Dice Environmental
Acoustics

3 High St, Wrexham
Noise Impact Assessment

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Executive Summary

Dice Environmental were commissioned by JRML Property Holdings Ltd to undertake a Residential Planning Noise Assessment to support a planning application for a commercial and residential development at 3 High St, Wrexham .

Noise Surveys

Environmental noise surveys have been completed to quantify the prevailing soundscape at the site. This comprised an unattended logging survey, supplemented with a series of short-term sample measurements around the site.

Residential Planning Noise Assessment

A 3D CadnaA noise model has been constructed including all significant noise sources at the site, primarily noise from road traffic on Wrexham High Street. This has been used to predict the noise levels incident upon the facades of the proposed residential development.

Accordingly, appropriate consideration has been given towards the mitigation measures required to ensure that the internal ambient noise level requirements set out in BS8233:2014 can be met for the development. A range of double-glazing configurations from $R_w + C_{tr}$ 25 dB to $R_w + C_{tr}$ 33 dB would be required to control noise break-in from external sources and achieve the requirements of BS8233.

Overheating Assessment

A number of plots are predicted to exceed the noise levels set out in Approved Document O *Overheating* for bedrooms at night when windows are open. Open windows should not be relied upon as the standard means of cooling for overheating scenarios in these locations.

Plant Noise Assessment

No specific plant information is available at this stage in the project. Plant noise rating limits have been set at 48 dB for nighttime (23:00-07:00) and 49 dB (07:00-23:00) for daytime. A full BS4142 assessment should be carried out on any proposed plant to be installed within the site boundary.

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1. Introduction

1.1. Background

Dice Environmental has been commissioned by JRML Property Holdings Ltd, to provide a Noise Impact Assessment to support a planning application for a residential development at 3 High St, Wrexham, to be referred to hereafter as "the site".

The site is located in the town centre of Wrexham on the main high street and is identified as a potential site for residential development. The development comprises a total of 4 storeys with the lower floor being commercial use with the upper 3 floors to be converted to a 9-bedroom house of multiple occupation.

The site is a pre-existing terraced building on the main high street, consisting of 4 floors with predominantly front facing facades towards the high street and some rear facades.

The key sources of noise impacting upon the site are road traffic noise from the high street, and other minor roads around the site.

This assessment has been undertaken with due regard to the supplied planning layout shown on Daccus' drawing (2-) AP004 (dated July 2024). The site layout is shown in Figure 2 of Appendix III.

1.2. Limitations

All limitations of this report are presented in Appendix I.

1.3. Confidentiality

Dice Environmental has prepared this report solely for the use of the Client and those parties with whom a warranty agreement has been executed, or with whom an assignment has been agreed. Should any third party wish to use or rely upon the contents of the report, written approval must be sought from Dice Environmental; a charge may be levied against such approval.

2. Assessment Methodology

2.1. National Planning Policy Framework

National Planning Policy Framework [1] states that noise needs to be considered when new developments may create additional noise and when new developments would be sensitive to the prevailing acoustic environment. When preparing local or neighbourhood plans, or taking decisions about new development, there may also be opportunities to consider improvements to the acoustic environment.

Local planning authorities' plan-making and decision-taking should take account of the acoustic environment and in doing so consider:

- Whether or not significant adverse effect is occurring or is likely to occur
- Whether or not adverse effect is occurring or is likely to occur; and
- Whether or not a good standard of amenity can be achieved.

In line with the Explanatory Note of the Noise Policy Statement for England [2], this would include identifying whether the overall effect of the noise exposure (including the impact during the construction phase wherever applicable) is, or would be, above or below the significant observed adverse effect level and the lowest observed adverse effect level for the given situation.

The Observed Effect Levels are as follows:

- Significant Observed Adverse Effect Level (SOAEL): This is the level of noise exposure above which significant adverse effects on health and quality of life occur;
- Lowest Observed Adverse Effect Level (LOAEL): This is the level of noise exposure above which adverse effects on health and quality of life can be detected;
- No Observed Adverse Effect Level (NOAEL): This is the level of noise exposure at which the noise is noticeable but has no effect at all on health or quality of life.
- No Observed Effect Level (NOEL): This is the level of noise exposure below which noise is not audible.

Table 1 summarises the noise exposure hierarchy, based on the likely average response.

Table 1: Noise exposure hierarchy

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

The subjective nature of noise means that there is not a simple relationship between noise levels and the impact on those affected. This will depend on how various factors combine in any particular situation.

These factors include:

- The source and absolute level of the noise together with the time of day it occurs. Some types and level of noise will cause a greater adverse effect at night than if they occurred during the day – this is because people tend to be more sensitive to noise at night as they

are trying to sleep. The adverse effect can also be greater simply because there is less background noise at night;

- For non-continuous sources of noise, the number of noise events, and the frequency and pattern of occurrence of the noise; and
- The spectral content and general character of the noise. The local topology and topography should also be taken into account along with the existing and, where appropriate, the planned character of the area.

More specific factors to consider when relevant:

- Where applicable, the cumulative impacts of more than one source should be taken into account, along with the extent to which the source of noise is intermittent and of limited duration.
- Consideration should also be given to whether adverse internal effects can be completely removed by closing windows and, in the case of new residential development, if the proposed mitigation relies on windows being kept closed most of the time. In both cases a suitable alternative means of ventilation is likely to be necessary. Further information on ventilation can be found in the Building Regulations.
- If external amenity spaces are an intrinsic part of the overall design, the acoustic environment of those spaces should be considered so that they can be enjoyed as intended.

2.2. British Standard 8233:2014 *Guidance on sound insulation and noise reduction for buildings*

2.2.1. Noise Criterion Limits

The scope of this standard [3] is the provision of recommendations for the control of noise in and around buildings. It suggests appropriate criteria and limits for different situations, which are primarily intended to guide the design of new buildings or refurbished buildings undergoing a change of use, rather than to assess the effect of changes in the external noise climate.

The standard suggests ambient noise levels in dwellings from external noise sources should not exceed the values given in Table 2.

Table 2: BS8223 Recommended indoor ambient noise level limits

Activity	Location	Limit $L_{Aeq,T}$ (dB)	
		Daytime (07:00-23:00)	Night-time (23:00-07:00)
Suitable resting/sleeping conditions	Living Room	35	-
	Bedroom	35	30
Dining	Dining room	40	-

BS8233 goes on to recommend noise levels for external amenity spaces (i.e., gardens, balconies etc.). According to BS8233;

> *It is desirable that the external noise level does not exceed 50 dB $L_{Aeq,T}$, with an upper guideline value of 55 dB $L_{Aeq,T}$ which would be acceptable in noisier environments. However, it is also recognised 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 might be warranted.*

BS8233 goes on to say:

> *In such a situation, development should be designed to achieve the lowest practicable levels in these external amenity spaces but should not be prohibited.*

2.2.2. Ventilation Requirements

Where a partially open window cannot be relied upon to provide an adequate level of facade sound insulation, it is necessary to consider alternative ventilation for habitable rooms. Section 8.4.5.4 of BS8233 states:

> *The Building Regulations' supporting documents on ventilation [4, 5, 6] recommend that habitable rooms in dwellings have background ventilation. Where openable windows cannot be relied upon for this ventilation, trickle ventilators can be used and sound attenuating types are available. However, windows may remain openable for rapid or purge ventilation, or at the occupant's choice.*
>
> *Alternatively, acoustic ventilation units (see 7.7.2) are available for insertion in external walls. These can provide sound reduction comparable with double glazed windows. However, ducted systems with intakes on the quiet side of the building might be required in very noisy situations, or where appearance rules out through-the-wall fans.*

Section 7.7.2 states:

> *NOTE 5: If relying on closed windows to meet the guide values, there needs to be an appropriate alternative ventilation that does not compromise the façade insulation or the resulting noise level.*

2.3. Building Regulations Approved Document O: *Overheating*

Approved Document O of the Building Regulations 2010 *Overheating* (ADO) [7] concerns ventilation and overheating requirements in dwellings. Requirement O1(2)(a) concerns the maximum acceptable noise levels in homes during overheating scenarios. These represent a 10 dB relaxation on the noise levels set out in BS8233 [3] and WHO Guidelines [8] that apply in non-overheating scenarios. Table 3 sets out these limits.

