

Timber Products Facility
Unit 2 Earlsfield Park
Knowsley Lane
Huyton
L34 4AH

Plant Noise Impact Assessment

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For and on behalf of Noise Solutions Ltd				

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1.0 Introduction

- 1.1. Noise Solutions Ltd (NSL) has been commissioned to undertake a plant noise assessment relating to a proposed fixed plant installation at Unit 2, Earlsfield Park, Prescott.
- 1.2. An environmental sound survey has previously been undertaken, with a planning condition imposed requiring compliance with the levels outlined within the report. An assessment has been made of noise levels resulting from fixed plant installations at the premises.
- 1.3. To assist with the understanding of this report a brief glossary of acoustic terms can be found in **Appendix A**. A more in-depth glossary of acoustic terms can be assessed at the following web address <http://www.acoustic-glossary.co.uk/>.

2.0 Details of development proposals

- 2.1. Full planning permission is sought for:

"The erection of plant comprised of: forklift truck enclosure, sprinkler tanks, ancillary sprinkler buildings, roof access ladder, access stairs and biomass boiler facility including wood chipper enclosure, extract dust silo and boiler room at Unit 2 Earlsfield Park, Prescott"

- 2.2. The proposed layout of the site is shown in **Appendix C**.
- 2.3. Conditions 14 and 15 of application reference 25/00614/FUL state that noise from fixed plant and machinery should be at least 5dB below the existing L_{A90} background noise level. The full conditions are outlined in 4.13 and 4.14 below.
- 2.4. The following items of plant are proposed.
 - 4no. fans, external but with no atmospheric duct openings;
 - Biomass boiler and additional fan, within an external plant compound; and
 - A wood chipper, within an external plant compound.
 - The wood chipper will only operate for 30-minutes at a time, and only roughly 4 to 5 times per day.

3.0 Nearest noise sensitive receptors

- 3.1. The area surrounding the site is mixed residential and commercial in use. The site is bounded to the north by the M57 motorway, to the east by other commercial premises, to the south by Arley Drive, the sole access road to the site, and by a residential housing estate to the west.

- 3.2. Receptor R1 has been identified as 133 Knowsley Lane, approximately 160m from the closest item of plant, with full line of sight.
- 3.3. Receptor R2 has been identified as 64 Higherfield Crescent. The plant is approximately 150m from this receptor and is screened by the commercial unit itself.
- 3.4. Receptors along Fountain Way, and Henhouse Drive have increased distance and screening compared with receptors R1, and R2, as such noise levels from the plant proposals outlined within this report will be lower at receptors on Fountain Way and Henhouse drive than R1, and R2.
- 3.5. **Appendix B** contains an aerial photograph showing the site and surrounding area.

4.0 Acoustic Standards and planning conditions

BS 4142:2014 + A1:2019 Methods for Rating and Measuring Industrial and Commercial Sound

- 4.1. BS 4142:2014+A1:2019 describes a method for rating and assessing sound of an industrial 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; and
 - 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.
- 4.2. Therefore, for the first time in the UK, noise associated with store deliveries (i.e. sound from loading and unloading of goods) has a recognised and approved assessment methodology as this type of noise was not included in the scope of previous versions of BS 4142.
- 4.3. The industrial or commercial sound is assessed outside a dwelling or premises used for residential purposes, upon which sound is incident.
- 4.4. The procedure contained in BS4142:2014 + A1:2019 is to quantify the "specific sound level", which is the measured or predicted level of sound from the source in question over a one hour period for the daytime and a 15-minute period for the night-time. Daytime is defined in the standard as 07:00 to 23:00 hours, and night-time as 23:00 to 07:00 hours.

- 4.5. The specific sound level is converted to a rating level by adding penalties on a sliding scale to account for either potentially tonal or impulsive elements. The standard sets out objective methods for determining the presence of tones or impulsive elements, but notes that it is acceptable to subjectively determine these effects.
- 4.6. The penalty for tonal elements is between 0dB and 6dB, and the standard notes: "Subjectively, this can be converted to a penalty of 2 dB for a tone which is just perceptible at the noise receptor, 4 dB where it is clearly perceptible, and 6 dB where it is highly perceptible."
- 4.7. The penalty for impulsive elements is between 0dB and 9dB, and the standard notes: "Subjectively, this can be converted to a penalty of 3 dB for impulsivity which is just perceptible at the noise receptor, 6 dB where it is clearly perceptible, and 9 dB where it is highly perceptible."
- 4.8. The background sound level should be established in terms of the L_{A90} noise index. The standard states that the background sound level should be measured over a period of sufficient length to obtain a representative value. This should not normally be less than 15-minute intervals. The standard states that: "A representative level ought to account for the range of background sound levels and ought not automatically to be assumed to be either the minimum or modal value."
- 4.9. The assessment outcome results from a comparison of the rating level with the background sound level. The standard states:

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.

Adverse impacts include, but are not limited to, annoyance and sleep disturbance. Not all adverse impacts will lead to complaints and not every complaint is proof of an adverse impact."

