

**Proposed Residential Development
Land North of B4265
Boverton
Vale of Glamorgan**

**Environmental Noise Survey
3309/ENS1**

6th February 2014

For: **Mr David Lloyd**
Barratt Homes, South Wales Division
Oak House, Village Way
Tongwynlais
Cardiff
CF15 7NE
Email: david.j.lloyd@barratthomes.co.uk



Henstaff Court Business Centre
Llantrisant Road, Pontyclun
Cardiff CF72 8NG

Tel: 02920 891 020

Fax: 02920 891 870

Email: info@hunteracoustics.co.uk

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1.0 Introduction

A residential development is proposed on land north of B4265, Boverton, Vale of Glamorgan.

The site is bounded by the B4265 road to the south and the Vale of Glamorgan train line to the north. Existing dwellings lie on the opposite side of the train line to the northeast of the site.

This report has been commissioned to assess existing ambient and background noise levels impinging on the site from local road traffic and rail noise. Survey results have been used for comparison with Local Authority Planning Conditions and planning guidance.

Appendix A contains graphs, tables and diagrams referenced in this report.

Appendix B explains acoustic terminology used in this report.

Appendix C contains noise maps referenced in this report.

2.0 Planning Guidance

2.1 Technical Advice Note (Wales) 11

Table 1 from Annex A of TAN 11 defines four noise exposure categories with advice as follows:

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

Noise bands defining categories A-D of TAN 11 are set in terms of L_{Aeq} (16-hour) daytime, and (8-hour) night time levels for road traffic noise, free field 1.2 – 1.5m above ground level as follows;

Noise Source	Time	Noise Exposure Categories			
		A	B	C	D
Road Traffic	07:00-23:00	<55	55-63	63-72	>72
	23:00-07:00	<45	45-57	57-66	>66
Rail Traffic	07:00-23:00	<55	55-66	66-74	>74
	23:00-07:00	<45	45-59	59-66	>66
Air Traffic	07:00-23:00	<57	57-66	66-72	>72
	23:00-07:00	<48	48-57	57-66	>66
Mixed Sources	07:00-23:00	<55	55-63	63-72	>72
	23:00-07:00	<45	45-57	57-66	>66

Note: In addition, sites where individual noise events regularly exceed 82dB(A) L_{max} (slow), several times in any night time hour should be treated as being in NEC C, unless the L_{eq} (8 hour) already puts the site in NEC D.

The above L_{max} guidance included in TAN 11 can be read in conjunction with BS 8233:1999 which recommends individual noise events should not 'normally' exceed 45dB(A) L_{max} (fast) in bedrooms between 2300-0700hrs - night-time.

No guidance on what constitutes 'normally' is given, however World Health Organisation (WHO) Guidelines for Community Noise states "For a good sleep, it is believed that indoor sound pressure levels should not exceed approximately 45dB L_{max} more than 10-15 times per night (Vallet & Vernet 1991)".

2.2 Typical Planning Conditions

The following typical planning conditions have been issued by a neighbouring Local Planning Authority relating to road and railway noise, based on guidance from TAN 11 quoted above.

Noise levels in the planning conditions quoted below relate to the boundary between NEC B / C in TAN 11 – i.e. additional acoustic insulation and mechanical ventilation is proposed for NEC C facades.

2.2.1 Road Noise

Prior to commencement of development a scheme shall be submitted to and approved in writing by the Local Planning Authority to provide that all habitable rooms exposed to external road noise in excess of 63 dBA L_{eq} 16 hour (free field) during the day (07.00 to 23.00 hours) or 57 dBA L_{eq} 8 hour (free field) at night (23.00 to 07.00 hours) shall be subject to sound insulation measures to ensure that all such rooms achieve an internal noise level of 40 dBA L_{eq} 16 hour during the day and 35 dBA L_{eq} 8 hour at night. The submitted scheme shall ensure that habitable rooms subject to sound insulation measures shall be able to be effectively ventilated without opening windows. No dwelling shall be occupied until the approved sound insulation and ventilation measures have been installed to that property in accordance with the approved details. The approved measures shall be retained thereafter in perpetuity.

Reason: To ensure that the amenities of future occupiers are protected.

2.2.2 Railway Noise

“Prior to commencement of development a scheme shall be submitted to and approved in writing by the Local Planning Authority to provide that all habitable rooms exposed to external railway noise in excess of 66 dBA L_{eq} 16 hour (free field) during the day (07.00 to 23.00 hours) or 59 dBA L_{eq} 8 hour (free field) at night (23.00 to 07.00 hours) shall be subject to sound insulation measures to ensure that all such rooms achieve an internal noise level of 40 dBA L_{eq} 16 hour during the day and 35 dBA L_{eq} 8 hour at night. The submitted scheme shall ensure that habitable rooms subject to sound insulation measures shall be provided with acoustically treated active ventilation units. Each ventilation unit (with air filter in position), by itself or with an integral air supply duct and cowl (or grille), shall be capable of giving variable ventilation rates ranging from –

1. *an upper rate of not less than 37 litres per second against a back pressure of 10 newtons per square metre and not less than 31 litres per second against a back pressure of 30 newtons per square metre,*

to

2. *a lower rate of between 10 and 17 litres per second against zero back pressure.*

No habitable room shall be occupied until the approved sound insulation and ventilation measures have been installed in that room. Gardens shall be designed to provide an area which is at least 50% of the garden area for sitting out where the maximum day time noise level does not exceed 55 dBA L_{eq} 16 hour [free field].

REASON: To ensure that the amenities of future occupiers are protected.”

2.2.3 Railway Vibration

The following condition is based on guidance of BS6472 'Guide to evaluation of human exposure to vibration in buildings'.

Prior to commencement of development a scheme shall be submitted to and approved in writing by the Local Planning Authority to provide that the dwellings are designed and constructed so as to ensure that vibration dose values do not exceed $0.4\text{m/s}^{1.75}$ between 07.00 and 23.00 hours, and $0.26\text{m/s}^{1.75}$ between 23.00 and 07.00 hours, as calculated in accordance with BS 6472-1:2008, entitled "Guide to Evaluation of Human Exposure to Vibration in Buildings", [1Hz to 80Hz]. The dwellings shall be constructed in accordance with the approved scheme.

Reason: To ensure that the amenities of future occupiers are protected.

2.2.4 Garden Noise

Prior to the commencement of development a scheme shall be submitted to and approved in writing by the Local Planning Authority to provide that the maximum day time noise level in outdoor living areas exposed to external road or railway noise shall not exceed 55 dBA L_{eq} 16 hour [free field] in 50% of the garden area. The scheme of noise mitigation as approved shall be constructed in its entirety prior to the first occupation of any dwelling and shall be retained thereafter in perpetuity.

Reason: To ensure that the amenities of future occupiers are protected.

2.3 Planning Policy Wales / Vale of Glamorgan Adopted UDP

As well as noise impinging on the development, the Planning Policy Wales (PPW) Edition 5 document Policy Section 13.15 and the Vale of Glamorgan Council's Adopted Unitary Development Plan (UDP) HOUS 8 also include guidance on noise emissions from new developments to neighbouring environments. As a residential development, noise emissions from the developed site to the neighbouring environment would not be significant.

