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Lower Leighton
Leighton
Welshpool
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Proposed Anaerobic Digestion Plant

Plant Noise Assessment

Acoustics Report M2571/R01a
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1 Introduction

This acoustic report documents a plant noise assessment for the proposed Anaerobic Digestion Plant at Lower Leighton, Welshpool; Figures 1 and 2.

The report is divided into the following sections:

- Section 2: Overview of the Development
- Section 3: Noise Assessment Criteria
- Section 4: Noise Impact Assessment
- Section 5: Conclusion
- Appendix A: Calculations

2 Overview of the Development

The proposed scheme is for an Anaerobic Digestion Plant (ADP) at Lower Leighton, Welshpool; Figures 1 and 2. With the exception for periods of maintenance, the plant will be operational 24/7.

2.1 Noise Sources

The proposed ADP has a number of items of fixed plant that generate noise, which will potentially operate 24/7. Table 1 provides the source noise levels of the identified plant, colour coded with refence to Figure 2. Note that the source noise data is either client supplied or based on client provided survey data of an operating ADP at Bangley Quarry, Scotland.

The emergency generator, which is required in the event of failure of one of the CHP units, will be tested once a week during the working day period only.

2.2 Nearest Dwellings

The nearest private dwellings (i.e.., not in the client's ownership), labelled Receptors A – E in Figure 1, are between 115m – 310m from the proposed development site boundary. All five receptors have a clear view of the site.

2.3 Mitigation measures

For the assessment noise barriers have been included as indicated in Figure 2. The noise barriers must be of a solid construction with a surface mass of no less than 10kg/m^2. The height of the barriers required is expected to be between 2 – 3m; this will be reviewed during detailed design (the line of sight between the receptor and plant must be fully blocked).

