

REPORT REF: 20868R01CPmdw

NOISE ASSESSMENT.

PROPOSED RESIDENTIAL DEVELOPMENT AND M.U.G.A., WREXHAM ROAD, HOLT, WREXHAM LL13 9TS.



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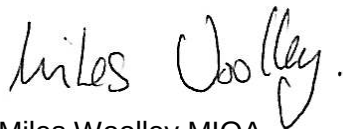
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Executive Summary

Environoise Consulting Limited has been commissioned by William Homes (Bala) Limited to prepare a noise assessment to inform a planning application for a proposed residential development and Multi-Use Games Area (MUGA) at Wrexham Road, Holt, Wrexham LL13 9TS.

A partially attended noise survey was carried out on the proposal site between 12.30hrs, Friday 2nd June and 12.30hrs, Monday 5th June 2017 to establish the existing noise levels due to sources in the surrounding area.

Recommendations for glazing and ventilation strategies have been made for proposed facades to habitable rooms. By following the recommendations internal average noise levels would be within recommended target values. The following strategies have been recommended to satisfy internal noise criteria:

Façades to North-Western Boundary of Site

- For proposed living areas, 32dB R_w (28dB $R_w + C_{tr}$) double glazed window units and in-wall acoustic ventilator units (39dB $D_{n,e,w}$) are required.
- For proposed bedrooms, 35dB R_w (32dB $R_w + C_{tr}$) double glazed window units and in-wall acoustic ventilator units (42dB $D_{n,e,w}$) are required.

Façades to South-Eastern Boundary of Site

- For proposed living areas, 29dB R_w (25dB $R_w + C_{tr}$) double glazed window units and acoustic in-frame slot ventilator units (31dB $D_{n,e,w}$) are required.
- For proposed bedrooms, 29dB R_w (25dB $R_w + C_{tr}$) double glazed window units and in-wall acoustic ventilator units (39dB $D_{n,e,w}$) are required.

Noise levels for outdoor amenity areas should be within recommended target values for proposed dwellings if gardens are enclosed with acoustic barriers (e.g. close boarded timber fence) of ≥ 1.8 m high.

It has been established that the noise impact from the proposed MUGA would not be significant in accordance with IEMA Guidelines for Environmental Noise Impact Assessment.

1 Introduction

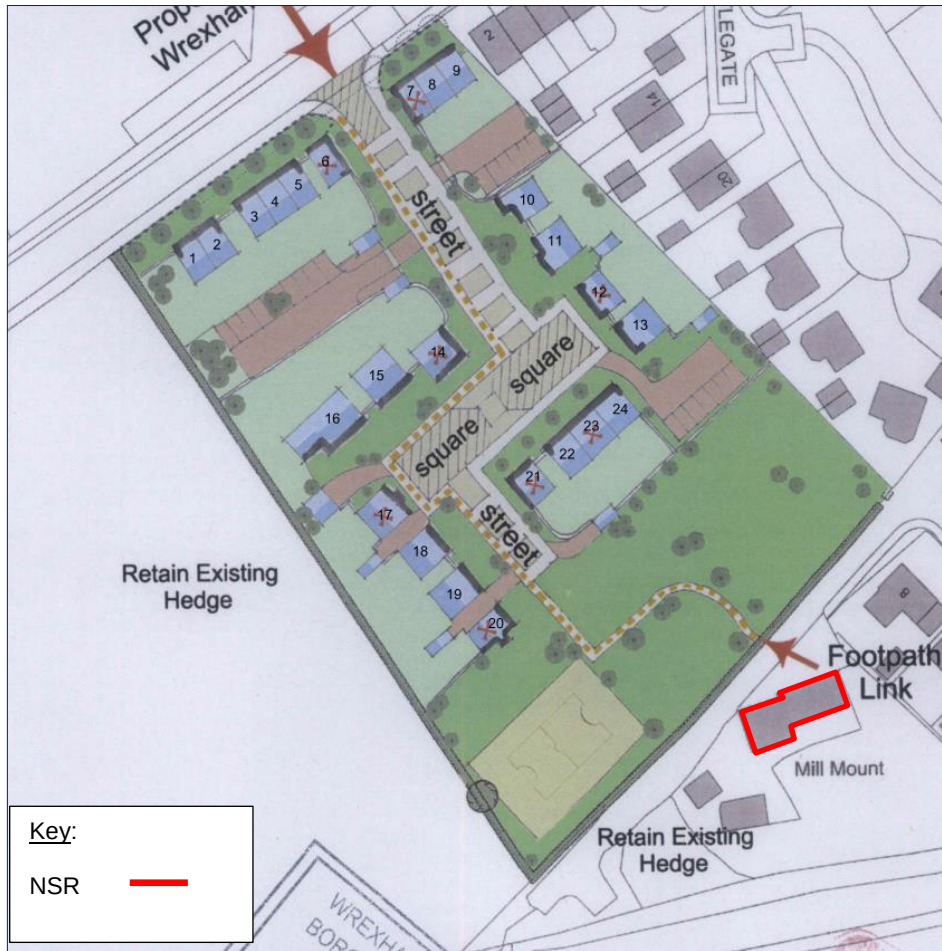
- 1.1.1 Environoise Consulting Limited has been commissioned by Williams Homes (Bala) Limited to prepare a noise assessment for a proposed residential development and Multi-Use Games Area (MUGA) for the scheme located to the south off Wrexham Road, Holt.
- 1.1.2 The proposed development consists of 24 dwellings with gardens in a parcel of land sandwiched between Wrexham Road (B5102) to the north and Francis Lane to the south. Slightly further to the south is the A534. The application also includes a Multi-Use Games Area (MUGA).
- 1.1.3 The purpose of the noise assessment is to address noise related planning conditions for an approved planning application (ref: HOL P /2013/0823) and determine the levels of noise currently affecting the site and provide, if required, recommendations for mitigation measures to achieve Local Authority internal noise criteria within proposed dwellings and in outdoor garden areas.
- 1.1.4 The site is bounded to the north-west by the B5102 (Wrexham Road), a 30mph single carriageway linking Holt to the A534. To the north-east are residential dwellings on Castlegate; to the south east are residential properties on Francis Lane and to the south-west is agricultural land.
- 1.1.5 The site location is shown in Figure 1.1.

Figure 1.1: Site location



- 1.1.6 The proposed site layout plan is shown in Figure 1.2. Also shown is the nearest noise sensitive receptor (NSR) to the MUGA - 'Mill Mount', a residential unit on Francis Lane to the east of the proposed MUGA; other buildings located closer to the proposed MUGA are domestic garages

Figure 1.2: Site layout plan and NSR



2 Noise Criteria

2.1 Local Authority Requirements

2.1.1 Wrexham County Borough Council have imposed two conditions¹ pertinent to acoustics summarised below.

2.1.2 Condition 9 states that:

'No part of the development shall commence until a noise survey in order to determine noise levels for both day and night has been carried out, and a detailed report of the survey findings together with a detailed scheme of noise attenuation and/ or noise insulation measures has been submitted to and approved in writing by the Local Planning Authority. The measures as are approved shall be fully implemented prior to the first occupation/ use of the development'

2.1.3 In 'Notes to the Applicant' from the same letter it states:

'The development sit is in close proximity to the A534 and the developer is therefore required to carry out a noise survey in connection with condition no.09 in order to determine noise levels for both day (0700 – 2300hrs) and night (2300 – 0700hrs) having regard to Planning Guidance (Wales), Technical Advice Note (TAN) 11 – Noise. The report of the noise survey findings shall include:

- a) Noise levels arising from day/ night-time activities in the vicinity of the proposed development site and the impact upon the proposed accommodation, and*
- b) A detailed scheme of noise insulation and/ or attenuation measures so designed to safeguard the amenity of the future occupants of the proposed accommodation hereby approved.'*

2.1.4 Condition 12 states that:

'No part of the development shall commence until full details of the proposed MUGA have been submitted to and approved, in writing, by the Local Planning Authority. Works shall be carried out strictly in accordance with a timescale as agreed as part of the submitted details.

2.2 Technical Advice Note 11 (TAN 11) Noise

2.2.1 TAN 11 Noiseⁱ provides guidance to local authorities on the use of their planning powers to minimise the adverse impact of noise. It introduces the concept of Noise Exposure Categories (NEC) which is intended to assist in decisions for new residential developments. See Table 2.1 for Noise Exposure Categories for traffic, mixed sources and air traffic.

¹ Letter reference HOL P/2013/0823 (Decision date 11.03.2016) sent to Mr. P Jenkins, Barkin Development Limited and Mr. P. Lloyd, P L Planning from 'Officer Appointed for this purpose Head of Environment and Planning', Wrexham County Borough Council.

Table 2.1: Noise levels corresponding to NEC for new dwellings [$L_{Aeq, T}$ (dB)]

Noise Source	Period	Noise Exposure Category (NEC)			
		A	B	C	D
Road Traffic / Mixed Sources	07:00hrs – 23:00hrs	<55	55 - 63	63 - 72	>72
	23:00hrs – 07:00hrs*	<45	45 - 57	57 - 66	>66

*Night-time noise levels (23.00 - 07.00): sites where individual noise events regularly exceed 82 dB L_{Amax} (S time weighting) several times in any hour should be treated as being in NEC C, regardless of the $L_{Aeq, 8h}$ (except where the $L_{Aeq, 8h}$ already puts the site in NEC D).

