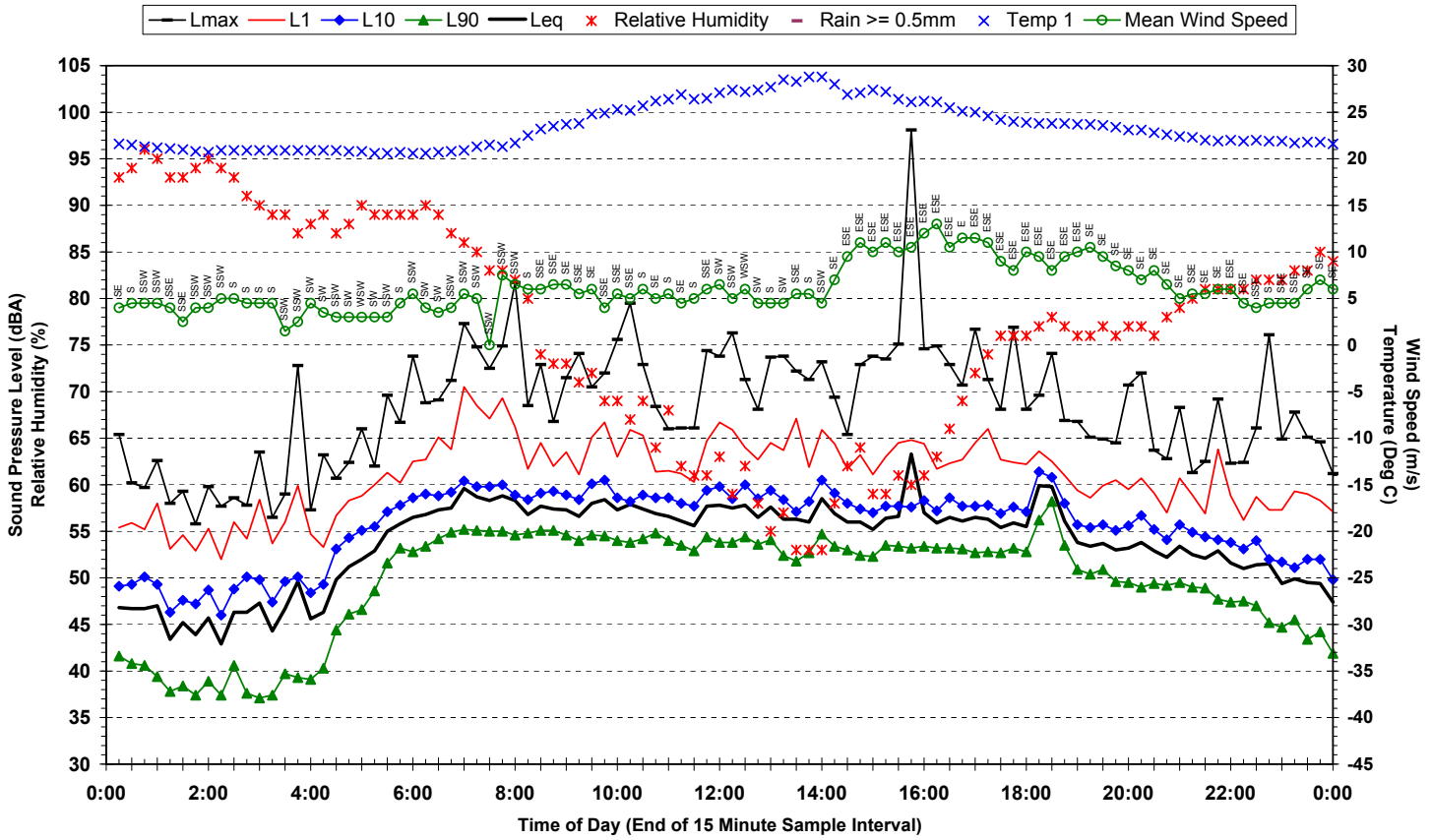
Statistical Ambient Noise Levels
20-1854 31 Valentine St - Saturday 4 April 2009



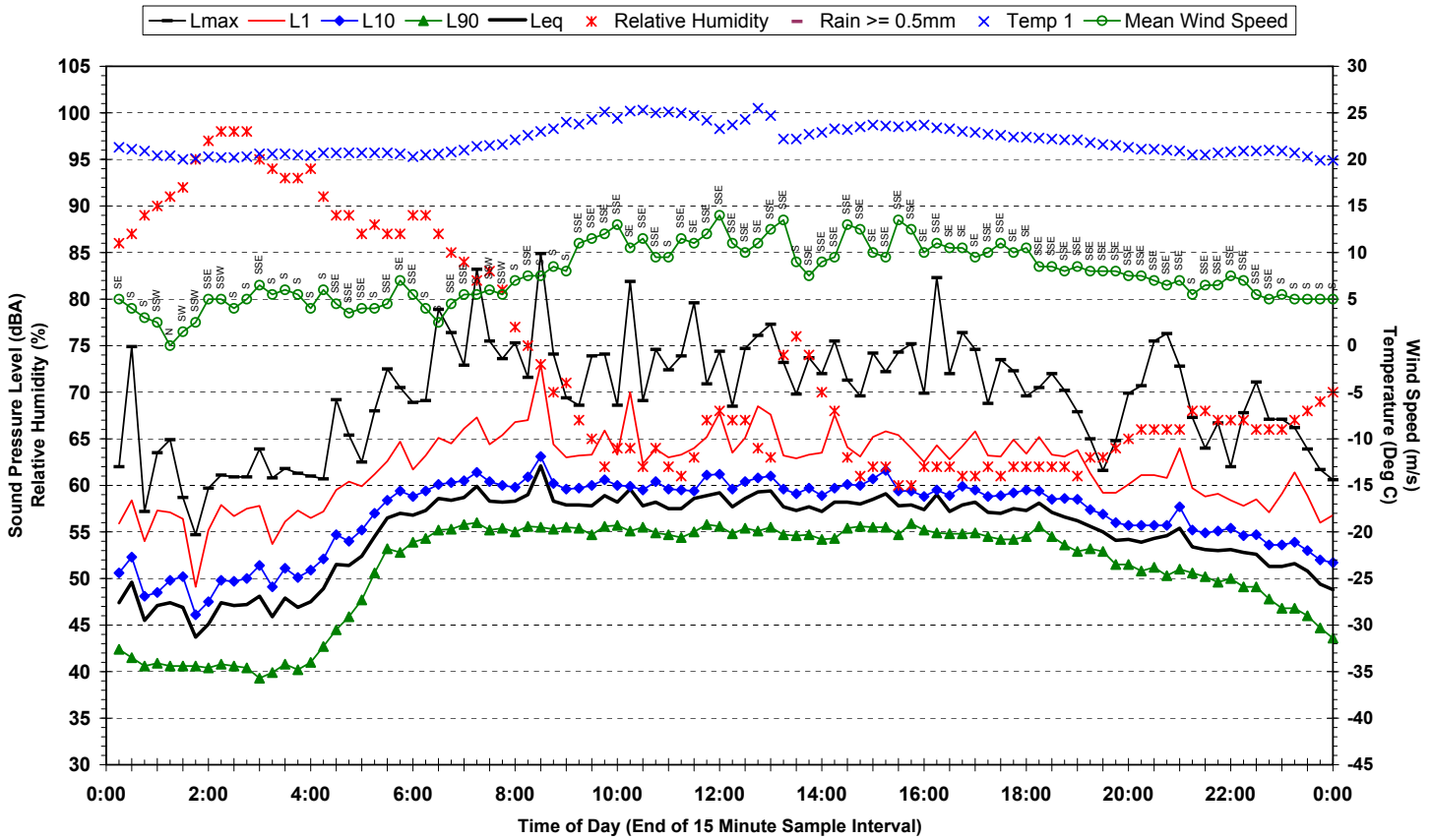
Statistical Ambient Noise Levels
20-1854 31 Valentine St - Sunday 5 April 2009



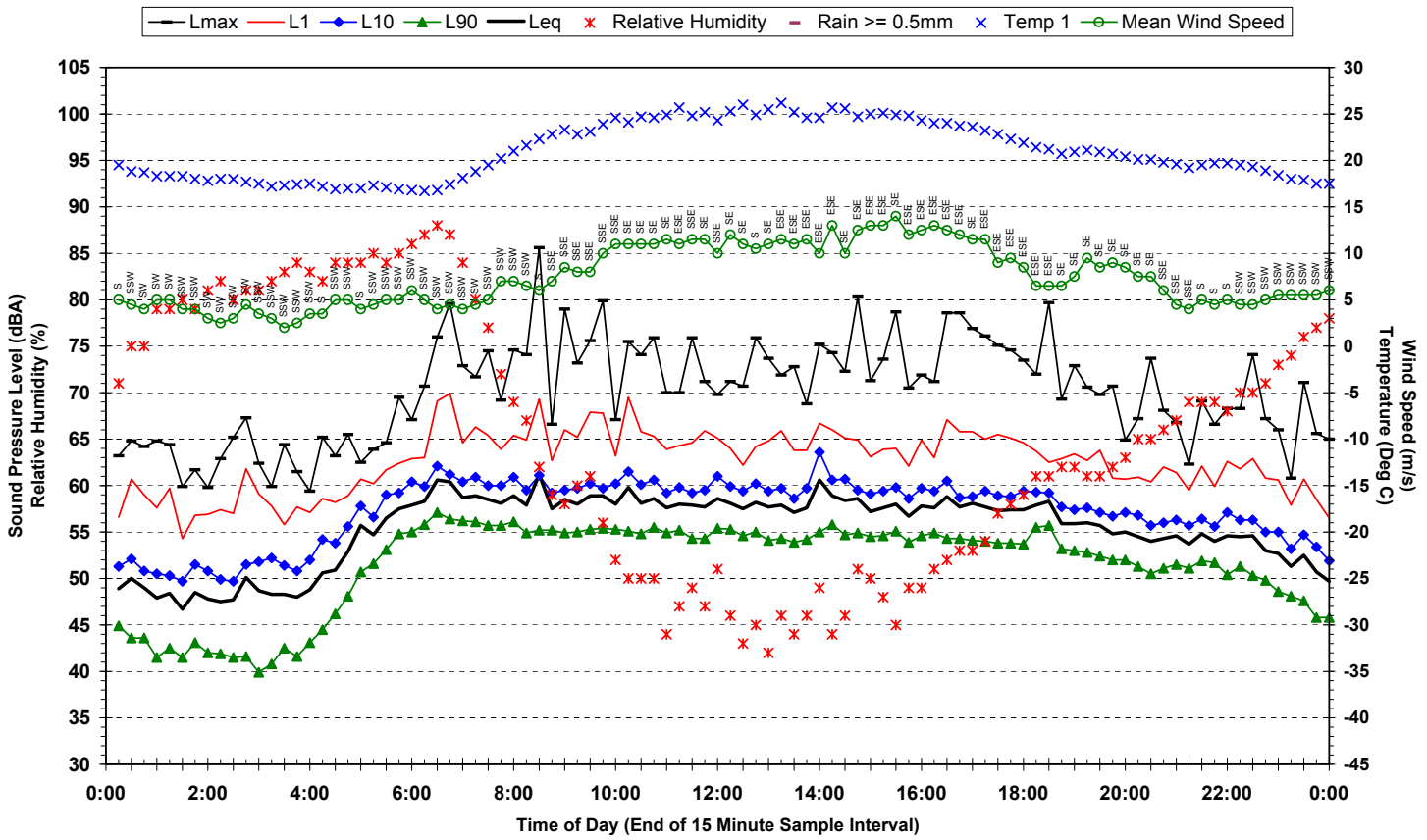
Statistical Ambient Noise Levels
20-1854 31 Valentine St - Monday 6 April 2009



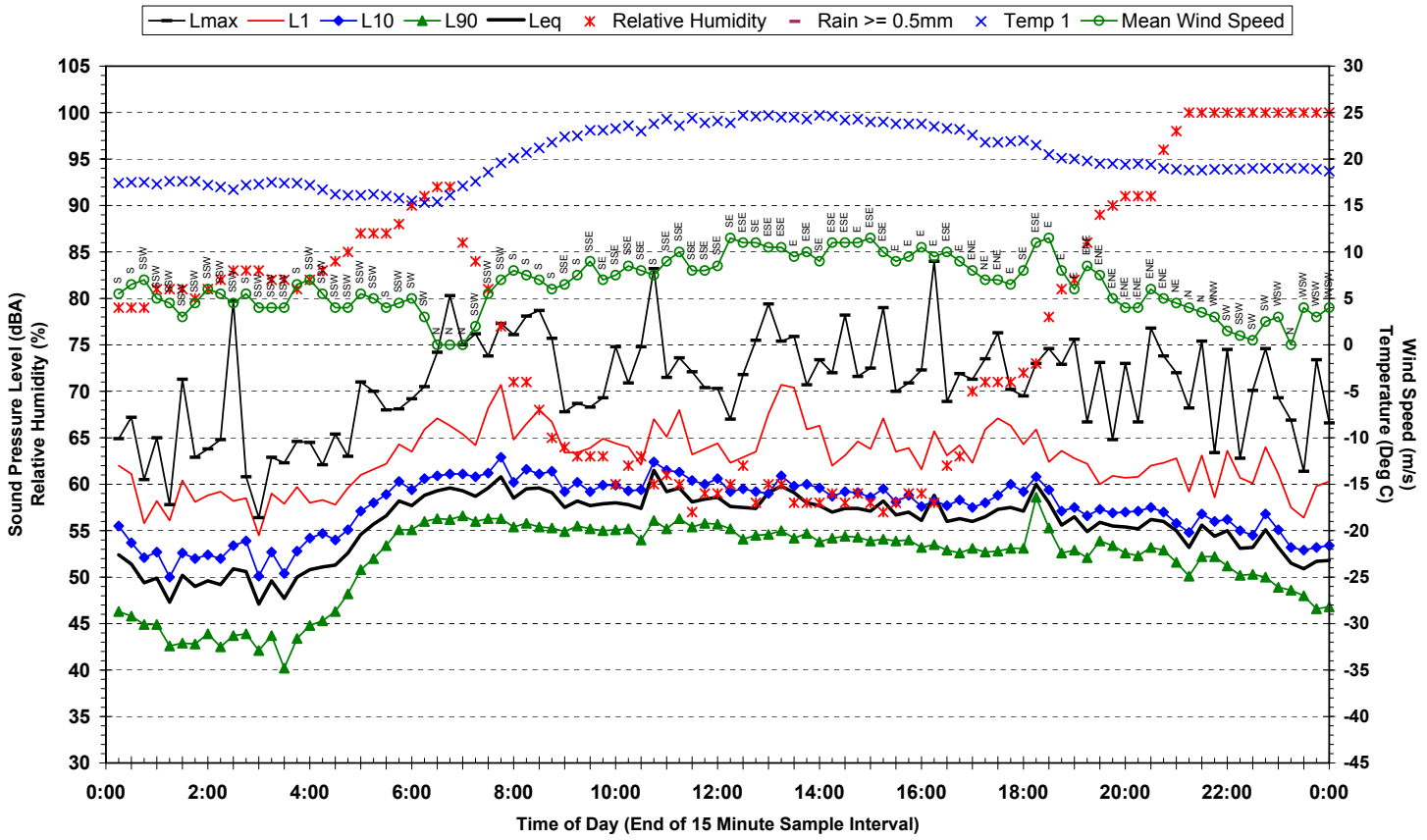
Statistical Ambient Noise Levels
20-1854 31 Valentine St - Tuesday 7 April 2009



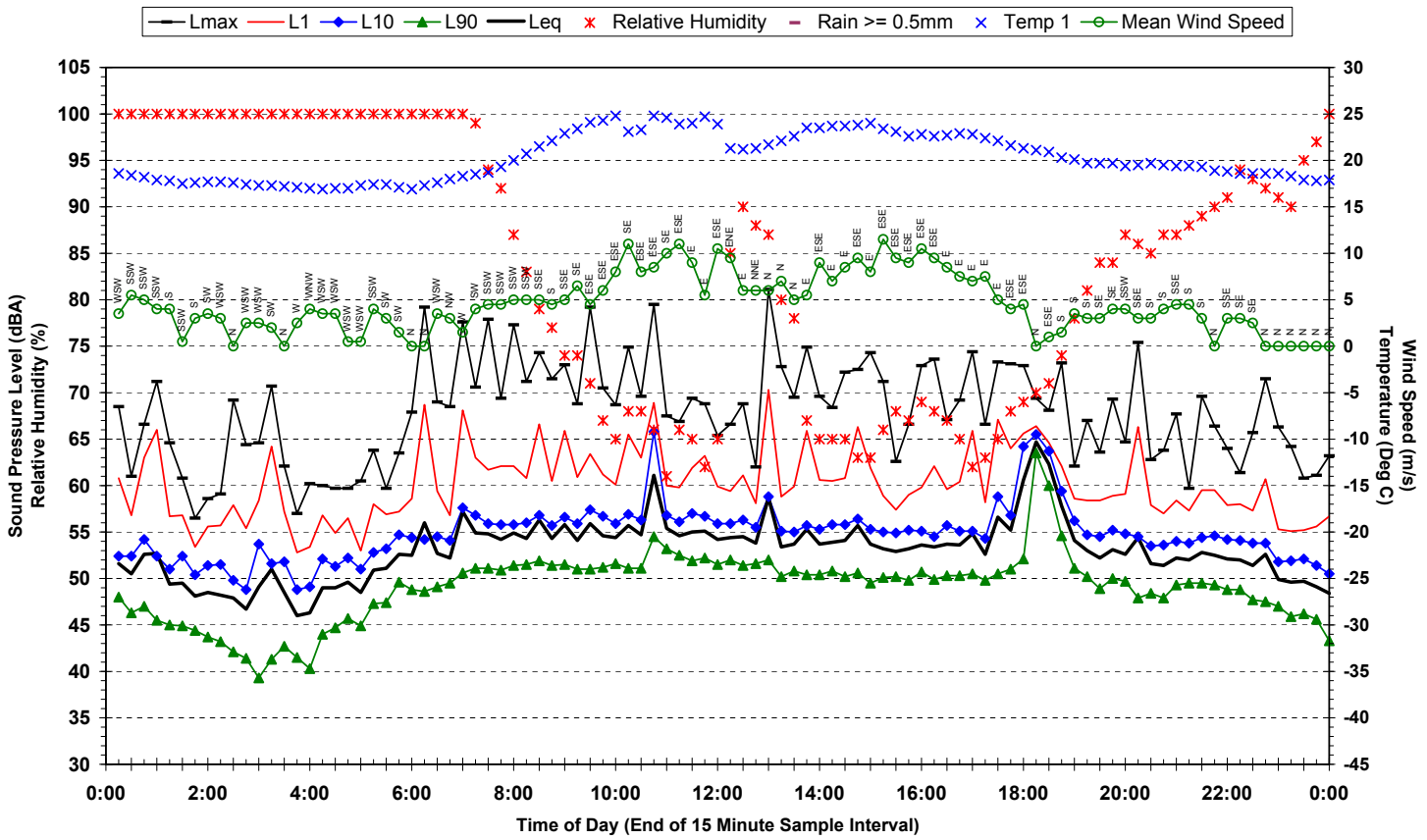
Statistical Ambient Noise Levels
20-1854 31 Valentine St - Wednesday 8 April 2009



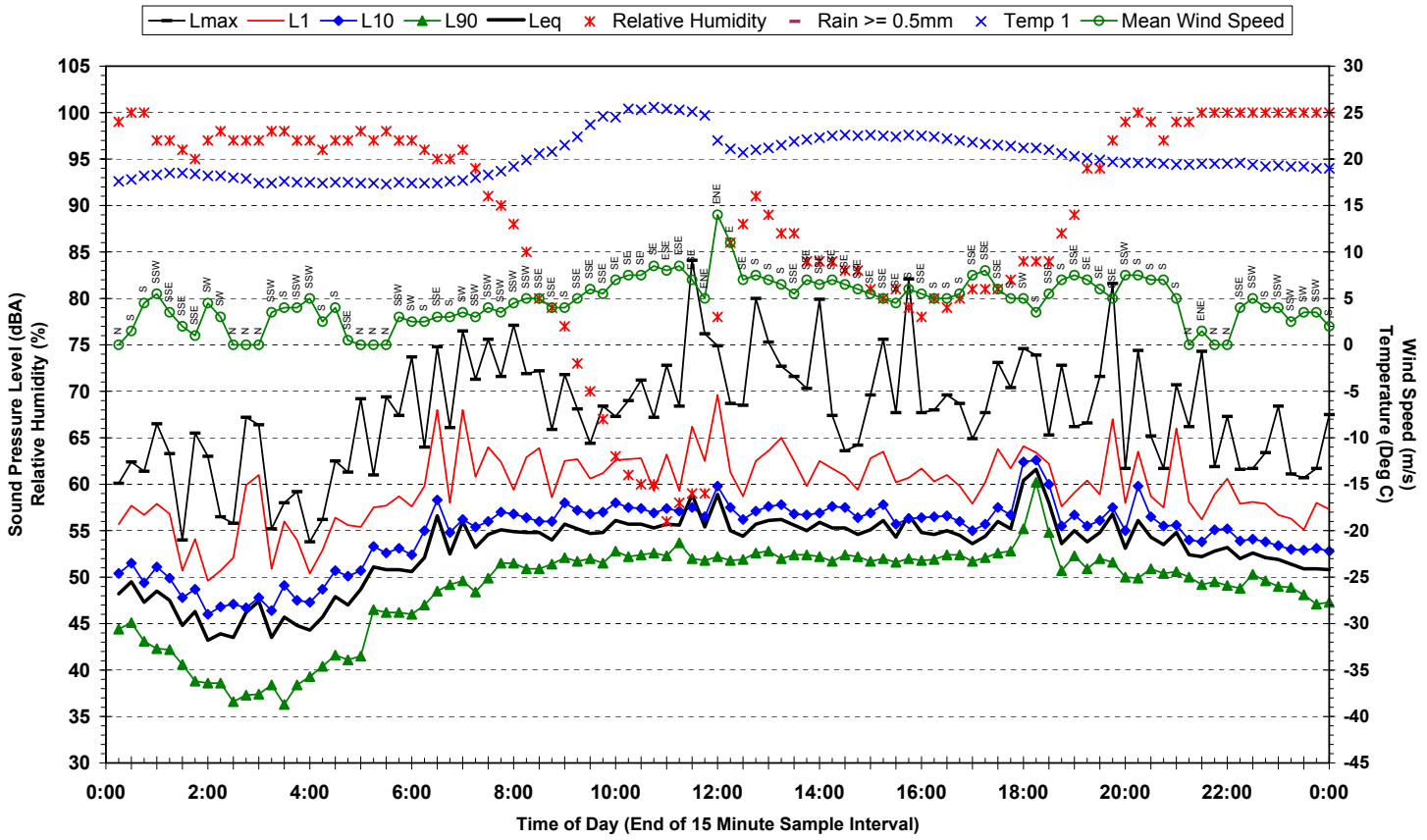
Statistical Ambient Noise Levels
20-1854 31 Valentine St - Thursday 9 April 2009



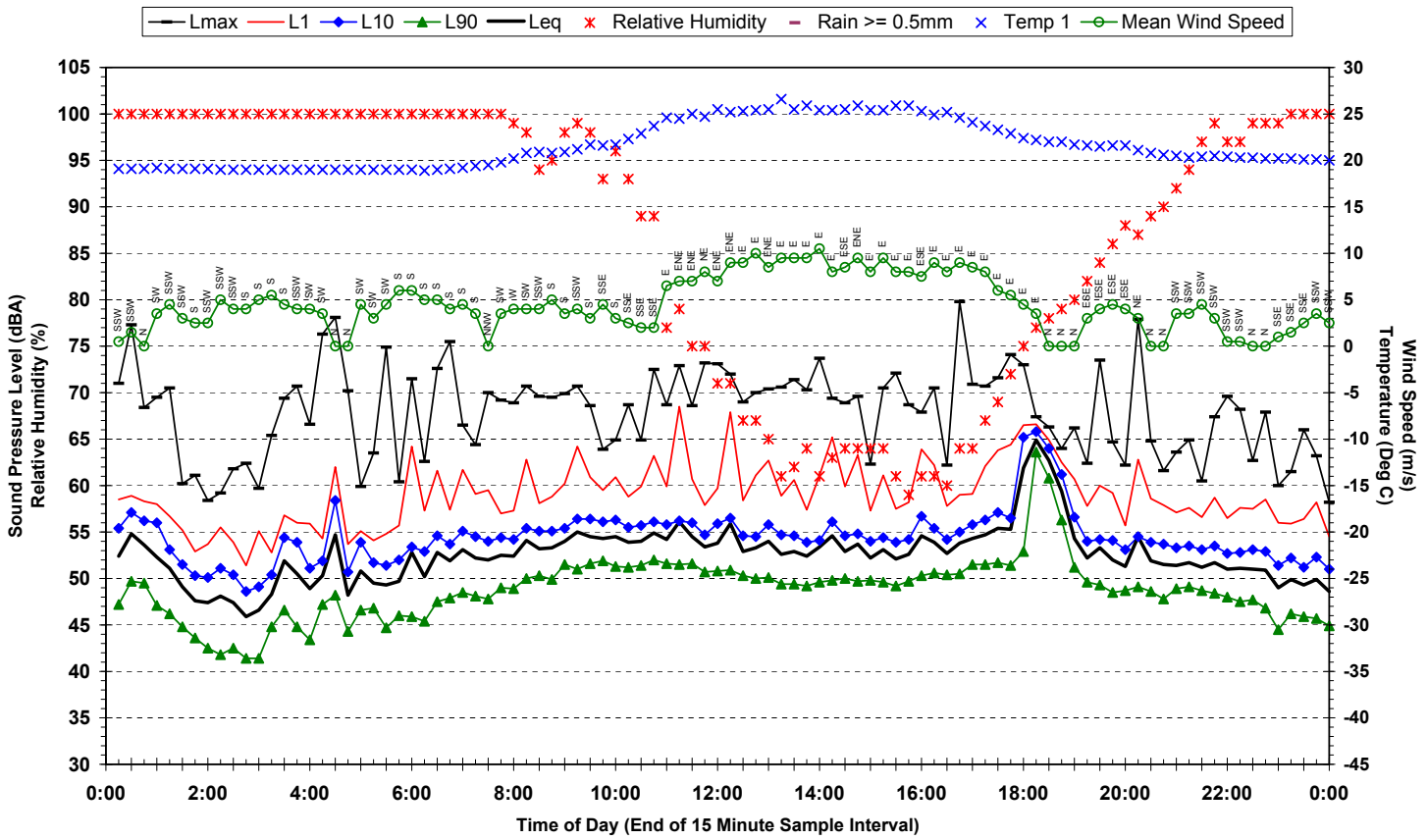
Statistical Ambient Noise Levels
20-1854 31 Valentine St - Friday 10 April 2009



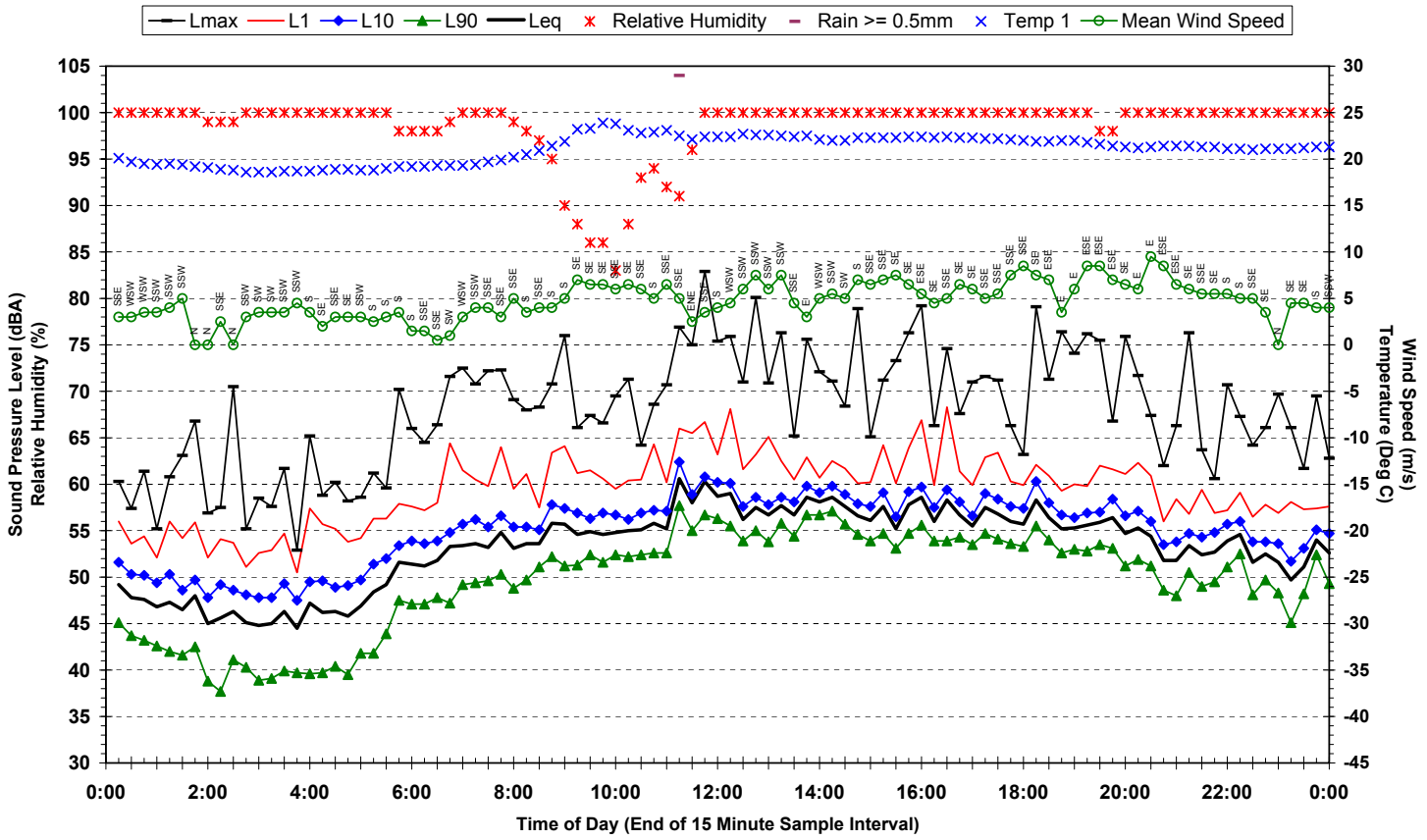
Statistical Ambient Noise Levels
20-1854 31 Valentine St - Saturday 11 April 2009



