



Former M-Block, Gravesend

Noise Assessment for Planning

19th August 2022

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1. INTRODUCTION

1.1. Overview

inacoustic has been commissioned to assess the impact of noise at the Former M-Block, Gravesend Hospital, Gravesend in respect of the site's suitability for residential development.

The assessment is based upon environmental noise measurements undertaken at the site and a predictive exercise. An assessment of the sound insulation between commercial and residential spaces has also been conducted.

This noise assessment is necessarily technical in nature; therefore a glossary of terms is included in Appendix A to assist the reader.

1.2. Scope and Objectives

The scope of the noise assessment can be summarised as follows:

- A sound monitoring survey was undertaken at discrete locations around the Site;
- A detailed assessment of the suitability of the Site, in accordance with relevant standards in respect of sound from the existing sources; and
- Recommendation of mitigation measures, where necessary, to comply with the requirements of the National Planning Practice Guidance in England: Noise¹, BS8233:2014² and BS4142:2014+A1:2019³.

¹ Department for Communities and Local Government (DCLG), 2019. National Planning Practice Guidance for England: Noise. DCLG.

² British Standard Institution. BS 8233:2014 Guidance on sound insulation and noise reduction for buildings.

³ British Standard 4142: 2014+A1:2019 *Method for rating and assessing commercial sound*. BSI

2. LEGISLATION AND POLICY FRAMEWORK

The development proposals for the Site are guided by the following policy directives and guidance:

2.1. National Policy

2.1.1. National Planning Policy Framework, 2021

The *National Planning Policy Framework* (NPPF)⁴ sets out the Government's planning policies for England. Planning policy requires that applications for planning permission must be determined in accordance with the development plan, unless material considerations indicate otherwise.

The NPPF is also a material consideration in planning decisions. It sets out the Government's requirements for the planning system and how these are expected to be addressed.

Under Section 15; *Conserving and Enhancing the Natural Environment*, in Paragraph 174, the following is stated:

"Planning policies and decisions should contribute to and enhance the natural and local environment by:

- e) preventing new and existing development from contributing to, being put at unacceptable risk from, or being adversely affected by, unacceptable levels of soil, air, water or noise pollution or land instability".*

Paragraph 185 of the document goes on to state:

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

- a) mitigate and reduce to a minimum potential adverse impacts resulting from noise from new development - and avoid noise giving rise to significant adverse impacts on health and the quality of life;*
- b) identify and protect tranquil areas which have remained relatively undisturbed by noise and are prized for their recreational and amenity value for this reason"*

Paragraph 185 refers to the Noise Policy Statement for England, which is considered overleaf.

⁴ Ministry of Housing, Communities and Local Government (MHCLG), July 2021. National Planning Policy Framework. HMSO. London.

2.1.2. Noise Policy Statement for England, 2010

The underlying principles and aims of existing noise policy documents, legislation and guidance are clarified in *DEFRA: 2010: Noise Policy Statement for England* (NPSE)⁵. The NPSE sets out the “Long Term Vision” of Government noise policy as follows:

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

The NPSE outlines three aims for the effective management and control of environmental, neighbour and neighbourhood noise:

- *“Avoid significant adverse impacts on health and quality of life;*
- *Mitigate and minimise adverse impacts on health and quality of life; and*
- *Where possible, contribute to the improvement of health and quality of life”.*

The guidance states that it is not possible to have a single objective noise-based measure that defines “Significant Observed Adverse Effect Level (SOAEL)” that is applicable to all sources of noise in all situations and that not having specific SOAEL values in the NPSE provides the necessary policy flexibility until further evidence and suitable guidance is available.

2.1.3. National Planning Practice Guidance in England: Noise, 2019 (PPGNoise)

Paragraph: 002 of the PPGNoise states the following:

“Can noise override other planning concerns?”

It can, where justified, although it is important to look at noise in the context of the wider characteristics of a development proposal, its likely users and its surroundings, as these can have an important effect on whether noise is likely to pose a concern.”

As such, Paragraph: 003 of the NPPG states that:

“Plan-making and decision making need to take account of the acoustic environment and in doing so consider:

- *whether or not a significant adverse effect is occurring or likely to occur;*
- *whether or not an adverse effect is occurring or likely to occur; and*
- *whether or not a good standard of amenity can be achieved.*

In line with the Explanatory note of the NPSE, this would include identifying whether the overall effect of the noise exposure ... is, or would be, above or below the significant observed adverse effect level and the lowest observed adverse effect level for the given situation.”

Consequently, the *National Planning Practice Guidance in England: Noise* (NPPG Noise)⁶ summarises the noise exposure hierarchy, based on the likely average response. The following three observed effect levels are identified below, as identified in Paragraph 004:

⁵ Department for Environment, Food and Rural Affairs (DEFRA), 2010. Noise Policy Statement for England. DEFRA.

⁶ Department for Communities and Local Government (DCLG), 2019. National Planning Practice Guidance for England: Noise. DCLG.

- **Significant Observed Adverse Effect Level:** This is the level of noise exposure above which significant adverse effects on health and quality of life occur;
- **Lowest Observed Adverse Effect Level:** This is the level of noise exposure above which adverse effects on health and quality of life can be detected; and
- **No Observed Adverse Effect Level:** This is the level of noise exposure below which no effect at all on health or quality of life can be detected.

Importantly, Paragraph: 004 of the PPGNoise states that:

“Although the word ‘level’ is used here, this does not mean that the effects can only be defined in terms of a single value of noise exposure. In some circumstances adverse effects are defined in terms of a combination of more than one factor such as noise exposure, the number of occurrences of the noise in a given time period, the duration of the noise and the time of day the noise occurs.”

Paragraph: 005 of the PPGNoise expands the significant criteria related to each of these levels, which are reproduced in Table 1 below.

TABLE 1: SIGNIFICANCE CRITERIA FROM NPPG IN ENGLAND: NOISE

Perception	Examples of Outcomes	Increasing Effect Level	Action
No Observed Effect Level			
Not Noticeable	No Effect	No Observed Effect	No specific measures required
No Observed Adverse Effect Level			
Noticeable and Not Intrusive	Noise can be heard, but does not cause any change in behaviour, attitude or other physiological response. Can slightly affect the acoustic character of the area but not such that there is a change in the quality of life.	No Observed Adverse Effect	No specific measures required
Lowest Observed Adverse Effect Level			
Noticeable and Intrusive	Noise can be heard and causes small changes in behaviour, attitude or other physiological response, e.g. turning up volume of television; speaking more loudly; where there is no alternative ventilation, having to close windows for some of the time because of the noise. Potential for some reported sleep disturbance. Affects the acoustic character of the area such that there is a small actual or perceived change in the quality of life.	Observed Adverse Effect	Mitigate and reduce to a minimum
Significant Observed Adverse Effect Level			
Present and Disruptive	The noise causes a material change in behaviour, attitude or other physiological response, e.g. avoiding certain activities during periods of intrusion; where there is no alternative ventilation, having to keep windows closed most of the time because of the noise. Potential for sleep disturbance resulting in difficulty in getting to sleep, premature awakening and difficulty in getting back to sleep. Quality of life diminished due to change in acoustic character of the area.	Significant Observed Adverse Effect	Avoid
Present and Very Disruptive	Extensive and regular changes in behaviour, attitude or other physiological response and/or an inability to mitigate effect of noise leading to psychological stress, e.g. regular sleep deprivation/awakening; loss of appetite, significant, medically definable harm, e.g. auditory and non-auditory.	Unacceptable Adverse Effect	Prevent

Paragraph: 006 of the PPGNoise expands on what factors influence whether noise could be a concern; those factors relevant to this Planning Application are reproduced below:

“The subjective nature of noise means that there is not a simple relationship between noise levels and the impact on those affected. This will depend on how various factors combine in any particular situation.

