Specialist Consultant Studies Compendium

Gunlake Quarries
Gunlake Quarry Project

ENVIRONMENTAL ASSESSMENT

VOLUME III

Part 4
Heggies Pty Ltd
Proposed Gunlake Quarry, Marulan,NSW. Construction, Operational and Transportation Noise and Blasting Impact Assessment.

Part 5
Heggies Pty Ltd
Air Quality Impact Assessment. Proposed Gunlake Quarry – Marulan.

Part 6
Australian Archaeological Survey Consultants Pty Ltd
Preliminary Archaeological Assessment. Proposed Gunlake Quarry Marulan NSW.

February 2008

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HEGGIES

REPORT 10-5106-R1

Revision 0

Proposed Gunlake Quarry, Marulan, NSW
Construction, Operational and Transportation Noise and Blasting Impact Assessment

PREPARED FOR

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14 FEBRUARY 2008

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Proposed Gunlake Quarry, Marulan, NSW Construction, Operational and Transportation Noise and Blasting Impact Assessment

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DOCUMENT CONTROL

Reference	Status	Date	Prepared	Checked	Authorised
10-5106-R1	Revision 0	14 February 2008	Dick Godson	Mark Blake	Dick Godson

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1 INTRODUCTION

Gunlake Quarries (hereafter, "the Proponent"), a division of Rollers Australia Pty Ltd, proposes to establish and operate a hard rock quarry located approximately 8 km northwest of Marulan, NSW. The rock, a tuffaceous rhyodacite, will be drilled and blasted and processed in an on-site crushing and screening plant. Products from this process will include a range of concrete and sealing aggregates, rail ballast, and roadbase.

Heggies Pty Ltd (hereafter, "Heggies") has been commissioned by the Proponent, to undertake a Noise and Blasting Impact Assessment (hereafter, "NBIA") of the proposed Gunlake Quarry Project (hereafter, "the Project") for inclusion in their Environmental Assessment (EA).

Gunlake proposes to operate a hard rock quarry on 230 hectares of Gunlake owned land at Marulan, situated 8 km northwest of Marulan, NSW. The proposal involves the production of 500,000 tonnes per annum (tpa) in sales.

This report identifies the potential construction, operational and traffic noise and blasting impacts associated with the proposed development on the Marulan community.

1.1 Noise and Vibration Assessment Procedures

The NSW Department of Environment and Climate Change (DECC), formerly the DEC, has regulatory responsibility for the control of noise from "scheduled premises" under the Protection of the Environment Operations Act 1997. In implementing the NSW "*Industrial Noise Policy",* 2000 (INP), the DECC has two broad objectives:

- Controlling intrusive noise impacts in the short-term; and
- Maintaining noise level amenity for particular land uses over the medium to long-term.

On-Site Construction Noise Emissions

The assessment of impact from on-site construction works remains according to the DECC's "*Environmental Noise Control Manual"* (ENCM) 1994, Chapter 171 Noise Control Guideline - Construction Site Noise.

On-Site Operating Noise Emissions

The INP provides non-mandatory procedures for setting acceptable $L_{Aeq(15minute)}$ intrusive and $L_{Aeq(period)}$ amenity noise levels for various receiver areas as well as guidelines for assessing noise impacts from on-site noise sources.

Sleep Disturbance

The DECC's most recent policy considers sleep disturbance as the emergence of the $L_{A1(1minute)}$ level above the $L_{A90(15minute)}$ level at the time. Appropriate screening criteria for sleep disturbance are determined to be an $L_{A1(1minute)}$ level 15 dBA above the Rating Background Level (RBL) for the night-time period (2200 hours to 0700 hours).

When the criterion is not met, a more detailed analysis may be required which should cover the maximum noise level or $L_{A1(1minute)}$ the extent that the maximum noise level exceeds the background level and the number of times this happens during the night-time period. Some guidance on possible impacts is contained in the review of research results in the appendices to the NSW Environmental Criteria for Road Traffic Noise (ECRTN).

Other factors that may be important in assessing the extent of impacts on sleep include:

- How often high noise events will occur;
- Time of day (normally between 10.00 pm and 7.00 pm); and
- Whether there are times of the day when there is a clear change in the noise environment (such as during early morning shoulder periods).

Off-Site Road Traffic Noise Emissions

The NSW DECC "*Environmental Criteria for Road Traffic Noise"* 1999 (ECRTN) provides non-mandatory procedures for setting acceptable L_{Aeq} noise levels on arterial, collector and local roads as well as guidelines for assessing noise impacts from off-site road traffic.

On-Site Blast Emissions

The DECC currently adopts the Australian and New Zealand Environment Council (ANZEC) "*Technical Basis for Guidelines to Minimise Annoyance due to Blasting Overpressure and Ground Vibration*" dated September 1990 for assessing potential annoyance from blast emissions during daytime hours.

The assessment of blast emission impacts outside the hours advocated by ANZEC remains according to the DECC's Chapter 154 Noise Control Guideline - Blasting.

British Standard BS 7385-2 1993 *"Evaluation and Measurement for Vibration in Buildings - Part 2: Guide to Damage Levels from Ground Bourne Vibration"* (BS 7385) provides guideline criteria for evaluating the effects of vibration on structures.

2 LOCAL SETTING AND PROJECT OVERVIEW

2.1 Site Location

The Proponent proposes to develop and operate a hard rock quarry located approximately 8 km northwest of Marulan, in the Southern Highlands of NSW. The Project Site is currently accessed via Brayton Road, a two-lane sealed road servicing existing quarry operations and communities west of Marulan.

The regional setting of the Project is given in **Figure 1**.

Figure 1 Regional Setting of the Project

2.2 Existing Sensitive Receptor Locations

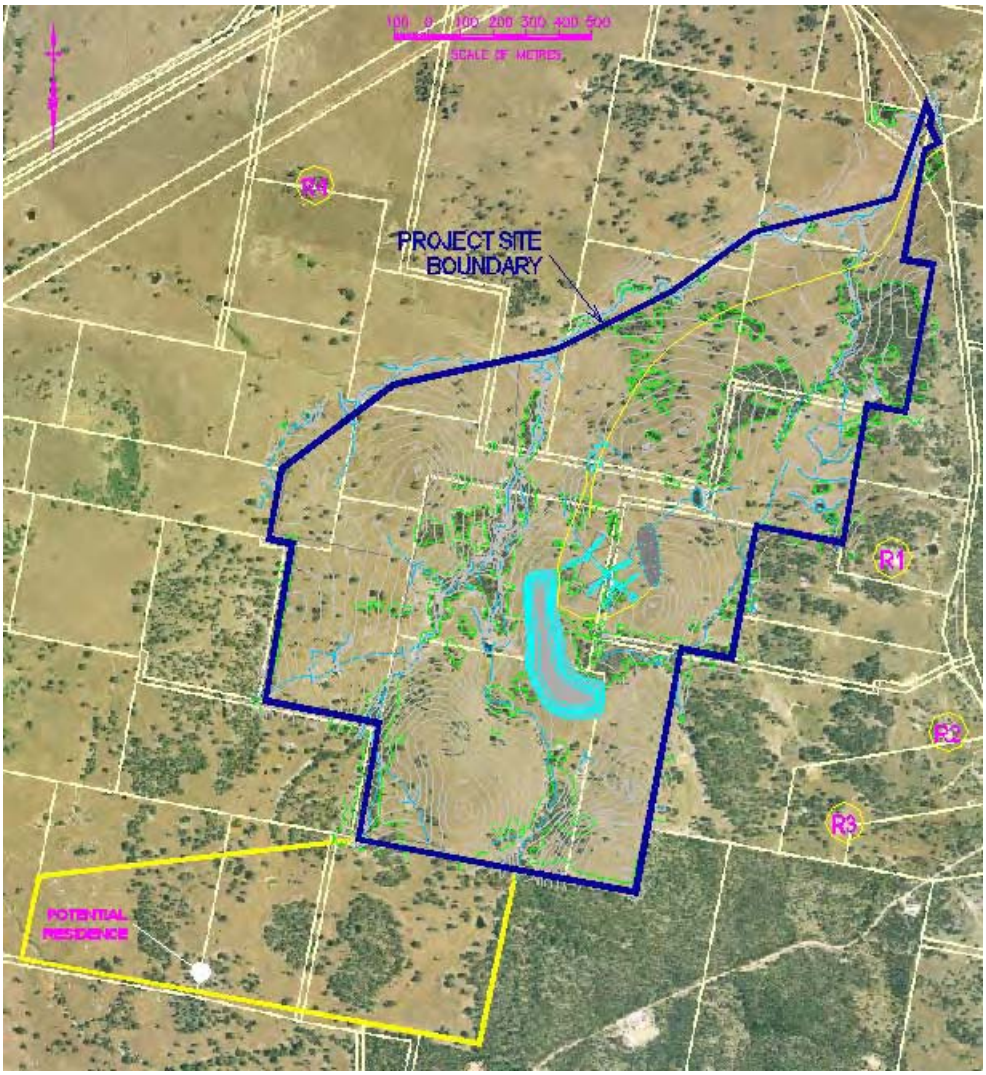
The closest sensitive receptors to the site are four residences located within a distance of approximately 1 km of the processing plant. Noise and blasting emission levels are predicted at these four points. Receptor locations and distances to Project Site boundary and the processing plant are given in **Table 1**.

Table 1 Closest Sensitive Receptors

Sensitive Receptor	Easting (m)	Northing (m)	Distance to Project Site boundary (km)	Distance to processing plant (km)
R1	772790	6159473	0.2	0.7
R2	772982	6158938	0.7	1
R3	772644	6158651	0.5	0.9
R4	771074	6160589	0.6	1.4
Proposed Residence -R5	770646	6158064	0.6	1.7

Locations of sensitive receptors in relation to the Project Site are shown in **Figure 2**.

Figure 2 Locations of Existing Sensitive Receptors in the Project Vicinity



2.3 Proposed Development

2.3.1 Quarrying

It is proposed that the quarry will produce 500,000 tonnes per annum of finished product and will be operated as a conventional hard rock, open cut quarry. The proposed development will incorporate the following:

- Overburden removal using excavators and dump trucks, stockpiled initially on the eastern side of the crushing plant area to create a bund wall extending the line of an existing ridge. The bund wall will become an effective noise and visual barrier; virtually eliminating lines of sight from the east.
- Conventional drill and blast techniques will be used to quarry the stone from face heights of approximately 13 m. It is proposed that quarrying will commence at the northern end of the 30 year quarry site and proceed in a southerly direction. As required, each new quarry bench will be opened up and developed in the north to south direction.

- Any secondary breaking required will be done by hydraulic rockbreaker.

The quarried stone will be loaded by front end loaders and hauled by dump trucks to the crushing and screening plant.

2.3.2 Processing

The crushing plant will be a three-stage plant with crushing to be followed by the appropriate screening process resulting in the final products which will be sized and stockpiled. The three crushing stages will most likely be done with a primary jaw crusher, a secondary gyratory crusher and tertiary cone crushers. A portable crushing plant may be used initially to produce road making materials for the on site roadways.

The permanent crushing plant is envisaged to have a production throughout of up to 300 tonnes per hour.

Product from the proposed quarry will comprise a range of high quality concrete and sealing aggregates, manufactured sand, rail ballast and road base.

2.3.3 Transport

It is proposed that the crushed products will be hauled by road from the quarry site direct to the Sydney market, and to other markets to the north and south of Marulan.

Initially haulage would be via existing truck routes through the outskirts of Marulan (Brayton Road) to the Hume Highway interchange near the truck checking station at an average of 25 truck movements per day. Products will be hauled both north and south on the Highway, with approximately 80% or more to the north.

As production increases, a bypass route around Marulan will be constructed (by the Proponent) to allow product destined for northern markets to bypass Marulan. This route is shown on **Figure 1** together with the quarry and plant site.

The bypass route involves the construction of a haul road over land owned by the Proponent to link with a new road to be constructed along a Crown Road Reserve to Red Hills Road. The bypass road will be a public road and not for the exclusive use of the Proponent. The proposed construction of the bypass road will be timed for when quarry sales growth would result in truck movements through Marulan exceeding the average of 25 truck movements per day. It is anticipated that this will occur within 3 to 5 years from commencement of aggregate production on the site.

When constructed, all traffic for northern markets will use this route. Returning trucks from the north will not turn right at the Hume Highway to enter Red Hills Road, but will continue to the Marulan exit near the truck checking station, pass under the Highway, negotiate a new roundabout at the intersection of Brayton Road and George Street and return via the Highway to turn left into Red Hills Road.

Trucks travelling south will continue to use Brayton Road to the Hume Highway interchange but returning trucks will turn left into Red Hills Road. Truck movements using the Brayton Road route will continue to be an average of 25 per day for the life of the quarry.

2.3.4 Hours of Operation

The quarry will operate from 0700 hours to 1800 hours, Monday to Saturday with blasting conducted between 0900 hours and 1700 hours Monday to Friday and material haulage, to the north along the proposed bypass route when constructed, between 2100 hours Sunday and 1800 hours Saturday.

The hours of operation are presented in **Table 2**.

Table 2 Hours of Operation

Task	Proposed Hours
Overburden Removal	0700 hours to 1800 hours Monday to Saturday
Drilling	0700 hours to 1800 hours Monday to Saturday
Blasting	0900 hours to 1700 hours Monday to Friday
Quarrying and Processing	0700 hours to 1800 hours Monday to Saturday
Maintenance	24 hours 7 days
Truck Loading and Haulage[1]	2100 hours Sunday to 1800 hours Saturday

Note 1: After construction of the bypass route, there will be no haulage through Marulan outside the hours of 0600 hours to 1800 hours Monday to Saturday.
Truck movements through Marulan will not exceed an average of 25 truck movements per day.

3 NOISE IMPACT ASSESSMENT PROCEDURE

3.1 Environmental Noise Control - General Objectives

Residential Receiver

Responsibility for the control of noise emission in New South Wales is vested in Local Government and the DECC. The DECC has released the NSW Industrial Noise Policy (INP), dated January 2000, which provides a framework and process for deriving noise criteria for consents and licences that will enable the DECC to regulate premises that are scheduled under the Protection of the Environment Operations Act 1997.

The specific policy objectives are to:

- Establish noise criteria that would protect the community from excessive intrusive noise and preserve the amenity for specific land uses.
- Use the criteria as the basis for deriving project specific noise levels.
- Promote uniform methods to estimate and measure noise impacts, including a procedure for evaluating meteorological effects.
- Outline a range of mitigation measures that could be used to minimise noise impacts.
- Provide a formal process to guide the determination of feasible and reasonable noise limits for consents or licences that reconcile noise impacts with the economic, social and environmental considerations of the industrial development.
- Carry out functions relating to the prevention, minimisation and control of noise from the premises scheduled under the Act.

Assessing Intrusiveness

For assessing intrusiveness, the background noise generally needs to be measured. The intrusiveness criterion essentially means that the equivalent continuous noise level (L_{Aeq}) of the source should not be more than 5 dBA above the measured (or default) Rating Background Level (RBL).

Assessing Amenity

The amenity assessment is based on noise criteria specific to the land use and associated activities. The criteria relate only to industrial-type noise and do not include road, rail or community noise. If present, the existing noise level from industry is generally measured. If it approaches the criterion value, then noise levels from new industries need to be designed so that the cumulative effect does not produce noise levels that would significantly exceed the criterion. For high-traffic areas there is a separate amenity criterion. The cumulative effect of noise from industrial sources also needs to be considered in assessing the impact.

An extract from the INP that relates to the amenity criteria is given in **Table 3**.

Table 3 Amenity Criteria - Recommended L_{Aeq} Noise Levels from Industrial Noise Sources

Type of Receiver	Indicative Noise Amenity Area	Time of Day	Recommended L_{Aeq} Noise Level	
			Acceptable	Recommended Maximum
Residence	Rural	Day	50 dBA	55 dBA
		Evening	45 dBA	50 dBA
		Night	40 dBA	45 dBA
	Suburban	Day	55 dBA	60 dBA
		Evening	45 dBA	50 dBA
		Night	40 dBA	45 dBA
	Urban	Day	60 dBA	65 dBA
		Evening	50 dBA	55 dBA
		Night	45 dBA	50 dBA
	Urban/Industrial Interface - for existing situations only	Day	65 dBA	70 dBA
		Evening	55 dBA	60 dBA
		Night	50 dBA	55 dBA
School classrooms - internal	All	Noisiest 1-hour period when in use	35 dBA	40 dBA
Hospital ward				
- internal	All	Noisiest 1-hour period	35 dBA	40 dBA
- external	All	Noisiest 1-hour period	50 dBA	55 dBA
Place of worship - internal	All	When in use	40 dBA	45 dBA
Area specifically reserved for passive recreation (eg National Park)	All	When in use	50 dBA	55 dBA
Active recreation area (eg School playground, golf course)	All	When in use	55 dBA	60 dBA
Commercial premises	All	When in use	65 dBA	70 dBA
Industrial premises	All	When in use	70 dBA	75 dBA

Notes: For Monday to Saturday, Daytime 0700 hours - 1800 hours; Evening 1800 hours - 2200 hours; Night-time 2200 hours - 0700 hours.

On Sundays and Public Holidays, Daytime 0800 hours - 1800 hours; Evening 1800 hours - 2200 hours; Night-time 2200 hours - 0800 hours.

The L_{Aeq} index corresponds to the level of noise equivalent to the energy average of noise levels occurring over a measurement period.

INP Assessment of Prevailing Weather Conditions

Wind

Wind has the potential to increase noise at a receiver when it is light and stable and blows from the direction of the noise source. As the strength of the wind increases the noise produced by the wind will obscure noise from most industrial and transport sources.

Wind effects need to be considered when wind is a feature of the area under consideration. Where the source to receiver wind component at speeds of up to 3 m/s occur for 30% or more of the time in any seasonal period (during the day, evening or night), then wind is considered to be a feature of the area and noise level predictions must be made under these conditions.

The INP Section 5.3 Wind Effects states:

> *"Wind effects need to be assessed where wind is a feature of the area. Wind is considered to be a feature where source to receiver wind speeds (at 10 m height) of 3 m/s or below occur for 30 percent of the time or more in any assessment period in any season."*

In order to determine the prevailing conditions for the subject site, weather data for the period April 2004 to July 2007 were obtained from a weather station at Marulan South operated by Hydrometric Consulting Services Pty Ltd for Blue Circle Southern Cement. The data was analysed in order to determine the frequency of occurrence of winds of speeds up to 3 m/s in each season.

The results of the on-site weather station analysis for daytime, evening and night-time winds are presented in **Table 4**, **Table 5** and **Table 6** respectively.

In each table, the wind directions and percentage occurrence are those dominant during each season.

Table 4 Seasonal Frequency of Occurrence Wind Speed Intervals - Daytime

Period	Calm (<0.5 m/s)	Wind Direction ±(45°)	Wind Speed		
			0.5 to 2.0 m/s	2 to 3 m/s	0.5 to 3 m/s
Summer	0.8%	ENE	9.5%	24.2%	33.7%
Autumn	4.7%	E	13.3%	11.8%	25.1%
Winter	5.9%	WSW	9.4%	16.6%	22%
Spring	0.8%	ENE	6.3%	13.8%	19.8%

Table 5 Seasonal Frequency of Occurrence Wind Speed Intervals - Evening

Period	Calm (<0.5 m/s)	Wind Direction ±(45°)	Wind Speed		
			0.5 to 2.0 m/s	2 to 3 m/s	0.5 to 3 m/s
Summer	3.2%	ENE	23.8%	31.6%	55.4%
Autumn	13.7%	E	20.3%	8.8%	27.6%
Winter	18.4%	W	15%	11.2%	26.3%
Spring	7.4%	NE	18.5%	13.7%	32.1%

Table 6 Seasonal Frequency of Occurrence Wind Speed Intervals - Night-time

Period	Calm (<0.5 m/s)	Wind Direction ±(45°)	Wind Speed		
			0.5 to 2.0 m/s	2 to 3 m/s	0.5 to 3 m/s
Summer	15.4%	ENE	29.6%	6.3%	35.9%
Autumn	26.8%	WNW	17.2%	7.6%	24.8%
Winter	22.7%	W	16.8%	10.3%	27.1%
Spring	15.6%	NW	19.2%	9.3%	28.6%

The prevailing winds less than (or equal to) 3 m/s with a frequency of occurrence greater than (or equal to) 30% and considered to be relevant to the site in accordance with the INP are presented in **Table 7**, where the dominant conditions are underlined.

Table 7 Project Prevailing Wind Conditions in Accordance with NSW INP (2000)

Season	Winds ± ≤ 3 m/s with frequency of Occurrence ≥ 30%[1]		
	Daytime	Evening	Night-time
Summer	ENE (34%), E (32%), NE (31%)	NNE (37%), NE (52%), ENE (55%), E (50%), ESE (32%)	NNE (30%), NE (35%), ENE (36%), E (32%)
Autumn	Nil	Nil	Nil
Winter	Nil	Nil	Nil
Spring	Nil	NE (32%), ENE (31%)	Nil

Note 1: The dominant seasonal wind speeds are underlined

Temperature Inversion

Temperature inversions, when they occur, have the ability to increase noise levels by focusing sound waves. Temperature inversions occur predominantly at night during the winter months. For a temperature inversion to be a significant characteristic of the area it needs to occur for 30% or more of the total night-time during winter or about two nights per week.

The INP states that temperature inversions need only be considered for the night-time noise assessment period ie 2200 hours to 0700 hours.

The INP Section 5.2 Temperature Inversions states:

> *"Assessment of impacts is confined to the night noise assessment period (10.00 pm to 7.00 am), as this is the time likely to have the greatest impact - that is, when temperature inversions usually occur and disturbance to sleep is possible."*

The default value scenario for temperature inversions has been adopted in this assessment in accordance with Section 5.2 of the INP.

Drainage Flow Winds

The INP identifies that a default wind drainage value be applied where sources are situated at a higher altitude than receivers with no intervening topography.

The drainage-flow wind does not apply to this development as intervening topography exists between sources and receivers.

Additional DECC Noise Assessment Information

The DECC's recommended noise assessment criteria aim to limit potential intrusive noise emissions and preserve noise amenity. In cases where the limiting noise assessment criterion (in this case $L_{Aeq(15minute)}$ intrusiveness criterion) cannot be achieved, then practicable and economically feasible noise control measures should be applied. This usually requires demonstration that Best Achievable Technology and Best Environmental Management Practices have been implemented in order to mitigate adverse acoustical impacts.

In the event that the lowest achievable noise emission levels remain above the noise assessment criteria, the potential noise impact needs to be balanced and assessed against any economic and social benefits the project may bring to the community. It then follows that where the consenting authority may consider that the development does offer community benefits, then these may be grounds for permitting achievable noise emission levels as statutory compliance levels.

4 EXISTING ACOUSTICAL ENVIRONMENT

4.1 Unattended Background Noise Surveys

Unattended background noise monitoring was conducted between Wednesday 6 June 2007 and Thursday 21 June 2007 at a number of representative locations in the vicinity of the proposed quarry operations. Environmental noise loggers were used to continuously record noise levels at the respective monitoring locations over the survey period.

Within the periods selected as being representative of the background noise level, noise data during periods of any rainfall and/or wind speeds in excess of 5 m/s (approximately 9 knots) were discarded.

A summary of the results of the background noise surveys is presented in **Table 8** (and presented graphically in **Appendices A** to **E**) for the proposed operational hours of the quarry.

Table 8 Summary of Existing L_{A90} Rating Background Levels (RBL's) and Existing L_{Aeq} Ambient Noise Levels - dBA re 20 µPa

Monitoring Locations	$L_{A90(15minute)}$ Rating Background Noise Level[1,2]			$L_{Aeq(period)}$ Existing Ambient Noise Level[1]		
	Daytime 0700-1800 Hours	Evening 1800-2200 Hours	Night 2200-0700 Hours	Daytime 0700-1800 Hours	Evening 1800-2200 Hours	Night 2200-0700 Hours
R1 - 575 Brayton Road	34	33	31	47	42	40
R2 - 531 Brayton Road	36	35	32	47	43	42
R3 - 529 Brayton Road	34	33	31	45	49	44
R4 - 1540 Carrick Road	30	31	30	46	39	40
17 Brayton Road[3]	47	47	38	60	57	54

Note 1: The L_{A90} represents the level exceeded for 90% of the interval period and is referred to as the average minimum or background noise level.
The L_{Aeq} is the equivalent continuous noise level defined as the level of noise equivalent to the energy average of noise levels occurring over a measurement period.

Note 2: In accordance with INP procedures, if the RBL is below 30 dBA, then 30 dBA shall be the assumed RBL.

Note 3: This residence is situated in Marulan Village near the intersection with George Street.

Review of the data presented in **Table 8** indicates that the $L_{A90(15minute)}$ RBL's at the various monitoring locations ranged from 30 dBA to 47 dBA during the daytime, 31 dBA to 47 dBA during the evening and were 30 dBA to 38 dBA during the night-time. The measured background noise levels are typical of those of a rural environment with natural noise sources and some transportation noise contributions associated with the Hume Highway.

4.2 Operator-Attended Noise Surveys

At selected locations, operator-attended noise surveys of 15 minutes duration were conducted during the deployment and collection of the noise loggers on Wednesday 6 June 2007 and Thursday 21 June 2007 respectively.

The operator-attended noise measurements were conducted using a precision integrating sound level meter in order to qualify the results obtained with the unattended noise loggers. During the attended noise surveys, the operator identified the character and duration of acoustically significant ambient noise sources. Wherever possible, the operator quantified local traffic flows and made a qualitative assessment of the prevailing weather conditions.

The operator-attended noise survey results are presented in **Table 9** for 6 June 2007 and 20 June 2007.

Table 9 $L_{Aeq(15minute)}$ Operator-Attended Noise Survey Results

Location	Date/ Time (Hours)	Primary Noise Descriptor (dBA re 20 µPa)			Description of Noise Emission Sources
		L_{A10}	L_{A90}	L_{Aeq}	
R1 - 575 Brayton Road	7/6/07 1400	34	26	32	Quarry Trucks (dist) 29-39 Trucks Dumping (dist) 33 Birds (dist) 30-40 Cars 35-44
R3 - 529 Brayton Road	7/6/07 1530	31	20	31	Trucks Dumping (Quarry) 28 Trucks 28-33 Reversing Alarms 26-27 Horses 37-47 Birds 30-50
R4 - 1540 Carrick Road	21/6/07 1630	42	30	41	Highway Traffic (distant exhaust brakes) 31-37 Wind 35 Birds 33-45 Insects 33 Aircraft 57
17 Brayton Road	21/6/07 1120	59	48	60	Trucks 82 Cars 71-81 Wind 52-57 Dogs 53-57 Birds 49-55

The operator-attended noise measurement results confirm the results obtained from the unattended noise loggers and support the use of the noise levels in being representative of the background noise environment at all residences, except at the eastern boundary residence. Farming plant was constructing a dam at the time of this attended measurement, therefore the results for this location were considered unrepresentative. In order to obtain a better indication of representative noise levels at this location, a typical weekday fifteen minute monitoring period was selected from the noise logger data.

5 CONSTRUCTION NOISE EMISSION CRITERIA

The DECC has published guidelines in its Environmental Noise Control Manual, 1994 (Chapter 171-1) for the control of construction noise.

In summary, the DECC's preferred approach to the control of construction noise involves the following:

a. Noise Level restrictions

b. Time restrictions

c. Silencing

a. Noise Level Restrictions

For a cumulative period of exposure to noise from construction activity of up to four (4) weeks in duration, the $L_{A10(15minute)}$ noise level emitted by the works, when measured at a residential receiver, should not exceed the $L_{A90(15minute)}$ RBL by more than 20 dBA.

For a cumulative period of exposure to noise from construction activity of between 4 weeks and 26 weeks duration, the $L_{A10(15minute)}$ noise level emitted by the works, when measured at a residential receiver, should not exceed the $L_{A90(15minute)}$ RBL more than 10 dBA.

For a cumulative period of exposure to noise from construction activity in excess of 26 weeks duration, the $L_{A10(15minute)}$ noise level emitted by the works, when measured at a residential receiver, should not exceed the $L_{A90(15minute)}$ RBL by more than 5 dBA.

b. Time Restrictions

Monday to Friday 0700 hours to 1800 hours

Saturday 0700 hours to 1300 hours if inaudible on residential premises; otherwise 0800 hours to 1300 hours

No work on Sundays or Public Holidays

c. Silencing

All practical measures should be used to silence construction equipment, particularly in instances where extended hours of operation are required.

On the basis of the foregoing construction noise guidelines and the daytime $L_{A90(15minute)}$ RBLs (presented in **Table 8**) calculated from the background noise logging, relevant quarry construction noise assessment criteria, based on a 4 to 26 week construction period, are presented in **Table 10**.

Table 10 Daytime Construction Noise Criteria - dBA re 20 µPA

Receiver	$L_{A10(15minute)}$ Construction Criteria
R1 - 575 Brayton Road	44
R2 - 531 Brayton Road	46
R3 - 529 Brayton Road	44
R4 - 1540 Carrick Road	40

6 OPERATIONAL NOISE CRITERIA

The Gunlake Quarry operational noise emission criteria have been set with reference to the INP, as outlined in **Section 3.1**. Establishing the operational noise criteria includes an assessment of the RBLs, the intrusiveness criteria and the amenity criteria.

The intrusiveness criteria have been set for the proposed hours of quarry operation based on the RBLs (refer to **Table 8**) at the surrounding residences.

The existing ambient L_{Aeq} in the area surrounding the project site was controlled by rural sources and road traffic noise. The residences in the vicinity of the proposed quarry operations are best described by the "rural" receiver type. There being no other significant industrial noise sources in the area, the amenity criteria have been set using the recommended $L_{Aeq(period)}$ contribution from industrial noise as presented in **Table 3**.

The resulting operational intrusive and amenity noise emission criteria are given in **Table 11**.

Table 11 Operational Noise Emission Criteria - dBA 20 µPa[1]

Receiver	Intrusiveness Criterion LAeq(15minutes)			Amenity Criterion LAeq(period)		
	Daytime 0700 - 1800 Hours	Evening 1800 - 2200 Hours	Night 2200 - 0700 Hours	Daytime 0700 - 1800 Hours	Evening 1800 - 2200 Hours	Night 2200 - 0700 Hours
R1 - 575 Brayton Road	39	38	36	50	45	40
R2 - 531 Brayton Road	41	40	37	50	45	40
R3 - 529 Brayton Road	39	38	36	50	45	40
R4 - 1540 Carrick Road	35	36	35	50	45	40
17 Brayton Road	52	47	38	N/A	N/A	N/A

Review of the criteria presented in **Table 11** indicates that the amenity criteria noise levels are significantly higher than the intrusiveness criteria noise levels at all locations. Compliance with the intrusiveness criteria, therefore, will demonstrate compliance with the amenity criteria. Accordingly, the following assessment is based on the intrusiveness criteria being the controlling noise criteria.

7 ROAD TRANSPORTATION NOISE ASSESSMENT CRITERIA

Whilst operating on the project site, the assessment procedure for vehicle noise is as previously outlined in **Section 3**. That is, road vehicle noise contributions are included in the overall predicted $L_{Aeq(15minute)}$ quarry operational noise emissions. On public roads, including the bypass road, different noise assessment criteria apply to the vehicles, which would be regarded as "traffic", rather than as part of the quarrying operations noise sources.

In some instances, an intermediate approach between the "private" and "public" roadway assessment approaches may be appropriate. This could, for example, apply to the access roads well away from construction, quarrying and processing operations, where the vehicle noise would be clearly perceived as "traffic" noise, rather than as part of the operations.

In June 1999, the DECC (then the EPA) issued a document entitled "*Environmental Criteria for Road Traffic Noise*". In terms of the functional categories of roads, the DECC's document states that:

"It is noted that some industries (such as mines and extractive industries) are, by necessity, in locations that are often not served by arterial roads. Heavy vehicles must be able to get to their bases of operation, and this may mean travelling on local roads. Good planning practice recognises that we must acknowledge this type of road use and develop ways of managing any associated adverse impacts. To this end, the concept of 'principal haulage routes' has been endorsed by the Department of Urban Affairs and Planning's North Coast Extractive Industries Standing Committee. Ways of identifying 'principal haulage routes' and managing associated adverse impacts have not yet been fully defined. Where local authorities identify a 'principal haulage route', the noise criteria for the route should match those for collector roads, recognising the intent that they carry a different level and mix of traffic to local roads."

Accordingly, the Project related traffic on Brayton Road, the bypass road (Red Hills Road) as well as on the Interchange Underpass and George Street (adjacent to the new roundabout) has been assessed as a collector road.

Based on the above, the relevant assessment criteria for the Gunlake Quarry are presented in **Table 12**.

Table 12 Road Traffic Noise Criteria

Type of Development		Criteria LAeq(1hour) Daytime	Criteria LAeq(1hour) Night-time	Where Criteria Are Already Exceeded
8.	Land use developments with potential to create additional traffic on collector roads	60 dBA	55 dBA	Where feasible and reasonable, existing noise levels should be mitigated to meet the noise criteria. Examples of applicable strategies include appropriate location of private access roads; regulating times of use; using clustering; using "quiet" vehicles; and using barriers and acoustic treatments. In all cases, traffic arising from the development should not lead to an increase in existing noise levels of more than 2 dBA

Note: Total traffic noise contribution including existing and project related vehicle movements.
$L_{Aeq(1hour)}$ represents the highest L_{Aeq} noise level for any hour during daytime (0700 hrs to 2200 hrs) and night-time (2200 hrs to 0700 hrs).Blast Emissions Assessment Criteria.

8 BLAST EMISSIONS ASSESSMENT CRITERIA

8.1 Ground Vibration - Structural Damage

In terms of the most recent relevant blast vibration damage criteria, British Standard 7385:Part 2-1993 "*Evaluation and Measurement for Vibration in Buildings Part 2"* is a definitive standard against which the likelihood of building damage from ground vibration can be assessed. This is the Standard recommended in Australian Standard AS 2187: Part 2-2006 "*Explosives - Storage and Use - Part 2: Use of Explosives*" as the guideline values and assessment methods "are applicable to Australian conditions".

Although there is a lack of reliable data on the threshold of vibration-induced damage in buildings both in countries where national standards already exist and in the UK, BS 7385:Part 2 has been developed from an extensive review of UK data, relevant national and international documents and other published data. The standard sets guide values for building vibration based on the lowest vibration levels above which damage has been credibly demonstrated. These levels are judged to give a minimum risk of vibration-induced damage, where minimal risk for a named effect is usually taken as a 95% probability of no effect.

Sources of vibration which are considered in the standard include blasting (carried out during mineral extraction or construction excavation), demolition, piling, ground treatments (eg compaction), construction equipment, tunnelling, road and rail traffic and industrial machinery.

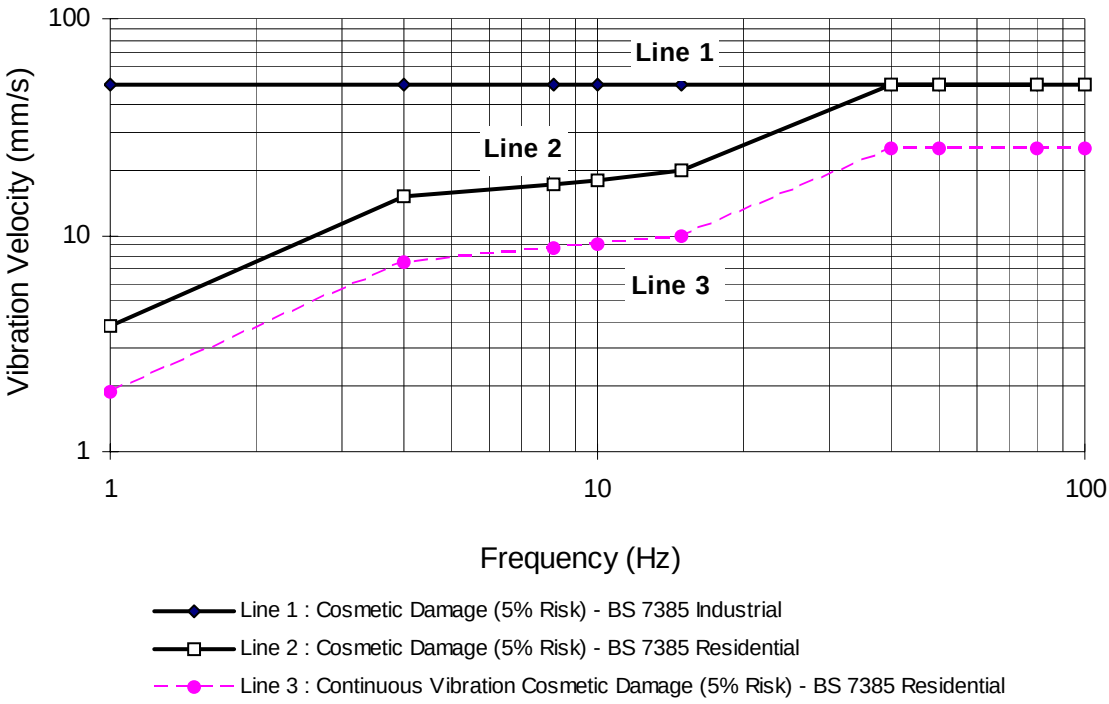
As the strain imposed on a building at the foundation level is proportional to the peak particle velocity, but is inversely proportional to the propagation velocity of the shear or compressional waves in the ground, this quantity (ie peak particle velocity) has been found to be the best single descriptor for correlating with case history data on the recurrence of vibration-induced damage.

The guide values from this standard for transient vibration judged to result in a minimal risk of cosmetic damage to residential buildings and industrial buildings are presented numerically in **Table 13** and graphically in **Figure 3**.

Table 13 Transient Vibration Guide Values for Cosmetic Damage

Line	Type of Building	Peak Component Particle Velocity in Frequency Range of Predominant Pulse	
		4 Hz to 15 Hz	**15 Hz and above**
1	Reinforced or framed structures Industrial and heavy commercial buildings	50 mm/s at 4 Hz and above	
2	Unreinforced or light framed structures Residential or light commercial type buildings	15 mm/s at 4 Hz increasing to 20 mm/s at 15 Hz	20 mm/s at 15 Hz increasing to 50 mm/s at 40 Hz and above

Figure 3 Graph of Transient Vibration Guide Values for Cosmetic Damage



In the lower frequency region where strains associated with a given vibration velocity magnitude are higher, the guide values for the building types corresponding to Line 2 are reduced. Below a frequency of 4 Hz where a high displacement is associated with the relatively low peak component particle velocity value, a maximum displacement of 0.6 mm (zero to peak) is recommended. This displacement is equivalent to a vibration velocity of 3.7 mm/s at 1 Hz.

The standard goes on to state that minor damage is possible at vibration magnitudes which are greater than twice those given in **Table 13** and major damage to a building structure may occur at values greater than four times the tabulated values.

Fatigue considerations are also addressed in the standard and it is concluded that unless calculation indicates that the magnitude and number of load reversals is significant (in respect of the fatigue life of building materials) then the guide values in **Table 13** should not be reduced for fatigue considerations.

