EUTOPIA
HOMES

AECOM

NOISE AND VIBRATION REPORT

Exmouth Junction, Exeter

April 2019

Quality information

Prepared by	Checked by	Verified by	Approved by
			
Eddie Robinson Associate Acoustics Consultant	Colin O'Connor, Principal Acoustics Consultant	Colin O'Connor, Principal Acoustics Consultant	Yuyou Liu, Regional Acoustics Manager

Revision History

Revision	Revision date	Details	Authorized	Name	Position
1	19/03/2019	Original	YL	Yuyou Liu	Regional manager
2	29/03/19	Client comments	YL	Yuyou Liu	Regional manager

Distribution List

# Hard Copies	PDF Required	Association / Company Name

Prepared for:

Eutopia Homes (Exeter) Limited

Prepared by:

Eddie Robinson
Associate Acoustics Consultant

AECOM Limited
St. George's House
5 St. George's Road
London SW19 4DR
United Kingdom

T: +44 (207) 963 9800
aecom.com

Table of Contents

Figures

Tables

1. Introduction

AECOM has been appointed by Eutopia Homes (Exeter) Limited to undertake a noise and vibration impact assessment in relation to the redevelopment of the Exmouth Junction site on Prince Charles Road in Exeter (hereafter referred to as the 'Site'), which is on land administered by Exeter City Council (ECC). The proposed redevelopment of the site (hereafter referred to as the 'Proposed Development') is a residential-led development.

This report contains the following:

- Identification of nearest noise and vibration sensitive receptors.
- Establishment of baseline noise levels in the locality.
- Establishment of baseline vibration levels at the site.
- Suitability of the Site for proposed residential uses, including preliminary mitigation requirements.
- Assessment of the resulting noise levels at the nearest noise sensitive receptors from the proposed works, including:
  - Construction noise and vibration assessment (including construction traffic on public roads).
  - Operational noise assessment (including site traffic on public roads).

Details of terminology relevant to this report are provided in Appendix A.

2. Legislative and Planning Policy Context

2.1 National Legislation

2.1.1 Control of Pollution Act (1974)

The Control of Pollution Act 1974[1] (CoPA) requires that Best Practicable Means (BPM) (as defined in section 72 of CoPA) are adopted to control construction noise on any given site. Sections 60 and 61 of the CoPA provide the main legislation regarding demolition and construction site noise and vibration. A Section 60 notice may be issued by the local authority with instructions to cease work until specific measures to reduce noise have been adopted.

Section 61 of the CoPA provides a means for applying for prior consent to carry out noise generating activities during demolition and construction. Once prior consent has been agreed under Section 61, a Section 60 notice cannot be served provided the agreed measures are maintained on the site.

2.1.2 Environment Protection Act (1990)

The Environmental Protection Act 1990[2] (EPA) Part 3 prescribes that noise (and vibration) emitted from premises (including land) may be defined as a 'statutory nuisance' if it is considered prejudicial to health or a nuisance.

Local authorities are required to investigate any public complaints of noise and if they are satisfied that a statutory nuisance exists, or is likely to occur or recur, they must serve a noise abatement notice. A notice is served on the person responsible for the nuisance. It requires either simply the abatement of the nuisance or works to abate the nuisance to be carried out, or it prohibits or restricts the activity. Contravention of a notice without reasonable excuse is an offence. Right of appeal to the Magistrates Court exists within 21 days of a noise abatement notice having been served.

In determining if a noise complaint amounts to a statutory nuisance the local authority can take account of various guidance documents and existing case law as no statutory noise limits exist. Demonstrating the use of BPM to minimise noise levels is an accepted defence against a noise abatement notice.

2.2 National Planning Policy

2.2.1 National Planning Policy Framework (2019)

The aim of the NPPF[3] in terms of noise and vibration is to prevent both "*new and existing development from contributing to, being put at unacceptable risk from, or being adversely affected by unacceptable levels of….. noise pollution…*" (paragraph 170).

Section 15 of the NPPF is concerned with protecting the natural environment, including the matters that should be considered for planning decisions in relation to ground conditions and pollution. This includes ensuring "*that new development is appropriate for its location taking into account the likely effects (including cumulative effects) of pollution on health, living conditions and the natural environment, as well as the potential sensitivity of the site or the wider area to impacts that could arise from the development. In doing so they should:*

- *Mitigate and reduce to a minimum other adverse impacts resulting from noise from new development and avoid noise giving rise to significant adverse impacts on health and quality of life; and*
- *Identify and protect tranquil areas which have remained relatively undisturbed by noise and are prized for their recreational and amenity value for this reason." (Paragraph 180).*

These policies must be applied in the context of Government policy on sustainable development.

With regards to 'adverse effects' and 'significant adverse effects', the NPPF refers to the Noise Policy Statement for England[4] (NPSE).

[1] Her Majesty's Stationery Office (1974); Control of Pollution Act.
[2] Her Majesty's Stationary Office (1990); Environmental Protection Act 1990.
[3] Ministry of Housing, Communities and Local Government (MHCLG) (February 2019) Revised National Planning Policy Framework
[4] Noise Policy Statement for England (2010); Department for Environment Food and Rural Affairs.

2.2.2 Noise Policy Statement for England (2010)

The NPSE seeks to clarify the underlying principles and aims in existing policy documents, legislation and guidance that relate to noise. The statement applies to all forms of noise, including environmental noise, neighbour noise and neighbourhood noise.

The NPSE sets out the long-term vision of the government's noise policy, which is to "*promote good health and a good quality of life through the effective management of noise within the context of policy on sustainable development".*

This long-term vision is supported by three aims:

- *"avoid significant adverse impacts on health and quality of life;*
- *mitigate and minimise adverse impacts on health and quality of life; and*
- *where possible, contribute to the improvements of health and quality of life."*

The long-term policy vision and aims are designed to enable decisions to be made regarding what is an acceptable noise burden to place on society.

The Explanatory Note within the NPSE provides further guidance on defining 'significant adverse effects' and 'adverse effects' using the following concepts:

- No Observed Effect Level (NOEL) – the level below which no effect can be detected. Below this level no detectable effect on health and quality of life due to noise can be established;
- Lowest Observable Adverse Effect Level (LOAEL) – the level above which adverse effects on health and quality of life can be detected; and
- Significant Observed Adverse Effect Level (SOAEL) – the level above which significant adverse effects on health and quality of life occur.

With reference to the SOAEL, the NPSE states:

"It is recognised that it is not possible to have a single objective noise-based measure that defines SOAEL that is applicable to all sources of noise in all situations. Consequently, the SOAEL is likely to be different for different noise sources, for different receptors and at different times. It is acknowledged that further research is required to increase our understanding of what may constitute a significant adverse impact on health and quality of life from noise. However, not having specific SOAEL values in the NPSE provides the necessary policy flexibility until further evidence and suitable guidance is available."

For situations where noise levels are between the LOAEL and SOAEL, all reasonable steps should be taken to mitigate and minimise the effects. However, this does not mean that such adverse effects cannot occur.

2.2.3 Planning Practice Guidance: Noise (2018)

The national Planning Practice Guidance: Noise [5] (PPGN) "*advises on how planning can manage potential noise impacts in new development"* and provides guidelines that are in line with the NPPF.

The PPGN states that local planning authorities should take account of the acoustic environment and in doing so consider:

- *"whether or not a significant adverse effect is occurring or likely to occur;*
- *whether or not an adverse effect is occurring or likely to occur; and*
- *whether or not a good standard of amenity can be achieved."*

Factors to be considered in determining whether noise is a concern are identified including the absolute noise level of the source, the existing ambient noise climate, time of day, frequency of occurrence, duration, character of the noise and cumulative effects.

Further details on the hierarchy of noise effects are presented in Table 2-1, which has been reproduced from PPGN.

[5] Department for Communities and Local Government (2018); Planning Practice Guidance.

Table 2-1. Planning Practice Guidance: Noise

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

2.3 Local Planning Policy

The current Exeter Local Plan[6] and Core Strategy[7] sets out the ECC's planning framework to guide planning decisions until 2026 and contains policies saved from the previous version of the Local Plan. Policy EN5 is the only saved policy relevant to noise and vibration and states:

"Noise-generating development will not be permitted if it would be liable to increase adversely the noise experienced by the users of existing or proposed noise- sensitive development nearby."

"Noise-sensitive development will not be permitted if its users would be affected by noise from existing or proposed noise-generating uses unless adequate mitigation works can be implemented to achieve an acceptable environment."

[6] Exeter City Council (2005); Local Plan
[7] Exeter City Council (2012); Core Strategy

2.4 Other Relevant Policy, Standards and Guidance

2.4.1 World Health Organisation Guidelines for Community Noise, 1999

The World Health Organisation's (WHO) 'Guidelines for Community Noise'[8] recommend external daytime and evening environmental noise limits and internal night-time limits to avoid sleep disturbance.

2.4.2 British Standard 8233:2014

British Standard (BS) 8233 *'Sound Insulation and Noise Reduction for Buildings – Code of Practice'*[9] provides criteria for the assessment of internal noise levels for various uses including dwellings and commercial properties. It is noted that internal noise criteria are defined by a single set of criteria, replacing the 'Good' and 'Reasonable' categories in BS 8233:1997.

2.4.3 British Standard 4142:2014

BS 4142 *'Method for Rating Industrial Sound Affecting Mixed Residential and Industrial Areas'*[10] can be used for assessing the effect of noise from mechanical services plant. The method compares the difference between the 'rating level' of the new sound source, with the 'background level' at the receptor position

2.4.4 British Standard 7445-2:1991

BS 7445 'Description and Measurement of Environmental Noise'[11] defines the parameters, procedures and instrumentation requirements for noise measurement and analysis.

2.4.5 British Standard 5228:2009+A1:2014

BS 5228-1 *'Code of practice for noise and vibration control on construction and open sites. Noise'*[12] provides examples of BPM in a 'best practice' guide for noise control and includes Sound Power Level (L_w) data for individual plant as well as a calculation method for noise from construction activities. BS: 5228-2 'Code of practice for noise and vibration control on construction and open sites. Vibration'[13] provides comparable 'best practice' for vibration control, including guidance on the human response to vibration.

2.4.6 British Standard ISO 4866:2010

ISO 4866 'Mechanical vibration and shock – Vibration of fixed structures – Guidelines for the measurement of vibrations and evaluation of their effects on structures'[14] establishes principles for carrying out vibration measurement and processing data with regard to evaluating vibration effects on structures.

2.4.7 British Standard 6472:2008

BS 6472-1 'Guide to evaluation of human exposure to vibration in buildings Part 1: Vibration sources other than blasting'[15] presents recommended frequency weighted vibration spectra (for continuous vibration) and Vibration Dose Values (VDV) (for intermittent vibration) above which adverse comment is likely to occur in residential properties.

