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Queensferry Sludge Treatment Centre

Bioaerosol risk assessment

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1 Introduction

1.1 Overview

Dŵr Cymru Welsh Water (DCWW) are applying for a new bespoke environmental permit for the Queensferry Sludge Treatment Centre (STC). Sludge treatment activity is covered by the Environmental Permitting Regulations (EPR) 2016, which incorporates the application of the Industrial Emissions Directive (IED). The site currently operates under a T21 exemption and does not have an environmental permit.

Technical Guidance Note M17[1], issued October 2015 by Natural Resource Wales (NRW), states that all sites that have a permit for the treatment of biological waste within 250 metres of a sensitive receptor (a place where people live or work for more than 6 hours at a time) must carry out a site-specific bioaerosol risk assessment. As sensitive receptors are found close the boundary of the site, the closest of which is approximately 95m from the nearest potential source of bioaerosols at Queensferry STC, a bioaerosol risk assessment has been undertaken to accompany the permit application for this site.

This bioaerosol risk assessment has assessed the magnitude of risk from potential emissions of bioaerosols from Queensferry STC at nearby sensitive human health receptors. The assessment has been undertaken in accordance with the methods and principles outlined in Environment Agency's "*Guidance on the evaluation of bioaerosol risk assessments for composting facilities*"[2].

1.2 Site location

Queensferry STC is situated within the Queensferry Industrial Estate, adjacent to the River Dee, in Deeside. The location of the STC is shown in Figure 1.1. The site includes two anaerobic digestors which are located towards the north east of the site.

[1] Natural Resource Wales (2014) Technical Guidance Note M17 (Monitoring) – Monitoring Particulate Matter in Ambient Air around Waste Facilities. Available online at: https://naturalresources.wales/media/2129/technical-guidance-note-m17-monitoring-monitoring-particulate-matter-in-ambient-air-around-waste-facillities.pdf

[2] Drew, G.H., Deacon, L.J., Pankhurst, L., Pollard, S.J.T. and Tyrrel, S.F. (2009). Guidance on the evaluation of bioaerosol risk assessments for composting facilities. Environment Agency.

Figure 1.1: Queensferry STC site layout plan

Emissions Ref	Emissions Points	Assets Ref	Assets	Type	X	Y
				Emission point	332335	368300
S01	Condensate Line Drain			Emission point	332346	368294
A01	Methane Gas Flare Stack	1	Methane Flare Stack	Emission point	332375	368230
A02	Boiler Stack 1&2	2	Dual Fuel Boiler 1&2	Emission point	332334	368301
A03	Boiler Stack 3	3	Gas Oil Boiler 3	Emission point	332337	368299
A04	CHP Plant Stack	4	CHP Plant	Emission point	332339	368291
A05	Pressure Relief Valve 1	5	Anaerobic Digester (AD) No. 1	Emission point	332351	368280
A06	Pressure Relief Valve 2	6	Anaerobic Digester (AD) No. 2	Emission point	332371	368266
		7	Gas Bag Holder	Installation point	332388	368250
A07	Gas Bag Pressure Relief Valve	7	Gas Bag Holder (Valve)	Emission point	332383	368257
A08	Standby Generator Exhaust Stack	8	Standby Generator	Emission point	332254	368226
A09	OCU 1	9	Odour Control Unit 1	Emission point	332311	368206
A10	OCU 2	10	Odour Control Unit 2	Emission point	332299	368263
		11	Gas Oil Fuel Tank	Installation point	332338	368304
		12	Boiler Building	Installation point	332332	368295
		13	Sludge Holding Tank 2 (Consolidatice Tank)	Installation point	332317	368288
		14	Sludge Holding Tank 1 (Consolidatice Tank)	Installation point	332316	368275
		15	Digester Feed Tank	Installation point	332328	368280
		16	Returned Liquors Tank	Installation point	332331	368213
		17	Screened Sludge Tank	Installation point	332328	368207
		18	Imported Sludge Tank	Installation point	332325	368203
		19	Digested Sludge Tank 1 (Zone 1)	Installation point	332311	368182
		20	Digested Sludge Tank 2 (Zone 1)	Installation point	332298	368190
		21	Digested Sludge Holding Tank 3 (Zone 2)	Installation point	332305	368213
		22	Screenings Skip	Installation point	332317	368210
		23	Rotamat (Screen)	Installation point	332316	368214
		24	Digested Sludge Holding Tank 4 (Zone 3)	Installation point	332297	368232
		25	Centrifuge Feed Tank	Installation point	332281	368234
		26	Centrifuge Building	Installation point	332256	368231
		27	Diesel Fuel Tank	Installation point	332245	368229
		28	Cake Bays x 3	Installation point	332243	368267
		29	Digested Sludge Holding Tank 6&7 (Zone 5)	Installation point	332270	368264
		30	Digested Sludge Holding Tank 5 (Zone 4)	Installation point	332278	368259
		31	Sludge Thickener Building	Installation point	332308	368260
M01	Centrate Returns Monitoring Point	32	Centrate Returns Well	Sampling point	332261	368246
M02	Thickener Returns Monitoring Point	33	Thickener Returns Well	Sampling point	332306	368240
M03	AD 1 Condensate Monitoring	34	AD 1 Condensate Trap	Sampling point	332357	368288
M04	AD 2 Condensate Monitoring	35	AD 2 Condensate Trap	Sampling point	332375	368275
M05	Gas Bag Condensate Trap	36	Gas Bag Condensate Trap	Sampling point	332382	368262

2 Methodology

2.1 Overview

Bioaerosols are naturally present in the air, but they are also associated with composting, anaerobic digestion (AD) and mechanical biological treatment, which are the main processes used to treat organic waste in the UK.

Bioaerosols are micro-organisms which are suspended in the air; these can include bacteria, fungi and viruses, or parts of living organisms, such as spores and plant pollen. Bioaerosols range in size from 0.02-100µm but are generally smaller than 10µm in diameter so can easily be breathed into the human respiratory system where they can cause adverse health impacts such as respiratory and gastrointestinal illnesses. Especially relevant to waste treatment facilities are infections of the respiratory system caused by *Aspergillus fumigatus*, which can be fatal, especially for at-risk and immuno-compromised patients. Bioaerosols can also cause eye irritation and dermatitis if they come into contact with the eyes and skin.[3]

2.2 Guidance

There is minimal regulatory guidance available for assessing bioaerosol emissions from AD facilities. Regulatory Position Statement (RPS) 031[4] states that bioaerosol concerns would normally be associated with composting activities, which are defined as: *'biological decomposition of biodegradable waste under conditions that are predominantly aerobic and that allow the development of thermophilic temperatures as a result of biologically produced heat'*.

This RPS also defines operations which are *'likely to result in the uncontrolled release of high levels of bioaerosols'* as including '*the shredding of waste and the turning of waste in the sanitisation, stabilisation and maturation stages of composting where these operations are not contained or are not subject to exhaust ventilation and scrubbing/filtering'*.

These activities do not occur at Queensferry STC as the biological decomposition of waste occurs under controlled, anaerobic conditions. Therefore, Queensferry STC is unlikely to be a high-risk site for bioaerosol emissions. This is supported by a 2012 EA guidance note[5] which states that the EA do not consider bioaerosols from anaerobic digestion to be of serious concern (provided composting activities are not undertaken at the facility).

Nonetheless, current NRW[1] and Environment Agency guidance[6] requires any facility which could release bioaerosols to provide a site-specific bioaerosol risk assessment if there are sensitive receptors within 250m of activities. For new permits there is also a requirement to monitor bioaerosols if the site is within 250m of a sensitive receptor[7]. However, following a Schedule 5 notice from the Environment Agency for another similar WTW, a conservative

[3] Drew, G.H., Deacon, L.J., Pankhurst, L., Pollard, S.J.T. and Tyrrel, S.F. (2009). Guidance on the evaluation of bioaerosol risk assessments for composting facilities. Environment Agency.

[4] Environment Agency. 2011. Composting and potential health effects from bioaerosols: our interim guidance for permit applicants. Regulatory Position Statement 031.

