Appendix 4.3

SWIP Plant Data

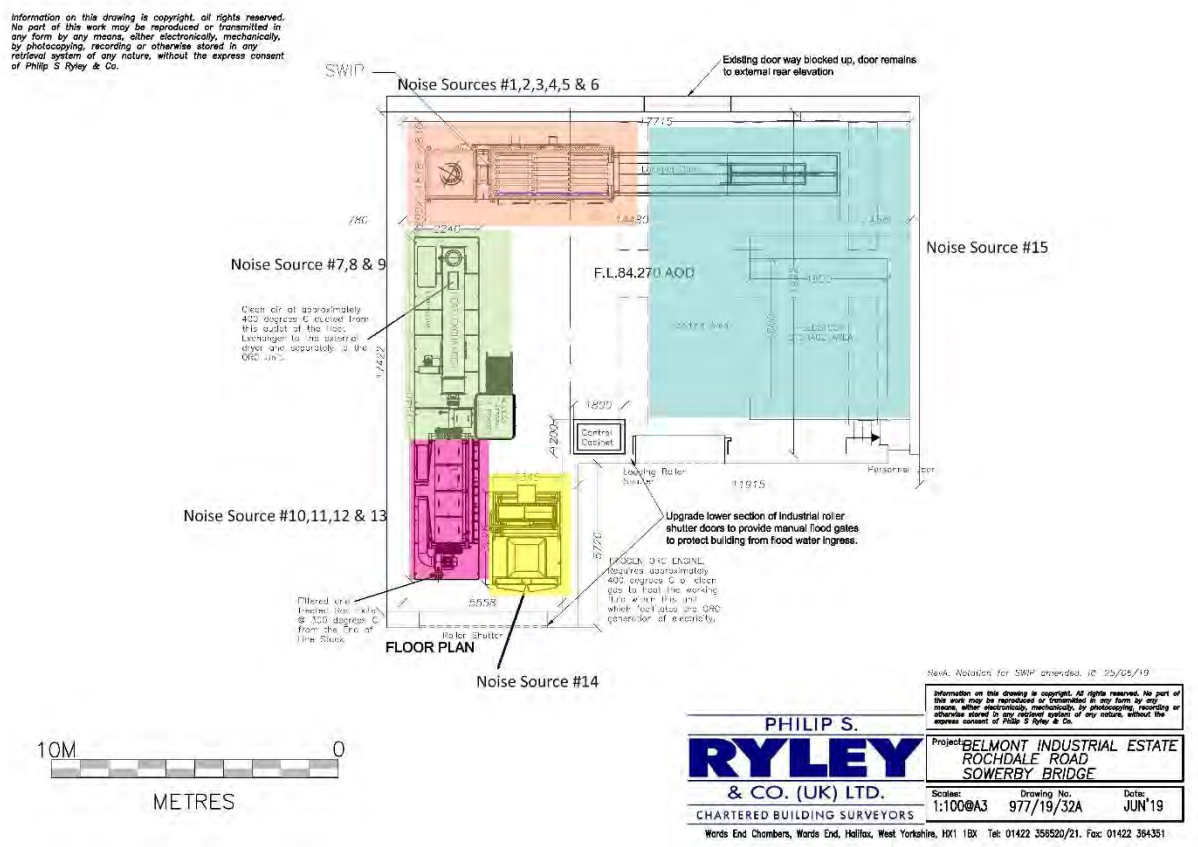
4.3 SWIP PLANT DATA

4.3.1 The following data has been sourced from the plant providers.

Noise sources within the SWIP Building

4.3.2 The plant layout within the SWIP building has been confirmed by discussions with 'Inciner8 Ltd', the plant providers. Figure 4.3.1 shows the proposed layout.

