BACTON LOW RISE

REDEVELOPMENT

Camden

pba peterbrett

Noise & Vibration

Assessment

Bacton Low Rise Redevelopment

Noise and Vibration Assessment

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Executive Summary

Peter Brett Associates LLP (PBA) has been commissioned by the London Borough of Camden (LBC) to undertake a noise assessment for submission with a full planning application for The Bacton Low Rise Redevelopment, Camden.

The planning application comprises 290 residential units, comprising both affordable and market properties across two sites. The sites are the District Housing Office (DHO) site which lies between Vicar's Road to the south and the railway line to the north and The Bacton Low Rise (BLR) Estate which lies to the north and west of Wellesley Road.

The purpose of this report is to establish the noise climate of the development sites to determine their suitability for residential development, having regard to local planning policy and national guidance documents. Noise mitigation measures have been recommended where necessary

The vibration due to trains using the railway line to the north of the DHO site has also been assessed.

A baseline noise and vibration survey has been undertaken. A noise model, validated with the noise survey results, has been used to establish the noise levels across the sites for comparison with LBC policy DP28 and to set demolition and construction noise limits

Noise survey data has also been used to set noise limits for the proposed combined heat and power plant.

Mitigation is required for both the DHO and BLR sites to meet the 'good' internal noise criteria specified in BS 8233 'Sound Insulation and Noise Reduction for Buildings – Code of Practice'. The window areas for the north façade of the northern DHO buildings will include a double glazing system separated by 100mm (e.g. a single glazing pane (10mm), 100mm air cavity and double glazing unit comprising of 10mm and 6mm panes). It is anticipated that the combined glazing system will provide a total sound reduction of approximately R_w 51dB.

Outdoor garden noise levels will meet the BS 8233:1999 criteria at both the DHO and BLR sites. Vibration levels from the trains using the railway line to the north of the site also fall within the acceptable criteria defined by LBC.

This Executive Summary contains an overview of the key findings and conclusions. However, no reliance should be placed on any part of the executive summary until the whole of the report has been read.

1 Introduction

1.1 Background

1.1.1. Peter Brett Associates LLP (PBA) has been commissioned by the London Borough of Camden (LBC) to undertake a Noise and Vibration Assessment for submission with a full planning application for the Bacton Low Rise Redevelopment, Camden.

1.2 Site Description

1.2.1. The site is made up of two separate areas:

- Phase 1: the District Housing Office (DHO) site which lies between Vicar's Road to the south and the railway line to the north; and
- Phases 2 & 3: The Bacton Low Rise Estate (BLR) which lies to the north and west of Wellesley Road.

1.2.2. The sites are surrounded by existing residential units, the majority of which are at least three storeys high. St Martin's Gospel Oak Church is situated to the east of the Phases 2 & 3 sites on the opposite side of Wellesley Road.

1.3 Proposed Development

1.3.1. The planning application comprises demolition of Bacton Low Rise buildings (numbers 121-219), 113a and 115 Wellesley Road (the District Housing Office) and 2-16 Vicar's Road (workshops building) and residential development of circa. 290 residential units, comprising both affordable and market properties across two sites.

1.4 Scope of Assessment

1.4.1. The purpose of this report is to establish the noise climate of the development sites to determine their suitability for residential development, having regard to local planning policy and national guidance documents. Noise mitigation measures will be recommended where necessary to accord with internal noise levels provided in BS 8233 'Sound Insulation and Noise Reduction for Buildings – Code of Practice'.

1.4.2. The vibration due to trains using the railway line to the north of the DHO site has also been assessed.

1.4.3. The remainder of the document is structured as follows:

Section 2 outlines the legislative framework and guidelines which have been applied to complete this assessment and draw conclusions from;

Section 3 outlines the methodology that has been applied in order to complete the assessment**;**

Section 4 outlines the baseline noise and vibration levels across the site(s);

Section 5 provides an assessment of the noise and vibration levels;

Section 6 outlines suitable mitigation to achieve an acceptable noise climate for proposed residential use; and

Section 7 sets out the conclusions and recommendations from the assessment.

2 Legislation, Policy and Guidance

2.1 Introduction

2.1.1. A Glossary of Acoustic Terms is provided in **Appendix A**.

2.2 Consultation with London Borough of Camden

2.2.1. Following consultation with the Environmental Health Officer (EHO)[1] at London Borough of Camden (LBC) on 16th August 2012, technical note reference TN ESP N1 ‘Noise Survey and Assessment Methodology’ dated 23 August 2012 (provided as **Appendix B**) outlining PBA’s survey and assessment methodology was sent to the EHO and approved by email on 29 August 2012.

2.3 Local Planning Policy

Camden Development Policies 2010-2025, Local Development Framework

2.3.1. During the consultation, the EHO advised that Development Policy 28 (DP28) ‘Noise and vibration’ applies to this development. DP28 states that:

“The council will seek to ensure that noise and vibration is controlled and managed and will not grant planning permission for:

a) Development likely to generate noise pollution; or
b) Development sensitive to noise in locations with noise pollution, unless appropriate attenuation measures are provided.

Development that exceeds Camden’s Noise and Vibration Thresholds will not be permitted.

The Council will only grant permission for the plant or machinery if it can be operated without cause [sic] harm to amenity and does not exceed our noise thresholds.

The Council will seek to minimise the impact on local amenity from the demolition and construction phases of development. Where these phases are likely to cause harm, conditions and planning obligations may be used to minimise the impact.”

2.3.2. The relevant threshold levels that are applicable to this development are contained within Tables A, B, C and E of DP28 and have been reproduced for reference as **Tables 2.1-2.4**.