Table 3: Internal noise level limits in overheating scenarios

Location	Time	Noise limits in overheating conditions
Bedroom	Daytime (07:00-23:00)	$L_{Aeq,16h}$ 45 dB
	Night (23:00-07:00)	$L_{Aeq,8h}$ 40 dB L_{AFmax} 55 dB not exceeded more than 10 times per night

2.4. World Health Organisation's (WHO) *Guidelines for Community Noise*

The WHO *Guidelines for Community Noise* [8] offer advice with regard to setting noise criteria applicable to sleep disturbance. Section 4.2.3 specifies:

> *If the noise is not continuous, L_{Amax} or SEL are used to indicate the probability of noise-induced awakenings. Effects have been observed at individual L_{Amax} exposures of 45 dB or less. Consequently, it is important to limit the number of noise events with a L_{Amax} exceeding 45 dB.*

The guidelines go on to state:

> *At night, sound pressure levels at the outside façades of the living spaces should not exceed 45 dB L_{Aeq} and 60 dB L_{Amax}, so that people may sleep with bedroom windows open. These values have been obtained by assuming that the noise reduction from outside to inside with the window partly open is 15 dB.*

The sound insulation performance value of 15 dB for a façade containing a partially open window accords with the guidance offered in BS8233 [3]. The guidelines reference a study by Vallet & Vernet [9], which concluded that:

> *For a good sleep, it is believed than indoor sound pressure levels should not exceed approximately 45 dB L_{AFmax} more than 10-15 times per night.*

Accordingly, this assessment has utilised the 10th highest measured maximum noise level from the night-time period and allows for an assessment of a typical maximum noise level in determining façade sound insulation performance.

2.5. British Standard 4142:2014+A1:2019 *Methods for rating and assessing industrial and commercial sound*

BS4142 [10] describes methods for rating and assessing sound of an industrial or commercial nature which includes:

- Sound from industrial and manufacturing processes
- Sound from fixed installations which comprise mechanical and electrical plant and equipment
- Sound from the loading and unloading of goods and materials at industrial and/or commercial premises
- Sound from mobile plant and vehicles that is an intrinsic part of the overall sound emanating from processes or premises, such as that from forklift trucks, or that from train or ship movements on or around an industrial or commercial site.

The procedure detailed in the standard compares the measured or predicted noise level, 'the specific noise level', from any of the above detailed noise sources with the background sound level at a residential dwelling. The measured background sound level at a receptor should be reliable and should not necessarily ascertain a lowest measured background sound level, but rather to quantify what is typical.

The specific noise level also acknowledges the following reference time intervals depending upon whether the noise source operates during daytime or night-time periods:

- Daytime (07:00-23:00): 1 hr; and,
- Night-time (23:00-07:00): 15 minutes.

There are a number of 'penalties' which can be attributed to the specific sound level depending upon the 'acoustic features' of the sound under investigation as follows. These penalties vary in their weighting depending upon the severity of the acoustic feature, as follows:

Tonality

- +2 dB: where the tonality is just perceptible
- +4 dB: where the tonality is clearly perceptible
- +6 dB: where the tonality is highly perceptible

Impulsivity

- +3 dB: where the impulsivity is just perceptible
- +6 dB: where the impulsivity is clearly perceptible
- +9 dB: where the impulsivity is highly perceptible

Intermittency

- +3 dB: where the intermittency is readily distinctive against the acoustic environment

In addition to the above acoustic features, there is a penalty for 'other sound characteristics' of +3 dB where a sound exhibits characteristics that are neither tonal nor impulsive, though are readily distinctive against the acoustic environment.

BS4142 goes on to state that the rating level is equal to the specific sound level if there are no such features present or expected to be present.

Assessment of the rating level relative to the background noise level can yield the following commentary:

- Typically, the higher the rating level is above the background sound level, the greater the magnitude of 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.
- Where the rating level does not exceed the background sound level, this is an indication of the specific sound source having a low impact.

With the above in mind, it is common that a Local Planning Authority will specify their own criteria (Section **Error! Reference source not found.**) for the rating level relative to the background sound level and, where this is the case, this criterion usually takes precedence over a simple comparison of the rating level against the background sound level.

BS4142 includes the following text in relation to areas with low and very low noise levels:

> *Where background sound levels and rating levels are low, absolute levels might be as, or more, relevant than the margin by which the rating level exceeds the background. This is especially true at night.*

3. SURVEYS

3.1. Measurement Locations

Dice Environmental has conducted a background and ambient noise survey over an entire weekend and weekday period. The dominant noise source at the site is road traffic noise, primarily from the High Street.

Position L1 is shown in Figure 1 in blue. This position was chosen to be representative of the noise levels at the facade of the proposed buildings. This position is also situated withtin 10m of the roadside, allowing noise levels to be calculated from both the rooad and the general background levels.

