



ACOUSTIC CONSULTANTS LTD
noise and acoustic specialists since 1987

Environmental Noise Assessment

**Proposed Residential Development
121 Palatine Road, Manchester**

**Reference: 8235/PR/DO
Date: March 2020**

Proposed Residential Development 121 Palatine Road, Manchester



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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 external noise 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

CLIC Sargent appointed Acoustic Consultants Ltd to undertake an environmental noise assessment for the proposed change of use from offices (Class B1) to residential from at 121 Palatine Road, Didsbury, Manchester M20 3YA, in support of the planning application Ref. No. 125235/FO/2019.

This report also addresses the following planning condition No. 3 (Ref. 125235/FO/2019) which states:

"3) Before the development commences a scheme for acoustically insulating the proposed residential accommodation against noise from Palatine Road and the tram line shall be submitted to and approved in writing by the City Council as local planning authority.

There may be other actual or potential sources of noise which require consideration on or near the site, including any local commercial/industrial premises. The approved noise insulation scheme shall be completed before any of the dwelling units are occupied.

Noise survey data must include measurements taken during a rush-hour period and Night time to determine the appropriate sound insulation measures necessary. The following noise criteria will be required to be achieved:

*Bedrooms (night time - 23.00 - 07.00) 30 dB L_{Aeq}
(individual noise events shall not exceed 45 dB $L_{Amax,F}$ by more than 15 times)*

Living Rooms (daytime - 07.00 - 23.00) 35 dB L_{Aeq}

Gardens and terraces (daytime) 55 dB L_{Aeq}

Upon completion of the development and before first occupation of the residential units, a verification report will be required to validate that the work undertaken throughout the development conforms to the recommendations and requirements in the approved acoustic consultants report. The report shall also undertake post completion testing to confirm that the internal noise criteria has been met. Any instances of non-conformity with the recommendations in the report shall be detailed along with any measures required to ensure compliance with the internal noise criteria.

Due to the proximity of the development to the tram line, it will be necessary for vibration criteria to apply which can be found in BS 6472: 2008 "Guide to evaluation of human exposure to vibration in buildings". Groundborne noise/re-radiated noise should also be factored into the assessment and design.

Reason: In order to protect future residents from noise nuisance, pursuant to policies SP1, H1 and DM1 of the Core Strategy."



The report is based upon noise and vibration levels measured at the site. This report considers the impact of tram traffic (tram) noise and vibration from passing trams near the development.

The report identifies relevant planning, noise and vibration guidance, establishes environmental noise and vibration levels and provides mitigation measures to the proposed dwellings in support of a planning application.

The author of this report is a Member of the Institute of Acoustics (MIOA) with a recognised acoustic qualification and 10 years' experience within the field.

2. The Site and Proposals

The proposed site is an existing office, located at 121 Palatine Road, Didsbury, Manchester M20 3YA. The site is located within a mixed-use area, with offices and residential dwellings. Transportation noise was considered to form the predominant noise.

It is proposed to convert the existing office buildings into residential flats.

The existing and proposed site location plan is provided in the figures below.

Figure 1: Existing site plan



Figure 2: Proposed site plan





3. Assessment Criteria

3.1. Internal Ambient Noise Levels

Planning condition No. 3 (Ref. 125235/FO/2019) states the following regarding internal ambient noise levels.

"Noise survey data must include measurements taken during a rush-hour period and Night time to determine the appropriate sound insulation measures necessary. The following noise criteria will be required to be achieved:

- *Bedrooms (night time - 23.00 - 07.00) 30 dB L_{Aeq}
(individual noise events shall not exceed 45 dB $L_{Amax,F}$ by more than 15 times)*
- *Living Rooms (daytime - 07.00 - 23.00) 35 dB L_{Aeq}*

3.2. External Amenity Levels

Planning condition No. 3 (Ref. 125235/FO/2019) states the following regarding external amenity ambient noise levels.

- *Gardens and terraces (daytime) 55 dB L_{Aeq}*

3.3. Vibration

Planning condition No. 3 (Ref. 125235/FO/2019) states the following regarding the exposure to vibration.

"Due to the proximity of the development to the tram line, it will be necessary for vibration criteria to apply which can be found in BS 6472: 2008 "Guide to evaluation of human exposure to vibration in buildings". Groundborne noise/re-radiated noise should also be factored into the assessment and design. "

The standard provides ranges of vibration for different classes of building (e.g., houses, offices, etc.,) for acceptable magnitudes of vibration for daytime and night-time periods.

The British Standard also provides an interpretation for residential buildings of the probability of adverse comment for different levels of exposure to vibration.

The measurement scale used for impulsive vibration is one that effectively accumulates the vibration energy received over the daytime or night-time period, the Vibration Dose Value (VDV). The criteria for evaluating the likelihood of adverse comment are set out in Table 1 below.



Table 1: Vibration Dose Values ($\text{m/s}^{-1.75}$) of which various degrees of adverse comment may be expected

Place and time	Low probability of adverse comment	Adverse comment possible	Adverse comment probable
Residential Buildings 16-hour day	0.2 to 0.4	0.4 to 0.8	0.8 to 1.6
Residential Buildings 8-hour night	0.1 to 0.2	0.2 to 0.4	0.4 to 0.8

Where feasible, the aim is to keep the Vibration Dose Value (VDV) within the low probability of adverse comment range or lower.



4. Noise and Vibration Monitoring

A partially attended noise and vibration survey was undertaken between the 3rd March 2020 and 4th March 2020 to determine the existing tram traffic, road traffic and ambient noise and vibration levels in the area.

4.1. Monitoring Equipment

Sound Pressure Levels were measured using a Class 1 sound level meter with a half-inch condenser microphone, using the 'fast' setting. The equipment is checked regularly using a Quality System meeting the requirements of British Standard EN ISO/IEC 17025:2017 "General requirements for the competence of testing and calibration laboratories"; in accordance with British Standard EN 10012:2003 "Measurement management systems. Requirements for measurement processes and measuring equipment"; and traceable to the National Standards.

Vibration Dose Values were measured using a Rion XV-2P Tri-Axial Vibration Meter configured to enable Vibration Dose Value (VDV) measurements, PPV and Acceleration across the three axes. The equipment is checked using a Quality System to ensure it conforms with the requirements set out in British Standard 6472:1992, British Standard 7385-1:1990 and British Standard 7385-2:1993. All the recorded parameters were weighted as stated in the British Standard 6472 – 1:2008. This equipment was checked and calibrated by the manufacturers.

This equipment was checked and calibrated as noted below and the certificates are available for inspection.

Table 2: Equipment and Calibration Status

Equipment Description / Manufacturer / Type	Serial Number	Date of Calibration	Calibration Certification Number
SLM, NTI, XL2	A2A-13617-E0	13/09/18	FL-18-082
Pre-Amp, NTI, MA220	7727	13/09/18	FL-18-082
Microphone, NTI, MC230A	A16151	13/09/18	FL-18-082
Calibrator, Larson Davis, CAL200	12605	27/08/19	32690
SLM, NTI, XL2	A2A-11041-E0	05/04/19	31440
Pre-Amp, NTI, MA220	6428	05/04/19	31440
Microphone, NTI, MC230A	9583	05/04/19	31439
Calibrator, Larson Davis, CAL200	12605	27/08/19	32690
Vibration meter, Rion, XV-2P 3-Axis	380058	43168	-

The measurement systems were checked before and after use with the calibrators and no significant drift was detected.



