MOTT MACDONALD

Peacehaven Wastewater Treatment Works & Sludge Treatment Centre Environmental Permit Application

Bioaerosol risk assessment
790101_ERA_BioaRA_PEA

July 2022

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Contents

1 Introduction

1.1 Overview

Southern Water is applying to vary their existing bespoke environmental permit to include the sludge treatment facilities at the Peacehaven Wastewater Treatment Works (WTW) and Sewage Treatment Centre (STC) ('the Site'). Sludge treatment activities are covered by the Environmental Permitting Regulations (EPR) 2016, which incorporates the application of the Industrial Emissions Directive (IED). The Site currently operates under T21, S2 and U6 exemptions and has one existing environmental permit for the combined heat and power unit (CHP) (Permit ref. EPR/KB3435RB).

Regulatory Position Statement 209[1], issued 23 January 2018 by the Environment Agency, 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 160m from the nearest potential source of bioaerosols at the Site, a bioaerosol risk assessment has been undertaken.

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

1.2 Site location

The Site is situated north-east of Peacehaven, East Sussex. The Site is surrounded by agricultural fields to the north and east, and public open space (which includes three recreational playgrounds) to the south and west. Beyond these areas of public open space, there are areas of residential properties to the south-east, south and west.

The layout of the Site is shown in 790101_MSD_SiteLayoutPlan_PEA.

[1] 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

[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.

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

Nonetheless, current 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].

[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.'

As sensitive human health receptors are found within 250m of the activities at the Site which have the potential to release bioaerosols, a bioaerosol risk assessment has been undertaken.

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:

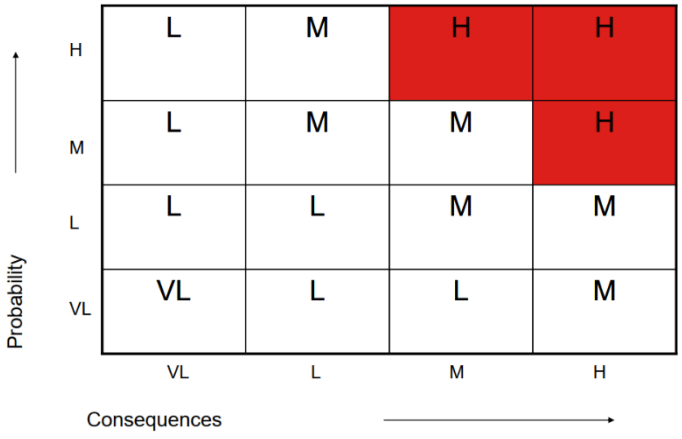
- High – exposure is probable, direct exposure likely with no/few barriers between source and receptor
- Medium – exposure is fairly probable, barriers less controllable
- Low – exposure unlikely, barriers exist to mitigate
- Very low – exposure very unlikely, effective and multiple barriers

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 Site (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 Site, using the risk matrix above.

3 Source – Pathway – Receptor model

3.1 Overview

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

3.2 Sources

3.2.1 Overview

The Site includes the following assets which could release bioaerosols:

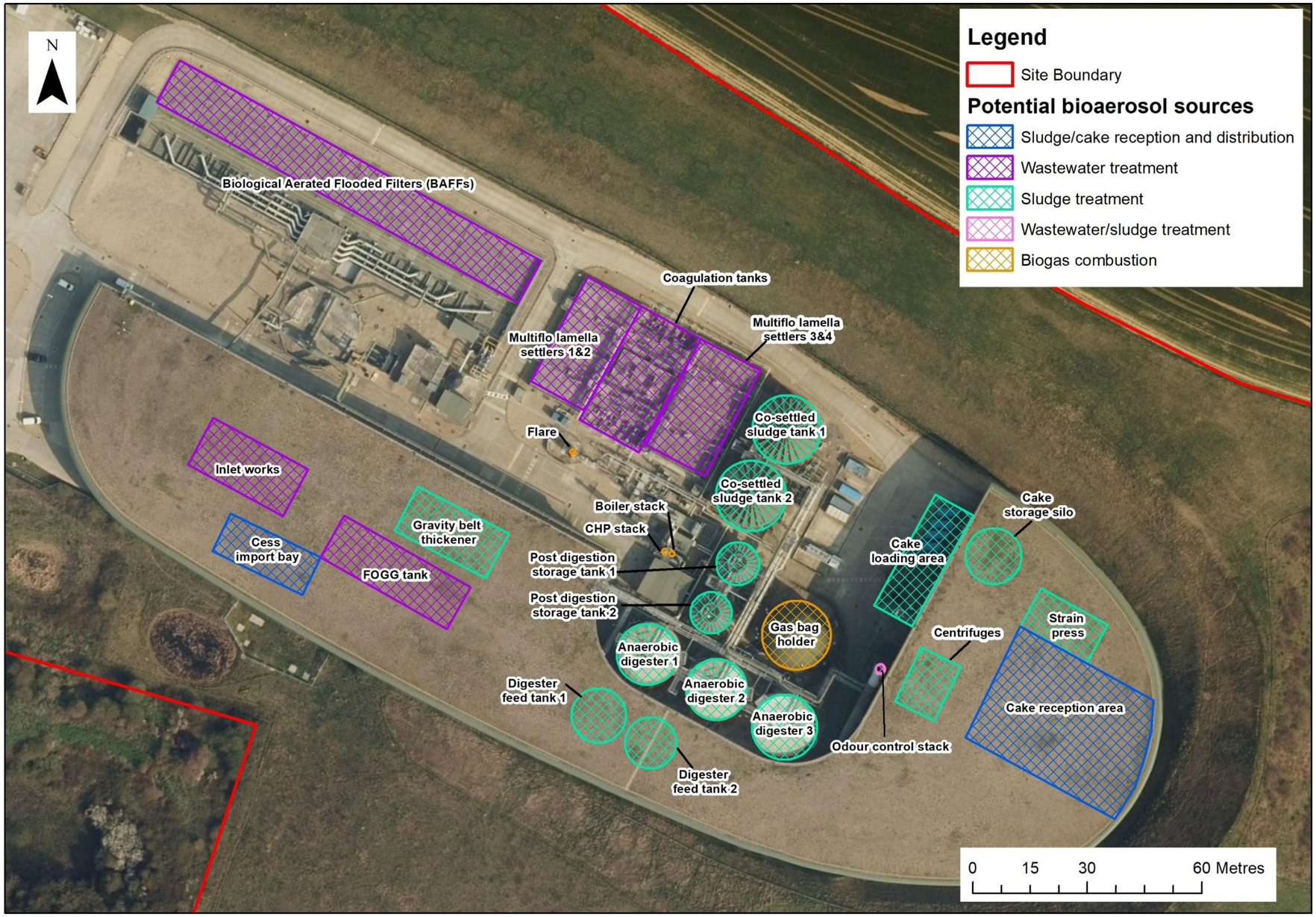
- One cake import bay
- One cess import bay
- Inlet works (includes three inlet screens)
- Three fat, oil, grit and grease (FOGG) removal tanks
- Two coagulation tanks
- Four multiflo lamella settlers
- Ten Biological Aerated Flooded Filters (BAFFs)
- Two co-settled sludge tanks
- Three gravity belt thickeners
- Two digester feed tanks
- Three anaerobic digesters
- Two post digestion storage tanks
- Two centrifuges
- Strain press
- One cake storage silo
- Six cake storage Roll-on and Roll-off (ro-ro) containers
- One odour control unit (include one stack)
- One flare
- One gas bag holder
- One Combined Heat and Power (CHP) unit (include one stack)
- Two boilers (include one stack)

