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One Vinyl Square
Hayes, London

Environmental & Intrusive Noise Study
P2022-REP01-JPR P02
22 June 2022

PROJECT:	One Vinyl Square Hayes, London Environmental & Intrusive Noise Study
CLIENT:	ARJ Construction Ltd Bedford House Stevenage SG1 2EF
DOCUMENT REFERENCE:	P2022-REP01-JPR P02
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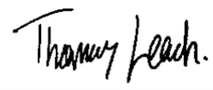
CHECKED:	 THOMAS LEACH
DATE:	22 June 2022

ONE VINYL SQUARE
ENVIRONMENTAL & INTRUSIVE NOISE STUDY
P2022-REP01-JPR P02

SUMMARY

Sol Acoustics Ltd has been commissioned by ARJ Construction Limited to undertake an acoustic design assessment of the One Vinyl Square development, Hayes.

The purpose of this report is to assess the scheme in terms of intrusive noise and to determine an appropriate acoustic performance specification for the building envelope, all as based on the pre-existing environmental noise climate on site as surveyed in March 2022, noise model results, the intrusive noise requirements of BS8233: 2014, Planning Condition requirements and the currently available Architectural design drawings.

In order to predict the likely resultant environmental noise levels at the development site, a 3D computer-based environmental noise model was created using the DataKustik 'CadnaA' Noise Mapping software. The results obtained from this 3D noise model have been used as part of the environmental and intrusive noise assessment.

This report demonstrates that appropriate indoor ambient noise levels can be achieved within all proposed internal habitable spaces across the project with the implementation of the glazing strategy recommended within this report.

An Acoustics, Ventilation, and Overheating framework assessment has been undertaken as is required by Planning Condition 21 and it is considered that for specific façade areas the use of openable windows to mitigate overheating may result in a significant adverse noise impact to a limited number of residential units, therefore, an alternative overheating mitigation must be developed.

Additionally, as required by Planning Condition 22, appropriate M&E plant daytime and night time environmental noise limits have also been prescribed herein, all as based on the environmental noise survey undertaken at site.

Others must check other non-acoustic aspects, such as Architectural and aesthetic considerations, SAP/overheating strategies and suchlike.

Please refer to the main report and appendices for further information.

CONTENTS

1 INTRODUCTION

Sol Acoustics Ltd ("Sol") has been commissioned by ARJ Construction Limited ("ARJ") to undertake an acoustic design assessment of the One Vinyl Square Development in Hayes, London.

The purpose of this report is as follows:

- To assess the scheme in terms of intrusive noise and to determine an appropriate acoustic performance specification for the building envelope and glazing, as required by Planning Condition 20.
- To undertake an Acoustics, Ventilation and Overheating assessment for the development, as required by Planning Condition 21.
- To set appropriate M&E plant daytime and night time environmental noise limits as required by Planning Condition 22.

This report is based on the results of an Environmental Noise Survey undertaken at site, a 3D noise model constructed for the scheme and the architectural design drawings available to Sol at the time of reporting (March 2022).

2 DESCRIPTION OF SITE

The development site is located on Blyth Road, Hayes, London and is part of the larger Old Vinyl Factory development site at the former site of EMI records. The site is currently empty and has been hoarded off pending future development.

The site is located within an area currently under redevelopment. The site is bound by Blythe Road to the north east, Vinyl Square outdoor public amenity space to the south east, and car park access roads to the north west and south west.

Further to the north east is Dhamecha Cash and Carry which is a wholesale supplier for retailers, the site comprises the main store building with a car park to the front (off Blythe Road) and a service yard to the north west of the building where deliveries are offloaded. This delivery area is at a sufficient distance and screened from the development site such that delivery activities are not deemed to impact the development site.

Further to the south east of the site is Global Academy which is a college facility specialising in media-based courses. To the south of Global Academy is an active construction site ('Assembly Buildings') with ongoing works. To the south of the site is the Cabinet Building. To the south west of the site is the Music Box multi-storey car park which is clad with a perforated metal cladding for natural ventilation and is therefore somewhat acoustically transparent.

To the north west is an open site which is understood to have permission for the construction of the 'Veneer Store' multi-storey car park with commercial spaces. It is understood that the building will comprise a five-storey car park with three small commercial units at ground floor level.

N.B. It is assumed that any noise from fixed plant or commercial activity associated with the 'Veneer Store' will be suitably assessed and controlled to not adversely impact the consented One Vinyl Square development. As such it should be confirmed by Hillingdon Borough Council that suitable Planning Conditions have been imposed on the Veneer Store development.

Further to the east of the site are residential buildings and car parking, on either side of Trevor Road.

Figure 1, overleaf, shows the development site in relation to the existing surrounding area.

Figure 1: Image showing site location in relation to the surroundings (Google Earth 2022)

2.1 Development Proposals

It is proposed that the development site will consist of a total of 134 new residential units within a new-build 9-11 storey building with ground floor commercial space. The building is to be arranged in a 'U' shape with a central garden amenity space to the centre at ground level as well as rooftop gardens on top of the blocks, as shown in Figure 2:

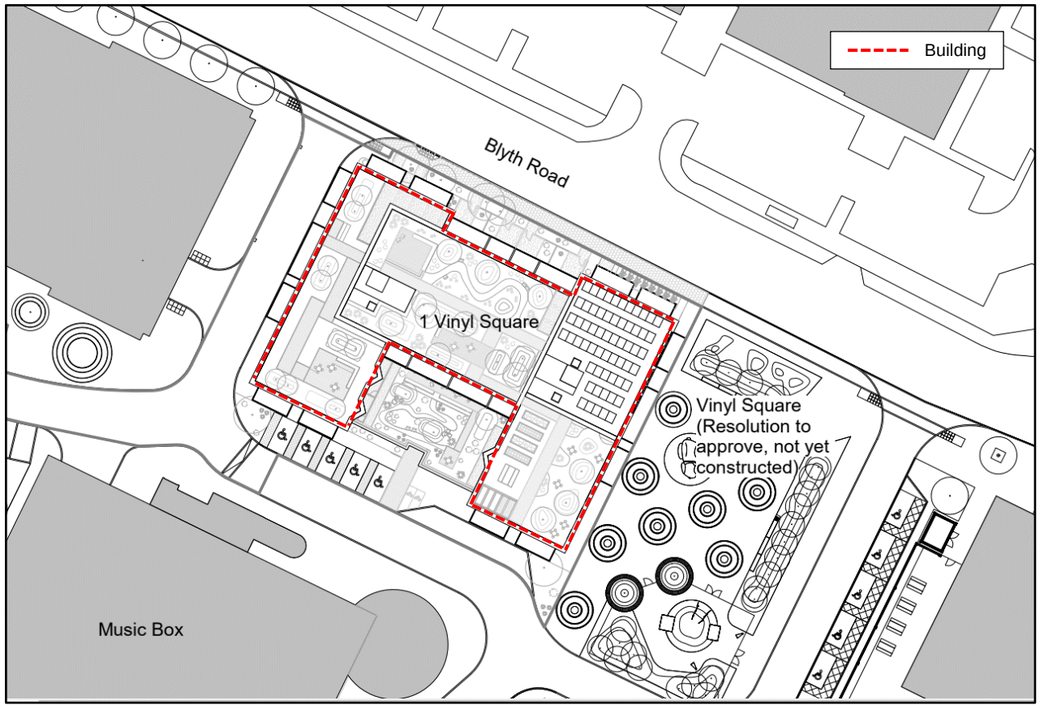


Figure 2: Site plan

It is understood that the building is to be constructed using a brick façade finish with full-height windows as shown in Figure 3:

Figure 3: Elevation drawing (north elevation).

3 DETAILS OF INVESTIGATION

3.1 Basis of Assessment

In order to inform the environmental and intrusive noise study, it will be necessary to determine the potential noise impact expected from the key identified noise sources, namely road traffic on Blyth Road and Dawley Road as well as the surrounding road network.

3.2 Noise Survey Methodology

An environmental noise survey was conducted at two measurement positions on site from c.16:00 hours on Friday 25 March 2022 to c.15:30 hours on Tuesday 29 March 2022.

This consisted of two measurement positions at the development site as shown on Figure 4 and described in Table 1:

Measurement Position	Description
MP1	Boom-mounted microphone positioned at the north eastern boundary of the development site in a free-field position at a height of 4m. The soundscape at this position was composed of road traffic noise from Blyth Road.
MP2	Boom-mounted microphone positioned at the south western boundary of the development site in a free-field position at a height of 4m. The soundscape at this position was composed of road traffic noise from Blyth Road.

Table 1: Noise monitoring measurement positions summary

The prevailing weather conditions were suitable for the purposes of environmental noise measurements throughout the noise survey. Average wind speeds were below 5m/s for the entirety of the survey period.

Notwithstanding the weather conditions recorded, the microphone systems were entirely weatherproofed and fitted with all-weather environmental windshields, each with a bird spike.

Type 1 Precision Grade sound measuring instrumentation was exclusively used for all surveys and microphone windshields were in use at all times. Full details of all the instrumentation used, and corresponding traceable calibration records, are retained on file by Sol and available for inspection if required.

Figure 4: Image showing noise survey measurement positions (Google 2022)

4 ENVIRONMENTAL NOISE SURVEY RESULTS

Table 2 provides a basic summary of the average, free field environmental noise levels measured at Positions MP1 and MP2:

Position	Typical Measured Noise Level (Range L_{Aeq}, Highest L_{Amax}, Range L_{A90})				
	Daytime (07:00 – 23:00 hrs)		Night time (23:00 – 07:00 hrs)		
	dB $L_{Aeq,16hour}$	dB $L_{A90,15min}$	dB $L_{Aeq,8hour}$	dB L_{Amax}	dB $L_{A90,15min}$
MP1	65 - 67	40 - 59	59 - 61	90	33 - 55
MP2	54 - 58	41 - 60	48 - 50	79	34 - 53

Table 2: Summary of typical, measured environmental noise levels, broadband terms

Table 3 summarises the corresponding unweighted, time-averaged ($L_{Aeq,T}$) daytime and period ambient noise levels used for the assessment, in linear octave band frequency terms:

Measurement Location	Broadband Noise Level, dB $L_{Aeq,T}$	Sound Pressure Level (dB) @ Octave Band Centre Frequency (Hz)						
		63	125	250	500	1k	2k	4k
Position MP1								
Daytime	67	69	65	63	62	64	59	51
Night time	61	61	57	57	55	58	54	44
Position MP2								
Daytime	56	65	57	52	50	52	49	42
Night time	50	56	51	47	45	47	42	34

Table 3: Summary of time-averaged environmental noise levels, in octave band terms

Appendix A provides further information and a full summary of the measurement data.

5 ENVIRONMENTAL NOISE INTRUSION ASSESSMENT CRITERIA

5.1 Planning Condition 20

Planning Permission (ref: 59872/APP/2019/3852) for One Vinyl Square was granted by the London Borough of Hillingdon in November 2020. Condition 20 of the permission relates to intrusive noise levels and states:

> *'Prior to commencement of any works above first floor slab level a scheme of mitigation shall be submitted to and approved by the Local Planning Authority which would allow the following noise criteria to be achieved with windows closed and adequate ventilation provided:*
>
> *- Daytime (living rooms) 35dB $L_{Aeq,T}$*
>
> *- Night-time (Bedrooms) 30dB $L_{Aeq,T}$ 45dB L_{Amax}*
>
> *The details shall be implemented as approved and shall remain in force for the life of the building.*
>
> *REASON To safeguard the amenity of surrounding areas in accordance with Policy DMHB 11 of the Hillingdon Local Plan: Part 2 Development Management Policies (January 2020).'*

With respect to the requirement for 'adequate ventilation provided' it is assumed this refers to Approved Document F background ventilation rates only and not under overheating mitigation conditions as this is addressed by a separate Planning Condition.

N.B. Regarding the 45dB L_{Amax} night time noise limit within bedrooms, this is presented in the Condition as an absolute limit to be achieved. As written, this is considered unduly onerous and is not consistent with current British Standards and guidance as presented in the following sections.

It is strongly recommended that a derogation of the Planning Condition in line with current British Standards and Guidance is sort. Sol will gladly assist the client in this respect.

5.2 Employers Requirements

Sol are not aware of any Employer's Requirements specifically relating to environmental noise intrusion.

