APPENDIX 8/A
INTRODUCTION TO NOISE, INCLUDING A GLOSSARY OF TERMINOLOGY

An Introduction to Noise

Noise is defined as unwanted sound. The human ear is able to respond to sound in the frequency range 18 Hz (deep bass) to 18,000 Hz (high treble) and over the audible range of 0 dB (the threshold of perception) to 140 dB (the onset of pain). The ear does not respond equally to different frequencies of the same magnitude, but is more responsive to mid-frequencies than to lower or higher frequencies. To quantify noise in a manner that approximates the response of the human ear, a weighting (filtering) mechanism is used. This reduces the importance of lower and higher frequencies, approximating the response of the human ear.

Furthermore, the perception of noise may be determined by a number of other factors, which may not necessarily be acoustic. Noise can be perceived to be louder or more noticeable if the source of the noise is observed; e.g. roads, trains, factories, building sites etc. In general, the impact of noise depends upon its level, the margin by which it exceeds the background level, its character and its variation over a given period of time. In some cases, the time of day and other acoustic features such as tonality may be important, as may the disposition of the affected individual. Any assessment of noise should give due consideration to all of these factors when assessing the significance of a noise source. Various noise indices have been derived to describe the fluctuation of noise levels that vary over time. Usually, these noise indices relate to specific types of noise, and as such different noise indices are used to describe road traffic noise, background noise, construction noise, etc.

The weighting mechanism that best corresponds to the response of the human ear is the 'A'-weighting scale. This is widely used for environmental noise measurement and the levels are denoted as dB(A) or L_{Aeq}, L_{A10}, etc, according to the parameter being measured.

The standard noise index used to describe road traffic noise in the UK is the $L_{A10,18hour}$, which is defined as the noise level that is exceeded for 10% of the time during an 18 hour period between 06:00 hours and 24:00 hours. Also used is the $L_{A10,1hour}$, which is defined as the noise level exceeded for 10% of the time during a one hour period, usually taken to be the peak hour when traffic volumes are at their highest.

The standard noise index used to describe background noise is the $L_{A90,T}$, which is defined as the noise level that is exceeded for 90% of the time during the specified period T.

The standard noise index used to describe construction site noise is the $L_{Aeq,T}$, the equivalent continuous noise level. This can be defined as the level of a notional steady sound that, if continued over the time period (T), would contain the same amount of sound energy as the actual, possibly fluctuating, sound that was recorded during that same time period.

Noise is measured on the decibel scale, which is logarithmic rather than linear. As a result of this, a 3dB increase in sound level represents a doubling of the sound energy present. Judgement of sound is subjective, but as a general guide a 10dB(A) increase can be taken to represent a doubling of loudness, whilst an increase in the order of 3dB(A) is generally regarded as the minimum difference needed to perceive a change. Table 8A.1 demonstrates a few examples of noise levels typically experienced during everyday activities.

Table 8/A.1

Typical Sound Levels found in the Environment

Sound Level	Location
0 to 10dB(A)	Threshold of hearing
10 to 20dB(A)	Broadcasting studio
20 to 30dB(A)	Quiet bedroom at night
30 to 40dB(A)	Living room during the day
40 to 50dB(A)	Typical office
50 to 60dB(A)	Inside a car
60 to 70dB(A)	Typical high street
70 to 90dB(A)	Inside a factory or noisy pub
100 to 110dB(A)	Burglar Alarm at 1m
110 to 130dB(A)	Pneumatic drill at 1m away
140dB(A)	Threshold of Pain

