

Princes Ltd, Bridge Road, Long Sutton, PE12 9EQ

Noise Assessment - Substation

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Comments

Comments

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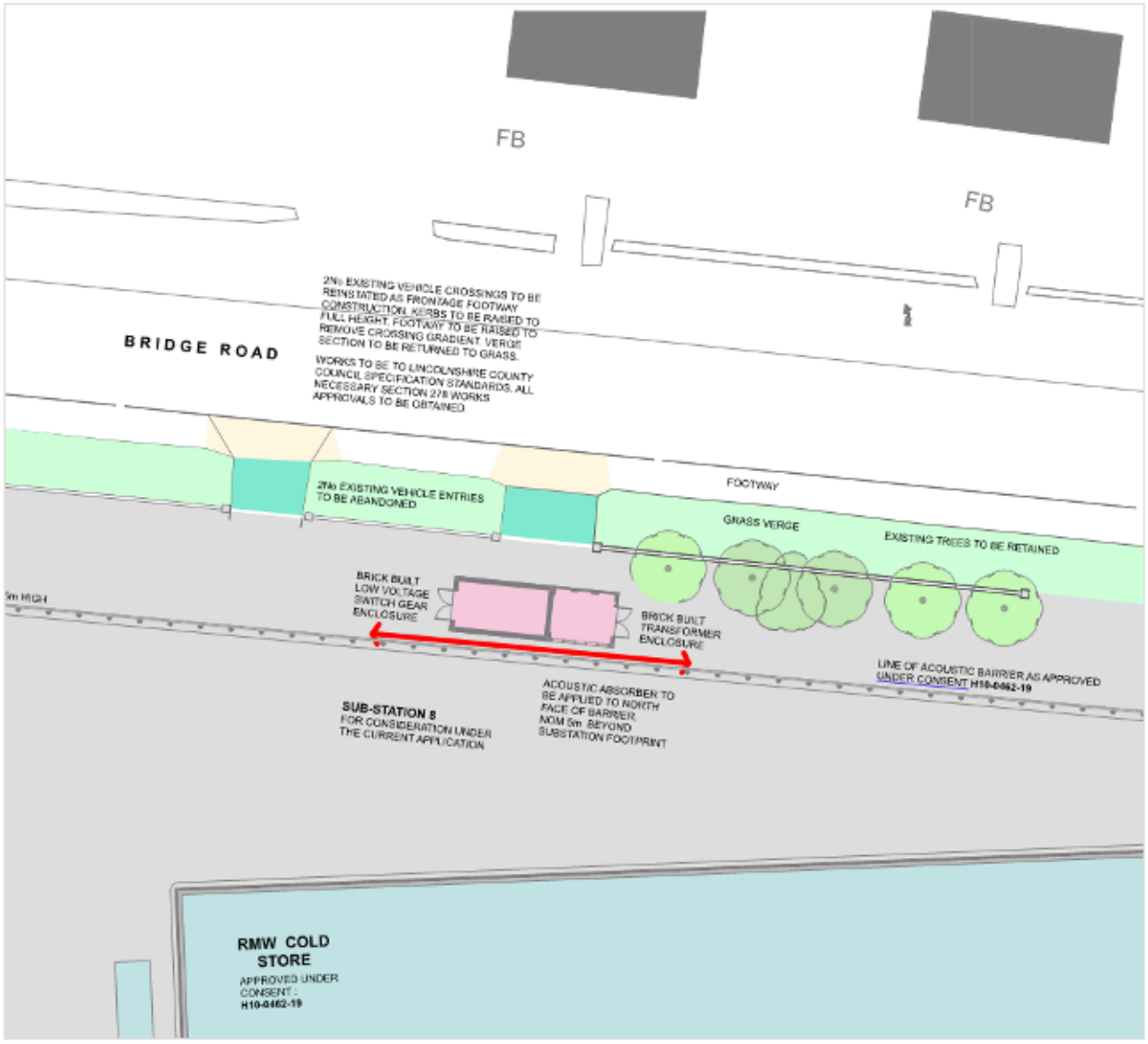
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1. Introduction

A new sub-station is required at the Princes' Long Sutton site to ensure provision of sufficient power to key areas of the manufacturing process following permitted development for the main warehouse (H10-0915-18), pea plant enclosure (H10-0136-19) and relocation of acoustic barrier (H10-0462-19 and H10-0064-20).

Due to site constraints location of sub-station is at the northern site boundary opposite residential houses on Bridge Road.

Figure 1: Site Location Plan Substation



This report assesses the potential impact of noise emissions from the substation on residents of Bridge Road.