5.3 BS8233: 2014 *'Guidance on sound insulation and noise reduction for buildings'*

BS8233: 2014 *'Guidance on sound insulation and noise reduction for buildings'* provides appropriate criteria for acceptable levels of noise ingress within dwellings.

In particular, Section 7.2.2 of the Standard, titled 'Internal ambient noise levels in dwellings' states that *'… In general, for steady external noise sources, it is desirable that the internal ambient noise level does not exceed the guideline values in Table 4* [of BS8233]*'* as duplicated below in Table 4:

BS8233: 2014 – Indoor ambient noise levels for dwellings			
Activity	**Location**	**07:00 to 23:00**	**23:00 to 07:00**
Resting	Living room	35 dB $L_{Aeq,\ 16\ hours}$	-
Dining	Dining room / area	40 dB $L_{Aeq,\ 16\ hours}$	-
Sleeping (daytime resting)	Bedroom	35 dB $L_{Aeq,\ 16\ hours}$	30 dB $L_{Aeq,\ 16\ hours}$

Table 4: Internal ambient noise level requirements as per BS8233

Note 7 of BS8233: 2014 states that: *'… Where development is considered necessary or desirable, despite external noise levels above WHO guidelines, the internal target levels may be relaxed up to 5 dB and reasonable internal conditions still achieved*. …'.

No specific performance recommendation is given within BS8233: 2014 regarding maximum (L_{Amax}) intrusive noise levels within bedrooms. Clarification is presented in the Institute of Acoustics joint publication *'ProPG: Planning and Noise, New Residential Development'* which expands on the guidance presented in BS8233: 2014.

Section 2.31 states (our emphasis added)*'… In noise sensitive rooms at night (e.g. bedrooms) individual noise events (from all sources)* ***should not normally exceed 45dB $L_{Amax,F}$ more than 10 times a night as this represents a threshold below which the effects of individual noise events on sleep can be regarded as negligible****.'*

5.3.1 *Outdoor Amenity Spaces*

Regarding outdoor amenity spaces, BS8233: 2014 states the following (emphases added):

> *'… For traditional external areas that are used for amenity space, such as gardens and patios, it is desirable that the external noise level does not exceed 50dB $L_{Aeq,T}$, with an upper guideline value of 55dB $L_{Aeq,T}$ …*
>
> *…However, it is also recognized that these guideline values are not achievable in all circumstances where development might be desirable. In higher noise areas, such as city centres or urban areas adjoining the strategic transport 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 needs can be met, might be warranted. In such a situation, development should be designed to achieve the lowest practicable levels in these external amenity spaces, but should not be prohibited.*
>
> *Other locations, such as balconies, roof gardens and terraces, are also important in residential buildings where normal external amenity space might be limited or not available, i.e. in flats, apartment blocks etc. In these locations, specification of noise limits is not necessarily appropriate.*
>
> ***Small balconies may be included for uses such as drying washing or growing pot plants, and noise limits should not be necessary for these uses**. However, the general guidance on noise in amenity space is still appropriate for larger balconies, roof gardens and terraces, which might be intended to be used for relaxation. In high-noise areas, consideration should be given to protecting these areas by screening or building design to achieve the lowest practicable levels. Achieving levels of 55dB $L_{Aeq,T}$ or less might not be possible at the outer edge of these areas, but should be achievable in some areas of the space. …'*

In summary therefore, the "upper guideline" noise level for external amenity spaces, as recommended by the Standard, is 55dB $L_{Aeq(16\ hour)}$, albeit it is duly recognised that this may be exceeded for urban developments, and is not applicable to "small balconies".

5.4 Criteria Summary

Based upon the above, the criteria in Table 5 have been adopted as the basis of our assessment:

Noise Source	Location	07:00 to 23:00	23:00 to 07:00
Anonymous (e.g. Road Traffic Noise)	Living rooms	35dB $L_{Aeq,\ 16\ hours}$	-
	Bedroom	35dB $L_{Aeq,\ 16\ hours}$	30dB $L_{Aeq,\ 8\ hours}$ 45dB L_{Afmax}*
	Gardens and outdoor amenity spaces	55dB $L_{Aeq,\ 16\ hours}$	
	Balconies	No noise criteria applied	
* an absolute limit not to normally be exceeded, as based on the requirements of Planning Condition 20			

Table 5: Proposed intrusive noise criteria summary

6 RESIDENTIAL INTRUSIVE NOISE ASSESSMENT

By taking account of the levels of ambient and maximum noise levels as measured and predicted at the site façade locations, the proposed areas of façade elements and their intended constructions (i.e. glazing and walls), as well as the likely acoustic characteristics of the noise sensitive receiving space (i.e. living rooms, bedrooms), the required sound reduction performance specification of glazing has been determined through acoustic calculation.

The window areas, room dimensions, elevations, floor and site layouts used in all calculations are all as shown by the JTP Studios planning drawings as received by Sol via email during March 2022. If there are any subsequent changes to any of the proposed glazing areas and/or room layouts and floor plans, for any habitable room(s), these must be evaluated acoustically.

It is understood that the Part F ventilation strategy for the Block F development is based on Mechanical Ventilation Heat Recovery (“MVHR”) units and that no natural background ventilation within residential units is proposed.

6.1 Wind Noise

Please note that the scope of this report does not include for the assessment of any wind noise. Wind noise modelling must be undertaken by others, e.g. Façade Consultant, once full architectural and façade design details become available.

6.2 Predicted Development Environmental Noise Levels

In order to predict the likely resultant environmental noise levels impinging noise sensitive receptors, 3D computer based environmental noise models have been created using the DataKustik ‘CadnaA’ Noise Mapping software. The following assumptions have been made in the generation of the noise model:

- The noise model was set up to apply the noise prediction methodology set out in ISO 9613-2: *‘Acoustics – Attenuation of Sound propagation outdoors – Part 2: General Method of Calculation’*;
- The model was set to include up to second order reflected noise from solid structures;
- Ground absorption has been set to G = 0 (hard ground);
- Acoustic screening and reflections afforded by nearby buildings and solid structures.

Based upon the above, the daytime and night time free field noise levels have been predicted across all proposed external facades of the development as shown in Appendix B, Figure B1 and Figure B2. A 3D example of the Noise Map is also shown in Figure 5:

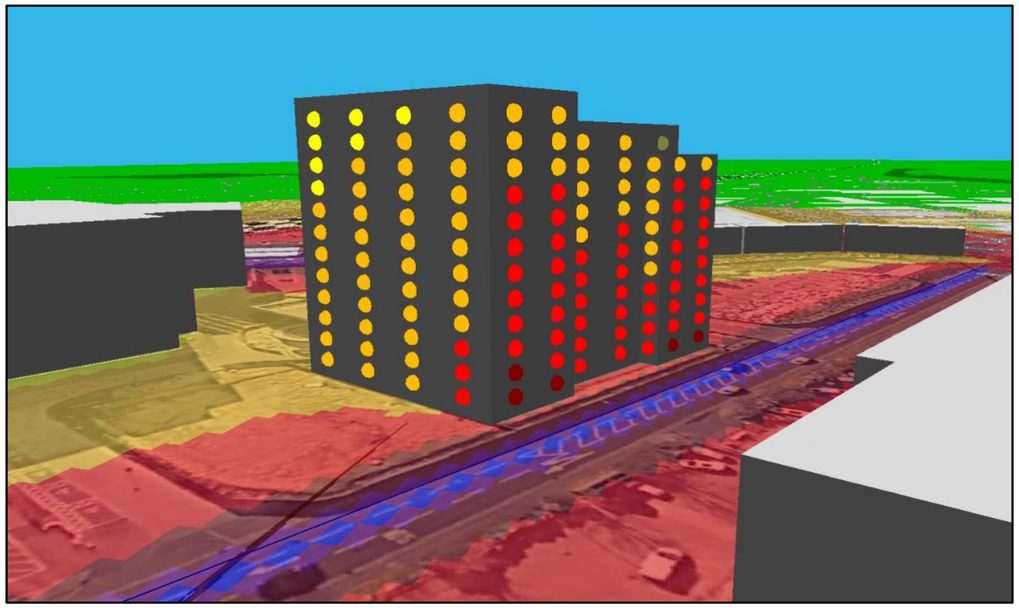


Figure 5: Example of CadnaA Noise Map.

6.3 Building Envelope

6.3.1 External wall

Table 6 provides the recommended minimum acoustic performance requirements for the external building envelope, in terms of sound reduction indices:

Wall Construction	Weighted Sound Reduction Index dB ($R'_w + C_{tr}$)
External Wall	55

Table 6: Minimum building fabric acoustic airborne sound insulation performance requirements

At present, the exact façade construction is unknown. However, it is understood to comprise of a traditional brick (i.e. masonry) façade, which is likely to be suitable. However, final construction proposals must be submitted to Sol for review as they become available.

6.3.2 Acoustic Specification for Glazing to Habitable Rooms

It is understood that an MVHR Part F background ventilation strategy is proposed for all apartments; therefore, all of the following recommendations have been given in terms of the minimum sound reduction for glazing forming part of the building envelope.

The acoustic performance specifications presented in Table 7 should be read in conjunction with Figures 6 to 10, which identifies the location of each "façade zone".

Zone	Room Type	Example Double Glazing Configuration	Minimum Weighted Sound Reduction Index ($R'_w + C_{tr}$)
Zone A	Bedroom	Saint Gobain 88.2 Stadip Silence / 15 / 88.2 Stadip Silence	43
Zone B	Living Room	6mm / 20mm / 4mm Double Glazing	30
	Bedroom	Saint Gobain 10 Planilux / 16 / 66.1 Stadip Silence	38
Zone C	Living Room	4mm / 20mm / 4mm Double Glazing	27
	Bedroom	Saint Gobain 4 Planilux / 6 / 10 Planilux	32

Table 7: Recommended minimum glazing system acoustic specification, per zone, **to meet Planning Condition 20, as written.**

6.3.3 Derogation of Planning Condition 20

As stated in Section 5.1 it is strongly recommended that Planning Condition 20 is derogated with respect to the 45dB L_{Amax} that is to be achieved in bedrooms during the night time period.

The following alternative wording is suggested in line with ProPG guidance as presented in Section 5.3:

> *'individual noise events should not normally exceed 45dB $L_{Amax,F}$ more than 10 times a night within bedrooms'*

Should the above derogation be deemed acceptable by the local authority, the acoustic performance specifications presented in Table 8 would be suitable to meet the requirements:

Zone	Room Type	Example Double Glazing Configuration	Minimum Weighted Sound Reduction Index ($R'_w + C_{tr}$)
Zone A	Bedroom	6mm / 16mm / 8mm (laminated)	34
Zone B	Living Room	6mm / 20mm / 4mm Double Glazing	30
	Bedroom		
Zone C	Living Room	4mm / 20mm / 4mm Double Glazing	27
	Bedroom		

Table 8: Recommended minimum glazing system acoustic specification, per zone, **with suggested derogation of night time L_{Amax} criteria**

6.3.4 Glazing Configurations and Specification Compliance

Appendix C provides example calculations for demonstration purposes only to show that the acoustic specifications are suitable for compliance with Planning Condition 20 requirements for the worst affected apartments within each façade "zone". Please note these are based on the specification provided to meet Planning Condition 20 as written i.e. Table 7 specifications.

In all cases, example glazing configurations are provided for guidance only. All glazing, including any glazed doors, inclusive of framing systems, seals, and hardware must achieve the minimum acoustic performance specifications as indicated.s

The sound reduction performance must be confirmed and corroborated by independent acoustic laboratory test data in accordance with BS EN ISO 10140-2:2010 of identical constructions (i.e. including window frames) which must be submitted to Sol for approval.

Please note that the performance values in Table 7 and Table 8 are given in terms of the on-site performance requirement ($R'_w + C_{tr}$). For large format windows and glazed doors a suitable correction term (i.e. further safety tolerance) of typically up to +2dB may need to be applied to the tabulated values (i.e. more onerous requirement).