The following processes undertaken at the Site involving these assets have the potential to release bioaerosols:

- Sludge/cake reception and distribution
- Wastewater treatment (FOGG removal tanks, coagulation tanks, multiflo lamella settlers, and BAFFs)
- Sludge treatment (co-settled sludge tanks, gravity belt thickeners, digester feed tanks, post digestion storage tanks, centrifuges, strain press, cake loading area)
- Biogas combustion (flare, gas bag holder, CHP stack, boiler stack)

Figure 3.1 shows the locations of these different processes and assets across the Site. A summary of the activities which occur at the Site involving these assets is presented below. Note: Activities that take place within the building are included within the assessment as the building is made up of a number of shutters which can be opened as required.

Figure 3.1: Potential sources of bioaerosols at the Site



Note: Potential bioaerosol sources within the building are approximate based on the information provided. Those sources include inlet works, cess import bay, gravity belt thickener, FOGG removal tank, digester feed tank 1 & 2, cake storage silo, strain press, centrifuges and cake reception area.

3.2.2 Sludge reception and distribution

The Site accepts imports of cess at the cess tanker bay where it is discharged directly from tankers into the inlet pumping station. The Site also accepts approximately ten ro-ro's a week of cake imports from the Newhaven WTW. Imported cake is deposited directly into the cake import bay.

3.2.3 Wastewater treatment and sludge treatment

3.2.3.1 Wastewater

Wastewater arriving at the Site is screened at the inlet pumping station before passing through the fat, oil, grit and grease (FOGG) removal tanks to remove FOGG from the sludge. These tanks remove FOGG, which is pumped into a separate grease concentrator and discharged into the digester feed tanks, while the effluent passes to coagulation tanks to be dosed with ferric chloride. The coagulated effluent then passes through the multiflo lamella settlers for primary treatment. The settled effluent from the lamella settlers then gravitate to the Biological Aerated Flooded Filters (BAFFs) plant for secondary treatment. The BAFF plant is for removal of carbonaceous pollutants (chemical oxygen demand (COD)/ biochemical oxygen demand (BOD)) and total suspended solids (TSS) from the sludge by providing oxygen. The treated effluent from the BAFFs plant then flows to the effluent sampling chamber for testing before being discharged to the English Channel via a long sea outfall.

3.2.3.2 Sludge treatment

The Site treats indigenous sludge (auto-desludged from multiflo lamella settlers) as well as imported cake. Indigenous sludge is pumped to the co-settled sludge tanks where it is blended with imported cake. This sludge is then thickened by gravity belt thickeners and discharged into digester feed tanks before passing to the anaerobic digesters for anaerobic digestion (AD). Anaerobic digestion provides a controlled environment where micro-organisms, including bacteria and fungi, can grow, multiply and break-down organic material to form water, carbon dioxide and methane (biogas).

The digested sludge from the AD process gravitates to post digestion storage tanks (PDSTs) before being fed into the centrifuges. The resulting cake is then transferred to the cake storage silo before it is transported offsite in sealed cake bins for recycling. Digested cake is stored in the cake storage silo for maximum 3 days over weekend.

3.2.4 Biogas combustion

Biogas produced during anaerobic digestion is transferred to the gas bag holder and then to the CHP where it is combusted to generate heat and electricity, which is used on-site to assist with the site running and sludge treatment processes. If the CHP is not available, for example when maintenance is being undertaken, the boilers are used instead.

When more biogas is produced on-site than can be combusted within the CHP or 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. This prevents excessive biogas pressure from building up in the gas bag holder. Currently, the flare is prioritised to be used in emergencies. If the flare is operational for more than 10% of the year, monitoring will be undertaken in accordance with the environmental permit.

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 2015-2019 wind rose for the nearest meteorological site, Shoreham Airport (located approximately 22km north-west of the Site), is shown in Figure 3.2. This monitoring site is located adjacent to the coast which is similar to the Site. This monitoring site experiences strong prevailing winds from the south-west, with frequent mild winds from the north. However, this meteorological site is located within a wide valley which channels winds from the north, resulting in the frequent mild northerly winds. This is different from the conditions at the Site, which is sheltered from winds from the north by the surrounding terrain so an atmospheric hindcast model (Vortex) has also been used to assess the wind conditions at the Site.

The Vortex model uses historic ERA5 data from the European Centre for Medium-Range Weather Forecasts (ECMWF) and works by combining past meteorological data with current weather models. This allows meteorological parameters, such as wind speed and direction, to be predicted at any location for any time period from the past 40 years, accounting for some localised effects. The data from this model is a popular dataset for climate modellers and is used by the World Meteorological Organization for their annual State of the Climate report.

Figure 3.3 presents the wind rose generated for the Site from the Vortex model for the period from 2015-2019. The wind rose demonstrates that historically this location also experiences strong prevailing winds from the south-west, with occasional gusts from the west and north east.

Overall, the two datasets show general agreement with the modelled data indicating the prevailing winds originate from a south-westerly direction. This suggests that sensitive receptors located to the north-east of the Site would be at the greatest risk from bioaerosol emissions from the Site as they would be downwind of the prevailing wind direction.