A glossary of the acoustic terminology used within this report is presented in Appendix A.

2. Noise Assessment Criteria

2.1 Local Authority Consultation

The Environmental Health Department of South Holland District Council (SHDC) confirmed that the target noise criteria is the rating level should not exceed prevailing background noise level by more than 5dB.

2.2 New Fixed External Plant

BS 4142:2014+A1:2019 '*Methods for Rating and Assessing Industrial and Commercial Sound*', provides an assessment and rating method to assess the potential impact from fixed external plant.

The measured or predicted noise level from the source in question, the 'specific sound level' ($L_{Aeq,T}$), immediately outside the dwellings is compared with the 'background sound level' ($L_{A90,T}$). Where the sound contains certain acoustic features at the assessment location (e.g. tones, impulses, intermittency etc.), then a scaled character correction is added to the specific sound level to obtain the 'rating level ($L_{Ar,Tr}$). Typically, the greater the difference between the rating level and the background sound level the greater the potential of an adverse effect.

BS 4142 states:-

- A difference of + 10dB or more is likely to be an indication of a significant adverse impact, depending on the context.
- A difference of +5dB or more is likely to be an indication of an adverse impact, depending on the context.
- 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.

As noted in BS4142 *'Adverse impacts include, but are not limited to, annoyance and sleep disturbance. Not all adverse impacts will lead to complaints and not every complaint is proof of an adverse impact.'*

Context is an important consideration when assessing the potential for adverse impacts. This takes account of the absolute level of sound, the character of the residual sound compared to the character and level of the specific sound and acoustic screening.

SHDC seek a target rating level ($L_{Ar,Tr}$) at the nearest sensitive receptors not to exceed the prevailing background sound level (L_{A90}) by 5dB.

3. Environmental Noise Survey

3.1 Sensitive Receptors

The nearest sensitive receptors to the Substation are the residential houses fronting Bridge Road to the north of the eastern area of the Site. They are located approximately 30 metres from the Substation.

3.2 Environmental Noise Levels

A baseline environmental noise survey conducted at Princes Long Sutton, from Wednesday 18th July to Thursday 19th July 2018 established the prevailing ambient noise levels within the vicinity of the nearest existing sensitive receptors to the Site.

An environmental noise logger was installed at the northern boundary with Bridge Road approximately 15 metres from the road edge. This monitoring location was considered to be representative of prevailing noise levels at houses fronting onto Bridge Road which themselves are located approximately 15 metres from the road edge.

Table 1 presents a summary of the measured environmental noise levels. Full details of the baseline survey are presented in Appendix B. The daytime period is taken as 07:00-23:00 with night-time period as 23:00-07:00.

Table 1: Summary of Baseline Survey Results At Northern Boundary

Period	L_{Aeq}[1]	L_{AFmax}[2]	L_{A10}[3]	L_{A90}[3]	Modal L_{A90}
Day	59	78	63	44	45
Night	53	75	51	43	44 (39 when pea processing plant not operational)

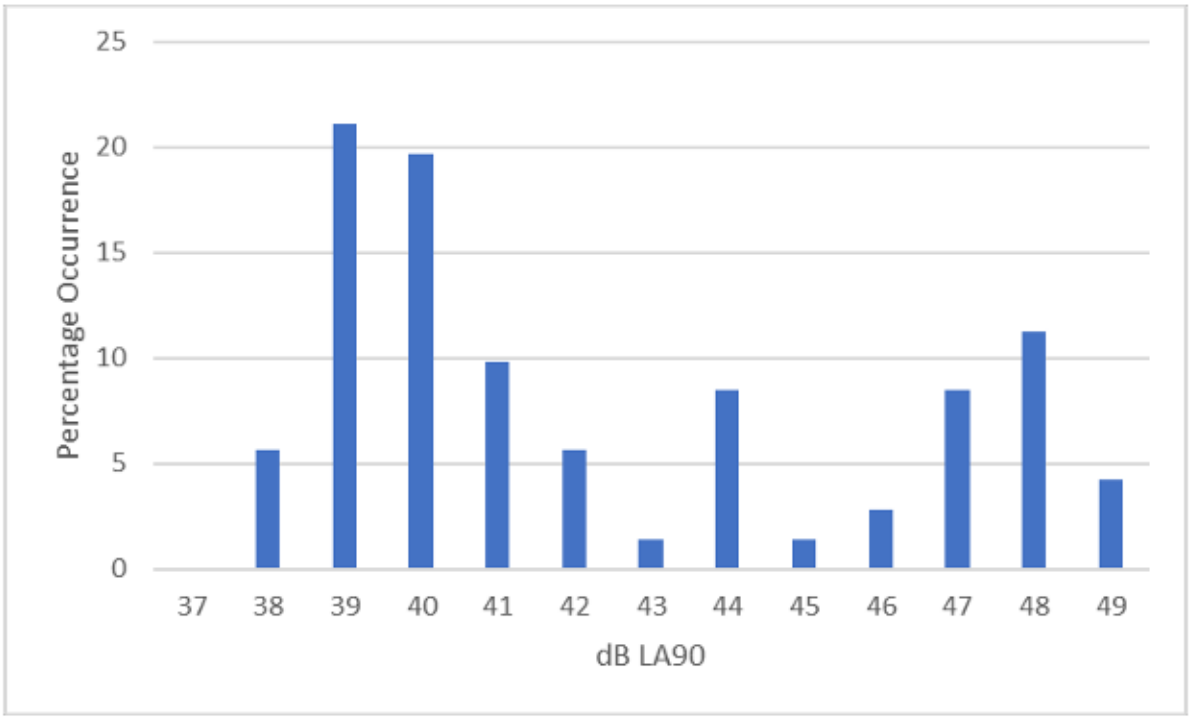
Note: [1] Logarithmic average. [2] 95th Percentile. [3] Arithmetic average.