Figure 4.3.1 Plant Layout within the SWIP Building



4.3.3 The noise level for the plant sources within the SWIP building are shown in Table 4.3.1.

Table 4.3.1 Sound Power Levels for plant within the SWIP Building

Source #	Item	63 Hz	125 Hz	250 Hz	500 Hz	1000 Hz	2000 Hz	4000 Hz	8000 Hz	% on-time	Data Source
						dB (Z)					
1	Blower/Cooler Fan	81	79	82	74	72	69	66	63	100	Incer8 Ltd
2	Blower/Cooler Fan	82	80	83	75	73	70	67	64	100	Incer8 Ltd
3	Blower/Cooler Fan	82	80	83	75	73	70	67	64	100	Incer8 Ltd
4	Blower/Cooler Fan	83	81	84	76	74	71	68	65	100	Incer8 Ltd
5	Blower/Cooler Fan	84	82	85	77	75	72	69	66	100	Incer8 Ltd
6	Blower/Cooler Fan	84	82	85	77	75	72	69	66	100	Incer8 Ltd
7	Blower/Cooler Fan	83	81	84	76	74	71	68	65	100	Incer8 Ltd
8	Blower/Cooler Fan	83	81	84	76	74	71	68	65	100	Incer8 Ltd
9	Blower/Cooler Fan	81	79	82	74	72	69	66	63	100	Incer8 Ltd
10	Blower/Cooler Fan	78	76	79	71	69	66	63	60	100	Incer8 Ltd

Source #	Item	63 Hz	125 Hz	250 Hz	500 Hz	1000 Hz	2000 Hz	4000 Hz	8000 Hz	% on-time	Data Source
						dB (Z)					
11	Blower/Cooler Fan	78	76	79	71	69	66	63	60	100	Incer8 Ltd
12	Blower/Cooler Fan	78	76	79	71	69	66	63	60	100	Incer8 Ltd
13	ID Fan	84	82	85	77	75	72	69	66	100	Incer8 Ltd
14	TRIOGEN OCR	72	74	75	76	77	74	70	65	100	Incer8 Ltd
15	Mini tracked excavator/loader	84	76	73	67	65	61	54	45	50	BS5228:2014

Reverberant Sound Calculation

4.3.4 The above source noise levels have been aggregated and corrected for reverberation within the SWIP building resulting in the following noise levels:

	63 Hz	125 Hz	250 Hz	500 Hz	1000 Hz	2000 Hz	4000 Hz	8000 Hz
Wall Absorption co-efficient	0.05	0.05	0.04	0.02	0.04	0.05	0.05	0.05
Ceiling Absorption co-efficient	0.15	0.10	0.08	0.05	0.05	0.05	0.05	0.05
Floor Absorption co-efficient	0.01	0.01	0.01	0.02	0.02	0.02	0.02	0.02
Average	0.07	0.05	0.04	0.03	0.04	0.04	0.04	0.04
10 log(4/$R_{constant}$)	-12.97	-11.98	-11.02	-9.07	-10.45	-11.02	-11.02	-11.02
Reverb time, T60 (Norris-Eyring), sec	4.46	5.57	6.91	10.76	7.86	6.92	6.92	6.92
Lp, dB	80.8	79.5	83.3	77.6	74.5	71.0	67.9	64.6

