MOTT MACDONALD

# Cambridge Sludge Treatment Centre

## Bioaerosol risk assessment to accompany environmental permit application

November 2021

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# Issue and Revision Record

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# Contents

# 1 Introduction

## 1.1 Overview

Anglian Water Services Limited (AWS) is applying to vary their existing standard rules permit (EPR/LP3196ER) and waste operations environmental permit (EPR/WP3535HT) to consolidate these into a bespoke installation environmental permit for the Cambridge Sludge Treatment Centre (STC) (hereafter referred to as 'the Site') at Cambridge Water Recycling Centre (WRC). The purpose of this application is to ensure that the Site is permitted in accordance with the Environmental Permitting Regulations (EPR) 2016, as amended and the Industrial Emissions Directive (IED).

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 and the associated WRC, the closest of which is approximately 15m from the nearest potential source of bioaerosols at the Site or the associated WRC, a bioaerosol risk assessment has been undertaken to accompany the permit variation for this Site.

This bioaerosol risk assessment has assessed the magnitude of risk from potential emissions of bioaerosols from the Site and associated WRC 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]

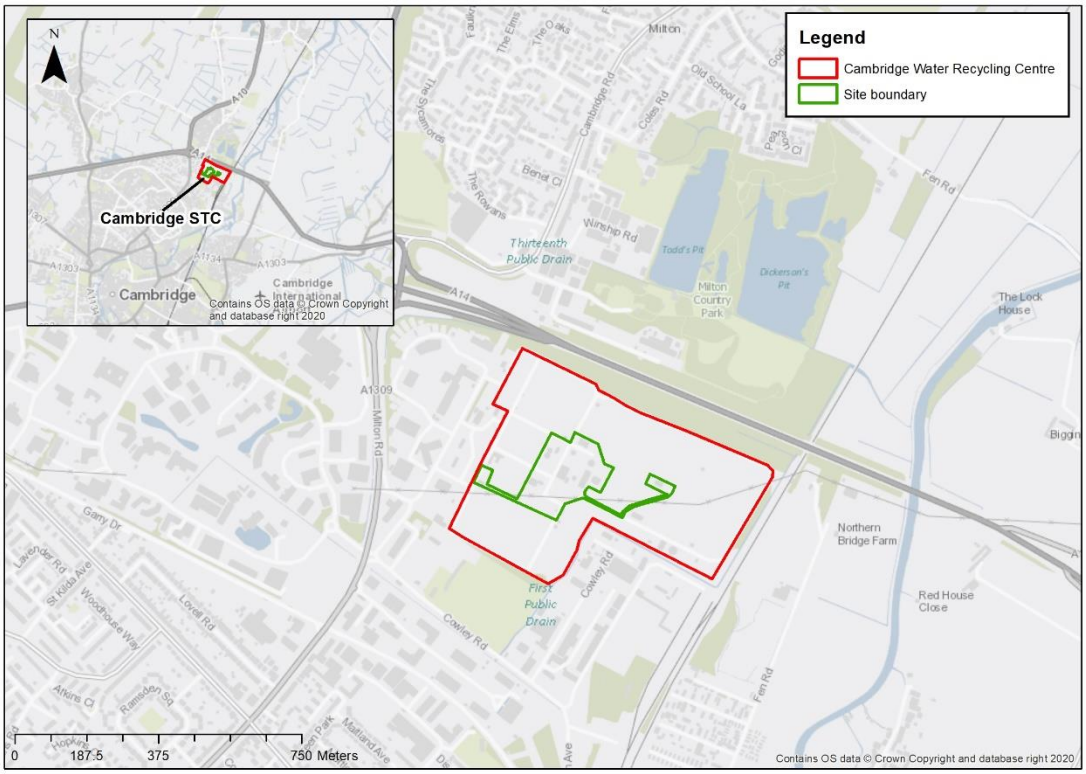
## 1.2 Site location

The Site is situated on Cowley Road, Cambridge, within the administrative area of Cambridge City Council (CCC). The location of the Site and the associated WRC 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 or associated WRC as the biological decomposition of waste occurs under controlled, anaerobic conditions. Therefore, the Site and associated WRC are 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].

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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.'

