ACOUSTIC CONSULTANTS LTD

Environmental Noise Assessment

Proposed Residential Development
Badminton Road, Old Sodbury

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1. Introduction

Grassroots Planning appointed Acoustic Consultants Ltd to undertake an environmental noise assessment for the proposed residential development at Badminton Road, Old Sodbury.

The report is based upon noise and vibration levels measured at the site. This report considers the impact of rail traffic noise and vibration from passing trains, as well as road traffic on the proposed residential development.

The report identifies relevant planning, noise and vibration guidance, establishes environmental noise and vibration levels and provides mitigation measures to the proposed dwellings in support of a planning application.

The assessment has been undertaken in accordance with the guidance in the National Planning Policy Framework (NPPF), Noise Policy Statement for England (NPSE), National Planning Practice Guidance (NPPG), British Standard 8233:2014 (BS8233), and British Standard 6472-1:2008.

2. The Site and Proposals

The proposed site is located on Badminton Road, Old Sodbury. The proposed site has existing residential developments to the East. The site is located near a residential area and is adjacent to the Bristol to Swindon railway line to the South and Badminton Road (A432) to the North. Transportation noise was considered to form the predominant noise and vibration source in the area. The railway line to the South is within a gully. The site is approximately 250m from the opening of the train tunnel.

It is proposed to demolish existing buildings at the site and erect 36 units. A road is also proposed to connect the residential dwellings to Badminton Road.

The proposed site location plan is provided in Figure below.

Figure 1: Proposed site plan

3. Planning and Noise

3.1. National Planning Policy Framework

The National Planning Policy Framework (NPPF) was published in March 2012 and revised in February 2019. Section 15 entitled 'Conserving and enhancing the natural environment' addresses noise as a requirement of planning. Paragraph 170 states:

"170. 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;

Paragraph 180 states:

"180. 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[1]
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; and
c) limit the impact of light pollution from artificial light on local amenity, intrinsically dark landscapes and nature conservation. "

The document does not prescribe any assessment methodology or criteria to assess the adverse effect of noise.

[1] *See Explanatory Note to the Noise Policy Statement for England (Department for Environment, Food & Rural Affairs, 2010*

3.2. Noise Policy Statement for England

The NPPF refers to the Noise Policy Statement for England (NPSE). This was published in March 2010 and aims to provide clarity regarding current policies and practices to enable noise management decisions to be made within the wider context, at the most appropriate level, in a cost-effective manner and in a timely fashion and applies to all forms of noise including environmental noise, neighbour noise and neighbourhood noise.

The NPSE sets out the long term vision of Government noise policy. This long term vision is supported by three noise policy aims as follows:

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

- *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 improvement of health and quality of life."*

The NPSE introduces the concept of "Significant adverse" and "Adverse" impacts of noise which relate to the noise policy aims. These are applied as follows:

NOEL – No Observed Effect Level - This is the level below which no effect can be detected. In simple terms, below this level, there is no detectable effect on health and quality of life due to the noise.

LOAEL – Lowest Observed Adverse Effect Level - This is the level above which adverse effects on health and quality of life can be detected.

SOAEL – Significant Observed Adverse Effect Level - This is the level above which significant adverse effects on health and quality of life occur.

The Noise Policy Statement for England (NPSE) states that noise levels above the Lowest Observed Adverse Effect Level are acceptable in planning where reduced to a minimum.

With regard to where there is potential for noise impact it states the following in relation to the second noise policy aim:

"The second aim of the NPSE refers to the situation where the impact lies somewhere between LOAEL and SOAEL. It requires that 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 (paragraph 1.8). This does not mean that such adverse effects cannot occur."

The NPSE does not provide any assessment criteria for the noted effect levels and each case must be considered on its merits. The NPSE does, however, emphasise that in dealing with noise Local Planning Authorities are required to take a balanced approach in considering the benefits of development as against any adverse effects which arise. Paragraph 2.18 of the NPSE is particularly relevant in this respect and states:

"There is a need to integrate consideration of the economic and social benefits of the activity or policy under examination with proper consideration of the adverse environmental effects, including the impact of noise on health and quality of life. This should avoid noise being treated in isolation in any particular situation, i.e. not focusing solely on the noise impact without taking into account other related factors."

The planning need is outside the scope of noise and acoustics and will need to be addressed by others.

3.3. National Planning Practice Guidance, Noise

The National Planning Practice Guidance (NPPG) on noise, referred to here, is based on the current version (July 2019) as provided on the Planning Guidance Website. It states that *"Noise needs to be considered when new developments may create additional noise and when new developments would be sensitive to the prevailing acoustic environment."*

The document provides generic guidance on how to determine the impact of noise and what factors could be a concern.

It includes the option types to mitigate any adverse effects of noise stating that there are four broad types of mitigation. These are engineering, layout, using planning conditions or obligations and noise insulation.

Paragraph 5 of the NPPG provides a table identifying the effect level and examples of effect relating to the impact effect levels provided in the NPSE. The table is duplicated on the following page.

Table 1: NPPG Noise – Perception of Effect Levels

Response	Examples of Outcomes	Increasing Effect Level	Action
No Observed Effect Level			
Not Present	No Effect	No Observed Effect	No specific measures required
Present 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			
Present 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			
Present 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
Present 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

The table does not provide any objective assessment which equates to the noted effect levels.

The NPPG identifies that where noise is audible it is not necessarily intrusive. The effect and impact on people is based primarily on the level of noise.

The Noise Policy Statement for England (NPSE) states that noise levels above the Lowest Observed Adverse Effect Level are acceptable in planning where reduced to a minimum and when taken into account against all other planning considerations.

