Acoustic Associates Sussex Ltd

Road Traffic Noise Assessment for a Planning Application

Site: **8 Fishermans Walk, Shoreham by Sea**
Client: **Edward Bartlett**

Report by: Simon Barrett BSc(Hons) MSc MIOA

Date: 25/09/19
Project: J2793

Issue: 1

Acoustic Associates Sussex Ltd.

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Issue No.	Date	Comments
1	25/09/2019	Initial Issue

1 Introduction

Acoustic Associates have been appointed to undertake an acoustic assessment of sound levels affecting a proposed residential development adjacent to 8 Fishermans Walk, Shoreham by Sea.

This purpose of this report is to identify and assess the sound levels in accordance with the following standards in order to support a planning application:

- Noise and Planning Policy Framework (NPPF): 2019
- Noise Policy Statement for England (NPSE): 2010
- ISO9613 (Attenuation of sound during propagation outdoors): 1996
- BS8233 (Sound insulation and noise reduction for buildings): 2014
- Pro-PG (Planning and Noise guidance): 2017

The results of the assessment show that the most exposed façade (that which faces the road), acoustically enhanced double-glazing (when closed) with acoustically enhanced background ventilators will be able to provide sufficient sound reduction for the building envelope such that the internal ambient noise levels within bedrooms and lounges during daytime and night time will satisfy the requirements of BS8233:2014 as well as the Night time Lmax criterion of ProPG 2017. Please see Sections 6.2 and 6.3 for this discussion.

In terms of outdoor amenity areas, all “local to the property” outdoor space is above the upper limit of 55dB as required by BS8233:2014. Mitigation Measures are required here in that an alternative area will need to be designated as a quiet amenity space. Please see Section 6.4 for this discussion.

Based upon the results of this assessment within this report, it is considered that all if the mitigation measures proposed within Section 6 of this document are adopted, the development will satisfy the requirements of BS8233:2014 and ProPG 2017 and thus the Local Authority’s planning condition could be discharged relating to acoustics / noise.

2 Context, Noise Criteria & Noise Assessment Methodology

2.1 Site Description

The site is directly south of the A259 (Brighton Road) – a major infrastructure road running between Lancing and Shoreham. This site is bounded to the south by existing housing.

An existing layout plan and a proposed site plan can be seen in the appendices of this report.

2.2 BS8233:2014 Noise Criteria

Table 4 of BS8233 provides the following guideline values:

Activity	Location	Time period of day	
		07:00-23:00	23:00-07:00
Resting	Living Rooms	35dB $L_{Aeq,16hour}$	-
Dining	Dining Room/Area	40dB $L_{Aeq,16hour}$	-
Sleeping (daytime resting)	Bedroom	35dB $L_{Aeq,16hour}$	30dB $L_{Aeq,8hour}$

Table 1: BS8233 Criteria

With regard to outdoor amenity areas BS8233 states the following:

To protect the majority of people from being seriously annoyed during the daytime, the outdoor sound level from steady, continuous noise should not exceed 55dB(A) on balconies, terraces and in outdoor living areas.

To protect the majority of people from being moderately annoyed during the daytime, the outdoor sound level from steady, continuous noise should not exceed 50dB(A) on balconies, terraces and in outdoor living areas.

2.3 Noise Policy Statement for England (NPSE) 2010

The document "Noise Policy Statement for England" sets out the following vision for on- going noise policy:

"Promote good health and quality of life through the effective management of noise within the context of Government policy on sustainable development."

This vision should be achieved through the following Noise Policy Aims:

"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 minimize adverse impacts on health and quality of life; and where possible, contribute to the improvement of health and quality of life".

2.4 NPSE Noise "Effect Levels"

To achieve these objectives the Noise Policy Statement sets out three noise levels to be defined by the assessor:

- 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 considers that noise levels above the SOAEL would be seen to have, by definition, significant adverse effects and would be considered unacceptable.

Where the assessed noise levels fall between the LOAEL and the SOAEL noise levels, the Policy Statement requires that:

"All reasonable steps should be taken to mitigate and minimize adverse effects on health and quality of life while also taking into account the guiding principles of sustainable development... .. This does not mean that such adverse effects cannot occur."

Where noise levels are below the LOAEL it is considered there will be no adverse effect. Once noise levels are below the NOEL there will be no observable change.

2.5 ProPG –Planning and Noise: 2017 - new residential development

The following has been copied from the Association of Noise Consultants' (ANC) website:

Over recent years, we have seen the introduction of the Noise Policy Statement for England, as well as substantial changes in national planning policy. But these developments have not been accompanied by detailed technical acoustic advice.

The lack of detailed guidance can lead to inconsistent application of policy, that may in turn result in unsatisfactory development and affect quality of life.

To fill that gap and facilitate efficient and consistent decision-making in the development control process, the Institute of Acoustics, the Association of Noise Consultants and the CIEH have joined to produce a Professional Practice Guidance (ProPG) focussing on noise sensitive development.

The following extract has been taken (Figure 2, Page 13) from the May 2017 ProPG document:

ACTIVITY	LOCATION	07:00 – 23:00 HRS	23:00 – 07:00 HRS
Resting	Living room	35 dB $L_{Aeq,16\ hr}$	-
Dining	Dining room/area	40 dB $L_{Aeq,16\ hr}$	-
Sleeping (daytime resting)	Bedroom	35 dB $L_{Aeq,16\ hr}$	30 dB $L_{Aeq,8\ hr}$ 45 dB $L_{Amax,F}$ (Note 4)

NOTE 1 The Table provides recommended internal L_{Aeq} target levels for overall noise in the design of a building. These are the sum total of structure-borne and airborne noise sources. Ground-borne noise is assessed separately and is not included as part of these targets, as human response to ground-borne noise varies with many factors such as level, character, timing, occupant expectation and sensitivity.

NOTE 2 The internal L_{Aeq} target levels shown in the Table are based on the existing guidelines issued by the WHO and assume normal diurnal fluctuations in external noise. In cases where local conditions do not follow a typical diurnal pattern, for example on a road serving a port with high levels of traffic at certain times of the night, an appropriate alternative period, e.g. 1 hour, may be used, but the level should be selected to ensure consistency with the internal L_{Aeq} target levels recommended in the Table.

NOTE 3 These internal L_{Aeq} target levels are based on annual average data and do not have to be achieved in all circumstances. For example, it is normal to exclude occasional events, such as fireworks night or New Year's Eve.