It is noteworthy that extra to the guide values nominated in **Table 13**, the standard states that:

> *"Some data suggests that the probability of damage tends towards zero at 12.5 mm/s peak component particle velocity. This is not inconsistent with an extensive review of the case history information available in the UK."*

Also that:

> *"A building of historical value should not (unless it is structurally unsound) be assumed to be more sensitive."*

8.2 Airblast - Structural Damage

Based largely on work carried out by the US Bureau of Mines, the US Office of Surface Mining has presented the following regulatory limits for airblast from blasting (depending on the low frequency limit of the measuring system):

Low Frequency Limit	Peak Airblast Level Limit
2 Hz or lower	132 dB Linear
6 Hz or lower	130 dB Linear

These levels are generally consistent with the level of 133 dB Linear nominated in AS 2187.2-2006.

The US criteria are structural damage limits based on relationship between the level of airblast and the probability of window breakage, and include a significant safety margin. It has been well documented that windows are the elements of residential buildings most at risk to damage from airblast from blasting.

While cracked plaster is the type of damage most frequently monitored in airblast complaints, research has shown that window panes fail before any other structural damage occurs (USBM, RI 8485-1980). The probabilities of damage to windows exposed to a single airblast event are as shown in **Table 14**.

Table 14 Probability of Window Damage from Airblast

Airblast dB Linear	Level kPa	Probability of Damage	Effects and Comments
140	0.2	0.01%	“No damage” - windows rattle
150	0.6	0.5%	Very occasional failure
160	2.0	20%	Substantial failures
180	20.0	95%	Almost all fail

8.3 Human Comfort and Disturbance Considerations

The ground vibration and airblast levels which cause concern or discomfort to residents are significantly lower than the damage limits. Humans are far more sensitive to some types of vibration than is commonly realised. They can detect and possibly even be annoyed at vibration levels which are well below those causing any risk of damage to a building or its contents.

The criteria normally recommended for blasting in NSW, based on human discomfort, are contained in the DECC's Environmental Noise Control Manual (Chapter 154). However, for recent projects the DECC has advocated the use of the Australian and New Zealand Environment Council (ANZEC) guidelines.

The ANZEC criteria for the control of blasting impact at residences are as follows:

- The recommended maximum level for airblast is 115 dB Linear.
- The level of 115 dB Linear may be exceeded on up to 5% of the total number of blasts over a period of 12 months. The level should not exceed 120 dB Linear at any time.

The recommended maximum level for ground vibration is 5 mm/s (peak particle velocity (ppv)).

- The ppv level of 5 mm/s may be exceeded on up to 5% of the total number of blasts over a period of 12 months. The level should not exceed 10 mm/s at any time.
- Blasting should generally only be permitted during the hours of 0900 hours to 1700 hours Monday to Saturday. Blasting should not take place on Sundays and public holidays.

9 QUARRY NOISE MODELLING PROCEDURE

9.1 Prediction of Noise Emissions - General Discussion

In order to determine the acoustical impact of the proposed Gunlake Quarry, a computer model was developed to incorporate the significant noise sources and the intervening terrain to the closest potentially affected residential properties.

The computer model was prepared using the SoundPLAN V6.4 Industrial Module, a commercial software system developed by Braunstein and Berndt GmbH in Germany. The software allows the use of various internationally recognised noise prediction algorithms. The CONCAWE algorithm, suitable for the assessment of large industrial plants, has been selected for this assessment as it also enables meteorological influences to be assessed.

The noise modelling takes into account source sound level emissions and locations, screening effects, receiver locations, meteorological effects, ground topography and noise attenuation due to spherical spreading and atmospheric absorption. Ground contours were obtained from the client and supplemented by topographical maps.

Noise predictions were calculated to four residential/rural receivers surrounding the proposed Gunlake Quarry.

9.2 Prediction of Noise Emissions - Construction

Noise prediction models were conducted for the construction and operation of the proposed Gunlake Quarry. One construction scenario was required as Gunlake have proposed to construct a bund wall up to 15m high adjacent to the proposed processing plant. The construction scenario modelled the following items of plant and equipment:

Construction Scenario

- CAT D10 creating plateau for processing plant at RL 652m.
- Grader constructing roads.
- 12t Roller compacting plateau.

9.3 Prediction of Noise Emissions - Operation

Two operational scenarios for day and night were assessed in order to represent the development stages throughout the quarry life and were based on a maximum output of 500,000 tpa. These scenarios have been referred to as:

- Start-up of initial work at a pit depth of RL 660 m.
- 50% of the quarry life at a pit depth of RL 582 m.

The majority of plant (mobile and fixed) noise used in the proposed Gunlake Quarry has been obtained from the existing Heggies reference levels. Where appropriate the noise model included multiple plant items undertaking particular tasks during the fifteen minute sample period, such as trucks being loaded and departing and returning to be reloaded. **Table 34** presents maximum overall maximum A-weighted sound power level (SWL) for each item of plant and equipment which Gunlake have indicated will be used at the Gunlake Quarry.

The two operational scenarios modelled for this assessment comprised the following concurrent operations:

Operational Scenarios - Year 1, Year 10+

- Dump trucks on the haul route between the pit and the crusher.
- Loaders loading haul trucks in the pit.
- Processing plant.
- Loaders loading road trucks at the processing plant.
- Water truck watering the road.
- Blasthole drilling in an elevated position on the top of the pit bench (two drills approximately 1 day per week - daytime only).
- Hydraulic rockbreaker in pit.
- Road trucks leaving the site via the access road to Brayton Road.

Within the noise model, operations consisted of all plant items operating concurrently in order to simulate the overall maximum potential noise emission.

It should be noted that the sound power levels given for each item of mobile equipment do not include noise emissions which emanate from reversing alarms.

In the event that reversing alarm noise is considered to be a source of disturbance, the alarm noise level should be checked against the appropriate regulatory and health and safety requirements and the necessary mitigating action taken to achieve an acceptable noise reduction without compromising safety standards.

9.4 Meteorological Parameters

As discussed in **Section 3.1**, the frequency analysis showed that there were prevailing winds that occurred for 30% or more during any period.

The INP states that temperature inversions need only be considered for the night-time noise assessment period ie 2200 hours to 0700 hours.

At the subject quarry, truck loading and haulage will be required to operate during the evening and night-time periods. Consequently, in accordance with the INP, these night-time operations are required to be assessed under prevailing temperature inversion conditions.

Noise Modelling Meteorology

The contributed noise emissions for the proposed operational scenarios at the nearest potentially affected residential properties have been calculated with the following meteorological parameters (refer to **Section 3.1**):

Daytime Operations (0700 hours to 1800 hours)

Calm

- During "calm" summer conditions (15°C air temperature, 75% Relative Humidity, 0 m/s wind speed and 0°C/100 m temperature gradient).

Adverse Wind

- During summer "adverse wind" conditions (15°C air temperature, 75% Relative Humidity, 0°C/100 m temperature gradient and a 3 m/s wind speed from the east-northeast and from the northeast).

Evening Operations (1800 hours to 2200 hours)

Calm

- During "calm" summer conditions (10°C air temperature, 75% Relative Humidity, 0 m/s wind speed and 0°C/100 m temperature gradient).

Adverse Wind

- During summer "adverse wind" conditions (10°C air temperature, 75% Relative Humidity, 0°C/100 m temperature gradient and a 3 m/s wind speed from the east-southeast.

Night-time Operations (2200 hours to 0700 hours)

Calm

- During "calm" summer conditions (5°C air temperature, 75% Relative Humidity, 0 m/s wind speed and 0°C/100 m temperature gradient).

Adverse Wind

- During summer "adverse wind" conditions (5°C air temperature, 75% Relative Humidity, 0°C/100 m temperature gradient and a 3 m/s wind speed from the east-northeast).

Temperature Inversion and Calm Wind

- Prevailing moderate temperature inversion (0°C air temperature, 85% relative humidity, 3°C/100 m temperature inversion and calm winds, as there are no prevailing winds above 30% occurrence during winter).

10 NOISE IMPACT ASSESSMENT

10.1 Noise Impact Assessment - Construction

The likely duration of construction for the proposed Gunlake Quarry is between 4 weeks and 26 weeks duration. This includes the erection of static plant (including crushing plant and screens) and the construction of an earth bund wall along the northeast boundary. Therefore, the $L_{A10(15minute)}$ noise level emitted by the works when measured at a residential receiver should not exceed the $L_{A90(15minute)}$ RBL by more than 10 dBA.

Based on the meteorological parameters from **Section 9.4**, output results from the noise model are presented in **Table 15** together with the respective criteria.

Table 15 Predicted Daytime Construction Noise Levels - dBA re 20 µPa

Receiver	Predicted LA10(15minute) Noise Level	LA10(15minute) Construction Criterion
R1 - 575 Brayton Road	43	44
R2 - 531 Brayton Road	38	46
R3 - 529 Brayton Road	39	44
R4 - 1540 Carrick Road	37	40
R5 - Proposed Residence	25	40

The results presented in **Table 15** indicate that the proposed construction activities will comply with the construction noise criteria at all surrounding residential receivers.

10.2 Noise Impact Assessment - Operations

Based on the output from the noise model and on the noise emissions criteria presented in **Table 11**, **Table 16**, **Table 17** and **Table 18** present the predicted $L_{Aeq(15minute)}$ noise level contributions from the proposed quarry operations together with the respective criteria. These predicted noise levels have been modelled assuming the noise management recommendations described in **Section 14** of this report have been implemented.

Blasthole drilling will occur on average 1 day per week (daytime only) and was therefore not modelled in the scenarios given in **Table 16, Table 17** and **Table 18**. There will be no blasthole drilling during the evening and night-time hours. Modelling with the blasthole drills indicated that the daytime $L_{Aeq(15minute)}$ noise levels increase by 0 dBA to 2 dBA at the nominated receivers for the Year 1 scenario. There was no corresponding noise level increase with the addition of the two blasthole drills to the Year 10 Scenario.

Table 16 Daytime (0600-1800 hrs) Noise Level Impact Assessment - dBA re 20 µPa

Receiver	Predicted $L_{Aeq(15minute)}$ Noise Level			$L_{Aeq(15minute)}$ Intrusive Criterion
	Calm	3m/s ENE Wind	3 m/s NE Wind	
Year 1 Scenario				
R1	38	34	35	39
R2	34	30	32	41
R3	35	32	34	39
R4	32	35	32	35
R5	21	23	23	35
Year 10 Scenario				
R1	37	34	35	39
R2	33	29	31	41
R3	33	31	33	39
R4	31	34	31	35
R5	19	22	22	35

Table 17 Evening (1800-2200 hrs) Noise Level Impact Assessment - dBA re 20 µPa

Receiver	Predicted $L_{Aeq(15minute)}$ Noise Level		$L_{Aeq(15minute)}$ Intrusive Criterion
	Calm	3m/s ESE Wind	
Year 1 Scenario			
R1	32	26	38
R2	27	21	40
R3	24	18	38
R4	25	30	36
R5	7	11	35
Year 10 Scenario			
R1	32	26	38
R2	27	21	40
R3	24	18	38
R4	25	30	36
R5	7	11	35

Table 18 Night-time (2200-0700 hrs) Noise Level Impact Assessment - dBA re 20 µPa

Receiver	Predicted $L_{Aeq(15minute)}$ Noise Level			$L_{Aeq(15minute)}$ Intrusive Criterion
	Calm	3m/s ENE Wind	3 m/s Wind 3°C/100 m Inversion	
Year 1 Scenario				
R1	32	28	35	36
R2	27	24	32	37
R3	24	23	28	36
R4	25	29	29	35
R5	7	12	12	35
Year 10 Scenario				
R1	32	28	35	36
R2	27	24	32	37
R3	24	23	28	36
R4	25	29	29	35
R5	7	12	12	35

The results presented in **Table 16, Table 17** and **Table 18** indicate that the proposed operations will comply with the noise criteria during each assessment at all surrounding residential receivers.

11 ROAD TRAFFIC NOISE IMPACT ASSESSMENT

Further to the road vehicles included in the Gunlake Quarry noise model, as described in **Section 9.3**, the noise impact of the quarry related road traffic on the Brayton Road and Red Hills Road was conducted via the prediction of future (with the quarry operating) peak hourly traffic noise levels on the subject roads.

The US Environment Protection Agency's method was used for the prediction of the L_{Aeq} traffic noise levels for the offset distances of the closest residences adjacent to the proposed quarry.

The US EPA's method for prediction of the L_{Aeq} noise levels from traffic is an internationally accepted theoretical traffic noise prediction model which takes into account the L_{Amax} vehicle noise levels (light and heavy), receiver offset distance, passby duration, vehicle speed, ground absorption (based on the ratio of soft ground and average height of propagation), number of hourly vehicle movements, receiver height, truck exhaust height and the height and location of any intervening barriers.

Based on the existing traffic flows and traffic mix presented in the Traffic Count Study of Brayton Road, Red Hills Road and the Interchange Underpass, Marulan prepared by CFE Information Technologies (May/June 2007) and on the proposed quarry related traffic volumes presented in the Transport of the Proposed Gunlake Quarry, Brayton Road (Christopher Hallam & Associates Pty Ltd, February 2008), **Table 19**, **Table 20, Table 21, Table 22** and **Table 23** summarise the existing and future traffic flow data.

Table 19 Existing Traffic Movements
Brayton Road - South of Proposed Quarry

Period	Maximum Hourly		Minimum Hourly		7 Day Average Maximum Hourly	
	Light	Heavy	Light	Heavy	Light	Heavy
Day	31	23	1	0	22	14
(0700-2200 hours)	(1500-1600 hours)		(2100-2200 hours)		(0800-0900 hours)	
Night	10	11	0	0	10	5
(2200-0700 hours)	(0600-0700 hours)		(0200-0300 hours)		(0600-0700 hours)	

Table 20 Existing Traffic Movements
Brayton Road - Marulan Village

Period	Maximum Hourly		Minimum Hourly		7 Day Average Maximum Hourly	
	Light	Heavy	Light	Heavy	Light	Heavy
Day (0700-2200 hours)	41	26	11	0	50	13
	(2100-2200 hours)		(2000-2100 hours)		(0800-0900 hours)	
Night (2200-0700 hours)	25	22	1	0	27	4
	(0600-0700 hours)		(0200-0300 hours)		(0600-0700 hours)	

Table 21 Existing Traffic Movements
Red Hills Road

Period	Maximum Hourly		Minimum Hourly		7 Day Average Maximum Hourly	
	Light	Heavy	Light	Heavy	Light	Heavy
Day (0700-2200 hours)	5 (1200-1300 hours)	6	0 (2000-2100 hours)	0	8 (1600-1700 hours)	1
Night (2200-0700 hours)	2 (0600-0700 hours)	1	0 (0300-0400 hours)	0	2 (0600-0700 hours)	0

Table 22 Existing Traffic Movements
Brayton Road - Interchange Underpass

Period	Maximum Hourly		Minimum Hourly		7 Day Average Maximum Hourly	
	Light	Heavy	Light	Heavy	Light	Heavy
Day (0700-2200 hours)	41 (1500-1600 hours)	12	2 (2100-2200 hours)	1	45 (1600-1700 hours)	3
Night (2200-0700 hours)	14 (0700-0800 hours)	4	0 (0100-0200 hours)	0	14 (0600-0700 hours)	3

Table 23 Existing Traffic Movements - Peak Hour Flows
George Street (North of Portland Avenue)

Period	Maximum Hourly	
	Light	Heavy
0630-0730 hours	43	15
0800-0900 hours	47	14
1200-1300 hours	82	16
1730-1830 hours	65	3

The daytime and night-time traffic noise level predictions for Brayton Road, south of the quarry entrance, at the closest residential receiver to the road are presented in **Table 24**. This residence is located 71 m from Brayton Road. Also presented in **Table 24** are the maximum allowable truck movements (passbys), based on the DECC's criteria.

Table 25 presents the predicted existing and future traffic noise level predictions for the other more distant residences on this section of Brayton Road.

Table 24 Predicted Future $L_{Aeq(1hour)}$ Traffic Noise Levels - Brayton Road South of Proposed Quarry Entrance - 71 m from Road Centre

	Maximum Hourly Existing Plus Quarry				Minimum Hourly Existing Plus Quarry				7 Day Average Maximum Hourly Existing Plus Quarry			
Number of Hourly Quarry Truck Movements	1	2	4	8	1	2	4	8	1	2	4	8
Day (0700-2200 hours)	52.6	52.8	53.0	53.5	42.8	43.9	45.5	47.6	50.9	51.1	51.4	52.1
Maximum Allowable Trucks Movements	170				176				175			
Night (2200-0700 hours)	49.6	49.9	50.3	51.1	42.5	43.7	45.4	47.5	47.6	48.0	48.7	49.9
Maximum Allowable Trucks Movements	55				55				52			

Table 25 Predicted Existing and Future $L_{Aeq(1hour)}$ Traffic Noise Levels - Brayton Road - North of Marulan Village

EA Residence Identifier/ Offset Distance	Existing Maximum Hourly - dBA (Day / Night)	Existing Maximum Hourly Plus Quarry (3 movements/hr) - dBA (Day / Night)
5 - 195 m	45.5 / 42.0	46.2 / 43.4
7 - 80 m	51.4 / 47.9	52.1 / 49.3
8 - 530 m	38.9 / 35.4	39.6 / 36.8
12 - 155 m	47.0 / 43.5	47.7 /44.9
15 - 160 m	46.8 /43.3	47.5 / 44.7
16 - 165 m	46.6 / 43.1	47.3 / 44.5
17 - 75 m	51.8 / 48.3	52.5 / 49.7
19 - 75 m	51.8 / 48.3	52.5 / 49.7
21 - 420 m	40.5 / 36.9	41.2 / 38.4
22 - 230 m	44.4 / 40.9	45.1 / 43.3
23 - 640 m	37.7 / 34.9	38.4 / 35.6

The daytime and night-time $L_{Aeq(1hour)}$ traffic noise level predictions at the closest residences to Brayton Road, Marulan Village and Red Hills Road are presented in **Table 26** and **Table 28** respectively based on the maximum hourly quarry related traffic and the minimum existing hourly traffic.

Table 26 Predicted Future $L_{Aeq(1hour)}$ Traffic Noise Levels Brayton Road - Marulan Village - 21 m from Road Centre

	Maximum Hourly Existing Plus Quarry				Minimum Hourly Existing Plus Quarry				7 Day Average Maximum Hourly Existing Plus Quarry			
Number of Hourly Quarry Truck Movements	1	2	4	8	1	2	4	8	1	2	4	8
Day (0700-2200 hours)	62.7	62.8	63.0	63.4	54.7	55.3	56.4	57.9	61.3	61.5	61.8	62.3
Maximum Allowable Trucks Movements	18[1]				16				13[1]			
Night (2200-0700 hours)	61.7	61.9	62.1	62.6	52.4	53.5	55.0	57.0	58.2	58.5	59.1	60.0
Maximum Allowable Trucks Movements	14[1]				4				4[1]			

Note 1 Based on increasing the existing traffic noise level by 2 dBA

Table 27 presents the predicted and future traffic noise level predictions for the other more distant residences on the Marulan Village section of Brayton Road. However, there is only one residential receiver on the quarry access road section of Red Hills Road.

Table 27 Predicted Existing and Future $L_{Aeq(1hour)}$ Traffic Noise Levels - Brayton Road, Marulan Village

Number of Residences/ Range of Offset Distances	Existing Maximum Hourly - dBA	Maximum Hourly Existing Plus Quarry (3 movements/hr) - dBA
North/South Road Section		
13 Residences / 21 m to 50 m	56.6 to 62.3 (Day)	57.2 to 62.9 (Day)
	55.5 to 61.2 (Night)	56.3 to 62.0 (Night)
East/West Road Section		
36 Residences / 21 m to 50 m	56.6 to 62.3 (Day)	57.2 to 62.9 (Day)
	55.5 to 61.2 (Night)	56.3 to 62.0 (Night)

Table 28 Predicted Future $L_{Aeq(1hour)}$ Traffic Noise Levels Red Hills Road - 350 m from Road Centre

	Maximum Hourly Existing Plus Quarry				Minimum Hourly Existing Plus Quarry				7 Day Average Maximum Hourly Existing Plus Quarry			
Number of Hourly Quarry Truck Movements	1	2	4	8	1	2	4	8	1	2	4	8
Day (0700-2200 hours)	37.0	37.4	38.2	39.3	32.0	33.2	34.8	37.0	34.7	35.3	36.4	38.0
Maximum Allowable Trucks Movements									2000			
Night (2200-0700 hours)	33.6	34.4	35.7	37.6	32.0	33.2	34.8	37.0	32.5	33.6	35.1	37.2
Maximum Allowable Trucks Movements									650			

The daytime and night-time traffic noise level predictions for the Interchange Underpass at the closest residential receiver adjacent to (south of) the proposed roundabout are presented in **Table 29**. This residence has facades located 52 m from the Interchange Underpass and 30 m from George Street. Also presented in **Table 29** are the maximum allowable truck movements (passbys), based on the DECC's criteria.

Table 29 Predicted Future $L_{Aeq(1hour)}$ Traffic Noise Levels[1] Brayton Road - Interchange Underpass - 52 m from Road Centre

	Maximum Hourly Existing Plus Quarry				**Minimum Hourly Existing Plus Quarry**				**7 Day Average Maximum Hourly Existing Plus Quarry**			
Number of Hourly Quarry Truck Movements	1	2	4	8	1	2	4	8	1	2	4	8
Day (0700-2200 hours)	57.0	57.2	57.5	58.2	49.7	50.6	52.1	54.1	54.8	55.1	55.7	56.7
Maximum Allowable Trucks Movements[2]	23				40				31			
Night (2200-0700 hours)	53.2	53.6	54.4	55.7	47.9	49.3	51.2	53.5	52.7	53.2	54.1	55.4
Maximum Allowable Trucks Movements[2]	6				42				10			

Note 1: All predictions include 10 quarry related light vehicles.

Note 2: Number of trucks required to achieve the respective 60 dBA and 55 dBA night-time LAeq(1hour) criteria.

The existing $L_{Aeq(1hour)}$ traffic noise level predictions for George Street are presented in **Table 30**, based on the existing peak hour traffic flows, together with the corresponding $L_{Aeq(1hour)}$ criteria for the quarry related traffic and the maximum allowable hourly quarry related traffic.

Table 30 Predicted Existing $L_{Aeq(1hour)}$ Traffic Noise Levels - Peak Periods George Street, Marulan - 30 m from Road Centre

Period	**Existing Peak $L_{Aeq(1hour)}$ Noise Level**	**$L_{Aeq(1hour)}$ Criterion[1]**	**Allowable Vehicle Movements (Passbys)**	
			Light	**Heavy**
0630-0730 hours	60.6 dBA	62.6 dBA	10	11
0800-0900 hours	60.5 dBA	62.5 dBA	10	11
1200-1300 hours	61.9 dBA	63.9 dBA	10	16
1730-1830 hours	58.5 dBA	60.5 dBA	10	6

Note 1: Based on increasing the existing noise level by 2 dBA.

Review of the road traffic noise level predictions presented in **Table 24**, **Table 26 Table 28**, **Table 29** and **Table 30** and the traffic noise criteria presented in **Table 12** indicates the following:

- The existing daytime and night-time $L_{Aeq(1hour)}$ noise levels are lower than the NSW DEC's recommended assessment criteria of 60 dBA and 55 dBA at the closest residences on Brayton Road, south of the proposed quarry, and at the closest residence on Red Hills Road but exceed the criteria at the closest residence in Marulan Village (based on the measured maximum hourly traffic flows).
- Based on the controlling traffic flow scenarios of the existing maximum daytime hourly traffic and the existing 7 day average maximum hourly night-time traffic on Brayton Road, south of the quarry, plus quarry traffic, the allowable number of trucks to comply with the 60 dBA and 55 dBA $L_{Aeq(1hour)}$ criteria for the daytime and night-time are 170 trucks per hour and 52 trucks per hour respectively.

- Based on the controlling traffic flow scenarios of the 7 day average maximum hourly daytime and night-time traffic on Brayton Road, through Marulan Village, the allowable number of trucks to comply with the allowable 2 dBA increase in the existing $L_{Aeq(1hour)}$ traffic noise levels are 13 trucks per hour during daytime and 4 trucks per hour during the night.
- Based on the controlling traffic flow scenarios of the 7 day average maximum hourly daytime and night-time traffic on Red Hills Road, the allowable number of trucks to comply with the 60 dBA and 55 dBA $L_{Aeq(1hour)}$ criteria respectively are 2,000 trucks per hour and 650 trucks per hour respectively.
- The existing daytime and night-time $L_{Aeq(1hour)}$ noise levels from traffic on the Interchange Underpass are lower than the NSW DECC's recommended assessment criteria of 60 dBA and 55 dBA at the closest residence to the proposed roundabout.
- Based on the controlling traffic flow scenarios of the existing maximum daytime and night-time hourly traffic on the Interchange Underpass, plus quarry traffic, the allowable number of truck movements to comply with the 60 dBA and 55 dBA $L_{Aeq(1hour)}$ criteria for the daytime and night-time are 23 truck movements per hour and 6 truck movements per hour respectively.
- The existing peak hour $L_{Aeq(1hour)}$ noise levels from the traffic on George Street are higher than the NSW DECC's recommended assessment criteria at the closest residence to the proposed roundabout.
- Based on the controlling 1730 hours to 1830 hours peak traffic flow scenario on George Street, the allowable number of truck movements to comply with the allowable 2 dBA increase in the existing peak $L_{Aeq(1hour)}$ traffic noise level is 6 truck movements per hour.

In conclusion, the predicted existing plus worst case quarry traffic noise levels (from the proposed maximum of 3 truck movements per hour) will clearly comply with the NSW DECC's daytime and night-time traffic noise criteria nominated in **Table 12** on Brayton Road, Red Hills Road and at the Interchange Underpass and George Street (adjacent to the new roundabout).

12 CUMULATIVE NOISE ASSESSMENT

In order to assess any cumulative noise emissions, it is important to appreciate and distinguish between the INP's first and second environmental noise control objectives as follows:

Intrusive Noise Criteria $L_{Aeq(15minute)}$

The INP's first objective, that the intrusive noise emission from any single development does not exceed the background level by more than 5 dBA, relates to individual industrial sites where the intrusive noise limit is generally specified in the Development Consent and/or Pollution Control Licence.

There is no established procedure (or regulatory requirement) to derive intrusive $L_{Aeq(15minute)}$ noise criteria for the cumulative operation of existing and/or approved industrial developments in a locality.

Noise Amenity Criteria $L_{Aeq(period)}$

The INP's second objective, that the $L_{Aeq(period)}$ amenity level (ie non-transport related) does not exceed the specified "acceptable" or "maximum" noise level appropriate for the particular locality and land use, is aimed at restricting the potential cumulative increase in amenity noise levels, otherwise known as "background creep".

Accordingly, the cumulative impact of the project area with existing and proposed noise sources (ie the Johnniefelds Quarry and the Lynwood Quarry respectively) has been assessed via the determination of compliance with the amenity noise criteria.

Review of the relative locations of the various residential receivers relative to the quarries indicates that Residence R1 is potentially most affected by noise from the Johnniefelds Quarry and the proposed Residence R5 is potentially most affected by noise from the Lynwood Quarry.

The cumulative noise at these receiver locations (ie R1 and R5) would be higher than at other locations equidistant from all three quarries.

The highest predicted $L_{Aeq(15minute)}$ noise level from the proposed quarry at Residence R1 is 38 dBA during daytime (refer to **Table 16**). This noise level is 12 dBA lower than the amenity criterion of 50 dBA $L_{Aeq(day)}$ (refer to **Table 11**).

The estimated $L_{Aeq(15minute)}$ noise level contribution at Residence R1 from the Johnniefelds Quarry, based on the attended noise survey data (refer to **Table 9**), would be less than 32 dBA. This noise level is 18 dBA lower than the amenity criterion of 50 dBA $L_{Aeq(day)}$.

Given that the $L_{Aeq(day)}$ industrial noise levels would be at least 3 dBA lower than the $L_{Aeq(15minute)}$ intrusive levels, the cumulative impact at Residence R1 would be considerably (approximately 15 dBA) lower than the $L_{Aeq(day)}$ 50 dBA criterion.

Similarly, for the proposed Residence R5, the highest predicted $L_{Aeq(15minute)}$ noise level from the proposed quarry is 23 dBA during daytime (refer to **Table 16**). This noise level is 27 dBA lower than the amenity criterion of 50 dBA $L_{Aeq(day)}$.

The estimated worst case $L_{Aeq(15minute)}$ noise level contribution at Residence R5 from the Lynwood Quarry, from a review of the Noise Impact Assessment noise contours, is less than 25 dBA. This noise level is 25 dBA lower than the 50 dBA $L_{Aeq(day)}$ amenity criterion.

Again, given that the $L_{Aeq(day)}$ industrial noise levels would be at least 3 dBA lower than the $L_{Aeq(15minute)}$ intrusive levels, the cumulative impact at the proposed Residence R5 would be considerably (approximately 23 dBA) lower than the 50 dBA $L_{Aeq(day)}$ criterion.

13 BLAST EMISSIONS IMPACT ASSESSMENT

13.1 Proposed Blasting Practices

The proposed method of material extraction for the Gunlake Quarry is by drill and blast techniques incorporating free-face blasting. A summary of indicative blast design details is presented in **Table 31**.

Table 31 Indicative Blast Design Details

Parameter	Free-Face
Bench height	Up to 13 m
Sub-drill	0 m
Stemming (using 14 mm aggregate)	2.5 m
Blasthole diameter	76 mm
Blasthole inclination (to vertical)	10°
Blasthole spacing	2.5 m
Burden	2.5 m
Maximum Instantaneous Charge (MIC)	49 kg (for 13 m bench)

13.2 Blast Emission Levels

The blasting site laws developed from the blast emission data obtained from Readymix's nearby Johniefelds Quarry for their Lynwood Quarry have been used to assess the blasting impacts from the subject Gunlake Quarry. These site laws were published in Appendix 10 of the EIS for Readymix's Lynwood Quarry prepared by Umwelt (Australia) Pty Ltd dated May 2005. The blast emission results monitored between February 2000 and June 2004 were used in the analysis.

The ground vibration and airblast criteria advocated by the DECC and the ANZEC cater for the inherent variation in emission levels from a given blast design by allowing a five percent exceedance of a general criterion up to a (never to be exceeded) maximum. Correspondingly, the "5% exceedance" prediction formulae were generated in the blast emission site laws.

The resulting 5% site laws for ground vibration and airblast are:

Ground Vibration

$$PVS\ (mm/s)\ (5\%) = 3{,}447\ (SD)^{-1.6}$$

Airblast

$$SPL\ (dBL)\ (5\%) = 172 - 25 \log (SD)$$

where PVS (5%) and SPL (5%) are the levels of ground vibration (Peak Vector Sum - mm/s) and airblast (dB Linear) respectively, above which 5% of the total population (of data points) will lie, assuming that the population has the same statistical distribution as the underlying measured sample.

PVS = Peak Vector Sum ground vibration level (mm/s)
dB = Peak airblast level (dB Linear)
R = Distance between charge and receiver (m)
Q = Charge mass per delay (kg)

The relationship between distance and the peak vector sum (PVS) ground vibration and peak airblast from the quarry blasting are presented in **Figure 4** and **Figure 5** respectively for an MIC of 49 kg (corresponding to firing a full 13 m bench).

Figure 4 Peak Vector Sum Ground Vibration for an MIC of 49 kg

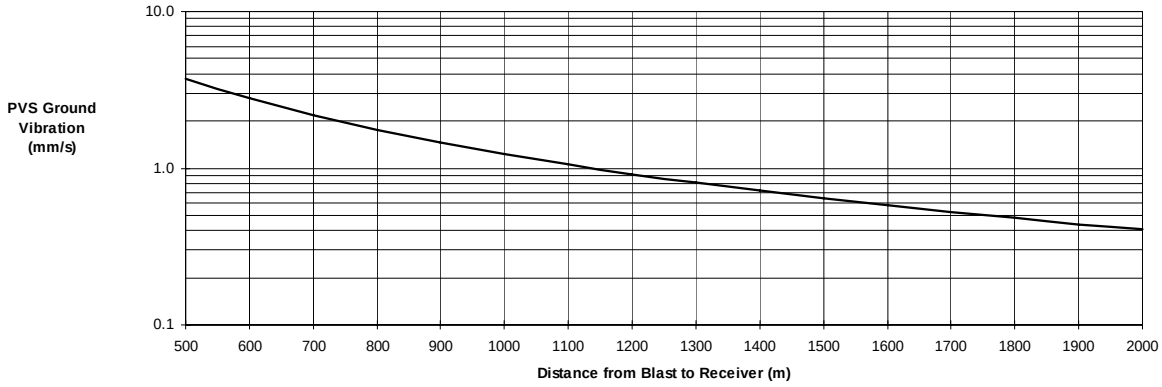
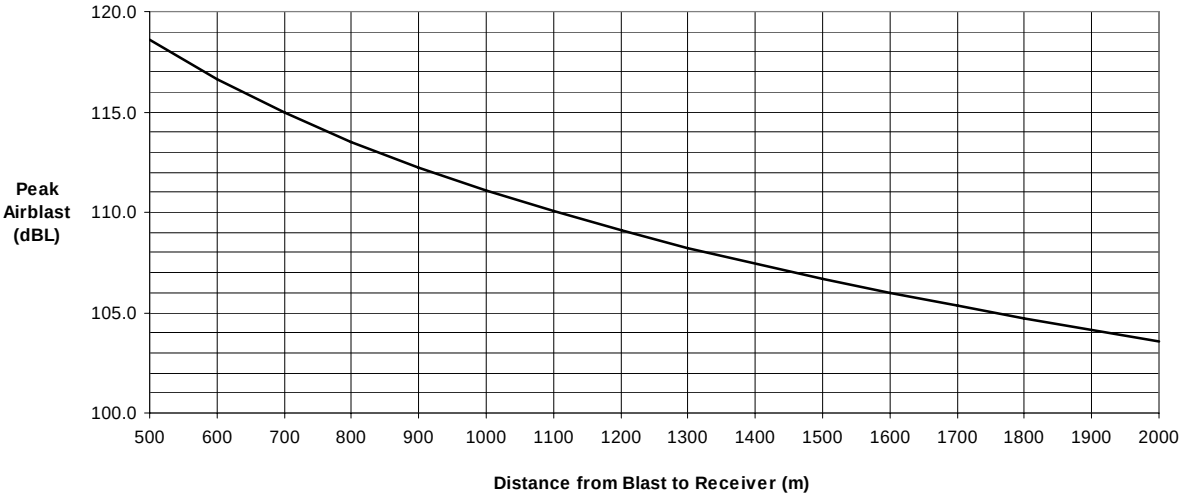


Figure 5 Peak Airblast for an MIC of 49 kg



The predicted level of blast emissions were then determined using the appropriate (near and far) distances to the quarry extraction boundary. The predicted levels of Peak Vector Sum (PVS) ground vibration velocity and peak airblast at the nearest potentially affected properties to the quarry blasting are presented in **Table 32**.

Table 32 Predicted Levels of Blast Emissions for a 49 kg MIC

Residence	Distance from Blasting	PVS Ground Vibration	Peak Airblast
R1 - 575 Brayton Road	1,170 m - 1,020 m	1.0 - 1.2 mm/s	109 - 111 dB Linear
R2 - 531 Brayton Road	1,260 m - 960 m	0.8 - 1.3 mm/s	108 - 111 dB Linear
R3 - 529 Brayton Road	1,200 m - 780 m	0.9 - 1.8 mm/s	109 - 114 dB Linear
R4 - 1540 Carrick Road	1,810 m - 1,330 m	0.5 - 0.8 mm/s	105 - 108 dB Linear
R5 - Proposed Residence	1,760 m - 1,600 m	0.5 - 0.6 mm/s	105 - 106 dB Linear

The following information is derived from the predicted levels of blast emissions:

- The predicted levels of ground vibration at all nearby residences comply with the ANZEC general human comfort criterion (of 5 mm/s) and consequently with the ANZEC maximum human comfort criterion as well as the BS 7385 structural damage criterion of 15 mm/s (at 4 Hz).
- The maximum predicted ground vibration level of 1.8 mm/s occurs at Residence R3 using an MIC of 49 kg (corresponding to blasting a full height 13 m bench).
- The predicted levels of peak airblast at all residences comply with the ANZEC general human comfort criterion of 115 dB Linear and consequently with the ANZEC maximum human comfort criterion.
- The predicted levels of peak airblast are clearly well below the US Bureau of Mines damage limit of 132 dB Linear (2 Hz cut off) at all residences.

Notwithstanding the above, it is recommended that all blasts are monitored at the closest/potentially most affected residence in order to establish compliance with the nominated criteria and to progressively update the blast emissions site laws (ground vibration and airblast) in order to optimise future blast designs, based on actual site conditions. In this way, the site laws can be used to assist with the blast designs in order to ensure compliance with the ANZEC criteria are met at all nearby residences.

By adopting this approach, in conjunction with the inevitable future introduction of improved blasting products, it is anticipated that the blast emissions criteria can be met without imposing any significant constraints on the blast designs throughout the life of the quarry.

14 NOISE MANAGEMENT AND CONTROL

The INP states that the project specific criteria derived in accordance with the policy have been designed to protect at least 90% of the population living in the vicinity of industrial noise sources from the adverse effects of noise for at least 90% of the time. Provided the criteria in the INP are achieved, it is unlikely that most people would consider the resultant noise levels excessive.

In those cases where the INP project specific assessment criteria are not achieved, it does not automatically follow that all people exposed to the noise would find the noise unacceptable. In subjective terms, exceedances of the INP project specific assessment criteria can be generally described as follows:

- Negligible noise level increase <1 dBA (not noticeable by all people).
- Marginal noise level increase 1 dBA to 2 dBA (not noticeable by most people).
- Moderate noise level increase 3 dBA to 5 dBA (not noticeable by some people but may be noticeable by others).
- Appreciable noise level increase >5 dBA (noticeable by most people).

In view of the foregoing, **Table 33** presents the methodology for assessing noise levels which may exceed the INP project specific noise assessment criteria.

Table 33 Noise Impact Assessment Methodology

Assessment Criteria	Project Specific Criteria	Noise Management Zone
Intrusive	Rating background level plus 5 dBA	≤ 5 dBA above project specific criteria
Amenity	INP based on existing industrial level	≤ 5 dBA above project specific criteria

For the purposes of assessing the potential noise impacts, the management zone is further defined as follows:

Noise Management Zone

Depending on the degree of exceedance of the project specific criteria (1 dBA to 5 dBA) noise impacts could range from negligible to moderate. It is recommended, in accordance with the INP, that management procedures be implemented including:

- Noise monitoring on site and within the community.
- Prompt response to any community issues of concern.
- Refinement of on site noise mitigation measures and quarry operating procedures, where practical.
- Discussions with relevant property holders to assess concerns.
- Consideration of acoustical mitigation at the receivers.
- Consideration of negotiated agreements with property holders.

Note that the management procedures described above are in addition to ensuring that feasible noise controls, as included in the predictive modelling, have been implemented for all stages of this project including:

- Blasthole drilling operations being restricted to daytime only.