Section 4 of this report identifies guidance which is considered to provide noise criteria equivalent to effect levels below the Lowest Observed Adverse Effect Level. This is where the perception of noise is "not noticeable" or "noticeable but not intrusive" as indicated in Table 1 above.

3.4. South Gloucestershire Specific Guidance Note 1 – Planning & Noise

The South Gloucestershire Specific Guidance Note 1 scope states that *"has been prepared by South Gloucestershire Council (SGC) and is intended to provide all those involved in the planning of new or modified developments, including developers and their noise consultants, with a clear idea of the standards expected in relation to noise and vibration".*

The document identifies the relevant planning guidance documents (as those stated in the previous sections) and provides the cope of information required to be provided and the general noise criteria to work to.

Section 6.1.2 provides comment on the control of external noise for dwellings. It states:

"Where possible, the development layout should consider the positioning of buildings and structures that are less sensitive to noise in such a way that amenity areas or facades containing windows to habitable rooms are protected from high levels of environmental noise. Consideration of appropriate development placement, layout and room orientation within the individual dwellings from the outset of the design process can reduce the reliance on high levels of mitigation.

Sustainability concepts are paramount in design. For example, the ability to open a window for fresh air purposes should normally take precedence over the requirement for mechanical ventilation solely to meet internal noise level criteria. SGC acknowledges that mitigation measures, such as acoustic ventilation, may be required for certain developments in order to meet internal noise criteria. The application of British Standard 8233:2014 'Guidance on sound insulation and noise reduction for buildings' assists in ensuring the appropriate use of such mitigation measures for any proposed development. Internal noise level criteria shall be achieved when both external noise intrusion and noise from internal building services are considered.

Areas that are intended to be used for amenity are to be designed to the criteria outlined within BS 8233."

4. Assessment Criteria

4.1. Noise Impact

4.1.1. Internal Levels

British Standard 8233:2014 entitled "Guidance on sound insulation and noise reduction for buildings" came into effect on 28th February 2014. Section 7.7.2 Table 4 of the British Standard 8233:2014 provides internal ambient noise levels for dwellings from noise sources 'without a specific character'. The British Standard guideline states that noise levels should not exceed those as noted in Table 4 of the British Standard and this is summarised below:

Table 2: British Standard 8233:2014 Internal Noise Criteria

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

Section 7.7.2 Note 4 of the British Standard states *"Regular individual noise events (for example, scheduled aircraft or passing trains) can cause sleep disturbance. A guideline value may be set in terms of SEL or $L_{Amax,F}$ depending on the character and number of events per night. Sporadic noise events could require separate values".*

Section 3.4 of the "Guidelines for Community Noise" published by the World Health Organisation in 1999 (WHO 1999) states *"For a good sleep, it is believed that indoor sound pressure levels should not exceed approximately 45 L_{Amax} more than 10-15 times per night (Vallet & Verbey 1991)".*

4.1.2. External Amenity areas

Section 7.7.3.2 of British Standard 8233:2014 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 50 dB LAeq,T, with an upper guideline value of 55 dB LAeq,T which would be acceptable in noisier environments. However, it is also recognised that these guideline values are not achievable in all circumstances where development might be desirable. In higher noise areas, such as city centres of 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."

4.2. Vibration

As there is a railway line located close to the proposed residential development, the impact due to vibrations from the railway line in the proposed dwellings and the effects on the people within the dwellings needs to be considered.

The most relevant document is British Standard 6472-1:2008 *"Guide to evaluation of human exposure to vibration in buildings".* The standard provides ranges of vibration for different classes of building (e.g., houses, offices, etc.,) for acceptable magnitudes of vibration for daytime and night-time periods.

The British Standard also provides an interpretation for residential buildings of the probability of adverse comment for different levels of exposure to vibration.

The measurement scale used for impulsive vibration is one that effectively accumulates the vibration energy received over the daytime or night-time period, the Vibration Dose Value (VDV). The criteria for evaluating the likelihood of adverse comment are set out in Table 3 below.

Table 3: Vibration Dose Values ($m/s^{-1.75}$) of which various degrees of adverse comment may be expected

Place and time	Low probability of adverse comment	Adverse comment possible	Adverse comment probable
Residential Buildings 16-hour day	0.2 to 0.4	0.4 to 0.8	0.8 to 1.6
Residential Buildings 8-hour night	0.1 to 0.2	0.2 to 0.4	0.4 to 0.8

Where feasible, the aim is to keep the Vibration Dose Value (VDV) within the low probability of adverse comment range or lower.

5. Noise & Vibration Monitoring

A partially attended survey was undertaken for 24 hours from 16:30 on 8th March 2021 to determine the impact of existing road traffic noise levels on the proposed site.

An attended survey was undertaken between 15:20 and 16:50 hours on 9th March 2021 to measure noise levels and vibration due to train pass events on the proposed development.

5.1. Monitoring Equipment

Sound Pressure Levels were measured using a Class 1 sound level meter with a half-inch condenser microphone, using the 'fast' setting. The equipment is checked regularly using a Quality System meeting the requirements of British Standard EN ISO/IEC 17025:2017 "General requirements for the competence of testing and calibration laboratories"; in accordance with British Standard EN 10012:2003 "Measurement management systems. Requirements for measurement processes and measuring equipment"; and traceable to the National Standards.