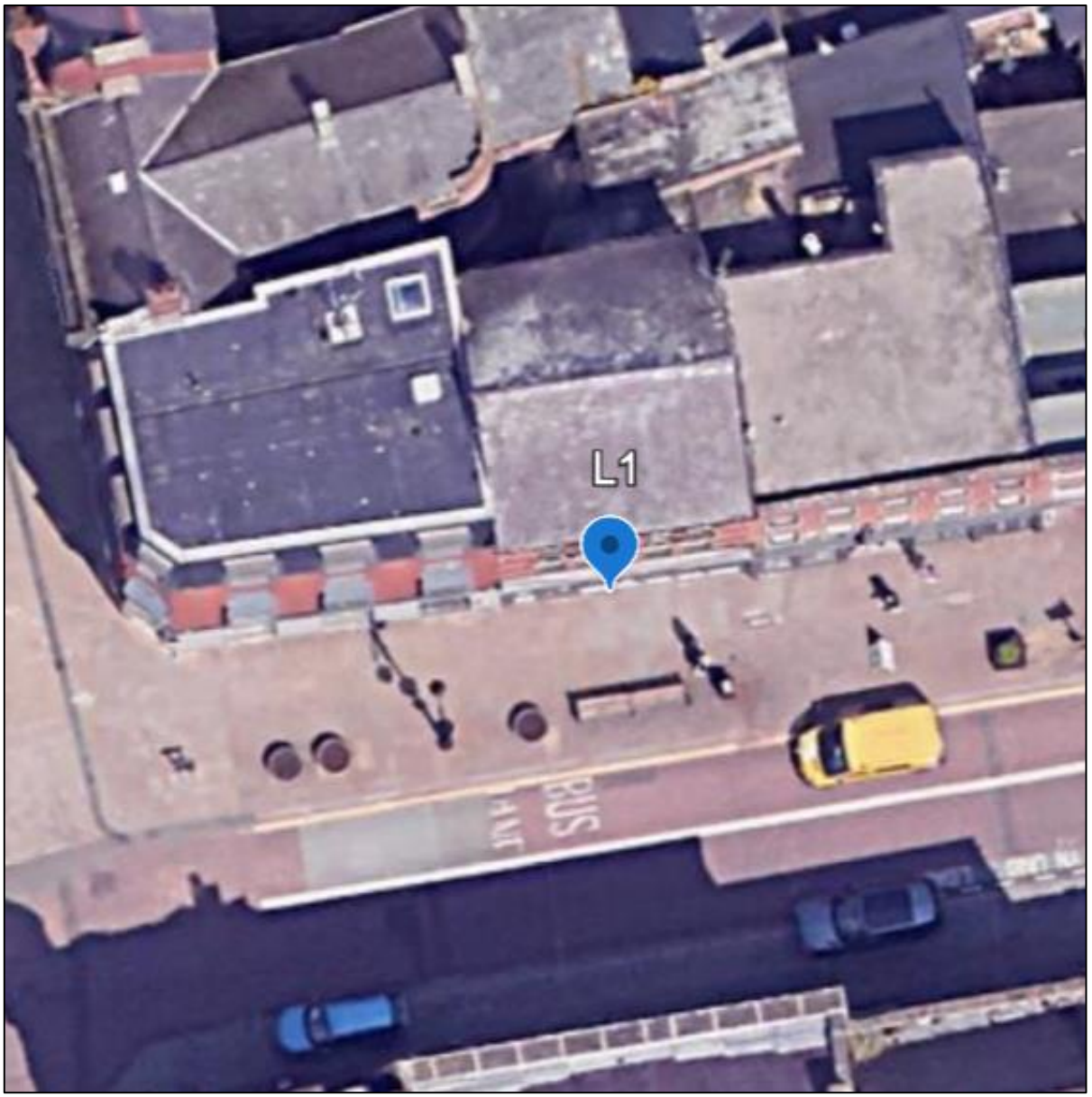


Figure 1: Measurement position

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3.2. Background and Ambient Noise Survey

The noise survey took place over the following period:

- 14:40 Friday 25th October 2024 – 14:25 Monday 28th October 2024

A full time history of the measured noise data is given in Appendix V. A summary of the measured sound pressure levels is presented in Table 4.

Table 4: Summary of measured noise levels

Date range	Period	Ambient sound level, $L_{Aeq,T}$, dB	Background sound level, $L_{A90,T}$, dB		10th highest Max level, $L_{AFmax,1min}$ (dB)
			Range	Typical*	
Friday 25th October 2024 – Monday 28th October 2024	Day (07:00-23:00)	61	38-66	49	-
	Night (23:00-07:00)	62	33-65	48	80

* Based on the median measured value during the measurement period

3.3. Road Traffic Noise Survey – High Street

Dice Environmental has conducted a road traffic noise survey to measure the level of noise generated by vehicles using High Street. The noise survey took place over the following period:

- 10:10 to 13:10 Monday 28th October 2024.

The following location was chosen for the survey:

- Noise Measurement Position 1 (NMP1): Dice undertook a road traffic measurement of High Street in a position considered representative of the noise associate with traffic movements on the street. The microphone was installed at an approximate height of 5m and 10m from the nearest kerbside. Noise at this location was dominated by traffic associated with High Street.

A summary of the measured sound pressure levels is presented in Table 5.

Table 5: Summary of Measured Road Traffic Noise Levels

Period Start Time	Average Measured Sound Pressure Levels, Free-Field (dB)		Representative $L_{Amax,f}$
	$L_{Aeq,T}$	$L_{A10,T}$	
28/10/2024 - 10:10	62.2	62.7	79.3
28/10/2024 - 11:10	64.8	67.9	
28/10/2024 - 12:10	66.8	71.5	
$L_{Aeq,16hr}$ as calculated from CRTN [11]	64.4		
$L_{Aeq,8hr}$ as calculated from CRTN and TRL [12]	56		

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3.4. Noise Survey Conditions

The weather conditions during the noise surveys were conducive towards the measurement of environmental noise being fine and dry with wind speeds below 5 m/s.

The noise survey was completed using the following noise measurement equipment.

Table 6: Noise Measurement Equipment

Position	Description	Manufacturer & Type	Serial No.	Calibration Expiry
N1	Sound Level Meter	Rion NL-53	00330162	29th April 2025
	Pre-amplifier	Rion NH-25	32836	
	Microphone	Rion UC-59	23171	
	Calibrator	01dB Cal21	34975432(2017)	30th May 2025

The sound level meter was field-calibrated on site prior to and after the measurements were taken. No significant drift was witnessed.

4. Residential Planning – Noise Impact Assessment

In order to accurately assess noise propagation across the site, a 3D noise model has been constructed using the modelling software CadnaA. The following assumptions, inputs and considerations have been included in the model:

- Planning layout drawing as described in Section 1
- Existing buildings that provide shielding from any of the noise sources
- L1 has been successfully used to calibrate the model
- A reflection order of 2 has been used in all calculations
- Building heights are as supplied by the client
- Noise levels generated using ISO 9613-1 [13] and ISO 9613-2 [14] as incorporated into CadnaA software.

4.1. Internal Noise Impact for Proposed Dwellings (Non-overheating scenarios)

In order to accurately determine the noise level within habitable rooms, noise levels at 1 m outside the façades have been calculated in the noise model for the proposed layout.

Table 13 of BS6262-2 [15] suggests that a standard double-glazing unit with configuration 4mm glass/12mm cavity/4mm glass affords a sound insulation performance in the order of R_w 29 dB; however, this is for a pink noise spectrum. The same unit, weighted for road traffic noise using the '+ C_{tr}' correction, has a sound insulation performance of approximately $R_w + C_{tr}$ 25 dB and so this value, along with the attenuation values for further glazing configurations, has been used to determine internal noise levels.

The Acoustics Ventilation and Overheating: Residential Design Guide [16] also recommends that a partially open window provides approximately 13 dB attenuation, and this value is also used in the following assessment.

In order to achieve the noise criteria stated within the BS8233 and WHO Guidelines [8] for bedrooms and living areas, a range of glazing specifications are required. Figures 3 to 6 of Appendix III presents the minimum glazing sound insulation performance required to achieve the WHO's noise criteria across each façade. **Error! Reference source not found.** relates this to a typical glazing configuration and ventilation strategy for achieve this.

Table 7: Typical glazing configuration and sound insulation requirements

Sound insulation performance, $R_w + C_{tr}$ (dB)	Typical glazing configuration (mm)	Ventilation strategy*
13	4/12/4	Open windows
15		$D_{n,e,w} + C_{tr}$ ≥15 dB trickle vent
16		$D_{n,e,w} + C_{tr}$ ≥16 dB trickle vent
18		$D_{n,e,w} + C_{tr}$ ≥18 dB trickle vent
20		$D_{n,e,w} + C_{tr}$ ≥20 dB trickle vent
22		$D_{n,e,w} + C_{tr}$ ≥22 dB trickle vent
25		$D_{n,e,w} + C_{tr}$ ≥25 dB trickle vent
30	6/12/6	$D_{n,e,w} + C_{tr}$ ≥30 dB trickle vent
33	6.4/12/6	$D_{n,e,w} + C_{tr}$ ≥33 dB trickle vent
36	6.4/12/10	$D_{n,e,w} + C_{tr}$ ≥36 dB trickle vent

* Based on a single trickle vent per window. If more than one vent is to be used, the performance should increase by 3dB with every doubling of the number of vents, i.e., +3dB for 2 vents, +6dB for 4 vents, etc.

