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25th May 2021

Stopford Energy & Environment

Assessment of noise impact of 6 No. proposed
Containerised CHPs and associated equipment at
Knowsley Industrial Park, L33 7UG

Prepared for :-

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1.0 SUMMARY

The general noise climate during the day was dominated by local traffic, and industrial estate activity, including fork lift trucks and reversing alarms. During the evening and night, the traffic was less and the industrial estate generally more audible.

The proposed units have all been modelled and are likely to be below what BS 4142 would rate as "*low impact depending on the context*". in all normal circumstance. The context is an established industrial estate and, most importantly, the proposed site is for peak demand only (1500 hours per year, nearly always 07:00 to 19:00) and we would suggest that the impact would generally be negligible. It is extremely unlikely that the site would run into the late evening and more or less a certainty that it would run through the night. On this basis the impact can also be considered very low.



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P J Durell

2.0 INTRODUCTION

ADC was asked to carry out an independent assessment of the above site with regards to the impact of eight new CHPs and associated equipment..

This report begins by summarising assessment standards and, where appropriate, discusses alternative interpretations.

After describing the modelling process and assumptions, and a brief statement of survey details we discuss basic results and the resulting assessment. The predicted noise is assessed and discussed along with any recommendations for mitigation.

3.0 ASSESSMENT STANDARDS

3.1 NPPE, NPSE and NPPG

The National Planning Policy Framework (NPPF), the Noise Policy Statement for England (NPSE) and the National Planning Practice Guidance (NPPG) provide nothing in the way of quantitative criteria but instead provide general policy aims and statements and some guidance on how certain situation can be interpreted.

The NPPF's main statement on noise is to be found in paragraph 180:-

- 180 Planning policies and decisions should also ensure that new development is appropriate for its location taking into account the likely effects (including cumulative effects) of pollution on health, living conditions and the natural environment, as well as the potential sensitivity of the site or the wider area to impacts that could arise from the development. In doing so they should:
- a) mitigate and reduce to a minimum potential adverse impacts resulting from noise from new development – and avoid noise giving rise to significant adverse impacts on health and the quality of life^(footnote here refers to NPSE – see below);
 - b) identify and protect tranquil areas which have remained relatively undisturbed by noise and are prized for their recreational and amenity value for this reason; and
 - c) limit the impact of light pollution from artificial light on local amenity, intrinsically dark landscapes and nature conservation.

Paragraph 182 is also relevant:-

- 182 Planning policies and decisions should ensure that new development can be integrated effectively with existing businesses and community facilities (such as places of worship, pubs, music venues and sports clubs). Existing businesses and facilities should not have unreasonable restrictions placed on them as a result of development permitted after they were established. Where the operation of an existing business or community facility could have a significant adverse effect on new development (including changes of use) in its vicinity, the applicant (or 'agent of change') should be required to provide suitable mitigation before the development has been completed.

The NPPF refers to the NPSE which sets out the following aims:-

1. avoid significant adverse impacts on health and quality of life;
2. mitigate and minimise adverse impacts on health and quality of life; and
3. where possible, contribute to the improvement of health and quality of life.

It also introduces the concepts of:

- NOEL – No Observed Effect Level. In simple terms, below this level, there is no detectable effect on health and quality of life due to the 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.

SOAEL is clearly something the policy seeks to avoid in aim 1. Aim 2 represents situations between SOAEL and LOAEL, and seeks to minimise and mitigate the effects.

The NPPG section on noise adds some further detail, much of it reproducing the NPPF and NPSE, but some useful qualitative guidance is provided in a table as reproduced below.

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

It also makes the point that the subjective nature of noise means that there is not a simple relationship between noise levels and the impact on those affected. This will depend on how various factors combine in any particular situation, including the level of the noise in absolute terms and how it might compare with the underlying background noise, the impulsiveness or intermittence pattern of the noise, its spectral content, and the time of day. It discusses in very general terms the issues to consider when introducing noise sources to existing noise sensitive area, new residential development in areas affected by existing noise

sources (most of which have their own specific guidance, such as BS 4142, BS 8233, etc.) and the potential impact on wildlife.

3.2 BS 8233

BS 8233 was updated in March 2014. Quantitatively, however, the design criteria are little changed – just expressed differently to reduce ambiguity in certain situations.

Table 4 of BS 8233 gives the desirable criteria for indoor ambient noise levels for dwellings as follows:-

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

Note that the standard accepts the widely used rule of thumb that, for a partly open window, the levels just outside will be 15dB higher than those just inside. This brings us to an external equivalent of the above table, as follows:-

Activity	Location	07:00 to 23:00	23:00 to 07:00
Resting	Living room	50 dB $L_{Aeq,16hour}$	-
Dining	Dining room/area	55 dB $L_{Aeq,16hour}$	-
Sleeping (daytime resting)	Bedroom	50 dB $L_{Aeq,8hour}$	45 dB $L_{Aeq,8hour}$

It goes on to state that, where necessary, the criteria can be relaxed by up to 5 dB and still achieve reasonable conditions. Note that the new version does not explicitly state criteria for bedroom noise in terms of dB L_{Amax} .

Garden area criteria are unchanged with 50 dB L_{Aeq} and 55 dB L_{Aeq} being considered desirable and reasonable respectively.

Note that the new version of BS 8233 more explicitly specifies the assessment periods as 16 hour and 8 hour for daytime and night time respectively.

3.3 BS 4142

BS 4142 was updated in November 2014. The standard is very complicated but, basically, it describes methods for rating and assessing sound of an industrial and/or commercial nature, which includes:

- sound from industrial and manufacturing processes
- sound from fixed installations which comprise mechanical and electrical plant and equipment
- sound from the loading and unloading of goods and materials at industrial and/or commercial premises

- d) sound from mobile plant and vehicles that is an intrinsic part of the overall sound emanating from premises or processes, such as that from forklift trucks, or that from train or ship movements on or around an industrial and/or commercial site.

