Building Services Noise Commissioning Measurements

Base Building

Manchester

M15 6LR

Stroma Built Environment Ltd.

SBE Ref: PRO-062587 – AC – 3v1

I. Revision History

Revision	Date	Description		
3v1	04/08/2022	First Issue		
		Compiled By	**Authorised By**	
		Ben Reed MIOA Senior Acoustic Consultant	Tom Chaffer MIOA Principal Acoustic Consultant	
3v2	13/10/2022	Update to include MCC discussions		
		Compiled By	**Authorised By**	
		Ben Reed MIOA Senior Acoustic Consultant	Tom Chaffer MIOA Principal Acoustic Consultant	

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II. Executive Summary

Stroma Built Environment (SBE) has been appointed to undertake a building services plant noise impact assessment for the Base Building at Manchester Science Park.

A desktop assessment of noise impact due to operation of building services plant associated with the building has previously been undertaken and summarised in report '*PRO-062587 AC 1v1 External Plant Noise Assessment Base Building Manchester'.* This report has been issued to Manchester City Council planning team in support of discharge of Planning Condition 18.

The report calculates noise rating levels at identified NSR based on manufacturers noise data for all sources of building services plant in line with the methodology set out in BS 4142. The report sets out calculations to demonstrate that the noise rating level for building services plant is at least 5 dB below the site representative sound level during both daytime and night time periods. The report concludes that building services plant meets a BS 4142 assessment of 'low noise impact' and meets the requirements of the first part of Planning Condition 18 set out by Manchester City Council.

To validate the above report, further site measurements of installed and commissioned building services noise have been undertaken.

Based on previous site visits, it was anticipated that noise measurements would likely be affected by road traffic and potentially other noise sources, as measurements to inform the assessment were undertaken in the evening period between 8pm and 10pm.

Building services plant noise associated with the Base Buildings was not audible at any measurement position nor immediately outside the building during the assessment.

A BS 4142 assessment has been undertaken based on site noise measurements. The assessment indicates that operational noise from plant is at least 5 dB below the background sound level during the daytime at all NSRs. The assessment indicates that operational noise from plant is at least 3 dB below the background sound level at the residential properties on Greenheys Lane during the night. This is primarily expected to be due to the effect of other noise sources such as vehicle movements. In addition, the background sound levels which the assessment is based on uses the lowest background sound levels measured between 03:00 and 03:15, which are expected to be much lower than those during the plant night-time operating hours of 06:00-07:00 therefore the difference between plant noise levels and background sound levels during this period are expected to be greater in practice. It is considered that the practical difficulties in isolating plant noise on site amongst other environmental noise sources has limited the assessment as opposed to plant noise levels being above the prescribed limits. As such it should be considered that the requirements of Condition 18 are also met for the night-time.

From the results of the assessment in combination with the subjective assessment of plant inaudibility it is concluded that building services plant associated with the Base Building meets a the requirements of Planning Condition 18.

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1. Introduction

1.1 Stroma Built Environment (SBE) has been appointed by Caddick Construction to provide acoustic consultancy services for the Base Building at Manchester Science Park.

1.2 The scheme involved the construction of a single building, comprising primarily office space, with ground floor 'Maker Space' and ancillary workshop.

1.3 The purpose of this assessment is to assess the noise impact of new sources of building services plant equipment associated with the development upon the existing noise climate at the nearest noise sensitive receptors (NSR).

1.4 A desktop assessment of noise impact due to operation of building services plant associated with the building has previously been undertaken and summarised in report '*PRO-062587 AC 1v1 External Plant Noise Assessment Base Building Manchester'.* The report calculates noise rating levels at identified NSRs based on manufacturers noise data for all sources of building services plant in line with the methodology set out in BS 4142. The report sets out calculations to demonstrate that the noise rating level for building services plant is at least 5 dB below the site representative sound level during both daytime and night time periods. The report concludes that building services plant meets a BS 4142 assessment of 'low noise impact' and meets the requirements of the first part of Planning Condition 18 set out by Manchester City Council.