- 2.2.2 Having measured and assessed the day and night time NEC rating of the site, the recommended action specific to applications for planning permission are tabulated in TAN 11 and reproduced in Table 2.2.

Table 2.2: Noise Exposure Category (NEC) descriptions

NEC	Determination
A	Noise need not be considered as a determining factor in granting planning permission, although the noise level at the high end of the category should not be regarded as a desirable level.
B	Noise should be taken into account when determining planning applications and, where appropriate, conditions imposed to ensure an adequate level of protection against noise.
C	Planning permission should not normally be granted. Where it is considered that permission should be given, for example because there are no alternative quieter sites available, conditions should be imposed to ensure a commensurate level of protection against noise.
D	Planning permission should normally be refused.

- 2.2.3 For example, an area of a site subject predominantly to road traffic noise an existing daytime noise level of less than 55dB $L_{Aeq, 16h}$ corresponds to Noise Exposure Category A. An existing night time noise level of less than 45dB $L_{Aeq, 8h}$ corresponds to Noise Exposure Category A. No noise mitigation works would normally be required at a site falling entirely into NEC A for day and night time purposes.

- 2.2.4 For areas falling into Noise Exposure Category B or C and in some cases D, it is possible to address moderate or high levels of environmental noise for future residents by specifying noise reduction measures such as acoustic barriers to reduce noise levels to future gardens and facades, and acoustic ventilation and glazing to reduce internally transmitted noise.

2.3 BS8233:2014

- 2.3.1 BS 8233:2014ⁱⁱ presents recommendations for the control of noise both in and around buildings and suggests criteria and limits appropriate to their function.

- 2.3.2 For dwellings, the main considerations are:

- for bedrooms, the acoustic effect on sleep; and
- for other rooms, the acoustic effect on resting, listening and communicating.

- 2.3.3 It is desirable that the internal ambient noise level does not exceed the guideline values as replicated in Table 2.3.

Table 2.3: Internal ambient noise level targets.

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

- 2.3.4 For external areas that are used for amenity space, such as gardens, it is desirable that the external noise level does not exceed 50dB $L_{Aeq, T}$, with an upper guideline value of 55dB $L_{Aeq, T}$.
- 2.3.5 The levels shown in Table 2.3 are consistent with the existing guidelines issued by the WHO as outlined below.

2.4 World Health Organisation Criteria

- 2.4.1 The World Health Organisation 'Guidelines for Community Noise'ⁱⁱⁱ aims to provide environmental health authorities and professionals with guidance on the adverse health effects of community noise on people.
- 2.4.2 Guideline values have been derived according to specific environments. The values relevant to proposed residential developments are shown in Table 2.4.

Table 2.4: Guideline Values for Community Noise in Specific Environments (WHO).

Specific Environment	Critical Health Effect(s)	L_{Aeq} (dB)	Time base (hrs)	$L_{Amax,f}$ (dB)
Outdoor living area	Serious annoyance, daytime and evening	55	16	-
	Moderate annoyance, daytime and evening	50	16	-
Dwelling, indoors	Speech intelligibility and moderate annoyance, daytime and evening	35	16	-
Inside bedrooms	Sleep disturbance, night-time	30	8	45
Outside bedrooms	Sleep disturbance, window open (outdoor values)	45	8	60

- 2.4.3 WHO expands the issue of potential sleep disturbance further by stating that:

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

2.5 IEMA Guidelines for Environmental Noise Impact Assessment

2.5.1 The potential change in ambient noise levels due to MUGA use can be assessed using the Guidelines for Environmental Noise Impact Assessment^{iv} published by the Institute of Environmental Management & Assessment (IEMA) in October 2014.

2.5.2 The guidelines provide specific support on how noise impact assessments fit within the Environmental Impact Assessment (EIA) process. They cover the scoping process, the baseline study, prediction of changes in noise levels as a result of implementing development proposals and the evaluation of the significance of the effect of changes. However, the principles in the guidelines are relevant to all types of project regardless of size including small developments which are not screened as EIA development but have the potential to cause potentially substantive local noise effects.

2.5.3 In Section 3 of the Guidelines, noise impact is defined as:

'The difference in the acoustic environment before and after the implementation of the proposals (also known as the magnitude of change). This includes any change in noise level and in other characteristics/features, and the relationship of the resulting noise level to any standard benchmarks'

2.5.4 Noise effect is defined as follows:

'The consequence of the noise impact. This may be in the form of a change in the annoyance caused, a change in the degree of intrusion or disturbance caused by the acoustic environment, or the potential for the change to alter the character of the area such that there is a perceived change in quality of life. This will be dependent on the receptor and its sensitivity.'

2.5.5 The significance of the effect is relevant only to assessments that form part of the EIA process and is defined as follows:

'The evaluation of the noise effect and, particularly if the noise impact assessment is part of a formal EIA, deciding whether or not that impact is significant'

2.5.6 In Section 7 of the Guidelines, a number of factors affecting the assessment process are identified and explored, they are summarised in Table 2.5.

Table 2.5: Assessment factors explored in the IEMA Guidelines for Noise Impact Assessment.

Factor	Issue
Averaging Period	Is the averaging time so long that it might mask a greater impact at certain times, or does the noise change occur for such a small proportion of the time that it therefore can be considered of little consequence?
Time of Day/Night/Week	Is the change occurring at a time that might increase or reduce its effect from that implied by the basic noise change?
Nature of the Noise Source	For a given level of noise, it is often considered that a source which emits a continuous noise level is less annoying or disturbing than a source that is intermittent enough to attract attention. This should be taken into account. For existing sources, is there a change in the nature of the noise source which might alter the effect?
Frequency of Occurrence	How does the frequency of the occurrence of the noise source affect the effect? (e.g. development proposals may include noise sources that do not occur every day)
Spectral Characteristics	Is there a change in the spectral characteristics which might affect the effect? If a new source is expected to exhibit a very different frequency spectral shape from the baseline noise, there may be a difference in effect beyond that suggested by the simple difference expressed in dB(A).
Noise Indicator	Has the indicator(s) which best correlates with the specific effect been correctly identified? (i.e. does the change in level as described by the indicator used adequately reflect the change that would be experienced by those exposed to it and could be affected by it?)
Absolute Level (Benchmark)	How does the change relate to any applicable published guidance? A development proposal which would cause an increase in an existing level that is already well above an existing guideline should probably be regarded as worse than if the existing level were below the guideline.

2.5.7 Once all these factors have been taken into account, the assessor is in a position to form a view about the magnitude of the impact and, where necessary, the significance of the effect. Table 2.6 replicates the generic scale (adverse effects only) for describing a range of noise effects on a receptor.

Table 2.6: Generic relationship between noise impact (magnitude) and noise effect (magnitude + sensitivity) including the evaluation of effect significance.

Magnitude (Nature of impact)	Description of Effect (on a specific sensitive receptor)	Significance (as required within EIA)
Negligible	N/A – No discernible effect on the receptor	Not significant
Slight	Receptor perception = Non-intrusive Noise impact can be heard but does not cause any change in behaviour or attitude, e.g. turning up volume of television; speaking more loudly; closing windows. Can slightly affect the character of the area but not such that there is a perceived change in the quality of life.	Less likely to be significant (Greater justification needed – based on impact magnitude and receptor sensitivities – to justify a significant effect)
Moderate	Receptor perception = Intrusive Noise impact can be heard and causes small changes in behaviour and/or attitude, e.g. turning up volume of television; speaking more loudly; closing windows. Potential for non-awakening sleep disturbance. Affect the character of the area such that there is a perceived change in the quality of life.	
Substantial	Receptor perception = Disruptive Causes a material change in behaviour and/or attitude, e.g. avoiding certain activities during periods of intrusion. Potential for sleep disturbance resulting in difficulty in getting to sleep, premature awakening and difficulty getting back to sleep. Quality of life diminished due to change in character of the area.	
Severe	Receptor perception = Disruptive Significant changes in behaviour and/or an inability to mitigate effect of noise leading to psychological stress or physiological effects, e.g. regular sleep deprivation/awakening; loss of appetite, significant, medically definable harm, e.g. auditory and non-auditory.	More likely to be significant Significant

2.5.8 To determine the overall noise impact, the magnitude and sensitivity criteria are combined into a Degree of Effect matrix see Table 2.7, with the corresponding descriptors shown in Table 2.8.

Table 2.7: Degree of Effect Matrix.

		Importance / Sensitivity of Receptor			
		High	Medium	Low	Negligible
Magnitude / Scale of Change	Large	Very Substantial	Substantial	Moderate	None
	Medium	Substantial	Substantial	Moderate	None
	Small	Moderate	Moderate	Slight	None
	Negligible	None	None	None	None

Table 2.8: Effect descriptors.

