



BS 4142 Noise Impact Assessment

Paston Road, Manchester

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ENVIRONMENTAL AND
SUSTAINABILITY CONSULTANTS

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Executive Summary

A sound survey was undertaken to inform the assessment of the likelihood of adverse impact from the construction safety equipment supplies depot on the south-west of Paston Road, Sharston Industrial Estate, Wythenshawe, Manchester. The sound survey was carried out in compliance with BS 4142:2014+A1:2019 as detailed in this report. The sound survey considers the impacts at residential dwellings on Roundwood Road.

Sound measurements were taken at two locations that represent properties that are directly exposed to activity sounds from the construction safety equipment supplies depot, as well as those that are benefitting from attenuation provided by the 4.8m high fence that covers a large portion of the western boundary. The two assessment locations also represent the difference in sound levels between properties located towards the northern and southern extremes of the boundary between the site and properties on Roundwood Road. These are due to existing sound sources, particularly the M56.

The assessment outcome predicts that if adequate mitigation measures are effectively implemented, the impact of operations at the site should be reduced to below the level that indicates adverse effect. When the worst-case daytime period is considered, the assessment predicts that site operations will have a significant adverse impact on residential properties represented by the assessment location at no.125, as well as adverse effect on properties represented by the assessment location at no.107, if unmitigated. This report outlines recommendations and mitigation measures. These recommendations are based on achieving a rating level below that which indicates adverse effect and consider the worst-case. These recommendations **are predicted to reduce** the impact to below the level that indicates adverse effect being likely during the worst-case daytime activities and therefore all periods during normal recognised operational hours. A summary of the recommendations and mitigation measures is shown below.

Summary of Recommendations and Mitigation

- Activities such as the transportation of heavy scaffolding poles and loading of HGVs should be located at the eastern end of the site and therefore further away from the noise sensitive receptors. Up to 3 dB of attenuation from the specific sound level could potentially be achieved if the centre of activity was to be moved 50m east.
- The 4.8m barrier that runs for most of the western site boundary should be extended to the southern boundary to provide screening for the properties at the southern end of Roundwood Road. Applying the same amount of screening to the properties at the south of Roundwood Road could potentially provide them with 17 dB of attenuation from the specific sound level.
- Items of plant should be carefully selected to reduce noise levels to lowest levels reasonably practicable. If possible, the current reverse signals on company HGVs and forklifts should be replaced by those that do not contain tonal elements, such as white noise signals.

1 Introduction

1.1 Overview

Encon Associates Ltd have been commissioned to prepare an environmental noise impact assessment for a construction safety equipment supplies depot that is currently operating at the land on the south-west of Paston Road, Sharston Industrial Estate, Wythenshawe, Manchester, M22 4TF.

The following report has been produced to accompany a planning application that is to be submitted to Manchester City Council.

This report details existing background sound levels at the noise sensitive receptors considered as the worst affected, as well as noise emissions associated with the operations that are taking place on-site.

Due to the necessary technical nature of the report, a glossary of terms can be found in Appendix A to assist the reader.

1.2 Scope & Objectives

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

- Baseline sound monitoring to evaluate the prevailing acoustic environment at the worst affected noise sensitive receptors in relation to the site;
- A detailed assessment of the sound emissions from the site, in accordance with relevant standards in respect of sound emissions from the site;
- Distance and barrier calculations in accordance with ISO9613 - 1 prediction methodology to predict sound levels at the worst affected noise sensitive receptors;
- Recommendation of mitigation measures, where necessary, to comply with the requirements of BS4142: 2014+A1:2019, and other relevant standards.

2 Site Description & Background Information

2.1 Site & Surrounding Area

The site is located on the land on the south-west of Paston Road, Sharston Industrial Estate, Wythenshawe, Manchester, M22 4TF. The immediate area surrounding the site comprises a mixture of residential dwellings and commercial units. A coach depot operated by Selwyn Travel Group lies immediately to the north, whereas a concrete plant operated by Aggregate Industries is situated on the other side of Paston Road to the east. Immediately to the south of the site lies an active railway line. Approximately 100m south of the site boundary lies the M56, which facilitates high traffic flow during the day and night. Residential dwellings on Roundwood Road are situated to the west of the site.



Figure 1.0 - Site and Surrounding Area

2.2 Background

A building trade supplies company are currently operating on the site between the hours of 06:00 and 18:00 Monday to Friday. Most of the site area is being used for storage of materials and equipment with vehicles accessing the site from Paston Road. The site office and car park are situated on the eastern boundary by the entrance on Paston Road. HGVs access the depot from Paston Road to load/unload materials. HGV manoeuvring and the loading/unloading of materials generally take place on the southern side of the yard anywhere between the site entrance and approximately 20m from the western site boundary.

A retrospective planning application is to be submitted for the current occupants to continue to operate at the site. Consequently, a noise impact assessment was required in order to determine the likelihood of adverse impact upon nearby residents.

Activities observed (and measured) at the site were the sound of metal scaffolding colliding, forklift truck movements and reverse sensors as well HGV manoeuvres and sensors were clearly audible at the identified worst-affected noise sensitive receptors on Roundwood Road during operational hours. The acoustic environment at the receptors was otherwise dominated by road traffic along the M56.

Due to the proximity of the active railway line, regular train passages also contributed to the acoustic environment. As well as road traffic and train passages, activity from other nearby industrial and commercial units, particularly Selwyn Travel Group was also audible at the assessment locations along with birdsong and leaf rustle. Regular aircraft passages overhead associated with Manchester International Airport were also observed at this location.

A 4.8m high fence runs along a significant part of the western boundary, which reduces the impact of noise on the residential properties excepting those at the southern end of Roundwood Road.

3 Legislation, Policy and Guidance

This report is based on the following policy, guidance and legislation.

3.1 BS4142: 2014 + A1: 2019 'Methods for rating and assessing industrial and commercial sound

British Standard 4142: 2014 + A1:2019 describes methods for rating and assessing sound of an industrial and/or commercial nature, which includes:

- Sound from industrial and manufacturing processes;
- Sound from fixed installations which comprise mechanical and electrical plant and equipment;
- Sound from the loading and unloading of goods and materials and/or commercial premises; and
- Sound from mobile plant and vehicles that is an intrinsic part of the overall sound emanating from premises or processes, such as the from fork-lift trucks, or that from train or ship movements on or around an industrial and/or commercial site.

The methods described in the standard use outdoor sound levels to assess the likely effects of sound on people who might be inside or outside a dwelling or premises used for residential purposes upon which sound is incident.

The standard presents methods to measure and determine ambient, background and residual sound levels, and the rating levels of industrial/commercial sound. BS4142:2014+A1+2019 requires consideration of the level of uncertainty in the data and associated calculations.

The determination of noise amounting to a nuisance is beyond the scope of BS4142. The standard stipulates that it not intended to be applied to the rating and assessment of sound from the passage of vehicles of vehicles on public roads and railway systems, recreational activities, music and entertainment, shooting grounds, construction and demolition, domestic animals, public address systems and other sources not specified within the document.

The Reference Time Interval, T , is defined in the standard as the "specified interval over which the specific sound level is determined", which is 1 hour during the daytime (07:00 to 23:00 hours) and 15 minutes during the night (23:00 to 07:00 hours).

Ambient sound is defined as "totally encompassing sound in a given situation at a given time, usually composed of sound from many sources near and far". It comprises the residual sound and the specific sound when present.

Residual sound is defined as "ambient sound remaining at the assessment location when the specific sound source is suppressed to such a degree that it does not contribute to the ambient sound".

The background sound level is the $L_{A90, T}$ of the residual sound level, and is the underlying level of sound. Measurements of background sound level should be undertaken at the assessment location where possible or at a comparable location.

The measurement time interval should be sufficient to obtain a representative value (normally not less than 15 minutes) and the monitoring duration should reflect the range of background sound levels across the assessment period. The background sound level used for the assessment should be representative of the period being assessed.

The specific sound level is the $L_{Aeq, T}$ of the sound source being assessed over the reference time interval, Tr . BS 4142: 2014 + A1: 2019 advises that Tr should be 1 hour during the day and 15 minutes at night.

The rating level is the specific sound level plus any adjustment for the characteristics that are present with the sound including tonality, impulsivity, intermittency or other acoustic characteristics. The standard describes subjective and objective methods to establish the appropriate adjustment. The characteristics and coinciding adjustments are defined as:

- **Tonality:** A rating penalty of + 2dB is applicable for a tone which is “just perceptible”, +4 dB where a tone is “clearly perceptible”, and +6 dB where a tone is “highly perceptible”.
- **Impulsivity:** A rating penalty of +3 dB is applicable for impulsivity which is “just perceptible”, +6 dB where it is “clearly perceptible”, and +9 dB where it is “highly perceptible”.
- **Intermittency:** When the specific sound has identifiable on/off conditions, the specific sound level ought to be representative of the time period of length equal to the reference time interval which contains the greatest total amount of on-time if the intermittency is readily distinctive against the residual acoustic environment, a penalty of +3dB can be applied.”
- **Other Sound Characteristics:** Where the specific sound features that are neither tonal nor impulsive but are otherwise readily distinctive against the residual acoustic environment, a 3 dB penalty can be applied.

The level of impact is assessed by comparing the rating level with the background sound level. Typically the greater the difference between the rating level and background sound level the greater the magnitude of impact, depending on context. A difference of +5 dB is likely to indicate an adverse impact and a difference of +10 dB is likely to indicate a significant adverse impact, depending on context.

4 Environmental Noise Survey

To characterise the acoustic environment of the area, a long-term noise survey was carried out from the 14th-16th September 2021 and further measurements were taken on-site on 28th September 2021.

4.1 Measurement Methodology

Long-term unattended monitoring was carried out at two measurement positions (MP). One sound level meter (MP1) was positioned in the woodland behind 107 Roundwood Road. The microphone was mounted onto a tripod 1.5m above the ground in free-field conditions (more than 3.5m from any reflective surfaces apart from the ground). The other sound level meter (MP2) was positioned in the back garden of 125 Roundwood Road. The microphone was mounted onto a tripod 1.5m above the ground in free-field conditions. These measurement positions were chosen to obtain representative background sound levels during the daytime and night-time periods. Long-term environmental noise monitoring was carried out at MP1 and MP2 due to background sound levels being likely to differ as a result of the differential distance from the M56. Attended measurements were taken on 28th September 2021 on the site (MP3) to capture the ambient and residual sound levels in order to establish the specific sound level, as the difference between the ambient sound level and residual sound level at MP1 and MP2 were not 3 dB or greater due to the nature of the specific sound. These measurement positions are shown in Figure 2.0.



Figure 2.0 - Measurement Positions

4.2 Instrumentation

Equipment	Serial No.	Laboratory Calibration
Cirrus Optimus Green+ Class 1 Sound Level Meter	G303153	19/08/2021
Cirrus Optimus Green+ Class 1 Sound Level Meter	G303154	19/08/2021
Cirrus CR:515 Class 1 Acoustic Calibrator	96656	19/08/2021

Table 1.0 - Instrumentation

All sound level meters were field calibrated immediately before and after the measurement period and no significant drift (≤ 0.5 dB) occurred. Laboratory calibration by a third-party is carried out on all sound level meters every twenty-four months with all calibrators being calibrated every twelve months. All microphones were fitted with a protective windshield. Calibration certificates can be seen in Appendix G.

4.3 Weather Conditions

Localised meteorological conditions were recorded throughout the survey period during the measurement of the background sound levels from 14th-16th September 2021 using a Kestrel 5500 weather meter. The conditions were considered suitable i.e. in accordance with those laid out in BS 7445-2:1991 and provided no significant uncertainty to the measured data. Meteorological conditions were also recorded during the measurement of ambient and residual sound levels on 28th September 2021 and also had no significant impact on the measured levels. A summary of the meteorological conditions can be found in Appendix C.

4.4 Survey Results

Time History Graphs showing the results of the automated survey can be found in Appendix B. These graphs display the 15-minute L_{A90} , L_{Aeq} , and L_{AFmax} sound levels at each monitoring location throughout the survey period

4.4.1 Background Measurement Results

The table below shows the L_{A90} measurements at MP1 throughout the day-time operational hours.

Measurement Position 1			
Daytime Operation Hours (07:00 - 18:00)	Typical $L_{A90, 15 \text{ min}}$ (mode)	Min. $L_{A90, 15 \text{ min}}$	Max. $L_{A90, 15 \text{ min}}$
Tuesday 14/09/21	47	44	50

Table 2.0 - Operational Hours Daytime Background Measurements - MP1

The site operations between the hours of 06:00 and 07:00, which BS4142 considers to be night-time hours. The background measurements at MP1 for this period are shown below. It was not possible to represent the typical background intensity by mode so the typical value has been expressed by the median.

Measurement Position 1			
Night-time Operation Hours (06:00 - 07:00)	Typical $L_{A90, 15 \text{ min}}$ (median)	Min. $L_{A90, 15 \text{ min}}$	Max. $L_{A90, 15 \text{ min}}$
Wednesday - 15/09/21	48	46	49

Table 3.0 - Operational Hours Night-time Background Measurements - MP1

Measurement Position 2			
Daytime Operation Hours (07:00 - 18:00)	Typical $L_{A90, 15min}$ (mode)	Min. $L_{A90, 15min}$	Max. $L_{A90, 15min}$
Wednesday - Thursday 15 - 16/09/21	50	49	53

Table 4.0 - Operational Hours Daytime Background Measurements - MP2

Measurement Position 2			
Night-time Operation Hours (06:00 - 07:00)	Typical $L_{A90, 15min}$ (median)	Min. $L_{A90, 15min}$	Max. $L_{A90, 15min}$
Thursday - 16/09/21	50	48	51

Table 5.0 - Operational Hours Night-time Background Measurements - MP2

The tables above demonstrate the range of background sound levels at the noise sensitive receptors. Considering that the background sound levels have not been influenced by on-site activity, the $L_{A90, 15min}$ sound levels measured at the noise sensitive receptors during the same periods that activities were taking place are to be used for the assessment.

4.4.2 Specific Sound Levels

Continuous 5-minute sound measurements were taken at MP3, where the acoustic environment was dominated by activity taking place at the depot. Ambient sound levels were measured while activity was taking place on-site and residual sound levels were obtained on-site during non-operational periods prior to or immediately after the activity sounds.

Intense activity took place between 11:20 and 12:20 with long metal scaffolding poles being unloaded either manually or via forklift onto various stockpiles. The centre of activity was estimated to be 20m north of MP3 with the source height being estimated as 1m. This given hour represents the worst-case sound levels measured on-site. Table 6.0 shows the specific sound level for the worst-case 1-hour daytime period. The calculations for the residual sound level are shown in Appendix E.