As sensitive human health receptors are found within 250m of the activities at the Site and associated WRC 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:

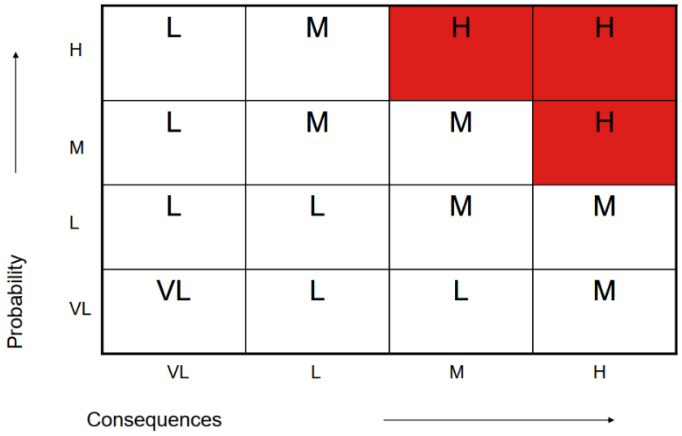
- High – exposure is probable, direct exposure likely with no/few barriers between source and receptor
- Medium – exposure is fairly probable, barriers less controllable
- Low – exposure unlikely, barriers exist to mitigate
- Very low – exposure very unlikely, effective and multiple barriers

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 and associated WRC (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 and associated WRC, 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 associated WRC and the potential pathways that the bioaerosols could travel to sensitive human health receptors.

## 3.2 Sources

### 3.2.1 Overview

The Site and associated WRC include the following assets which could release bioaerosols:

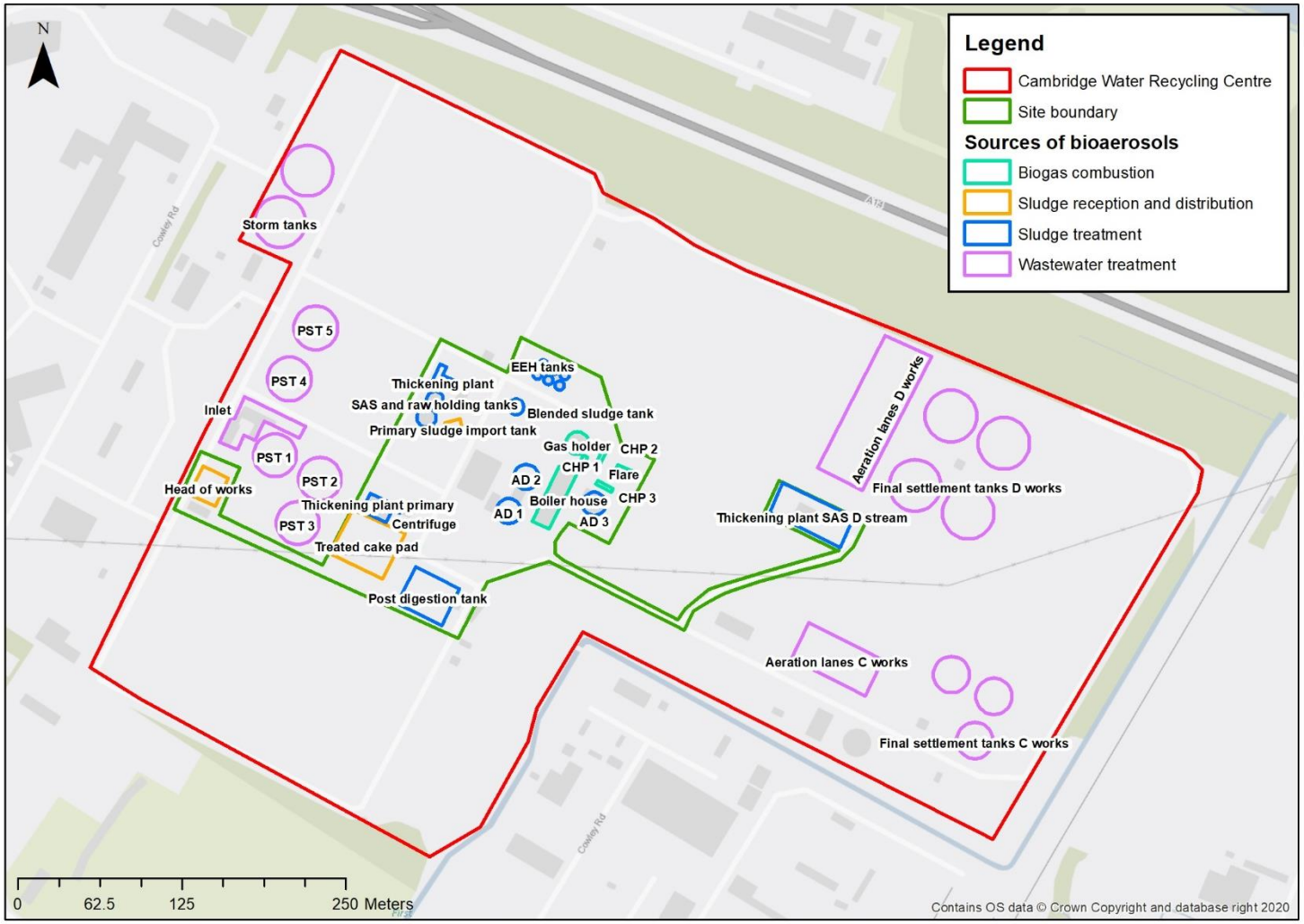
- Five primary settlement tanks (PST)
- Two storm tanks
- One inlet (liquor return)
- Aeration lanes D works
- Four final settlement tanks D works
- Aeration lanes C works
- Three final settlement tanks C works
- Three anaerobic digesters
- One biogas flare stack
- Three combined heat and power (CHP) plant
- One gas holder
- One surplus activated sludge (SAS) and raw holding tank
- One blended sludge tank
- One post digestion tank
- One primary thickening plant
- One SAS, indigenous and imported thickening plant
- One SAS D stream thickening plant
- Six enhanced enzymic hydrolysis (EEH) tanks
- One primary sludge import tank
- One centrifuge building
- One treated cake pad
- One boiler house
- One head of works

