

Noise Assessment

on behalf of

**BENJAMIN PROPERTY COMPANY LIMITED, WITH
UNITED LIVING**

for the site at

**ONE PARK PLACE, CHEETHAM HILL,
MANCHESTER, M4 4EZ**

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Summary

An environmental noise assessment has been undertaken on behalf of Benjamin Property Limited, in support of a full planning application for a proposed residential-led mixed-use development at One Park Place, Cheetham Hill, Manchester, M4 4EZ.

Measurements were undertaken at the proposed site to identify the pre-development noise levels.

A noise model has been assembled for the proposed development site, the results from which are provided within this report.

The assessment has concluded that appropriate levels of internal amenity can be achieved with closed windows, and acoustically rated façade elements have been proposed to provide appropriate levels of internal amenity across the development. A TM59 overheating assessment has been carried out by Futureserv Ltd (ref: *OPL-FUT-L6150-RP-05*) which should be read in conjunction with this report for the mitigation measures considered for Part O Overheating Compliance.

Mechanical services noise limits have also been set for the development in line with the typical requirements of Manchester City Council.

Record of changes

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Date:

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1 Introduction

- 1.1 Miller Goodall Ltd has undertaken an environmental noise impact assessment on behalf of Benjamin Property Company Limited, with United Living, in support of a full planning application for a residential-led mixed-use development at One Park Place, Manchester.
- 1.2 To inform the noise impact assessment, an environmental sound survey has been undertaken at the site. A CadnaA computer noise model has been developed based on the results of the survey. The results of the survey and CadnaA model form the basis of the noise assessment detailed herein.
- 1.3 This report considers external building fabric requirements with respect to internal ambient noise levels.
- 1.4 Plant noise limits have been proposed based on the results of the survey.

2 Site Description

- 2.1 The site is located at One Park Place, Cheetham Hill, Manchester, M4 4EZ. The site location is shown in Appendix 1.
- 2.2 The site is in an urban location, surrounded by commercial and residential buildings.
- 2.3 The primary noise source at the site is Cheetham Hill Road which runs along the eastern boundary of the site.

3 Proposed Development

- 3.1 The application is for the demolition of existing building and erection of a part 25 and part 15 storey residential building comprising 154 units with ground floor commercial units (Use Class E), associated residents amenity space, cycle parking, substation, servicing, and associated landscaping works.
- 3.2 In addition to background ventilation the Mechanical Ventilation Heat Recovery System (MVHR) shall have the ability to run an overheating boost mode.

4 Policy Context

4.1 Noise Policy Statement for England

4.1.1 The Noise Policy Statement for England (NPSE¹), published in March 2010, sets out the long-term vision of Government noise policy. The Noise Policy aims, as presented in this document, are:

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

- avoid significant adverse effects on health and quality of life;
- mitigate and minimise adverse effects on health and quality of life; and
- where possible, contribute to the improvement of health and quality of life.”

4.1.2 The NPSE makes reference to the concepts of NOEL (No Observed Effect Level) and LOAEL (Lowest Observed Adverse Effect Level) as used in toxicology but applied to noise impacts. It also introduces the concept of SOAEL (Significant Observed Adverse Effect Level) which is described as the level above which significant adverse effects on health and the quality of life occur.

4.1.3 The first aim of the NPSE is to avoid significant adverse effects, taking into account the guiding principles of sustainable development (as referenced in Section 1.8 of the Statement). The second aim seeks to provide guidance on the situation that exists when the potential noise impact falls between the LOAEL and the SOAEL, in which case:

“...all reasonable steps should be taken to mitigate and minimise adverse effects on health and quality of life while also taking into account the guiding principles of sustainable development”.

4.1.4 Importantly, the NPSE goes on to state:

“This does not mean that such adverse effects cannot occur”.

4.1.5 The Statement does not provide a noise-based measure to define SOAEL, acknowledging that the SOAEL is likely to vary depending on the noise source, the receptor and the time in question. NPSE advises that:

¹ Noise Policy Statement for England, Defra, March 2010

“Not having specific SOAEL values in the NPSE provides the necessary policy flexibility until further evidence and suitable guidance is available”

- 4.1.6 It is therefore likely that other guidance will need to be referenced when applying objective standards for the assessment of noise, particularly in reference to the SOAEL, whilst also taking into account the specific circumstances of a proposed development.

4.2 National Planning Policy Framework

- 4.2.1 The National Planning Policy Framework (NPPF²) initially published in March 2012, was updated most recently in September 2023. One of the documents that the NPPF replaces is Planning Policy Guidance Note 24 (PPG 24) “Planning and Noise”³.

- 4.2.2 The revised NPPF advises that the planning system has three overarching objectives, which are interdependent and need to be pursued in mutually supportive ways (so that opportunities can be taken to secure net gains across each of the different objectives). One of these is an environmental objective which is described in par. 8 (c):

“to protect and enhance our natural, built and historic environment; including making effective use of land, improving biodiversity, using natural resources prudently, minimising waste and pollution, and mitigating and adapting to climate change, including moving to a low carbon economy.”

- 4.2.3 At par. 174 we are advised that:

“Planning policies and decisions should contribute to and enhance the natural and local environment by:

e) preventing new and existing development from contributing to, being put at unacceptable risk from, or being adversely affected by, unacceptable levels of soil, air, water or noise pollution or land instability. Development should, wherever possible, help to improve local environmental conditions such as air and water quality, taking into account relevant information such as river basin management plans...”

² National Planning Policy Framework, Ministry of Housing, Communities and Local Government, September 2023

³ Planning Policy Guidance 24: Planning and Noise, DCLG, September 1994

4.2.4 Par. 185 goes on to state:

“Planning policies and decisions should also ensure 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:

a) mitigate and reduce to a minimum potential adverse impacts resulting from noise from new development – and avoid noise giving rise to significant adverse impacts on health and the quality of life;

b) identify and protect tranquil areas which have remained relatively undisturbed by noise and are prized for their recreational and amenity value for this reason; ...”

4.2.5 Par. 187 seeks to ensure that any development does not prejudice the legally permitted operations and activities of other, existing non-residential uses, stating:

“Planning policies and decisions should ensure that new development can be integrated effectively with existing businesses and community facilities (such as places of worship, pubs, music venues and sports clubs). Existing businesses and facilities should not have unreasonable restrictions placed on them as a result of development permitted after they were established. Where the operation of an existing business or community facility could have a significant adverse effect on new development (including changes of use) in its vicinity, the applicant (or ‘agent of change’) should be required to provide suitable mitigation before the development has been completed.”

4.3 Planning Practice Guidance – Noise

4.3.1 As of March 2014, a Planning Practice Guidance⁴ for noise was issued which provides additional guidance and elaboration on the NPPF, the guidance was updated in July 2019. It advises that when plan-making and decision-taking, the Local Planning Authority should consider the acoustic environment in relation to:

- Whether or not a significant adverse effect is occurring or likely to occur;

⁴ Planning Practice Guidance – Noise, <https://www.gov.uk/guidance/noise--2> 22nd July 2019.

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

4.3.2 In line with the Explanatory Note of the NPSE, the PPG goes on to reference the LOAEL and SOAEL in relation to noise impact. It also provides examples of outcomes that could be expected for a given perception level of noise, plus actions that may be required to bring about a desired outcome. However, in line with the NPSE, no objective noise levels are provided for LOAEL or SOAEL although the PPG acknowledges 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”.

4.3.3 Examples of these factors include:

- The source and absolute noise level of the source along with the time of day that it occurs;
- Where the noise is non-continuous, the number of noise events and pattern of occurrence;
- The frequency content and acoustic characteristics of the noise;
- The effect of noise on wildlife;
- The acoustic environment of external amenity areas provided as an intrinsic part of the overall design;
- The impact of noise from certain commercial developments such as night clubs and pubs where activities are often at their peak during the evening and night.

4.3.4 The PPG also provides general advice on the typical options available for mitigating noise. It goes on to suggest that Local Plans may include noise standards applicable to proposed developments within the Local Authority's administrative boundary, although it states that:

“Care should be taken, however, to avoid these being implemented as fixed thresholds as specific circumstances may justify some variation being allowed”.

