Appendix 3.10 Calculation of Odour Emissions

Design of Deodorization System

DO 1 (Inlet Works + PST)

Building	TKO Location	Nos.	B.W.L./T.W.L./ Base Level (mPD)	Ceiling Level (mPD)	Air Phase Height (m)	Length (m)	Width (m)	Unit Measured Area (m2)	Safety Factor	Total Odour Emission Area (m2)	Air Phase Volume (m3)	Air Exchange Rate (Air Changes / hr)	SOER (ou/m2/s) [1]	Unmitigated Odour Emission Rate (ou/s)	Flow Rate (m3/hr)	Total Flow Rate (m3/s)	Velocity (m/s)	Number of Exhaust Point (nos.)	Elevation (m)	Height of the Deodorizer Exhaust Point (mAG)	Diameter of the Deodorizer Exhaust Point (m)	Removal Efficiency (%) [2]	Mitigated Odour Emission Rate (ou/s)	Temperature at exhaust point (C)
Inlet Works	Inlet Channel	1	2.50	7.00	4.50	15.00	2.00	30	1.2	36	162	3	3.26	117	486	14.22	7.50	2	6.75	8.00	1.10	95.0%	230	Ambient
Inlet Works	Coarse Screen Channel	4	2.45	7.00	4.55	10.00	2.00	20	1.2	24	437	3	3.26	313	1,310									
Inlet Works	Coarse Screen Outlet Channel	1	2.35	7.00	4.65	15.00	2.00	30	1.2	36	167	3	3.26	117	502									
Inlet Works	Wet Well	2	0.00	7.00	7.00	8.00	8.00	64	1.2	77	1,075	3	3.26	501	3,226									
Inlet Works	Fine Screen Inlet Channel	1	10.90	12.00	1.10	15.00	2.00	30	1.2	36	40	3	3.26	117	119									
Inlet Works	Fine Screen Chamber	4	10.80	12.00	1.20	12.00	2.50	30	1.2	36	173	3	3.51	505	518									
Inlet Works	Fine Screen Outlet Channel	1	10.65	12.00	1.35	15.00	2.00	30	1.2	36	49	3	3.26	117	146									
Inlet Works	Grit Trap Inlet Channel	4	10.50	12.00	1.50	10.00	2.00	20	1.2	24	144	3	3.26	313	432									
Inlet Works	Grit Trap	4	10.35	12.00	1.65	6.00	6.00	36	1.2	43	285	3	3.26	563	855									
Inlet Works	Grit Trap Outlet Channel	4	10.25	12.00	1.75	12.00	2.00	24	1.2	29	202	3	3.26	376	605									
PST	PST Inlet Channel	1	10.15	12.00	1.85	35.00	2.50	87.5	1.2	105	194	3	3.26	342	583									
PST	PST Tanks	5	9.50	12.00	2.50	32.00	6.00	192	1.2	230	2,880	12	4.03	4,643	34,560									
PST																								
PST																								
PST																								
PST	PST Outlet Channel	1	9.25	12.00	2.75	35.00	2.50	87.5	1.2	105	289	3	1.54	162	866									
PST	Scum Tank	2	7.00	12.00	5.00	4.00	2.00	8	1.2	10	96	3	4.03	77	288									
Sludge Digestion	Digested Sludge Holding Tank	2	7.00	16.30	9.30	10.00	10.00	100	1.2	120	2,232	3	3.98	955	6,696									
													sub-total	**9,220**	**51,192**									

PST = Primary Sedimentation Tank

DO 2 (Biological Treatment + Secondary Treatment + Sludge Thickening)