The weather conditions during the survey period were monitored remotely with reference to weather station ID ISPALDIN8 at Long Sutton located approximately 2.2km to the west of the Site. Conditions during the survey period were suitable for noise monitoring, being dry and wind speed less than 5 m/s.

The dominant noise source at the monitoring location was considered to be road traffic noise. Traffic movements on Bridge Road were noted as being frequent but not continuous.

Figure 2 presents a frequency plot of the measured background noise levels during the night-time period excluding the data sets when the pea processing plant was operational. The modal background noise level during the night-time period when the pea processing unit wasn't operational was 39dB L_{A90}. This is considered the limiting factor to the Substation development and it is against this parameter that a BS4142 assessment has been undertaken which is considered to be a conservative approach.

Figure 2: Frequency Plot Night-Time L_{A90} (excluding period when pea processing unit operational)



4. BS4142 Assessment

4.1 Substation Details

The proposed transformer is a 2000 kVA Wilson e3 Ultra Low Amorphous. The noise data provided by Wilson's via EME Power Systems is as follows:

- Sound power level: 72dB(A)
- Sound pressure level at 0.3m: 59dB(A)
- Estimated sound pressure level at 10m: 52dB(A)

The approximate dimension of the transformer are:

1985 mm x 2242 mm x 1750 mm

EME Power Systems have stated that transformer will not create electromagnetic interferences.

The switch gear for the Substation will be located within a brick building with flat roof. The construction details are understood to be as follows:

- Walls single skin brick (with air bricks 2 high level 2 low level)
- Roof 19mm external grade ply on sw joist to receive membrane
- Door with weather louvres

The transformer located to the east of the switch gear building will also be located in a building which is understood to be constructed as follows:

- Walls single skin brick except southern façade
- Acoustic louvre southern façade to allow air flow for cooling
- Kingspan composite flat roof
- Acoustic louvre door on eastern façade

4.2 Noise Considerations

There are normally 3 noise sources associated with substations:

1. Transformer (constant low frequency hum)
2. Switch gear (operation of circuit breakers 'impulsive' in character)
3. Auxiliary plant (diesel generators and air compressors)

With regard to this development there is not auxiliary plant.

The main source of complaint from substations is normally associated with **externally** located transformer noise which typically has a low frequency hum and is normally characterised by harmonics of the fundamental frequency 100Hz which is twice the line supply frequency. Noise from switch gear are normally adequately attenuated by the building structure they are located within.

4.3 Noise Model

In order to accurately predict the potential impact of the substation, a 3-dimensional (3D) environmental noise model was constructed using the acoustic software package Cadna-A®. The model calculates industrial noise propagation according to the guidance provided in ISO 9613-2 "Acoustics – Attenuation of sound during propagation outdoors", accounting for geometrical spreading, local topography, ground

absorption, screening and meteorological effects, as appropriate.

Table 2 presents the predicted reverberant noise level within the transformer building based on noise data information provided by Wilson's (the manufacturer) and typical transformer noise spectrum[1], together with the sound insulations afforded by the brick wall[2], roof and acoustic louvre elements of the transformer building. Further details are presented within Appendix C.