[5] Environment Agency. 2012. Guidance for developments requiring planning permission and environmental permits' (England)

[6] Environment Agency (2018) Bioaerosol monitoring at regulated facilities - use of M9: RPS 209. Available online at: https://www.gov.uk/government/publications/bioaerosol-monitoring-at-regulated-facilities-use-of-m9-rps-209/bioaerosol-monitoring-at-regulated-facilities-use-of-m9-rps-209

[7] *"Sensitive receptor – any building, other structure or installation, in which at least one person normally lives or works, other than a building, structure or installation within the same ownership or control as the operator/owner of the composting facility."* Taken from 'Guidance on the evaluation of bioaerosol risk assessments for composting facilities.'

approach has been undertaken and human receptors within 500m of the Site have been considered instead of the 250m specified in NRW[1] and Environment Agency[6] guidance.

2.3 Methodology

The method used for this bioaerosol risk assessment is adapted from the Environment Agency's '*Guidance on the evaluation of bioaerosol risk assessments for composting facilities*'[8], which recommends using a Source-Pathway-Receptor model to help determine the magnitude of the risk associated with bioaerosol emissions from a facility.

The magnitude of risk is a function of both the probability of exposure and the consequences of the hazard. The probability of exposure to bioaerosols can be described as:

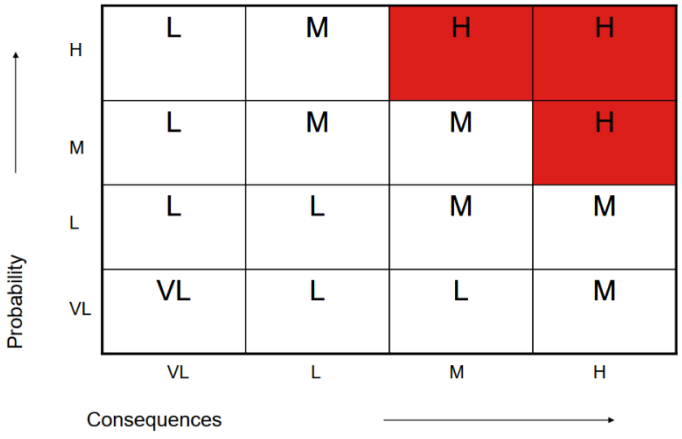
- High – exposure is probable, direct exposure likely with no/few barriers between source and receptor
- Medium – exposure is fairly probable, barriers less controllable
- Low – exposure unlikely, barriers exist to mitigate
- Very low – exposure very unlikely, effective and multiple barriers

The consequence of the hazard considers the nature of the source, the hazard and receptor. These consequences can be described as:

- High – severe consequences, evidence that exposure may result in serious damage
- Medium – significant consequences, evidence that exposure may result in damage that is not severe and is reversible
- Low – minor consequences, damage not apparent, reversible adverse changes possible
- Very low – negligible consequences, no evidence for adverse changes

The probability of exposure and consequence of the hazards are then combined to determine the overall magnitude of the risk, as demonstrated in Figure 2.1.

Figure 2.1: Magnitude of risk matrices



Source: Environment Agency, 2009

[8] Drew, G.H., Deacon, L.J., Pankhurst, L., Pollard, S.J.T. and Tyrrel, S.F. (2009). Guidance on the evaluation of bioaerosol risk assessments for composting facilities. Environment Agency.

For this bioaerosol risk assessment, a Source-Pathway-Receptor model has been used to help assess the probability of exposure associated with different processes at the Queensferry STC (Section 3). Existing control measures have also been identified to help inform the probability of exposure (Section 4). This has then been combined with the consequence of the hazard in Section 5 to determine the overall magnitude of risk associated with the different sources of bioaerosols at the Queensferry STC, using the risk matrix above.

3 Source – Pathway – Receptor model

3.1 Overview

This section provides a summary of the sources of bioaerosols at Queensferry STC and the potential pathways that the bioaerosols could travel to sensitive human health receptors.

3.2 Sources

3.2.1 Overview

Queensferry STC includes the following assets which could release bioaerosols:

- 3 No. Cake storage bays (70m^3 each)
- 3 No. Digested sludge holding tanks (3 Lanes) (950m^3 each) (Zones 4 & 5)
- 1 No. Drum thickener, housed in thickener building
- 2 No. Screened sludge holding tanks (243m^3 each)
- 1 No. Digester feed tank (243 m^3)
- 1 No. Digester feed pumps
- 2 No. Digesters (1705 m^3 each)
- 1 No. Biogas flare
- 1 No. Sludge reception tank (164m^3), connected to a sludge transfer pumping station and rotomat (screen)
- 2 No. Digested sludge storage tanks (1720m^3 &1806m^3) (concrete) (Zones 2 (enclosed) & 3)
- 2 No. Digested sludge tanks (GFS) (468m^3 each) (Zone 1)
- 1 No. Centrifuge feed tank (159m^3)
- 1 No. Standby diesel generator
- 1 No. Centrifuge, located in centrifuge building
- 1 No. Gas bag holder
- 1 No. Liquor returns storage tank (aka. supernatant tank) which is connected to a liquor return pumping station
- 1 No. CHP unit (0.545MWth)
- 3 No. Boilers (0.39MWth) (2 No. dual fuel (biogas and gas oil) and 1 No. gas oil only)

The following are outputs from the process:

- Cake (dewatered post digestion sludge) - exported to Five fords for AAD treatment
- Bio-gas - stored in an existing gas holder, and is then either:
  - Burnt in CHPs, with the power exported to the grid;
  - Flared in the waste biogas burner.
- Grit and screenings (small amount) - deposited in skips before taken off-site.

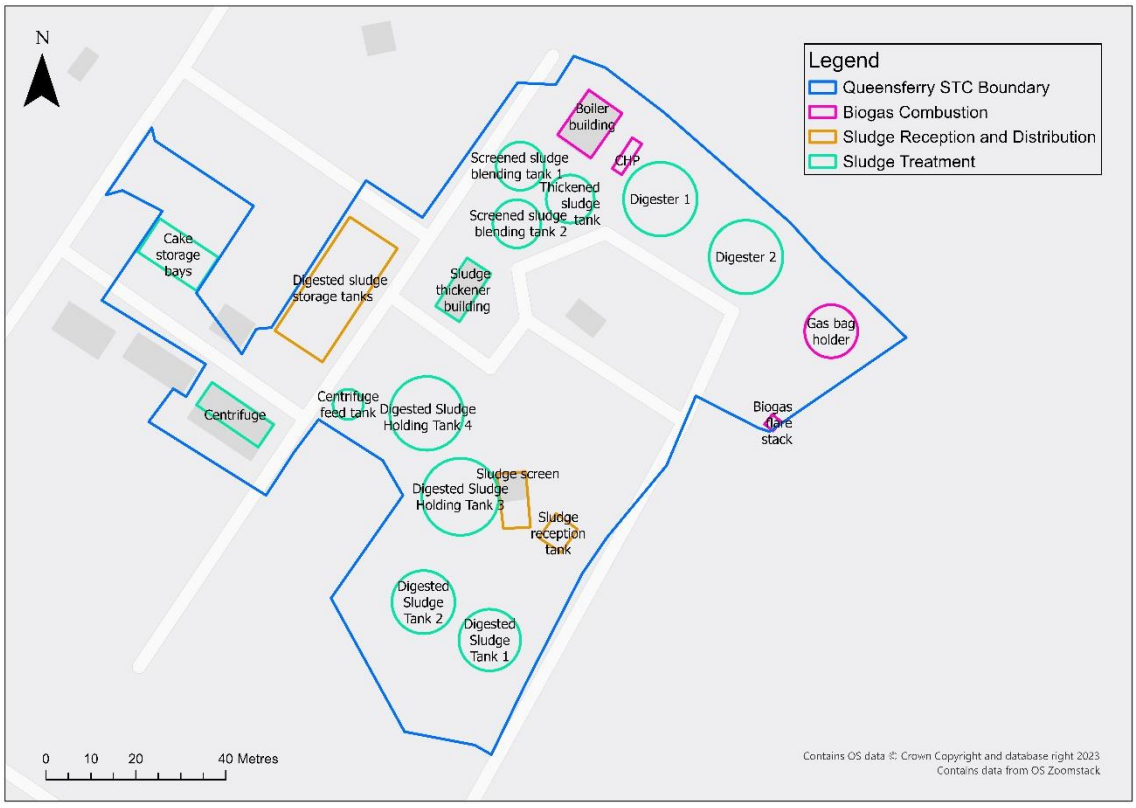
The following processes undertaken at Queensferry STC involving these assets, therefore, have the potential to release bioaerosols:

- Sludge reception and distribution
- Sludge treatment through anaerobic digestion

- Biogas combustion

Figure 3.1 shows the locations of these different processes and assets across the site. A summary of the activities which occur at Queensferry STC involving these assets is then presented below.