Date & Time	$dBL_{Aeq, 5min}$	Ambient Sound Level $dBL_{Aeq, 1hour}$	Residual Sound Level $dBL_{Aeq, 15 min}$	Specific Sound Level $dBL_{Aeq, 1hour}$
28/09/21 - 11:20	59.0	69.3	56.8	69.0
28/09/21 - 11:25	66.3			
28/09/21 - 11:30	67.8			
28/09/21 - 11:35	65.8			
28/09/21 - 11:40	74.3			
28/09/21 - 11:45	65.1			
28/09/21 - 11:50	69.4			
28/09/21 - 11:55	64.9			
28/09/21 - 12:00	60.5			
28/09/21 - 12:05	67.5			
28/09/21 - 12:10	66.3			
28/09/21 - 12:15	75.4			

Table 6.0 - Worst-case daytime activity specific sound levels

For the night-time operational hours between 06:00 and 07:00. It was observed during this period that activities on-site only lasted for a maximum of ten minutes given any fifteen-minute period during this hour. BS 4142 specifies a 15-minute night-time reference level and therefore an on-time correction has been applied to determine the specific sound level. The table below represents the worst-case intensity of operations in a given 15-minute period.

Night-time HGV Loading Measurement Position 3 (dB _A)		
Date	Measured Activity Noise	66.6% on-time
Tuesday 28/09/21	62.8	60.2

Table 7.0 - Night-time specific sound level

Approaching the end of the working day, it was observed that company HGVs are loaded with stock to prepare them to leave the site the following morning. Although the measured sound levels associated with this part of the day are not as substantial as the highest measured during the worst-case daytime period, this activity still generates relatively high sound pressure levels over a 1-hour period. The specific level for the 1-hour reference period has been determined from twelve consecutive $L_{Aeq,5\text{ min}}$ measurements to reflect the potential impact, which represent the worst-case for this period of activity. The residual sound measurements were taken at 16:30 to 16:45, when on-site activity had stopped (Residual Sound Level calculations shown in Appendix E). The table below shows the specific sound level for the late afternoon HGV loading period.

Date & Time	dB _{L_{Aeq,5min}}	Ambient Sound Level dB _{L_{Aeq,1hour}}	Residual Sound Level dB _{L_{Aeq,15 min}}	Specific Sound Level dB _{L_{Aeq,1hour}}
28/09/21 - 15:15	64.1	65.6	55.1	65.2
28/09/21 - 15:20	61.5			
28/09/21 - 15:25	62.0			
28/09/21 - 15:30	61.2			
28/09/21 - 15:35	63.4			
28/09/21 - 15:40	65.1			
28/09/21 - 15:45	65.9			
28/09/21 - 15:50	61.2			
28/09/21 - 15:55	64.1			
28/09/21 - 16:00	67.8			
28/09/21 - 16:05	71.7			
28/09/21 - 16:10	64.9			

Table 8.0 - Afternoon specific sound level

5 BS 4142:2014+A1:2019 Assessments

4.1 BS 4142 Assessment Tables

Worst-case daytime period - 107 Roundwood Road			
Assessment		Relevant Clause	Commentary
Specific Sound Level @20m	69.0 dB _{L_{Aeq},5min}		The residual sound level of has been subtracted from the Ambient Sound Level as shown in table 6. Appendix E for residual calculations
Background Sound Level	47 dB _{L_{A90},15min}	8.1.1 8.1.2 8.1.3 8.1.4 8.6	The median L _{A90} , 15min from the same hour. The median used as the mode was not possible
On-time correction	N/A	7.3.10	L _{Aeq, 1hour} determined by logarithmic average of 12 consecutive L _{Aeq} , 5min measurements. Table 6.0
Distance Correction Point Source Change in level =20log (r2/r1) =20log (77/20)	-11.7 dB _A		Defined as a point source by (b/π) where b = largest dimension of source (Watson & Downey, 2013) Distances shown in Appendix F
Barrier Attenuation	-18.3 dB _A		Barrier calculations - Appendix D
Specific Sound Level at Receiver	39.0 dB _A		
Acoustic Character Correction: Impulsivity = +9 dB Tonality = +4 dB	+13 dB	9.2	The sound of large scaffolding poles being unloaded and colliding with each other is highly impulsive Clearly perceptible tones from vehicle sensors
Rating Level at Receiver	(39.0+ 13) = 52.0 dB _A	9.1	
Excess of rating level over background level	(52 - 47) = +5 dB _A	11	Rounded to nearest integer at the final phase of the calculation
Impact	The Assessment indicates likelihood of adverse impact, depending on context	11	The rating level is 5 dB _A above the background sound level and is at the level of +5 dB _A which indicates likelihood of adverse impact

Table 9.0 - BS 4142: 2014+A1:2019 Assessment - Worst-case daytime period, 107 Roundwood Road

Worst-case daytime period - 125 Roundwood Road			
Assessment		Relevant Clause	Commentary
Specific Sound Level @20m	69.0 dB _{L_{Aeq},5min}		The residual sound level of has been subtracted from the Ambient Sound Level as shown in table 6. Appendix E for residual calculations
Background Sound Level	51 dB _{L_{A90},15min}	8.1.1 8.1.2 8.1.3 8.1.4 8.6	The modal L _{A90} , 15min from the same hour.
On-time correction	N/A	7.3.10	L _{Aeq} , 1hour determined by logarithmic average of 12 consecutive LAeq, 5min measurements. Table 6.0
Distance Correction Point Source Change in level =20log (r2/r1) =20log (75/20)	-11.5 dB _A		Defined as a point source by (b/π) where b = largest dimension of source (Watson & Downey, 2013) Distances shown in Appendix F
Barrier Attenuation	0 dB _A		The receptor has a clear line of sight to the source
Specific Sound Level at Receiver	57.5 dB _A		
Acoustic Character Correction: Impulsivity = +9 dB Tonality = +4 dB	+13 dB _A	9.2	The sound of large scaffolding poles being unloaded and colliding with each other is highly impulsive Clearly perceptible tones from vehicle sensors
Rating Level at Receiver	(57.5 + 13) = 70.5 dB _A	9.1	
Excess of rating level over background level	(71 - 51) = +20 dB _A	11	Rounded to nearest integer at the final phase of the calculation
Impact	The Assessment indicates likelihood of significant adverse impact	11	The excess of rating level over background sound level is +20 dB _A , which is 10 dB _A greater than the +10 difference that indicates likelihood of significant adverse impact, depending on context

Table 10.0 - BS 4142: 2014+A1:2019 Assessment - Worst-case daytime period, 125 Roundwood Road

Night-time Assessment - 107 Roundwood Road			
Assessment		Relevant Clause	Commentary
Specific Sound Level @20m	61.9 dB _{L_{Aeq},5min}		The residual sound level of has been subtracted from the 'Night-time HGV Loading' in table 6. Appendix E for residual calculations
Background Sound Level	48 dB _{L_{A90},15min}	8.1.1 8.1.2 8.1.3 8.1.4 8.6	
On-time correction	$10\log(10/15) = -1.8$ dB _A	7.3.14	Total on-time of ten minutes during 15-minute reference interval. Section 4.4.2
Distance Correction Point Source Change in level = $20\log(r_2/r_1)$ = $20\log(77/20)$	-11.7 dB _A		Defined as a point source by (b/π) where b = largest dimension of source (Watson & Downey, 2013) Distances shown in Appendix F
Barrier Attenuation	-16.1 dB _A		Barrier calculations - Appendix D
Specific Sound Level at Receiver	32.3 dB _A		
Acoustic Character Correction: Impulsivity = +6 dB Tonality = +4 dB	+10 dB	9.2	The sound of large scaffolding poles being unloaded and colliding with each other is clearly impulsive Clearly perceptible tones from vehicle sensors
Rating Level at Receiver	$(32.3 + 10) = 42.3$ dB _A	9.1	
Excess of rating level over background level	$(42 - 48) = -6$ dB _A	11	Rounded to nearest integer at the final phase of the calculation
Impact	The Assessment indicates that adverse impact is unlikely, depending on context	11	The rating level is 6 dB _A below the background sound level and is 11 dB _A below the level which indicates likelihood of adverse impact, that of +5 dB _A

Table 11.0 - BS 4142: 2014+A1:2019 Assessment - Night-time Assessment, 107 Roundwood Road

Night-time Assessment - 125 Roundwood Road			
Assessment		Relevant Clause	Commentary
Specific Sound Level @20m	61.9 dB _{LAeq,5min}		The residual sound level of has been subtracted from the 'Night-time HGV Loading' in table 6. Appendix E for residual calculations
Background Sound Level	50 dB _{LA90,15min}	8.1.1 8.1.2 8.1.3 8.1.4 8.6	The median L _{A90, 15min} from the same hour. The median used as the mode was not possible
On-time correction	10log (10/15) = - 1.8 dB _A	7.3.14	Total on-time of ten minutes during 15-minute reference interval. Section 4.4.2
Distance Correction Point Source Change in level =20log (r2/r1) =20log (75/20)	-11.5 dB _A		Defined as a point source by (b/π) where b = largest dimension of source (Watson & Downey, 2013) Distances shown in Appendix F
Barrier Attenuation	0 dB _A		Barrier calculations - Appendix D
Specific Sound Level at Receiver	48.6 dB _A		
Acoustic Character Correction: Impulsivity = +6 dB Tonality = +4 dB	+10 dB _A	9.2	The sound of large scaffolding poles being unloaded and colliding with each other is clearly impulsive Clearly perceptible tones from vehicle sensors
Rating Level at Receiver	(48.6 + 10) = 58.6 dB _A	9.1	
Excess of rating level over background level	(59 - 50) = +9 dB _A	11	Rounded to nearest integer at the final phase of the calculation
Impact	The Assessment indicates likelihood of adverse impact, depending on context	11	The excess of rating level over background sound level is +9 dB _A , which is 4 dB _A above the level of difference that indicates likelihood of adverse impact, depending on context

Table 12.0 - BS 4142: 2014+A1:2019 Assessment - Night-time Assessment, 125 Roundwood Road

Late Afternoon Assessment - 107 Roundwood Road			
Assessment		Relevant Clause	Commentary
Specific Sound Level @20m	65.2 dB _{L_{Aeq},1hour}		The residual sound level of has been subtracted from the Ambient Sound Level as shown in table 8. Appendix E for residual calculations
Background Sound Level	47 dB _{L_{A90},15min}	8.1.1 8.1.2 8.1.3 8.1.4 8.6	The median L _{A90} , 15min from around the same hour. The median used as the mode was not possible
On-time correction	N/A	7.3.10	L _{Aeq} , 1hour determined by logarithmic average of 12 consecutive LAeq, 5min measurements
Distance Correction Point Source Change in level =20log (r2/r1) =20log (75/20)	-11.7 dB _A		Defined as a point source by (b/π) where b = largest dimension of source (Watson & Downey, 2013) Distances shown in Appendix F
Barrier Attenuation	-16.8 dB _A		Barrier calculations - Appendix D
Specific Sound Level at Receiver	36.7 dB _A		
Acoustic Character Correction: Impulsivity = +9 dB Tonality = +4 dB	+13 dB _A	9.2	The sound of large scaffolding poles being unloaded and colliding with each other is clearly impulsive Clearly perceptible tones from vehicle sensors
Rating Level at Receiver	(36.7 + 13) = 49.7 dB _A	9.1	
Excess of rating level over background level	(50 - 47) = +3 dB _A	11	Rounded to nearest integer at the final phase of the calculation
Impact	The Assessment indicates that adverse impact is unlikely, depending on context	11	The rating level is 3 dB _A above the background sound level and is 2 dB _A below the level which indicates likelihood of adverse impact, that of +5 dB _A

Table 13.0 - BS 4142: 2014+A1:2019 Assessment - Late Afternoon Assessment, 107 Roundwood Road

Late Afternoon Assessment - 125 Roundwood Road			
Assessment		Relevant Clause	Commentary
Specific Sound Level @20m	65.2 dB _{LAeq,5min}		The residual sound level of has been subtracted from the Ambient Sound Level as shown in table 8. Appendix E for residual calculations
Background Sound Level	50 dB _{LA90,15min}	8.1.1 8.1.2 8.1.3 8.1.4 8.6	The median $L_{A90, 15min}$ from around the same hour. The median used as the mode was not possible
On-time correction	N/A	7.3.10	
Distance Correction Point Source Change in level =20log (r2/r1) =20log (75/20)	-11.5 dB _A		Defined as a point source by (b/π) where b = largest dimension of source (Watson & Downey, 2013) Distances shown in Appendix F
Barrier Attenuation	0 dB _A		Barrier calculations - Appendix D
Specific Sound Level at Receiver	53.7 dB _A		
Acoustic Character Correction: Impulsivity = +9 dB Tonality = +4 dB	+13 dB	9.2	The sound of large scaffolding poles being unloaded and colliding with each other is clearly impulsive Clearly perceptible tones from vehicle sensors
Rating Level at Receiver	(53.7 + 13) = 66.7 dB _A	9.1	
Excess of rating level over background level	(67 - 50) = +17 dB _A	11	Rounded to nearest integer at the final phase of the calculation
Impact	The Assessment indicates likelihood of significant adverse impact	11	The excess of rating level over background sound level is +17 dB _A , which is 7 dB _A greater than the +10 difference that indicates likelihood of significant adverse impact, depending on context

Table 14.0 - BS 4142: 2014+A1:2019 Assessment - Late Afternoon Assessment, 125 Roundwood Road

5.2 Discussion

5.2.1 Overview

The assessment of adverse impact at the noise sensitive receptors considered to be the worst affected has been employed by the measured sound levels from the environmental noise survey. The measurement and subsequent assessment have been carried out in accordance with methodology outlined in BS 4142:2014+A1:2019. BS 4142 requires that human response to activity sound is rated via numerical values as well as careful consideration for the context in which the sound exists.

107 Roundwood Road

The assessment at 107 Roundwood indicates likelihood of adverse impact during the worst-case daytime period, depending on context. In the other cases at 107 Roundwood Road, the rating level is below the level where there is likelihood of adverse impact, subject to context. The protection provided by the 4.8m fence is the sole reason for the difference in predicted outcomes compared to 125 Roundwood Road. Considering that one of the assessments indicates that adverse impact is likely at the location, depending on context, mitigation measures discussed in section 6 of this report must be implemented.

125 Roundwood Road

The assessment at 125 Roundwood Road indicates likelihood of significant adverse impact during the worst-case daytime period and the late afternoon loading period and adverse impact during the night-time period, subject to context. Considering that the initial assessments indicate that the rating levels are unacceptable, mitigation measures discussed in section 6 of this report must be implemented.

5.2.2 Context

It is stated in section 11 of BS 4142: 2014:+A1:2019 that “where the initial estimate of the impact needs to be modified due to context, take all pertinent factors into consideration, including the following.”

- 1) The absolute level of sound. For a given difference between the rating level and the background sound level, the magnitude of the overall impact might be greater for an acoustic environment where the residual sound level is high. In this instance the residual sound level is high due to other sources such as road traffic along the M56, train passages, other industrial activity and aircraft passages. Therefore, the magnitude of impact may be greater than predicted by the initial estimate of impact.
- 2) The character and level of the residual sound compared to the character and level of the specific sound. Considering that the specific sound exists within an industrial and residential area, it must be reasonable to expect that the nearby residents would expect an acoustic climate which includes noise from industrial activity. However, sound from the scaffolding hire depot, particularly the sound of metal ‘clanging’ is very much distinguishable from the activity that is taking place on other nearby sites such as Selwyn Travel and Aggregate Industries where the noise mainly consists of diesel engines associated with vehicles due to the difference in the frequency spectrum and impulsivity.