Table 2.1 (DP28 Table A): Noise levels on residential streets adjoining railways and roads at which planning permission will not be granted

Noise description and location of measurement	Period	Time	Sites adjoining railways	Sites adjoining roads
Noise at 1 metre external to a sensitive façade	Day	0700-1900	74 dB $L_{Aeq,12h}$	72 dB $L_{Aeq,12h}$

[1] Mario Houska

Noise description and location of measurement	Period	Time	Sites adjoining railways	Sites adjoining roads
Noise at 1 metre external to a sensitive façade	Evening	1900-2300	74 dB $L_{Aeq,4h}$	72 dB $L_{Aeq,4h}$
Noise at 1 metre external to a sensitive façade	Night	2300-0700	66 dB $L_{Aeq,8h}$	66 dB $L_{Aeq,8h}$

Table 2.2 (DP28 Table B): Noise levels on residential streets adjoining railways and roads at and above which attenuation measures will be required

Noise description and location of measurement	Period	Time	Sites adjoining railways	Sites adjoining roads
Noise at 1 metre external to a sensitive façade	Day	0700-1900	65 dB $L_{Aeq,12h}$	62 dB $L_{Aeq,12h}$
Noise at 1 metre external to a sensitive façade	Evening	1900-2300	60 dB $L_{Aeq,4h}$	57 dB $L_{Aeq,4h}$
Noise at 1 metre external to a sensitive façade	Night	2300-0700	55 dB $L_{Aeq,1h}$	52 dB $L_{Aeq,1h}$
Individual noise events several times an hour	Night	2300-0700	>82 dB L_{ASmax}	>82 dB L_{ASmax}

2.3.3. It can be seen that during the night-time that mitigation is required if the L_{Aeq} in each hour exceeds 55 dB for sites adjacent to railways and 52 dB for sites adjacent to roads.

Table 2.3 (DP28 Table C): Vibration levels on residential streets adjoining railways and roads at which planning permission will not be granted

Vibration description and location of measurement	Period	Time	Vibration Levels
Vibration inside critical areas such as hospital operating theatre	Day, evening and night	0000-2400	0.1 VDV $ms^{-1.75}$
Vibration inside dwellings	Day and evening	0700-2300	0.2 to 0.4 VDV $ms^{-1.75}$
Vibration inside dwellings	Night	2300-0700	0.13 VDV $ms^{-1.75}$
Vibration inside offices	Day, evening and night	0000-2400	0.4 VDV $ms^{-1.75}$

Vibration description and location of measurement	Period	Time	Vibration Levels
Vibration inside workshops	Day, evening and night	0000-2400	0.8 VDV $ms^{-1.75}$
N.B. Where dwellings may be affected by ground-borne regenerated noise internally from, for example, railways or underground trains within tunnels, noise levels within the rooms should not be greater than 35 dB(A)max			

Table 2.4 (DP28 Table E): Noise levels from plant and machinery at which planning permission will not be granted

Noise description and location of measurement	Period	Time	Noise Level
Noise at 1 metre external to a sensitive façade	Day, evening and night	0000-2400	5 dB(A) < L_{A90}
Noise that has a distinguishable discrete continuous note (whine, hiss, screech, hum) at 1 metre external to a sensitive façade	Day, evening and night	0000-2400	10 dB(A) < L_{A90}
Noise that has distinct impulses (bangs, clicks, clatters, thumps) at 1 metre external to a sensitive façade	Day, evening and night	0000-2400	10 dB(A) < L_{A90}
Noise at 1 metre external to a sensitive façade where L_{A90} > 60 dB	Day, evening and night	0000-2400	55 dB L_{Aeq}

2.4 National Planning Policy

National Planning Policy Framework (NPPF)

2.4.1. The National Planning Policy Framework was published in March 2012. However, the EHO at LBC advised that it is not currently implemented in the local planning policy.

2.5 British Standards and Other Guidance

British Standard 8233:1999 'Sound Insulation and Noise Reduction for Buildings – Code of Practice'[2]

2.5.1. LBC policy DP28 provides the external levels at which mitigation is required. BS 8233, in relation to this planning application, sets out the recommended noise level criteria inside habitable rooms, such as living rooms and bedrooms. For simplicity BS 8233 only considers anonymous noise sources, and does not consider those that are not clearly identifiable as emanating from a single identifiable source. Road and rail traffic are examples of anonymous noises. The recommended noise criteria are given in **Table 2.5** below.

[2] British Standards Institution, 1999. *BS 8233:1999 Sound insulation and noise reduction for buildings – Code of Practice*. London: BSI.

Table 2.5: BS 8233 Recommended Internal Ambient Noise Levels

Criterion	Typical Situations	Design Range $L_{Aeq,T}$ dB	
		Good	Reasonable
Reasonable resting /sleeping conditions	Living rooms	30	40
	Bedrooms[1]	30	35
Reasonable conditions for study and work requiring concentration	Cellular offices	40	50
	Meeting rooms, executive offices	35	40
Reasonable industrial working conditions	Light engineering, garages and warehouses	65	75
[1] For a reasonable standard in bedrooms at night, individual noise events (measured with fast time-weighting) should not normally exceed 45 dB L_{Amax}.			

2.5.2. For gardens and balconies, the standard advises that a desirable steady noise level is 50 dB $L_{Aeq,T}$ with 55 dB $L_{Aeq,T}$ regarded as the upper limit, consistent with the World Health Organization guidelines (see below).

World Health Organization, Guidelines for Community Noise, 1999[3] (WHO)

2.5.3. Community noise is considered to include noise from road, rail and air traffic, industries, construction and public work, and the neighbourhood.

2.5.4. The WHO Guidelines provide guideline values for specific health effects of noise and for specific environments. The Guidelines can therefore be used to assess noise in outdoor amenity areas such as gardens, balconies and open spaces.

2.5.5. The Guidelines state that:

"To protect the majority of people from being seriously annoyed during the daytime, the sound pressure level on balconies, terraces and outdoor living areas should not exceed 55 dB L_{Aeq} for a steady, continuous noise. To protect the majority of people from being moderately annoyed during the daytime, the outdoor sound pressure level should not exceed 50 dB L_{Aeq}".