Figure 3.1: Queensferry STC potential sources of bioaerosols



Source: DCWW

3.2.2 Sludge reception and distribution

Queensferry STC receives domestic sludge imports from the Queensferry Wastewater Treatment Work's (WwTWs) primary settlement tanks which are pumped directly into the inlet works and from DCWW satellite sludge imports via the sludge centre. Imported sludge arrives to the STC via enclosed tankers which discharge the sludge into the enclosed sludge reception tank.

3.2.2.1 Odour control

An Odour Control Unit (OCU) is located at the inlet works adjacent to the skip enclosure. The unit is designed to reduce the nuisance from hydrogen sulphide odours. Foul air is extracted from the inlet works and pushed through the deodorisation system and upwards through an exhaust stack that discharges to the atmosphere.

3.2.3 Sludge treatment

Indigenous primary sludge is transferred to two 243m^3 covered concrete sludge holding tanks where it is mixed with screened sludge imports. The Imported sludge is initially discharged

below ground to the covered concrete reception tank, then pumped up to a rotomat screen where rag is removed. The screened sludge is then transferred to the two-sludge holding tanks where it is combined with indigenous site sludge.

The combined sludge is pumped to a covered drum thickener, which thickens the sludge to approximately 6% dry solids with the aid of a polymer. The sludge is then stored in the third covered concrete sludge storage tank, which is called the digester feed tank. From here the combined sludge is transferred to two 17050m^3 concrete digester tanks on a timed basis to undergo mesophilic anaerobic digestion. After a set retention time the digested sludge is then transferred and held in three 950m^3 open topped concrete rectangular secondary digesters for a further set time period. The treated sludge is then pumped to a 159m^3 open glass fused steel centrifuge feed tank and then de-watered via a single centrifuge with the aid of polymer to increase the percentage dry solids to between 20 and 25%. The de-watered sludge is then transferred and stored on open concrete cake pads ready for export.

Refer to B16383-123532-XX-XX-DR-ZA-DH0115 -QUY Block Flow Diagram P02 March 2021 for a schematic of the sludge treatment process and B16383-123532-XX-XX-DR-ZA-DH0116 – QUY Site Layout Plan October 2024, for location of the sludge treatment assets.

3.2.3.1 Odour control

The biological treatment and sludge treatment processes are all covered or enclosed. The only exceptions are the two sludge storage tanks, the centrifuge tank and the cake storage bays.

A leak detection (methane gas analyser) is installed on the biogas holder to ensure any leaks from the inner bag are detected. Any leaks detected on the biogas system would always be fixed immediately by DCWW due to the process safety risk of posed by biogas.

There are two OCUs designed to reduce the nuisance from hydrogen sulphide odours from sludge treatment. One is located adjacent to the imported sludge works and the other located behind the sludge thickener building. Foul air is extracted from the imported sludge works, sludge thickener building and sludge holding tanks (consolidation tanks) and pushed through the deodorisation systems and upwards through the exhaust stacks that discharge to the atmosphere.

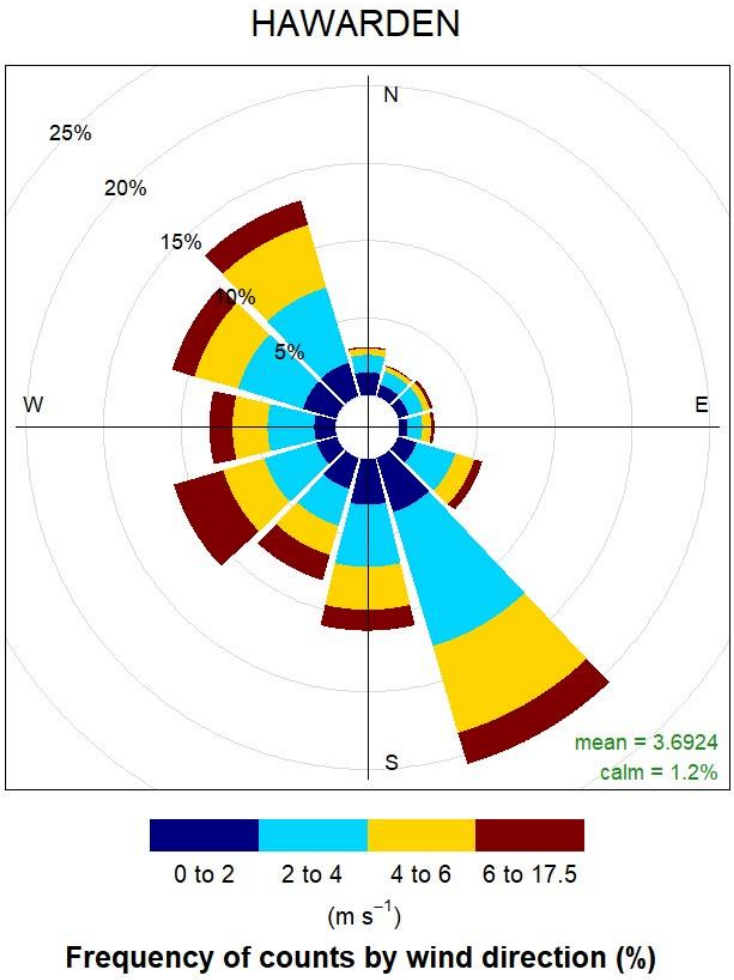
3.2.4 Biogas combustion

Biogas produced during AD is transferred to the gas bag holder and then to the CHP and boilers where it is combusted to generate heat and electricity, which is used onsite to assist with the wastewater and sludge treatment processes. When more biogas is produced onsite than can be combusted within the CHP and boilers and there is insufficient space in the gas bag holder to store surplus biogas, excess biogas is sent to the flare to be burned.

3.3 Pathways

Bioaerosols are very small and light in weight so can easily be transport by the wind from their source to a receptor. The 2019-2023 wind rose for the nearest meteorological site, Hawarden Airport (located approximately 3.5km south east of Queensferry STC), is shown in Figure 3.2. This monitoring site experiences strong prevailing winds from the south east, with frequent winds from the south east.

Figure 3.2: Average wind rose for Hawarden Airport meteorological site, 2019- 2023



Concentrations of bioaerosols decline rapidly within the first 100m from a source and generally decrease to background concentrations within 250m[9]. The local terrain in the 250m area surrounding the Queensferry STC is generally flat, with some low-lying trees bordering the site to the north, east and south which could present natural obstacles to the transportation of bioaerosols by the wind.

3.4 Receptors

Although NRW[1] and Environment Agency[6] guidance recommends a screening distance of 250m from bioaerosol emission sources to static receptor locations, a screening distance of 500m has been used as a conservative approach. Sensitive receptors are defined as:

"*permitted activities where people are likely to be for prolonged periods. This term would therefore apply to dwellings (including any associated gardens) and to many types of workplaces. We would not normally regard a place where people are likely to be present for less*

[9] Environment Agency. 2011. Composting and potential health effects from bioaerosols: our interim guidance for permit applicants. Regulatory Position Statement 031.

than 6 hours at one time as being a sensitive receptor. The term does not apply to those controlling the permitted facility, their staff when they are at work or to visitors to the facility, as their health is covered by Health and Safety at Work legislation, but would apply to dwellings occupied by the family of those controlling the facility."

