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NOISE SURVEY REPORT
THE HALL SCHOOL

RAMBØLL ENVIRON

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EXECUTIVE SUMMARY

Ramboll Environ was commissioned to provide a noise survey report in support of a planning application for the redevelopment of The Hall Senior School in Belsize Park, London.

A baseline noise survey has been undertaken at the site of the proposed new building in order to determine the current noise levels around the site and at representative positions of the noise-sensitive receptors during the daytime and late evening. The methodology and results of this noise survey are summarised in this report.

An assessment of the noise levels affecting the proposed development has been made in relation to the internal ambient noise criteria provided in BB93:2015 'Acoustic design of schools: performance standards'[1]. The results have been used to inform the sound insulation requirement of the building envelope and the ventilation strategy. Natural ventilation is suitable for all teaching spaces with limited window openings.

Noise level limits have been recommended for building services plant associated with the development in accordance with BS 4142:2014[2]. It is anticipated that this target can be achieved with the provision of standard attenuation measures and no adverse impact is predicted at the nearest noise-sensitive receptors. Meeting these plant noise limits will mean that the requirements of BREEAM credit POL05 are also met.

Construction noise limits at nearby noise sensitive receptors have been recommended based on the methodologies within BS5228.

[1] Department for Education (2014), 'Acoustic design of schools: performance standards', Building Bulletin 93.

[2] BS 4142:2014 'Methods for rating and assessing industrial and commercial sound', BSI Standards Publication.

1. INTRODUCTION

A baseline noise survey has been conducted at the site of The Hall Senior School building on Tuesday 6 September 2016. The purpose of the survey is to assess the suitability of the site for an extension to the current building, and to set appropriate limits for building services plant noise emissions at nearest noise-sensitive receptors.

The methodology, survey results and assessment are given below.

Acoustic terminology used in this report is presented in Appendix 1.

2. SURVEY DETAILS

2.1 Site description

The site of the proposed new development is located on Crossfield Road, Belsize Park, North London. The school is in a residential area and there is a preparatory school near the back of the proposed development. The A41 is approximately 300m to the south west of the site.

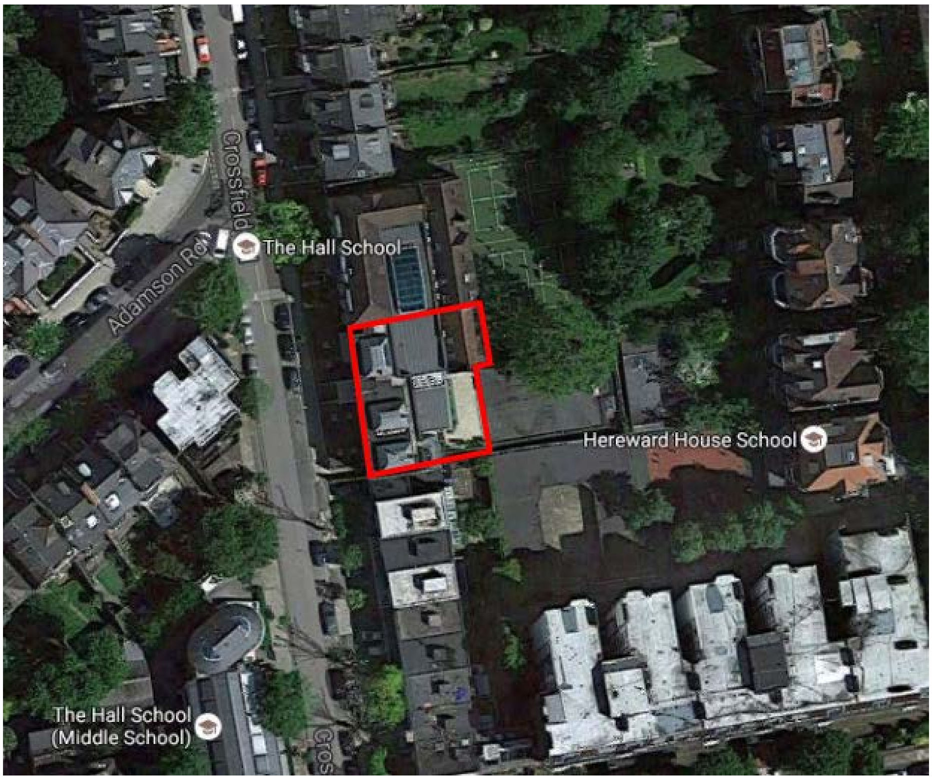

Figure 1 shows the site of the new development.

