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Banbury STC

Bioaerosol risk assessment to accompany permit application

November 2021

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Contents

1 Introduction

1.1 Overview

Thames Water Utilities Ltd (TW) is applying for a biological treatment permit (EPR/PP3409MH/A001) to comply with the requirements of the Industrial Emissions Directive (IED) for the Banbury Sludge Treatment Centre (STC) (hereafter referred to as 'the Site') at Banbury Sewage Treatment Works (STW). 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.

Regulatory Position Statement 209[1], issued 23 January 2018 by the Environment Agency (EA), 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 25m from the nearest potential source of bioaerosols at the Site, 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 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 (EA) "*Guidance on the evaluation of bioaerosol risk assessments for composting facilities.*" [2]

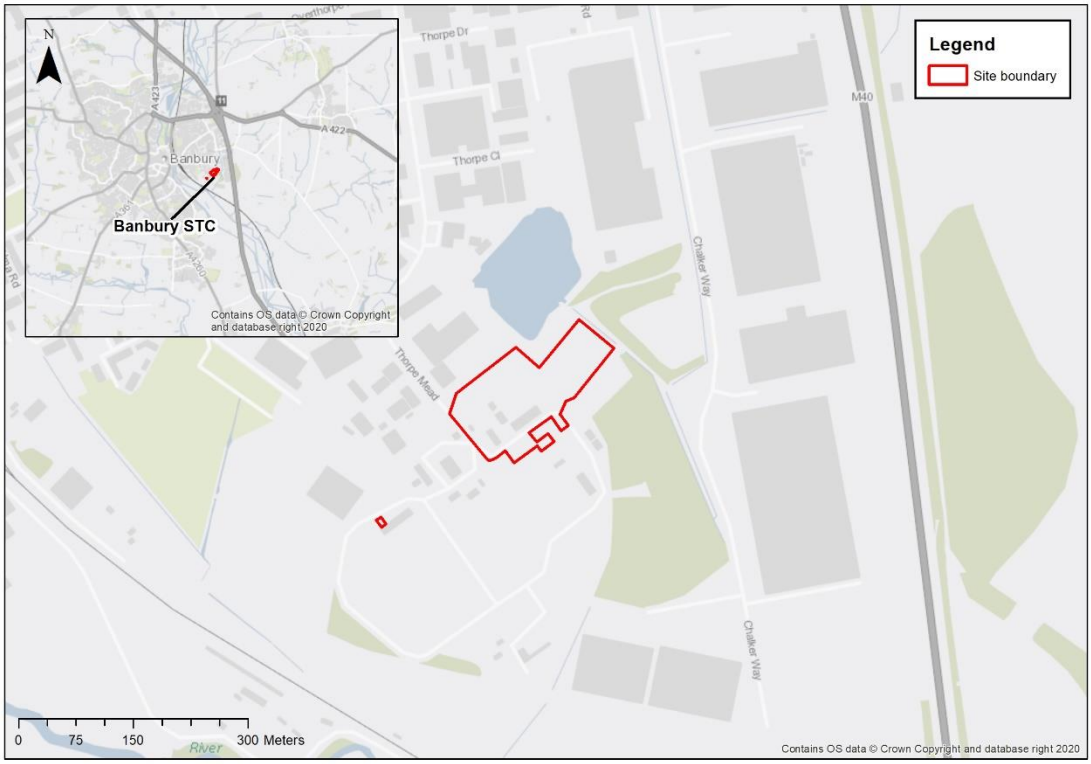
1.2 Site location

The Site is situated within the Thorpe Industrial Estate in Banbury, within the administrative area of Cherwell District Council (CDC). The location of the Site is shown in Figure 1.1.

[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.

Figure 1.1: Site location



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 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 EA guidance[6] requires any facility which could release bioaerosols to provide a site-specific bioaerosol risk assessment as part of the permit application 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].

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[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.'

The Site is part of a new permit application which includes new or replaced assets with the potential to release bioaerosols. Additionally, sensitive human health receptors are found within 250m of the activities at the Site which have the potential to release bioaerosols, therefore a bioaerosol risk assessment has been undertaken.