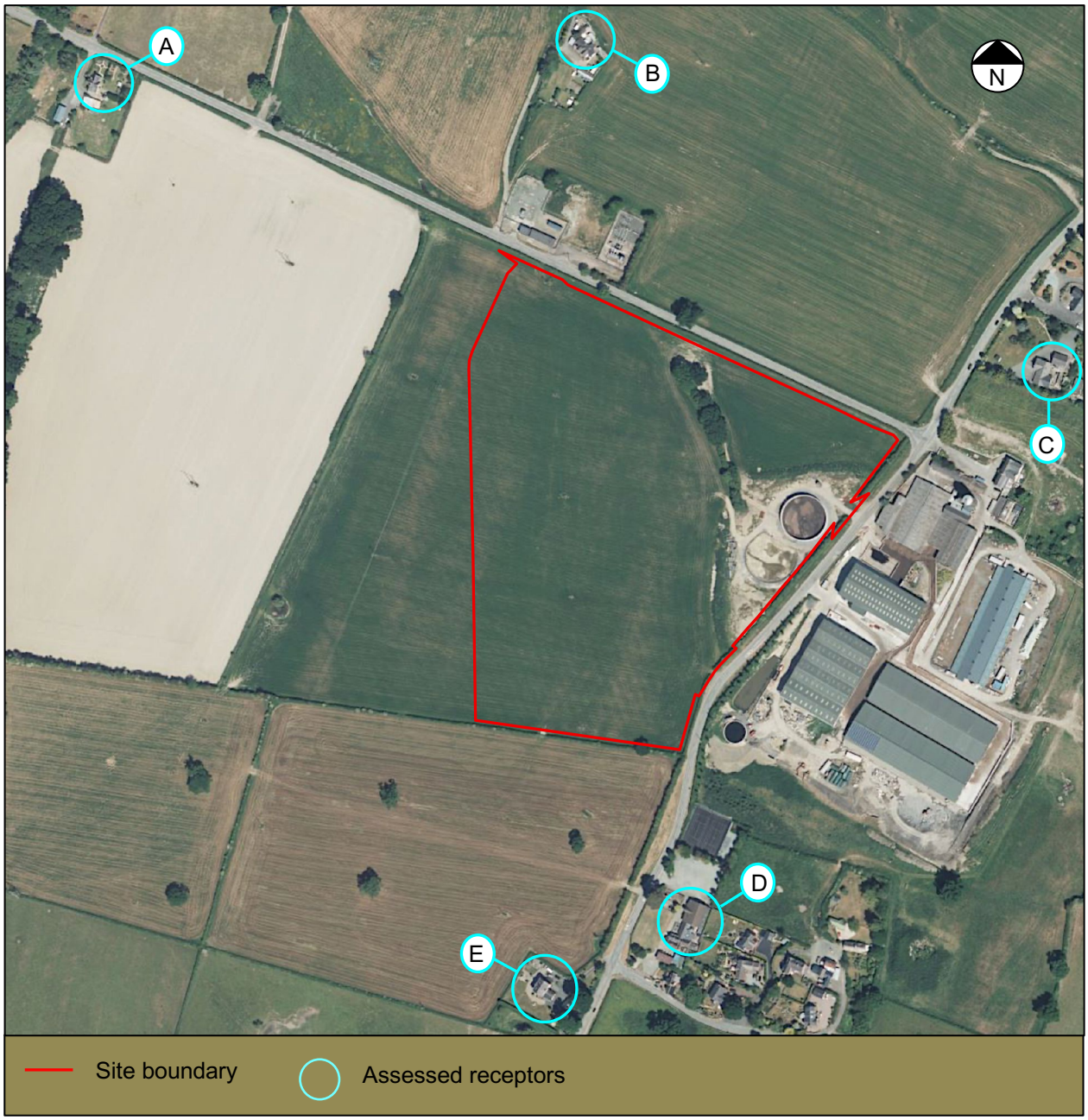

Figure 1. Ariel view (source: www.bing.com) with site boundary and assessed receptors identified