2.4 General Comments

- A central ventilation MVHR system designed to the latest Building Regulations Part F may be considered as an alternative to the mechanical vents quoted above – to be confirmed with Local Planning Authority/EHO.
- Garden Criterion - When assessing the application of an outdoor design aim of 55dB(A) L_{eq} , which is derived from World Health Organisation guidance, it is important to take into account the feasibility of achieving such a level. A review of 'Health effect based noise assessment methods: A review and feasibility study' (NPL Report CMAN 16 1998 advised;

"Perhaps the main weaknesses of the WHO-inspired documents is that they fail to consider the practicality of actually being able to achieve any of the stated guideline values ...We know from the most recent national survey of noise exposure carried out in England and Wales (Sargent 93) that around 56% of the population are exposed to daytime noise levels exceeding 55dB(A) L_{eq} and that around 65% are exposed to night time noise levels exceeding 45dB(A) L_{eq} (as measured outside the house in each case)...The percentages exposed above the WHO guideline values could not be significantly reduced without drastic action to virtually eliminate road traffic noise and other forms of transportation noise (including public transport) from the vicinity of houses. The social and economic consequences of such action would be likely to be far greater than any environmental advantages of reducing the proportion of the population annoyed by noise. In addition there is no evidence that anything other than a small minority of the population exposed at such noise levels find them to be particularly onerous in the context of their daily lives."

3.0 Environmental Noise Surveys

Note: From previous work in the area and from information provided by Network Rail, we understand normal freight usage along this line is from the Aberthaw Power Station, however maintenance on the South Wales Main Line means that freight trains are re-routed down the Vale of Glamorgan line every night for approximately 1 week in every 6 (according to Network Rail).

We have liaised with Network Rail to ensure this survey was undertaken during a period when the South Wales Main Line was closed during the night to ensure a worst case scenario in terms of night-time freight train movements.

As maintenance may be carried out over several nights in any month, (averaging at around 1 week in 6), we have specified external building fabric performance requirements based on the levels measured during our survey.

3.1 Procedures

3.1.1 Continuous Monitoring

Continuous noise monitoring was carried out from 1300hrs on 29/01/2014 at Positions A and B. Data including L_{max} , L_{eq} and background L_{90} were logged at 5-minute intervals over the monitoring period.

3309/SP1 – Site Plan showing Monitoring Locations



Site Plan 3309/SP1 shows the development site and continuous monitoring positions used, namely:

- | | |
|------------|--|
| Position A | Located on north-eastern boundary approximately 10m from rail line at 1.5m above local ground level with full line of site to rail line. |
| Position B | Located on south-western boundary approximately 15m from B4265 at 1.5m above local ground level with full line of sight of B4265. Local ground level is elevated approximately 4m above road height. |

3.1.2 CRTN Measurements

Sample measurements were taken at Position 1 on 30/01/2014 in accordance with the shortened measurement procedures outlined in Department of Transport's "Calculation of Road Traffic Noise 1988" (CRTN) over a 3-hour period to gather noise data in the north western corner of the site. Site Plan 3309/SP1 shows the sample measurement position used, namely:

Position 1 Located on north-western boundary approximately 10m from road, 1.5m above local ground level. Full line of site to road. Local ground level is elevated approximately 2m above road height.

3.1.3 Sample Measurements

Sample noise measurements were taken over 5-minute periods around the site to aid calibration of a noise map. Site Plan 3309/SP1 shows the measurement positions used, namely:

Position 2 Located approximately 15m from south western boundary

Position 3 Located approximately 30m from south western boundary

Position 4 Located approximately 30m from south western boundary

Position 5 Located approximately 30m from south western boundary

Position 6 Located approximately 30m from south western boundary

Parameters recorded include L_{max} and L_{eq} levels including 1/3-octave band L_{eq} spectra.

3.1.4 Continuous Vibration Monitoring

Continuous vibration monitoring was carried out from 1300hrs on 29/01/2014 to 1300hrs on 30/01/2014 covering rail traffic movements on the Vale of Glamorgan train line.

Vibration levels were monitored in three orthogonal axes: radial (horizontal, perpendicular to line of tracks), tangential (horizontal, parallel to line of tracks) and vertical.

Consecutive 1 minute 1/3-octave RMS acceleration spectra (arms) were recorded via the accelerometer as well as hourly VDV's at Position A;

Position A Located at the base of concrete fence post, approximately 10 metres from closest rail line.

3.2 Equipment Used

The following equipment was used:

Make	Description	Model	Serial Number	Last Calibrated	Certificate No.
Norsonic AS	Type 1 - Integrating - averaging Sound Level Meter	140	1403003	16-Sep-13	U14448
Norsonic AS	Preamplifier	1209	12403	16-Sep-13	U14448
Norsonic AS	Microphone	1225	91797	16-Sep-13	11927
Norsonic AS	Calibrator (114.11dB @ 1001.90Hz)	1251	31826	16-Sep-13	U14446
Norsonic AS	Type 1 - Integrating - averaging Sound Level Meter	118	31808	28-Aug-12	U11929
Norsonic AS	Preamplifier	1206	30892	28-Aug-12	U11929
Norsonic AS	Microphone	1225	62659	28-Aug-12	11927
Norsonic AS	Calibrator (114.06dB @ 999.34Hz)	1251	24202	02-Sep-13	U14368
Larson Davis	Type 1 - Sound Level Meter	820	1334	09-May-13	20437
Larson Davis	Preamplifier	828	1960	09-May-13	20437
PCB	Microphone 1/2" Prepolarized FF	377B02	LW135480	09-May-13	20437
Svantek	Type 1 - Sound & Vibration Data Logger	SVAN 948	6962	12-Aug-13	1308348
Dytran	Tri-axial Accelerometer	3233A	158	12-Aug-13	1108348
Dytran	Cable	6483A09	-	12-Aug-13	1108346

The measurement systems were calibrated before and after the surveys, no variation occurred.

3.3 Weather Conditions

Weather conditions were damp and cold with a light breeze throughout the survey period.

4.0 Results

4.1 Continuous Monitoring

Time history graphs 3309/TH1 & TH2 show L_{max} , L_{eq} and L_{90} sound pressure levels measured over consecutive 5-minute periods at Positions A & B respectively.

The following L_{eq} 16-hour daytime and 8-hour night-time noise levels have been measured;

Position A			
Daytime	0700-2300hrs	$L_{eq,16hr}$ = 52.8	NEC A
Night-time	2300-0700hrs	$L_{eq,8hr}$ = 53.1	NEC B

Position B			
Daytime	0700-2300hrs	$L_{eq,16hr}$ = 68.5	NEC C
Night-time	2300-0700hrs	$L_{eq,8hr}$ = 60.3	NEC C

There were 2 $L_{max,F}$ events over 82dB at position A and 3 over 82dB at position B during the night-time period (2300-0700hrs).

These events were spread out across the 8 hour night-time period and therefore 'individual noise events are not exceeding 82dB(A) $L_{max}(slow)$, several times in any night time hour' when comparing with TAN11 L_{max} guidance, as shown in 3309/TH1 & TH2.

L_{eq} and L_{max} spectra for sprinter and freight pass-bys are shown in graphs 3309/G1 & G2 respectively.

4.2 CRTN Source Measurement

Results of the road traffic noise survey at position 1 are shown in table 3309/T1 below. The table goes on to predict the $L_{eq,16hr}$ daytime road traffic source noise level using methodology specified in CRTN and TAN 11.

3309/T1 – $L_{eq,16hr}$ Daytime Road Traffic Noise Prediction

CRTN Position 1	L_{Aeq} (dB)	L_{A10} (dB)	$L_{Amax,F}$ (dB)
1100-1200hrs	58.7	62.5	71.4
1200-1300hrs	60.3	63.6	76.6
1300-1400hrs	59.4	62.6	77.1

Mean L_{10}	62.9
**16hr L_{eq}	59.9

**Predicted in accordance with CRTN and TAN11

Typical spectra measured during CRTN measurement is shown in graph 3309/G3.