4.2. Noise Monitoring Procedure

A partially attended noise monitoring exercise was carried out at two different locations, between 13:30 hours on the 3rd March 2020 and 13:30 hours on the 4th March 2020 at Monitoring Location A and between 13:50 hours on the 3rd March 2020 and 13:45 hours on the 4th March 2020 at Monitoring Location B.

The purpose of this monitoring exercise was to measure noise levels of passing trams travelling on adjacent tramline to the east of the site and the road traffic noise levels along Palatine Road to the north of the site.

At 'Monitoring Location A', the meter was mounted externally on the fire escape stairs at approximately 4.5 metres above the ground and in a free field level position. At the 'Monitoring Location B', the meter was mounted externally at the rear steps of the building at approximately 1.5 metres height and in a free field position.

The monitoring locations for both are shown on the Figure 3 below.

Figure 3: Noise monitoring locations



Figure 4: Monitoring Location A (left) and Location B (right) views



4.3. Vibration Monitoring Procedure

The vibration monitoring position was located at basement level within the rear existing room. The transducer was sat directly on the existing timber floor. The measurement location is shown on Figure 5 and below.

Figure 5: Train Pass by Vibration Monitoring within the existing south eastern basement room

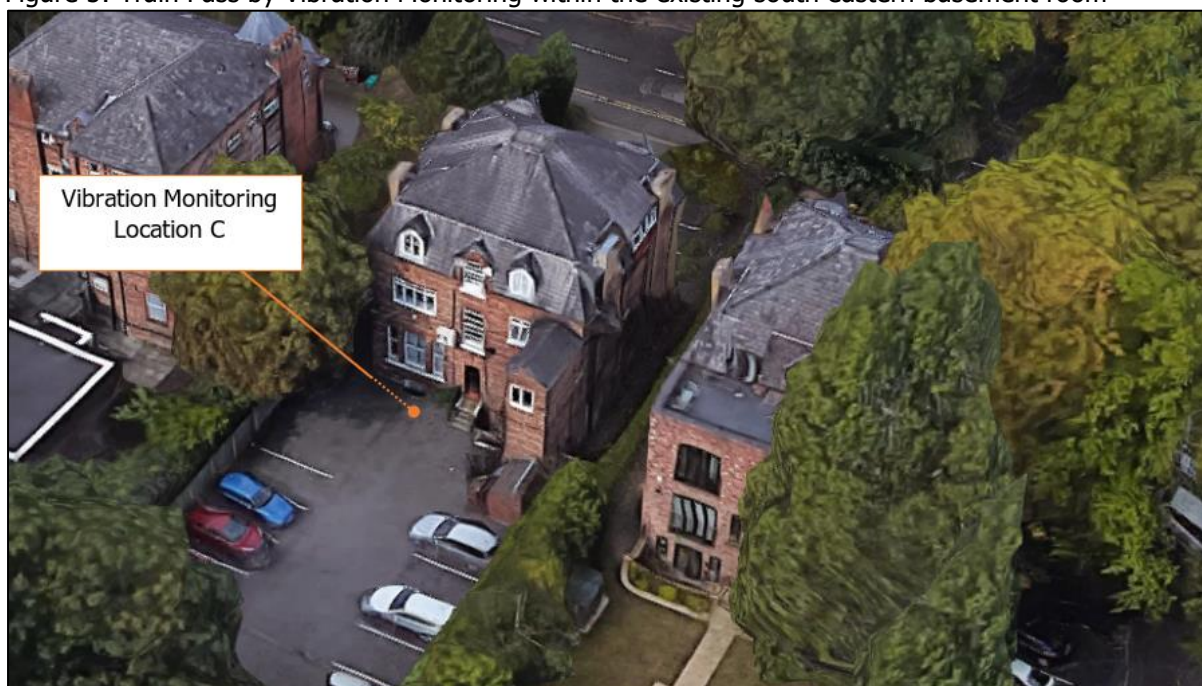
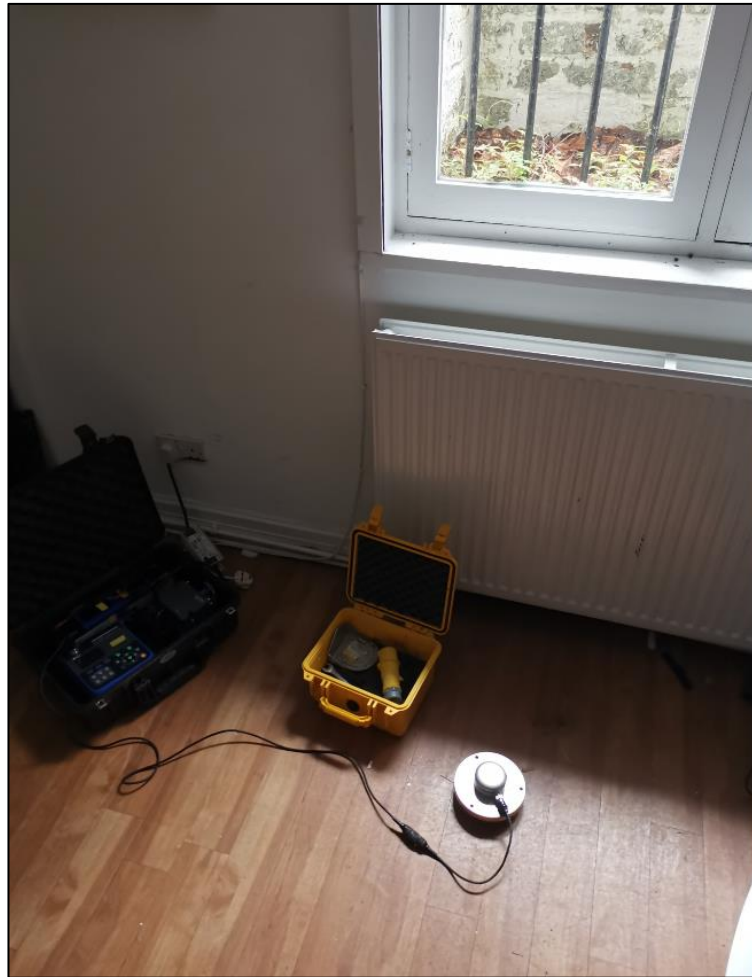


Figure 6: Vibration Meter installed within the rear basement room



4.4. Weather Conditions

During the measurement the weather was dry with an average temperature of approximately 2-7 degrees Celsius, with partial cloud and wind speeds below 5 m.s. These weather conditions are not expected to have adversely affected the measured noise data.

4.5. Measured Noise Levels

4.5.1. Monitoring Location A – Road Traffic Noise

The meter was set to record five-minute measurement periods and 0.1 second log data over the total monitoring period. The relevant data for the assessment is the octave band and A-weighted L_{eq} , L_{max} and L_{10} parameters.

A chart of the variation in ambient noise levels (0.1 second log) with time is provided below. The design noise levels determined at the monitoring location and used in our report to assess the impact of both road and tram noise is also summarised and shown below.

