

Land at
Providence Hill
Bursledon
Hampshire
SO31 8AU

Sound Level Assessment



May 2022

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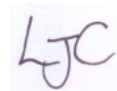
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1 Introduction and assessment brief

1.1 Introduction

Apple Environmental Limited has been commissioned to undertake a sound level assessment for the land adjacent to 4 Brookfield, Providence Hill, Eastleigh, in support of a proposed planning application for the development of the land for 16 new dwellings and a veterinary practice.

This work has been requested due to the close proximity of the A27 at Providence Hill, and the potentially high volume of traffic using the road on a daily basis. In addition to this, the M27 Motorway lies around 275m to the northeast of the site, at its closest, and Southampton Airport lies around 6.5km to the northwest at its closest. Both of these features could potentially be considered a noise nuisance also.

1.2 Aims and objectives

In order to address the above noise concern an assessment has been carried out in accordance with the Department for Communities and Local Government National Planning Policy Framework 2021, and with reference to other guideline documents as detailed below in Section 2 and Section 6. In addition to this, reference has been made to the City of Southampton Local Development Plan.

The overall aim of this work therefore is to determine the extent to which the proposed development may be affected by the general ambient sounds in this area.

The objectives therefore are as follows:

- to identify all dominating sound source(s) at the site;
- to undertake continuous 48-hour monitoring for the determining of day-time and night-time noise levels;
- to undertake a 1/3 octave analysis at each monitored location to ascertain dominant sound frequencies and other characteristics such as tonality;
- to determine the impact from any identified sound sources on the proposed residential development; and
- to make recommendations accordingly.

2 Relevant guidance

2.1 Overview

Since the revocation of Planning Policy Guidance 24 (PPG24), the National Planning Policy Framework (NPPF) has been introduced - and subsequently revised in July 2021. This document provides some general guidance to local authorities on considering the impact of noise in planning and policy decisions. This includes guidance for local authorities, in which they should ‘...aim to avoid noise from giving rise to significant adverse impacts on health and quality of life as a result of new development’.

No specific guidance is provided in the NPPF on acoustic criteria, therefore the British Standard 7445-1:2003 ‘Description and measurement of environmental noise – Part 1: Guide to quantities and procedures’ has been consulted for guidance on the noise measurement parameters required to undertake a suitable assessment.

In addition to this, the British Standard 8233:2014 ‘Guidance on sound insulation and noise reduction for buildings’ has been used to determine acceptable noise criteria within dwellings. The World Health Organisation Night Noise Guidelines for Europe, 2009, and Guidelines for Community Noise, 1999, have also been referred to. Where relevant, elements of each have been discussed below.

2.2 British Standard 7445-1:2003

Part 1 of the British Standard 7445-1:2003 defines the basic quantities required for the description of noise in community environments and describes basic procedures for the determination of these quantities. It provides guidance on the positioning of instrumentation including the distance from the exposed building and the preferred height of the microphone as well as detailing measurements to be taken during preferable meteorological conditions.

2.3 British Standard 8233:2014

British Standard 8233:2014 has reviewed and amended the former 1999 standard. As before, it sets out guidance on desirable internal ambient noise levels for dwellings. Table 1 below summarises the recommended acoustic design criteria for a dwelling.

Table 1 BS 8233:2014 desirable acoustic design criteria for good standard

Location	Internal noise level	
	Daytime	Night time
Living room	35dB $L_{Aeq, (16hr)}$	-
Dining room	40dB $L_{Aeq, (16hr)}$	-
Bedroom	35dB $L_{Aeq, (16hr)}$	30dB $L_{Aeq, (8hr)}$

It is therefore generally recommended that for a dwelling, acceptable internal noise levels during the daytime should not exceed 35dB $L_{Aeq,16hr}$, and during the night time, noise levels of 30dB $L_{Aeq,8hr}$.

In addition to the above, BS8233 also states that where development is considered desirable or necessary then despite external noise levels exceeding these guidelines, the internal target may be relaxed by up to 5dB and reasonable conditions can still be achieved.

The standard also reiterates the fact that it is desirable that noise levels in outdoor amenity areas such as gardens and balconies do not exceed 50dB $L_{Aeq,T}$ and that 55dB $L_{Aeq,T}$ should be regarded as the upper limit. However it also states that this may not be achievable in some areas, such as city centres, and that a compromise between noise and the convenience of living in these areas can be met.

2.4 WHO Night Noise Guidelines for Europe, 2018

The WHO Night Noise Guidelines for Europe have published guidelines for night time noise based upon exposure effects relationships which take into account the effects of noise on public health and wellbeing when sleeping.

The night noise guideline values are recommended for the protection of public health from night noise and are shown below in Table 2.

Table 2 WHO recommended night noise guidelines for Europe

Guideline	Noise level
Night noise guideline (NNG)	$L_{\text{night, outside}}$ 40dB(A)
Interim Target (IT)	$L_{\text{night, outside}}$ 55dB(A)

For the primary prevention of subclinical adverse health effects related to night noise in the population, it is recommended that the population should not be exposed to night noise levels greater than 40dB(A) of $L_{\text{night, outside}}$ during the part of the night when most people are in bed.

The lowest observed adverse effect level (LOAEL) of night noise, 40dB(A) $L_{\text{night, outside}}$, can be considered a health based limit value of the night noise guidelines (NNG) necessary to protect the public, including most of the vulnerable groups such as children, the chronically ill and the elderly, from the adverse health effects of night noise.

An interim target (IT) of 55dB(A) $L_{\text{night, outside}}$ is recommended in the situations where the achievement of NNG is not feasible in the short term for various reasons. It should be noted that the interim target is not a health-based limit value by itself. Vulnerable groups cannot be protected at this level. Therefore, the interim target should be considered only as a feasibility-based intermediate target which can be temporarily considered by policy-makers for exceptional local situations.

2.5 WHO Guidelines for Community Noise, 1999

The WHO Guidelines for Community Noise also consider the impact of night-time exposure to noise and sleep disturbance, such that if negative effects on sleep are to be avoided, the equivalent sound pressure level ($L_{\text{Aeq, 8hr}}$) should not exceed 30dB indoors for continuous noise.

If the noise is not continuous, sleep disturbance correlates best with L_{Amax} and effects have been observed at 45dB or less. These guidelines state that this is particularly true if the background level is low. Noise events exceeding 45dB(A) should therefore be limited where possible.

More specifically, the document states that 10 to 15 occurrences per night that exceed the limiting L_{Amax} external noise level of 45dB may be considered acceptable.

For sensitive groups, an even lower limit would be preferred but this value is not specified. It also declares that it should be possible to sleep with a bedroom window slightly open (resulting in a reduction of 15dB(A) from outside to inside). To prevent sleep disturbances, the equivalent sound pressure level and the number and level of sound events should be considered. Mitigation targeted to the first part of the night is believed to be effective for the ability to fall asleep.

The WHO Guidelines for Community Noise are considered to be complimentary to the WHO Night Noise Guidelines for Europe.

2.6 The City of Southampton Local Development Plan

This is a collection of local adopted plans, one of which includes the Local Plan Review (amended 2015). The Plan is confident that the vast majority of the adopted policies are in conformity with the NPPF. Noise issues are specifically covered within Policy SPD16, which states that:

- (i) noise-generating development will not be permitted if it would cause an unacceptable level of noise impact;
- (ii) noise-sensitive development will not be permitted if its users would be adversely affected by significant noise from existing or proposed noise-generating uses.

Residential development is considered to be a noise-sensitive feature, for which the Local Plan special measures will be necessary for all noise sensitive developments located adjacent to the main arterial road routes into the city.

2.7 The Calculation of Road Traffic Noise 1988 (CRTN)

CRTN provides general guidance on the direct measurement of road traffic noise in which L_{A10} (18hr) values are generally referred to. In situations where road traffic noise is clearly dominant and relatively consistent the guidance allows for a shortened assessment to be undertaken, in which arithmetic average values can be obtained over three consecutive 1 hour periods between 10.00H and 17.00H.

In doing so the L_{A10} (18hr) value can be supplemented for a L_{A10} (3hr) - 1dB. This in turn can be converted to a day-time L_{eq} by means of the following: L_{Aeq} (16hr) = L_{A10} (18hr) - 2dB.

In this specific instance the application of this means of assessment was not deemed to be entirely appropriate, due principally to the fact that previous monitoring undertaken in this location had identified the night-time period as being equally concerning as the day-time.

2.8 Professional Practice Guidance on Planning and Noise 2017 (ProPG)

The Professional Practice Guidance: Planning & Noise (ProPG) was published in 2017 by the Association of Noise Consultants (ANC), the Institute of Acoustics (IOA) and the Chartered Institute of Environmental Health (CIEH). It aims to provide guidance on noise during the planning stage for new residential development and provides a standardised approach to assess the suitability. It is not the purpose of this guidance to replace that which is in the NPPF, although it does significantly expand on the noise policies within that framework.

