adrian james acoustics limited

TECHNICAL REPORT

GRUNDON SERVICES, BANBURY

Acoustic assessment

Adrian James Acoustics Document Control Sheet

Report prepared for:	JSA Planning Tavistock House Waltham Road Woodlands Park Maidenhead Berkshire SL6 3NH
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QA Control

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-	03 August 2018	Mat Tuora MIOA	Ian Rees MIOA	Andy Thompson MIOA
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Revision History

Rev	Details
A	Update to site plan and minor wording corrections

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1 INTRODUCTION

1.1 Background

We have been appointed by JSA Planning to review and expand on an outline noise assessment carried out by Rupert Taylor Ltd for a proposed residential development at Higham Way, Banbury.

We understand that following the submission of the outline noise assessment the Local Council's Environmental Health Officer, Trevor Dixon, has asked for further information as follows:

"As discussed we would need to be satisfied that acceptable internal and external noise levels can be achieved for the proposed residential development before permission is granted, otherwise we could potentially be forced in to accepting a lower standard on the basis that it the best that can be achieved in the circumstances. In my opinion the submitted acoustic report doesn't show this is the case".

The aim of this report is therefore to establish building envelope constructions for the new dwellings to control noise break-in from the railway.

The aims of this report are to provide an acoustic assessment in clearly understood terms and to provide guidance on practical means of achieving the required acoustic conditions. It is not necessary to be familiar with the technical aspects of acoustic design to understand our conclusions and recommendations. Because of the technical nature of acoustic design, however, this document contains a number of specialised terms which are explained in the Appendices.

1.2 Structure of this report

The structure of this report is as follows:

- Section 2 describes the criteria used in this assessment
- Section 3 describes the proposed development and sets out our assumptions based on the information provided to us
- Section 4 presents the acoustic model and results
- Section 5 describes noise control measures to meet the internal ambient noise criteria
- Section 6 presents a summary of our conclusions
- Technical terms and units used in this report are described in Appendix A.

1.3 Sources of information, assumptions and limitations

This assessment is based on the following information provided to us by JSA Planning:

Drawing No.	Revision	Title
PL-111	F	Proposed Site plan
PL-110	A	Indicative Movement Parameter Plan
PL-111	A	Indicative Trees and Landscaping areas
PL-114	A	Indicative Land Use Plan
PL-115	A	Proposed Levels

Document No.	Revision	Title
SMD/GWB1	1	Grundon Waste Management Depot Banbury – Noise and Vibration Report (Rupert Taylor Ltd)
BAN/EIA/14/1808	Final	Banbury Light Maintenance Depot Environmental Statement ES Volume 1: Main Statement (Spectrum Acoustics)

Our appointment is limited to a desktop study of noise break-in only. This report relies wholly on the accuracy and reliability of the information and data set out in:

- The Rupert Taylor Ltd report
- Traffic count data obtained from https://www.dft.gov.uk/traffic-counts/cp.php?la=Oxfordshire#73852
- The ES chapter prepared by Spectrum Acoustics which is contained in chapter 9 of Banbury Light Maintenance Depot Environmental Statement ES Volume 1: Main Statement, issued by Chiltern Railways.

Where information that we have requested could not be provided we have stated this along with any associated assumptions.

2 NOISE CRITERIA

2.1 National Planning Policy Framework

The National Planning Policy Framework (NPPF) came into force in March 2012 and has recently revised in July 2018. The NPPF replaced a series of Planning Policy Guidance (PPG) and Planning Policy Statement (PPS) documents. These included Planning Policy Guidance 24 "Planning and Noise" (PPG24), which outlined considerations in determining planning applications for noise-sensitive developments and for activities that generate noise. The NPPF does not set out numerical criteria for noise affecting proposed development sites, but states that planning policies and decisions should aim to:

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

Further guidance on internal noise criteria for residential development can be taken from the World Health Organisation (WHO) Guidelines for Community Noise and recommended internal noise levels set out in BS8233.

