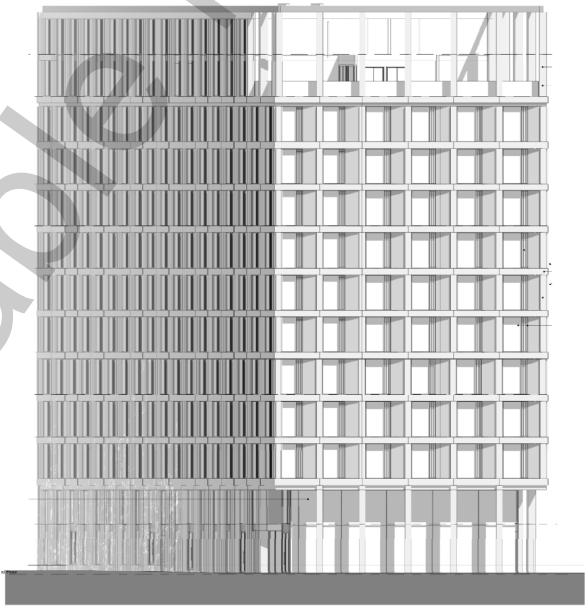




REPORT REF: D480-ENV-ZZ-XX-RP-Y-1005

FAÇADE STRATEGY REVIEW (Stage 5) – ACOUSTICS

PROPOSED APARTMENT DEVELOPMENT, BENDIX STREET, NEW
CROSS, MANCHESTER M4



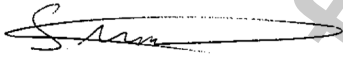


CLIENT: GMI Construction
Carvers Warehouse
77 Dale Street
Manchester M1 2HG

Report written and prepared by:


Paul Kelly MIOA Principal Acoustics Consultant

Checked and approved by:


Sam Williams MIOA Senior Acoustics Consultant

Revision Schedule:

Report	Date	Version
D480-ENV-ZZ-XX-RP-Y-1005	30.04.2022	C01



Executive Summary

Environoise Consulting Limited has been instructed by GMI Construction to review the Stage 5 façade strategy for the proposed residential apartment scheme on Bendix Street, Manchester M4.

Noise surveys and modelling of the site has been done to inform an assessment of the level of noise ingress into residential spaces and external amenity areas.

Façade Recommendations

The proposed façade constructions are considered suitable.

Proposed glazing specifications with sound insulation performances of 33dB to 42dB $R_w + C_{tr}$ are considered suitable across the building.

Mechanical ventilation is to be provided throughout the entire building with openable window panes also provided to residential spaces for purge ventilation.

External Amenity

An ambient noise level of 53dB $L_{Aeq,T}$ has been predicted on the 11th floor Communal Terrace using the SoundPLAN® model. These noise levels are deemed acceptable considering that the development is in an 'urban area adjoining strategic transport network', as described in BS 8233:2014.

Limiting Plant Noise Levels

Limiting levels have been provided to aid in the specification of fixed external plant.



