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| **Project:** | Travelodge, 9-19 Paradise Road Richmond | | | |
| **Client:** | Hurleypalmerflatt | | | |
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## Contents

# 1.0 Introduction

It is proposed that the existing office building at 9-19 Paradise Road, Richmond upon Thames be demolished and a new Travelodge Hotel be built upon the site. Paragon Acoustic Consultants Ltd has been commissioned to conduct environmental noise surveys to obtain statistical noise data characterising the existing local background and ambient noise climate at the site. This information will be used to determine the Noise Exposure Categories applicable to any prevailing noise sources affecting the proposed development, in accordance with relevant Government planning policy guidance.

Outline comments regarding any noise control measures that may be required will also be given, to demonstrate that the ingress of external noise may be adequately controlled.

The assessments contained within this report will be based on the principles and recommendations contained within the following documents.

- DoE Planning Policy Guidance PPG 24 *"Planning and noise"*
- World Health Organization 1999 *"Guidelines for Community Noise"*
- DoE/Welsh Office *"Calculation of road traffic noise"*
- BS 7445:1991 *"Description and measurement of environmental noise: Part 2. Guide to the acquisition of data pertinent to land use"*
- BS 8233:1999 *"Sound insulation and noise reduction for buildings – Code of practice"*
- Proposals for amending the Building Regulations Approved Document E *"Resistance to the passage of Sound"*

# 2.0 Site Description

The site under consideration is 9-19 Paradise Road, Richmond upon Thames. The site lies on the southern elevation of Paradise Road, with Halford Road to the west and Vineyard Passage to the east.

Paradise Road is a busy one way trafficked highway with traffic travelling in an east to west directions. The lane of the highway on the south side of the Paradise Road is a dedicated bus lane. Beyond Paradise Road to the north lie residential premises of 10-16 Paradise Road, with residential dwellings extending in a north westerly direction along St James's cottages.

To the east of St James's cottages lies a large four storey office block known as Eton House, to the east of which lies Eaton Street.

To the west of the site lies Halford Road, beyond which lie residential properties. To the south of the site, running along the east side of Halford Road, lie residential properties, certain of which are located with their garden boundary abutting the proposed Travelodge site.

To the east of the site lies Vineyard Passage, beyond which lies The Old Courthouse.

The site and its adjoining land uses are illustrated by plan in Appendix A.

# 3.0 Existing Noise Climate

The existing noise climate proximal to the site is primarily affected by the vehicular traffic on the Paradise Road. It was notes that a high percentage of the vehicular traffic joins Paradise Road via Eton Street, whereby they accelerate on a slight incline to join Paradise Road. Busses are frequent along the Paradise Road, with the lane nearest the proposed site being a dedicated bus lane. Airplane overflights were also observed during the survey, although their contribution to the noise climate is considered likely to be minimal.

# 4.0 Guidance on the Assessment of Noise Levels

## 4.1 Planning Policy Guidance Note PPG24 *"Planning and Noise"*

Planning policy guidance note PPG 24 gives guidance to Local Authorities in England on the use of their planning powers to minimise the adverse impacts of noise and builds upon the advice previously contained in DoE Circular 10/73.

The PPG outlines the considerations to be taken into account when determining planning application both for noise-sensitive developments and for those activities that will generate noise. It introduces a number of pertinent standards including BS 8233:1987[1] *"Sound insulation and noise reduction for buildings"*, CRTN *"Calculation of road traffic noise"*, BS 7445 *"Description and measurement of environmental noise"*, BS 6472:1992 *"Evaluation of human exposure to vibration in buildings (1 Hz to 80 Hz)"* etc.

The concept of noise exposure categories for residential development is introduced and recommendations are made regarding appropriate levels of exposure to different sources of noise.

Four noise exposures categories are defined:

| NEC | |
|---|---|
| A | Noise need not be considered as a determining factor in granting planning permission, although the level at the high end of the category should not be regarded as a desirable level |
| B | Noise conditions should be taken into account when determining applications and, where appropriate, conditions imposed to ensure an adequate level of protection against noise. |
| C | Planning permission should not normally be granted. Where it is considered that permission should be given, for example because there are no alternative quieter sites available, conditions should be imposed to ensure a commensurate level of protection against noise. |
| D | Planning permission should normally be refused. |

The noise levels corresponding to the NEC's for road, air and mixed sources are given below. Values in the table refer to nose levels measured on an open site at the position of the proposed dwellings well away from existing buildings and 1.2m to 1.5m above the ground.

[1] Superseded by BS 8233:1999

| **Noise Levels[0] Corresponding to the Noise Exposure Categories for New Dwellings $L_{Aeq,T}$ dB** | | | | |
|---|---|---|---|---|
| | **Noise Exposure Category** | | | |
| **Noise Source** | **A** | **B** | **C** | **D** |
| **Road traffic** | | | | |
| 07.00-23.00 | <55 | 55-63 | 63-72 | >72 |
| 23.00-07.00[1] | <45 | 45-57 | 57-66 | >66 |
| **Rail traffic** | | | | |
| 07.00-23.00 | <55 | 55-66 | 66-74 | >74 |
| 23.00-07.00[1] | <45 | 45-59 | 59-66 | >66 |
| **Air traffic[2]** | | | | |
| 07.00-23.00 | <57 | 57-66 | 66-72 | >72 |
| 23.00-07.00[1] | <48 | 48-57 | 57-66 | >66 |
| **Mixed sources** | | | | |
| 07.00-23.00 | <55 | 55-63 | 63-72 | >72 |
| 23.00-07.00[1] | <45 | 45-57 | 57-66 | >66 |

Notes

[0]Noise Levels: the noise level(s) ($L_{Aeq,T}$) used when deciding the NEC of a site should be representative of typical conditions.

[1]Night-time noise levels (23.00-07.00): sites where individual noise events regularly exceed 82 dB $L_{Amax}$ (S time weighting) several times in any hour should be treated as being in NEC C, regardless of the $L_{Aeq,8h}$ (except where the $L_{Aeq,8h}$ already puts the site in NEC D).

[2]Aircraft noise: daytime values accord with the contours adopted by the Department of Transport which relate to levels measured 1.2m above open ground. For the same amount of noise energy, contour values can be up to 2 dB(A) higher than those of other sources because of ground reflection effects.

The PPG also provides general advice on the approach that may be used to limit the impact of noise, i.e.:

(i) **Engineering:** reduction of noise at point of generation (e.g. by using quiet machines and/or quiet methods of working); containment of noise generated (e.g. by insulating buildings which house machinery and/or providing purpose-built barriers around the site) and protection of surrounding noise-sensitive buildings (e.g. by improving sound insulation in these buildings and/or screening them by purpose built barriers)

(ii) **Lay-out:** adequate distance between source and noise sensitive buildings or area; screening by natural barriers, other buildings, or non-critical rooms in buildings;

(iii) **Administrative:** limiting operating time of the source; restricting activities allowed on site; specifying an acceptable noise limit.

The glossary of the PPG contains definitions of various acoustic terms and states that a change of 3 dB(A) is the minimum perceptible under normal conditions.

## 4.2 World Health Organization 1999 *"Guidelines for Community Noise"*

This document provides a review of the effects of noise and a description of the principles of the WHO health criteria and guidelines for Community Noise.

The effects of noise in dwellings are identified as sleep disturbance, annoyance and speech interference. For bedrooms, the critical effect is sleep disturbance. Indoor guideline values for bedrooms are 30 dB $L_{Aeq}$ for continuous noise and 45 dB $L_{Amax}$ for sound events. At night time, outside sound levels about 1 metre from facades of living spaces should not exceed 45 dB $L_{Aeq}$ so that people may sleep with bedroom windows open. This value is equivalent to that specified in the WHO Criteria 12 Document, although it is assumed that the sound reduction from outside to inside with windows open is 15 dB.

To enable casual conversation indoors during the daytime, the sound level of the interfering noise should not exceed 35 dB $L_{Aeq}$.

## 4.3 BS8233: 1999 *"Sound insulation and noise reduction for buildings"*

Intrusive noise from sources such as road traffic is usually assessed in accordance with BS 8233:1999 "*Sound insulation and noise reduction for buildings*", which recommends maxima for "Good" and "Reasonable" indoor ambient continuous noise levels as follows:

| Criterion | Typical Situations | Design range $L_{Aeq,T}$ dB | |
|---|---|---|---|
| | | Good | Reasonable |
| Reasonable resting/sleeping condition | Living rooms<br>Bedrooms [a] | 30<br>30 | 40<br>30 |
| [a] For a reasonable standard in bedrooms at night, individual noise events (measured with F time-weighting) should not normally exceed 45 dB $L_{Amax}$ | | | |

The Standard also gives guidance regarding the design limits for intrusive external noise. Under Clause 7.6.1.2 it is stated that:

> *"For dwellings, the main criteria are reasonable resting/sleeping conditions in bedrooms and good listening in other rooms. Occupants will usually tolerate higher levels of anonymous noise, such as that from road traffic, than noise from neighbours which may trigger complex emotional reactions that are disproportionate to the noise level."*

## 4.4 Proposed Design Criteria

For the purposes of this project, it is provisionally suggested that the noise design targets given in BS 8233:1999 should aim to be achieved. These are detailed below.

It is further recommended that the quoted $L_{AFmax}$ criterion should relate to the average of the measured event data.

For this particular project, the following target internal limiting noise levels are proposed:

- Hotel Bedrooms / Living rooms, day : $L_{Aeq,16h}$ = 40 dB
- Hotel Bedrooms / Living rooms, night : $L_{Aeq,8h}$ = 35 dB and $L_{AFmax}$ = 45 dB

The assessment period T shall be specified to reflect normal occupancy periods, i.e. 07:00 to 23:00 hours for day and 23:00 to 07:00 hours for night. The $L_{AFmax}$ criterion used relates to the arithmetic average of the measured event data.

The stated design limits will not provide absolute control of transient noise sources such as car horns, police sirens, etc., which may occasionally occur. However, the final building design should limit to a minimal degree any resultant annoyance caused to the occupants.

# 5.0 Subjective Impression of Noise Increases

The following scale relates changes in sound level to human response, based on Table 3.1 of HA 213/08.

Table A: Subjective effect of changes in sound pressure level

| Noise Change, dB(A) | Subjective Reaction | Magnitude of Impact |
|---|---|---|
| 0.0 | No change | None |
| 0.1 to 0.9 | Imperceptible change | Negligible |
| 1.0 to 2.9 | Perceptible change | Minor |
| 3.0 to 4.9 | Perceptible change | Moderate |
| 5.0 to 9.9 | Up to a doubling of loudness | Major |
| 10.0 or more | More than a doubling of loudness | Major |

# 6.0 Development Site Noise Levels

The site was not considered to be secure, and as such manned surveys were undertaken. The daytime noise monitoring commenced on 12/07/2011 at approximately 12:20 hours and continued until approximately 15:00 hours. Evening / night time period noise surveys were undertaken commencing approximately 02:18 on 13/07/2011 when two hours of samples were undertaken, and from approximately 05:00 to 07:00. The measurements were generally made at the assessment location as described below.

- **MP1**: In the vicinity of the corner of Paradise Road and Halford Road
- **MP2**: 2.5m from the building on the Paradise Road elevation towards the east of the proposed site
- **MP3**: Along the Halford Road, to the south of the site.
- **MP4**: Within the rear courtyard of the existing building.

Measurements were obtained using the following instrumentation complying with the Type 1 specification of IEC 60651, IEC 60804, IEC 61260 and IEC 61672:

- Norsonic 118 sound level analyser, serial numbers 31990

Each sound level analyser was calibrated prior to and after completion of measurements using a Norsonic Type 1251 acoustical calibrator complying with Class 1 of IEC 942 (1988), calibration level 114.0 dB ± 0.3 dB, @ 1.0 kHz.

