



MR R DANIELS

**RESIDENTIAL DEVELOPMENT
SUNNYMEAD FARM, NORTH END ROAD, YAPTON**

NOISE IMPACT ASSESSMENT

TECHNICAL REPORT: RFE-0205-18-03

DATE: NOVEMBER 2018



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SUNNYMEAD FARM, NORTH END ROAD, YAPTON NOISE IMPACT ASSESSMENT

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1.0 INTRODUCTION

- 1.1 RF Environmental Ltd (RFE) was commissioned by Mr R Daniels in April 2017 to provide an acoustic report to accompany a planning application for a proposed residential development at Sunnymead Farm, North End Road, Yapton, West Sussex.
- 1.2 The purpose of this assessment is to undertake an initial site noise and vibration risk assessment to consider the appropriateness of the site for residential development. The findings of the assessment are reported herein.
- 1.3 The existing site is described in the following section of this report, whilst the legislation and criteria used for the assessment are presented in Section 3. The noise survey is presented in Section 4, whilst the noise impact assessment is addressed in Section 5. Mitigation options are considered in Section 6 and finally, the conclusions of this study are summarised in Section 7. A glossary of useful acoustic terms is presented in Appendix C.
- 1.4 The report has been produced by Richard Fenton (MIOA). Richard is experienced in the production of noise impact assessments following the criteria presented in BS8233:2014 and undertaking the calculations to produce the assessments. Richard has produced a significant number of noise assessments in consultancy roles and reviewed them in local authority roles.



2.0 SITE DESCRIPTION AND PROPOSED DEVELOPMENT

- 2.1 The development site is currently a single private dwelling with associated garden space, located in Yapton, West Sussex, within the boundary of Arun District Council.
- 2.2 The site is bounded to the north by a railway line, which serves the Bognor Regis to London Victoria train services. To the west of the site is the B2132 North End Road, which has individual residential dwellings on either side. Beyond these dwellings is open farmland.
- 2.3 The ambient noise climate in the immediate vicinity of the development site is dominated by road traffic noise from the B2132 and the railway line.
- 2.4 An aerial plot of the site and immediate area is presented in Figure A1 of Appendix A.
- 2.5 The proposed development consists of up to 7 two storey residential dwellings. The proposed site layout is presented in Figure A2 of Appendix A.

3.0 ASSESSMENT CRITERIA

Noise Policy Statement for England (NPSE)

- 3.1 The Noise Policy Statement for England (March 2010) ^[1], sets out the long-term vision of Government noise policy.
- 3.2 The vision of the NPSE is to 'Promote good health and a good quality of life through the effective management and control of noise within the context of Government policy on sustainable development.' This vision is supported by three key aims:
- avoid significant adverse impacts on health and quality of life;
 - mitigate and reduce to a minimum other adverse impacts on health and quality of life; and
 - where possible, contribute to the improvement of health and quality of life.
- 3.3 The NPSE should apply to all forms of noise including environmental noise, neighbour noise and neighbourhood noise but does not apply to noise in the workplace (occupational noise).
- 3.4 The NPSE had adopted the following concepts, to help consider whether noise is likely to have 'significant adverse' or 'adverse' effects on health and quality of life:

NOEL – No Observed Effect Level

This is the level below which no effect can be detected. In simple terms, below this level, there is no detectable effect on health and quality of life due to noise.

LOAEL – Lowest Observed Adverse Effect Level

This is the level above which adverse effects on health and quality of life can be detected.

SOAEL – Significant Observed Adverse Effect Level

This is the level above which significant adverse effects on health and quality of life occur.

- 3.5 However the NPSE goes on to state that:

'it is not possible to have a single objective noise-based measure that defines SOAEL that is applicable to all sources of noise in all situations. Consequently, the SOAEL is likely to be different for different noise sources, for different receptors and at different times. It is acknowledged that further research is required to increase our understanding of what may constitute a significant adverse impact on health and quality of life from noise. However, not having specific SOAEL values in the NPSE provides the necessary policy flexibility until further evidence and suitable guidance is available.'

National Planning Policy Framework

- 3.6 The Department for Communities and Local Government introduced the National Planning Policy Framework (NPPF) in April 2012 ^[2]. This framework replaced most national planning policy, circulars and guidance, including Planning Policy Guidance 24: Planning and Noise.



3.7 The NPPF defines the Government’s planning policy for England and sets out the framework, within which local authorities must prepare their local and neighbourhood plans, reflecting the needs and priorities of their communities. Paragraph 123 of the NPPF requires Local Authorities to develop local policies and make decisions which aim to:

- avoid noise from giving rise to significant adverse impacts on health and quality of life as a result of new development;
- mitigate and reduce to a minimum other adverse impacts on health and quality of life arising from new development, including through the use of conditions;
- recognise that development will often create some noise and existing businesses wanting to develop in continuance of their business should not have unreasonable restrictions put on them because of changes in nearby land uses since they were established; and
- Identify and protect areas of tranquillity which have remained relatively undisturbed by noise and are prized for their recreational and amenity value for this reason.

Planning Practice Guidance - Noise

3.8 Planning Practice Guidance (PPG) on noise ^[3] was issued in March 2014. This web-based guidance advises local planning authorities to take into account the acoustic environment, and in doing so consider the following:

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

3.9 The PPG includes examples of how to recognise when noise could be a concern and provides example outcomes to which the Observed Effect Levels can apply. The PPG noise exposure hierarchy is presented in Table 3.1, based on the likely average response, along with example outcomes.

3.10 While it is acknowledged that planning and nuisance regimes are separate entities, the hierarchy table does provide useful information regarding how the concept of SOAELs and LOAELs, introduced through the NPSE, could be applied and does allow for subjective observations to be considered in the context of potential effect levels. The presence of an “Effect Level” does not infer whether a nuisance is or is not present.

Perception	Examples 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 area such that there is a perceived change in the quality of life.	Observed Adverse Effect	Mitigate and reduce to a minimum
		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 3.1: PPG NOISE EXPOSURE HIERARCHY

(Source –Planning Practice Guidance)

- 3.11 The PPG guidance states that “if external amenity spaces are an intrinsic part of the overall design, the acoustic environment of those spaces should be considered so that they can be enjoyed as intended.” Furthermore the guidance goes on to say “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.”

British Standard 8233:2014

- 3.12 BS 8233:2014 Guidance on sound insulation and noise reduction for buildings ^[4] gives recommendations for the control of noise in and around buildings. The Standard suggests appropriate criteria and limits for different situations to guide the design of new or refurbished buildings undergoing a change of use.
- 3.13 Desirable upper noise levels inside residential habitable rooms are specified in the Standard and are reproduced below in Table 3.2.

Activity	Room	Ambient Indoor Noise Level 07:00 to 23:00 hrs, dB LAeq,1hr	Ambient Indoor Noise Level 23:00 to 07:00 hrs, dB LAeq,1hr
Resting	Living Room	35	-
Dining	Dining room/ area	40	-
Sleeping (daytime resting)	Bedroom	35	30

TABLE 3.2: BS8233 INDOOR AMBIENT NOISE LEVELS FOR DWELLING

- 3.14 Where development is considered necessary or desirable, despite external noise levels above WHO guidelines, the internal target levels may be relaxed by up to 5 dB and reasonable internal conditions still achieved.
- 3.15 In external amenity spaces, such as private gardens and patios, BS 8233 indicates that it is desirable that the external noise level in these areas does not exceed 50 dB $L_{Aeq,T}$ with an upper guideline value of 55 dB $L_{Aeq,T}$ in noisier environments.
- 3.16 The standard does recognise that these guideline values for outdoor noise levels are not achievable in all circumstances where development might be desirable. In higher noise areas, such as in city centres or urban areas adjoining a 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.

World Health Organisation

- 3.17 Guideline values for community noise in specific environments are presented in the WHO's Guidelines for Community Noise ^[5] document. The guideline values pertinent to this noise assessment are presented in Table 3.3.

Specific Environment	Critical Health Effect(s)	dB $L_{Aeq,T}$	Time Base (hours)	dB $L_{Amax,T}$
Outdoor living area	Serious annoyance, daytime and evening	55	16	-
	Moderate annoyance, daytime and evening	50	16	-
Dwelling indoors	Speech intelligibility and moderate annoyance, daytime and evening	35	16	-
Inside bedrooms	Sleep disturbance, night-time	30	8	45

TABLE 3.3: WHO GUIDELINE NOISE VALUES

Pro PG Planning and Noise

- 3.18 The Professional Practice Guidance on Planning and Noise (ProPG)^[6] sets out a recommended approach to the management of noise for new residential developments in England.
- 3.19 The recommended approach set out in the guidance includes a framework to determine where or not noise is likely to be an issue and to identify the extent of risk at noisier sites.
- 3.20 It aims to complement Government planning and noise policy and, alongside other key aims, strives to:



- Advocate full consideration of the acoustic environment from the earliest possible stages of the development control process;
- Encourage the process of good acoustic design in and around new residential developments; and
- Assist the delivery of sustainable development.

BS6472:2008 - Part 1

3.21 BS 6472-1 'Guide to Evaluation of Human Exposure to Vibration in Buildings Part 1: Vibration Sources other than Blasting' [7] presents recommended frequency weighted vibration spectra (for continuous vibration) and vibration dose values (VDV) (for intermittent vibration) above which adverse comment is likely to occur in residential properties. Human response to vibration in buildings is assessed in terms of VDV's defined over daytime and night-time periods and takes into account the frequency, content and duration of the vibration events that comprise the periods. The values pertinent to this assessment are presented in Table 3.4 below.

Place and Time	Low Probability of Adverse Comment ($\text{ms}^{-1.75}$)	Adverse Comment Possible ($\text{ms}^{-1.75}$)	Adverse Comment Probable ($\text{ms}^{-1.75}$)
Residential Buildings (16hr day)	0.2 to 0.4	0.4 to 0.8	0.8 to 1.6
Residential Buildings (8hr night)	0.1 to 0.2	0.2 to 0.4	0.4 to 0.8

TABLE 3.4: VDV LIMITS IN ACCORDANCE WITH BS6472:2008

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 hour day.

4.0 ENVIRONMENTAL NOISE SURVEY

Continuous Baseline Noise Survey

- 4.1 Unattended continuous monitoring of existing noise levels was undertaken at the monitoring location shown as LT1 on Figure A1 of Appendix A. The equipment used during the survey is presented in Table 4.1 below.