Table 8/A.2
Terminology Relating to Noise

Sound Pressure	Sound, or sound pressure, is a fluctuation in air pressure over the static ambient pressure.
Sound Pressure Level (Sound Level)	The sound level is the sound pressure relative to a standard reference pressure of 20μPa ($20x10^{-6}$ Pascals) on a decibel scale.
Sound Power	The sound energy radiated per unit time by a sound source. Measured in Watts (W).
Sound Power Level, L_W	Sound power measured on a decibel scale, relative to a reference value of 10^{-12} W
Decibel (dB)	A scale for comparing the ratios of two quantities, including sound pressure and sound power. The difference in level between two sounds s_1 and s_2 is given by $20 \log_{10} (s_1 / s_2)$. The decibel can also be used to measure absolute quantities by specifying a reference value that fixes one point on the scale. For sound pressure, the reference value is 20μPa.
A-weighting, dB(A)	The unit of sound level, weighted according to the A-scale, which takes into account the increased sensitivity of the human ear at some frequencies.
Noise Level Indices	Noise levels usually fluctuate over time, so it is often necessary to consider an average or statistical noise level. This can be done in several ways, so a number of different noise indices have been defined, according to how the averaging or statistics are carried out.
$L_{Aeq,T}$	A noise level index called the equivalent continuous noise level over the time period T. This is the level of a notional steady sound that would contain the same amount of sound energy as the actual, possibly fluctuating, sound that was recorded.
$L_{max,T}$	A noise level index defined as the maximum noise level during the period T. L_{max} is sometimes used for the assessment of occasional loud noises, which may have little effect on the overall L_{eq} noise level but will still affect the noise environment. Unless described otherwise, it is measured using the 'fast' sound level meter response.
$L_{90,T}$ or Background Noise Level	A noise level index. The noise level exceeded for 90% of the time over the period T. L_{90} can be considered to be the "average minimum" noise level and is often used to describe the background noise.
$L_{10,T}$	A noise level index. The noise level exceeded for 10% of the time over the period T. L_{10} can be considered to be the "average maximum" noise level. Generally used to describe road traffic noise.
Free-Field	Far from the presence of sound reflecting objects (except the ground), usually taken to mean at least 3.5m
Façade	At a distance of 1m in front of a large sound reflecting object such as a building façade.
Fast Time Weighting	An averaging time used in sound level meters. Defined in BS5969.
Rating Level	As defined in BS 4142, the rating level or L_{Ar} is the $L_{Aeq, T}$ noise level produced by the source of concern corrected for the acoustic characteristics of the noise.
Ambient Noise	As defined in BS 4142, the ambient noise is the totally encompassing sound in a given situation at a given time usually composed of sound from many sources near and far

APPENDIX 8/B
CRITERIA FOR THE ASSESSMENT OF NOISE

Consultation with Local Authorities

Oxford County Council's Planning Department has been consulted during this assessment. It was confirmed that the Environmental Health Department of Cherwell District Council should be consulted on noise-related issues.

Noise-sensitive receptors and a survey methodology were agreed with Cherwell District Council's Environmental Health Department. It was agreed that an assessment in accordance with BS4142 *Method for rating industrial noise affecting mixed residential and industrial areas* should be undertaken. No assessment criterion was set for the BS4142 assessment.

The British Standards and guidance documents used in this assessment are listed below.

British Standard 5228:2009

British Standard 5228:2009 *Noise and vibration control on construction and open sites,* Part 1: *Noise* and Part 2: *Vibration* sets out a methodology for predicting noise levels arising from a wide variety of construction and related activities. As such, it can be used to predict noise levels arising from the operations of proposed minerals extraction sites. BS5228 also sets out tables of sound power levels generated by a wide variety of mobile equipment.

Noise levels generated by the site operations and experienced at local receptors will depend upon a number of variables, the most significant of which are:

- the amount of noise generated by plant and equipment being used at the development site, generally expressed as a sound power level;
- the periods of operation of the plant at the development site, known as the "on-time";
- the distance between the noise source and the receptor, known as the "stand-off";
- the attenuation due to ground absorption or barrier screening effects; and
- reflections of noise due to the presence of hard vertical faces such as walls.

The noise predictions in this section have been undertaken using a proprietary software-based noise model, Cadna/A, which implements the full range of UK calculation methods.

BS5228:2009 gives several examples of acceptable limits for construction or demolition noise. The most simplistic being based upon the exceedance of fixed noise limits and states in paragraph E.2:

"*Noise from construction and demolition sites should not exceed the level at which conversation in the nearest building would be difficult with the windows shut.*"

Paragraph E.2 goes on to state:

"*Noise levels, between say 07.00 and 19.00 hours, outside the nearest window of the occupied room closest to the site boundary should not exceed:*

- *70 decibels (dBA) in rural, suburban areas away from main road traffic and industrial noise;*
- *75 decibels (dBA) in urban areas near main roads in heavy industrial areas.*

These limits are for daytime working outside living rooms and offices."

Given the rural setting of the site, the assessment criterion used in this assessment for construction noise is 70dB $L_{Aeq,12hours}$.

Draft Guidelines for Noise Impact Assessment

The draft *Guidelines for Noise Impact Assessment* produced by the Institute of Acoustics/Institute of Environmental Management and Assessment Working Party have been referenced in relation to the potential changes in ambient noise level during the construction works and during the operational use of the proposed energy from waste facility.