5.2.3 Rating Level Assessment

BS 4142 requires the assessment of acoustic features. This was carried out with first-hand observations of the character of the sounds and the absolute level of these activity sounds in relation to the background. Predominant sounds on-site included the unloading of metal scaffolding, the sound of diesel engines and reversing warning signals. The sound of metal scaffolding being transported and colliding with one another was highly discernible at both 107 and 125 Roundwood Road. The sound is assessed as being impulsive and highly perceptible and therefore a 9dB penalty rating is applied during the worst-case daytime period. For the night-time assessment the sound associated with the loading and unloading of was still impulsive but not as prominent as during the daytime and therefore a 6dB penalty rating is applied instead of a 9dB, as impulsivity was deemed as likely to be clearly perceptible instead of highly perceptible during this period at the receptors. During the late-afternoon loading period, the 'clanging' sound of heavy metal objects colliding was observed to be noticeably more prominent than during the night-time hour and subsequently a rating penalty of 9dB is applied as impulsivity is deemed more likely to be highly perceptible at the noise sensitive receptors.

The sound of diesel engines is masked by M56 traffic noise as well train and aircraft passages. Observations of activity showed that diesel engines on the site were barely perceptible at both assessment locations. No rating penalty has been applied for the diesel engines. The reversing signals associated with forklifts and HGVs on-site consisted of tonal 'beeps' that were clearly perceptible at the assessment location, thus resulting in a 4 dB penalty rating.

5.2.4 On-time Impact

BS 4142:2014+A1:2019 uses a reference period of 1-hour during the daytime and 15-minutes during the night-time to assess the likelihood of adverse impact. The activities within these periods are required to be typical of the operation under investigation both in terms of level and duration. This identifies whether the sounds associated with the activity have the likelihood of adverse impact, depending on context. The proportion of time the activity takes place within extended periods of time greater than the one-hour and fifteen-minute reference periods provides part of the acoustic context that the BS 4142:2014+A1:2019 assessment is subject to. The calculated on-time activity provides a representative impact for the 15-minute night-time reference period of activities observed whilst on site.

Observations made whilst at the site as well as information provided by site managers and operatives indicate that the activities taking place on-site were typical and therefore the assessments are representative of normal operations. Stock deliveries and collections take place daily with HGVs and LGVs regularly coming to and from the site. Furthermore, forklifts are used daily to transport stock around the yard as well as loading and unloading stock to and from HGVs. Along with the use of mobile plant, scaffolding poles are also loaded manually onto from forklifts onto stockpiles and vice-versa. These activities were observed and took place during the measurements and were the predominant contributors to the specific sound level. Therefore, it is deemed that the assumed on-time accurately represents the impact of site activity.

5.2.5 Uncertainty

Reasonable steps have been undertaken to reduce uncertainty in both measurement and assessment in line with section 10 of BS 4142:2014+A1:2019. These steps include the use of class 1 instrumentation, measurements being taken in suitable weather conditions, the measurement locations chosen to obtain background sound levels being representative of the assessment locations, the number of measurements taken, ensuring that residual sound measurements were taken in similar conditions to the ambient sound level and the number of measurements that were taken. Uncertainty has been reduced by the inclusion of considered and supported contextual issues, as they provide a greater understanding of the residual acoustic environment and the level of variability in sound emission from the source.

6 Assessment of Impacts and Potential Mitigation

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 effective assessment cannot be conducted without an understanding of the reason(s) for the assessment and the context in which the sound occurs/will occur. When making assessments and arriving at decisions, therefore, it is essential to place the sound in context. An initial estimate of the impact of the specific sound is made by subtracting the background level.

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

Based on the above, the assessments indicate that significant adverse impact is likely to occur at 125 Roundwood Road during the worst-case daytime period, as well as adverse impact and significant adverse impact being likely during the night-time period and late afternoon loading period respectively. Contextual observations such as the residual sound level relating to the absolute level of sound and the character of the specific sound compared to the residual acoustic environment suggest that the magnitude of impact may be greater than indicated by the rating level compared to the background sound level. However, these observations do not alter the overall assessment outcomes.

The assessments indicate that adverse impact is likely to occur during the worst-case daytime period at 107 Roundwood Road. The assessments indicate that adverse impact is not likely to occur during the night-time at 107 Roundwood Road, due to the rating level being significantly below the level which indicates likelihood of adverse impact. The assessment of the late afternoon loading period indicates that adverse impact is not likely to occur at 107 Roundwood, however, the rating level for this period is not significantly below the level which indicates adverse impact. Considering the context in which the specific sound occurs, the magnitude of impact may be greater based on observations outlined in section 5.2.2. However, the overall assessment outcomes are not altered by these factors.

This section of the report provides consideration of possible mitigation procedures and their effectiveness in reducing the level of impact at the noise sensitive receptors.

Location of Activities

It was observed on site that the majority of noise generating activities took place towards the south-west corner of the site approximately 30m from the western boundary. The noise generating activities that took place around this area included the manual handling of large metal scaffolding poles, the operation of mobile plant and the loading and unloading of HGVs manually and via forklift. It was observed that large metal scaffolding was stored at south-west corner of the site along with other metal scaffolding parts.

In terms of reducing noise emissions at the worst affected noise sensitive receptors, an effective control measure is to increase the distance between the noise generating activities and the noise sensitive receptors. Considering that the dwellings on Roundwood Road run parallel with the western site boundary, the recommendation is made that the greatest noise generating activities are moved further east, with the lower noise generating activities taking place towards the western boundary of the site.

Heavy items such as large scaffolding poles and fixings are currently being stored towards the western boundary. These items generate noise that is very impulsive in nature when they collide. These items could be relocated to where lighter items such as plastic rubbish shoot, wooden scaffolding board and heras security fencing are currently stored. This rearrangement would create greater distance between the highly impulsive 'clanging' of heavy metal products and the noise sensitive receptors.

Collections and deliveries, particularly those involving heavy metal items should be moved so that they are taking place as far away from the noise sensitive receptors as possible. At present the centre of noise generating activity is located 77m and 75m respectively away from 107 and 125 Roundwood Road. If the centre of noise generating activity were to move 50m east, 3dB and 4dB is the predicted improvement at 107 and 125 Roundwood Road respectively during the worst-case daytime period (calculations shown in Appendix E).

As well as the increase in distance providing attenuation to the specific sound level, the increase in distance could also potentially reduce the influence of acoustic characteristics within the activity sound. For instance, the impulsivity associated with the 'clanging' of large metal scaffolding poles is likely to be less perceptible at greater distance as the absolute level with relation to the background level decreases as the distance increases and the higher frequencies associated with this sound are more readily attenuated. If impulsivity were to become clearly perceptible rather than highly perceptible, this would reduce the rating by 3 dB.

Barrier and Screening

The assessment outcomes strongly suggest that number 125 and other properties at the southern end of Roundwood Road are more exposed to the activities taking place on the site due to the 4.8m concrete fence ending further north, approximately adjacent to property number 123. Acoustic barriers attenuate sound by increasing the distance between the source and the receiver. Acoustic barriers are particularly affective at attenuating high frequency sounds such as that of hard metal surfaces colliding. The extension of the existing 4.8m fence so that it runs right until the southern boundary, thus screening the properties at the end of Roundwood Road could provide substantial attenuation to the rating sound level at these dwellings. The barrier calculations in Appendix D (page 37) suggest that 17 dB_A of attenuation could be provided to the properties at the southern end of Roundwood Road during the worst-case daytime period if the currently exposed properties were to have the same level screening.

Other Mitigation Measures

As well as increasing the horizontal distance between the source and receiver, other measures can be implemented to reduce the impact of sound from the building trade materials depot upon the noise sensitive receptors. A +4 dB penalty rating has been applied to the specific sound level across the assessments due to the tonality of vehicle signals. It is recommended that signals that are not tonal be implemented instead, such as those that emit white noise instead of beeps.

In terms of reducing the sound at source, the methods that members of staff are using to carry out their work should also be evaluated. It was observed on site that operatives were dropping metal objects onto piles and into bins and skips. Drop heights should be reduced as much as reasonably practicable to reduce the impact of the objects colliding with each other and if possible, objects should be placed instead of thrown or dropped.

Summary of Mitigation Measures

The calculations suggest that extending the 4.8m fence to protect properties at southern end of Roundwood Road should attenuate the rating sound level by 17 dB_A and therefore reduce the levels of impact to below 5dB over the background sound level at these properties.

Moving the centre of activities 50m east should provide 3 dB_A to the rating level at the properties represented by 107 Roundwood Road, which would reduce the rating level to below the level which indicates adverse impact.

The rating level could potentially be reduced by 2 dB_A if the current 'beeping' reverse signals were to be replaced by white noise sensors.

The calculations also suggest that if the centre of activities were to be moved directly 50m east of the current location, as well as the barrier being extended to protect properties at the southern end of Roundwood Road, that the rating sound level could be attenuated by 19 dB_A. These two measures in conjunction with the change to white noise vehicle reverse sensors could reduce the rating level by 21 dB_A at properties at the south end of Roundwood Road, thus reducing the rating sound level to well below the level which indicates significant adverse impact. It is therefore recommended that all of these measures be implemented.

7 Conclusions

A sound survey was undertaken to inform the assessment of the likelihood of adverse impact from the construction safety equipment supplies depot on the south-west of Paston Road, Sharston Industrial Estate, Wythenshawe, Manchester. The sound survey was carried out in compliance with BS 4142 as detailed in this report. The sound survey considers the impacts at residential dwellings on Roundwood Road.

Sound measurements were taken at two locations that represent properties that are directly exposed to activity sounds from the construction safety equipment supplies depot as well as those that are benefitting from attenuation provided by the 4.8m high fence that covers a large portion of the western boundary. The two assessment locations also represent the difference in sound levels between properties located towards the northern and southern extremes of the boundary between the site and properties on Roundwood Road. These are due to existing sound sources, particularly the M56.

The assessment location at 107 Roundwood Road, representing properties at the northern end of the boundary has activity sounds attenuated by the 4.8m fence. However, these properties are further away from the M56 and background sound levels are therefore lower. The assessment of the worst-case daytime period indicates the likelihood of adverse impact. The assessment of the night-time period and late afternoon activities fall below this level. The contextual considerations required by BS 4142 suggest that the impact may be greater than suggested by the rating level compared to the background level, however, further mitigation measures demonstrate the potential to reduce the rated impact to below the level that indicates adverse impact if implemented. This would also reduce the influence of contextual factors.

Properties represented by the assessment location at 125 Roundwood Road have direct line of sight of activity sounds from the site. However, background sound levels are higher as a result of a reduced distance from the M56. The assessment of the worst-case daytime period and the afternoon activities indicate the likelihood of significant adverse impact. The attenuation provided by the 4.8m fence to properties further north on Roundwood Road demonstrate that an extension of the fence to cover entirety of the western boundary is predicted to reduce these assessments to below the level which indicates adverse impact without any further mitigation measures. This would also reduce the the influence of contextual factors.

The mitigation measures of extending the fence to meet the southern boundary, replacing reversing beepers with white noise signals and relocating noise generating to the eastern side of the site away from the noise sensitive receptors, are predicted to reduce the levels to below the indication of adverse impact for all properties on Roundwood Road.

This Report concludes that from the measured sound levels and subsequent BS 4142 assessment, that mitigation is required and that if mitigation identified within this Report is actioned, the predicted levels are unlikely to result in adverse impact.

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Signed for and on behalf of Encon Associates Limited

A handwritten signature in black ink, appearing to read 'B. Phipps', is written over a faint, light blue rectangular stamp or watermark.

Ben Phipps BSc (Hons), AMIOA

Acoustic Consultant

Date: 19th January 2022

Appendix A - Acoustic Terminology & Definitions

Sound Pressure	The fluctuations in air pressure, from the steady atmospheric pressure, created by sound, measured in pascals (Pa).
Sound Pressure Level (SPL)	The sound pressure measured on a decibel scale relative to a standard reference pressure of 20μPa (20x10 ⁻⁶ Pascals).
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.
Frequency (Hz)	The pitch of the sound, measured in Hertz (Hz)
Integrating Sound Level Meter	An instrument used for measuring sound levels with the capacity to perform calculations to derive other parameters.
Calibration	A check of the function of a sound level meter by comparing the meter reading with a known sound pressure level. This is performed in the field before and after measurement and by a laboratory every year calibrators and every two years for Sound Level Meters.
A-Weighting, dB(A)	A frequency weighting devised to attempt to take the fact that human response to sound is not equally sensitive at all frequencies into account.
Z-Weighting	A zero frequency weighting (often referred to as unweighted).
Attenuation	Noise reduction, measured in decibels.
Ambient Sound Level $L_{Aeq,T}$	The total encompassing sound in a given situation, at a given time. Usually composed of sounds from many sources, near and far.
Residual Sound Level $L_{Aeq,T}$	The ambient sound remaining when the specific sound source is suppressed to a degree it does not contribute to the ambient sound.
Specific Sound Level $L_{Aeq,T}$	The equivalent continuous A-weighted sound pressure level produced by the specific sound source at the assessment location over a given reference time interval, T_r
Rating Level $L_{Ar, tr}$	The specific sound level plus any adjustment for the characteristic features of the sound
Background Sound Level $L_{A90,T}$	A-weighted sound pressure level that is exceeded by the residual sound at the assessment location for 90% of a given time interval, T, measured using time weighting F and quoted to the nearest whole number of decibels.
Frequency Analysis	Analysis of a sound into its frequency components. Commonly 1/1 or 1/3 octave bands
Frequency Spectrum	A graph resulting from frequency analysis and showing different levels of the signal in the various frequency bands.
Octave-bands	A division of the frequency range into bands, the upper frequency limit of each band being twice the lower frequency limit.
Noise Index	A method of evaluating or rating a noise, usually by assigning a single number to it, based on some combination of its physical parameters (sound pressure level, frequency, duration) and other factors such as time of day, tonal characteristics and impulsive characteristics.
Leq, T	Otherwise referred to as the 'continuous equivalent noise level' of a period of time (T). This is the steady noise level which contains the same amount of energy as the time varying sound level that was recorded.
Lmax,T	The maximum RMS sound pressure level that occurs within a specified time period. It is used often to describe occasional loud noise events that may have little influence on the Leq but will have an effect on the overall acoustic environment. The time weighting (Fast or Slow) is usually specified.

L90, T	The noise level exceeded for 90% of the specified time period (T). It is often used to characterise the background noise.
L10, T	The noise level exceeded for 10% of the specified time period (T). It is often used to characterise road traffic noise.
Free-Field	A situation where the radiation from a sound source is completely unaffected by the presence of reflective surfaces. In terms of environmental noise measurement, it is usually taken to mean at least 3.5m away from reflective surfaces with the exception of the ground.
Façade Noise Level	A noise level measured within 3m of a building façade, which contains a contribution arising from reflection of sound at the façade. The difference between the façade level and free-field level is described as the façade correction factor.
Noise Sensitive Receptor	Premises that are used for purposes sensitive to noise and that require protection.
Line Source	A source of sound that as distance increases away from the source it still appears large in one dimension. Attenuation of this form of source occurs at a distance of (a/π) where a is the largest dimension of the source.
Point Source	A source of sound that as distance increases away from the source it appears as a point in space. Attenuation of this form of source occurs at a distance of (b/π) where b is the smallest dimension of the source.
Time Weighting	One of the standard averaging times (Fast, Slow or Impulsive) used for the measurement of RMS sound pressure level in sound level meters, specified in ISO 61671-1.
Rw	Single number quantity which characterises the airborne sound insulation of a material or building element over a range of frequencies, based on laboratory measurements.
DnT,w + Ctr	A single value that characterises the airborne sound insulation performance using the Ctr: spectrum adaption terms described in BS EN ISO 717-1. The value is based on field measurements and the value represents total sound transmission including flanking sound, not just the partition.