2.3 Methodology

The method used for this bioaerosol risk assessment is adapted from the EA'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:

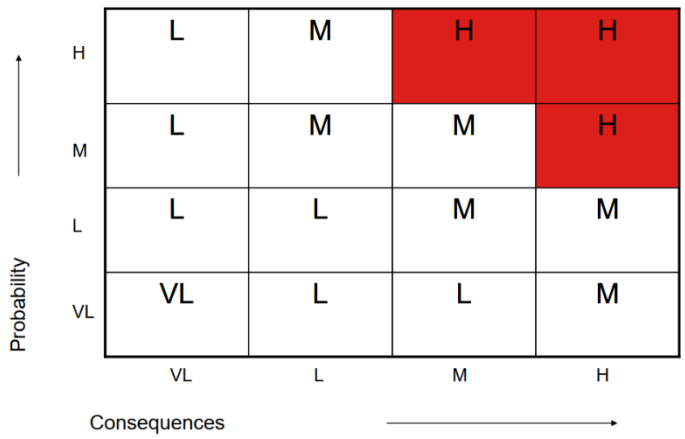
- High – exposure is probable, direct exposure likely with no/few barriers between source and receptor
- Medium – exposure is fairly probable, barriers less controllable
- Low – exposure unlikely, barriers exist to mitigate
- Very low – exposure very unlikely, effective and multiple barriers

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) such as if the sources are covered, wet and/or at the stage of the treatment process that they are. For example, at the Site only processes which are not covered are the three secondary digester tanks, the rag pad and the cake storage bays, however as the sludge has already been through the digestion process and is at the end of the process for the cake, the risk of bioaerosol releases are lower at these stages. Additionally, the sludge in the secondary digesters and the rag pad is wet so the likelihood of the resuspension of bioaerosols is minimised, again reducing the risk. The probability of exposure 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:

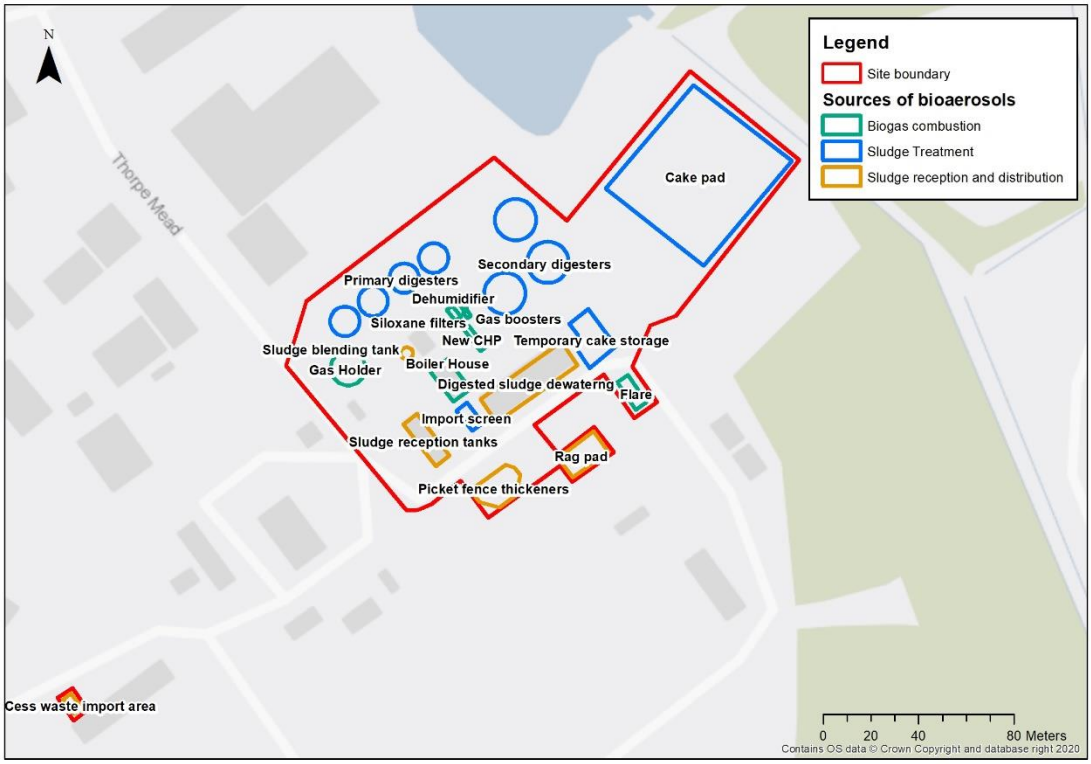
- One sludge reception tank
- One cess waste import area
- One sludge blending tank
- One digested sludge dewatering plant
- Two picket fence thickeners
- Four primary digester tanks
- Three secondary digester tanks
- One rag pad
- One import screen
- One gas bag holder
- One combined heat and power (CHP) plant
- Two siloxane filters
- One dehumidifier
- One biogas booster
- Three boilers
- One biogas flare stack
- Three cake storage bays within the cake pad
- One temporary cake storage bay

The following processes undertaken at the Site involve these assets and therefore, have the potential to release bioaerosols:

- Sludge reception and distribution
- Sludge treatment
- 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 the Site involving these assets is provided within the subsequent sections.

