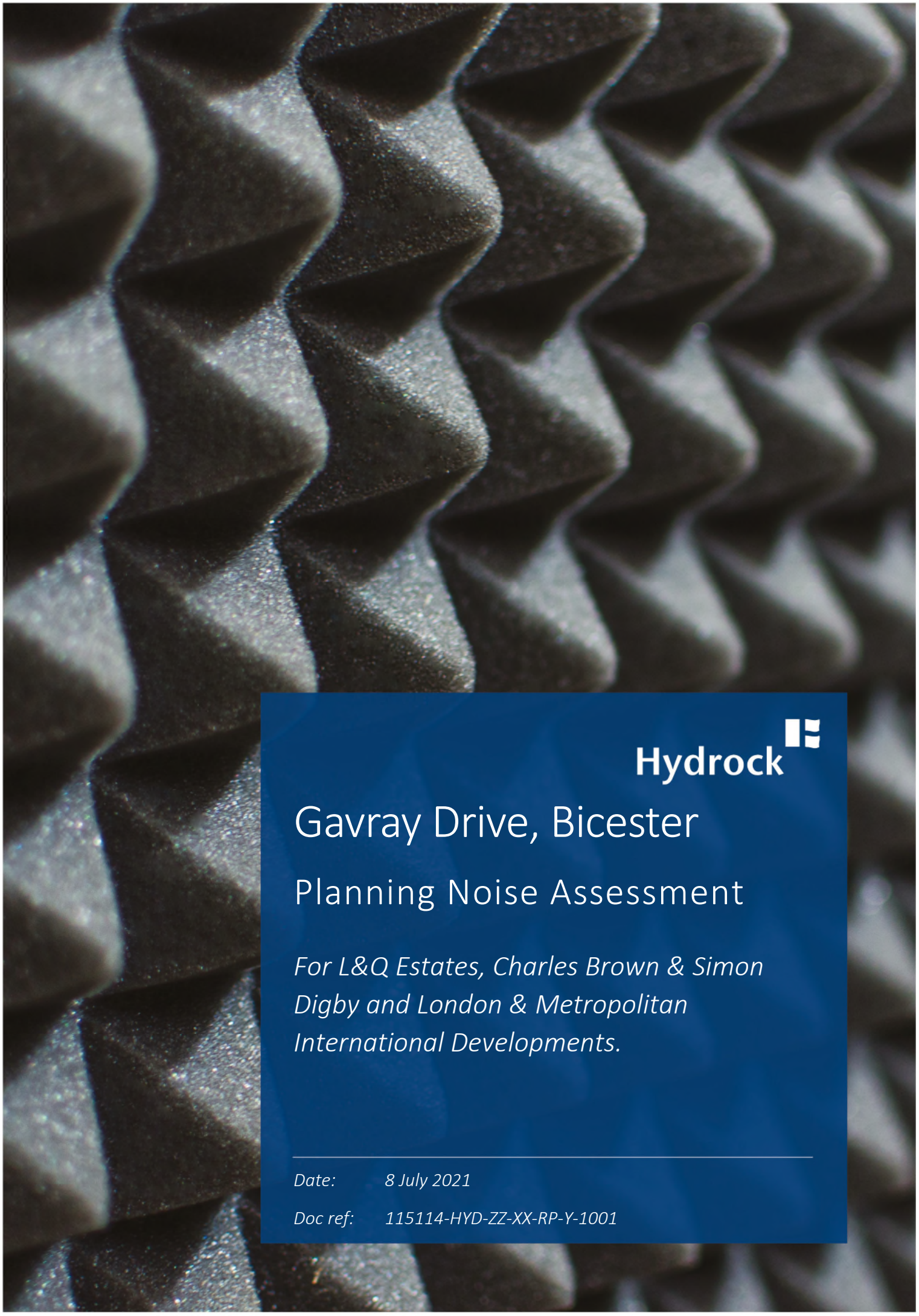

Hydrock

Gavray Drive, Bicester

Planning Noise Assessment

For L&Q Estates, Charles Brown & Simon Digby and London & Metropolitan International Developments.

Date: *8 July 2021*

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Appendix A Vibration Results

Noise Planning Report

Gavray Drive, Bicester

1. INTRODUCTION

Hydrock Consultants have been appointed by L&Q Estates, Charles Brown & Simon Digby and London & Metropolitan International Developments to provide acoustic consultancy services in relation to the proposed residential development at Gavray Drive, Bicester.

This report has been prepared by Vince Taylor at Hydrock to provide an assessment of the impact of existing and future environmental noise and vibration levels on the sensitive uses (250 dwellings) within the proposed development.

The development comprises residential development for up to 250 dwellings including affordable housing and ancillary uses including retained Local Wildlife Site, public open space, play areas, localised land remodelling, compensatory flood storage, structural planting and access.

The proposed development will include noise sensitive uses. The impact on these from the following noise sources has been considered:

- Railway movements to the North and West;
- Gavray Drive to the South;
- A4421 to the East.

2. DESCRIPTION - DEVELOPMENT SITE

The site is located North East of Gavray Drive, and is bounded by industrial uses to the North East, and rail to the North and West.

The key noise sources in context are indicated below in Figure 1.

Figure 1: Key noise sources

The most recent masterplan is presented below:

Figure 2: Illustrative Masterplan

3. PLANNING POLICY

3.1 Noise policy Statement for England (NPSE)

The NPSE is intended to apply to environmental noise and neighbourhood noise of all forms but excluding noise occurring in the workplace.

The NPSE cites concepts from toxicology and advises that impacts should be considered with regards to health effects and quality of life:

"There are two established concepts from toxicology that are currently being applied to noise impacts, for example, by the World Health Organisation. They are:

- *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.

Extending these concepts for the purpose of this NPSE leads to the concept of a significant observed adverse effect level.

- *SOAEL – Significant Observed Adverse Effect Level*

This is the level above which significant adverse effects on health and quality of life occur."

The NPSE does not provide any numerical thresholds for determining the magnitude of a noise impact. Moreover, the document advises that it is not possible to have "a single objective noise-based measure…that is applicable to all sources of noise in all situations". It further advises that the sound level at which an adverse effect occurs is "likely to be different for different noise sources, for different receptors and at different times."

3.2 National Planning Policy Framework (NPPF)

The National Planning Policy Framework (NPPF) is a key part of the Government's reforms to make the planning system less complex and more accessible, to protect the environment and to promote sustainable growth.

The NPPF constitutes guidance for local planning authorities and decision makers when drawing up plans and is a material consideration in determining applications.

