

SHARPS REDMORE

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Report (Rev 2)

Noise Assessment

Plant associated with Kent
Police, Thames Way,
Northfleet

Prepared by

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Project No 2422382

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Contents

- 1.0 Introduction
- 2.0 Assessment Methodology and Criteria
- 3.0 Noise Survey Details
- 4.0 Noise Assessment
- 5.0 Assessment Conclusions

Appendices

- A. Noise Survey Results
- B. Noise Model Input Data
- C. Predicted Noise Level Summary – Day and Night-time
- D. Acoustic Terms

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1.0 Introduction

- 1.1 Sharps Redmore (SR) has been instructed to undertake a noise survey for proposed heating/cooling plant to serve the Kent Police, Thames Way, Northfleet, Gravesend DA11 8BD.
- 1.2 The proposal is for the installation of 4x air source heat pumps (ASHPs) on a new plant deck within the existing car park at Kent Police.
- 1.3 The objective of the assessment is to determine how noise generated from the fixed plant would affect nearby noise sensitive receptors.
- 1.4 Section 2 contains a discussion of the available methods of assessment and assessment criteria.
- 1.5 Section 3 of this report presents details of the environmental noise survey undertaken at the site.
- 1.6 Section 4 details the plant noise assessment.
- 1.7 The assessment conclusions are contained in Section 5.
- 1.8 A guide to the acoustic terminology used within the report is included in Appendix D.

2.0 Assessment Methodology and Criteria

National Planning Policy Framework (NPPF)

- 2.1 The National Planning Policy Framework (NPPF), December 2023, sets out the Government's planning policies for England and "these policies articulate the Government's vision of sustainable development." In respect of noise, Paragraph 191 of the NPPF states the following:

"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;*
- 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".*

- 2.2 Guidance on the interpretation of the policy aims contained within the NPPF is contained within National Planning Policy Guidance (NPPG). The NPPG introduces the concept of a noise exposure hierarchy based on likely average response. The guidance contained in the NPPG is summarised in the table below:

TABLE 2.1: Noise Exposure Hierarchy

Response	Examples of Outcomes	Increasing Effect Level	Action
No Observed Effect Level			
Not noticeable	No Effect	No Observed Effect	No specific measures required
No Observed Adverse Effect Level			
Present and not intrusive	Noise can be heard, but does not cause any change in behaviour, attitude or other physiological response. Can slightly affect the acoustic character of the area but not such that there is a change in the quality of life.	No Observed Adverse Effect	No specific measures required
Lowest Observed Adverse Effect Level			
Present and intrusive	Noise can be heard and causes small changes in behaviour, attitude or other physiological response, 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 small actual or perceived change in the quality of life.	Observed Adverse Effect	Mitigate and reduce to a minimum
Significant Observed Adverse Effect Level			
Present and disruptive	The noise causes a material change in behaviour, attitude or other physiological response, 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
Present and very disruptive	Extensive and regular changes in behaviour, attitude or other physiological response and/or an inability to mitigate effect of noise leading to psychological stress, e.g. regular sleep deprivation/awakening; loss of appetite, significant, medically definable harm, e.g. auditory and non-auditory	Unacceptable Adverse Effect	Prevent

2.3 The NPPF and NPPG reinforce the March 2010 DEFRA publication, “Noise Policy Statement for England” (NPSE), which states three policy aims, as follows:

“Through the effective management and control of environmental, neighbour and neighbourhood noise within the context of Government policy on sustainable development:

- *avoid significant adverse impacts on health and quality of life;*
- *mitigate and minimise adverse impacts on health and quality of life; and*
- *where possible, contribute to the improvement of health and quality of life.”*

- 2.4 Together, the first two aims require that no significant adverse impact should occur and that, where a noise level which falls between a level which represents the lowest observable adverse effect and a level which represents a significant observed adverse effect, then according to the explanatory notes in the statement:

“... all reasonable steps should be taken to mitigate and minimise adverse effects on health and quality of life whilst also taking into consideration the guiding principles of sustainable development. This does not mean that such effects cannot occur.”

- 2.5 Taking an overview of national policy aims and guidance it is clear that when considering the impact of noise that the fact can be heard and causes impact, is not reason to refusal an application as consideration should also be given to the significance of the impact and the mitigation measures available.

- 2.6 It is possible to apply objective standards to the assessment of noise and the effect produced by the introduction of a certain noise source may be determined by several methods, as follows:

- i) The effect may be determined by reference to guideline noise values, such as those contained in the World Health Organisation (WHO) *“Guidelines for Community Noise”*.
- ii) Alternatively, the impact may be determined by considering the change in noise level that would result from the proposal, in an appropriate noise index for the characteristic of the noise in question. There are various criteria linking change in noise level to effect. This is the method that is suited to, for example, the assessment of noise from road traffic because it is capable of displaying impact to all properties adjacent to a road link irrespective of their distance from the road.
- iii) Another method is described within BS 4142:2014 to determine the significance of sound impact from sources of industrial and/or commercial nature. The sources that the newly revised standard is intended to assess are sound from industrial and manufacturing processes, sound from fixed plant installations, sound from loading and unloading of goods at industrial and/or commercial premises and the sound from mobile plant and vehicles, such as forklift, train or ship movements.