[8] World Health Organisation (1999); Guidelines for Community Noise.
[9] British Standards Institute (2014); BS 8233 – Guidance on sound insulation and noise reduction for buildings, BSi, London.
[10] British Standards Institute (2014); BS 4142 – Methods for rating and assessing industrial and commercial sound, BSi, London.
[11] British Standards Institute (1991); BS 7445 - Description and Measurement of Environmental Noise. Part 2: Guide to the Acquisition of Data Pertinent to Land Use, BSi, London.
[12] British Standards Institute (2014); BS 5228:2009+A1 – Code of practice for noise and vibration control on construction and open sites. Noise, BSi, London.
[13] British Standards Institute (2014); BS 5228-2 – Code of practice for Noise and Vibration control on construction and open sites. Vibration, BSi, London.
[14] International Standards Organisation, (2010); ISO 4866 Mechanical vibration and shock -- Vibration of fixed structures -- Guidelines for the measurement of vibrations and evaluation of their effects on structures.
[15] British Standards Institute, (2008); BS 6472-1 – Guide to evaluation of human exposure to vibration in buildings. Vibration sources other than blasting.

2.4.8 Calculation of Road Traffic Noise (1998)

The Department of Transport/Welsh Office Memorandum *'Calculation of Road Traffic Noise'*[16] (CRTN) describes procedures for traffic noise calculation and is suitable for environmental assessments of schemes where road traffic noise may have an effect.

2.4.9 Institute of Environmental Management and Assessment: Guidelines for Environmental Noise Impact Assessment (2014)

The Institute of Environmental Management and Assessment (IEMA) 'Guidelines for environmental noise impact assessment'[17] (2014) provides guidance on how noise impact assessment fits within the Environmental Impact Assessment process. Example criteria in the IEMA guidelines for the assessment of changes in noise level have been adopted for the assessment of changes in road traffic noise levels along the local road network.

2.4.10 Professional Practice Guidance: Planning and Noise, 2017

The Institute of Acoustics, the Association of Noise Consultants, and the Chartered Institute of Environmental Health (CIEH) have joined to produce a Professional Practice Guidance[18] (ProPG) focussing on noise sensitive development. The ProPG has been produced to provide practitioners with guidance on a recommended approach to the management of noise within the planning system in England. ProPG provides planning guidance for the consideration of new residential development that will be exposed predominantly to airborne noise from transport sources. The document provides advice on how guidance within BS 8233:2014 and WHO Guidelines for Community Noise may be applied to improve in the consistency and quality of plan-making and decision-taking in relation to acoustic matters.

[16] Department of Transport/Welsh Office (1998); Calculation of Road Traffic Noise.
[17] Institute of Environmental Management and Assessment (2014); Guidelines for environmental noise impact assessment.
[18] Association of Noise Consultants/ Institute of Acoustic/ Chartered Institute of Environmental Health (2017); Professional Planning Guidance: Planning and Noise.

3. Assessment Methodology

3.1 Baseline Environment and Sensitive Receptors

3.1.1 Site Location

The Site is situated within the Pennsylvania ward of Exeter, approximately 1.2 km to the north east of the city centre. The site is bounded by a railway line to the south, a Morrisons supermarket and Network Rail owned land to the east, residential dwellings to the west, on Tresillian Gardens (just off Mount Pleasant Road), and an area of allotments to the north.

To the south of the Site is the existing railway line which links Exeter Central with stations such as St James' Park, Polsloe Bridge, and Pinhoe. The railway line separates the site from an area of terraced housing and Priory Park.

To the north of the Site is Prince Charles Road allotments. Immediately to the north of the allotments is Prince Charles Road, which runs east-west, linking Stoke Hill roundabout with the Morrisons store. Further to the north of this is the Stoke Hill residential area, which is characterised by two-storey semi-detached houses.

Immediately to the west of the Site is a small number of residential dwellings accessed from Tresillian Gardens, which is itself accessed from Mount Pleasant Road. The houses in this location generally comprise two storey detached houses, but there are two storey terraces fronting Mount Pleasant Road.

Immediately to the east of the Site is a small area of land owned by Network Rail, which will be retained to provide access to the railway. This is enclosed by a secure 2.4m high palisade fence for security purposes. Further east is a Morrisons supermarket measuring 5,816 sq. m (GIA), which also includes a 399 space car park, and a petrol filling station.

Within close proximity of the site are other important local amenities, including Mount Pleasant Health Centre, St James' Church, The Stoke Arms public house, and Stoke Hill Infants and Junior schools.

3.1.2 Noise Monitoring Methodology

Long-term noise surveys were undertaken from 25th January 2019 to 7th February 2019 at five locations (LT1 to LT5) to establish the baseline noise environment around the Site. Noise monitoring locations around the Site illustrated in Figure 3-1. Details of the noise monitoring methodology and equipment specifications are provided in Appendix B.

Noise monitoring locations were selected based on professional experience to provide suitably representative information on noise levels at the Site and at nearby sensitive receptors. The baseline noise surveys were undertaken in accordance with guidance as specified in BS 7445: Part 2. The sound level meters logged environmental noise measurement parameters including average ambient (L_{Aeq}), maximum (L_{Amax}) and background (L_{A90}) noise levels, and all measurements were undertaken in free-field conditions (i.e. greater than 3m from a reflecting surface other than the ground).

3.1.3 Vibration Monitoring Methodology

Baseline vibration surveys were undertaken to establish existing levels of vibration experienced at the southern Site boundary nearest to adjacent rail lines and to provide a means to assess vibration ingress affecting users of the occupied Site.

Long-term vibration surveys were undertaken from 25th January 2019 to 1st February 2019. The vibration monitoring location (V1) is illustrated in Figure 3-1. The baseline vibration surveys were undertaken in accordance with technical guidance contained in BS ISO 4866:2010. Details of the vibration monitoring methodology and equipment specifications are provided in Appendix B.

3.1.4 Sensitive Receptors

The identified sensitive receptors are those nearest receptors to the Site i.e. the receptors that will experience the highest levels of noise and vibration. Although noise and vibration may be perceivable at other receptors in the area around the Site, effects will not be significant if they are suitably controlled at the identified receptors.

The nearest noise sensitive receptors to the Site have been selected for assessment. Each receptor has been assigned a measurement location for the purposes of the assessment, where the intention is to apply appropriate noise level data at each receptor location for the assessment purposes. Sensitive receptors that have been considered in the assessment are illustrated in Figure 3-1 and described in Table 3-1 and their relative locations around the Site illustrated in Figure 3-1. .

Table 3-1. Sensitive Receptors

Receptor	Receptor Address	Corresponding Measurement Location	Receptor Type
R01	St James' Church	LT2	Place of worship
R02	1-4 Tresillian Gardens	LT2	Residential
R03	St James Court	LT2	Residential
R04	79-81 Mount Pleasant Road	LT1	Residential
R05	1-89 Priory Road	LT1	Residential
R06	34-38 Whitefriars Walk	LT5	Residential
R07	1-3 Whitefriars Walk	LT5	Residential
R08	82-106 Chaucer Grove	LT5	Residential
R09	1-63 Prince Charles Road	LT3	Residential

Figure 3-1. Noise/Vibration Monitoring and Noise Sensitive Receptors Locations

3.2 Methodology for Determining Suitability of the Site for Development

3.2.1 Ambient Noise within the Proposed Development

BS 8233 provides recommended criteria for internal ambient noise levels when rooms are unoccupied, dependent on their intended use. Table 3-2 presents the desirable internal noise levels that should not be exceeded in new developments.

Table 3-2. Target Indoor Ambient Noise Levels

Activity	Location	Daytime (07:00 to 23:00)	Night-time (23:00 to 07:00)
Resting	Living room	35 dB $L_{Aeq,16h}$	-
Dining	Dining room/area	40 dB $L_{Aeq,16h}$	-
Sleeping (daytime resting)	Bedroom	35 dB $L_{Aeq,16h}$	30 dB $L_{Aeq,8h}$ 45 dB L_{Amax} (from WHO and ProPG guidance)

To achieve the internal noise levels detailed in Table 3-2, external noise ingress must be controlled by the building façade. Some flexibility to the internal $L_{Aeq,T}$ noise criteria is provided by BS 8233 is provided in the statement that: *"Where development is considered necessary or desirable, despite external noise levels above WHO guidelines, the internal target levels may be relaxed by up to 5 dB and reasonable internal conditions still achieved."*

ProPG expands on this be defining exceedances of greater than 5 dB as 'unreasonable'. These exceedances may be allowable in developments if applicants can provide detailed information on how the number of rooms affected has been kept to a minimum. Once internal noise levels exceed BS 8233 criteria by 10 dB, ProPG defines the internal noise conditions as 'unacceptable'.

Although there is some flexibility that can be adopted in façade design, this assessment focuses on the required mitigation (defined using the 'simple' calculation method from BS 8233) to achieve target noise levels presented in Table 3-2.

3.2.2 Ambient Vibration within the Proposed Development

An assessment of vibration affecting humans in existing and proposed buildings due to train movements has been undertaken in accordance with BS 6472-1:2008 by considering the VDV in terms of $ms^{-1.75}$. The VDV levels take into account the level and duration of vibration events, allowing both continuous and intermittent vibration events to be assessed using the same assessment metric.

The significance of existing vibration levels at the Site has been derived from BS 6472-1:2008, which rates vibration in terms of varying degrees of adverse comment, ranging from 'adverse comment not expected' to 'adverse comment very likely'. These ranges of varying degrees of adverse comment are presented in Table 3-3.

Table 3-3. Guidance on Indoor Ambient Vibration Levels

Period	Low Probability of Adverse Comment (VDV $m.s^{-1.75}$)	Adverse Comment Possible (VDV $m.s^{-1.75}$)	Adverse Comment Probable (VDV $m.s^{-1.75}$)
Residential 16 Hour Daytime (07:00-23:00)	0.2 – 0.4	0.4 – 0.8	0.8 – 1.6
Residential 8 Hour Night-time (23:00-07:00)	0.1 – 0.2	0.2 – 0.4	0.4 – 0.8

3.2.3 Outdoor Amenity Area Noise

Guidance provided in BS 8233 states a lower guideline value of 50 dB $L_{Aeq,T}$ for outdoor amenity areas (e.g. gardens and patios). An upper guideline value of 55 dB $L_{Aeq,T}$ is quoted in BS 8233 that that is considered acceptable in higher noise environments, such as sites near strategic transport links. Given the urban location of the site, the upper guideline value of 55 dB $L_{Aeq,T}$ is considered applicable for proposed outdoor amenity areas in the Proposed Development.

It is accepted in BS 8233 that achieving the guideline values may not be practicable in high noise environments such as city and town centres. Consequently, it is considered appropriate that outdoor amenity areas within the Proposed Development be designed to achieve as low a noise level as practicable through screening, landscaping or building design. Exceedances of the guideline level may be allowable given that a good acoustic design process has been followed.

3.3 Methodology for Determining Construction Effects

3.3.1 Construction Noise

Specific details of the proposed construction works will be available once a detailed methodology has been prepared following completion of the detailed design. Therefore, at this stage, representative construction activities and worst-case assumptions including the likely type and number of construction plant have been assumed based on professional experience of similar projects.

For the purposes of assessing noise from construction activities, sound power level L_w data for representative plant to be used have been sourced from BS 5228 (Part 1). Noise predictions of construction activities have also been undertaken using Cadna-A noise modelling software. Cadna-A applies methodologies within BS 5228 to predict construction noise. The methodology applied in construction noise predictions is presented in 0.

BS 5228 provides practical information on construction noise and vibration reduction measures and promotes a BPM approach to control noise and vibration. The calculation method provided in BS 5228 is based on the number and type of equipment operating, their associated Sound Power Level (L_w), and the distance to sensitive receptors.

