

Report VA3983.220408.NIA

12 Tilbury Close, Caversham, Reading

Noise Impact Assessment - Class MA

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Urban Planning Practice

01962 461016
0203 8650332
mail@ventaacoustics.com

registered company no. 10139494

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1. Introduction

It is proposed to change the use of 12 Tilbury Close, Caversham, Reading to create four new residential units over two levels under Class MA of the General Permitted Development Order.

Venta Acoustics has been commissioned by Urban Planning Practice to undertake an assessment of the current environmental noise impact on the site and provide recommendations of acoustic mitigation where required in support of the application.

An environmental noise survey has been undertaken to determine the noise levels incident on the site. These levels are then used to undertake an assessment of the likely impact in accordance with Class MA of the GPDO.

All staff at Venta Acoustics are fully qualified and members of the Institute of Acoustics, the recognised UK professional body for acoustics, noise and vibration professionals and are fully competent to undertake BS4142 assessments.

2. Guidance and Legislation

2.1 Permitted Development – Class MA

Class MA of the General Permitted Development Order provides the following requirements.

Conditions

MA.2. (1) *Development under Class MA is permitted subject to the conditions*

(2) *Before beginning development under Class MA, the developer must apply to the local planning authority for a determination as to whether the prior approval of the authority will be required as to—*

- (a) transport impacts of the development, particularly to ensure safe site access;*
- (b) contamination risks in relation to the building;*
- (c) flooding risks in relation to the building;*
- (d) impacts of noise from commercial premises on the intended occupiers of the impacts of noise from commercial premises on the intended occupiers of the development;*
- (e) (e)where—*
 - (i) the building is located in a conservation area, and*
 - (ii) the development involves a change of use of the whole or part of the ground floor,*

the impact of that change of use on the character or sustainability of the conservation area;

- (f) the provision of adequate natural light in all habitable rooms of the dwellinghouses;*
- (g) the impact on intended occupiers of the development of the introduction of residential use in an area the authority considers to be important for general or heavy industry, waste management, storage and distribution, or a mix of such uses; and*
- (h) where the development involves the loss of services provided by—*
 - (i) a registered nursery, or*
 - (ii) a health centre maintained under section 2 or 3 of the National Health Service Act 2006(4), the impact on the local provision of the type of services lost.*

(3) An application for prior approval for development under Class MA may not be made before 1 August 2021.

(4) The provisions of paragraph W (prior approval) of this Part apply in relation to an application under this paragraph as if in the introductory words in sub-paragraph (5), for “and highways impacts of the development” there were substituted “impacts of the development, particularly to ensure safe site access”.

(5) Development must be completed within a period of 3 years starting with the prior approval date.

(6) Any building permitted to be used as a dwellinghouse by virtue of Class MA is to remain in use as a dwellinghouse within the meaning of Class C3 of Schedule 1 to the Use Classes Order and for no other purpose, except to the extent that the other purpose is ancillary to the use as a dwellinghouse.”.

Part 3, paragraph W(10)(b) of the GPDO states that the local planning authority must, when determining an application, have regard to the National Planning Policy Framework so far as relevant to the subject matter of the prior approval as if the application were a planning application.

2.2 The National Planning Policy Framework (2021)

The revised *National Planning Policy Framework* (NPPF), published in July 2021, sets out the Government’s planning policies for England, superseding all previous planning policy statements and guidance.

In respect of noise, the NPPF states that the planning system should contribute to and enhance the natural and local environment by preventing both new and existing developments from contributing to or being put at unacceptable risk from, or being adversely affected by unacceptable levels of noise pollution.

Hence, Paragraph 185 states that *planning policies and decisions should also ensure new development is appropriate for its location taking into account the likely effects (including cumulative effects) of pollution on health, living conditions and the natural environment, as well as*

the potential sensitivity of the site or the wider area to impacts that could arise from the development. In doing so they should:

- a) mitigate and reduce to a minimum potential adverse impacts resulting from noise from new development – and avoid noise giving rise to significant adverse impacts on health and the quality of life*
- b) identify and protect tranquil areas which have remained relatively undisturbed by noise and are prized for their recreational and amenity value for this reason*

In regards to the term adverse impact, reference is made to the Noise Policy for England:

2.3 Noise Policy Statement for England (2010)

The Noise Policy Statement for England (NPSE) sets out the long term vision of Government noise policy: to promote good health and a good quality of life through the effective management of noise within the context of Government policy on sustainable development.

This vision is supported by the following aims:

- *avoid significant adverse impacts on health and quality of life;*
- *mitigate and minimise adverse impacts on health and quality of life; and*
- *where possible, contribute to the improvement of health and quality of life.*

The terms “significant adverse” and “adverse” are related to the following concepts:

- No Observed Effect Level (NOEL) - the level below which no effect on health and quality of life can be detected.
- Lowest Observed Adverse Effect Level (LOAEL) - the level above which adverse effects on health and quality of life can be detected.
- Significant Observed Adverse Effect Level (SOAEL) - the level above which significant adverse effects on health and quality of life occur.

The guidance acknowledges that it is not possible to have a single objective noise-based measure that defines SOAEL that is applicable to all sources of noise in all situations, but will be different for different noise sources, receptors and times.

