1.5.6 ACOUSTIC REPORT

ACOUSTIC
CONSULTANTS LTD

Acoustic Design Advice

Redcliff Quarter, PBSA Block - Acoustic Design Advice

Reference: 10014/AW

Client:	Architect
winvic	WESTWORKS

Document Control				
Version	**Revision Description**	**Date**	**Author:**	**Reviewed by:**
1.0	--	22/12/22	Andrew Warren AMIOA	Blake Lucas MIOA
Rev A		09/02/23	Andrew Warren AMIOA	Blake Lucas MIOA
Rev B	Amended ventilation provisions	14/02/23	Andrew Warren AMIOA	Blake Lucas MIOA
Rev C	Amended window constructions	11/04/23	Andrew Warren AMIOA	Blake Lucas MIOA
Document Reference: 10014/AW/BL				

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

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

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1. Introduction

Acoustic Consultants Limited have been appointed provide noise and acoustic advice for the purpose built student accommodation development at Redcliff Quarter, Bristol.

The site has planning approval (application number 21/04306/F) with two noise related conditions (condition 8 & 11) relating to external noise control (C8), and plant noise impact upon the nearest sensitive receivers within the development and in the surrounding premises (C11).

This report provides comment and advice on the internal separating and flanking element constructions, room acoustics, external noise ingress, and plant noise and vibration with respect to compliance with the design criteria.

The development is to be designed to meet the planning consent and Approved Document E.

2. The Site and Proposals

The site is a 14 storey building and is part of a large mixed-use scheme in the city centre of Bristol. The ground floor will house plant rooms, a bin store, amenity space, an office/welfare room. All floors above are for student accommodation.

This report does not address the other elements of the wider development.

The main noise sources affecting the site are road traffic along St Thomas Street to the East, Three Queens lane to the South and Redcliff Street to the West.

The nearest noise sensitive receivers to this development will be the proposed residential dwelling as part of the wider Redcliff Quarter development, and the existing flats directly to the north of the site.

The following figures show the site location, ground and first floor GA plans and roof plan.

Figure 1: Proposed Full Development location

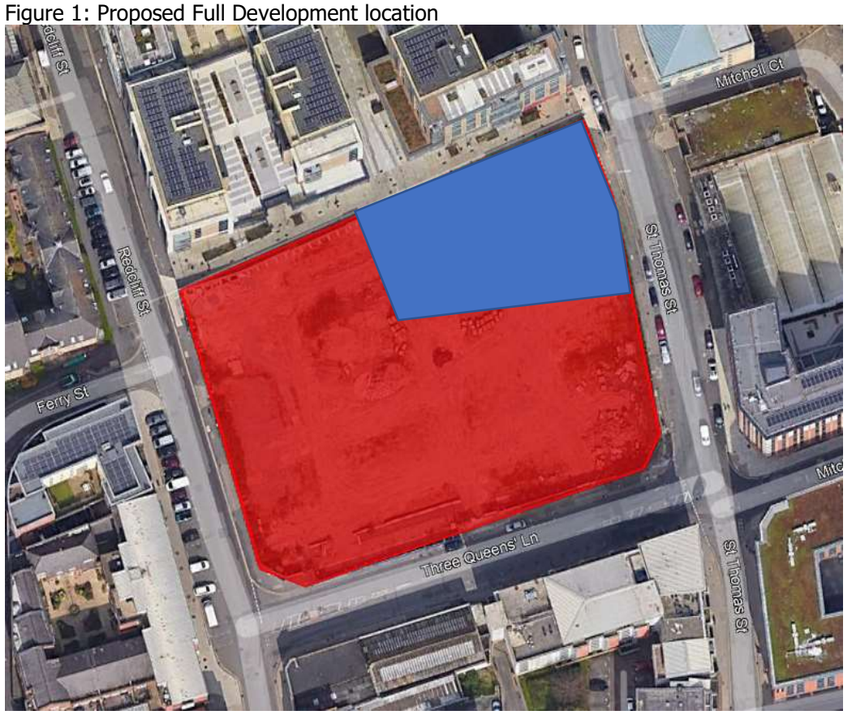
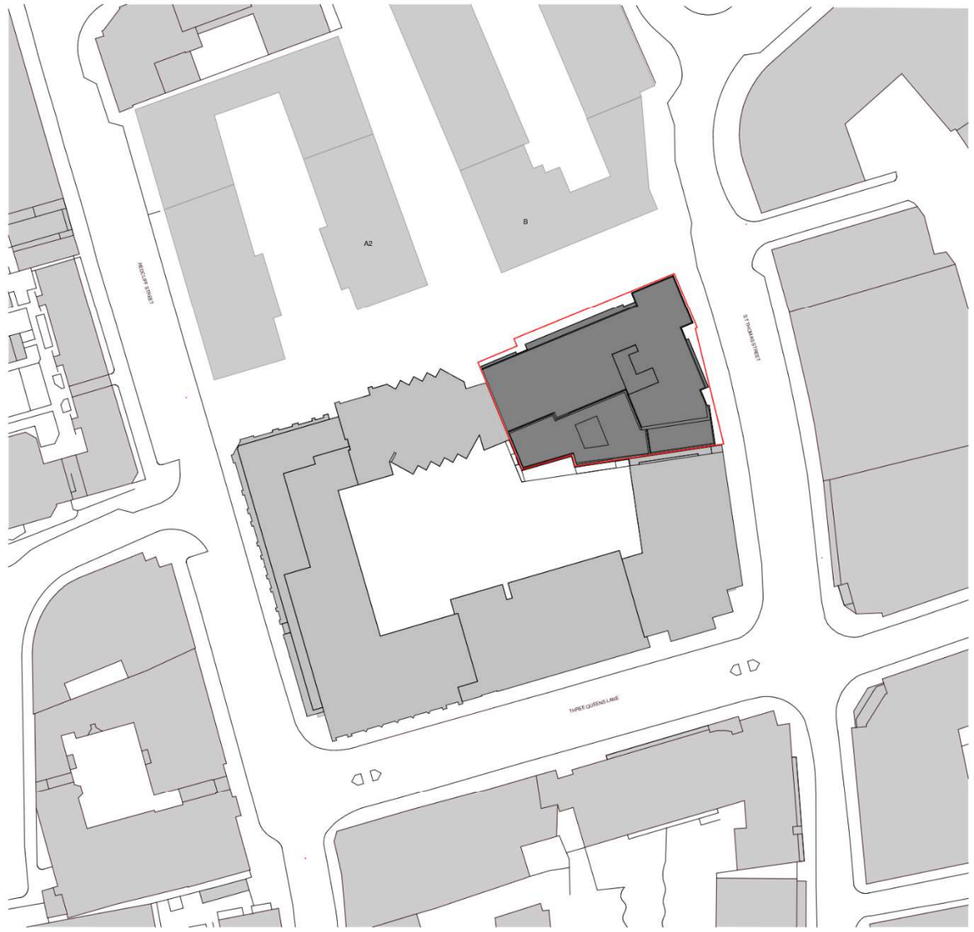


Figure 2: Proposed Site Plan

CDM 2015 Health & Safety Information

This information relates only to 'Significant Hazards' identified on this drawing and is to be read in conjunction with the Designer's Risk Assessment Register.



10 0 10 20 30 40 50 m

Scale 1:1000@A3

Client's Name: Winvic

Drawing Title: Site Plan 1-1000

Job No	Origin	Volume	Level	Type	Role	Number	Rev
P22-022	WW	ZZ	ZZ	DR	A	1000	P01

Drawn: CK | Checked: AB | Date: 12/09/22

Job Title: Redcliff Quarter Student Block

Job No.: W0740

Status: PRELIMINARY

Rev	Date	Revision Details	Dr	Ch
P01	12/09/22	Issued for Draft Stage 3	AB	CK

Bristol: Westworks, Beacon Tower, Colston Street, Bristol, BS1 4XE
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CAD Plot Date: 12/09/2022 17:07:21

Figure 3: Proposed Ground Floor GA Plan

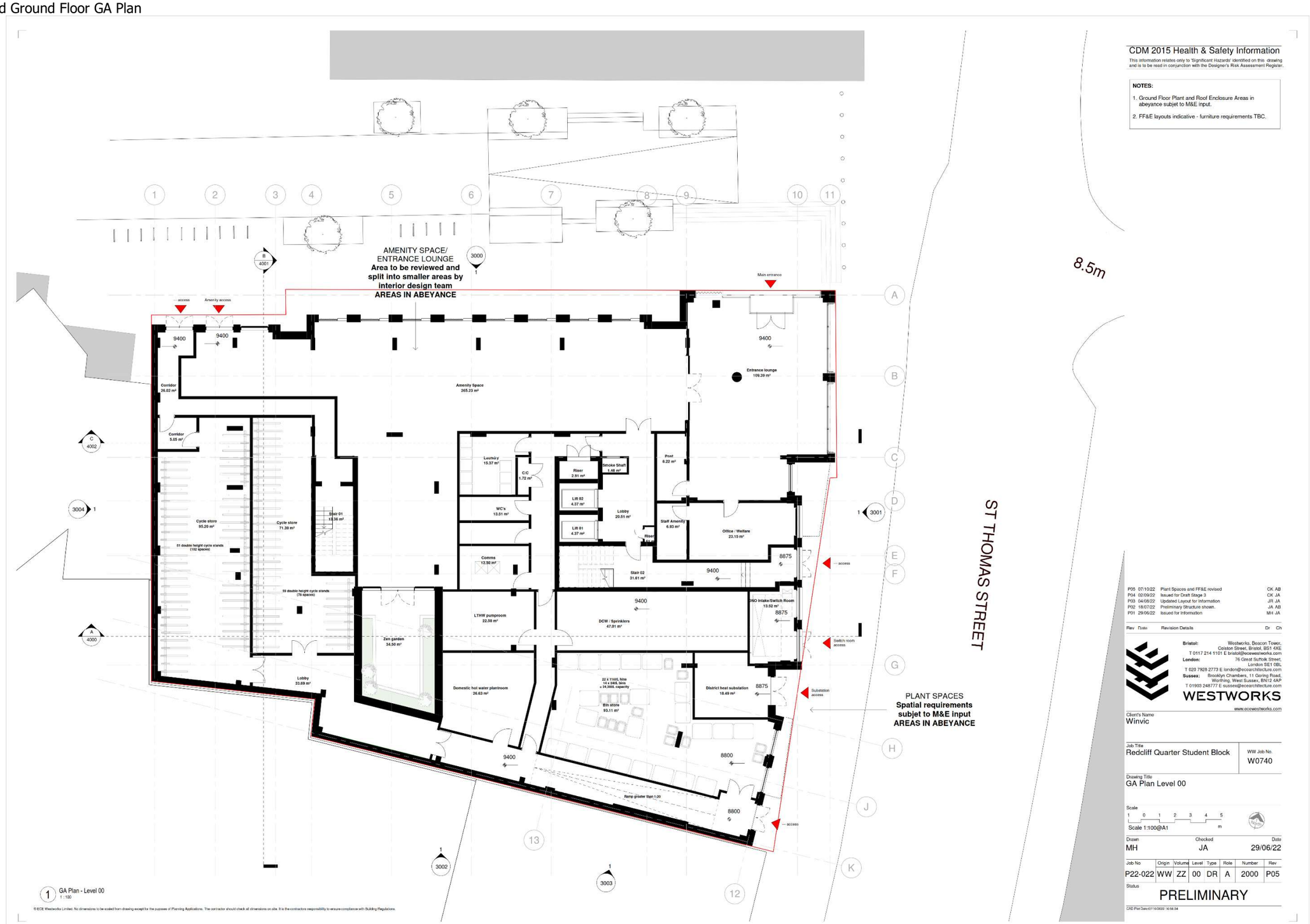

Figure 4: Ground First Floor GA

CDM 2015 Health & Safety Information

This information relates only to 'Significant Hazards' identified on this drawing and is to be read in conjunction with the Designer's Risk Assessment Register.

Key:

- DS01 - Min. Area 22.0m2
- DS02 - Min. Area 26.0m2
- E01 - Min Area 13.5m2
- E02 - Min Area 15.0m2
- E03 - Min Area 14.2m2
- S01 - Min Area 16.5m2
- S02 - Min Area 17.5m2
- S03 - Min Area 19.0m2
- TH01 - Min Area 54.0m2
- TW01 - Min Area 36.0m2

NOTES:

1. Ground Floor Plant and Roof Enclosure Areas in abeyance subjet to M&E input.
2. FF&E layouts indicative - furniture requirements TBC.

Rev	Date	Revision Details	Dr	Ch
P03	07/10/22	Plant Spaces and FF&E revised	CK	AB
P02	02/09/22	Issued for Draft Stage 3	CK	JA
P01	18/07/22	Preliminary Structure shown.	JA	AB

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Client's Name: Winvic

Job Title: Redcliff Quarter Student Block

WW Job No.: W0740

Drawing Title: GA Plan Level 01

Scale: Scale 1:100@A1

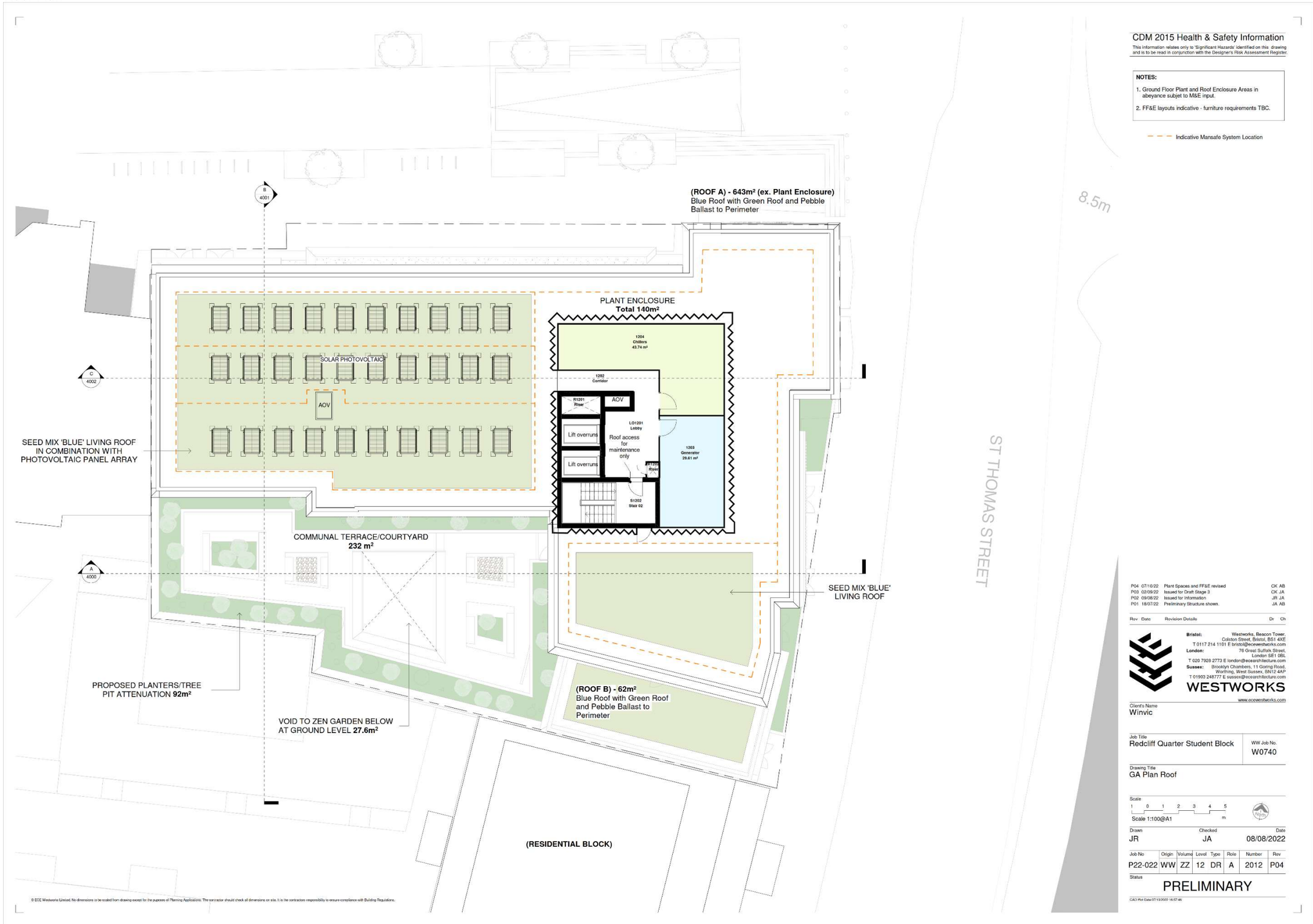
Drawn: JA | Checked: AB | Date: 07/07/22

Job No	Origin	Volume	Level	Type	Role	Number	Rev
P22-022	WW	ZZ	01	DR	A	2001	P03

Status: PRELIMINARY

CAD File Date:07/10/2022 10:50:39

Figure 5: Proposed Roof Plan



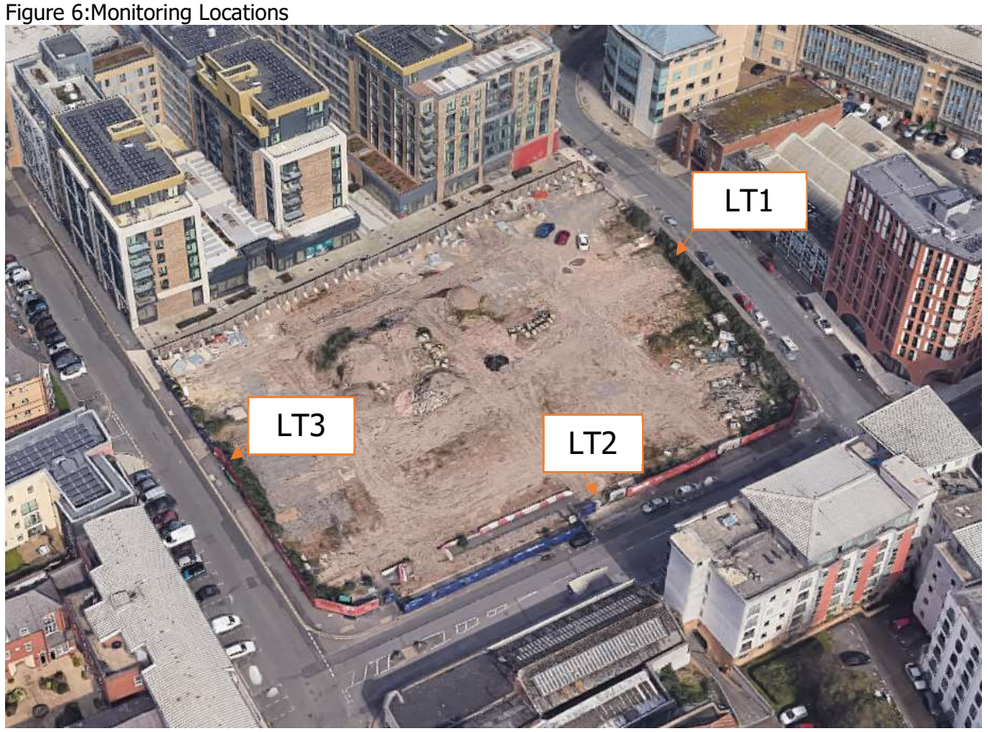
3. Noise Survey

3.1. Monitoring Procedure

A long-term noise survey was undertaken between the 11th and the 15th of August 2022 to determine the existing noise climate at the site. The full survey details are within our planning report. Each sound level meter was positioned to monitor the noise levels from each surrounding road.

The monitoring locations are shown on the following figure:

Figure 6:Monitoring Locations



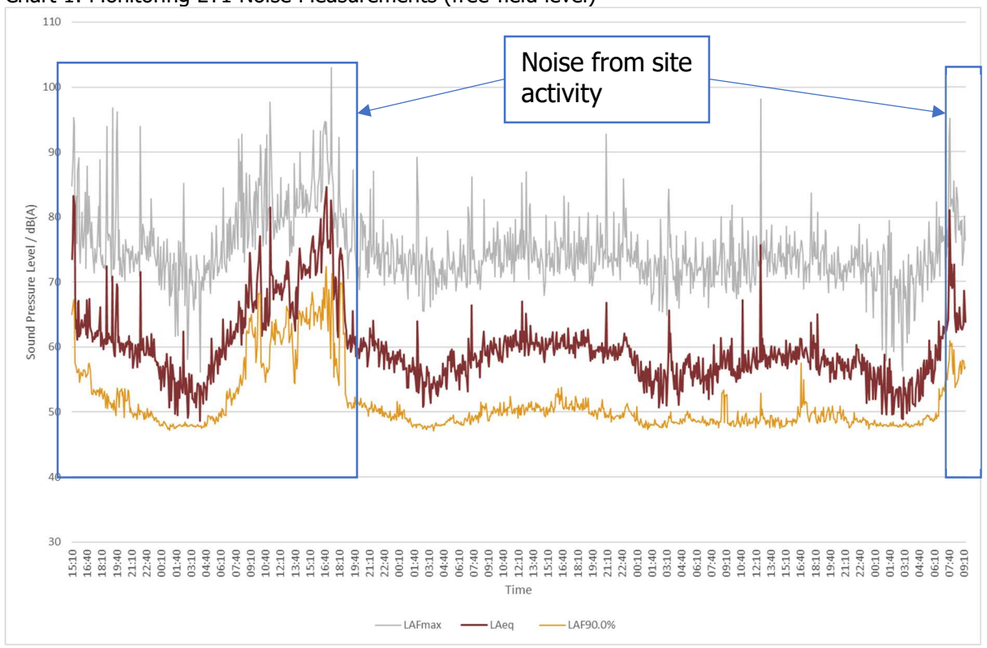
3.2. Measured Noise Levels

As this is an active building site, the measurements at each location were affected by noise from onsite activities during the weekday periods. As such, our design ambient levels have been determined only from the weekend measurements. The following section provides the measured long-term data at each location in chart format along with the typical noise level in tabular format.