Figure 3.1: Potential sources of bioaerosols at the Site



3.2.2 Sludge reception and distribution

In addition to the sludge transferred from the primary settlement tanks to the digesters, the Site receives sludge imports from satellite sites from enclosed tankers which connect onto bauer connection points on the sludge reception tank. Imported sludge is screened and pumped to the sludge blending tank where sludge is mixed with indigenous sludge before being pumped to the primary digesters. Cess waste imports are also delivered via enclosed tankers where it is processed through the STW before also transferring to the digesters from the primary settlement tanks.

3.2.3 Sludge treatment

Indigenous primary sludge from the Banbury STW is pumped to two covered steel picket fence thickeners where it is thickened and transferred to a sludge transfer pumping station and mixed with the screened sludge imports. Imported sludge is initially discharged into three 470m^3 enclosed sludge reception tanks before gravitating via subsurface pipes, through screens to remove inorganic content to the sludge transfer pumping station where it is combined with the indigenous sludge.

The combined sludge is pumped to a covered steel blending tank to prevent settling of the sludge before it is transferred to four 1,367m^3 to 1,407m^3 covered steel primary digester tanks to undergo mesophilic anaerobic digestion (AD). After a minimum of 16 days, the digested sludge is then transferred and held in three 899m^3 open topped concrete secondary digesters for a minimum of 48 hours.

The treated sludge is de-watered via a two klampress dewatering units with the aid of polymer[9] to increase the percentage of dry solids. The de-watered sludge is then transferred and stored on open concrete cake pads ready for export.

B22849AM-JAC-BBY-STC IED permit Banbury STW - Block Flow Diagram schematic of the sludge treatment process and B22849AM-JAC-BBY-DR-0002 -STC IED permit Banbury STW - Installation boundary and air emission points, provide further details on the location of the sludge treatment assets.

3.2.4 Odour control

An odour control unit (OCU) is fitted on the Site and serves the sludge reception tanks, picket fence thickeners, sludge screens, blending tanks, dewatering plant and sludge well for the pumping station.

The biological treatment and sludge treatment processes are all covered or enclosed. The only exceptions are the three secondary digester tanks, and the cake storage bays.

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

3.2.5 Biogas combustion

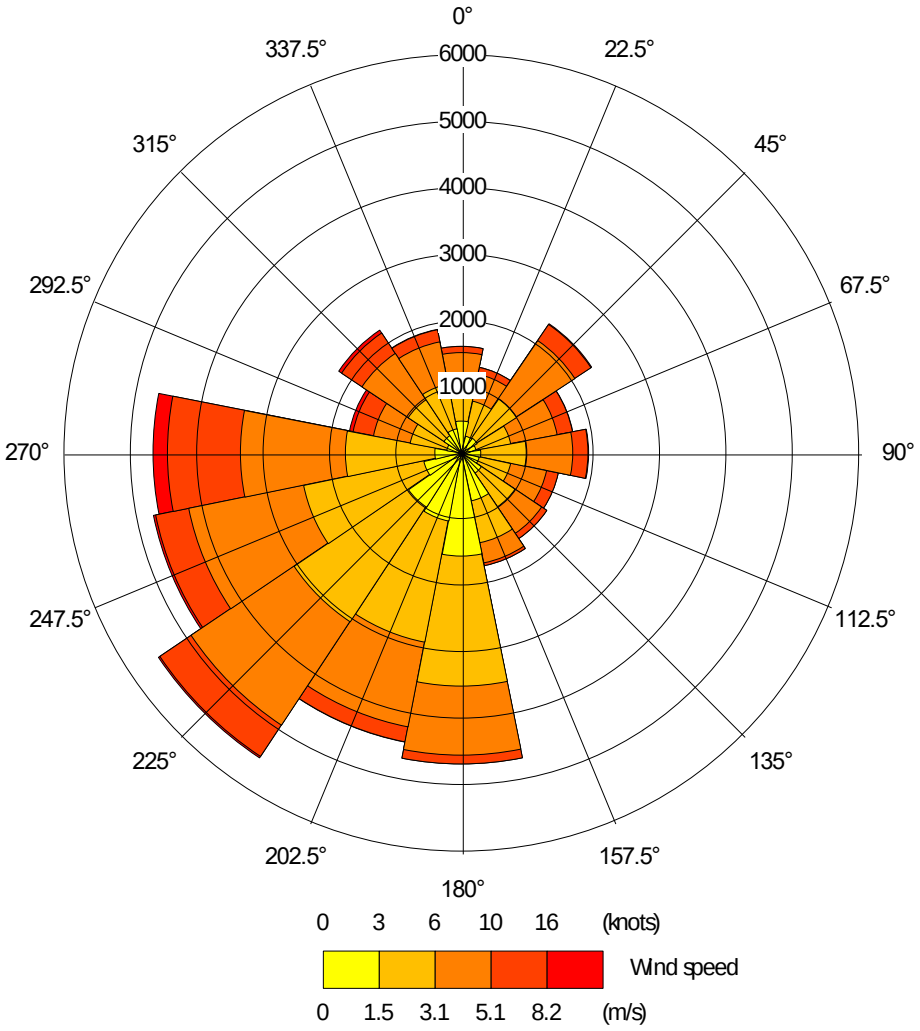
Biogas produced during AD is transferred to the gas bag holder, processed through the siloxane filters, dehumidifier, and biogas boosters before reaching the CHP engine and boilers where it is combusted to generate heat and electricity, which is used onsite to assist with the sludge treatment processes and exported to the National Grid. 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 2016-2020 wind rose for the most representative meteorological site, Church Lawford (located approximately 34km north of the Site), is shown in Figure 3.2. This meteorological site experiences dominance in winds from the south west.