Building	TKO Location	No. of Units (Duty)	B.W.L./T.W.L./ Base Level (mPD)	Ceiling Level (mPD)	Air Phase Height (m)	Length (m)	Width (m)	Unit Measured Area (m2)	Safety Factor	Total Odour Emission Area (m2)	Air Phase Volume (m3)	Air Exchange Rate (Air Changes / hr)	SOER (ou/m2/s) [1][4]	Unmitigated Odour Emission Rate (ou/s)	Flow Rate (m3/hr)	Total Flow Rate (m3/s)	Velocity (m/s)	Number of Exhaust Point (nos.)	Elevation (m)	Height of the Deodorizer Exhaust Point (mAG)	Diameter of the Deodorizer Exhaust Point (m)	Removal Efficiency (%) [2]	Mitigated Odour Emission Rate (ou/s)	Temperature at exhaust point (C)
MBBR	MBBR Inlet Channel	1	9.20	10.50	1.30	70	2.5	175	1.2	210	273	3	1.65	347	819	12.2	7.50	2	6.75	8.00	1.02	95.0%	352	Ambient
MBBR	MBBR Trains	5	9.00	10.50	1.50	13	45	585	1.2	702	5,265	3	1.65	5,792	15,795									
MBBR	MBBR Outlet Channel	1	8.40	10.50	2.10	70	2.5	175	1.2	210	441	3	0.02	4	1,323									
DAF	DAF Flocculation Tank	6	8.10	10.50	2.40	8	8	64	1.2	77	1,106	3	0.02	9	3,318									
DAF	DAF Tank	6	7.80	10.50	2.70	16	8	128	1.2	154	2,488	3	3.98	3,668	7,465									
DAF			7.60	10.50	2.90			0	1.2	0	0	3												
DAF	DAF Effluent Channel	6	7.50	10.50	3.00	8	4	32	1.2	38	691	3	3.98	917	2,074									
DAF			7.50	10.50	3.00			0	1.2	0	0	3												
STH	Blended Sludge Storage Tank	2	4.00	10.00	6.00	7	7	49	1.2	59	706	3	3.98	468	2,117									
STH	Thickening Centrifuge	3	10.00	12.00	2.00	6	2	12	1.2	14	86	3	3.98	172	259									
STH	Thickened Sludge Storage Tank	2	4.00	10.00	6.00	6	6	36	1.2	43	518	3	3.98	344	1,555									
STH	Centrate Storage Tank	2	4.00	10.00	6.00	6	6	36	1.2	43	518	3	3.98	344	1,555									
SDH	Dewatering Centrifuge	3	10	12	2.00	6	2	12	1.2	14	86	3	3.98	172	259									
SDH	Sludge Silo	3	7	9	2.00	6	3	18	1.2	22	130	3	0.43	28	389									
SDH	Sludge Cake Skips	3	7	10	3.00	6	3	18	1.2	22	194	12	3.51	227	2,333									
SDH	Screw Conveyor	3	8	8.5	0.50	8	2	16	1.2	19	29	3	3.51	202	86									
SS	Anammox Process Tanks	1	14	16	2.00	12	32.0	384	1.2	461	922	3	2.68	1,235	2,765									
SS	Thickened Sludge Tank	1	10	16	6.00	2	4	8	1.2	10	58	3	3.98	38	173									
SS	Sludge Mixing Tank	1	10	16	6.00	2	3	6	1.2	7	43	3	3.98	29	130									
SS	Sludge Holding Tank	1	10	16	6.00	3	6	18	1.2	22	130	3	3.98	86	389									
													sub-total	**14,081**	**43,969**									

MBBR = Membrane Bioreactor, DAF = Dissolved Air Floatation, STH = Sludge Thickening
SDH = Sludge Dewatering House, SS = Side Stream

Remarks:

[1] SOER Reference: Shek Wu Hui effluent polishing plant https://www.epd.gov.hk/eia/register/report/eiareport/eia_2132013/eia/pdf/appendix/appendix_3-8.pdf. The SOER from SWHEPP was adopted because SWHEPP receives similar nature of sewage without seawater flushing, adopts the same sewage treatment process of the EPP. Among Hong Kong's sewage treatment works with the above similar nature of sewage and treatment process, SWHEPP is of the nearest order of capacity compared to EPP, with the capacity of SWHEPP at 190000 m^3/day and that of EPP at 54000 m^3/day. Note that the approved EIA for Hung Shui Kiu effluent polishing plant (AEIAR-240/2022) also refers to Shek Wu Hui effluent plant for the SOER.

[2] The odour removal efficiency for deodourization units is referenced from Scottish Executive Environment Group Code of Practice on Assessment and Control of Odour Nuisance from Waste Water Treatment Works.