Sound Reduction Index (SRI) Calculations

4.3.5 The following figure shows the designation for the walls used for the SRI calculations

Figure C2 SRI Wall Designation

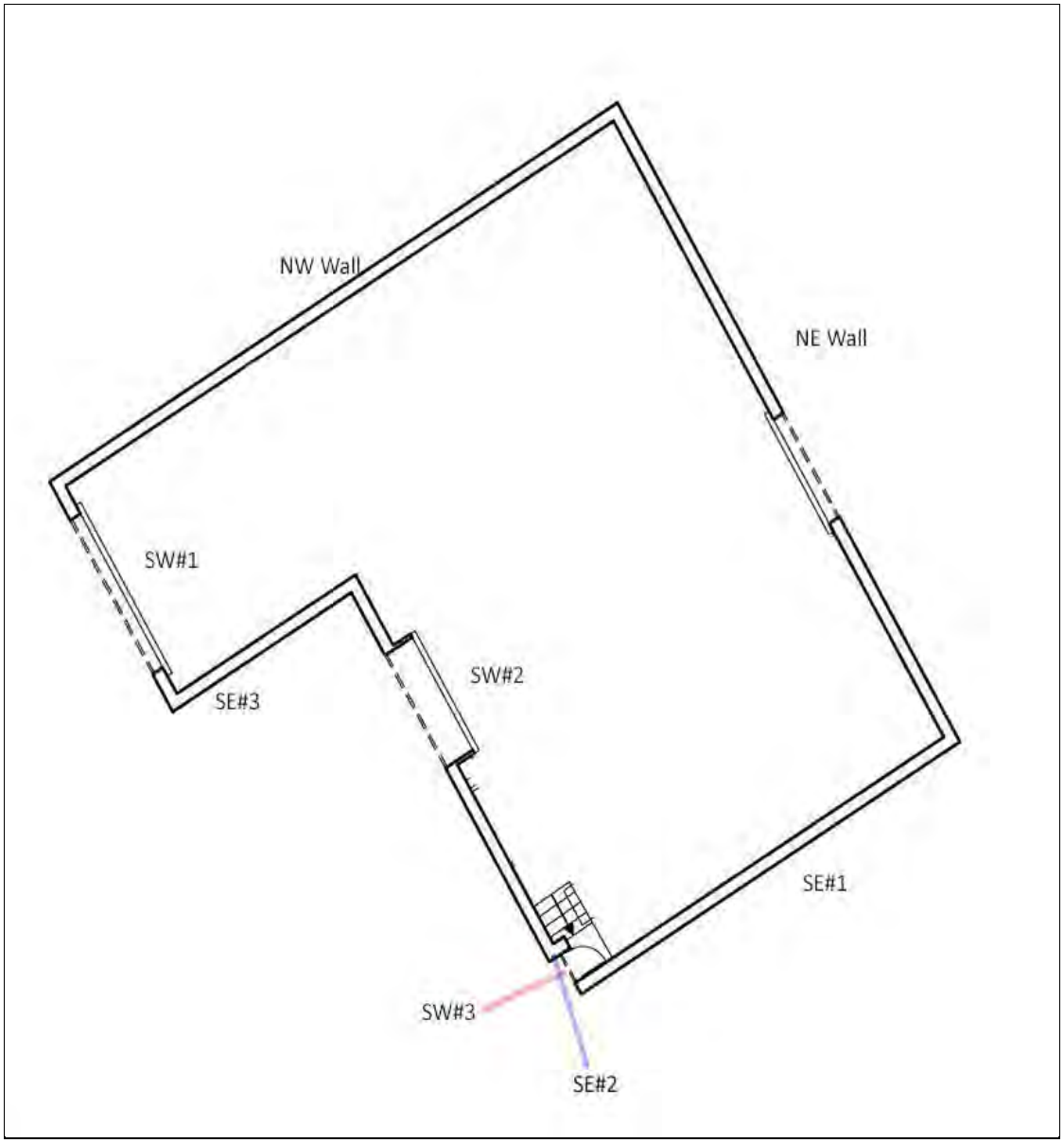


Table 4.3.2 SRI Calculation

SW #1												
					63 Hz	125 Hz	250 Hz	500 Hz	1 kHz	2 kHz	4 kHz	8 kHz
	Brick Wall		dB	Rw	30	36	37	40	46	54	57	59
				t	0.001	0.000251	0.0002	0.0001	2.51189E-05	3.98107E-06	1.99526E-06	1.25893E-06
SRI	Metal Cladding		dB	Rw	16	17	18	23	21	29	32	30
				t	0.0251189	0.019953	0.015849	0.005011872	0.007943282	0.001258925	0.000630957	0.001
	Door		dB	Rw	15	17	17	18	20	21	23	24
				t	0.0316228	0.019953	0.019953	0.015848932	0.01	0.007943282	0.005011872	0.003981072
		Width, m	Height, m									
Rav												
	Door	4.4	5.3									
	Wall	2.76	5.3									
	Cladding	7.16	2.2									
			Wall		0.014628	0.003674	0.002919	0.0014628	0.000367439	5.82351E-05	2.91867E-05	1.84156E-05
			Cladding		0.3956724	0.314294	0.249652	0.078947013	0.125122584	0.019830593	0.00993884	0.015752
			Door		0.7374432	0.465295	0.465295	0.369597092	0.2332	0.185237344	0.116876863	0.092838592
			Tav		0.0213732	0.014586	0.013368	0.008380017	0.006679516	0.003819854	0.002362102	0.002022514
	Composite SRI	**SW#1**	**Av Rw**	**dB**	**17**	**18**	**19**	**21**	**22**	**24**	**26**	**27**
SW #2												
					63 Hz	125 Hz	250 Hz	500 Hz	1 kHz	2 kHz	4 kHz	8 kHz
	Brick Wall		dB	Rw	30	36	37	40	46	54	57	59
				t	0.001	0.000251	0.0002	0.0001	2.51189E-05	3.98107E-06	1.99526E-06	1.25893E-06