Its core principle is to advocate a presumption in favour of sustainable development, which, in literal terms, means that if the adverse impacts of a development are outweighed by the benefits, when assessed as a whole, then the development should be approved. Local policy should reflect this principle and therefore the Local Authority has a key role in determining within its Local Plan and noise policies, what is acceptable in terms of any adverse noise effects within its area.

In reference to noise, the NPPF states (Section 123): Planning policies and decisions should aim to:

"Avoid noise from giving rise to significant adverse impacts on health and quality of life as a result of new development;

mitigate and reduce to a minimum other adverse impact on health and quality of life arising from noise from new development, including through the use of conditions;

recognise that development will often create some noise and existing businesses wanting to develop in continuance of their business should not have unreasonable restrictions put on them because of changes in nearby land uses since they were established.

identify and protect areas of tranquillity which have remained relatively undisturbed by noise and are prized for their recreational and amenity value for this reason"

3.3 Planning Practice Guidance

Planning Practice Guidance for Noise (PPG - Noise) is published online (https://www.gov.uk/guidance/noise--2). The guidance draws on the principles of the Noise Policy Statement for England (NPSE) and in particular the concepts of NOEL, LOAEL and SOAEL as described below:

- Significant observed adverse effect level (SOAEL): This is the level of noise exposure above which significant adverse effects on health and quality of life occur.
- Lowest observed adverse effect level (LOAEL): this is the level of noise exposure above which adverse effects on health and quality of life can be detected.
- No observed effect level (NOEL): this is the level of noise exposure below which no effect at all on health or quality of life can be detected.

The noise exposure hierarchy proposed by PPG - Noise is summarised in the Table below:

Table 1: Noise exposure hierarchy from PPG-N

Perception	Examples of outcomes	Increasing effect level	Action
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 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.	Significant observed adverse effect	Avoid
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

PPG-Noise does not provide numerical values for the different effect levels, instead recognising that *"The subjective nature of noise means that there is not a simple relationship between noise levels and the impact on those affected. This will depend on how various factors combine in any particular situation"*. These factors include:

The source and absolute level of the noise together with the time of day it occurs. Some types and levels of noise will cause a greater adverse effect at night than if they occurred during the day – this is because people tend to be more sensitive to noise at night as they are trying to sleep. The adverse effect can also be greater simply because there is less background noise at night.

For non-continuous sources of noise, the number of noise events, and the frequency and pattern of occurrence of the noise.

The spectral content of the noise (ie whether or not the noise contains particular high or low frequency content) and the general character of the noise (ie whether or not the noise contains particular tonal characteristics or other particular features). The local topology and topography should also be taken into account along with the existing and, where appropriate, the planned character of the area.

Consideration should also be given to whether adverse internal effects can be completely removed by closing windows and, in the case of new residential development, if the proposed mitigation relies on windows being kept closed most of the time. In both cases a suitable alternative means of ventilation is likely to be necessary.

3.4 Cherwell District Local Plan (1996)

The Cherwell District Local Plan was adopted in November 1996. Review of this document indicated that the following policies are in relation to noise and vibration:

ENV1 "Development which is likely to cause materially detrimental levels of noise, vibration, smell, smoke, fumes or other type of environmental pollution will not normally be permitted." And

ENV 3 "Development sensitive to noise generated by road traffic will be:

Refused where external noise levels exceed $L_{Aeq,16hr}$=72dB and $L_{Aeq,8hr}$=66dB between 07:00-23:00 hrs and 23:00-7:00 hrs respectively.

Generally resisted where external noise levels between 07:00-23:00 hrs and 23:00-07:00 hrs fall into the ranges $L^{Aeq16hr}$=63 to 72dB and $L_{Aeq,8hr}$=57 to 66dB respectively.

Expected to achieve a specified internal acoustic environment when the external noise levels between 07:00-23:00 hrs and 23:00-07:00 hrs fall into the ranges $L_{Aeq.16hr=}$55 to 63dB and $L_{Aeq,8hr}$=45 to 57dB respectively."

ENV 4 "Development sensitive to noise generated by rail traffic will be:

Refused where external noise levels exceed LAeq.16hr=74dB between 07:00 - 23:00 hrs and $L_{Aeq,8hr}$ = 66dB between 23:00 and 07:00 hrs.

Generally resisted where external noise levels between 07:00 - 23:00 and 23:00 - 07:00 fall into the ranges $L_{Aeq.16hr}$=66 to 74dB and LAeq,8hr=59 to 66dB respectively.

Expected to achieve a specified internal acoustic environment when external noise levels between 07:00 - 23:00 and 23:00 - 07:00 hrs fall into the ranges $L_{Aeq.16hr}$ = 55 to 66dB and $L_{Aeq,8hr}$=45 to 59dB respectively."

ENV5 “Notwithstanding policies ENV3 and ENV4, development sensitive to vibration will be resisted in locations where vibration levels are likely to affect the material comfort of end users”

3.5 The Non-Statutory Cherwell District Local Plan 2011 (2004)

The Non-Statutory Cherwell Local Plan 2011 was intended to review and update the Local Plan adopted in 1996. Due to changes to the planning system introduced by the Government, in December 2004, the Council decided to discontinue work on the draft Cherwell Local Plan 2011 and has begun preparing a Local Development Framework (LDF) under the new planning system.

The Council also decided on this date to approve the draft Cherwell Local Plan 2011 as interim policy. Review of this document indicated that the following policy is in relation to noise:

- EN 7 which reiterates Policy ENV3 of the Cherwell District Local Plan (1996).
- EN 8 which reiterates Policy ENV4 of the Cherwell District Local Plan (1996).
- EN 9 which reiterates Policy ENV 5 of the Cherwell District Local Plan in relation to EN7 and EN8 (1996).

3.6 Cherwell Local Plan 2011-2031 (Adopted July 2015)

10.1.1 The Adopted Cherwell Local Plan 2011-2031 contains strategic planning policies for development and the use of land. It forms part of the statutory Development Plan for Cherwell to which regard must be given in the determination of planning applications.

10.1.2 The Plan was formally adopted by the Council on 20 July 2015. Policy Bicester 13 was re-adopted on 19 December 2016

10.1.3 Key policies identified above have been readopted or adapted for the current local plan.

3.7 The Control of Pollution Act 1974

The Control of Pollution Act provides Local Authorities with the power to control noise from construction sites. This may include specific controls to restrict certain activities identified as causing particular problems. Also, conditions regarding hours of operation will generally be specified and noise and vibration limits at certain locations may be applied in some cases.