2.2 World Health Organisation Guidelines and BS 8233 Noise Guidelines

The World Health Organisation (WHO) Guidelines for Community Noise were published in 2000. The guidance recommends internal levels within dwellings of 35dB $L_{Aeq,16hr}$ for daytime and 30dB $L_{Aeq,8hr}$ at night. British Standard BS 8233 suggests similar design standards for internal noise levels.

The WHO suggests that to protect the majority of people from being moderately annoyed during the daytime, the sound pressure level on balconies, terraces and outdoor living areas should not exceed 50dB L_{Aeq} for a steady, continuous noise. BS8233: 2014 (Section 7.7.3.2) states:

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

The guidelines recommend that at night, sound pressure levels outside façades of living spaces should not exceed 45dB L_{Aeq} and 60dB $L_{Amax(fast)}$, so that people may sleep with bedroom windows open. These values have been obtained by assuming that the noise reduction from outside to inside with the window partly open is 15dB. British Standard BS 8233 suggests similar design standards for internal noise levels.

Both the WHO Guidelines and BS 8233 are really only appropriate for "impersonal noise" such as continuous road traffic. Noise which is attributable to a particular source or which has a tonal or intermittent characteristic may cause annoyance at lower levels than these and in such cases an assessment linked to background noise levels may be more appropriate.

2.3 Criteria set by the council

We have had discussions with Trevor Dixon at South Northamptonshire Council and Cherwell District Council. Mr Dixon has agreed that noise levels within dwellings and in external amenity areas should not exceed the levels set out in BS 8233:2014.

Mr Dixon also asked us to consider noise generated from a nearby service depot.

3 REVIEW OF INFORMATION AND INPUT DATA

3.1 Site description

We understand that the proposed development would comprise eleven blocks, ranging from three to six storeys in height, accommodating up to 200 dwellings.

Review of the information provided shows the topography of the site is relatively flat with less than two metres variation between the highest and lowest point of the site. Chiltern Mainline Railway runs adjacent to the south-west boundary of the site. We have not been provided with precise elevations of the railway line relative to the site but we understand that the railway is roughly level with the north-west end of the site and marginally higher than the south-east end of the site. We have discussed the site with the author of the Rupert Taylor Ltd report, who confirms that the railway line is not significantly elevated above the proposed development site.

The layout of the proposed development is shown in Figure 1.

Figure 1 – Proposed site layout

We understand that the M40 motorway is approximately 950m east of the site, running north / south.

3.2 Sources of noise data

Noise levels set out in the Rupert Taylor Ltd report are provided in terms of single-figure L_{Aeq} or $L_{Amax(slow)}$. To calculate noise break-in to the proposed dwellings we need to consider the frequency content of the noise sources. We have contacted Rupert Taylor Ltd to request octave-band noise data but we understand that this is unavailable. We have therefore taken a train noise spectrum from our measurement database, which include contribution from passenger and freight trains.

The Rupert Taylor report indentifies that the M40 was audible during the time of the survey, although the report states that the train line was the dominant source of noise. To assess the noise contribution from the M40 we have used the most recently available traffic count data available from the Department for Transport website in our computer model of the site. The day and night levels were adjusted in accordance with the Transport Research Laboratory's 'Method for Converting the UK Road Traffic Noise Index $L_{A10,18h}$ to the EU Noise Indices for Road Noise Mapping'.

The Department for Transport data only states the percentage of heavy goods vehicles over a 24-hour period, and does not state separate figures for day and night-time. We have therefore used a distribution percentage of 25% HGVs during the day and 45% HGVs at night. The assumed daytime HGV percentage is significantly higher than that shown in the M40 24-hour traffic count data and is therefore likely to represent a worst case. For the purposes of our noise break-in calculations we have assumed a typical traffic noise spectrum as set out in BS EN 1793 Part 3.