Effect	Descriptor
Very Substantial	Greater than 10 dB L_{Aeq} change in sound level perceived at a receptor of great sensitivity to noise
Substantial	Greater than 5 dB L_{Aeq} change in sound level at a noise sensitive receptor, or a 5 to 9.9 dB L_{Aeq} change in sound level at a receptor of great sensitivity to noise
Moderate	A 3 to 4.9 dB L_{Aeq} change in sound level at sensitive or highly sensitive noise receptor, or a greater than 5 dB L_{Aeq} change in sound level at a receptor of some sensitivity
Slight	A 3 to 4.9 dB L_{Aeq} change in sound level at a receptor of some sensitivity
None/Not Significant	Less than 2.9 dB L_{Aeq} change in sound level and/or all receptors are of negligible sensitivity to noise or marginal to the zone of influence of the proposals

3 Noise Survey

3.1 Noise Survey Procedure

- 3.1.1 Partially attended noise level measurements were made between 12.30hrs, Friday 2nd June and 12.30hrs, Monday 5th June 2017 at two positions representative of proposed dwellings. Position 2 is also considered representative of the nearest existing noise sensitive receptor (NSR) identified in Figure 1.2. Noise monitoring positions are shown in Figure 3.1.

Figure 3.1: Site, noise measurement and nearest noise sensitive receptor locations.



- 3.1.2 At each position, noise levels were measured in free-field conditions (at least 3.5m from any vertical reflective surfaces) using a sound level meter with its corresponding microphone attached to an extension cable and mast. The microphone was fitted with a windshield and was situated approximately 1.5m above ground level.
- 3.1.3 Noise level measurements were made over contiguous 1-minute and 15-minute periods at Positions 1 and 2 respectively. Overall A-weighted maximum ($L_{Amax, fast}$) and ambient (L_{Aeq}) noise levels were measured as well as associated linear octave band frequencies.
- 3.1.4 Noise levels and measurement times are shown in section 4.0 of this report. All noise surveys were compliant with BS7445-1:2003 'Description and measurement of environmental noise. Guide to quantities and procedures'.

3.2 Noise Climate

- 3.2.1 The noise climate during survey commissioning and decommissioning was observed to be dominated by road traffic noise from Wrexham Road and birdsong.

3.3 Weather Conditions

- 3.3.1 Weather data has been sourced from a local meteorological station and is summarised in Table 3.1.

Table 3.1: Weather conditions.

Date	Period	Conditions	Temperature (°C)	Wind Speed (m/s)
Fri 02/06/2017	Day	Frequent periods of rain.	14 - 16	1 - 4
Fri 02/06/2017 – Sat 03/06/2017	Night	Dry	10 - 13	1 - 2
Sat 03/06/2017	Day	Generally dry, showers between 15.20 – 16.20hrs	12 - 19	2 - 8
Sat 03/06/2017 – Sun 04/06/2017	Night	Dry	11 - 12	1 - 4
Sun 04/06/2017	Day	Generally dry, showers between 09.20 – 10.50hrs	12 - 18	3 - 8
Sun 04/06/2017 – Mon 05/06/2017	Night	Generally dry, showers between 06.50 – 07.00hrs	9 - 11	3 - 6
Mon 05/06/2017	Day	Mostly rain	11 - 16	5 - 8

3.4 Instrumentation

- 3.4.1 Details of instrumentation used during the survey are presented in Table 3.2.

Table 3.2: Instrumentation details

Manufacturer	Equipment type	Serial number	Date of laboratory calibration
Rion	NC-74 calibrator with ½" adaptor	34825715	18 th August 2016
	NL-52 sound level meter	00654072	
	NH-25 preamplifier	54117	
	UC-59 Microphone	08333	
Rion	NA-28 sound level meter	00501403	25 th May 2017
	NH-23 preamplifier	01440	
	UC-59 Microphone	03881	

Calibration

- 3.4.2 The sound level meters were calibrated at the start and end of the noise survey, there was no recorded drift greater than 0.1dB at 1 kHz and therefore measurements are acceptable. The calibration chain is traceable via National Standards held at the National Physical Laboratory (NPL).

4 Results

4.1 Overview

- 4.1.1 Charts to show the time histories of measured noise levels are shown in Appendix B, Figures B.1 and B.2. Other noise level data is available upon request.
- 4.1.2 Noise levels measured during periods of adverse weather (rainfall or wind speeds > 5m/s) have been discounted from the noise assessment (see Table 3.1). A summary of noise levels measured in good conditions is provided in Table 4.1.

Table 4.1: Noise level summary.

Position	Measurement Interval	Night-time Maximum noise level ($L_{Amax,fast}$) dB range	Ambient noise level range [$L_{Aeq,T}$ (dB)]	
			Daytime range	Night-time range
1	1-minute	30 - 83	33 – 70	25 – 67
2	15-minute	54 - 88	51 – 66	37 – 68

4.2 External Noise Levels for Façade Assessment

Ambient Noise Levels

- 4.2.1 Logarithmically averaged 16-hour daytime (07.00 – 23.00hrs) and 8-hour night-time (23.00 – 07.00hrs) ambient noise levels measured at Positions 1 and 2 are presented in Table 4.2.

Table 4.2: Logarithmically averaged ambient noise levels.

Position	Period	$L_{eq,T}$ at octave band centre frequency (Hz)							[$L_{Aeq,T}$ (dB)]
		63	125	250	500	1k	2k	4k	
1	Daytime (07.00 – 23.00hrs)	66	59	56	56	59	54	48	62
	Night-Time (23.00 – 07.00hrs)	58	50	45	45	48	43	37	51
2	Daytime (07.00 – 23.00hrs)	62	56	48	49	54	49	54	59
	Night-time (23.00 – 07.00hrs)	52	44	39	41	46	40	55	57

Maximum Noise Levels

- 4.2.2 The highest ‘regularly occurring’ night-time maximum noise levels for Positions 1 and 2 are presented in Table 4.3 as these are pertinent to the assessment.

Table 4.3: Maximum noise levels.

Position	Period	L _{max,fast} at octave band centre frequency (Hz)							[L _{Amax,fast} (dB)]
		63	125	250	500	1k	2k	4k	
1	Night-time (23.00 – 07.00hrs)	79	68	71	72	76	66	58	77
2	Night-time (23.00 – 07.00hrs)	61	51	44	54	66	52	36	67

4.3 Baseline Noise Levels for MUGA Assessment

4.3.1 We understand² that the MUGA will not be floodlit but will not be gated or locked. Therefore, at this stage the anticipated daily use is between 09.00hrs and 21.00hrs.

4.3.2 A summary of measured noise levels at Position 2, during the anticipated MUGA operational hours, is provided in Table 4.4.

Table 4.4: Summary of hourly ambient noise levels at Position 2 during anticipated MUGA operating times.

Period	Ambient noise level range [L _{Aeq,1hr} (dB)]
Friday 2 nd June (12.30 – 21.00hrs)	55 - 59
Saturday 3 rd June (09.00 – 21.00hrs)	56 - 63
Sunday 4 th June (09.00 – 21.00hrs)	56 - 58
Monday 5 th June* (09.00 – 12.30hrs)	N/A*

**It was not possible to measure noise data in good weather conditions during this time period*

² As per conversation on 12th June 2017 between Rob Bailey of Williams Homes (Bala) Limited and Chris Parker of Environoise Consulting Limited

5 TAN 11 Noise Assessment

5.1 NEC Categories

- 5.1.1 As discussed in Section 2, TAN 11 uses Noise Exposure Categories (NEC) to assist in decisions for new residential developments. See Table 5.1 for Noise Exposure Categories for traffic, mixed sources and air traffic.

Table 5.1: Noise levels corresponding to NEC for new dwellings [$L_{Aeq,T}$ (dB)]

Noise Source	Period	Noise Exposure Category (NEC)			
		A	B	C	D
Road Traffic / Mixed Sources	07:00hrs – 23:00hrs	<55	55 - 63	63 - 72	>72
	23:00hrs – 07:00hrs*	<45	45 - 57	57 - 66	>66

*Night-time noise levels (23.00 - 07.00): sites where individual noise events regularly exceed 82 dB L_{Amax} (S time weighting) several times in any hour should be treated as being in NEC C, regardless of the $L_{Aeq,8h}$ (except where the $L_{Aeq,8h}$ already puts the site in NEC D).

5.2 NEC Classification

- 5.2.1 The results presented in Section 4 show daytime (07.00 - 23.00hrs) of 59 – 62dB $L_{Aeq,16hr}$ and night noise levels of 52 – 57dB $L_{Aeq,8hr}$. This would place the site into Category B where, according to the descriptions detailed in Table 2.2:

'Noise should be taken into account when determining planning applications and, where appropriate, conditions imposed to ensure an adequate level of protection against noise.'

