APPENDIX 8A-8D: NOISE ASSESSMENT TECHNICAL APPENDIX.

APPENDIX 8A: NOISE PERCEPTION AND TERMINOLOGY

Between the quietest audible sound and loudest tolerable sound there is a million to one ratio in sound pressure (measured in pascals, Pa). Because of this wide range a noise levels scale based on logarithms is used in noise measurement call the decibel (dB) scale. Audibility of sound covers a range of approximately 0 to 140 dB.

The human ear system does not respond uniformly to sound across the detectable frequency range and consequently instrumentation used to measure noise is weighted to represent the performance of the ear. This is known as the 'A weighting' and annotated as dB(A) or LpA dB. Table 8A.1 below lists the sound pressure level in dB(A) for common situations.

Table 8A.1: Sound pressure levels for a range of situations

NOISE LEVEL DB(A)	TYPICAL SITUATION
0	Threshold of hearing
30	Rural area at night, still air
40	Public library, refrigerator humming at 2 m
50	Quiet office, no machinery. Boiling kettle at 0.5 m
60	Normal conversation
70	Telephone ringing at 2 m. Vacuum cleaner at 3 m
80	General factory noise levels
100	Pneumatic drill at 5 m
120	Discotheque – 1 m in front of loudspeaker
140	Threshold of pain

The noise level at a measurement point is rarely steady, even in rural areas, and varies over a range dependent upon the effects of local noise sources. Close to a busy road, the noise level may vary over a range of 5 dB(A), whereas in a suburban area this may increase up to 40 dB(A) and more due to the multitude of noise sources in such areas (cars, dogs, aircraft etc.) and their variable operation. Furthermore, the range of night time noise levels will often be smaller and the levels significantly reduced compared to daytime levels.

Background Noise Levels

A parameter that is widely accepted as reflecting human perception of the ambient noise is the background noise level, L90, this is usually A weighted and can be displayed as L90 dB(A) or LA90 (dB). This is the noise level exceeded for 90% of the measurement period and generally reflects the noise level in the lulls between individual noise events. Over a one hour period, the LA90 will be the noise level exceeded for 54 minutes.

Ambient or Activity Noise Levels

The equivalent continuous A-weighted sound pressure level, LAeq (or Leq dB(A)) is the single number that represents the total sound energy measured over that period. LAeq is the sound level of a notionally steady sound having the same energy as a fluctuating sound over a specified measurement period. It is commonly used to express the energy level from individual sources that vary in level over their operational cycle.

Noise Changes

Human subjects are generally only capable of noticing changes in noise levels of no less than 3 dB(A). It is generally accepted that a change of 10 dB(A) in an overall, steady noise level is perceived to the human ear as a doubling (or halving) of the noise level. (These findings do not necessarily apply to transient or non-steady noise sources such as changes in noise due to changes in road traffic flow, or intermittent noise sources).

Sound Power

Sound power is the rate per unit time at which airborne sound energy is radiated by a source. It is expressed it watts (W). Sound power level or acoustic power level is a logarithmic measure of the sound power in comparison to the reference level of 1 pW (picowatt). The sound power level is given the letter "Lw" or SWL. It is not the same thing as sound pressure (Lp). Any Lp value is dependent of the distance from the noise source and the environment in which it was measured. Lw values are preferred for noise prediction purposed as their value is independent of distance or environment. There are recognised formulas for converting Lw to Lp.

A-weighted sound power levels are usually denoted LwA (dB) or sometimes Lw (dBA) or SWL (dBA).

Sound Reduction Index

The sound insulation properties of a material are described by the term 'sound reduction index' (R) i.e. it is a measure of the reduction in the amount of sound transmitted through a material. The higher the sound reduction index the greater the attenuation provided by the material. The value of R depends on a range of factors, in particular the mass of the material, the nature of the material, and the frequency of the sound. The R values for individual octave bands can be combined into an overall single figure, the weighted sound reduction index Rw.

Internal Noise Levels

In an enclosed space such as an individual room, or a building, the noise from a source cannot propagate in the same way as outdoors because the propagation of the sound is obstructed by the boundaries (walls, ceiling and floor) of the building. These surfaces together with the contents of the building reflect a proportion of the sound back inside the building or room, the amount depending on the absorption coefficient of the various surfaces. Therefore the overall noise level at a position within the building is a combination of the sound received directly from the source (the direct sound field) and the sound received from reflections from the internal surfaces (the reverberant sound field). The more absorptive the surfaces in a building the less sound is reflected and the lower the contribution of the reverberant sound field to the overall noise level.