Manufacturer	Model No.	Description	Serial No.	Calibration Due Date
Larson Davis	LxT	Sound Level Meter	0004768	April 2020
Larson Davis	LxTPRM1L	Microphone Preamplifier	042613	April 2020
Larson Davis	337B02	½" Electret microphone	161390	April 2020
Larson Davis	CAL200	Calibrator	12981	April 2019

TABLE 4.1: SOUND MONITORING EQUIPMENT

- 4.2 The sound level meter was powered by dry cell batteries and stored inside a weatherproof security box.
- 4.3 Measurements were obtained using the 'F' time weighting and A-weighting frequency network. The equipment was calibrated before and after the survey to generate a calibration level of 114.0 dB at 1 kHz.
- 4.4 15-minute measurements of $L_{Amax,F}$, $L_{Aeq,15min}$, and $L_{A90,15min}$ noise levels were obtained at this monitoring location between 09:00 hrs Friday 11th May and 07:45 hrs Wednesday 16 May 2018, with the microphone position set at a height of approximately 1.5 m above local ground level. A photograph of the monitoring equipment can be seen in Figure A3 of Appendix A.
- 4.5 The dominant noise sources observed during site visits are discussed in section 2. Road and rail traffic noise dominated at the unattended monitoring position.

Attended Noise Measurements

- 4.6 Supplementary attended short-term noise measurements were obtained at monitoring locations ST1 – ST3, as shown on Figure A1 of Appendix A, to understand the variation in noise levels across the development site.
- 4.7 The attended measurements were obtained between 08:09 hrs and 08:57 hrs on Friday 11th May 2018.
- 4.8 All noise measurements were made in free-field conditions. The microphone at each location was approximately 1.5 m above local ground.
- 4.9 The sound level meter was configured to measure A-weighted noise indices, which included $L_{Amax,F}$, $L_{A10,5min}$, $L_{Aeq,5min}$ and $L_{A90,T}$ levels. Sets of 10-minute measurements were obtained at each attended noise monitoring location.

Attended Vibration Measurements

- 4.10 An attended vibration survey of train pass-bys was undertaken on Friday 11th May 2018.
- 4.11 A Rion VM-54 tri-axial vibration meter and a Rion PV-83CW tri-axial accelerometer were used to take samples of vibration from train pass-by events. The instrument used a sampling frequency of 512Hz.
- 4.12 The measurements were made on the surface of the ground at the location identified as V1 in Figure A1 in Appendix A. The accelerometer was attached to a heavy mounting plate to ensure a firm coupling to the ground.
- 4.13 Short term measurements were made of VDV and PPV values during a number of train pass-bys.

Weather Conditions

- 4.14 Weather conditions during the site visits are presented below in Table 4.2.

Site Visit	Date and Time	Noted Weather
Setup	11/05/18 08:00am	No rain, 2/8 cloud cover, 15 °, windspeed <1m/s
Collection	16/05/18 07:00am	No rain, sunny, 3/8 cloud cover, 12 °, windspeed <1 m/s

TABLE 3.2: WEATHER CONDITIONS DURING SITE VISITS

- 4.15 A history of the weather conditions during the continuous survey period has been obtained from an internet source (www.wunderground.com IYAPTON3). Analysis of the data shows a period of light rain during the survey. This does not appear to have influenced the noise levels and therefore has not been removed from the measurement data. The weather conditions obtained for the survey period are summarised in Figure A4 of Appendix A.

Continuous Noise Survey Results

- 4.16 The results of the unattended sound measurement survey are presented graphically in Figure A5 of Appendix A and summarised in Table 4.3 below.

Date	Measured Noise Levels, dB					
	Daytime (07:00 - 23:00)			Night-time (23:00 - 07:00)		
	Leq,max	Leq,10hr	Leq,1min	Leq,max	Leq,1hr	Leq,1min
Fri 11/05/18	74(68-85)*	57*	44*	61(40-76)	54	39
Sat 12/05/18	73(69-82)	56	44	64(45-76)	55	39
Sun 13/05/18	74(66-83)	57	42	68(47-81)	57	39
Mon 14/05/18	75(69-82)	57	46	66(53-79)	55	42
Tue 15/05/18	74(69-82)	58	46	68(54-79)	56	40
Average	74(73-75)	57	44	65(61-68)	55	40

TABLE 4.3: SUMMARY OF DAYTIME UNATTENDED NOISE MEASUREMENTS, LT1

*Note: * denotes incomplete period.*

- 4.17 The results of the unattended noise measurement show that ambient day time $L_{Aeq,16hr}$ sound levels ranged from 56 to 58 dB with a arithmetic average of 57 dB $L_{Aeq,16hr}$. The night time $L_{Aeq,8hr}$ sound levels ranged from 54 to 57 dB, with an arithmetic average of 55dB.
- 4.18 The maximum sound levels ranged from 66 to 85 dB $L_{Amax,F}$ with an arithmetic average of 74 dB during the daytime, while the night time maximum sound levels ranged from 40 to 81 dB $L_{Amax,F}$ with an arithmetic average of 65 dB.

Attended Noise Survey Results

- 4.19 The results of the attended measurements obtained on Friday 11th May 2018 are summarised in Table 4.4 below.

Monitoring Location	Date	Start Time	Duration	Measured Noise Levels, dB			Observations
				$L_{Amax,F}$	$L_{Aeq,T}$	$L_{A90,T}$	
ST1	11/05/2018	08:09:43	00:15:00	79.9	60	47.4	2m from edge of road. Traffic noise dominates.
ST2		08:26:15	00:15:00	79.1	55.5	50.3	Centre of garden. Traffic noise, with train passes every 5 minutes.
ST3/LT1		08:41:55	00:15:00	73.1	55.5	46.1	5m from boundary to railway line. Train noise dominates. Bird song also prevalent.

TABLE 4.4: SUMMARY OF SHORT-TERM ATTENDED NOISE SURVEY

Attended Vibration Survey Results

- 4.20 The results of the individual train pass-by measurements are presented in Table 4.5 below.

Activity	Date	Start Time	Duration	Maximum Recorded Vibration Levels			
				ppv mm/s-1	VDV, ms ^{-1.75}		
					X	Y	Z
Train Pass-by	11/05/2018	07:58:38	0:00:10	0.02	0.003	0.003	0.010
Train Pass-by*		08:00:07	1:00:48	0.02	0.006	0.006	0.019
Train Pass-by		09:03:53	0:00:11	0.02	0.003	0.003	0.011
Train Pass-by		09:05:18	0:00:12	0.02	0.002	0.002	0.008
Train Pass-by		09:09:26	0:00:11	0.01	0.002	0.002	0.007

Note: * continuous measurement of train pass-bys – not individual pass-by

- 4.21 The results indicate that the highest VDV measurement during a train pass-by was 0.011m/s-1.75. This was measured in the Z-axis, during a train pass-by on the near side track.

5.0 ASSESSMENT OF NOISE LEVELS

Calculation of Noise Levels across the Site

Noise Prediction Model

- 5.1 A computer model of noise propagation has been constructed using SoundPLAN version 4.1. This commercial software package implements complex calculations using acoustical ray-tracing techniques, taking into account the acoustically reflective and absorptive properties of the building elements. The environmental noise propagation from source to receiver position is calculated in accordance with the procedures defined in ISO 9613-2:1996 Attenuation of sound during propagation outdoors, part 2: General method of calculation ^[8], using the following acoustic algorithm:

$$L_{ft}(DW) = L_w + D_c - A$$

where

$L_{ft}(DW)$	=	equivalent continuous downwind octave-band sound pressure level at a receiver location
L_w	=	sound power level of the noise source
D_c	=	directivity correction
A	=	attenuation that occurs during propagation from the point sound source to the receiver. $A = A_{div} + A_{atm} + A_{gr} + A_{bar} + A_{misc}$
A_{div}	=	attenuation due to geometrical divergence
A_{atm}	=	attenuation due to atmospheric absorption
A_{gr}	=	attenuation due to the ground effect
A_{bar}	=	attenuation due to a barrier
A_{misc}	=	attenuation due to miscellaneous other effects

- 5.2 The derived day and night-time current site noise levels presented in Table 4.3 and Table 4.4 have been used to calibrate the road and rail source noise levels used in the noise prediction model, with the site in its current form. A screenshot of the computer noise model is presented in Figure 5.1 below. The noise contours for daytime and night time are presented in Figures A6 and A7 of Appendix A respectively.

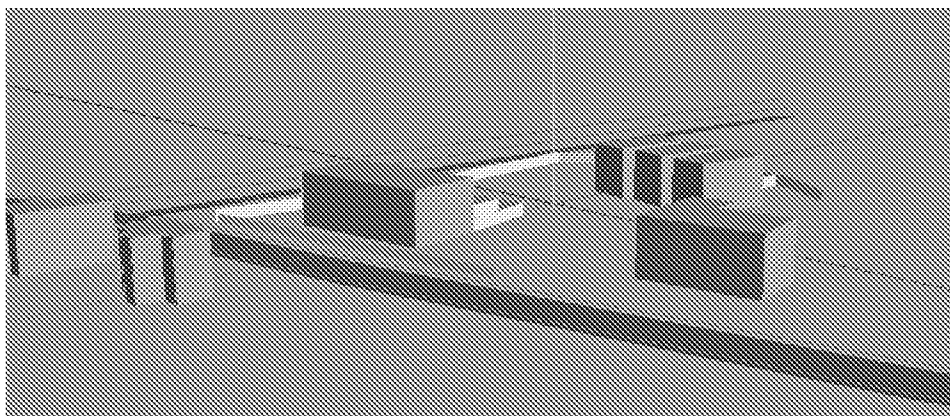


FIGURE 5.1: SCREENSHOT OF COMPUTER NOISE MODEL



5.3 The following assumptions have been considered in the computer model:

- ground cover has been modelled as hard ground;
- receivers have been modelled at a height of 1.5 m above local ground, with a floor height of 2.8m;
- the model assumes a 1.8m close boarded fence along the boundary with the railway line and a 1.2m fence along the boundary with the road;
- buildings and any solid barriers, such as walls and fences, are modelled as reflective acoustic screens;

Assessment of External Noise Levels

- 5.4 BS8233 states that a desirable level for steady continuous noise should not exceed 50dB $L_{Aeq, T}$, with an upper guideline value of 55dB $L_{Aeq, T}$, which should be acceptable in noisier environments. Similar criteria levels are also presented in WHO noise guidelines for the identification of 'moderate' and 'serious' annoyance critical health effects.
- 5.5 The predicted noise levels in the external amenity areas selected for assessment, range between 45dB and 48dB $L_{Aeq, 16hr}$, which comply with the desirable level prescribed in BS8233:2014. This indicates that a good standard of amenity will be achieved.
- 5.6 These results are based on the assumption that a 1.8m noise barrier is installed along the boundary with the railway line. Should there be a reason why this mitigation option cannot be provided, the levels assessed would increase, with some external amenity spaces exceeding the upper guideline value. In these circumstances, a good standard of amenity would not be achieved in the worst affected gardens, closest to the railway line.