4.2. Overheating noise assessment

Analysis of the noise model indicates that there are some locations where open windows cannot be relied upon to provide cooling in overheating scenarios, as the noise limits of ADO [7] will be exceeded. These are indicated in Figures 7 and 8 in Appendix III.

In these locations, an alternative form of cooling will be required in overheating scenarios. Where this will be a mechanical system, the noise generated by the system must also be assessed.

4.3. Proposed Plant

Consideration should be given to potential noise arising from the proposed plant associated with the development, such as kitchen and bathroom extraction fans, upon the existing noise sensitive dwellings. Table 8 illustrates the calculation of plant rating level limits for the daytime and night-time periods based on BS4142 [10]. These limits apply to all plant units operating simultaneously.

Table 8: Plant noise limits

Period	Representative background level $L_{A90,T}$ (dB)	Plant rating level $L_{Ar,Tr}$ (dB)
Day (07:00-23:00)	49	49
Night (23:00-07:00)	48	48

It should be noted that the emission limit is a rating level which can include for a range of penalties or 'acoustic feature corrections' as detailed in BS4142 and as such the actual measured or calculated sound pressure level outside the closest habitable window could be up to 18dB lower than the rating level values presented here.

At this stage in the design there is no information available regarding the proposed plant units to be installed at the site, so it has not been possible to carry out a full plant noise assessment. Once selections have been made, an assessment should be carried out to ensure that the limits can be met.

Once this is done, it is considered that the likelihood of adverse comment arising as a result of noise from the plant will be low and that the NOAEL will be achieved, which would be barely noticeable and not intrusive, resulting in the following:

> *Noise can be heard but does not cause any change in behaviour or attitude. Can slightly affect the acoustic character of the area but not such that there is a perceived change in the quality of life.*

5. CONCLUSION

Dice Environmental has been commissioned by JRML Property Holdings Ltd to provide a Noise Impact Assessment to support a planning application for a residential development at 3 High St, Wrexham .

Environmental noise surveys have been completed to quantify the prevailing noise environment, dominated by road traffic noise from the High Street.

This noise survey has been used to develop a 3D computer model of noise propagation across the site including all significant noise sources and with full topography, and to inform a scheme of mitigation measures required to ensure a commensurate level of protection against noise for future occupants.

Accordingly, appropriate consideration has been given towards the mitigation measures required to ensure that the internal ambient noise level requirements set out in BS8233 [3] can be met for the development. A range of double-glazing configurations from $R_w + C_{tr}$ 25 dB to $R_w + C_{tr}$ 33 dB would be required to control noise break-in from external sources and achieve the requirements of BS8233 and ADO.

Noise limits have been set to apply to all externally located plant units proposed for the site including, but not limited to, kitchen and bathroom extraction units. These are determined in accordance with BS4142.

A number of plots are predicted to exceed the noise levels set out in Approved Document O *Overheating* for bedrooms at night with windows open. Open windows should not be relied upon as the standard means of cooling for overheating scenarios in these locations.

The assessment is based upon robust and worst-case assumptions and demonstrates that, in principle and subject to the incorporation of the identified mitigation measures, there should be no adverse impact at the proposed dwellings as a result of existing noise. The site is suitable for the promotion of residential development.

Appendix I – Limitations

1. This report and its findings should be considered in relation to the terms of reference and objectives agreed between Dice Environmental and the Client as indicated in Section 1.2.
2. The executive summary, conclusions and recommendations sections of the report provide an overview and guidance only and should not be specifically relied upon without considering the context of the report in full.
3. Dice Environmental cannot be held responsible for any use of the report or its contents for any purpose other than that for which it was prepared. The copyright in this report and other plans and documents prepared by Dice Environmental is owned by them and no such plans or documents may be reproduced, published or adapted without written consent. Complete copies of this may, however, be made and distributed by the client as is expected in dealing with matters related to its commission. Should the client pass copies of the report to other parties for information, the whole report should be copied, but no professional liability or warranties shall be extended to other parties by Dice Environmental in this connection without their explicit written agreement there to by Dice Environmental.
4. Where a noise survey is required to inform the assessment, Dice Environmental will endeavour to ensure that all noise measurements taken are robust, representative and reliable in order to inform an accurate noise impact assessment. Where limitations or constraints exist which prevent a suitable noise survey being completed, Dice Environmental will take all reasonable steps to make the client fully aware of any such limitations or constraints with a view to achieving the best possible outcome for the client. Where additional sound surveys are required, over and above those specified in our scope of works, then Dice Environmental reserves the right to charge additional fees.
5. Where mitigation measures are specified in our report, it should be noted that these measures are relative to a specific sound source, both in terms of the measured sound pressure level and the character of the source. Where either the sound pressure level or the character of the sound varies following completion of the sound survey, Dice Environmental cannot be held responsible for any subsequent variations in the proposed mitigation performance.

Appendix II – Glossary of Acoustic Terminology

Noise is defined as unwanted sound. Human ears are able to respond to sound in the frequency range 20 Hz (deep bass) to 20,000 Hz (high treble) and over the audible range of 0 dB (the threshold of perception) to 140 dB (the threshold of pain). The ear does not respond equally to different frequencies of the same magnitude but is more responsive to mid-frequencies than to lower or higher frequencies. To quantify noise in a manner that approximates the response of the human ear, a weighting mechanism is used. This reduces the importance of lower and higher frequencies, in a similar manner to the human ear.

Furthermore, the perception of noise may be determined by a number of other factors, which may not necessarily be acoustic. In general, the impact of noise depends upon its level, the margin by which it exceeds the background level, its character, and its variation over a given period of time. In some cases, the time of day and other acoustic features such as tonality or impulsivity may be important, as may the disposition of the affected individual. Any assessment of noise should give due consideration to all of these factors when assessing the significance of a noise source.

The most widely used weighting mechanism that best corresponds to the response of the human ear is the 'A'-weighting scale. This is widely used for environmental noise measurement, and the levels are denoted as dB(A) or L_{Aeq}, L_{A90} etc., according to the parameter being measured.

The decibel scale is logarithmic rather than linear, and hence a 3 dB increase in sound level represents a doubling of the sound energy present. Judgement of sound is subjective, but as a general guide a 10 dB(A) increase can be taken to represent a doubling of loudness, whilst an increase in the order of 3 dB(A) is generally regarded as the minimum difference needed to perceive a change under normal listening conditions.

An indication of the range of sound levels commonly found in the environment is given in the Table A1.

