HOODLANDS, BRISTOL

Environmental Noise Survey

Reference: 10905.RP01.ENS.0
Prepared: 15 July 2021
Revision Number: 1

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Revision	Comment	Date	Prepared By	Approved By
0	First issue of report	18 June 2021	Joe Allen	Torben Andersen
1	Updated to include outcome if surrounding development is not in place	15 July 2021	Joe Allen	Torben Andersen

Terms of contract:

The recommendations within this report relate to acoustics performance only and will need to be integrated within the overall design by the lead designer to incorporate all other design disciplines such as fire, structural integrity, setting-out, etc. Similarly, any sketches appended to this report illustrate acoustic principles only and again will need to be developed in to full working drawings by the lead designer to incorporate all other design disciplines.

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1. INTRODUCTION

The land at the Hoodlands, Hambrook Lane, is being developed into 50 residential dwellings. The development is part of the wider East of Harry Stoke New Neighbourhood Policy Allocation.

RBA Acoustics have been commissioned to undertake an acoustic assessment of the site to determine its suitability for development in support of the planning application. This report presents the results of the noise measurements and associated assessment.

2. SITE DESCRIPTION

The site is situated within the 'East of Harry Stoke New Neighbourhood' development area and is shown in relation to its surroundings in the site plan in Figure 1 (Appendix C).

To the East of the site lies the M4/M32 interchange approximately 420m away, with the M4 running North-South past the Eastern border of the development, and the M32 running South-West to the South-East of the site. The M4 passes at a closest distance of approximately 420m to the site. The M32 passes at a closest distance of approximately 250m to the site.

To the West of the site lies the Stoke-Gifford Bypass, approximately 75m away at the closest point to the site. To the North of the site, lies the railway line serving Bristol Parkway railway station, at a distance of approximately 80m at the closest point.

Throughout the Hoodlands site, the noise climate was dominated by road traffic noise from the M4/M32. At the Northern edge of the site, closest to the railway line, occasional contributions to the noise climate were noted from passing trains. However, these were noted to be relatively rare, occurring only around six times in every hour during the daytime periods that we were on site. To the Western edge of the boundary there were occasional contributions from construction traffic on the Stoke-Gifford bypass.

3. ENVIRONMENTAL NOISE SURVEY

3.1 Survey Methodology

Monitoring of the prevailing background noise was undertaken over the following period:

Thursday 22 April to Tuesday 27 April 2021.

As the survey was unattended it is not possible to comment with certainty regarding meteorological conditions throughout the entire survey period. However, based on observations during the site visits and weather reports for the area, conditions were generally considered suitable for obtaining representative noise measurements, being predominantly dry with little wind. It was noted that there were periods of rain and winds in excess of 5m/s, however these are not considered to have adversely affected the results of the survey.

Measurements were made of the L_{A90}, L_{Amax} and L_{Aeq} noise levels over sample periods of 15 minutes.

3.2 Measurement Locations

To determine the existing noise climate around the site, unattended noise measurements were undertaken at the following locations. The measurement positions are also illustrated on the site plan attached in Figure 1 in Appendix E.

Measurement Position 1 – Eastern Boundary

Noise measurements were undertaken with the microphone fixed to a tripod at a height of approximately 1.5m above ground. The tripod was positioned approximately 3m back from the boundary line to provide a stable position, and approximately halfway along the Eastern boundary. The noise climate was noted to be dominated by road traffic noise from the nearby M4/M32.

Measurement Position 2 – Northern Boundary

Noise measurements were undertaken with the microphone fixed to a tripod at a height of approximately 1.5m above ground. The tripod was position approximately 3m back from the boundary line to provide a stable position, and at the most northern point of the site. The noise climate was noted to be dominated by road traffic noise from the nearby M4/M32. Trains were noted to pass by with a frequency of approximately six times in every hour, which would contribute to the noise climate.

Measurement Position 3 – Western Boundary

Noise measurements were undertaken with the microphone fixed to a tripod at a height of approximately 3m above ground. The tripod was positioned at the boundary line of the site, and approximately halfway along the Western boundary. The noise climate was noted to be dominated by road traffic noise from the nearby M4/M32. During the survey period, the Stoke-Gifford bypass which runs along the Western boundary was closed to regular traffic and was used predominantly by construction traffic. Construction traffic pass-bys along the Stoke-Gifford bypass were audible at this measurement position.

3.3 Instrumentation

For information regarding the equipment used for the measurements please refer to Appendix D.

The sound level meters were calibrated both prior to and on completion of the survey with no significant calibration drifts observed.

3.4 Results

The noise levels measured are shown as time-histories on the attached Graphs 1-6 (Appendix E).

The lowest L_{A90} and the period averaged L_{Aeq} noise levels measured at each position are summarised in Tables 1 to 3, along with typical L_{AFmax} levels measured during the night-time.

Table 1 – Measured Levels at Measurement Position 1 – Eastern Boundary

Measurement Period	Lowest $L_{A90,15min}$ (dB)	$L_{Aeq,T}$ (dB)	Typical $L_{AFmax,15min}$ (dB)
Daytime (07:00 – 19:00)	48	59	N/A
Night-time (23:00 – 07:00)	42	55	76

Table 2 – Measured Levels at Measurement Position 2 – Northern Boundary

Measurement Period	Lowest $L_{A90,15min}$ (dB)	$L_{Aeq,T}$ (dB)	Typical $L_{AFmax,15min}$ (dB)
Daytime (07:00 – 19:00)	48	59	N/A
Night-time (23:00 – 07:00)	42	55	74

Table 3 – Measured Levels at Measurement Position 3 – Western Boundary

Measurement Period	Lowest $L_{A90,15min}$ (dB)	$L_{Aeq,T}$ (dB)	Typical $L_{AFmax,15min}$ (dB)
Daytime (07:00 – 19:00)	52	59	N/A
Night-time (23:00 – 07:00)	45	55	70

Please note – the tripod at measurement position 3 was knocked over after approximately 44 hours of measurements. The results presented in Table 3 only take into account the levels measured prior to this.

It is noted that the noise levels, particularly the L_{Aeq}, are consistent across the measurement positions which reflects the dominant and distant nature of the M4/M32 noise sources.

4. ASSESSMENT CRITERIA

The sections below outline the assessment criteria we have adopted for the assessment of noise affecting the Proposed Development.

4.1 National Planning Policy Framework

The National Planning Policy Framework (NPPF), February 2019, sets out the Government's planning policies for England. In respect of noise, Paragraph 180 of the NPPF states the following:

Planning policies and decisions should ensure that new development us appropriate for its location taking into account the likely effects (including cumulative effects) of pollution on health, living conditions and the natural environment, as well as the potential sensitivity of the site or the wider area to impacts that could arise from the development. In doing so they should:

- Mitigate and reduce to a minimum potential adverse impacts resulting from noise from new development – and avoid giving rise to significant adverse impacts on health and the quality of life

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

The above presents no quantitative guidance on a site's suitability for residential development and we have therefore, for the purposes of this assessment, made reference to the following document.

4.2 ProPG

ProPG: Planning & Noise provides guidance on a recommended approach to the management of noise within the planning system in England and was published by the Association of Noise Consultants, the Institute of Acoustics and the Chartered Institute of Environmental Health in May 2017.

It encourages better acoustic design for new residential development and aims to protect people from the harmful effects of noise. In light of the recent publication of ProPG, it was considered appropriate to make use of this document for this report, containing the results of our noise survey and provides advice for the pre-planning stage of development conditions.