3.3 Data used in assessment

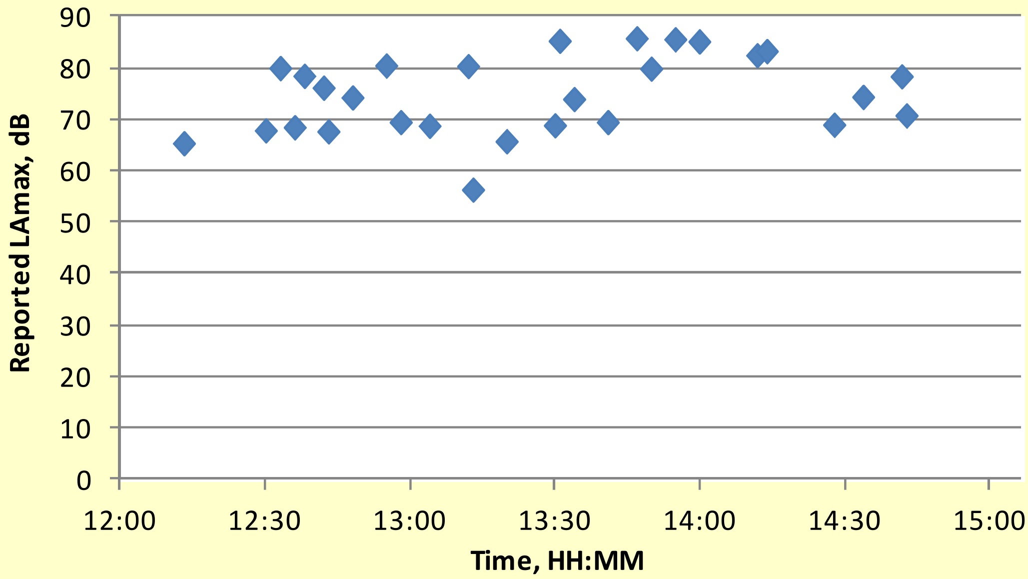
The following data, taken from the Rupert Taylor Ltd report, has been used for the purposes of calibrating our model:

Measurement location	$L_{Aeq,16hr}$ Daytime	$L_{Aeq,8hr}$ Night-time	$L_{AS,max}$ Night-time
5 metres from site boundary	63.5 dB	62.5 dB	85 dB

Table 1 – Reported noise levels at 5m from site boundary

The Rupert Taylor Ltd report states that there are likely to be 22 passenger trains and 36 freight trains passing through the Banbury station at night-time. The report did not take any measurements at night-time, and we therefore have to use daytime L_{Amax} levels measured at 5 metres from the train line as shown in Figure 2.

Figure 2 – Reported $L_{AS,max}$ levels in Rupert Taylor report



It can be seen that there is a significant spread of results. As it is not possible to establish how frequently the maximum levels occur at night-time, for the purposes of our assessment we have considered a max event level of 85dB $L_{Amax,\ T}$ to be representative.

It should be noted that the data provided was measured in terms of $L_{Amax(slow)}$. BS8233 and the WHO guidelines set out criteria for internal maximum levels in terms of $L_{Amax(fast)}$. In previous train noise measurements where we have simultaneously measured fast and slow time-weighted maximum levels from passing trains, the difference between these has been typically around 1dB. We would therefore not expect $L_{Amax(fast)}$ levels to differ significantly from the $L_{Amax(slow)}$ levels reported by Rupert Taylor Ltd.

3.4 Light Rail Maintenance Depot

The Rupert Taylor Ltd report discusses the addition of a Light Rail Maintenance Depot which was proposed but not built at the time of the initial survey.

Following a conversation with Trevor Dixon from Cherwell and South Northants Council's Environmental Health Department, we understand that noise generated from activities surrounding the train depot is currently attracting complaints from other residential areas close to the depot.

The noise assessment for the proposed depot prepared by Spectrum Acoustics indicates that average operational noise levels from the depot would be approximately 45 – 50dB(A) at the closest parts of the development site. This is significantly lower than the noise reported from passing trains, and we would therefore not expect noise from the depot to significantly contribute to noise at the residential facades or in external amenity areas. The Spectrum Acoustics report does not discuss maximum levels from the maintenance depot and therefore we cannot assess these.