3.2.1. Monitoring Location LT1

The following chart shows the measured noise levels during the entire monitoring exercise:

Chart 1: Monitoring LT1 Noise Measurements (free-field level)



We have determined the following ambient noise levels from LT1:

Table 1: Spectral Design noise levels at LT1 (free-field) at Monitoring Location 1

Parameter	Octave Band								dB(A)
	63	125	250	500	1kHz	2kHz	4kHz	8kHz	
Day, $L_{eq(16\ hour)}$	66	61	60	56	57	51	44	37	61
Night, $L_{eq\ (8hour)}$	62	56	55	53	54	48	41	33	57
Night, L_{AFMax}	74	76	72	72	74	69	63	57	77

We have also determined the following modal background sound level at LT1:

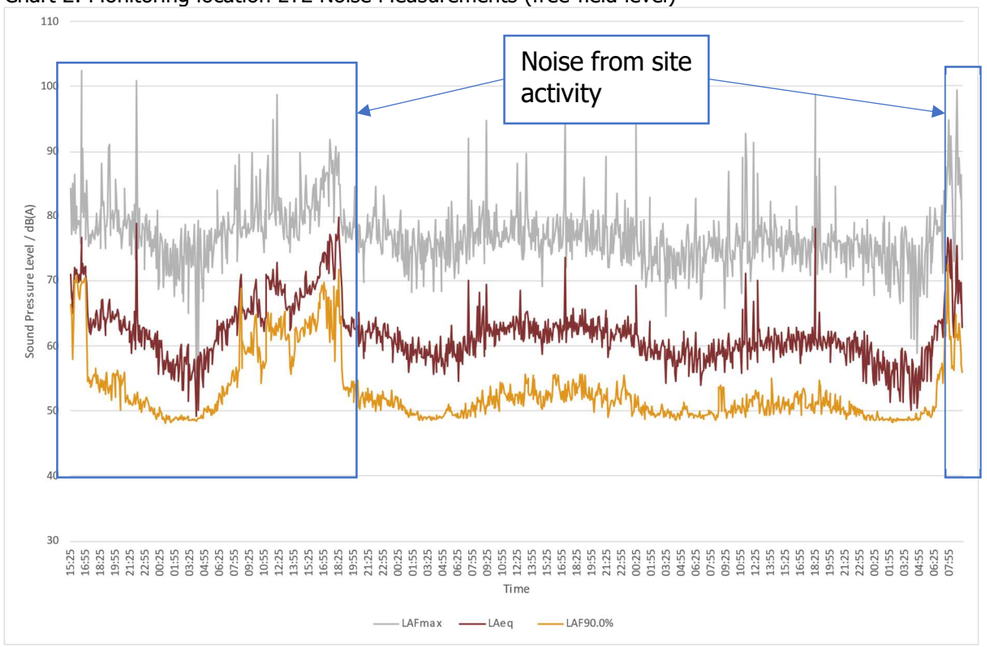
Table 2: Modal background and residual noise levels at LT1

Period	dB $L_{A90,5min}$		dB $L_{Aeq,5min}$	
	Range	Mode	Range	Mode
Day (07:00 - 23:00)	48 - 58	49	52 - 76	58
Night (23:00 - 07:00)	47 - 54	48	49 - 66	55

3.2.2. Monitoring Location LT2

The following chart shows the measured noise levels during the entire monitoring exercise:

Chart 2: Monitoring location LT2 Noise Measurements (free-field level)



We have determined the following ambient noise levels from Monitoring Location LT2:

Table 3: Spectral Design noise levels at Location 2 (free-field) at Monitoring Location LT2

Parameter	Octave Band								dB(A)
	63	125	250	500	1kHz	2kHz	4kHz	8kHz	
Day, $L_{eq(16\ hour)}$	68	63	61	59	59	56	50	45	63
Night, $L_{eq\ (8hour)}$	64	59	58	55	57	53	46	40	60
Night, L_{AFMax}	70	77	73	72	77	70	60	51	79

We have also determined the following modal background sound level at location LT2:

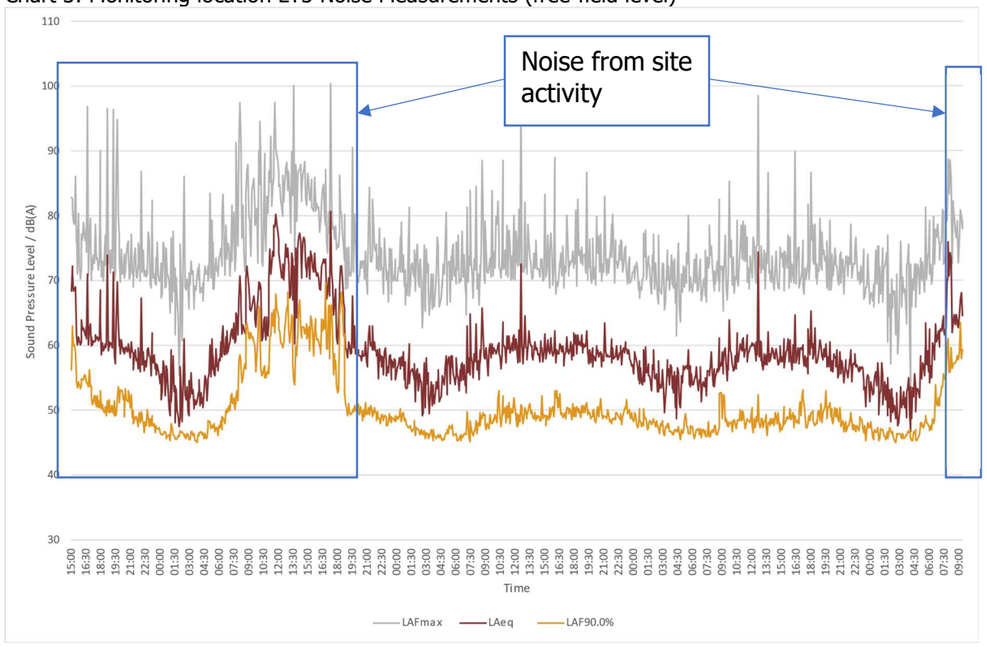
Table 4: Modal background and residual noise levels at LT2

Period	dB $L_{A90,5min}$		dB $L_{Aeq,5min}$	
	Range	Mode	Range	Mode
Day (07:00 - 23:00)	49 – 56	50	55 – 78	61
Night (23:00 - 07:00)	48 – 56	49	50 – 69	57

3.2.3. Monitoring Location LT3

The following chart shows the measured noise levels during the entire monitoring exercise:

Chart 3: Monitoring location LT3 Noise Measurements (free-field level)



We have determined the following ambient noise levels from Monitoring Location LT3:

Table 5: Spectral Design noise levels at Location 3 (free-field) at Monitoring Location LT3

Parameter	Octave Band								dB(A)
	63	125	250	500	1kHz	2kHz	4kHz	8kHz	
Day, $L_{eq(16\ hour)}$	66	61	59	56	57	52	46	38	60
Night, $L_{eq\ (8hour)}$	63	56	54	52	53	48	40	31	56
Night, L_{AFMax}	73	70	71	72	73	65	56	48	75

We have also determined the following modal background sound level at location LT3:

Table 6: Modal background and residual noise levels at LT3

Period	dB $L_{A90,5min}$		dB $L_{Aeq,5min}$	
	Range	Mode	Range	Mode
Day (07:00 - 23:00)	45 – 53	49	52 – 74	58
Night (23:00 - 07:00)	45 – 54	47	47 – 64	54

4. Performance Specification

The following performance specification has been produced. By meeting this performance, the planning requirements, building regulations, BREEAM 2018 and good acoustic design can be met.

4.1. Sound Insulation

4.1.1. BREEAM Hea 05

Hea 05 states there are two credits for sound insulation, Table 5.19 of Hea 05 states:

First & second credit - Sound insulation	
Criteria	**One credit** Airborne sound insulation values are at least 3 dB higher and impact sound insulation values are at least 3 dB lower than the performance standards in the relevant building regulations or standards. **Two credits** Airborne sound insulation values are at least 5 dB higher and impact sound insulation values are at least 5 dB lower than the performance standards in the relevant building regulations or standards.

It is understood that the client is targeting 2 credits.

Regulation E1 - *"Protection against sound from other parts of the building and adjoining buildings".*

Compliance with Regulation E1 will be demonstrated by on-site pre-completion sound insulation testing. The sound insulation performance for separating walls and floors for rooms for residential are specified in Table 0.1a and 0.1b of the "Approved Document 'E' (2003 Edition)" of the Building Regulations 2000. This is replicated in the table below.

4.1.2. Residential Areas

It is our understanding that the rooms are designated as cluster flats and studios, and the Regulation E1 criteria applies between cluster flats/studios and any other space, and not bedrooms within a cluster flat. Building Control have not yet confirmed that this is correct.

Regulation E1 – Sound Transmission between Rooms

Regulation E1 - *"Protection against sound from other parts of the building and adjoining buildings".*

Compliance with Regulation E1 will be demonstrated by on-site pre-completion sound insulation testing. The sound insulation performance for separating walls and floors for dwellings (between cluster flats) and rooms for residential (between studios) are specified in Table 0.1a and 0.1b of the "Approved Document 'E' (2003 Edition incorporating 2004, 2010, 2013, 2015 amendments)" of the Building Regulations 2003. This is replicated in the table below.

Table 7: Approved Document 'E' (2003) Separating Element Performance Standards

Table 0.1a/b: Dwelling - Performance standards for separating walls, separating floors, and stairs that have a separating function.	Airborne sound insulation $D_{nT,w} + C_{tr}$ dB	Impact sound insulation $L'_{nT,w}$ dB
New Build Dwelling		
Walls	≥45	-
Floors and stairs	≥45	≤62
Rooms for Residential		
Walls	≥43	-
Floors and stairs	≥45	≤62

Regulation E2 – Sound Transmission within a Dwelling

Regulation E2 - *"Protection against sound within a dwelling-house etc".*

The Approved Document 'E' only specifies a performance for walls between bedrooms or WC's and any other dwelling room.

The performance requirement is for walls to achieve a laboratory rated value of at least 40 dB R_w. It is our understanding this applies to walls between bedrooms within cluster flats, twodios and threedios.

4.1.3. Summary of Sound Insulation Criteria

Based on the above documents the following sound insulation requirements should be met between all of the following spaces of the development where there are no doors, vision panels or openings within the partition. The full performance is as shown in the appendix. The following requirements have been confirmed by building control.

Table 8: Sound Insulation Criteria

Source Room	Receive Room	Minimum Airborne Sound Insulation	Maximum Impact Sound Insulation in Receive room
Cluster Flat Studio (Floors)	Cluster Flat Studio (Floors)	≥50 dB $D_{nTw} + C_{tr}$	≤57 dB L_{nTw} dB
Studio (separating walls)	Studio (separating walls)	≥48 dB $D_{nTw} + C_{tr}$	
Cluster Flat Bedroom (Wall)	Cluster Flat Bedroom (Wall)	≥40 dB R_w	
Lift/Plant/Substation/ Refuse Areas	Dwellings/Office/Amenity	≥60 dB D_{nTw}[1]	

[1] Subject to lift / plant noise levels, this is on the basis maximum noise level in plant / lift room will not exceed NR65.

4.1.4. Doors

Where the entrance door of a dwelling opens into a communal circulation area there is a building regulations requirement for the door to provide a reasonable level of sound insulation. The following table shows the minimum laboratory sound reduction performance. This performance is also noted on the marked up drawings in the Appendix.

Table 9: Door Sound Insulation Criteria

Source Room	Receive Room	Minimum Sound Reduction dB R_w
Dwelling	Corridor	29
Ground Floor Amenity Area	Corridor	35
Plant/Refuse/Shaft Risers	Corridor	40

4.1.5. Sound Transmission between Noise Generating Elements & Apartments

In addition to the criteria stated above, we would recommend that between the plant rooms and apartments; and lift shaft and apartments, the design criteria be increased. This is to protect the residential occupiers from noise generated in these spaces. The criteria are as noted in the summary below.

4.2. Room Acoustics

4.2.1. BREEAM Hea 05

Hea 05 states there is one credit for room acoustics, Table 5.19 of Hea 05 states:

Fourth credit - Room acoustics	
Criteria	Achieve the requirements relating to sound absorption within residential spaces and within the common spaces of the building described in the relevant building regulations or building standards national guidance.
Testing requirement	Installation of a specification compliant with the relevant building described in the relevant building regulations or building standards national guidance demonstrates compliance. A site inspection by the developer or SQA is required to confirm that a compliant specification has been installed.

4.2.2. Residential Areas

Regulation E3 - "*Reverberation in the common internal parts of buildings containing flats or dwelling purposes*".

Within the communal corridors which open into the dwelling the reverberation time needs to be suitably controlled for Building Regulations. There are two methods of demonstrating compliance, Method A and B. By meeting this criteria both building regulations and BREEAM Hea 05 is met for these areas.

4.2.3. Communal Areas

BREEAM Hea 05 refers to British Standard 8233:2014 for the other areas, the standard does not provide any performance criteria in terms of reverberation time control. As such, we have used our experience for other similar sites to set the reverberation time limits.

The limits considered relevant to the sensitive communal areas are described below. The Reverberation Time (T_{mf}) criteria is the arithmetic average of the mid frequency bands (500 Hz, 1KHz, and 2 KHz).

Table 10: Maximum Reverberation Time

Type of Room	Reverberation Time Criteria T_{mf} (seconds) *
Office/Welfare	$\leq$1.0

* Based on a fully fitted out and furnished space.

4.3. Indoor Ambient Noise Levels

4.3.1. Planning Condition 8

Condition 8 of the Notice of Decision for Application no. 21/04306/F states the following:

"Noise Impact Assessment

The development shall only be carried out in accordance with the recommendations of the Noise Impact Assessment carried out by Adnitt Acoustics (ref. E21065/ENV/R1- dated 16 June 2021). All recommendation detailed in the Noise Assessments submitted with the application with regards to sound insulation and ventilation of residential properties shall be implemented in full prior to the commencement of the use permitted and be permanently maintained.

Reason: In the interests of protecting residential amenity."

Adnitt Acoustics report followed the guidance of BS8233, which is provided below.

4.3.2. BREEAM Hea 05

Hea 05 states there is one credit for indoor ambient noise levels, Table 5.19 of Hea 05 states:

Third credit - Indoor ambient noise levels	
Criteria	Achieve indoor ambient noise levels that comply with the design ranges given in Section 7 of BS 8233:2014
Testing requirement	A programme of pre-completion acoustic testing is carried out by a compliant test body in accordance with the acoustic testing and measurement procedures outlined in Methodology below.

4.3.3. Residential Areas

Normal Conditions

BS8233, entitled 'Guidance on sound insulation and noise reduction for buildings', provides advice on noise as it affects buildings of all types, giving consideration to various common sources of noise and forms part of the planning consent for the scheme.

It outlines design guidance in general terms and provides criteria for the indoor ambient noise levels (IANLs) for different types of room. These are stated in terms of the 'equivalent continuous

sound pressure level' over the reference time period, the $L_{Aeq,\ T}$. The IANLs specified by British Standard 8233 that are relevant to this development are as follows.

Table 11: IANL criteria of British Standard 8233:2014 under normal conditions

Activity	Location	07:00 to 23:00	23:00 to 07:00
Resting	Living room	35 dB $L_{Aeq,\ 16\ hr}$	--
Dining	Dining room / area	40 dB $L_{Aeq,\ 16\ hr}$	--
Sleeping (daytime resting)	Bedroom	35 dB $L_{Aeq,\ 16\ hr}$	30 dB $L_{Aeq,\ 8\ hr}$

Section 7.7.2 Note 4 of the British Standard states *"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".*

British Standard 8233:2014 provides no definitive criteria for maximum noise levels from individual events ($L_{Amax,F}$). Section 3.4 of the WHO Guidance states *"For a good sleep, it is believed that indoor sound pressure levels should not exceed approximately 45 L_{Amax} more than 10-15 times per night (Vallet & Verbey 1991)".*

This criteria is referred to in both planning and BREEAM. By meeting this criteria both planning and the BREEAM Hea 05 criteria is met for these areas.

Overheating Conditions

There is no planning requirement within BANES to consider noise and overheating, and the development is not required to meet Building Regulations Part O. .

However, in absence of other guidance, the principles of ADO can be followed in terms of noise. Therefore, during the day or night a +10dB uplift over BS8233.

Table 12: IANL criteria under Overheating conditions

Activity	Location	07:00 to 23:00	23:00 to 07:00
Resting	Living room	45 dB $L_{Aeq,\ 16\ hr}$	--
Sleeping (daytime resting)	Bedroom	45 dB $L_{Aeq,\ 16\ hr}$	40 dB $L_{Aeq,\ 8\ hr}$
			55 dB L_{AFmax}

4.3.4. Commercial Areas

For the commercial areas we have set the criteria based on BS8233 and our knowledge of other schemes. British Standard 8233:2014 does not provide full performance criteria for this scheme, as such we have set limits as follows:

Table 13: Maximum Indoor Ambient Noise Level

Type of Room	Maximum IANL $L_{Aeq(60min)}$ dB
Office/Welfare	40

4.4. Room Acoustics

4.4.1. Residential Areas

Regulation E3 - "*Reverberation in the common internal parts of buildings containing flats or dwelling purposes*".

Within the communal corridors which open into the dwelling the reverberation time needs to be suitably controlled for Building Regulations. There are two methods of demonstrating compliance, Method A and B.

Compliance with Regulation E3 will be demonstrated on a drawing or in a report, which should include plans indicating the assignment of the absorptive material (normally applied to the ceiling) in the enclosed space.

4.5. External Plant Noise Control

4.5.1. Condition 11

Condition 11 of the Notice of Decision for Application no. 21/04306/F states the following:

"Noise from plant & equipment

The rating level of any noise generated by plant & equipment as part of the development shall be at least 5 dB below the pre-existing background level as determined by BS4142: 2014 Methods for rating and assessing industrial and commercial sound. Prior to the commencement of the use of this development an assessment to show that the rating level of any plant & equipment will be at least 5 dB below the background level has been submitted to and approved in writing by the Council. The assessment must be carried out by a suitably qualified acoustic consultant/engineer and be in accordance with BS4142: 2014 Methods for rating and assessing industrial and commercial sound.

Reason: In the interests of residential amenity."

4.5.2. BREEAM 2018 Pol 05

We have been advised the development is targeting one credit under BREEAM 2018 Pol 05. These relate to plant noise break out to nearby sensitive receivers. There is one credit within Pol 05 for the control of plant. The credit can be awarded under the following conditions.

1 There are no noise-sensitive areas within the assessed building or within 800 m radius of the assessed site.

OR

2 Where there are noise-sensitive areas within the assessed building or noise-sensitive areas within 800 m radius of the assessed site, a noise impact assessment compliant with BS 4142:2014[1] is commissioned. Noise levels must be measured or determined for:

2.a: Existing background noise levels:

2.a.i at the nearest or most exposed noise-sensitive development to the proposed assessed site

2.a.ii including existing plant on a building, where the assessed development is an extension to the building

2.b: Noise rating level from the assessed building.

3 The noise impact assessment must be carried out by a suitably qualified acoustic consultant.

4 The noise level from the assessed building, as measured in the locality of the nearest or most exposed noise-sensitive development, must be at least 5dB lower than the background noise throughout the day and night.

5 If the noise sources from the assessed building are greater than the levels described in criterion 4, measures have been installed to attenuate the noise at its source to a level where it will comply with the criterion.

4.5.3. **BS4142:2014**

For industrial and commercial noise, the most relevant guidance is provided within British Standard 4142:2014+A1:2019. The methods described in the British Standard use outdoor sound levels to assess the likely effects of sound upon people who might be inside or outside a dwelling or other premises used for residential purposes.

The initial estimate principle is that of establishing the 'difference' between the 'rating level' and the 'background sound level'. The 'rating level' is the 'specific sound level' of the source over a period of one hour during the day (07:00 to 23:00 hours) and over a period of 15 minutes during the night (23:00 to 07:00 hours). Clause 9 entitled 'Rating Level' states:

"Certain acoustic features can increase the significance of impact over that expected from a basic comparison between the specific sound level and the background sound level. Where such features are present at the assessment location, add a character correction to the specific sound level to obtain the rating level."

An acoustic character correction should be added to the 'specific sound level' if it exhibits any tonality, impulsivity, other specific characteristics and/or intermittency at the assessment location. The value of the character correction varies, dependent on the prominence of the character of the sound source at the assessment location.

In Clause 11 of the Standard, entitled 'Assessment of the Impacts', it states:

"Obtain an initial estimate of the impact of the specific sound by subtracting the measured background sound level (see Clause 8) from the rating level (see Clause 9) and consider the following.