Table A1: Typical Sound Pressure Levels

Sound Pressure Level dB(A)	Location/Example
0	Threshold of hearing
20-30	Quiet bedroom at night
30-40	Living room during the day
40-50	Typical office
50-60	Inside a car
60-70	Typical high street
70-90	Inside factory
100-110	Burglar alarm at 1m away
110-130	Jet aircraft on take off
140	Threshold of pain

Table A2: Terminology

Descriptor	Explanation
Ambient Noise	Encompassing sound, at a given place, being usually a composite of sounds from many sources near and far.
C_{tr}	Sound insulation performance spectrum adaptation term that accounts for the A-weighted urban traffic noise spectrum.
dB (decibel)	The scale on which sound pressure level is expressed. It is defined as 20 times the logarithm of the ratio between the root-mean-square pressure of the sound field and a reference pressure (20 µPa).
dB(A)	A-weighted decibel. This is a measure of the overall level of sound across the audible spectrum with the 'A' frequency weighting to compensate for the varying sensitivity of the human ear to sound at different frequencies.
$D_{n,e,w}$	Weighted element normalized level difference. A single-number quantity that describes the sound insulation of ventilators.
$L_{Aeq,\ T}$	A-weighted, equivalent continuous sound pressure level. L_{Aeq} is defined as the notional steady sound level which, over a stated period of time (T), would contain the same amount of acoustical energy as the A-weighted fluctuating sound measured over that period.
L_{Amax}	L_{Amax} is the maximum A-weighted sound pressure level recorded over the period stated. L_{Amax} is sometimes used in assessing environmental noise where occasional loud noises occur, which may have little effect on the overall L_{eq} noise level but will still affect the noise environment. Unless described otherwise, it is measured using the 'fast' time-weighting response.
$L_{Ar,Tr}$	Sound rating level. The A-weighted L_{eq} sound level of an industrial noise during a specified time period, adjusted for tonal character and impulsivity.
L_{10} & L_{90}	If a non-steady noise is to be described, it is necessary to know both its level and the degree of fluctuation. The L_n indices are used for this purpose, and the term refers to the level exceeded for n% of the time. Hence L_{10} is the level exceeded for 10% of the time and as such can be regarded as the 'average maximum level'. Similarly, L_{90} is the 'average minimum level' and is often used to describe the background noise. It is common practice to use the L_{10} index to describe traffic noise.
Free-Field Level	A sound field determined at a point away from reflective surfaces other than the ground with no significant contributions due to sound from other reflective surfaces. Generally, this is measured outside and away from buildings.
Fast	A time-weighting used in the root mean square section of a sound level meter with a 125-millisecond time constant.
Pink Noise Spectrum	Noise whose power spectral density is inversely proportional to frequency.
Residual Noise	The ambient sound remaining when the specific sound is suppressed.
R_w	Weighted Sound Reduction Index. A single number quantity which characterises the airborne sound insulation of a material or building element over a range of frequencies, based on laboratory measurements.
Slow	A time-weighting used in the root mean square section of a sound level meter with a 1000-millisecond time constant.
Specific Noise	Noise from the sound source under investigation as defined in BS4142, method for rating industrial noise affecting mixed residential and industrial areas.

Appendix III – Figures

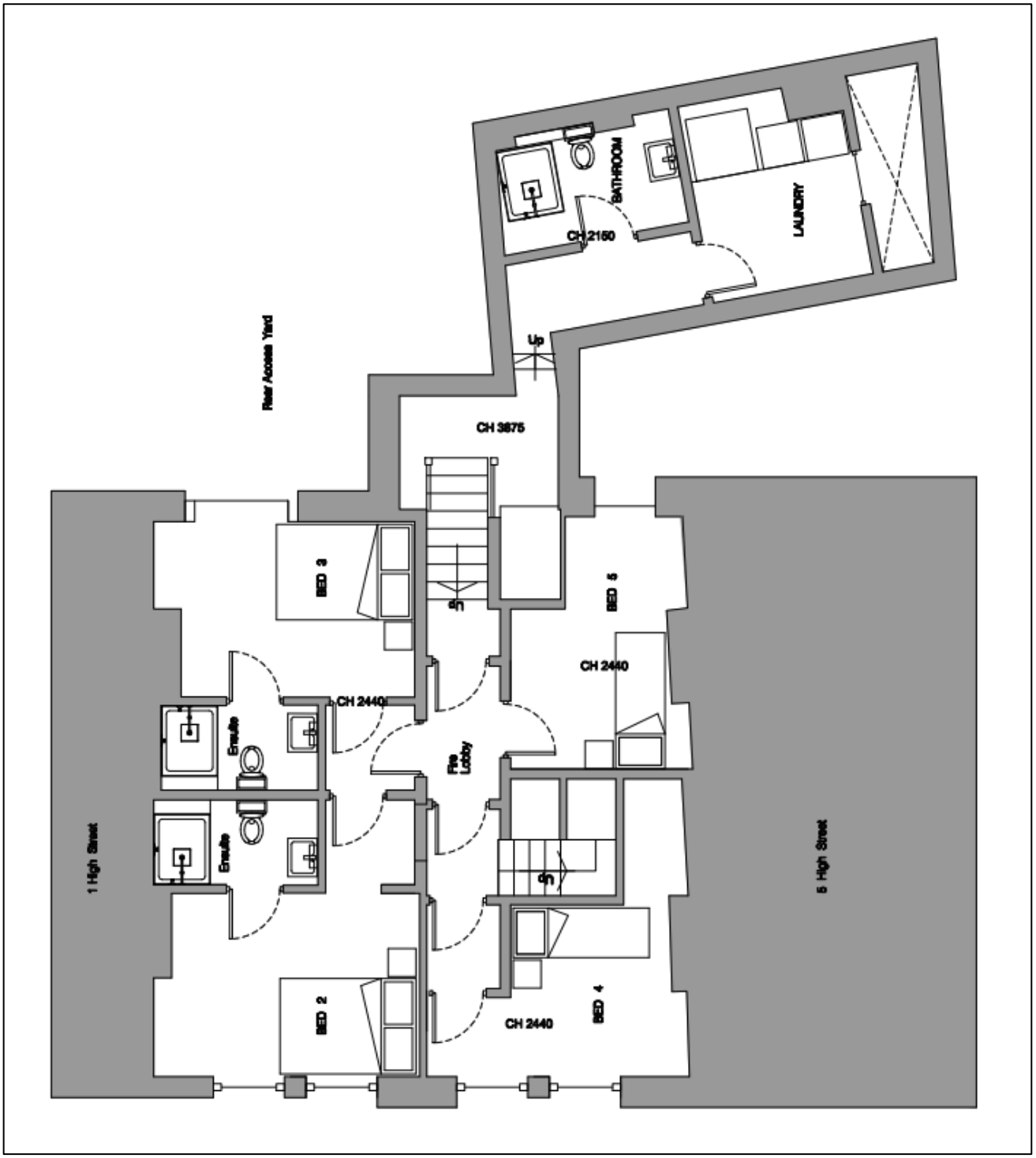


Figure 2: Site Layout (ground floor)