The methods described in this British Standard use outdoor sound levels to assess the likely effects of sound on people who might be inside or outside a dwelling or premises used for residential purposes upon which sound is incident.

Characteristics and Context

Certain acoustic features can increase the significance of impact over that expected from a basic comparison between the specific sound level and the background sound level. Where such features are present at the assessment location, we need to add a character correction to the specific sound level to obtain the rating level.

These features can include tonality, impulsivity and intermittency with corrections typically ranging potentially from 0dB to 9 dB. Corrections at the higher end would represent characteristics which are highly perceptible in the context of the ambient noise as a whole. Corrections at the lower end would represent characteristics which are just perceptible in the presence of the ambient noise as a whole,

The significance of sound of an industrial and/or commercial nature depends upon both the margin by which the rating level of the specific sound source exceeds the background sound level and the context in which the sound occurs. An effective assessment cannot be conducted without an understanding of the reason(s) for the assessment and the context in which the sound occurs/will occur. When making assessments and arriving at decisions, therefore, it is essential to place the sound in context.

Assessment

We obtain an initial estimate of the impact of the specific sound by subtracting the measured background sound level from the rating level and considering the following.

- a) Typically, the greater this difference, the greater the magnitude of the impact.
- b) A difference of around +10 dB or more is likely to be an indication of a significant adverse impact, depending on the context.
- c) A difference of around +5 dB is likely to be an indication of an adverse impact, depending on the context.
- d) The lower the rating level is relative to the measured background sound level, the less likely it is that the specific sound source will have an adverse impact or a significant 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.

Where the initial estimate of the impact needs to be modified due to the context, pertinent factors need to be taken into consideration, including the following.

1) The absolute level of sound.

For a given difference between the rating level and the background sound level, the magnitude of the overall impact might be greater for an acoustic environment where the residual sound level is high than for an acoustic environment where the residual sound level is low.

Where background sound levels and rating levels are low, absolute levels might be as, or more, relevant than the margin by which the rating level exceeds the background. This is especially true at night.

Where residual sound levels are very high, the residual sound might itself result in adverse impacts or significant adverse impacts, and the margin by which the rating level exceeds the background might simply be an indication of the extent to which the specific sound source is likely to make those impacts worse.

2) The character and level of the residual sound compared to the character and level of the specific sound.

We need to consider whether it would be beneficial to compare the frequency spectrum and temporal variation of the specific sound with that of the ambient or residual sound, to assess the degree to which the specific sound source is likely to be distinguishable and will represent an incongruous sound by comparison to the acoustic environment that would occur in the absence of the specific sound. Any sound parameters, sampling periods and averaging time periods used to undertake character comparisons should reflect the way in which sound of an industrial and/or commercial nature is likely to be perceived and how people react to it.

3) The sensitivity of the receptor and whether dwellings or other premises used for residential purposes will already incorporate design measures that secure good internal and/or outdoor acoustic conditions.

3.4 Local Authority

We are not aware of any other criteria associated with this project such as planning conditions.

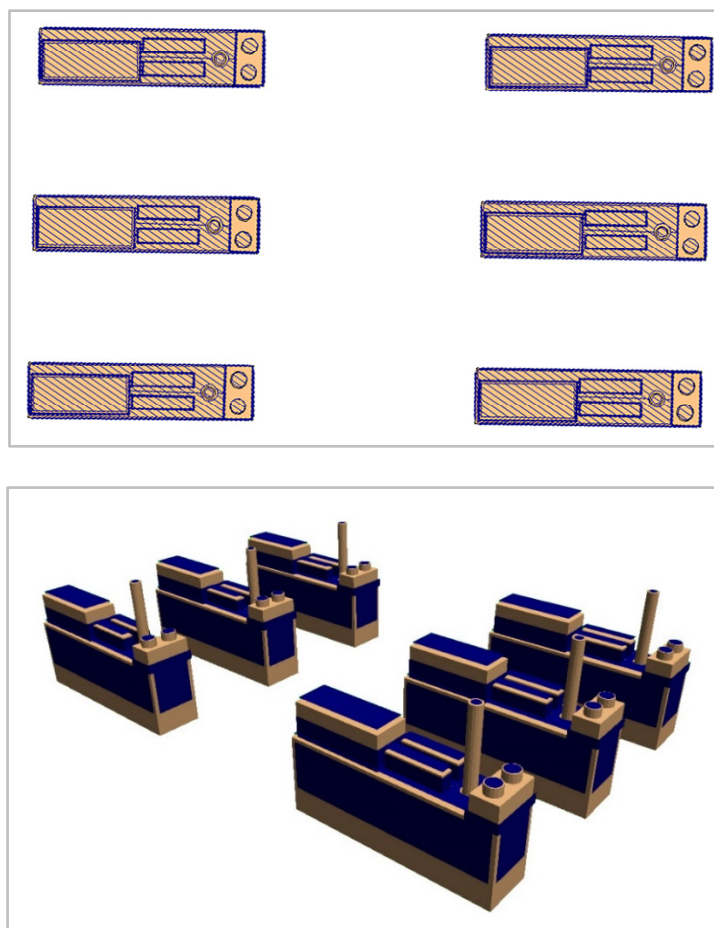
4.0 GUIDE TO MODELLING

We have used our CadnaA modelling software which calculates noise propagation based on the processes of *ISO 9613 : Acoustics – Attenuation of sound during propagation outdoors*. Obviously, modelling software is reliant on the inputs and assumptions. The key ones are:-

1. The ground is assumed to be mainly reflective (coefficient of 0.11 assumed).
2. Calculations are based on two orders of reflections.
3. The site building and the surrounding buildings are assumed to be mainly reflective (0.5 dB loss on reflection assumed).
4. The surrounding trees and vegetation will provide a small degree of absorption but this has been neglected.
5. The CHPs are housed in containers, with a radiator and condenser on top. The exhaust silencers and the exhaust stack are also on top. Each combined unit as a whole is specified at 75 dB(A) at 1m all around. See Appendix 3 for the calibration of a unit to 75 dB(A).