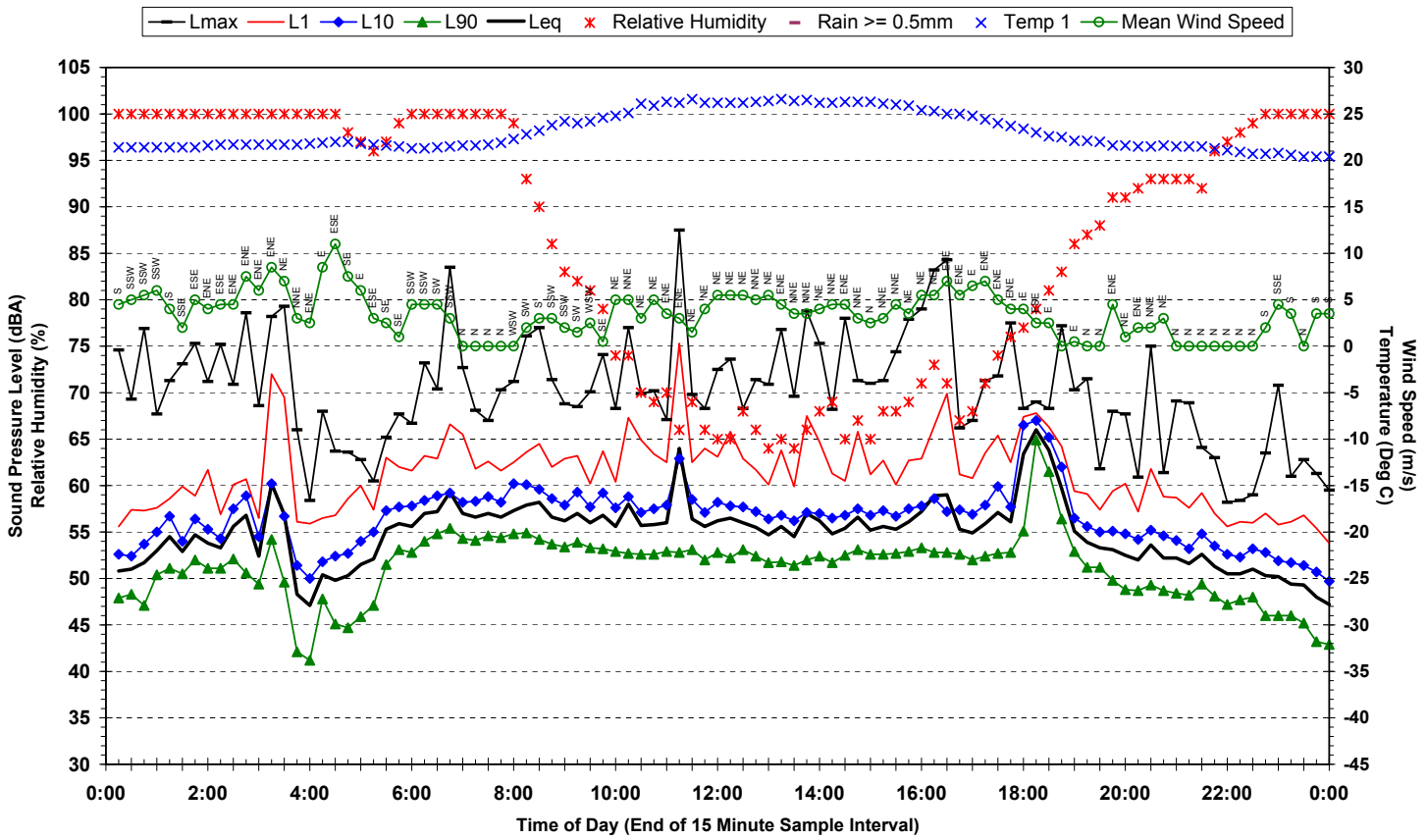
Statistical Ambient Noise Levels
20-1854 31 Valentine St - Sunday 12 April 2009



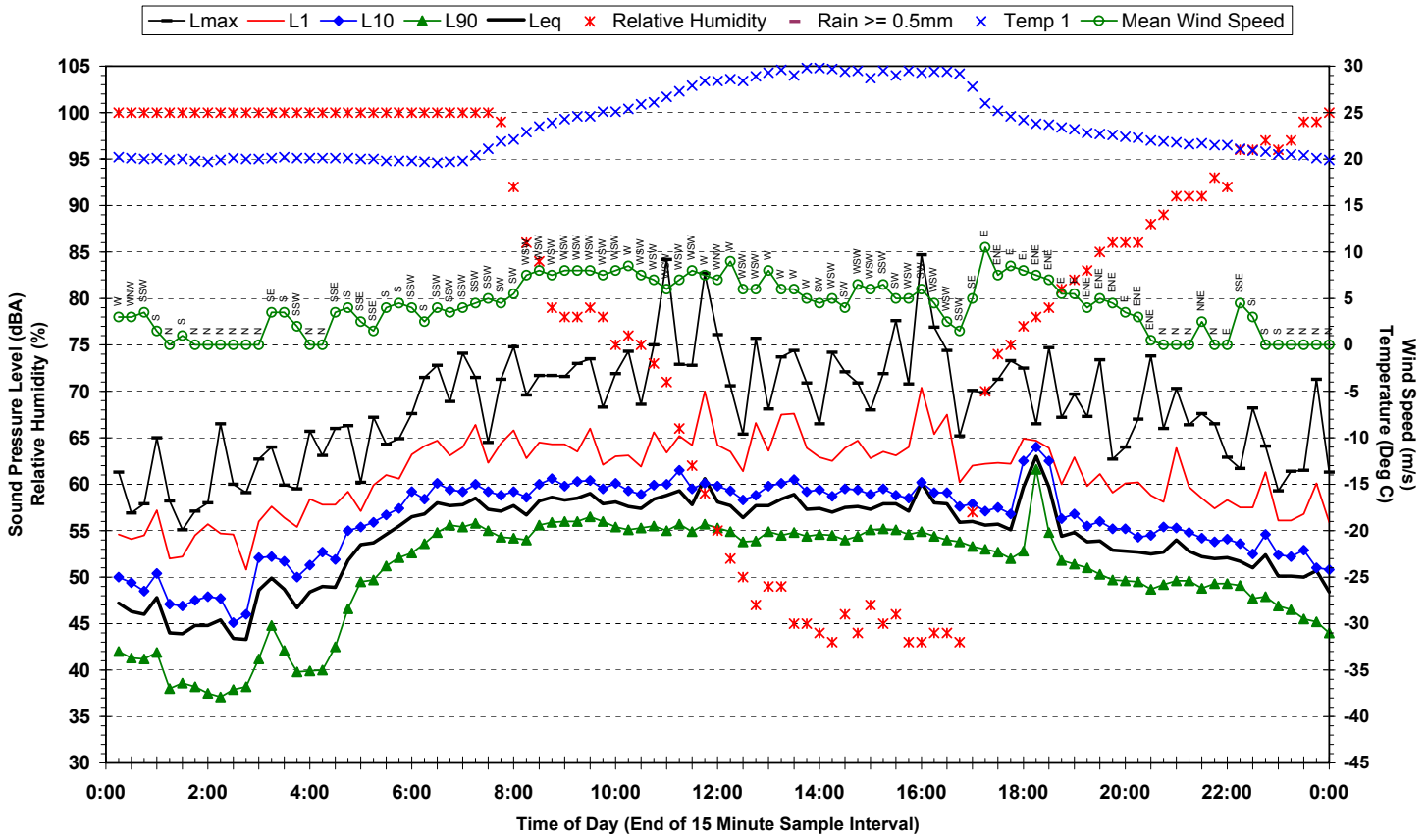
Statistical Ambient Noise Levels
20-1854 31 Valentine St - Monday 13 April 2009



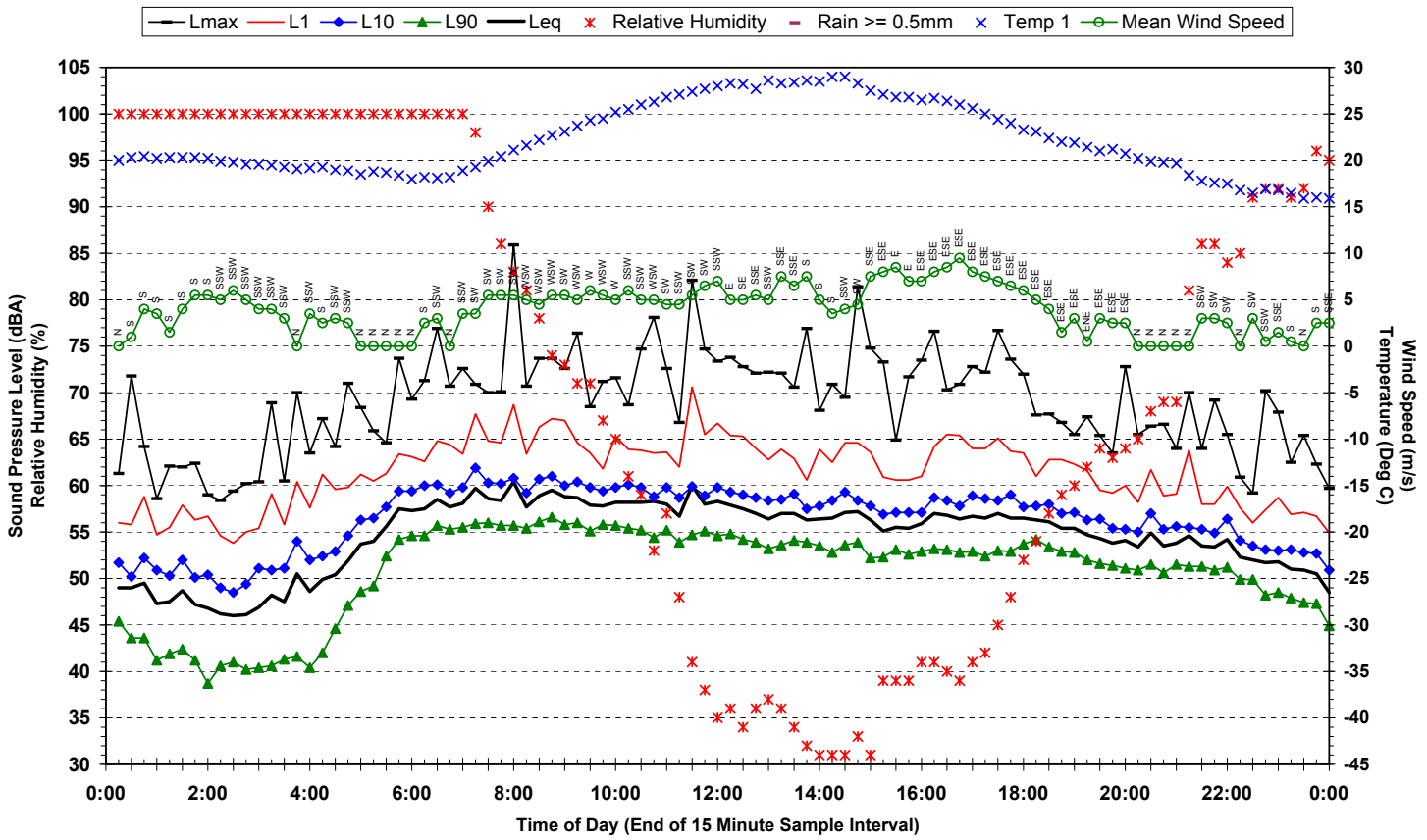
Statistical Ambient Noise Levels
20-1854 31 Valentine St - Tuesday 14 April 2009



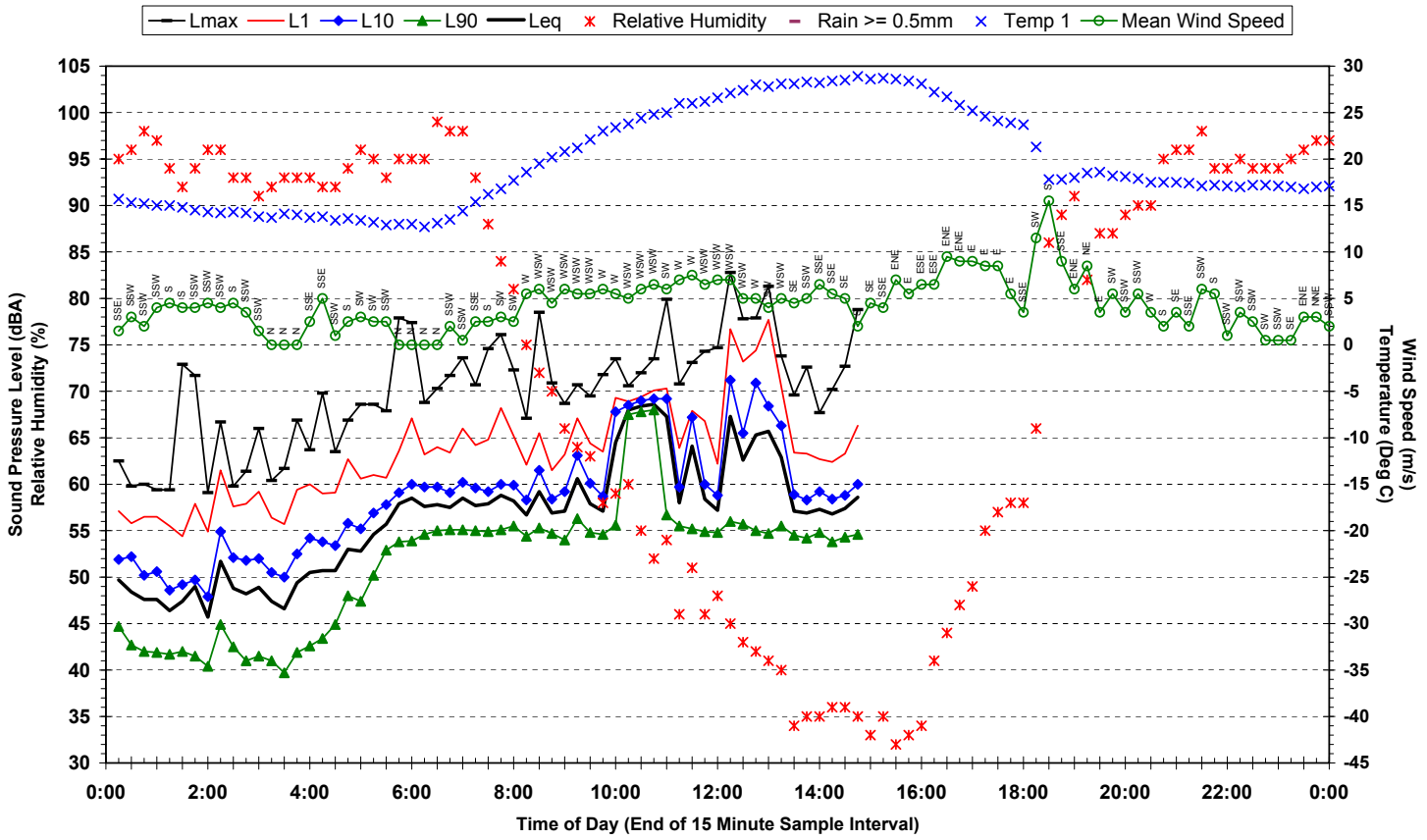
Statistical Ambient Noise Levels
20-1854 31 Valentine St - Wednesday 15 April 2009



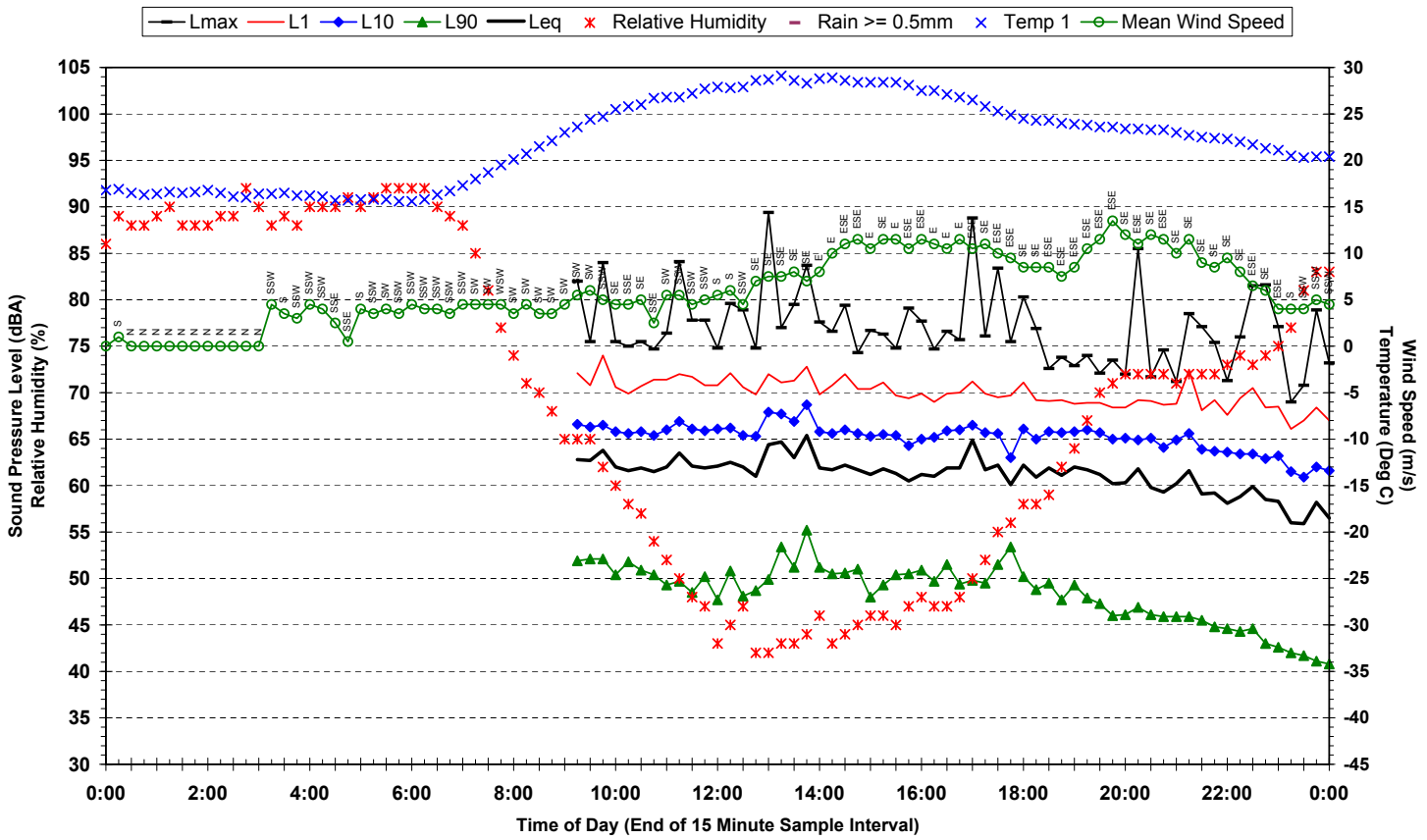
Statistical Ambient Noise Levels
20-1854 31 Valentine St - Thursday 16 April 2009



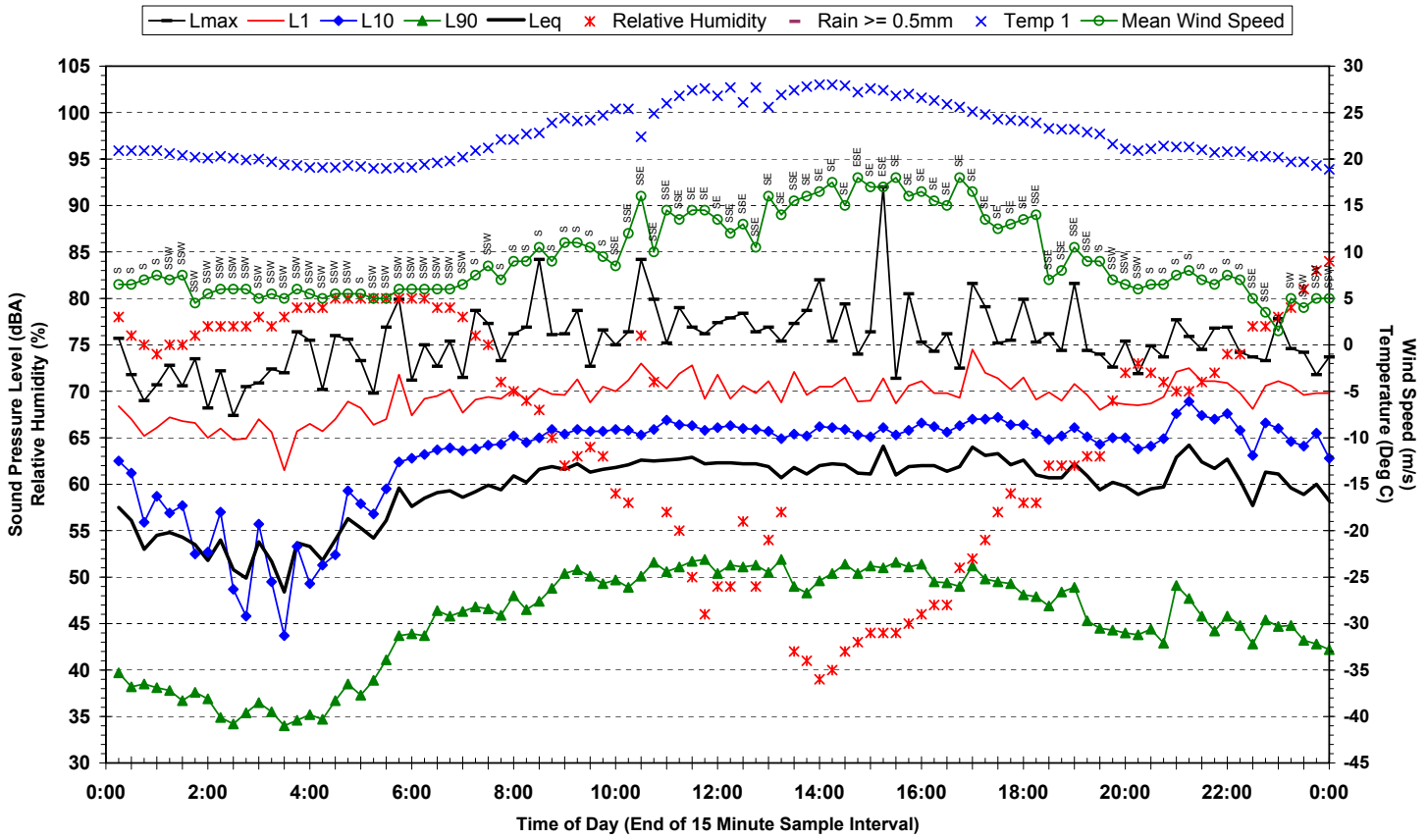
Statistical Ambient Noise Levels
20-1854 31 Valentine St - Friday 17 April 2009



Statistical Ambient Noise Levels
27/03/2009 128 Sylvan Rd - Friday 27 March 2009



Statistical Ambient Noise Levels
27/03/2009 128 Sylvan Rd - Saturday 28 March 2009



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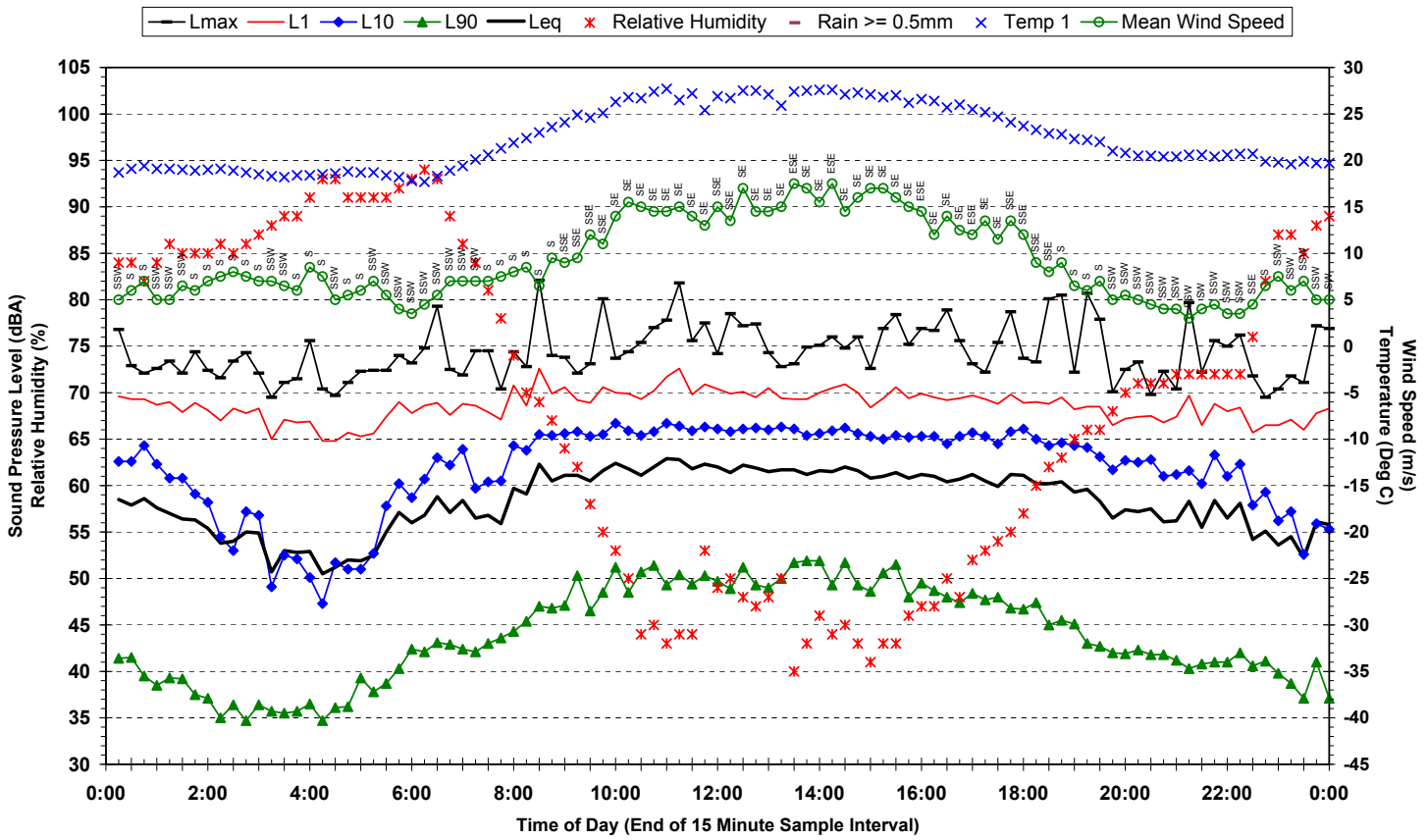

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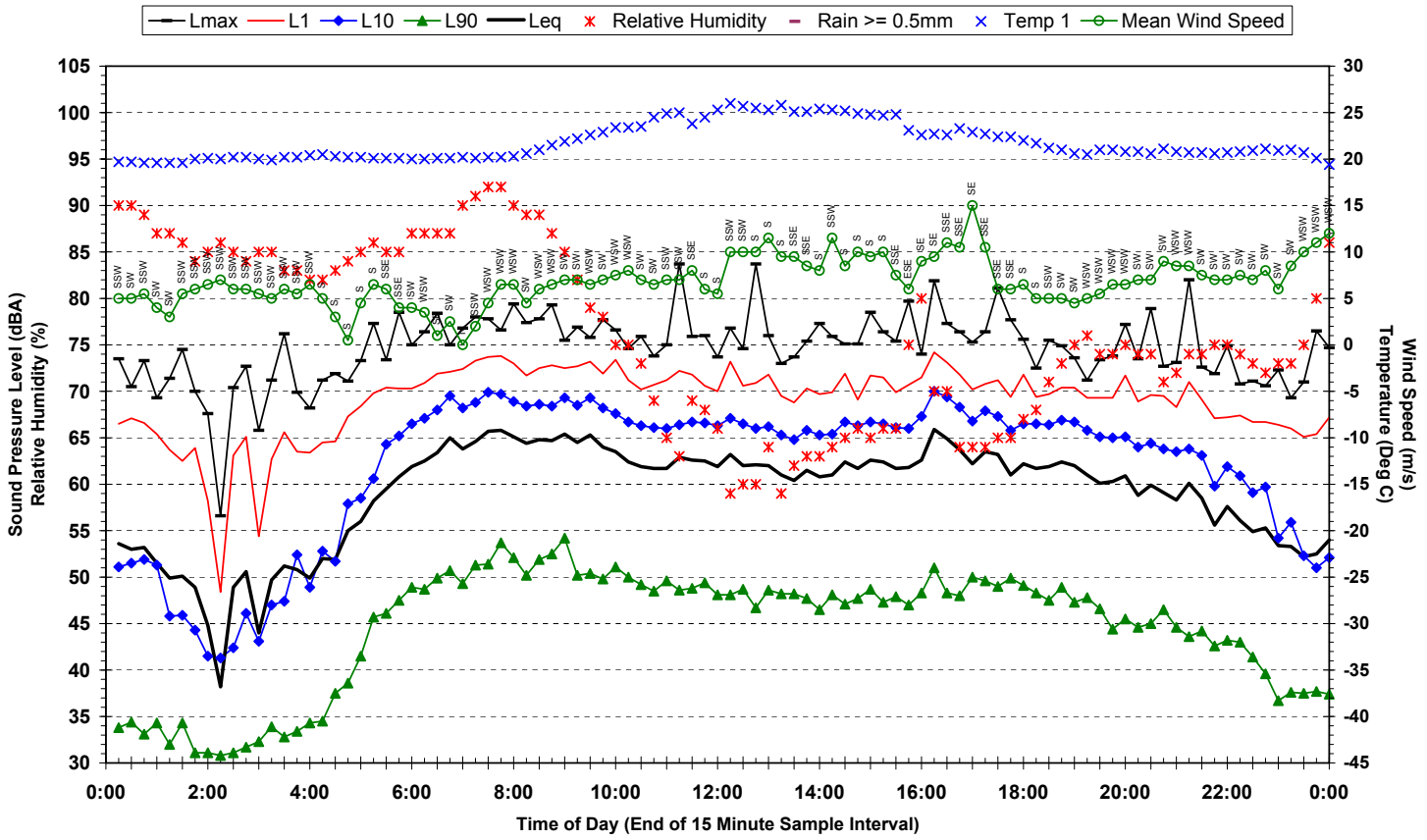