In order to enable assessment of impacts in line with these requirements, reference should be made to other currently available guidance.

2.4 WHO Guidelines for Community Noise (1999)

The guidance in this document details suitable noise levels for various activities within residential and commercial buildings.

The relevant sections of this document are shown in Table 2.1.

Criterion	Environment	Design range $L_{Aeq,T}$ dB
Maintain speech intelligibility and avoid moderate annoyance, daytime and evening	Living Room	35 dB
Prevent sleep disturbance, night time	Bedrooms	30 dB

Table 2.1 – Excerpt from WHO

[dB ref. 20µPa]

This guidance also states:

For a good sleep, it is believed that indoor sound pressure levels should not exceed approximately 45dB L_{Amax} more than 10-15 times a night (Vallet & Vernet 1991).

2.5 BS8233:2014

BS8233 *Guidance on sound insulation and noise reduction for buildings* provides guidance as to desirable internal ambient noise levels for different areas within residential buildings.

The relevant section of the standard is shown below in Table 2.2.

Activity	Location	07:00 to 23:00	23:00 to 07:00
Resting	Living Room	35 dB $L_{Aeq, 16 \text{ hour}}$	-
Dining	Dining Room	40 dB $L_{Aeq, 16 \text{ hour}}$	-
Sleeping (daytime resting)	Bedroom	35 dB $L_{Aeq, 16 \text{ hour}}$	30 dB $L_{Aeq, 8 \text{ hour}}$

Table 2.2 – Excerpt from BS8233:2014 - Indoor ambient noise levels for dwellings

[dB ref. 20µPa]

2.6 BS4142:2014

British Standard BS4142:2014 *Methods for rating and assessing industrial and commercial sound* describes a method for rating and assessing sound of an industrial and/or commercial nature, which includes sound from fixed installations comprising mechanical and/or electrical plant and equipment;

The assessment methodology considers the Specific Sound Level, as measured or calculated at a potential noise sensitive receptor, due to the source under investigation. A correction factor is added to this level to account for the acoustic character of the sound as follows:

Tonality – A correction of up to 6dB depending on the prominence of tones;

Impulsivity - A correction of up to 9dB depending on the prominence of impulsivity;

Other sound characteristics - A 3dB correction may be applied where a distinctive acoustic character is present that is neither tonal nor impulsive;

Intermittency - A 3dB correction may be applied where the specific sound has identifiable on/off conditions.

An estimate of the impact of the source is obtained by subtracting the typical background noise level from the corrected Specific Sound Level.

- Typically, the greater this difference, the greater the magnitude of the impact.

- A difference of around +10 dB or more is likely to be an indication of a significant adverse impact, depending on the context.
- A difference of around +5 dB could be an indication of an adverse impact, depending on the context.
- The lower the rating level is relative to the measured background sound level, the less likely it is that there will be an adverse impact. Where the rating level does not exceed the background sound level, this is an indication of the specific sound having a low impact, depending on the context.

3. Site Description

As illustrated on attached site plan VA3983/SP1, the building is located at the end of Tilbury Close to the rear of a row of shops in a predominantly residential area.

The commercial premises include a bicycle shop immediately to the south, take away restaurants, convenience stores and a betting store. There is a car repair garage 25m to the east.

The garage is believed to operate between 8:30 – 17:30 Monday – Thursday; 08:30 – 16:30 on Fridays and is closed on the weekend.

The nearest takeaway restaurant operates between 12:00-14:00 and 17:00-21:30 Monday – Saturday.

4. Environmental Noise Survey

4.1 Survey Procedure & Equipment

In order to establish the existing background noise levels at the site, a noise survey was carried out between Tuesday 11th and Thursday 13th January 2022 at first floor level at the location shown in site plan VA3983/SP1. This location was chosen to be representative of the ambient noise level affecting the proposed new receivers.

Continuous 5-minute samples of the L_{Aeq} , L_{Amax} , L_{A10} and L_{A90} sound pressure levels were undertaken at the measurement location.

The weather during the survey period was generally dry with periods of rain which have been omitted from the assessment data.

Measurements were made generally in accordance with ISO 1996 2:2017 *Acoustics - Description, measurement and assessment of environmental noise – Part 2: Determination of sound pressure levels*.

The following equipment was used in the course of the survey:

Manufacturer	Model Type	Serial No	Calibration	
			Certificate No.	Date
NTi Class 1 Integrating SLM	XL2	A2A-11586-E0	UCRT20/1565	29/6/20
Larson Davis calibrator	CAL200	13069	UCRT20/1562	26/6/20

Table 4.1 – Equipment used for the survey

The calibration of the sound level meter was verified before and after use with no significant calibration drift observed.

4.2 Results

The measured sound levels are shown as time-history plots on the attached charts VA3983/TH1-3.

Review of the sound data and spectral data shows mechanical plant operating between 12:00 and 14:00 and between 18:00 and 21:30. The overall noise levels are similar to the ambient noise but the operation is identified by an elevated 100Hz tone between 42 and 46dB.