Table of Contents

1 Introduction5

1.1 Overview5

1.2 Site Description.....5

2 Criteria6

2.1 Internal Noise Levels6

2.2 External Plant Noise8

3 Noise Surveys and Results9

3.1 Noise Survey Notes9

3.2 Instrumentation and Weather Conditions9

3.3 Noise Survey Results10

4 Façade Recommendations.....12

4.1 Noise Ingress Assessment12

4.2 Ventilation13

4.3 Glazing.....14

5 External Amenity Noise21

5.1 Ambient Noise Level Target21

5.2 Communal Terrace, 11th floor.....21

6 Limiting Plant Noise Levels22

6.1 Noise Targets at Existing NSRs22

Appendix A: SoundPLAN® Model23

Appendix B: Calculation.....24

Appendix C: Risk Management Schedule25

References.....27

1 Introduction

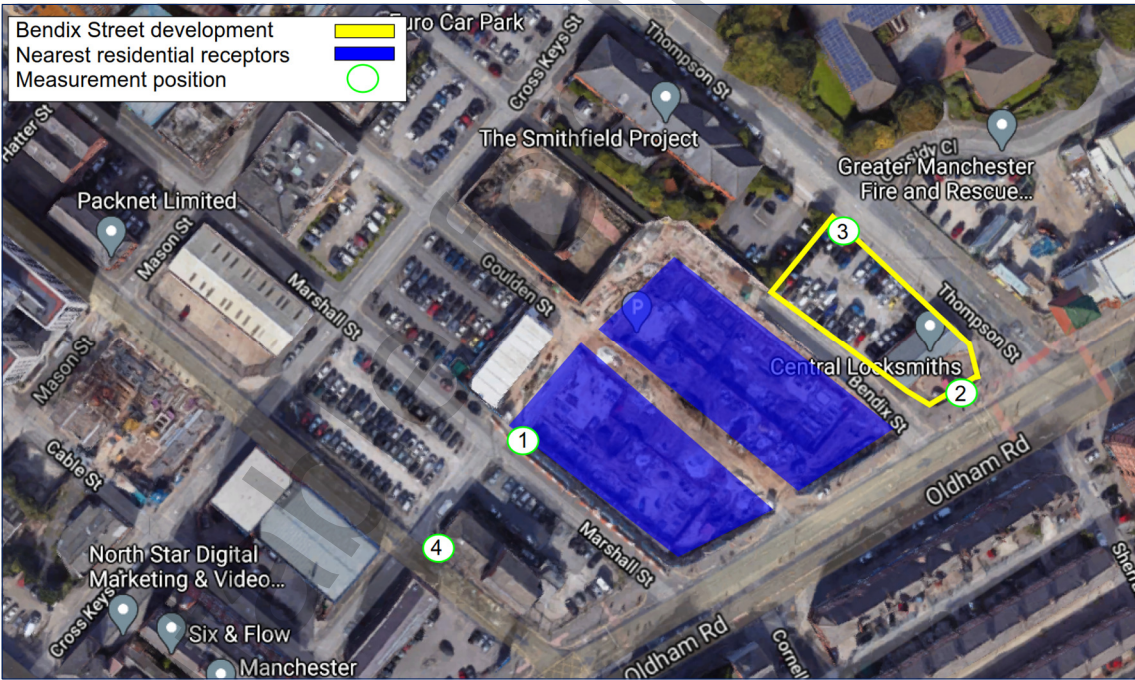
1.1 Overview

1.1.1 Environoise Consulting Limited has been instructed by GMI Construction to review the Stage 5 façade strategy for the proposed residential apartment scheme on Bendix Street, Manchester M4.

1.2 Site Description

1.2.1 The proposal site is situated on a plot of land which contains Central Locksmiths and a car park. The site is bound by Smithfield Detox and Rehab to the north west, Thompson Street to the east, Oldham Road to the south and Bendix Street and the Broadside apartment buildings (the nearest residential receptors) to the west. Figure 1.1 shows the proposal site, surrounding area and noise measurement positions.

Figure 1.1: Proposal site, surrounding area and measurement positions.





2 Criteria

2.1 Internal Noise Levels

Residential

2.1.1 We have referred to guidance given in Table 4 of BS 8233 ‘Guidance on sound insulation and noise reduction for buildings’ⁱ and World Health Organisation (WHO) Guidelines; ‘Community and Noise,1999’ⁱⁱ to recommend internal ambient and maximum noise levels respectively to be achieved in habitable spaces, see Table 2.1.

Table 2.1: Recommended internal noise level targets for residential spaces.

Activity	Location	07:00 to 23:00	23:00 to 07:00
Resting	Living Room	35dB LAeq,16hour	N/A
Sleeping (daytime resting)	Bedroom	35dB LAeq,16hour	30dB LAeq,8hour 45dB LAmax,fast *

* not to be exceeded more than 10-15 times during the night-time period (23.00 – 07.00hrs).

Non-Residential

2.1.2 We recommend the internal ambient noise level targets for non-residential spaces, also informed by BS 8233, in Table 2.2.



Table 2.2: Recommended internal noise level targets for non-residential spaces.

Space	Internal ambient noise level target [$L_{Aeq,T}$ (dB)]
Staff Office	40
Entrance Lobby	45
Commercial Unit	

2.1.3 We recommend the building services noise level targets given in Table 2.3 to meet the internal noise level targets given in Tables 2.1 and 2.2.

Table 2.3: Recommended building services noise level targets for non-residential spaces.

Space	Noise rating level [$NR L_{eq,T}$]
Bedrooms	20 (constant minimum fresh air ventilation)
Living Rooms	25 (constant minimum fresh air ventilation)
Staff Office	30
Entrance Lobby	35
Commercial Unit	

External Amenity Areas

2.1.4 External amenity ambient noise level should ideally be less than 50dB $L_{Aeq,16hour}$ with an acceptable upper limit of 55dB $L_{Aeq,16hour}$ ¹.

¹ For outdoor amenity or gardens areas, BS 8233:2014 states that it is 'desirable' for the steady noise level in external amenity spaces (such as gardens, balconies or outdoor living areas) to be less than 50dB $L_{Aeq,16hour}$ to 'prevent the onset of moderate annoyance' with 55dB $L_{Aeq,16hour}$ regarded as an upper limit to 'prevent the onset of serious annoyance' for occupants.