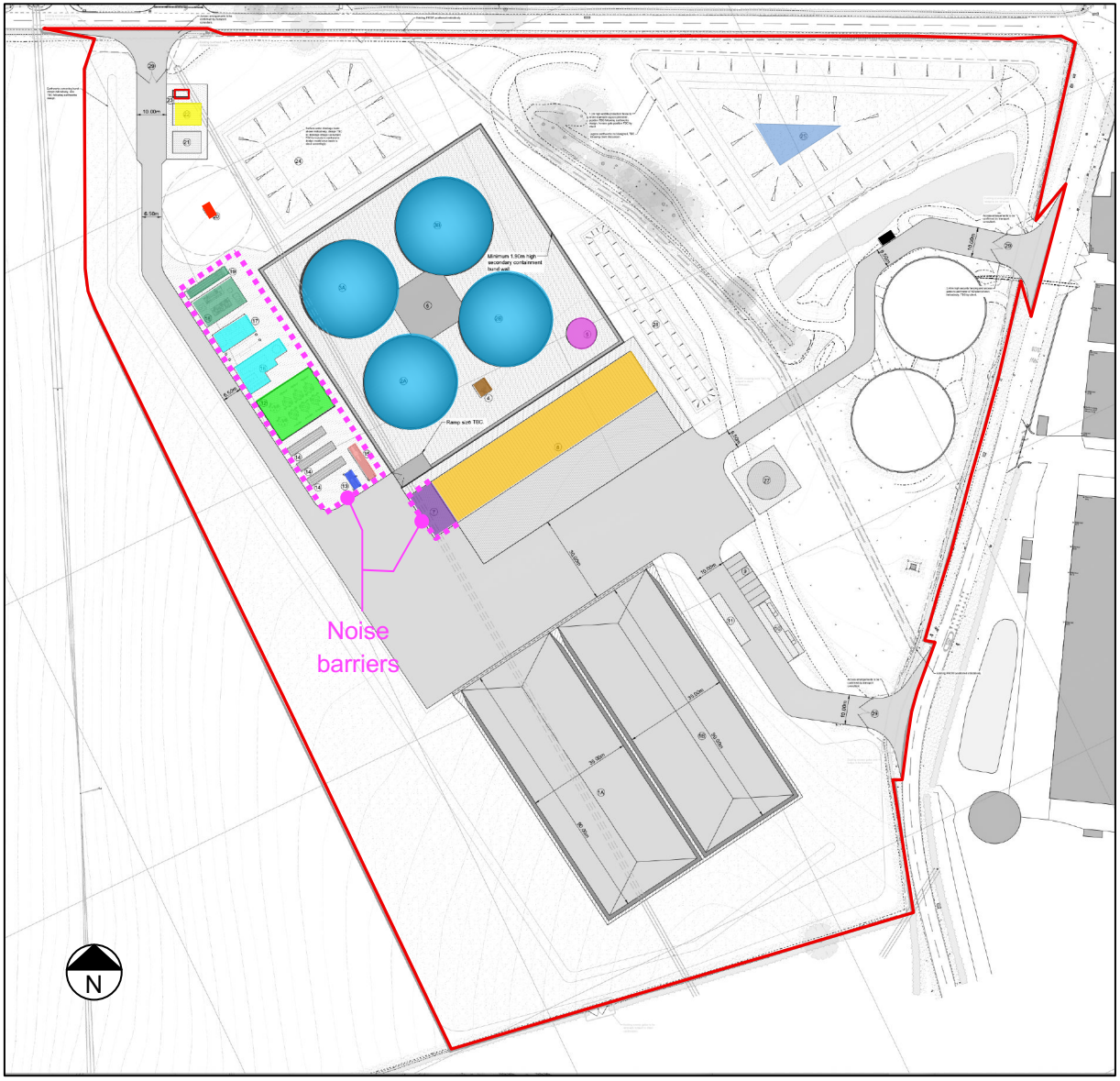

Figure 2. Site plan with noise producing items of fixed plant identified with reference to Table 1

Table 1. Source Noise Levels		
Id No	Noise Source	
2A	Digester (2No. 32.00mØ x 8m high) – 2 Lateral Mixers	63dB(A) at 2m
2B	Digester (2No. 32.00mØ x 8m high) – 2 Submersible Mixer (in digester)	50dB(A) at 1m from container
3A	Post Digester (2No. 32.00mØ x 8m high) – Lateral Mixer	50dB(A) at 1m
3B	Post Digester (2No. 32.00mØ x 8m high) – Submersible Mixer	50dB(A) at 1m from container
4	Ferric Chloride Tank – 1,5kW pump	20dB(A) at 1m
5	Slurry Storage – 15kW Mixer	63dB(A) at 1m
5	Slurry Storage – 11kW Pump	63dB(A) at 1m
7	Technical Building (Control Panel, pumps, gas analyser) – Excentric pumps	50dB(A) at 1m
7	Bio Filter – Blower	67dB(A) at 1m
8	Screw Press Separators & Solid Digestate Storage (Inside Building)	65dB(A) at 1m from building
8	Excentric pump for Digestate Separator	65dB(A) at 1m from container
8	Feedhoppers (2No. Inside Building) - Feeder	45dB(A) at 1m
8	Feedhoppers (2No. Inside Building) - Premix	45dB(A) at 1m
12	Heated tank - Pump	55dB(A) at 1m
12	Heated tank - 11 kW Excentric pump	60dB(A) at 1m from container
12	Heated tank - Rotacut	60dB(A) at 1m
13	Boiler	36dB(A) at 1m from container
15	HCP	75dB(A) at 1m from container
15	Heat Recovery Container (3No.) - Heat pump	74dB(A) at 1m
16 & 17	CO_2 Recovery	80dB(A) at 1m
18 & 19	Gas Pre-Treatment Container / Upgrading	75dB(A) at 1m
20	Flare	75dB(A) at 1m, at 90° lateral
23	Emergency Generator	72dB(A) at 1m
22	Transformer	20dB(A) at 1m
25	Lagoon 3,000m3 – 3 mixers	50dB(A) at 1m
26	Digestate Off-take Point – 30kW pump	65dB(A) at 1m

3 Noise Assessment Criteria

To review the noise impact of the proposed development's noise emissions, the following guidance documents have been considered;

3.1 BS4142:2014+A1:2019

BS4142 provides a methodology to assess the impact of industrial and commercial noise affecting dwellings, whereby the 'typical' background noise level is deducted from the industrial noise Rating Level (industrial noise corrected to account for the 'on-time' and noise character of the noise source. The following guidance is given based on the established difference:

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

Context, as defined in BS4142:2014, includes the consideration of the following factors:

- The absolute level of the noise emissions
- Character and level of the residual sound compared to the character and level of the Specific Level
- Sensitivity of the receptor and any acoustic design measures (e.g., façade sound insulation, use of mechanical ventilation and acoustic screening) incorporated at premises used for residential purposes

To take account of industrial/commercial noise sources that do not operate continually an 'on-time' correction is applied using:

$$- 10 \log (r/r_{ref})$$

Where:

$r_{ref.}$ = reference time (1hr between 07:00 – 23:00hrs and 15 minutes between 23:00 – 07:00hrs)

r = total 'on-time' during the reference period

Note that the shorter reference time interval between 23:00 – 07:00hrs is designed to penalise industrial/commercial noise events that occur during the night.

BS4142 provides four noise character correction categories with associated penalties that must be applied when determining the Rating Level, namely:

- **Tonality:**
  - Not perceptible = 0dB
  - Just perceptible = +2dB
  - Clearly perceptible = +4dB
  - Highly perceptible = +6dB
- **Impulsivity:**
  - Not perceptible = 0dB
  - Just perceptible = +3dB
  - Clearly perceptible = +6dB
  - Highly perceptible = +9dB

- **Intermittency:** +3dB if the intermittency of operation is readily distinctive against the residual noise environment
- **Other:** +3dB applied if the specific sound is neither tonal or impulsive but features noise characteristics that are readily distinctive against the residual noise environment

With regard to noise ingress (noise from outside to inside), BS4142 states that *'The standard is not intended to be applied to the assessment of indoor sound levels'* and the assessment methodology *'... is not intended to be used to assess the extent of the impact at indoor locations'*; in the worked Examples 6 and 8 given in BS4142, comparison with BS8233 noise ingress limits is used to review potential acceptability.

3.2 Noise Ingress (BS8233:2014)

BS8233 provides guidance noise ingress limits for habitable rooms within residential premises, namely;

- Living rooms: $L_{Aeq,16hr}$ 35dB (day)
- Dining room/area: $L_{Aeq,16hr}$ 40dB (day)
- Bedrooms: $L_{Aeq,16hr}$ 35dB (day), $L_{Aeq,8hr}$ 30dB (night)

In order to avoid sleep disturbance, in accordance with guidance given in PRoPG, individual noise events should not exceed 45 dB $L_{Amax,F}$ more than 10 times within bedrooms during the night period.

The above noise limits must be met with windows closed and trickle vents (if applicable) open.

Where the external noise source has a specific character, such as a strong low-frequency content or is irregular enough to attract attention, BS8233 advises lower noise limits might be appropriate.

Although adverse characteristics of the noise emissions from the proposed development are not expected, as a precautionary measure we consider noise ingress levels 5dB below BS8233 noise ingress limits should be designed for.

Purge ventilation, which could be required on occasion to mitigate against overheating, may require open windows. It is generally accepted that there is a compromise between providing rapid ventilation via an open window and the unavoidable higher noise ingress levels (a façade with an open window provides around a 13dB reduction between outside to inside).

For this situation 'Acoustics Ventilation and Overheating - Residential Design Guide: 2020' (AVO) advises that 'reasonable' internal conditions for habitable rooms may be considered to be noise ingress levels up to 5dB above BS8233's noise ingress limits.

In line with AVO's guidance, we therefore consider that 'reasonable' poultry development noise ingress levels via an open window will be 5dB above are suggested noise ingress level with windows closed; this equates to parity with the noise ingress limits given in BS8233.

4 Noise Impact Assessment

4.1 Representative background noise level

A noise survey has not been undertaken to establish the existing background noise levels at the nearest dwellings.

In rural locations typical background noise levels are not normally below:

- Day (07:00 – 23:00hrs): L_{A90} 35dB
- Night (23:00 – 07:00hrs): < L_{A90} 30dB

For the assessment the above background noise levels, which are low, have been taken to be representative to the 'typical' background noise levels that will occur at Receptors A - E.