[3] Iowa State University Extension (May 2004). "The Science of Smell Part 1: Odor perception and physiological response" (PDF). PM 1963a)

[4] SOER of Anammox Process Tank: approved EIA for Hung Shui Kiu effluent polishign plant (AEIAR-240/2022).

Appendix 3.10 Calculation of Odour Emissions

EPP Detail Calculation of Source Odour Emission Rate

Exhaust Design

Deodouriser	Description	Source Type	Exhaust Location		Exhaust Diameter (m)	Height (mAG)	Exit Temperature (K)	Exit Velocity (m/s)
			X	Y				
EPP01A	Exhaust point (Inlet Works + PST)	POINTHOR	846494.21	814654.77	1.10	8.00	Ambient	7.5
EPP01B	Exhaust point (Inlet Works + PST)	POINTHOR	846494.21	814654.77	1.10	8.00	Ambient	7.5
EPP02A	Exhaust point (Membrane Bioreactor + Dissolved Air Floatation + Sludge Thickening + Digesters)	POINTHOR	846549.67	814621.57	1.02	8.00	Ambient	7.5
EPP02B	Exhaust point (Membrane Bioreactor + Dissolved Air Floatation + Sludge Thickening + Digesters)	POINTHOR	846549.67	814621.57	1.02	8.00	Ambient	7.5

Remark
1. The desgin parameters are provided by engineeres.

Conversion of 1-hour Average to 5-second Average Concentration

Deodouriser	Emission Rate (OU/s)	Stability Class	Conversion Multiplier	Emission Rate with 5-second Peak Factor (OU/s)	Reference
EPP01A	230	A, B, C, D, E, F	2.3	530.12	- Approved Methods for the Modelling and Assessment of Air Pollutants in New South Wales. - Katestone Scientific 1995, The Evaluation of Peak-to-Mean Ratios for Odour Assessments, volumes I and II, Katestone Scientific Pty Ltd, Brisbane. - Katestone Scientific 1998, Peak-to-Mean Concentration Ratios for Odour Assessments, Katestone Scientific Pty Ltd, Brisbane.
EPP01B	230	A, B, C, D, E, F	2.3	530.12	
EPP02A	352	A, B, C, D, E, F	2.3	809.67	
EPP02B	352	A, B, C, D, E, F	2.3	809.67	

Emission Source Listing in AERMOD

Source ID	Type	X	Y	Exhaust Diameter (m)	Height (mAG)	Exit Temperature (K)	Exit Velocity(m/s)	Emission Rate with 5-second Peak Factor (OU/s)
EPP01A	POINTHOR	846494.21	814654.77	1.10	8.00	0	7.5	530.12
EPP01B	POINTHOR	846494.21	814654.77	1.10	8.00	0	7.5	530.12
EPP02A	POINTHOR	846549.67	814621.57	1.02	8.00	0	7.5	809.67
EPP02B	POINTHOR	846549.67	814621.57	1.02	8.00	0	7.5	809.67

Appendix 3.10 Calculation of Odour Emissions

Proposed Sewage Pumping Station

Design of Sewage Pumping Station

Location	Total Odour Emission Area (m^2) [1]	SOER ($ou/m^2 \cdot s$) [2]	Unmitigated Odour Emission Rate (ou/s)	Removal Efficiency (%)	Mitigated Odour Emission Rate (OU/s)
SPS at Inlet Channel	3.75	8.79	32.96	95.00	1.65
SPS at Coarse Screen Channels	15.75	8.79	138.44	95.00	6.92
SPS at Outlet Channel	5.00	8.79	43.95	95.00	2.20
SPS at Wet Well	21.00	8.79	184.59	95.00	9.23
Total	45.50	8.79	399.95	95.00	20.00

Remark

1. The odour emission area is provided by engineers.
2. The SOER refers to the approved EIA for Sai O Trunk Sewage Pumping Station (AEIAR-230/2021) because of their similar operation nature.