Chart 1: Measured noise levels at Monitoring Location A – Road Traffic Noise

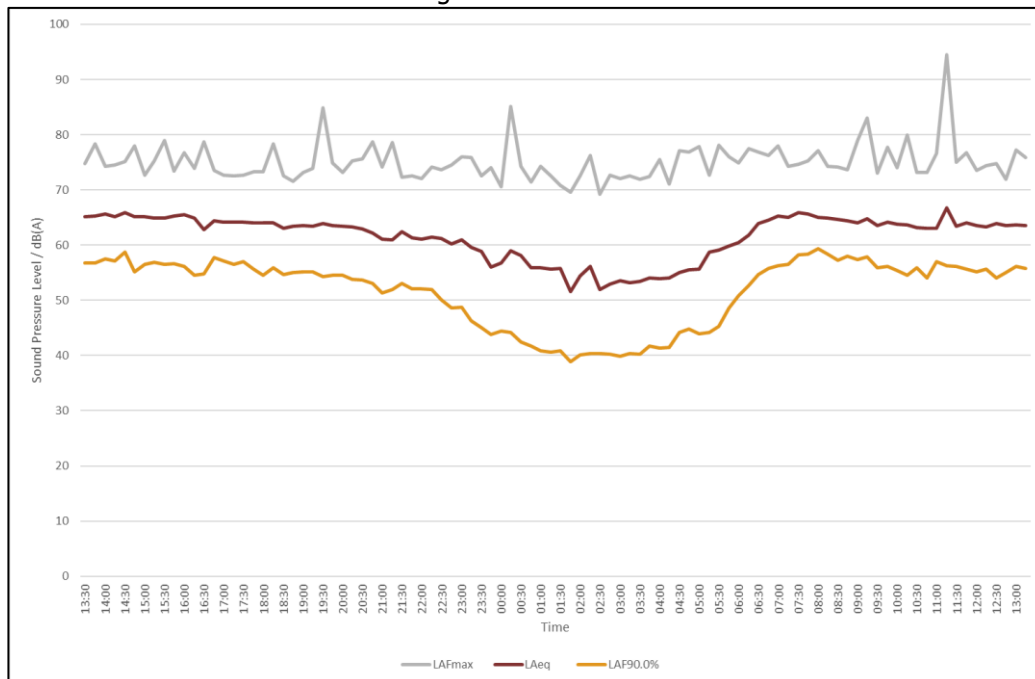


Table 3: Spectral Design road traffic noise levels at monitoring Location A (free-field)

Period	Frequency (Hz)								dBA
	63	125	250	500	1K	2K	4K	8K	
Daytime Leq (16hrs)	67	58	59	58	61	57	48	42	64
Night Time Leq (8hrs)	58	50	52	52	55	51	42	35	58
Night-time L _{maxF} ⁽¹⁾	76	69	71	71	75	71	62	57	78

⁽¹⁾ This maximum noise level is approximately the 10th highest maximum night time noise level as defined in WHO

4.5.2. Monitoring Location B –Tram Traffic Noise

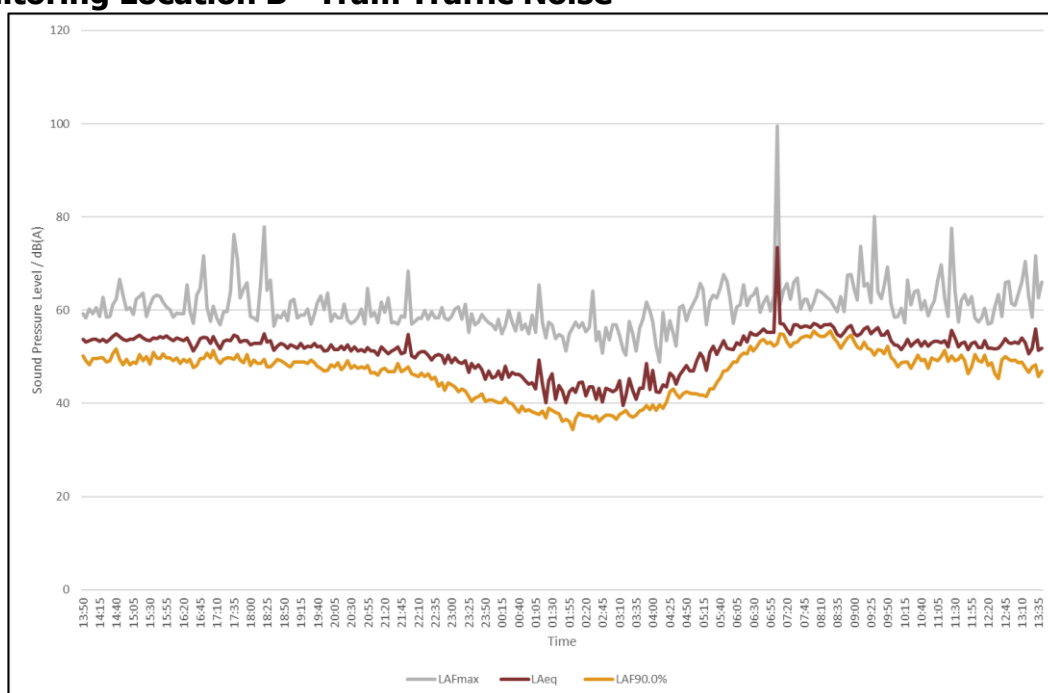


Table 4: Spectral Design tram noise levels at monitoring Location B (free-field)

Period	Frequency (Hz)								
	63	125	250	500	1K	2K	4K	8K	dBA
Daytime L_{eq} (16hrs)	59	54	52	48	51	45	42	51	55
Night Time L_{eq} (8hrs)	52	47	46	44	46	41	34	30	49
Night-time L_{maxF} ⁽¹⁾	61	59	60	57	57	59	50	40	63

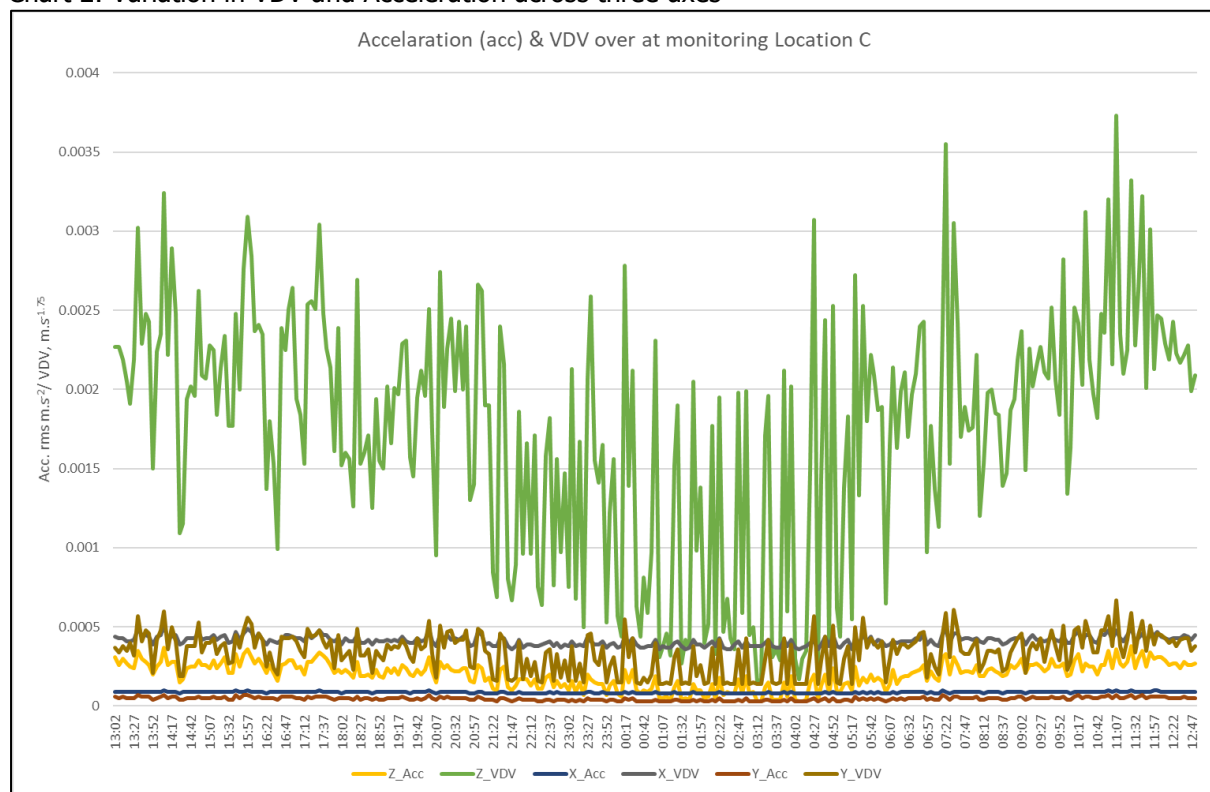
⁽¹⁾ This maximum noise level is approximately the 10th highest maximum night time noise level as defined in WHO