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

We have provided plant noise limits at the nearest noise sensitive dwellings based on the monitoring data obtained on site and planning Condition 11 which requires noise rating levels to be at least 5dBA below the background at the nearest dwellings.

4.6. **Fixed Plant Noise Limits**

Any plant associated with the proposed is understood to operate 24 hours a day. At this stage, no plant information has been provided. As such, we have provided plant noise limits at the nearest noise sensitive dwellings based on the monitoring data obtained above and above documents.

We have provided plant noise limits when measured at the nearest existing noise sensitive dwellings based on the monitoring data stated in this report, and the above documents. The maximum cumulative rating noise limits of noise from plant associated with the development are as follows:

Table 14: Proposed Plant Noise Limits

Period	**Limits at Receivers $L_{AR(T)}$**
Day (07:00 to 23:00)	44 dB
Night (23:00 – 07:00)	42 dB

The Rating Level of noise from the site is to include an acoustic feature correction as applicable in accordance with Section 9 of BS4142:2014 for any tonality, impulsivity, intermittency or other sound characteristics. With these limits being met the impact will be low in terms of BS4142:2014+A1:2019.

4.7. **Building Services Noise & Vibration**

The recommended criteria for internal noise from mechanical and electrical services are provided below:

Table 15: Maximum NR Level due to Building Services

Room Type	**Building Services Limits**	
	Plant within room	**Plant from outside the room**
Dwelling (Bedrooms)	≤NR25	≤NR15
Dwelling (Living rooms)	≤NR30	≤NR20
Corridors/Lobbies	≤NR45	≤NR35
Office/Welfare	≤NR30	≤NR20
Plant Rooms	≤NR65	--

4.8. **Lift Noise & Vibration**

Noise from the lift should be controlled to acceptable levels. The maximum recommended noise levels within the rooms due to lift operation should not exceed the values given in the table below.

Table 16: Maximum Lift Noise Levels

Room Type	**Maximum Lift Noise Level $L_{Amax(fast)}$**
Dwelling	25 dB
Other Areas	35 dB
Lift Lobby	55 dB

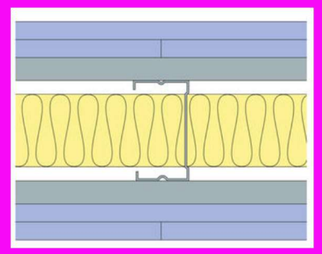
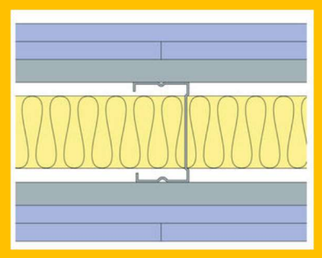
The lift motor and associated equipment should be installed on suitable anti-vibration mountings to prevent the transmission of excessive vibration and/or structure-borne noise to any parts of the living accommodation. The lift should be suitably selected to ensure any vibration is no greater than a VDV 1hr of 0.04 $ms^{-1.75}$ within the sensitive rooms.

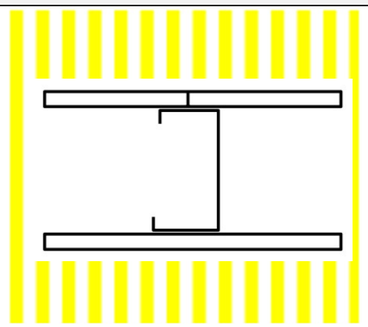
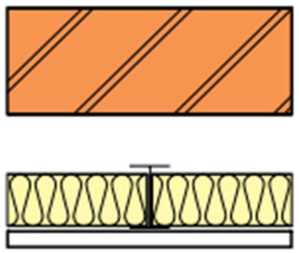
6. Internal Sound Insulation

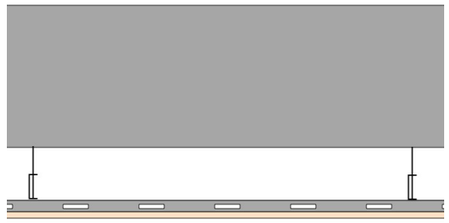
6.1. Wall & Floor Constructions

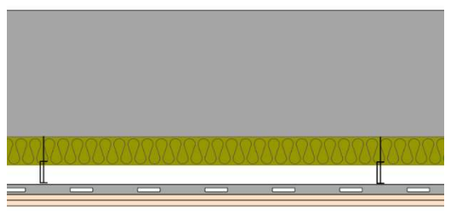
The wall and floor constructions have not yet been specified, as such the following advice is based on typical construction to meet the required performance where the exact wall build up is not known. It should be noted that all separating walls should run slab to slab and should be fully sealed with mastic or mortar. Plasterboard should be staggered and sealed. The laboratory rated (R_w / R_w + C_{tr}) performance is to be used as a guide with the exception of between rooms within the same cluster flat. The colour code refers to our mark up in Appendix 2.

Table 17: Proposed Wall and Floor Constructions

Type	Required Performance		Construction Description
	On Site	Laboratory	
	≥50 dB $D_{nT,w}$ + C_{tr}	≥57 dB R_w + C_{tr}	This partition could be constructed as follows: • 2 layers of staggered and sealed rigid board comprising of 15mm plasterboard (mass per board ≥12Kg/m²), such as Soundbloc. • Resilient Bar. • 70mm C stud with 50mm Isover Acoustic Roll (≥16Kg/m³) between studs. • Resilient Bar. • 2 layers of staggered and sealed rigid board comprising of 15mm plasterboard (mass per board ≥12Kg/m²), such as Soundbloc. With the proposed system the performance criteria can be met subject to the correct detailing and installation.
	≥50 dB $D_{nT,w}$ + C_{tr}	≥57 dB R_w + C_{tr}	If masonry core walls are between dwellings and stairwells/corridors, these can comprise at a single layer of at least 150mm thick reinforced concrete (mass ≥ 360kg/m²).
	≥48 dB $D_{nT,w}$ + C_{tr}	≥55 dB R_w + C_{tr}	This partition could be constructed as follows: • 2 layers of staggered and sealed rigid board comprising of 12.5mm plasterboard (mass per board ≥12Kg/m²), such as Soundbloc. • Resilient Bar. • 92mm C stud with 50mm Isover Acoustic Roll (≥16Kg/m³) between studs. • Resilient Bar. • 2 layers of staggered and sealed rigid board comprising of 12.5mm plasterboard (mass per board ≥12Kg/m²), such as Soundbloc. With the proposed system the performance criteria can be met subject to the correct detailing and installation.

Type	Required Performance		Construction Description
	On Site	Laboratory	
	N/A	≥40 dB R_w	This partition could be constructed as follows: • 1 layer of 12.5mm plasterboard (mass per board ≥10Kg/m²), such as Soundbloc. • 70mm C stud • 1 layer of 12.5mm plasterboard (mass per board ≥10Kg/m²), such as Soundbloc. With the proposed system the performance criteria can be met subject to the correct detailing and installation.
	≥60 dB D_{nTw}	≥67 dB R_w	This wall type can be used between noise generating areas and dwellings. The minimum performance is as per the pink walls above, however we have advised uplifting it over and above building regulations. This wall comprises an independent wall liner one side of a masonry wall. The build up would comprise the following: • 2 layers of 15mm Acoustic Plasterboard (mass ≥12Kg/m²) and skim finish • 25mm Isover Acoustic Partition Roll • Gyplyner bracket system • 240mm thick concrete (mass ≥ 365 kg/m³) Wie expect this system to achieve 70 dB R_w. With the proposed system the performance criteria can be met subject to the correct detailing and installation.

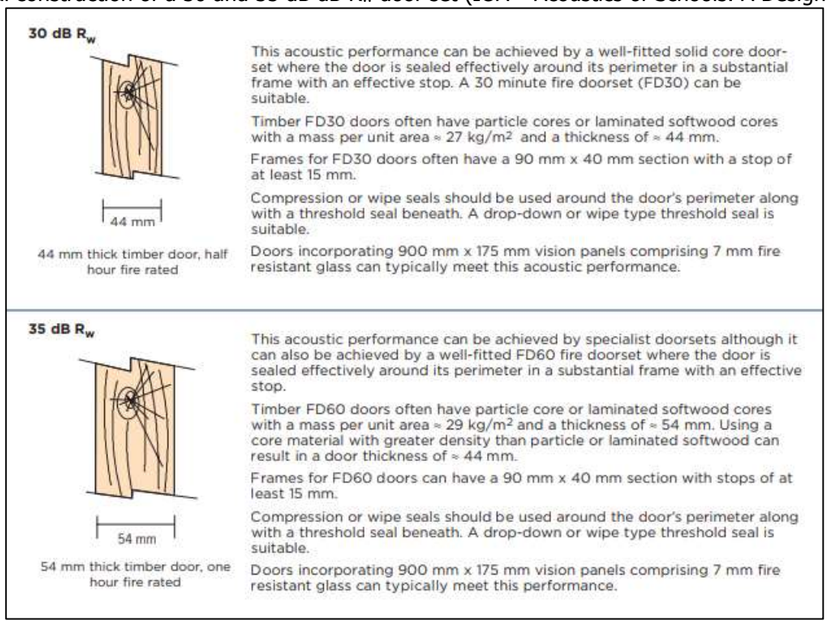

Separating Floor between dwellings
	≥50 dB D_{nTw} + C_{tr}
	&
	≤57 dB L'_{nTw}
		≥57 dB R_w + C_{tr}	We understand the separating floor construction is to be 225mm thick in situ reinforced concrete deck with a suspended ceiling underneath. The floor will need to be suitably deigned to control airborne, flanking and impact noise between spaces. The floor construction could comprise:
			• 225mm thick in situ concrete slab (mass ≥ 365kg/m²)
			• MF ceiling to provide a minimum 150mm cavity minimum and one layer of 12.5mm thick plasterboard (mass ≥ 10kg/m²).
			• Between the slab and the final floor finish a resilient layer with the following properties will be installed:
			  ○ any resilient material, or material with a resilient base, with an overall uncompressed thickness of at least 4.5mm; or
			  ○ any floor covering with a weighted reduction in impact sound pressure level (ΔL_w) of not less than 17dB when measured in accordance with British Standard EN ISO 140-8:1998 and calculated in accordance with British Standard EN ISO 717-2:1997
			With the proposed system the performance criteria can be met subject to the correct detailing and installation.


Floor above noise generating areas
	≥60 dB D_{nTw} + C_{tr}
	&
	≤57 dB L'_{nTw}
		≥67 dB R_w + C_{tr}	This floor is between noise generating areas and dwellings. This will need to be suitably designed to control airborne, flanking and impact noise between spaces. The build up should be as follows:
			• 225mm thick in situ concrete slab (mass ≥ 365kg/m²)
			• MF ceiling to provide a cavity of at least minimum 100mm
			• 50mm Mineral Wool insulation in the cavity (density ≥ of 24 kg/m³)
			• Two layers of 12.5mm thick plasterboard (mass ≥ 10kg/m² per board).
			• Between the slab and the final floor finish a resilient layer with the following properties will be installed:
			  ○ any resilient material, or material with a resilient base, with an overall uncompressed thickness of at least 4.5mm; or
			  ○ any floor covering with a weighted reduction in impact sound pressure level (ΔL_w) of not less than 17dB when measured in accordance with British Standard EN ISO 140-8:1998 and calculated in accordance with British Standard EN ISO 717-2:1997
			With the proposed system the performance criteria can be met subject to the correct detailing and installation.

6.2. **Doors**

Where the entrance door of a dwelling opens into a communal circulation area there is a building regulations requirement for the door to provide a reasonable level of sound insulation. Building regulations advise the doors should achieve at least 29dB R_w. The typical construction of a 30dB R_w door set is shown below.

Figure 7: Typical construction of a 30 and 35 dB dB R_w door set (IOA – Acoustics of Schools: A Design Guide)



For door sets on the ground floor opening into plant rooms, refuse stores and office areas, please see section 4.1.6 of this report.

6.3. **Flanking Details**

The following flanking details are in outline and will be developed as the scheme progresses. The detailing in all areas will require careful consideration. These relate to the residential areas but can also be applied to the ancillary areas.

6.3.1. **Roof Detail**

We would advise that the separating walls should run fully to the underside of the roof. From the roof type drawings, the roof is concrete with high mass.

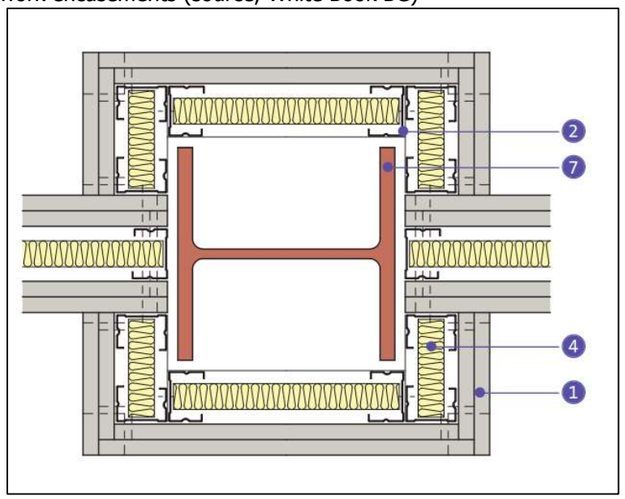
The ceiling detail in these areas with the concrete roof, if well sealed with mastic, can consist of one layer of 12.5mm plasterboard on a metal frame.

6.3.2. **Steelwork**

As a guide, where steelwork traverses between two sensitive rooms, it will need to be suitably encased to control flanking noise. Where steelwork is exposed within a room it will need to be encased with two layers of rigid plaster board (total mass $\geq$ 20 Kg/m^2) with 50 millimetres of mineral fibre (30 Kg/m^3) within the cavities. The plasterboard encasement and associated support system should be independent of the steelwork or on resilient fixings.

Steelwork encasements and junctions with partitions should follow British Gypsum Guidance as per the image below:

Figure 8: Example of steelwork encasements (source, White Book BG)

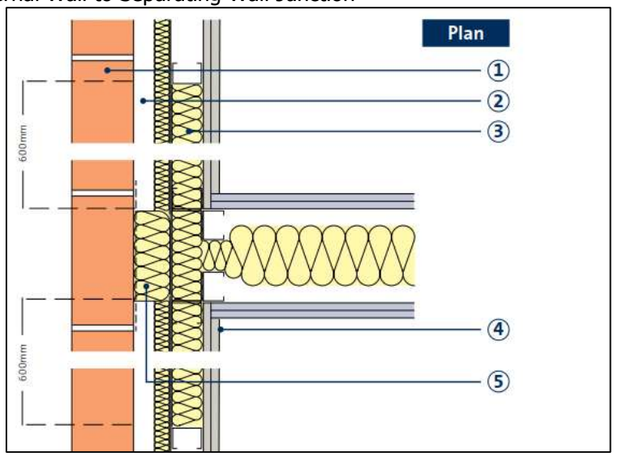


6.3.3. **Flanking Walls**

Light Weight Walls

For flanking noise control, where a separating wall abuts the inner plasterboard skin of the external wall. The lining should follow the below detail:

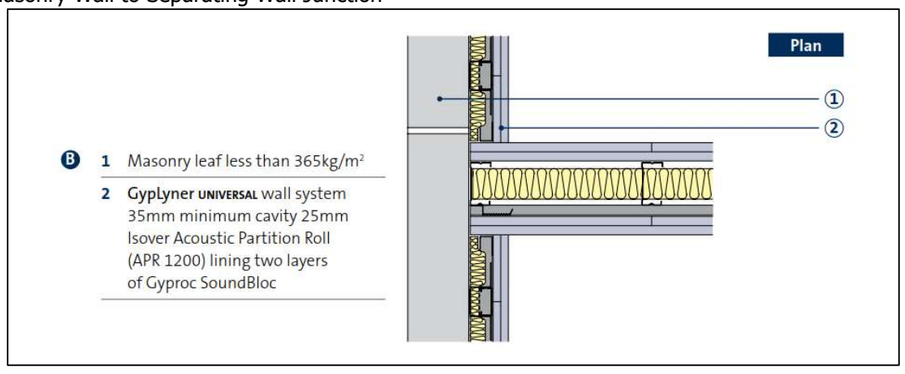
Figure 9: Light weight External Wall to Separating Wall Junction



6.3.4. **Masonry Walls**

Where a masonry wall or other solid masonry element and the separating wall abuts this element then a liner will also be required if the mass is low. The lining should follow the below British Gypsum detail where the masonry or other solid element has a mass ≤than 365 Kg/m^2.

Figure10: Masonry Wall to Separating Wall Junction



6.3.5. **Slab Edge Detail**

The slab edge detail will need to suitably control flanking noise. Please issue a detail when ready. As a guide, at the slab edge any gap should be boxed in both sides with two layers of 12.5mm Soundbloc plasterboard (or equivalent board with total mass ≥20 Kg/m^2) and a mineral wool cavity closer.

6.3.6. **Floor Slab**

The concrete slab should have a mass of at least 365Kg/m^2. This is expected to be the case throughout.

6.3.7. **Curtain Walling**

There will be curtain walling throughout the scheme. These will be a flanking weak path, it is advised where the mullions and transoms traverse between two dwellings, these elements are filled with Siderise mineral wall inserts which achieve a minimum flanking sound transmission of 55 dB $D_{nFw} + C_{tr}$.

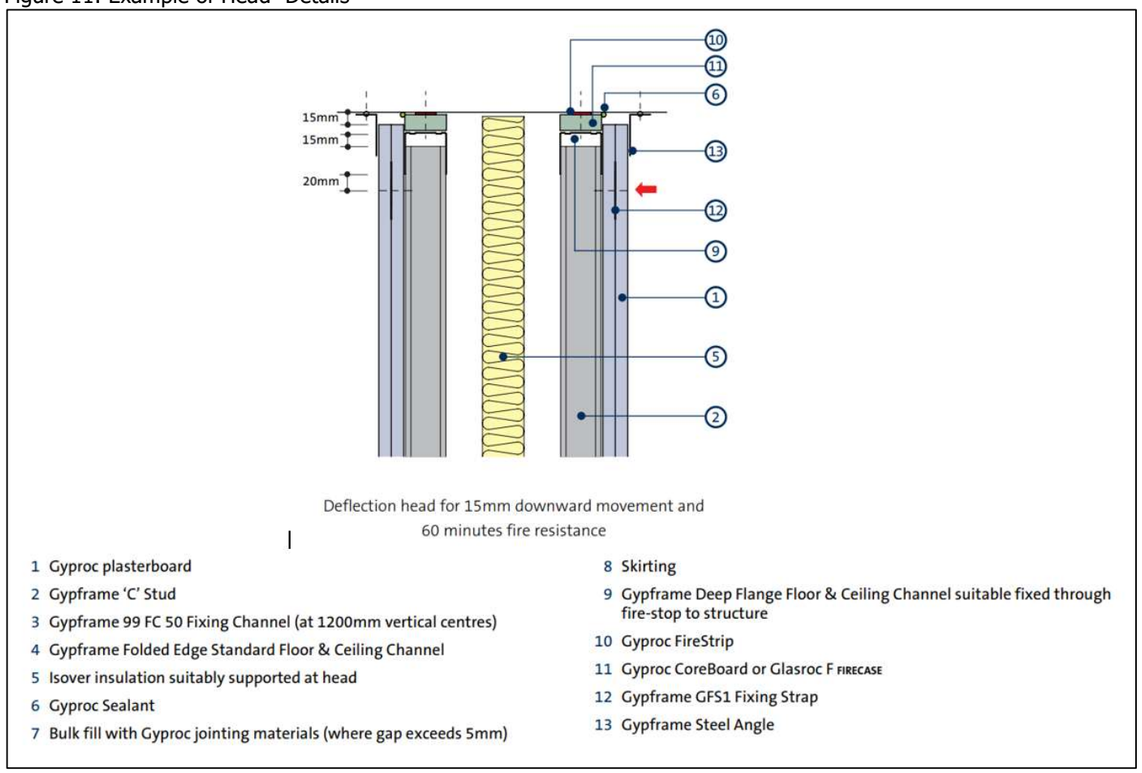
6.3.8. **Separating Wall Head & Base Detail**

The partition head detail will need to be suitably addressed. Separating walls should run from slab to slab. All junctions should be fully sealed with dense non setting mastic.

All junctions will need to be carefully addressed to ensure there are no flanking weak points in the construction.

Head junctions will need to include deflection heads as per the manufacturer's acoustic details and sealed with dense, non-setting mastic as shown in the figure below.