All fixed and mobile plant being selected to have a sound power level not exceeding those outlined in **Table 34**.

Table 34 SWL of Plant for Gunlake Quarry

Plant Items	SWL L_{Aeq} (dBA)
Primary Jaw Crusher	94
Secondary Gyratory Crusher	105
Tertiary Cone Crusher	105
Screen 1	105
Screen 2	88
Excavator	104
Face Loader (FEL)	109
Stock Pile Loader	108
Road Trucks	105
Quarry Truck	100
D10 Dozer	116
12t Roller	109
Grader	110
Blasthole Drills	112

Recommended Noise Compliance Limits

In accordance with the procedures described in the INP, initial consultation should be undertaken with the DECC in relation to the setting of achievable noise limits for the project.

15 SUMMARY OF RESULTS AND FINDINGS

This report presents the results and findings of an assessment of the potential impacts of the construction and operation of the proposed Gunlake Quarry, located 8 km northwest of Marulan, NSW.

From an analysis of background noise measurements conducted in accordance with the INP (refer to **Section 3.1**), the daytime construction and daytime, evening and night-time intrusive noise level criteria at the potentially most affected residences were established.

In relation to the operational noise impact assessment conducted for this project, compliance with operational $L_{Aeq(15minute)}$ intrusive noise criteria would also result in compliance with the $L_{Aeq(period)}$ amenity criteria. The controlling noise criterion is therefore the intrusive criterion for each respective period.

Review of the data presented in **Table 15** indicates that the predicted daytime construction $L_{A10(15minute)}$ noise emissions comply with the nominated criteria at all nearby residences during the anticipated construction period of between 4 weeks and 26 weeks.

Review of the data presented in **Table 16** indicates that the predicted daytime, evening and night-time noise levels comply with the intrusive (and amenity) noise assessment criteria at all nearby receivers, assuming the noise management recommendations described in **Section 14** are adopted.

Based on the sleep disturbance criteria nominated in **Section 1.1**, there is no potential for sleep disturbance at any nearby noise sensitive receiver from the proposed Gunlake Quarry.

It is therefore concluded that, based on the predicted noise levels, the operation of the proposed Gunlake Quarry would have a negligible noise impact at the nearest residences.

Notwithstanding the above, in accordance with the procedures described in the INP, consultation should be undertaken with the DECC in relation to the setting of achievable noise limits for the project

The US Environment Protection Agency's method was used for the prediction of the $L_{Aeq(1hour)}$ traffic noise levels at offset distance of the closest residence adjacent to Brayton Road and Red Hills Road.

Based on the respective controlling traffic flow scenarios presented in **Table 19**, **Table 20** and **Table 21**, the predicted existing plus worse case quarry traffic noise levels will clearly comply with the NSW DECC's daytime and night-time traffic noise criteria nominated in **Table 12** on Brayton Road and Red Hills Road.

Further, the predicted existing plus worst case quarry traffic noise levels (from the proposed maximum of 3 truck movements per hour) will clearly comply with the NSW DECC's daytime and night-time traffic noise criteria nominated in **Table 12** at the closest residence, and therefore at the more distant residences, to the proposed Brayton Road/George Street roundabout.

The predicted levels of blast emissions were determined using the appropriate distances to the quarry boundary. The predicted levels of Peak Vector Sum (PVS) ground vibration velocity and peak airblast at the nearest potentially affected properties to the quarry blasting were conducted for the maximum MIC proposed (of 49 kg).

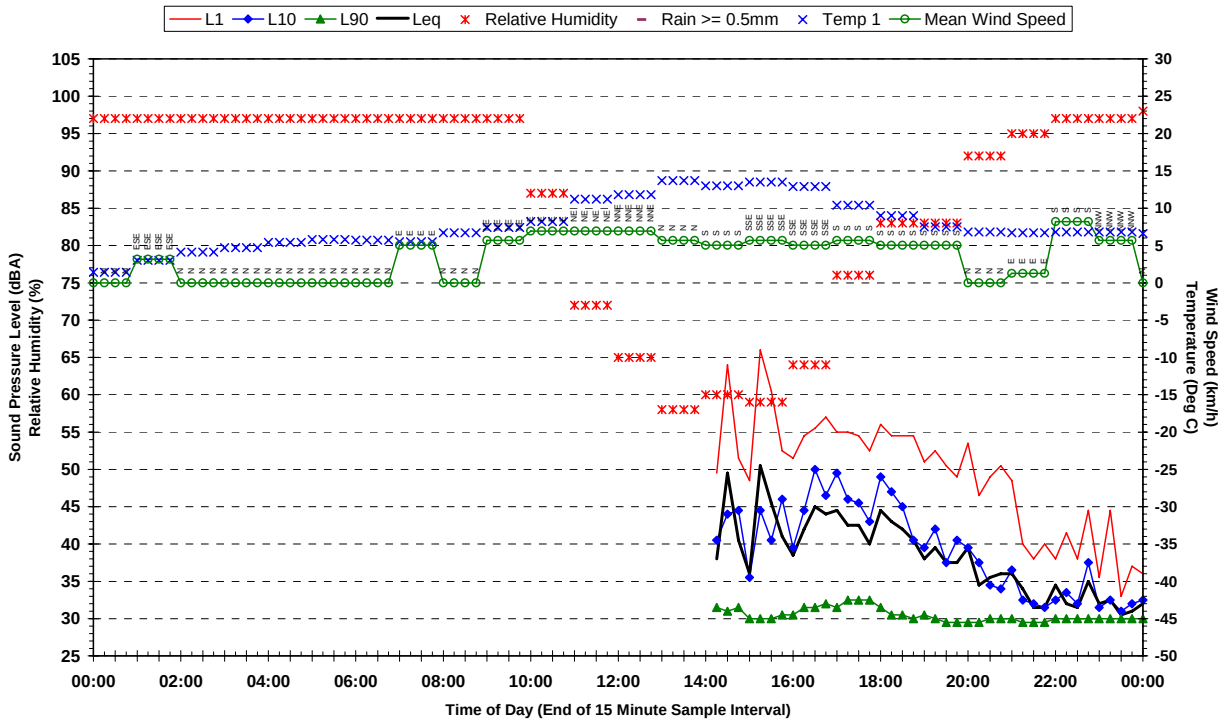
The following information is derived from the predicted levels of blast emissions:

- The predicted levels of ground vibration at all nearby residences comply with the ANZEC general human comfort criterion (of 5 mm/s) and consequently with the ANZEC maximum human comfort criterion as well as the BS 7385 structural damage criterion of 15 mm/s (at 4 Hz).
- The maximum predicted ground vibration level of 1.8 mm/s occurs at Residence R3 using an MIC of 49 kg (corresponding to blasting a full height 13 m bench).
- The predicted levels of peak airblast at all residences comply with the ANZEC general human comfort criterion of 115 dB Linear and consequently with the ANZEC maximum human comfort criterion.
- The predicted levels of peak airblast are clearly well below the US Bureau of Mines damage limit of 132 dB Linear (2 Hz cut off) at all residences.

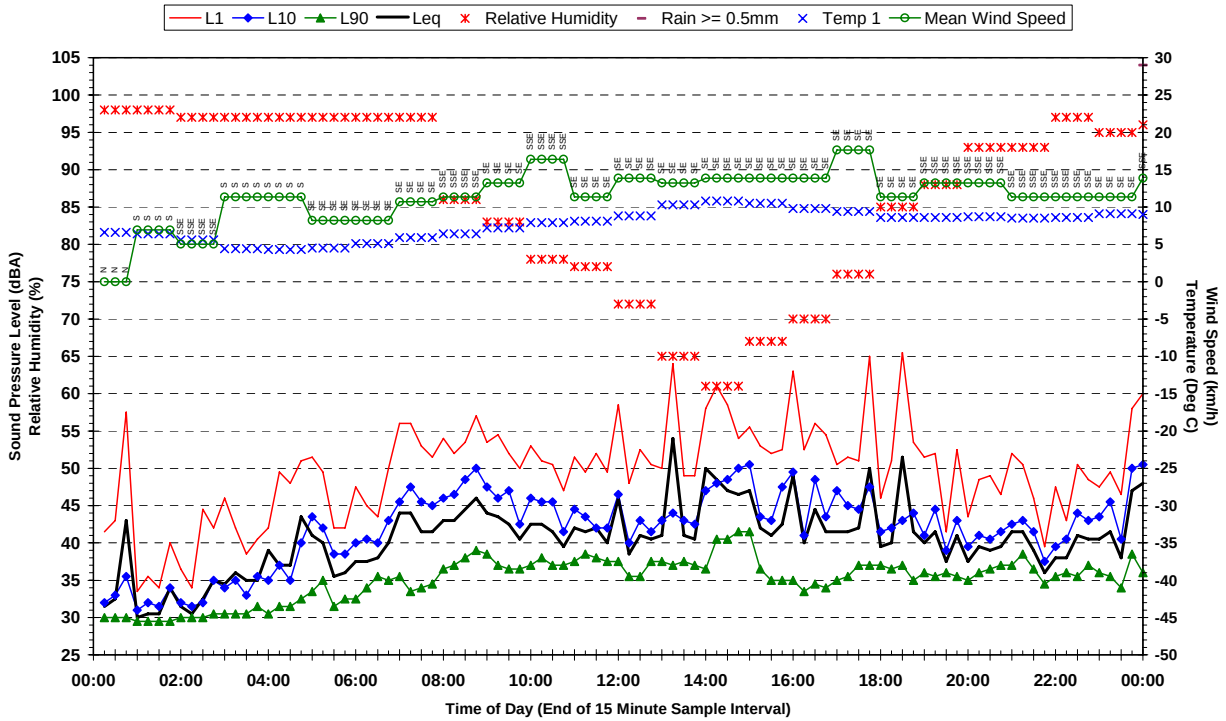
Notwithstanding the above, it is recommended that all blasts are monitored at the closest/potentially most affected residence in order to establish compliance with the nominated criteria and to progressively update the blast emissions site laws (ground vibration and airblast) in order to optimise future blast designs, based on actual site conditions. In this way, the site laws can be used to assist with the blast designs in order to ensure compliance with the ANZEC criteria are met at all nearby residences.

By adopting this approach, in conjunction with the inevitable future introduction of improved blasting products, it is anticipated that the blast emissions criteria can be met without imposing any significant constraints on the blast designs throughout the life of the quarry.

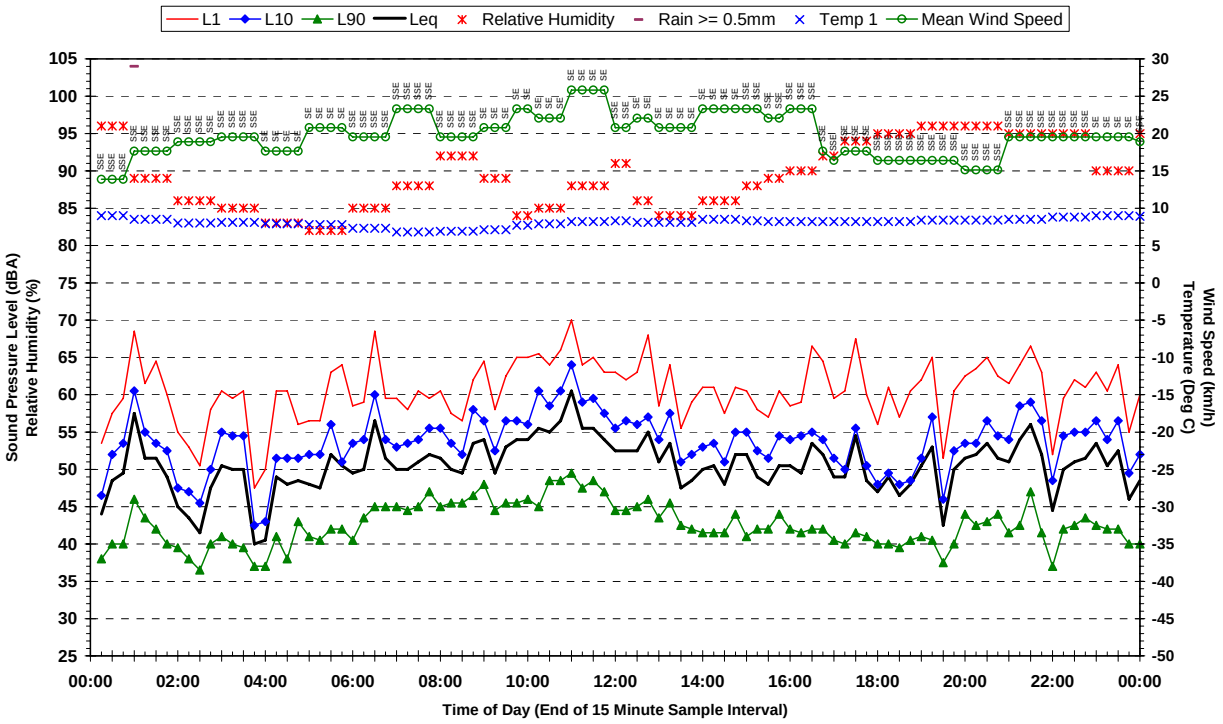
Statistical Ambient Noise Levels
Gunlake Quarries Background Noise Survey - 575 Brayton Road - Wednesday 6 June 2007



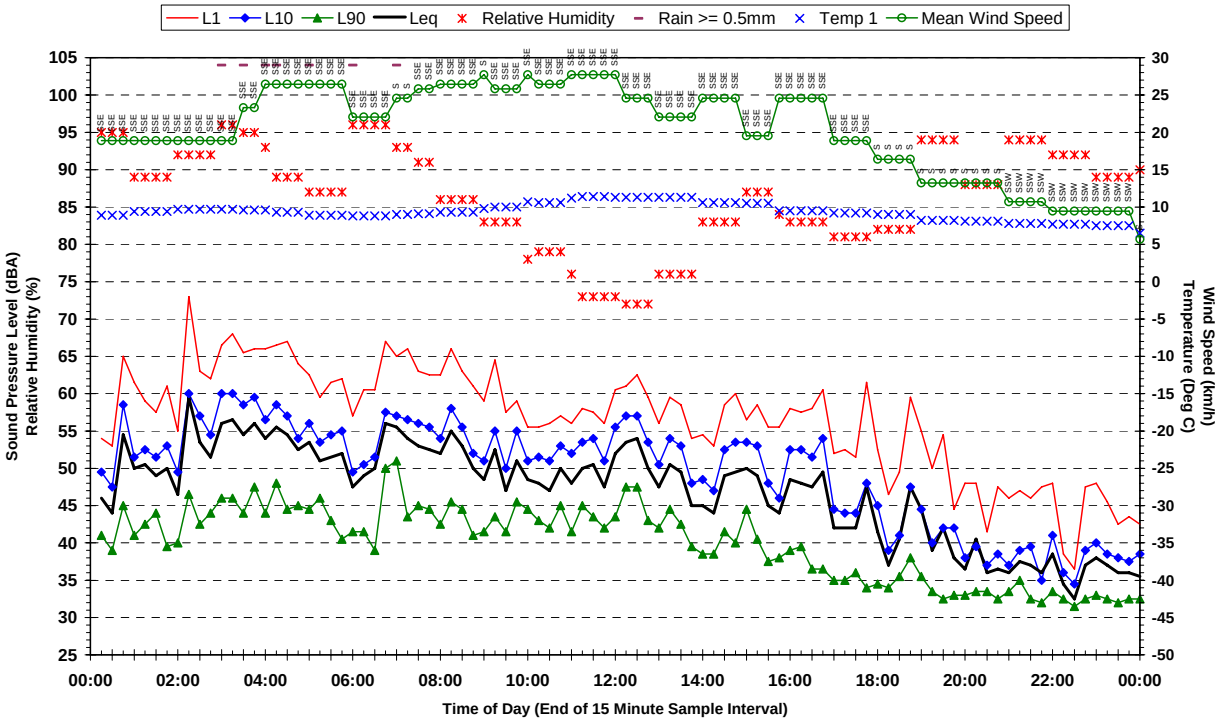
Statistical Ambient Noise Levels
Gunlake Quarries Background Noise Survey - 575 Brayton Road - Thursday 7 June 2007



Statistical Ambient Noise Levels
Gunlake Quarries Background Noise Survey - 575 Brayton Road - Friday 8 June 2007



Statistical Ambient Noise Levels
Gunlake Quarries Background Noise Survey - 575 Brayton Road - Saturday 9 June 2007



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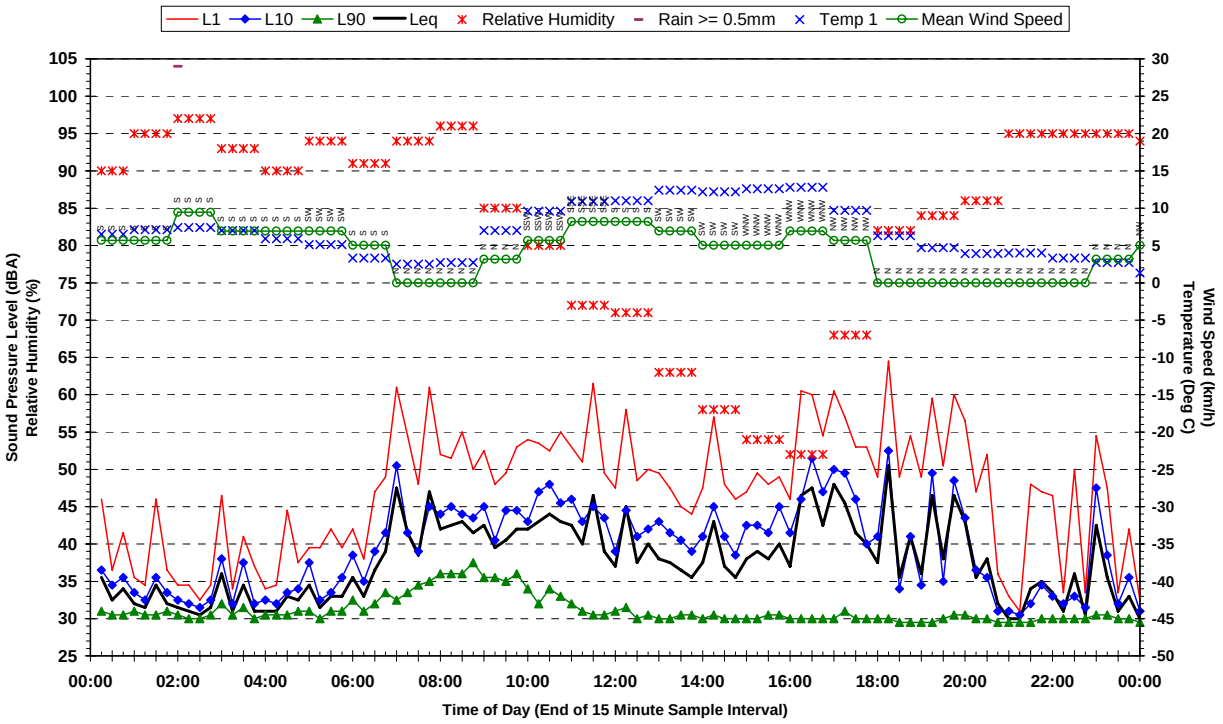
Gunlake Quarries Background Noise Survey - 575 Brayton Road - Sunday 10 June 2007



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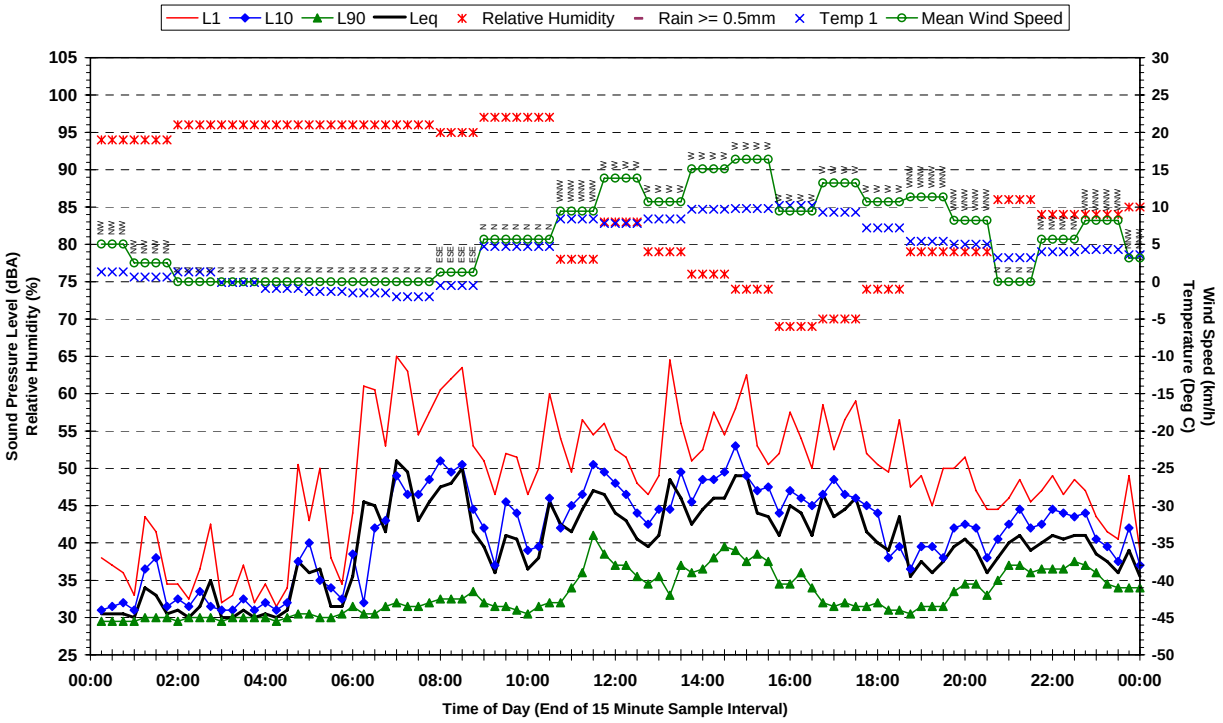
Gunlake Quarries Background Noise Survey - 575 Brayton Road - Monday 11 June 2007



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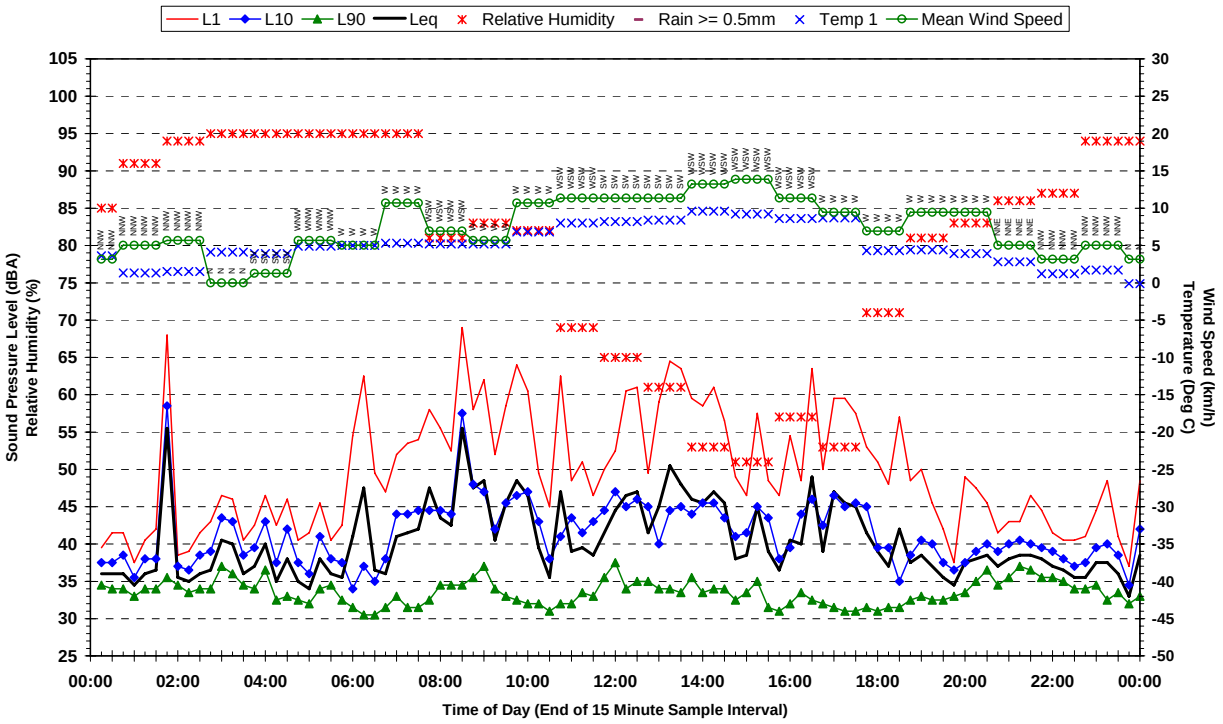
Gunlake Quarries Background Noise Survey - 575 Brayton Road - Tuesday 12 June 2007



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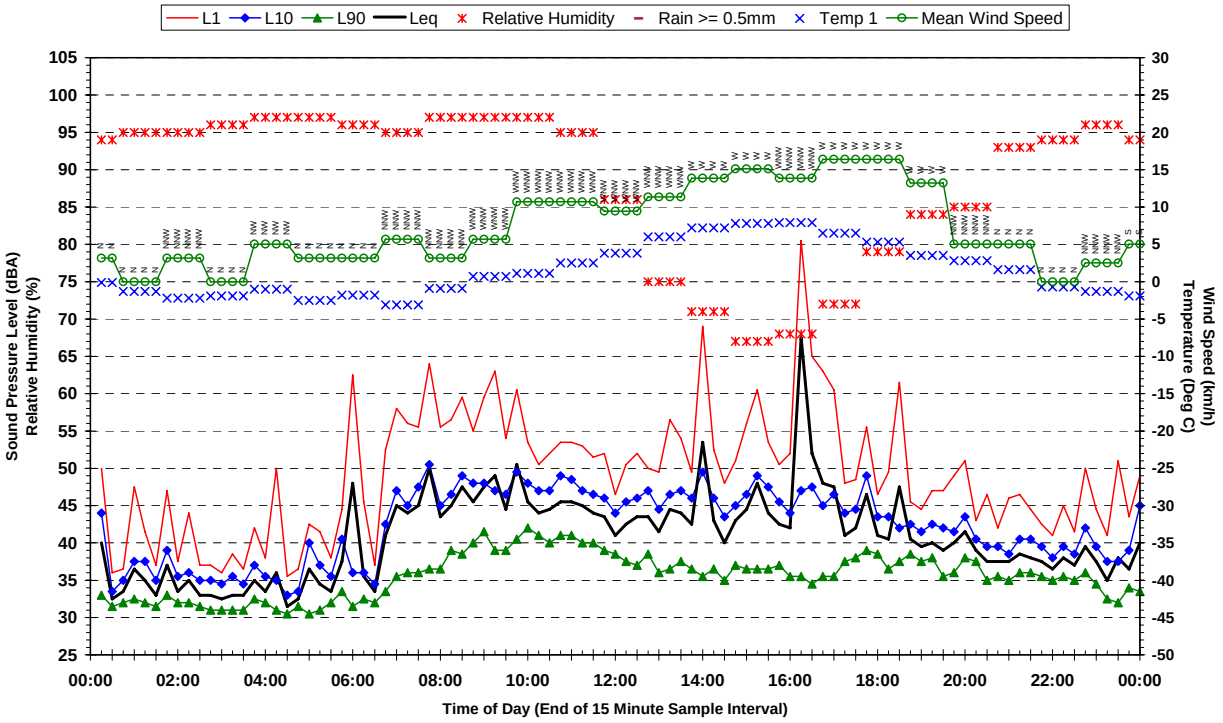
Gunlake Quarries Background Noise Survey - 575 Brayton Road - Wednesday 13 June 2007



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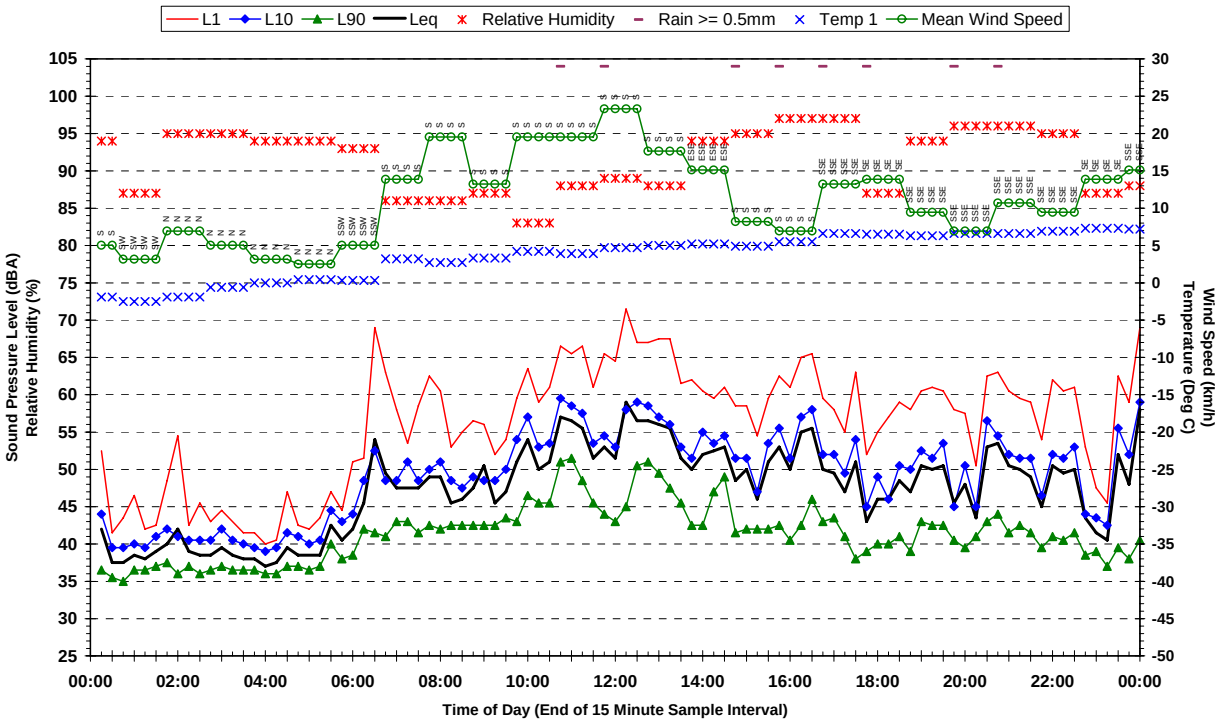
Gunlake Quarries Background Noise Survey - 575 Brayton Road - Thursday 14 June 2007



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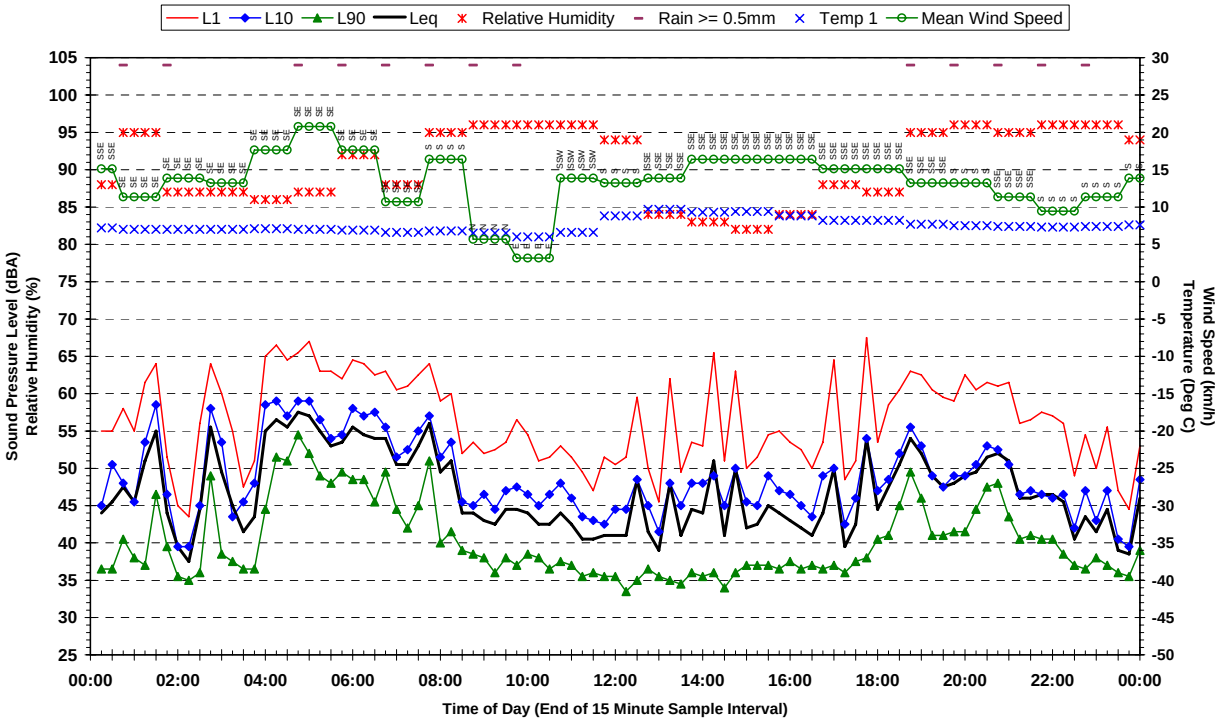
Gunlake Quarries Background Noise Survey - 575 Brayton Road - Friday 15 June 2007



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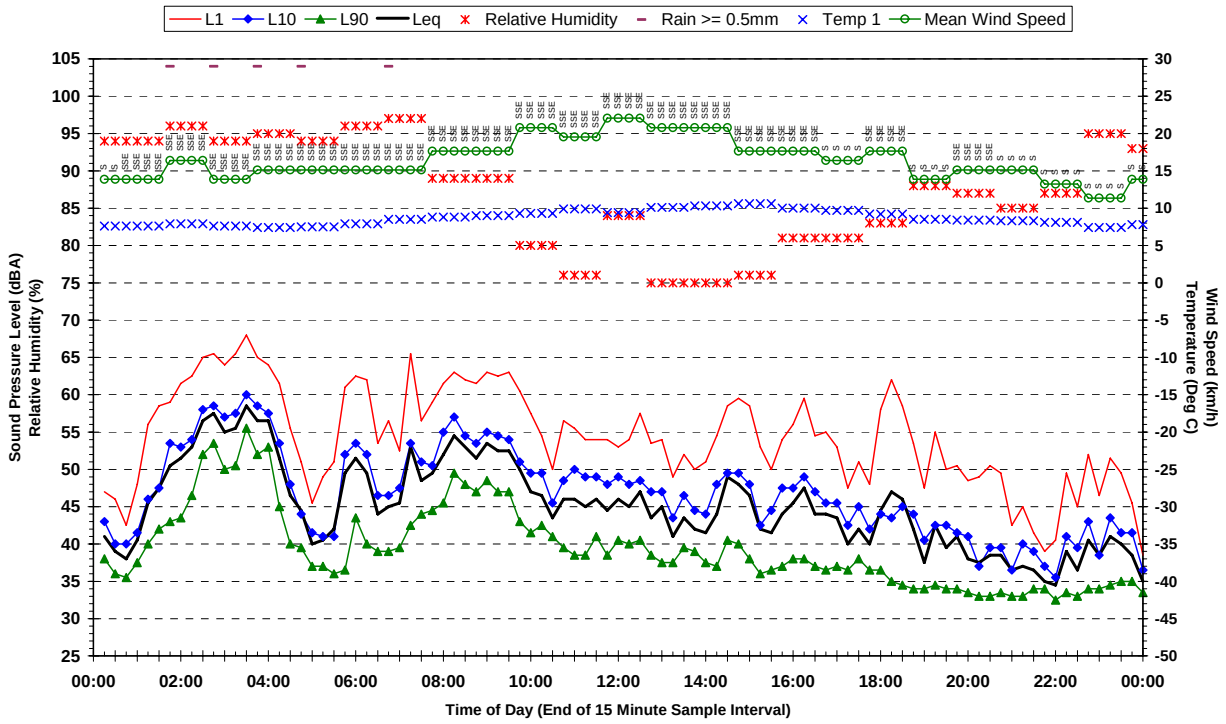
Gunlake Quarries Background Noise Survey - 575 Brayton Road - Saturday 16 June 2007



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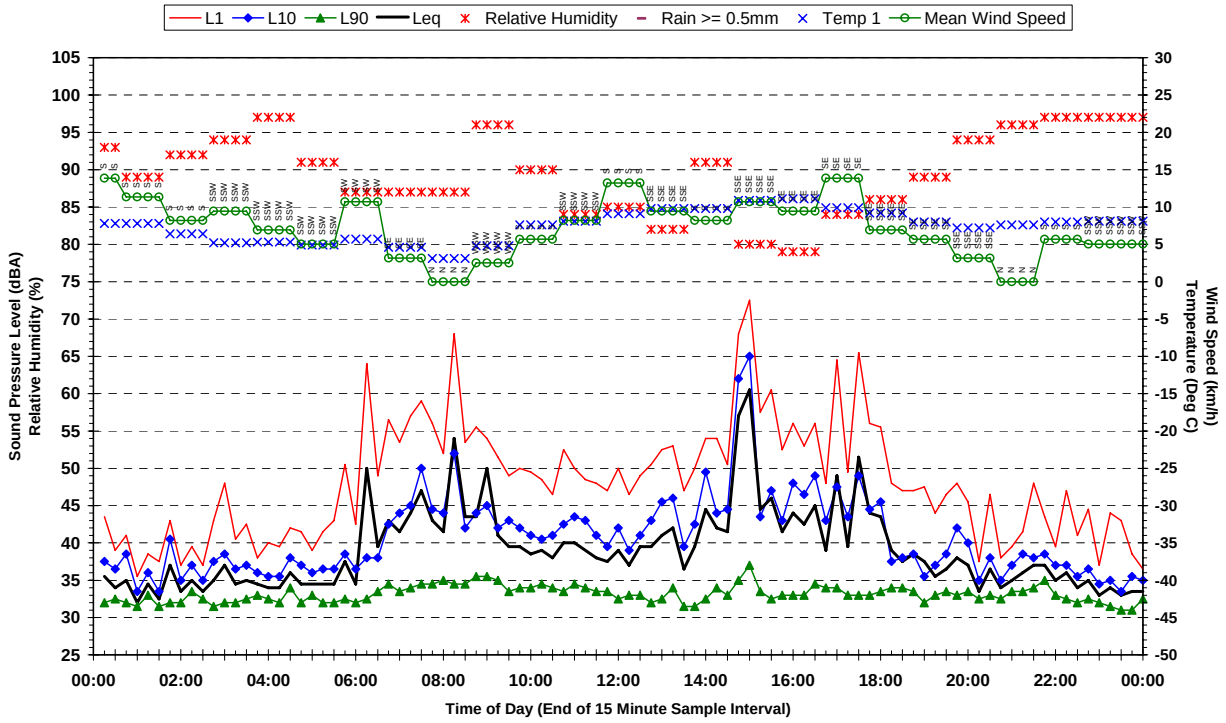
Gunlake Quarries Background Noise Survey - 575 Brayton Road - Sunday 17 June 2007