To assess potential noise impacts that may occur due to activities during the construction, the assessment has considered construction activities during the following phases of construction:

- Piling;
- Substructure
- Superstructure;
- Envelope; and
- Fit-out.

There are no current national standards or guidelines that present noise limits for construction sites. However, Annex E of BS 5228 provides some guidance on acceptable levels of construction noise and provides example criteria for the assessment of the significance of construction noise effects. Criteria for assessing construction noise effects have been defined with reference to 'example method 1 – the ABC method' as defined in BS 5228 1:2009+A1:2014. Category A criteria in the ABC method are interpreted as LOAEL and Category C criteria are considered equivalent to SOAEL.

The criteria adopted in this assessment, with reference 'significant adverse effects' and 'adverse effects' provided in the NPSE, are summarised in Table 3-4.

Table 3-4. Construction Noise Effects

Description	Effect Level
65 dB $L_{Aeq,T}$ construction noise threshold	LOAEL
75 dB $L_{Aeq,T}$ construction noise threshold	SOAEL

3.4 Construction Vibration

During construction activities, the highest levels of vibration are typically generated during piling activities. BS 5228-2 provides a set of sample vibration data that could potentially be generated during piling activities; however, the level of vibration generated at a nearby receptor is dependent on the piling method, ground conditions, and distance to the receptor. Potential locations for piling have been defined by the extents of the Proposed Development building footprints.

It is assumed that the piling method adopted will be auger piling, as is common for similar developments. The level of vibration depends on the type of piling, ground conditions, and receptor distance. Table 3-5 provides PPV levels for auger piling activities at various distances from piling locations which are sourced from BS 5228 Part 2.

Table 3-5. Example Piling Vibration Levels

BS 5228 Reference No.	Soil Conditions	Piling Mode	Plan Distance (m)	PPV (mm/s)
D.6 - 101	Fill / dense ballast / London Clay	Augering	20	0.05
		Auger hitting base of hole	20	0.23
D.6 - 103	Fill clay	Augering	20	0.30
		Dollying casing	20	0.55
		Spinning off	20	0.44
D.6 - 104	Fill / sand / clay	Augering	15	0.10
		Auger hitting base of hole	14	0.30
		Mudding in	14	0.20
		Dollying casing	14	0.80

Table 3-6 details Peak Particle Velocity (PPV) vibration levels and provides a semantic scale for the description of construction vibration impacts on human receptors based on guidance contained in BS 5228-2. The SOAEL is classified at 1 mms^{-1} PPV, which is the level above which vibration may cause complaint. The LOAEL is set at 0.3 mms^{-1} PPV, which is the point at which construction vibration is likely to become perceptible.

Table 3-6. Construction Vibration (PPV) Assessment Criteria

Peak Particle Velocity Level	Description	Approximate Distance to Receptor
< 0.3 mm/s	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.	>= 20 m
0.3 to < 1 mm/s	Vibration might be just perceptible in residential environments.	10 m to < 20 m
1.0 to < 10 mm/s	It is likely that vibration of this level in residential environments will cause complaint, but can be tolerated if prior warning and explanation has been given to residents.	5 m to < 10 m
>= 10 mm/s	Vibration is likely to be intolerable for any more than a very brief exposure to this level.	< 5 m

The criteria set out in Table 3-6 relate to occupants of buildings and therefore the same criteria are used for all receptors. At receptors above the SOAEL, further consideration of whether an effect is significant has been undertaken using professional judgement, taking account of the duration and frequency of the effect, as well as the time of day that the effect would be experienced.

In addition to human annoyance, building structures may be damaged by high levels of vibration. The levels of vibration that may cause building damage are far in excess of those that may cause annoyance. Consequently, if vibration levels are controlled to those specified by human annoyance, then it is unlikely that buildings will be damaged by demolition and construction vibration.

3.4.1 Construction Traffic Noise

Due to the high density of road traffic flows on the local road network, it is unlikely that construction traffic will result in a perceptible change in road traffic noise. Consequently, an assessment of construction traffic noise has been scoped out of the assessment. Although construction traffic noise is unlikely to adversely affect sensitive receptors, best practice will be adopted for delivery procedures to ensure that HGV noise is kept to a minimum. These measures are as follows:

- All deliveries will be scheduled in with the Site Team 48 hours prior to delivery to ensure no congestion build up on the nearby highways.
- If required holding zones will be established away from site if the deliveries cannot be accommodated due to overrun.
- All vehicle movements will be under banksman supervision.
- All suppliers and sub-contractors will be notified of any site delivery constraints and specific directions at time of order. Specific delivery times will also be included within the orders to ensure no deliveries take place during peak traffic times.

3.5 Methodology for Determining Operational Noise Effects

3.5.1 Road Traffic Noise

The Proposed Development may have an impact on traffic flows on existing roads in the area surrounding the Site once the Proposed Development is operational. The assessment focuses on the impact at existing residential properties located along affected roads in the vicinity of the Site.

Road traffic noise levels have been calculated with reference to methodology within the CRTN which contains an equation for the calculation of the Basic Noise Level (BNL) from a road in terms of the 18-hour AAWT (Average Annual Weekday Traffic) flow from 06:00 to 24:00. Road traffic noise levels have been calculated and compared for the following scenarios:

- Future 2021 baseline; and
- Future 2021 baseline + Proposed Development.

The magnitude of a noise impact due to changes in road traffic noise levels as a result of operational traffic has been assessed with reference to criteria outlined in the IEMA guidance and summarised in Table 3-7. It is generally accepted that changes in noise levels of 1 dB $L_{A10,18h}$ or less are imperceptible, and changes of 1 to 3 dB $L_{A10,18h}$ are not widely perceptible. Consequently, the SOAEL is set at a change in traffic noise of +5 dB $L_{A10,18h}$ and the LOAEL at +1 dB $L_{A10,18h}$.

Table 3-7. Road Traffic Noise Assessment Criteria

Magnitude of Impact	Noise Change Band, $L_{A10,18h}$
Very Low	≥ 0 dB and < 3 dB
Low	≥ 3 dB and < 5 dB
Medium	≥ 5 dB and < 10 dB
High	≥ 10 dB

3.5.2 Building Services and Fixed Plant Noise

BS 4142 provides a means of assessing the significance of industrial and commercial noise. A key aspect of the BS 4142 assessment procedure is a comparison between the background noise level in the vicinity of receptor locations and the rating level of the noise source under consideration. The relevant parameters in this instance are as follows:

- Background Sound Level, $L_{A90,T}$, defined in the Standard as the 'A-weighted sound pressure level that is exceeded by the residual sound for 90% of a given time interval, T, measured using time weighting F and quoted to the nearest whole number of decibels';
- Specific Sound Level, $L_{Aeq,Tr}$,the 'equivalent continuous A-weighted sound pressure level produced by the specific sound source at the assessment location over a given reference time interval, Tr'; and
- Rating Level, $L_{Ar,Tr}$, the specific sound level plus any adjustment made for the characteristic features of the sound'.

BS 4142 provides guidance as to the likely response from sensitive residential receptors to new fixed noise sources (e.g. building plant or services) through comparison of the rating level of the new noise source with the existing background level. The higher the rating noise level in comparison to the background noise level, the greater the likelihood of complaints arising. BS 4142 requires separate analysis for day and night time periods.

The criteria for determining the significance of changes in noise levels from building services plant, based on guidance within BS 4142, and the potential impact on noise sensitive receptors are presented in Table 3-8. Noise criteria for fixed plant are in line with the requirements of BCC as set out in Table 2 of their Noise and Vibration Regulation and Enforcement note.

Table 3-8. BS 4142 Noise Rating Criteria

Rating Level minus Background Level (dB)	NPSE/PPG Effect Level
+0 approximately	LOAEL
+10 approximately	SOAEL

It is noted that for the Site to be eligible for BREEAM noise pollution credit[19], building services and fixed plant noise should achieve 5 dB below the background noise level. Consequently, noise criteria have been defined at a level of 5 dB below the LOAEL, as defined in Table 3-8.

3.6 Assumptions and Limitations

A series of assumptions were made regarding some elements of existing noise sources that have the potential to affect noise levels at the Site.

To assess the potential noise and vibration effect of the Proposed Development, it was necessary to determine the baseline conditions. It is considered that the baseline noise measurements that were undertaken at the Site in

[19] Pol 05 – BREEAM UK (2018), BREEAM UK New Construction

January and February 2019 are representative of the typical noise environment of the Site at the time of submission of this report.

Digital modelling of the ambient noise environment across the Site has incorporated the dominant noise sources i.e. road traffic and rail movements. Data of road traffic flows have been sourced from road traffic survey data, which include projected growth figures for future baseline scenarios. Rail traffic noise levels have been compared against existing National Rail timetable information and validated against the noise survey results. While other less dominant or intermittent noise sources are present (e.g. existing sources such as aircraft or future sources such as car parking and loading / delivery areas), due to the limitations of digital noise modelling and as the precise details of future operations are yet to be finalised, these cannot be accurately included into a model as a continuous noise source. However, the inclusion of the dominant noise sources in the area into the noise models provides a realistic view of the typical noise environment across the Site.

Construction noise predictions have been undertaken using typical items of plant that are used in such developments. These items of plant are taken to be representative of the plant that will be used during the construction process of the Proposed Development. Noise predictions were carried out to represent a conservative scenario where all construction plant is operational. Consequently, noise predictions may overestimate construction noise levels and can therefore be considered as worst case.

The measured $L_{A90,T}$ background noise level is used to define design criteria for fixed plant associated with the Proposed Development. Background noise levels may change in the period between the survey and the opening year of development; however, as the $L_{A90,T}$ background noise level is a statistical value based on a range of measured noise data, it is not possible to predict future background noise levels with any degree of accuracy. It is considered that background noise levels are unlikely to reduce in the intervening period between the baseline survey and the development opening year. Consequently, it is considered that the derived design criteria provide suitable noise thresholds for future scenarios.

4. Baseline Conditions

4.1 Noise Survey Results

The results of baseline noise monitoring undertaken is summarised in Table 4-1. Data during adverse weather conditions (e.g. periods of rain and/or wind speeds < 5m/s) have been excluded from the analysis. Further data is provided in Appendix B.

At all locations, the noise environment was observed to be dominated by road traffic along the local road network. Along the south boundary of Site, rail movements were observed to be an additional dominant noise contributor.

Table 4-1. Long-term Noise Survey Results Summary

Location	Daytime (07:00-23:00)		Night (23:00-07:00)		
	$L_{Aeq,16h}$ dB	$L_{A90,1h}$ dB	$L_{Aeq,8h}$ dB	$L_{A90,15min}$ dB	L_{Amax} dB
LT1	51	45	44	32	70
LT2	48	41	42	29	64
LT3	47	42	41	32	62
LT4	59	55	52	46	72
LT5	69	66	63	58	92

4.2 Vibration Survey Results

The results of vibration monitoring at location V1 are summarised in Table 4-2.

The VDVs presented are the averages of the measured VDVs for the 16-hour daytime period and the 8-hour night period across the monitoring duration.

Table 4-2. Long-term Vibration Survey Results Summary

Period	VDV $m.s^{-1.75}$
Daytime (16 hours, 07:00-23:00)	0.04
Night-time (8 hours, 23:00-07:00)	0.03

5. Assessment of Site Suitability

5.1 Ambient Noise within the Proposed Development

This section assesses the suitability of the Site for development in respect of existing noise conditions and the proposed end uses of the proposed development. Where internal noise levels (as specified in relevant British Standards for daytime periods) that are desirable for new developments are not achievable through a typical building construction design as part of the proposed development, mitigation measures have been identified.

