

Slate Wharf Castlefield Manchester

Noise Impact Assessment Report

29795/NIA1

16 December 2022

For:

Prestbury Estates
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Document Control

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2	16/12/2022	Updated to include additional noise survey results			
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1	18/11/2022	Updated to reflect external building services noise from 'The Wharf'	George Grenfell Senior Consultant MSc, BSc(Hons), AMIOA	Tom Bonnert Senior Associate BEng(Hons), MIOA	
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Noise Impact Assessment Report 29795/NIA1

Contents	Page
1.0 Introduction	1
2.0 Acoustic Terminology	1
3.0 Site Description	1
4.0 Proposed Development	2
5.0 Planning Policy, Standards & Guidance	3
6.0 Baseline Noise Surveys	11
7.0 Baseline Vibration Survey	15
8.0 Incident Noise Levels	17
9.0 Achieving Internal Noise Levels	17
10.0 Outdoor Living Spaces	22
11.0 Vibration Assessment	23
12.0 Building Services Acoustics	25
13.0 Conclusions	30

Attachments

Appendix A – Acoustic Terminology

Appendix B – National Planning Policies

Appendix C – MCC Liaison

Appendix D – Time History Plots – Noise

Appendix E – Vibration Survey Results

Appendix F – AVO Assessment Results



1.0 Introduction

A residential scheme is proposed in Castlefield, Manchester. We understand that the scheme has been previously approved, however, several layout changes have been made meaning that an additional planning application is to be submitted. As part of this new application Manchester City Council has suggested that additional criteria regarding noise, not previously considered, is assessed.

Hann Tucker have been appointed to review the revised design and overheating strategy and confirm compliance with relevant criteria based on the noise levels previously measured on site.

The site itself comprises the erection of a 4-storey blocks providing 24no new homes, as well as resident amenities.

The site is subject to rail noise from the adjacent train/tram tracks, as well as building services and entertainment noise associated with The Wharf Pub, which holds intermittent music events.

Baseline noise conditions have been established by means of a detailed noise survey, presented herein. The findings have subsequently been used to assess the suitability of the site for residential use. Measures required to mitigate noise impacts for the proposed development (when operational) have been discussed in context with relevant national & local planning policies, design standards and good practice guides.

2.0 Acoustic Terminology

For an explanation of the acoustic terminology used in this report please refer to Appendix A enclosed.

3.0 Site Description

3.1 Location

The proposed development is located on land east of the A635 and falls under the jurisdiction of Manchester City Council (MCC). The site is adjacent to 'The Wharf' bar and south of a dual railway/tram line. The site is bounded by existing and established residential dwellings to the north and west and Bridgewater Canal to the east.



See below figure illustrating site location and surrounding buildings.



Location Plan (Google Maps 2021)

4.0 Proposed Development

The development is to comprise 24no. bespoke apartments across 4no. floors, with the third floor consisting of duplex apartments, which have a small private terrace and windows overlooking the canal. Residential amenities are located on the ground floor.



Proposed Eastern Elevation (c/o Ollier Smurthwaite Architects 2021)



5.0 Planning Policy, Standards & Guidance

5.1 National Planning Policies

In order to provide a suitable assessment a number of national planning policies have been considered, including:

- The National Planning Policy Framework (NPPF), 2021
- The Noise Policy Statement for England (NPSE), 2010
- Planning Practice Guidance – Noise (PPGN), 2019

The above documents highlight the importance of considering the potential noise effects on any new residential development and provide a qualitative approach to assessment. However, each of the above does not provide any quantitative guidance. As such, all quantitative guidance used to form a noise impact assessment is taken from various other standards and guidance as detailed in the following sections.

A detailed summary of each of the above National Planning Policies is provided in Appendix B for reference.

5.2 Standards & Guides

5.2.1 ProPG: Planning & Noise

ProPG: Planning & Noise 'Professional Practice Guidance on Planning & Noise' was issued in May 2017 with the primary goal of assisting the delivery of sustainable residential development by promoting good health and well-being through the effective management of noise. It seeks to do that through encouraging a good acoustic design process in and around proposed new residential development having regard to national policy on planning and noise.

It is applicable to noise from existing transport sources (noting that good professional practice should have regard to any reasonably foreseeable changes in existing and/or new sources of noise). The recommended approach is also considered suitable where some industrial or commercial noise contributes to the acoustic environment provided that is "not dominant".

ProPG advocates a systematic, proportionate, risk based, 2-stage, approach. The approach encourages early consideration of noise issues, facilitates straightforward accelerated decision making for lower risk sites, and assists proper consideration of noise issues where the acoustic environment is challenging.



The two sequential stages of the overall approach are:

- **Stage 1** – an initial noise risk assessment of the proposed development site; and
- **Stage 2** – a systematic consideration of four key elements.
 - Element 1 – demonstrating a “Good Acoustic Design Process”;
 - Element 2 – observing internal “Noise Level Guidelines”;
 - Element 3 – undertaking an “External Amenity Area Noise Assessment”; and
 - Element 4 – consideration of “Other Relevant Issues”.

The ProPG considers suitable guidance on internal noise levels found in BS 8233 (see below) with the addition of an $L_{Amax,f}$ requirement for bedrooms at night, as below.

“Regular individual noise events (for example, scheduled aircraft or passing trains) can cause sleep disturbance. A guideline value may be set in terms of SEL or $L_{Amax,F}$, depending on the character and number of events per night. Sporadic noise events could require separate values. In most circumstances in noise-sensitive rooms at night (e.g. bedrooms) good acoustic design can be used so that individual noise events do not normally exceed 45 dB $L_{Amax,F}$ more than 10 times a night. However, where it is not reasonably practicable to achieve this guideline then the judgement of acceptability will depend not only on the maximum noise levels but also on factors such as the source, number, distribution, predictability and regularity of noise events.”

5.2.2 BS 8233:2014

British Standard 8233: 2014 “Sound insulation and noise reduction for buildings” recommends design criteria for internal ambient noise levels for dwellings providing a reasonable or good level of protection from external noise. It states that it is desirable that ambient noise levels do not exceed the following guidelines:

Activity	Location	Desirable Internal Ambient Noise Levels	
		07:00 – 23:00	23:00 – 07:00
Resting	Living Rooms	35 dB $L_{Aeq,16hour}$	-
Dining	Dining Room/Area	40 dB $L_{Aeq,16hour}$	-
Sleeping (Daytime Resting)	Bedroom	35 dB $L_{Aeq,16hour}$	30 dB $L_{Aeq,8hour}$

Note 1: the above provides recommended levels for overall noise in the design of a building. However, ground borne noise is assessed separately and is not included as part of these targets, as human response to ground borne noise varies with many factors such as level, character, timing, occupant expectation and sensitivity

Note 2: If relying on closed windows to meet the guide values, there needs to be an appropriate alternative ventilation that does not compromise the façade insulation or the resulting noise level.

Note 3: Where development is considered necessary or desirable, despite external noise levels above WHO guidelines, the internal target levels may be relaxed by up to 5 dB and reasonable internal conditions still achieved.

Note 4: The levels detailed in the table above are based on the existing guidelines issued by the WHO and assume normal diurnal fluctuations in external noise and are not appropriate in all locations. Where atypical external noise levels are measured (ie high levels of traffic during certain times of the night) an appropriate alternative assessment period (eg 1 hour) and an assessment of individual night time events in terms of SEL or $L_{Amax,F}$ may be more suitable.



For outdoor living spaces, BS 8233 states For traditional external areas that are used for amenity space, such as gardens and patios, it is desirable that the external noise level does not exceed 50 dB $L_{Aeq,T}$, with an upper guideline value of 55 dB $L_{Aeq,T}$ which would be acceptable in noisier environments. However, it is also recognized that these guideline values are not achievable in all circumstances where development might be desirable and 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.

Other locations, such as balconies, roof gardens and terraces, are also important in residential buildings where normal external amenity space might be limited or not available, i.e. in flats, apartment blocks, etc. In these locations, specification of noise limits is not necessarily appropriate. Small balconies may be included for uses such as drying washing or growing pot plants, and noise limits should not be necessary for these uses.

5.2.3 World Health Organisation (WHO)

The current Environmental Noise Guidelines 2018 for the European Region (ENG) supersede the Guidelines for Community Noise from 1999 (CNG). Nevertheless, the ENG recommends that all CNG indoor guideline values and any values not covered by the current guidelines (such as industrial noise and shopping areas) remain valid. A summary of the guidance from the ENG and CNG is shown in the table below.

Noise Source	CNG guideline indoors all sources	ENG guideline outdoors noise from specific source only
Road traffic	35 dB $L_{Aeq, 16h}$	53 dB L_{den}
	30 dB $L_{Aeq, 8h}$	45 dB L_{night}
Railway	35 dB $L_{Aeq, 16h}$	54 dB L_{den}
	30 dB $L_{Aeq, 8h}$	44 dB L_{night}
Aircraft	35 dB $L_{Aeq, 16h}$	45 dB L_{den}
	30 dB $L_{Aeq, 8h}$	40 dB L_{night}

With regard to single-event noise indicators, Section 2.2.2 of the WHO Environmental Noise Guidelines 2018 state:

“In many situations, average noise levels like the L_{den} or L_{night} indicators may not be the best to explain a particular noise effect. Single-event noise indicators – such as the maximum sound pressure level (L_{Amax}) and its frequency distribution – are warranted in specific situations, such as in the context of night-time railway or aircraft noise events that can clearly elicit awakenings and other physiological reactions that are mostly determined by $L_{A,max}$.”



Nevertheless, the assessment of the relationship between different types of single-event noise indicators and long-term health outcomes at the population level remains tentative. The guidelines therefore make no recommendations for single-event noise indicators.”

5.2.4 Acoustics, Ventilation & Overheating Residential Design Guide

The Acoustics, Ventilation and Overheating Residential Design Guide (Version 1.1) was issued in January 2020 by the Association of Noise Consultants (ANC) and the Institute of Acoustics (IOA). This document provides guidance on the interdependence between acoustics, ventilation and overheating.

The AVO guide recommends a two-level approach to assess the potential impact of noise ingress through windows that have been opened to mitigate overheating and also noise from any mechanical services used to provide comfort cooling. The level 1 assessment relates to incident environmental noise levels across a proposed site, it is used to define “risk categories” for each building façade based on these levels. These categories are set out below:

Risk category for Level 1 assessment ^[Note 5]	Potential Effect without Mitigation	Recommendation for Level 2 assessment
$L_{Aeq,T}$ ^[Note 3] during 07:00 - 23:00 65 dB 60 dB 55 dB 50 dB High Medium Low Negligible $L_{Aeq,8hr}$ during 23:00 - 07:00 55 dB 50 dB 45 dB	↑ Increasing risk of adverse effect Use of opening windows as primary means of mitigating overheating is not likely to result in adverse effect	Recommended Optional Not required



Where a Level 2 assessment is recommended the AVO guide states that the Significant Observed Adverse Effect Level (SOAEL), which is the noise level above which significant adverse effects on health and quality of life occur, is dependent on how frequently and for what duration the overheating condition occurs (i.e. how often the windows need to be open to mitigate overheating). However, the document refers to the overheating condition being “rare” or “most of the time” rather than providing specific durations. Therefore, this is open to interpretation.

At planning stage, the level of information required to undertake a level 2 assessment in-line with the AVO guide is often not available and a level 1 assessment, which establishes the risk categories of each proposed façade would be most suitable.

5.2.5 BS 4142:2014

BS 4142: 2014 describes methods for rating and assessing the effects of outdoor sound levels, of an industrial and/or a commercial nature, *“on people who might be inside or outside a dwelling or premises used for residential purposes upon which sound is incident”*.

The impact of a specific sound is indicated by subtracting the existing background noise level from the rating level (i.e. noise level from the proposed items of plant/machinery/etc plus any acoustic feature corrections). The standard states that:

- “a difference of around +10dB or more is likely to be an indication of a significant adverse impact”;
- “a difference of around +5dB is of marginal significance is likely to be an indication of an adverse impact”;
- “where the rating level does not exceed the background sound level, this is an indication of the specific sound source having a low impact”.

The noise from the new development is expressed in terms of a rating level and given as a $L_{Aeq, T}$ noise level. The existing background noise level is expressed in terms of a $L_{A90, T}$ noise level. T is the assessment time interval, which is 1-hour for operations during daytime hours (07:00 to 23:00) and 15-minutes for operations during night-time hours (23:00 to 07:00).

BS 4142:2014 states that if a noise source contains an ‘acoustic feature’, such as tonality, intermittency or impulsiveness, an appropriate penalty should be applied.