There are 11 areas of sensitive receptors found within 500m of potential bioaerosol emission sources at Queensferry STC. As demonstrated in Figure 3.3, areas of residential properties are found to the north, north east, south and south west of the Site, whilst industrial land use is found to the north east, south east, south west and north west. Retail land use and an army reserve centre are also found to the northwest. For these 11 areas of sensitive receptors, the distance and direction from each potential bioaerosol emission source to a sensitive receptor within the area has been identified below in

Table 3.1. Where multiple assets exist for the same process, such as digesters or blending tanks, only the closest asset has been presented.

A number of these sensitive receptors are found to the northwest of the site, downwind of the prevailing wind direction. The closest potential bioaerosol emission source to these receptors are the cake storage bays, which are approximately 145m upwind of these receptors.

The receptor closest to a potential emission source is an industrial estate east of the STC, which is located approximately 95m northeast of the flare.

Figure 3.3: Sensitive receptors within 500m

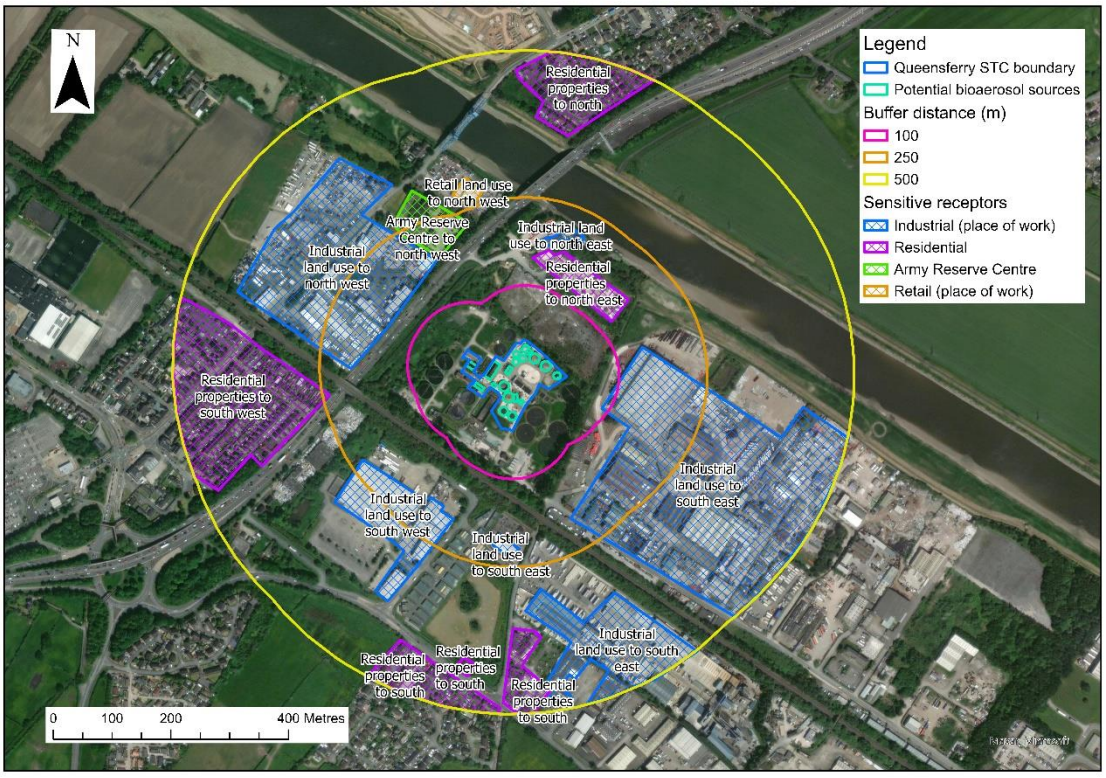


Table 3.1: Receptors within 500m of potential emission sources

Nearest potential emission source to receptor	Process	Distance (m) and direction of different receptors[a] from nearest potential emission source [b]										
		Residential properties			Industrial land use						Retail (place of work)	Army Reserve Centre
		North of the Site (m)	Northeast of the Site (m)	South of the Site (m)	Southwest of the Site (m)	Southeast of the Site (m)	South east of the Site (m)	Southwest of the Site (m)	North west of the Site (m)	North east of the Site (m)	North west of the Site (m)	North west of the Site (m)
Digested sludge storage tanks	Sludge reception and distribution	405m, Northeast	**175m, Northeast**	425m, South	265m, Southwest	185m, Northeast	265m, Southeast	225m, Southwest	180m, Northwest	210m, Northeast	260m, Northwest	200m, Northwest
Sludge reception tank	Sludge reception tank	460m, North	200m, Northeast	380m, South	325m, Southwest	**135m, Northeast**	225m, Southeast	215m, Southwest	255m, Northwest	260m, Northeast	335m, Northwest	280m, Northwest
Sludge screen	Sludge screen	450m, North	200m, Northeast	385m, South	315m, Southwest	**145m, Northeast**	225m, Southeast	215m, Southwest	240m, Northwest	250m, Northeast	325m, Northwest	265m, Northwest
Screened sludge blending tanks	Sludge treatment	380m, Northeast	**140m, Northeast**	450m, South	315m, Southwest	160m, Southeast	290m, Southeast	270m, Southwest	200m, Northwest	180m, Northeast	255m, Northwest	205m, Northwest
Digested sludge holding tanks	Sludge treatment	430m, Northeast	195m, Northeast	385m, South	290m, Southwest	**150m, Southeast**	225m, Southeast	210m, Southwest	210m, Northwest	235m, Northeast	300m, Northwest	235m, Northwest
Digested sludge tanks	Sludge treatment	475m, Northeast	225m, Northeast	355m, South	290m, Southwest	**145m, Southeast**	195m, Southeast	185m, Southwest	235m, Northwest	280m, Northeast	340m, Northwest	275m, Northwest
Thickened sludge tank	Sludge treatment	380m, Northeast	**140m, Northeast**	455m, South	330m, Southwest	155m, Southeast	300m, Southeast	280m, Southwest	210m, Northwest	185m, Northeast	265m, Northwest	215m, Northwest
Digesters	Sludge treatment	375m, North	125m, Northeast	440m, South	345m, Southwest	**110m, Southeast**	290m, Southeast	285m, Southwest	225m, Northwest	180m, North	270m, Northwest	230m, Northwest
Centrifuge feed tank	Sludge treatment	440m, Northeast	210m, Northeast	410m, South	275m, Southwest	**185m, Northeast**	250m, Southeast	215m, Southwest	200m, Northwest	245m, Northeast	300m, Northwest	230m, Northwest

Nearest potential emission source to receptor	Process	Distance (m) and direction of different receptors[a] from nearest potential emission source [b]										
		Residential properties				Industrial land use					Retail (place of work)	Army Reserve Centre
		North of the Site (m)	Northeast of the Site (m)	South of the Site (m)	Southwest of the Site (m)	Southeast of the Site (m)	South east of the Site (m)	Southwest of the Site (m)	North west of the Site (m)	North east of the Site (m)	North west of the Site (m)	North west of the Site (m)
Centrifuge	Sludge treatment	450m, Northeast	225m, Northeast	410m, South	245m, Southwest	205m, Northeast	245m, Southeast	200m, Southwest	**175m, Northwest**	255m, Northeast	295m, Northwest	220m, Northwest
Cake storage bays	Cake storage bays	420m, Northeast	205m, Northeast	445m, Southeast	240m, Southwest	225m, East	280m, Southeast	230m, Southwest	**145m, Northwest**	230m, Northeast	260m, Northwest	185m, Northwest
Gas bag holder	Biogas combustion	405m, North	125m, Northeast	430m, South	385m, Southwest	**90m, Southeast**	280m, Southeast	295m, Southwest	275m, Northwest	215m, North	315m, Northwest	275m, Northwest
Boilers	Biogas combustion	365m, North	**120m, Northeast**	470m, South	335m, Southwest	160m, Southeast	310m, Southeast	295m, Southwest	210m, Northwest	170m, Northeast	250m, Northwest	205m, Northwest
CHP unit	Biogas combustion	370m, North	**125m, Northeast**	465m, South	345m, Southwest	150m, Southeast	310m, Southeast	295m, Southwest	220m, Northwest	175m, Northeast	260m, Northwest	220m, Northwest
Flare stack	Biogas combustion	425m, North	150m, Northeast	410m, South	370m, Southwest	**95m, Northeast**	260m, Southeast	265m, Southwest	280m, Northwest	235m, North	330m, Northwest	290m, Northwest

Source: (a) Refers to the receptors presented within Figure 3.3.
(b) Distance from source to receptor is rounded to the nearest 5m

3.5 Summary

Table 3.2 below summarises the potential sources of bioaerosol emissions at Queensferry STC, the sensitive receptors most at risk and the pathways through which the bioaerosols could travel from source to receptor.