The first step of a ProPG assessment is to measure noise levels around a receptor site in order to understand the noise climate. Once this is completed, it sets out various assessment risk-based routes which are dependent on those noise levels. It is important to note that ProPG is generally applicable to transport noise only, and should not be used to assess industrial noise.

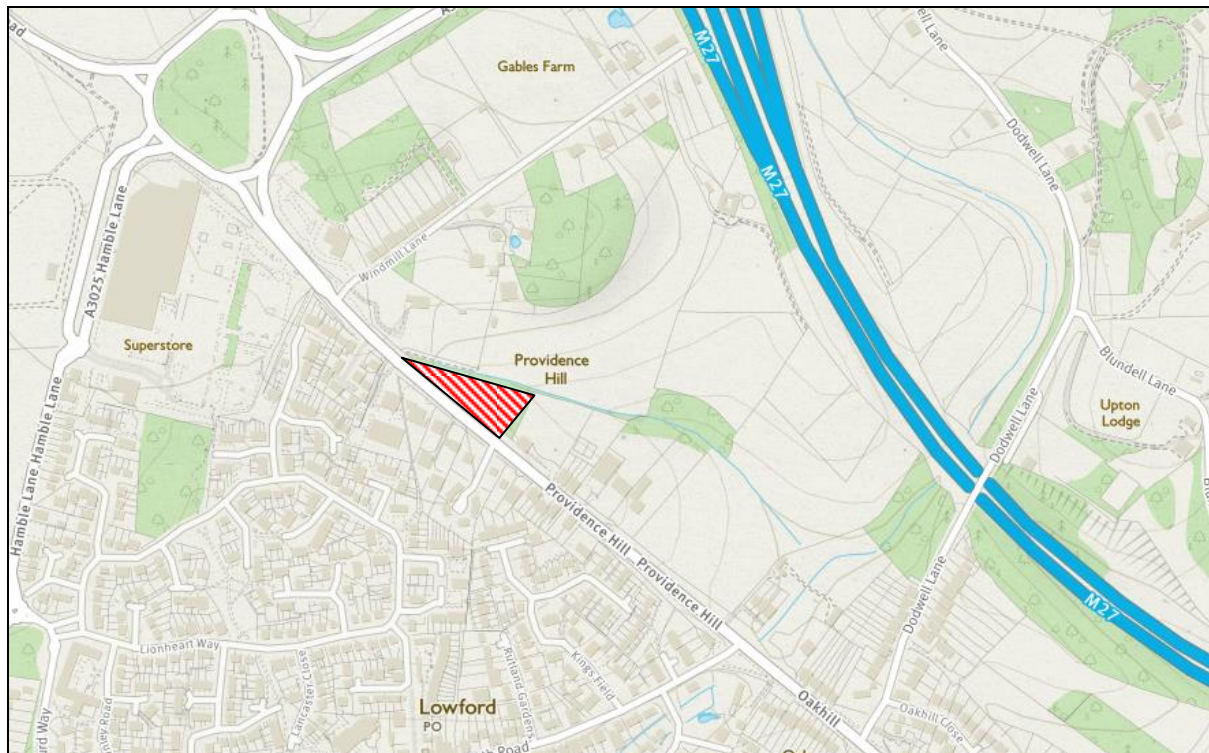
3 Site description

The site to which this assessment relates exists as a largely unused area of vegetated land, located within a predominantly residential part of Bursledon. The site slopes steeply down from Providence Hill, and essentially lies within a valley. At its lowest point the site is around 10m lower than the road. The land subsequently ascends steeply away northwards up from the site, towards the direction of the M27 motorway.

The site is entirely soft landscaped, being surrounded on all sides by trees. At the time of undertaking this assessment in March 2022 the trees were only partially in leaf, although the boundary vegetation was still fairly dense to a height of around 1.2m.

Providence Hill to the immediate south of the site also slopes steeply downhill. Other than private driveways and Windmill Lane (no-through access road), there were no through-roads leading off Providence Hill in the vicinity of the site. The nearest potentially influential feature is the Windhover Roundabout, some 270m to the northwest of the site at its closest. The site is shown below in Figure 1.

Figure 1 The location of the proposed development site



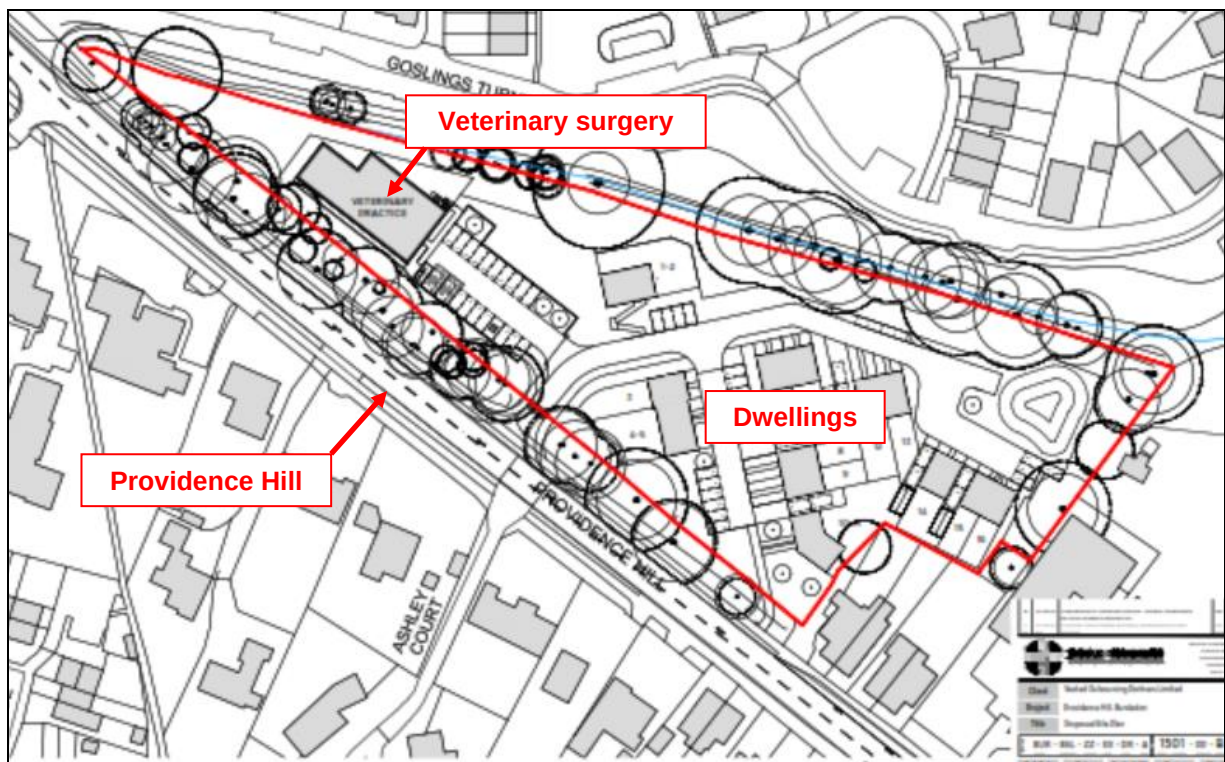
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Site 

4 Development proposal

This report has been prepared in support of the proposal to redevelop the site for the introduction of 16 new dwellings and a commercial veterinary surgery, with access coming from the northern side of Providence Hill. The proposed layout has been shown below in Figure 2.

Figure 2 The proposed development



The proposed layout of the dwellings has been indicated below more clearly below in Figure 3.

The estimated distance from the southwest façade of each of these dwellings to the Providence Hill carriageway edge has been shown below in Table 1.

Figure 3 The proposed positioning of dwellings



Table 1 The estimated distance of each proposed dwelling to the road edge

Dwelling No.	Approx. distance from carriageway edge /m	Dwelling No.	Approx. distance from carriageway edge /m
1	40	9	28
2	40	10	22
3	25	11	20
4	22	12	42
5	20	13	48
6	44	14	52
7	48	15	54
8	30	16	56

5 Survey methodology

This report aims to determine the expected impact of traffic-related sound, on the proposal site principally from traffic using the adjacent Providence Hill, in accordance with the requirements of the National Planning Policy Framework, and through reference to appropriate guidelines detailed within BS8233:2014.

The assessment itself has been based upon values obtained during a 48-hour measurement period, obtained from a single position close to the site boundary. This was performed from 07.00H on the 17th March 2022 through to 07.05H on the 19th March 2022. The road surface was dry throughout this period.