6 Noise Ingress Assessment

6.1 Overview

- 6.1.1 Generally, it is accepted that glazing and ventilation openings within external façades will be the weakest elements acoustically compared with robust external and roof constructions. Therefore, specifying glazing and ventilation that is sufficiently robust to attenuate the highest levels of noise will provide a comfortable acoustic environment – any supplementary attenuation offered by the more substantial construction of the structural façade (e.g. masonry) would serve to further reduce internal noise levels.
- 6.1.2 Noise ingress levels have been calculated considering the measured ambient and maximum noise levels detailed in Tables 4.2 and 4.3, propagation of sound across the site and assessment method given in BS EN 12354-3:2000^v to determine the required performance of glazing and ventilation strategy to meet internal noise criteria (see section 2.3) and provide recommendations. A reverberation time of 0.8 seconds has been used for all living rooms and 0.6 seconds for bedrooms. See Appendix C, Figures C1 and C2 for example noise ingress calculations.
- 6.1.3 The exact room layout, dimensions and construction details for proposed residential dwellings on the development site are yet to be determined. Therefore, a generic configuration of constructions (including rooms sizes and window areas) have been assumed as follows:
- External wall comprising brick / cavity / block or brick / cavity / timber stud and plasterboard lining.
 - Typical living room dimensions will be 5m x 4m x 2.4m (h) and glazing areas will be 2.5m².
 - Typical bedroom dimensions will be 4m x 3m x 2.4m (h) and glazing areas will be 2m².
- 6.1.4 We have assumed that opening windows are not part of the ventilation strategy other than to provide additional ventilation / cooling through user discretion. An open window will typically provide between 10 to 15dBA attenuation from outside to inside according to BS8233:2014 meaning internal noise targets would be exceeded. The level of attenuation will depend on the free open area of the window and the angle of the window relative to the dominant external noise source.

7 Façade Recommendations

7.1 Overview

- 7.1.1 Internal average noise levels within habitable rooms are expected to be within Local Authority target limits, as per BS8233:2014 criteria (see Section 2.3), using appropriate configurations of glazing and ventilation.
- 7.1.2 Glazing and ventilation specifications have been provided for bedroom and living areas in proposed residential dwellings located at the front and rear of the site based on the measured noise data.

7.2 Façades to North-Western Boundary of Site

- 7.2.1 To satisfy the daytime and night-time internal noise criteria, for properties at the north-western boundary of the site, the minimum typical glazing sound insulation performance are given in Tables 6.1 and 6.2. Minimum typical ventilation sound insulation performances are given in Tables 6.3 and 6.4.

Glazing – Living Rooms

Table 6.1: Minimum typical glazing sound insulation performance.

Sound reduction performance (R) at octave band centre frequency (Hz)							Overall R _w (dB)	Overall R _w + C _{tr} (dB)
63	125	250	500	1k	2k	4k		
17	21	20	26	38	37	39	32	28

- 7.2.2 Typically, requirements could be met with a double-glazed window unit consisting of 6mm pane / 6mm to 20mm cavity / 4mm pane.

Glazing – Bedrooms

Table 6.2: Minimum typical glazing sound insulation performance.

Sound reduction performance (R) at octave band centre frequency (Hz)							Overall R _w (dB)	Overall R _w + C _{tr} (dB)
63	125	250	500	1k	2k	4k		
21	24	24	32	37	37	44	35	32

- 7.2.3 Typically, requirements could be met with a double-glazed window unit consisting of 10mm pane / 6mm to 20mm cavity / 6mm pane.

Ventilation – Living Rooms

Table 6.3: Minimum typical ventilation strategy.

Element normalized level difference (D _{n,e}) at octave band centre frequency (Hz)							D _{n,e,w} (dB)
63	125	250	500	1k	2k	4k	
30	41	40	35	48	43	46	39

- 7.2.4 Typically, requirements could be met with an in-wall acoustic ventilator.

Ventilation – Bedrooms

Table 6.4: Minimum typical ventilation strategy.

Element normalized level difference ($D_{n,e}$) at octave band centre frequency (Hz)							$D_{n,e,w}$ (dB)
63	125	250	500	1k	2k	4k	
30	41	40	35	50	53	55	42

7.2.5 Typically, requirements could be met with an in-wall acoustic ventilator.

7.3 Façades to South-Eastern Boundary of Site

7.3.1 To satisfy the daytime and night-time internal noise criteria, for properties at the south-eastern boundary of the site, the following glazing and ventilation strategy is recommended.

Glazing – Living Rooms and Bedrooms

Table 6.5: Minimum typical glazing strategy.

Sound reduction performance (R) at octave band centre frequency (Hz)							Overall R_w (dB)	Overall $R_w + C_{tr}$ (dB)
63	125	250	500	1k	2k	4k		
17	21	17	25	35	37	31	29	25

7.3.2 Typically, requirements could be met with a double-glazed window unit consisting of 4mm pane / 6mm to 20mm cavity / 4mm pane.

Ventilation – Living Rooms

Table 6.7: Minimum typical ventilation strategy.

Element normalized level difference ($D_{n,e}$) at octave band centre frequency (Hz)							$D_{n,e,w}$ (dB)
63	125	250	500	1k	2k	4k	
29	29	33	33	31	31	31	31

7.3.3 Typically, requirements could be met with an acoustic in-frame slot ventilator (open position).

Ventilation – Bedrooms

Table 6.8: Minimum typical ventilation strategy.

Element normalized level difference ($D_{n,e}$) at octave band centre frequency (Hz)							$D_{n,e,w}$ (dB)
63	125	250	500	1k	2k	4k	
30	41	40	35	48	43	46	39

7.3.4 Typically, requirements could be met with an in-wall acoustic ventilator.

7.4 Glazing Performance

- 7.4.1 Glazing with a larger air or inert gas (e.g. Argon) cavity is acceptable providing both pane thicknesses remain the same as recommended. Laminated glazing in place of traditional glazing is acceptable providing it is the same thickness. The glazing performance should be constant across the overall assembly, so the framing should be of similar or greater performance than the glazing recommended. The performance of the glazing units also depends on the quality of framing and good contact with window seals.
- 7.4.2 The sound insulation of a window is usually measured over a wide range of frequencies from low to high in accordance with BS EN ISO 140-3: 1995, but it is often convenient for specifiers to represent the insulation by a single figure, see below:
- R_w , the weighted sound reduction, more useful, as it incorporates a correction for the response of the human ear.
 - $R_w + C_{tr}$ is the weighted sound reduction with a low frequency spectrum adaptation term (C_{tr} is usually a negative number) suitable for urban traffic noise and low speed rail traffic³.
 - R_{TRA} , the weighted reduction against typical low speed urban road traffic noise.

³ The C_{tr} adaption term was introduced in BS EN ISO 717-1: 1997 'Acoustics - Rating of sound insulation in buildings and building elements Part 1'

8 Outdoor Amenity Spaces

8.1 Guidance and Noise Level

- 8.1.1 Guidance given in BS8233 and the WHO Guidelines for Community Noise states that it is desirable for the steady noise level in external amenity spaces (such as gardens, balconies or outdoor living areas) to be less than 50dB $L_{Aeq,16hr}$ to prevent 'moderate annoyance' with 55dB $L_{Aeq,16hr}$ regarded as an upper limit to prevent 'serious annoyance' for occupants. Outdoor amenity spaces within the proposed development include garden areas to the rear of proposed dwellings.
- 8.1.2 Measurements at Position 1 indicate that gardens at the north-western boundary with direct line of sight of Wrexham Road would encounter ambient noise levels of 62dB $L_{Aeq,16hr}$.
- 8.1.3 Measurements at Position 2 indicate that gardens at the south-eastern boundary with direct line of sight of Wrexham Road would encounter ambient noise levels of 59dB $L_{Aeq,16hr}$.

8.2 Assessment

- 8.2.1 For gardens areas exposed to noise above the target noise criterion, barrier attenuation calculations (See Appendix C, Figures C3 to C5 for example barrier calculations) have been done considering the 16-hour ambient noise level, distances of the noise source (i.e. road traffic along Wrexham Road) and barrier to the centre of garden areas, a source height of 0.5m and a receiver height (i.e. head height) of 1.5m.

8.3 Recommendations

- 8.3.1 Calculations indicate that the target criterion in garden areas nearest to and with direct line of sight Wrexham Road, will be met with acoustic barriers (e.g. close boarded timber fence) of ≥ 1.8 m high.

Barrier Construction

- 8.3.2 The performance of the barrier is determined largely by the effective height as it is diffraction over the top which limits performance. The barrier material however must have attenuation properties significantly higher than that determined by the barrier geometry. An insertion loss of approximately 20dB is therefore needed for the barrier material.
- 8.3.3 Suitable barrier construction would be a close boarded timber fence with a surface mass of $\geq 15\text{kg/m}^2$. The fencing itself and between the fence and the ground must be free from gaps. A suitable commercial product is provided by Jacksons:
https://www.jacksonsfencing.co.uk/pages/catalogues/order_cat.aspx
- 8.3.4 An example specification is shown in Appendix D, Figures D1.

9 MUGA Noise Assessment

9.1 AGP Source Noise Levels

- 9.1.1 In August 2015, Sports England published a Design Guidance Note - 'Artificial Grass Pitch (AGP) Acoustics – Planning Implications'^{vi}. The document details noise levels measured during nine sports sessions on three separate AGPs as follows:

'The sessions included football, hockey and rugby and participation by men, women and children. The purpose was to determine a 'typical' noise level generated from a 'typical' AGP sports session.

Noise level measurements were taken at a distance of 10 metres behind the mid-way points along goal lines and side-lines. They were found to be highest behind the side-line halfway line.

