

Acoustic Associates Sussex Ltd

Environmental Noise Assessment for Planning Application

Site: Hampton Quay - Littlehampton
Client: Stolon Studio Limited

Report by: Martyn Chambers BA(Hons) TechIOA

Date: 27/09/19
Project: J2750



Acoustic Associates

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Sound Insulation Testing - Acoustic Design of Buildings - BS4142 - PPG24 - Schools Acoustics BS683 -
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1 Introduction

Acoustic Associates have been appointed to undertake an acoustic assessment ahead of a planning application on the land between the A259 and the River Arun in Littlehampton. The planned development will include residential properties, as well as residential moorings to the north of the site. There is also planned to be new commercial units on site.

The purpose of this assessment is to assess the following:

- Noise levels affecting the planned development.
- Provide mitigation proposals to show how the site can meet the acoustic guidelines relevant to the site.

Transportation 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:

- World Health Organisation (WHO) - Guidelines for Community Noise 1999
- ISO9613 (Attenuation of sound during propagation outdoors) 1996
- BS8233 (Sound insulation and noise reduction for buildings) 2014
- Pro-PG (Planning and Noise guidance) 2017
- BS4142: 2014 Methods for rating and assessing Industrial and commercial sound
- Sussex Planning Noise and Advice Document 2015

Mitigation methods summary

- In order to meet the requirements of BS4142: 2014, the $L_{A_{r,Tr}}$ shall not exceed 52 dB, at the nearest noise sensitive receptor, in the daytime and shall not exceed 32 dB during the night time period, unless the land is reassessed for specific locations on the site.
- In order to meet the requirements of Pro-PG:2017, BS8233:2014 and WHO:1999:
 - Plots facing the A259 to the south of the site have a building envelope Sound Reduction Index of at least 35dB.
 - In the mid-section of the site the maximum SRI required would be 32dB.
 - At locations to the north of the site the maximum SRI required would be 26dB
 - The report demonstrates that even at locations where the sound levels are predicted to be at the highest on the site, the required SRI can be achieved using off the shelf products.
- The report demonstrates that even with the current site layout WHO External Noise Criteria can be achieved. Building on the site will create 'shadow zones' where noise levels will be lower still.
- Prior to construction works commencing an assessment in accordance with BS5228 shall be undertaken, with a site noise management plan agreed with the local authority.

If the above mitigation methods are implemented then it is considered that planning permission would not likely be refused on noise grounds

2 Context

2.1 Site Description

The site is a strip of land between the A259 and the River Arun. The entrance to the site is from a roundabout, where a current access road leads onto the site. At the south of the site a road bridge goes over the River Arun.

Noise from the site comes nearly exclusively from road traffic noise. However, there is a railway that runs approximately 100m to the north of the site. Rail noise has little impact on the soundscape of the site due to noise from the traffic on the A259 and the distance from the site. Together these factors mean that even at the northern border, train passes are subjectively barely audible.

2.2 Existing Site Plan



Figure 1: Site Location Map

3 Criteria & Noise Assessment Methodology

3.1 BS8233: 2014 Noise Criteria

Table 1 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 LAeq,16hour	-
Dining	Dining Room/Area	40dB LAeq,16hour	-
Sleeping (daytime resting)	Bedroom	35dB LAeq,16hour	30dB LAeq,8hour

Table 1: BS8233 Criteria

3.2 WHO Internal Noise Criteria

The target internal levels are based on guidelines laid out by the World Health Organisation (WHO) and are as follows:

Room Type Target Maximum Internal Level - LAeq dB (A)

Living rooms 35 (Daytime only)

Bedrooms 30 (Night)

Room Type Maximum Internal Level – LAmax dB(A)

Bedrooms 45 (not more than 10-15 times per Night)

The target maximum internal noise level for a bedroom during the night time corresponds to the threshold of sleep disturbance. WHO state that the noise level outside a bedroom window would be less than 45dB(A) this assumes that an open window provides 15dB attenuation.

3.3 WHO External Noise Criteria

With regard to outdoor amenity areas WHO 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.

3.4 Noise Policy Statement for England (NPSE)

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".

3.5 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.

3.6 ProPG –Planning and Noise: 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 $L_{Aeq,15hr}$	-
Dining	Dining room/area	40 dB $L_{Aeq,15hr}$	-
Sleeping (daytime resting)	Bedroom	35 dB $L_{Aeq,15hr}$	30 dB $L_{Aeq,8hr}$ 45 dB $L_{Amax,15min}^{(1)}$ (max 2)

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 $L_{Amax,15min}$, 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 $L_{Amax,15min}$ 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 2: ProPG Criteria

3.7 BS4142: 2014: Methods for rating and assessing industrial and commercial sound

This document provides a means of assessing the impact of industrial or commercial sound upon nearby noise-sensitive receptors, including residential properties.

It does this by comparing the Rating Level of the noise from the industrial or commercial source with the pre-existent L_{90} background noise level affecting the same noise-sensitive premises. The Standard provides guidance that:

- a) Typically, the greater the difference, the greater the magnitude of the impact.
- b) A difference of around +10dB or more is likely to be an indication of a significant adverse impact, depending on the context.
- c) A difference of around +5dB is likely to be an indication of an adverse impact, depending on the context.
- d) The lower the rating level is relative to the measured background sound level, the less likely it is that the specific sound source will have an adverse impact or a significant adverse impact. Where the rating level does not exceed the background noise level, this is an indication of the specific sound source having a low impact, depending on the context.

3.8 Sussex Planning Noise and Advice Document 2015:

Sussex Planning Noise and Advice Document 2015 give the following guidelines for the comparison of plant compared to the measured background noise level:

- 2.2.1. The starting point for designing any industrial/ commercial development should be to minimise noise "as far as reasonably practicable". The rating level of the plant/process, when measured in accordance with BS4142:2014, should, where practicable, be no greater than the existing background levels when measured in accordance with BS4142:2014.

Figure 3: Sussex Planning Noise and Advice Document 2015

4 Road Noise Survey Baseline Conditions and Results

4.1 Baseline Conditions

- Survey carried out by:
 - Martyn Chambers BA (Hons) TechIOA
- Equipment used: 2 x Castle Mirus
- Weather conditions: Variable: (Wet and dry) Wind: variable direction sometimes greater than 3ms^{-2}

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

4.2 Survey Locations

A noise survey was carried out from the 11th July 2019 to the 17th of July 2019 in order to measure noise levels associated with the nearby A259 Road. Noise measurements were taken in two locations marked in the below plan.

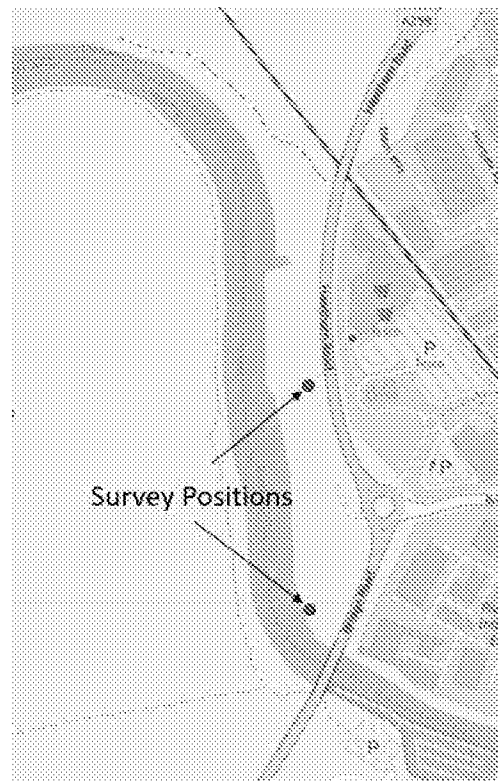


Figure 4: Survey Locations

The northern survey location was on top of the approximately 3m high bund that runs around that section of the site. The microphone was on top of a 2.5 pole secured to a fence. The readings taken at this location were all free field. A photo of the northern location can be seen below:



Figure 5: Northern Survey Location

The southern survey point was near the bank of the River Arun on a tripod around 2.5m high from the topography at the location. The readings taken at this location were all free field. A photo of the location can be seen below