1.5 The second part of Condition 18 requires that verification measurements be undertaken of installed and commissioned building services plant on site along with a subjective assessment on noise impact by a suitably qualified acoustic consultant. Condition 18 is set out in full in Section 3 of this report.

1.6 This document has been prepared for the sole use, benefit and information of Caddick Construction for the purposes set out in the document or instructions commissioning the works. The liability of SBE in respect of the information contained herein will not extend to any third party.

1.7 This report is limited to addressing the specific acoustic issues contained herein and is based on information and drawings provided by the Client.

1.8 Whilst every effort has been made to ensure that this report is easy to understand, it is technical in nature. A glossary of terminology is included in Appendix III.

2. Site Baseline Conditions

2.1 The development is located within Manchester Science Park, Greenheys, Manchester. Greenheys Lane borders the site to the west with residential properties beyond that. Commercial buildings generally bound the site to the north and east with Darul Aman Mosque located to the south.

2.2 The closest noise sensitive receptors (NSRs) to the proposed building have been identified per the below list and are highlighted in Figure 1:

- Residential properties on Greenheys Lane to the west;
- Darul Aman Mosque to the south;
- Rutherford House office building to the east; and
- Greenheys Technology building to the north

Figure 1: Site location and noise sensitive receptors

2.3 A baseline noise survey has been undertaken in and around the site previously by BDP in April 2019. Data obtained from the measurements and subsequent calculations were used to establish relevant background noise criteria for noise assessment from building services plant in accordance with the requirements of Condition 18.

2.4 Full details of the measurements conducted by BDP are presented in the BASE, Manchester Environmental Noise Assessment Report (ref. P3000608/(REP)U002) dated August 2019 and are reproduced in Appendix II .

3. Noise Assessment Guidance and Criteria

Planning Requirements

3.1 Planning approval was granted for the development by Manchester City Council in January 2020, subject to conditions. Condition 18 is repeated below.

"18) Prior to occupation of the development a scheme for the acoustic insulation of any externally mounted ancillary equipment to ensure that it achieves a rating level (L_{Aeq}) of 5dB below the existing background (L_{A90}) in each octave band at the nearest noise sensitive location shall be submitted to and approved in writing by the City Council as local planning authority in order to secure a reduction in the level of noise emanating from the equipment.

Upon completion of the development a verification report will be required to validate that the work undertaken throughout the development conforms to the recommendations and requirements in the approved acoustic report. The report shall also undertake post completion testing to confirm that the noise criteria has been met. Any instances of non-conformity with the recommendations in the report shall be detailed along with any measures required to ensure compliance with the agreed noise criteria. The approved scheme shall be implemented prior to occupancy and shall remain operational thereafter.

Reason - To safeguard the amenities of the occupiers of nearby residential accommodation, pursuant to policies SP1 and DM1 of the Core Strategy."

3.2 Based on measured background noise survey data, total emission levels for plant noise, including acoustic feature corrections where applicable, should not exceed the maximum rating level values provided in Table 1.

Table 1: Maximum plant noise limits

NSR	Assessment period	Representative background noise level (dB $L_{A90,T}$)	Rating noise limit (dB $L_{Ar,Tr}$)
Residential properties on Greenheys Lane	Daytime (07:00-23:00)	48	≤ 43
	Night Time (23:00-07:00)	38	≤ 33
Darul Aman Mosque	Daytime (07:00-23:00)	42	≤ 37
Rutherford House	Daytime (07:00-23:00)	43	≤ 38
Greenheys Technology building	Daytime (07:00-23:00)	45	≤ 40

BS 4142:2014 + A1:2019: '*Methods for rating and assessing industrial and commercial sound'*

3.3 BS 4142 describes a method for assessing the likelihood of complaints from noise sources that are of an industrial nature (e.g. fans, pumps, chillers, air handling units etc.). The assessment methodology is based upon determining a 'rating level' for the equipment being assessed, which is the level of noise from the item or items of plant being assessed (measured as L_{Aeq}).