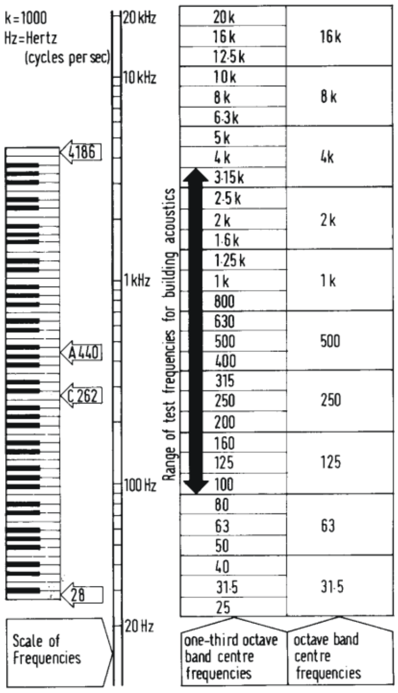
Frequency Spectrum

Frequency is the rate at which the air particles vibrate. The more rapid the vibrations, the higher the frequency and perceived pitch. Frequency is measured in Hertz (Hz).

A young person with average hearing can generally detect sounds in the range 20 Hz to 20,000 Hz (20 kHz). Figure 9A.1 below illustrates the range of frequencies, for example, the lowest note on a full scale piano, 'A', has a fundamental at 28 Hz, and the highest, 'G', a fundamental at 4186 Hz (there will be higher order harmonics). Human speech is predominantly in the range 250 Hz - 3000 Hz.

The musical term 'octave' is the interval between the first and eighth note in a scale and represents a doubling of frequency. A series of octave and one-third octave bands have been derived, as shown on Figure A7.1.1 and these are commonly used in noise measurements where it is necessary to describe not only the level of the source noise but also the frequency content. The frequency content of a noise source can be useful for identifying acoustic features such as a whine, hiss or screech.

Figure 8A.1: Octave and 1/3 octave frequency bands



APPENDIX 8B: NOISE MONITORING

Noise Survey Instrumentation

All measurements were taken at approximately 1.2-1.5 m above ground level, and in accordance with the requirements of British Standard (BS) 7445 (BSI, 1991 and 2003). All monitoring locations were positioned at least 3.5 m from any reflecting surface, other than the ground (i.e. free-field). Details of ongoing activities and typical noise sources in the area were recorded during visits to the monitoring locations to set up and collect the measurement equipment.

All SLMs used were Class 1 precision instruments. Each was programmed to log a number of parameters including L_{Aeq}, L_{A90}, L_{A10} and L_{Amax} values, in 15-minute contiguous intervals.