The standard goes on to note that: "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."

- 4.10. In addition to the margin by which the Rating Level of the specific sound source exceeds the Background Sound Level, the 2014 edition places emphasis upon an appreciation of the context, as follows:

"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."

- 4.11. BS 4142:2014 + A1:2019 requires uncertainties in the assessment to be considered, and where the uncertainty is likely to affect the outcome of the assessment, steps should be taken to reduce the uncertainty.

Planning conditions

- 4.12. A condition on the site regarding commercial noise has been set by Knowsley Metropolitan Borough Council.
- 4.13. Condition 14 of application reference 25/00614/FUL states the following.

"Fixed plant and machinery associated with the development shall be designed to a level that is at least 5dB(A) below the existing LA90 background noise level as measured during the relevant time period.

Any tonal, impulsive or irregular noise would be addressed by imposing a penalty as per the methodology set out in BS 4142:2014+A1:2019. Methods for rating and assessing industrial and commercial sound.

Noise limits for fixed plant are to apply at a position 1 metre from the closest affected window of the nearest noise sensitive property on Knowsley Lane, Highfield Crescent and Fountain Way.

Reason: To safeguard local residents from noise and disturbance, and to comply with Policy ENV2 of the Knowsley Replacement Unitary Development Plan adopted June 2006.

Application of criteria

- 4.14. Condition 15 of application reference 25/00614/FUL states the following.

The level of noise emitted from activities associated with the site shall not exceed the existing LA90 background noise level as set out within the Noise Impact Assessment submitted with the application (AC103830-1R13) and as measured at the following times:

- LAeq (1 hour) between 0700-2300
- LAeq (15 mins) between 2300-0700

Noise limits are to apply at a position 1 metre from the closest affected window of the nearest noise sensitive property on Knowsley Lane, Fountain Way and Highfield Crescent.

Reason: To safeguard local residents from noise and disturbance, and to comply with Policy ENV2 of the Knowsley Replacement Unitary Development Plan adopted June 2006.

- 4.15. Based on guidance within BS 4142:2014+A1:2019, alongside planning Conditions 14, and 15, the following noise limits have been set at nearby receptors.

Table 1 Maximum plant noise rating level at receptors

Period	Maximum Rating level, L _{Ar} , dB from fixed plant installations at nearby receptors
Daytime (07:00 – 23:00)	47

- 4.16. The above level of 47dB is based on 5dB below the lowest measured weekday background sound pressure level of 52dB LA90 from Ensaf Consultants' report¹ titled "AC103830-1R13" at NMP3, for which the following was noted.

NMP3: Located in an existing hedgerow to the north of existing receptors off Knowsley Lane and Lyme Close. The microphone of the sound level meter was positioned at a height of 1.5m above ground level and in free-field conditions. The noise climate at this location was dominated by road traffic sound.

- 4.17. With the above measurement being taken along Knowsley Lane, this position is likely an accurate representation of anticipated background sound levels at Receptor R1.

5.0 External plant noise assessment

- 5.1. The cumulative plant noise level at the most affected noise sensitive receptors has been predicted. The assessment has taken into consideration distance attenuation and directivity corrections. Predictions are inclusive of the following:

¹ Ensaf Consultants report titled "Noise Impact Assessment for ION Property Developments LTD at Knowsley Lane, Huyton AC103830-1R13" Dated 17/11/2020

- Acoustic enclosures formed of 1.2mm Galvanised Steel, with 50mm acoustic absorption internally, providing a 10dB attenuation loss to all fans.
- External housing for the Biomass boiler, and woodchipper to be formed of the same cladding as the main warehouse, and comprises of;
 - Outer façade: 0.50mm galvanized steel cladding (Tata Steel HPS200 Ultra)
 - Cavity: 200mm Airgap, 75mm fibreglass mineral infill, with 1.45mm thick steel frames.
 - Inner facing: 12.5mm plasterboard

The external housing for both includes a roller-shutter door. The roller shutter will be kept closed, except for access.

- 5.2. Sound reduction indexes of the external housing, and roller shutter door used for predictions within this assessment are outlined within the table below.

Table 2 Sound reduction indexes of external housing

Façade Build-up	Sound reduction index dB, at octave band centre frequencies (Hz)							
	63	125	250	500	1k	2k	4k	8k
External housing	11	18	37	46	47	62	63	63
Roller shutter door	10	15	17	23	18	25	40	46

- 5.3. It should be noted that the proposed ventilation plant will operate during operational hours only and is not anticipated to exhibit any tonal or impulsive characteristics provided it is well maintained. For robustness a +3dB feature correction has been applied to all ventilation plant, and the biomass boiler for the possible presence of " ...characteristics that are neither tonal nor impulsive, though otherwise are readily distinctive against the residual acoustic environment..." as described in BS 4142:2014+A1:2019.
- 5.4. It is anticipated that the proposed woodchipper will likely exhibit some impulsive, and tonal characteristics. For robustness a +6dB feature correction has been applied for impulsivity, and a +4dB feature correction has been applied for tonality.
- 5.5. Table 3 below summarises the results of the assessment outside the nearest noise-sensitive premises. All other nearby receptors benefit from increased distance/screening to the plant such that resulting noise levels will be lower than at the receptors considered. The full calculations are presented in [Appendix E](#).