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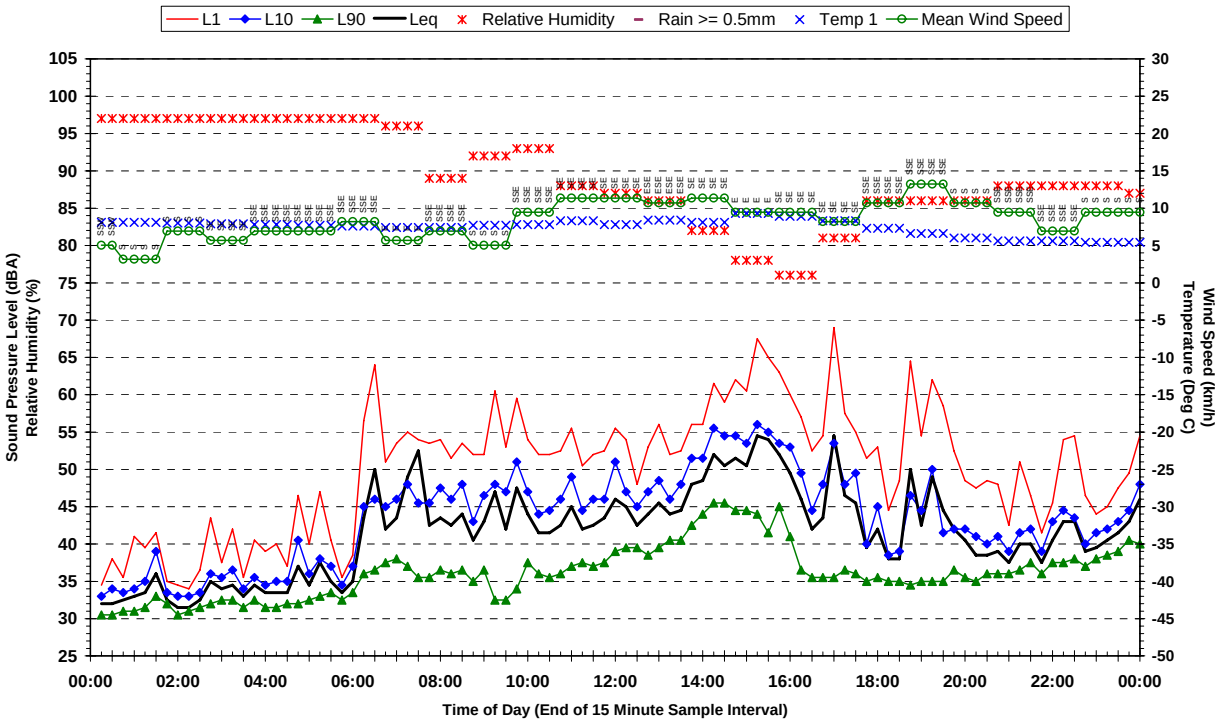
Gunlake Quarries Background Noise Survey - 575 Brayton Road - Monday 18 June 2007



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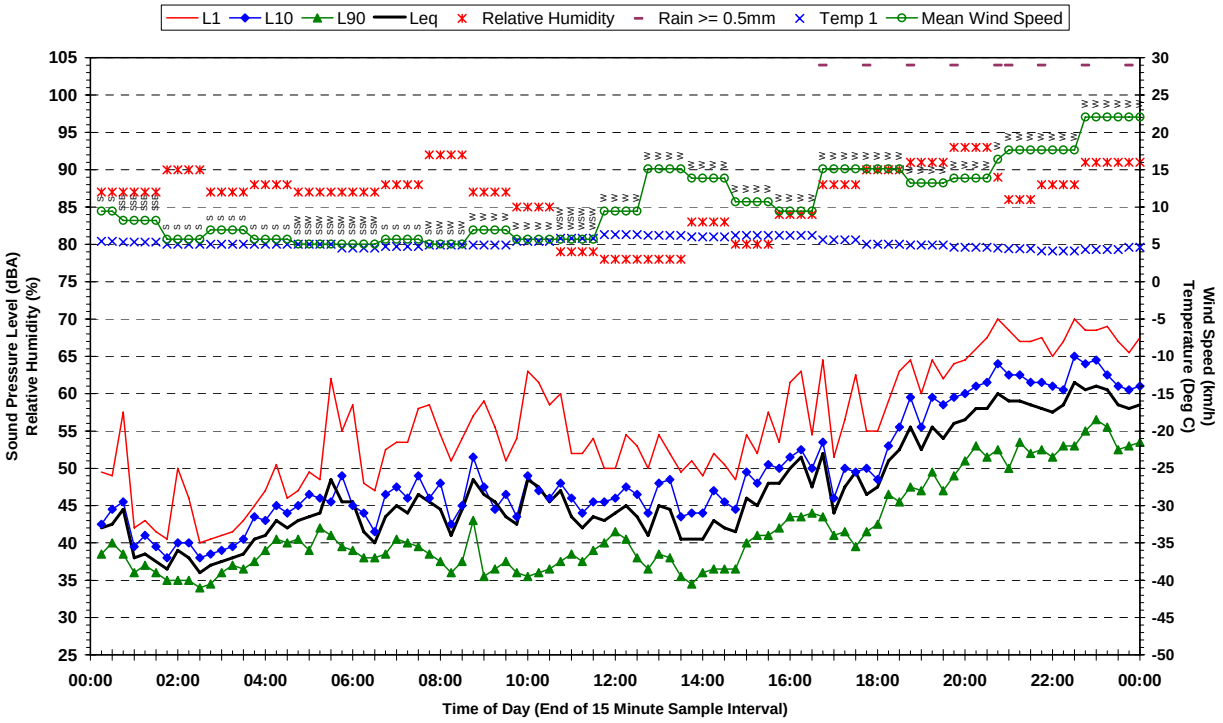
Gunlake Quarries Background Noise Survey - 575 Brayton Road - Tuesday 19 June 2007



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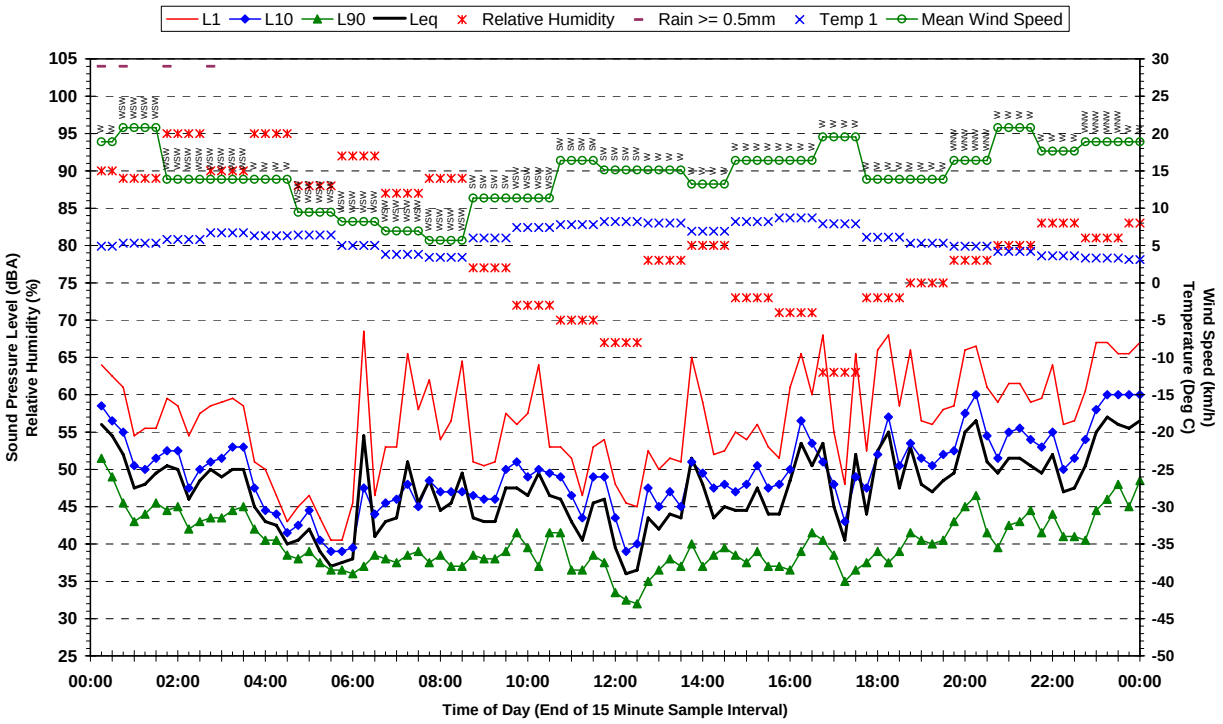
Gunlake Quarries Background Noise Survey - 575 Brayton Road - Wednesday 20 June 2007



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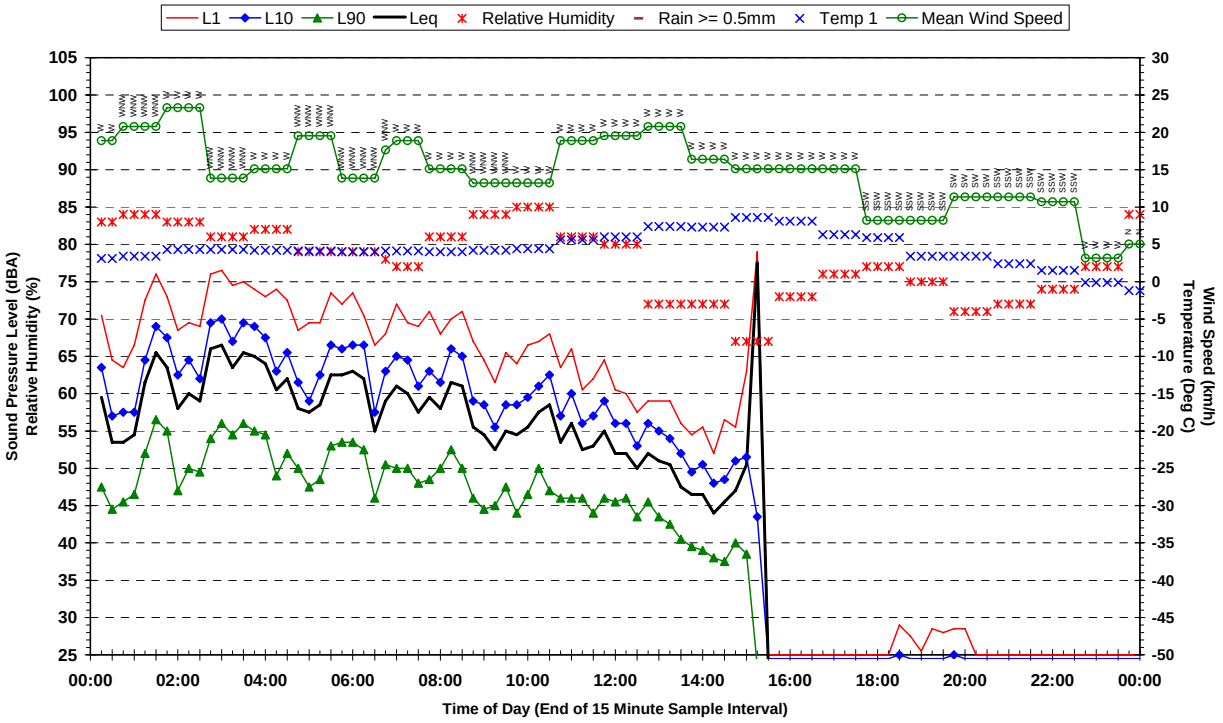
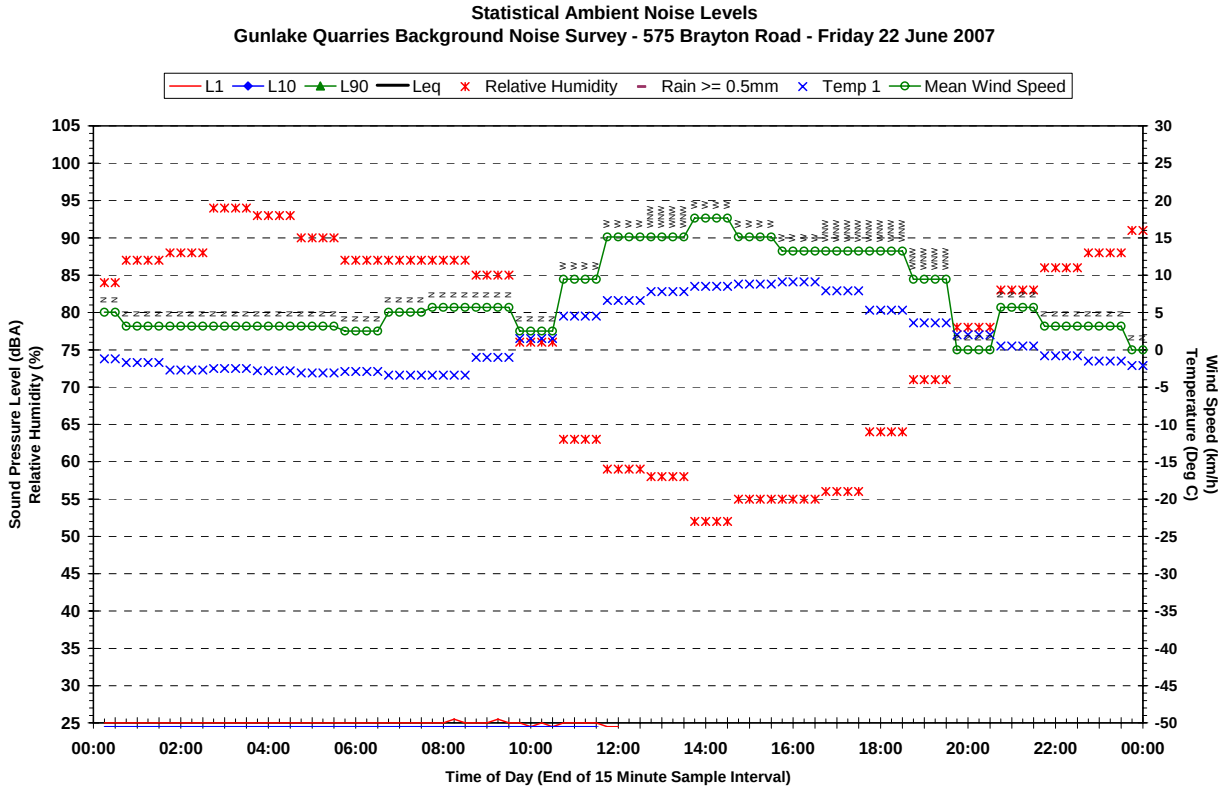
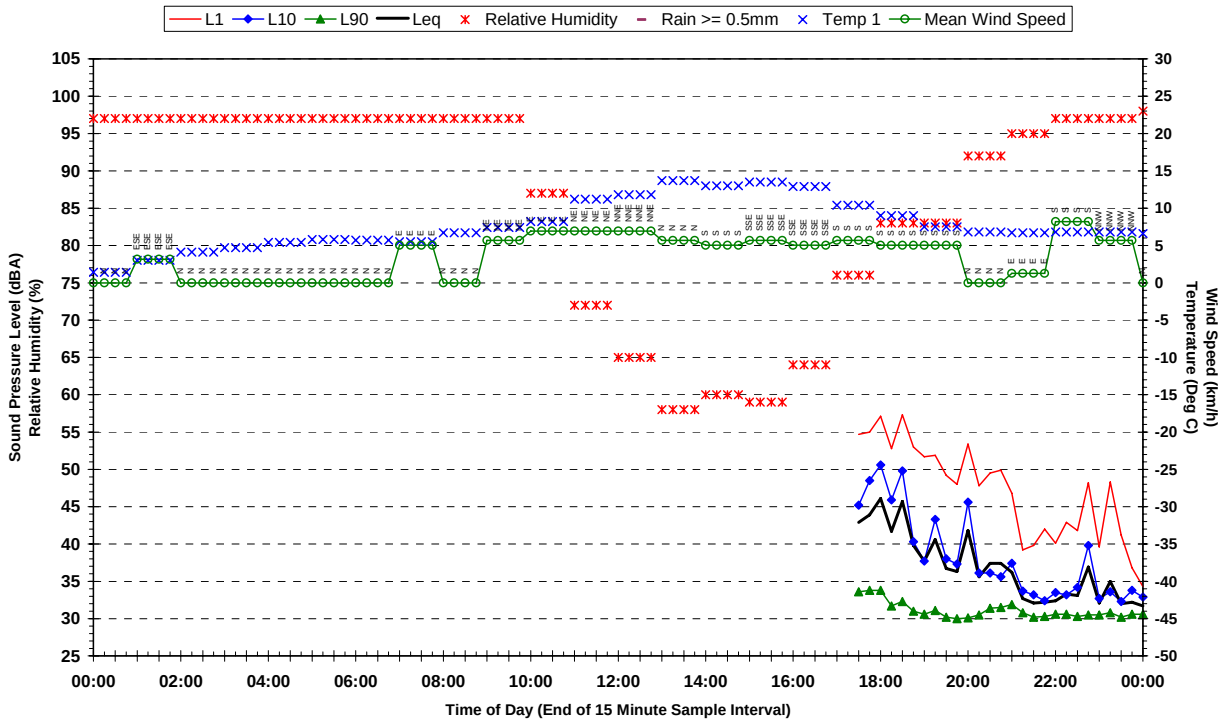
Gunlake Quarries Background Noise Survey - 575 Brayton Road - Thursday 21 June 2007




Statistical Ambient Noise Levels
Gunlake Quarries Background Noise Survey - 575 Brayton Road - Friday 22 June 2007
L1
L10
L90
Leq
Relative Humidity
Rain >= 0.5mm
Temp 1
Mean Wind Speed
Sound Pressure Level (dBA)
Relative Humidity (%)
Wind Speed (km/h)
Temperature (Deg C)
Time of Day (End of 15 Minute Sample Interval)
00:00
02:00
04:00
06:00
08:00
10:00
12:00
14:00
16:00
18:00
20:00
22:00
00:00

Statistical Ambient Noise Levels
Gunlake Quarries Background Noise Survey - 531 Brayton Road - Wednesday 6 June 2007



Statistical Ambient Noise Levels
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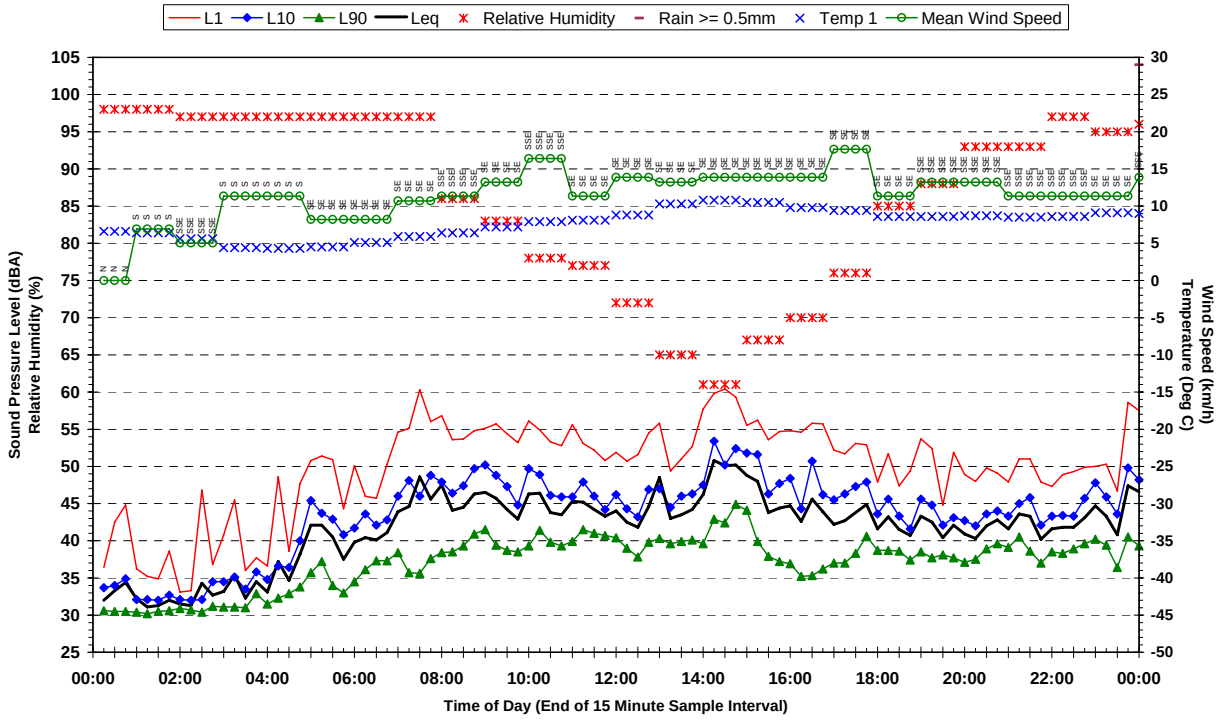
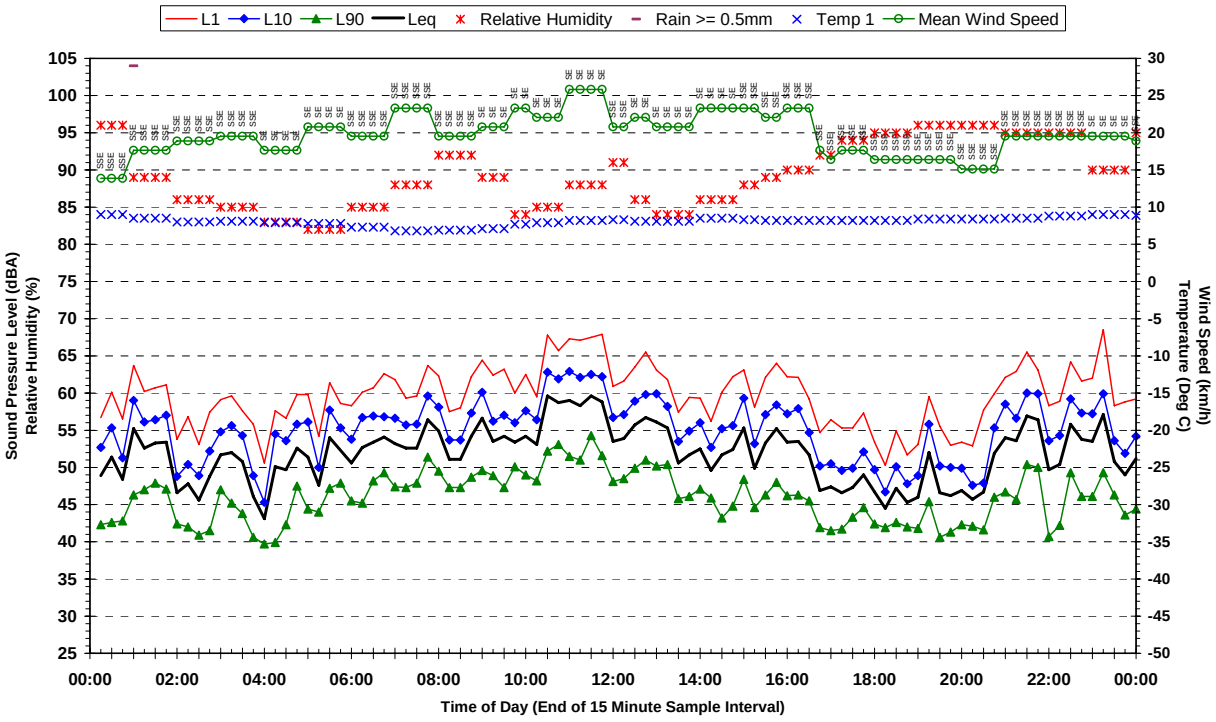
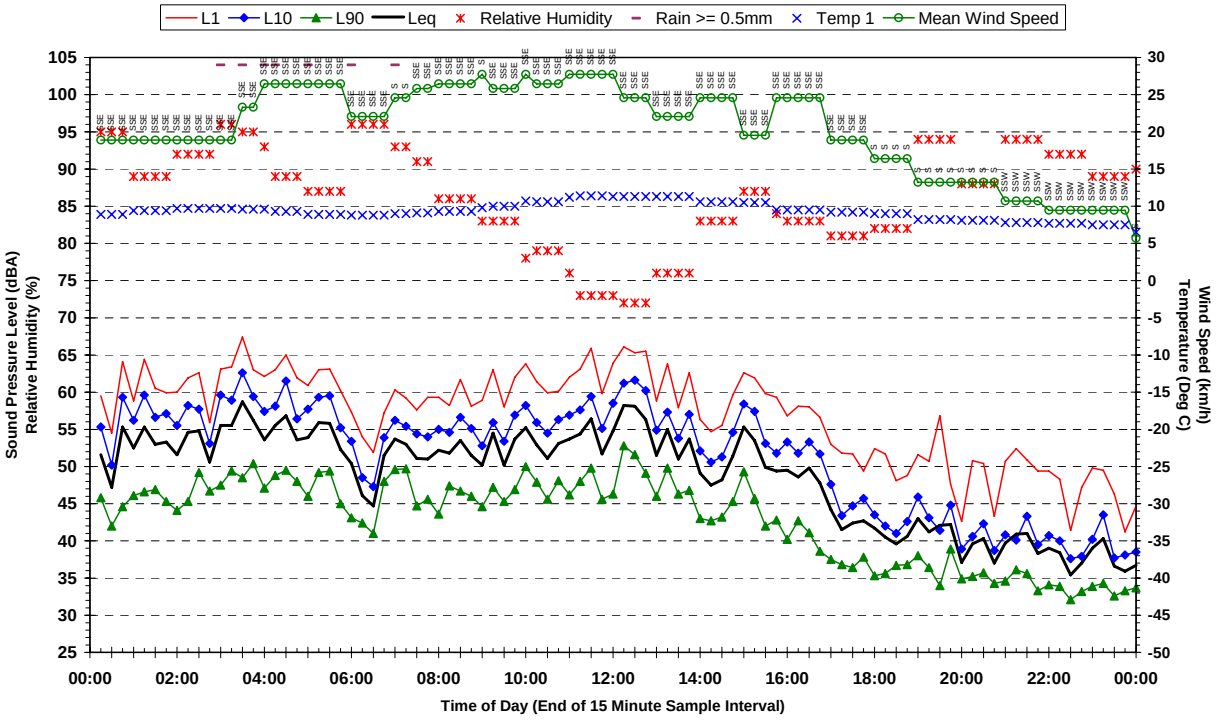


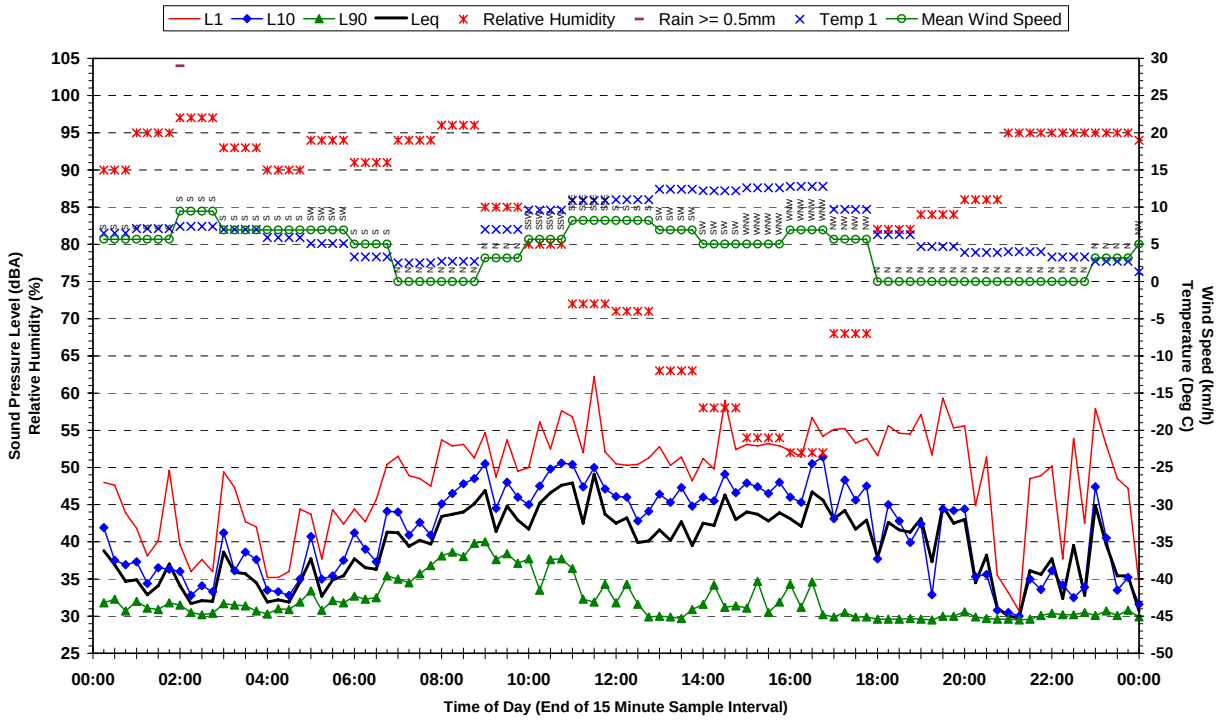
Statistical Ambient Noise Levels
Gunlake Quarries Background Noise Survey - 531 Brayton Road - Friday 8 June 2007



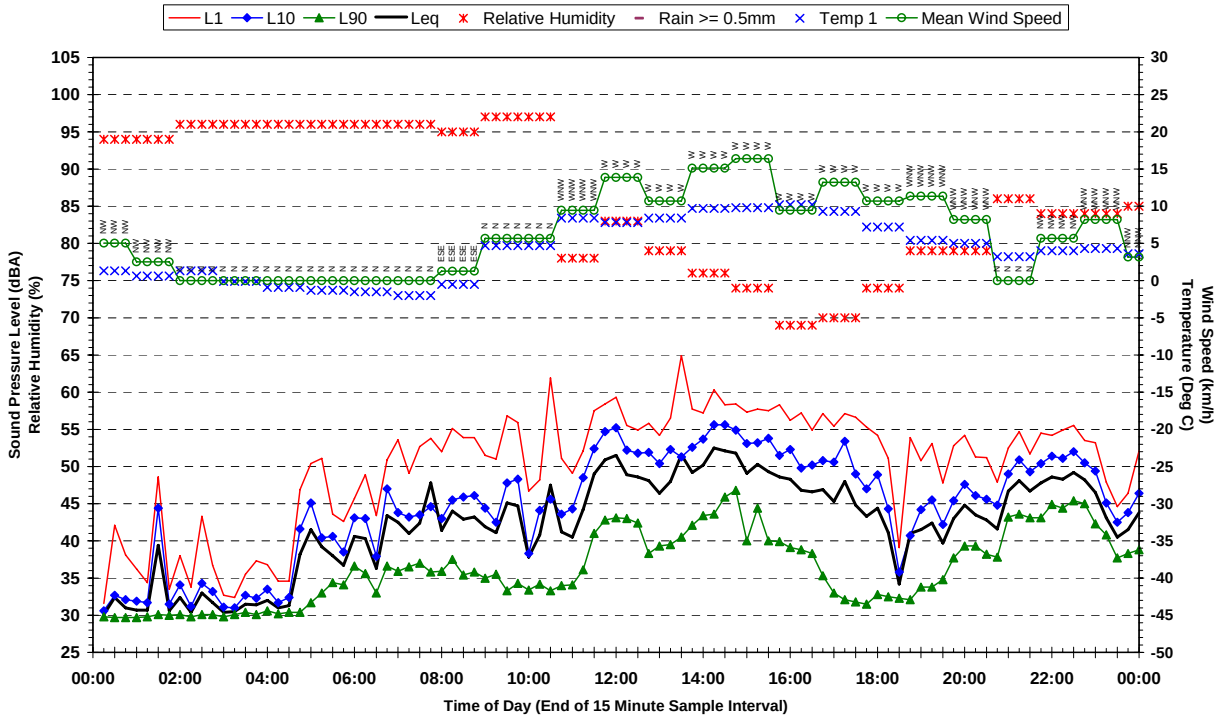
Statistical Ambient Noise Levels
Gunlake Quarries Background Noise Survey - 531 Brayton Road - Saturday 9 June 2007



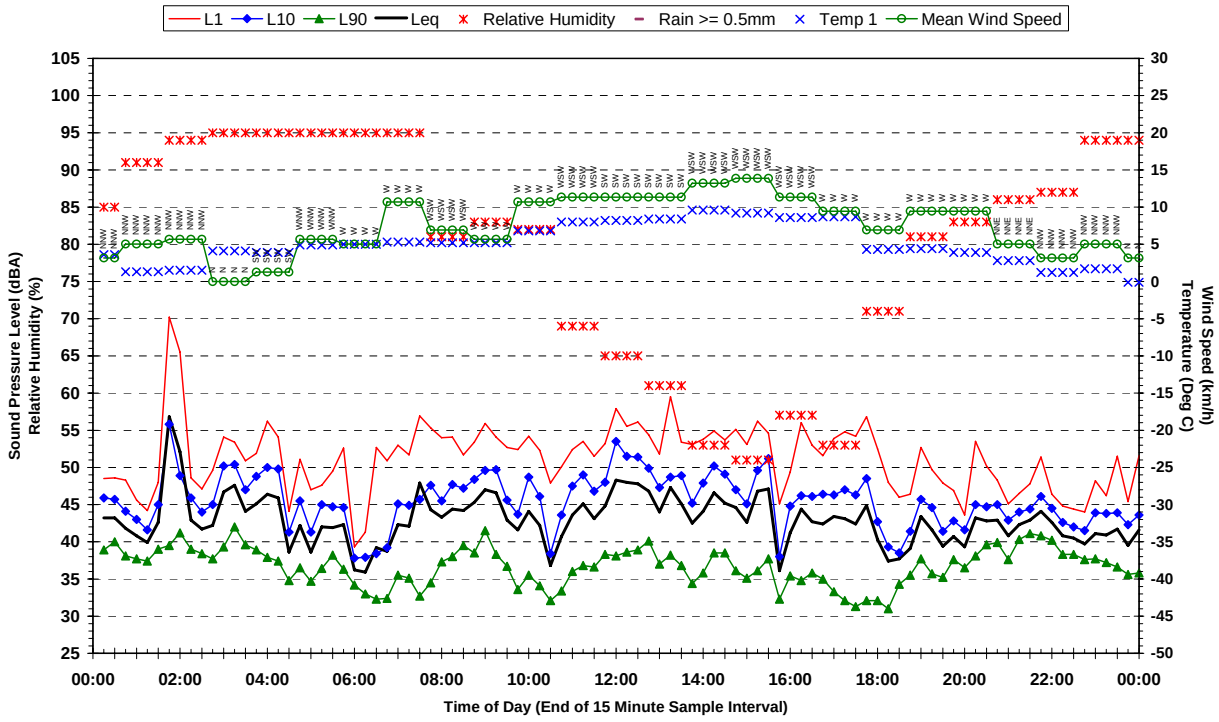
Statistical Ambient Noise Levels
Gunlake Quarries Background Noise Survey - 531 Brayton Road - Sunday 10 June 2007



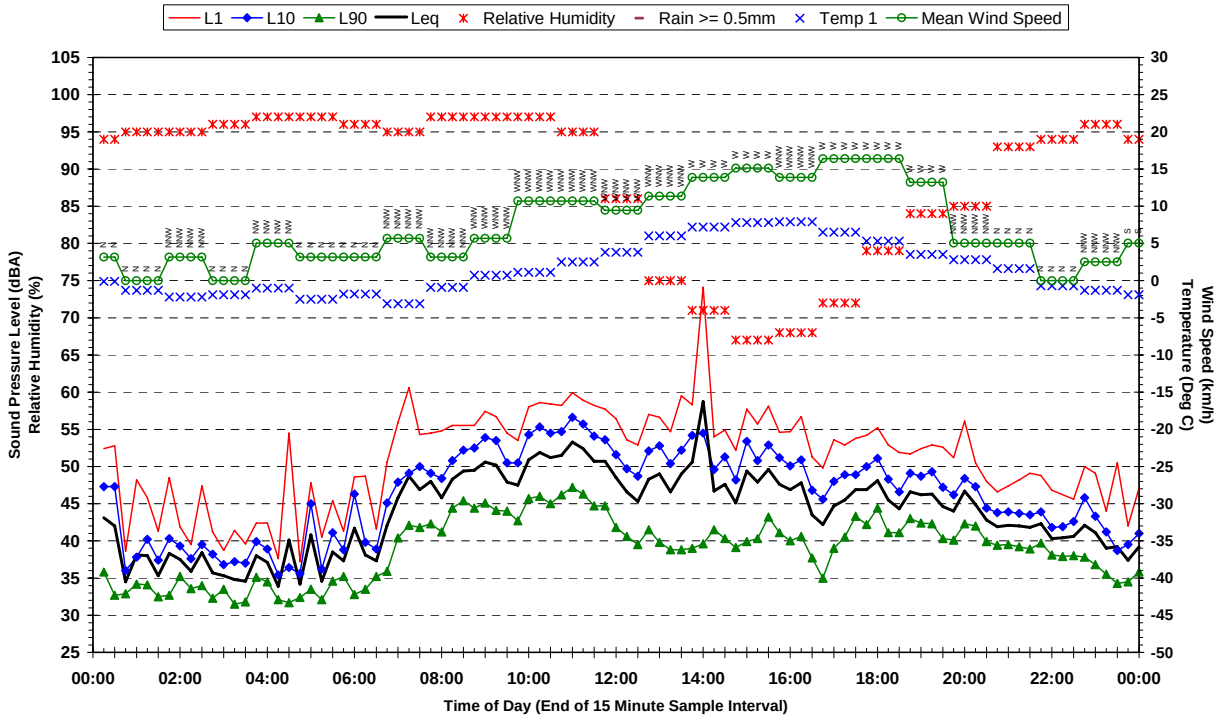
Statistical Ambient Noise Levels
Gunlake Quarries Background Noise Survey - 531 Brayton Road - Monday 11 June 2007