5.3 Local Planning Guidance

5.3.1 Planning Conditions

The planning conditions that have been set for the scheme are as follows:

13) Before the development commences a scheme for acoustically insulating the residential accommodation against noise from Chester Road, nearby transport networks and any other actual or potential sources of noise that require consideration on or near the site, including any local commercial/industrial premises, shall be submitted to and approved in writing by the City Council as local planning authority. The approved noise insulation scheme shall be completed before any of the dwelling units are first occupied. Noise survey data shall include measurements taken during a rush-hour period and night-time to determine the appropriate sound insulation measures necessary. The following noise criteria shall 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) Designed to achieve the lowest practicable levels.*

b. The approved noise insulation scheme shall be completed and a post-completion verification report (including validation that the work undertaken throughout the development conforms to the recommendations and requirements of the acoustic report approved under part a. above and including the results of post-completion testing to confirm that the internal noise criterion have been met) shall be submitted to and approved in writing by the City Council as local planning authority before first occupation of the development. Any instances of non-conformity with the approved acoustic report shall be detailed within the post-completion report along with any measures required to ensure compliance with internal noise criteria. Those measures shall be implemented in full before any of the dwellings are first occupied.

Reason - To secure a reduction in noise from the main roads and surrounding road networks and any other potential sources of noise, in order to protect future residents from noise nuisance, pursuant to policies SP1, H1 and DM1 of the Core Strategy.



14) Before first occupation of the development the building, together with any externally mounted ancillary equipment, shall be acoustically insulated in accordance with a scheme submitted to and approved in writing by the City Council as local planning authority in order to secure a reduction in the level of noise emanating from the equipment.

Externally mounted ancillary plant, equipment and servicing shall be selected and/or acoustically treated in accordance with a scheme designed so as to achieve a rating level of 5dB (L_{Aeq}) below the typical background (L_{A90}) level at the nearest noise sensitive location. Reason - To safeguard the amenities of the occupiers of nearby residential accommodation, pursuant to policies SP1 and DM1 of the Core Strategy

5.3.2 Summary of Local Authority Criteria

Since planning permission was previously granted, Manchester City Council (MCC) has produced an updated Planning & Noise Technical Guidance in June 2022. The document aims to provide help and advice in relation to noise in a planning context to encourage good acoustic design. It outlines what is expected in relation to current guidance and policy with the aspiration that new developments achieve the highest possible standards without compromising the health and wellbeing of people that live and work within the City of Manchester.

The following sections summarise the relevant section of the above document that relate to this site.

Residential Developments

Section 7.3.1.1 states that The Council has adopted the following noise limits for residential properties:

- “Bedrooms (night time - 23.00 - 07.00) 30 dB L_{Aeq} (individual noise events should not normally exceed 45 dB $L_{Amax,F}$ by more than 10 times)
- Living Rooms (daytime - 07.00 - 23.00) 35 dB L_{Aeq}
- Gardens and terraces (daytime) 55 dB L_{Aeq} ”

Entertainment Venues

Section 3.7.1.2 discusses the potential impact of introducing a new music venue or introducing new residential near a premises that plays music. The document states that “when considering the potential impact of a proposal for an entertainment venue, consultants should consider the overall noise level (L_{Aeq}) and the 63 Hz and 125 Hz octave band noise levels (L_{eq}).”



With respect to the above, the MCC guidance on controlling music noise is to ensure *“music noise levels in the 63Hz and 125Hz octave centre frequency bands (L_{eq}) should be controlled so as not to exceed (in habitable rooms) 47dB and 41dB ($L_{eq,5min}$), respectively”*

Noise and vibration from fixed plant / equipment

Section 3.7.1.5 states that:

“Externally mounted ancillary plant, equipment and servicing shall be selected and/or acoustically treated in accordance with a scheme designed so as to achieve a rating level of 5dB (L_{Aeq}) below the typical background (L_{A90}) level at the nearest noise sensitive location”.

Ventilation & Overheating

Section 5.3.1.7 relates to ventilation and overheating and states that *“an overheating assessment might not always be undertaken for a project and without this information it is difficult to identify noise impacts that may occur during the overheating condition. It is recommended that either where a condition has been imposed to control internal noise levels for residential development or where overheating may be an issue, the guidance provided in the AVO Guide is followed.”*

Vibration

Section 5.3.1.8 relates to vibration and states that *“a vibration assessment (which is usually based on BS 6472: 2008) will be required where railway/tram lines are within 20m of a proposed development site. It is important that vibration issues are considered, and measurement data supplied in the report, together with mitigation proposals if vibration without these works has been identified as a potential problem.”*

5.3.3 Consultation

The Design Team on the project has liaised with the MCC environmental health team during the development of the previous and current schemes. This email liaison has been provided in Appendix C.



6.0 Baseline Noise Surveys

6.1 Previous Noise Survey (Royal Haskoning)

A previous noise survey was carried out at the site by Royal Haskoning in support of the planning application for the development. The methodology and results are presented in their report I&BPB5246R001F01.

In the interest of brevity, we have summarised the key findings of the Royal Haskoning baseline noise survey in the following sections.

6.1.1 Predicted Incident Environmental Noise Levels

It is noted that Royal Haskoning undertook acoustic modelling to predict the environmental noise levels incident upon the various facades of the previously consented scheme. These incident noise levels are presented in the following table, and where necessary these have been corrected from façade to free-field.

Elevation	Predicted Incident Free-field Environmental Noise Level (dB)		
	Daytime 07:00 – 23:00 $L_{Aeq,16hrs}$	Night-time 23:00 to 07:00 $L_{Aeq,8hrs}$	Night-time 23:00 to 07:00 $L_{Amax,15 mins}$
East	64	61	72
West	61	58	72
South	56	53	72

6.1.2 Predicted Incident Entertainment Noise Levels

To calculate the incident noise levels at the proposed development, Royal Haskoning have modelled The Wharf Pub as having an internal noise level of 94dBA during a live music event and the encompassing façade as 100mm concrete with a weighted sound reduction index of R_w 48. The external beer garden was also modelled as an area source with a sound power level of 66 L_w per m^2 , further detail can be found in their report (ref: 113617_FO_2016—558389). The following incident entertainment noise levels as predicted by Royal Haskoning shall be adopted in our BS 8233 noise intrusion assessment.

The predicted incident noise levels from entertainment noise sources are as shown in the table below. These values have been corrected from façade to free field.



Facade	Predicted Incident Free-field Entertainment Noise Level (dB)	
	Daytime 07:00 – 23:00 $L_{Aeq,T}$	Night-time 23:00 to 07:00 $L_{Aeq,T}$
East	52	41
West	41	31
South	55	43

To assess the impact of entertainment noise in accordance with the low frequency, Royal Haskoning obtained octave band measurements at the closest proposed facade location over the course of a live music event at 'The Wharf'. The results are presented in table below as free-field sound pressure levels:

Frequency band	Measured L_{eq} (dB)
63Hz	71
125Hz	61

6.2 Hann Tucker Noise Survey

6.2.1 Procedure

Unattended noise level measurements were undertaken from 15:30 hours on Friday 12 November 2021 to 07:00 hours on Tuesday 16 November 2021 to establish typical noise levels over weekday and weekend periods.

All measurements were taken of the A-weighted (dBA) L_{10} , L_{90} , L_{eq} and L_{Fmax} sound pressure levels over discrete 5- and 15-minute periods (15-minute periods reported herein). Measurements were undertaken in general accordance with BS 7445-1:2003 *Description and Measurement of Environmental Noise*.

Since the completion of the above survey, the building structure was in place at the time of writing to this revision. Following a maintenance service of the kitchen extract fan serving The Wharf, additional attended measurements have been undertaken on 29 November 2022 to establish incident building services noise from The Wharf extract fan, at level 3 (worst case location) of the south façade.

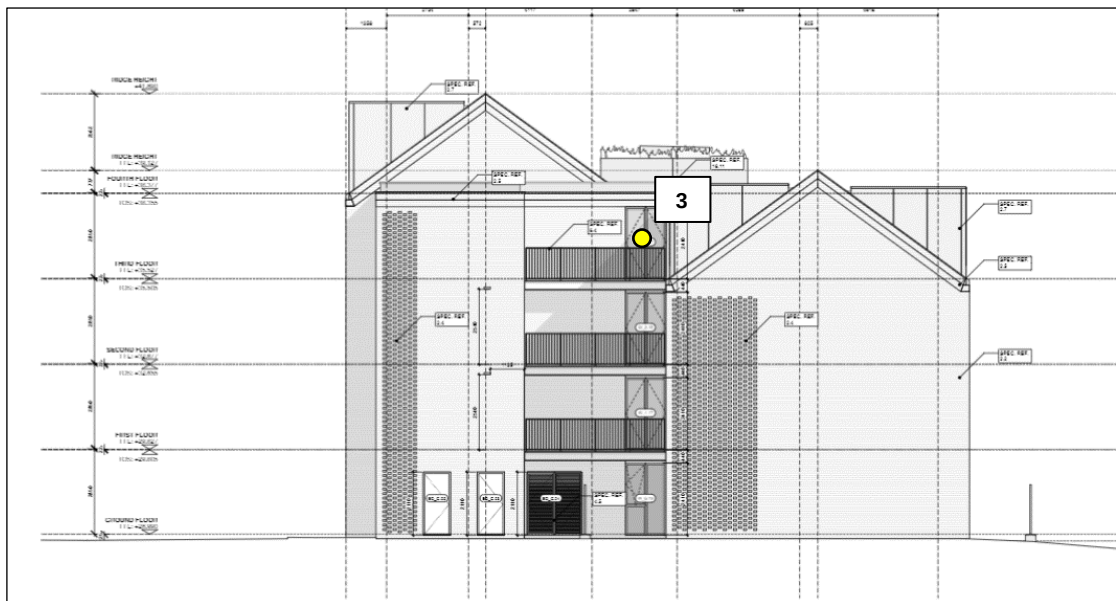
6.2.2 Measurement Positions

The measurement positions were as described below and illustrated overleaf.

Position	Type	Description
1	Unattended	Unattended free-field measurement overlooking Slate Wharf at the south of the site, microphone approx. 2.5 metres above ground.
2	Unattended	Unattended free-field measurement at overlooking Slate Wharf at the north of the site, microphone approx. 1.5 metres above ground.
3	Attended	Attended free field measurement approximately 12m from 'The Wharf' Louvre, stood on level 3 balcony area of the development's south facade. Microphone was handheld, approximately 10m above ground level



Site Plan (© maps.google.co.uk)



South Elevation c/o Ollier Smurthwaite Architects 2021



6.2.3 Weather Conditions

For the unattended survey, local weather reports indicated no notable periods of prolonged and/or heavy rainfall and wind speeds less than 5m/s. During our time on site, skies were largely clear with patchy cloud cover, wind conditions were calm and road surfaces were largely dry.

During the attended visit on 29 November 2022, weather conditions were calm and dry, and the sky was overcast. The wind speed was less than 5m/s during the measurement period and road surfaces were dry.

Weather conditions were deemed suitable for obtaining representative noise readings.

6.2.4 Instrumentation

The instrumentation used during the survey is presented in the table below.

Position	Description	Manufacturer	Type	Serial Number	Last Calibration
1	Type 1 Data Logging Sound Level Meter	Larson Davis	824	3824	15/07/2021
2	Type 1 Data Logging Sound Level Meter	Larson Davis	LxT	4086	15/07/2021
3	Type 1 Data Logging Sound Level Meter	B&K	2250	3025397	10/06/2022
3	Type 1 Calibrator	B&K	4231	2271905	30/09/2022
1 & 2	Type 1 Calibrator	Larson Davis	CAL200	3083	06/05/2021

Each unattended sound level meter was housed in a weatherproof case with the microphone connected via an extension cable. All microphones were fitted with a windshield.

Each sound level meter was calibrated prior to and on completion of the survey. No significant deviations occurred (not more than 0.3 dB).

6.2.5 Results

The results of the automated survey have been plotted on Time History Graphs 28795/TH1 - TH2 enclosed in Appendix D. These graphs present the 15-minute A-weighted (dBA) L_{90} , L_{eq} and L_{max} levels at each position throughout the duration of the survey.

A summary of the results from the unattended and attended noise surveys, as used to inform subsequent assessments against current guidelines, is presented in the tables below. L_{A90} values represent the 'typical lowest' 15-minute level (observed) and $L_{A_{fmax}}$ values are taken as the 'mean 10th highest' 5-minute value.



Unattended Measurements						
Position	Daytime(07:00 – 23:00 hrs)		Night-time (23:00 – 07:00 hrs)			
	$L_{Aeq,16hr}$	L_{A90}	$L_{Aeq,8hr}$	L_{A90}	Ventilation L_{Amax}	Overheating L_{Amax}
1	62	49	54	44	78	78
2	61	50	53	49	69	69

¹External L_{AFmax} noise level not normally exceeded more than 10 times a night. This is considered to be the ventilation design case.

²Not normally exceeded absolute night-time maximum events should be calculated in-line with the paper *Assessing L_{max} for residential developments: the AVO Guide Approach*. This is considered to be the overheating design case when assessing opening windows as a means of overheating control.