Table 3 Predicted plant noise emissions at noise sensitive residential receptors

Receptor	Period	Predicted plant rating level at receptor, L_{Aeq} (dB)	Proposed design criterion (dB)	Difference (dB)
R1	Warehouse operation (08.30 – 17.00 hours)	44	47	-3
R2	Warehouse operation (08.30 – 17.00 hours)	38	47	-9

- 5.6. The noise level predictions at nearby residential receptors, inclusive of robust feature corrections, demonstrate that cumulative noise emissions from the proposed plant will comply with the requirements of Condition 14.

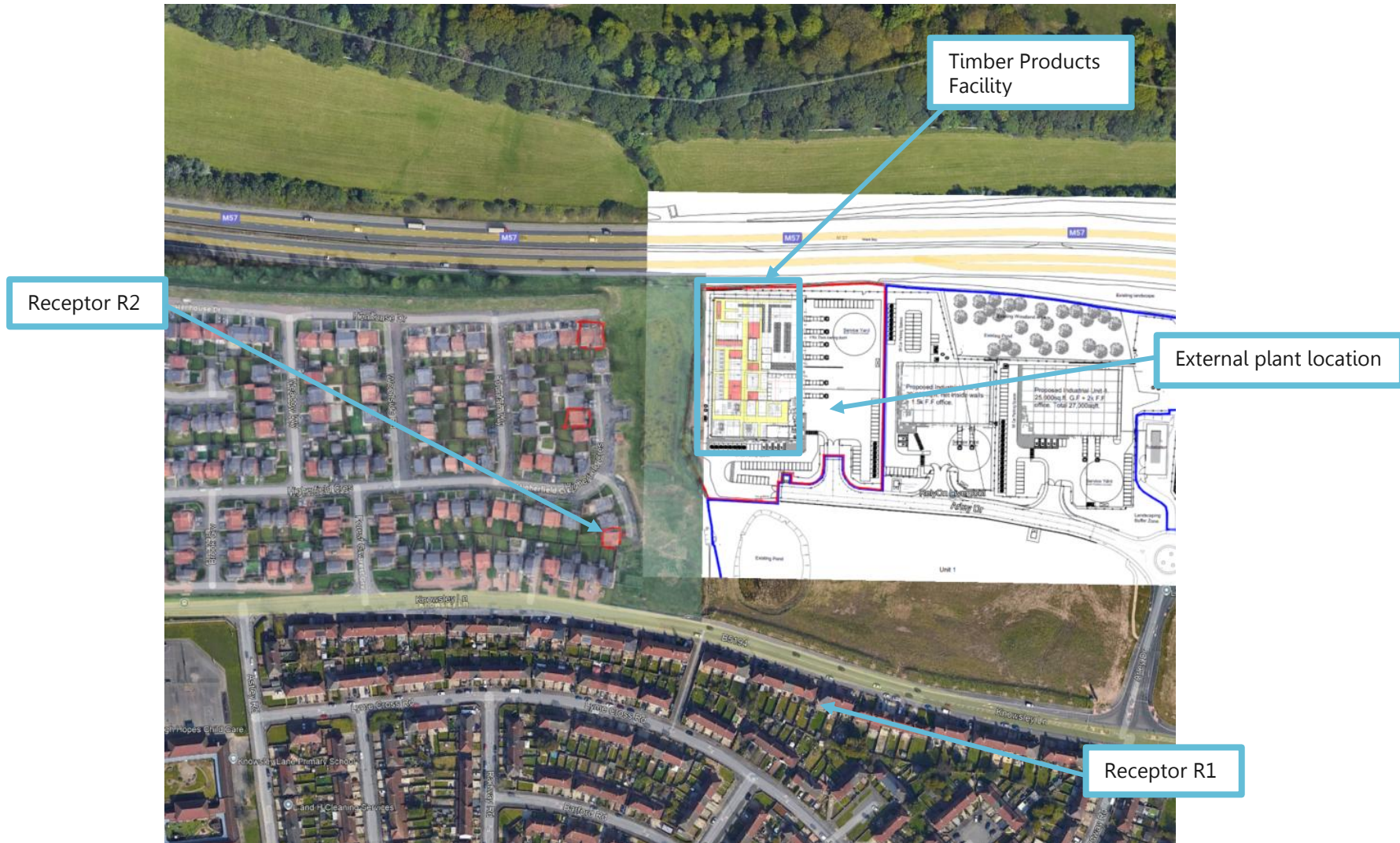
6.0 Summary

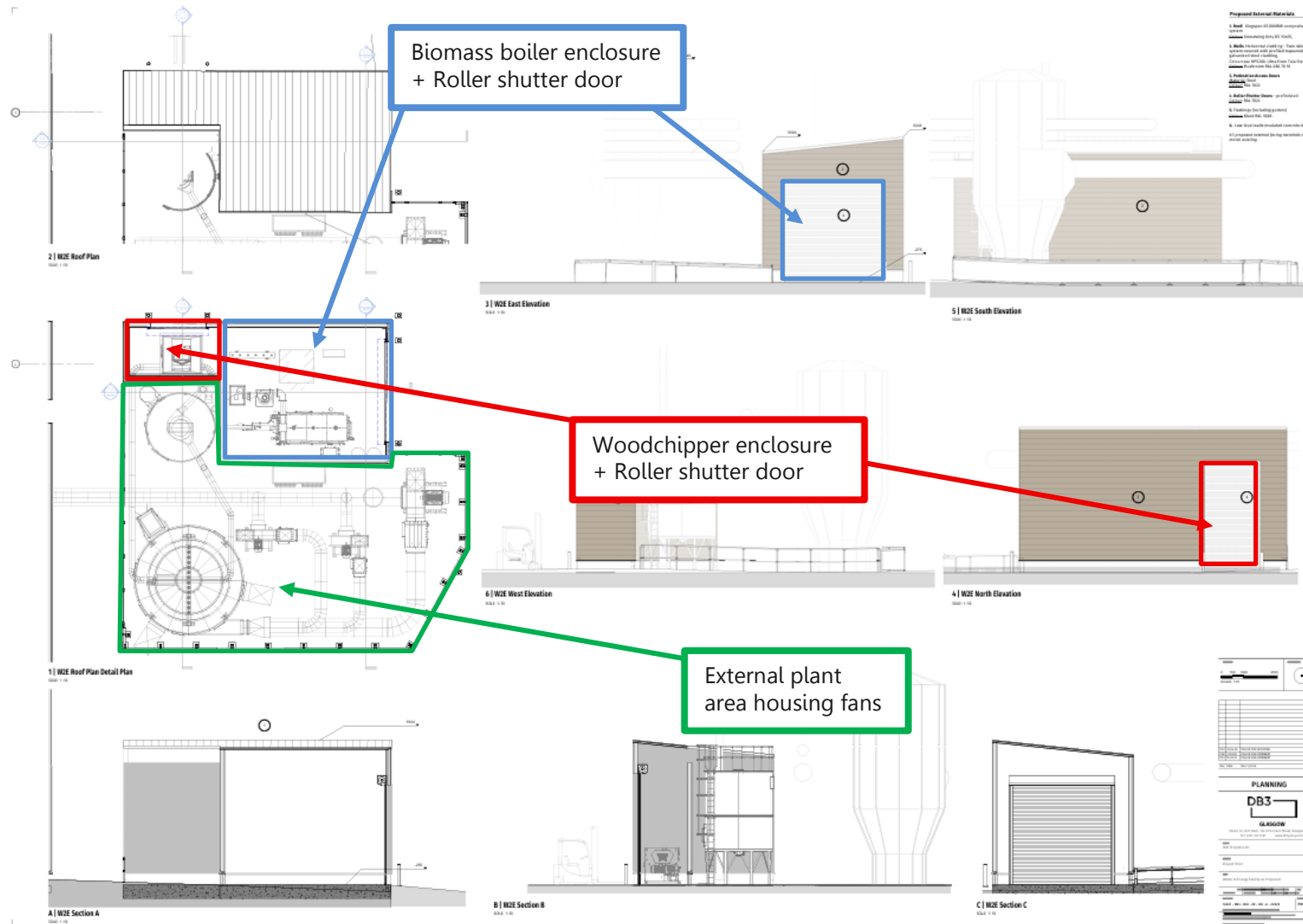
- 6.1. Noise Solutions Ltd (NSL) has been commissioned to provide an assessment of noise relating to a proposed development at Unit 2, Earlsfield Park, Knowsley Lane, Huyton, L34 4AH.
- 6.2. Conditions 14, and 15 of application reference 25/00614/FUL states outlines noise from fixed plant and machinery should be at least 5dB below the existing L_{A90} background noise level.
- 6.3. Predicted noise levels for proposed plant when assessed at the nearest noise sensitive receptor are no louder than the existing background sound level outlined in Ensafe Consultants' report, and thus satisfying Conditions 14 and 15. Predictions are inclusive of the following mitigation measures:
- 4no. ventilation fans to be housed within acoustic enclosures;
 - Biomass boiler and additional fan to be housed within an enclosure comprised of composite panelling similar to the main building structure; and
 - Wood chipper to be housed within an enclosure comprised of composite panelling similar to the main building structure.
- 6.4. Based on the findings of this assessment, noise should not be grounds for refusal of planning permission for the proposed plant.

