AIRO

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for
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RAILWAY NOISE AND VIBRATION

SURVEY AND ASSESSMENT

57 SOUTH PARK GARDENS

BERKHAMSTED

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BERKHAMSTED

1. INTRODUCTION

This report provides the results of an environmental noise and vibration assessment in respect of proposals for 6 new dwellings at 57 South Park Gardens, Berkhamsted, which is adjacent to the West Coast Mainline railway.

The noise and vibration assessments reported herein are based on noise and vibration level measurements made at the site on 18 and 19 April 2018 in relation to the adjacent railway.

Reference is made to current national planning guidance and the noise level measurements have been used to provide mitigation advice aimed at satisfying noise level limits outlined in British Standard BS 8233:2014 (ref 1) and World Health Organization document Guidelines for Community Noise (ref 2).

In relation to groundborne vibration reference is made to guidance given in British Standard BS 6472:2008 (ref 3).

2. DESCRIPTION OF THE SITE

Richard Farris drawing number Drg.HP4/1432/P/02 C provides a planning layout and elevational drawings of the proposals.

Six detached dwellings in a crescent are proposed with the closest dwellings being about 10 metres from the railway boundary. The railway is on an embankment as it passes the site. The site slopes relatively steeply upwards from the lowest levels along the railway boundary.

3. NOISE AND VIBRATION MEASUREMENT UNITS

3.1 A-Weighted Equivalent Continuous Sound Level - $L_{Aeq,T}$

As its name suggests, the $L_{Aeq,T}$ is a measure of the acoustic energy of a fluctuating noise climate over a given period *T* expressed as the single continuous noise level having the same energy as the time varying signal.

The 'A' within the descriptor means A-weighted, an internationally agreed frequency response generally similar to that of the human ear so that A-weighted sound levels in dB correspond reasonably well with what is heard.

For assessment purposes, the day is typically divided into a 16-hour daytime period (07:00 to 23:00) and an 8-hour night-time period (23:00 to 07:00). The period values may be derived from the logarithmic average of the relevant hourly values.

3.2 Maximum Noise Level - L_{AFmax}, L_{ASmax}

In some circumstances it is useful to quantify the maximum level of fluctuating noise and a commonly used descriptor is L_{Amax}. The L_{Amax} represents the maximum reading given by a sound level meter for a given event or period of time and is usually qualified by F for 'Fast' or S for 'Slow' according to the response time setting of the meter.

3.3 Vibration Dose Value - VDV

Vibration Dose Value, VDV, is based on the frequency range 0.5 Hz to 80 Hz which has been shown to be the most important in respect of the human perception of whole body vibration and is weighted in a manner which reflects human sensitivity to the various frequencies.

Triaxial measurements utilise two frequency weightings specified for different orientations to the vibration. In accordance with BS 6472-1:2008 (ref 3) the "W_b" weighting is used for the vertical component (referred to as the 'z' axis) and the "W_d" weighting is used for the horizontal components of vibration (referred to as the 'x' and 'y' axes).

The VDV measurement strongly reflects the importance of significant single vibration events while still taking account of the fact that many such events will give rise to greater adverse comment than one. The unit for VDV is $m/s^{1.75}$.

4. MEASUREMENT SURVEY

Measurements of noise and vibration were made at the site during the period 09:00 hours on Wednesday 18 April to 09:00 hours on Thursday 19 April 2018.

The measurements were made using a data logging meter which measured and stored triaxial vibration levels and the sound level every second continuously over the measurement period.

The triaxial accelerometer was mounted on a heavy metal disk with three metal spikes which was placed on the concrete base of a greenhouse.

The microphone was mounted on a stand to be 1.2 to 1.5 metres above local ground level in free-field conditions.

Figure 1 indicates the measurement locations, Appendix A provides further details of the instrumentation used and Appendix B provides details of the weather during the survey.

Table 1 sets out the main results of the sound level measurements. Table 2 sets out the measured period Vibration Dose Values.