The most significant noise levels were found to be generally derived from the voices of players, with the exception of hockey where impact noises of balls hitting perimeter strike boards and goal back boards were more noticeable. Such impact noises can be mitigated by incorporating shock absorbing noise reduction measures. Assuming such mitigation measures, the most significant noise source from typical AGP sports sessions is therefore voice and as such, a typical noise level can be determined. From the measurement data, a typical free-field noise level of 58 dB $L_{Aeq}(1 \text{ hour})$ at a distance of 10 metres from the side-line halfway marking has been determined as representative for noise from an AGP.'

- 9.1.2 A 1-hour time interval was used as this coincides with the duration of a typical AGP session.

9.2 Calculated MUGA Noise Levels

- 9.2.1 We consider the AGP noise level of 58dB $L_{Aeq,1\text{hour}}$ at 10m distance, as detailed above, appropriate for use in calculating noise from the proposed MUGA. Calculated noise levels at the nearest NSRs include distance attenuation corrections and barrier attenuation where appropriate. Line source noise propagation has been assumed due to the shape of the noise source and the proximity of the NSRs.

Existing Receptor

- 9.2.2 The existing NSR is approximately 32m from the nearest side-line halfway marker of the MUGA. Using a distance attenuation correction, the calculated MUGA noise level at the nearest existing NSR is 53dB $L_{Aeq,1\text{hour}}$. No barrier attenuation has been assumed.
- 9.2.3 With reference to the baseline data presented in Table 4.4, the calculated noise levels are 2dB below the lowest existing hourly ambient noise levels, $L_{Aeq, 1\text{hr}}$, for periods between 09.00 – 21.00hrs.

Proposed Receptor

- 9.2.4 The nearest proposed dwelling (Plot 20) will be approximately 18m from the nearest side-line halfway marker of the MUGA. Using a distance attenuation correction, the calculated MUGA noise level at the nearest Plot 20 will be 48dB $L_{Aeq,1hr}$.
- 9.2.5 Calculations assume that the garden area of Plot 20 will be enclosed with an acoustic barrier (e.g. close boarded timber fence) of ≥ 1.8 m high as recommended in Section 8.3, see Appendix C, Figure C6 for barrier calculation).
- 9.2.6 With reference to the baseline data presented in Table 4.4, the calculated noise levels are 7dB below the lowest existing hourly ambient noise levels $L_{Aeq, 1hr}$, for periods between 09.00 – 21.00hrs.

9.3 Change in Ambient Noise Levels

- 9.3.1 Based on the calculated MUGA noise level and the lowest ambient noise level shown in Table 4.4, the cumulative noise level has been calculated at each NSR (See Appendix C, Figure C7 for calculation) using logarithmic addition. The cumulative noise level has been compared with the baseline noise level to determine the change in ambient noise level due to the proposals.

Existing Receptor

- 9.3.2 The change in the ambient noise level at the existing NSR, as a result of MUGA use, is calculated to be +2dB $L_{Aeq, 1hr}$ for periods 09.00 – 21.00hrs. With reference to the guidance presented in Table 2.8, these changes are deemed to be of 'no impact' and are 'not significant'.

Proposed Receptor

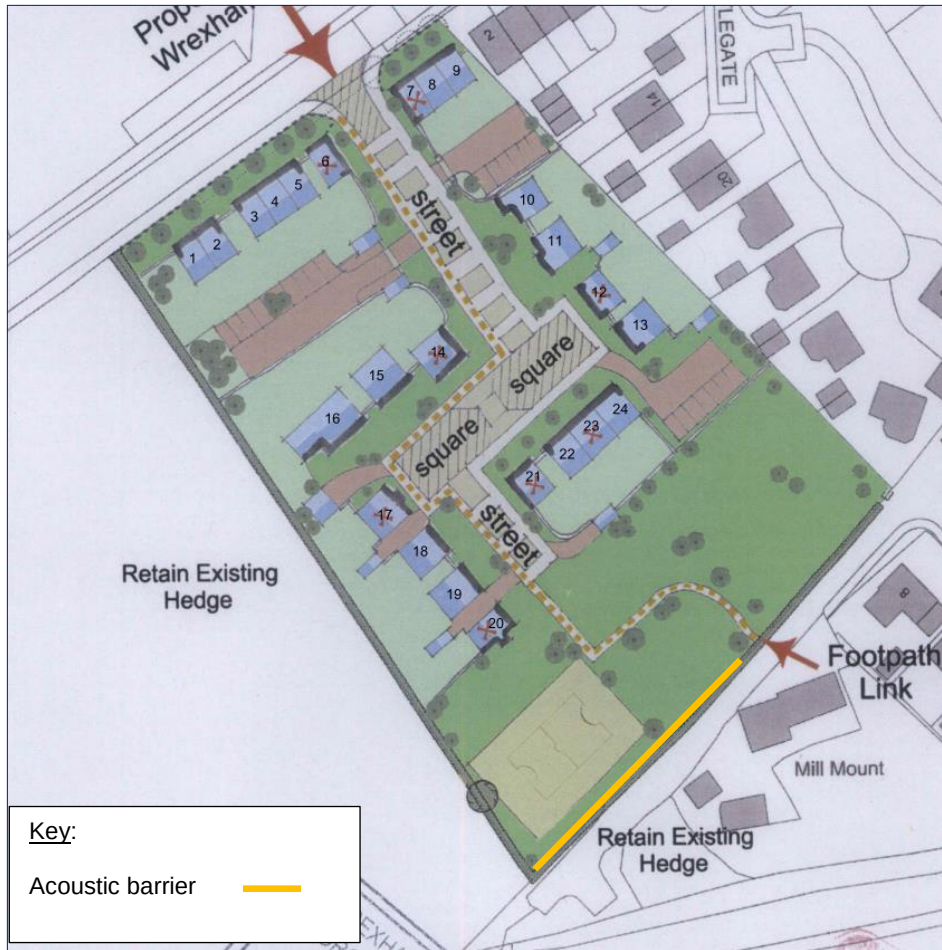
- 9.3.3 The change in the ambient noise level at the nearest NSRs as a result of MUGA use is calculated to be +1dB $L_{Aeq, 1hr}$ for periods 09.00 – 21.00hrs. With reference to the guidance presented in Table 2.8, these changes are deemed to be of 'no impact' and are 'not significant'.

10 Recommendations

10.1 MUGA

- 10.1.1 In Section 9.1 a noise level of 58dB $L_{Aeq,1hr}$ was determined for a typical AGP (which we have adopted for a MUGA). In the absence of ball impact noise, AGP (and thus MUGA) noise is primarily due to vocal contributions from participants. However, it was observed that the impact noise of hockey balls hitting the strike boards, goal boards and fencing has the potential to generate higher noise levels than from users. In addition, there was a difference in the character of the noise. These impact noises were found to be significantly reduced by the use of padding and the careful design and selection of perimeter fencing.
- 10.1.2 We therefore recommend that shock absorbing noise reduction measures are incorporated into the design of the MUGA to avoid potential underestimates of MUGA source levels. These include:
- Side wall panels constructed of PVC or rubber coated weld mesh (rather than traditional chain-link type fence) in order to reduce rattle and ball impact noise.
 - Panels should be securely clamped with resilient anti-vibration (AV) fixings to dampen the panels and minimise structure-borne noise transmission.
 - Polymeric playing surface.
 - Avoid sheet metal advertising signs. Where signage must be installed it is recommended that they are made of soft vinyl.
 - Design MUGA such that entrance and access route is located away from nearby housing where possible (users tend to congregate close to these areas).
- 10.1.3 If it is not possible to implement the noise mitigation measures detailed above, the anticipated source noise levels are likely to be higher than the 58dB $L_{Aeq,1hr}$ level determined by Sport England. This could result in an adverse impact upon the nearest existing NSR to the east.
- 10.1.4 It is recommended that an acoustic barrier is installed at the south-eastern boundary of the site (see Figure 10.1) to reduce this potential adverse impact. See section 8.3 and Appendix D for recommendations regarding barrier construction.

Figure 10.1: Location of recommended acoustic barrier.



11 Conclusions

11.1 TAN 11 Noise Assessment

11.1.1 A noise survey has been completed at the application site at façade representative positions.

11.1.2 Daytime (07.00-23.00hrs) noise levels of 59 – 62 dB $L_{Aeq,16hr}$ and night noise levels of 52 – 57 dB $L_{Aeq,8hr}$ were measured. This would place the site into Category B where:

'Noise should be taken into account when determining planning applications and, where appropriate, conditions imposed to ensure an adequate level of protection against noise.'

11.2 Noise Ingress Assessment

11.2.1 Noise levels at the site are such that internal noise level targets can be achieved with appropriate glazing and ventilation strategies for proposed dwellings.

11.2.2 Noise targets in garden areas can be met by following the recommendations outlined in this report.

11.3 Façade Strategies

11.3.1 The following strategies have been recommended to satisfy internal noise criteria:

Façades to North-Western Boundary of Site

- For proposed living areas, 32dB R_w (28dB $R_w + C_{tr}$) double glazed window units and in-wall acoustic ventilator units (39dB $D_{n,e,w}$) are required.
- For proposed bedrooms, 35dB R_w (32dB $R_w + C_{tr}$) double glazed window units and in-wall acoustic ventilator units (42dB $D_{n,e,w}$) are required.

