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Castlefield Viaduct - Entertainment Noise Impact Assessment

1 Introduction

The National Trust have commissioned Royal HaskoningDHV to assist in discharging condition 9 and 10 of the planning consent granted for the repurposing of Castlefield Viaduct, Manchester, M3 4PU (herein referred to as 'the proposed development') by Manchester City Council (MCC) (planning application reference 131621/FO/2021). Conditions 9 and 10 are worded as follows:

9a *The premises shall be acoustically insulated and treated to limit the break out of noise in accordance with a noise study of the premises and a scheme of acoustic treatment that has been submitted to and approved in writing by the City Council as local planning authority. The scheme shall be implemented in full before the use commences or as otherwise agreed in writing by the City Council as local planning authority.*

Where entertainment noise is proposed the L_{Aeq} (entertainment noise) shall be controlled to 10dB below the L_{A90} (without entertainment noise) in each octave band at the facade of the nearest noise sensitive location, and internal noise levels at structurally adjoined residential properties in the 63Hz and 125Hz octave frequency bands shall be controlled so as not to exceed (in habitable rooms) 47dB and 41dB, respectively.

9b *Prior to occupation of the development a verification report will be required to validate that the work undertaken throughout the development conforms to the recommendations and requirements in the approved acoustic consultant's report.*

The report shall also undertake post completion testing to confirm that acceptable 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 agreed noise criteria. Those measures shall be implemented in full before the use commences.

10a *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.*

Prior to commencement of the use hereby approved the scheme shall be submitted to and approved in writing by the City Council as local planning authority in order to secure a reduction in the level of noise emanating from the site

10b *Prior to occupation of the development a verification report shall be submitted to and approved in writing by the City Council as local planning authority to validate that the work undertaken throughout the development conforms to the recommendations and requirements in the approved acoustic report.*

The report shall also undertake post completion testing to confirm that the noise criteria 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 agreed noise criteria. Those measures shall be implemented in full before the use commences.

A summary of acoustic terminology relevant to this assessment is provided in Appendix A.

2 Consultation

Royal HaskoningDHV have consulted with MCC Environmental Health department regarding the above conditions¹ as summarised in Table 1.

Table 1 Consultation summary

Planning Condition	ROYAL HASKONINGDHV Comment	MCC Response	Action
9b	The conditioned noise level limits are taken from the MCC's 'Planning and Noise Technical Guidance' ² document, which specifies that they are for the control of noise from entertainment venues. The only music noise anticipated will be inside the events space, at the end of the proposed walking tours for up to 50 people. This is not considered to qualify as an entertainment venue in the meaning assigned to it by the MCC guidance. Such music is highly unlikely to be audible outside the proposed development and only 3 such events per month are anticipated; hence, the risk of complaints occurring due to music noise impacts is very low. In addition, the noise level limits	This condition "was recommended before the details of the intended use were provided. Based on the information and confirmations submitted since and the intended use and explanation provided with regards to the nature of the proposed events, (and so as long as there is no amplification) then I would agree that the requirements of the condition are not necessary for the temporary use."	A technical note outlining the calculations of likely music noise levels at nearby residential properties would be submitted to MCC, to enable discharge of the condition.

¹ Emails between Royal HaskoningDHV Principal Acoustic Consultant and MCC Environmental Health Officer in December 2020 and January 2021

² Manchester City Council (2015). Planning & Noise Technical Guidance. Available at https://www.manchester.gov.uk/download/downloads/id/23747/noise_and_planning_guidance.pdf

Planning Condition	ROYAL HASKONINGDHV Comment	MCC Response	Action
	applied to structurally adjoined properties are not necessary as there are no residential properties structurally adjoined to the proposed development.	Accepted that post-completion testing (required by condition 9b) is no longer required.	
10a, 10b	Plant sound emissions from the proposed development will be very minor, explained as follows: - All proposed heating for the buildings will be electrical and power will be supplied by a new single LV supply for the site with less than 60kVa, connecting from the local network, so no audible sound emissions are expected from this. Similarly, sanitary WC provisions will required no external plant. - Any catering for evening events will be brought on site by external contractors and removed following the event. Any associated noise emitting plant would be the responsibility of the external contractor and National Trust would have no control over this. - Hot and cold drinks and snacks will be sold at the welcome area, the partner plots or the event space, but these would be operated as discreet 'pop ups' with a stand-alone operation. For the pilot scheme and purposes of planning, any refrigeration will be internal and the pops ups won't require generators. Based on the above, predictions and post-completion testing of plant noise emissions from the proposed development are considered unnecessary as they are likely to be inaudible.	The condition is discharged based on the information provided and no predictions or post-completion measurements are required.	None