For all positions the sound level analysers were tripod mounted such that the microphone diaphragm was 1.2 metres above the local ground plane.

Weather conditions were generally warm and dry with a slight breeze.

## 6.1 Daytime noise levels

Two methods have been employed to establish 16 hour daytime LAeq values, as follows:

### 6.1.1 Method A

Calculation of Road traffic noise sets out a shortened method whereby LA1018h noise levels can be determined from 3 hourly values measured between 10:00-17:00 hours. The measured daytime noise data have been processed as set out below. The daytime values of $L_{A10}$ have been converted to values of $L_{A10,18h}$ using the following relation:

$$L_{10,18h} = L_{10,3h} - 1\ \text{dB(A)} \qquad [1]$$

where:

$$L_{10,3h} = \frac{1}{3} \sum_{10 \le t \le 14}^{t+2} L_{10(\text{hourly})t} \qquad [2]$$

and t signifies the start time of the individual hourly $L_{A10}$ values. The calculated $L_{A10,18h}$ values can then be converted to $L_{Aeq,16h}$ values following PPG24, equation 3 refers:

$$L_{Aeq,16h} = L_{A10,18h} - 2\ \text{dB(A)} \qquad [3]$$

### 6.1.2 Method B

Using details provided in a paper produced for an IAO conference titled: "Investigation Into The Relationship Between Long And Short Measurements For The Assessment Of Road Traffic Noise" compiled by S Bird of Bird Acoustics, Princes Risborough, Bucks and M Fillery of the Symonds Group Ltd, Altringham, Manchester. Three simple equations are detailed that can be used to predict the long term LAeq values from the short ones and are reproduced as follows:

- LAeq(0700 - 2300 hours) = LAeq(3 hour between 1000 and 1700 hours) + 0
- LAeq(2300 - 0700 hours) = LAeq (2 hour between 2300 and 0100 hours) + 0.5
- LAeq(2300 - 0700 hours) = LAeq (2 hour between 0500 and 0700 hours) - 3.5

The paper concludes that the relationships quoted above are best when used for A roads. This is probably because the traffic is more likely to be freely flowing, the noise levels are higher and it is also probably easier to define an A road than other types. Using this data and the simple relationships above, the noise levels could be predicted to within ± 2 dB for 95% of cases for A roads, and to within ± 2 dB for the night-time relationship based on a measurement between 0500 and 0700 hours. The Bird and Fillery paper is appended to the end of this report for information.

### 6.1.3 Results, Method A and Method B

The calculation results for method A concurred with method B. The results of the surveying were converted to free field measurements and provide the following 16 hour LAeq (07:00 – 23:00hours)

- MP1: 68 dB LAeq16h
- MP2: 70 dB LAeq16h
- MP3: 57 dB LAeq16h
- MP3: 48 dB LAeq16h

### 6.2 Night time noise levels

Using the methodology detailed in the paper detailed in Section 6.1.2, the LAeq 8 hour night time noise levels were obtained by the following equation:

- LAeq(2300 - 0700 hours) = LAeq(2 hour between 0500 and 0700 hours) - 3.5

The results of the surveying therefore gave the following 8 hour LAeq (23:00 – 07:00hours)

- MP1: 59 dB LAeq8h
- MP2: 62 dB LAeq8h
- MP3:49 dB LAeq8h
- MP4:38 dB LAeq8h

In addition, certain other measuring positions were used in order to establish sample noise levels at a number of locations to assist calibrate the acoustic model.

## 7.0 Summary of Noise Exposure Data

The measurement data have been corrected to derive free-field values and values of $L_{Aeq,16h}$ and $L_{Aeq,8h}$ applicable.

Due to the layout of the proposed scheme it is evident that noise levels will be subject to significant variation towards the rear of the site, being affected by factors such as source-receiver distance, screening due to intervening obstacles, multiple reflection effects etc.. In order to quantify such variables, a detailed three dimensional computer model of the locality has been constructed using CADNA A software, illustrated in Figures A isometric views, which implements the procedures contained in pertinent documents such as *"Calculation of Road Traffic Noise"* and ISO 9613-2: *"Acoustics - Abatement of sound propagation outdoors, Part 2: General method of calculation"*..

For calculation purposes, two orders of mirror source reflection have been allowed for using ray tracing, as opposed to the uniform +1.5 dB reflection allowance given in Calculation of Road Traffic Noise. Experience has shown that this approach more accurately models the influence of multiple reflections between plane surfaces and is considered to represent the worst-case situation.

Calculated free field noise levels have been subsequently determined. These are reported in Table 2 below and assessed against the noise levels corresponding to the various Noise Exposure Categories as defined in the PPG.

Fig A: Isometric view of 3D CadnaA Model (viewed from south east of site)

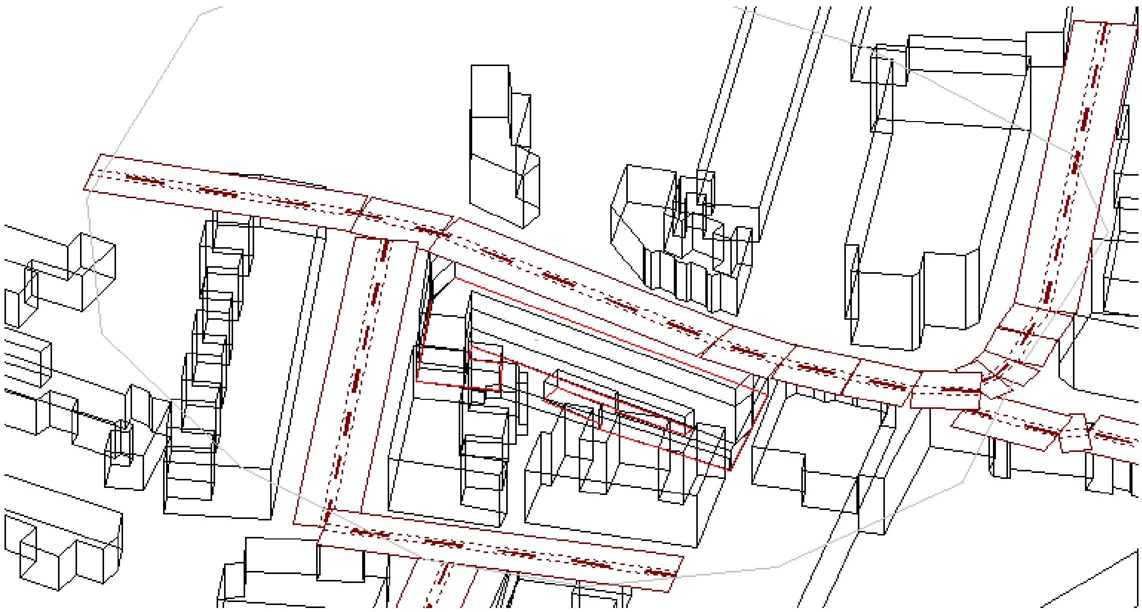


**Table 1:** Summary of Noise Exposure Data

| Facade | Source | Day (07:00 to 23:00 hrs) | | Night (23:00 to 07:00 hrs) | | |
|---|---|---|---|---|---|---|
| | | $L_{Aeq,16h}$ | NEC | $L_{Aeq,8h}$ | $L_{AFmax^*}$ | NEC |
| East | **Road Traffic** | 62 dB | B | 54 dB | 74 dB | B |
| South | **Road Traffic** | 49 dB | A | 43 dB | 66 dB | A |
| West | **Road Traffic** | 58-66 dB | B/C | 52-58 dB | 73-78 dB | B/C |
| North | **Road Traffic** | 71 dB | C | 62 dB | 82 dB | C |

* With regard to the LAFmax data given in Table 1. Strict interpretation of PPG 24 would requirement measurement of transients using the sound level meter slow detector response, however the current approach has been taken as maximum noise levels measured using fast response given that fast time-weighted levels represent the worst case/ highest levels and it is the criterion in BS 8233 that will be of most relevance ultimately when specifying the building envelope sound insulation requirements.

Fig 1 to 3 show the predicted noise levels acquired using CadnaA software for the Daytime $L_{Aeq,16h}$, Night $L_{Aeq,8h}$ and Night $L_{AFmax}$ levels.