4.3.5 The PPG was amended in December 2014 to clarify guidance on the potential effect of noise from existing businesses on proposed new residential accommodation. Even if existing noise levels are intermittent (for example, from a live music venue), noise will need to be carefully considered and appropriate mitigation measures employed to control noise at the proposed accommodation.

4.4 Local Planning Policy

- 4.4.1 In October 2022, Manchester City Council published the latest edition of their Planning and Noise Technical Guidance document, which details the general approach to noise. This supersedes previous editions of the document, and is more recent than the planning application previously submitted for a similar scheme at this site in 2018.

Residential Developments

- 4.4.2 For residential developments, the Council has adopted the following noise limits:

- *Bedrooms (night time – 23.00 – 07.00) 30 dB L_{Aeq} (individual noise events should not normally exceed 45 dB $L_{Amax,F}$ by more than 10 times)*
- *Living rooms (daytime – 07.00 – 23.00) 35 dB L_{Aeq}*
- *Gardens and terraces (daytime) 55 dB L_{Aeq}*

- 4.4.3 These standards appear to have been drawn from BS 8233:2014 (see Section 6.2mix for more detail). The document later advises that a noise limit of “no more than 35dB for internal rooms during daytime”. Additionally, it is assumed that “Gardens and terraces” refers to all external amenity areas.

Noise and vibration from fixed plant / equipment

- 4.4.4 Specifically with regard to noise from fixed plant / equipment, the document states in Section 3.7.1.5 that:

“Externally mounted ancillary plant, equipment and servicing shall be selected and/or acoustically treated in accordance with a scheme designed so as to achieve a rating level of 5dB (L_{Aeq}) below the typical background (L_{A90}) level at the nearest noise sensitive location.”

- 4.4.5 The document also advises that structure-borne noise and vibration should be considered, e.g. where ventilation equipment is being installed on the roof of a residential apartment block.

5 Local Authority Consultation

5.1 Graeme Souter (Environmental Protection Officer) at Manchester City Council was consulted in respect of the methodology used in this assessment⁵. It was agreed that attended noise monitoring should be undertaken from 23:00 – 01:00 and 06:00 – 09:00 at one location representative of the noise levels at the site. This was to ensure that worst-case day- and night-time noise levels were recorded for undertaking noise break-in calculations, as well as lowest background noise levels for the setting of plant noise limits.

6 Acoustic Standards and Guidance

6.1 **ProPG: Planning & Noise – Professional Practice Guidance on Planning & Noise – New Residential Development – May 2017**

6.1.1 ProPG: Planning and Noise is new guidance with the aim of delivering sustainable development and promoting good health and well-being through the effective management of noise which may impact on new residential developments. The guidance aims to complement the national planning policy and encourages the use of good acoustic design at the earliest phase of the planning process. It builds upon the recommendations of various other guidance documents including NPPF, NPSE and PPG-Noise, BS 8233 and WHO.

6.1.2 The guidance is applicable to new residential developments which would be exposed predominantly to noise from existing transport sources. The ProPG advocates a risk-based approach to noise using a two-stage process:

- Stage 1 – an initial noise risk assessment of the proposed development site; and
- Stage 2 – a systematic consideration of four key elements: –
 - Element 1 – demonstrating a ‘Good Acoustic Design Process’;
 - Element 2 – observing internal ‘Noise Level Guidelines’;
 - Element 3 – undertaking an ‘External Amenity Area Noise Assessment’; and

⁵ Email to Graeme Souter, 25 August 2023

- Element 4 – consideration of 'Other Relevant Issues'.

6.1.3 The ProPG approach is underpinned by the preparation and delivery of an 'Acoustic Design Statement' (ADS), whereby the higher the risk for noise at the site, the more detailed the ADS. The ADS should address the following issues:

- Present the initial site noise risk assessment, including the pre-development acoustic conditions prior to development;
- Describe the external noise levels that occur across the site both before and after any necessary mitigation measures have been incorporated. The external noise assessment with mitigation measures in place should use an informed judgement of typical worst-case conditions;
- Demonstrate how good acoustic design is integrated into the overall design and how the proposed acoustic design responds to specific circumstances of the site;
- Confirm how the internal noise level guidelines will be achieved, including full details of the design measures and building envelope specifications;
- A detailed assessment of the potential impact on occupants should be undertaken where individual noise events are expected to exceed 45 dB $L_{AF,max}$ more than 10 times a night inside bedrooms;
- Priority should be given to enable the use of openable windows where practical across the development. Where this is not practical to achieve the internal noise level guidelines with windows open, then full details of the proposed ventilation and thermal comfort arrangements must be provided;
- Present the findings of the external amenity area noise assessment;
- Present the findings of the assessment of other relevant issues;
- Confirm for a low-risk site how adverse impacts of noise will be mitigated and minimised;
- Confirm for a medium or high noise risk site how adverse impacts of noise will be mitigated and minimised and clearly demonstrate that a significant adverse noise impact has been avoided.

6.1.4 ProPG target noise levels are based on existing guidance from BS 8233 and WHO (see below). Table 1 below outlines the guidance noise levels for different room types during day and night times.

Table 1: ProPG guideline indoor ambient noise levels for dwellings

Activity	Location	07:00 to 23:00	23:00 to 07:00
Resting	Living Room	35 dB $L_{Aeq,16hr}$	–
Dining	Dining room/area	40 dB $L_{Aeq,16hr}$	–
Sleeping (daytime resting)	Bedroom	35 dB $L_{Aeq,16hr}$	30 dB $L_{Aeq,8hr}$ 45 dB $L_{Amax,F}$

6.1.5 The footnotes to this table suggest that internal noise level limits can be relaxed by up to 5 dB where development is considered necessary or desirable, and still represent “reasonable” internal conditions. They also suggest that in such cases, external levels which exceed WHO guidance target levels (see WHO section below) may still be acceptable provided that reasonable internal noise levels are achieved. Although, where the acoustic environment of external amenity areas is intrinsic to the overall design, “noise levels should ideally not be above the range 50 – 55 dB $L_{Aeq,16hr}$ ”. The wording of ProPG (and BS 8233:2014) is clear that exceedance of guideline noise levels in external areas should not prohibit the development of desirable developments in any event.

6.2 **BS 8233:2014 Guidance on Sound Insulation and Noise Reduction for Buildings**

6.2.1 This standard carries the full weight of an adopted British Standard, provides recommended guideline acoustic design criteria for new dwellings and is supported by guidance contained within WHO GCN⁶. The guideline noise design criteria of BS 8233 apply to external noise “*without a specific character*” (previously and sometimes termed or referred to as “*anonymous noise*”) such as that associated with road and rail traffic.

Internal Amenity

6.2.2 The Standard states that for external noise without a specific character, such as road traffic, it is desirable that the internal ambient noise level does not exceed the guideline values shown in Table 2, below.

6.2.3 The note to paragraph 7.7.1 states that where noise has a specific character (i.e. it contains features such as a distinguishable, discrete and continuous tone, is irregular enough to attract attention, or has strong low-frequency content) “*lower noise limits might be appropriate*”.

⁶ World Health Organisation Guidelines for Community Noise, 1999

Table 2: BS 8233: 2014 guideline indoor ambient noise levels for dwellings

Location	Activity	07:00 to 23:00	23:00 to 07:00
Living Room	Resting	35 dB $L_{Aeq,16hr}$	–
Dining room/area	Dining	40 dB $L_{Aeq,16hr}$	–
Bedroom	Sleeping (daytime resting)	35 dB $L_{Aeq,16hr}$	30 dB $L_{Aeq,8hr}$

6.2.4 Note 7 to Table 4 of BS 8233 states:

“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.”

6.2.5 Guidance on reasonable acoustic design criteria for individual noise events are also provided, and the Standard advises that:

“regular individual noise events...can cause sleep disturbance. A guideline value may be set in terms of SEL^7 or $L_{Amax,F}$ depending on the character and number of events per night. Sporadic noise events could require separate values”.

6.2.6 For Internal spaces, the Standard states that;

“..to avoid sleep disturbance, sound pressure levels at the outside facades of living spaces should not exceed 45 dB L_{Aeq} (taken as a façade level, and equating to a free-field external level of 42 dB L_{Aeq}) and 60 dB L_{AFmax} so that people may sleep with bedroom windows open.”