Vibration Dose Values were measured using a Rion XV-2P Tri-Axial Vibration Meter configured to enable Vibration Dose Value (VDV) measurements, PPV and Acceleration across the three axes. The equipment is checked using a Quality System to ensure it conforms with the requirements set out in British Standard 6472:1992, British Standard 7385-1:1990 and British Standard 7385-2:1993. All the recorded parameters were weighted as stated in the British Standard 6472 – 1:2008.

This equipment was checked and calibrated as noted below and the certificates are available for inspection.

Table 4: Equipment and Calibration Status

Equipment Description / Manufacturer / Type	Serial Number	Date of Calibration	Calibration Certification Number
SLM, Svantek, 959	14784	22/04/2020	34608
Microphone, GRAS, 40AE	183810	22/04/2020	34608
Calibrator, Norsonic, 1251	35230	15/01/2020	33792
SLM, Cirrus Research, CR:171C	G080650	23/06/2020	142691
Microphone, Cirrus Research, MK224	210551D	23/06/2020	142691
Calibrator, Cirrus Research, CR:515	84377	23/06/2020	142693
Vibration meter, Rion, XV-2P 3-Axis	380058	28/04/2020	34654

The measurement systems were checked before and after use with the calibrators noted and no significant drift was detected.

5.2. Noise Monitoring Procedure

Events of trains passing (noise and vibration) were measured approximately 25m from the Bristol to Swindon railway line in the position marked in the figure below. A total of 4 measurements were taken.

A partially attended long term road traffic noise survey was carried out for a 24 hour period from 16:30 hours on 8th March 2021 to assess the impact of road traffic from Badminton Road to the north, on the proposed development. The monitoring location was at a distance of approximately 15 metres from the road.

Sound level meters were mounted on tripods approximately 1.5 metres above the ground and in a free field level position. The vibration monitoring position was located at ground level.

The monitoring locations for noise and vibration surveys are shown in Figure 2 below. The approximate proposed development location is marked in red.

Figure 2: Noise monitoring location

5.3. Weather Conditions

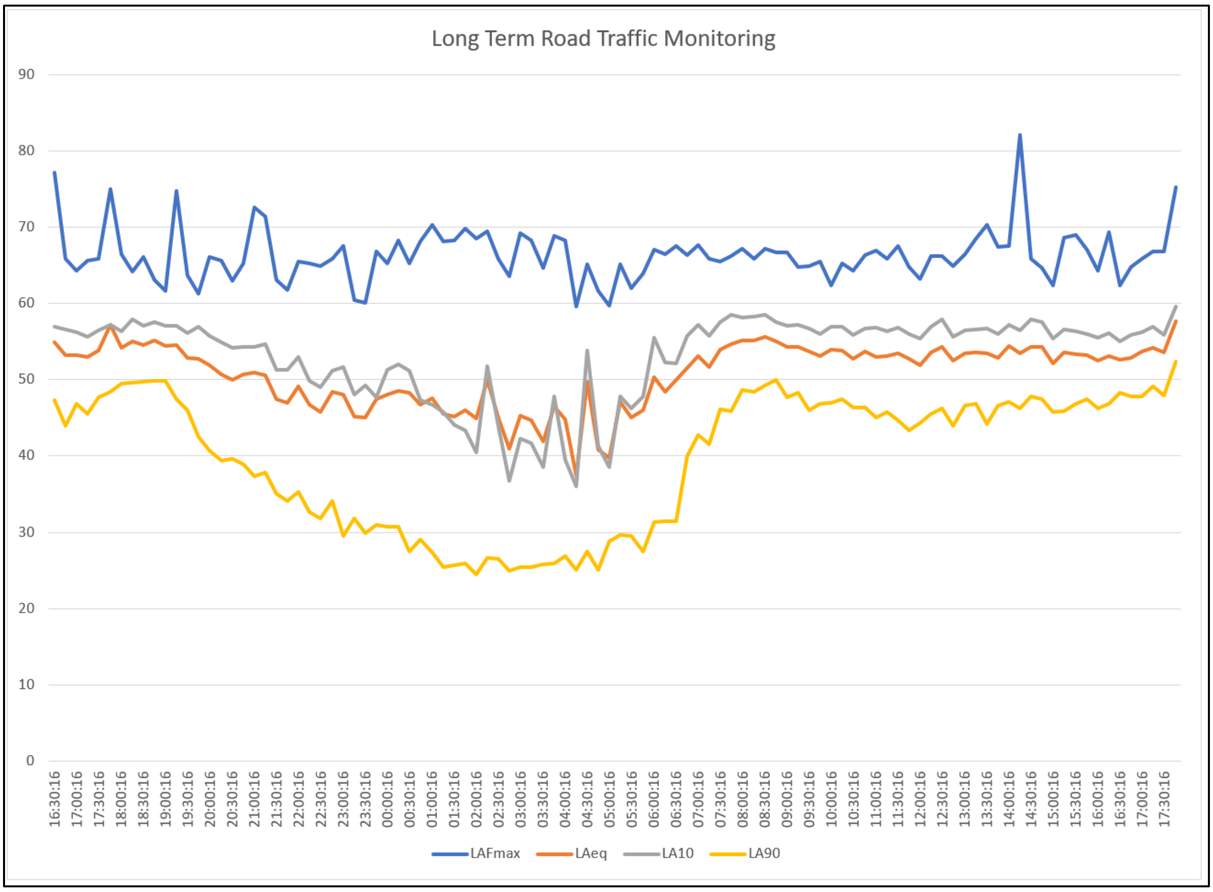
During the measurement the weather was dry with an average temperature of approximately 5 degrees Celsius, with partial cloud and wind speeds generally below 5 m/s. These weather conditions are not expected to have adversely affected the measured noise data.