4.3 Sample Measurements

On site sample measurements were taken at positions 2-6 to aid calibration of a noise map. Results of measurements are shown in Table 3309/T2 below.

3309/T2 – Sample Measurements

Position	Time (hrs:mins)	Duration (Secs)	LAeq (dB)	LAm _{ax,F} (dB)
2	11:11	300	57.4	74.3
3	11:29	300	49.8	55.4
4	11:43	300	52.6	59.6
5	11:55	300	54.6	63.0
6	12:01	300	54.5	62.7

4.4 Continuous Vibration Monitoring

Table 3309/T3 shows hourly vibration dose values measured at Position A, together with the daytime (0700-2300hrs) and night-time (2300-0700hrs) VDV levels for comparison with criteria quoted in the typical local authority planning condition.

Graphs 3309/G4 & G5 show 1/3-octave band RMS vibration spectra for typical sprinter and freight train pass-by respectively. These include the old BS 6472:1992 curves (for information only).

For train movements the vertical axis of vibration is assessed as critical, therefore vertical VDV_v figures are assessed.

VDVs for comparison with the typical planning condition are as follows:

$$\begin{aligned} \text{VDV}_{b,\text{day}(0700-2300\text{hrs})} &= 0.040 \text{ m/s}^{1.75} & \text{Limit} &= 0.4 \text{ m/s}^{1.75} \\ \text{VDV}_{b,\text{night}(2300-0700\text{hrs})} &= 0.013 \text{ m/s}^{1.75} & \text{Limit} &= 0.26 \text{ m/s}^{1.75} \end{aligned}$$

Train vibration levels are therefore within the $0.4 \text{ m/s}^{1.75}$ day and $0.26 \text{ m/s}^{1.75}$ night criteria discussed in section 2.2.3 of this report.

5.0 Noise Predictions

Results from the noise surveys discussed above have been used to aid calibration of the noise maps. Noise maps have been plotted using NoiseMap Five software (version 5.0.17) which in turn uses methodology from Department of Transport's Calculation of Road Traffic Noise (CRTN) and Calculation of Rail Noise (CRN).

Noise Maps 3309/NM1 & NM2 in Appendix C show predicted daytime and night-time noise levels respectively at 1.5m above local ground level on the undeveloped site.

These noise maps show the majority of the site falls under NEC A of TAN 11 daytime with only the south-western boundary with the B4265 falling under NEC C. Night-time, the majority of the site falls under NEC B, with only the south-western boundary falling under NEC C.

Noise Map 3309/NM3 below shows predicted daytime noise levels at 1.5m above local ground level across the developed site. Garden fences have been modelled as 1.8m high closed boarded fences.

3309/NM3 – $L_{eq,16hr}$ Daytime (0700 – 2300hrs); Developed Site (Ground Floor Level)



Note: Red line indicates 1.8m high closed boarded fences that have been included in the noisemap models.

Noise Map 3309/NM4 shows predicted night-time noise levels at 1.5m above local ground level across the developed site.

3309/NM4 – $L_{eq,8hr}$ Night (2300 – 0700hrs); Developed Site (Ground Floor Level)



Noise maps 3309/NM5 & NM6 in Appendix C show predicted noise at first floor level during the daytime and night-time respectively.

5.1 Daytime

Noise maps indicate the B4265 road is the most critical noise source.

Plots 1 and 65 are indicated to exceed the 'trigger levels' given in section 2.0 for additional sound insulation measures at both ground and first floor level – refer to section 6.0 below. Plot 10 is indicated to exceed the 'trigger level' at first floor level.

5.2 Night-time

Noise maps indicates the site falls into NEC B with the boundary to the B4265 falling into NEC C.

At first floor level, only plots 1 and 65 are indicated to exceed the 'trigger levels' given in Section 2.0 however first floor bedrooms on plots facing the railway line and the road are indicated to require additional sound insulation measures to protect against $L_{max,F}$ events. For additional sound insulation measures refer to section 6.0 below.

6.0 External Building Fabric Assessment

Based on survey results and the standard planning conditions, we have carried out an external building fabric assessment to control noise intrusion on critical façades.

Red lines indicate façades of habitable rooms at both ground and first floor level need treating and **blue** lines indicate bedroom façades at first floor level only need treating. These are shown on site plan 3309/SP2 below.

The external building fabric has been designed so that dwellings achieve the internal noise levels quoted in typical planning conditions discussed in section 2.2 of this report.

3309/SP2 – Façades Requiring Acoustic Glazing and Ventilation



All habitable rooms on the façades highlighted require up-rated acoustic glazing and/or ventilation as specified below:

The following constructions have been used in our external building fabric assessment;

Roof: Pitched tiled roof, timber trusses, plasterboard ceiling with 100mm mineral wool insulation.

Walls: Brick / Cavity / Block including NIR vent

The following SRI performance figures are taken from BS 8233 for “tiles on felt roof with 100mm mineral wool on plasterboard ceiling” (roof) and BRE’s Sound Control for Homes 1999 for “plastered solid brickwork (480kg/m²) including NIR ventilator” (wall).

Note: Habitable rooms include bedrooms, lounges, dining rooms and kitchen/diners but not kitchens or bathrooms.

There should be no rooms in roof / mansard sections included on critical plots.

These figures have been used in our assessment however your preferred wall and roof supplier shall confirm their proposed systems meet these figures:

3309/T3 – Wall and Roof Sound Reduction Index Figures

Element	Description	Sound Reduction Index (SRI: BS EN ISO 140) at Octave Band Centre Frequency (Hz)				
		125	250	500	1k	2k
Wall	Plastered solid brickwork with NIR vent in wall	32	41	48	52	53
Roof	Pitched tiled roof, timber trusses, plasterboard ceiling with 100mm mineral wool	28	34	40	45	49

6.1 Ventilation

All habitable rooms on facades highlighted in **red** require mechanical ventilation at ground and first floor levels or a whole house ventilation system. All first floor bedrooms on facades highlighted in **blue** require mechanical ventilation.

- Mechanical acoustic ventilators meeting requirements of the Noise Insulation Regulations 1988 or,
- A whole house ventilation system (meeting the requirements of Part F of the Building Regulations) – to be confirmed acceptable by the local planners/EHO.

Do not include trickle ventilation within window frames on critical facades.

6.2 Glazing

Site plan 3309/SP2 shows façades where windows require up-rating. The following sound reduction index figures shall be met for window glazing on these critical façades:

3309/T4 – Window Glazing Sound Reduction Index Figures

Element	Description	Sound Reduction Index (SRI: BS EN ISO 140) at Octave Band Centre Frequency (Hz)				
		125	250	500	1k	2k
Window Glazing	For budgetary guidance, based on Pilkington 10/6-20/6	24	24	32	37	37

For initial budgetary guidance, 10/6-20/6 glazing should be capable of achieving these figures based on Pilkington test data, however;

The successful glazing suppliers shall provide independent laboratory test data confirming their proposed systems (including frames/seals) meet the quoted octave band sound reduction performance figures above.

This glazing specification should also be suitable to control typical L_{max} events from vehicle pass-bys and trains to within the 45dB(A) $L_{max,F}$ bedroom standard quoted in BS 8233.

For all other façades standard thermal double-glazing and trickle ventilation should be sufficient.

6.3 Gardens

Noisemap 3309/NM3 indicates that all gardens on the proposed development should meet the 55dB(A) in 50% of garden area during the daytime with the inclusion of 1.8m high closed boarded garden fences.

7.0 Conclusions

An environmental noise survey has been carried out to assess existing ambient and background noise levels impinging on the proposed development site at land north of B4265, Boverton, Vale of Glamorgan from local road traffic and rail noise.