Statistical Ambient Noise Levels
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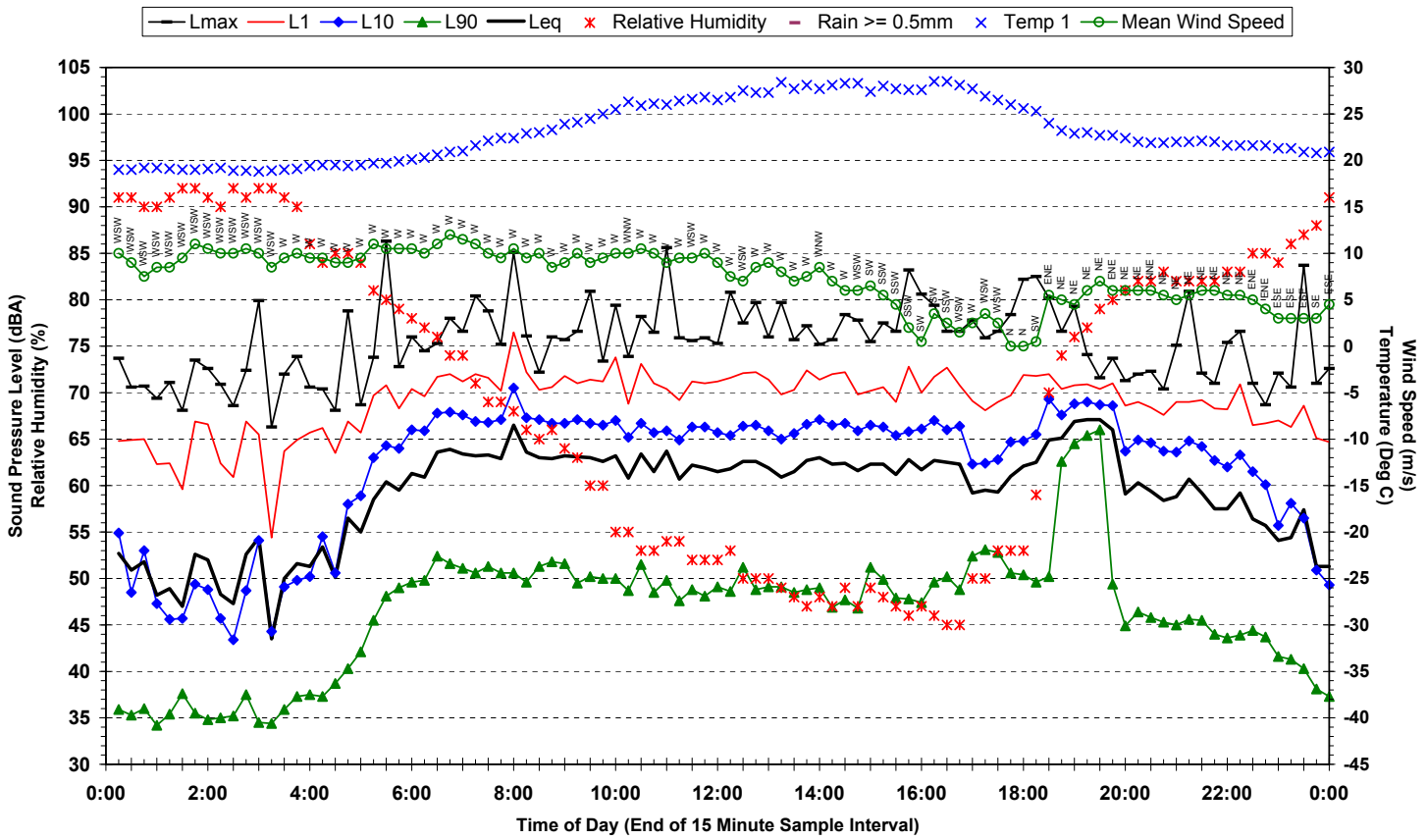

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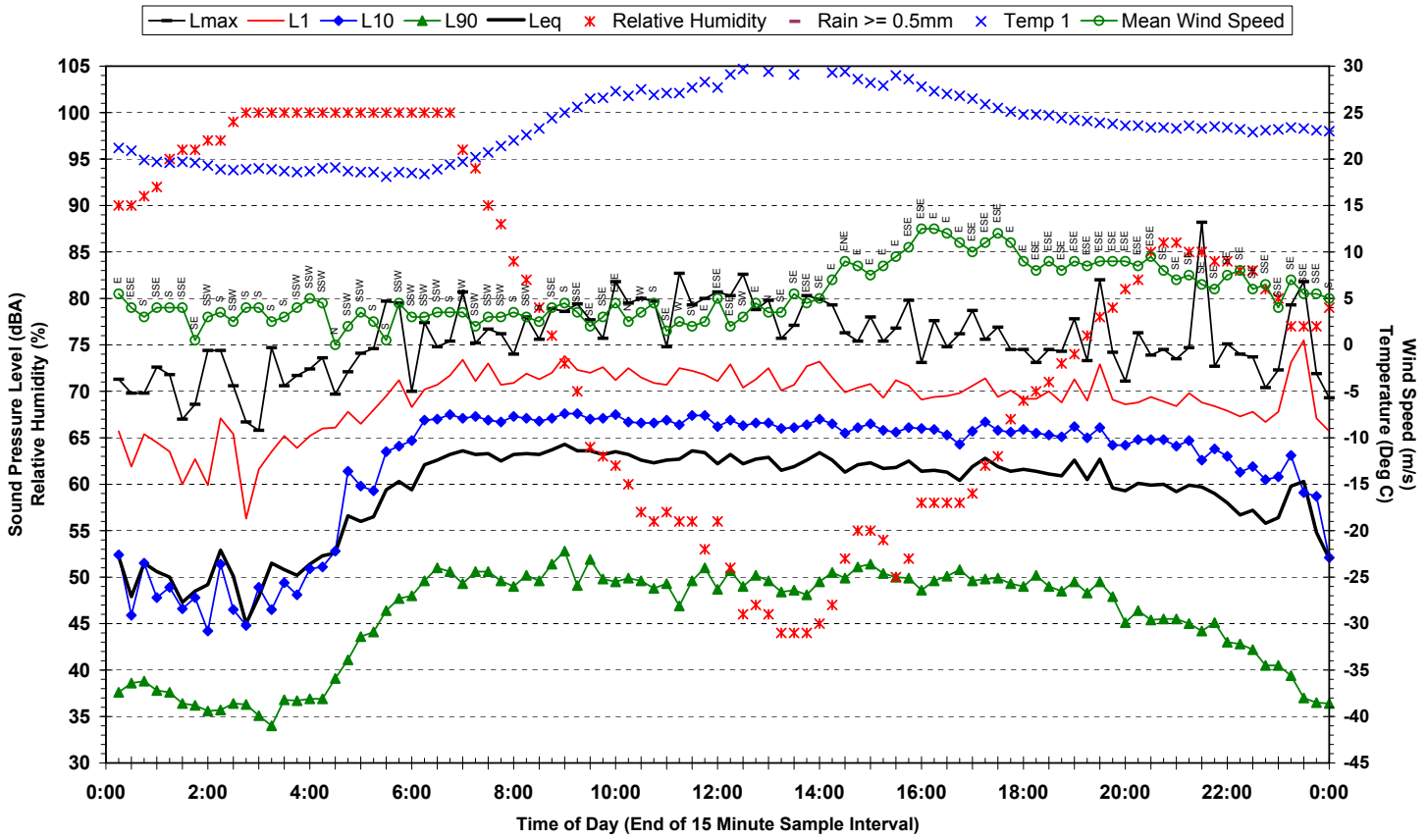

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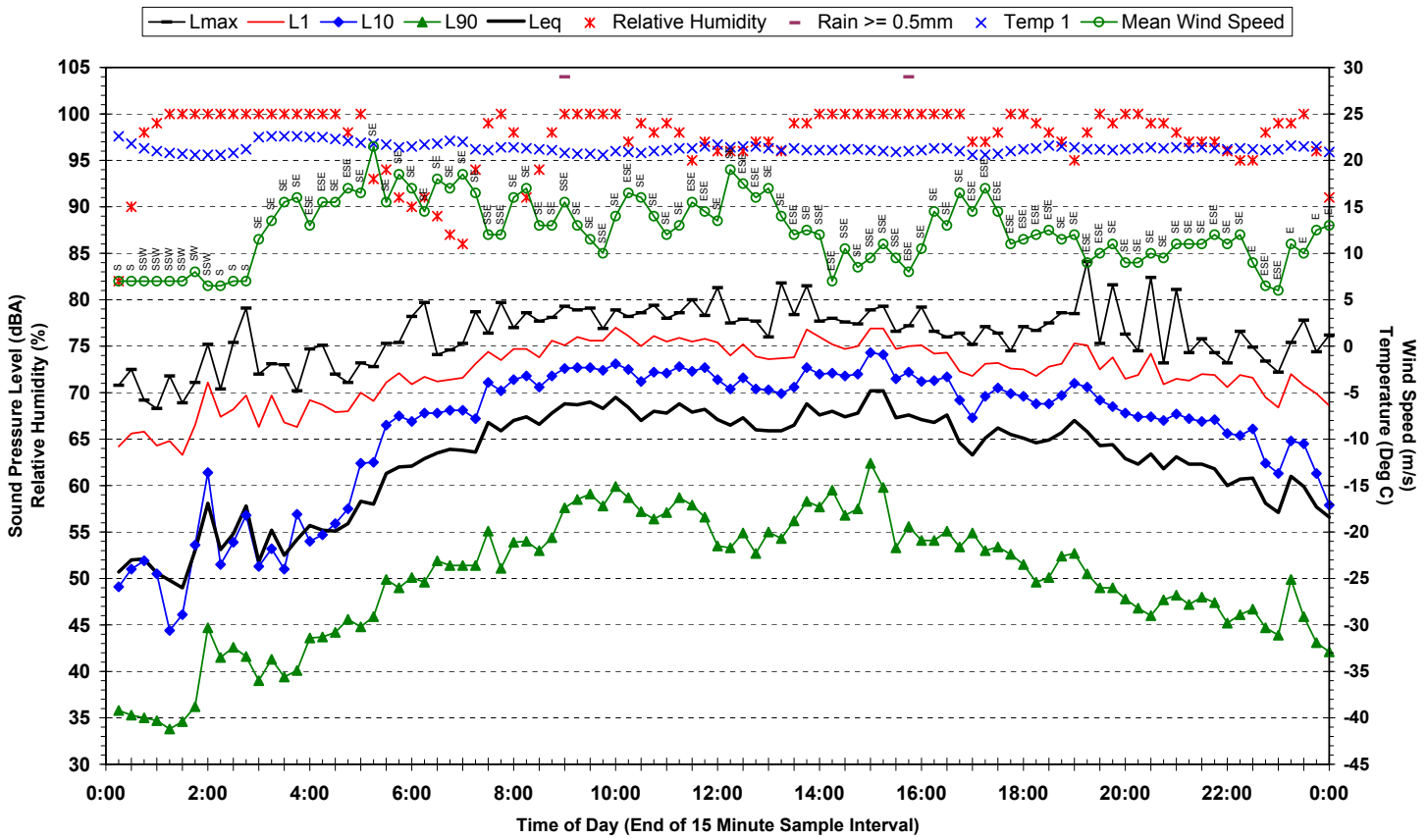

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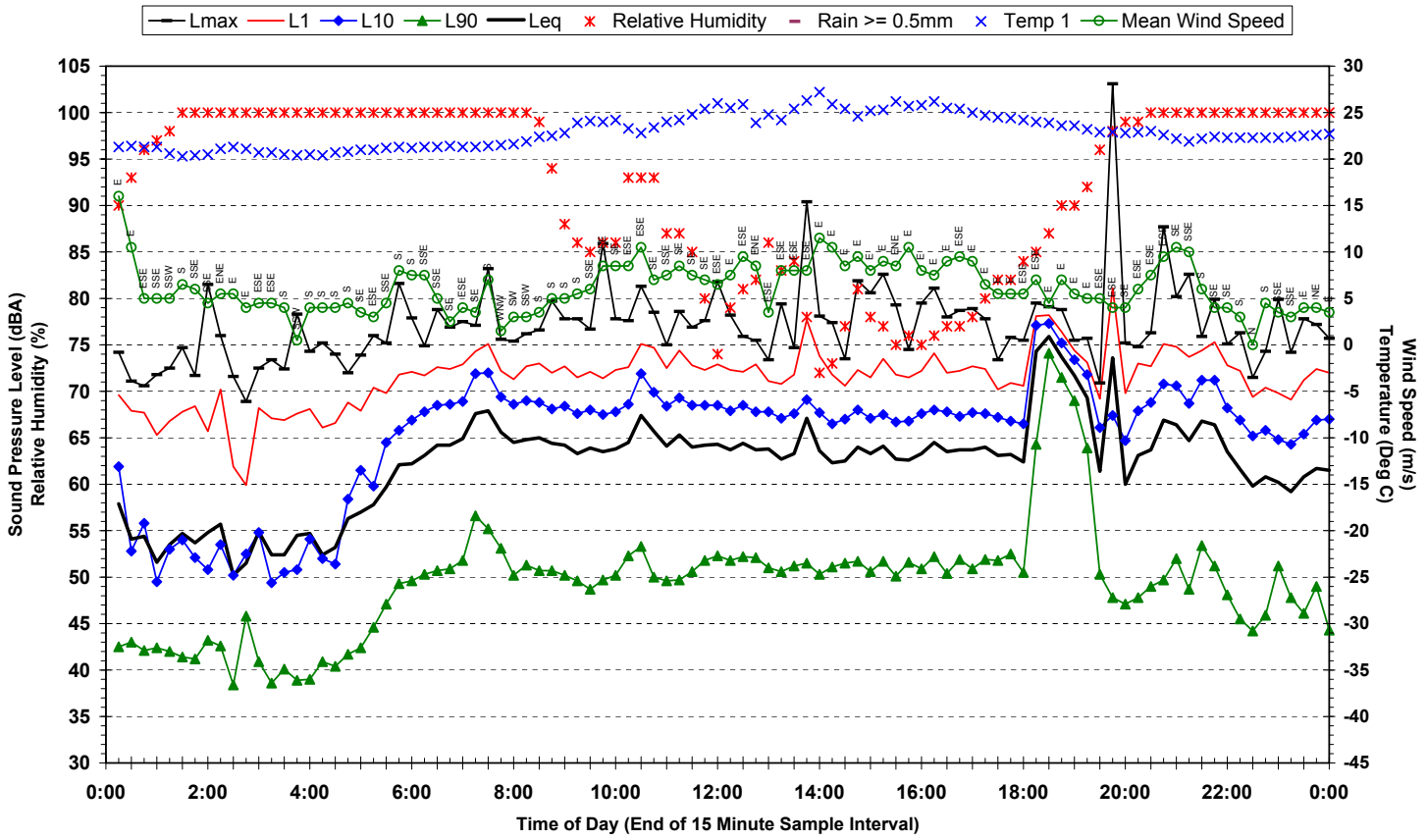

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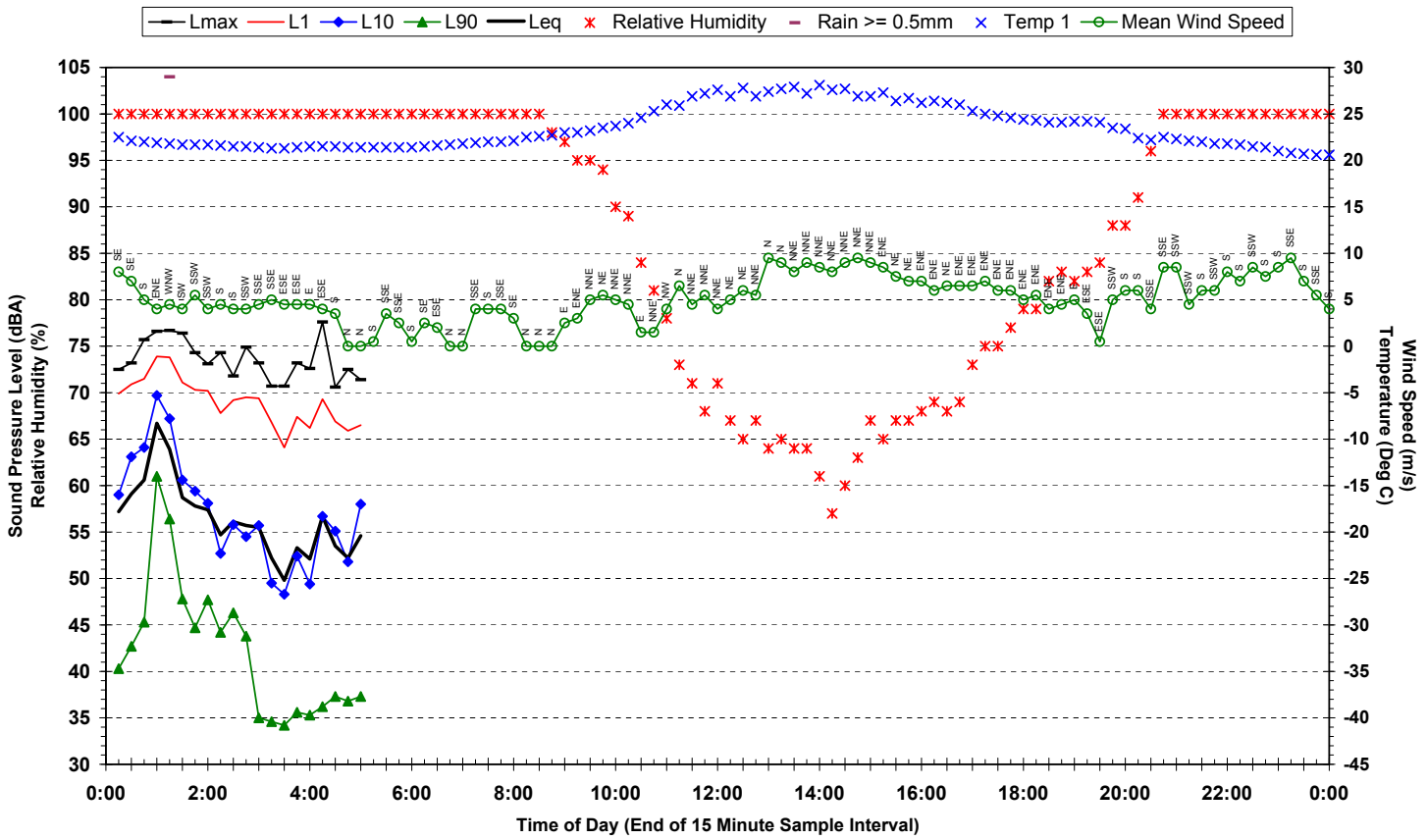

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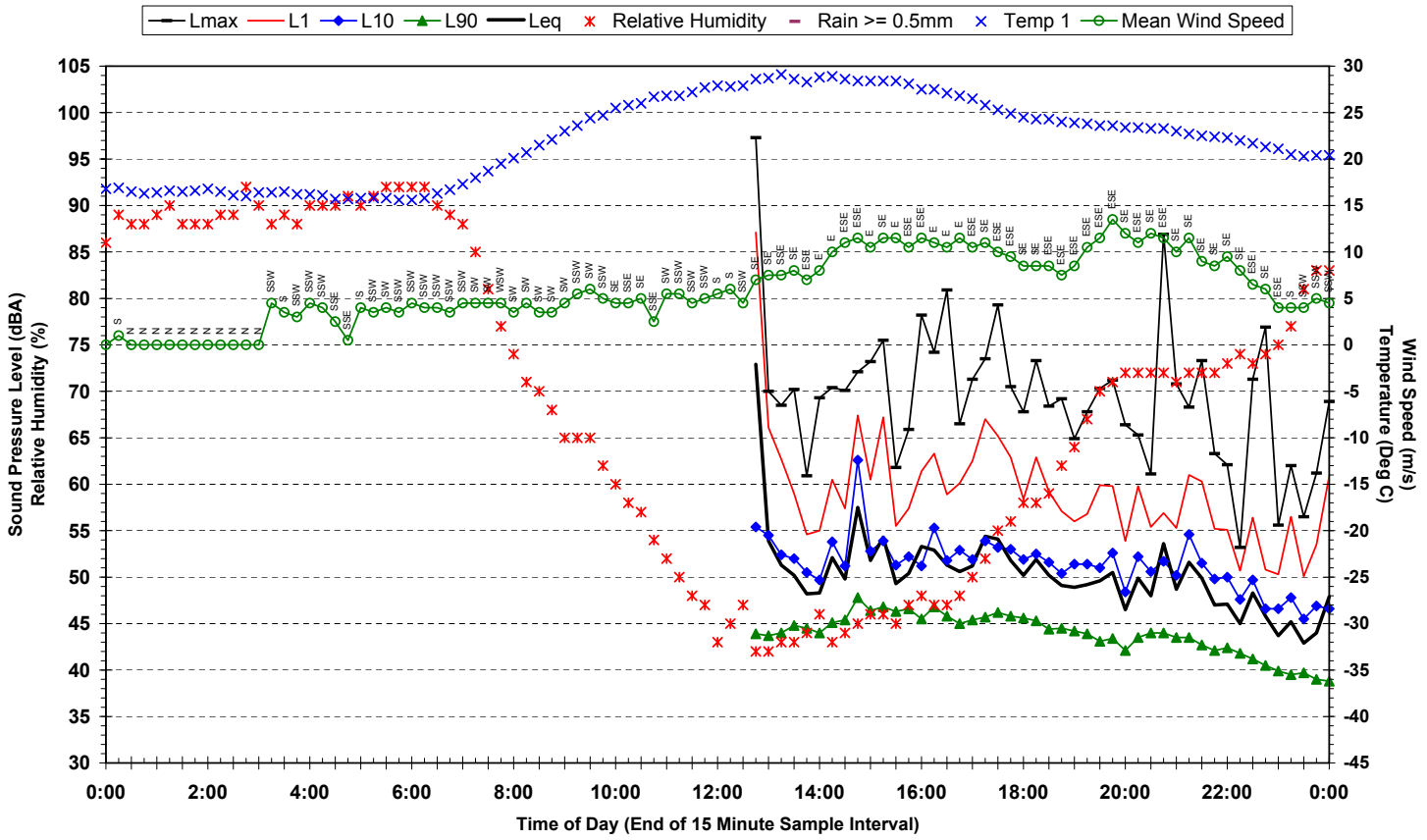

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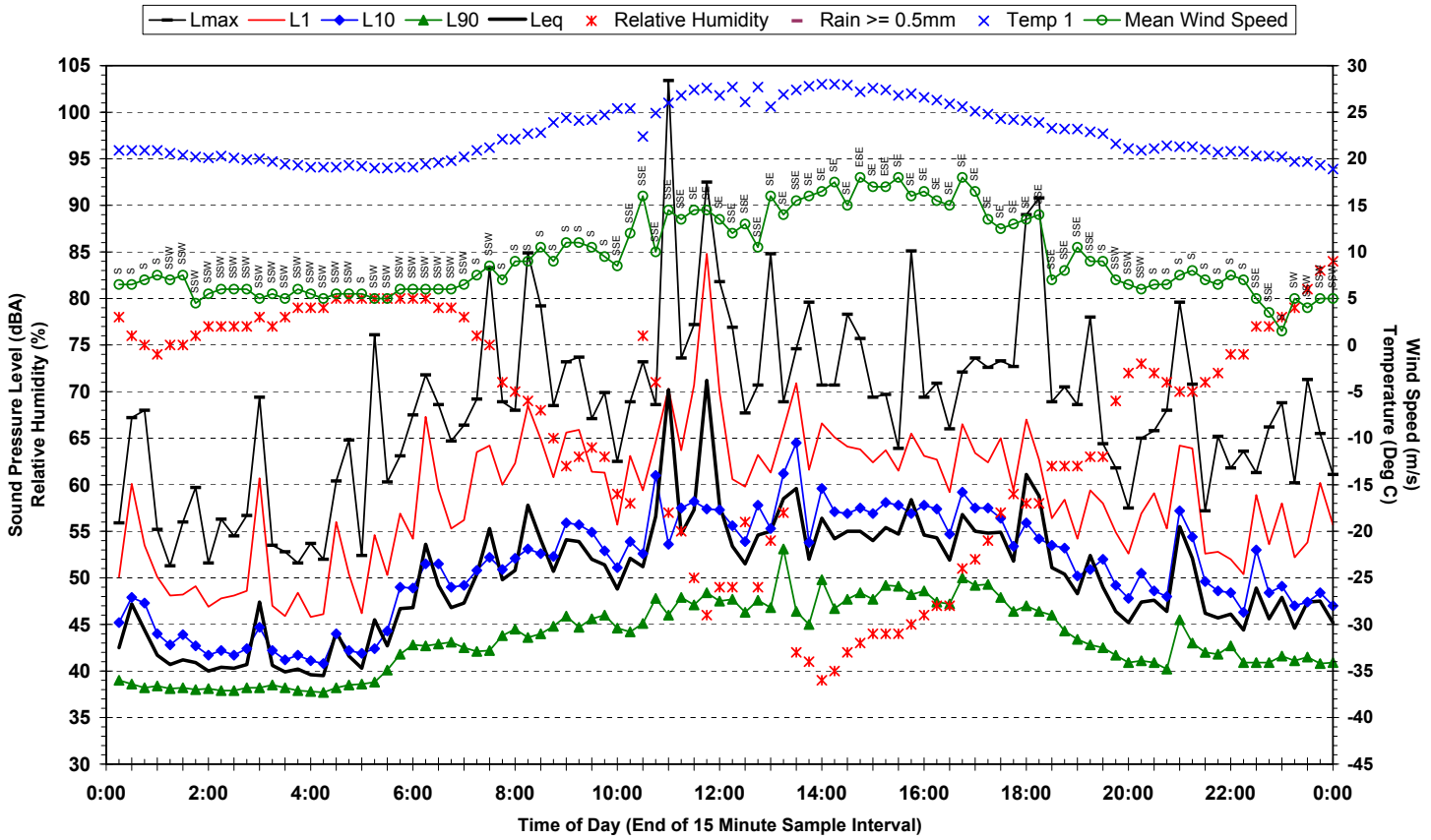

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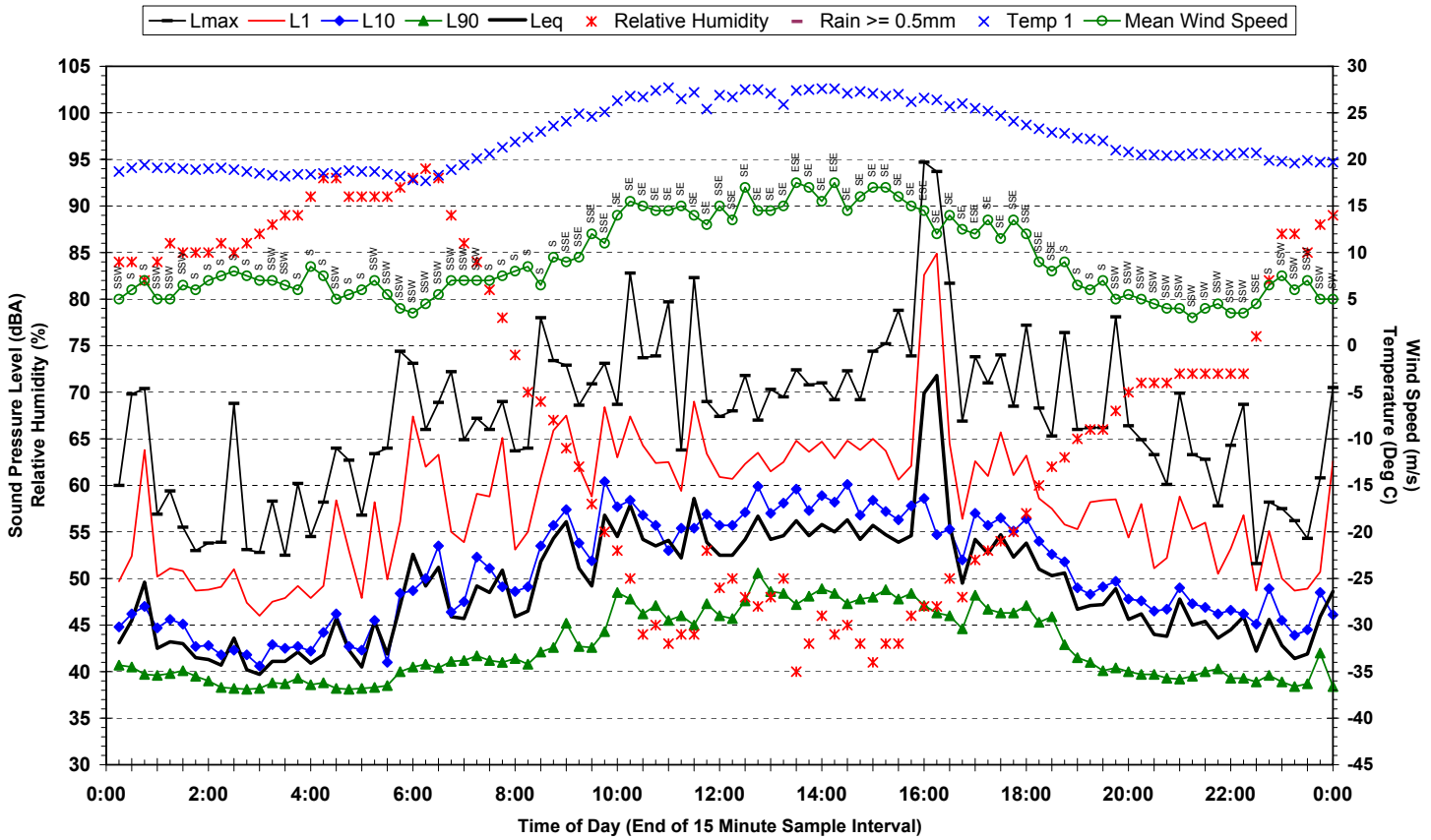