4.2 Derivation of aggregate Specific Level

The individual noise level of each identified noise source has been calculated at Receptors A - E; Figures 1 and 2. The following corrections have been applied to the source noise data (Table 1):

- **Reflections:** 3dB added to account for reflections. Note that this correction is not applicable for high level exhausts i.e., these will be away from any reflective surfaces.
- **Distance correction:** 20 x log (d_1/d_0), where d_1 = distance between receptor and the noise source and d_0 = reference distance.
- **Shielding attenuation:** Where the line of sight between the noise source and dwelling is fully blocked by a solid barrier (e.g., by suitable noise barrier and/or other solid site structures) a 10dB shielding correction has been applied in accordance with BS5228-1 2009. Where the line of sight is partially blocked, the shielding attenuation is reduced to 5dB
- **Ground absorption correction:** ISO 9613-2: Attenuation of sound during propagation

  $$A_{gr} = 4.8 – (2h_m/d)[17 + (300/d)]$$

  Where,

  h_m = mean height of the propagation path above ground
  d = distance from source to receptor

  In accordance with ISO 9613-2 the ground absorption correction is assumed to be zero when the line of sight of the noise source is partially or fully blocked by a solid body (i.e., when a shielding correction is applicable)
- **Atmospheric attenuation:** ISO 9613-2: Attenuation of sound during propagation outdoors, Formula 8:

  $$A_{atm} = \alpha d/100$$

  Where,

  α = is the atmosphere attenuation coefficient for a temperature of 10°C and 70% relative humidity
  d = distance from source to receptor

  It should be highlighted that the calculations provided in ISO 1996-2 assume a downwind propagation.

  In accordance with ISO 9613-2 the attenuation at 500Hz has been used as only the dB(A) value of the noise sources are known.
- **On-time:** The worst-case scenario of all the plant operating concurrently for the full BS4142 assessment period has been assumed. For transport activities, it has been assumed that they occur over a total of 30miuntes within any 1hr period, which equates to a 3dB ‘on-time’ correction.

The full calculation is provided in Appendix A, with the resultant aggregate noise levels (Specific Level) provided in Table 2.

4.3 Rating Level

The noise characteristics of the individual noise sources are unknown. Due to the low absolute noise emissions of each noise source at the nearest dwellings, their individual noise characteristics are not however expected to be identifiable at the nearest dwellings. As a precautionary measure however a global +3dB BS4142 character correction has been applied to the aggregate Specific Level to establish the Rating Level. The resultant Rating Levels are given in Table 2.

4.4 Assessment Level

We define Assessment Level = RL – min L_{A90} dB, where:

RL = Rating Level, dB(A)

L_{A90} dB = representative typical background noise level, L_{A90} (assumed level commensurate with a rural area)

Table 2 provides the resultant day period Assessment Levels at Receptors A - E.

Table 2. Calculated Aggregate Plant Specific, Rating and Assessment Levels

Receptors	Specific Level, dB	Rating Level, dB	Day Period Representative L_{A90} dB	Day Assessment Level, dB
A	29	32	35	-3
B	32	35	35	0
C	31	34	35	-1
D	32	35	35	0
E	31	34	35	-1
Note that the representative background noise levels are assumed values, commensurate with a rural area				

Where the Rating Level is at parity with the typical background noise level (Assessment Level = 0 dB) BS4142 states that the Specific Level will have a low impact; an adverse impact is indicated where the Rating Level is ≥ 5dB and <10dB above the typical background noise level.

As can be seen in Table 2, the day Assessment Levels in all cases do not exceed 0dB. We therefore conclude that, with the inclusion of suitable noise barriers as indicated in Figure 2, the noise impact will be low during the day.

During the night period (23:00 – 07:00hrs) we consider the context that occupiers of the nearest dwellings will be within their houses during is relevant, and consequently it will be noise ingress that will inform on the noise impact. Based on a room with an open window providing 13dB sound reduction from outside to inside, the highest aggregate (all plant running) noise ingress would be $L_{Aeq,15min}$ 19dB.