As discussed in Table 1, conditions 10a and 10b have effectively been discharged through the consultation process. This letter presents the calculations of external music noise levels undertaken to discharge condition 9a, noting that the requirement of condition 9a relating to internal noise levels in structurally adjoined properties is not required. Whilst this assessment applies the entertainment noise limits in condition 9a, the MCC EHO has accepted that the condition as it stands is not necessary, because the proposed events are small scale, infrequent and will not run into the night. The MCC EHO has agreed that post-completion entertainment noise measurements are not required; hence, this letter should also be sufficient to discharge condition 9b.

The limits in condition 9a are meant to avoid significant noise effects for entertainment venues, which would hold larger scale, more frequent events which are present during the night. Hence, it is apparent that the music noise levels from the proposed development could be louder than the limits in the condition without causing a significant effect.

3 External Entertainment Noise Impact Assessment

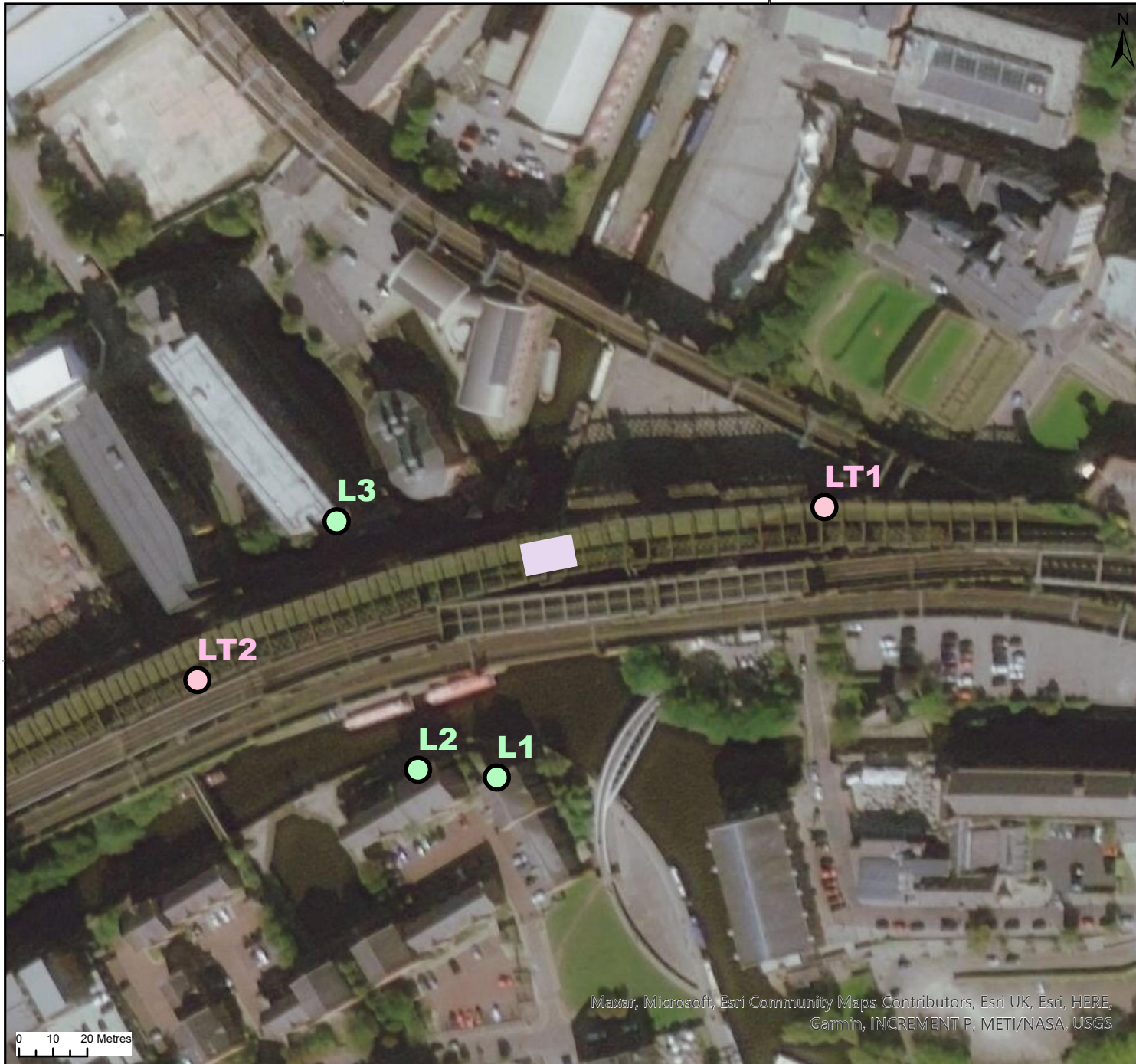
As discussed in Table 1, music is anticipated to be played from a TV inside the proposed development Events Space, as part of the gatherings at the end of walking tours. These events are likely to be in the evenings and will finish no later than 22:00 hrs.