Glazing recommendations have been defined using the (R_w+C_{tr}) index, a commonly used single figure term used to specify the sound insulation requirements of façades affected by traffic noise (i.e. urban road traffic and low speed rail noise), and are provided as three numerical values, for example 4-16-6. These values relate to the: glazing thickness – air gap – glazing thickness, each in millimetres (mm).

Noise predictions have been carried out to determine the highest predicted noise incident on each building façade. The highest predicted daytime and night-time noise levels on the building façades (calculated at each floor) can be seen graphically in the figures provided in Appendix D. The noise plots are colour coded to provide an indication of mitigation requirements along each proposed building façade. The mitigation colour coding assumes that:

- A partially open window for ventilation provides an R_w+C_{tr} of approximately 12 dB;
- Thermal double glazing provides an R_w+C_{tr} of approximately 30 dB; and
- Acoustic laminate double glazing can provide an R_w+C_{tr} of up to 40 dB.

Appropriate double-glazing specifications to achieve suitable internal noise levels in the buildings considered in this report are presented in Table 5-1. Example glazing specifications are based on the scenario that results in the highest predicted noise level at each building.

Table 5-1. Example Glazing Specifications

	Daytime 07:00-23:00			Night-time 23:00-07:00		
Block	Upper range of predicted façade noise levels, $L_{Aeq,16h}$ dB	Reduction to achieve 'desirable' conditions, dB R_w+C_{tr}	Example glazing configuration	Upper range of predicted façade noise levels, $L_{Aeq,8h}$ dB	Reduction to achieve 'desirable' conditions, dB R_w+C_{tr}	Example glazing configuration
A	68	33	6/16/10.8 mm Acoustic double glazing	61	31	6/16/10.8 mm Acoustic double glazing
B	70	35	6/16/10.8 mm Acoustic double glazing	64	34	6/16/10.8 mm Acoustic double glazing
C	63	28	4/16/6 mm Thermal double glazing	57	27	4/16/6 mm Thermal double glazing
D	63	28	4/16/6 mm Thermal double glazing	58	28	4/16/6 mm Thermal double glazing
Town houses	69	34	6/16/10.8 mm Acoustic double glazing	63	33	6/16/10.8 mm Acoustic double glazing

In addition to the average noise levels for daytime and night-time periods, individual train movements at night should be appropriately mitigated. For the majority of facades across the Proposed Development, it is considered that the recommended reductions and glazing configurations summarised in Table 5-1 would be sufficient to achieve the WHO and ProPG internal noise guidance levels of 45 dB L_{Amax}.

The noise measurements indicate that the southern façades of Block B residential units that are nearest to and in direct line-of-sight of rail tracks may experience L_{Amax} levels from night-time train movements of up to 92 dB. Consequently, should any bedrooms be located on these façades facing rail tracks, glazing would be required which could perform to a specification of at least 47 dB R_w+C_{tr}. This may require a high specification acoustic glazing unit e.g. a 6/200/6 sealed frame unit where the internal cavity is lined with absorbent reveals.

For the majority of the Proposed Development, windows would need to remain closed in order to achieve the BS 8233:2014 internal ambient noise criteria for residential spaces. When windows are opened (e.g. for purge ventilation / temperature control) then internal ambient noise criteria may be exceeded; however, this will be at the discretion of the room occupant. As opening windows to control heat is considered to be a typical situation, particularly in summer, an alternative means of cooling should be provided as an alternative to opening windows.

Ventilation options include acoustically attenuated trickle ventilation. However, the attenuation performance of any alternative ventilation system must be specified to achieve a value of no less than that provided by the glazed element of the façade. Façades that experience noise levels below 50 dB $L_{Aeq,16h}$ (daytime) and 45 dB $L_{Aeq,8h}$ (night-time) as marked in grey in the Appendix D figures would be able to achieve internal noise guidance levels with windows open.

Windows and ventilation systems should be acoustically sealed and fitted with high standards of workmanship. Poorly fitting windows and build quality can decrease sound insulation performance significantly. It should be noted that the glazing specifications provided above are for acoustic purposes only and, therefore, any structural, safety, thermal or other issues will require to be addressed separately by the appropriate specialists.

The results of the assessment indicate that suitable mitigation measures can be implemented into the building designs to achieve suitable internal noise levels. The glazing and ventilation strategy to be adopted should be finalised at the detailed acoustic design stage.

5.2 Outdoor Amenity Area Noise

Courtyards and any other areas physically screened by building massing from road or rail traffic noise are expected to achieve the external noise criteria of 50-55 dB L_{Aeq}. Where noise criteria in outdoor amenity areas are not achievable (in particular, along the southern boundary near to rail line), ProPG provides advice on how impacts may be offset. Where a good acoustic design process has been followed, exceedances of the upper threshold may be partially off-set if the residents are provided with access to:

- *"a relatively quiet façade (containing openable windows to habitable rooms) or a relatively quiet externally ventilated space (i.e. an enclosed balcony) as part of their dwelling; and/or*
- *a relatively quiet alternative or additional external amenity space for sole use by a household, (e.g. a garden, roof garden or large open balcony in a different, protected, location); and/or*
- *a relatively quiet, protected, nearby, external amenity space for sole use by a limited group of residents as part of the amenity of their dwellings; and/or*
- *a relatively quiet, protected, publicly accessible, external amenity space (e.g. a public park or a local green space designated because of its tranquillity) that is nearby (e.g. within a 5 minutes walking distance)."*

With the inclusion of courtyard gardens and a village green within the scheme, and proximity to local civic parks and spaces (e.g. Mincinglake Valley Park to the north and Bettysmead Playing Fields to the east) it is considered that the provision of quieter outdoor spaces will be made available to future occupants of the scheme.

5.3 Ambient Vibration within the Proposed Development

The measured VDV along the southern boundary which is predominantly influenced by rain movements is 0.04 $m.s^{-1.75}$ during the day and 0.03 $m.s^{-1.75}$ at night.

The measured VDV levels were taken in an open ground area so the eventual transfer of ground-borne vibration into the Proposed Development will be dependent on the vibration energy that reaches the building foundation, the coupling of the building foundation to the soil, and the propagation of the vibration through the building. The transfer of ground-borne vibration into the building foundations and into the structure is likely to result in a reduction in vibration level.

Consequently, the measured VDV levels are unlikely to be perceivable in the Proposed Development and is below the level at which there is a ‘low probability of adverse comment’ per BS 6472-1 guidance. No specific mitigation measures to address ambient vibration are considered necessary.

6. Assessment of Effects

6.1 Construction Phase

6.1.1 Construction Noise Effects

The levels of unmitigated noise predicted at the identified receptors are presented Table 6-1. The forecast noise levels demonstrate the level of construction noise that may occur at sensitive receptors during representative periods of high activity. The corresponding construction noise effect level has been defined using criteria in Table 3-4. Noise contour plots showing the propagation of noise during each construction phase are presented in Table 6-1.

Table 6-1. Predicted $L_{Aeq,T}$ dB Noise Levels due to Construction Activities

Receptor	Predicted $L_{Aeq,T}$ dB Noise Level and Effect due to Construction Activities				
	Piling	Substructure	Superstructure	Envelope	Fit-out
R01	60 (below LOAEL)	57 (below LOAEL)	55 (below LOAEL)	54 (below LOAEL)	53 (below LOAEL)
R02	72 (greater than LOAEL but below SOAEL)	64 (below LOAEL)	63 (below LOAEL)	60 (below LOAEL)	58 (below LOAEL)
R03	64 (below LOAEL)	59 (below LOAEL)	58 (below LOAEL)	56 (below LOAEL)	56 (below LOAEL)
R04	65 (equal to LOAEL)	60 (below LOAEL)	58 (below LOAEL)	57 (below LOAEL)	56 (below LOAEL)
R05	65 (equal to LOAEL)	64 (below LOAEL)	63 (below LOAEL)	61 (below LOAEL)	60 (below LOAEL)
R06	59 (below LOAEL)	58 (below LOAEL)	56 (below LOAEL)	55 (below LOAEL)	54 (below LOAEL)
R07	59 (below LOAEL)	59 (below LOAEL)	57 (below LOAEL)	55 (below LOAEL)	54 (below LOAEL)
R08	57 (below LOAEL)	60 (below LOAEL)	59 (below LOAEL)	57 (below LOAEL)	55 (below LOAEL)
R09	62 (below LOAEL)	61 (below LOAEL)	60 (below LOAEL)	57 (below LOAEL)	56 (below LOAEL)

Receptors R02, R04 and R05 may experience construction noise levels during piling works equal to or exceeding the LOAEL. As exceedances of the LOAEL represents noise that is considered to be noticeable and intrusive, mitigation measures and noise management plans should be put into place to ensure that construction noise is minimised at all times throughout the construction programme. The SOAEL is not predicted to be exceeded.

Construction noise predictions are based on worst case scenarios that are representative of high periods of construction activity where, over the course of a working day, all plant are operational at all areas of all worksites. In reality, it is likely that the worst-case noise levels predicted will only occur for limited periods of time when plant are operational at the closest point to sensitive receptors.

6.1.2 Construction Vibration Effects

The estimated distances from identified sensitive receptors to the Site are presented in Table 6-2 along with the potential vibration effect based on sample data in Table 3-5. The potential vibration effects are derived from the criteria in Table 3-6.

Table 6-2. Potential Construction Vibration Effects

Receptor	Approximate distance from the Proposed Development Building Footprint (m)	Estimated Level of Piling Vibration	Potential Vibration Effect Level
R01	67	< 0.3 mm/s	Below the LOAEL
R02	57	< 0.3 mm/s	Below the LOAEL
R03	58	< 0.3 mm/s	Below the LOAEL
R04	33	< 0.3 mm/s	Below the LOAEL
R05	81	< 0.3 mm/s	Below the LOAEL
R06	128	< 0.3 mm/s	Below the LOAEL
R07	78	< 0.3 mm/s	Below the LOAEL
R08	95	< 0.3 mm/s	Below the LOAEL
R09	57	< 0.3 mm/s	Below the LOAEL

The assessment of vibration from construction activities indicates that the level of vibration generated from construction activities is likely to be below the LOAEL at all nearby sensitive receptors. As such, vibration may be perceivable at nearby receptors but is unlikely to be of magnitude that will cause any changes to behaviour or attitude, or result in structural damage to buildings.

6.2 Operational Phase

6.2.1 Road Traffic Noise Effects

Road traffic flow data is presented Table 6-3. Calculated BNLs and the change in noise levels between the future 2021 baseline scenario and full occupation of the proposed development are presented in Table 6-3. The resultant change in noise levels along each assessed road link is considered to be representative of the change in road noise that may be experienced at nearby noise sensitive receptors.