The resultant ambient noise level is very low, being significantly below our suggested noise ingress limit (5dB below the noise ingress limits given in BS8233). We therefore conclude that during the night the plant noise emissions from the proposed ADP will result in a low noise impact.

5.1 Assessment Uncertainty

With all calculations there is a level of uncertainty, which in this case we do not expect to be greater than +/-3dB (3dB is a just perceptible change in noise level). This small level of uncertainty does not have any significance to the outcome of the assessment.

The assumed representative typical background noise levels used in the assessment are low, being commensurate with a quiet rural area; with the existing plant and activity noise emissions from Lower Leighton Farm, lower typical background noise levels are not expected.

The assessment has been conducted on the assumption that all plant is running concurrently 24/7. It is likely that this worst-case scenario will not occur for the majority of the time, and consequently the aggregate noise emissions are expected to typically be lower than calculated.

The assessment has been conducted on the supplied data for the proposed plant. If higher noise producing plant is selected than used in the assessment, the assessment can be updated;

mitigation measures such as localised noise barriers and/or acoustic enclosures are available if required.

5 Conclusion

A noise impact assessment has been undertaken for the proposed Anaerobic Digestion Plant at Lower Leighton, Welshpool; Figures 1 and 2.

The assessment has been based on:

- Noise data for the selected plant; Table 1
- Plant operating 24/7
- The mitigation measures of noise barriers (provisionally between 2- 3m high) around the highest noise producing items of plant as indicated in Figure 2
- Calculations of the plant noise emissions and corresponding Rating Levels at the nearest dwellings; Table A1, Appendix A and Table 2

The findings of the assessment established that:

- *Day period:* The aggregate plant noise emissions at the nearest private dwellings (Receptors A - E, Figure 1) will not exceed the assumed representative background noise levels commensurate with a quiet rural area. This indicates a low noise impact.
- *Night:* Taking into account the context that the occupiers of the nearest dwellings will be expected to be indoors during the night period, the noise ingress via an open window has been reviewed. The resultant ambient noise ingress levels are significantly below our suggested noise ingress limit (5dB below the noise ingress limits given in BS8233). We therefore conclude that during the night the noise impact will be low.

On the basis that the plant noise emissions from the proposed development, with the inclusion of the noise barriers, will not result in an adverse noise impact at the nearest dwellings, we conclude that the proposed scheme is acceptable with regard to noise.