Condition 9a imposes limits on entertainment noise at the façade of the nearest noise sensitive location. Publicly available mapping data has been used to identify the closest noise sensitive locations (NSL) to

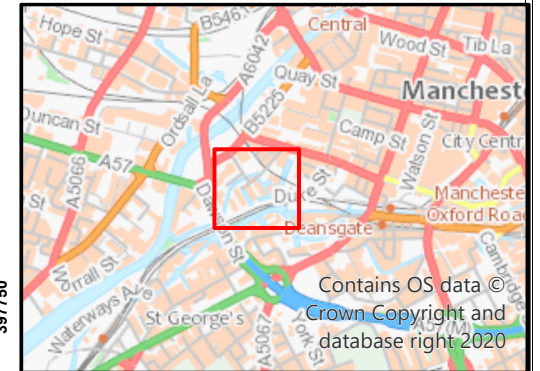
the proposed development, as shown in Table 2. The location of the proposed Events Space and the closest NSLs are shown on Figure 1.

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**Legend:**

- Baseline sound measurement locations
- Noise sensitive locations
- Proposed events space

Client:
National Trust

Project:
PC2387
Castlefield Viaduct,
Manchester

Title:
Baseline sound, receptors and events space locations

Figure: 1 Drawing No: N/A

Revision:	Date:	Drawn:	Checked:	Size:	Scale:
01	26/01/2022	TB	HM	A4	1:1,700

Co-ordinate system: British National Grid

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Table 2 Noise Sensitive Locations

NSL Reference	Address	Description
L1	1 to 17 Slate Wharf	4 storey residential property
L2	Ashton House, Slate Wharf	4 storey residential property
L3	37 Potato Wharf	7 storey residential property

The limit in condition 9a is that “the L_{Aeq} (entertainment noise) shall be controlled to 10dB below the L_{A90} (without entertainment noise) in each octave band”. To identify the applicable limit values, the baseline sound measurements undertaken as part of the Noise Impact Assessment (NIA)³ which accompanied the planning application for the proposed development have been used. From the measurements at LT1 and LT2, octave-band L_{90} levels during the period 19:00 to 22:00 hrs have been established, as shown in Table 3. The condition refers to A-weighted octave-band values for both the L_{Aeq} (entertainment noise) and L_{A90} (without entertainment noise). It is standard practice to tabulate the linear (i.e. without A-weighting) frequency spectral sound levels. As the condition refers to a difference between the octave-band levels, the frequency weighting does not affect compliance, so long as it is consistently applied to both parameters. Hence, this report provides linear frequency spectral values.

The presented values are the minimum of the arithmetic average and modal values of the $L_{90,15\text{-minute}}$ levels in each octave band from 63 Hz to 2 kHz. The proposed sound system is unlikely to generate significant music sound levels in the octave bands outside this range. The minimum value in each octave band is also provided, these are considered representative of a reasonable worst-case in that they are the lowest levels likely to be present at the façade of the closest NSLs.