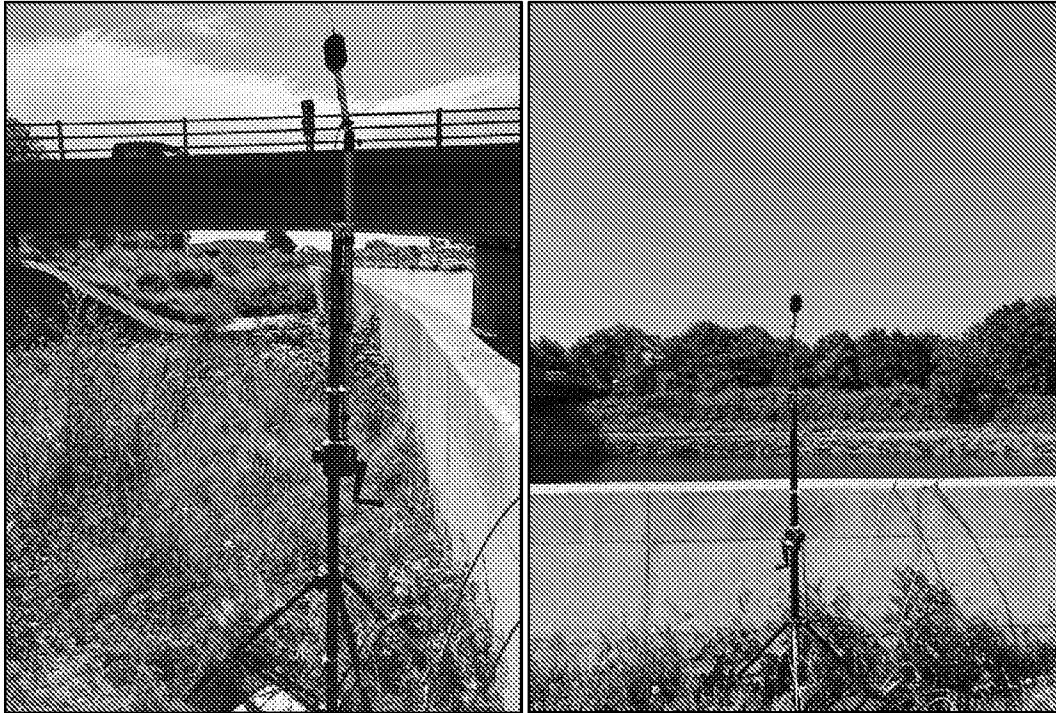


Figure 6: Southern Survey Location

4.3 Road Noise Survey Results

The survey data has been used to calculate the 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 positions.

Date July (2019)	Day	Time Period	Northern Survey L _{Aeq,16hr/8hr} dB(A)	Southern Survey L _{Aeq,16hr/8hr} dB(A)
12 th	Friday	07:00-23:00hrs	56.4	61.2
13 th	Saturday	07:00-23:00hrs	56.6	60.9
14 th	Sunday	07:00-23:00hrs	55.6	61
15 th	Monday	07:00-23:00hrs	56.6	61.8
16 th	Tuesday	07:00-23:00hrs	55.7	61.6
Average	All days	07:00-23:00hrs	56.2	61.3
11 th /12 th	Thurs/Fri	23:00-07:00hrs	51.4	57.9
12 th /13 th	Fri/Sat	23:00-07:00hrs	51.7	55.8
13 th /14 th	Sat/Sun	23:00-07:00hrs	50.6	55.1
14 th /15 th	Sun/Mon	23:00-07:00hrs	52.3	57
15 th /16 th	Mon/Tues	23:00-07:00hrs	52.8	57.9
16 th /17 th	Tues/Weds	23:00-07:00hrs	53.5	57.8
Average	All Nights	23:00-07:00hrs	52.1	56.9

Table 2: Survey Noise Level

5 Road Computer Noise Model

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 proposed development 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 first completed to allow the calibration of the noise source (road). The existing site model contained nearby buildings and the existing buildings.

The A259 was then added to the “Survey” noise model as line sources. The line sources day/night time sound power level was then adjusted until the level at the survey reception points (RP) matched the survey data in section 3. To ensure a robust report the worst-case day and night time readings were used in the model calibration process. The model can be found below:

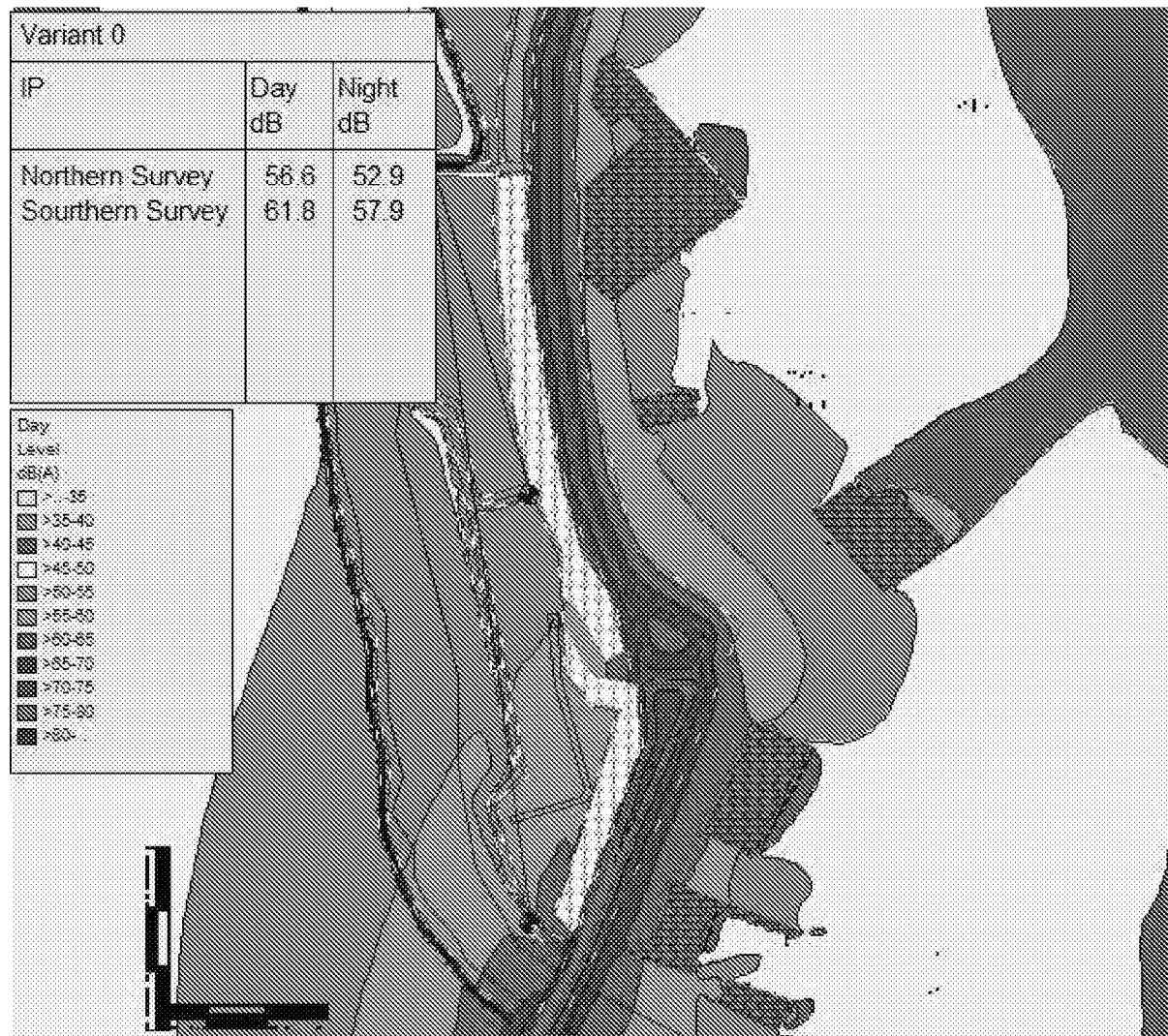


Figure 7: Noise Model

6 Railway Noise

Subjectively, while standing on the northern border of the site, which is the point nearest the railway line, the dominant noise source is still the road traffic noise, over which the train noise was barely audible. However, to ensure a robust assessment of the site a shortened train survey was conducted, and the worst-case Sound Exposure Level (SEL) value used to assess the impact from the railway line traffic on the site.

6.1 Noise Survey Results

At the northern boundary of the site, the noise from the train passes was not 10dB above the ambient noise level, so an assessment of train noise was impractical at this location. In order to measure the trains on this section of the line it was necessary to find a closer location.

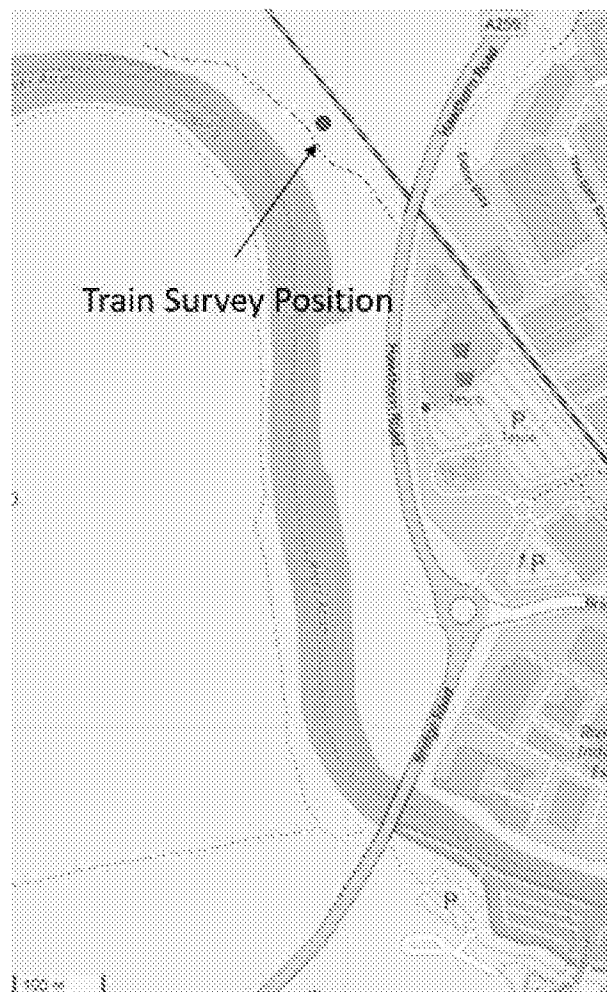


Figure 8: Train Survey Location

Unfortunately, during the day of the survey agricultural works were taking place at the location, which made obtaining representative measurements of train passes challenging. Of the measurements that were not corrupted by agricultural noise and were 10dB greater than the ambient noise level the worst-case levels were used. These are displayed in the table below.