Fig 1: Predicted Facade Daytime $L_{Aeq,16h}$

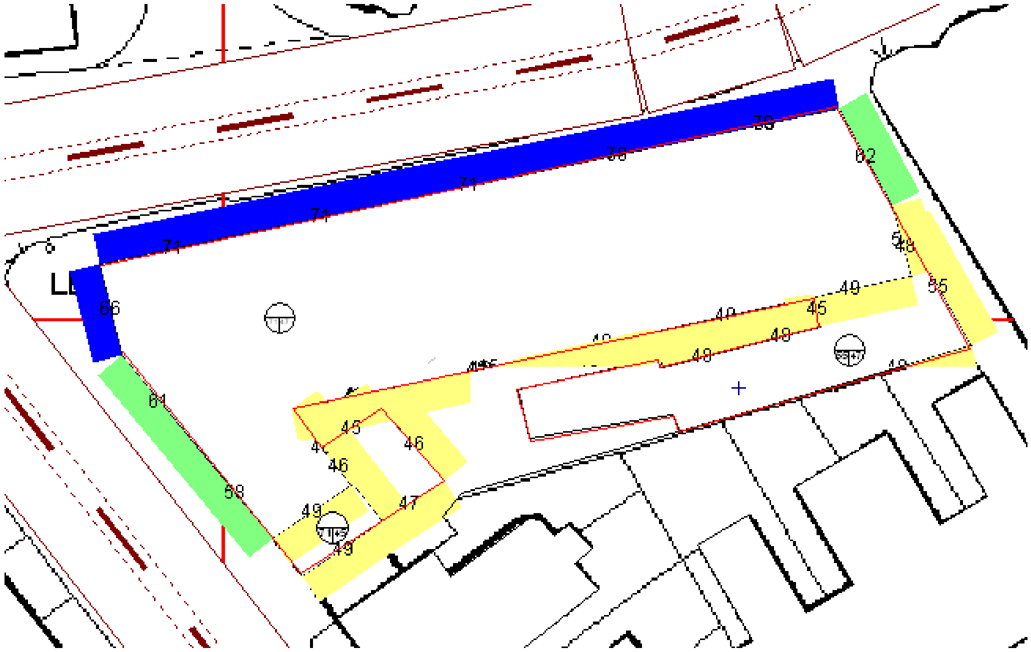


Fig 2: Predicted Facade Night time $L_{Aeq,8h}$

Fig 3: Predicted Facade Night time $L_{AFmax}$

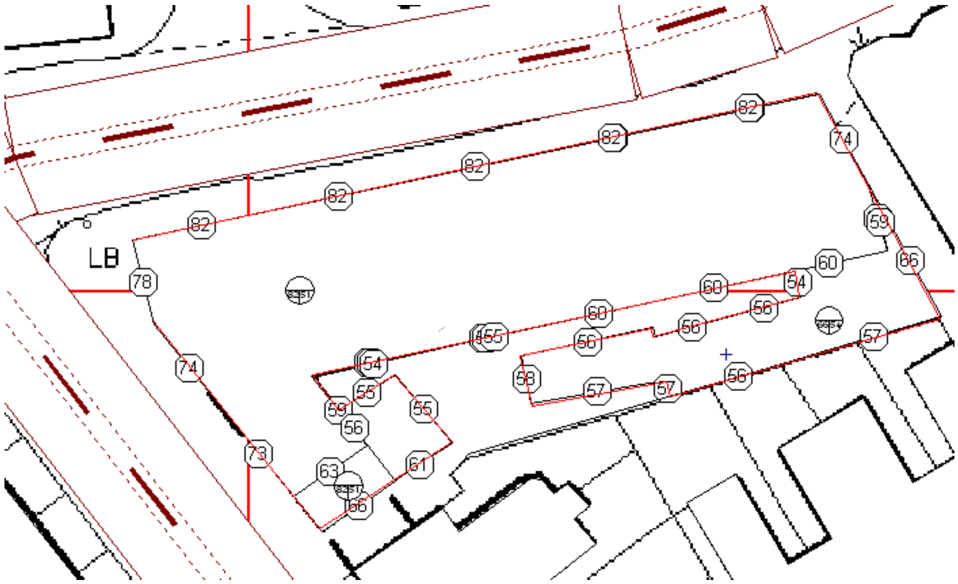
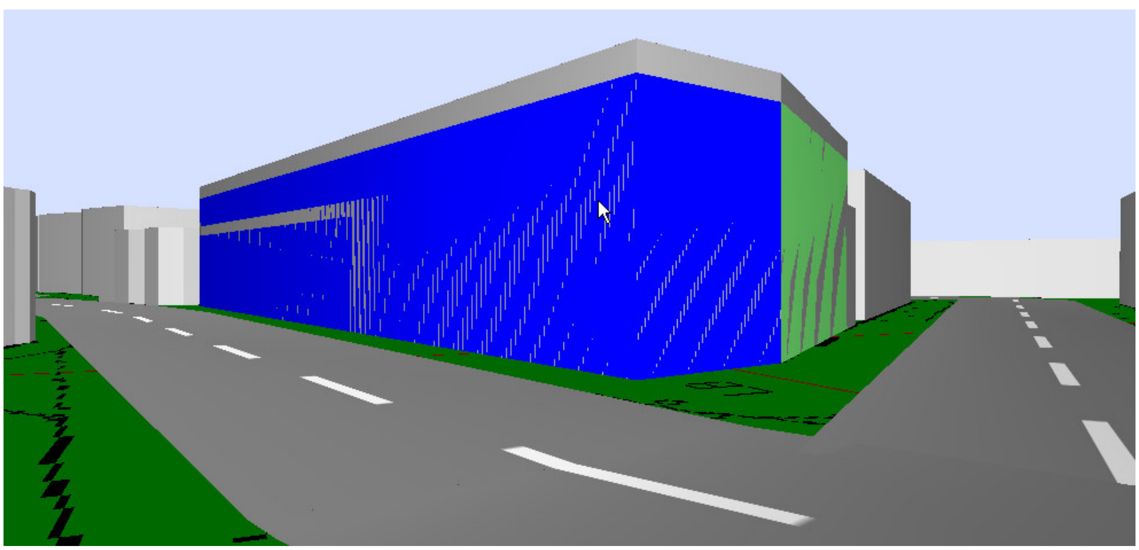



Fig 4: screenshot of 3D model from north side of Paradise Road, in a position north west from the site, approx 1.7 above ground level .



## 8.0 Noise Control Requirements

Examination of the Table 2 data shows that the NEC's vary from B to D depending on the period and site boundary under consideration.

For boundaries lying in NEC A, the PPG advises that:

> *"Noise need not be considered as a determining factor in granting planning permission, although the level at the high end of the category should not be regarded as a desirable level"*

For boundaries lying in NEC B, the PPG advises that:

> *"Noise conditions should be taken into account when determining applications and, where appropriate, conditions imposed to ensure an adequate level of protection against noise"*

For boundaries lying in NEC C, the PPG advises that:

> *"Planning permission should not normally be granted. Where it is considered that permission should be given, for example because there are no alternative quieter sites available, conditions should be imposed to ensure a commensurate level of protection against noise."*

Although the building contains facades that fall within exposure category C it must be remembered that almost any building within the Borough in the vicinity of the A roads will have the same constraints.

The Table 2 data implies that a suitable degree of protection will be required to control noise to appropriate levels within any potentially affected dwellings, following the principles of Annex 1 of PPG 24. In practice, this could be achieved by appropriate specification of the façade sound insulation and internal layout planning, i.e. following the **engineering** and **layout** principles of the PPG.

Due to the early stage of the project's development it is inappropriate to specify spectral sound insulation performance requirements for individual structural elements; however the current data does allow the overall building envelope sound insulation requirement to be quantified using appropriate single figure indices.

## 8.1 Sound Insulation Terminology

Due to the numerous methods used to quantify sound insulation performance, it is necessary to define the various acoustic parameters that are encountered.

**Table 2:** Sound Insulation Parameters

| Quantity | Definition | Description |
|---|---|---|
| $R$ | Sound Reduction Index | The sound reduction index *R* is a property of the building element, independent of its surface area and absorption within the receiving room. *R* is obtained from the results of **Laboratory** tests, thus eliminating flanking transmission, such that the sound insulation performance of the test sample only is established. |
| $R_w$ | Weighted Sound Reduction Index | Single figure sound insulation value derived from the measured sound reduction index ***R*.** |
| $C$; $C_{tr}$ | Spectrum adaptation terms 1 and 2. Used with single figure ratings as required by ISO 717-1:1996 | *C* - calculated with spectrum No. 1 (A-weighted pink noise);<br>$C_{tr}$ - calculated with spectrum No. 2 (A-weighted urban traffic noise).<br><br>The spectra of most commonly encountered indoor and outdoor noise sources lie in the range |

| | | |
|---|---|---|
| | | of spectra Nos. 1 and 2; the spectrum adaptation terms *C* and $C_{tr}$ may therefore be used to characterize sound insulation with respect to many types of noise. |

## 8.2 Building Envelope Sound Insulation

Evaluation of the data given in Table 1 indicates that to achieve the internal design noise criteria recommended in Section 4.4, the building envelope would need to achieve the composite $R_w$ + $C_{tr}$ values given in Table 3 as follows:

**Table 3:** Building Envelope Sound Insulation Requirement

| Elevation | Space | Design intent | | Noise exposure | | Target $R_w$ + $C_{tr}$ |
|---|---|---|---|---|---|---|
| | | $L_{Aeq,T}$ | $\overline{L_{AFmax}}$ | $L_{Aeq,T}$ | $\overline{L_{AFmax}}$ | |
| East facade facing vineyard passage | Living room | 40 dB | - | 62 | - | 29 dB |
| | Bedroom | 35 dB | 45 dB | 54 | 74 | |
| South facade facing rear of properties with their frontage on Halford Road | Living room | 40 dB | - | 49 | - | 21 dB |
| | Bedroom | 35 dB | 45 dB | 43 | 66 | |
| West facade facing Halford Road | Living room | 40 dB | - | 66 | - | 33 dB |
| | Bedroom | 35 dB | 45 dB | 58 | 78 | |
| North facade facing Paradise Road | Living room | 40 dB | - | 71 | | 37 dB |
| | Bedroom | 35 dB | 45 dB | 62 | 82 | |

The hotel guest rooms are living / bedroom spaces, therefore the higher Target Rw+Ctr shall be used for the building envelope sound insulation as dictated by the bedroom requirements.

Masonry constructions usually have better sound insulation than other elements in the building envelope, and to achieve $R_w$ + $C_{tr}$ values of up to the order 37 dB(A), it is necessary to consider the specification detailing and construction of windows, lightweight cladding (if applicable) and method of ventilation.

Experience of comparable projects has shown that the required $R_w$ + $C_{tr}$ values identified in Table 4 can be achieved using proprietary glazing, cladding and ventilation products in-conjunction with the existing building masonry elements. A detailed product spectral sound insulation performance specification can be issued at an appropriate stage of the project's development.

The night $L_{AFmax}$ values reported in Table 3 represent the arithmetic average of the range of data measured and assessed over the night periods.

# 9.0 Ventilation

## 9.1 Ventilation Arrangements

Current Building Regulations require a certain degree of background ventilation to all habitable rooms. The mechanical Services consultant has advised that the project will be subject to part F 2010 and that this building comes under part L2A and is therefore assesses via the EPC rating not SAP.

The form of ventilation is yet to be finalized. The south façade may potentially be able to use trickle vents pending further assessment. The Preliminary intention is to use high performance acoustic passive ventilators for the north and west facades and possibly east facade of the building. This will require further development in the detailed design stages to ensure that acoustic requirements are met. However, it is possible that a ducted system may be required. Future assessment of the ventilation system shall be undertaken at the detailed design stage to determine the appropriate acoustic treatment and method ventilation in conjunction with the mechanical services consultant.

It is noted that future systems may potentially require noise attenuation hardware to be installed to the intake / outlet vents to atmosphere to reduce the transmission of external noise to internal areas via the ventilation ducts. This practise can assist with the selection of the attenuators when the system selected has been established.

# 10.0 Mechanical plant to atmosphere

## 10.1 Local Authority

The Local Authority is likely to impose stringent noise limits in relation to the noise emissions of mechanical plant. Previous dealings with the London Borough of Richmond upon Thames have determined that their likely noise condition is likely to be as follows:

> *"The measured or calculated rating level of the noise emitted from the (describe plant area / ventilation extraction system etc) to which the application refers, shall be lower than the existing background noise level (insert level day, evening, night, days of week, as appropriate) by at least 5dB(A) or (10dB(A) below if there is a particular tonal or discrete component to the noise,) (at all times that the ventilation extraction system operates.)*
>
> *The noise levels shall be determined at the nearest noise sensitive premises and in accordance to the latest British Standard 4142; Method for Rating Industrial Noise Affecting Mixed Residential and Industrial Areas.*
>
> *Reason; To protect the amenity of residents of nearby properties*"

Background noise levels have been measured at the site and as such the limits can be established.

## 10.2 Commercial Properties

It is also necessary to consider commercial properties existing in the locality of the site. BS 8233:1999 "*Sound insulation and noise reduction for buildings*", recommends maxima for “Good” and “Reasonable” indoor ambient continuous noise levels, certain of which are reproduced as follows:

| Area | Design range $L_{Aeq,T}$ dB | |
|---|---|---|
| | Good | Reasonable |
| Meeting room, executive office | 35 | 40 |
| Open Plan office | 45 | 50 |

In view of the details presented above it is considered reasonable to adopt a noise criterion of 45 dB $L_{Aeq,T}$ for commercial office space in the proximity of the site.

BS 8233:1999 indicates that any type of window in a façade when partially open will provide a weighted sound reduction index of 10-15 dB $R_w$. It is reasonable to consider a noise criterion external to commercial property windows that take account of the internal design range plus the loss expected through an openable window (10 dB being used as this is at the lower value of the range given in the Standard). This provides the following criteria:

**Noise criteria external to Commercial office space = 55 dB $L_{Aeq,T}$**

## 10.3 Background Noise levels

The recorded statistical broad-band sound pressure levels are shown within Appendix B, and the lowest representative daytime, evening and night-time background noise levels obtained are rounded to the nearest integer and summarised in Table 4.

**Table 4:** Lowest Background Sound Pressure Level Measurements

| Measurement Position | Day time $L_{A90(07:00-19:00)}$ | Night time $L_{A90(23:00-07:00)}$ |
|---|---|---|
| MP1 | 54 | 33 |
| MP3 | 45 | 32 |
| MP4 | 40 | 30 |

## 10.4 External Noise Criteria

The derived external noise criteria to which the new building services plant shall be required to achieve are summarised in Table 5:

**Table 5:** Limiting Noise Criteria Applicable @ 1m From the Affected Premises

| Plant location | Receptor | Rating level Daytime (07:00-19:00) $L_{ArT}$ | Rating level Night time (23:00-07:00) $L_{ArT}$ |
|---|---|---|---|
| Any location on site | 1 metre outside all residential windows to the south / west of the site (all residential properties with their frontage on Halford Road) | 35 dB | 25 dB |
| Any location on site | 1 metre outside all residential windows to the north / east of the site | 49 dB | 27 dB |

| | | | |
|---|---|---|---|
| Any location on site | 1 metre outside all commercial windows | 55 dB | N/A |

If mechanical plant contains noise of a distinguishable, discrete continuous note (whine, hiss, screech, hum) and/or distinct impulses (bangs, clicks, clatters, thumps) and/or the plant is irregular enough to attract attention, a 5 dB penalty shall be included within the assessment as described within BS 4142:1997 “Method for rating industrial noise affecting mixed industrial and residential areas” and the Local Authority Noise Policy.