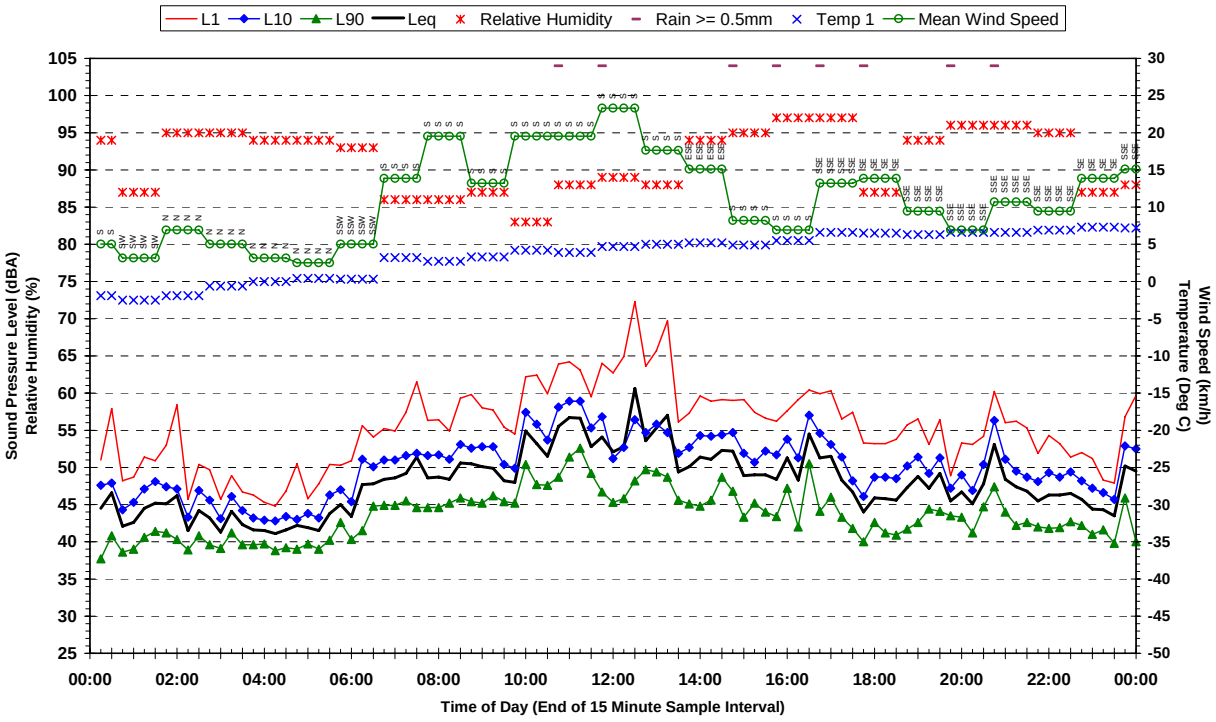
Statistical Ambient Noise Levels
Gunlake Quarries Background Noise Survey - 531 Brayton Road - Tuesday 12 June 2007



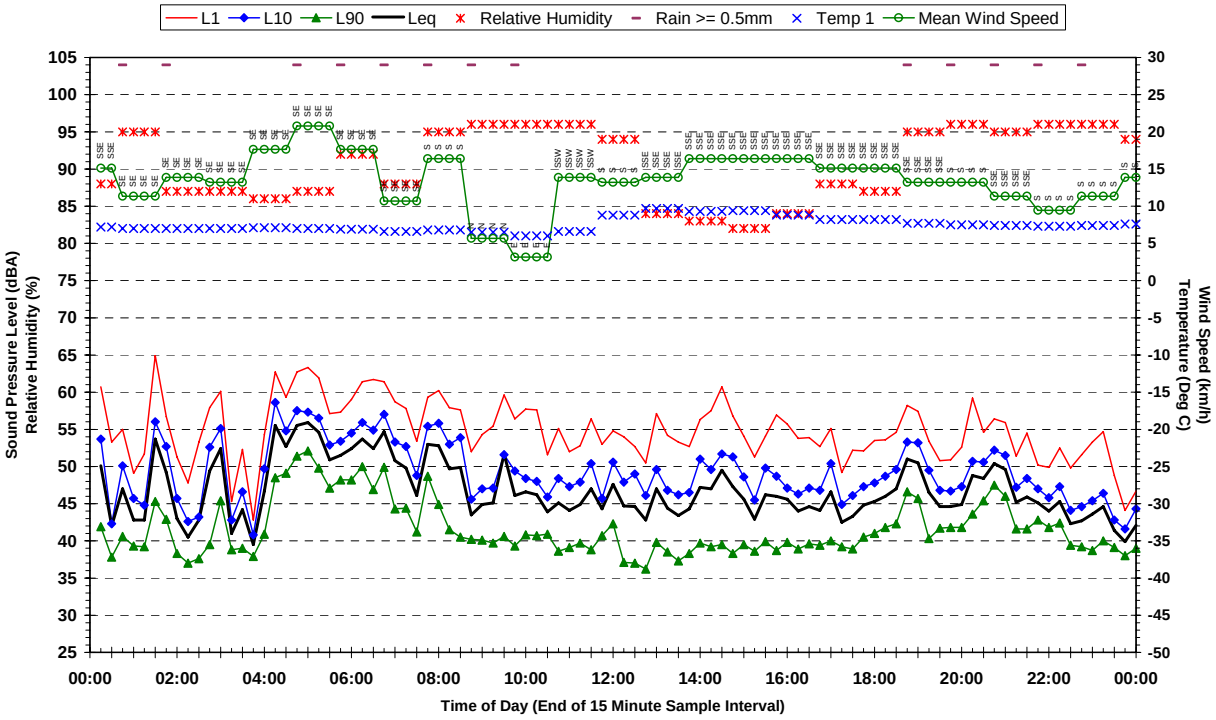
Statistical Ambient Noise Levels
Gunlake Quarries Background Noise Survey - 531 Brayton Road - Wednesday 13 June 2007



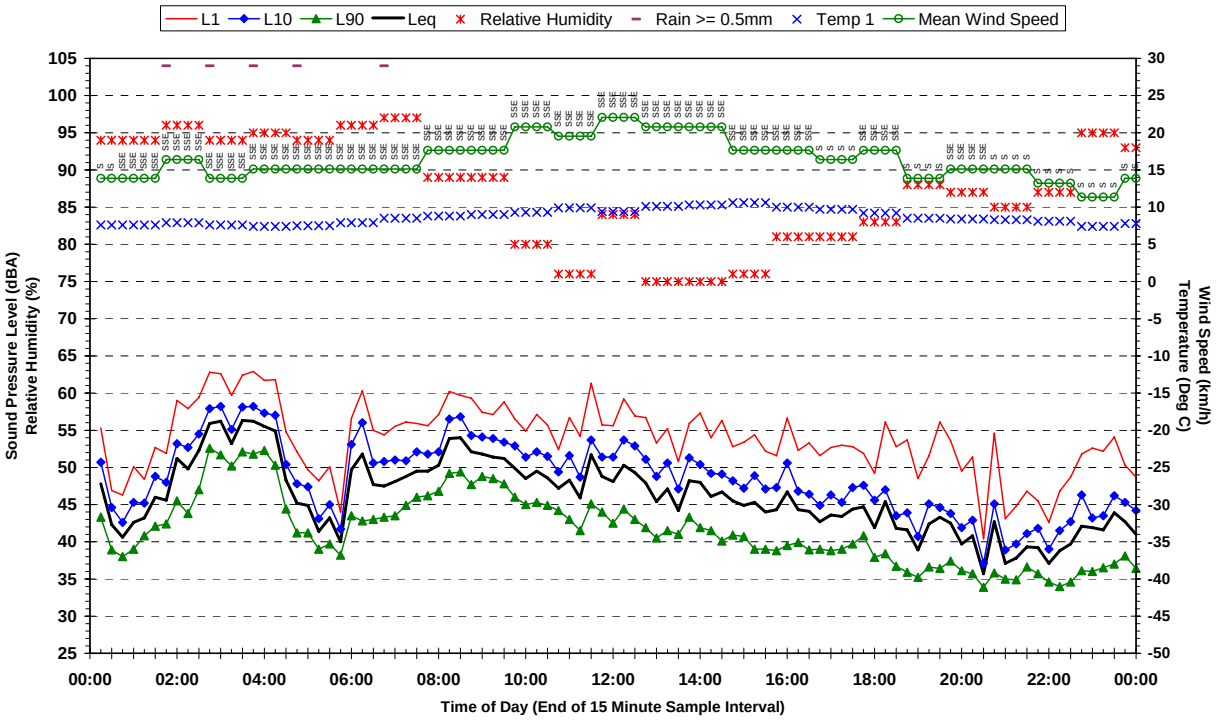
Statistical Ambient Noise Levels
Gunlake Quarries Background Noise Survey - 531 Brayton Road - Thursday 14 June 2007



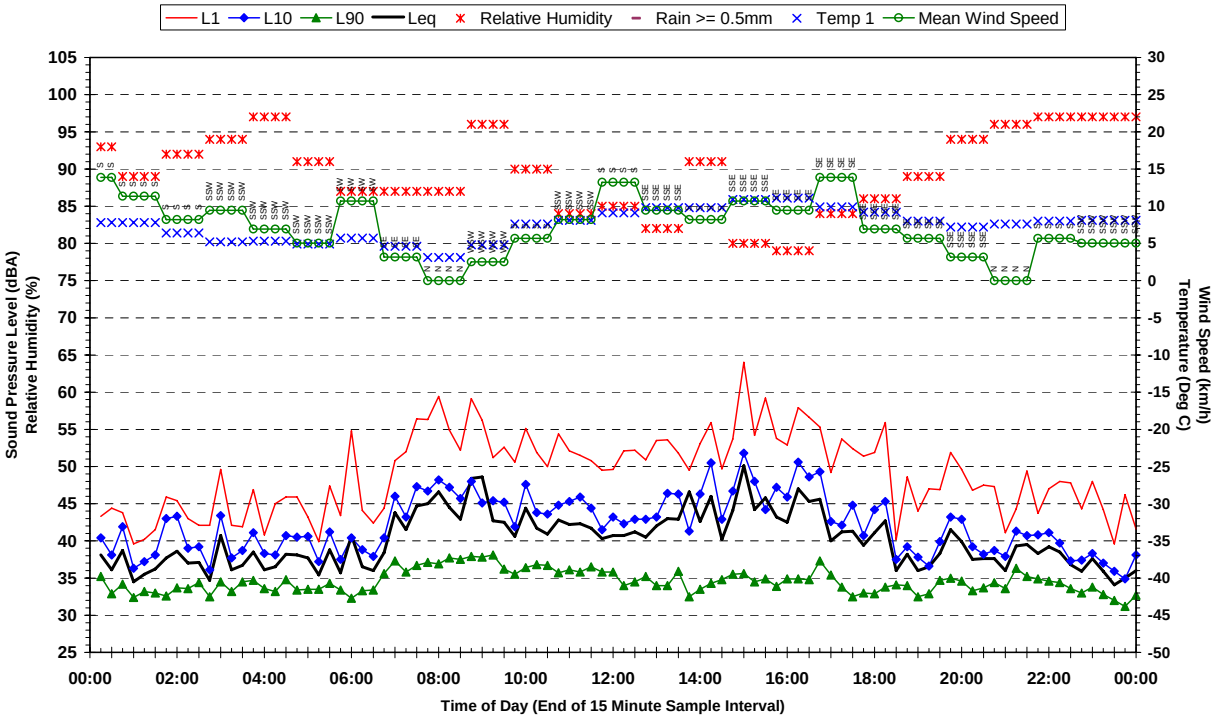
Statistical Ambient Noise Levels
Gunlake Quarries Background Noise Survey - 531 Brayton Road - Friday 15 June 2007



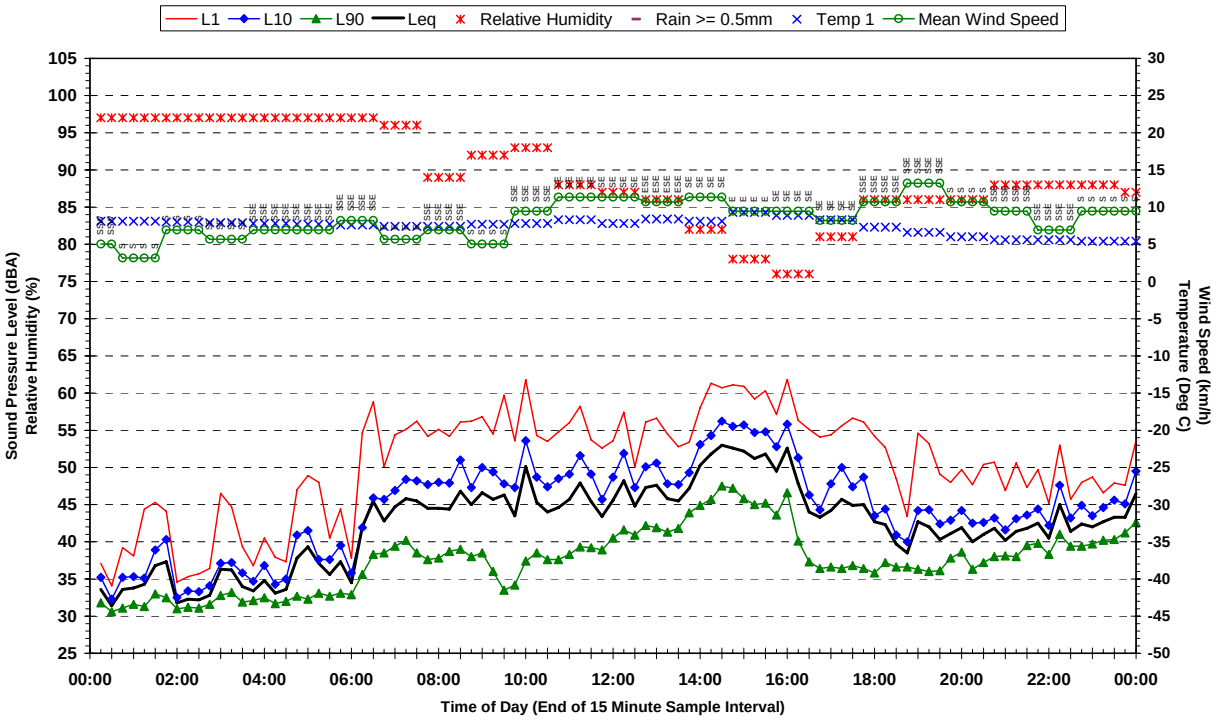
Statistical Ambient Noise Levels
Gunlake Quarries Background Noise Survey - 531 Brayton Road - Saturday 16 June 2007



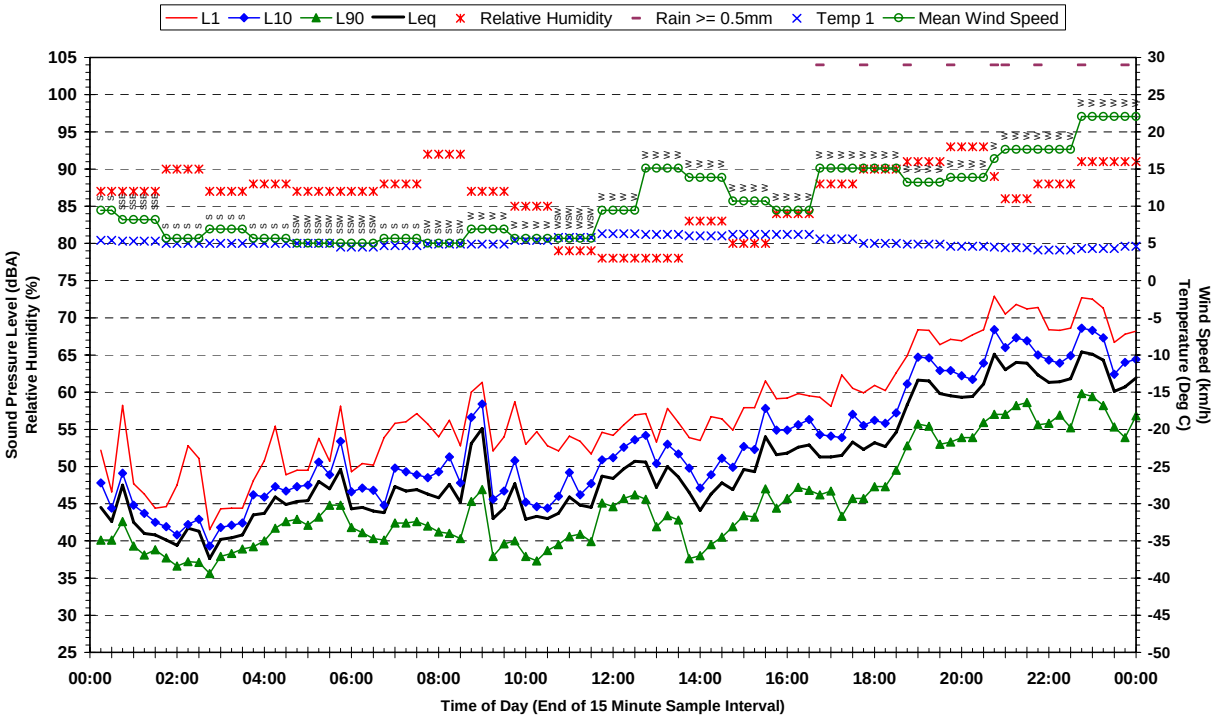
Statistical Ambient Noise Levels
Gunlake Quarries Background Noise Survey - 531 Brayton Road - Sunday 17 June 2007



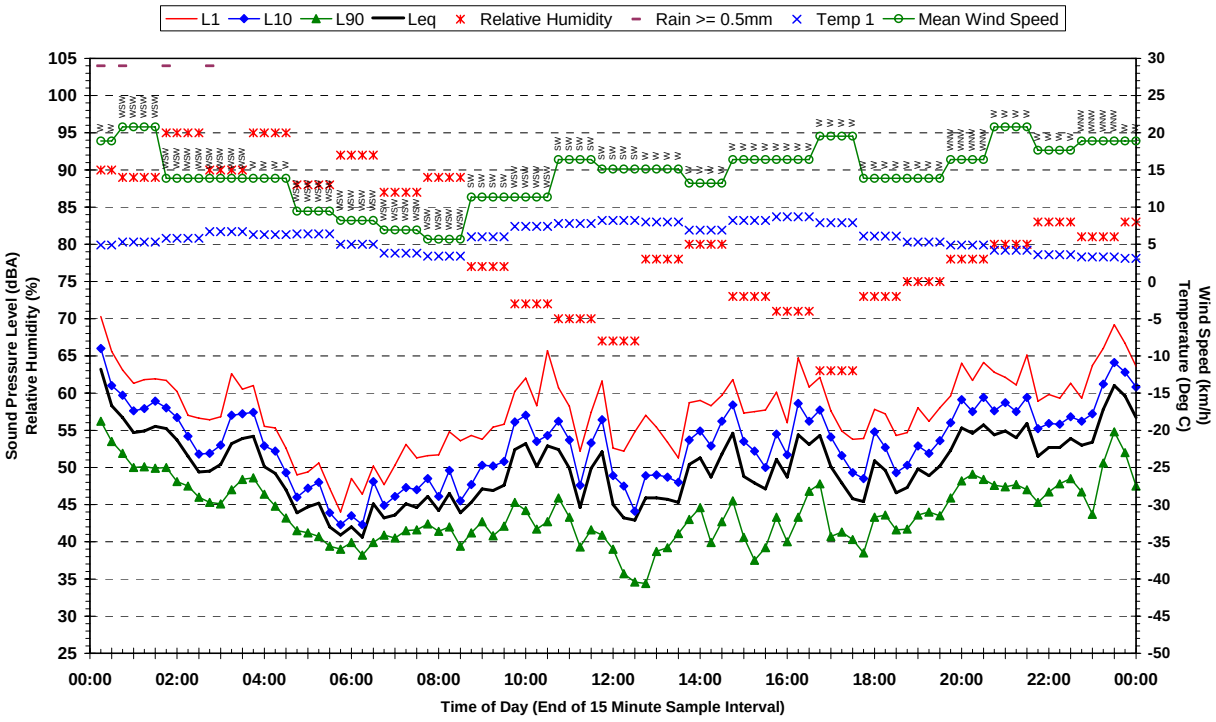
Statistical Ambient Noise Levels
Gunlake Quarries Background Noise Survey - 531 Brayton Road - Monday 18 June 2007



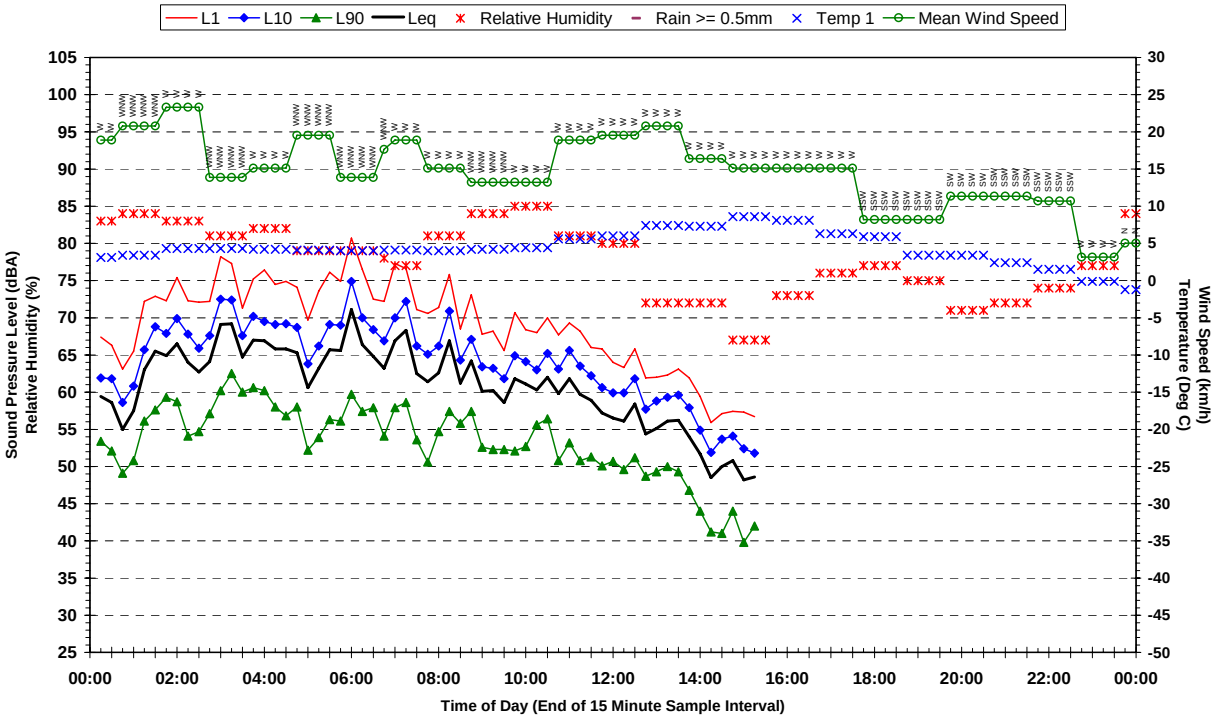
Statistical Ambient Noise Levels
Gunlake Quarries Background Noise Survey - 531 Brayton Road - Tuesday 19 June 2007



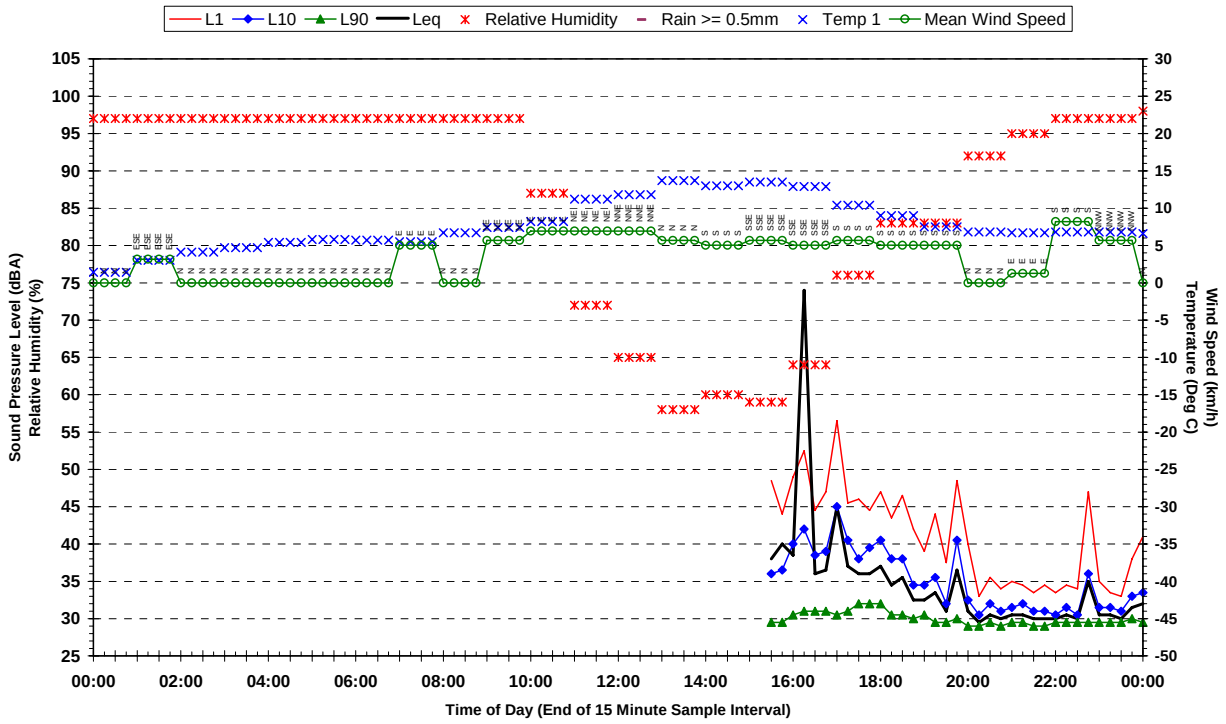
Statistical Ambient Noise Levels
Gunlake Quarries Background Noise Survey - 531 Brayton Road - Wednesday 20 June 2007



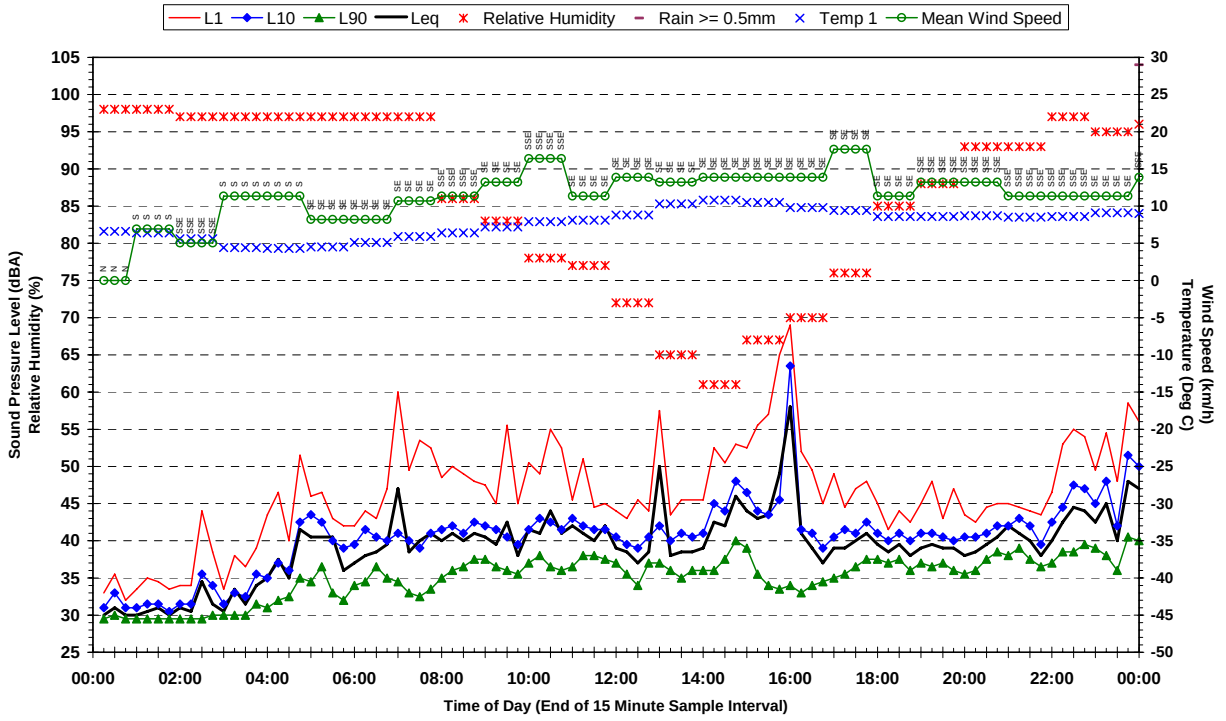
Statistical Ambient Noise Levels
Gunlake Quarries Background Noise Survey - 531 Brayton Road - Thursday 21 June 2007



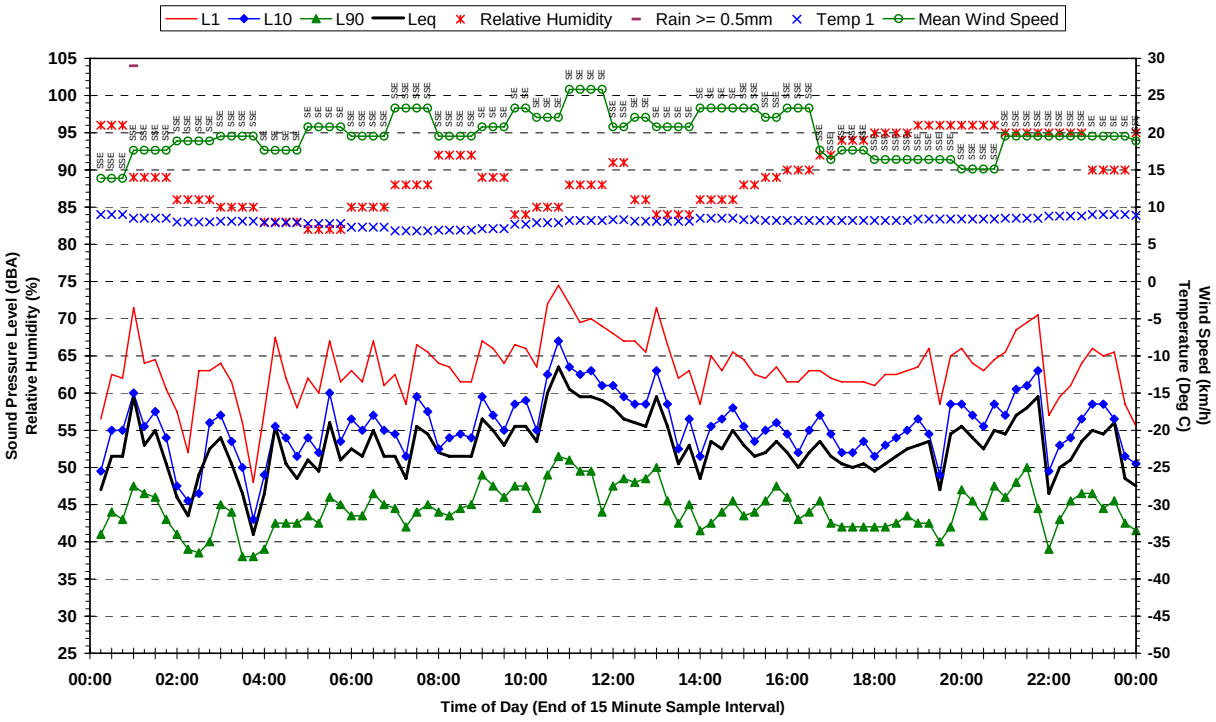
Statistical Ambient Noise Levels
Gunlake Quarries Background Noise Survey - 529 Brayton Road - Wednesday 6 June 2007



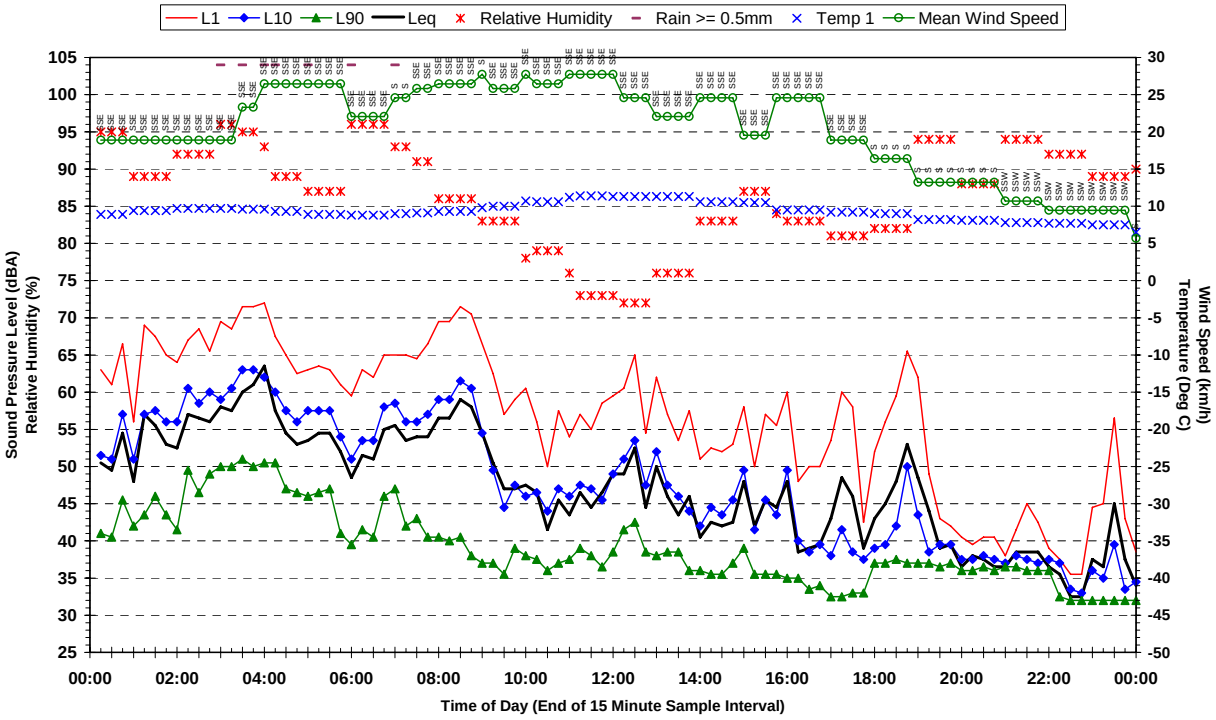
Statistical Ambient Noise Levels
Gunlake Quarries Background Noise Survey - 529 Brayton Road - Thursday 7 June 2007



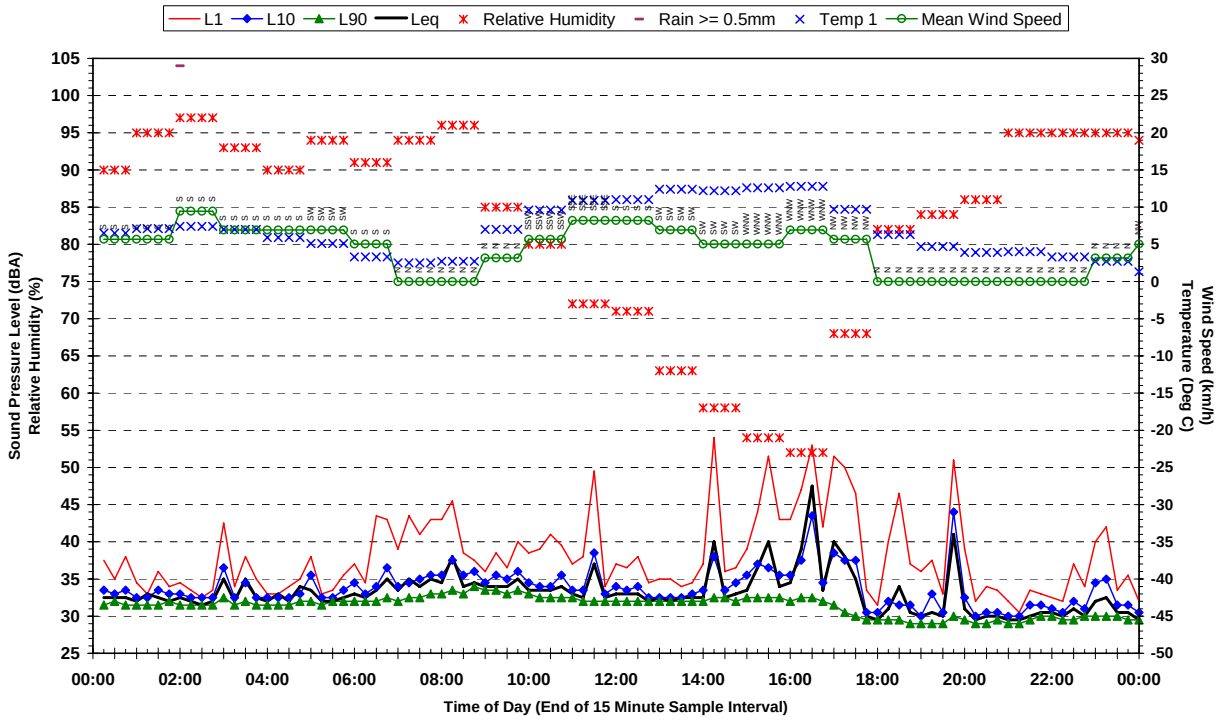
Statistical Ambient Noise Levels
Gunlake Quarries Background Noise Survey - 529 Brayton Road - Friday 8 June 2007



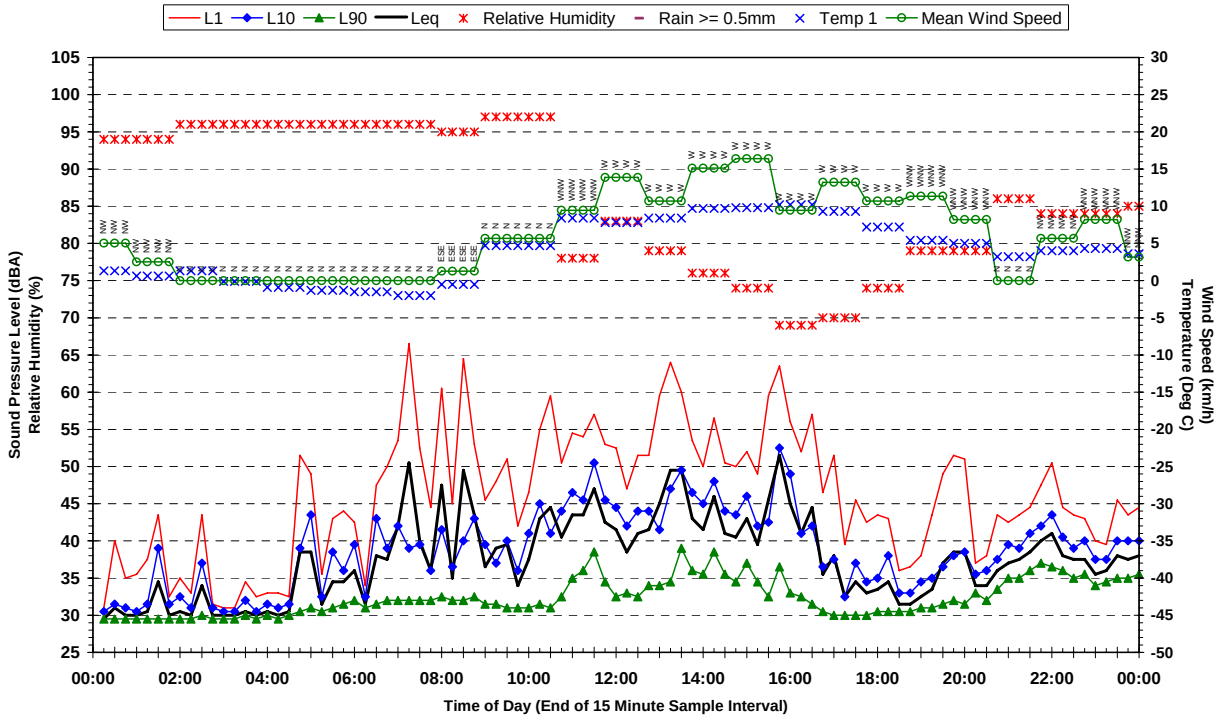
Statistical Ambient Noise Levels
Gunlake Quarries Background Noise Survey - 529 Brayton Road - Saturday 9 June 2007