ProPG provides the following Noise Risk Assessment scale:

Table 4 – ProPG Noise Risk Assessment Scale

Noise Risk	Indicative $L_{Aeq, period}$ Noise Levels (dB)		Comments
	Daytime $L_{Aeq,\ 18\ hr}$ (07:00 – 23:00)	Night-time $L_{Aeq,\ 8\ hr}$ (23:00 – 07:00)	
Negligible	<50 dB	<40 dB	These noise levels indicate that the development site is likely to be acceptable, and the application need not normally be delayed on noise grounds.
Low	50 dB < L < 60 dB	40 dB < L < 50 dB	At low noise levels, the site is likely to be acceptable from a noise perspective provided that a good acoustic design process is followed and is demonstrated in an ADS which confirms how the adverse impacts of noise will be mitigated and minimised in the finished development.
Medium	60 dB < L <70 dB	50 dB < L <60 dB	As noise levels increase, the site is likely to be less suitable from a noise perspective and any subsequent application may be refused unless a good acoustic design process is followed and is demonstrated in an ADS which confirms how the adverse impacts of noise will be mitigated and minimised, and which clearly demonstrate that a significant adverse noise impact will be avoided in the finished development.
High	>70 dB	>60 dB	High noise levels indicate that there is an increased risk that development may be refused on noise grounds. This risk may be reduced by following a good acoustic design process that is demonstrated in a detailed ADS. Applicants are strongly advised to seek expert advice.

4.3 British Standard 8233:2014

BS 8233:2014 *Guidance on sound insulation and noise reduction for buildings* draws on the results of research and experience to provide information on achieving internal acoustic environments appropriate to their functions.

The noise level values given are in terms of an average (L_{Aeq}) level.

The standard advises internal ambient noise levels for achieving suitable resting and sleeping conditions within residential properties as set out in Table 5. A brief explanation of the acoustic terminology used in this report is shown in Appendix A attached.

Table 5 – BS8233:2014 Residential Criteria

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

4.4 World Health Organisation: Guidelines for Community Noise

The document describes guideline levels that are *"essentially values for the onset of health effects from noise exposure"*.

A table of guideline values is included, relating to adverse health effects, referred to as any temporary or long-term deterioration in physical, psychological, or social functioning that is associated with noise exposure.

Table 5 sets out the guidance from *Table 4.1: Guideline values for community noise in specific environments*, as stated in the document.

Table 6 – Guidelines Values for Community Noise

Specific Environment	Critical Health Effect(s)	L_{Aeq} (dB)	Time Base (hours)	$L_{Amax,f}$ (dB)
Outdoor living area	Serious annoyance, daytime and evening	55	16	-
	Moderate annoyance, daytime and evening	50	16	-
Dwelling, indoors	Speech intelligibility and moderate annoyance, daytime and evening	35	16	-
Inside bedrooms	Sleep disturbance, night-times	30	8	45
Outside bedrooms	Sleep disturbance, window open (outdoor values)	45	8	60

With reference to maximum noise levels the following guidance is provided within the WHO guidance:

> *"For a good sleep, it is believed that indoor sound pressure levels should not exceed approximately 45dB L_{Amax} more than 10-15 times per night (Vallet & Vernet 1991) and most studies show an increase in the percentage of awakenings at SEL values of 55-60 dBA (Passchier-Vermeer 1993; Finegold et al. 1994; Pearsons et al. 1995). For intermittent events that approximate aircraft noise, with an effective duration of 10-30s, SEL values of 55-60 corresponds to a L_{Amax} value of 45dB. Ten to 15 of these events during an 8 hour night-time implies a $L_{Aeq, 8h}$ of 20-25dB. This is 10-15dB below the $L_{Aeq, 8h}$ or 30dB for continuous night-time noise exposure, and shows that intermittent character of noise must be taken into account when setting night-time noise limits for noise exposure. For example, this can be achieved by considering the number of noise events and the difference between the maximum sound pressure level and the background of these events."*

Therefore, the frequency of occurrence of maximum noise events should not typically exceed 10-15 times in any night.

4.5 Internal Noise Criterion

Based upon the above, we have adopted the following internal noise level criteria;

Bedroom	Night-time (23:00-07:00)	30dB L_{Aeq} 45dB $L_{Amax,f}$
Living Rooms	Daytime (07:00-23:00)	35dB L_{Aeq}

5. EXTERNAL NOISE ASSESSMENT

As discussed in Section 4.2, ProPG provides an early indication of the likely suitability of a site for new residential development and provides a framework for considering good acoustic design.

As noted from the measurement results provided in Section 3.4, the noise levels across the site do not vary substantially due to the dominant noise source being approximately 280m. Therefore, the full site can be assigned a single category based on the ProPG guidance outlined in Section 4.2.

Based on the measured levels detailed in Section 3.4, the site can be categorised as a **Low Noise Risk** during the daytime and a **Medium Noise Risk** during the night-time.

ProPG states that as noise levels increase, a good acoustic design process should be followed and demonstrated.

It should be noted that the development is located within the wider East of Harry Stoke New Neighbourhood Policy Allocation. As such, there is further development being undertaken around the Hoodlands site with significant numbers of residential dwellings being constructed between the Hoodlands site and the surrounding noise sources. Therefore, the noise levels within the development site are likely to be reduced by approximately 5dB due to the screening provided by the surrounding development.

Based on this reduction, the site would be categorised as a **Low Noise Risk** for both daytime and night-time.

6. EXTERNAL BUILDING FABRIC

6.1 Background

External noise levels are such that noise control measures are required in order to result in acceptable internal noise levels within future dwellings. Appropriate internal noise levels can be achieved providing suitable building envelope constructions are employed.

An initial analysis of the external building fabric has been undertaken in order to demonstrate achievable internal noise levels and outline methods of ensuring such noise levels.

6.2 Assumptions

Our external building fabric analyses have assumed the following:

(a) Drawings

The assessment has been based on indicative site layout plans and drawing information provided by Boklok and JTP Architects.

(b) Noise Levels

The assessment has been based on the measured levels as detailed in Section 3.4.

(c) Room Absorption

The calculations assume that bedrooms are acoustically 'soft' with carpets, curtains and other soft furnishings. The living rooms are assumed to be less acoustically absorptive (with a hard floor finish, although with furnishings).

Details of the absorption coefficients assumed in the calculations are provided in Appendix B.

(d) External Wall

External non-glazed areas are to comprise the following:

- External slate façade
- ~50mm void
- 2 layers 9mm cementitious board
- Timber frame creating 170mm void filled with mineral wool
- 1 layer 9mm OSB sheathing board
- Timber frame creating 45mm void filled with mineral wool
- 2 layer 13mm dense plasterboard (min. 10.6kg/m^2 per board)

As such we have assumed the following sound reduction indices (equating to an overall R_w of 53dB) for all non-glazed façade areas comprising the above construction.

Table 7 – Sound Reduction Indices of Non-Glazed Elements

Assumed Sound Reduction Index (dB) at Octave Band Centre Frequency (Hz)							
63	125	250	500	1k	2k	4k	8k
21	32	45	55	55	55	55	55

Should proposals for non-glazed areas change, it is critical we are informed at the earliest opportunity as this could have a significant impact on the sound insulation performance requirements of the glazing systems.