Worse case SEL - dB(A)	
North	South
83.9	77.6

Table 3: Worse Case Train SEL

6.2 Train Timetable

Train timetable information for trains operating on this line were examined. Trains are operated by Southern Rail or Thameslink, the timetables that were downloaded and considered are valid from 14th May 2019 to 14th December 2019. Analysis of the timetables suggests the following train movements past the site.

Number of Trains			
East		West	
Day	Night	Day	Night
66	13	66	13

Table 4: Train timetable info.

6.3 Converting Sound Exposure Levels (SEL) to L_{Aeq} Levels (measurement position)

In paragraph 3 CRN states that having established, by measurement, the mean values for the SELs the day and the night time noise levels ($L_{Aeq,16hr}$ and $L_{Aeq,8h}$) can be calculated. The day and the night time period noise level relating to each train type can be calculated using the following formula

$$\text{Train Type } L_{Aeq, \text{ day/night}} = \text{SEL} - 10\log T + 10\log N$$

- N = no. of events in period (For each train type based upon timetable information)
- Day = 07:00-23:00hrs & Night = 23:00-07:00hrs
- T = no. of seconds in period (57600 seconds for the day and 28800 for the night)

6.4 Train Type Day/Night Noise Levels

Table 5 below shows the calculated results of the train type noise levels with the formula from 6.3 and the SEL's from Table 5 applied in each train operator and direction.

Train Type	Calculated L_{Aeq} Values dB(A)			
	North		South	
	Day	Night	Day	Night
Worse Case L_{Aeq}	54.5	50.4	48.2	44.1

Table 5: Train Type Day/Night Noise levels

6.5 Total Noise Level at Measurement Position

The noise levels detailed above can be added together (logarithmically) to show the total day and night time noise level at the measurement position for all trains in both directions. For daytime this would be $10 \cdot \log(10^{5.45} + 10^{4.82}) = 55.4 \text{ dB(A)}$.

- $L_{Aeq,07:00-23:00} = 55.4 \text{ dB(A)}$
- $L_{Aeq,23:00-07:00} = 51.3 \text{ dB(A)}$

6.6 Rail Computer Noise Model

A rail computer noise model was created using the same methodology as with the road model. A reception point (RP) was also added to the model at the northern edge of the proposed site (labelled Rail Test) so see the influence that the rail noise has on the sound scape at this location, which would be the location worst affected by rail noise. It is worth noting that the Rail Test RP is 16.4dB quieter than the Rail Survey RP. This attenuation will become important when discussing L_{Amax} events later in the report. The model can be seen below.

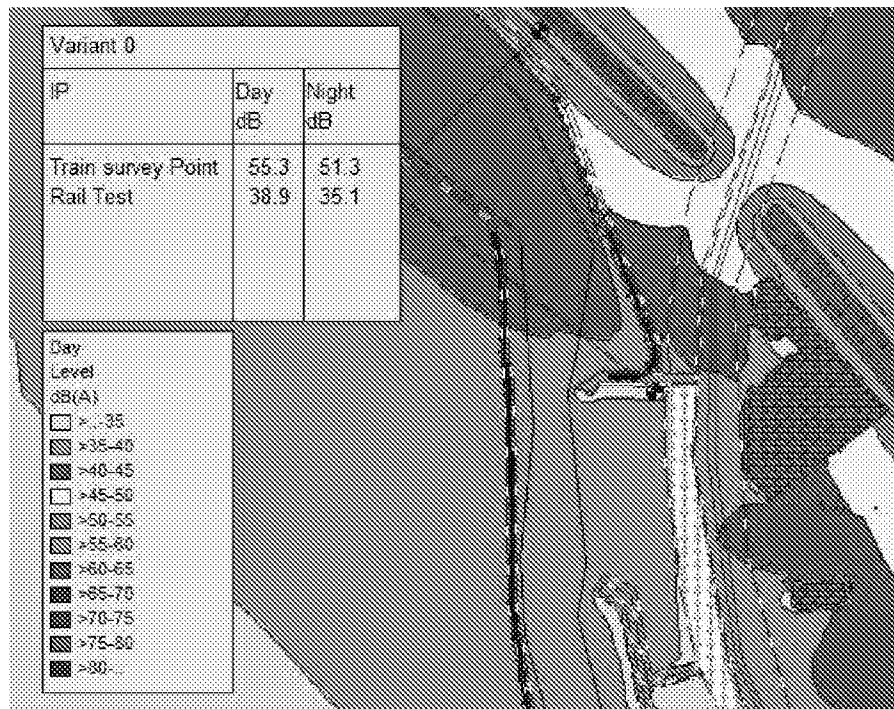


Figure 9: Rail Model

A joint road and rail survey was then constructed with a reception point added, to see what, (if any) effect adding the rail line source has on the survey RP's. As can be seen from the model below, despite the introduction of the rail line source, it has not affected the level at the two survey positions which remain the same level as the worst-case day and night measured L_{Aeq} levels during the survey. This shows that the model is working correctly and has been correctly calibrated. The combined railway and road traffic model can be seen below:

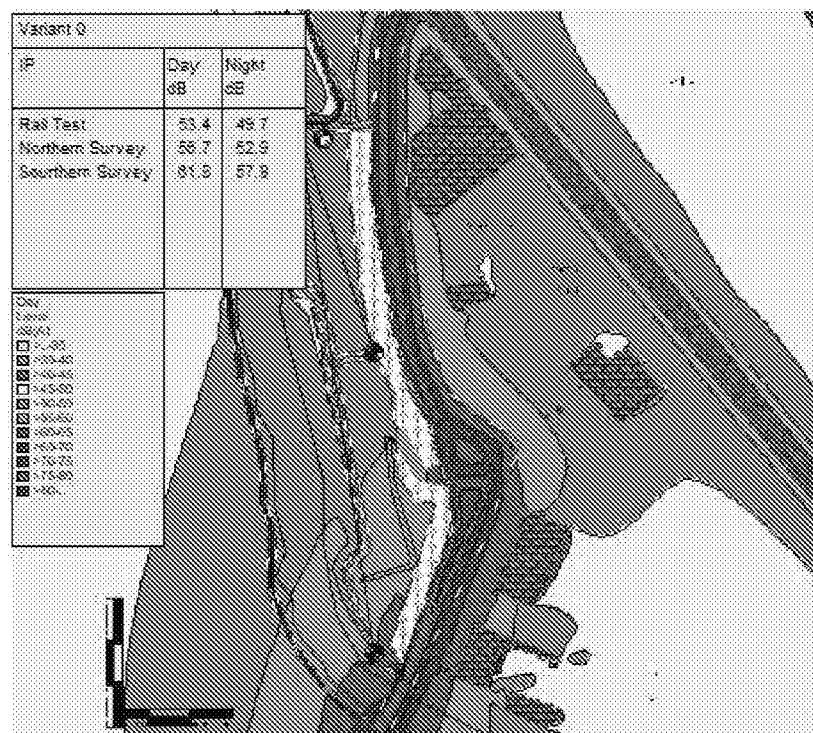


Figure 10: Rail + Road Noise Model

7 Future Traffic Movements.

7.1 Alterations to the A259

Currently the A259 is undergoing changes to its layout, which will have an effect on the roundabout where the site entrance is located. The planned changes are to add a dedicated flare for traffic moving east bound. Also, a dedicated flare allowing traffic to enter the Tesco industrial estate.

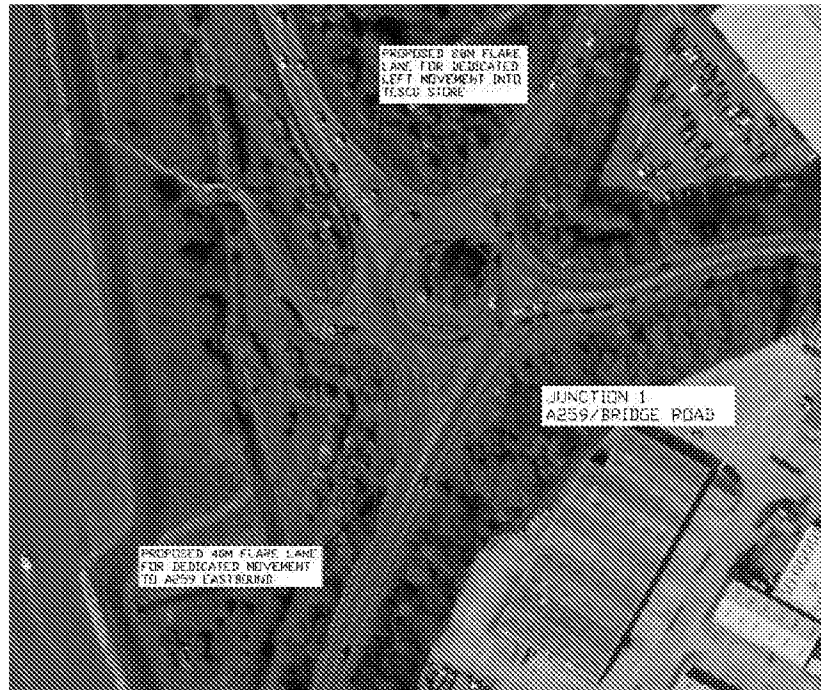


Figure 11: A259 Improvements

It is hard to detail exactly how these changes will affect the soundscape of the location; However, it is worth noting that the principles of acoustics dictate that doubling of a sound source provides a 3dB increase in sound levels. So, in this case a doubling of the volume of traffic, which in this case is the sound source, would result in a 3dB increase in sound levels at the site. While this is extremely unlikely due to the already high traffic levels at the location, in order to future proof the project and provide a worse-case scenario, 3dB will be added to the sound power levels of the A259 in the model as shown at the end of this section and all subsequent models.