Table 6-3. Changes in Road Traffic Noise due to Operational Road Traffic Flows

Road Link	2021 Baseline BNL $L_{A10,18h}$ dB	2021 Baseline + Development BNL $L_{A10,18h}$ dB	Difference dB	Potential Road Traffic Noise Effect
Union Road	67	67	0	Very low
Stoke Hill	68	68	0	Very low
Prince Charles Road (Stoke Hill Roundabout)	68	69	0	Very low
Mount Pleasant Road	66	66	0	Very low
Old Tiverton Road	66	66	0	Very low
Prince Charles Road (Calthorpe Road Roundabout)	65	65	0	Very low
Calthorpe Road	65	66	0	Very low
Prince Charles Road (East)	56	56	0	Very low
Morrisons	59	62	3	Low

Predicted noise level increases range from 0 dB (i.e. no change) to 3 dB. These are considered to be of 'very low' to 'low' impact and are below the LOAEL. Changes to road traffic noise levels due to the introduction of the Proposed Development are not considered to be noticeable or intrusive.

6.2.2 Building Services and Fixed Plant Noise

Table 6-4 presents the recommended operational noise limits for proposed building services plant within the Proposed Development at nearby sensitive receptors. These operational noise limits are derived as 5 dB below the measured representative background noise level at each receptor and are equivalent to a ‘low impact’ per BS 4142 guidance.

Table 6-4. Recommended Building Services and Fixed Plant Criteria

Receptor	Background Level $L_{A90,15min}$ dB		Operational Noise Limit $L_{Ar,15min}$ dB	
	Daytime 07:00-23:00	Night-time 23:00-07:00	Daytime 07:00-23:00	Night-time 23:00-07:00
R01	41	29	36	24
R02	41	29	36	24
R03	41	29	36	24
R04	45	32	40	27
R05	45	32	40	27
R06	66	58	61	53
R07	66	58	61	53
R08	66	58	61	53
R09	42	32	38	27

7. Mitigation Measures

7.1 Mitigation and Monitoring During Construction

Mitigation measures will be employed to ensure that potential noise impacts at nearby sensitive receptors due to construction activities are minimised. Good industry standards, guidance and practice procedures (i.e. construction contractors to sign-up to the Considerate Contractors scheme) will be followed in order to minimise noise and vibration effects during construction. Noise and vibration will be managed to avoid and minimise impact magnitude and so resultant effects, and mitigation measures will be documented within a Construction Environmental Management Plan (CEMP), which will take into account the relevant key guidance documents.

The preferred approach for controlling construction noise is to reduce source levels where possible, but with due regard to practicality. The simplest and most effective method of reducing noise at nearby receptors is to ensure that noisy plant is located as far from receptors as practicable and screened using temporary barriers. Noise can also be reduced by limiting the daily time that noisy equipment is operated; however, it is acknowledged that sometimes a greater noise level may be acceptable if the duration of the construction activity, and therefore length of disruption, is reduced.

Noise and vibration will also be minimised through the adoption of BPM as standard working practices across the site to ensure that noise and vibration is reduced whenever practicable. The following provisions are examples of BPM and will be adhered to where practicable throughout the demolition and construction programme:

- Vehicles and mechanical plant will be fitted with effective exhaust silencers, maintained in good and efficient working order and operated in such a manner as to minimise noise emissions. The principal contractor will ensure that all plant complies with the relevant statutory requirements;
- Construction will only take place during core daytime working periods as follows:
    - Monday to Friday: 8am to 6pm;
    - Saturdays: 8am to 1pm; and
    - Sundays and bank holidays: No work permitted, or noisy work prohibited.
- Machines in intermittent use will be shut down or throttled down to a minimum when not in use. Engines will not be unnecessarily revved;
- Compressors will be fitted with properly lined and sealed acoustic covers which will be kept closed whenever in use. Pneumatic percussive tools will be fitted with mufflers or silencers of the type recommended by the manufacturers;
- Equipment which breaks concrete, brickwork or masonry by bending, bursting or ‘nibbling’ will be used in preference to percussive tools. The use of impact tools will be avoided where the Site is close to occupied premises;
- Rotary drills and bursters activated by hydraulic, chemical or electrical power will be used for excavating hard or extrusive material;
- Equipment powered by mains electricity will be used in preference to equipment powered by internal combustion engine or locally generated electricity;
- No part of the works nor any maintenance of plant will be carried out in such a manner as to cause unnecessary noise except in the case of an emergency when the work is absolutely necessary for the saving of life or property or the safety of the works;
- Plant will be maintained in good working order so that extraneous noise from mechanical vibration, creaking and squeaking is kept to a minimum;
- Noise emitting machinery which is required to run continuously will be housed in a suitable acoustically lined enclosure; and
- Monitoring of noise levels at the site boundary will be undertaken to identify where work procedures need to be modified should exceedances of noise limits occur.

7.2 Mitigation and Monitoring During Operation

The design of the Proposed Development will include a mitigation strategy to ensure that a suitable glazing and ventilation strategy is selected so that desirable internal noise conditions (see Table 5-1) are achieved. The glazing scheme will be finalised during the detailed acoustic design of the Proposed Development.

Building services plant will be designed to achieve the operational limits (see Table 6-4) consistent with the guidance set out in BS 4142 which may require mitigation to be incorporated into the fixed plant design. Should the noise exhibit any such acoustic features then the relevant penalty/ correction should be applied in accordance with BS 4142 to ensure that the resultant rating level falls within the limit levels.

8. Conclusions

An assessment of the suitability of the Site has been undertaken based on the façades of the Proposed Development worst affected by noise. The assessment indicates that suitable internal noise conditions are achievable with suitable mitigation in the form of glazing and ventilation be incorporated into the building envelope design. Ambient vibration is not considered to be perceivable in the Proposed Development so no mitigation is considered necessary.

Noise and vibration generated by construction activities may result in exceedances of the LOAEL at nearby sensitive receptors during piling works. Given the adoption of BPM to reduce construction noise as far as reasonably practicable, it is considered that all reasonable steps have been undertaken to reduce noise emissions.

Changes in road traffic noise due to operational traffic have been identified as below the LOAEL.

Operational noise limits for building services and fixed plant have been recommended that are 5 dB below the background noise level. Building services plant shall be designed to achieve the recommended noise limits at nearby sensitive receptors.

In summary, the Proposed Development has been assessed in line with current planning policy. The Site is considered suitable for its intended uses and no significant noise and vibration effects (i.e. exceedances of the SOAEL) are likely to occur during the construction and operational phases.

Appendix A Acoustic Terminology

Term	Definition
Decibel (dB)	The range of audible sound pressures is approximately 2 x 10^{-5} Pa to 200 Pa. Using decibel notation presents this range in a more manageable form, 0 dB to 140 dB. Mathematically Sound Pressure level = 20 log {p(t)/p_0} Where P_0 = 2 x 10^{-5} Pa.
A" Weighting (dB(A))	The human ear does not respond uniformly to different frequencies. "A" weighting is commonly used to simulate the frequency response of the ear. It is used in the assessment of risk of damage of hearing due to noise.
Frequency (Hz)	The number of cycles per second, for sound this is subjectively perceived as pitch.
Frequency Spectrum	Analysis of the relative contributions of different frequencies that make up a noise.
Ambient Sound	Totally encompassing sound in a given situation at a given time usually composed of sound from many sources near and far (The ambient sound comprises the residual sound and the specific sound when present).
Ambient Sound Level **$L_a = L_{Aeq,T}$**	Equivalent continuous A-weighted sound pressure level of the totally encompassing sound in a given situation at a given time, usually from many sources near and far, at the assessment location over a given time interval, T.
Background Sound Level $L_{A90,T}$	A-weighted sound pressure level that is exceeded by the residual sound at the assessment location for 90% of a given time interval, T, measured using time weighting F and quoted to the nearest whole number of decibels.
Equivalent Continuous A-weighted Sound Pressure Level $L_{Aeq,T}$	Value of the A-weighted sound pressure level in decibels of continuous steady sound that, within a specified time interval, T = $t_2 - t_1$, has the same mean-squared sound pressure as a sound that varies with time, and is given by the following equation: $$L_{Aeq,T} = 10lg_{10}\left\{\left(\frac{1}{T}\right)\int_{t1}^{t2}\left[p_A\frac{(t)^2}{{p_0}^2}\right]dt\right\}$$ Where p0 is the reference sound pressure (20μPA); and PA(t) is the instantaneous A-weighted sound pressure level at time t
Peak Particle Velocity	Is the greatest instantaneous particle velocity during a given time interval. If measurements are made in 3-axis then the resultant PPV is the vector sum is the square root of the summed squares of the maximum velocities, regardless of when in the time history those occur.

Appendix B Baseline Monitoring

B.1 Noise Monitoring Equipment

The noise monitoring equipment used in the survey is presented in . The long-term equipment was set to measure the L_{Aeq}, L_{A90} and L_{Amax} for 15-minute periods.

The calibration of the survey equipment was checked before and after all measurements, and no drift greater than ±0.3 dB was experienced during the monitoring periods.

Table B-1. Noise Survey Equipment

Monitoring Location	Sound level meter	Calibration Date	Field calibrator (start)	Field calibrator (end)
LT1	Rion NL-32	13/08/2018	Rion NC-74	Rion NC-74
	Serial no. 840884		Serial no. 35173436	Serial no. 35173436
LT2	Rion NL-52	28/08/2018	Rion NC-74	Rion NC-74
	Serial no. 542906		Serial no. 35173436	Serial no. 35173436
LT3	Rion NL-32	13/08/2018	Rion NC-74	Rion NC-74
	Serial no. 840885		Serial no. 34304647	Serial no. 34304647
LT4	Rion NL-52	22/02/2017	Rion NC-74	Rion NC-74
	Serial no. 542907		Serial no. 34304647	Serial no. 34304647
LT5	Svantek SVAN958	30/11/2017	Rion NC-74	Rion NC-74
	Serial no. 14212		Serial no. 34304647	Serial no. 34304647

B.2 Meteorological Conditions

The weather during the survey period was noted at the beginning and the end of the survey, as well as checked using online weather stations.

B.3 Baseline Noise Results

The results of baseline unattended measurements at LT1 to LT5 are presented below.

For analysis of long-term unattended noise data, the $L_{Aeq,T}$ noise metrics are calculated using the logarithmic average of 15-minute measurements made during each day and night period. The subsequent day and night $L_{Aeq,T}$ noise levels are averaged arithmetically to provide the typical levels presented. The $L_{A90,T}$ is the statistical mode of all measurements made during day and night period. The L_{Amax} is the 90th percentile value of night measurement so excludes the upper range of noise events that are typically considered to be anomalous.