A noise map has been plotted to allow the noise climate to be predicted across the site in its undeveloped and developed state.

The site in its undeveloped state is indicated to fall mainly into NEC A of TAN11 during the daytime and NEC B during the night-time, with only part of the south-western boundary with the B4265 falling under NEC C of TAN 11.

A 1.8m high closed boarded fence is proposed along the south-western boundary to the B4265 which controls garden noise levels in line with the proposed criterion. Additional sound insulation measures in the form of up-rated glazing and acoustic ventilation are proposed on critical façades overlooking the B4265 and to bedroom façades along the north eastern boundary facing the rail line.

Rail vibration levels have also been measured over a 24-hour period for comparison with daytime and night time criteria quoted in BS6472 'Guide to evaluation of human exposure to vibration in buildings'. Measured levels are well below the criteria - vibration is not indicated to be an issue on this site.

As a residential development, noise emissions from the developed site to the neighbouring environment would not be significant.

Prepared by:



Meirion Townsend
BSc(Hons) MIOA
Hunter Acoustics

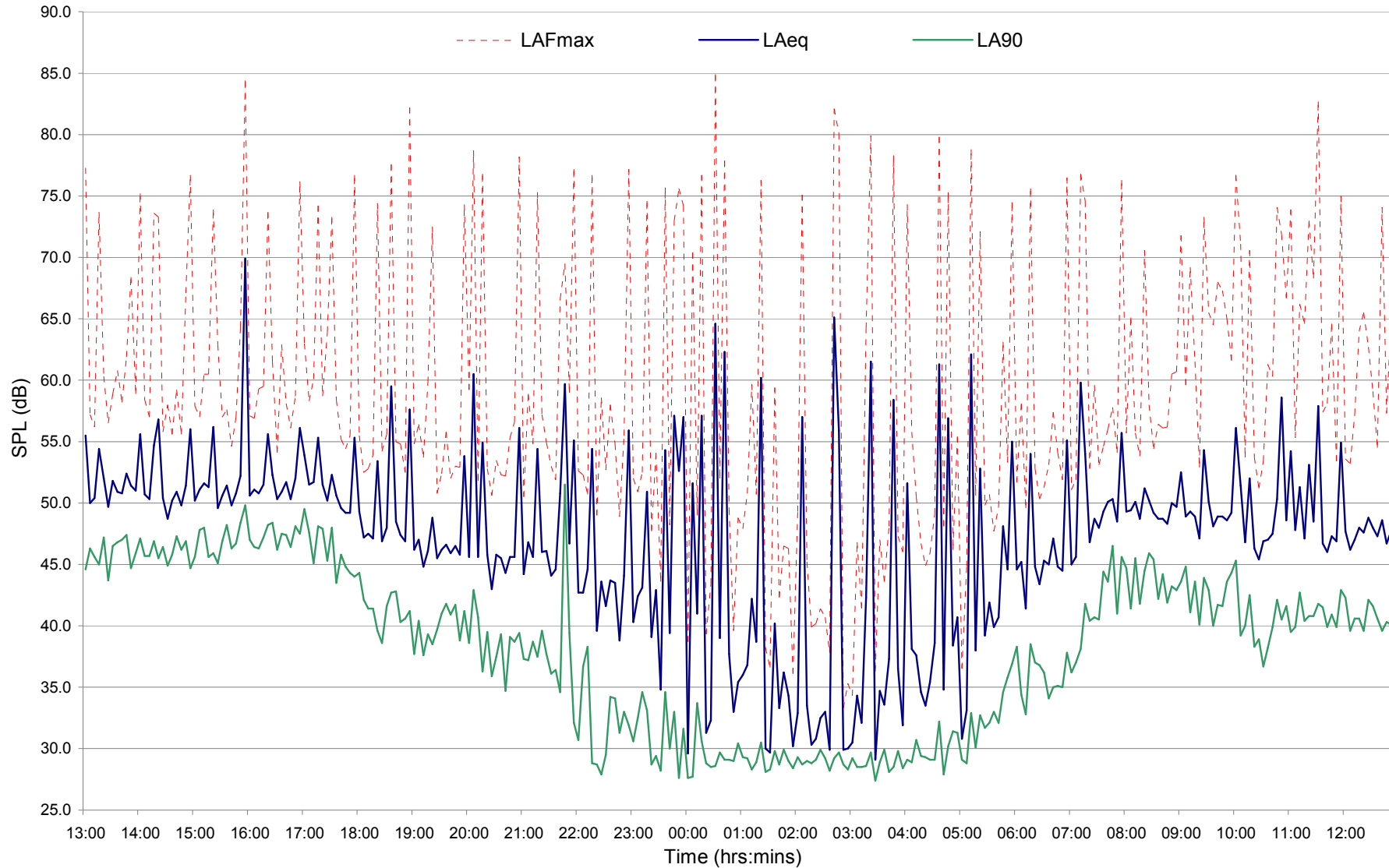
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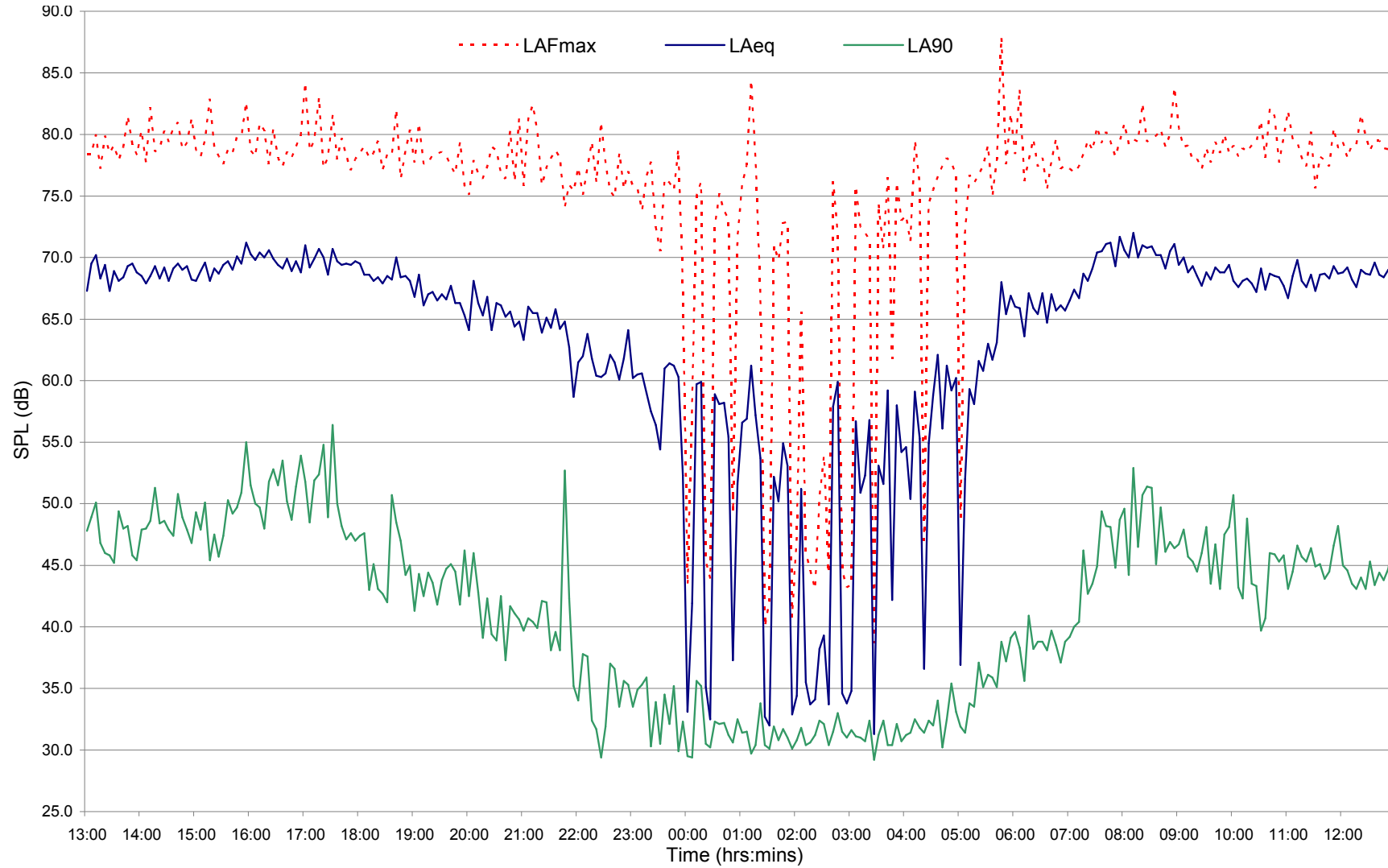
David Hunter
BSc(Hons) MSc MIOA
Hunter Acoustics