External Amenity

6.2.7 BS 8233:2014 adopts guideline external noise values provided in WHO for external amenity areas such as gardens, patios and private outdoor amenity spaces. BS 8233:2014 adopts guideline external noise level limits provided in WHO for external amenity areas such as gardens and patios. The standard states that it is “desirable” that the external noise does not exceed 50 dB $L_{Aeq,16hr}$ with an upper guideline value of 55 dB $L_{Aeq,16hr}$ whilst recognising in paragraph 7.7.3.2 that development

⁷ Sound exposure level or L_{AE}

in higher noise areas, such as urban areas or those close to the transport network, may require a compromise between elevated noise levels (i.e., above 55 dB $L_{Aeq,16hr}$) and other factors that determine if development in such areas is warranted. In such circumstances, the development should be designed to achieve the lowest practicable noise levels in external amenity areas, but should not be prohibited.

6.2.8 The standard also states:

“Other locations, such as balconies, roof gardens and terraces, are also important in residential buildings where normal external amenity space might be limited or not available, i.e. in flats, apartment blocks, etc. In these locations, specification of noise limits is not necessarily appropriate. Small balconies may be included for uses such as drying washing or growing pot plants, and noise limits should not be necessary for these uses. However, the general guidance on noise in amenity space is still appropriate for larger balconies, roof gardens and terraces, which might be intended to be used for relaxation. In high-noise areas, consideration should be given to protecting these areas by screening or building design to achieve the lowest practicable levels. Achieving levels of 55 dB $L_{Aeq,T}$ or less might not be possible at the outer edge of these areas, but should be achievable in some areas of the space.”

6.3 Acoustics, Ventilation and Overheating: Residential Design Guide

6.3.1 The published Associated of Noise Consultants Guide Acoustics, Ventilation and Overheating – Residential Guide is an attempt to rationalise the conflicting interests of providing adequate ventilation and cooling to the inside of buildings through natural ventilation i.e. with windows being open and that of reducing sound in buildings by closing windows.

6.3.2 The AVO guide provides the first in depth guide to allow for buildings to be naturally ventilated whilst still achieving suitable acoustic conditions internally. The guidance is limited to noise from external transportation noise sources. Guidance is also provided for assessing internal sound levels from mechanical equipment that provides a solution to the overheating requirement. The guide splits the requirement into two areas, these being

- ventilation and;
- overheating.

6.3.3 Ventilation in the AVO guidance is defined as the requirement to achieve compliance with the requirements of Approved Document F of Building Regulations 2010. There are three types of ventilation in Approved Document F which are as follows:

- Whole House Ventilation: This is the continuous ventilation of rooms at very low rates to dilute and remove indoor pollutants and water vapour not removed by extract ventilation, purge ventilation or infiltration as well as supply outside air to the building.
- Extract Ventilation: This is the removal of air direct from a space to the outside. This can either be provided by mechanical (fan unit) or passive means (stack ventilation). This is usually required in bathrooms and kitchens to minimise the spread of water vapour, cooking odours and smoke to the rest of the building.
- Purge Ventilation: This is the manual control of the ventilation for a room, usually by a window which opens to the outside but can also be provided by fan units. The main purpose of purge ventilation is to remove water vapour and other pollutants rapidly due to accidental release or temporary activities such as burning food or decorating.

6.3.4 The above methods of ventilation can be provided by four principal ventilation systems. These are termed System 1, System 2, System 3 and System 4. In practice System 1, System 3 and System 4 are commonly used. System 2 is rarely used in the United Kingdom.

- System 1: This is a passive ventilation system that uses trickle ventilators to supply air via widow or wall vents and is used in combination with intermittent mechanical extract such as a kitchen fan unit or bathroom fan unit.
- System 2: This is a passive ventilation system that uses trickle ventilators to supply air via widow or wall vents and is used in combination with a passive stack ventilator that produces a draft as air passes over the stack.
- System 3: This is a continuous mechanical extract system where the internal air is extracted continuously from the building and air is supplied by trickle ventilators via widow or wall vents.
- System 4: This is a mechanical system with heat recovery where the internal air is extracted continuously from the building but the heat is removed and transferred to fresh cold air via a centralised heat exchanger unit. All of the above systems rely on purge ventilation being provided by openable windows.

6.3.5 Overheating is not regulated by Approved Document F and the systems above are not designed to regulate the thermal comfort of the building. The AVO guide states that where ventilation is the only consideration and overheating is not a constraint, then the sound levels in BS8233:2014 for System Types 1-4 in Approved Document F are the desirable internal levels to be achieved for transport noise sources. Table 2 summarises the requirements for the ventilation condition.

Table 2: AVO Guide Ventilation Condition Internal Noise Levels

	Desirable Internal Noise Levels from Transport Noise Sources				
	$L_{Aeq,16hr}$ dB (07:00 – 23:00)			$L_{Aeq,8hr}$ (23:00–07:00)	L_{AFmax} dB 23:00 – 07:00)
	Living Room	Dining Room	Bedroom	Bedroom	Bedroom
Whole House Ventilation	35	40	35	30	45
Purge Ventilation	No acoustic criteria				

6.3.6 For ventilation strategies that use mechanical extraction (System 1, 3 and 4), sound contribution from the extract fans should be considered. Table 3 presents the recommended sound level limits to be achieved for each ventilation condition.

Table 3: AVO Recommended Mechanical Services Noise Level During Operation

Ventilation Condition	System / Design Solution	Desirable Internal Noise Levels $L_{Aeq,T}$ dB			
		Bedroom	Living Room	Dining Room	Bathroom/WC /Kitchen
Whole House Ventilation	System 3 and 4	≤26–30	≤35	≤35	–
Extract Ventilation	System 1, 2 and 3	≤26–30	≤35	≤35	≤45

Purge Ventilation	Manual system – 4 air changes per hour	No acoustic criteria
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- 6.3.7 Overheating is the second aspect of the AVO guide that requires consideration as part of the acoustic assessment.
- 6.3.8 The overheating condition requires a two level assessment, Level 1 and Level 2. If the outcome of the Level 1 assessment results in a risk of negligible then a Level 2 assessment is not considered necessary. If the outcome of the Level 1 assessment is low or medium risk then a Level 2 assessment is considered optional. If the outcome of the Level 1 assessment produces a high risk rating then a Level 2 assessment is recommended.
- 6.3.9 For the purpose of this assessment we have determined that negligible and low risk rating sites do not require a Level 2 assessment whilst medium and high risk ratings do require a Level 2 assessment.
- 6.3.10 Table 4 presents the recommended Matrix by which to determine the risk rating of the site and is based on the AVO guide.

Based on the values in Table 4, overheating can be controlled for negligible and low risk sites with openable windows and for high risk sites using mechanical cooling, whilst providing design considerations for mechanical services noise.

Table 4: AVO Risk Rating Guide

Risk Rating	External Free-Field Sound Level			Suggested Design Actions
	$L_{Aeq,16hr}$	$L_{Aeq,8hr}$	L_{AFmax}	
High	≥65	≥55	≥80	Open windows unlikely to be able to be used to control overheating. CIBSE TM59 likely to be required and technical ventilation probably solution
Medium	60–65	50–55		Carry out Level 2 assessment using AVO diagrams to assess risk of adverse noise impact

Low	55-60	45-50		Open windows likely to be suitable and reasonable conditions still maintained- No action required
Negligible	≤55	≤45	≤60	Open windows will be suitable - No action required

6.3.11 If mechanical cooling is the only viable option for high noise level sites where the development is desirable due to other factors, the noise from mechanical services should also be considered. The AVO guide provides targets for acceptable internal noise levels from mechanical services. These are summarised in 5 below.

Table 5: Internal Noise Limits for Ventilation and Cooling Plant

System/Design Solution	Desirable Upper Internal Ambient Noise Levels $L_{Aeq,T}$ dB from Mechanical Services		
	Bedroom	Living Room	Dining Room
Ventilation or comfort cooling	30 (±5)	35 (±5)	35 (±5)

6.3.12 For medium risk sites, a combination of measures may be appropriate depending on the risk. The guidance therefore introduces the concept of the noise risk being a function of duration of the overheating condition.