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

- Wastewater treatment
- Sludge reception and distribution
- Sludge treatment
- Biogas combustion

Figure 3.1 shows the locations of these different processes and assets across the Site and WRC. A summary of the activities involving these assets is provided within the subsequent sections.

**Figure 3.1: Potential sources of bioaerosols at the Site and associated WRC**



### 3.2.2 Wastewater treatment

The WRC receives raw sewage into the inlet liquor return before it is transferred to five primary settlement tanks for initial treatment. Primary sludge is screened before it is pumped to the primary sludge thickening tank. The remaining wastewater is transferred to either the aeration lanes C works or D works where it is mixed with activated sludge and SAS is removed. The D works wastewater is transferred to a 250m$^3$ holding tank before thickened on thickener belts and delivered to the sludge buffer tank. The C works wastewater is transferred to the 462m$^3$ SAS holding tank.

### 3.2.3 Sludge reception and distribution

The Site receives sludges in two forms, indigenous sludge and thickened surplus activated sludge (SAS) from the Cambridge WRC and imported liquid sludge. Imported sludge is transferred from enclosed tankers into the enclosed 140m$^3$ primary sludge import tank where it is screened and then transferred to the primary sludge pre-thickening tank. Indigenous sludge is pumped directly into the enclosed primary sludge pre-thickening tank where it is combined with the imported sludge.

### 3.2.4 Sludge treatment

The combined screened sludge is thickened by gravity belt thickeners before it is blended with thickened indigenous SAS in the sludge buffer tanks.

The combined sludge is pumped to six 230m$^3$ EEH tanks where the sludge is subjected to biological hydrolysis to condition the sludge for digestion and is pasteurised to reduce pathogens before being pumped to three enclosed 2700m$^3$ anaerobic digestion tanks. The sludge is held here to undergo mesophilic anaerobic digestion (AD) for approximately 14 days.

The treated sludge from the anaerobic digesters is stored in two post digestion storage tanks before it is pumped to two centrifuges to increase the dry solids content in the sludge before transferring from a conveyor into open skips on the treated cake pad ready for disposal off site.

There are two main odour control units (OCU) fitted on the Site, one controls the gases from the EEH buffer tank a second one controls the gases from the primary and SAS holding tanks. The units are manufactured by Bord Na Mona Monashell. There is a third unit on the primary sludge import tank. Shell media filters are used to treat the odorous air.

The biological treatment and sludge treatment processes on the Site are all covered or enclosed, with the exception of the head of works, one of the two centrifuges and the treated cake pad.