Figure 11: Example of Head- Details

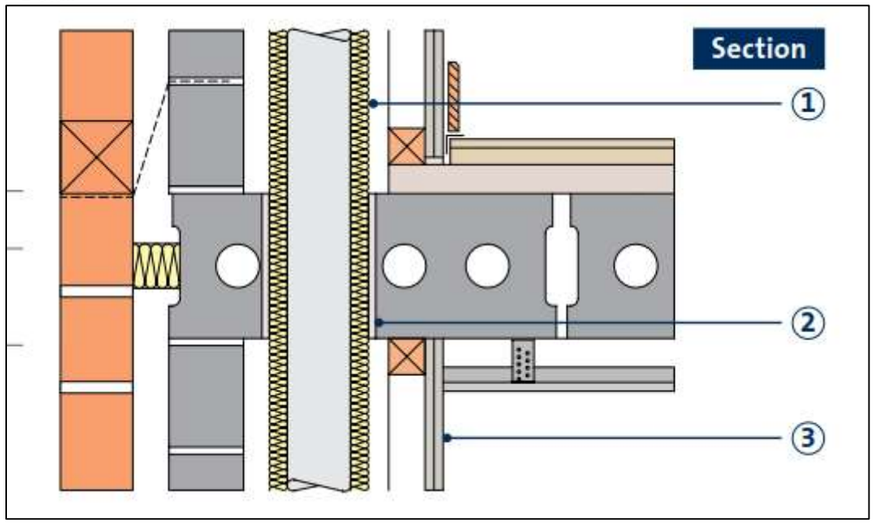


6.3.9. **Floor Penetrations**

Pipes and ducts, SVP, RWP that penetrate a floor separating different dwelling should be enclosed for their full height in each room. The enclosure should comprise of plasterboard (mass $\geq$15 Kg/m^2) and 25mm mineral wrapped around the pipes/ducts/SVP/RWP. There should be a small gap of approximately 5 millimetres between the enclosure and the floor slab. This should be sealed with sealant or neoprene.

Please note the current SVP enclosure does not include mineral wool. This should be included. A typical detail is provided below:

Figure 12: SVP Detail



6.3.10. **Service Routes**

Where any service penetration is between a dwelling and a communal corridor, the infill material is required to achieve a sound reduction rating of at least 40 dB R_w. A number of propriety products can meet this requirement. Services should run from the corridor into the dwelling and not directly through the separating walls between any dwellings. There should be no ventilators, services, cable trays, air return grilles, holes etc. between dwellings unless suitably addressed for flanking.

6.3.11. **Downlighters**

If the ceiling is punctured to install services, then the performance of the floor will be affected. The ceiling can include holes cut for recessed lighting, provided they are maximum 100mm across; and no more than one per 2m^2 of ceiling in the room affected. Therefore, for most bedrooms of about 10m^2 the room can be fitted with up to five recessed light fittings. The downlighters should be spaced at a minimum of 1 downlighter per 2m^2 of ceiling area and at not less than 0.75m spacings. (e.g. 10m^2 of ceiling area equates to at least 5 downlighters).

6.3.12. **Supply and Extract Fans**

Extract fans can also be accommodated, but with these, the aperture has to be fully sealed to the duct to prevent air paths into the ceiling void; and the duct must not create a rigid connection of the ceiling lining to the floor structure. Other issues such as fire, and the environmental noise of the fan operating, will also need to be considered. Any ductwork exiting the ceiling must be fully boxed-in using gypsum board to the same specification as that used for the ceiling.

6.3.13. **Inspection Hatches**

A number of services can be run above the ceiling; and if this includes a gas flue, you may need to think about fitting inspection hatches. If this is the case, then ensure the hatch is acoustically rated to be at least as good as the gypsum board that it is replacing.

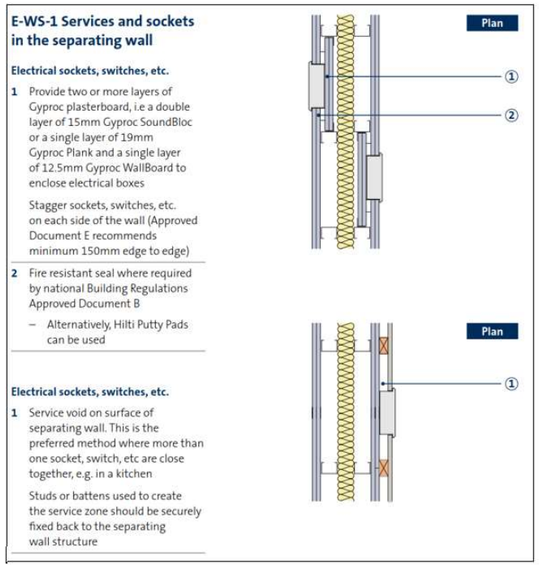
6.3.14. **Further Advice**

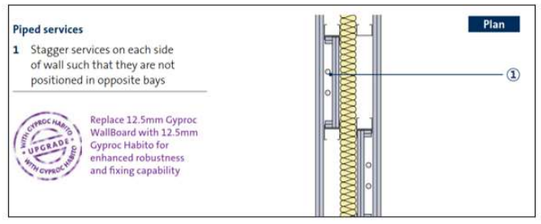
If number or size of apertures is larger than described above, then we would recommend installing a secondary ceiling to take the fittings. This will ensure the primary ceiling remains intact. The secondary ceiling should be hung from the metal frame or resilient bars, and not from the structural floor. Alternatively, acoustic rated hoods should be placed over the back of the service penetrations or acoustically rated products should be installed.

6.3.15. **Sockets, Switches, Pipes**

All electrical sockets/switches, chases etc. should be staggered on each side of the separating wall. The boxing in of electrical sockets etc should be as follows:

Figure 13: Socket, Switches, Pipe Details





7. Room Acoustics

7.1. Areas Requiring Treatment

Regulation E3 - "*Reverberation in the common internal parts of buildings containing flats or rooms for residential purposes*".

This was clarified further by the Department for Communities and Local Government with their publication "Approved Document E Frequently Asked Questions" dated "March 2016" which states:

To satisfy Requirement E3 (Reverberation in the common internal parts of buildings containing flats or rooms for residential purposes), is it necessary to treat all the common parts?

The purpose of this Requirement is to protect residents from noise produced in reverberant common areas. The Requirement only applies to "corridors, stairwells, hallways, and entrance halls which give access to the flat or room for residential purposes". To comply with this, it is recommended that absorbent treatment should normally be applied only to common areas onto which dwellings open directly.

Where separating walls, without doors or windows, are adjacent to common areas it would not normally be necessary to treat the common areas, assuming normal usage. Other situations are dealt with in paragraph 0.8 of Approved Document E (2003).

Therefore, where bedrooms open directly into communal corridors this regulation applies and the reverberation time needs to be suitably controlled for Building Regulations.

7.2. Corridors, Hallways and Stairwells

In the corridors and hallways an area not less than the floor area must be fitted with a 'Class C' absorber or better. This is a building regulations requirement.

This could be achieved by fitting the entire ceiling area of such spaces with a sound absorbing ceiling tile system having a British Standard EN ISO 11654:1997 rating of Class A, B or C. Please note, if using a Class A or B system, the coverage can be reduced. We can advise further if this is an approach you will be following.

8. Indoor Ambient Noise Levels

8.1. Noise Modelling

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

The software predicts road traffic noise propagation using the method of 'The Calculation of Road Traffic Noise 1988' (CRTN'88), and a verification model has been created to ensure the measured and predicted levels are comparable.

Road traffic noise was the most onerous and predominant noise source in the area and therefore this was the main noise source used to build our noise model.

8.2. Noise Modelling Parameters

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

- The noise model has been calibrated using the data at from the monitoring exercise.
- To determine the noise levels across the site and surrounding areas, this has been taken as a hard-reflective ground which is a worst-case scenario.
- The proposed building heights are based off architectural drawings.
- The site's topography is determined to be flat.
- Building noise maps display the worst case noise level at each façade.
- Noise grid is at 5.5 metres above ground, representative of the accommodation on the first floor as the worst case affected rooms.
- Reflections have been determined via the correction method (+1.5dB) of CRTN rather than reflection.
- Ground is considered hard and reflective.

8.3. Noise Modelling Results

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

Based on the obtained results, it will be necessary to design the building fabric of the residential properties to control road traffic noise levels internally.

Figure 14: Day-time Noise Map, $L_{Aeq,16hrs}$ dB

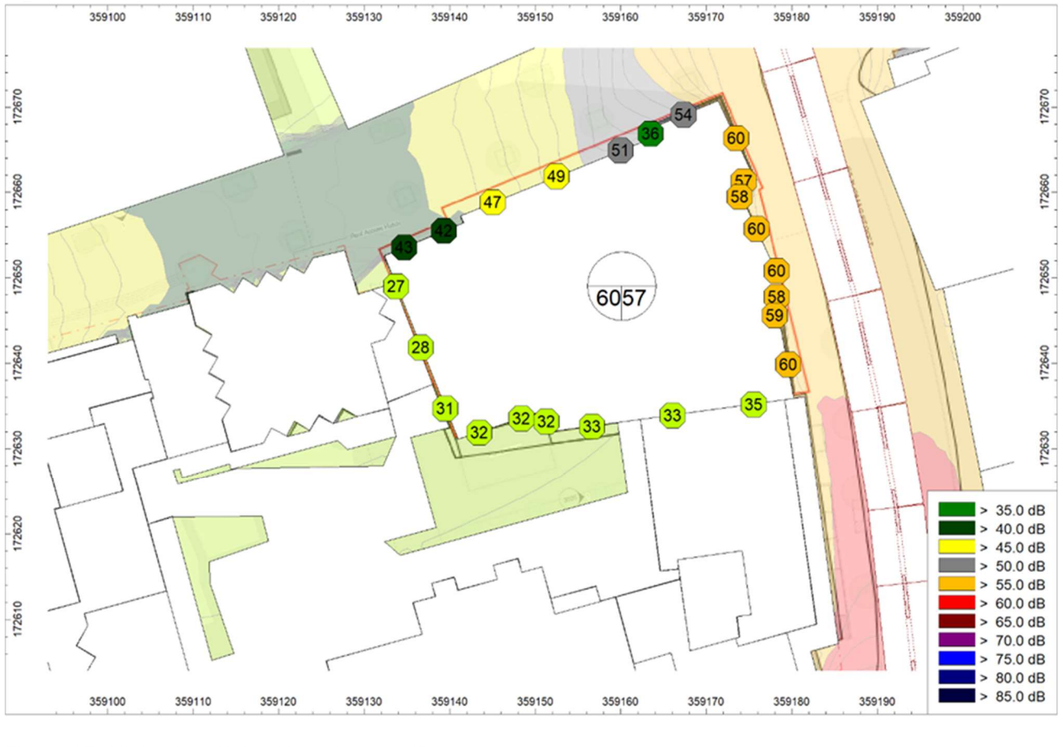


Figure 15: Night-time Noise Map , $L_{Aeq,8hrs}$ dB

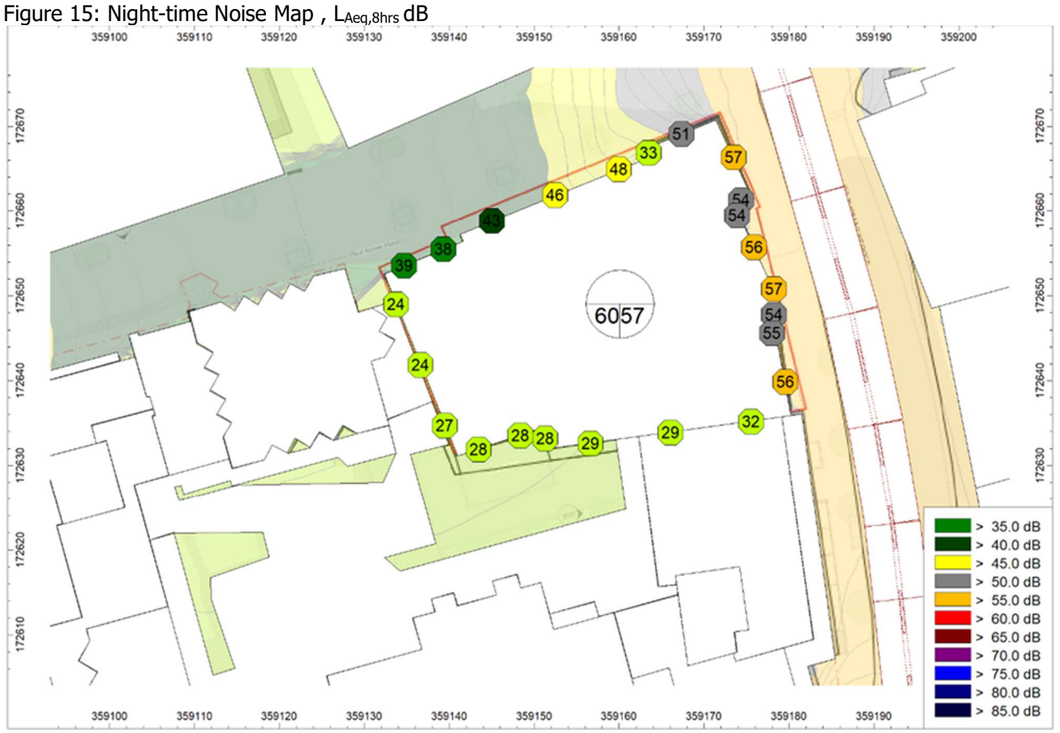
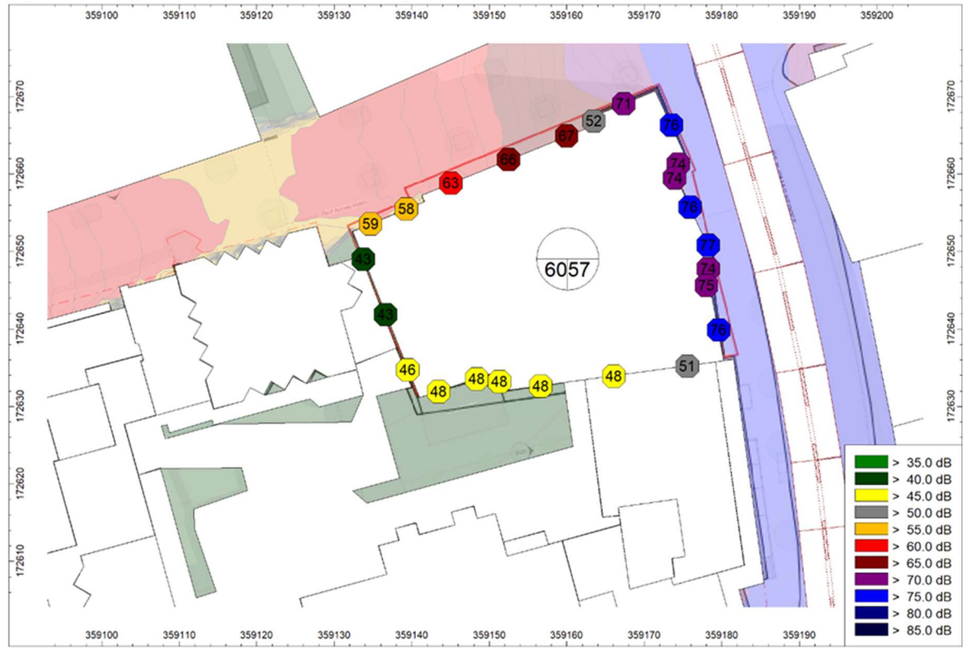


Figure 16: Night time Maximum Noise Map, L_{AFMax} dB



8.4. Calculation Method

Calculations for the internal ambient noise levels due to road traffic noise have been undertaken using the calculation method provided in Annex G Section G.2 of British Standard 8233:2014, the building facade construction specified below, and the octave band free-field design equivalent noise levels and maximum noise levels taken from the measured noise spectra noted above.

The room dimensions are based off the architectural drawings.

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

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

8.4.1. Noise Mitigation Zones

The following figure show the colour coded mitigation zones referred to in the following sections:

Figure 17: Mitigation Zones

8.4.2. External Wall Construction

We have been provided with details of the proposed external wall types on drawing 'P22-022-WW-ZZ-XX-DR-A-6500A-P03'.

EWT-01/02/03/04/05/09

External wall types 01/02/03/04/05/09, are all based on the following construction:

- 102.5mm Brick
- Stainless steel brick restraint system/ wall ties fixed to SFS studs
- Varying size of cavity with each wall type (50mm to 125mm)
- 100mm Rockwool Nyrock Insulation
- Waterproof membrane
- 150mm SFS with 150mm full fill Rockwool steel frame slab insulation between studs
- 22mm top-hats
- 2 layers of 12.5mm plasterboard (mass 8kg/m^2 per board)

The above construction (50mm cavity for a worst case) has been modelled within the proprietary software 'Insul' and is expected to achieve the following sound reduction indices:

Table 18: Required minimum sound insulation performance of external walls

Type	Sound Reduction Index / dB per Octave Band (Hz)							R_w (dB)
	63	125	250	500	1k	2k	4k	
External Wall	40	51	53	62	67	70	71	65

Any alternative wall build up should be confirmed with the manufacturer to achieve the above sound reduction indices or provided to us for review.

EWT 06/07/10

External wall types 06/07/10 are party walls with the adjoining development. This wall comprises the following construction:

- Insulation zone between the party walls (EWT-06)
- 100mm blockwork (EWT-06/10) or 102.5mm brick (EWT-07)
- Ancon Teplo-BF2 or similar fixed to inner leaf of blockwork
- 160mm Rockwool full fill insulation
- 140mm blockwork
- 2 layers of 12.5mm plasterboard (mass $\geq$ 8kg/m^2) with skim finish (EWT-06)

The above construction has been modelled within the proprietary software 'Insul' and is expected to achieve the following sound reduction indices:

Table 19: Required minimum sound insulation performance of external walls

Type	Sound Reduction Index / dB per Octave Band (Hz)							R_w (dB)
	63	125	250	500	1k	2k	4k	
External Wall	41	45	46	50	60	70	80	57

Any alternative wall build up should be confirmed with the manufacturer to achieve the above sound reduction indices or provided to us for review.

EWT 08

This wall comprises the following construction:

- 200mm precast stone
- 170mm Rockwool Nyroc insulation
- 100mm fairfaced blockwork
- 22mm top-hats
- 2 layers of 12.5mm plasterboard (mass $\geq$ 8kg/m^2) with skim finish

The above construction has been modelled within the proprietary software 'Insul' and is expected to achieve the following sound reduction indices:

Table 20: Required minimum sound insulation performance of external walls

Type	Sound Reduction Index / dB per Octave Band (Hz)							R_w (dB)
	63	125	250	500	1k	2k	4k	
External Wall	45	50	54	59	68	78	88	65

Any alternative wall build up should be confirmed with the manufacturer to achieve the above sound reduction indices or provided to us for review.

All proposed external walls are expected to achieve the required sound insulation performance.

8.4.3. Roof Construction

It is proposed for the roofs to be 'Blue Roofs'. All of the proposed roofs are based on a reinforced concrete deck (assumed 150mm thick and surface mass $\geq$ 365kg/m^2) with 150mm PIR rigid insulation (density $\geq$ 40kg/m^3) above. There are different roof finishes throughout.

The basic roof build-up has been modelled within the software 'Insul' and is expected to achieve, at a minimum, the following sound reduction indices:

Table 21: Expected minimum sound insulation performance of external walls

Type	Sound Reduction Index / dB per Octave Band (Hz)							R_w (dB)
	63	125	250	500	1k	2k	4k	
Proposed Roofs	45	46	40	54	76	88	96	56

Below the proposed rooftop plant area the roof is proposed to be concrete paving slabs (assumed surface mass $\geq$ 65 kg/m^2) on pedestals. This roof is expected to achieve the following sound reduction indices:

Table 22: Expected minimum sound insulation performance of external walls

Type	Sound Reduction Index / dB per Octave Band (Hz)							R_w (dB)
	63	125	250	500	1k	2k	4k	
Proposed Roofs	45	38	48	69	82	100	114	61

Any alternative roof constructions should achieve the above at a minimum or be provided to us for review.

8.4.4. Window Construction

The windows could be openable at user discretion. The windows should be housed in sealed good quality frames with airtight compression seals. The sound insulation performance for the windows should achieve the following as a minimum. The supplier should provide test data confirming the product meets the below performance.

Table 23: Required Sound Insulation Index performance for each window

Façade	Level	R (dB), Octave Band Frequency (Hz)								Rw	Typical Glazing
		63	125	250	500	1KHz	2KH	4KHz	8KHz		
North (Yellow)	1 - 5	16	21	21	27	34	30	30	30	**30**	Double Glazed: 6/12/6
	6 - 11	No mitigation is required to the windows in these areas (1), the recommended internal noise levels can be achieved with standard double glazing									
North (Green)	All Levels	No mitigation is required to the windows in these areas (1), the recommended internal noise levels can be achieved with standard glazing									
East (Orange)	1 - 3	21	26	27	34	40	38	46	46	**37**	Double Glazed: 10/12/6
	4 - 6	16	21	20	31	39	37	47	46	**33**	Double Glazed: 6/12/6.4
	7 - 11	16	21	21	27	34	30	30	30	**30**	Double Glazed: 6/12/6
South (Green)	All Levels	No mitigation is required to the windows in these areas (1), the recommended internal noise levels can be achieved with standard double glazing									
West (Green)	All Levels	No mitigation is required to the windows in these areas (1), the recommended internal noise levels can be achieved with standard double glazing									
Courtyard	All Levels	No mitigation is required to the windows in these areas (1), the recommended internal noise levels can be achieved with standard glazing									

(1) Daytime and Night-time rooms - BS8233:2014 internal level

8.4.5. Ventilation Provisions

The habitable rooms will need to be ventilated via attenuated means. The ventilation should include the necessary sound attenuation in order that the ingress of external noise is controlled to be compatible with the building fabric.

It is understood that the scheme is going to ventilated naturally with an MEV system. The following table summarises the minimum weighted normalised level difference ($D_{n,e,w}$) performance for the vents in the open position. The supplier should provide test data confirming ventilation meets the below performance in the open position.