Appendix A – Graphs, Tables and Diagrams

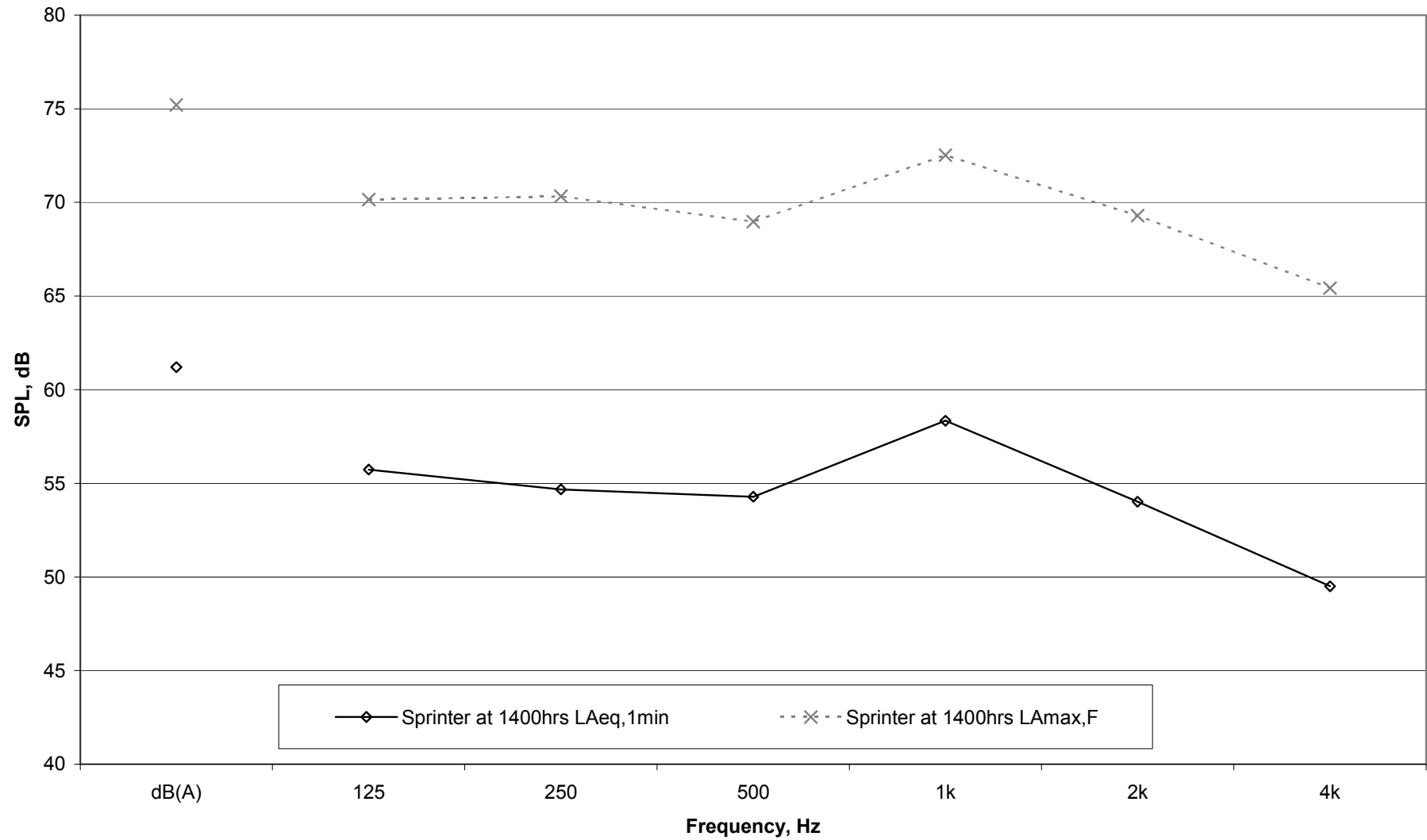
3309/TH1 – Continuous Monitoring Time History: Position A



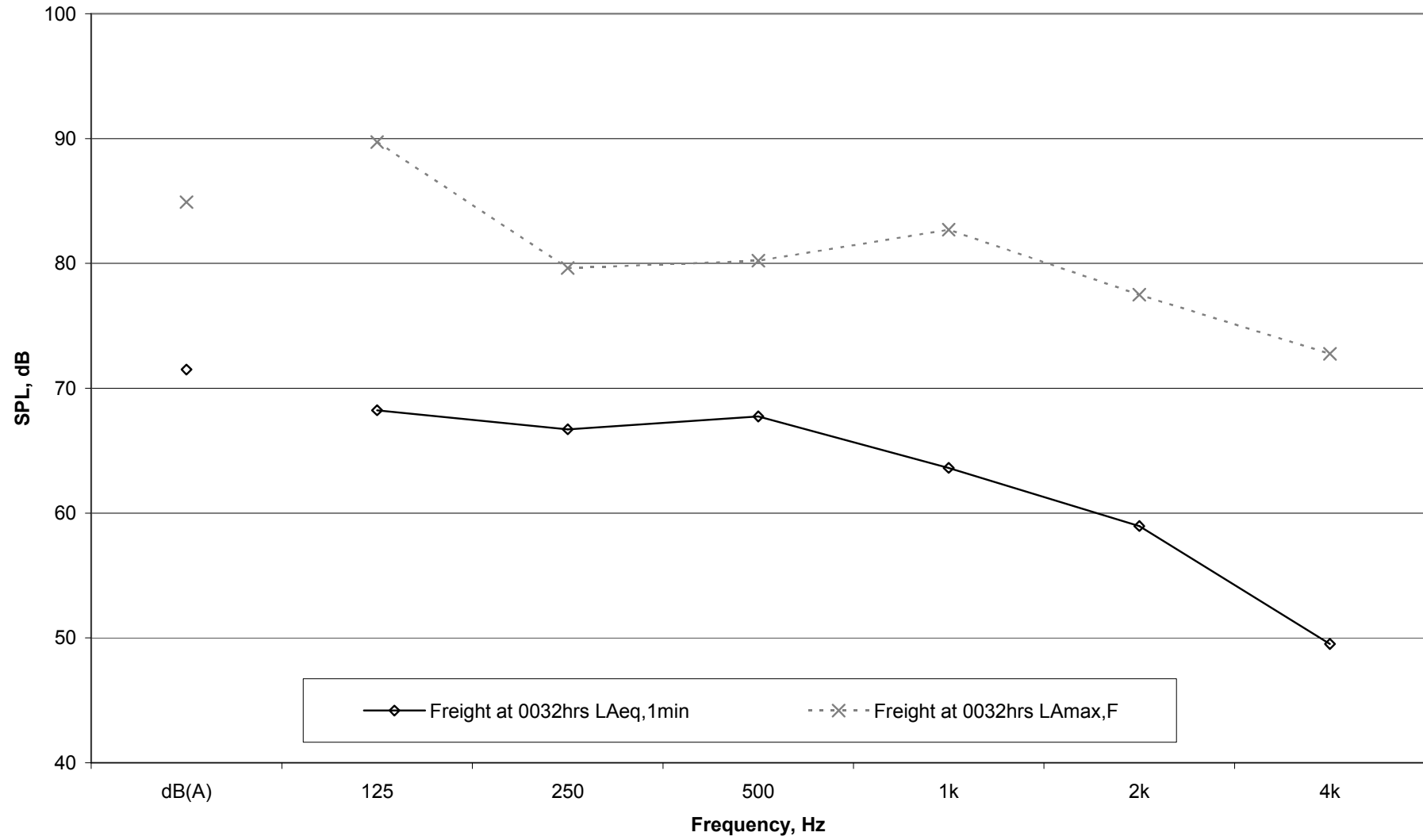
3309/TH2 – Continuous Monitoring Time History: Position B