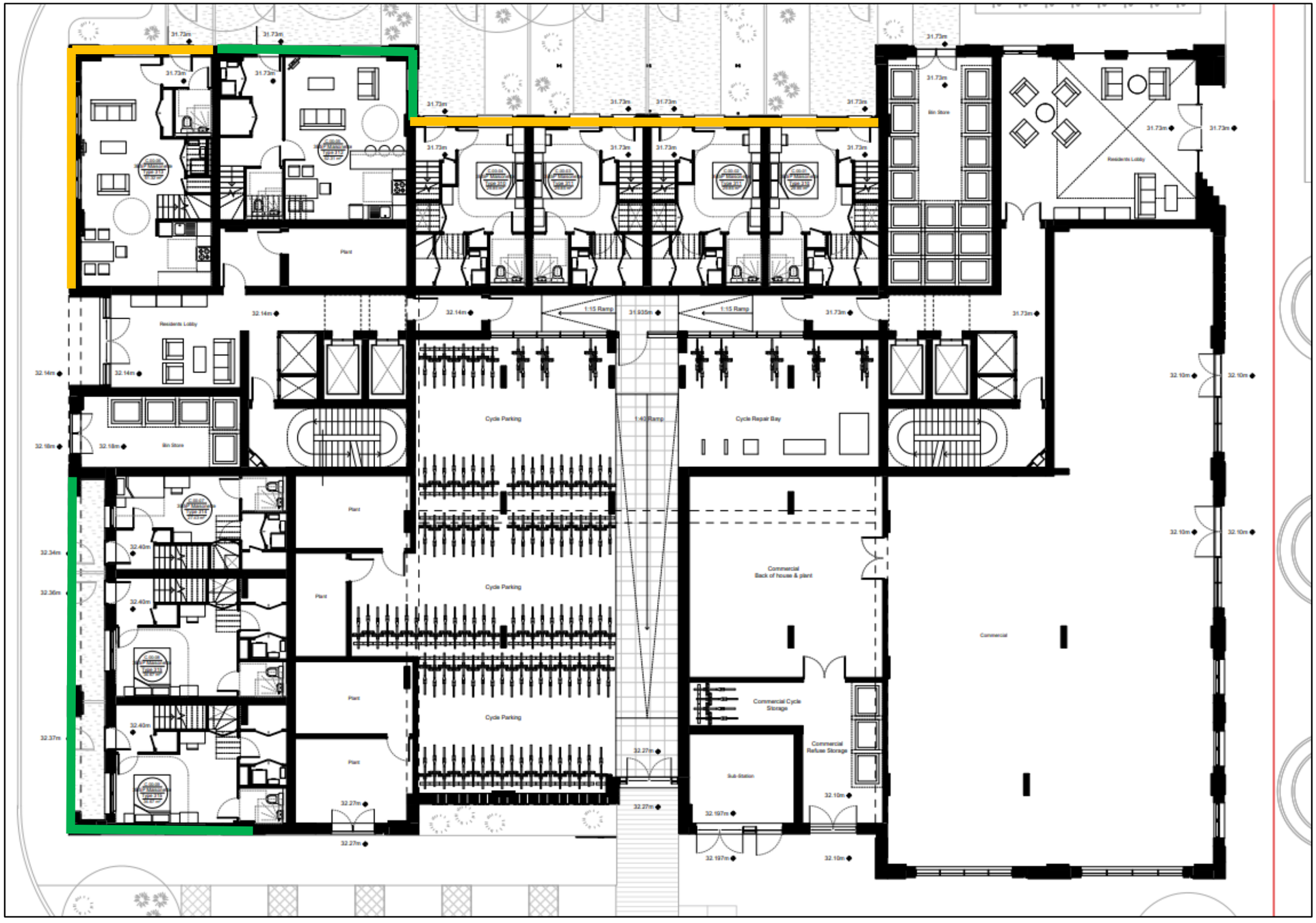


Figure 6: Acoustic glazing "Façade Zones" – **Ground Floor**

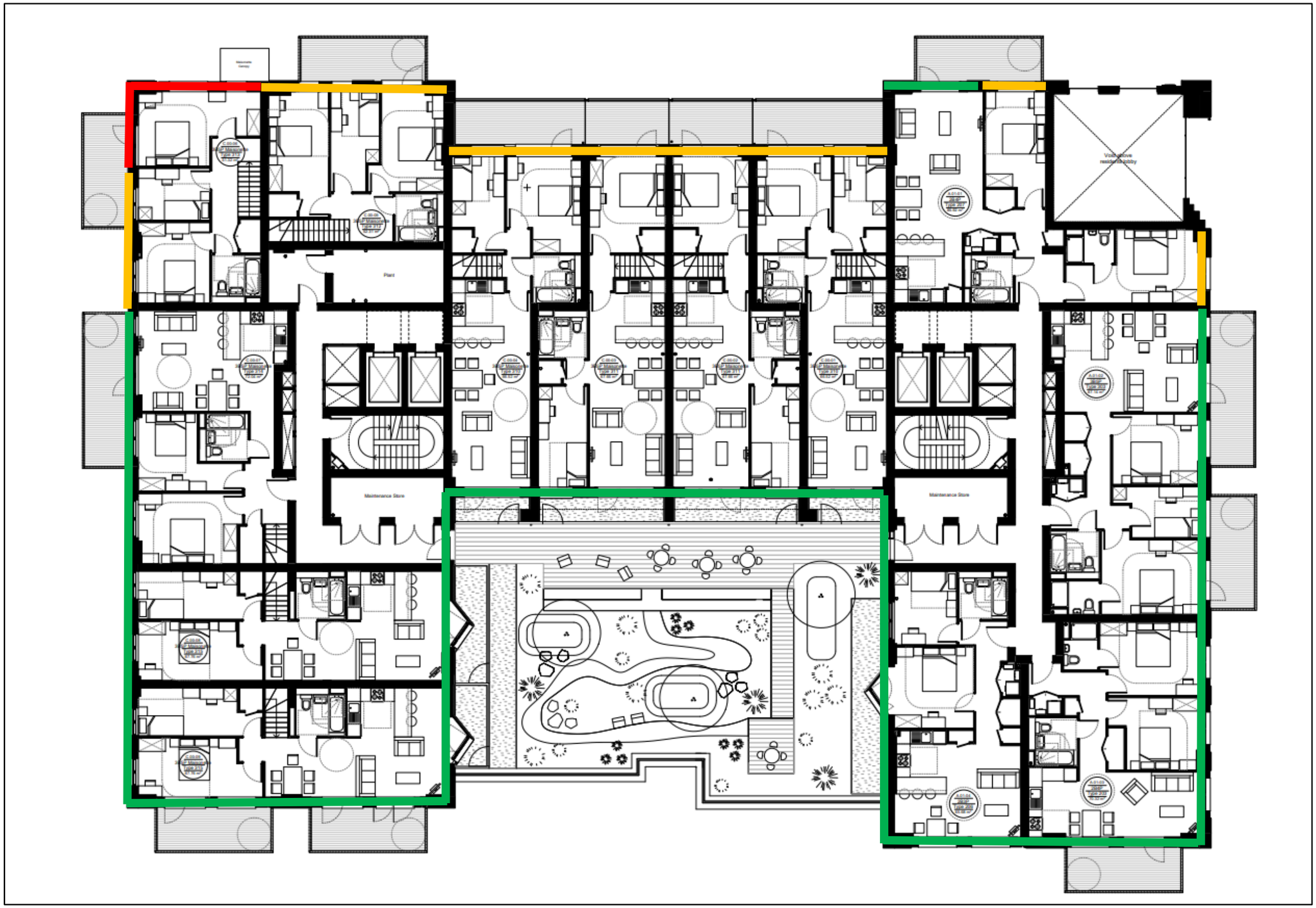


Figure 7: Acoustic glazing “Façade Zones” – **Level 01**

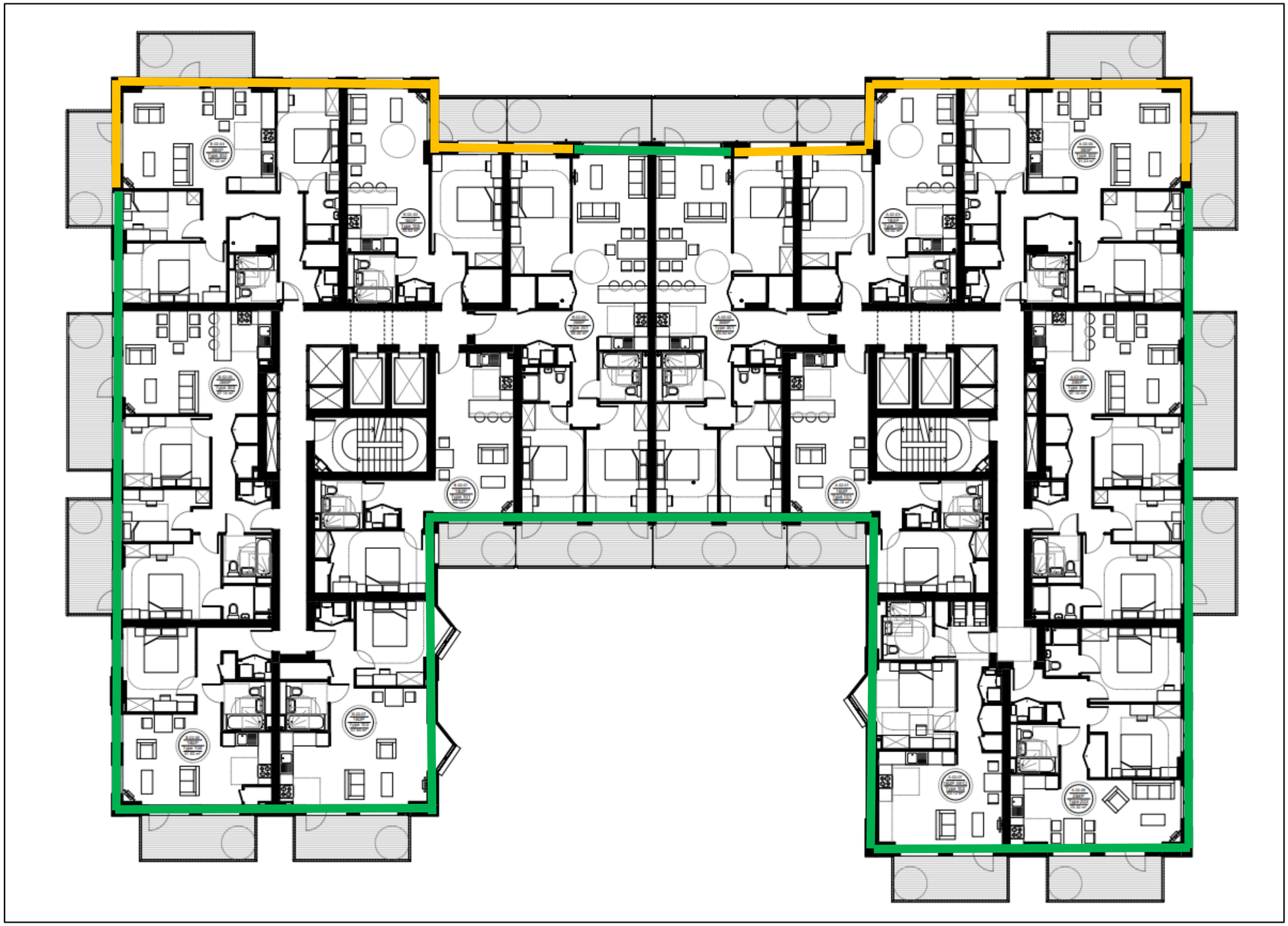


Figure 8: Acoustic glazing “Façade Zones” – **Level 02 to Level 04**

Figure 9: Acoustic glazing “Façade Zones” –**Level 05 to Level 08**

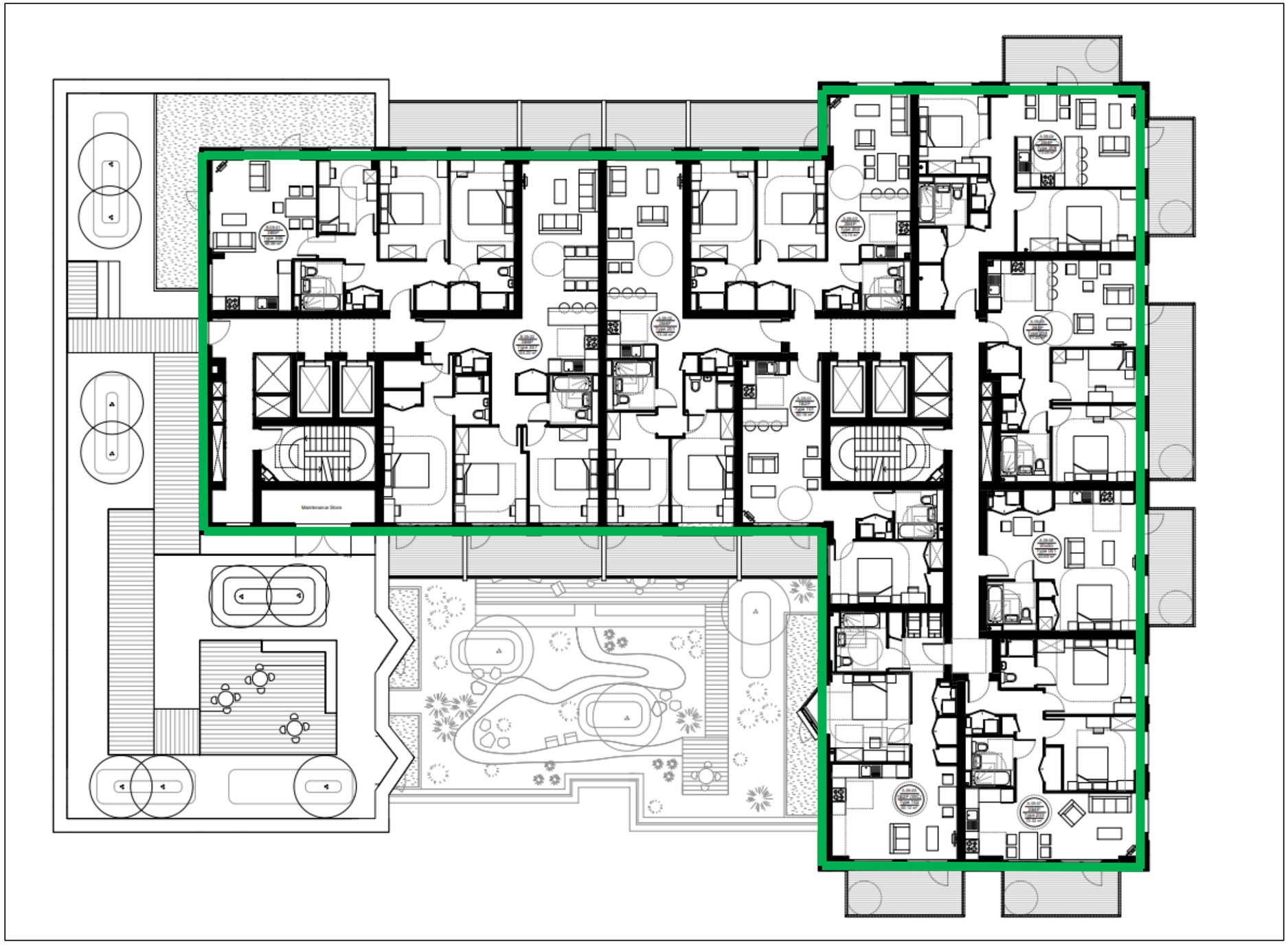


Figure 10: Acoustic glazing “Façade Zones” –**Level 09**

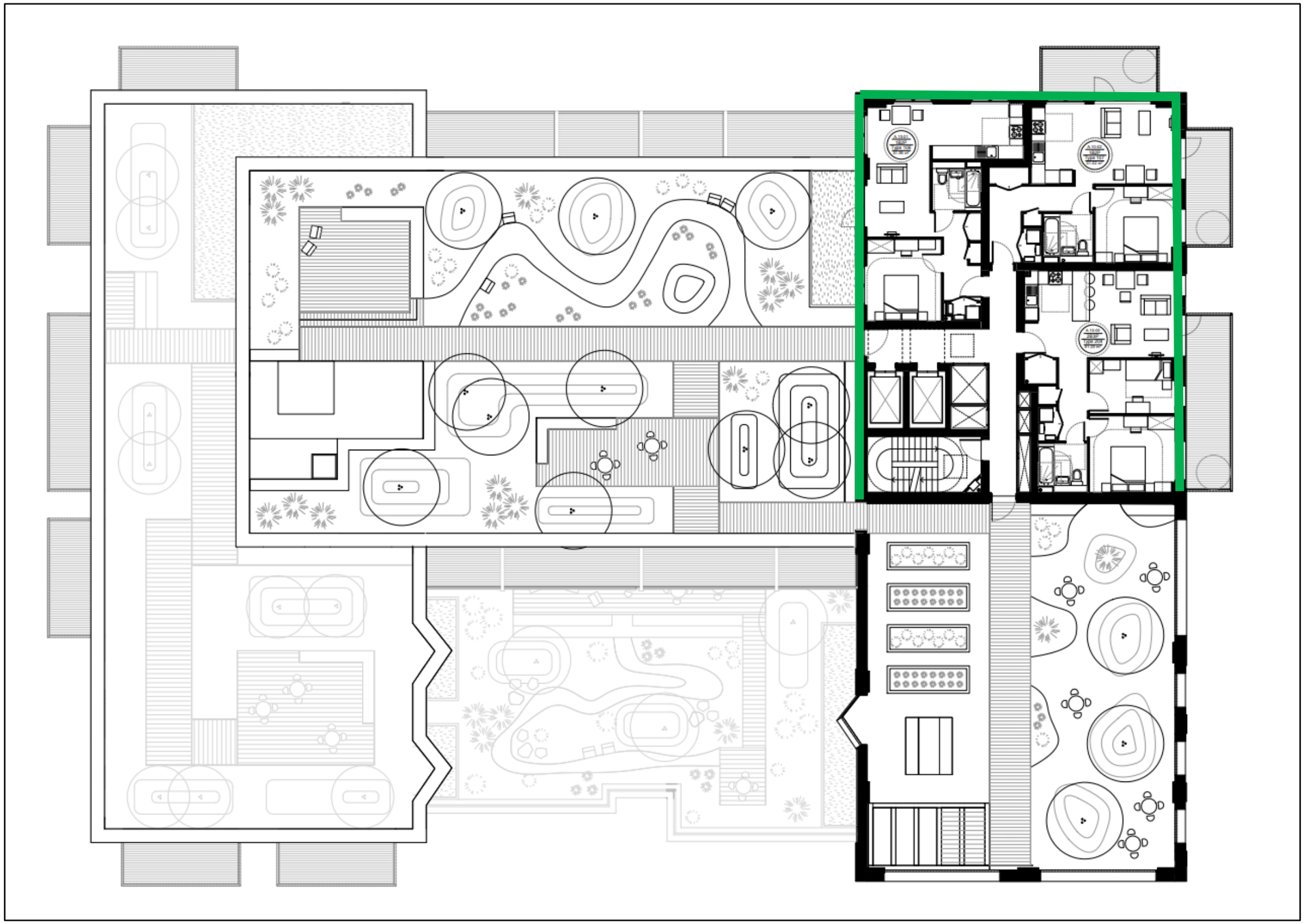


Figure 11: Acoustic glazing “Façade Zones” –**Level 10**

6.4 Predicted Daytime Environmental Noise at External Amenity Areas

6.4.1 Central garden area

As previously stated, there is to be an external garden/amenity area located centrally in between the blocks that form the residential building.

Based upon the results of the 3D environmental noise model, the daytime noise levels in the external amenity area should not exceed the upper guideline noise limit of 55dB $L_{Aeq,16hour,}$ as shown in Figure 12:

Figure 12: Predicted daytime noise level within the external amenity area ($L_{Aeq,16\ hour}$)

This is therefore in line with the BS8233 desirable external amenity space upper noise limit of 55dB $L_{Aeq,16hour}$ and it is therefore considered that this space would be a suitable external amenity space for residents.

6.4.2 Rooftop Terraces

With regards to the roof terraces within daytime noise levels are predicted to be in line with the BS8233 desirable external amenity space noise level limit of 50dB $L_{Aeq,16hour}$ and it is therefore considered that these spaces would provide suitable external amenity space for residents from a noise perspective.

7 ACOUSTICS, VENTILATION & OVERHEATING FOR RESIDENTIAL DWELLINGS

7.1 Planning Condition 21

Condition 21 of Planning Permission (ref: 59872/APP/2019/3852) for One Vinyl Square relates to acoustics, ventilation and overheating and states:

> *'Prior to commencement of any works above first floor slab level an assessment of Acoustics Ventilation and Overheating should be submitted to and approved by the Local Planning Authority to demonstrate suitable amenity for future residents can be achieved with proposed ventilation and overheating control measures in place. The details shall be implemented as approved and shall remain in force for the life of the building.*
>
> *REASON To safeguard the amenity of surrounding areas in accordance with Policy DMHB 11 of the Hillingdon Local Plan: Part 2 Development Management Policies (January 2020).'*

7.2 Approved Document O

As full planning permission has been granted it is assumed that Building Regulations Approved Document O ("ADO"), which takes effect on 15 June 2022, does not apply to the development.

7.3 AVO Assessment Framework

The *'Acoustics, Ventilation and Overheating Guide'* ("AVO Guide") published by the Association of Noise Consultants in 2020 provides a recommended framework for the early design stage assessment of new residential development that takes due regard of the interdependence of provisions for acoustics, ventilation and overheating.

Typically, new residential developments in urban environments require closed windows for reasonable internal noise conditions in accordance with BS8233: 2014. Until recently, this has often been assessed separately from the overheating strategy, which may require windows open for reasonable thermal conditions. This can result in residential accommodation in which the occupants may choose either acoustic comfort or indoor air quality and thermal comfort, but not achieve both simultaneously.

The AVO Guide provides a two-stage assessment, as shown in Figure 13, to highlight at the planning stage residential facades which may result in adverse or significant adverse noise impact when using an open window ventilation strategy, and to help the design team identify suitable overheating mitigation strategies.

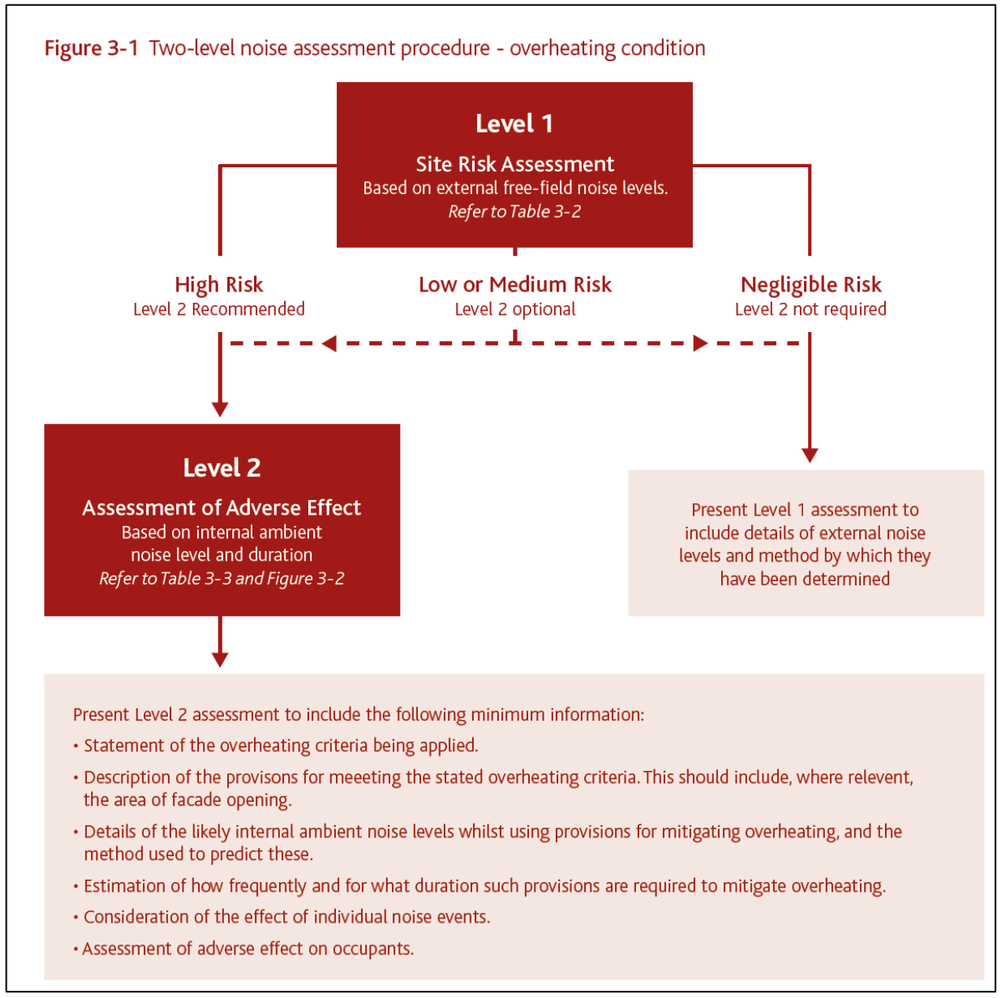


Figure 13: AVO Guide two stage assessment framework

7.4 Level 1 Site Risk Assessment

The AVO Level 1 Site Risk Assessment framework is shown in Figure 14. The framework dictates whether a Level 2 assessment is recommended based on daytime and night time transportation noise levels at the development site.