The average noise levels for the Daytime and Night-time periods, as measured at the automated monitoring position were:

Monitoring Period	$L_{Aeq,T}$	Typical L_{A90}
07:00 – 23:00 hours	55 dB	41 dB
23:00 – 07:00 hours	45 dB	30 dB
Garage Operational Hours	56 dB	42 dB

Table 4.2 – Ambient noise levels at measurement location

[dB ref. 20µPa]

The typical night time L_{Amax} events, were recorded to be in the order of 57dB $L_{Amax,fast}$.

5. Commercial Noise Impact Assessment

5.1 Garage

The noise impact of the garage are assessed following the methodology of BS4142: 2014 *Methods for rating and assessing industrial and commercial sound*.

The other surrounding uses are not expected to have a significant impact on the site relative to these workshops.

Observations on site suggest that the majority of mechanical work is undertaken within the garage workshop.

5.1.1 Source Noise Data

The following noise levels are attributed to activities in and around the workshops:

Noise Source	Measurement Distance	Measured L _{Aeq}	Notes
Wheel Gun	20m	61dB	Works take place inside building
Car horn	20m	60dB	
Angle Grinder	Library data	70dB @ 10m	10dB loss applied as used inside
Car manoeuvring out of garage	Library data	63dB @ 5m	-
Air Wrench	Library data	58dB @ 10m	10dB loss applied as used inside

Table 5.1 – Measured and library data noise sources used for assessment

5.1.2 Acoustic Character Correction

The subjective method of allocating corrections to the sound source has been used following the methodology provided in BS4142:2014.

Noise Source	Subjective Description	Allocated Corrections
Wheel Gun	Clearly perceived impulsive character with intermittent characteristics. High pitched but not tonal at the proposed new dwellings.	Tonality: 0dB Impulsivity: +6dB Intermittency: +3dB
Angle Grinder	Expected to be slightly perceptible above background and intermittent and impulsive in use.	Tonality: +2dB Impulsivity: 0dB Intermittency: +3dB
Car manoeuvring out of garage	Intermittent, not tonal and not impulsive	Tonality: 0dB Impulsivity: 0dB Intermittency: +3dB
Air Wrench	Impulsive noise from occurring intermittently	Tonality: 0dB Impulsivity: +6dB Intermittency: +3dB

Table 5.2 – Acoustic character corrections

These penalties are applied to the specific noise level in section 5.1.3 to obtain the rating noise level.

5.1.3 Rating Noise Level and Assessment

The rating noise levels at the assessment locations are compared against the relevant background noise levels to assess the notional significance of the noise impact as follows. Operations are adjusted to the appropriate on times.

Results		Relevant Clause	Commentary
Source Sound Levels	61dB @ 20m	7.3.4	Library Data
Distance Loss (25m)	-2dB	7.3.5	Assumed a point source
Specific Sound Level	L _{Aeq} 59dB		
Assume operation 2mins	-15dB	7.2	Not in constant operation
Acoustic feature correction	+9 dB	9.2	+6 dB for Impulsivity, +3dB for intermittency
Rating level	L _{Ar} 53 dB	9.2	
Day time background sound level	L _{A90} 42 dB	8	
Excess of rating over background sound level	11 dB	11	
Assessment indicates an Adverse Impact		11	Depending on context

Table 5.3 – BS4142 Assessment of wheel gun in workshop

Results		Relevant Clause	Commentary
Source Sound Levels	70dB @ 10m	7.3.4	Library Data
Distance Loss (25m)	-8dB	7.3.5	Assumed a point source
Specific Sound Level	L _{Aeq} 62dB		
Assume operation 5mins	-11dB	7.2	Used occasionally
Acoustic feature correction	+5 dB	9.2	+2 for tonality, +3dB for intermittency
Rating level	L _{Ar} 56 dB	9.2	
Day time background sound level	L _{A90} 42 dB	8	
Excess of rating over background sound level	14 dB	11	
Assessment indicates An Adverse Impact		11	Depending on context

Table 5.4 – BS4142 Assessment of angle grinder in workshop

Results		Relevant Clause	Commentary
Source Sound Levels	63dB @ 5m	7.3.4	Library Data
Distance Loss (55m)	-14dB	7.3.5	Assumed a point source
Specific Sound Level	L _{Aeq} 49dB		
Assume operation 10mins	-8dB	7.2	
Acoustic feature correction	+3 dB	9.2	+3dB for intermittency
Rating level	L _{Ar} 44 dB	9.2	
Day time background sound level	L _{A90} 42 dB	8	
Excess of rating over background sound level	2 dB	11	
Assessment indicates Marginal Impact		11	Depending on context

Table 5.5 – BS4142 Assessment of car manoeuvring out of the workshop

Results		Relevant Clause	Commentary
Source Sound Levels	58dB @ 10m	7.3.4	Library Data
Distance Loss (55m)	-8dB	7.3.5	Assumed a point source
Specific Sound Level	L _{Aeq} 50dB		
Assume operation 10mins	-8dB	7.2	Used occasionally
Acoustic feature correction	+9 dB	9.2	+6 dB for Impulsivity, +3dB for intermittency
Rating level	L _{Ar} 51 dB	9.2	
Day time background sound level	L _{A90} 42 dB	8	
Excess of rating over background sound level	9 dB	11	
Assessment indicates adverse impact		11	Depending on context

Table 5.6 – BS4142 Assessment of air wrench in workshop

5.1.4 Context

The BS4142 standard aims to cover a wide variety of situations under the same base assessment methodology and so has some inherent shortcomings. To allow for this, the guidance encourages consideration of the site context as a means of adapting the base assessment to specific scenarios.