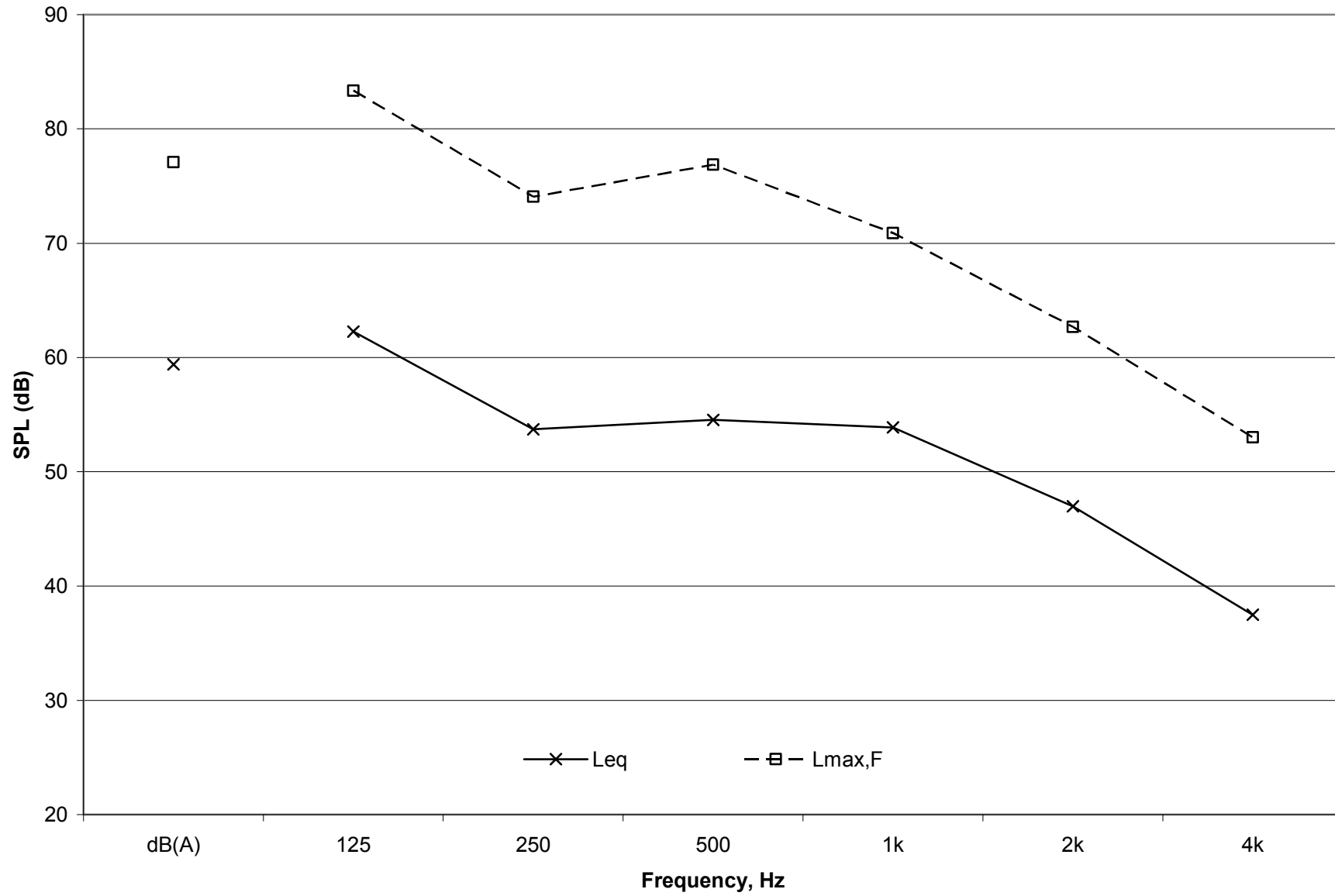
3309/G1 – Sprinter Pass-by at Position A



3309/G2 – Freight Pass-by at Position A



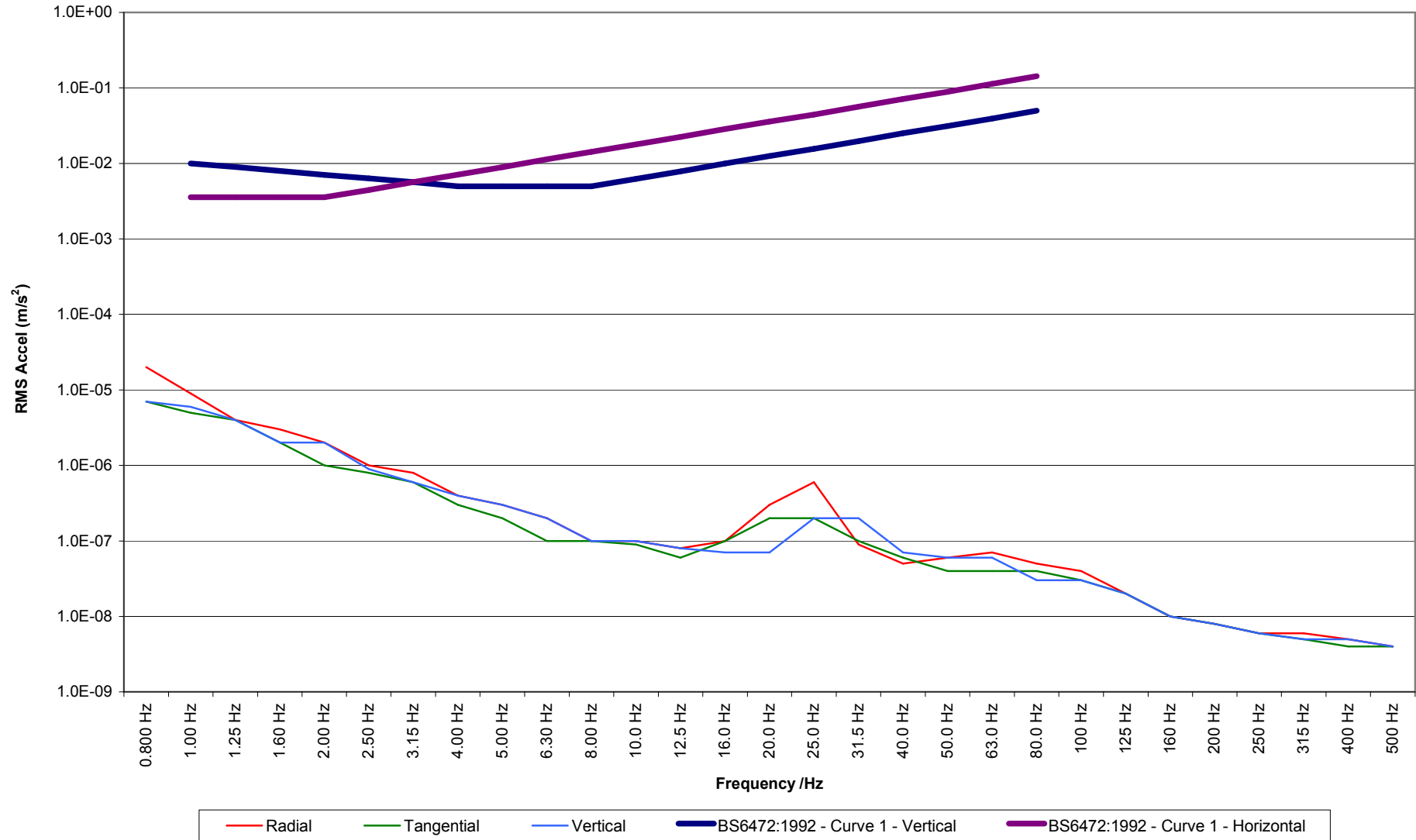
3309/G3 – Road Traffic Spectra at Position 1