British Standard 4142:1997 'Method for rating industrial noise affecting mixed residential and industrial areas'[4]

2.5.6. Where building services plant is proposed noise should be assessed with regard to BS 4142:1997 'Method for Rating Industrial Noise Affecting Mixed Industrial and Residential Areas'. This standard sets out a method for determining the level of noise of an industrial nature, together with procedures for assessing whether the noise is likely to give rise to complaints from people living nearby.

[3] World Health Organization, 1999. *Guidelines for community noise*. Geneva: WHO.
[4] British Standards Institution, 1997. *BS 4142:1997 Rating industrial noise affecting mixed residential and industrial areas*. London: BSI.

2.5.7. The method subtracts the background level ($L_{A90,T}$) from the 'rating level', ($L_{Ar,Tr}$) which is calculated by adjusting the noise source for a character correction where the noise:

- Contains a distinguishable, discrete, continuous note;
- Contains distinct impulses; and
- Is irregular enough to attract attention

2.5.8. **Table 2.4** summarises the DP28 requirements for fixed plant and machinery which are based on BS 4142.

British Standard 7445: Part 1:2003 Description and Measurement of Environmental Noise. Guide to Quantities and Procedures[5] (BS 7445-1:2003)

2.5.9. BS 7445-1 describes methods and procedures for measuring noise from all sources which contribute to the total noise climate of a community environment, individually and in combination. The results are expressed as equivalent continuous A-weighted sound pressure levels, $L_{Aeq,T}$.

2.5.10. BS 7445-1 states that sound level meters that are used should conform to Class 1 (or Class 2 as a minimum) as described in BS EN 61672:2003 and should be calibrated according to the instructions of the manufacturer and field calibration should be undertaken at least before and after each series of measurements.

2.5.11. Key aspects of the outdoor measurement procedure are:

- Whenever possible the measurement should be completed more than 3.5m from a reflective structure other than the ground.
- The ideal measurement height is between 1.2m and 1.5m, and
- Measurement time intervals should be chosen so that measurements are completed within specified meteorological conditions.

2.5.12. The standard also provides advice on selecting appropriate parameters when recording various types of noise, e.g. steady noise, fluctuating noise etc.

Calculation of Road Traffic Noise (CRTN)[6]

2.5.13. The noise modelling software uses CRTN methodology to calculate the $L_{A10,18h}$ from road traffic over the period 06:00 - 24:00 hours.

2.5.14. The CRTN shortened measurement procedure in paragraph 43 recognises the trends in traffic profiles and corrects the arithmetic mean of three 1-hour readings taken in consecutive hours between 10:00 -17:00 hours to provide a reliable estimate of the $L_{A10,18h}$ over the period 06:00 - 24:00 hrs.

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[5] British Standards Institution, 2003. *BS 7445:2003 Description and measurement of environmental noise*. London: BSI.
[6] Department of Transport Welsh Office, 1988. *Calculation of Road Traffic Noise*. London: HMSO.

Method for converting the UK Road Traffic Noise Index $L_{A10,18hr}$ to the EU Indices for Road Noise Mapping[7]

2.5.15. The method for converting the UK Road Traffic noise index to the EU indices for road noise mapping was published by Defra, TRL and Casella Stanger in 2006.

2.5.16. The methodology detailed in this document is used within the SoundPLAN noise modelling software used for this assessment to derive daytime ($L_{Aeq,16h}$) and night-time ($L_{Aeq,8h}$) noise levels from road traffic.

Calculation of Railway Noise (CRN)[8]

2.5.17. The Calculation of Railway Noise describes the procedure for calculating the noise from moving railway vehicles at a given location.

2.5.18. Corrections can be used with a baseline sound exposure level (L_{AE}) to predict noise levels from the railway if the train vehicle types are known. It is used within the noise modelling software to predict noise from railway lines.

2.5.19. CRN advises that the period of measurement should be 06:00 to 24:00 hrs and/or 00:00 to 06:00 hrs.

Additional railway noise source terms for "Calculation of Railway Noise 1995"[9]

2.5.20. In addition to the corrections within CRN, Defra have calculated additional corrections in Additional Railway Noise Source Terms for Calculation of Railway Noise.

British Standard 5228-1:2009 'BS 5228-1:2009 Code of practice for noise and vibration control on construction and open sites Part 1 Noise'[10]

2.5.21. Noise and vibration generated during the demolition phase of the existing buildings on site has been assessed qualitatively advising use of the best practicable means to minimise the effect of construction noise and vibration to nearby receptors, as stated in BS 5228:2009 Parts 1 (Noise) and 2 (Vibration).

2.5.22. Although BS 5228-1 Annex E is informative, and as such is not afforded the same level of authority as the British Standard itself, it provides useful guidance on the significance of effects and examples of limits for construction noise based on the pre-existing noise climate (i.e. the pre-construction baseline). Day, evening and night-time periods are defined, with recommended construction noise limits shown in **Table 2.6** below.

Table 2.6: BS 5228-1 Annex E Recommended Construction Noise Limits

Assessment category and threshold value period	Threshold Value ($L_{Aeq\ T}$) (dB)		
	Category A [A)]	Category B [B)]	Category C [C)]
Night-time (23.00−07.00)	45	50	55

[7] Defra, 2006. *Method for Converting the UK Road Traffic Noise Index $L_{A10,18h}$ to the EU Noise Indices for Road Noise Mapping.* TRL Cassella Stanger.
[8] Department of Transport, 1995. *Calculation of Railway Noise*. London: HMSO
[9] Department for Environment, Food and Rural Affairs, 2007. *Additional railway noise source terms for "Calculation of Railway Noise 1995"*. London: HMSO.
[10] British Standards Institution, 2009. *BS 5228-1:2009 Code of practice for noise and vibration control on construction and open sites Part 1 Noise*. London: BSI.