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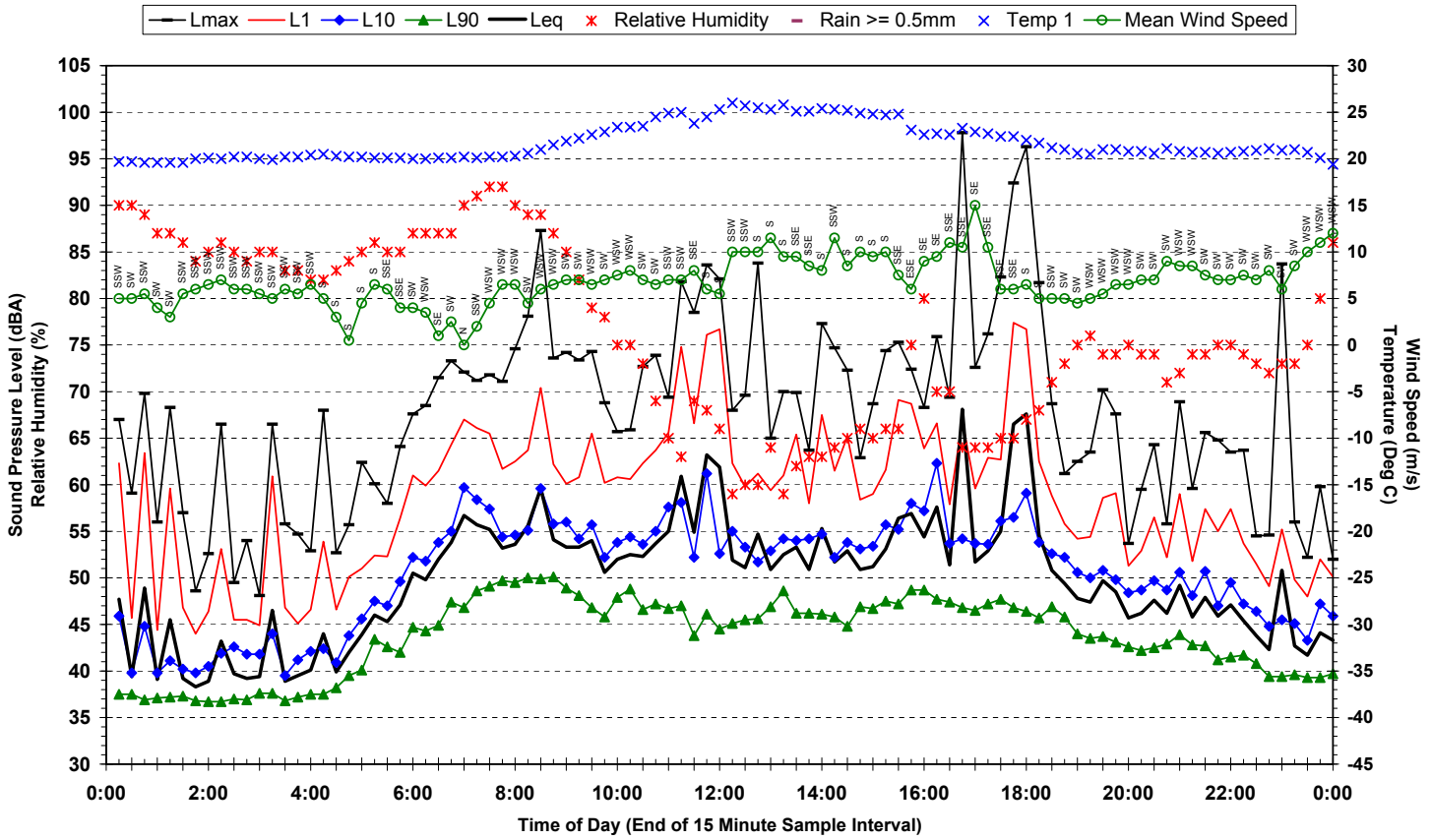

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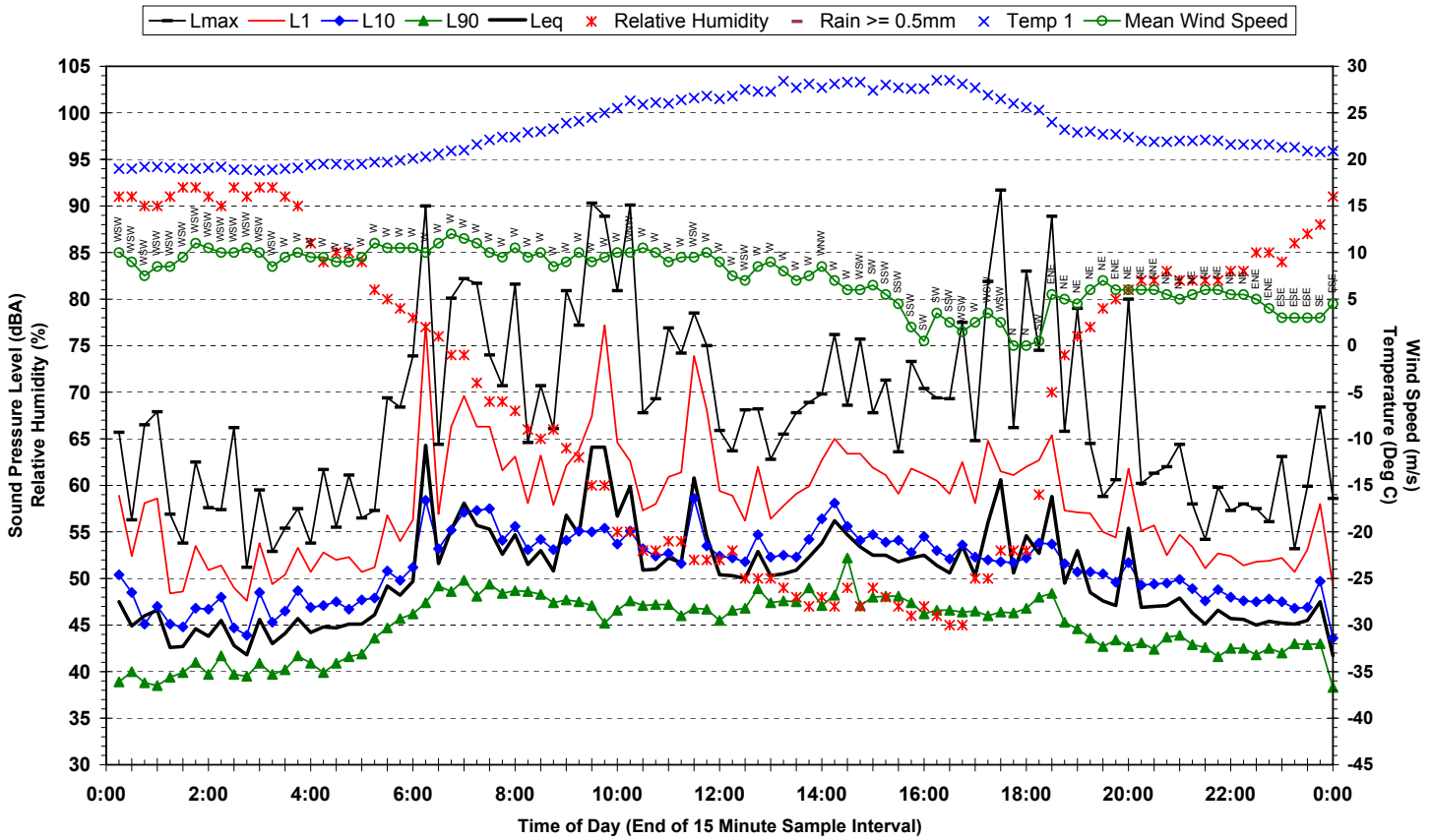

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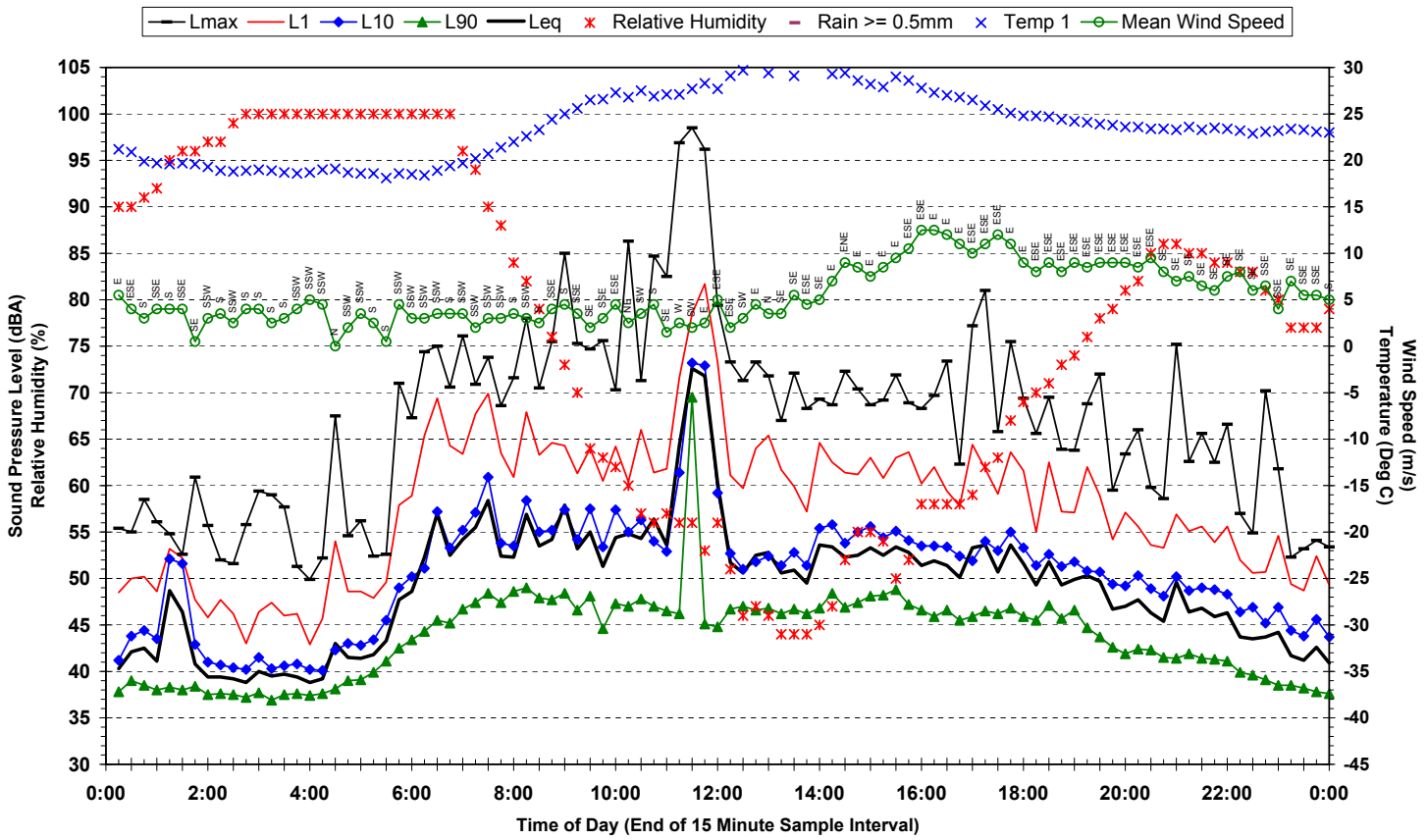

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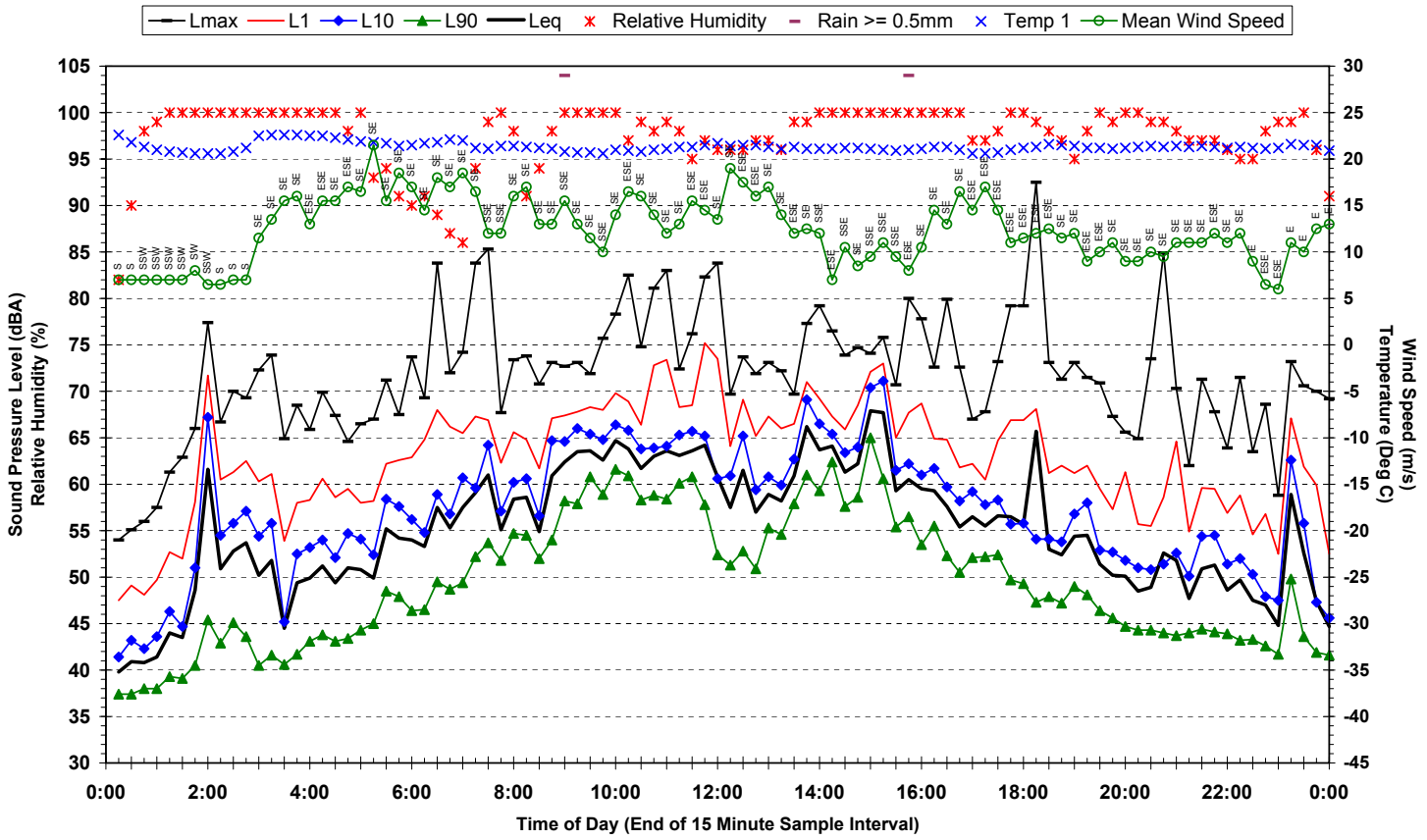

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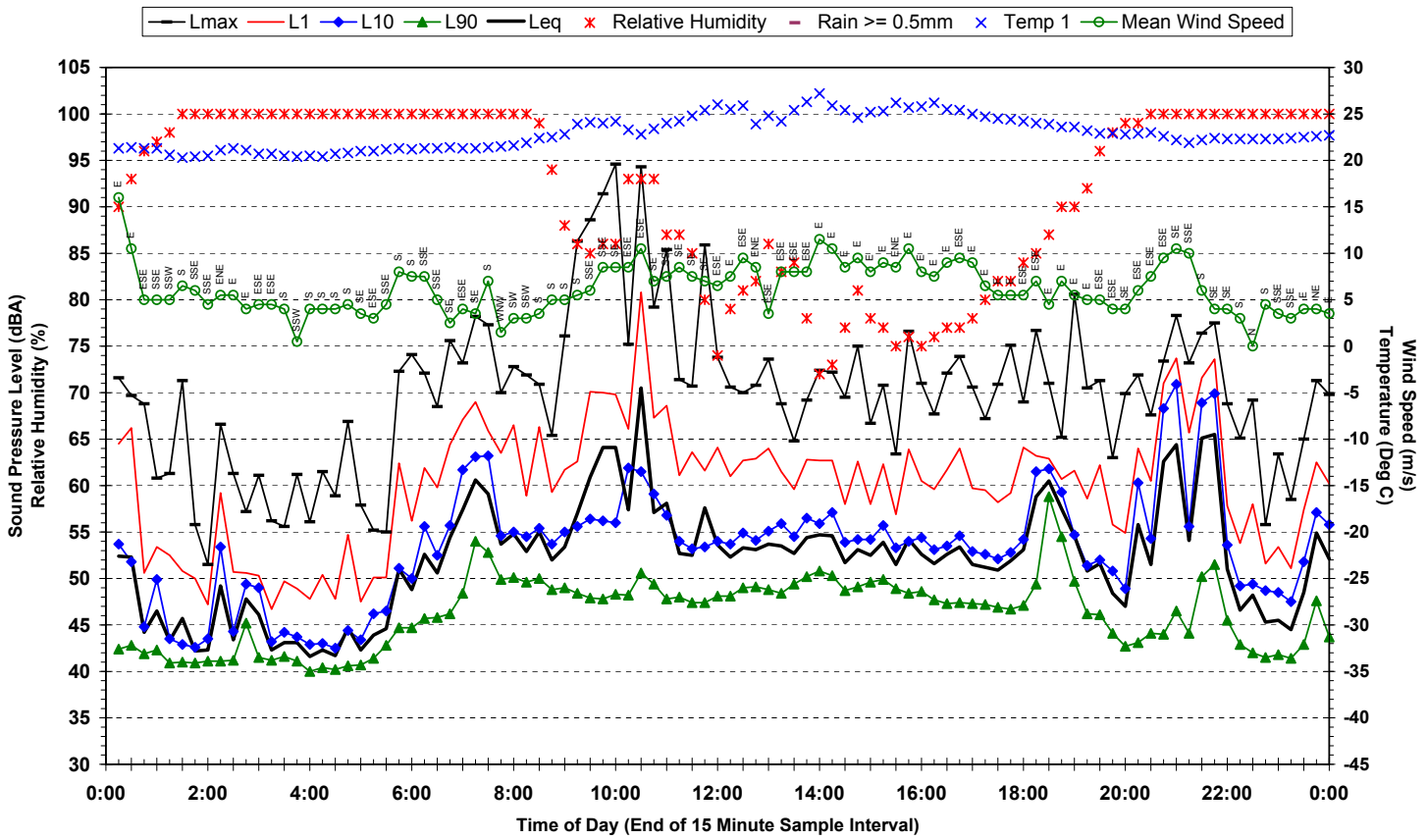

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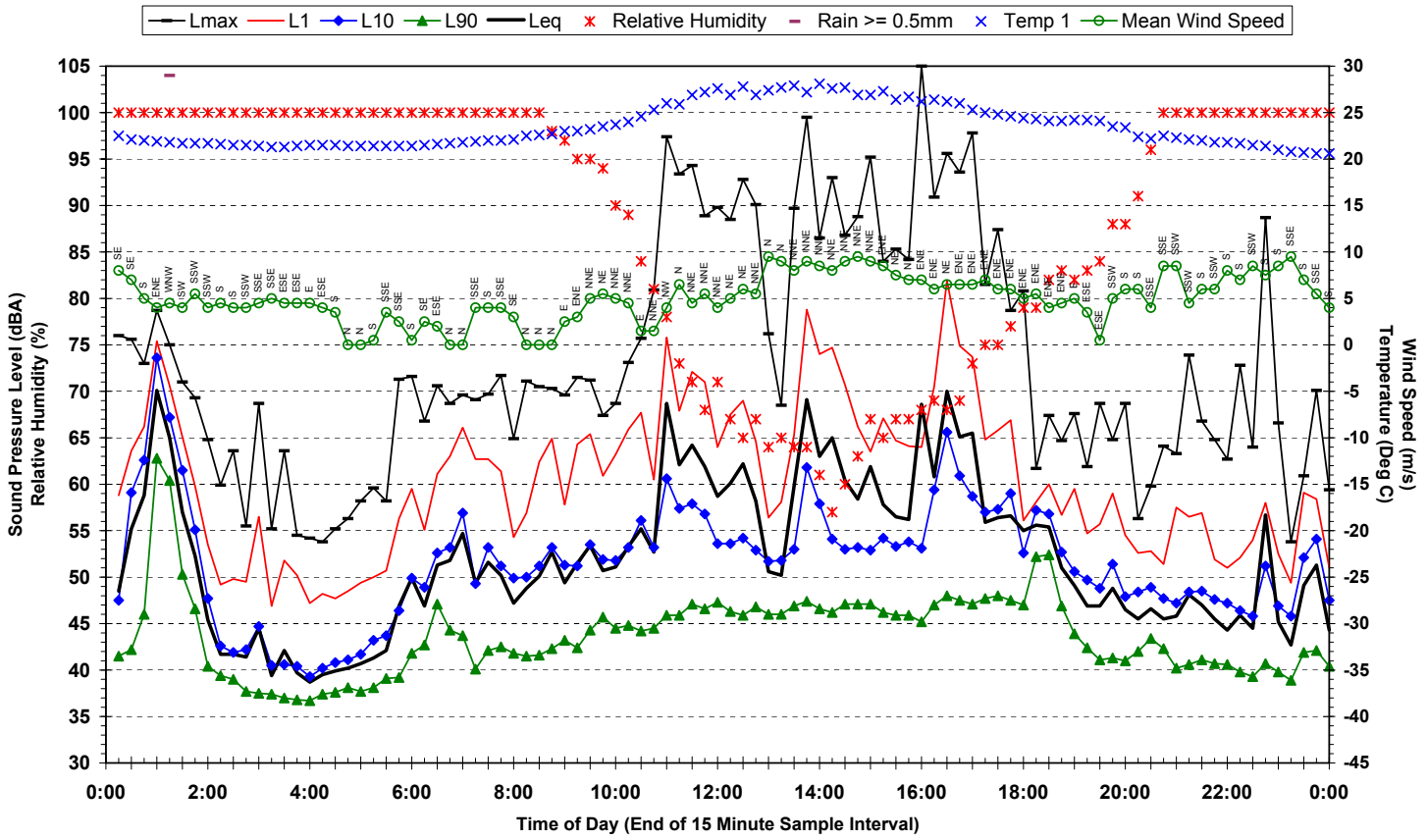

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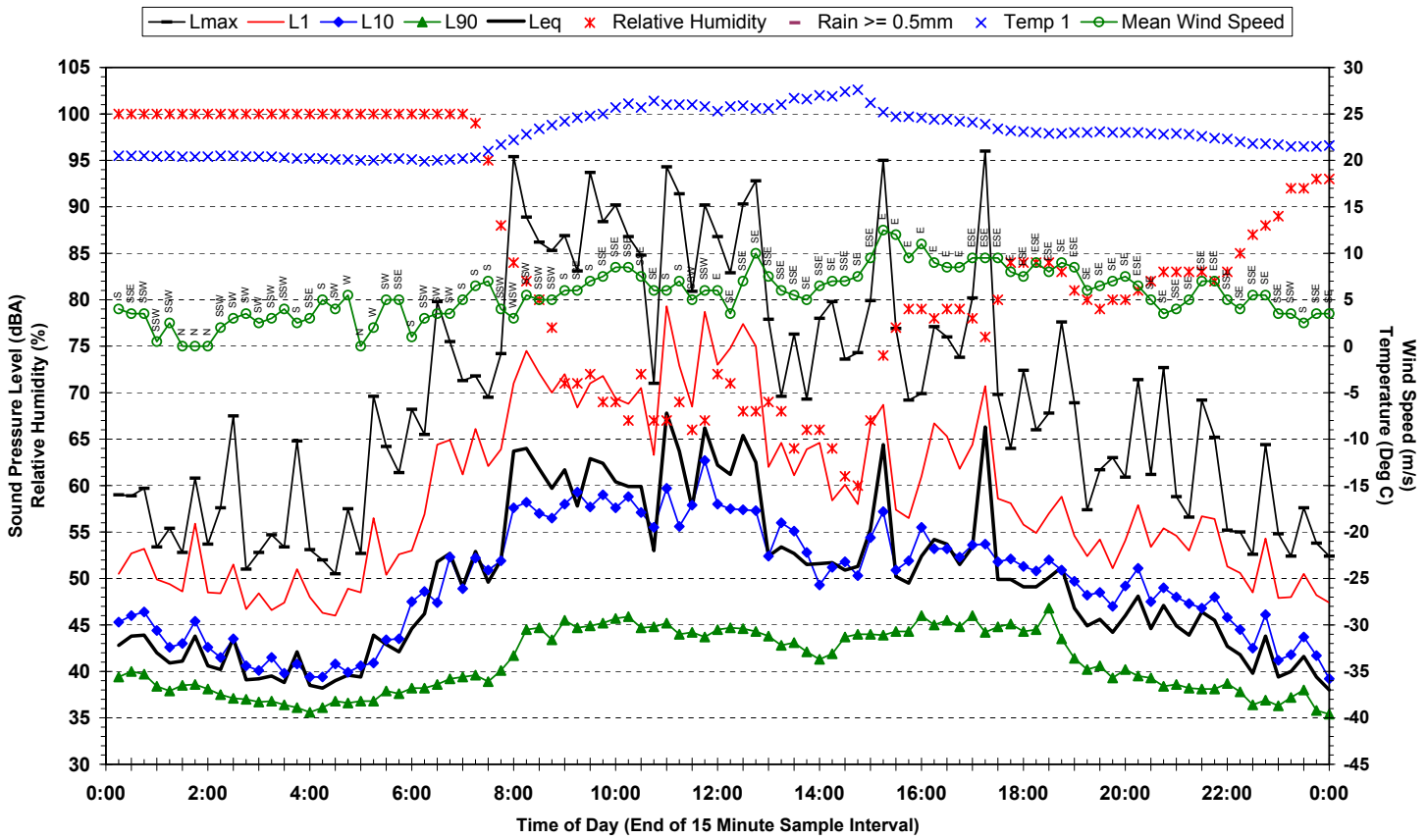

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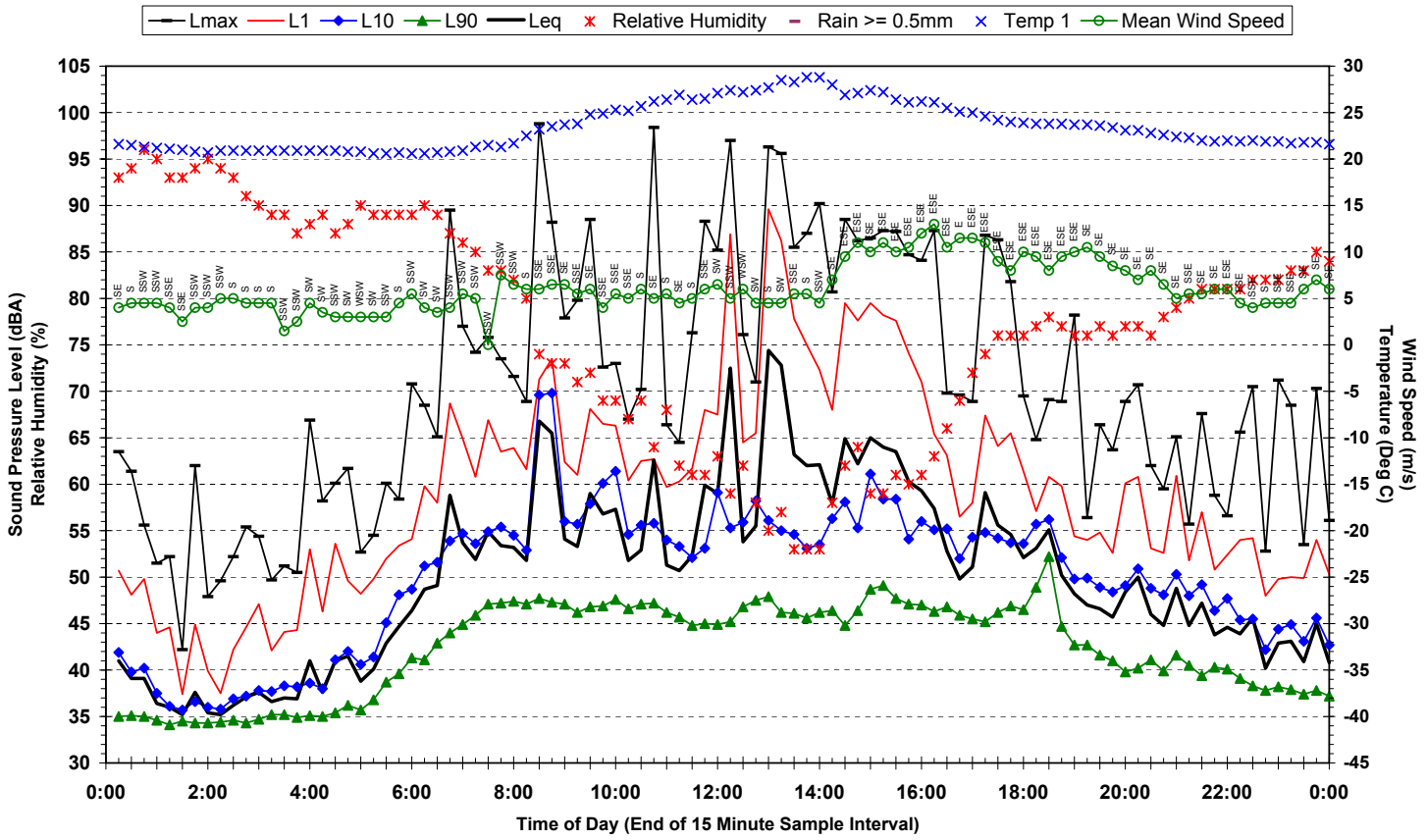

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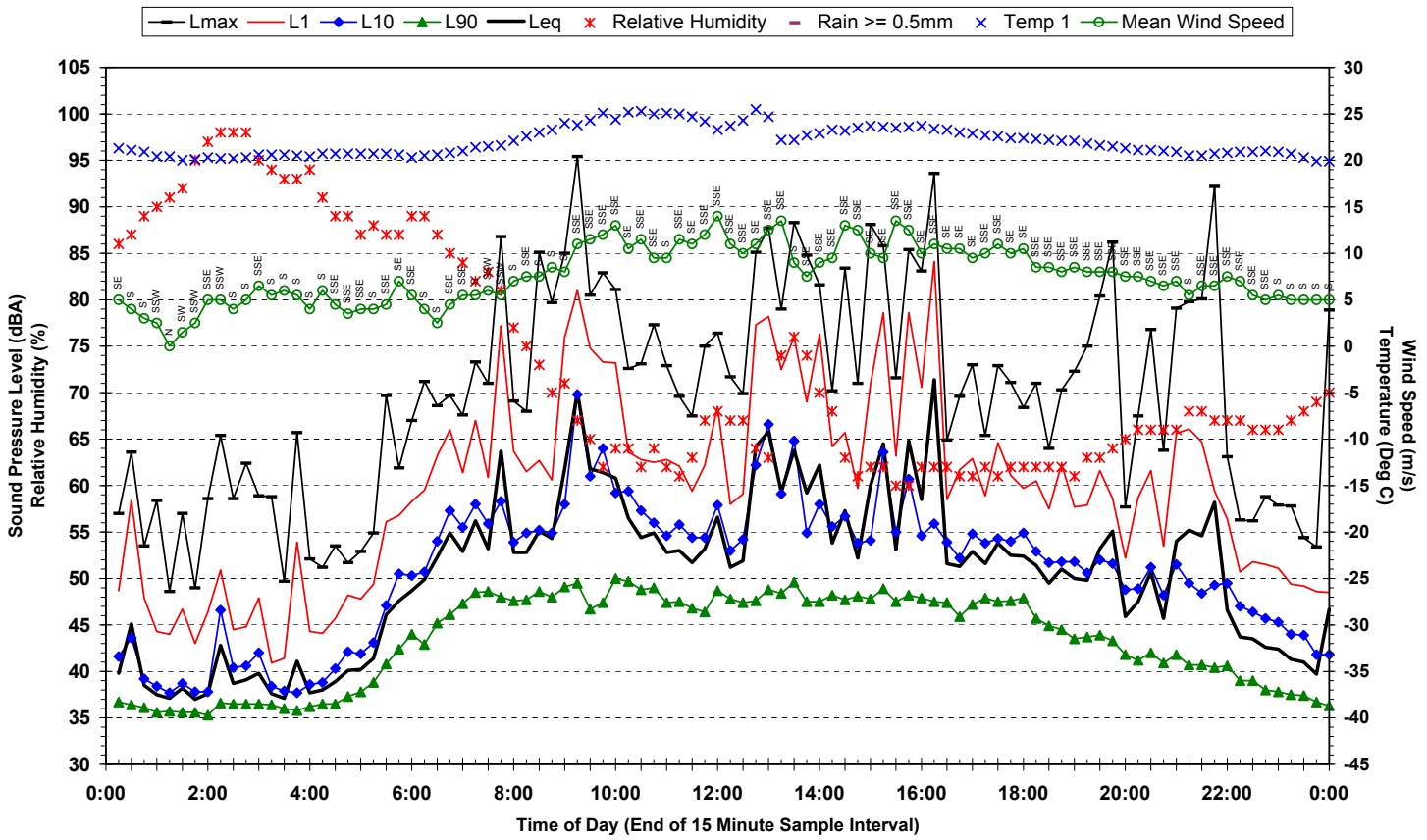