SRI	**Metal Cladding**		dB	Rw	16	17	18	23	21	29	32	30
				t	0.0251189	0.019953	0.015849	0.005011872	0.007943282	0.001258925	0.000630957	0.001
	Door		dB	Rw	15	17	17	18	20	21	23	24
				t	0.0316228	0.019953	0.019953	0.015848932	0.01	0.007943282	0.005011872	0.003981072
		Width, m	**Height, m**									
Rav												
	Door	3.2	3									
	Wall	7.5	5.3									
	Wall	3.2	2.3									
			Cladding		0.00736	0.001849	0.001469	0.000736	0.000184875	2.93007E-05	1.46851E-05	9.26569E-06
			Door		0.3035787	0.191545	0.191545	0.152149746	0.096	0.076255511	0.048113974	0.038218288
			Tav		0.0061839	0.003586	0.003543	0.002766016	0.00171369	0.001347964	0.000850079	0.000674971
	Composite SRI	**SW#2**	**Av Rw**	**dB**	**22**	**24**	**25**	**26**	**28**	**29**	**31**	**32**
SE #1												
					63 Hz	**125 Hz**	**250 Hz**	**500 Hz**	**1 kHz**	**2 kHz**	**4 kHz**	**8 kHz**
	Brick Wall		dB	Rw	30	36	37	40	46	54	57	59
				t	0.001	0.000251	0.0002	0.0001	2.51189E-05	3.98107E-06	1.99526E-06	1.25893E-06
SRI	**Metal Cladding**		dB	Rw	16	17	18	23	21	29	32	30
				t	0.0251189	0.019953	0.015849	0.005011872	0.007943282	0.001258925	0.000630957	0.001
	Door		dB	Rw	15	17	17	18	20	21	23	24
				t	0.0316228	0.019953	0.019953	0.015848932	0.01	0.007943282	0.005011872	0.003981072
		Width, m	**Height, m**									
Rav												
	Wall	5.81	7.47									

			Wall		0.0434007	0.010902	0.00866	0.00434007	0.001090176	0.000172781	8.65958E-05	5.46382E-05
			Tav		0.001	0.000251	0.0002	0.0001	2.51189E-05	3.98107E-06	1.99526E-06	1.25893E-06
	Composite SRI	**SE#1**	**Av Rw**	**dB**	**30**	**36**	**37**	**40**	**46**	**54**	**57**	**59**
SE #2												
					63 Hz	**125 Hz**	**250 Hz**	**500 Hz**	**1 kHz**	**2 kHz**	**4 kHz**	**8 kHz**
	Brick Wall		dB	Rw	30	36	37	40	46	54	57	59
				t	0.001	0.000251	0.0002	0.0001	2.51189E-05	3.98107E-06	1.99526E-06	1.25893E-06
SRI	**Metal Cladding**		dB	Rw	16	17	18	23	21	29	32	30
				t	0.0251189	0.019953	0.015849	0.005011872	0.007943282	0.001258925	0.000630957	0.001
	Door		dB	Rw	15	17	17	18	20	21	23	24
				t	0.0316228	0.019953	0.019953	0.015848932	0.01	0.007943282	0.005011872	0.003981072
		Width, m	**Height, m**									
Rav												
	Wall	0.35	7.47									
			Wall		0.0026145	0.000657	0.000522	0.00026145	6.56733E-05	1.04085E-05	5.21661E-06	3.29146E-06
			Tav		0.001	0.000251	0.0002	0.0001	2.51189E-05	3.98107E-06	1.99526E-06	1.25893E-06
	Composite SRI	**SE#2**	**Av Rw**	**dB**	**30**	**36**	**37**	**40**	**46**	**54**	**57**	**59**
SE #3												
					63 Hz	**125 Hz**	**250 Hz**	**500 Hz**	**1 kHz**	**2 kHz**	**4 kHz**	**8 kHz**
	Brick Wall		dB	Rw	30	36	37	40	46	54	57	59
				t	0.001	0.000251	0.0002	0.0001	2.51189E-05	3.98107E-06	1.99526E-06	1.25893E-06
SRI	**Metal Cladding**		dB	Rw	16	17	18	23	21	29	32	30
				t	0.0251189	0.019953	0.015849	0.005011872	0.007943282	0.001258925	0.000630957	0.001
	Door		dB	Rw	15	17	17	18	20	21	23	24
				t	0.0316228	0.019953	0.019953	0.015848932	0.01	0.007943282	0.005011872	0.003981072