(e) Ventilation

It is understood the chosen strategy is natural ventilation via trickle ventilators. These have also been assessed and the guidance performance specification for such trickle ventilators is detailed below.

It should be noted the trickle ventilators provide background trickle ventilation only and that the windows are generally to be openable to provide rapid ventilation. During those periods where windows are opened for purge/ventilation, noise levels will naturally be increased internally. This is discussed in further detail in Section 0.

6.3 Specification & Guidance Constructions

Appendix C details the sound reduction performance specification for the ventilators and glazed elements of the external building fabric.

The glazing performance specifications apply to the glazing package as a whole - inclusive of glazing, louvres, spandrel panels, framing, opening lights, doors, seals, etc. The performance of the glazing system will depend on many factors such as the glazing configuration, size of window panels, quality of framing, quality of sealing, etc.

Please note – *The glazing configurations described in Table 8 and ventilator types described in Table 9 are given for costing purposes only. All window systems should be capable of meeting the performance specifications shown in Appendix C, with laboratory test certificates being made available in support of the quoted performance. Glazing proposals which simply reflect the guidance constructions indicated in this report will not, in isolation, be sufficient evidence that a window configuration will meet the performance specification.*

Without Surrounding Harry Stokes Development

For guidance purposes RBA would typically expect the following glazing configurations to prove commensurate with achieving the sound insulation performance specifications detailed within Appendix C.

Table 8 – Guidance on Glazing Constructions

Glazing Type	Example Glazing Configuration
G1	Standard thermal double glazing with differing pane thicknesses, e.g. 4mm glass / 12mm cavity / 6mm glass

It should be noted that due to the non-acoustic reasons (security, thermal or structural purposes), the specifications may exceed those stated above in some locations.

For guidance purposes RBA would typically expect the following trickle ventilator types to prove commensurate with achieving the sound insulation performance specifications detailed within Appendix C.

Table 9 – Guidance on Trickle Ventilators

Ventilator Type	Example Ventilator Type
V1	Medium specification, acoustically-rated tickle ventilator, e.g. Renson Invisivent EVO AK Basic

With Surrounding Harry Stokes Development

As discussed in Section 5, the incoming surrounding development would likely lead to a 5dB reduction in noise levels. As such, for guidance purposes RBA would typically expect the following glazing configurations to prove commensurate with achieving the sound insulation performance specifications detailed within Appendix C.

Table 10 – Guidance on Glazing Constructions

Glazing Type	Example Glazing Configuration
G1	Standard thermal double glazing with differing pane thicknesses, e.g. 4mm glass / 12mm cavity / 6mm glass

It should be noted that due to the non-acoustic reasons (security, thermal or structural purposes), the specifications may exceed those stated above in some locations.

For guidance purposes RBA would typically expect the following trickle ventilator types to prove commensurate with achieving the sound insulation performance specifications detailed within Appendix C.

Table 11 – Guidance on Trickle Ventilators

Ventilator Type	Example Ventilator Type
V2	Nominally acoustically-rated, low specification through-the-frame trickle ventilator

7. ACOUSTIC MODELLING

In order to predict the noise levels at the different façades an acoustic model of the proposed site has been generated using the CadnaA platform.

The software allows the site topography, existing buildings and sound sources to be built into the model such that the sound sources (i.e. the main surrounding roads) can then be calibrated according to the on-site measurement data. The proposed buildings are subsequently built into the model and calculations using the methodology outlined in ISO9613 are undertaken to predict façade incident noise levels at all floor heights and to produce noise contours for the site. The future road networks serving the development are to be built in and will provide an estimate of the noise levels within the development once it is completed.

The acoustic modelling is used for the analysis undertaken in the next section.

8. ACOUSTICS VENTILATION AND OVERHEATING

The Acoustics, Ventilation and Overheating Residential Design Guide (AVO guidance) was published by the Association of Noise Consultants in January 2020. It is intended to provide guidance on the conflict between opening windows for ventilation and overheating and the associated increase in internal noise levels that inevitably occurs.

The principles of the AVO guidance are as follows:

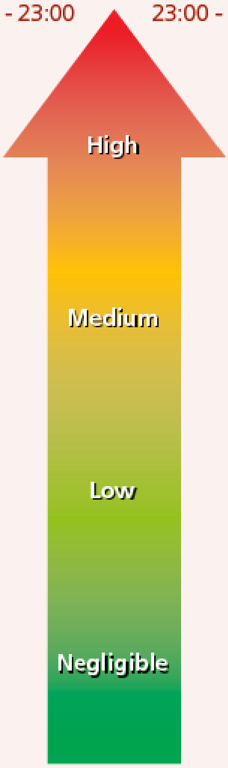
- There are three conditions to consider – background ventilation, purge ventilation, and overheating;
- If open windows are relied upon for background ventilation, appropriate internal noise levels in line with the relevant standards need to be met with open windows.
- If alternative means of background ventilation are provided, appropriate internal noise levels should be met with closed windows;
- Opening windows for purge ventilation even in high noise areas is not considered problematic, as these are typically infrequent events of short duration (e.g. getting rid of paint fumes);
- Where opening windows are required to control overheating, typically a relaxed internal noise level can be adopted, although this depends on the extent of the overheating issue – what portions of the year overheating is expected to occur, and whether it occurs at night etc.

In general, the guidance promotes a two-stage approach, of carrying out an initial high-level assessment for a proposed residential development site. If the first stage assessment indicates that noise could be an issue, a more detailed second assessment is then required.

"Level 1 is a site risk assessment based on external noise levels and the assumption that opening windows are the primary means of mitigating overheating. Based on the Level 1 indication of risk, a subsequent Level 2 assessment may be required."

Table 3.2 of the document, provided below, provides the basis for Level 1 or Level 2 risk assessment:

Table 12 – Guidance for Level 1 Site risk assessment

Risk category for Level 1 assessment [Note 5]	Potential Effect without Mitigation	Recommendation for Level 2 assessment
$L_{Aeq,T}$ [Note 3] during 07:00 - 23:00 $L_{Aeq,8hr}$ during 23:00 - 07:00  65 dB 60 dB 55 dB 50 dB 55 dB 50 dB 45 dB	Increasing risk of adverse effect	Recommended Optional
	Use of opening windows as primary means of mitigating overheating is not likely to result in adverse effect	Not required

The acoustic modelling described in Section 0 was used to calculate the noise levels at the façades of the development, based on the measured noise levels in Tables 1 to 3.

Figures 2 to 5 show the results of the modelling, providing colour coding for where the noise levels fall within the noise level ranges outlined in Table 6. Green indicating that a Level 2 assessment is not required, yellow indicating that a Level 2 assessment is optional, and red indicating that a Level 2 assessment is recommended.

Without Surrounding Harry Stokes Development

The worst-case incident façade noise levels are given in Table 14. It is therefore considered that the risk of noise issues associated with opening windows at the proposed development site will generally be as follows:

Table 13 - Overheating Noise Impact Risk

Worst-case Average $L_{Aeq, period}$ Noise Level (dB)			
Daytime (07:00 – 23:00)	Risk Category	Night-time (23:00 – 07:00)	Risk Category
61	Medium	57	Medium/High

The results of the Level 1 assessment classify the site as a **Medium/High Noise Risk** for both day and night-time in terms of overheating and noise. As such, a Level 2 assessment is recommended.