Table 24: Minimum Ventilation Performance

Zone	Room Type	Typical Construction	Element Normalised Level Difference, $D_{n,e}$ per Octave Band, Hz								D_{new} (dB)
			63	125	250	500	1k	2k	4k	8k	
	All Habitable Rooms	No mitigation is required to the windows in these areas (*), this window can achieve recommended internal noise levels through partially open window									
	Living Rooms	Standard Trickle Vent *Titon XS13 4400 EA+XC13 412 Canopy*	30	35	35	36	34	29	33	34	32
	All Habitable Rooms	Acoustic Trickle Vent *Titon SF X V75 / SFSA C75*	45	47	46	50	55	65	68	60	44

Alternatively, if the rooms are to be ventilated via MVHR systems, to achieve the internal noise level criteria of BS8233:2013, the sound level difference, out to in, to 'habitable rooms' should be the following at a minimum:

Table 25: Minimum sound level difference of MVHR systems

Zone	Minimum Sound Level Difference
	23 dBA
	32 dBA
	42 dBA

This is the difference between the outside façade level and the level inside a furnished room at one and a half metres from the vent. It is the responsibility of the vent supplier to confirm that the chosen ventilation system will achieve the sound level differences stated above.

8.4.6. Effect of Mitigation Measures

With the noted mitigation measures above, the predicted internal levels under normal conditions within the bedrooms and living rooms are below BS8233:2014 with regards to road traffic noise and are therefore considered acceptable and within planning criteria.

The calculations for the worst case rooms are provided below:

Figure 18: BS8233 calculations for 110 D – Orange Zone 1st Floor

Free Field Level at Façade

Octave Band	63	125	250	500	1000	2000	4000	8000	dBA
Day, $L_{eq(16\ hour)}$	66	61	60	56	57	51	44	37	60
Night $L_{eq\ (8hour)}$	62	56	55	53	54	48	41	33	57
Night-time $L_{max(fast)}$	74	76	72	72	74	69	63	57	77

Building Façade Construction

External Element		63	125	250	500	1000	2000	4000	8000
SF X V75 / SFSA C75 (open) - 44 Dnew	D_{nw}	30	37	37	36	47	49	55	61
	Number of	1							
		0.00148	0.00030	0.00030	0.00036	0.00003	0.00002	0.00000	0.00000
Wall: User Defined		28	47	55	58	59	68	71	71
	Area	3							
		0.00059	0.00001	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000
Double Glazed: 10/12/6.4 - 39 Rw		22	27	29	36	41	42	52	50
	Area	4							
		0.00397	0.00126	0.00079	0.00016	0.00005	0.00004	0.00000	0.00001

Calculations to BS EN 12354

	63	125	250	500	1000	2000	4000	8000
Sum	0.00604117	0.001559261	0.001089422	0.000522403	8.07275E-05	5.7597E-05	8.47612E-06	7.42395E-06
10log sum	-22.188787	-28.07081309	-29.62803711	-32.81994014	-40.9297851	-42.39600373	-50.71803083	-51.29364771
10log S/A	-2.00891013	-2.008910125	-0.814273252	0.277628666	0.993294871	-1.156721356	-2.337291922	-2.337291922
correction factor +3	3	3	3	3	3	3	3	3

Octave Band	63	125	250	500	1000	2000	4000	8000	dBA
Day, $L_{eq(16\ hour)}$	44.8	33.9	32.6	26.5	20.1	10.4	-6.1	-13.6	**28.5**
Night $L_{eq\ (8hour)}$	40.8	28.9	27.6	23.5	17.1	7.4	-9.1	-17.6	**24.6**
Night-time $L_{max(fast)}$	52.8	48.9	44.6	42.5	37.1	28.4	12.9	6.4	**43.2**

9. Building Services Noise and Vibration

9.1. Plant Room Noise Limits

The noise generated by any plant will need to be controlled to acceptable levels. Based on current known building structure information, we would advise the noise within all plant rooms to be controlled to no more than NR65.

9.2. Noise Limits within Sensitive Rooms

Noise from the mechanical system should be selected to meet the performance noted above. This should include duct borne noise, grille noise, vibration and structure borne noise. A fixed plant noise assessment is to be completed. When we have received ventilation layouts and noise data for ventilation and cooling units, we can review the design and selection.

9.3. Building Services Vibration

All plant, flues, duct, and equipment should be provided with vibration control provisions. The installer/manufacturer of the plant should confirm the proposed system will not cause excessive vibration and/or structure-borne noise to any parts of the building.

It is advised that the proposed fans and compressors are provided with vibration control provisions. They will all require anti-vibration supports. The supports, however, will need to be of a specialist supply. The supports should be selected by specialist suppliers to provide an isolation efficiency of at least 95% at the lowest forcing frequency. Please note that the systems will deflect and the design would need to cater for this element.

It will also be necessary to provide flexible vibration isolation provisions on the duct connections. If required this would include the pipe work, ductwork, and electrical services (which can be coiled) connections. The isolated ductwork and pipe work support to all services should be fitted with specialist mounts to provide an isolation efficiency of at least 95% at the lowest forcing frequency.

It is advised that the necessary anti-vibration provisions on plant and equipment are made to ensure compliance with the design noise and vibration levels.

10. Lift Noise

The design of the lift will need to consider both the control of noise and vibration from lift movements to minimise disturbance from lift movements to those in dwelling. the lift design should be considered in conjunction with the structure of the building.

It is the responsibility of the lift manufacturer to ensure the noise and vibration limits noted in Section 4.7 is not exceeded.

The levels in Section 4.7 in relate to the highest noise levels during any part of the lift cycle and with any occupancy level between zero and the recommended maximum number of people in a car. The values below should be regarded as upper guideline values and every effort should be made in the design of the lift systems and components to minimize noise and vibration at source such that lower levels result in practice.

To advise further we would need to be provided with details of the lift design, along with Lift operational noise data.

11. External Plant Noise Control

11.1. Proposed Plant

It is proposed to install a roof top plant area. The proposed plant is one chiller (Mitsubishi PURY-P350/400) and a standby generator.

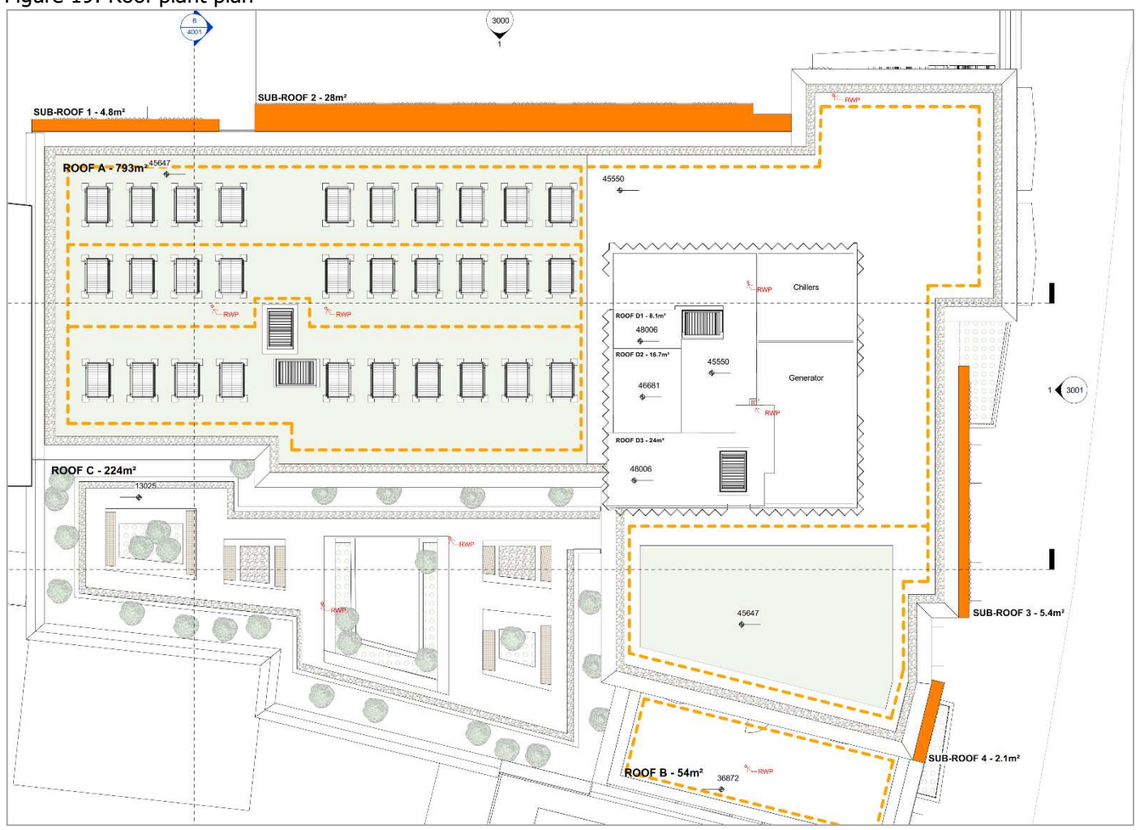
The following table shows the manufacturer sound levels provided by the client:

Table 26: Proposed Plant Sound Levels

Plant	Sound Level
Mitsubishi PURY-P350/400	88dB(A) (Sound Power Level)
Generator	77dB(A) @ 1m (Sound pressure Level)

The following roof plan shows the proposed plant area:

Figure 19: Roof plant plan



11.2. Plant Noise Limits

We have provided plant noise limits when measured at the nearest existing noise sensitive dwellings based on the monitoring data stated in this report, and the above documents. The maximum cumulative rating noise limits of noise from plant associated with the development are as follows:

Table 27: Proposed Plant Noise Limits

Period	Limits at Receivers $L_{AR(T)}$
Day (07:00 to 23:00)	44 dB
Night (23:00 – 07:00)	42 dB

The Rating Level of noise from the site is to include an acoustic feature correction as applicable in accordance with Section 9 of BS4142:2014 for any tonality, impulsivity, intermittency or other sound characteristics. With these limits being met the impact will be low in terms of BS4142:2014+A1:2019.

11.3. Plant Noise Modelling

Noise modelling has been undertaken using Cadna:A by Datakustik. We have used the same modelling parameters as detailed in Section 8.2 of this report, except third order reflections have been used, not reflections via the CRTN method (+1.5dB).

Plant noise sources have been input as point sources using the supplied sound level data. We have created one model with only the chiller om, and another model with the chiller aswell as the generator. As the generator is expected to be tested occasionally for 30 minutes only during daytime hours, the sound level has been time corrected (-3dB) for a one hour assessment. The following figures show the noise maps:

Figure 20: Chiller – Noise prediction map, day-time and night-time

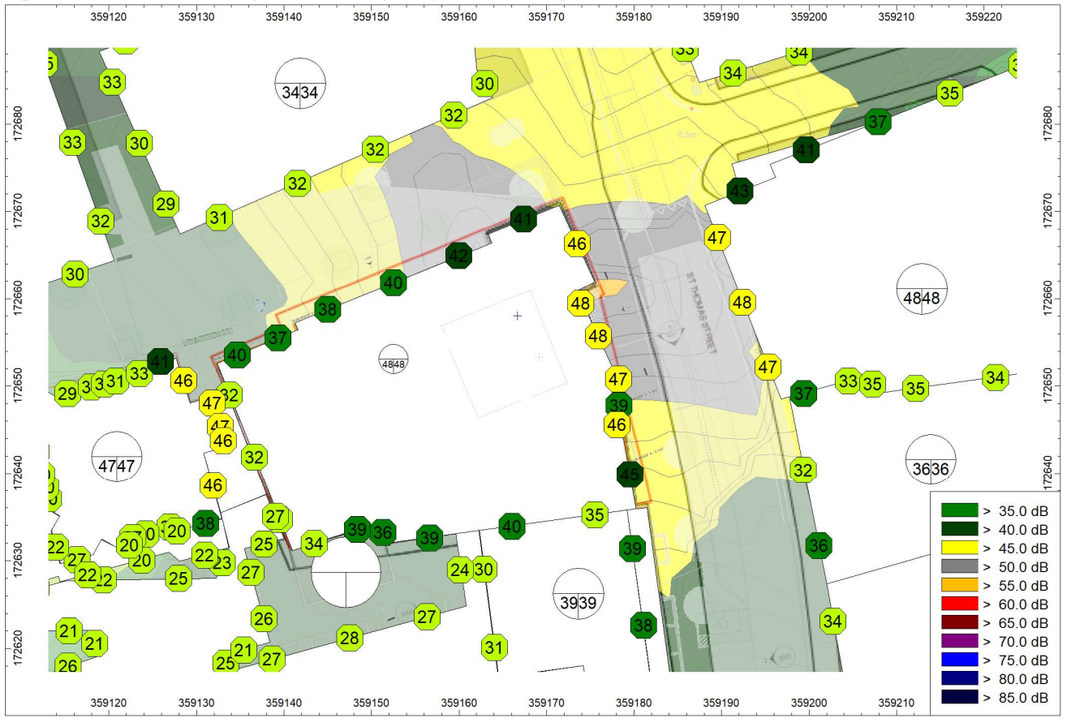
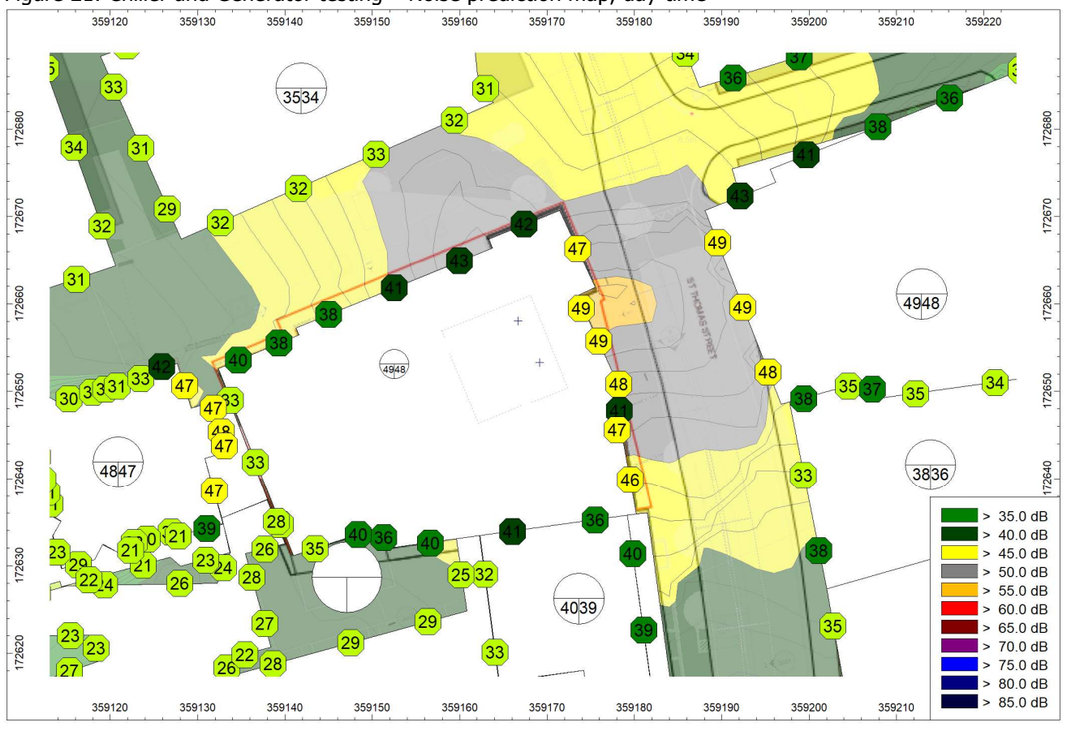


Figure 21: Chiller and Generator testing – Noise prediction map, day-time



11.4. **Plant Rating Level**

A plant noise assessment has been undertaken at the sensitive receivers on the site.

Background Sound Level

From the measured data we have determined a typical night-time background sound level to be 49dB $L_{A90,1hour}$ during the day and 47 dB $L_{A90,15min}$ during the night at a location representative of the noise-sensitive receivers.

Predicted Specific Sound Level

The specific sound level of the chiller at the worst-case receiver is 48 dB $L_{Aeq,1hour}$ (free-field level) during the day-time and the night-time. The cumulative specific sound level of the chiller and the generator during scheduled testing at the worst-case receiver is 49 dB $L_{Aeq,1hour}$ (free-field level). This is the level determined at the noise sensitive receivers without any character corrections applied.

Character Corrections

Character corrections should be added to the 'specific sound level' if it exhibits any *tonality, impulsivity, other specific characteristics and/or intermittency* at the assessment location. Based on our site visit and knowledge of such heating units, corrections to be applied are as follows:

Tonality – From our experience, this type of plant is not usually tonal however the supplier and installer of the proposed plant should ensure any tonality is not distinguishable at the noise-sensitive receivers in the area.
Impulsivity – Plant such as this is not normally impulsive.
Intermittency – We do not expect that the intermittency of the plant will be distinguishable at the sensitive receiver over the residual noise climate and we have not applied correction for intermittency. We have also assumed all plant is running continuously within our noise model.
Other Sound Characteristics – We do not believe any correction is due to other characteristics.

The determined rating sound levels, after character corrections of the plant are as bellow:

Table 28: Plant Rating Levels

Plant	Rating Level, dB L_{Ar}	Difference against background sound level, dB(A)	
		Day	Night
Chiller	48	-1	+1
Chiller and Generator under testing operation	49	0	+2

Because the generator is for emergency use and for scheduled testing during day time hours only, we consider an appropriate criterion to be +5dB difference with the background sound level, and is therefore considered acceptable in terms of noise.

As can be seen above, the predicted rating sound level of the chiller at the noise sensitive receivers does not achieve the criteria of -5dB difference against the background sound level during the day

and night. As such, it will be necessary to change the plant selection to a unit with lower sound levels, or install additional plant noise control measures.

11.5. Plant Noise Mitigation

It will be necessary to reduce the sound level of the chiller by at least 7dB(A), or change the selection to a unit with a maximum manufacturer's sound power level of 80dB(A). The required sound attenuation could be provided by a specialist acoustic enclosure.

With this attenuation, the predicted sound rating level is within the criteria and would therefore be considered acceptable.

11.6. Plant Noise Transfer

It is proposed to build studios directly below the plant area. As such, noise transfer through the roof to the studios below needs to be considered, as well as plant noise breaking in through the facades of the studios.

With the proposed roof type detailed in Section 8.4.3 and the advised window selection in 8.4.4, the internal noise level within the studio due to plant noise is expected to be below the criteria of NR15.

The M&E/plant supplier should introduce anti vibration mounts/fixings to control vibration levels (mainly low frequency) and structure borne noise to the rooms below. If required, anti-vibration mounts can be sought with specialised companies such as Mason UK, AMC Mecanocaucho, TVS Acoustics or similar.

12. Detailing, Workmanship & Verification

Noise control predictions have been based on the constructions as listed in this report with no allowance made for weak points. Small weaknesses in the fabric design and/or installation are likely to significantly reduce the predicted noise control performance. Predictions are based upon the best available information with regards to the performance of the building materials and systems.

It is therefore necessary to ensure that all detailing is carefully designed so that there are no weak points present. All brick and blockwork joints should be completely in-filled with mortar. It is also necessary to provide comprehensive site construction checks to ensure that the installation matches the design intent. In general terms it should also be noted that there should be no gaps in the constructions and that all components should be carefully sealed airtight using suitable dense non-setting mastics (NOT FOAM) where appropriate. All walls, unless noted otherwise, should run the full height up to the slab soffit or underside of the roof. The details at these joins will require careful consideration.

All the elements should be constructed in accordance with the manufacturer's recommendations.

In terms of achieving the acoustic requirements of particular elements as noted in this report, the only contractual link is between the Contractor (the Builder) and Supplier. As such, it is very important that all purchase contracts include for the particular elements to comply with the acoustic requirements as noted in this report. The verification should be in accordance with the appropriate British Standard or International Standards Organisation Standards. Weighted sound reduction indices (Rw) should be measured in accordance with British Standard EN ISO 140-3:1995 and rated in accordance with British Standard EN International Standards Organisation 717-1:1997. Sound absorption coefficients should be in accordance with International Standards Organisation 354 and rated in accordance with British Standard EN ISO 11654.1997.

13. Appendix 1 – Glossary

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

A-weighted sound pressure level, L_{pA} - quantity of A-weighted sound pressure given by the following formula in decibels (dBA)

$L_{pA} = 10 \log_{10} (p_A/p_0)^2$

where:

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

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

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

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

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

where:

p_0 is the reference sound pressure (20 μPa); and
$p_A(t)$ is the instantaneous A-weighted sound pressure (Pa) at time t

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

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

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

Octave and Third Octave Bands – The human ear is sensitive to sound over a range of frequencies between approximately 20 Hz to 20 kHz and is generally more sensitive to medium and high frequencies than to low frequencies within the range. There are many methods of describing the frequency content of a noise. The most common methods split the frequency range into defined bands, in which the mid-frequency is used as the band descriptor and in the case of octave bands is double that of the band lower. For example, two adjacent octave bands are 250 Hz and 500 Hz. Third octave bands provide a fine resolution by dividing each octave band into three bands. For example third octave bands would be 160 Hz, 250 Hz, 315 Hz for the same 250 Hz octave band.