4.6. Measured Vibration Levels

A partially attended vibration monitoring exercise was undertaken on the site between 13:02 hours and 12:57 hours between 3rd and 4th March 2020.

A chart showing the variation in Vibration Dose Value (VDV) measurements and Acceleration across the three axes (30 sec log) with time is provided below. The x axis was approximately aligned with the tram line.

Chart 2: Variation in VDV and Acceleration across three axes



5. Noise Assessment

5.1. Noise Modelling

5.1.1. Modelling Parameters

To determine noise levels across the site, noise modelling has been undertaken using computer modelling package Cadna:A by DataKustik and the road and tram traffic noise level data noted above measured on site.

The software predicts road and tram traffic noise propagation using the method of 'The Calculation of Road Traffic Noise 1988' (CRTN'88) and 'Calculation of Railway Noise, 1995 (CRN'95) methodology' respectively, and a verification model has been created to ensure the measured and predicted levels are comparable. This model is available upon request.

The noise predictions have been undertaken using supplied plans of the proposed site and the following general modelling parameters:

- The noise model has been completed using the determined road traffic and tram traffic data above
- To determine the noise levels across the site and surrounding areas, this has been taken as a hard-reflective ground which is a worst-case scenario.
- Reflections from opposite façades have been determined via the correction method (+1.5 dB), as defined in CRTN/CRN.
- The proposed building heights are based on provided architectural drawings. Receivers for each storey are considered to be at the proposed window midpoint height.
- The topography of the site and surrounding area was modelled using open source online Lidar data (1x1m grid).
- Noise control barriers were introduced as proposed and shown on the architectural drawings within the rear external amenity areas of the development. These vary between 1.8 m and 2.1 metres high.

5.1.2. Noise Modelling Results

Predicted noise emission maps for equivalent noise levels during the daytime ($L_{Aeq,16hour}$) and night-time ($L_{Aeq,8hour}$), and maximum noise events (L_{AFmax}) during the night-time are provided below in the figures below.

Figure 7: Daytime $L_{Aeq, 16\text{hours}}$ Noise Map due to Road and Tram Traffic Noise (1.5 metres height)



Figure 8: Night Time $L_{Aeq, 8\text{hours}}$ Noise Map due to Road and Tram Traffic Noise (1.5 metres height)



Figure 9: Night Time $L_{A_{max}}$ Noise Map due to Road Traffic Noise (1.5 metres height)