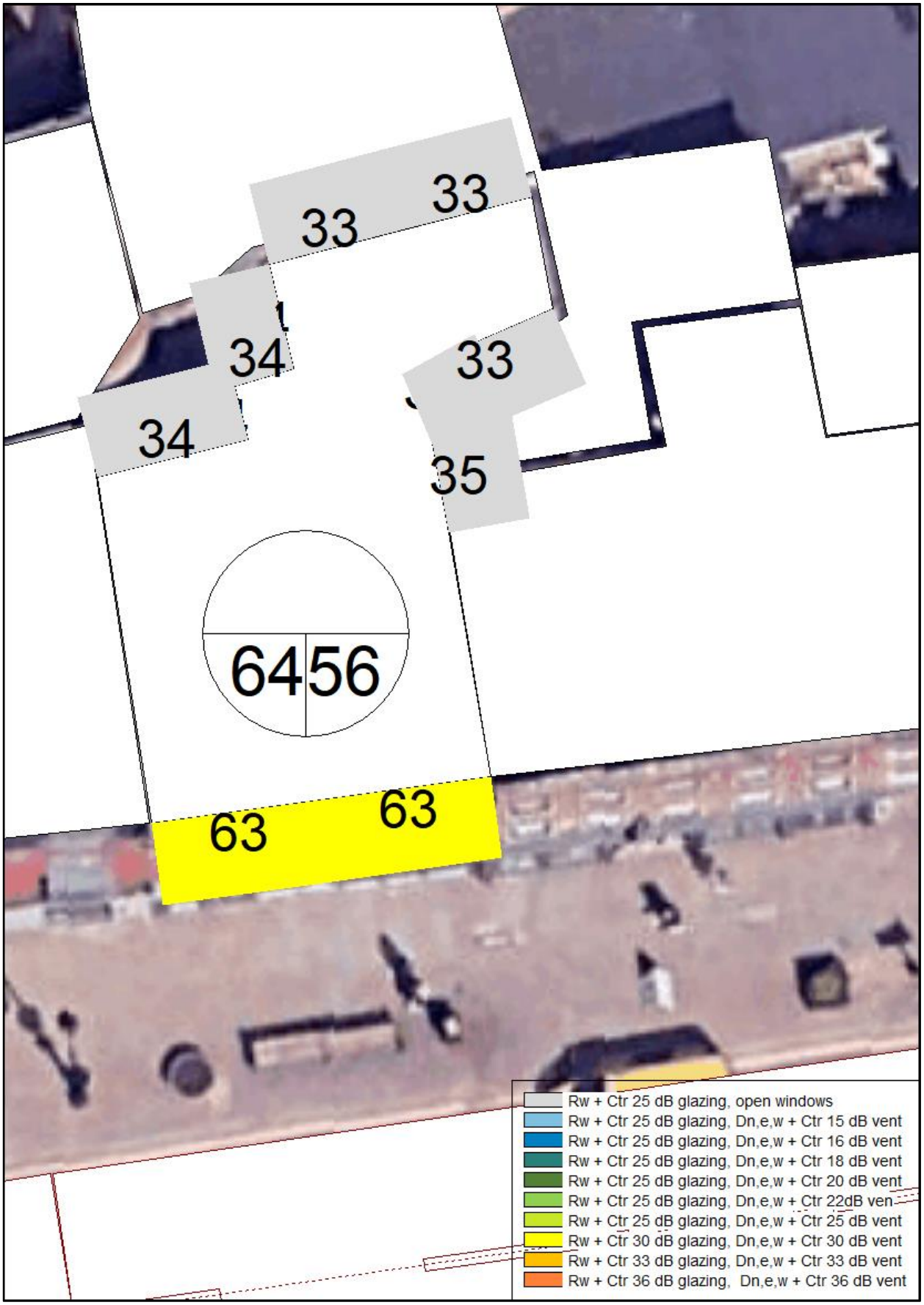


Figure 3: Glazing and Ventilation Strategy – 1st and 2nd floor (living areas)

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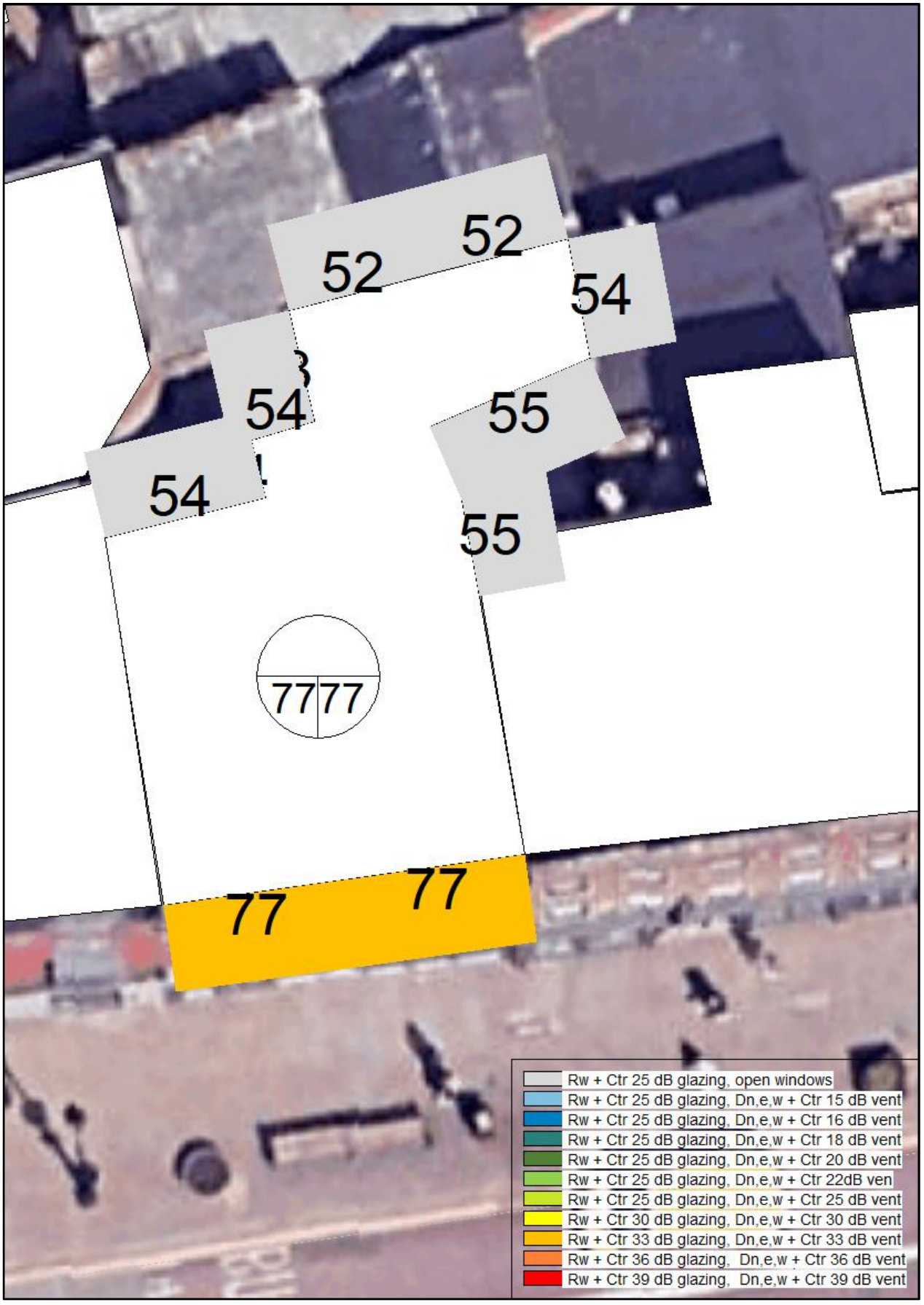


Figure 4: Glazing and Ventilation Strategy – 1st floor (bedrooms)