6.3.13 The first stage therefore, is to consider the risk of overheating. The Good Homes Alliance has produced a scoring matrix that allows early design stage assessment of the overheating risk. The risk assessment is likely to return a result of Medium or High risk, except where the following requirements are applicable:

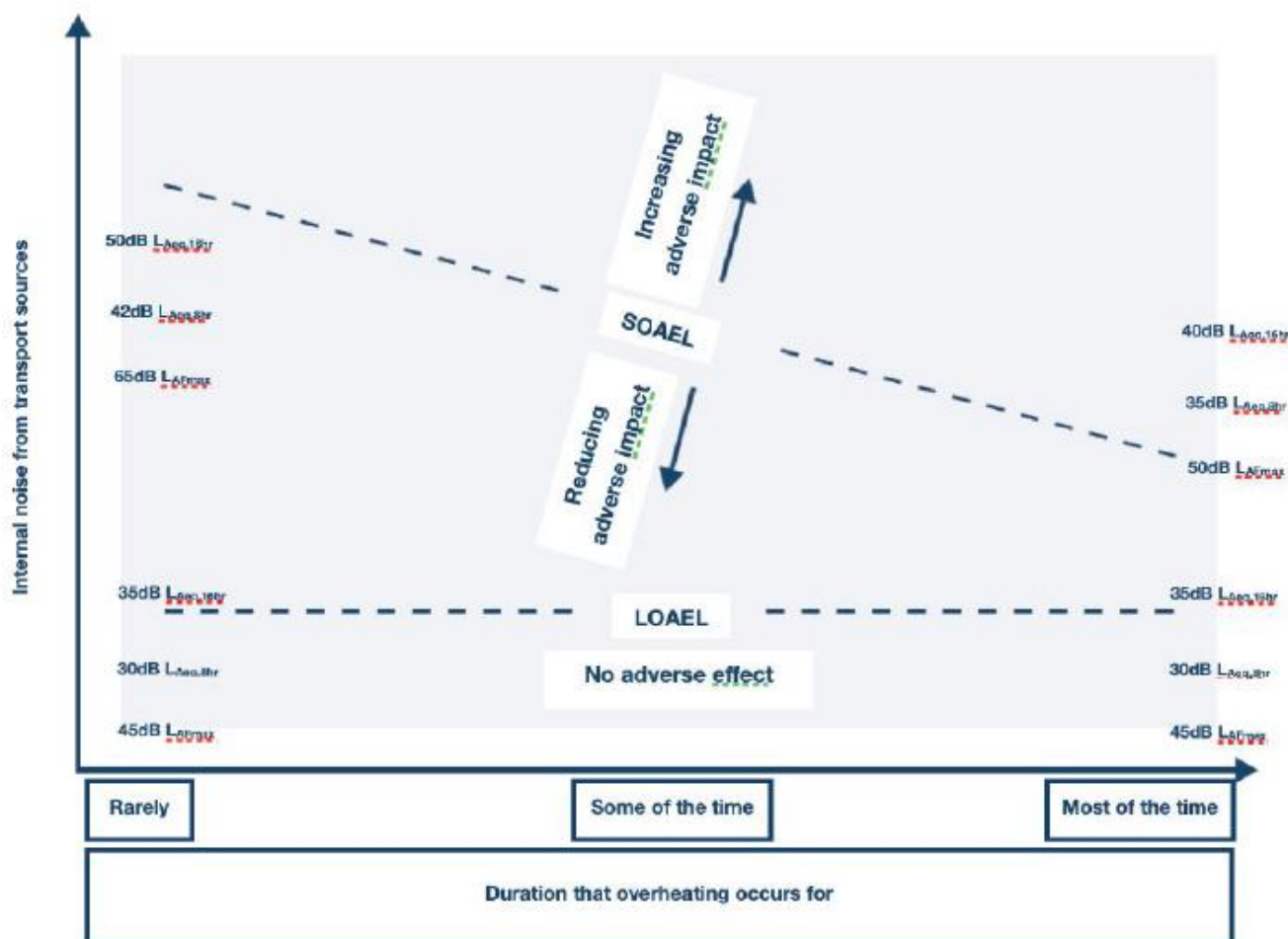
- The site is located in Northern England, Scotland or Northern Ireland.
- There are limited barriers to requiring windows to remain closed during both the daytime and night-time e.g. some windows can be openable on the quiet side.
- Glazing to facade ratios are generally less than 35%
- Ceiling heights above 2.8m
- Effective solar shading i.e. from existing trees

- Nearby blue/green infrastructure or light-coloured surfaces to reflect light such as external facades, roof tops etc...

6.3.14 Figure 1 below shows the Adopted AVO diagrams to be used in determining the impact from noise. Based on the above AVO diagram we have formulated the data in Table 6 which provides guidance on suitable external free-field sound levels where windows can be opened to help control overheating.

Table 6: Adopted free-field external noise levels for use with openable windows

Time of Day	NPSE Impact	Overheating Duration/Overheating Risk					
		Rarely/Low		Sometimes/Medium		Most of the time/High	
		$L_{Aeq,T}$	L_{AFmax}	$L_{Aeq,T}$	L_{AFmax}	$L_{Aeq,T}$	L_{AFmax}
Daytime (07:00–23:00)	NOEL	≤ 50	–	≤ 50	–	≤ 50	
	LOAEL	50–65	–	50–60	–	50–55	
	SOAEL	≥ 65	–	≥ 60	–	≥ 55	
Night-time (23:00–07:00)	NOEL	≤ 45	≤ 60	≤ 45	≤ 60	≤ 45	≤ 60
	LOAEL	45–55	60–80	45–52	60–70	45–48	60–65
	SOAEL	≥ 55	≥ 80	≥ 52	≥ 70	≥ 48	≥ 65

Figure 1: AVO Impact Assessment Diagram for Overheating

6.3.15 In summary, where ventilation is considered to be the only constraint then the requirements in BS8233:2014, WHO 1999 and ProPG are the required targets to achieve. Ventilation can either be achieved with openable windows or a system type identified in Approved Document F or other suitable alternative, assuming the building control body approves its use with windows remaining closed. Purge ventilation can be supplied by openable windows.

6.4 World Health Organisation (WHO) Guidelines for Community Noise 1999

6.4.1 The WHO Guidelines 1999 recommends that to avoid sleep disturbance, indoor night-time guideline noise values of 30 dB LAeq for continuous noise and 45 dB LA_{F,max} for individual noise events should be applicable. It is to be noted that the WHO Night Noise Guidelines for Europe 2009⁸ makes

⁸ WHO Night Noise Guidelines for Europe 2009

reference to research that indicates sleep disturbance from noise events at indoor levels as low as 42 dB $L_{AF,max}$. The number of individual noise events should also be taken into account and the WHO guidelines suggest that indoor noise levels from such events should not exceed approximately 45 dB $L_{AF,max}$ more than 10 – 15 times per night.

6.4.2 The WHO document recommends that steady, continuous noise levels should not exceed 55 dB L_{Aeq} on balconies, terraces and outdoor living areas. It goes on to state that to protect the majority of individuals from moderate annoyance, external noise levels should not exceed 50 dB L_{Aeq} .

6.5 **BS 4142:2014+A1:2019 'Methods for rating and assessing industrial and commercial sound'**

6.5.1 BS 4142:2014+A1:2019⁹ provides guidance on the assessment of the likelihood of complaints relating to noise from industrial sources. It replaced the 1997 edition of the Standard in October 2014 and was amended in June 2019. The amended version corrected a number of printing errors and further clarified that the standard is used to assess external noise levels, and not internal noise levels (although this can form part of the discussion regarding context). The key aspects of the Standard are summarised below.

6.5.2 The standard presents a method of assessing potential noise impact by comparing the noise level due to industrial sources (the Rating Level) with that of the existing background noise level at the nearest noise sensitive receiver in the absence of the source (the Background Sound Level).