Note that the limiting noise criteria apply to the noise level at 1m from the receptor location with all mechanical plant operating. The selection of future mechanical plant items must allow for the combined effect of all plant noise to be introduced to the 9-19 Paradise Road Richmond.

## 10.5 Proposed mechanical plant

Provisional plant has been advised by the client. In the absence of a detailed scheme design the following preliminary comments are provided:

**Cold Water Booster Set**

Plant details provided:

Cold Water Booster Set within ground floor plant room

Sound Pressure Level 70dB(A) at 1m

Comment:

The present proposals indicate that the plantroom doors are of acoustic louvre design. The level of 70 dBA at 1m is such that an enclosure will be required to the Cold Water Booster Set within ground floor plant room. It is recommended that provision be made for an enclosure to give a 35dBA insertion loss to the unattenuated noise level quoted.

**VRF Condenser**

Plant details provided:

VRF Condenser mounted within ground floor acoustic enclosure

Sound Pressure Level 59dB(A) at 1m

Sound Power 72dB(A)

Comment:

It is assumed that the condenser will be located at least 5m distance from a residential use associated window. Provisional assessment indicates that the VRF Condenser shall be installed with an enclosure to give a minimum 25 dBA reduction to the unattenuated noise level quoted. It is envisaged that an enclosure shall be required such as those supplied by:

Environ Technologies Ltd

Regus House,
1010 Cambourne Business Park,
Cambourne,
CB23 6DP

**DACHs mini CHP units**

Plant details provided:

DACHs mini CHP units

Located within Second Floor Plantroom

Sound Pressure = 56dB(A) at 1m (assume that this is at 1m from flue terminal on roof)

Comment:

Assuming a noise levels of 56dB(A) at 1m from flue terminal on roof it is envisaged that residential properties may be 15m away from the roof terminal, hence the noise at the residential would be in the order (56-23=33) Based on site measurements it is considered appropriate to allow for attenuation to the flue reduce the noise levels by a further 10 dBA.

**Gas Fired Water Heaters**

Plant details provided:

Sound Pressure = 51dB(A) at 2m from flue terminal on roof

Comment:

Assuming a noise levels of 51dB(A) at 2m from flue terminal on roof it is envisaged that residential properties may be 15m away from the roof terminal, hence the noise at the residential would be in the order (51-17=34) Based on site measurements it is considered appropriate to allow for attenuation to the flue reduce the noise levels by a further 10 dBA.

**Roof Mounted Twin Extract Fan**

Plant details provided:

| Induct inlet Sound Power levels dB re lpW (+ correction for open outlet) | | | | | | | **Breakout dBA@3M** |
|---|---|---|---|---|---|---|---|
| **125** | **250** | **500** | **1000** | **2000** | **4000** | **8000** | |
| 81(+7) | 82(+2) | 77(+**11**) | **77(+10)** | **74(+8)** | **71(+9)** | **68(+8)** | **61** |

Comment:

Attenuation to be provisioned for such that the noise of all parts of the system including outlet, duct / flexible connection breakout / fan casing breakout etc do not exceed 36 dBA at 3m from the fan and associated system. It is recommended that at this stage duct attenuation on the atmosphere side of the system is allowed, together with a fan enclosure and appropriate duct lagging / secondary duct acoustic panels.

The above comments are provisional comments only based on preliminary plant data. When full and final plant selections are known their noise emissions must be fully evaluated and noise mitigation measures revised as necessary to ensure compliance with the derived noise limits in Table 5.

# 11.0 Vibration Measurements

## 11.1 Groundborne Vibration (BS 6472:2008)

Structural vibration in buildings can be detected by the occupants and can affect them in many ways; their quality of life can be reduced, as can their working efficiency. The first overt sign of an unfavourable reaction to building vibration is adverse comment, whereby occupants express negative responses to the vibration.

The prevalence of adverse comment depends on specific circumstances, which can include parallel effects such as re-radiated noise. The acceptable magnitudes for building vibration might depend similarly on these parallel effects. BS6472-1:2008 provides the best available information on the application of methods of measuring and evaluating vibration in order to assess the likelihood of adverse comment.

Because a building may be used for many activities, standing, sitting and lying may all occur, vertical vibration for example may enter the body as either x-axis, y-axis or z-axis vibration. A basicentric co-ordinate system that moved with the orientation of the human body has in the past been used, however under the 2008 revisions this was replaced by the geocentric coordinate system in which the vertical and horizontal axes are earth centred and hence the weightings for supine subjects exposed to motion in the back-to-chest and foot-to-head axes are exchanged compared with the previous standard.

The significance of vibration exposure in terms of human response can be derived from Table 1 of BS 6472-1:2008, reproduced as Table 6 below. The judgement made is of the probability that the determined vibration dose might result in adverse comment by those who experience it. The values represent the best judgement currently available and may be used for both vertical and horizontal vibration, provided that they are correctly weighted. It is inevitable that the criteria have to be presented as ranges rather than discrete values. This stems largely from widely differing susceptibility to vibration among members of the population, but also from their differing expectations of the vibration environment. Parallel effects can also exert some influence. Because there is a range of values for each category, it is clear that the judgement can never be precise.

Clause 3.3 of the standard sets out values approximating the threshold of vibration perception. Perception thresholds for continuous whole-body vibration vary widely among individuals. Approximately half the people in a typical population, when standing or seated, can perceive a vertical weighted peak acceleration of 0.015 $ms^{-2}$. The weighting used is $W_b$. A quarter of the people would perceive a vibration of 0.01 $ms^{-2}$ peak, but the least sensitive quarter would only be able to detect a vibration of 0.02 $ms^{-2}$ peak, or more. Perception thresholds are slightly higher for vibration duration of less than about 1 s.

**Table 1:** Vibration dose value ranges which might result in various probabilities of adverse comment within residential buildings (after BS 6472-1:200, Table 1)

| Place and time | Low probability of adverse comment $m.s^{-1.75}$ [1] | Adverse comment possible $m.s^{-1.75}$ | Adverse comment probable $m.s^{-1.75}$ [2] |
|---|---|---|---|
| Residential buildings 16 h day | 0.2 to 0.4 | 0.4 to 0.8 | 0.8 to 1.6 |
| Residential buildings 8 h night | 0.1 to 0.2 | 0.2 to 0.4 | 0.4 to 0.8 |

[1] Below these ranges adverse comment is not expected.

[2] Above these ranges adverse comment is very likely.

The note to Table 1 of the standard advocates that for offices a multiplying factor of 2 should be applied to the above vibration dose value ranges for a 16 h day.

## 11.2 Survey Methodology

Groundborne noise and vibration measurements were carried out on 12th July 11 within the ground floor of the existing building. However, it must be noted that the measurements were taken within the existing building that is to be demolished

The empty building was not partitioned and spaces were unfurnished.

Noise and vibration measurements were taken at ground and 2nd floor locations illustrated below, denoted MP1.

The vibration transducer was affixed to the floor base using a mounting-method set out in BS 7129:1989.

MP1 Ground floor

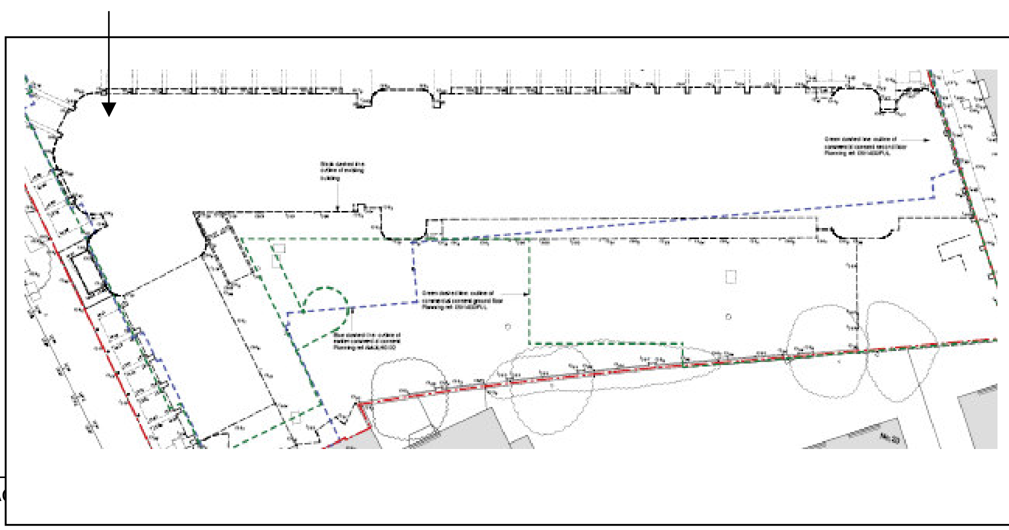


**Figure 1:** Measurement position (indicative only)

The noise climate within the building was relatively quiet although extraneous external events were clearly audible on occasions.

The following instrumentation was used:

- SVAN 958 4-channel vibration analyser;
- SVAN 212 environmental case;
- SVAN SA207 mounting box and tri-axial accelerometer;
- Dytran 3100D24 accelerometer.

### 11.3 Results

24 hour noise monitoring was not possible due to site security. Values of the vibration dose value $VDV_{b,day}$ and $VDV_{d,day}$ have been estimated from the measurement data reproduced in Appendix B and compared with the likelihood of adverse comments as defined in BS 6472:2008.

**Table 2:** Summary of VDV measurement data

| Space | Vibration Dose Value $ms^{-1.75}$ | | | Likely Impact |
|---|---|---|---|---|
| | $VDV_{b,day}$ | $VDV_{d,day}$ | $VDV_{d,day}$ | |
| Ground floor | 0.009 | 0.012 | 0.008 | Below low probability of adverse comment |

## 12.0 Noise from Use of Development

The pre- application response letter issued by the London Borough of Richmond upon Thames states as follows:

> A hotel will have a different pattern of activity, noise and disturbance when compared to the authorised use of the site as offices. In this respect the proposed use is likely to generate additional noise in the late evenings when offices are often closed. Although Paradise Road is a mix of commercial and residential, Halford Road is not, being predominately residential and therefore its residents are likely to expect a lower level of noise and disturbance. In this respect I note that the entrance is on the corner of Paradise Road and that you will be submitting an acoustic report to demonstrate that the impact upon residents will be satisfactory.

Noise associated with the entrance on Paradise Road is likely to comprise pedestrian traffic entering the site only, as the site does not include residents parking. As such, it is possible that speech noise levels are potentially a source of noise in the area external to the foyer. This subject is evaluated in Section 12.2.

As part of the assessment, following discussions with the project team, a preliminary noise assessment of television noise via hotel bedroom windows has also been undertaken, this being assessed in Section 12.1 as follows:

## 12.1 Assessment of Television noise breakout from hotel rooms with open windows.

A preliminary assessment of television noise breakout has been undertaken. As will be appreciated, there are a number of unknown parameters involved, such as the levels of noise of the television, the amount that windows are open, number of rooms with their television on, etc. In order to undertake a provisional analysis, the following are assumed:

- Television noise at two different levels as follows, being assumed as reasonable. It is not considered realistic to assess television noise at unreasonably high volumes.
  54dBA estimated low volume of TV at 2 metres
  64 dBA estimated volume of TV at 2 metres
- That the windows are partially open, giving a $0.6m^2$ open area of window
- That three hotel rooms have their windows open whilst watching television
- A likely worst case location is assumed whereby three rooms on the southern facade of the property (where residents in Halford Road benefit from a quieter noise environment)

## 12.11 Subjective Effect of Changes in Sound Pressure

The following scale relates changes in sound level to human response, based on Table 3.1 of HA 213/08.