7.2 Traffic Movements on Site

A robust assessment will also assess the effects of traffic movements within the site. Current plans are for the site to provide parking for up to 225 vehicles. The parking would will be located in enclosed parking under the new structures, due to the need for the ground floor levels of these buildings needing to be high enough to remove the risk of flooding. CRTN states that; *“Calculations of noise level for traffic flows below 50 veh/h or 1000 veh/18-hour day are unreliable and measurements and should be taken when evaluating such cases”*. As it is likely that the site in discussion will fall into this category, and it has not been possible to follow the recommendation within CRTN to take measurements on site, due to it not having been built yet. Assumptions are therefore needed in order to complete the assessment.

Assuming every parking space has a vehicle that departs and returns to site a maximum of 2 times, that would equal 900 vehicle movements. Then, consider additional 50 movements for deliveries and taxis. This adds up to 950 movements in a 24, hour period.

A reasonable assumption would mean a maximum approximation of 200 of these would happen over the 8-hour night time period. This leaves 750 movements in the day period.

All these vehicles movements will be distributed around the site, adding 2-line sources to the computer model, both entering the site from the turn off at the A259. Then split these line sources, with one heading to the north of the site, the other to the south. The sound power for each line source will be the equivalent of 350 vehicle movements during the day and 75 for the night, as this is half the number of discussed vehicle movements. The method for calculating these levels are detailed in the below sections.

7.2.1 Vehicle Noise Measurements

Noise measurements from a moving vehicle were conducted close to the Acoustic Associates Sussex office which had low background noise levels. The noise from an Audi A4 (2 litre diesel) was measured with air conditioning on full. For the drive by tests the noise from the vehicle was measured (free-field measurement at 5m from centre of vehicle) as the vehicle was passing and the time taken to manoeuvre into a marked 2.4m wide vehicle bay. The drive pasts were replicated a number of times. Details of the measurements can be found below:

Duration	Measured Level dB(A)
	SEL
19 Seconds	68.6
15 Seconds	69.9
15 Seconds	71.2
Average	69.9 (70)

Table 6: Vehicle Noise Measurements

Definitions of the terms above can be found below (Taken from BS8233:2014 and CRN,1995 respectively):

- $L_{Aeq,T}$ Is the value of the A-weighted sound pressure level in decibels (dB) of a continuous, steady sound, that within a specified time interval, T.
- Sound Exposure Level (SEL) is the level at a reception point which, if maintained for a period of 1 second, would cause the same A-weighted sound energy to be received as it is actually received from a given noise event.

7.2.2 Vehicle Noise Level

The measured SEL and the information regarding the number of vehicle movements can be used to predict the day (07:00-23:00hrs) and night (23:00-07:00hrs) time noise level ($L_{Aeq,day/night}$):

$$L_{Aeq, day/night} = SEL - 10\log T + 10\log N$$

- $N =$ no. of events (425) or (100) (as these are half the traffic flow numbers as discussed earlier in this section)
- $T =$ no. of seconds in period (57600/28800 seconds for the day/nights)

The predicted day and night time noise levels can be seen below:

$$L_{Aeq, day} = 70 - 10\log (57600) + 10\log (350) = 48.7 \text{ dB (A)}$$

$$L_{Aeq, night} = 70 - 10\log (28800) + 10\log (75) = 45.4 \text{ dB (A)}$$

As discussed, two-line sources will be calibrated using these sound levels applying the methodology discussed earlier in this report. These will be added to the model in the below section showing the possible affects that future traffic levels may have on the site.

7.3 Updated Site Noise Model

As discussed, the below model increases the sound power level of the A259 by 3dB as a worst-case measure to future proof the project against a rise in traffic levels. As detailed in the previous section, access roads have been added using the levels calculated. The routes of these access roads have been based on the below plan provided to Acoustic Associates.

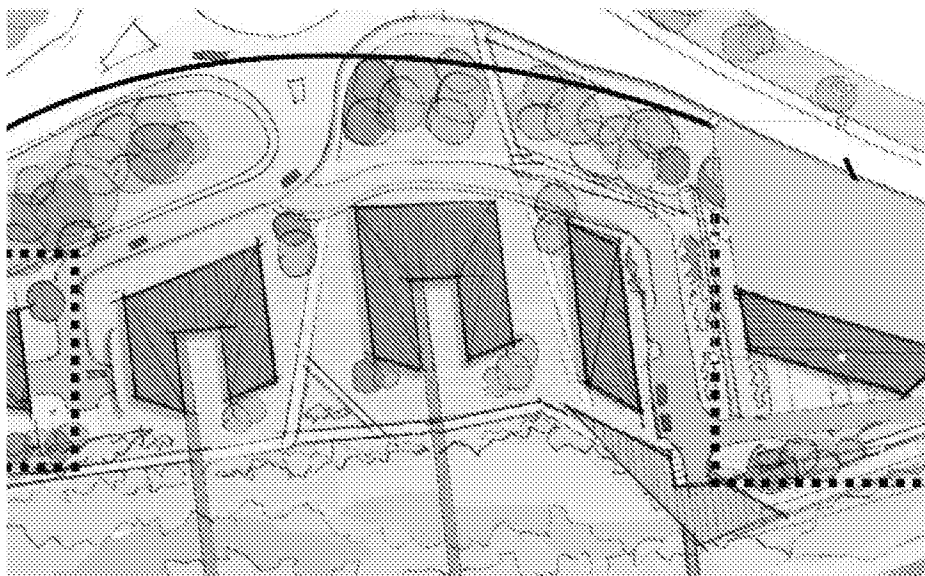


Figure 12: Access Roads

The impact of the additional traffic movements on site has been entered into the computer model and the increased sound level can be seen at the survey points.

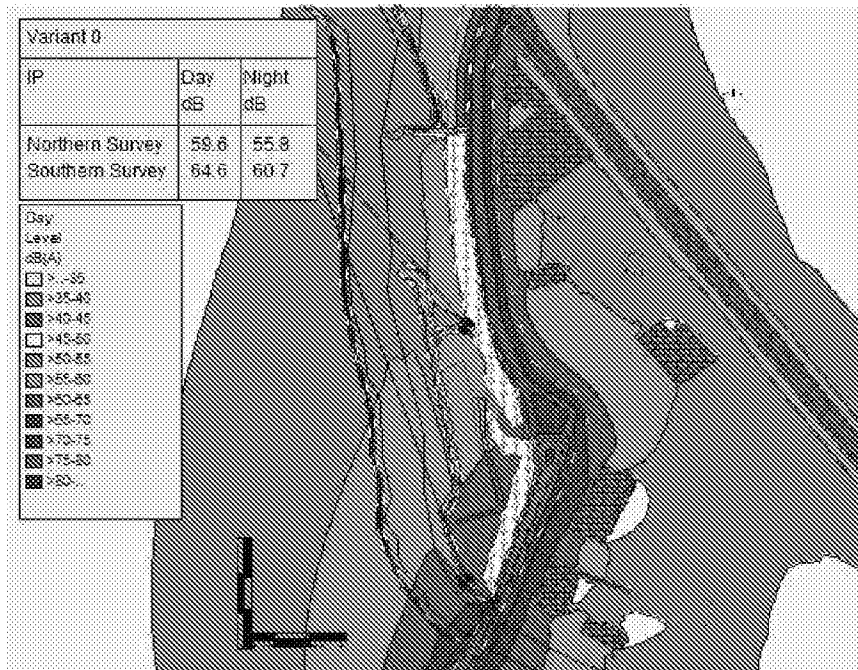


Figure 13: Future Traffic Model

8 Noise Mitigation Measures and Methodology

As at the time of the report writing the plans for the site have not been finalised by the client. The methodology the report proposes to use is to show how the noise levels from the various relevant criterion could be met at different locations throughout the site. Special consideration will be given to the areas of the site that have the highest predicted sound levels.