Assessment Using BS 4142:2014+A1:2019 (BS 4142)

- 2.7 As outlined, this British Standard enables the significance of sound impact to be determined in relation to industrial and commercial sources. The significance of sound impact is to be determined according to the following summary process:

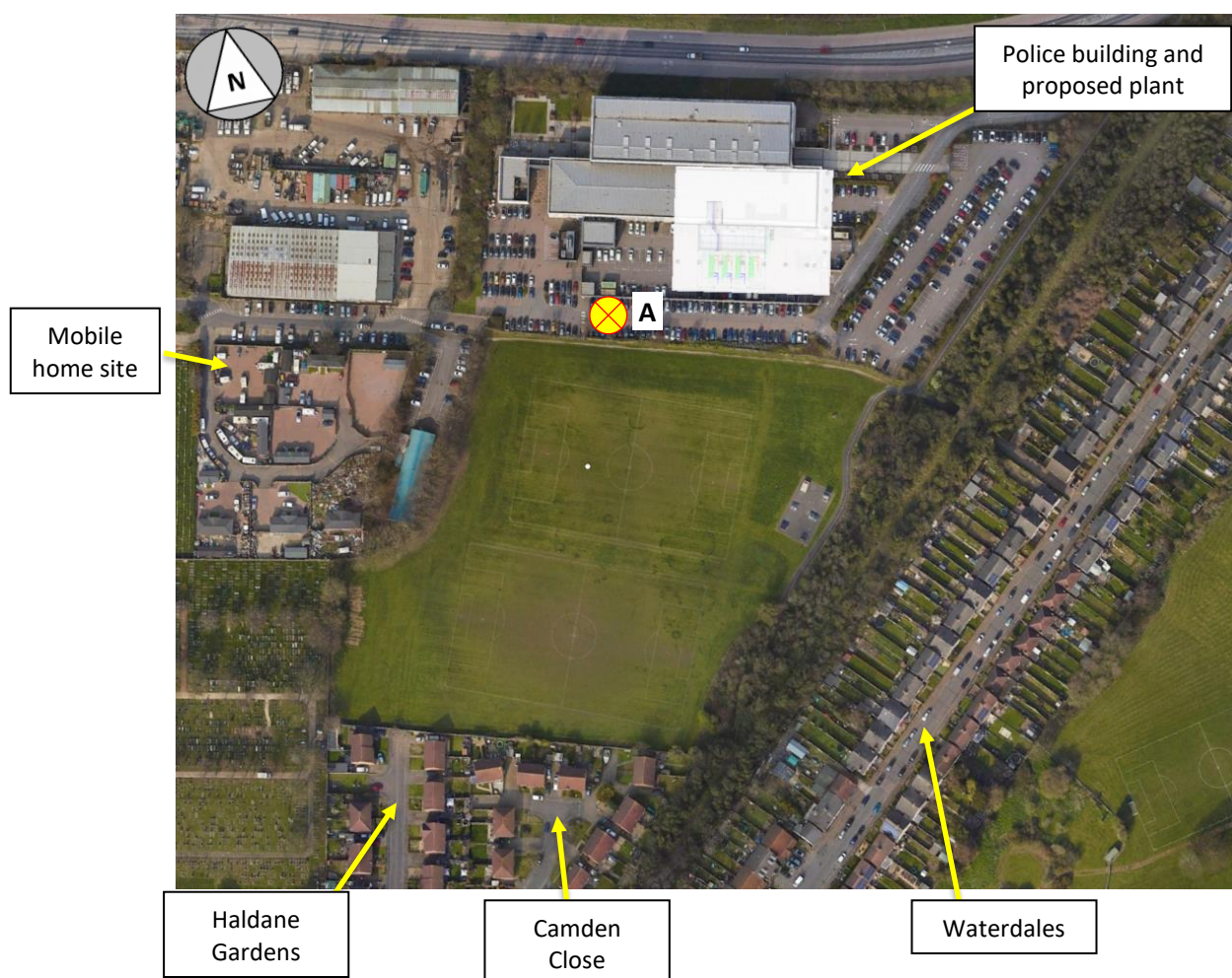
- i) Determine the background sound levels, in terms of the index L_{A90} , at the receptor locations of interest.
- ii) Determine the specific sound level of the source being assessed, in terms of its L_{AeqT} level ($T = 1$ hour for day or 15 minutes for night), at the receptor location of interest.
- iii) Apply a rating level acoustic feature correction if the source sound has tonal, impulsive, intermittent, or other characteristics which attract attention.
- iv) Compare the rating sound level with the background sound level; the greater the difference between the two, the higher the likelihood of adverse impact.