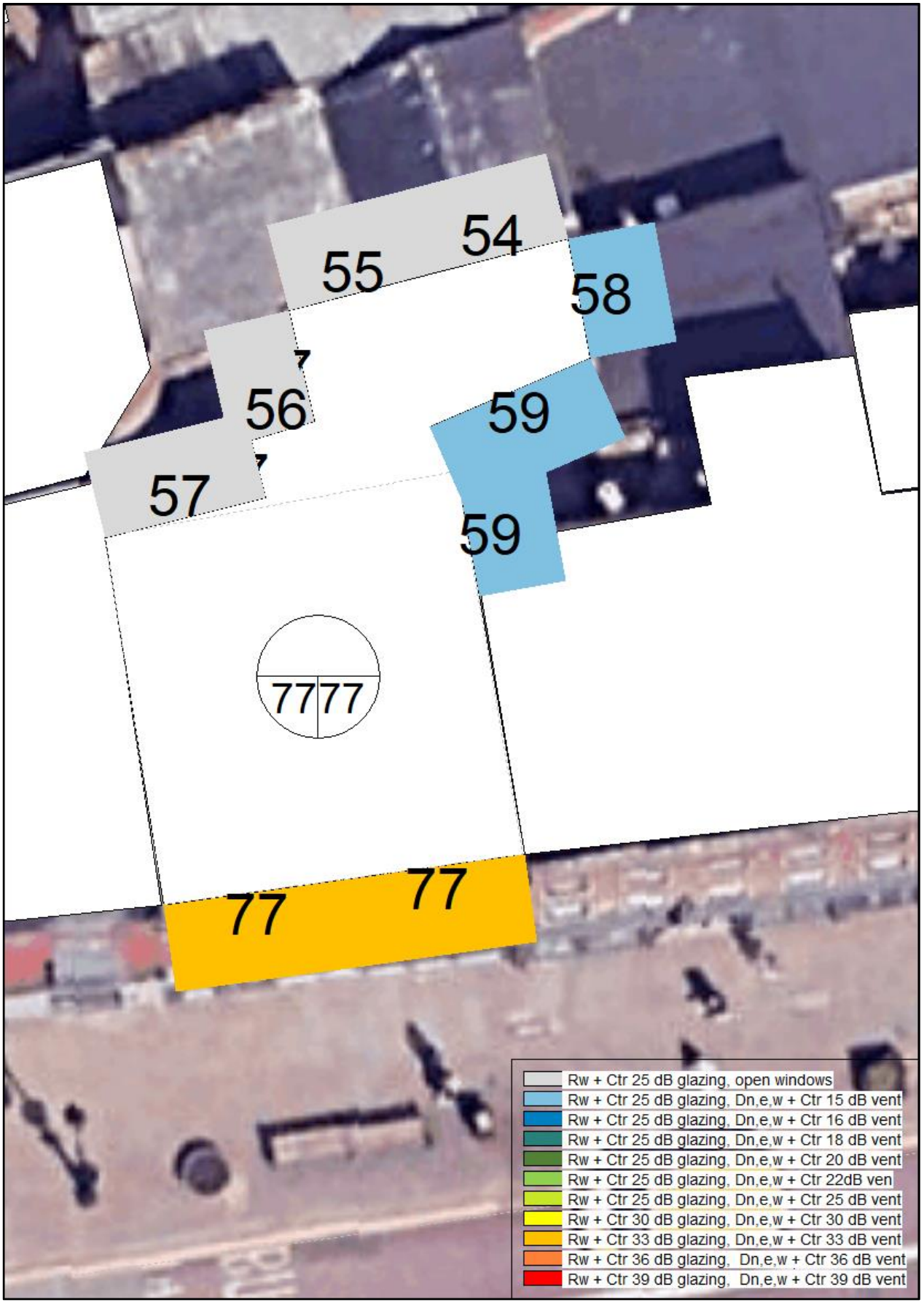


Figure 5: Glazing and Ventilation Strategy – 2nd floor (bedrooms)

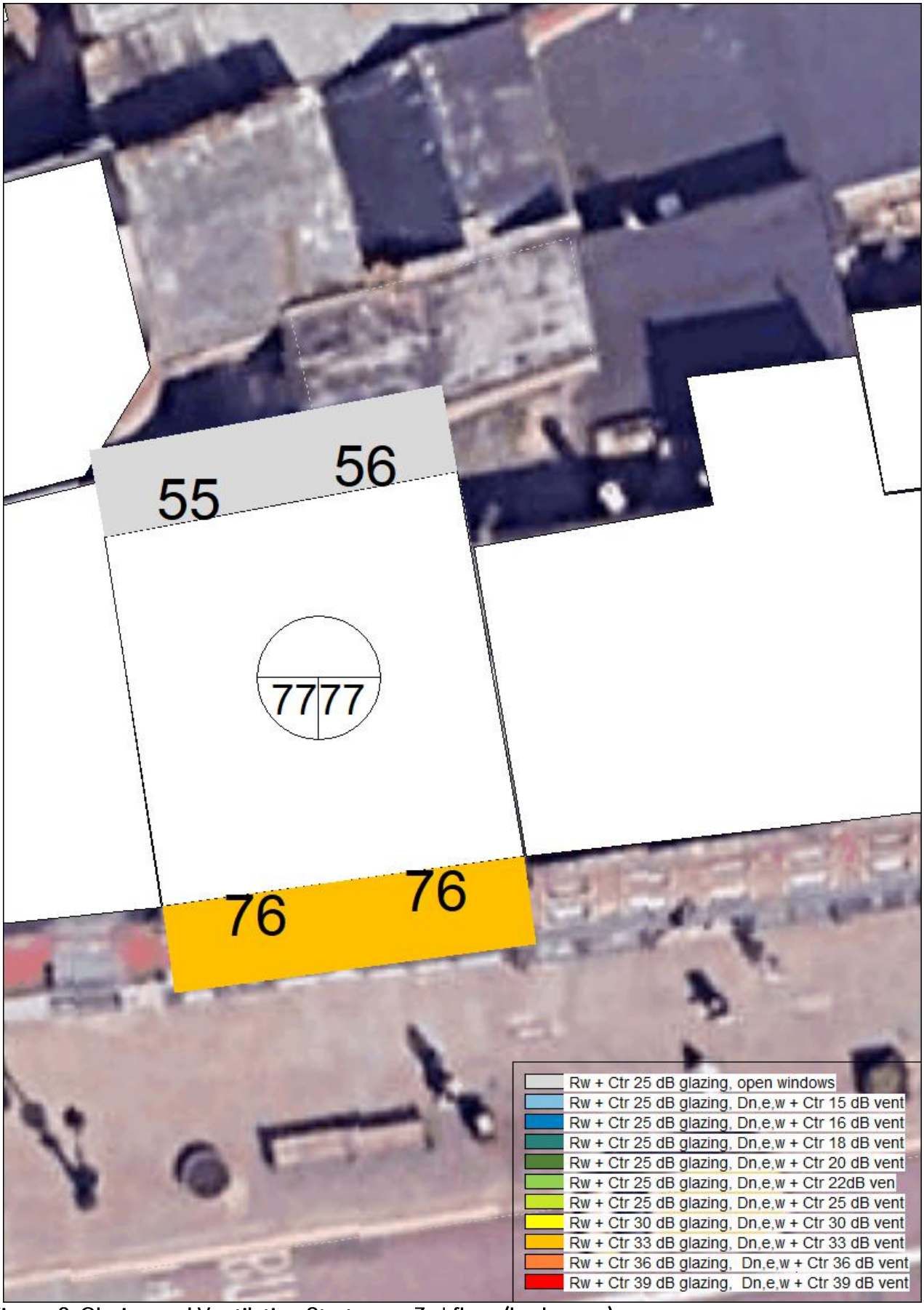


Figure 6: Glazing and Ventilation Strategy – 3rd floor (bedrooms)

