

BS5228 Assessment

Laystall Street

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The report has been prepared in good faith, with all reasonable skill and care, based on information provided or available at the time of its preparation and within the scope of work agreement with the Client. We disclaim any responsibility to the Client and others in respect of any matters outside the scope of the above. The report is provided for the sole use of the named Client and is confidential to them and their professional advisors. No responsibility is accepted to other parties.

The report limits itself to addressing solely on the noise, acoustics or vibration aspects as included in this report. We provide advice only in relation to noise and acoustics. It is recommended that appropriate expert advice is sought on all the ramifications (e.g. CDM, structural, condensation, fire, legal, etc.) associated with any proposals in this report or as advised and concerning the appointment. It should be noted that noise predictions are based on the current information as we understand it and on the performances noted in this report. Any modification to these parameters can alter the predicted level. All predictions are in any event subject to a degree of tolerance of normally plus or minus three decibels. If this tolerance is not acceptable, then it would be necessary to consider further measures.

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1. Introduction

Acoustic Consultants Limited have been appointed to undertake the construction noise and vibration assessment for the development works at Laystall Street, Manchester.

This report provides noise and vibration limits for the development, a BS5228 assessment of noise and also provides measures to control the impact of noise and vibration, including a monitoring strategy.

The author of this report is a full Member of the Institute of Acoustics with over 5 years' experience within the field and, as such, is considered suitably qualified to undertake a noise impact assessment.

2. The Site and Development

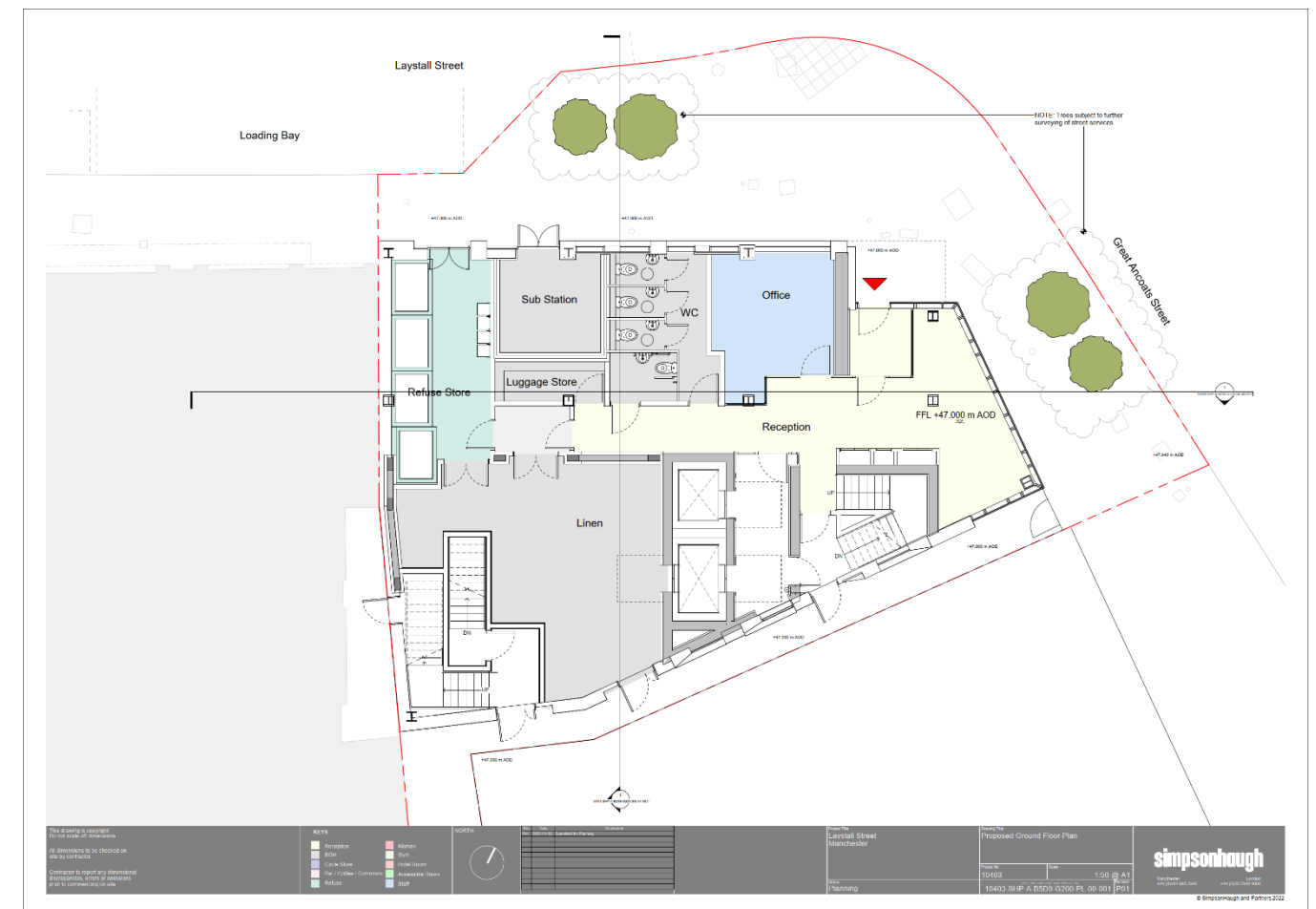
The site is currently a brown field site located between Laystall Street and Lomax Street. The site is located in a mixed-use area with a combination of residential/hotel and commercial properties. The proposal is for the erection of a new 154 bed, 20 storey hotel development (use Class C1).