Only the overall dB(A) figure is given, ie.no information about how the levels vary across the frequency spectrum. For this we have used the spectrum shape of numerous other CHP project we have done over the years, including containerised CHPs, radiators, exhausts, etc.

6. The sources are entered into the CadnaA model as area sources. In the image below the hatched areas are horizontal area sources of container roofs, radiator tops, exhaust outlets, etc. The vertical area sources of the sides of the various components are the heavier blue lines. These are difficult to see in plan view, but visible in 3D view.



5.0 SURVEY DETAILS

5.1 Site times and Personnel

The daytime, evening and night-time measurements were carried out on 1st/2nd March 2021 by Mark Pickering of ADC Acoustics.

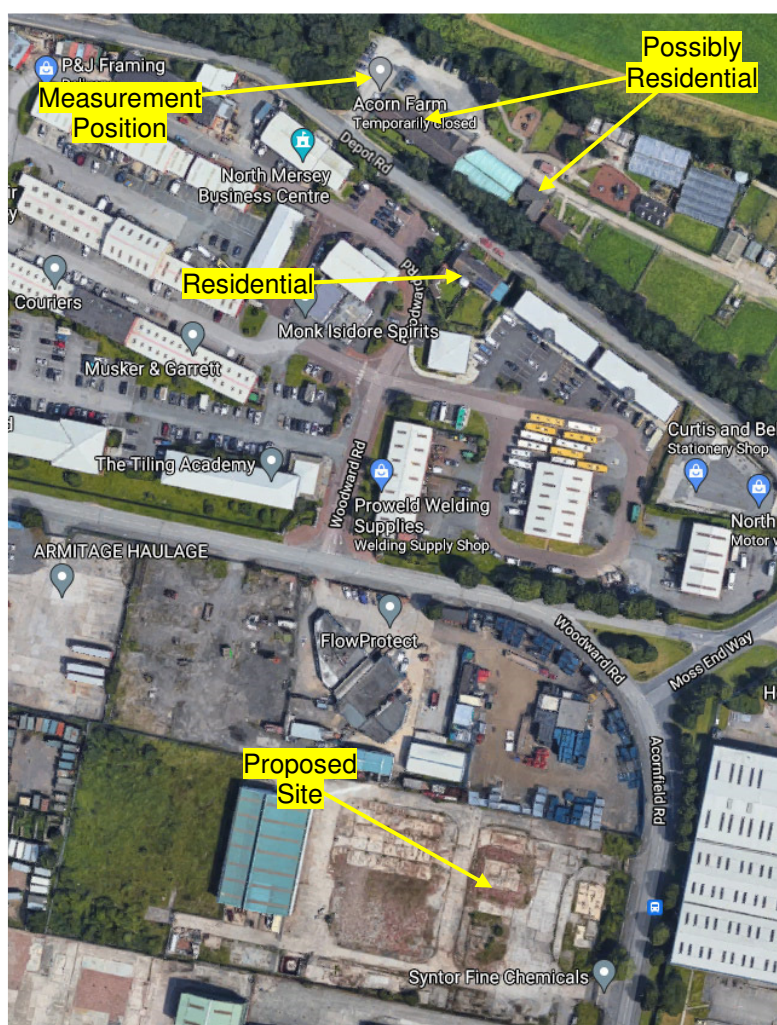
Measurements were carried out between approximately 13:00 to 15:00 hours to represent non-rush hour daytime, between 21:00 hours and 23:00 hours to represent late evening, and between 02:00 and 04:00 hours to represent what is likely to be the quietest time of night.

5.2 Instrumentation

Instrumentation used was a Rion NL-52. This is a precision grade sound level meter which holds a current calibration certificate and which was field-calibrated as necessary. The meter was set up to measure consecutive 5 minute samples in terms of dB L_{eq}, dB L_{max} and dB L₉₀ in overall A-weighted terms, and in octave bands across the frequency range. See Definition of Acoustic Terms in Appendix 1.

5.3 Measurement Positions

The main measurement position was as shown on the following plan.



The measurement position was chosen to represent the most sheltered residential locations.

The microphone was 1.5 m above ground and well away from other reflecting surfaces.