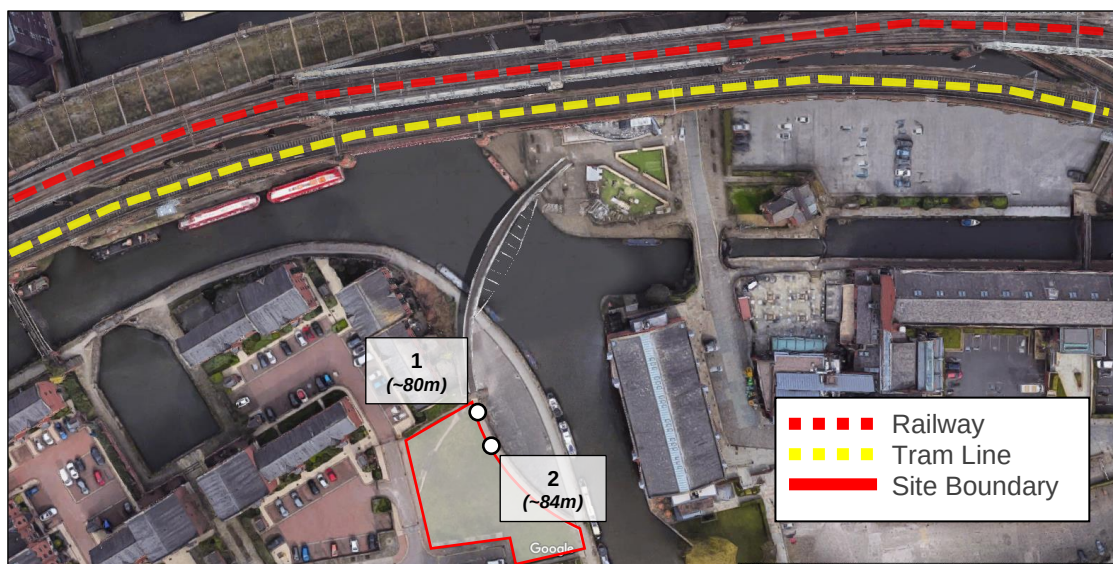
Attended Measurement		
Position	$L_{Aeq,1min}$	$L_{A90,1min}$
3	65	64
	65	65
	65	64

7.0 Baseline Vibration Survey

7.1.1 Procedure

A fully manned vibration survey was undertaken on Friday 12 November between approximately 15:00 and 16:30 hours. Vibration measurements were undertaken at two (2No) positions on-site in order to establish the prevailing vibration levels during tram and train movements, as illustrated below.

Measurements were recorded on concrete hard-stand and were undertaken in general accordance with “*Measurement and Assessment of Groundborne Noise and Vibration*”, by The Association of Noise Consultants.



Site Plan showing measurement positions, distances are to closest track (© maps.google.co.uk)



7.1.2 Instrumentation

The detailed manned measurements were recorded and analysed using the following instrumentation:

- 2No. Dytran Accelerometers
- 01dB – dB4 Hardware Interface
- 01dB – dBTrig V4.704 vibration Acquisition Software
- 01dB – dBTrait V4.704 Vibration Analysis Software
- Microsoft Windows Based Laptop Computer

The 01dB hardware and software connects to two accelerometers via a USB multi channel unit. The system can record data in 'real-time' to a computer allowing simultaneous analysis in both the time and frequency domains.

All equipment was calibrated prior to and upon completion of the measurements. No significant deviations in response occurred.

7.1.3 Results

Typical measured vibration levels for several tram and train pass-bys recorded at each position are presented on Graphs 28795/G1-G3 enclosed in Appendix E.

7.1.4 Discussion

The tramlines and train lines the north-west edge of the site (approximately 80 metres between closest site edge to closest platform-end) and, along this section, trams and trains are travelling at relatively low speeds and are either accelerating from or decelerating into Deansgate/Castlefield tram stop and train station to the east (approximately 350 metres between closest site edge to closest platform-end). The tram and trainlines lines are on a raised viaduct which passes over Castle Street and Bridgewater Canal north of the site. There are numerous track joints along the section of tram and train tracks which were audible but did not appear to have any adverse impacts on vibration measurements.

Trams were typically two-carriage and measurements were taken with a variety of loads (tram occupancy) from sparsely occupied to almost fully occupied. Trains were of varied in carriage length and of type, diesel, electric and freight.

Note: our assessment does not (and should not) account for the possibility of increased vibration caused by poorly maintained tracks or degraded/uneven joints. It would be the responsibility of TFGM to maintain.



8.0 Incident Noise Levels

The incident noise levels utilised to inform our assessment are based on the results of both surveys where applicable and are summarised in the table below.

Dwelling	Daytime $L_{Aeq,16h}$	Night-time $L_{Aeq,8h}$	Night-time $L_{A_{fmax}}$
South Façade	65 dB ⁽¹⁾	53 dB	69
East Façade	59 dB	53 dB	69
West Façade	59 dB	53 dB	78
North Façade	59 dB	54 dB	69

(1) Note: The south façade daytime noise level is elevated due to the extract fan which is currently operating at the adjacent Pub (The Wharf), during daytime periods.

The incident noise levels from the entertainment noise sources are summarised in the table below. These are based on the noise levels measured by Royal Haskoning on the previous noise survey.

Dwelling	Daytime L_{Aeq}	Night-time L_{Aeq}
Worst Case External Incident Entertainment Noise Level	55 dB	43 dB

To assess the impact of entertainment noise in accordance with the low frequency criteria specified in Section 5.3.2, incident octave band measurements at the closest proposed facade location over the course of a live music event at 'The Wharf' have been presented in table below as free-field sound pressure levels:

Frequency band	Measured L_{eq} (dB)
63Hz	71
125Hz	61

9.0 Achieving Internal Noise Levels

9.1 Proposed External Walls

In relation to the external wall build up we understand that across the whole development several different construction types are proposed. However, acoustically, the façade can be split up into façade type groups as the constructions are broadly similar. These façade types are as described below:



Façade Type	Nominal Specification
Type A_1, A_2, A_3	102.5mm Facing Brick - Cavity (min 50mm) 80mm Rockwool Rainscreen Duo slab insulation - Breather Membrane 12.5mm Siniat Weather Defence Board 100mm Rockwool RWA45 Insulation between SFS supports - VCL 2x12.5mm Gyproc Soundbloc 3mm Skim Finish, Painted
Type A_4	140mm deep Ideal Combi Glazing unit with opaque treatment to glass. - Cavity to suit depth of adjacent wall type A_3. 80mm Rockwool Rainscreen Duo Slab Insulation, Tyvex FireCurb breather Membrane on 12.5mm Siniat Weather Defence Board - SFS Walling as Detailed in Types A1-3
Type B_1, B_2, B_3	102.5mm Facing Brick - Cavity 50mm 200mm Rockwool high performance partial fill insulation - Breather Membrane 200mm Concrete - SE Details
Type C_1	- Ash & Lacy VariAl-H aluminium cladding in "Timeless Rust" finish - refabricated panels to be fixed in front of thermal wall element with minimum 38mm ventilated cavity 80mm Rockwool Rainscreen Duo Slab Insulation - Tyvex FireCurb breather Membrane 12.5mm Siniat Weather Defence Board, - SFS Walling - see Type A

We have calculated that the acoustic performance of the external walls across the development should be no less than the values presented in the table below for each specific facade type:

Façade Type	Minimum Sound Reduction Index, R (dB) at Octave Band Centre Frequency (Hz)						R _w + C _{tr} (dB)
	125	250	500	1000	2000	4000	
Type A_1, A_2, A_3	33	42	45	50	50	55	41
Type B_1, B_2, B_3	37	40	45	50	55	55	43
Type C_1	27	40	46	52	51	50	41

9.2 Proposed Roof

In relation to the roof build up we understand that across the whole development several different constructions build ups are proposed. However, acoustically, the roof can be split up into 3No. types. In these locations the roof build-up is understood to be as follows:



Façade Type (As per Specification)	Nominal Specification
3.1 Pitched Slate Roofs*	- Kentdale Blue/Grey Spanish slate fixed to 25mm thk. treated SW battens on counter battens. - Kingspan Nilvent breather membrane 70mm Kingspan Kooltherm K7 Rigid Insulation fixed over 195mm timber joists to S.E.'s design. 70mm Kingspan Kooltherm K7 Rigid Insulation between rafters 2x15mm SoundBloc Plasterboard on timber studs with resilient rail.
3.2 Flat Roof Sections Including Dormers	- Triflex liquid applied membrane system to subcontractor design, installed over 150mm Kingspan TR27 insulation bonded to screed with water-based inhibitor to 1:40 fall. - Concrete deck to S.E.'s design (BS EN13670 plain finish) 150mm service zone - British Gypsum Casoline MF Ceiling construction (consisting of Primary Support Channel, Ceiling Section Channel, 12.5mm Plasterboard w/ 2.5mm plaster skim).
3.3 Flat Roof Terraces to Third and Fourth Floor	20mm porcelain tiles on pedestals to sit level above Specification Item 3.2. - Corten planters on raised feet to edge of fourth floor roof terraces, as per Specification item 16.11. 1100mm high structural, frameless glass balustrades to third floor roof - terraces, fixed into steel channel at base.

Based on the above build-ups, we have calculated that the acoustic performance of the main roofing across the development which should be no less than the values presented in the table below.

Façade Type	Minimum Sound Reduction Index, R (dB) at Octave Band Centre Frequency (Hz)							R _w + C _{tr} (dB)
	63	125	250	500	1000	2000	4000	
3.1	19	37	48	54	57	56	61	51
3.2 / 3.3	41	44	51	60	65	70	76	57

9.3 Ventilation Measures

We understand that the building will be ventilated via MVHR units. As such, no façade ventilators are proposed.

9.4 Minimum Glazing Specifications

With regards to the potential music and environmental noise incident on the development and the proposed external wall and roof constructions, calculations have been carried out to establish the minimum glazing specifications at each octave band with a view to establishing the MCC criteria set out in Section 5.3.2. These are set out below and should be capable of controlling both music and environmental noise.



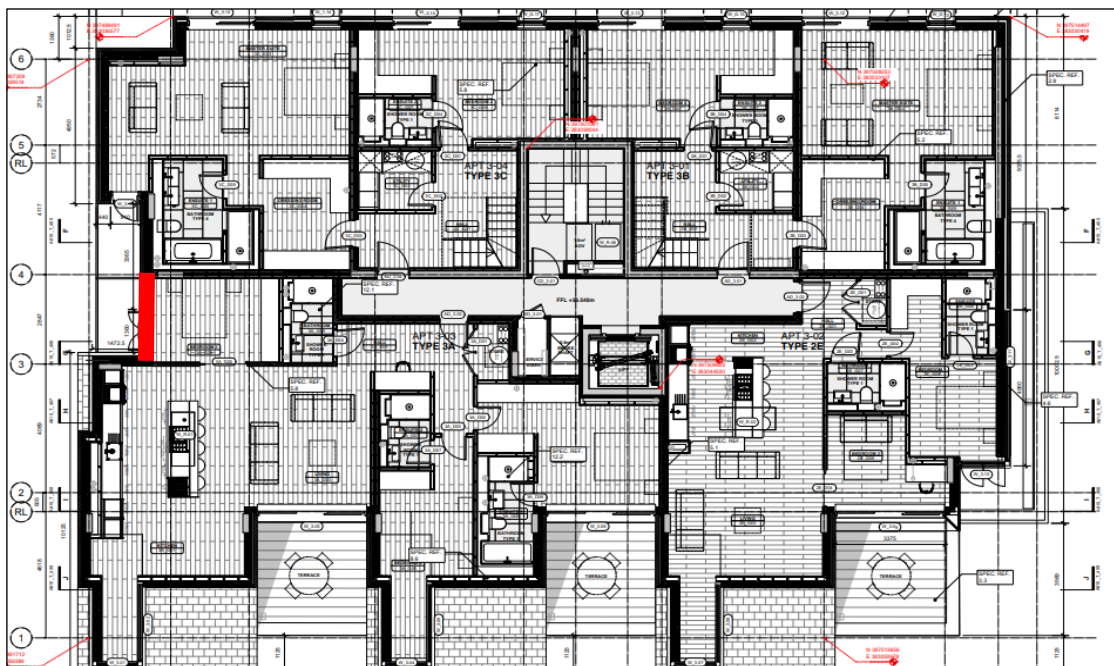
Glazing Location	Minimum Sound Reduction Index (dB) at Octave Band Centre Frequency (Hz)						Overall (dB) $R_w + C_{tr}$
	125	250	500	1000	2000	4000	
South Façade (Bedroom)	27	29	33	43	38	32	35
All Other Facades	19	26	35	38	41	41	31

We understand that the glazing for the scheme has been selected. In total there are 3No different glazing performances as set out below.

Product	Minimum Sound Reduction Index (dB) at Octave Band Centre Frequency (Hz)						Overall (dB) $R_w + C_{tr}$
	125	250	500	1k	2k	4k	
Futura+/- Futura+I	21	27	36	39	49	47	33
Frame IC	24	26	32	40	42	44	33
Futura +/- Futura+I	19	26	35	38	41	41	31

It can be seen from the above that the proposed glazing performances on the south façade, fall short of the minimum requirements calculated. As such, the bedroom windows on the south façade (as Highlighted in **red** in the image below) should be uprated in line with the minimum performances calculated in table overleaf (ie circa 35dB $R_w + C_{tr}$ glazing). It is understood that secondary glazing is being considered to these areas, which would be considered commensurate with the minor up-lift required.

