



NOISE AND VIBRATION ASSESSMENT

TODDINGTON LANE, LITTLEHAMPTON

RAPLEYS LLP

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NOISE AND VIBRATION ASSESSMENT TODDINGTON LANE, LITTLEHAMPTON

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1 INTRODUCTION

Anderson Acoustics Ltd has been commissioned by Rapleys LLP to provide advice on the likely noise and vibration impact incident on the proposed development at Toddington Lane, Wick, Littlehampton.

The project consists of the redevelopment of an existing site to provide a new residential development comprising of four 4 bedroom, two 3 bedroom and four 2 bedroom open market units. The site is located in proximity to Toddington Lane and the West Coastway Railway Line.

A noise and vibration assessment has been undertaken to assess the impact of a nearby railway line and road on the proposed properties.

The details of the assessment are documented in this report to support the planning application to Arun District Council.

Noise units, acoustic terminology and environmental noise criteria relevant to the assessment have been presented and briefly discussed in Section 2 of this report.

A brief description of the site and proposed development is given in Section 3.

The methodology and results of an environmental noise survey undertaken at the site are given in Section 4.

Section 5 provides details of the design of the building envelope against environmental noise.

Section 6 provides details of the vibration assessment.

The report is summarised in Section 7.

2 NOISE UNITS, POLICY AND CRITERIA

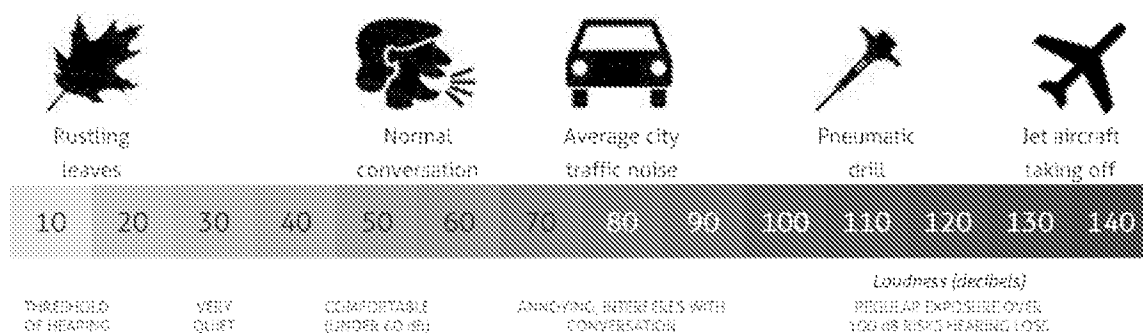
2.1 Noise Units

There is a million to one ratio between the threshold of hearing and the highest tolerable sound pressure. Noise is therefore measured using a logarithmic scale, to account for this wide range, called the decibel (dB). Noise is defined as unwanted sound and the range of audible sound varies from around 0 dB to 140 dB.

The human ear is capable of detecting sound over a range of frequencies from around 20 Hz to 20 kHz, however its response varies depending on the frequency and is most sensitive to sounds in the mid frequency range of 1 kHz to 5 kHz. Instrumentation used to measure noise is therefore weighted across the frequency bands to represent the sensitivity of the ear. This is called 'A weighting' and is represented as dB(A).

It is generally accepted that under normal conditions humans are capable of detecting changes in steady noise levels of 3 dB, whilst a change of 10 dB is perceived as a doubling or halving of the noise level. An indication of the range of noise levels commonly found in the environment is given below.

Figure 2.1: Typical noise levels



A number of different indices are used to describe the fluctuations in noise level over certain time periods. The main indices include:

- L_{A90,T}** This is the noise level exceeded for 90% of the measurement period and provides a measurement of the quieter 'lull' periods in between noise events. It is often referred to as the background noise level.
- L_{Aeq,T}** This is the "equivalent continuous A weighted sound pressure level" and is the level of a notional steady sound which has the same acoustic energy as the fluctuating sound over a specified time period. It is often used for measuring all sources of noise in the environment, which can be referred to as the ambient noise.
- L_{Amax,F}** This is the maximum sound pressure level measured in a given time period with the sound level meter set to 'fast' response.

Reference is often made to acoustic measurements being undertaken in 'free-field' or 'façade' locations. Free-field measurements represent a location away from vertical reflecting surfaces, normally by at least 3.5 metres. A façade measurement is undertaken, or calculated to a position 1 metre from an external façade and a correction of up to 3 dB can be applied to account for the sound reflected from the façade. This latter position is often used when assessing the impact of external noise affecting residents inside properties.

2.2 Noise policy

2.2.1 Noise Policy Statement for England

The Noise Policy Statement for England (NPSE) [1] was published on 15 March 2010. It sets out the long term vision of the Government's noise policy, which is to promote good health and a good quality of life through the management of noise within the context of sustainable development.

The NPSE sets out the following aims:

"Through the effective management and control of environmental, neighbour and neighbourhood noise within the context of Government policy on sustainable development:

- 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 NPSE describes a number of effect levels that may be used to define effects in the context of noise policy, as follows:

- **NOEL – No Observed Effect Level** - This is the level below which no effect can be detected. In simple terms, below this level, there is no detectable effect on health and quality of life due to the noise.
- **LOAEL – Lowest Observed Adverse Effect Level** - This is the level above which adverse effects on health and quality of life can be detected.
- **SOAEL – Significant Observed Adverse Effect Level** - This is the level above which significant adverse effects on health and quality of life

In March 2014 further guidance on interpreting the effect levels was published on the Government's Planning Practice Guidance. This includes a table that summarises noise exposure hierarchy, noting this is based on the likely average response of a population. This table is reproduced below:

Table 2.1: Noise exposure hierarchy and effect levels

Perception	Examples of Outcomes	Increasing Effect Level	Action
No Observed Effect Level			
Not noticeable	No Effect	No Observed Effect	No specific measures required
Noticeable and not intrusive	Noise can be heard, but does not cause any change in behaviour or attitude. Can slightly affect the acoustic character of the area but not such that there is a perceived change in the quality of life.	No Observed Adverse Effect	No specific measures required
Lowest Observed Adverse Effect Level			
Noticeable and intrusive	Noise can be heard and causes small changes in behaviour and/or attitude, e.g. turning up volume of television; speaking more loudly; where there is no alternative ventilation, having to close windows for some of the time because of the noise. Potential for some reported sleep disturbance. Affects the acoustic character of the area such that there is a perceived change in the quality of life.	Observed Adverse Effect	Mitigate and reduce to a minimum
Significant Observed Adverse Effect Level			
Noticeable and disruptive	The noise causes a material change in behaviour and/or attitude, e.g. avoiding certain activities during periods of intrusion; where there is no alternative ventilation, having to keep windows closed most of	Significant Observed Adverse Effect	Avoid

Perception	Examples of Outcomes	Increasing Effect Level	Action
	the time because of the noise. Potential for sleep disturbance resulting in difficulty in getting to sleep, premature awakening and difficulty in getting back to sleep. Quality of life diminished due to change in acoustic character of the area.		
Noticeable and very disruptive	Extensive and regular changes in behaviour and/or an inability to mitigate effect of noise leading to psychological stress or physiological effects, e.g. regular sleep deprivation/awakening; loss of appetite, significant, medically definable harm, e.g. auditory and non-auditory	Unacceptable Adverse Effect	Prevent

2.2.2 National Planning Policy Framework

The National Planning Policy Framework (NPPF) [2] was published on 27 March 2012. Along with the introduction of this document, a number of detailed planning policy guidance notes were withdrawn, including PPG24, on planning and noise.

The NPPF sets out how the Government's planning policies should be applied. In terms of the detail of policies on environmental issues such as noise, the intention is for Local Planning Authorities to set their own guidance. This will form part of or be referred to in the relevant Local Plan.

2.3 Relevant Guidance

2.3.1 General

In assessing appropriate criteria for the proposed development to ensure environmental noise has no detectable effect on health and quality of life (NOEL effect level), a number of design criteria need to be considered.

For the residential units consideration needs to be given to both general ambient noise level and individual noise events such as those created by vehicle pass-bys.

All relevant criteria are discussed below.

2.3.2 British Standard 8233

British Standard BS 8233: 2014: Sound insulation and noise reduction for buildings – Code of practice [3] provides guideline values for internal noise levels within a number of building types including residential dwellings.

The following absolute values for good and reasonable indoor noise levels are presented in The Standard:

Table 2.2: British Standard 8233

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

2.3.3 World Health Organisation Guidelines

The following guideline values for community ambient noise levels in specific environments are presented in the World Health Organization (WHO) Guidelines for Community Noise [4].

Table 2.3: WHO Guideline Noise Values

Specific Environment	Critical Health Effect(s)	dB $L_{Aeq,T}$	Time Base hours	dB $L_{Amax,F}$
Dwelling indoors	Speech intelligibility and moderate annoyance, daytime and evening	35	16	-
Inside bedrooms	Sleep disturbance, night-time	30	8	45
Outdoor living area	Serious annoyance, daytime and evening	55	16	-

The 45 dB $L_{AF,max}$ criterion applies to “single sound events” within bedrooms at night. This guideline is generally interpreted as the value that individual noise events should not normally exceed. We have interpreted this as no more than two events per hour, which therefore equates to up to 16 events over an 8 hour night-time period.

2.4 Summary of Environmental Noise Criteria

Having considered the above criteria, Anderson Acoustics propose design limits of 35 dB $L_{Aeq,16hr}$ for living rooms and 30 dB $L_{Aeq,8hr}$ in bedrooms at night. In addition, individual noise events should not normally exceed 45 dB $L_{AF,max}$ within bedrooms at night.

Outdoor living areas will be assessed to a design target of 55dB $L_{Aeq,16hr}$ based on best practicable means.

2.5 Vibration Criteria

2.5.1 British Standard 6472

BS 6472:2008 - Guide to Evaluation of Human Exposure to Vibration in Buildings [5] provides guidance on predicting human response to vibration in buildings.

Table 1 of British Standard 6472:2008 provides guidance on the Vibration Dose Values (VDV) above which various degrees of adverse comment may be expected in residential buildings, see Table 2.4 below.

Table 2.4: BS6472: 2008 Vibration dose values above which adverse comment may be expected

Period	Vibration Dose Value (m/s 1.75)		
	Low probability of adverse comment	Adverse comment possible	Adverse comment probable
Residential buildings 16h day	0.2 to 0.4	0.4 to 0.8	0.8 to 1.6
Residential buildings 8h night	0.1 to 0.2	0.2 to 0.4	0.4 to 0.8

3 SITE DESCRIPTION

3.1 Existing Site

The proposed development site is located alongside Toddington Lane opposite the junctions to Butts Mead to the east and Five Stones to the north. It sits adjacent to the West Coastway train line running between Angmering station and Ford and Littlehampton stations, to the south. The site is boarded by a number of car workshops to the west and by Toddington Farm cottages to the south. Toddington Lane to the north and east hosts residential properties that front the street and there is an embankment of soil along the western boundary and the site is raised approximately 2.5m above Toddington Lane.

The existing site consists of a commercial building occupying a small area at the centre of the site which, along with the immediate surrounding area is currently being used as storage. The remainder of the site consists of unkempt brown field space currently unused.

Observations during site visits indicated noise levels around the development site to be generally low for the majority of the day and night. The acoustic environment is dominated by train movements Along the rail line to the south and vehicle pass-bys on Toddington Lane. Noise breakout from nearby commercial premises was observed to be negligible. There is a low level of constant road noise across the site from the A259 to the East.

The location of the site is shown in Figure A1 Appendix A.

3.2 Proposed Development

The proposal is to demolish the existing commercial building found in the centre of the site and introduce a total of 10 new residential units including public and private open space and access road system.

