Acute Acoustics Ltd
8 Bayliss Close
Quorn, Loughborough
LE12 8PF
01509 550 335
info@acuteacoustics.co.uk

NOISE & VIBRATION ASSESSMENT
Proposed Development at 'Land North of Whitehouse Road',
Ruskington, Sleaford, NG34 9TP.

Client: Rippon Homes Ltd.

Report by
P M Dyson BSc Dip Acoustics MIOA

Acute Acoustics Ltd.

Report Date: 11th June 2019
Ref: 2205 Ruskington – Whitehouse Road [Rev B]
Site Visited by: P M Dyson
Site Visit: 6th-13th March 2018

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1.0 INTRODUCTION

Acute Acoustics Ltd had been instructed by Mr. Stephen Elkington to carry out an assessment of environmental noise and vibration on a proposed development at a site 'Land North of Whitehouse Road', Ruskington, Sleaford, NG34 9TP. This project has now been taken over by Rippon Homes Ltd.

This is to support an outline planning application (North Kesteven District Council (NKDC) Ref: 17/01840/OUT) with the aim of building 73no new dwellings.

This report considers measurements taken onsite, the requirements of relevant legislation and makes recommendations as necessary. Acoustic terminology is explained at Appendix 1; my qualifications at Appendix 2, References at Appendix 3, Detailed Results at Appendices 4 & 5, Graphs at Appendix 6, calculations at Appendix 7, existing and preliminary site plans at Appendix 8 and preliminary glazing and ventilation zones, acoustic fence position plan at Appendix 9 and Architects Plan at Appendix 10 showing the rooms used for internal noise level calculations.

Revision B includes the change of client, revised site plan and plot specific calculations.

2.0 ASSESSMENT CRITERIA - NOISE

2.1 National Planning Policy Guidance - Noise

The National Planning Policy Guidance – Noise [Ref 1] (NPPG) is a qualitative rather than quantitative guidance on acceptable noise levels that may affect a development.

In paragraph 5 of the NPPG, various noise categories and thresholds are set out and Table 1 below summarises the noise exposure hierarchy, based on the likely average response.

Perception	Example of Outcomes	Increasing Effect Level	Action
Not Noticeable	No Effect	No Observed Effect	No Specific Measures required
Noticeable and not intrusive	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.	No Observed Adverse Effect	No Specific Measures required
		Lowest Observed Adverse Effect Level	
Noticeable and Intrusive	Noise can be heard and causes small changes in behaviour and/or attitude, 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	Observed Adverse Effect	Mitigate and reduce to a minimum

	area such that there is a perceived change in the quality of life.		
		Significant Observed Adverse Effect Level	
Noticeable and disruptive	The noise causes a material change in behaviour and/or attitude, 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
Noticeable and very disruptive	Extensive and regular 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	Unacceptable Adverse Effect	Prevent

Table 1: Noise Exposure Hierarchy

For noise impacts considered to be up to and including "Noticeable and Intrusive", it seems likely that the intention is to recognise that

whilst the noise levels are not desirable, planning consent should be granted provided that the noise can be mitigated and the intrusion reduced to a minimum.

Noise which is "Noticeable and disruptive" should be avoided, which presumably means such noise levels are permissible under certain circumstances; however, it is the next level of disturbance "Noticeable and very disruptive" that should be prevented, i.e. not permissible under any circumstances.

It can be seen that the NPPG noise guidance envisages that if properties are provided with a suitable external envelope with ventilation and acoustic glazing, designed to ensure "acceptable" internal noise levels, then internal noise levels would not exceed the "Significant Observed Adverse Effect Level" and hence that planning consent could readily be granted. The guidance states *"If the exposure is above this level the planning process should be used to avoid this effect occurring, by use of appropriate mitigation such as by altering the design and layout."*

It follows on from the above that the guidance is not recommending assessing noise based on a comparison of external noise levels with the external background, which is the approach of BS4142: 2114 "Methods for Rating and Assessing Industrial and Commercial Sound"

[Ref 2] and its predecessor BS4142: 1997, i.e. the wording of the Guidance indicates that BS4142 should not be used to assess noise.

At Paragraph 9, the Guidance states that there are other matters that can mitigate the impact of noise on residential developments if residents *"…have access to:*

- *a relatively quiet facade (containing windows to habitable rooms) as part of their dwelling, and/or;*
- *a relatively quiet external amenity space for their sole use, (e.g. a garden or balcony). Although the existence of a garden or balcony is generally desirable, the intended benefits will be reduced with increasing noise exposure and could be such that significant adverse effects occur, and/or;*
- *a relatively quiet, protected, nearby external amenity space for sole use by a limited group of residents as part of the amenity of their dwellings, and/or;*
- *a relatively quiet, protected, external publically accessible amenity space (e.g. a public park or a local green space designated because of its tranquility) that is nearby (e.g. within a 5 minutes walking distance)"*

Unlike PPG24 [Ref 3], the NPPG makes no direct reference to using British (or other) Standards to assess noise; PPG24 had directly referred to both BS8233 [Ref 4] and BS4142; therefore, the current

government guidance does not appear to endorse directly the use of these documents.

At paragraph 10 of NPPG, it is stated that local plans can include noise standards, which presumably would/could be based upon relevant British Standards. Paragraph 10 states: "*Care should be taken, however, to avoid these being implemented as fixed thresholds as specific circumstances may justify some variation being allowed.*"

It is clear therefore that current guidance envisages that quantitative standards can be used, provided that there is flexibility in their application.

2.2 British Standard 8233:2014

The latest version of BS8233:2014 'Guidance on Sound Insulation and Noise Reduction for Buildings' states the following:

"*In general, for steady external noise sources, it is desirable that the internal ambient noise level does not exceed the guideline values in Table 4.*

Table 4 Indoor ambient noise levels for dwellings

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

The footnotes to this table make it clear that:

- the guidance is based on the current WHO recommendations and that the above internal levels can be relaxed by 5dB to achieve "reasonable" internal conditions;
- planning consent can be granted when external levels exceed the WHO guidance targets provided that appropriate internal noise levels are achieved;
- the levels shown in Table 4 assume normal diurnal fluctuations. *'In cases where local conditions do not follow a normal diurnal pattern, for example on a road serving a port with high levels of traffic at certain times of the night, an appropriate alternative period, e.g. 1 hour, may be used, but the level should be selected to ensure consistency with the levels recommended in Table 4'*.

It should be noted that BS8233:2014 does not include the 45dB LAmax[F] night time criterion that the previous version of BS8233 specified but for "regular individual noise events (for example, scheduled aircraft or passing trains)" which "can cause sleep disturbance. A guideline value may be set in terms of SEL or LAmax[F] depending on the character and number of events per night.

With regard to **external noise levels**, BS8233:2014 states:

"7.7.3.2 Design criteria for external noise

For traditional external areas that are used for amenity space, such as gardens and patios, it is desirable that the external noise level does not exceed 50 dB LAeq,T, with an upper guideline value of 55 dB LAeq,T which would be acceptable in noisier environments. However, it is also recognized that these guideline values are not achievable in all circumstances where development might be desirable. In higher noise areas, such as city centres or urban areas adjoining the strategic transport network, a compromise between elevated noise levels and other factors, such as the convenience of living in these locations or making efficient use of land resources to ensure development needs can be met, might be warranted. In such a situation, development should be designed to achieve the lowest practicable levels in these external amenity spaces, but should not be prohibited.

Other locations, such as balconies, roof gardens and terraces, are also important in residential buildings where normal external amenity space might be limited or not available, i.e. in flats, apartment blocks, etc. In these locations, specification of noise limits is not necessarily appropriate. Small balconies may be included for uses such as drying washing or growing pot plants, and noise limits should not be necessary for these uses. However, the general guidance on noise in amenity space is still appropriate for larger balconies, roof gardens and terraces, which might be intended to be used for relaxation. In high-noise areas, consideration should be given to protecting these areas by screening or building design to achieve the lowest practicable levels.

Achieving levels of 55 dB LAeq,T or less might not be possible at the outer edge of these areas, but should be achievable in some areas of the space."

From the wording, it is clear that there is no intention for the guideline noise levels to be applied to the general spaces external to apartment blocks and that the limits are only intended to apply to more private amenity spaces such as gardens and patios and larger balconies where residents would be expected to spend some time relaxing.

The wording of BS8233 also makes it clear that the guideline noise levels for gardens, patios, larger balconies etc, are not overriding planning considerations in any event.

2.3 Local Authority

Jonathan Henson, EHO at NKDC, was consulted about the site and it was agreed that noise and vibration monitoring for a week long survey would be required for this site.

It is understood that there has been an increase in rail traffic on this Doncaster-Lincoln-Peterborough line which has led to a number of complaints to NKDC (although not specifically from residents in Ruskington) and so NKDC would wish to see suitable acoustic protection built into this significant development of new housing.

3.0 ASSESSMENT CRITERIA – VIBRATION

3.1 National Planning Policy Framework

The National Planning Policy Framework document contains no specific regulations or guidelines regarding acceptable vibration levels but instead leaves local authorities to draw up planning policies and make decisions with the aim of avoiding noise [and presumably vibration] from giving rise to significant adverse impacts and quality of life as a result of new development. The Noise Policy Statement for England is referenced which sets out a generic long term vision for noise [and presumably vibration] policy supported by the following aims:

- To avoid significant adverse impacts on health and quality of life;
- Mitigate and minimise adverse impacts on health and quality of life; and
- Where possible, contribute to the improvement of health and quality of life.

It has therefore been assumed that the aims set out for noise impacts in this document also apply to vibration impacts. Noise/Vibration impacts which are “Noticeable and disruptive” should be avoided; however, it is the next level of disturbance “Noticeable and very disruptive” that should be prevented.

3.2 British Standard BS 6472-1:2008

Guide to evaluation of human exposure to vibration in buildings, Part 1: Vibration sources other than blasting, [Ref 8] provides guidance as the likelihood of adverse comment from vibration in buildings.

The standard uses the measure Vibration Dose Value or $VDV_{b/d}$, which is derived from frequency-weighted vibration measurements. The VDV is used to estimate the probability of adverse comment which might be expected from human beings experiencing vibration in buildings. Consideration is given to the time of day, the use made of occupied space (eg. residential, office, workshop, etc), whether the vibration is permanent or temporary (eg. from construction), the broad characteristics (continuous, intermittent, occasional etc), as well as the detailed characteristics (eg. constant/steady, varying in level, impulsive, etc).

The basic criteria are shown in Table 1 of BS 6472-1:2008. This table and the note which follows it, are shown below:-

Vibration dose value ranges which might result in various Probabilities of adverse comment within residential buildings			
Place and time	Low probability of adverse comment ($ms^{-1.75}$)	Adverse comment possible ($ms^{-1.75}$)	Adverse comment probable ($ms^{-1.75}$)
Residential buildings 16 h day	0.2 to 0.4	0.4 to 0.8	0.8 to 1.6

Residential buildings 8 h night	0.1 to 0.2	0.2 to 0.4	0.4 to 0.8

NOTE For offices and workshops, multiplying factors of 2 and 4 respectively should be applied to the above vibration dose value ranges for a 16 h day.

4.0 SITE DESCRIPTION

The site of the proposed development is a cultivated field, approximately square, situated to the North of Whitehouse Road and to the west of the Doncaster-Lincoln-Peterborough railway line. It is understood from Network Rail (and from observations made onsite) that this stretch of railway carries both regular freight and passenger services.

The railway line is at approximately the same level as the site and the rails appear to have been continuously welded as no 'jointed track' noise was audible. As well as reducing noise impact, continuously welded rails tend to lead to lower ground borne vibration levels.

The dominant noise source is likely to be rail traffic.

The preliminary site layout plan shown at Appendix 8 shows that

nearest façades of the proposed dwellings are some 17m from the nearest railhead.