So far, the sound contours that have been shown in the computer model have been based around a relative height (it changes with contours of the map) of 1.5m. Acoustic Associates have been informed that due to the flood risk at the site the ground floor level will be 5.5m. So, the grid height for the calculations to show the areas with high sound levels will be also be relative to this. Reception points for what are likely to be the location of facades facing the A259 have then been added along the site. This model can be seen below:

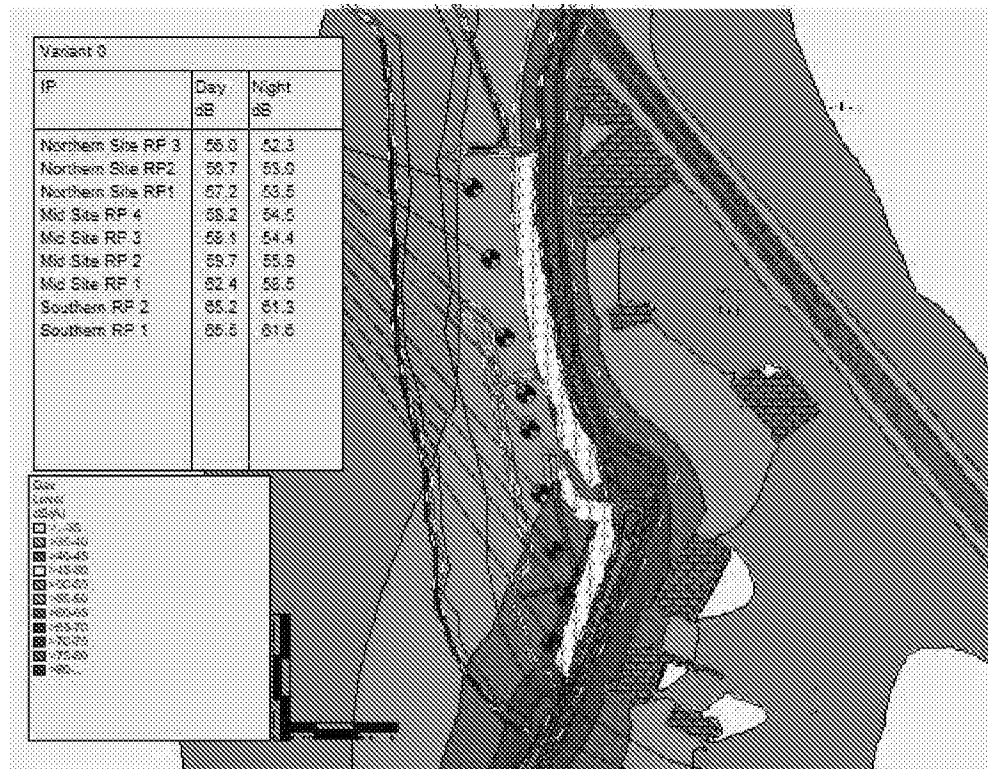


Figure 14: Representative Reception Points Model

8.1 Noise Criteria

8.1.1 Continuous Noise Levels

The BS8233 2014 and WHO noise criteria are applied to specify the noise mitigation measures for all habitable rooms. The maximum internal noise level for each area is as follows:

- Bedrooms (Day 35dB $L_{Aeq, 16hours}$ / Night 30dB $L_{Aeq, 8 hours}$)
- Lounges (Day 35dB $L_{Aeq, 16hours}$)

8.1.2 Road Noise Maximum Noise Levels

For L_{Amax} events the ProPG noise L_{Amax} 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 L_{AFmax} 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 L_{Amax} 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.

8.2 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 (L_{Amax} discussed in next sub section).

The table below shows the required Sound Reduction (SRI) which will have to be achieved by the building envelope, if we assumed that a worst-case reception point, which would be a bedroom, would be located at the location of each RP. Please note that the levels shown in figure 14 are free field levels in order make them facade levels we would need to add 3dB. This has been done in the below table.

Location	Ext. Noise Level Day	Criterion (Day)	Req SRI	Ext. Noise Level Night	Criterion (Night)	Req SRI
Southern RP 1	68.5	35.0	33.5	64.6	30.0	34.6
Southern RP 2	68.2	35.0	33.2	64.3	30.0	34.3
Mid Site RP 1	65.4	35.0	30.4	61.5	30.0	31.5
Mid Site RP 2	62.7	35.0	27.7	58.9	30.0	28.9
Mid Site RP 3	61.1	35.0	26.1	57.4	30.0	27.4
Mid Site RP 4	61.2	35.0	26.2	57.5	30.0	27.5
Northern Site RP 1	60.2	35.0	25.2	56.5	30.0	26.5
Northern Site RP 2	59.7	35.0	24.7	56.0	30.0	26.0
Northern Site RP 3	59.0	35.0	24.0	55.3	30.0	25.3

Table 7: Required SRI

As can be seen the worst-case living space using this premise would be the Southern RP 1. This location would require an SRI of 35dB (rounded from 34.6).

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

As discussed in the section above, for the worst-case location is Southern Reception Point 1, to achieve the continuous noise level criterion, the building envelope at the location would need to achieve an SRI of 35dB.

This level of SRI was used to calculate the number of $L_{Amax,5min}$ events in the worst-case bedroom. This was achieved by taking into account the difference between sound level at the survey point and the RP in question. Then subtracting the suggested SRI at these points and seeing how many $L_{Amax,5min}$ there would be in the bedrooms in question over a night time period (between 23:00 and 07:00).

Using this method, the below table shows the number of $L_{Amax,5min}$ over 45dBA for each night which the survey took place.

Reception Point	Night 1	Night 2	Night 3	Night 4	Night 5	Night 6	Average
Reception Point 1	4	1	0	1	2	2	2

Table 8: $L_{Amax,5min}$ with Suggested SRI of 35

Table 8 shows that even on the worse night the L_{Amax} criterion will be achieved if the building envelope SRI is derived from the continuous noise level results.

This calculation does not take into account L_{Amax} events that could possibly be caused by the rail noise. The worst case L_{Amax} measured from our train survey was 84dB. As stated in the section discussing train noise, we noted that the northern most point of the site receives 16.4dB more attenuation from train noise from the train survey location. Add in the 25dB SRI that the reception point nearest this location (Northern Site RP 3), requires to mitigate for continuous noise level. This will bring the L_{Amax} level from a train pass to 42.6dB measured inside a bedroom environment, below the criterion for L_{Amax} events.

10 Achieving the required SRI

The BS8233 “Rigorous Calculation” (detailed in BS8233, Annex G.2) is a method of predicting the sound attenuation provided by the fabric of a structure and subsequently the internal noise levels.

As at the time of the report writing the full layout and fabric of the buildings has not been finalised, to demonstrate the feasibility of the site we can use the example calculation within BS8233. This shows how an SRI of 31dB can be achieved, this would be satisfactory to all but the three southern reception points. To demonstrate the feasibility of achieving an SRI satisfactory for these locations a higher specification of glazing and trickle vent was entered into the calculation. For the higher specification glazing data for Pilkington 10-12-6 glazing was used and data from Venttec VT 301 trickle vent, though other products with similar levels of acoustic attenuation are available.

This calculation shows that even at locations where the sound levels are predicted to be at the highest on the site the required SRI can be achieved using off the shelf products. The full calculation can be seen in figure 15.

Non Frequency Dependent Variables			Key for Table Below	
Term	Derivation	Value	R _{wi}	Sound Reduction of Window (Octave)
A ₀	Given in BS EN 20140-10 = 10 (m ²)	10	R _{ew}	Sound Reduction Index of External Wall (Octave)
S _f	Total Facade Area (m ²)	40	R _{rr}	Sound Reduction Index of Roof/Ceiling (Octave)
S _{wi}	Window Area (m ²)	1.5	A	Equivalent Absorption Area of Rx Room
S _{ew}	External Wall Area (m ²)	8.5	D _{n,e}	Insulation of Trickle Vent (BS EN 20140-10)
S _{rr}	Ceiling Area (m ²)	2.5		
S	Total Area sound enters the room (m ²)	25		

Frequency Dependent Variables							
Term	Description	Octave Band Centre Frequency					
		125	250	500	1000	2000	4000
L _{eq,ff}	Free-Field External Noise Level	61.8	61.4	62.1	65.5	60.9	50.8
D _{n,e}	Venttec VT 301 vent	43	41	37	38	43	48
R _{wi}	10_12_6	26	27	34	40	38	46
R _{ew}	Sound reduction index (octave band value) of the external wall	40	44	45	51	56	56
R _{rr}	Sound reduction index (octave band values) of the roof/ceiling	28	34	40	45	49	49
A	Equivalent Absorption Area of Room (Copied from BS8233)	11.00	14.00	16.00	16.00	15.00	15.00

BS8233 Calculation Details							
Term From Equation Below		Octave Band Centre Frequency					
		125	250	500	1000	2000	4000
L _{eq,ff}		61.761618	61.39046	62.09927	65.45082988	60.89118257	50.79813278
A ₀ /S . 10 [^] (-D _{n,e} /10)		2.005E-05	3.18E-05	7.98E-05	6.33957E-05	2.00475E-05	6.33957E-06
S _{wi} /S . 10 [^] (-R _{wi} /10)		0.0001507	0.00012	2.39E-05	0.000006	9.50936E-06	1.50713E-06
S _{ew} /S . 10 [^] (-R _{ew} /10)		0.000034	1.35E-05	1.08E-05	2.70072E-06	8.54041E-07	8.54041E-07
S _{rr} /S . 10 [^] (-R _{rr} /10)		0.0001585	3.98E-05	0.00001	3.16228E-06	1.25893E-06	1.25893E-06
10log10(S/A)+3		6.5654732	5.51812	4.9382	4.93820026	5.218487496	5.218487496
L _{eq,2}		33.929148	30.02262	27.98738	29.15459849	21.11612537	5.999070388
A-Weighting		-16.1	-8.6	-3.2	0	1.2	1
A-Weighted L _{eq}		17.829148	21.42262	24.78738	29.15459849	22.31612537	6.999070388

A-Weighted Level Outside	68
BS8233 Predicted Internal A-Weighted Level	32
Predicted Building Envelope SRI	36

BS8233 Example Calculation with Improved Glazing & Vents

BS8233 Calculation can be seen below:

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

Figure 15: BS8233 Rigorous Calculation

10.1 Ventilation

Ventilation and glazing are inextricably linked, as whilst glazing may provide protection against sound levels incident on the façade, any ventilation strategy must not inadvertently compromise the protection and performance provided by the glazing.