The powers include prosecution for failure to comply with the requirements of a notice served under the act, and a system of providing prior consents for works to be carried out in a specified manner so as to reduce the likelihood of causing disturbance (‘s.61 consents’). Noise generators can use the defence that best practicable means have been employed to control noise emissions.

3.8 Environmental Protection Act 1995

The Environmental Protection Act provides local authorities and individuals with powers to serve, or request a magistrate to serve, abatement notices against noise (including vibration) from premises that are considered to be a nuisance. Noise generators can use the defence that best practicable means have been used to control noise emissions or (in relation to construction noise) that the alleged nuisance arose from activities that were compliant with an extant consent under s.61 of the Control of Pollution Act (prior consent).

4. DESIGN STANDARDS AND GUIDANCE

4.1.1 British Standard BS 6472:2008 Part 1

British Standard BS 6472:2008 "Guide to evaluation of human exposure to vibration in buildings, Part 1 Vibration sources other than blasting" is the British Standard methodology used for measuring and evaluating human exposure to vibration from sources such as railways. The table below summarises the levels of vibration dose values (VDV) and the corresponding probability of adverse comments.

Table 2: Vibration dose values which might result in various probabilities of adverse comment within residential buildings.

Place and Time	Low probability of adverse comment ($m/s^{1.75}$)	Adverse comment possible ($m/s^{1.75}$)	Adverse comment probable ($m/s^{1.75}$)
Residential buildings - 16hr day	0.2 - 0.4	0.4 - 0.8	0.8 - 1.6
Residential buildings - 8hr night	0.1 - 0.2	0.2 - 0.4	0.4 - 0.8

4.2 British Standard BS 8233:2014

BS 8233 provides guidance for the control of noise in and around buildings. The guidance provided within the document is applicable to the design of new buildings, or refurbished buildings undergoing a change of use, but does not provide guidance on assessing the effects of changes in the external noise levels to occupants of an existing building. The guidance provided includes appropriate internal and external noise level criteria which are applicable to dwellings and other types of building. Target internal noise levels for dwellings are presented in Table 3.

Table 3: Internal Noise Limits for Dwellings from BS8233:2014

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

Whilst BS 8233:2014 recognises that a guideline value may be set in terms of SEL or L_{AFmax} in bedrooms of dwellings during the night-time to minimise the risk from regular individual noise events that can affect sleep quality, a specific criterion is not stipulated. Therefore, guidance on maximum night-time noise levels from World Health Organisation (WHO) 1999: "Guidelines for Community Noise" are often used in the UK.

From WHO: *"When the background noise is low, noise exceeding 45 dB L_{AFmax} should be limited, if possible, and for sensitive persons an even lower limit is preferred. Noise mitigation targeted to the first part of the night is believed to be an effective means for helping people fall asleep. It should be noted that the adverse effect of noise partly depends on the nature of the source."*

For noise in external amenity areas (gardens and balconies) BS8233:2014 gives an upper guideline level of 55 dB L_{Aeq} but states that 50 dB L_{Aeq} is desirable. However, with reference to the National Noise Incidence Survey carried out in 2000 / 2001 (BRE), 54% of the UK population are exposed to daytime noise levels at or above 55 dB LAeq 16hr. Therefore, it will not be possible to achieve the upper guideline noise level at many suitable residential sites and it is often necessary to compromise. This is acknowledged in BS8233:2014, as follows:

"…it is also recognised 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 convenience of living in these locations or making efficient use of land resources to ensure development needs can be met, might be warranted."

4.3 British Standard 4142:2014+A1:2019

The standard method for assessing noise from commercial and industrial premises in the UK is British Standard BS 4142 "Method for rating and assessing industrial and commercial sound". The standard is applicable for assessing noise affecting "dwellings or premises used for residential purposes" and can be used to assess the impact of new commercial or industrial types of noise (including mechanical plant) on existing dwellings or existing noise generating uses on proposed dwellings.

A BS 4142 assessment is made by determining the difference between the specific noise under consideration and the background sound level, as represented by the LA90 parameter, determined in the absence of the commercial sound. The LA90 parameter is defined as the level exceeded for 90% of the measurement time. This parameter therefore excludes short duration noise events, such as individual vehicle movements, and represents the underlying continuous noise.

The commercial or industrial sound is assessed in terms of the equivalent continuous noise level, L_{Aeq}. The equivalent continuous noise level (L_{Aeq}) of the commercial or industrial sound, over the applicable assessment period, is known as the specific sound level.

A character correction penalty can be applied to the specific sound level where the commercial noise exhibits distinguishable tones, impulsiveness, intermittency or other characteristics which "are otherwise readily distinctive against the residual acoustic environment".

The specific noise level with the character correction (if necessary) is known as rating level (L_{Ar}) and the difference between the background noise and the rating level is determined to make the BS 4142 assessment. The following is then considered.

"a) Typically, the greater this difference, the greater the magnitude of the impact.

b) A difference of around +10 dB or more is likely to be an indication of a significant adverse impact, depending on the context.

c) A difference of around +5 dB is likely to be an indication of an adverse impact, depending on the context.

d) The lower the rating level is relative to the measured background sound level, the less likely it is that the specific sound source will have an adverse impact or a significant adverse impact. Where the rating level does

not exceed the background sound level, this is an indication of the specific sound source having a low impact, depending on the context."

The standard highlights the importance of considering the context in which a sound occurs. Factors including the absolute sound level, the character of the sound, the sensitivity of the receptor and the existing acoustic character of the area should be considered when assessing the noise impact. The use of the proposed premises for residential use is also pertinent to the consideration of context.

The standard notes the need to consider absolute sound levels where background sound levels are low:

"For a given difference between the rating level and the background sound level, the magnitude of the overall impact might be greater for an acoustic environment where the residual sound level is high than for an acoustic environment where the residual sound level is low.

Where the background sound levels and rating level are low, absolute levels might be as, or more, relevant than margin by which the rating level exceeds the background. This is especially true at night."

4.4 World Health Organisation (WHO) Guidelines on Community Noise

The WHO "Guidelines on Community Noise", Berglund et. al., 1999 provides guidance on all types of noise excluding noise in the work place. This includes noise from: transport infrastructure, industrial and commercial activity, and other forms of neighbourhood noise. The document discusses the impacts of noise with reference to health effects, annoyance, sleep disturbance, performance, interference with speech communication and other activity specific impacts.