Table A: Subjective effect of changes in sound pressure level

| Noise Change, dB(A) | Subjective Reaction | Magnitude of Impact |
|---|---|---|
| 0.0 | No change | None |
| 0.1 to 0.9 | Imperceptible change | Negligible |
| 1.0 to 2.9 | Perceptible change | Minor |
| 3.0 to 4.9 | Perceptible change | Moderate |
| 5.0 to 9.9 | Up to a doubling of loudness | Major |
| 10.0 or more | More than a doubling of loudness | Major |

## 12.12 Assessed Effect of Changes in Sound Pressure

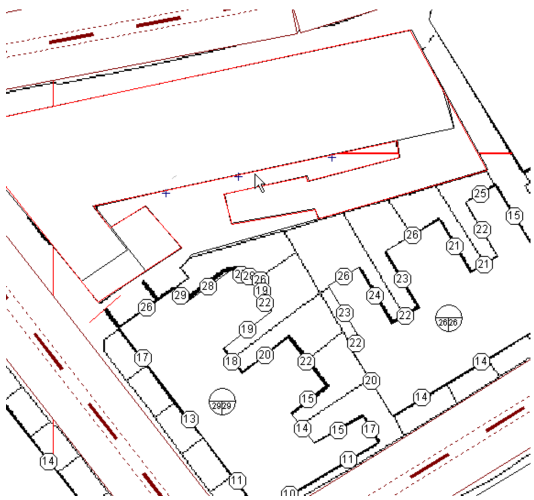
The predicted television noise has been has been assessed against the likely increase in the existing background noise levels and the changes in sound level to human response, based on Table 3.1 of HA 213/08.

| Cadna A model predicted TV noise level at 2m from TV | worst case predicted noise level at receiver dB LAEQ noise level | existing ambient - night time | predicted increase in abmient noise | Subjective Reaction | Magnitude of Impact |
|---|---|---|---|---|---|
| Low (54 dBAat 2m ) | 29 | 41 | 0.3 | Imperceptible change | Negligible |
| Med (64 dBA at 2m) | 39 | 41 | 2.1 | Perceptible change | Minor |

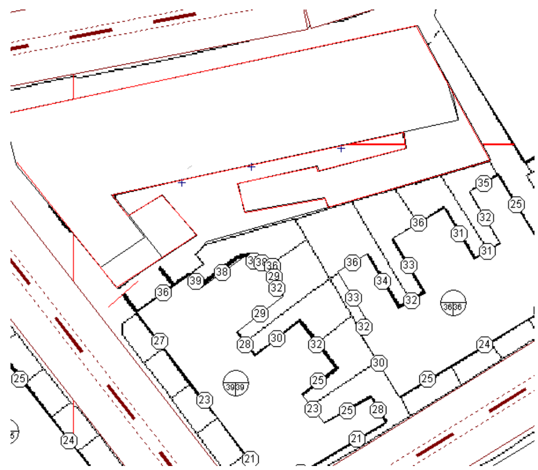
It will be seen that the worst case magnitude of impact predicted is “minor”

The CadnaA screenshots of the assessment are shown as follows:

Predicted low levels of TV noise



Predicted medium levels of TV noise



## 12.2 Assessment speech external to the hotel entrance.

A preliminary assessment of speech noise transmission external to the entrance foyer has been undertaken. In the unlikely event that hotel residents queue to enter the hotel entrance, an assessment has been made of likely speech transmission assuming that this may occur during the quietest period of the night.

Speech noise levels used have been taken from average speech levels at 7m distance from the source as detailed in Sound Research Laboratories publication "Noise Control in Building Services"

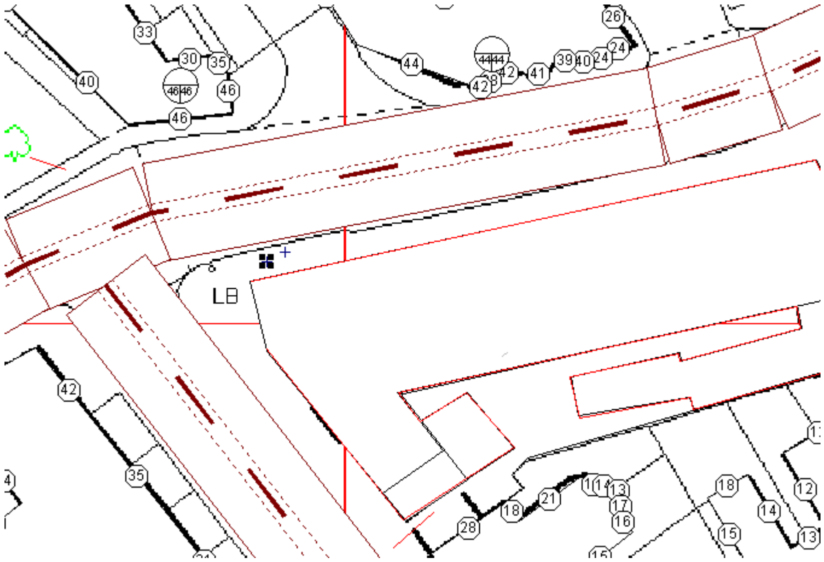
The assessment again uses the following scale detailed in Section 12.11 relating changes in sound level to human response.

The assessment assumes two people (two speech levels) external to the entrance foyer.

| Location | predicted noise level at receiver dB LAEQ noise level due to TV | existing ambient - night time | predicted increase in abmient noise | Subjective Reaction | Magnitude of Impact |
|---|---|---|---|---|---|
| 2 Paradise Road | 46 | 50 | 1.5 | Perceptible change | Minor |
| 10/12/14/16 Paradise Road | 44 | 50 | 1.0 | Perceptible change | Minor |
| 1/5/7/9 Halford Road | 42 | 43 | 2.5 | Perceptible change | Minor |

It will be seen that the worst case magnitude of impact predicted is "minor"

The CadnaA screenshots of the assessment are shown as follows:



## 13.0 Product Verification

Upon final selection of the façade elements, the relevant specialist trade contractors shall provide test data to demonstrate that the performance values of the glazed elements identified previously will be achieved. The test data will have been obtained from tests carried out in an accredited laboratory in accordance with BS EN ISO 140-3:1995, rated to BS ISO 717-1:2006.

## 14.0 Conclusions

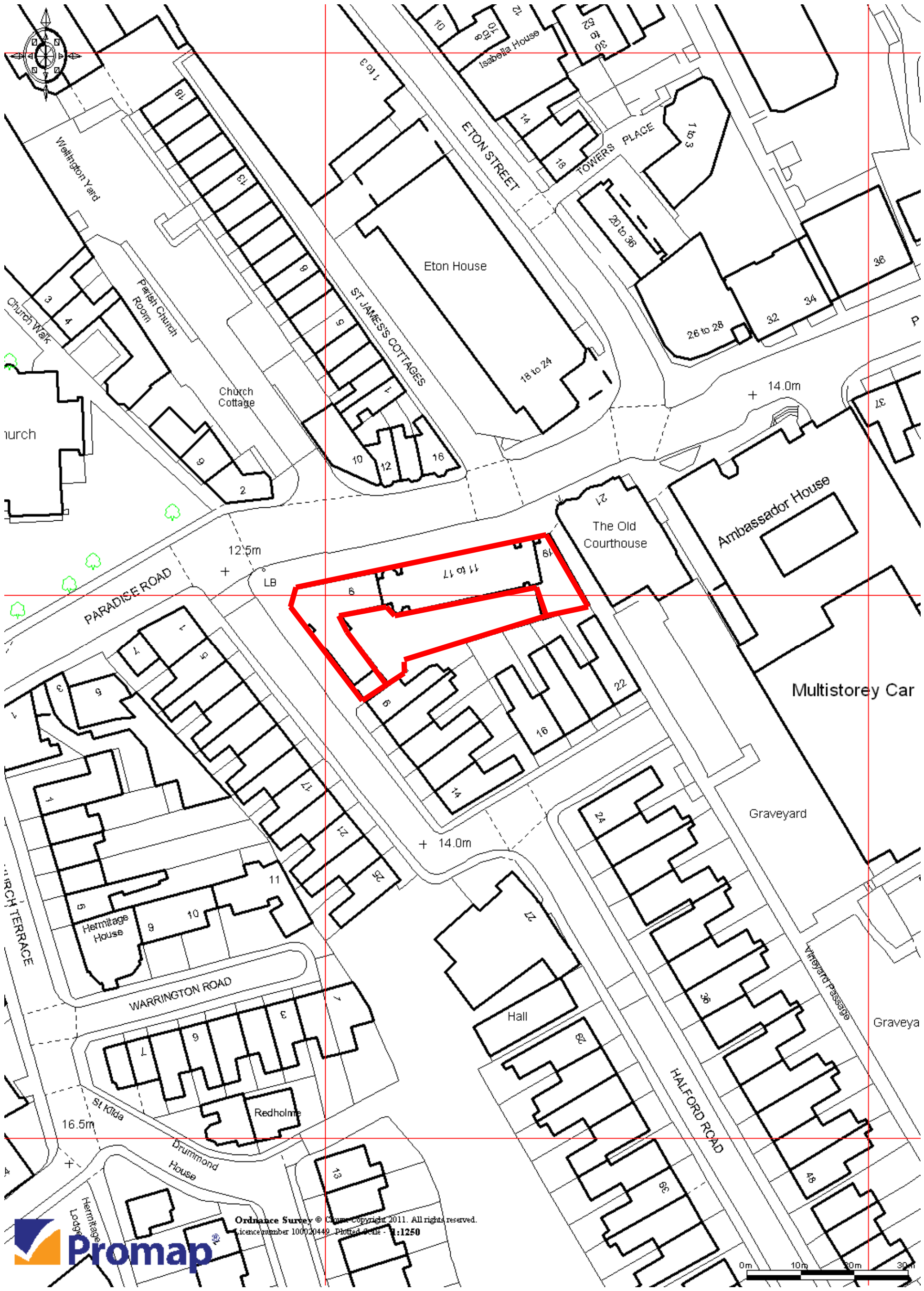
Detailed environmental noise surveys and analyses have been undertaken to determine noise exposure due to the noise sources affecting the proposed development site. The resultant data have been assessed against the Noise Exposure Categories as defined in the appropriate planning policy guidance document i.e., PPG 24:1994. Intrusive noise design criteria have been proposed for habitable rooms of the development and corresponding single figure building envelope sound insulation requirements have been reported.

Although at the planning stage, careful detailing and modern facade treatments are such nowadays that the necessary acoustic separation can be accommodated.

Mechanical plant noise limits to atmosphere have been established and preliminary comments provided relating to likely plant items. Vibration measurements samples have been assessed and reported. Noise from the use of the development has been provisionally assessed and the impacts indicated herein.

Due to all the above considerations it is felt that there should be no obstacles in granting planning permission for this scheme from an acoustic perspective.