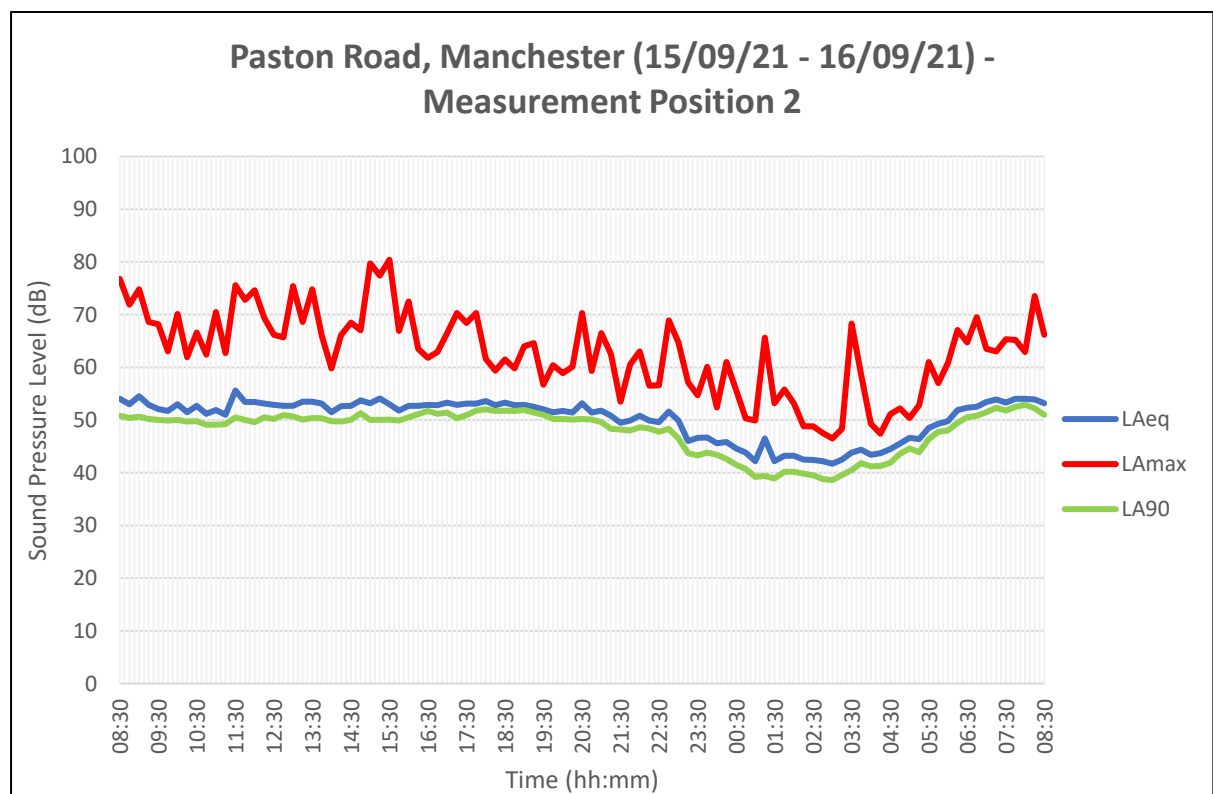
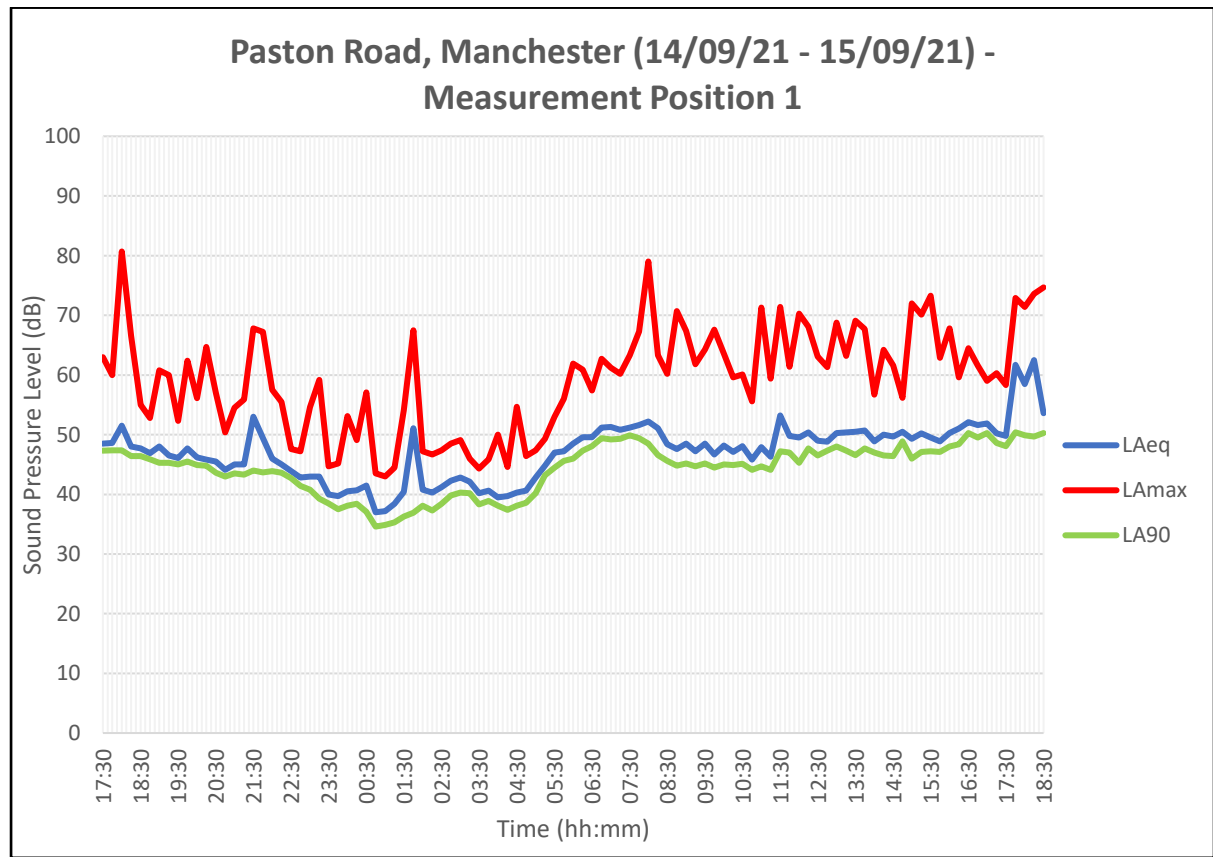
The table below presents an indication of sound levels associated with the environment starting from 0dB (the threshold of hearing) to 140dB (The threshold of pain).

cat

Sound Level	Location/Activity
0 dB(A)	Threshold of Hearing
20 - 30 dB(A)	Inside Quiet Bedroom at Night
30 - 40 dB(A)	Inside a Living Room During the Day
40 - 50 dB(A)	Inside Typical Office
50 - 60 dB(A)	Inside a Car
60 - 70 dB(A)	Typical High Street
70 - 90 dB(A)	Inside Factory
100 - 110 dB(A)	Burglar Alarm at 1m
110 - 130 dB(A)	Jet Aircraft on Take Off
140 dB(A)	Threshold of Pain

The 'A' denotes the A-weighting scale used to replicate the frequency response of the human ear.

Appendix B - Time History Graphs



Appendix C - Weather Conditions

Upon installation of the noise monitoring equipment at MP1 and MP2 on 14/09/2021 the sky had 30% cloud cover with bright sunshine. During 15/09/2021 the sky had <10% cloud cover throughout the day. On the morning of 16/09/21 when the equipment at MP2 was collected, the sky had 40% with bright sunshine. No rainfall occurred when sound levels were being measured 14/09/21 - 16/09/2021.

It should be noted that the dates shown below are a day ahead of when the meteorological conditions were recorded i.e. data shown as '15/09/21' represents weather conditions on 14/09/21.

Device Information:									
Name:	WEATHER - 2655332				Time	Temp	Rel. Hum.	Wind Spe	True Dir.
Model:	5500				yyyy-MM-dd hh:mm:ss	Celsius	%	m/s	Degrees
Serial:	2655332				16/09/2021 00:00	13.2	85.2	0	293
Firmware:	1.47				16/09/2021 00:10	13	85.6	0	295
Profile Version:					16/09/2021 00:20	13	85.9	0	295
Hardware Version:	Rev 14				16/09/2021 00:30	12.9	86.1	0	294
LINK Version:	1.04.04				16/09/2021 00:40	13	86.5	0	294
					16/09/2021 00:50	13.1	86.9	0	293
Time	Temp	Rel. Hum.	Wind Spe	True Dir.	16/09/2021 01:00	13.1	87.4	0	294
yyyy-MM-dd hh:mm:ss	Celsius	%	m/s	Degrees	16/09/2021 01:10	13.1	87.8	0	294
15/09/2021 17:20	19.4	70.9	0	8	16/09/2021 01:20	13.1	88.2	0	294
15/09/2021 17:30	17.8	75.3	0	280	16/09/2021 01:30	13.2	88.6	0	293
15/09/2021 17:40	17.3	77	0	293	16/09/2021 01:40	13.2	89	0	295
15/09/2021 17:50	17.4	76.3	0	287	16/09/2021 01:50	12.9	89.2	0	294
15/09/2021 18:00	16.9	76.3	0.4	293	16/09/2021 02:00	12.6	89.1	0	295
15/09/2021 18:10	16.9	76.4	0	285	16/09/2021 02:10	12.4	88.9	0	293
15/09/2021 18:20	16.8	76.4	0	273	16/09/2021 02:20	12.3	88.6	0	294
15/09/2021 18:30	16.6	76.6	0	272	16/09/2021 02:30	12.4	88.7	0	295
15/09/2021 18:40	16.6	76.8	0	273	16/09/2021 02:40	12.5	89	0	295
15/09/2021 18:50	16.5	76.8	0.8	289	16/09/2021 02:50	12.6	89.4	0	293
15/09/2021 19:00	16.4	76.9	0	287	16/09/2021 03:00	12.7	89.8	0	293
15/09/2021 19:10	16.2	76.8	0	285	16/09/2021 03:10	12.8	90.3	0	293
15/09/2021 19:20	16	76.9	0	293	16/09/2021 03:20	12.9	90.7	0	297
15/09/2021 19:30	15.9	77.1	0	293	16/09/2021 03:30	13.1	91.2	0	295
15/09/2021 19:40	15.8	77.2	0	293	16/09/2021 03:40	13.1	91.7	0	296
15/09/2021 19:50	15.7	77.2	0	293	16/09/2021 03:50	13.1	92.1	0	294
15/09/2021 20:00	15.3	77.2	0	294	16/09/2021 04:00	13.1	92.5	0	294
15/09/2021 20:10	15	77.2	0	293	16/09/2021 04:10	13.2	92.9	0	294
15/09/2021 20:20	15	77.3	0	295	16/09/2021 04:20	13.2	93.3	0	292
15/09/2021 20:30	14.8	77.6	0	294	16/09/2021 04:30	13.3	93.7	0	295
15/09/2021 20:40	14.8	77.8	0	295	16/09/2021 04:40	13.3	94	0	294
15/09/2021 20:50	14.8	78.1	0	294	16/09/2021 04:50	13.4	94.2	0	295
15/09/2021 21:00	14.7	78.4	0	293	16/09/2021 05:00	13.4	94.4	0	294
15/09/2021 21:10	14.4	78.6	0	293	16/09/2021 05:10	13.3	94.5	0	295
15/09/2021 21:20	14.2	78.7	0	294	16/09/2021 05:20	13.1	94.4	0.5	292
15/09/2021 21:30	13.9	78.8	0	293	16/09/2021 05:30	12.8	94	0.5	294
15/09/2021 21:40	13.7	79	0	294	16/09/2021 05:40	12.6	93.6	0	295
15/09/2021 21:50	13.6	79.2	0	294	16/09/2021 05:50	12.4	93.2	0	294
15/09/2021 22:00	13.4	79.3	0	293	16/09/2021 06:00	12.3	92.9	0	294
15/09/2021 22:10	13.4	79.6	0	293	16/09/2021 06:10	12.2	92.5	0	294
15/09/2021 22:20	13.3	79.9	0	293	16/09/2021 06:20	12.1	92.4	0	295
15/09/2021 22:30	13.1	80.2	0	295	16/09/2021 06:30	12.2	92.3	0	294
15/09/2021 22:40	13	80.4	0	292	16/09/2021 06:40	12.3	92.5	0	294
15/09/2021 22:50	12.8	80.6	0	295	16/09/2021 06:50	12.4	92.7	0	294
15/09/2021 23:00	12.8	80.8	0	295	16/09/2021 07:00	12.2	92.7	0	294
15/09/2021 23:10	12.8	81.3	0	294	16/09/2021 07:10	12.1	92.7	0.7	296
15/09/2021 23:20	13.1	82.1	0	294	16/09/2021 07:20	12	92.6	0	295
15/09/2021 23:30	13.3	83	0	294	16/09/2021 07:30	11.9	92.5	0	295
15/09/2021 23:40	13.5	83.9	0	295	16/09/2021 07:40	12	92.6	0	295
15/09/2021 23:50	13.4	84.7	0	295	16/09/2021 07:50	12.1	92.8	0	294