Table 3-2 Guidance for Level 1 site risk assessment of noise from transport noise sources [Note 1] relating to overheating condition

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

Figure 14: AVO Guide Level 1 site risk transportation noise levels thresholds

Based on the environmental noise survey results and the 3D environmental noise model of the site, the noise level from transportation noise sources at the most exposed residential facades of the development is predicted to be c.65dB $L_{Aeq,16h}$ during the daytime and c.59dB $L_{Aeq,8h}$ during the night time.

In line with the AVO Level 1 Site Risk Assessment framework, the worst-case facades fall into the "**High Risk"** category and therefore a more detailed Level 2 assessment is required.

7.5 Level 2 Assessment of Adverse Effects

The Level 2 Assessment provides a detailed assessment of the likely adverse effects on occupants relating to the magnitude of indoor ambient noise levels. Table 3-3 of the AVO Guide, as shown in Figure 15, provides a table of typical outcomes for occupants with regards to changes in noise level:

Table 3-3 Guidance for Level 2 assessment of noise from transport noise sources[Note 1] relating to overheating condition

Internal ambient noise level [Note 2]			Examples of Outcomes [Note 5]	
$L_{Aeq,T}$ [Note 3] during 07:00 – 23:00 [Note 6]	$L_{Aeq,8h}$ during 23:00 – 07:00	Individual noise events during 23:00 – 07:00 [Note 4]		
> 50 dB	> 42 dB	Normally exceeds 65 dB $L_{AF,max}$	Noise causes a material change in behaviour e.g. having to keep windows closed most of the time	Avoiding certain activities during periods of intrusion. Having to keep windows closed most of the time because of the noise. Potential for sleep disturbance resulting in difficulty in getting to sleep, premature awakening and difficulty in getting back to sleep. Quality of life diminished due to change in acoustic character of the area.
Increasing noise level			Increasing likelihood of impact on reliable speech communication during the day or sleep disturbance at night	At higher noise levels, more significant behavioural change is expected and may only be considered suitable if occurring for limited periods. As noise levels increase, small behaviour changes are expected e.g. turning up the volume on the television; speaking a little more loudly; having to close windows for certain activities, for example ones which require a high level of concentration. Potential for some reported sleep disturbance. Affects the acoustic environment inside the dwelling such that there is a perceived change in quality of life. At lower noise levels, limited behavioural change is expected unless conditions are prevalent for most of the time. [Note 8]
≤ 35 dB	≤ 30 dB	Do not normally exceed $L_{AF,max}$ 45 dB more than 10 times a night	Noise can be heard, but does not cause any change in behaviour	Noise can be heard, but does not cause any change in behaviour, attitude, or other physiological response[Note 9]. Can slightly affect the acoustic character of the area but not such that there is a perceived change in the quality of life.

Figure 15: AVO Guide IANL assessment of effect from transport noise sources

7.5.1 *Planning Practice Guidance on Noise*

Planning Practice Guidance on Noise ("PPGN") provides a summary of the noise exposure hierarchy, and links the significance of effect based on the likely average response to noise levels to the Noise Policy Statement for England, 2010 defined categories for Observed Adverse Effect Levels:

- No Observed Effect Level ("NOEL") which is the level below which no effect can be detected;
- Lowest Observed Adverse Effect Level ("LOAEL") which is the level above which adverse effects on health and quality of life can be detected;
- Significant Observed Adverse Effect Level ("SOAEL") which is the level above which significant adverse effects on health and quality of life occur.

Table 9 provides the significance of effect based on the internal ambient noise level presented in the AVO Level 2 Assessment Guide:

Indoor Ambient Noise Levels			**Significance of Effect**
Daytime $L_{Aeq,16h}$	**Night Time $L_{Aeq,8h}$**	**Individual night time noise events**	
> 50dB	> 42dB	Normally exceeds 65dB $L_{AF,max}$	SOAEL
Between 36dB and 50dB	Between 31dB and 42dB	Normally in between 45dB and 65dB $L_{AF,max}$	LOAEL
≤ 35dB	≤ 30dB	Do not normally exceed 45dB more than 10 times a night	NOEL

Table 9: Internal ambient noise level significance of effect

7.5.2 Level 2 Overheating Noise Impact Assessment

An assessment has been undertaken based on the predicted façade noise levels and the corresponding predicted daytime and night time internal ambient noise levels, as based on a typical open window providing a minimum of 13dB attenuation in line with the AVO Guide.

The façade areas shown in **red** within Figure 16 (daytime 07:00 to 23:00 hours) and Figure 17 (night time 07:00 to 23:00 hours) are considered to result in a "**Significant Observed Adverse Effect Level"** for residents when open windows are required to control overheating.

It is understood that a suitable overheating strategy has been developed such that windows within the red facade areas serving habitable rooms can remain closed within the specified time periods during overheating mitigation conditions to mitigate the significant adverse effect of external noise intrusion.

Note - In accordance with the good acoustic design principles of ProPG it is still recommended that openable windows are provided for user-controlled comfort and purge ventilation.

Figure 16: Highlighted façade areas where natural ventilation via open windows is likely to result in SOAEL during overheating conditions during the **daytime** period (northern façade).

Figure 17: Highlighted façade areas where natural ventilation via open windows is likely to result in SOAEL during overheating conditions during the **night time** period - **All floors up to Level 05**

8 M&E PLANT NOISE LEVELS

8.1 Environmental Noise Level Criterion

Condition 22 of Planning Permission (ref: 59872/APP/2019/3852) for One Vinyl Square relates to the control of M&E plant noise and states:

> *'Any noise associated with fixed mechanical plant on/in the building shall fall at least 10dB below the monitored representative background noise level in terms of L_{A90} when measured at a location 1m from the facade the of nearest identified noise sensitive receptors.*
>
> *REASON To safeguard the amenity of surrounding areas in accordance with Policy DMHB 11 of the Hillingdon Local Plan: Part 2 Development Management Policies (January 2020) and Policy EM8 of the Hillingdon Local Plan: Part 1 - Strategic Policies (November 2012).'*

8.1.1 BS 4142: 2014

BS4142: 2014+A1: 2019: *'Method for rating and assessing industrial and commercial sound'* (BS4142) is intended to be used to assess noise of an industrial nature, which includes sound from fixed installations comprising mechanical and electrical plant and equipment.

The procedure contained in BS4142 for assessing environmental noise impact is to compare the measured or predicted noise level from the source in question, the "Specific Sound Level" immediately outside the noise sensitive premises, with the corresponding representative "Background Sound Level". Where the noise contains attention attracting characteristics such as tonal, impulsive and/or intermittent elements, it may be appropriate to apply a correction to the Specific Sound Level to obtain the "Rating Level".

BS4142 states that the significance of sound arising from 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 also the context in which the sound occurs:

a) Typically, the greater this difference, the greater the magnitude of the impact.

b) A difference of around +10dB or more is likely to be an indication of a significant adverse impact, depending on the context.

c) A difference of around +5dB is likely to be an indication of an adverse impact, depending on the context.

d) 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.

For the daytime, the assessment is carried out over a one-hour period, and over a 15-minute period at night. The daytime and night time periods are defined as occurring between 07:00 hours to 23:00 hours, and 23:00 hours to 07:00 hours, respectively.

8.2 Environmental Plant Noise Limits

Based on the requirements of Condition 22, fixed plant and equipment it is required to achieve a cumulative rating noise level 10dB below the representative background sound level when assessed in accordance with BS4142: 2014.

The representative background levels are based on the modal measured $L_{A90,15mins}$ at the relevant measurement positions in line with BS 4142 guidance. An example histogram for measurement position MP1 is shown in Figure 18:

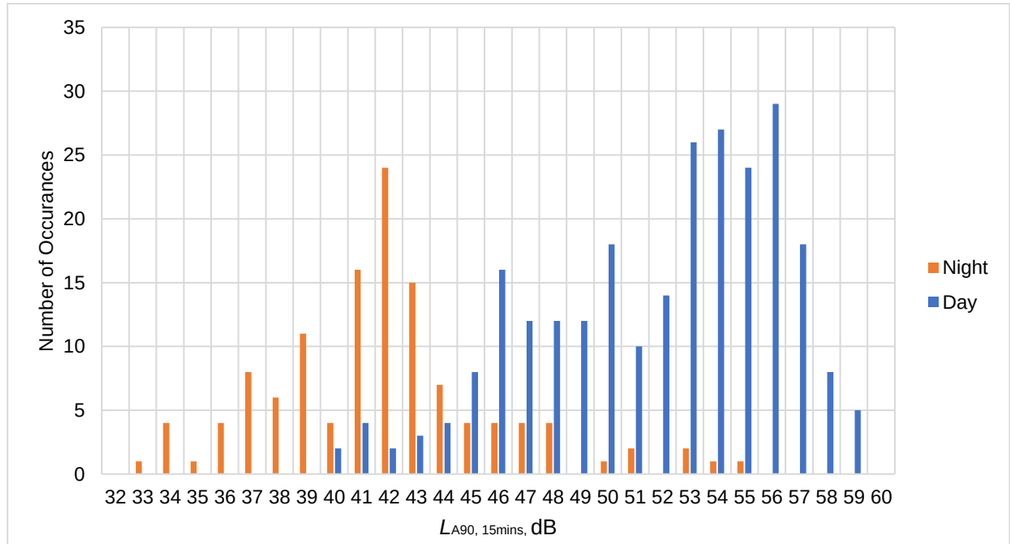


Figure 18: Histogram of measured $L_{A90,15mins}$ levels at Measurement Position MP1

Therefore, based on the noise survey undertaken at site, the total, aggregate environmental noise from all M&E plant must be controlled to not exceed the rating noise levels ($L_{Ar,\,Tr}$) presented in Table 10:

Zone	Cumulative Plant Noise Limit at any Façade dB $L_{Ar,Tr}$ (free field)	
	Daytime (07:00 – 23:00hrs)	Night Time (07:00 – 23:00hrs)
Red façade zones in Figure 17	46	32
All others	41	

Table 10: Maximum permissible noise level limits for all M&E plant

8.3 Building Services Noise Limits

8.3.1 MVHR within Residential Apartments – Part F

In terms of internal room noise levels arising due to the operation of MVHR units (and/or other domestic ventilation fans, if used), these room noise levels *must not* exceed the following noise limits:

- NR25 in the case of any bedroom;
- NR30 in the case of any living room;
- NR35 in all other areas.

In practical terms, this will mean all MVHR units must be appropriately selected and sized to **operate only at low fan speeds** and furthermore, proprietary in line **duct attenuators must be fitted** as required on the supply and extract to achieve the above noise level criteria.

8.3.2 MVHR within Residential Apartments – Overheating Conditions

During overheating conditions, the recommend desirable upper internal ambient noise limit from mechanical services at high ventilation rates (ventilative/comfort cooling) are:

- 30dB $L_{Aeq,1h}$ (+5dB) in the case of any bedroom;
- 35dB $L_{Aeq,1h}$ (+5dB) in the case of any living room;

CIBSE Guide A 2015 states that a +5dB relaxation to the noise limits may be acceptable depending on the duration, frequency, and degree of occupant control during the overheating conditions. Higher noise levels (+5dB) are likely to be acceptable where rapid changes to the cooling or ventilation rates quickly improve the thermal comfort of the occupant but should not be used where high ventilation rates are required for extended periods of time to control overheating.

Others will need to advise on the duration and frequency of any proposed high ventilation mechanical services and details of the mechanical cooling system will need to be submitted to Sol for acoustic evaluation and approval.

8.3.3 MVHR within Residential Apartments – Grilles, Diffusers, Ductwork and Volume Control Devices

It should be noted that all supply and extract air grilles and diffusers must be suitably sized and selected to ensure they are compatible with the required room noise limits for all required modes of MVHR operation in each and every case, as commissioned for both “trickle” and “overheating/boost” unit operational modes. The same applies to the correct sizing of all ductwork and louvres.