5.0 NOISE & VIBRATION MEASUREMENTS

5.1 Noise Measurements

The site was visited on Tuesday 6th March 2017 and noise and vibration monitoring equipment was installed at a position some 9m from the nearest railhead to measure railway noise and vibration.

The site was revisited on Friday 9th March to check the equipment and carry out a battery change.

The meter was left gathering data for a total of 7 days from 6-13 March.

The weather conditions during the monitoring period were mainly cloudy and dry with occasional sunny intervals, temperatures were generally 1-10 degrees Celsius. Wind speeds were mainly low, 0-2 Beaufort Scale and were checked when onsite with a Kestrel 2000 hand held anemometer (s/n 2080552) to check that wind speed did not exceed 5m/s.

Weather information was from observations made at the time of the

site visits and also sourced from the Met Office website using the data for Waddington monitoring station, some 12 miles from site.

The sound level meter was a Svan type 948 (s/n 6593); mounted on a tripod at a height of 1.2m and fitted with a RION WSO2 “all-weather” wind muff. The meter calibrated correctly before and after the measurements using a Castle calibrator type GA607 (s/n 039893).

The meter and calibrator had been laboratory calibrated within the preceding 2 years.

5.2 Vibration Measurements

The Svan 948 meter was also used to carry out simultaneous measurements of vibration in vertical, and two horizontal directions [along the railway and perpendicular to the railway] by means of a Svantek SV84 accelerometer [s/n D2296], that had been calibrated in the preceding two years. The ground conditions at the measurement location were compacted soil.

The accelerometer was fixed to a heavy steel base plate that sat directly on the ground surface with a "sand bag" weighing down the accelerometer and achieving good coupling with the ground. The results were filtered using the vertical weighting network “Wb” and "Wd" for the horizontal directions, as appropriate.

6.0 NOISE RESULTS

6.1 Measurement Results – Rail Traffic

The main results are shown at Appendix 4 and the derived results below in Figure 1 together with the highest daily value and the arithmetic average of the weekday values.

The detailed frequency analysis results are shown at Appendix 4 and the arithmetically averaged results in Figure 2 below. Graph 1 below shows the variations in LAeq,1hr.

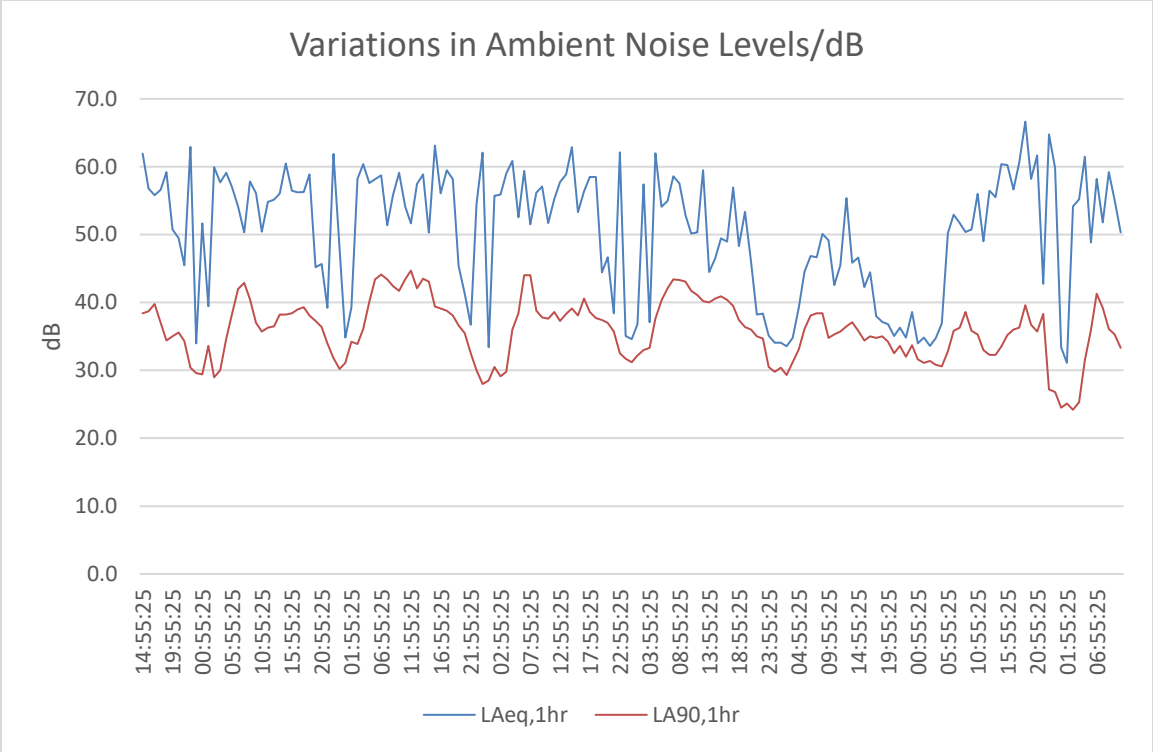
Start Day	LAeq,16hr	LAeq,8hr
Tues 6th	57.5	56.2
Wed 7th	56.5	56.8
Thurs 8th	56.7	58.3
Fri 9th	57.3	55.3
Sat 10th	53.6	40.9
Sun 11th	46.9	46.1
Mon 12th	59.8	56.7
Highest Day	**59.8**	**58.3**
Average	**55.5**	**52.9**

Figure 1: Derived Results/dB

The morning results of Tuesday 13th March have been combined with the later morning/afternoon/evening results of Tuesday 6th March to derive the 16hour period results for 6th March.

Frequency/Hz	63	125	250	500	1000	2000	4000	8000
Source Level/dBLin	**56.1**	**52.5**	**46.6**	**44.1**	**45.5**	**42.8**	**39.7**	**33.5**

Figure 2: Average Frequency Analysis Results/dBLin



Graph 1: Variations in LAeq,1hr – Rail Traffic

6.2 Subjective Assessments

It was noted at the time of the site visits that rail traffic noise was the dominant noise source. Other noise sources noted was light birdsong and occasional distant agricultural machinery.

Considering Graph 1 above, it can be seen that LA90 noise levels followed a fairly typical diurnal pattern but LAeq,1hr levels followed a much less pronounced diurnal pattern apart from the weekend period when fewer rail movements generally occur.

7.0 VIBRATION RESULTS

The detailed results are shown at Appendix 5. It can be seen that the highest results were recorded in the vertical direction. BS6472 states that the assessment should be performed for the most significant direction.

Figure 3 below shows the derived daytime and night time period VDVs (in $m/s^{1.75}$) using the formula taken from BS6472

Period $$VDV = \left(\sum_{n=1}^{n=N} VDVn^4 \right)^{0.25}$$

Where VDVn = hourly VDV values

Start Day	VDVb,day	VDVb,night
Tues 6th	0.048	0.038
Wed 7th	0.056	0.034
Thurs 8th	0.052	0.031
Fri 9th	0.058	0.030
Sat 10th	0.032	0.003
Sun 11th	0.039	0.010
Mon 12th	0.045	0.032
Highest	**0.058**	**0.038**
Average Wk Day	0.052	0.033

Figure 3: Derived period DVDs

The highest daily value and the arithmetic average of the weekday values are also shown.

The morning results of Tuesday 13th March have been combined with the later morning/afternoon/evening results of Tuesday 6th March to derive the 16hour period results for 6th March.

7.2 Subjective Observations – Vibration

It was noted at the times of the site visits that, when stood close to the monitoring position, vibration was only just perceptible through the soles of the feet when a passenger or freight train passed by.

8.0 ASSESSMENT OF RESULTS - NOISE

8.1 External Noise Levels – Rail Traffic - LAeq

As mentioned, the daytime and night time periods are given in terms of L_{Aeq},16 hour for day (07.00 -23.00) and L_{Aeq},8 hour for night (23.00 – 07.00).

The individual Daytime and Night time LAeqs are shown in Figure 1 above with the arithmetically averaged values and highest daily values.

However, monitoring was carried out at a position 9m from the nearest railhead whereas the nearest façade is to be at a distance of some 17m so a distance correction of -3dB is required.

The average Daytime **LAeq,16hr = 53dB** (56-3 to nearest whole number).

The average Night time **LAeq,8hr = 50dB** (53-3 to nearest whole number).

For worst case consideration the following internal noise level calculations use the highest daytime LAeq,16hr = **57dB** (60-3 Monday 12th) and highest night time LAeq,8hr = **55dB** (58-3 Thursday 8th).

8.2 Maximum Noise Levels – Rail Traffic

Considering the LAmax[F] levels from Graphs 2, 3 & 4 at Appendix 6, which show maximum night time noise levels for Fast weighting for four weekday nights and two weekend nights, the typical maximum noise level was 88dBA[F] at the monitoring position which equates to **85dBA[F]** at the nearest façade position.

It can be seen that there were virtually no night time train movements during the Saturday and Sunday nights.

9.0 ASSESSMENT OF RESULTS – VIBRATION

The Association of Noise Consultants (ANC) has produced a publication, 'Measurement & Assessment of Groundborne Noise & Vibration' [Ref 9] that includes guidance on appropriate transfer functions from in-ground vibration levels to completed buildings

constructed later on site.

Condition	Attenuation [dB]
Ground Surface to a Building Slab in contact with ground or if foundations on rock	0
Ground Surface to Timber frame building foundation	-5
Ground Surface into 2 to 4 storey masonry building	-10
Reduction per floor up the building 1-5 floors	-2
Reduction per floor up the building 5-10 floors	-1
Floor Resonance from walls to floor centre	+6

Here the measurement position corresponds to Ground Surface. It is assumed that the proposed dwelling would be of masonry construction and so the vibration levels would be as follows:

Ground Floor = Measured Level - 10 + 6 = Measured Level -4dB.

First Floor = Measured Level - 10 -2 + 6 = Measured Level -6dB.

VDV is directly proportional to the vibration level; therefore the transfer functions derived above can be taken into account using the following formula:

Difference in Levels in dB = 20 * Log (VDV_1/VDV_2)

Thus the highest measured daytime value of 0.058m/$s^{1.75}$ Wb equates to 0.036 m/$s^{1.75}$ Wb at the centre of the ground floor and 0.029 m/$s^{1.75}$ Wb at the centre of the first floor (for day time resting). These figures are well below the "low probability of adverse comment" threshold of 0.2m/$s^{1.75}$ contained in BS.6472-1:2008 for daytime vibration.

The highest measured night time value of 0.038 m/$s^{1.75}$ Wd equates to 0.024 m/$s^{1.75}$ Wd at the centre of the ground floor and 0.019 m/$s^{1.75}$ Wb at the centre of the first floor. These figures are again well below the "low probability of adverse comment" threshold of 0.1 m/$s^{1.75}$ contained in in BS.6472-1:2008 for night time vibration.

It should be noted that there are circumstances where magnification of vibration could occur; if for example the incident vibration coincided with a resonant frequency of a part of the structure, equally the type of foundation selected can alter the transmission of vibration to the structure; such considerations are beyond the scope of this study. Similarly on large sites vibration propagation conditions can vary across the site; consequently measurements at a single location, albeit relatively long term and covering numerous train movements, must be regarded in that light.

10.0 DISCUSSION OF PROPERTY NOISE LEVELS

10.1 External Noise Levels

With regard to daytime noise levels the average weekday external daytime noise levels of 56dB LAeq,16hr at the approximate position of the midpoint of the gardens nearest to the railway exceeds the maximum recommended level from BS8233:2014 of 55dB LAeq,16hr for amenity space such as garden or patio. It can be seen that each weekday LAeq,16hr exceeds the 55dB criteria.