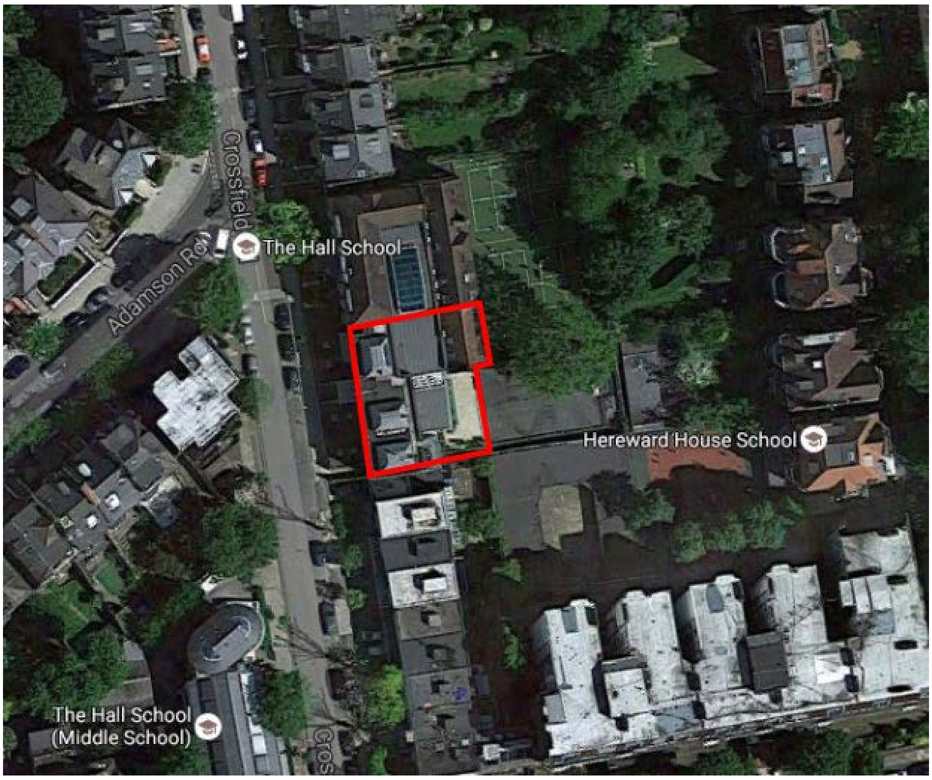

Figure 1 Site of the new development

2.2 Methodology

The daytime noise survey was conducted by Tamasine Leighton-Crawford AMIOA and the late evening noise survey was conducted by Eric Bustamante of Ramboll Acoustics. Noise measurements were taken at locations representative of the proposed facades of the building and representative of the nearest identified noise-sensitive receptors.

The survey comprised three sets of 10 minute measurements per location during the daytime and three sets of 10 minute measurements per location during the late evening periods. The measurement periods were 14:00 – 16:00 and 21:00 – 22:30.

Measurements were taken at approximately 1.2 metres above ground level and at a distance of at least 3 metres from the façade of any buildings and are considered representative of free-field measurements.

The sound level meter calibration was checked immediately before and after the measurement periods. No significant fluctuation in calibration was detected.

2.3 Weather

During the measurement period, weather conditions were noted as dry with 100% cloud cover. There was a light breeze at ground level; the wind speed was less than 5 m/s^{-1}.

2.4 Measurement locations

The measurement locations are shown in Figure 2.