All other facades match or exceed the required specification across the development. As such, internal noise levels should be in-line with the MCC criteria.



Example floor plan highlighting uprated glazing areas on the south façade (all floors)



9.5 Ventilation & Overheating

9.5.1 AVO Assessment Overview

With regards to overheating control, we are in receipt of the TM59 assessment results where a detailed breakdown of the number of hours the 23No apartments will need to have open windows open to mitigate overheating targets.

The TM59 assessment considered the months of May to September (Inclusive) and highlights the number of hours the operative temperature for the occupied rooms is expected to exceed 22 degrees Celsius at which the windows are assumed to be open.

The TM59 assessment has been given the total number of hours the windows will need to be open during the whole assessment period. As such, the SOAEL has been determined based on the percentage of the whole assessment period that windows need to be open.

For example, Bedroom 01 in Apt 00.01 exceeds 22 degrees Celsius for 702No hours during the months of May to September. The total number of hours in this time period is 3672No. As such, window would be open for 19% of the total time which would equate to a SOAEL of 49 dB L_{Aeq} during the day and 41 dB L_{Aeq} at night internally.

The calculated levels are shown in the table in Appendix F, however, to summarise, both the day and night-time ambient noise levels are below the SOAEL for rooms that have windows on the north, east or west facing facades, and therefore in-line with the AVO guide. The southern elevation requires further consideration, which is presented in the sections below.

9.5.2 AVO Assessment - Southern elevation (Day Time)

Based on the incident noise levels and window locations shown in Section 4.0 we have calculated the daytime internal noise level in each of the south apartments with the windows open. In line with the AVO guide we have assumed a 13 dBA reduction from the open window during the overheating condition.

On the south façade (in close proximity to The Wharf extract fan) we advise that reliance on openable windows to mitigate overheating is removed entirely to satisfy internal noise level targets during daytime periods when the extract fan is operating. This would likely take the form of increased MVHR ventilation rates to achieve TM59 compliance with windows shut in specified rooms (see results highlighted red in Appendix F).



The assessment of MVHR noise levels uses boost operation (60%) as a worst-case assessment. However, at the time of writing, it has not yet been confirmed that MVHR units running on boost (60%) completely satisfies the requirements during periods of overheating to completely remove reliance on openable windows on the southern facade. Subsequently any changes to the ventilation duty that may be required should be reviewed by Hann Tucker to confirm compliance with both AVO and the noise limits defined within the planning conditions.

9.5.3 AVO Assessment - Southern elevation (Night-time)

Typically, the AVO guide criteria for maximum night-time noise events is that internal levels should not normally exceed 65dB L_{AFmax} between 23:00 and 07:00. Ambient noise during the night-time shall also not exceed 41 dB L_{Aeq} .

With reference to the night-time noise levels (maximum and ambient), internal noise levels below that of the SOAEL should be readily achieved with open windows on all facades when considering a 13 dBA reduction for an open window.

10.0 Outdoor Living Spaces

There are balconies proposed as part of this development. Specifically on the South façade and the roof area. Considering the external noise level measures, as detailed in Section 6.0, we would expect the noise level on the rooftop gardens to exceed the the 55 dB L_{Aeq} target for external amenity by 1 dB up to 5 dB. However, in this regard BS8233:2014 states that *“these guideline values may not be achievable in all circumstances where development might be desirable. In such a situation, development should be designed to achieve the lowest practicable noise levels in these external amenity spaces but should not be prohibited.”*

Based on the above, we feel the external noise levels would be as low as practicably possible and therefore should be considered acceptable. ProPG states that where desirable garden noise levels cannot be achieved *“a relatively quiet, protected, publicly accessible, external amenity space (e.g. a public park or a local green space designated because of its tranquillity) that is nearby (e.g. within a 5 minutes walking distance). The local planning authority could link such provision to the definition and management of Quiet Areas under the Environmental Noise Regulations.”*

With reference to the above, the site is located in close proximity to Castlefield Urban Heritage Park (5 minute walk) and St-George's Park (11 minute walk) which should provide a tranquil green space for the residents of the scheme.



The smaller balconies on the south façade could exceed the 55 dB L_{Aeq} by up to 10 dBA. However, small balconies are not generally considered as ‘outdoor living’ due to their size. In this regard, BS 8233 states:

“Small balconies may be included for uses such as drying washing or growing pot plants, and noise limits should not be necessary for these uses. However, the general guidance on noise in amenity space is still appropriate for larger balconies, roof gardens and terraces, which might be intended to be used for relaxation... Achieving levels of 55 dB $L_{Aeq,T}$ or less might not be possible at the outer edge of these areas, but should be achievable in some areas of the space.”

11.0 Vibration Assessment

11.1 Rail Movements

Information relating to tram movements has been derived using timetables for 2021 available on the ‘Transport for Greater Manchester’ (TFGM) website.

The following table presents the estimated number of tram passes on the lines running past the site boundary during daytime (07:00-23:00) and night-time (23:00-07:00) periods.

Type	Estimated Total Tram Pass-bys	
	Daytime (07:00 – 23:00)	Night-Time (23:00 – 07:00)
Tram	860	120
Train	330	41
Freight	31	26

11.2 Building Response

The building development superstructure will modify the surveyed vibration levels, superstructures often amplifying foundation vibration levels. Our analysis assumes:

- Empirically researched floor amplification factors as given within “*A Prediction for Rail Transportation Ground-borne Noise and Vibration*” James Turner Nelson and High Saurenman Transportation Research Record 1143.
- Empirically researched floor amplification factors as given within “*Handbook for Urban Noise and Vibration Control*” Saurenman, Nelson, Wilson US Department of Commerce National Technical Information Services – February 1982.
- The typical maximum recorded vibration levels for different tram pass-bys shall be used.
- The proposed building super-structures could be concrete or steel frame (worst-case structure assumed) with piled foundations, concrete cores, lightweight partitioning/linings.



11.3 Vibration Assessment

Based on the typical maximum recorded vibration levels we have calculated the predicted vibration levels within the proposed residences on the first suspended residential floor level. Using estimated tram and train movement frequency (Section 11.1), our calculations indicate the following estimated vibration dose values (e.V.D.V) in the worst affected apartment. Our suggested targets (BS 6472 limits for “low probability of adverse comment”) are also presented for ease of reference.

Period	Rail Type	Calculated e.V.D.V ($\text{m/s}^{1.75}$)	Target V.D.V ($\text{m/s}^{1.75}$)
Daytime (07:00 – 23:00)	Tram	0.02	< 0.4
	Train	0.01	
	Freight	< 0.01	
Night-Time (23:00 – 07:00)	Tram	0.01	< 0.2
	Train	< 0.01	
	Freight	< 0.01	

11.4 Re-radiated Noise

In lieu of detailed information relating to the building super-structure, calculations of re-radiated noise are very much “indicative” with a wide error range (in the region of +/- 10 dB). Our calculations indicating predicted re-radiated noise levels as a result of rail induced vibration are presented in the table below.

Period	Predicted Re-radiated Noise Level ($L_{Amax,s}$)	Target Re-radiated Noise Level ($L_{Amax,s}$)
Tram	17 dB	35 dB
Train	13 dB	
Freight	16 dB	

11.5 Discussion

Our calculations indicate a worst-case estimated vibration dose values in the worst affected apartments (habitable rooms located closest to the train line) below the proposed target. In accordance with BS 6472, this would indicate a “low probability of adverse comment”.

Our calculations indicate re-radiated noise level targets should be achievable in all dwellings with the use of most modern residential building methods (e.g. traditional concrete/steel frames, natural frequencies of slabs in the region of 5-15 Hz).



11.6 Vibration Mitigation Measures

Our preliminary assessment indicates train-induced vibration levels in apartments are likely to bring a “low probability of adverse comment” in accordance with BS 6472.

Whilst it would be prudent to analyse vibration (and re-radiated noise) levels through design – i.e. to verify the suitability of the preferred structural design – at this stage we would not anticipate any specific train-induced vibration mitigation measures being required.

12.0 Building Services Acoustics

12.1 Apartment MVHR Units

All apartments are noted to be ventilated with MVHR units providing the minimum background ventilation rate. Units should be selected to achieve the limits presented in Condition 13 and 14.

12.1.1 Documents Reviewed

The ventilation layout drawings used to inform the building services noise assessment are listed in the table below:

Document Reference	Document Title
SLW-FUT-MEC-ZZ-TY-5001	Apartment mechanical service layout- type 1B
SLW-FUT-MEC-ZZ-TY-5002	Apartment mechanical service layout- type 1A
SLW-FUT-MEC-ZZ-TY-5003	Apartment mechanical service layout- type 1C
SLW-FUT-MEC-ZZ-TY-5004	Apartment mechanical service layout- type 1D
SLW-FUT-MEC-ZZ-TY-5005	Apartment mechanical service layout- type
SLW-FUT-MEC-ZZ-TY-5006	Apartment mechanical service layout- type 2B
SLW-FUT-MEC-ZZ-TY-5007	Apartment mechanical service layout- type 2C
SLW-FUT-MEC-ZZ-TY-5008	Apartment mechanical service layout- type 2D Sheet 1
SLW-FUT-MEC-ZZ-TY-5009	Apartment mechanical service layout- type 2D Sheet 2
SLW-FUT-MEC-ZZ-TY-5010	Apartment mechanical service layout- type 2E
SLW-FUT-MEC-ZZ-TY-5011	Apartment mechanical service layout- type 3A Sheet 1



Document Reference	Document Title
SLW-FUT-MEC-ZZ-TY-5012	Apartment mechanical service layout- type 3A Sheet 2
SLW-FUT-MEC-ZZ-TY-5013	Apartment mechanical service layout- type 3B Sheet 1
SLW-FUT-MEC-ZZ-TY-5014	Apartment mechanical service layout- type 3B Sheet 2
SLW-FUT-MEC-ZZ-TY-5015	Apartment mechanical service layout- type 3C Sheet 1
SLW-FUT-MEC-ZZ-TY-5016	Apartment mechanical service layout- type 3C Sheet 2

12.1.2 Proposed Site Installations

Based on the duct layouts provided in the above documents, an assessment has been undertaken to establish cumulative sound pressure level within internal living spaces.

We understand that normal operational duty of the MVHR is 50%, with boost duty at 60%. At the time of writing there is no data available for the MVHR units running at 50%, only 40% or 50%. As such Boost (60%) duty has been used as a worst case assessment

The induct sound power levels of the units is provided below.

Make/ Model	Fan	MVHR Limiting in duct Sound Power Levels (dB) Octave Band Centre Frequency (Hz)							
		63	125	250	500	1000	2000	4000	8000
Vent Axia / Lo-Carbon Sentinel Kinetic FH	Extract	68	62	67	59	52	43	33	28
	Supply	73	73	82	64	60	54	46	40
	Breakout	54	53	66	58	52	48	42	39

We understand that attenuators are currently proposed on supply ducts serving bedrooms, which shall achieve the following specification:

Attenuator reference	Dynamic Insertion Loss Octave Band Centre Frequency (Hz)							
	63	125	250	500	1000	2000	4000	8000
ATT01	0	8	31	24	25	23	16	12

There are currently no attenuators proposed on extract ductwork.