2.2 External Plant Noise

2.2.1 The Manchester City Council 'Planning & Noise – Technical Guidance' document states the following:

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



3 Noise Surveys and Results

3.1 Noise Survey Notes

3.1.1 A-weighted ambient, background and maximum noise levels ($L_{Aeq,T}$, L_{A90} , $L_{Amax,fast}$) and associated Z-weighted octave band noise levels ($L_{eq,T}$, L_{90} , $L_{max,fast}$) were taken at four positions between 04.30hrs and 09.53hrs, Tuesday 13th October 2020. 15-minute measurement periods were used alternating between the four locations listed below:

- **Position 1:** Representative of Broadside apartment building which is the nearest residential receptor.
- **Position 2:** Facing Oldham Road (9m from centre of road).
- **Position 3:** Facing Thompson Street (6m from centre of road).
- **Position 4:** Facing Addington Street (4m from centre of road).

3.2 Instrumentation and Weather Conditions

3.2.1 The sound level meter was calibrated at the start and end of the noise survey. The recorded drift was 0.1dB and therefore acceptable, see Table 3.1. Weather conditions including periods of adverse weather which have been discounted from assessment are given in Table 3.2.

Table 3.1: Instrumentation details for noise surveys.

Manufacturer	Equipment type	Equipment serial number	Laboratory calibration date
Rion	NA-28 sound level meter	00501401	23/05/2019
	NH-25 preamplifier	01440	
	UC-59 microphone	03881	
Pulsar	Model 105 calibrator	70865	14/11/2019

Table 3.2: Weather conditions during noise surveys.

Date	Rainfall	Maximum wind speed (m/s)	Observed cloud cover (oktas)	Temperature (°c)
13/08/2020	None	3	6	4 - 6



3.3 Noise Survey Results

Ambient Noise Levels for Façade Assessment

3.3.1 Logarithmically averaged daytime and night-time ambient noise levels from Positions 2 to 4 have been used in the assessment of noise ingress, see Table 3.3.

Table 3.3: Logarithmically averaged octave-band ambient noise levels.

Position	Period	L _{eq,T} at octave band centre frequency (Hz)							L _{Aeq,T} (dB)
		63	125	250	500	1k	2k	4k	
2	Daytime (07.00 – 10.00 hrs)	75	68	67	65	65	61	55	69
	Night-time (05.00 – 07.00hrs)	70	66	62	60	61	56	48	64
3	Daytime (07.00 – 10.00 hrs)	69	65	62	61	64	60	51	67
	Night-time (05.00 – 07.00hrs)	65	61	59	58	61	56	48	64
4	Daytime (07.00 – 10.00 hrs)	72	68	67	65	68	64	55	71
	Night-time (05.00 – 07.00hrs)	67	64	63	63	67	63	53	69

Maximum Noise Levels for Façade Assessment

3.3.2 The ‘regularly occurring’ maximum noise level is considered to be the level not exceeded more than 10 times during a night-time period as per WHO Guidelines. However, for this assessment, we have used the 2nd highest measured noise level due to the shorter measurement period, see Table 3.4.

Table 3.4: 2nd highest octave-band maximum noise levels from any one night-time period.

Position	Measurement time	L _{max(fast)} at octave band centre frequency (Hz)							L _{Amax,fast} (dB)
		63	125	250	500	1k	2k	4k	
2	06.10hrs, Tuesday 13 th October 2020	84	67	75	75	78	71	62	80
3	06.29hrs, Tuesday 13 th October 2020	82	81	76	74	71	74	69	79
4	05.44hrs, Tuesday 13 th October 2020	76	70	77	78	84	81	69	87



Background Noise Levels for Limiting Noise Levels

3.3.3 To assess the impact of plant, BS 4142:2014+A1:2019 'Methods of rating and assessing industrial and commercial sound'ⁱⁱⁱ requires the use of a 'representative' background noise level, which suggests that this can be determined using the modal value. However, due to the short-term measurement period, the lowest level of 42dB L_{A90} (15min) has been used, see Table 3.5.

Table 3.5: Background noise levels.