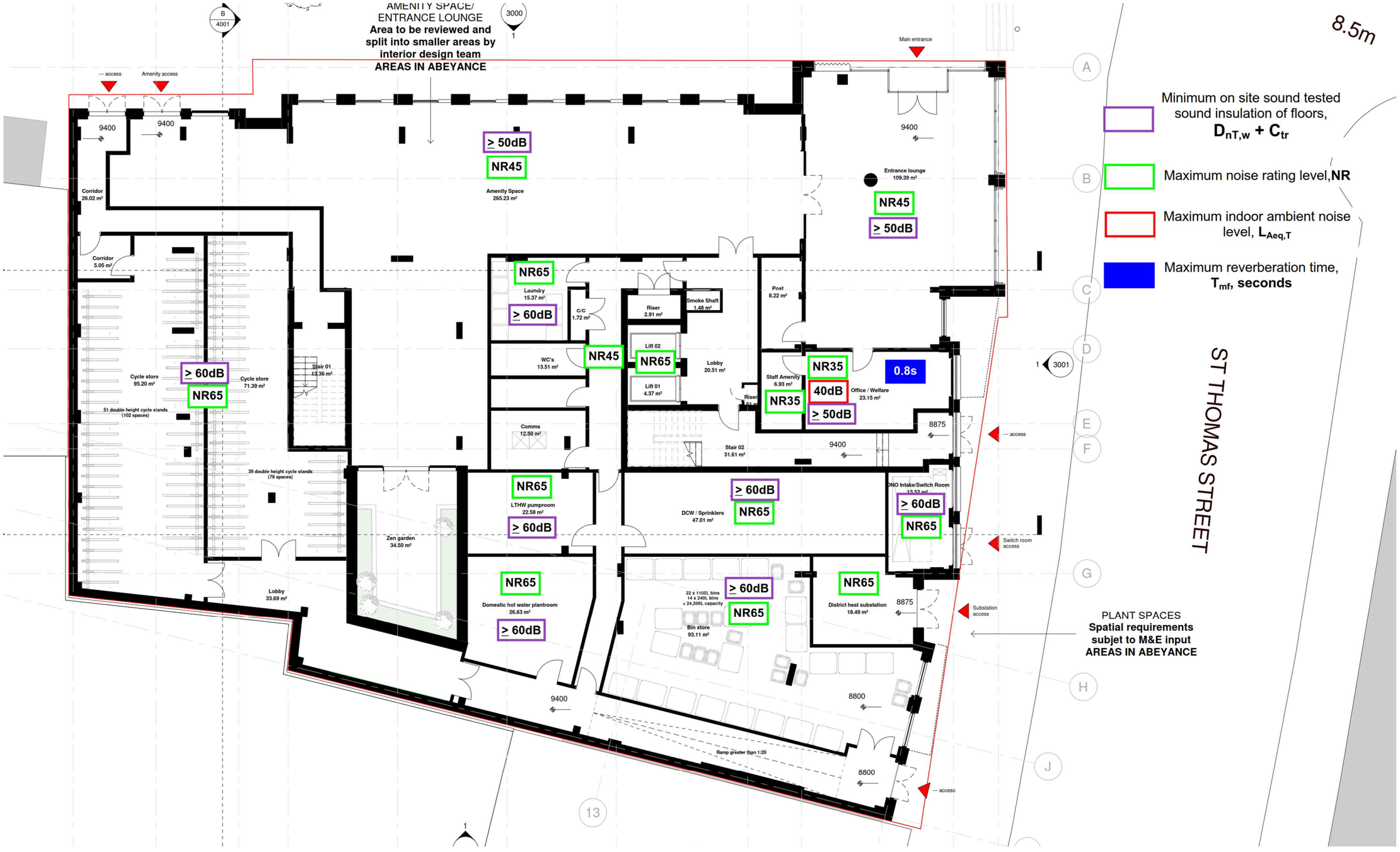
Sound pressure level – Sound pressure level is stated on many of the charts. It is the amplitude of the acoustic pressure fluctuations in a sound wave, fundamentally measured in Pascals (Pa), typically from 20 micro-Pascals to 100 Pascals, but commonly simplified onto the decibel scale.

Specific sound level, $L_s = L_{Aeq,Tr}$ – equivalent continuous A-weighted sound pressure level produced by the specific sound source at the assessment location over a given reference time interval, T_r.

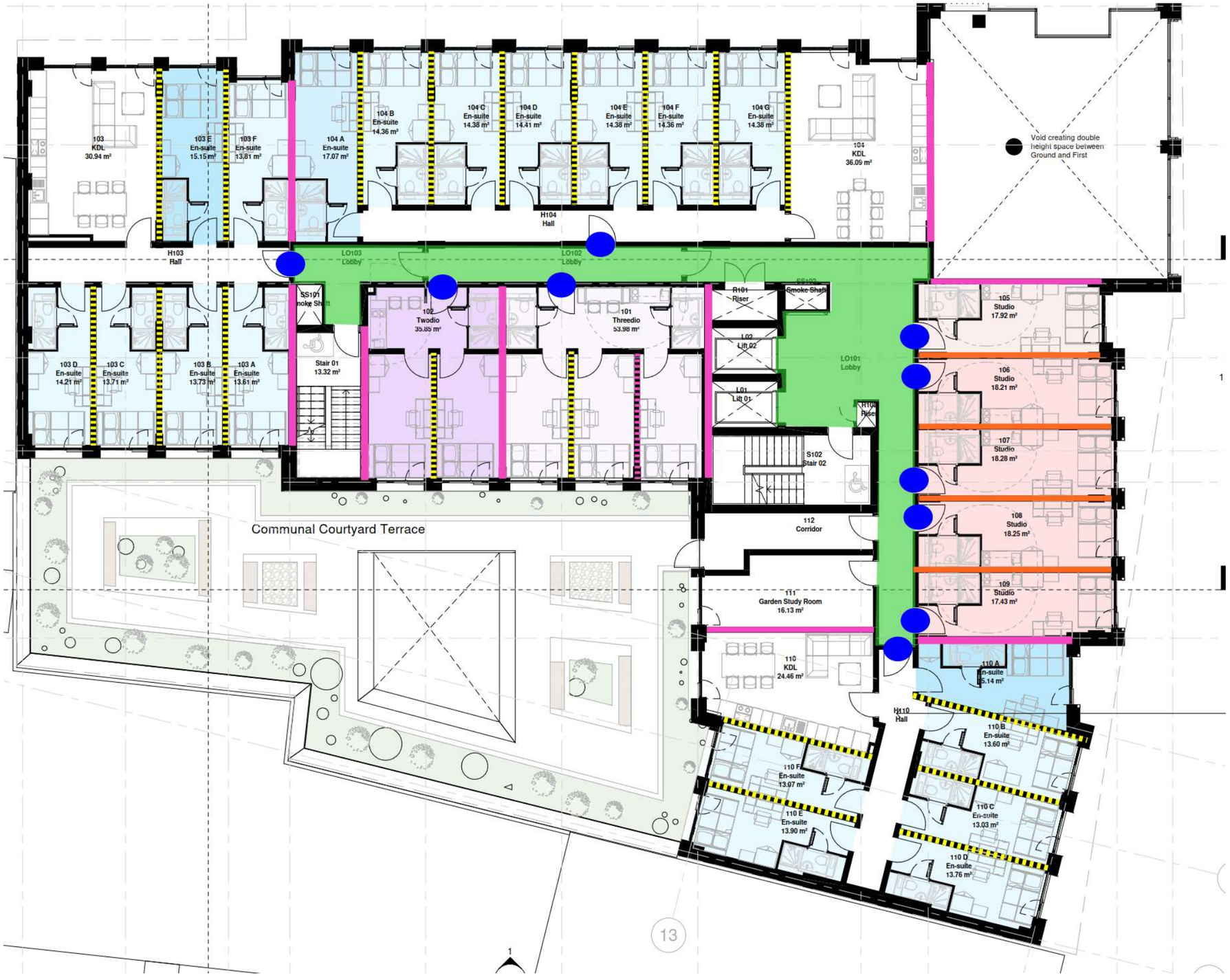
Rating level, $L_{Ar,Tr}$ – Specific sound level plus any adjustment for the characteristic features of the sound.

14. Appendix 2 - Acoustic Criteria

14.1. Ground Floor Criteria



14.2. **Residential Areas Sound Insulation Criteria**



- Orange Walls – Regulation E1 Table 0.1b with a + 5 dB uplift for BREEAM
- Pink Walls – Regulation E1 Table 0.1a with a + 5 dB uplift for BREEAM.
- Yellow Walls – Regulation E2.
- Blue Dots – 29 dB Rw doors as per ADE guidance.
- Green Ceiling Areas – Regulation E3
- All other doors/walls/ceilings – no building reg Approved Document E requirements.

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Head Office: 194 West Street, Bedminster, Bristol, BS3 3NB

Site Address:	Redcliffe PBSA Block, Bristol
Technical Design Note Description:	Review of ground floor amenity areas
Our Reference:	10014/AW
Date:	19 February 2024

The following Technical Note has been prepared to provide minimum acoustic performance criteria and to review the proposals for the ground floor amenity areas associated with this project.

1. Performance Specification of Ground Floor Areas

The following performance specification is based on Approved Document E, BS8233:2014 guidance, BREEAM 2018 and achieving good acoustic conditions.

Airborne Sound Insulation of Floors

The table below provides design targets for sound insulation between acoustically sensitive rooms:

Table 1: Airborne Sound insulation criteria of ceilings/floors

Source Room	Receive Room	Minimum Airborne Sound Insulation
026 Social Space 025 Study Room 002 Office/Welfare 004 Post 003 Staff Kitchenette All WCs 030 Games Area 012/013 Cycle Store	First Floor Dwellings	(1) $\geq$ 50 dB $D_{nTw} + C_{tr}$
024 Gym 023 Yoga/Flexible Room 027 Cinema Room All Plantrooms 019 Bin Store 006 Laundry	First Floor Dwellings	(2) $\geq$ 60 dB D_{nTw}

(1) For this scheme, to achieve both available BREEAM credits for sound insulation, a +5dB uplift in criteria is required for separating elements between dwellings.
(2) Subject to plant/cinema/gym/laundry noise levels, this is on the basis the maximum noise level within the source rooms will not exceed NR65.

Impact Sound Insulation of Floors

We recommend the following maximum standardised impact sound pressure levels within the ground floor acoustically sensitive areas. This is based on achieving good acoustic conditions for the use of each space:

Table 2: Impact Sound insulation criteria of ceilings/floors

Source Room	Minimum Airborne Sound Insulation
026 Social Space 025 Study Room 002 Office/Welfare 004 Post 027 Cinema Room	≤ 60 dB $L_{nT,w}$
003 Staff Kitchenette 030 Games Area 024 Gym 023 Yoga/Flexible Room	≤ 65 dB $L_{nT,w}$

Airborne Sound Insulation of Separating Walls

The table below provides design targets for sound insulation between acoustically sensitive rooms where there are no doors, vision panels or openings within the partition. The table also provides minimum lab rated sound insulation ratings for the selected walls to achieve:

Table 3: Sound insulation criteria of ground floor separating walls

Source Room	Receive Room	Minimum Airborne Sound Insulation	Minimum Laboratory Rated Performance
024 Gym	025 Study Room	≥ 52 dB D_{nTw}	≥ 59 dB R_w
026 Social Space	025 Study Room	≥ 42 dB D_{nTw}	≥ 49 dB R_w
002 Office/Welfare	004 Post	≥ 37 dB D_{nTw}	≥ 54 dB R_w
006 Laundry	030 Games Area	≥ 37 dB D_{nTw}	≥ 54 dB R_w
007 WC's	030 Games Area	≥ 37 dB D_{nTw}	≥ 54 dB R_w
007 WC's	006 Laundry	≥ 37 dB D_{nTw}	≥ 44 dB R_w
016 Plantroom	030 Games Area	≥ 47 dB D_{nTw}	≥ 54 dB R_w

[1] Subject to lift / plant/cinema noise levels, this is on the basis maximum noise level within the source rooms will not exceed NR65.

Where there are doors within the partitions, the wall should be selected with a sound reduction index of 40dB R_w, and the door 30dB R_w. This also applies to corridor walls.

All separating walls that are not mentioned above do not require a specific sound insulation performance.

Indoor Ambient Noise Levels

The following table provides noise limits for indoor ambient noise levels. This is the cumulative noise level from building services and noise ingress from external sources.

The design upper limit for indoor ambient noise levels is stated in the table below. This is a cumulative level of all noise sources, including building services , external noise ingress, and noise transfer from adjacent spaces:

Table 4: Internal Ambient noise level criteria

Source Room	Maximum Equivalent Noise Level, dB $L_{Aeq,T}$	Maximum Noise Rating Level of Building Services
027 Cinema Room	30	NR25
023 Yoga Room	40	NR35
024 Gym	45	NR40

025 Study Room	35	NR30
026 Social Space	40	NR35
001 Entrance Lounge	45	NR40
002 Office/Welfare	40	NR35
011 Staff WC	50	NR45
003 Staff Kitchenette	50	NR45
004 Post	40	NR35
007 WC's	50	NR45
006 Laundry	50	NR45
030 Games Area	40	NR35
Corridors	40	NR35
All Plantrooms	-	NR65
019 Bin Store	-	NR65
012 & 013 Cycle Stores	-	NR65

Room Acoustics (Reverberation Time)

The requirement for reverberation times performance standards is to ensure good communication and concentration specific to the proposed use of each room. The table below provides minimum performance requirements:

Table 5: Internal Ambient noise level criteria

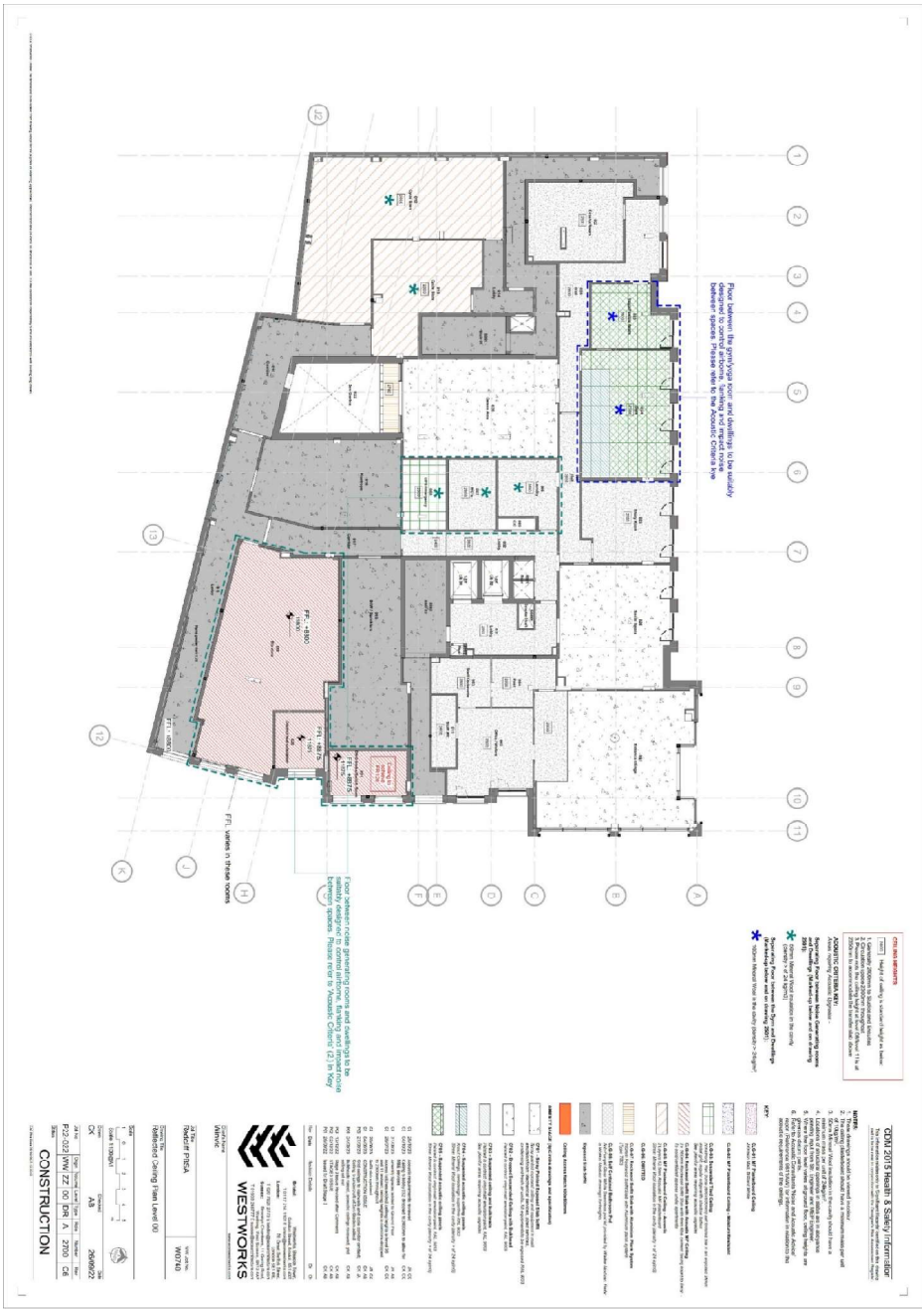
Source Room	Maximum Reverberation Time (T_{mf} seconds)
027 Cinema Room	0.4
023 Yoga Room/024 Gym	1.5
025 Study Room	0.8
026 Social Space	1.0
001 Entrance Lounge	1.5
002 Office/Welfare	1.0
011 Staff WC	1.5
003 Staff Kitchenette	1.5
004 Post	1.0
007 WC's	1.5
006 Laundry	1.5
030 Games Area	1.0
Bin Store and Plant Rooms below dwellings[(1)]	1.5 – 2.0

[1] To reduce the reverberant noise levels within the bin store and plant rooms, it is advised to install sound absorption where possible. It is recommended to aim to achieve a maximum reverberation time of around 1.5-2 seconds.

2. Sound Insulation Review of Ceilings

Review of Reflected Ceiling Plan (P22-022-WW-ZZ-00-DR-A-2700-C6)

The reflected ceiling plan for level 00 is shown below:



019 Bin Store, 020 District Heat Substation, 021 IDNO Intake/switch room

We have advised that due to the plant noise within the rooms there should be a suspended plasterboard ceiling with mineral wool in the cavity.

The proposed ceiling is two layers of 160mm thick Rockwool soffit slab, with one board of 6mm thick fibre cement board below. The cement board should be suspended 100mm below the soffit slab insulation on a metal frame. It is necessary to enhance the proposed ceiling to include a layer 50mm thick mineral wool (density $\geq$ 10kg/m^3 within the cavity.

All services should be located below the board.

With the above enhancements, the ceiling is expected to be acceptable in terms of airborne sound insulation, subject to no-significant flanking paths, correct installation, quality detailing and workmanship.

016 Plantroom, 018 DCW/Sprinklers

It is proposed for the ceiling to comprise of the exposed soffit. Full details including octave band sound power levels of all plant being installed within the plantroom and Sprinkler Room should be issued to use for review.

There are no dwellings directly above the plantroom, as such the proposals are acceptable.

008 UPS Emergency

It is proposed to installed a suspended MF ceiling with 50mm mineral wool, and lay-in-grid Armstrong Dune ceiling tiles. Octave band sound power levels of any noise generating equipment within this room should be issued to us for review.

006 Laundry, 007 WC's

We have been advised that the laundry room will comprise of a washer and a tumble dryer, which have stated sound levels of 64dBA SPL@3m for the washer, and 53dBA SPL@3m for the dryer. We have not been provided with spectral sound level data. As such, based on the limited data available, we cannot accurately predict the airborne noise transfer to the adjacent rooms. It will be the supplier's responsibility to select equipment so to not exceed the noise limits within the adjacent dwellings (NR15).

The suppliers of the laundry equipment should ensure the level of vibration is no greater than 0.05 PPV in adjacent rooms, along with the level of structure borne noise is no greater than 15 dBA in rooms.

The proposed ceiling comprises 50mm mineral wool and a MF plasterboard ceiling. The ceiling should comprise of 2no. layers of plasterboard (mass per board 10kg/m^2) and at least 50mm of mineral wool in the cavity.

004 Post, 003 Staff Kitchenette, 011 Staff WC, 002 Office/Welfare

The proposed ceiling comprise a suspend MF ceiling with one layer of plasterboard (mass $\geq$ 10kg/m^2).

With the proposed 230mm thick RC slab, the proposed ceiling is acceptable in terms of airborne sound insulation subject to no-significant flanking paths, correct installation, quality detailing and workmanship.

026 Social Space, 001 Entrance Lounge, 030 Games Area

It is proposed to have an exposed soffit in these rooms. Based on the proposed 230mm thick RC slab with a density of 2500kg/^{3}, the proposal is expected to achieve the airborne sound insulation criteria, subject to no-significant flanking paths, correct installation, quality detailing and workmanship.

025 Study Room

It is proposed to have a suspended MF ceiling with one layer of plasterboard (mass $\geq$ 10kg.m^2). The proposal is expected to achieve the airborne sound insulation criteria, subject to no-significant flanking paths, correct installation, quality detailing and workmanship.

027 Cinema Room

As previously advised via email, the ceiling within the cinema room is required to include an MF ceiling with two layers of 15mm plasterboard, and 100mm of mineral wool in the cavity. The current proposal does not achieve this.