3.4 The rating level is then compared with the underlying background noise level (measured as L_{A90}) in the absence of noise from the item or items of plant being assessed.

- A difference of around +10 dB or more is likely to be an indication of a significant adverse impact, depending on the context.
- A difference of around +5 dB 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.

3.5 BS 4142 states that a penalty should be added for any plant which gives rise to noise features that may increase disturbance such as tonal, impulsive or intermittent characteristics. With respect to the acoustic feature correction, BS 4142 states:

"Certain acoustic features can increase the significance of impact over that expected from a basic comparison between the specific sound level and the background sound level. Where such features are present at the assessment location, add a character correction to the specific sound level to obtain the rating level."

3.6 A rating penalty for a sound may be based on a subjective assessment of its characteristics or using objective methods to determine tonality.

Consultation with Manchester City Council (MCC)

3.7 Consultation discussions were carried out between SBE and Lisa Jones, Environmental Protection Officer at MCC regarding the proposed methodology to discharge Condition 18.

3.8 During these discussions MCC agreed generally with SBEs approach and understood the limitations of carrying out these type of verification measurements due to the affects from other noise sources outside of the site. It was agreed that it would be unfeasible to completely remove all other noise sources (e.g. road traffic noise, local businesses) and the proposed methodology to monitor where environmental noise

was likely to be reduced during the evening time would be suitable. It was agreed that the discussion of context in the assessment would be key in combination with subjective commentary on the consultants analysis of audibility whilst on site (see paragraphs 4.11, 4.12 and 4.14).

4. Noise Impact Assessment

4.1 A desktop assessment of noise impact due to operation of building services plant associated with the building has previously been undertaken and summarised in report '*PRO-062587 AC 1v1 External Plant Noise Assessment Base Building Manchester*'. This report has been issued to Manchester City Council planning team in support of discharge of Planning Condition 18.

4.2 The report calculates noise rating levels at identified NSR based on manufacturers noise data for all sources of building services plant in line with the methodology set out in BS 4142. The report sets out calculations to demonstrate that the noise rating level for building services plant is at least 5 dB below the site representative sound level during both daytime and night time periods. The report concludes that building services plant meets the requirements of the first part of Condition 18 set out by Manchester City Council.

4.3 The second part of Condition 18 requires that verification measurements are undertaken to ensure that the above noise levels at receptors are met. Based on SBE's previous experience of similar projects and the practical difficulty in obtaining these measurements a subjective assessment of plant noise by an acoustic consultant to supplement on site measurements is considered suitable to aid assessment which has been acceptable to Manchester City Council on previous projects.

4.4 It is understood that building services plant does not operate during the majority of the night time period, however building management systems are automated to turn heating and ventilation systems on at 06:00 hours, which then turn off again at 19:00 hours.

4.5 SBE attended site on 28th July 2022 in order to undertake an assessment of plant noise. Based on previous site visits, it was anticipated that noise measurements would likely be affected by road traffic and potentially other noise sources, as measurements to inform the assessment were undertaken in the evening period between 8pm and 10pm to minimise these effects as far as practicable.

4.6 Measurements were undertaken at each of the four identified receptors around the site identified in Figure 1. Approximate measurement positions are shown in Figure 2.

Figure 2: Plant noise measurement positions

4.7 Noise levels were measured using UKAS calibrated NTi XL2 precision integrating sound level meter. Calibration checks were carried out both before and after the measurements with no significant variance observed. Calibration certificates are available on request. Weather conditions during the survey were dry with wind speeds of less than 5 ms^{-1}. The sound level meter was mounted on a tripod at an approximate height of 1.5 metres and fitted with a proprietary outdoor microphone kit.