Time	Temp	Rel. Hum.	Wind Spe	True Dir.	Time	Temp	Rel. Hum.	Wind Spe	True Dir.
yyyy-MM-dd hh:mm:ss	Celsius	%	m/s	Degrees	yyyy-MM-dd hh:mm:ss	Celsius	%	m/s	Degrees
16/09/2021 08:00	12.3	93	0	294	16/09/2021 16:10	20.7	70.4	1	293
16/09/2021 08:10	12.4	93.4	0	295	16/09/2021 16:20	19.7	70	0.6	299
16/09/2021 08:20	12.5	93.8	0.4	293	16/09/2021 16:30	20.4	69.7	0.5	265
16/09/2021 08:30	12.7	94.1	0	295	16/09/2021 16:40	20.5	69.1	1.4	317
16/09/2021 08:40	12.9	94.6	0	296	16/09/2021 16:50	20	68.5	0.5	304
16/09/2021 08:50	13.2	95.1	0	294	16/09/2021 17:00	20.4	68.4	0.9	251
16/09/2021 09:00	13.6	95.6	0	295	16/09/2021 17:10	20.1	68.1	0.5	285
16/09/2021 09:10	14.1	96.2	0	294	16/09/2021 17:20	20.2	67.8	0	321
16/09/2021 09:20	14.1	96.6	0	294	16/09/2021 17:30	20	67.5	0.8	305
16/09/2021 09:30	14.4	97.1	0	294	16/09/2021 17:40	19.9	67	0.3	323
16/09/2021 09:40	14.7	97.4	0	294	16/09/2021 17:50	19.8	66.6	1	305
16/09/2021 09:50	15.4	97.6	0.6	298	16/09/2021 18:00	20.1	66.7	0.8	290
16/09/2021 10:00	15.9	97.4	0	299	16/09/2021 18:10	19.5	66.6	1.3	305
16/09/2021 10:10	16.5	97	0	297	16/09/2021 18:20	19.4	66.3	0.7	320
16/09/2021 10:20	16.3	96.9	0	297	16/09/2021 18:30	19.1	66.1	0.7	313
16/09/2021 10:30	16.3	96.4	0	296	16/09/2021 18:40	18.2	65.2	0.7	293
16/09/2021 10:40	19.4	95.9	0	298	16/09/2021 18:50	18.1	65	0	256
16/09/2021 10:50	20.9	95.2	0.6	296	16/09/2021 19:00	17.9	65.5	0.5	286
16/09/2021 11:00	17.1	93.9	0.5	296	16/09/2021 19:10	19.9	67.9	0	42
16/09/2021 11:10	17	92.5	0.4	289	16/09/2021 19:20	20.4	70.5	0	43
16/09/2021 11:20	16.7	90.9	0.6	300	16/09/2021 19:30	18.9	64.7	0	129
16/09/2021 11:30	16.8	89.3	0	313	16/09/2021 19:40	17.1	69.9	0	160
16/09/2021 11:40	18.9	88.5	0	311	16/09/2021 19:50	16.6	71.6	0	160
16/09/2021 11:50	18.3	87.2	0	293	16/09/2021 20:00	16.4	71.5	0	159
16/09/2021 12:00	19.3	86.3	0.7	319	16/09/2021 20:10	15.7	71.5	0	161
16/09/2021 12:10	17.6	84.8	0.5	302	16/09/2021 20:20	15.3	71.7	0	160
16/09/2021 12:20	18.1	83.1	0.9	339	16/09/2021 20:30	14.8	72	0	161
16/09/2021 12:30	18.1	82.2	1.8	346	16/09/2021 20:40	14.5	72.3	0	160
16/09/2021 12:40	17.8	81.1	0.7	285	16/09/2021 20:50	14.3	72.6	0	160
16/09/2021 12:50	17.9	80.2	0.6	241	16/09/2021 21:00	14.2	73	0	158
16/09/2021 13:00	18.1	79	0	276	16/09/2021 21:10	14	73.3	0	159
16/09/2021 13:10	18.4	78.1	0	341	16/09/2021 21:20	14.4	73.8	0	161
16/09/2021 13:20	18.9	77.8	0.6	300	16/09/2021 21:30	14.4	74.2	0	160
16/09/2021 13:30	18.7	77.1	0.8	300	16/09/2021 21:40	14.7	74.7	0	159
16/09/2021 13:40	18.6	76.8	0.6	306	16/09/2021 21:50	14.8	75.2	0	160
16/09/2021 13:50	18.7	76.2	0	324	16/09/2021 22:00	14.8	75.7	0	160
16/09/2021 14:00	19.3	75.7	0.8	280	16/09/2021 22:10	14.6	76.2	0	161
16/09/2021 14:10	19.2	75.4	0	289	16/09/2021 22:20	14.8	76.7	0	160
16/09/2021 14:20	18.9	74.9	0.4	310	16/09/2021 22:30	14.9	77.2	0	160
16/09/2021 14:30	19	74.3	0	308	16/09/2021 22:40	15.1	77.8	0	160
16/09/2021 14:40	19.3	74.1	0	337	16/09/2021 22:50	15	78.2	0	161
16/09/2021 14:50	19.6	73.6	0.6	288	16/09/2021 23:00	15.1	78.6	0	161
16/09/2021 15:00	19.4	73	0.7	285	16/09/2021 23:10	15.2	78.8	0	161
16/09/2021 15:10	19.3	72.4	0.7	300	16/09/2021 23:20	15.1	78.9	0	160
16/09/2021 15:20	19.9	72.1	0	303	16/09/2021 23:30	15.1	79.1	0	160
16/09/2021 15:30	19.9	71.7	0.8	314	16/09/2021 23:40	14.9	79.4	0	160
16/09/2021 15:40	22.8	71.4	0	347	16/09/2021 23:50	14.8	79.8	0	161
16/09/2021 15:50	21.9	71	0	288					
16/09/2021 16:00	20.9	70.5	0.5	300					

While measurements were being taking on 28/0921, the sky had cloud cover of 75%-100% and there were consistent periods of rain. Considering that measurements were taken close to the source of that residual measurements were taken during identical conditions, the meteorological conditions have not provided any uncertainty to the sound measurements taken on this date.

Device Information:				
Name:	WEATHER - 2655332			
Model:	WEATHER - 26553325500			
Serial:	2655332			
Firmware:	1.47			
Profile Version:				
Hardware Version:	Rev 14			
LINK Version:	1.04.04			
Time	Temp	Rel. Hum	Wind Spd	True Dir.
yyyy-MM-dd hh:mm:ss	Celsius	%	m/s	Degrees
28/09/2021 06:00	10.1	46.2	0	292
28/09/2021 06:10	10.2	47.5	0	284
28/09/2021 06:20	10.9	81.1	0	101
28/09/2021 06:30	10.8	83.4	0	101
28/09/2021 06:40	10.7	84	0	102
28/09/2021 06:50	10.8	84.4	0	96
28/09/2021 07:00	10.8	85.1	0	82
28/09/2021 07:10	10.8	85.9	0	82
28/09/2021 07:20	10.8	85.6	0	83
28/09/2021 07:30	10.7	89	0	162
28/09/2021 07:40	10.5	93.5	0	120
28/09/2021 07:50	10.8	94	0.6	118
28/09/2021 08:00	11	94.5	0	23
28/09/2021 08:10	11	95	0	23
28/09/2021 08:20	11.2	95.1	0	22
28/09/2021 08:30	11.4	95.8	0	24
28/09/2021 08:40	11.4	95.8	0	22
28/09/2021 08:50	11.5	95.7	0	22
28/09/2021 09:00	11.6	95.6	0	22
28/09/2021 09:10	11.8	95.9	0.4	14
28/09/2021 09:20	12	95.5	0	20
28/09/2021 09:30	12.2	96	0	23
28/09/2021 09:40	12.8	95.9	0	21
28/09/2021 09:50	12.9	95.1	0	25
28/09/2021 10:00	13.2	92.3	0	23
28/09/2021 10:10	13.7	91.6	0	20
28/09/2021 10:20	13.6	88.9	0	18
28/09/2021 10:30	13.6	89	0	24
28/09/2021 10:40	13.9	88.8	0.4	12
28/09/2021 10:50	14	88.2	0.7	16
28/09/2021 11:00	14.1	81.9	0	49
28/09/2021 11:10	14	80.2	0.7	45
28/09/2021 11:20	14	81	0.6	5
28/09/2021 11:30	14.8	80.7	0	350
28/09/2021 11:40	14.4	79	0.7	356
28/09/2021 11:50	14.8	78.8	0.4	357
28/09/2021 12:00	15.1	78.7	0.4	353
28/09/2021 12:10	14.8	78.8	0.7	355
28/09/2021 12:20	15.2	79	0.5	355
28/09/2021 12:30	15.4	75.7	0.6	3
28/09/2021 12:40	15.3	76.4	0.5	10
28/09/2021 12:50	15	76.3	0.5	1
28/09/2021 13:00	14.6	75.3	0.8	2
28/09/2021 13:10	15.2	74.9	0	6
28/09/2021 13:20	14.4	84	0.6	11
28/09/2021 13:30	14.3	85.1	0.6	11
28/09/2021 13:40	14.5	85.1	0	14
28/09/2021 13:50	14.1	84.7	0.6	19
28/09/2021 14:00	13.6	85	0.5	19
28/09/2021 14:10	13.4	85.3	0	23
28/09/2021 14:20	13.2	96.8	0	31
28/09/2021 14:30	12.8	98.5	0	30
28/09/2021 14:40	12.5	100	0	29
28/09/2021 14:50	12.4	100	0	31
28/09/2021 15:00	12.3	100	0	30
28/09/2021 15:10	12.2	100	0	30
28/09/2021 15:20	12.2	100	0	30
28/09/2021 15:30	12	100	0	30
28/09/2021 15:40	11.9	100	0	31
28/09/2021 15:50	11.8	100	0	30
28/09/2021 16:00	12	100	0	29
28/09/2021 16:10	11.8	100	0	29
28/09/2021 16:20	11.7	99.8	0	29
28/09/2021 16:30	11.6	99.3	0	28
28/09/2021 16:40	11.6	98.9	0	31
28/09/2021 16:50	11.7	100	0	34
28/09/2021 17:00	11.7	100	0	23
28/09/2021 17:10	12.4	100	0	267
28/09/2021 17:20	12.5	100	0	3
28/09/2021 17:30	12.9	100	0	4
28/09/2021 17:40	13.4	100	0	4
28/09/2021 17:50	13.7	100	0	4
28/09/2021 18:00	13.9	100	0	4

Appendix D - Barrier Calculations

Worst-case daytime period - 107 Roundwood Road.

Barrier Calculation Source Data

Source to barrier: 40.00m
 Barrier to receiver: 37.00m
 Barrier height difference to source: 3.80m
 Barrier height difference to receiver: 4.00m
 Height difference Source to receiver: 0.20m

Source to barrier top: 40.18m
 Source to receiver direct (c): 77.00m
 Receiver to barrier top: 37.22m

Path difference (c-(a+b)): 0.40m

Reduction = $10 \cdot \log(3 + (40 \cdot \text{Path Difference} \cdot \text{Frequency}) / 344)$

Broadband LAeq with barrier	
Measured Level	69.3
Reduction	18.3
Mitigated Figure	51.0

Frequency Band (Hz)	Path Difference (m)	Reduction (dB)	Reading (Day)	With Barrier
12.5	0.40	5.5	0.0	0.0
16	0.40	5.7	2.4	0.0
20	0.40	5.9	7.0	1.1
25	0.40	6.2	19.0	12.8
31.5	0.40	6.5	32.4	25.9
40	0.40	6.9	30.2	23.4
50	0.40	7.3	37.4	30.2
63	0.40	7.7	38.9	31.2
80	0.40	8.3	36.5	28.2
100	0.40	5.5	42.7	33.9
125	0.40	9.5	40.1	30.7
160	0.40	10.2	41.0	30.8
200	0.40	10.9	43.9	33.0
250	0.40	11.7	44.9	33.2
315	0.40	12.5	45.6	33.1
400	0.40	13.3	48.8	35.4
500	0.40	14.2	51.7	37.5
630	0.40	15.1	53.2	38.1
800	0.40	16.0	55.0	39.0
1000	0.40	16.9	58.2	41.3
1250	0.40	17.9	59.4	41.5
1600	0.40	18.9	61.2	42.3
2000	0.40	19.8	63.0	43.1
2500	0.40	20.8	61.9	41.1
3150	0.40	21.7	58.5	36.8
4000	0.40	22.8	55.4	32.6
5000	0.40	23.7	57.7	34.0
6300	0.40	24.7	52.2	27.5
8000	0.40	25.7	49.0	23.2
10000	0.40	26.7	44.1	17.4
12500	0.40	27.7	37.0	9.3
16000	0.40	28.7	28.5	0.0
20000	0.40	29.7	19.2	0.0
Broadband LAeq with Barrier	-	-	-	51.0

Night-time Assessment - 107 Roundwood Road.

Barrier Calculation Source Data

Source to barrier: 40.00m
 Barrier to receiver: 37.00m
 Barrier height difference to source: 3.80m
 Barrier height difference to receiver: 4.00m
 Height difference source to receiver: 0.20m

Source to barrier top: 40.18m
 Source to receiver direct (c): 77.00m
 Receiver to barrier top: 37.22m

Path difference (c-(a+b)): 0.40m

Reduction = $10 \cdot \log(3 + (40 \cdot \text{Path Difference} \cdot \text{Frequency}) / 344)$

Broadband LAeq with barrier	
Measured Level	63.2
Reduction	16.1
Mitigated Figure	47.1

Frequency Band (Hz)	Path Difference (m)	Reduction (dB)	Reading (Night)	With Barrier
12.5	0.40	5.5	0.0	0.0
16	0.40	5.7	2.8	0.0
20	0.40	5.9	6.0	0.1
25	0.40	6.2	26.6	20.4
31.5	0.40	6.5	32.4	25.9
40	0.40	6.8	27.8	20.9
50	0.40	7.2	40.2	32.9
63	0.40	7.7	39.5	31.8
80	0.40	8.2	41.4	33.1
100	0.40	5.5	41.5	32.7
125	0.40	9.4	40.7	31.2
160	0.40	10.1	41.3	31.1
200	0.40	10.8	43.1	32.2
250	0.40	11.6	45.5	33.8
315	0.40	12.4	47.5	35.0
400	0.40	13.3	49.9	36.6
500	0.40	14.1	51.2	37.0
630	0.40	15.0	51.6	36.5
800	0.40	15.9	52.1	36.1
1000	0.40	16.8	53.3	36.4
1250	0.40	17.8	52.9	35.0
1600	0.40	18.8	53.7	34.8
2000	0.40	19.7	52.8	33.0
2500	0.40	20.7	50.5	29.7
3150	0.40	21.6	51.7	30.0
4000	0.40	22.7	47.7	24.9
5000	0.40	23.6	47.9	24.2
6300	0.40	24.6	44.2	19.5
8000	0.40	25.6	41.6	15.9
10000	0.40	26.6	35.7	9.0
12500	0.40	27.6	29.9	2.2
16000	0.40	28.6	23.4	0.0
20000	0.40	29.7	15.7	0.0
Broadband LAeq with Barrier	-	-	-	47.1

Afternoon Assessment - 107 Roundwood Road

Barrier Calculation Source Data

Source to barrier: 40.00m
 Barrier to receiver: 37.00m
 Barrier height difference to source: 3.80m
 Barrier height difference to receiver: 4.00m
 Height difference - Source to receiver: 0.20m

Source to barrier top: 40.18m
 Source to receiver direct (c): 77.00m
 Receiver to barrier top: 37.22m

Broadband LAeq with barrier	
Measured Level	65.6
Reduction	16.8
Mitigated Figure	48.8

Path difference (c-(a+b)): 0.40m

Reduction = $10 \cdot \log(3 + (40 \cdot \text{Path Difference} \cdot \text{Frequency}) / 344)$