Façades to South-Eastern Boundary of Site

- For proposed living areas, 29dB R_w (25dB $R_w + C_{tr}$) double glazed window units and acoustic in-frame slot ventilator units (31dB $D_{n,e,w}$) are required.
- For proposed bedrooms, 29dB R_w (25dB $R_w + C_{tr}$) double glazed window units and in-wall acoustic ventilator units (39dB $D_{n,e,w}$) are required.

11.4 Outdoor Amenity Spaces

11.4.1 External noise levels during the daytime (07.00 – 23.00hrs) were found to be up to 58dB $L_{Aeq,16hr}$.

11.4.2 Calculations indicate that the target criterion in garden areas nearest to and with direct line of sight with Wrexham Road, will be met with acoustic barriers (e.g. close boarded timber fence) of $\geq 1.8m$ high.

11.5 Noise from MUGA

- 11.5.1 The calculated MUGA noise level at the nearest existing NSR is 2dB below the lowest existing hourly ambient noise levels, $L_{Aeq, 1hr}$, for periods between 09.00 – 21.00hrs.
- 11.5.2 The calculated MUGA noise level at the nearest proposed dwelling (Plot 20) is 7dB below the lowest existing hourly ambient noise levels, $L_{Aeq, 1hr}$, for periods between 09.00 – 21.00hrs.
- 11.5.3 With reference to the guidance set out in Section 2.4, since the change in ambient noise levels at both receptors will be than 2.9 dB, the impact of noise from the proposed MUGA is not considered to be significant.
- 11.5.4 Since ambient noise levels are not expected to rise significantly during MUGA use, the findings of the primary assessment regarding glazing and ventilation specification are maintained.

Appendix A: Acoustic Terms

Between the quietest audible sound and the loudest tolerable sound there is a million to one ratio in sound pressure (measured in Pascal, Pa). Because of this wide range a noise level scale based on logarithms is used in noise measurement called the decibel (dB) scale. Audibility of sound covers a range of approximately 0 to 140 dB.

The human ear system does not respond uniformly to sound across the detectable frequency range and consequently instrumentation used to measure noise is weighted to represent the performance of the ear. This is known as the 'A weighting' and annotated as dB (A). Table 10.1 lists the sound pressure level in dB (A) for common situations.

Table A1: Noise levels for common situations.

Typical noise level dB(A)	Example
0	Threshold of hearing
30	Rural area at night, still air
40	Public library, refrigerator humming at 2m
50	Quiet office, no machinery, Boiling kettle at 0.5m
60	Normal conversation
70	Telephone ringing at 2m, Vacuum cleaner at 3m
80	General factory noise level, heavy goods vehicle from pavement
90	Powered lawn motor, operators ear
100	Pneumatic drill at 5m
120	Discotheque – 1m in front of loudspeaker
140	Threshold of pain

The noise levels at a measurement point are rarely steady, even in rural areas, and vary over a range dependent upon the effects of local noise sources. Close to a busy motorway, the noise levels may vary over a range of 5 dB(A), whereas in a suburban area this may increase up to 40 dB(A) and more due to the multitude of noise sources in such areas (cars, dogs, aircraft etc.) and their variable operation. Furthermore, the range of night-time noise levels will often be smaller and the levels significantly reduced compared with daytime levels. When considering environmental noise, it is necessary to consider how to quantify the existing noise (the ambient noise) to account for these second to second variations.

Human subjects are generally only capable of noticing changes in steady levels of no less than 3 dB(A). It is generally accepted that a change of 10 dB(A) in an overall, steady noise level is perceived to the human ear as a doubling (or halving) of the noise level. (These findings do not necessarily apply to transient or non-steady noise sources such as changes in noise due to change in road traffic flow, or intermittent noise sources). The equivalent continuous A-weighted sound pressure level, L_{Aeq} , is the single number that represents the average sound energy measured over that period. The L_{Aeq} is the sound level of a notionally steady sound having the same energy as a fluctuating sound over a specified measurement period. It is commonly used to express the energy value from individual sources that vary in level over their operational cycle.

Appendix B: Noise Survey Results

Figure B1: Time history of sound level measurements at Position 1.

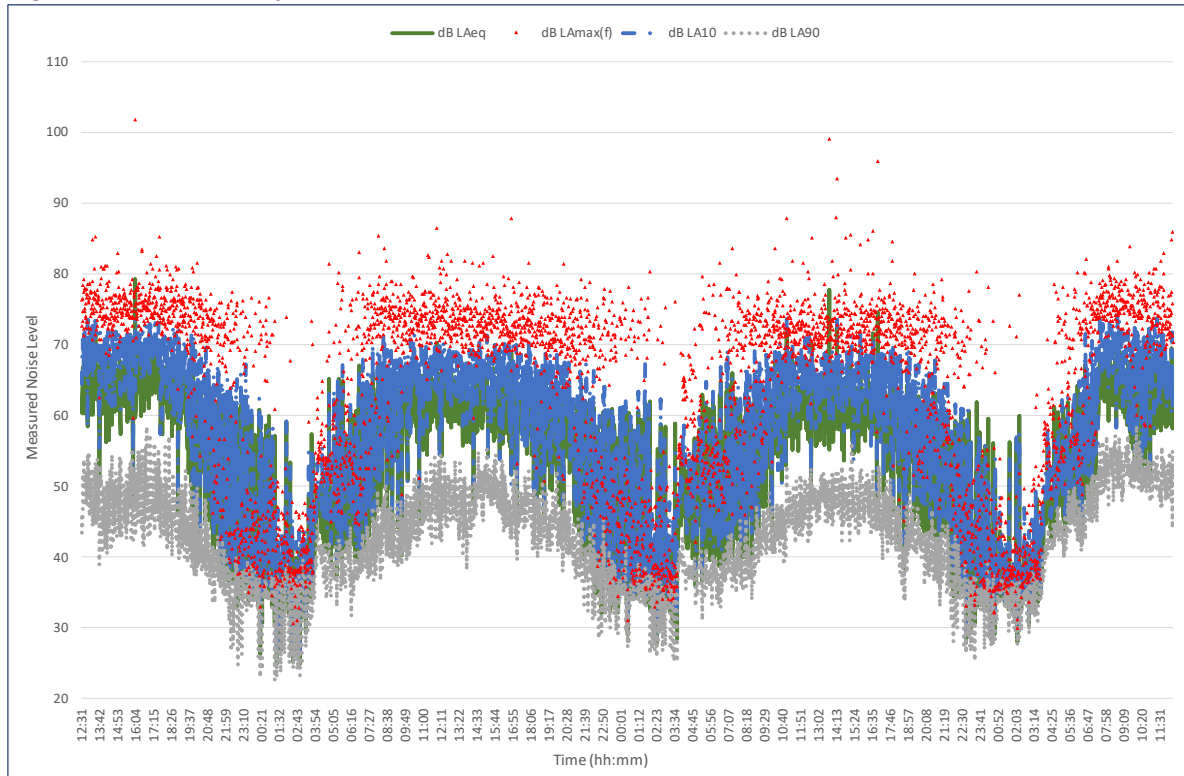
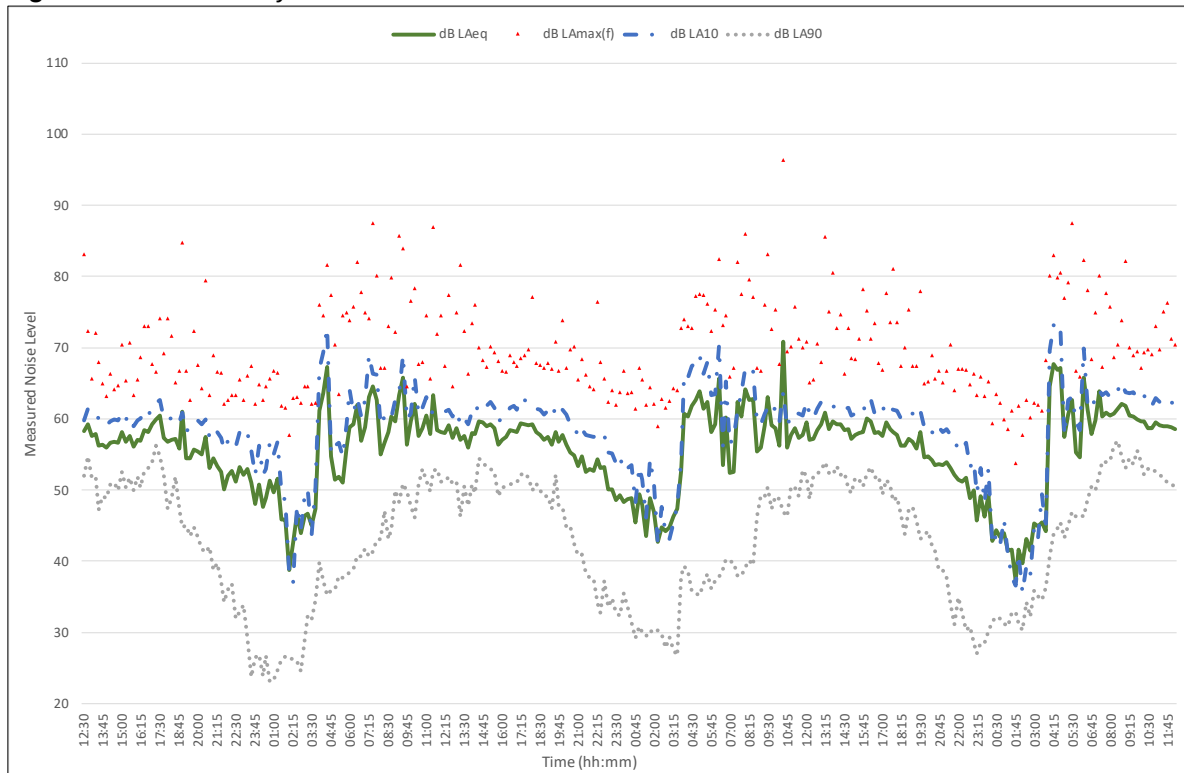


Figure B2: Time history of sound level measurements at Position 2.