Assessment category and threshold value period	Threshold Value ($L_{Aeq\ T}$) (dB)		
	Category A [A)]	Category B [B)]	Category C [C)]
Evenings and weekends [D)]	55	60	65
Daytime (07.00−19.00) and Saturdays (07.00−13.00)	65	70	75
NOTE 1 A significant effect has been deemed to occur if the total L_{Aeq} noise level, including construction, exceeds the threshold level for the Category appropriate to the ambient noise level. NOTE 2 If the ambient noise level exceeds the threshold values given in the table (i.e. the ambient noise level is higher than the above values), then a significant effect is deemed to occur if the total LAeq noise level for the period increases by more than 3 dB due to construction activity. NOTE 3 Applied to residential receptors only. A) Category A: threshold values to use when ambient noise levels (when rounded to the nearest 5 dB) are less than these values. B) Category B: threshold values to use when ambient noise levels (when rounded to the nearest 5 dB) are the same as category A values. C) Category C: threshold values to use when ambient noise levels (when rounded to the nearest 5 dB) are higher than category A values. D) 19.00–23.00 weekdays, 13.00–23.00 Saturdays and 07.00–23.00 Sundays.			

British Standard 5228-2:2009 Code of practice for noise and vibration control on construction and open sites Part 2 Vibration'[11]

2.5.23. Human beings are known to be very sensitive to vibration, the threshold of perception typically being in the peak particle velocity (PPV) range of 0.14mm/s to 0.3mm/s. Vibration above these levels can disturb, startle, cause annoyance or interfere with work activities. Vibration nuisance is often associated with the assumption that if vibrations can be felt then damage is inevitable. However, considerably greater levels of vibration are required to cause damage to buildings and structures.

2.5.24. BS 5228-2 provides advice on the human response to construction vibration. For the assessment of construction effects the magnitude descriptors in **Table 2.7** refers to this advice.

Table 2.7: Table of Human Response to Vibration Magnitude

Magnitude	Vibration Level	Description
Negligible	0.14 mms^{-1}	Vibration might be just perceptible in the most sensitive situations for most vibration frequencies associated with construction. At lower frequencies, people are less sensitive to vibration.
Small	0.3 mms^{-1}	Vibration might just be perceptible in residential environments

[11] British Standards Institution, 2009. *BS 5228-1:2009 Code of practice for noise and vibration control on construction and open sites Part 1 Noise*. London: BSI.

Medium	1.0 mms^{-1}	It is likely that vibration at this level in residential environments will cause complaint, but can be tolerated if prior warning and explanation has been given to residents
Large	10 mms^{-1}	Vibration is likely to be intolerable for any more than a very brief exposure to this level

3 Methodology

3.1 Baseline Noise Survey

3.1.1. A baseline noise survey was undertaken on 6th and 7th September 2012 to determine the ambient noise climate of the site using the procedure provided in BS 7445-1:2003.

3.1.2. **Table 3.1** details the measurement locations (shown in **Figure 1**).

Table 3.1: Details of the Measurement Locations for the Baseline Noise Survey

Measurement Location reference (see Figure 1)	Description
LT	Adjacent to the railway wall
ST1	5 m from the carriageway of Vicar's Road
ST2	4 m from the carriageway of Wellesley Road to the east of Phases 2 and 3

3.1.3. Location LT was selected due to the proximity to the railway line, Location ST1 was selected to measure noise levels from road traffic using Wellesley Road and Location ST2 was selected to measure noise levels from road traffic using Vicar's Road.

3.1.4. The survey consisted of an unattended 24-hour measurement at location LT starting at 13:55 hrs on 6th September 2012.

3.1.5. Three consecutive attended 1-hour measurements were undertaken at ST2 starting from approximately 12:58 on 6th September 2012 and ST1 starting from approximately 10:55 on 7th September 2012 in accordance with the CRTN shortened measurement procedure (see **paragraph 2.5.14**).

3.1.6. The night time noise survey consisted of two non-consecutive attended 15-minute measurements at ST1 and ST2 between approximately 23:04 and 00:30 on 6th September 2012 and two 15-minute measurements between approximately 05:01 and 06:18 on 7th September.

3.1.7. **Table 3.2** provides details of the instrumentation used during the noise survey.

Table 3.2: Instrumentation Used During the Noise Survey

Item	Type	Manufacturer	Serial Number	Laboratory Calibration Date
Long Term Measurement				
Hand-Held Analyzer	2250	Brüel & Kjær	2626233	23/01/2012
½ " Microphone	4189	Brüel & Kjær	2621212	20/01/2012

Item	Type	Manufacturer	Serial Number	Laboratory Calibration Date
B&K Sound Calibrator	4231	Brüel & Kjær	2619375	20/01/2012
Short Measurements				
Hand-Held Analyzer	2250	Brüel & Kjær	2626232	23/01/2012
½ " Microphone	4189	Brüel & Kjær	2621211	20/01/2012
B&K Sound Calibrator	4231	Brüel & Kjær	2619375	20/01/2012

3.1.8. On-site calibration checks were performed before and after all measurements with no significant deviation being observed. The sound level meters and calibrators have valid laboratory calibration certificates.

3.1.9. For Location 1 the sound level meter was tripod-mounted with the microphone approximately 2m above ground level so that the microphone was positioned above the top of the boundary wall of the railway line. In locations ST1 and ST2 the sound level meter was tripod-mounted with the microphone approximately 1.5m above ground level.

3.1.10. A windshield was fitted over the microphones at all times during the survey periods to minimise the effects of any wind induced noise.

3.1.11. The weather during the daytime of 6th and 7th September 2012 was warm dry and calm. The maximum gust of wind measured during the short noise measurements was 3.4 ms^{-1} which is below the recommended maximum wind speed of approximately 5 ms^{-1}. The temperature during the daytime measurement at ST2 on 6th September 2012 was approximately 18°C to 21°C and at ST1 on 7th September 2012 was approximately 20°C to 25°C.

3.1.12. During the night-time between 6th to 7th September 2012 weather conditions were clear with an occasional light breeze, a temperature of approximately 17°C for the first set of night-time measurements and approximately 12°C during the second set of night-time measurements and a maximum wind speed of approximately 2.1 ms^{-1}.