023 Yoga/Flexible Room, 024 Gym

As previously advised via email, the ceiling within the cinema room is required to include an MF ceiling with two layers of 15mm plasterboard, and 100mm of mineral wool in the cavity. It is unclear whether the proposal achieves this, as CF05 ceiling type states 'suspended acoustic ceiling panels). This should be confirmed and amended accordingly if incorrect.

012/013 Cycle Stores

The airborne sound insulation criteria of the ceiling for these rooms was previously 60dB $D_{nT,w}$. However, if there is no noise generating plant within the rooms, a lower criterion of 50dB $D_{nT,w}+C_{tr}$ can be applied. Based on the lower criteria, the proposed ceiling is expected to be acceptable subject to no-significant flanking paths, correct installation, quality detailing and workmanship.

If there is any noise generating plant within the rooms, details of these including octave band sound power levels should be issued to use for review.

3. Impact Sound Insulation

The following table shows the minimum manufacturer stated impact sound level reduction performance of any soft floor finishes, or resilient layers below hard floor finishes, to be located within the rooms directly above the noise sensitive rooms:

Table 6: Required impact sound reduction

Receive Room Impact Sound Pressure Level Criteria	Minimum Impact Sound Pressure Level Reduction of Floor
60 dB $D_{nT,w}$	Δ L_w 17 dB
65 dB $D_{nT,w}$	Δ L_w 12 dB

4. Room Acoustics Review

To achieve the performance criteria, the following table provides minimum surface area of Class A absorption that should be installed to the rooms. This can be in the form of wall panels, ceiling tiles, or suspended panels. As per the provided floor finishes plans, all rooms have a vinyl floor finish. It should be noted that if a carpet floor finish can be used, the minimum area of extra absorption needed will be reduced. We recommend doing this in the cinema room.

Table 7: Minimum Class A absorption

Source Room	Minimum Area of Extra Class A absorption
027 Cinema Room	29]
023 Yoga Room	2
024 Gym	5
025 Study Room	10
026 Social Space	21
001 Entrance Lounge	44
002 Office/Welfare	7

Source Room	Minimum Area of Extra Class A absorption
011 Staff WC	
003 Staff Kitchenette	
004 Post	2
007 WC's	
006 Laundry	1
030 Games Area	21
Bin Store and Plant Rooms below dwellings(1)	10

(1) To reduce the reverberant noise levels within the bin store and plant rooms, it is advised to install sound absorption where possible. It is recommended to aim to achieve a maximum reverberation time of around 1.5-2 seconds. We have not yet been provided with details of plant located in the plant rooms, this requirement can be reviewed when issued to us.

5. Indoor Ambient Noise Levels

All building services should be designed to not exceed the noise rating levels and the cumulative equivalent noise levels within each space, as defined earlier in this Technical Note.

It is our understanding the ground floor amenity areas will be ventilated by MVHR. Full details of the proposed ventilation system including in-duct, and casing breakout, octave band sound power levels should be issued to us for review.

6. Flanking Transmission

To ensure the sound insulation performance between storeys is achieved, the flanking noise path through the junction section between the external façade/ curtain wall and concrete floor as well as through the curtain wall mullions/ transoms will need to be sufficiently controlled to achieve a sound insulation performance that is at least 5 to 10 dB above the required on-site performance.

We understand the on-site performance is Approved Document E and BREEAM. As the on-site performance is 50 dB $D_{nTw} + C_{tr}$ the laboratory flanking $D_{nf,w} + C_{tr}$ performance would need to be 55 – 60 dB $D_{nf,w} + C_{tr}$. To achieve this, it is advised the mullions and transoms are filled with Siderise mineral wool inserts which achieve this flanking performance. Siderise should be contacted for comment and to provide a solution.

I trust this is of assistance. Please contact me should you require any further information or clarification.

Yours sincerely,

Andy Warren
BSc (Hons), BSc, AMIOA
Acoustic Consultant

ACOUSTIC CONSULTANTS LTD

Plant Noise Impact Assessment

Redcliff PBSA Block, Bristol

Reference: 10014/AW

Client:
winvic

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1.0	1st Issue	29/01/2024	Andy Warren AMIOA	Blake Lucas MIOA	Blake Lucas MIOA
Revision A	Amended error	31/01/2024	Andy Warren AMIOA	Blake Lucas MIOA	Blake Lucas MIOA
Revision B	Amended proposals	16/02/2024	Andy Warren AMIOA	Blake Lucas MIOA	Blake Lucas MIOA

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

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

Table of Contents

1. Introduction

Winvic appointed Acoustic Consultants Limited to provide a noise impact assessment for the proposed externally located roof top plant associated with the purpose-built student accommodation (PBSA) development at Redcliff Quarter, Bristol.

The site has planning approval (application number 21/04306/F) with one condition (11) relating to plant noise impact upon the nearest sensitive receivers within the development and in the surrounding premises.

This report provides the results of a baseline noise survey conducted at the existing site and a noise impact assessment of the proposed external plant, in support of the planning application.

The assessment has been undertaken in accordance with British Standard 4142:2014+A1:2019.

2. The Site

The proposal is for new purpose-built student accommodation (PBSA) at Redcliff Quarter, Bristol.

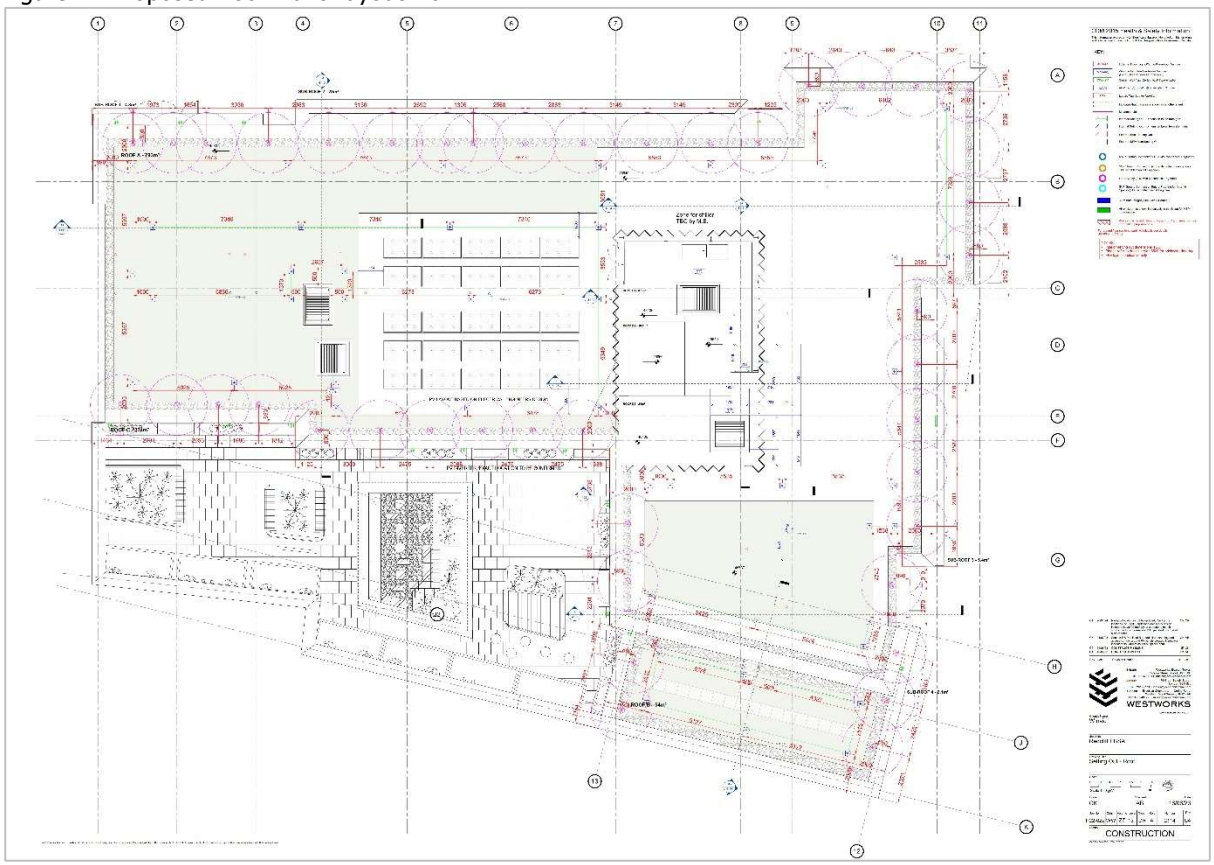
There is new external plant to be located on the rooftop as part of the refurbishment.

The nearest noise sensitive receivers to this development will be the proposed residential dwelling as part of the wider Redcliff Quarter development, and the existing flats directly to the north of the site.

The following figures show the site location and the proposed roof top plant layout drawing:

Figure 1: Site Location

Figure 2: Proposed Roof Plant Layout Plan



3. Planning Condition 11

Condition 11 of the Notice of Decision for Application no. 21/04306/F states the following:

"Noise from plant & equipment

The rating level of any noise generated by plant & equipment as part of the development shall be at least 5 dB below the pre-existing background level as determined by BS4142: 2014 Methods for rating and assessing industrial and commercial sound. Prior to the commencement of the use of this development an assessment to show that the rating level of any plant & equipment will be at least 5 dB below the background level has been submitted to and approved in writing by the Council. The assessment must be carried out by a suitably qualified acoustic consultant/engineer and be in accordance with BS4142: 2014 Methods for rating and assessing industrial and commercial sound.

Reason: In the interests of residential amenity."

4. Assessment Criteria

4.1. British Standard 4142:2014+A1:2019

For plant noise, the relevant guidance is within British Standard 4142:2014+A1:2019 entitled 'Method for rating and assessing industrial and commercial sound' uses outdoor sound levels to assess the likely effects of sound upon people who might be inside or outside a dwelling or other premises used for residential purposes. The principle is that of establishing the 'difference' between the 'rating level' and the 'background sound level'.

The 'rating level' is the 'specific sound level' of the source over a period of one hour during the day (07:00 to 23:00 hours) and over a period of 15 minutes during the night (23:00 to 07:00 hours).

Section 9 entitled 'Rating Level' states: "*Certain acoustic features can increase the significance of impact over that expected from a basic comparison between the specific sound level and the background sound level. Where such features are present at the assessment location, add a character correction to the specific sound level to obtain the rating level.*"

An acoustic character correction should be added to the 'specific sound level' if it exhibits any tonality, impulsivity, other specific characteristics and/or intermittency at the assessment location. The value of the character correction varies, dependent on the prominence of the character of the sound source at the assessment location.

Section 11 of the British Standard, entitled 'Assessment of the Impacts', states:

"*Obtain an initial estimate of the impact of the specific sound by subtracting the measured background sound level (see Clause 8) from the rating level (see Clause 9) and consider the following*.

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

Based on the initial assessment outcomes of BS4142, and depending on context, it is our opinion that the NOEL, LOAEL and SOAEL levels stated in the Noise Policy

Statement for England would generally fall within the following categories when considered in conjunction with the effect levels of the PPG Noise.

Table 1: BS4142 Difference in Relation to Effect Levels

BS4142+A1:2019 Assessment Difference	**Corresponding Effect Level***	**Action***
-10 dB	No Observed Effect	No specific measures required
-9.9 dB to 0 dB	No Observed Adverse Effect	No specific measures required
	Lowest Observed Adverse Effect Level	
0.1 dB to 5 dB	Observed Adverse Effect	Mitigate and reduce to a minimum
	Significant Observed Adverse Effect Level	
5.1 dB to 10 dB	Significant Observed Adverse Effect	Avoid
10.1 dB	Unacceptable Adverse Effect	Prevent

* BS4142+A1:2019 states that "where the initial estimate of the impact needs to be modified due to the context, take all pertinent factors into consideration". Therefore, the assessment levels and effect levels above are not definitive and can be modified due to context.

It should be noted that the numerical outcome only represents the initial estimate of impact, as stated in the first paragraph of Clause 11, and that contextual matters should be considered before determining what the potential impact is. This paragraph states:

> *"The significance of sound of an industrial and/or commercial nature depends upon both the margin by which the rating level of the specific sound source exceeds the background sound level and the context in which the sound occurs. An effective assessment cannot be conducted without an understanding of the reason(s) for the assessment and the context in which the sound occurs/will occur. When making assessments and arriving at decisions, therefore, it is essential to place the sound in context."*

The second part of Clause 11 sets out three contextual matters that should be taken into account once the initial numerical estimate has been determined. It is important to note that the three listed are not exhaustive and all pertinent factors should be considered.

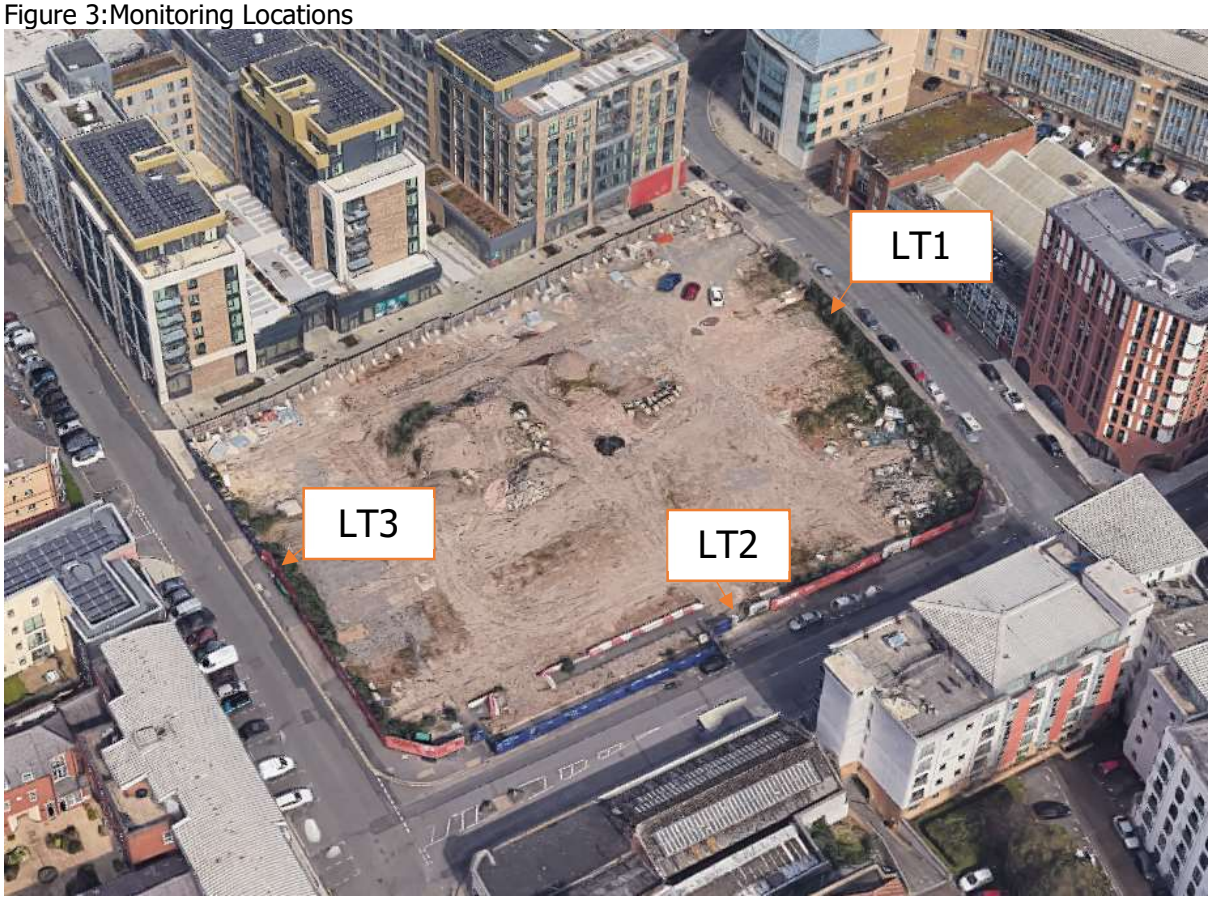
5. Noise Survey

5.1. Monitoring Procedure

A long-term noise survey was undertaken between the 11th and the 15th of August 2022 to determine the existing noise climate at the site. The full survey details are within our planning report. Each sound level meter was positioned to monitor the noise levels from each surrounding road.

The monitoring locations are shown on the following figure:

Figure 3:Monitoring Locations



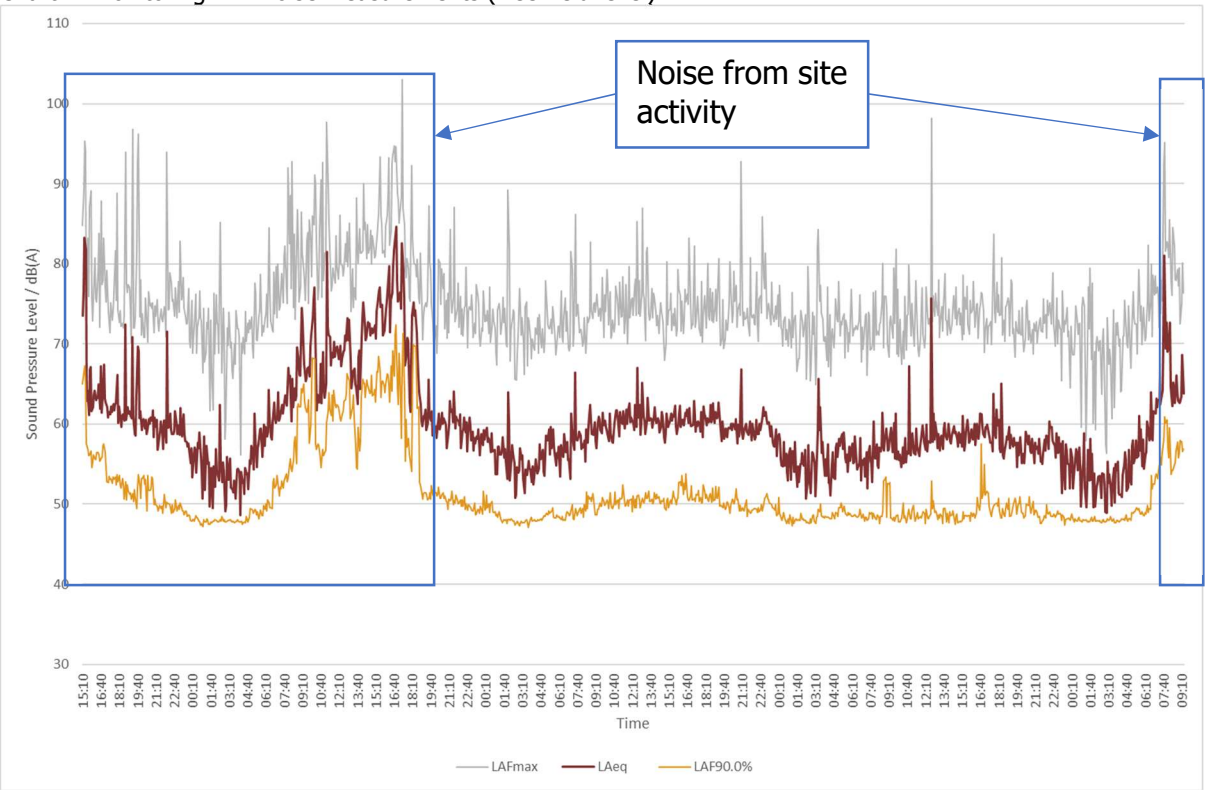
5.2. Measured Noise Levels

As this is an active building site, the measurements at each location were affected by noise from onsite activities during the weekday periods. As such, our design ambient levels have been determined only from the weekend measurements. The following section provides the measured long-term data at each location in chart format along with the typical noise level in tabular format.