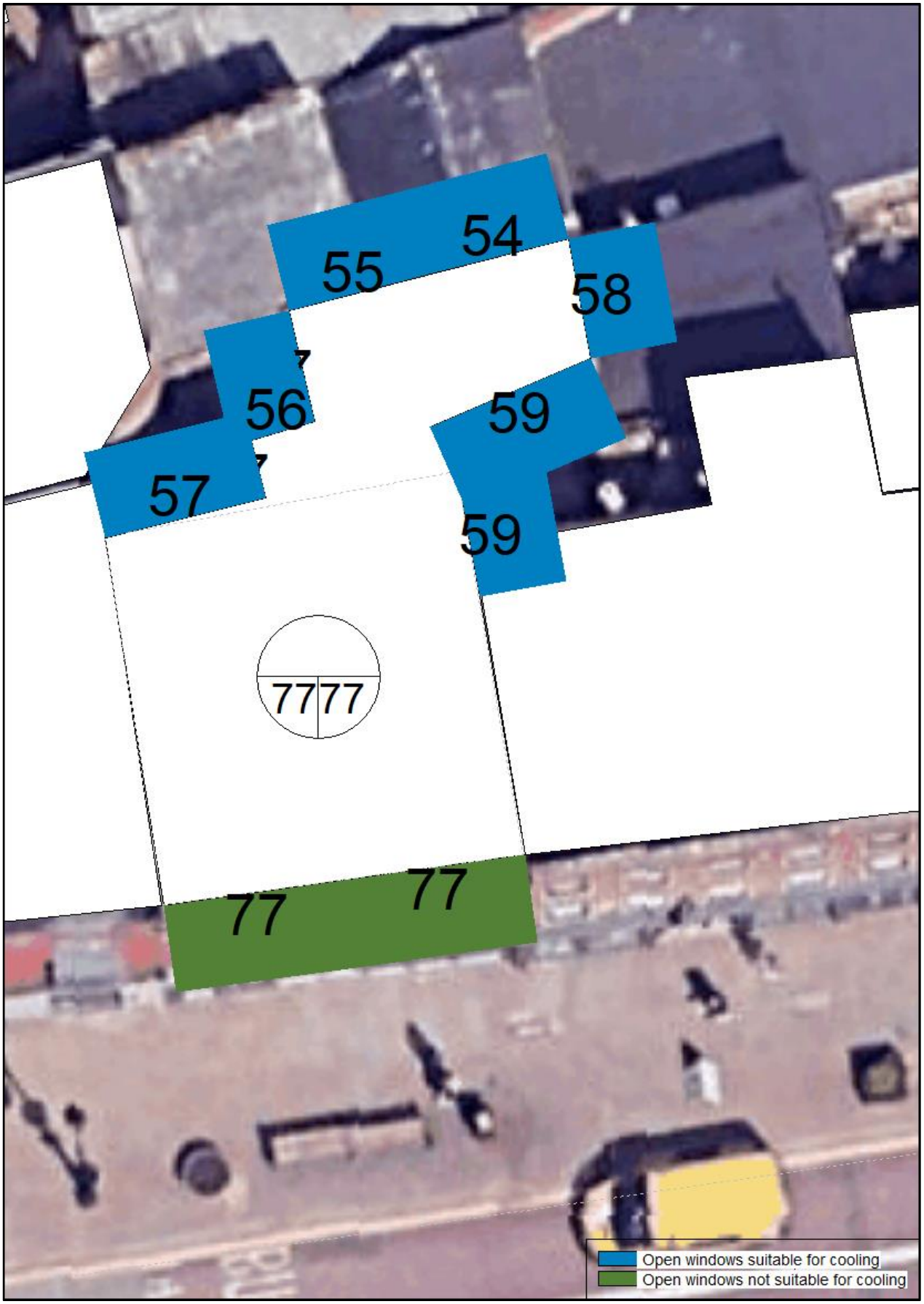


Figure 7: Cooling strategy 1st and 2nd floors

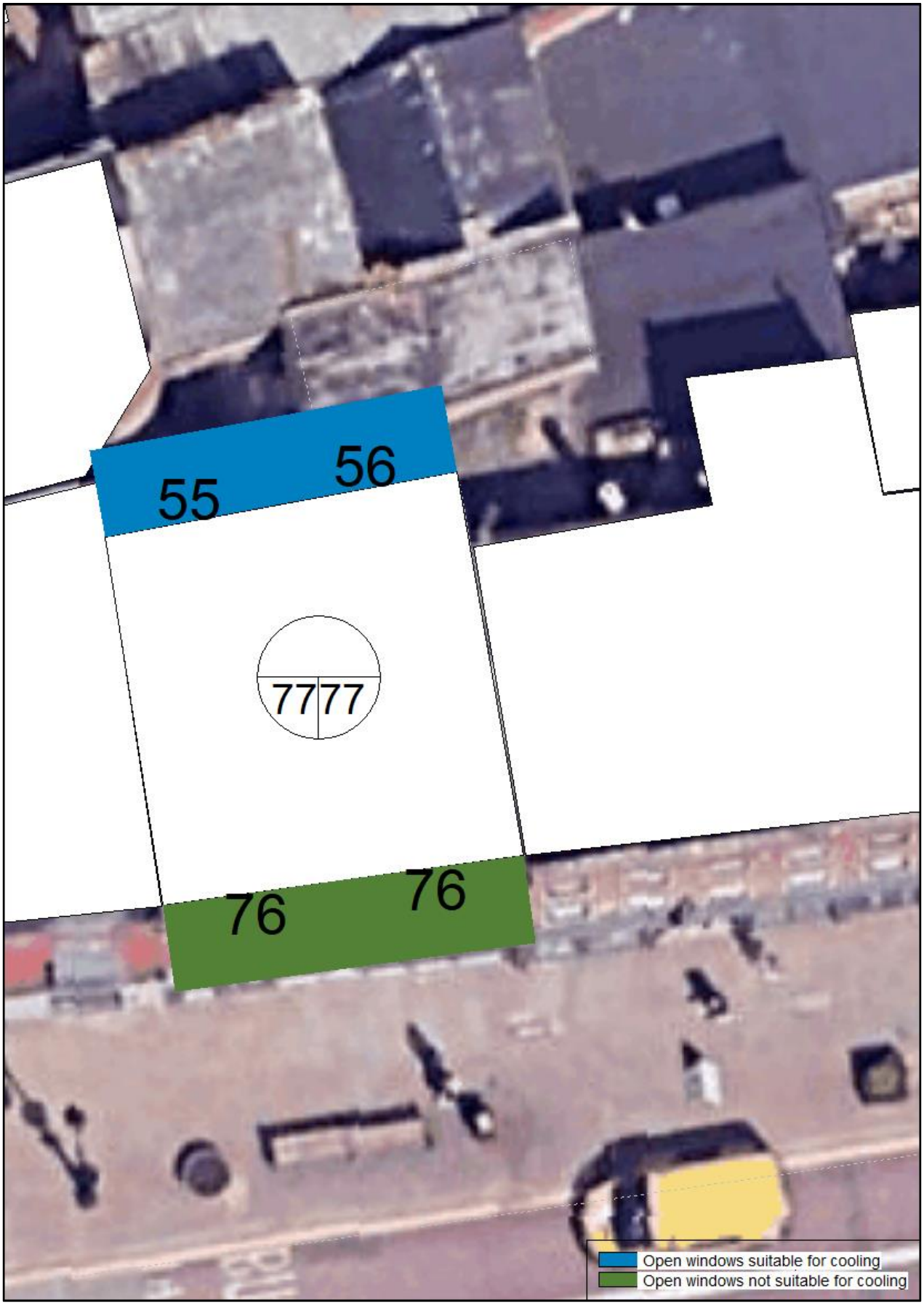


Figure 8: Cooling strategy 3rd floor

Appendix IV – Bibliography

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Appendix V – Noise survey results