Table B-2. Noise Monitoring Results at LT1

Date	Daytime (07:00-23:00)		Night-time (23:00-07:00)		
	$L_{Aeq,16h}$ dB	$L_{A90,15min}$ dB	$L_{Aeq,8h}$ dB	$L_{A90,15min}$ dB	L_{Amax} dB
25/01/2019	-	-	44	29	72
26/01/2019	51	42	51	40	71
27/01/2019	52	48	44	28	72
28/01/2019	51	44	44	29	71
29/01/2019	51	46	44	29	70
30/01/2019	51	43	44	34	72
31/01/2019	51	46	43	33	70
01/02/2019	51	47	43	32	71

Date	Daytime (07:00-23:00)		Night-time (23:00-07:00)		
	$L_{Aeq,16h}$ dB	$L_{A90,15min}$ dB	$L_{Aeq,8h}$ dB	$L_{A90,15min}$ dB	L_{Amax} dB
02/02/2019	50	43	41	30	58
Summary	**51**	**45**	**44**	**32**	**70**

Table B-3. Noise Monitoring Results at LT2

Date	Daytime (07:00-23:00)		Night-time (23:00-07:00)		
	$L_{Aeq,16h}$ dB	$L_{A90,15min}$ dB	$L_{Aeq,8h}$ dB	$L_{A90,15min}$ dB	L_{Amax} dB
25/01/2019	-	-	39	27	63
26/01/2019	51	40	49	35	72
27/01/2019	47	41	36	22	54
28/01/2019	49	38	40	27	61
29/01/2019	49	45	40	26	63
30/01/2019	51	38	40	33	62
31/01/2019	51	45	40	29	64
01/02/2019	47	42	40	27	67
02/02/2019	46	37	35	26	57
03/02/2019	45	38	46	33	70
04/02/2019	49	38	40	33	62
05/02/2019	50	43	41	23	63
06/02/2019	48	41	50	34	70
07/02/2019	47	43	45	33	69
Summary	**48**	**41**	**42**	**29**	**64**

Table B-4. Noise Monitoring Results at LT3

Date	Daytime (07:00-23:00)		Night-time (23:00-07:00)		
	$L_{Aeq,16h}$ dB	$L_{A90,15min}$ dB	$L_{Aeq,8h}$ dB	$L_{A90,15min}$ dB	L_{Amax} dB
25/01/2019	-	-	37	29	62
26/01/2019	47	42	49	39	70
27/01/2019	47	44	36	26	59
28/01/2019	48	40	40	32	60
29/01/2019	47	45	37	29	58
30/01/2019	47	41	41	36	62
31/01/2019	50	46	38	31	56
01/02/2019	46	44	36	28	59
02/02/2019	45	40	38	29	60
03/02/2019	45	40	45	38	66
04/02/2019	46	39	42	35	65
05/02/2019	47	43	41	27	63
06/02/2019	47	41	50	36	69
07/02/2019	48	44	43	34	65
Summary	**47**	**42**	**41**	**32**	**62**

Table B-5. Noise Monitoring Results at LT4

Date	Daytime (07:00-23:00)		Night-time (23:00-07:00)		
	$L_{Aeq,16h}$ dB	$L_{A90,15min}$ dB	$L_{Aeq,8h}$ dB	$L_{A90,15min}$ dB	L_{Amax} dB
25/01/2019	-	-	51	47	72
26/01/2019	60	56	53	48	73
27/01/2019	59	56	51	46	73
28/01/2019	59	54	51	44	74
29/01/2019	58	55	52	44	67
Summary	**59**	**55**	**52**	**46**	**72**

Table B-6. Noise Monitoring Results at LT5

Date	Daytime (07:00-23:00)		Night-time (23:00-07:00)		
	$L_{Aeq,16h}$ dB	$L_{A90,15min}$ dB	$L_{Aeq,8h}$ dB	$L_{A90,15min}$ dB	L_{Amax} dB
25/01/2019	-	-	64	63	91
26/01/2019*	-	-	-	-	-
27/01/2019*	-	-	-	-	-
28/01/2019	69	69	61	56	91
29/01/2019	70	64	63	55	92
30/01/2019	68	64	63	59	94
31/01/2019*	-	-	-	-	-
Summary	**69**	**66**	**63**	**58**	**92**

*Data for subsequent dates have been excluded due to poor weather conditions

B.4 Vibration Monitoring Equipment

Vibration monitoring equipment was set up approximately 7 m away from the railway. Vibration monitoring equipment is detailed below. The accelerometer was placed onto hard, level floor and covered with a sandbag. The vibration meter was set up to tri-axially to measure VDVs contiguously over 1-second intervals.

Table B-7. Vibration Monitoring Equipment

Monitoring Location	Vibration meter	Calibration Date
V1	Svantek SVAN958	30/11/2017
	Serial no. 14212	

B.5 Baseline Vibration Results

The results of baseline vibration measurements at LT1 are presented below.

Table B-8. Vibration Monitoring Results at LT1

Date	Daytime 07:00-23:00 VDV $ms^{-1.75}$	Night-time 23:00-07:00 VDV $ms^{-1.75}$
25/01/2019	0.04	0.02
26/01/2019	0.04	0.04
27/01/2019	0.04	0.02
28/01/2019	0.04	0.02
29/01/2019	0.04	0.02
30/01/2019	0.04	0.03
31/01/2019	0.04	0.02
01/02/2019	0.03	-
Summary	**0.04**	**0.03**

Appendix C Noise Modelling

C.1 Noise Modeling Software

CadnaA® is a sophisticated noise modelling software package that predicts noise levels based on the appropriate input data e.g. location and orientation of equipment and sound power data. The software package can take into account a variety of information about the site including topography, buildings, and construction noise sources.

The construction noise model has followed the procedures for prediction of construction noise set out in BS 5228-1:2009.

The road and rail traffic noise model has followed the procedures from Calculation of Road Traffic Noise (1988) and Calculation of Rail Noise (1995).

C.2 Noise Modeling Assumptions

The following assumptions have been made when producing the noise model:

- Mixed ground conditions have been modelled (G=0.5);
- Air temperature was assumed to be 10 degrees and humidity 70%; and
- One order of reflection was modelled.

C.3 Construction Noise Predictions

Assumed plant schedules for each stage of works are summarised below.

Table C-1. Plant Sound Power Levels

Plant	Sound Power Level, Lw dB(A)	BS 5228 reference
Excavator	104	BS5228-1: Table C.2 Item 5
Mobile Craneage / Tower Cranes	104	BS5228-1: Table C.4, Item 48
Hoist	104	BS5228-1: Table D.7, Item 93
Small tools	93	BS5228-1: Table C.3, Item 35
Hydraulic vibratory compactor	106	BS5228-1: Table C.2, Item 42
Mobile Access Platforms	95	BS5228-1: Table C.4, Item 57
Forklift Trucks	104	BS5228-1: Table D.7, Item 93
Piling Rig	111	BS5228-1: Table C.3, Item 14
Welding	101	BS5228-1: Table C.3, Item 31
Concrete Pump	106	BS5228-1: Table C.3, Item 25
Generator	97	BS5228-1: Table D.7, Item 56
Scaffolding	95	BS5228-1: Table C.4, Item 57

Table C-2. Plant Schedule - Piling

Plant	Sound Power Level (dB)	Time 'on'	Number of plant	Corrected for number of plant and time 'on'	Lw dB(A)
Excavator	104	70	1	-2	102
Mobile Crane/Tower crane	104	30	1	-5	99
Cutters, Drills and Small Tools	93	40	4	+2	95
Compactor / Roller	106	70	1	-2	104
MEWP	95	20	2	-4	91
Fork lift truck	104	30	2	-2	102
Piling Rig	111	40	1	-4	107
Welding Plant	101	70	1	-2	99
Concrete Pump	106	70	1	-2	104
Generator	97	40	1	-4	93
Scaffolding	95	20	2	-4	91

Table C-3. Plant Schedule - Substructure

Plant	Sound Power Level (dB)	Time 'on'	Number of plant	Corrected for number of plant and time 'on'	Lw dB(A)
Excavator	104	70	1	-2	102
Mobile Crane/Tower crane	104	30	1	-5	99
Cutters, Drills and Small Tools	93	40	4	+2	95
Compactor / Roller	106	70	1	-2	104
MEWP	95	20	2	-4	91
Fork lift truck	104	30	2	-2	102
Welding Plant	101	70	1	-2	99
Concrete Pump	106	70	1	-2	104
Generator	97	40	1	-4	93
Scaffolding	95	20	2	-4	91

Table C-4. Plant Schedule - Superstructure

Plant	Sound Power Level (dB)	Time 'on'	Number of plant	Corrected for number of plant and time 'on'	Lw dB(A)
Mobile Crane/Tower crane	104	30	1	-5	99
Hoist	104	30	2	-2	102
Cutters, Drills and Small Tools	93	40	4	+2	95
MEWP	95	20	2	-4	91
Fork lift truck	104	30	2	-2	102
Welding Plant	101	70	1	-2	99
Concrete Pump	106	70	1	-2	104

Plant	Sound Power Level (dB)	Time 'on'	Number of plant	Corrected for number of plant and time 'on'	Lw dB(A)
Generator	97	40	1	-4	93
Scaffolding	95	20	2	-4	91

Table C-5. Plant Schedule - Envelope

Plant	Sound Power Level (dB)	Time 'on'	Number of plant	Corrected for number of plant and time 'on'	Lw dB(A)
Mobile Crane/Tower crane	104	30	1	-5	99
Cutters, Drills and Small Tools	93	40	4	+2	95
Hoist	104	30	2	-2	102
MEWP	95	20	2	-4	91
Fork lift truck	104	30	2	-2	102
Welding Plant	101	70	1	-2	99
Generator	97	40	1	-4	93
Scaffolding	95	20	2	-4	91

Table C-6. Plant Schedule – Fit-out

Plant	Sound Power Level (dB)	Time 'on'	Number of plant	Corrected for number of plant and time 'on'	Lw dB(A)
Hoist	104	30	2	-2	102
Cutters, Drills and Small Tools	93	40	4	+2	95
Fork lift truck	104	30	2	-2	102
Generator	97	40	1	-4	93

C.4 Road Traffic Data

Road traffic data used in the prediction of future ambient noise levels and the assessment of operational road traffic noise effects is summarised below.

Table C-7. Road Traffic Data

Road Link Survey Site	Scenario						Average Speed (mph)
	2018 Baseline		2021 Future Baseline		2021 Future Baseline with Development		
	AAWT	HGV%	AAWT	HGV%	AAWT	HGV%	
Union Road	10569	2%	11203	2%	11635	2%	30
Stoke Hill	13418	3%	14223	3%	14329	3%	30
Prince Charles Road (Stoke Hill Roundabout)	16138	3%	17106	3%	18249	2%	30
Mount Pleasant Road	9829	2%	10419	2%	10419	2%	30
Old Tiverton Road	9361	4%	9923	4%	10528	4%	30
Prince Charles Road (Calthorpe Road Roundabout)	10736	3%	11380	3%	12464	2%	20
Calthorpe Road	11492	2%	12181	2%	13651	2%	20
Prince Charles Road (East)	1284	1%	1361	1%	1361	1%	20
Morrisons	2927	0%	3102	0%	5655	0%	20

Appendix D Noise Contour Plots

Figure D-2. Block B, Block C and Block D Site Suitability Noise Predictions Daytime