The sound insulation requirements for the building envelope are primarily determined by night-time maximum levels from train movements, which are significantly higher than the operational noise levels reported above. It is therefore unlikely that operational noise from the depot would cause internal noise levels in proposed dwellings facing the railway to exceed the criteria set out in Section 2.2. However, a detailed assessment of noise from the depot (for example, in accordance with BS 4142:2014) is beyond the scope of this report.

3.5 Uncertainty

Given the outline nature of the data in the Rupert Taylor assessment, and the necessary assumptions made in our calculations, there will naturally be associated uncertainty. We have therefore tended towards a worst-case noise assessment, which will result in correspondingly high-specification glazing and acoustic ventilation measures. We therefore expect that our assessment should be robust, although it may result in over-specification of noise control measures.

It would be possible to reduce this uncertainty, and hence potentially the specification of the noise control measures, with a detailed acoustic survey and modelling.

4 NOISE MODEL AND RESULTS

4.1 Methodology

To assess noise levels affecting the development, we created a computer model of the site using proprietary modelling software (CadnaA by DataKustik Gmbh). The software allows us to assess noise propagation across the proposed site and determine noise levels at the facades of the proposed dwellings.

4.1.1 Road noise

As discussed in Section 3.2 of this report, we have calculated road traffic noise levels from the M40 using the CRTN (Calculation for Road Traffic Noise) guidance published by the Department of Transport.

4.1.2 Rail noise

We have used railway noise levels measured by Rupert Taylor Ltd 5 metres from the south-west site boundary to calibrate the model. To model noise from the railway line it is necessary to know the effective noise source height of the trains. The Department of Transport's document *Calculation of Railway Noise* states:

"*…….the top surface of the near-side railhead of a particular track defines the source line for noise generated by moving railway vehicles, apart for diesel locomotives operating at full power settings*", and;

"When the source of noise is a diesel locomotive operating on full power the source position is located 4m above the near side rail".

As we do not know the nature of the rail noise measured, we have considered the noise source height to be at 4m. This would represent a worst case assessment and it is likely that levels actually affecting the site would be lower due to the shielding effect of the barrier. However, this cannot be determined without a more detailed site survey.

4.2 Proposed mitigation measures

We understand that it is proposed to install earth bunds and a noise barrier around the south-west boundary of the site as shown in Figure 3. We understand that the proposed bunds and fencing would be 3 metres high.

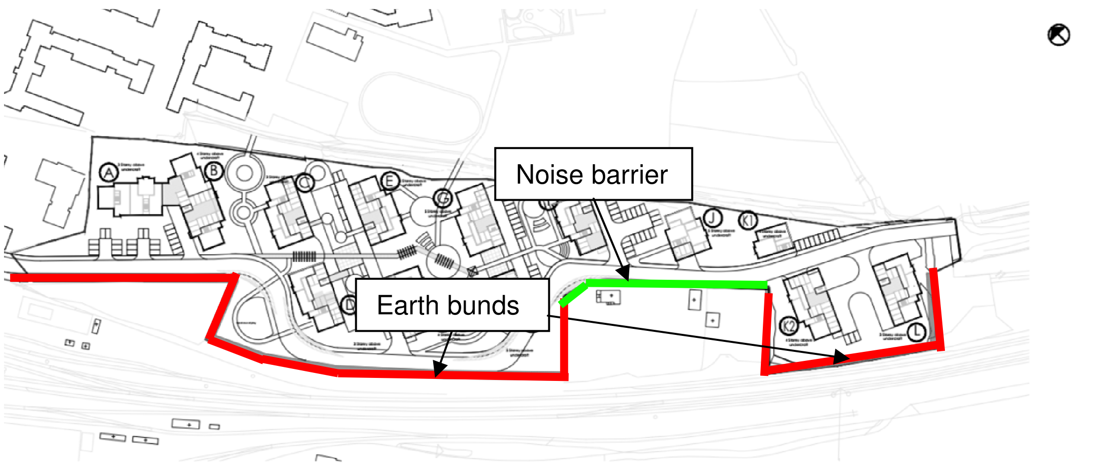


Figure 3 - Location of mitigation measures

We have included the proposed screening in the model to assess noise levels at different heights on the building facades. The model predicts that the bunding and barrier has relatively little effect on screening noise from the railway. This is because the majority of the train noise is being assumed to be generated at a height of 4 metres as discussed in Section 4.1.2 of this report. In practice, we would expect some reduction of noise levels from the barrier and bunding, depending on the proportion of noise generated by diesel trains at full power. However, we do not have sufficient information to accurately assess this.