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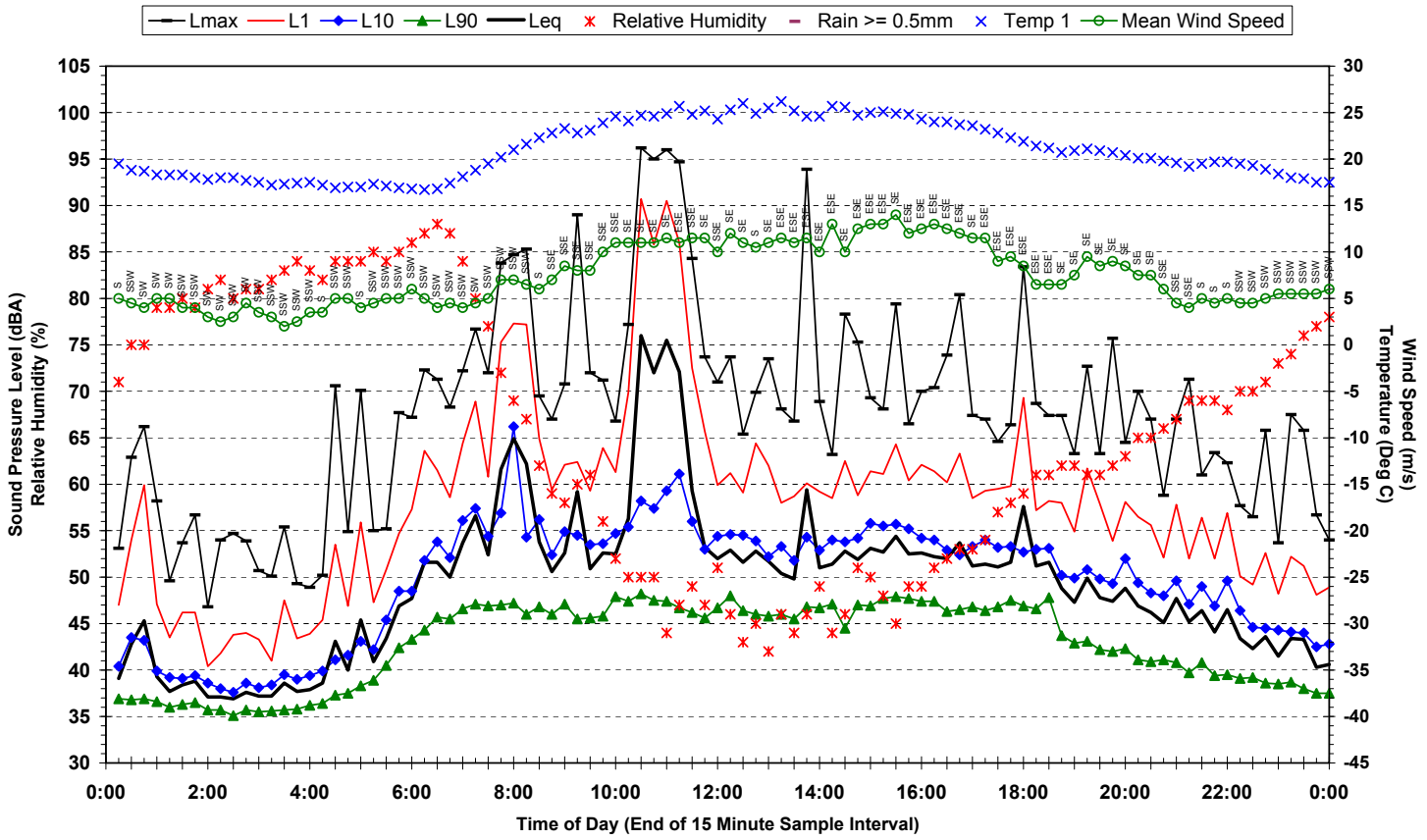

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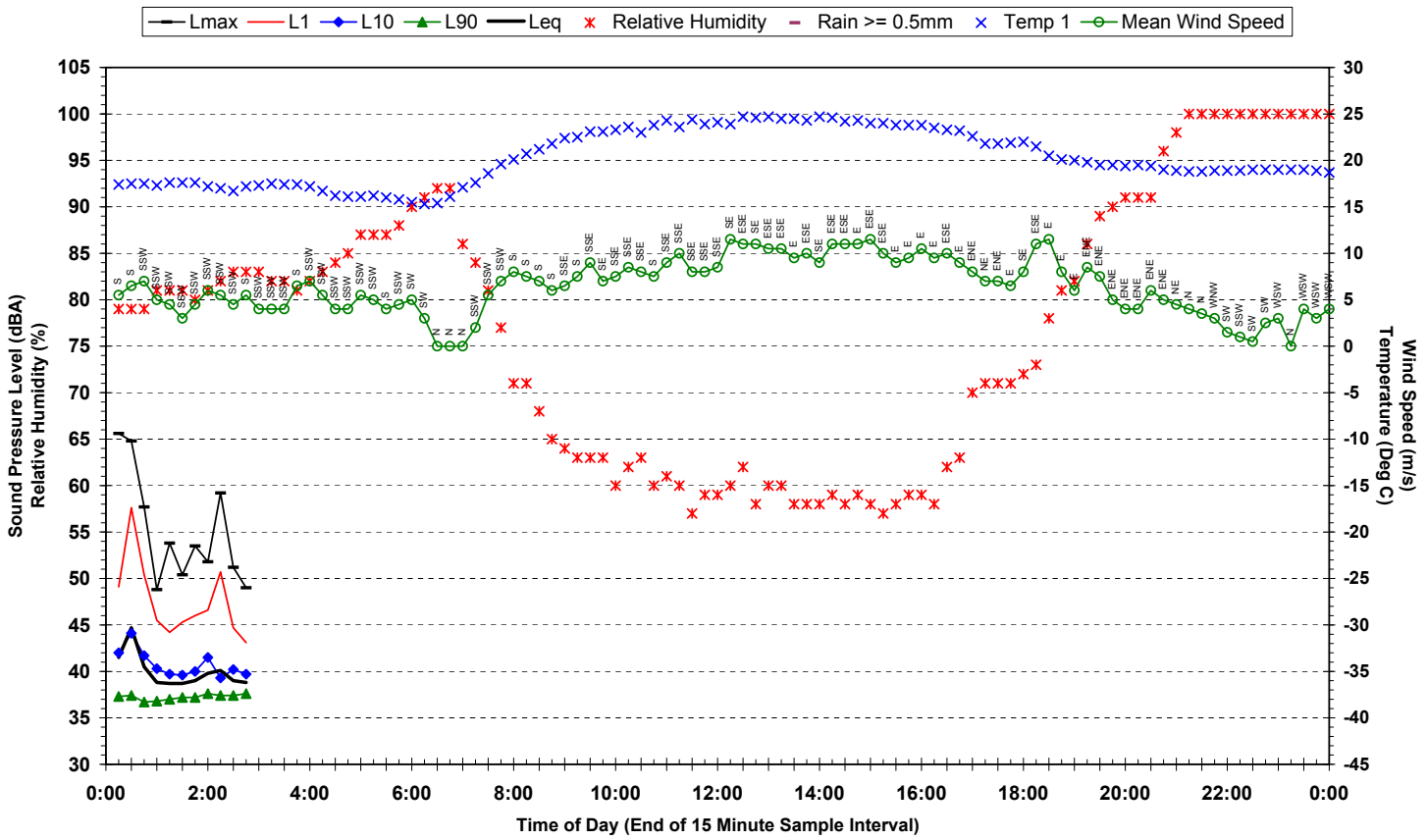

Statistical Ambient Noise Levels
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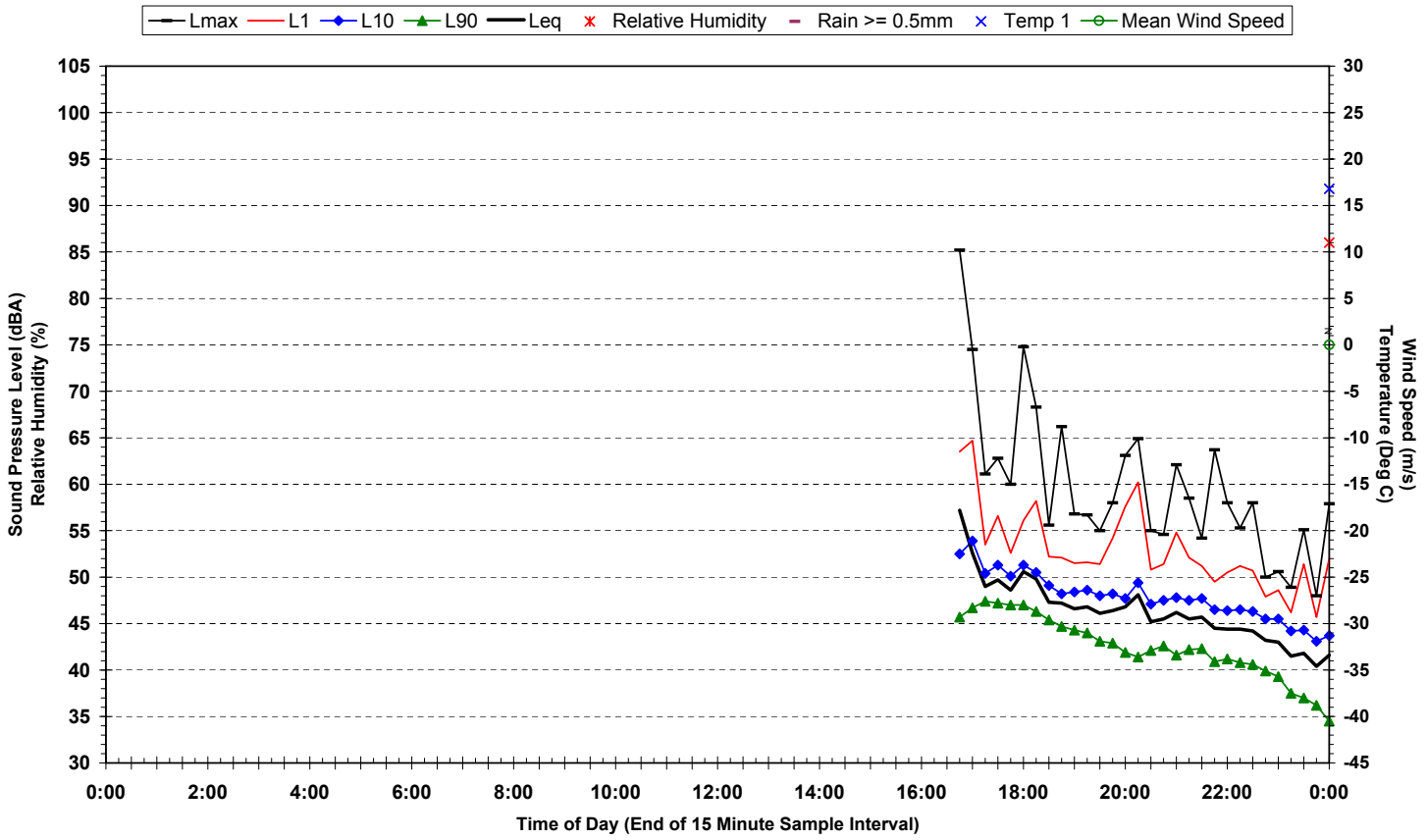

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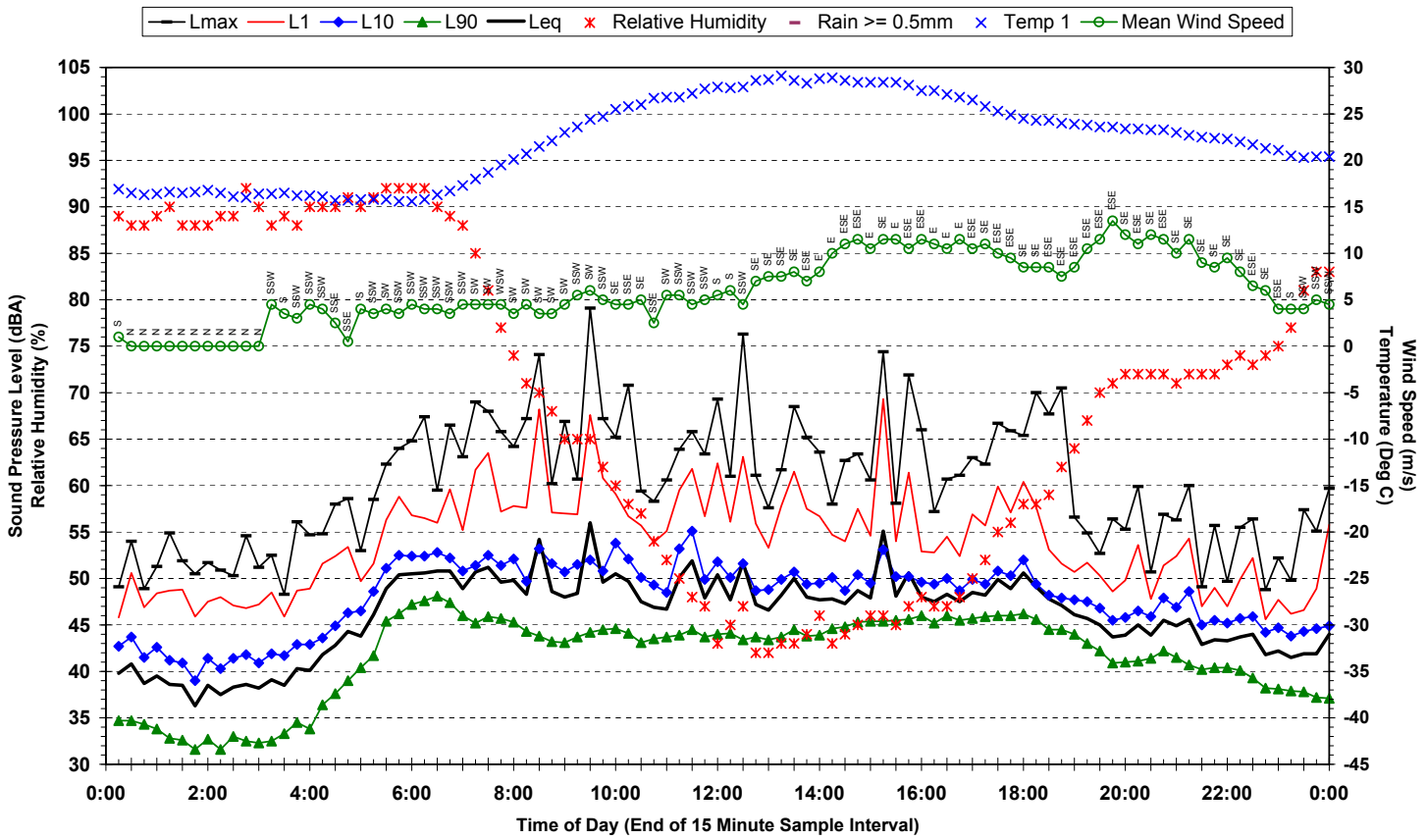

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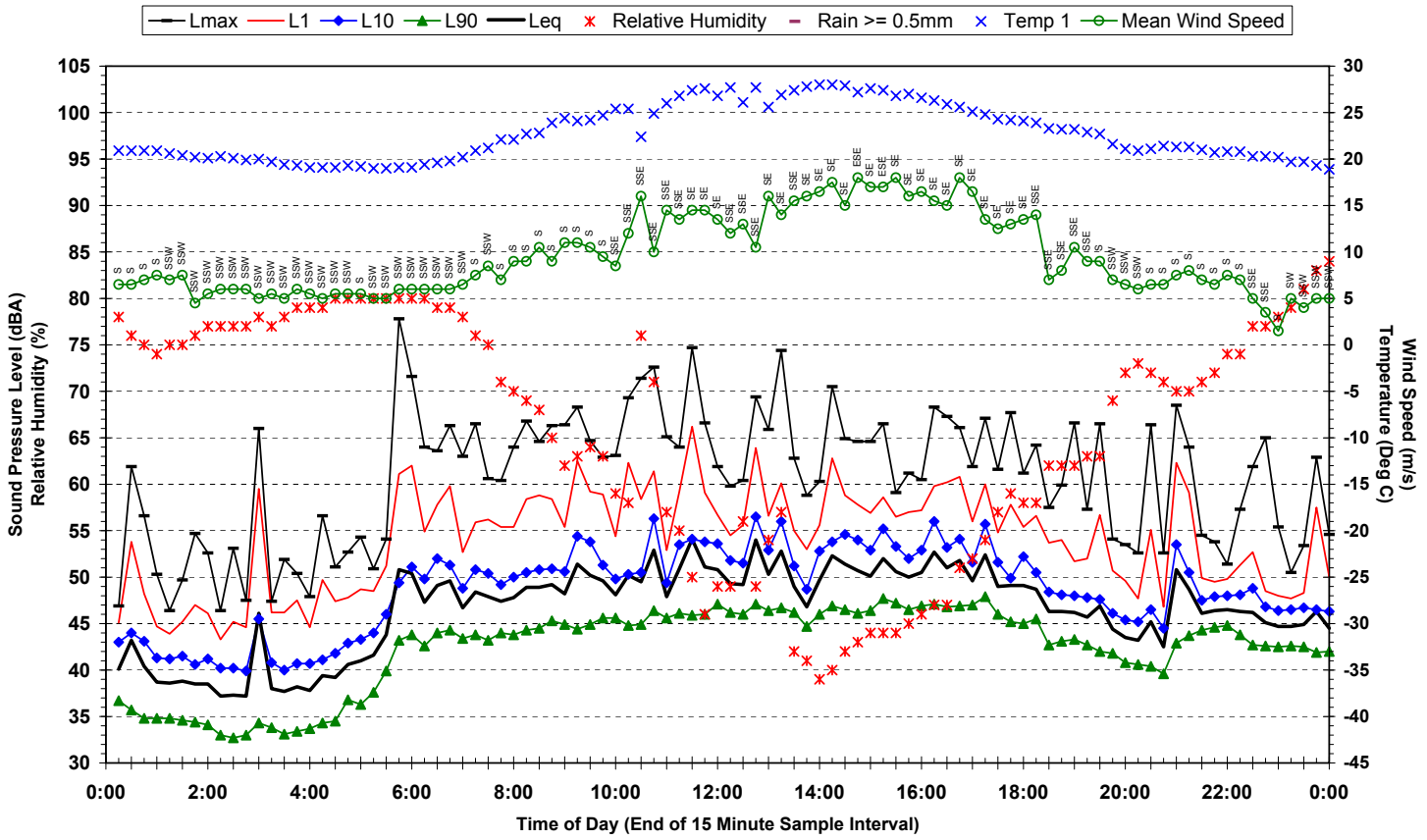

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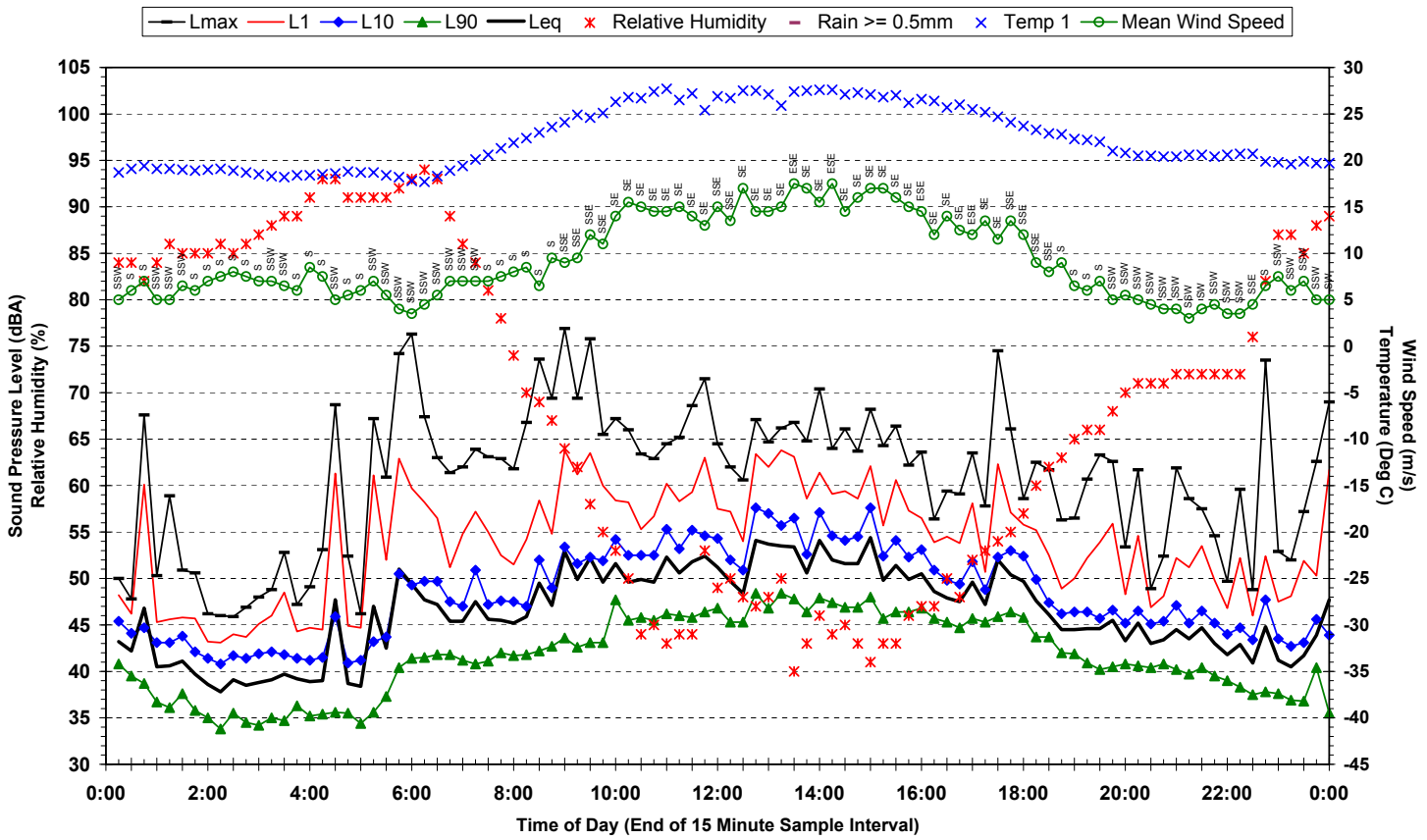

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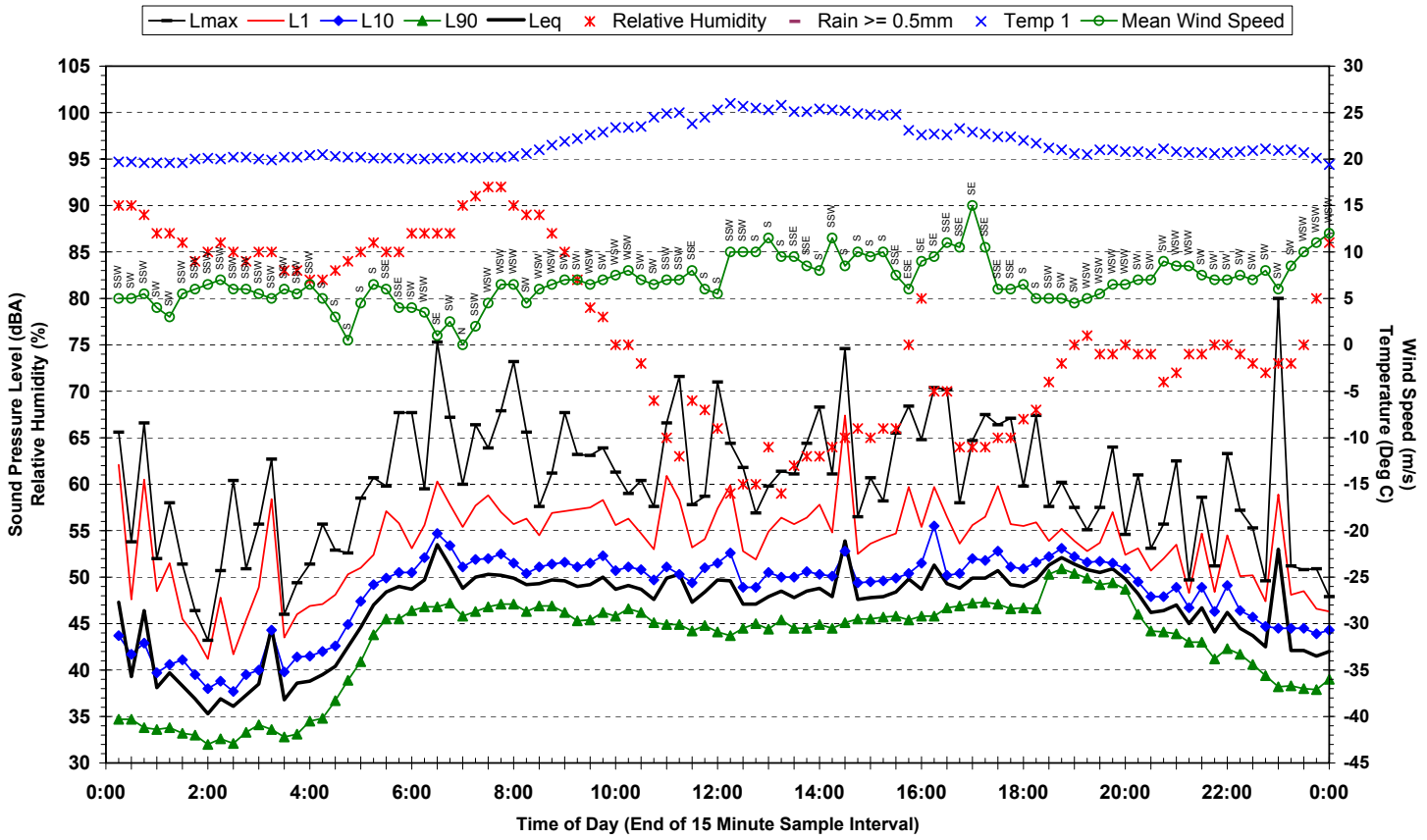

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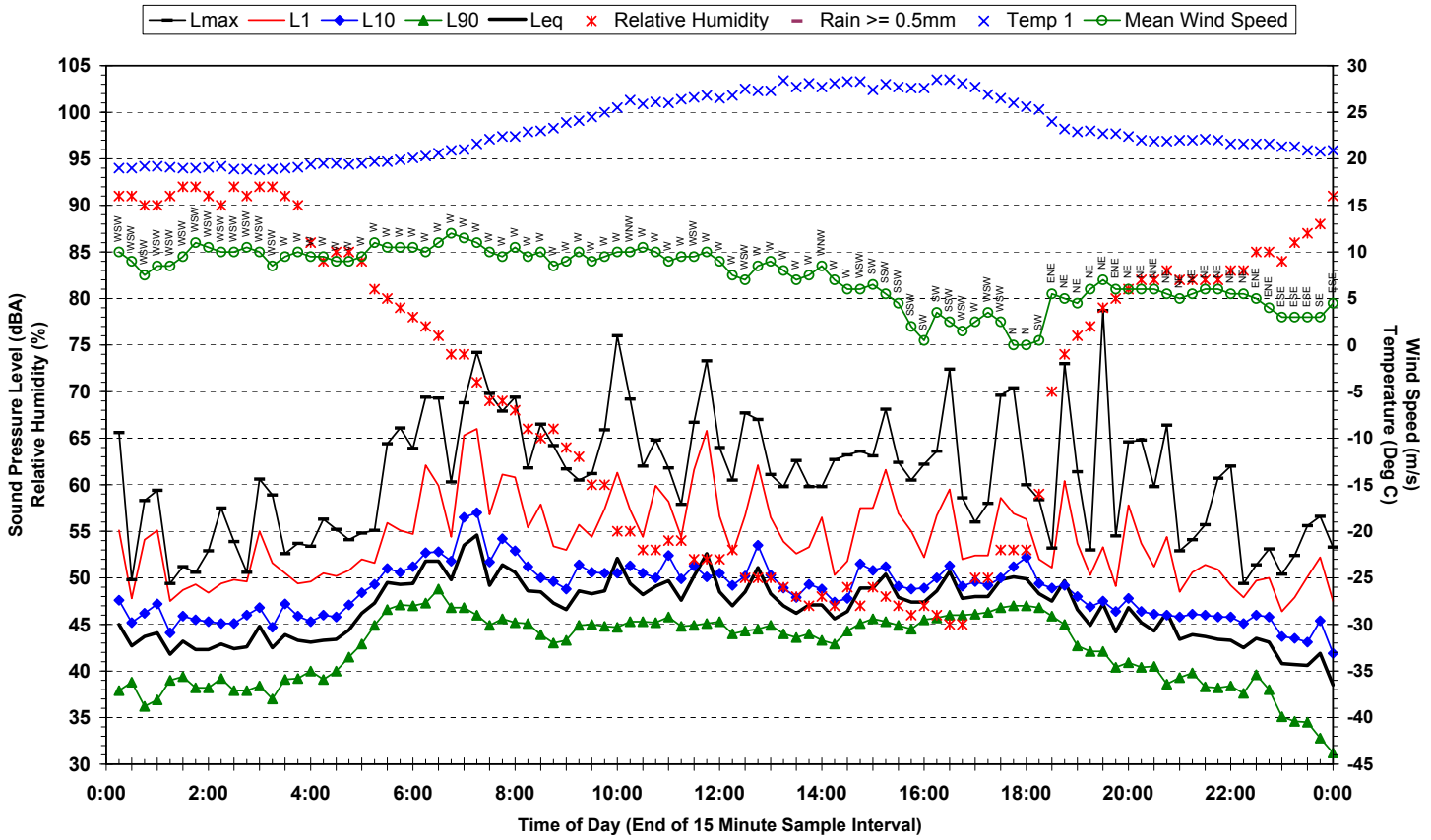