It is understood that general construction of the new buildings will be brick blockwork with cavity and insulation and that natural ventilation by open windows and trickle ventilators is the preferred strategy.

4 ENVIRONMENTAL NOISE ASSESSMENT

4.1 General

In order to capture the dictating noise levels incident on the site, a combination of unattended and attended noise surveys were carried out.

The measurement locations are set out in Figure A1 Appendix A.

4.1.1 Unattended survey

To capture noise levels across the site an unattended noise monitor was installed with line of sight to the railway line see position NMU in Figure A1 Appendix A.

Noise levels were measured using a Rion NL-52 precision integrating sound level meter. The microphone was mounted on a pole extension attached to a security box and was fitted with a weatherproof windshield. The sound level meter was powered by cell batteries and stored inside the security box.

Measurements were obtained using the 'F' time weighting and A-weighting frequency network. 5-minute consecutive measurements of $L_{Amax,F}$, $L_{Aeq,T}$, $L_{A90,T}$ noise levels were obtained between approximately 12:00 hrs on Friday 3rd February and 11:00 hrs on Wednesday 8th February 2017.

The equipment was calibrated before and after the survey using a Rion NC-74 sound level meter calibrator to generate a calibration level of 94.0 dB at 1 kHz. No significant calibration drift was observed.

4.1.2 Equipment Details

Table 4.1: Noise Survey Equipment Details

Equipment	Make & Model	Serial No	Calibration Item	Calibration Due	Calibration Certification Number ¹
Sound Level Meter	Rion NL-52	00620960	1/3 Octave	18/08/17	UCRT16/1264
Calibrator	Rion NC-74	35173438	-	05/04/17	UCRT16/1117

4.1.3 Weather Conditions

Weather conditions during the survey period have been obtained from internet sources www.wunderground.com (Weather station at Worthing IENGLAND833) which indicates no periods of significant rainfall during the survey period. At the time of set-up and collection of the noise monitor the weather conditions were dry with low winds. Temperatures ranged between 0 and 11 degrees Celsius. Measured noise levels throughout the survey are consistent and therefore do not indicate an impact due to weather conditions.

Graphical data of the weather conditions are presented in Figure A3 of Appendix A.

4.1.4 Results

The results of the continuous noise monitoring survey are presented in graphical form in Figure A2 of Appendix A. A summary of the daytime ambient $L_{Aeq,16hr}$ and night-time ambient $L_{Aeq,8hr}$ noise levels is presented below in Table 4.2. An addition of 3 dB has been applied to account for façade conditions.

Table 4.2: Summary of Continuous Noise Monitoring Results

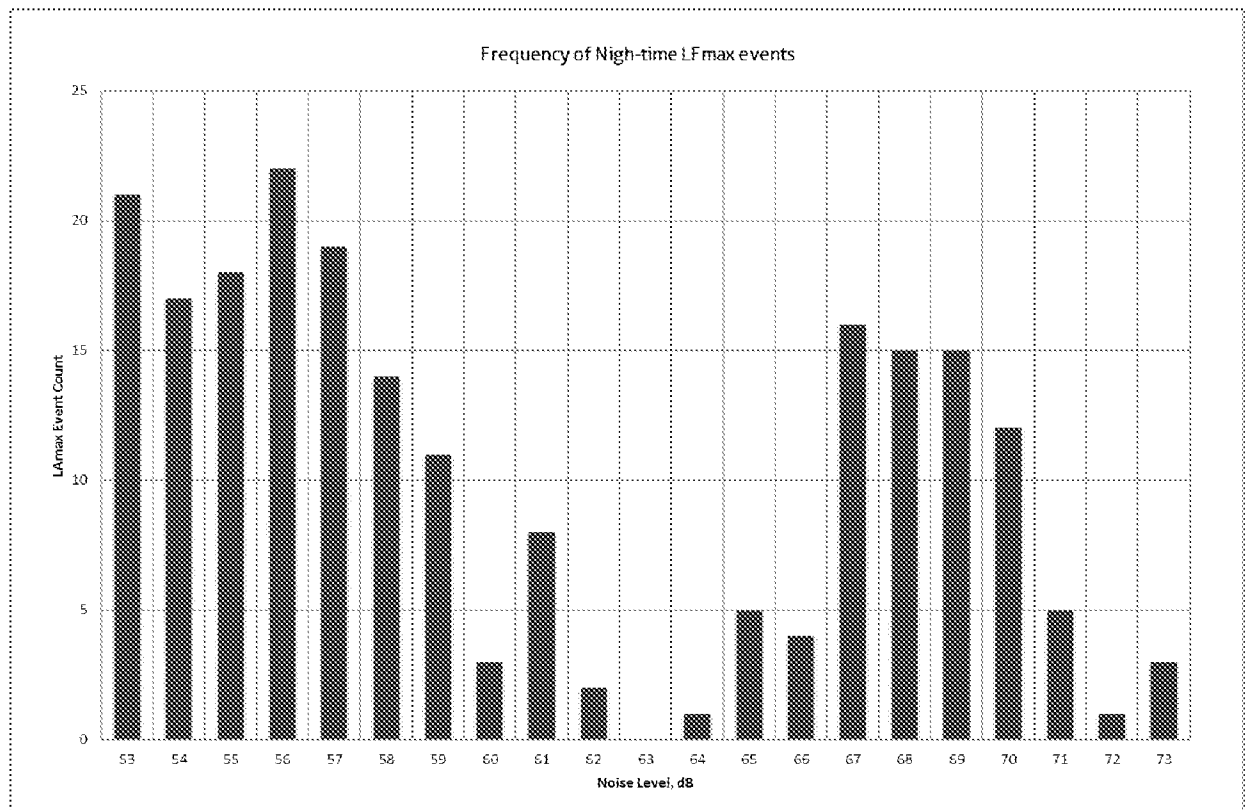
Period	Measured Noise Levels, dB					
	Daytime			Night time		
	$L_{Aeq,16hr}$	$L_{A,F,max,5min}$ Range	$L_{A90,16hr}$	$L_{Aeq,8hr}$	$L_{A,F,max,5min}$ Range	$L_{A90,8hr}$
Fri 03/02/17	53.7	47 - 82	48.1	43.4	38 - 70	52.7
Sat 04/02/17	49.9	50 - 82	42.3	45.1	38 - 68	55.0
Sun 05/02/17	47.9	36 - 74	40.6	45.1	33 - 70	47.0
Mon 06/02/17	52.8	53 - 83	47.7	44.3	37 - 70	53.1
Tue 07/02/17	48.8	44 - 77	39.4	43.5	33 - 70	46.6
Wed 08/02/17	51.0	52 - 76	42.7	-	-	-
Average	50.7	47 - 79	43.5	44.3	36 - 70	50.9