The findings of the Working Party are draft at present although they are of some assistance in this exercise. The draft guidelines state that for any assessment, the noise level threshold and significance statements should be determined by the assessor, based upon the specific evidence and likely subjective response to the noise

The impact scale adopted in this assessment is shown below.

Table 8/B.1
Impact Scale for Comparison of Future Noise against Existing Noise

Change in Noise Level dB(A)	Subjective Response	Significance
0	No change	No Impact
0.1-2.9	Barely perceptible	Minor Impact
3.0-9.9	From a noticeable change to a doubling or halving in loudness	Moderate impact
10.0 or more	More than a doubling or halving in loudness	Large impact

The criteria above reflect key benchmarks that relate to human perception of sound. A change of 3dB is generally considered to be the smallest change in noise that is perceptible. A 10dB change in noise represents a doubling or halving of the noise level.

It is considered that the criteria specified in the above table provide a good indication as to the likely significance of changes in noise levels in this case. Therefore, the noise threshold levels and significance statements above have been used to supplement the assessment of construction noise impacts and assess the impact of operational noise sources.

Noise from Fixed Plant

British Standard (BS) 4142:1997: *Method for rating industrial noise affecting mixed residential and industrial area.*

BS4142 is intended to be used to assess whether noise from factories, industrial premises or fixed installations and sources of an industrial nature in commercial premises is likely to give rise to complaints from people residing in nearby dwellings. The procedure contained in BS4142 for assessing the likelihood of complaint is to compare the measured or predicted noise level from the source in question, the "specific noise level", immediately outside the dwelling with the background noise level. Where the noise contains a *"distinguishable discreet continuous note (whine, hiss, screech, hum etc.) or if there are distinct impulses in the noise (bangs, clicks, clatters or thumps), or if the noise is irregular enough to attract attention"* then a correction of +5dB is added to the specific noise level to obtain the "rating level" or L_{Ar}.

The likelihood of noise provoking complaints is assessed by subtracting the background noise level from the rating noise level. BS4142 states:

"A difference of around 10dB or higher indicates that complaints are likely. A difference of around 5dB is of marginal significance. A difference of -10dB is a positive indication that complaints are unlikely."

This assessment is carried out over a one hour period for the daytime and a five minute period for the night-time. Day or night are not defined in the standard but it states that night should cover the times when the general adult population are preparing for sleep or are actually sleeping. For the purposes of this assessment, it is assumed that day and night are as described in PPG24; day is 07:00 to 23:00 hours and night-time is 23:00 to 07:00 hours.

ISO9613

The noise levels generated by the operation of the proposed development have been calculated using the proprietary noise modelling software Cadna/A, which implements the common European methods of noise prediction. In this instance, the noise predictions have been undertaken in accordance with the noise prediction framework set out in ISO 9613-2 *Acoustics – Attenuation of sound during propagation outdoors – Part 2 General method of calculation*.

The noise prediction model assumes that individual noise sources act as point sources; the noise level reducing by 6dB for every doubling of distance. The model takes into account the distance between the sources and the receptors and the amount of attenuation due to atmospheric absorption.

The model assumes downwind propagation, i.e. a wind direction that assists the propagation of noise from the source to all receptors.

The topography on and around the site has been modelled using OS mapping and observations made on and around the site. The acoustic absorbency is modelled according to local conditions.