Recommended equivalent continuous (average) internal noise levels for habitable rooms are generally in line with those from BS8233:2014 but the document also recommends a limit for individual short term noise events:

"When noise is continuous, the equivalent sound pressure level should not exceed 30 dB(A) indoors, if negative effects on sleep are to be avoided. For noise with a large proportion of low-frequency sound a still lower guideline value is recommended. When the background noise is low, noise exceeding 45 dB L_{Amax} should be limited, if possible, and for sensitive persons an even lower limit is preferred. Noise mitigation targeted to the first part of the night is believed to be an effective means for helping people fall asleep. It should be noted that the adverse effect of noise partly depends on the nature of the source."

The short-term maximum noise limit for good sleep appears to be based on research from Vallet & Vernet which is quoted by the WHO Guidelines as follows:

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

Therefore, the 45 dB L_{AFmax} criterion is not intended to be an absolute limit, i.e., a limited number of exceedances is acceptable and these may be less significant in the middle of the night or early morning.

The WHO Guidelines also suggests external noise limits for mitigating annoyance:

"The capacity of a noise to induce annoyance depends upon its physical characteristics, including the sound pressure level, spectral characteristics and variations of these properties with time. During daytime, few people are highly annoyed at L_{Aeq} levels below 55 dB(A), and few are moderately annoyed at L_{Aeq} levels below 50 dB(A). Sound levels during the evening and night should be 5–10 dB lower than during the day. Noise with low-frequency components require lower guideline values. For intermittent noise, it is emphasized that it is necessary

to take into account both the maximum sound pressure level and the number of noise events. Guidelines or noise abatement measures should also take into account residential outdoor activities."

Note, the WHO external noise thresholds for moderate annoyance are approximately equal to the recommended internal noise levels for habitable rooms based on the standard assumption (used within the WHO Guidelines) of 15 dB attenuation through an open window.

In the UK, the annoyance thresholds from the WHO Guidelines are often assumed to only relate to transports or "anonymous" noise sources. That is, ambient noise for which no individual person or commercial operation can be held responsible. This is not always how the WHO Guidelines are interpreted, for example the World Bank imposes a 45 dB L_{Aeq} external noise limit on new power stations for which it provides funding which is likely based on the WHO Guidelines.

The UK common interpretation may be because internal noise limits equivalent to the WHO annoyance thresholds were previously said to relate to "anonymous" noise in pre 2014 editions of BS8233 or due to the generally lower noise limits which would result from a BS4142 assessment of industrial or commercial noise. It should be noted that the current edition of BS8233 omits the word "anonymous" and instead qualifies the internal noise limits as relating to "noise without a specific character".

However, the WHO Guidelines do point out that various non-acoustic factors can impact the level of annoyance resulting from a given source, which is in line with the 2014 update to BS4142:

"Annoyance in populations exposed to environmental noise varies not only with the acoustical characteristics of the noise (source, exposure), but also with many non-acoustical factors of social, psychological, or economic nature (Fields 1993). These factors include fear associated with the noise source, conviction that the noise could be reduced by third parties, individual noise sensitivity, the degree to which an individual feels able to control the noise (coping strategies), and whether the noise originates from an important economic activity."

4.5 ProPG: Planning & Noise

Professional Practice Guidance on Planning and Noise, IoA, ANC, CIEH (May 2017) provides guidance on transportation noise affecting new residential developments. It is specifically for assessing noise from predominantly transportation sources.

The guidance promotes a two-stage assessment approach:

- Stage 1 – Initial site noise risk assessment based on external noise levels;
- Stage 2 – Full assessment including assessment of internal noise levels.

Where the Stage 1 assessment indicates a negligible noise risk a Stage 2 assessment is not required. A negligible noise risk approximately correlates to external noise levels below 50dB $L_{Aeq, 16hr}$ (daytime) and 40 dB $L_{Aeq, 8hr}$ (night).

In terms of internal noise limits ProPG says *"It is considered that suitable guidance on internal noise levels can be found in BS8233:2014: Guidance on sound insulation and noise reduction for buildings"* and appends the BS8233:2014 noise limits by mirroring the WHO Guidelines, as follows:

"In most circumstances in noise sensitive rooms at night (e.g. bedrooms) good acoustic design can be used so that individual noise events do not normally exceed 45dB L_{AFmax} more than 10 times a night. However, where it is not reasonably practicable to achieve this guideline then the judgement of acceptability will depend not only on the maximum noise levels but also on factors such as the source, number, distribution, predictability and regularity of noise events"

4.6 Acoustics Ventilation and Overheating – Residential Design Guide (AVO Guide)

A document published by the Institute of Acoustics (IOA) and Association of Noise Consultants (ANC) that recommends an approach to the assessment of environmental noise impact on new dwellings that takes due regard to the interdependence of provisions for acoustics, ventilation, and overheating.

The document provides a means by which designers can consider the effects of noise when windows are open to cool an overheating room and the impact of having to keep windows closed due to excessive external noise in line with PPG – Noise, i.e:

"Consideration should also be given to whether adverse internal effects can be completely removed by closing windows and, in the case of new residential development, if the proposed mitigation relies on windows being kept closed most of the time."

5. NOISE AND VIBRATION SURVEY

A site noise and vibration survey was carried out over the period 22nd January 2021 to 26th January 2021.

5.1 Measurement Positions

Figure 2 shows the identified noise sources impacting the site and the measurement positions.

Figure 2: Identified noise sources and measurement positions (west)

MV1 was the railway vibration measurement position. The vibration measurements were carried out externally on the ground.

ML1 & 2 mark the location of long-term noise monitors. Microphones were mounted on poles 1.2m above ground level and in free field locations (at least 3.5m from reflective surfaces).

5.2 Equipment

A summary of the equipment used for the survey is presented in Table 5.

Table 5: Survey Equipment

Equipment Used				Type of Measurement	Time Interval	Description
Measurement Position	Manufacturer	Instrument	Type			
ML1	Rion	Sound Level Meter	NL52	Long term unattended	5 min	Selected to capture background noise levels and any train and industrial noise
		Pre-Amplifier	NH25			
		Microphone	UC59			
ML2	Rion	Sound Level Meter	NL52	Long term unattended	5 min	Selected to capture background noise levels and any train and industrial noise
		Pre-Amplifier	NH25			
		Microphone	UC59			
		Pre-Amplifier	ZC 0032			
		Microphone	4189			
ML1 & 2	Rion	Acoustic Calibrator	NC74	Calibration	N/A	94.0 dB @ 1kHz, drift within normal tolerances
MV1	Rion	Vibration Meter	XV-29	Vibration	N/A	Vibration

Average recorded wind speeds during the survey did not exceed 5 m/s and therefore wind noise would not have significantly affected measurements. There was no rainfall recorded during the survey.