- v) A difference (rating – background) of around +10 dB is an indication of significant adverse impact, depending on the context; a difference of +5 dB is 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 upon context.
 - vi) The intent of the planning system is to ensure that a development does not result in “significant adverse impacts on health and quality of life.” BS 4142 considers that the threshold of significant adverse impact is “a difference around +10 dB or more ... depending upon the context”. However, the NPPF and NPPG state that where a noise level which falls between a level which represents the lowest observable adverse effect and a level which represents a significant observed adverse effect, then according to the explanatory notes in the statement “*...all reasonable steps should be taken to mitigate and minimise adverse effects in health and quality of life while together taking into account the guiding principles of sustainable development. This does not mean that adverse effects cannot occur but that effort should be focused on minimising such effects*”.
- 2.8 BS 4142 introduces the concept of ‘context’ to the process of identifying noise impact. Section 11 of BS 4142 explains “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 (our emphasis). 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” (our emphasis).
- 2.9 There are many *context* points to consider when undertaking an assessment of sound impact including:
- The absolute level of sound;
 - The character and level of the specific sound in the context of the existing noise climate; for example, is the sound to occur in a location already characterised by similar activities as those proposed?
 - The sensitivity of the receptors;
 - The time and duration that the specific sound is to occur;
 - The conclusions of assessments undertaken using alternative assessment methods, for example WHO guidelines noise values or change in noise level;
- 2.10 It is therefore entirely possible that whilst the numerical outcome of a BS 4142 assessment is indicative of adverse or significant adverse impact, when the proposal is considered in *context* the significance of the impact is reduced to an acceptable level.
- 2.11 Based on the guidance available, the noise assessment will be undertaken in accordance with BS 4142:2014+A1:2019.

3.0 Noise Survey Details

- 3.1 A noise survey was undertaken between 11:45 hours on Thursday 6th and 11:30 hours on Friday 7th June 2024. Attended and unattended measurements were taken at two locations around the site. Unattended measurements were taken at approximately 2m above local ground level within the secure car park of the police site (Location A). The meter was set to record noise levels in 15-minute periods. Attended measurements were taken at nearby houses on Haldane Gardens (Location B) throughout the day and night-time. The meter was set to record noise levels in 5-minute periods. Location B was chosen to be repetitive of the nearest noise sensitive properties along Haldane Gardens, Camden Close, Waterdales and the mobile home site along Springhead Road. The measurement locations are shown in Figure 3.1 below.

FIGURE 3.1: Measurement locations.



- 3.2 Noise levels were recorded using two Norsonic 140 Class 1 sound level meters which were calibrated before and after the survey with no drift in accuracy found in either meter. Weather conditions throughout the noise survey were suitable for taking noise measurements being dry with calm wind conditions.
- 3.3 Table 3.1 below presents the attended measurements.

TABLE 3.1: Attended noise measurements

Start Time (hours)	Noise Level (dB)	
	L _{Aeq,5min}	L _{A90,5min}
13:00	47	45
13:05	52	44
13:10	47	45
13:15	50	48
13:20	48	46
13:25	49	47
13:30	48	46
13:35	50	47
13:40	50	46
13:45	48	44
13:50	47	45
13:55	48	45
14:00	46	45
14:05	47	44
14:10	46	44
14:15	49	46
14:20	49	47
14:25	51	48
14:30	50	48
14:35	48	47
14:40	50	48
14:45	50	47
Late daytime		
22:03	49	48
22:05	49	47
22:10	49	47
22:15	49	47
22:20	49	48
22:25	49	48
22:30	49	47
22:35	48	47
22:40	49	48
22:45	49	48
22:50	49	47
Night-time		
01:04	47	45
01:05	46	44
01:10	47	45
01:15	46	45
01:20	46	45

- 3.4 The attended noise levels were similar to those from the unattended measurements. Table 3.2 below presents a summary of the noise levels obtained. See Appendix A for a graph of results from the unattended measurements.

TABLE 3.2: Summary of noise results – 6th to 7th June 2024 – attended and unattended

Period	Noise Level (dB)	
	Ambient ($L_{Aeq,T}$)	Background ($L_{A90,T}$)
Daytime (0700-2300)	49	46
Night-time (2300-0700)	46	44

3.5 Noise levels were dominated by road traffic both local and distant.

4.0 Noise Assessment

- 4.1 The objective assessment of plant sound sources in commercial premises is typically undertaken in accordance with British Standard 4142:2014+A1:2019. This Standard enables the resultant sound levels from new plant equipment to be compared against the existing typical background sound level (L_{A90}) of an area to establish the significance of the sound impact.
- 4.2 In terms of seeking to set appropriate plant rating sound limits for residential receptors, the advice in BS 4142:2014 is that *“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 of having a low impact, depending on the context”* (clause 11, note ‘d’).
- 4.3 The following table summarises the mechanical services plant equipment source noise levels.