		Width, m	Height, m									
Rav												
	Wall	12.76	5.3									
			Wall		0.067628	0.016987	0.013494	0.0067628	0.001698739	0.000269232	0.000134936	8.51386E-05
			Tav		0.001	0.000251	0.0002	0.0001	2.51189E-05	3.98107E-06	1.99526E-06	1.25893E-06
	Composite SRI	**SE#3**	**Av Rw**		**30**	**36**	**37**	**40**	**46**	**54**	**57**	**59**
NE												
					63 Hz	**125 Hz**	**250 Hz**	**500 Hz**	**1 kHz**	**2 kHz**	**4 kHz**	**8 kHz**
	Brick Wall		dB	Rw	30	36	37	40	46	54	57	59
				t	0.001	0.000251	0.0002	0.0001	2.51189E-05	3.98107E-06	1.99526E-06	1.25893E-06
SRI	**Metal Cladding**		dB	Rw	16	17	18	23	21	29	32	30
				t	0.0251189	0.019953	0.015849	0.005011872	0.007943282	0.001258925	0.000630957	0.001
	Door		dB	Rw	15	17	17	18	20	21	23	24
				t	0.0316228	0.019953	0.019953	0.015848932	0.01	0.007943282	0.005011872	0.003981072
		Width, m	**Height, m**									
Rav												
	Door	2.9	3.1									
	Wall	19.05	5.3									
	Cladding	19.05	2.17									
			Wall		0.091975	0.023103	0.018351	0.0091975	0.002310308	0.000366159	0.000183514	0.00011579
			Cladding		1.0383762	0.824812	0.655171	0.207183285	0.328363377	0.052042088	0.02608283	0.0413385
			Door		0.2842888	0.179374	0.179374	0.142481898	0.0899	0.071410108	0.045056732	0.035789835
			Tav		0.020918	0.01519	0.012612	0.005306422	0.006218928	0.001830874	0.001054638	0.001142191
	Composite SRI	**NE**	**Av Rw**	**dB**	**17**	**18**	**19**	**23**	**22**	**27**	**30**	**29**

	Loading Door SW#2 (open)											
SRI	Wall		dB	Rw	30	36	37	40	46	54	57	59
				t	0.001	0.000251	0.0002	0.0001	2.51189E-05	3.98107E-06	1.99526E-06	1.25893E-06
	Open Door		dB	Rw	5	5	5	5	5	5	5	5
				t	0.3162278	0.316228	0.316228	0.316227766	0.316227766	0.316227766	0.316227766	0.316227766
		Width, m	Height, m									
Rav												
	Door	3.2	3									
	Wall	7.5	5.3									
			Wall		0.04711	0.011833	0.0094	0.004711	0.00118335	0.000187548	9.39968E-05	5.9308E-05
			Open Door		3.0357866	3.035787	3.035787	3.035786554	3.035786554	3.035786554	3.035786554	3.035786554
			Tav		0.0543625	0.05374	0.053698	0.05361484	0.053552635	0.053535075	0.053533425	0.053532814
	Composite SRI	SW#3 Open Door	**Av Rw**	**dB**	**13**	**13**	**13**	**13**	**13**	**13**	**13**	**13**
	Roof		dB	Rw	13	14	15	20	18	26	29	27
				t	0.0501187	0.039811	0.031623	0.01	0.015848932	0.002511886	0.001258925	0.001995262
Rav	Roof		Area	286.43								
			Roof		14.355686	11.40313	9.057826	2.864336	4.539666627	0.719488673	0.360598538	0.571510168
			Tav		0.0501187	0.039811	0.031623	0.01	0.015848932	0.002511886	0.001258925	0.001995262
	Composite SRI	Roof	**Av Rw**	**dB**	**13**	**14**	**15**	**20**	**18**	**26**	**29**	**27**
NW												
					63 Hz	**125 Hz**	**250 Hz**	**500 Hz**	**1 kHz**	**2 kHz**	**4 kHz**	**8 kHz**
	Brick Wall		dB	Rw	30	36	37	40	46	54	57	59
				t	0.001	0.000251	0.0002	0.0001	2.51189E-05	3.98107E-06	1.99526E-06	1.25893E-06
SRI	**Metal Cladding**		dB	Rw	16	17	18	23	21	29	32	30