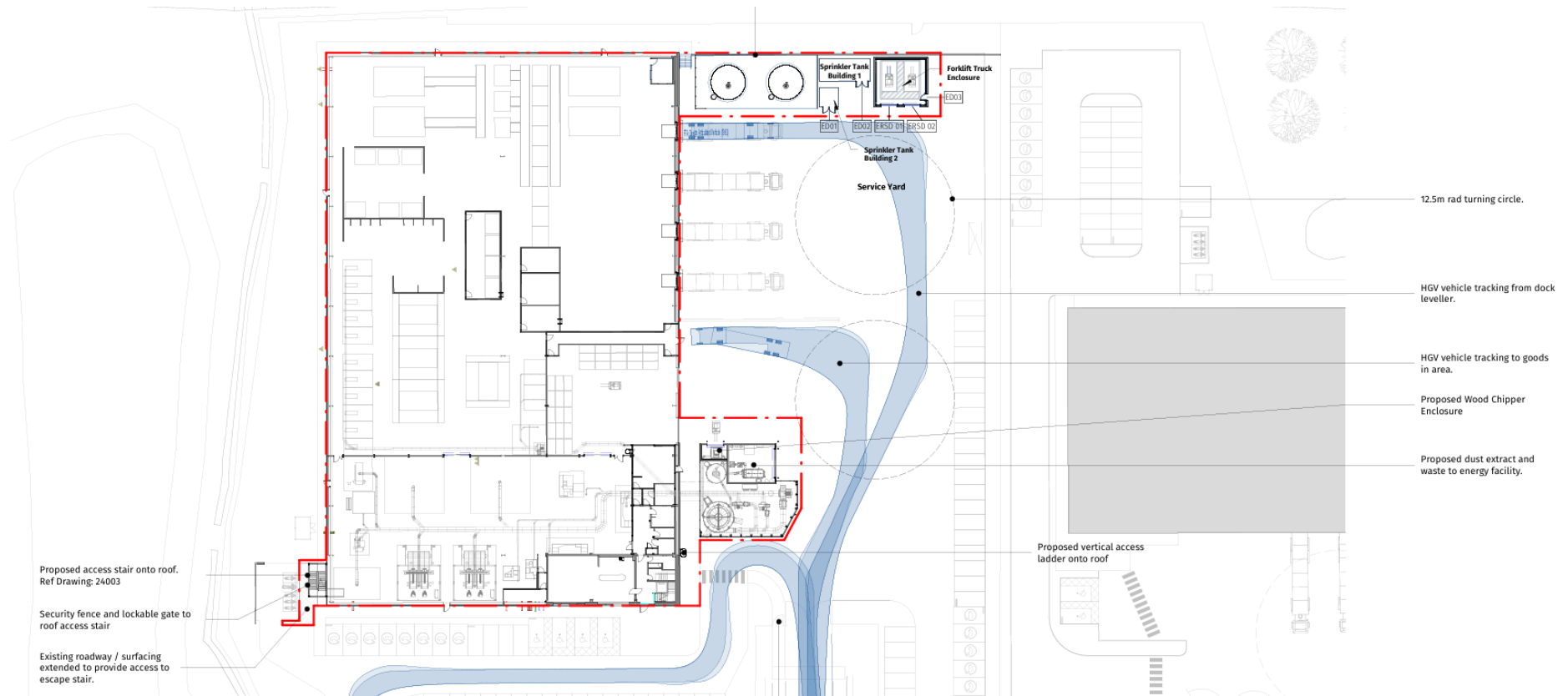
Appendix A Acoustic terminology

Parameter	Description
Ambient Noise Level	The totally encompassing sound in a given situation at a given time, usually composed of a sound from many sources both distant and near ($L_{Aeq,T}$).
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 $20\mu\text{Pa}$. The threshold of normal hearing is in the region of 0 dB and 140 dB is the threshold of pain. A change of 1 dB is only perceptible under controlled conditions.
dB(A), L_{Ax}	Decibels measured on a sound level meter incorporating a frequency weighting (A weighting) which differentiates between sounds of different frequency (pitch) in a similar way to the human ear. Measurements in dB(A) broadly agree with people's assessment of loudness. A change of 3 dB(A) is the minimum perceptible under normal conditions, and a change of 10 dB(A) corresponds roughly to halving or doubling the loudness of a sound. The background noise in a living room may be about 30 dB(A); normal conversation about 60 dB(A) at 1 metre; heavy road traffic about 80 dB(A) at 10 metres; the level near a pneumatic drill about 100 dB(A).
Fast Time Weighting	Setting on sound level meter, denoted by a subscript F, that determines the speed at which the instrument responds to changes in the amplitude of any measured signal. The fast time weighting can lead to higher values than the slow time weighting when rapidly changing signals are measured. The average time constant for the fast response setting is 0.125 (1/8) seconds.
Free-field	Sound pressure level measured outside, far away from reflecting surfaces (except the ground), usually taken to mean at least 3.5 metres
Façade	Sound pressure level measured at a distance of 1 metre in front of a large sound reflecting object such as a building façade.
$L_{Aeq,T}$	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 recorded during a noise event with a 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.
$L_{10,T}$	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. $L_{A10,18h}$ is the A-weighted arithmetic average of the 18 hourly $L_{A10,1h}$ values from 06:00-24:00.
$L_{90,T}$	A noise level index. The noise level that is exceeded for 90% of the measurement time interval, T. It gives an indication of the lower levels of fluctuating noise. It is often used to describe the background noise level and can be considered to be the "average minimum" noise level and is a term used to describe the level to which non-specific noise falls during quiet spells, when there is lull in passing traffic for example.