5.3 Results

5.3.1 Environmental Noise Survey

A baseline noise survey was carried out over the period 22nd to 26th January 2021, covering both weekday and weekend periods. Weekday and weekend daytime periods were found to be relatively similar in level over the survey period.

Given the practicalities of forming properly validated judgements on noise surveys undertaken in 2021, due to the influence of variable Covid-19 lockdown impacts on rail timetables and road traffic, a baseline noise map model has been prepared to accompany noise surveying undertaken. The baseline noise model has been generated using inputs from rail timetables and road traffic count data for periods unaffected by Covid-19 restrictions.

Observations made during the surveys allowed any significant existing noise sources which contribute to the measured levels, to be identified. In addition, measurements undertaken at ML1 and ML2 included audio recording to allow retrospective analysis of the existing noise environment. The following noise sources were identified.

- Road Traffic Noise: Noise from the adjacent road network was a contributing source for the majority of the daytime and night-time periods. Prevailing road noise sources include:

  - Gavray Drive to the south-west
  - A4421 to the east
- **Rail Noise:** Noise from rail movements on the London to Portsmouth via Basingstoke rail line, was dominant during the daytime and night time periods at the North and Eastern part of the site.
- **Industrial Noise**: Industrial noise was not found to be regularly audible during the daytime period and was inaudible during the night-time period.
- **Other:** Bird song and other wildlife noises were occasionally audible during the daytime and night-time period. Noise from distant aircraft was occasionally audible.

Measured noise levels at each measurement location (ML) have been determined for daytime (0700 to 2300 hours) and night-time (2300 to 0700 hours) periods.

The main acoustic parameters were measured using a time interval of 5-minutes for ML1 and 15 minutes for ML2. Table 2 and 3 present the daytime and night-time values at each measurement location, used to inform this assessment.

Three main acoustic parameters were measured at ML1 and ML2 as described below.

- $L_{Aeq,T}$ dB, defined as the 'A' weighted equivalent continuous sound pressure level. Over a defined time period 'T', it is the sound pressure level equivalent to the acoustic energy of the fluctuating sound signal. It is often referred to as the 'ambient noise level'.
- $L_{Amax,F,T}$ dB, defined as the 'A' weighted maximum sound pressure level that occurred during the time period 'T' acquired using a 'fast' time weighting (i.e. a sample every 125ms). It is commonly used to describe the highest noise level that occurred during an event such as a vehicle pass-by.
- $L_{A90,T}$ dB, defined as the 'A' weighted sound pressure level exceeded for 90% of the measurement period 'T'. It is a statistical parameter and cannot be directly combined with other acoustic parameters. It is generally used to describe the prevailing background noise level.

The results at the two measurement locations are presented in Table 4 & 5.

Table 4: Average Measured Daytime and Night-time Noise Levels -ML1

Start Time	End Time	Log Average L_{Aeq}, dB	L_{Amax} dB (Maximum)	L_{Amax} dB (Average)	L_{Amax}, dB exceeded 10 times	L_{A90} Mean, dB	L_{A90} Mode dB
22/01/2021 16:10:00	22/01/2021 23:00:00	55	87	62	80	42	45
22/01/2021 19:00:00	22/01/2021 23:00:00	54	87	58	73	39	45
22/01/2021 23:00:00	23/01/2021 07:00:00	46	79	49	65	35	32
23/01/2021 07:00:00	23/01/2021 23:00:00	54	89	62	79	41	43
23/01/2021 19:00:00	23/01/2021 23:00:00	54	89	61	76	39	40
23/01/2021 23:00:00	24/01/2021 07:00:00	45	78	48	53	34	33
24/01/2021 07:00:00	24/01/2021 23:00:00	52	82	59	79	36	37
24/01/2021 19:00:00	24/01/2021 23:00:00	51	80	57	65	36	37
24/01/2021 23:00:00	25/01/2021 07:00:00	47	80	48	64	36	34
25/01/2021 07:00:00	25/01/2021 23:00:00	51	85	59	78	43	45
25/01/2021 19:00:00	25/01/2021 23:00:00	50	80	56	64	40	42
25/01/2021 23:00:00	26/01/2021 07:00:00	49	80	50	64	39	37
26/01/2021 07:00:00	26/01/2021 15:10:00	54	87	63	78	48	48

Table 5: Average Measured Daytime and Night-time Noise Levels -ML2

Start Time	End Time	Log Average L_{Aeq}, dB	L_{Amax} (Maximum), dB	L_{Amax} (Average) dB	L_{Amax}, dB exceeded 10 times	L_{A90} Mean, dB	L_{A90} Mode dB
22/01/2021 15:45:00	22/01/2021 23:00:00	52	82	70	74	42	45
22/01/2021 19:00:00	22/01/2021 23:00:00	51	77	69	66	38	36
22/01/2021 23:00:00	23/01/2021 07:00:00	44	74	55	64	35	35
23/01/2021 07:00:00	23/01/2021 23:00:00	51	82	72	74	40	40
23/01/2021 19:00:00	23/01/2021 23:00:00	50	75	72	71	39	39
23/01/2021 23:00:00	24/01/2021 07:00:00	43	74	53	53	34	36
24/01/2021 07:00:00	24/01/2021 23:00:00	49	83	67	73	34	33
24/01/2021 19:00:00	24/01/2021 23:00:00	47	73	63	65	33	32
24/01/2021 23:00:00	25/01/2021 07:00:00	44	78	55	66	34	30
25/01/2021 07:00:00	25/01/2021 23:00:00	49	84	63	72	43	45
25/01/2021 19:00:00	25/01/2021 23:00:00	47	74	62	51	39	39
25/01/2021 23:00:00	26/01/2021 07:00:00	46	76	55	61	38	37
26/01/2021 07:00:00	26/01/2021 13:00:00	53	86	68	72	48	48

Vibration Results

The full measurement results are presented on the time history graphs in Appendix A in terms of the 1-minute Vibration Dose Values (VDV) and Peak Particle Velocity (PPV). Where measurements where clearly "atypical" and not as a result of train movements, i.e. are due to either animal/pedestrian/dogwalker or engineer interference with the equipment, these have been excluded from the assessment.