4.8 Comparative site measurements with plant on and off are summarised in Table 2.

Table 2: Summary of commissioning measurements

Measurement Location	Plant Operation	Start Time	Measurement Duration	Measured Sound Pressure Level	
				dB $L_{Aeq,T}$	dB L_{A90}
ST1	Off	20:03	00:05:00	54	44
	On	21:17		54	42
ST2	Off	20:09		44	41
	On	21:23		41	39
ST3	Off	20:20		50	47
	On	21:35		48	46
ST4	Off	20:31		66	45
	On	21:10		63	45

4.9 The noise climate at the time of measurements was controlled primarily by local and distant traffic noise, music and noise from patrons at The Old Abbey Taphouse, birdsong and noise from vehicle at the Darul Aman Mosque car park.

4.10 BS4142:2014 states that where the difference between the ambient sound level and residual sound level is ≤3 dB, which is the case here, then the specific sound level should be determined by calculation.

4.11 Given the steady state nature of the plant and comparatively transient nature of road traffic noise, it is considered suitable to base the assessment with reference to the background sound level. Building services plant noise associated with the building was not audible at any measurement position during the assessment. This subjective assessment of inaudibility implies that the specific noise level of plant is at least 10 dB below the existing background noise level. As such the assessment has been based on noise levels which are 10 dB below the background noise levels for each location.

4.12 BS 4142 presents a method to assess the 'specific' noise due to a noise source from comparison of measurements with and without the sound source in operation. An assessment based on the BS 4142 methodology is outlined in Table 3. It is not possible to calculate a rating level in accordance with BS 4142 as the residual noise levels (with plant off) are higher than the ambient noise levels (with plant on). This is an indication that the specific plant noise level does not increase the ambient noise level, and hence it is concluded that the specific plant noise level is at least 10 dB below the measured ambient noise level. The rating level has been calculated by comparison of the background $L_{A90,T}$ measurements with both plant operational and not in operation. Due to the noise climate around the site being heavily influenced by traffic noise, it is considered that the L_{A90} parameter provides a better assessment of steady state underlying plant noise. An example BS 4142 assessment calculation is provided in Appendix I.

Table 3: Summary of BS 4142 Assessments

NSR	Assessment period	Assessed BS 4142 Rating Level $L_{Ar,Tr}$ (dB)	Representative background noise level (dB $L_{A90,T}$)	Difference
Residential properties on Greenheys Lane	Daytime (07:00-23:00)	≤ 35	48	-13
	Night Time (23:00-07:00)		38	-3
Darul Aman Mosque	Daytime (07:00-23:00)	≤36	42	-6
Rutherford House	Daytime (07:00-23:00)	≤29	43	-14
Greenheys Technology building	Daytime (07:00-23:00)	≤32	45	-13

4.13 The results of the BS 4142 assessment indicate that the plant noise rating level at the closest NSR is at least 5 dB below the representative pre-construction background noise levels for daytime periods at all receptors. This is a low noise impact in line with BS 4142 assessment.

4.14 The night-time assessment shows that the plant noise rating level calculated to be at least 3 dB below the representative background noise level at the residential properties on Greenheys Lane. Based on the subjective assessment of inaudibility and the likelihood of the measurements being driven primarily by other noise sources off site including road traffic, it is considered that the outcome of the assessment for the night-time period is being driven by other noise sources other than plant noise from the building. Additionally, the background sound level used for the night-time noise assessment is based on the lowest measured $L_{A90,T}$ between 03:00 and 03:15 which is expected to be lower than the background sound levels when the plant will actually operate during the final hour of the night-time period (06:00-07:00). It is considered that the practical difficulties in isolating plant noise on site amongst other environmental noise sources has limited the assessment as opposed to plant noise levels being above the prescribed limits. As such it should be considered that the requirements of Condition 18 are also met for the night-time.

5. Conclusions

5.1 A plant noise impact assessment has been undertaken for external building services plant associated with the Base Building at Manchester Science Park. The assessment is based on site measurements undertaken on 28th July 2022.