NOTE 4 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. In most circumstances in noise-sensitive rooms at night (e.g. bedrooms) good acoustic design can be used so that individual noise events do not normally exceed 45dB $L_{Amax,F}$ more than 10 times a night. However, where it is not reasonably practicable to achieve this guideline then the judgement of acceptability will depend not only on the maximum noise levels but also on factors such as the source, number, distribution, predictability and regularity of noise events (see Appendix A).

NOTE 5 Designing the site layout and the dwellings so that the internal target levels can be achieved with open windows in as many properties as possible demonstrates good acoustic design. Where it is not possible to meet internal target levels with windows open, internal noise levels can be assessed with windows closed, however any façade openings used to provide whole dwelling ventilation (e.g. trickle ventilators) should be assessed in the "open" position and, in this scenario, the internal L_{Aeq} target levels should not normally be exceeded, subject to the further advice in Note 7.

NOTE 6 Attention is drawn to the requirements of the Building Regulations.

NOTE 7 Where development is considered necessary or desirable, despite external noise levels above WHO guidelines, the internal L_{Aeq} target levels may be relaxed by up to 5 dB and reasonable internal conditions still achieved. The more often internal L_{Aeq} levels start to exceed the internal L_{Aeq} target levels by more than 5 dB, the more that most people are likely to regard them as "unreasonable". Where such exceedances are predicted, applicants should be required to show how the relevant number of rooms affected has been kept to a minimum. Once internal L_{Aeq} levels exceed the target levels by more than 10 dB, they are highly likely to be regarded as "unacceptable" by most people, particularly if such levels occur more than occasionally. Every effort should be made to avoid relevant rooms experiencing "unacceptable" noise levels at all and where such levels are likely to occur frequently, the development should be prevented in its proposed form **(see Section 3.D)**.

Figure 1: ProPG Criteria

2.6 Local Authority's Planning Condition

04. Construction work shall not commence until a scheme for protecting the proposed noise sensitive development from noise from the road has been submitted to and approved by the local planning authority. All works, which form part of the scheme, shall be completed before any part of the noise sensitive development is occupied. The scheme shall achieve the indoor ambient noise levels for dwellings and rear garden noise level specified in BS8233:2014 and shall have regard to the principles contained within the World Health Organization community noise guidelines. Following approval and completion of the scheme, a competent person employed by the developer shall undertake a test to demonstrate that the attenuation measures proposed in the scheme meet the specified levels.

3 Road Noise Survey Baseline Conditions and Results

A noise survey was carried out from the 10th September to the 16th September 2019 in order to measure noise levels associated with the adjacent road. The noise monitoring location can be seen in the existing layout/block plan that is in the appendix.

3.1 Baseline Conditions

- Survey carried out by: Simon Barrett BSc(Hons) MSc MIOA
- Equipment used: Rion NL18 Type 1 Sound Level Meter
- Weather conditions: Dry; Wind: variable direction less than 5m/s

The Meter was calibrated before and after commencing the noise measurements (@94dB no drift).

The microphone was placed on top of a flat roof of a garage currently belonging to the owners of 8 Fishermans Walk. The micorphone was positioned on a tripod and pole system at 1st floor window height (approximately 4m from the ground and approximately 14m from the centre line of the A259 Road. It follows from the microphone position that the sound levels recorded are "Free-Field Condition" values.

3.2 Road Noise Survey Results

The survey data has been used to calculate the logarithmic 16hr day time and the 8hr night time period noise levels. The Table below shows the day and night time period noise levels that were measured at the survey position – it can be seen that the sound levels are very consistent for each day and night periods.

Date (2019)	Day	Time Period	Freefield Level $L_{Aeq,16hr/8hr}$ – dB(A) (Rounded)
11 September	Wednesday	07:00-23:00hrs	64
12 September	Thursday	07:00-23:00hrs	65
13 September	Friday	07:00-23:00hrs	66
14 September	Saturday	07:00-23:00hrs	66
15 September	Sunday	07:00-23:00hrs	65
Average (Arithmetic)	**All days**	**07:00-23:00hrs**	**65**
10 September	Tuesday	23:00-07:00hrs	61
11 September	Wednesday	23:00-07:00hrs	62
12 September	Thursday	23:00-07:00hrs	62
13 September	Friday	23:00-07:00hrs	61
14 September	Saturday	23:00-07:00hrs	60
15 September	Sunday	23:00-07:00hrs	61
Average (Arithmetic)	**All Nights**	**23:00-07:00hrs**	**61**

Table 2: Survey Noise Levels

4 Road Computer Noise Model

4.1 General Methodology

In order to see how noise varies at different positions around the proposed development it is possible to produce a noise contour map. A computer noise model has been completed using the computer package IMMI. The survey data and drawings of the existing & proposed site layout plans have been used to complete the noise models. IMMI faithfully implements the propagation method of ISO-9613:1996; Acoustics – Attenuation of sound during propagation outdoors. An “existing site” noise model was completed first to allow the calibration of the noise source (road). The existing site model contained nearby buildings and the height contour of the field in relation to the road.

The A259 road (Brighton Road) was added to the “Survey” noise model as a line source. The line source day/night time sound power was adjusted until the received noise level at survey reception point (RP) matched the mean average sound levels from the survey data in section 3.

4.2 Proposed Development Noise Model Methodology

Once this model calibration had been completed, the model was then adapted to show the proposed new site layout with the proposed building included and the existing garage removed. Reception points were added for the different window positions of the habitable rooms and the computer prediction was re-run to show the sound levels at these reception points, along with showing noise level colour contours across the site in broad-band dBA.

4.3 Computer Noise Model Output

Tabulated data of the predicted noise levels are provided for the different window positions around the proposed new dwelling.

Computer noise contour plots for ground floor and 1st floor window heights have also been created and are also provided within the appendices of this report.

This section provides details of the worst-case noise levels incident upon the site: These are Leq,16hr 65dBA during the daytime period of 07:00-23:00 and Leq,8hr 61dBA during the night time period of 23:00-07:00. These sound levels are associated with the Lounge and Bedroom 2. The full table of results is found within the appendices of this report.

The difference in sound level between the measurement location and the reception points has also been calculated in order to assist with the Lmax assessment later in this report.

5 Noise Assessment

5.1 Noise Criteria

5.1.1 Continuous Noise Levels

The BS8233 2014 noise criteria will be used to specify the noise mitigation measures for all habitable rooms. The maximum internal noise level for each area is as follows:

- Bedrooms 35/30dBA (Day/Night)
- Lounges 35dBA Day

5.1.2 Road Noise Maximum Noise Levels

For LAmax events the ProPG noise LAmax criterion will be used to specify the noise mitigation measures for bedrooms only:

For a reasonable standard in noise sensitive rooms at night (e.g. bedrooms) individual noise events should not normally exceed 45dB LAFmax more than 10 times a night.