5.4 Survey Conditions

Weather conditions were as follows :-

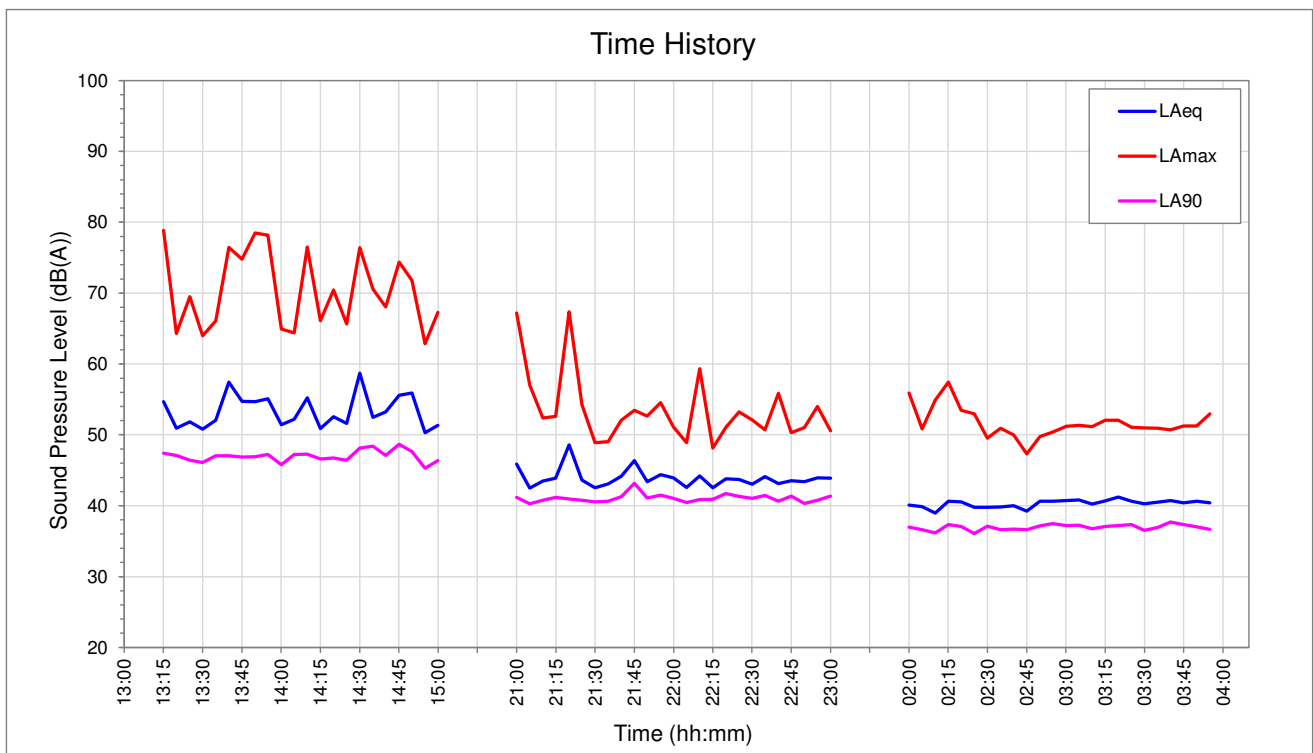
Rain	:	none, dry roads
Cloud	:	10%
Temperature	:	4 to 11 Celsius
Wind	:	less than 5m/s, plus occasional gusts above this.

6.0 RESULTS AND DISCUSSIONS

The general noise climate during the day was dominated by local traffic, and industrial estate activity, including fork lift trucks and reversing alarms. During the night the traffic was less and the industrial estate generally more audible.

6.1 Existing Noise Levels

Results of existing noise measurements are presented graphically as follows:-



A summary of the lowest 15 minute periods (lowest in terms of the dB LA90 index) is as follows:-

<i>Lowest 15 Minute Period</i>	<i>Index</i>	<i>dB(A)</i>
Daytime	Leq	52
	Lmax	67
	L90	47
Evening	Leq	44
	Lmax	63
	L90	41
Night Time	Leq	40
	Lmax	54
	L90	37

Very importantly, BS 4142 does not require the lowest measurements to be used as the representative Background Sound Level. However, we have used the lowest here as a means of assuming a worst case, for instance to mitigate for variations on different days.

Also, of vital importance is that these background levels are based on the climate at the time (beginning of March 2021) which will inevitably have been affected by the coronavirus restrictions. However, it is almost certain that any difference would be to *reduce* the noise climate which would make for a *more* robust assessment.

6.2 Impact of Proposed Units

The CadnaA software was used to model the potential impact of the units as described in Section 4.

The model is based on all units running throughout the day, evening and night.

The first image below shows the overall view of the site and nearest residential locations. Note that:-

- The beige shapes are proposed units and surrounding buildings.
- The contours are shown for guidance as to how the noise propagates. Key contours are labelled and show the noise levels from the proposed site in dB L_{Aeq}.
- The magenta lines are fences around the residential gardens

The second image is a zoomed in view of the houses. Note that:-

- The numbers in the coloured circles are the façade noise levels from the proposed site.
- The software automatically selects the noisiest floor level.



6.3 Assessments

For the assessment of proposed noise, BS 4142 requires us to assess the predicted industrial noise against the “background sound level” which is the noise climate without development described in terms of the underlying dB L_{A90} index. This is established in 6.1 above.

The noisiest positions in terms of proposed impact is 41 dB L_{Aeq}. It will be almost exclusively a daytime impact but late evening and night time are also shown for completeness, with *context* being a crucial consideration.

The BS 4142 assessments are as follows:-

Daytime

Specific Sound Level:	41 dB L _{Aeq}
Feature Corrections – footnote ¹ below	
tonality:	0 dB L _{Aeq}
impulsivity:	0 dB L _{Aeq}
intermittency:	0 dB L _{Aeq}
other:	0 dB L _{Aeq}
Rating Level:	41 dB L _{Ar}
Background Sound Level:	47 dB L _{A90}
Rating Level Excess re. Background	-6 dB

This well below what BS 4142 rates as “*low impact depending on the context*”. The context is an established industrial area with infrequent operation of the proposed site (1500 hours per year). The impact is expected to be negligible.