Measurement position	Measurement period	Measured background noise level range [L _{A90} (15min) (dB)]
1	04.30 – 05.00hrs, Tuesday 13 th October 2020	42 – 43



4 Façade Recommendations

4.1 Noise Ingress Assessment

4.1.1 To determine the noise levels affecting the facades of the proposed accommodation, a noise model of the site has been produced using SoundPLAN® 8.2 noise modelling software, see Appendix A. Noise ingress levels have been calculated in accordance with BS EN 12354-3:2000^{iv} with a reverberation time of 0.6 seconds for bedrooms and 0.8 seconds for living rooms, see Appendix B for example calculation. Details of proposed room layouts, room and facade dimensions and external wall and roof constructions have been considered from architectural drawings. Table 4.1 provides predicted sound insulation performances for proposed external wall constructions with a recommended enhancement (location indicated by red dash line in Figure 4.3). The proposed roof construction is deemed suitable due to the 250mm concrete top-deck.

Table 4.1: Calculated SRI of façade construction.

Construction	Build-up	Sound reduction indices [SRI (dB)] at octave band centre frequency (Hz)							R _w + C _{tr} (dB)
		63	125	250	500	1k	2k	4k	
External Wall Type 1	• Glass-reinforced concrete cladding (assumed ≥12mm thick and ≥2350kg/m ³)								
	• Variable depth cavity (assumed ≥125mm) with 75mm mineral wool insulation								
	• 10mm cementitious sheathing board								
	• 150mm SFS with 150mm insulation								
	• Two layers of 15mm Gyproc SoundBloc (25.2kg/m ²)	25	38	43	47	51	47	62	47
External Wall Type 2	• Aluminium cladding (assumed 3mm thick)								
	• Variable depth cavity (assumed ≥125mm) with 75mm mineral wool insulation								
	• 10mm cementitious sheathing board	16	34	41	46	50	51	57	45
	• 150mm SFS with 150mm insulation								
	• Two layers of 15mm Gyproc SoundBloc (25.2kg/m ²)								



Table 4.1 (continued): Calculated SRI of façade construction.

Construction	Build-up	Sound reduction indices [SRI (dB)] at octave band centre frequency (Hz)							R _w + C _{tr} (dB)
		63	125	250	500	1k	2k	4k	
	Same as specification above but with <u>three</u> layers of 15mm Gyproc SoundBloc (27.8kg/m ²) to the internal lining.	20	37	44	48	53	52	59	48

4.2 Ventilation

4.2.1 Supply and extract mechanical ventilation is proposed throughout the entire building. A review of the level of noise break-in via the ducted external wall vents in the ceiling void has been done² and determined to be suitably low.

Purge Ventilation

4.2.2 Proposed openable panes to habitable spaces for the purpose of purge ventilation are suitable. No internal noise level targets are applicable for purge ventilation; however, the openable pane specification should comply with the requirements given in Appendix B of The Building Regulations ‘Approved Document F: Ventilation’^v.

Overheating

4.2.3 Additional assessment has been done in accordance with Association of Noise Consultants ‘Acoustics Ventilation and Overheating - Residential Design Guide’^{vi} (AVOG) for noise ingress in the case of the proposed panels being partially open to control overheating³.

4.2.4 Habitable spaces on the Oldham Road, Bendix Street and Thompson Street elevations will experience an excess of the AVOG internal noise levels with the panels in the open position. AVOG notes that this may cause a material change in behaviour for the resident as follows:

- Avoiding certain activities during periods of noise intrusion.

² E-mail from Sam Williams, Environoise to Adrian Cronin, GMI on 17.03.2022.

³ Assessed against a daytime ambient criterion of <50dB L_{Aeq,16hour} and night-time criteria of <42dB L_{Aeq,8hour} and <65dB L_{Amax,fast}. A laboratory sound insulation performance of 41dB R_w has been considered for the openable panel in the closed position. When partially opened, as considered in the AVOG assessment, a reduction of 10dB has been considered.



- Having to keep the pane closed most of the time because of the noise.
- Potential for sleep disturbance resulting in difficulty getting to sleep, premature awakening and difficulty in getting back to sleep.
- Quality of life diminished due to change in acoustic character of the area.

4.2.5 Therefore, the mechanical ventilation system is recommended to be designed to provide suitable thermal conditions for habitable spaces on the Oldham Road, Bendix Street and Thompson Street elevations with the use of the openable panels as a means of controlling overheating only suitable for the rear elevation.

4.3 Glazing

4.3.1 Proposed SGG Stadip glazing specifications G1 to G4A together with forwarded⁴ laboratory test certificate data (for G1 to G3) have been reviewed for their suitability. Corresponding suitable locations are given in Figures 4.1 to 4.4.

Table 4.2: Minimum sound insulation performances for glazing and trickle vents.