It is therefore recommended that a 2m high close boarded acoustic timber fence is built along the eastern site boundary and returned along the northern and southern boundaries so noise levels would be expected to be some 10dB lower at **46dB LAeq,16hr** which meets the criteria with BS8233. The site plan at Appendix 9 shows the position of the acoustic fence.

10.2 Internal Noise levels

The above daytime LAeq, night time LAeq and LAmax[F] results can be combined with the average frequency analysis measurements shown in Figure 2 and used to predict internal noise levels using the methodology described in BS EN 12354-3:2000 [Ref 7].

The detailed results appear at Appendix 7 and are summarised below.

10.3 Glazing and Ventilation Calculations

For the purposes of prediction the following have been assumed:-

(**Please inform Acute Acoustics if any of the assumptions are incorrect**).

- Plot 9 ground floor Kitchen/Dining Room with glazed patio doors and windows that face the railway line, is the habitable room used for the daytime calculation, **LAeq,16hr = 47dB** (57-10) assuming 2m high acoustic fence.
- Plot 9 first floor Bedroom 2, with windows that face the railway line, is the habitable room used for the night time calculation, **LAeq,8hr = 55dB**, **LAmax[F] = 85dB**.
- The Living Room has a reverberation time of 0.5s, the Bedroom – 0.3s
- The walls are cavity masonry.
- Typical room and window dimensions have been assumed with ceiling heights of 2.4m.

10.4 Plot 9 Kitchen/Dining Room - Daytime

Volume	= 32m^3
Window & Patio Door Area	= 4.2m^2
Wall Area	= 6.4m^2

From Figure 4 at Appendix 7, it can be seen that the predicted internal daytime noise level of **24dB LAeq,16hr for 4/12/4 thermal**

glazing and 2 x trickle vents with indirect air path providing 8000mm^2 of ventilation meets the BS8233 criterion of ≤35dBA for daytime with a safety margin of 12dB.

10.5 Plot 9 Bedroom 2 – Night time

Volume	= 18m^3
Window Area	= 1.4m^2
Wall Area	= 4.1m^2

From Figure 5 at Appendix 7, it can be seen that the predicted internal night time noise level of **14dB LAeq,16hr** for **8/12/8.4A acoustic glazing and a Greenwood MA3051 Acoustic Wall Vent** meets the BS8233 criterion of ≤30dBA for night time with a safety margin of 17dB.

BS8233:2014 does not contain recommendations for night time Lmax levels. Purely as a comparison, the previous version recommended that regular night time events should not exceed 45dBA[F] LAmax. Here the bedroom building envelope reduces noise by 41dBA so typical internal LAmax levels would be **44dB[F]** (85-41) which meets the criterion of individual noise events not normally exceeding 45dB LAmax[F] at night time.

With regard to **daytime**, the predicted internal noise level is **16dB**

LAeq,16hr [57-41] which meets the BS8233 criterion of ≤35dBA for daytime resting within bedrooms.

10.6 Preliminary Glazing and Ventilation Summary

All **first floor bedrooms in Zone 1** that overlook or have a significant view of the railway to be fitted with 8/12/8.4A acoustic glazing (*or alternative with minimum 40dB Rw*) coupled with a Greenwood MA3051 Acoustic Wall Vent (*or alternative with minimum 55dB Dnew).* - **Glazing/Ventilation Package A**

All **first floor bedrooms in Zone 2** that overlook or have a significant view of the railway to be fitted with 10/12/6 glazing (*or alternative with minimum 37dB Rw*) coupled with a Passivent TVALdN 450 Acoustic Trickle Vent (*or alternative with minimum 40dB Dnew).* - **Glazing/Ventilation Package B.**

All other bedrooms not included above to be fitted with 4/12/4 or 4/16/4 thermal glazing, well-sealed when closed, with a trickle vent with indirect air path – **Glazing Package C**.

All other rooms to be fitted with 4/12/4 or 4/16/4 thermal glazing, well-sealed when closed, with a trickle vent with indirect air path – **Glazing Package C**.

The site plan at Appendix 9 shows Zones 1 & 2.

10.7 Mechanical Ventilation

In order to provide rapid cooling to bedrooms in Zones 1 & 2 that overlook or have a significant view of the railway without opening windows, it is recommended that the trickle ventilation should be combined with a Mechanical Extract Ventilation (MEV) or a Positive Input Ventilation (PIV) system which extracts/supplies air from the habitable rooms, but which does not allow significant noise to enter from the outside, either because of the system's attenuation or because it vents to a quiet façade. Either 'whole house' or 'room by room' solutions are available.

11.0 CONCLUSIONS

11.1 In summary it is recommended that:-

1. A 2m high close boarded timber fence is built along the eastern site boundary and returned along the northern and southern boundaries.
2. Walls – brick/block cavity, brick clad timber frame or timber frame with light weight cladding.

3. Roof – Tiled/slated roof, 10kg/m^2 plasterboard ceiling, 100mm sound absorbing layer above the ceiling (e.g. mineral wool loft insulation) **or roof type of equivalent performance**.
4. All **first floor bedrooms in Zone 1** that overlook or have a significant view of the railway to be fitted with 8/12/8.4A acoustic glazing (*or alternative with minimum 40dB Rw*) coupled with a Greenwood MA3051 Acoustic Wall Vent (*or alternative with minimum 55dB Dnew).* - **Glazing/Ventilation Package A**.
5. All **first floor bedrooms in Zone 2** that overlook or have a significant view of the railway to be fitted with 10/12/6 glazing (*or alternative with minimum 37dB Rw*) coupled with a Passivent TVALdN 450 Acoustic Trickle Vent (*or alternative with minimum 40dB Dnew).* - **Glazing/Ventilation Package B**.
6. All other bedrooms not included above to be fitted with 4/12/4 or 4/16/4 thermal glazing, well-sealed when closed, with a trickle vent with indirect air path – **Glazing Package C**.
7. All other rooms to be fitted with 4/12/4 or 4/16/4 thermal glazing, well-sealed when closed, with a trickle vent with indirect air path – **Glazing Package C**.
8. In order to provide rapid cooling to bedrooms in Zones 1 & 2 that overlook or have a significant view of the railway without opening windows, it is recommended that the trickle ventilation should be combined with a Mechanical Extract

Ventilation (MEV) or a Positive Input Ventilation (PIV) system which extracts/supplies air from the habitable rooms, but which does not allow significant noise to enter from the outside, either because of the system's attenuation or because it vents to a quiet façade. Either ‘whole house’ or ‘room by room’ solutions are available.

APPENDIX 1

EXPLANATION OF ACOUSTIC TERMS

The dB or the decibel, is the unit of noise. The number of decibels or the level, is measured using a sound level meter. It is common for the sound level meter to filter or 'weight' the incoming sound so as to mimic the frequency response of the human ear. Such measurements are designated **dB(A).**

A doubling of the sound is perceived, by most people, when the level has increased by 10 dB(A). The least discernible difference is 2 dB(A). Thus most people cannot distinguish between, say 30 and 31 dB(A).

If a noise varies over time then the **equivalent continuous level, or LAeq**, is the notional constant level of noise which would contain the same amount of acoustic energy as the time varying noise.
The following table gives an indication of the comparative loudness of various noises expressed in terms of the A weighted scale:

Source of noise	dB(A)	Nature of Noise
Inside Quiet bedroom at night	30	Very Quiet
Quiet office	40	
Rural background noise	45	
Normal conversational level	60	
Busy restaurant	65	
Typewriter @ 1m	73	
Inside suburban electric train	76	
Alarm clock ringing @ .5m	80	
Hand clap @ 1m	80	
HGV accelerating @ 6m	92	Very Loud

APPENDIX 2

The measurements were carried out and the report prepared by Peter Dyson of Acute Acoustics Ltd., a consultancy company which specialises in Environmental and Workplace Noise.

He holds the Institute of Acoustics Diploma in Acoustics and Noise Control, a Bachelor's degree in Mechanical Engineering, The Institute of Acoustics Certificates of Competence in Environmental Noise Assessment and in Workplace Noise Measurement. He is a Member of the Institute of Acoustics.

He is also an ANC accredited Sound Insulation tester for Martec Environmental Consultants Ltd., a consultancy company which also specialises in Environmental and Workplace Noise.

Acute Acoustics Ltd is a member of the Association of Noise Consultants.

APPENDIX 3

REFERENCES

1 National Planning Policy Guidance – Noise - http://planningguidance.planningportal.gov.uk/blog/guidance/noise/noise-guidance/

2 BS4142:1997 "Method for Rating Industrial Noise affecting mixed Residential and Industrial Areas".

3 Planning Policy Guidance 24: Planning and Noise. – http://www.communities.gov.uk/publications/planningandbuilding/ppg24

4 BS.8233: 'Guidance on Sound Insulation and Noise Reduction for Buildings'

5 Calculation of Road Traffic Noise (CRTN) – Department of Transport and the Welsh Office, HMSO,1988, ISBN 0-11-550847-3

6 Method for Converting the UK Road Traffic Noise Index $L_{A10,18h}$ to the EU Noise Indices for Road Noise Mapping – TRL/Casella Stanger http://www.defra.gov.uk/environment/quality/noise/research/crtn/documents/noise-crtn-update2006.pdf

7 BS EN 12354-3:2000 *Building Acoustics-Estimation of Acoustic Performance in buildings from the performance of elements. Part 3 Airborne sound Insulation against outdoor sound*

8 BS 6472-1:2008 "Guide to evaluation of human exposure to vibration in buildings - Part 1: Vibration sources other than blasting"

9 ANC Guidelines "Measurement and Assessment of Groundborne Noise & Vibration" - The Association of Noise Consultants 2001

APPENDIX 4

Detailed Main Results – Rail Noise

Day/Date	Start Time	Duration,T	LAeq,T	LA1	LA10	LA90	LAmax[F]
Tues 6	14:55:25	01:00:00	62.0	64	48	38.4	90.4
Tues 6	15:55:25	01:00:00	56.8	61.1	48	38.7	89.4
Tues 6	16:55:25	01:00:00	55.8	67.1	46.8	39.8	84.4
Tues 6	17:55:25	01:00:00	56.6	70	43.1	37	86.7
Tues 6	18:55:25	01:00:00	59.2	64.5	41.9	34.4	90.8
Tues 6	19:55:25	01:00:00	50.8	52.9	41.4	35	82.7
Tues 6	20:55:25	01:00:00	49.5	55.6	52.5	35.6	76.6
Tues 6	21:55:25	01:00:00	45.5	50.7	48.7	34.3	68.0
Tues 6	22:55:25	01:00:00	62.9	74.6	43.4	30.4	90.7
Tues 6	23:55:25	01:00:00	34.0	40.7	35.8	29.6	62.0
Wed 7	00:55:25	01:00:00	51.7	49.1	36.9	29.4	80.9
Wed 7	01:55:25	01:00:00	39.5	45.8	43	33.6	65.7
Wed 7	02:55:25	01:00:00	60.0	75.1	39.8	29	86.5
Wed 7	03:55:25	01:00:00	57.7	58	37.2	30	86.6
Wed 7	04:55:25	01:00:00	59.1	73.7	43.9	34.7	87.4
Wed 7	05:55:25	01:00:00	57.0	62.6	50.5	38.3	86.0
Wed 7	06:55:25	01:00:00	54.1	63.5	54.6	42	79.7
Wed 7	07:55:25	01:00:00	50.3	59.1	50.3	42.9	76.9
Wed 7	08:55:25	01:00:00	57.8	67.5	52.9	40.5	88.9
Wed 7	09:55:25	01:00:00	56.1	65.6	53.6	37	87.1
Wed 7	10:55:25	01:00:00	50.4	61.8	51.5	35.7	76.6
Wed 7	11:55:25	01:00:00	54.8	64.5	51	36.3	83.3
Wed 7	12:55:25	01:00:00	55.2	65.1	46.9	36.5	84.1
Wed 7	13:55:25	01:00:00	56.0	69.1	45.8	38.2	83.0
Wed 7	14:55:25	01:00:00	60.5	64.6	46.5	38.2	88.9
Wed 7	15:55:25	01:00:00	56.5	56.4	43.3	38.4	89.2
Wed 7	16:55:25	01:00:00	56.2	69.1	45.4	39	85.8
Wed 7	17:55:25	01:00:00	56.3	69.1	44.2	39.3	86.6
Wed 7	18:55:25	01:00:00	58.9	63.2	43.9	38.1	90.1
Wed 7	19:55:25	01:00:00	45.2	47.2	43.4	37.3	76.5
Wed 7	20:55:25	01:00:00	45.7	48.3	43.1	36.4	77.2
Wed 7	21:55:25	01:00:00	39.2	46.4	41.8	34	56.6
Wed 7	22:55:25	01:00:00	61.9	75	40	31.8	88.3
Wed 7	23:55:25	01:00:00	48.0	46.9	39.2	30.2	76.5
Thur 8	00:55:25	01:00:00	34.8	41.9	37.2	31.1	48.7
Thur 8	01:55:25	01:00:00	39.2	45.9	42.5	34.2	49.5