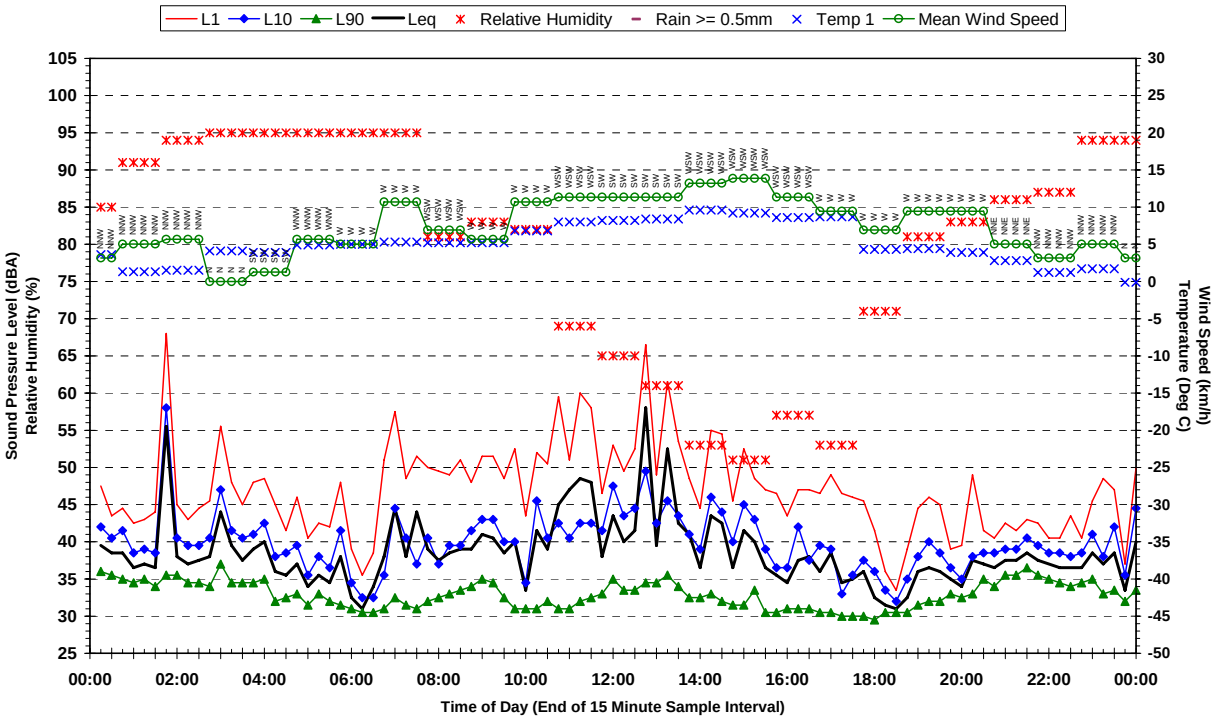
Statistical Ambient Noise Levels
Gunlake Quarries Background Noise Survey - 529 Brayton Road - Sunday 10 June 2007



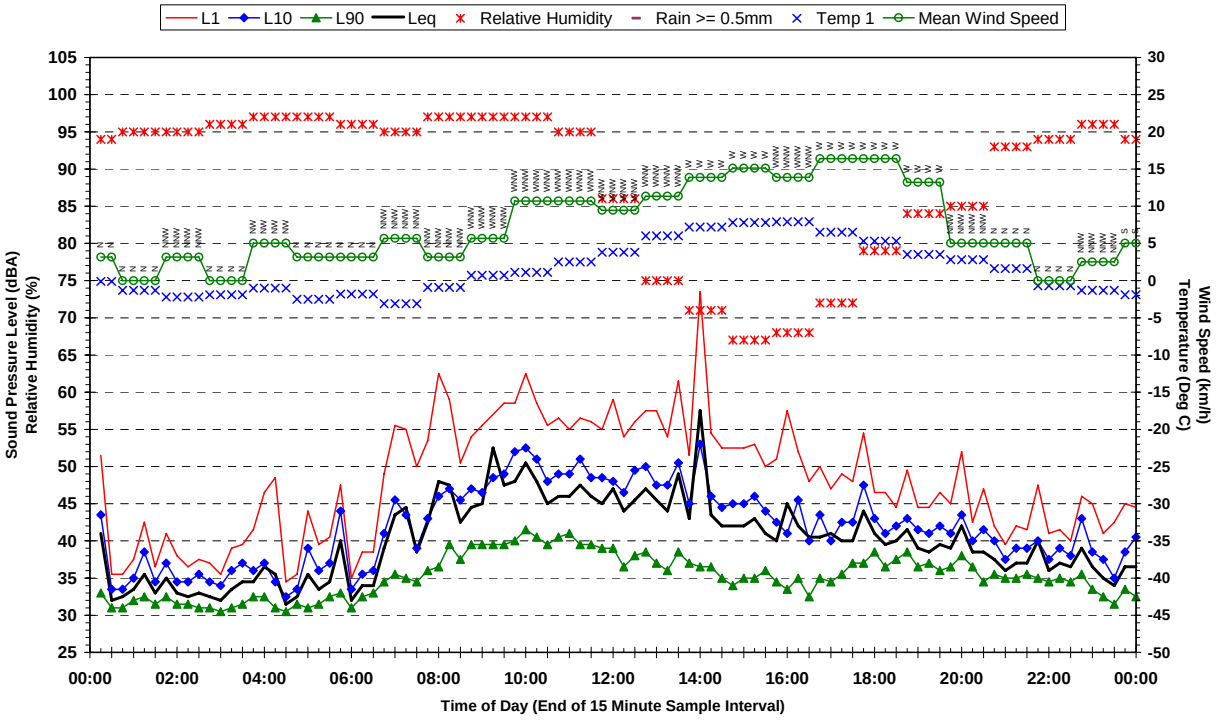
Statistical Ambient Noise Levels
Gunlake Quarries Background Noise Survey - 529 Brayton Road - Monday 11 June 2007



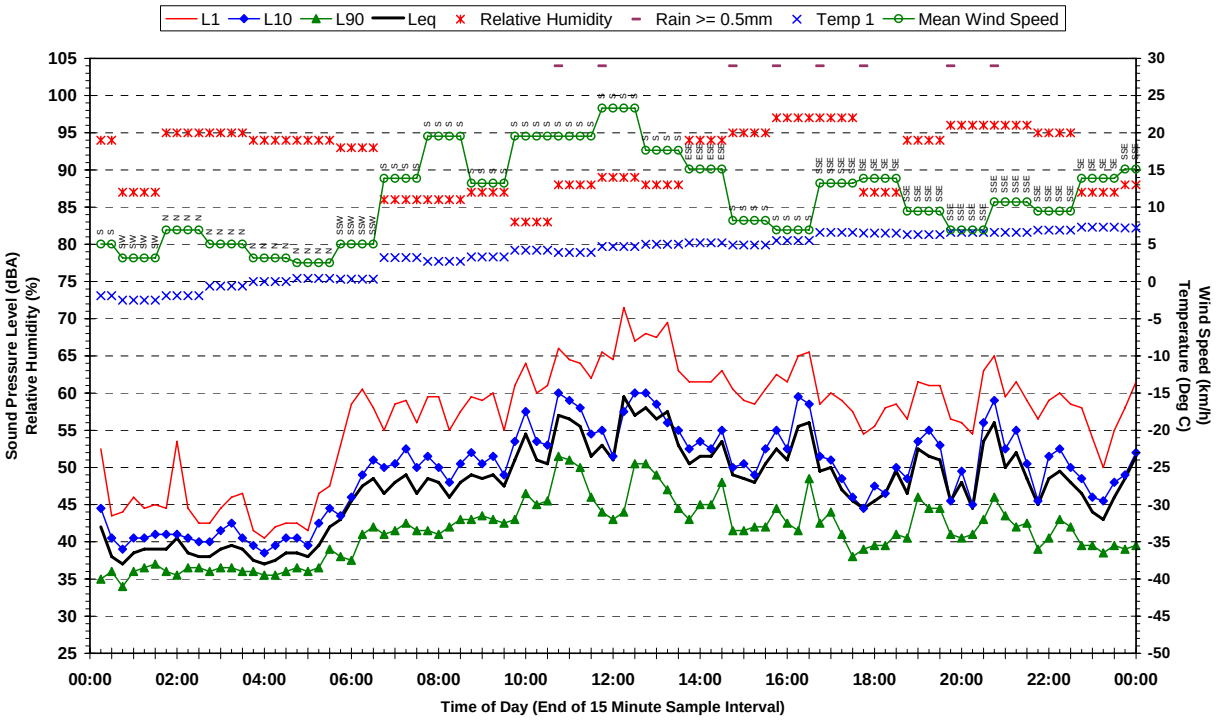
Statistical Ambient Noise Levels
Gunlake Quarries Background Noise Survey - 529 Brayton Road - Tuesday 12 June 2007



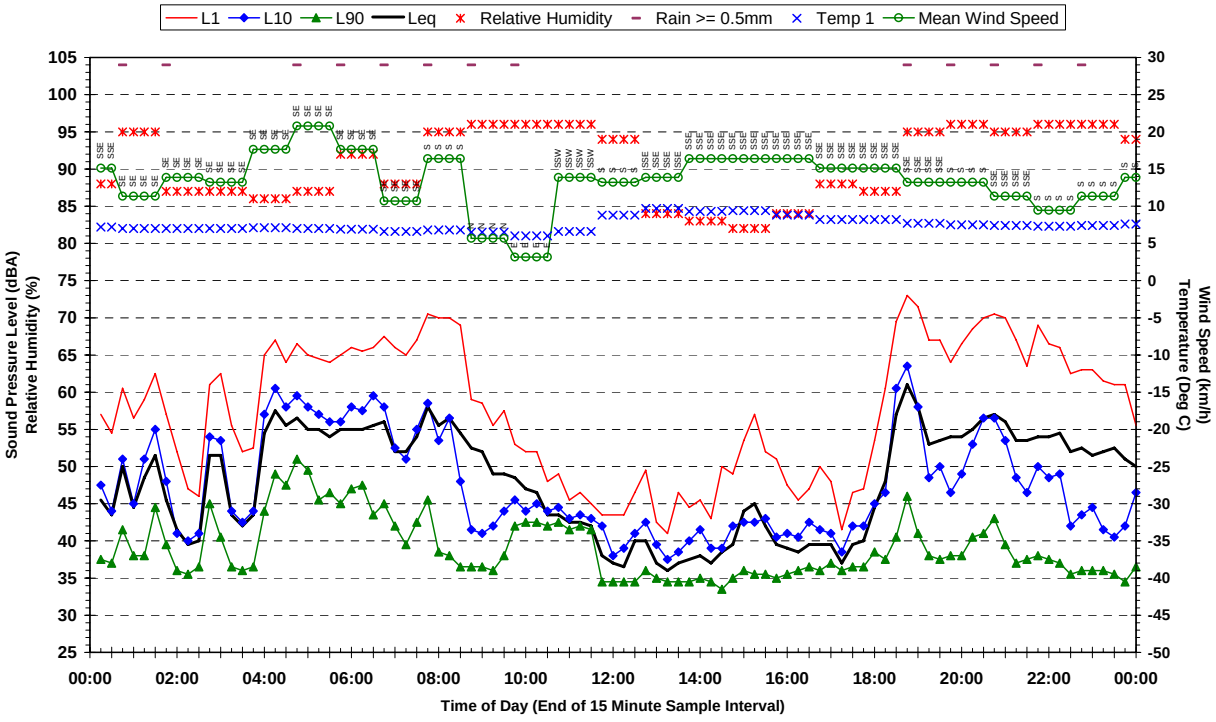
Statistical Ambient Noise Levels
Gunlake Quarries Background Noise Survey - 529 Brayton Road - Wednesday 13 June 2007



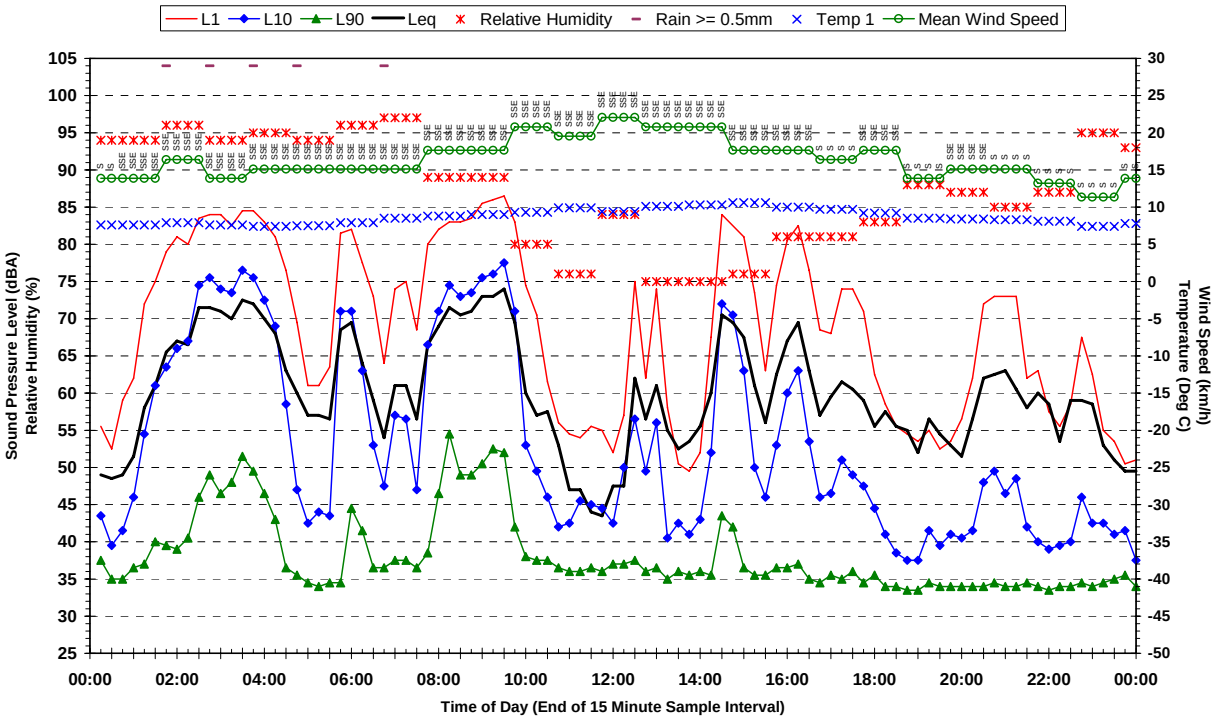
Statistical Ambient Noise Levels
Gunlake Quarries Background Noise Survey - 529 Brayton Road - Thursday 14 June 2007



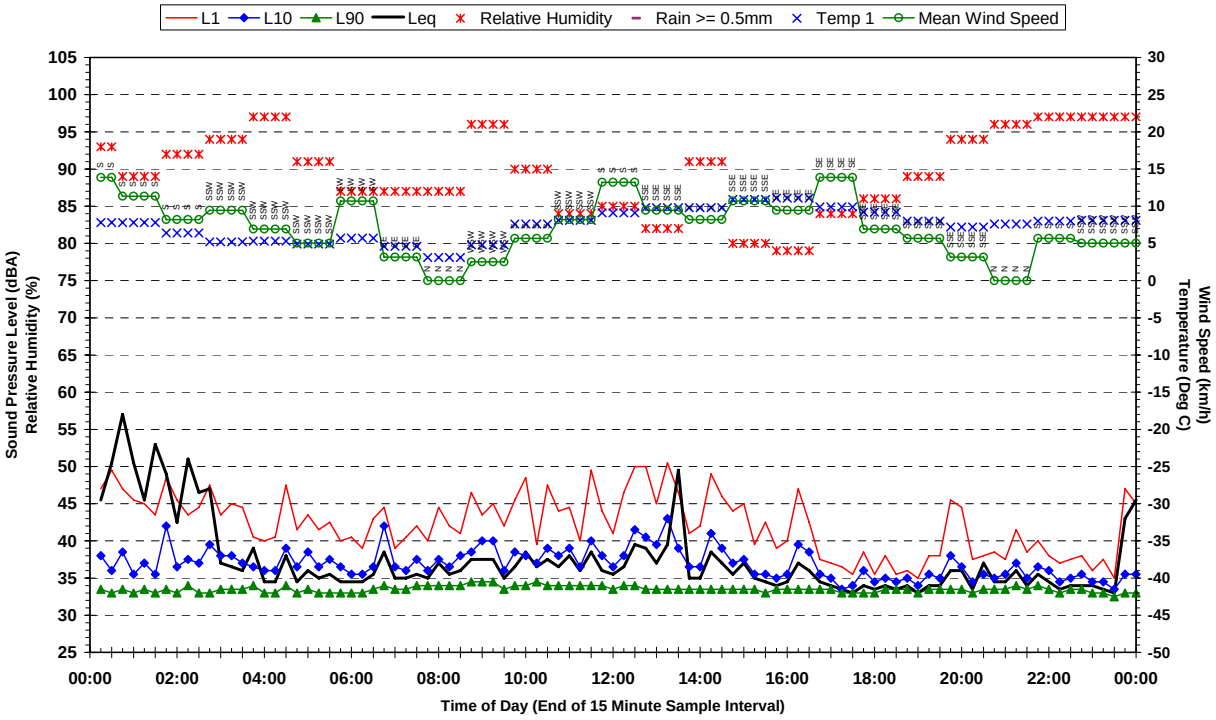
Statistical Ambient Noise Levels
Gunlake Quarries Background Noise Survey - 529 Brayton Road - Friday 15 June 2007



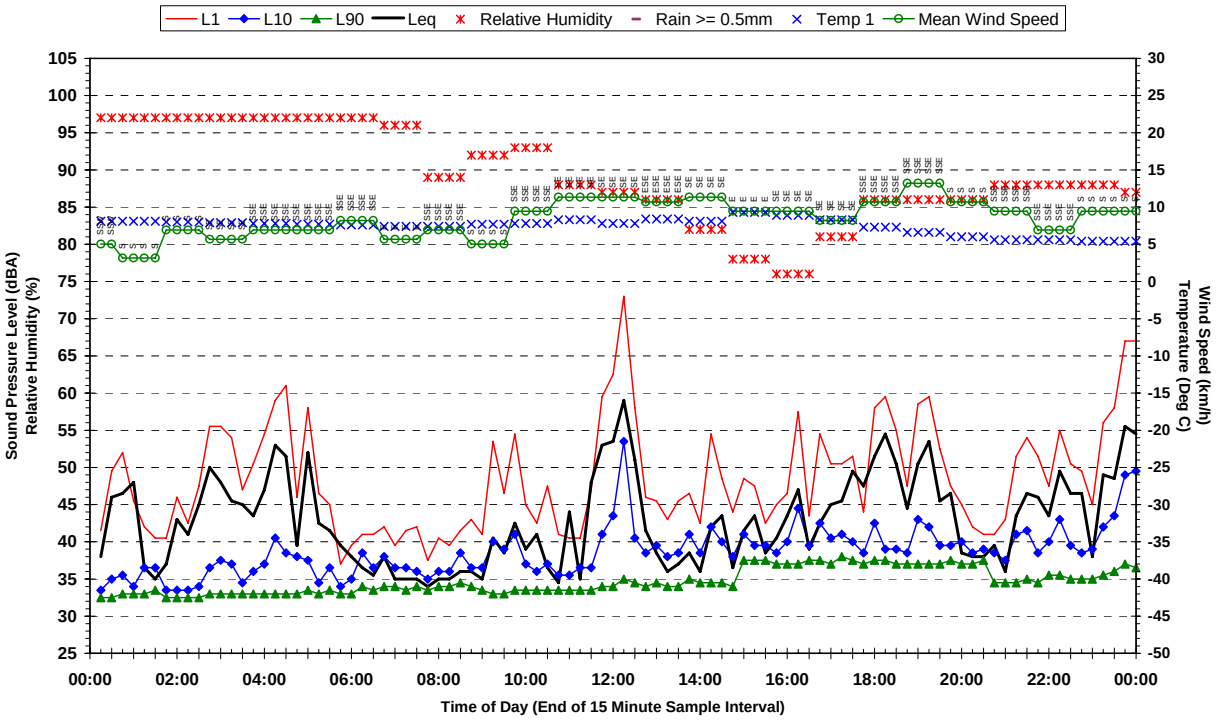
Statistical Ambient Noise Levels
Gunlake Quarries Background Noise Survey - 529 Brayton Road - Saturday 16 June 2007



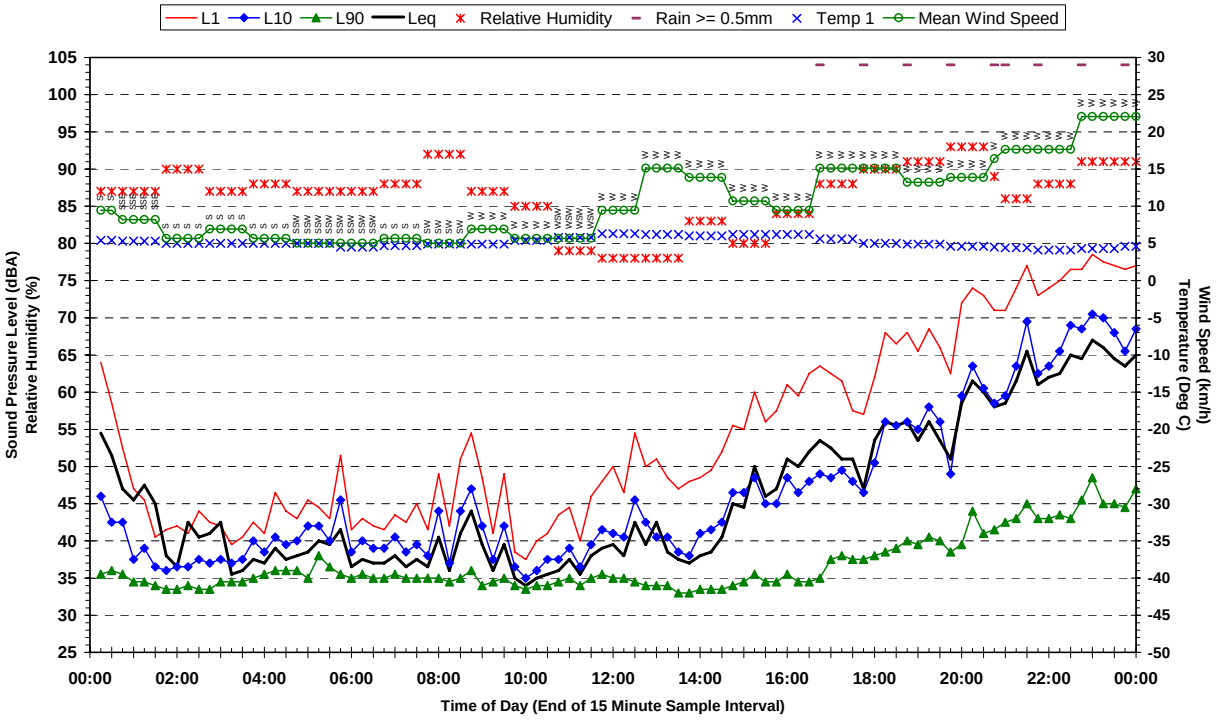
Statistical Ambient Noise Levels
Gunlake Quarries Background Noise Survey - 529 Brayton Road - Sunday 17 June 2007



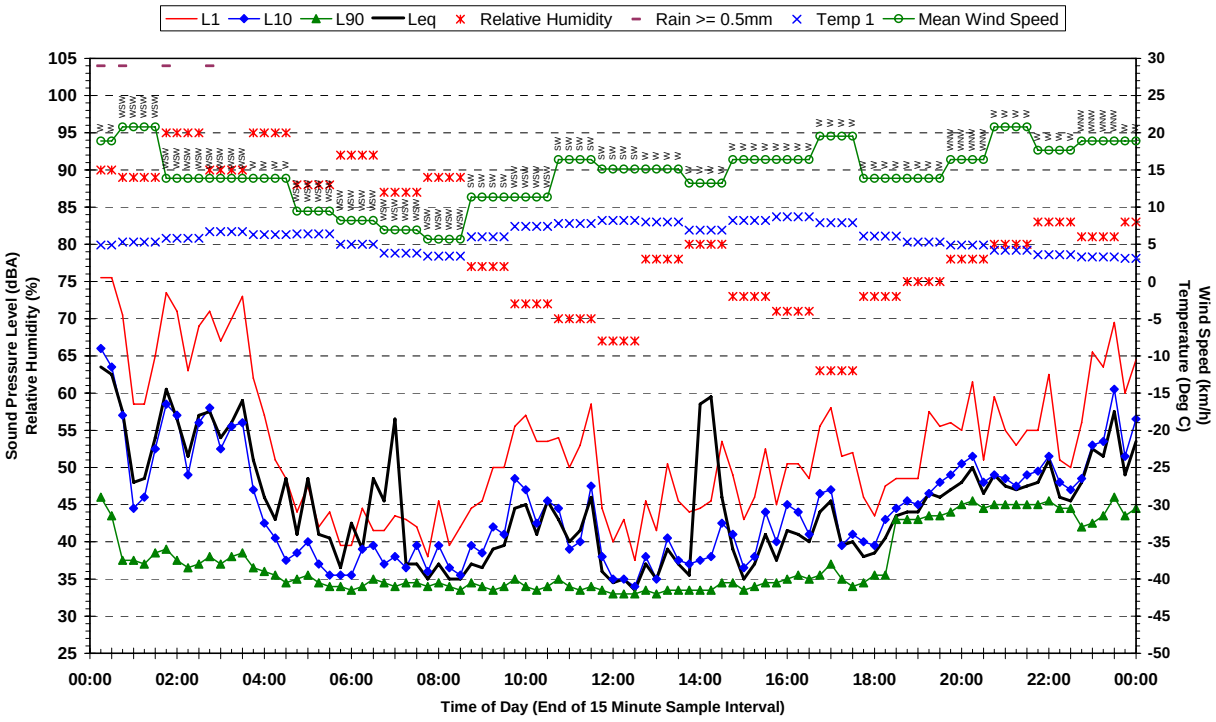
Statistical Ambient Noise Levels
Gunlake Quarries Background Noise Survey - 529 Brayton Road - Monday 18 June 2007



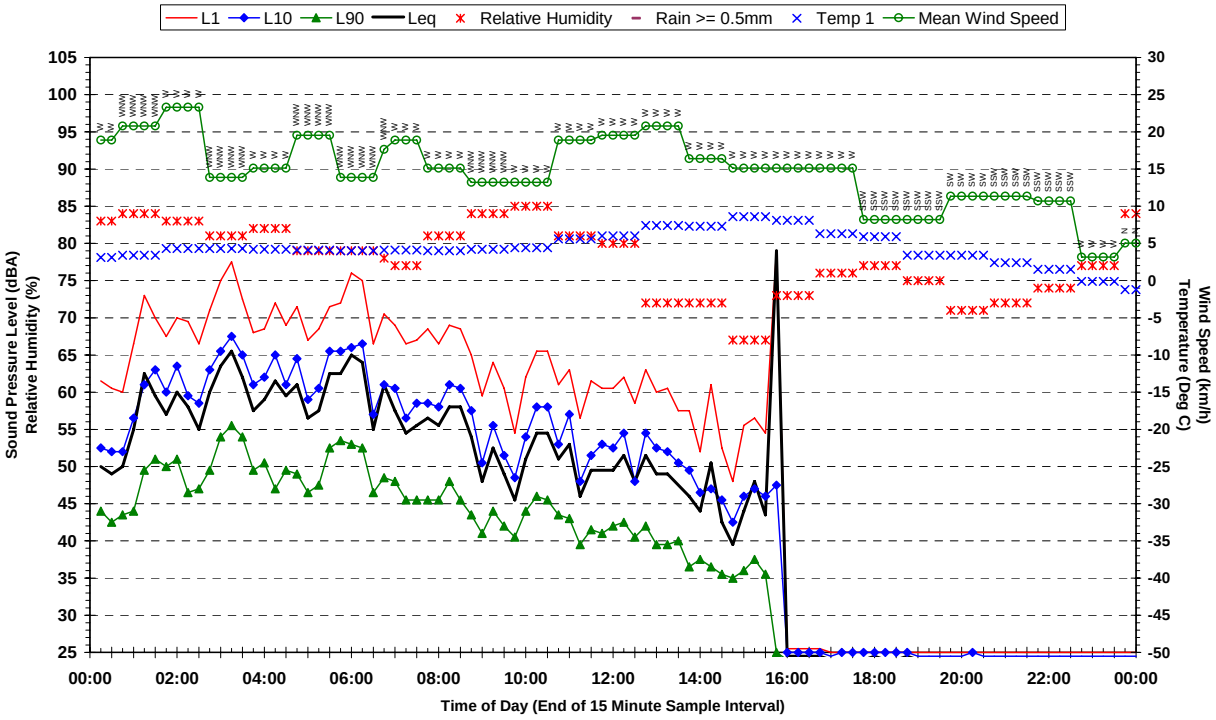
Statistical Ambient Noise Levels
Gunlake Quarries Background Noise Survey - 529 Brayton Road - Tuesday 19 June 2007



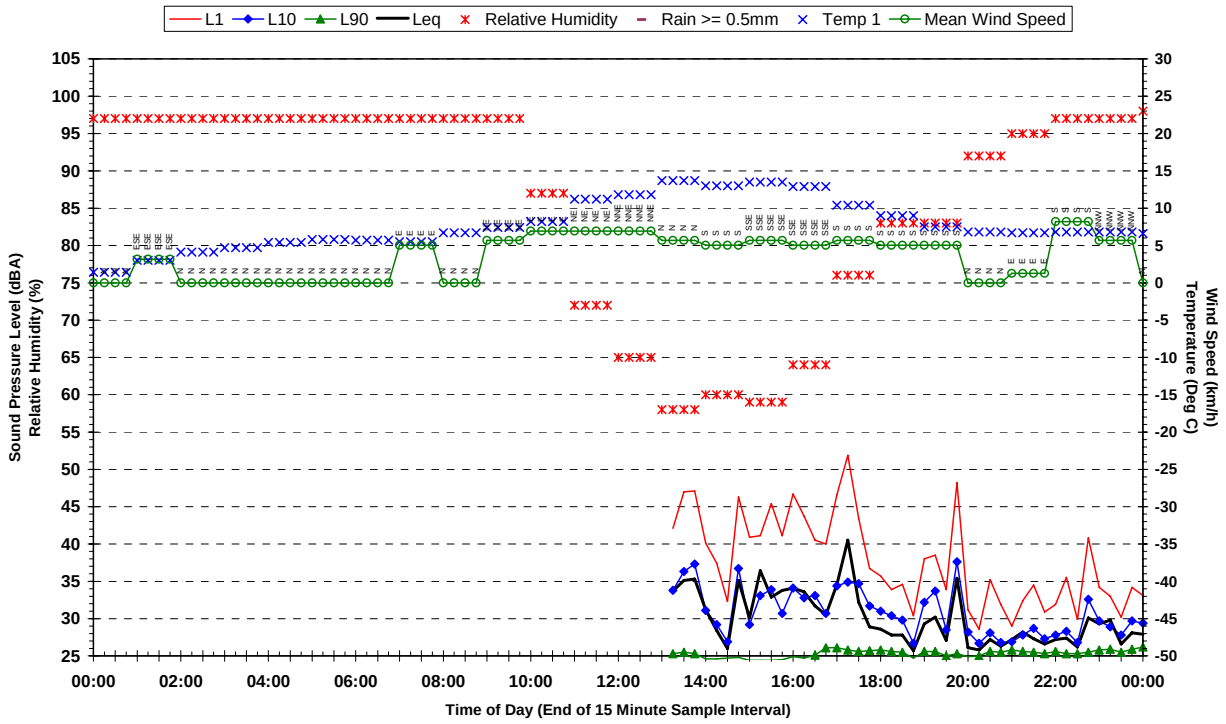
Statistical Ambient Noise Levels
Gunlake Quarries Background Noise Survey - 529 Brayton Road - Wednesday 20 June 2007



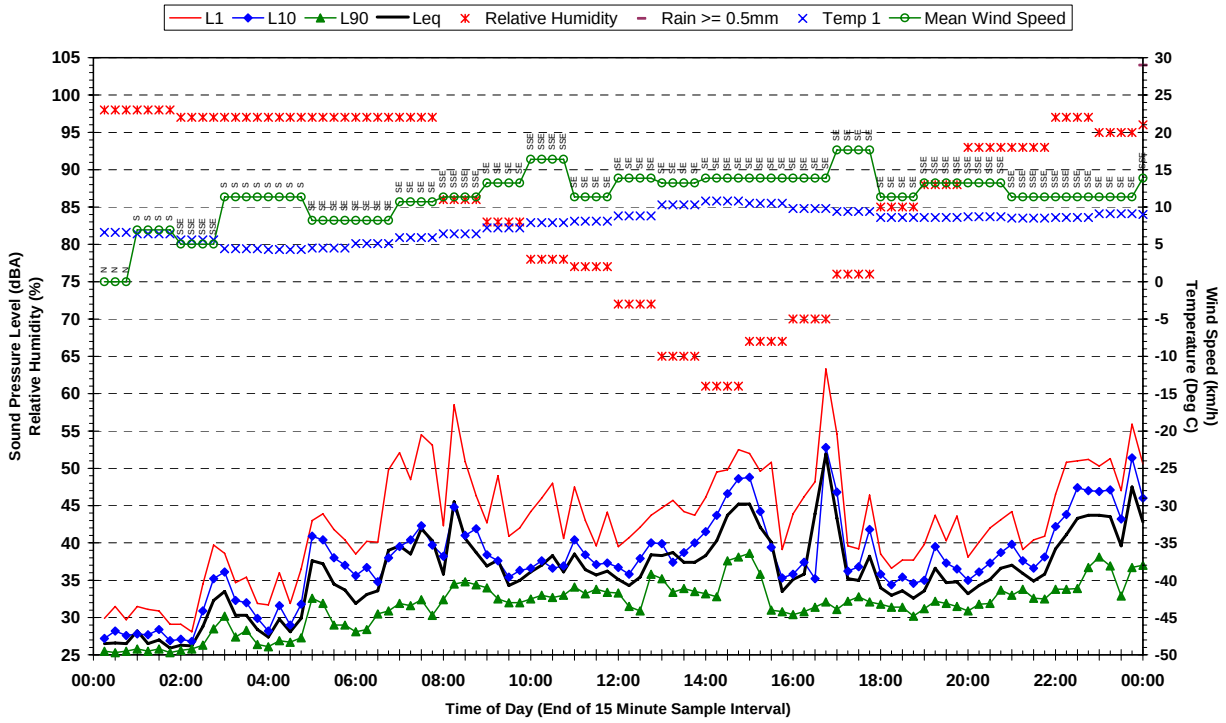
Statistical Ambient Noise Levels
Gunlake Quarries Background Noise Survey - 529 Brayton Road - Thursday 21 June 2007



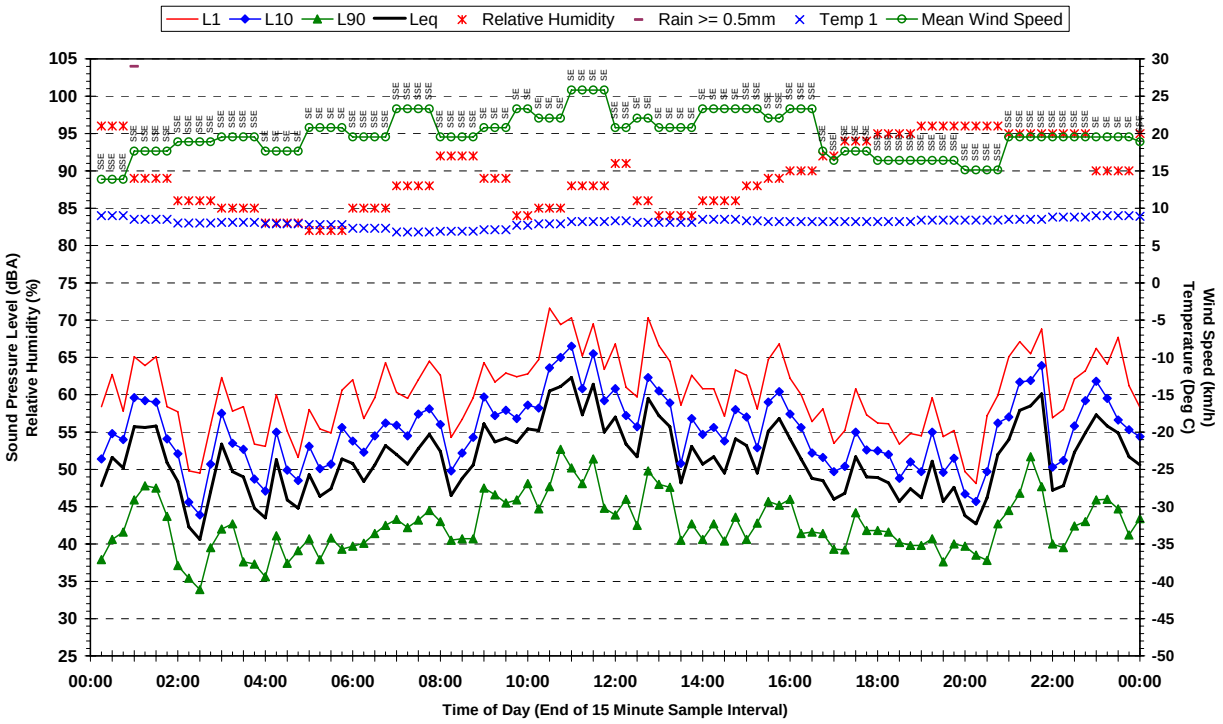
Statistical Ambient Noise Levels
Gunlake Quarries Background Noise Survey - 1540 Carrick Road - Wednesday 6 June 2007