6.5.3 The Specific Noise Level – the noise level produced by the source in question at the assessment location – is determined and a correction applied for certain undesirable acoustic features such as tonality, impulsivity or intermittency. The corrected Specific Noise Level is referred to as the Rating Level.

6.5.4 In order to assess the noise impact, the Background Sound Level is arithmetically subtracted from the Rating Level. The standard states the following:

- *Typically, the greater this difference, the greater the magnitude of the impact,*
- *A difference of around +10 dB or more is likely to be an indication of a significant adverse impact, depending on the context,*

⁹ BS 4142:2014+A1:2019 Methods for rating and assessing industrial and commercial sound

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

6.5.5 In addition to the margin by which the Rating Level of the specific sound source exceeds the Background Sound Level, the 2014+A1:2019 edition places emphasis upon an appreciation of the context, as follows:

An effective assessment cannot be conducted without an understanding of the reason(s) for the assessment and the context in which the sound occurs/will occur. When making assessments and arriving at decisions, therefore, it is essential to place the sound in context.

6.5.6 The 2014 edition of BS 4142 also introduced a requirement to consider and report the uncertainty in the data and associated calculations and to take reasonably practicable steps to reduce the level of uncertainty.

7 Noise Survey

7.1 Measurements of Existing Noise Sources

Noise measurements were undertaken at a single position representative of the proposed development in accordance with BS 7445-1: 2003¹⁰ by William Bateman and Sarah Cook of Miller Goodall Ltd. The calibration of the sound level meter was checked before and after measurements with negligible deviation (≤ 0.1 dB). Details of the equipment used are shown in Table 3 below.

¹⁰ BS 7445-1: 2003 Description and measurement of environmental noise – Part 1: Guide to quantities and procedures

Table 3: Noise monitoring equipment

Equipment Description	Type Number	Manufacturer	Serial No.	Date Calibrated	Calibration Certification Number
Class 1 ^{11,12} Integrating Real Time 1/3 Octave Sound Analyser	NOR 140	Norsonic	1407510	15/12/2021	05552/1
Pre-amplifier	NOR 1209	Norsonic	22462	15/12/2021	05552/1
Microphone	NOR 1225	Norsonic	384687	15/12/2021	05552/1
Class 1 Calibrator ¹³	NOR 1251	Norsonic	34123	13/10/2022	05972/1
Outdoor microphone housing	NOR 1217	Norsonic	1217538	N/A	N/A
Class 1 ^{14,15} Integrating Real Time 1/3 Octave Sound Analyser	NTi XL2-TA	NTi Audio	A2A-15860-E0	27/02/2023	06143/1
Pre-amplifier	NTi MA220	NTi Audio	8102	27/02/2023	06143/1
Microphone	NTi MC230A	NTi Audio	A16445	27/02/2023	06143/1
Outdoor microphone housing	NTi WP30	NTi Audio	NA	NA	NA
Class 1 Calibrator ¹⁶	CAL 200	Larson Davies	14154	10/10/2022	05964/1

7.1.1 Specific, background and ambient noise monitoring was undertaken at the times specified in Table 4 below. Weather conditions were determined both at the start and on completion of the survey. It is considered that meteorological conditions were appropriate for environmental noise measurements. Measurement locations are shown in Appendix 1.

¹¹ IEC 61672-1 (2002) Electroacoustics – Sound level meters Part 1: Specifications

¹² IEC 61260 (1995) Electroacoustics – Octave-band and fractional-octave-band filters

¹³ IEC 60942 (2003) Electroacoustics – Sound calibrators

¹⁴ IEC 61672-1 (2002) Electroacoustics – Sound level meters Part 1: Specifications

¹⁵ IEC 61260 (1995) Electroacoustics – Octave-band and fractional-octave-band filters

¹⁶ IEC 60942 (2003) Electroacoustics – Sound calibrators

Table 4: Dates, times and weather conditions during noise measurements

Measurement Location	Date	Time	Weather conditions
MPI	07/09/2023	23:00 – 00:00	Overcast, dry, 16 °C, still
	08/09/2023	00:00 – 01:00	Overcast, dry, 16 °C, still
		06:00 – 09:00	Overcast, dry, 17 °C, slight wind (≤ 1 m/s) from south west

7.1.2 Measurements were made under free-field conditions at a height of approximately 1.5 m above local ground level.

7.1.3 The measurement locations are detailed below and indicated in Appendix 2.

- MPI approximately 3 m from the road edge.

7.1.4 The noise sources within the vicinity of the measurement locations are summarised in Table 5, below:

Table 5: Description of noise sources affecting the site

Measurement Locations	Noise Sources
MPI	Road traffic on Cheetham Hill Road

7.2 Monitoring Results

A summary of the broadband measurement data is provided in Table 6 below. All data are sound pressure levels in dB re 20 μ Pa.

Table 6: Summary of noise measurements

Start Time (hh:mm)	Elapsed Time (hh:mm)	$L_{Aeq,T}$ (dB)	Overall $L_{AF,max}$ (dB)	$L_{AF10,T}$ (dB)	$L_{AF90,T}$ (dB)
23:00	01:00	68.7	93.6	72	55
06:00	07:00	68.8	86.7	73	54
07:00	09:00	70.9	99.8	73	61

- 7.2.1 Each measurement period consisted of sequential 100 ms samples which therefore allowed the variation in noise level over time to be assessed. This data was subsequently used to determine a representative highest $L_{AF,max}$ noise level. This data was subsequently utilised within the noise model.
- 7.2.2 The 100 ms noise levels have not been presented in this report but are kept on file for future reference.
- 7.2.3 The results of the noise monitoring have been assessed against the ProPG noise risk levels to determine the potential effect of noise on the proposed site without mitigation measures. The risk level has been determined based on the predicted daytime and night time noise levels at the worst affected façade(s) for the proposed development.

Table 7: ProPG Noise Risk Level Assessment

Noise Risk Assessment	Potential Effect Without Noise Mitigation	Pre-Planning Application Advice
Indicative Daytime Noise Levels $L_{Aeq,16hr}$ Indicative Night-time Noise Levels $L_{Aeq,8hr}$ 68 dB ← High 70 dB → 70 dB Medium 65 dB 60 dB Low 55 dB 50 dB Negligible 60 dB 55 dB 50 dB 45 dB 40 dB	Increasing risk of adverse effect	High noise levels indicate that there is an increased risk that development may be refused on noise grounds. This risk may be reduced by following a good acoustic design process that is demonstrated in a detailed ADS. Applicants are strongly advised to seek expert advice.
		As noise levels increase, the site is likely to be less suitable from a noise perspective and any subsequent application may be refused unless a good acoustic design process is followed and is demonstrated in an ADS which confirms how the adverse impacts of noise will be mitigated and minimised, and which clearly demonstrate that a significant adverse noise impact will be avoided in the finished development.
		At low noise levels, the site is likely to be acceptable from a noise perspective provided that a good acoustic design process is followed and is demonstrated in an ADS which confirms how the adverse impacts of noise will be mitigated and minimised in the finished development.
	No Adverse effect	These noise levels indicate that the development site is likely to be acceptable from a noise perspective, and the application need not normally be delayed on noise grounds.
Typical Night-time L_{Amax} (dB)	> 60 dB?	L_{Amax} Level Comment
90	Yes	An indication that there may be more than 10 noise events at night-time with $L_{Amax} > 60$ dB means the site should not be regarded as negligible risk.

Table Notes:

- a. Indicative noise levels should be assessed without inclusion of the acoustic effect of any scheme specific noise mitigation measures.
- b. Indicative noise levels are the combined free-field noise level from all sources of transport noise and may also include industrial/commercial noise where this is present but is not dominant.

7.2.4 As can be seen in Table 7 above, the noise levels measured at the site indicate high noise levels and therefore there is an increased risk that the development may be refused on noise grounds. If a good acoustic design process is followed and demonstrated in a detailed ADS then the risk of refusal may be reduced.

7.2.5 Octave band frequency data was obtained during surveying and this was utilised within noise ingress calculations to determine suitable mitigation in terms of glazing and ventilation requirements.