12.1.3 Internal MVHR Noise Levels

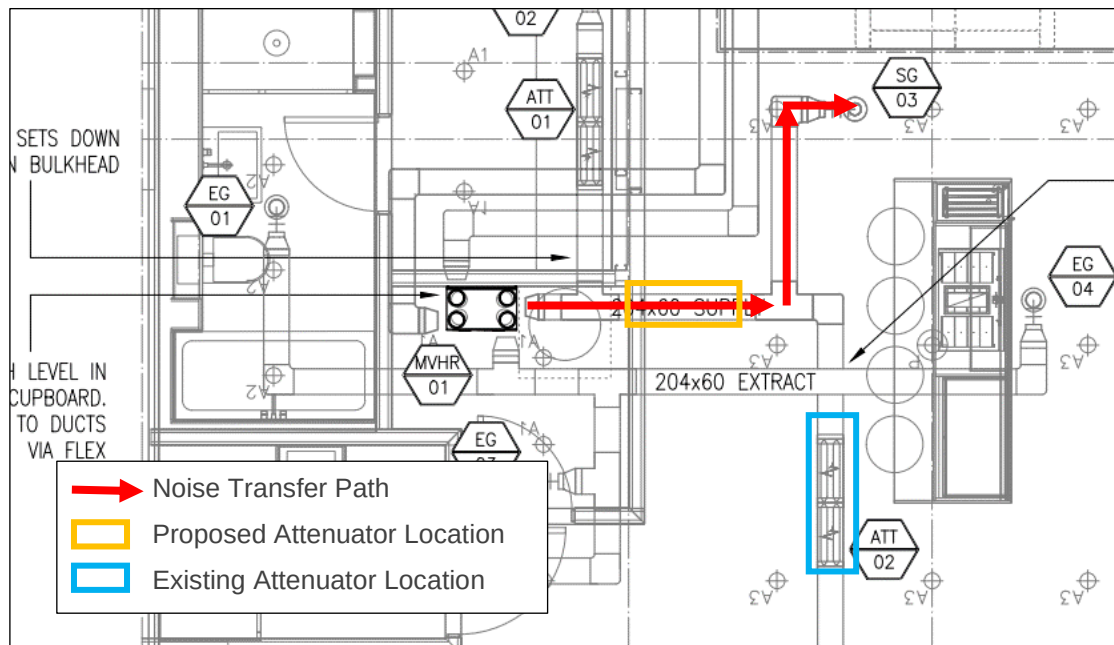
Octave band calculations have been undertaken to establish the sound pressure level at 1.5m from the MVHR connections within a selection example spaces, the results are presented in the table below, with exceedances highlighted in red:

Room Reference	Fan	Calculated internal MVHR noise levels NR (Boost)	Internal Noise Level Criteria NR (Trickle/Boost)
1A Kitchen	Extract	30	30/35
1A Bedroom	Supply	25	25/30
2B Bedroom	Supply	25	25/30
2B Kitchen	Extract	30	30/35
2C Livingroom	Supply	44	30/35
2D Livingroom	Supply	42	30/35
2D Bathroom	Extract	31	35/40
2D Bedroom	Supply	25	25/30
3B Dressing Room	Supply	24	30/35
3B Master Suite	Supply	23	25/30

It should be noted that the proposed ventilation strategy should be capable of achieving internal noise levels in the majority of spaces, however, where the supply fan is ducted straight to living spaces without passing through an attenuator, internal noise levels are likely to be exceeded. The rooms in which this occurs are listed below:

- 2C Livingroom / Kitchen
- 2D Livingroom / Kitchen
- 2E Livingroom / Kitchen
- 3A Livingroom / Kitchen
- 3B Dressing Room
- 3C Dressing Room

The image below shows an example of the noise transfer path and a suitable location for an attenuator, in this particular example it may be possible to relocate the attenuator to serve 2no rooms by placing it on the main ductwork branch:



In all the spaces listed above, attenuators should be positioned such that MVHR supply ductwork serving kitchens/living rooms and dressing rooms is also fitted with an attenuator, where possible attenuators may be relocated to the main ductwork branch (as indicated on the image above) to negate the need for additional units.

12.1.4 Noise Egress Calculations

Octave band calculations have been undertaken to establish the sound pressure level at 1m from the MVHR connections to atmosphere, as well as a cumulative (worst-case) sound pressure level at the nearest residential receptor to the development. The calculation of sound pressure levels is presented in the following table for the worst-case receptor (Connect House) and reported as an A-weighted value only so that direct comparison with the internal noise level limits set out in Condition 13.

Description	Octave Band Centre Frequency (Hz)							
	63	125	250	500	1k	2k	4k	8k
Open Inlet Sound Power Level (dB)	73	73	82	64	60	54	46	40
Total Duct/grille Insertion Loss (dB)	-24	-26	-22	-27	-27	-27	-29	-27-
Sound Power Level Inlet to atmosphere (dB)	49	47	60	37	33	27	17	13
Distance Loss to 19m (dB)	-34	-34	-34	-34	-34	-34	-34	-34
Level increase for 27 Apartments (dB)	14	14	14	14	14	14	14	14
Sound Pressure Level at receptor (dB)	29	27	40	17	13	7	0	0
	31 dBA							



Description	Octave Band Centre Frequency (Hz)							
	63	125	250	500	1k	2k	4k	8k
Open Outlet Sound Power Level (dB)	67	62	67	59	52	43	33	28
Total Duct/grille Insertion Loss (dB)	-23	-25	-21	-26	-27	-26	-28	-27
Sound Power Level Outlet to atmosphere (dB)	44	37	46	33	25	17	5	1
Distance Loss to 19m (dB)	-34	-34	-34	-34	-34	-34	-34	-34
Level increase for 27 Apartments (dB)	14	14	14	14	14	14	14	14
Sound Pressure Level at receptor (dB)	24	18	26	13	6	0	0	0
	19dBA							

Description	Sound Level (dBA)	
Inlet Sound Pressure Level at Receptor	31	
Outlet Sound Pressure Level at Receptor	19	
Cumulative Sound Pressure Level at Receptor	31	
Plant Noise Limit	Daytime	Night-time
	47	39

NB: Assumes that all 27 apartments with MVHR are equal distance to receptor (taken as the minimum distance between any noise source and receptor), which is considered worst case as this does not account for screening or increased distance due to development geometry.

Based on the above, it can be seen that the non-emergency operating plant items are below the daytime and night-time plant noise limits and so comply with the planning decision condition requirements.

12.1.5 MVHR Façade Openings

All residential units shall be ventilated with MVHR units, which shall be designed to achieve sufficient external to internal sound reduction and maintain the acoustic integrity of the façade.

Subsequently MVHRs atmospheric side terminations and associated duct-runs have been reviewed in detail and an assessment has been undertaken of external noise break-in through façade openings. The results of a sample of façade openings have been presented in the table below:

MVHR Noise Egress Assessment - Summary		
Apartment/Duct Ref	Calculated Sound Insulation Performance of Duct Opening and Ductwork dB	Calculated internal noise level dBA
3A G04 Bedroom 1 (Intake)	57 $D_{ne,w+Ctr}$	8
2E G06 Bedroom 2 (intake)	56 $D_{ne,w+Ctr}$	11



MVHR Noise Egress Assessment - Summary		
Apartment/Duct Ref	Calculated Sound Insulation Performance of Duct Opening and Ductwork dB	Calculated internal noise level dBA
2E G06 Bedroom 2 (exhaust)	57 $D_{ne,w+Ctr}$	10

As shown in the table above, proposed façade openings have sufficient sound reduction performance to mitigate external noise break-in to well below the internal noise level criteria. As such, no further mitigation measures should be required.

13.0 Conclusions

A detailed environmental noise and vibration survey has been undertaken in order to establish the currently prevailing environmental noise climate around the site.

The environmental noise impact upon the proposed dwellings has been assessed in the context of Planning Conditions 13 and 14.

Appropriate target internal noise levels have been proposed. These are achievable when considering the proposed external walls/roof and glazing on the north, east and west facades. Bedrooms along the south façade are directly impacted by building services noise associated with 'The Wharf' Pub, such that uprated glazing is likely to be required, which has been specified within the report.

A vibration assessment has been carried out and the levels of vibration and re-radiated noise are considered to be suitable for residential dwellings.

A Level 2 overheating assessment in-line with the AVO has been carried out and the results show that the levels of environmental noise break-in should be below the SOEAL on the north, east and west facades. Due to the building services noise associated with 'The Wharf' pub on the south façade, reliance on openable windows to mitigate overheating should be removed to prevent exceedances of internal noise limits. Prior to occupation, confirmation should be provided that the MVHR boost duty (60%) can achieve the necessary ventilation requirements.

An assessment of internal building services noise has been undertaken, confirming that the specified ductwork and MVHR units can meet the internal noise level requirements within bedrooms, however some additional attenuators may be required to ensure this is achieved for all living spaces.



An assessment of external noise egress has been undertaken and has indicated that the proposed MVHR units are unlikely to cause an exceedance of the plant noise limits at the nearest noise sensitive receptor.

An assessment of noise break-in through façade openings has been undertaken. The results show that the sound reduction performance of the façade has been maintained with the proposed façade openings in place.

Appendix A – Acoustic Terminology

The acoustic terms used in this report are defined as follows:

dB	Decibel - Used as a measurement of sound level. Decibels are not an absolute unit of measurement but an expression of ratio between two quantities expressed in logarithmic form. The relationships between Decibel levels do not work in the same way that non-logarithmic (linear) numbers work (e.g. 30dB + 30dB = 33dB, not 60dB).
dBA	The human ear is more susceptible to mid-frequency noise than the high and low frequencies. The 'A'-weighting scale approximates this response and allows sound levels to be expressed as an overall single figure value in dBA. The _A subscript is applied to an acoustical parameter to indicate the stated noise level is A-weighted It should be noted that levels in dBA do not have a linear relationship to each other; for similar noises, a change in noise level of 10dBA represents a doubling or halving of subjective loudness. A change of 3dBA is just perceptible.
L _{90,T}	L ₉₀ is the noise level exceeded for 90% of the period <i>T</i> (i.e. the quietest 10% of the measurement) and is often used to describe the background noise level.
L _{eq,T}	L _{eq,T} is the equivalent continuous sound pressure level. It is an average of the total sound energy measured over a specified time period, <i>T</i> .
L _{max}	L _{max} is the maximum sound pressure level recorded over the period stated. L _{max} is sometimes used in assessing environmental noise where occasional loud noises occur, which may have little effect on the L _{eq} noise level.
L _p	Sound Pressure Level (SPL) is the sound pressure relative to a standard reference pressure of 2×10^{-5} Pa. This level varies for a given source according to a number of factors (including but not limited to: distance from the source; positioning; screening and meteorological effects).
L _w	Sound Power Level (SWL) is the total amount of sound energy inherent in a particular sound source, independent of its environment. It is a logarithmic measure of the sound power in comparison to a specified reference level (usually 10^{-12} W).

Appendix B –National Planning Policies

National Planning Policy Framework (NPPF)

The National Planning Policy Framework (NPPF) was first published in 2012, replacing the existing Planning Policy Guidance Note 24 (PPG24) “Planning and Noise”, and sets out the government’s planning policies for England and how these are expected to be applied.

The latest revision of the NPPF (July 2021) states that planning system should contribute to, and enhance, the natural and local environment by (amongst others) *“preventing both new and existing development from contributing to or being put at unacceptable risk from, or being adversely affected by unacceptable levels of soil, water or noise pollution or land stability.”*

NPPF advises that planning policies and decisions should ensure:

“...new development is appropriate for its location taking into account the likely effects (including cumulative effects) of pollution on health, living conditions and the natural environment, as well as the potential sensitivity of the site or the wider area to impacts that could arise from the development.” [In doing so they should] *“mitigate and reduce to a minimum potential adverse impacts resulting from noise from new development – and avoid noise giving rise to significant adverse impacts on health and the quality of life”* and *“identify and protect tranquil areas which have remained relatively undisturbed by noise and are prized for their recreational and amenity value for this reason.”*

“...new development can be integrated effectively with existing businesses and community facilities (such as places of worship, pubs, music venues and sports clubs). Existing businesses and facilities should not have unreasonable restrictions placed on them as a result of development permitted after they were established. Where the operation of an existing business or community facility could have a significant adverse effect on new development (including changes of use) in its vicinity, the applicant (or ‘agent of change’) should be required to provide suitable mitigation before the development has been completed.”

The NPPF makes reference to the Noise Policy Statement for England.

Noise Policy Statement for England (NPSE)

The Noise Policy Statement for England (NPSE) was published in March 2010 (i.e. before the NPPF). The NPSE is the overarching statement of noise policy for England and applies to all forms of noise other than occupational noise, setting out the long term vision of Government noise policy which is to *“Promote good health and a good quality of life through the effective management of noise within the context of Government policy on sustainable development.”*

That vision is supported by the following NPSE noise policy aims which are reflected in three of the four aims of planning policies and decisions in the NPPF as below:

“Through the effective management and control of environmental, neighbour and neighbourhood noise within the context of Government policy on sustainable development:

- *avoid significant adverse impacts on health and quality of life;*
- *mitigate and minimise adverse impacts on health and quality of life; and*
- *where possible, contribute to the improvement of health and quality of life.”*

The Explanatory Note to the NPSE has three concepts for the assessment of noise in this country:

NOEL – No Observed Effect Level

This is the level below which no effect can be detected and below which there is no detectable effect on health and quality of life due to noise.

LOAEL – Lowest Observable Adverse Effect Level

This is the level above which adverse effects on health and quality of life can be detected.

SOAEL – Significant Observed Adverse Effect Level

This is the level above which significant adverse effects on health and quality of life occur.

None of these three levels are defined numerically and for the SOAEL the NPSE makes it clear that the noise level is likely to vary depending upon the noise source, the receptor and the time of day/day of the week, etc. The need for more research to investigate what may represent an SOAEL for noise is acknowledged in the NPSE and the NPSE asserts that not stating specific SOAEL levels provides policy flexibility in the period until there is further evidence and guidance.

The NPSE concludes by explaining in a little more detail how the LOAEL and SOAEL relate to the three NPSE noise policy aims listed above. It starts with the aim of avoiding significant adverse effects on health and quality of life, then addresses the situation where the noise impact falls between the LOAEL and the SOAEL when *“all reasonable steps should be taken to mitigate and minimise adverse effects on health and quality of life while also taking into account the guiding principles of sustainable development.”* The final aim envisages pro-active management of noise to improve health and quality of life, again taking into account the guiding principles of sustainable development which include the need to minimise travel distance between housing and employment uses in an area.