5.4. Measured Noise Levels

5.4.1. Long Term Road Traffic Noise Levels

A chart of the variation in long-term noise levels over time, at the noted monitoring location, is provided below.

Chart 1: Variation in Noise Levels



The equivalent noise levels and design night time maximum noise levels determined directly from the measurement data at the monitoring location due to road traffic are provided in Table 5 below.

Table 5: CRTN Monitoring Noise Levels (free field level)

Period	Frequency (Hz)								
	63	125	250	500	1K	2K	4K	8K	dB(A)
Day $L_{10(16hrs)}$	65	56	53	54	54	44	35	27	57
Night $L_{10(8hrs)}$	53	46	41	45	48	37	22	14	49
Max L_{maxF}	67	66	77	73	67	57	42	22	73

5.4.2. Rail Traffic Events

The meter was set to record a continuous measurement for each train that passed over a total period of 1.5 hours. A summary of the measured rail traffic event noise levels is shown in Table 6 below.

Table 6: Rail Traffic Noise Survey at monitoring location

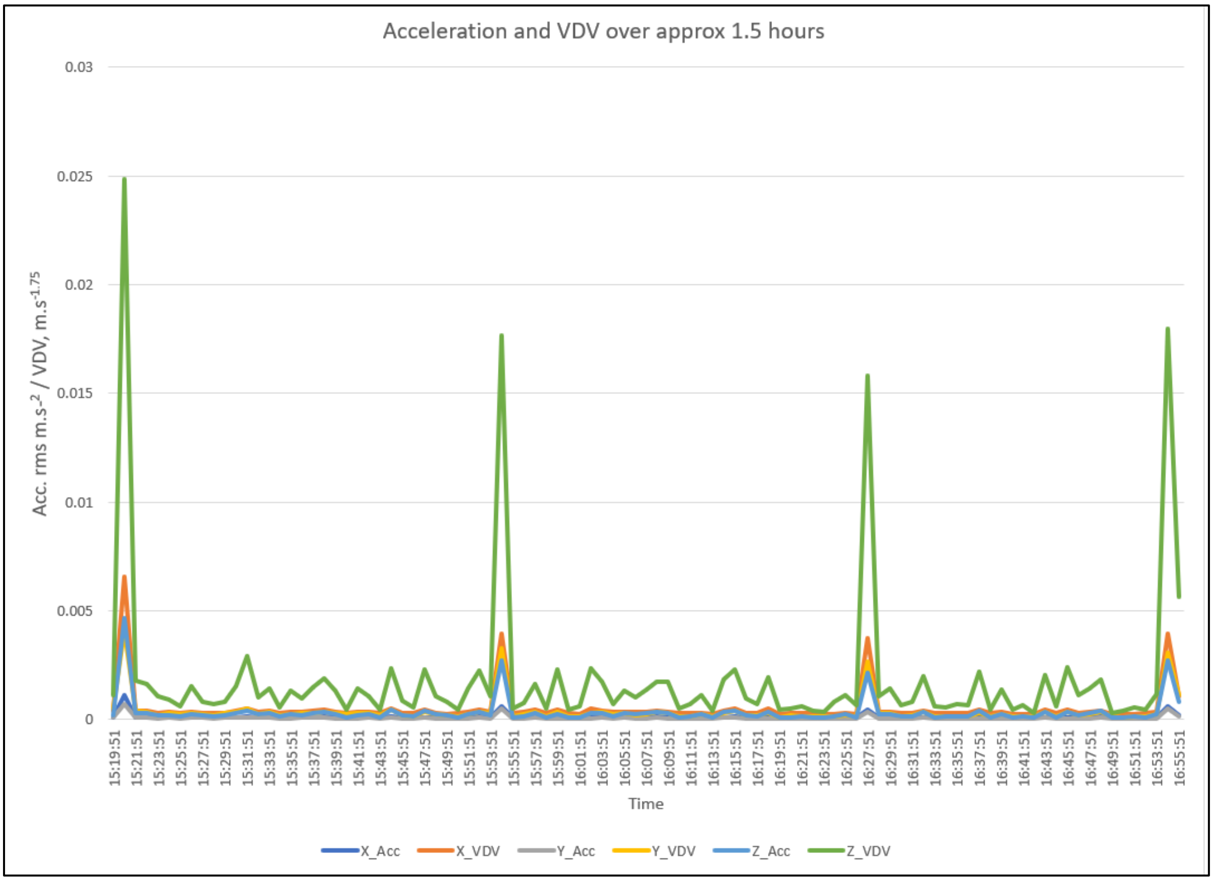
Train Event	Monitoring Time (hh:mm)	Pass by Time (sec)	L_{AFmax} dB	L_{Aeq} dB	SEL dBA
1	15:22	61	67	59	77
2	15:56	47	51	58	75
3	16:29	23	69	60	74
4	16:55	73	66	57	76

5.5. Measured Vibration Levels

A short-term attended vibration monitoring exercise was undertaken on the site between 15:20 and 16:50 hours on 9th March 2021.

A chart showing the variation in Vibration Dose Value (VDV) measurements and Acceleration across the three axis (30 sec log) with time is provided below.