With Surrounding Harry Stokes Development

The worst-case incident façade noise levels are given in Table 14. It is therefore considered that the risk of noise issues associated with opening windows at the proposed development site will generally be as follows:

Table 14 - Overheating Noise Impact Risk

Worst-case Average $L_{Aeq, period}$ Noise Level (dB)			
Daytime (07:00 – 23:00)	Risk Category	Night-time (23:00 – 07:00)	Risk Category
56	Low/Medium	52	Low/Medium

The results of the Level 1 assessment classify the site as a **Low/Medium Noise Risk** for both day and night-time in terms of overheating and noise. As such, a Level 2 assessment is not required.

9. EXTERNAL AMENITY SPACE

Noise within external amenity spaces should also be considered. BS8233:2014 states the following with regards to noise in external amenity areas:

"For traditional external areas that are used for amenity space, such as gardens and patios, it is desirable that the external noise level does not exceed 50dB $L_{Aeq,T}$, with an upper guideline value of 55dB $L_{Aeq,T}$ which would be acceptable in noisier environments."

Based on the assumption of a 5dB reduction outlined in Section 7, the measured noise levels indicate that the period averaged daytime noise levels are generally above the recommended amenity space noise target of 50dB $L_{Aeq,T}$. However, the period averaged daytime noise levels are below the recommended upper limit amenity space noise target of $L_{Aeq,\,period}$ 55dB provided for noisier environments.

If the surrounding development is not in place, the 5dB reduction is removed and the period averaged daytime noise levels are generally above the recommended upper limit amenity space noise target of $L_{Aeq,\,period}$ 55dB.

It is noted that the site is in close proximity to the M4/M32 and the railway line. BS8233:2014 states

"In higher noise areas, such as city centres or urban areas adjoining the strategic transport network, a compromise between elevated noise levels and other factors, such as the convenience of living in these locations or making efficient use of land resources to ensure development needs can be met, might be warranted. In such a situation, development should be designed to achieve the lowest practicably levels in the external amenity spaces, but should not be prohibited."

As such, the predicted noise levels for the external amenity space should be considered acceptable.

10. CONCLUSION

RBA Acoustics have undertaken noise monitoring at the proposed development site of Hoodlands, Bristol. The measured noise levels are presented within this report. The measured noise levels were used for the assessment of the glazing requirements to ensure suitable internal noise levels are capable of being achieved at the proposed development with reference to BS 8233 and WHO. Consideration was also given to the external amenity space areas.

We can confirm internal noise levels can be effectively controlled by specification of suitable glazing and ventilation configurations.

Consideration has also been given to the potential for noise impact due to overheating within dwellings. Assuming that the surrounding development is not in place, the assessment concludes that further assessment is recommended. However, with the surrounding development in place the assessment concludes that further assessment is not required but may be desired.

We therefore consider that planning approval should be acceptable in terms of noise impact.

Appendix A – Acoustic Terminology

A-weighting (e.g. dB(A))	A correction applied across the frequency bands to take into account the response of the human ear, and therefore considered to be more representative of the sound levels people hear.
DeciBel (dB)	Unit used for many different acoustic parameters. It is the logarithmic ratio of the level being assessed to a standard reference level.
$D_{n,e,w}$	A single number weighted quantity which characterises the airborne sound insulation through a specified small element. A higher numerical quantity represents a better performance.
$L_{eq,T}$	The level of a notional steady sound which, over a stated period of time, *T*, would have the same acoustic energy as the fluctuating noise measured over that period. Typically used to represent the average or ambient noise level.
$L_{Aeq,T}$	The A-weighted level of a notional steady sound which, over a stated period of time, *T*, would have the same acoustic energy as the fluctuating noise measured over that period. Typically used to represent the average or ambient noise level.
L_{An} (e.g. L_{A10}, L_{A90})	The sound level exceeded for n% of the time. E.g. L_{A10} is the A-weighted level exceeded for 10% of the time and as such can be used to represent a typical maximum level. Similarly, L_{A90} is the level exceeded for 90% of the measurement period, and is often used to describe the underlying background noise.
$L_{Amax,T}$	The instantaneous maximum A-weighted sound pressure level which occurred during the measurement period, *T*. It is commonly used to measure the effect of very short duration bursts of noise, e.g. sudden bangs, shouts, car horns, emergency sirens etc. which audibly stand out from the ambient level.
Octave band	A frequency band in which the upper limit of the band is twice the frequency of the lower limit.
1/3 Octave band	A frequency band which is one-third of an octave band.
R_w	A single number quantity which characterises the airborne sound insulation of a material or building element in a laboratory test.

Appendix B – Room Absorption Coefficients

For the purposes of the analyses RBA have assumed the absorption coefficients detailed in Table B1 for bedrooms and Table B2 for living rooms.

Table B1 – Bedroom Absorption Coefficients

Absorption Coefficient (α) at Octave Band Centre Frequency (Hz)							
63	125	250	500	1k	2k	4k	8k
0.15	0.18	0.25	0.27	0.31	0.32	0.32	0.32

Table B2 – Living Room Absorption Coefficients

Absorption Coefficient (α) at Octave Band Centre Frequency (Hz)							
63	125	250	500	1k	2k	4k	8k
0.15	0.18	0.20	0.22	0.22	0.22	0.23	0.27

Appendix C – External Building Fabric Acoustic Specification

External facade constructions and components, such as brise soleil, grilles, ventilators, curtain walling systems or other architectural features, are not to give rise to intrusive whistling, creaking, rattling or other noises as a result of wind or other climatic effects.

The Contractor shall take reasonable precautions to avoid unwanted noise including creaking, rattling and whistling being generated by the Contractors works when subject to environmental conditions (including wind) and thermal expansion over the life of the façade.

1.0 Window Sound Insulation Performance

Glazed units (inclusive of glazing, louvres, timber panels, spandrel panels, infill panels, framing, opening lights, balcony/terrace doors, seals, etc. as appropriate) should achieve the following minimum sound reduction indices as tested in general accordance with BS EN ISO 10140-2:2010:

Table C1 – Window Sound Insulation Performance Specification

Type	Minimum Recommended Sound Reduction Index (dB) at Octave Band Centre Frequency (Hz)								R_w (dB)
	63	125	250	500	1k	2k	4k	8k	
G1	19	23	24	23	32	38	35	35	31

Note: R_w is the "overall weighted sound reduction index" tested in a laboratory.

N.B. as the internal noise criteria are expressed in overall terms, other frequency-specific performance levels may ultimately prove acoustically acceptable. Test data for representative samples of all glazing systems shall be submitted to RBA Acoustics for approval to demonstrate compliance with the above performance specifications.

2.0 Ventilator Sound Insulation Performance

Trickle ventilators (in their open state) should achieve the following minimum element-normalised level differences as tested in accordance with BS EN 20140-10:2010:

Table C2 – Ventilator Sound Insulation Performance Specification

Type	Minimum Recommended $D_{n,e}$ (dB) at Octave Band Centre Frequency (Hz)								$D_{n,e,w}$ (dB)
	63	125	250	500	1k	2k	4k	8k	
V1	27	31	36	31	38	28	28	28	32

Note: $D_{n,e,w}$ is the "overall weighted element normalised level difference" tested in a laboratory.

Please note the above specification assumes one trickle ventilator will be installed per room, i.e. a continuous mechanical extract system (ADF System 3) will be utilised. The specification should be increased by a factor of 10Log(N) should N ventilators be required per room, i.e. increase by +3dB or +5dB respectively should two or three ventilators be required per room.