A-weighted, fast-response noise readings were taken throughout by means of a Cirrus Optimus CR171B Class I integrating sound pressure level meter. This was calibrated prior to and following use at 94dB using a CR151 Cirrus Acoustic Calibrator. The instrumentation details and serial numbers are as shown below in Table 3. The calibration documentation for each have been appended to this report.

Table 3 Sound level instrumentation used

Equipment	Description	Serial No.
Cirrus Optimus CR:171B	Class 1 sound level meter with 1/3 octave frequency analyser	G068537
Cirrus Acoustic Calibrator CR:151	IEC 60942.2003 Class 1 calibrator	70846

The microphone of the sound level meter was positioned at an approximate height of 1.8m, and at an approximate distance of 15m from the road carriageway edge. More specifically, the microphone was secured onto one of the vertical branches of a sapling by means of an extension lead.

The measurement position was fairly sheltered, and there were very few leaves on the branches of the sapling, nor any nearby flat surfaces. As such, the measured values were unlikely to have seen any significant influence from its surroundings.

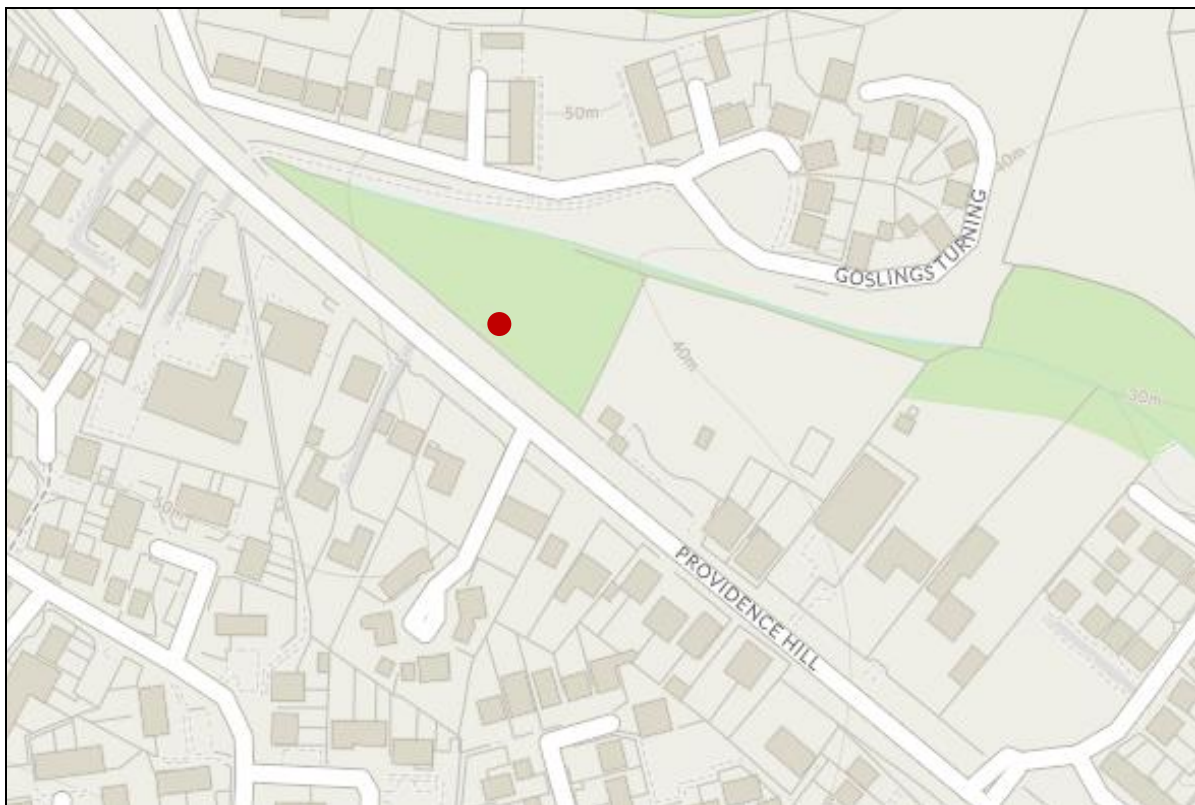
The ground surface at this point was heavily covered with low-lying vegetation, typified by other saplings and brambles. Despite the southwestern boundary of the site being tree-lined, the trees were only partially in leaf, such that there was a semi-clear line of sight from the measurement position through to the traffic using the road.

The road is used by all types of vehicles; however a recent study (undertaken for an air quality assessment) has indicated that cars were found to make up around 92% of the vehicle movements, with heavy vehicles accounting for less than 1% of the total daily movements.

The approximate location of the measurement point has been shown below in Photograph 1, and indicated on the site plan, Figure 4.

The mean weather conditions throughout the monitoring period have also been recorded, and detailed below in Section 5.

Figure 4 Sound level monitoring position



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● Measurement position

Photograph 1 The location of the instrument as viewed from the road



6 Monitoring results

A 48-hour assessment was undertaken over a continuous period running from 07.00H on Thursday 17th March 2022 through to 07.00H on Saturday 19th March 2022.

The measurement parameters obtained are reproduced below in Table 6. These have been shown as a day-time period of 18 hours on Day 1 from 07.00H through to 23.00H, followed by a night-time period of 8 hours from 23.00H on Day 1 through to 07.00 on Day 2, and then a day-time period of 18 hours on Day 2 from 07.00H through to 23.00H, and finally a second night-time period from 23.00H through to 07.00H on the third day.

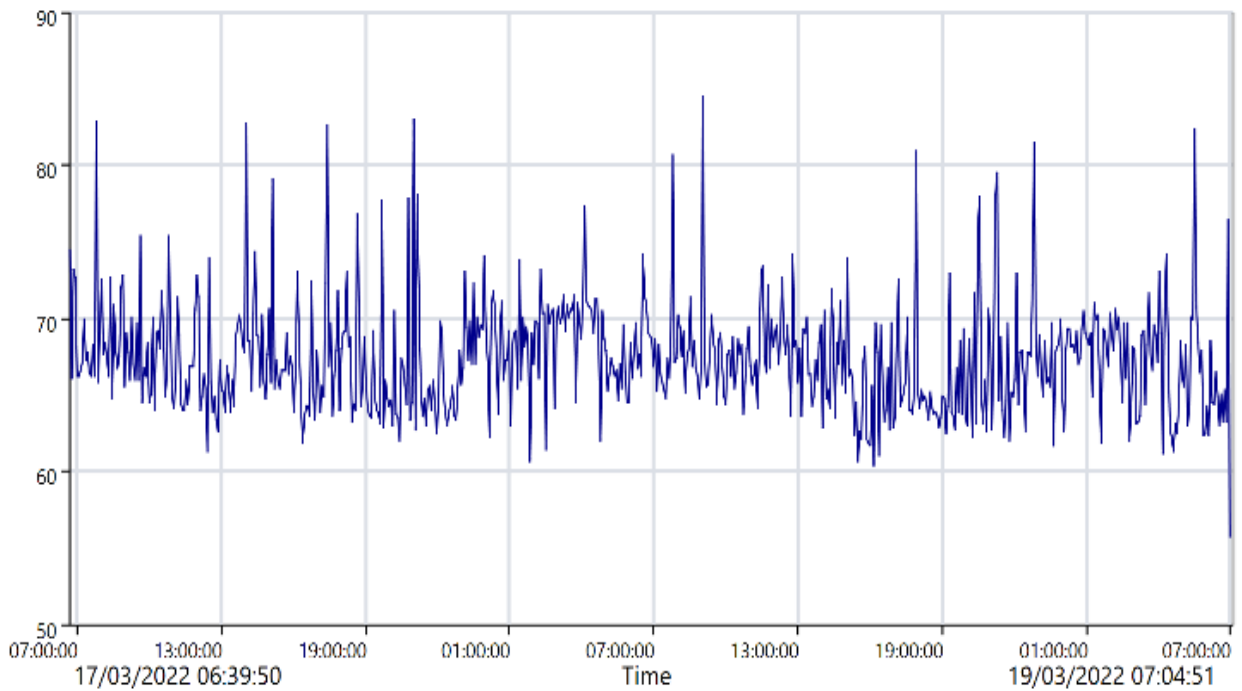
The table below includes the L_{Aeq} measurements for each of the above periods, along with the L_{Amax} reading and the 10th highest L_{Amax} reading, and a range of percentiles.