Exhaust Design

Deodouriser	Description	Source Type	Exhaust Location		Exhaust Diameter (m)	Height (mAG)	Exit Temperature (K)	Exit Velocity (m/s)
			X	Y				
TKO 132 SPS	Exhaust point of SPS	POINTHOR	843656.12	817028.70	2.00	4.35	Ambient	5.00

Remark

1. The exhaust parameters are provided by engineers.

Conversion of 1-hour Average to 5-second Average Concentration

Deodouriser	Emission Rate (OU/s)	Stability Class	Conversion Multiplier	Emission Rate with 5-second Peak Factor (OU/s)	Reference
SPS01	20	A, B, C, D, E, F	2.3	45.99	- Approved Methods for the Modelling and Assessment of Air Pollutants in New South Wales. - Katestone Scientific 1995, The Evaluation of Peak-to-Mean Ratios for Odour Assessments, volumes I and II, Katestone Scientific Pty Ltd, Brisbane. - Katestone Scientific 1998, Peak-to-Mean Concentration Ratios for Odour Assessments, Katestone Scientific Pty Ltd, Brisbane.

Emission Inventory for Odour Emission (SPS)

Source ID	Type	X	Y	Exhaust Diameter (m)	Height (mAG)	Exit Temperature (K)	Exit Velocity (m/s)	Mitigated Odour Emission Rate (OU/s)
SPS01	POINTHOR	843656.12	817028.70	2.00	4.35	0.00	5.00	45.99

Appendix 3.10 Calculation of Odour Emissions

Proposed Refuse Transfer Station

H2S and NH3 Monitoting data at WKTS

Maximum Total Odour Emssion at DO Inlets (OU/s)	Odour Contribution by H_2S (OU/s)	Odour contribution by NH_3 (OU/s)
1879840.11	1834999.62	44840.49

Remark:
Based on the monitoring data recorded from Jan 2021 to Sep 2024 in West Kowloon Refuse Transfer Station (WKTS) and it covers the odour from the wastewater treatment plant.
Odour thershold of H_2S = 0.00047 ppm
Odour thershold of NH_3 = 0.037 ppm

MSW Handling Capacity of Proposed RTS (tpd)	MSW Handling Capacity of WKTS (tpd)	Odour Emission Adjustment factor
4000	2700	1.48

Remark:
The MSW handling capacity of WKTS is provided by WKTS.

Estimation of Odour Emission from Proposed RTS

	Emission Rate (OU/s)	Adjustment factor	Removal Efficiency	Controlled Odour Emission (OU/s)
Odour by H_2S	1834999.62	1.48	99.90%	2718.52
Odour by NH_3	44840.49	1.48	90.00%	6643.04
			Total odour emission (OU/s)	9361.55

Remark:
The emission rates are calculated based on the monitoring data recorded from Jan 2021 to Sep 2024 in WKTS.
Two stage deodorisation system with 99.9% and 90% removal efficiency for H2S and NH3 are adopted for the proposed RTS.
Continuous monitoring of actual H_2S and NH_3 concentrations after commissioning is required.
The odour emission rate is the total emission rate to be evenly distributed among the six deodourizing units RTS_DO1-RTS_DO6 below.

Exhaust Points of Waste Transfer Building

Deodouriser	Description	Source Type	Exhaust Location		Exhaust Diameter (m)	Height (mAG)	Exit Temperature (K)	Exit Velocity (m/s)
			X	Y				
RTS_DO1	Exhaust point	POINT	843675.43	816739.17	1.20	41.41	Ambient	15.0
RTS_DO2	Exhaust point	POINT	843681.94	816745.95	1.20	41.41	Ambient	15.0
RTS_DO3	Exhaust point	POINT	843754.78	816662.98	1.20	41.41	Ambient	15.0
RTS_DO4	Exhaust point	POINT	843761.29	816669.76	1.20	41.41	Ambient	15.0
RTS_DO5	Exhaust point	POINT	843767.80	816676.54	1.20	41.41	Ambient	15.0
RTS_DO6	Exhaust point	POINT	843774.31	816683.32	1.20	41.41	Ambient	15.0

Remark:
The exhaust parameters refers to the RTS in the approved EIA for San Tin / Lok Ma Chau Development Node (AEIAR-261/2024).