The above is similar to guidance in the WHO Guidelines for Community Noise 1999 document. However, the ProPG criteria suggests limiting the number of LAmax events (over 45dBA) to less than 10 times a night as opposed to less than 10-15 times a night as stipulated by the WHO.

5.2 Required Sound Reduction of Building Envelope – Continuous Noise levels

The SRI has initially been calculated so that the continuous noise level criteria can be achieved (the L_{Amax} sound levels are discussed in the next sub section).

This information can be found within the table within the appendices. It shows that for the worst-case façade, 32dB attenuation is required as a minimum by the building envelope during the daytime period (Bedroom 2 and Lounge) and 33dB attenuation is required by the building envelope during the night time period (Bedroom 2). The next worst-case plot will require 28dB attenuation during daytime periods and 29dB during night time periods (Bedroom 1).

As a partially open window (according to Annex G of BS8233:2014) is stated to provide an attenuation of only 15dB, it is clear that using partially open windows for background ventilation measures is not something which can be relied upon and so adopting System 1, 3 or 4 from Approved Document F will certainly be needed, not just for controlling the background ventilation rate, but for acoustic purposes also.

Please see Section 6 regarding mitigation of these sound levels.

5.3 Required Sound Reduction of Building Envelope – L_{Amax}

As discussed in the section above, for the worst-case façade, 32dB attenuation is required during the daytime and 33dB attenuation is required for the night time, but this relates only to continuous noise levels during the relevant periods.

The number of $L_{Amax,5min}$ events in each of the bedrooms of the proposed dwelling has been calculated: The difference between sound level at the survey point and the Reception Points (RP) of the most exposed façade during night time was also taken in to account as part of this calculation. The suggested SRI at these points was then subtracted to see how many $L_{Amax,5min}$ there would be in the bedrooms in question over a night time period (between 23:00 and 07:00). This has been conducted for the Windows Closed situation. This showed that the attenuation requirements as discussed in Section 5.2 of this report, also satisfies the requirements for the L_{AMax} criterion.

For completeness, using this method (described above), the below table shows the number of $L_{Amax,5min}$ over 45dBA for each night which the survey took place:

Reception Point	Bedroom 1	Bedroom 2 (Worst Case)
Difference from Survey Position (dB)	-2	+2
Night 1	4	11
Night 2	4	10
Night 3	3	11
Night 4	0	8
Night 5	3	6
Night 6	2	4

Table 3: $L_{Amax, 5min}$ Windows Closed – number of occurrences over 45dBA

The above table shows that on the worst-case nights, the SRI of the building envelope will need to be increased such that the L_{Amax} criterion of ProPG 2017 is satisfied.

6 Mitigation Measures

6.1 Wall/Ceiling Make-up

The sound reduction of the proposed 1st floor wall, has been modelled and is relatively poor at certain frequencies which are relevant to road traffic. It is therefore recommended that the plasterboard lining to the ceiling and walls is upgraded from 1x 12.5mm Standard Plasterboard, to 2x 12.5mm Soundbloc plasterboard layers. Otherwise, the glazing and ventilation specifications will exceed that of the wall and ceiling make-up.

6.2 Glazing

It has been found from sections 5.2 and 5.3 that the most onerous sound reduction requirement for the building envelope (L_{max} sound levels) of the most exposed façade will be at least 34dB. This can be achieved by enhanced acoustic double glazing which typically has a sound reduction performance of at least **R_{Tra} 32dB (or Rw 38dB)**

It is, of course, important to note that the sound source is road traffic. As a consequence of this sound source, a BS8233 Rigorous Calculation has been carried out to confirm the above, taking into account the façade make-up as well as the ratio of glazing to wall and the overall area of façade.

All other façades, will benefit from further attenuation due to distance from or angle of incidence to this road. Furthermore, the less exposed façades of this development will benefit from further attenuation due to the house itself.

6.3 Ventilation

Based upon the information found within Annex G of BS8233:2014 and also commonly accepted data, a window that is partially opened for providing background ventilation can only provide around 12 – 15dB of sound reduction compared to a closed window, which is capable of providing around at least 33dB when set in a frame as part of the overall façade.

Background ventilation is typically provided by one of the four methods provided within Approved Document F rather than opening windows. It has been calculated that if System 1 is used (Natural Ventilation with Intermittent Extractors) the required background ventilation methods can be achieved whilst still adhering to the criteria of BS8233:2014 for internal ambient noise levels within lounges and bedrooms. This has been proved by the use of the BS8233 Rigorous Calculation for the worst-case rooms which shows that either “slot” type or “through-the-wall” type trickle ventilators within the heads of the window frames (which provide a D,ne,w of 31dB), can be used.

It is an important point that these trickle ventilators must be suitably acoustically rated:

Products such as those made by Greenwood (i.e. 5000EAW.AC2, or the AAB or the MA3051) or Rytons (i.e. AAC1250HP) would be suitable here.

Alternatively, the use of acoustically attenuated whole house ducted ventilation (i.e. MVHR) would be suitable.

6.4 Outdoor Amenity Areas

The criterion laid out in section 2.2 of this report for outdoor amenity spaces recommends that outdoor amenity spaces should not exceed 55 dBA in order to protect against serious annoyance.

The computer noise models show that the local designated outdoor amenity areas are above the upper limit of 55dB with the exception of the area situated within a “shadow-zone” behind the house.

Alternative means for outdoor amenity will therefore need to be provided.

With the above being apparent, the following solution, successfully adopted by other nearby developments is provided:

Whilst the sound level on many of the balconies would be above the guideline values, the latest governing noise guidance used for planning and sound insulation of buildings (BS8233:2014) has a major caveat detailed in its Section 7.7.3.2. It recognises that in areas where development (or re-development) is needed but where the areas are in noisier environments (i.e. by the busy transport network or in urban areas, a compromise on the noise levels in areas such as balconies can be made to ensure that development needs are indeed met. The statement also states that planning consent should not be prohibited on the basis of sound levels in these areas.

The official quotation is as follows:

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 recognized 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.***

Further to the above, Planning Practice Guidance 2014 (Noise) states noise impact may be partially off-set if a relatively quiet, protected, external publicly accessible amenity space is nearby (e.g. within a 5-minute walking distance).