The assessment indicates a potential adverse impact from the louder operations in the garage. Observations on site suggested that the garage is generally quiet with hand tools used inside the workshop. The louder operations would occur occasionally.

It is noted that the garage only operates during the working days with no use in evenings or on the weekends. The specific sound levels are not considered loud in absolute terms and the rating sound levels are generally below the ambient noise. The noise can readily be excluded through the use of appropriate glazing to the building.

This is a proposal to introduce a new residential development in an established residential area with commercial uses to the south and existing residential uses to the north, east and west. The introduction of the new residential dwellings would not be expected to place additional restrictions on the operation of the garage.

In the case of residents moving to such an area, the sensitivity to some commercial sound is typically lower than the case of a new noise source moving to an established residential area. The likely impact is therefore reduced.

5.2 Uncertainty

This section considers the variable in the assessment that may cause variations within the final results and describes how these have been addressed.

- Use of a Class 1 sound level meter is considered to reduce instrument error to insignificant levels as compared with environmental variations. The calibration of the instrumentation was confirmed before and after the noise surveys.

- These measurement location was selected to be representative of the background noise levels expected to be experienced by the proposed dwellings without being unduly influenced by extraneous noise sources.
- Where library data has been used, propagation calculations have been used to correct noise levels to the relevant distance at the receiver.

Overall, the uncertainty is considered to have been be minimised to a suitable range so as not to risk significant variations in the impact assessment of typical operations.

5.3 Plant Noise Impact

Noise levels from the operation of the fan was deemed to be 41dB with the background falling to 36dB immediately after fans turn off.

The following BS4142 assessment would apply to the fan:

Results		Relevant Clause	Commentary
Fan	L_{Aeq} 41dB		Measured on site
Acoustic feature correction	+2 dB	9.2	+2dB for tonality
Rating level	L_{Ar} 43 dB	9.2	
Background sound level	L_{A90} 36 dB	8	Immediately after fan turns off
Excess of rating over background sound level	+7 dB	11	
Assessment indicates an adverse impact		11	Depending on context
Context	The plant operates for a limited period at lunch time and in the evening. The sound level is at moderate levels, being below the ambient noise level in the locality. BS8233 allows a 10-15dB loss through a partially open window. The internal noise levels due to the plant noise (including character penalties) would be below the daytime BS8233 limits. With windows specified to control the ambient noise the plant noise is unlikely to be audible.		
Uncertainty	The specific and background noise levels were measured on site with a Class 1 sound level meter over several nights to provide a good representation of the noise levels involved. The specific noise level could not be directly measured due to the plant noise being quieter than the residual noise level. A robust estimate is made based on the measured L_{A90} values.		

Table 5.7 – BS4142 Assessment – Plant Noise

6. Internal Noise Assessment

Permitted development applications only take into consideration commercial and industrial noise sources affecting potential new receivers, and do not include for the assessment of traffic noise.

To control sound from the commercial uses, the sound insulation performance of the building glazing will be specified to control the Rating noise level (including BS4142 penalties) to below the recommended values in BS8233. This hybrid approach of assessing commercial noise with a BS4142 penalty against the BS8233 criteria (over a shortened assessment period) is endorsed in the ProPG guidance.

However, for the purposes of the client and provide good acoustic design (as recommended by the ProPG guidance) an assessment of the external building fabric performance has been undertaken with regards to road noise against BS8233 and the WHO Guidelines, which can be utilised in the

scheme should the developer wish to do so. It should be highlighted, that this is advisory and not part of the Permitted Development application.

6.1 Sound Reduction Performances of Building Elements

It has been assumed that all the non-glazed elements, i.e. walls and roof systems, will be capable of providing the following minimum sound insulation performance, when tested in accordance with BS EN ISO 10140-2:2010 *Acoustics - Laboratory measurement of sound insulation of building elements – Part 2: Measurement of airborne sound insulation*.

Building Element	Single figure weighted sound reduction index, dB
Masonry	R _w 51

Table 6.1 – Assumed sound reductions performances of non-glazed elements

6.2 Sound Reduction Performance of Windowsets and Vents

The monitoring data has been used to calculate the required sound insulation performance for the windowsets (glazing and frame combination) and open ventilators for the building. These are summarised in Table 6.2 below.

Glazing Location	Required Glazing SRI, dB	Ventilator Performance, dB
Front (South / East)	R _w 32	D _{n,e,w} 35
Rear (North / West)	R _w 27	Non-acoustic vents

Table 6.2 – Required minimum sound reduction indices for glazing and ventilators

6.3 Windowset Performances

It is important that the performance shown in Table 6.2 are achieved by the entire windowset including frames, ventilators, seals, etc. Glass performance alone would not be likely to show compliance with the specification as the other elements typically provide the weakest noise transmission path.

Ventilation

The ventilation scheme will be designed to meet the relevant building regulations and standards applicable to permitted development. It is understood that a mechanical ventilation system is being proposed and that this will be specified to allow windows to remain closed without compromising the comfort of residents. The details of this system will be developed during the detailed design stage and can be secured by condition.