4.3 Results

The calculated free field levels from our CadnaA model are provided in Table 2.

Location	$L_{Aeq,16hr}$ Daytime	$L_{Aeq,8hr}$ Night-time	$L_{AS,max}$ Night-time
Facades facing the railway line	60dB	59dB	81dB
Facades facing away from the railway line	54dB	50dB	64dB

Table 2 – Free-field levels at facades

4.4 External noise levels in amenity areas

The WHO Guidelines suggest that to protect the majority of people from being moderately annoyed during the daytime, the sound pressure level in outdoor living areas should not exceed 50dB $L_{Aeq,16-hr}$ for a steady, continuous noise. BS8233:2014 sets the design criteria for external noise at 50dB $L_{Aeq,16-hr}$ with an upper value of 55dB $L_{Aeq,16-hr}$.

Figure 4 shows calculated external daytime noise levels across the proposed site at a height of 1.5 metres. This includes the effects of proposed screening discussed in Section 4.2 of this report.

Figure 4 – External daytime levels across the site at 1.5m height (LAeq,T) if the train noise source height is taken to be 4m

Areas which comply with the lower design criterion set out BS8233:2014 are shown in green. Most other areas on the site do not exceed the upper noise value of 55dB, even when the source of train noise is considered to be at 4 metres. This is shown in yellow.

Areas shown in orange slightly exceed the recommended criteria set out in BS8233. However, it is likely that the model slightly overestimates noise levels due to the assumptions stated in Section 4.1.2 of this report. Again, we would need more detailed survey information to assess this.

5 INTERNAL NOISE LEVELS AND PRINCIPLES FOR NOISE CONTROL

5.1 Noise criteria

Internal noise levels should meet the A-weighted BS 8233 / WHO guideline values discussed in Section 2.2 of this report. These levels are summarised below:

- 35dB $L_{Aeq,16hr}$ daytime
- 30dB $L_{Aeq,8hr}$ night-time (Bedrooms only)
- 45dB $L_{AF,max}$ night-time (Bedrooms only)

5.2 Noise control - general principles

Within conventional facade constructions, windows and unattenuated ventilators are normally the weakest areas of sound insulation of a conventional masonry façade. Opening windows for ventilation purposes will further reduce the effective sound insulation. Regardless of the quality of window or sound insulation of the glazing, the overall insulation of an open window will generally be limited to 10-15dB(A).

The Rupert Taylor Ltd report identifies that mechanical ventilation is likely to be required. For the purposes of this assessment we have assumed that a natural ventilation strategy will be favoured for background ventilation where possible and our report sets out the minimum element-normalised level difference which will need to be achieved by the ventilation elements. We have also provided maximum noise levels to be achieved by mechanical ventilation systems.