Glazing key	Recommended minimum laboratory sound insulation performance [R _w + C _{tr} (dB)]	Proposed glazing specification and performance
	41	G3: 12.8mm pane/16mm argon cavity/8.8mm pane [42dB R_w + C_{tr}]
	38	G2: 10mm pane/16mm argon cavity/8.8mm pane [38dB R_w + C_{tr}]
	34	G1: 6mm pane/16mm argon cavity/6.8mm pane [33dB R_w + C_{tr}]* G4, G4 A 8mm pane/16mm argon cavity/8.8mm pane [36dB R_w + C_{tr}]

*The glazing performance falls short of the recommended overall minimum target by 1dB. However, noise ingress calculations using the laboratory test data indicate that internal noise targets are met and the proposed specification is suitable.

⁴ E-mail from Jamie Vaughan, Elite Aluminium Systems Ltd dated 14.04.2022



Glazing Sound Insulation Performances

- 4.3.2 The glazing performance should be constant across the overall assembly, so the framing should be of similar or greater performance than the glazing recommended. The performance of the glazing units also depends on the quality of framing and good contact with window seals.
- 4.3.3 The sound insulation of a window is usually measured over a wide range of ascending frequencies in accordance with BS EN ISO 140-3:1995, but it is often convenient for specifiers to represent the insulation by a single figure, see below:
 - $R_w + C_{tr}$ is the weighted sound reduction with a low frequency spectrum adaptation term (C_{tr} is usually a negative number) suitable for urban traffic noise and low speed rail traffic.
- 4.3.4 Forwarded⁵ laboratory test certificate data for proposed window framing systems indicate compliance with the G1 to G3 minimum sound insulation performance targets in Table 4.2 and are therefore suitable.

Glazing Sound Insulation Performance Locations

- 4.3.5 Figures 4.1 to 4.5 provide the locations of recommended sound insulation performances for glazing which corresponds with Table 4.2.

⁵ E-mail from Jamie Vaughan, Elite Aluminium Systems Ltd dated 14.04.2022

[illegible]

Figure 4.3: Recommended glazing and external wall performances – 2nd to 6th floors.

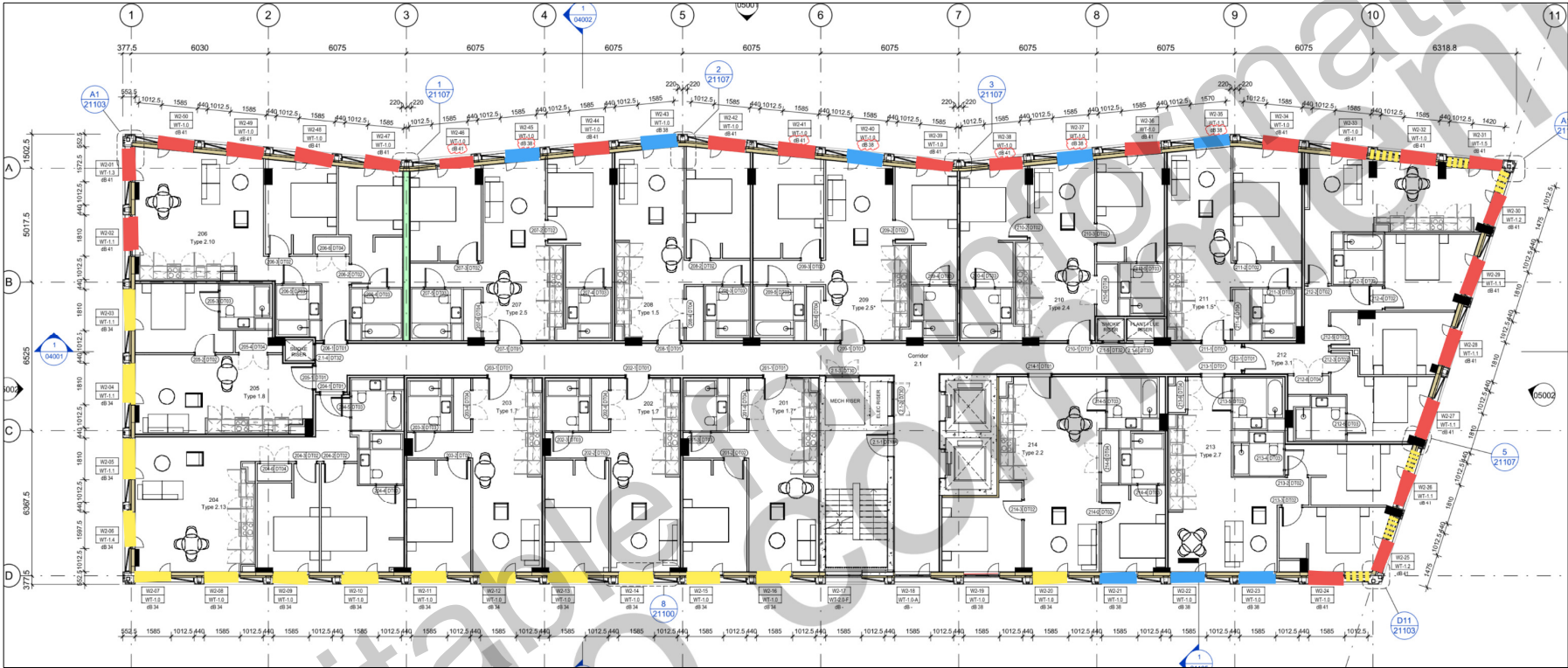


Figure 4.5: Recommended glazing performances – 11th and 12th floors.