Table 6 Adjusted sound level readings - 48 hour assessment

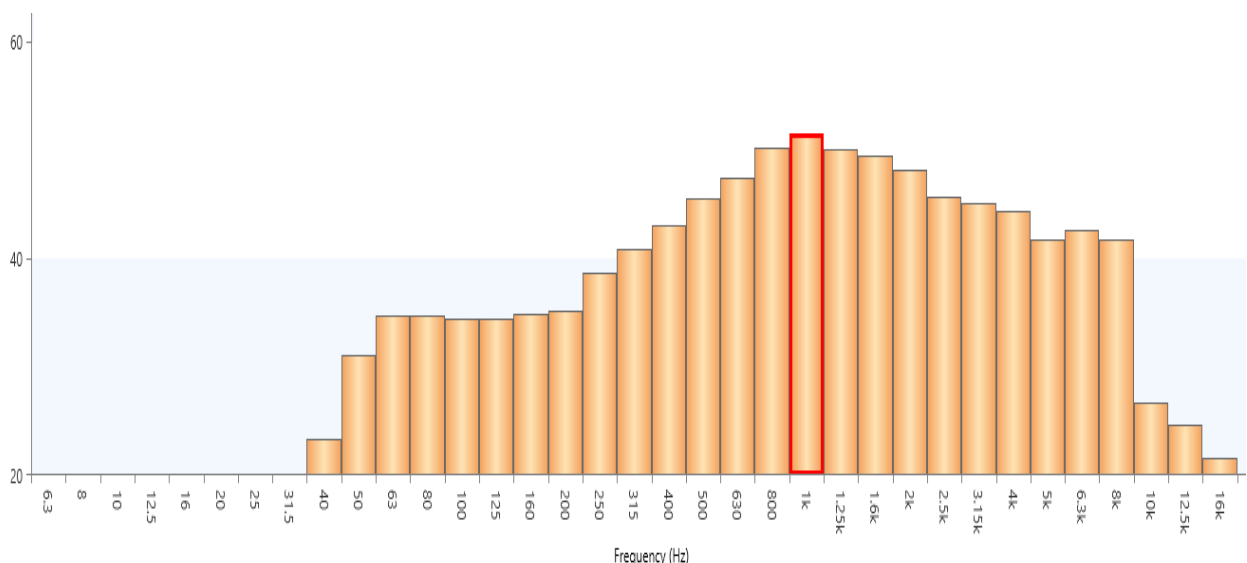
Parameter	Day-time 1	Night-time 1	Day-time 2	Night-time 2
	07.00H - 23.00H /dB	23.00H - 07.00H /dB	07.00H - 23.00H /dB	23.00H - 07.00H /dB
L_{Aeq}	59.3	57.7	59.6	56.8
L_{Amax}	86.9	79.0	86.7	86.3
10 th highest L_{Amax}	71.6	74.3	77.0	72.3
L_{A1}	68.3	69.7	68.9	69.6
L_{A5}	64.5	65.3	64.5	63.4
L_{A10}	63.3	63.1	63.1	61.2
L_{A50}	59.0	54.4	59.3	53.0
L_{A90}	51.2	43.9	53.9	45.3
L_{A95}	48.8	42.3	52.6	43.9
L_{A99}	44.5	40.0	50.4	41.4

A plotted profile showing the $L_{Aeq(24H)}$ trend throughout the entire continuous monitoring period has been reproduced below in Graph 1. Again, 1/3 octave band analyses were also obtained from the entire monitoring period, the results from which are reproduced below in Graph 2.

Graph 1 L_{Aeq} measurement profile over the complete 48-hour period



Graph 2 1/3 octave band profile for the 48-hour measurement period



The weather data obtained throughout the measurement period has been reproduced below in Table 7. As shown, the conditions were generally stable with regards to temperature, wind and rainfall throughout the three one-hour periods.

Table 7 Weather conditions throughout the measurement period

Date and Time	Mean temperature	Rainfall total	Mean wind direction	Mean wind speed
Thursday 17.03.2022 06.00H - 12.00H	12°C	0.0mm	Southwest	1.7m/s
Thursday 17.03.2022 12.00H - 18.00H	13°C	0.0mm	Southwest	3.3m/s
Thursday 17.03.2022 18.00H - 00.00H	10°C	0.0mm	Southwest	1.3m/s
Friday 18.03.2022 00.00H - 06.00H	1°C	0.0mm	North	0.4m/s
Friday 18.03.2022 06.00H - 12.00H	14°C	0.0mm	East	2.2m/s
Friday 18.03.2022 12.00H - 18.00H	16°C	0.0mm	Northeast	2.6m/s
Friday 18.03.2022 18.00H - 00.00H	13°C	0.0mm	Northeast	2.5m/s
Saturday 19.03.2022 00.00H - 06.00H	8°C	0.0mm	East	1.7m/s

7 Interpretation of monitoring results

Through reference to Graph 1 it is apparent that traffic noise in this location was generally persistent, with day-time sound levels showing only a marginal variation over the night-time sound levels.

Through reference to Graph 2 above, which shows the frequency profiles at the measurement position, again the dominant low-middle frequency noise is typical of road traffic.

It is however noted that the area was additionally characterised by dominant high frequency noise, which in the absence of any specifically identifiable industrial source, is strongly suspected to be due to bird song.

For the purposes of determining sound pressure levels with distance from the source the following equation has been used:

$$L_2 = L_1 - (10\log(r_2/r_1))\text{dB}$$

Where: L_1 is the measured averaged $L_{Aeq(16hr)}$ value for a 16-hour day-time period or $L_{Aeq(8hr)}$ for the 8-hour night-time period, r_1 is the distance from the source to the measurement position, r_2 is the distance from the source to the receptor.

The potential impact at the nearest façade of each of the proposed dwellings has been calculated for each proposed dwelling below, and summarised in Table 8, using the average day-time and night-time L_{Aeq} values obtained at a distance of 15m from the source, in conjunction with the above equation.

For this purpose, the average day-time L_{Aeq} has been calculated as 60dB, and the average night-time L_{Aeq} has been calculated as 57dB.

In each instance the calculated impact has been shown as the theoretical L_{Aeq} and 10th highest L_{Amax} values, based on the assumption that all dwellings would be at the same ground height as the nearest noise source (Providence Hill); which in actuality is not the case, as discussed below in Section 8.

For the proposed **Dwelling 1**

Estimated shortest distance of the closest façade to traffic using the road = 40m

$$\text{Day-time } L_{Aeq} = 60 - 10\log(40/15) = \underline{\underline{56\text{dB}}}$$

$$\text{Night-time } L_{Aeq} = 57 - 10\log(40/15) = \underline{\underline{53\text{dB}}}$$

$$\text{Night-time } L_{Amax} = 73 - 10\log(40/15) = \underline{\underline{69\text{dB}}}$$

For the proposed **Dwelling 2**

Estimated shortest distance of the closest façade to traffic using the road = 40m

$$\text{Day-time } L_{Aeq} = 60 - 10\log(40/15) = \underline{\underline{56\text{dB}}}$$

$$\text{Night-time } L_{Aeq} = 57 - 10\log(40/15) = \underline{\underline{53\text{dB}}}$$

$$\text{Night-time } L_{Amax} = 73 - 10\log(40/15) = \underline{\underline{69\text{dB}}}$$

For the proposed **Dwelling 3**

Estimated shortest distance of the closest façade to traffic using the road = 25m

$$\text{Day-time } L_{Aeq} = 60 - 10\log(25/15) = \underline{\underline{58\text{dB}}}$$

$$\text{Night-time } L_{Aeq} = 57 - 10\log(25/15) = \underline{\underline{55\text{dB}}}$$

$$\text{Night-time } L_{Amax} = 73 - 10\log(25/15) = \underline{\underline{71\text{dB}}}$$

For the proposed **Dwelling 4**

Estimated shortest distance of the closest façade to traffic using the road = 22m

$$\text{Day-time } L_{Aeq} = 60 - 10\log(22/15) = \underline{\underline{58\text{dB}}}$$

$$\text{Night-time } L_{Aeq} = 57 - 10\log(22/15) = \underline{\underline{55\text{dB}}}$$

$$\text{Night-time } L_{Amax} = 73 - 10\log(22/15) = \underline{\underline{71\text{dB}}}$$

For the proposed **Dwelling 5**

Estimated shortest distance of the closest façade to traffic using the road = 20m

$$\text{Day-time } L_{Aeq} = 60 - 10\log(20/15) = \underline{\underline{59\text{dB}}}$$

$$\text{Night-time } L_{Aeq} = 57 - 10\log(20/15) = \underline{\underline{56\text{dB}}}$$

$$\text{Night-time } L_{Amax} = 73 - 10\log(20/15) = \underline{\underline{72\text{dB}}}$$

For the proposed **Dwelling 6**

Estimated shortest distance of the closest façade to traffic using the road = 44m

$$\text{Day-time } L_{Aeq} = 60 - 10\log(44/15) = \underline{\underline{55\text{dB}}}$$

$$\text{Night-time } L_{Aeq} = 57 - 10\log(44/15) = \underline{\underline{52\text{dB}}}$$

$$\text{Night-time } L_{Amax} = 73 - 10\log(44/15) = \underline{\underline{68\text{dB}}}$$