It is therefore important to note that within 5 minutes' walk is the Seafront, which is significantly reduced in noise level in terms of sound from the road that is local to the proposed property. This seafront is also close to Lancing Beach Green - a further short walk in a westward direction and Shoreham Beach Green in an eastward direction. These areas would satisfy the requirements of the sound level requirements of BS8233:2014 and the WHO.

7 Conclusion

Noise levels affecting the planned development have been measured and assessed.

The dominant source of noise affecting the proposed development relates to vehicles traveling on the adjacent A259 coast road of “Brighton Road”.

Transportation (road) noise has been measured on the existing site.

Noise propagation around the planned development has been predicted using the computer program IMMI (Wolfel).

The noise levels for the day and the night time period have been assessed in terms of and following the guidelines of the documents listed below:

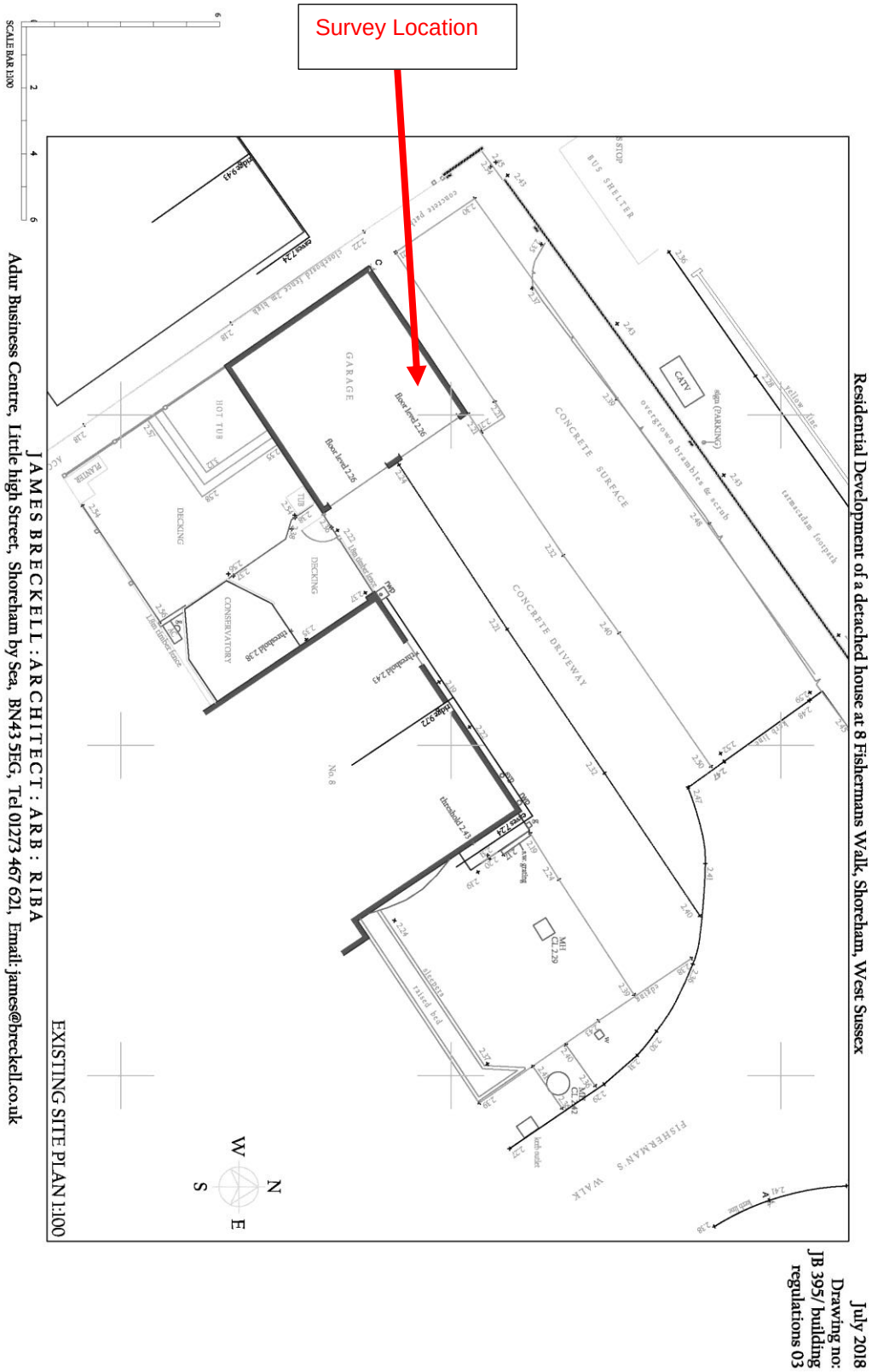
- Noise and Planning Policy Framework (NPPF): 2019
- Noise Policy Statement for England (NPSE): 2010
- ISO9613 (Attenuation of sound during propagation outdoors) 1996
- BS8233 (Sound insulation and noise reduction for buildings) 2014
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The results of the assessment show that the most exposed façade (that which faces the road), acoustically enhanced double-glazing (when closed) with acoustically enhanced background ventilators will be able to provide sufficient sound reduction for the building envelope such that the internal ambient noise levels within bedrooms and lounges during daytime and night time will satisfy the requirements of BS8233:2014 as well as the Night time Lmax criterion of ProPG 2017. Please see Sections 6.2 and 6.3 for this discussion.