Chart 2: Variation in VDV and Acceleration across three axis



In addition, the typical acceleration of a passing train was also measured at the attended position directly adjacent to the railway line. The results are as follows:

Table 7: Typical Acc. rms per Train

Axis	X	Y	Z
Typical measured Acc. rms (per train) m.s^{-2}	0.00048	0.00038	0.00214

6. Noise Assessment

6.1. Noise Modelling

6.1.1. Calculated Rail Traffic Noise Levels

The daytime equivalent noise level ($L_{Aeq,\ 16hour}$) and the night-time equivalent noise level ($L_{Aeq,\ 8hour}$) due to noise from the passing trains was calculated using the methodologies detailed in Calculation of Railway Noise, 1995 (CRN'95) and shown below:

1) *Calculate the Sound Exposure Level (SEL) of the trains - logarithmically averaging the exposure levels of each triggered event (see results above)*
2) *Calculate the $L_{Aeq(1\ second)}$ - Multiply the SEL by the number of passenger trains that pass by the site throughout the day.*

Information on passenger train movements on the Bristol - Swindon route has been obtained by published online timetables. (http://www.realtimetrains.co.uk) This was determined to be approximately 103 during the day, and 23 during the night during the survey.

However Covid has had an effect on railway timetables, historically there have been on an average daytime period 245 passenger trains and 31 freight. During the night we have assumed there are 23 passenger trains and 27 freight. This is as estimated from the historic Network Rail Timetables.

3) *Time correct $L_{Aeq(1\ second)}$ to $L_{Aeq(16\ hour)}$ and $L_{Aeq\ (8\ hour)}$.*

The determined $L_{Aeq\ (16\ hour)}$ and $L_{Aeq\ (8\ hour)}$ of the noise generated from the trains throughout the day and night are as follows at the monitoring location. As mentioned above, there are approximately 50 passing trains during the night time period and therefore as defined in WHO, the maximum noise level of passing trains need to be considered.

Table 8: Rail Traffic Noise Predictions at monitoring Location

Period	Frequency (Hz)								
	63	**125**	**250**	**500**	**1K**	**2K**	**4K**	**8K**	**dBA**
Daytime $L_{eq\ (16hrs)}$	$L_{Aeq\ (16hrs\ )}$= SEL – 47.6 +10logQ dB								
	57	49	44	42	43	38	29	16	46
Night Time $L_{eq\ (8hrs)}$	$L_{Aeq\ (8hrs)}$ = SEL – 44.6 +10logQ dB								
	52	44	38	36	37	33	23	10	41
$L_{max(F)}$ (1)	70	60	54	55	57	49	41	31	59

(1) This maximum noise level is the typical maximum noise level obtained during the survey

6.1.2. **Measured Road Traffic Noise Levels**

Table 9: Spectral Design noise levels at the façade (free-field)

Period	Frequency (Hz)								
	63	**125**	**250**	**500**	**1k**	**2k**	**4k**	**8k**	**dB(A)**
Daytime $L_{eq(16hrs)}$	65	56	53	54	54	44	35	27	57
Night Time $L_{eq(8hrs)}$	53	46	41	45	48	37	22	14	49
Night-time $L_{max(F)}$ (1)	67	66	77	73	67	57	42	22	73

6.1.3. **Modelling Parameters**

To determine noise levels across the site, noise modelling has been undertaken using computer modelling package Cadna:A by DataKustik and the road and rail traffic noise data noted above.

The software predicts road and rail traffic noise propagation using the method of *'The Calculation of Road Traffic Noise 1988'* (CRTN'88) and *'Calculation of Railway Noise, 1995 (CRN'95) methodology'* respectively, and a verification model has been created to ensure the measured and predicted levels are comparable. This model is available upon request.

The noise predictions have been undertaken using supplied plans of the proposed site and the following general modelling parameters:

- The noise model has been completed using the determined road traffic and rail traffic data above
- To determine the noise levels across the site and surrounding areas, this has been taken as a hard-reflective ground which is a worst-case scenario.
- Reflections from opposite façades have been determined via the correction method (+1.5 dB), as defined in CRTN/CRN.
- The proposed building heights are based on provided architectural drawings. Receivers for each storey are considered to be at the proposed window midpoint height

6.2. **Noise Modelling Results**

Predicted noise emission maps for equivalent noise levels during the daytime ($L_{Aeq,16hour}$) and night-time ($L_{Aeq,8hour}$), and maximum noise events (L_{AFmax}) during the night-time are provided below in the figures below.

Figure 3: Daytime $L_{Aeq,\,16hours}$ Noise Map due to Road and Rail Traffic Noise (1.5 metres height)

Figure 4: Night Time $L_{Aeq,\ 8hours}$ Noise Map due to Road and Rail Traffic Noise (4.5 metres height)

Figure 5: Night Time L_{AFmax} Noise Map due to Road and Rail Traffic Noise (4.5 metres height)

6.3. Internal Ambient Noise Levels

6.3.1. Calculation Method

Calculations for the internal ambient noise levels due to road and rail traffic noise have been undertaken using the calculation method provided in Annex G Section G.2 of British Standard 8233:2014.

The calculations have been undertaken using the building façade construction specified below and the octave band free-field design equivalent noise levels and maximum noise levels taken from the measured noise spectra noted above.

The calculations assume the following, based on the layout architectural drawings provided:

- Room size: 12m^2 to daytime rooms and bedrooms
- Windows: 4m^2 to daytime rooms and 2m^2 to bedrooms
- Façade: 10m^2 to daytime rooms and 8m^2 bedrooms
- Vents: 3 to living rooms and 2 to bedrooms; all vents are open

We advise that building elements, having the sound insulation performances noted below, be incorporated into the design of the façades including the windows, doors, floor, and the building roof.

Alternative constructions to those noted below could be used, however they would need to be assessed to ensure they control external noise to within the BS 8233:2014 recommended internal ambient noise level criteria.