3.2 Baseline Vibration Survey

3.2.1. A vibration survey was undertaken between 30th and 31st August 2012 to measure the baseline vibration across the DHO site due to railway traffic using the railway line to the north of the site.

3.2.2. Three vibration measurement locations were chosen and are summarised in **Table 3.3** below and shown on **Figure 1**.

Table 3.3: Details of the Measurement Locations for the Baseline Vibration Survey

Measurement Location reference (see Figure 1)	Description
V1	Approximately 3 m from the wall forming the northern boundary of the DHO site
V2	Within the DHO building, in a room on the first floor
V3	Approximately 23 m from the wall forming the northern boundary of the DHO site

3.2.3. Locations V1 and V3 were selected as representative of the external vibration levels at ground level. Location V2 was selected as indicative of internal vibration levels, however, it should be noted that the vibration levels inside the proposed residential units will depend on the foundations and type of piling used and the internal vibration levels measured during this vibration survey are indicative.

3.2.4. The survey consisted of 2-hour daytime measurements in locations V1 (starting at 12:04:00 on 30th August 2012) and V3 (starting at 14:10:00 on 30th August 2012). The periods were carefully selected to coincide with timetabled freight train movements, however, no freight trains passed by the site during the measurement at V1.

3.2.5. A measurement was set up in location V2 from 16:46:17 to approximately 09:07:57 to measure vibration during the daytime and to cover an 8-hour night-time period. Observations were made during timetabled freight train movements, however, no freight trains were observed during the measurement (although observations were not made throughout the entire night).

3.2.6. **Table 3.4** provides details of the instrumentation used during the vibration survey.

Table 3.4: Instrumentation Used During the Vibration Survey

Item	Type	Manufacturer	Serial Number	Laboratory Calibration Date
Tri-Axial Vibration Meter	VM-54	Rion	00750087	26/07/2012
Tri-Axial Accelerometer	PV-83CW	Rion	17907	26/07/2012
Whole Body Vibration (UK) program card	VX-54WB1	Rion		26/07/2012

3.2.7. The accelerometer was mounted on a metal plate on the concrete ground of a car park adjacent to the railway line in location V1 and V3 and on a metal plate approximately in the centre of a room on the first floor of the DHO building.

3.3 Noise Model

3.3.1. A SoundPLAN v 7.1 noise model of the site has been prepared including the road traffic flows along Wellesley Road and Vicar's Road and rail traffic data for the Midland Main Line which runs adjacent to the northern boundary of the site.

3.3.2. The site topography and existing buildings have been included within the model and so corrections for these factors are included within the calculations in accordance with 'Calculation of Road Traffic Noise' (CRTN) guidance. SoundPLAN v7.1 uses CRTN methodology to model noise from road traffic.

Road Traffic

3.3.3. The road traffic data was collected using an automatic traffic count (ATC) on Wellesley Road between 12 and 18 September 2012. Unfortunately no suitable location for an ATC could be found on Vicar's Road, however, during the noise survey it was observed that Vicar's Road had approximately 49% of the total number of vehicles in three hours as Wellesley Road (with HGV's approximately 11% of the total vehicles on Vicar's Road) and that Grafton Road had approximately 71% of the total number of vehicles in three hours as Wellesley Road (with HGV's approximately 8% of the total vehicles on Vicar's Road). The three hour periods were not simultaneous but both were outside of peak traffic flow times.

3.3.4. The results of the ATC and subsequent calculations for traffic flow along Vicar's Road and Grafton Road are included in **Appendix D**.

Rail Traffic

3.3.5. The rail traffic data was collated and provided by Reid Rail. The Reid Rail report and a summary table are included in **Appendix D**.

3.4 Noise Model Validation

3.4.1. The $L_{Aeq,12h}$, $L_{Aeq,4h}$ and $L_{Aeq,8h}$ at location ST1 and ST2 have been calculated using the CRTN shortened measurement procedure (summarise in **paragraph 2.5.14**) and Defra methodology (**paragraph 2.5.15**).

3.4.2. The noise model results at each location were compared to the $L_{Aeq,12h}$, $L_{Aeq,4h}$ and $L_{Aeq,8h}$ measured during the noise survey (or calculated from the survey measurements for ST1 and ST2) at the same location.

3.4.3. A change in noise levels of 3 dB is considered to be the minimum perceptible under normal conditions. Therefore, if the measured and modelled results are within ±3 dB it is considered to demonstrate a good correlation.

3.5 Noise Assessment

3.5.1. The noise surveys give a good indication of the noise climate of the site at the specific time and locations of the surveys.

3.5.2. A noise model is a useful additional tool for providing a typical day and night time assessment of the entire site. It can also be used to investigate more closely any areas of the site where noise levels are identified to be higher than is desirable. This assessment uses the noise model to determine the noise levels across the whole site and to test and demonstrate the efficacy of any proposed mitigation measures.

3.5.3. The drawing 202_A_D_DHO_100_00, dated 4th October 2012, has been used to position the dwellings of the proposed development in the noise model. This layout is consistent with the submitted scheme.

Construction and Demolition Noise and Vibration

3.5.4. Demolition and construction noise could potentially increase the ambient noise levels at existing noise-sensitive receptors and proposed noise-sensitive receptors of Phases 1 and 2 that are inhabited whilst construction continues. The mitigation section outlines requirements for the reduction of construction noise and vibration which could be applied so as to minimise the effects due to noise from the construction phase of the development.

3.5.5. BS 5228:2009 Annex E (Informative) states that noise predictions should be undertaken to determine eligibility for noise insulation or temporary re-housing. However, the informative also states that these assessments should be undertaken when a contractor has been appointed and detailed method statements on the construction programme and plant to be used are available. Therefore, a quantitative assessment of the construction phase may be required at the appropriate stage in the programme.

3.5.6. Groundborne vibration is often a cause for concern to occupants of buildings, particularly in relation to construction. The methodology for demolition of existing structures will be finalised once a contractor has been appointed.