N.B. as the internal noise criteria are expressed in overall terms, other frequency specific performance levels may ultimately prove acoustically acceptable. Test data for the trickle vents in their open state shall be submitted to RBA Acoustics for approval.

Appendix D – Instrumentation

The following equipment was used for the measurements.

Table B3 – Equipment Calibration Details

Manufacturer	Model Type	Serial No.	Calibration	
			Certificate No.	Valid Until
Norsonic Type 1 Sound Level Meter	Nor140	1403226	U36698	5 January 2023
Norsonic Pre Amplifier	1209A	12066		
Norsonic ½" Microphone	1225	168180	36697	5 January 2023
Norsonic Sound Calibrator	1251	31988	U36696	4 January 2023
Norsonic Type 1 Sound Level Meter	Nor140	1406255	U31223	12 March 2021
Norsonic Pre Amplifier	1209	20491		
Norsonic ½" Microphone	1225	225529	31222	12 March 2021
Norsonic Sound Calibrator	1251	34391	U31221	12 March 2021

Appendix E – Graphs and Site Plans

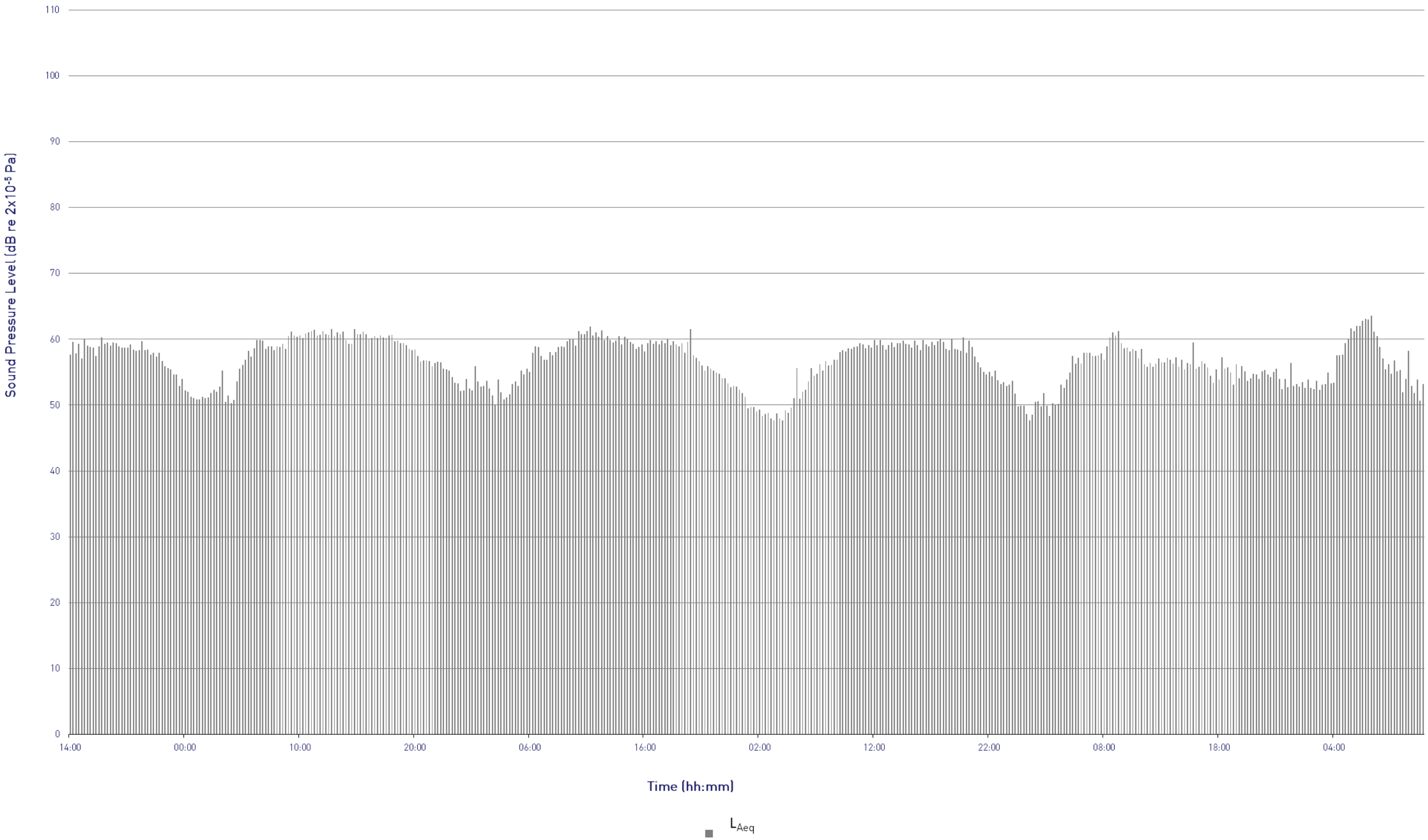
The Hoodlands, Bristol

L_{Aeq} Time History

Measurement Position 1 - Eastern Boundary

Project: 10905

Graph 1



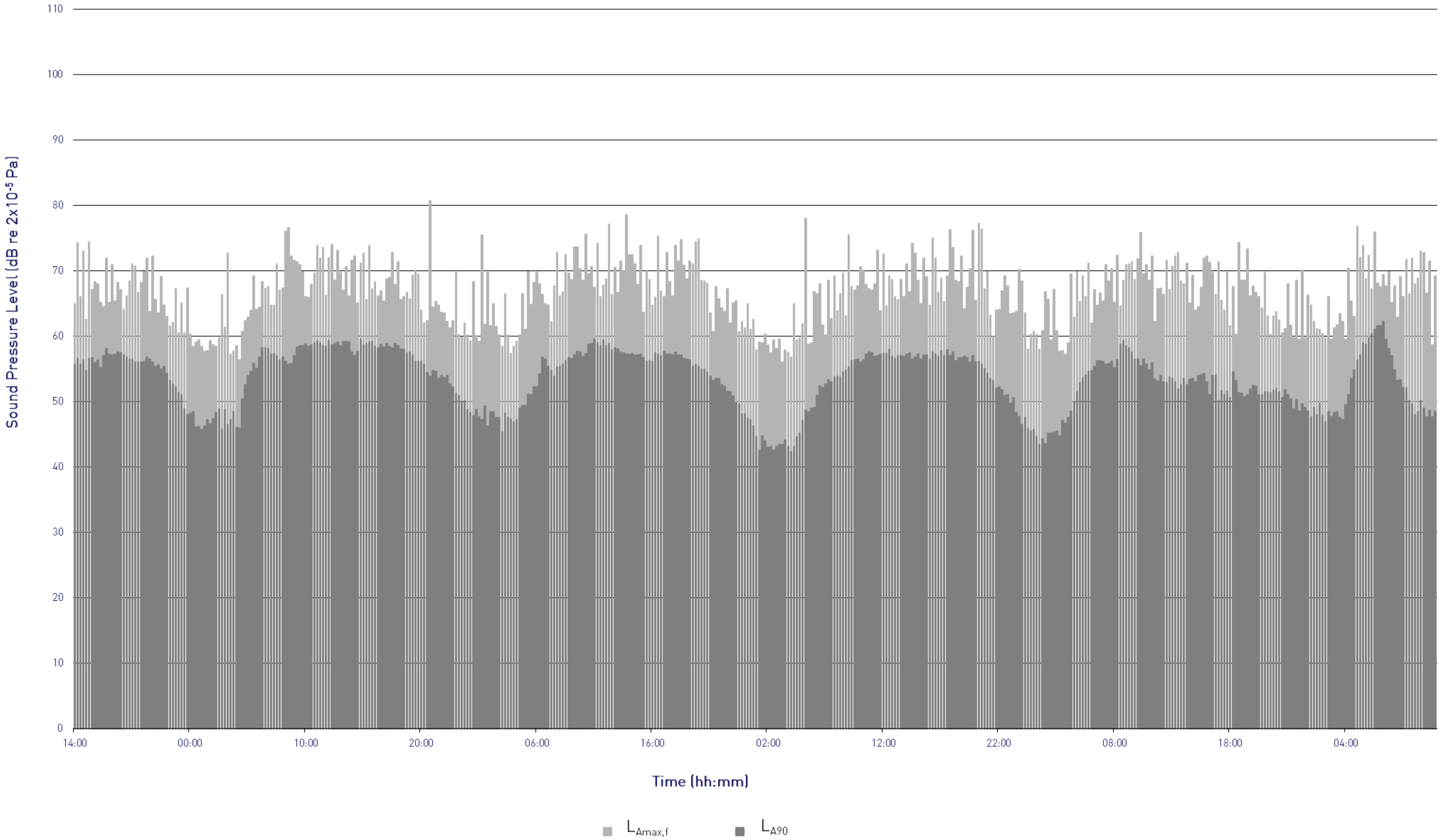
The Hoodlands, Bristol

$L_{Amax,f}$ and L_{A90} Time History

Measurement Position 1 - Eastern Boundary

Project: 10905

Graph 2



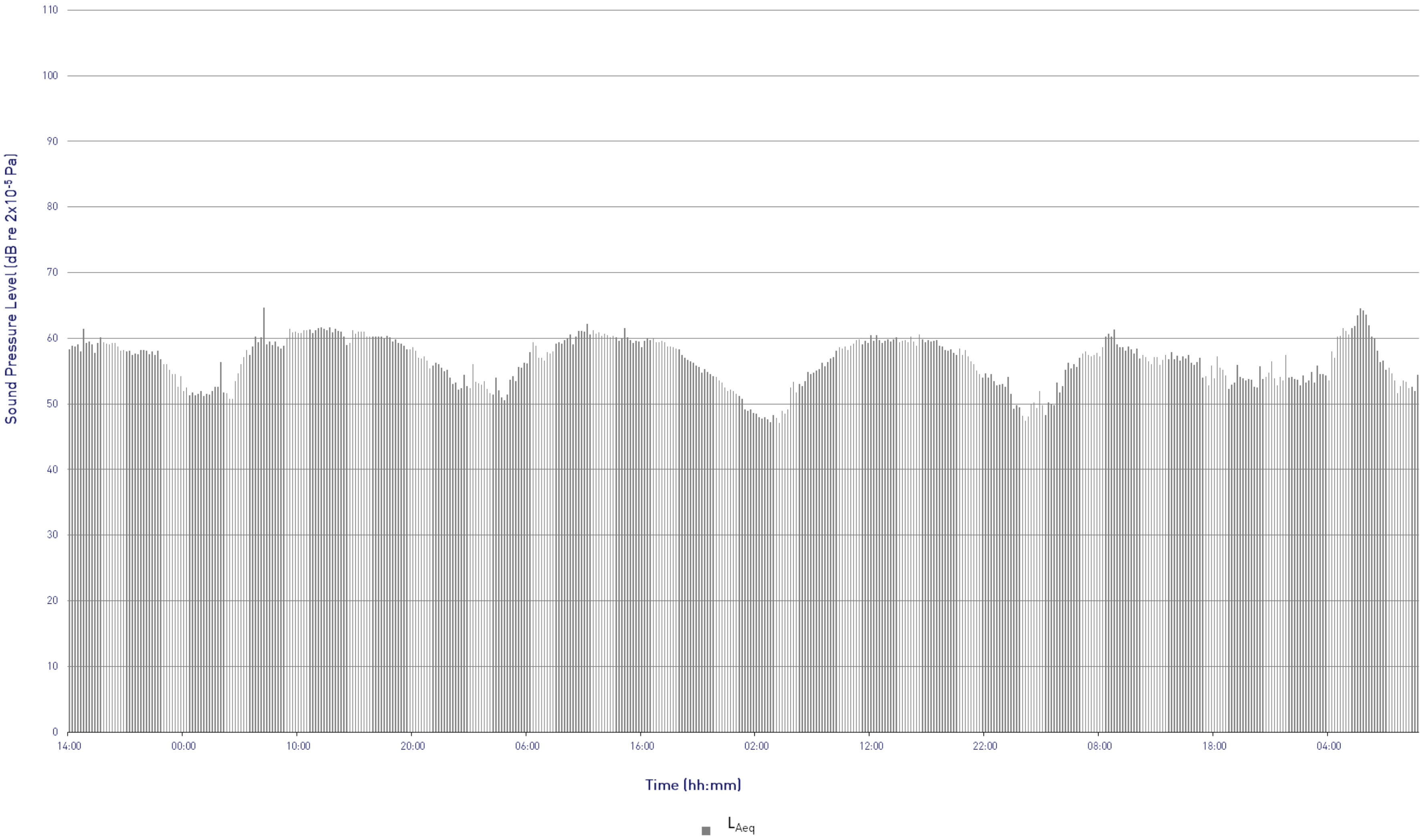
The Hoodlands, Bristol

L_{Aeq} Time History

Measurement Position 2 - Northern Boundary

Project: 10905

Graph 3



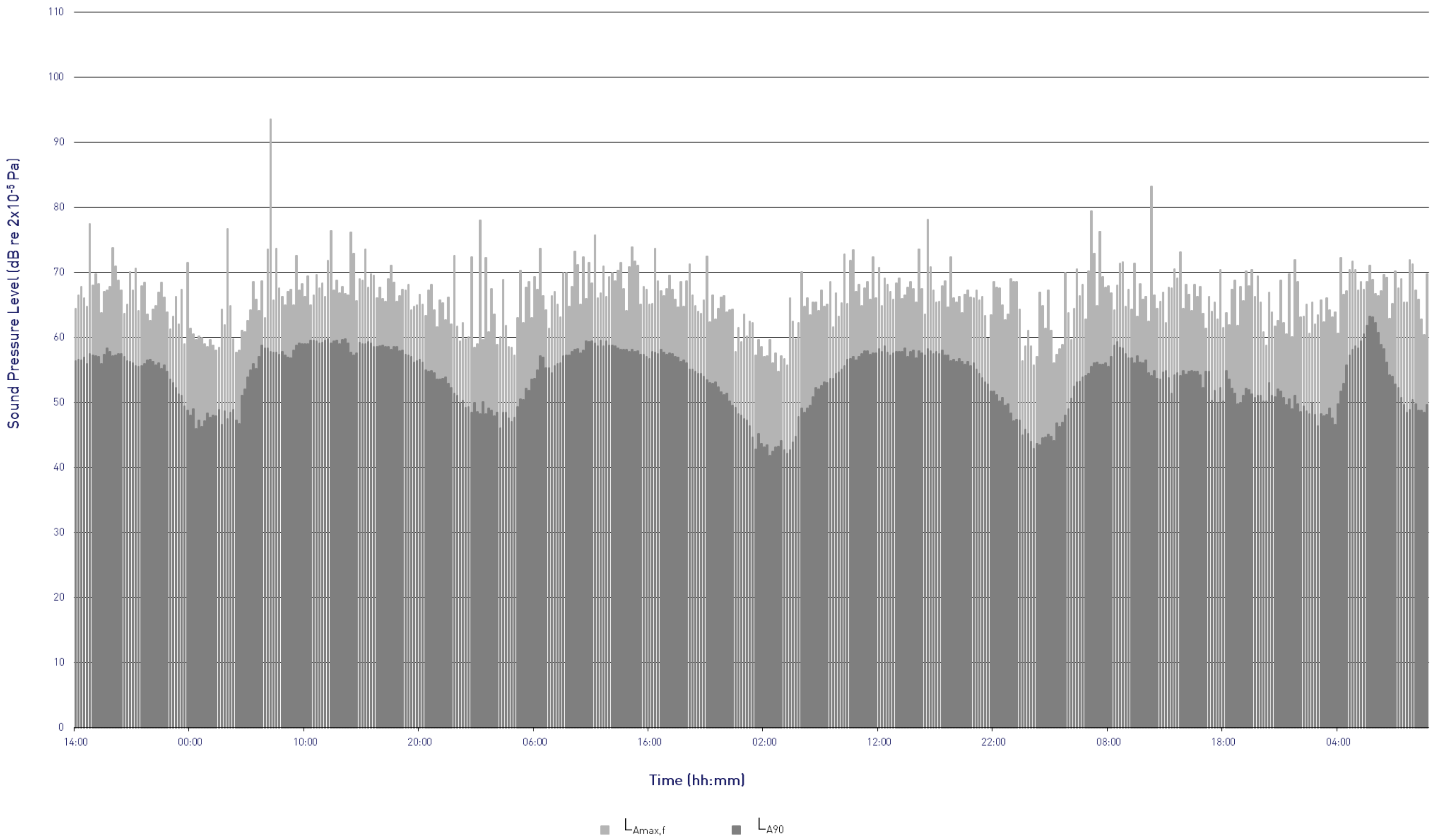
The Hoodlands, Bristol