Conversion of 1-hour Average to 5-second Average Concentration

Deodouriser	Emission Rate (OU/s)	Stability Class	Conversion Multiplier	Emission Rate with 5-second Peak Factor (OU/s)	Reference
RTS_DO1	1560	A, B, C, D, E, F	2.3	3588.60	- Approved Methods for the Modelling and Assessment of Air Pollutants in New South Wales. - Katestone Scientific 1995, The Evaluation of Peak-to-Mean Ratios for Odour Assessments, volumes I and II, Katestone Scientific Pty Ltd, Brisbane. - Katestone Scientific 1998, Peak-to-Mean Concentration Ratios for Odour Assessments, Katestone Scientific Pty Ltd, Brisbane.
RTS_DO2	1560	A, B, C, D, E, F	2.3	3588.60	
RTS_DO3	1560	A, B, C, D, E, F	2.3	3588.60	
RTS_DO4	1560	A, B, C, D, E, F	2.3	3588.60	
RTS_DO5	1560	A, B, C, D, E, F	2.3	3588.60	
RTS_DO6	1560	A, B, C, D, E, F	2.3	3588.60	

Remark:

6-stack configuration is assumed for the proposed RTS, with reference to the expansion of WKTS with 3,182 tpd in Refurbishment and Upgrading Studies for (A) West Kowloon Transfer Station and (B) Island West and Island East Transfer Stations.

Emission Source Listing in AERMOD

Source ID	Type	X	Y	Exhaust Diameter (m)	Height (mAG)	Exit Temperature (K)	Exit Velocity(m/s)	Emission Rate with 5-second Peak Factor (OU/s)
RTS_DO1	POINT	843675.43	816739.17	1.20	41.41	Ambient	15.00	3588.60
RTS_DO2	POINT	843681.94	816745.95	1.20	41.41	Ambient	15.00	3588.60
RTS_DO3	POINT	843754.78	816662.98	1.20	41.41	Ambient	15.00	3588.60
RTS_DO4	POINT	843761.29	816669.76	1.20	41.41	Ambient	15.00	3588.60
RTS_DO5	POINT	843767.80	816676.54	1.20	41.41	Ambient	15.00	3588.60
RTS_DO6	POINT	843774.31	816683.32	1.20	41.41	Ambient	15.00	3588.60

Appendix 3.10 Calculation of Odour Emissions

ASB Biodiesel (Hong Kong) Limited

Emission Sources Listing in AERMOD

Emission Source [1]	Source ID	Type	X	Y	Elevation (m)	Stack Height (mAG)	Exit Temperature (K)	Exit Velocity (m/s)	Stack Diameter (m)	Emission Rate
										Odour (OU/s)
ASB Biodiesel (Hong Kong) Limited	ASB02	POINT	845687.00	816178.00	5.00	31.00	373.00	1.75	0.75	1.0000E+03
ASB Biodiesel (Hong Kong) Limited	ASB05	POINT	845687.00	816178.00	5.00	13.80	0.00	0.17	1.20	2.8600E+01
ASB Biodiesel (Hong Kong) Limited	ASB06	POINT	845687.00	816178.00	5.00	4.40	0.00	0.17	0.49	5.0000E+00

Remark

1. Emission inventory of ASB Biodiesel (Hong Kong) Limited refers to SP Licence No.: L-25-019(4).

Appendix 3.10 Calculation of Odour Emissions

Emission Inventory for Odour Emission (SENTX)