[9] Polymer is made up from a bulk powder silo using potable water and is automatically made up and dosed to each press, as required.

Figure 3.2: Average wind rose for Church Lawford meteorological site, 2016- 2020



Concentrations of bioaerosols decline rapidly within the first 100m from a source and generally decrease to background concentrations within 250m[10]. The local terrain in the 250m area surrounding the Site is generally flat, with some low-lying trees bordering the Site to the north, and east and west of the cake pads which could present natural obstacles to the transportation of bioaerosols by the wind.

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

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 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 multiple sensitive receptors found within 250m of potential bioaerosol emission sources at the Site. As demonstrated in Figure 3.3, these receptors are found predominantly to the west, north and east of the Site. A small number of sensitive receptors are found to the north east 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 170m upwind of these receptors.

Seven areas of sensitive receptors have been identified below in Table 3.1 based on their location and receptor type. For each of these areas, the distance and direction from each potential bioaerosol emission source to the closest sensitive receptor within the area has been identified. Where multiple assets exist for the same process, such as digesters, only the closest asset has been presented.

The receptor closest to a potential emission source is an industrial estate west of the STC, which is located approximately 25m west of the primary digesters.

[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 3.3: Sensitive receptors within 250m

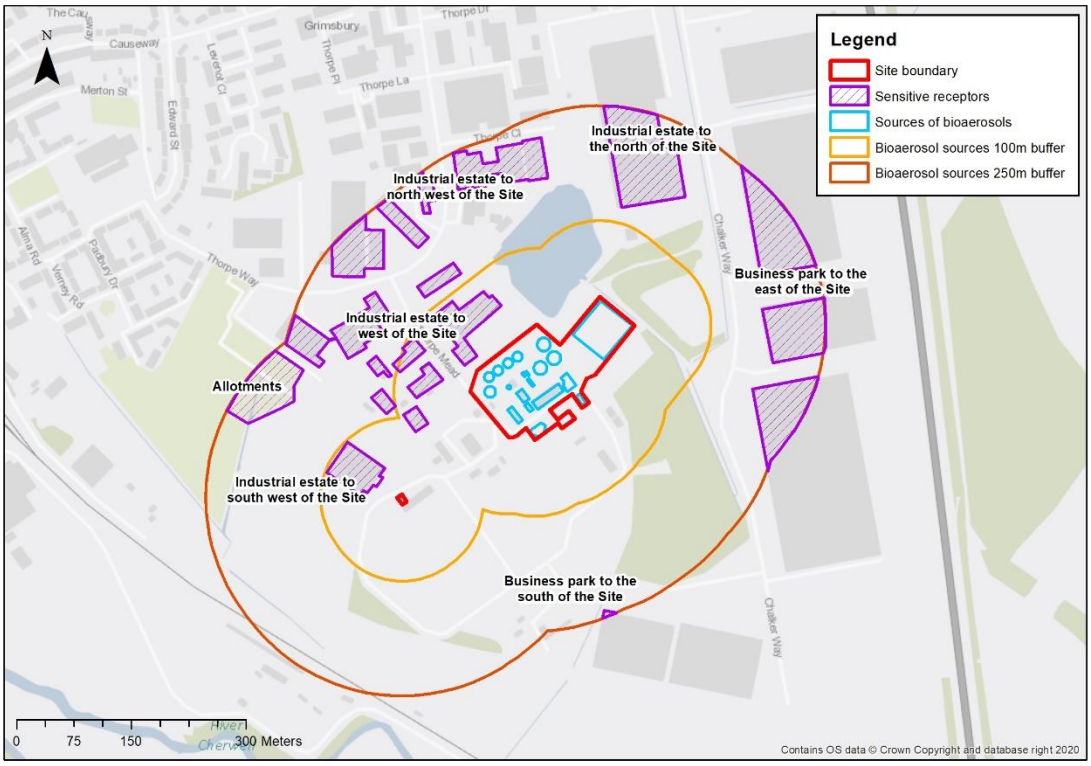


Table 3.1: Receptors within 250m of potential emission sources

Receptor	Nearest potential emission source to receptor	Process	Distance (m) from nearest potential emission source (a)	Direction of receptor from closest emission source
Industrial estate (place of work) to the west of the Site	Sludge reception tank	Sludge reception and distribution	80	North west
	Sludge blending tank	Sludge reception and distribution	55	North west
	Sludge dewatering plant	Sludge reception and distribution	95	North west
	Picket fence thickeners	Sludge reception and distribution	120	North west
	Primary digester tanks	Sludge treatment	25	North west
	Secondary digester tanks	Sludge treatment	65	North west
	Gas bag holder	Biogas combustion	40	North west
	CHP	Biogas combustion	80	North west
	Boiler house	Biogas combustion	70	North west
	Flare stack	Biogas combustion	140	North west
	Siloxane filters	Biogas combustion	65	North west
	Dehumidifier	Biogas combustion	65	North west
	Biogas booster	Biogas combustion	70	North west

	Cake storage bays	Sludge treatment	100	West
	Temporary cake storage	Sludge treatment	115	North west
	Cess waste import area	Sludge reception and distribution	85	North
	Rag pad	Sludge reception and distribution	135	North west
	Import screen	Sludge treatment	90	North west