Planning Practice Guidance on Noise (PPG)

Planning Practice Guidance (PPG) under the NPPF has been published by the Government as a web based resource. This includes specific guidance on Noise although, like the NPPF and NPSE, the PPG does not provide any quantitative advice. It seeks to illustrate a range of effect levels in terms of examples of outcomes as set out in the following table:

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

Appendix C

Local Authority Liaison

On 17 June 2022 Tom Flannagan from Paul Butler associates sent the following email to MCC Senior Planner Lucy Harrison pertaining to the revised scheme and submission of a s73 application and the discharge of existing Conditions:

Hi Lucy

I was wondering whether any comments have been received on the s73 application that require our response. Also, if you have any queries on the proposed changes please can you let me know.

As set out in the application covering letter, we understand that the proposed changes may require a variation to the previously approved Section 106 Agreement. Would you be able to action this with the Council's solicitors so that it doesn't delay a decision being issued?

Also, we are hoping to discharge a number of the conditions (6, 9, 11, 12 and 13) attached to the original application prior to the section 73 application being determined. Details for these conditions have been submitted under applications CDN21/0461 and CDN/21/0675. I have attached the latest correspondence on these conditions and it would be useful if they could be discharged.

If you are able to provide an update that would be much appreciated.

Thanks,

Tom

The following comments were sent back from MCC in response to the above:

Hi Tom

Please see the comments below from Environmental Health with regard to the above application:

Regarding the change to the refuse store, we need confirmation of the refuse store size to demonstrate compliance with MCC GD04 requirements

With regard to the change in window plans and glazing, an updated noise and overheating assessment will be required to take into consideration the revised scheme to address the original noise condition which I recommend is attached to the amendment application as outlined below.

NSE4(b)

Residential sound insulation AND overheating

a) Before the development commences a scheme for acoustically insulating the proposed residential accommodation against noise from surrounding roads and streets 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 such.

The potential for overheating shall also be assessed and the noise insulation scheme shall take this into account. The approved noise insulation and ventilation scheme shall be completed before any of the dwelling units are occupied.

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

Bedrooms (night time - 23.00 - 07.00)	30 dB LAeq (individual noise events shall not exceed 45 dB LAmax,F by more than 15 times)
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Living Rooms (daytime - 07.00 - 23.00)	35 dB LAeq
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Gardens and terraces (daytime)	55 dB LAeq
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Due to the proximity of the development to the train line it shall 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 shall also be factored into the assessment and design.

Additionally, where entertainment noise is a factor in the noise climate the sound insulation scheme shall be designed to achieve internal noise levels in the 63Hz and 125Hz octave centre frequency bands so as not to exceed (in habitable rooms) 47dB and 41dB (Leq,5min), respectively.

b) Prior to first occupation of the residential units, a verification report shall be required to validate that the work undertaken throughout the development conforms to the recommendations and requirements in the approved acoustic consultant's report. The report shall also undertake post completion testing to confirm that the internal noise criteria have 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.

Reason: To secure a reduction in noise from traffic or other sources in order to protect future residents from noise disturbance and to reduce the potential for overheating.

*There were quite a few points still to be addressed from the original noise assessment comments under application ref 113617 sent on 14th July 2021 which I have copied below for ease so these will need to be fed into the revised assessment and report:

Condition 13 – Acoustic Insulation

I have reviewed the Hann Tucker acoustic assessment reference HT28795/PTM1 dated 4th June 21 and I have the following comments:

1. Assessment or comment should be included to assess impact from vibration due to the proximity of the development to the nearby train 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 must/shall also be factored into the assessment and design
2. Façade assessment has been undertaken and glazing performance has been recommended at the various facades and has also taken into account the lower frequency restrictions with regard to entertainment noise from the nearby Wharf public house. The performance specification may need to be amended upon response to the above point. We will also require confirmation that the façade and glazing performance has been designed to ensure the L_{Amax} noise events do not exceed the night time criteria detailed in the condition. Once a response to the above and L_{Amax} criteria has been provided or comment provided and glazing performance confirmed, we will require examples of the necessary glazing system / build up / specification that will be required to meet the performance recommended
3. In order for the internal noise criteria to be met windows will need to remain closed except for temporary purge ventilation to remove stale odours such as cooking odours and occupants should not need to rely on opening windows for comfort cooling. Ventilation

options have been discussed in the report and MVHR has been recommended as the preferred option. The system should be capable of providing suitable comfort cooling to the property so occupants do not need to open windows. The system should be selected so the internal noise criteria is not exceeded whilst the system is in full use including any boost function if this is applicable. The details shall be provided to the consultant for review once selected and assessment should be undertaken and confirmation providing or insulation measures recommending to ensure that the selected system meets this requirement

4. Assessment of any wall penetrations for air intake / extract will be required and details of any necessary treatment or insulation to ensure that the penetrations do not compromise the acoustic integrity of the facade and impact the internal noise level or lead to an exceedance of the criteria

5. Assessment of any service risers for lifts will be required and insulation recommendations providing for these areas to ensure noise or vibration does not exceed the internal noise criteria in the bedrooms and living rooms whilst lifts are in use. Ideally, lifts or risers should not be located next to habitable rooms, in particular bedrooms.

Prior to 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 consultant's report. The report shall also undertake post completion testing to confirm that the internal noise criteria have 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.

I should be grateful if you would address the above comments as soon as possible.

I shall instruct solicitors to amend the S106 and review the outstanding conditions.

Regards

Lucy

Subsequently a conversation was had between Paul Butler Associates and Hann Tucker discussing the need for an updated planning report to support the revised scheme. The following email was sent following this discussion on 17/07/2022:

Hi Jake

Good to talk earlier.

As discussed, please find below the comments raised by the Council's EHO in response to a s73 application that we have recently submitted. The below link provides access to the revised scheme drawings, and the attached document prepared by Ollier Smurthwaite Architects identifies the differences between the previously consented scheme and latest proposals.

133713/JO/2022 | Variation of condition 2 (drawing numbers) of planning permission 113617/FO/2016 to allow amendments including: creation of central lift core and lift overrun; relocation of cycle store; amendments to layouts of apartments; replacement of some duplex apartments with single level apartments; additional windows to east elevation; increase in the width of windows on the west elevation; and change of design of dormer windows on the east elevation to allow opening windows. | Blantyre Street Manchester M15 4JT

The previously provided Noise report will need updating in response to the scheme changes, whilst an overheating assessment is also now required.

The EHO makes reference to the previous noise assessment sent on 14th July 2021 and points to previous comments raised on this report. However, the report was updated (see attached) and there was correspondence in relation to the comments raised. However, these comments may need revisiting in response to the latest scheme and below comments.

If you could confirm your timescales for undertaking this work that would be much appreciated. As you will be aware, the scheme is well underway on site and there is an urgency to get this latest application approved and all pre-commencement conditions discharged.

If fees need to be revisited, please can you liaise directly with the client: Simon Kimble simon@prestburyestates.co.uk and Matt Fisher Matt@prestburyconstruction.co.uk

I look forward to hearing back from you.

Kind regards,

Tom

On 30 April 2021 Hann Tucker received comments from Graeme Souter (MCC) pertaining to our proposed survey and assessment methodology for the discharge of Planning Condition 13. The main concerns raised by MCC have been numbered below:

1. *"In addition to the existing assessment, we will also need an assessment of vibration from the trains 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 shall also be factored into the assessment and design".*
2. *"Details of the mechanical ventilation measures will need to be recommended and assessment of any penetrations to the building envelope for air intakes / extract / louvres etc associated with the ventilation proposals with necessary acoustic insulation measures recommending in these areas. Also assessment of the proposed ventilation system to confirm that when in full operation (including any boost mode if applicable) the noise will not exceed the internal noise criteria."*
3. *In addition, it is noted that the external amenity space is unlikely to achieve the design criteria although bearing in mind the location this can be considered in context and we can look at relaxing this criteria. However, details of any mitigation measures should still be recommended where possible in order to achieve a level as close as practically possible to the criteria.*
4. *"I am not sure of the stage of design yet but it may be worth conducting a supplementary survey to support the design later in the year as noise levels start to return to normal and maybe updated recommendations where required."*

Our response to the above on 6 May 2021 highlighted that the scheme has already been granted planning permission and that we are primarily working to discharge a pre-commencement condition (Condition 13). As the planning condition discharge report is not for planning purposes there is no scope for validation works, and as there is no mention of vibration or ventilation in the conditions, we do not consider them to be applicable to our pre-commencement report.

Following this we issued a preliminary technical memorandum (287951-PTM-GLG-R1) intended to offer guidance to the design team while the final proposals for the development were pending issuance.

Comments on 287951-PTM-GLG-R1 were received from MCC on 14 July 2021 which have once more been numbered in a list below. On 12 August 2021 Hann Tucker issued written responses to these points which are highlighted in **red** below:

1. *“Assessment or comment should be included to assess impact from vibration due to the proximity of the development to the nearby train 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 must/shall also be factored into the assessment and design.”*

A vibration assessment has not been undertaken (true at the time of writing) as it has not been specified within the planning conditions.

2. *“Façade assessment has been undertaken and glazing performance has been recommended at the various facades and has also taken into account the lower frequency restrictions with regard to entertainment noise from the nearby Wharf public house. The performance specification may need to be amended upon response to the above point. We will also require confirmation that the façade and glazing performance has been designed to ensure the L_{Amax} noise events do not exceed the night time criteria detailed in the condition. Once a response to the above and L_{Amax} criteria has been provided or comment provided and glazing performance confirmed, we will require examples of the necessary glazing system / build up / specification that will be required to meet the performance recommended”*

It is not entirely clear what you mean by “The performance specification may need to be amended upon response to the above point”. By our interpretation, this relates to the vibration assessment. We feel this should not have a bearing on the façade specifications as the criteria for vibration is not directly comparable with the criteria for noise intrusion. There is also no condition pertaining to vibration control, therefore our response to comment 1) is applicable to this also.

For the avoidance of doubt, L_{Amax} levels have been included in the report and our current specification has factored this in.

On the final note, our report was issued for guidance prior to the receipt of final design information, therefore given the final building specification details are not known at this stage, a re-assessment will be included based on chosen materials/building layouts. This is expected to ultimately be the correspondence to discharge the condition.

3. *“In order for the internal noise criteria to be met windows will need to remain closed except for temporary purge ventilation to remove stale odours such as cooking odours and occupants should not need to rely on opening windows for comfort cooling. Ventilation options have been discussed in the report and MVHR has been recommended as the preferred option. The system should be capable of providing suitable comfort cooling to the property so occupants do not need to open windows. The system should be selected so the internal noise criteria is not exceeded whilst the system is in full use including any boost function if this is applicable. The details shall be provided to the consultant for review once selected and assessment*

should be undertaken and confirmation providing or insulation measures recommending to ensure that the selected system meets this requirement.”

Assessment will be undertaken upon receipt of ventilation details and included in forthcoming correspondence

4. *“Assessment of any wall penetrations for air intake / extract will be required and details of any necessary treatment or insulation to ensure that the penetrations do not compromise the acoustic integrity of the facade and impact the internal noise level or lead to an exceedance of the criteria”*

Assessment required upon receipt of ventilation details. Notwithstanding, this is ultimately considered a design item, and this level of information is not normally required for planning conditions pertaining to internal noise.

5. *“Assessment of any service risers for lifts will be required and insulation recommendations providing for these areas to ensure noise or vibration does not exceed the internal noise criteria in the bedrooms and living rooms whilst lifts are in use. Ideally, lifts or risers should not be located next to habitable rooms, in particular bedrooms.”*

Assessment required upon receipt of ventilation details. Notwithstanding, this is ultimately considered a design item, and this level of information is not normally required for planning conditions pertaining to internal noise.

6. *“Prior to 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 consultant's report. The report shall also undertake post completion testing to confirm that the internal noise criteria have 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.”*

Noted

On 27 October 2021 MCC issued the most recent responses to date which have been numbered below:

1. *“I appreciate that the original condition may not have stipulated vibration criteria to be met but I think this is due to the age of the application and when the comments were made. It would be normal for us to ask for these criteria to apply to residential properties when close to rail lines or metrolink lines under more recent applications which is why I have picked this up in the later responses. I also provided this guidance earlier this year when asked if we would accept the original baseline noise assessment. I*

understand the position but our preference would be for vibration assessment to be included in order to ensure occupiers are protected against potential impact from vibration.”