TABLE 4.1: Plant schedule source noise levels

Description	Octave band (Hz) sound power levels [dB L _w]							
	63	125	250	500	1K	2K	4K	8K
Omicron units (x4)	98	87	87	94	89	87	82	80

- 4.4 SR uses an environmental noise modelling software package called ‘NoysPlot’. This software enables coordinates to be entered for the relative positions of noise sources, receivers and barriers to calculate a resultant noise level at a given noise receptor. The software carries out ‘text book’ atmospheric side calculations with regard to distance and screening attenuation by referencing relative source and receiver positions.
- 4.5 The noise levels presented in Table 4.2 are for the whole units, but in the noise model, the noise data has been input as a sound power level per pairs of fans for each unit, to ensure a robust scenario.
- 4.6 The plant has been selected on a N+1 scenario. Therefore, only 3No units will ever run at once. There is no specific unit which is designated as the back-up. The units rotate in operation regularly to ensure even wear on the units. The model presented in Appendix B is based on 2x omicron units and 1x Tetris unit running, however, other combinations of plant have also been tested to ensure different scenarios can meet the criteria.
- 4.7 Since building is in use 24/7, 3no. of the units have been modelled to operate all of the time.
- 4.8 The schedule of source noise data produced by the noise model is presented in Appendix B.
- 4.9 The height coordinates (‘z’) used in the ‘NoysPlot’ model have been taken from the Avison Young drawings. The horizontal coordinates are referenced from an arbitrary ‘x’, ‘y’ position on a grid system. The relative heights are described below, all above ‘0’ line representing local ground level:
- 8.8m – Louvre
 - 8.5m – Plant
 - 5.3m – plant deck bottom of structure
 - 5.8m – plant deck floor
 - 2.0m – Mobile home
 - 4.5m – All other residential

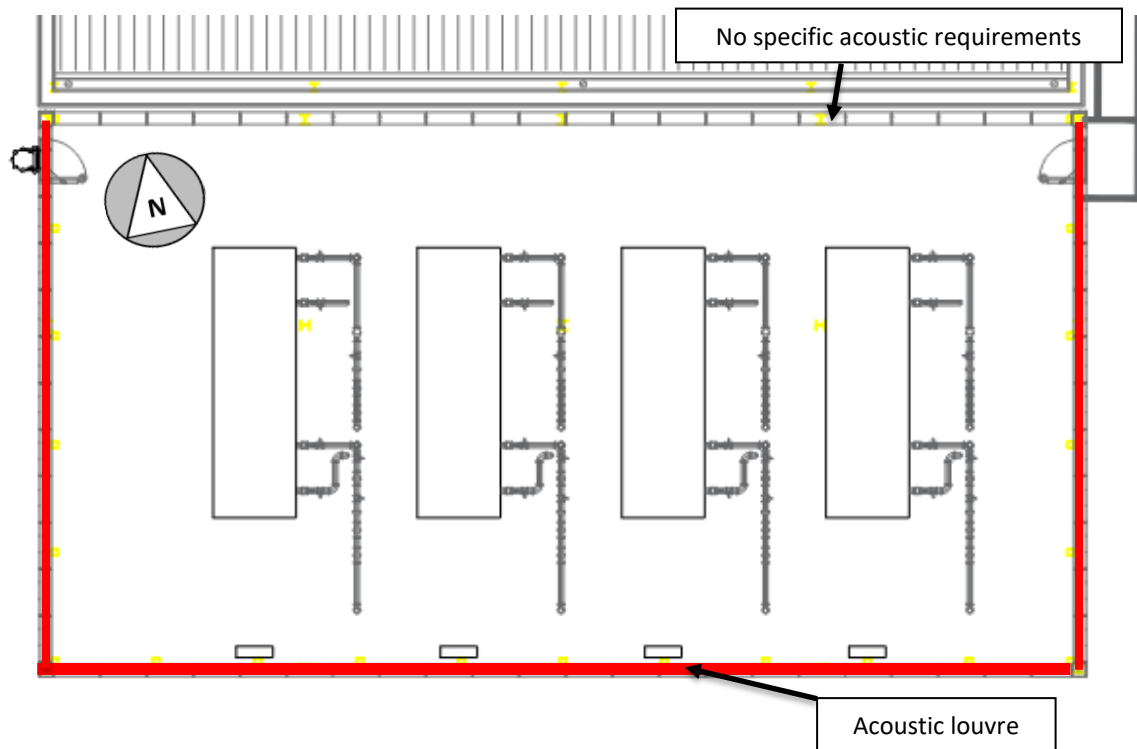
- 4.10 NoysPlot uses operating time information to calculate noise levels for daytime and night time operation. The time period that the equipment is assumed to be operating is denoted by 'D' to indicate daytime only operation; 'N' to denote night time usage and 'A' to indicate that the equipment runs all the time. As explained previously, 3no. of the plant equipment would operate all of the time. A rating level correction of 3 dB for each unit, in accordance with BS 4142 for noticeable acoustic characteristic at the receptor locations.
- 4.11 NoysPlot has the capability to accept input noise data in a number of formats. Where available, the ventilation plant manufacturer's sound power level data (designated by the letter W in the L_p/L_w column of the input schedule) is used. Where the sound power level data is not available the manufacturer's un-weighted octave band sound pressure levels at a stated distance are used (designated P but with an N in the dBA column of the schedule to indicate un-weighted). Alternatively, measured or manufacturer's A-weighted, single figure, averaged level at the stated distance is used (designated 'P' with 'Y' in the dBA column of the schedule). For this assessment octave band sound power levels have been used.
- 4.12 The surface directivity is also assessed for all cases – this depends on the number of adjacent reflective surfaces – the number can be seen in the column headed Q in the input schedule.
- 4.13 Summaries of the atmospheric noise calculations for daytime are displayed in Appendix C. Calculations for each source to receiver can be made available upon request. These calculations take into account the attenuation afforded by distance, outlet reflection, angular and surface directivity and acoustic screening. The software maintains a logarithmic summation for each receiver position and ranks the individual noise sources in order of contribution to the overall noise level (highest at the top of the list). This assists with the identification of those noise sources requiring additional noise control.
- 4.14 The input data defining the locations of the noise sources, the receivers and screening are shown in Appendix B. The NoysPlot noise model principally considers two noise barrier types; the barrier descriptor 'R' is used in the schedule to denote a ring type whereby only noise transmitted over the top of the barrier is considered; whilst noise barriers denoted 'F' for finite consider noise transmitted over the top and around the ends of the barrier. 'F1' combines the properties of 'F' with a user defined acoustic louvre performance. This assessment models the proposed plant deck floor as a ring barrier, whilst screening as a finite barriers.
- 4.15 The NoysPlot calculation (see Appendix C) shows the following resultant plant noise levels:

TABLE 4.2: Summary of predicted plant rating noise levels

Location	Predicted dB L _{Aeq}	Daytime (0700-2300)		Predicted dB L _{Aeq}	Night (2300-0700)	
		Background dB L _{A90}	Difference (dB)		Background dB L _{A90}	Difference (dB)
Mobile home site	44	46	-2	44	44	0
(83A) Waterdales	44		-2	44		0
(28) Haldane Gardens	42		-4	42		-2
(40) Camden Close	42		-4	42		-2

4.16 The above predicted noise levels are achieved by applying attenuation in the form of acoustic louvres around the units, as illustrated in the Figure 4.1 below. The top of the acoustic louvres will need to be 8.8m above local ground level which equates to 3m above the plant deck floor and 0.3m above the plant.

FIGURE 4.1: Screening diagram



4.17 The acoustic louvres are required to have the following minimum performance.

TABLE 4.3: Acoustic louvre performance

Mid frequency octave bands (Hz)							
63	125	250	500	1K	2K	4K	8K
6	7	10	18	31	28	26	25

- 4.18 The predicted rating noise levels are at least 2 dB below the daytime background noise level and are matching or below the night time background noise level. In terms of an assessment in accordance with BS 4142, this situation, where plant rating noise levels are well below the background sound level, is indicative of low impact, depending upon context.