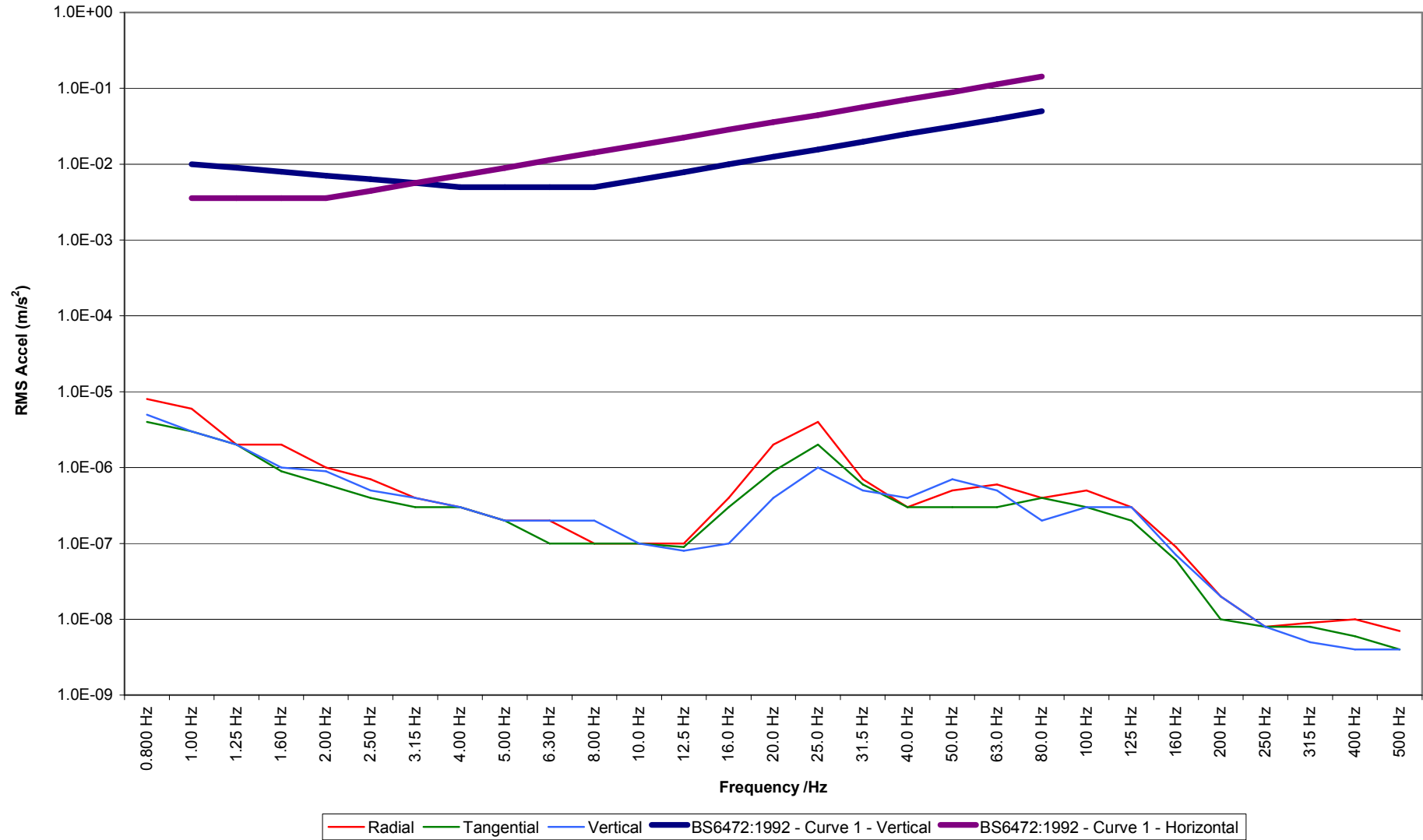
3309/T2 – Hourly Vibration Dose Values at Position A