$L_{Amax,f}$ and L_{A90} Time History

Measurement Position 2 - Northern Boundary

Project: 10905

Graph 4



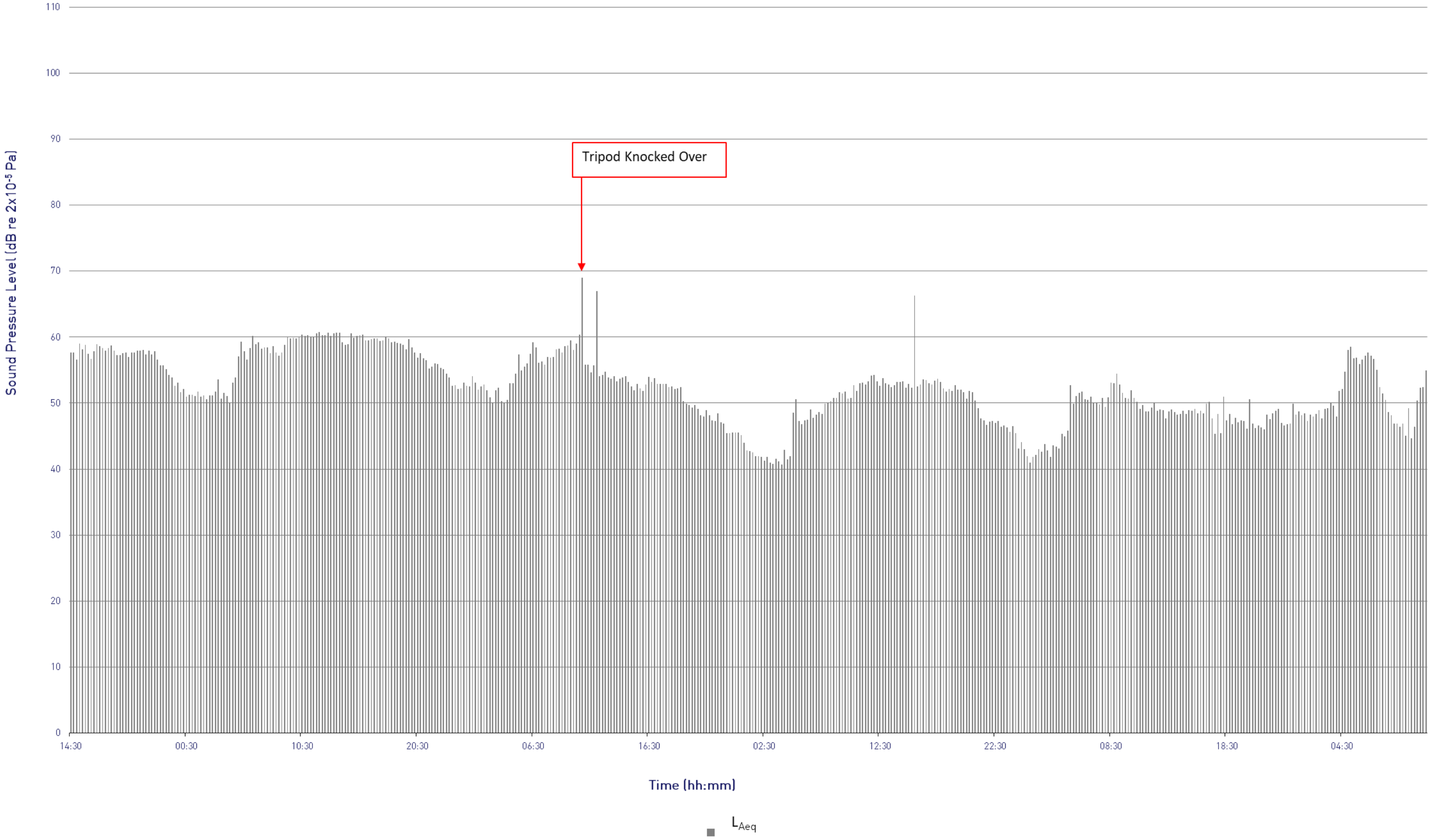
The Hoodlands

L_{Aeq} Time History

Measurement Position 3 - Western Boundary

Project: 10905

Graph 5



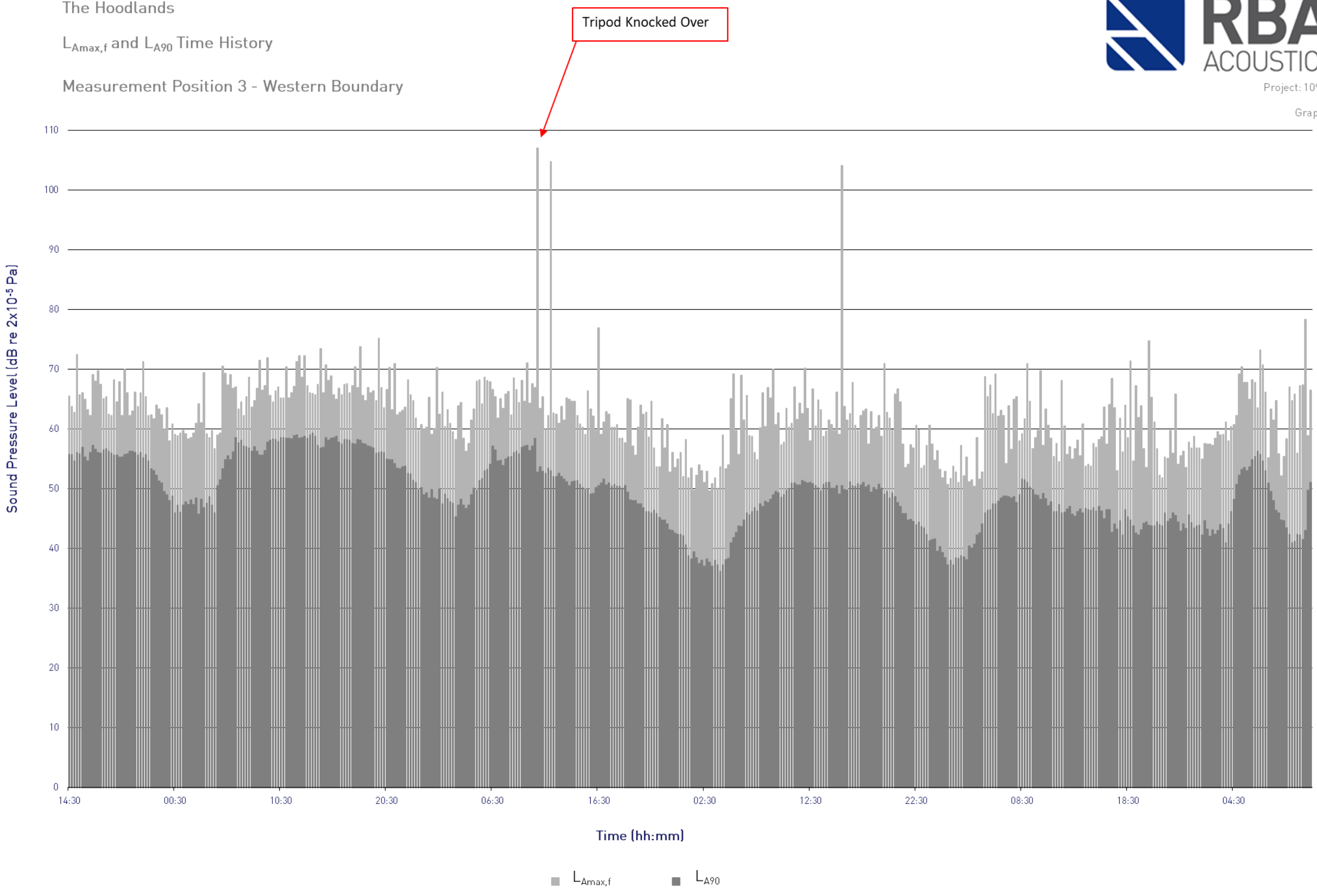
The Hoodlands

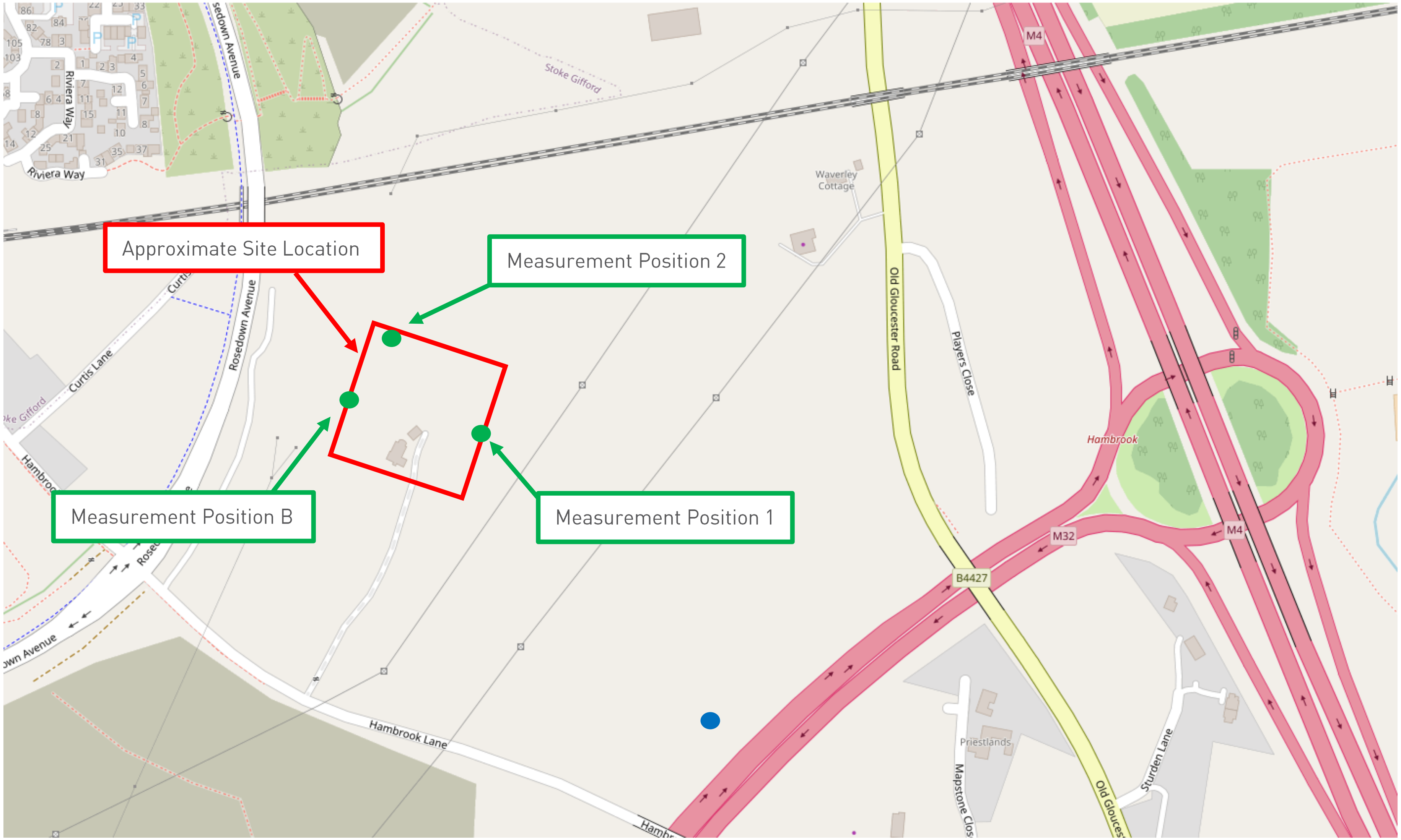
$L_{Amax,f}$ and L_{A90} Time History

Measurement Position 3 - Western Boundary

Project: 10905

Graph 6





Hoodlands, Bristol

Site Plan

Project 10905

Figure 1

15 July 2021

Not to Scale

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Hoodlands, Bristol

Acoustic Modelling Daytime Noise Levels – Without Surrounding Development

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Figure 2

15 July 2021

Not to Scale

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Acoustic Modelling Night-time Noise Levels – Without Surrounding Development

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Figure 3

15 July 2021

Not to Scale

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Hoodlands, Bristol

Acoustic Modelling Daytime Noise Levels – With Surrounding Development

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Figure 4

15 July 2021

Not to Scale

RBA ACOUSTICS

Hoodlands, Bristol

Acoustic Modelling Night-time Noise Levels – With Surrounding Development

Project 10905

Figure 5

15 July 2021

Not to Scale

RBA ACOUSTICS

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