Figure 3.2: Average wind rose for Shoreham Airport meteorological site 2015- 2019

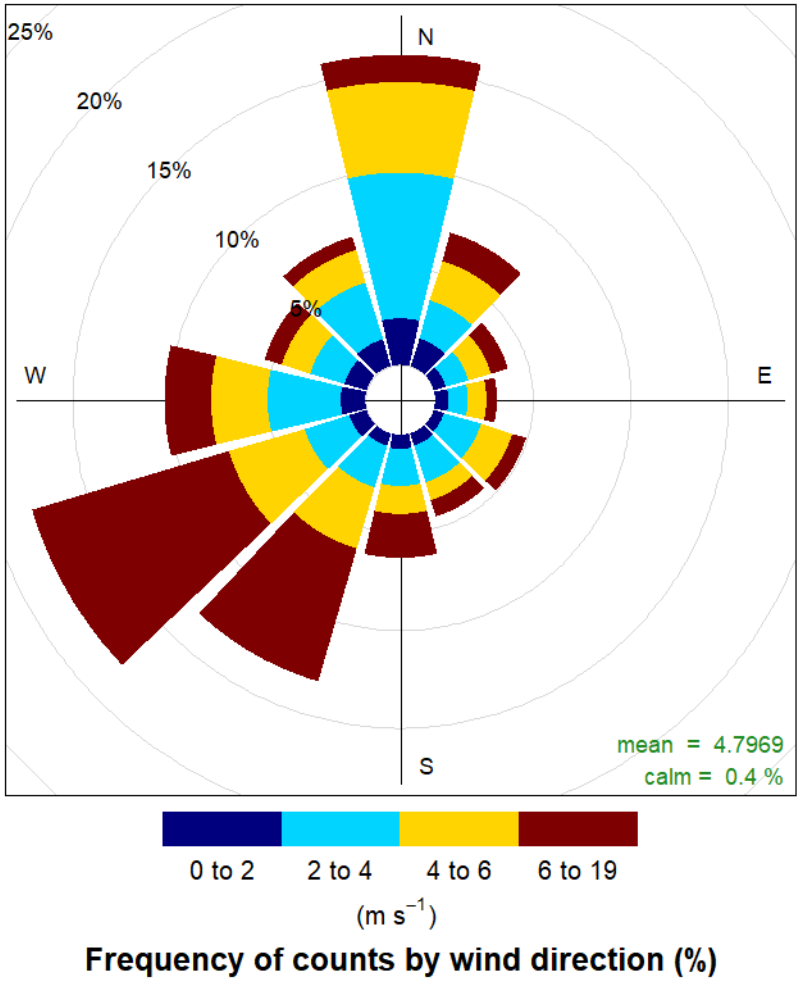
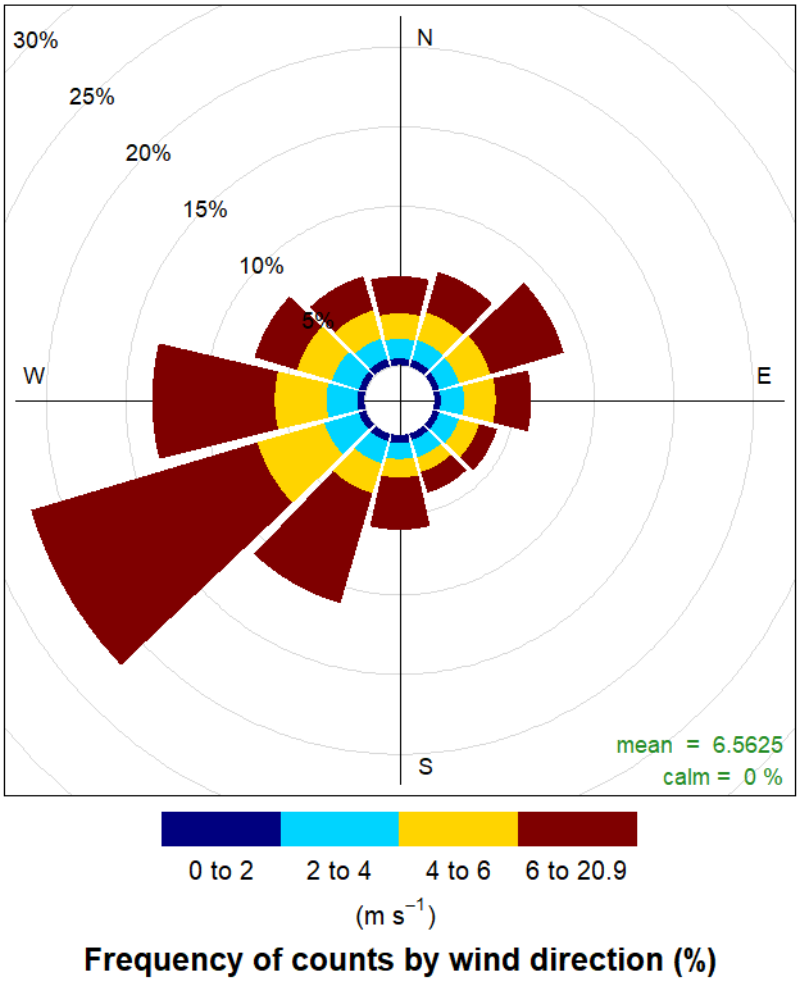


Figure 3.3: Average wind rose for the Site from the Vortex model, 2015- 2019



Concentrations of bioaerosols decline rapidly within the first 100m from a source and generally decrease to background concentrations within 250m[9,10]. The man-made bund surrounding the Site presents a natural barrier to the transportation of bioaerosols by the wind. However, the effectiveness is dependent on the release height of bioaerosols on Site. The area surrounding the Site has relatively flat terrain.

3.4 Receptors

Environment Agency guidance[11] recommends a screening distance of 250m from bioaerosol emission sources to static receptor locations. 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.

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

[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

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 two areas of sensitive receptors found within 250m of potential bioaerosol emission sources at the Site. As demonstrated in Figure 3.4, two areas of residential receptor are found to the southeast and south of the Site (Cissbury Avenue and Westview Close). The nearest of these areas to a potential bioaerosol source is the area of residential properties located in southeast of the Site, approximately 160m south east of the cake reception area.

For these two areas of receptors, the distance and direction from each potential bioaerosol emission source on Site to the receptors has been identified below in Table 3.1Where multiple assets exist for the same process, such as digesters, only the closest asset to the receptors has been presented.