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.

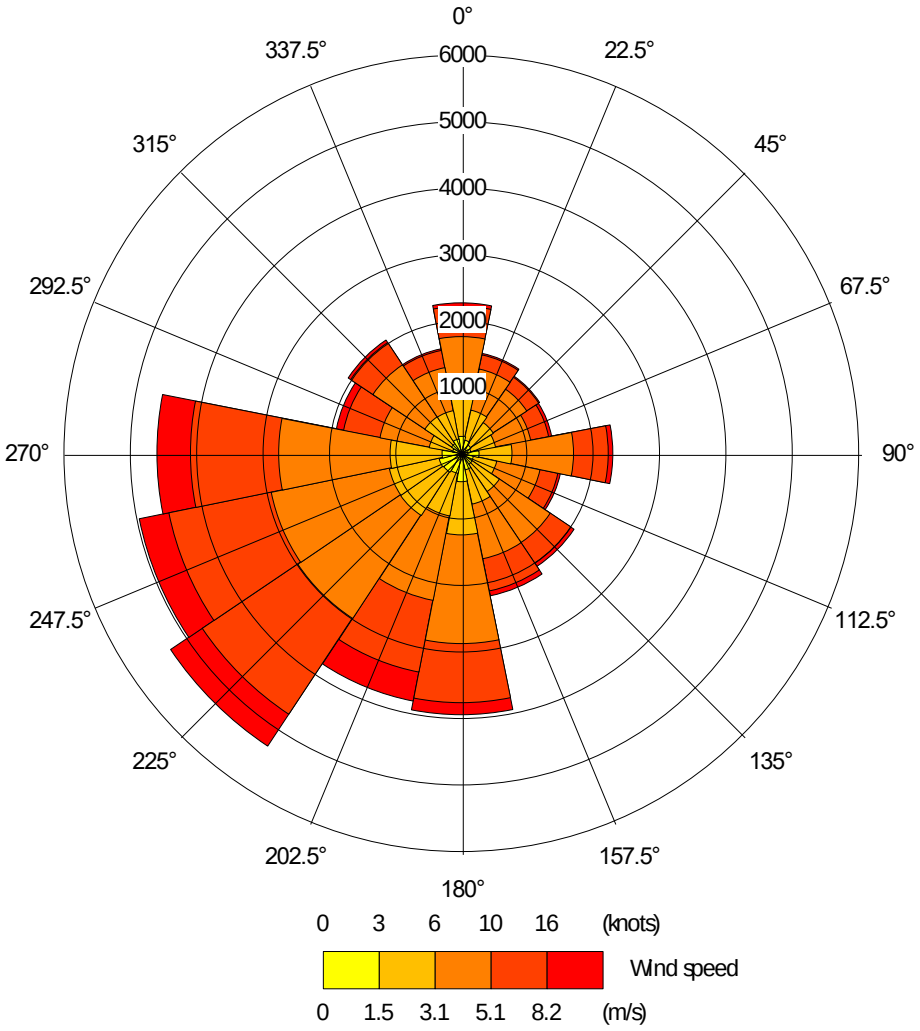
### 3.2.5 Biogas combustion

Biogas produced during AD is transferred to the gas bag holder and then to the CHPs 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 combusted.

## 3.3 Pathways

Bioaerosols are very small and light in weight so can easily be transport by the wind from source to a receptor. The 2016-2020 wind rose for the most representative meteorological site, Mildenhall (located approximately 26km north east of the Site), is shown in Figure 3.2. This meteorological site experiences dominance in winds from the south west.

**Figure 3.2: Average wind rose for Mildenhall meteorological site, 2016- 2020**




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

[9] 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[10] 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*.'