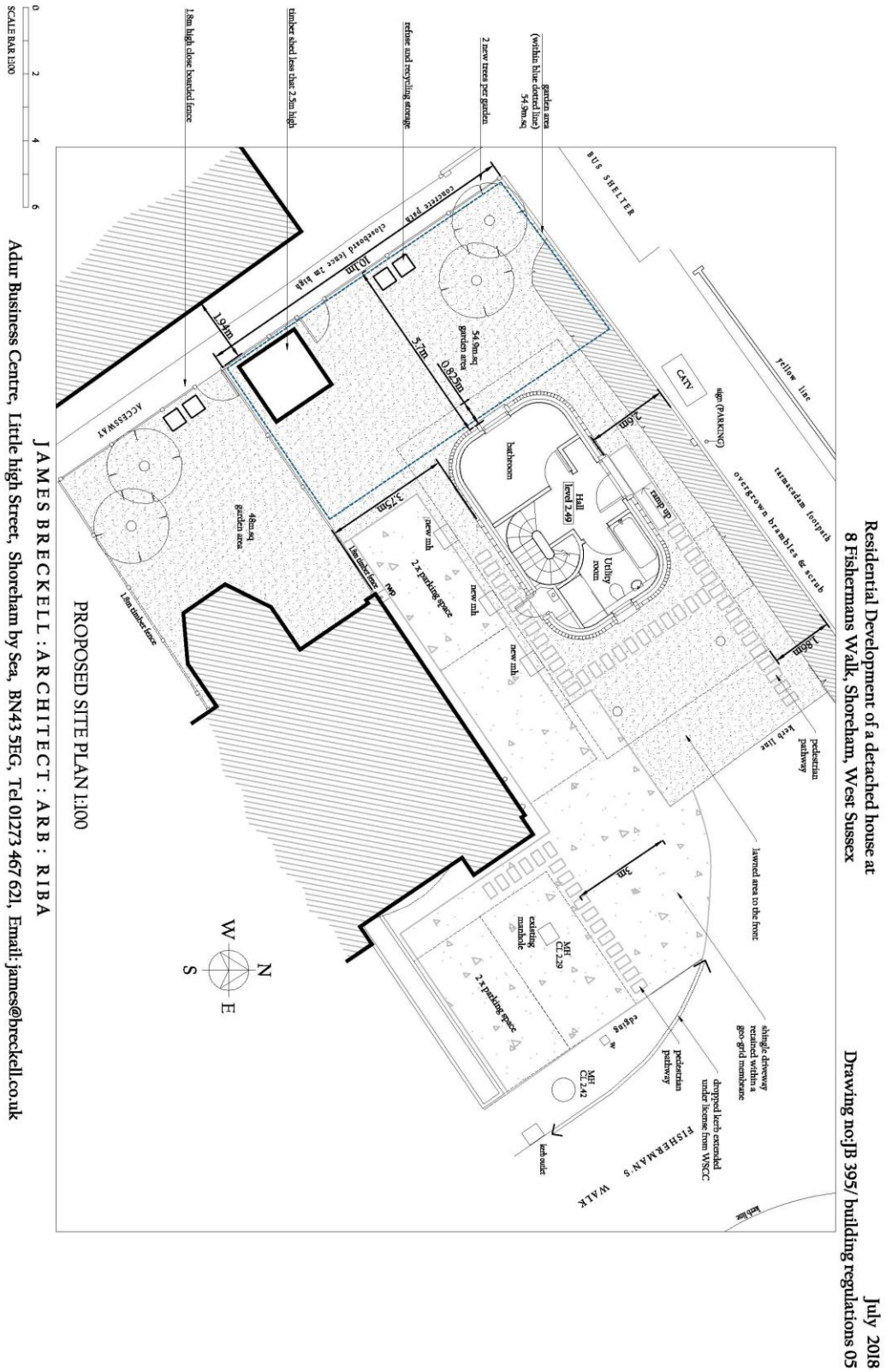
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Based upon the results of this assessment within this report, it is considered that all if the mitigation measures proposed within Section 6 of this document are adopted, the development will satisfy the requirements of BS8233:2014 and ProPG 2017 and thus the Local Authority’s planning condition could be discharged relating to acoustics / noise.