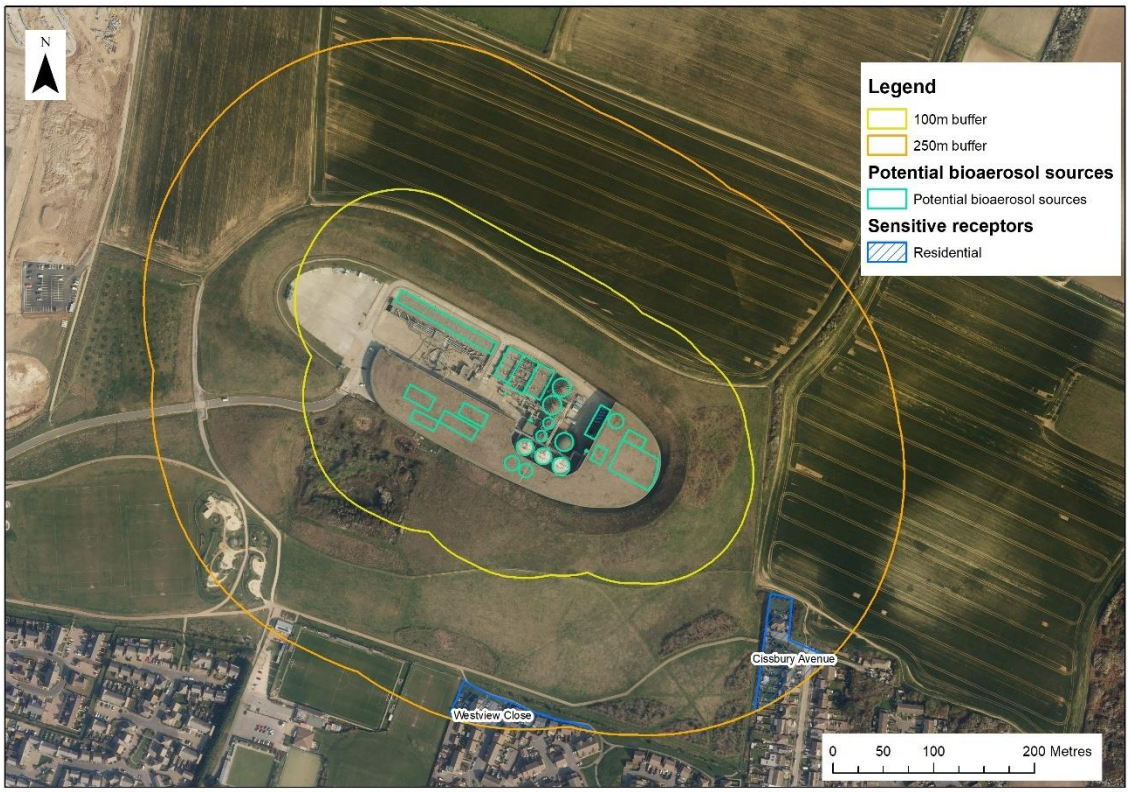
Table 3.1: Receptors within 250m of potential emission sources at the Site

Receptor[a]	Nearest potential emissions source to receptor	Process	Distance (m) from nearest potential emission source [b]	Direction of receptor from closest emission source
Cissbury Avenue Residential properties - south east of the Site	Cake import bay	Sludge/cake reception and distribution	160	Southeast
	Cess import bay	Sludge/cake reception and distribution	>250	Southeast
	Inlet works	Wastewater treatment	>250	Southeast
	FOGG removal tanks	Wastewater treatment	>250	Southeast
	Coagulation tanks	Wastewater treatment	>250	Southeast
	Multiflo lamella settlers	Wastewater treatment	>250	Southeast
	Biological Aerated Flooded Filters (BAFFs)	Wastewater treatment	>250	Southeast
	Co-settled sludge tanks	Sludge treatment	>250	Southeast
	Gravity belt thickeners	Sludge treatment	>250	Southeast
	Digester feed tanks	Sludge treatment	>250	Southeast
	Anaerobic digesters	Sludge treatment	235	Southeast
	Post digestion storage tank (PDSTs)	Sludge treatment	>250	Southeast
	Centrifuges	Sludge treatment	210	Southeast
	Strain press	Sludge treatment	190	Southeast
	Cake loading area	Sludge treatment	230	Southeast
	Odour control stack	Wastewater/Sludge treatment	230	Southeast
	Flare	Biogas combustion	>250	Southeast
	Gas bag holder	Biogas combustion	245	Southeast
	Combined Heat and Power (CHP) stack	Biogas combustion	>250	Southeast
	Boiler stack	Biogas combustion	240	Southeast
	Cake reception area	Sludge/cake reception and distribution	>250	Southeast

Receptor[a]	Nearest potential emissions source to receptor	Process	Distance (m) from nearest potential emission source [b]	Direction of receptor from closest emission source
Westview Close Residential properties - south of the Site	Cess import bay	Sludge/cake reception and distribution	>250	Southeast
	Inlet works	Wastewater treatment	240	Southeast
	FOGG removal tanks	Wastewater treatment	>250	South
	Coagulation tanks	Wastewater treatment	>250	South
	Multiflo lamella settlers	Wastewater treatment	>250	South
	Biological Aerated Flooded Filters (BAFFs)	Wastewater treatment	>250	South
	Co-settled sludge tanks	Sludge treatment	250	Southeast
	Gravity belt thickeners	Sludge treatment	210	South
	Digester feed tanks	Sludge treatment	225	South
	Anaerobic digesters	Sludge treatment	250	South
	Post digestion storage tank (PDSTs)	Sludge treatment	>250	South
	Centrifuges	Sludge treatment	250	South
	Strain press	Sludge treatment	>250	South
	Cake loading area	Sludge treatment	>250	South
	Odour control stack	Wastewater/Sludge treatment	>250	South
	Flare	Biogas combustion	250	South
	Gas bag holder	Biogas combustion	>250	South
	Combined Heat and Power (CHP) stack	Biogas combustion	>250	South
	Boiler stack	Biogas combustion	>250	South

Source: (a) Refers to the receptors presented within Figure 3.4.
(b) Distance from source to receptor is rounded to the nearest 5m

Figure 3.4: Sensitive receptors within 250m



Note: Activities that take place within the building are included within the assessment as the building is made up of a number of shutters which can be opened as required.

3.5 Summary

Table 3.2 below summarises the potential sources of bioaerosol emissions at the Site, 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	Nearest receptor
Sludge/cake reception and distribution	Cake import bay	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)	Cissbury Avenue Residential - 160m southeast
	Cess import bay		Westview Close Residential - 270m southeast
Wastewater treatment	Inlet works		Westview Close Residential - 270m southeast
	FOGG removal tanks		Westview Close Residential - 240m southeast

Source process	Potential emission source	Pathway	Nearest receptor
	Coagulation tanks		Westview Close Residential - 290m south
	Multiflo lamella settlers		Westview Close Residential - 290m south
	Biological Aerated Flooded Filters (BAFFs)		Westview Close Residential - 325m south
Sludge treatment	Co-settled sludge tanks		Cissbury Avenue Residential - 275m southeast
	Gravity belt thickeners		Westview Close Residential - 250m southeast
	Digester feed tanks		Westview Close Residential - 210m south
	Anaerobic digesters		Westview Close Residential - 225m south
	Post digestion storage tank		Westview Close Residential - 250m south
	Centrifuges		Cissbury Avenue Residential - 210m southeast
	Strain press		Cissbury Avenue Residential - 190m southeast
	Cake loading area		Cissbury Avenue Residential - 230m southeast
Wastewater/Sludge treatment	Odour control stack		Cissbury Avenue Residential - 230m southeast
Biogas combustion	Flare		Westview Close Residential - 285m south
	Gas bag holder		Cissbury Avenue Residential - 245m southeast
	CHP stack		Westview Close Residential - 265m south
	Boiler stack		Westview Close Residential - 265m south