Table 2: CadnaA Noise Model Inputs

Item	Linear dB								Overall
	63Hz	125Hz	250Hz	500Hz	1kHz	2kHz	4kHz	8kHz	
Reverberant Noise Level Transformer Building	64	85	82	80	67	58	58	52	79dB(A)
Sound Reduction Roof (Kingspan KS1000)	20	18	20	24	20	29	39	47	24dB R_w
Single Skin Brick	32	36	37	32	40	48	56	53	39dB R_w
Acoustic Louvre (Allaway Acoustics L60E)	4	4	5	8	12	16	15	13	12dB R_w

The noise assessment is based on the following construction detail:

- The transformer is not acoustically coupled to the enclosure;
- The space between the transformer tank and the building (enclosure) does not coincide with the half the wavelength of the main frequency thereby avoiding the build-up of standing wave;
- There are no gaps between the various building elements which noise could escape; and
- That all transformer connections are made as flexible as possible.

To safeguard against reflections from the permitted acoustic fence located to the south of the louvred façade of the transformer building, it is recommended to include an absorptive section of fence.

4.4 Noise Assessment

Figure 5 presents the highest predicted transformer noise level at receptors on Bridge Street due to break-out through the transformer building structure, which is predominantly via the acoustic louvres, together with the measured prevailing night-time noise levels. Overall, the predicted noise level from the transformer is lower than the measured prevailing noise levels. It is more than 10dB below the average night-time ambient noise level of 54dB L_{Aeq} and below the modal background noise level of 39dB L_{A90}. At an 1/1 octave noise level, the predicted transformer level is below the prevailing noise levels except at 125Hz where it is predicted to exceed the modal background noise value by 3dB. A noise level difference in environmental noise of this magnitude is not normally discernible. However, for the purpose of the BS4142 assessment, based on the predicted 1/1 octave noise level, a +2dB tonality penalty will be added to the predicted specific noise level indicating 'just perceptible' at the receptor location.

Figure 4 presents the predicted transformer noise contour plot at 4 metres above ground level which is reflective of the bedroom location.

[1] Gange Michael. (2011) Low-frequency and Tonal Characteristics of Transformer Noise. Proceedings of ACOUSTICS 2011.
[2] Insul v8.0.3

Figure 3: Prevailing Noise Levels & Predicted Transformer Noise Levels

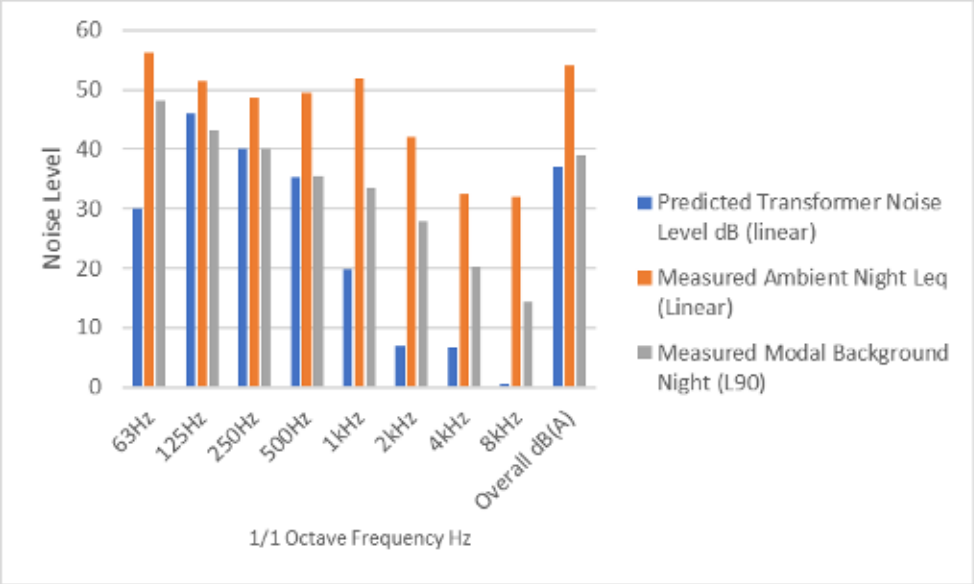
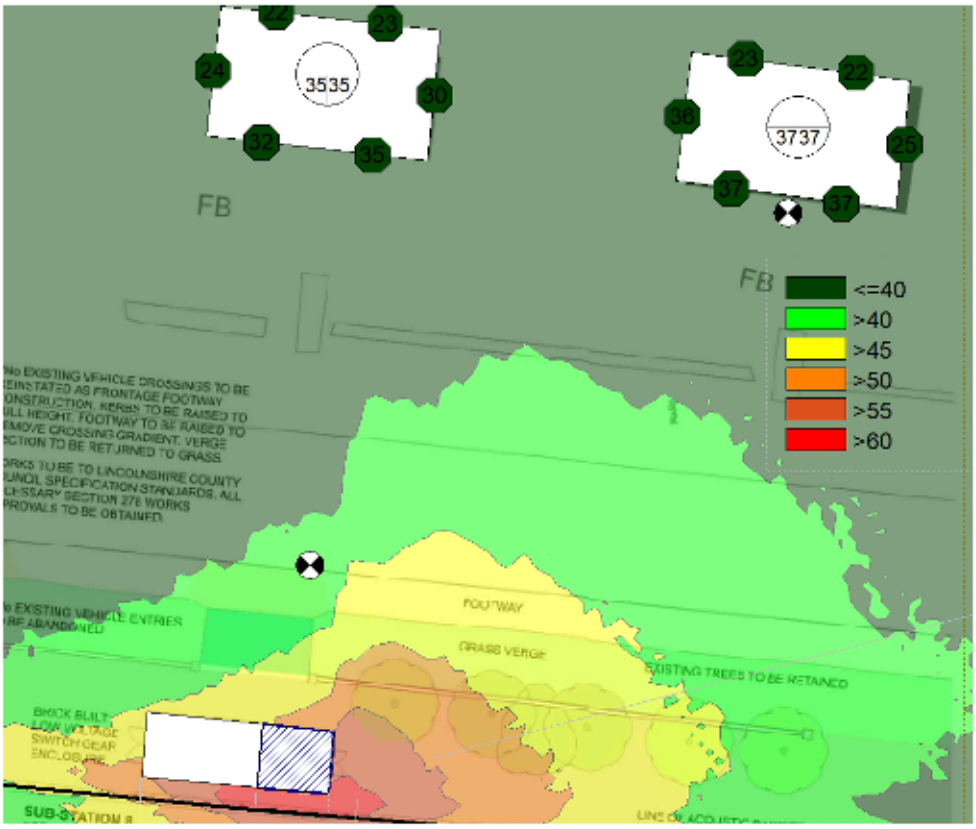