The unattended noise survey results indicate that the site is exposed to average free-field daytime and night-time ambient noise levels of 48 to 54 dB $L_{Aeq,16hr}$ and 43 to 45 dB $L_{Aeq,8hr}$ respectively.

The frequency of maximum night time noise events has been assessed for the unattended survey period and can be seen in Figure 4.1. As stated in Section 2.2.5 the typical maximum noise event is selected as that which is not normally exceeded during the night, which we interpret as more than twice an hour.

In this instance, the highest maximum noise events are caused by train movements between Angmering station and Littlehampton and Ford stations station between 6:00 am and 7:00 am, which occur more than twice during this period. The levels likely to be caused by train movements (cross referenced with attended measurement data) are those between 65 and 71 dB. Consequently a level of 68 dB has been selected as typical.

Figure 4.1: Maximum night time $L_{A_{fmax}}$ events (free-field)



4.2 Attended Noise Survey

4.2.1 Procedure

Attended noise measurements were carried out on Wednesday 8th February to further understand the spread of noise around the site.

Noise levels were recorded in three positions (see Figure A2 Appendix A) using a Rion NL-52 precision integrating sound level meter mounted on a tripod approximately 1.2 m above ground. The meter was set up to measure ambient noise levels over consecutive 1 minute periods.

The equipment was calibrated before and after the survey using a Rion NC-74 sound calibrator to generate a calibration level of 94.0 dB at 1 kHz. No significant calibration drifts were observed.

4.2.2 Weather Conditions

Weather conditions during the survey were dry with light winds. It is considered that the weather had no adverse effect on the recorded noise levels.

4.2.3 Results

The results from the attended noise measurements are summarised below in Table 4.3. An addition of 3 dB has been applied to levels measured to account for façade conditions.

Table 4.3: Octave Band Summary Results of Attended Noise Survey (façade)

Description	Octave Band Centre Frequency, Hz						dB(A)
	125	250	500	1k	2k	4k	
Position 1							
Average $L_{eq,30min}$	59	56	57	60	55	45	62
Typical L_{Fmax}	86	84	85	87	79	69	89
Reference Average $L_{eq,30min}$	51	48	50	49	43	38	52
Reference Typical L_{Fmax}	69	65	67	70	61	51	72
Position 2							
Average $L_{eq,30min}$	62	57	56	59	56	50	62
Typical L_{Fmax}	72	77	74	81	74	69	82
Reference Average $L_{eq,30min}$	53	49	50	50	45	40	54
Reference Typical L_{Fmax}	55	79	77	75	61	53	78
Position 3							
Average $L_{eq,15min}$	59	56	57	56	53	52	61
Typical L_{Fmax}	71	68	72	72	68	64	75
Reference Average $L_{eq,15min}$	58	52	51	49	44	42	54
Reference Typical L_{Fmax}	74	74	74	67	64	53	73

The attended noise survey results show the spread of noise around the site with comparison to reference position at the unattended monitoring location. Positions 2 and 3 are located in proximity to Toddington lane to the east and north of the site respectively and position 1 is located in proximity to the rail line to the south of the site. Comparison between the measured reference levels and the results from the unattended survey in Table 4.2 show that the noise environment during the measurement periods were representative of a standard high level noise, providing a robust worst case representative noise environment.

4.3 Ambient Noise Level Results

The results indicate that the noise across the site is not uniform due to the contribution of distinct sources effecting different site boundaries. It is concluded that plots at the centre of the site are represented by the unattended monitoring position and that the plots overlooking the road experience the same noise levels and that the results from the attended noise survey provide best representation.

Considering the road to be the dominant source incident on the east and north areas of the site, a distance propagation correction is applied to the attended measurement results to predict the noise level incident on the building facades in these locations overlooking the road. The relevant noise levels are described in Table 4.4 below.

Table 4.4: Ambient Noise Levels Incident on Building Façades

Description	Octave Band Centre Frequency, Hz						dB(A)
	125	250	500	1k	2k	4k	
Plots 4, 5 & 6 (centre of site – exposed to Rail line to the south)							
L _{Aeq,day}	50	45	46	47	42	40	51
L _{Aeq,night}	42	37	39	41	35	36	44
L _{Fmax}	61	57	61	64	58	49	68
Plots 1-3 & 7-10 (north and east of site – exposed to Toddington Lane)							
L _{Aeq,day}	60	55	54	57	54	48	60
L _{Aeq,night}	53	48	47	50	47	41	53
L _{Fmax}	69	66	69	69	65	62	73

5 SOUND INSULATION OF BUILDING ENVELOPE

This section of the report sets out proposed measures to ensure the development is sufficiently protected against noise.

The assessment assumptions are set out below together with the calculated minimum sound insulation requirements. Example glazing specifications are given where relevant to indicate what glazing would achieve the performance requirements.

The assessed ambient noise levels incident on the site are taken from Table 4.4.

Full spectral calculations are provided in Appendix B.

The area of glazing and method of ventilation in any particular room, along with the room size and room acoustic conditions, affect the degree of reduction in noise transmission from outside to inside. An assessment using some generic assumptions has been carried out. These may require reviewing during detail design development.