Appendix B Photograph of site showing areas of interest







Appendix D Sound survey results from "AC103830-1R13"

Table 6: Summary of Measured Ambient and Background Sound Levels

Date	Period	Range of Measured Sound Pressure Level, $L_{Aeq,T}$ (dB)	Range of Measured Background Sound Level, $L_{A90,T}$ (dB)
Thursday 31 st August 2017	Daytime (14:00 – 23:00)	59.0 – 64.3	56.2 – 62.7
	Night-time (23:00 – 07:00)	54.0 – 64.8	49.4 – 62.2
Friday 1 st September 2017	Daytime (07:00 – 23:00)	59.3 – 64.3	56.7 – 64.2
	Night-time (23:00 – 07:00)	52.8 – 60.1	49.4 – 57.0
Saturday 2 nd September 2017	Daytime (07:00 – 23:00)	52.7 – 61.6	50.7 – 56.6
	Night-time (23:00 – 07:00)	47.5 – 53.1	44.5 – 50.6
Sunday 3 rd September 2017	Daytime (07:00 – 23:00)	50.1 – 58.3	48.0 – 57.4
	Night-time (23:00 – 07:00)	43.9 – 56.1	39.8 – 54.3
Monday 4 th September 2017	Daytime (07:00 – 12:00)	53.5 – 57.4	51.5 – 56.3

Appendix E Plant make/ models

Plant	Make/ Model	No. of units	Location	Manufacturer stated Sound Pressure Level
Fan 1*	Air Plants/ 915HE 110kW	1	External	83dBA at 1m
Fan 2*	Air Plants/ 710HP 22kW	1	External	81dBA at 1m
Fan 3*+4	Air Plants/ 710HP 30kW	2	3. External 4. Within Boiler enclosure	81dBA at 1m
Fan 5*	Air Plants/ Load 5 18.5kW	1	External	85dBA at 1m
Biomass Boiler	Talbotts/ MWE 300 Boiler	1	Boiler enclosure	78dBA at 1m
Woodchipper	Talbotts/ Bulldog BD800	1	Woodchipper enclosure	82dBA at 1m

**Each external fan will be housed within an acoustic enclosure comprising 1.2mm galvanized steel, and lined with a 50mm class A absorber, providing 10dB of insertion loss.*

Appendix F Plant noise calculations

Calculations for biomass enclosure noise at façades

Description	Sound reduction index, dB, at 1/1 octave band centre frequencies, Hz								dBA
	63	125	250	500	1k	2k	4k	8k	
Biomass Boiler Southern Façade (Radiating wall = 7.2m x 6.2m)									
Total source sound power level L _w	92	90	86	86	86	83	80	68	90
Surface absorption coefficient (Hard room)	0.05	0.05	0.08	0.08	0.08	0.1	0.1	0.1	n/a
Total absorption	12.2	12.2	19.6	19.6	19.6	24.5	24.5	24.5	
Krev	-5	-5	-7	-7	-7	-8	-8	-8	
Reverberant pressure level L _p	87	84	78	78	78	75	72	60	83
Façade SRI (Cladding)	11	18	37	46	47	62	63	63	n/a
Sound pressure level 1m from façade	79	69	44	35	34	16	11	-1	56
+3dB Directivity correction									
+3dB BS 4142 Feature correction									
Level at R1	48	38	13	4	3	-15	-20	-31	25
Level at R2 (-10dB screening)	38	28	3	-6	-7	-25	-30	-41	15

Description	Sound reduction index, dB, at 1/1 octave band centre frequencies, Hz								dBA
	63	125	250	500	1k	2k	4k	8k	
Biomass Boiler Western Façade (Radiating wall = 3.6m x 6.2m)									
Total source sound power level L_w	92	90	86	86	86	83	80	68	90
Surface absorption coefficient (Hard room)	0.05	0.05	0.08	0.08	0.08	0.1	0.1	0.1	n/a
Total absorption	12.2	12.2	19.6	19.6	19.6	24.5	24.5	24.5	
Krev	-5	-5	-7	-7	-7	-8	-8	-8	
Reverberant pressure level L_p	87	84	78	78	78	75	72	60	83
Façade SRI (Cladding)	11	18	37	46	47	62	63	63	n/a
Sound pressure level 1m from façade	76	66	41	32	31	13	8	-4	53
+3dB Directivity correction									
+3dB BS 4142 Feature correction									
Level at R1	43	33	8	-1	-2	-20	-25	-36	20
Level at R2 (-15dB screening)	29	19	-6	-15	-16	-34	-39	-51	6