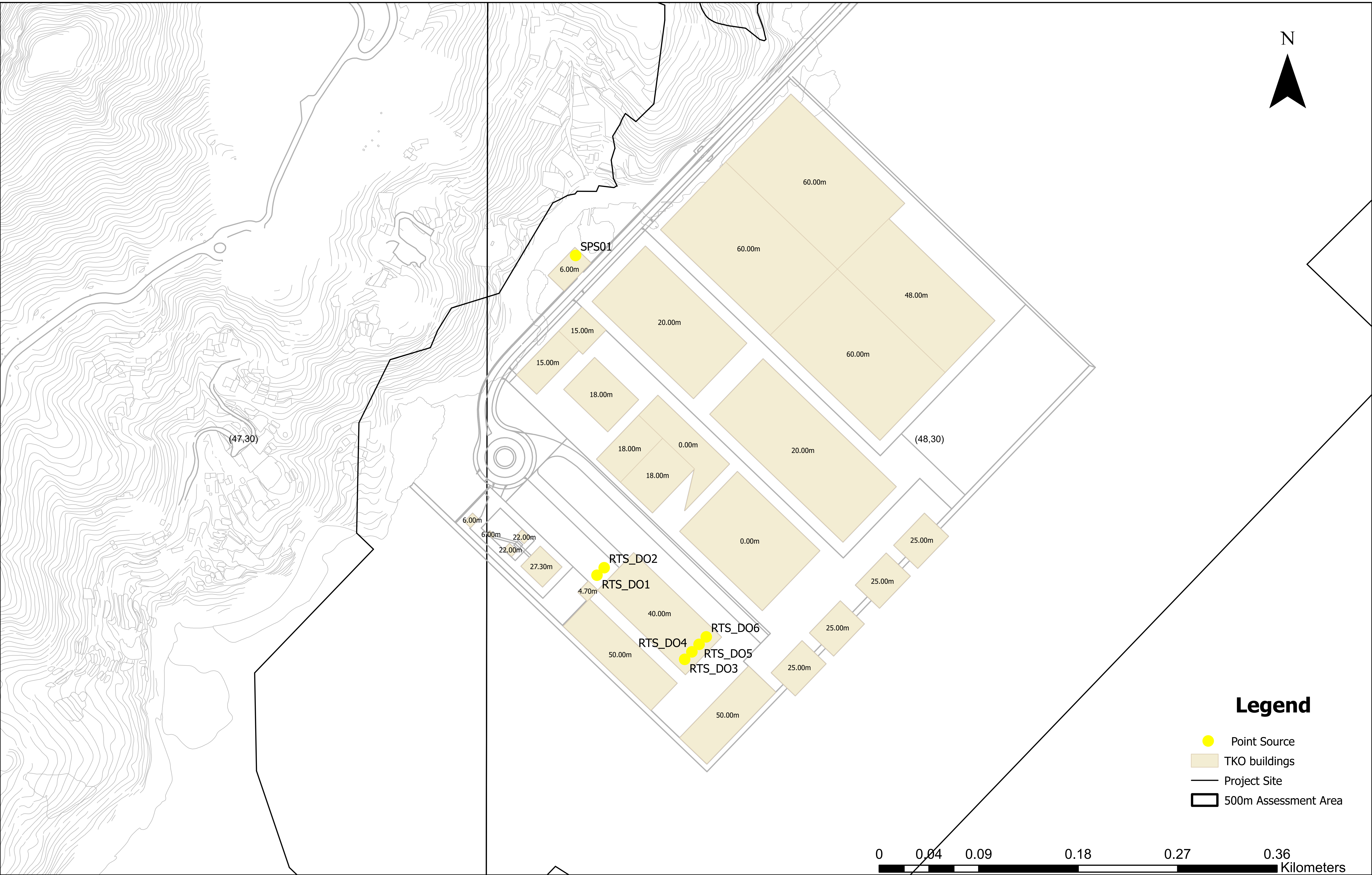
Source	Source ID	Type	X	Y	Elevation (m)	Odour Emission Rate (Operation Phase of SENTX, OU/m^2·s)	Capacity (Aftercare Phase of SENTX, %)	Odour Emission Rate (Aftercare Phase of SENTX, OU/m^2·s)	Release Height (mAG)	Xlength (m)	Ylength (m)	Angle
MBR tank 1	M1_1	AREA	846511	814694	6.00	0.04900	32%	0.01568	5	20	30	-20
MBR tank 2	M1_2	AREA	846535	814704	6.00	0.04900	32%	0.01568	5	20	30	-20

Remark

1. The odour emission rate during the operation phase of SENTX and the stack parameters refer to the approved *Environmental Review of the Revised Scheme of SENT Landfill Extension, 2016* .
2. According to the approved *Environmental Review of the Revised Scheme of SENT Landfill Extension, 2016* , the potential odour emission source during the aftercare phase would only be the open SBR tanks, with about 32% of the original emission strength.