Date	Start	Channel	Weighting	VDV, ms ^{-1.75}	Date	Start	Channel	Weighting	VDV, ms ^{-1.75}
29/01/2014	13:00	Radial	W _d	1.54E-02	29/01/2014	01:00	Radial	W _d	1.04E-02
29/01/2014	13:00	Tangential	W _d	1.58E-02	29/01/2014	01:00	Tangential	W _d	6.54E-03
29/01/2014	13:00	Vertical	W _b	1.92E-02	29/01/2014	01:00	Vertical	W _b	7.68E-03
29/01/2014	14:00	Radial	W _d	3.90E-02	30/03/2010	02:00	Radial	W _d	2.44E-02
29/01/2014	14:00	Tangential	W _d	2.81E-02	30/03/2010	02:00	Tangential	W _d	6.89E-03
29/01/2014	14:00	Vertical	W _b	3.90E-02	30/03/2010	02:00	Vertical	W _b	7.74E-03
29/01/2014	15:00	Radial	W _d	9.90E-03	30/03/2010	03:00	Radial	W _d	2.18E-02
29/01/2014	15:00	Tangential	W _d	1.03E-02	30/03/2010	03:00	Tangential	W _d	7.10E-03
29/01/2014	15:00	Vertical	W _b	1.24E-02	30/03/2010	03:00	Vertical	W _b	8.36E-03
29/01/2014	16:00	Radial	W _d	8.50E-03	30/03/2010	04:00	Radial	W _d	2.32E-02
29/01/2014	16:00	Tangential	W _d	7.77E-03	30/03/2010	04:00	Tangential	W _d	6.92E-03
29/01/2014	16:00	Vertical	W _b	9.97E-03	30/03/2010	04:00	Vertical	W _b	8.26E-03
29/01/2014	17:00	Radial	W _d	7.52E-03	30/03/2010	05:00	Radial	W _d	9.42E-03
29/01/2014	17:00	Tangential	W _d	7.31E-03	30/03/2010	05:00	Tangential	W _d	7.01E-03
29/01/2014	17:00	Vertical	W _b	8.95E-03	30/03/2010	05:00	Vertical	W _b	8.18E-03
29/01/2014	18:00	Radial	W _d	1.93E-02	30/03/2010	06:00	Radial	W _d	7.37E-03
29/01/2014	18:00	Tangential	W _d	1.03E-02	30/03/2010	06:00	Tangential	W _d	5.98E-03
29/01/2014	18:00	Vertical	W _b	1.64E-02	30/03/2010	06:00	Vertical	W _b	7.56E-03
29/01/2014	19:00	Radial	W _d	1.04E-02	30/03/2010	07:00	Radial	W _d	1.25E-02
29/01/2014	19:00	Tangential	W _d	6.31E-03	30/03/2010	07:00	Tangential	W _d	5.63E-03
29/01/2014	19:00	Vertical	W _b	7.69E-03	30/03/2010	07:00	Vertical	W _b	6.57E-03
29/01/2014	20:00	Radial	W _d	7.60E-03	30/03/2010	08:00	Radial	W _d	8.56E-03
29/01/2014	20:00	Tangential	W _d	7.17E-03	30/03/2010	08:00	Tangential	W _d	5.90E-03
29/01/2014	20:00	Vertical	W _b	8.75E-03	30/03/2010	08:00	Vertical	W _b	7.23E-03
29/01/2014	21:00	Radial	W _d	1.03E-02	30/03/2010	09:00	Radial	W _d	9.54E-03
29/01/2014	21:00	Tangential	W _d	6.29E-03	30/03/2010	09:00	Tangential	W _d	6.42E-03
29/01/2014	21:00	Vertical	W _b	7.57E-03	30/03/2010	09:00	Vertical	W _b	7.76E-03
29/01/2014	22:00	Radial	W _d	7.95E-03	30/03/2010	10:00	Radial	W _d	1.00E-02
29/01/2014	22:00	Tangential	W _d	5.61E-03	30/03/2010	10:00	Tangential	W _d	6.38E-03
29/01/2014	22:00	Vertical	W _b	6.59E-03	30/03/2010	10:00	Vertical	W _b	7.63E-03
29/01/2014	23:00	Radial	W _d	1.23E-02	30/03/2010	11:00	Radial	W _d	9.42E-03
29/01/2014	23:00	Tangential	W _d	6.45E-03	30/03/2010	11:00	Tangential	W _d	6.89E-03
29/01/2014	23:00	Vertical	W _b	7.80E-03	30/03/2010	11:00	Vertical	W _b	7.72E-03
29/01/2014	00:00	Radial	W _d	2.36E-02	30/03/2010	12:00	Radial	W _d	1.02E-02
29/01/2014	00:00	Tangential	W _d	7.24E-03	30/03/2010	12:00	Tangential	W _d	6.19E-03
29/01/2014	00:00	Vertical	W _b	8.22E-03	30/03/2010	12:00	Vertical	W _b	7.57E-03
								VDV _b (Day : 0700-2300hrs)	0.040 ms ^{-1.75}
								VDV _b (Night : 2300-0700hrs)	0.013 ms ^{-1.75}

3309/G4 – 1/3-Octave Band RMS Vibration Spectra for Typical Sprinter Pass-by (1400hrs)



3309/G5 – 1/3-Octave Band RMS Vibration Spectra for Typical Freight Pass-by (0032hrs)



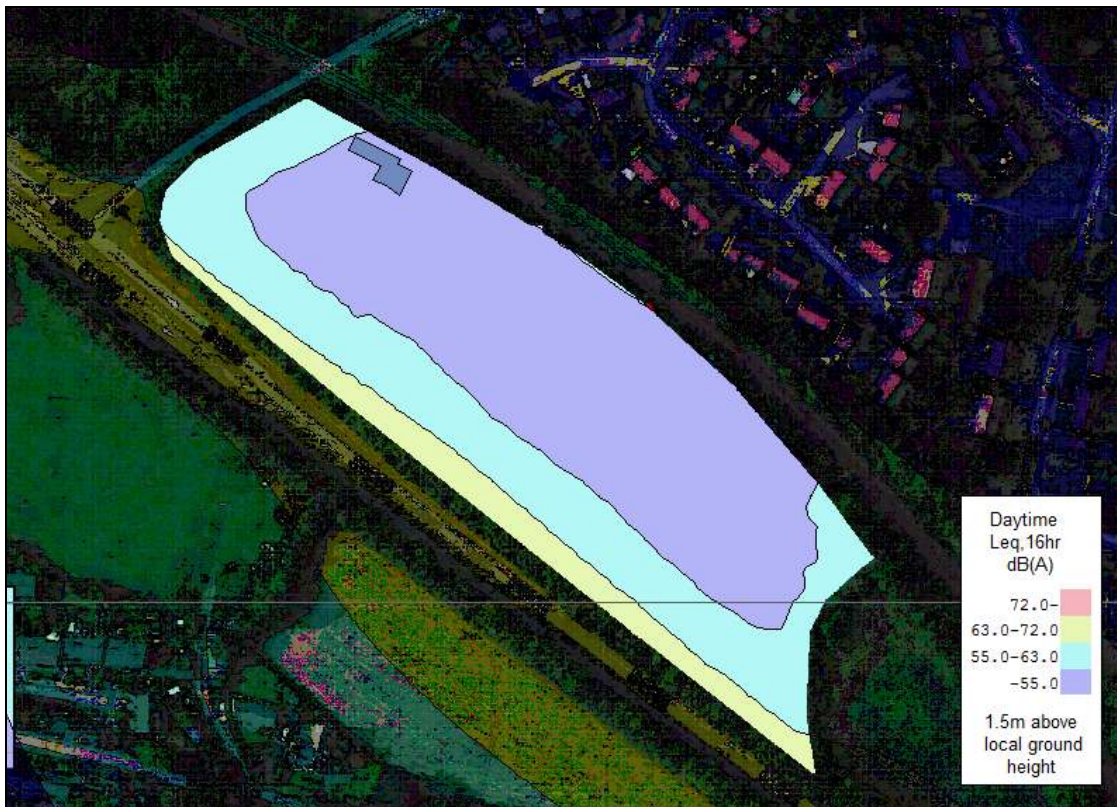
Appendix B – Acoustic Terminology

Human response to noise depends on a number of factors including; loudness, frequency content, and variations in level with time. Various frequency weightings and statistical indices have been developed in order to objectively quantify 'annoyance'. The following units have been used in this report:

- dB(A): The sound pressure level weighted to correspond with the frequency response of the human ear, and therefore a persons subjective response to frequency content.
- L_{eq} : The equivalent continuous sound level is a notional steady state level which over a quoted time period would have the same acoustic energy content as the actual fluctuating noise measured over that period.
- L_{90} : The sound level which is exceeded for 90% of the measurement period. i.e. The level exceeded for 54 minutes of a 1-hour measurement. It is often used to define the background noise level.
- L_{10} : The sound level which is exceeded for 10% of the measurement period. i.e. The level exceeded for 6 minutes of a 1-hour measurement
- SEL: 'Sound Exposure Level', the dB(A) level which, if it lasted 1 second, would produce the same sound energy as the event in question (e.g. a train pass-by).

Appendix C – Noisemaps

3309/NM1 – $L_{eq,16hr}$ Daytime (0700 – 2300hrs); Undeveloped Site



3309/NM2 – $L_{eq,8hr}$ Night (2300 - 0700hrs); Undeveloped Site



3309/NM5 – $L_{eq,16hr}$ Daytime (0700 – 2300hrs); Developed Site (First Floor Level)



3309/NM6 – $L_{eq,8hr}$ Night-time (2300 – 0700hrs); Developed Site (First Floor Level)