Industrial estate (place of work) to the north west of the Site	Primary digester tanks	Sludge treatment	220	North
	Secondary digester tanks	Sludge treatment	210	North
	Cake storage bays	Sludge treatment	175	North west
Industrial estate (place of work) to the north of the Site	Sludge dewatering plant	Sludge reception and distribution	245	North east
	Primary digester tanks	Sludge treatment	230	North east
	Secondary digester tanks	Sludge treatment	200	North east
	Cake storage bays	Sludge treatment	130	North east
	Temporary cake storage	Sludge treatment	230	North east
Business park (place of work) to the east of the Site	Sludge dewatering plant	Sludge reception and distribution	245	East
	Flare stack	Biogas combustion	220	East
	Cake storage bays	Sludge treatment	170	East
	Temporary cake storage	Sludge treatment	230	East
	Rag pad	Sludge reception and distribution	235	East
Business park (place of work) to the south of the Site	Picket fence thickeners	Sludge reception and distribution	245	South
	Rag pad	Sludge reception and distribution	240	South
Industrial estate (place of work) to the south west of the Site	Sludge reception tank	Sludge reception and distribution	105	South west
	Sludge blending tank	Sludge reception and distribution	115	South west
	Sludge dewatering plant	Sludge reception and distribution	140	South west
	Picket fence thickeners	Sludge reception and distribution	135	South west
	Primary digester tanks	Sludge treatment	95	South west
	Secondary digester tanks	Sludge treatment	155	South west
	Gas bag holder	Biogas combustion	85	South west
	CHP	Biogas combustion	145	South west
	Boiler house	Biogas combustion	120	South west
	Flare stack	Biogas combustion	200	South west
	Siloxane filters	Biogas combustion	220	South west
	Dehumidifier	Biogas combustion	220	South west
	Biogas booster	Biogas combustion	220	South west
	Cake storage bays	Sludge treatment	220	South west

	Temporary cake storage	Sludge treatment	185	South west
	Cess waste import area	Sludge reception and distribution	30	North west
	Rag pad	Sludge reception and distribution	235	South west
	Import screen	Sludge treatment	200	South west
Allotments	Primary digester tanks	Sludge treatment	240	West
	Gas bag holder	Biogas combustion	240	West
	Cess waste import area	Sludge reception and distribution	185	North west

Notes: (a) 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 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	Distance to nearest receptor (m)
Sludge reception and distribution	Sludge reception tank	Air transport then: • Inhalation (through nose or mouth) • Ingestion (eating or swallowing) • Absorption/contact (through skin or eyes)	80
	Sludge blending tank		55
	Sludge dewatering plant		95
	Picket fence thickeners		120
	Cess waste import area		30
	Rag pad		135
Sludge treatment	Primary digester tanks		25
	Secondary digester tanks		65
	Cake storage bays		100
	Import screen		90
Biogas combustion	Gas bag holders		40
	Boilers		70
	CHP		80
	Flare		140
	Siloxane filters		65
	Dehumidifier		65
	Biogas booster		70

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 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 3.2.5.