The most sensitive receivers to construction noise are the residential dwellings (Northern Quarters Serviced Apartments - NQSA) directly to the southeast of the proposed development. The location of the site is shown in Figure 1 and Figure 2.

Figure 1: Site Location



Figure 2: Proposed Site Plan



3. Guidance Documents

The following sections provides commentary on the guidance documents related to the impact of construction activities on the nearby sensitive receivers.

3.1. British Standard 5228-1 - Noise

British Standard 5228-1:2009 entitled "Code of Practice for Noise and Vibration Control on Construction and Open Sites – Part 1: Noise" provides guidance on the methods that can be used to predict and measure noise from construction activities and how to assess the impact on those exposed to it. Annex E provides different methods of determining the significance of noise effects due to construction works. Annex E states:

"A pragmatic approach needs to be taken when assessing the noise effects of any construction project, i.e. the guidance provided below would generally only apply to projects of significant size, and lesser projects might not need to be assessed or might only require general consideration of noise effects and mitigation. Generally, the local planning authority, or a planning consultant experienced in these matters, will be able to advise as to the extent of the assessment that might be required."

Section E.2 states:

For projects of significant size such as the construction of a new railway or trunk road, historically, there have been two approaches to determining whether construction noise levels are significant or not. The older and more simplistic is based upon exceedance of fixed noise limits which were originally promoted by the Wilson Committee in their report on noise [60] as presented to Parliament in 1963. These noise limits were then included in Advisory Leaflet 72 [61], first published in 1968; the accompanying wording was subsequently revised and the 1976 version is quoted below:

"Noise from construction and demolition sites should not exceed the level at which conversation in the nearest building would be difficult with the windows shut. The noise can be measured with a simple sound level meter, as we hear it, in A-weighted decibels (dB(A))– see note below. Noise levels, between say 07.00 and 19.00 hours, outside the nearest window of the occupied room closest to the site boundary should not exceed:

- *70 decibels (dBA) in rural, suburban and urban areas away from main road traffic and industrial noise;*
- *75 decibels (dBA) in urban areas near main roads in heavy industrial areas.*

These limits are for daytime working outside living rooms and offices. In noise-sensitive situations, for example, near hospitals and educational establishments – and when working outside the normal hours say between 19.00 and 22.00 hours – the allowable noise levels from building sites will be less: such as the reduced values given in the contract specification or as advised by the Environmental Health Officer (a reduction of 10 dB(A) may often be appropriate). Noisy work likely to cause annoyance locally should not be permitted between 22.00 hours and 07.00 hours."

The above principle has been expanded over time to include a suite of noise levels covering the whole day/week period taking into account the varying sensitivities through these periods. An example is provided in E.3 and these levels are also often used as limits above which noise insulation would be provided if the temporal criteria are also exceeded.

Annex E.3.2 provides an ABC method which states that for the appropriate period (night, evening/weekends or day) the measured ambient noise level ($L_{Aeq(T)}$ without construction noise present) is rounded to the nearest 5 dB. This is then compared with the cumulative $L_{Aeq(T)}$ of ambient noise and construction noise rounded to the nearest 5 dB.

If the total noise level exceeds the appropriate category value, then a significant effect is deemed to occur. The example thresholds for significant effects at dwellings are shown below and extracted directly from Annex E of British Standard 5228-1:2009.

Table E.1 Example threshold of significant effect at dwellings

Assessment category and threshold value period (L_{Aeq})	Threshold value, in decibels (dB)		
	Category A ^{A)}	Category B ^{B)}	Category C ^{C)}
Night-time (23.00–07.00)	45	50	55
Evenings and weekends ^{D)}	55	60	65
Daytime (07.00–19.00) and Saturdays (07.00–13.00)	65	70	75

NOTE 1 A significant effect has been deemed to occur if the total L_{Aeq} noise level, including construction, exceeds the threshold level for the Category appropriate to the ambient noise level.

NOTE 2 If the ambient noise level exceeds the threshold values given in the table (i.e. the ambient noise level is higher than the above values), then a significant effect is deemed to occur if the total L_{Aeq} noise level for the period increases by more than 3 dB due to construction activity.

NOTE 3 Applied to residential receptors only.

^{A)} Category A: threshold values to use when ambient noise levels (when rounded to the nearest 5 dB) are less than these values.

^{B)} Category B: threshold values to use when ambient noise levels (when rounded to the nearest 5 dB) are the same as category A values.

^{C)} Category C: threshold values to use when ambient noise levels (when rounded to the nearest 5 dB) are higher than category A values.

^{D)} 19.00–23.00 weekdays, 13.00–23.00 Saturdays and 07.00–23.00 Sundays.

It should be noted that the above limits are external limits, which would be monitored/assessed externally to a sensitive residential location.

3.2. British Standard 8233:2014

British Standard 8233:2014 also provides indoor ambient noise criteria for various professional and commercial spaces where privacy is required. Table 2 in Section 7.3 of the British Standard provides design ranges for appropriate indoor ambient noise levels, this is provided below:

Table 1: Internal Ambient Noise Level Criteria from BS8233:2014

Room Type	BS8233 Indoor Ambient Noise Level Criteria $L_{Aeq,30min}$ dB
Open Plan Office	≤ 50 dB
Staff, meeting room, training room	≤ 45 dB
Executive office	≤ 40 dB

3.3. British Standard 5228-2 – Vibration

British Standard 5228-2:2009 entitled "Code of Practice for Noise and Vibration Control on Construction and Open Sites – Part 2: Vibration" provides guidance on the methods that can be used to assess the impact of vibration and how to mitigate it on sensitive receivers.