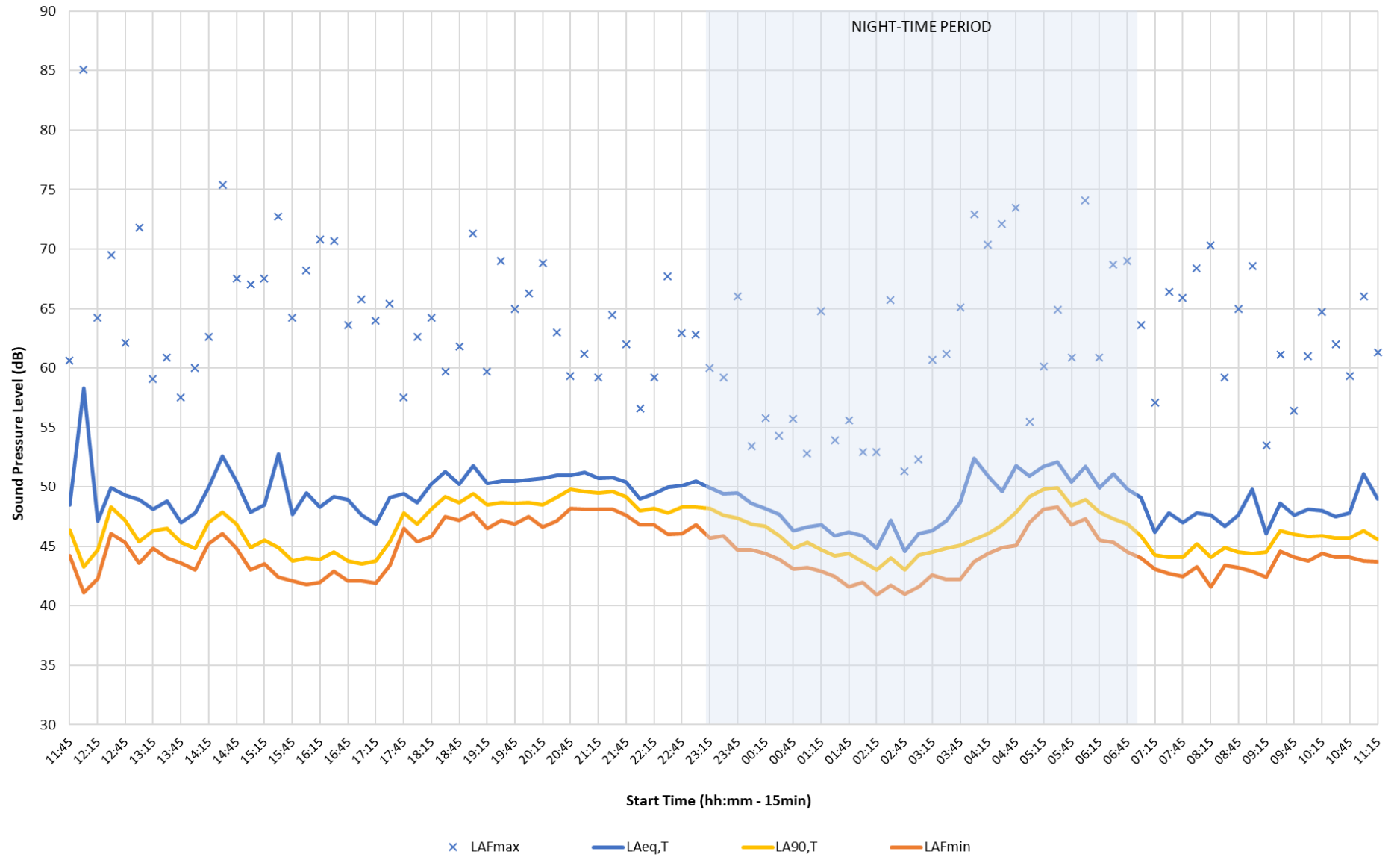
5.0 Assessment Conclusions

- 5.1 This assessment has been undertaken in accordance with BS 4142:2014+A1:2019 “Methods for rating and assessing industrial and commercial sound.”
- 5.2 Based on the proposed plant selections and installation location, the predicted noise from the plant does not exceed the background noise climate during the day or night. Based on the guidance in BS 4142, this is considered to be a low impact.
- 5.3 This assessment objectively demonstrates that noise arising from the fixed plant complies with the requirement of paragraph 191 of the NPPF to avoid significant adverse impact.

APPENDIX A

NOISE SURVEY RESULTS

Kent Police HQ, car park south-west. Thursday 6th to Friday 7th June 2024.



APPENDIX B

NOISE MODEL INPUT DATA

Client:				Appendix B Page: 1 of 1							
Project: Kent Police HQ				Project no: 2422382							
Consultant: HKW				Date: 20 August 2024							
Sound power levels (Lw) & sound pressure levels (Lp) for fans & other equipment											
Equipment name/reference	Lw/ Lp	Dist. (m)	On time D/N/A	Mid-frequency Octave Bands (Hz)							
				63	125	250	500	1k	2k	4k	8k
Plant - 1 - Omicron	Lw		A	98	87	87	94	89	87	82	80
Plant - 2 - Omicron	Lw		A	98	87	87	94	89	87	82	80
Plant - 3 - Omicron	Lw		A	98	87	87	94	89	87	82	80
Plant - 4 - Omicron	Lw		D	98	87	87	94	89	87	82	80
Notes: 1. Lw/Lp Lw means sound power level (dB) Lp means sound pressure level at the stated distance (dB@m) 2. On times (On.time D/N/A): D (Day) means that the fan/equipment could operate at any time between 0700 and 2300 hours N (Night) means that the fan/equipment could operate at any time between 2300 and 0700 hours A (All) means that the fan/equipment could operate at any time during the day and night											

Appendix B: NoysPlot input data, source, receptor and barrier data

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Filename: P:\24 - Projects\2422382 Kent Police HQ-MOT\NoysPlot\120624_080824 update
 Date: 20 August 2024
 Entries by: HKW
 Project no: 2422382
 Project title: Kent Police HQ
 Client's name:

Map/plot details: Length: 3200
 Width: 3200
 Height: 250

Source data - description, co-ordinates, outlet size, percentage to atmosphere, directivity, sound levels and running period

Source description	Co-ordinates			Outlet details			%	Q	Run d/n/a	Lp/ Lw	dBA Y/N	Dist (m)	Noise level - Octave band centre frequency Hz							
	X m	Y m	Z m	Amm	Bmm	Ang.							63	125	250	500	1k	2k	4k	8k
Plant - 1 - Omicron	406.0	408.8	8.5	0	0	0	200	1	A	W	N	0.0	98	87	87	94	89	87	82	80
Plant - 2 - Omicron	411.5	408.8	8.5	0	0	0	200	1	A	W	N	0.0	98	87	87	94	89	87	82	80
Plant - 3 - Omicron	417.0	408.8	8.5	0	0	0	200	1	A	W	N	0.0	98	87	87	94	89	87	82	80
Plant - 4 - Omicron	422.5	408.8	8.5	0	0	0	200	1	D	W	N	0.0	98	87	87	94	89	87	82	80

