Appendix B

Walker Beak Mason Limited

01604 771101 | hq@wbm.co.uk | www.wbm.co.uk

WBM ACOUSTIC CONSULTANTS

Ref **5318**

For **Marcus Watts**

Environmental Health Manager (Protection)

Uttlesford District Council

Council Offices

London Road

Saffron Walden

Essex

CB11 4ER

Mortimers Gate, Saffron Walden

Saffron Walden Substation

Noise Impact Assessment

Date 25 November 2022

Author Sarah Large

The Author

Sarah Large MA (Cantab) MSc Dip (IoA) MIOA (Senior Consultant) obtained a degree in music from Cambridge University in 2007. She has worked in acoustic consultancy since 2009, completing the Institute of Acoustics Diploma in Acoustics and Noise Control in 2010 and a Master of Science degree in Environmental Acoustics from South Bank University in 2012. Sarah has extensive experience in environmental acoustics including noise modelling, noise monitoring and assessments. Sarah joined WBM in 2021 and is working on architectural and environmental acoustic projects including mineral sites.

WBM

WBM (the trading name of Walker Beak Mason Limited) is an established independent acoustic consultancy specialising in architectural & building acoustics, environmental noise, planning issues and expert work. WBM is a member of the Association of Noise Consultants and is also a Corporate Member of the Institute of Environmental Management & Assessment. The consultants are members of the Institute of Acoustics.

This report has been prepared with all reasonable skill, care and diligence as appropriate for an acoustic consultancy practice under the terms and brief agreed with our Client. The document is the copyright of WBM and no third party may rely upon this document without the prior and express written agreement of WBM.

Document Control

Revision	Description	Date	Prepared by	Checked by
-	DRAFT	25/11/2022	SL	RHC

Contents

DRAFT

1 Introduction

WBM was appointed by Uttlesford District Council (UDC) to undertake noise monitoring and an assessment of transformer substation noise at the Mortimers Gate residential development in Saffron Walden.

It is understood that complaints have been received by UDC regarding the substation noise and that these complaints are ongoing.

This report summarises the findings and results of a noise survey undertaken on the evening / night time period of 11th – 12th October 2022.

To aid comprehension, a glossary of acoustic terms is presented in Appendix A.

2 Site Description

The Mortimers Gate residential development comprises recently built housing located to the north east of Saffron Walden. To the south of the development is Ashdon Road and other areas of residential development within Saffron Walden. Residential development is also located to the west of the site. Farmland lies to the north of the site and an existing commercial building to the east of the site. Within the north western corner of the Mortimers Gate development is the Saffron Walden substation. The substation is surrounded by a 4m high wooden close boarded fence. The predominant noise sources in the area are local and distant road traffic and the substation.

3 Assessment Approach

There is no clear guidance for the noise from the substation, which emits a strong 100Hz (low frequency) tone.

British Standard (BS) 4142:2014+A1:2019 "*Methods for rating and assessing industrial and commercial sound*" ("BS4142") provides a method for rating and assessing sound of an industrial or commercial nature on residential properties. The noise under investigation (the specific level) is compared to the background sound level, which should be measured in the absence of the noise under investigation. The specific level can be adjusted with addition of decibel penalties to account for any distinguishable acoustic features to give a rating level. A summary of BS4142 is provided in Appendix B.

The greater the difference between the rating level and the background sound level, generally the greater the impact.

- A difference of 0 dB or less indicates a low impact, depending on the context.
- A difference of around +5 dB is likely to indicate an adverse impact, depending on the context.
- A difference of around +10 dB or more is likely to indicate a significant adverse impact, depending on the context.

Context must be considered when making an assessment of impact and can include factors such as the absolute level of the noise, the character of the ambient sound environment, the sensitivity of the receptor and scope for mitigating the noise. A summary of the assessment method given in BS4142: 2014 is provided in Appendix B.

Whilst the most relevant guidance for this type of noise source (the substation) is BS 4142, it being of a commercial / industrial nature, the scope of the standard states "*The standard is not applicable to the assessment of low frequency noise*" and refers the user to the Defra document "*Procedure for the assessment of low frequency noise complaints*" (NANR45).

The NANR45 procedure relies on internal measurements and uses a reference curve of 1/3rd octave band levels between 10Hz and 160Hz against which noise measurements can be assessed. However, the assessment in this report is based on external measurements and as such the NANR45 procedure and reference curve cannot be directly used.

A paper submitted to the ICBEN conference in 2017 written by Downey and Parnell "*Assessing low frequency noise from industry – a practical approach*" proposes an adjustment to the internal NANR45 low frequency noise curve so that assessment can be based on externally measured free field noise levels. The adjusted curve is reproduced below in Table 3.1.

Table 3.1 – Third octave low frequency noise adjustment thresholds (NANR45 criteria adjusted for façade noise reductions to give an external value)

Hz	**1/3rd octave band externally modified NANR45 criteria**												
	10	12.5	16	20	25	31.5	40	50	63	80	100	125	160
dB	92	89	86	77	69	61	54	50	50	48	48	46	44

DRAFT

The above table is reproduced as a guide only and is not UK recognised guidance. However, it could be used with external measurements as an indicator of an indoor low frequency noise issue as recognised by NANR45 (subject also to the caveats and guidance notes in that report).

BS4142 provides a list of suggested further reading, which includes, for low frequency noise, a paper submitted to Acoustic Australia by Broner (2011) "*A simple outdoor criterion for assessment of low frequency noise emission.*" The paper discusses various low frequency noise sources and approaches to the assessment of these sources. In Table 2 of the paper, reproduced below as Table 3.2, a summary of outdoor criteria for low frequency noise is given. As with the Downey and Parnell paper, the criteria in the Broner paper are reproduced as a guide only; the criteria are not recognised as UK guidance.