Figure 2 shows the sound level time history for the night time period.

Figure 1 – Existing Site Plan indicating Measurement Positions

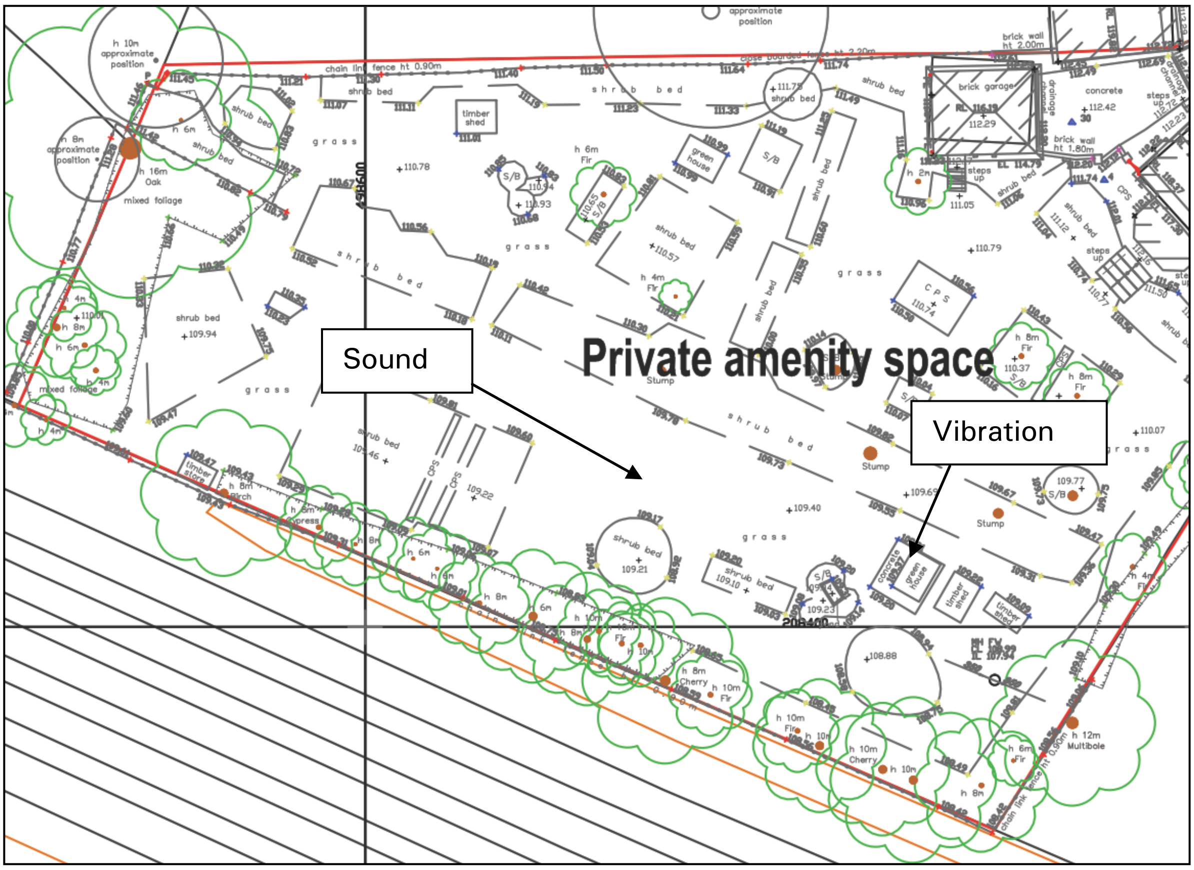
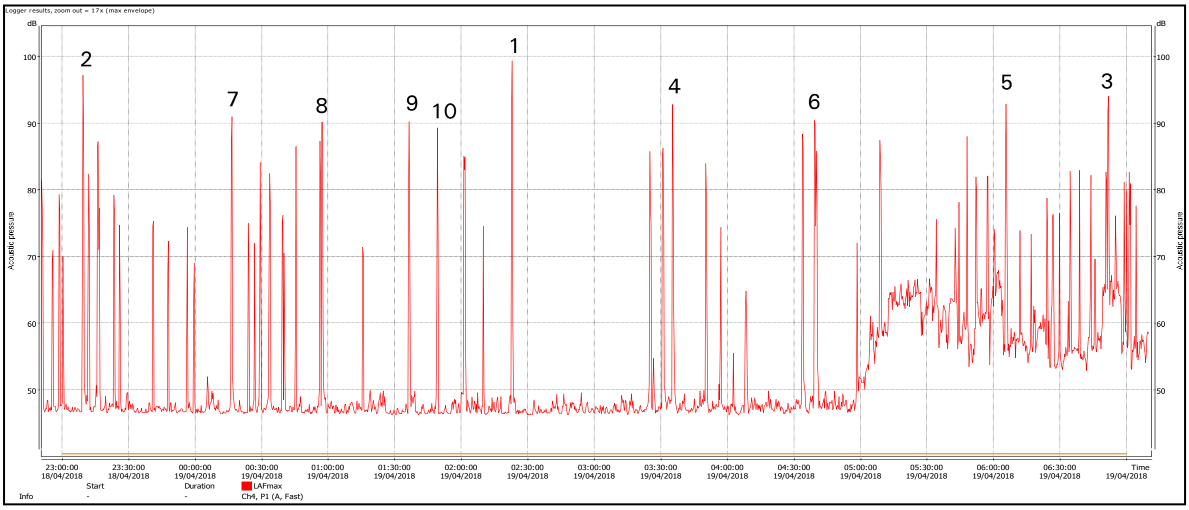