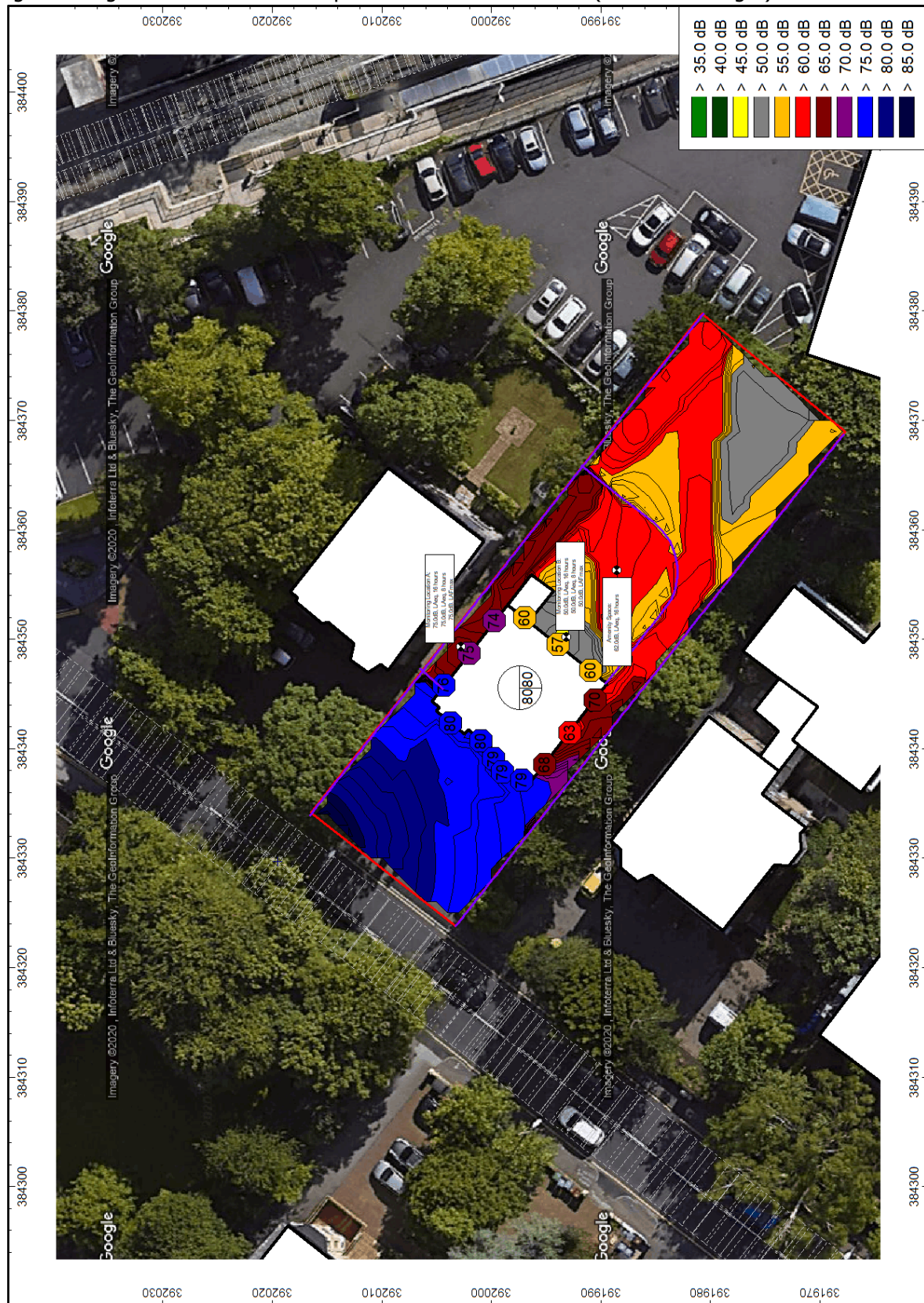
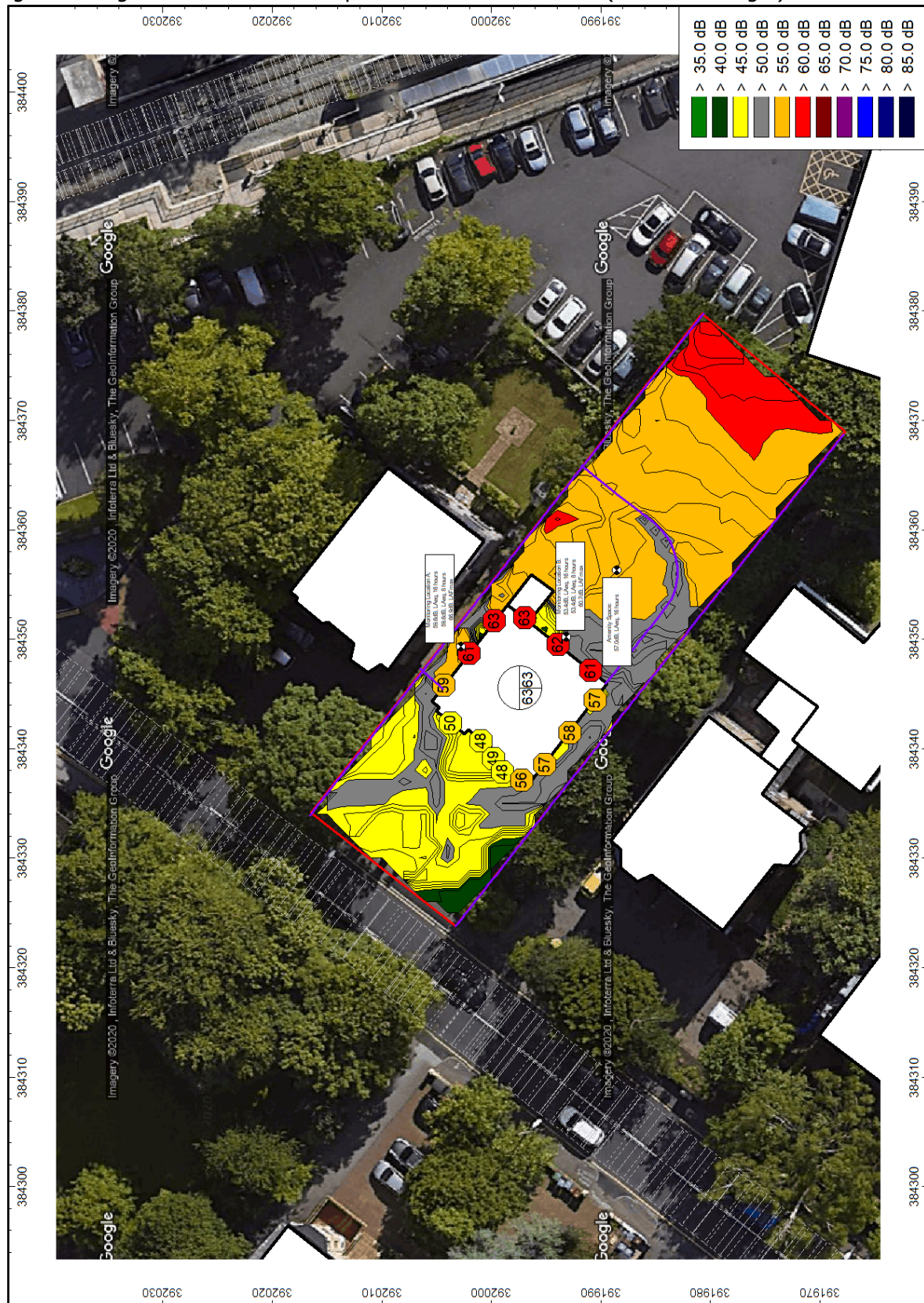


Figure 10: Night Time L_{AFmax} Noise Map due to Tram Traffic Noise (1.5 metres height)



5.2. Internal Ambient Noise Levels

5.2.1. Calculation Method

Calculations for the internal ambient noise levels due to road and tram traffic noise have been undertaken using the calculation method provided in Annex G Section G.2 of British Standard 8233:2014.

The calculations have been undertaken using the building façade construction specified below and the octave band free-field design equivalent noise levels and maximum noise levels taken from the measured noise spectra noted above.

The calculations assume the following, based on the layout architectural drawings provided (worst case rooms):

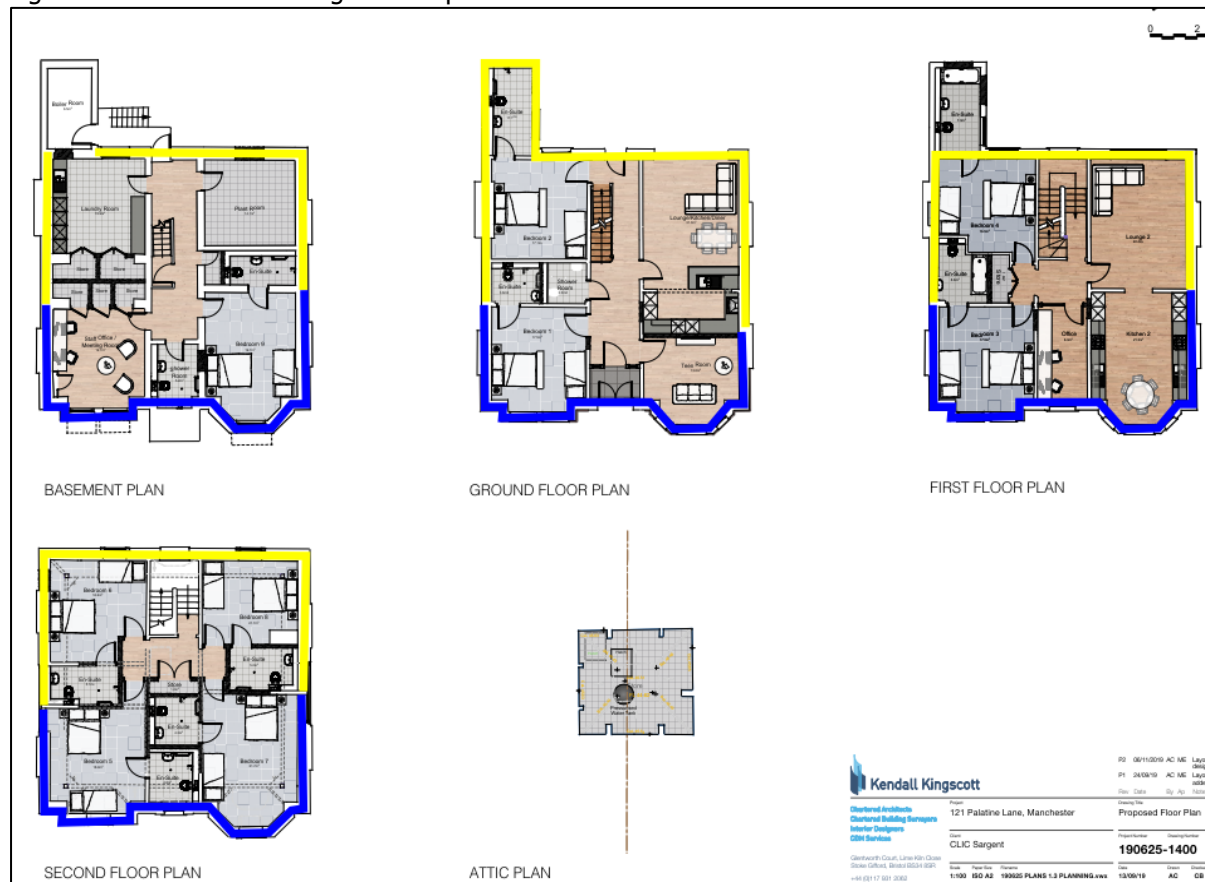
- Room size: 13.6m² to living rooms and 17.5m² to bedrooms
- Windows: 6m² to living rooms and 5.2m² to bedrooms
- Façade: 25m² to living rooms and 30m² to daytime bedrooms
- Vents: 2 to living rooms, 1 to bedrooms; all vents are open (if mechanically ventilated, no window/wall vents considered)