Table 3.2: Source-Pathway-Receptor model

Source process	Potential emission source	Pathway	Distance to nearest receptor (m)
Sludge reception and distribution	Digested sludge storage tanks	Air transport then: • Inhalation (through nose or mouth) • Ingestion (eating or swallowing) • Absorption/contact (through skin or eyes) • Injection (by high pressure equipment/ contaminated sharp objects)	175m, northeast (residential properties)
	Sludge reception tank		135m, northeast (industrial land use)
	Sludge screen		145m, northeast (industrial land use)
Sludge treatment	Screened sludge blending tanks		140m, northeast (residential properties)
	Digested sludge holding tanks		150m, Southeast (industrial land use)
	Digested sludge tanks		145m, Southeast (industrial land use)
	Thickened sludge tank		140m, northeast (residential properties)
	Digestors		110m, southeast (industrial land use)
	Centrifuge feed tank		185m, northeast (industrial land use)
	Centrifuge		175m, northwest (industrial land use)
	Cake storage bays		145m, northwest (industrial land use)
Biogas combustion	Gas bag holders		90m, southeast (industrial land use)
	Boilers		120m, northeast (residential properties)
	CHP		125m, northeast (residential properties)
	Flare		95m, northeast (industrial land use)

4 Control measures

4.1 Overview

The three primary ways to mitigate emissions of bioaerosols[10] is to:

- Reduce emissions
- Contain emissions
- Enhance dispersion

The sections below outline the different control measures in place at Queensferry STC. These control measures aim to reduce and contain emissions of bioaerosols to prevent the source-pathway-receptor link associated with each of the potential emission sources identified in Section 3.5.

4.2 Control measures

4.2.1 Sludge reception and distribution

Domestic sludge offloads into the inlet channel through an enclosed connection. The inlet is currently uncovered; however, the sludge will only be exposed for a short period of time. Imported sludge is offloaded from an enclosed tanker into the covered imported sludge tank via an enclosed connection, so the potential for release of bioaerosols is minimal.

The processed sludge is transported from the centrifuge to the cake bays via an enclosed pipe. The cake bays are open to air, however once deposited, the cake is not disturbed until loaded into trucks, which are covered before transport, for offsite disposal.

If a spillage of sludge/cake occurs, operators will carry out clean up as soon as possible. If the spillage is caused by a lorry or tanker, the driver is responsible for cleaning up the spill before leaving site. If a lorry or tanker left a spillage behind, operators will log and report any incident observed and the driver or company involved will be asked to return to the site immediately to clean up. Significant spillage incidents will be recorded in the site diary.

Lorry and tanker drivers are required to hose down any spillage after each loading or unloading.

No wheel wash facility is available on site but a standpipe is available and can be utilised to wash spillage from vehicles as required. Vehicles entering public roads are not to enter cake bay areas.

4.2.2 Sludge treatment

4.2.2.1 Containment of emissions

To contain emissions of bioaerosols during sludge treatment, doors, covers and hatches to the buildings housing the sludge reception and distribution works and sludge treatment works are kept closed at all times except when access is required. When access is required for operation and maintenance, the doors and hatches to these treatment facilities will only be opened for

[10] Wheeler P.A., Stewart, I., Dumitrean, P. and Donovan, B., 2001. Health Effects of Composting: A Study of Three Compost Sites and Review of Past Data. R&D Technical Report P1-315/TR, Environmental Agency, Bristol.

minimum periods. If access is required for an extended period of time, such as for maintenance activities, the site would be closed down, in which case, no bioaerosols would be produced.

To further contain bioaerosol emissions, the tanks used for sludge reception and treatment (reception tank, sludge screen, digesters and centrifuge) are covered. The only processes which are not covered are the two digested sludge storage tanks, the centrifuge tank and the cake storage bays, however as the sludge has already been through the digestion process, the concentrations of bioaerosols are lower at these stages. Additionally, the sludge is wet so the likelihood of the resuspension of bioaerosols is minimised.

4.2.2.2 Reduce emissions

Throughout the sludge treatment process, biological material which could give rise to emissions of bioaerosols is broken down, which primarily occurs during AD. Therefore, at each stage of the sludge treatment process, the quantity of bioaerosols decreases; the concentration of bioaerosols that could potentially be emitted from the cake bays (at the end of the sludge treatment process) is much lower than from the primary settlement tanks (pre-AD).

To further reduce potential bioaerosol emissions, sludge produced on site is processed immediately. This prevents processing of old sludge which is more odorous and difficult to process. Sludge arriving onsite is also processed immediately to help minimise bioaerosol emissions. As discussed above, processes with the greatest potential to release bioaerosols are covered.

4.2.3 Biogas combustion

Biogas produced during AD is stored within the gas bag holder before being combusted at high temperatures within the CHP, boilers or flare. The gas bag holder stores the biogas within an air-tight container which prevents the release of bioaerosol emissions. During combustion, any bioaerosols present within the biogas would be destroyed. Therefore, emissions of bioaerosols associated with biogas combustion would be de minimis.

4.3 Maintenance of control measures

Daily checks, measurements and sampling is conducted of the treatment processes on site to ensure the equipment is working correctly. The parameters measured include: sludge blanket thickness, turbidity and temperature (full list of parameters monitored are found within the operating plan for Queensferry). Where desired operating parameters are not met, various corrective actions and operating procedures are in place to rectify the problem. Performance issues and equipment problems are also reported promptly to Process Scientists, M&E technicians, ICA technicians or Specialist Contractors as appropriate.

Daily, weekly and monthly maintenance tasks/servicing is also performed on key equipment across the site by DCWW staff and specialist contractors if needed. DCWW have also issued generic maintenance task manuals for use across all their sites which include protocols for the maintenance of equipment.

Currently bioaerosols are not directly monitored, however future monitoring will be accordance with M9 where appropriate. Alternatively, the Odour Management Plan requires routine sniff tests and mitigation to odours, and therefor ethe Plan will indirectly aid the prevention and monitoring of bioaerosol.

Odour is controlled via three OCUs which are located at the inlet works, adjacent to the imported sludge works and located behind the sludge thickener building. The OCU treats air from these processes.

Odour is controlled with an odour removal efficiency of 99.5% for all three systems and total flow rate of 2,470m^3/hr – 15m/s for the combined assets. Treated odour streams are discharged to the environment through the OCU stacks and monitored hourly to ensure the absence of odorous compounds.

The OCUs are maintained in accordance with manufacturer's requirements to ensure treatment of bioaerosols and odours are effective.

Most of the Site operations are fully enclosed or covered with the exception of the digested sludge storage tanks, centrifuge feed tank and cake storage bays which are uncovered. With the exception of the cake bays, these operations are not part of the sludge treatment process, they are also all 'wet' processes therefore the likelihood of the resuspension of bioaerosols, and the probability of exposure, is minimised.

Diffuse emissions from the cake bays, are minimised by:

- Sludge cake is not disturbed until being loaded into trucks
- All sludge cake being exported is transported in covered trucks.

To minimise odour nuisance, it is important to ensure that the Queensferry STC is operating as designed. Covers and hatches are replaced to maintain the integrity of enclosures provided to collect odorous air.

The effectiveness of measures to prevent and limit bioaerosols, as well as odour, is undertaken by reviewing the Supervisory Control and Data Acquisition (SCADA) system to identify out of specification operation of assets. Whereby alerts are raised the measures within the Odour Management Plan will be followed to bring the operations in line with normal conditions.