5 External Amenity Noise

5.1 Ambient Noise Level Target

5.1.1 For any dedicated outdoor amenity spaces, BS 8233:2014 and the WHO Guidelines for Community Noise states that it is desirable for the steady noise level in external amenity spaces (such as gardens, balconies or outdoor living areas) to be less than 50dB $L_{Aeq,16hour}$ to 'prevent the onset of moderate annoyance' with 55dB $L_{Aeq,16hour}$ regarded as an upper limit to 'prevent the onset of serious annoyance' for occupants.

5.1.2 BS 8233:2014 recognises that guideline values are not achievable in all circumstances where development might be desirable, it states that:

'In higher noise areas, such as city centres or urban areas adjoining strategic transport network, a compromise between elevated noise levels and other factors, such as the convenience of living in these locations or making efficient use of land resources to ensure development need can be met, might be warranted. In such a situation, development should be designed to achieve the lowest practicable levels in these external amenity spaces, but should not be prohibited.'

5.2 Communal Terrace, 11th floor

5.2.1 An ambient noise level of 53dB $L_{Aeq,T}$ has been predicted on the 11th floor Communal Terrace using the SoundPLAN® model. These noise levels are deemed acceptable considering that the development is in an 'urban area adjoining strategic transport network', as described in BS 8233:2014.



6 Limiting Plant Noise Levels

6.1 Noise Targets at Existing NSRs

6.1.1 Limiting plant noise levels have been provided to aid in the specification of fixed external plant. Limiting plant noise levels have been recommended to satisfy Manchester City Council target described in section 2.2.

Table 6.1: Limiting plant noise levels.

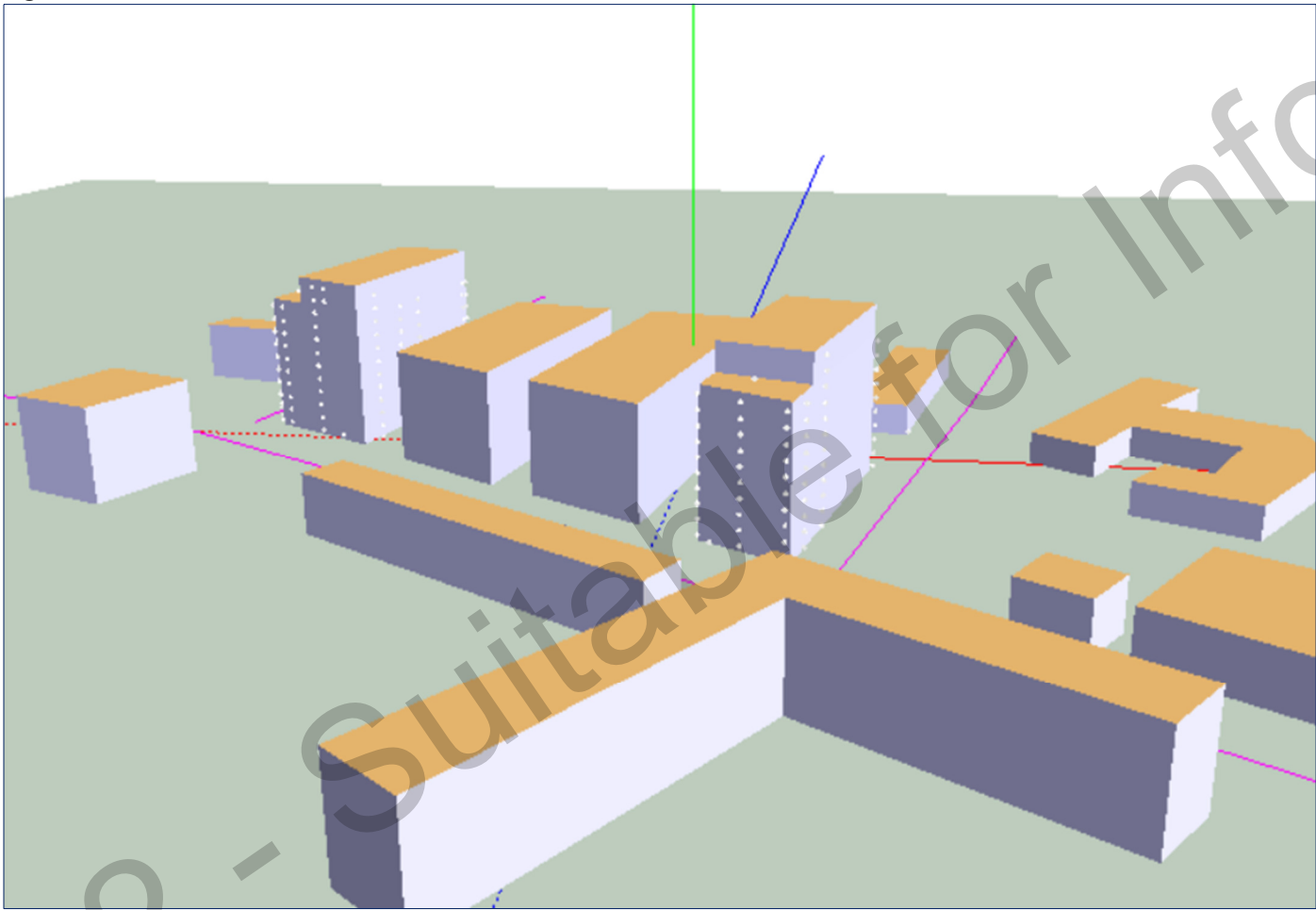
NSR	Period	Measured background noise level [L _{A90} (15mins) (dB)]	Plant rating noise limiting level at 1m from NSR [L _{Ar,Tr} (dB)]
Broadside Apartments	Night-time (23.00 – 07.00hrs)	42	37