Appendix C: Example Calculations

Figure C1: Example noise ingress calculation – Plot 1 Living Room (Day).

ENVIRONOISE		Leq - Living Room								
Project	Wrexham Road, Holt LL13 9TS									
Client	Williams Homes (Bala) Limited									
Room	Living Room	TYPE	LIVING AREA							
Enter Facade Correction	0 dB	Notes: ☐ Bedroom ☒ Living Area								
Receiving Room										
Height of room	2.4 m									
Width of room	4.0 m									
Length of room	5.0 m									
Volume of room	48.0 m³									
Element										
Area 1 - Glazing	0.0 m²	No data								
Area 2 - Glazing & TV	2.5 m²	6/6-20/4 Pilkington Standard Double Glazing 32dB Rw (-4 Ctr) and Greenw								
Area 3 - Non Glazed	0.0 m²	Trickle Vent EA (5000mm²)								
Area 4 - Non Glazed	9.6 m²	Brick/Block Cavity Wall								
Angle of incidence	0 deg									
Frequency Hz	63	125	250	500	1000	2000	4000	8000		
Reverberation time (sec)	0.80	0.80	0.80	0.80	0.80	0.80	0.80	0.80		
Absorption (sabines)	9.7	9.7	9.7	9.7	9.7	9.7	9.7	9.7		
Frequency Hz	63	125	250	500	1000	2000	4000	8000	dB(A)	
External dB	66.0	59.0	56.0	56.0	59.0	54.0	48.0		62	
External Freefield										
External Freefield Leq dB	66	59	56	56	59	54	48	0	62	
Additional Correction	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0		
10log(cos(angle))	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0		
SRI Ref	Area									
	0.0 m²	0	0	0	0	0	0	0	No data	
Glazing and Trickle Vent	2.5 m²	16	21	20	24	37	34	36	36	
	0.0 m²	0	0	0	0	0	0	0		
52	9.6 m²	38	41	45	45	54	58	61	64	
Combined SRI		23	28	27	31	43	41	43	43	
Criterion (NR at 1kHz)		59	48	40	34	30	27	25	23	
Additional SRI Required		0.0	0.0	0.0	0.0	0.0	0.0	0.0	To Meet NR30	
Internal Leq dB		50	38	36	32	23	20	12	-36	33 dB(A)

Figure C2: Example noise ingress calculation – Plot 1 Bedroom (Night).

		Leq - Bedroom							
Project	Wrexham Road, Holt LL13 9TS								
Client	Williams Homes (Bala) Limited								
Room	Bedroom	TYPE	BEDROOM						
Enter Facade Correction	0 dB	Notes: ☒ Bedroom ☐ Living Area							
Receiving Room									
Height of room	2.4 m								
Width of room	3.0 m								
Length of room	4.0 m								
Volume of room	28.8 m³								
Element									
Area 1 - Glazing	0.0 m²	No data							
Area 2 - Glazing & TV	2.0 m²	10/6-20/6 Pilkington Standard Double Glazing 35dB Rw (-3 Ctr) and Green							
Area 3 - Non Glazed	0.0 m²	Trickle Vent EA (5000mm²)							
Area 4 - Non Glazed	7.2 m²	Brick/Block Cavity Wall							
Angle of incidence	0 deg								
Frequency Hz	63	125	250	500	1000	2000	4000	8000	
Reverberation time (sec)	0.50	0.50	0.50	0.50	0.50	0.50	0.50	0.50	
Absorption (sabines)	9.3	9.3	9.3	9.3	9.3	9.3	9.3	9.3	
Frequency Hz	63	125	250	500	1000	2000	4000	8000	dB(A)
External dB	58.0	50.0	45.0	45.0	48.0	43.0	37.0		51
External Freefield									
External Freefield Leq dB	58	50	45	45	48	43	37	0	51
Additional Correction	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	
10log(cos(angle))	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	
SRI Ref	Area								
	0.0 m²	0	0	0	0	0	0	0	No data
Glazing and Trickle Vent	2.0 m²	19	24	23	27	36	36	43	43
	0.0 m²	0	0	0	0	0	0	0	
52	7.2 m²	38	41	45	45	54	58	61	64
Combined SRI		25	30	30	33	42	43	49	49
Criterion (NR at 1kHz)		59	48	40	34	30	27	25	23
Additional SRI Required		0.0	0.0	0.0	0.0	0.0	0.0	0.0	To Meet NR30
Internal Leq dB		39	26	21	18	12	6	-6	-43
Internal Lfmax dB		60	44	47	45	40	29	15	-43
									20 dB(A)
									45 dB(A)

Figure C3: Example barrier calculation – garden area at Plot 1.

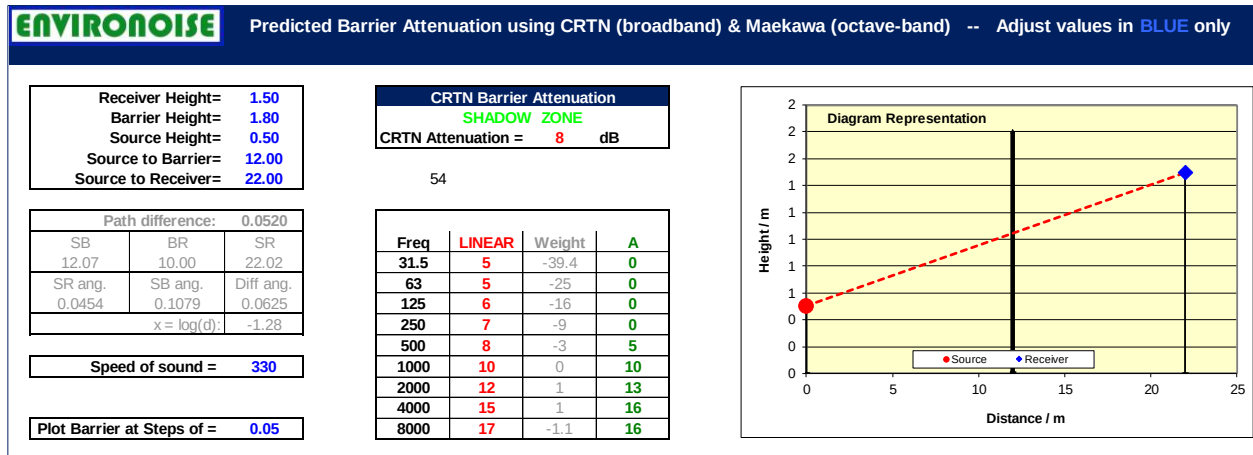


Figure C4: Example barrier calculation – garden area at Plot 16.

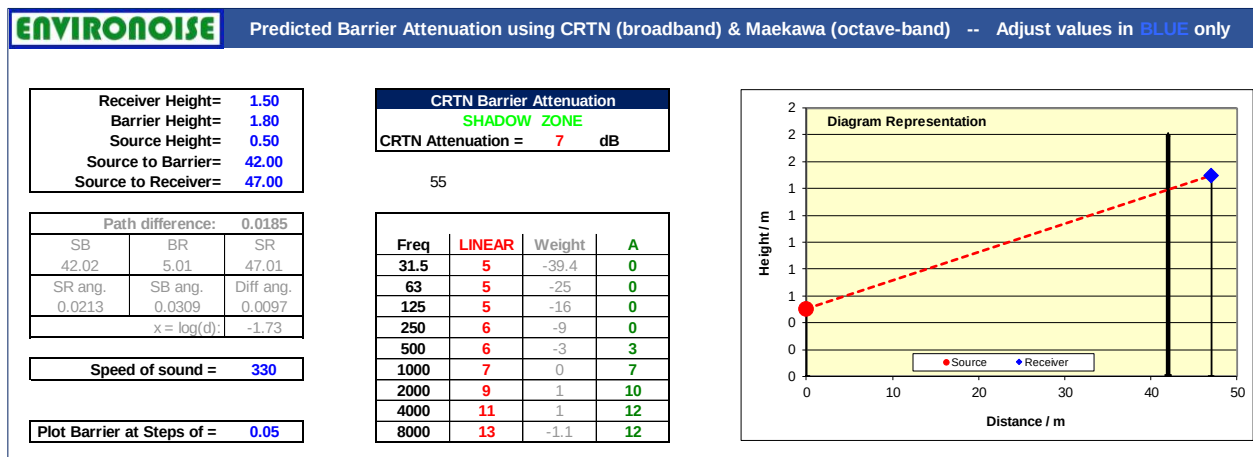


Figure C5: Example barrier calculation – garden area at Plot 19.