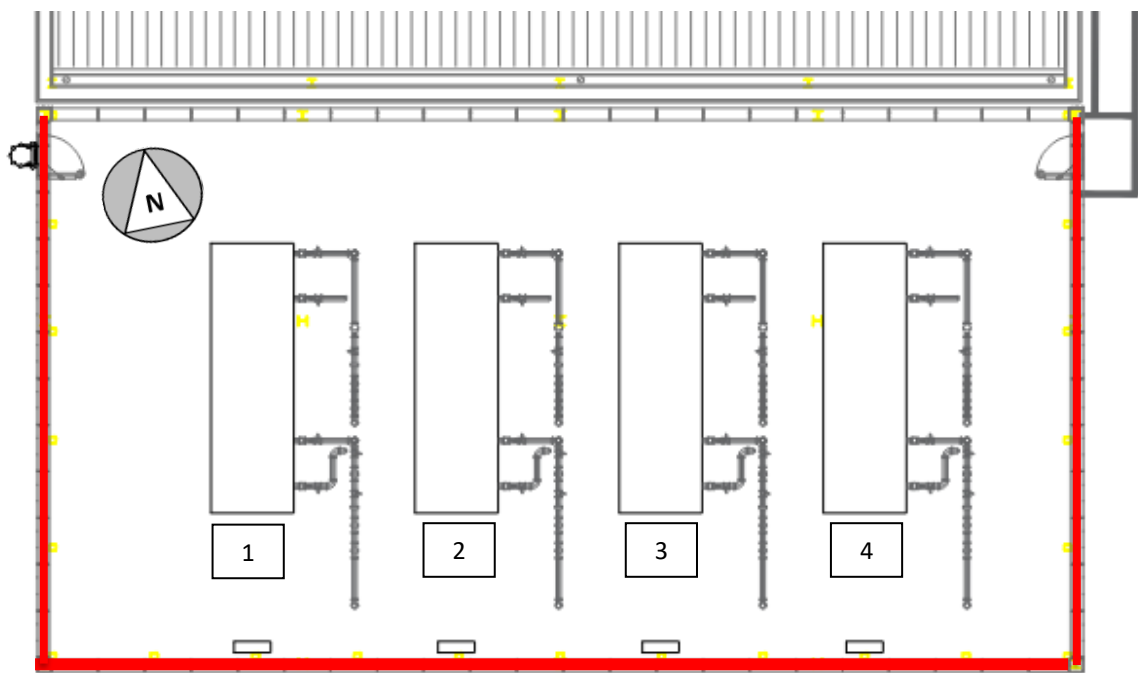
Receptor data - description and co-ordinates

Receptor description	Co-ordinates			DNA
	X m	Y m	Z m	
(40) Camden Close	384.3	207.9	4.5	A
(28) Haldane Gardens	297.7	208.4	4.5	A
(83A) Waterdales	545.0	330.6	4.5	A
Mobile home site	275.9	359.9	2.0	A

Barrier data - description and co-ordinates

Barrier description	Co-ordinates					
	Start			End		
	X m	Y m	Z m	X m	Y m	Z m
R	400.0	400.0	5.3	400.0	415.4	5.3
R	400.0	415.4	5.3	428.5	415.4	5.3
R	428.5	415.4	5.3	428.5	400.0	5.3
R	428.5	400.0	5.3	400.0	400.0	5.3
F1	400.0	400.0	8.8	400.0	415.4	8.8
F1	428.5	415.4	8.8	428.5	400.0	8.8
F1	428.5	400.0	8.8	400.0	400.0	8.8

Figure B1: Plant references



APPENDIX C

PREDICTED NOISE LEVEL SUMMARY – DAY AND NIGHT-TIME

Appendix C: Predicted night-time noise levels

Overall receptor listings

Period: Day and night-time

Overall daytime plant noise levels (dB)	Mid frequency octave bands (Hz)								
	63	125	250	500	1k	2k	4k	8k	dBA
(83A) Waterdales	52	40	39	44	38	34	27	22	44
Mobile home site	53	41	40	44	37	33	26	22	44
(40) Camden Close	50	38	37	42	36	32	25	21	42
(28) Haldane Gardens	49	38	37	42	36	32	25	21	42

Source noise levels at receiver: (40) Camden Close

Period: Day and night-time

Plant item	Mid frequency octave bands (Hz)								
	63	125	250	500	1k	2k	4k	8k	dBA
Plant - 3 - Omicron	45	33	32	37	31	27	20	16	37
Plant - 2 - Omicron	45	33	32	37	31	27	20	16	37
Plant - 1 - Omicron	45	33	32	37	31	27	20	16	37
Total Free field Lp and dBA	50	38	37	42	36	32	25	21	42