The use of opposed blade dampers (“OBDs”) incorporated as part of final grille/diffuser air terminals must be avoided; airflow balancing must be achieved where required via the use of duct-mounted volume control dampers (“VCDs”).

8.3.4 Noise Limits Within Other Internal Areas

In terms of internal room noise levels arising due to the operation of M&E plant, these room noise levels *must not* exceed the following noise limits:

- NR40 in the case of any common area corridor and/or public stairwell;
- NR50 – NR55 within any ventilated car park (with extract air plant operating at 6 air changes per hour and all induction fans simultaneously operating);
- NR70 within any plantroom (with all plant operating at full speed).

8.4 Vibration Isolation of M&E Plant and Substation Transformers

It is essential that all M&E plant (e.g. pumps, fans, adiabatic coolers etc.) are wholly and effectively vibration isolated from all building structures. This requirement also extends to all substation transformers, much must also be entirely vibration isolated from all building elements and structures.

Proprietary vibration isolators must be used in all cases, and these must be installed strictly in accordance with manufacturer guidelines.

9 CONCLUSION

Sol Acoustics Ltd has been commissioned by ARJ Construction Limited to undertake an acoustic design assessment of the One Vinyl Square development, Hayes.

The purpose of this report is to assess the scheme in terms of intrusive noise and to determine an appropriate acoustic performance specification for the building envelope, all as based on the pre-existing environmental noise climate on site as surveyed in March 2022, noise model results, the intrusive noise requirements of BS8233: 2014, Planning Condition requirements and the currently available Architectural design drawings.

In order to predict the likely resultant environmental noise levels at the Development site, a 3D computer based environmental noise model was created using the DataKustik 'CadnaA' Noise Mapping software. The results obtained from this 3D noise model have been used as part of the environmental and intrusive noise assessment.

This report demonstrates that appropriate indoor ambient noise levels can be achieved within all proposed internal habitable spaces across the project with the implementation of the glazing strategy recommended within this report.

An Acoustics, Ventilation, and Overheating framework assessment has been undertaken as is required by Planning Condition 21 and it is considered that for specific façade areas the use of openable windows to mitigate overheating may result in a significant adverse noise impact to a limited number of residential units and an alternative overheating mitigation must be developed. (*Others must check other non-acoustic aspects, such as Architectural and aesthetic considerations, SAP/overheating strategies and suchlike*).

Additionally, as required by Planning Condition 22, appropriate M&E plant daytime and night time environmental noise limits have also been prescribed herein, all as based on the environmental noise survey undertaken at site.

APPENDIX A. NOISE SURVEY DETAILS AND SUMMARY RESULTS

LOCATION

One Vinyl Square, Hayes, London

DATES & TIMES

c.16:00 hours on Friday 25 March 2022 to c. 16:00 hours on Tuesday 29 March 2022.

WEATHER CONDITIONS

Date	Daytime (07:00 - 23:00)				Night Time (23:00 – 07:00)			
	Temp, °C	Rain, mm	Wind Direction	Average Wind Speed, m/s	Temp, °C	Rain, mm	Wind Direction	Average Wind Speed, m/s
25/03/2022	13	0	SE	1	6	0	SE	0
26/03/2022	14	0	SE	1	8	0	SE	1
27/03/2022	10	0	SE	1	5	0	NE	1
28/03/2022	12	0	SE	1	9	0	E	1
29/03/2022	10	0	E	1	N/A			

PERSONNEL PRESENT DURING MEASUREMENTS

Jamie Ross MIOA – Sol Acoustics Ltd
Tim Walton MIOA – Sol Acoustics Ltd
Daniel Reeves AMIOA – Sol Acoustics Ltd

INSTRUMENTATION

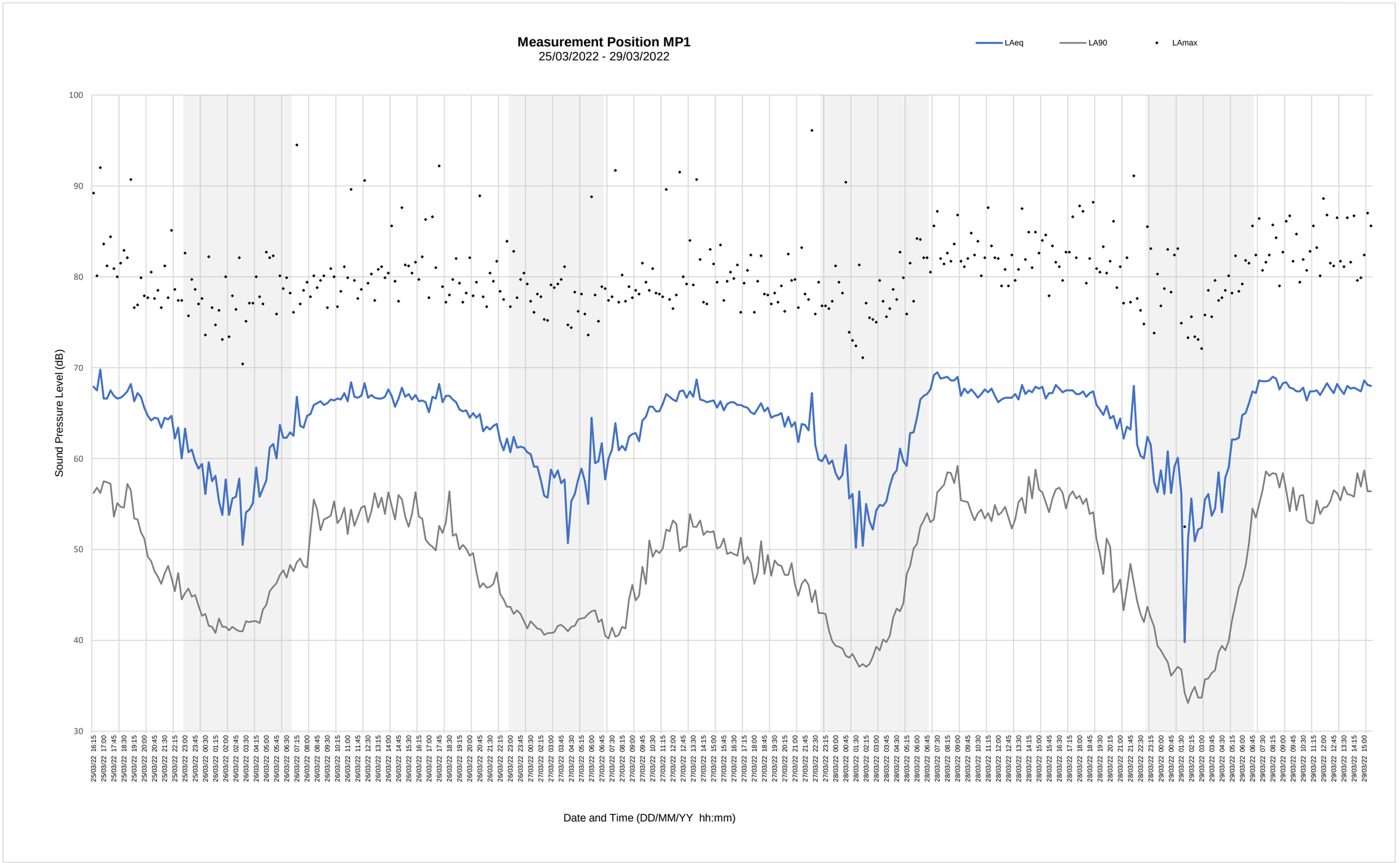
01dB Cube Sound level meter (Serial no. 11228)
01dB Cube Sound level meter (Serial no. 12070)
01dB CAL 21 Acoustic calibrator (Serial no. 34375244)

METHODOLOGY

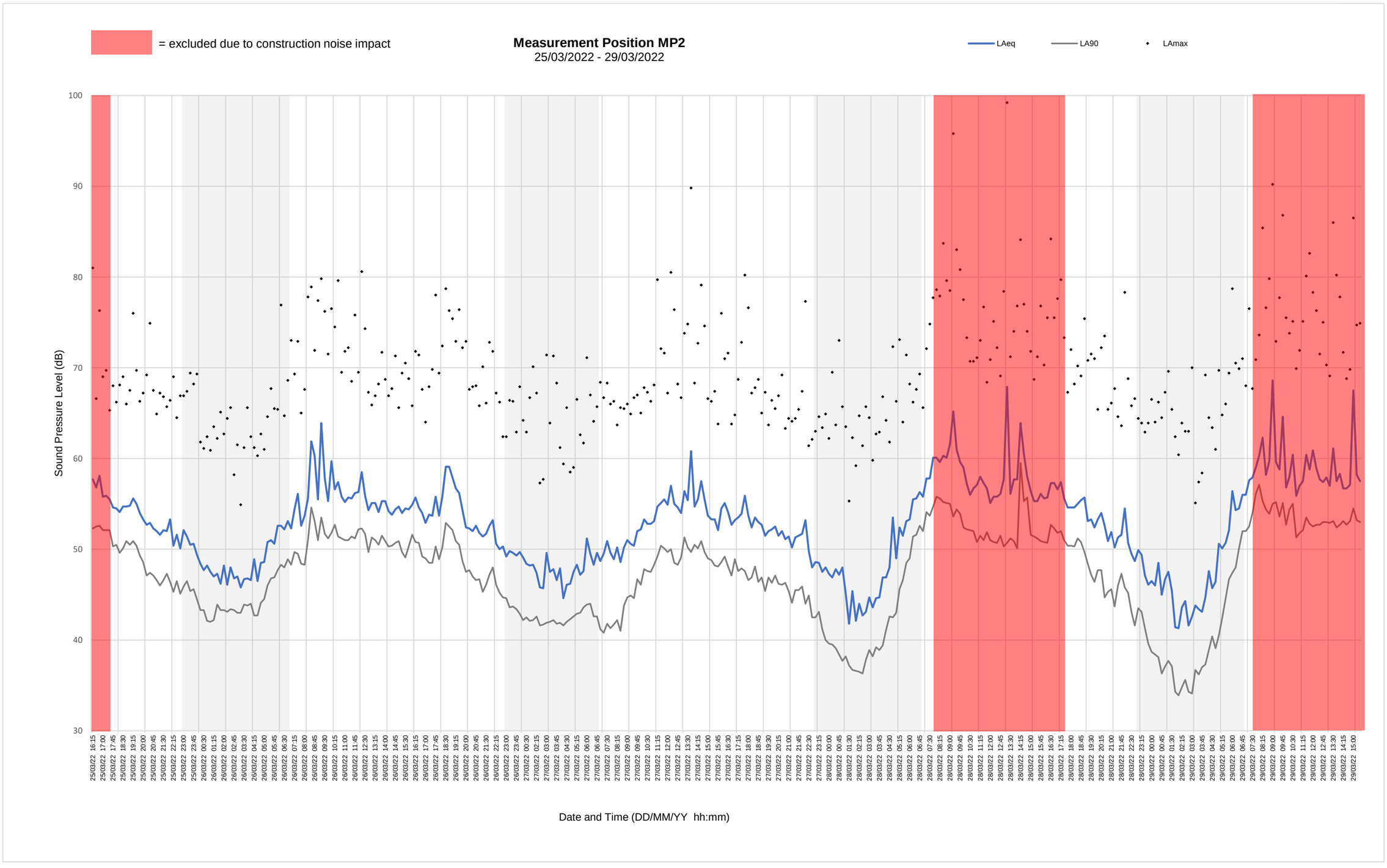
Before and after the measurements the sound level meters were checked and calibrated to an accuracy of ±0.3dB using the 01dB CAL 21 Calibrator. The calibrator produces a sound pressure level of 94 dB re 2x10-5 Pa @ 1kHz.

MEASUREMENT RESULTS

Graphs A1, and A2 summarise the results obtained from the noise surveys at Measurement Position MP1, and Measurement Position MP2 respectively.



Graph A1: Graph showing measured environmental noise levels, Measurement Position MP1, 25 March 2022 – 29 March 2022.



Graph A2: Graph showing measured environmental noise levels, Measurement Position MP2, 25 March 2022 – 29 March 2022.