These factors include:

- *the source and absolute level of the noise together with the time of day it occurs. Some types and level of noise will cause a greater adverse effect at night than if they occurred during the day – this is because people tend to be more sensitive to noise at night as they are trying to sleep. The adverse effect can also be greater simply because there is less background noise at night;*
- *the spectral content of the noise (i.e. whether or not the noise contains particular high or low frequency content) and the general character of the noise (i.e. whether or not the noise contains particular tonal characteristics or other particular features), and;*
- *the local arrangement of buildings, surfaces and green infrastructure, and the extent to which it reflects or absorbs noise.*

More specific factors to consider when relevant include:

- *the cumulative impacts of more than one source of noise;*
- *whether any adverse internal effects can be completely removed by closing windows and, in the case of new residential development, if the proposed mitigation relies on windows being kept closed most of the time (and the effect this may have on living conditions). In both cases a suitable alternative means of ventilation is likely to be necessary. Further information on ventilation can be found in the Building Regulations.*
- *where external amenity spaces are an intrinsic part of the overall design, the acoustic environment of those spaces should be considered so that they can be enjoyed as intended.”*

Paragraph: 009 of the PPGNoise expands on whether future noise generation could be a concern; which are reproduced below

“Development proposed in the vicinity of existing businesses, community facilities or other activities may need to put suitable mitigation measures in place to avoid those activities having a significant adverse effect on residents or users of the proposed scheme.

In these circumstances the applicant (or ‘agent of change’) will need to clearly identify the effects of existing businesses that may cause a nuisance (including noise, but also dust, odours, vibration and other sources of pollution) and the likelihood that they could have a significant adverse effect on new residents/users. In doing so, the agent of change will need to take into account not only the current activities that may cause a nuisance, but also those activities that businesses or other facilities are permitted to carry out, even if they are not occurring at the time of the application being made.

The agent of change will also need to define clearly the mitigation being proposed to address any potential significant adverse effects that are identified. Adopting this approach may not prevent all complaints from the new residents/users about noise or other effects, but can help to achieve a satisfactory living or working environment, and help to mitigate the risk of a statutory nuisance being found if the new development is used as designed (for example, keeping windows closed and using alternative ventilation systems when the noise or other effects are occurring).”

Paragraph: 010 of the PPGNoise outlines various approaches to reducing the adverse effects of noise; the approach considered in this report relates to providing a suitably design building façade.

Further to the comment on the previous page regarding Paragraph: 006 with respect to external amenity spaces, Paragraph: 011 of the PPGNoise goes on to state:

"Noise impacts may be partially offset if residents have access to one or more of:

- *a relatively quiet facade (containing windows to habitable rooms) as part of their dwelling;*
- *a relatively quiet external amenity space for their sole use, (e.g. a garden or balcony). Although the existence of a garden or balcony is generally desirable, the intended benefits will be reduced if this area is exposed to noise levels that result in significant adverse effects;*
- *a relatively quiet, protected, nearby external amenity space for sole use by a limited group of residents as part of the amenity of their dwellings; and/or*
- *a relatively quiet, protected, external publically accessible amenity space (e.g. a public park or a local green space designated because of its tranquillity) that is nearby (e.g. within a 5-minute walking distance)."*

PPGNoise recognises it would, of course, be preferable to have access to a relatively quiet external amenity space that is not subject to a significant adverse effect, but that this may not always be possible, and that it is *"generally desirable"* to have access to some external amenity space even if *"this area is exposed to noise levels that result in significant adverse effects"*.

Finally, Paragraph: 015 of the PPGNoise outlines other information that is available to assist in assessing noise. The paragraph, amongst other standards, recommends the use of:

- BS8233:2014 – Guidance on Sound Insulation and Noise Reduction for Buildings

Critically, Paragraph: 015 of the PPGNoise states the following:

"Some of these documents contain numerical criteria. These values are not to be regarded as fixed thresholds and as outcomes that have to be achieved in every circumstance."

2.2. British Standards

2.2.1. BS8233:2014 *Guidance on sound insulation and noise reduction for buildings*

BS 8233:2014 draws on the results of research and experience to provide information on achieving internal acoustic environments appropriate to their functions. The guideline values provided are in terms of an average (L_{Aeq}) level.

The standard advises that, for steady external noise sources, it is desirable for internal ambient noise levels to not exceed the guidance values, as detailed below in Table 2.

TABLE 2: BS8233:2014 AMBIENT NOISE LEVELS

Activity	Location	07:00 to 23:00	23:00 to 07:00
Resting	Living room	35 dB $L_{Aeq,16hour}$	-
Dining	Dining room	40 dB $L_{Aeq,16hour}$	-
Sleeping	Bedroom	35 dB $L_{Aeq,16hour}$	30 dB $L_{Aeq,8hour}$

BS8233:2014 goes on to suggest that where development is considered necessary or desirable, the internal target levels may be relaxed by up to 5 dB and reasonable internal conditions will still be achieved.

With regard to maximum noise levels, the standard identifies that regular individual noise events (such as passing trains or scheduled aircraft etc) can cause sleep disturbance. The standard does not provide a guideline design target, but simply goes on to suggest that a guideline value may be set in terms of SEL or $L_{Amax,F}$, depending upon the character and number of events per night. It goes on to suggest that more sporadic noise events could require separate values.

In respect of external noise levels, the guidance in BS8233:2014 suggests that *“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”*.

BS8233:2014 provides a much more detailed narrative on noise levels in external amenity areas and acknowledges that it may not always be necessary or feasible to ensure that noise levels remain within these guideline values.

In respect of gardens and patios, BS8233:2014 states;

“...it is also recognized that these guideline values are not achievable in all circumstances where development might be desirable.”

BS8233: 2014 goes on to state, for areas adjoining the strategic transport network:

“...a compromise between elevated noise levels and other factors, such as the convenience of living in these locations or making efficient use of land resources to ensure development needs can be met, might be warranted. In such a situation, development should be designed to achieve the lowest practicable levels in these external amenity spaces, but should not be prohibited”.

In respect of balconies, roof gardens and terraces, BS8233:2014 states; *“Other locations, such as balconies, roof gardens and terraces, are also important in residential buildings where normal*

external amenity space might be limited or not available, i.e. in flats, apartment blocks, etc. In these locations, specification of noise limits is not necessarily appropriate. Small balconies may be included for uses such as drying washing or growing pot plants, and noise limits should not be necessary for these uses; however, the general guidance on noise in amenity space is still appropriate for larger balconies, roof gardens and terraces, which might be intended to be used for relaxation. In high-noise areas, consideration should be given to protecting these areas by screening or building design to achieve the lowest practicable levels. Achieving levels of 55 dB $L_{Aeq,T}$ or less might not be possible at the outer edge of these areas, but should be achievable in some areas of the space”.

It is clear from the narrative of BS8233:2014, that proposed development within noisy environments should be designed to ensure that the recommended internal design standards are achieved, and that noise levels in external amenity areas are designed to effectively control and reduce noise levels, although it acknowledges that in certain circumstance meeting the external design recommendations may not be feasible, or necessary, especially where the provision of such spaces is desirable for other technical, planning or policy reasons.