Source noise levels at receiver: (28) Haldane Gardens

Period: Day and night-time

Plant item	Mid frequency octave bands (Hz)								
	63	125	250	500	1k	2k	4k	8k	dBA
Plant - 1 - Omicron	45	34	33	38	32	28	21	17	38
Plant - 2 - Omicron	44	32	31	36	30	27	20	16	36
Plant - 3 - Omicron	44	32	31	36	30	27	20	16	36
Total Free field Lp and dBA	49	38	37	42	36	32	25	21	42

Source noise levels at receiver: (83A) Waterdales

Period: Day and night-time

Plant item	Mid frequency octave bands (Hz)								
	63	125	250	500	1k	2k	4k	8k	dBA
Plant - 1 - Omicron	47	35	34	39	33	29	22	18	39
Plant - 2 - Omicron	47	35	34	39	33	29	22	18	39
Plant - 3 - Omicron	47	35	34	39	33	29	22	17	39
Total Free field Lp and dBA	52	40	39	44	38	34	27	22	44

Source noise levels at receiver: Mobile home site

Period: Day and night-time

Plant item	Mid frequency octave bands (Hz)								
	63	125	250	500	1k	2k	4k	8k	dBA
Plant - 3 - Omicron	49	37	35	40	33	29	21	17	40
Plant - 2 - Omicron	48	37	35	40	33	29	21	17	39
Plant - 1 - Omicron	48	36	35	39	32	28	21	17	39
Total Free field Lp and dBA	53	41	40	44	37	33	26	22	44

APPENDIX D

ACOUSTIC TERMS

Acoustic Terminology

- 1 Noise, defined as unwanted sound, is measured in units of decibels, dB. The range of audible sounds is from 0 dB to 140 dB. Two equal sources of sound, if added together will result in an increase in level of 3 dB, i.e. 50 dB + 50 dB = 53 dB. Increases in continuous sound are perceived in the following manner:
 - 1 dB increase - barely perceptible.
 - 3 dB increase - just noticeable.
 - 10 dB increase - perceived as twice as loud.
- 2 Frequency (or pitch) of sound is measured in units of Hertz. 1 Hertz (Hz) = 1 cycle/second. The range of frequencies audible to the human ear is around 20Hz to 18000Hz (or 18kHz). The capability of a person to hear higher frequencies will reduce with age. The ear is more sensitive to medium frequency than high or low frequencies.
- 3 To take account of the varying sensitivity of people to different frequencies a weighting scale has been universally adopted called "A-weighting". The measuring equipment has the ability automatically to weight (or filter) a sound to this A scale so that the sound level it measures best correlates to the subjective response of a person. The unit of measurement thus becomes dBA (decibel, A-weighted).
- 4 The second important characteristic of sound is amplitude or level. Two units are used to express level, a) sound power level - L_w and b) sound pressure level - L_p . Sound power level is an inherent property of a source whilst sound pressure level is dependent on surroundings/distance/directivity, etc. The sound level that is measured on a meter is the sound pressure level, L_p .
- 5 External sound levels are rarely steady but rise or fall in response to the activity in the area - cars, voices, planes, birdsong, etc. A person's subjective response to different noises has been found to vary dependent on the type and temporal distribution of a particular type of noise. A set of statistical indices have been developed for the subjective response to these different noise sources.
- 6 The main noise indices in use in the UK are:
 - L_{A90} : The sound level (in dBA) exceeded for 90% of the time. This level gives an indication of the sound level during the quieter periods of time in any given sample. It is used to describe the "background sound level" of an area.
 - L_{Aeq} : The equivalent continuous sound level in dBA. This unit may be described as "the notional steady noise level that would provide, over a period, the same energy as the intermittent noise". In other words, the energy average level. This unit is now used to measure a wide variety of different types of noise of an industrial or commercial nature, as well as aircraft and trains.
 - L_{A10} : The sound level (in dBA) exceeded for 10% of the time. This level gives an indication of the sound level during the noisier periods of time in any given sample. It has been used over many years to measure and assess road traffic noise.
 - L_{AMAX} : The maximum level of sound measured in any given period. This unit is used to measure and assess transient noises, i.e. gun shots, individual vehicles, etc.

- 7 The sound energy of a transient event may be described by a term SEL - Sound Exposure Level. This is the L_{Aeq} level normalised to one second. That is the constant level in dBA which lasting for one second has the same amount of acoustic energy as a given A weighted noise event lasting for a period of time. The use of this unit allows the prediction of the L_{Aeq} level over any period and for any number of events using the equation;

$$L_{AeqT} = SEL + 10 \log n - 10 \log T \text{ dB.}$$

Where

n = Number of events in time period T.

T = Total sample period in seconds.

- 8 In the open, known as free field, sound attenuates at a rate of 6 dB per each doubling of distance. This is known as geometric spreading or sometimes referred to as the Inverse Square Law. As noise is measured on a Logarithmic scale, this attenuation in distance = $20 \log$ (ratio of distances), e.g. for a noise level of 60 dB at ten metres, the corresponding level at 160 metres is:

$$60 - 20 \log \frac{160}{10} = 60 - 24 = 36 \text{ dB.}$$