3.5.7. Sources of vibration include piling activities and any construction phases that include piling should be considered to be the most likely to produce perceptible levels of vibration and therefore the most likely to cause concern to nearby residents. This will be considered in more detail once the construction phasing and methodology is finalised.

3.5.8. The guide values advised in BS 6472 to determine the probability of human discomfort due to groundborne vibration are more stringent than those recommended for structural damage. It is therefore anticipated that any likely structural damage caused by construction will be in the first instance covered by recommendations given in BS 6472.

3.5.9. Consideration should be given to the potential damage level from groundborne vibration to existing buildings, in accordance with BS 7385. The type of building foundation, ground conditions and state of repair of the building should be taken into account.

Design Criteria

3.5.10. The noise model has been used to assess noise levels across the site. Mitigation measures have been recommended to reduce the internal noise levels to the ‘good’ criteria in BS 8233.

3.5.11. The usual time period for assessment of night-time noise is $L_{Aeq,8h}$ between 23:00 hrs and 07:00 hrs. LBC require assessment of the night-time $L_{Aeq,1h}$ the time period 02:00 to 03:00 has been used within the noise model for this assessment. However, for the assessment of requirement of mitigation with regard to BS 8233, the $L_{Aeq,8h}$ has been used.

3.5.12. The acoustic performance required of the glazing in bedrooms and living rooms has been calculated. Within the noise model receptors were created on the facades of the buildings at all floor levels so that the external noise levels of the proposed dwellings could be determined. The facades assessed are shown in **Figure 2.** For each façade the highest noise level from the different floor levels was then used to calculate the glazing specification needed to meet the internal noise levels for the different room types.

3.5.13. When designing the mitigation, consideration has also been given to the maximum noise levels L_{Amax} dB guideline values recommended by BS8233 within bedrooms during the night-time period. Due to the proximity of the railway line, the maximum noise levels are dominated by trains during the night.

3.5.14. Break-in noise calculations have been undertaken to determine the internal noise levels within habitable rooms of the proposed development. The acoustic performance for building elements has been taken into account in the calculations.

3.5.15. The break-in noise calculations have been undertaken utilising the Building Envelope Insulation spreadsheet prepared by the Building Research Establishment (BRE). This is based on BS EN 12354-3:2000 'Building Acoustics – estimation of acoustic performance in buildings from the performance of elements, airborne sound against outdoor sound'.

3.5.16. Contour plots have also been produced at ground floor height to present the noise levels at outdoor amenity areas. These have been assessed against the BS8233:1999 garden noise levels.

Fixed Plant

3.5.17. The model of any fixed plant associated with the development is yet to be decided, therefore the background noise levels measured during the noise survey and the LBC criteria summarised in **Table 2.4** have been used to set rating noise limits for fixed plant associated with the development.

3.5.18. The noise limits are the cumulative limit of all fixed plant associated with the development.

3.6 Vibration Assessment

3.6.1. BS 6472-1 states that if the dominant direction of vibration is clear it is only necessary to assess vibration in that direction. The baseline vibration measurements clearly show that vibration in the z-axis is dominant (see graphs in **Appendix E**) therefore the x- and y-axes have not been assessed.

3.6.2. The VDV_{day} and VDV_{night} at the measurement locations have been calculated using equation 3 of BS 6472-1 section 3.5, replicated as **Equation 1** below.

$$VDV_{\mathrm{b/d,day/night}} = \left(\sum_{n=1}^{n=N} VDV_{b/d,t_n}^{4} \right)^{0.25} \quad (1)$$

- In location V3 equation (1) has been used to calculate the VDV of each train passby, then the arithmetic average of these has been taken as the $VDV_{passenger}$ and the same process has been used to calculate the $VDV_{freight}$. The vibration measurement included three freight train passby, however, one of these provided a much lower VDV than the other two (which were similar) and has therefore been excluded from the average;

- In location V1 the same process has been used to calculate the $VDV_{passenger}$. No freight trains passed the site during the measurement, therefore a correction has been calculated from the vibration measurement at V3

$$VDV_{freight_{V_1}} = \frac{VDV_{passenger_{V_1}}}{VDV_{passenger_{V_3}}} \times VDV_{freight_{V_3}} \quad (2)$$

- In location V2, the same process has been used to calculate the $VDV_{passenger}$ using observations on site. There were no freight train movements observed, however, looking at the duration of train passby and listening to the audio from the long term noise measurement it is likely that the movement at 04:00:27 on 31st August 2012 is a freight train movement. The $VDV_{passenger}$ and $VDV_{freight}$ have then been calculated as the arithmetic average of the results of the two V2 measurements;

- In all locations the VDV_{day} has been calculated using equation (1) with the $VDV_{passenger}$ and $VDV_{freight}$ calculated for each location, as has the VDV_{night} for V1 and V3;
- For location V2 the arithmetic average of the two VDV_{night} measurements taken on site has been used as the VDV_{night}.

3.7 Limitations

Road Traffic Data

3.7.1. Road traffic data for Wellesley Road has been acquired by Community Systems Ltd with use of automatic traffic counts (ATC's). It is assumed that the week of the traffic measurement was a typical week as there is no known reason to think otherwise.

3.7.2. It is also assumed that Community Systems Ltd installed the ATC's correctly.

3.7.3. Road traffic data for Vicar's Road and Grafton Road has been calculated using data from Wellesley Road and on-site observations during the noise survey regarding number of vehicles on each of these roads compared to a similar period on Wellesley Road. It is assumed that the traffic flow during the noise survey was representative of the typical scenario as there is no known reason to think otherwise.

Rail Traffic Data

3.7.4. Rail traffic data has been provided by the rail transport consultant Reid Rail and is assumed to be an accurate representation of the typical rail traffic movements passed the site.

Mapping and Topography

3.7.5. Site mapping and topography have been provided by email from Karakusevic Carson Architects LLP and are assumed to be accurate, with the exception outlined in **paragraph 3.7.7**.