Thur 8	02:55:25	01:00:00	58.2	72.7	40.7	33.9	85.4
Thur 8	03:55:25	01:00:00	60.4	74.3	42.1	36.1	86.2
Thur 8	04:55:25	01:00:00	57.6	71.7	47.5	40.1	86.3
Thur 8	05:55:25	01:00:00	58.2	68.5	54.2	43.4	86.3
Thur 8	06:55:25	01:00:00	58.7	70.3	52.6	44.1	88.2
Thur 8	07:55:25	01:00:00	51.4	61.3	51.7	43.4	76.4
Thur 8	08:55:25	01:00:00	55.8	69.1	52.7	42.4	83.0
Thur 8	09:55:25	01:00:00	59.1	72.6	54.8	41.7	86.8
Thur 8	10:55:25	01:00:00	54.2	64.8	55.7	43.4	83.5
Thur 8	11:55:25	01:00:00	51.7	60.4	54.6	44.7	71.6
Thur 8	12:55:25	01:00:00	57.4	69.9	55	42.1	84.5
Thur 8	13:55:25	01:00:00	58.9	70.6	58.3	43.5	86.1
Thur 8	14:55:25	01:00:00	50.3	59.6	53.3	43.1	71.2
Thur 8	15:55:25	01:00:00	63.1	76.4	49.9	39.4	89.4
Thur 8	16:55:25	01:00:00	56.1	66.1	46.5	39.1	86.5
Thur 8	17:55:25	01:00:00	59.5	73.8	45.6	38.8	87.5
Thur 8	18:55:25	01:00:00	58.2	66.5	44.2	38.1	88.5
Thur 8	19:55:25	01:00:00	45.4	45.1	41.2	36.6	77.6
Thur 8	20:55:25	01:00:00	41.3	43.8	40	35.5	71.3
Thur 8	21:55:25	01:00:00	36.7	42.3	39.1	32.5	55.3
Thur 8	22:55:25	01:00:00	54.5	49.6	36.4	30	86.5
Thur 8	23:55:25	01:00:00	62.1	54.4	37.5	28	90.6
Fri 9	00:55:25	01:00:00	33.4	43.1	35.6	28.5	49.8
Fri 9	01:55:25	01:00:00	55.7	48.9	41.7	30.5	82.5
Fri 9	02:55:25	01:00:00	55.9	52.6	37.3	29.1	86.2
Fri 9	03:55:25	01:00:00	59.0	72.6	38.4	29.8	86.3
Fri 9	04:55:25	01:00:00	60.9	74.8	42.9	36	86.9
Fri 9	05:55:25	01:00:00	52.6	64.1	52.3	38.4	83.2
Fri 9	06:55:25	01:00:00	59.4	68.1	52.5	44	88.2
Fri 9	07:55:25	01:00:00	51.5	60.6	51.9	44	77.7
Fri 9	08:55:25	01:00:00	56.2	63.3	50.9	38.8	84.5
Fri 9	09:55:25	01:00:00	57.1	60.6	49.1	37.8	88.7
Fri 9	10:55:25	01:00:00	51.7	59	45.6	37.6	76.0
Fri 9	11:55:25	01:00:00	55.3	66.8	46.8	38.6	81.2
Fri 9	12:55:25	01:00:00	57.7	66.2	43.6	37.3	87.4
Fri 9	13:55:25	01:00:00	58.9	71	45.7	38.3	88.6
Fri 9	14:55:25	01:00:00	62.9	63.6	45.7	39.1	91.2
Fri 9	15:55:25	01:00:00	53.3	67.4	44.9	38.1	79.5
Fri 9	16:55:25	01:00:00	56.4	66	45.5	40.6	85.0
Fri 9	17:55:25	01:00:00	58.5	73.2	44.7	38.6	84.2
Fri 9	18:55:25	01:00:00	58.5	61.4	42.7	37.7	88.8

Fri 9	19:55:25	01:00:00	44.4	44.7	40.9	37.4	76.5
Fri 9	20:55:25	01:00:00	46.7	45.4	41.9	37	78.6
Fri 9	21:55:25	01:00:00	38.4	43.4	40.2	35.7	48.7
Fri 9	22:55:25	01:00:00	62.1	73.5	39	32.5	90.2
Fri 9	23:55:25	01:00:00	35.1	41.6	37.3	31.7	48.9
Sat 10	00:55:25	01:00:00	34.6	40.8	37.1	31.2	46.6
Sat 10	01:55:25	01:00:00	36.8	42.9	40	32.2	49.2
Sat 10	02:55:25	01:00:00	57.4	72.5	47.3	33	84.9
Sat 10	03:55:25	01:00:00	37.1	43.4	40.5	33.3	45.8
Sat 10	04:55:25	01:00:00	62.0	75.7	43.6	37.6	91.2
Sat 10	05:55:25	01:00:00	54.1	66.7	56.4	40.3	77.2
Sat 10	06:55:25	01:00:00	55.0	66.3	55.6	42.1	79.7
Sat 10	07:55:25	01:00:00	58.6	65.2	52.2	43.4	89.4
Sat 10	08:55:25	01:00:00	57.6	63.3	50.4	43.3	89.0
Sat 10	09:55:25	01:00:00	52.9	59	50.2	43.1	81.1
Sat 10	10:55:25	01:00:00	50.2	56.3	48	41.7	79.9
Sat 10	11:55:25	01:00:00	50.3	54.8	47.6	41.1	80.9
Sat 10	12:55:25	01:00:00	59.5	74	49.2	40.2	87.1
Sat 10	13:55:25	01:00:00	44.5	53.8	45.3	40	64.6
Sat 10	14:55:25	01:00:00	46.5	54.9	46.4	40.6	73.1
Sat 10	15:55:25	01:00:00	49.4	55.7	46.1	40.9	77.4
Sat 10	16:55:25	01:00:00	49.0	52.6	45.5	40.4	77.9
Sat 10	17:55:25	01:00:00	57.0	63.7	45	39.5	87.3
Sat 10	18:55:25	01:00:00	48.3	48.8	41.7	37.4	79.4
Sat 10	19:55:25	01:00:00	53.4	52.7	41.1	36.4	82.2
Sat 10	20:55:25	01:00:00	46.0	47.2	41.2	36	75.9
Sat 10	21:55:25	01:00:00	38.2	43.8	40.5	35	50.7
Sat 10	22:55:25	01:00:00	38.4	43.9	40.8	34.7	49.8
Sat 10	23:55:25	01:00:00	35.1	42.7	37.7	30.5	49.7
Sun 11	00:55:25	01:00:00	34.1	42	36.5	29.8	49.2
Sun 11	01:55:25	01:00:00	34.1	40.3	36.5	30.4	45.8
Sun 11	02:55:25	01:00:00	33.6	41.1	36.2	29.3	49.7
Sun 11	03:55:25	01:00:00	34.8	41.8	36.5	31.2	52.8
Sun 11	04:55:25	01:00:00	39.2	47.5	41.7	33.1	63.3
Sun 11	05:55:25	01:00:00	44.6	54.5	48.2	36.1	65.7
Sun 11	06:55:25	01:00:00	46.9	58.1	49.2	38.1	66.0
Sun 11	07:55:25	01:00:00	46.7	57.9	48.6	38.4	66.0
Sun 11	08:55:25	01:00:00	50.1	62.2	51.5	38.4	72.9
Sun 11	09:55:25	01:00:00	49.1	61.9	50.1	34.8	72.5
Sun 11	10:55:25	01:00:00	42.6	53.8	44.6	35.3	62.9
Sun 11	11:55:25	01:00:00	45.5	56.9	46.1	35.7	67.6

Sun 11	12:55:25	01:00:00	55.4	58.7	49	36.5	85.0
Sun 11	13:55:25	01:00:00	45.9	56.7	46.5	37.1	68.9
Sun 11	14:55:25	01:00:00	46.6	59.4	46.4	35.8	70.5
Sun 11	15:55:25	01:00:00	42.3	55.1	41.1	34.4	67.5
Sun 11	16:55:25	01:00:00	44.5	57.2	43.1	35	68.1
Sun 11	17:55:25	01:00:00	38.0	44.7	39.5	34.8	56.9
Sun 11	18:55:25	01:00:00	37.2	42.1	38.9	35	49.1
Sun 11	19:55:25	01:00:00	36.8	42.8	38.4	34.2	51.9
Sun 11	20:55:25	01:00:00	35.0	40.7	36.8	32.5	50.0
Sun 11	21:55:25	01:00:00	36.3	40.9	38.5	33.6	45.3
Sun 11	22:55:25	01:00:00	34.8	43.1	36.4	32	46.4
Sun 11	23:55:25	01:00:00	38.6	44.6	41.9	33.7	50.0
Mon 12	00:55:25	01:00:00	34.0	37.9	35.7	31.6	45.1
Mon 12	01:55:25	01:00:00	34.8	40.6	36.1	31.1	67.0
Mon 12	02:55:25	01:00:00	33.6	37.9	35.3	31.4	54.6
Mon 12	03:55:25	01:00:00	34.8	43.8	35.2	30.8	58.5
Mon 12	04:55:25	01:00:00	36.9	47.7	37.8	30.6	63.8
Mon 12	05:55:25	01:00:00	50.2	59	49.7	32.8	82.2
Mon 12	06:55:25	01:00:00	52.9	62.3	51	35.8	79.0
Mon 12	07:55:25	01:00:00	51.7	62	52.2	36.3	79.2
Mon 12	08:55:25	01:00:00	50.4	61.2	49.9	38.6	76.9
Mon 12	09:55:25	01:00:00	50.8	61.8	49.2	35.8	78.9
Mon 12	10:55:25	01:00:00	56.0	62.7	47.9	35.3	85.5
Mon 12	11:55:25	01:00:00	49.0	55.4	45.7	33	78.8
Mon 12	12:55:25	01:00:00	56.5	62.8	46.1	32.3	87.1
Mon 12	13:55:25	01:00:00	55.5	64	42	32.3	86.4
Mon 12	14:55:25	01:00:00	60.4	65.9	43.3	33.5	89.1
Mon 12	15:55:25	01:00:00	60.3	73.4	43.5	35.2	89.0
Mon 12	16:55:25	01:00:00	56.6	62.2	44.7	36	87.6
Mon 12	17:55:25	01:00:00	60.6	71.9	46.8	36.3	88.8
Mon 12	18:55:25	01:00:00	66.7	79.8	63.8	39.6	90.5
Mon 12	19:55:25	01:00:00	58.2	71.2	47.9	36.7	86.0
Mon 12	20:55:25	01:00:00	61.7	73	47.7	35.7	94.3
Mon 12	21:55:25	01:00:00	42.8	51	45	38.3	58.7
Mon 12	22:55:25	01:00:00	64.8	76.1	44.6	27.2	95.5
Mon 12	23:55:25	01:00:00	59.8	72.3	35.8	26.8	88.1
Tues 13	00:55:25	01:00:00	33.4	45.2	33.6	24.5	59.5
Tues 13	01:55:25	01:00:00	31.1	39.5	35.1	25.1	45.8
Tues 13	02:55:25	01:00:00	54.2	53.3	34.9	24.2	84.9
Tues 13	03:55:25	01:00:00	55.2	49.1	34.3	25.3	86.2
Tues 13	04:55:25	01:00:00	61.5	74.6	41.9	31.5	91.3