				t	0.0251189	0.019953	0.015849	0.005011872	0.007943282	0.001258925	0.000630957	0.001
	Door		dB	Rw	15	17	17	18	20	21	23	24
				t	0.0316228	0.019953	0.019953	0.015848932	0.01	0.007943282	0.005011872	0.003981072
		Width, m	Height, m									
Rav												
	Wall	18.94	5.3									
			Wall		0.091975	0.023103	0.018351	0.0091975	0.002310308	0.000366159	0.000183514	0.00011579
			Tav		0.0009162	0.00023	0.000183	9.1625E-05	2.30152E-05	3.64766E-06	1.82816E-06	1.15349E-06
	Composite SRI	**NW**	**Av Rw**	**dB**	**30**	**36**	**37**	**40**	**46**	**54**	**57**	**59**
SW#3												
					63 Hz	**125 Hz**	**250 Hz**	**500 Hz**	**1 kHz**	**2 kHz**	**4 kHz**	**8 kHz**
	Brick Wall		dB	Rw	30	36	37	40	46	54	57	59
				t	0.001	0.000251	0.0002	0.0001	2.51189E-05	3.98107E-06	1.99526E-06	1.25893E-06
SRI	**Metal Cladding**		dB	Rw	16	17	18	23	21	29	32	30
				t	0.0251189	0.019953	0.015849	0.005011872	0.007943282	0.001258925	0.000630957	0.001
	Door		dB	Rw	15	17	17	18	20	21	23	24
				t	0.0316228	0.019953	0.019953	0.015848932	0.01	0.007943282	0.005011872	0.003981072
		Width, m	**Height, m**									
Rav												
	Door	1	2									
	Wall	1.08	5.4									
			Wall		0.091975	0.023103	0.018351	0.0091975	0.002310308	0.000366159	0.000183514	0.00011579
			Tav		0.0157707	0.003961	0.003147	0.001577075	0.000396143	6.27845E-05	3.14668E-05	1.98542E-05
	Composite SRI	**SW#3**	**Av Rw**	**dB**	**18**	**24**	**25**	**28**	**34**	**42**	**45**	**47**

4.3.6 The ES used the following SRI:

Table 4.3.3 ES and Addendum SRI data for the roof, door and the walls, Rw dB

Freq	63 Hz	125 Hz	250 Hz	500 Hz	1 kHz	2 kHz	4 kHz	8 kHz
ES data for roof and walls	23	21	27	33	34	35	43	43
ES data for the roller shutter Doors	15	17	17	18	20	21	23	24
Addendum data for the roller shutter door	15	17	17	18	20	21	23	24
Addendum Data for the roof	13	14	15	20	18	26	29	27
Addendum data for the part brick wall	30	36	37	40	46	54	57	59
Addendum data for the part metal cladding wall	16	17	18	23	21	29	32	30

SWIP related on-site mobile sources

4.3.7 The haul route from the recycling shed to the SWIP building carrying RDF waste and then from the SWIP building either carrying the ash in a sealed container to the ash drop-off and then back to the recycling shed or directly back to the recycling shed has been included in the noise assessment using the following data. This is based on there being 5 two-way movements per hour i.e. a total of 10 movements per hour.

Table 4.3.4 SWIP haul Route Data

Source data	$L_{Aeq,T}$ dB	Distance, m	Time, sec	no of events	Total Time, sec	% on-time for 1hr
Wheeled Loader to SWIP and back via containerized ash drop-off or back to the recycling shed	76.4	10	60	10	600	16.8

Noise data provided for the Dryer by the plant providers

4.3.8 The dryer provider, Stronga Drying Systems has indicated that the 'FlowDrya FD17' dryer consists of a Heatex 500DF, associated fans and the dryer bed. Discussions with the provider indicated that it is not possible to separate the noise egress from the separate sources. Their assessment is that with the dryer loaded with aggerates and the fans on full power, the sound power level of the system is 78 dB(A). The loading and unloading activities of the dryer is based upon site data for the CASE front wheeled loader undertaking similar activities and measured at 89.4 dB (10m) $L_{Aeq,T}$. This level is corrected for the percentage time of 10% (90 seconds for each activity with four movements in an hour) results in sound power level of 79.8 dB for any working hour.

Ventilation Vent Opening

4.3.9 For ventilation of the SWIP building, one vent opening (measuring 0.7m by 0.7m) will be installed at the south-west façade of the SWIP building which will enable the Induced Draft Fan (ID Fan) to draw in adequate amounts of natural air. The noise model uses the following parameters to calculate noise levels at the receptors.