Table 3.2 – Summary of outdoor criteria for low frequency noise (Broner 2011)

Developed by	Citeria
Hoover	67 dBC (70 dB at 31.5 Hz) should never be exceeded
Challis	72 dBC overall with 70 dB @ 16 Hz 60 dBC overall with 60 dB @ 31.5 Hz
ANSI B133.8 1977	75-80 dBC
Hessler	Max 70 dBC when L_{90} >40dBA daytime intermittent, normal suburban, Max 65 dBC when L_{90} >40dBA 24/7, normal suburban Max 65 dBC when L_{90} <40dBA daytime intermittent, quiet suburban, Max 60 dBC when L_{90} <40dBA 24/7, quiet suburban
Newman	57 dBC - 6 dB @ 31.5 Hz
ANSI S12.9	67 dBC to minimise annoyance 72 dBC to prevent noise induced rattles
Oregon USA	65 dBC between 10pm-7am 68 dBC between 7am-10pm
Hale	65 dBC
Hessler	65 dBC with a maximum regulatory limit of 70 dBC (wind turbines)

For the purposes of this assessment, noise levels from the substation are assessed primarily in relation to the BS4142 methodology. Commentary on the measured noise levels with regard to the Downey and Parnell (2017) and Broner (2011) papers are provided to supplement the BS4142 assessment.

4 Noise Surveys

4.1 Measurement Description

Noise monitoring was undertaken on 11th – 12th October 2022 at the locations shown on Figure 4.1 below. At locations 1 – 12 (red circles) measurements were undertaken at 1.5m and approximately 3.5-4m height above local ground level for a duration of 5 minutes. At locations 13 – 23 (yellow squares) shorter sample measurements of approximately 20-50 seconds were undertaken at 1.5m height above local ground level. At the end of the survey background sound levels were measured at the location indicated on the plan (BGSL) for one 15 minute period at approximately 3.5-4m height above local ground level and for two 15 minute periods at 1.5m height above local ground level.

Figure 4.1 – Aerial view showing noise monitoring locations

The predominant source of noise closest to the substation was the transformer noise, which emitted a clear 100Hz tone. With increasing distance from the substation, road traffic noise became more audible, though at the majority of locations the substation noise remained dominant.

4.2 Results

The results of the noise survey are presented in Table 4.1. The results include the overall A weighted noise levels ($L_{Aeq,T}$) and due to the low frequency dominance of the substation transformer noise (with tonality in the 100Hz third octave band) the C weighted noise levels are also given ($L_{Ceq,T}$).

Table 4.1 – Noise survey results 11-12th October 2022

Location	Start Time	Duration T	1.5m height $L_{eq,T}$			3.5-4m height $L_{eq,T}$		
	(hh:mm)	(mm:ss)	dB(A)	dB(C)	100Hz	dB(A)	dB(C)	100Hz
1	21:55	05:00	54	72	72	50	67	67
2	22:05	05:00	47	65	65	43	60	60
3	22:13	05:00	43	59	58	50	64	64
4	22:21	05:00	41	57	56	40	50	44
5	22:30	05:00	37	49	42	38	48	39
6	22:40	05:00	39	53	53	38	54	53
7	22:48	05:00	41	53	52	43	54	53
8	22:56	05:00	42	57	57	41	50	44
9	23:05	05:00	36	49	48	34	47	44
10	23:14	05:00	38	52	45	39	54	51
11	23:26	05:00	55	73	74	55	72	72
12	23:34	05:00	43	59	59	42	52	47
13	23:44	00:35	53	71	72	-	-	-
14	23:45	00:50	46	62	62	-	-	-
15	23:47	00:31	44	57	56	-	-	-
16	23:49	00:43	47	63	63	-	-	-
17	23:50	00:42	49	67	67	-	-	-
18	23:51	00:32	46	63	63	-	-	-

Location	Start Time	Duration T	1.5m height $L_{eq,T}$			3.5-4m height $L_{eq,T}$		
	(hh:mm)	(mm:ss)	dB(A)	dB(C)	100Hz	dB(A)	dB(C)	100Hz
19	23:51	00:45	45	62	62	-	-	-
20	23:52	00:28	40	55	54	-	-	-
21	23:54	00:43	43	60	60	-	-	-
22	23:55	00:32	41	58	58	-	-	-
23	23:57	00:39	45	62	62	-	-	-

Background sound levels were measured at a proxy location where the substation could not be heard. The background sound levels measured were as follows:

Table 4.2 – Background sound level measurement results 11-12th October 2022

Start time (hh:mm)	1.5m height dB T=15 minutes			3.5-4m height dB T=15 minutes		
	$L_{Aeq,T}$	$L_{Ceq,T}$	$L_{A90,T}$	$L_{Aeq,T}$	$L_{Ceq,T}$	$L_{A90,T}$
00:14	44	57	34	45	56	35
00:40	37	53	34	-	-	-

5 UK Power Network Report May 2019

A noise survey and preliminary investigation of the Saffron Walden substation noise was undertaken by Industrial Noise Reduction Ltd on behalf of the UK Power Network in 2019. The survey included measurements inside the substation and the report provides a description of the plant within the substation along with associated noise levels. At the time of the survey the residential development at Mortimers Gate was still under construction. Additional measurements of the substation noise were undertaken at some of the nearby dwellings that were occupied, both inside and outside of dwellings. A 4m high wooden close boarded fence was also being constructed around the substation at the time of the survey, but was incomplete.