Table 3 Measured octave-band L_{90} levels at LT1 and LT2, 19:00 to 22:00

Measurement Location	Measured L_{90} (dB) in octave band					
	63 Hz	125 Hz	250 Hz	500 Hz	1 kHz	2 kHz
LT1	56	54	50	49	49	41
LT2	56	51	48	48	50	43
Minimum	56	51	48	48	49	41

To identify the L_{Aeq} (entertainment noise) as required by the condition, calculations have been undertaken of the breakout of sound from the proposed Events Space utilising a 3-d computational model of the proposed development and surroundings, created in noise modelling software (SoundPLAN version 8.2). This model has been used to predict entertainment sound levels at each floor of the NSLs identified in Table 2. Details of the modelling procedures are provided in Appendix B.

The first stage in the calculation process is to identify likely entertainment sound levels in the Events Space. The proposed presentations will incorporate music as a background to the video, rather than as the focus of the event. The sound system volume will be set to make sure it is intelligible over the break-in sound levels from external sources (trains and trams). As part of the NIA, measurements were made of tram and train sound, from these, the external sound level at the façade of the Events Space has been calculated to be around 74 dB L_{Aeq} . Calculated train/tram pass by sound levels in the events space are around 58 dB L_{Aeq} . So that the video presentations are audible, the sound system will need to be around 20 dB above the internal sound level from external sources i.e. around 78 dB(A). Octave band internal

³ RHDHV (2021). Castlefield Viaduct, Manchester, Noise Survey Report.

sound levels are based on a typical frequency spectrum for background sound in a similar environment⁴, corrected to an overall level of 78 dB(A), as shown in Table 4.

Table 4 Likely internal reverberant entertainment sound levels in events space

Entertainment sound level L_{eq} (dB) in octave band					
63 Hz	125 Hz	250 Hz	500 Hz	1 kHz	2 kHz
75	75	74	74	75	70

The breakout of entertainment sound from the Events Space was calculated using the following equation:

$$L_w = L_i + c - R$$

Where: L_w is the sound power level per square metre of the element of the building;

L_i is the internal reverberant sound level inside the building;

c is a correction factor to convert from the internal reverberant sound field to the external free field, which has been taken to be -3; and

R is the sound reduction index of the building element.

The calculations incorporate breakout through the building walls, roof, doors, closed windows and include one open window to provide 0.8 m² free area as per the mechanical engineers ventilation design proposals. The sound reduction indices for these materials are provided in Appendix B.

The calculated entertainment sound L_{eq} levels, at the NSL where the highest levels are predicted (L3), are shown in Table 5, along with the measured L_{90} sound levels. These are compared with the criterion from the planning condition, which is that the entertainment sound L_{eq} must be at least 10 dB below the measured L_{90} .

Table 5 Comparison of predicted entertainment sound levels and measured background sound levels

Parameter	Sound levels (dB) in octave band					
	63 Hz	125 Hz	250 Hz	500 Hz	1 kHz	2 kHz
Predicted entertainment sound level (L_{eq})	37	33	31	30	31	26
Measured background sound level (L_{90})	56	51	48	48	49	41
Difference	19	18	17	18	18	15

Table 5 shows that the predicted entertainment sound levels are at least 15 dB below the measured L_{90} sound levels in each octave band i.e. compliant with the criteria in condition 9a.

4 Conclusion

Royal HaskoningDHV have provided acoustic support to the National Trust to enable discharge of conditions 9 and 10 of the planning consent for the proposed Castlefield Viaduct development in Manchester (MCC planning application reference 131621/FO/2021).

⁴ ACA Acoustics (2017). Acoustic assessment of sound insulation at 11 – 16 St Martin's Walk, Dorking. Available at [Acoustic assessment of sound insulation at 11 – 16 St Martin's Walk, Dorking \(molevalley.gov.uk\)](https://www.molevalley.gov.uk/acoustic-assessment-of-sound-insulation-at-11-16-st-martin-s-walk-dorking)

Through Royal HaskoningDHV's consultation with the MCC Environmental Health department, including provision of additional information regarding the proposed events and mechanical plant required to service the proposed development, conditions 10a and 10b are understood to have been discharged.

Condition 9a requires that the entertainment noise levels are at least 10 dB below the background sound levels in each octave band. Calculations have been undertaken of potential entertainment noise emissions from the proposed events space. Predicted entertainment noise levels at the closest noise sensitive location have been compared with background sound levels which were measured as part of the NIA which accompanied the planning application for the proposed development. The difference between these parameters is at least 15 dB; hence, the proposed development is compliant with the criteria in condition 9a and conditions 9a and 9b can therefore also be discharged.