The following assumptions have been used for the assessment of the sound insulation requirements of the building envelope:

- Predictions made using the general method set out in BS EN 12354-3:2000;
- Sound insulation data based on both library data and specific manufacturers' data. It has been assumed that the on-site performance will be comparable with manufacturer's claimed performance;
- The predictions assume good quality workmanship, for example that windows, doors and opening lights are well sealed. Poor workmanship or low quality seals may result in predicted internal noise levels being exceeded;
- External walls are understood to be of cavity masonry construction throughout;
- It is understood that the proposed ventilation strategy is for natural ventilation with trickle ventilators in habitable rooms. The number of trickle ventilators has a substantial influence on the sound insulation of the building envelope. Current guidance on complying with the Building Regulations (Approved Document F) offers many options to provide adequate ventilation. Some of these are preferable with regards to noise break-in, such as whole house ventilation with heat recovers as no trickle vents are required. Other options require anywhere between 1 and 6 vents per room. This report assumes 2 no. ventilators in the living rooms and 1 no. ventilator in bedrooms.
- Key room dimensions taken from drawings for 'Land at Toddington Lane' ref: 6436/010/A – 'Plots 4, 5 & 6 Plans and Elevations', 6436/011/A – 'Plots 1, 2 & 3 Plans and Elevations' and 6436/012/A – 'Plots 7-10 Plans and Elevations' provided by ECE Architecture.
- Daytime ambient noise levels in living rooms not to exceed 35 dB $L_{Aeq,16hr}$; and
- Ambient noise levels in the bedrooms at night not to exceed 30 dB $L_{Aeq,8hr}$ and for individual noise levels (from vehicle pass-bys) not normally to exceed 45 dB $L_{AF,max}$.

The sound insulation requirements of the glazing are applicable to the window system as a whole, including frames, mullions and panels. They are based on BS EN ISO 140-3: 1995 "*Laboratory measurement of airborne sound insulation of building elements and rated in accordance with BS EN ISO 717-1:2013 Acoustics – Rating of sound insulation in buildings and of building elements Part 1. Airborne sound insulation*".

For unit ventilators, the measurements are based on BS EN ISO 140-10: 1995 Laboratory measurement of airborne sound insulation of small building elements and rated in accordance with

BS EN ISO 717-1:2013 "Acoustics – Rating of sound insulation in buildings and of building elements Part 1. Airborne sound insulation"

The recommended performance requirements of the windows and ventilators are given in Table 5.1.

Table 5.1: Internal Noise Level Calculations with Glazing and Ventilation Recommendations

Location	Performance Requirements	
	Window Units	Ventilators
Bedrooms in plots 1-3 & 7-10 facing road, (east /north facing façades)	Requirement for thermal purpose will provide necessary acoustic performance	Acoustic passive trickle ventilators with a minimum performance of 38 dB $D_{n,e,w}$ and 36 dB $D_{n,e,w} + C_{tr}$ such as Freshflow AL-dB 450
Bedrooms in plots 4, 5 & 6 facing rail track (south facing façade)	Requirement for thermal purpose will provide necessary acoustic performance	Passive trickle ventilators with a minimum performance of 31 dB $D_{n,e,w}$ and 30 dB $D_{n,e,w} + C_{tr}$
Living rooms in plot 1 facing road (east /north facing façades)	Requirement for thermal purpose will provide necessary acoustic performance	Passive trickle ventilators with a minimum performance of 31 dB $D_{n,e,w}$ and 30 dB $D_{n,e,w} + C_{tr}$
Living rooms in plots 4, 5 & 6 facing rail track, (south facing façades)	No acoustic specification applicable.	No acoustic specification applicable.

6 VIBRATION ASSESSMENT

6.1 Vibration survey

An attended 4 hour survey was conducted on Friday 3rd February 2017 in the neighbouring premises forecourt in a position considered to represent worst case for the proposed new development.

Vibration Dose Values (VDVs) were measured in the x-axis, y axis and z axis at the boarder to the site and approximately 10 m from the train line, the measurement position can be seen in Figure A1 of Appendix A.

The measurements were made using a Rion VM-54 Tri-axial Vibration Meter with a VX-54WB Whole Body Vibration Card fitted with a Rion PV-83CW Tri-axial Accelerometer securely coupled to a concrete slab at ground level.

Five minute consecutive measurements of VDV were obtained in each of the X, Y and Z axis between 13:30 and 17:30 hrs Friday 3rd February. The y axis was positioned parallel to the direction of the railway line.

A further set of VDV levels for single train pass by events were recorded on Wednesday 8th February at the same location.

Table 6.1: Vibration Survey Equipment Details

Location	Equipment	Make & Model	Serial No
VM1	Tri-Axial Vibration Meter	Rion VM-54	360140

6.2 Vibration Results

A summary of the VDV results in each axis for the 4 hour monitoring period is presented below in Table 6.2.

Table 6.2: Summary of Continuous Vibration Monitoring Results

Period	VDV ($\text{ms}^{-1.75}$) 3 Hour		
	X Axis	Y Axis	Z Axis
13:30-17:30	0.012	0.003	0.068

A summary of the daily VDV levels in each axis for single train pass-by measurements is presented below in Table 6.3.

Table 6.3: Summary of Single Train Pass-By Event Monitoring

Measurement No.	VDV ($\text{ms}^{-1.75}$) 20 second		
	X Axis	Y Axis	Z Axis
1	0.002	0.000	0.015
2	0.005	0.000	0.034
3	0.004	0.000	0.028

In order to assess the 16 hour day and 8 hour night VDV values the four hour VDV results have been converted to represent the entire period using the equation below taken directly from BS6472.

$$\text{VDV}_{\text{b/d,day}} = \left(\frac{t_{\text{day}}}{t_r} \right)^{0.25} \times \text{VDV}_{\text{b/d,r}}$$

Where:

t_r is the length of the event in seconds

t_{day} is the number of seconds in the day/night time period

$\text{VDV}_{\text{b/d,r}}$ is the average measured VDV level for each axis

The resultant VDV for the 16 hour day and 8 hour night derived from the 4 hour measurement are shown below in Table 6.4.