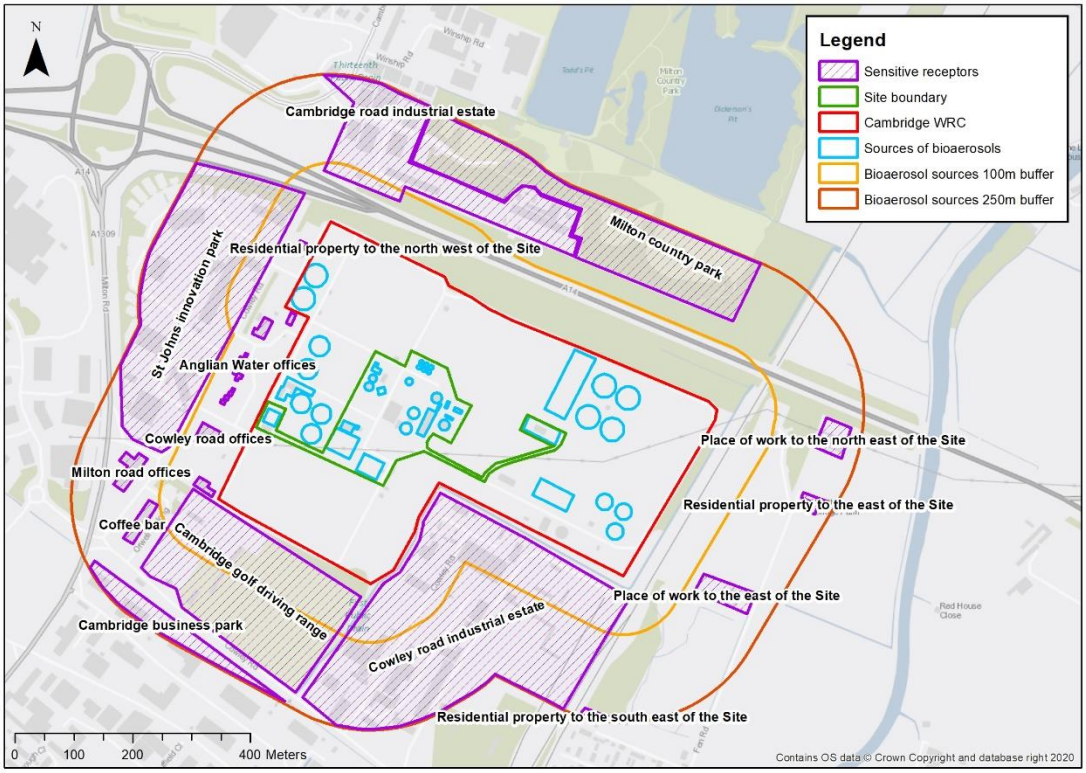
There are multiple sensitive receptors found within 250m of potential bioaerosol emission sources at the Site and associated WRC. As demonstrated in Figure 3.3, these receptors are found predominantly to the south, west, and north, with only a few receptors located to the east of the Site and associated WRC. There is a place of work located within 250m of the WRC boundary to the north east of the Site and WRC, downwind of the prevailing wind direction, which has been considered as a sensitive receptor however it is located further than 250m from any sources of bioaerosols, therefore has not been assessed further within this assessment.

Eleven 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 office to the west of the Site and WRC, which is located approximately 15m south of the storm tanks.

[10] 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 of the Site and associated WRC




## 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 |
|---|---|---|---|---|
| Anglian Water offices to the north west of the Site | Storm tanks | Wastewater treatment | 15 | South |
| | Primary settlement tanks | Wastewater treatment | 40 | West |
| | Inlet | Wastewater treatment | 65 | West |
| | Head of works | Sludge reception and distribution | 65 | West |
| | Treated cake pad | Sludge reception and distribution | 185 | West |
| | Thickening plant primary | Sludge treatment | 190 | West |
| | Centrifuge building | Sludge treatment | 215 | West |
| | Post digestion tank | Sludge treatment | 245 | West |
| | SAS and raw holding tanks | Sludge treatment | 160 | West |
| | Thickening plant, SAS indigenous and import | Sludge treatment | 155 | West |
| | Sludge import tank | Sludge reception and distribution | 210 | West |
| | Blended sludge tank | Sludge treatment | 215 | West |
| | EEH tanks | Sludge treatment | 225 | West |