Assessment of Internal Noise Levels

- 5.7 The assessment of internal noise levels has been undertaken using the site layout shown in Figure A2, with assessment locations labelled as R1 to R9.
- 5.8 BS 8233:2014 contains recommended guideline levels of 35 dB $L_{Aeq, T}$ for resting inside bedrooms and living rooms during the daytime, 40 dB $L_{Aeq, T}$ for dining areas and 30 dB $L_{Aeq, T}$ for sleeping inside bedrooms at night.
- 5.9 The approximate sound reduction value provided in Annex G of BS 8233 for a closed insulating glass window unit is 33 dB R_w . With a window open to provide background ventilation, the sound insulation of the window reduces to approximately 15 dB from a free-field level.
- 5.10 Taking this typical sound reduction performance into consideration, and on the understanding that the external facade will consist of block and brick construction, it is clear that the glazing will be the weakest part of the construction and internal noise levels have

been predicted inside the dwellings, assuming windows are fully closed or partially open for ventilation purposes.

- 5.11 Noise levels have been calculated in the noise prediction model and the results for each facade location are summarised in Table 5.1.

Receptor/ Floor	Predicted Daytime Facade Noise Level $L_{Aeq,10hr}$	Predicted Daytime Internal Noise Level, dB $L_{Aeq,10hr}$		Predicted Night-Time Facade Noise Level $L_{Aeq,8hr}$	Predicted Night-Time Internal Noise Level, dB $L_{Aeq,8hr}$	
		Windows Partially Open	Windows Closed		Windows Partially Open	Windows Closed
R1 - Gnd	58	43	25	50	35	17
R1 - 1st	62	47	29	54	39	21
R2 -Gnd	47	32	14	45	30	12
R2 - 1st	55	40	22	53	38	20
R3 - Gnd	58	43	25	50	35	17
R3 - 1st	62	47	29	54	39	21
R4 - Gnd	45	30	12	43	28	10
R4 - 1st	50	35	17	47	32	14
R5 - Gnd	48	33	15	45	30	12
R5 - 1st	53	38	20	50	35	17
R6 - Gnd	49	34	16	43	28	10
R6 - 1st	52	37	19	47	32	14
R7 - Gnd	43	28	10	41	26	8
R7 - 1st	50	35	17	47	32	14
R8 - Gnd	48	33	15	41	26	8
R8 - 1st	51	36	18	44	29	11
R9 - Gnd	42	27	9	39	24	6
R9 - 1st	46	31	13	44	29	11

TABLE 5.1: ASSESSMENT OF ESTIMATED DAYTIME NOISE LEVELS

Note: [1] assuming a 15dB(A) reduction for windows partially open

[2] assuming a 33dB(A) reduction for windows closed

[3] red text indicates exceedance of criteria for living room/bedroom (daytime) and bedrooms (night time).

- 5.12 Based on the assumed typical facade reductions, the noise predictions show that internal noise levels remain below the daytime and night-time criterion of 35 and 30 dB $L_{Aeq, T}$ respectively, with windows closed, at all assessment locations across the development site.
- 5.13 With windows partially open, the noise predictions show that internal noise levels fall below the daytime and night time criteria at some locations but exceed the criteria at the worst affected locations. However, with the provision of alternative background ventilation, the windows will be able to be kept closed if required by the occupants and the ingress of external noise will be adequate controlled.

World Health Organisation $L_{Amax, f}$ Noise Levels

- 5.14 Maximum $L_{Amax,F}$ noise levels generated at night have also been considered at the proposed development site.
- 5.15 WHO guideline noise criteria sets an internal sleep disturbance noise limit of 45 dB $L_{Amax,F}$ for the onset of critical health effects, which is a level which should not be exceeded on a regular basis. Based on an interpretation that for a noise to be regular, it needs to occur several (i.e. more than two) times per hour, the $L_{Amax,F}$ noise needs to be based upon an average of at least 10-15 events that are typical in nature.
- 5.16 On this basis, the aim of protecting against maximum noise levels is to ensure protection against typical intermittent noise rather than one-off events, whereby an arithmetic average of the typical maximum events across the survey period has been used to determine the $L_{Amax, F}$ value presented in Table 5.2 below. These levels were measured at LT1 and are considered to be representation of the worst case $L_{Amax, F}$ levels across the site.

Location	Typical Facade Noise Levels	Estimated Internal Noise Level		BS 8233 Internal Noise Criterion Achieved	
		Windows Partially Open	Windows Closed	Windows Partially Open	Windows Closed
		Bedroom			
LT1	78	63	45	N	Y

TABLE 5.2: ASSESSMENT OF ESTIMATED $L_{Amax, F}$ CRITERIA BASED ON TYPICAL MAXIMUM EVENTS

Note: [1] assuming a 15dB(A) reduction for windows partially open

[2] assuming a 33dB(A) reduction for windows closed

- 5.17 The results indicate that the $L_{Amax,F}$ criteria would be exceeded by 18dB with windows open but the criteria would be achieved with windows closed, assuming a sound level difference of 33dB.
- 5.18 It should be noted that the measurement location LT1 is closer to the railway line than any of the windows serving habitable rooms and therefore the $L_{Amax, F}$ levels are likely to be below those shown in Table 5.2.

BS6472 Assessment

- 5.19 Vibration levels in the ground will be reduced when transferred into a building due to the mass loading, with the degree of the reduction varying, depending upon the mass and dynamic response of the building and soil structure of the site however, to ensure a robust, worst case assessment, no reduction has been made to the external measured levels.
- 5.20 Vibration levels on a suspended floor of a building can be expected to be higher than the vibration levels at the same location measured on the foundation of a building. The degree of magnification varies, depending upon the dynamic response of the building and the floor, but experience shows that 2 to 3 times is a reasonable range of values. This assessment assumes dynamic magnification of 2.5 times for vertical vibration.



5.21 The assessment is based upon determining the number of train pass-bys that may be expected to occur during a day or night-time period and calculating the VDV based on a maximum measured sample. The method for manipulating VDV's is provided by BS6472.

5.22 BS6472 states:

'If, in a day, there is a total of N periods of various durations with a vibration dose value, VDV_n, the total vibration dose for the day is given by

$$VDV_{b/d, day/night} = \left(\sum_{n=1}^N VDV_{b/d, tn}^4 \right)^{0.25}$$

5.23 Information obtained from the local railway station at Barnham indicates that there are approximately 160 train passes during the daytime period (07:00 to 23:00) and 26 during the night time period (23:00 to 07:00).

5.24 The results of the assessment are presented in Table 5.3 below.

Period	Number of trains	Highest Event VDV m/s 1.75	Period VDV m/s 1.75 (Gnd Floor)	Period VDV m/s 1.75 (Upper floor)
Daytime (07:00 - 23:00)	160	0.01	0.04	0.09
Night Time (23:00 - 07:00)	26	0.01	0.02	0.06

TABLE 5.3: RESULTS OF THE VIBRATION ASSESSMENT

5.25 The results indicate that the period VDV's for daytime and night time are expected to fall below the values at which, according to BS6472, there is a low probability of adverse comment.

5.26 Based on the above assessment, no further mitigation will be required to control vibration.

Uncertainty

5.27 All reasonable skill and care has been taken to accurately measure the ambient sound levels at the assessment location.

5.28 The level of uncertainty in the ambient noise survey is minimised by measuring over a 4-day period whilst avoiding adverse weather conditions and in a location representative of the nearest residential receptors.

5.29 The computer modelling package SoundPlan Essential 4.1 follows the calculation procedure specified in ISO 9613-2. This calculation methodology has an estimated accuracy of ± 3 dB.

5.30 Rounding has been used in the derivation of the ambient sound level and calculations, to avoid an impression of precision to decimal places. Rounding has been to integer values with 0.5 being rounded up on completion of the statistical analysis.



6.0 MITIGATION OPTIONS

- 6.1 The initial assessment has indicated that satisfactory internal noise levels can be achieved with appropriate glazing and alternative background ventilation, which will allow windows to be kept closed, if required.
- 6.2 Windows on the development should be specified to achieve a minimum sound level difference of 33dB.
- 6.3 Ventilation could take the form of acoustic passive ventilation or whole house ventilation systems such as mechanical ventilation with heat recovery (MVHR) so that windows can remain closed if the occupier wishes.
- 6.4 The assessment has assumed the inclusion of noise barriers, in the form of a 1.8m high acoustic fence along the boundary with the railway line and a 1.2 m high close boarded fence along the boundary with the road. This should be considered an important mitigation option, without which the noise levels across the site, especially at ground floor level, will be higher than those predicted in the assessment.
- 6.5 Other design options, such as consideration of internal room layout should ensure that noise across the site is reduced as far as reasonably practicable and that a good standard of amenity is achieved.
- 6.6 For example, it would be good practice to avoid the inclusion of windows for habitable rooms on the facades directly facing the railway line.



7.0 CONCLUSIONS

- 7.1 RF Environmental Ltd was appointed to undertake a noise impact assessment for the proposed development site at Sunnymead Farm, North End Road, Yapton.
- 7.2 British Standard BS8233:2014 has been used to determine the likely external and internal noise levels from existing road and rail traffic noise at locations across the site.
- 7.3 The existing noise environment has been established, which is considered representative of the development site, through unattended and attended noise monitoring.
- 7.4 Computer noise modelling software has been used to predict the external noise levels across the development site.
- 7.5 The external noise assessment indicates that with the provision of a noise barrier along the boundary of the railway line and road, the noise levels in the external amenity areas will not exceed the desirable levels set out in BS8233 and therefore a good standard of amenity should be achieved.
- 7.6 The internal noise assessment indicates that the recommended daytime and night time guideline levels prescribed in BS 8233:2014 will be achieved in all habitable rooms with windows closed, assuming standard double glazing which can provide a sound level difference of 33dB.
- 7.7 With windows open for ventilation, some receptors will achieve the desirable internal noise criteria, while the noise levels at the worst affected receptors will exceed the criteria.
- 7.8 A suitable background ventilation strategy is likely to be required to allow windows to remain closed, where required.
- 7.9 The incorporation of suitable noise barriers along the boundary with the railway line and road will ensure that noise levels are reduced across the site as far as reasonably practicable and a good standard of residential amenity can be achieved.
- 7.10 With the recommended measures in place it is therefore concluded that there should be no reason on noise grounds why the application should be refused planning permission.