Appendix A – Survey Location and Existing Site Plan



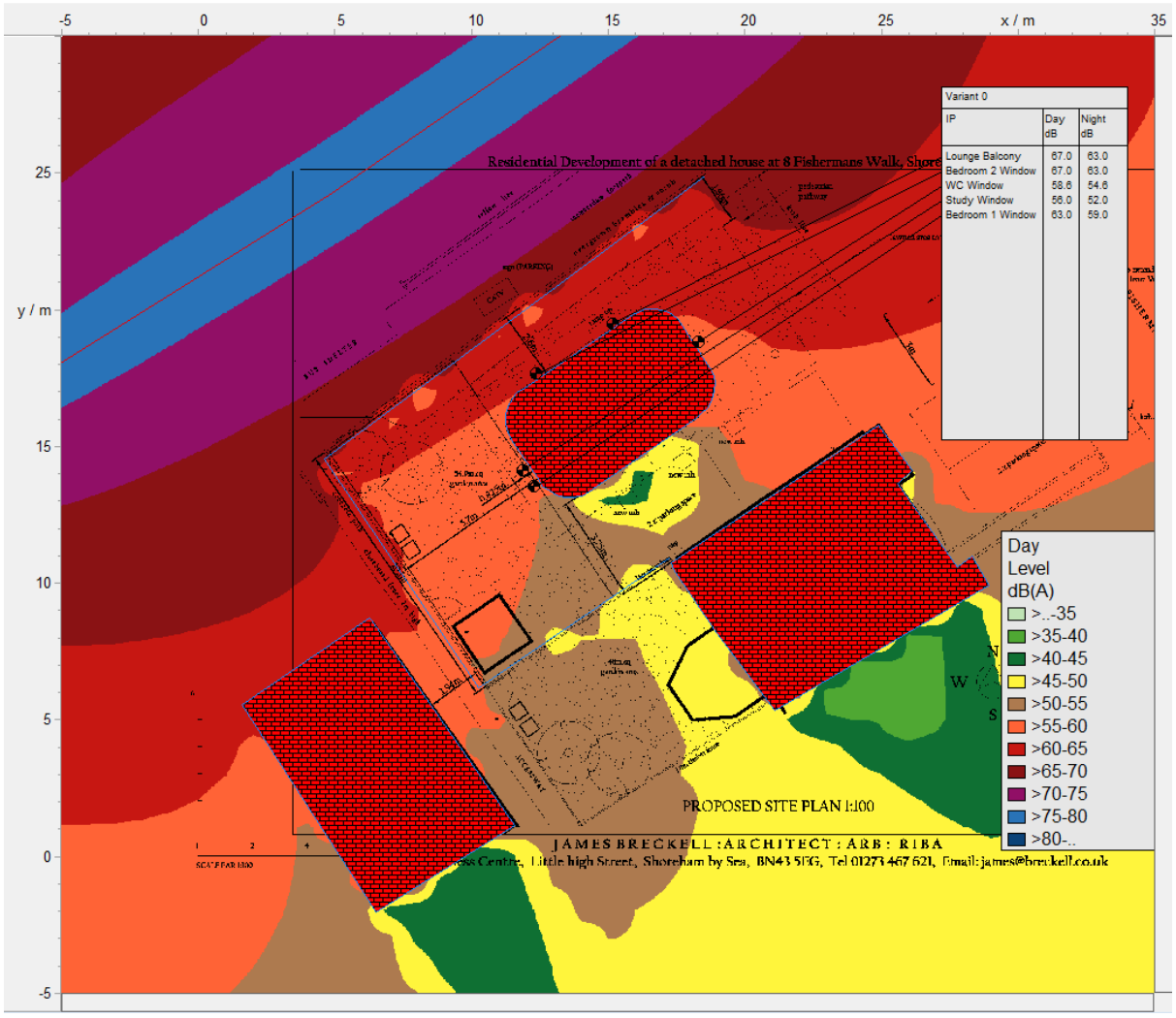
Appendix B – Proposed Site Plan



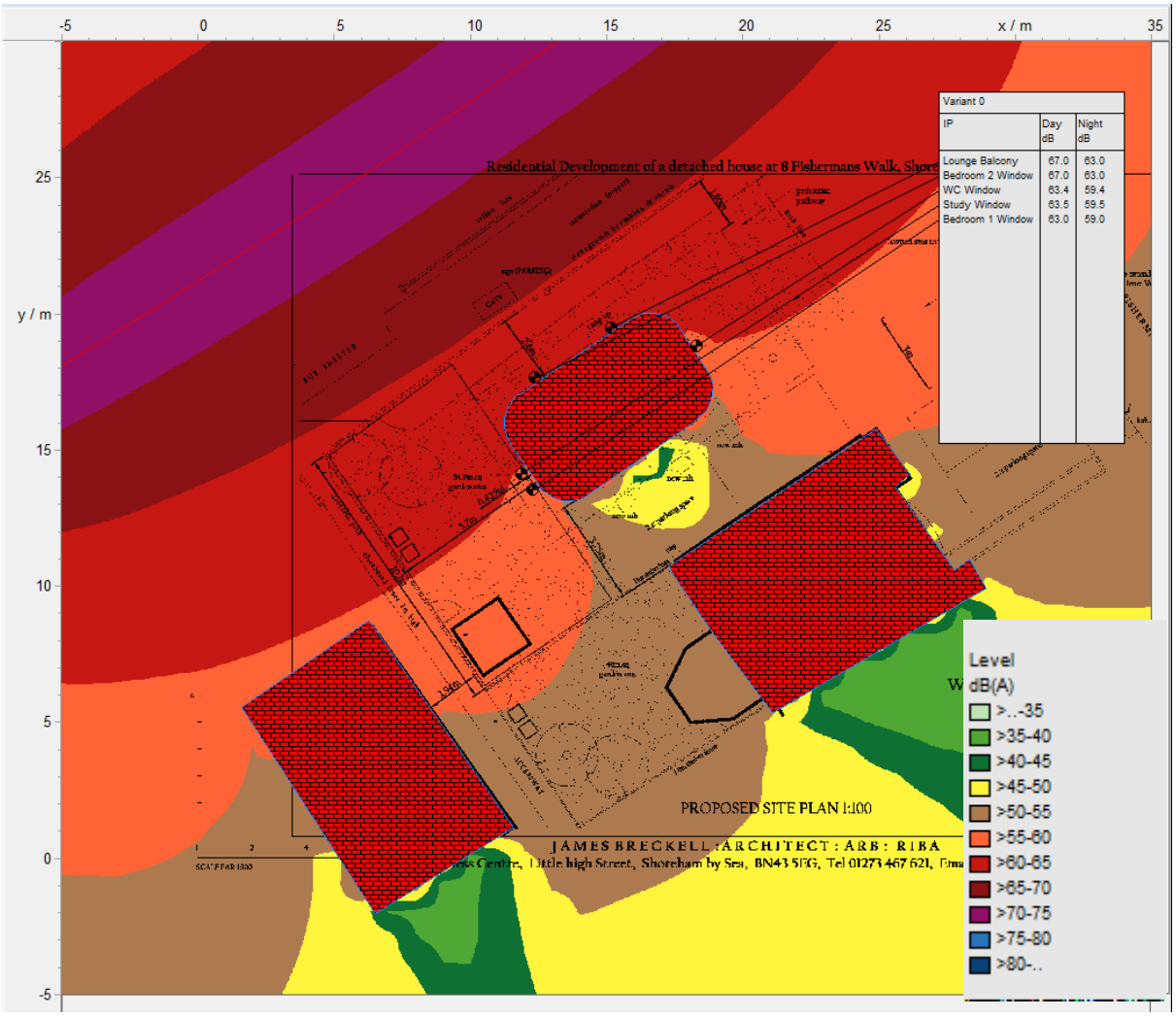
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Appendix C – 2D Immi Noise Models