4.2 Control measures

4.2.1 Sludge reception and distribution

Domestic sludge is delivered directly into the covered inlet channel through an enclosed connection. Imported sludge is offloaded from an enclosed tanker into the covered imported sludge reception tanks via an enclosed connection and cess waste is pumped directly into an enclosed slogger unit before being processed through the STW. Additionally, an odour control unit is installed which serves the sludge reception tanks, picket fence thickeners, sludge screens, blending tanks, dewatering plant and sludge well for the pumping station, so the potential for the release of bioaerosols is minimal.

If a spillage 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 the Site but a standpipe is available and can be utilised to wash spillage from vehicles as required. Vehicles entering public roads are not permitted 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 minimum periods. If access is required for an extended period of time, such as for maintenance activities, the sludge process area will be isolated and process stream diverted or sludge

[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.

removed from site via tankers to allow maintenance. Sludge will be contained within the existing process areas and therefore no additional bioaerosols will be released.

To further contain bioaerosol emissions, the tanks used for sludge reception and treatment (reception tank, blending tanks, dewatering tank and digesters) are covered. The only processes which are not covered are the three secondary digester tanks, the rag pad and the cake storage bays, however as the sludge has already been through the digestion process and is at the end of the process for the cake, the concentrations of bioaerosols are lower at these stages. Additionally, the sludge in the secondary digesters and the rag pad 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 (at the end of the sludge treatment process) is much lower than from the primary settlement tanks (before AD).

To further reduce potential bioaerosol emissions, sludge produced on Site and sludge that is delivered is processed immediately. This prevents processing of old sludge which is more odorous and difficult to process.

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.

As discussed above in Section 4.2.2.1, to prevent emissions from sludge treatment activities, processes with the greatest potential to release bioaerosols are covered and odour controlled. The odorous air is then treated within the odour control unit to remove odour and bioaerosols before it is released to the atmosphere. While the scrubbers are unable to remove 100% of bioaerosols, any bioaerosol emissions released from the odour control are anticipated to be negligible.

4.2.3 Biogas combustion

All tanks capable of producing biogas are sealed and connected to the biogas system. Biogas produced from these tanks is stored within the gas bag holder before being processed through sealed siloxane filters, dehumidifier and biogas boosters and then combusted at high temperatures within the CHP, boilers or flare. The gas bag holder stores the biogas within an air-tight bag and the siloxane filters, dehumidifier and biogas boosters are fully sealed which mitigates the release of bioaerosol emissions. During combustion, any bioaerosols present within the biogas would be destroyed. The biogas system is also carefully monitored so that any leaks can be immediately identified and sealed. Therefore, emissions of bioaerosols associated with biogas combustion and probability of exposure to bioaerosols 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. The quality of the treated air from the odour control unit is also monitored for hydrogen sulphide (H_2S) concentrations and recorded on the site SCADA system. 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 TW staff and specialist contractors if needed. TW have also issued generic maintenance task manuals for use across all their sites which include protocols for the maintenance of equipment.

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 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, 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. If the on-call technicians are already engaged upon other response work, there is the facility to access staff from other TW geographic divisions, coordinated by the Duty Manager. All faults, breakdowns 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 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. The greatest probability of exposure from bioaerosols emitted from the Site is from uncovered operations such as the secondary digesters, rag pad and the cake bays. However, the secondary digesters and rag pad are ‘wet’ processes so the likelihood of the resuspension of bioaerosols, and therefore the probability of exposure, is minimised. The cake is at the end of the sludge treatment process, is managed to control row height and arrangement and requires no further treatment before being deposited on agricultural land and therefore is likely to have a low concentration of bioaerosols, therefore the probability of exposure from this source is also minimised.

Across the Site, the potential for bioaerosol emissions which could result in significant consequence is limited. The greatest risk of significant 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 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 EA 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 reception and distribution
- Sludge treatment
- 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 25m from the primary digester tanks. 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. The predominant probability of exposure of sensitive receptors to bioaerosols from sources at the Site is 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, which consist of covered processes.