Table A1. Calculation of Plant Specific and Rating Levels at Receptors A - E

Id No	Noise Source	[A] External Level	Reflections, dB	Receptor					Receptor					Receptor					Receptor					Receptor					Receptor				
				A	B	C	D	E	A	B	C	D	E	A	B	C	D	E	A	B	C	D	E	A	B	C	D		A	B	C	D	E
				Distance, m					[B] Distance correction, dB					[C] Shielding Attenuation, dB					[D] Ground Absorption, dB					[E] Atmospheric Attenuation, dB					[A] - [B] - [C] - [D] - [E] Specifc Level, dB				
2A	Digester (2No. 32.00mØ x 8m high) – 2 Lateral Digester (2No. 32.00mØ x 8m high) – 2 Lateral Mixers	63 dB(A) at 2 m	3	472	289	351	395	446	47.4	43.2	44.9	45.9	47.0	0	0	0	0	0	4.6	4.4	4.5	4.5	4.5	0.9	0.5	0.7	0.8	0.8	14.1	18.9	16.9	15.8	14.7
2B	Digester (2No. 32.00mØ x 8m high) – 2 Submersible Mixer (in digester)	50 dB(A) at 1 m from container	3	514	313	317	369	430	54.2	49.9	50.0	51.3	52.7	0	0	0	0	0	4.6	4.4	4.4	4.5	4.5	1.0	0.6	0.6	0.7	0.8	-5.8	-0.9	-1.0	-2.5	-4.0
3A	Post Digester (2No. 32.00mØ x 8m high) – Lateral Mixer	50 dB(A) at 1 m	0	460	277	356	407	457	53.3	48.9	51.0	52.2	53.2	0	0	0	0	0	4.2	3.7	4.0	4.1	4.2	0.9	0.5	0.7	0.8	0.9	-7.4	-2.1	-4.7	-6.1	-7.3
3B	Post Digester (2No. 32.00mØ x 8m high) – Submersible Mixer	50 dB(A) at 1 m from container	3	490	276	318	407	466	53.8	48.8	50.1	52.2	53.4	0	0	0	0	0	4.6	4.4	4.4	4.5	4.6	0.9	0.5	0.6	0.8	0.9	-5.3	0.3	-1.1	-3.5	-4.9
4	Ferric Chloride Tank – 1,5kW pump	20 dB(A) at 1 m	3	511	328	336	354	411	54.2	50.3	50.5	51.0	52.3	0	0	0	0	0	4.6	4.5	4.5	4.5	4.5	1.0	0.6	0.6	0.7	0.8	-35.8	-31.4	-31.6	-32.2	-33.6
5	Slurry Storage – 15kW Mixer	63 dB(A) at 1 m	3	541	332	299	352	419	54.7	50.4	49.5	50.9	52.4	0	0	0	0	0	4.7	4.6	4.5	4.6	4.6	1.0	0.6	0.6	0.7	0.8	6.6	11.4	12.4	10.8	9.2
5	Slurry Storage – 11kW Pump	63 dB(A) at 1 m	3	541	332	299	352	419	54.7	50.4	49.5	50.9	52.4	0	0	0	0	0	4.7	4.6	4.5	4.6	4.6	1.0	0.6	0.6	0.7	0.8	6.6	11.4	12.4	10.8	9.2
7	Technical Building (Control Panel, pumps, gas analyser) – Excentric pumps	50 dB(A) at 1 m	3	504	355	374	332	379	54.0	51.0	51.5	50.4	51.6	10	10	10	10	10	0.0	0.0	0.0	0.0	0.0	1.0	0.7	0.7	0.6	0.7	-11.0	-7.7	-8.2	-7.0	-8.3
7	Bio Filter – Blower	67 dB(A) at 10 m	3	504	355	374	332	379	34.0	31.0	31.5	30.4	31.6	10	10	10	10	10	0.0	0.0	0.0	0.0	0.0	1.0	0.7	0.7	0.6	0.7	26.0	29.3	28.8	30.0	28.7
8	Screw Press Separators & Solid Digestate Storage (Inside Building)	65 dB(A) at 1 m from building	3	540	360	330	322	383	54.7	51.1	50.4	50.2	51.7	0	0	0	0	0	4.6	4.5	4.4	4.4	4.5	1.0	0.7	0.6	0.6	0.7	8.7	12.7	13.6	13.8	12.1
8	Excentric pump for Digestate Separator	65 dB(A) at 1 m from container	3	540	360	330	322	383	54.7	51.1	50.4	50.2	51.7	0	0	0	0	0	4.6	4.5	4.4	4.4	4.5	1.0	0.7	0.6	0.6	0.7	8.7	12.7	13.6	13.8	12.1