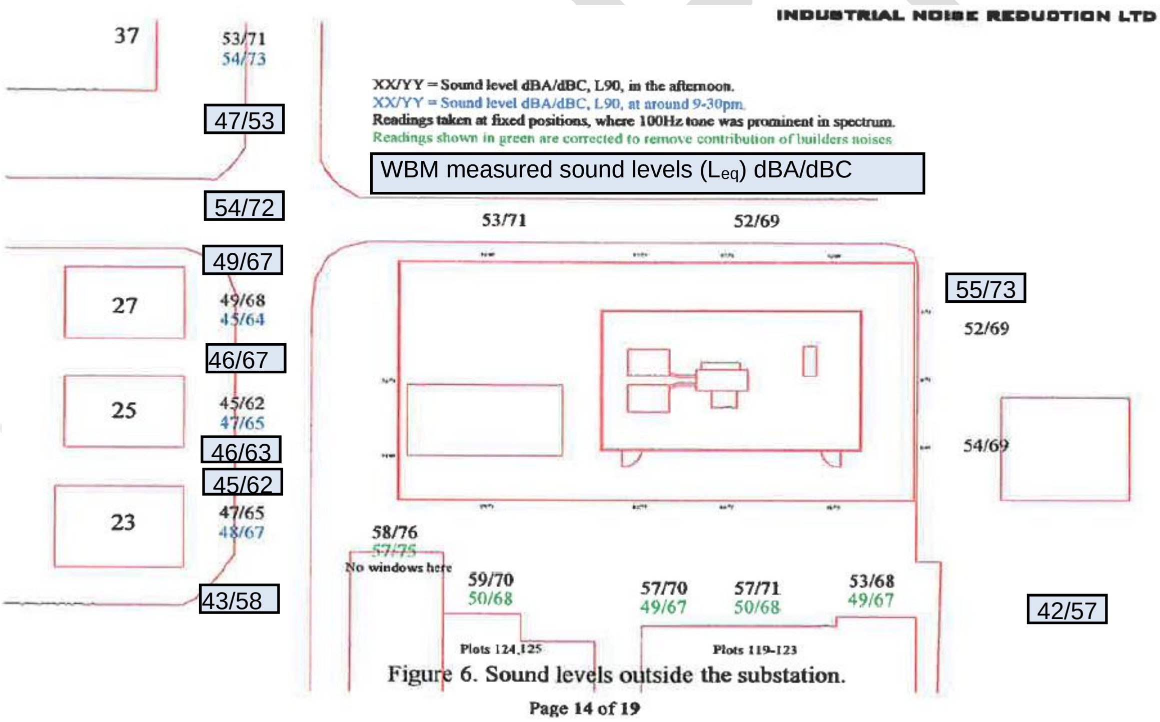
The report provided by Industrial Noise Reduction Ltd on behalf of the UK Power Network ("the UKPN report") gives a helpful summary of the plant at the substation as well as the immediate surroundings.

DRAFT

Figure 6 in the UKPN report summarises the measured noise levels around the substation during daytime and evening and provides the average A weighted and C weighted results. Figure 6 from the UKPN report is reproduced below with the WBM measured noise levels from 11th – 12th October 2022 added.

The results in Figure 6 show a good correlation between the UKPN report and WBM measured noise levels, with the exception of a location used by WBM between 27 and 37 Mapletoft Avenue (“54/72”). This higher result is likely a result of localised effects discussed further in sections 6 and 7 below. The good correlation between the UKPN report and WBM measured noise levels indicates that there has been little change in the noise from the substation between the UKPN measurements in 2019 and the survey undertaken by WBM in October 2022.

Figure 5.1 – Sound level results UKPN (2019) and WBM (2022)



The UKPN report also outlines noise measurements undertaken in close proximity of the substation, identifying the main source of noise as that from the transformer (there appears minimal contribution from the radiators). The mean level beside the transformer is given as 74dB(A) (88dB(C)) corresponding to a sound power level of 91dB(A) (105dB(C)).

6 Noise Modelling

The residential development and substation noise was modelled using SoundPlan noise mapping software to assess the extent to which the noise propagates across the development. The purpose of the modelling was to establish the number of dwellings potentially impacted by the substation noise.

A mean sound power level of 91dB L_{WA} has been used for the transformer in the model based on the measurements presented in the UKPN report close to the transformer and the good correlation observed between the UKPN report and WBM measurements outside of the substation. As greater variation was observed in the measured noise levels at 3.5-4m height, the noise modelling is based on predictions at 1.5m height only. A noise map showing the results of the modelling is provided in Appendix E. Further information regarding the noise modelling inputs can be provided on request.

A table summarising the results of the modelling is presented below for the receiver locations used in the WBM noise survey undertaken on 11th – 12th October 2022. At most locations the predicted noise levels provide a reasonable approximation of the measured noise levels; however, there are some locations closest to the substation where predicted noise levels underestimate the measured noise levels.

During the noise survey on 11th – 12th October 2022 a high variability in the noise from the substation was noted particularly at dwellings closest to the substation. The differences in predicted and measured noise levels are likely a result of localised affects that cannot be accurately accounted for in the noise model including interaction of the transformer noise with the wooden fencing and reflected noise.

Comparison of the measured and predicted noise levels indicates that at the majority of locations the predicted noise levels can provide a reasonable representation of the transformer noise levels, but care should be taken at the dwellings closest to the substation to the north of the site (locations 8 and 11 on Figure 4.1), at dwellings to the south west of the site (locations 1 and 2 on Figure 4.1) and at dwellings near the junction of Mapletoft Avenue and Archer Road (locations 21 and 22 on Figure 4.1). At these locations the predicted noise levels significantly underestimate impact and any assessment of impact at these dwellings should refer to the measured noise levels.