The exception to this are the secondary digester tanks, rag pad and cake storage bays, which are not covered, although they do have relevant management controls in place. The probability of exposure from the secondary digester tanks and the rag pad 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 secondary digester tanks and the rag pad. 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	Sludge reception tank	Very Low	Stringent loading and unloading procedures. Covered, 'wet' process and odour controlled - uncontrolled release of bioaerosols very unlikely
	Sludge blending tank	Very Low	Covered, 'wet' process and odour controlled - uncontrolled release of bioaerosols very unlikely

[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.

	Sludge dewatering plant	Very Low	Covered, 'wet' process and odour controlled - uncontrolled release of bioaerosols very unlikely
	Picket fence thickeners	Very Low	Covered, 'wet' process and odour controlled - uncontrolled release of bioaerosols very unlikely
	Cess waste import area	Very Low	Covered, 'wet' process - uncontrolled release of bioaerosols very unlikely
	Rag pad	Low	Uncovered, 'wet' process - uncontrolled release of bioaerosols unlikely
Sludge treatment	Primary digester tanks	Very Low	Covered, process monitored and regularly maintained – uncontrolled release of bioaerosols very unlikely
	Secondary digester tanks	Low	Uncovered, 'wet' process - uncontrolled release of bioaerosols unlikely
	Cake storage bays	Very Low	Cake at the final stage of the sludge treatment process before being deposited on agricultural land – release of bioaerosols very unlikely as bioaerosol content of cake anticipated to be de minimis
	Import screen	Very Low	Covered, 'wet' process and odour controlled - uncontrolled release of bioaerosols very unlikely
Biogas combustion	Gas holder	Very Low	Gas holder sealed 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
	Siloxane filters	Very Low	Sealed to prevent uncontrolled release of bioaerosols – uncontrolled release of bioaerosols very unlikely
	Dehumidifier	Very Low	Sealed to prevent uncontrolled release of bioaerosols – uncontrolled release of bioaerosols very unlikely
	Biogas booster	Very Low	Sealed to prevent uncontrolled release of bioaerosols – uncontrolled release of bioaerosols very unlikely

5.3 Consequence of hazard

While the probability of exposure of receptors to bioaerosols is predominantly '**very low**' or at worst '**low**' as a result of the control measures in place, there is still a risk that nearby receptors could be exposed bioaerosols, for example while cake is being loaded into lorries or 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.

If exposure to bioaerosols did occur, the worst-case impacts could include 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. 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 of bioaerosol sources and downwind of the prevailing wind direction 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", 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 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, 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

Process	Potential source of bioaerosols	Nearest receptor	Consequence of exposure	Justification
Sludge reception and distribution	Sludge reception tank	80m north west, industrial area	Medium	Nearest receptor <100m away from potential source, not downwind of prevailing wind direction
	Sludge blending tank	55m north west, industrial area	Medium	Nearest receptor <100m away from potential source, not downwind of prevailing wind direction
	Sludge dewatering plant	95m north west, industrial area	Medium	Nearest receptor <100m from potential source, not downwind of prevailing wind direction
	Picket fence thickeners	120m north west, industrial area	Low	Nearest receptor >100m from potential source, not downwind of prevailing wind direction

[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.

Process	Potential source of bioaerosols	Nearest receptor	Consequence of exposure	Justification
	Cess waste import area	30m north west, industrial area	Medium	Nearest receptor <50m away from potential source, not downwind of prevailing wind direction
	Rag pad	135m north west, industrial area	Low	Nearest receptor >100m from potential source, not downwind of prevailing wind direction
Sludge treatment	Primary digester tanks	25m north west, industrial area	Medium	Nearest receptor <50m away from potential source, not downwind of prevailing wind direction
	Secondary digester tanks	65m north west, industrial area	Medium	Nearest receptor <100m away from potential source, not downwind of prevailing wind direction
	Cake storage bays	100m west, industrial area	Medium	Nearest receptor <100m away from potential source, not downwind of prevailing wind direction
	Import screen	90m north west, industrial area	Medium	Nearest receptor <100m away from potential source, not downwind of prevailing wind direction
Biogas combustion	Gas bag holders	40m north west, industrial area	Medium	Nearest receptor <500m away from potential source, not downwind of prevailing wind direction
	Boilers	70m north west, industrial area	Medium	Nearest receptor <100m away from potential source, not downwind of prevailing wind direction
	CHP	80m north west, industrial area	Medium	Nearest receptor <100m away from potential source, not downwind of prevailing wind direction
	Flare	140m north west, industrial area	Low	Nearest receptor >100m from potential source, not downwind of prevailing wind direction
	Siloxane filters	65m north west, industrial area	Medium	Nearest receptor <100m away from potential source, not downwind of prevailing wind direction
	Dehumidifier	65m north west, industrial area	Medium	Nearest receptor <100m away from potential source, not downwind of prevailing wind direction
	Biogas booster	70m north west, industrial area	Medium	Nearest receptor <100m away from potential source, not downwind of prevailing wind direction