2. *“Thanks for confirming LAmax levels were factored into the current specification. Noted and we will await the updated report once the final design building specification details are known.”*
3. *“Agreed”*
4. *“We will require assessment for any service penetrations to the façade addressing under the internal noise criteria. These areas can potentially impact on the acoustic integrity of the façade and if not factored into the assessment or recommendations regarding the insulation scheme provided for wall penetrations then the internal noise criteria may be exceeded so recommendations will be need to be provided in the updated report and when ventilation details have been supplied to you”*
5. *“Recommendations for the insulation of any service risers or lift shafts should be included in the updated report to protect occupants from noise from these sources once the design and lift location / specification has been made available”*

Following the receipt of these comments it was agreed to go ahead with a vibration survey and additional noise survey, which have both been included in this report to discharge the pre-commencement planning condition 13.

Regardless of whether the vibration survey and assessment was stipulated in the condition, to avoid project delay it was agreed that this be carried out to ensure the development aligned with the latest planning requirements. This is considered to be captured within this report, and no further work is considered necessary on vibration.

A reassessment of noise intrusion has been undertaken upon the receipt of finalised design details and is captured within this report, and no further work is considered necessary to discharge Condition 13.

The ventilation comments raised in point 3 have been addressed via email correspondence to the Client, in which attenuation recommendations were provided. Ultimately, it is considered post completion testing will confirm compliance with the criteria, and no further work is considered necessary to discharge Condition 13.

We noted that points 4 and 5 were ultimately design items and as such should not prevent the discharge of Condition 13. Comments have been included in design reports issued to the design team and it is considered post completion testing will confirm compliance with the criteria, and no further work is considered necessary to discharge Condition 13.

Appendix D

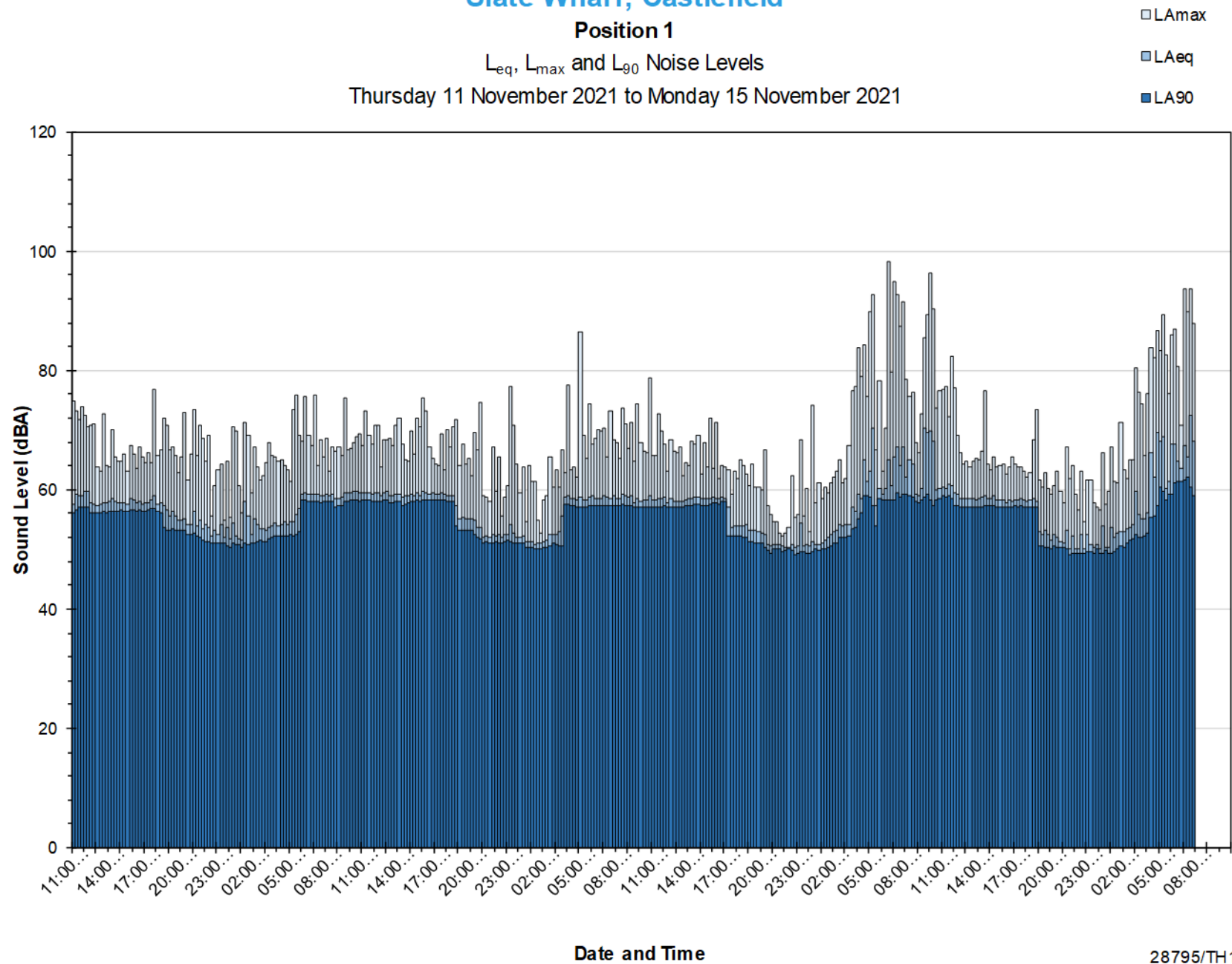
Time History Plots – Noise

Slate Wharf, Castlefield

Position 1

L_{eq} , L_{max} and L_{90} Noise Levels

Thursday 11 November 2021 to Monday 15 November 2021

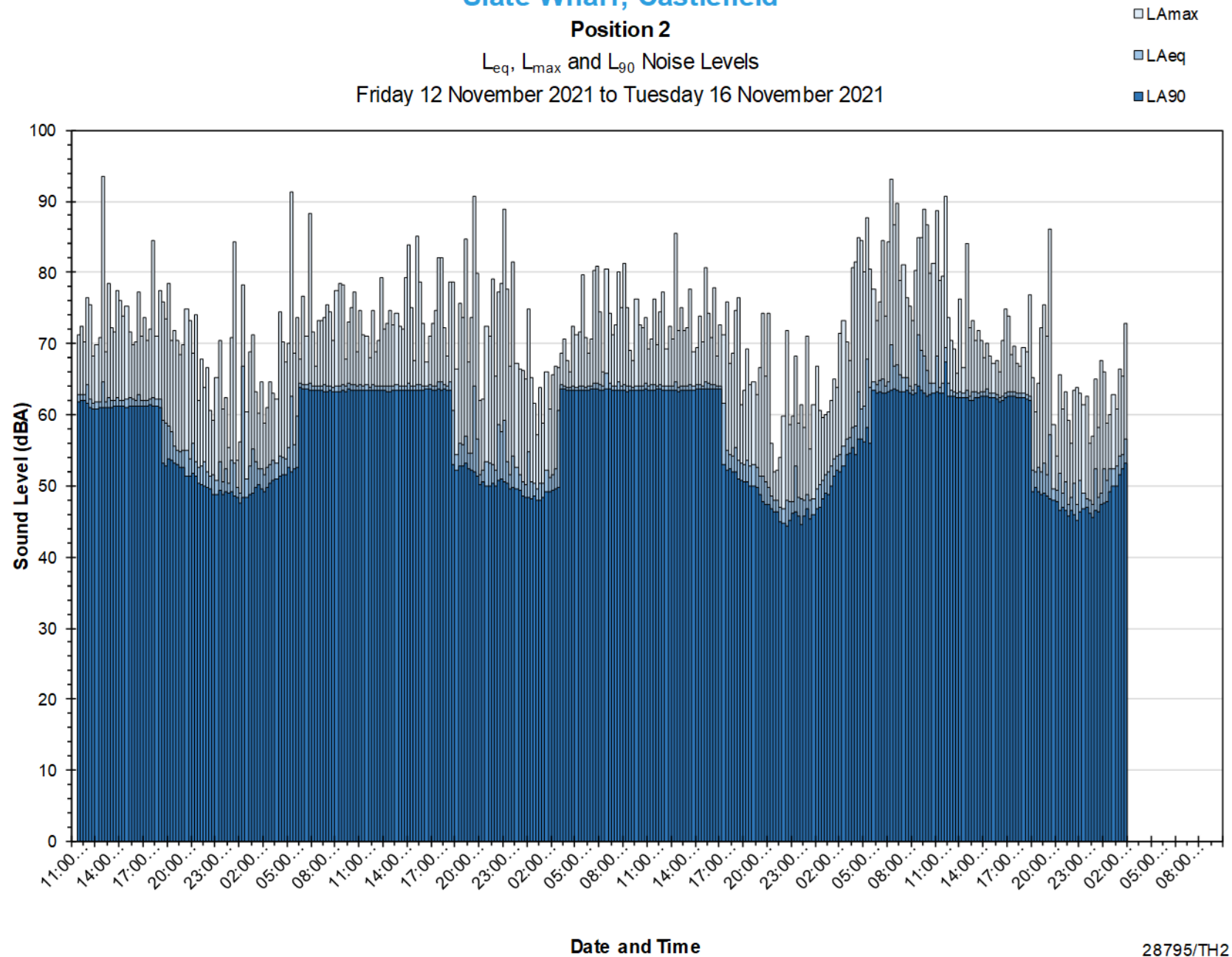


Slate Wharf, Castlefield

Position 2

L_{eq} , L_{max} and L_{90} Noise Levels

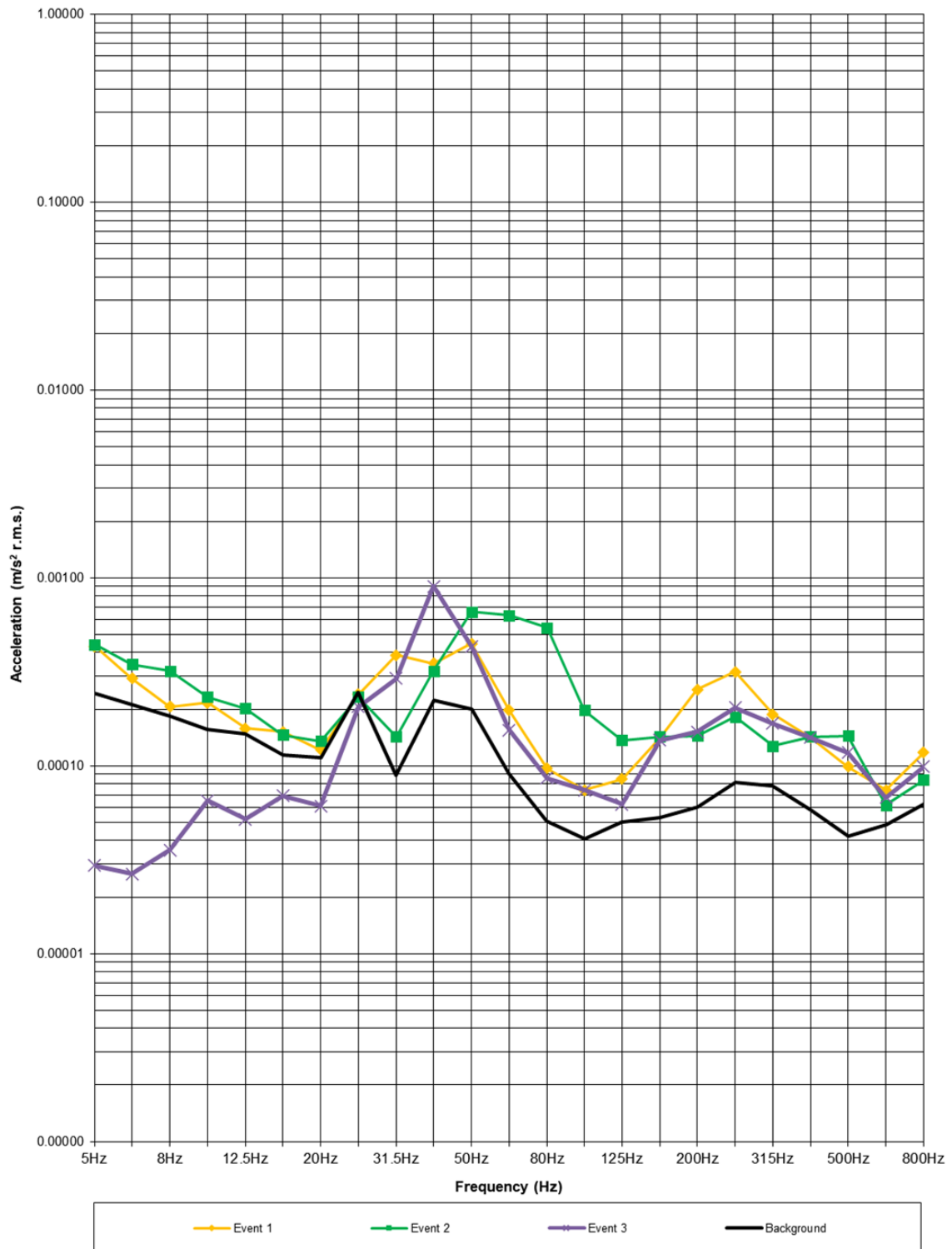
Friday 12 November 2021 to Tuesday 16 November 2021