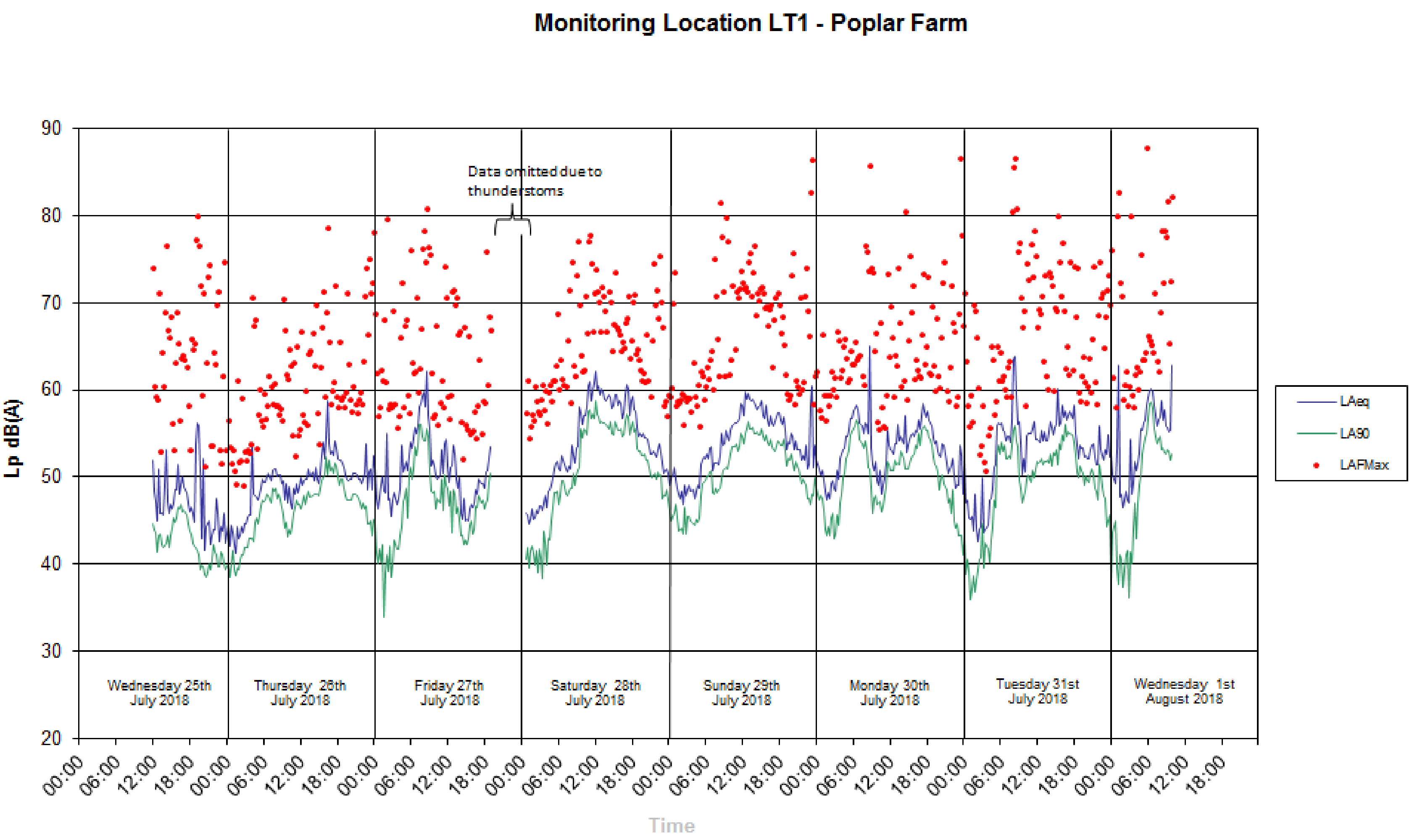
The calibration levels were checked prior to and following all measurements. No significant drift, more than 0.2 dB, occurred. Full calibration details are available upon request.