Table 6.1 – Predicted noise levels (compared with measured noise levels) 1.5m height

Location**	Measured noise level 1.5m height $L_{eq,T}$		Predicted noise level 1.5m height $L_{eq,T}$		Difference (Predicted – Measured)	
	dB(A)	125Hz (1/1 octave) dB(A)	dB(A)	125Hz (1/1 octave) dB(A)	dB(A)	125Hz (1/1 octave) dB(A)
1	54	53	47	44	-6	-10
2	47	46	43	39	-4	-7
3	43	39	45	41	1	1
4	40*	38	38	35	-2	-3
5	37	27	33	30	-5	4
6	38*	34	35	34	-3	0
7	40*	33	38	36	-2	3
8	42	38	47	44	5	6
9	34*	29	30	28	-4	-1
10	31*	29	34	32	3	3
11	55	55	49	45	-6	-9
12	43	40	43	40	1	0
13	53	53	50	47	-3	-6
14	46	43	47	44	1	1
15	44	37	47	44	3	6
16	47	44	47	43	1	-1
17	49	48	47	44	-2	-4
18	46	44	47	44	1	-1
19	45	43	46	43	1	-1
20	40	36	41	32	1	-4
21	43	41	33	31	-10	-10
22	41	39	31	29	-10	-9
23	45	43	44	40	-1	-3

*Based on contemporaneous notes (i.e. excluding extraneous noise)
** See Figure 4.1

DRAFT

7 Noise Assessment and Discussion

During the noise survey on 11th – 12th October 2022 a high variability in the noise from the substation was noted particularly at dwellings closest to the substation. Moving to and from a location approximately 4-5m apart could result in large differences in the measured noise levels and particularly the 100Hz tone. This is likely to be a result of nodes and anti-nodes created by reflections off building facades and / or could also be an interaction between the noise from the transformer and the wooden perimeter fence around the substation area. It is noted that the UKPN report notes a similar experience.

The measured noise levels at 3.5m – 4m height appear to show greater variability from the measurements at 1.5m height particularly at 100Hz. The majority of measurements at 1.5m height were dominated by 100Hz sound energy. As such assessment has been based on the measured noise levels at 1.5m height.

7.1 Measured Noise Levels

BS4142: 2014 +A1:2019

The scope of the BS4142 standard states "*The standard is not applicable to the assessment of low frequency noise*" and refers the user to the Defra low frequency noise criteria (NANR45), which the Downey & Parnell 2017 paper is based on. However, an objective method for assessing the audibility of tones in sound (one-third octave method) is provided in Annex C of BS4142. This method includes assessing noise in the low frequency range and provides the following criteria for identifying a tone:

The level differences between adjacent one-third-octave bands that identify a tone are:

- 15 dB in the low-frequency one-third-octave bands (25 Hz to 125 Hz);
- 8 dB in middle-frequency one-third-octave bands (160 Hz to 400 Hz);
- 5 dB in high-frequency one-third-octave bands (500 Hz to 10 000 Hz)

At all measurement locations at 1.5m height except for location 5 and location 10, a tone would be identified in the 100Hz third octave band using the BS4142 objective third octave band method.

Background sound levels were measured in a proxy location where the 100Hz substation noise could not be heard. At 1.5m height the background sound level was 34dB $L_{A90,15minute}$.

The measured A weighted noise levels are presented for locations 1-12 below along with a BS4142 style assessment. A full BS4142 assessment has not been provided but additional information (including the "Information to be reported", see Section 12 of BS4142) can be provided on request.

The assessment is based on the measured levels at 1.5m height. In some cases the A-weighted noise levels taken from contemporaneous notes have been used in the assessment as the overall measured level was influenced by extraneous noise.

To determine the rating level, a 6dB penalty has been added to the measured A-weighted noise level to account for a highly perceptible tone (100Hz) except for locations 5 and 10, where no tonal penalty is identified based on third octave band analysis.

Table 7.1 – BS4142 style assessment of transformer noise at Mortimers Gate

Location	Start Time	Measured noise level 1.5m height	Rating level	Background sound level	Difference
	(hh:mm)	dB $L_{Aeq,T}$	dB $L_{Ar,T}$	dB $L_{Aeq,T}$	dB
1	21:55	54	60	34	26
2	22:05	47	53	34	19
3	22:13	43	49	34	15
4	22:21	40*	46	34	12
5	22:30	37	37**	34	3
6	22:40	38*	44	34	10
7	22:48	40*	46	34	12
8	22:56	42	48	34	14
9	23:05	34*	40	34	6
10	23:14	31*	31**	34	-3
11	23:26	55	61	34	27
12	23:34	43	49	34	15

*Based on contemporaneous notes (i.e. excluding extraneous noise)
** No tonal penalty applicable.

DRAFT

At all locations except for locations 5, 9 and 10 the difference between the rating level and the background sound level indicates a significant adverse impact is likely to arise, based on the guidance in BS 4142. Consideration of context has not been made, but is unlikely to change the outcome of the assessment.

The measured average noise levels ($L_{Aeq,T}$) were lower at 3.5-4m height in all cases except for locations 3, 5, 7 and 10. At location 5, the 100Hz third octave band sound level is lower at 4m height than at 1.5m height and as such the higher noise level at 3.5-4m height is unlikely to be caused by the substation hum. At location 3 and 7 the assessment at 1.5m height indicates a significant adverse impact and this would not change considering the assessment at 3.5-4m height. At location 10 there is a 1dB increase in noise level between 1.5m and 3.5-4m height, but this would not change the outcome at this location that impact is likely to be below the point at which adverse impact arises.

An aerial plan showing the BS4142 style assessment results for all the locations at which measurements were taken at 1.5m height is provided in Figure 7.1 below. It is noted that to conform with BS4142 methodology an assessment period of 15 minutes is required during the night time period (23:00 – 07:00). The measured noise levels at locations 1-12 were of 5 minute duration and are considered representative of the substation noise output, as it was steady and continuous at the monitoring location. At locations 13-23 the measurement duration was shorter, but can also be considered reasonably representative of a longer duration measurement due to the steady and continuous nature of the noise at the monitoring location.

Figure 7.1 – Difference between rating level and background sound level (BS4142), based on measured noise levels 11-12th October 2022.