Location of Odour Emission Sources

Location of Odour Emission Sources



Scottish Executive Environment Group

Code of Practice on Assessment and Control of Odour Nuisance from Waste Water Treatment Works

April 2005
Paper 2005/9

- The design of tanks and covers should minimise the need for regular access for maintenance and inspection as confined space entry systems will be required
- The vent volumes need to be adequate to ensure no odour escape and also to account for air quality inside the cover (occupational exposure, corrosion and explosion hazard).
- Ventilation rates will depend upon the exact process operations but for tanks the design flows are typically 0.5 – 12 air changes per hour based upon the empty tank volume or 120% of the maximum filling rate. In the case of thickener tanks, the volume may increase to 200% of the maximum fill rate
- The design will take account of the fill and empty rate, maximum rate of change in headspace, likely gaps and leakage, evolution rate of flammables to maintain <25% LEL for methane (10% is good design)
- Allowance should be made for emergency ventilation of the tanks
- One problem with tank covers is that they cannot be easily inspected therefore tend to be poorly maintained.

Additionally, guidance on the design of waste water treatment plants in BS EN 12255 advises designers to :-

- Locate sources requiring abatement close together to optimise abatement options and minimise costs
- Consider explosion risk, corrosion, access and health and safety.

14.2 Odour Abatement Equipment

The air which is exhausted from enclosures usually requires abatement to avoid odour nuisance. It is possible to establish performance criteria to reflect what constitutes best practicable means (bpm) in relation to abatement equipment. This can be specified as follows:-

> *Any odour abatement equipment installed on contained emissions (ventilation air from the process building) should have an odour removal efficiency of not less than 95%[2]. Determination of the destruction efficiency should be by dynamic olfactometry based upon manual extractive sampling undertaken simultaneously at the inlet and outlet of the odour control equipment. At least three samples should be taken from both the inlet and outlet.*

There is a wide range of odour abatement equipment that can be used to treat emissions of contained air from WWTW. There are many factors which will affect the choice of equipment including required odour removal efficiency, flow rate and inlet odour concentration, type of chemical species in the odour, variability in flow and load, space requirements and infrastructure (power, drainage etc.). The range of technologies available is detailed in the Environment Agency H4 Guidance Note on odour.

[2] *Where the inlet odour concentrations are very low and the 95% destruction efficiency is difficult to demonstrate due to measurement reproducibility and equipment efficiency at low concentrations, the final discharge to air should contain less than 500 odour units/m^3.*

It is important when evaluating the most appropriate control technology to consider both total cost (capital and operating) and environmental impact (such as energy use, chemical use and secondary pollutant generation). Often operating costs are closely linked with environmental impact (that is costs for energy, raw materials etc.) and wherever possible the most environmentally sustainable technique should be selected.

As odour abatement plant capacity is usually tightly specified (little spare capacity), the assumption is that all other measures are being correctly used – covers, doors, chemicals replenished etc. This therefore becomes a key management issue that should be included in the Odour Management Plan.

The site layout may permit a centralised plant or due to locational constraints it may be necessary to use more than one system for example on the inlet works and the sludge process. It may be economical to provide a number of smaller biofilters for individual sources but if the selected technology is wet scrubbing it may be more cost effective to provide a single system. In some cases it may be appropriate to divide the odour streams and use different technology based upon the load and characteristics of each system.

Table 2 below summarises the main types of abatement equipment and the odour abatement efficacy that may be achieved.

SYSTEM	CAPITAL	CONSUMABLES	EFFECTIVENESS
Biofilters	Moderate	Need space, fan energy, media replacement 3 – 5 years	High >95% - not able to rapidly adjust to changes in flow or load
Bioscrubbers	Moderate	Fan energy, effluent needs oxygenation	High >95% - can handle higher H_2S loads than biofilters
Activated sludge plant	Low additional	Needs fully aerobic sludge	90 – 95% for H_2S and NH_3 ; may be ideal as a polishing stage
Wet scrubbers	High	Fan energy, pump energy, dosing chemicals and effluent disposal – high energy user	Single stage <80% but multiple stage - >98%
Dry scrubbing (carbon or impregnated media)	High	Media replacement is a high cost with strong odours, suffer with moisture loading	> 95% ; Widely used for passive sources. Need several seconds residence for treatment
Catalytic iron oxidation	Moderate	Low operating cost	Specific for H_2S – good for low flow high load
Thermal oxidation	High	Fan energy and support fuel	>98% ; good for dryer vents and VOC loads
Ozone	Moderate	Replacement of source and energy for fan and ozone generator	>90% on low concentrations – good for building vents
Counteractants and masking	Low	Replenishment of chemicals	Not an abatement method – may be suitable for short-term use