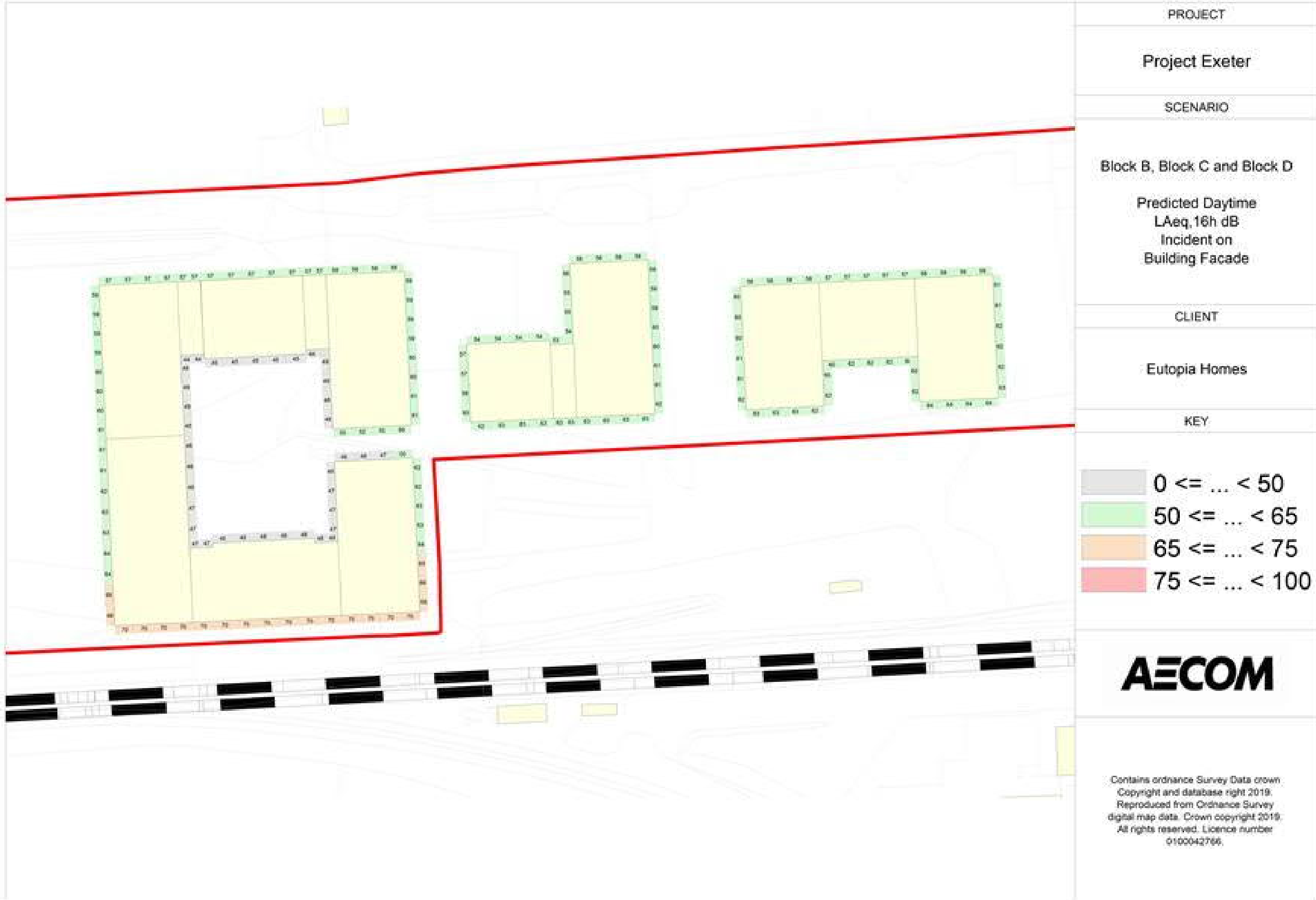

Figure D-3. Block B, Block C and Block D Site Suitability Noise Predictions Night time

Figure D-4. Block A and Town houses Site Suitability Noise Predictions Daytime

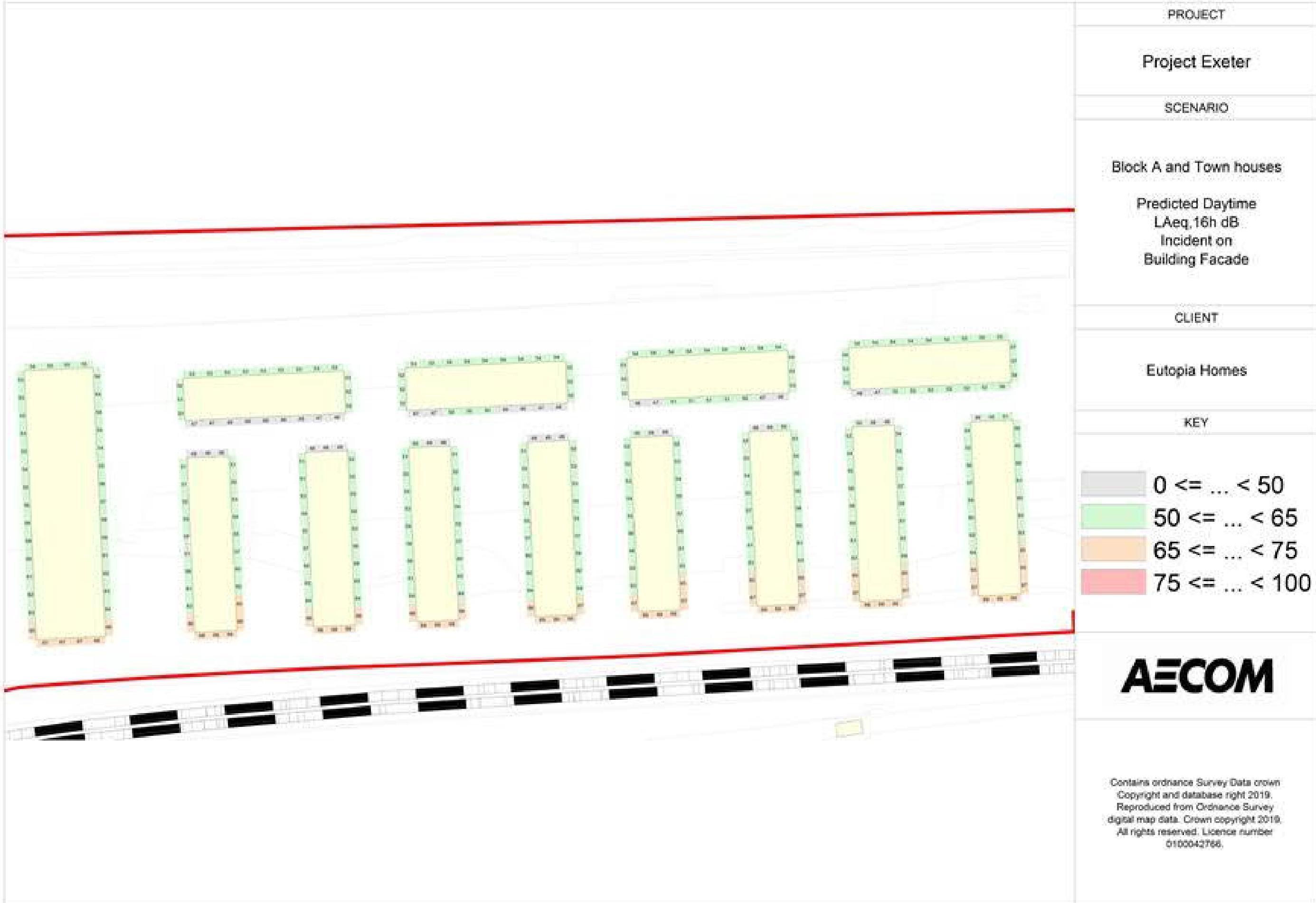

Figure D-5. Block A and Town houses Site Suitability Noise Predictions Night time