Description	Sound reduction index, dB, at 1/1 octave band centre frequencies, Hz								dBA
	63	125	250	500	1k	2k	4k	8k	
Biomass Boiler Eastern Façade (Radiating wall = 5.8m x 6.2m)									
Total source sound power level L_w	92	90	86	86	86	83	80	68	90
Surface absorption coefficient (Hard room)	0.05	0.05	0.08	0.08	0.08	0.1	0.1	0.1	n/a
Total absorption	12.2	12.2	19.6	19.6	19.6	24.5	24.5	24.5	
Krev	-5	-5	-7	-7	-7	-8	-8	-8	
Reverberant pressure level L_p	87	84	78	78	78	75	72	60	83
Façade SRI (Roller door)	10	15	17	23	18	25	40	46	n/a
Sound pressure level 1m from façade	79	71	63	57	62	52	33	15	64
+3dB Directivity correction									
+3dB BS 4142 Feature correction									
Level at R1 (-5dB screening)	40	33	24	18	24	13	-5	-23	26
Level at R2 (-15dB screening)	31	24	15	9	15	4	-14	-32	17

Description	Sound reduction index, dB, at 1/1 octave band centre frequencies, Hz								dBA
	63	125	250	500	1k	2k	4k	8k	
Biomass Boiler Northern Façade (Radiating wall = 7.2m x 6.2m)									
Total source sound power level L_w	92	90	86	86	86	83	80	68	90
Surface absorption coefficient (Hard room)	0.05	0.05	0.08	0.08	0.08	0.1	0.1	0.1	n/a
Total absorption	12.2	12.2	19.6	19.6	19.6	24.5	24.5	24.5	
Krev	-5	-5	-7	-7	-7	-8	-8	-8	
Reverberant pressure level L_p	87	84	78	78	78	75	72	60	83
Façade SRI (Cladding)	11	18	37	46	47	62	63	63	n/a
Sound pressure level 1m from façade	79	69	44	35	34	16	11	-1	56
+3dB Directivity correction									
+3dB BS 4142 Feature correction									
Level at R1 (-10dB screening)	37	27	2	-7	-8	-26	-31	-42	14
Level at R2 (-15dB screening)	33	23	-2	-11	-12	-30	-35	-46	10

Description	Sound reduction index, dB, at 1/1 octave band centre frequencies, Hz								dBA
	63	125	250	500	1k	2k	4k	8k	
Biomass Boiler Roof (Radiating area = 7.2m x 5.8m)									
Total source sound power level L _w	92	90	86	86	86	83	80	68	90
Surface absorption coefficient (Hard room)	0.05	0.05	0.08	0.08	0.08	0.1	0.1	0.1	n/a
Total absorption	12.2	12.2	19.6	19.6	19.6	24.5	24.5	24.5	
Krev	-5	-5	-7	-7	-7	-8	-8	-8	
Reverberant pressure level L _p	87	84	78	78	78	75	72	60	83
Façade SRI (Cladding)	11	18	37	46	47	62	63	63	n/a
Sound pressure level 1m from façade	78	69	43	35	34	15	11	-1	55
+3dB Directivity correction									
+3dB BS 4142 Feature correction									
Level at R1 (-5dB screening)	41	31	6	-3	-4	-22	-27	-38	18
Level at R2 (-15dB screening)	32	22	-3	-12	-13	-31	-36	-47	9

Calculations for woodchipper enclosure noise at façades

Description	Sound reduction index, dB, at 1/1 octave band centre frequencies, Hz								dBA
	63	125	250	500	1k	2k	4k	8k	
Woodchipper Enclosure Southern Façade (Radiating wall = 4m x 6.2m)									
Total source sound power level L_w	96	93	89	89	89	87	84	69	93
Surface absorption coefficient (Hard room)	0.05	0.05	0.08	0.08	0.08	0.1	0.1	0.1	n/a
Total absorption	4.7	4.7	7.6	7.6	7.6	9.4	9.4	9.4	
Krev	-1	-1	-3	-3	-3	-4	-4	-4	
Reverberant pressure level L_p	95	92	86	85	85	83	79	65	90
Façade SRI (Cladding)	11	18	37	46	47	62	63	63	n/a
Sound pressure level 1m from façade	84	74	49	39	38	21	16	2	61
+3dB Directivity correction									
+3dB BS 4142 Feature correction									
Level at R1	50	40	15	5	4	-13	-18	-32	27
Level at R2 (-10dB screening)	36	26	1	-9	-10	-27	-32	-46	13