3.7.6. Additional topography data was purchased from emapsite and is also assumed to be accurate with the exception outlined in **paragraph 3.7.7**.

3.7.7. Adjustments to the topography data were made to represent the deep railway cutting based on on-site observations of the depth of this cutting.

Site Layout

3.7.8. The mitigation calculations have been based on the site layout provided in the 202_A_D_DHO_100_00. If the site layout is altered significantly the calculations will need to be repeated.

3.7.9. The elevation details as shown on the submitted plans have been used for mitigation calculations, with the surface area of the windows of the proposed dwellings taken as 1.5 m^2 and the reverberation time within habitable rooms is 0.5 s. These values are based on typical values as used in BS 8233 but will be refined at the detailed design stage.

3.7.10. The ventilation strategy of the development includes mechanical ventilation with no air intakes proposed in any of the external walls containing habitable rooms. Therefore, any acoustic weakness generated by these façade ventilation units has not been taken into account in the calculations.

4 Results

4.1 Baseline Noise Survey

4.1.1. The noise survey locations are shown in **Figure 1.** At location LT the dominant noise source is rail traffic using the railway adjacent to the northern border of the site.

4.1.2. Rail traffic movements were also clearly audible at location ST1.

4.1.3. During the daytime, rail traffic movements were just about audible in location ST2 in between road traffic movements. However, during the night-time, rail traffic was more noticeable but the dominant noise source is considered to be distance road traffic.

4.1.4. **Tables 4.1** and **4.2** provides a summary of the noise survey results. The full results are provided in **Appendix E**.

Table 4.1: Summary of Results of the Daytime Noise Survey

Location	Date	Duration (hh:mm:ss)	$L_{Aeq,T}$ (dB)	$L_{AF10,T}$ (dB)	$L_{AF90,T}$ (dB)	L_{AFmax} (dB)
LT	06/09/2012 – 07/09/2012	16:00:00	67	67	42	92
ST1	07/09/2012	3:00:00	58	61	45	86
ST2	06/09/2012	3:00:00	60	62	45	83

Table 4.2: Summary of Results of the Night-Time Noise Survey

Location	Date	Duration (hh:mm:ss)	$L_{Aeq,T}$ (dB)	$L_{AF10,T}$ (dB)	$L_{AF90,T}$ (dB)	L_{AFmax} (dB)
LT	06/09/2012 – 07/09/2012	8:00:00	62	45	38	87
ST1	06/09/2012 – 07/09/2013	1:00:00	49	48	39	69
ST2	06/09/2012 – 07/09/2014	1:00:00	44	45	39	64

4.1.5. The averages in **Tables 4.1** and **4.2** have been calculated as: the logarithmic average of the $L_{Aeq,T}$ measurements, the lowest measured $L_{A90,T}$ and maximum measured L_{AFmax}.

4.2 Baseline Vibration Survey

4.2.1. **Appendix E** provides the results of the baseline vibration survey. **Table 4.3** provides a summary of the measurement VDVs when using equation 3 in section 3.5 of BS 6472-1.

Table 4.3: VDVs of the Vibration Measurements

Location	Start Time (dd/mm/yyyy hh:mm:ss)	End Time (dd/mm/yyyy hh:mm:ss)	Period τ (s)	VDV_{τ} ($ms^{-1.75}$)
V1	30/08/2012 12:04:38	30/08/2012 14:04:38	7200	0.0551
V2 (Daytime)	30/08/2012 19:00:07	30/08/2012 22:59:57	14400	0.0953
V2 (Night-Time)	30/08/2012 23:00:07	31/08/2012 06:59:57	28800	0.0909
V3	30/08/2012 14:10:44	30/08/2012 16:10:44	7200	0.0285

4.3 Noise Model

4.3.1. **Figures 3** to **6** provide the noise contours for the site, for the railway only, as requested by LBC

4.4 Noise Model Validation

4.4.1. **Table 4.4** provides a comparison of the noise model results with the noise survey results at each measurement location.

Table 4.4: Comparison of Noise Model and Noise Survey Results

Location	$L_{Aeq,12h}$ Daytime (dB)			$L_{Aeq,4h}$ Evening (dB)			$L_{Aeq,8h}$ Night-Time		
	Survey	Model	Difference	Survey	Model	Difference	Survey	Model	Difference
LT	67	68	1	66	68	2	65	64	-1
ST1	58	58	0	55	56	1	50	51	1
ST2	59	62	3	56	59	3	51	53	2

4.4.2. It can be seen that the noise survey and model are within ±3 dB at each of the measurement locations, therefore the model is considered to provide a good representation of the existing noise climate.

5 Assessment

5.1 Construction and Demolition

Noise

5.1.1. The noise survey has been used to determine the existing ambient noise levels $L_{Aeq,T}$ at the nearest noise sensitive receptors potentially affected by demolition and construction noise.

5.1.2. **Table 5.1** provides the results of the BS 5228-1 Annex E assessment of construction and demolition noise thresholds outlined in **paragraph 2.5.22**.

Table 5.1: BS 5228-1 Annex E Assessment

Location	$L_{Aeq,T}$ from Measured on Site (to the Nearest 5 dB) (dB)			BS 5228 $L_{Aeq,T}$ Limit (dB)		
	Day (L_d)	Evening (L_e)	Night (L_n)	Day (L_d)	Evening (L_e)	Night (L_n)
LT	65	65	65	70	65	55
ST1	60	55	50	65	60	55
ST2	60	55	50	65	60	55

5.1.3. Once dwellings are inhabited they become receptors to the next stage of development and the BS 5228 limits shown in **Table 5.1** should be used.

Vibration

5.1.4. Vibration transmitted from construction activities through the ground to the receiver cannot be reliably calculated. Many factors such as rock/soil type, water content, solid damping, etc, greatly influence the way in which vibration travels through the ground. Therefore, monitoring of vibration levels as a result of construction / demolition is required in the Code of Construction Practice (CoCP) for each phase for periods when piling is necessary.