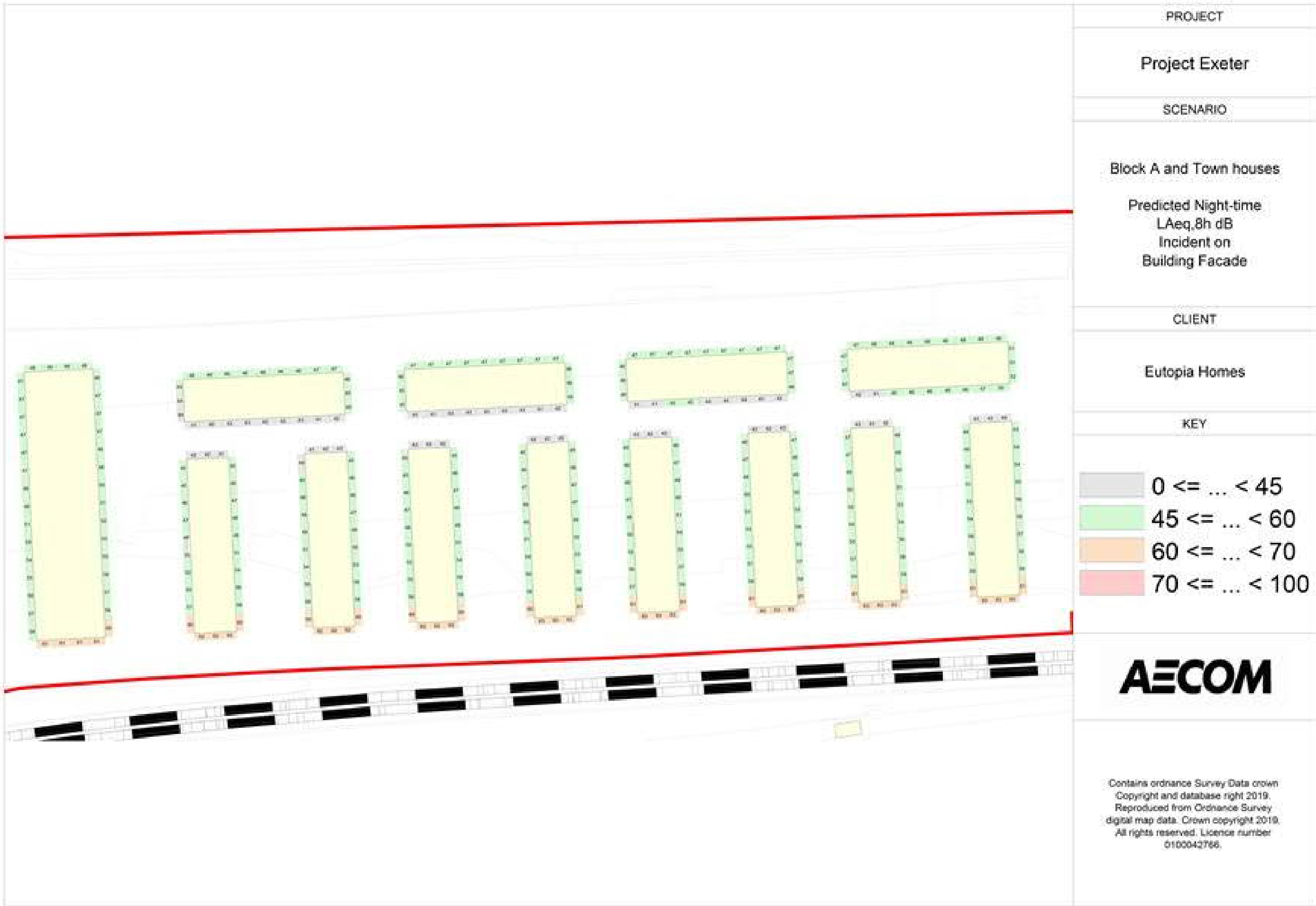

Figure D-6. Construction noise - Piling

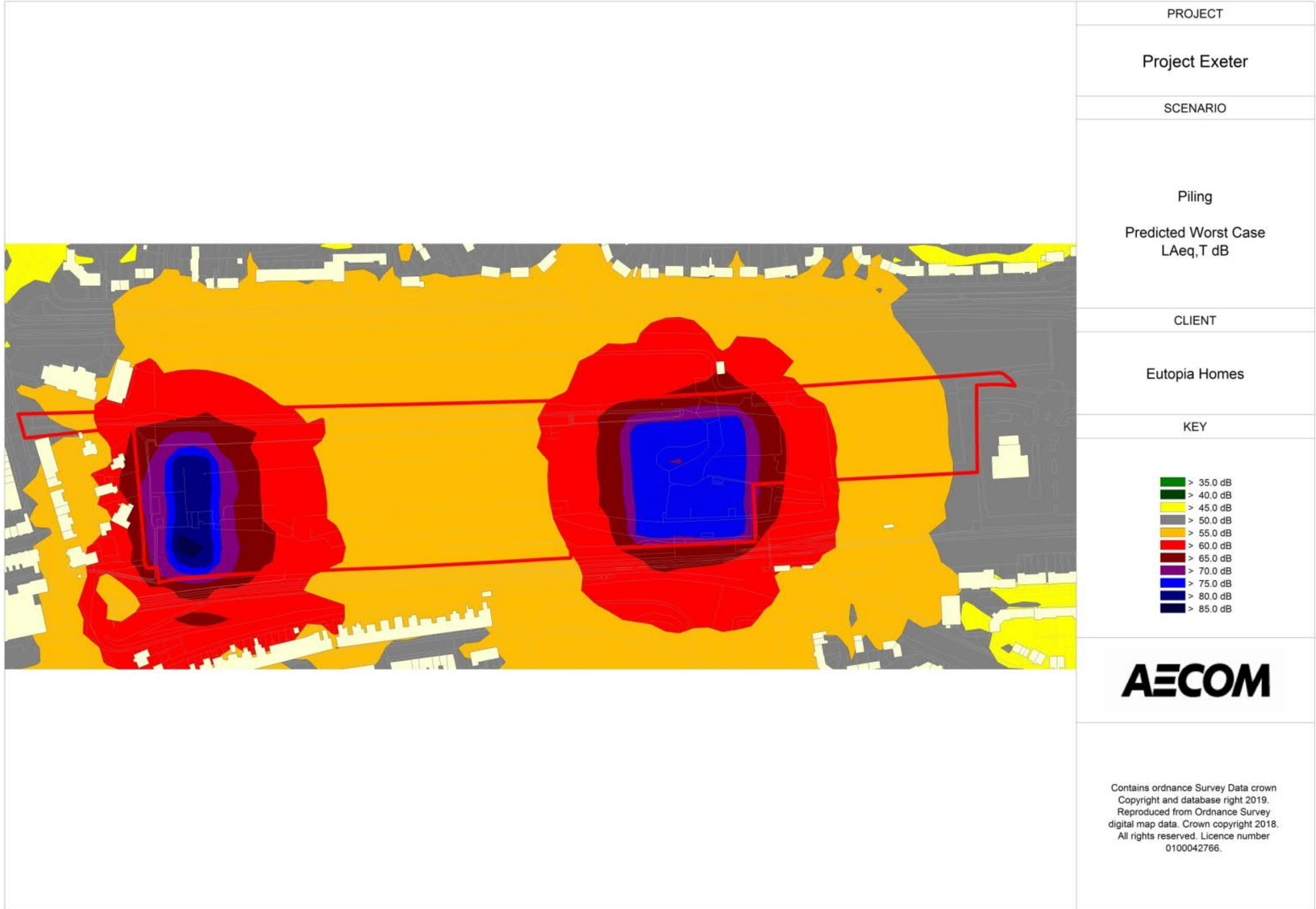

Figure D-7. Construction noise - Substructure

Figure D-8. Construction noise - Superstructure

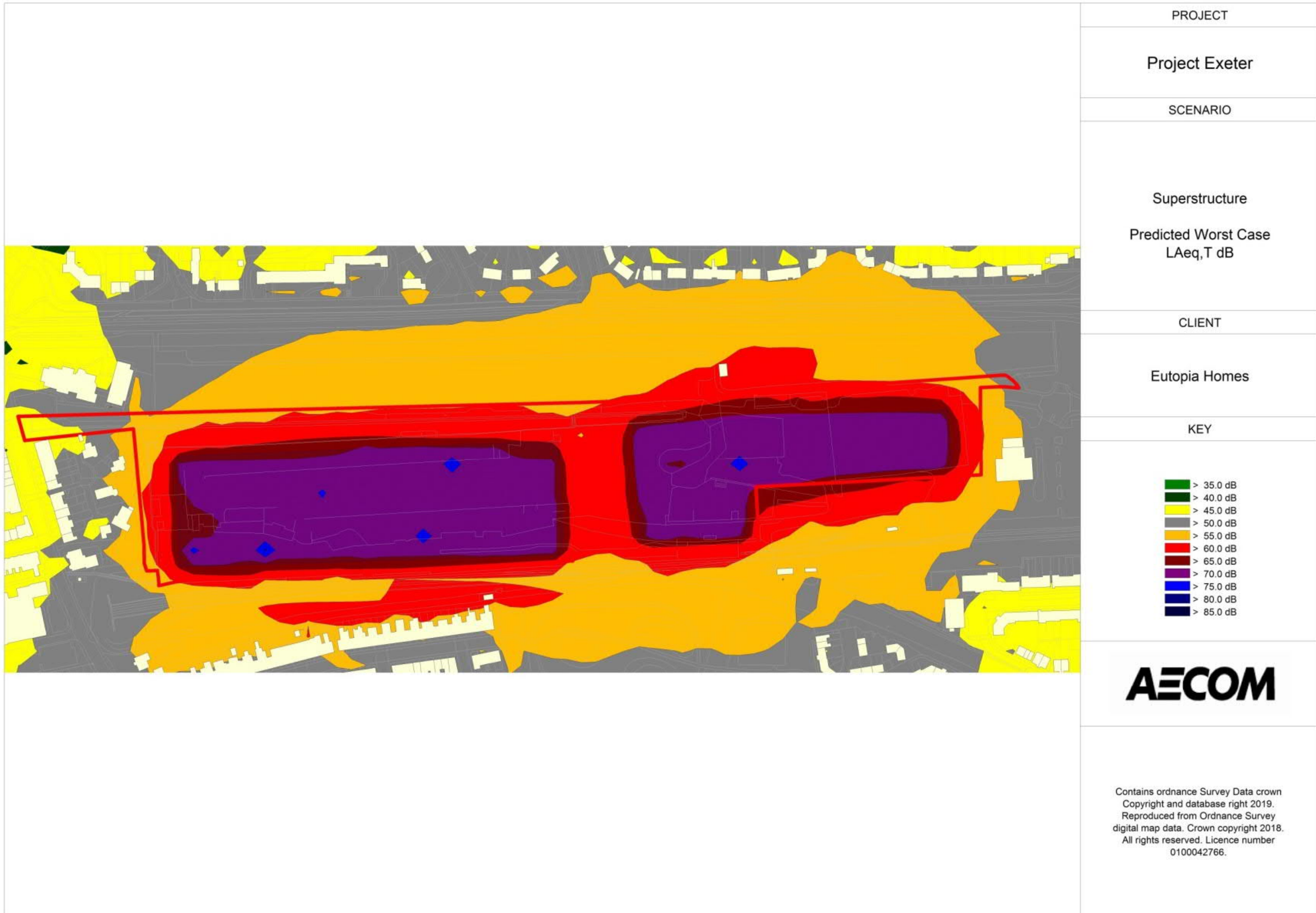

Figure D-9. Construction noise - Envelope

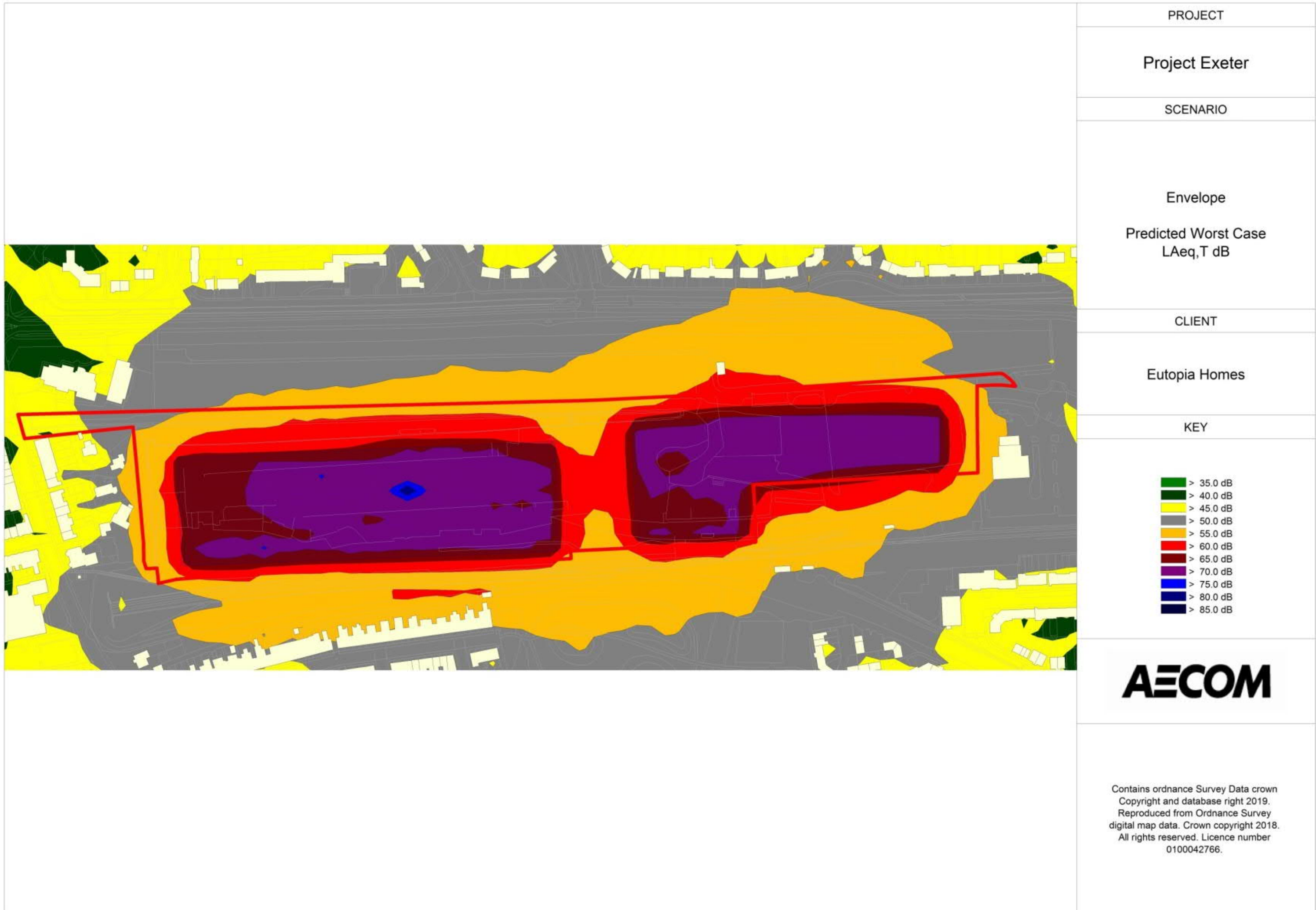

Figure D-10. Construction noise – Fit-out

EUTOPIA
HOMES

DARLING ASSOCIATES
ARCHITECTS