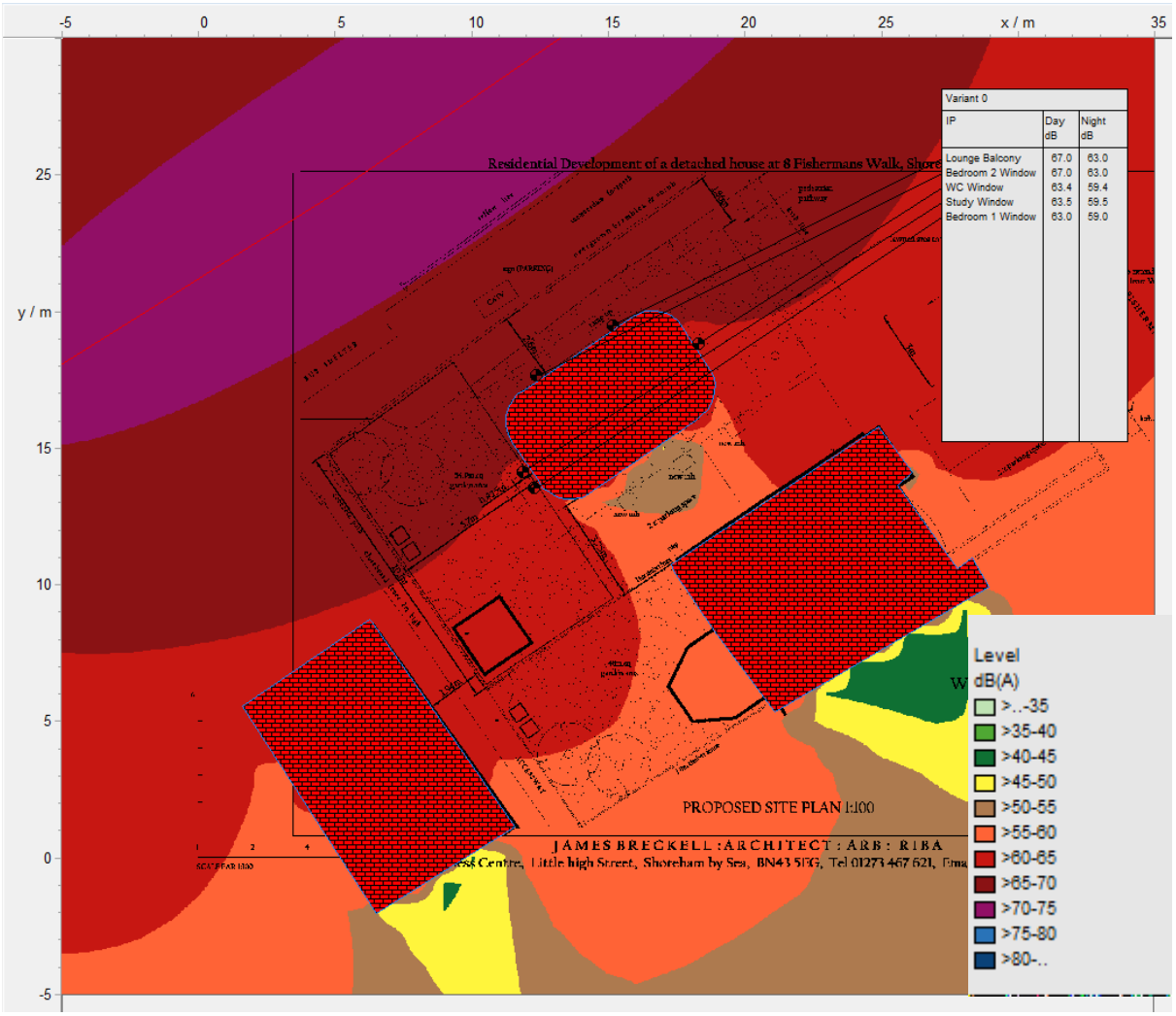
Ground Floor – Daytime



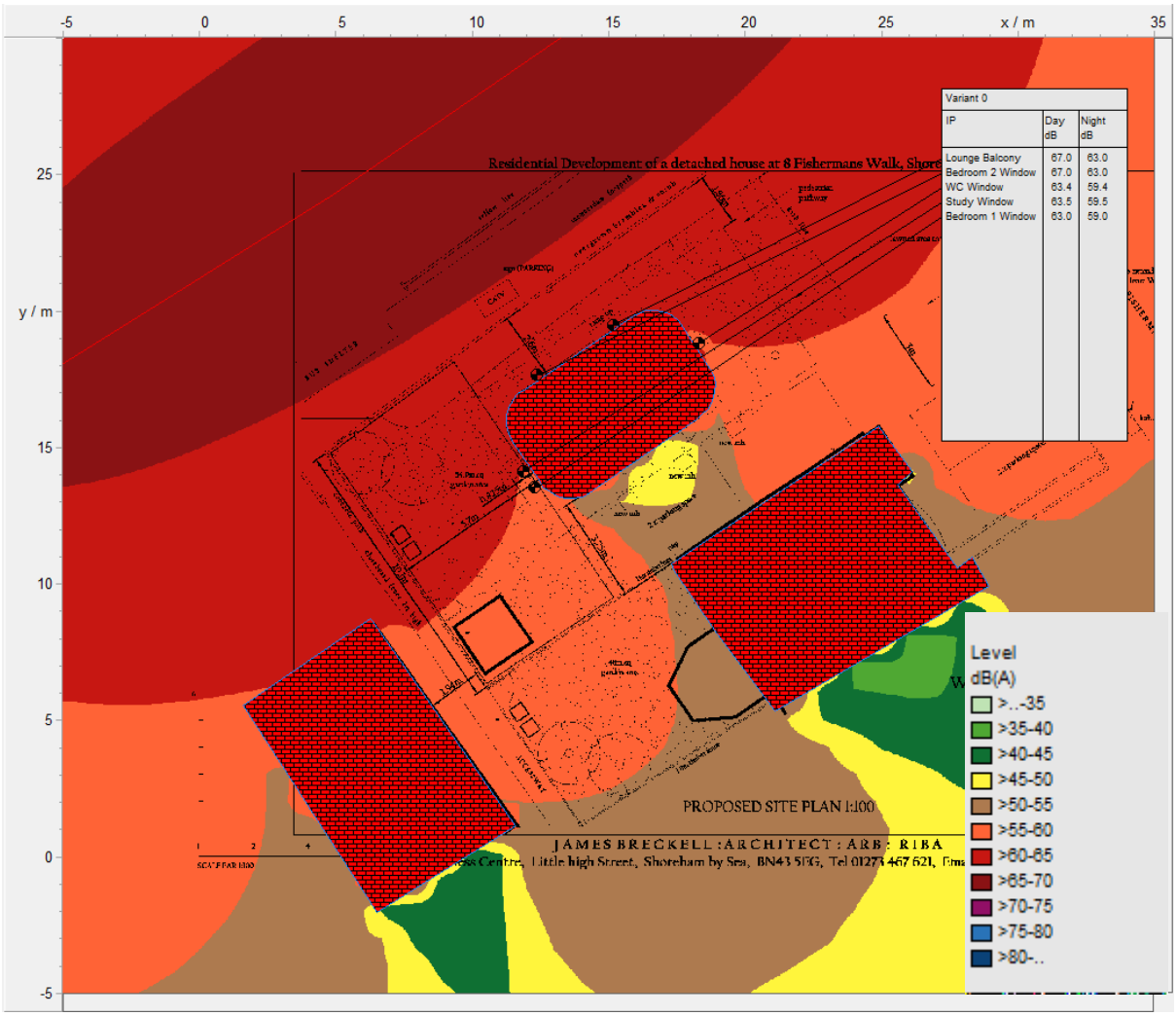
Ground Floor – Night time



1st Floor – Daytime



1st Floor – Night time



Appendix D – BS 8233 Rigorous Calculations

Most Exposed Façade – Daytime

Non Frequency Dependent Variables		
Term	Derivation	Value
A_o	Given in BS EN 20140-10 = 10 (m^2)	10
S_f	Total Facade Area (m^2)	21.6
S_{wi}	Window Area (m^2)	1.8
S_{ew}	External Wall Area (m^2)	11.4
S_{rr}	Ceiling Area (m^2)	8.4
S	Total Area sound enters the room (m^2)	21.6

Key for Table Below	
R_{wi}	Sound Reduction of Window (Octave)
R_{ew}	Sound Reduction Index of External Wall (Octave)
R_{rr}	Sound Reduction Index of Roof/Ceiling (Octave)
A	Equivalent Absorbtion Area of Rx Room
$D_{n,e}$	Insulation of Trickle Vent (BS EN 20140-10)