Downey & Parnell (2017) / Broner (2011)

The Downey and Parnell (2017) paper proposes an adjustment to the internal DEFRA low frequency noise criteria so that assessment can be based on externally measured free field noise levels. The adjusted curve is reproduced in Table 3.1 above. At 100Hz (third octave band) the noise adjustment threshold is 48dB (Lin).

The 100Hz criterion level of 48dB is exceeded at all measurement locations at 1.5m height at Mortimers Gate apart from locations 5, 9, 10 and the location used for measuring background sound levels.

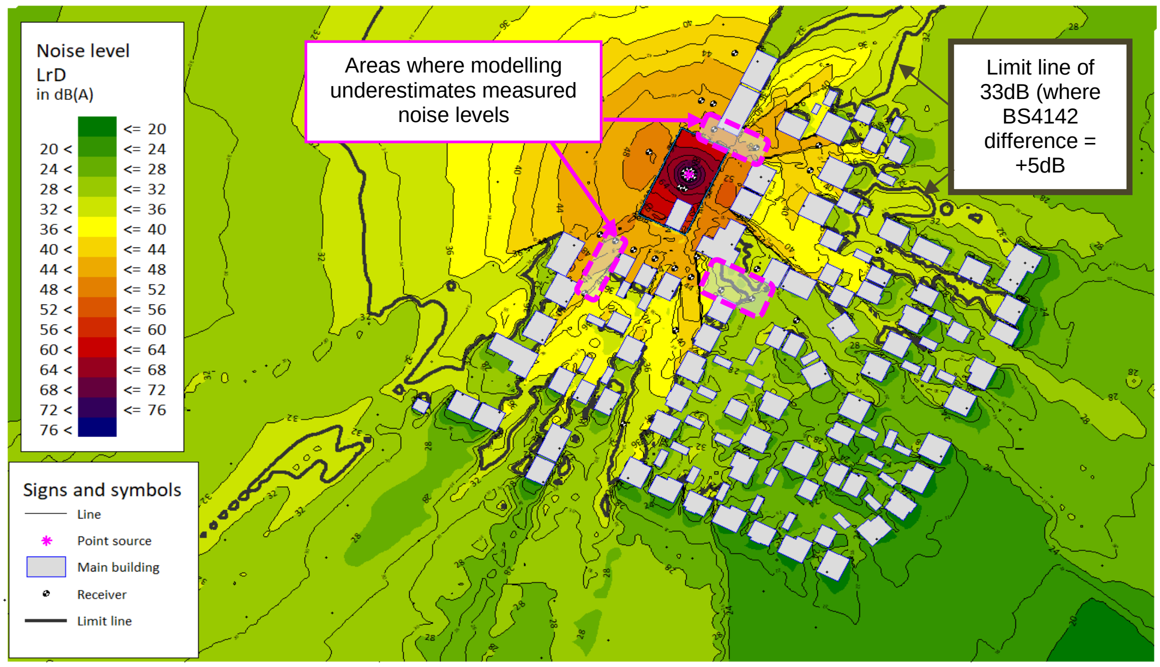
The Broner 2011 paper provides a summary of outdoor criteria for low frequency noise, see Table 3.2 above. Comparison of the measured noise levels at Mortimers Gate with the criteria in the table indicates a range of C weighted average levels ranging from 57-80 dB(C), though many fall within the 60-67 dB(C) range.

The criteria proposed in the Downey and Parnell (2017) and Broner (2011), whilst not recognised as UK guidance, corroborate the findings of the BS4142 assessment indicating that there is a noise issue at all measurement locations with the exception of locations 5, 9 and 10 (and the background sound level monitoring location).

7.2 Predicted Noise Levels

A noise map showing the results of modelling is provided in Appendix E in terms of calculated $L_{Aeq,T}$. The noise map provides a visual representation of how the noise from substation propagates across the Mortimers Gate development. As noted above, the noise model was found to underestimate impact compared to the measured noise levels at some locations closest to the substation. Figure 7.2 below shows the noise map from Appendix E with the areas where noise levels are underestimated marked. All other areas are reasonably well represented by the noise model.

Figure 7.2 – Predicted substation noise levels (dB $L_{Aeq,T}$)



A limit line is marked on the noise map showing the boundary where noise levels would be considered an adverse impact based on a BS4142 style assessment with a difference between the substation rating level and background sound level of 5dB. The limit line has been derived from the measured background level at the proxy location (34 dB $L_{A90,T}$). In order for the rating level to not exceed "adverse impact" according to BS 4142 would require the value not to exceed 34+5=39 dB $L_{Ar,T}$.

As indicated above, as the noise from the substation is tonal, there is a 6 dB penalty meaning that the specific sound from the substation would need to be at or below 39-6=33 dB $L_{Aeq,T}$. Hence 33 dB $L_{Aeq,T}$ is considered to be the upper limit in order to avoid adverse impact. Dwellings located beyond the limit line are expected to be relatively unaffected by the substation noise.

Similarly, for the substation noise to achieve a low level of impact as indicated by the BS 4142 method (i.e. a difference between the substation rating level and the background sound level of 0) the predicted noise level should be 28 dB $L_{Aeq,T}$.

8 Summary and Conclusions

WBM was appointed by Uttlesford District Council (UDC) to undertake noise monitoring and assessment of transformer substation noise at the Mortimers Gate residential development in Saffron Walden. It is understood that complaints have been received by UDC regarding the substation noise and that these complaints are ongoing.

This report summarises the findings and results of a noise survey undertaken on the evening / night time period of 11th – 12th October 2022. The predominant source of noise closest to the substation was the transformer noise, which emitted a clear 100Hz tone. With increasing distance from the substation, road traffic noise became more audible, though at the majority of locations the substation noise remained dominant.