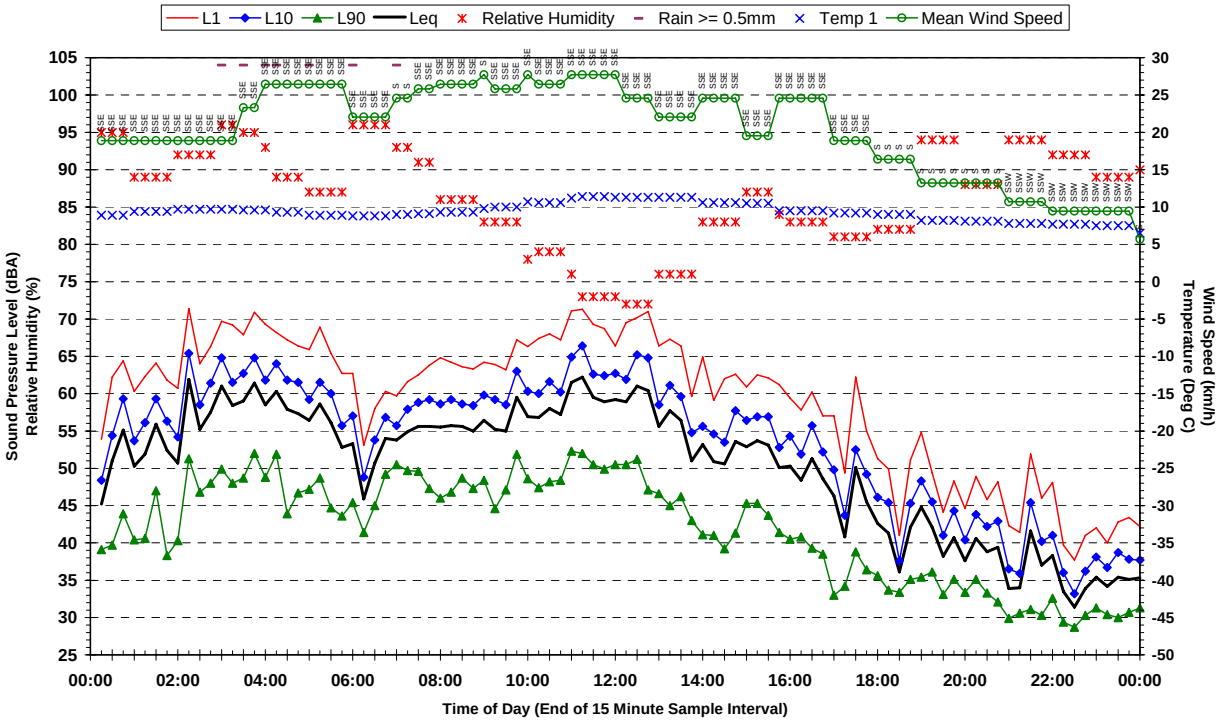
Statistical Ambient Noise Levels
Gunlake Quarries Background Noise Survey - 1540 Carrick Road - Thursday 7 June 2007



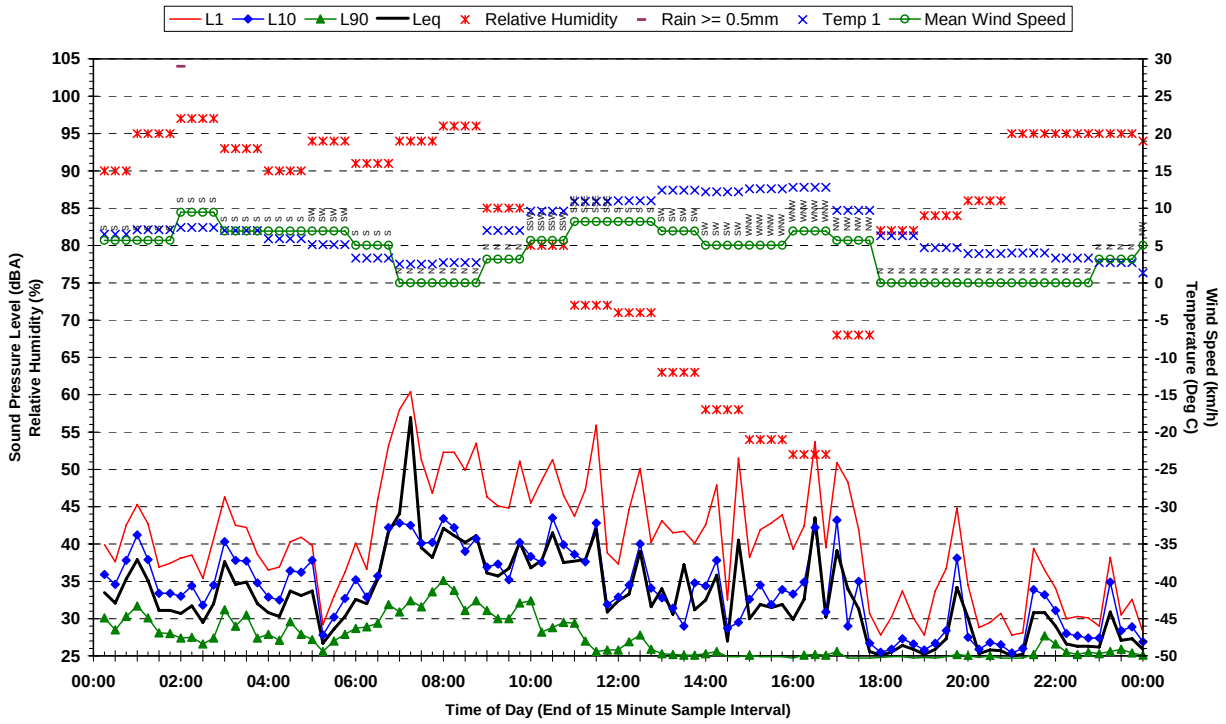
Statistical Ambient Noise Levels
Gunlake Quarries Background Noise Survey - 1540 Carrick Road - Friday 8 June 2007



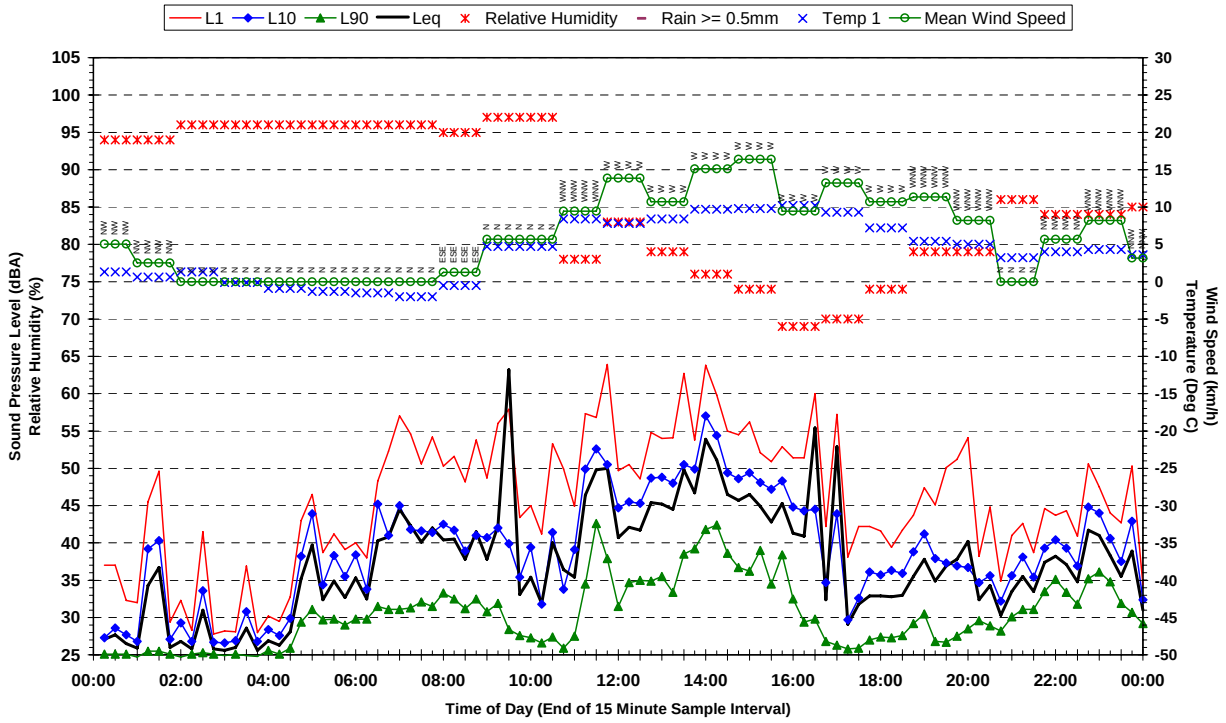
Statistical Ambient Noise Levels
Gunlake Quarries Background Noise Survey - 1540 Carrick Road - Saturday 9 June 2007



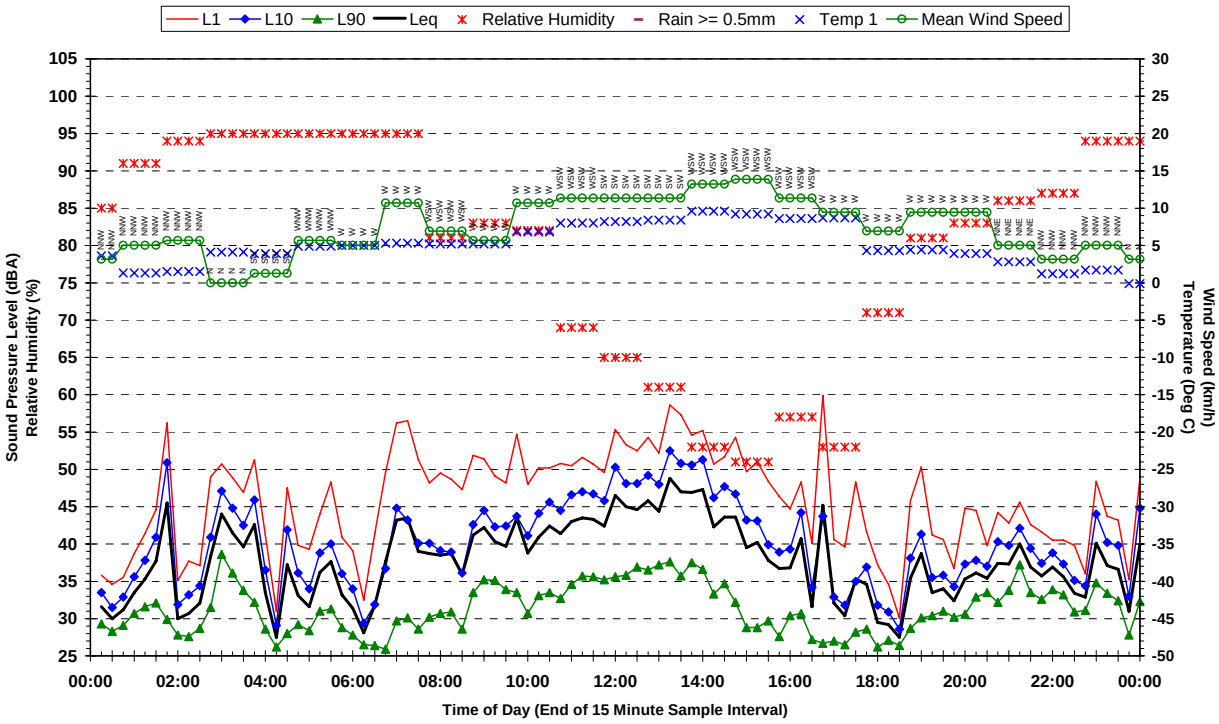
Statistical Ambient Noise Levels
Gunlake Quarries Background Noise Survey - 1540 Carrick Road - Sunday 10 June 2007



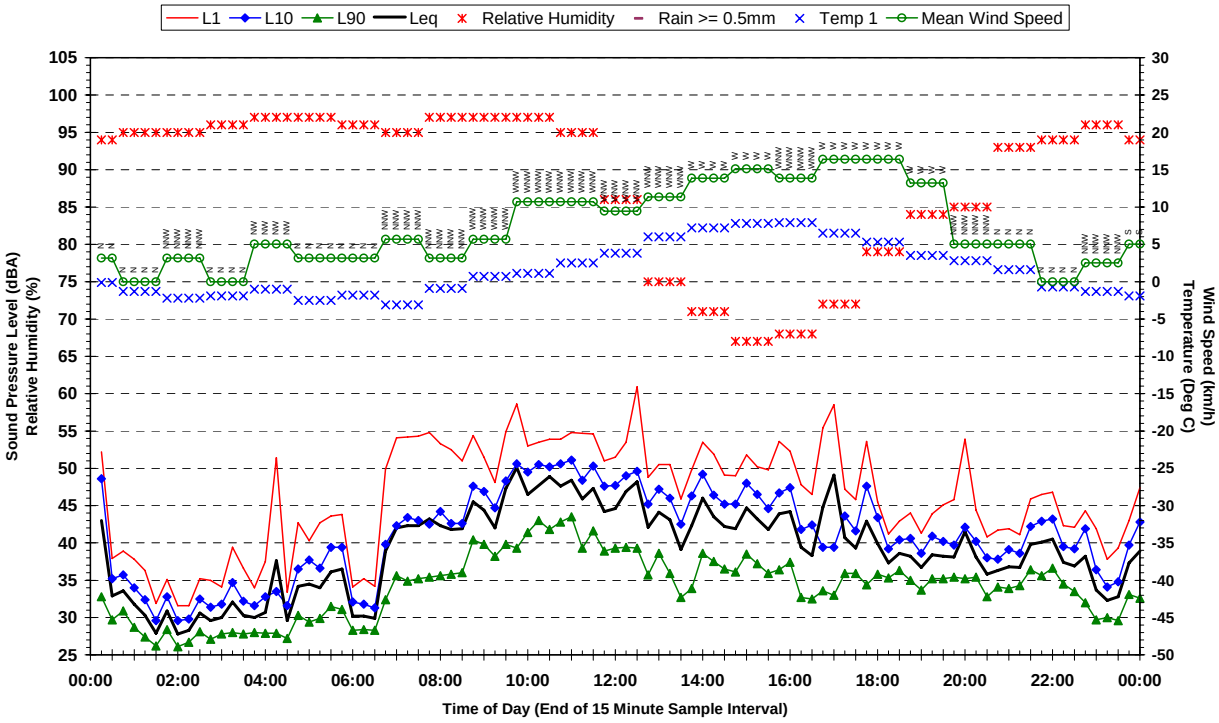
Statistical Ambient Noise Levels
Gunlake Quarries Background Noise Survey - 1540 Carrick Road - Monday 11 June 2007



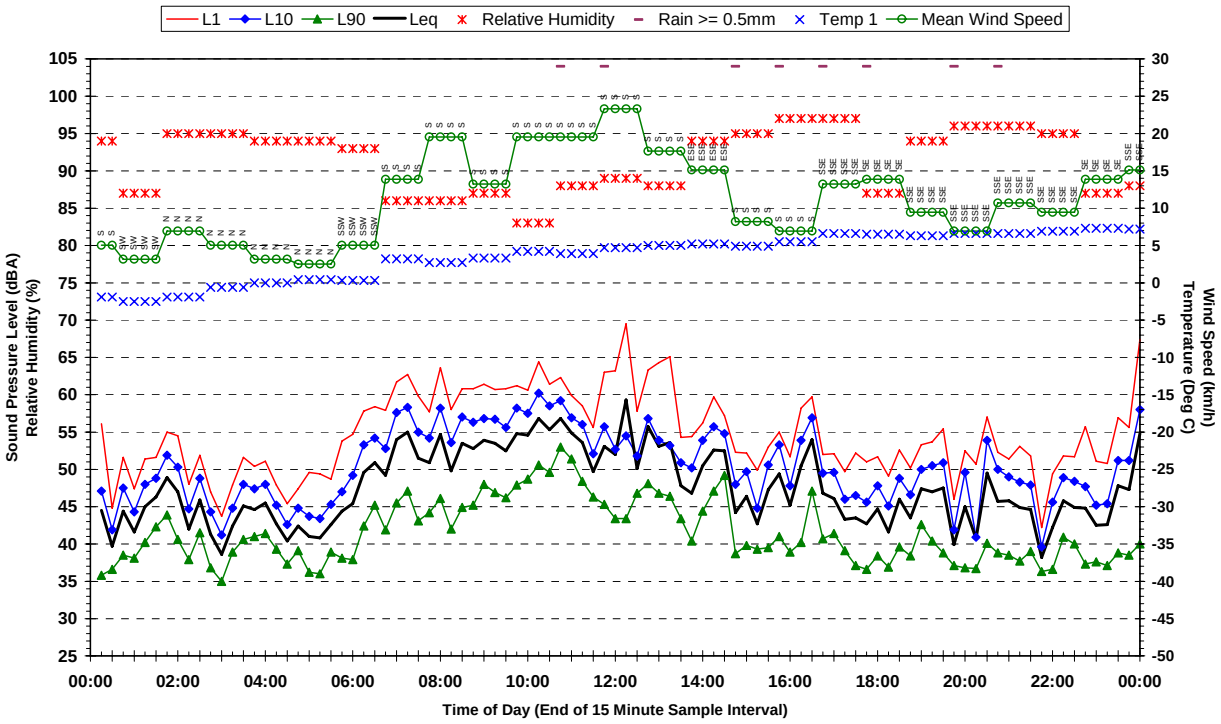
Statistical Ambient Noise Levels
Gunlake Quarries Background Noise Survey - 1540 Carrick Road - Tuesday 12 June 2007



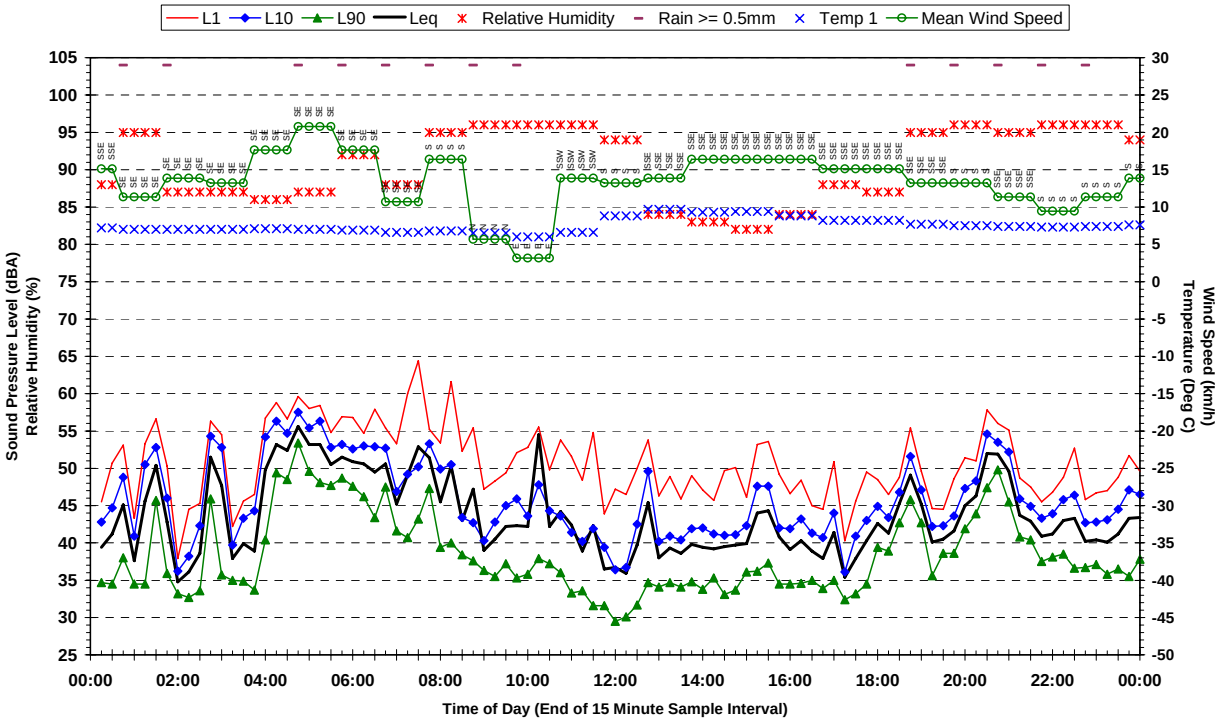
Statistical Ambient Noise Levels
Gunlake Quarries Background Noise Survey - 1540 Carrick Road - Wednesday 13 June 2007



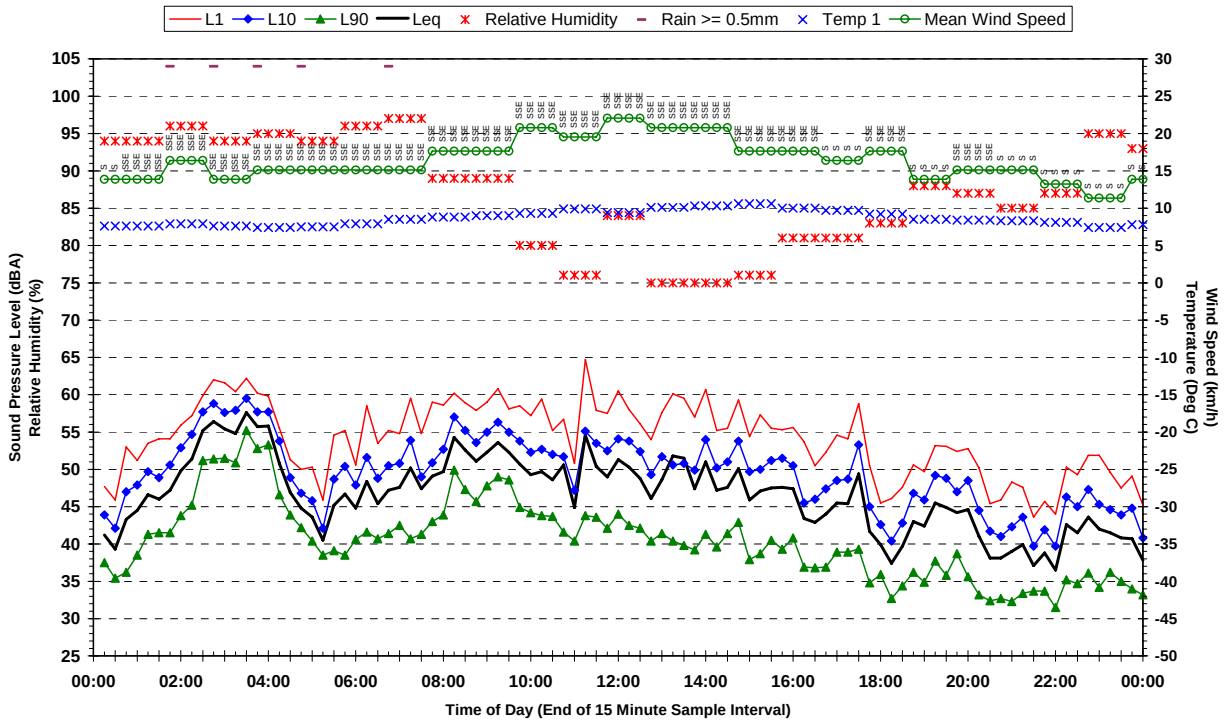
Statistical Ambient Noise Levels
Gunlake Quarries Background Noise Survey - 1540 Carrick Road - Thursday 14 June 2007



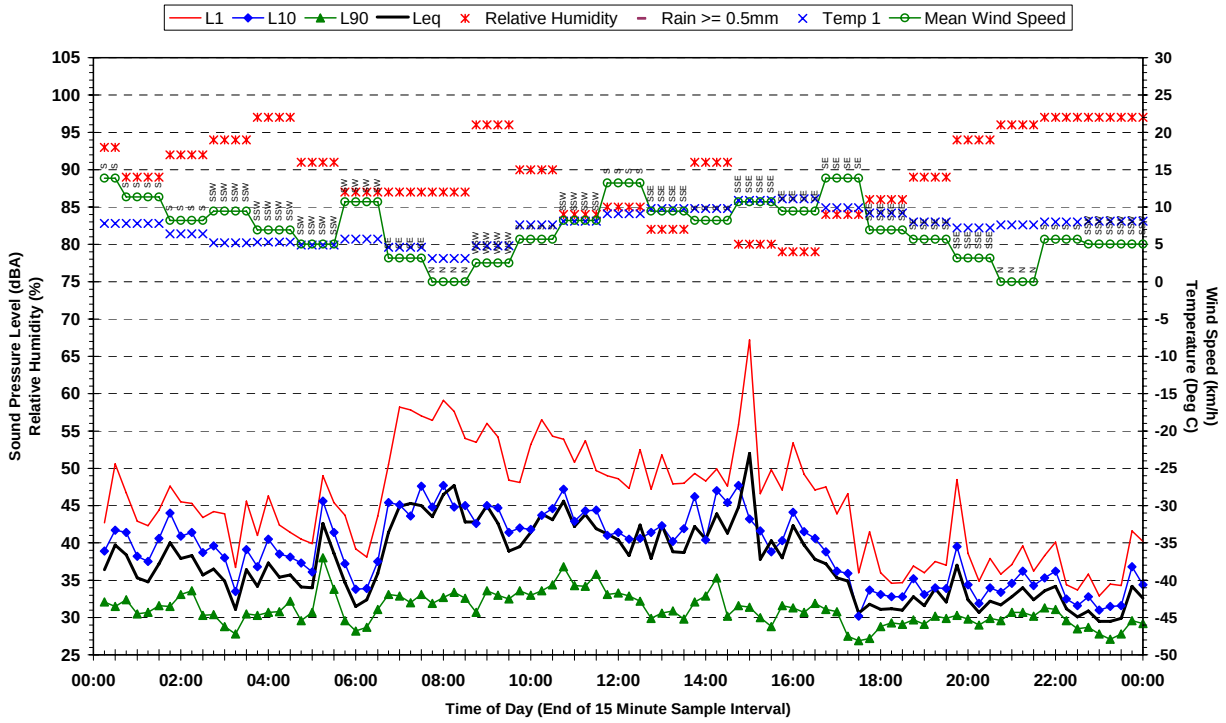
Statistical Ambient Noise Levels
Gunlake Quarries Background Noise Survey - 1540 Carrick Road - Friday 15 June 2007



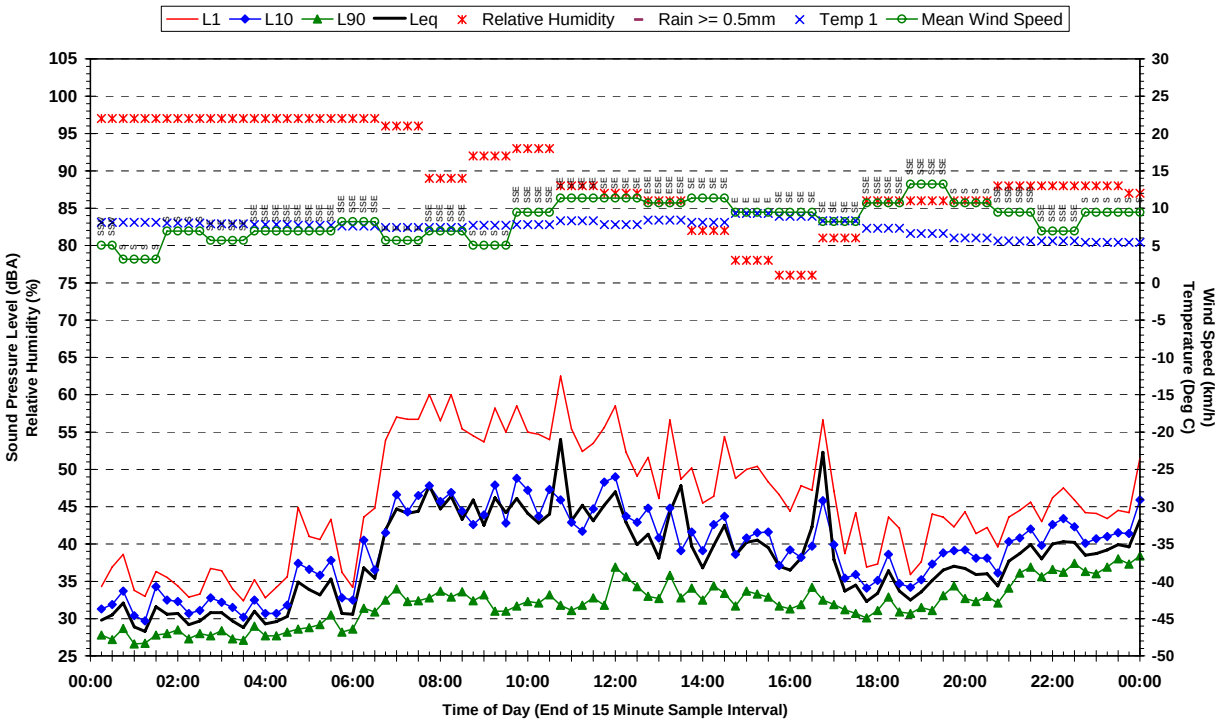
Statistical Ambient Noise Levels
Gunlake Quarries Background Noise Survey - 1540 Carrick Road - Saturday 16 June 2007



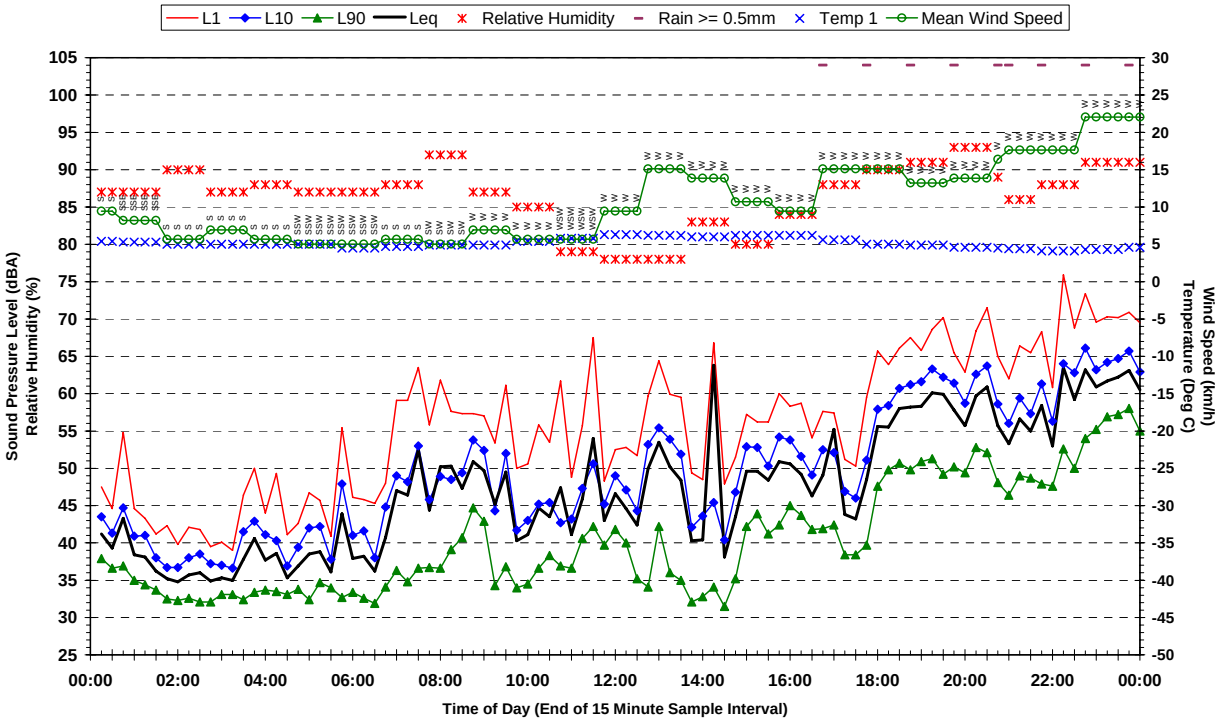
Statistical Ambient Noise Levels
Gunlake Quarries Background Noise Survey - 1540 Carrick Road - Sunday 17 June 2007



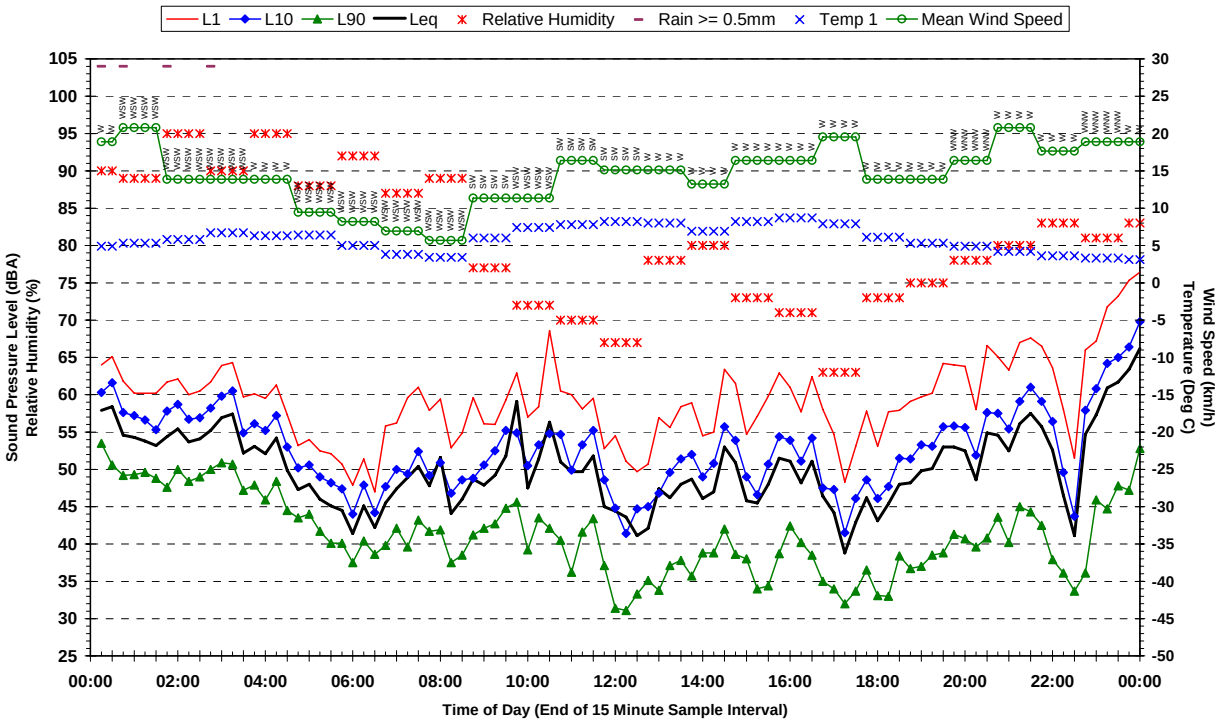
Statistical Ambient Noise Levels
Gunlake Quarries Background Noise Survey - 1540 Carrick Road - Monday 18 June 2007



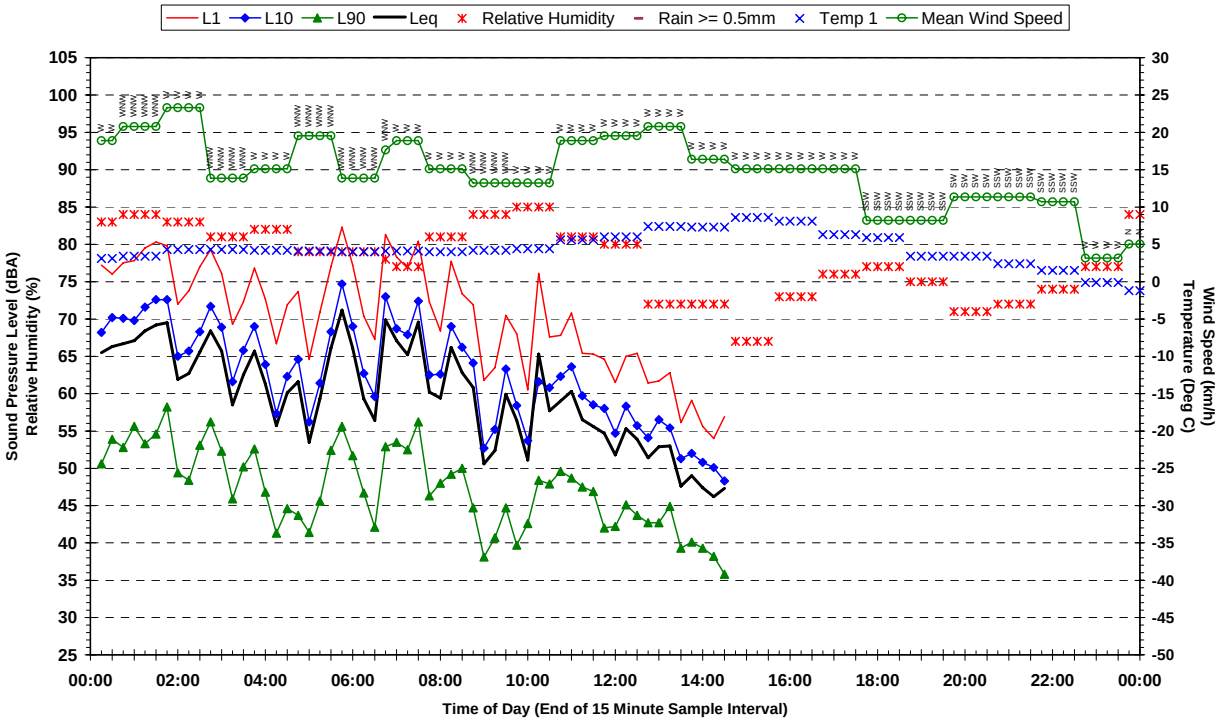
Statistical Ambient Noise Levels
Gunlake Quarries Background Noise Survey - 1540 Carrick Road - Tuesday 19 June 2007



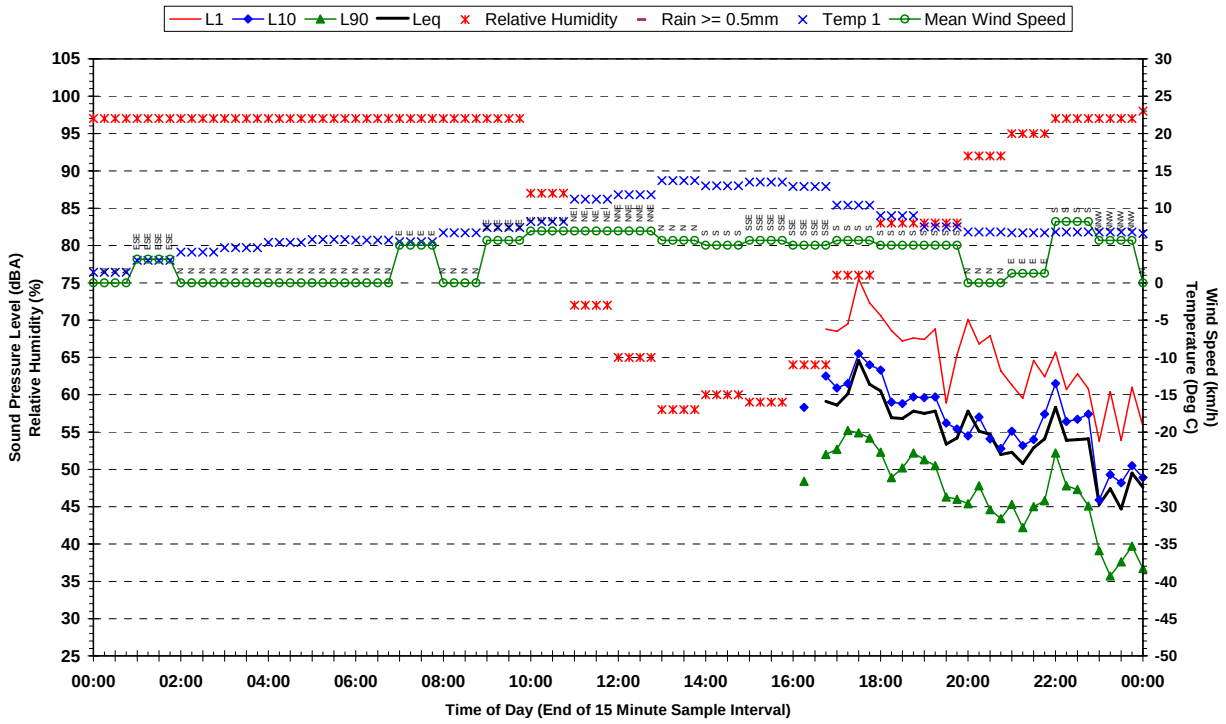
Statistical Ambient Noise Levels
Gunlake Quarries Background Noise Survey - 1540 Carrick Road - Wednesday 20 June 2007