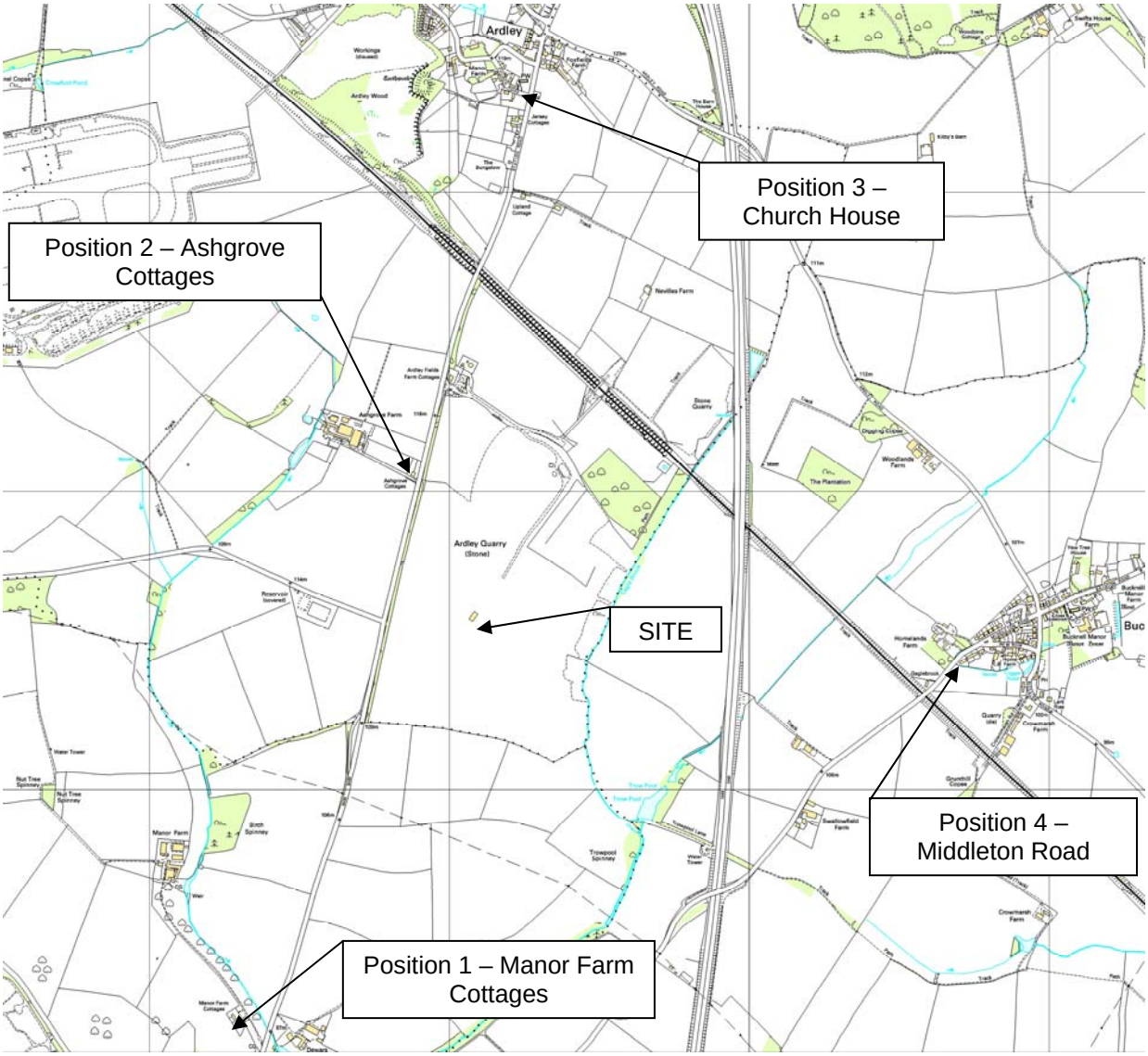
APPENDIX 8/C
NOISE MONITORING EQUIPMENT

Table 8/C.1
Noise Monitoring Equipment

Positions	Equipment	Serial number
All Positions	Norsonic 140 type 1 sound level meter	1403011
	Norsonic Nor-1251 acoustic calibrator	31874

APPENDIX 8/D
NOISE MONITORING LOCATIONS

Figure 8/D.1
Noise Monitoring Locations



APPENDIX 8/E
FULL SURVEY RESULTS

Table 8/E.1
Noise Levels Measured at Position 1, Manor Farm Cottages, free-field dB

Date	Time	Duration	$L_{Aeq,T}$	L_{A90}	L_{A10}	L_{ASmax}
06/05/2008	13:19	15:00	57.2	49.0	61.2	71.0
	16:49	15:00	62.2	54.2	65.7	70.7
	19:39	15:00	57.8	49.8	63.0	69.3
07/05/2008	02:58	15:00	50.4	46.5	50.3	67.8
	04:25	15:00	65.7	49.8	55.5	93.8
	09:34	15:00	60.6	49.1	64.8	70.7

Table 8/E.2
Noise Levels Measured at Position 2 – Ashgrove Cottage, free-field dB