Ventilation Noise Parameters

	63 Hz	125 Hz	250 Hz	500 Hz	1K Hz	2K Hz	4K Hz	8k Hz
Sound Power Level dB, ID fan	84	82	85	77	75	72	69	66
Attenuator (900mm, model 3LFS)	7	11	21	23	25	21	17	14
Reflection at louvre	-7	-3	-1	0	0	0	0	0
Sound Power Level at louvre	70	68	63	54	50	51	52	52
Directivity on axis	6	6	7.5	8	8.5	9	9	9
Unidirectional directivity	3	3	3	3	3	3	3	3
Final Sound Power Level, dB	79	77	73.5	65	61.5	63	64	64

Chimney Stack Calculations

4.3.10 The chimney stack noise level at the opening at the top of chimney is estimated using the engineering method outlined in the German Standard VDI 3733 'Noise at Pipes' which includes a sub-section on 'Radiation of airborne sound by open pipes, particularly by chimney stacks'.

4.3.11 The noise egress from the chimney stack is determined by the longitudinal attenuation (LA) of the stack. The LA in turn is dependent on the type of internal lining of the chimney stack, the pipe slenderness (ϕ) and ratio of the circumference of the stack to the wavelength (U_w).

4.3.12 The following method is used to estimate the noise level at the top of the stack opening:

Table 4.3.5 VDI 3733 Calculation for Noise Egress at the Chimney Stack opening

Item	Description	Value
dim	Mean inside diameter of tapered pipes (chimney stacks)	0.4m
l	Pipe length	12m
Tf	Temp of fluid	573K
TL	Temp of ambient air	283K
WF	Flow velocity fluid	21.3 m/s
WL	Flow velocity ambient air	3 m/s
CF	Sound velocity in fluid	343 m/s

Item	Description	Value								
		Hz	63	125	250	500	1000	2000	4000	8000
Normalised pipe slenderness	ϕ' = l/(20*dim)	1.5								
Ratio	Uw=(π.dim.f/CF)		0.230	0.458	0.916	1.832	3.665	7.330	14.660	29.321
Longitudinal attenuation ratio	DL/ϕ'		2	2	2	2	2	2	2	2
Sound Power Level Lw (Stack Base)		dB	84	82	85	77	75	72	69	66
Longitudinal attenuation	(DL/ϕ').ϕ'		3	3	3	3	3	3	3	3
Directivity	DI (ChartD2,VDI 3733)		-3	-2	-2	-3	-4	-5	-5	-5
Sound Power Level for effective for emission	SWL=Lw+DI-DL	dB	78	77	80	71	68	64	61	58