8.0 REFERENCES

1. Department for Environment, Food and Rural Affairs (DEFRA). *Noise Policy Statement for England (NPSE)*, 2010.
2. Department of Communities and Local Government. *National Planning Policy Framework*, 2012.
3. Department for Communities and Local Government: *Planning Practice Guidance – Noise*. Revision date March, 2014.
4. British Standard BS 8233: 2014: *Guidance on Sound Insulation and Noise Reduction for Buildings*.
5. World Health Organisation. *Guidelines for Community Noise*. 1999.
6. *ProPG: Planning and Noise - Professional Practice Guidance on Planning and Noise*. 2017.
7. British Standard BS 6472: 2008 – Part 1: *Guide to Evaluation of Human Exposure to Vibration in Buildings Part 1: Vibration Sources other than Blasting*.
8. ISO 9613-2:1996 *Attenuation of sound during propagation outdoors, part 2: General method of calculation*

APPENDIX A: FIGURES

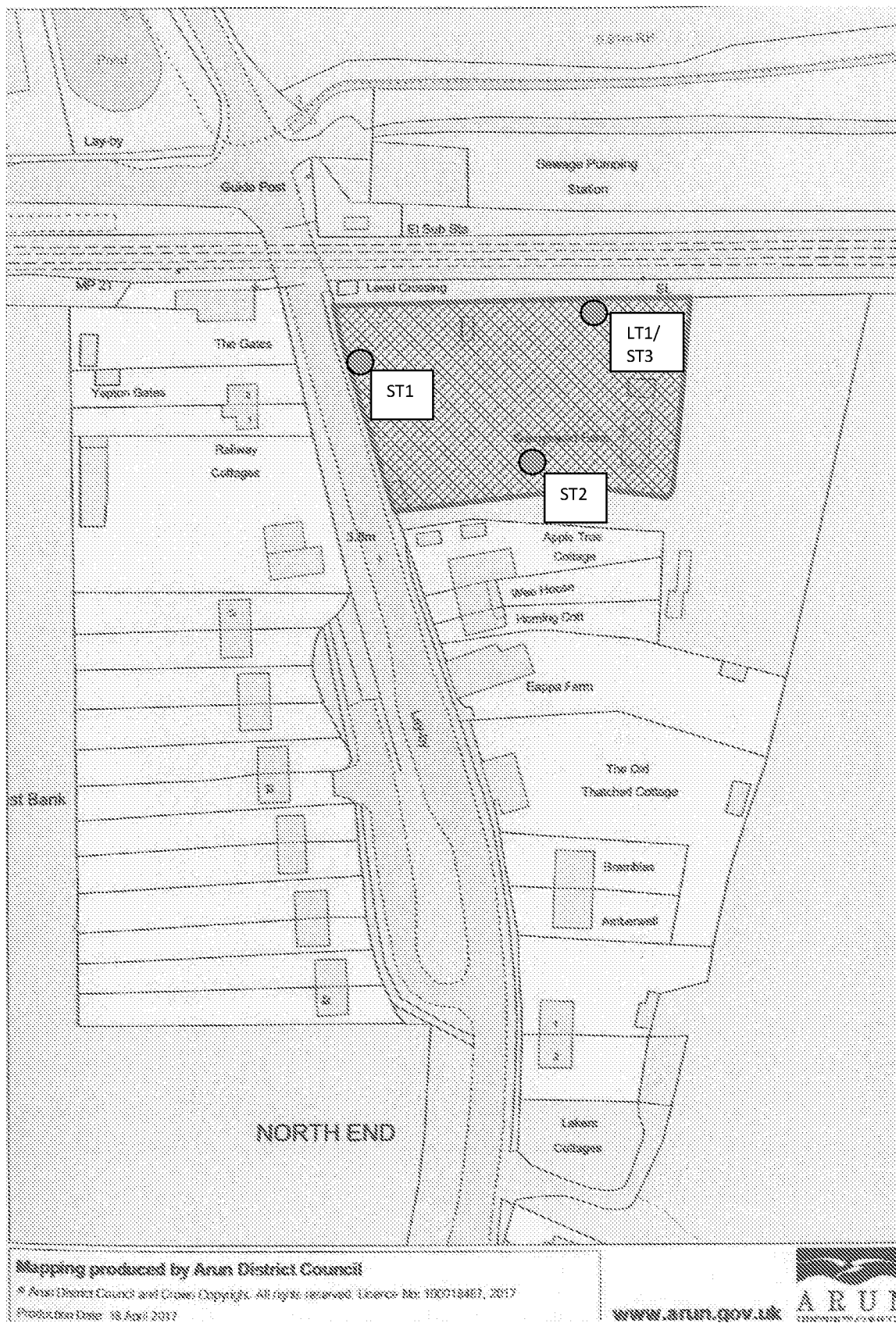


FIGURE A1: LOCATION OF PROPOSED DEVELOPMENT SITE

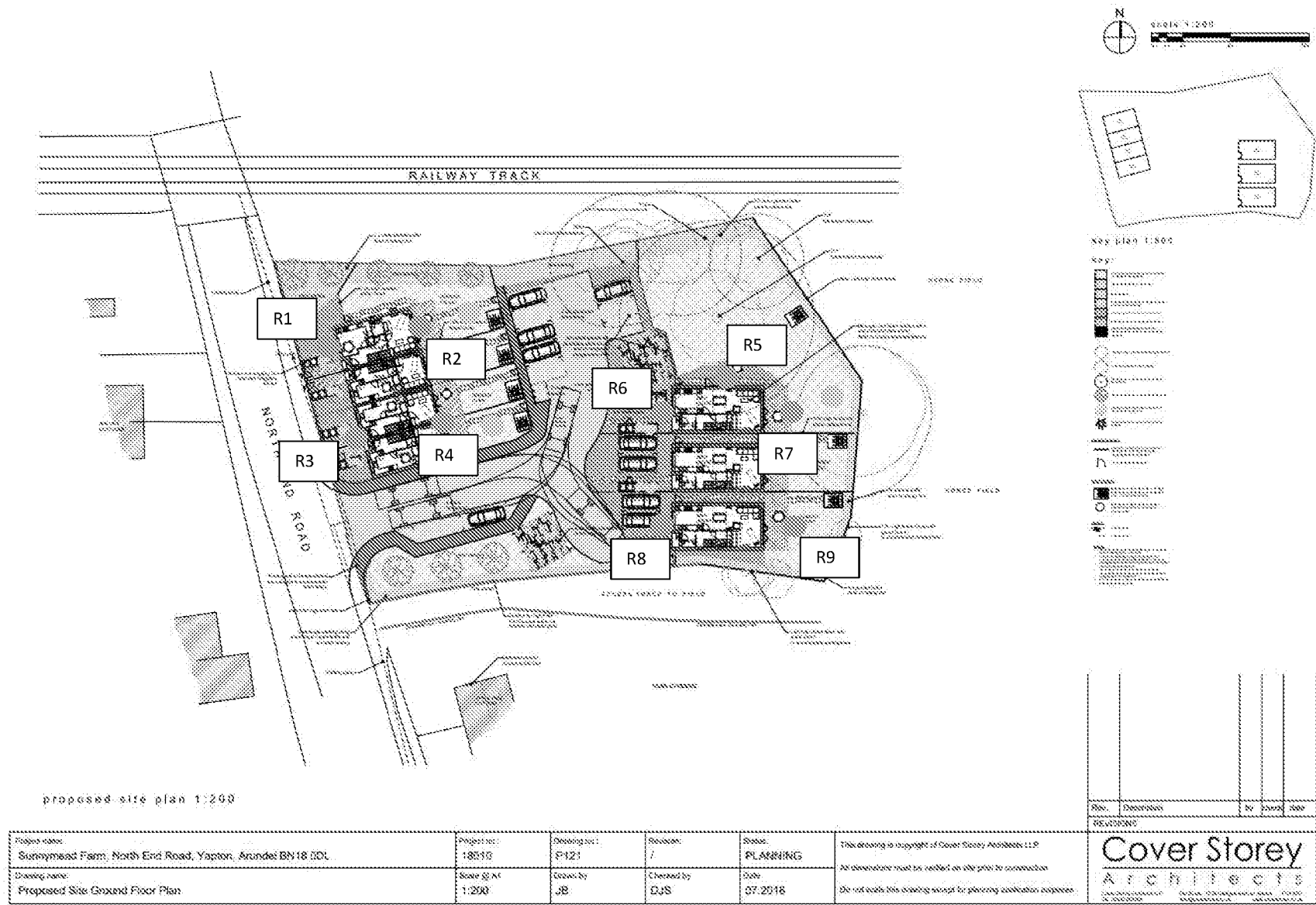


FIGURE A2: PROPOSED SITE LAYOUT

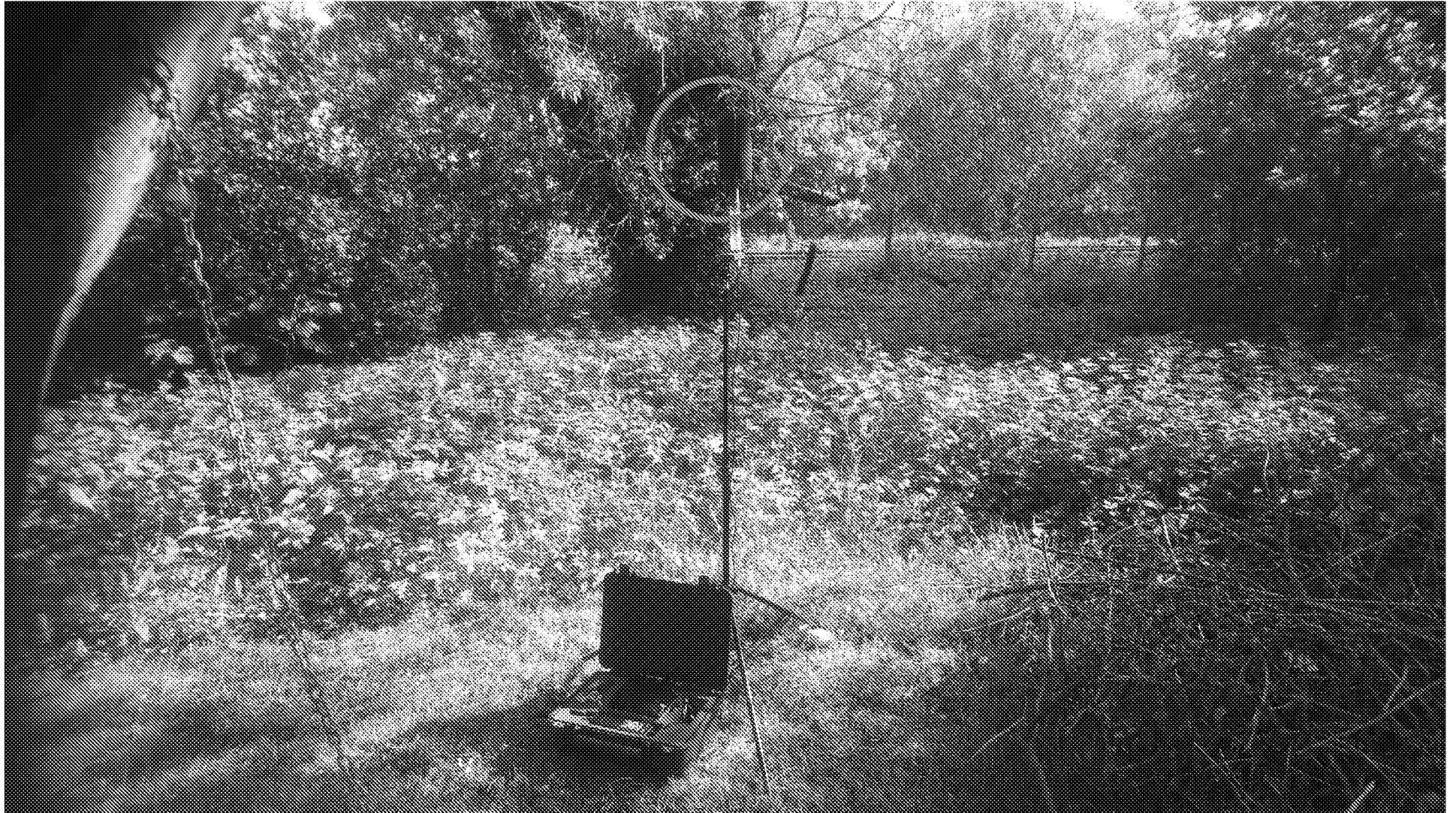


FIGURE A3: PHOTOGRAPH SHOWING UNATTENDED (LT1) MONITORING LOCATION

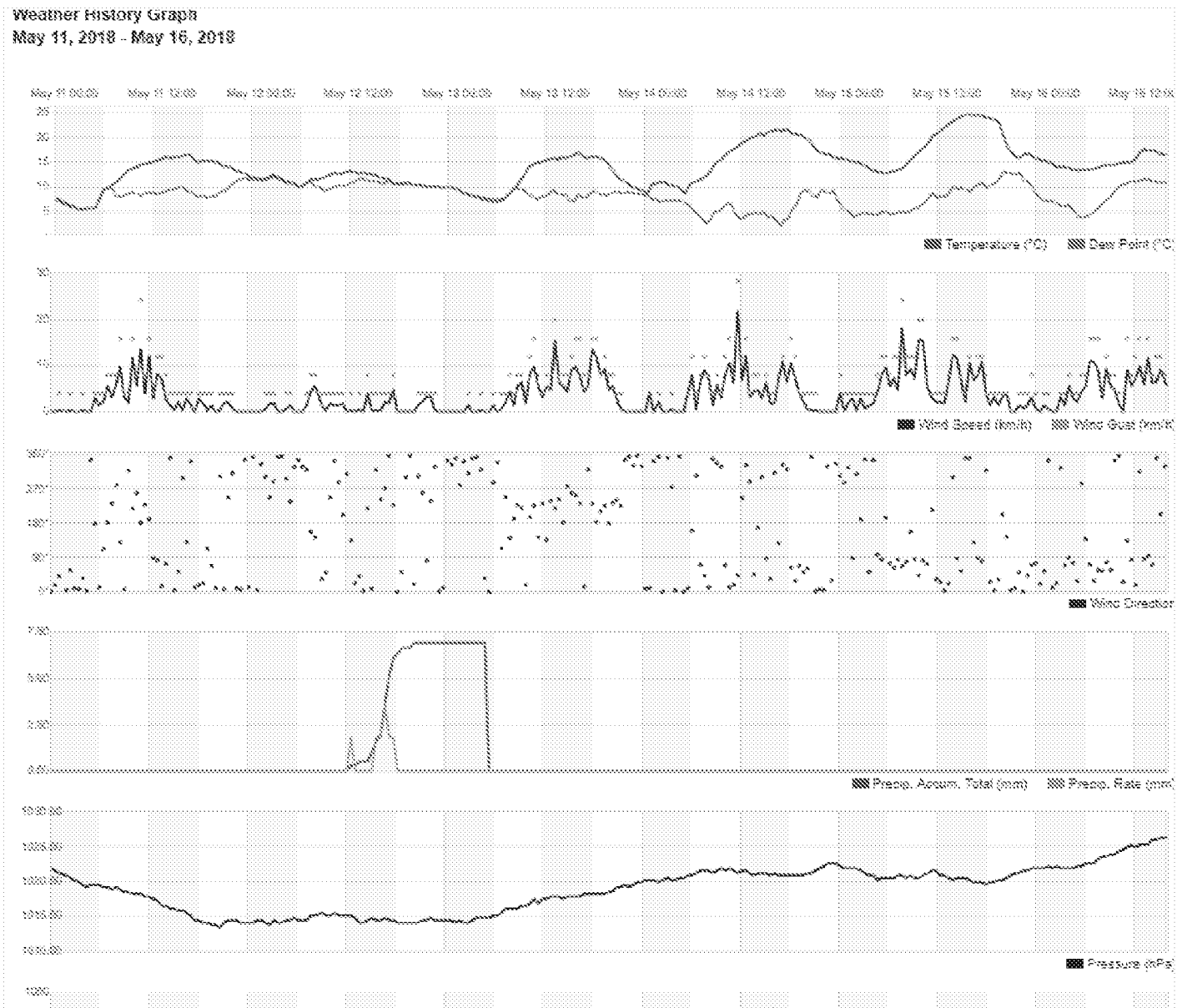


FIGURE A4: WEATHER DATA DURING MONITORING PERIOD FRIDAY 11th MAY TO WEDNESDAY 16th MAY 2018

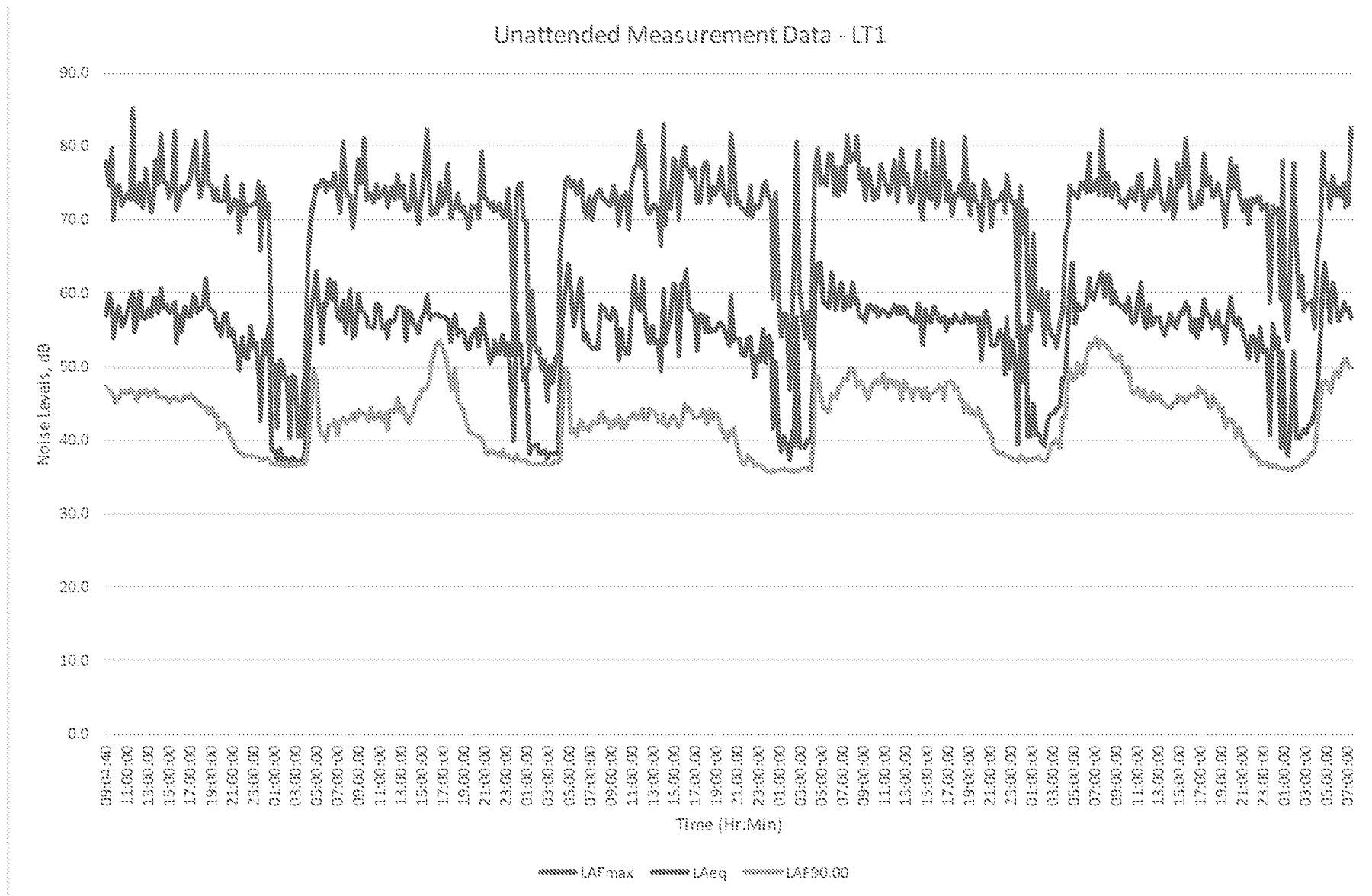


FIGURE A5: CONTINUOUS SOUND MONITORING RESULTS AT LT1, FRIDAY 11TH MAY TO WEDNESDAY 16TH MAY 2018

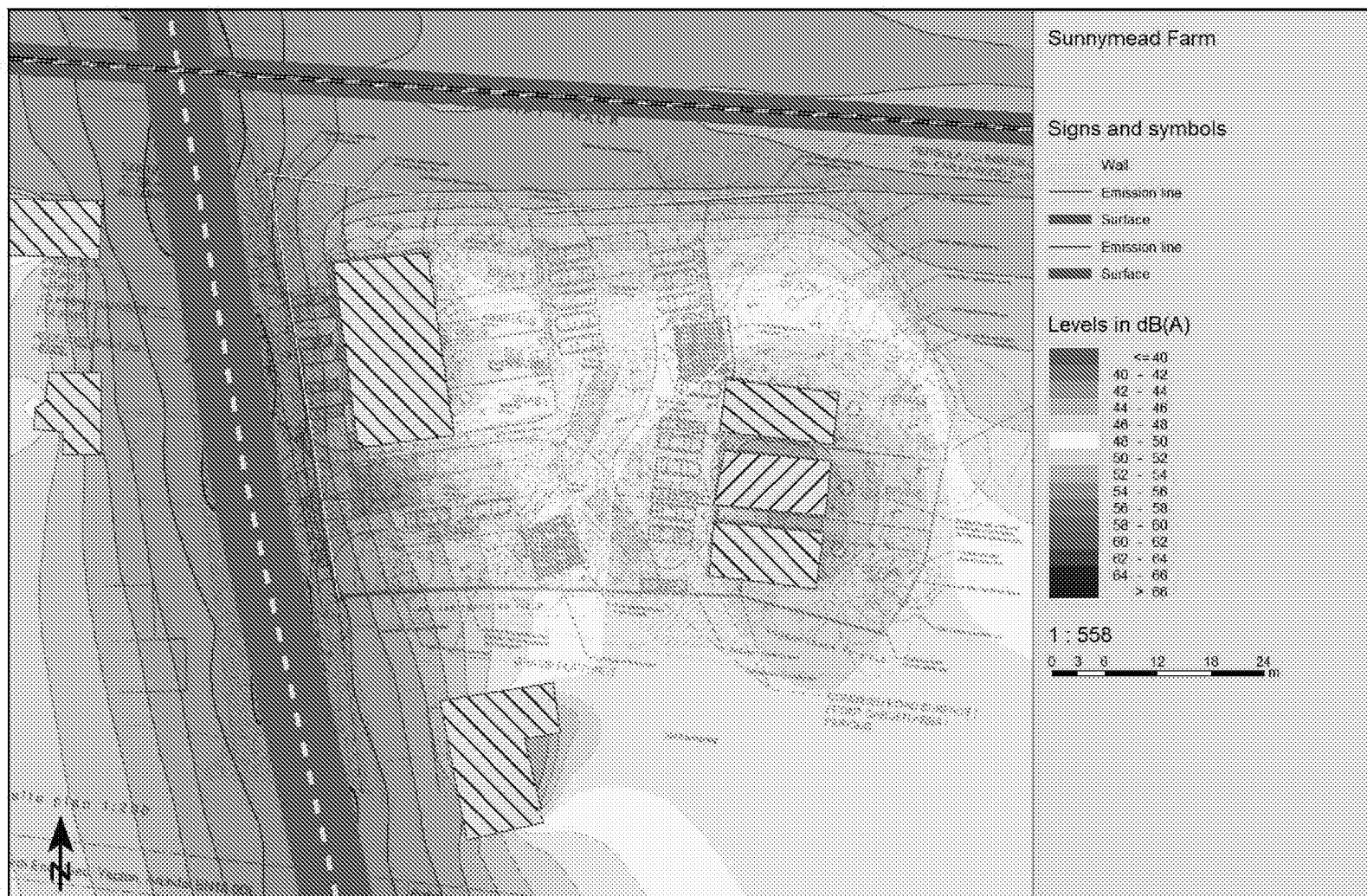


FIGURE A6: DAYTIME NOISE CONTOURS



FIGURE A7: NIGHT TIME NOISE CONTOURS

APPENDIX B: TABLES

Date of Meas.	Start Time	Measured Noise Levels, dB			
		Leqmax1	Leq10min	Leq1hour	Leq15min
Friday 11th May 2018	09:04:40	78.0	57.8	57.1	47.2
	09:15:00	74.6	64.5	60.0	46.9
	09:30:00	79.9	61.2	58.4	46.5
	09:45:00	70.1	54.6	54.0	46.0
	10:00:00	74.1	59.4	56.8	45.2
	10:15:00	74.9	60.1	58.2	46.0
	10:30:00	72.0	55.9	55.5	46.6
	10:45:00	72.5	57.1	56.0	46.6