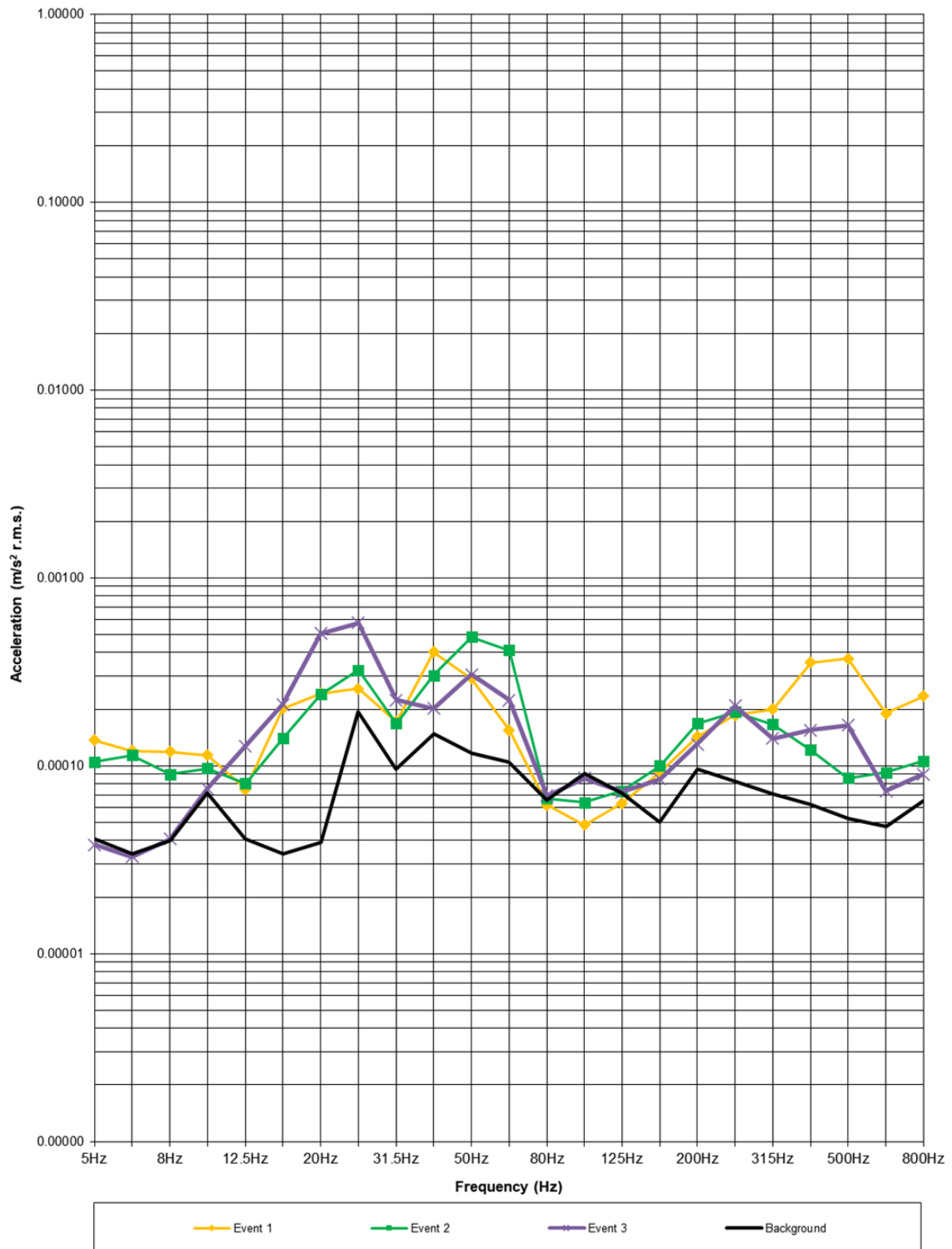
Appendix E

Vibration Measurement Results

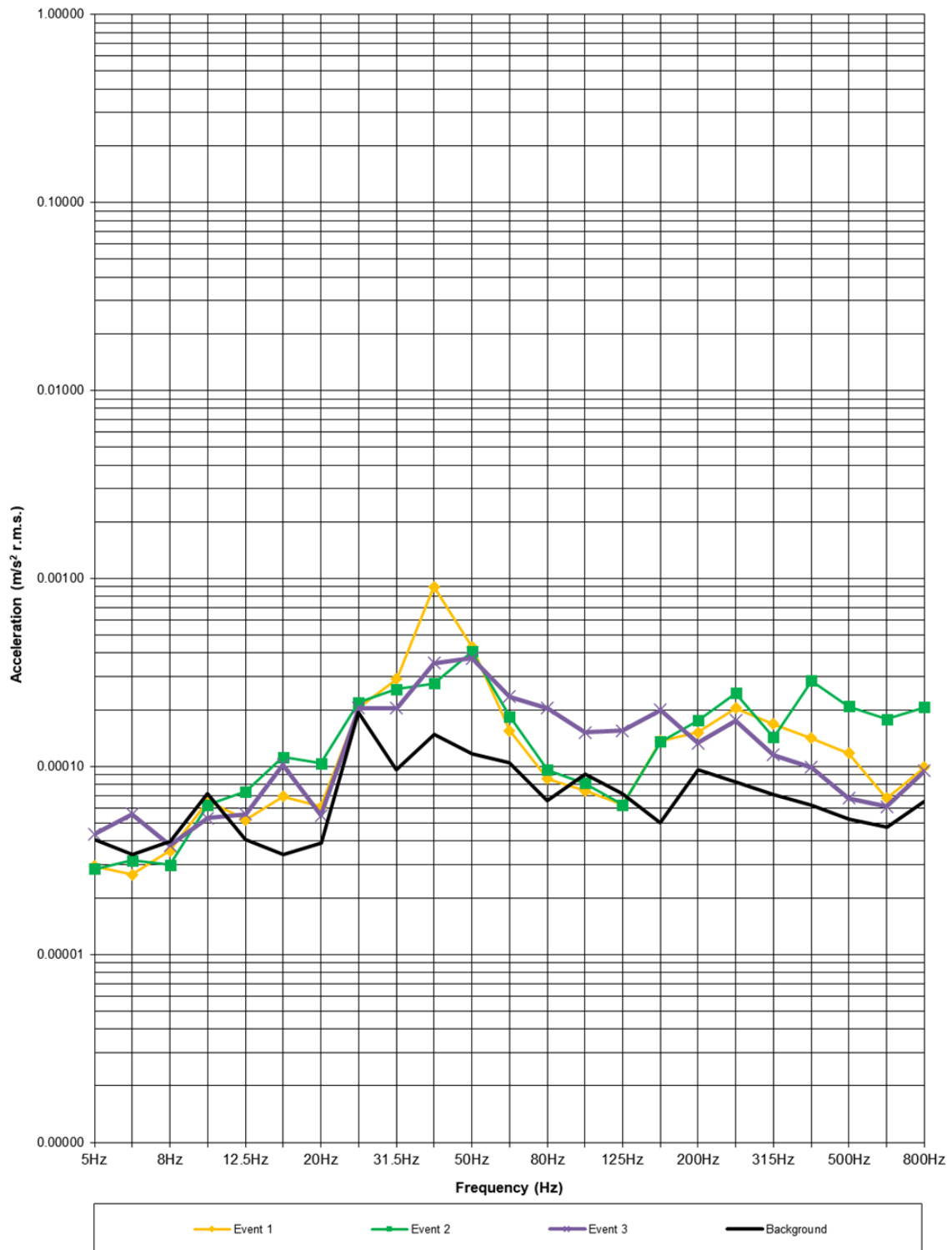
Slate Wharf, Manchester
Measured Vibration (Vertical) of Tram Passbys
At Position 1 (80m) on Monday 15 November 2021



Slate Wharf, Manchester
Measured Vibration (Vertical) of Train Passbys
At Position 1 (80m) on Monday 15 November 2021



Slate Wharf, Manchester
Measured Vibration (Vertical) of Freight Passbys
At Position 1 (80m) on Monday 15 November 2021



Appendix F

AVO Assessment Results

Room	Window Open %	SOAEL Levels		Incident Noise Levels		Calculated Internal Noise Level	
		Day	Night	Day	Night	Day	Night
00.01 - Bedroom 01	19	49	41	60	53	47	40
00.01 - Living/Kitchen	29	48	40	60	53	47	40
00.02 - Bedroom 01	18	49	41	60	53	47	40
00.02 - Living/Kitchen	30	47	40	60	53	47	40
00.03 - Bedroom 01	19	49	41	60	53	47	40
00.03 - Bedroom 02	18	49	41	60	53	47	40
00.03 - Living/Kitchen	30	48	40	60	53	47	40
00.04 - Bedroom 01	18	49	41	60	53	47	40
00.04 - Bedroom 02	17	49	41	60	53	47	40
00.04 - Living/Kitchen	28	48	40	60	53	47	40
00.05 - Bedroom 01	15	49	42	60	53	47	40
00.05 - Bedroom 02	15	49	42	65	53	52	40
00.05 - Living/Kitchen	27	48	40	60	53	47	40
00.06 - Bedroom 01	19	49	41	60	53	47	40
00.06 - Living/Kitchen	28	48	40	60	53	47	40
01.01 - Bedroom 01	18	49	41	60	53	47	40
01.01 - Living/Kitchen	27	48	41	60	53	47	40
01.02 - Bedroom 01	17	49	41	60	53	47	40
01.02 - Living/Kitchen	27	48	41	60	53	47	40

Room	Window Open %	SOAEL Levels		Incident Noise Levels		Calculated Internal Noise Level	
		Day	Night	Day	Night	Day	Night
01.03 - Bedroom 01	16	49	41	60	53	47	40
01.03 - Bedroom 02	15	49	42	60	53	47	40
01.03 - Living/Kitchen	29	48	40	60	53	47	40
01.04 - Bedroom 01	18	49	41	60	53	47	40
01.04 - Bedroom 02	18	49	41	60	53	47	40
01.04 - Living/Kitchen	30	48	40	60	53	47	40
01.05 - Bedroom 01	16	49	42	60	53	47	40
01.05 - Bedroom 02	16	49	41	65	53	52	40
01.05 - Living/Kitchen	29	48	40	65	53	52	40
01.06 - Bedroom 01	18	49	41	60	53	47	40
01.06 - Living/Kitchen	19	49	41	65	53	52	40
01.07 - Bedroom 01	18	49	41	60	53	47	40
01.07 - Living/Kitchen	27	48	41	60	53	47	40
02.01 - Bedroom 01	18	49	41	60	53	47	40
02.01 - Living/Kitchen	25	48	41	60	53	47	40
02.02 - Bedroom 01	17	49	41	60	53	47	40
02.02 - Living/Kitchen	24	48	41	60	53	47	40
02.03 - Bedroom 01	14	49	42	60	53	47	40
02.03 - Bedroom 02	14	49	42	60	53	47	40

Room	Window Open %	SOAEL Levels		Incident Noise Levels		Calculated Internal Noise Level	
		Day	Night	Day	Night	Day	Night
02.03 - Living/Kitchen	23	48	41	60	53	47	40
02.04 - Bedroom 01	17	49	41	60	53	47	40
02.04 - Bedroom 02	21	49	41	60	53	47	40
02.04 - Living/Kitchen	24	48	41	60	53	47	40
02.05 - Bedroom 01	15	49	42	60	53	47	40
02.05 - Bedroom 02	16	49	42	65	53	52	40
02.05 - Living/Kitchen	24	48	41	65	53	52	40
02.06 - Bedroom 01	17	49	41	60	53	47	40
02.06 - Living/Kitchen	19	49	41	65	53	52	40
02.07 - Bedroom 01	18	49	41	60	53	47	40
02.07 - Living/Kitchen	25	48	41	60	53	47	40
03.01 - Bedroom 01 (Master Suite)	16	49	42	60	53	47	40
03.01 - Bedroom 02	16	49	41	60	53	47	40
03.01 - Bedroom 03	18	49	41	60	53	47	40
03.01 - Living/Kitchen	22	48	41	60	53	47	40
03.02 - Bedroom 01	14	49	42	60	53	47	40
03.02 - Bedroom 02	14	50	42	60	53	47	40
03.02 - Living/Kitchen	25	48	41	60	53	47	40
03.03 - Bedroom 01	13	50	42	60	53	47	40

Room	Window Open %	SOAEL Levels		Incident Noise Levels		Calculated Internal Noise Level	
		Day	Night	Day	Night	Day	Night
03.03 - Bedroom 02	17	49	41	60	53	47	40
03.03 - Bedroom 03	15	49	42	65	53	52	40
03.03 - Living/Kitchen	22	48	41	65	53	52	40
03.04 - Bedroom 01 (Master Suite)	12	50	42	65	53	52	40
03.04 - Bedroom 02	16	49	42	60	53	47	40
03.04 - Bedroom 03	16	49	41	60	53	47	40
03.04 - Living/Kitchen	22	48	41	60	53	46	40