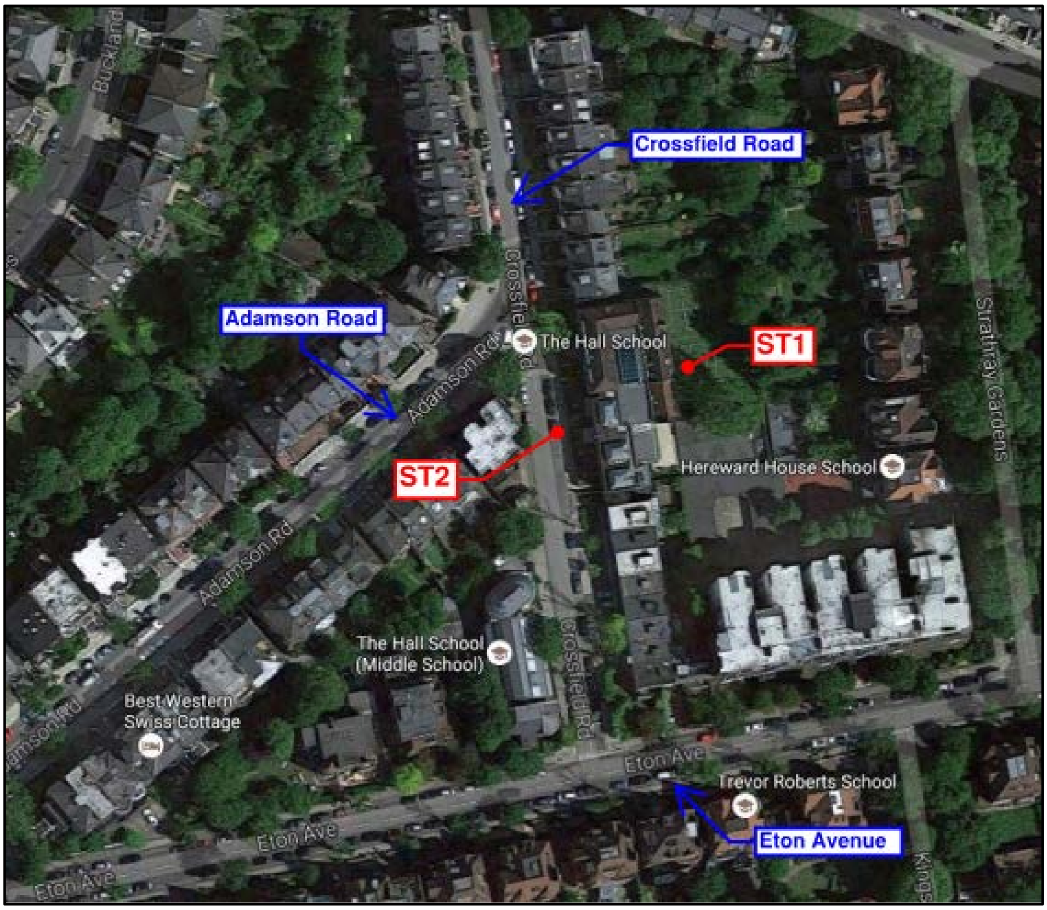

Figure 2 Noise monitoring locations ST1 and ST2

2.4.1 Location ST1

The measurement location ST1 was 5m from the current building façade, chosen to be representative of the East façade of the proposed building and the nearest noise-sensitive receptors at the rear of Crossfield Road, Eton Avenue and Strathray Gardens.

Figure 3 Measurement location ST1

2.4.2 Location ST2

The measurement location ST2 was chosen to be representative of the West façade of the building and the nearest noise-sensitive receptors on Crossfield Road.

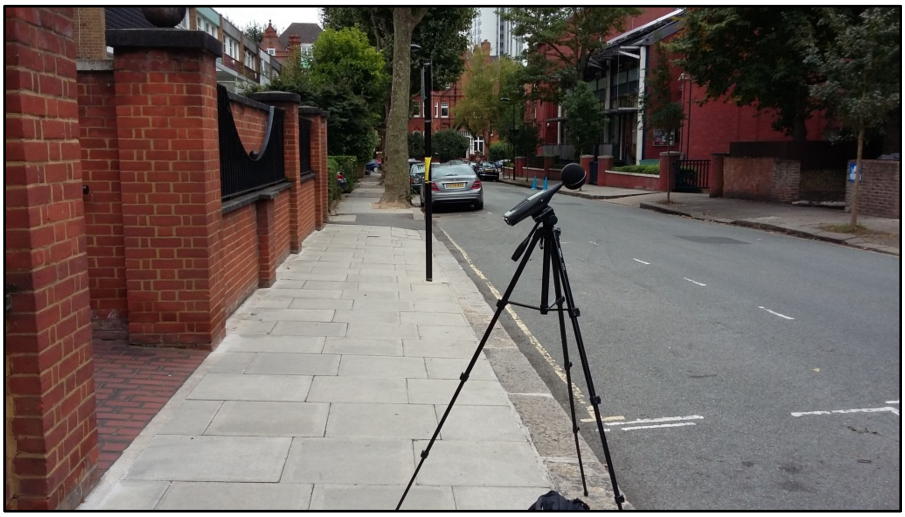

Figure 4 Measurement location ST2

2.5 Equipment

The following equipment was used to measure noise levels:

- Brüel and Kjær 2250 'Class 1' Sound Level Analyser
- Brüel and Kjær 4231 'Class 1' Sound Level Calibrator
- Rion NA 28 Sound Level Analyser
- Rion NC 74 Sound Level Calibrator

All noise measurement equipment is owned by Ramboll Environ and is subject to annual calibration checks traceable to national standards. Copies of calibration certificates are available on request.