For the proposed **Dwelling 7**

Estimated shortest distance of the closest façade to traffic using the road = 48m

$$\text{Day-time } L_{Aeq} = 60 - 10\log(48/15) = \underline{\underline{55\text{dB}}}$$

$$\text{Night-time } L_{Aeq} = 57 - 10\log(48/15) = \underline{\underline{52\text{dB}}}$$

$$\text{Night-time } L_{Amax} = 73 - 10\log(48/15) = \underline{\underline{68\text{dB}}}$$

For the proposed **Dwelling 8**

Estimated shortest distance of the closest façade to traffic using the road = 30m

$$\text{Day-time } L_{Aeq} = 60 - 10\log(30/15) = \underline{\underline{57\text{dB}}}$$

$$\text{Night-time } L_{Aeq} = 57 - 10\log(30/15) = \underline{\underline{54\text{dB}}}$$

$$\text{Night-time } L_{Amax} = 73 - 10\log(30/15) = \underline{\underline{70\text{dB}}}$$

For the proposed **Dwelling 9**

Estimated shortest distance of the closest façade to traffic using the road = 28m

$$\text{Day-time } L_{Aeq} = 60 - 10\log(28/15) = \underline{\underline{57\text{dB}}}$$

$$\text{Night-time } L_{Aeq} = 57 - 10\log(28/15) = \underline{\underline{54\text{dB}}}$$

$$\text{Night-time } L_{Amax} = 73 - 10\log(28/15) = \underline{\underline{70\text{dB}}}$$

For the proposed **Dwelling 10**

Estimated shortest distance of the closest façade to traffic using the road = 22m

$$\text{Day-time } L_{Aeq} = 60 - 10\log(22/15) = \underline{\underline{58\text{dB}}}$$

$$\text{Night-time } L_{Aeq} = 57 - 10\log(22/15) = \underline{\underline{55\text{dB}}}$$

$$\text{Night-time } L_{Amax} = 73 - 10\log(22/15) = \underline{\underline{71\text{dB}}}$$

For the proposed **Dwelling 11**

Estimated shortest distance of the closest façade to traffic using the road = 20m

$$\text{Day-time } L_{Aeq} = 60 - 10\log(20/15) = \underline{\underline{59\text{dB}}}$$

$$\text{Night-time } L_{Aeq} = 57 - 10\log(20/15) = \underline{\underline{56\text{dB}}}$$

$$\text{Night-time } L_{Amax} = 73 - 10\log(20/15) = \underline{\underline{72\text{dB}}}$$

For the proposed **Dwelling 12**

Estimated shortest distance of the closest façade to traffic using the road = 42m

$$\text{Day-time } L_{Aeq} = 60 - 10\log(42/15) = \underline{\underline{55\text{dB}}}$$

$$\text{Night-time } L_{Aeq} = 57 - 10\log(42/15) = \underline{\underline{52\text{dB}}}$$

$$\text{Night-time } L_{Amax} = 73 - 10\log(42/15) = \underline{\underline{68\text{dB}}}$$

For the proposed **Dwelling 13**

Estimated shortest distance of the closest façade to traffic using the road = 48m

$$\text{Day-time } L_{Aeq} = 60 - 10\log(48/15) = \underline{\underline{55\text{dB}}}$$

$$\text{Night-time } L_{Aeq} = 57 - 10\log(48/15) = \underline{\underline{52\text{dB}}}$$

$$\text{Night-time } L_{Amax} = 73 - 10\log(48/15) = \underline{\underline{68\text{dB}}}$$

For the proposed **Dwelling 14**

Estimated shortest distance of the closest façade to traffic using the road = 52m

$$\text{Day-time } L_{Aeq} = 60 - 10\log(52/15) = \underline{\underline{55dB}}$$

$$\text{Night-time } L_{Aeq} = 57 - 10\log(52/15) = \underline{\underline{52dB}}$$

$$\text{Night-time } L_{Amax} = 73 - 10\log(52/15) = \underline{\underline{68dB}}$$

For the proposed **Dwelling 15**

Estimated shortest distance of the closest façade to traffic using the road = 54m

$$\text{Day-time } L_{Aeq} = 60 - 10\log(54/15) = \underline{\underline{54dB}}$$

$$\text{Night-time } L_{Aeq} = 57 - 10\log(54/15) = \underline{\underline{51dB}}$$

$$\text{Night-time } L_{Amax} = 73 - 10\log(54/15) = \underline{\underline{67dB}}$$

For the proposed **Dwelling 16**

Estimated shortest distance of the closest façade to traffic using the road = 56m

$$\text{Day-time } L_{Aeq} = 60 - 10\log(56/15) = \underline{\underline{54dB}}$$

$$\text{Night-time } L_{Aeq} = 57 - 10\log(56/15) = \underline{\underline{51dB}}$$

$$\text{Night-time } L_{Amax} = 73 - 10\log(56/15) = \underline{\underline{67dB}}$$

Table 8 Predicted impact of traffic noise at each receptor façade closest to the road

Dwelling No.	Approx. distance from source / m	Predicted day-time L_{Aeq} /dB(A)	Predicted night-time L_{Aeq} /dB(A)	Predicted night-time 10 th highest L_{Amax} /dB(A)
1	40	56	53	69
2	40	56	53	69
3	25	58	55	71
4	22	58	55	71
5	20	59	56	72
6	44	55	52	68
7	48	55	52	68
8	30	57	54	70
9	28	57	54	70
10	22	58	55	71
11	20	59	56	72
12	42	55	52	68
13	48	55	52	68
14	52	55	52	68
15	54	54	51	67
16	56	54	51	67

8 Assessment evaluation

8.1 Unmitigated evaluation

This assessment has taken the view that the dominant sound source at the proposed development site is traffic-related, principally emanating from vehicles using the adjacent Providence Hill to the immediate south; albeit possibly with some degree of low frequency vehicular drone from the distant M27 motorway to the north at times.

As discussed above, the subject site effectively lies within a valley, in which it slopes downwards from the adjacent road, to a point some 10m below the road level. The approximate ground height difference between the road level and each dwelling level has been shown in Table 9.

Table 9 Approximate ground height difference between the road and each proposed dwelling

Dwelling No.	Road position height / m	Dwelling position height / m	Height difference / m	Dwelling No.	Road position height / m	Dwelling position height / m	Height difference / m
1	49	42.0	-7.0	9	46	42.3	-3.7
2	49	42.0	-7.0	10	46	42.7	-3.3
3	48	43.5	-4.5	11	46	42.7	-3.3
4	48	43.2	-4.8	12	46	39.9	-6.1
5	48	43.2	-4.8	13	46	39.6	-6.1
6	47	42.7	-4.3	14	45	38.7	-6.3
7	47	42.3	-4.7	15	45	39.0	-6.0
8	46	42.3	-4.7	16	45	39.0	-6.0

In attempting to determine the theoretical façade sound exposure level at each of the proposed dwellings, it is generally accepted that traffic noise can be attenuated by up to 10dB if there is an acoustic barrier in place offering no line of sight to the source, or up to 5dB where there may be a partial line of sight.

It is further suggested here that the roadside boundary vegetation at the site in conjunction with the steep ground-slope down to the proposed dwellings itself should be able to offer some additional degree of noise reduction over distance; although in the absence of being able to accurately quantify any such reduction, it is suggested that it may be reasonable to consider these to offer at least a further combined 5dB reduction applicable to all dwellings.

One further consideration should be the barrier-effect that dwellings themselves may provide to other dwellings further from the road, which should result in a 3dB reduction for 40 - 65% screening, or a 5dB for 60 - 90% screening. Any further screening offered by a second row of dwellings would be expected to provide an additional 1.5dB sound reduction.

In actuality, the noise reduction offered by the ground-slope and dwelling vertical surfaces is complex and difficult to calculate due to all the potential surfaces where both adsorption and reflection can occur, with the extent, and efficiency of each very much dependent upon a large number of variables. It is therefore noted that this report aims to offer a simplified overview of the behaviour of roadside noise across the site, which quite possibly underestimates the degree of reduction evident at each dwelling façade. Each proposed dwelling has been considered individually below.

Dwelling Nos.1 and 2

The daytime L_{Aeq} has been calculated as 56dB, the night-time L_{Aeq} as 53dB and the 10th highest L_{Amax} as 69dB.

The dwellings lie around 40m from the road with an estimated height difference of 7m below the road level. This implies that there should be no line of sight between the road and the ground floor and first floor rooms.

As such it is suggested that a 5dB noise reduction could be applied to each of these values, resulting in a daytime L_{Aeq} of 51dB, night-time L_{Aeq} as 48dB and a 10th highest night-time L_{Amax} of 64dB.

Dwelling Nos.3 and 4

The daytime L_{Aeq} has been calculated as 58dB, the night-time L_{Aeq} as 55dB and the 10th highest L_{Amax} as 71dB.