Figure 4: Transformer Noise Contour dB L_{Aeq} (4m agl)



4.5 BS4142 Assessment

Table 3 presents details of the BS4142 assessment. As stated earlier, the specific noise level has been adjusted by +2dB to derive the rating level, to account for just perceptible tonality at the receptor location.

Table 3: BS4142 Assessment RRDs Closed – Normal Operations

Assessment	1-2 Bridge Road	3-4 Bridge Road
Specific Sound Level (SSL), (dB $L_{Ar,Tr}$)	35	37
Acoustic Feature Correction	+2	+2
Rating Level (RL), (dB $L_{Ar,Tr}$)	37	39
Modal Background Sound Level (BSL), (dB $L_{A90,night}$ excluding pea processing)	39	39
Excess of RL over BSL	-2	0
Excess of RL over noise limit of 39+5=44dB $L_{Ar,Tr}$	-7	-5

The predicted rating level does not exceed the modal night-time background sound level at the nearest residential receptors or the noise limit of ≤L_{A90}-5dB. This indicates that noise from the substation would have a low impact and would not adversely affect the existing residential amenity of the area.

4.5.1 Uncertainty

Section 10.2 of BS 4142 states several factors which give rise to uncertainty associated with calculations. Regard has been given to uncertainties such as the noise source, weather, instrumentation, and rounding together with uncertainties associated with calculation methods. The combined uncertainty of these has been derived based on guidance contained within 'Considering uncertainty when performing environmental noise measurements[3]'. Table 4 presents a summary of the considered uncertainty with full details within Appendix C.

Table 4: Calculation of Combined Uncertainty

Source of Uncertainty (refer to Appendix C)	Uncertainty (Half Width) dB	Uniform Distribution Assumed	Standard Uncertainty (Uncertainty/1.73)
1.Noise source data.	3	√3 = 1.73	1.7
2. Weather	3	√3 = 1.73	1.7
3a. Survey Equipment	1.1	√3 = 1.73	0.6
3b. Surveyor	3	√3 = 1.73	1.7
4. Rounding of values	1.0	√3 = 1.73	0.6
5. CadnaA calculation	1.4	√3 = 1.73	0.8
6. Intra personal differences	3	√3 = 1.73	1.7
Combined Uncertainty (Root sum of squares of standard uncertainty)			**±3.7 dB**

Compliance with the required noise limit is still achieve when account is take of potential uncertainties associated with measurement and calculation.