A colour code mitigation maps was created to outline the different noise mitigation measures required for daytime rooms and night time bedrooms on each façade of the proposed residential buildings; see figure below.

Figure 6: Colour Code Mitigation Map

6.3.2. External Wall Construction

Within all zones the external walls can be of a conventional masonry stone/brick construction.

- The masonry construction could comprise of at least two skins of block (one of density 1850 Kg/m3, 100mm cavity, 100mm block (density of 400 Kg/m3).

The above constructions are expected to achieve the following sound reduction indices:

Table 10: Required minimum sound insulation performance of external walls

Frequency (Hz)	63	125	250	500	1k	2k	4k	8k	R_w
R (dB)	31	38	46	45	55	66	77	70	**52**

6.3.3. Roof Construction

Within all zones the dwellings could have a roof constructed using traditional techniques, such as a timber construction with concrete/slate tiles (minimum mass per unit area of 30 Kg/m^2) with a loft space and a plasterboard ceiling above the habitable rooms. The above constructions are expected to achieve the following sound reduction indices:

Table 11: Required minimum sound insulation performance of roof

Frequency (Hz)	63	125	250	500	1k	2k	4k	8k	R_w
R (dB)	25	39	47	53	58	56	60	55	**56**

6.3.4. Window Construction

The windows on all elevations could be openable. However, they need to be sealed airtight to control external noise when the windows are closed within the areas noted above. There should be no un-attenuated vents or openings in the building façade.

The performance for each window based on the room type is provided below, other constructions may also achieve this level of sound attenuation. The supplier should provide test data confirming that the octave band sound reduction indices stated below for each window type are achievable.

Table 12: Required minimum sound insulation of windows

Colour Code Facade	Room	R / dB per Octave Band (Hz)								R_w (dB)	Typical Construction
		63	125	250	500	1k	2k	4k	8k		
Orange	Bedrooms	21	26	27	34	40	38	46	46	**37**	10/12/6
	Living Rooms	20	24	20	25	35	38	35	36	**31**	4/12/4
Blue	Bedrooms	20	25	22	33	40	43	44	44	**36**	10/12/4
	Living Rooms	20	24	20	25	35	38	35	36	**31**	4/12/4
Yellow	Bedrooms	20	24	20	25	35	38	35	36	**31**	4/12/4
	Living Rooms	20	24	20	25	35	38	35	36	**31**	4/12/4
Green	Bedrooms	20	24	20	25	35	38	35	36	**31**	4/12/4
	Living Rooms	20	24	20	25	35	38	35	36	**31**	4/12/4

The glazing supplier should confirm the above performance is achievable when tested to the current British Standards.

6.3.5. Ventilation Provisions

Most habitable rooms of the development, except for living rooms on facades shown in green in Figure 6 above, will need to be ventilated via attenuated means.

Trickle/wall ventilation is sufficient to achieve the planning requirements. The vents are required to achieve the following element normalised level difference ($D_{n,e}$) in the open position.

Table 13: Required minimum sound insulation of vents

Colour Code Facade	Room	$D_{n,e}$ per Octave Band (Hz)								$D_{n,e,w}$ (dB)	Typical Construction
		63	125	250	500	1k	2k	4k	8k		
Orange	Bedrooms and Living Rooms	45	47	46	50	55	65	68	60	**54**	Wall Vent, Greenwood MA3051
Blue	Bedrooms	45	47	46	50	55	65	68	60	**54**	Wall Vent, Greenwood MA3051
	Living Rooms	32	32	36	36	35	34	35	38	**35**	Standard trickle vent
Yellow	Bedrooms	30	37	37	36	47	49	55	61	**44**	Titon SF X V75 / SFSA C75 (open)
	Living Rooms	32	32	36	36	35	34	35	38	**35**	Standard trickle vent
Green	Bedrooms	32	32	36	36	35	34	35	38	**35**	Standard trickle vent
	Living Rooms	Open window									

The glazing supplier should confirm the above performance is achievable when tested to the current British Standards.

6.3.6. Effect of Mitigation Measures

With the mitigation measures installed to habitable rooms of the dwellings in the rooms noted above, the predicted internal noise levels are below British Standard 8233:2014 and WHO (1999) criteria and, on this basis, we would consider noise to be below the lowest observed adverse effect level of the NPPG. The predictions are shown for the worst-case room below:

Free Field Level at Façade

Octave Band	63	125	250	500	1000	2000	4000	8000	dBA
Day, $L_{eq(16\ hour)}$	68	59	56	57	57	47	38	30	60
Night $L_{eq\ (8hour)}$	56	49	44	48	51	40	25	17	52
Night-time $L_{max(fast)}$	71	70	81	77	71	61	46	26	77

Building Façade Construction

External Element		63	125	250	500	1000	2000	4000	8000
Wall Vent - Greenwood MA3051 – 54 Dnew	D_{ne}	44.5	47	46	50	55	65	68	60
	Number of	1							
		0.00002	0.00001	0.00001	0.00001	0.00000	0.00000	0.00000	0.00000
2x100mm block plastered/render both sides 100mm void, 1880 Kg/m3 + 400 kg/m3 - 52 Rw		31	38	46	45	55	66	77	70
	Area	8							
		0.00034	0.00007	0.00001	0.00001	0.00000	0.00000	0.00000	0.00000
Double Glazed: 10/12/6.4 - 39 Rw		22	27	29	36	41	42	52	50
	Area	2							
		0.00051	0.00016	0.00010	0.00002	0.00001	0.00001	0.00000	0.00000
Pitched Roof - 56 Rw		25	39	47	53	58	56	60	55
	Area	9							
		0.001538405	6.1245E-05	9.70668E-06	2.43821E-06	7.71029E-07	1.222E-06	4.86486E-07	1.53841E-06