Table 1 – Hourly Sound Levels		
	Period Commencing	Sound Levels L_{Aeq}
Wednesday 18 April 2018	09:00	66
	10:00	67
	11:00	66
	12:00	65
	13:00	67
	14:00	69
	15:00	67
	16:00	67
	17:00	68
	18:00	69
	19:00	66
	20:00	67
	21:00	68
	22:00	61
	23:00	65
Thursday 19 April 2018	00:00	66
	01:00	61
	02:00	65
	03:00	64
	04:00	65
	05:00	63
	06:00	66
	07:00	66
	08:00	67
	09:00	68
Daytime (07:00 – 23:00)		67
Night-time (23:00 – 07:00)		64

Table 2 – Period Vibration Dose Values (VDV)		
Period	Vibration Dose Value VDV m/s$^{1.75}$	
	Vertical W_b	Horizontal W_d
Daytime	0.034	0.007
Night-time	0.024	0.005

Figure 2 – Night-time Sound Level History, L_{AFmax}



The numbered events are the 10 events for which the highest values of L_{AFmax} were measured during the night-time. The 10th highest event gave rise to an L_{AFmax} of 89 dB.

5. ASSESSMENT GUIDANCE

Since its publication on 27 March 2012 the National Planning Policy Framework (NPPF) (ref 4) provides the current national planning policies for England, including those related to noise. It is accompanied by the Planning Practice Guidance (ref 5) updated in March 2014.

With particular reference to noise, the NPPF and the Planning Practice Guidance refer to the Noise Policy Statement for England (NPSE) (ref 6), published in March 2010. The NPSE provides the long-term vision of Government noise policy:

"Noise Policy Vision

Promote good health and a good quality of life through the effective management of noise within the context of Government policy on sustainable development."

The NPSE says that the long-term vision is supported by the following aims:

"Noise Policy 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 impact on health and quality of life;*
- *mitigate and minimise adverse impact on health and quality of life; and*
- *where possible, contribute to the improvement of health and quality of life."*

The Explanatory Note to the NPSE and the Planning Practice Guidance discuss the terms "*Significant adverse*" and "*adverse*" linking concepts from toxicology that are being applied to noise impacts (for example, by the World Health Organization). The concepts are "NOEL" and "LOAEL" which are the "No Observed Effect Level" and "Lowest Observed Adverse Effect Level" respectively. The Note extends these concepts to introduce a "SOAEL" (Significant Observed Adverse Effect Level) but recognises that objective noise measures or limits are not developed for SOAEL.