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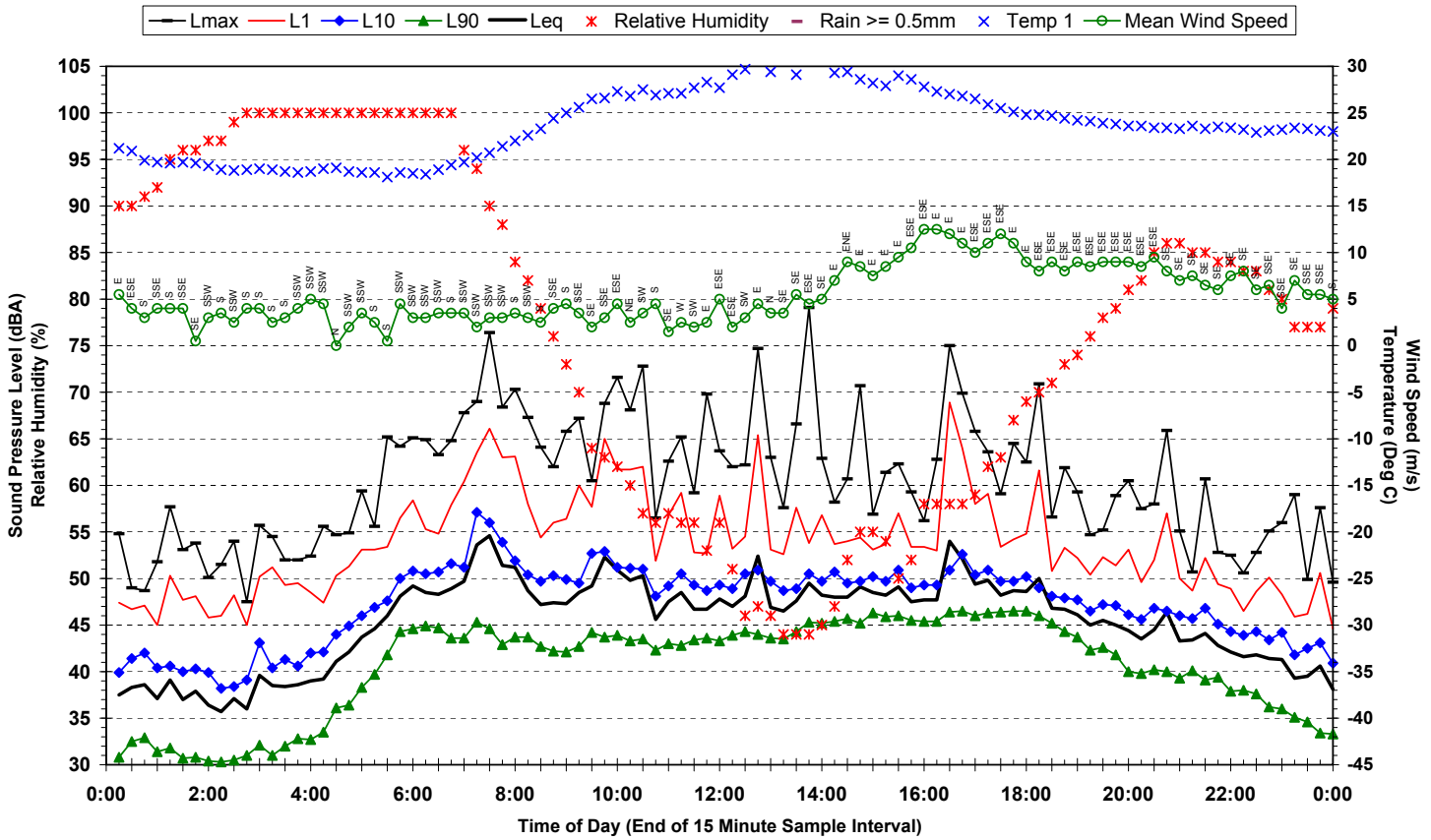

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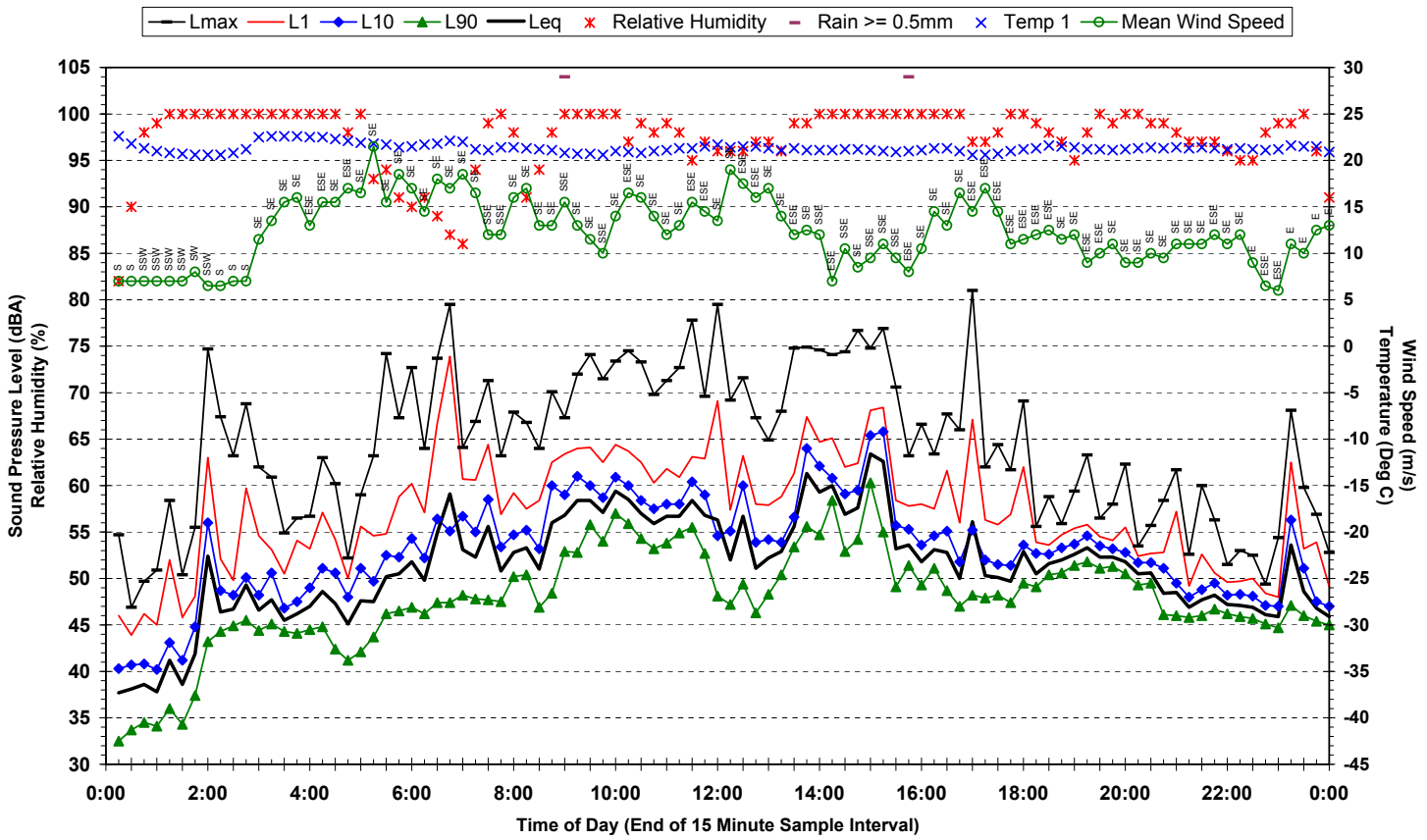

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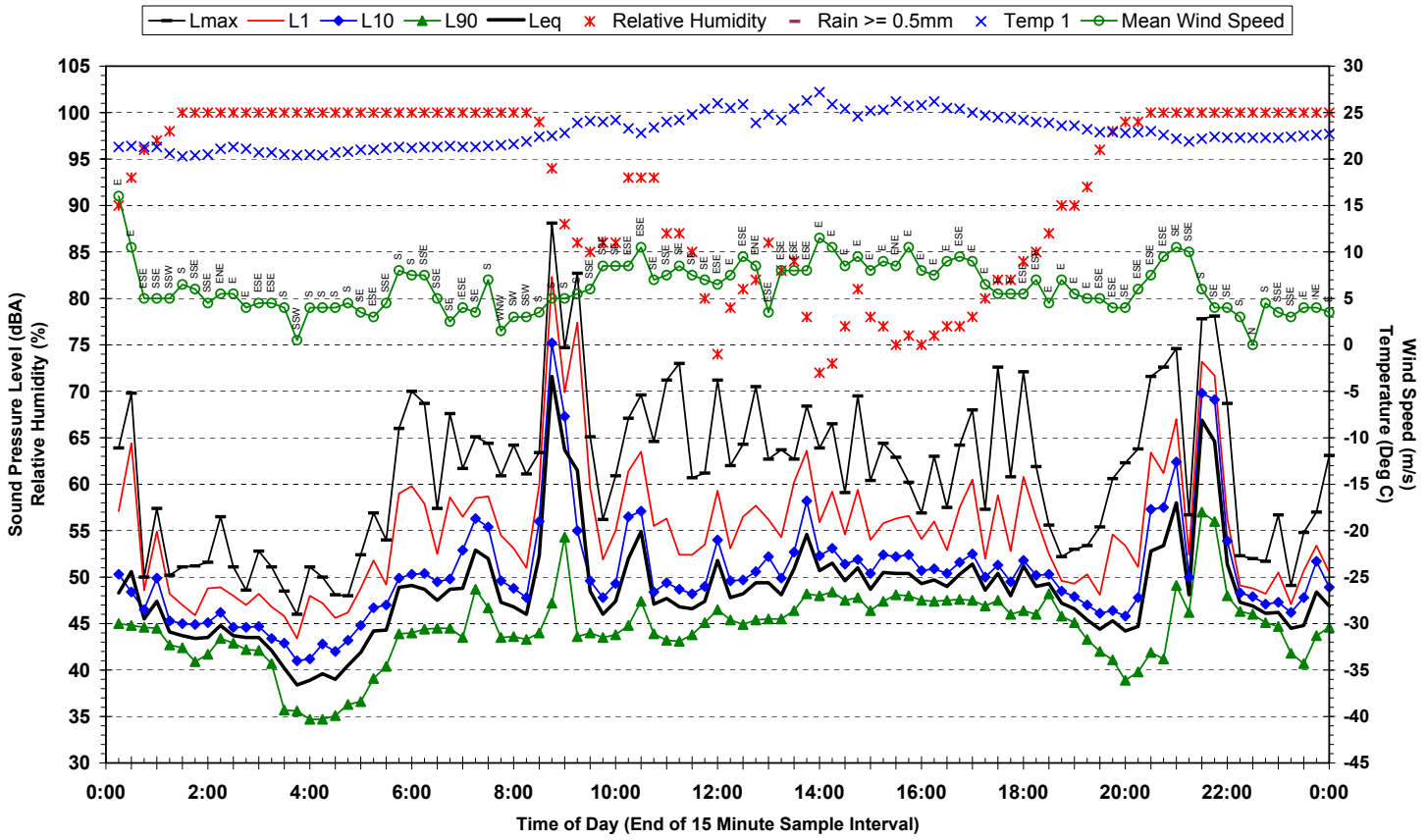

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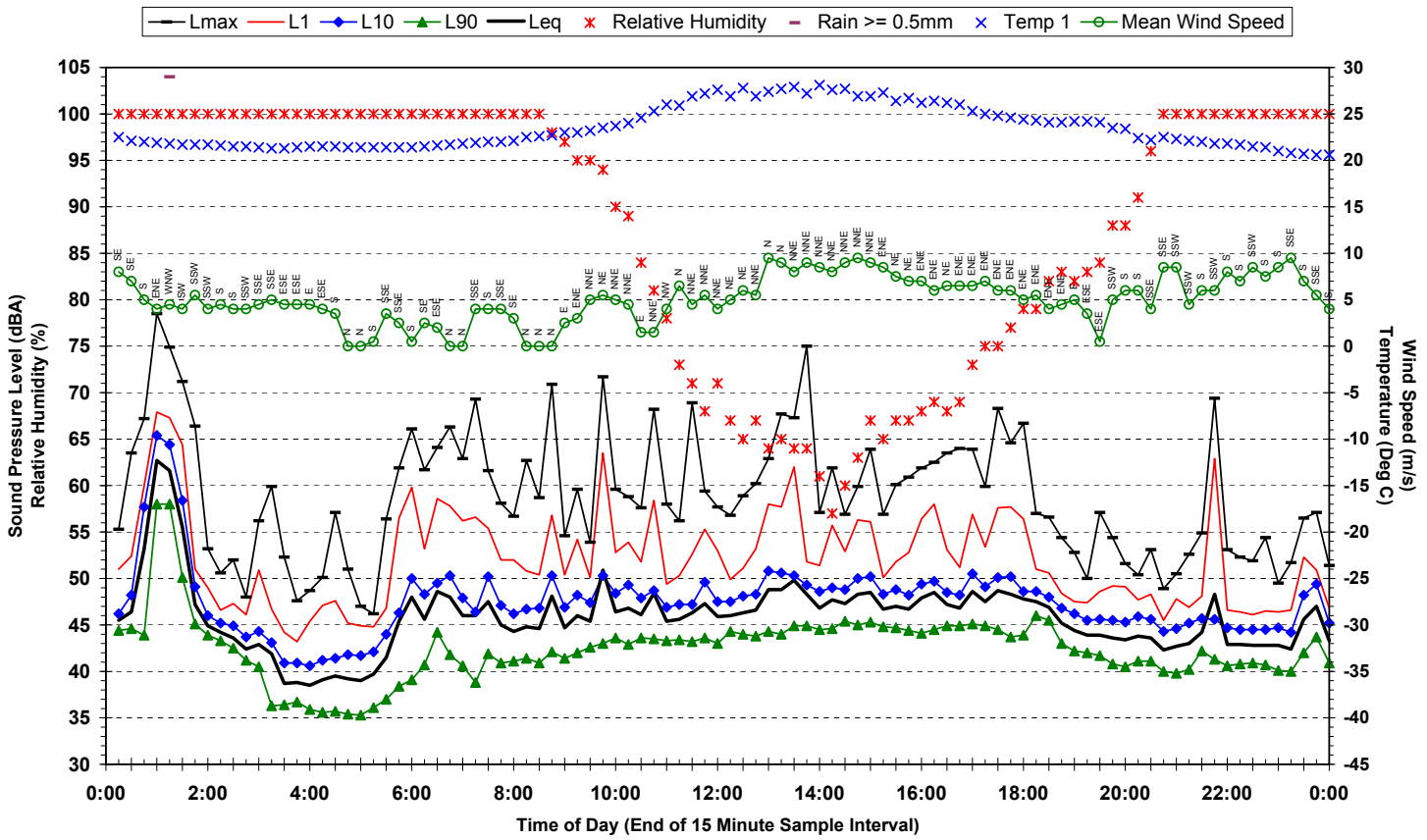

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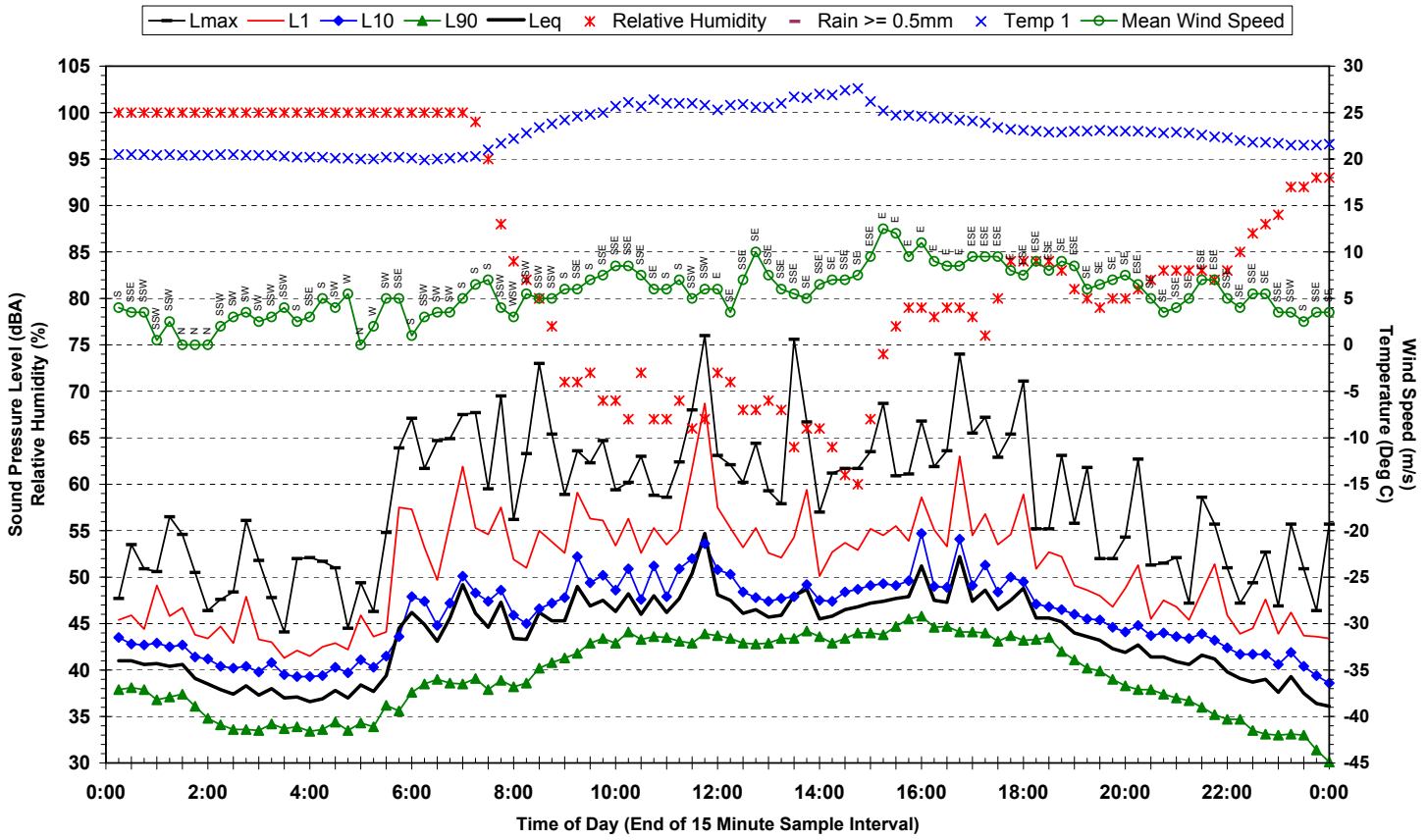

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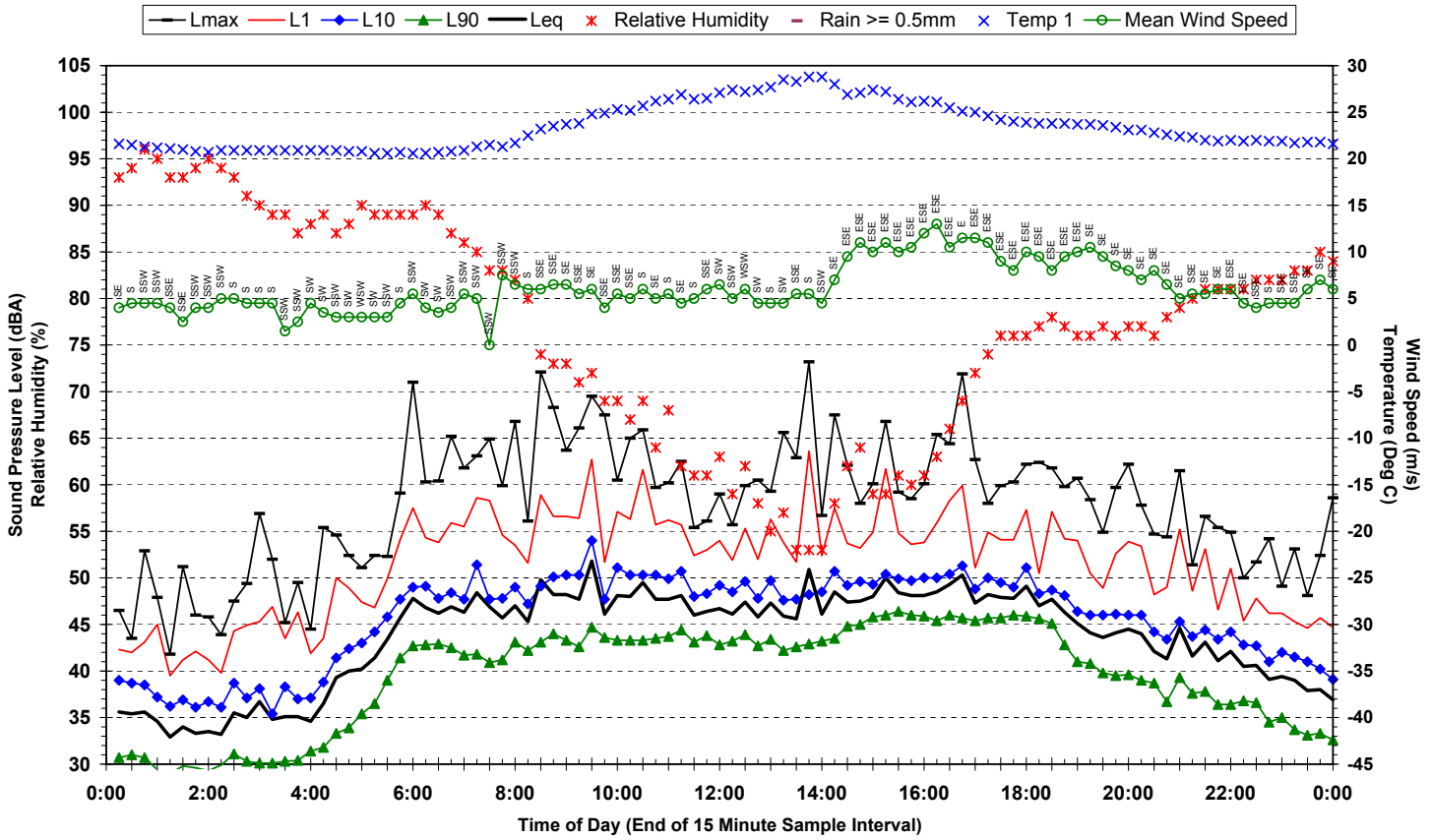

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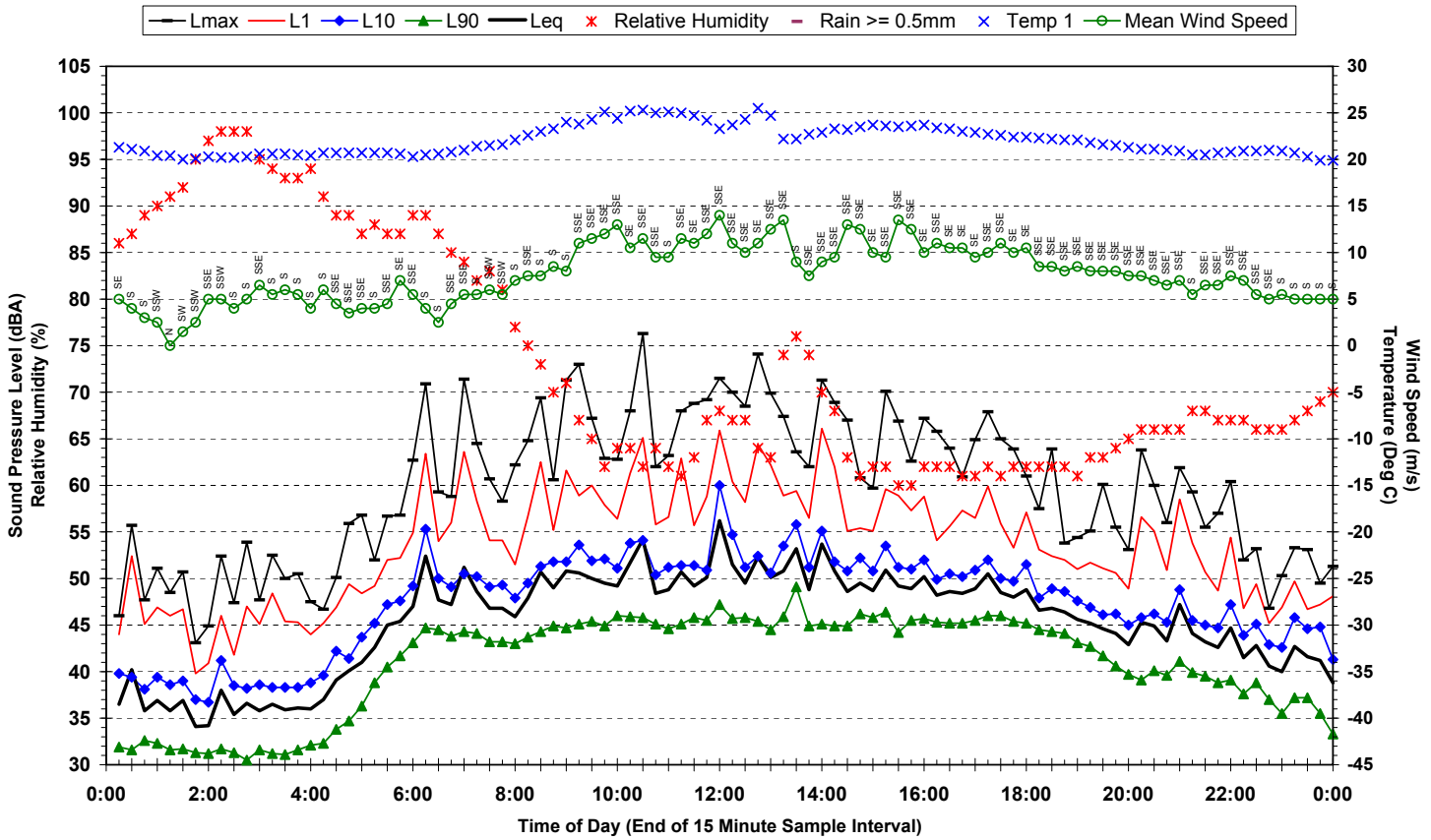

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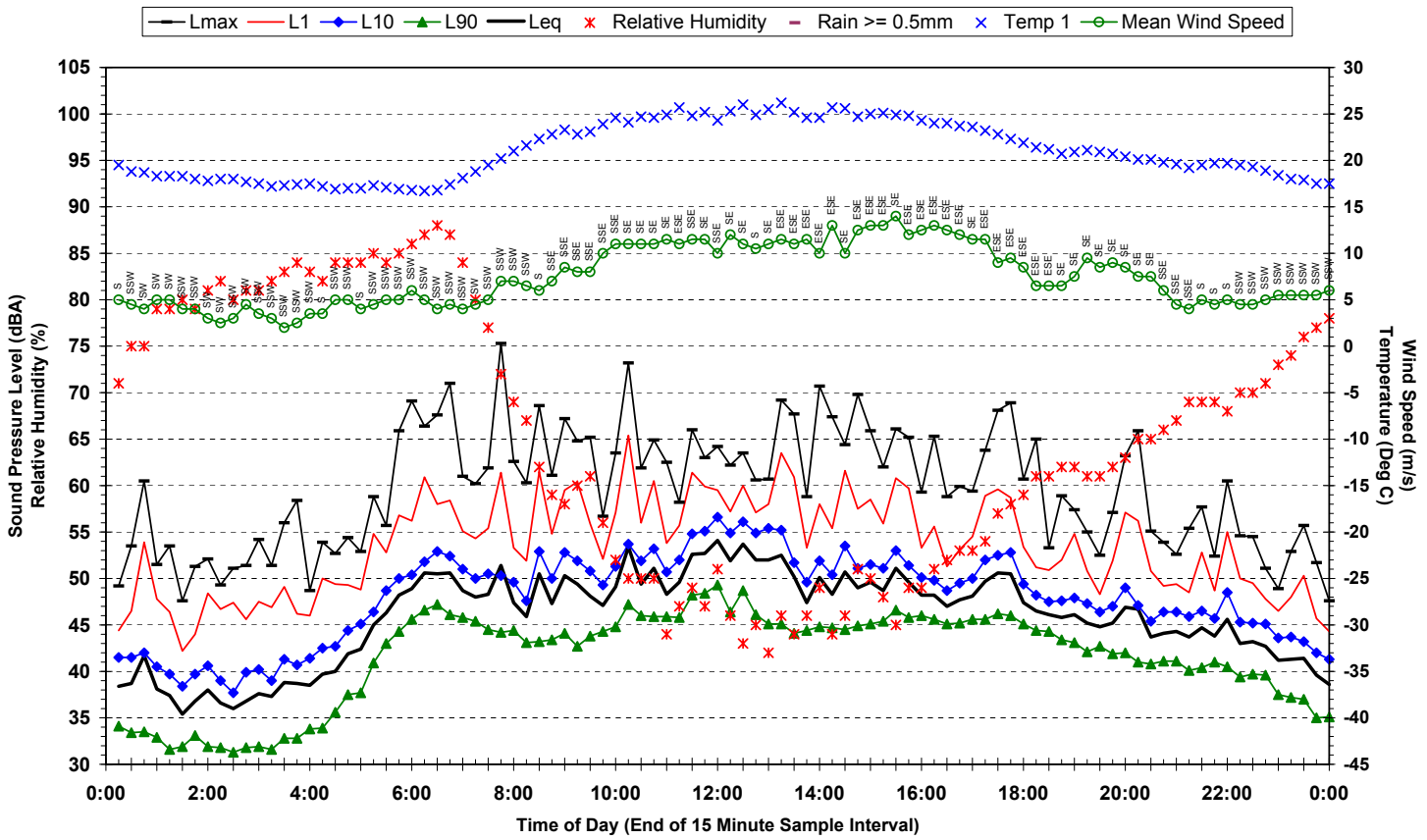