3. NOISE CLIMATE

3.1 Daytime measurements

The dominant noise sources at measurement location ST1 were distant road traffic, voices coming from the school through open windows and birdsong.

The dominant noise sources at measurement location ST2 were road traffic noise on Crossfield Road, road traffic noise on Eton Avenue and voices coming from the school through open windows.

Aircraft noise was occasionally 'just' audible in gaps between the other noise sources.

3.2 Late evening measurements

The dominant noise sources at location ST1 were distant road traffic noise, leaves moving in the trees and voices from nearby residences.

The dominant noise sources at location ST2 were road traffic noise from Eton Avenue and plant noise from the residential building on the opposite side of the road.

4. SURVEY RESULTS

4.1 Noise survey results

A summary of the noise survey results is presented below in Figure 5.

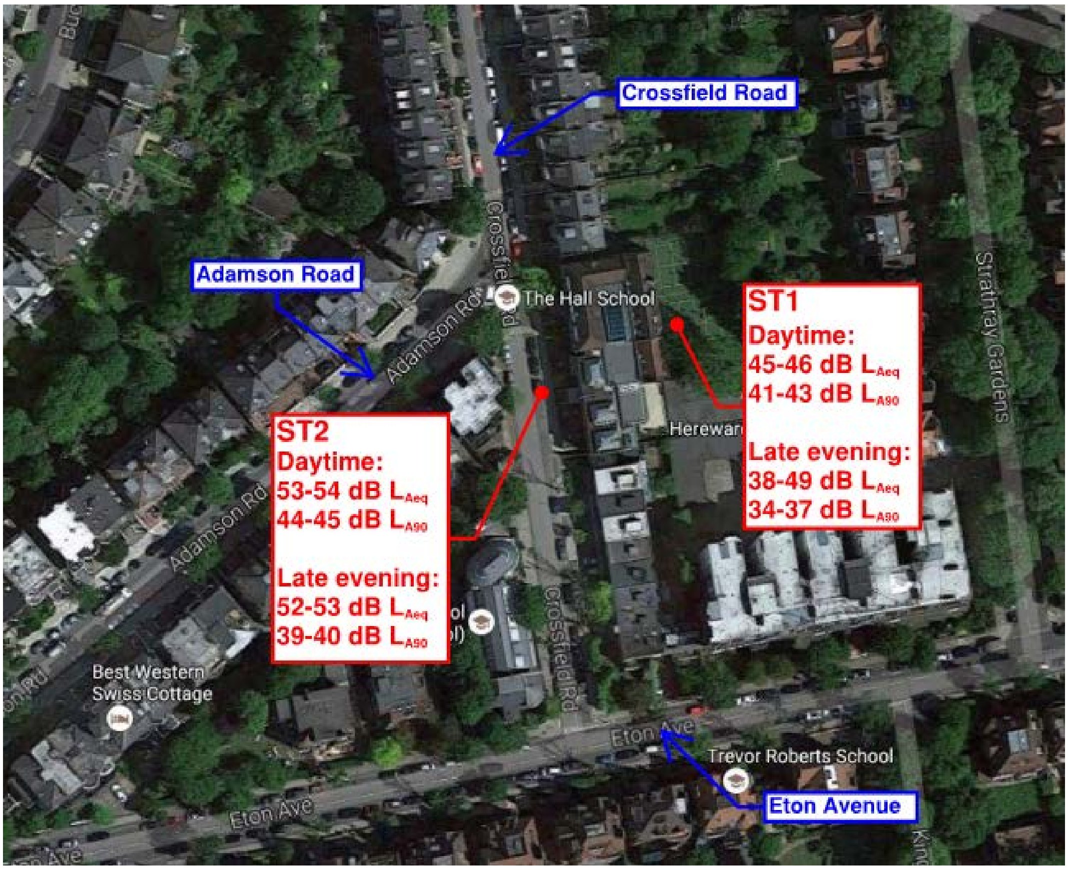

Figure 5 Summary of noise measurement results

Detailed measurement results are provided in Appendix 2.