During the noise survey on 11th – 12th October 2022 a high variability in the noise from the substation was noted particularly at dwellings closest to the substation. Moving to and from a location approximately 4-5m apart could result in large differences in the measured noise levels and particularly the 100Hz tone. This is likely to be a result of nodes and anti-nodes created by reflections off building facades and / or could also be an interaction between the noise from the transformer and the wooden perimeter fence around the substation area. It is noted that the UKPN report notes a similar experience.

A good correlation between the UKPN report and WBM measured noise levels indicates that there has been little change in the noise from the substation between the UKPN measurements in 2019 and the survey undertaken by WBM in October 2022.

Following a BS4142 style assessment, at all locations except for locations 5, 9 and 10 the difference between the substation rating level and the background sound level indicates a significant adverse impact is likely to arise. Consideration of context has not been made, but is unlikely to change the outcome of the assessment.

The site has been modelled using SoundPlan noise mapping software. The noise map provides a visual representation of how the noise from the substation propagates across the Mortimers Gate development. The noise map can be used as a guide for how many dwellings within the development are impacted by the substation noise (albeit with caveats as outlined in Section 6 and 7 above). For the substation noise to achieve a low level of impact as indicated by the BS4142 method (i.e. a difference between the substation rating level and the background sound level of 0) the predicted noise level should be at or below 28 dB $L_{Aeq,T}$. For the substation noise to achieve a level indicative of adverse noise impact (but below the point at which significant adverse impact would be expected to arise) the predicted noise level should be at or below 33 dB $L_{Aeq,T}$ (i.e. a difference between the substation rating level and the background sound level of +5dB).

A limit line is marked on the noise map showing the boundary where noise levels would be considered an adverse impact based on a BS4142 style assessment with a difference between the substation rating level and background sound level of 5dB. Dwellings located beyond the limit line are expected to be relatively unaffected by the substation noise.

Sarah Large MA (Cantab) MSc Dip (IoA) MIOA
Senior Consultant

(This document has been generated electronically and therefore bears no signature)

Appendix A – Glossary of Acoustic Terms

General Noise and Acoustics

The following section describes some of the parameters that are used to quantify noise.

Decibels dB

Noise levels are measured in decibels. The decibel is the logarithmic ratio of the sound pressure to a reference pressure (2x10^{-5} Pascals). The decibel scale gives a reasonable approximation to the human perception of relative loudness. In terms of human hearing, audible sounds range from the threshold of hearing (0 dB) to the threshold of pain (140 dB).

A-weighted and C-weighted Decibels, dB(A) and dB(C)

The 'A'-weighting filter emulates human hearing response for low levels of sound whereas the 'C'-weighting filter emulates human hearing at high levels of sound. The filter networks are incorporated electronically into sound level meters.

Sound pressure levels measured using an 'A'-weighting filter have units of dB(A) which is a single figure value to represent the overall noise level for the entire frequency range.

A change of 3 dB(A) is the smallest change in noise level that is perceptible under normal listening conditions. A change of 10 dB(A) corresponds to a doubling or halving of loudness of the sound. The background noise level in a quiet bedroom may be around 20 –30 dB(A); normal speech conversation around 60 dB(A) at 1 m; noise from a very busy road around 70-80 dB(A) at 10m; the level near a pneumatic drill around 100 dB(A).

Sound pressure levels measured using the 'C'-weighting filter have units of dB(C). The C-weighting filter is generally flatter compared to A-weighting, with less attenuation at low frequencies.

Façade Noise Level

Façade noise measurements are those undertaken near to reflective surfaces such as walls, usually at a distance of 1m from the surface. Façade noise levels at 1m from a reflective surface are normally around 3 dB greater than those obtained under freefield conditions.

Freefield Noise Level

Freefield noise measurements are those undertaken away from any reflective surfaces other than the ground

Frequency Hz

The frequency of a noise is the number of pressure variations per second, and relates to the "pitch" of the sound. Hertz (Hz) is the unit of frequency and is the same as cycles per second. Normal, healthy human hearing can detect sounds from around 20 Hz to 20 kHz.

Octave and Third-Octave Bands

Two frequencies are said to be an octave apart if the frequency of one is twice the frequency of the other. The octave bandwidth increases as the centre frequency increases. Each bandwidth is 70% of the band centre frequency.

Two frequencies are said to be a third-octave apart if the frequency of one is 1.26 times the other. The third octave bandwidth is 23% of the band centre frequency.

There are recognised octave band and third octave band centre frequencies. The octave or third-octave band sound pressure level is determined from the energy of the sound which falls within the boundaries of that particular octave of third octave band.

DRAFT

Appendix A (continued)

Day Evening Night Level L_{den}

The day evening night level is the average A-weighted sound level over a 24 hour period, determined from the L_{day} ($L_{Aeq,12hr}$ 7am-7pm), $L_{evening}$ ($L_{Aeq,4hr}$ 7pm-11pm) and L_{night} ($L_{Aeq,8hr}$ 11pm-7am), with a 5 dB penalty added to the $L_{evening}$ and a 10 dB penalty added to the L_{night}.

Equivalent Continuous Sound Pressure Level $L_{Aeq,T}$

The 'A'-weighted equivalent continuous sound pressure level $L_{Aeq,T}$, is a notional steady level which has the same acoustic energy as the actual fluctuating noise over the same time period T. The $L_{Aeq,T}$ unit is dominated by higher noise levels, for example, the $L_{Aeq,T}$ average of two equal time periods at, for example, 70 dB(A) and 50 dB(A) is not 60 dB(A) but 67 dB(A).

The $L_{Aeq,}$ is the chosen unit of BS 7445-1:2003 "Description and Measurement of Environmental noise".

Maximum Sound Pressure Level L_{Amax}

The L_{Amax} value describes the overall maximum 'A'-weighted sound pressure level over the measurement interval. Maximum levels are measured with either a fast or slow time weighted, denoted as $L_{Amax,f}$ or $L_{Amax,s}$ respectively.