Frequency Band (Hz)	Path Difference (m)	Reduction (dB)	Reading (Day)	With Barrier
12.5	0.40	5.5	0.0	0.0
16	0.40	5.7	0.5	0.0
20	0.40	5.9	7.0	1.1
25	0.40	6.2	19.6	13.4
31.5	0.40	6.5	29.2	22.7
40	0.40	6.8	32.6	25.8
50	0.40	7.2	41.2	33.9
63	0.40	7.7	38.4	30.6
80	0.40	8.2	37.0	28.8
100	0.40	5.5	41.6	32.8
125	0.40	9.4	40.5	31.1
160	0.40	10.1	41.5	31.3
200	0.40	10.8	44.9	34.0
250	0.40	11.6	45.6	33.9
315	0.40	12.4	46.5	34.0
400	0.40	13.3	49.0	35.6
500	0.40	14.1	51.7	37.5
630	0.40	15.0	53.3	38.3
800	0.40	15.9	55.2	39.1
1000	0.40	16.8	57.2	40.3
1250	0.40	17.8	57.5	39.7
1600	0.40	18.8	56.2	37.3
2000	0.40	19.7	56.9	37.0
2500	0.40	20.7	54.8	34.1
3150	0.40	21.6	52.2	30.5
4000	0.40	22.7	49.5	26.8
5000	0.40	23.6	48.1	24.4
6300	0.40	24.6	45.1	20.4
8000	0.40	25.6	41.9	16.2
10000	0.40	26.6	36.0	9.3
12500	0.40	27.6	31.8	4.1
16000	0.40	28.6	25.3	0.0
20000	0.40	29.7	18.3	0.0
Broadband LAeq with Barrier	-	-	-	48.8

Worst-case daytime period - 125 Roundwood Road

Barrier Calculation Source Data

Source to barrier: 39.50m
 Barrier to receiver: 35.50m
 Barrier height difference to source: 3.80m
 Barrier height difference to receiver: 3.00m
 Height difference - Source to receiver: 0.80m

Source to barrier top: 39.68m
 Source to receiver direct (c): 77.00m
 Receiver to barrier top: 35.63m

Path difference (c-(a+b)): 0.31m

Broadband LAeq with barrier	
Measured Level	69.3
Reduction	17.2
Mitigated Figure	52.1

Reduction = $10 \cdot \log(3 + (40 \cdot \text{Path Difference} \cdot \text{Frequency}) / 344)$

Frequency Band (Hz)	Path Difference (m)	Reduction (dB)	Reading (Day)	With Barrier
12.5	0.31	5.4	0.0	0.0
16	0.31	5.5	2.4	0.0
20	0.31	5.7	7.0	1.3
25	0.31	5.9	19.0	13.0
31.5	0.31	6.2	32.4	26.2
40	0.31	6.5	30.2	23.8
50	0.31	6.8	37.4	30.6
63	0.31	7.2	38.9	31.7
80	0.31	7.7	36.5	28.8
100	0.31	5.4	42.7	37.4
125	0.31	8.8	40.1	31.4
160	0.31	9.4	41.0	31.5
200	0.31	10.1	43.9	33.8
250	0.31	10.8	44.9	34.1
315	0.31	11.6	45.6	34.0
400	0.31	12.4	48.8	36.4
500	0.31	13.2	51.7	38.5
630	0.31	14.1	53.2	39.1
800	0.31	15.0	55.0	40.0
1000	0.31	15.9	58.2	42.3
1250	0.31	16.8	59.4	42.6
1600	0.31	17.8	61.2	43.4
2000	0.31	18.8	63.0	44.2
2500	0.31	19.7	61.9	42.2
3150	0.31	20.7	58.5	37.8
4000	0.31	21.7	55.4	33.7
5000	0.31	22.6	57.7	35.1
6300	0.31	23.6	52.2	28.6
8000	0.31	24.6	49.0	24.3
10000	0.31	25.6	44.1	18.5
12500	0.31	26.6	37.0	10.4
16000	0.31	27.6	28.5	0.8
20000	0.31	28.6	19.2	0.0
Broadband LAeq with Barrier	-	-	-	52.1

Worst-case daytime period - 107 Roundwood Road (Activities Moved East)

Barrier Calculation Source Data

Source to barrier: 85.00m
 Barrier to receiver: 32.00m
 Barrier height difference to source: 3.80m
 Barrier height difference to receiver: 4.00m
 Height difference Source to receiver: 0.20m

Source to barrier top: 85.08m
 Source to receiver direct (c): 117.00m
 Receiver to barrier top: 32.25m

Path difference (c-(a+b)): 0.33m

Broadband LAeq with barrier	
Measured Level	69.3
Reduction	17.5
Mitigated Figure	51.8

Reduction = $10 \cdot \log(3 + (40 \cdot \text{Path Difference} \cdot \text{Frequency}) / 344)$

Frequency Band (Hz)	Path Difference (m)	Reduction (dB)	Reading (Day)	With Barrier
12.5	0.33	5.5	0.0	0.0
16	0.33	5.7	2.4	0.0
20	0.33	5.9	7.0	1.3
25	0.33	6.2	19.0	13.0
31.5	0.33	6.5	32.4	26.1
40	0.33	6.9	30.2	23.7
50	0.33	7.3	37.4	30.5
63	0.33	7.7	38.9	31.6
80	0.33	8.3	36.5	28.7
100	0.33	5.5	42.7	34.4
125	0.33	9.5	40.1	31.2
160	0.33	10.2	41.0	31.4
200	0.33	10.9	43.9	33.6
250	0.33	11.7	44.9	33.9
315	0.33	12.5	45.6	33.8
400	0.33	13.3	48.8	36.1
500	0.33	14.2	51.7	38.2
630	0.33	15.1	53.2	38.9
800	0.33	16.0	55.0	39.7
1000	0.33	16.9	58.2	42.1
1250	0.33	17.9	59.4	42.3
1600	0.33	18.9	61.2	43.1
2000	0.33	19.8	63.0	43.9
2500	0.33	20.8	61.9	41.9
3150	0.33	21.7	58.5	37.6
4000	0.33	22.8	55.4	33.5
5000	0.33	23.7	57.7	34.8
6300	0.33	24.7	52.2	28.3
8000	0.33	25.7	49.0	24.0
10000	0.33	26.7	44.1	18.2
12500	0.33	27.7	37.0	10.1
16000	0.33	28.7	28.5	0.6
20000	0.33	29.7	19.2	0.0
Broadband LAeq with Barrier	-	-	-	51.8

Worst-case daytime period - 125 Roundwood Road (Activities moved east)

Barrier Calculation Source Data

Source to barrier: 84.50m
 Barrier to receiver: 34.50m
 Barrier height difference to source: 3.80m
 Barrier height difference to receiver: 3.00m
 Height difference - Source to receiver: 0.80m

Source to barrier top: 84.59m
 Source to receiver direct (c): 119.00m
 Receiver to barrier top: 34.64m

Path difference (c-(a+b)): 0.31m

Broadband LAeq with barrier	
Measured Level	69.3
Reduction	16.1
Mitigated Figure	53.2

Reduction = $10 \cdot \log(3 + (40 \cdot \text{Path Difference} \cdot \text{Frequency}) / 344)$

Frequency Band (Hz)	Path Difference (m)	Reduction (dB)	Reading (Day)	With Barrier
12.5	0.23	5.2	0.0	0.0
16	0.23	5.4	2.4	0.0
20	0.23	5.5	7.0	1.5
25	0.23	5.6	19.0	13.3
31.5	0.23	5.8	32.4	26.5
40	0.23	6.1	30.2	24.1
50	0.23	6.4	37.4	31.1
63	0.23	6.7	38.9	32.2
80	0.23	7.1	36.5	29.4
100	0.23	5.2	42.7	35.2
125	0.23	8.0	40.1	32.1
160	0.23	8.6	41.0	32.3
200	0.23	9.2	43.9	34.6
250	0.23	9.9	44.9	35.0
315	0.23	10.6	45.6	35.0
400	0.23	11.4	48.8	37.4
500	0.23	12.1	51.7	39.5
630	0.23	13.0	53.2	40.2
800	0.23	13.9	55.0	41.1
1000	0.23	14.7	58.2	43.5
1250	0.23	15.6	59.4	43.8
1600	0.23	16.6	61.2	44.6
2000	0.23	17.5	63.0	45.4
2500	0.23	18.4	61.9	43.4
3150	0.23	19.4	58.5	39.1
4000	0.23	20.4	55.4	35.0
5000	0.23	21.4	57.7	36.4
6300	0.23	22.3	52.2	29.9
8000	0.23	23.4	49.0	25.6
10000	0.23	24.3	44.1	19.8
12500	0.23	25.3	37.0	11.7
16000	0.23	26.3	28.5	2.1
20000	0.23	27.3	19.2	0.0
Broadband LAeq with Barrier	-	-	-	53.2

Worst-case daytime period - 125 Roundwood Road (Barrier extended by 30m)

Barrier Calculation Source Data

Source to barrier edge: 42.34m
 Source to receiver direct (c): 95.60m
 Receiver to barrier edge: 57.46m

Path difference (c-(a+b)): 14.39m

Broadband LAeq with barrier	
Measured Level	69.3
Reduction	28.1
Mitigated Figure	41.2

Reduction = $10 \cdot \log(3 + (40 \cdot \text{Path Difference} \cdot \text{Frequency}) / 344)$

Frequency Band (Hz)	Path Difference (m)	Reduction (dB)	Reading (Day)	With Barrier
12.5	4.20	9.6	0.0	0.0
16	4.20	10.3	2.4	0.0
20	4.20	11.1	7.0	0.0
25	4.20	11.8	19.0	7.1
31.5	4.20	12.6	32.4	19.7
40	4.20	13.5	30.2	16.7
50	4.20	14.4	37.4	23.1
63	4.20	15.3	38.9	23.6
80	4.20	16.2	36.5	20.3
100	4.20	17.1	42.7	25.6
125	4.20	18.1	40.1	22.1
160	4.20	19.1	41.0	21.9
200	4.20	20.0	43.9	23.8
250	4.20	21.0	44.9	23.9
315	4.20	22.0	45.6	23.6
400	4.20	23.0	48.8	25.8
500	4.20	23.9	51.7	27.8
630	4.20	24.9	53.2	28.3
800	4.20	26.0	55.0	29.0
1000	4.20	26.9	58.2	31.3
1250	4.20	27.9	59.4	31.5
1600	4.20	28.9	61.2	32.2
2000	4.20	29.9	63.0	33.1
2500	4.20	30.9	61.9	31.0
3150	4.20	31.9	58.5	26.6
4000	4.20	32.9	55.4	22.5
5000	4.20	33.9	57.7	23.9
6300	4.20	34.9	52.2	17.3
8000	4.20	35.9	49.0	13.0
10000	4.20	36.9	44.1	7.2
12500	4.20	37.9	37.0	0.0
16000	4.20	38.9	28.5	0.0
20000	4.20	39.9	19.2	0.0
Broadband LAeq with Barrier	-	-	-	41.2

Appendix E – Calculations

The table below shows the residual sound level for worst-case daytime assessment period. Three consecutive five-minute measurements were taken while activity on-site had stopped. The three 5-minute LAeq values were averaged logarithmically to calculate one 15-minute LAeq, which would be used as the residual sound level for this period.

Date & Time	dBL _{Aeq,5min}	Residual Sound Level dBL _{Aeq,15min}
28/09/21 - 10:35	57.7	56.8
28/09/21 - 10:40	55.9	
28/09/21 - 10:45	56.7	

The equation below is used to logarithmically average a series of measurements:

$$L_a = 10 \log (1/n (10^{0.1 L_1} + 10^{0.1 L_2} + \dots + 10^{0.1 L_n}))$$

where

L_a = average sound pressure level (dB)

$L_1 \dots L_n$ = sound pressure level source 1 .. n (dB)

n = number of sources

The table below shows the residual sound level for the night-time assessment. As with the worst-case daytime assessment period, three consecutive 5-minute LAeq values have been logarithmically averaged to obtain one 15-minute LAeq that was used as the residual sound level for this period. The three consecutive five-minute measurements were taken when the on-site activity had stopped.

Date & Time	dBL _{Aeq,5min}	Residual Sound Level dBL _{Aeq,15min}
28/09/21 - 06:45	55.4	55.4
28/09/21 - 06:50	55.9	
28/09/21 - 06:55	54.9	

The residual measurements for the late afternoon loading period were taken between 16:30 and 16:45. The table below shows how three consecutive 5-minute measurements were used to determine one 15-minute measurement that was used as the residual sound level for this period. The three consecutive five-minute measurements were taken when the on-site activity had stopped.

Date & Time	dBL _{Aeq,5min}	Residual Sound Level dBL _{Aeq,15min}
28/09/21 - 16:30	56.3	55.1
28/09/21 - 16:35	55.1	
28/09/21 - 16:40	53.5	

BS 4142 specifies that the specific sound level be determined from the ambient and residual sound levels using the following equation:

$$L_s = 10 \lg(10^{L_a/10} - 10^{L_r/10})$$

where:

L_s is the specific sound level;

L_a is the ambient sound level; and

L_r is the residual sound level.

Using the night-time assessment as an example:

Ambient Sound Level = 62.8 dB_A

Residual Sound Level = 55.4 dB_A

Specific Sound Level = $10 \lg(10^{6.28} - 10^{5.54}) = 61.9$ dB_A

The following equation is used to calculate the on-time correction:

On-time Correction = $10 \lg$ (On-time/reference time interval)

For the night-time levels, where the activity on-time was observed to be 10 minutes. This is taken as the on-time period within the reference period of 15-minutes.

$10 \lg (10/15) = -1.8$ dB_A

The calculations below predict the specific sound levels during the worst-case daytime period at the noise sensitive receptors if the centre of activity was to be moved 50m to the east.

107 Roundwood Road				
Specific Sound Level @20m	Distance Correction =20log (117/20)	Barrier Attenuation	Specific Sound Level at Receptor	Comparison with current activity location
69.0 dB _A	-15.3 dB _A	-17.5 dB _A	36.2 dB _A	-2.8 dB _A

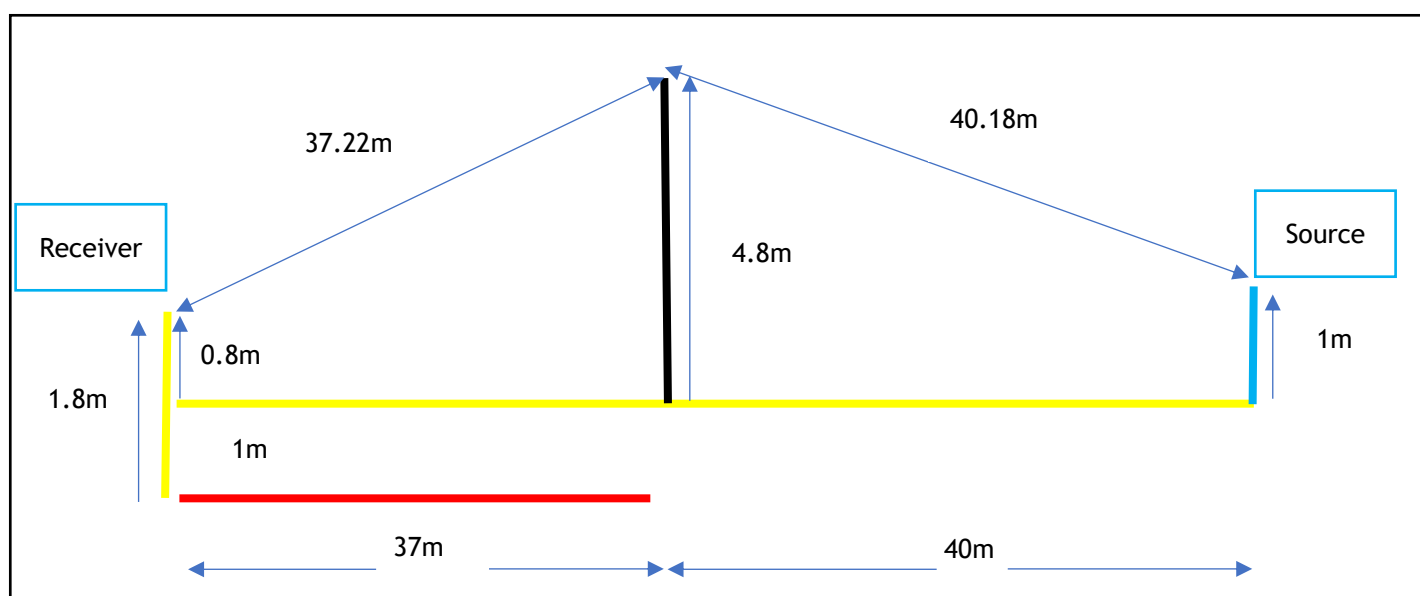
125 Roundwood Road excluding 4.8m barrier				
Specific Sound Level @20m	Distance Correction =20log (119/20)	Barrier Attenuation	Specific Sound Level at Receptor	Comparison with current activity location
69.0 dB _A	-15.5 dB _A	0 dB _A	53.5 dB _A	-2.5 dB _A

125 Roundwood Road including 4.8m barrier				
Specific Sound Level @20m	Distance Correction =20log (119/20)	Barrier Attenuation	Specific Sound Level at Receptor	Comparison with current activity location
69.0 dB _A	-15.5 dB _A	-16.1 dB _A	37.4 dB _A	-18.6 dB _A

Appendix F - Site Plan and Distances

Source and barrier distances, 107 Roundwood Road

According to Google Earth elevation profile, the land of the activity is 1m higher than the 107 Roundwood and therefore the receiver height has been stated as 0.8m taking into account a height of 1.8m for a standing adult.