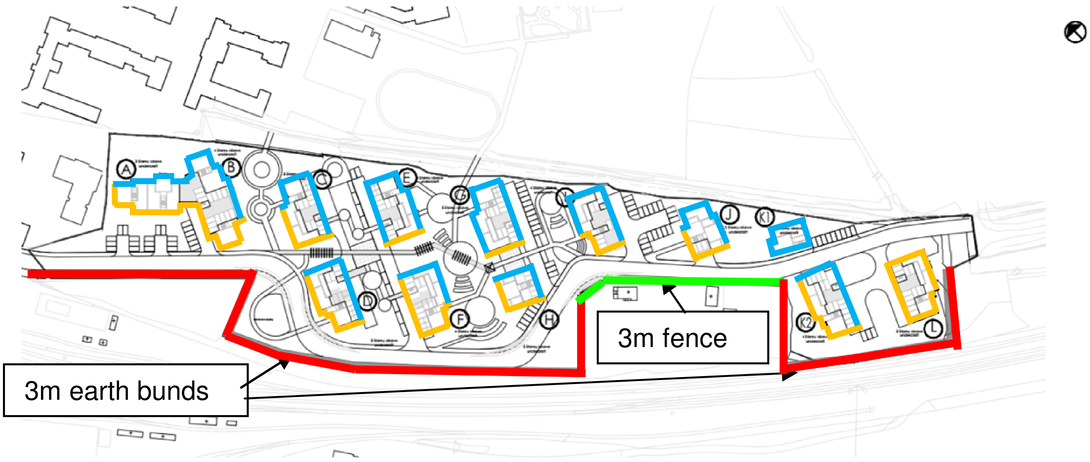


Figure 5 – Plan of noise mitigation measures

We have calculated internal noise levels for a sample of typical residential rooms in the following locations:

- Facades facing the railway (shown orange in Figure 5)
- Facades facing away from the railway (shown blue in Figure 5)

We do not have proposed floor plans for the dwellings so we have assumed room dimensions of 4m x 3m x 2.4m for a typical bedroom, with a reverberation time of 0.5 seconds for a furnished room.

Calculations have been made using noise data as set out in Section 5.3 of this report.

5.3 Sound insulating constructions

5.3.1 Facades facing railway (shown in orange)

Our calculations indicate that habitable rooms on facades shown in orange in Figure 5 will require glazing and ventilators with the following minimum acoustic ratings. Recommended specifications for these elements are as follows:

- **Glazing:** Glazed units for dwellings on these facades should have a minimum weighted sound reduction index of 45dB Rw.

  We have used the following sound reduction index data:

	Octave band SRI (dB)						**Rw (dB)**
Glazing	125	250	500	1k	2k	4k	
10mm / 16mm / 9.1mm Pilkington Optiphon Acoustic Laminate (sealed units)	29	33	44	46	49	57	**45**

  This performance requirement applies to the complete glazing unit as installed including the window frame, up to a total of 4m^2 of glazing per room. Higher specification units may be required if larger areas of glazing are to be installed.

- **Ventilation:** Background ventilation with windows closed should be via trickle ventilators or airbricks with a weighted element-normalised level difference of at least 43dB $D_{ne,w} + 10\log(n)$ where 'n' is the number of units.

  The manufacturer of the chosen ventilator will need to confirm that their product is capable of meeting this criterion with ventilators open. For our calculations we have used data for two Greenwood Airvac AAB4000 Acoustic airbricks.

  Domestic mechanical ventilation and heat recovery (MVHR) units may be used to provide ventilation if required. This is discussed in Section 5.5.

5.3.2 Facades facing away from railway (shown in blue)

Our calculations indicate that habitable rooms on facades shown in blue in Figure 5 will require glazing and ventilators with the following minimum acoustic ratings. Recommended specifications for these elements are as follows:

- **Glazing:** Glazed units with a minimum weighted sound reduction index of 31dB Rw. This should be achievable with standard double-glazed units as follows:

	Octave band SRI (dB)						Rw (dB)
Glazing	125	250	500	1k	2k	4k	
4mm / 12mm / 4mm sealed units	24	20	25	35	38	35	**31**

  This performance requirement applies to the complete glazing unit as installed including the window frame, up to a total of $4m^2$ of glazing per room. Higher specification units may be required if larger areas of glazing are to be installed.

- **Ventilation:** Background ventilation with windows closed should be via trickle ventilators or airbricks with a weighted element-normalised level difference of at least 31dB $D_{ne,w} + 10\log(n)$ where 'n' is the number of units.

  The manufacturer of the chosen ventilator will need to confirm that their product is capable of meeting this criterion with ventilators open. For our calculations we have used data for one standard hit and miss trickle vents.

  Again, domestic mechanical ventilation and heat recovery (MVHR) units may be used and are further discussed in Section 5.5.