Annex B provides vibration levels at which adverse effect/comment may occur. These are based on the Peak Particle Velocity (PPV). BS5228:2009-2 also refers to criteria set in other standards, namely BS6472 and BS7385. As BS5228 provides guidance on both human response and structural damage, this standard is primarily referred to below.

3.3.1. Human Response to Vibration

Annex B.2 relates to the human response to vibration, Section B.2 states: *"Human beings are known to be very sensitive to vibration, the threshold of perception being typically in the PPV range of $0.14\text{mm}\cdot\text{s}^{-1}$ to $0.3\text{mm}\cdot\text{s}^{-1}$. Vibrations above these values can disturb, startle. Cause annoyance or interfere with work activities. At higher levels can be described as unpleasant or even painful. In residential accommodation, vibrations can promote anxiety lest some structural mishap might occur. Guidance on the effects on physical health of vibration at sustained high levels is given in BS 6841, although such levels are unlikely to be encountered as a result of construction and demolition activities.*

BS 6472 sets down vibration levels at which minimal adverse comment is likely to be provoked from the occupants of the premises being subjected to vibration. It is not concerned with short-term health hazards or working efficiency.

It points out that human response to vibration varies quantitatively according to the direction in which it is perceived. Thus, generally, vertical vibrations are more perceptible than horizontal vibrations, although at very low frequencies this tendency is reversed. A kindred problem is that vibrations can cause structure-borne noise which can be an additional irritant to occupants of the buildings. Loose fittings are prone to rattle and movement.

BS 6472, as stated, provides guidance on human response to vibration in buildings. Whilst the assessment of the response to vibration in BS 6472 is based on the VDV and weighted acceleration, for construction it is considered more appropriate to provide guidance in terms of the PPV, since this parameter is likely to be more routinely measured based upon the more usual concern over potential building damage.

Furthermore, since many of the empirical vibration predictors yield a result in terms of PPV, it is necessary to understand what the consequences might be of any predicted levels in terms of human perception and disturbance. Some guidance is given in Table B.1."

Table B1 from BS5228 is provided below:

Table B.1 Guidance on effects of vibration levels	
Vibration level ^{A), B), C)}	Effect
$0.14\text{ mm}\cdot\text{s}^{-1}$	Vibration might be just perceptible in the most sensitive situations for most vibration frequencies associated with construction. At lower frequencies, people are less sensitive to vibration.
$0.3\text{ mm}\cdot\text{s}^{-1}$	Vibration might be just perceptible in residential environments.
$1.0\text{ mm}\cdot\text{s}^{-1}$	It is likely that vibration of this level in residential environments will cause complaint, but can be tolerated if prior warning and explanation has been given to residents.
$10\text{ mm}\cdot\text{s}^{-1}$	Vibration is likely to be intolerable for any more than a very brief exposure to this level ^{A)} in most building environments ^{A)} .
^{A)} The magnitudes of the values presented apply to a measurement position that is representative of the point of entry into the recipient. ^{B)} A transfer function (which relates an external level to an internal level) needs to be applied if only external measurements are available. ^{C)} Single or infrequent occurrences of these levels do not necessarily correspond to the stated effect in every case. The values are provided to give an initial indication of potential effects, and where these values are routinely measured or expected then an assessment in accordance with BS 6472-1 or -2, and/or other available guidance, might be appropriate to determine whether the time varying exposure is likely to give rise to any degree of adverse comment. ^{A)}	

3.3.2. Structural Damage

Annex B.3 relates to the structural response of a building to vibration. The relevant extracts of B.3 are below *The response of a building to ground borne vibration is affected by the type of foundation, underlying ground conditions, the building construction and the state of repair of the building. BS 7385 provides guidance on vibration measurement, data analysis and reporting as well as building classification and guide values for building damage. Extracts are provided below.*

The damage threshold criteria presented in BS 7385-2 are based upon systematic studies using a carefully controlled vibration source in the vicinity of buildings. Strains imposed in a building by ground motion will tend to be greater if lower frequencies predominate. The relative displacements associated with cracking will be reached at higher vibration magnitudes with higher frequency dependent threshold levels which are judged to give a minimal risk of vibration-induced damage.

The dominant frequency to use for the assessment is that associated with the greatest amplitude. If the building vibration is multi-frequency in nature, the frequencies should be determined from an amplitude-frequency plot, with each significant peak being examined in turn.

Limits for transient vibration, above which cosmetic damage could occur, are given numerically in Table B.2 and graphically in Figure B.1 in terms of the component PPV. In the lower frequency region where strains associated with a given vibration velocity magnitude are higher, the guide values for the building types corresponding to line 2 are reduced. Below a frequency of 4 Hz where a high displacement is associated with a relatively low component PPV a maximum displacement of 0.6mm (zero to peak) should be used."