Tues 13	05:55:25	01:00:00	48.8	56.9	50	35.9	78.2
Tues 13	06:55:25	01:00:00	58.2	64.1	51.7	41.3	87.0
Tues 13	07:55:25	01:00:00	51.8	61.1	50	39.2	78.8
Tues 13	08:55:25	01:00:00	59.2	68.8	51.2	36.1	90.1
Tues 13	09:55:25	01:00:00	55.1	65.8	48.2	35.3	85.0
Tues 13	10:55:25	01:00:00	50.4	58.9	47.2	33.3	80.8

Detailed Frequency Analysis Results – Rail Noise/dBLin

Frequency/Hz																							
50	**63**	**80**	**100**	**125**	**160**	**200**	**250**	**315**	**400**	**500**	**630**	**800**	**1000**	**1250**	**1600**	**2000**	**2500**	**3150**	**4000**	**5000**	**6300**	**8000**	**10000**
59	58	56	59	55	51	51	49	47	47	46	50	53	53	50	56	53	50	45	44	41	38	33	27
51	55	56	59	52	52	51	48	47	46	45	48	49	50	48	45	45	43	41	40	38	35	32	27
55	55	56	56	60	52	50	49	48	46	44	47	45	46	46	45	45	44	42	41	38	35	29	24
60	60	57	58	58	50	48	45	48	44	44	47	48	49	47	46	46	44	42	40	38	35	29	25
55	54	56	54	55	48	48	47	44	47	46	50	52	52	50	50	48	46	44	43	39	36	31	26
47	46	50	53	41	42	45	37	36	35	38	39	42	44	41	41	39	37	36	36	36	37	36	34
48	50	45	43	50	40	35	33	32	35	35	45	42	42	39	36	38	35	34	34	31	27	23	21
48	52	46	42	44	37	32	29	29	35	40	40	39	38	37	34	29	24	18	16	17	18	19	20
60	56	59	57	56	51	50	48	47	48	45	48	51	51	53	58	55	51	47	46	43	39	32	26
46	43	41	39	34	32	30	25	24	24	26	27	27	26	24	21	18	15	15	16	17	18	19	20
57	63	55	56	50	48	48	46	44	42	41	44	44	43	41	41	40	37	34	34	33	28	25	23
47	45	43	42	38	35	33	29	27	27	30	33	34	33	30	26	22	16	15	16	17	18	19	20
62	58	59	59	59	55	52	51	49	48	46	48	49	49	50	52	51	49	46	44	42	39	33	27
54	52	59	54	54	50	49	45	42	44	43	48	50	50	50	48	48	45	43	41	37	34	28	23
60	58	60	60	58	54	53	49	47	48	46	50	51	51	49	50	48	47	45	43	40	37	31	26
58	57	57	56	53	49	48	45	42	46	44	46	47	46	46	48	49	46	42	42	44	40	30	24
51	50	51	53	44	48	48	42	43	39	39	41	43	44	42	40	42	41	44	45	46	41	31	23
51	49	47	47	43	42	41	41	40	38	36	39	41	42	39	37	37	37	36	38	43	39	26	21
56	56	56	56	55	51	49	49	48	47	45	48	49	50	48	47	46	45	43	44	46	43	34	25
54	54	55	55	55	53	52	51	49	48	46	46	47	47	46	45	45	43	40	40	43	39	31	24
48	49	48	50	51	47	45	47	47	45	43	40	41	39	38	36	37	35	33	35	40	35	23	20
56	54	54	53	53	52	52	50	47	45	42	43	43	45	44	43	46	44	40	39	41	36	28	23
54	53	55	54	54	50	50	49	47	46	43	45	45	46	45	45	45	44	41	40	37	34	28	24
58	56	58	57	57	51	50	49	47	46	44	45	46	48	46	46	45	44	42	40	38	35	30	26
59	57	58	61	56	51	50	47	47	47	47	51	53	52	49	53	51	48	44	43	40	36	30	25
52	53	58	54	52	51	50	49	46	45	45	47	49	48	48	44	44	44	45	40	38	34	32	26

56	54	57	59	53	49	48	47	47	44	43	45	46	49	47	45	47	44	42	40	38	35	28	23
56	60	58	57	60	51	47	46	48	46	44	47	47	48	46	46	46	44	41	41	38	34	29	24
61	60	60	60	59	52	50	47	45	46	46	49	51	51	50	49	48	47	45	43	40	36	31	26
47	51	44	41	38	36	36	33	33	33	34	36	38	38	35	34	33	34	30	32	26	25	21	20
46	44	43	42	39	38	37	37	37	35	34	35	36	38	37	35	36	34	32	30	27	24	20	20
46	44	42	43	42	37	31	27	27	30	32	32	33	33	29	25	20	16	15	16	17	18	19	20
63	59	60	61	59	53	52	49	46	47	46	49	51	51	52	56	53	50	46	45	42	38	32	27
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Arithmetically Averaged Frequency Analysis Results – Rail Noise/dBLin

Frequency/Hz																						
50	**63**	**80**	**100**	**125**	**160**	**200**	**250**	**315**	**400**	**500**	**630**	**800**	**1000**	**1250**	**1600**	**2000**	**2500**	**3150**	**4000**	**5000**	**6300**	**8000**	**10000**
52	51	50	50	47	45	44	41	40	39	39	40	41	41	40	39	38	37	35	35	34	32	27	23
	56			**53**			**47**			**44**			**45**			**43**			**40**			**34**	

APPENDIX 5

Vibration Detailed Results – Railway/dB

Day/Date	Start Time	Duration,T	VDV [m/s^1.75]	VDV [m/s^1.75]	VDV [m/s^1.75]
Tues 6	14:55:25	01:00:00	0.005559043	0.004446313	0.021208014
Tues 6	15:55:25	01:00:00	0.010435181	0.009874156	0.042413098
Tues 6	16:55:25	01:00:00	0.003552221	0.007524887	0.021727012
Tues 6	17:55:25	01:00:00	0.004758828	0.007413102	0.0251478
Tues 6	18:55:25	01:00:00	0.004523765	0.00614469	0.020346982
Tues 6	19:55:25	01:00:00	0.001066596	0.003732502	0.007585776
Tues 6	20:55:25	01:00:00	0.001004616	0.001011579	0.005260173
Tues 6	21:55:25	01:00:00	0.000820352	0.001031573	0.014979593
Tues 6	22:55:25	01:00:00	0.005597576	0.00572796	0.024888573
Tues 6	23:55:25	01:00:00	0.000502343	0.00053765	0.000533949
Wed 7	00:55:25	01:00:00	0.002837919	0.004634469	0.01761976
Wed 7	01:55:25	01:00:00	0.000479181	0.00048809	0.00049831
Wed 7	02:55:25	01:00:00	0.005122713	0.006776415	0.032998941
Wed 7	03:55:25	01:00:00	0.003643343	0.004461696	0.021627185
Wed 7	04:55:25	01:00:00	0.004988845	0.005888437	0.025351286
Wed 7	05:55:25	01:00:00	0.002958012	0.003868121	0.016768723
Wed 7	06:55:25	01:00:00	0.001513561	0.002246467	0.011885022
Wed 7	07:55:25	01:00:00	0.000985145	0.001061696	0.005741165
Wed 7	08:55:25	01:00:00	0.00312968	0.00548277	0.022335722
Wed 7	09:55:25	01:00:00	0.003044388	0.013396767	0.021379621
Wed 7	10:55:25	01:00:00	0.002457537	0.002847738	0.005451299
Wed 7	11:55:25	01:00:00	0.004528976	0.004430982	0.020464446
Wed 7	12:55:25	01:00:00	0.005248075	0.005260173	0.021453591
Wed 7	13:55:25	01:00:00	0.003784426	0.006942246	0.036433425
Wed 7	14:55:25	01:00:00	0.002700847	0.004270709	0.020917029
Wed 7	15:55:25	01:00:00	0.003868121	0.004544645	0.019186687
Wed 7	16:55:25	01:00:00	0.00423643	0.004847301	0.041352331
Wed 7	17:55:25	01:00:00	0.002837919	0.004270709	0.020773037
Wed 7	18:55:25	01:00:00	0.003396253	0.004451435	0.019565908
Wed 7	19:55:25	01:00:00	0.000751623	0.005438761	0.00459727
Wed 7	20:55:25	01:00:00	0.000820352	0.00076913	0.003618262
Wed 7	21:55:25	01:00:00	0.000475335	0.000486407	0.000394912
Wed 7	22:55:25	01:00:00	0.005308844	0.009908319	0.043102256
Wed 7	23:55:25	01:00:00	0.002338837	0.003467369	0.016481624