# Appendix A: Drawings



# Appendix B: Measurement Data

| Date | Position | LAeq | LAFmax | LAF90% |
|---|---|---|---|---|
| (2011/07/13 02:18:27.00) | MP4 | 41.0 | 52.5 | 30.0 |
| (2011/07/13 02:34:12.00) | MP1 | 55.6 | 78.9 | 33.2 |
| (2011/07/13 02:48:12.00) | MP3 | 43.5 | 58.5 | 32.3 |
| (2011/07/13 03:04:05.00) | MP4 | 41.2 | 53.6 | 31.1 |
| (2011/07/13 03:21:34.00) | MP1 | 50.0 | 75.1 | 35.8 |
| (2011/07/13 03:37:34.00) | MP3 | 46.6 | 82.2 | 32.5 |
| (2011/07/13 05:12:49.00) | MP1 | 61.1 | 77.8 | 40.3 |
| (2011/07/13 05:23:55.00) | MP2 | 62.6 | 80.0 | 41.3 |
| (2011/07/13 05:34:48.00) | MP3 | 51.6 | 73.5 | 38.3 |
| (2011/07/13 05:46:02.00) | MP4 | 41.3 | 58.3 | 35.4 |
| (2011/07/13 05:58:43.00) | MP1 | 63.9 | 78.8 | 41.1 |
| (2011/07/13 06:11:42.00) | MP2 | 67.3 | 83.0 | 46.5 |
| (2011/07/13 06:22:51.00) | MP3 | 53.9 | 69.6 | 42.0 |
| (2011/07/13 06:34:11.00) | MP4 | 41.4 | 56.2 | 37.4 |
| (2011/07/12 12:20:11.00) | MP1 | 68.5 | 88.8 | 54.6 |
| (2011/07/12 12:42:29.00) | MP2 | 69.6 | 81.6 | 55.3 |
| (2011/07/12 12:53:37.00) | MP3 | 55.3 | 68.0 | 45.3 |
| (2011/07/12 13:07:06.00) | MP4 | 49.4 | 64.6 | 42.2 |
| (2011/07/12 13:19:30.00) | MP1 | 65.6 | 83.6 | 53.6 |
| (2011/07/12 13:30:14.00) | MP2 | 69.2 | 84.0 | 57.8 |
| (2011/07/12 13:46:58.00) | MP3 | 56.3 | 71.8 | 48.0 |
| (2011/07/12 13:58:59.00) | MP4 | 47.3 | 60.9 | 41.4 |
| (2011/07/12 14:11:15.00) | MP1 | 67.3 | 86.1 | 54.4 |
| (2011/07/12 14:22:03.00) | MP2 | 70.2 | 84.9 | 60.1 |
| (2011/07/12 14:35:48.00) | MP3 | 59.3 | 80.2 | 48.9 |
| (2011/07/12 14:47:30.00) | MP4 | 45.6 | 60.0 | 40.6 |

| | | | | Ch1 (VLM) | Ch2 (VLM) | Ch3 (VLM) |
|---|---|---|---|---|---|---|
| | | | | P1 (Wb, 1 s) | P1 (Wd, 1 s) | P1 (Wd, 1 s) |
| No | Date & time | Filename | Elapsed time | VDV [m/s^1.75] | VDV [m/s^1.75] | VDV [m/s^1.75] |
| 4 | 12/07/2011 12:08:10 | @TP3 | 00:01:00 | 0.000757705 | 0.001099006 | 0.001193988 |
| 5 | 12/07/2011 12:09:10 | @TP4 | 00:01:00 | 0.001306171 | 0.001661499 | 0.001177606 |
| 6 | 12/07/2011 12:10:10 | @TP5 | 00:01:00 | 0.000679986 | 0.001608792 | 0.000857038 |
| 7 | 12/07/2011 12:11:10 | @TP6 | 00:01:00 | 0.001095217 | 0.001048335 | 0.000892278 |
| 8 | 12/07/2011 12:12:10 | @TP7 | 00:01:00 | 0.000567545 | 0.001 | 0.000726106 |
| 9 | 12/07/2011 12:13:10 | @TP8 | 00:01:00 | 0.001203649 | 0.000859014 | 0.001258925 |
| 10 | 12/07/2011 12:14:10 | @TP9 | 00:01:00 | 0.000807235 | 0.000861986 | 0.001 |
| 11 | 12/07/2011 12:15:10 | @TP10 | 00:01:00 | 0.001124605 | 0.000976113 | 0.001127197 |
| 12 | 12/07/2011 12:16:10 | @TP11 | 00:01:00 | 0.000652379 | 0.00094189 | 0.000715319 |
| 13 | 12/07/2011 12:17:10 | @TP12 | 00:01:00 | 0.001135011 | 0.001115578 | 0.001086426 |
| 14 | 12/07/2011 12:18:10 | @TP13 | 00:01:00 | 0.000566239 | 0.001597718 | 0.000710395 |
| 15 | 12/07/2011 12:19:10 | @TP14 | 00:01:00 | 0.000604644 | 0.001568556 | 0.000881049 |
| 16 | 12/07/2011 12:20:10 | @TP15 | 00:01:00 | 0.001261828 | 0.001563148 | 0.00108268 |
| 17 | 12/07/2011 12:21:10 | @TP16 | 00:01:00 | 0.001238797 | 0.001903268 | 0.001245948 |
| 18 | 12/07/2011 12:22:10 | @TP17 | 00:01:00 | 0.001410912 | 0.000892278 | 0.001213389 |
| 19 | 12/07/2011 12:23:10 | @TP18 | 00:01:00 | 0.001136318 | 0.001049542 | 0.001099006 |
| 20 | 12/07/2011 12:24:10 | @TP19 | 00:01:00 | 0.000568198 | 0.001279381 | 0.000750758 |
| 21 | 12/07/2011 12:25:10 | @TP20 | 00:01:00 | 0.001111732 | 0.000882064 | 0.000969393 |
| 22 | 12/07/2011 12:26:10 | @TP21 | 00:01:00 | 0.000564287 | 0.001313711 | 0.000850159 |
| 23 | 12/07/2011 12:27:10 | @TP22 | 00:01:00 | 0.001072754 | 0.001842892 | 0.000978363 |
| 24 | 12/07/2011 12:28:10 | @TP23 | 00:01:00 | 0.000895365 | 0.001943122 | 0.001037528 |
| 25 | 12/07/2011 12:29:10 | @TP24 | 00:01:00 | 0.001331987 | 0.001522299 | 0.001383566 |
| 26 | 12/07/2011 12:30:10 | @TP25 | 00:01:00 | 0.001009253 | 0.001020939 | 0.001195364 |
| 27 | 12/07/2011 12:31:10 | @TP26 | 00:01:00 | 0.001324342 | 0.001254585 | 0.00127497 |
| 28 | 12/07/2011 12:32:10 | @TP27 | 00:01:00 | 0.001548817 | 0.001743813 | 0.001356751 |
| 29 | 12/07/2011 12:33:10 | @TP28 | 00:01:00 | 0.001131097 | 0.00209894 | 0.001169499 |
| 30 | 12/07/2011 12:34:10 | @TP29 | 00:01:00 | 0.000686278 | 0.001001152 | 0.000914113 |
| 31 | 12/07/2011 12:35:10 | @TP30 | 00:01:00 | 0.000597723 | 0.001545254 | 0.00082699 |
| 32 | 12/07/2011 12:36:10 | @TP31 | 00:01:00 | 0.000669114 | 0.001840772 | 0.000750758 |
| 33 | 12/07/2011 12:37:10 | @TP32 | 00:01:00 | 0.00053889 | 0.001890166 | 0.000861986 |
| 34 | 12/07/2011 12:38:10 | @TP33 | 00:01:00 | 0.001207814 | 0.001667247 | 0.001060474 |
| 35 | 12/07/2011 12:39:10 | @TP34 | 00:01:00 | 0.000580096 | 0.001686553 | 0.000844306 |
| 36 | 12/07/2011 12:40:10 | @TP35 | 00:01:00 | 0.001008092 | 0.001817607 | 0.001032761 |
| 37 | 12/07/2011 12:41:10 | @TP36 | 00:01:00 | 0.001423967 | 0.001956591 | 0.001355189 |
| 38 | 12/07/2011 12:42:10 | @TP37 | 00:01:00 | 0.001213389 | 0.001790606 | 0.001128496 |
| 39 | 12/07/2011 12:43:10 | @TP38 | 00:01:00 | 0.001235947 | 0.001688496 | 0.001188502 |
| 40 | 12/07/2011 12:44:10 | @TP39 | 00:01:00 | 0.000843335 | 0.001853532 | 0.000954993 |
| 41 | 12/07/2011 12:45:10 | @TP40 | 00:01:00 | 0.001058035 | 0.001870682 | 0.001 |
| 42 | 12/07/2011 12:46:10 | @TP41 | 00:01:00 | 0.000934329 | 0.001536385 | 0.000987416 |
| 43 | 12/07/2011 12:47:10 | @TP42 | 00:01:00 | 0.000582103 | 0.001755901 | 0.000892278 |
| 44 | 12/07/2011 12:48:10 | @TP43 | 00:01:00 | 0.001682674 | 0.0015417 | 0.001472313 |
| 45 | 12/07/2011 12:49:10 | @TP44 | 00:01:00 | 0.001472313 | 0.002120801 | 0.001113012 |
| 46 | 12/07/2011 12:50:10 | @TP45 | 00:01:00 | 0.000591562 | 0.001489361 | 0.001017419 |
| 47 | 12/07/2011 12:51:10 | @TP46 | 00:01:00 | 0.001129796 | 0.001733804 | 0.001120727 |
| 48 | 12/07/2011 12:52:10 | @TP47 | 00:01:00 | 0.001269112 | 0.001958845 | 0.001173546 |
| 49 | 12/07/2011 12:53:10 | @TP48 | 00:01:00 | 0.000597723 | 0.00164248 | 0.000743019 |
| 50 | 12/07/2011 12:54:10 | @TP49 | 00:01:00 | 0.000733669 | 0.00165577 | 0.000815643 |
| 51 | 12/07/2011 12:55:10 | @TP50 | 00:01:00 | 0.00124882 | 0.001745822 | 0.001085176 |
| 52 | 12/07/2011 12:56:10 | @TP51 | 00:01:00 | 0.000946237 | 0.001874995 | 0.001025652 |
| 53 | 12/07/2011 12:57:10 | @TP52 | 00:01:00 | 0.000733669 | 0.001263281 | 0.000818465 |
| 54 | 12/07/2011 12:58:10 | @TP53 | 00:01:00 | 0.001066596 | 0.001214787 | 0.001205036 |
| 55 | 12/07/2011 12:59:10 | @TP54 | 00:01:00 | 0.000880035 | 0.001792669 | 0.000945148 |
| 56 | 12/07/2011 13:00:10 | @TP55 | 00:01:00 | 0.001170847 | 0.001790606 | 0.001024472 |
| 57 | 12/07/2011 13:01:10 | @TP56 | 00:01:00 | 0.001095217 | 0.001168154 | 0.001228853 |
| 58 | 12/07/2011 13:02:10 | @TP57 | 00:01:00 | 0.000578096 | 0.001485936 | 0.000834642 |
| 59 | 12/07/2011 13:03:10 | @TP58 | 00:01:00 | 0.001071519 | 0.001784432 | 0.001045924 |
| 60 | 12/07/2011 13:04:10 | @TP59 | 00:01:00 | 0.001283808 | 0.001592209 | 0.0011508 |
| 61 | 12/07/2011 13:05:10 | @TP60 | 00:01:00 | 0.001188502 | 0.001903268 | 0.00110535 |
| 62 | 12/07/2011 13:06:10 | @TP61 | 00:01:00 | 0.001093956 | 0.001331987 | 0.001135011 |
| 63 | 12/07/2011 13:07:10 | @TP62 | 00:01:00 | 0.000656145 | 0.001731809 | 0.001001152 |
| 64 | 12/07/2011 13:08:10 | @TP63 | 00:01:00 | 0.001153453 | 0.001497959 | 0.001086426 |
| 65 | 12/07/2011 13:09:10 | @TP64 | 00:01:00 | 0.001022116 | 0.001619944 | 0.001033951 |
| 66 | 12/07/2011 13:10:10 | @TP65 | 00:01:00 | 0.000551442 | 0.001619944 | 0.000676862 |
| 67 | 12/07/2011 13:11:10 | @TP66 | 00:01:00 | 0.000530884 | 0.001465548 | 0.0008531 |
| 68 | 12/07/2011 13:12:10 | @TP67 | 00:01:00 | 0.001113012 | 0.001905461 | 0.000877001 |
| 69 | 12/07/2011 13:13:10 | @TP68 | 00:01:00 | 0.001438799 | 0.001264736 | 0.001350517 |
| 70 | 12/07/2011 13:14:10 | @TP69 | 00:01:00 | 0.001318257 | 0.001830206 | 0.001237371 |
| 71 | 12/07/2011 13:15:10 | @TP70 | 00:01:00 | 0.001350517 | 0.001747833 | 0.001114295 |
| 72 | 12/07/2011 13:16:10 | @TP71 | 00:01:00 | 0.001156112 | 0.001169499 | 0.001153453 |
| 73 | 12/07/2011 13:17:10 | @TP72 | 00:01:00 | 0.001412538 | 0.001322818 | 0.001336596 |
| 74 | 12/07/2011 13:18:10 | @TP73 | 00:01:00 | 0.000705505 | 0.001457136 | 0.001012745 |
| 75 | 12/07/2011 13:19:10 | @TP74 | 00:01:00 | 0.000588166 | 0.001370882 | 0.000752489 |
| 76 | 12/07/2011 13:20:10 | @TP75 | 00:01:00 | 0.000616595 | 0.001849269 | 0.000914113 |
| 77 | 12/07/2011 13:21:10 | @TP76 | 00:01:00 | 0.001049542 | 0.00206063 | 0.000952796 |
| 78 | 12/07/2011 13:22:10 | @TP77 | 00:01:00 | 0.001008092 | 0.001688496 | 0.000956093 |
| 79 | 12/07/2011 13:23:10 | @TP78 | 00:01:00 | 0.0012218 | 0.002046445 | 0.001037528 |
| 80 | 12/07/2011 13:24:10 | @TP79 | 00:01:00 | 0.000936483 | 0.001692388 | 0.000930037 |
| 81 | 12/07/2011 13:25:10 | @TP80 | 00:01:00 | 0.000694225 | 0.001914256 | 0.001006932 |
| 82 | 12/07/2011 13:26:10 | @TP81 | 00:01:00 | 0.000743019 | 0.002002166 | 0.000864968 |
| 83 | 12/07/2011 13:27:10 | @TP82 | 00:01:00 | 0.00108019 | 0.002009093 | 0.001035142 |
| 84 | 12/07/2011 13:28:10 | @TP83 | 00:01:00 | 0.000694225 | 0.00092683 | 0.000988553 |
| 85 | 12/07/2011 13:29:10 | @TP84 | 00:01:00 | 0.001188502 | 0.001723852 | 0.001030386 |
| 86 | 12/07/2011 13:30:10 | @TP85 | 00:01:00 | 0.001361445 | 0.002115924 | 0.001226027 |
| 87 | 12/07/2011 13:31:10 | @TP86 | 00:01:00 | 0.001348963 | 0.001909853 | 0.001144195 |
| 88 | 12/07/2011 13:32:10 | @TP87 | 00:01:00 | 0.001051962 | 0.001894524 | 0.001049542 |
| 89 | 12/07/2011 13:33:10 | @TP88 | 00:01:00 | 0.001188502 | 0.001936422 | 0.001156112 |
| 90 | 12/07/2011 13:34:10 | @TP89 | 00:01:00 | 0.000713674 | 0.002006781 | 0.000703882 |
| 91 | 12/07/2011 13:35:10 | @TP90 | 00:01:00 | 0.001165467 | 0.001809256 | 0.001058035 |
| 92 | 12/07/2011 13:36:10 | @TP91 | 00:01:00 | 0.000601866 | 0.001766038 | 0.00082319 |
| 93 | 12/07/2011 13:37:10 | @TP92 | 00:01:00 | 0.000740457 | 0.00165577 | 0.000899498 |
| 94 | 12/07/2011 13:38:10 | @TP93 | 00:01:00 | 0.000976113 | 0.001631173 | 0.00104472 |
| 95 | 12/07/2011 13:39:10 | @TP94 | 00:01:00 | 0.001054387 | 0.001492794 | 0.000985145 |
| 96 | 12/07/2011 13:40:10 | @TP95 | 00:01:00 | 0.001146833 | 0.001813427 | 0.00108893 |
| 97 | 12/07/2011 13:41:10 | @TP96 | 00:01:00 | 0.001148154 | 0.001601401 | 0.001028016 |
| 98 | 12/07/2011 13:42:10 | @TP97 | 00:01:00 | 0.0012218 | 0.001629296 | 0.001122018 |
| 99 | 12/07/2011 13:43:10 | @TP98 | 00:01:00 | 0.001205036 | 0.002157744 | 0.001138938 |
| 100 | 12/07/2011 13:44:10 | @TP99 | 00:01:00 | 0.001217587 | 0.001547035 | 0.001154782 |
| 101 | 12/07/2011 13:45:10 | @TP100 | 00:01:00 | 0.001572172 | 0.001335058 | 0.001137627 |
| 102 | 12/07/2011 13:46:10 | @TP101 | 00:01:00 | 0.001001152 | 0.001735801 | 0.000914113 |
| 103 | 12/07/2011 13:47:10 | @TP102 | 00:01:00 | 0.000611646 | 0.001100272 | 0.000619441 |
| 104 | 12/07/2011 13:48:10 | @TP103 | 00:01:00 | 0.000568198 | 0.001482518 | 0.000662217 |
| 105 | 12/07/2011 13:49:10 | @TP104 | 00:01:00 | 0.000547016 | 0.001414165 | 0.000899498 |
| 106 | 12/07/2011 13:50:10 | @TP105 | 00:01:00 | 0.001004616 | 0.001035142 | 0.001045924 |
| 107 | 12/07/2011 13:51:10 | @TP106 | 00:01:00 | 0.0011259 | 0.001711985 | 0.000976113 |
| 108 | 12/07/2011 13:52:10 | @TP107 | 00:01:00 | 0.001559553 | 0.00197697 | 0.001435489 |
| 109 | 12/07/2011 13:53:10 | @TP108 | 00:01:00 | 0.001224616 | 0.0017002 | 0.001176251 |
| 110 | 12/07/2011 13:54:10 | @TP109 | 00:01:00 | 0.000978363 | 0.001061696 | 0.000895365 |
| 111 | 12/07/2011 13:55:10 | @TP110 | 00:01:00 | 0.001009253 | 0.001538155 | 0.000958297 |
| 112 | 12/07/2011 13:56:10 | @TP111 | 00:01:00 | 0.000587489 | 0.000998849 | 0.000714496 |
| 113 | 12/07/2011 13:56:21 | @TP112 | 00:00:11 | 0.000365595 | 0.000893305 | 0.000464515 |