5. ACOUSTIC DESIGN

The results of the noise survey inform three aspects of the acoustic design for the development:

- The highest measured ambient noise levels affecting the site determine the site suitability for school development, ventilation strategy and any sound insulation requirements for the external building envelope.
- The representative background noise levels provide a baseline which informs the plant noise emission criteria.
- The measured ambient noise levels at the nearby noise sensitive receptors inform the construction noise assessment.

5.1 Façade sound insulation and ventilation strategy

The building envelope must provide sufficient sound insulation from external noise sources in order to achieve suitable internal ambient noise levels. BB93 sets out indoor ambient noise level (IANL) criteria for different spaces. These include noise contributions from:

- External noise sources outside the school premises
- Building services noise

The maximum IANLs are summarised in Table 1:

Space	Target limit for internal ambient noise level $L_{Aeq, 30min}$ (dB)	Corresponding limit for building services noise (NR)
Teaching Spaces Main Hall / Multi-purpose hall	**35**	**30**
Meeting rooms Activity Studio Staff room, Offices	**40**	**35**
Dining room Circulation, Stairs Entrance, Reception, Cloak rooms	**45**	**40**
Toilets, Kitchen	**50**	**45**

Table 1 BB93 Indoor ambient noise level criteria

BB93 states that for spaces which are naturally ventilated, the noise level including external noise ingress may exceed the IANL limit by up to 5 dB.

A façade with an open window, limited to no more than 5% of the floor space, typically provides up to 15 dB attenuation from external noise. Accounting for this attenuation, levels inside the proposed classrooms will be approximately 39 dB L_{Aeq} on the Crossfield Road side of the proposed development and approximately 31 dB L_{Aeq} on the back of the development. Taking the BB93 allowance of +5 dB into account, these levels are within the maximum IANL limit of 40 dB L_{Aeq} for teaching spaces. The indoor ambient noise levels should be achievable with natural ventilation.

Most standard façade build-ups will be suitable in terms of achieving the indoor ambient noise level criteria. This includes standard thermal double-glazed windows and non-specified rating for cladding/external walls.

5.2 Plant noise emission

BS 4142:2014 'Methods for rating and assessing industrial and commercial sound' describes a method for assessing the impact of the sound levels from fixed plant installations, industrial and manufacturing processes and other activities, on nearby noise sensitive receptors.

The assessment procedure described in BS 4142:2014 is based on the comparison of rating a sound level from industrial sources with the prevailing background sound level at the assessment locations. The assessment of impact is determined using the categories shown in Table 2.

Difference between rating level and background noise level	Impact category
+10 dB or more	Significant adverse impact
+5 dB or more	Adverse impact
0 dB or less	Low impact

Table 2 Classification of industrial noise impacts

During normal school hours, a noise limit of 41 dB L_{Aeq} is proposed for plant noise emission at nearby residential receptors, based on measured background levels at a representative location, which will result in low impact.

If the school is used in the evening, a noise limit of 34 dB L_{Aeq} is proposed for plant noise emission at nearby residential receptors, based on measured background levels at a representative location, which will result in low impact.

In addition plant noise must be controlled to no higher than 50 dB L_{Aeq} in external teaching areas and to no more than 45 dB L_{Aeq} outside any windows or facade openings where the ventilation strategy relies upon them being open. This is the cumulative plant noise level with all plant operating at its normal duty.

5.2.1 Mitigation

All proposed plant will be housed within plant rooms inside the building. Inlets and exhausts to air handling units will be ducted to atmosphere.

Plant noise will be controlled by selection of appropriate plant and attenuation, as required, to achieve the above noise emission limit. Full plant specifications are not available at this stage; therefore it is not possible to specify the exact mitigation measures required.

5.2.2 BREEAM Credit POL05

BREEAM credit POL05 states:

"*The noise level from the proposed site/building, as measured in the locality of the nearest or most exposed noise-sensitive development, is a difference no greater than +5dB during the day (07:00 to 23:00) and +3dB at night (23:00 to 07:00) compared to the background noise level."*

Meeting a plant noise limit of a noise limit of 41 dB L_{Aeq} during normal school hours and 34 dB L_{Aeq} in the evening (as specified in Section 5.2) at the nearby residential receptors will mean that the BREEAM POL05 credit can be awarded by default.