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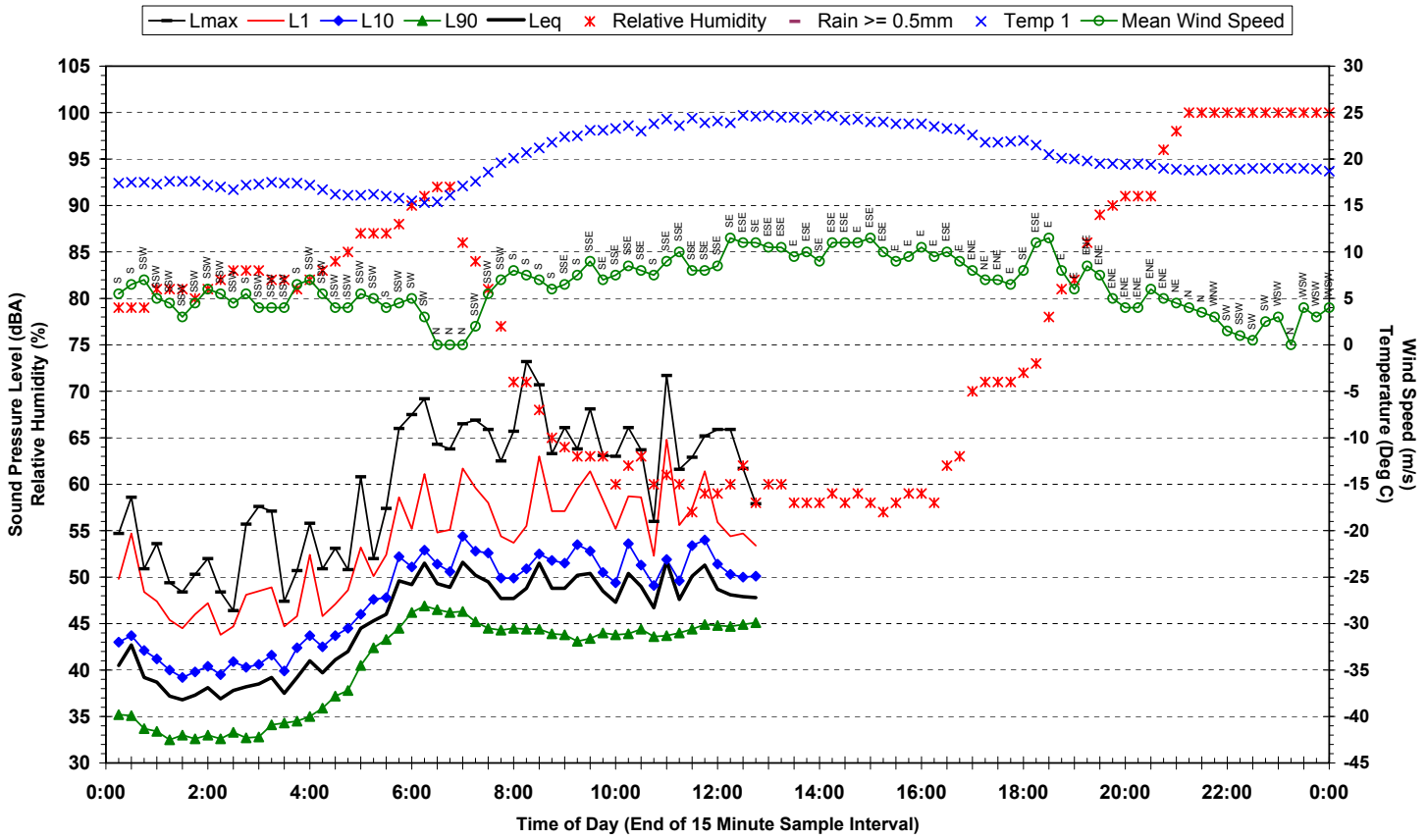

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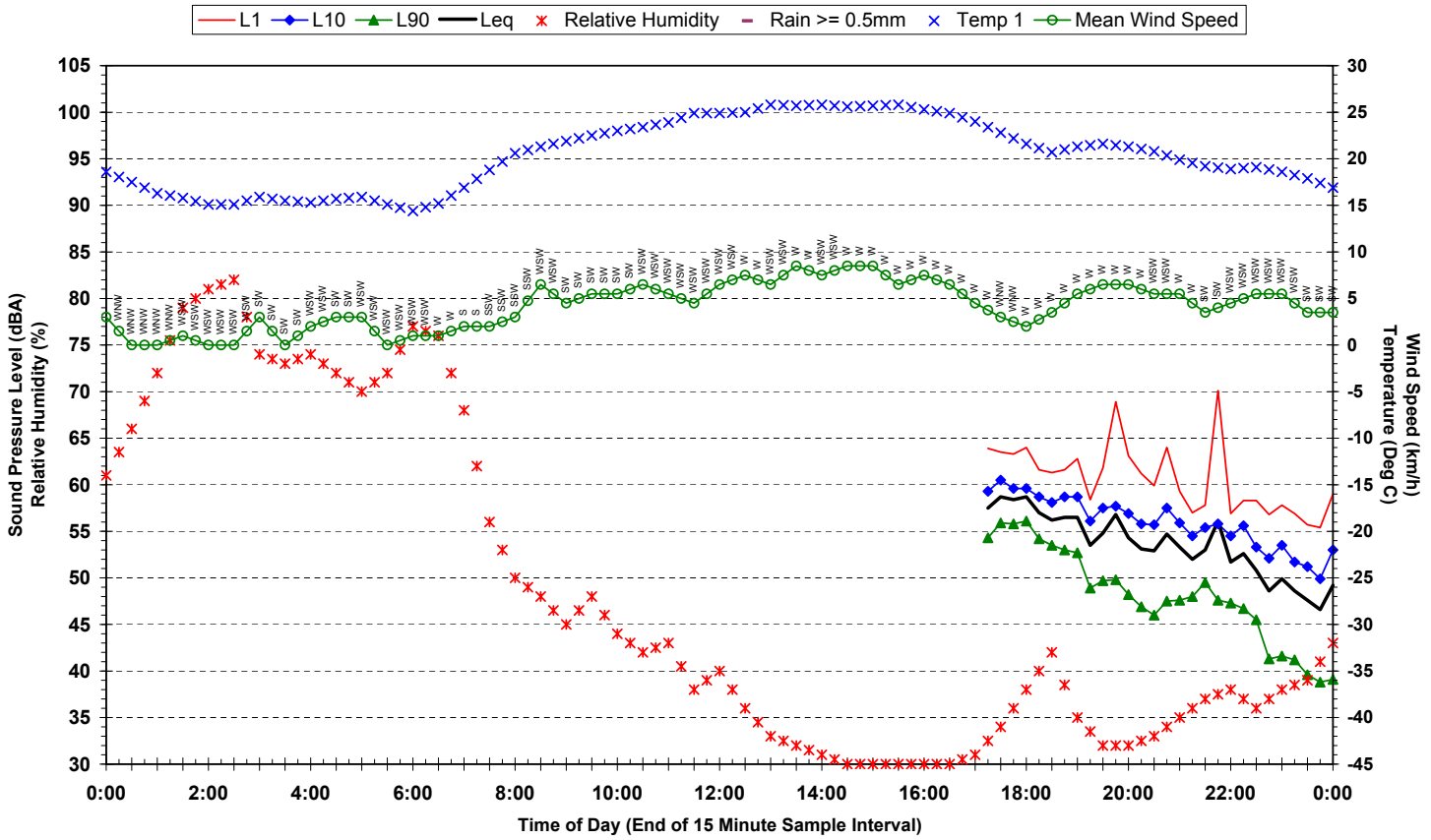

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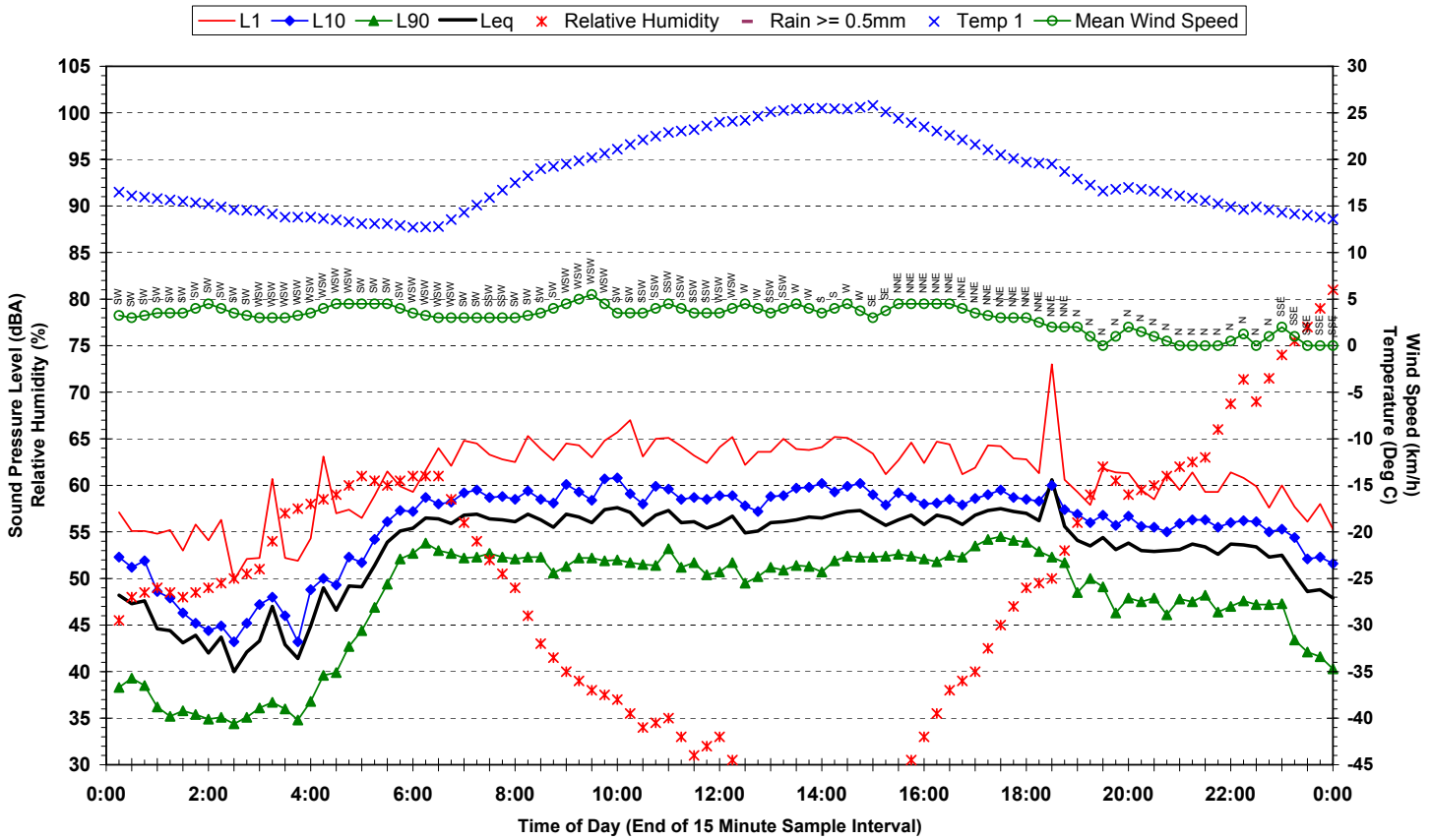

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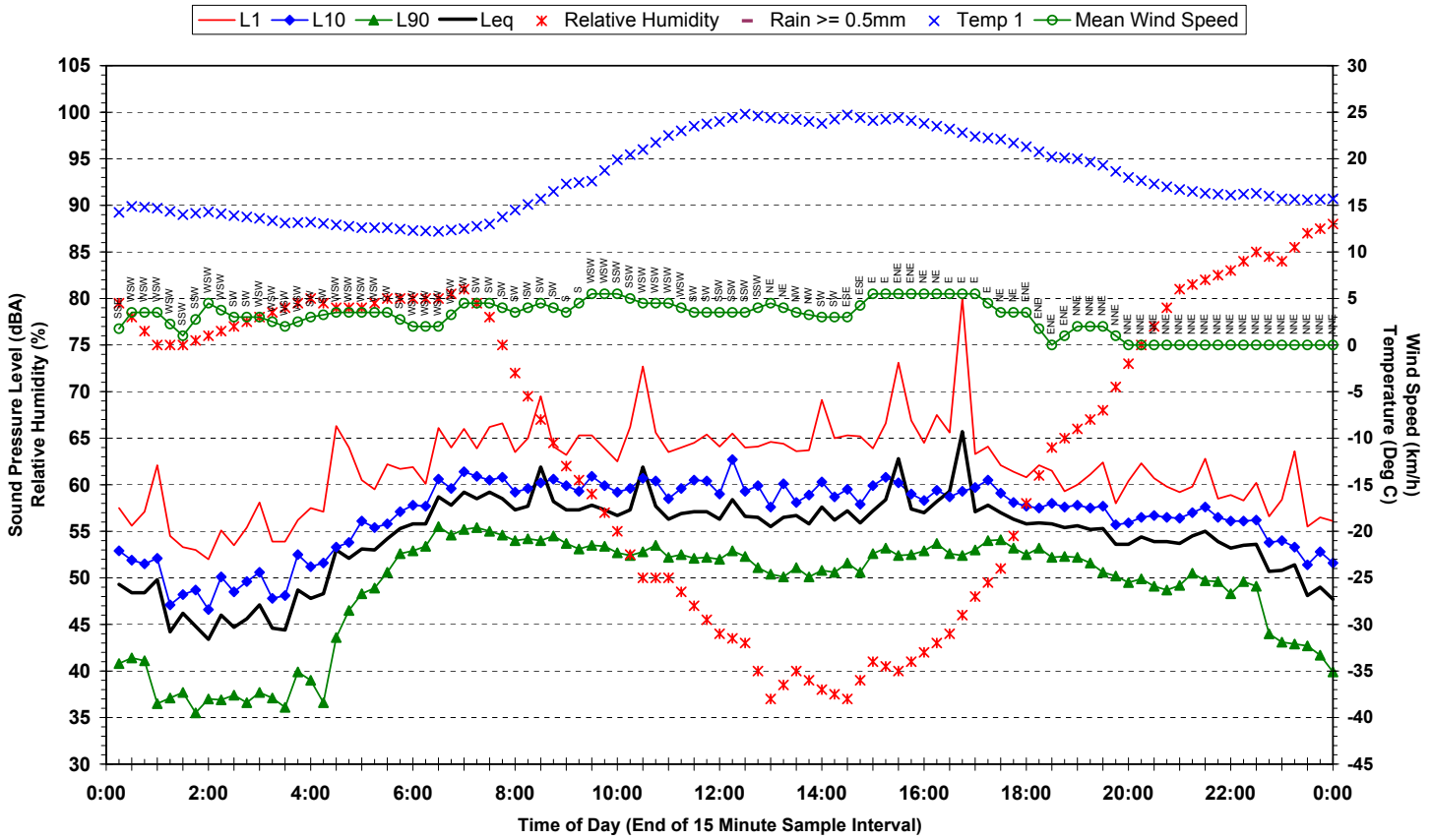

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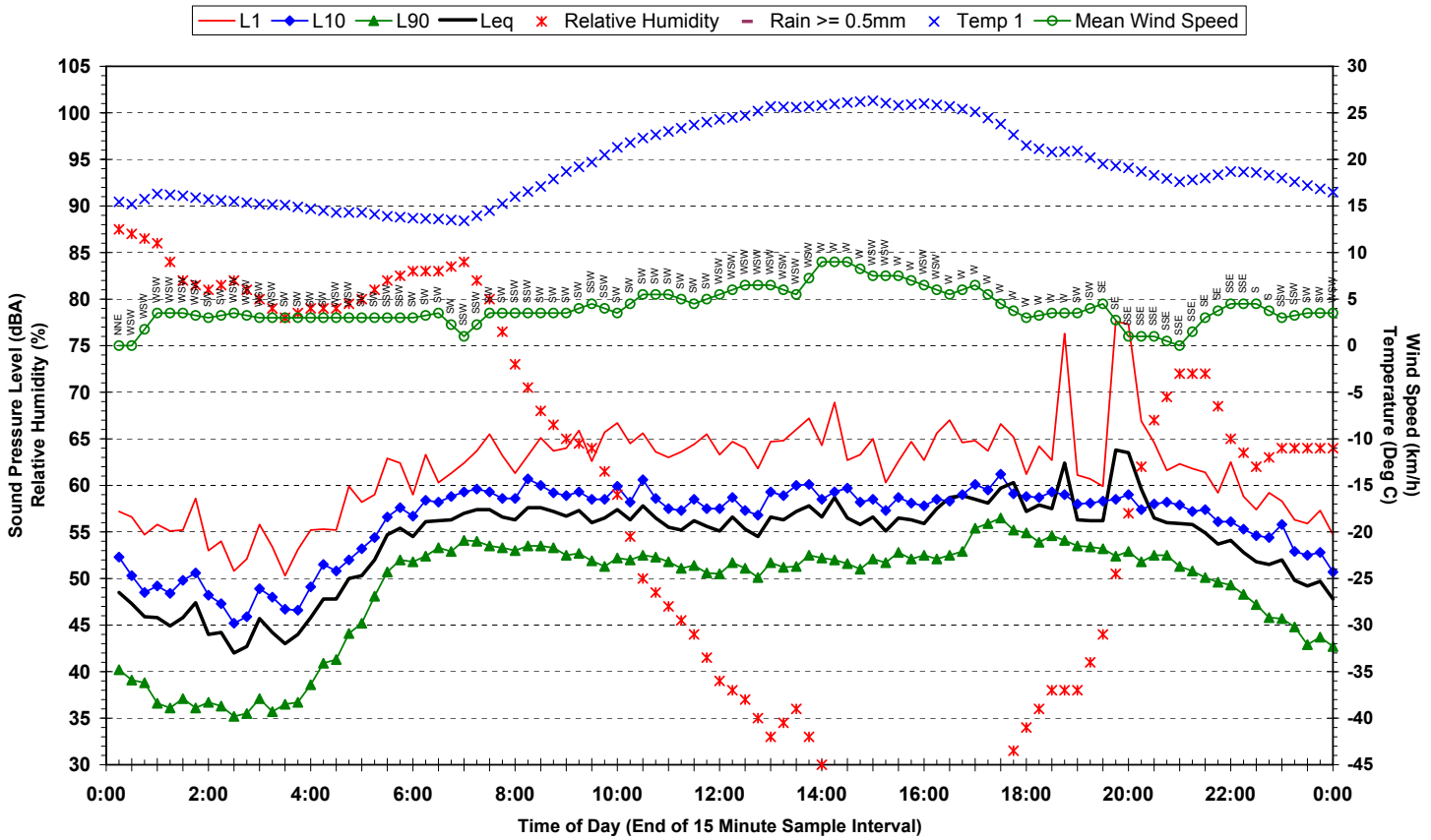

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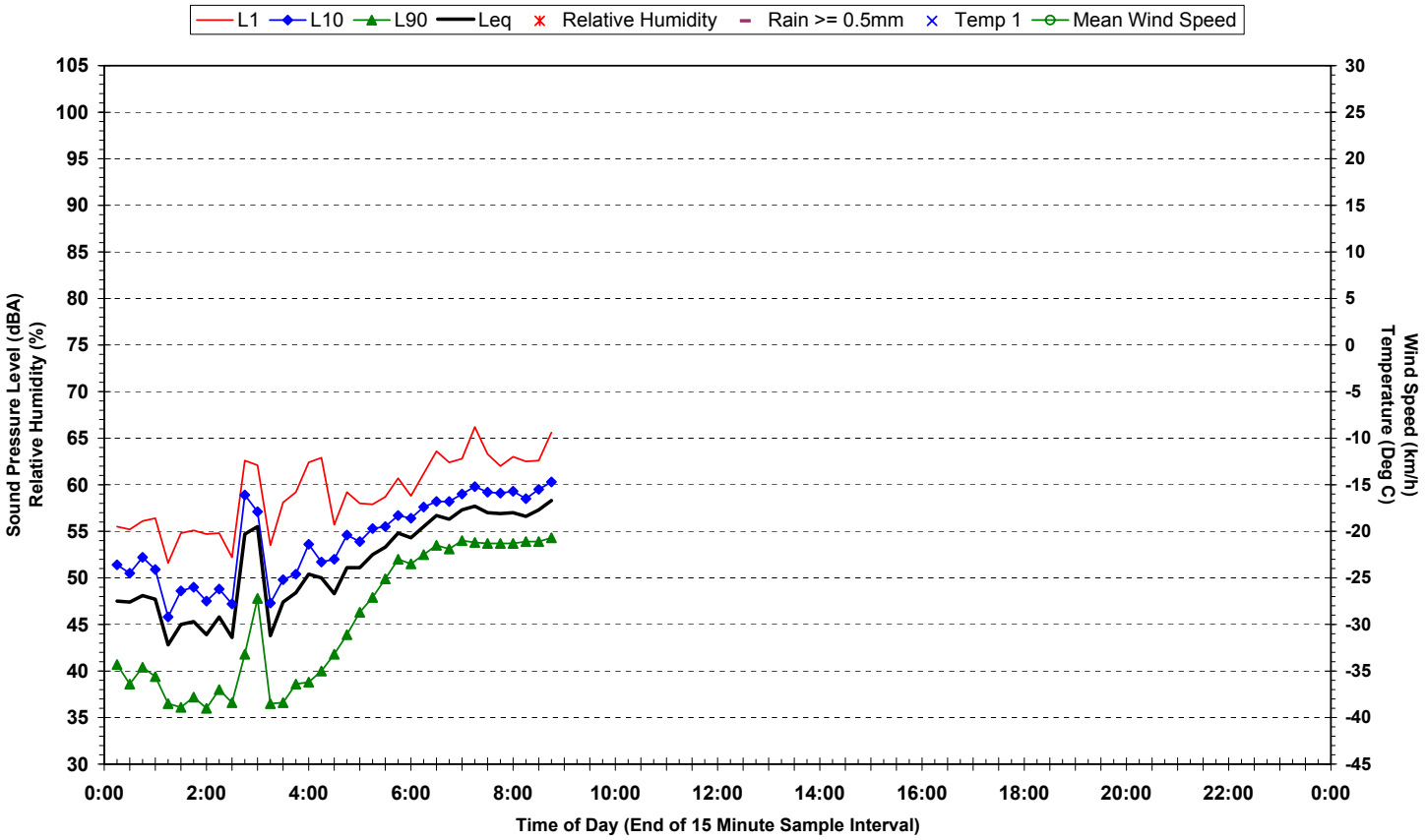

HEGGIES

16 March 2009

20-1854 SuppEIS LR 20090518.doc

SKM-CW JV
433 Boundary St
Spring Hill Qld 4004

Supplementary Noise and Vibration Report for the Northern Link Project (without local connections)

1 Introduction

Heggies has undertaken a study to identify changes to the noise and vibration impacts documented in the Northern Link EIS for the EIS Reference Project without the local connections in Toowong and at Kelvin Grove Road. The EIS Reference Project without these local connections is referred to as the Project.

Heggies' analysis is based on revised traffic data for the Project contained within Chapter 4 *Traffic and Transport* of the Northern Link Supplementary Report. No revised 3D design information has been received or assessed for the Project.

The following sections summarise the expected changes to the noise and vibration impacts.

2 Construction Noise and Vibration

No revised information regarding construction surface works activities has been provided. However, for the Project the construction sites and surfaces works associated with the Toowong and Kelvin Grove connections would not be required. Therefore, all noise and vibration impacts contained in the EIS associated with these construction sites/surface works would no longer occur. This would have greatest benefit for those homes directly adjacent both the Toowong and Kelvin Grove worksites.

Furthermore, regenerated noise and vibration from the (roadheader) driven tunnelling associated with these 2 connections would not occur should the connections not be constructed. For the southern section of Frederick St where only roadheader impacts were predicted in the EIS, this impact would be completely removed. At the northern end of Frederick St (and east thereof where the on/off ramp tunnels from the EIS Reference Project begin to run parallel with the mainline tunnels), there would be little change from the impacts in the EIS as the (TBM driven) mainline tunnel predictions were greater than the on/off ramp levels that are now removed.

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Similarly for the Kelvin Grove Rd on/off ramp constructions, for most of the construction (western and middle sections), the dominant regenerated noise and vibration impacts would still exist as the mainline tunnels are being driven by a TBM in this area, which results in higher predictions than for the roadheaders constructing the Kelvin Grove Road connecting ramps. At the most eastern section, where the ramps deviate north of the mainline tunnels, a significant reduction in impact is predicted where the ramps are no longer constructed to Kelvin Grove Rd.

Heggies are informed that with the removal of the Toowong or Kelvin Grove ramps the depth of the mainline tunnels would alter. The mainline tunnels would be able to be deepened, and significant reductions in regenerated noise and vibration would be achieved in the shallowest areas (eg vibration levels would approximately halve if the tunnel depth went from 10m to 15m and there would be a "noticeable" approximately 5 dBA reduction in regenerated noise level over the same increase in depth). At the deeper depths (30m to 50m), there would be minimal changes (for a 5m change in depth) to the predictions contained in the EIS for the mainline tunnels.

Changes in road traffic noise due to spoil haulage have been predicted based on the revised traffic data and the truck movement data contained within the EIS. The revised predictions are shown in **Table 1**.

Table 1 Effect of Construction Truck Movements on Traffic Noise Levels along Spoil Routes

Roadway	Road Section	Change in $L_{A10(18hour)}$ Traffic Noise Level (dBA)	
		EIS Reference Project (with local connections)	The Project (without the local connections)
Mt Coot-tha Rd	Western Fwy to Frederick St	+0.2	0
Western Fwy	West of Mt Coot-tha Rd	+0.1	+0.1
Milton Rd	Gregory St to Croydon St	+0.2	0
Kelvin Grove Rd	ICB to Victoria St	+0.1	0
ICB	Kelvin Grove Rd to Kingsford Smith Dr	+0.4	+0.2
Kingsford Smith Dr	ICB to Gateway Mwy	+0.2	+0.1

The results in **Table 1** indicate that, compared to the EIS Reference Project, construction traffic noise will not change or very negligibly decrease from the reference design levels.

3 Operational Noise and Vibration

The revised traffic data was used to estimate (via spreadsheet calculations) the changes in the predicted Year 2026 road traffic noise levels modelled for the EIS Reference Design as they relate to the two noise barrier options investigated in the EIS, being the "Planning" Level and the "Status-Quo" Level.

3.1 Changes to Planning Level Noise Barriers

For most road segments, the change in the predicted Year 2026 $L_{A10(18hour)}$ noise level was less than ±0.5 dBA. Roads with more significant changes in $L_{A10(18hour)}$ noise levels, based on the revised traffic data, are summarised in **Table 2**.

Table 2 Predicted Change in Absolute Year 2026 $L_{A10(18hour)}$ Noise Levels for the Project Compared to EIS Reference Project.

Road	Road Segment	Change in $L_{A10(18hour)}$ [1]
Western End		
Croydon St	All	-0.7 to -1.6 (-1.2)
Dean St	Wool St to Mt Coot-tha Rd	+1.0
Jephson St	Sylvan Rd to Augustus St	-0.8
Morley St	Gregory St to Darce St	+0.6
Mt Coot-tha Rd	Richer St to Western Fwy	+0.4 to +1.5 (+1.1)
Scenic Dr	Mt Coot-tha Rd to Sir Samuel Griffith Dr	+2.8
Sir Samuel Griffith Dr	All	+1.2 to +1.3 (+1.2)
Sylvan Rd	All	+0.6 to +1.4 (+1.0)
Tunnel off-ramp	To Western Fwy	-0.6
Western Fwy	Near roundabout	+1.2 to +1.5 (+1.3)
Eastern End		
Countess St	All	+1.5
ICB on-ramp	From Kelvin Grove Rd	+1.0
ICB on-ramp	From Musgrave Rd	+1.4
Kelvin Grove Rd	Blamey St to Victoria St	-0.4 to -1.4 (-0.9)
Kelvin Grove Rd	Victoria St to Musk Ave	+0.4 to +0.6 (+0.5)
Kelvin Grove Rd	Ithaca St to Musk Ave (outbound only)	+0.6 to +1.3 (+0.9)
Kelvin Grove Rd	Ithaca St to College Rd	-0.3 to -1.0 (-0.7)
Musgrave Rd	Petrie Tce to Lower Clifton Tce (outbound only)	-0.7 to -1.4 (-1.0)
Musgrave Rd	Exit to Kelvin Grove Rd on-ramp	-0.4 to -4.6 (-2.6)

Note 1 Average change in $L_{A10(18hour)}$ is shown in brackets.

At the western end for the Project, the Planning Level noise barriers recommended in the EIS along Frederick Street, Milton Road and Croydon Street (refer to Appendix H8 of EIS Chapter 9B) would not be required due to the absence of the Toowong connections. For the Western Freeway, the predicted change in noise level is less than 0.5 dBA except near the Mt Coot-tha Road roundabout. Based on the 3D modelling conducted for the EIS Reference Project and this predicted (marginal) increase, all noise sensitive locations adjacent to the Western Freeway are still predicted to comply with Main Roads' 68 dBA $L_{A10(18hour)}$ planning noise level. During detailed design, further noise modelling should be undertaken to ensure compliance with Main Road's 68 dBA $L_{A10(18hr)}$ planning noise level is achieved for the final design.

At the eastern end, only the Planning Noise Level barriers directly adjacent the ICB would be required (refer to Appendix I8 of EIS Chapter 9B). No barriers along Kelvin Grove Road would be required as there would be no road works in this area. The noise barriers designed for the EIS Reference Project adjacent the ICB are:

- already at the maximum considered height (8m) and therefore no increase in height will be required, or
- at a height of 6m where an increase in height in the order of 0.5m is likely to be sufficient to mitigate the marginal increase in predicted noise levels (in the order of 0.5 dBA – which is the cumulative effect of the on-ramps [increase up to 1.4 dBA] and the main ICB through-lanes [increase of less than 0.3 dBA]).

3.2 Changes to 'Status Quo' Noise Barriers

The 'Status Quo' noise barriers consider the difference in predicted Year 2026 $L_{A10(18hour)}$ noise level for the "with Northern Link" and "Do Minimum" or "without Northern Link" scenarios. The changes in 'Status Quo' noise levels from those documented for the EIS Reference Project have been predicted for the Project. For most road segments, the change in the 'Status Quo' noise levels was less than ±0.5 dBA. Roads with more significant changes, based on the revised traffic data, are summarised in **Table 2**.

Table 3 Predicted Change in 'Status Quo' Noise Levels for the Project Compared to EIS Reference Project

Road	Road Segment	Change in $L_{A10(18hour)}$ [1]
Croydon St	Near Sylvan Rd	-1.6
Croydon St	Near Milton Rd	-0.7
Dean St	Wool St to Mt Coot-tha Rd	+1.4
Jephson St	Sylvan Rd to Augustus St	-0.7
Miskin St	Wool St to Mt Coot-tha Rd (northbound)	-1.1
Miskin St	Wool St to Mt Coot-tha Rd (southbound)	+0.9
Mt Coot-tha Rd	Richer St to Western Fwy	+0.8 to +1.8 (+1.1)
Mt Coot-tha Rd	Slip lane to Frederick St and overpass from Frederick St	+0.6
Scenic Dr	Mt Coot-tha Rd to Sir Samuel Griffith Dr	+2.9
Sir Samuel Griffith Dr	All	+1.2 to +1.3 (+1.2)
Sylvan Rd	All	+0.7 to +1.1 (+1.0)
Western Fwy	Near roundabout	+1.0 to +1.7 (+1.4)
Countess St	All	+1.6
Hale St On-ramp	From Musgrave Rd	+0.9
ICB On-ramp	From Musgrave Rd	+2.6
Kelvin Grove Rd	Blamey St to Victoria St	-0.1 to -1.5 (-0.8)
Kelvin Grove Rd	Victoria St to Musk Ave	+0.4 to +0.8 (+0.6)
Kelvin Grove Rd	Ithaca St to Musk Ave (outbound only)	+0.4 to +1.1 (+0.8)
Kelvin Grove Rd	Exit to Hale St (southbound) to Ithaca St (inbound only)	+0.7
Kelvin Grove Rd	Ithaca St to College Rd (inbound only)	-0.8
Kelvin Grove Rd	On-ramp to ICB	+1.3
Musgrave Rd	Hale St on-ramp (southbound) to Lower Clifton Tce (outbound only)	-1.2
Musgrave Rd	Exit to Kelvin Grove Rd on-ramp	-0.3 to -5.3 (-2.2)

Note 1 Average change in $L_{A10(18hour)}$ is shown in brackets.