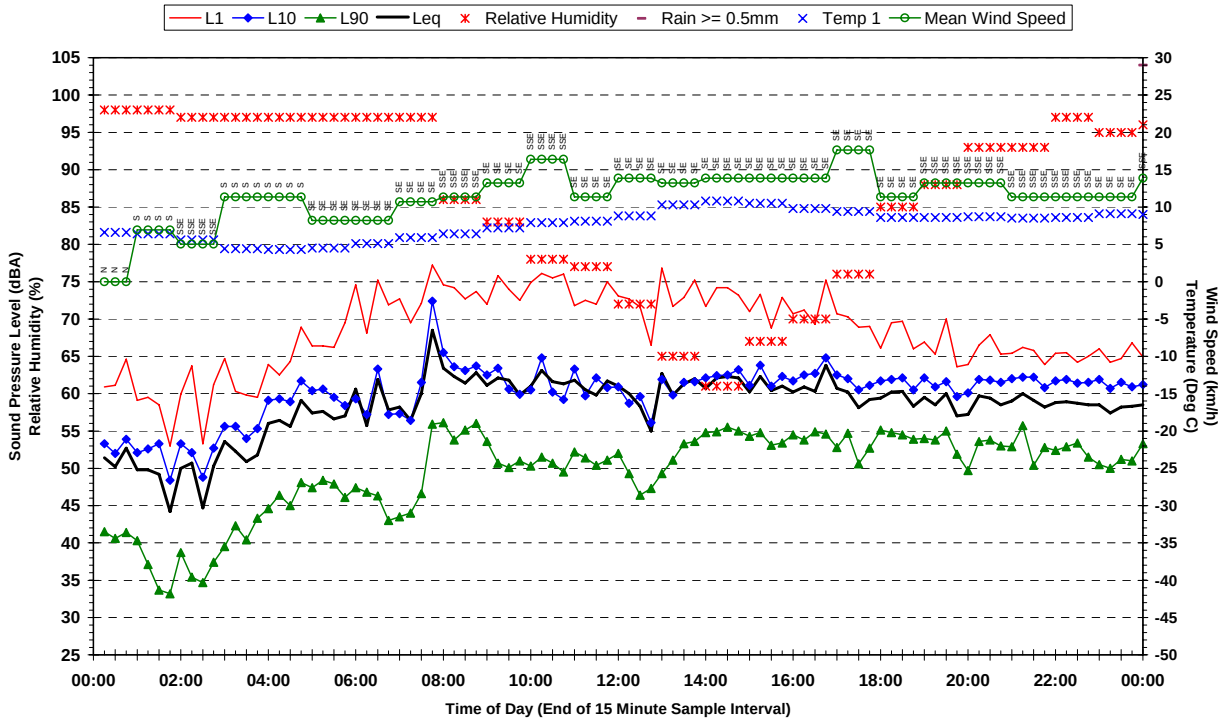
Statistical Ambient Noise Levels
Gunlake Quarries Background Noise Survey - 1540 Carrick Road - Thursday 21 June 2007



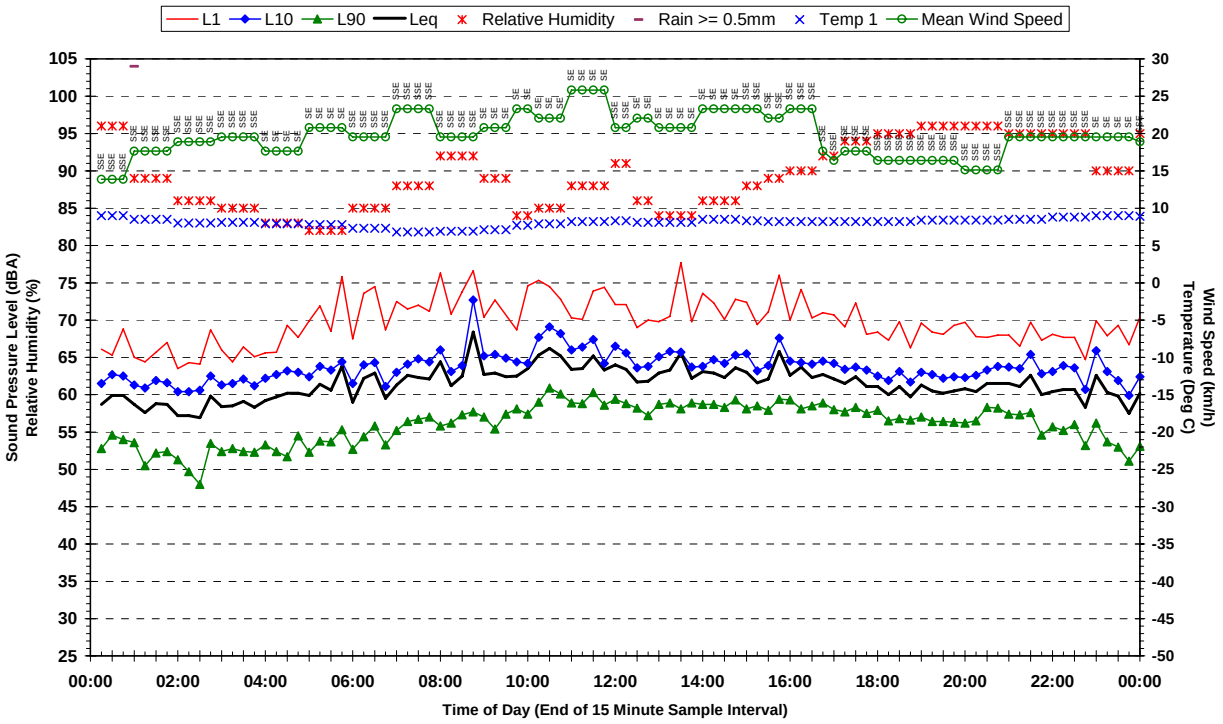
Statistical Ambient Noise Levels
Gunlake Quarries Background Noise Survey - 17 Brayton Road - Wednesday 6 June 2007



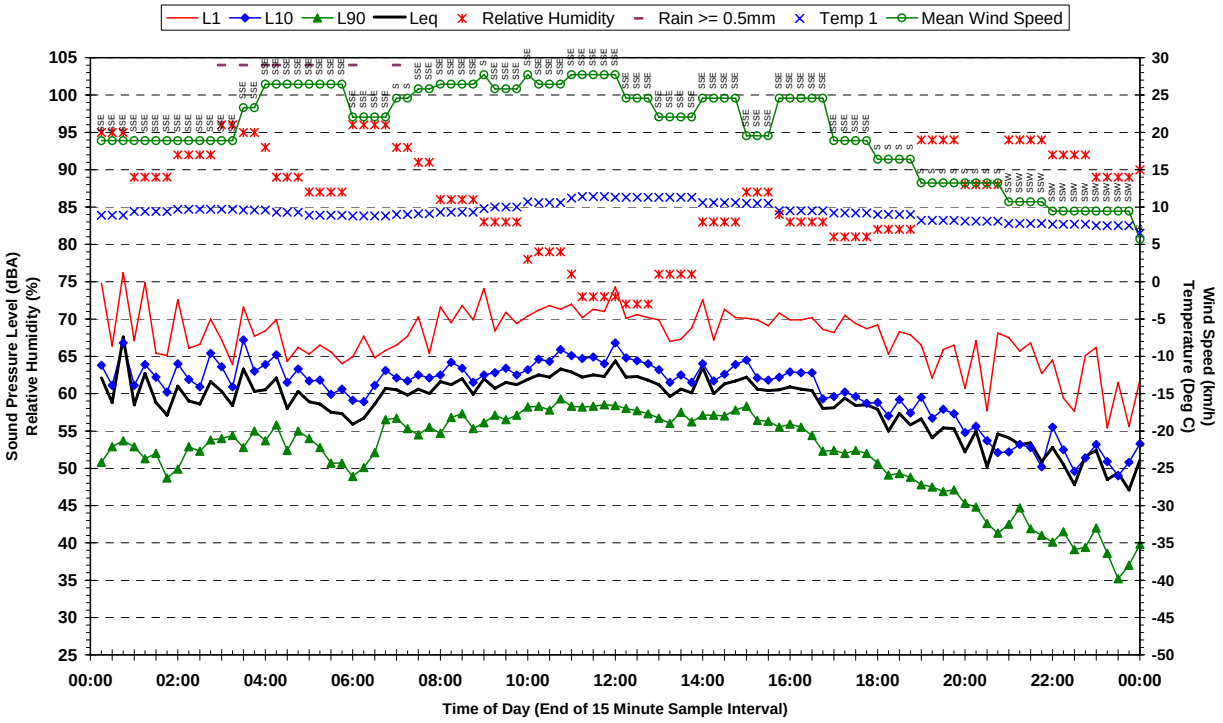
Statistical Ambient Noise Levels
Gunlake Quarries Background Noise Survey - 17 Brayton Road - Thursday 7 June 2007



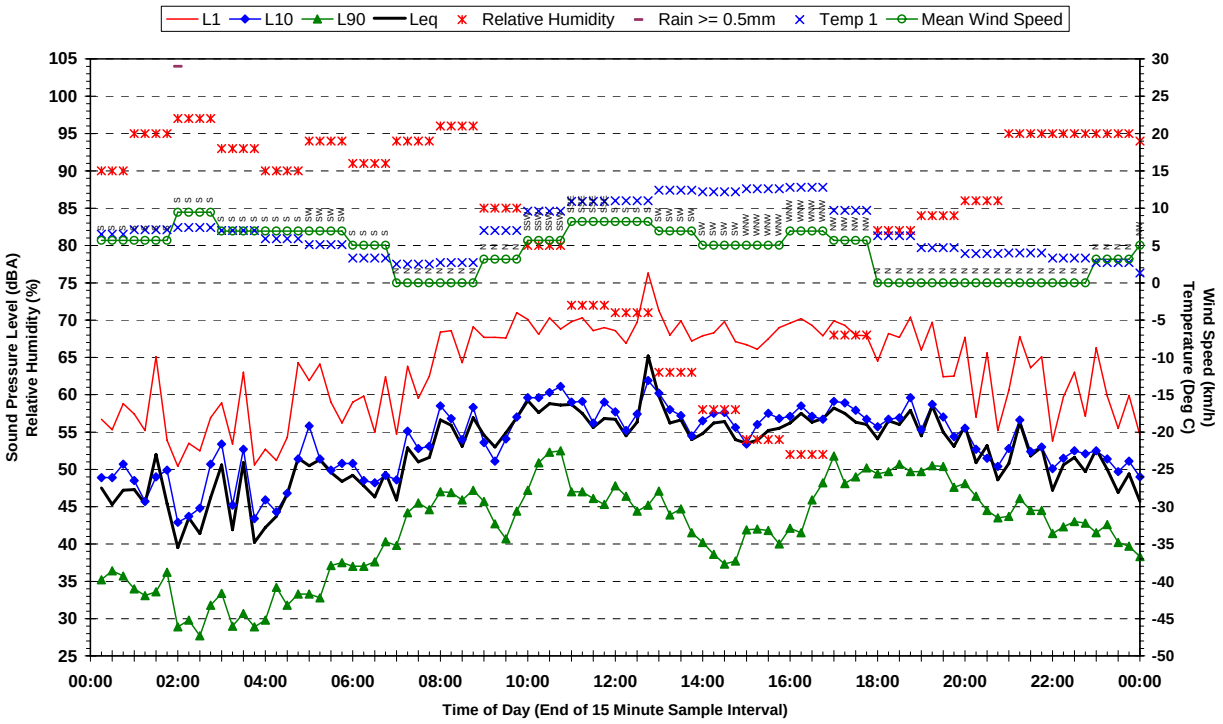
Statistical Ambient Noise Levels
Gunlake Quarries Background Noise Survey - 17 Brayton Road - Friday 8 June 2007



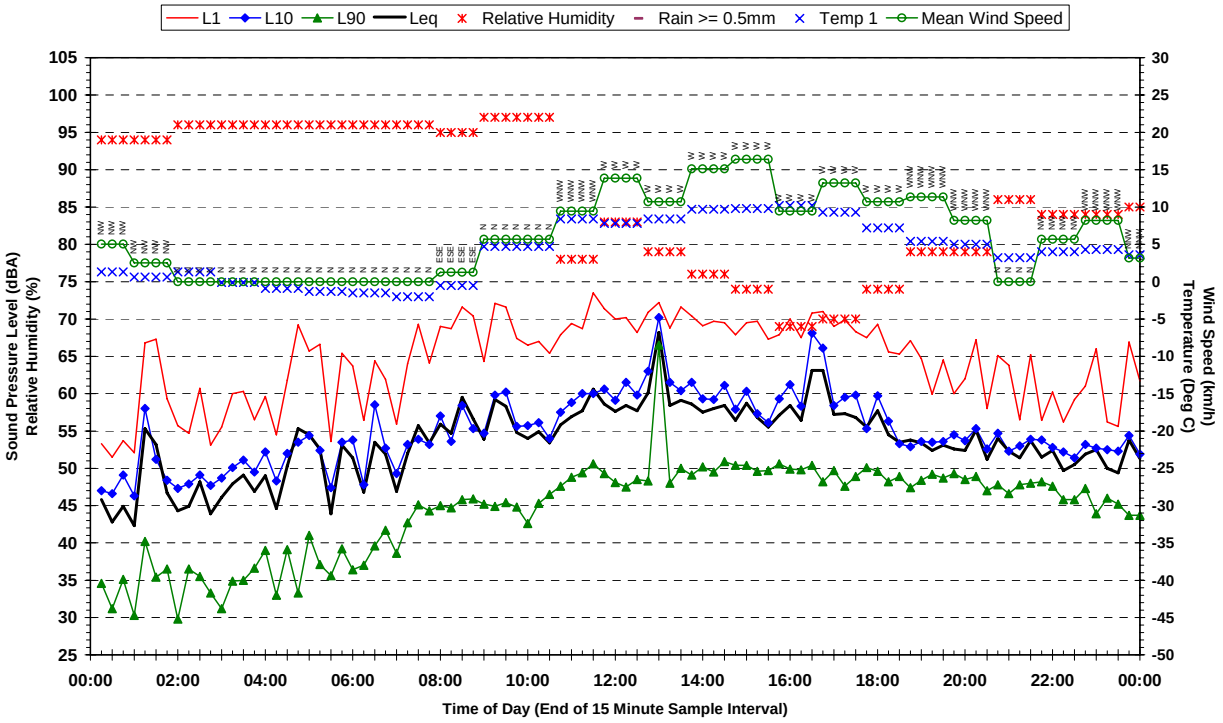
Statistical Ambient Noise Levels
Gunlake Quarries Background Noise Survey - 17 Brayton Road - Saturday 9 June 2007



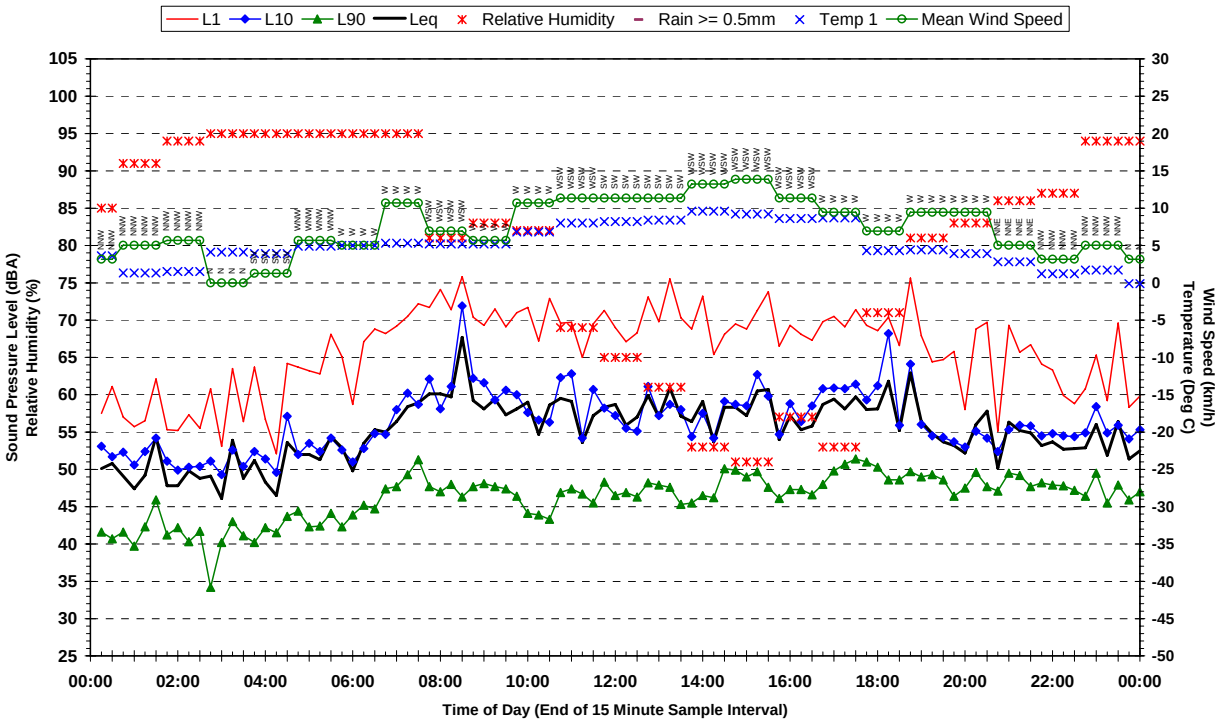
Statistical Ambient Noise Levels
Gunlake Quarries Background Noise Survey - 17 Brayton Road - Sunday 10 June 2007



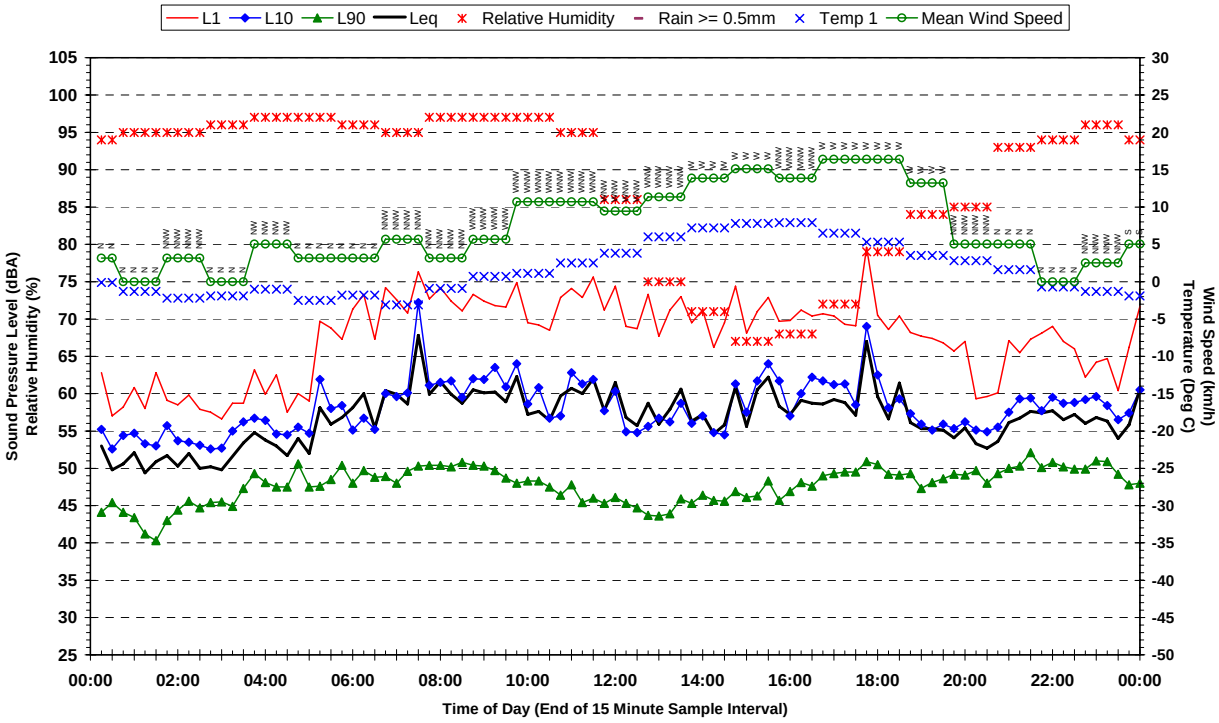
Statistical Ambient Noise Levels
Gunlake Quarries Background Noise Survey - 17 Brayton Road - Monday 11 June 2007



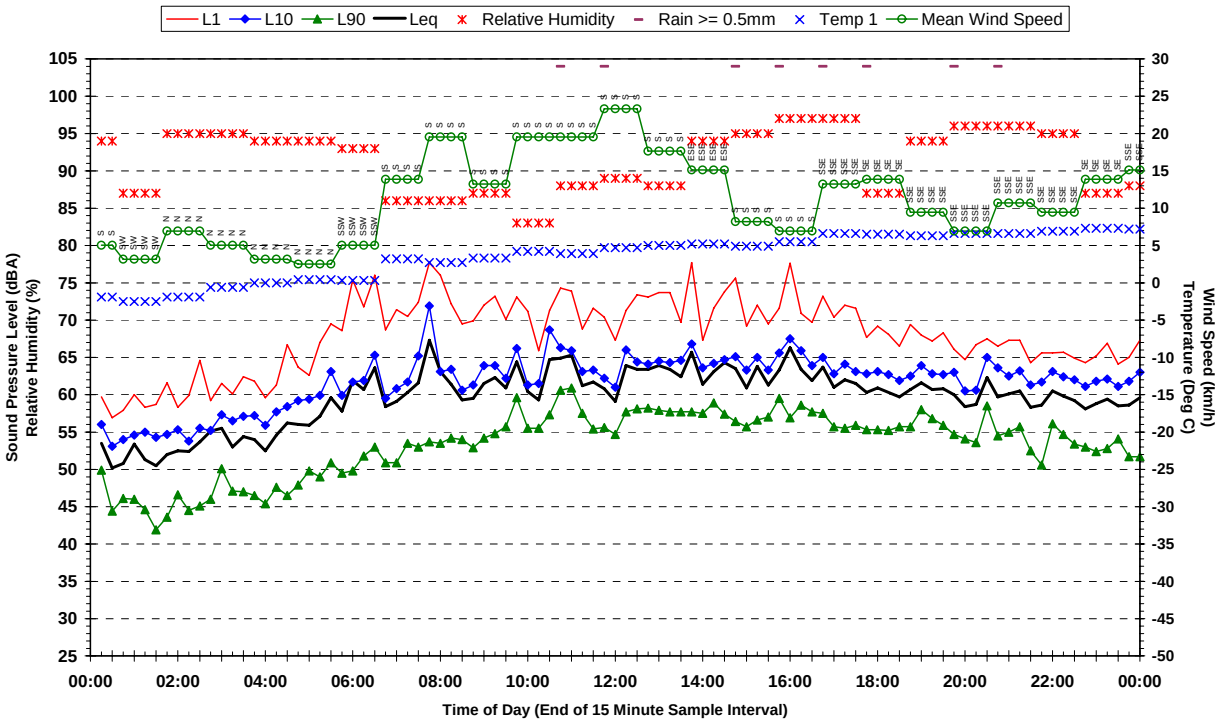
Statistical Ambient Noise Levels
Gunlake Quarries Background Noise Survey - 17 Brayton Road - Tuesday 12 June 2007



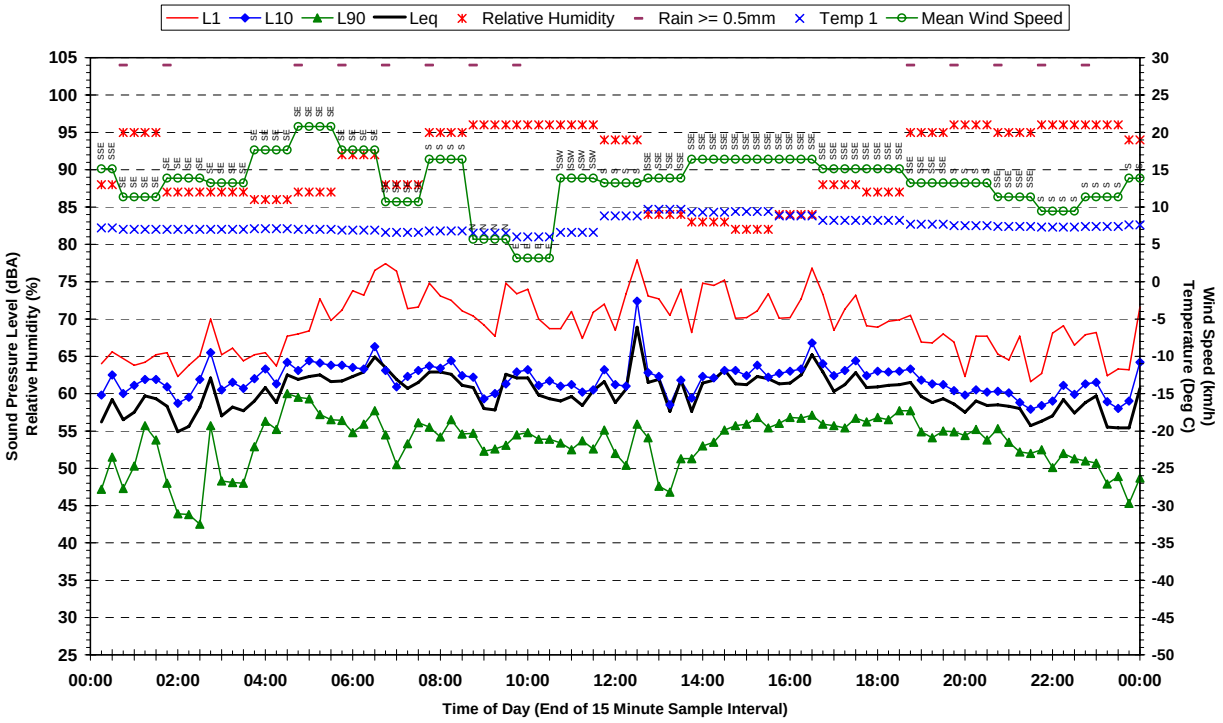
Statistical Ambient Noise Levels
Gunlake Quarries Background Noise Survey - 17 Brayton Road - Wednesday 13 June 2007



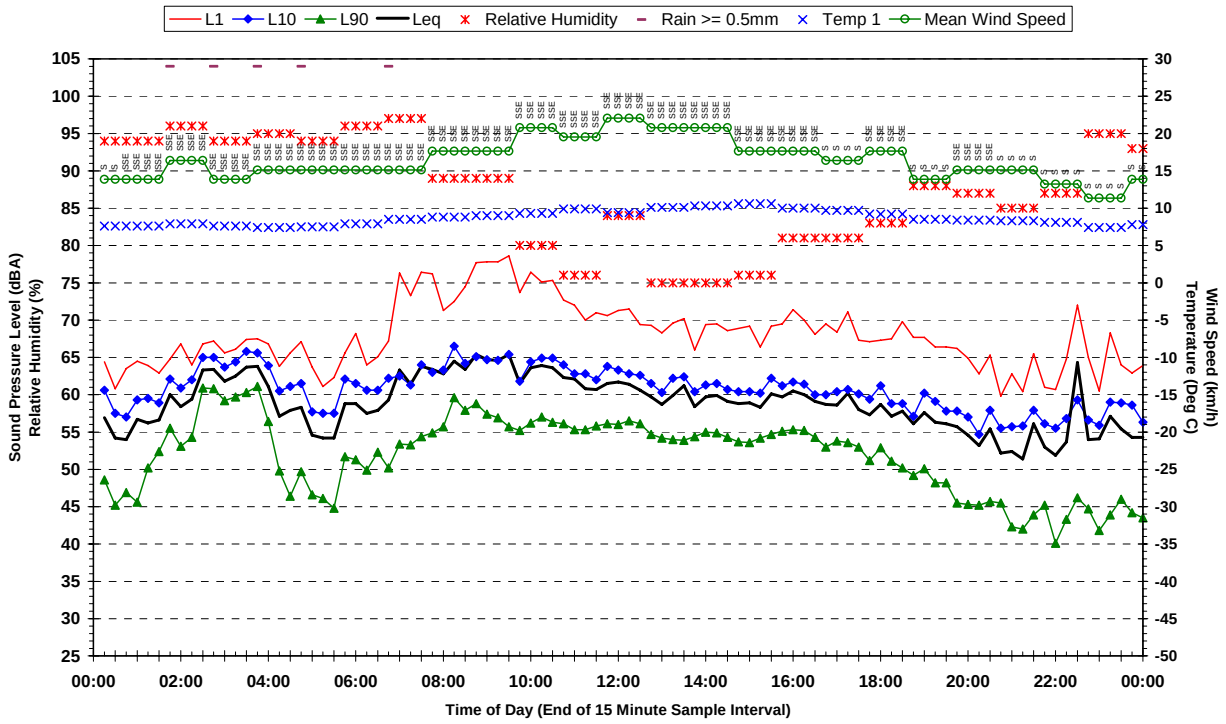
Statistical Ambient Noise Levels
Gunlake Quarries Background Noise Survey - 17 Brayton Road - Thursday 14 June 2007



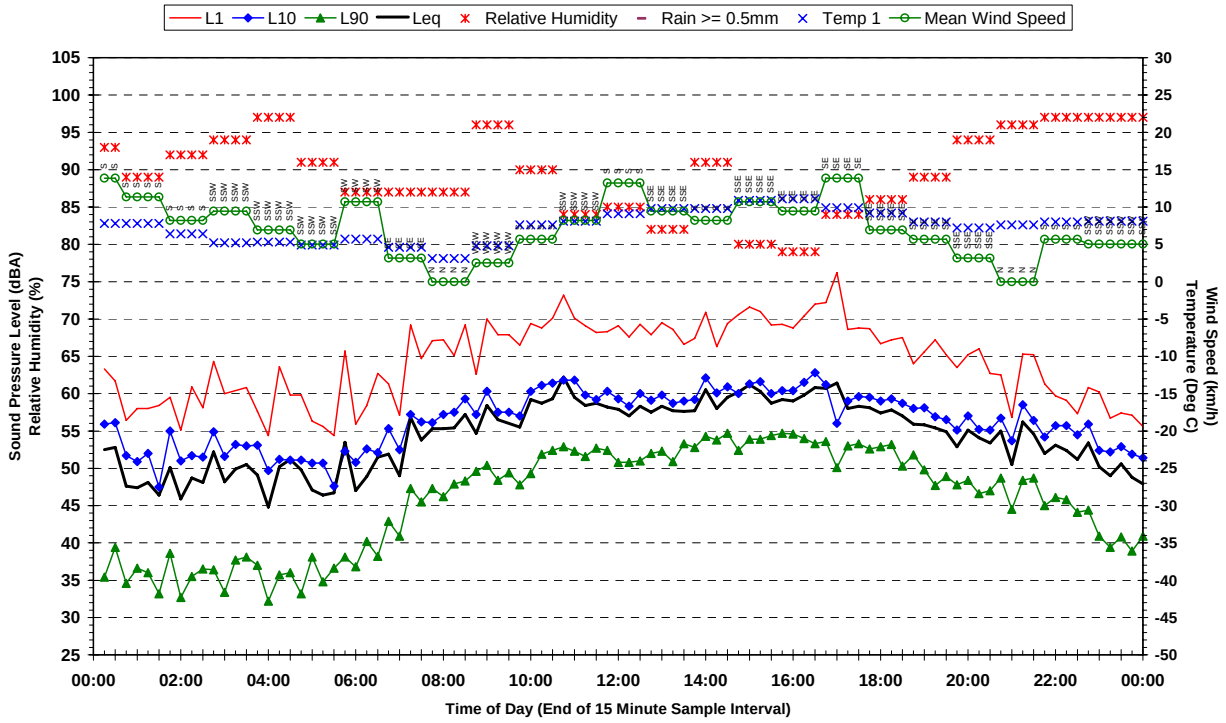
Statistical Ambient Noise Levels
Gunlake Quarries Background Noise Survey - 17 Brayton Road - Friday 15 June 2007



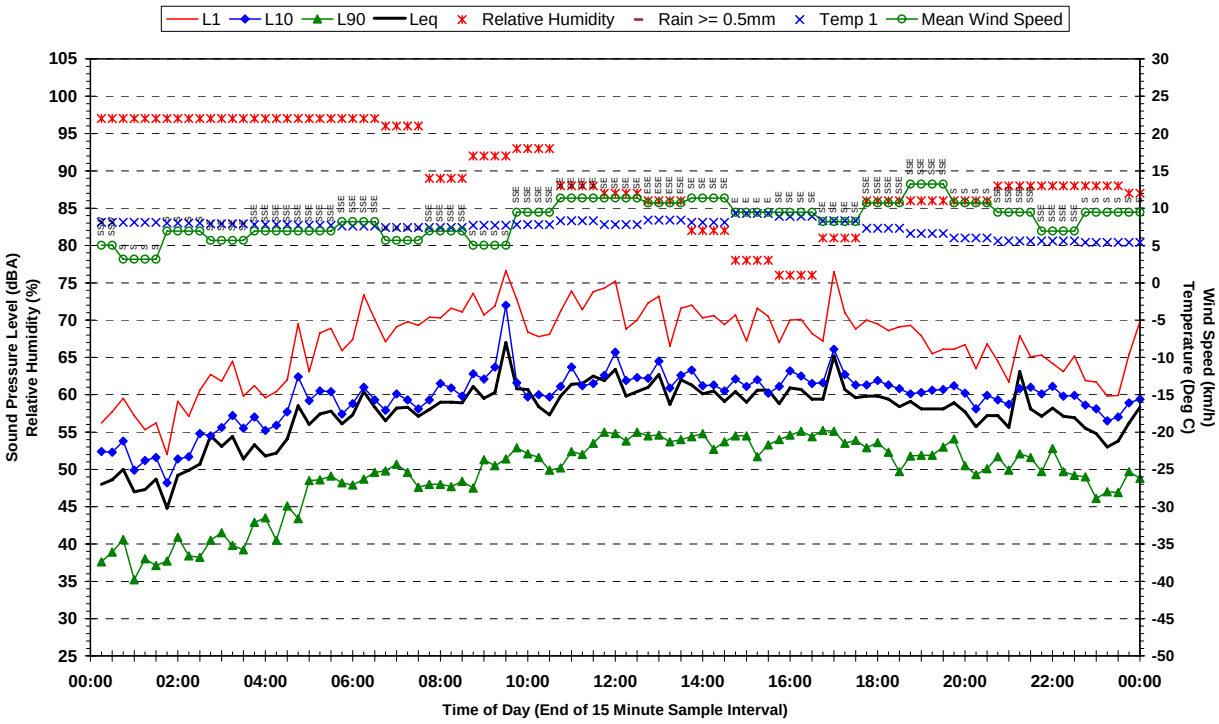
Statistical Ambient Noise Levels
Gunlake Quarries Background Noise Survey - 17 Brayton Road - Saturday 16 June 2007



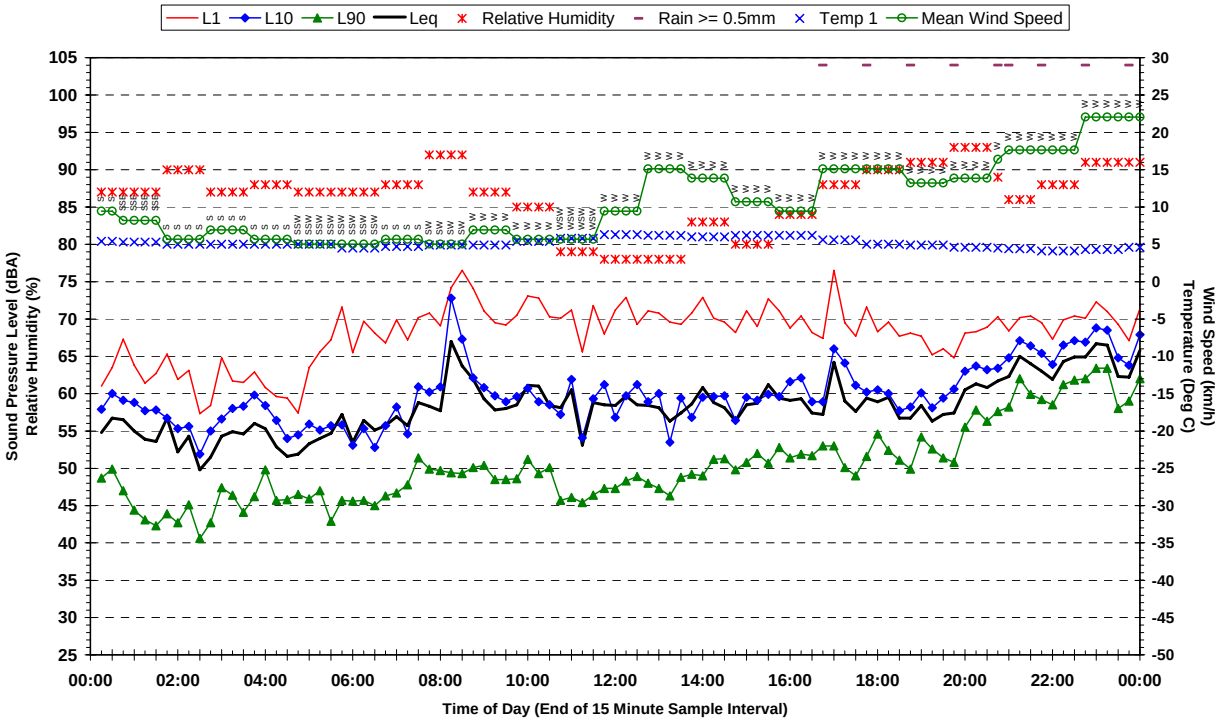
Statistical Ambient Noise Levels
Gunlake Quarries Background Noise Survey - 17 Brayton Road - Sunday 17 June 2007



Statistical Ambient Noise Levels
Gunlake Quarries Background Noise Survey - 17 Brayton Road - Monday 18 June 2007



Statistical Ambient Noise Levels
Gunlake Quarries Background Noise Survey - 17 Brayton Road - Tuesday 19 June 2007



Statistical Ambient Noise Levels
Gunlake Quarries Background Noise Survey - 17 Brayton Road - Wednesday 20 June 2007