Table B.2 of the standard is provided below:

Line (see Figure B.1)	Type of building	Peak component particle velocity in frequency range of predominant pulse	
		4 Hz to 15 Hz	15 Hz and above
1	Reinforced or framed structures Industrial and heavy commercial buildings	50 mm/s at 4 Hz and above	50 mm/s at 4 Hz and above
2	Unreinforced or light framed structures Residential or light commercial buildings	15 mm/s at 4 Hz increasing to 20 mm/s at 15 Hz	20 mm/s at 15 Hz increasing to 50 mm/s at 40 Hz and above

NOTE 1 Values referred to are at the base of the building.

NOTE 2 For line 2, at frequencies below 4 Hz, a maximum displacement of 0.6 mm (zero to peak) is not to be exceeded.

The standard states that minor damage is possible at vibration levels which are greater than twice those given in Table B.2, and major damage at values greater than 4 times the tabulated values. The standard also states, "BS 7385-2 notes that the probability of damage tends zero at 12.5mm^s peak component particle velocity".

4. Construction Noise & Vibration Limits

Considering the guidance documents noted above, we would advise the following limits are applied at the development. The aim of the RED limit is to ensure structural damage is not caused and an acceptable level is maintained. The aim of the AMBER limit is to enable the contractor to manage alerts and ensure a RED alert does not occur:

Table 2: Operation Limits for the Construction Works

Alert Level ⁽¹⁾	Location	Criteria ⁽²⁾	
		Noise	Vibration ⁽³⁾
RED	Dwellings	≤ 70 dB L _{Aeq,10hr}	≤ 7.0 mms ⁻¹
AMBER	Dwellings	≤ 68 dB L _{Aeq,10hr}	< 5.0 mms ⁻¹

⁽¹⁾ The RED action limits are the maximum permissible and should be agreed by all parties. AMBER action limits are set for the contractor to manage the operations. The alerting protocol is provided in Section 7 below.

⁽²⁾ It should be noted these limits are also subject to change as the scheme progress (a potential uplift or reduction). This will be subject to level of complaint which may occur during the work, the essential work being undertaken, and attenuation/transfer function of the building structure.

⁽³⁾ The level of vibration on the floor and ceiling will need to be determined via the engineering analysis of BS 7385-1, i.e. a transfer function. After determining the transfer function these limits maybe increased or reduced further.

5. Construction Method

The following information has been supplied by the contractor.

5.1. Summary of Works

This impact assessment has been produced following the details provided by the contractor of the likely construction plant. A summary of the construction phases and likely associated construction plant is presented below:

Table 3: Phases of construction and associated plant

Phase	Type	Associated Plant
1	Pre-construction enabling works	- 25T Backhoe - Dumper - 20T Tipper Lorry - JCB
2	Ground works and Slab	- Crane 100T - Telehandler - Angle grinder - JCB - Dumper - 20T Tipper Lorry - Tubular piling rig - Sheet piling rig
3	Building fabric / steel works	- 20T tipper lorry - Vibratory roller - Concrete Pump - Telehandler - Dumper - Angle Grinder
4	278 works	- Dumper - 20T tipper lorry - Vibratory roller - JCB

6. Proposed Plant & Predicted Noise Levels

From the supplied information from the client, the following plant has been chosen from the Library Data provided in BS5228-1:2009+A:2014 to be representative. The tables below provide the operational noise levels and expected operational times from our own survey work, BS5228, manufacturer's data and client supplied information. The client should confirm the details in the table below. Predictions have been completed using the standard formulas for noise predictions and the operational times and quantities noted above. The assessment considers all plant equipment being used simultaneously.

For the assessment we have undertaken the noise prediction exercise to one, which is deemed to be the worst-case dwellings (directly adjacent to the construction site). Between the works area and the receivers there will be site hoarding, at least 2.5m high which will likely achieve between 5-10dB attenuation of noise given the proximity of the site hoarding to both the source and receiver. The predictions are as follows:

Table 4: Worst Case Plant Operational Noise Levels and Predictions

PHASE 1 Pre-construction enabling HOURS IN WORKING DAY (T)													
Index	Reference	Equipment Description	L _{Aeq,T} at 10m (dB)	Quantity	% Soft Ground	Distance* to Receptor (m)	Distance Attenuation excluding screening (dB)	Duration of activity in working day (hours)	Duration of activity as % of working day	Activity on time correction (dB)	Reflection (dB) e.g. +3	Screening (dB) e.g. -10	Activity L _{Aeq,T} (dB)
163	C4.63	Tracked excavator, 223 kW - 40t	77	1	0	5	6	5.5	55	-2.6	0	-10	70.4
103	C4.3	Dumper*, 81 kW - 7t	76	1	0	5	6	5	50	-3.0	0	-10	69.0
292	C8.20	Tipper lorry*	79	1	0	5	6	1.5	15	-8.2	0	-10	66.8
26	C2.8	Wheeled backhoe loader, 62 kW - 8t	68	1	0	5	6	5.5	55	-2.6	0	-10	61.4
Total Activity L _{Aeq,T} Pre-construction enabling													74.0
PHASE 2 Ground Works & Slab HOURS IN WORKING DAY (T)													
Index	Reference	Equipment Description	L _{Aeq,T} at 10m (dB)	Quantity	% Soft Ground	Distance* to Receptor (m)	Distance Attenuation excluding screening (dB)	Duration of activity in working day (hours)	Duration of activity as % of working day	Activity on time correction (dB)	Reflection (dB) e.g. +3	Screening (dB) e.g. -10	Activity L _{Aeq,T} (dB)
93	C3.28	Tracked mobile crane, 184 kW - 110t	67	1	0	5	6	5.5	55	-2.6	0	-10	60.4
155	C4.55	Telescopic handler, 75 kW - 3.7t	70	1	0	5	6	4	40	-4.0	0	-10	62.0
188	C4.93	Angle grinder (grinding steel), 2.3 kW - 4.7kg	80	1	0	5	6	1.5	15	-8.2	0	-10	67.8
26	C2.8	Wheeled backhoe loader, 62 kW - 8t	68	1	0	5	6	5.5	55	-2.6	0	-10	61.4
103	C4.3	Dumper*, 81 kW - 7t	76	1	0	5	6	5	50	-3.0	0	-10	69.0
292	C8.20	Tipper lorry*	79	1	0	5	6	1.5	15	-8.2	0	-10	66.8
68	C3.2	Hydraulic hammer rig, 188 kW - 4t hammer	87	1	0	5	6	3.5	35	-4.6	0	-10	78.5
77	C3.11	Piling, 980 kN - 7.4t / 12m length / 500mm width	59	1	0	5	6	3.5	35	-4.6	0	-10	50.5
Total Activity L _{Aeq,T} Ground Works & Slab													79.7
PHASE 3 Building Fabric / Steel Work HOURS IN WORKING DAY (T)													
Index	Reference	Equipment Description	L _{Aeq,T} at 10m (dB)	Quantity	% Soft Ground	Distance* to Receptor (m)	Distance Attenuation excluding screening (dB)	Duration of activity in working day (hours)	Duration of activity as % of working day	Activity on time correction (dB)	Reflection (dB) e.g. +3	Screening (dB) e.g. -10	Activity L _{Aeq,T} (dB)
292	C8.20	Tipper lorry*	79	1	0	5	6	1.5	15	-8.2	0	-10	66.8
211	C5.20	Vibratory roller, 98 kW - 8.9t	75	1	0	5	-4	4	40	-4.0	0	-10	57.0
92	C3.28	Concrete pump, 25 kW - 120mm diameter / 50 bar	75	1	0	5	6	4	40	-4.0	0	-10	67.0
155	C4.55	Telescopic handler, 75 kW - 3.7t	70	1	0	5	6	4	40	-4.0	0	-10	62.0
103	C4.3	Dumper*, 81 kW - 7t	76	1	0	5	6	5	50	-3.0	0	-10	69.0
188	C4.93	Angle grinder (grinding steel), 2.3 kW - 4.7kg	80	1	0	5	6	1.5	15	-8.2	0	-10	67.8
Total Activity L _{Aeq,T} Building Fabric / Steel Work													74.1
PHASE 4 278 Works HOURS IN WORKING DAY (T)													
Index	Reference	Equipment Description	L _{Aeq,T} at 10m (dB)	Quantity	% Soft Ground	Distance* to Receptor (m)	Distance Attenuation excluding screening (dB)	Duration of activity in working day (hours)	Duration of activity as % of working day	Activity on time correction (dB)	Reflection (dB) e.g. +3	Screening (dB) e.g. -10	Activity L _{Aeq,T} (dB)
103	C4.3	Dumper*, 81 kW - 7t	76	1	0	5	6	5	50	-3.0	0	-10	69.0
292	C8.20	Tipper lorry*	79	1	0	5	6	1.5	15	-8.2	0	-10	66.8
211	C5.20	Vibratory roller, 98 kW - 8.9t	75	1	0	5	6	4	40	-4.0	0	-10	67.0
26	C2.8	Wheeled backhoe loader, 62 kW - 8t	68	1	0	5	6	5.5	55	-2.6	0	-10	61.4
Total Activity L _{Aeq,T} 278 Works													72.8

The prediction methodology used assumes that the noise sources are located at the closest boundary of the construction area to the prediction location and are all operational simultaneously, making it a definite worst-case scenario. This is very unlikely to be the case for the length of the works with work taking place over the entire site and with large portions of the time where not all plant will be running simultaneously. This therefore represents an absolute worst-case scenario in terms of mechanical equipment location and combined operation and is only likely to occur for a very short period in a very small number of locations.

While Acoustic Consultants Ltd have endeavoured to match the supplied information from the client directly with library data provided in BS5228-1:2009+A1:2014, it should be noted that the $L_{Aeq, T}$ used may vary slightly from that used. In the case where multiple items of plant are detailed in the 5228 library, the loudest of the appropriate options was chosen. This therefore provides a worst-case scenario, where in practice the measured levels at the noise sensitive receptors are likely to be below what has been predicted in Table 4.

Given that the absolute worst-case scenario in terms of operational location and the sound pressure level for prediction have been used, the measurable construction noise levels are likely to be below the predicted levels.

The worst case predicted level in Table 4 suggests a level above the red alert level would be likely, this can be managed to an acceptable level using noise and vibration control measures and limiting the time that construction plant is used simultaneously.