The dwellings lie around 22 - 25m from the road with an estimated height difference of around 4.5 - 4.8m below the road level. This implies that there should be no line of sight between the road and the ground floor rooms but potentially a partial line of sight between the road and first floor rooms.

As such it is suggested that a 5dB noise reduction could still be applied to both ground and first floor values (due to the tree-line and ground-slope) resulting in a daytime L_{Aeq} of 53dB, night-time L_{Aeq} as 50dB and a 10th highest L_{Amax} of 66dB.

Dwelling No. 5

The daytime L_{Aeq} has been calculated as 59dB, the night-time L_{Aeq} as 56dB and the 10th highest L_{Amax} as 72dB.

The dwelling lies around 20m from the road with an estimated height difference of around 4.8m below the road level. This implies that there should be no line of sight between the road and the ground floor rooms but potentially could be between the road and first floor rooms.

As such it is again suggested that a 5dB noise reduction could still be applied to both ground and first floor values resulting in a daytime L_{Aeq} of 54dB, night-time L_{Aeq} as 51dB and a 10th highest L_{Amax} of 67dB.

Dwelling Nos.6 and 7

The daytime L_{Aeq} has been calculated as 55dB, the night-time L_{Aeq} as 52dB and the 10th highest L_{Amax} as 68dB.

The dwellings lie around 44 - 48m from the road with an estimated height difference of 4.3 - 4.7m below the road level. This implies that there should be no line of sight between the road and the ground floor rooms but potentially could be between the road and first floor rooms.

As such it is suggested that a 5dB noise reduction could once again still be applied to each of these values, resulting in a daytime L_{Aeq} of 50dB, night-time L_{Aeq} of 47dB and a 10th highest night-time L_{Amax} of 63dB.

In this instance it is also expected for there to be further noise attenuation due to the dwellings in-between these dwellings and the road, thereby offering at least another 3dB reduction, giving a more realistic daytime L_{Aeq} of 47dB, night-time L_{Aeq} of 44dB and a 10th highest night-time L_{Amax} of 60dB.

Dwelling Nos.8 and 9

The daytime L_{Aeq} has been calculated as 57dB, the night-time L_{Aeq} as 54dB and the 10th highest L_{Amax} as 70dB.

The dwellings lie around 28 - 30m from the road with an estimated height difference of around 3.7m below the road level. This implies that there should be no line of sight between the road and the ground floor rooms but potentially could be between the road and first floor rooms.

As such it is suggested that a 5dB noise reduction could similarly be applied to each of these values for both ground floor and first floor rooms, resulting in a daytime L_{Aeq} of 52dB, night-time L_{Aeq} as 49dB and a 10th highest L_{Amax} of 65dB.

Dwelling No.10

The daytime L_{Aeq} has been calculated as 58dB, the night-time L_{Aeq} as 55dB and the 10th highest L_{Amax} as 71dB.

The dwelling lies around 22m from the road with an estimated height difference of around 3.3m below the road level. This implies that there should be no line of sight between the road and the ground floor rooms but potentially could be between the road and first floor rooms.

As such it is suggested that a 5dB noise reduction could again be applied to each of these values for both ground floor and first floor rooms, resulting in a daytime L_{Aeq} of 53dB, night-time L_{Aeq} as 50dB and a 10th highest L_{Amax} of 66dB.

Dwelling No.11

The daytime L_{Aeq} has been calculated as 59dB, the night-time L_{Aeq} as 56dB and the 10th highest L_{Amax} as 72dB.

The dwelling lies around 20m from the road with an estimated height difference of around 3.3m below the road level. This implies that there should be no line of sight between the road and the ground floor rooms but potentially could be between the road and first floor rooms.

As such it is suggested that a 5dB noise reduction could similarly be applied to each of these values for both ground floor and first floor rooms, resulting in a daytime L_{Aeq} of 54dB, night-time L_{Aeq} as 51dB and a 10th highest L_{Amax} of 67dB.

Dwelling Nos.12, 13 and 14

The daytime L_{Aeq} has been calculated as 55dB, the night-time L_{Aeq} as 52dB and the 10th highest L_{Amax} as 68dB.

The dwellings lie around 42 - 52m from the road with an estimated height difference of 6.1 - 6.3m below the road level. This implies that there should be no line of sight between the road and the ground floor and first floor rooms.

As such it is suggested that a 5dB noise reduction could be applied to each of these values, resulting in a daytime L_{Aeq} of 50dB, night-time L_{Aeq} of 47dB and a 10th highest night-time L_{Amax} of 63dB.

In this instance it is once again expected for there to be further noise attenuation due to the dwellings in-between these dwellings and the road, thereby offering at least another 3dB reduction, giving a more realistic daytime L_{Aeq} of 47dB, night-time L_{Aeq} of 44dB and a 10th highest night-time L_{Amax} of 60dB.

Dwelling Nos. 15 and 16

The daytime L_{Aeq} has been calculated as 55dB, the night-time L_{Aeq} as 52dB and the 10th highest L_{Amax} as 68dB.

The dwellings lie around 42 - 48m from the road with an estimated height difference of 6.0m below the road level. This implies that there should be no line of sight between the road and the ground floor and first floor rooms.

As such it is suggested that a 5dB noise reduction could be applied to each of these values, resulting in a daytime L_{Aeq} of 50dB, night-time L_{Aeq} of 47dB and a 10th highest night-time L_{Amax} of 63dB.

In this instance it is once again expected for there to be further noise attenuation due to the dwellings in-between these dwellings and the road, thereby offering at least another 3dB reduction, giving a more realistic daytime L_{Aeq} of 47dB, night-time L_{Aeq} of 44dB and a 10th highest night-time L_{Amax} of 60dB.

On the basis of these assumptions the estimated noise exposure level for road-facing rooms and externals at all proposed dwellings has been summarised in Table 10 below.

In doing so, this has considered the use of acoustic glazing capable of at least 30dB broadband sound reduction when closed, and a maximum sound reduction of 15dB with a partially open window (Ref. WHO Guidelines for Community Noise 1999).

There are a number of glazing products that should be able to provide appropriate mitigation, such as the Pilkington Optiphon products. More specifically, the 6mm / 16mm argon / 6.8mm Optiphon insulating glass unit offers an $Rw+C_{tr}$ (sound reduction with an adjustment for traffic) rating of 34dB.

In considering the impact that traffic noise may have, reference is made to the guideline criteria published within BS8233, where essentially the internal noise level should not exceed 35dB(A) during the day-time, and not exceed 30dB(A) during the night-time

As seen in Table 10 below, there appear to be nine of the proposed dwellings where these criteria are unlikely to be fully met in the absence of mitigation. These have been highlighted in red type.

Table 10 Predicted internal and external road-facing noise exposure levels in the absence of any additional mitigation

Dwelling No.	External day-time façade sound level / dB(A)	Internal day-time L_{Aeq} /dB(A)		Internal night-time L_{Aeq} /dB(A)		Internal night-time 10 th highest L_{Amax} /dB(A)	
		Window closed	Window open	Window closed	Window open	Window closed	Window open
1	51	<35	36	<30	33	34	49
2	51	<35	36	<30	33	34	49
3	53	<35	38	<30	35	36	51
4	53	<35	38	<30	35	36	51
5	54	<35	39	<30	36	37	52
6	47	<35	<35	<30	<30	30	45
7	47	<35	<35	<30	<30	30	45
8	52	<35	37	<30	34	35	50
9	52	<35	37	<30	34	35	50
10	53	<35	38	<30	35	36	51
11	54	<35	39	<30	36	37	52
12	45	<35	<35	<30	<30	<30	45
13	45	<35	<35	<30	<30	<30	45
14	45	<35	<35	<30	<30	<30	45
15	45	<35	<35	<30	<30	<30	45
16	45	<35	<35	<30	<30	<30	45

8.2 Mitigated evaluation

Through reference to Table 10 above, it is apparent that the occupants of each dwelling could be impacted by road traffic noise to varying extents; principally when windows facing Providence Hill are open.

It is therefore necessary for mitigation measures to be considered in order to address this issue.

In the first instance it is understood that a 2500mm acoustic barrier fence would be placed along the road-facing boundary of each garden belonging to the dwellings closest to the road. More specifically, these are dwelling Nos. 1, 2, 3, 4, 5 along with a partial barrier adjacent to dwelling No.11.

The proposed positioning of these fence sections have been indicated below in Figure 5 by the green lines.

It is noted that dwelling Nos. 1 and 2 have been included here due to the fact that they are unlikely to benefit from the tree-line boundary to the same extent as other dwellings may, as they directly face the site entrance where the tree-line would have to be broken. They should still however benefit from the reduction expected to be offered by the ground slope down from Providence Hill.