5.2 Noise Assessment

Internal Noise Levels

5.2.1. **Table 5.2** provides a summary of the noise level at selected façades, including those adjacent to Wellesley Road, Vicar's Road and the Midland Main Line, without mitigation predicted by the noise model. The location of the different façades is shown on **Figure 2**.

Table 5.2: Summary of Free Field Noise Level at Selected Façades

Receiver Reference	Height	Dominant Noise Source	Predicted Façade Noise Levels (dB)			
			Daytime $L_{Aeq,12h}$ (dB)	Evening $L_{Aeq,4h}$ (dB)	Night-Time $L_{Aeq,1h}$ (dB)	Night-Time L_{AFmax} (dB)
DHO East 1	Ground floor (1.5 m)	Road traffic	59	57	51	70
	Second floor (8 m)		59	57	51	68
	Fifth floor (20 m)		59	58	51	66
DHO East 2	Ground floor (1.5 m)	Road traffic	57	57	51	70
	Second floor (8 m)		57	55	50	71
	Fifth floor (20 m)		55	53	47	70
DHO East (North façade)	Ground floor (1.5 m)	Rail traffic	60	60	51	79
	Second floor (8 m)		72	72	63	91
DHO North 1	Ground floor (1.5 m)	Rail traffic	62	62	54	81
	Second floor (8 m)		73	73	66	92
DHO North 3	Ground floor (1.5 m)	Rail traffic	61	61	53	80
	Second floor (8 m)		73	73	66	92
DHO South East (North façade)	Ground floor (1.5 m)	Rail traffic	50	50	43	70
	Second floor (8 m)		51	51	43	70
DHO South West	Ground floor (1.5 m)	Rail traffic	51	50	43	69
	Second floor (8 m)		51	50	43	69
DHO South West (East façade)	Ground floor (1.5 m)	Rail traffic	51	51	44	69
	Second floor (8 m)		52	52	45	69
BLR (Phase 2) East	Ground floor (1.5 m)	Road traffic	62	59	54	65
	Second floor (8 m)		60	57	52	62
	Fifth floor		56	53	48	58

Receiver Reference	Height	Dominant Noise Source	Predicted Façade Noise Levels (dB)			
			Daytime $L_{Aeq,12h}$ (dB)	Evening $L_{Aeq,4h}$ (dB)	Night-Time $L_{Aeq,1h}$ (dB)	Night-Time L_{AFmax} (dB)
	(20 m)					
BLR (Phase 2) South (North façade)	Ground floor (1.5 m)	Rail traffic	42	42	34	61
	Second floor (8 m)		42	42	34	61
BLR (Phase 2) South West	Ground floor (1.5 m)	Road traffic	62	59	54	64
	Second floor (8 m)		61	58	52	63
	Fifth floor (20 m)		57	54	49	60
BLR (Phase 2) West (East façade)	Ground floor (1.5 m)	Road traffic	45	44	38	50
	Second floor (8 m)		46	44	38	50
	Fifth floor (20 m)		46	45	38	51
BLR (Phase 3) North West	Ground floor (1.5 m)	Rail traffic	49	49	40	68
	Second floor (8 m)		51	51	41	70
	Fifth floor (20 m)		55	55	44	74
BLR (Phase 3) South East	Ground floor (1.5 m)	Road traffic	56	53	48	59
	Second floor (8 m)		56	53	48	59
BLR (Phase 3) South (North façade)	Ground floor (1.5 m)	Rail traffic	44	44	37	63
	Second floor (8 m)		44	44	37	63
BLR (Phase 3) West	Ground floor (1.5 m)	Rail traffic	49	49	40	68
	Second floor (8 m)		49	48	40	67
	Fifth floor (20 m)		51	51	41	70

5.2.2. The external noise levels fall below the noise levels at which LBC policy DP28 states that "planning permission will not be granted." Glazing mitigation required to reduce the internal noise levels to the 'good' internal noise criteria in BS 8233 is summarised in **Section 6**.

5.2.3. The night-time L_{AFmax} has been calculated by comparing the $L_{Aeq,8h}$ at the nearest noise survey location with the $L_{Aeq,8h}$ predicted by the noise model to obtain a correction and applying this to the nearest measured $L_{AFmax.}$

External Areas

5.2.4. **Figure 7** presents the ground level daytime noise levels as a worst case. For outdoor garden areas, this shows that the noise levels will not exceed 55dB(A) which is the outdoor criteria in BS 8233:1999

Fixed Plant

5.2.5. The criteria for the rating level of fixed plant are provided in **Table 2.4**. It can be seen that the background noise level does not exceed 60 dB $L_{AF90,T}$ at any of the measurement locations, therefore the criteria is 5 dB below the background noise level 1 m from a sensitive façade or 10 dB below if there is a distinguishable discrete continuous note or distinct impulses.

5.2.6. Using the above criteria, the rating noise limits from fixed plant associated with the site, 1 m from the nearest façade, is shown in **Table 5.3**. It has been assumed that the noise from the building services plant may have a tonal element to provide a worst-case assessment.

Table 5.3: Summary of the Cumulative Rating Noise Limits of all Fixed Plant Associated with the Development

Location	Daytime and Evening		Night-Time	
	Lowest Measured $L_{A90,1h}$ (dB)	Required Rating Level $L_{Ar,1h}$ (dB)	Lowest Measured $L_{A90,5min}$ (dB)	Required Rating Level $L_{Ar,5min}$ (dB)
Vicar's Road site	41	31	37	27
East of Phase 2 site	45	35	39	29
South of Phase 2 site	45	35	39	29

5.3 Vibration Assessment

5.3.1. **Table 5.4** provides a summary of the calculations of VDV in the three vibration measurement locations.

Table 5.4: Summary of the VDVs in the Vicar's Road Site

Location	Daytime VDV ($ms^{-1.75}$)		Night-Time VDV ($ms^{-1.75}$)	
	Calculated	Conclusion	Calculated	Conclusion
V1	0.07	Below threshold of planning permission refusal	0.03	Below threshold of planning permission refusal