Chimney Stack Opening Directivity

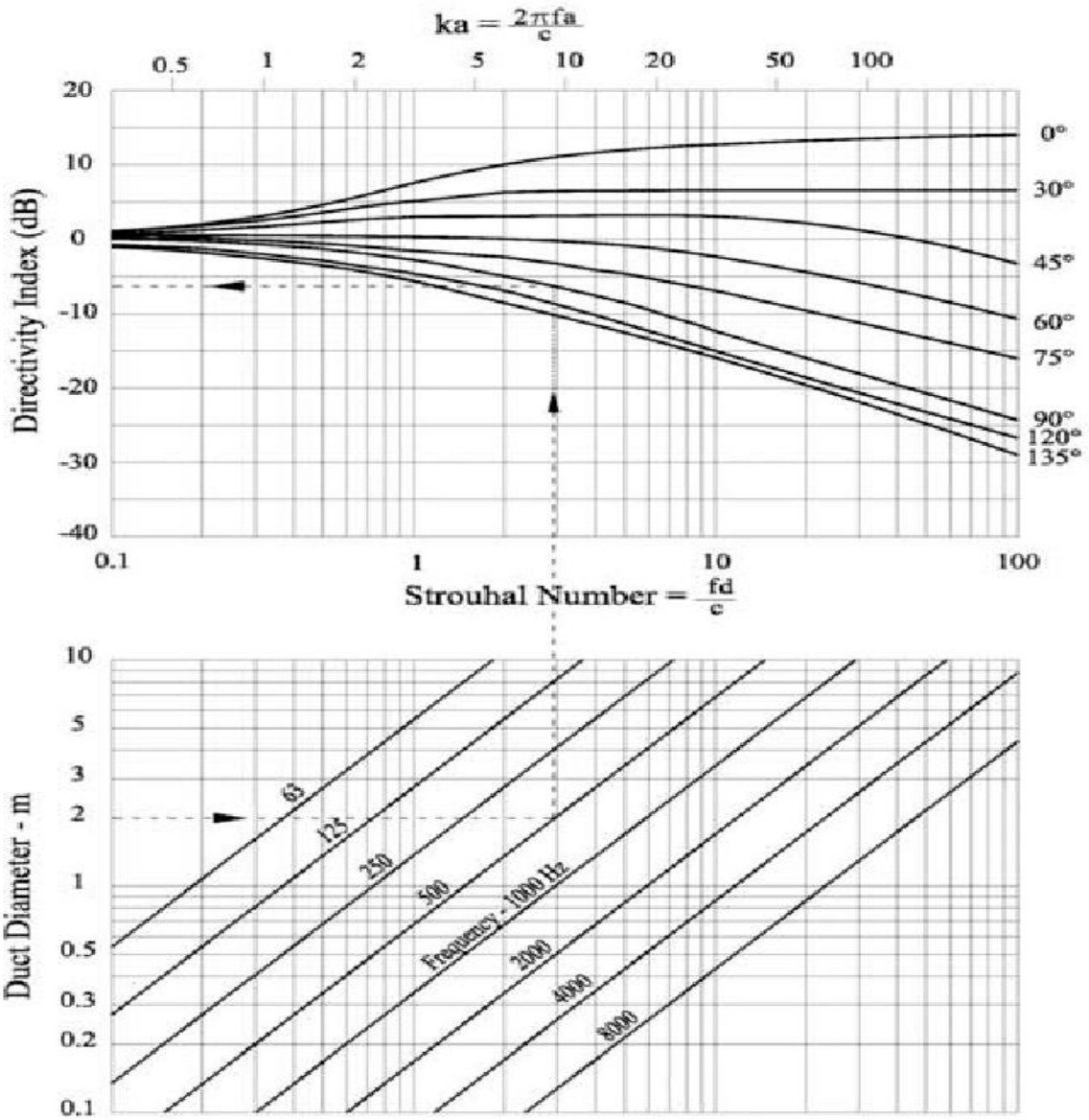
4.3.13 The directivity of noise egress propagation to a nearby receptor from an exhaust stack opening needs to be taken into consideration.

4.3.14 DI is the directivity index given by intensity in any one direction I_ϕ divided by the intensity averaged over all possible directions:

$DI(\phi)= 10*\log (I_\phi/I_{average})$

4.3.15 The above relationship is further described by the following chart developed by Hansen & Bies (‘Engineering Noise Control’) and again further refined by Hansen in 2009:

Figure 4.3.3 Exhaust stack directivity index measured in the field vs ka where a is the stack diameter and k is the wavenumber.



4.3.16 The receptors adjacent to the application site are between 82 and 86 degrees from the vertical. The average directivity from the above chart is presented below and included in the calculations.

Table 4.3.6 Directivity Correction for Sound Propagation (Hansen & Bies)

Frequency (Hz)	63	125	250	500	1000	2000	4000	8000
Sound Power Level at Chimney Opening dB	78	77	80	71	68	64	61	58
Directivity Index	0	0	0	-1	-2	-4	-6	-9
Corrected Sound Power Level at Chimney Opening for propagation to receptors dB (inserted into noise model)	78	77	80	70	66	60	55	49

Stack Noise Radiation through Chimney Wall

In additional to the noise from the chimney stack opening, noise levels from the chimney walls has also been assessed. Rather like the noise egress from a building, ISO 9613 methodology has been applied to gauge the noise transmission through the chimney walls. The noise model uses a series of finite straight lines to build a circular chimney wall. The sound reduction index of the chimney wall is presented in Table 4.37 and the sound power level is assumed be that of the stack base presented in Table 4.35 (without any loss of power going up the stack).

Table 4.3.7 Sound Reduction of the Chimney, Rw dB

Frequency (Hz)	63	125	250	500	1000	2000	4000	8000
Sound Reduction Index of the steel chimney	3	8	14	20	26	32	38	40

4.3.17 The noise model uses the following parameters for the ISO 9613 and BS 5228 calculations:

- Temperature 10^0 C;
- Humidity 70%; and
- Ground Cover: Hard (no soft ground absorption)