2.2.2. BS4142:2014+A1:2019 *Methods for rating and assessing industrial and commercial sound*

BS4142:2014+A1:2019 sets out a method to assess the likely effect of sound from factories, industrial premises or fixed installations and sources of an industrial nature in commercial premises, on people who might be inside or outside a dwelling or premises used for residential purposes in the vicinity.

The procedure contained in BS4142:2014+A1:2019 for assessing the effect of sound on residential receptors is to compare the measured or predicted sound level from the source in question, the $L_{Aeq,T}$ ‘specific sound level’, immediately outside the dwelling with the $L_{A90,T}$ background sound level.

Where the sound contains a tonality, impulsivity, intermittency and other sound characteristics, then a correction depending on the grade of the aforementioned characteristics of the sound is added to the specific sound level to obtain the $L_{Ar,Tr}$ ‘rating sound level’. A correction to include the consideration of a level of uncertainty in sound measurements, data and calculations can also be applied when necessary.

BS4142:2014+A1:2019 states: *“The significance of sound of an industrial and/or commercial nature depends upon both the margin by which the rating level of the specific sound source exceeds the background sound level and the context in which the sound occurs”*. An estimation of the impact of the specific sound can be obtained by the difference of the rating sound level and the background sound level and considering the following:

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

During the daytime, the assessment is carried out over a reference time period of 1-hour, with a referencing period of 15 minutes used during the night. The periods associated with day or night, for the purposes of the Standard, are considered to be 07.00 to 23.00 and 23.00 to 07.00, respectively.

3. SITE DESCRIPTION

3.1. Site and Surrounding Area

The Proposed Development is situated on the Former M-Block of the Gravesend Hospital, and the site area can be seen in Figure 1, below.

The ambient sound across the site was mainly influenced by moderate levels of road traffic noise arising from vehicles on the A226 Road, to the east of the development.

FIGURE 1: PROPOSED DEVELOPMENT SITE AND SURROUNDING AREA



FIGURE 3: PROPOSED DEVELOPMENT – EXAMPLE FLOOR PLAN (FIRST FLOOR TO FIFTH FLOOR)



FIGURE 4: PROPOSED DEVELOPMENT – SIXTH FLOOR PLAN



FIGURE 5: PROPOSED DEVELOPMENT – SEVENTH FLOOR PLAN

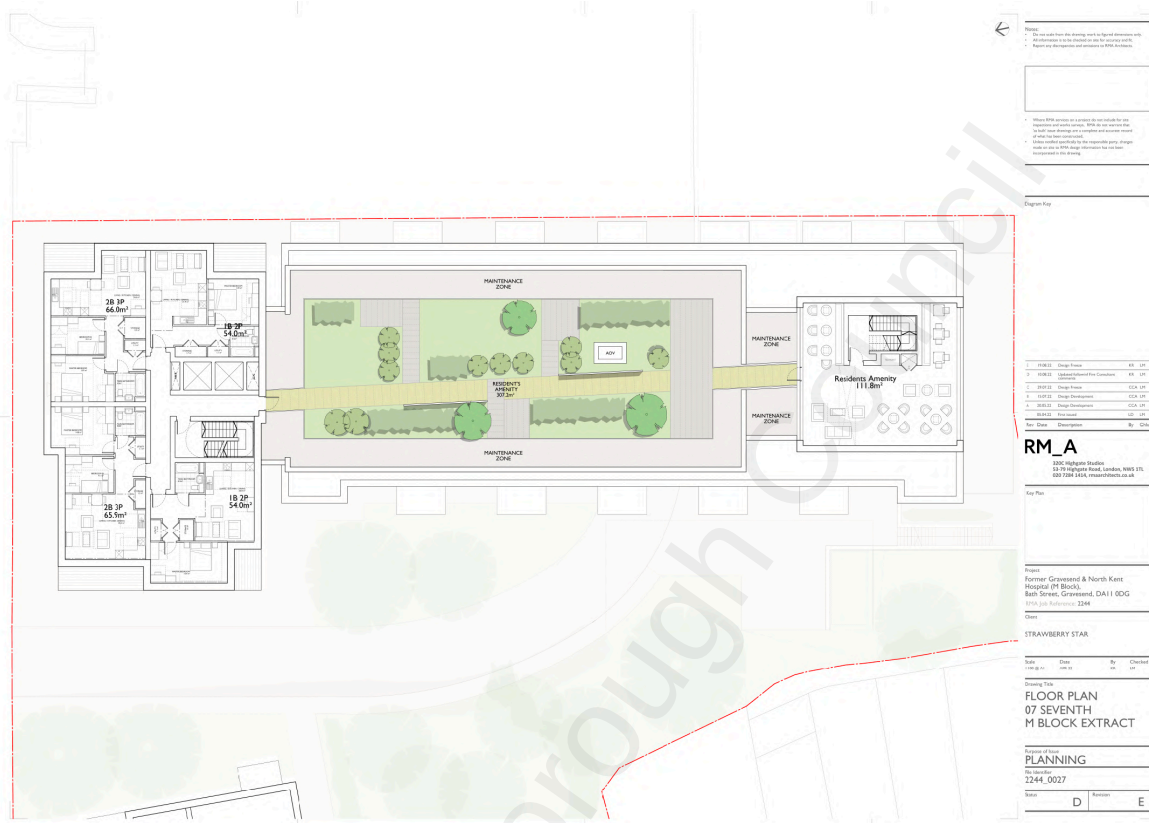
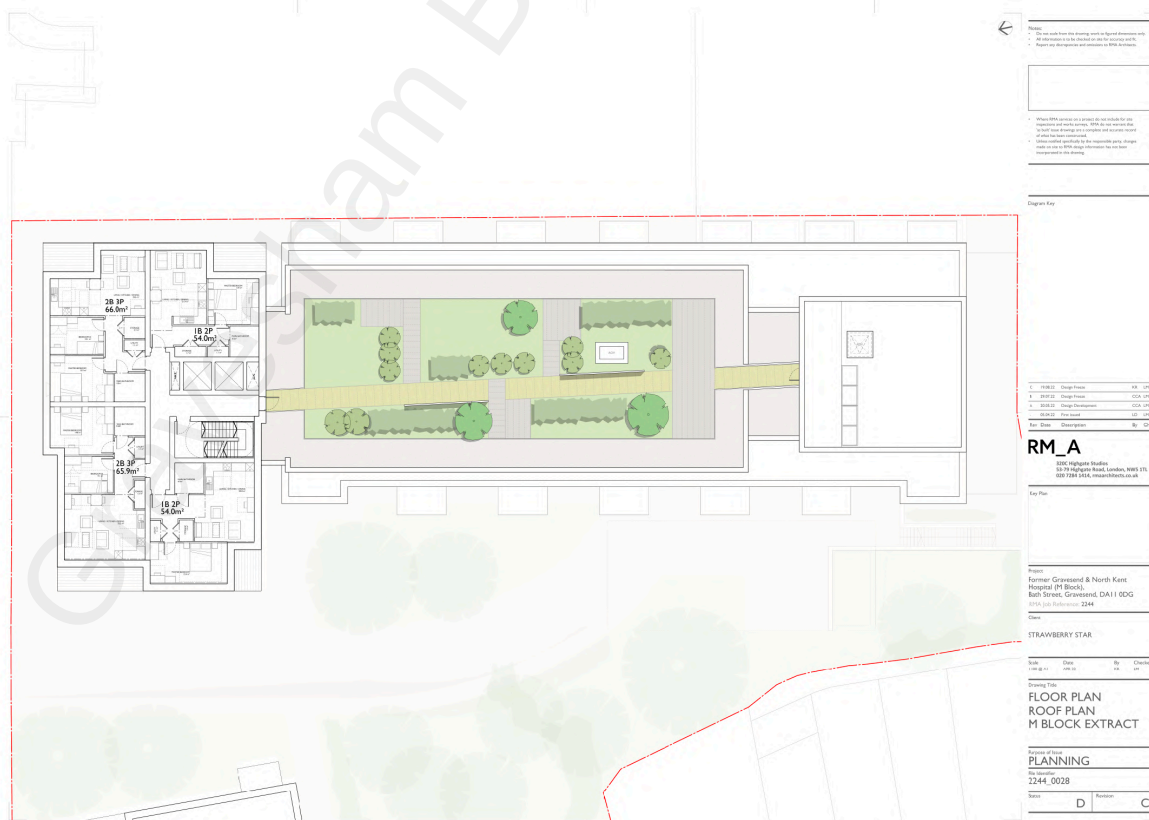