8 Impact of Existing Noise Sources on the Development

8.1 Computer Modelling

8.1.1 Predictions of existing noise levels on the site have also been undertaken using the CadnaA noise modelling package. Specific model parameters were applied as follows:

- Propagation of noise using algorithms within ISO 9613: 1993 *Acoustics – Attenuation of sound during propagation outdoors*. Roads were modelled as line sources at a height of 0.5 m above ground level and calibrated using spectral data measured during the survey.
- Default ground absorption $G = 0$ (equivalent to areas acoustically hard ground and consistent with the dominant ground cover at the site).
- Ground attenuation: spectral all sources
- No adverse meteorological effects
- Two orders of reflection
- Topographical data was obtained using DEFRA LIDAR contours for the site and surrounding assessment area.

8.2 Validation of the Noise Model

- 8.2.1 Noise level receptor points were incorporated into the CadnaA model at the noise survey measurement locations to calibrate the model using the measured octave band L_{eq} and L_{Fmax} noise levels. The modelled results agreed with the measured results to within ± 0.1 dB.

8.3 Noise Model Predictions

- 8.3.1 Three scenarios were modelled using the indicative master plan provided: daytime L_{Aeq} noise levels affecting the site, night-time L_{Aeq} noise levels and night-time $L_{AF,max}$ noise levels.
- 8.3.2 The noise modelling demonstrates the drop-off in noise levels with increasing distance and screening from Cheetham Hill Road, the most significant noise sources affecting the site. The model also indicates that the external noise levels in the south-west courtyard to the rear of the development and in the 15th floor terraced area are below the level of 55 dB L_{Aeq} during the day recommended by WHO for external amenity areas.

8.4 Predicted Internal Noise Levels Assessed to ProPG Guidance Levels

- 8.4.1 Based on ProPG guidance levels, it is proposed that noise from the development is controlled to 30 dB L_{Aeq} in bedrooms at night and 35 dB L_{Aeq} in habitable rooms during the day, and that noise from individual events such as vehicle pass-bys does not regularly exceed an indoor level of 45 dB $L_{AF,max}$.
- 8.4.2 The generally accepted rule of thumb is that a window left open for ventilation provides 10 – 15 dB attenuation from external noise sources with the WHO Guidelines for Community Noise suggesting 15 dB. The DEFRA report NANR116: Open/Closed Window Research¹⁷ suggests the figure to be between 12 and 18 dB for road and rail traffic. ProPG indicates that where external noise levels are more than 15 dB higher than the internal noise targets, openable windows should not be relied upon as the sole means of ventilation and some form of acoustically attenuated ventilation may be required. This equates to an external noise level of 45 dB L_{Aeq} / 60 dB $L_{AF,max}$ during the night or 50 dB L_{Aeq} during the day.

¹⁷ NANR116: 'Open/closed window research' Sound Insulation through ventilated open windows, Defra April 2007

8.4.3 External noise levels recorded at the site are above the threshold levels below which internal noise levels remain achievable with the use of open windows for ventilation, and therefore mitigation measures to reduce the noise impact have been applied as described in the following section of this report.

8.5 Mitigation for Achieving Good Acoustic Design

8.5.1 In order to assess the potential glazing and ventilation requirements for dwellings, noise ingress calculations were undertaken based on the methodology in BS EN 12354-3¹⁸. The following assumptions were made regarding the internal rooms:

- Room volumes are based on drawings issued 15/09/2023
- 'Normal' internal surface finishes e.g. carpeted with curtains etc.
- Glazed areas are based on drawings issued 15/09/2023
- Reverberation time 0.5 s in bedrooms and 0.8 s in living rooms

8.5.2 To determine the glazing requirements, living rooms and bedrooms have been assessed at multiple locations on floors 2, 6, 10, 14, 18, 22 and 24.

8.5.3 Noise ingress calculation results are summarised in Table 8, below:

¹⁸ BS EN 12354-3:2000 Building acoustics. Estimation of acoustic performance in buildings from the performance of elements - Airborne sound insulation against outdoor sound

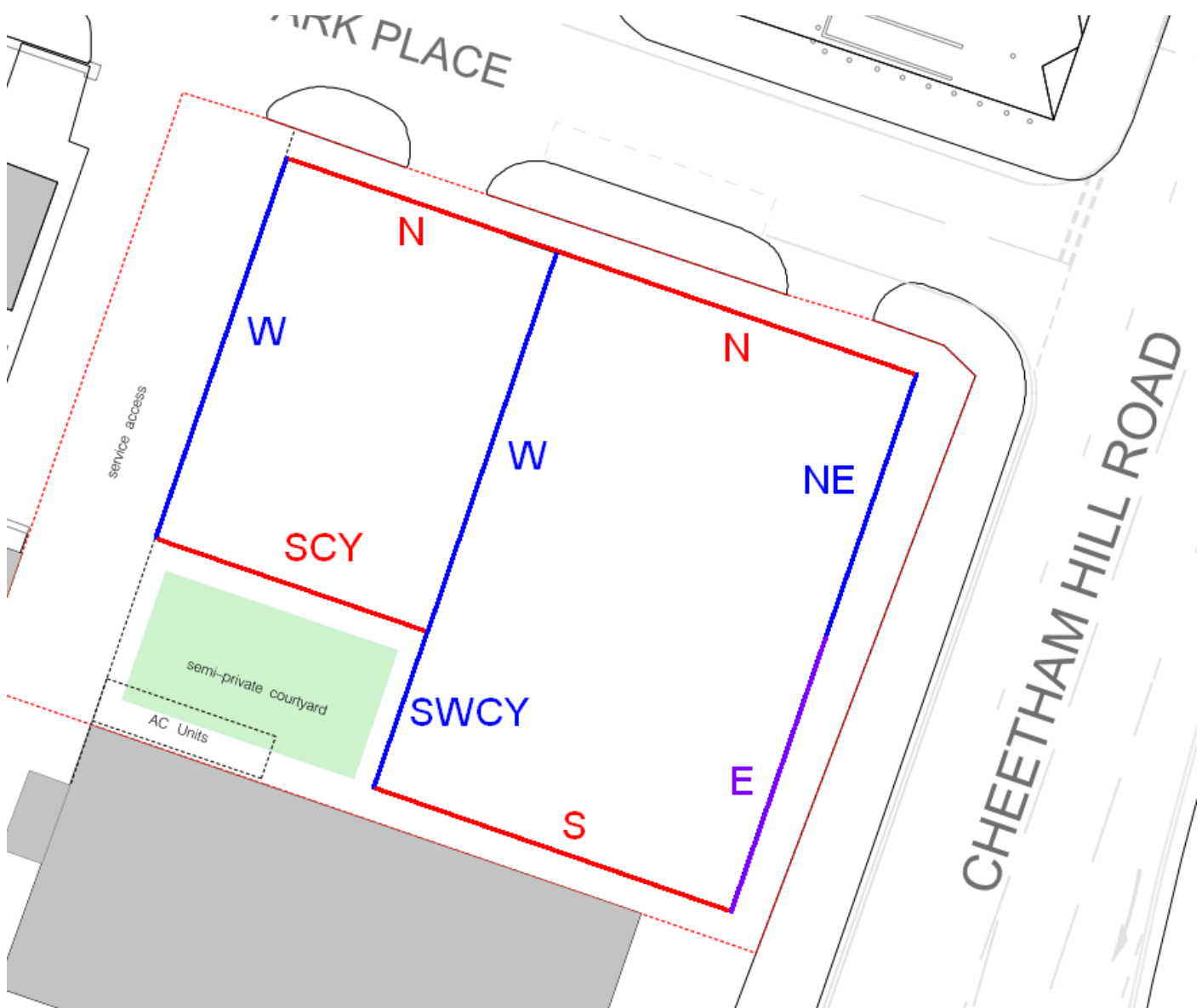
Table 8: Locations and glazing types required