Figure 5 The proposed positioning of the acoustic barrier fence



Such a barrier should ideally be continuous and close to the source (Providence Hill) in order to gain a maximum amount of sound reduction; however even a partial barrier should be able to provide some degree of noise reduction through partial reflection and absorption.

In considering firstly the impact that the proposed fencing should have on dwelling Nos 1, 2, 3, 4, and 5, it is apparent that as in each instance the fence is positioned some distance from the road, and at a similar ground height to the corresponding dwelling, it is only expected to reduce the noise level within the road-facing gardens and ground floor rooms. Consequently the noise within first floor rooms is expected to remain as stated in Table 10 above.

As the barrier fence would be discontinuous in each instance it would be prudent to consider a resultant 5dB noise reduction only within these ground floor areas.

To compensate for this situation it is further understood that the road-facing first-floor rooms within each of these dwellings would be fitted with mechanical ventilation, thereby eliminating the need for these first-floor windows to be opened for ventilation.

The design of such is beyond the scope of this report, and should be discussed with a competent contractor. In selecting appropriate plant it is important to firstly ensure that there are an adequate number of hourly/daily air changes without the need to have any windows open, and secondly to ensure that it does not contribute to the sound exposure level within any of the rooms. It is suggested that once the desired plant has been selected, the manufacturer sound data should be reviewed, and included within a revised reassessment of overall risk.

Considering therefore the combined mitigation of an acoustic barrier fence for road-facing ground floor rooms and external recreation areas, with mechanical ventilation for first floor rooms, it should now be possible for the aforementioned day-time and night-time guideline criteria to be adequately achieved at each of these dwellings.

With specific regard to dwelling Nos. 8, 9, 10 and 11 a similar situation is evident, other than for the fact that the external recreation area for each is to be positioned on the other side of the dwelling, thereby protected from road noise by the associated dwelling in each instance.

As there should be no direct line of sight between ground floor rooms and the road, then a similar 5dB reduction would be expected for these ground floor rooms, whereas first floor rooms would similarly be fitted with mechanical ventilation.

Once again considering the combined mitigation offered by the ground slope, the dwelling itself, and mechanical ventilation, it should now be possible for the day-time and night-time guideline criteria to be adequately achieved here also.

Taking into consideration the above detailed mitigation, the corresponding revised predicted internal and external noise exposure levels within these nine dwellings has been shown below in Table 11.

Table 11 Revised predicted internal and external sound exposure levels for the dwellings directly facing the road

Dwelling No.	External day-time garden sound level / dB(A)	Internal day-time L_{Aeq} /dB(A)		Internal night-time L_{Aeq} /dB(A)	
		Ground floor road-facing room with window open	First floor road-facing room with mechanical ventilation	Ground floor road-facing room with window open	First floor road-facing room with mechanical ventilation
1	46	31	<30	<30	<30
2	46	31	<30	<30	<30
3	48	33	<30	30	<30
4	48	33	<30	30	<30
5	49	34	<30	31	<30
8	42	32	<30	<30	<30
9	42	32	<30	<30	<30
10	43	33	<30	30	<30
11	44	34	<30	31	<30

8.3 Consideration of night-time 10th highest L_{Amax} values

The WHO Guidelines for Community Noise state that it may be considered acceptable for an L_{Amax} external noise level of 45dB to be exceeded on 10 to 15 occurrences per night. As such, it should be possible to assess this by means of considering the aforementioned BS8233 internal sound level criteria against the 10th highest measured L_{Amax} value.

Table 10 above had listed the expected 10th highest measured internal L_{Amax} values in the absence of any additional mitigation, whereas Table 12 below provides an indication of how the aforementioned mitigation may lower this value.

The mitigation in this instance relates to an arbitrary 30dB reduction offered by a closed window with mechanical ventilation within dwelling Nos. 1, 2, 3, 4, 5, 8, 9, 10 and 11, but no further mitigation for dwelling Nos. 6, 7, 12, 13, 14, 15 and 16. As before, the reduction offered by a partially open window has been taken as 15dB.

Table 12 The predicted impact that mitigation may have on 10th highest night-time L_{Amax} value within each proposed dwelling at first-floor road-facing level with a partially open window

Dwelling No.	Internal first-floor road-facing night-time 10 th highest L _{Amax} /dB(A)	Dwelling No.	Internal first-floor road-facing night-time 10 th highest L _{Amax} /dB(A)
1	<30	9	<30
2	<30	10	<30
3	<30	11	<30
4	<30	12	45
5	<30	13	45
6	45	14	45
7	45	15	45
8	<30	16	45

As shown above in Table 12, it would appear that all dwellings should be able to comply with the WHO Guidelines for Community Noise with regards to maximum night-time noise levels; namely having a 10th highest L_{Amax} of no greater than 45dB(A).

9 Summary and limitations

9.1 Summary

Taking the above features and mitigation into consideration, the predicted noise levels have been summarised below in Table 13. These have been generated to account for two characteristic situations; namely a two-storey dwelling positioned closest to Providence Hill (as typified by dwelling No.5) and a dwelling positioned behind the first row of dwellings - hence with no direct line of sight to the road due to other buildings in-between (as typified by dwelling No.12)

Table 13 Expected noise exposure levels at dwellings No.5 and No.12

Parameter	Calculated day-time noise level / dB(A)		Calculated night-time noise level / dB(A)	
	No.5	No.12	No.5	No.12
External road-facing façade at first floor level	49	45	54	50
Internal road-facing ground floor rooms with windows closed	<35	<35	<30	<30
Internal road-facing first floor rooms with windows closed	<35	<35	<30	<30
Internal road-facing ground floor rooms with windows partially open	<35	<35	31	<30
Internal road-facing first floor rooms with windows partially open or mechanical ventilation	<35	<35	<30	<30
External rear façade at first floor level	39	<35	<30	<30
Internal rear facing ground floor rooms with windows closed	<35	<35	<30	<30
Internal rear facing first floor rooms with windows closed	<35	<35	<30	<30
Internal rear facing ground floor rooms with windows partially open	<35	<35	<30	<30
Internal rear facing first floor rooms with windows partially open	<35	<35	<30	<30

Considering the theoretical values shown above in Table 13, it would appear unlikely for anyone occupying any of the proposed dwellings, or using the associated garden areas, to be exposed to noise levels in excess of the referenced guideline criteria.

9.2 Limitations

The above concluded findings are reached on the understanding that the mitigation detailed within this report is appropriately applied.

The key features of this mitigation are firstly that the dwellings with a direct line of site to Providence Hill will have mechanical ventilation installed at first-floor level for all rooms facing the road. Secondly, that the road-facing front or rear gardens associated with these dwellings will additionally have - or benefit from - close-boarded acoustic barrier fences to a minimum height of 2500mm.

Thirdly, all windows will contain acoustic glazing allowing a sound reduction of at least 30dB (broadband) to be achieved when closed.

It is noted that the overall exposure levels have been calculated on the basis that the dwellings would be constructed at the specific locations and ground heights shown on the proposed site plan, and although it is recognised that some presumptions may have been made regarding the manner in which the sound levels may be influenced by the natural and constructed characteristics of this site, it is believed that the final conclusions have been made with regard to basic scientific understanding and professional judgement.

Finally, it must be stated that the results and associated inferences within this report rely upon the sound levels obtained at the time of monitoring only, and relate to that specific exercise only. They cannot be used to assess the sound characteristics at any other location in the area, at any other time, or under any other environmental conditions.

APPENDIX

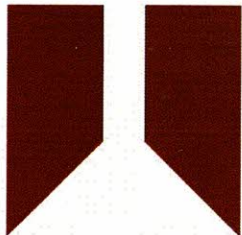
Sound level instrument calibration

CERTIFICATE OF CALIBRATION

ISSUED BY Cirrus Research plc

DATE OF ISSUE 03 November 2021

CERTIFICATE NUMBER 165285



Cirrus Research plc
Acoustic House
Bridlington Road
Hunmanby
North Yorkshire
YO14 0PH
United Kingdom

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Approved signatory

T. Goodrich

Electronically signed:

Sound Level Meter : IEC 61672-3:2006

Instrument information

Manufacturer: Cirrus Research plc

Notes:

Model: CR:171B

Serial number: G068537

Class: 1

Firmware version: 2.4.1569

Test summary

Date of calibration: 02 November 2021

The calibration was performed respecting the requirements of ISO/IEC 17025:2017.

Periodic tests were performed in accordance with procedures from IEC 61672-3:2006.

The sound level meter submitted for testing has successfully completed the class 1 periodic tests of IEC 61672-3:2006, for the environmental conditions under which the tests were performed.

As public evidence was available, from an independent testing organisation responsible for approving the results of pattern evaluation tests performed in accordance with IEC 61672-2:2003, to demonstrate that the model of sound level meter fully conformed to the requirements in IEC 61672-1:2002, the sound level meter submitted for testing conforms to the class 1 requirements of IEC 61672-1:2002.