A further assessment has been undertaken to predict the typical levels likely to be experienced by the closest noise sensitive receptors during construction in an 'average' location. The noise predictions have been undertaken from one location, which is deemed to be an average distance from the receptors (20 m). Between the works area and receivers there will be site hoarding, at least 2.5m high which will achieve at least 5dB attenuation in noise. The predictions are as follows:

Table 5: Typical Plant Operational Noise Levels and Predictions

PHASE 1		Pre-construction enabling											
HOURS IN WORKING DAY (T)		10											
Index	Reference	Equipment Description	L _{Aeq,T} at 10m (dB)	Quantity	% Soft Ground	Distance* to Receptor (m)	Distance Attenuation excluding screening (dB)	Duration of activity in working day (hours)	Duration of activity as % of working day	Activity on time correction (dB)	Reflection (dB) e.g. +3	Screening (dB) e.g. -10	Activity L _{Aeq,T} (dB)
183	C4.63	Tracked excavator, 223 kW - 40t	77	1	0	18	-5	5.5	55	-2.6	0	-5	84.3
103	C4.3	Dumper*, 81 kW - 7t	76	1	0	18	-5	5	50	-3.0	0	-5	82.9
292	C8.20	Tipper lorry*,	79	1	0	18	-5	1.5	15	-8.2	0	-5	80.7
26	C2.8	Wheeled backhoe loader, 62 kW - 8t	68	1	0	18	-5	5.5	55	-2.6	0	-5	55.3
Total Activity L _{Aeq,T} Pre-construction enabling													67.9
PHASE 2		Ground Works & Slab											
HOURS IN WORKING DAY (T)		10											
Index	Reference	Equipment Description	L _{Aeq,T} at 10m (dB)	Quantity	% Soft Ground	Distance* to Receptor (m)	Distance Attenuation excluding screening (dB)	Duration of activity in working day (hours)	Duration of activity as % of working day	Activity on time correction (dB)	Reflection (dB) e.g. +3	Screening (dB) e.g. -10	Activity L _{Aeq,T} (dB)
93	C3.28	Tracked mobile crane, 184 kW - 110t	67	1	0	18	-5	5.5	55	-2.6	0	-5	54.3
155	C4.55	Telescopic handler, 75 kW - 3.7t	70	1	0	18	-5	4	40	-4.0	0	-5	55.9
188	C4.93	Angle grinder (grinding steel), 2.3 kW - 4.7kg	80	1	0	18	-5	1.5	15	-8.2	0	-5	61.7
26	C2.8	Wheeled backhoe loader, 62 kW - 8t	68	1	0	18	-5	5.5	55	-2.6	0	-5	55.3
103	C4.3	Dumper*, 81 kW - 7t	76	1	0	18	-5	5	50	-3.0	0	-5	82.9
292	C8.20	Tipper lorry*,	79	1	0	18	-5	1.5	15	-8.2	0	-5	80.7
68	C3.2	Hydraulic hammer rig, 186 kW - 4t hammer	87	1	0	18	-5	3.5	35	-4.6	0	-5	72.3
77	C3.11	Piling, 980 kN - 7.4t / 12m length / 500mm width	59	1	0	18	-5	3.5	35	-4.6	0	-5	44.3
Total Activity L _{Aeq,T} Ground Works & Slab													73.6
PHASE 3		Building Fabric / Steel Work											
HOURS IN WORKING DAY (T)		10											
Index	Reference	Equipment Description	L _{Aeq,T} at 10m (dB)	Quantity	% Soft Ground	Distance* to Receptor (m)	Distance Attenuation excluding screening (dB)	Duration of activity in working day (hours)	Duration of activity as % of working day	Activity on time correction (dB)	Reflection (dB) e.g. +3	Screening (dB) e.g. -10	Activity L _{Aeq,T} (dB)
292	C8.20	Tipper lorry*,	79	1	0	18	-5	1.5	15	-8.2	0	-5	80.7
211	C5.20	Vibratory roller, 98 kW - 8.9t	75	1	0	18	-5	4	40	-4.0	0	-5	81.0
92	C3.26	Concrete pump, 25 kW - 120mm diameter / 50 bar	75	1	0	18	-5	4	40	-4.0	0	-5	80.9
155	C4.55	Telescopic handler, 75 kW - 3.7t	70	1	0	18	-5	4	40	-4.0	0	-5	55.9
103	C4.3	Dumper*, 81 kW - 7t	76	1	0	18	-5	5	50	-3.0	0	-5	82.9
188	C4.93	Angle grinder (grinding steel), 2.3 kW - 4.7kg	80	1	0	18	-5	1.5	15	-8.2	0	-5	61.7
Total Activity L _{Aeq,T} Building Fabric / Steel Work													68.7
PHASE 4		278 Works											
HOURS IN WORKING DAY (T)		10											
Index	Reference	Equipment Description	L _{Aeq,T} at 10m (dB)	Quantity	% Soft Ground	Distance* to Receptor (m)	Distance Attenuation excluding screening (dB)	Duration of activity in working day (hours)	Duration of activity as % of working day	Activity on time correction (dB)	Reflection (dB) e.g. +3	Screening (dB) e.g. -10	Activity L _{Aeq,T} (dB)
103	C4.3	Dumper*, 81 kW - 7t	76	1	0	18	-5	5	50	-3.0	0	-5	82.9
292	C8.20	Tipper lorry*,	79	1	0	18	-5	1.5	15	-8.2	0	-5	80.7
211	C5.20	Vibratory roller, 98 kW - 8.9t	75	1	0	18	-5	4	40	-4.0	0	-5	80.9
26	C2.8	Wheeled backhoe loader, 62 kW - 8t	68	1	0	18	-5	5.5	55	-2.6	0	-5	55.3
Total Activity L _{Aeq,T} 278 Works													68.7

The predicted level in Table 5 suggests that during the 'typical' construction works, the construction noise levels are likely to be below both the suggested red alert levels for all phases except ground works. It is likely that this can be mitigated through use of best practise and by limiting operational plant, so it does not all run simultaneously.