Noise Penalty

6.1.2 A noise character correction should be applied if the plant contains any tonal, intermittent, or impulsive acoustic characteristics in accordance with BS 4142:2014. It should be noted that the plant noise limiting levels shown in Table 6.1 are the highest allowable noise levels at 1 metre from the nearest receptor with all plant associated with the development in simultaneous operation.

Appendix A: SoundPLAN® Model

Figure A1: 3D view of SoundPLAN® model.



Appendix B: Calculation

Figure B1: Example noise ingress calculation.

ENVIRONOISE

Leq - Apartment 2.3, Sm Bed

Project	Oldham Road, Manchester								
Client	GMI Construction								
Room	Apartment 2.3, Sm Bed				1st floor				
Enter Facade Correction	0 dB								
Receiving Room									
Height of room	2.4 m								
Width of room	3.2 m								
Length of room	3.6 m								
Volume of room	27.4 m³								
<div><div></div> Bedroom</div> <div><div></div> Living Area</div>									
Element									
Area 1 - Glazing	2.7 m²	8.8mm pane/16mm argon cavity/12.8mm pane - 48dB Rw (42dB Rw + Ctr)							
Area 2 - Op. Panel	1.1 m²	8.8mm pane/16mm argon cavity/12.8mm pane - 48dB Rw (42dB Rw + Ctr)							
Area 3 - Non Glazed	2.5 m²	EWT 2 - Aluminium Cladding (enhanced)							
Area 4 - Non Glazed	0.0 m²								
Angle of incidence	0 deg								
Frequency Hz									
Reverberation time (sec)	0.60	0.60	0.60	0.60	0.60	0.60	0.60	0.60	
Absorption (sabines)	7.3	7.3	7.3	7.3	7.3	7.3	7.3	7.3	
Frequency Hz									
External dB	66	61	59	58	60	55	47	47	63
External Freefield									
External Freefield Leq dB	66	61	59	58	60	55	47	47	63
Additional Correction									
10log(cos(angle))	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	
SRI Ref									
Area	2.7 m²	31	30	35	46	54	55	63	66
29	1.1 m²	31	30	35	46	54	55	63	66
23	2.5 m²	16	34	41	46	50	49	57	57
21	0.0 m²	22	37	42	47	52	51	57	57
Combined SRI		20	31	37	46	52	52	60	60
EWT 1 - GRC Cladding									
Criterion (NR at 1kHz)									
Additional SRI Required	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	To Meet NR29
Internal Leq dB									
Internal Lfmax dB	51	35	27	17	13	9	-7	-8	27 dB(A)
	67	54	44	32	23	27	14	13	43 dB(A)



Appendix C: Risk Management Schedule

Table C1: Assessment of risks with control measures.