4 Control measures

4.1 Overview

The three primary ways to mitigate emissions of bioaerosols[12] is to:

- Reduce emissions
- Contain emissions
- Enhance dispersion

The sections below outline the different bioaerosol control measures in place at the Site. 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

The transfer of imported cake has a short duration and, under normal operations, takes place up to 10 times a week. These imports arrive to the Site via sealed ro-ro trucks and are offloaded directly into the raw cake bay, which is inside a covered building that is odour controlled. Air extracted from the building is treated by acid and alkali scrubbers. The scrubbed air is then released to atmosphere. Therefore, the potential for release of bioaerosols is minimal.

If a spillage of cake occurs, operators will carry out clean up as soon as possible (using disinfectant where necessary). If the spillage is caused by a truck, the driver is responsible for cleaning up the spill before leaving the Site. If a truck 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.

Appropriate wash up facilities are also provided for drivers to clean the vehicles after loading or unloading. Truck drivers are required to hose down any spillage after each loading or unloading and clean contaminated wheels before leaving the Site.

4.2.2 Wastewater and sludge treatment

4.2.2.1 Containment of emissions

To contain emissions of bioaerosols during wastewater and sludge treatment, the inlet works, FOGG tank, digester feed tanks, gravity belt thickeners, strain press and cake storage silos are all contained within a building. Doors and hatches of this buildings are kept closed at all times except when access is required. When access is required for operation and maintenance, the doors and hatches to the building will only be opened for minimum periods. If access is required for an extended period of time, such as for maintenance activities, additional mitigation measures are implemented to minimise the impact associated with bioaerosols. The contractor will put nitrogen in a tank, and spray off all gas pipes which are associated with the individual

[12] 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.

tanks so that gases cannot escape into the tank which is being drained. The Site is also an enclosed site with earth bunds.

To further contain bioaerosol emissions, all BAFFs, multiflo lamella settlers and processes associated with sludge treatment (co-settled sludge tanks, anaerobic digesters, PDSTs) are sealed and covered.

4.2.2.2 Reduce emissions

Throughout the sludge treatment process, biological material which could give rise to emissions of bioaerosols is broken down. This primarily occurs during anaerobic digestion which removes microorganisms which could give rise to bioaerosols. Therefore, at each stage of the sludge treatment process, the potential quantity of bioaerosols decreases, reducing the risk of exposure; the concentration of bioaerosols that could potentially be emitted from the co-settled sludge tanks, anaerobic digesters, PDSTs and cake loading area (at the end of the sludge treatment process) is much lower than the sludge prior to anaerobic digestion.

Therefore, while the cake loading area is uncovered, this area contains digested cake which is near the end of the sludge treatment process so the bioaerosol content and associated risk of exposure is reduced. In addition, the digested cake is pumped directly from the cake storage silo into the sealed ro-ro cake bins in the cake loading area to be transported offsite for recycling. This reduces the risk of bioaerosol emissions as agitation of cake could facilitate the resuspension of any remaining bioaerosols into the air.

Odorous air from all covered/sealed wastewater and sludge treatment processes is also extracted and treated by two-stage chemical scrubber systems with acid scrubbers, alkaline and hypochlorite scrubbers to remove odorous compounds.

4.2.3 Biogas combustion

Biogas produced during anaerobic digestion is stored within the gas bag holder before being combusted at high temperatures within the CHP, boilers or flare. The biogas holder stores the biogas within an air-tight membrane 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 are conducted of the treatment processes on-site to ensure the equipment is working correctly. The parameters measured include: influent flow, sludge blanket thickness, turbidity, feed rate of digesters, polymer dose and biogas flow (full list of parameters monitored are found within the operating plan for the Site). 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.

All equipment is connected to the OCU apart from the digesters and post digestion storage tanks.

The Site is equipped with a comprehensive ventilation and odour control system. Treatment buildings and processes are provided with fresh air supply and foul air extraction systems to prevent escape of odours. The odour control unit undergoes monthly scheduled maintenance by specialised contractors.

Extracted odorous air is treated by a two-stage chemical scrubber system which utilises 3 No. acid scrubbers followed by 3 No. alkaline hypochlorite scrubbers.

Odour is controlled with an odour removal efficiency of XXXX% (average and peak) and total flow rate of XXXX m^3/hour. Filtered odour streams are discharged into the environment through OCU stack as shown by A05 in 790101_MSD_SitelayoutPlan_PEA and are monitored hourly to ensure the absence of odorous compounds.

There are no open storage of wastes on the Site. All processes/equipment are covered or enclosed. Sludge cake is pumped directly in sealed ro-ro containers, there is no exposure to environmental air. Sludge cake is not handled and is removed from the Site in the sealed ro-ro's. Any spills from the pumping of cake into the ro-ros are cleared as soon as practicable.

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

Daily, weekly and monthly maintenance tasks/servicing are also performed on key equipment across the Site by Southern Water staff and specialist contractors. Southern Water has also issued generic maintenance task manuals for use across all their sites which include protocols for the maintenance of equipment such as absorbers, biological filters, fresh air supply ducting, wet scrubber (cleaning, pre-winter service, pH probe calibration, redox probe calibration), direct driven fan, belt driven fan and dryer exhaust ducting.

Stocks of chemicals on-site are also carefully managed to ensure there are sufficient stocks 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 Supervisory Control and Data Acquisition (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, a mechanical or electrical technician, both of whom are on-call 24-hours, would be contacted and would attend the Site as soon as practicable if required. Where the on-call technicians are already engaged upon other response work, there is the facility to access staff from other Southern Water 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, gas holder and PDSTs, which would release bioaerosols. This occurs to prevent over pressurisation of the digesters and gas systems. If this occurs, the feed to the digesters is reduced until the situation is rectified.

4.5 Summary

As discussed above, there are a number of control measures in place at the Site to reduce and contain emissions of bioaerosols. These control measures are regularly maintained to sustain their efficacy and reduce the risk of equipment failure.