[3] Kerry G, Waddington DC. (2005). Considering uncertainty when performing environmental noise measurements. University of Salford Manchester.

4.5.2 Context

Character of Neighbourhood

The area surrounding the Site is a mix of rural and industrial. Noise emissions from Princes Ltd contribute to the local noise climate together with road traffic noise from Bridge Road and distant road traffic noise from the A17. Noise from the substation transformer with the inherent mitigation measures should not change the character of the neighbourhood.

Absolute Sound Level

The predicted sound level resultant from the substation of 35 to 37dB L_{Aeq} is significantly below the measured prevailing night-time noise level of 53dB L_{Aeq}. Night-time noise levels of this magnitude should not adversely impact the existing residential amenity during both the day and night-time period.

During the night-time period (2300-0700) residents are generally indoors and in bedrooms. External noise levels of this magnitude would not normally be a material consideration to planning.

Mitigation Measures

The transformer would be enclosed within a brick building with acoustic louvre on the southern façade facing the Site away from receptors on Bridge Road. The access door to the transformer would also include acoustic louvre panels. The roof to the transformer building would be Kingspan composite panel (25dB R_w) or other with comparable sound insulation. To safeguard against reflections from the permitted acoustic fence, the section directly adjacent to the substation would be adsorptive.

5. Conclusions

The conclusions are as follows:

- The prevailing night-time background sound level established through survey is 39dB LA90.
- The South Holland District Council plant noise limit is 44dB $L_{Ar, Tr}$.
- The predicted rating level of 37-39dB $L_{Ar,Tr}$ for the substation does not exceed the prevailing background sound level and plant noise limit the BS4142 potential impact is therefore considered to be low.
- When account is taken of uncertainty and context, with the proposed mitigation (brick building enclosure with southern acoustic louvred façade and absorptive section of acoustic fence), noise emissions from the substation, namely the transformer should not adversely impact the existing residential amenity.

APPENDICES

A. Glossary of Acoustic Terminology

Ambient sound	The totally encompassing sound in a given situation at a given time, usually composed of sound from all sources near and far.
Assessment period	The period in a day over which assessments are made.
A-weighting	A frequency weighting applied to measured or predicted sounds levels in order to compensate for the non-linearity of human hearing.
Background noise	Background noise is the term used to describe the noise measured in the absence of the noise under investigation. It is described as the average of the minimum noise levels measured on a sound level meter and is measured statistically as the A-weighted noise level exceeded for ninety percent of a sample period. This is represented as the L_{90} noise level (see below).
Broadband	Containing the full range of frequencies.
Decibel [dB]	The level of noise is measured objectively using a Sound Level Meter. This instrument has been specifically developed to mimic the operation of the human ear. The human ear responds to minute pressure variations in the air. These pressure variations can be likened to the ripples on the surface of water but of course cannot be seen. The pressure variations in the air cause the eardrum to vibrate and this is heard as sound in the brain. The stronger the pressure variations, the louder the sound that is heard. The range of pressure variations associated with everyday living may span over a range of a million to one. On the top range may be the sound of a jet engine and on the bottom of the range may be the sound of a pin dropping. Instead of expressing pressure in units ranging from a million to one, it is found convenient to condense this range to a scale 0 to 120 and give it the units of decibels. The following are examples of the decibel readings of every day sounds: Four engine jet aircraft at 100m 120 dB Riveting of steel plate at 10m 105 dB Pneumatic drill at 10m 90 dB Circular wood saw at 10m 80 dB Heavy road traffic at 10m 75 dB Telephone bell at 10m 65 dB Male speech, average at 10m 50 dB Whisper at 10m 25 dB Threshold of hearing, 1000 Hz 0 dB
dB(A): A-weighted decibels	The ear is not as effective in hearing low frequency sounds as it is hearing high frequency sounds. That is, low frequency sounds of the same dB level are not heard as loud as high frequency sounds. The sound level meter replicates the human response of the ear by using an electronic filter which is called the 'A' filter. A sound level measured with this filter switched on is denoted as dB(A). Practically all noise is measured using the A filter. The sound pressure level in dB(A) gives a close indication of the subjective loudness of the noise.
Façade Noise Level	A noise level measured or predicted at the façade of a building, typically at a distance of 1m, containing a contribution made up of reflections from the façade itself (+3 dB).
Free-Field	Free field is a measurement area not subject to significant reflection of acoustical energy. A free field measurement is typically not closer than 3.5 metres to any large flat object (other than the ground) such as a fence or wall..
L_{Amax} noise level	This is the maximum noise level recorded over the measurement period.
L_{Amin} noise level	This is the lowest level during the measurement period.
$L_{Aeq,T}$ noise level	This is the 'equivalent continuous A-weighted sound pressure level, in decibels' and is defined in British Standard 7445 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, noise from industrial premises and is the most suitable unit for the description of other forms of environmental noise.
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 quieter periods. It is often referred to as the background noise level and is used in the assessment of disturbance from industrial noise.
L_{A10} noise level	This is the noise level which is achieved for 10% of the monitoring period and is often used to describe road traffic noise.
Rating Level dB $L_{Ar,Tr}$	Specific sound level plus any adjustment for the characteristic features of the sound.
Residual Sound	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.
Sound Reduction Index (R)	The sound reduction index is a single-number rating of the sound reduction through a wall or other building element. Since the sound reduction may be different at different frequencies, test measurements are subjected to a standard procedure which yields a single number that is about equal to the average sound reduction in the middle of the human hearing range.
Specific Sound Level dB $L_{Aeq,Tr}$	Equivalent continuous A-weighted sound pressure level produced by the specific sound source at the assessment location over a given reference time interval, T_r.
Weighted Sound Reduction Index (R_W)	Single number rating used to describe the **laboratory** airborne sound insulation properties of a material or building element over a range of frequencies, typically 100-3150Hz.
C_{TR}	An adjustment to the Rw scale to take account of the lower performance against a typical spectrum of road traffic noise dominated by low frequencies.
$D_{ne,W}$	Weighted element normalised level difference.