Location	Room Type	Glazing Ref:	$R_w + C_{tr}$ (dB)
NE - Level 2 – 9	Bedroom	Type 1	46
N - Level 2 – 13	Bedroom	Type 2	38
NE - Level 10 – 21	Bedroom	Type 2	38
S - Level 2 – 17	Bedroom	Type 2	38
E - Level 2 – 9	Living Room	Type 3	33
N - Level 14+	Bedroom	Type 3	33
NE - Level 22+	Bedroom	Type 3	33
S - Level 18 – 21	Bedroom	Type 3	33
E - Level 10 – 13	Living Room	Type 4	29
N - Level 2 – 9	Living Room	Type 4	29
S - Level 22+	Bedroom	Type 4	29
E - Level 14+	Living Room	Type 5	27
N - Level 10+	Living Room	Type 5	27
SCY - Level 2+	Bedroom	Type 5	27
SWCY - Level 10+	Bedroom	Type 5	27
W - Level 2+	Living Room	Type 5	27

- **Type 1** – Glazing with minimum weighted sound reduction index of 46 dB $R_w + C_{tr}$ (e.g. typically achieved using 10.8 mm laminated glass / 24 mm argon-filled air gap / 16.8 mm laminated glass);
- **Type 2** – Glazing with minimum weighted sound reduction index of 38 dB $R_w + C_{tr}$ (e.g. typically achieved using 10 mm float glass pane / 12 mm air gap / 16 mm laminated glass);
- **Type 3** – Glazing with minimum weighted sound reduction index of 33 dB $R_w + C_{tr}$ (e.g. typically achieved using 10 mm float glass pane / 12 mm air gap / 6 mm float glass pane);
- **Type 4** – Glazing with minimum weighted sound reduction index of 29 dB $R_w + C_{tr}$ (e.g. typically achieved using 6 mm float glass pane / 12 mm air gap / 6 mm glass pane);
- **Type 5** – Glazing with minimum weighted sound reduction index of 27 dB $R_w + C_{tr}$ (e.g. typically achieved using standard thermal double glazing, i.e. 4 mm float glass pane / 12 mm air gap / 4 mm float glass pane).

8.5.4 It can be seen from Table 8 that there is a large variability in the acoustic performance requirements of glazing across the development. To ensure that internal noise limits are achieved throughout the development. Locations are determined by façade, room type and floor level, the façades are marked up below in Figure 1.

Figure 1: Façade markup for glazing



8.6 External Noise Levels

- 8.6.1 The predicted daytime noise levels in external amenity areas facing west, including both courtyards at ground floor and 15th floors are below 55 dB $L_{Aeq,15hr}$.

8.7 Acoustic Design Statement

Typical Issues for low / medium / high risk sites	Statement
Relevant noise sources identified	This assessment has considered noise from road traffic.
Assess extent of noise risk for unmitigated site (current and foreseeable future, 15 years ahead)	Unmitigated site will see risk of excessive noise levels, principally from high levels of road traffic noise from Cheetham Hill Road.
Adequate non-sensitive use for screening	Not possible for this development
Opportunities to mitigate the noise source within the site	Unable to mitigate traffic noise at source.
Opportunities to mitigate the noise source outside owned land; Physical mitigation; Operational management	Unable to mitigate traffic noise at source.
Maximise separation	Achieved by setting back development to rear of site.
Existing topographical advantages; Change site level	Not applicable, effectively a flat site between source and receptor.
Noise barriers – screening opportunities	Not applicable at this site
Site layout – protecting residential units	Achieved utilising set back
Design external amenity spaces (e.g. balconies) to reduce noise entering sensitive rooms	External amenity areas proposed away from noise source where relevant
Site layout – protecting external amenity space	Achieved utilising self-screening by new building. All external amenity areas located on the quieter rear elevation.
Access to quiet open space on or off-site	Achieved by provision of shielded rear courtyards.

Non-sensitive elements as screens	Not possible,
Orientation of noise sensitive rooms away from the source of noise exposure i.e. quiet facades	Achieved where possible, within constraints of development
Building treatment to screen openings	Not relevant
Consideration of alternative acoustic options	Acoustically rated glazing and mechanical ventilation proposed
Window location & size on affected facades	Internal noise criteria achieved by utilising acoustic glazing rather than reducing glazing size
Façade insulation design	Insulated concrete cladding façade construction, is not the weak point of the façade.
Ventilation – natural, from quiet facade	Mechanical ventilation throughout

Acoustic performance of ventilation; Thermal comfort	A Thermal Comfort TM59 Overheating Assessment has been carried out by Futureserv Ltd Rpeort Ref OPL-FUT-L6150-RP-05 which summaries the following measures: • Day to day general background ventilation inline with approved document Part F shall be provided by a Mechanical Ventilation Heat Recovery System (MVHR), therefore no requirement for trickle ventilation or opening windows to provide day to day background ventilation. • Lower G values have been applied to the glass specification to reduce solar gain. • All Apartments have been simulated with windows closed throughout the night (11pm to 8am) for the overheating assessment with the MVHR system incorporating increased ventilation overheating flowrates available via a boost switch within each apartment during the night time hours. • Windows have been simulated as opening on all facades during the day time hours (8am to 11pm) set to begin to open when the internal temperature exceeds 22°C with a gradually opening profile and fully open when the internal temperature reaches 26°C. A less reactive window opening scenario was also tested with windows triggered when the internal temperature exceeds 23°C and all rooms were still compliant with TM59 reducing to the average opening hours during the summer months May-Sept of 10 hours a day. The proposed overheating strategy is subject to a Level 2 AVO assessment.
Complete Acoustic Design Process throughout	Yes

9 Plant noise limits

- 9.1 Mechanical services noise is likely to be conditioned so as not to exceed a level equivalent to -5 dB relative to background for the combined noise emissions from all mechanical services plant. This is typical of the requirements of Manchester City Council to avoid background noise creep.
- 9.2 Based on the quietest background noise levels measured at night during the environmental noise survey and the expected requirements of MCC, the noise limits at the nearest noise sensitive receptors is shown below in Table 9:

Table 9: Plant noise limits

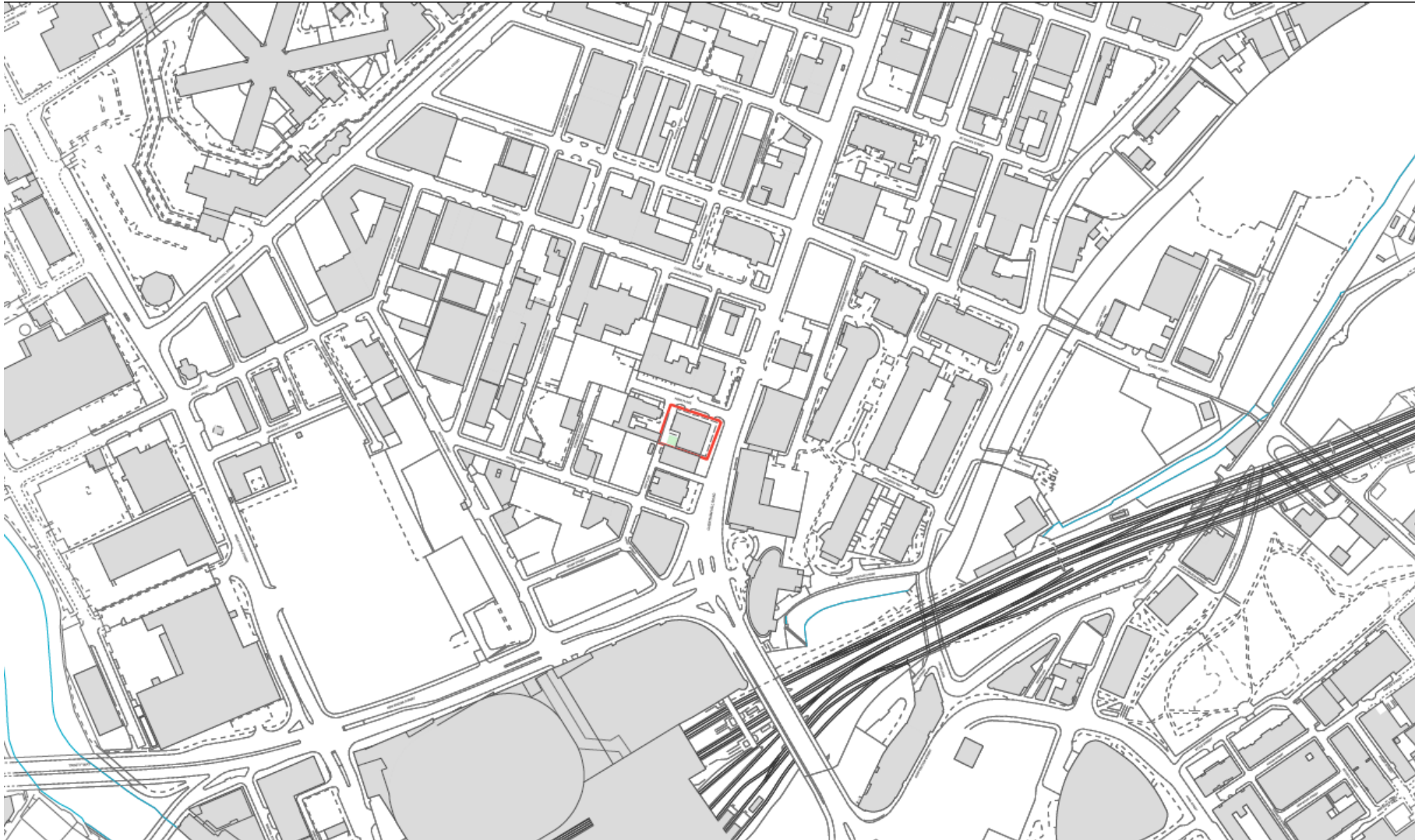
Background Noise (dB)	Criteria	Plant Noise Rating Limit (dB)
54	-5	49