# Appendix C: Bird & Fillery Report

**Investigation Into The Relationship Between Long And Short Measurements For The Assessment Of Road Traffic Noise" compiled by S Bird of Bird Acoustics, Princes Risborough, Bucks and M Fillery of the Symonds Group Ltd, Altringham, Manchester**

# INVESTIGATION INTO THE RELATIONSHIP BETWEEN LONG AND SHORT MEASUREMENTS FOR THE ASSESSMENT OF ROAD TRAFFIC NOISE.

S Bird Bird Acoustics, Princes Risborough, Bucks
M Fillery Symonds Group Ltd., Altringham, Manchester

## 1. INTRODUCTION

### 1.1 Reason for investigation

A significant amount of work carried out by consultants in the noise and acoustics field is concerned with planning applications and environmental assessments. In the planning field, since 1994 the document used primarily is the Department of the Environment's Planning Policy Guidance PPG24, Planning and Noise (1994) [1]. This document gives noise categories for road, rail and air traffic and also for mixed sources, which define a noise band for daytime and night-time noise. On the basis of which category a site falls within, guidance is given on whether or not permission should be granted, and if so what conditions should control the development.

Ideally there will be a building on the site where noise monitoring equipment can be left, and automatic readings over at least 24 hours can be obtained. However, many sites are clear and there is no secure place to leave equipment over this length of time. An alternative is to carry out an attended 24 hour noise measurement, a very uncomfortable and expensive activity. It would therefore be advantageous to be able to predict, with reasonable accuracy, both the daytime and night-time figures from a short measurement in the day and night.

### 1.2 Aims and Objectives

It was therefore decided to use existing 24 hour measured data to investigate the relationship between the noise level over a short period and the noise level over the whole day or night period, whichever was relevant. Thus there are 3 aims, each of which are of practical nature, and they are

1. Is there a relationship between a short measurement of $L_{Aeq}$ noise levels for traffic noise by day and the 16 hour daytime $L_{Aeq}$ value?

2. Is there a relationship between a short measurement of $L_{Aeq}$ noise levels for traffic noise by night (say between 2300 and 0100 or between 0500 and 0700) and the 8 hour night-time $L_{Aeq}$ value?

3. Can simple relationships (e.g. $y = x + c$ where c is a constant) be found which could be used practically and with reasonable accuracy.

If a relationship can be established and its significance assessed, then it should become clear whether a shortened measurement can be used confidently to predict daytime and night time levels.

# 2. METHODOLOGY

## 2.1 Data

In order to be able to substantiate any relationships between long and short term measurements, a statistically large body of data needed to be examined, so the first task was to identify data which would be suitable.

The 2000/2001 National Noise Incidence Survey [2] from DEFRA carried out 24 hour measurements at over 1000 sites. The data was consistent, and had specific information about the sites which was enough to be able to put the datasets in some sort of categories. The data can be found on http://www.defra.gov.uk/environment/noise/nis0001/index.htm.

It was decided that this data would be used as the information appeared to be ideal for the study, providing as it does

- a large amount of objective unbiased data from a reputable secondary source
- a standardised measurement method
- data that was well documented and clearly laid out

A total of 1160 24-hour measurements were carried out in the 2000/2001 NIS. The data relevant to this study was the hourly $L_{Aeq}$ for each site over the 24 hours.

## 2.2 Sift Criteria

The measurement locations were not chosen for their suitability to measure one particular type of noise. As a relationship specifically for traffic noise is sought, it was appreciated that some, if not most of the sites may be unsuitable. In order to find the most suitable measurements, some 'sift' criteria were applied to the data. The criteria were as follows.

a) The $L_{Aeq\ (16\ hour)}$ daytime and $L_{Aeq\ (8\ hour)}$ night-time noise levels should be at least as high as those defined in PPG24 as Category B (55 dB by day and 45 dB by night).

b) The site should not be classed as an 'estate' road.

c) The site should only be affected by one noise source.

## 2.3 Comparisons to be made

The object of this project is to be able to predict noise levels over 8 and 16 hour periods from monitoring over much shorter periods. It has already been established over 25 years that the 18 hour daytime $L_{A10}$ noise level can be predicted from a 3 hour measurement made in the daytime between 1000 and 1700 hours ([3] and [4]). It was therefore decided that these same 3 hour measuring periods should be used as the shortened period for the daytime.

For the night-time there are no established methods for predicting the noise level, so two periods were chosen, the one at the beginning of the night-time period, and the one at the end. Hence the two short periods used were those between 2300 hours and 0100 hours, and between 0500 hours on 0700 hours.

The following values were calculated from the figures

1. The 5 possible average contiguous 3 hour $L_{Aeq}$s between 10.00 and 1700 hours, these are 10.00 - 13.00 hours, 11.00 - 14.00 hours, 12.00 - 1500 hours, 13.00 - 16.00 hours, 14.00 - 17.00 hours. They are the shortened time periods as recommended in Calculation of Road Traffic Noise.

2. The 16 hour daytime $L_{Aeq,}$ from 0700 - 2300 hours.

3. The 2 hour average $L_{Aeq}$ between 2300 and 0100 hours, and between 0500 and 0700 hours.

4. The 8 hour night-time $L_{Aeq}$ from 2300 - 0700 hours.

Comparisons were made for the day and night periods by plotting the values obtained by averaging the short period $L_{Aeq}$ data against the calculated long period $L_{Aeq}$.