FIGURE 6: PROPOSED DEVELOPMENT – ROOF PLAN



4. MEASUREMENT METHODOLOGY

4.1. General

The prevailing noise conditions in the area have been determined by an environmental noise survey conducted during both daytime and night-time periods between Thursday 10th and Friday 11th January 2019.

4.2. Measurement Details

All noise measurements were undertaken by a consultant certified as competent in environmental noise monitoring, and, in accordance with the principles of BS 7445⁷.

All acoustic measurement equipment used during the noise survey conformed to Type 1 specification of British Standard 61672⁸. A full inventory of this equipment is shown in Table 3 below.

TABLE 3: INVENTORY OF SOUND MEASUREMENT EQUIPMENT

Measurement Position	Make, Model & Description	Serial Number
MP1	Rion NL-52 Sound Level Meter	00943282
	Rion NH-25 Preamplifier	43298
	Rion UC-59 Microphone	07045
MP2	Svantek 955 Sound Level Meter	23676
	Svantek SV 12L Preamplifier	25615
	ACO 7052E Microphone	49543
Both	Cirrus CR:515 Acoustic Calibrator	76798

The sound measurement equipment used during the survey was field calibrated at the start and end of the measurement period. A UKAS accredited calibration laboratory has calibrated the field calibrator used within the twelve months preceding the measurements. A drift of less than 0.2 dB in the field calibration was found to have occurred on all sound level meters.

The weather conditions during the survey were conducive to environmental noise measurement; it being dry, with little or no discernable wind.

The microphones were fitted with protective windshields for the measurements, which are described in Table 3, with an aerial photograph indicating their respective locations shown in Figure 7.

⁷ British Standard 7445: 2003: Description and measurement of environmental noise. BSI

⁸ British Standard 61672: 2013: Electroacoustics. Sound level meters. Part 1 Specifications. BSI.

TABLE 3: MEASUREMENT POSITIONS DESCRIPTIONS

Measurement Position	Description
MP1	A largely unattended measurement of ambient sound at the façade line, overlooking the A226. The measurement was undertaken under free-field conditions, with the microphone located at a height of 4 metres above local ground level, on the flat roof of the existing building. The sound environment was dominated by road traffic using the A226.
MP2	A largely unattended measurement of ambient sound at the façade line, overlooking Stuart Road and Clifton road. The measurement was undertaken under free field conditions, with the microphone located at a height of 4 metres above local ground level, on the flat roof of the existing building. The sound environment was dominated by flanking road traffic noise from vehicles using the A226.

FIGURE 7: MEASUREMENT POSITIONS



The summarised results of the environmental noise measurements are presented in Table 4.

TABLE 4: SUMMARY OF NOISE MEASUREMENT RESULTS

Measurement Position	Period	Noise Level, dB			
		L _{Aeq,T}	L _{AMax}	L _{A10}	L _{A90}
MP1	Day	59	72	62	53**
	Night	53	69	56	45**
MP2	Day	55	71	58	47*
	Night	49	66	51	43*

* Calculated using Statistical Analysis. see Appendix B

**Calculated using Mean Average

TABLE 5: SPECTRAL MEASUREMENT RESULTS

Period	dB(A)	Octave Band (Hz) Sound Level (dB)							
		63	125	250	500	1000	2000	4000	8000
MP1									
L _{eq,T}									
Day	59	65	56	55	54	56	52	43	34
Night	53	59	52	50	49	49	45	39	30
L _{FMax}									
Night	69	69	56	60	61	67	61	50	36
MP2									
L _{eq,T}									
Day	55	62	55	53	51	53	48	39	30
Night	49	57	52	50	46	45	40	34	25
L _{FMax}									
Night	66	74	69	67	63	62	57	51	42

5. NOISE ASSESSMENT

5.1. Introduction

Given the layout of the Proposed Development, the assessment is based on the worst affected façade overlooking the A226.

5.2. Façade Requirements

In order to achieve appropriate noise levels within internal living spaces, in those areas where such levels will not be achieved with open windows, the dwellings themselves need to be considered with regard to the level of façade mitigation required in order to achieve internal noise levels of $L_{Aeq,16-hour} < 35$ dB in habitable rooms during the day; $L_{Aeq,8-hour} < 30$ dB and typical L_{AFMax} levels of < 45 dB during the night.

The glazing and ventilation elements are typically the weakest acoustic link in the construction of a building façade. Therefore, in order to assess the acoustic performance of the proposed dwellings, it is appropriate in the first instance to explore the level of protection that will be afforded by the performance of the glazing and ventilation elements.

Windows do not reduce noise equally across the entire frequency spectrum, so the frequency content of the sound will influence the overall sound reduction performance of a given window and by extension, the resulting noise levels within the receiving room.

Many glazing manufacturers test their products under laboratory conditions using a typical road traffic noise frequency spectrum source. The resultant measured noise attenuation, in dB, gives a very useful guide to in-situ sound reduction performance of the window for situations where road traffic noise dominates. This performance index is known as the R_{TRA} , or $R_w + C_{tr}$.

Table 1 in Annex 6 of PPG 24, which is now superseded, but does contain some useful and relevant information, provides examples of typical noise reductions for a dwelling façade with windows set in a brick/block wall. The table shows various levels of noise reduction provided by different glazing configurations and for different noise sources. The values shown are the level difference (in dBA) between the outside and the inside of a typical dwelling and to represent worst case, it is assumed that the outside level is a façade measurement and that the relative contribution through any ventilation elements is negligible.

For a $R_w + C_{tr}$, PPG24 states that standard thermal double glazing will provide a façade sound insulation performance of 33 dB(A), which for free-field noise levels as predicted in this case would be 30 dB(A). As an example of a glazing unit that could achieve the above performance, the glazing manufacturer SG states that its 4/12/4 double glazed window unit has an $R_w + C_{tr}$ of 27 dB. This is considered to be a reliable performance expectation in the context of what would be installed on the quietest facades of the development. The 4/12/4 notation refers to a glazing unit comprising a 4 mm pane of glass and a 4 mm pane of glass, separated by a 12 mm air gap.

The Building Regulations recommend on ventilation that habitable rooms in dwellings have background ventilation. Internal noise levels should be considered in the context of room ventilation requirements. In this instance, the target internal noise levels will only be achieved in the majority of dwellings when windows are closed. An alternative means of ventilation will therefore be required to comply with the requirements of the Building Regulations Approved Document F.