	11:00:00	73.5	59.7	57.4	46.2
	11:15:00	72.8	63.8	59.1	46.9
	11:30:00	85.2	63.8	60.1	46.5
	11:45:00	72.7	55.9	54.7	46.2
	12:00:00	72.3	58.1	56.0	45.3
	12:15:00	75.0	65.3	60.3	46.6
	12:30:00	71.6	60.3	56.6	46.3
	12:45:00	76.9	57.1	56.7	46.9
	13:00:00	74.1	60.3	57.8	46.0
	13:15:00	71.0	60.3	56.8	46.5
	13:30:00	73.6	63.9	59.2	46.5
	13:45:00	78.0	63.6	59.3	46.9
	14:00:00	74.9	60.7	57.3	46.0
	14:15:00	81.8	63.4	60.6	46.0
	14:30:00	75.0	62.2	58.0	45.7
	14:45:00	75.0	60.9	58.3	45.8
	15:00:00	72.9	58.9	57.4	44.9
	15:15:00	74.6	60.0	57.9	45.7
	15:30:00	82.1	59.5	58.8	46.0
	15:45:00	71.4	54.5	53.2	45.8
	16:00:00	72.2	59.7	57.1	45.3
	16:15:00	74.7	55.2	54.8	45.4
	16:30:00	74.1	62.3	58.2	46.1
	16:45:00	74.6	58.4	56.8	45.8
	17:00:00	75.8	58.9	56.8	46.3
	17:15:00	78.9	61.6	59.7	45.7
	17:30:00	80.8	59.6	59.1	45.8
	17:45:00	76.0	57.3	57.4	45.1
	18:00:00	73.1	60.8	57.8	44.9
	18:15:00	74.8	61.8	58.2	44.6
	18:30:00	81.9	67.3	62.1	44.6
	18:45:00	74.6	62.7	58.2	43.7
	19:00:00	74.6	62.0	57.6	44.4
	19:15:00	72.7	58.7	57.7	43.5
	19:30:00	74.2	55.3	55.3	43.5
	19:45:00	72.7	54.2	55.7	41.5

	20:00:00	72.5	50.2	54.2	42.1
	20:15:00	72.5	60.9	57.2	42.4
	20:30:00	76.0	55.0	57.2	41.9
	20:45:00	71.1	50.1	54.1	40.5
	21:00:00	71.6	50.9	55.0	39.9
	21:15:00	72.7	48.1	53.2	38.9
	21:30:00	72.3	44.7	51.6	38.4
	21:45:00	68.3	45.9	49.6	38.2
	22:00:00	74.8	46.7	53.9	38.3
	22:15:00	70.9	45.3	51.7	37.9
	22:30:00	72.0	45.5	51.1	37.9
	22:45:00	72.0	50.6	55.4	37.8
	23:00:00	72.2	45.9	52.7	37.6
	23:15:00	72.2	44.9	53.1	37.6
	23:30:00	75.3	44.0	48.6	37.6
	23:45:00	65.8	43.7	42.7	37.3
Saturday 12th May 2018	00:00:00	74.4	44.2	53.5	37.2
	00:15:00	70.3	47.1	51.9	37.4
	00:30:00	72.1	47.1	55.5	37.4
	00:45:00	50.5	40.3	38.7	36.9
	01:00:00	50.3	39.5	38.4	36.7
	01:15:00	41.8	37.8	37.2	36.7
	01:30:00	50.9	41.0	38.8	36.8
	01:45:00	50.3	37.7	37.3	36.6
	02:00:00	48.4	37.9	37.5	36.6
	02:15:00	48.4	37.9	37.4	36.7
	02:30:00	40.4	37.6	37.1	36.5
	02:45:00	48.7	38.2	37.7	36.6