Evening

Specific Sound Level:	41 dB L _{Aeq}
Feature Corrections – footnote ¹ below	
tonality:	0 dB L _{Aeq}
impulsivity:	0 dB L _{Aeq}
intermittency:	0 dB L _{Aeq}
other:	0 dB L _{Aeq}
Rating Level:	41 dB L _{Ar}
Background Sound Level:	41 dB L _{A90}
Rating Level Excess re. Background	0 dB

This is right on what BS 4142 rates as “*low impact depending on the context*”. The context is an established industrial area with infrequent operation of the proposed site (1500 hours per year). It is also highly unlikely that the site will run beyond 19:00 and less likely still that it will

¹ The noise is clearly not impulsive tonal or intermittent. Therefore, none of the main character/feature corrections apply. It is possible that, at the quietest times on night (in the highly unlikely event that it runs at night), the site may be audible, but characteristic are unlikely to be “*readily distinctive against the residual acoustic environment*”. See BS 4142, section 9.2 commentary.

run up to the latest times of the evening. We would suggest that the impact will be very low.

Night Time

Specific Sound Level:	41 dB LAeq
Feature Corrections ¹	
tonality:	0 dB LAeq
impulsivity:	0 dB LAeq
intermittency:	0 dB LAeq
other:	0 dB LAeq
Rating Level:	41 dB LAr
Background Sound Level:	37 dB LA90
Rating Level Excess re. Background	+4 dB

This is above what BS 4142 rates as “*low impact depending on the context*” but just below “*adverse impact depending on the context*”. The context is an established industrial area with infrequent operation of the proposed site (1500 hours per year). It is also highly unlikely that the site will run beyond 19:00 and more or less a certainty that it will not run up into the small hours of the night. We would suggest that the impact will be very low.

6.4 Mitigation

There should be no need for any physical mitigation.

6.5 Discussion of Uncertainty

BS 4142 requires us to

“Consider the level of uncertainty in the data and associated calculations. Where the level of uncertainty could affect the conclusion, take reasonably practicable steps to reduce the level of uncertainty”.

The main uncertainty is the existing noise climate which will inevitably be affected by the current coronavirus lockdown. The uncertainty, however, would be almost certain to make the assessment *more* robust, especially during the evening and night.

The measurements of Background/Residual Sound were taken at times regarded as representing what are likely to be the worst case (quietest) time of the day or night. BS 4142 does not state what would be a representative background noise but there is certainly no suggestion that it should be lowest. However, in order to allow for the possibility of variation in levels, we have used the lowest 15minute periods for daytime, evening and night time.

Source data is likely to be variable but we understand that the suppliers have committed to a level of 75 dB(A) at 1m all around. From our experience of numerous similar installations, this should be readily achievable.

Calculations are based on the processes of *ISO 9613 : Acoustics – Attenuation of sound during propagation outdoors*. We know of no concerns within our industry as to the basic reliability of these methods and it is cited in BS 4142 as “*a validated method of calculating sound levels*”. The CadnaA software uses this standard and the input assumptions err on the side of caution and are stated in Section 4.

Varying meteorological conditions are unlikely to have an impact on results. Note, however, that there was no significant wind during our survey of background noise, but ISO 9613 assumes an unfavourable wind, so the calculations should be robust.

7.0 CONCLUSIONS/RECOMMENDATIONS

The proposed units have all been modelled and are likely to be below what BS 4142 would rate as “*low impact depending on the context*”. in all normal circumstance. The context is an established industrial estate and, most importantly, the proposed site is for peak demand only (1500 hours per year, nearly always 07:00 to 19:00) and we would suggest that the impact would generally be negligible. It is extremely unlikely that the site would run into the late evening and more or less a certainty that it would run through the night. On this basis the impact can also be considered very low.

Not physical mitigation is proposed.

Our only recommendation is that you issue this report to Planners and/or your client invite them to contact us directly with any queries.

Appendix 1

Definition of Acoustic Terms

The Decibel

The decibel is the basic unit of noise measurement and is denoted dB. Technically, it is a means of expressing the difference in noise level between the measured noise and a standard level of noise. Most often the threshold of human hearing is used as the standard reference but it really should be stated. The threshold of human hearing is a sound pressure of 20 μ Pa or a sound power of 1pW.

A sound pressure level or SPL should be expressed in dB(re. 20 μ Pa). A sound power level or SWL should be expressed in dB(re. 1pW). If the reference levels are omitted, it will often (but not always) be safe to assume that they are referenced to the threshold of human hearing.

A-Weighting and dB(A)

The human hearing system responds differently to different frequencies. The A-weighting system takes account of this by emphasising mid and high frequencies more than low frequencies to give an overall level. An A-Weighted noise level, therefore, reflects the way normal, healthy hearing would perceive the overall level of the noise. The basic unit is dB(A), although other systems of expressing an A-weighted levels are discussed below.

Other weighting systems, such as C-Weighting, denoted dB(C), reflect the human hearing system's response at higher noise levels.

NR and NC Levels

NR curves and NC curves are a series of curves representing noise levels across the frequency range. A given noise climate has an NR level or NC level if it equals a point on the curve at any frequency. They are particularly, although by no means exclusively, used as a means of specifying noise limits in an indoor environment, for instance from mechanical services or traffic noise break-in from the outside. They are typically expressed as NR or NC followed by a number, e.g. NR40, NC55, etc.

Equivalent Continuous Sound Level, L_{eq}

This can be simplistically described as a way of expressing the average noise level.

The unit is dB L_{eq} . For A-weighted levels the unit is dB(A) L_{eq} or, in more modern units, dB L_{Aeq} .

Maximum Level, $L_{\max}$

This is the maximum level reached (usually for a fraction of a second) in the measurement period.

The unit is dB $L_{\max}$. For A-weighted levels the unit is dB(A) $L_{\max}$ or, in more modern units, dB $L_{A\max}$.

Statistical (Percentile) Levels, L_n

During a measurement of fluctuating noise, it is often useful to establish the levels exceed for a percentage of the time. L_n is the index representing the level exceeded for $n\%$ of the measurement period.