Across the Site, the potential for bioaerosol emissions which could result in significant consequences is limited. The greatest risk of significant bioaerosol emissions from the Site where there would be the greatest consequence of the hazard, is associated with emergency

situations such as a failure of the digester, which could result in uncontrolled emissions of bioaerosols. However, such an emergency event would be unlikely, 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 the Site to determine the overall magnitude of risk. The descriptors used ('very low' to 'high') are based on the descriptors outlined in the Environment Agency guidance[13], as summarised in Section 2.3.

5.2 Probability of exposure

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

- Sludge/cake reception and distribution
- Wastewater treatment (FOGG removal tanks, coagulation tanks, multiflo lamella settlers,and BAFFs)
- Sludge treatment (co-settled sludge tanks, gravity belt thickeners, digester feed tanks, post digestion storage tanks, centrifuges, strain press, cake loading area)
- Biogas combustion/ treatment (flare, gas bag holder, CHP stack, boiler stack)

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. However, as discussed in Section 4, there are multiple control measures in place at the Site which restrict the Source-Pathway-Receptor link by reducing and containing emissions of bioaerosols from these processes. Therefore, across all potential bioaerosol sources at the Site, the overall probability of exposure is '**very low**'.

The final probability of exposures to bioaerosols assessed for each emission source is presented below in Table 5.2.

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

Process	Potential source of bioaerosols	Probability of exposure	Justification
Sludge/cake reception and distribution	Cake reception area	Very Low	Stringent loading and unloading procedures. Cake import activities are within a covered building. Odorous air from the building is extracted and treated by the OCU – uncontrolled release of bioaerosols very unlikely.
	Cess import bay	Very Low	Stringent loading and unloading procedures. Cess import activities are within a covered building. Odorous air from the building is extracted and treated by the OCU – uncontrolled release of bioaerosols very unlikely.
Wastewater treatment	Inlet works	Very Low	Inlet works are within a covered building. Odorous air from the building is extracted and treated by the OCU. Process monitored and

[13] 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
			regularly maintained – uncontrolled release of bioaerosols very unlikely.
	FOGG removal tanks	Very Low	Tanks are sealed and are within a covered building. Odorous air from the building is extracted and treated by the OCU. Process monitored and regularly maintained – uncontrolled release of bioaerosols very unlikely.
	Coagulation tanks	Very Low	Tanks are covered and odorous air is extracted and treated by the OCU. Processes monitored and regularly maintained - uncontrolled release of bioaerosols very unlikely.
	Multiflo lamella settlers	Very Low	Tanks are covered and odorous air is extracted and treated by the OCU. Processes monitored and regularly maintained - uncontrolled release of bioaerosols very unlikely.
	Biological Aerated Flooded Filters (BAFFs)	Very Low	Tanks are covered and odorous air is extracted and treated by the OCU. Process monitored and regularly maintained - uncontrolled release of bioaerosols very unlikely.
Sludge treatment	Co-settled sludge tanks	Very Low	Tanks sealed and odorous air is extracted and treated by the OCU. Process monitored and regularly maintained – uncontrolled release of bioaerosols very unlikely.
	Gravity belt thickeners	Very Low	Thickeners are sealed and are within a covered building. Odorous air from the building is extracted and treated by the OCU. Process monitored and regularly maintained – uncontrolled release of bioaerosols very unlikely.
	Digester feed tanks	Very Low	Tanks are sealed and are within a covered building. Odorous air from the building is extracted and treated by the OCU. Process monitored and regularly maintained – uncontrolled release of bioaerosols very unlikely.
	Anaerobic digesters	Very Low	Digesters sealed and odorous air is extracted and treated by the OCU. Process monitored and regularly maintained – uncontrolled release of bioaerosols very unlikely.
	Post-digestion storage tanks (PDSTs)	Very Low	Tanks are sealed and are within a covered building. Odorous air from the building is extracted and treated by the OCU. Process monitored and regularly maintained – uncontrolled release of bioaerosols very unlikely.
	Centrifuges	Very Low	Centrifuges are sealed and are within a covered building. Odorous air from the building is extracted and treated by the OCU. Process monitored and regularly maintained – uncontrolled release of bioaerosols very unlikely.
	Strain press	Very Low	Strain press sealed and is within a covered building. Odorous air from the building is extracted and treated by the OCU. Process monitored and regularly maintained – uncontrolled release of bioaerosols very unlikely.
	Cake loading area	Very Low	Cake pumped directly into the RORO bins. Stringent loading and unloading procedures – uncontrolled release of bioaerosols very unlikely.

Process	Potential source of bioaerosols	Probability of exposure	Justification
Wastewater/ Sludge treatment	Odour control stack	Very Low	Odorous air from the WTW is treated by two-stage chemical scrubber system which would remove odorous compounds and bioaerosols. Process monitored and regularly maintained - uncontrolled release of bioaerosols very unlikely.
Biogas combustion	Flare	Very Low	Combustion of biogas at very high temperatures which would destroy bioaerosols – uncontrolled release of bioaerosols very unlikely.
	Gas bag holder	Very Low	Gas bag holder sealed to prevent uncontrolled release of bioaerosols – uncontrolled release of bioaerosols very unlikely
	Combined Heat and Power (CHP) stack	Very Low	Combustion of biogas at very high temperatures which would destroy bioaerosols – uncontrolled release of bioaerosols very unlikely.
	Boiler stack	Very Low	Combustion of biogas at very high temperatures which would destroy bioaerosols – uncontrolled release of bioaerosols very unlikely.

5.3 Consequence of hazard

While the probability of exposure of receptors to bioaerosols is 'very low' as a result of the control measures in place and the nature of processes on Site, there is still a risk that nearby receptors could be exposed to bioaerosols, for example if there was a failure of the control equipment. Should this occur, any exposure to bioaerosols would likely be temporary/infrequent. Furthermore, if the exposure was due to a failure of control equipment, 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) [14,15]. Therefore, receptors within 100m of bioaerosol emission sources will experience a greater hazard consequence than those more than 100m from the emission source.

For the purpose of this assessment, receptors within 50m of bioaerosol sources and downwind of the prevailing wind direction are considered to be '**high**' consequence of hazard. This is

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

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

because within 50m of a source, consequences could be “severe”, and “exposure may result in significant damage”, as being downwind of the prevailing wind direction also increases the likelihood of exposure. Receptors within 50m of bioaerosols that are upwind of the prevailing wind direction are considered to have a ‘**medium**’ consequence of hazard, as though they are in close proximity to a bioaerosol source, they are less likely to be exposed due to the prevailing wind direction.

Sources of bioaerosols within 50-100m of receptors are also considered to have a ‘**medium**’ consequence of hazard, irrespective of whether they are upwind or downwind of the emission source. 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, 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.

The final consequence of hazard assessed for each emission source is presented below in Table 5.2.