Frequency Dependent Variables							
		Octave Band Centre Frequency					
Term	Description	125	250	500	1000	2000	4000
$L_{eq,ff}$	Free-Field External Noise Level	66.9	62.9	60.9	60.9	57.9	50.9
$D_{n,e}$	Greenwood 5000EAW.AC2	39.9	37.9	31.8	46.7	53.3	48.1
R_{wi}	10_12_4	25	22	33	40	43	44
R_{ew}	2x12.5 Wallboard Timber Frame Mineral Fibre Ply and Render	35	42	47	51	46	52
R_{rr}	Flat timber joist roof, asphalt on boarding, 12mm plasterboard ceiling, thermal insuation	45	45	45	45	45	45
A	Equivalent Absorbtion Area of Room (Copied from BS8233)	11.00	14.00	16.00	16.00	15.00	15.00

BS8233 Calculation Details						
	Octave Band Centre Frequency					
Term From Equation Below	125	250	500	1000	2000	4000
$L_{eq,ff}$	66.9	62.9	60.9	60.9	57.9	50.9
Ao/S . 10^(-Dn,e/10)	4.737E-05	7.51E-05	0.000306	9.89797E-06	2.16544E-06	7.17045E-06
Swi/S . 10^(-Rwi/10)	0.0002635	0.000526	4.18E-05	8.33333E-06	4.17656E-06	3.31756E-06
Sew/S . 10^(-Rew/10)	0.0001669	3.33E-05	1.05E-05	4.19229E-06	1.32572E-05	3.33005E-06
Srr/S . 10^(-Rrr/10)	1.23E-05	1.23E-05	1.23E-05	1.22977E-05	1.22977E-05	1.22977E-05
10log10(S/A)+3	5.9306107	4.883257	4.303338	4.303337685	4.583624921	4.583624921
Leq,2	39.733401	35.88881	30.89087	20.6093025	17.52111317	9.652659288
A-Weighting	-16.1	-8.6	-3.2	0	1.2	1
A-Weighted Leq	**23.633401**	**27.28881**	**27.69087**	**20.6093025**	**18.72111317**	**10.65265929**

A-Weigted Level Outside	**65**
BS8233 Predicted Internal A-Weigted Level	**32**
Prediced Building Envelope SRI	**33**

BS8233 Calculation can be seen below:

$$L_{eq,2} \approx L_{eq,ff} + 10\log_{10}\left(\frac{A_0}{S}10^{\frac{-D_{n,e}}{10}} + \frac{S_{wi}}{S}10^{\frac{-R_{wi}}{10}} + \frac{S_{ew}}{S}10^{\frac{-R_{ew}}{10}} + \frac{S_{rr}}{S}10^{\frac{-R_{rr}}{10}}\right) + 10\log_{10}\left(\frac{S}{A}\right) + 3$$

Acoustic Associates Sussex Ltd.

Most Exposed Façade - Night time

Non Frequency Dependent Variables		
Term	**Derivation**	**Value**
A_o	Given in BS EN 20140-10 = 10 (m^2)	10
S_f	Total Facade Area (m^2)	21.6
S_{wi}	Window Area (m^2)	1.8
S_{ew}	External Wall Area (m^2)	11.4
S_{rr}	Ceiling Area (m^2)	8.4
S	Total Area sound enters the room (m^2)	21.6

Key for Table Below	
R_{wi}	Sound Reduction of Window (Octave)
R_{ew}	Sound Reduction Index of External Wall (Octave)
R_{rr}	Sound Reduction Index of Roof/Ceiling (Octave)
A	Equivalent Absorbtion Area of Rx Room
$D_{n,e}$	Insulation of Trickle Vent (BS EN 20140-10)

Frequency Dependent Variables							
		Octave Band Centre Frequency					
Term	**Description**	**125**	**250**	**500**	**1000**	**2000**	**4000**
$L_{eq,ff}$	Free-Field External Noise Level	62.9	58.9	56.9	56.9	53.9	46.9
$D_{n,e}$	Greenwood 5000EAW.AC2	39.9	37.9	31.8	46.7	53.3	48.1
R_{wi}	10_12_4	25	22	33	40	43	44
R_{ew}	2x12.5 Wallboard Timber Frame Mineral Fibre Ply and Render	35	42	47	51	46	52
R_{rr}	Flat timber joist roof, asphalt on boarding, 12mm plasterboard ceiling, thermal insuation	45	45	45	45	45	45
A	Equivalent Absorbtion Area of Room (Copied from BS8233)	11.00	14.00	16.00	16.00	15.00	15.00

BS8233 Calculation Details						
	Octave Band Centre Frequency					
Term From Equation Below	**125**	**250**	**500**	**1000**	**2000**	**4000**
$L_{eq,ff}$	62.9	58.9	56.9	56.9	53.9	46.9
Ao/S . 10^(-Dn,e/10)	4.737E-05	7.51E-05	0.000306	9.89797E-06	2.16544E-06	7.17045E-06
Swi/S . 10^(-Rwi/10)	0.0002635	0.000526	4.18E-05	8.33333E-06	4.17656E-06	3.31756E-06
Sew/S . 10^(-Rew/10)	0.0001669	3.33E-05	1.05E-05	4.19229E-06	1.32572E-05	3.33005E-06
Srr/S . 10^(-Rrr/10)	1.23E-05	1.23E-05	1.23E-05	1.22977E-05	1.22977E-05	1.22977E-05
10log10(S/A)+3	5.9306107	4.883257	4.303338	4.303337685	4.583624921	4.583624921
Leq,2	35.733401	31.88881	26.89087	16.6093025	13.52111317	5.652659288
A-Weighting	-16.1	-8.6	-3.2	0	1.2	1
A-Weighted Leq	**19.633401**	**23.28881**	**23.69087**	**16.6093025**	**14.72111317**	**6.652659288**

A-Weigted Level Outside	**61**
BS8233 Predicted Internal A-Weigted Level	**28**
Prediced Building Envelope SRI	**33**

BS8233 Calculation can be seen below:

$$L_{eq,2} \approx L_{eq,ff} + 10\log_{10}\left(\frac{A_0}{S}10^{\frac{-D_{n,e}}{10}} + \frac{S_{wi}}{S}10^{\frac{-R_{wi}}{10}} + \frac{S_{ew}}{S}10^{\frac{-R_{ew}}{10}} + \frac{S_{rr}}{S}10^{\frac{-R_{rr}}{10}}\right) + 10\log_{10}\left(\frac{S}{A}\right) + 3$$