Tim Britton

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Appendix A Noise and Vibration Terminology

This document provides a layperson's explanation of the acoustics terms that commonly appear in reports. It is not intended to give full scientific definitions or explain why these terms are as they are. Some obsolete terms and abbreviations have been included as they still appear in documents from time to time.

Table A.1 Common acoustic terms

Term	Description
Sound	the physical phenomenon of the transmission of energy through gaseous or liquid media via rapid fluctuations in pressure.
Level	values measured in decibels
Loudness	the human perception of the level of sound
Noise	no strict definition and is often used interchangeably with sound however it is usually taken to mean unwanted sound
Index	a value based on the mathematical processing of raw data
Indicator	a value used to indicate the likelihood of a particular response of effect e.g. $L_{10,18hr}$ is an index based on statistical processing of sound pressure data that is used as an indicator for road traffic noise response.
Weighted	spectral values have been modified to reflect a frequency sensitivity.
Directivity	the amount by which a source radiates more sound in one direction than another.
Decibels dB	a logarithmic ratio of two values of a variable. The decibel is not a true measurement unit nor is it exclusive to acoustics. Decibels are used because they can represent very wide ranges of ratios (from trillionths and billionths to billions and trillions) with a small range of decibel values. Decibels can be used to represent measured values by using a known reference value in the ratio. When using decibels to measure something it is therefore important to specify what variable is being measured and what reference level has been used. This is done by adding a reference value statement in the form "dB re x units", where the units indicate the variable being measured and x is the reference value. Decibels are used in acoustics because the human ear responds to sound pressure in a logarithmic way and the quantities measured in acoustics vary over wide ranges. As the decibel is used in acoustics to represent a range of sound level parameters, there is a standardised notation system. This takes the form of an italic capital letter 'L' (referring to 'level') and subscript characters which give specific details of what is being represented. Because decibels are logarithmic, they must be added, subtracted, multiplied, divided and averaged using different techniques from normal numbers.
Sound Pressure Level L_p obsolete – SPL	the basic measure of how much sound there is at a given location. It is a measure of the size of the pressure fluctuations in the air that we perceive as sound. Sound Pressure Level is expressed in decibels with a reference level of 20×10^{-6} Pa (L_p in dB re 20 μ Pa)
Sound Power Level L_w obsolete – SWL	is the total amount of sound produced by a source. It cannot be measured directly but it can be calculated from Sound Pressure Level measurements in known conditions. It can be used to predict the Sound Pressure Level at any point. Sound Power Level is expressed in decibels with a reference level of 1×10^{-12} W (L_w in dB re 1 pW).

Term	Description
A-weighting L_A or L_{pA} , L_{WA}	is an electronic filter which is equal to the frequency sensitivity of the human ear. Our sensitivity is at a maximum at around 2 kHz and steadily decreases above and below. Below 20 Hz and above about 20 kHz we can't hear at all. Within its operating limits a precision measurement microphone measures all frequencies the same so the output it produces does not reflect what we would hear. When considering impacts on humans, it is therefore often necessary to apply an A-weighting to the measured sound frequency spectrum. When A-weighted, the Sound Pressure Level L_p becomes L_{pA} (or L_A) and the Sound Power Level L_w becomes L_{WA}.
similar – C-weighting L_C or L_{pC} , L_{WC}	The response of the human ear varies depending on how loud the sound is. A-weighting matches the response of a sound level meter to human hearing at low levels (~ 40-90 dB). For higher levels there are other weightings, the most common of which is the C-weighting.