The unit is dB L_n . For A-weighted levels, the unit is dB(A) L_n or, in more modern units, dB L_{An} .

Common examples are as follows :-

dB L_{A90} is the A-weighted level exceeded for 90% of the time and is often used to describe the underlying background noise.

dB L_{A50} is the A-weighted level exceeded for 50% of the time. Mathematically, it is the median, another kind of average.

dB L_{A10} is the A-weighted level exceeded for 10% of the time and has traditionally been used to describe the intermittent highs in the noise climate such as passing cars or aircraft.

Frequency Analysis

Here the audible frequency range is divided up into bands and the noise level is expressed in each frequency band from low pitches to high pitches.

Octave Band analysis is where the frequency range is divided into 8 bands from 63 Hz to 8kHz, or sometimes into 10 bands from 31.5 Hz to 16kHz.

1/3 Octave Band analysis provides more detailed subdivision into 24 bands from 50 Hz to 10kHz, or sometimes into 30 bands from 20Hz to 20kHz.

Narrow Band analysis takes this further with the possibility of many thousands of bands, possibly only 1Hz wide, or even less.

In all types of frequency analysis, the level in each band can be expressed in terms of L_{eq} , $L_{\max}$, L_n , etc. as defined above.

Sound Insulation

Sound insulation is best expressed across the frequency range in octave bands or third octave bands. Often, however, in known environments such as domestic sound insulation and speech privacy, it is simpler to express the sound insulation as a single figure. A higher value means better sound insulation.

The most common ways are dB D_{nTw} , dB R_w and dB_(mean 100-3150Hz). The first two are ways of expressing average sound insulation, weighted to account for speech frequencies. The third is simply an un-weighted mean value.

The Building Regulations Approved Document E (ADE) routinely refer to $D_{nTw} + C_{tr}$. The C_{tr} term is a negative number which is used to modify the D_{nTw} value for the insulation properties at lower frequencies.

ADE also uses the L_{nTw} index for impact sound transmission. It is a measure of the level of noise in the room below a room in which a standard tapping machine is being used. It represents the impact sound transfer such as footfall noise, scraping chairs, washing machines, etc. A lower value means better insulation.

Reverberation Time

The most common measure of Reverberation Time is, effectively the time taken for sound from a steady source to decay by 60 dB after it has been abruptly cut off. In practice it is often difficult to measure a 60 dB decay and so decays of 30 dB, 20 dB, or even 10 dB are often used and adjusted pro rata, although the exact measure is not quite the same.

Reverberation Time is generally expressed as RT in seconds. We may, if we are being precise, add subscripts 60, 30, etc to show whether the basis of the measure is 60 dB decay, 30 dB decay, etc. E.g. the $RT_{60} = 0.52s$, the $RT_{30} = 0.49s$, etc.

RT can be expressed in octave bands or 1/3 octave bands across the frequency range, or at central frequencies such as 500 Hz or 1kHz.

Appendix 2

Measurements in Full

<i>Time Period</i>	<i>Index</i>	<i>dB(A)</i>	63	125	250	500	1k	2k	4k	8k
13:15	Leq	55	69	57	52	54	50	42	35	29
	Lmax	79	76	65	74	80	74	64	50	50
	L90	47	63	52	46	44	43	37	32	22
13:20	Leq	51	67	56	50	48	46	40	34	28
	Lmax	64	74	63	63	63	60	52	50	40
	L90	47	61	54	46	44	42	37	30	21
13:25	Leq	52	63	55	52	48	48	41	35	34
	Lmax	69	71	69	76	66	61	51	48	54
	L90	46	59	51	46	43	42	36	29	21
13:30	Leq	51	68	55	50	46	47	40	32	24
	Lmax	64	74	62	61	60	62	52	44	43
	L90	46	63	51	45	42	42	36	29	20
13:35	Leq	52	69	56	51	48	47	41	40	34
	Lmax	66	74	73	63	65	59	53	56	50
	L90	47	64	53	46	43	42	37	30	21
13:40	Leq	57	68	55	51	53	53	46	51	43
	Lmax	76	73	69	65	69	73	65	70	62
	L90	47	64	52	46	43	43	38	31	23
13:45	Leq	55	69	55	50	46	46	41	51	46
	Lmax	75	76	65	61	60	62	59	73	63
	L90	47	64	52	46	43	42	37	30	22
13:50	Leq	55	69	57	51	51	51	44	44	40
	Lmax	78	75	69	69	74	77	64	65	59
	L90	47	64	53	46	43	42	36	31	22
13:55	Leq	55	68	57	51	51	52	46	39	33
	Lmax	78	78	71	65	75	76	69	60	52
	L90	47	59	53	47	44	43	37	30	21
14:00	Leq	51	67	55	51	47	47	40	41	36
	Lmax	65	74	68	63	60	61	53	56	51
	L90	46	62	52	46	42	41	35	32	21
14:05	Leq	52	69	55	51	48	48	41	41	35
	Lmax	64	76	68	62	60	60	54	55	50
	L90	47	64	52	47	44	43	37	30	21
14:10	Leq	55	66	59	54	51	51	46	43	37
	Lmax	76	76	81	75	72	72	69	66	61
	L90	47	60	53	47	44	43	37	30	21
14:15	Leq	51	62	56	51	47	47	40	34	26
	Lmax	66	71	71	63	62	63	52	53	41
	L90	47	59	52	47	43	42	37	30	21
14:20	Leq	53	63	56	51	48	48	45	40	33
	Lmax	70	77	75	72	63	65	63	57	53
	L90	47	59	52	46	43	42	38	31	21
14:25	Leq	52	67	55	51	47	47	41	42	37
	Lmax	66	79	70	67	61	60	55	56	51
	L90	46	60	52	46	43	42	37	32	21
14:30	Leq	59	73	60	54	55	55	50	45	38
	Lmax	76	83	71	66	71	74	68	59	52
	L90	48	65	53	46	45	43	38	33	23
14:35	Leq	52	70	56	51	49	48	43	37	29
	Lmax	71	78	78	70	70	65	58	53	45
	L90	48	65	52	46	45	44	38	32	23
14:40	Leq	53	71	56	52	50	48	43	37	29
	Lmax	68	76	67	66	63	66	58	54	48
	L90	47	63	52	46	43	43	37	31	22
14:45	Leq	56	69	57	53	51	52	47	43	33
	Lmax	74	79	74	71	69	71	67	64	51
	L90	49	64	53	47	45	45	39	32	22
14:50	Leq	56	65	57	53	53	52	46	42	33
	Lmax	72	77	73	67	69	68	63	55	48
	L90	48	60	52	48	44	43	39	33	23
14:55	Leq	50	62	54	50	46	47	40	34	27
	Lmax	63	70	62	64	58	59	49	55	41
	L90	45	57	50	45	42	41	35	29	20
15:00	Leq	51	61	54	49	46	48	44	37	28
	Lmax	67	66	62	59	61	63	63	54	46
	L90	46	58	51	46	43	42	36	30	21