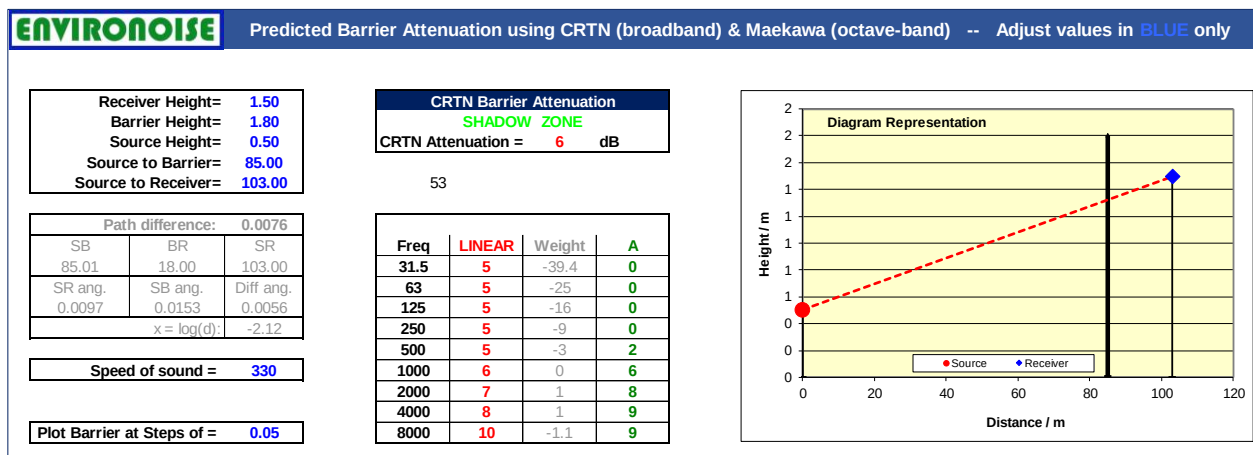


Figure C6: Example barrier calculation – MUGA to Plot 20.

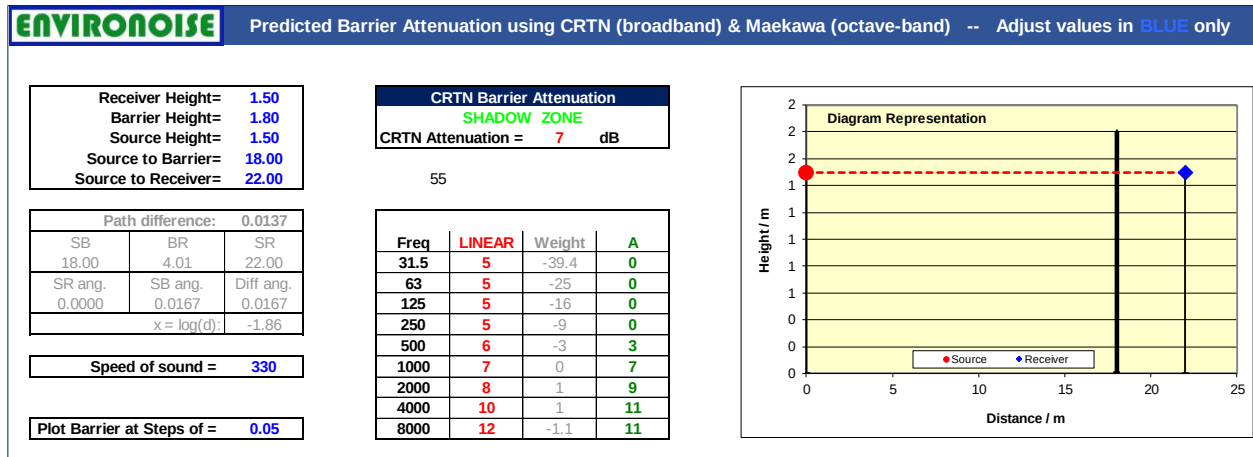
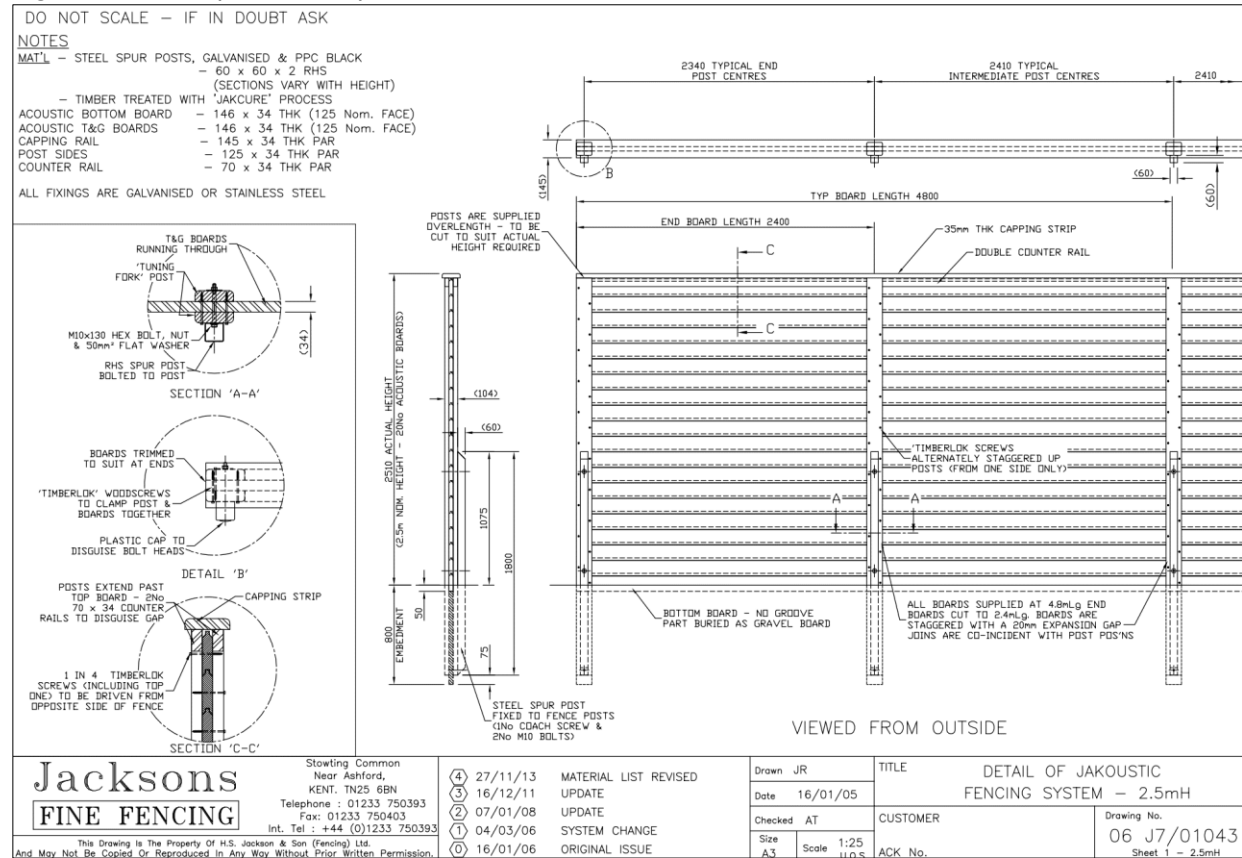


Figure C7: MUGA noise propagation calculation.

ENVIRONOISE										
Receptor	Source Level [LAeq (dB)]	Meas. Distance (m) [R1(m)]	Distance to NSR (m) [R2(m)]	Distance Correction (dB) (10log(R1/R2))	Barrier Correction (dB)	Level at NSR [LAeq (dB)]	Existing Ambient Level [LAeq (dB)]	Diff (dB)	Cumulative Level [LAeq (dB)]	Increase (dB)
Mill Mount	58	10	32	-5	0	53	55	-2	57.1	2.1
Plot 20	58	10	18	-3	-7	48	55	-7	55.9	0.9

Appendix D: Example Barrier Specifications

Figure D1: Example barrier specification.



References

ⁱ Technical Advice Note (TAN) 11: Noise. Welsh Office (1997).

ⁱⁱ BS8233:2014 'Guidance on sound insulation and noise reduction for buildings'. British Standards Institution (BSI), 2014.

ⁱⁱⁱ Guidelines for Community Noise. World Health Organisation (WHO), 1999.

^{iv} Guidelines for Environmental Noise Impact Assessment, Institute of Environmental Management & Assessment (IEMA), 2014.

^v BS EN 12354-3:2000 Building acoustics. Estimation of acoustic performance in buildings from the performance of elements. Airborne sound insulation against outdoor sound. British Standards Institution (BSI), 2000.

^{vi} Design Guidance Note - Artificial Grass Pitch (AGP) Acoustics – Planning Implications. Sports England, 2015.