5.2 A desktop assessment of noise impact due to the operation of building services plant associated with both schools has previously been undertaken and summarised in report ''*PRO-062587 AC 1v1 External Plant Noise Assessment Base Building Manchester'.* This report has been issued to Manchester City Council planning team in support of discharge of planning condition 18.

5.3 The report calculates noise rating levels at identified NSR based on manufacturers noise data for all sources of building services plant in line with the methodology set out in BS 4142. The report sets out calculations to demonstrate that the noise rating level for building services plant is at least 5 dB below the site representative sound level during both daytime and night time periods. The report concludes that building services plant meets the requirements of the first part of Condition 18 set out by Manchester City Council.

5.4 Based on previous site visits, it was anticipated that noise measurements would likely be affected by road traffic and potentially other noise sources, as measurements to inform the assessment were undertaken in the evening period between 8pm and 10pm.

5.5 Building services plant noise associated with the Base Buildings was not audible at any measurement position nor immediately outside the building during the assessment.

5.6 A BS 4142 assessment has been undertaken based on site noise measurements. The assessment indicates that operational noise from plant is at least 5 dB below the background sound level during the daytime at all NSRs. The assessment indicates that operational noise from plant is at least 3 dB below the background sound level at the residential properties on Greenheys Lane during the night. This is primarily expected to be due to the effect of other noise sources such as vehicle movements. In addition, the background sound levels which the assessment is based on uses the lowest background sound levels measured between 03:00 and 03:15, which are expected to be much lower than those during the plant night-time operating hours of 06:00-07:00 therefore the difference between plant noise levels and background sound levels during this period are expected to be greater in practice. It is considered that the practical difficulties in isolating plant noise on site amongst other environmental noise sources has limited the assessment as opposed to plant noise levels being above the prescribed limits. As such it should be considered that the requirements of Condition 18 are also met for the night-time.

5.7 From the results of the assessment in combination with the subjective assessment of plant inaudibility it is concluded that building services plant associated with the Base Building meets the requirements of Planning Condition 18.

Appendix I. BS 4142 Assessments

ST4 (Residential properties on Greenheys Lane) Day Time

Measured ambient sound level	$L_{Aeq,T}$ = 63 dB	Plant on
Residual sound level	$L_{Aeq,T}$ = 66 dB	Plant off
Representative Background sound level	$L_{A90,T}$ = 48 dB	Pre construction background level
Specific sound level at measurement position	$L_{Aeq,T}$ = 35 dB	Calculated from background sound level (-10 dB)
BS 4142 Rating level	$L_{Ar,Tr}$ = 35 dB	No corrections are applied for tonality, impulsivity or other sound characteristics
Excess of rating over background sound level	-13 dB	Indication that specific noise source does not have an adverse impact

ST4 (Residential properties on Greenheys Lane) Night Time

Measured ambient sound level	$L_{Aeq,T}$ = 63 dB	Plant on
Residual sound level	$L_{Aeq,T}$ = 66 dB	Plant off
Representative Background sound level	$L_{A90,T}$ = 38 dB	Pre construction background level
Specific sound level at measurement position	$L_{Aeq,T}$ = 35 dB	Calculated from background sound level (-10 dB)
BS 4142 Rating level	$L_{Ar,Tr}$ = 35 dB	No corrections are applied for tonality, impulsivity or other sound characteristics
Excess of rating over background sound level	-3 dB	Indication that specific noise source does not have an adverse impact

ST3 (Darul Aman Mosque) Day Time

Measured ambient sound level	$L_{Aeq,T}$ = 48 dB	Plant on
Residual sound level	$L_{Aeq,T}$ = 50 dB	Plant off
Representative Background sound level	$L_{A90,T}$ = 42 dB	Pre construction background level
Specific sound level at measurement position	$L_{Aeq,T}$ = 36 dB	Calculated from background sound level (-10 dB)
BS 4142 Rating level	$L_{Ar,Tr}$ = 36 dB	No corrections are applied for tonality, impulsivity or other sound characteristics
Excess of rating over background sound level	-6 dB	Indication that specific noise source does not have an adverse impact