8	Feedhoppers (2No. Inside Building) - Feeder	45 dB(A) at 1 m	3	540	360	330	322	383	54.7	51.1	50.4	50.2	51.7	0	0	0	0	0	4.6	4.5	4.4	4.4	4.5	1.0	0.7	0.6	0.6	0.7	-11.3	-7.3	-6.4	-6.2	-7.9
8	Feedhoppers (2No. Inside Building) - Premix	45 dB(A) at 1 m	3	540	360	330	322	383	54.7	51.1	50.4	50.2	51.7	0	0	0	0	0	4.6	4.5	4.4	4.4	4.5	1.0	0.7	0.6	0.6	0.7	-11.3	-7.3	-6.4	-6.2	-7.9
12	Heated tank - Pump	55 dB(A) at 1 m	3	451	306	390	388	429	53.1	49.7	51.8	51.8	52.6	10	10	10	10	10	0.0	0.0	0.0	0.0	0.0	0.9	0.6	0.7	0.7	0.8	-5.0	-1.3	-3.5	-3.5	-4.4
12	Heated tank - 11 kW Excentric pump	60 dB(A) at 1 m outside of container	3	451	306	390	388	429	53.1	49.7	51.8	51.8	52.6	10	10	10	10	10	0.0	0.0	0.0	0.0	0.0	0.9	0.6	0.7	0.7	0.8	0.0	3.7	1.5	1.5	0.6
12	Heated tank - Rotacut	60 dB(A) at 1 m	3	451	306	390	388	429	53.1	49.7	51.8	51.8	52.6	10	10	10	10	10	0.0	0.0	0.0	0.0	0.0	0.9	0.6	0.7	0.7	0.8	0.0	3.7	1.5	1.5	0.6
13	Boiler	36 dB(A) at 1 m outside of container	3	475	336	390	357	398	53.5	50.5	51.8	51.0	52.0	10	10	10	10	10	0.0	0.0	0.0	0.0	0.0	0.9	0.6	0.7	0.7	0.8	-24.4	-21.1	-22.5	-21.7	-22.8
15	HCP	75 dB(A) at 1 m outside of container	3	477	331	382	360	403	53.6	50.4	51.6	51.1	52.1	10	10	10	10	10	0.0	0.0	0.0	0.0	0.0	0.9	0.6	0.7	0.7	0.8	14.5	18.0	16.7	17.2	16.1
15	Heat Recovery Container (3No.) - Heat pump	74 dB(A) at 1 m	3	477	331	382	360	403	53.6	50.4	51.6	51.1	52.1	10	10	10	10	10	0.0	0.0	0.0	0.0	0.0	0.9	0.6	0.7	0.7	0.8	13.5	17.0	15.7	16.2	15.1
16/17	CO_2 Recovery	80 dB(A) at 1 m	3	435	288	394	407	447	52.8	49.2	51.9	52.2	53.0	10	10	10	10	10	0.0	0.0	0.0	0.0	0.0	0.8	0.5	0.7	0.8	0.8	20.4	24.3	21.4	21.0	20.2
18 & 19	Gas Pre-Treatment Container / Upgrading	75 dB(A) at 1 m	3	419	264	395	431	472	52.4	48.4	51.9	52.7	53.5	10	10	10	10	10	0.0	0.0	0.0	0.0	0.0	0.8	0.5	0.7	0.8	0.9	15.8	20.1	16.4	15.5	14.6
20	Flare	75 dB(A) at 1 m, at 90° lateral	0	470	333	393	361	401	53.4	50.5	51.9	51.1	52.1	0	0	0	0	0	4.6	4.5	4.5	4.5	4.5	0.9	0.6	0.7	0.7	0.8	17.1	20.4	18.9	19.7	18.6
22	Transformer	20 dB(A) at 1 m	3	404	202	382	486	532	52.1	46.1	51.6	53.7	54.5	0	0	0	0	0	4.1	3.3	4.0	4.2	4.3	0.8	0.4	0.7	0.9	1.0	-33.0	-25.8	-32.3	-34.8	-35.8
25	Lagoon 3,000m3 – 3 mixers	50 dB(A) at 1 m	3	608	337	200	391	477	55.7	50.6	46.0	51.8	53.6	0	0	0	0	0	4.7	4.6	4.4	4.6	4.6	1.2	0.6	0.4	0.7	0.9	-7.6	-1.8	3.2	-3.1	-5.1
26	Digestate Off-take Point – 30kW pump	65 dB(A) at 1 m	3	638	382	204	350	441	56.1	51.6	46.2	50.9	52.9	0	0	0	0	0	4.7	4.6	4.4	4.6	4.6	1.2	0.7	0.4	0.7	0.8	6.0	11.1	17.0	11.8	9.7
																												Aggregate Specific Level, dB	29	32	31	32	31
																												Global BS4142 Character Correction	3	3	3	3	3
																												Rating Level	32	35	34	35	34
23	Emergency Generator	72 dB(A) at 1 m	3	401	195	383	493	539	52.1	45.8	51.7	53.9	54.6	0	0	10	10	10	4.1	3.2	0.0	0.0	0.0	0.8	0.4	0.7	0.9	1.0	18.0	25.6	12.6	10.2	9.4