Noise Rating NR

The noise rating level is a single figure index obtained from an octave band analysis of a noise. The NR level is obtained by comparing the octave band sound pressure levels to a set of reference curves and the highest NR curve that is intersected by the sound pressure levels gives the NR level.

Sound Exposure Level L_{AE} or SEL

The sound exposure level is a notional level which contains the same acoustic energy in 1 second as a varying 'A'-weighted noise level over a given period of time. It is normally used to quantify short duration noise events such as aircraft flyover or train passes.

Statistical Parameters L_N

In order to cover the time variability aspects, noise can be analysed into various statistical parameters, i.e. the sound level which is exceeded for N% of the time. The most commonly used are the $L_{A01,T}$, $L_{A10,T}$ and the $L_{A90,T}$.

$\mathbf{L_{A01,T}}$ is the 'A'-weighted level exceeded for 1% of the time interval T and is often used to gives an indication of the upper maximum level of a fluctuating noise signal.

$\mathbf{L_{A10,T}}$ is the 'A'-weighted level exceeded for 10% of the time interval T and is often used to describe road traffic noise. It gives an indication of the upper level of a fluctuating noise signal. For high volumes of continuous traffic, the $L_{A10,T}$ unit is typically 2–3 dB(A) above the $L_{Aeq,T}$ value over the same period.

$\mathbf{L_{A90,T}}$ is the 'A'-weighted level exceeded for 90% of the time interval T, and is often used to describe the underlying background noise level.

DRAFT

Appendix B – BS 4142 Summary

British Standard (BS) 4142:2014+A1:2019 "*Methods for rating and assessing industrial and commercial sound*" describes methods for assessing the likely effects of sound of an industrial and/or commercial nature on residential properties. It includes the assessment of sound from industrial and manufacturing processes, M&E plant and equipment, loading and unloading of goods and materials, and mobile plant/vehicles on the site. It can be used to assess sound from proposed, new, modified or additional industrial/commercial sources, at existing or new premises used for residential purposes.

The standard describes methods to measure and determine ambient, background and residual sound levels, and the rating levels of industrial/commercial sound. The standard also requires consideration of the level of uncertainty in the data and associated calculations.

BS 4142 is not intended to be used for the derivation or assessment of internal sound levels, or for the assessment of non-industrial/commercial sources such as recreational activities, motorsport, music and entertainment, shooting grounds, construction and demolition, domestic animals, people, and public address systems for speech. In addition, BS 4142 is not intended to be applied to other sources falling within the scope of other standards or guidance.

Sound of an industrial / commercial nature does not include sound from the passage of vehicles on public roads and railway systems.

Ambient sound is defined in BS 4142 as "*totally encompassing sound in a given situation at a given time, usually composed of sound from many sources near and far*". It comprises the residual sound and the specific sound when present.

Residual sound is defined in BS 4142 as "*ambient sound remaining at the assessment location when the specific sound source is suppressed to such a degree that it does not contribute to the ambient sound*". The background sound level is the $L_{A90,T}$ of the residual sound level, and is the underlying level of sound. Measurements of background sound level should be undertaken at the assessment location where possible or at a comparable location. The measurement time interval should be sufficient to obtain a representative value (normally not less than 15 minutes) and the monitoring duration should reflect the range of background sound levels across the assessment period. The background sound level used for the assessment should be representative of the period being assessed.

The specific sound level is the $L_{Aeq,Tr}$ of the sound source being assessed at the assessment location over the reference time interval, Tr. BS 4142 advises that Tr should be 1 hour during the day and 15 minutes at night.

The rating level is the specific sound level plus any adjustment for the characteristics of the sound at the assessment location (tone, impulse, intermittent or other acoustic feature). The standard describes subjective and objective methods to establish the appropriate adjustment. The adjustments for the different features and assessment methods are summarised below.

Appendix B (continued)

Summary of Potential Acoustic Feature Adjustments

Acoustic Feature	**Adjustment for Acoustic Feature**		
	Subjective Methods	**Objective Methods**	
Tonality	+2 dB if just perceptible +4 dB if clearly perceptible +6 dB if highly perceptible	Third Octave Analysis +6 dB if tones identified	Narrow Band Analysis Sliding scale of 0 to +6 dB depending on audibility of tone
Impulsivity	+3 dB if just perceptible +6 dB if clearly perceptible +9 dB if highly perceptible	Sliding scale of 0 to +9 dB depending on prominence of impulsive sound	
Intermittency	+ 3 dB if intermittency is readily distinctive	n/a	
Other	+ 3 dB if neither tonal nor impulsive, but otherwise readily distinctive	n/a	

Where tonal and impulsive characters are present in the specific sound within the same reference period then these two corrections can both be taken into account. If one feature is dominant, it might be appropriate to apply a single correction.

The rating level is equal to the specific sound level if there are no features present.

The level of impact is assessed by comparing the rating level of the specific sound source with the background sound level. Typically, the greater the difference, the greater the magnitude of the impact depending on the context. Other factors that may require consideration include the absolute level of sound, the character and level of the residual sound compared to the specific sound, and the sensitivity of the receptor and scope for mitigation.

When the rating level is above the background sound level, a difference of around +5 dB is likely to indicate an adverse impact and a difference of around +10 dB or more is likely to indicate a significant adverse impact, depending on the context.

The lower the rating level with respect to the background sound level, the less likely it is that the specific sound source will have an adverse impact. Where the rating level does not exceed the background sound level, this is an indication of the specific sound source having a low impact, depending on the context.

DRAFT

WBM ACOUSTIC CONSULTANTS

Appendix C – Survey Details

Date and Locations of Survey

21:30 on 11th October 2022 – 01:00 on 12th October 2022

Noise measurement locations in the vicinity of Mortimers Gate residential development.

Survey carried out by

Sarah Large

Weather Conditions

Dry, cool, clear sky, very still, southerly wind direction (4mph forecast speed). 6-7°C.