10 Conclusions

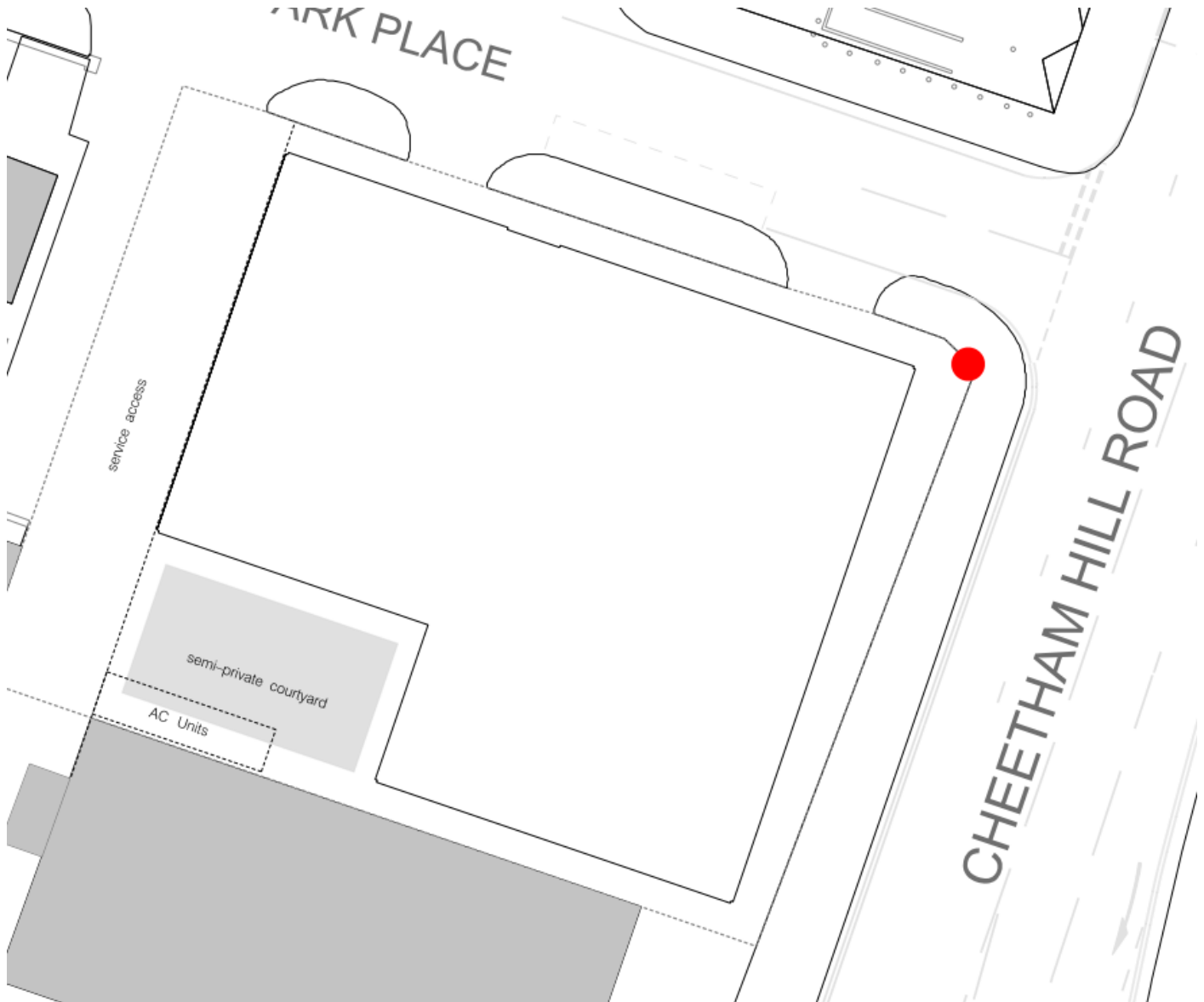
- 10.1 A noise assessment has been undertaken to predict the impact of noise on a proposed new residential development at One Park Place, Cheetham Hill, Manchester, M4 4EZ.
- 10.2 The assessment concludes that to achieve appropriate internal noise levels, it will be necessary to provide acoustic façade mitigation in the form of acoustically uprated glazing. The requirements for glazing types and locations are laid out in this report.

APPENDICES

Appendix I: Site Location



Appendix 2: Measurement Position



Glossary of Terms

Decibel (dB) The unit used to quantify sound pressure levels; it is derived from the logarithm of the ratio between the value of a quantity and a reference value. It is used to describe the level of many different quantities. For sound pressure level the reference quantity is 20 μPa , the threshold of normal hearing is in the region of 0 dB, and 140 dB is the threshold of pain. A change of 1 dB is usually only perceptible under controlled conditions.

dB L_A Decibels measured on a sound level meter incorporating a frequency weighting (A weighting) which differentiates between sounds of different frequency (pitch) in a similar way to the human ear. Measurements in dB L_A broadly agree with an individual's assessment of loudness. A change of 3 dB L_A is the minimum perceptible under normal conditions, and a change of 10 dB L_A corresponds roughly to halving or doubling the loudness of a sound. The background noise level in a living room may be about 30 dB L_A ; normal conversation about 60 dB L_A at 1 meter; heavy road traffic about 80 dB L_A at 10 meters; the level near a pneumatic drill about 100 dB L_A .

$L_{A90,T}$ The A weighted noise level exceeded for 90% of the specified measurement period (T). In BS 4142: 2014+A1:2019 it is used to define background noise level.

$L_{Aeq,T}$ The equivalent continuous sound level. The sound level of a notionally steady sound having the same energy as a fluctuating sound over a specified measurement period (T). $L_{Aeq,T}$ is used to describe many types of noise and can be measured directly with an integrating sound level meter.

L_{Amax} The highest A weighted noise level recorded during the time period. It is usually used to describe the highest noise level that occurred during the event.

$L_{A10}(18 \text{ hour})$ Often referred to as the UK road traffic noise index, this is the arithmetic average of the values of L_{A10} hourly for each of the 18 one hour periods between 06:00 and 00:00.

NOEL No observed effect level: the level of noise exposure below which no effect at all on health or quality of life can be detected.

LOAEL Lowest observed adverse effect level: the level of noise exposure above which adverse effects on health or quality of life can be detected.

SOAEL Significant observed adverse effect level: the level of noise exposure above which significant adverse effects on health or quality of life can be detected.

R_w Single number rating used to describe the sound insulation of building elements and is defined in BS EN ISO 10140-2: 2010 (formerly BSEN ISO 140-3:1995). It is derived by measurement under laboratory conditions and does not take into account the effects of flanking transmissions.

C_{tr} A single-number spectrum adaptation term used to characterise the sound insulation rating with respect to urban traffic. It is defined in ISO 717-1:2013.