Table 6.4: Summary of Derived daytime & night-time VDV values from 4 Hour Measurement

VDV $\text{ms}^{-1.75}$ Day			VDV $\text{ms}^{-1.75}$ Night		
X	Y	Z	X	Y	Z
0.018	0.004	0.097	0.007	0.001	0.043

An alternative method of determining the 16 hour day and 8 hour night VDV values has also been followed using the single train pass-by events. The period values have been calculated using the equation below also taken directly from BS6472.

$$\text{VDV}_{\text{b/d,day/night}} = \left(\sum_{n=1}^{n=N} \text{VDV}_{\text{b/d},t_n}^4 \right)^{0.25}$$

Where:

N is the number of train events per day/night

$\text{VDV}_{\text{b/d},t_n}^4$ is the average measured VDV level for each axis

The number of train pass-bys during a day and night period has been taken from train operators timetables and is shown below in Table 6.5.

Table 6.5: Train Movements

Period	No. Train pass-bys
Day 07:00-23:00	284
Night 23:00-07:00	22

The resultant VDV for the 16 hour day and 8 hour night derived from the highest measured single pass by event is shown below in Table 6.6.

Table 6.6: Summary of Derived daytime & night-time VDV values from Single Pass-by Events

VDV $\text{ms}^{-1.75}$ Day			VDV $\text{ms}^{-1.75}$ Night		
X	Y	Z	X	Y	Z
0.020	0.001	0.139	0.011	0.001	0.073

6.3 Perception of vibration within the building

An assessment has been undertaken to investigate whether ground borne vibration is likely to give rise to any adverse comments with regards to sensation of vibration.

The continuous and single event VDV's measured at ground level have been used to derive the day and night VDV's presented in Table 6.6 above.

By comparison with the criteria in Table 2.4 it can be seen that during the day and night time periods the measured VDV's at ground level do not exceed the values at which there is a low probability of adverse comment.

It can therefore be concluded that daytime and night-time vibration levels in the ground from train movements are unlikely to give rise to adverse comment in the proposed residential properties.

7 CONCLUSIONS

Anderson Acoustics has carried out a noise and vibration assessment of the proposed development of 10 new residential dwellings on the land at Toddington Lane, Wick, Littlehampton. The assessment has been carried out to support the planning application for the development.

The development is predominantly effected by noise from road traffic to the east and north of the site and by noise and vibration from rail movements to the south of the site.

A set of attended and unattended noise surveys have been carried out and advice provided on the design of the building envelope to ensure that internal noise levels inside habitable rooms lie within guideline limits of BS8233:2014.

An unattended vibration survey has also been carried out and calculations undertaken which showed that vibration from train movements does not exceed the range of "Low probability of adverse comment" as in Table 1 of BS 6472:2008.

8 REFERENCES

- 1 Noise Policy Statement for England (NPSE). 15 March 2010
- 2 National Planning Policy Framework (NPPF). 27 March 2012
- 3 British Standards Institution. Sound Insulation and Noise Reduction for Buildings – Code of Practice. BS 8233: 2014
- 4 World Health Organization Guidelines for Community Noise. 2000
- 5 British Standards Institution. Guide to evaluation of human exposure to vibration in buildings Part:1 Vibrations sources other than blasting. BS 6472-1:2008