Description	Sound reduction index, dB, at 1/1 octave band centre frequencies, Hz								dBA
	63	125	250	500	1k	2k	4k	8k	
Woodchipper Enclosure Western Façade (Radiating wall = 2.2m x 6.2m)									
Total source sound power level L_w	96	93	89	89	89	87	84	69	93
Surface absorption coefficient (Hard room)	0.05	0.05	0.08	0.08	0.08	0.1	0.1	0.1	n/a
Total absorption	4.7	4.7	7.6	7.6	7.6	9.4	9.4	9.4	
Krev	-1	-1	-3	-3	-3	-4	-4	-4	
Reverberant pressure level L_p	95	92	86	85	85	83	79	65	90
Façade SRI (Cladding)	11	18	37	46	47	62	63	63	n/a
Sound pressure level 1m from façade	81	72	46	37	36	18	14	-1	58
+3dB Directivity correction									
+3dB BS 4142 Feature correction									
Level at R1	44	34	9	-1	-2	-19	-24	-38	21
Level at R2 (-10dB screening)	35	25	0	-10	-11	-28	-33	-47	12

Description	Sound reduction index, dB, at 1/1 octave band centre frequencies, Hz								dBA
	63	125	250	500	1k	2k	4k	8k	
Woodchipper Enclosure Northern Façade (Radiating wall = 4m x 6.2m)									
Total source sound power level L_w	96	93	89	89	89	87	84	69	93
Surface absorption coefficient (Hard room)	0.05	0.05	0.08	0.08	0.08	0.1	0.1	0.1	n/a
Total absorption	4.7	4.7	7.6	7.6	7.6	9.4	9.4	9.4	
Krev	-1	-1	-3	-3	-3	-4	-4	-4	
Reverberant pressure level L_p	95	92	86	85	85	83	79	65	90
Façade SRI (Roller door)	10	15	17	23	18	25	40	46	n/a
Sound pressure level 1m from façade	85	77	69	62	67	58	39	19	70
+3dB Directivity correction									
+3dB BS 4142 Feature correction									
Level at R1 (-10dB screening)	40	32	24	17	22	13	-6	-26	25
Level at R2 (-15dB screening)	37	29	21	14	19	10	-9	-29	22

Description	Sound reduction index, dB, at 1/1 octave band centre frequencies, Hz								dBA
	63	125	250	500	1k	2k	4k	8k	
Woodchipper Enclosure Roof (Radiating area = 4m x 2.2m)									
Total source sound power level L _w	96	93	89	89	89	87	84	69	93
Surface absorption coefficient (Hard room)	0.05	0.05	0.08	0.08	0.08	0.1	0.1	0.1	n/a
Total absorption	4.7	4.7	7.6	7.6	7.6	9.4	9.4	9.4	
Krev	-1	-1	-3	-3	-3	-4	-4	-4	
Reverberant pressure level L _p	95	92	86	85	85	83	79	65	90
Façade SRI (Cladding)	11	18	37	46	47	62	63	63	n/a
Sound pressure level 1m from façade	79	70	44	35	34	16	12	-3	57
+3dB Directivity correction									
+3dB BS 4142 Feature correction									
Level at R1 (-5dB screening)	36	26	1	-9	-10	-27	-32	-46	13
Level at R2 (-15dB screening)	27	17	-8	-18	-19	-36	-41	-55	4

Remaining plant noise calculations at R1

Unit	Manufacturer source noise level		Distance correction		Directivity, dB	Attenuation, dB	Screening, dB	BS 4142 Feature correction	Rating level, dBA
	L _{pA}	at / m	Distance, m	Correction, dB					
Fan 1	83	1	160	-44	3	-10	0	3	35
Fan 2	81	1	160	-44	3	-10	0	3	33
Fan 3	81	1	160	-44	3	-10	0	3	33
Fan 5	85	1	160	-44	3	-10	0	3	37
Woodchipper (door open)	82	1	170	-45	3	0	-10	10	40
Rating level at R1 – Daytime									44

Remaining plant noise calculations at R2

Unit	Manufacturer source noise level		Distance correction		Directivity, dB	Attenuation, dB	Screening, dB	BS 4142 Feature correction	Rating level, dBA
	L _{pA}	at / m	Distance, m	Correction, dB					
Fan 1	83	1	150	-44	3	-10	-10	3	25
Fan 2	81	1	150	-44	3	-10	-10	3	23
Fan 3	81	1	150	-44	3	-10	-10	3	23
Fan 5	85	1	150	-44	3	-10	-10	3	27
Woodchipper (door open)	82	1	150	-44	3	0	-15	10	36
Rating level at R1 – Daytime									38

Resultant cumulative levels at receptors

Façade	Resultant rating level at receptor L_{Ar} , dB	
	R1	R2
Fan 1	35	25
Fan 2	33	23
Fan 3	33	23
Fan 5	37	27
Woodchipper operating	40	36
Biomass Enclosure Southern Façade	24	15
Biomass Enclosure Eastern Façade	26	17
Biomass Enclosure Northern Façade	14	10
Biomass Enclosure Western Façade	20	6
Biomass Enclosure Roof	18	9
Chipper Enclosure Southern Façade	27	12
Chipper Enclosure Western Façade	25	12
Chipper Enclosure Northern Façade	21	21
Chipper Enclosure Roof	13	4
Cumulative rating level	44	38