	03:00:00	48.1	37.7	37.3	36.5
	03:15:00	40.5	37.6	37.1	36.6
	03:30:00	40.5	37.7	37.2	36.7
	03:45:00	47.8	37.8	37.3	36.8
	04:00:00	48.6	41.2	38.8	36.8
	04:15:00	64.5	51.3	48.5	39.0
	04:30:00	70.2	61.8	57.0	43.9
	04:45:00	72.6	64.1	60.0	49.7
	05:00:00	74.6	67.9	63.0	48.1
	05:15:00	74.4	56.9	57.4	41.7
	05:30:00	75.3	53.6	53.1	40.8
	05:45:00	75.2	59.6	58.7	40.4
	06:00:00	73.8	60.7	58.3	39.9
	06:15:00	75.0	67.6	62.0	41.8
	06:30:00	74.5	63.0	59.1	42.1
	06:45:00	76.4	65.9	61.4	42.7
	07:00:00	73.5	56.6	56.9	40.8
	07:15:00	71.1	57.6	56.2	42.6

	07:30:00	80.7	57.0	58.9	43.1
	07:45:00	74.9	54.7	54.6	42.2
	08:00:00	73.2	57.5	56.6	42.6
	08:15:00	73.3	66.5	60.5	42.8
	08:30:00	68.9	55.7	54.0	43.7
	08:45:00	72.6	55.4	54.6	42.7
	09:00:00	78.4	63.1	59.9	43.9
	09:15:00	74.9	61.2	57.6	43.7
	09:30:00	81.1	56.5	57.4	43.7
	09:45:00	72.8	58.7	56.6	43.3
	10:00:00	73.7	56.5	55.4	42.7
	10:15:00	73.6	56.4	55.4	44.3
	10:30:00	72.4	57.0	55.3	42.9
	10:45:00	74.8	61.4	58.5	43.0
	11:00:00	73.2	61.5	58.4	43.8
	11:15:00	73.8	57.0	55.3	42.7
	11:30:00	74.5	56.8	55.8	43.6
	11:45:00	71.7	51.4	53.9	41.3
	12:00:00	72.8	55.1	56.2	43.8
	12:15:00	74.4	57.3	56.1	44.0
	12:30:00	72.7	57.7	56.5	43.8
	12:45:00	76.1	61.6	58.2	45.8
	13:00:00	72.9	62.6	58.2	43.8
	13:15:00	74.6	62.3	58.1	44.4
	13:30:00	71.5	52.9	53.6	43.1
	13:45:00	71.5	62.7	57.6	42.3
	14:00:00	71.7	61.8	57.5	43.3
	14:15:00	76.2	56.8	55.8	43.7
	14:30:00	71.7	59.3	55.7	45.1
	14:45:00	69.4	57.0	54.5	45.6
	15:00:00	72.9	59.9	56.7	46.8
	15:15:00	76.2	60.7	57.2	46.8
	15:30:00	82.3	54.6	59.8	47.1
	15:45:00	73.4	58.6	56.4	48.2
	16:00:00	70.6	59.1	57.0	50.5
	16:15:00	71.5	57.9	57.0	51.9
	16:30:00	70.8	58.4	57.2	53.1
	16:45:00	75.0	56.4	56.7	53.5
	17:00:00	72.0	56.4	56.9	52.5
	17:15:00	73.6	57.8	56.7	51.6
	17:30:00	77.7	54.7	56.5	49.8
	17:45:00	70.3	53.9	53.3	47.6
	18:00:00	71.3	57.4	55.6	46.9
	18:15:00	71.8	60.4	57.0	49.7
	18:30:00	73.4	54.1	54.3	45.1
	18:45:00	71.1	57.8	54.8	44.7