Time Period	Index	dB(A)	63	125	250	500	1k	2k	4k	8k
21:00	Leq	46	55	49	44	41	44	35	22	17
	Lmax	67	76	70	63	59	66	56	42	39
	L90	41	52	46	42	38	37	29	16	14
21:05	Leq	42	54	48	44	39	39	31	19	14
	Lmax	57	67	59	59	54	53	41	28	22
	L90	40	52	46	42	37	36	27	16	14
21:10	Leq	43	55	48	44	39	40	33	19	14
	Lmax	52	66	55	54	51	46	41	29	21
	L90	41	52	46	42	38	37	28	16	14
21:15	Leq	44	56	49	44	40	41	32	19	14
	Lmax	53	68	58	52	48	49	40	32	28
	L90	41	53	46	42	38	37	27	16	14
21:20	Leq	49	57	50	47	44	46	39	28	19
	Lmax	67	70	64	61	61	66	58	47	37
	L90	41	53	46	42	38	37	27	16	14
21:25	Leq	44	55	48	43	39	41	32	18	14
	Lmax	54	67	55	50	53	51	42	31	24
	L90	41	52	46	41	37	37	28	16	14
21:30	Leq	43	54	47	44	39	39	30	18	14
	Lmax	49	60	52	48	44	47	37	26	23
	L90	41	51	45	42	37	37	27	15	14
21:35	Leq	43	55	48	44	39	40	31	18	14
	Lmax	49	64	52	48	44	46	38	29	24
	L90	41	52	46	42	38	36	28	16	14
21:40	Leq	44	55	48	44	40	41	33	19	14
	Lmax	52	66	56	48	49	49	40	32	20
	L90	41	52	46	43	38	37	29	16	14
21:45	Leq	46	56	49	45	41	44	36	22	15
	Lmax	53	66	57	52	46	51	44	35	30
	L90	43	53	47	43	39	40	31	18	14
21:50	Leq	43	56	50	44	40	39	32	18	14
	Lmax	53	68	66	47	47	44	38	29	24
	L90	41	52	47	43	38	37	28	16	14
21:55	Leq	44	56	50	44	40	41	34	20	14
	Lmax	55	63	68	51	47	48	44	35	30
	L90	41	53	46	43	38	38	29	16	14
22:00	Leq	44	55	49	44	41	40	32	20	14
	Lmax	51	64	58	49	49	46	41	30	22
	L90	41	51	46	43	39	37	28	16	14
22:05	Leq	43	53	47	44	39	39	32	18	14
	Lmax	49	61	51	47	43	45	42	30	22
	L90	40	51	46	42	38	36	27	16	14
22:10	Leq	44	55	50	44	40	41	33	20	14
	Lmax	59	68	69	54	46	57	49	36	21
	L90	41	51	46	43	38	37	28	16	14
22:15	Leq	43	54	48	44	39	39	30	18	14
	Lmax	48	60	53	48	44	43	36	39	24
	L90	41	51	47	43	38	37	27	16	14
22:20	Leq	44	55	49	45	40	40	32	20	14
	Lmax	51	64	54	50	44	48	41	33	21
	L90	42	53	47	43	39	37	29	17	14
22:25	Leq	44	55	49	45	40	40	33	19	14
	Lmax	53	70	62	52	49	48	42	34	29
	L90	41	53	47	43	39	37	28	17	14
22:30	Leq	43	55	49	44	40	39	32	19	14
	Lmax	52	62	57	49	46	44	49	34	23
	L90	41	52	47	43	38	36	28	17	14
22:35	Leq	44	55	48	45	40	41	33	20	14
	Lmax	51	66	53	50	45	47	41	29	23
	L90	41	52	46	43	39	37	29	17	14
22:40	Leq	43	55	49	45	40	39	31	20	14
	Lmax	56	70	56	50	50	54	42	32	18
	L90	41	51	47	43	38	35	27	16	14
22:45	Leq	44	55	49	44	40	40	33	20	14
	Lmax	50	64	54	49	47	46	40	33	24
	L90	41	52	47	43	39	37	30	18	14
22:50	Leq	43	55	48	44	40	40	33	19	14
	Lmax	51	63	53	48	49	47	42	32	27
	L90	40	52	46	42	38	35	28	16	14
22:55	Leq	44	56	49	44	40	40	33	27	23
	Lmax	54	68	58	53	48	48	46	44	40
	L90	41	52	46	42	38	36	28	18	14
23:00	Leq	44	55	49	44	40	40	33	29	26
	Lmax	51	63	55	50	45	45	42	41	38
	L90	41	52	47	43	38	37	29	23	20