In order to achieve the target daytime and night-time internal noise levels, it is necessary to determine the minimum acoustic performance requirements of each façade component. It is typically assumed that the default choice of glazing for the habitable rooms of the proposed

development will be thermal double glazing and the default choice for ventilation will be a hit and miss, window-mounted trickle vent system.

As already stated; in order to provide a robust assessment and a high quality living environment for future residents, providing internal noise levels of <35 dB $L_{Aeq,16\text{-hour}}$ by day and <30 dB $L_{Aeq,8\text{-hour}}$ by night, as well as <45 dB typical L_{AFMax} by night, as defined in BS 8233 has been adopted as the design target for the proposed development.

To determine the glazing and ventilation requirements in order to provide an adequate level of protection against external noise intrusion, $L_{Aeq,16\text{hour}}$ daytime, $L_{Aeq,8\text{hour}}$ and typical L_{AFMax} night-time noise levels have been determined at the building façade, making appropriate distance correction allowances for differences between the measurement location and proposed façade location.

Accordingly, the required composite $R_w + C_{tr}$ sound reduction performance for the building facades of the development, to provide appropriate internal noise levels during both daytime and night-time periods, as described, are identified in Table 6

TABLE 6: REQUIRED SOUND LEVEL DIFFERENCE OUTSIDE TO INSIDE, dB

Index	Predicted Free-field Noise Level, dB		Target Internal Noise Level - dB		Required Sound Level Difference, dB
	Day	Night	Day	Night	
North Façade (Eastern Avenue)					
L _{Aeq,T}	59	53	35	30	24
L _{AFMax}	-	69	-	45	24
West Façade					
L _{Aeq,T}	55	49	35	30	20
L _{AFMax}	-	66	-	45	21

Table 6 identifies that the sound reduction requirements for the proposed development are driven by meeting the adopted target night-time L_{AFMax} internal noise limit of 45 dB.

It should also be noted that the sound reduction detailed in Table 6 apply to habitable rooms such as living rooms, dining rooms and bedrooms only. For non-habitable rooms such as kitchens, bathrooms, stairways, halls, landings, lower performance standards would be permissible.

Based upon the latest layout proposals and robust assumptions of up to 50% of a room façade being glazed and a room volume of 30m³, calculations have been carried out to determine the likely required acoustic performances for the external façade elements, in order to provide appropriate internal noise levels in rooms during both the daytime and night-time periods.

The outline performance requirements are presented in Table 7.

TABLE 7: MINIMUM ACOUSTIC PERFORMANCES FOR GLAZING AND VENTILATION

Example Glazing	Octave Band (Hz) Sound Level (dB)							
	63	125	250	500	1000	2000	4000	dB(A)
	Sound Reduction Performance, R dB							
All Facades								
4/12/4 Double Glazing	20	24	20	25	35	38	35	31
Example Ventilation	Octave Band (Hz) Sound Level (dB)							
	63	125	250	500	1000	2000	4000	dB(A)
	Element Normalised Level Difference (D,n,e) dB							
All Facades								
Hit and Miss Trickle Vent	30	34	39	34	41	31	31	35
Example Walls	Octave Band (Hz) Sound Level (dB)							
	63	125	250	500	1000	2000	4000	dB(A)
	Sound Reduction Performance, R dB							
All Facades								
Façade Wall	36	41	45	45	54	58	58	52
*Brick/ Blockwork Cavity Wall (BS8233)								

The above mitigation measures demonstrate that appropriate internal noise levels are entirely achievable through the use of suitable façade treatments, resulting in No Observed Adverse Effect.

Other units may be suitable and it is the responsibility of the glazing manufacturer to recommend and provide appropriate systems. The above analysis is provided to demonstrate that a design solution is feasible at the site for the purposes of a planning application and not necessarily for the purposes of detailed design or glazing procurement.

The detailed design of the proposed properties may affect both the required sound reduction performance and the appropriate selection of glazing units. The aspects of the detailed design that are important are the room dimensions, room finishes, window dimensions and the sound reduction performance of non-glazing elements.

5.2.1. Predicted Indoor Noise Levels

Considering the ventilation, glazing and external wall specifications outlined in this section, the following indoor ambient and maximum noise level incident on façade overlooking A226 (the worst affected) has been predicted using BS EN 12354-3:2000.

The predicted indoor ambient and maximum noise levels, are detailed in Table 8 below, against the requirements of BS8233:2014 and the WHO Guidance.

TABLE 8: INDOOR SOUND LEVEL ASSESSMENT (FAÇADE MITIGATION)

Period	Predicted Indoor Sound Levels (dB)		Indoor Sound Level Criterion (dB)		Exceedance (dB)	
	Ambient Sound Level, $L_{Aeq,T}$	Maximum Sound Level, L_{AFmax}	Ambient Sound Level, $L_{Aeq,T}$	Maximum Sound Level, L_{AFmax}	Ambient Sound Level, $L_{Aeq,T}$	Maximum Sound Level, L_{AFmax}
Front Façade Overlooking A226 (Worst Effected)						
Day	31	-	35	-	-4	-
Night	25	38	30	45	-5	-7

It can be seen that, incorporating the façade design outlined in this section, that the requirements of BS8233:2014 and the WHO Guidance can be achieved.

5.3. Outdoor Amenities

Outdoor amenity areas have been proposed in the form of balconies, outdoor terraces and a roof top shared outdoor amenity space. BS8233:2014 advises that noise levels in external amenity spaces should not exceed a daytime $L_{Aeq,T}$ value of 55 dB, subject to local factors.

In the case of the balconies of the Proposed Development, the noise levels during the day time are anticipated to be in the region of 55-59 dB(A) on the worst effected balconies. This has been determined by noise measurements taken at MP1 and MP2.

Around the perimeter of the balconies overlooking the A226, the balustrade design will be steered by acoustic requirements; It is recommended that a solid balustrade form is adopted, so as to minimise noise intrusion from the surrounding roads below. This measure will aim to ensure that noise levels on either of the rear terrace/balcony spaces should not exceed the 55 dB(A) daytime criterion.

The shared outdoor amenity area on the rooftop benefits from screening from the built form of the existing building. Therefore, when applying 5dB for partial screening, the noise levels throughout much of the outdoor space will be less than the 55 dB(A) daytime criterion.

However, in respect of balconies, roof gardens and terraces, BS8233:2014 states; *“Other locations, such as balconies, roof gardens and terraces, are also important in residential buildings where normal external amenity space might be limited or not available, i.e. in flats, apartment blocks, etc. In these locations, specification of noise limits is not necessarily appropriate. Small balconies may be included for uses such as drying washing or growing pot plants, and noise limits should not be necessary for these uses; however, the general guidance on noise in amenity space is still appropriate for larger balconies, roof gardens and terraces, which might be intended to be used for relaxation. In high-noise areas, consideration should be given to protecting these areas by screening or building design to achieve the lowest practicable levels. Achieving levels of 55 dB $L_{Aeq,T}$ or less might not be possible at the outer edge of these areas, but should be achievable in some areas of the space”.*

6. BUILDING SERVICES NOISE

6.1. Plant Noise Limits

Plant rooms are proposed on the ground floor along with a large outdoor area on the first floor level which will house the Air Source Heat Pumps (ASHP) associated with the building. The exact details of any static plant to be installed as part of the Proposed Development are not currently known, therefore, for the purposes of this noise assessment, it is considered appropriate to set plant noise emission limits in accordance with British Standard requirements, which can be incorporated into an appropriately worded planning condition, to be discharged at a later date.