Date	Time	Duration	$L_{Aeq,T}$	L_{A90}	L_{A10}	L_{ASmax}
06/05/2008	13:40	15:00	60.3	51.7	64.0	74.5
	17:09	15:00	62.6	52.6	66.5	78.2
	19:59	15:00	58.9	51.1	62.4	75.3
07/05/2008	03:21	15:00	51.8	47.9	52.6	76.2
	05:07	15:00	57.7	53.1	59.5	77.4
	09:55	15:00	60.6	47.3	64.0	78.2

Table 8/E.3
Noise Levels Measured at Position 3 – Church House, free-field dB

Date	Time	Duration	$L_{Aeq,T}$	L_{A90}	L_{A10}	L_{ASmax}
06/05/2008	14:00	15:00	58.0	52.7	58.6	76.2
	17:30	15:00	59.1	54.6	60.4	75.3
	20:19	15:00	56.0	53.6	57.5	70.6
07/05/2008	03:40	15:00	50.6	48.0	52.4	65.1
	05:26	15:00	60.0	53.2	63.3	77.2
	10:15	15:00	54.4	46.0	57.2	71.3

Table 8/E.4
Noise Levels Measured at Position 4 – Middleton Road, free-field dB

Date	Time	Duration	$L_{Aeq,T}$	L_{A90}	L_{A10}	L_{ASmax}
06/05/2008	14:23	15:00	51.6	45.5	53.4	69.5
	16:20	15:00	52.3	45.0	54.0	75.1
	19:16	15:00	47.1	41.9	48.1	66.1
07/05/2008	02:34	15:00	40.0	37.0	42.0	54.3
	04:02	15:00	44.3	39.9	44.0	77.1
	09:12	15:00	49.9	45.4	50.9	75.8

APPENDIX 8/F
LIST OF PLANT

Table 8/F.1
List of Mobile Plant for Construction Phases

Phase	Plant	Number of Plant	Sound Power Level dB
Site preparation	Tracked excavator	1	114
	Bulldozer	1	112
	Lorry unloading	1	105
	Dump truck	1	110
Piling	Concrete pump	1	109
	Concrete truck	1	109
	Piling rig	1	118
Foundation work	Vibrating poker	1	98
	Concrete pump	1	109
	Concrete Truck	1	109
Building erection	Hammering	1	107
	Lorry pulling up	1	98
	Lorry unloading	1	112
	Generator for crane	1	110
	Poker vibrator	1	98
	Compressor	1	112
	Tracked crane	1	103
	Scaffolding	1	100

Table 8/F.2
Details of EfW Plant

Plant	Octave Band Noise Data								
	32.5	63	125	250	500	1000	2000	4000	8000
Air Cooled Condensers L_{WA}	92.3	92.3	90.3	87.8	86.1	83.2	78.4	71.7	62.9
Turbine Air Coolers L_{WA}	83.2	83.2	83.2	79.2	76.2	80.2	71.2	62.2	52.2
Stack L_{WA}	117.0	112.5	103.8	91.2	72.6	76.5	73.4	73.4	79.9
Bottom Ash Hall $L_{P(reverb)}$	86.0	85.0	77.0	71.0	71.0	69.0	68.0	68.0	59.0
Tipping Hall & Refuse Bunker $L_{P(reverb)}$	84.0	84.0	84.0	77.0	74.0	74.0	74.0	65.0	71.0
Furnance/Boiler & Flue Gas Treatment Hall $L_{P(reverb)}$	81.0	81.0	78.0	78.0	77.0	73.0	73.0	72.0	66.0
Turbine Hall $L_{P(reverb)}$	87.5	84.5	89.5	87.5	89.0	90.0	89.9	84.5	79.0

APPENDIX 8/G
LIST OF ATTENUATION PROVIDE BY BUILDING MATERAILS/ELEMENTS

Table 8/G.1
Attenuation Provided by Building Materials/Elements, dB

Material or Element	Sound Reduction Index								
	32.5	**63**	**125**	**250**	**500**	**1000**	**2000**	**4000**	**8000**
Concrete 16cm	34	38	38	44	48	52	56	60	64
Acoustic Door	5	10	15	20	25	30	35	35	40
0,7mm Steel (5,5kg/m^2)	1	3	8	14	20	24	28	32	37
0.9mm Kalzip Aluminium (2,43kg/m^2)	0	0	1.7	7.7	14	19.7	25.7	31.8	37.8
Danpalon 16	6	9	12	13	17	23	26	22	16
Danpalon 8	0	3	6	7	11	17	20	16	10
Acoustic Louvre (min)	2	4	6	8	11	17	15	13	12