Calculations to BS EN 12354

	63	125	250	500	1000	2000	4000	8000
Sum	0.0024127	0.00030366	0.000136222	4.1885E-05	1.03282E-05	6.60238E-06	1.09237E-06	2.933E-06
10log sum	-26.17503	-35.1761218	-38.65753733	-43.77941744	-49.85977268	-51.80299163	-59.61629605	-55.32687945
10log S/A	3.9037675	3.903767522	5.143552972	6.276852391	7.001453622	4.948500217	3.795544281	3.795544281
correction factor +3	3	3	3	3	3	3	3	3

Octave Band	63	125	250	500	1000	2000	4000	8000	dBA
Day, $L_{eq(16\ hour)}$	48.7	30.7	25.5	22.5	17.1	3.1	-14.8	-18.5	**26.1**
Night $L_{eq\ (8hour)}$	36.7	20.7	13.5	13.5	11.1	-3.9	-27.8	-31.5	**16.3**
Night-time $L_{max(fast)}$	51.7	41.7	50.5	42.5	31.1	17.1	-6.8	-22.5	**44.0**

6.4. External Amenity Spaces

Without mitigation, the level within gardens of the dwellings north of the proposed development (facing on to Badminton Road) is between 55-57 dB $L_{Aeq,\ 16\ hour}$. This is above the BS8233:2014/ WHO recommended amenity level of 50-55dB $L_{Aeq,\ 16\ hour}$. As such, a barrier should be constructed for the amenity areas of these dwellings. The barrier should be 1.8m in height and could be constructed of high close boarded timber fence or masonry wall.

Figure 7: Worst-case amenity area (barrier shown in pink to surround amenity areas of north dwellings)

Figure 7 above provides the daytime noise map of the proposed amenity areas at the residential development. It can be seen that both road and rail traffic noise levels within the worst-case proposed amenity areas are likely to be within the BS8233:2014/ WHO recommended amenity level of 50-55dB $L_{Aeq,\ 16\ hour}$ for all proposed dwellings, once a 1.8m barrier is installed around amenity areas for dwellings north of the site.

7. Vibration Assessment

7.1. Calculated eVDV

At the measurement position the estimated vibration dose values over the daytime (07:00 to 23:00 hours) and night-time (23:00 to 07:00 hours) have been established from the short-term vibration levels and train timetables for this line. The calculation is based on Annex B.2 of BS6472 which is summarised below:

$$eVDT = 1.4 \times a(t)_{r.m.s.} \times t^{0.25}$$

Covid has had an effect on railway timetables, historically there have been on an average daytime period 245 passenger trains and 31 freight. During the night we have assumed there are 23 passenger trains and 27 Freight. This is as estimated from the historic Network Rail Timetables.

We have determined a typical frequency weighted r.m.s. acceleration for the typical train to be:

Table 14: Typical Acc. rms per Train

Axis	X	Y	Z
Typical measured Acc. rms (per train) m.s^{-2}	0.00048	0.00038	0.00214

Using the typical weighted r.m.s. acceleration the calculated eVDV at the measured location is as follows:

Table 15: Calculated eVDV (free-field level)

Time Period	eVDV X (m.s$^{-1.75}$)	eVDV Y (m.s$^{-1.75}$)	eVDV Z (m.s$^{-1.75}$)
Daytime (07:00-23:00)	0.008	0.006	0.034
Night-time (23:00-07:00)	0.005	0.004	0.022

7.2. Transfer Function

The measured level is a free-field level. Noise transfer from outside to inside the properties needs also to be considered. Predictions are also shown below. The transfer is based on methodology followed by "Transfer Function (TRL HS2 Study, Brick Built, with wooden floors).

Table 16: Calculated internal eVDV per floor storey with Transfer Function (Timer Frame Construction)

Floor Level	Time Period	X ($m.s^{-1.75}$)	Y ($m.s^{-1.75}$)	Z ($m.s^{-1.75}$)
Ground Floor (x2)	Daytime (07:00-23:00)	0.02	0.01	0.07
	Night-time (23:00-07:00)	0.01	0.01	0.04
Other Floors (x4)	Daytime (07:00-23:00)	0.03	0.02	0.14
	Night-time (23:00-07:00)	0.02	0.02	0.09

From the measured data it can be seen that the measured vibration dose values for the daytime and night-time fall within the British Standard 6472 range for a "Low probability of adverse comment".

This indicates that proposed plots closest to the railway line will not require mitigation in terms of vibration isolation for the building. As such with a suitably designed building structure vibration can be controlled to acceptable levels.

8. Summary and Conclusions

Grassroots Planning appointed Acoustic Consultants Ltd to undertake an environmental noise assessment for the proposed residential development at Badminton Road, Old Sodbury.

The report is based upon noise and vibration levels measured at the site. This report considers the impact of rail traffic noise and vibration from passing trains, as well as road traffic on the proposed residential development.

The report identifies relevant planning, noise and vibration guidance, establishes environmental noise and vibration levels and provides mitigation measures to the proposed dwellings in support of a planning application.

The assessment has been undertaken in accordance with the guidance in the National Planning Policy Framework (NPPF), Noise Policy Statement for England (NPSE), National Planning Practice Guidance (NPPG), British Standard 8233:2014 (BS8233), and British Standard 6472-1:2008.