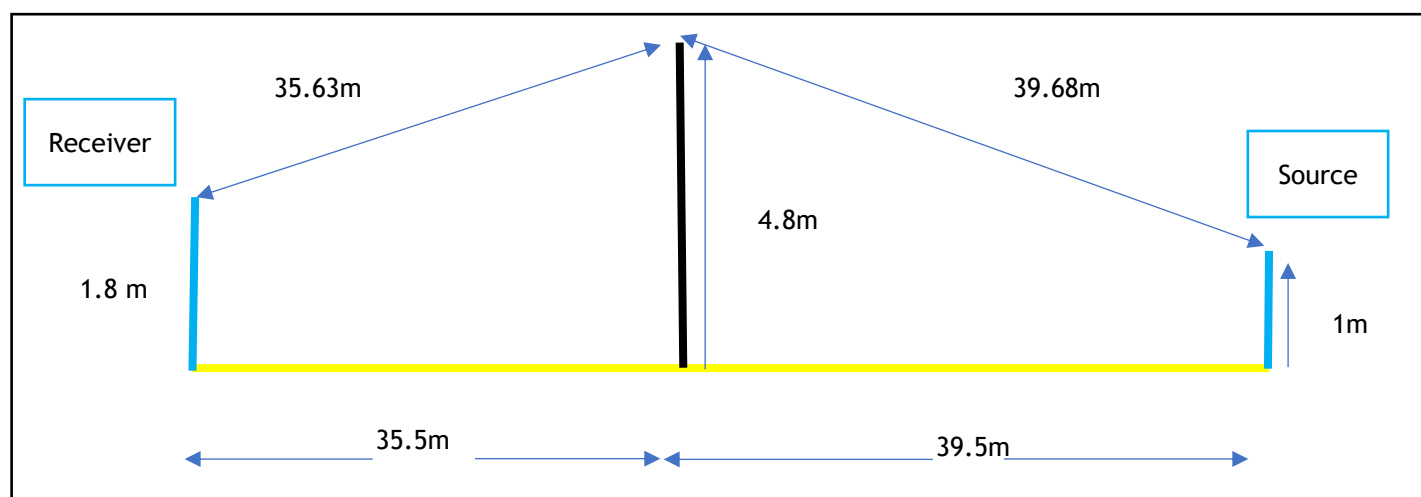
Google Earth elevation profile – Source to 107 Roundwood Road



Source to receiver distance, 125 Roundwood Road



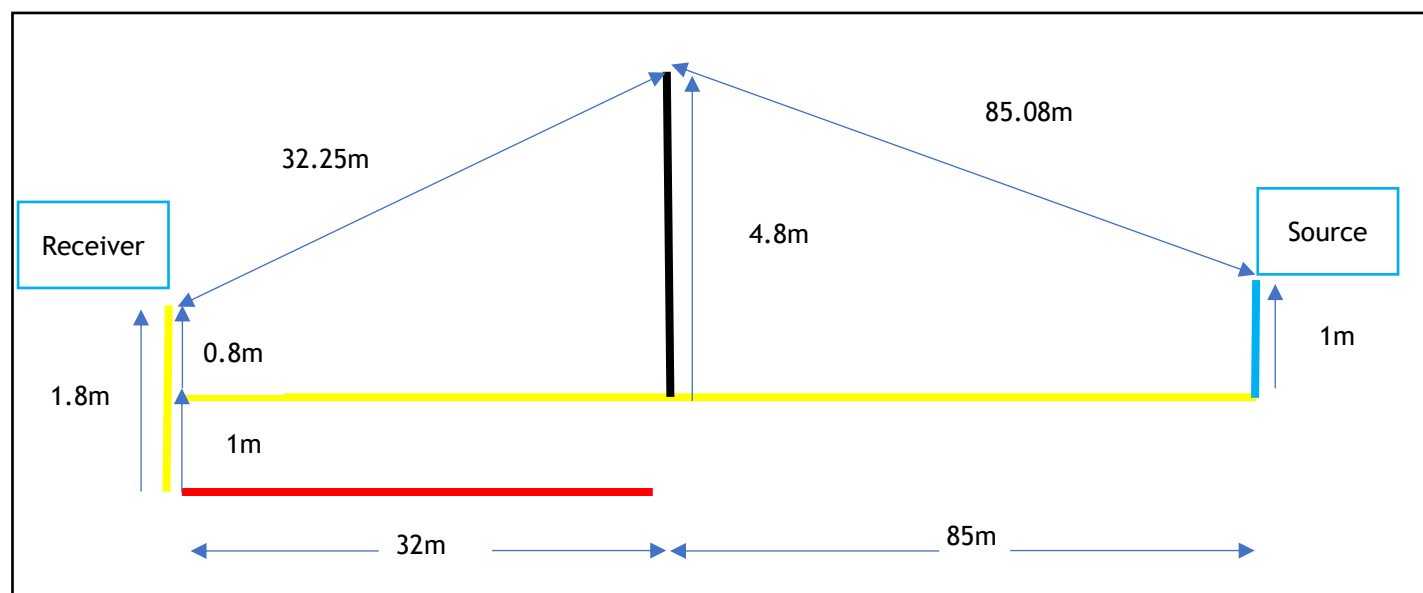
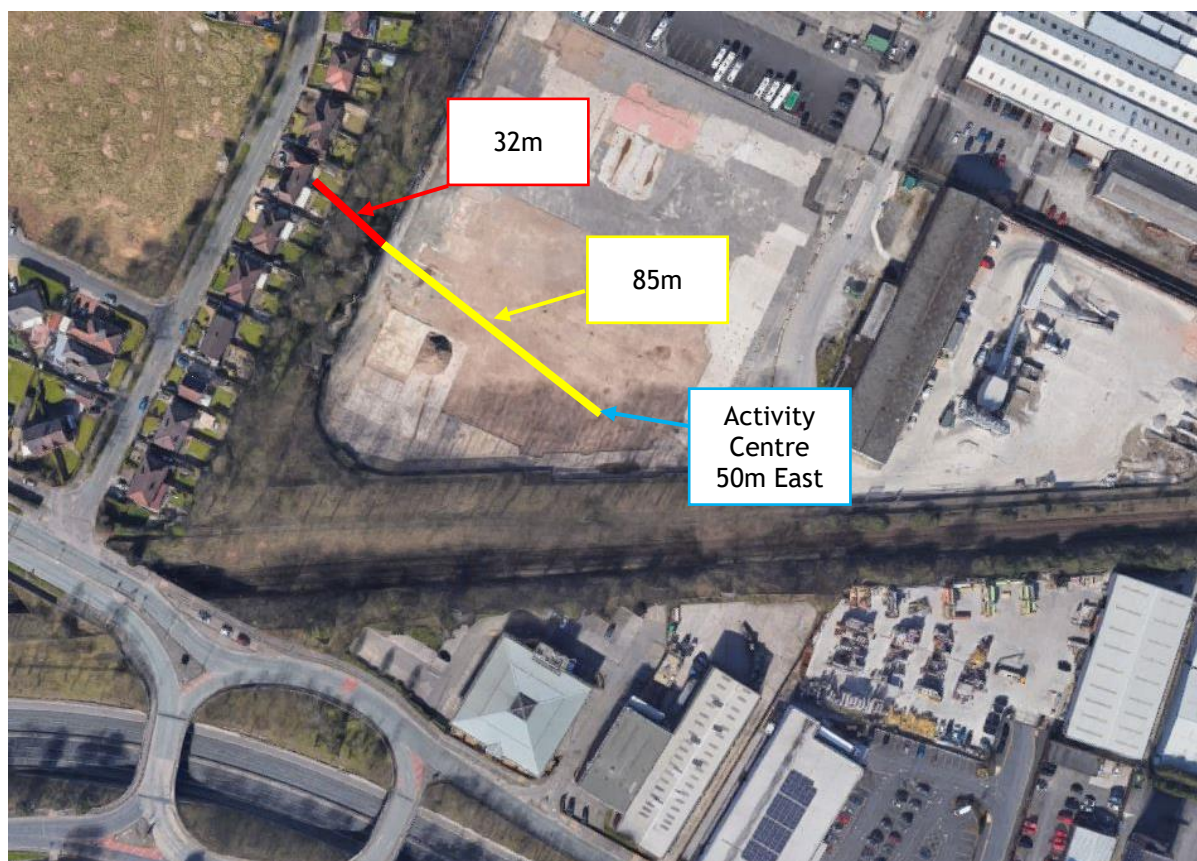
The elevation profile on Google Earth shows no height difference between the site and 125 Roundwood. Therefore, the receiver height is 1.8m based on the height of a standing adult.



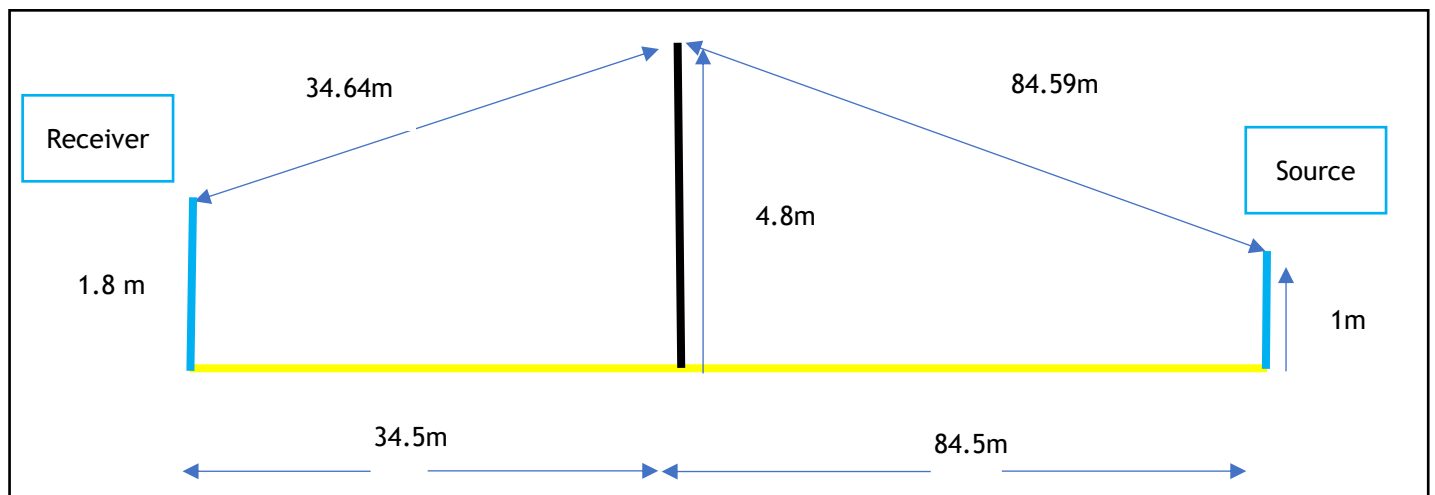
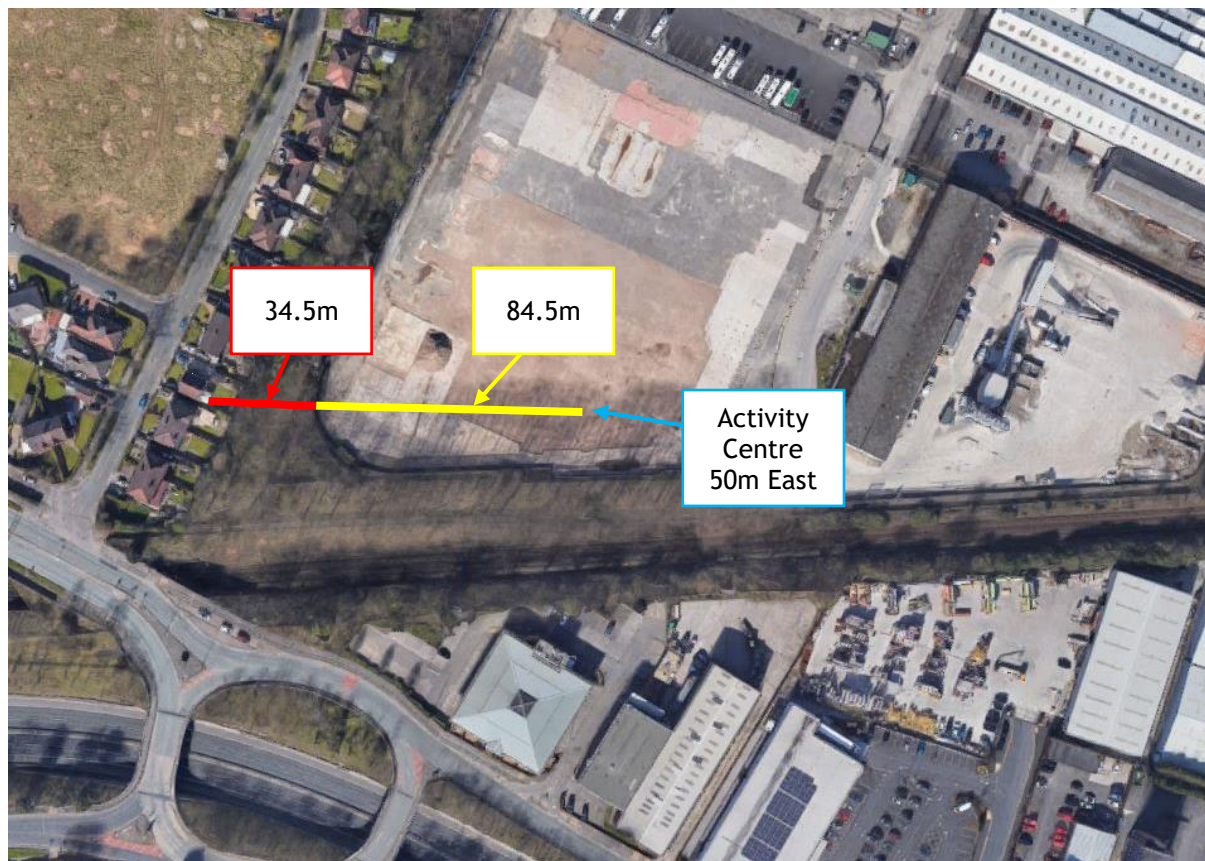
Google Earth Elevation View – Source to 125 Roundwood Road



Source to Receiver, 107 Roundwood Road – Activities moved east



Source to Receiver, 125 Roundwood Road – Activities moved east



The image below shows the measurement of the fence located at the western boundary in relation to ground level on-site.