ST2 (Rutherford House) Day Time

Measured ambient sound level	$L_{Aeq,T}$ = 41 dB	Plant on
Residual sound level	$L_{Aeq,T}$ = 44 dB	Plant off
Representative Background sound level	$L_{A90,T}$ = 43 dB	Pre construction background level
Specific sound level at measurement position	$L_{Aeq,T}$ = 29 dB	Calculated from background sound level (-10 dB)
BS 4142 Rating level	$L_{Ar,Tr}$ = 29 dB	No corrections are applied for tonality, impulsivity or other sound characteristics
Excess of rating over background sound level	-14 dB	Indication that specific noise source does not have an adverse impact

ST1 (Greenheys Technology Building) Day Time

Measured ambient sound level	$L_{Aeq,T}$ = 54 dB	Plant on
Residual sound level	$L_{Aeq,T}$ = 54 dB	Plant off
Representative Background sound level	$L_{A90,T}$ = 45 dB	Pre construction background level
Specific sound level at measurement position	$L_{Aeq,T}$ = 32 dB	Calculated from background sound level (-10 dB)
BS 4142 Rating level	$L_{Ar,Tr}$ = 32 dB	No corrections are applied for tonality, impulsivity or other sound characteristics
Excess of rating over background sound level	-13 dB	Indication that specific noise source does not have an adverse impact

Appendix II. BDP Noise Survey

4.3 Survey Methodology

A series of manned short-term measurements were undertaken by BDP Acoustics at a number of locations on and in the vicinity of the proposed Project site during 'worst-case' daytime, evening and night-time periods.

The approximate measurement positions are presented in Figure 1. Measurement positions were selected in order to:

- Measure worst-case, i.e. noisiest, daytime (0900 – 1120 hours) noise levels at the locations of the proposed building façades in order to establish the noise levels that will impact upon the façades of the proposed building (Positions 1 – 6);

- Provide data representative of the worst-case, i.e. quietest, daytime (1120 – 1300 hours), evening (2200 – 2300 hours) and night-time (0300 – 0400 hours) noise levels at the nearest or most exposed noise sensitive receptors for the purposes of informing environmental plant noise limits to maintain residential amenity (Positions 3 – 5 and 7 – 9).

Weather conditions during the daytime survey were dry with low wind speeds (<2m/s), temperatures varying around 10°C and cloud cover of approximately 10%. Weather conditions during the evening survey were dry with no wind, temperatures of 12°C and 100% cloud cover. Weather conditions during the night-time survey were dry with no wind, temperatures of 8°C and no cloud cover.

The instrumentation used for measurements consisted of 2no. Rion NA-28 sound level meters and 1no. Bruel & Kjaer 2260 sound level meter, which were all calibrated before and after the surveys, with no significant drift in sensitivity observed.

At each position octave band and A-weighted fast response levels were recorded for a comprehensive suite of noise level metrics.

All readings were taken at a height of 1.5m above local ground level in free-field conditions, with the exception of façade measurements taken at Position 1.

Measurements were carried out by Gavin Stevenson MIOA, Dan Forbes AMIOA and Martha Sadler SMIOA.

4.4 Results

A summary of the measured results are presented in Table 2 below.