B. Baseline Noise Survey

An unattended baseline noise survey was conducted at 15 metres set-back from the northern site boundary with Bridge Road from Wednesday 18th July to Thursday 19th July 2018.

The noise parameters logged throughout the survey period were L_{Aeq}, L_{A90} $L_{A10,}$ and L_{Amax} measured as contiguous 5-minute periods. These parameters are described in full in Appendix A. The L_{Aeq} level is the equivalent continuous sound pressure level over the measurement period; L_{A90} is used as a descriptor of background noise levels and is the noise level exceeded for 90% of the measurement period, L_{A10} is the noise level which is achieved for 10% of the monitoring period and is often used to describe road traffic noise and L_{Amax} is an indicator of the highest sound level during the measurement period.

In addition, 1/3 octave noise measurements were measured.

Monitoring was undertaken by trained and competent Member of the Institute of Acoustics (MIOA).

The sound level meters were field calibrated before and on completion with no significant drift detected. Table B1 presents details of the equipment used in the baseline noise survey. All equipment used holds a valid calibration certificate which are available on request.

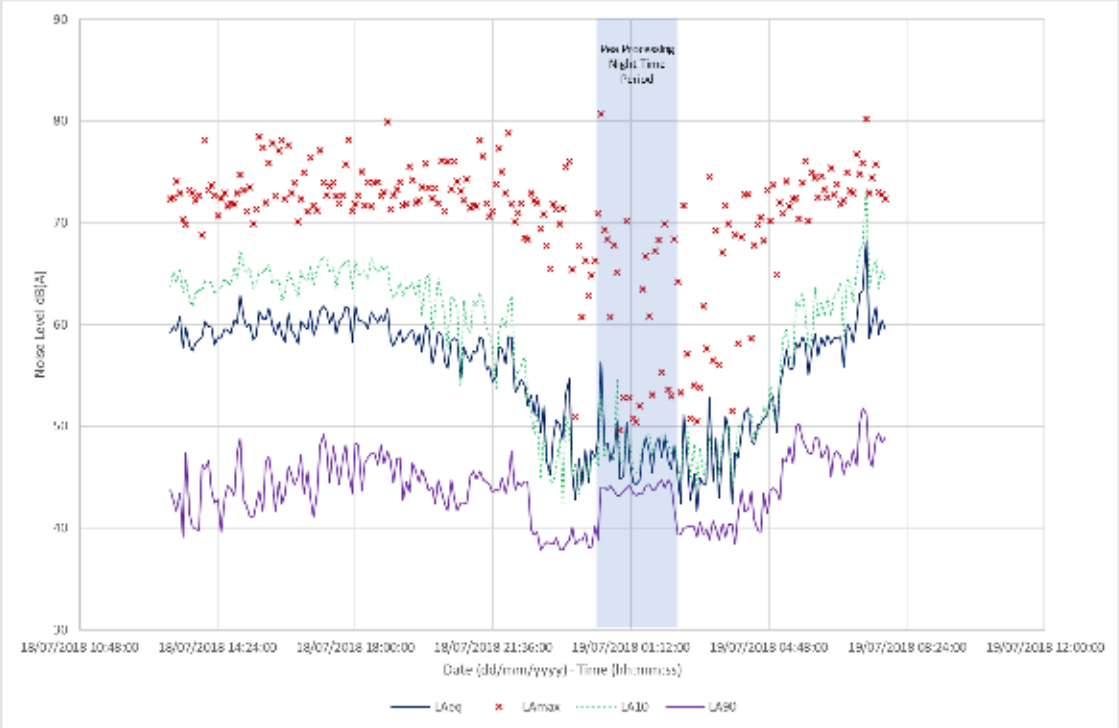
Table B1: Equipment Details

Location	Equipment	Model	Serial No.
15m south of Bridge Road	Sound Level Meter	Rion NL-52 Type 1 Sound Level Meter	976152
	Microphone	Rion UC-59 Microphone	12045
	Pre-amplifier	Rion NH-25 Pre-amplifier	76269
	Acoustic Calibrator	Acoustic Calibrator Rion NC-74	35173533

The weather conditions during the survey period were monitored remotely with reference to weather station ID ISPALDIN8 at Long Sutton located approximately 2.2km to the west of the Site. On Wednesday 18th July 2018 average temperature was 18.7°C, dry, sunny, calm up to 3 m/s northerly wind speed and direction. On Thursday 19th July 2018 average temperature was 20.8oC, dry, sunny, calm up to 3 m/s SSW wind speed and direction.

Figure B1 presents the time history plot.

Figure B1: Time History Plot of Noise Levels at LT2 (15m Set Back Northern Site Boundary Bridge Road)



Photograph B1: Noise Monitoring Location



C. Calculation Details

Reverberant Noise Levels

Sound Pressure Reverberant = Sound Power Level + 6 – 10 Log A

Where A – total absorption

Table C1: Calculation of Reverberant Noise Levels

Description	Value
Estimated Absorption coefficient (brick)	0.02
Estimated Area of Absorption M^2	75
Estimated Total Absorption- A	1.49
Estimated Reverberant Noise Level dB(A)	79

Uncertainty

Table C2: Uncertainty Associated with Noise Assessment