VDVs during train movements were typically in the range 0.005 $m/s^{1.75}$ to 0.01 $m/s^{1.75}$ and the highest measured value that is considered to have possibly resulted from a train was 0.02 $m/s^{1.75}$. Triaxial resultant PPV values were in the range 0.3 mms^{-1} to 0.5 mms^{-1} and the highest measured value was approximately 0.9 mm/s^{-1}

6. NOISE MODELLING

6.1 Noise Modelling Methodology

6.1.1 Road Traffic Modelling Data

Due to the influence of Covid-19 on local road traffic, road traffic count data from 2014, expanded to 2019 "pre covid 19" levels have been used.

6.1.2 Rail Traffic Modelling Data

Hydrock have progressed this report by using rail passenger and freight timetable source data from 2021 including cancellations made due to the Covid-19 travel reductions.

Where relevant Hydrock have also sourced information from noise survey measurements taken by Environmental Resources Management (ERM) at the site to accompany the Chiltern Railways application for the now operational Bicester Chord development works (shown on Figure 10.1). The data is found in "Scheme of Assessment for Route Section A", reference 0221083/11/04 January 2014.

The model outputs are used here to determine the baseline noise climate on the site. This approach is robust in that it uses recent representative survey data and data derived from rail movement data for the local rail track infrastructure to provide a baseline assessment.

The recognized national calculation method for airborne noise from railways which was used here is given in Calculation of Railway Noise, 1995 (CRN), with additional source terms given in "Additional railway noise source terms for Calculation of Railway Noise 1995". This approach was agreed with the Local Authority and was also used in the ERM assessment to inform the Chiltern Railways application for the Bicester Chord, which was accepted as appropriate.

The Scheme of Assessment for Route Section A advised on an acoustic barrier of 2.5m. However, based on Hydrock on site observations the acoustic barrier has only been installed to the extent such that it protects existing noise sensitive receptors as would be expected and for a short reach into the proposed development site western boundary before the railway line moves to an elevated position to the north of the site, and as such proposed development will still be exposed to rail noise along the chord without further mitigation being designed into the development.

6.1.3 Rail Traffic

In relation to the "east west" rail expansion, the prior ES Chapter Noise Chapter within "The Network Rail (East West Rail Western Section Phase 2) Order EIA", assessed two rail service specifications, one for the "opening year" (2024) and one for a "future year" (2035).

The future year scenario takes account of the maximum possible increase in rail services, given the constraints of the wider railway network. As such this represents the reasonable worst case in terms of frequency of rail movements via this link, giving consideration for future expansion.

The project includes a combination of passenger and freight services, the operational periods for passenger and freight trains is as follows:

- Passenger services will run between 05:00 and 01:00
- Freight trains may operate to schedule 24 hours a day.

For passenger services the project includes varying train types, however the majority of passenger services will be DMUs (Diesel Multiple Units), for freight trains services will likely be Class 66 and Class 70 locomotives.

6.2 Modelling Results

Noise modelling has been carried out using CadnaA Software. Free field and façade noise levels have been predicted across the site.

6.2.1 Free-field Noise levels

The figures below show the predicted noise levels across the site as a result of rail and road noise. Noise levels are calculated at 1.5 meters above ground, with ground absorption set at 80% (i.e. 80% soft ground).

Figure 3: Road and rail noise levels across the site (daytime)

Figure 4: Road and rail noise levels across the site (night time)

6.2.2 Facade Noise Levels

The predicted ambient façade noise levels are presented in Figures 5 to 8. These are the highest predicted levels at any height above ground.

Short-term maximum noise levels from rail movements during the night have also been predicted for the west of the site using a modelled moving noise source. These are presented in Figure 9.

Figure 5: dB $L_{Aeq,\ T}$ Noise Map South (Daytime 0700-2300

Figure 6: dB $L_{Aeq,T}$ Noise Map West (Daytime 0700-2300)

Figure 7: dB $L_{Aeq,T}$ Noise Map South (Night time 2300-0700)

Figure 8: dB $L_{Aeq,\ T}$ Noise Map West (Night time 2300-0700)

Figure 9: dB L_{AFaxT} Maximum Noise Event Map West (Night time 2300-0700)

7. ASSESSMENT

7.1 Assessment and Mitigation - Residential

The sound insulation properties of the building envelope depend upon the external noise levels present at each façade. We would therefore advise that the development be designed to ensure internal noise levels in accordance with the guidance of BS 8233:2014.

The current assessment is based on a typical illustrative masterplan specifically developed for the purposes of this assessment; other layouts may well be suitable subject to detailed assessment.

7.2 Noise Barrier

Calculations included in this assessment assume a noise barrier (shown in blue on Figure 3 &4) will be installed to the north western site boundary up to the railway footbridge. The barrier shall be solid, a minimum of 3.5m height above ground, and no less than 10kg/m^2 surface mass with no gaps.

7.3 Building Fabric Design

With reference to figures 5 to 9 the higher noise exposure categories due to maximum or ambient noise levels shall take priority with regards to prescribed mitigation measures.

Detailed noise break-in calculations for each house type and habitable room type have been carried out in order to determine glazing and ventilation requirements for dwellings

At this stage of the project, detailed information has not yet been developed regarding façade construction, and ventilation strategy etc. The guidance contained herein is therefore subject to development during technical design.

The recommended mitigation measures to control noise ingress into new dwellings are presented in Table 6.

Table 6: Required Façade, Window and Trickle Vent Performance

Exposure Category	Indicative Façade performance dB R_w	Indicative Glazing performance dB R_w	Trickle Vents dB $D_{n,e,w}$	Outline Design Mitigation
High Noise Exposure (Blocks D and E)	53dB R_w	46dB R_w	MVHR	Orientate corridors, stairwells and ancillary non-sensitive spaces (i.e WC, bathrooms and kitchen) towards high noise exposure level facades. Avoid bedrooms on facades with high noise exposure. Suitable high performance acoustic laminate double glazing (e.g 46dB R_w) and mechanical ventilation should be provided to control normal maximum noise levels to <45dB L_{AFMax} internally at night. Ventilation systems and thermal design should avoid the need to open windows to control overheating, except in extreme circumstances. Window area should not exceed 1m^2 for a typical bedroom of volume 27-36m^2
Medium Noise Exposure	53dB R_w	37R_w	47dB D_{new}	Avoid bedrooms on facades with these noise levels incident where possible. Suitable acoustic double glazing and acosutic trickle vents should be provided to control normal maximum noise levels to <45dB L_{AFMax} internally at night. Ventilation systems and thermal design should minimise need to open windows as far as possible in line with assessment with guidance contained within the AVO (Acoustics, ventilation and overheating guide).
Low Noise Exposure	NA	NA	NA	No specific mitigation, standard double-glazing and “Mode 3” ventilation under Building Regulations Part F

In addition to the above, where external noise levels incident at the proposed dwellings are in the high noise exposure category, window will need to remain closed most of the time, and therefore thermal and ventilation

design should seek to provide comfortable temperatures without opening windows. Alternatively habitable rooms should be avoided at high noise exposure facades. The following room types are not considered sensitive to noise and can be located at high noise exposure facades without specific mitigation: WCs, Bathrooms, Kitchens (excluding dining), Access Corridors, Hallways, Stair cores, and Utility Rooms.