5.4 Internal levels with proposed treatment

Table 3 shows the free-field external levels and calculated internal levels using the above treatments.

	External free field level			Internal reverberant level		
Location	**LAeq,16hr Daytime**	**LAeq,8hr Night-time**	**LAS,max Night-time**	**LAeq,16hr Daytime**	**LAeq,8hr Night-time**	**LAS,max Night-time**
Facades facing the railway line	60dB	59dB	81dB	23dB	22dB	45dB
Facades facing away from the railway line	54dB	50dB	64dB	30dB	27dB	45dB

Table 3 – External and internal levels

5.5 Noise from plant and services

Where mechanical ventilation systems are specified to ventilate residential rooms, the M&E engineer or contractor should ensure that fan noise and external noise break in through the ventilation system do not cause the daytime and night-time internal noise criteria set out in Section 5.1 of this report to be exceeded, or restrict the performance of sound insulating constructions. In practice, this will require internal reverberant noise levels from mechanical ventilation systems to be no more than the following:

Room	Noise limit
Living Rooms	30dB(A) / NR25
Bedrooms	25dB(A) / NR20

Higher levels are acceptable in non-habitable rooms such as kitchens and bathrooms, and rapid extract ventilation does not need to meet these limits.

There are a number of noise issues to be considered in the design of mechanical ventilation, including:

- Fan noise and other duct-borne noise in noise-sensitive rooms
- Aerodynamic noise, e.g. from high speed airflows at diffusers and in ducts
- Noise from ventilator actuators and dampers – there are special requirements for these and we can assess specific systems against these requirements if required
- Cross-talk through ducts between residential rooms: cross-talk attenuators may be required
- Airborne and structure-borne noise transmission from plant rooms to adjoining residential rooms. In particular, plant may require efficient vibration isolation and possibly inertia blocks.
- Noise emissions to the atmosphere from plant room louvres, intake or discharge terminals.

Noise from services should be steady and broadband in nature with no recognisable tones or characteristics such as 'hums', 'clicks' or 'buzzes'. It is the responsibility of the M&E designer or contractor to design plant and services to meet these requirements.

5.6 Noise barrier

Where fencing is used, the barrier should have no holes or gaps and have a minimum density of 10kg/m^2. A close boarded timber fence with minimum board thickness of 20mm should meet those requirements. This will be important in reducing the noise levels at the facades of the dwellings and controlling noise levels in amenity areas across the site.

6 SUMMARY OF CONCLUSIONS

- We have assessed noise levels across the proposed site using the data contained within the Rupert Taylor report.
- Assumptions as to the frequency content of the noise sources and the level of contribution from the M40 were made and are discussed in Section 3. We consider that this assessment therefore represents a worst-case, and a more accurate assessment could be carried out with an additional detailed survey.
- Due to the relatively high noise levels across the site it is clear that the site cannot be ventilated by openable windows and meet the internal noise criteria set out by the council. Noise mitigation measures are discussed in Section 5.3 of this report
- With the proposed mitigation measure and the facade treatments in place, internal noise levels should comply with the noise criteria set out by the council. The calculated internal noise levels are set out in Section 5.4 of this report.
- Most of the site complies with the upper external noise limit as set out in BS8233. Some areas may slightly exceed this level, but as discussed, we consider that this is likely to be a worst-case. Again, a more comprehensive survey would allow this to be assessed in more detail.

APPENDIX A - TECHNICAL TERMS AND UNITS USED IN THIS REPORT

Decibel (dB) - This is the unit used to measure sound level. The range of human hearing from the quietest detectable sound to the threshold of pain is very large. If a normal linear scale of measurement were used, it would have to range from 20 µPa to 200,000,000 µPa. Using such large figures would be unmanageable and for this reason sound pressure levels are expressed on a logarithmic scale, which corresponds to the almost logarithmic response of the ear and which compresses the range to a manageable 0dB to140dB.