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APPENDIX A

FIGURES

Figure A1: Site location and vibration/noise measurement position



Google Earth 2016

Figure A2: Unattended Survey NMU Results

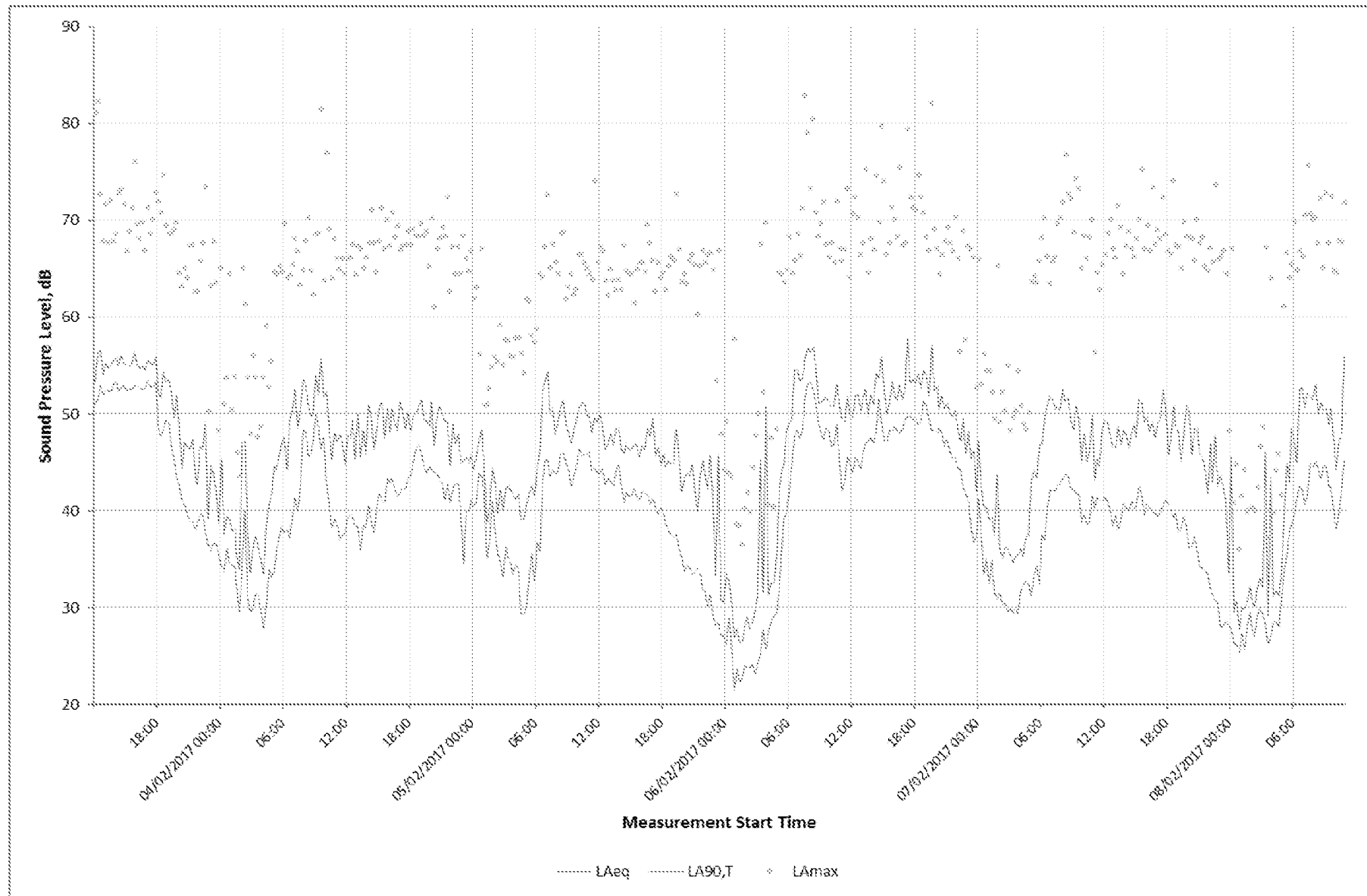
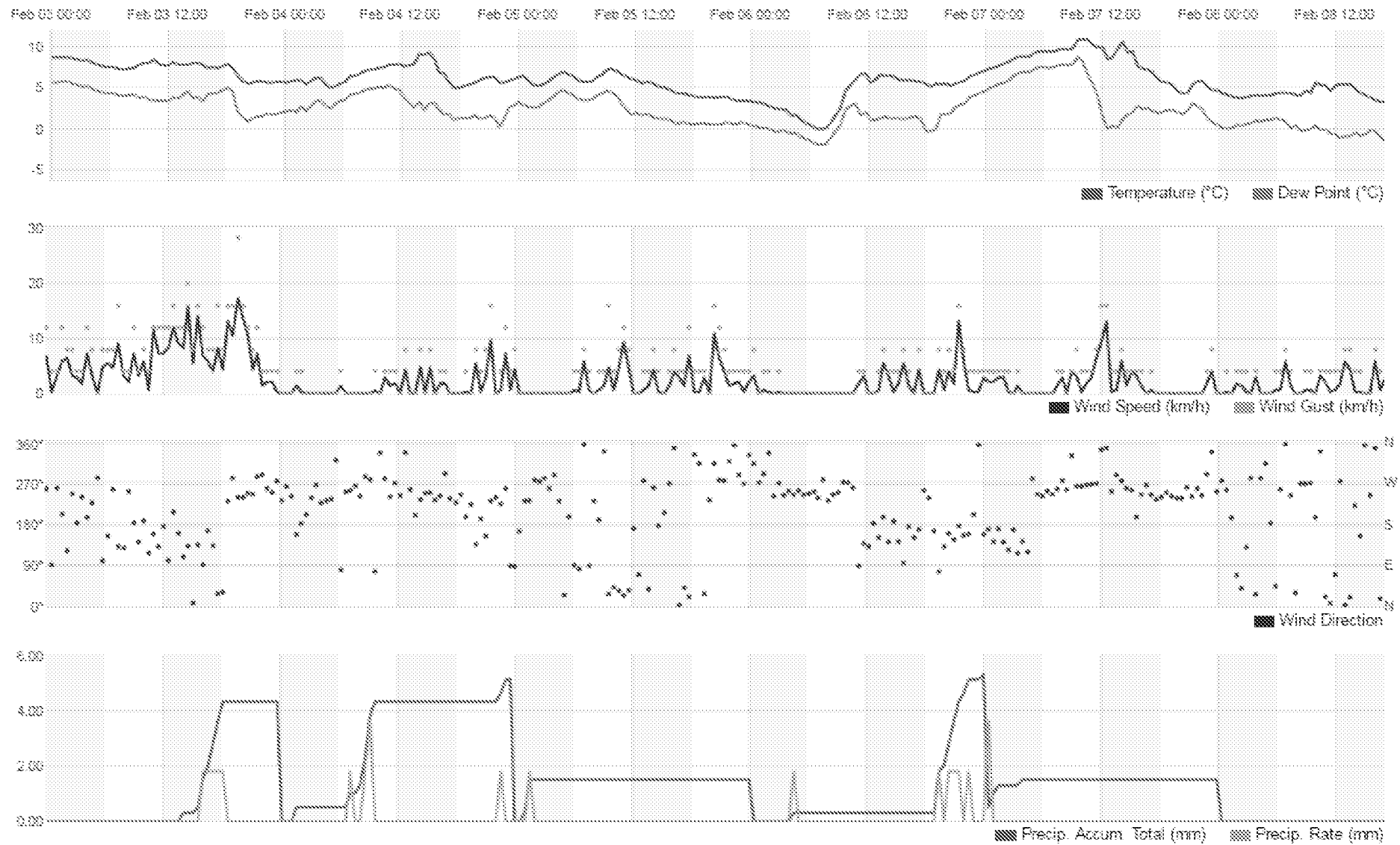