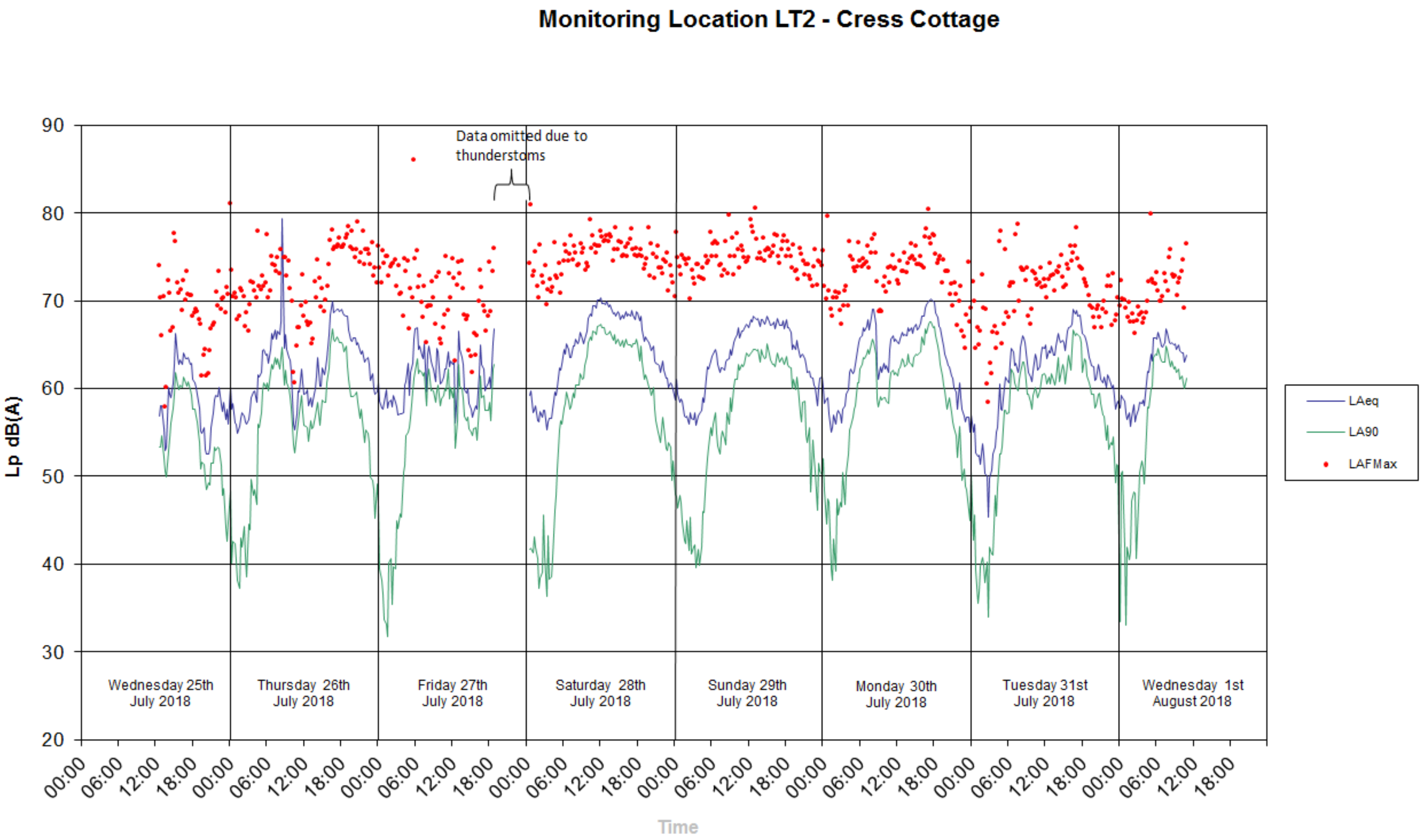
Details of the meters used in the assessment are given in Table 8C.1.