Table 2: Summary of noise measurement results

Measurement Position	Start Time (dd/mm/yyyy hh:mm)	$L_{Aeq,5mins}$ Range (dB)	$L_{AFmax,5mins}$ Range (dB)	$L_{A90,5mins}$ Range (dB)
1	29/04/2019 09:08	58	64 - 75	56
1	29/04/2019 10:07	52 - 53	62 - 70	43 - 45
2	29/04/2019 09:28	65 - 67	76 - 84	49 - 57
2	29/04/2019 10:31	63 - 64	74 - 77	49 - 50
3	29/04/2019 09:48	52 - 54	65 - 72	45 - 46
3	29/04/2019 10:55	51 - 53	61 - 63	45 - 48
3	29/04/2019 12:00	53 - 54	66 - 72	46 - 47
4	29/04/2019 09:03	48 - 50	56 - 75	46 - 47
4	29/04/2019 10:06	46 - 47	60 - 61	42 - 43
4	29/04/2019 11:21	47 - 49	61 - 65	43 - 44
5	29/04/2019 09:21	46 - 49	52 - 60	44 - 45
5	29/04/2019 10:24	48 - 51	60 - 66	45 - 46
5	29/04/2019 11:38	46 - 47	57 - 67	43 - 44
6	29/04/2019 09:38	46 - 47	54 - 63	42
6	29/04/2019 10:41	48 - 50	60 - 65	41 - 45
7	29/04/2019 11:45	64 - 65	76 - 78	48 - 50
7	30/04/2019 22:03	60 - 63	73 - 77	44 - 46
7	02/05/2019 03:00	47 - 50	66 - 70	38 - 39
8	29/04/2019 12:22	48 - 51	61 - 71	44 - 45
9	30/04/2019 22:27	45 - 46	55 - 61	38 - 39
9	02/05/2019 03:24	40	46 - 53	38

Figure 1: Approximate survey measurement positions

Figure 2: Noise monitoring positions (1 to 9 from top left to bottom right)

Appendix III. Acoustic Glossary

Sound pressure level and the decibel, dB

A sound wave is a small fluctuation of atmospheric pressure. The human ear responds to these variations in pressure, producing the sensation of hearing. The ear can detect a very wide range of pressure variations. In order to cope with this wide range of pressure variations, a logarithmic scale is used to convert the values into manageable numbers. The decibel is the logarithmic unit used to describe sound (or noise) levels. The usual range of sound pressure levels is from 0 dB (threshold of hearing) to 120 dB (threshold of pain).

Frequency and hertz, Hz

Frequency is a measure of the rate of fluctuation of a sound wave. The unit used is cycles per second, or hertz (Hz). Sometimes large frequency values are written as kilohertz (kHz), where 1 kHz = 1000 Hz. The human range of hearing is commonly accepted to be 20 Hz to 20,000 Hz. Additionally, an octave can be used to describe the interval between a frequency in Hz and either half or double that frequency.

Frequency weighting

Different weighting networks can be applied to a given sound level in each stated octave band by a specified amount, in order to better represent the response of the human ear. The most commonly used weighting network is the 'A' weighting, and the letter 'A' will be included within a descriptor to indicate that the value has been 'A' weighted, e.g. $L_{Aeq,T}$ or L_{A90}. An 'A' weighted noise level may also be written as dB(A). Other weightings less commonly used are 'C' and 'D' weighting.

Noise indices

When a noise level varies with time, the measured 'A' weighted dB level will vary as well. In this case it is therefore not possible to represent the noise climate with a simple 'A' weighted dB value. In order to describe noise where the level is continuously varying, a number of other indices, including statistical parameters, are used. The various indices used are described as below:

$L_{Aeq,T}$	The 'A' weighted 'equivalent continuous noise level' which is an average of the total sound energy measured over a specified time period, *T*
L_{Amax}	The maximum 'A' weighted noise level that was recorded during the monitoring period.
L_{A10}	The 'A' weighted noise level that was recorded for at least 10% of the monitoring period.
L_{A90}	The 'A' weighted noise level that was recorded for at least 90% of the monitoring period, usually taken as the underlying 'background' noise level.

Sound level difference, *D*

The sound level difference between two internal spaces, or between internal and external spaces. The '*D*' value is used to denote the differences at each third octave or octave band, with a single figure 'weighted' value to describe an overall performance. Note that the '*D*' value will always describe an in-situ or on-site acoustic performance. All values are described using the decibel.