We would consider external noise to be suitably controlled within the habitable rooms of the residential development and below the lowest observed adverse effect level of the NPPG. In addition, the road and rail traffic noise levels within the proposed amenity areas are likely to be within the BS8233:2014 / WHO recommended amenity level of 50-55dB $L_{Aeq,\ 16\ hours}$, providing barriers are constructed around the amenity areas of dwellings north of the proposed site.

From the measured data it can be seen that the vibration dose values for the daytime and night-time fall within the British Standard 6472 range for "Low probability of adverse comment" during the night time and daytime period. As such with a suitably designed building structure vibration can be controlled to acceptable levels.

We would consider that with a suitably designed scheme, both noise and vibration will not adversely effect the proposed dwellings on the site and the development achieves the aims of the NPPF.

9. Appendix 1 – Glossary of Acoustic Terminology

A-weighted sound pressure pA – value of overall sound pressure, measured in pascals (Pa), after the electrical signal derived from a microphone has been passed through an A-weighting network

A-weighted sound pressure level, L_{pA} - quantity of A-weighted sound pressure given by the following formula in decibels (dBA)

$L_{pA} = 10 \log_{10} (p_A/p_0)^2$

where:

p_A is the A-weighted sound pressure in pascals (Pa);
p_0 is the reference sound pressure (20 μPa)

Background sound level, $L_{A90,T}$ – A-weighted sound pressure level that is exceeded by the residual sound assessment location for 90% of a given time interval, T, measured using weighting F and quoted to the nearest whole number of decibels

Break-in - noise transmission into a structure from outside.

Decibel (dB) – The decibel is the unit used to quantify sound pressure levels. The human ear has an approximately logarithmic response to acoustic pressure over a very large dynamic range (typically 20 micro-Pascals to 100 Pascals). Therefore, a logarithmic scale is used to describe sound pressure levels and also sound intensity and power levels. The logarithms are taken to base 10. Hence an increase of 10 dB in sound pressure level is equivalent to an increase by a factor of 10 in the sound pressure level (measured in Pascals). Subjectively, this increase would correspond to a doubling of the perceived loudness of sound.

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 = t2 – t1, has the same mean-squared sound pressure as a sound that varies with time, and is given by the following equation:

$$L_{\mathrm{Aeq},T} = 10\lg_{10}\left\{(1/T)\int_{t_1}^{t_2}[p_{\mathrm{A}}(t)^2/p_0^2]\mathrm{d}t\right\} \quad (1)$$

where:

p_0 is the reference sound pressure (20 μPa); and

$p_A(t)$ is the instantaneous A-weighted sound pressure (Pa) at time t

NOTE The equivalent continuous A-weighted sound pressure level is quoted to the nearest whole number of decibels.

Facade level – sound pressure level 1 m in front of the façade. Facade level measurements of L_{pA} are typically 1 dB to 3 dB higher than corresponding free-field measurements because of the reflection from the facade.

Free-field level – sound pressure level away from reflecting surfaces. Measurements made 1.2 m to 1.5 m above the ground and at least 3.5 m away from other reflecting surfaces are usually regarded as free-field. To minimize the effect of reflections the measuring position has to be at least 3.5 m to the side of the reflecting surface (i.e. not 3.5 m from the reflecting surface in the direction of the source).

Octave and Third Octave Bands – The human ear is sensitive to sound over a range of frequencies between approximately 20 Hz to 20 kHz and is generally more sensitive to medium and high frequencies than to low frequencies within the range. There are many methods of describing the frequency content of a noise. The most common methods split the frequency range into defined bands, in which the mid-frequency is used as the band descriptor and in the case of octave bands is double that of the band lower. For example, two adjacent octave bands are 250 Hz and 500 Hz. Third octave bands provide a fine resolution by dividing each octave band into three bands. For example third octave bands would be 160 Hz, 250 Hz, 315 Hz for the same 250 Hz octave band.

Sound pressure level – Sound pressure level is stated on many of the charts. It is the amplitude of the acoustic pressure fluctuations in a sound wave, fundamentally measured in Pascals (Pa), typically from 20 micro-Pascals to 100 Pascals, but commonly simplified onto the decibel scale.

Sound reduction index, R – laboratory measure of the sound insulating properties of a material or building element in a stated frequency band.

Specific sound level, $L_s = L_{Aeq,Tr}$ – equivalent continuous A-weighted sound pressure level produced by the specific sound source at the assessment location over a given reference time interval, T_r.
Structure-borne noise – audible noise caused by the vibration of elements of a structure, the source of which is within a building or structure with common elements

Rating level, $L_{Ar,Tr}$ – Specific sound level plus any adjustment for the characteristic features of the sound.

Reverberation Time, T – The reverberation time is defined as the time taken for a noise level in an enclosed space to decay by 60 dB from a steady level, once the noise source has stopped. It is measured in seconds. Often a 60 dB decay cannot be measured so the reverberation time is measured over a lesser range and corrected back to the time for a 60 dB drop assuming a constant decay rate. Common parameters are T20 (time taken for a 20 dB decay multiplied by three) and T30 (time taken for a 30 dB decay multiplied by two).

Vibration Dose Value, VDV – measure of the total vibration experienced over a specified period of time.

Estimated Vibration Dose Value, eVDV – estimation of the total vibration experienced over a specified period of time. This is usually based on the number of events and shortened measurement data.

Weighted sound reduction index, R_w – Single-number quantity which characterizes the airborne sound insulating properties of a material or building element over a range of frequencies. The weighted sound reduction index is used to characterize the insulation of a material or product that has been measured in a laboratory (see BS EN ISO 717-1).

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