Table 5.2: Consequence of hazard from bioaerosols at the Site

Source process	Potential source of bioaerosols	Nearest receptor	Consequence of hazard	Justification
Sludge/cake reception and distribution	Cake import bay	160m, south east	Low	Nearest receptor <250m from potential source
	Cess import bay	>250m, southeast	Very Low	Nearest receptor >250m from potential source
Wastewater treatment	Inlet works	>250m, southeast	Very Low	Nearest receptor >250m from potential source
	FOGG removal tanks	240m, southeast	Low	Nearest receptor <250m from potential source
	Coagulation tanks	>250m, south	Very Low	Nearest receptor >250m from potential source
	Multiflo lamella settlers	>250m, south	Very Low	Nearest receptor >250m from potential source
	Biological Aerated Flooded Filters (BAFFs)	>250m, south	Very Low	Nearest receptor >250m from potential source
Sludge treatment	Co-settled sludge tanks	>250m, southeast	Very Low	Nearest receptor >250m from potential source
	Gravity belt thickeners	>250m, southeast	Very Low	Nearest receptor >250m from potential source

Source process	Potential source of bioaerosols	Nearest receptor	Consequence of hazard	Justification
	Digester feed tanks	210m, south	Low	Nearest receptor <250m from potential source
	Anaerobic digesters	225m, south	Low	Nearest receptor <250m from potential source
	Post digestion storage tank (PDSTs)	>250m, south	Low	Nearest receptor <250m from potential source
	Centrifuges	210m, southeast	Low	Nearest receptor <250m from potential source
	Strain press	190m, southeast	Low	Nearest receptor <250m from potential source
	Cake loading area	230m, southeast	Low	Nearest receptor <250m from potential source
Wastewater/Sludge treatment	Odour control stack	230m, southeast	Low	Nearest receptor <250m from potential source
Biogas combustion/ treatment	Flare	>250m, south	Very Low	Nearest receptor >250m from potential source
	Gas bag holder	245m, southeast	Low	Nearest receptor <250m from potential source
	Combined Heat and Power (CHP) stack	>250m, south	Very Low	Nearest receptor >250m from potential source
	Boiler stack	>250m, south	Very Low	Nearest receptor >250m from potential source

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 the Site. Across all sources, there is a ‘very 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 hazard is described as ‘very low’ to ‘low’ depending on the proximity of the potential emission source to a sensitive receptor.

In accordance with Environment Agency guidance[16], across all potential bioaerosol emission sources, the magnitude of risk is described as ‘**very low**’ or ‘**low**’. Therefore, operation of the Site is unlikely to lead to significant impacts at nearby sensitive receptors from bioaerosol emissions.

[16] 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.

Nonetheless, due to the proximity of the Site to sensitive receptors, monitoring of bioaerosols should be undertaken at the Site[17]. The requirements for bioaerosol monitoring at the Site will need to be agreed with the Environment Agency within the Environmental Permit issued for the Site.

[17] 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

Table 5.3: Magnitude of risk from bioaerosols at the Site

Process	Potential source of bioaerosols	Probability of exposure	Consequence of Hazard	Magnitude of risk	Justification
Sludge/cake reception and distribution	Cake import bay	Very Low	Low	Low	Stringent loading and unloading procedures. Cake import activities are within a covered building. Odorous air from the building is extracted and treated by the OCU – uncontrolled release of bioaerosols very unlikely. Nearest receptor <250m from potential source
	Cess import bay	Very Low	Very Low	Very Low	Stringent loading and unloading procedures. Cess import activities are within a covered building. Odorous air from the building is extracted and treated by the OCU – uncontrolled release of bioaerosols very unlikely. Nearest receptor >250m from potential source
Wastewater treatment	Inlet works	Very Low	Very Low	Very Low	Inlet works are within a covered building. Odorous air from the building is extracted and treated by the OCU. Process monitored and regularly maintained – uncontrolled release of bioaerosols very unlikely. Nearest receptor >250m from potential source
	FOGG removal tanks	Very Low	Low	Low	Tanks are sealed and are within a covered building. Odorous air from the building is extracted and treated by the OCU. Process monitored and regularly maintained – uncontrolled release of bioaerosols very unlikely. Nearest receptor <250m from potential source
	Coagulation tanks	Very Low	Very Low	Very Low	Tanks are covered and odorous air is extracted and treated by the OCU. Processes monitored and regularly maintained - uncontrolled release of bioaerosols very unlikely. Nearest receptor >250m from potential source
	Multiflo lamella settlers	Very Low	Very Low	Very Low	Tanks are covered and odorous air is extracted and treated by the OCU. Processes monitored and regularly maintained - uncontrolled release of bioaerosols very unlikely. Nearest receptor >250m from potential source
	Biological Aerated Flooded Filters (BAFFs)	Very Low	Very Low	Very Low	Tanks are covered and odorous air is extracted and treated by the OCU. Process monitored and regularly maintained - uncontrolled release of bioaerosols very unlikely. Nearest receptor >250m from potential source

Process	Potential source of bioaerosols	Probability of exposure	Consequence of Hazard	Magnitude of risk	Justification
Sludge treatment	Co-settled sludge tanks	Very Low	Very Low	Very Low	Tanks sealed and odorous air is extracted and treated by the OCU. Process monitored and regularly maintained – uncontrolled release of bioaerosols very unlikely. Nearest receptor >250m from potential source
	Gravity belt thickeners	Very Low	Very Low	Very Low	Thickeners are sealed and are within a covered building. Odorous air from the building is extracted and treated by the OCU. Process monitored and regularly maintained – uncontrolled release of bioaerosols very unlikely. Nearest receptor >250m from potential source
	Digester feed tanks	Very Low	Low	Low	Tanks are sealed and are within a covered building. Odorous air from the building is extracted and treated by the OCU. Process monitored and regularly maintained – uncontrolled release of bioaerosols very unlikely. Nearest receptor <250m from potential source
	Anaerobic digesters	Very Low	Low	Low	Digesters sealed and odorous air is extracted and treated by the OCU. Process monitored and regularly maintained – uncontrolled release of bioaerosols very unlikely. Nearest receptor <250m from potential source
	Post digestion storage tank (PDSTs)	Very Low	Low	Low	Tanks are sealed and are within a covered building. Odorous air from the building is extracted and treated by the OCU. Process monitored and regularly maintained – uncontrolled release of bioaerosols very unlikely. Nearest receptor <250m from potential source
	Centrifuges	Very Low	Low	Low	Centrifuges are sealed and are within a covered building. Odorous air from the building is extracted and treated by the OCU. Process monitored and regularly maintained – uncontrolled release of bioaerosols very unlikely. Nearest receptor <250m from potential source
	Strain press	Very Low	Low	Low	Strain press sealed and is within a covered building. Odorous air from the building is extracted and treated by the OCU. Process monitored and regularly maintained – uncontrolled release of bioaerosols very unlikely. Nearest receptor <250m from potential source
	Cake loading area	Very Low	Low	Low	Cake pumped directly into the RORO bins. Stringent loading and unloading procedures – uncontrolled release of bioaerosols very unlikely. Nearest receptor <250m from potential source