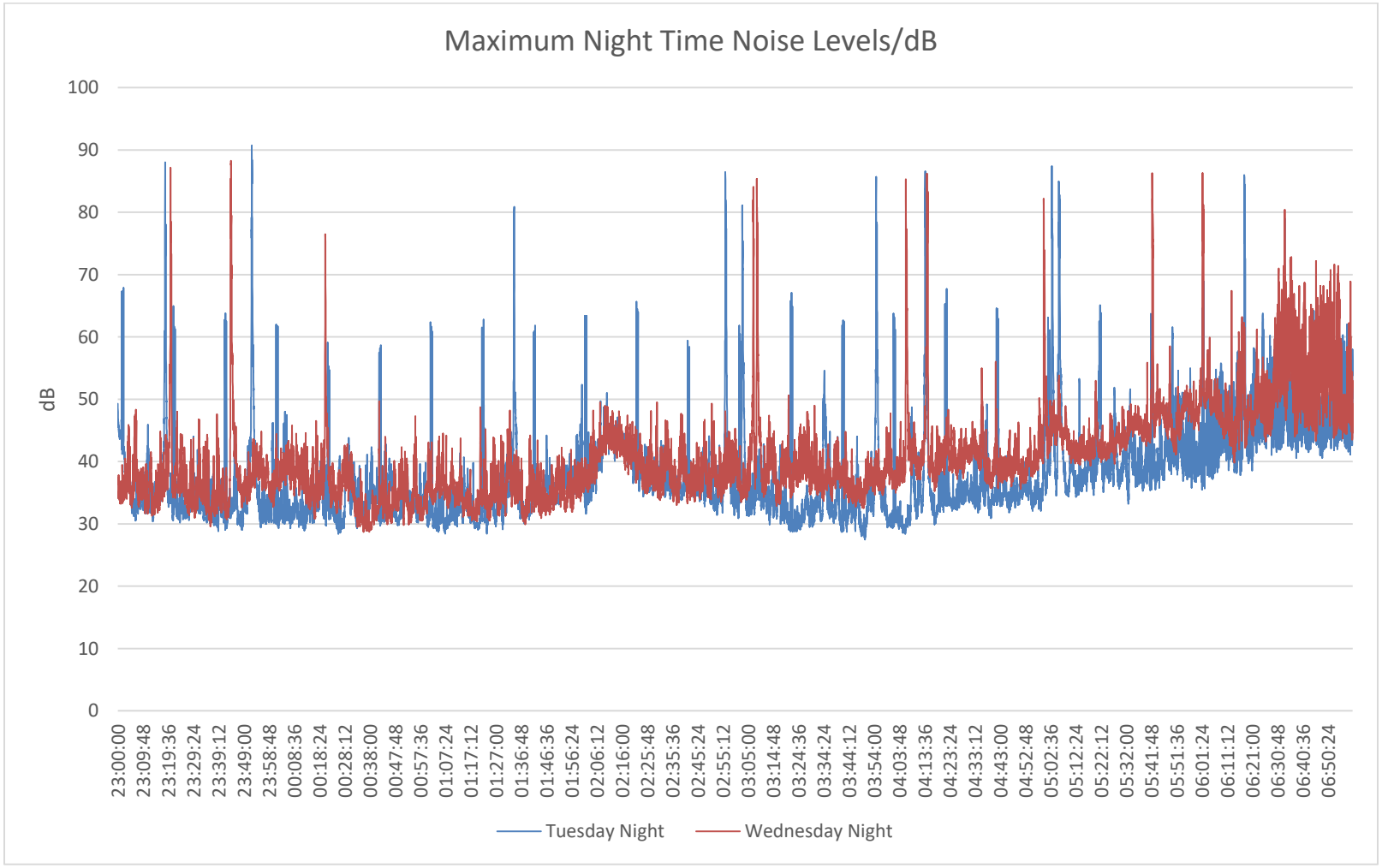
Thur 8	00:55:25	01:00:00	0.000484172	0.000492606	0.000396735
Thur 8	01:55:25	01:00:00	0.000473151	0.000491473	0.000397192
Thur 8	02:55:25	01:00:00	0.004135233	0.004841724	0.020941125
Thur 8	03:55:25	01:00:00	0.003715352	0.004769798	0.022335722
Thur 8	04:55:25	01:00:00	0.0033458	0.004405549	0.02053525
Thur 8	05:55:25	01:00:00	0.003209963	0.004965923	0.020511622
Thur 8	06:55:25	01:00:00	0.003767038	0.00616595	0.026121614
Thur 8	07:55:25	01:00:00	0.001122018	0.001025652	0.005357967
Thur 8	08:55:25	01:00:00	0.004178304	0.00597723	0.029107171
Thur 8	09:55:25	01:00:00	0.003392345	0.003912911	0.018879913
Thur 8	10:55:25	01:00:00	0.000972747	0.001090184	0.006375291
Thur 8	11:55:25	01:00:00	0.000949511	0.001114295	0.004335109
Thur 8	12:55:25	01:00:00	0.004420791	0.017498467	0.022105483
Thur 8	13:55:25	01:00:00	0.005052426	0.006737519	0.02618183
Thur 8	14:55:25	01:00:00	0.001153453	0.001333521	0.004360136
Thur 8	15:55:25	01:00:00	0.005623413	0.009057326	0.035727284
Thur 8	16:55:25	01:00:00	0.003810658	0.004836153	0.036643757
Thur 8	17:55:25	01:00:00	0.004295364	0.004948801	0.038681205
Thur 8	18:55:25	01:00:00	0.003326596	0.004677351	0.02032357
Thur 8	19:55:25	01:00:00	0.000698232	0.000833681	0.004948801
Thur 8	20:55:25	01:00:00	0.000946237	0.000798914	0.002999163
Thur 8	21:55:25	01:00:00	0.000490343	0.000490343	0.000375405
Thur 8	22:55:25	01:00:00	0.003090295	0.00419276	0.018030177
Thur 8	23:55:25	01:00:00	0.004539416	0.005861382	0.018302061
Fri 9	00:55:25	01:00:00	0.000503501	0.000533949	0.000556545
Fri 9	01:55:25	01:00:00	0.003247132	0.004698941	0.018728371
Fri 9	02:55:25	01:00:00	0.003890451	0.004130475	0.015703628
Fri 9	03:55:25	01:00:00	0.003315126	0.003985658	0.019611012
Fri 9	04:55:25	01:00:00	0.004069115	0.004753352	0.024945947
Fri 9	05:55:25	01:00:00	0.001107899	0.001165467	0.004954502
Fri 9	06:55:25	01:00:00	0.002722701	0.003985658	0.018749945
Fri 9	07:55:25	01:00:00	0.001174898	0.0009977	0.005040806
Fri 9	08:55:25	01:00:00	0.003507519	0.019164611	0.023768403
Fri 9	09:55:25	01:00:00	0.004340103	0.01124605	0.047807937
Fri 9	10:55:25	01:00:00	0.003903912	0.006714289	0.02529298
Fri 9	11:55:25	01:00:00	0.004836153	0.004477133	0.020114072
Fri 9	12:55:25	01:00:00	0.003585089	0.003976491	0.020183664
Fri 9	13:55:25	01:00:00	0.005489086	0.007219382	0.038636698
Fri 9	14:55:25	01:00:00	0.003273407	0.004144766	0.018706821
Fri 9	15:55:25	01:00:00	0.005164164	0.006942246	0.034197944

Fri 9	16:55:25	01:00:00	0.003376758	0.003872576	0.020206914
Fri 9	17:55:25	01:00:00	0.00423643	0.004836153	0.026546056
Fri 9	18:55:25	01:00:00	0.003519654	0.004965923	0.020820924
Fri 9	19:55:25	01:00:00	0.000680769	0.000800756	0.004931738
Fri 9	20:55:25	01:00:00	0.000814704	0.000770903	0.004050419
Fri 9	21:55:25	01:00:00	0.000493742	0.000487528	0.001536385
Fri 9	22:55:25	01:00:00	0.004886524	0.005807644	0.022672531
Fri 9	23:55:25	01:00:00	0.000487528	0.000485289	0.000950605
Sat 10	00:55:25	01:00:00	0.000489779	0.000484172	0.000437522
Sat 10	01:55:25	01:00:00	0.000492606	0.000484172	0.0015417
Sat 10	02:55:25	01:00:00	0.003819443	0.004216965	0.022935066
Sat 10	03:55:25	01:00:00	0.000509331	0.000511093	0.00142725
Sat 10	04:55:25	01:00:00	0.006095369	0.007490314	0.027574015
Sat 10	05:55:25	01:00:00	0.001339677	0.001428894	0.005266232
Sat 10	06:55:25	01:00:00	0.001169499	0.001389953	0.007311391
Sat 10	07:55:25	01:00:00	0.003930972	0.00620869	0.024717241
Sat 10	08:55:25	01:00:00	0.00389942	0.005655878	0.020511622
Sat 10	09:55:25	01:00:00	0.001496236	0.0017002	0.007925013
Sat 10	10:55:25	01:00:00	0.001651962	0.001480812	0.004549881
Sat 10	11:55:25	01:00:00	0.000903649	0.00121899	0.005929253
Sat 10	12:55:25	01:00:00	0.00610942	0.006950243	0.023200642
Sat 10	13:55:25	01:00:00	0.000563638	0.000615886	0.000901571
Sat 10	14:55:25	01:00:00	0.000801678	0.00094189	0.004534193
Sat 10	15:55:25	01:00:00	0.001146833	0.001071519	0.005457579
Sat 10	16:55:25	01:00:00	0.000922571	0.001086426	0.005333349
Sat 10	17:55:25	01:00:00	0.003672823	0.003890451	0.016826741
Sat 10	18:55:25	01:00:00	0.000924698	0.001054387	0.005242036
Sat 10	19:55:25	01:00:00	0.003815048	0.004726068	0.020230192
Sat 10	20:55:25	01:00:00	0.000978363	0.000993116	0.006237348
Sat 10	21:55:25	01:00:00	0.000508159	0.000570164	0.000405509
Sat 10	22:55:25	01:00:00	0.000515822	0.000672977	0.000394457
Sat 10	23:55:25	01:00:00	0.00049545	0.001135011	0.00048809
Sun 11	00:55:25	01:00:00	0.000492606	0.00049545	0.002754229
Sun 11	01:55:25	01:00:00	0.000485848	0.00049831	0.000375405
Sun 11	02:55:25	01:00:00	0.00048473	0.000477529	0.000371963
Sun 11	03:55:25	01:00:00	0.000482503	0.000474788	0.00037325
Sun 11	04:55:25	01:00:00	0.000485289	0.000478079	0.00037368
Sun 11	05:55:25	01:00:00	0.000483615	0.000480839	0.000397649
Sun 11	06:55:25	01:00:00	0.000484172	0.000492606	0.000401791
Sun 11	07:55:25	01:00:00	0.000501765	0.000657658	0.000430031