We advise that building elements, having the sound insulation performances noted below, be incorporated into the design of the façades including the windows, doors, floor, and the building roof.

Alternative constructions to those noted below could be used, however they would need to be assessed to ensure they control external noise to within the BS 8233:2014 recommended internal ambient noise level criteria.

A colour code mitigation maps was created to outline the different noise mitigation measures required for daytime rooms and night time bedrooms on each façade of the proposed residential buildings; see Figure 11 below.

Figure 11: Colour Code Mitigation Map



5.2.2. External Wall Construction

Within all zones the external walls are understood to be of a conventional construction, assumed to comprise the following.

- The masonry construction could comprise of at least two skins of block (one of density 1880 Kg/m³, 100mm cavity, 100mm block (density of 400 Kg/m³). Room side of the block work would be plastered or plasterboard on dabs.

The above constructions are expected to achieve the following sound reduction indices:

Table 5: Required minimum sound insulation performance of external walls

Frequency (Hz)	63	125	250	500	1k	2k	4k	8k	R _w
R (dB)	31	38	46	45	55	66	77	70	52

Any alternative constructions must achieve the above noted performance.



5.2.3. Roof Construction

Within all zones the dwellings could have a roof constructed using traditional techniques, such as a timber construction with concrete/slate tiles (minimum mass per unit area of 30 Kg/m²) with a loft space and a plasterboard ceiling above the habitable rooms. This roof construction and performance can also be applied to the top floor rooms.

The above constructions are expected to achieve the following sound reduction indices:

Table 6: Required minimum sound insulation performance of roof

Frequency (Hz)	63	125	250	500	1k	2k	4k	8k	R _w
R (dB)	25	39	47	53	58	56	60	55	56

Any alternative constructions must achieve the above noted performance.

5.2.4. Window Construction

The windows on all elevations could be openable. However, they need to be sealed airtight to control external noise and should be normally closed within the areas noted above. There should be no un-attenuated vents or openings in the building façade.

The performance for each window based on the room type is provided below, other constructions may also achieve this level of sound attenuation. The supplier should provide test data confirming that the octave band sound reduction indices stated below for each window type are achievable.

Table 7: Required minimum sound insulation of windows

Colour Code Facade	Room	Sound Reduction Index / dB per Octave Band (Hz)								R _w (dB)	Typical Construction
		63	125	250	500	1k	2k	4k	8k		
Blue	Bedrooms	22	27	29	36	41	42	52	50	39	10/12/6.4
	Living Rooms	22	27	29	36	41	42	52	50	39	10/12/6.4
Yellow	Bedrooms	20	24	20	25	35	38	35	36	31	4/12/4
	Living Rooms	20	24	20	25	35	38	35	36	31	4/12/4

The glazing and ventilation supplier should confirm the above performance is achievable when tested to the current British Standards.

5.2.5. Ventilation Provisions

All habitable rooms of the development shown on the mitigation map on Figure 11 above will need to be ventilated via attenuated means. Rooms facing Palatine Road could be ventilated via wall ventilators (natural) or mechanical ventilation (whole house ventilation).



Wall Ventilation

Wall ventilation is sufficient to achieve the planning requirements. The vents are required to achieve the following element normalised level difference ($D_{n,e}$) in the open position.

Table 8: Required minimum sound insulation of vents

Colour Code Facade	Room	Required Ventilator Sound Insulation Performance (dB), $D_{n,e}$ per Octave Band (Hz)								$D_{n,e,w}$ (dB)	Typical Construction
		63	125	250	500	1k	2k	4k	8k		
Blue	Bedrooms										
	Living Rooms	45	47	46	50	55	65	68	60	54	Wall Vent, Greenwood MA3051
Yellow	Bedrooms										
	Living Rooms	30	35	35	36	34	29	33	34	32	Titon XS13 4400 EA+XC13 412 Canopy

Mechanical Ventilation

Alternatively, mechanical ventilation can be used within the most exposed rooms to road traffic noise (blue areas) facing Palatine Road. If mechanical ventilation is used instead in the above blue areas, the system will need to be suitably designed to ensure external noise transfer through the ventilation system does not adversely affect the residents.

The minimum 'sound level difference' in dB(A) broadband for the ventilation system is provided in the table below. This is the difference between the outside façade level and the level inside a room at one-and-a-half metres from the vent inside a furnished room.

The required sound level difference to 'habitable rooms' is shown below:

Table 9: Ventilation Sound Level Difference Requirements in dB(A)

Minimum Sound level difference
45 dB(A)

Approved Document 'F' of the Building Regulations 2010 covers ventilation. Section 4.36 of this document states: "*To ensure good acoustic conditions, the average A-weighted sound pressure level in noise-sensitive rooms, such as bedrooms and living rooms, should not exceed 30dB $L_{Aeq,T}$.*" We would advise the noise of the ventilation system is also designed to meet this level within the sensitive spaces.



5.2.6. Effect of Mitigation Measures

With the mitigation measures installed to habitable rooms of the dwellings in the rooms noted above, the predicted internal noise levels are below the Local Authority criteria specified above in Condition 3.

The predictions for the worst-case rooms are shown in more detail in Appendix 2 below.

5.3. External Amenity Spaces

Figure 152 below provides the daytime noise map of the proposed amenity areas which are to be located at the rear of the proposed development.

It can be seen that both road and tram traffic noise levels within the proposed amenity areas are considered to be between 55 to 57dB $L_{Aeq, 16 \text{ hours}}$. These levels are therefore considered to be marginally above the recommended amenity level of less than 55dB $L_{Aeq, 16 \text{ hours}}$ as defined in Condition 3. This is including consideration to the proposed 1.8 – 2.1 metre barriers to the rear of the site, which do not have a substantial effect due to the distance between the tramline and the site boundary.

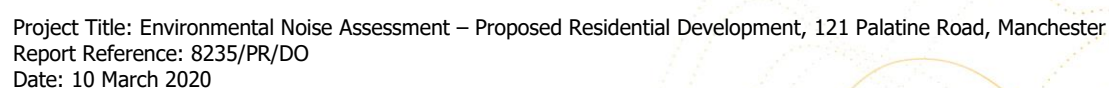
With regard to its upper guideline for noise levels within external amenity spaces being exceeded, British Standard 8233:2014 states the following:

"It is recognised that these guideline values are not achievable in all circumstances where development might be desirable. In higher noise areas, such as city centres or urban areas adjoining the strategic transport link, a compromise between elevated noise levels and other factors, such as the convenience of living in these locations or making efficient use of land resources to ensure development needs can be met, might be warranted. In such a situation, development should be designed to achieve the lowest practicable levels in these external amenity spaces, but should not be prohibited."