Ventilation requirements are dictated by the Building Regulations and currently Approved Document F. It is therefore appropriate that your ventilation engineer or M+E consultant check the requirements and proposals of this particular report to ensure that the requirements of Approved Document F are met in respect of the rooms and in particular to ensure adequate background ventilation.

10.2 Outdoor Amenity Spaces

The criterion laid out in section 3.4 of this report for external amenity spaces states that outdoor living spaces should not exceed 55 dBA when measured over a 16-hour daytime period. In the model below, it shows that even in the current site layout, areas of the site are below this level.

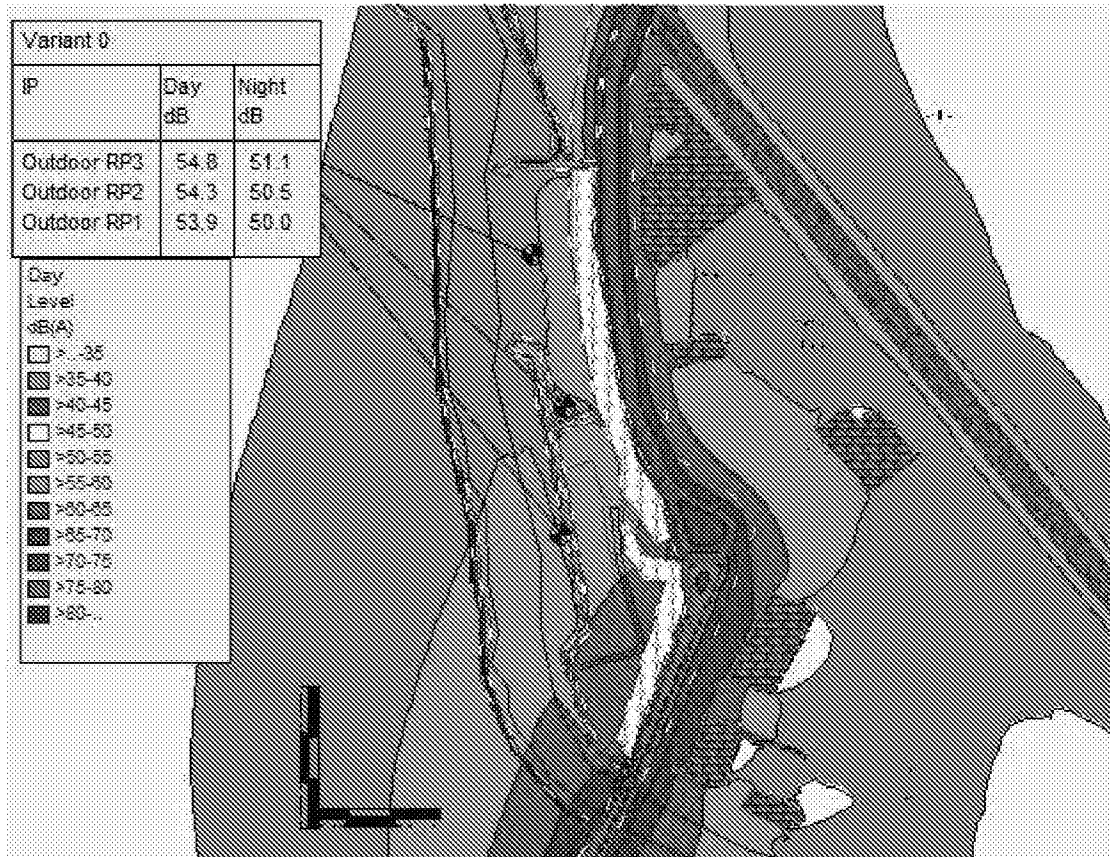


Figure 16: Outdoor Amenity Spaces

Please note the grid height of the above model is set at a relative 1.5m.

It is also worth noting that once construction is complete the buildings will act as a barrier creating 'shadow zones' where noise levels will be lower, and therefore more suitable for outdoor amenity spaces in these areas.

11 BS4142 Survey Results & Assessment

Currently it is not known what types and models of fixed plant would be introduced at the locations. This section of the report details what criterion would need to be in place for any fixed external plant installed at the site.

11.1 Weather Conditions

As is good practice, and in line with BS4142:2014, a weather station was co-located with the survey equipment and demonstrated that the meteorological conditions were adequate for environmental monitoring. In this case it was located alongside the northern survey location. The graph below shows the conditions experienced.

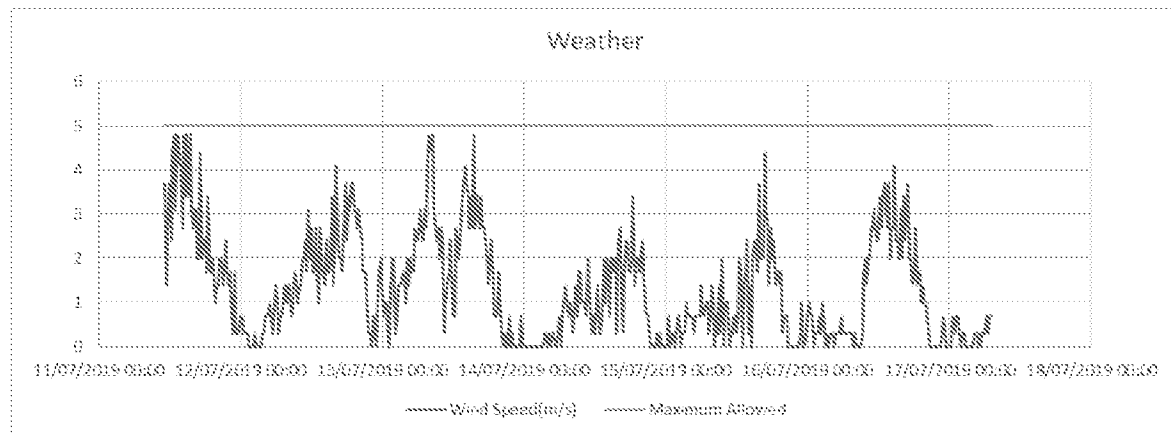


Figure 17: Weather Graph

11.2 Representative Background Sound Level

BS4142 states the following on page 11 (Note 1):

To obtain a representative background sound level a series of either sequential or disaggregated measurements ought to be carried out for the period(s) of interest, possibly on more than one occasion. A representative level ought to account for the range of background sound levels and ought not automatically to be assumed to be either the minimum/modal value.

Further statistical analysis has been completed to establish the most commonly occurring value for both the day time and the night time period. This was done for both the northern and southern survey locations

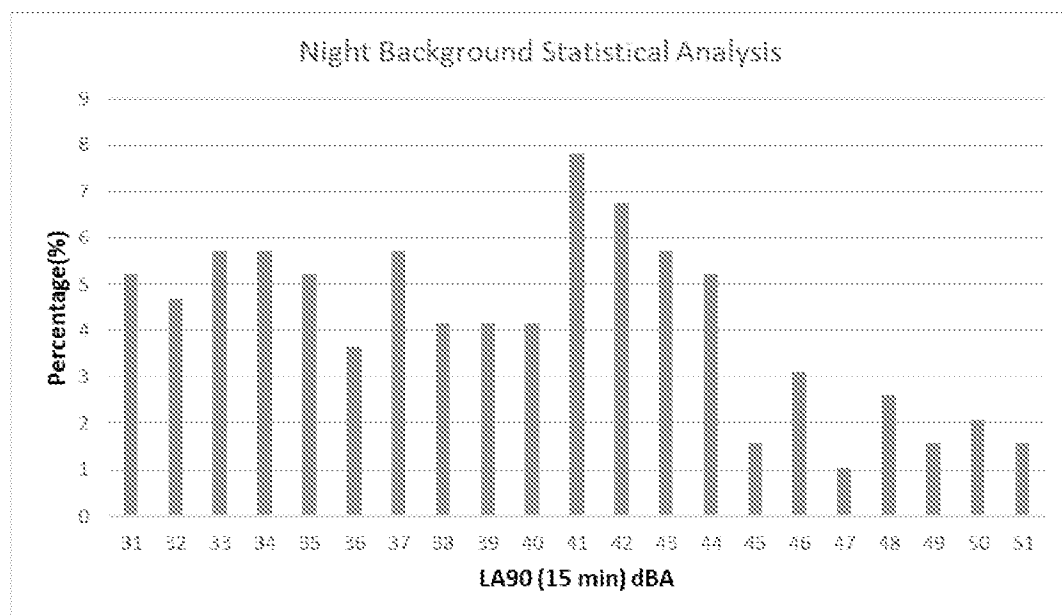


Figure 18: Northern survey Location night time background noise levels, 23:00-07:00 hours

The above figure shows that the background levels obtained through statistical analysis during this period, at the northern survey point, is likely to be 41dB LA90, 15mins.