At the western end, the 'Status Quo' noise barriers recommended in the EIS along Frederick Street, Milton Road and Croydon Street (refer to Appendix H7 of EIS Chapter 9B), would not be required due to the absence of the Toowong connection.

At the eastern end, only the 'Status Quo' Noise Level barriers directly adjacent the ICB would be required (refer to Appendix I7 of EIS Chapter 9B). No barriers along Kelvin Grove Road would be required as there would be no road works in this area. The noise barriers designed for the EIS Reference Project adjacent the ICB are at heights of 5m to 6m where an increase in height in the order of 1m is likely to be sufficient to mitigate the marginal increase in predicted noise levels (in the order of 1 dBA – which is the cumulative effect of the on-ramps [increase up to 2.6 dBA] and the main ICB through-lanes [increase of less than 0.5 dBA]).

4 Road Network Remote from Portal Areas

Based on the revised traffic data, road traffic noise impacts on major roads remote from the portal areas has also been reconsidered.

Table 4 summarises the predicted change in road traffic noise levels due to the Northern Link project for the EIS Reference Project and the Project when compared to the "Do Minimum" scenario.

Table 4 Change in $L_{A10(18hour)}$ Noise Levels on Roads Remote from Portal Areas

	Change in $L_{A10(18hour)}$ Noise Level	
Location	**EIS Reference Project (with the local connections)**	**The Project (without the local connections**
Roads in Vicinity of Western Portal		
Western Fwy (Between Mount Coot-tha Rd and Moggill Rd)	+1.2	+1.2
Western Fwy (Between Moggill Rd off-ramps)	+1.0	+0.8
Mount Coot-tha Rd (Between Western Fwy and Frederick St)	-0.9	-0.8
Mount Coot-tha Rd (North of Western Fwy)	-2.0	-0.9
Frederick St	-0.8	-0.5
Milton Rd (Between Croydon St and Dixon St)	-0.4	-0.3
Milton Rd (Between Eagle Tce and Grimes St)	-0.4	-0.2
Coronation Drive (Between Park Rd and Lang Pde)	-0.9	-0.7
Roads in Vicinity of Eastern Portal		
Hale St (South of Caxton St)	-0.1	-0.1
Musgrave Rd (West of ICB)	-0.2	-0.1
College Rd	+0.2	-0.1
Kelvin Grove Rd (North of Victoria St)	+0.6	-0.1
ICB (Between Kelvin Grove Rd and Bowen Bridge Rd)	+0.8	+1.1

The results in **Table 4** show that the expected changes in the traffic noise as a result of the the Project are considered to be minor and would not be generally noticeable from those documented in the EIS for the Reference Project.

* * *

Kind regards

Shane Elkin
Director

SUPPLEMENTARY REPORT

AIR QUALITY ASSESSMENT: BRISBANE NORTHERN LINK FURTHER OPTIONS

SKM/Connell Wagner Joint Venture

Job No: 2959

22 May 2009

PROJECT TITLE:	**AIR QUALITY ASSESSMENT: BRISBANE NORTHERN LINK FURTHER OPTIONS**
JOB NUMBER:	**2959**
PREPARED FOR:	Peter Zahnleiter **SKM/CONNELL WAGNER JOINT VENTURE**
PREPARED BY:	Kerry Holmes
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1 INTRODUCTION

This report has been prepared by PAEHolmes (formerly Holmes Air Sciences) for the Sinclair Knight/Connell Wagner Joint Venture (SKM-CW JV). The purpose of the report is to identify any air quality impacts of the proposed changes to the Northern Link (NL) project compared to those documented in the EIS.

Holmes Air Sciences (2008) undertook an Air Quality Impact Assessment (AQIA) for the Northern Link EIS Reference Project based on traffic numbers supplied by SKM. The traffic numbers are used to estimate vehicle emissions which in turn are used to predict concentrations of pollutants in the ambient air near the roadways.

The proposed project included a tunnel with connections at Toowong and Kelvin Grove. This will be referred to in this report as the EIS Reference Project. This supplementary report considers the effect of the removal of the local connections at Toowong and Kelvin Grove and this will be considered in this report as the Project.

The traffic numbers for the "no build" case have been updated since the EIS for both the EIS Reference Project and the Project. The base future road networks have been updated to incorporate contemporary descriptions of key future projects, which date from after the EIS modelling was undertaken. Such projects include:

- Hale Street Link (HSL) – July 2008 Changed Project including Coronation Drive viaduct and right turn from Hale Street to Coronation Drive outbound;
- Coronation Drive – removal of tidal flow operation (as at October 2008) resulting in three traffic lanes inbound and two traffic lanes outbound;
- Airport Link – BrisConnections Conforming Design as per the Airport Link Request for Project Change (May 2008);
- Airport Roundabout Upgrade (ARU) – BrisConnections design including Fast Diamond interchange;
- Ipswich Motorway Upgrade – based on public information from DMR (2008); and
- BCC Road Action Plan updates and updating of the expected timing of future network projects consistent with Council's programs.

This supplementary report provides a review of changes in the modelled traffic numbers to determine if there are any significant implications for the Project in terms of emissions and hence air quality and subsequent health risks. The health risk assessment for the EIS Reference Project focused on the change in air quality rather than the absolute values, all of which showed compliance with air quality goals. Therefore this assessment also focuses on changes in air quality.

The EIS AQIA adopted a "worst-case" approach and focused on roads where there was an increase in traffic for the "build" case. This report examines the potential for a scenario where there is a greater change in air pollution levels than was assessed in the EIS.

2 TRAFFIC DATA

As noted above SKM have generated traffic information for the project as follows:

- Annualised Average Daily Traffic (AADT) for years 2014 and 2026;
- Scenarios "No NL" (equivalent to "without NL" in the EIS), "EIS Reference Project" (equivalent to "with NL" in the EIS), "the Project" (equivalent to the EIS Reference Project without the local connections at Toowong and Kelvin Grove Road), from the updated traffic model.

The modelled AADT data provided by SKM have been reviewed and the changes summarised in the tables below which present differences between the old and new sets of modelled traffic data for the no build case and the build case.

As stated above, base future road networks and associated traffic numbers for the "no build" or the base case without the Northern Link project have been updated since the EIS for both the EIS Reference Project and the Project. The first step in this report has been to compare the new traffic data with the EIS traffic data.

For the no build case, the EIS Reference Project data is referred to as "without NL" and for the new data the no build case is referred to as "No NL". For the build case the EIS Reference Project data is referred to as "with NL" and the new traffic data is referred to as "NL". Throughout the Report, NL refers to the EIS Reference Project with the local connections.

The corresponding scenarios for the EIS data and the new traffic data were compared and changes of more than 4000 AADT or 10% total traffic have been treated as significant. The differences for "significant" cases are summarised in Table 1.

The difference between the build and the no build cases for the EIS Reference Project are summarised in Table 2.

Table 1 Significant differences between EIS and new traffic data

Road Section	AADT Total difference	Percentage difference
Year modelled – 2014	"No NL" vs "without NL"	
Stewart Road	-8830	-16.5
Lewisham Street	-4390	-25.4
	"NL" vs "with NL"	
Lewisham Street	-3350	-20.8
Coronation Drive (east of Park Road)	-7320	-10.7
Year Modelled – 2026	""No NL" vs "without NL"	
Given Terrace	2270	16.2
Simpson Road	5720	64.8
Mount Coot-tha Road	3660	24.5
Coronation Drive (east of Park Road)	-11130	-12.6
Lewisham Drive	-5870	-30.6
Montague Road	3550	29.2
	"NL" vs "with NL"	
Given Terrace	2100	14.5
Mount Coot-tha Road	-2200	-14.7
Coronation Drive (east of Park Road)	-7650	-10.9
Lewisham Street	-4660	-26.2
Kingsford Smith Drive (west of Crescent Road)	8070	13.6
Sir Fred Schonnel Drive	2640	14.8

Note – Positive values indicate an increase in traffic numbers for the current model over the previous model.

Table 2 Differences between build and no build for EIS and updated traffic data

Road Section	EIS traffic data	Updated traffic data	Absolute difference
2014	"with NL" vs "Without NL"	NL vs No NL	Updated vs EIS
Stewart Road	-13510	-3770	9740
Coronation Drive (east of Park Road)	-4420	-10330	-5910
2026			
Kingsford Smith Drive (west of Crescent Road)	-6840	110	6730
Simpson Road	1420	-4380	-2960
Mount Coot-tha Road	20	-5840	-5820

Most of the trends are for less traffic with the updated model and less change between the build and no build cases.

There are no absolute increases in total traffic for the "NL" (EIS Reference Project) compared to the No NL case greater than those assessed in the EIS. Therefore on the basis of the new traffic data, "worst-case" air quality impacts of the EIS Reference Project option remain as presented in the EIS.

The traffic numbers in the tunnel were less than those predicted in the EIS and hence the predicted "worst-case" impact of emission from the ventilation outlets also remain as presented in the EIS.

The next step in the review has been to consider the differences between the EIS Reference Project and the Project (that is without the local connections) using the current modelling data.

These are summarised in **Table 3**.

Table 3 Comparison of project options - differences in AADT

Road Section	EIS Reference Project vs no NL	Project vs No NL	Project vs EIS Reference Project	EIS "with NL" vs "Without NL"
2014				
Kelvin Grove Road (north of Herston Road)	5310	1580	-3550	3780
Inner City Bypass (east of Kelvin Grove Road)	14490	19730	5240	16900
Hale Street	-2600	-5200	-2600	-2580
Mount Coot-tha Road	-7710	-3750	3960	-7430
Milton Road (west of Torwood Road)	-8150	-2870	5280	-6660
Western Freeway (South of Mount Coot-tha Road)	21840	21100	-740	22830
2026				
Kelvin Grove Road (north of Herston Road)	5050	240	-4810	5310
Inner City Bypass (east of Kelvin Grove Road)	23360	33380	10020	24540
Countess Street	-1680	-2150	-470	-3100
Simpson Road	-4380	-1810	2570	-3970
Mount Coot-tha Road	-5840	-900	4940	20
Western Freeway (South of Mount Coot-tha Road)	31310	30090	-1220	30540

AADT values provided in Column 2 are the differences between the EIS Reference Project and the No NL totals. The values in Column 3 are the differences between the Project and the No NL totals. Positive values indicate that the respective scenario will cause an increase in traffic on that road section, negative values indicate a decrease.

The next column compares the EIS Reference Project with the Project. Positive numbers mean that the Project would have a greater impact that the EIS Reference Project and negative numbers mean a lesser impact.

The final column presents the difference between the EIS traffic predictions for the with NL and without NL cases.

There are four significant changes.

- The decrease in traffic on Milton Road for the Project case is less than the decrease in traffic for the EIS Reference Project case.
- The decrease in traffic on Mt Coot-tha Road for the Project is less than the decrease in traffic for the EIS Reference Project case.
- The increase in traffic on the ICB for the Project case is more than the increase in traffic for the EIS Reference Project case.
- The increase in traffic on Western Freeway for the Project case is less than the increase in traffic for the EIS Reference Project case.

If we compare the numbers in Column 3, the Project vs the no NL case with Column 5, the equivalent EIS comparisons, we can see that there is still a benefit for Milton Road and Mt Coot-tha Road in 2014, although it is not as great as that predicted in the EIS. By 2026, the benefit to Mt Coot-tha Road is very marginal and in the EIS there was no benefit predicted.

For the ICB, there is a predicted greater increase in traffic in 2014 and 2026 for the Project case that is significantly more than that predicted in the EIS for the NL case.

The difference in 2026 is greater than any other traffic difference presented in the EIS and this road has therefore been remodelled using the roadway model Cal3qhcr.

3 IMPACT ASSESSMENT AND CONCLUSIONS

Predicted maximum roadside concentrations for the ICB east of Kelvin Grove Road in 2026 are summarised in Table 4.

Concentrations of carbon monoxide (CO), nitrogen dioxide (NO_2), particulate matter less than 10 micrometres in diameter (PM_{10}) have been predicted at kerbside and at 10, 30 and 50 metres from the kerb as done for the EIS.

Table 4 Predicted roadside concentrations adjacent to ICB east of Kevin Grove Road 2026

Distance from kerb	8-hour CO (mg/m³)		1-hour NO_2 (µg/m³)		Annual NO_2 (µg/m³)		24-hour PM_{10} (µg/m³)		Annual PM_{10} (µg/m³)	
	No NL	Project	No NL	Project	No NL	Project	No NL	Project	No NL	Project
W_50m	0.19	0.25	15.6	20.4	4.2	5.2	1.4	1.8	0.5	0.7
W_30m	0.25	0.33	20.9	27.3	5.8	7.2	1.9	2.4	0.7	0.9
W_10m	0.44	0.57	26.0	34.1	10.1	12.6	3.1	4.0	1.2	1.6
W_Kerb	0.80	1.06	34.6	41.6	19.6	24.6	5.2	6.9	2.4	3.1
E_Kerb	0.87	1.11	36.5	46.9	17.6	21.7	5.8	7.4	2.1	2.7
E_10m	0.45	0.57	28.2	36.5	8.2	10.3	3.0	3.9	1.0	1.3
E_30m	0.26	0.34	21.7	28.1	4.6	5.8	1.7	2.3	0.5	0.7
E_50m	0.20	0.26	15.6	20.2	3.3	4.2	1.3	1.6	0.4	0.5

Table 5 compares the difference between the Project and no NL case at 10 metres from the ICB (where the difference is greatest) with the equivalent predictions in the EIS and with maximum difference anywhere along the route assessed in the EIS in terms of health risk. This was the section of the Western Freeway South of Mt Coot-tha Road in 2016, 2021. For the Project option, the maximum difference is next to the ICB in 2026.

The differences in pollutant levels between the Project and No NL options decrease with distance from the road and at greater than 50 metres the differences will be barely discernible. The assessment has therefore focused on the impacts at 10 metres from the road. In reality no-one is living this close to the Freeway or the ICB; however this distance was used in the EIS HRA to provide an extreme worst-case.

Table 5 Predicted maximum differences in concentration at 10 metres from the ICB kerb for the updated traffic data and for the EIS Reference Project

	8-hour CO (mg/m³)	1-hour NO_2 (µg/m³)	Annual NO_2 (µg/m³)	24-hour PM_{10} (µg/m³)	Annual PM_{10} (µg/m³)
Project vs no NL (2026) next to ICB	0.13	8.3	2.5	1.0	0.4

NL vs no NL (EIS) next to ICB	0.1	6.1	1.7	0.7	0.3
NL vs no NL (2016,2021 Western Freeway EIS used for HRA)	0.3	11.74	7.50	2.26	0.83

The differences in pollutant levels at 10 metres from the ICB for the Project compared to the no NL are all greater than the levels predicted in the EIS for that section of the route. However they are less than the levels predicted in the EIS close to the Western Freeway used for the worst-case HRA assessment.

The comparisons are complicated by the decrease in individual vehicle emission rates between 2016 and 2026. Thus although the 2016 EIS traffic number increases on the Western Freeway were less than those now predicted in 2026 on the ICB, the emissions per vehicle were greater in 2016 and consequently the predicted impacts are greater.

For example, the predicted increase in maximum 1-hour NO_2 at 10 metres from the ICB is 8.3 $\mu g/m^3$ for the Project in 2026. This is less than the predicted maximum increase of 11.74 $\mu g/m^3$ assessed for health risk effects in the EIS for the Reference Project in 2016 at a distance of 10 metres from the Western Freeway south of Mt Coot-tha Road.

In summary, while there will be differences in the traffic distributions with the Project, the "worst-case" health impacts would be no greater than those identified in the EIS for the Reference Project.

Brisbane City Council
Northern Link
Supplementary Cost Benefit Analysis Modelling

- 4 June 2009
- Reference 24531-023
- Revision E

Contents

1. Introduction

1.1 Background

Supplementary Cost Benefit Analysis (CBA) modelling was updated for both the Northern Link EIS Reference Project and the Project without the local connections at Toowong and Kelvin Grove Road as described in **Table 1** below:

- **Table 1 Northern Link project scenarios**

Project scenarios	Design description
1. The EIS Reference Project (with the local connections)	The EIS Reference Project with local connections to Toowong and Kelvin Grove Road based on updated traffic network inputs into the Northern Link Traffic Model.
2. The Project (without the local connections)	The Project without the local connections to Toowong and Kelvin Grove Road based on updated traffic network inputs into the Northern Link Traffic Model. The Project also assumed the same horizontal alignments for the mainline tunnels as the EIS Reference Project but with some increased depth to the the vertical alignment from the mid point sag, east to the ICB connection..

The CBA Model provides investment results to assess economic viability in terms of travel time-savings, vehicle operating costs savings, road safety savings, environmental and externality benefits. The economic viability can be quantified in terms of investment criteria as described in **Table 2**.

- **Table 2 CBA investment criteria**

Investment Criteria	Description
Net Present Value (NPV)	Calculation of the net discounted value (i.e. present value of benefits minus present value of costs) over the assessment period. A positive NPV indicates that the project is economically justified under the set of assumptions in the CBA.
Benefit Cost Ratio (BCR)	Ratio of the total present value of benefits over the present value of costs. BCR greater than 1.0 indicates that the project is economically justified under the set of assumptions in the CBA.
Present Value of Costs (PVC)	Represents the capital and operating costs over the assessment period after the allowance for discounting.
Present Value of Benefits (PVB)	Represents the discounted travel time benefits, vehicle operating costs benefits, road safety benefits and externalities benefits over the assessment period.

2. CBA Modelling Assumptions

2.1 Background

The most significant data inputs that impact on the CBA modelling are:

- CAPEX and OPEX cost estimates;
- Network traffic data for the Without Project and With Project Case; and
- Discount rate of 6 percent assumed for the Project Case reporting in accordance with DMR guidelines for major road projects.

The supplementary modelling utilised inputs updated from the previous modelling, specifically:

- CAPEX estimates
- OPEX estimates
- Network traffic data

2.2 Cost inputs

2.2.1 Construction costs (CAPEX)

The CAPEX cash flow (in December 2008 prices) used in the supplementary CBA modelling extends from 2010 to 2014 and comprises the following:

- land acquisition costs;
- preconstruction costs;
- non-construction costs;
- constructions costs; and
- risk.

Table 3 below outlines the CAPEX requirements for the EIS Reference Project and **Table 4** the CAPEX requirements for the Project for all risk adjusted levels. The CAPEX is non-escalated and excludes finance costs. Risk is in two parts, all CAPEX is inclusive of P90 'planned' risks. P10, P50, P90 refer to variability of unplanned risks. The P50 level represents the expected CAPEX and is adopted as the project case CAPEX. The remaining P10 (i.e. best case) and P90 (i.e. worst case) have been used in the CBA to model CAPEX sensitivity across the range of risk adjusted levels.

Table 3 EIS Reference Project update with cash flow at P10, P50 and P90 risk adjusted CAPEX levels

Year	2010	2011	2012	2013	2014	Total
P10	$90.9 m	$688.0 m	$534.7 m	$604.4 m	$167.2 m	**$2,085.1 m**
P50	$90.9 m	$717.4 m	$553.8 m	$622.8 m	$183.9 m	**$2,168.8 m**
P90	$90.9 m	$748.1 m	$573.7 m	$641.9 m	$201.4 m	**$2,256.0 m**

- **Table 4 The Project cash flow at P10, P50 and P90 risk adjusted CAPEX levels[1]**

Year	2009	2010	2011	2012	2013	2014	Total
P10	$16.3 m	$25.4 m	$313.7 m	$307.7 m	$342.7 m	$259.2 m	**$1,265.0 m**
P50	$16.3 m	$25.4 m	$332.6 m	$317.4 m	$354.3 m	$268.4 m	**$1,314.4 m**
P90	$16.3 m	$25.4 m	$352.7 m	$328.1 m	$366.8 m	$278.3 m	**$1,367.6 m**

Table Note

1) Excludes inflation and finance costs.
2) Costs incurred in 2009 relate to preconstruction costs

Based on the building price index (BPI) assumptions (approx 8%), the P90 CAPEX of $1,368m is forecast to be $1,778m.

2.2.2 Operations and maintenance costs (OPEX)

The operations and maintenance (OPEX) costs (in December 2008 prices) over the 40 year assessment life are provided for both the EIS Reference Project and the Project in **Table 5**. The OPEX schedule has been estimated on an annual basis using the OPEX schedule from the CBA modelling for the EIS and has been time adjusted to commence from end 2014. The OPEX includes the following:

- tunnel traffic management facilities, signage, roadway lighting, CCTV, utilities and radio broadcast;
- fire and life safety, mechanical and electrical systems including tunnel ventilation, power supplies, fire response and protection facilities, communication and security systems and emergency egress; and
- plant management and control systems.

- **Table 5 Operations and maintenance costs (in December 2008) over 40 years**

Project scenarios	OPEX
EIS Reference Project	$1,716 m
The Project	$1,441 m

2.2.3 Traffic modelling inputs

The traffic modelling inputs were updated for the supplementary CBA modelling. The base future road networks updates incorporated contemporary descriptions of key future projects, which date from after the EIS modelling was undertaken. Such projects include:

- Hale Street Link (HSL) – July 2008 Changed Project including Coronation Drive viaduct and right turn from Hale Street to Coronation Drive outbound;
- Coronation Drive – removal of tidal flow operation (as at October 2008) resulting in three traffic lanes inbound and two traffic lanes outbound;

- Airport Link – BrisConnections Conforming Design as per the Airport Link Request for Project Change (May 2008);
- Airport Roundabout Upgrade (ARU) – BrisConnections design including Fast Diamond interchange;
- Ipswich Motorway Upgrade – based on public information from DMR (2008); and
- BCC Road Action Plan updates and updating of the expected timing of future network projects consistent with Council's programs.

2.2.4 CBA modelling inputs and assumptions

The CBA modelling inputs and assumptions are listed in **Table 6**. The most significant inputs for the CBA model are the CAPEX estimates for the project case and network traffic data for the base case and project case. Other critical inputs include the parameter values to be used in the determination of road user benefits namely travel time benefits, vehicle operating costs benefits, road safety benefits and externalities benefits. The current DMR/Austroads standards for these values are in 2007 (June) prices. These June 2007 values were escalated to December 2008 prices using the Consumer Price Index (CPI) for Brisbane from the Australian Bureau of Statistics.

Table 6 CBA model assumptions

Item	Assumptions
Price Terms	CAPEX and OPEX costs and benefits are presented in real terms (ie constant December 2008 dollars).
CAPEX	CAPEX cash flow for Northern Link would commence in 2010 and be completed by end 2014. CAPEX is costed at P10, P50 and P90 risk levels; that is the 10th, 50th and 90th percentile confidence levels for the CAPEX estimate, where P50 is the expected or likely CAPEX.
Operating and Maintenance (OPEX) Costs	OPEX cash flow has been provided and is presented from 2014 to 2054 for the Project Case.
Benefit Assessment Period	Project CAPEX starts 2010 and ends in 2014. Road user operations for the Project Case commence in 2014 and the post construction assessment period extends over 40 years to 2054.
Discount Rate (Project Case)	6% in line with current State guidelines.
Traffic Data	Traffic assignment years for 2014, 2016, 2021 and 2026. Without Project Base Case and Project Case vehicle data by assignment years (i.e. Average Speed, VHT and VKT). Without Project Base Case and Project Case traffic data segmented by AM peak, PM peak, other business hours and other hours. Using Daily Traffic Profile data on a 24 hour basis from the local network. Vehicle segmentation by Light Vehicles (composition comprising private vehicles 77% and business vehicles 23%) and heavy vehicles.

<table>
<tr><th>Item</th><th>Assumptions</th></tr>
<tr><td>Traffic Modelling</td><td>

Toll = $3.93($2008), HCV Toll multiplier = 2.00.
PIFU Medium demographics with enhanced mode choice
Surface treatment.

<table>
<tr><th>Surface Road Segment</th><th>Number of lanes</th></tr>
<tr><td>Centenary Highway & Western Freeway (northbound – Centenary Hwy/Ipswich Mwy interchange and Northern Link portal)</td><td>2 lanes prior to 2016
2 lanes + T2 lane from 2016 (excluding bridge)</td></tr>
<tr><td>Centenary Highway & Western Freeway (southbound – between Northern Link portal and Centenary Hwy/Ipswich Mwy interchange)</td><td>2 lanes prior to 2016
2 lanes + T2 lane from 2016 (excluding bridge)</td></tr>
<tr><td>Coronation Drive (eastbound)</td><td>2 lanes + inbound bus lane</td></tr>
<tr><td>Coronation Drive (westbound)</td><td>2 lanes</td></tr>
<tr><td>Milton Road[3] (eastbound)</td><td>2 lanes</td></tr>
<tr><td>Milton Road[3] (westbound)</td><td>2 lanes</td></tr>
<tr><td>Inner City Bypass at Landbridge (eastbound)</td><td>3 lanes</td></tr>
<tr><td>Inner City Bypass at Landbridge (westbound)</td><td>3 lanes</td></tr>
</table>
</td></tr>
<tr><td>Average Travel Speed</td><td>Determined by traffic analysis for vehicle category and assignment years.</td></tr>
<tr><td>Annualisation</td><td>

342 for light vehicles
300 for heavy vehicles
Average 340 for all vehicles

</td></tr>
<tr><td>Inter Assignment Year Interpolation</td><td>Linear average annual growth between traffic assignment years.</td></tr>
<tr><td>Travel Time Parameter Values</td><td>DMR/Austroads endorsed values for Urban Travel Time June 2007 escalated to December 2008 using CPI for Brisbane have been used for CBA modelling.</td></tr>
<tr><td>Vehicle Occupancy Rates</td><td>The vehicle occupancy rates are as follows:

Private Vehicle: 1.6 passengers
Business Light Vehicle: 1.4 passengers
Heavy Vehicle (3 axle): 1 passenger.

</td></tr>
<tr><td>Vehicle Operating Cost (VOC)</td><td>The vehicle operating cost model is used to determine VOC by vehicle category for the future base case traffic network. Model coefficients were taken from DMR/Austroads standards and were escalated to December 2008 values.</td></tr>
<tr><td>Road Safety Benefits</td><td>The inputs into the road safety benefits analysis are as follows:

AADT VKT values used for With and Without Project Case
Accident cost values (2008 dollars) for local and freeway networks adjusted for additional road safety benefit for the tunnel environment

</td></tr>
<tr><td>Residual Value</td><td>The residual value of Northern Link after 40 years of operation is assumed to be $0.</td></tr>
<tr><td>Sensitivity</td><td>Sensitivity testing of P10, P50 and P90 risk adjusted CAPEX.</td></tr>
<tr><td>Decision Outputs</td><td>The following CBA decision outputs have been delivered for the project scenarios:

Benefit Cost Ratio
Net Present Value
Present Value of costs
Present Value of benefits segmented by travel time benefits, VOC benefits, road safety benefits and environmental benefits.

</td></tr>
</table>

3. CBA model results

The results from the CBA for the modelled Northern Link scenarios with a risk adjusted (P50) CAPEX at a discount rate of 6% are shown in **Table 7**.

- **Table 7 Project scenarios P50 CBA findings (6 percent discount rate)**

Output	EIS Reference Project	The Project
Present Value of Benefits (PVB)	$3,720.2 m	$3,260.8 m
Present Value of Costs (PVC)	$2,456.6 m	$1,514.6 m.
Net Present Value (NPV)	$1,263.5 m	$1,746.2 m
Benefit Cost Ratio (BCR)	**1.5**	**2.2**

The present value of benefits (PVB) has been segmented by benefit type, namely:

- travel time savings;
- vehicle operating cost (VOC) savings;
- road safety savings; and
- environmental externalities benefits.

The breakdown of the benefits by type is provided in **Table 8**. It highlights the importance of VOC savings at approximately 50 percent of total benefits that will accrue to the future road network with the construction of Northern Link. Travel time savings at approximately 41 percent of all benefits are also significant benefits to road users. Road safety and environmental externalities are smaller but nevertheless important benefits.

- **Table 8 Northern Link present value of benefits (PVB) by benefit type**

Benefit	EIS Reference Project	The Project
Travel time	$1,521.9 m	$1,357.6 m
VOC	$1,832.9 m	$1,599.3 m
Road Safety	$160.3 m	$121.7 m
Externalities	$205.0 m	$182.1 m
Total Discounted Benefits	**$3,720.2 m**	**$3,260.8 m**

Table 9 shows the travel time savings generated by the project scenarios segmented by vehicle type. Travel time savings represent the second largest economic net benefit to the project. Private light vehicles are the largest contributor to travel time savings with 51 percent over the 40 year assessment period.

- **Table 9 Discounted travel time savings by vehicle type**

Benefit	EIS Reference Project	The Project
Private Light Vehicles	$772.0 m	$690.0 m
Business Light Vehicles	$654.6 m	$585.1 m
Heavy Vehicles	$95.3 m	$82.5 m
Travel Time Benefits Total	**$1,521.9 m**	**$1,357.6 m**

The present value of costs (PVC) in **Table 7** refers to the present value of the capital investment and the annual operating and maintenance costs over the 40 year assessment period.

Investment criteria that have been calculated in this CBA are net present value (NPV) and benefit cost ratio (BCR).

The NPV is the value of the discounted total future benefits minus discounted total future costs over the 40 year assessment period used for the CBA. On the basis of the assumptions that have been adopted, the CBA model returns a strong positive NPV for each scenario over the assessment life of the project and represents a strong economic justification for proceeding with the project.

The BCR is equal to the discounted total benefits over the assessment period divided by the discounted total costs (i.e. CAPEX and OPEX). A higher BCR indicates that the project has greater economic merit. A ratio great than 1 indicates that the project is economically viable in the context of the CBA.

3.1 Sensitivity Analysis

Sensitivity testing across all risk levels (P10, P50, and P90) has been undertaken in the CBA model.

- **Table 10 Sensitivity test of CBA results for the project scenarios**

Risk Levels	Investment Criteria	EIS Reference Project	The Project
P10	NPV	$1,337.0 m	$1,787.1 m
	BCR	1.6	2.2
P50	NPV	**$1,263.5 m**	**$1,746.2 m**
	BCR	**1.5**	**2.2**
P90	NPV	$1,186.9 m	$1,701.9 m
	BCR	1.5	2.1

3.2 CBA Conclusions

The CBA results, under the modelling assumptions that have been adopted, and at the P10, P50 and P90 risk adjusted capital cost levels, provide an acceptable economic justification to proceed with either project scenario. While both project scenarios provide acceptable investment options, the Project, without the local connections, would present a better economic return.