TABLE 2– ODOUR ABATEMENT

Experience in operation of peat and heather type biofilters has shown that they do not perform well when the flow or odour load from the process is variable although other media (shell-type material) appears to perform better for these applications. There has been a considerable amount

of biofilter and bioscrubber equipment installed at WWTW. The units range in size from 75 – 435,000m^3/hr but are typically 1600 – 3000m^3/hr. The suppliers tend to offer 95-98% odour removal, 95-99.9% H_2S removal and 300 ou_E/m^3 in exhaust gases.

The industry approach is that emission sources which exhibit strong odour peaks are best treated in wet scrubbers or carbon systems as some bio systems have been overloaded previously. It is increasingly common to have scrubbers on the sludge processing operations (often 3 or 4-stage scrubbers are used).

Quantification of NH_3 Emission From Sidestream Anammox Process

The NH_3 emission from the sidestream anammox process is calculated as 13.4 ppm in total according to *Appendix A of Dynamic of nitric oxide and nitrous oxide emission during full-scale reject water treatment (Kampschreur, et. al, 2008)* (12 ppm from the nitritation reactor and 1.4 ppm from the anammox reactor, therefore a total of 13.4 ppm emission).

In anammox process, there are two main reactors, the nitritation reactor and the anammox reactor. Air is blown from the bottom of the nitritation reactor, which is referred to as aeration. In the literature, the average aeration rate is 2.2×10^4 Nm^3/day over the measurement period, which is equivalent to 2.2 x 10^4/24 = 916.7 m^3/hr, assuming the aeration rate is constant.

The ammonia and Total Kjeldahl Nitrogen (TKN) loading of the quoted process is also similar to HSKEPP design. Therefore, the NH_3 gaseous emission from the quoted paper is considered representative of the HSKEPP NH_3 gaseous emission and adopted in this calculation of NH_3 emission for HSKEPP's anammox process.

Converting 13.4 ppm gas phase NH_3 to OU, by using 0.037 ppm NH_3 = 1 OU/m^3 (Odour threshold of NH3 is 0.037 ppm, reference from *Iowa State University Extension (May 2004). "The Science of Smell Part 1: Odor perception and physiological response" (PDF). PM 1963a)*

The OU concentration of gas phase NH_3 = 13.4 ppm NH_3 / (0.037 ppm NH_3/(OU/m^3)) = 362 OU/m^3. This is corresponding to the WWTP studied by the reference paper which treated 773 m^3 of influent per day.

The dewatering centrate flow for HSKEPP is estimated to be 1300 m^3 per day so the OU concentration can be prorated as 362 / 773 × 1300 = 609 OU/m^3.

The odour extraction air flow rate of the anammox process in HSKEPP's design is 3,854 m^3/hr = (3,854 m^3/hr / (3600s/hr) = 1.07 m^3/s while the total surface area of the sidestream treatment facility is 631 m^2.

Hence, the Specific Odour Emission Rate (SOER) of sidestream treatment in the proposed HSKEPP due to NH_3 emission = 609 OU/m^3 x 1.07 m^3/s /631 m^2 = 1.03 OU/m^2/s.

The total SOER adopted for sidestream treatment = 1.65 (SOER value referenced from bioreactor of Shek Wu Hui STW) +1.03 (due to NH_3 gas emission) = 2.68 OU/m^2/s.

Reference:

Kampschreur, M. J.; van der Star, W.R.L.; Wielders, H.A.; Mulder, J.W.; Jetten, M.S.M.; van Loosdrecht, M.C.M. 2008. Dynamic of nitric oxide and nitrous oxide emission during full-scale reject water treatment. Water Research 42 (2008), p812 – 826

Iowa State University Extension (May 2004). "The Science of Smell Part 1: Odor perception and physiological response" (PDF). PM 1963a