| Receptor | Nearest potential emission source to receptor | Process | Distance (m) from nearest potential emission source (a) | Direction of receptor from closest emission source |
|---|---|---|---|---|
| | Anaerobic digesters | Sludge treatment | 245 | West |
| Cowley road offices to the south west of the Site | Head of works | Sludge reception and distribution | 75 | South west |
| | Treated cake pad | Sludge reception and distribution | 180 | South west |
| | Thickening plant primary | Sludge treatment | 200 | South west |
| | Centrifuge building | Sludge treatment | 225 | South west |
| | Post digestion tank | Sludge treatment | 240 | West |
| | Primary settlement tanks | Wastewater treatment | 130 | South west |
| | Inlet | Wastewater treatment | 110 | South west |
| | Storm tanks | Wastewater treatment | 245 | South |
| St Johns innovation park to the west of the Site | Primary settlement tanks | Wastewater treatment | 125 | West |
| | Inlet | Wastewater treatment | 120 | West |
| | Storm tanks | Wastewater treatment | 60 | West |
| | Head of works | Sludge reception and distribution | 115 | West |
| | Treated cake pad | Sludge reception and distribution | 240 | West |
| | Thickening plant primary | Sludge treatment | 245 | West |
| Residential property to the north west of the Site | Primary settlement tanks | Wastewater treatment | 145 | North west |
| | Inlet | Wastewater treatment | 215 | North west |
| | Storm tanks | Wastewater treatment | 30 | North west |
| | Thickening plant, SAS indigenous and import | Sludge treatment | 225 | North west |
| | SAS and raw holding tanks | Sludge treatment | 240 | North west |
| Milton road offices to the south west of the Site | Head of works | Sludge reception and distribution | 205 | South west |
| | Inlet | Wastewater treatment | 245 | South west |
| Coffee bar to the south west of the Site | Head of works | Sludge reception and distribution | 230 | South west |
| Cambridge golf driving range to the south of the Site | Head of works | Sludge reception and distribution | 165 | South |
| | Treated cake pad | Sludge reception and distribution | 185 | South |
| | Thickening plant primary | Sludge treatment | 220 | South |
| | Centrifuge building | Sludge treatment | 240 | South |
| | Post digestion tank | Sludge treatment | 180 | South |

| Receptor | Nearest potential emission source to receptor | Process | Distance (m) from nearest potential emission source (a) | Direction of receptor from closest emission source |
|---|---|---|---|---|
| | Primary settlement tanks | Wastewater treatment | 170 | South |
| | Inlet | Wastewater treatment | 205 | South |
| Cowley road industrial estate to the south east of the Site | Post digestion tank | Sludge treatment | 105 | East |
| | Treated cake pad | Sludge reception and distribution | 160 | East |
| | Thickening plant primary | Sludge treatment | 180 | South east |
| | Centrifuge building | Sludge treatment | 170 | South east |
| | Anaerobic digesters | Sludge treatment | 115 | South east |
| | Sludge import tank | Sludge reception and distribution | 195 | South east |
| | SAS and raw holding tanks | Sludge treatment | 210 | South east |
| | Thickening plant, SAS indigenous and import | Sludge treatment | 230 | South east |
| | Blended sludge tank | Sludge treatment | 190 | South east |
| | EEH tanks | Sludge treatment | 200 | South east |
| | Boiler house | Biogas combustion | 100 | South |
| | Gas holder | Biogas combustion | 155 | South |
| | CHP 1 | Biogas combustion | 140 | South |
| | CHP 2 | Biogas combustion | 145 | South |
| | CHP 3 | Biogas combustion | 125 | South |
| | Flare | Biogas combustion | 140 | South east |
| | Thickening plant SAS D stream | Sludge treatment | 160 | South east |
| | Primary settlement tanks | Wastewater treatment | 225 | East |
| | Aeration lanes D works | Wastewater treatment | 210 | South |
| | Final settlement tanks D works | Wastewater treatment | 215 | South |
| | Aeration lanes C works | Wastewater treatment | 70 | South |
| | Final settlement tanks C works | Wastewater treatment | 75 | South |
| Place of work to the east of the Site | Final settlement tanks C works | Wastewater treatment | 155 | East |
| Milton country park | Aeration lanes D works | Wastewater treatment | 150 | North |
| | Final settlement tanks D works | Wastewater treatment | 165 | North |
| | Storm tanks | Wastewater treatment | 235 | North |
| Cambridge road industrial estate | Storm tanks | Wastewater treatment | 150 | North |
| | Aeration lanes D works | Wastewater treatment | 160 | North west |