Instrumentation and Calibration

The instrumentation used (including serial number in brackets) is tabulated below. The sensitivity of the meter was verified on site immediately before and after the survey using the field calibrator. The measured calibration levels were as follows:

Instrumentation	Measurement height	Start Cal	End Cal
Norsonic 140 Sound Level Meter (1403138)	1.5m	113.8 dB(A)	113.8 dB(A)
Norsonic 1251 Calibrator (31991)			
Norsonic 140 Sound Level Meter (1404819)	3.5-4m	113.8 dB(A)	113.9 dB(A)
Norsonic 1251 Calibrator (33321)			

The meters and calibrators are tested monthly against Norsonic Calibrators, type 1253 (serial number 22906) and type 1256 (serial number 125626100) both with UKAS approved laboratory certificates of calibration. In addition, the meters and calibrators undergo traceable calibration at an external laboratory every two years.

Survey Details

At locations 1 – 12 (see Figure 4.1) measurements were undertaken at 1.5m and approximately 3.5-4m height above local ground level for a duration of 5 minutes. At locations 13 – 23 shorter sample measurements of approximately 20-50 seconds were undertaken at 1.5m height above local ground level. At the end of the survey background sound levels were measured at the location indicated on the plan (BGSL) for one 15 minute period at approximately 3.5-4m height above local ground level and for two 15 minute periods at 1.5m height above local ground level.

Observations

The predominant noise sources in the area were distant road traffic and the substation.

DRAFT

Appendix D – Survey Results

11th – 12th October 2022 – 3.5-4m height (substation noise)

Location	Start Time	Duration T (mm:ss)	Results dB			Comments / Observations
			$L_{Aeq,T}$	$L_{Ceq,T}$	$L_{A90,T}$	
1	21:55	05:00	50	67	49	Hum, bins being moved briefly in middle of period.
2	22:05	05:00	43	60	43	
3	22:13	05:00	50	64	49	
4	22:21	05:00	40	50	39	Slightly more distant road traffic noise at this location.
5	22:30	05:00	38	48	36	Hum still audible but much reduced. At 22:31:07 100Hz sound much reduced / quieter. Both dB(A) and 100Hz influenced by distant road traffic noise. Along front of Russel Green Gardens only just audible hum / masked by road traffic noise. Aircraft noise at end of period.
6	22:40	05:00	38	54	38	
7	22:48	05:00	43	54	43	Hum, intermittent talking in nearby gardens just audible.
8	22:56	05:00	41	50	40	Hum and distant road traffic noise. See also 315Hz at 4m / 400Hz at 1.5m
9	23:05	05:00	34	47	33	Hum and noise from bathroom fan at nearby dwelling.
10	23:14	05:00	39	54	34	Hum audible but much lower here,
11	23:26	05:00	55	72	55	Significant hum. Approx 3-3.5m from fence
12	23:34	05:00	42	52	40	Hum. Moved 4m mast closer to source by approx. 2m and 100Hz increases. Aircraft noise at end (23:34)
NE end of Miller Street	00:14	15:00	45	56	35	Background sound level. Hum not audible. Dead still - no wind. Distant jet aircraft.

DRAFT

Appendix D (continued)

11th – 12th October 2022 – 1.5m height (substation noise)

Location	Start Time	Duration T (mm:ss)	Results dB			Comments / Observations
			$L_{Aeq,T}$	$L_{Ceq,T}$	$L_{A90,T}$	
1	21:55	05:00	54	72	53	Hum, bins being moved briefly in middle of period.
2	22:05	05:00	47	65	46	
3	22:13	05:00	43	59	42	
4	22:21	05:00	41	57	39	Slightly more distant road traffic noise at this location.
5	22:30	05:00	37	49	35	Hum still audible but much reduced. At 22:31:07 100Hz sound much reduced / quieter. Both dB(A) and 100Hz influenced by distant road traffic noise. Along front of Russel Green Gardens only just audible hum / masked by road traffic noise. Aircraft noise at end of period.
6	22:40	05:00	39	53	38	
7	22:48	05:00	41	53	39	Hum, intermittent talking in nearby gardens just audible.
8	22:56	05:00	42	57	41	Hum and distant road traffic noise. See also 315Hz at 4m / 400Hz at 1.5m
9	23:05	05:00	36	49	33	Hum and noise from bathroom fan at nearby dwelling.
10	23:14	05:00	38	52	31	Hum audible but much lower here,
11	23:26	05:00	55	73	55	Significant hum. Approx 3-3.5m from fence
12	23:34	05:00	43	59	42	Hum. Moved 4m mast closer to source by approx. 2m and 100Hz increases. Aircraft noise at end (23:34)
13	23:44	00:35	53	71	53	
14	23:45	00:50	46	62	43	
15	23:47	00:31	44	57	43	
16	23:49	00:43	47	63	46	
17	23:50	00:42	49	67	49	
18	23:51	00:32	46	63	46	
19	23:51	00:45	45	62	44	
20	23:52	00:28	40	55	39	
21	23:54	00:43	43	60	42	
22	23:55	00:32	41	58	40	
23	23:57	00:39	45	62	44	

DRAFT

Appendix D (continued)

12th October 2022 – 1.5m height (proxy baseline)

Location	Start Time	Duration T (mm:ss)	Results dB			Comments / Observations
			$L_{Aeq,T}$	$L_{Ceq,T}$	$L_{A90,T}$	
NE end of Miller Street	00:14	15:00	44	57	34	Background sound level. Hum not audible. Dead still - no wind. Distant jet aircraft.
	00:29	09:40	52	68	38	Car arrives towards start of measurement and engine left idling. Stopped measurement due to engine noise.
	00:40	14:59	37	53	34	Distant road traffic noise. Hum not audible.

DRAFT

Appendix E – Predicted Noise Levels (1.5m height) dB $L_{Aeq,T}$