Table A.2 Different types of decibels commonly used in acoustics

Term	Description
L_p L_{pA} (or L_A)	The instantaneous sound pressure level (L_p) The A-weighted instantaneous sound pressure level (L_{pA} or L_A) This is the root mean square size of the pressure fluctuations in the air. This level can fluctuate wildly even for seemingly steady sounds. To make sound level meters easier to read the values on the display are smoothed or damped out. This is effectively done by taking a rolling average of the previous 0.125 s (FAST time constant) or the previous 1 s (SLOW time constant).
L_{AF} , L_{AS}	The letters F or S are added to the subscripts in the notation to indicate when the FAST or SLOW time constant has been used. These are often omitted but it is good practice to include them.
L_{max} L_{Amax} L_{AFmax}	The maximum instantaneous sound pressure level (L_{max}), The A-weighted maximum instantaneous sound pressure level (L_{Amax}) The A-weighted maximum instantaneous sound pressure level with a FAST time constant (L_{AFmax}). This is the highest instantaneous sound pressure level reached during a measurement period. The opposite of the L_{max} is the <i>minimum instantaneous sound pressure level</i> or L_{min} etc.
L_{min} , L_{Fmin}	It is good practice to include the letter which identifies the time constant used as this can make a significant difference to the value.
$L_{N,T}$ $L_{AN,T}$, $L_{AFN,T}$ N = %age value, 0-100 T = measurement time e.g. L_{A90} , L_{A10} , L_{AF90} , 5 min	The percentage exceedance sound pressure level ($L_{N,T}$), The A-weighted percentage exceedance sound pressure level ($L_{AN,T}$), the A-weighted percentage exceedance sound pressure level with a FAST time constant ($L_{AFN,T}$). This is the sound pressure level exceeded for $N\%$ of the time T. e.g. If an A-weighted level of x dB is exceeded for a total of 6 minutes within one hour, the level will have been above x dB for 10% of the measurement period. This is written as $L_{A10,1hr} = x$ dB. L_{A0} (the level exceeded for 0 % of the time) is equivalent to the L_{Amax} and L_{A100} (the level exceeded for 100 % of the time) is equivalent to the L_{Amin}. It is good practice to include the letter which identifies the time constant used as this can make a significant difference to the value. The most commonly used index is the L_{90} (i.e. the sound pressure level that is exceeded for 90% of the measurement duration) which is referred to as the <i>background sound level</i>.
$L_{eq,T}$ $L_{Aeq,T}$ T = measurement time eg. $L_{Aeq,5min}$	The equivalent continuous sound pressure level over period T ($L_{eq,T}$), The A-weighted equivalent continuous sound pressure level over period T ($L_{Aeq,T}$). This is effectively the average sound pressure level over a given period. As the decibel is a logarithmic quantity the L_{eq} is not a simple arithmetic mean value. The L_{eq} is calculated from the raw sound pressure data. It is not appropriate to include a reference to the FAST and SLOW time constants in the notation

Appendix B Acoustic Modelling Details

Prediction Methodology

Modelling of sound levels from the development have been undertaken using SoundPLAN (V8.2) acoustic modelling software. This software implements the sound propagation calculation methodology set out in ISO 9613-2:1996 – Attenuation of sound during propagation outdoors

Acoustic modelling input data

Data sources used for this modelling are shown in Table B-1.

Table B-1 Data sources

Data	Source file	Received From
Nearby building locations	OSM_Building.geo	OpenStreetMap (via SoundPLAN)
Site topography	CAD drawing entitled 'Top Level of Viaduct', ref 21554_01, dated 14/12/21. Spatial Dimensions. Drawing file name J21554_01.dwg	Twelve Architects
Wider area topography	SJ89nw_DTM_1m.tif DSM_SJ8095_P_10661_20200205_20200310.tif	Defra LiDAR survey data (available at Defra Survey Data Download)
Site layout	CAD drawing entitled 'Stage 4 Masterplan', number (GA)001 rev. C, dated 22/09/21. Twelve Architects. Drawing file name 122019(GA)001.dwg	Twelve Architects
Event space elevations	PDF drawing entitled 'Events Space Wall Elevations', number (21)400 rev. B, dated 08/10/21. Twelve Architects. Drawing file name 122019(21)400.pdf	Twelve Architects
Event space building fabric	<i>External wall</i> PDF drawing entitled 'Wall Type Details', number (21)700 rev. A, dated 08/10/21. Twelve Architects. Drawing file name 122019(21)700.pdf	Twelve Architects
	<i>Roof</i> PDF drawing entitled 'Events Space Roof Details', number (27)700 rev. C, dated 08/10/21. Twelve Architects. Drawing file name 122019(27)700.pdf	
Event space ventilation proposals	PDF drawing entitled 'Combined Mechanical Services Layout', ID CVI-ARUP-ZZ-GF-DR-M-000501, rev. P01, dated 26/11/21. ARUP. Drawing file name CVI-ARUP-ZZ-GF-DR-M-000501.pdf	Twelve Architects

Sound reduction index data used for building elements in the acoustic modelling are set out in Table B-2.