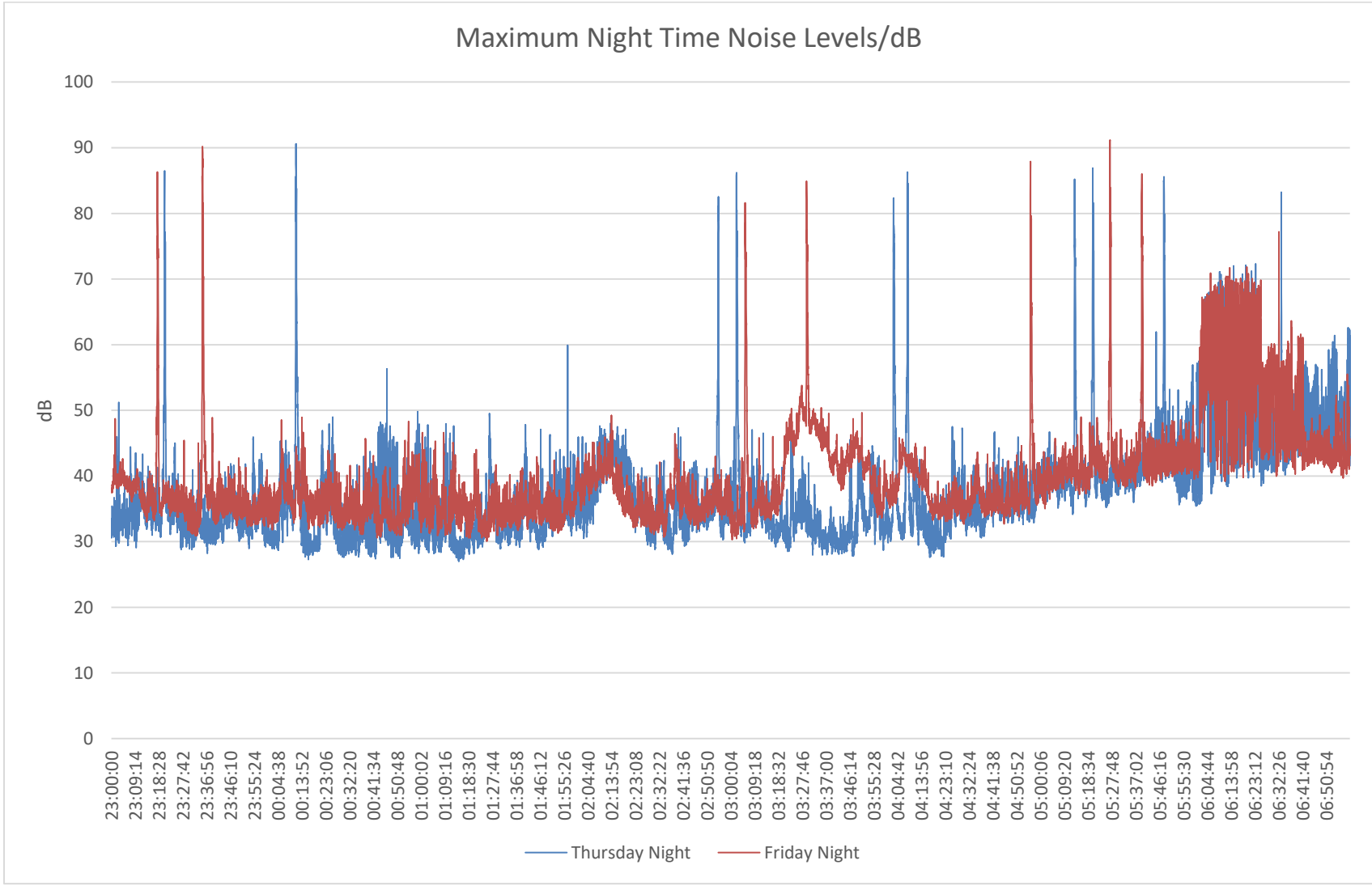
Sun 11	08:55:25	01:00:00	0.000528445	0.000588166	0.000437019
Sun 11	09:55:25	01:00:00	0.000551442	0.00072527	0.000453419
Sun 11	10:55:25	01:00:00	0.001240224	0.001492794	0.000935406
Sun 11	11:55:25	01:00:00	0.020606299	0.001934194	0.009806183
Sun 11	12:55:25	01:00:00	0.007014553	0.010727536	0.038503481
Sun 11	13:55:25	01:00:00	0.000590201	0.000707131	0.000449262
Sun 11	14:55:25	01:00:00	0.000579429	0.001017419	0.00063387
Sun 11	15:55:25	01:00:00	0.000647888	0.001104079	0.000536414
Sun 11	16:55:25	01:00:00	0.00074559	0.000715319	0.000492606
Sun 11	17:55:25	01:00:00	0.000511093	0.000560402	0.000437019
Sun 11	18:55:25	01:00:00	0.000511682	0.000505243	0.000430031
Sun 11	19:55:25	01:00:00	0.000500611	0.000504081	0.000427071
Sun 11	20:55:25	01:00:00	0.000494311	0.000511682	0.000402717
Sun 11	21:55:25	01:00:00	0.000493742	0.000492606	0.000512861
Sun 11	22:55:25	01:00:00	0.000504661	0.000533335	0.000682339
Sun 11	23:55:25	01:00:00	0.000503501	0.000514636	0.002118361
Mon 12	00:55:25	01:00:00	0.000493174	0.00048809	0.000755092
Mon 12	01:55:25	01:00:00	0.000488652	0.000486407	0.000991973
Mon 12	02:55:25	01:00:00	0.000484172	0.000483059	0.000383266
Mon 12	03:55:25	01:00:00	0.000487528	0.000481393	0.000384149
Mon 12	04:55:25	01:00:00	0.000485289	0.000486407	0.00061235
Mon 12	05:55:25	01:00:00	0.001715932	0.0015417	0.006404718
Mon 12	06:55:25	01:00:00	0.001455459	0.001883649	0.009332543
Mon 12	07:55:25	01:00:00	0.001131097	0.001185769	0.006053409
Mon 12	08:55:25	01:00:00	0.001018591	0.001012745	0.005296634
Mon 12	09:55:25	01:00:00	0.000848203	0.000980618	0.004841724
Mon 12	10:55:25	01:00:00	0.004073803	0.00490343	0.017559009
Mon 12	11:55:25	01:00:00	0.001004616	0.001114295	0.005364139
Mon 12	12:55:25	01:00:00	0.003447466	0.003689776	0.018901662
Mon 12	13:55:25	01:00:00	0.003797519	0.004847301	0.031805337
Mon 12	14:55:25	01:00:00	0.002958012	0.003967345	0.018620871
Mon 12	15:55:25	01:00:00	0.004221823	0.00531496	0.023496328
Mon 12	16:55:25	01:00:00	0.00482503	0.005296634	0.018599446
Mon 12	17:55:25	01:00:00	0.002508996	0.003823843	0.017538805
Mon 12	18:55:25	01:00:00	0.003151374	0.00461849	0.018945235
Mon 12	19:55:25	01:00:00	0.000701455	0.000762079	0.004226686
Mon 12	20:55:25	01:00:00	0.000803526	0.000746449	0.003184198
Mon 12	21:55:25	01:00:00	0.000514636	0.000512271	0.002927521
Mon 12	22:55:25	01:00:00	0.004775293	0.010543869	0.037411059
Mon 12	23:55:25	01:00:00	0.004045759	0.004173496	0.01561349

Tues 13	00:55:25	01:00:00	0.00049204	0.00049545	0.000611646
Tues 13	01:55:25	01:00:00	0.000489215	0.000480286	0.00042658
Tues 13	02:55:25	01:00:00	0.004335109	0.005000345	0.0161808
Tues 13	03:55:25	01:00:00	0.004375221	0.005093309	0.017478333
Tues 13	04:55:25	01:00:00	0.005236004	0.006032537	0.023686451
Tues 13	05:55:25	01:00:00	0.001536385	0.001447105	0.00610942
Tues 13	06:55:25	01:00:00	0.004111497	0.006622165	0.025911944
Tues 13	07:55:25	01:00:00	0.001414165	0.001646266	0.007559621
Tues 13	08:55:25	01:00:00	0.006302313	0.004926063	0.021305906
Tues 13	09:55:25	01:00:00	0.002995712	0.004466836	0.022003917
Tues 13	10:55:25	01:00:00	0.004446313	0.00474242	0.005069907

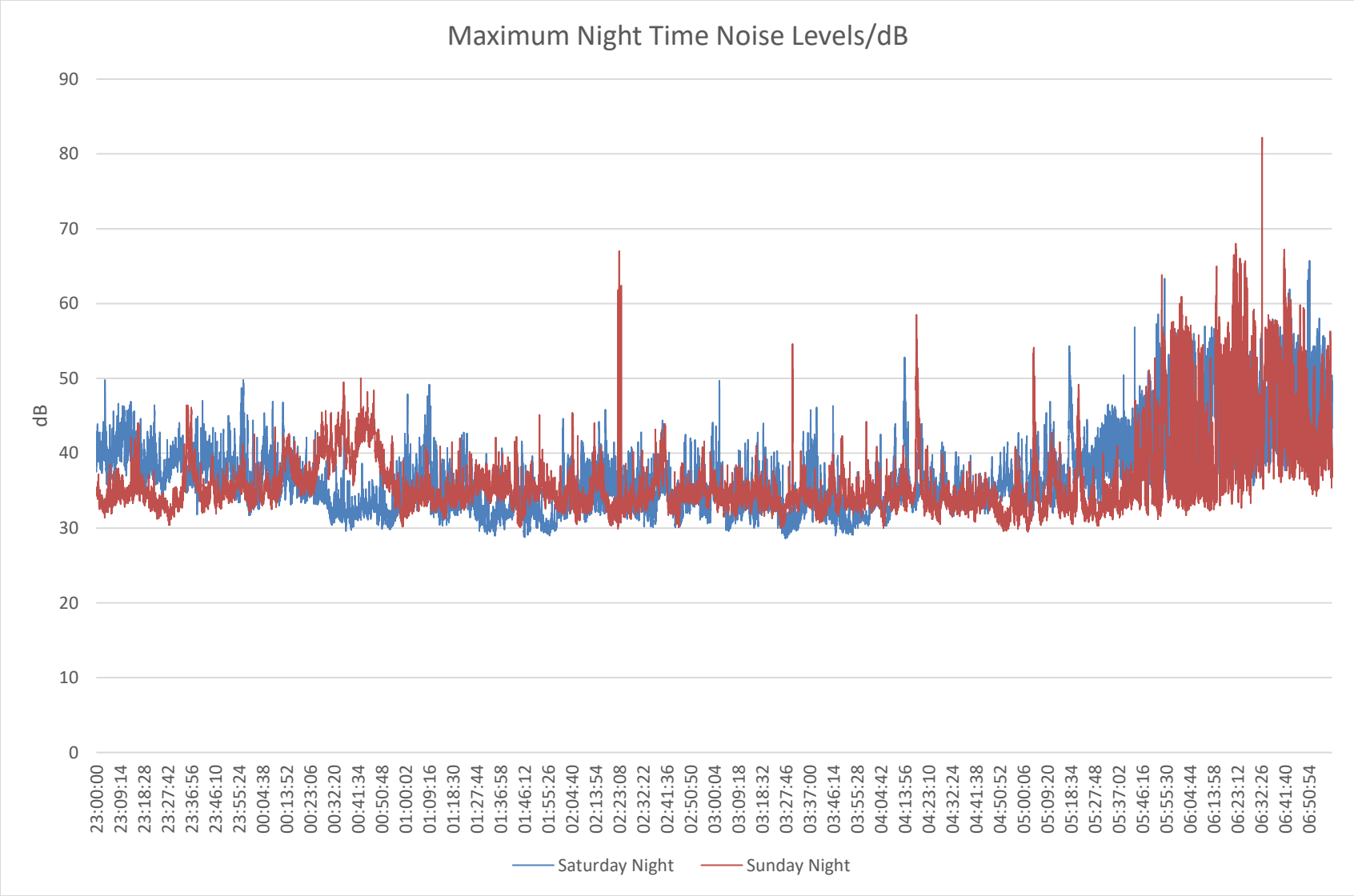
APPENDIX 6



Graph 2: Maximum Noise Levels – Tuesday & Wednesday/dB



Graph 3: Maximum Noise Levels – Thursday & Friday/dB



Graph 4: Maximum Noise Levels – Saturday & Sunday/dB

APPENDIX 7

Figure 4: Plot 9 Ground Floor Living Room – Daytime Internal LAeq,16hr

BS EN 12354-Calcs	Use	Volume	Volume	32.0					
Version 4	length						Building Atten dBA (47.0 - 24.1)		23
© 2017 Martec Environmental Consultants Ltd	width		RT	0.5					
& Acute Acoustics Ltd	height		Octave Band Centre Frequency [Hz]						dBA
			125	250	500	1k	2k		
	External Spectrum Leq (Free Field & Lin)		52.5	46.6	44.1	45.5	42.8		49.2
	Adjustment to Given Level if required								47.0
	External Spectrum Adjusted for Level		50.3	44.4	41.9	43.2	40.6		47.0
Wall		Area m2	Element Sound Reduction Index [SRI]					Contrib	NR
Brick/block/cavity		6.4	41	45	45	54	58	-0.8	0
Drs/Wndws									
4/12/4_double_glazing		4.2	24	20	25	34	37	18.3	12
Roof Lights									
None		0.0	0	0	0	0	0	0.0	3
Door									
None		0.0	0	0	0	0	0	0.0	3
Roof									
None		0.0	0	0	0	0	0	0.0	3
Vent Dn,e		# Vents							
Trickle_vent_with_indirect_air_path_(4000mm^2)		2.0	30	31	31	32	28	22.8	22
								dBA	NR
	Internal SPL/dBLin		28.9	24.9	19.4	17.7	18.6	24.1	22