The limits are presented in Table 9 and are based on the cumulative Noise Rating Level arising from any new mechanical plant being at least 5 dB below the measured Background sound level at 1m from the nearest window of the closest noise sensitive residential receptor to the plant areas.

TABLE 9: PLANT RATING LEVELS AT THE NEAREST RECEPTORS

Period	Proposed Plant "Rating Level" at the Nearest Residential Receptor - dB(A)
Nearest Noise Sensitive Receptors	
Daytime (07:00 - 23:00)	42
Night time (07:00 - 23:00)	38

The above limits would apply to the total noise emission level from all plant within the Proposed Development. Individual plant items may need to be designed to a lower limit such that the overall total achieves the stated criteria above at the nearest noise sensitive receptors.

6.2. Practical Control Measures

Screening of any external plant as well as provision of sound attenuators to items of plant may be necessary to control the transmission of sound and achieve the above criteria as well as to reduce the sound level produced by the plant to a reasonable extend around the footprint of the development itself.

Environmental attenuators and possibly other means of sound mitigation such as acoustic louvres or acoustic screens may be required to control sound emanating from plantrooms, air intake and discharge points or from externally mounted plant.

Locating the future plant installation as far as possible from the NSRs and using the proposed building to screen any future plant items would to ensure compliant emissions sound levels.

7. INTERNAL BUILDING FABRIC ASSESSMENT

7.1. Sound Insulation Design Criteria

A noise transfer study has been carried out to mitigate the impact of commercial noise transmitting into the proposed residential properties above. At this stage, there are currently no detailed designs of the separating floors, therefore, the following Section outlines the different assessment criteria used to provide a robust assessment and aim to protect the amenity of the adjacent residents. The design criteria outlined should be met during the design stage. It is considered appropriate sound insulation limits in accordance with British Standard requirements, which can be incorporated into an appropriately worded planning condition, to be discharged at a later date.

7.1.1. Building Regulations – Approved Document E

The Approved Document E (ADE) provides acoustic performance standards that must be achieved when developing a new residential building.

Table 10 below provides the sound insulation requirements of ADE applicable to purpose built dwelling houses and flats. However, the Approved Document E 2015 goes on to state: “A *higher standard of sound insulation may be required between spaces used for normal domestic purposes and communal or non-domestic purposes. In these situations the appropriate level of sound insulation will depend on the noise generated in the communal or non-domestic space*”.

TABLE 10: ADE SOUND INSULATION PERFORMANCE REQUIREMENTS – DWELLING-HOUSES & FLATS

Separating Element	Airborne Sound Insulation $D_{nT,w} + C_{tr}$ dB (Minimum Values)	Impact Sound Insulation $L'_{nT,w}$ dB (Maximum Values)
Purpose Built Houses and Flats - Walls	≥ 45	-
Purpose Built Houses and Flats - Floors and Stairs	≥ 45	≤ 62

7.1.2. Design Target

Standard ADE targets may be considered not sufficient between light commercial/ plant rooms and a residential dwelling, as it is intended as a target between two living spaces. There is no recognised standard above those in Table 10 for commercial and residential buildings, although ADE does state that a higher level of sound insulation may be appropriate. BS8233:2014 provides an example of design criteria adopted by hotel groups for acoustic standards for airborne sound insulation in Table H.1. It is considered that an average of NR 15 dB (L_{Aeq}) and NR 20 dB (L_{AFmax}) would result in commensurate amenity in the residential units from activity noise in the commercial units. Considering the above, the resultant sound insulation design targets are outlined overleaf.

TABLE 11: DESIGN CRITERIA TO BE MET DURING DESIGN STAGE AND ASSIGNED TO PLANNING CONDITION

Partition	Airborne Sound Insulation D _{nT,w} dB (Minimum Values)	Internal Noise Levels Design Criteria (Residential)
Commercial - Residential	≥60	NR 15
Plant Room - Residential	≥60	NR 15

8. CONCLUSION

inacoustic has been commissioned to assess the impact of noise at the Former M-Block, Gravesend, in respect of the site's suitability for residential development.

The following technical noise assessment has been produced to provide supporting information to accompany a planning application to Gravesham Borough Council and is based upon environmental noise measurements undertaken at the site.

The suitability of the site for residential development has been assessed, based on the development proposals and the measured noise levels.

Specific consideration has been given to the internal noise criteria for the proposed residential properties, as quoted as within BS8233:2014, with façade mitigation measures proposed to achieve the criteria stipulated therein.

Further consideration has been given to the guidance set out in BS4142:2014+A1:2019, to assign plant limits surrounding the site for the proposed plant room and Air Source Heat Pumps. The need to control plant noise can be enforced with a suitably worded condition attached to the decision notice for the site.

An assessment has been carried out to determine the impact of the proposed commercial noise on the proposed residential units, with criteria for sound insulation outlined.

In light of the above, which demonstrates that the site is predicted to meet the requirements of the relevant British Standard and planning guidance, it is considered that noise does not present a constraint to the development.

9. APPENDICES

Gravesham Borough Council

9.1. Appendix A – Definition of Terms

Sound Pressure	Sound, or sound pressure, is a fluctuation in air pressure over the static ambient pressure.
Sound Pressure Level (Sound Level)	The sound level is the sound pressure relative to a standard reference pressure of 20µPa (20x10 ⁻⁶ Pascals) on a decibel scale.
Decibel (dB)	A scale for comparing the ratios of two quantities, including sound pressure and sound power. The difference in level between two sounds s1 and s2 is given by $20 \log_{10} (s1 / s2)$. The decibel can also be used to measure absolute quantities by specifying a reference value that fixes one point on the scale. For sound pressure, the reference value is 20µPa.
A-weighting, dB(A)	The unit of sound level, weighted according to the A-scale, which takes into account the increased sensitivity of the human ear at some frequencies.
Noise Level Indices	Noise levels usually fluctuate over time, so it is often necessary to consider an average or statistical noise level. This can be done in several ways, so a number of different noise indices have been defined, according to how the averaging or statistics are carried out.
$L_{eq,T}$	A noise level index called the equivalent continuous noise level over the time period T. This is the level of a notional steady sound that would contain the same amount of sound energy as the actual, possibly fluctuating, sound that was recorded.
$L_{max,T}$	A noise level index defined as the maximum noise level during the period T. L_{max} is sometimes used for the assessment of occasional loud noises, which may have little effect on the overall L_{eq} noise level but will still affect the noise environment. Unless described otherwise, it is measured using the 'fast' sound level meter response.
$L_{90,T}$	A noise level index. The noise level exceeded for 90% of the time over the period T. L_{90} can be considered to be the "average minimum" noise level and is often used to describe the background noise.
$L_{10,T}$	A noise level index. The noise level exceeded for 10% of the time over the period T. L_{10} can be considered to be the "average maximum" noise level. Generally used to describe road traffic noise.
Free-Field	Far from the presence of sound reflecting objects (except the ground), usually taken to mean at least 3.5m
Facade	At a distance of 1m in front of a large sound reflecting object such as a building façade.
Fast Time Weighting	An averaging time used in sound level meters. Defined in BS 5969.

In order to assist the understanding of acoustic terminology and the relative change in noise, the following background information is provided.

The human ear can detect a very wide range of pressure fluctuations, which are perceived as sound. In order to express these fluctuations in a manageable way, a logarithmic scale called the decibel, or dB scale is used. The decibel scale typically ranges from 0 dB (the threshold of hearing) to over 120 dB. An indication of the range of sound levels commonly found in the environment is given in the following table.