7. Noise & Vibration Control Measures

7.1. Community Liaison

There are many subjective factors that influence noise annoyance, with the largest contributing factors being the exposed persons attitude towards the source, as well as their ability to control the noise source. Clear and open communication with the residents and businesses is important and will aid in reducing any concerns about the adverse impacts due to construction.

The Main Contractor should ensure that a site notice board is clearly visible, this will ensure that local residents and business have a main point of contact for any complaints or questions.

7.2. Best Practicable Means

It is advised Best Practical Means is employed throughout the construction process to reduce the likelihood of noise and vibration complaints. All contractors and sub-contractors should be made aware of the working practices implemented to reduce complaints. This should be informed at all site inductions.

The proposals with regard to general noise and vibration mitigation would be in accordance with BPM as specified in BS 5228-1:2009 and would comprise of the following, where possible:

- a) Investigate the cause of complaint.
- b) Investigate as to whether the agreed limits have been exceeded.
- c) Provide a response regarding the complaint.

It is advised Best Practical Means is employed throughout the construction process to reduce the likelihood of noise and vibration complaints. All contractors and sub-contractors should be made aware of the working practices implemented to reduce complaints. This should be informed at all site inductions. The proposals, with regard to general noise and vibration mitigation, would be in accordance with BPM as specified in BS 5228-1:2009 and would comprise of the following, where necessary and possible:

- Good communication with the adjacent residents is required, especially during periods of high noise and vibration.
- Switching off engines where vehicles are standing for a significant period of time.
- Fitting of acoustic enclosures / enhanced barriers to suppress noisy equipment as appropriate. This can achieve a further reduction of up to 15dB.
- Operating plant at low speeds and incorporating automatic low speed idling.
- Selecting electrically driven equipment in preference to internal combustion power, hydraulic power in preference to pneumatic and wheeled in lieu of tracked plant.
- Properly maintaining all plant (greased, blown silencers replaced, saws kept sharpened, teeth set and blades flat, worn bearings replaced, etc.)
- It is advised noise and vibration monitoring is installed during the duration of the disruptive works. The monitoring system should have instant alerts when the agreed limits are exceeded.
- Reducing working hours to avoid disruption when an alert is received, this could be a 50% reduction if required.

7.3. Monitoring

To mitigate and monitor the effects of the construction stage, environmental noise and vibration monitoring will be completed on the site. We would advise monitoring is completed at 2 positions, 1 noise and 1 vibration. These are as follows:

- Vibration fixed as close to the façade of the closest noise sensitive receptor as is feasible.
- Noise at the site boundary to the closest noise sensitive receptor.

Based on the site layout, the above positions are expected to be sufficient for a scheme of this type.

NOISE MONITORING:

- a. Sound Pressure Levels will be measured using appropriate and fully calibrated equipment. The equipment will be set up as noted above before works commence.
- b. The equipment will have a web interface to issue alerts to ourselves, the main contractor and any representative if the noise limits are close to being exceeded.
- c. These alerts would be checked off site and we would advise the main contractor and representative of any exceedances in the noted limits. The limits would have a lower-level threshold (amber) and high level (red) based on the criteria noted in this report.
- d. If any exceedances occur the main contractor will be alerted and should mitigate to a minimum.
- e. Weekly reports will be issued by ourselves to the main contractor and any representatives.

VIBRATION:

- a. Vibration monitoring will be measured using appropriate and fully calibrated equipment. The equipment will be set up as noted above before works commence.
- b. The equipment will have a web interface to issue alerts to ourselves, the main contractor and any representative if the vibration limits are close to being exceeded.
- c. These alerts would be checked off site and we would advise the main contractor and representative of any exceedances in the noted limits. The limits would have a lower level threshold (amber) and high level (red) based on the criteria noted in this report.
- d. If any exceedances occur the main contractor will be alerted and should mitigate to a minimum.
- e. Weekly reports will be issued by ourselves to the main contractor and any representatives.

All monitoring should be installed, checked and reported by a suitably qualified acoustician with at least TechIOA membership. It is also advised monitoring is completed by a UKAS or ANC accredited acoustic consultancy.

8. Effect of Control Measures

The following table summarises the predicted level per phase with potential noise control measures implemented:

Table 6: Summary of Construction Noise Predictions

Phase	Works	Predicted Level $L_{Aeq}(10hr)$	Barriers or Enclosures	Reducing Working Hours	Predicted Level dB $L_{Aeq}(10hr)$
1	Worst-case	74	-10	-3	61
	Typical	68	-10	-3	55
2	Worst-case	80	-10	-3	67
	Typical	74	-10	-3	61
3	Worst-case	74	-10	-3	61
	Typical	69	-10	-3	56
4	Worst-case	73	-10	-3	60
	Typical	67	-10	-3	54

The assessment shows that it is possible to keep noise levels below 70 dB $L_{Aeq,10hr}$ during all phases of the works. This will need to be managed on site and when a noise alert is received the contractor should actively mitigate. Good community liaison is essential for these works.

We would advise mitigation (barriers or reduced hours) is implemented if an alert is received on 2 consecutive days (noise) or 3 times in one hour (vibration).

9. Summary and Conclusions

Acoustic Consultants Limited have been appointed to undertake the construction noise and vibration assessment for the development works at Laystall Street.