6. CONSTRUCTION NOISE

The exact working methodology and plant to be employed during construction has not been established at this stage in the design.

6.1 Residential receptors

The significance criteria for construction noise levels at residential receptors have been established by reference to ABC method described in BS 5228. The thresholds are determined relative to the pre-existing ambient noise levels at the assessment locations.

Table 6.1 Significance Criteria from ABC Method in BS5228

Assessment Period	Threshold Value dB $L_{Aeq,T}$		
	Category A	Category B	Category C
Daytime (07:00-19:00) Saturday (07:00-13:00)	65	70	75
Evening (19:00-23:00) Weekend	55	60	65
Night-time (23:00-07:00)	45	50	55

6.1.1 A potential significant noise effect is indicated when the construction noise exceeds the threshold level for the category appropriate to the ambient noise level:

- Threshold values of Category A for construction noise should be used when the pre-existing ambient noise level, when rounded to the nearest 5 dB, is less than those values;
- Threshold values of Category B should be used when pre-existing ambient noise level, when rounded to the nearest 5 dB, is equal to the values in Category A;
- Threshold values of Category C should be used when the pre-existing ambient noise level, when rounded to the nearest 5 dB, is more than the values in Category A.

6.1.2 The ambient noise levels measured around the site are below 65 dBA, therefore construction noise levels exceeding 65 dBA at the nearest residential receptors would constitute a significant adverse impact.

6.2 Non-residential receptors

Hereward House School, a non-residential receptor is located at the rear of the site, on Strathray Gardens. The significance criteria for construction noise levels at non-residential receptors have been established by reference to "2 – 5 dB(A) change" method described in BS 5228.

6.2.1 Example method 2 – 5 dB(A) change from BS 5228

Noise levels generated by site activities are deemed to be potentially significant if the total noise (pre-construction ambient plus site noise) exceeds the pre-construction ambient noise by 5 dB or more, subject to lower cut-off values of 65 dB, 55 dB and 45 dB $L_{Aeq,\ T}$ from site noise alone, for the daytime, evening and night-time periods, respectively; and a duration of one month or more, unless works of a shorter duration are likely to result in significant effect. These evaluative criteria are generally applicable to the following resources:

- residential buildings;
- hotels and hostels;
- buildings in religious use;
- buildings in educational use;
- buildings in health and/or community use.

6.2.2 The ambient noise levels measured around the site are below 65 dBA, therefore construction noise levels exceeding 65 dBA at the nearest non-residential receptors would constitute a significant adverse impact.

7. CONCLUSION

A noise survey was undertaken at the site of the proposed new development at The Hall Senior School, Belsize Park, North London to establish the existing noise climate. The results of the noise survey have been used to set the sound insulation of the building envelope and noise emission limits.

The measurements have been used to inform the design of the building envelope of the proposed new building to ensure the internal ambient noise level requirements are achieved. The measurements show that the internal ambient noise levels as specified in BB93 can be achieved with natural ventilation.

Background noise levels were measured at representative positions of the nearest noise-sensitive receptors. The results of these measurements are considered suitable to set noise emission limits from any plant associated with the new building at these locations. A noise emission limit of the existing background noise level is considered suitable with a resultant level of 41 dB L_{Aeq} during normal school hours and 34 dB L_{Aeq} in the evening. If noise emission limits are adhered to, no adverse impact is anticipated and BREEAM credit POL05 can be awarded.

APPENDIX 1
ACOUSTIC TERMINOLOGY

A.1 DECIBEL

The ratio of sound pressures which we can hear is a ratio of 10^6 (one million:one). For convenience, therefore, a logarithmic measurement scale is used. The resulting parameter is called the 'sound pressure level' (L_p) and the associated measurement unit is the decibel (dB). As the decibel is a logarithmic ratio, the laws of logarithmic addition and subtraction apply.

A.2 A-WEIGHTED DECIBEL

The unit generally used for measuring environmental, traffic or industrial noise is the A-weighted sound pressure level in decibels, denoted dB(A). An A-weighting network can be built into a sound level measuring instrument such that sound levels in dB(A) can be read directly from a meter. The weighting is based on the frequency response of the human ear and has been found to correlate well with human subjective reactions to various sounds. It is worth noting that an increase or decrease of approximately 10 dB corresponds to a subjective doubling or halving of the loudness of a noise, and a change of 2 to 3 dB is subjectively barely perceptible.