TABLE 12: TYPICAL SOUND LEVELS FOUND IN THE ENVIRONMENT

Sound Level	Location
0dB(A)	Threshold of hearing
20 to 30dB(A)	Quiet bedroom at night
30 to 40dB(A)	Living room during the day
40 to 50dB(A)	Typical office
50 to 60dB(A)	Inside a car
60 to 70dB(A)	Typical high street
70 to 90dB(A)	Inside factory
100 to 110dB(A)	Burglar alarm at 1m away
110 to 130dB(A)	Jet aircraft on take off
140dB(A)	Threshold of Pain

The ear is less sensitive to some frequencies than to others. The A-weighting scale is used to approximate the frequency response of the ear. Levels weighted using this scale are commonly identified by the notation dB(A).

In accordance with logarithmic addition, combining two sources with equal noise levels would result in an increase of 3 dB(A) in the noise level from a single source.

A change of 3 dB(A) is generally regarded as the smallest change in broadband continuous noise which the human ear can detect (although in certain controlled circumstances a change of 1 dB(A) is just perceptible). Therefore, a 2 dB(A) increase would not be normally be perceptible. A 10 dB(A) increase in noise represents a subjective doubling of loudness.

A noise impact on a community is deemed to occur when a new noise is introduced that is out of character with the area, or when a significant increase above the pre-existing ambient noise level occurs.

For levels of noise that vary with time, it is necessary to employ a statistical index that allows for this variation. These statistical indices are expressed as the sound level that is exceeded for a percentage of the time period of interest. In the UK, traffic noise is measured as the L_{A10} , the noise level exceeded for 10% of the measurement period. The L_{A90} is the level exceeded for 90% of the time and has been adopted to represent the background noise level in the absence of discrete events. An alternative way of assessing the time varying noise levels is to use the equivalent continuous sound level, L_{Aeq} .

This is a notional steady level that would, over a given period of time, deliver the same sound energy as the actual fluctuating sound.

To put these quantities into context, where a receiver is predominantly affected by continuous flows of road traffic, a doubling or halving of the flows would result in a just perceptible change of 3 dB, while an increase of more than 25%, or a decrease of more than 20%, in traffic flows represent changes of 1 dB in traffic noise levels (assuming no alteration in the mix of traffic or flow speeds).

Note that the time constant and the period of the noise measurement should be specified. For example, BS 4142 specifies background noise measurement periods of 1 hour during the day and 15 minutes during the night. The noise levels are commonly symbolised as $L_{A90,1\text{hour}}$ dB and $L_{A90,15\text{mins}}$ dB. The noise measurement should be recorded using a 'FAST' time response equivalent to 0.125 ms.