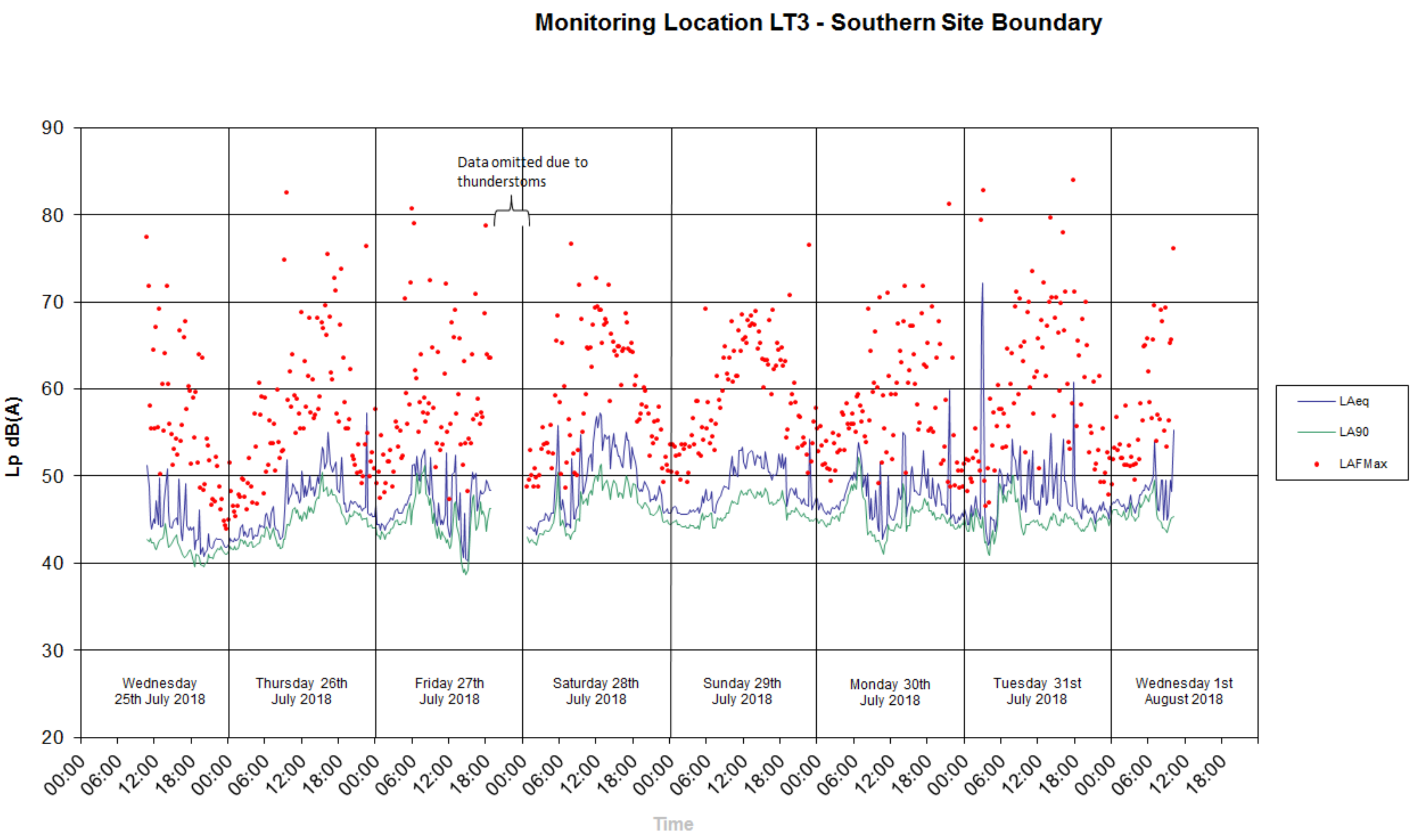
Table 8B.1: Measurement equipment

MONITORING LOCATION	MANUFACTURER	SLM MODEL	SLM SERIAL NUMBER
LT1	Rion	NL-52	01021280
LT2	Rion	NL-52	01021281
LT3	Rion	NL-52	01021278
ST1 and ST2	Rion	NL-52	01021282

Time History Plots




Monitoring Location LT2 - Cress Cottage
Lp dB(A)
90
80
70
60
50
40
30
20
Data omitted due to thunderstorms
Wednesday 25th July 2018
Thursday 26th July 2018
Friday 27th July 2018
Saturday 28th July 2018
Sunday 29th July 2018
Monday 30th July 2018
Tuesday 31st July 2018
Wednesday 1st August 2018
00:00
06:00
12:00
18:00
Time
LAeq
LA90
LAFMax



Monitoring Location LT3 - Southern Site Boundary
Data omitted due to thunderstorms
Lp dB(A)
90
80
70
60
50
40
30
20
Wednesday 25th July 2018
Thursday 26th July 2018
Friday 27th July 2018
Saturday 28th July 2018
Sunday 29th July 2018
Monday 30th July 2018
Tuesday 31st July 2018
Wednesday 1st August 2018
00:00
06:00
12:00
18:00
Time
LAeq
LA90
LAFMax

APPENDIX 8C: CONSTRUCTION

The assumed construction activities and plant are given in Table 8C.1, along with corresponding noise data.