The layout of the site has been optimised to attenuate noise across most of the site through the use of higher density "barrier blocks" close to the railway which provide shielding to homes and gardens further back. It would be advantageous for apartments within barrier blocks to be dual aspect to allow for ventilation via the less exposed facades and to facilitate residents being able to open windows without significant noise exposure. This would reduce reliance on other measures of controlling overheating (e.g. mechanical systems) without opening windows in the high noise exposure facade.

The following modelling assumptions have been made in the absence of detailed internal layout proposals:

- Living Room Volume: 4x5x2.7m
- Bedroom Volume: 3x4x2.7m
- Window Size Living Room 2m2 (it is recommended this is not exceeded at high noise exposure facades)
- Window Size Bedroom 1m2 (it is recommended this is not exceeded at high noise exposure facades)

8. DESIGN GUIDANCE – EXTERNAL AMENITY AREAS

BS 8233:2014 provides guidance on external noise levels for the protection of private amenity spaces of residential properties and states that:

'*It is desirable that the external noise level does not exceed 50 dB $L_{Aeq,T}$, 55 dB $L_{Aeq,T}$ should be regarded as the upper guideline value.'*

Noise levels withing the proposed external amenity areas are generally predicted to fall below the upper limit value of 55 dB $L_{Aeq,T}$ as a result of the proposed noise barrier and barrier blocks close to the railway.

9. OUTLINE DESIGN GUIDANCE – EXTERNAL PLANT AND SERVICES

Noise levels from proposed building services plant associated with the Proposed Development should be controlled to avoid a significant noise impact at Existing Sensitive Receptors.

The nearest noise sensitive properties have been identified as:

- Proposed existing receptors off Gavray Drive.
- New sensitive receptors as part of the Proposed development.

Suitable plant noise limits at the above receptors are presented in Table 7 based on the measured background sound levels and the advice contained in BS4142;2014.

Table 7:BS4142:2014 fixed plant and services limits

Monitoring Location	Parameter	Time Period	Proposed Rating Level $L_{Ar,T}$, dB
ML1	$L_{Ar,1hour}$	Daytime (0700hrs to 2300hrs)	40
	$L_{Ar,15mins}$	Night Time (2300hrs to 0700hrs)	31
ML2	$L_{Ar,1hour}$	Daytime (0700hrs to 2300hrs)	40
	$L_{Ar,15mins}$	Night Time (2300hrs to 0700hrs)	31

A full assessment of plant noise emissions is advised once detailed information becomes available, in accordance with BS4142:2014. A later assessment may include later or a more detailed assessment of the background sound levels.

The responsibility to achieve the above limits, or other limits set in accordance with BS4142:2014 and a later measured background sound level, would fall to those undertaking the building works.

The proposed plant noise limits are not expected to be onerous. However, as detailed information relating to fixed plant is unknown, Hydrock highlights that provision for the selection of low noise equipment, silencers, enclosures, screens and other acoustic attenuation measures may be required.

10. RAIL VIBRATION IMPACT ASSESSMENT

10.1 Vibration Dose Values

The estimated changes in vibration level for different building constructions is described in the ANC Guidelines *Measurement & Assessment of Groundborne Noise & Vibration*[2]. For this assessment the highest results have been multiplied by a factor of two in order to represent the worst case internal VDVs within dwelling.

There is a low probability of adverse comment even based on the highest measured VDV (0.02ms$^{-1.75}$) at the measurement locations and considering the potential for greater vibration magnitude within dwellings.

Due to the noise concerns, dwellings will be constructed at a significantly greater distance from the railway line than the vibration measurement location. Therefore, vibration levels within the proposed dwellings will be lower than measured close to the railway.

10.2 Re-Radiated Noise

A typical design target for re-radiated sound from railway-induced vibration is 35 dB L_{ASmax} in habitable rooms. Re-radiated sound within typical dwellings can be estimated using the equation below:

$$L_p = L_v - 27$$

Where:

- L_p (dB reference 20 µPa) is the predicted sound pressure level (L_{ASmax})
- L_v (dB reference 1 nm/s) is the measured RMS velocity

In lieu of RMS velocity levels, the highest typical Peak Particle Velocity (PPV) in each direction during the daytime and night-time have been utilized to provide a worst-case assessment.

Table 8 presents the results of the assessment.

Table 8: Assessment of Re-Radiated Sound

Description of Parameter	X-axis	Y-axis	Z-axis
Highest Measured Peak Particle Velocity (mm/s)	0.51	0.59	0.78
Predicted Re-Radiated Sound Level (dB)	27	28	31
Below Target Criterion? (35 dB L_{ASmax})	✓	✓	✓

Predicted levels of re-radiated sound will be below the target of 35 dB L_{ASmax}. Therefore, mitigation measures to reduce re-radiated sound will not be required.