<i>Time Period</i>	<i>Index</i>	<i>dB(A)</i>	63	125	250	500	1k	2k	4k	8k
02:00	Leq	40	53	47	41	36	36	30	20	15
	Lmax	56	66	58	52	52	54	43	35	27
	L90	37	50	44	39	34	32	25	17	15
02:05	Leq	40	53	46	40	36	36	29	19	15
	Lmax	51	62	52	46	49	46	42	33	33
	L90	37	50	44	38	33	32	25	16	14
02:10	Leq	39	52	46	40	35	35	27	17	14
	Lmax	55	64	61	60	49	50	37	25	24
	L90	36	49	43	38	33	31	24	15	14
02:15	Leq	41	53	47	41	36	37	31	21	15
	Lmax	57	62	52	48	52	56	42	33	23
	L90	37	49	44	39	34	33	26	17	14
02:20	Leq	41	53	46	40	37	36	30	21	15
	Lmax	53	65	52	46	53	48	44	36	38
	L90	37	50	43	38	34	32	26	17	14
02:25	Leq	40	54	47	41	35	35	29	19	15
	Lmax	53	69	56	51	46	51	40	32	21
	L90	36	49	44	39	32	30	24	16	15
02:30	Leq	40	52	47	41	35	35	30	18	15
	Lmax	50	66	59	49	41	45	40	32	24
	L90	37	49	44	39	33	32	25	16	14
02:35	Leq	40	55	47	41	36	35	28	19	15
	Lmax	51	68	55	51	50	44	36	27	24
	L90	37	51	43	39	33	31	24	16	15
02:40	Leq	40	53	46	42	36	36	29	19	15
	Lmax	50	64	56	50	42	47	39	27	25
	L90	37	49	44	39	33	31	25	16	14
02:45	Leq	39	50	46	42	35	34	28	17	14
	Lmax	47	56	51	53	40	40	35	34	26
	L90	37	48	44	40	33	31	25	16	14
02:50	Leq	41	51	47	42	37	36	29	18	15
	Lmax	50	61	56	54	44	44	38	33	26
	L90	37	48	44	40	33	32	26	16	14
02:55	Leq	41	52	47	42	36	36	29	26	22
	Lmax	50	62	53	51	42	43	40	45	38
	L90	37	49	44	40	34	32	26	17	14
03:00	Leq	41	50	47	42	36	35	29	30	25
	Lmax	51	60	51	52	45	45	40	45	40
	L90	37	48	44	40	34	32	26	16	14
03:05	Leq	41	50	47	42	36	36	30	30	26
	Lmax	51	57	52	51	43	44	40	46	41
	L90	37	48	45	40	34	32	26	16	14
03:10	Leq	40	50	47	42	35	35	29	30	26
	Lmax	51	57	52	50	43	44	40	46	40
	L90	37	48	44	39	33	31	25	16	14
03:15	Leq	41	51	47	42	36	35	29	30	25
	Lmax	52	60	52	52	44	46	41	47	40
	L90	37	48	44	40	33	32	25	16	14
03:20	Leq	41	52	47	43	37	36	30	30	26
	Lmax	52	61	54	53	47	44	40	47	40
	L90	37	49	44	40	34	32	26	17	14
03:25	Leq	41	51	47	42	36	35	30	30	26
	Lmax	51	59	53	51	43	44	41	46	41
	L90	37	49	44	40	34	32	26	16	14
03:30	Leq	40	51	46	42	35	35	29	30	26
	Lmax	51	59	53	51	41	42	39	47	42
	L90	37	48	44	39	33	31	25	16	14
03:35	Leq	40	51	46	42	36	35	30	30	26
	Lmax	51	60	51	50	41	43	41	46	41
	L90	37	48	44	40	33	31	25	16	14
03:40	Leq	41	51	47	43	36	35	30	30	26
	Lmax	51	58	52	51	40	41	42	46	40
	L90	38	48	45	40	34	32	26	17	14
03:45	Leq	40	51	47	42	35	35	30	30	27
	Lmax	51	58	52	51	41	41	41	47	41
	L90	37	48	45	40	34	32	26	17	14
03:50	Leq	41	52	47	42	36	35	30	31	27
	Lmax	51	60	52	49	43	41	43	47	42
	L90	37	49	44	39	33	32	25	16	14
03:55	Leq	40	51	46	41	36	35	30	31	27
	Lmax	53	60	55	53	50	44	41	47	41
	L90	37	49	44	39	33	31	25	17	14

<i>Lowest 15 Minute Period</i>	<i>Index</i>	<i>dB(A)</i>	<i>63</i>	<i>125</i>	<i>250</i>	<i>500</i>	<i>1k</i>	<i>2k</i>	<i>4k</i>	<i>8k</i>
Daytime	Leq	52	67	55	51	48	47	41	37	32
	Lmax	67	73	70	71	64	61	52	52	51
	L90	47	63	52	46	43	42	36	29	21
Evening	Leq	44	55	48	44	40	41	33	21	15
	Lmax	63	72	66	60	56	61	52	38	34
	L90	41	52	46	42	38	37	28	16	14
Night Time	Leq	40	53	46	41	36	35	29	19	15
	Lmax	54	65	58	56	50	51	41	32	29
	L90	37	49	44	38	33	31	25	16	14

Appendix 3

Calibration of a Unit to 75 dB(A) at 1m