Table 8C.1: Construction plant details

Activity	Plant	LWA	Activity On-Time (%)	Reference
Site Clearance	Chainsaw	114	10	BS 5228 Table D.2 no 14
	Excavator	105	50	BS 5228 Table C.2 no 2
	Loading lorries	106	20	BS 5228 Table C.2 nos. 26-28
Earthworks	Excavator	105	50	BS 5228 Table C.2 no 2
	Dumper	102	50	BS 5228 Table C.2 no 32
	Loading lorries	106	20	BS 5228 Table C.2 no.s 26-28
Drop Hammer Piling	Drop Hammer Piing Rig	122	50	BS 5228 Table C.12 average no.s 11, 13-25
	Service crane	97	50	BS 5228 Table C.3 ave no.s 28-29
	Cememt mixer truck	106	50	BS 5228 Table C.4 no 32
Foundations	Excavator	102	75	BS 5228 Table C.2 ave 14-25
	Lorry mounted concrete pump	107	50	BS 5228 Table C.2 ave 26-28
	Lorry mounted concrete pump	105	50	BS 5228 Table D.7 ave 121-122
	Cement mixer truck	106	50	BS 5228 Table C.4 no 32
	Poker vibrator	97	75	BS 5228 Table C.4 no 34
Slab Construction	Lorry mounted concrete pump	107	50	BS 5228 Table C.2 ave 26-28
	Lorry mounted concrete pump	105	50	BS 5228 Table D.7 ave 121-122
	Cement mixer truck	106	50	BS 5228 Table C.4 no 32
	Poker vibrator	97	75	BS 5228 Table C.4 no 34
Building Construction	Tower crane	105	50	BS 5228 Table C.4 ave 48-49
	Generator	94	100	BS 5228 Table C.4 ave 76-84
	Electric drills	104	50	BS 5228 Table D.6 no 54
	Lorry mounted concrete pump	105	25	BS 5228 Table D.7 ave 121-122
	Cement mixer truck	106	50	BS 5228 Table C.4 no 32
	Poker vibrator	97	75	BS 5228 Table C.4 no 34
Finishing and	Generator	94	100	BS 5228 Table C.4 ave

Fitting				76-84
	Electric drills	104	50	BS 5228 Table D.6 no 54
	Asphalt spreader	104	75	BS 5228 Table C.5 ave 30-31
	Welding plant	102	50	BS 5228 Table C.3 no 31
Access Roads and Car Parks	Excavator	102	75	BS 5228 Table C.2 ave 14-25
	Dumper	109	50	BS 5228 Table C.5 no 16
	Asphalt spreader	104	75	BS 5228 Table C.5 ave 30-31
	Road roller	103	75	BS 5228 Table C.5 ave 25-28

APPENDIX 8D: NOISE MODELLING

The following settings were used during the noise modelling.

Modelling Assumptions

The predicted operational noise levels have taken into account the worst-case scenario and have included the following assumptions:

- An internal level of 85 dB L_{Aeq} has been assumed within all buildings.
- External cladding to the EfW building will provide a low attenuation of 27 dB Rw;
- It has been assumed that louvres will be located at a high level and provide a low level of attenuation (11 dB Rw).
- 3 No. air inlets/outlets have been assumed on the top of the boiler house, emitting a sound power level of 97 dB Lw. Data has been sourced from similar facilities.
- 1 No. air inlet/outlet has been assumed on top of the turbine house, emitting a sound power level of 97 dB Lw. Data has been sourced from similar facilities.
- During all operational scenarios, doors into and doors out of the RDF reception building are assumed to be open at all times.
- The final site levels will be 2 m AOD.
- The proposed 2 m high fence around the Site boundary has not been included in the noise model.

Parameters

Ground Absorption:

- Hard ground (0) for Site, Estuary, surrounding industrial areas
- Surrounding area: Soft ground (1) for all other areas

(Note: Acoustically Soft = 1, Acoustically Hard = 0)

Proposed ground level:

- assumed to be 2 m AOD (the current ground level, assuming no land raising)

Receptor heights:

- 1.5 m for ground floor height, 4 m for first floor height.

Order of Reflections = 3

Prediction methodology:

- ISO 9613 (1996) Acoustics - Attenuation of sound during propagation outdoors
- Calculation of Rod Traffic Noise (CRTN), 1988

Data Sources

OS mapping: OS StreetView Raster 495030_657129. Purchased from Emapsite 15.08.2018.

Scheme design: Fichtner Drawing , 2522-027-R6,

Ground elevation data for wider area: environment.data.gov.uk/ds/survey#/

Inputted Data

Data for noise sources, cladding and louvres are given in Tables 8D.1 to 8D.3 and have been taken from similar schemes.