It is important to note that the NPSE says it makes a *"distinction between 'quality of life' which is a subjective measure that refers to people's emotional, social and physical well-being and 'health' which refers to physical and mental well-being"*.

The Noise Policy Aims include reference to both of these aspects.

Guidelines for Community Noise (GCN) (ref 2) published by WHO is often cited in relation to noise level limits.

Since its publication another WHO document, Night Noise Guidelines for Europe (NNG) published in 2009, has been released that also provides guidance in this area.

WHO defines health in the NNG as *"a state of complete physical, mental and social well-being and not merely the absence of disease or infirmity and recognizes the enjoyment of the highest attainable standard of health as one of the fundamental rights of every human being"*. This definition of 'health' clearly aligns with the joint definitions of 'quality of life' and 'well-being' presented in the NPSE.

It is reasonable therefore to suggest that the guideline limits presented by WHO can be drawn on in relation to the requirements of the NPPF.

Guidelines for Community Noise provides guideline noise level limits which it says are *"essentially values for the onset of health effects from noise exposure"* and includes consideration of various aspects including Sleep Disturbance, Mental Illness, Performance and Social and Behavioural Effects of Noise.

Night Noise Guidelines for Europe provides updated guidance with, as the title suggests, particular regard to night-time noise. Consideration and threshold noise level limits are given for Biological Effects, Sleep Quality, Well-being and Medical Conditions.

The indoor noise level limits presented where sufficient evidence is available align reasonably well with the night-time limits given in the earlier GCN. Indeed NNG says that it *"complements the 1999 guidelines"* and also that *"the recommendations on government policy framework on noise management elaborated in the 1999 Guidelines should be considered valid and relevant for the Member States to achieve the guideline values of this document"*.

AIRO interprets this to mean that the noise level limits given in Guidelines for Community Noise are current and relevant for newly built dwellings.

Table 3 sets out the guideline design limits for indoor ambient sound levels due to the ingress of external sound that derive from Guidelines for Community Noise and BS 8233.

Table 3 – Dwelling Indoor Ambient Noise Level Limits		
Location	07:00 to 23:00	23:00 to 07:00
Living Room	35 dB $L_{Aeq,16hour}$	--
Dining room/area	40 dB $L_{Aeq,16hour}$	--
Bedroom	35 dB $L_{Aeq,16hour}$	30 dB $L_{Aeq,8hour}$ 45 dB L_{AFmax} not exceeded more than 10 times a night

The following extract from BS 8233 relates to external amenity spaces:

> ***"Design criteria for external noise***
> ***For traditional external areas that are used for amenity space, such as gardens and patios, it is desirable that the external noise level does not exceed 50 dB LAeq,T, with an upper guideline value of 55 dB LAeq,T which would be acceptable in noisier environments. However, it is also recognized that these guideline values are not achievable in all circumstances where development might be desirable. In higher noise areas, such as city centres or urban areas adjoining the strategic transport network, a compromise between elevated noise levels and other factors, such as the convenience of living in these locations or making efficient use of land resources to ensure development needs can be met, might be warranted. In such a situation, development should be designed to achieve the lowest practicable levels in these external amenity spaces, but should not be prohibited."***

British Standard BS 6472:2008 "Guide to evaluation of human exposure to vibration in buildings" gives guidance on acceptable levels of vibration. A table is given in BS 6472 (Table 1, Section 6) which compares Vibration Dose Values with possible adverse comment in three bands. Table 4 below reproduces this information

Table 4 – Vibration Dose Values ($m/s^{1.75}$) against adverse comment (BS 6472)			
Place and Time	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