Notes: All of the closest receptors to the potential sources of bioaerosols are upwind of the sources (west or north west). Receptors which are downwind (north east of the sources) are all located over 100m away from any source of bioaerosols and therefore the overall consequence of exposure would not change

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**' 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's 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[16], across all potential bioaerosol emission sources, the magnitude of risk is described as '**low**' or '**medium**' and therefore operation of the Site 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 the Site[17]. The requirements for bioaerosol monitoring at the Site will

[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.

[17] 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

need to be agreed with the Environment Agency within the Environmental Permit issued for the site.

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	Sludge reception tank	Very Low	Medium	Low	Nearest receptor <100m away from potential source, not downwind of prevailing wind direction Covered, 'wet' process, odour controlled and stringent loading and unloading procedures – uncontrolled release of bioaerosols very unlikely
	Sludge blending tank	Very Low	Medium	Low	Nearest receptor <100m away from potential source, not downwind of prevailing wind direction Covered, 'wet' process and odour controlled - uncontrolled release of bioaerosols very unlikely
	Sludge dewatering plant	Very Low	Medium	Low	Nearest receptor <100m from potential source, not downwind of prevailing wind direction Covered, 'wet' process and odour controlled - uncontrolled release of bioaerosols very unlikely
	Picket fence thickeners	Very Low	Low	Low	Nearest receptor >100m from potential source, not downwind of prevailing wind direction Covered, 'wet' process and odour controlled - uncontrolled release of bioaerosols very unlikely
	Cess waste import area	Very Low	Medium	Low	Nearest receptor <50m away from potential source, not downwind of prevailing wind direction Covered, 'wet' process - uncontrolled release of bioaerosols very unlikely
	Rag pad	Low	Low	Low	Nearest receptor >100m from potential source, not downwind of prevailing wind direction Uncovered, 'wet' process - uncontrolled release of bioaerosols unlikely
Sludge treatment	Primary digester tanks	Very Low	Medium	Low	Nearest receptor <50m from potential source, not downwind of prevailing wind direction Digesters covered, process monitored and regularly maintained – uncontrolled release of bioaerosols very unlikely
	Secondary digester tanks	Low	Medium	Medium	Nearest receptor <100m from potential source, not downwind of prevailing wind direction Covered, process monitored and regularly maintained – Uncovered, 'wet' process - uncontrolled release of bioaerosols unlikely

Process	Potential source of bioaerosols	Probability of exposure	Consequence of exposure	Magnitude of risk	Justification
	Cake storage bays	Very Low	Medium	Low	Nearest receptor <100m from potential source, downwind of prevailing wind direction Cake at the final stage of the sludge treatment process before being deposited on agricultural land – release of bioaerosols very unlikely as bioaerosol content of cake anticipated to be de minimis
	Import screen	Very Low	Medium	Low	Nearest receptor <100m away from potential source, not downwind of prevailing wind direction Covered, 'wet' process and odour controlled - uncontrolled release of bioaerosols very unlikely
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	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
	CHPs	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
	Flare	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
	Siloxane filters	Very Low	Medium	Low	Nearest receptor <100m from potential source, not downwind of prevailing wind direction Sealed to prevent uncontrolled release of bioaerosols. Uncontrolled release of bioaerosols very unlikely
	Dehumidifier	Very Low	Medium	Low	Nearest receptor <100m from potential source, not downwind of prevailing wind direction

Process	Potential source of bioaerosols	Probability of exposure	Consequence of exposure	Magnitude of risk	Justification
					Sealed to prevent uncontrolled release of bioaerosols. Uncontrolled release of bioaerosols very unlikely
	Biogas booster	Very Low	Medium	Low	Nearest receptor <100m from potential source, not downwind of prevailing wind direction Sealed to prevent uncontrolled release of bioaerosols. Uncontrolled release of bioaerosols very unlikely

6 Summary

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

- Sludge reception and distribution
- Sludge treatment
- 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 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’ and ‘low’ probability of exposure and ‘low’ to ‘medium’ 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 ‘low’ to ‘medium’. This is primarily due to both the containment and the ‘wet’ nature of several processes undertaken at the Site, as well as 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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