On the basis of the above, the marginal exceedance of the upper guideline may be considered less significant than the development's convenient location near the West Didsbury tram stop, which would provide an easy public transport link to the city centre.

It is also understood that the proposed external rear areas are 'communal' amenity spaces. This is not considered to be the typical well-defined rear plot "*traditional external areas that are used for amenity space, such as gardens and patios*" as defined in BS8233 typically used for relaxation and where people expect to have privacy from neighbours.

Figure 12: Daytime $L_{Aeq, 16hours}$ Noise Map due to Road and Tram Traffic Noise (1.5 metres height) – Amenity Space





6. Vibration Assessment

At the measurement position the estimated vibration dose values over the daytime (07:00 to 23:00 hours) and night-time (23:00 to 07:00 hours) have been established from the short-term vibration levels. The calculation is based on equation (3) of BS6472 which is summarised below:

$$VDV_{b/d,day/night} = \left(\sum_{n=1}^{n=N} VDV_{b/d,t_n}^4 \right)^{0.25}$$

Using the typical weighted $VDV_{5 \text{ min}}$ the calculated $VDV_{\text{day/night}}$ at the measured location is as follows:

Table 10: Calculated VDV

Time Period	X ($\text{m.s}^{-1.75}$)	Y ($\text{m.s}^{-1.75}$)	Z ($\text{m.s}^{-1.75}$)
Daytime (07:00-23:00)	0.002	0.002	0.008
Night-time (23:00-07:00)	0.001	0.001	0.006

From the measured data, it can be seen that the measured vibration dose values for the daytime and night-time lie below or within the British Standard 6472 range for a low probability of adverse comment.

As such, vibration is not considered to be of an adverse level at this site and vibration mitigation measures do not need to be introduced.

7. Summary and Conclusions

CLIC Sargent appointed Acoustic Consultants Ltd to undertake an environmental noise assessment for the proposed change of use from offices (Class B1) to residential from at 121 Palatine Road, Didsbury, Manchester M20 3YA, in support of the planning application Ref. No. 125235/FO/2019. This report also addresses planning condition No. 3 (Ref. 125235/FO/2019).

The report identifies relevant planning, noise and vibration guidance, establishes environmental noise and vibration levels and provides mitigation measures to the proposed dwellings in support of a planning application.

With the proposed fabric construction and suitable ventilation provisions, the predicted internal equivalent noise levels due to road and tram traffic are within the recommended Local Authority noise criteria specified in condition 3 above.

In addition, the road and tram traffic noise levels within the proposed amenity areas are likely to be acceptable and between 55 - 57dB $L_{Aeq, 16 \text{ hours}}$.

These levels are therefore considered to be marginally above the recommended amenity level of less than 55dB $L_{Aeq, 16 \text{ hours}}$ as defined in Condition 3. When considering the guidance of BS8233:2014, we would consider the predicted external rear noise levels of 55 to 57 dB $L_{Aeq, 16 \text{ hours}}$ to be acceptable due to the close proximity of the site to public transport links and the communal nature of the amenity space.

From the measured data it can be seen that the measured vibration dose values for the daytime and night-time lie below or within the British Standard 6472 range for a low probability of adverse comment.

As such, vibration is not considered to be of an adverse level at this site and vibration mitigation measures do not need to be introduced.



8. Appendix 1 – 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, $T = t_2 - t_1$, has the same mean-squared sound pressure as a sound that varies with time, and is given by the following equation:

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

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, $L_s = L_{Aeq,Tr}$ – 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, $L_{Ar,Tr}$ – 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).

9. Appendix 2 – Calculation to Worst-Case Rooms

Figure 13: Predictions for internal ambient noise levels to worst-case bedroom facing Palatine Road

Free Field Level at Facade									
Octave Band	63	125	250	500	1000	2000	4000	8000	dBA
Day, $L_{eq}(16\text{ hour})$	73	64	65	64	67	63	54	48	70
Night $L_{eq}(8\text{ hour})$	64	56	58	58	61	57	48	41	64
Night-time $L_{max(10\text{ min})}$	78	71	73	73	77	73	64	59	80
Building Façade Construction									
External Element		63	125	250	500	1000	2000	4000	8000
Wall Vent - Greenwood MA3051 - 54 Dnew	D_{wv}	45	47	46	50	55	65	68	60
	Number of	1							
		0.00001	0.00001	0.00001	0.00000	0.00000	0.00000	0.00000	0.00000
2x100mm block plastered/render both sides 100mm void, 1880 Kg/m ³ + 400 kg/m ³ - 52 Rw		31	38	46	45	55	66	77	70
	Area	12							
		0.00031	0.00006	0.00001	0.00001	0.00000	0.00000	0.00000	0.00000
Double Glazed: 10/12/6.4 - 39 Rw		22	27	29	36	41	42	52	50
	Area	5.2							
		0.00109	0.00035	0.00022	0.00004	0.00001	0.00001	0.00000	0.00000
A3: User Defined - Rear Facade Lower Level Correction +3dB (Corner Room)	R	34	41	49	48	58	69	80	73
	Area	13							
		0.000175167	3.49504E-05	5.53927E-06	6.97353E-06	6.97353E-07	5.53927E-08	4.4E-09	2.20522E-08
With Mechanical Ventilated Room									
Calculations to BS EN 12354									
	63	125	250	500	1000	2000	4000	8000	
Sum	0.00157597	0.000442078	0.000233466	6.27404E-05	1.56885E-05	1.10891E-05	1.10577E-06	1.79405E-06	
10log sum	-28.0245293	-33.54500658	-36.31777032	-42.02452935	-48.04419784	-49.55103192	-59.56333464	-57.46164916	
10log S/A	3.3130354	3.313035402	4.510785337	5.597207868	6.320232147	4.16801226	2.982018337	2.982018337	
correction factor +3	3	3	3	3	3	3	3	3	
Octave Band	63	125	250	500	1000	2000	4000	8000	dBA
Day, $L_{eq}(16\text{ hour})$	51	37	36	31	28	21	0	-3	34
Night $L_{eq}(8\text{ hour})$	42	29	29	25	22	15	-6	-10	27
Night-time $L_{max(10\text{ min})}$	56	44	44	40	38	31	10	8	42
With Wall Ventilators									
Calculations to BS EN 12354									
	63	125	250	500	1000	2000	4000	8000	
Sum	0.00158779	0.000449541	0.000241839	6.60737E-05	1.67671E-05	1.11852E-05	1.1586E-06	2.12739E-06	
10log sum	-27.9920587	-33.47230837	-36.16474394	-41.79971361	-47.75541995	-49.51354408	-59.36064907	-56.72153791	
10log S/A	3.3130354	3.313035402	4.510785337	5.597207868	6.320232147	4.16801226	2.982018337	2.982018337	
correction factor +3	3	3	3	3	3	3	3	3	
Octave Band	63	125	250	500	1000	2000	4000	8000	dBA
Day, $L_{eq}(16\text{ hour})$	51	37	36	31	29	21	1	-3	34
Night $L_{eq}(8\text{ hour})$	42	29	29	25	23	15	-5	-10	27
Night-time $L_{max(10\text{ min})}$	56	44	44	40	39	31	11	8	43