| Receptor | Nearest potential emission source to receptor | Process | Distance (m) from nearest potential emission source (a) | Direction of receptor from closest emission source |
|---|---|---|---|---|
| | Final settlement tanks D works | Wastewater treatment | 215 | 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 and associated WRC within 250m of a sensitive receptor, 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) |
|---|---|---|---|
| Wastewater treatment | Storm tanks | Air transport then:<br>• Inhalation (through nose or mouth)<br>• Ingestion (eating or swallowing)<br>• Absorption/contact (through skin or eyes) | 15 |
| | Primary settlement tanks | | 40 |
| | Inlet | | 65 |
| | Aeration lanes D works | | 150 |
| | Final settlement tanks D works | | 165 |
| | Aeration lanes C works | | 70 |
| | Final settlement tanks C works | | 75 |
| Sludge reception and distribution | Head of works | | 65 |
| | Treated cake pad | | 185 |
| | Primary sludge import tank | | 195 |
| Sludge treatment | Thickening plant primary | | 190 |
| | Centrifuge building | | 170 |
| | Post digestion tank | | 105 |
| | Anaerobic digesters | | 115 |
| | SAS and raw holding tanks | | 160 |
| | Thickening plant SAS indigenous and import | | 155 |
| | EEH tanks | | 200 |
| | Blended sludge tank | | 190 |
| | Thickening plant SAS D stream | | 160 |
| Biogas combustion | Gas holder | | 155 |
| | Boiler house | | 100 |
| | CHPs | | 125 |
| | Flare | | 140 |

# 4 Control measures

## 4.1 Overview

The three primary ways to mitigate emissions of bioaerosols[11] is to:

- Reduce emissions
- Contain emissions
- Enhance dispersion

The sections below outline the different control measures in place at the Site and WRC. 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 Wastewater treatment

There are no specific control measures for the wastewater treatment processes, however the waste is wet for all stages, so the likelihood of the resuspension of bioaerosols is minimised.

### 4.2.2 Sludge reception and distribution

Domestic sludge is pumped through enclosed pipes directly into the enclosed primary sludge pre-thickening tanks. Imported sludge is delivered directly into the enclosed primary sludge import tank.

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.

### 4.2.3 Sludge treatment

#### 4.2.3.1 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

[11] 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 post digestion tank, anaerobic digesters, holding tanks, EEH tanks and blended sludge tanks are covered. The boilers, sludge thickeners, one of the centrifuges and the C works aeration blowers are all contained in buildings. The remaining processes are not covered, however the sludge is wet for all stages apart from the treated cake at the final stages of treatment, so the likelihood of the resuspension of bioaerosols is minimised. The cake is at the end of the treatment process and therefore concentrations of bioaerosols are lower at this stage.

#### 4.2.3.2 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 transferred via a conveyor to open skips on the treated cake pad. The cake pad is open to air, however once deposited, the cake is not disturbed until loaded into enclosed trucks for offsite disposal.

### 4.2.4 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 combusted at high temperatures within the CHP, boilers or flare. The gas bag holder stores the biogas within an air-tight bag 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 depth, turbidity and temperature. 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 AWS staff and specialist contractors if needed. AWS 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 and WRC 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 and WRC is from uncovered operations, however, all stages before the cake 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 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 and WRC, the potential for bioaerosol emissions which could result in significant consequence is limited. The greatest risk of significant bioaerosols from the Site and WRC is associated with emergency situations such as a failure of the flare or CHPs, 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 and WRC 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 and WRC 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[12], 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 and WRC are associated with:

- Wastewater treatment
- 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 15m from the storm tanks. However, as discussed in Section 4, there are multiple control measures in place at the Site and WRC which restrict the Source-Pathway-Receptor link by reducing and containing emissions of bioaerosols from these processes.

The probability of exposure of sensitive receptors to bioaerosols from uncovered sources at the Site and WRC, such as primary settlement tanks and aeration lanes, 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 or wastewater.

Probability of exposure from the covered sources at the Site, such as the digesters and thickening plant, 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 cake is at the end of the sludge treatment process and requires no further treatment before being deposited on agricultural land and therefore the probability of exposure of sensitive receptors has also been considered to be '**very low**'.