If trickle vents are used the performance shown in Table 6.2 will be required. The figures stated are for a single vent per room. If multiple vents are required, then the performance requirement shown in Table 6.2 will increase by a value equal to $+10\log(N)$, with N being the total number of vents serving the room. It should be noted that there is no reason why windows could not be opened as a matter of personal preference or for purge ventilation.

With the above recommendations implemented, the noise levels within the proposed dwellings would be expected to be in line with recommendations given in the WHO 1999 and BS8233:2014 guidance. The internal penalised noise levels from deliveries be below 20dB(A), 10dB below the recommended limit in BS8233. Internal noise levels can therefore be considered to be between the NOEL the LOAEL levels.

7. Conclusion

A baseline noise survey has previously been undertaken by Venta Acoustics to establish the prevailing noise climate in the locality of 12 Tilbury Close, Caversham, Reading.

The measured levels have been assessed against BS4142:2014 *Methods for rating and assessing industrial and commercial sound*, the National Planning Policy Framework and currently available standards and guidance documents including World Health Organisation *Guidelines for Community Noise* (1999) and BS8233:2014 *Guidance on sound Insulation and noise*.

When assessed using BS4142, noise from the nearby repair garage indicates an adverse impact. However, the sound level is not out of place in the context of the area and the noise levels are below the traffic noise. Plant noise is also assessed and found to have a marginal impact that can readily be controlled through the windows. Neither sound operates at night. In the local context the garage or plant noise are not expected to represent a continuous disturbance to residents.

An advisory discussion of potential mitigation in the form of building envelope performance has been included and through the use of this, external traffic noise levels can be mitigated to acceptable noise levels in the new dwellings, although this is not required under the class MA application.

With the recommended measures in place, the proposed scheme is not expected to experience a significant adverse noise impact and the site is considered acceptable for the proposed residential use under the requirements of class MA of the GPDO.