Stocks of chemicals onsite are also carefully managed to ensure there are sufficient stocks of chemicals on site so that the necessary treatment processes, control measures and maintenance activities can be undertaken when required.

4.4 Emergency procedures

In the event of plant failures or emergency situations, an alarm would be raised on the site SCADA or telemetry systems, which will be reacted to by on-site or regional control room operators and Duty Managers. Depending upon the nature of the fault or emergency, where required, an operator would contact a mechanical or electrical technician, both of whom are on-call 24-hours, to attend site as soon as practicable. Where the on-call technicians are already engaged upon other response work, there is the facility to access staff from other DCWW geographic divisions, coordinated by the Duty Manager. All faults, break-downs and emergencies are logged electronically together with records of the action taken and the solutions reached.

One such emergency event would be failure of the flare stack and/or CHP. Such an event would result in releases of biogas from the Whessoe Valves located on the roofs of the digesters and in the gas holder compound, which would release bioaerosols. This occurs to prevent over pressurisation of the digesters and gas systems. While the problem is rectified, biogas generation is reduced by reducing or inhibiting the digester feed.

4.5 Monitoring

4.5.1 Overview

Bioaerosol emissions associated with the operation of the Site will be monitored in line with the EA Technical Guidance Note (TGN) M9[11] requirements to monitor effectiveness of control measures.

Sampling of bioaerosols using either impaction, filtration or impingement samplers will be undertaken by an MCERTS accredited organisation. The final approach would be determined prior to appointment in accordance with the requirements of TGN M9.

4.5.2 Monitoring Locations

As detailed in Section 3.3, the prevailing wind direction at the Site is from the south east, therefore, in accordance with TGN M9, three samplers will be positioned to the north west of the Site to capture downwind bioaerosol concentrations and one sampler will be located upwind, to the south east of the Site.

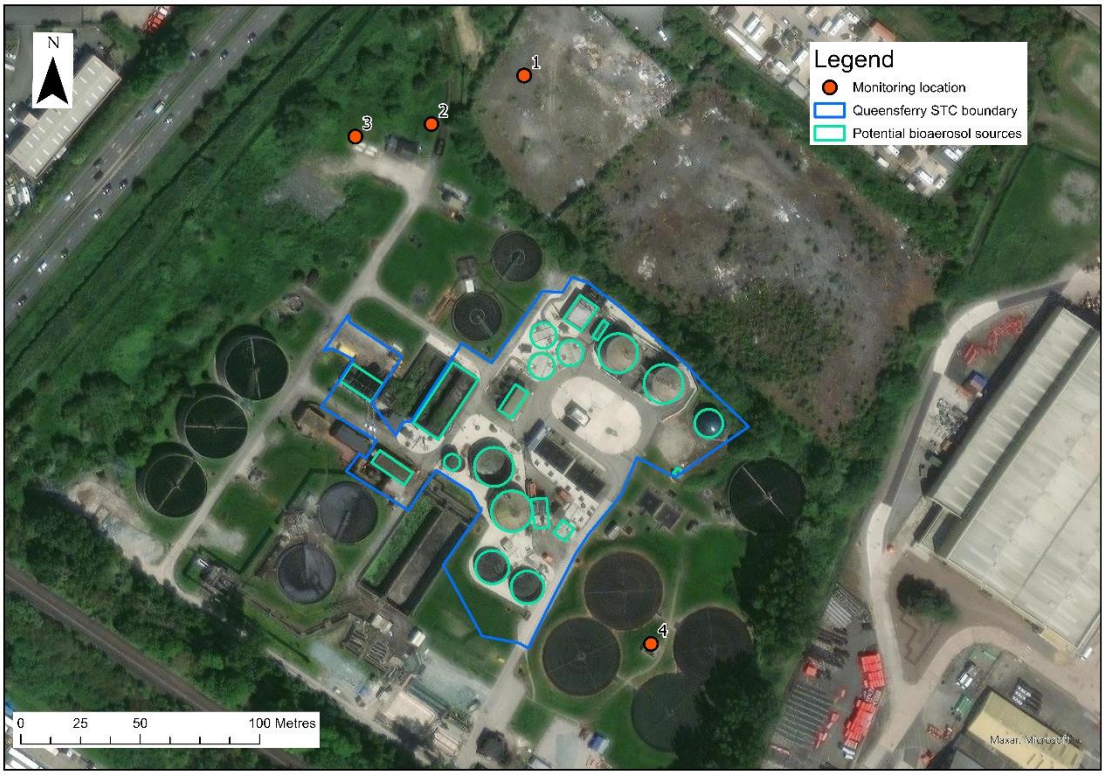
Figure 4.1 presents the indicative sampling locations identified for the Site. Locations 1, 2 and 3 represent the proposed locations for the three downwind samplers and are located at the same distance as the closest sensitive receptor (95m) from the nearest source of bioaerosols. The downwind samplers are arranged in a fan shape to ensure the maximum concentrations of bioaerosols are captured and variable wind directions will be accounted for.

The indicative monitoring location 4 represents the upwind sampler and is positioned approximately 50m from the nearest bioaerosol source. This location will provide a baseline concentration of bioaerosols, representative of background concentrations and any neighbouring sources of bioaerosols, such as agricultural activities, without contributions from the Site.

The exact sampling locations are dependent on the accessibility of each location and will be confirmed by the MCERTS accredited organisation that will conduct the sampling.

[11] Environment Agency (2018) Technical Guidance Note (Monitoring) M9 - Environmental monitoring of bioaerosols at regulated facilities. Available online at: https://assets.publishing.service.gov.uk/government/uploads/system/uploads/attachment_data/file/730226/M9_Environmental_monitoring_of_bioaerosols_at_regulated_facilities.pdf

Figure 4.1: Indicative bioaerosol monitoring locations



4.5.3 Sampling methodology and frequency

Appropriate sampling of bioaerosols will be conducted by an MCERTS accredited organisation using procedures relevant to the sampler type, as described in TGN M9. Sampling at the upwind and downwind locations will be undertaken concurrently so that results can be compared. Monitoring will be undertaken on a quarterly basis for the first 12months after permit issue and then six monthly thereafter. Where the bioaerosol action limit is exceeded, then quarterly monitoring will resume until such time that is it demonstrated that the site has adequate mitigation for a 12month period. Where it is confirmed that the risk is very low or low, DCWW will make the decision as to whether further monitoring will be needed and under what circumstances it may need to be resumed, if at all.

Sampling will be undertaken during appropriate weather conditions such as avoiding rain, sleet and snow, depending on the sampling technique, and will consider the wind speed and direction at the time of sampling. Meteorological conditions including wind speed, wind direction, cloud cover, temperature, relative humidity, and atmospheric conditions will be recorded by an automatic weather station with an integral data logger during monitoring periods and this data will be recorded. The meteorological station will be positioned in a suitable location, away from anything which could influence measurements, such as at locations very close to buildings.

A minimum of three measurements of Aspergillus fumigatus and mesophilic bacteria will be taken from each sampler during each monitoring visit. Appropriate equipment and methodologies for each sampler type are described in TGN M9 and this guidance will be followed during the bioaerosol monitoring.

Following the measurements, samples will be stored and transported appropriately before being analysed in a laboratory.

Detailed and accurate records of the bioaerosol monitoring will be kept and the data will be recorded using the standard report forms provided in TGN M9 or an appropriate alternative.

4.6 Summary

As discussed above, there are a number of control measures in place at Queensferry STC to reduce and contain emissions of bioaerosols. These control measures are regularly maintained to sustain their efficacy and reduce the risk of equipment failure. The greatest risk associated with emissions of bioaerosols from the site is associated with emergency situations such as a failure of the flare or CHP, which could result in uncontrolled emissions of bioaerosols. However, such events would be temporary and infrequent due to the extensive monitoring and maintenance programmes undertaken at the site as well as the emergency procedures and warning systems in place.

5 Risk assessment

5.1 Overview

This section assesses the probability of exposure and consequence of the hazard associated with potential emissions of bioaerosols at Queensferry STC to determine the overall magnitude of risk. The descriptors used ('very low' to 'high') are based on the descriptors outlined in the EA guidance[12], as summarised in Section 2.3.