5.2.1. **Monitoring Location LT1**

The following chart shows the measured noise levels during the entire monitoring exercise:

Chart 1: Monitoring LT1 Noise Measurements (free-field level)



We have determined the following ambient noise levels from LT1:

Table 2: Spectral Design noise levels at LT1 (free-field) at Monitoring Location 1

Parameter	Octave Band								dB(A)
	63	125	250	500	1kHz	2kHz	4kHz	8kHz	
Day, $L_{eq(16\ hour)}$	66	61	60	56	57	51	44	37	61
Night, $L_{eq\ (8hour)}$	62	56	55	53	54	48	41	33	57
Night, L_{AFMax}	74	76	72	72	74	69	63	57	77

We have also determined the following modal background sound level at LT1:

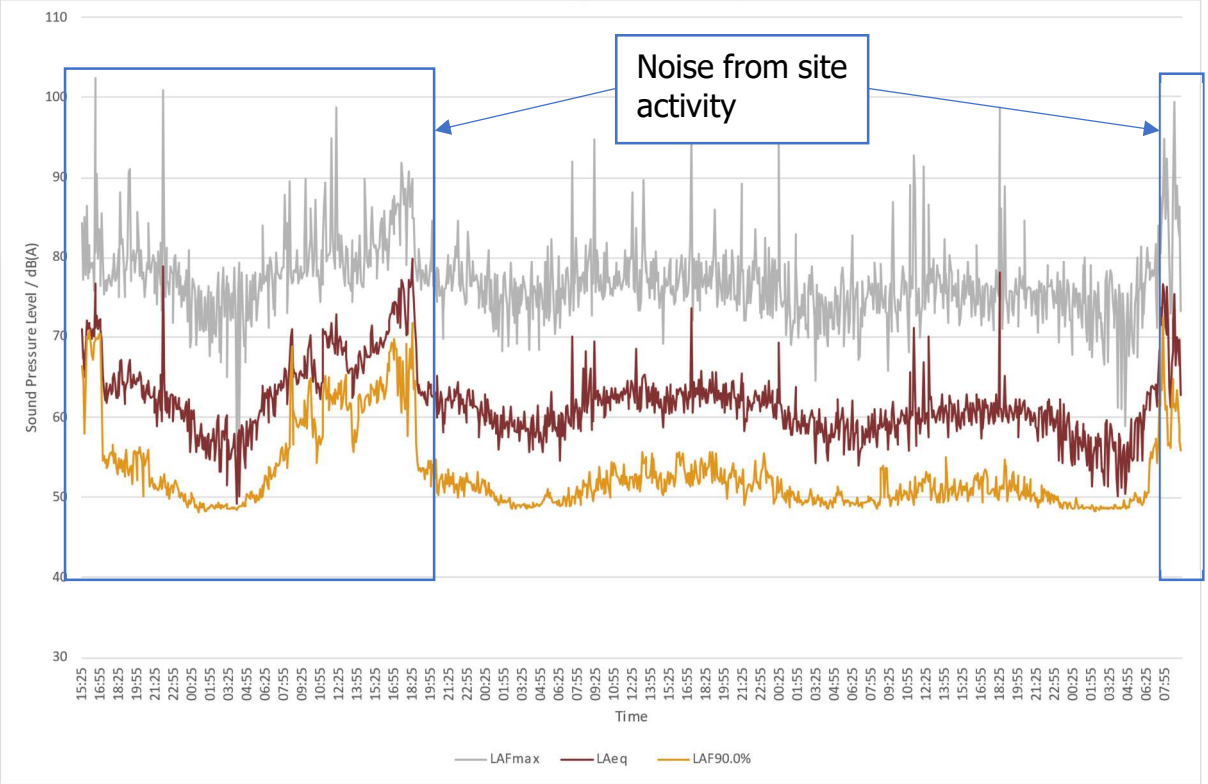
Table 3: Modal background and residual noise levels at LT1

Period	dB $L_{A90,5min}$		dB $L_{Aeq,5min}$	
	Range	Mode	Range	Mode
Day (07:00 - 23:00)	48 - 58	49	52 - 76	58
Night (23:00 - 07:00)	47 - 54	48	49 - 66	55

5.2.2. Monitoring Location LT2

The following chart shows the measured noise levels during the entire monitoring exercise:

Chart 2: Monitoring location LT2 Noise Measurements (free-field level)



We have determined the following ambient noise levels from Monitoring Location LT2:

Table 4: Spectral Design noise levels at Location 2 (free-field) at Monitoring Location LT2

Parameter	Octave Band								dB(A)
	63	125	250	500	1kHz	2kHz	4kHz	8kHz	
Day, $L_{eq(16\ hour)}$	68	63	61	59	59	56	50	45	63
Night, $L_{eq\ (8hour)}$	64	59	58	55	57	53	46	40	60
Night, L_{AFMax}	70	77	73	72	77	70	60	51	79

We have also determined the following modal background sound level at location LT2:

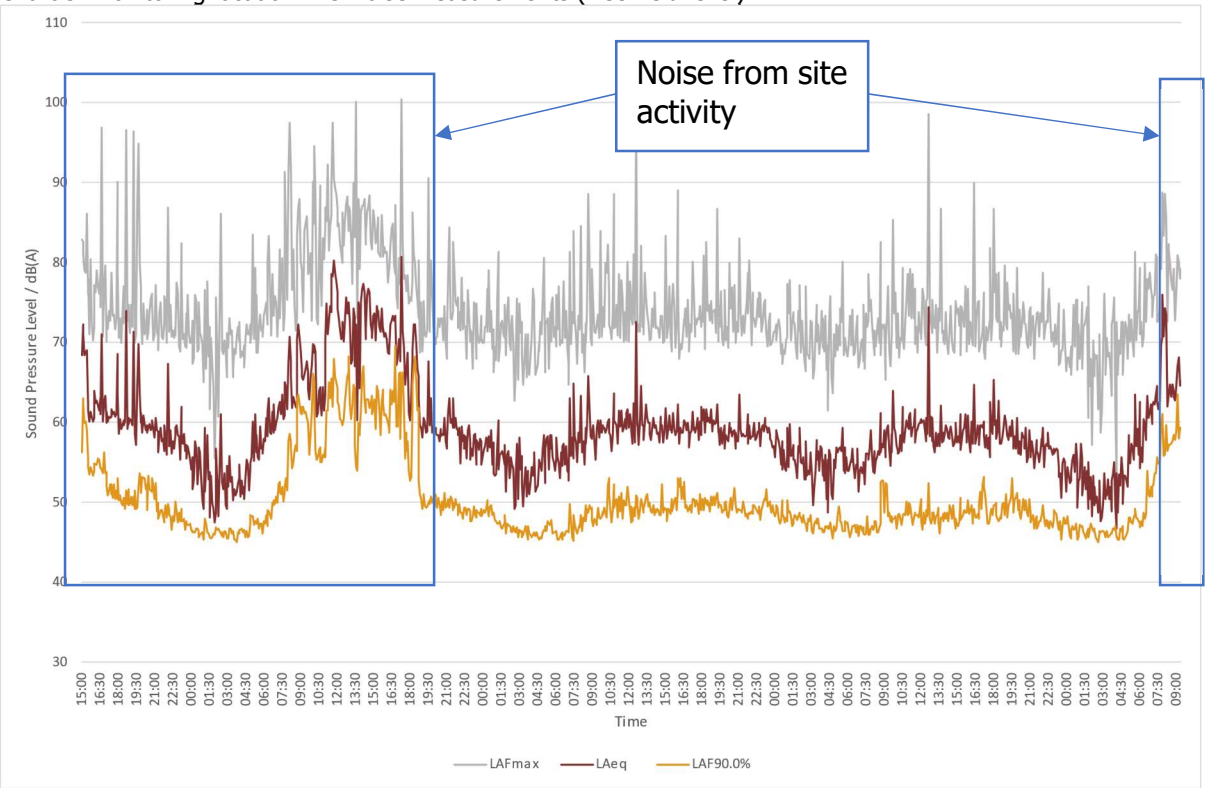
Table 5: Modal background and residual noise levels at LT2

Period	dB $L_{A90,5min}$		dB $L_{Aeq,5min}$	
	Range	Mode	Range	Mode
Day (07:00 - 23:00)	49 – 56	50	55 – 78	61
Night (23:00 - 07:00)	48 – 56	49	50 – 69	57

5.2.3. Monitoring Location LT3

The following chart shows the measured noise levels during the entire monitoring exercise:

Chart 3: Monitoring location LT3 Noise Measurements (free-field level)



We have determined the following ambient noise levels from Monitoring Location LT3:

Table 6: Spectral Design noise levels at Location 3 (free-field) at Monitoring Location LT3

Parameter	Octave Band								dB(A)
	63	125	250	500	1kHz	2kHz	4kHz	8kHz	
Day, $L_{eq(16\ hour)}$	66	61	59	56	57	52	46	38	60
Night, $L_{eq\ (8hour)}$	63	56	54	52	53	48	40	31	56
Night, L_{AFMax}	73	70	71	72	73	65	56	48	75

We have also determined the following modal background sound level at location LT3:

Table 7: Modal background and residual noise levels at LT3

Period	dB $L_{A90,5min}$		dB $L_{Aeq,5min}$	
	Range	Mode	Range	Mode
Day (07:00 - 23:00)	45 – 53	49	52 – 74	58
Night (23:00 - 07:00)	45 – 54	47	47 – 64	54

6. Plant Noise Assessment

6.1. Fixed Plant Noise Limits

It is understood that the proposals include for fixed plant at the site. The plant is proposed to be situated at roof level. The following provides cumulative noise limits to be applied across the site, when measured at the façade of nearby residential dwellings.

The noise limits are the cumulative effect of all plant and operations on the development site, including any character corrections required for plant noise characteristics.

These limits are based on the measured survey results, British Standard 4142:2014+A1:2019, and Planning Condition 11.

The maximum cumulative rating noise limits of noise from plant associated with the development are as follows:

Table 8: Proposed Plant Noise Limits

Period	Limits at Receivers $L_{Ar(T)}$
Day (07:00 to 23:00)	44 dB
Night (23:00 – 07:00)	42 dB

The Rating Level of noise from the site is to include an acoustic feature correction as applicable in accordance with Section 9 of BS4142:2014 for any tonality, impulsivity, intermittency or other sound characteristics. With these limits being met the impact will be low in terms of BS4142:2014+A1:2019.

6.2. Proposed Plant

It is proposed to install a roof top plant area comprising 2no. Daikin VRV units.

The following table shows the manufacturer sound levels provided by the client:

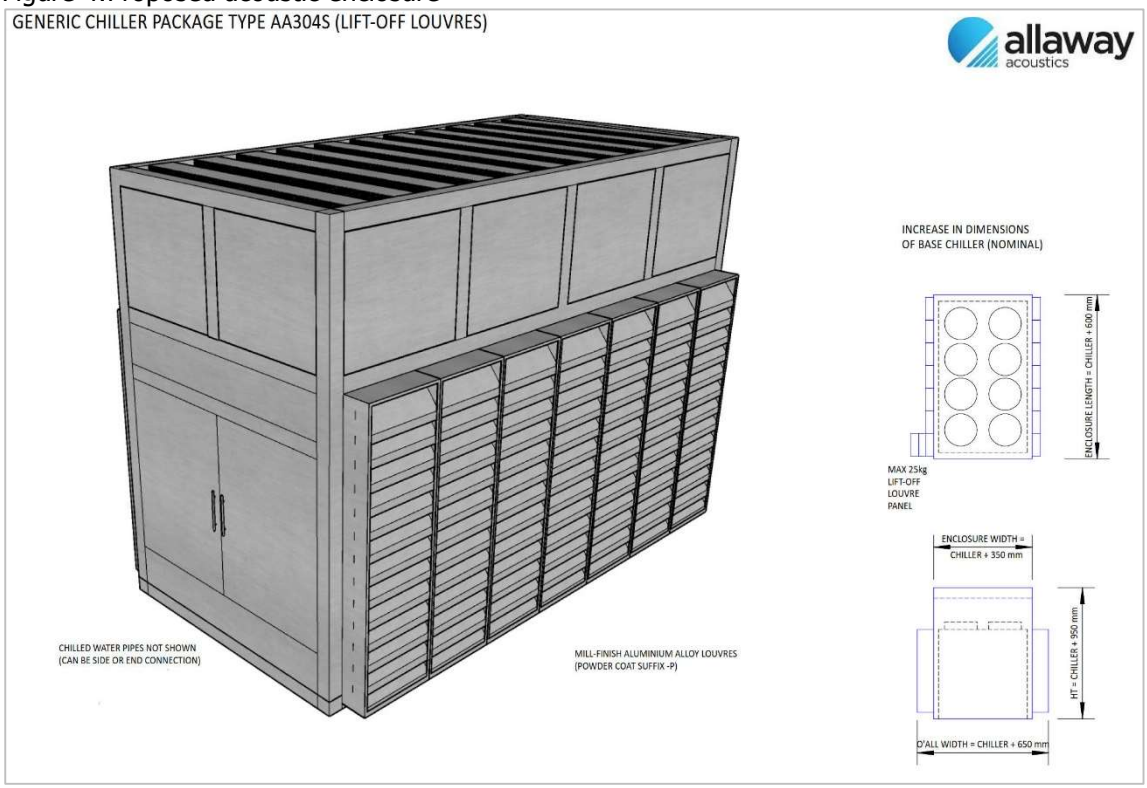
Table 9: Proposed Plant Sound Levels

Plant	Quantity	Sound Level
Daikin REYQ16U	1	86dB(A) (Sound Power Level)
Daikin REYQ8U	1	78dB(A) (Sound Power Level)

6.3. Acoustic Enclosure

It is proposed to install an acoustic enclosure around the chillers. The proposed enclosure is as follows:

Figure 4:Proposed acoustic enclosure



We have been advised that the above enclosure provides 8dBA of sound reduction, inside to out. The supplier/manufacturer should confirm that this sound reduction will be achieved.

6.4. Modelling Parameters

The plant noise emission has been modelled in the noise modelling software Cadna:A by DataKustik. The modelling software calculates sound levels based on the inputted sound emission values, source and receiver locations, and primarily distance, barrier and ground attenuation. Calculations are undertaken using the General Method of Calculation from ISO 9613.

The parameters within the Cadna:A model are as follows and are considered reasonable assumptions:

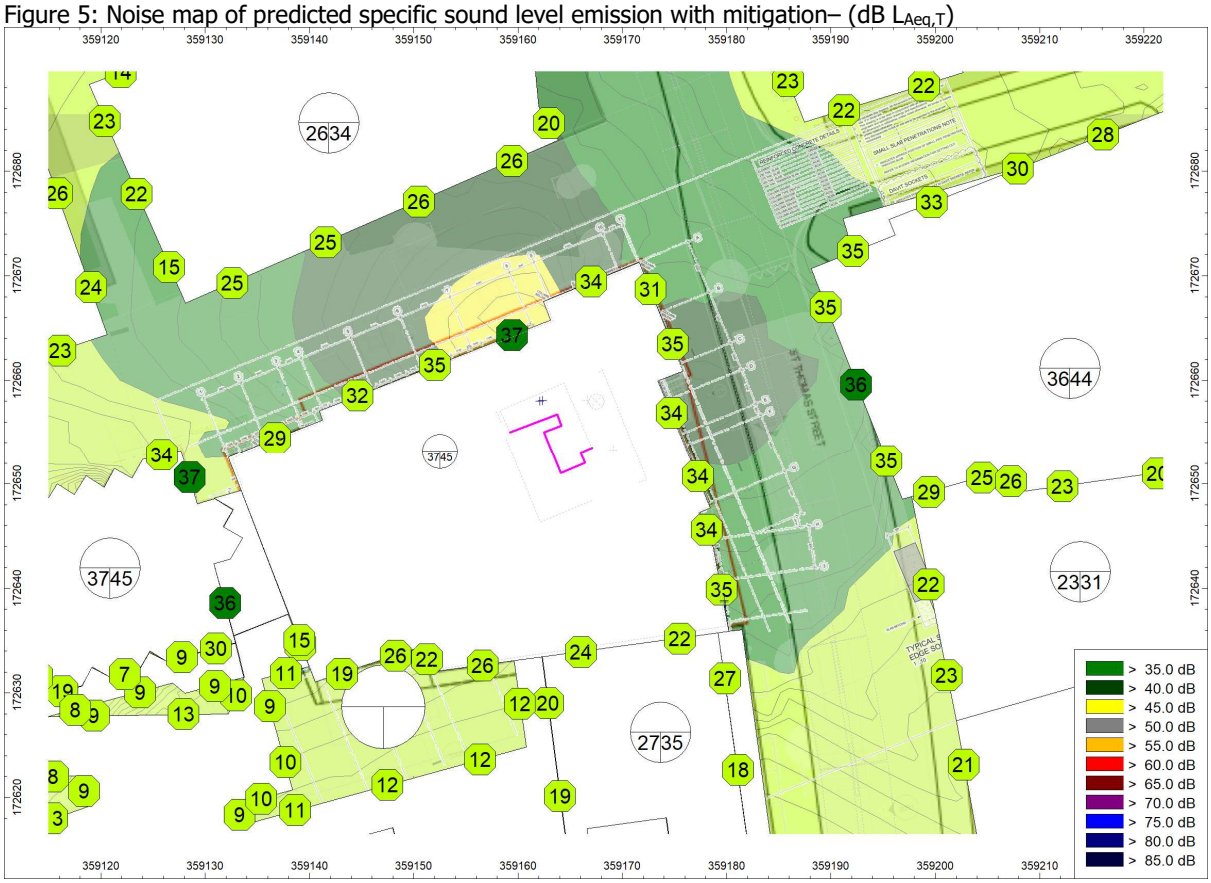
- The buildings have been based on Google Street View imagery and reasonable assumptions.
- The order of reflections is 3, and all buildings are considered reflective.
- The ground across the site and surrounding area is considered hard and reflective.
- The topography of the site is assumed to be flat.

- The predictions are based on all plant operating continuously and simultaneously.
- The chillers have been modelled with an acoustic enclosure providing 8dBA of sound reduction.
- The predicted building noise map levels indicate the maximum levels at each façade.
- The noise grid is displayed at 36m above ground.
- A 0.2m high parapet has been input around the perimeter of the roof top.
- The acoustic barrier and wall around the plant area as above has been included within the model.
- The noise mitigation measures detailed above have been implemented in the models.

6.5. **Modelling Results**

Noise maps of the plant specific sound levels including the above noise mitigation is provided below:

Figure 5: Noise map of predicted specific sound level emission with mitigation– (dB $L_{Aeq,T}$)



6.6. British Standard 4142:2014 Initial Estimate

6.6.1. Predicted Specific Sound Level

The highest predicted cumulative specific sound level is 37dB $L_{Aeq,}$ at the façade of the NSRs. These are the levels determined at the noise sensitive receivers without any character corrections applied.

6.6.2. Background Sound Level

The representative background sound level determined from the baseline survey is 49 dB $L_{A90,1hour}$ during the day (07:00 to 23:00 hours), and 47 dB $L_{A90,15minute}$ during the night (23:00 to 07:00 hours).

6.6.3. Character Correction

Character corrections should be added to the 'specific sound level' if it exhibits any *tonality, impulsivity, other specific characteristics and/or intermittency* at the assessment location. The corrections are as follows:

- *Tonality* – From our experience of other sites this type of plant is not usually tonal. It is not possible to determine tonality using a desktop approach without 3rd-octave band sound level data. The supplier and installer of the proposed plant should ensure any tonality is not distinguishable at the noise-sensitive receivers in the area.
- *Impulsivity* – Plant such as this is not normally impulsive.
- *Intermittency* – We do not expect that the intermittency of the plant will be distinguishable at the sensitive receiver over the residual noise climate and we have not applied correction for intermittency. We have also assumed all plant is running continuously within our noise model.
- *Other Sound Characteristics* – Plant is not expected to have any audible character due to the low level in comparison with the baseline noise levels in the area.

6.6.4. Estimate of Impact

Therefore, the British Standard 4142:2014 initial estimate at the most sensitive location is as follows:

Table 10: Initial Estimate of Impact

Parameter	Day	Night
Background Level, $L_{A90,T}$	49 dB	47 dB
Specific Sound Level, $L_{Aeq,T}$	37 dB	37 dB
Character Correction*	0 dB	0 dB
Rating Level, $L_{Ar,T}$	37 dB	37 dB
Excess of rating over the background level	-12 dB	-10 dB

This means that the plant rating noise level at the worst-case noise sensitive receiver will result in a 'difference' of -12 dB during the day, and -10 during the night. As such, the requirements of Planning Condition 11 are achieved during the day and night.

6.7. **Summary of Assessment**

With the proposed roof top plant and the acoustic enclosure, the requirements of Planning Condition 11 can be achieved.

7. Summary & Conclusions

Winvic appointed Acoustic Consultants Limited to provide a noise impact assessment for the proposed externally located roof top plant associated with the purpose-built student accommodation (PBSA) development at Redcliff Quarter, Bristol.

The site has planning approval (application number 21/04306/F) with one condition (11) relating to plant noise impact upon the nearest sensitive receivers within the development and in the surrounding premises.

This report provides the results of a baseline noise survey conducted at the existing site and a noise impact assessment of the proposed external plant, in support of the planning application.

A Cadna:A computer noise model was built for the proposed plant operation and the predicted levels compared to measured background noise levels. With the current proposals, the predicted specific sound levels of the plant at the NSRs is at least 10dB below the background sound level during the day and night.

As such, the requirements of Planning Condition 11 are expected to be achieved.

8. Appendix 1 – Glossary of Acoustic Terminology

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

A-weighted sound pressure level, L_{pA} - quantity of A-weighted sound pressure given by the following formula in decibels (dBA)

$L_{pA} = 10 \log_{10} (p_A/p_0)^2$

where:

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

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

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

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

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

$$L_{AeqT} = 10\lg_{10}\left\{(1/T)\int_{t1}^{t2}[p_A(t)^2/p_0^2]dt\right\} \quad (1)$$

where:

p_0 is the reference sound pressure (20 µPa); and
$p_A(t)$ is the instantaneous A-weighted sound pressure (Pa) at time t

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

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

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

Octave and Third Octave Bands – The human ear is sensitive to sound over a range of frequencies between approximately 20 Hz to 20 kHz and is generally more sensitive to medium and high frequencies than to low frequencies within the range. There are many methods of describing the frequency content of a noise. The most common methods split the frequency range into defined bands, in which the mid-frequency is used as the band descriptor and in the case of octave bands is double that of the band lower. For example, two adjacent octave bands are 250 Hz and 500 Hz. Third octave bands provide a fine resolution by dividing each octave band into three bands. For example, third octave bands would be 160 Hz, 250 Hz, 315 Hz for the same 250 Hz octave band.

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

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

Specific sound level, $L_s = L_{Aeq,Tr}$ – equivalent continuous A-weighted sound pressure level produced by the specific sound source at the assessment location over a given reference time interval, T_r.

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

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

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

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

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

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

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