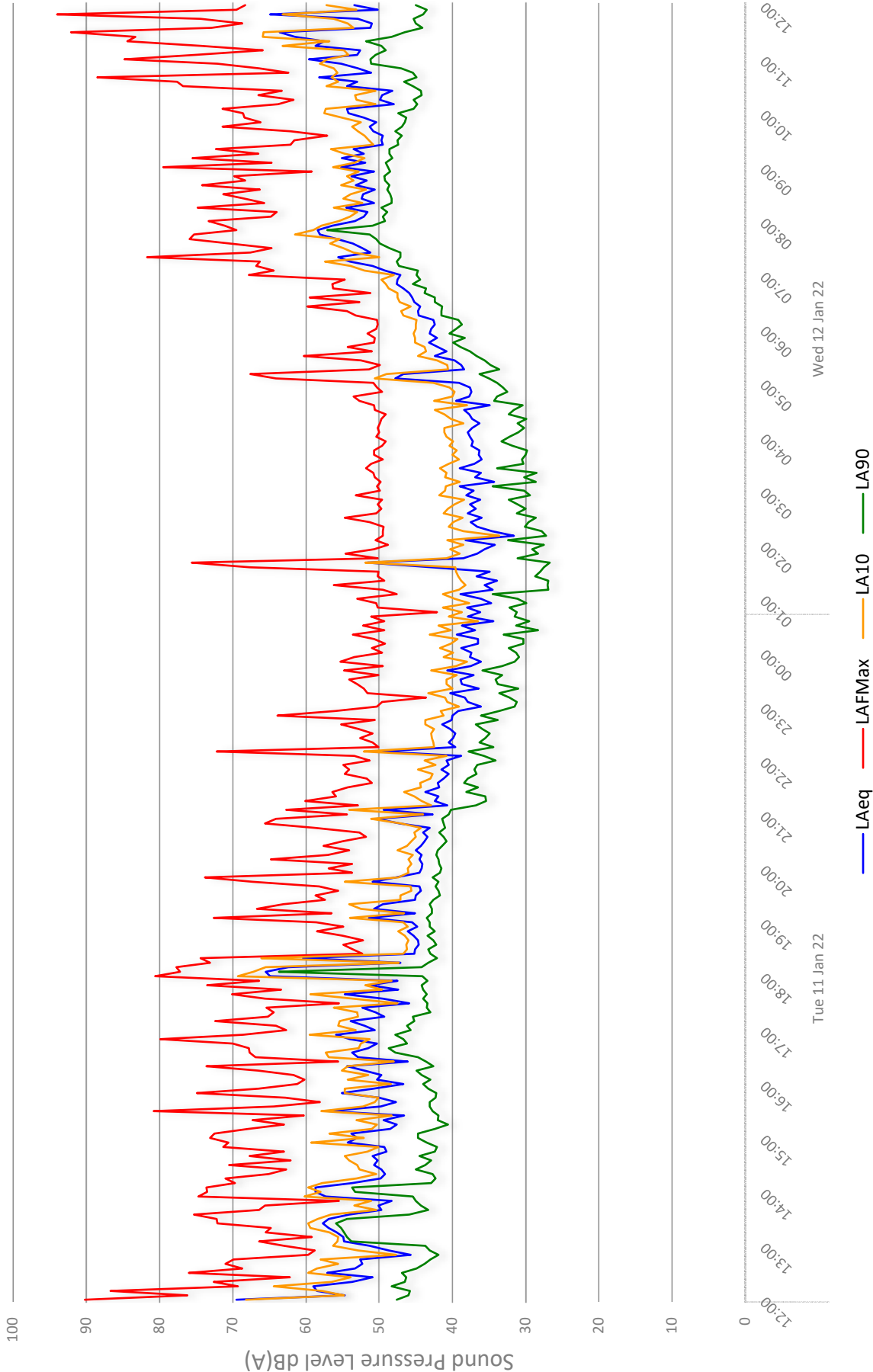
Steven Liddell MIOA



12 Tilbury Close, Caversham, Reading
Environmental Noise Time History: 1



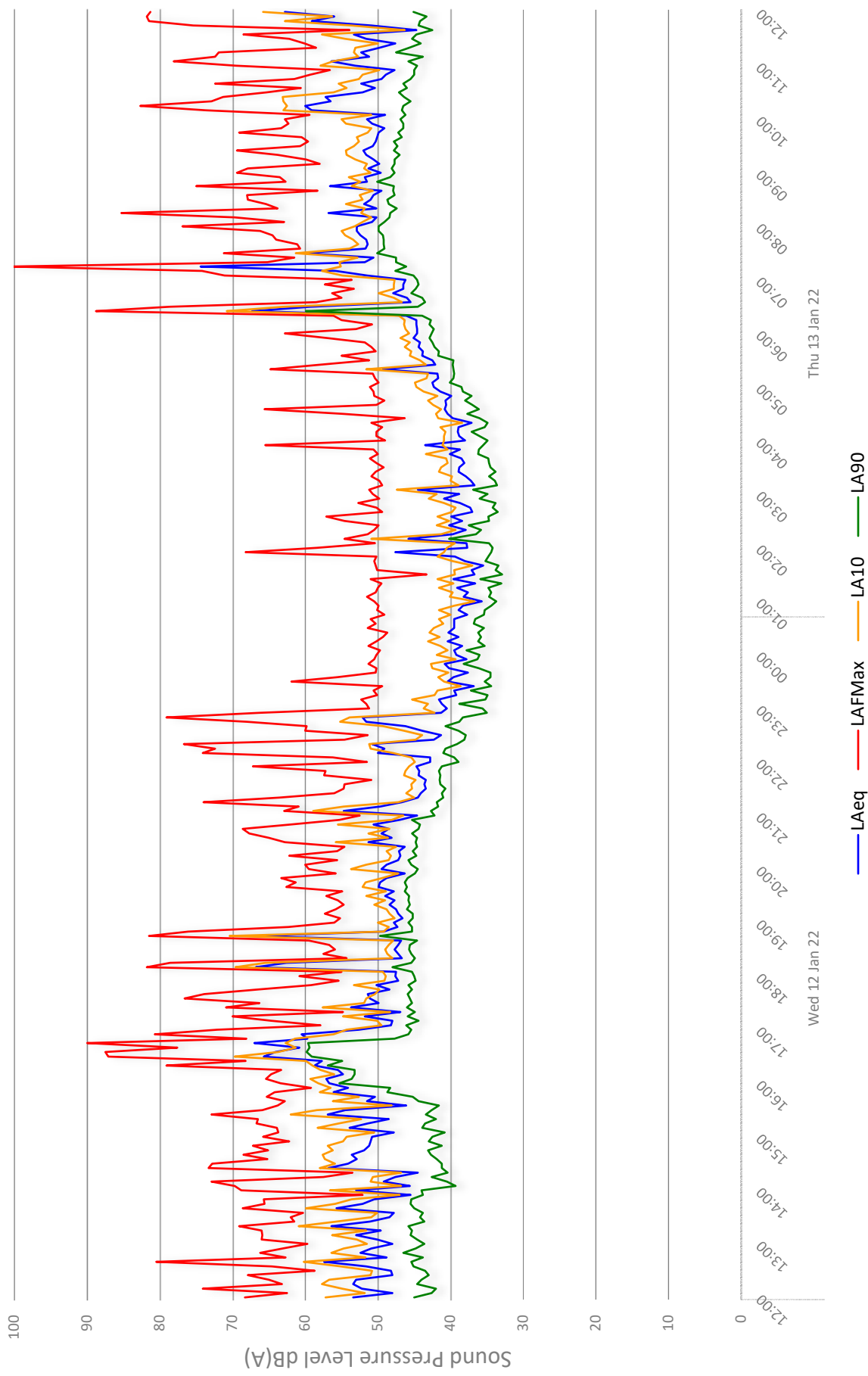
Figure VA3983/TH1

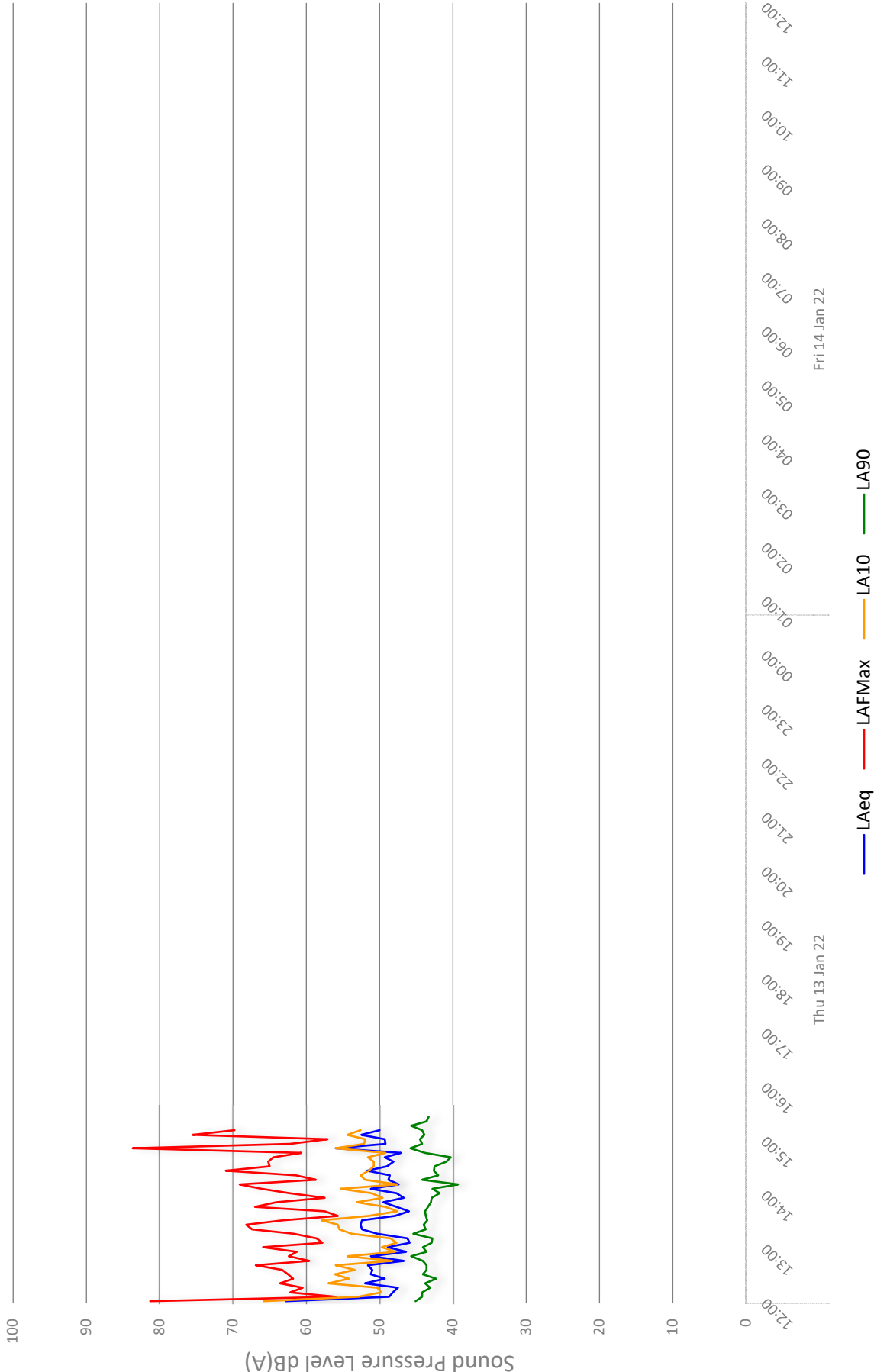


12 Tilbury Close, Caversham, Reading
Environmental Noise Time History: 2



Figure VA3983/TH2





APPENDIX A

Acoustic Terminology & Human Response to Broadband Sound

1.1 Acoustic Terminology

The human impact of sounds is dependent upon many complex interrelated factors such as 'loudness', its frequency (or pitch) and variation in level. In order to have some objective measure of the annoyance, scales have been derived to allow for these subjective factors.

Sound Vibrations propagating through a medium (air, water, etc.) that are detectable by the auditory system.

Noise Sound that is unwanted by or disturbing to the perceiver.

Frequency The rate per second of vibration constituting a wave, measured in Hertz (Hz), where 1Hz = 1 vibration cycle per second. The human hearing can generally detect sound having frequencies in the range 20Hz to 20kHz. Frequency corresponds to the perception of 'pitch', with low frequencies producing low 'notes' and higher frequencies producing high 'notes'.

dB(A): Human hearing is more susceptible to mid-frequency sounds than those at high and low frequencies. To take account of this in measurements and predictions, the 'A' weighting scale is used so that the level of sound corresponds roughly to the level as it is typically discerned by humans. The measured or calculated 'A' weighted sound level is designated as dB(A) or L_A .
A notional steady sound level which, over a stated period of time, would contain the same amount of acoustical energy as the actual, fluctuating sound measured over that period (e.g. 8 hour, 1 hour, etc).

L_{eq} : The concept of L_{eq} (equivalent continuous sound level) has primarily been used in assessing noise from industry, although its use is becoming more widespread in defining many other types of sounds, such as from amplified music and environmental sources such as aircraft and construction.
Because L_{eq} is effectively a summation of a number of events, it does not in itself limit the magnitude of any individual event, and this is frequently used in conjunction with an absolute sound limit.