5.2 Probability of exposure

As described in Section 3, the main potential sources of bioaerosols at Queensferry STC are associated with:

- Sludge reception and distribution
- Sludge treatment (sludge treatment, digestors, centrifuge and cake silo)
- Biogas combustion

These processes have the potential to emit bioaerosols, which are transported through the air by the wind and could cause harm to nearby human health receptors, the nearest of which is approximately 95m from the flare. However, as discussed in Section 4, there are multiple control measures in place at Queensferry STC which restrict the Source-Pathway-Receptor link by reducing and containing emissions of bioaerosols from these processes. The overall probability of exposure of sensitive receptors to bioaerosols at Queensferry STC is therefore considered to be '**very low**' as exposure of the receptors to bioaerosols is "very unlikely" due to the "effective and multiple barriers" (control measures) in place.

The exception to this are the digested sludge storage tanks, centrifuge tanks and cake storage bays, which are not covered and therefore the probability of exposure is considered to be '**low**' as exposure of the receptors to bioaerosols is "unlikely" as some "barriers exist to mitigate" such as the 'wet' nature of the sludge in the digested sludge storage and centrifuge tanks.

Although the cake bays are uncovered, the cake is at the end of the sludge treatment process and requires no further treatment before being deposited on agricultural land and therefore has also been considered to be '**very low**'.

The final probability of exposure to bioaerosols assessed for each emission source is presented below in Table 5.1.

Table 5.1: Probability of exposure to bioaerosols from different sources at the Site

Process	Potential source of bioaerosols	Probability of exposure	Justification
Sludge reception and distribution	Digested sludge storage tanks	Low	Uncovered, 'wet' process - exposure to bioaerosol emissions unlikely
	Sludge reception tank	Very Low	Covered, 'wet' process - exposure to bioaerosol emissions unlikely

[12] Drew, G.H., Deacon, L.J., Pankhurst, L., Pollard, S.J.T. and Tyrrel, S.F. (2009). Guidance on the evaluation of bioaerosol risk assessments for composting facilities. Environment Agency.

Process	Potential source of bioaerosols	Probability of exposure	Justification
	Sludge screen	Very Low	Covered, 'wet' process - exposure to bioaerosol emissions unlikely
Sludge treatment	Screened sludge blending tanks	Very Low	Covered, process monitored and regularly maintained – uncontrolled release of bioaerosols unlikely
	Digested sludge holding tanks	Low*	Uncovered, 'wet' process - exposure to bioaerosol emissions unlikely (Tank 4) Covered, 'wet' process - exposure to bioaerosol emissions unlikely (Tank 3)
	Digested sludge tanks	Low	Uncovered, 'wet' process - exposure to bioaerosol emissions unlikely
	Thickened sludge tank	Very Low	Covered, process monitored and regularly maintained – uncontrolled release of bioaerosols unlikely
	Digesters	Very Low	Covered, process monitored and regularly maintained – uncontrolled release of bioaerosols unlikely
	Centrifuge feed tank	Low	Uncovered, 'wet' process - exposure to bioaerosol emissions unlikely
	Centrifuge building	Very Low	Covered, process monitored and regularly maintained – uncontrolled release of bioaerosols very unlikely
	Cake storage bays	Very Low	Uncovered, however Cake storage at the end of the sludge treatment process and requires no further treatment before being deposited on agricultural land –release of bioaerosols very unlikely as bioaerosol content of cake anticipated to be de minimis
Biogas combustion	Gas holder	Very Low	Gas holder air-tight to prevent uncontrolled release of bioaerosols. SCADA system in place to detect leaks – uncontrolled release of bioaerosols very unlikely
	Boilers	Very Low	Combustion of biogas at very high temperatures which would destroy bioaerosols – uncontrolled release of bioaerosols very unlikely
	CHPs	Very Low	Combustion of biogas at very high temperatures which would destroy bioaerosols – uncontrolled release of bioaerosols very unlikely
	Flare	Very Low	Combustion of biogas at very high temperatures which would destroy bioaerosols – uncontrolled release of bioaerosols very unlikely

Remarks: Asterisk (*) means the worst-case scenario (i.e. uncovered Tank 4) has been taken to assess probability of exposure for digested sludge holding tanks.

5.3 Consequence of hazard

While the probability of exposure of receptors to bioaerosols is '**very low**' or '**low**' as a result of the control measures in place, there is still a risk that nearby receptors could be exposed bioaerosols, for example if there is a failure of the control equipment. Should this occur, any exposure to bioaerosols would likely be temporary as the fault would be detected by the SCADA system and the emergency protocols would be undertaken to rectify the fault as soon as possible.

However, if exposure to bioaerosols did occur, this could result in adverse health impacts at sensitive receptors. These impacts could include (but are not limited to):

- Respiratory infections and inflammation of the respiratory system
- Reduced lung function
- Allergic reactions
- Gastro-intestinal disorders
- Dermatitis
- Eye irritation

The consequence of the hazard at sensitive receptors (i.e. the severity of impacts on human health) is largely determined by the proximity of the receptor to the emission source; concentrations of bioaerosols decline rapidly within the first 50-100m from a source (and generally decrease to background concentrations within 250m) [13,14]. Therefore, receptors within 100m of bioaerosol emission sources will experience a greater hazard consequence than those more than 100m from the emission source. Receptors downwind of the prevailing wind direction which are more than 100m from an emission sources will also experience a greater hazard consequence than those upwind of the emission source at these distances.

For the purpose of this assessment, sources of bioaerosols within 50m are considered to be '**high**' consequence of hazard. This is because within 50m of a source, consequences could be "severe", and "exposure may result in significant damage". Sources of bioaerosols within 50-100m of receptors are considered to have a '**medium**' consequence of hazard. This is because within 50-100m of the source, concentrations of bioaerosols would reduce, so temporary exposure could result in "significant consequences" and potentially result in "damage that is not severe and is reversible". Beyond 100m, up to 250m, the consequence of the hazard is considered to be '**low**' as concentrations of bioaerosols would be lower so the consequence of the hazard would also be lower, resulting in "minor consequences" where damage is "not apparent, reversible adverse changes possible". Beyond 250m, up to 500m, the consequence is considered '**very low**' as concentrations of bioaerosols generally decrease to background concentrations at this distance so there would be "no evidence for adverse changes" at sensitive receptors at this distance. Beyond 500m, the consequence is not applicable (n/a). The final consequence of hazard assessed for each emission source is presented below in Table 5.2. Across all potential bioaerosol emission sources at the Site, the consequence of hazard is '**low**' to '**medium**'.

Table 5.2: Consequence of hazard from bioaerosols at Queensferry STC

Process	Potential source of bioaerosols	Nearest receptor	Consequence of exposure	Justification
Sludge reception and distribution	Digested sludge storage tanks	175m, northeast, residential properties	Low	Nearest receptor >100m away from potential source, not downwind of prevailing wind direction
	Sludge reception tank	145m, northeast, industrial land use	Low	Nearest receptor >100m from potential source, not downwind of prevailing wind direction

[13] Environment Agency. 2011. Composting and potential health effects from bioaerosols: our interim guidance for permit applicants. Regulatory Position Statement 031.

[14] Health and Safety Executive, 2010. Bioaerosol emissions from waste composting and the potential for workers' exposure.