D_w	Single figure weighted sound level difference, simply the measured source noise level minus receiver noise level, not adjusted to reference conditions
$D_{nT,w}$	Weighted normalised sound level difference – a single, weighted sound insulation value, normalised to a reference reverberation time using the measured reverberation time in the receive room
$D_{nT,w} + C_{tr}$	As above, with a spectral adaptation term applied to account for the effects of low frequency noise, and based on urban traffic noise
$D_{nf,w}$	Overall flanking normalised level difference - A parameter that defines the flanking transmission of sound from room to room where a dividing partition or floor construction abuts a flanking building element common to both rooms, such as the building façade or ceiling

Sound reduction index, *R*

This describes the sound transmitted through a material or building element, such as a wall, door or window. It is measured in a laboratory with suppressed flanking transmission. The '*R*' value is used to denote the differences at each third octave or octave band, with a single figure 'weighted' value to describe an overall performance. All values are described using the decibel.

R_w	Weighted single figure sound reduction index
$R_w + C_{tr}$	As above, with a spectral adaptation term applied to account for the effects of low frequency noise, and based on urban traffic noise
R'_w	The 'apparent sound reduction index', a field measurement to obtain the sound reduction index of a material or element, with all effects of site installation accepted.

Noise rating, NR

The noise rating or NR system is commonly used in the design of noise emitted by internal building services systems. The system is frequency dependent, and was empirically derived to prevent disturbance to occupants in habitable or working areas from building services noise that exhibits 'tonal' elements, e.g. rumbles, whines, whistles etc. There is no direct relationship between the average 'A' weighted noise level in dB and the NR. However, as a guide, and assuming the absence of strong low frequency content in a given noise, the NR could generally be said to be 6 dB less than the average 'A' weighted dB value.

Appendix IV. SBE Acoustic Credentials

SBE have specialised in providing the UK Construction Industry with a range of acoustics services since 2006. Specialising in Building Acoustics, all SBE acousticians are members of the Institute of Acoustics.

SBE has been accredited for on-site acoustic testing by United Kingdom Accreditation Service (UKAS) since 2006 (Testing Laboratory Number 2587).
SBE meet the relevant acoustic requirements typically required in the UK, including for sound insulation testing as defined in Approved Document E for the purposes of testing for Part E to the Building Regulations 2010.

This report has been prepared by Ben Reed, Senior Acoustic Consultant who meets the BREEAM requirements for a suitably qualified acoustician (SQA) as follows:

1. Holds an BEng (Hons) Acoustics degree.
2. Has been an Acoustic Consultant since August 2014 and therefore has more than three year's relevant experience (within the last five years). This experience includes a practical understanding of factors affecting acoustics in relation to construction and the built environment; including, acting in an advisory capacity to provide recommendations for suitable acoustic performance levels and mitigation measures.
3. Holds Corporate Membership of the Institute of Acoustics - MIOA membership.

This report has been read and reviewed and has been found to:

1. Represent sound industry practice.
2. Be appropriate given the building being assessed and scope of works proposed.
3. Avoid invalid, biased and exaggerated recommendations

Appendix V. Report Conditions

This document has been prepared for the sole use, benefit and information of the Client. The liability of Stroma Built Environment Ltd. in respect of the information contained herein will not extend to any third party unless prior agreement is obtained in writing from Stroma Built Environment Ltd.

This report is limited to addressing the specific acoustic issues contained herein. Advice has been provided for acoustic reasons only and it is recommended that appropriate expert advice be sought on all the ramifications, e.g. safety, fire, structural, CDM etc., associated with any proposals contained herein.

The in-situ performance of acoustic measures is influenced to a large extent by the quality of workmanship and compliance with the specifications on-site during construction, as such, Stroma Built Environment Ltd. accepts no liability for issues with acoustic performance arising from such factors.

Acoustic survey and testing work carried out for the project is representative of the prevailing conditions at the time of the work. Conditions can vary and no warranty is given as to the possibility of changes in the environment of the site and surrounding area at differing times.

In particular, it should be noted that where calculations are carried out that are based on assumptions regarding certain aspects where information has not been supplied, these are provided for indicative purposes only and should be treated as such.