APPENDIX B. CADNAA NOISE MAPS

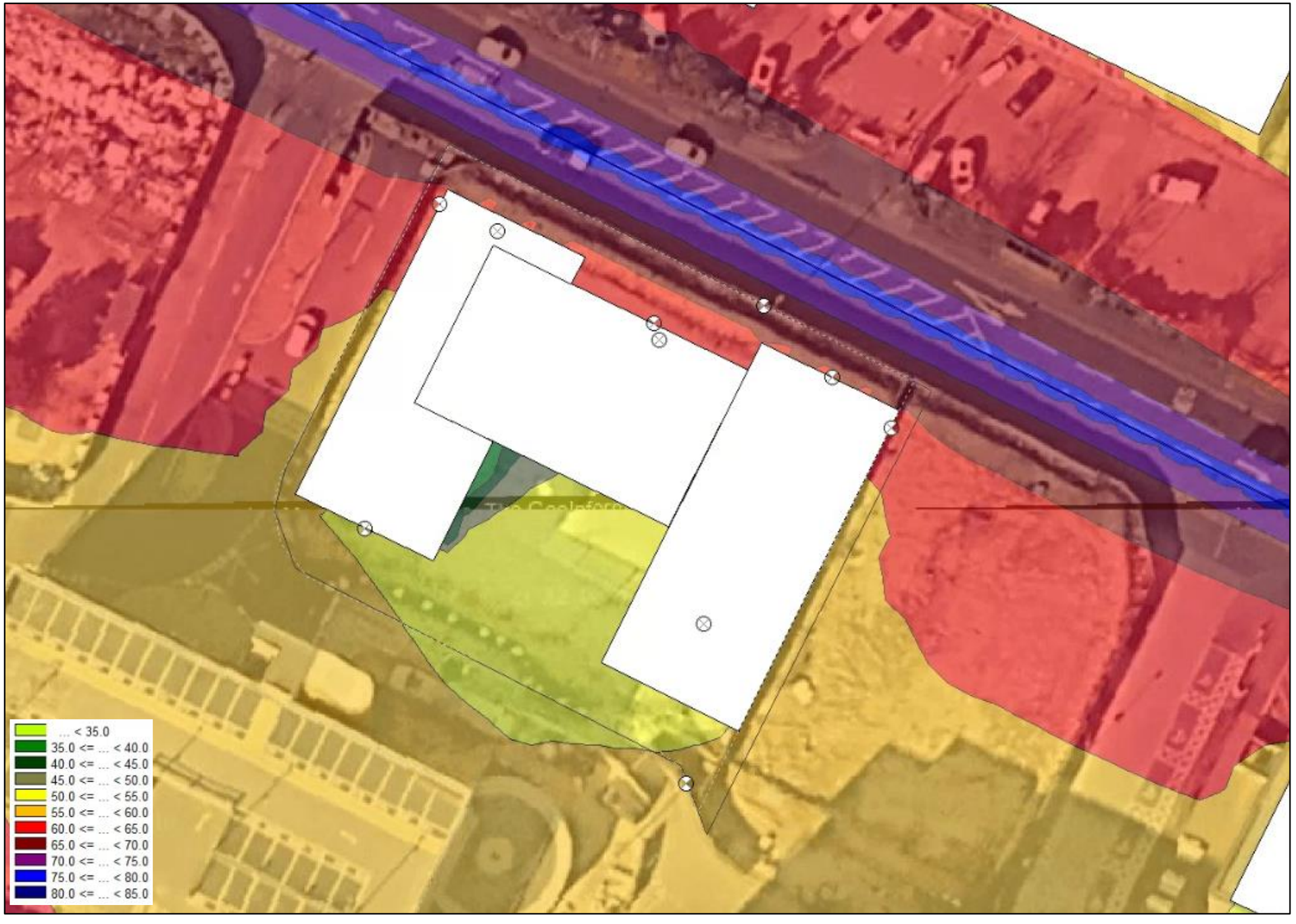


Figure B1: Predicted daytime environmental noise levels ($L_{Aeq,16\ hour}$)

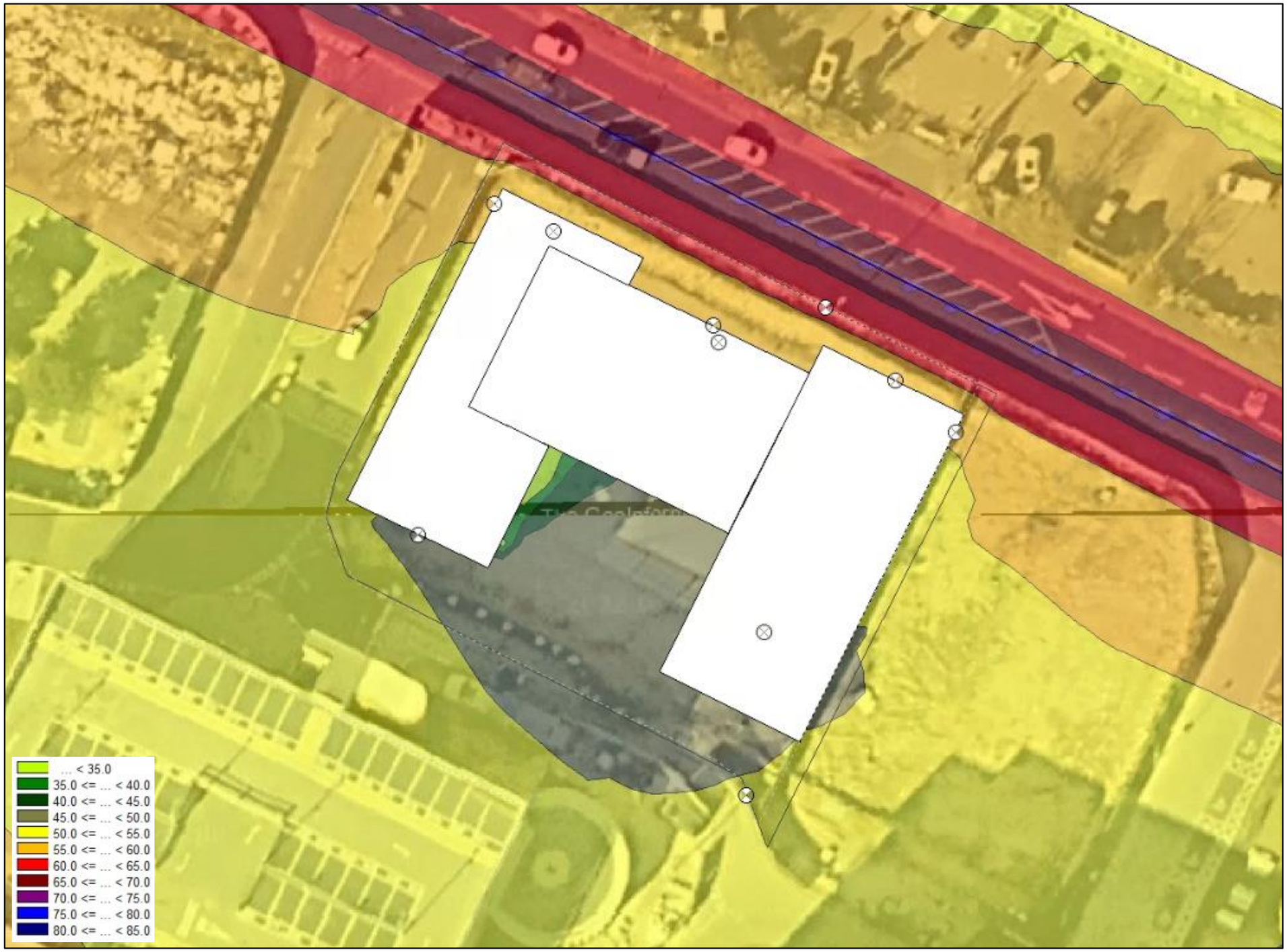


Figure B2: Predicted night time environmental noise levels ($L_{Aeq,8\ hour}$)

APPENDIX C. BS 8233 NOISE INTRUSION CALCULATION EXAMPLES

Zone A Bedrooms ($L_{Aeq,8hrs}$)

BS 8233:2014 Internal Noise Level from External Noise Sources Calculation

Night time ambient internal noise level calculation in

Facade element	Construction type	Area, m^2
External walls	Masonary Façade	13.18
Saint Gobain Double system	88.2 STADIP SILENCE / 15 / 88.2 STADIP SILENCE	11
Roof and ceiling	*A roof has not been considered in this location*	
Trickle vents	Approved Document F system 4 assumed	

Reverberation time in furnished room: 0.5 seconds

Reference letter of result	Term from BS 8233 equation	Description	Octave band centre frequency, Hz								L_A, dB	R_w, dB	C_{tr}, dB
			63	125	250	500	1000	2000	4000	8000			
A	$L_{eq,ff}$	Night time ambient external noise levels	60	54	53	52	55	51	42	33	58		
B	$D_{n,e}$	Ventilator sound reduction performances											
	$\frac{A_0}{S}10^{\frac{-D_{n,e}}{10}}$												
C	$R_{w\,i}$	Window sound reduction performances	31	35	41	47	50	52	65	65		50	-5
	$\frac{S_{wi}}{S_f}10^{\frac{-R_{wi}}{10}}$		0.00036	0.00014	0.00004	0.00001	0.00000	0.00000	0.00000	0.00000			
D	R_{ew}	External wall sound reduction performances	27	42	55	60	65	69	70	70		63	-8
	$\frac{S_{ew}}{S_f}10^{\frac{-R_{ew}}{10}}$		0.00109	0.00003	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000			
E	R_{rr}	Roof/ceiling sound reduction performances											
	$\frac{S_{rr}}{S_f}10^{\frac{-R_{rr}}{10}}$												
F	$10\log_{10}(B + C + D + E)$	Total facade sound reduction performances	-28	-37	-44	-50	-53	-55	-67	-67			
Absorption areas, A (assuming the room is furnished)			9	10	11	12	12	12	12	12			
G	$10\log\frac{S}{A}$	Correction for internal surface area and absorption	4	4	4	3	3	3	3	3			
Results	$L_{eq,2}$	Night time ambient internal noise levels	39	23	15	8	8	2	-19	-28			
	A-weighting dB		-26	-16	-9	-3	0	1	1	-1			
	$L_{eq,2}$ + A-weighting	Night time ambient internal A-weighted noise levels	13	7	6	5	8	3	-18	-29	16		
	Criterion and conclusion		Criterion met								30		

Zone A Bedrooms (L_{Amax})

BS 8233:2014 Internal Noise Level from External Noise Sources Calculation

Night time maximum internal noise level calculation in

Facade element	Construction type	Area, m²
External walls	Masonary Façade	13.18
Saint Gobain Double system	88.2 STADIP SILENCE / 15 / 88.2 STADIP SILENCE	11
Roof and ceiling	*A roof has not been considered in this location*	
Trickle vents	Approved Document F system 4 assumed	

Reverberation time in furnished room: 0.5 seconds

Reference letter of result	Term from BS 8233 equation	Description	Octave band centre frequency, Hz								L_A, dB	R_w, dB	C_{tr}, dB
			63	125	250	500	1000	2000	4000	8000			
A	$L_{eq,tf}$	Night time maximum external noise levels	80	91	75	73	72	68	57	42	78		
B	$D_{n,e}$	Ventilator sound reduction performances											
	$\frac{A_0}{S}10^{\frac{-D_{n,e}}{10}}$												
C	$R_{w\,i}$	Window sound reduction performances	31	35	41	47	50	52	65	65		50	-5
	$\frac{S_{wi}}{S_f}10^{\frac{-R_{wi}}{10}}$		0.00036	0.00014	0.00004	0.00001	0.00000	0.00000	0.00000	0.00000			
D	R_{ew}	External wall sound reduction performances	27	42	55	60	65	69	70	70		63	-8
	$\frac{S_{ew}}{S_f}10^{\frac{-R_{ew}}{10}}$		0.00109	0.00003	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000			
E	R_{rr}	Roof/ceiling sound reduction performances											
	$\frac{S_{rr}}{S_f}10^{\frac{-R_{rr}}{10}}$												
F	$10\log_{10}(B + C + D + E)$	Total facade sound reduction performances	-28	-37	-44	-50	-53	-55	-67	-67			
Absorption areas, A (assuming the room is furnished)			9	10	11	12	12	12	12	12			
G	$10\log\frac{S}{A}$	Correction for internal surface area and absorption	4	4	4	3	3	3	3	3			
Results	$L_{eq,2}$	Night time maximum internal noise levels	59	60	37	29	25	18	-4	-19			
	A-weighting dB		-26	-16	-9	-3	0	1	1	-1			
	$L_{eq,2}$ + A-weighting	Night time maximum internal A-weighted noise levels	13	7	6	5	8	3	-18	-29	45		
	Criterion and conclusion		Criterion met								45		