Process	Potential source of bioaerosols	Nearest receptor	Consequence of exposure	Justification
	Sludge screen	135m, northeast, industrial land use	Low	Nearest receptor >100m away from potential source, not downwind of prevailing wind direction
Sludge treatment	Screened sludge blending tanks	140m, northeast, residential properties	Low	Nearest receptor >100m from potential source, not downwind of prevailing wind direction
	Digested sludge holding tanks	150m, southeast, industrial properties	Low	Nearest receptor >100m from potential source, not downwind of prevailing wind direction
	Digested sludge tanks	145m, southeast, industrial properties	Low	Nearest receptor >100m from potential source, not downwind of prevailing wind direction
	Thickened sludge tank	140m, northeast, residential properties	Low	Nearest receptor >100m from potential source, not downwind of prevailing wind direction
	Digesters	110m, southeast, Industrial land use	Low	Nearest receptor >100m from potential source, not downwind of prevailing wind direction
	Centrifuge feed tanks	185m, northeast industrial land use	Low	Nearest receptor >100m from potential source, not downwind of prevailing wind direction
	Centrifuge	175m, northwest, industrial land use	Medium	Nearest receptor >100m from potential source, downwind of prevailing wind direction
	Cake storage bays	145m, northwest, industrial land use	Medium	Nearest receptor >100m from potential source, downwind of prevailing wind direction
Biogas combustion	Gas bag holders	90m, southeast, industrial land use	Medium	Nearest receptor <100m from potential source, not downwind of prevailing wind direction
	Boilers	120m, northeast, residential properties	Low	Nearest receptor >100m from potential source, not downwind of prevailing wind direction
	CHP	125m, northeast, residential properties	Low	Nearest receptor >100m from potential source, not downwind of prevailing wind direction
	Flare	95m, northeast, industrial land use	Medium	Nearest receptor <100m from potential source, not downwind of prevailing wind direction

5.4 Magnitude of risk

Table 5.3 below summarises the probability of exposure, consequence of hazard and resulting magnitude of risk for each potential bioaerosol emission source at Queensferry STC. Across all sources, there is a '**very low**' or '**low**' probability of exposure due to the nature of the processes and control measures in place which would prevent uncontrolled releases of bioaerosols. The consequence of exposure is described as '**low**' to '**medium**' depending on the potential emission source due to their proximity to sensitive receptors and the location of the receptor relative to the prevailing wind direction and potential emission source.

In accordance with EA guidance[15], across all potential bioaerosol emission sources, the magnitude of risk is described as '**low**' and therefore operation of the Queensferry STC is unlikely to lead to significant impacts at nearby sensitive receptors from bioaerosol emissions.

Nonetheless, due to the proximity of the site to sensitive receptors, monitoring of bioaerosols should be undertaken at Queensferry STC[16]. The requirements for bioaerosol monitoring at Queensferry STC will need to be agreed with NRW within the Environmental Permit issued for the site.

[15] Drew, G.H., Deacon, L.J., Pankhurst, L., Pollard, S.J.T. and Tyrrel, S.F. (2009). Guidance on the evaluation of bioaerosol risk assessments for composting facilities. Environment Agency.

[16] Natural Resource Wales (2014) Technical Guidance Note M17 (Monitoring) – Monitoring Particulate Matter in Ambient Air around Waste Facilities. Available online at: https://naturalresources.wales/media/2129/technical-guidance-note-m17-monitoring-monitoring-particulate-matter-in-ambient-air-around-waste-facillities.pdf

Table 5.3: Magnitude of risk from bioaerosols at the Site

Process	Potential source of bioaerosols	Probability of exposure	Consequence of exposure	Magnitude of risk	Justification
Sludge reception and distribution	Digested sludge storage tanks	Low	Low	Low	Nearest receptor >100m from potential source, not downwind of prevailing wind direction Uncovered, 'wet' process - exposure to bioaerosol emissions unlikely
	Sludge reception tank	Very Low	Low	Low	Nearest receptor >100m away from potential source, not downwind of prevailing wind direction Covered, 'wet' process - exposure to bioaerosol emissions unlikely
	Sludge screen	Very Low	Low	Low	Nearest receptor >100m away from potential source, not downwind of prevailing wind direction Covered, 'wet' process - exposure to bioaerosol emissions unlikely
Sludge treatment	Screened sludge blending tanks	Very Low	Low	Low	Nearest receptor >100m from potential source, not downwind of prevailing wind direction Covered, process monitored and regularly maintained – uncontrolled release of bioaerosols unlikely
	Digested sludge holding tanks	Low *	Low	Low*	Nearest receptor >100m from potential source, not downwind of prevailing wind direction Uncovered, 'wet' process - exposure to bioaerosol emissions unlikely (Tank 4) Covered, 'wet' process - exposure to bioaerosol emissions unlikely (Tank 3)
	Digested sludge tanks	Low	Low	Low	Nearest receptor >100m from potential source, not downwind of prevailing wind direction Uncovered, 'wet' process - exposure to bioaerosol emissions unlikely
	Thickened sludge tank	Very Low	Low	Low	Nearest receptor >100m from potential source, not downwind of prevailing wind direction Covered, process monitored and regularly maintained – uncontrolled release of bioaerosols unlikely
	Digesters	Very Low	Low	Low	Nearest receptor >100m from potential source, not downwind of prevailing wind direction Covered, process monitored and regularly maintained – uncontrolled release of bioaerosols very unlikely
	Centrifuge feed tanks	Low	Low	Low	Nearest receptor >100m from potential source, not downwind of prevailing wind direction Uncovered, 'wet' process - exposure to bioaerosol emissions unlikely

Process	Potential source of bioaerosols	Probability of exposure	Consequence of exposure	Magnitude of risk	Justification
	Centrifuge	Very Low	Medium	Low	Nearest receptor >100m from potential source, downwind of prevailing wind direction Covered, process monitored and regularly maintained – uncontrolled release of bioaerosols unlikely
	Cake storage bays	Very Low	Medium	Low	Nearest receptor >100m from potential source, downwind of prevailing wind direction Uncovered, however Cake storage at the end of the sludge treatment process and requires no further treatment before being deposited on agricultural land –release of bioaerosols very unlikely as bioaerosol content of cake anticipated to be de minimis
Biogas combustion	Gas holder	Very Low	Medium	Low	Nearest receptor <100m from potential source, not downwind of prevailing wind direction Gas holder air-tight to prevent uncontrolled release of bioaerosols. SCADA system in place to detect leaks -uncontrolled release of bioaerosols very unlikely
	Boilers	Very Low	Low	Low	Nearest receptor >100m from potential source, not downwind of prevailing wind direction Combustion of biogas at very high temperatures which would destroy bioaerosols - uncontrolled release of bioaerosols very unlikely
	CHPs	Very Low	Low	Low	Nearest receptor >100m from potential source, not downwind of prevailing wind direction Combustion of biogas at very high temperatures which would destroy bioaerosols - uncontrolled release of bioaerosols very unlikely
	Flare	Very Low	Medium	Low	Nearest receptor <100m from potential source, not downwind of prevailing wind direction Combustion of biogas at very high temperatures which would destroy bioaerosols- uncontrolled release of bioaerosols very unlikely

Remarks: Asterisk (*) means the worst-case scenario (i.e. uncovered Tank 4) has been taken to assess probability of exposure for digested sludge holding tanks.

6 Summary

At Queensferry STC, there is the potential for bioaerosol emissions from:

- Sludge reception and distribution
- Sludge treatment (sludge treatment, digestors, centrifuge and cake bays)
- Biogas combustion

Bioaerosol emissions associated with these processes could be transported by the wind to nearby sensitive human health receptors bordering the site, resulting in adverse health effects. As these sensitive human health receptors are within 250m of potential emission sources at Queensferry STC, a bioaerosol risk assessment has been undertaken in accordance with NRW and Environment Agency guidance. However, based on the latest comments from the Environment Agency for another similar WTW, a conservative approach has been undertaken and human receptors within 500m of the Site have been considered instead of 250m in the bioaerosol risk assessment.

To inform the assessment, a Source-Pathway-Receptor model was developed and the control measures at the facility to reduce and contain bioaerosol emissions were reviewed. This was undertaken to determine the probability of exposure, consequence of hazard and overall magnitude of risk associated with different processes at Queensferry STC.

Based on the ‘very low’ and ‘low’ probability of exposure and ‘low’ to ‘medium’ consequence of hazards associated with different processes at the STC, the overall magnitude of the risk associated with bioaerosols emissions from Queensferry STC is considered to be ‘low’. This is primarily due to the ‘wet’ nature of several processes undertaken at Queensferry STC and the control measures in place, which are considered to be effective at reducing and containing emissions of bioaerosols, inhibiting the pathway between source and receptor.