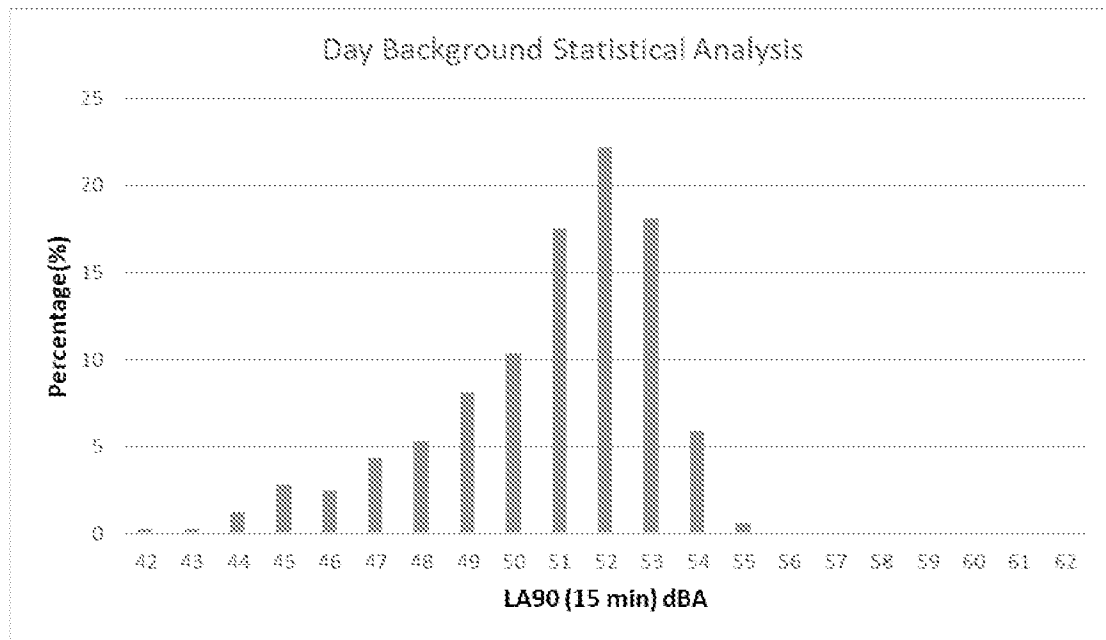


Figure 19: Northern survey daytime background noise levels, 07:00-23:00 hours

The above figure shows that the background levels obtained through statistical analysis (most frequently occurring) is likely to be 52dB LA90, 15mins.

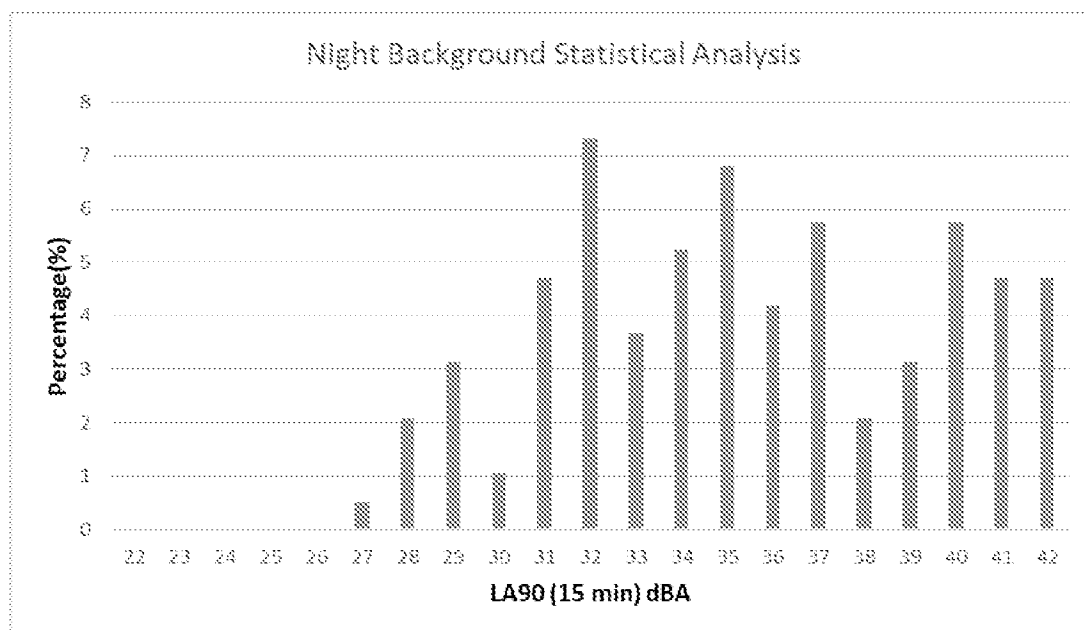


Figure 20 Southern survey Location night time background noise levels, 23:00-07:00 hours

The above figure shows that the background levels obtained through statistical analysis during this period, at the southern survey point, is likely to be 32dB LA90, 15mins.

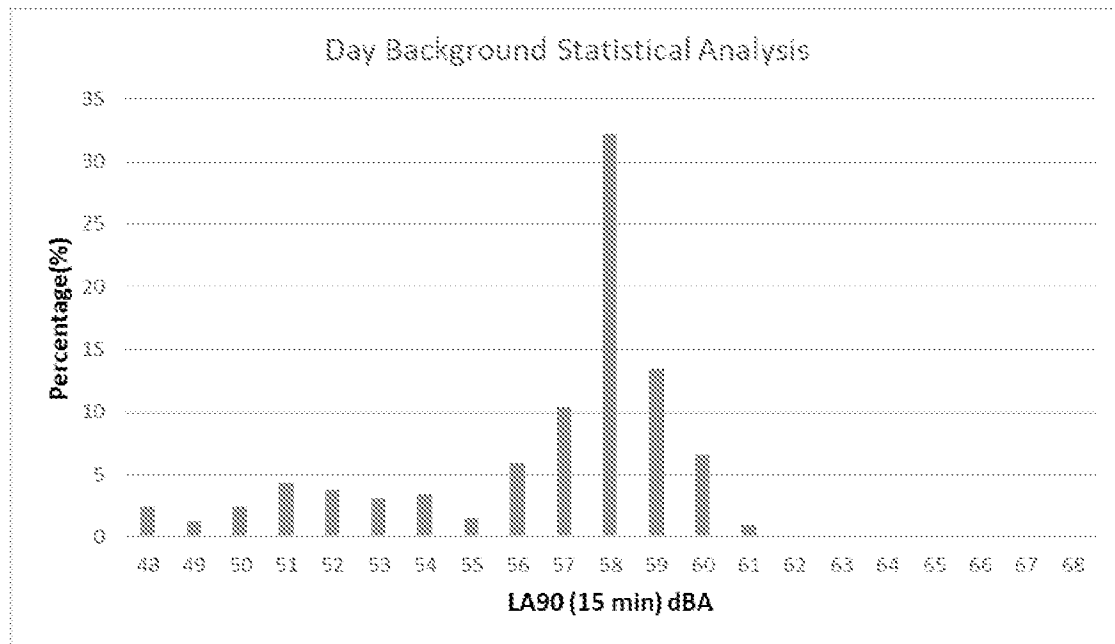


Figure 21: Southern survey daytime background noise levels, 07:00-23:00 hours

The above figure shows that the background levels obtained through statistical analysis (most frequently occurring) is likely to be 58dB $L_{A90, 15mins}$.

11.3 Summary and Discussion of L_{A90} Results

Location	07:00-23:00 hours, $L_{A90, 15mins}$	23:00-07:00 hours, $L_{A90, 15mins}$
Northern	52	41
Southern	58	32

Table 9: L_{A90} results summary

From the above tables and discussion in BS4142:2014 about the most frequently occurring background noise levels, the measured data demonstrates that at the northern survey point 52dB(A), $L_{A90, (15 mins)}$ may be acceptable to use as the representative background sound level for the daytime and 41dB(A) $L_{A90, (15 mins)}$ for the night time period. While at the southern survey point northern 58dB(A), $L_{A90, (15 mins)}$ may be acceptable to use as the representative background sound level for the daytime and 32dB(A) $L_{A90, (15 mins)}$ for the night time period.

Interestingly the $L_{A90 15mins}$, at the northern survey point is higher during the night time period than at the southern survey point, this is despite the fact L_{Aeq} is higher at the southern location. The probable reason for this is that as the level of traffic decreases over the night time period, other noise sources then play a factor in the soundscape. The northern survey point was approximately 70m from the Tesco garage at the opposite side of A259, it is possible that plant at this location is causing steady sounds that are raising the L_{A90} at the northern survey location.