Uncertainty Item	BS4142 Measurement Uncertainty	Comments
1	The complexity of the sound source and the level of variability in sound emission from the source	The uncertainty associated with the sound source stems from the laboratory uncertainty, measurement standard, and repeatability of the measurement. This can typically range between ±5dB at low frequencies (≤250Hz) and ±3dB for mid to high frequencies (≥500Hz)[4]. For the purposes of this plant noise assessment it has been assumed that the plant noise spectrum is **±3 dB** higher across the frequency range (125Hz to 4kHz) given in Table 2.
2	The range of suitable weather conditions during which measurements have been taken	The noise survey was undertaken in suitable weather conditions, no rain and wind speeds below 5m/s. The weather data not when on Site with full data obtained from historical weather (https://www.wunderground.com/). To account for local weather variability an uncertainty due to weather of **±3 dB** is considered.
3a & 3b	The measurement method and instrument variability between different practitioners in the way the method is applied	The noise survey was carried out with a Class 1 sound level meter having valid calibration certificates and with regard to BS 7445-1. Calibration checks were carried out both before and after the noise survey with the drift of the sound level meter observed to be within the tolerance of the sound meter (**±1.1 dB** at 1kHz **3a**). The measurement was carried out by Innes Urbanski who holds appropriate acoustic qualifications and experience. It is assumed the variability between surveyors would amount to **±3 dB (3b).**
4	The level of rounding of each measurement recorded	Rounding of measurements (L_{A90}) and specific noise predictions (Ls) have been carried out to the nearest whole number as per BS 4142 for the assessment. As such an uncertainty associated with rounding of the noise data to **±1 dB** is considered.

[4] Blazier, Geshwiler, and Mildred, Application of Manufacturers Sound Data, ASHRAE, October 1998.

Table C3: Uncertainty Associated with Calculations

Uncertainty Item	BS4142 Calculation Uncertainty	Comments
5	Uncertainty in the calculation method	Cadna software states that the uncertainty with propagation is as follows: $\sigma_D = 3*\log10(d)/10)$ in dB The distance between the transformer and the SRs is approximately 30 metres. The uncertainty associated with propagation is therefore **±1.4 dB**.
6	Uncertainty in the personal carrying out the calculation	The uncertainty of different personal carrying our noise is assumed to be **±3 dB**

UK and Ireland Office Locations