Zone B Living Rooms ($L_{Aeq,16hrs}$)

BS 8233:2014 Internal Noise Level from External Noise Sources Calculation

Daytime ambient internal noise level calculation in

Facade element	Construction type	Area, m^2
External walls	Masonary Façade	16.6
Saint Gobain Double syste	4 PLANILUX / 10 / 10 PLANILUX	14.6
Roof and ceiling	*A roof has not been considered in this location*	
Trickle vents	Approved Document F system 4 assumed	

Reverberation time in furnished room: 0.6 seconds

Reference letter of result	Term from BS 8233 equation	Description	Octave band centre frequency, Hz								L_A, dB	R_w, dB	C_{tr}, dB
			63	125	250	500	1000	2000	4000	8000			
A	$L_{eq,ff}$	Daytime ambient external noise levels	67	61	59	59	61	56	47	39	64		
B	$D_{n,e}$	Ventilator sound reduction performances											
	$\frac{A_0}{S}10^{\frac{-D_{n,e}}{10}}$												
C	R_{wi}	Window sound reduction performances	26	32	22	31	38	45	46	46		35	-5
	$\frac{S_{wi}}{S_f}10^{\frac{-R_{wi}}{10}}$		0.00129	0.00030	0.00295	0.00037	0.00007	0.00001	0.00001	0.00001			
D	R_{ew}	External wall sound reduction performances	27	41	55	60	65	69	70	70		62	-8
	$\frac{S_{ew}}{S_f}10^{\frac{-R_{ew}}{10}}$		0.00106	0.00004	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000			
E	R_{rf}	Roof/ceiling sound reduction performances											
	$\frac{S_{rf}}{S_f}10^{\frac{-R_{rf}}{10}}$												
F	$10\log_{10}(B + C + D + E)$	Total facade sound reduction performances	-26	-35	-25	-34	-41	-48	-49	-49			
	Absorption areas, A (assuming the room is furnished)		17	18	20	22	22	22	22	22			
G	$10 \log \frac{S}{A}$	Correction for internal surface area and absorption	3	2	2	2	2	2	2	2			
Results	$L_{eq,2}$	Daytime ambient internal noise levels	46	32	39	29	24	12	2	-6			
	A-weighting dB		-26	-16	-9	-3	0	1	1	-1			
	$L_{eq,2}$ + A-weighting	Daytime ambient internal A-weighted noise levels	20	16	30	26	24	13	3	-7	33		
	Criterion and conclusion		Criterion met								35		

Zone B Bedrooms ($L_{Aeq,8hrs}$)

BS 8233:2014 Internal Noise Level from External Noise Sources Calculation

Night time ambient internal noise level calculation in

Facade element	Construction type	Area, m^2
External walls	Masonary Façade	3.08
Saint Gobain Double syste	10 PLANILUX / 16 / 44.2 STADIP PROTECT	4.2
Roof and ceiling	*A roof has not been considered in this location*	
Trickle vents	Approved Document F system 4 assumed	

Reverberation time in furnished room: 0.5 seconds

Reference letter of result	Term from BS 8233 equation	Description	Octave band centre frequency, Hz								L_{A}, dB	R_w, dB	C_{tr}, dB
			63	125	250	500	1000	2000	4000	8000			
A	$L_{eq,ff}$	Night time ambient external noise levels	59	54	53	52	54	50	41	32	57		
B	$D_{n,e}$	Ventilator sound reduction performances											
	$\frac{A_0}{S}10^{\frac{-D_{n,e}}{10}}$												
C	$R_{w\,i}$	Window sound reduction performances	24	30	32	40	43	43	54	54		42	-4
	$\frac{S_{wi}}{S_f}10^{\frac{-R_{wi}}{10}}$		0.00230	0.00058	0.00036	0.00006	0.00003	0.00003	0.00000	0.00000			
D	R_{ew}	External wall sound reduction performances	27	46	54	57	65	69	70	70		63	-6
	$\frac{S_{ew}}{S_f}10^{\frac{-R_{ew}}{10}}$		0.00084	0.00001	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000			
E	R_{rf}	Roof/ceiling sound reduction performances											
	$\frac{S_{rf}}{S_f}10^{\frac{-R_{rf}}{10}}$												
F	$10\log_{10}(B + C + D + E)$	Total facade sound reduction performances	-25	-32	-34	-42	-45	-45	-56	-56			
	Absorption areas, A (assuming the room is furnished)		9	9	10	11	11	11	11	11			
G	$10\log\frac{S}{A}$	Correction for internal surface area and absorption	-1	-1	-1	-2	-2	-2	-2	-2			
Results	$L_{eq,2}$	Night time ambient internal noise levels	36	24	20	11	10	6	-14	-23			
	A-weighting dB		-26	-16	-9	-3	0	1	1	-1			
	$L_{eq,2}$ + A-weighting	Night time ambient internal A-weighted noise levels	10	8	11	8	10	7	-13	-24	17		
	Criterion and conclusion		Criterion met								30		

Zone B Bedrooms (L_{Amax})

BS 8233:2014 Internal Noise Level from External Noise Sources Calculation

Night time maximum internal noise level calculation in

Facade element	Construction type	Area, m^2
External walls	Masonary Façade	3.08
Saint Gobain Double syste	10 PLANILUX / 16 / 44.2 STADIP PROTECT	4.2
Roof and ceiling	*A roof has not been considered in this location*	
Trickle vents	Approved Document F system 4 assumed	

Reverberation time in furnished room: 0.5 seconds

Reference letter of result	Term from BS 8233 equation	Description	Octave band centre frequency, Hz								L_A, dB	R_w, dB	C_{tr}, dB
			63	125	250	500	1000	2000	4000	8000			
A	$L_{eq,ff}$	Night time maximum external noise levels	80	91	75	73	72	68	57	42	78		
B	$D_{n,e}$	Ventilator sound reduction performances											
	$\frac{A_0}{S}10^{\frac{-D_{n,e}}{10}}$												
C	R_{wi}	Window sound reduction performances	24	30	32	40	43	43	54	54		42	-4
	$\frac{S_{wi}}{S_f}10^{\frac{-R_{wi}}{10}}$		0.00230	0.00058	0.00036	0.00006	0.00003	0.00003	0.00000	0.00000			
D	R_{ew}	External wall sound reduction performances	27	46	54	57	65	69	70	70		63	-6
	$\frac{S_{ew}}{S_f}10^{\frac{-R_{ew}}{10}}$		0.00084	0.00001	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000			
E	R_{rr}	Roof/ceiling sound reduction performances											
	$\frac{S_{rr}}{S_f}10^{\frac{-R_{rr}}{10}}$												
F	$10\log_{10}(B + C + D + E)$	Total facade sound reduction performances	-25	-32	-34	-42	-45	-45	-56	-56			
Absorption areas, A (assuming the room is furnished)			9	9	10	11	11	11	11	11			
G	$10\log\frac{S}{A}$	Correction for internal surface area and absorption	-1	-1	-1	-2	-2	-2	-2	-2			
Results	$L_{eq,2}$	Night time maximum internal noise levels	57	60	42	32	28	23	2	-13			
	A-weighting dB		-26	-16	-9	-3	0	1	1	-1			
	$L_{eq,2}$ + A-weighting	Night time maximum internal A-weighted noise levels	10	8	11	8	10	7	-13	-24	45		
	Criterion and conclusion		Criterion met								45		

Zone C Living Rooms ($L_{Aeq,16hrs}$)

BS 8233:2014 Internal Noise Level from External Noise Sources Calculation

Daytime ambient internal noise level calculation in

Facade element	Construction type	Area, m^2
External walls	Masonary Façade	9.02
Saint Gobain Double syste	4 PLANILUX / 20 / 4 PLANILUX	8.4
Roof and ceiling	*A roof has not been considered in this location*	
Trickle vents	Approved Document F system 4 assumed	

Reverberation time in furnished room: 0.6 seconds

Reference letter of result	Term from BS 8233 equation	Description	Octave band centre frequency, Hz								L_A, dB	R_w, dB	C_{tr}, dB
			63	125	250	500	1000	2000	4000	8000			
A	$L_{eq,ff}$	Daytime ambient external noise levels	63	57	55	54	57	52	43	34	60		
B	$D_{n,e}$	Ventilator sound reduction performances											
	$\frac{A_0}{S}10^{\frac{-D_{n,e}}{10}}$												
C	$R_{w\,i}$	Window sound reduction performances	15	21	20	27	38	41	37	37		32	-5
	$\frac{S_{wi}}{S_f}10^{\frac{-R_{wi}}{10}}$		0.01525	0.00383	0.00482	0.00096	0.00008	0.00004	0.00010	0.00010			
D	R_{ew}	External wall sound reduction performances	27	42	54	57	65	69	70	70		62	-7
	$\frac{S_{ew}}{S_f}10^{\frac{-R_{ew}}{10}}$		0.00103	0.00003	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000			
E	R_{rr}	Roof/ceiling sound reduction performances											
	$\frac{S_{rr}}{S_f}10^{\frac{-R_{rr}}{10}}$												
F	$10\log_{10}(B + C + D + E)$	Total facade sound reduction performances	-18	-24	-23	-30	-41	-44	-40	-40			
	Absorption areas, A (assuming the room is furnished)		14	16	17	19	19	19	19	19			
G	$10\log\frac{S}{A}$	Correction for internal surface area and absorption	1	0	0	0	0	0	0	0			
Results	$L_{eq,2}$	Daytime ambient internal noise levels	49	36	35	26	19	11	5	-4			
	A-weighting dB		-26	-16	-9	-3	0	1	1	-1			
	$L_{eq,2}$ + A-weighting	Daytime ambient internal A-weighted noise levels	23	20	26	23	19	12	6	-5	30		
	Criterion and conclusion		Criterion met								35		

Zone C Bedrooms ($L_{Aeq,8hrs}$)

BS 8233:2014 Internal Noise Level from External Noise Sources Calculation

Night time ambient internal noise level calculation in

Facade element	Construction type	Area, m²
External walls	Masonary Façade	2.34
Saint Gobain Double syste	4 (8) 44.6	5.2
Roof and ceiling	*A roof has not been considered in this location*	
Trickle vents	Approved Document F system 4 assumed	

Reverberation time in furnished room: 0.5 seconds

Reference letter of result	Term from BS 8233 equation	Description	Octave band centre frequency, Hz								L_A, dB	R_w, dB	C_{tr}, dB
			63	125	250	500	1000	2000	4000	8000			
A	$L_{eq,ff}$	Night time ambient external noise levels	55	50	48	47	50	46	37	27	53		
B	$D_{n,e}$	Ventilator sound reduction performances											
	$\frac{A_0}{S}10^{\frac{-D_{n,e}}{10}}$												
C	$R_{w\,i}$	Window sound reduction performances	25	29	26	30	39	46	47	47		36	-4
	$\frac{S_{wi}}{S_f}10^{\frac{-R_{wi}}{10}}$		0.00224	0.00079	0.00190	0.00073	0.00008	0.00002	0.00001	0.00001			
D	R_{ew}	External wall sound reduction performances	27	42	54	57	65	69	70	70		62	-7
	$\frac{S_{ew}}{S_f}10^{\frac{-R_{ew}}{10}}$		0.00062	0.00002	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000			
E	R_{rr}	Roof/ceiling sound reduction performances											
	$\frac{S_{rr}}{S_f}10^{\frac{-R_{rr}}{10}}$												
F	$10\log_{10}(B + C + D + E)$	Total facade sound reduction performances	-25	-31	-27	-31	-41	-47	-48	-48			
	Absorption areas, A (assuming the room is furnished)		8	9	10	11	11	11	11	11			
G	$10\log\frac{S}{A}$	Correction for internal surface area and absorption	0	-1	-1	-2	-2	-2	-2	-2			
Results	$L_{eq,2}$	Night time ambient internal noise levels	32	21	23	17	10	0	-10	-20			
	A-weighting dB		-26	-16	-9	-3	0	1	1	-1			
	$L_{eq,2}$ + A-weighting	Night time ambient internal A-weighted noise levels	6	5	14	14	10	1	-9	-21	18		
	Criterion and conclusion		Criterion met								30		