L_{10} & L_{90} : Statistical L_n indices are used to describe the level and the degree of fluctuation of non-steady sound. The term refers to the level exceeded for n% of the time. Hence, L_{10} is the level exceeded for 10% of the time and as such can be regarded as a typical maximum level. Similarly, L_{90} is the typical minimum level and is often used to describe background noise.
It is common practice to use the L_{10} index to describe noise from traffic as, being a high average, it takes into account the increased annoyance that results from the non-steady nature of traffic flow.

L_{max} : The maximum sound pressure level recorded over a given period. L_{max} is sometimes used in assessing environmental noise, where occasional loud events occur which might not be adequately represented by a time-averaged L_{eq} value.

R *Sound Reduction Index.* Effectively the *Level Difference* of a building element when measured in an accredited laboratory test suite in accordance with the procedures laid down in BS EN ISO 10140-2:2010 and corrected for its size and the reverberant characteristics of the receive room.

D The sound insulation performance of a construction is described in terms of the difference in sound level on either side of the construction in the presence of a sound source on one side and the reverberant characteristics of the adjoining 'receive' space. *D* is the arithmetic *Level Difference* in decibels between the source and receive sound levels when filtered into frequency bands.

APPENDIX A

Acoustic Terminology & Human Response to Broadband Sound

D_{nT}	<i>Weighted Standardised Level Difference.</i> As defined in BS EN ISO 717-1, representing the <i>Weighted Level Difference</i> , when standardised for reference receiving room reverberant characteristics.
$D_{n,e}$	Normalised sound insulation of small building elements of fixed dimensions, such as vents, measured in an accredited laboratory test suite in accordance with the procedures laid down in BS EN ISO 10140-2:2010.
$D_{n,f}$	Flanking sound insulation of lightweight elements, such as curtain wall mullions, measured in an accredited laboratory test suite in accordance with the procedures laid down in ISO 10848-2:2006
R_w D_w $D_{nT,w}$ $D_{n,e,w}$ $D_{n,f,w}$	Value of parameter, determined as above, but weighted in accordance with the procedures laid down in BS EN ISO 717-1 to provide a single-figure value.
C , C_{tr}	Spectral adaptation terms to be added to a single number quantity such as $D_{nT,w}$, to take account of the sound insulation within frequency ranges of particular interest.
$L'_{nT,w}$	<i>Weighted Standardised Impact Sound Pressure Level</i> as defined in BS EN ISO 717-2, representing the level of sound pressure when measured within a space where the floor above is under excitation from a calibrated tapping machine, standardised for the receiving room reverberant characteristics.
ΔL_w	Change in impact sound pressure level when a floor is fitted with a 'soft' or resilient covering, as measured in an accredited laboratory test suite in accordance with the procedures laid down in BS EN ISO 10140-3:2010.

1.2 Octave Band Frequencies

In order to determine the way in which the energy of sound is distributed across the frequency range, the International Standards Organisation has agreed on "preferred" bands of frequency for sound measurement and analysis. The widest and most commonly used band for frequency measurement and analysis is the Octave Band. In these bands, the upper frequency limit is twice the lower frequency limit, with the band being described by its "centre frequency" which is the average (geometric mean) of the upper and lower limits, e.g. 250 Hz octave band extends from 176 Hz to 353 Hz. The most commonly used octave bands are:

Octave Band Centre Frequency Hz		63		125		250		500		1000		2000		4000		8000
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1.3 Human Perception of Broadband Noise

Because of the logarithmic nature of the decibel scale, it should be borne in mind that sound levels in dB(A) do not have a simple linear relationship. For example, 100dB(A) sound level is not twice as loud as 50dB(A). It has been found experimentally that changes in the average level of fluctuating sound, such as from traffic, need to be of the order of 3dB before becoming definitely perceptible to the human ear. Data from other experiments have indicated that a change in sound level of 10dB is perceived by the average listener as a doubling or halving of loudness. Using this information, a guide to the subjective interpretation of changes in environmental sound level can be given.

APPENDIX A

Acoustic Terminology & Human Response to Broadband Sound

Change in Sound Level dB	Subjective Impression	Human Response
0 to 2	Imperceptible change in loudness	Marginal
3 to 5	Perceptible change in loudness	Noticeable
6 to 10	Up to a doubling or halving of loudness	Significant
11 to 15	More than a doubling or halving of loudness	Substantial
16 to 20	Up to a quadrupling or quartering of loudness	Substantial
21 or more	More than a quadrupling or quartering of loudness	Very Substantial

1.4 Earth Bunds and Barriers - Effective Screen Height

When considering the reduction in sound level of a source provided by a barrier, it is necessary to establish the "effective screen height". For example if a tall barrier exists between a sound source and a listener, with the barrier close to the listener, the listener will perceive the sound as being louder if he climbs up a ladder (and is closer to the top of the barrier) than if he were standing at ground level. Equally if he sat on the ground the sound would seem quieter than if he were standing. This is explained by the fact that the "effective screen height" is changing with the three cases above. In general, the greater the effective screen height, the greater the perceived reduction in sound level.

Similarly, the attenuation provided by a barrier will be greater where it is aligned close to either the source or the listener than where the barrier is midway between the two.