This report provides noise and vibration limits for the development and provides a BS5228 assessment of noise and provides measures to control the impact of noise and vibration, including a monitoring strategy.

Construction activities may occasionally result in the noted limits being exceeded; however, this can be mitigated using a combination of best practicable means, limited plant on times, and screens or enclosures.

It is considered that with suitable monitoring during the disruptive phases of work and BPM followed, the impacts on the receivers in the area can be controlled and reduced to a minimum where necessary.

10. Appendix 2 – Glossary of Acoustic Terminology

A-weighted sound pressure p_A – value of overall sound pressure, measured in pascals (Pa), after the electrical signal derived from a microphone has been passed through an A-weighting network

A-weighted sound pressure level, L_{pA} – quantity of A-weighted sound pressure given by the following formula in decibels (dBA) " $L_{pA} = 10 \log_{10} (p_A/p_0)^2$ "

where:

p_A is the A-weighted sound pressure in pascals (Pa);
 p_0 is the reference sound pressure (20 μ Pa)

Background sound level, $L_{A90,T}$ – A-weighted sound pressure level that is exceeded by the residual sound assessment location for 90% of a given time interval, T, measured using weighting F and quoted to the nearest whole number of decibels

Break-in - noise transmission into a structure from outside.

Decibel (dB) – The decibel is the unit used to quantify sound pressure levels. The human ear has an approximately logarithmic response to acoustic pressure over a very large dynamic range (typically 20 micro-Pascals to 100 Pascals). Therefore, a logarithmic scale is used to describe sound pressure levels and also sound intensity and power levels. The logarithms are taken to base 10. Hence an increase of 10 dB in sound pressure level is equivalent to an increase by a factor of 10 in the sound pressure level (measured in Pascals). Subjectively, this increase would correspond to a doubling of the perceived loudness of sound.

Equivalent continuous A-weighted sound pressure level, $L_{Aeq,T}$ – value of the A-weighted sound pressure level in decibels of continuous steady sound that, within a specified time interval, T = t₂ – t₁, has the same mean-squared sound pressure as a sound that varies with time, and is given by the following equation:

$$L_{Aeq,T} = 10 \lg_{10} \left\{ (1/T) \int_{t_1}^{t_2} [p_A(t)^2/p_0^2] dt \right\} \quad (1)$$

where:

p_0 is the reference sound pressure (20 μ Pa); and

$p_A(t)$ is the instantaneous A-weighted sound pressure (Pa) at time t

NOTE The equivalent continuous A-weighted sound pressure level is quoted to the nearest whole number of decibels.

Facade level – sound pressure level 1 m in front of the façade. Facade level measurements of L_{pA} are typically 1 dB to 3 dB higher than corresponding free-field measurements because of the reflection from the facade.

Free-field level – sound pressure level away from reflecting surfaces. Measurements made 1.2 m to 1.5 m above the ground and at least 3.5 m away from other reflecting surfaces are usually regarded as free-field. To minimize the effect of reflections the measuring position has to be at least 3.5 m to the side of the reflecting surface (i.e. not 3.5 m from the reflecting surface in the direction of the source).

Octave and Third Octave Bands – The human ear is sensitive to sound over a range of frequencies between approximately 20 Hz to 20 kHz and is generally more sensitive to medium and high

frequencies than to low frequencies within the range. There are many methods of describing the frequency content of a noise. The most common methods split the frequency range into defined bands, in which the mid-frequency is used as the band descriptor and in the case of octave bands is double that of the band lower. For example, two adjacent octave bands are 250 Hz and 500 Hz. Third octave bands provide a fine resolution by dividing each octave band into three bands. For example, third octave bands would be 160 Hz, 250 Hz, 315 Hz for the same 250 Hz octave band.

Sound pressure level – Sound pressure level is stated on many of the charts. It is the amplitude of the acoustic pressure fluctuations in a sound wave, fundamentally measured in Pascals (Pa), typically from 20 micro-Pascals to 100 Pascals, but commonly simplified onto the decibel scale.

Sound reduction index, R – laboratory measure of the sound insulating properties of a material or building element in a stated frequency band.

Specific sound level, $L_s = L_{Aeq,T_r}$ – 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.

Structure-borne noise – audible noise caused by the vibration of elements of a structure, the source of which is within a building or structure with common elements

Rating level, L_{Ar,T_r} – Specific sound level plus any adjustment for the characteristic features of the sound.

Reverberation Time, T – The reverberation time is defined as the time taken for a noise level in an enclosed space to decay by 60 dB from a steady level, once the noise source has stopped. It is measured in seconds. Often a 60 dB decay cannot be measured so the reverberation time is measured over a lesser range and corrected back to the time for a 60 dB drop assuming a constant decay rate. Common parameters are T20 (time taken for a 20 dB decay multiplied by three) and T30 (time taken for a 30 dB decay multiplied by two).

Vibration Dose Value, VDV – measure of the total vibration experienced over a specified period of time.

Estimated Vibration Dose Value, eVDV – estimation of the total vibration experienced over a specified period of time. This is usually based on the number of events and shortened measurement data.

Weighted sound reduction index, R_w – Single-number quantity which characterizes the airborne sound insulating properties of a material or building element over a range of frequencies. The weighted sound reduction index is used to characterize the insulation of a material or product that has been measured in a laboratory (see BS EN ISO 717-1).



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