6. ASSESSMENTS AND MITIGATION

In relation to the assessment guidance described in Section 5, it may be concluded that:

a) external noise levels in the proposed gardens may be up to 67 dB L_{Aeq}, exceeding the upper guidance level of 55 dB L_{Aeq} by 12 dB,

b) to meet guidance for noise levels inside dwellings, sound insulation to provide minimum reductions of 32 dB and 44 dB to the most exposed living rooms and bedrooms respectively is necessary,

c) Vibration Dose Values are significantly below (better than) the “low probability of adverse comment” threshold,

6.1 Amenity Spaces

To reduce railway noise levels in the amenity spaces it would be necessary to provide a barrier.

In principle, barriers provide greatest benefits when close to the source. In general, a barrier that is at least 2 metres high with respect to the ground height at the source would be needed and would either need to extend along the railway beyond the site extents or return along the sides of the site such that there is no line of sight to the railway from the gardens.

Given that the railway is on an embankment as it passes the site, unless the barrier could be constructed on top of the embankment close to the rails, it would be necessary to make up the difference in height between the site boundary and the top of the embankment in addition to the 2 metre height above railway level. The embankment is estimated to be about 3 metres high indicating a total barrier height if constructed along the site boundary of at least 5 metres.

Given that it is extremely unlikely that barriers could be constructed on the top of the embankment on land outside of the site and the construction of a 5 metre structure is impractical, AIRO understands that a 2.5 to 3 metre high fence would be constructed that would provide some localized protection against railway noise.

It may be noted that noise levels in the garden of the existing property and the neighbouring gardens along the railway would be expected to be up to 67 L_{Aeq} and not less than 64 dB L_{Aeq} close to the houses. None-the-less, these spaces appear to be used and enjoyed as gardens by the householders and there are properties and gardens along the railway that are closer.

6.2 Building Envelope Sound Insulation Performance

External noise may be transmitted into habitable rooms through many paths but, in general, the most significant paths to consider are through windows, through any doors or patio doors giving direct access outside, through ventilators and through the external wall itself.

The overall or composite sound insulation depends on the sound insulation of the separate elements and on their area relative to the overall area of the façade (when viewed from inside the room of interest).

The noise level in the room will also depend on the sound absorption in the room which is affected by the volume of the room and by the amount and type of furnishings.

The data provided for external fabric building elements and glazing would normally be given in relation to railway noise in the form of '$R_w + C$' or '$R_w + C_{tr}$' values in dB. R_w is the Weighted Sound Reduction Index in dB, C is the Spectrum Adaptation term in dB for railway traffic at medium and high speeds and C_{tr} is the Spectrum Adaptation term in dB for railway traffic at low speeds. The R_w, C and C_{tr} performance indices are calculated from laboratory based tests carried out in accordance with BS EN ISO 10140-2 (formerly BS EN ISO 140-3) and rated in accordance with BS EN ISO 717-1.

The $R_w + C_{tr}$ performance specification is almost always the more stringent specification when considering a given noise source that requires both to be looked at and therefore in this instance the single figure '$R_w + C_{tr}$' performance value should be satisfied, which in turn should then also satisfy the $R_w + C$ requirement. The $R_w + C_{tr}$ performance value can be considered, in this case, equivalent to an 'A-weighted' sound level difference. As an example, a window having an $R_w + C_{tr}$ performance value of 33 dB would be expected to provide around 33 dB(A) sound attenuation against typical railway traffic noise spectrums for trains at low speeds.

The sound insulation of small elements such as ventilators is characterized by their $D_{n,e,w} + C_{tr}$ where $D_{n,e,w}$ is the Weighted Element Normalized Level Difference.

The highest levels of sound insulation are required to the railway facing bedrooms of Plots 2 to 5 in order to meet the internal maximum noise level criterion of 45 dB L_{AFmax} against an external maximum noise level of 89 dB exceeded by 10 night-time events.