9.2. Appendix B – Measurement Results

FIGURE 8: MEASURED TIME HISTORY MP1

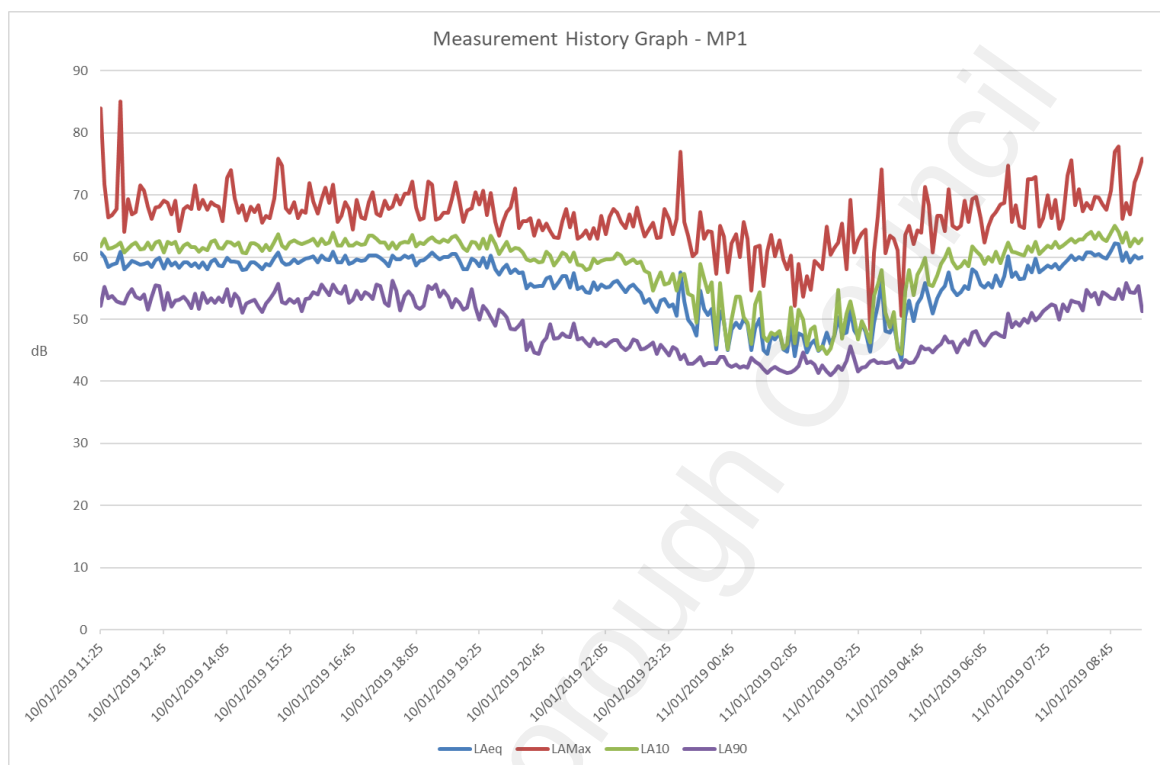


FIGURE 9: MEASURED TIME HISTORY MP2

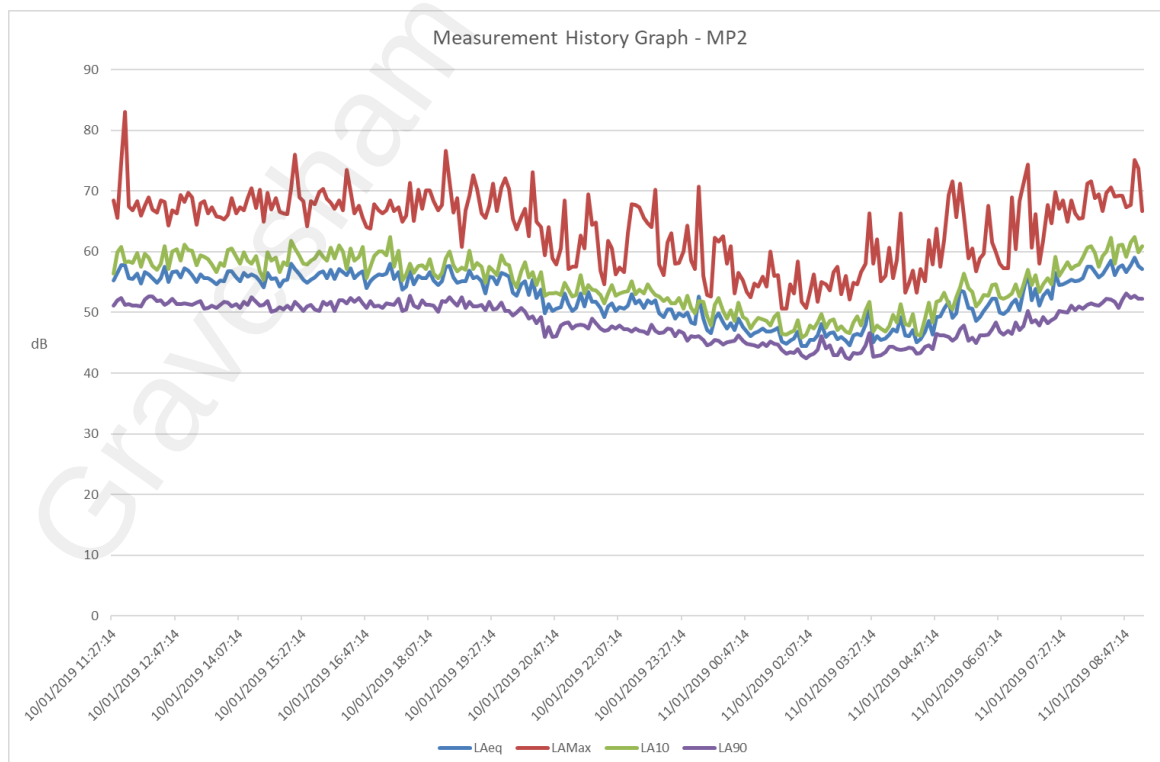


FIGURE 10: STATISTICAL ANALYSIS OF BACKGROUND L_{A90} SOUND LEVELS - DAYTIME

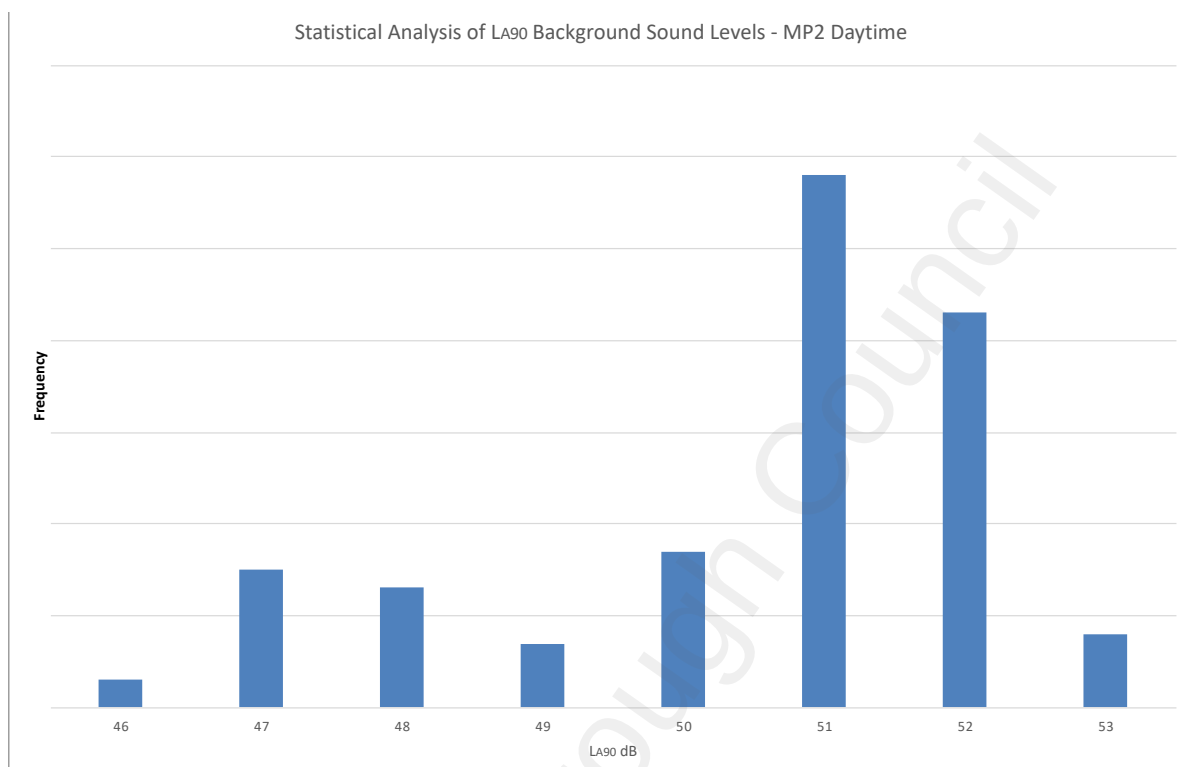
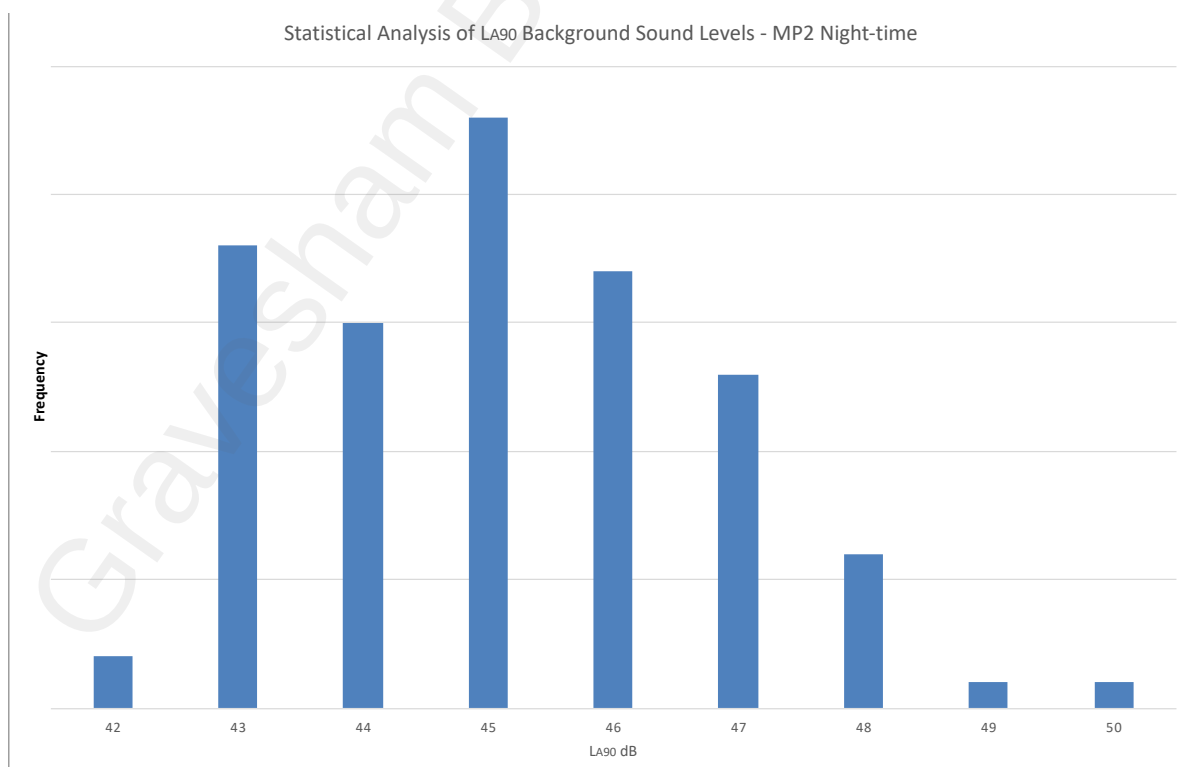


FIGURE 11: STATISTICAL ANALYSIS OF BACKGROUND L_{A90} SOUND LEVELS - NIGHT-TIME



9.3. Appendix C – Measurement Results

FIGURE 12: MICROPHONE LOCATIONS



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