Table 8D.1: Internal reverberant noise levels

Space	Wt.	Sum	Octave Band Centre Frequency dB(A)							
			63Hz	125Hz	250Hz	500Hz	1kHz	2kHz	4kHz	8kHz
Fuel Reception Hall	dB(A)	85.0	54.3	65.3	70.8	75.2	79.4	79.6	78.4	72.3
Fuel Bunker	dB(A)	85.0	28.8	46.9	64.4	74.8	81.0	81.2	73.0	65.9
Boiler Hall	dB(A)	85.0	32.2	56.3	66.8	79.2	80.4	79.6	73.4	68.3
Ash Bunker	dB(A)	85.0	28.8	46.9	64.4	74.8	81.0	81.2	73.0	65.9
Flue Gas Treatment	dB(A)	85.0	51.5	65.7	70.1	75.5	80.8	80.0	75.8	69.7
Turbine Hall	dB(A)	85.0	25.8	50.9	62.4	72.8	77.0	82.2	78.0	71.9
Compressed Air	dB(A)	85.0	52.7	62.8	70.3	75.7	78.9	78.1	77.9	77.8
Water Treatment	dB(A)	85.0	61.4	73.5	76.0	81.4	78.6	74.8	69.6	60.5

Table 8D.2: External plant Sound Power Levels

Plant Item	Wt.	Sum	Octave Band Centre Frequency dB(A)							
			63Hz	125Hz	250Hz	500Hz	1kHz	2kHz	4kHz	8kHz
ACC (per unit)	dB(A)	81.5	56.6	61.6	68.1	80.4	71.9	68.6	62.1	52.0
Stack	dB(A)	117.8	89.8	100.9	103.4	107.8	114.0	107.2	112.0	106.9
Air Inlet (per unit)	dB(A)	97.1	38.4	47.6	50.6	55.4	62.8	85.2	94.8	92.6
One HGV Pass-By	dB(A)	104.3	87.8	90.9	96.4	98.8	98.0	97.2	91.0	84.9
34 HGV Pass-bys	dB(A)	119.6	103.1	106.2	111.7	114.1	113.3	112.5	106.3	100.2
36 HGV Pass-bys	dB(A)	119.8	103.3	106.4	111.9	114.3	113.5	112.7	106.5	100.4
43 HGV Pass-bys	dB(A)	120.6	104.1	107.2	112.7	115.1	114.3	113.5	107.3	101.2
44 HGV Pass-bys	dB(A)	120.7	104.2	107.3	112.8	115.2	114.4	113.6	107.4	101.3

Table 8D.3: Façade elements sound reduction index data

Plant Item	Wt.	Rw	C	Ctr	Octave Band Centre Frequency								
					31Hz	**63Hz**	**125Hz**	**250Hz**	**500Hz**	**1kHz**	**2kHz**	**4kHz**	**8kHz**
Kingspan KS1000	dB	27	-1	-3	6	13	17	21	26	26	26	42	52
Roller Shutter Door (open)	dB	0	-1	-1	0	0	0	0	0	0	0	0	0
Louvres	dB	11	-1	-1	-	4	5	8	9	12	9	7	6

Construction and Operational Road Traffic Data

Road traffic data, including flow, speed and % HGV for both the construction and operational phases were provided from the transport assessment (refer to Chapter 9: Traffic and Transport), and are given in Tables 8D.4 and 8D.5.

Table 8D.4: Construction road traffic data

Link Ref.	Link Name	2020 Base + Committed No Construction Traffic		2020 Base + Committed With Construction Traffic		With and Without Construction Traffic
		18 Hour AAWT	% HGV	18 Hour AAWT	% HGV	Speed (km/h)
1	South Marsh Road (East of Hobson Way)	964	28	1830	21	56
2	South Marsh Road (West of Hobson Way)	953	8	1028	7	55
3	Hobson Way	1470	23	2261	20	72
4	A1173 (West of North Moss Lane)	8729	30	9520	29	64
5	A1173 (North of A180)	18496	18	19280	18	97
6	A180 North of A1173	22001	30	22637	29	105
7	A180 South of A1173	32791	21	32939	21	108

Table 8D.5: Operational road traffic data

Link Ref.	Link Name	2022 Base + Committed Do Minimum		2022 Base + Committed Do Something		Do Minimum and Do Something
		18 Hour AAWT	%HGV	18 Hour AAWT	%HGV	Speed (km/h)
1	South Marsh Road (East of Hobson Way)	990	28	1686	51	56
2	South Marsh Road (West of Hobson Way)	979	8	1031	7	55
3	Hobson Way	1509	23	2154	43	72
4	A1173 (West of North Moss Lane)	9122	31	9767	35	64
5	A1173 (North of A180)	18527	19	19169	22	97
6	A180 North of A1173	22539	30	22848	31	105
7	A180 South of A1173	33313	22	33644	23	108