	19:00:00	71.9	56.3	55.0	43.9
	19:15:00	70.4	51.7	53.1	42.4
	19:30:00	69.0	51.3	52.5	41.3
	19:45:00	71.9	53.5	54.4	40.9
	20:00:00	71.7	52.9	54.3	40.9
	20:15:00	71.7	54.6	55.1	40.6
	20:30:00	70.2	54.5	52.9	40.5
	20:45:00	79.3	59.0	57.1	40.3
	21:00:00	73.2	49.4	54.8	39.0
	21:15:00	72.5	46.2	53.2	38.0
	21:30:00	71.8	46.7	50.5	38.6
	21:45:00	72.3	45.5	51.4	38.5
	22:00:00	71.2	46.3	53.6	38.2
	22:15:00	71.4	47.7	51.8	38.2
	22:30:00	72.2	46.6	51.9	37.6
	22:45:00	70.5	47.3	54.4	38.6
	23:00:00	70.4	46.2	51.6	37.6
	23:15:00	74.2	46.7	53.2	37.8
	23:30:00	69.3	44.1	47.7	37.2
	23:45:00	51.5	42.8	40.0	37.1
Sunday 13th May 2018	00:00:00	73.1	55.9	57.2	38.0
	00:15:00	74.4	44.0	51.8	37.4
	00:30:00	75.0	42.5	53.0	37.0
	00:45:00	70.0	42.7	48.3	37.2
	01:00:00	69.9	42.2	49.8	37.1
	01:15:00	49.5	38.6	38.1	36.9
	01:30:00	60.4	39.6	39.2	36.7
	01:45:00	53.0	41.3	39.3	36.7
	02:00:00	51.8	41.9	39.4	36.7
	02:15:00	52.4	39.6	38.2	36.7
	02:30:00	49.6	39.6	38.3	36.8
	02:45:00	51.0	39.4	38.6	36.9
	03:00:00	45.4	38.1	37.4	36.7
	03:15:00	50.1	38.0	38.2	36.8
	03:30:00	47.9	38.7	38.0	36.9
	03:45:00	51.2	39.0	38.3	37.0
	04:00:00	51.7	38.3	38.1	36.9
	04:15:00	65.7	51.9	49.0	37.5
	04:30:00	70.1	62.2	57.7	45.7
	04:45:00	75.5	65.1	60.6	49.7
	05:00:00	75.9	69.1	64.0	48.7
	05:15:00	74.4	64.5	59.8	41.0
	05:30:00	75.3	55.5	55.5	41.5
	05:45:00	73.6	57.4	58.1	40.6
	06:00:00	74.8	66.8	61.3	42.2
	06:15:00	75.5	67.6	62.0	42.6

	06:30:00	71.6	54.8	53.6	41.5
	06:45:00	70.5	57.6	54.5	41.7
	07:00:00	73.1	51.9	52.9	41.3
	07:15:00	70.1	51.9	52.3	42.5
	07:30:00	73.0	53.0	52.6	42.4
	07:45:00	74.0	51.7	52.3	42.3
	08:00:00	74.0	60.1	58.4	43.6
	08:15:00	72.9	59.7	57.7	43.8
	08:30:00	72.8	61.7	57.9	42.4
	08:45:00	72.4	59.1	56.6	42.8
	09:00:00	72.0	59.3	56.5	41.7
	09:15:00	74.6	60.1	58.0	42.6
	09:30:00	73.5	60.5	57.1	42.1
	09:45:00	69.3	50.8	51.0	43.3
	10:00:00	73.2	52.4	55.1	41.6
	10:15:00	71.9	53.9	52.9	42.6
	10:30:00	73.7	50.2	51.8	41.6
	10:45:00	68.6	54.2	51.8	42.8
	11:00:00	74.8	59.4	57.0	43.3
	11:15:00	77.2	67.7	62.4	43.6
	11:30:00	77.3	60.2	58.5	42.9
	11:45:00	82.0	51.8	57.6	43.4
	12:00:00	77.1	67.4	62.0	44.2
	12:15:00	79.9	60.1	58.2	42.8
	12:30:00	71.5	56.8	54.6	42.8
	12:45:00	70.8	56.1	53.2	44.1
	13:00:00	71.9	55.8	55.5	44.0
	13:15:00	72.0	50.6	53.2	43.8
	13:30:00	71.1	51.5	53.6	42.6
	13:45:00	66.4	52.4	49.3	42.5
	14:00:00	83.1	58.0	60.4	43.4
	14:15:00	69.4	54.2	53.3	42.1
	14:30:00	73.7	57.4	55.3	41.8
	14:45:00	71.5	61.5	56.8	42.7
	15:00:00	78.3	64.9	61.3	43.4
	15:15:00	77.8	65.9	60.7	42.5
	15:30:00	70.0	50.1	51.5	41.8
	15:45:00	78.2	65.9	61.3	42.4
	16:00:00	80.0	65.2	61.6	44.9
	16:15:00	77.5	68.1	63.1	43.9
	16:30:00	76.8	59.9	58.1	44.3
	16:45:00	75.8	60.8	57.5	43.8
	17:00:00	77.1	54.9	57.1	43.1
	17:15:00	72.3	53.6	52.3	43.1
	17:30:00	72.4	61.8	57.2	43.2
	17:45:00	76.8	57.9	57.0	43.9

	18:00:00	78.0	52.2	54.6	43.2
	18:15:00	77.6	53.5	56.9	42.2
	18:30:00	72.5	52.0	54.7	44.2
	18:45:00	74.5	56.5	55.1	42.9
	19:00:00	73.4	53.0	54.9	43.7
	19:15:00	74.3	54.2	55.6	43.3
	19:30:00	77.1	55.5	56.0	41.5
	19:45:00	73.5	58.5	55.0	41.1
	20:00:00	72.9	50.8	54.1	40.0
	20:15:00	71.9	53.5	52.9	41.1
	20:30:00	81.7	57.0	59.6	41.0
	20:45:00	78.0	54.4	53.6	41.7
	21:00:00	72.2	50.1	53.7	39.6
	21:15:00	72.4	49.3	53.9	38.0
	21:30:00	71.5	46.3	51.7	36.9
	21:45:00	71.5	46.7	51.4	36.7
	22:00:00	70.7	49.2	53.8	37.8
	22:15:00	74.6	46.2	53.9	37.6
	22:30:00	70.4	48.4	51.7	37.3
	22:45:00	71.9	46.2	48.6	36.5
	23:00:00	71.6	45.8	51.4	36.7
	23:15:00	71.9	45.3	50.7	36.5
	23:30:00	74.6	48.7	55.1	36.2
	23:45:00	75.2	44.0	50.6	36.0
Monday 14th May 2018	00:00:00	72.9	44.0	54.1	35.8
	00:15:00	72.5	42.7	53.3	35.5
	00:30:00	59.3	43.0	41.5	35.9
	00:45:00	73.6	41.1	50.6	35.8
	01:00:00	59.8	41.1	40.6	36.0
	01:15:00	54.1	38.5	38.4	35.9
	01:30:00	57.2	40.3	40.5	36.1
	01:45:00	56.8	38.9	39.2	35.9
	02:00:00	46.8	38.5	37.2	35.7
	02:15:00	57.5	41.7	41.1	35.9
	02:30:00	62.9	37.7	39.2	35.8
	02:45:00	80.5	44.0	56.7	36.0
	03:00:00	60.2	40.7	39.1	35.7
	03:15:00	57.7	39.5	39.3	36.2
	03:30:00	53.9	40.6	38.9	36.2
	03:45:00	57.4	40.3	40.2	36.1
	04:00:00	52.6	42.8	39.9	36.0
	04:15:00	68.9	50.8	48.8	39.7
	04:30:00	77.1	63.8	60.1	47.7
	04:45:00	79.9	68.1	64.0	48.7
	05:00:00	74.9	69.7	64.1	46.3
	05:15:00	75.9	58.8	58.7	44.5

	05:30:00	74.6	62.7	58.6	44.2
	05:45:00	79.0	57.0	58.0	43.8
	06:00:00	78.8	68.2	62.9	46.3
	06:15:00	73.6	64.3	60.0	46.2
	06:30:00	77.2	54.2	57.8	45.8
	06:45:00	73.3	64.5	59.6	47.0
	07:00:00	77.2	65.1	61.5	47.6
	07:15:00	73.9	58.0	57.7	48.4
	07:30:00	81.6	57.6	59.4	48.3
	07:45:00	78.0	57.1	58.2	49.8
	08:00:00	78.8	59.0	61.4	49.7
	08:15:00	78.2	58.1	58.6	48.6
	08:30:00	81.3	59.5	59.3	47.3
	08:45:00	75.6	57.4	56.8	48.0
	09:00:00	76.9	58.3	56.7	47.6
	09:15:00	72.7	57.9	56.0	46.4
	09:30:00	77.0	58.1	58.4	45.5
	09:45:00	75.1	59.7	58.4	47.1
	10:00:00	72.8	59.3	57.6	47.8
	10:15:00	74.1	59.3	58.2	48.3
	10:30:00	73.0	57.2	56.8	47.6
	10:45:00	77.6	57.1	57.1	47.8
	11:00:00	76.0	57.2	57.7	49.0
	11:15:00	74.6	59.0	57.4	47.1
	11:30:00	73.4	58.8	56.9	48.2
	11:45:00	75.3	59.0	57.7	48.1
	12:00:00	78.2	59.8	58.3	47.3
	12:15:00	72.3	58.6	57.1	48.0
	12:30:00	75.1	59.2	58.1	47.7
	12:45:00	79.6	53.5	57.3	45.6
	13:00:00	74.8	59.4	58.1	48.0
	13:15:00	76.1	56.2	57.3	47.1
	13:30:00	72.4	56.7	56.5	46.8
	13:45:00	72.8	58.6	56.5	45.6
	14:00:00	75.0	55.9	56.1	47.1
	14:15:00	79.5	60.3	58.6	46.8
	14:30:00	72.6	59.7	57.7	46.9
	14:45:00	70.1	53.2	53.0	45.8
	15:00:00	76.6	55.5	57.8	47.1
	15:15:00	73.5	54.7	56.4	45.6
	15:30:00	72.8	56.1	56.2	46.2
	15:45:00	80.9	54.0	58.1	46.5
	16:00:00	71.8	58.0	57.4	46.8
	16:15:00	73.3	55.5	56.1	47.5
	16:30:00	80.6	55.6	56.4	46.8
	16:45:00	77.8	52.6	56.9	45.6