Severity Classifications (S)	Probability Classifications (P)	Degree of Risk (R)
1. Minor – Minor accident, resulting in no serious injuries or lost time; little or no damage to property or the environment.	1. Improbable – no known instances of such an event occurring.	0 – 5 = Low Risk; ensure controls are adhered to and activity need not alter.
2. Moderate – Potential injury necessitating less than 3 days off work; damage to property or the environment requiring remedial work.	2. Remote – experience suggests that event rarely occur.	6 – 10 = Moderate Risk; tolerable, but efforts should be made to reduce the risk where cost effective and reasonably practicable.
3. Serious – Accident reportable under RIDDOR 95; serious damage to property or the environment.	3. Possible – experience shows that events occur on occasions.	11 – 15 = Substantial Risk; all practicable measures must be taken to reduce the level of risk; tolerable only where further risk reduction is impracticable or disproportionate to the risk involved.
4. Major – Accident resulting in serious or permanent injury; major or permanent damage to property or the environment.	4. Probable – experience shows that events occur frequently.	16 – 25 = Extreme Risk; Unacceptable except in extraordinary circumstances; all control measures must be taken regardless of cost.
5. Catastrophic – Accident resulting in death or severe disablement; destruction of property; irreversible damage to the environment.	5. Likely – very likely to happen unless actively prevented.	>26. Works must be aborted, and project need to be reviewed.



Table C1 (continued): Assessment of risks with control measures.

Activity	Hazard	Consequence	Degree of Risk			Risk Control Measures	Residual Risk			Risk Owner
			S	P	R		S	P	R	
Access to/ from site	Tripping or slipping hazards and falling objects.	Low risk	2	2	4	Take due care and attention to avoid tripping hazards. Do not work externally at height. Always sign in and out of site if required.	2	1	2	Contractor and consultant
Lifting or moving blockwork	injury through heavy load or improper lifting technique	Low risk	2	3	6	Blocks should be less than 20kg. Workers should wear gloves, steel toe cap boots and protective glasses. Workers must lift by bending their knees not their back. Make sure path is not obstructed by items being carried.	2	2	4	Contractor
Handling sheets of plasterboard	Injury through heavy load or improper lifting technique	Low risk	2	3	6	Plasterboard handled should be less than 20kg per sheet. Regardless of the mass several contractors may be needed to carry boards. Workers should wear gloves, steel toe cap boots and protective glasses. Workers must lift by bending their knees not their back. Make sure path is not obstructed by items being carried.	2	2	4	Contractor
Handling sheets of glass	Injury through heavy load/ improper lifting technique or laceration	Moderate	3	3	9	Detailed review of handling and positioning of glass to be done before installation by contractor. Glazing may need to be craned into position due to high mass. All glazed units must be clearly marked with tape/ marker to avoid people walking into the glass. Glazing must be handled with appropriate gloves only. Regardless of the weight, several contractors may be needed to carry units. Workers should wear gloves, steel toe cap boots and protective glasses. Workers must lift by bending their knees not their back. Make sure path is not obstructed by items being carried.	3	2	6	Contractor
Dust inhalation	Injury through being temporarily blinded of damage to lungs	Low risk	2	3	6	Only work in well ventilated space and wear appropriate PPE including dust mask. If cutting material make sure gloves are worn. Signage may be required to prevent other workers entering the space.	2	2	4	Contractor



Table C1 (continued): Assessment of risks with control measures.

Activity	Hazard	Consequence	Degree of Risk			Risk Control Measures	Degree of Risk			Risk Owner
			S	P	R		S	P	R	
Hearing damage	Injury to hearing or consequence of verbal communication not being heard	Moderate	3	3	9	Review of construction or demolition methods and all workers exposed to high levels of noise to be provided with suitable hearing protection. In the case of sound insulation testing, suitable signage should be used to warn contractors of high noise risk to certain rooms.	3	2	6	Contractor. Contractor and acoustic consultant for sound insulation tests.

References

ⁱ BS 8233 'Guidance on sound insulation and noise reduction for buildings', 2014.

ⁱⁱ World Health Organisation (WHO) Guidelines; 'Community and Noise, 1999'

ⁱⁱⁱ BS 4142:2014+A1:2019 'Methods of rating and assessing industrial and commercial sound' 2014.

^{iv} BS EN 12354-3:2000 'Building acoustics. Estimation of acoustic performance in buildings from the performance of elements. Airborne sound insulation against outdoor sound', 2000.

^v The Building Regulations 'Approved Document F: Ventilation' (2010 edition incorporating 2010 and 2013 amendments.

^{vi} Association of Noise Consultants 'Acoustics Ventilation and Overheating - Residential Design Guide', Version 1.1, January 2020.