11. SUMMARY AND CONCLUSIONS

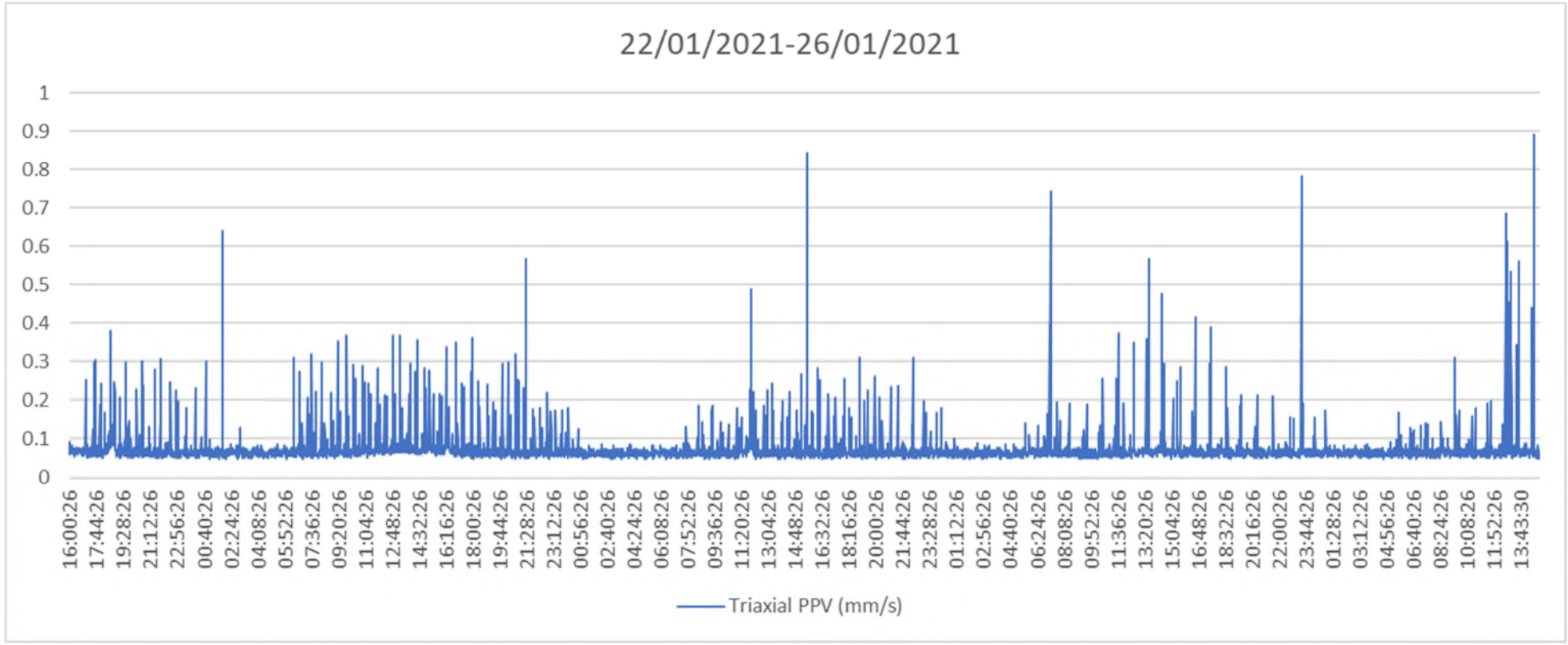
Hydrock Consultants have been appointed by L & Q Estates to provide acoustic consultancy services in relation to the proposed residential development located adjacent to Gavray Drive, Bicester.

The site is affected by road and railway noise. The most significant noise impact is from the railway. This has been considered in developing the masterplan, which has incorporated a suitable stand-off distance, a noise barrier along the railway, and high-density barrier blocks close to the railway to screen dwellings and gardens further back. Additional advice on building envelope sound insulation, ventilation strategies, and the layout of proposed barrier block are provided in this report.

Assuming the mitigation measures and recommendations outlined in this report are implemented, the development will meet the requirements of relevant local and national policy and guidance in terms of noise.

Railway vibration and re-radiated noise assessments have been carried out based on vibration measurements made close to the railway. There is a low probability of adverse comment due to vibration and a low impact from vibration induced re-radiated noise. No vibration mitigation is necessary.

Appendix A Vibration Results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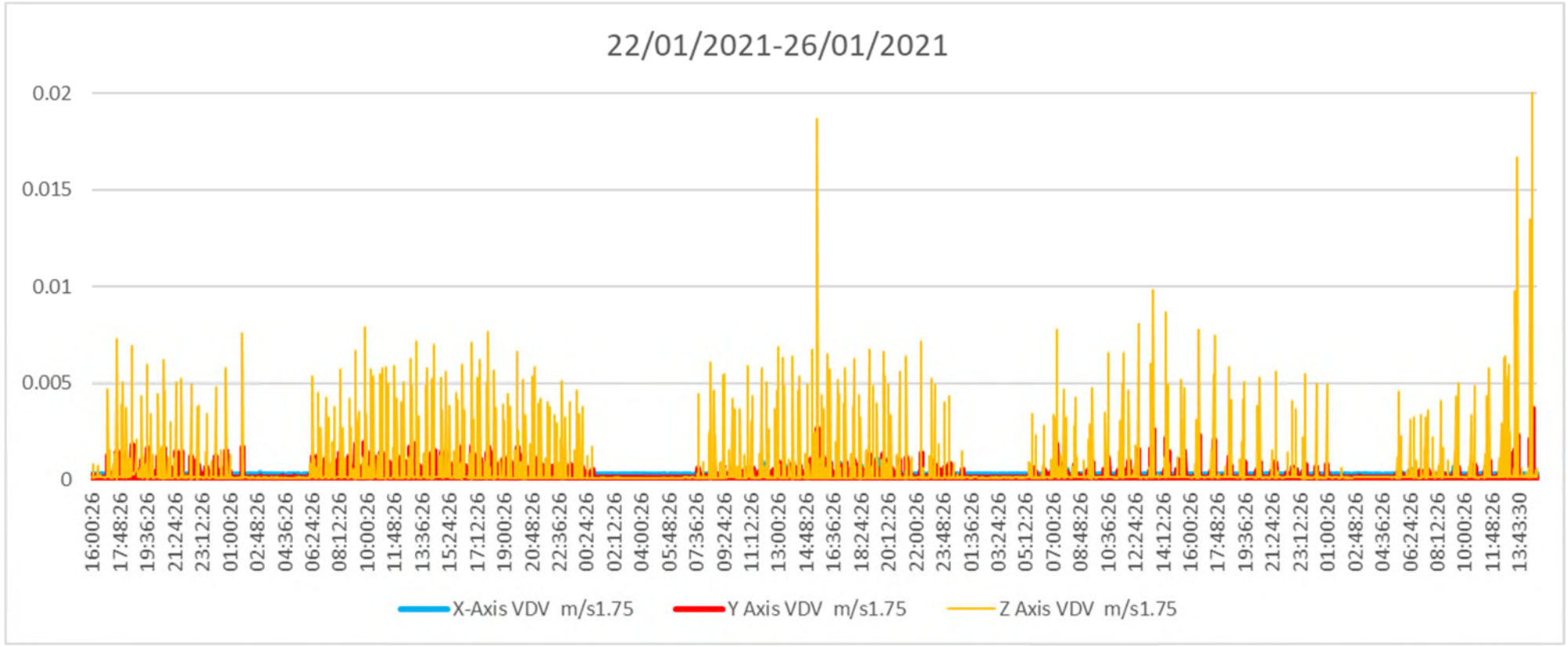
Triaxial PPV (mm/s)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