	17:00:00	72.5	55.4	54.9	47.9
	17:15:00	75.2	56.2	56.4	47.8
	17:30:00	70.7	56.1	55.9	48.1
	17:45:00	73.6	55.5	57.1	46.8
	18:00:00	73.3	54.5	56.2	47.1
	18:15:00	74.9	55.5	56.0	45.5
	18:30:00	72.9	57.6	56.0	45.4
	18:45:00	81.3	54.8	57.1	43.8
	19:00:00	73.4	56.6	56.8	44.9
	19:15:00	70.7	55.9	56.0	43.6
	19:30:00	74.9	57.4	56.9	43.9
	19:45:00	72.6	55.2	56.2	43.2
	20:00:00	71.9	57.4	56.7	44.4
	20:15:00	68.6	51.3	50.8	43.1
	20:30:00	75.3	57.9	57.3	41.8
	20:45:00	74.9	55.7	57.6	42.1
	21:00:00	74.2	54.2	56.5	41.1
	21:15:00	69.1	50.2	53.0	40.6
	21:30:00	72.3	48.6	52.7	38.8
	21:45:00	72.6	48.1	53.3	38.4
	22:00:00	72.7	49.2	54.8	38.0
	22:15:00	73.8	48.6	54.2	38.2
	22:30:00	71.0	47.2	49.0	37.9
	22:45:00	76.2	56.5	56.6	37.8
	23:00:00	73.7	44.4	49.8	37.7
	23:15:00	72.4	47.8	53.7	37.5
	23:30:00	72.5	42.7	50.7	37.3
	23:45:00	54.0	41.6	39.5	37.1
Tuesday 15th May 2018	00:00:00	74.7	54.7	55.7	37.9
	00:15:00	68.1	44.9	47.8	37.4
	00:30:00	71.5	49.5	55.3	37.1
	00:45:00	61.5	40.7	40.6	37.3
	01:00:00	54.9	43.6	40.6	37.3
	01:15:00	68.1	42.1	45.0	37.5
	01:30:00	58.2	42.1	40.8	37.5
	01:45:00	57.8	41.8	40.7	37.8
	02:00:00	60.5	39.3	39.8	37.3
	02:15:00	52.9	39.8	39.2	37.1
	02:30:00	60.0	44.5	42.4	37.4
	02:45:00	55.9	46.6	43.0	38.0
	03:00:00	54.1	46.3	43.5	39.4
	03:15:00	54.0	47.2	43.7	39.5
	03:30:00	52.6	47.6	44.3	40.2
	03:45:00	56.0	48.5	44.5	39.0
	04:00:00	57.5	51.5	48.4	43.0
	04:15:00	67.8	51.8	48.8	43.0

	04:30:00	69.5	58.9	56.2	48.8
	04:45:00	74.7	66.3	60.4	49.5
	05:00:00	73.7	69.4	64.2	48.2
	05:15:00	73.7	56.2	55.9	48.4
	05:30:00	72.8	60.5	58.5	50.5
	05:45:00	75.0	59.1	57.7	49.4
	06:00:00	75.1	58.8	58.0	49.0
	06:15:00	73.6	60.4	58.4	51.6
	06:30:00	79.1	66.1	61.9	52.7
	06:45:00	73.9	62.1	60.1	53.2
	07:00:00	74.0	61.1	59.2	53.0
	07:15:00	75.3	62.7	60.5	53.9
	07:30:00	73.6	66.9	61.7	52.6
	07:45:00	82.2	65.4	62.7	53.6
	08:00:00	73.3	62.2	59.5	53.2
	08:15:00	76.4	68.0	62.5	52.7
	08:30:00	74.0	66.8	62.1	52.1
	08:45:00	73.1	60.8	58.5	51.6
	09:00:00	75.0	64.0	60.4	51.3
	09:15:00	74.4	60.5	58.8	50.8
	09:30:00	72.4	59.4	58.2	51.7
	09:45:00	72.7	60.8	58.4	50.0
	10:00:00	71.8	59.4	57.4	49.1
	10:15:00	73.6	61.8	59.5	50.0
	10:30:00	74.2	56.4	56.4	46.8
	10:45:00	73.1	54.8	55.8	46.4
	11:00:00	72.6	56.6	56.2	46.3
	11:15:00	76.1	62.3	59.3	47.1
	11:30:00	76.2	66.4	61.4	46.0
	11:45:00	71.4	57.9	55.9	46.8
	12:00:00	72.5	54.9	55.3	45.6
	12:15:00	74.1	60.4	58.4	45.4
	12:30:00	72.9	55.0	55.7	46.4
	12:45:00	74.3	55.1	56.6	45.6
	13:00:00	78.0	54.3	56.6	45.7
	13:15:00	74.0	55.7	56.6	46.1
	13:30:00	72.4	53.7	55.1	45.2
	13:45:00	71.2	54.4	54.4	45.0
	14:00:00	71.8	55.3	55.5	44.5
	14:15:00	75.6	56.8	57.3	44.4
	14:30:00	70.3	57.1	55.7	45.2
	14:45:00	72.1	54.3	55.3	45.1
	15:00:00	77.7	54.9	56.2	46.1
	15:15:00	74.4	56.7	57.3	45.5
	15:30:00	75.1	56.2	57.2	45.9
	15:45:00	81.1	57.0	58.7	45.1

	16:00:00	75.1	57.0	57.8	45.8
	16:15:00	71.7	53.0	54.8	46.3
	16:30:00	71.5	55.8	56.4	46.3
	16:45:00	72.2	52.9	54.0	46.0
	17:00:00	73.7	56.6	56.4	47.3
	17:15:00	72.2	53.2	55.1	46.4
	17:30:00	79.0	59.3	59.1	46.7
	17:45:00	74.7	57.8	57.2	45.6
	18:00:00	75.8	54.6	56.6	44.4
	18:15:00	73.2	55.8	55.4	46.1
	18:30:00	73.5	55.2	56.1	45.0
	18:45:00	75.1	56.9	57.6	44.9
	19:00:00	74.1	54.5	55.4	44.0
	19:15:00	72.5	55.2	55.5	44.4
	19:30:00	69.2	53.3	53.2	41.7
	19:45:00	72.6	58.0	56.6	42.6
	20:00:00	78.3	61.5	59.4	42.8
	20:15:00	74.3	53.1	56.2	42.3
	20:30:00	77.4	50.4	55.7	40.4
	20:45:00	73.8	56.3	56.6	41.6
	21:00:00	72.7	52.8	56.0	41.4
	21:15:00	71.1	52.5	54.3	40.0
	21:30:00	72.7	49.3	53.3	39.2
	21:45:00	69.5	48.7	51.2	39.1
	22:00:00	72.9	48.9	54.1	37.9
	22:15:00	72.4	48.4	53.7	38.2
	22:30:00	73.1	46.7	50.9	37.6
	22:45:00	73.1	49.7	55.3	36.7
	23:00:00	71.3	47.4	53.3	36.9
	23:15:00	71.8	46.9	52.0	36.7
	23:30:00	72.2	47.9	52.2	36.9
	23:45:00	58.8	43.7	40.7	36.3
Wednesday 16th May 2018	00:00:00	72.0	47.8	56.0	36.5
	00:15:00	70.7	43.1	52.6	36.5
	00:30:00	71.5	47.4	54.0	36.4
	00:45:00	59.2	40.4	39.1	36.1
	01:00:00	78.0	40.5	52.1	36.1
	01:15:00	55.8	38.4	39.3	36.1
	01:30:00	53.6	37.6	37.9	36.0
	01:45:00	67.0	37.2	43.1	35.9
	02:00:00	77.7	41.8	52.0	36.3
	02:15:00	65.7	38.9	40.4	36.3
	02:30:00	59.6	40.5	40.2	36.5
	02:45:00	62.4	41.4	41.0	36.8
	03:00:00	57.6	42.4	41.4	37.3
	03:15:00	58.5	43.3	40.9	37.0

	03:30:00	58.6	43.0	42.0	37.9
	03:45:00	59.0	44.3	42.2	38.0
	04:00:00	55.4	47.5	44.2	38.8
	04:15:00	65.7	50.2	47.5	42.0
	04:30:00	68.3	54.9	53.5	45.7
	04:45:00	79.2	67.2	61.9	48.0
	05:00:00	75.1	70.0	64.2	48.1
	05:15:00	74.6	66.6	60.8	47.6
	05:30:00	71.6	56.2	56.1	46.5
	05:45:00	75.9	66.7	61.5	48.3
	06:00:00	73.3	62.0	59.4	49.3
	06:15:00	74.5	59.2	56.3	48.5
	06:30:00	73.2	58.0	57.0	49.7
	06:45:00	75.1	59.2	58.8	50.9
	07:00:00	71.9	59.1	57.7	51.0
	07:15:00	72.1	58.8	57.9	50.3
	07:30:00	82.6	55.7	56.6	49.9

TABLE B1: NOISE DATA FOR PERIOD FRIDAY 11th MAY TO WEDNESDAY 16TH MAY 2018

APPENDIX C: GLOSSARY OF ACOUSTIC TERMS

Noise

Noise is defined as unwanted sound. The range of audible sound is from 0 to 140 dB. The frequency response of the ear is usually taken to be around 18 Hz (number of oscillations per second) to 18000 Hz. The ear does not respond equally to different frequencies at the same level. It is more sensitive in the mid-frequency range than the lower and higher frequencies and because of this, the low and high frequency components of a sound are reduced in importance by applying a weighting (filtering) circuit to the noise measuring instrument. The weighting which is most widely used and which correlates best with subjective response to noise is the dBA weighting. This is an internationally accepted standard for noise measurements.

For variable sources, such as traffic, a difference of 3 dBA is just distinguishable. In addition, a doubling of traffic flow will increase the overall noise by 3 dBA. The 'loudness' of a noise is a purely subjective parameter, but it is generally accepted that an increase/ decrease of 10 dBA corresponds to a doubling/ halving in perceived loudness. Noise is measured on a logarithmic scale in decibels (dB) because of the ears' sensitivity to a wide range of pressure changes. The sound pressure level (SPL) of a signal is denoted by the symbol L_p and defined by the equation $L_p = 10 \log (p/p_0)^2$ where p is the root mean square pressure of the signal and p_0 is the reference sound pressure (2×10^{-5} Pa).

An indication of the range of sound pressure levels commonly found in the environment is given below:

<u>Location</u>	<u>L_{pA}dB(A)</u>
Normal threshold of hearing	-10 to 20
Music halls and theatres	20 to 30
Living rooms and offices	30 to 50
Inside motor vehicles	50 to 70
Industrial premises	70 to 100
Burglar alarms at 1 m	100 to 110
Jet aircraft on take-off	110 to 130
Threshold of pain	130 to 140

External noise levels are rarely steady, but rise and fall according to activities within an area. In attempt to produce a figure that relates this variable noise level to subjective response, a number of noise indices have been developed. These include:

i) The L_{Amax} noise level

This is the maximum noise level recorded over the measurement period.

ii) The L_{Aeq} noise level

This is "equivalent continuous A-weighted sound pressure level, in decibels" and is defined in British Standard BS 7445 [2] as the "value of the A-weighted sound pressure level of a

continuous, steady sound that, within a specified time interval, T, has the same mean square sound pressure as a sound under consideration whose level varies with time”.

It is a unit commonly used to describe construction noise and noise from industrial premises and is the most suitable unit for the description of other forms of environmental noise. In more straightforward terms, it is a measure of energy within the varying noise.

iii) The L_{A10} noise level

This is the noise level that is exceeded for 10% of the measurement period and gives an indication of the noisier levels. It is a unit that has been used over many years for the measurement and assessment of road traffic noise.

iv) The L_{A90} noise level

This is the noise level that is exceeded for 90% of the measurement period and gives an indication of the noise level during the quieter periods. It is often referred to as the background noise level and is used in the assessment of disturbance from industrial noise.

Community response to environmental noise sources is dependent on both acoustic and non-acoustic factors. The acoustic factors include absolute noise level, changes or exceedances of background and ambient levels as well as the characteristics, time, duration and frequency of noise.