Figure 5: Bedroom – Night time Internal LAeq,8hr/dB

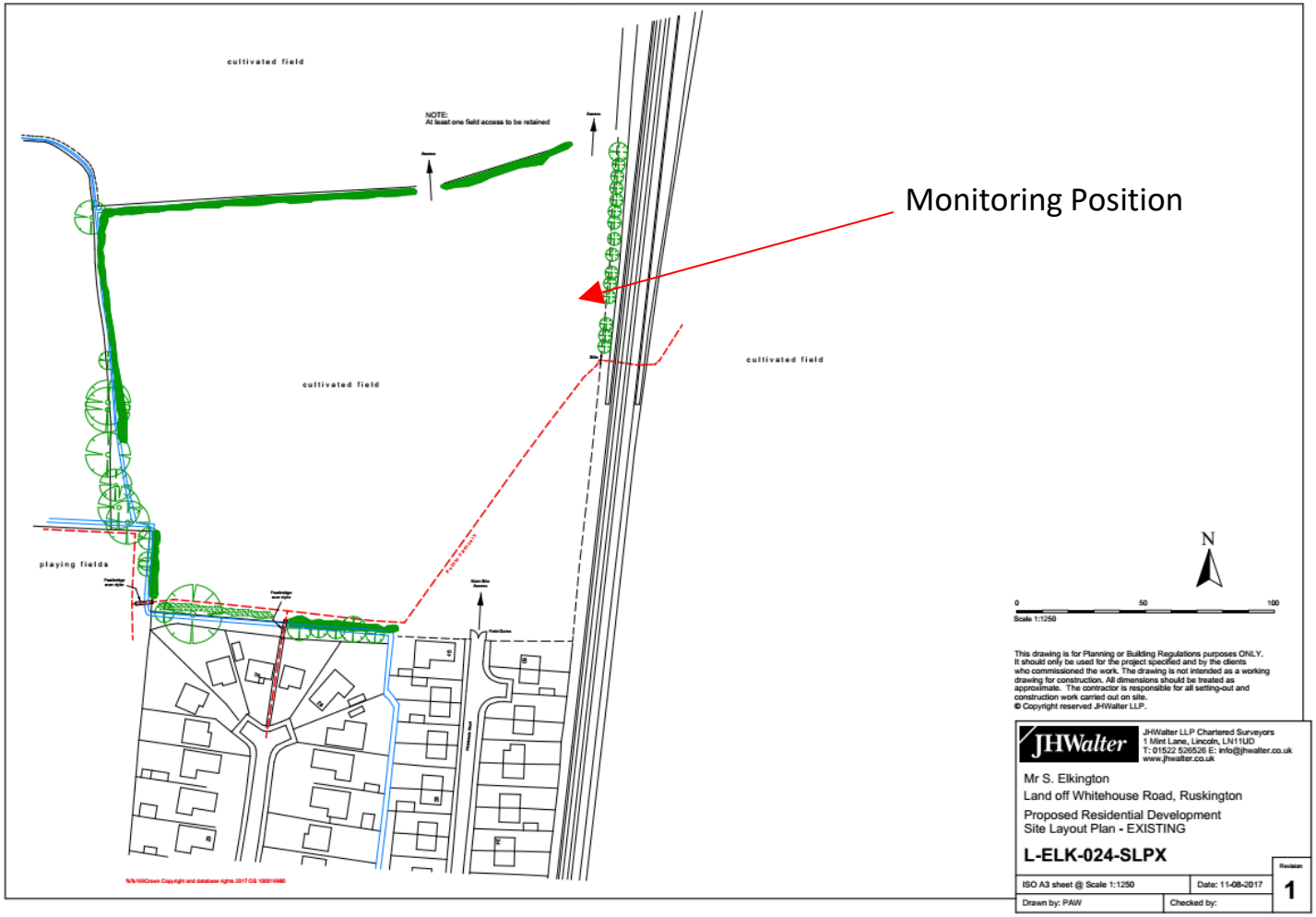
BS EN 12354-Calcs	Use	Volume	Volume	18.0				
Version 4	length						Building Atten dBA (55.0 - 14.4)	41
© 2017 Martec Environmental Consultants Ltd	width		RT	0.3				
& Acute Acoustics Ltd	height		Octave Band Centre Frequency [Hz]					dBA
			125	250	500	1k	2k	
	External Spectrum Leq (Free Field & Lin)		52.5	46.6	44.1	45.5	42.8	49.2
	Adjustment to Given Level if required							55.0
	External Spectrum Adjusted for Level		58.3	52.4	49.9	51.2	48.6	55.0
Wall		Area m2	Element Sound Reduction Index [SRI]					Contrib	NR
Brick/block/cavity		4.1	41	45	45	54	58	5.5	0
Drs/Wndws									
8 (12) 8.4A		1.4	31	28	36	45	47	13.0	8
Roof Lights									
None		0.0	0	0	0	0	0	0.0	3
Door									
None		0.0	0	0	0	0	0	0.0	3
Roof									
None		0.0	0	0	0	0	0	0.0	3
Vent Dn,e		# Vents							
Greenwood MA3051 Acoustic Wall vent		1.0	47	46	49	56	66	6.1	0
								dBA	NR
	Internal SPL/dBLin		23.7	19.7	10.9	3.9	-2.6	14	8

Predicted Internal Single Event, LAmax[F] = **44dB** (85 – 41)

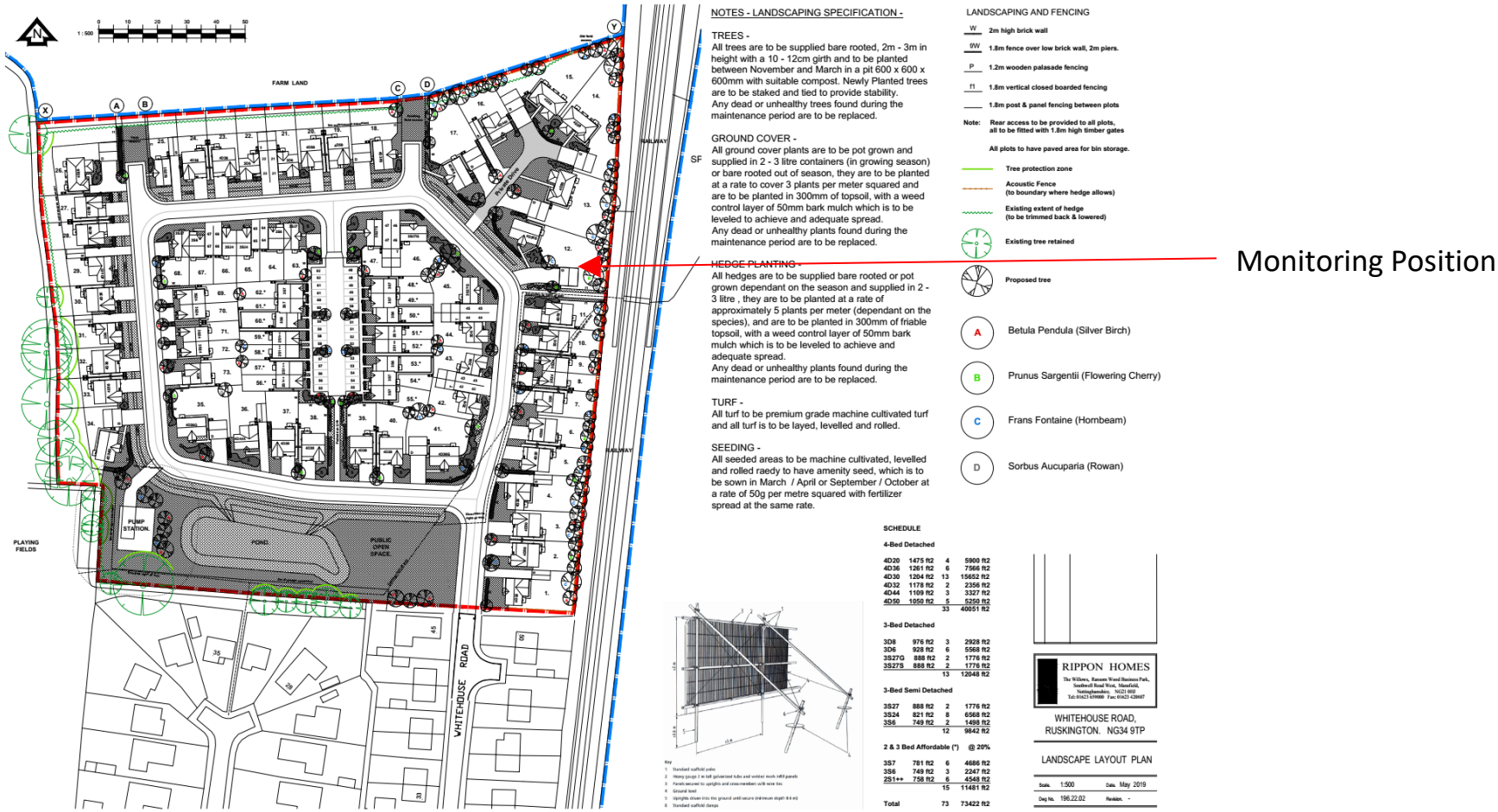
Predicted Daytime Internal Noise Level, LAeq,16hr = **16dB** (57-41)

APPENDIX 8

Existing Site Plan showing Monitoring Position



Preliminary Site Plan showing Monitoring Position



APPENDIX 9

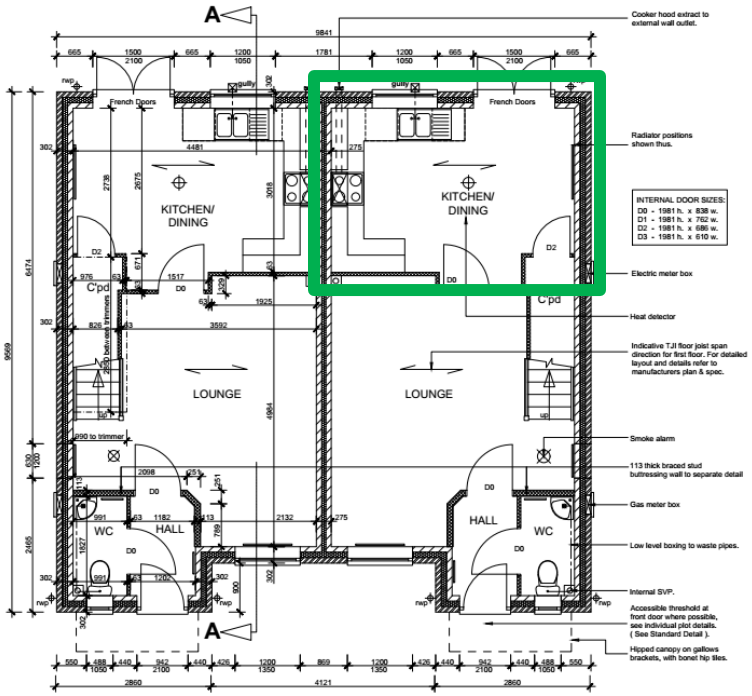
Preliminary Glazing/Ventilation Calculation Zones

Recommended Acoustic Fence Position

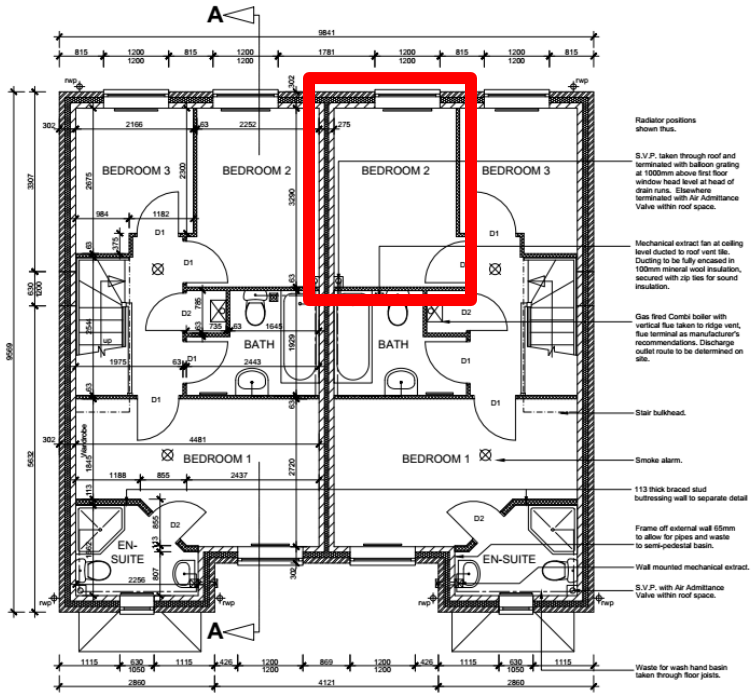
Acoustic Fence

APPENDIX 10

Architects Plans showing Rooms used for Internal Noise Level Calculations



GROUND FLOOR



FIRST FLOOR