Sound Pressure Level (Lp or SPL) - This is a function of the source and its surroundings and is a measure in decibels of the total instantaneous sound pressure at a point in space. The SPL can vary both in time and in frequency. Different measurement parameters are therefore required to describe the time variation and frequency content of a given sound. These are described below.

Frequency - This refers to the number of complete pressure **fluctuations** or cycles that occur in one second. Frequency is measured in Hertz (Hz). The rumble of thunder has a low frequency, while a whistle has a high frequency. The sensitivity of the ear varies over the frequency range and is most sensitive between 1KHz and 5KHz.

Octave and One-Third Octave Bands - The human ear is sensitive to sound over a frequency range of approximately 20 Hz to 20,000 Hz and is more sensitive to medium and high frequencies than to low frequencies. To define the frequency content of a sound, the spectrum is divided into frequency bands, the most common of which are octave bands. Each band is referred to by **its centre frequency**, and the centre frequency of each band is twice that of the band below it. Where it is necessary for a more detailed analysis octave bands may be divided into one-third octave bands.

'**A' Weighting** - The sensitivity of the human ear varies with frequency, some frequencies sound louder than others. The 'A'-weighting curve represents the non-linear frequency response of the human ear and is incorporated in an electronic filter used in sound level meters. Measurements using an 'A'-weighting filter makes the meter more sensitive to the middle range of frequencies, which approximates to the response of the ear and the subjective loudness of the sound. Sound level measurements using 'A'-weighting will include the subscript A, e.g. dB(A).

Statistical Analysis - These figures are normally expressed as LN, where L is the sound pressure level in dB and N is the percentage of the measurement period. The LN figure represents the sound level that is exceeded for that percentage of the measurement period. L90 is commonly used to give an indication of the background level or the lowest level during the measurement period. L10 may be used to measure road traffic noise. See Figure 1.

LAmax - The highest A weighted sound pressure level recorded during the measurement period. The time constant used (Fast or Slow) should be stated. See Figure 1.

Leq,T - The equivalent continuous sound level is used to measure sound that varies with time. The Leq,T is the notional equivalent steady sound level, which contains the same acoustic energy as the actual varying sound level over the period of measurement. Because the averaging process used is logarithmic, the Leq,T level tends to be dominated by the higher sound levels measured. See Figure A1 overleaf:

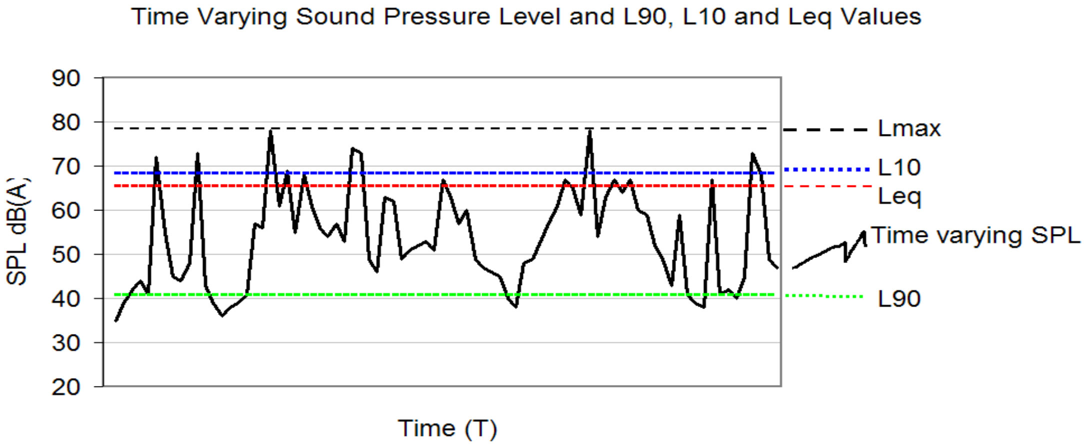


Figure A1 - Time varying sound pressure level

LAE The Single Noise Event level is a measure of the total sound energy contained within an event and is used to calculate the $L_{eq,T}$ over a given period due to a specific event such as train or aircraft passes.