Table B-2 Sound transmission data

Building Element	Sound Reduction Index (dB) at Octave Band Centre Frequency (Hz)							Overall R_w (dB)	Comments
	63	125	250	500	1000	2000	4000		
Wall	18	35	50	68	80	80	80	60	Predicted using INSUL sound insulation prediction software (v9.0.23) for the following make-up: 15mm thick plasterboard / 15mm thick particle board / 120mm wide timber stud frame (stud spacing 600mm), cavity filled with foam / 15mm thick particle board / 75mm wide timber stud frame (stud spacing 600mm) with empty cavity / 11mm thick weatherboard
Roof	13	21	38	65	83	85	85	48	Predicted using INSUL sound insulation prediction software (v9.0.23) for the following make-up: 4mm thick rubber / 225mm deep timber stud frame (stud spacing 600mm), cavity filled with mineral wool (33 kg/m ³) / 17.5mm thick

Building Element	Sound Reduction Index (dB) at Octave Band Centre Frequency (Hz)							Overall R_w (dB)	Comments
	63	125	250	500	1000	2000	4000		
									plywood / solid 417mm deep timber joist with empty cavity / 15mm thick plasterboard
Window	14	21	17	25	35	37	31	29	SoundPLAN library double glazing 4mm glass / 16mm gap / 4mm glass
Door	13	16	23	26	29	32	34	30	Overall R_w value as per sliding door data, Architectural Window Systems, Acoustics Tested Windows and Doors ⁵ . Spectral data taken from Engineering Noise Control by D.A. Bies & C. H. Hansen (1996).
Opening	0	0	0	0	0	0	0	0	

Acoustic model settings

Acoustic modelling has been undertaken using the following model settings:

- Maximum search radius of 5000m.
- Maximum number of reflections: 3
- Noise predictions carried out at each floor level of sensitive receptors, ground floor level is 1.5m above ground, each storey is 2.5m high.
- Side diffraction enabled.
- Ground absorption has been set as:
 - All set to $G=0$ (representing hard ground) to represent a conservative scenario.

Uncertainty in modelling

It should be noted that any predictions of sound levels have an associated degree of uncertainty. Modelling and measurement processes have been carried out in such a way to reduce such uncertainty; it is unavoidable that some remains. In particular, the following sources of uncertainty have been noted:

- Predictions of sound pressure levels according to ISO 9613 are based on an assumption of moderate downwind propagation, and hence could be considered as a worst-case calculation. However, the standard also indicates an estimated accuracy of ± 3 dB L_A in predicted levels.
- Sound insulation data, used to calculate the break-out of sound from within buildings, were not available for some of the construction materials, and have been estimated from the details of the construction, using industry standard methods, but a degree of uncertainty in sound breakout from the building will result from the use of these estimates. For example, sound insulation prediction software INSUL estimates a ± 3 dB R_w margin of error in the predictions.

In addition, any measurement of existing ambient or background sound levels will be subject to a degree of uncertainty. Environmental sound levels vary between days, weeks, and throughout the year due to variations in source levels and conditions, meteorological effects on sound propagation and other factors. Hence, any measurement survey can only provide a sample of the ambient levels. Every effort is made to ensure that measurements are undertaken in such a way as to provide a representative sample of conditions, such as avoiding periods of adverse weather conditions, and school holiday periods (which are often considered to result in atypical sound levels). However, a small degree of uncertainty will always remain in the values taken from such a measurement survey.

⁵ Available at [AWS-WHITEPAPER_Acoustics.pdf \(awsaustralia.com.au\)](https://awsaustralia.com.au/AWS-WHITEPAPER_Acoustics.pdf)

The following procedures were undertaken to minimise uncertainty in the measured data:

- Use of suitable Class 1 sound level meters which comply with the relevant standards and have been calibrated at a UKAS accredited laboratory within the previous year.
- Field calibration of the measurement system on site at the start and end of the monitoring period.
- Consideration of weather conditions through regular wind speed/direction measurements.

With regards to the calculations, uncertainties have been minimised as follows:

- The predictions have been completed using a reputable noise mapping software package (SoundPLAN) which implements a validated method of calculation (ISO 9613-2).