To check this theory, with the modelling software we added a point source at the location of the Tesco garage and calculated the difference in levels from such a source at both survey locations. The result was a 9dB difference, the same as the difference between the L_{A90} 's for the locations.

11.4 Site Criterion for Fixed Plant

As at this stage the fixed plant that may be installed at the development and at which locations, is not known. To ensure that the Sussex Planning Noise and Advice Document 2015 criterion is met, the worst-case location for the statistical LA90 readings would need to be used as the rating levels. The rating level, including any penalties applied in accordance with BS4142:2014. Therefore, criterion for any fixed plant installed as part of this development rating level or $L_{A_{r,Tr}}$ shall not exceed 52 dB in the daytime and shall not exceed 32 dB during the night time period. The noise measurements shall be made at the nearest noise sensitive premises, ie a habitable room window.

12 Pro-PG(2017) Assessment

Pro-PG (2017) requires that an initial site risk assessment is produced to inform decision makers of the soundscape and what level of risk this presents for the development. The results of the risk assessment are seen in the below table indicating a low/medium risk.

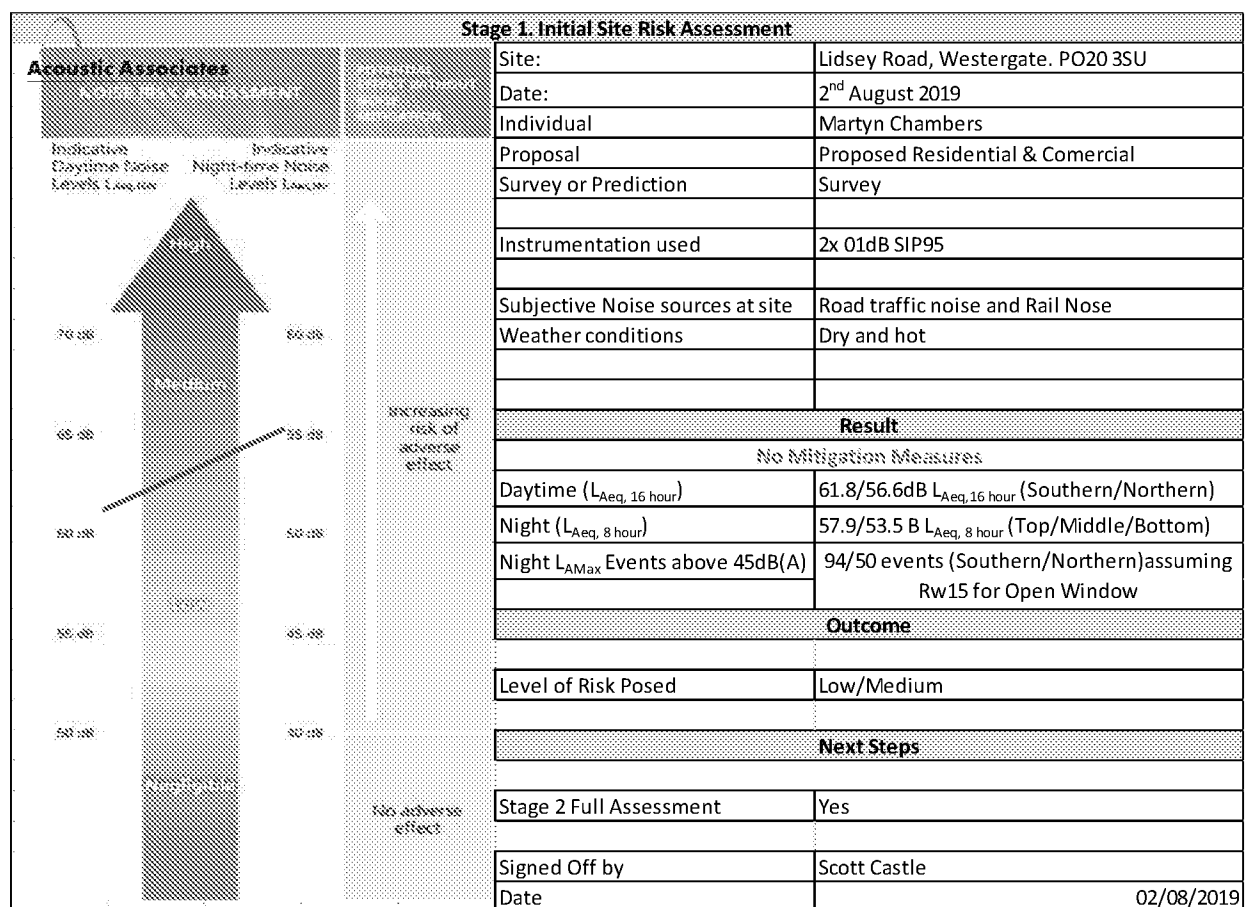


Figure 22: ProPG (2017) Initial Site Risk Assessment

ProPG (2017) also concerns good acoustic design, as such the following headings are applicable,

12.1.1 Element 1. Good Acoustic Design Process

While the assessment has been conducted to ensure the worst-case scenarios can be met, implementing good acoustic design will also help improve the living standards of those occupying the site. As such Acoustic Associates offers the following advice:

- Where possible design the plots so that the facades facing the A259 contains non-living spaces such as corridors/hallways bathrooms or store rooms. Avoiding placing bedrooms on the louder facades would be especially recommended.
- As discussed in Section 8.6 ensure that outdoor amenity spaces are created in areas where the new structures act as a barrier to the noise from the A259
- While the site is capable of achieving the relevant indoor criterion without a requirement for mechanical ventilation, if systems such as mechanical Ventilation with heat recovery(MVHR) are put in place at the site then the supply and extracts should be taken from the quieter facades.

12.1.2 Element 2. Internal Noise level guidelines

As demonstrated in section 8.4 the required internal noise levels in BS8233:2014 and ProPG2017 are capable of being met.

12.1.3 Element 3. External Amenity Area Assessment

As demonstrated in section 8.6 the required noise levels for outdoor amenity areas in the WHO External Noise Criterion are capable of being met.

12.1.4 Element 4. Assessment of other relevant issues

Element 4 may be broken down into the following headings with relevant narrative applied.

12.1.4.1 Compliance with relevant national and local policy

As discussed in sections 8 through 10 the criterion of BS4142:2014, Pro-PG:2017, BS8233:2014 and WHO:1999 are capable of being met.

12.1.4.2 Magnitude and extent of compliance with ProPG

It is considered that the requirements of the L_{Amax} events and good acoustic design contained within ProPG2017 have been met.

12.1.4.3 Likely occupants of the development

The homes will be designed for residential use.

12.1.4.4 Acoustic design v unintended adverse consequences

While good acoustic design is to situate the living spaces away from noise sources, at this location due to liner nature of the sound sources, and its close proximity to the River Arun, combined with the risk of flooding at the site, there is a risk that it may be too restrictive to situate all bedrooms on quieter facades. However, as has been discussed previously in this report even at the noisiest location, it is possible for relevant sound level criterion to be met.

12.1.4.5 Acoustic design v wider planning objectives

It is recommended that an assessment of construction noise in line with BS5228:2014 is undertaken before any development at the site takes place. Any assessment will need to take into account the ongoing works along the A259.

13 Discussion and Uncertainty

As this assessment has been completed while site plans have not been finalised. This report has taken the approach of assessing the site for its suitability to build from an acoustics perspective. To ensure a robust assessment this report has always assessed the worst-case scenario, for example using the worst-case day and night measurements or to adding 3dB for an unlikely doubling of traffic on the A259. The reality is that the site is likely to be quieter than what has been predicted.

14 Conclusion

Transportation 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:

- World Health Organisation (WHO) - Guidelines for Community Noise 1999
- ISO9613 (Attenuation of sound during propagation outdoors) 1996
- BS8233 (Sound insulation and noise reduction for buildings) 2014
- Pro-PG (Planning and Noise guidance) 2017
- BS4142: 2014 Methods for rating and assessing Industrial and commercial sound
- Sussex Planning Noise and Advice Document 2015

Mitigation methods summary

- In order to meet the requirements of BS4142: 2014, the $L_{A,T,r}$ shall not exceed 52 dB, at the nearest noise sensitive receptor, in the daytime and shall not exceed 32 dB during the night time period, unless the land is reassessed for specific locations on the site.
- In order to meet the requirements of Pro-PG:2017, BS8233:2014 and WHO:1999:
 - Plots facing the A259 to the south of the site have a building envelope Sound Reduction Index of at least 35dB.
 - In the mid-section of the site the maximum SRI required would be 32dB.
 - At locations to the north of the site the maximum SRI required would be 26dB
 - The report demonstrates that even at locations where the sound levels are predicted to be at the highest on the site, the required SRI can be achieved using off the shelf products.
- The report demonstrates that even with the current site layout WHO External Noise Criteria can be achieved. Building on the site will create 'shadow zones' where noise levels will be lower still.
- Prior to construction works commencing an assessment in accordance with BS5228 shall be undertaken, with a site noise management plan agreed with the local authority.

If the above mitigation methods are implemented then it is considered that planning permission would not likely be refused on noise grounds