30m Barrier Extension



The image above demonstrates the 30m point to which the 4.8m high fence is required. Attention is drawn to the barrier calculation on page 40, which considers the effect of the end of the fence as a horizontal barrier calculation. In order to achieve the 17 dB attenuation predicted by the barrier calculation on page 37 for the worst-case daytime period, the sound level travelling around the edge of the barrier must contribute a level of 10 dB or more below than that travelling over the top to not add any significant increase to the level of sound coming over the top of the barrier. The calculations based on the 30m extension of the barrier show that 28 dB of attenuation should be achieved as a result of the barrier horizontal at the property furthest south on Roundwood Road during the worst-case daytime period with the activities taking place in the current location. This suggests that the figure of 17 dB of attenuation over the top of the barrier should also be achieved.

Appendix G - Instrument Calibration Certificates

CERTIFICATE OF CALIBRATION		
ISSUED BY	Cirrus Research plc	
DATE OF ISSUE	19 August 2021	CERTIFICATE NUMBER 161680
	Cirrus Research plc Acoustic House Bridlington Road Hunmanby North Yorkshire YO14 0PH United Kingdom	Page 1 of 2 Approved signatory M.McDonald Electronically signed: M J McDonald
Sound Level Meter : IEC 61672-3:2013		
Instrument information		
Manufacturer:	Cirrus Research plc	Notes:
Model:	CR:171B	
Serial number:	G303153	
Class:	1	
Firmware version:	5.6.3177	
Test summary		
The calibration was performed respecting the requirements of ISO/IEC 17025:2017. Periodic tests were performed in accordance with procedures from IEC 61672-3:2013.		
The sound level meter submitted for testing successfully completed the class 1 periodic tests of IEC 61672-3:2013, for the environmental conditions under which the tests were performed.		
However, no general statement or conclusion can be made about conformance of the sound level meter to the full specifications of IEC 61672-1:2013 because (a) evidence was not publicly available, from an independent testing organisation responsible for pattern approvals, to determine that the model of sound level meter fully conformed to the class 1 specifications in IEC 61672-1:2013 or correction data for acoustical test of frequency weighting were not provided in the Instruction Manual and (b) because the periodic tests of IEC 61672-3:2013 cover only a limited subset of the specifications in IEC 61672-1:2013.		
Notes		
This certificate provides traceability of measurement to the SI system of units and/or to units of measurement realised at the National Physical Laboratory or other recognised national metrology institutes. This certificate may not be reproduced other than in full, except with the prior written approval of the issuing laboratory. The results within this certificate relate only to the items calibrated. The reported expanded uncertainty is based on a standard uncertainty multiplied by a coverage factor $k=2$, providing a coverage probability of approximately 95%.		

CERTIFICATE OF CALIBRATION

Certificate Number:
161680

Page 2 of 2

Environmental conditions

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

Before Pressure: 99.90 kPa Temperature: 21.9 °C Humidity: 38.7 %
After Pressure: 99.97 kPa Temperature: 22.0 °C Humidity: 42.1 %

Test equipment

Equipment	Manufacturer	Model	Serial number
Signal Generator	TTi	TGA1241	439193
Attenuator	Cirrus Research	ZE:952	80381
Environmental Monitor	Comet	T7510	17963955

Additional instrument information

Instruction manual:

Reference level range: Single range

Pattern approval: No

Source of pattern approval: -

Preamplifier

Model: MV:200F

Serial number: 11542F

Microphone

Model: MK:224

Serial number: 214523A

Test results summary

Test	Result
Toneburst response	Complies
Electrical noise-floor	Complies
Linearity	Complies
Electrical Frequency weightings	Complies
Frequency and time weightings at 1 kHz	Complies
C-weighted peak	Complies
Overload indication	Complies
High level stability	Complies
Long-term stability	Complies

CERTIFICATE OF CALIBRATION		
ISSUED BY	Cirrus Research plc	
DATE OF ISSUE	19/08/21	CERTIFICATE NUMBER 161682



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

Page 1 of 2

Test engineer:
D.Swalwell
Electronically signed:


Microphone

Microphone capsule

Manufacturer: Cirrus Research plc

Model: MK.224

Serial Number: 214523A

Calibration procedure

Open circuit: 50.1 mV/Pa

Sensitivity at 1 kHz: -26.0 dB rel 1 V/Pa

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

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

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

Environmental conditions

Pressure: 99.60 kPa

Temperature: 20.0 °C

Humidity: 31.0 %

CERTIFICATE OF CALIBRATION

Certificate Number:

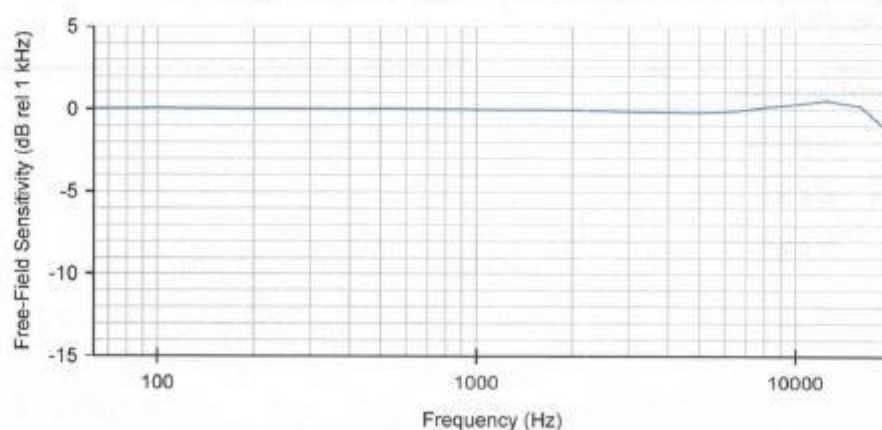
161682

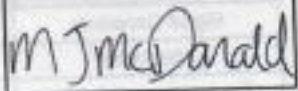
Page 2 of 2

Free-Field Frequency Response : Tabular

Frequency (Hz)	Free-Field Sensitivity (dB rel 1 kHz)	Actuator Response (dB)
63	0.06	-0.11
80	0.05	-0.01
100	0.09	0.12
125	0.05	0.09
160	0.05	0.11
200	0.04	0.11
250	0.05	0.13
315	0.04	0.09
400	0.02	0.09
500	0.04	0.10
630	0.03	0.08
800	0.01	0.06
1 000	0.00	0.03
1 250	-0.02	-0.03
1 600	-0.02	-0.10
2 000	-0.02	-0.20
2 500	-0.08	-0.39
3 150	-0.13	-0.67
4 000	-0.16	-1.05
5 000	-0.19	-1.55
6 300	-0.11	-2.19
8 000	0.14	-3.03
10 000	0.33	-4.33
12 500	0.58	-5.84
16 000	0.21	-7.59
20 000	-1.38	-10.39

Free-Field Frequency Response : Graphical



CERTIFICATE OF CALIBRATION		
ISSUED BY	Cirrus Research plc	
DATE OF ISSUE	19 August 2021	CERTIFICATE NUMBER 161679
 Cirrus Research plc Acoustic House Bridlington Road Hunmanby North Yorkshire YO14 0PH United Kingdom Page 1 of 2 Approved signatory M. McDonald Electronically signed: 		
Sound Level Meter : IEC 61672-3:2013		
Instrument information		
Manufacturer:	Cirrus Research plc	
Model:	CR:171B	
Serial number:	G303154	
Class:	1	
Firmware version:	5.6.3177	
Test summary		
The calibration was performed respecting the requirements of ISO/IEC 17025:2017. Periodic tests were performed in accordance with procedures from IEC 61672-3:2013. The sound level meter submitted for testing successfully completed the class 1 periodic tests of IEC 61672-3:2013, for the environmental conditions under which the tests were performed. However, no general statement or conclusion can be made about conformance of the sound level meter to the full specifications of IEC 61672-1:2013 because (a) evidence was not publicly available, from an independent testing organisation responsible for pattern approvals, to determine that the model of sound level meter fully conformed to the class 1 specifications in IEC 61672-1:2013 or correction data for acoustical test of frequency weighting were not provided in the Instruction Manual and (b) because the periodic tests of IEC 61672-3:2013 cover only a limited subset of the specifications in IEC 61672-1:2013.		
Notes		
This certificate provides traceability of measurement to the SI system of units and/or to units of measurement realised at the National Physical Laboratory or other recognised national metrology institutes. This certificate may not be reproduced other than in full, except with the prior written approval of the issuing laboratory. The results within this certificate relate only to the items calibrated. The reported expanded uncertainty is based on a standard uncertainty multiplied by a coverage factor k=2, providing a coverage probability of approximately 95%.		

CERTIFICATE OF CALIBRATION

Certificate Number:

161679

Page 2 of 2

Environmental conditions

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

Before Pressure: 99.97 kPa Temperature: 22.0 °C Humidity: 43 %
After Pressure: 99.91 kPa Temperature: 22.2 °C Humidity: 43 %

Test equipment

Equipment	Manufacturer	Model	Serial number
Signal Generator	TTi	TGA1241	439193
Attenuator	Cirrus Research	ZE:952	80381
Environmental Monitor	Comet	T7510	17963955

Additional instrument information

Instruction manual:

Reference level range: Single range

Pattern approval: No

Source of pattern approval: -

Preamplifier

Model: MV:200F

Serial number: 11733F

Microphone

Model: MK:224

Serial number: 214535A

Test results summary

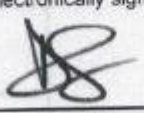
Test	Result
Toneburst response	Complies
Electrical noise-floor	Complies
Linearity	Complies
Electrical Frequency weightings	Complies
Frequency and time weightings at 1 kHz	Complies
C-weighted peak	Complies
Overload indication	Complies
High level stability	Complies
Long-term stability	Complies

CERTIFICATE OF CALIBRATION	
ISSUED BY	Cirrus Research plc
DATE OF ISSUE	19/08/21
CERTIFICATE NUMBER	161681



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

Page 1 of 2

Test engineer:
D.Swalwell
Electronically signed:


Microphone

Microphone capsule

Manufacturer: Cirrus Research plc

Model: MK.224

Serial Number: 214535A

Calibration procedure

Open circuit: 45.9 mV/Pa

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

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

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

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

Environmental conditions

Pressure: 99.60 kPa

Temperature: 20.0 °C

Humidity: 31.0 %

CERTIFICATE OF CALIBRATION

Certificate Number:

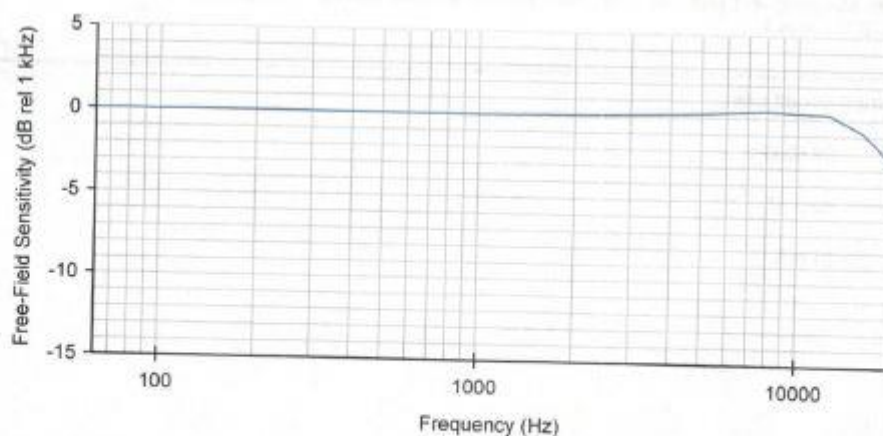
161681

Page 2 of 2

Free-Field Frequency Response : Tabular

Frequency (Hz)	Free-Field Sensitivity (dB rel 1 kHz)	Actuator Response (dB)
63	0.01	-0.19
80	0.02	-0.07
100	0.00	-0.06
125	0.03	0.02
160	0.03	0.04
200	0.02	0.05
250	0.03	0.06
315	0.01	0.01
400	0.01	0.03
500	0.01	0.02
630	0.01	0.02
800	0.02	0.01
1 000	0.00	-0.02
1 250	0.01	-0.04
1 600	0.03	-0.08
2 000	0.06	-0.15
2 500	0.09	-0.25
3 150	0.14	-0.43
4 000	0.19	-0.70
5 000	0.26	-1.09
6 300	0.36	-1.71
8 000	0.46	-2.70
10 000	0.37	-4.25
12 500	0.32	-6.19
16 000	-0.75	-8.70
20 000	-2.59	-11.71

Free-Field Frequency Response : Graphical



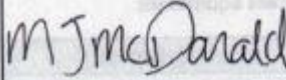
CERTIFICATE OF CALIBRATION	
ISSUED BY	Cirrus Research plc
DATE OF ISSUE	19 August 2021
CERTIFICATE NUMBER	161677



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

Page 1 of 2

Approved signatory
M. McDonald
Electronically signed:



Sound Calibrator : IEC 60942:2003

Instrument information

Manufacturer:	Cirrus Research plc	Notes:
Model:	CR:515	
Serial number:	96656	
Class:	1	

Test summary

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

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

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

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

Notes:

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

CERTIFICATE OF CALIBRATION

Certificate Number:

161677

Page 2 of 2

Environmental conditions

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

Pressure: 102.00 kPa
 Temperature: 23.0 °C
 Humidity: 38.2 %

Test equipment

Equipment	Manufacturer	Model	Serial number
Acoustic Calibrator	Bruel and Kjaer	4231	1795641
Distortion Meter	Keithley	2015	1175401
Multimeter	Fluke	8845A	9440017

Results

	Expected	Sample 1	Sample 2	Sample 3	Average	Deviation	Tolerance	Uncertainty
Level (dB)	94.00	94.00	94.00	93.99	94.00	0.00	±0.40	0.11 dB
Distortion (%)	< 3.00	1.25	1.34	1.34	1.31	1.31	+3.00	0.13 %
Frequency (Hz)	1000.0	1000.0	1000.0	1000.0	1000.0	0.0	±10.0	0.1 Hz

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

End of results