As well as looking at the relationship between the total long and short term measurements, the results were also sub categorised according to the road type. The NIS data gave some information about the roads, including whether they were motorways, A roads, B roads or unclassified, and the analysis was carried out for each road type to see whether this gave a closer relationship or a different relationship for each road type.

## 2.4 Statistical Analysis

The noise level from the shortened measurement was plotted against the level from the whole time period. The data was subjected to regression analysis, which can be observed as the 'best fit' line through the data when plotted on a graph. A relationship of the form $y = mx + c$ was found from this data. Once determined, the strength of the relationship was found by considering r, the coefficient of correlation. The value of the coefficient of correlation, r, will lie in the range -1 to +1, where $r = -1$ means perfect negative correlation, +1 means perfect positive correlation and 0 means there is no correlation.

As the aim of this study is to have a quick and easy way to predict long term values from measured short term ones, so the figures once produced were examined to see what would be an approximate term in the form $x = y \pm c$.

This simple relationship was then applied to the short measurements in order to predict the long term levels and compared with the actual measured levels. From the differences between the actual and predicted levels, the standard distribution was found, and, assuming a normal distribution, the 95% confidence limits were calculated from the figure of 2 x standard deviation.

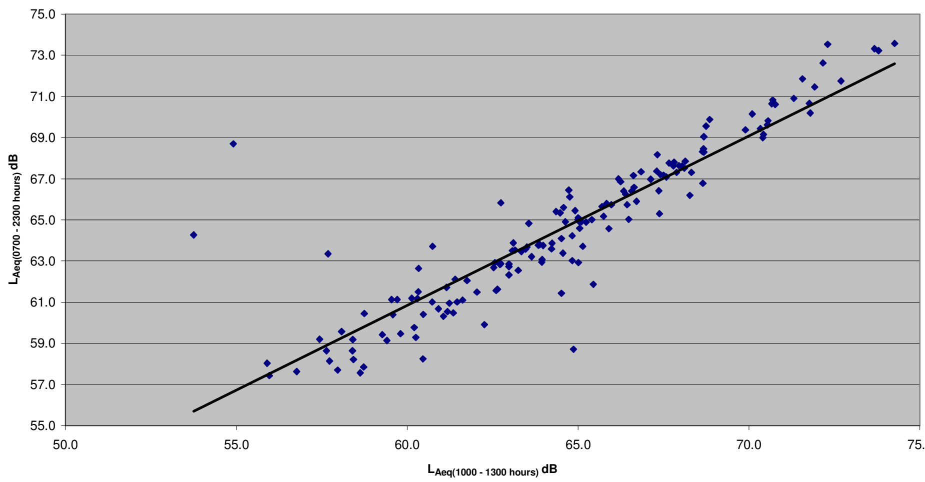
# 3. RESULTS

The figures were taken from the NIS as published on the DEFRA website, and after applying the 'sift' criteria,156 measurements remained, which were more or less equally distributed between A, B and Unclassified roads. Therefore, the data which was selected from the sift gave a reasonable number of data sets for each type of road. There were only 2 sets of data for motorways - not enough to be statistically significant, so this was not analysed nor included with any other group.

## 3.1 Comparison of long and short term measurements

For the daytime, the five possible 3 hour $L_{Aeq}$ noise levels between 1000 and 1700 hours were plotted against the $L_{Aeq(16\text{-}hour)}$ for the daytime for the measurements selected. Figure 1 shows an example of the graphs. From this the equation of the best fit line and the correlation factor was determined. As well as looking at the data for all the roads identified as relevant to this project, they were also divided into the different road categories, and the data for these were plotted separately. An example is shown below of the full data for the time of 10.00 - 1300 hours.

**All data $L_{Aeq(1000 - 1300\ hours)}$ v $L_{Aeq(0700 - 2300\ hours)}$**

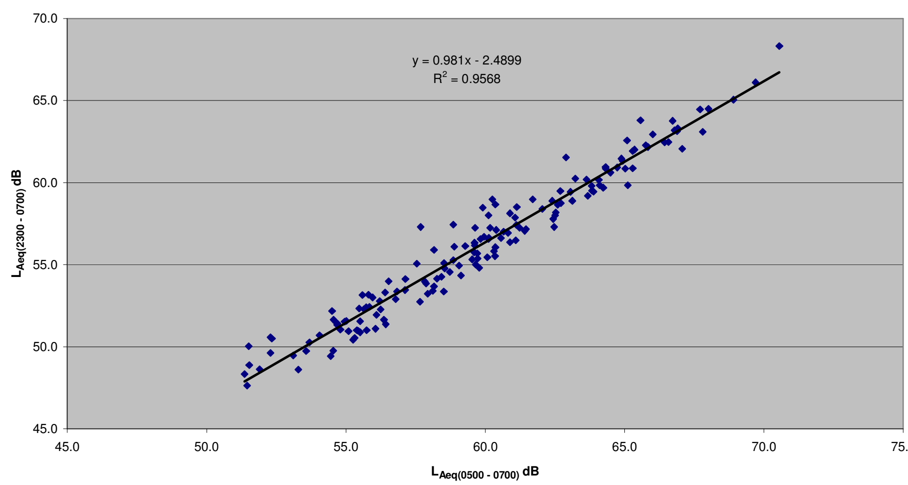



All the comparisons showed good agreement. For the daytime, using all selected data, the correlation factors were between .91 and .93. When the categories of road were separated, A roads showed correlation factors of 0.98 and 0.99. The worst agreement was for B roads, where the correlation factors were between 0.77 and 0.9. There was a variation between different short periods, but this did not seem to be consistent enough to show any trend.

For the night-time, a similar process was carried out but using data from the hours of 2300 - 0100 hours, and 0500 - 0700 hours, and an example is shown below for the full dataset and 0500 - 0700 hours.

**Figure 3.22**

**All roads $L_{Aeq\ (0500 - 0700)}$ v $L_{Aeq(2300 - 0700)}$**




For the 2300 - 0100 hour period, the correlation factor was 0.92, and for the 0500 - 0700 hours the correlation factor was 0.98. This pattern was also observed for specific categories of noise.

# 4. PROPOSAL OF SIMPLE RELATIONSHIPS

The analysis above demonstrates the relationship between the values for the short and long term measurements. It also statistically assesses the strength of the relationship. The aim of the study is to produce a simple relationship between the short term measurements and the long term required value, so the figures were examined to produce a simple relationship of the x = y ± c type.

## 4.1 Daytime levels

For the daytime, a difference of 0 dB was found in most cases between the shortened and complete measurements. Therefore, a difference of 0 dB was assumed for the daytime figures and the difference between the predicted and measured 16 hour daytime noise levels was calculated. The standard deviation for the differences between the two was found, and twice the standard deviation figure was used as the 95% confidence limit. These values can be seen below.

Confidence limits for daytime periods

| **Type of Road** | **95% confidence limits (dB)** | | | | |
|---|---|---|---|---|---|
| Time periods | 10-13hrs | 11-14hrs | 12-15hrs | 13-16hrs | 14-17hrs |
| All roads | 3.7 | 3.6 | 3.1 | 3.3 | 3.2 |
| A road | 1.2 | 1.3 | 1.6 | 1.7 | 1.7 |
| B road | 5.1 | 4.9 | 2.9 | 3.5 | 3.4 |
| Unclassified | 3.5 | 3.5 | 4.1 | 3.9 | 3.9 |

It is our opinion that an overall figure of 0 dB correction could be reasonably be used to convert from a 3 hour period of the type defined, and the 16 hour daytime $L_{Aeq}$. In other words

$$L_{Aeq(0700\ -\ 1600\ hours)} = L_{Aeq(3\ hour\ between\ 1000\ and\ 1700\ hours)} + 0$$

The confidence limits for A roads are such that 95% of measurements could be expected to predict a noise level which would be within 1.7 dB or less of the actual noise level. Other predictions are not so good, the B roads being particularly varied.

## 4.2 Night-time levels

For the night-time there were 2 values for the shortened measurement which were considered, and the analysis was examined to see which would be the most valid to use in practice.

It was found that a difference of +0.5 dB seemed to be appropriate for the period from 2300 - 0100 hours, and of -3.5 dB for 0500 - 0700 hours, so assuming these figures the difference between the predicted and measured 8 hour night-time noise levels was calculated. The standard deviation for the differences between the two was found, and twice the standard deviation figure was used as the 95% confidence limit. These values can be seen below.

Confidence limits for night-time periods

| Type of Road | 95% confidence limits (dB) | |
|---|---|---|
| Time periods | 23-01 hours | 05-07 hours |
| All roads | 4.4 | 1.8 |
| A road | 2.1 | 1.3 |
| B road | 5.1 | 2.1 |
| Unclassified | 4.5 | 1.7 |

It is therefore suggested that an overall figure of +0.5 dB correction would be the best figure to convert from a 2 hour $L_{Aeq}$ measured between 2300 and 0100, and the 8 hour night-time $L_{Aeq}$. In other words

$$L_{Aeq(2300\text{ - }0700\text{ hours})} = L_{Aeq(2\text{ hour between 2300 and 0100 hours})} + 0.5$$

However, the prediction from the simple relationship does not give good confidence limits other than in the case of A roads, and it may therefore be concluded that for this period only A roads give an accurate enough answer to be used with confidence.

It is also suggested that an overall figure of - 3.5 dB correction could be reasonably be used to convert from a 2 hour $L_{Aeq}$ measured between 0500 and 0700, and the 8 hour night-time $L_{Aeq}$. In other words

$$L_{Aeq(2300\text{ - }0700\text{ hours})} = L_{Aeq(2\text{ hour between 0500 and 0700 hours})} - 3.5$$

The simple relationship defined above would work well for predicting from the 0500 - 0700 hours period, where the correlation is likely to be very good and the 95% limits are less than $\pm$ 2 dB for all but B roads.

If the time periods are compared to see which gives the best correlation with the 8 hour period, it can be seen that for the all the data, the period from 0500 - 0700 hours appears to be better for all roads using the simple relationships above. Measuring the hours from 0500 - 0700 hours in the early morning would therefore give a more accurate prediction of the night-time 8 hour $L_{Aeq}$ noise level if this method were to be used.

## 4.3 Results for A roads

It appears that A roads give by far the most accurate prediction value, and one reason for this is that it is likely to have the highest noise levels which were not likely to have been affected by any other noises. Low traffic noise levels may run into background noise from other sources giving spurious results. Separate analyses confirmed that higher noise levels gave better results.

# 5. CONCLUSIONS

The relationship between the $L_{Aeq}$ noise values measured by a shortened measurement procedure during the daytime and night-time and the 16 hour daytime and 8 hour night-time noise levels from traffic appears to be strong, especially so for A roads.

The simple equations which can be used to predict the long term $L_{Aeq}$ values from the short ones are as follows.

$$L_{Aeq(0700\text{ - }2300\text{ hours})} = L_{Aeq(3\text{ hour between 1000 and 1700 hours})} + 0$$

$$L_{Aeq(2300\text{ - }0700\text{ hours})} = L_{Aeq(2\text{ hour between 2300 and 0100 hours})} + 0.5$$

$$L_{Aeq(2300\text{ - }0700\text{ hours})} = L_{Aeq(2\text{ hour between 0500 and 0700 hours})} - 3.5$$

For night-time noise levels the prediction from the short measurement between 2300 and 0100 hours is not as good as from the short measurement between 0500 and 0700 hours, and should only be used with caution except for A roads.

The relationships quoted above are best when used for A roads. This is probably because the traffic is more likely to be freely flowing, the noise levels are higher and it is also probably easier to define an A road than other types. Using this data and the simple relationships above, the noise levels could be predicted to within ± 2 dB for 95% of cases for A roads, and to within ± 2 dB for the night-time relationship based on a measurement between 0500 and 0700 hours. Other road types gave a greater variation.

## 6. REFERENCES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