Figure 14: Predictions for internal ambient noise levels to worst-case living rooms facing Palatine Road

Free Field Level at Facade									
Octave Band	63	125	250	500	1000	2000	4000	8000	dBA
Day, $L_{eq}(16\text{ hour})$	73	64	65	64	67	63	54	48	70
Night $L_{eq}(8\text{ hour})$	64	56	58	58	61	57	48	41	64
Night-time $L_{max(10\text{ min})}$	78	71	73	73	77	73	64	59	80
Building Façade Construction									
External Element		63	125	250	500	1000	2000	4000	8000
Wall Vent - Greenwood MA3051 - 54 Dnew	D_{wv}	45	47	46	50	55	65	68	60
	Number of	2							
		0.00003	0.00002	0.00002	0.00001	0.00000	0.00000	0.00000	0.00000
2x100mm block plastered/render both sides 100mm void, 1880 Kg/m ³ + 400 kg/m ³ - 52 Rw		31	38	46	45	55	66	77	70
	Area	9							
		0.00030	0.00006	0.00001	0.00001	0.00000	0.00000	0.00000	0.00000
Double Glazed: 10/12/6.4 - 39 Rw		22	27	29	36	41	42	52	50
	Area	6.0							
		0.00152	0.00048	0.00030	0.00006	0.00002	0.00002	0.00000	0.00000
A3: User Defined - Rear Facade Lower Level Correction +3dB (Corner Room)	R	34	41	49	48	58	69	80	73
	Area	10							
		0.000153487	3.06247E-05	4.85369E-06	6.11043E-06	6.11043E-07	4.85369E-08	3.85542E-09	1.93229E-08
With Mechanical Ventilated Room									
Calculations to BS EN 12354									
	63	125	250	500	1000	2000	4000	8000	
Sum	0.00197054	0.000570606	0.000317591	7.84487E-05	2.09326E-05	1.53461E-05	1.53169E-06	2.46631E-06	
10log sum	-27.0541407	-32.43663964	-34.98131876	-41.05414071	-46.79177361	-48.14000681	-58.14830045	-56.07952189	
10log S/A	2.50381633	2.503816326	3.701566261	4.787988791	5.511013071	3.358793184	2.172799261	2.172799261	
correction factor +3	3	3	3	3	3	3	3	3	
Octave Band	63	125	250	500	1000	2000	4000	8000	dBA
Day, $L_{eq}(16\text{ hour})$	51	37	37	31	29	21	1	-3	34
With Wall Ventilators									
Calculations to BS EN 12354									
	63	125	250	500	1000	2000	4000	8000	
Sum	0.00199904	0.000588587	0.000337767	8.64809E-05	2.35317E-05	1.55778E-05	1.65899E-06	3.26952E-06	
10log sum	-26.9917805	-32.30189109	-34.71383107	-40.63079997	-46.28346327	-48.07494019	-57.8015691	-54.85515512	
10log S/A	2.50381633	2.503816326	3.701566261	4.787988791	5.511013071	3.358793184	2.172799261	2.172799261	
correction factor +3	3	3	3	3	3	3	3	3	
Octave Band	63	125	250	500	1000	2000	4000	8000	dBA
Day, $L_{eq}(16\text{ hour})$	52	37	37	31	29	21	1	-2	34

	Site Name:								
	Date:								
	Room Type/Location		Bedroom						
	Criteria		35 dB LAeq(16hr), 30 dB LAeq(8hr), 45 dB LAFmax						
Reverberation Time Calculation									
Room Dimensions			Room Volume		0.16*Volume				
Room Height (m)			21.6		3.456				
Length (m)									
Width (m)									
Absorption Coefficient	Hz	Hz	Hz	Hz	Hz	Hz	Hz	Hz	m²
per octave band	63	125	250	500	1000	2000	4000	8000	Area
Standard Carpet Tiles	0.05	0.05	0.05	0.10	0.20	0.45	0.65	0.65	9.0
	0.5	0.5	0.5	0.9	1.8	4.1	5.9	5.9	-
Suspended plasterboard ceiling	0.20	0.20	0.15	0.10	0.05	0.05	0.05	0.05	9.0
	1.8	1.8	1.4	0.9	0.5	0.5	0.5	0.5	-
PB walls	0.20	0.20	0.15	0.10	0.05	0.05	0.05	0.05	24.8
	5.0	5.0	3.7	2.5	1.2	1.2	1.2	1.2	-
Window:Glazing (6mm)	0.10	0.10	0.06	0.04	0.03	0.02	0.02	0.02	2.0
	0.2	0.2	0.1	0.1	0.1	0.0	0.0	0.0	-
Doors:Solid Timber	0.14	0.14	0.10	0.06	0.08	0.10	0.10	0.10	2.0
	0.3	0.3	0.2	0.1	0.2	0.2	0.2	0.2	-
Total sound absorption (sq.m)	7.7	7.7	5.8	4.5	3.7	6.0	7.8	7.8	46.8
Frequency	63	125	250	500	1000	2000	4000	8000	T _{ref}
Reverberation Time	0.45	0.45	0.59	0.77	0.93	0.58	0.44	0.44	0.8
Free Field Level at Façade									
Octave Band	63	125	250	500	1000	2000	4000	8000	dBA
Day, L _{eq} (16 hour)	60	52	48	51	58	49	38	33	59
Night L _{eq} (8hour)	57	46	43	48	53	44	32	27	54
Night-time L _{max} (dayt)	64	54	52	57	64	54	43	36	65
Building Façade Construction									
External Element	63	125	250	500	1000	2000	4000	8000	
Standard Trickle - XS13 4400 EA+XC13 412 Canopy - 32 Dnew	D _{oe}	30	35	35.3	36.4	34	29.3	32.7	33.5
	Number of	1							
2x100mm block plastered/render both sides 100mm void, 1880 Kg/m³ + 400 kg/m³ - 52 Rw		0.00062	0.00020	0.00018	0.00014	0.00025	0.00073	0.00033	0.00028
	Area	31	38	46	45	55	66	77	70
		5							
Double Glazed: 4/12/4 - 31 Rw		0.00025	0.00005	0.00001	0.00001	0.00000	0.00000	0.00000	0.00000
	Area	20	24	20	25	35	38	35	36
		2							
Pitched Roof - 56 Rw		0.00123	0.00049	0.00123	0.00039	0.00004	0.00002	0.00004	0.00003
	Area	25	39	47	53	58	56	60	55
		9							
		0.001756821	6.99403E-05	1.10848E-05	2.78437E-06	8.80496E-07	1.39549E-06	5.55556E-07	1.75682E-06
Calculations to BS EN 12354									
	63	125	250	500	1000	2000	4000	8000	
Sum	0.00386364	0.000807506	0.001435889	0.000544751	0.000286681	0.000746288	0.000371104	0.00030853	
10log sum	-24.1300308	-30.92854202	-28.42879148	-32.63801862	-35.42600816	-31.27093479	-34.3050491	-35.10701931	
10log S/A	3.23588675	3.235886747	4.431021674	5.582370005	6.40411049	4.328138306	3.185354176	3.185354176	
correction factor +3	3	3	3	3	3	3	3	3	
Octave Band	63	125	250	500	1000	2000	4000	8000	dBA
Day, L _{eq} (16 hour)	42	27	27	27	32	25	9	4	34
Night L _{eq} (8hour)	39	22	22	24	27	20	3	-2	29
Night-time L									



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