Notes

This certificate provides traceability of measurement to the SI system of units and/or to units of measurement realised at the National Physical Laboratory or other recognised national metrology institutes. This certificate may not be reproduced other than in full, except with the prior written approval of the issuing laboratory. The results within this certificate relate only to the items calibrated. The reported expanded uncertainty is based on a standard uncertainty multiplied by a coverage factor $k=2$, providing a coverage probability of approximately 95%.

CERTIFICATE OF CALIBRATION

Certificate Number:
165285

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Environmental conditions

The following conditions were recorded at the time of the test:

Before	Pressure: 98.97 kPa	Temperature: 22.4 °C	Humidity: 41.9 %
After	Pressure: 98.98 kPa	Temperature: 22.7 °C	Humidity: 41.9 %

Test equipment

Equipment	Manufacturer	Model	Serial number
Signal Generator	TTi	TG4001	395851
Attenuator	Cirrus Research	ZE:952	78135
Environmental Monitor	Comet	T7510	16966334

Additional instrument information

Instruction manual:

Reference level range: Single range

Pattern approval: Yes

Source of pattern approval: PTB

Preamplifier

Model: MV:200F

Serial number: 4204F

Microphone

Model: MK:224

Serial number: 201385A

Test results summary

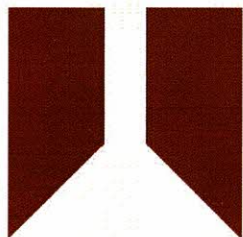
Test	Result
Toneburst response	Complies
Electrical noise-floor	Complies
Linearity	Complies
Electrical Frequency weightings	Complies
Frequency and time weightings at 1 kHz	Complies
C-weighted peak	Complies
Overload indication	Complies
Acoustic Frequency weightings	Complies

CERTIFICATE OF CALIBRATION

ISSUED BY Cirrus Research plc

DATE OF ISSUE 03/11/21

CERTIFICATE NUMBER 165281



Cirrus Research plc
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YO14 0PH
United Kingdom

Page 1 of 2

Test engineer:

B. Wigmore

Electronically signed:

Microphone

Microphone capsule

Manufacturer: Cirrus Research plc

Model: MK:224

Serial Number: 201385A

Calibration procedure

Date of calibration: 21 October 2021

Open circuit: 45.6 mV/Pa

Sensitivity at 1 kHz: -26.8 dB rel 1 V/Pa

The microphone capsule detailed above has been calibrated to the published data as described in the operating manual of the associated sound level meter (where applicable).

The frequency response was measured using an electrostatic actuator in accordance with BS EN 61094-6:2005 with the free-field response derived via standard correction data traceable to a National Measurement Institute.

The absolute sensitivity at 1 kHz was measured using an acoustic calibrator conforming to IEC 60942:2003 Class 1.

Environmental conditions

Pressure: 99.40 kPa

Temperature: 22.0 °C

Humidity: 34.0 %

CERTIFICATE OF CALIBRATION

Certificate Number:

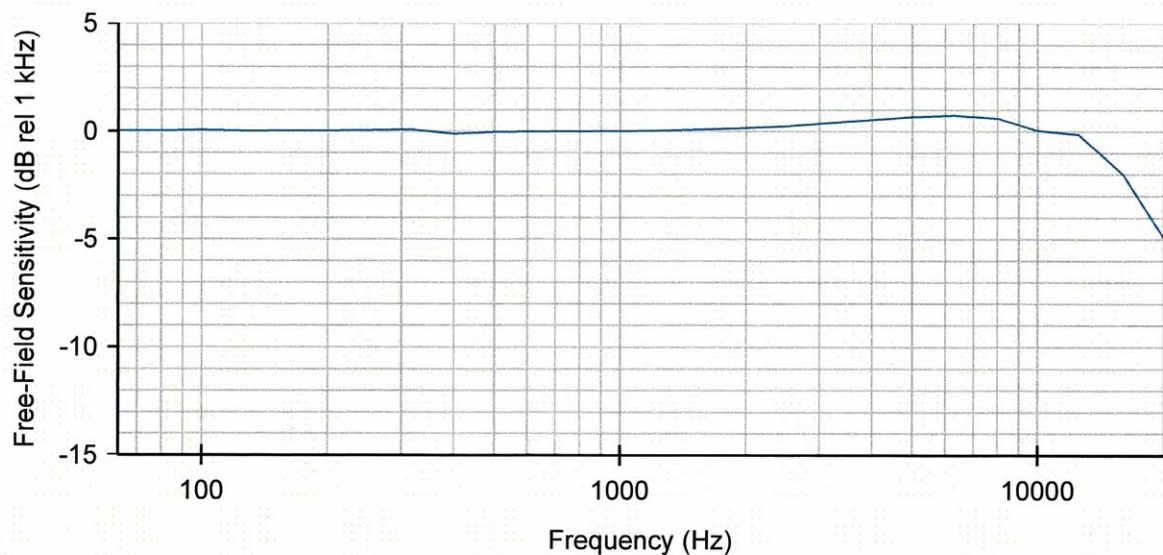
165281

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Free-Field Frequency Response : Tabular

Frequency (Hz)	Free-Field Sensitivity (dB rel 1 kHz)	Actuator Response (dB)
63	0.03	-0.17
80	0.01	-0.08
100	0.05	-0.01
125	0.01	-0.01
160	0.01	0.02
200	0.02	0.04
250	0.04	0.07
315	0.07	0.07
400	-0.13	-0.11
500	-0.04	-0.04
630	-0.02	-0.02
800	-0.01	-0.01
1 000	0.00	-0.02
1 250	0.03	-0.02
1 600	0.09	-0.03
2 000	0.16	-0.06
2 500	0.24	-0.10
3 150	0.38	-0.19
4 000	0.52	-0.37
5 000	0.66	-0.69
6 300	0.73	-1.34
8 000	0.59	-2.56
10 000	0.03	-4.59
12 500	-0.15	-6.66
16 000	-2.02	-9.98
20 000	-4.94	-14.05

Free-Field Frequency Response : Graphical

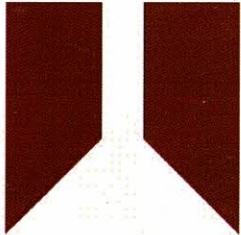


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DATE OF ISSUE 03 November 2021

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Page 1 of 2

Approved signatory

T. Goodrich

Electronically signed:

Sound Calibrator : IEC 60942:2003

Instrument information

Manufacturer: Cirrus Research plc

Notes:

Model: CR:515

Serial number: 70846

Class: 1

Test summary

Date of calibration: 03 November 2021

The sound calibrator detailed above has been calibrated to the published data as described in the operating manual and in the half-inch configuration. The procedures and techniques used are as described in IEC60942_2003 Annex B – Periodic Tests and three determinations of the sound pressure level, frequency and total distortion were made.

The sound pressure level was measured using a WS2F condenser microphone type MK:224 manufactured by Cirrus Research plc.

The results have been corrected to the reference pressure of 101.33 kPa using the manufacturer's data.

The manufacturer's product information indicates that this model of sound calibrator has been formally pattern approved to IEC60942_2003 Annex A to Class 1. This has been confirmed with the Physikalisch Technische Bundesanstalt (PTB), Laboratoire National d'Essais (LNE) and APPLUS.

Notes:

This certificate provides traceability of measurement to the SI system of units and/or to units of measurement realised at the National Physical Laboratory or other recognised national metrology institutes. This certificate may not be reproduced other than in full, except with the prior written approval of the issuing laboratory. The results within this certificate relate only to the items calibrated. The reported expanded uncertainty is based on a standard uncertainty multiplied by a coverage factor $k=2$, providing a coverage probability of approximately 95%.

CERTIFICATE OF CALIBRATION

Certificate Number:

165280

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Environmental conditions

The following conditions were recorded at the time of the test:

Pressure: 99.60 kPa

Temperature: 22.9 °C

Humidity: 43.1 %

Test equipment

Equipment	Manufacturer	Model	Serial number
Acoustic Calibrator	Bruel and Kjaer	4231	2610257
Distortion Meter	Keithley	2015	1046217
Multimeter	Fluke	8845A	9708001

Results

	Expected	Sample 1	Sample 2	Sample 3	Average	Deviation	Tolerance	Uncertainty
Level (dB)	94.00	94.05	94.04	94.04	94.04	0.04	±0.40	0.11 dB
Distortion (%)	< 3.00	0.38	0.29	0.37	0.35	0.35	+3.00	0.13 %
Frequency (Hz)	1000.0	1000.3	1000.3	1000.3	1000.3	0.3	±10.0	0.1 Hz

The measured quantities or deviations (as applicable), extended by the expanded combined uncertainty of measurement, must not exceed the corresponding tolerance.

End of results