Figure A3: Weather History Graph, February 3 – February 8 2017



APPENDIX B

CALCULATIONS


Table B1: Bedrooms, East/North Facade - $L_{Amax,Night}$

Job name: Toddington Lane				RESULT SUMMARY: L _{Amax} Night Predicted Internal Level: 40 dB L_{Aeq,T} Criterion: 45 dB L_{Aeq,T} Difference: -5 dB L_{Aeq,T}						
Job no.: 3187										
Façade: North and East façade - Plots 7&8/9&10 Bedroom										
SOUND INSULATION BY ELEMENT										
Formula	Description	Data	Units	Octave band centre frequency, Hz						dB(A)
				125	250	500	1000	2000	4000	
	Reverberation Time	0.5	s	0.5	0.5	0.5	0.5	0.5	0.5	
	Receiver Room Volume	20.1	m ³							
Element 1				Façade						
L1	Wall (database)	Leg		69	66	69	69	65	62	73
-R	Brick block cavity wall			41	45	45	54	58	58	
+10logS	Element Area	4.2	m ²	6	6	6	6	6	6	
-10logA	where A=0.16V/T			8	8	8	8	8	8	
+0				0	0	0	0	0	0	
=L2				26	19	22	13	5	2	21
L2tot	Running total			26	19	22	13	5	2	21
Element 2										
L1	Window (database)	Leg		69	66	69	69	65	62	
-R	SGG 4/12/6mm			23	22	27	38	40	41	
+10logS	Element Area	1.5	m ²	2	2	2	2	2	2	
-10logA	where A=0.16V/T			8	8	8	8	8	8	
+0				0	0	0	0	0	0	
=L2				40	38	36	25	19	15	35
L2tot	Running total			40	38	36	25	19	15	35
Element 3										
L1	Ventilator (database)	Leg		69	66	69	69	65	62	
-R	Acoustic trickle ventilator (generic)			30	33	38	37	36	36	
+10logSo	Reference Area	10.0	m ²	10	10	10	10	10	10	
-10logA	where A=0.16V/T			8	8	8	8	8	8	
+0				0	0	0	0	0	0	
=L2				41	35	33	34	31	28	38
L2tot	Running total			44	40	38	34	31	28	40

Table B2: Bedrooms, South Facade - $L_{Amax,night}$

Job name:		Toddington Lane		RESULT SUMMARY: Lmax Night						
Job no.:		3187		Predicted Internal Level: 40				dB LAeq, T		
Façade:		South façade - plots 4&5 Ground floor Bedroom 2		Criterion: 45				dB LAeq, T		
				Difference: -5				dB LAeq, T		
SOUND INSULATION BY ELEMENT										
Formula	Description	Data	Units	Octave band centre frequency, Hz						dB(A)
				125	250	500	1000	2000	4000	
	Reverberation Time	0.5	s	0.5	0.5	0.5	0.5	0.5	0.5	
	Receiver Room Volume	10.7	m³							
Element 1				Façade						
L1	Wall (database)	Leg		63	59	63	66	59	51	68
-R	Brick block cavity wall			41	45	45	54	58	58	
+10logS	Element Area	11.5	m²	11	11	11	11	11	11	
-10logA	where A=0.16V/T			8	8	8	8	8	8	
+0				0	0	0	0	0	0	
=L2				25	17	21	15	4	-4	20
L2tot	Running total			25	17	21	15	4	-4	20
Element 2										
L1	Window (database)	Leg		63	59	63	66	59	51	
-R	SGG 4/12/8mm			26	22	28	38	41	42	
+10logS	Element Area	2.5	m²	4	4	4	4	4	4	
-10logA	where A=0.16V/T			8	8	8	8	8	8	
+0				0	0	0	0	0	0	
=L2				33	33	31	24	14	5	30
L2tot	Running total			33	33	31	24	14	5	31
Element 3										
L1	Ventilator (database)	Leg		63	59	63	66	59	51	
-R	path (generic)			30	31	31	32	28	28	
+10logSo	Reference Area	10.0	m²	10	10	10	10	10	10	
-10logA	where A=0.16V/T			8	8	8	8	8	8	
+0				0	0	0	0	0	0	
=L2				35	30	34	36	33	25	39
L2tot	Running total			37	34	36	36	33	25	40


Table B3: Living Room, East/North Facade - $L_{Aeq,16hr}$

Job name:		Toddington Lane		RESULT SUMMARY: LAeq Day									
Job no.:		3187		Predicted Internal Level: 31 dB LAeq,T									
Façade:		North and East façade - Plot 1 living/dining room		Criterion: 35 dB LAeq,T									
				Difference: -4 dB LAeq,T									
SOUND INSULATION BY ELEMENT													
Formula		Description		Data		Units		Octave band centre frequency, Hz					
								125 250 500 1000 2000 4000 dB(A)					
		Reverberation Time		0.5		s		0.5 0.5 0.5 0.5 0.5 0.5					
		Receiver Room Volume		60.4		m³							
Element 1				Façade									
L1	Wall (database)		Leg		60 55 54 57 54 48 60								
-R	Brick block cavity wall				41 45 45 54 58 58								
+10logS	Element Area		19.4 m²		13 13 13 13 13 13								
-10logA	where A=0.16V/T				13 13 13 13 13 13								
+0					0 0 0 0 0 0								
=L2					19 10 9 3 -4 -10 10								
L2tot	Running total				19 10 9 3 -4 -10 10								
Element 2													
L1	Window (database)		Leg		60 55 54 57 54 48								
-R	SGG 4/12/8mm				26 22 28 38 41 42								
+10logS	Element Area		4.5 m²		7 7 7 7 7 7								
-10logA	where A=0.16V/T				13 13 13 13 13 13								
+0					0 0 0 0 0 0								
=L2					28 27 20 13 7 0 22								
L2tot	Running total				28 27 20 13 7 0 22								
Element 3													
L1	Ventilator (database)		Leg		60 55 54 57 54 48								
-R	path (generic)				30 31 31 32 28 28								
+10logSo	Reference Area		20.0 m²		13 13 13 13 13 13								
-10logA	where A=0.16V/T				13 13 13 13 13 13								
+0					0 0 0 0 0 0								
=L2					30 24 23 25 26 20 31								
L2tot	Running total				32 29 25 25 26 20 31								