In order to limit the sound insulation requirements of the windows, it is considered necessary to use an external wall construction that can achieve a minimum $R_w + C_{tr}$ of 54 dB. In general, a traditional cavity masonry wall would be expected to achieve an $R_w + C_{tr}$ of about 48 dB. Consequently, a construction that achieves more than this may be seen to be necessary. This could for example, require the addition of a independent wall lining system behind (on the room side) of a cavity masonry system.

An enhanced construction that could be considered would be to replace the room side plasterboard linings with a further, independent wall lining. This would be set 25 mm away from the inner leaf blockwork and consist of a suitable metal framework, mineral wool held between the frame, and 2 no. layers of 15 mm sound rated plasterboard.

With an external wall construction achieving an $R_w + C_{tr}$ of 54 dB, the windows to the relevant bedrooms would still need to achieve an $R_w + C_{tr}$ of 46 dB and the ventilator (if applicable) a $D_{n,e,w} + C_{tr}$ of 52 dB.

Secondary glazing systems will be able to offer higher sound insulation values up to 45 dB(A) depending on the thickness of the glass used and the depth of the cavity between the primary and secondary panes. A configuration comprising 10 mm glass, 200 mm sealed cavity and 6 mm glass would be expected to provide up to 45 dB $R_w + C_{tr}$. The side and top reveals of the windows should be lined with acoustically absorbent material which could comprise either 15 mm proprietary mineral fibre "acoustic" tiles (with a Noise Reduction Coefficient of 0.6 or more) or 25 mm thick mineral wool of around 50 kg/m^3 density retained behind a thin perforated metal or plastic facing sheet having 20% open area.

Secondary glazed systems utilizing double glazed units for both the primary and secondary elements can offer very high sound insulation performances. As an example, a primary unit comprising 8.4 mm laminated glass, 16 mm argon filled cavity and 6 mm glass together with a secondary unit consisting of 4 mm glass, 18 mm argon filled cavity and 6.4 mm laminated glass set with a 200 mm spacing between the glass of the separate units can achieve up to 51 dB $R_w + C_{tr}$.

A ventilator performance of 52 dB ($D_{n,e,w} + C_{tr}$) requires a separate (through-the-wall) unit complying with the requirements of the Noise Insulation Regulations 1975 or might be achieved with a carefully designed whole house (MEV or MVHR) system that does not have direct openings from outside to inside bedrooms. Mechanical Ventilation Heat Recovery (MVHR) or Mechanical Extraction Ventilation (MEV) systems work as a 'whole house' solution and are understood to require only two building envelope penetrations. This may therefore provide a more effective overall package, especially if the penetrations can be located away from the noisiest facade. Any self generated noise from systems of this type, or similar, must be maintained at a level at least 10 dB lower than the appropriate indoor noise level limit for the given room type (i.e. in addition to a suitable outside to inside sound insulation performance any self generated noise should be no more than 25 dB(A) in living areas and no more than 20 dB(A) in bedrooms).

The ventilation system should be designed such that the total noise provided to any given room, either through the system or otherwise generated by the system, should be no more than 25 dB(A) to living spaces and 20 dB(A) to bedrooms

Compared with Plots 2 to 5, the requirements for the bedrooms of Plot 6 are slightly reduced in view of the increased distance from and restricted view of the railway.

The requirements for Plot 1 and rooms other than bedrooms for all plots are significantly reduced compared with the bedrooms of Plots 2 to 6.

Table 5 summarises the sound insulation proposals to dwellings.