A.3 EQUIVALENT CONTINUOUS SOUND LEVEL

Another index for assessment for overall noise exposure is the equivalent continuous sound level, L_{eq}. This is a notional steady level which would, over a given period of time, deliver the same sound energy as the actual time-varying sound over the same period. Hence fluctuating levels can be described in terms of a single figure level.

A.4 FREQUENCY

The rate of repetition of a sound wave. The subjective equivalent in music is pitch. The unit of frequency is the Hertz (Hz), which is identical to cycles per second. A thousand hertz is often denoted kHz, e.g. 2 kHz = 2000 Hz. Human hearing ranges approximately from 20 Hz to 20 kHz. For design purposes, the octave bands between 63 Hz to 8 kHz are generally used. The most commonly used frequency bands are octave bands, in which the mid frequency of each band is twice that of the band below it. For more detailed analysis, each octave band may be split into three one-third octave bands or in some cases, narrow frequency bands.

A.5 MAXIMUM NOISE LEVEL

The maximum noise level identified during a measurement period. Experimental data has shown that the human ear does not generally register the full loudness of transient sound events of less than 125 ms in duration. Fast time weighting has an exponential time constant of 125 ms which reflects the ear's response. The maximum level measured with fast time weighting is denoted as $L_{AMax,f}$. Slow time weighting (S) with an exponential time constant of 1s is used to allow more accurate estimation of the average sound level on a visual display.

Impulse (I) time weighting has a fast rise (35ms) and a slow decay and is intended to mimic the ear's response to impulsive sounds.

A.6 STATISTICAL NOISE LEVELS

For levels of noise that vary widely with time, for example road traffic noise, it is necessary to employ an index which allows for this variation. The L_{10}, the level exceeded for ten per cent of the time period under consideration, has historically been adopted in the UK for the assessment of road traffic noise. The L_{90}, the level exceeded for ninety per cent of the time, has been adopted to represent the background noise level. The L_1, the level exceeded for one per cent of the time, is representative of the maximum levels recorded during the sample period. A weighted statistical noise levels are denoted L_{A10},dB L_{A90} etc. The reference time period (T) is normally included, e.g. dB $L_{A10,\ 5min}$ or dB $L_{A90,\ 8hr}$.

A.7 TYPICAL NOISE LEVELS

Some typical noise levels are given in the following table.

Noise Level dB(A)	Example
130	Threshold of pain
120	Jet aircraft take-off at 100 m
110	Chain saw at 1 m
100	Inside disco
90	Heavy lorries at 5 m
80	Kerbside of busy street
70	Loud radio (in typical domestic room)
60	Office or restaurant
50	Domestic fan heater at 1m
40	Living room
30	Ventilation Noise in Theatre
20	Remote countryside on still night
10	Sound insulated test chamber
0	Threshold of hearing

Table of Typical Noise Levels

APPENDIX 2
NOISE SURVEY RESULTS

NOISE SURVEY RESULTS

Measurement location	Start time	Duration	L_{Amax}	L_{A90}	L_{A10}	L_{Aeq}	Comments
ST1	14:11	10:00	56	41	49	46	Birdsong, voices from school, aircraft
	14:47	10:00	61	41	47	45	Birdsong, voices from school, aircraft
	15:18	10:00	58	43	48	46	Birdsong, children playing outside at school nearby, aircraft
	21:12	10:00	66	36	49	49	Distant road traffic noise, aircraft
	21:40	10:00	58	34	41	38	Distant traffic noise, leaves in trees, voices, aircraft
	22:10	10:00	61	37	45	43	Distant traffic noise, leaves in trees, aircraft
ST2	14:26	10:00	74	45	53	53	Voices from school, traffic noise Crossfield Rd/Adamson Rd
	15:02	10:00	74	44	54	54	Voices from school, hoover in flat opposite, traffic noise Crossfield Rd/Adamson Rd
	15:29	10:00	76	45	55	54	Voices, traffic noise Crossfield Rd/Adamson Rd
	21:00	10:00	77	39	49	53	Traffic noise Eton Ave, plant noise building opposite, aircraft noise
	21:25	10:00	70	40	52	53	Voices, road traffic noise Eton Ave, leaves in trees, aircraft noise
	21:55	10:00	74	39	50	52	Traffic noise Eton Ave, leaves in trees, aircraft noise