Process	Potential source of bioaerosols	Probability of exposure	Consequence of Hazard	Magnitude of risk	Justification
Wastewater/ Sludge treatment	Odour control stack	Very Low	Low	Low	Odorous air from the WTW is treated by two-stage chemical scrubber system which would remove odorous compounds and bioaerosols. Process monitored and regularly maintained - uncontrolled release of bioaerosols very unlikely. Nearest receptor <250m from potential source
Biogas combustion	Flare	Very Low	Very Low	Very Low	Combustion of biogas at very high temperatures which would destroy bioaerosols – uncontrolled release of bioaerosols very unlikely. Nearest receptor >250m from potential source
	Gas bag holder	Very Low	Low		Gas bag holder sealed to prevent uncontrolled release of bioaerosols – uncontrolled release of bioaerosols very unlikely. Nearest receptor <250m from potential source
	Combined Heat and Power (CHP) stack	Very Low	Very Low	Very Low	Combustion of biogas at very high temperatures which would destroy bioaerosols – uncontrolled release of bioaerosols very unlikely. Nearest receptor >250m from potential source
	Boiler stack	Very Low	Very Low	Very Low	Combustion of biogas at very high temperatures which would destroy bioaerosols – uncontrolled release of bioaerosols very unlikely. Nearest receptor >250m from potential source

6 Summary

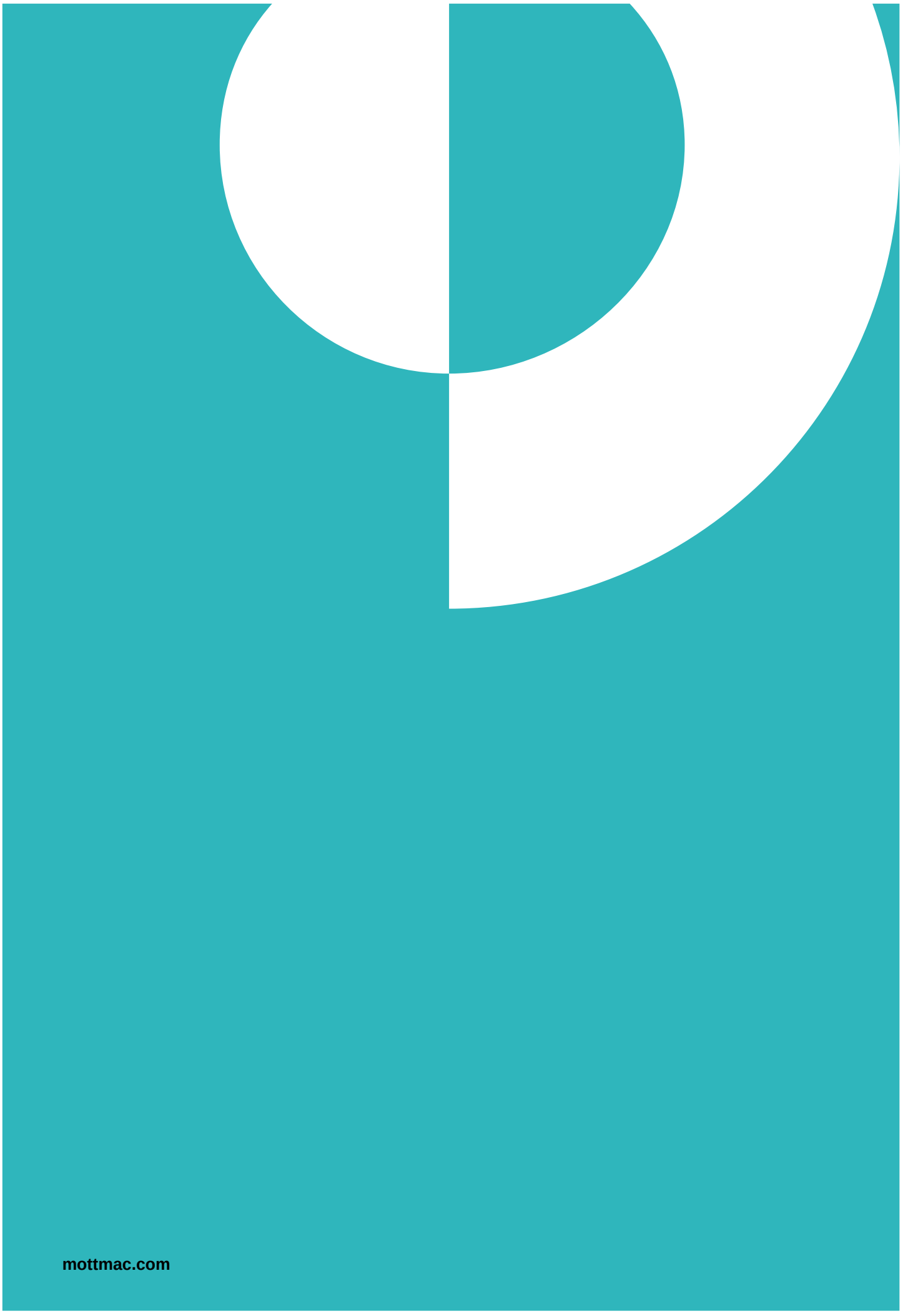
At the Site, there is the potential for bioaerosol emissions from:

- Sludge/cake reception and distribution
- Wastewater treatment (FOGG removal tanks, coagulation tanks, multiflo lamella settlers,and BAFFs)
- Sludge treatment (co-settled sludge tanks, gravity belt thickeners, digester feed tanks, post digestion storage tanks, centrifuges, strain press, cake loading area)
- Biogas combustion (flare, gas bag holder, CHP stack, boiler stack)

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 the Site, a bioaerosol risk assessment has been undertaken in accordance with EA guidance.

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 the Site.

Based on the ‘very low’ probability of exposure and ‘very low’ to ‘low’ consequence of hazards associated with different processes at the Site, the overall magnitude of the risk associated with bioaerosols emissions from the Site is considered to be ‘very low’ to ‘low’. Operation of the Site is therefore unlikely to lead to significant impacts at nearby sensitive receptors from bioaerosol emissions. This is primarily due to 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.



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