Table 5 – Minimum Sound Insulation to Plots

Location	$R_w + C_{tr}$ dB		$D_{n,e,w} + C_{tr}$ dB
	Wall	Windows	Ventilator
Plots 2 to 5			
Bedrooms 3, 4	54	46	52
Family/dining	48	33	38
Plot 6			
Bedrooms 3,4	54	41	52
Dining Room	48	25	35
Plot 1			
Bedrooms 2,3	48	38	47
Kitchen/Family/ Living	48	25	35
Everywhere Else	48	25	35

AIRO would consider that a typical proprietary double-glazed window with 4 mm glass either side of a 6 to 16 mm sealed cavity in a conventional masonry façade is capable of providing up to 28 dB(A) attenuation against road or rail traffic noise, provided that any integral vents are closed or omitted and that all units have effective seals, that is airtight when compressed and without there being distortion to any framing. With conventional trickle vents open the performance would be expected to drop to a maximum attenuation of around 25 dB(A).

A double-glazed unit with a 10 mm glass, 12 mm sealed cavity then 6 mm glass configuration would be expected to provide up to 33 dB $R_w + C_{tr}$.

High specification double-glazed units incorporating laminated glass e.g. a 16.8 mm laminated glass, 16 mm sealed cavity, 16.8 mm laminated glass configuration may be capable of providing up to 42 dB $R_w + C_{tr}$.

The manufacturer/supplier of the preferred system(s)/product(s) should be asked to provide independent test evidence, preferably from a United Kingdom Accreditation Service (UKAS) accredited laboratory and to the appropriate standards detailed above, that their system can provide the $R_w + C_{tr}$ or $D_{n,e,w} + C_{tr}$ performance(s) required.

6.3 Vibration Mitigation

The measured levels of groundborne vibration do not suggest special mitigation is required. In general, forms of constructions that may give rise to some amplification effects such as lightweight steel or timber frame construction, particularly in relation to the first floors should be avoided. General guidance suggests that 2 storey masonry buildings on piles or spread footings provide reasonable attenuation of vibration into the building from the ground.

7. CONCLUSIONS

This report has assessed proposals to construct 6 dwellings at 57 South Park Gardens, Berkhamsted in relation to potential noise and vibration arising from the nearby West Coast Mainline Railway.

The assessments have been based on a noise and vibration survey at the site on 18 and 19 April 2018.

Sound insulation proposals to meet guideline limits for noise inside dwellings have been made and the mitigation of external noise in gardens together with vibration effects discussed.

Report Approved by:

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REFERENCES

1. British Standard BS 8233:2014
   Guidance on sound insulation and noise reduction for buildings
   British Standards Institution, 2014

2. Guidelines for Community Noise
   World Health Organization, 1999

3. British Standard BS 6472:2008
   Guide to evaluation of human exposure to vibration in buildings
   British Standards Institution, 2008

4. National Planning Policy Framework
   Department for Communities and Local Government
   March 2012

5. Planning Practice Guidance
   Department for Communities and Local Government
   February 2014

6 Noise Policy Statement for England
   Department for Environment, Food and Rural Affairs
   2010

APPENDIX A - Schedule of Equipment

Table A1 - Schedule of Noise Instrumentation		
Use	Type	Serial No.
Measuring System	Svantek SVAN 958A	45502
Triaxial Accelerometer	Svantek SV84	D6018
Microphone	Microtech Gefell Gmbh MK 255	11730
Microphone Pre-amplifier	Svantek SV12L	47652
Vibration Calibrator	Svantek SV111	40587
Sound Level Calibrator	B&K 4230	1472196

CALIBRATION

AIRO is accredited by the United Kingdom Accreditation Service as a UKAS testing laboratory No. 0483 and although the measurements carried out for this survey are not listed on our schedule of accreditation, all of AIRO's noise measurement equipment is routinely calibrated as part of the calibration regime in our Quality Manual and these calibrations are traceable to National Standards.

In addition, the calibration level of the measuring equipment was checked at the start and the end of each survey period using the appropriate calibrator for the relevant meter/system.

APPENDIX B – Weather Conditions

Table B1 – Record of Weather Conditions

	18 April 2018	19 April 2018
Temperature, °C	14 to 23	12 to 15
Relative Humidity, %	34 to 84	68 to 79
Wind Speed, m/s	3 to 5	3 to 5
Wind Direction	SE to SW	E