The final probability of exposure to bioaerosols assessed for each emission source within 250m of a sensitive receptor 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 |
|---|---|---|---|
| Wastewater treatment | Storm tanks | Low | Uncovered, 'wet' process - uncontrolled release of bioaerosols unlikely |

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

| Process | Potential source of bioaerosols | Probability of exposure | Justification |
|---|---|---|---|
| | Primary settlement tanks | Low | Uncovered, 'wet' process - uncontrolled release of bioaerosols unlikely |
| | Inlet | Low | Uncovered, 'wet' process - uncontrolled release of bioaerosols unlikely |
| | Aeration lanes D works | Low | Uncovered, 'wet' process - uncontrolled release of bioaerosols unlikely |
| | Final settlement tanks D works | Low | Uncovered, 'wet' process - uncontrolled release of bioaerosols unlikely |
| | Aeration lanes C works | Low | Uncovered, 'wet' process - uncontrolled release of bioaerosols unlikely |
| | Final settlement tanks C works | Low | Uncovered, 'wet' process - uncontrolled release of bioaerosols unlikely |
| Sludge reception and distribution | Head of works | Low | Uncovered, 'wet' process - uncontrolled release of bioaerosols unlikely |
| | Treated cake pad | 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 |
| | Primary sludge import tank | Low | Uncovered, 'wet' process - uncontrolled release of bioaerosols unlikely |
| Sludge treatment | Thickening plant primary | Very Low | Covered process – uncontrolled release of bioaerosols very unlikely |
| | Centrifuge building | Low | Partially uncovered, 'wet' process - uncontrolled release of bioaerosols unlikely |
| | Post digestion tank | Very Low | Covered process – uncontrolled release of bioaerosols very unlikely |
| | Anaerobic digesters | Very Low | Covered, process monitored and regularly maintained – uncontrolled release of bioaerosols very unlikely |
| | SAS and raw holding tanks | Very Low | Covered process – uncontrolled release of bioaerosols very unlikely |
| | Thickening plant SAS indigenous and import | Very Low | Covered process – uncontrolled release of bioaerosols very unlikely |
| | EEH tanks | Very Low | Covered process – uncontrolled release of bioaerosols very unlikely |
| | Blended sludge tank | Very Low | Covered process – uncontrolled release of bioaerosols very unlikely |
| | Thickening plant SAS D stream | Very Low | Covered process – uncontrolled release of bioaerosols very unlikely |
| Biogas combustion | Gas holder | Very Low | Gas holder air-tight to prevent uncontrolled release of bioaerosols. SCADA system in place to detect leaks – uncontrolled release of bioaerosols very unlikely |
| | Boiler house | 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 |

| Process | Potential source of bioaerosols | Probability of exposure | Justification |
|---|---|---|---|
| | Flare | 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**' or '**low**' as a result of the control measures in place, there is still a risk that nearby receptors could be exposed bioaerosols, for example 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, this could result in adverse health impacts at sensitive receptors. These impacts could include (but are not limited to):

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

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

For the purpose of this assessment, sources of bioaerosols within 50m 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

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

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

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 |
|---|---|---|---|---|
| Wastewater treatment | Storm tanks | 15m south, offices | Medium | Nearest receptor <50m away from potential source, not downwind of prevailing wind direction |
| | Primary settlement tanks | 40m west, offices | Medium | Nearest receptor <50m away from potential source, not downwind of prevailing wind direction |
| | Inlet | 65m west, offices | Medium | Nearest receptor <100m away from potential source, not downwind of prevailing wind direction |
| | Aeration lanes D works | 150m north, country park | Low | Nearest receptor >100m away from potential source, not downwind of prevailing wind direction |
| | Final settlement tanks D works | 165m north, country park | Low | Nearest receptor >100m away from potential source, not downwind of prevailing wind direction |
| | Aeration lanes C works | 70m south, industrial estate | Medium | Nearest receptor <100m away from potential source, not downwind of prevailing wind direction |
| | Final settlement tanks C works | 75m south, industrial estate | Medium | Nearest receptor <100m away from potential source, not downwind of prevailing wind direction |
| Sludge reception and distribution | Head of works | 65m west, offices | Medium | Nearest receptor <100m away from potential source, not downwind of prevailing wind direction |
| | Treated cake pad | 185m west, offices | Low | Nearest receptor >100m away from potential source, not downwind of prevailing wind direction |
| | Primary sludge import tank | 195m south east, industrial estate | Low | Nearest receptor >100m away from potential source, not downwind of prevailing wind direction |
| Sludge treatment | Thickening plant primary | 190m west, offices | Low | Nearest receptor >100m away from potential source, not downwind of prevailing wind direction |
| | Centrifuge building | 170m south east, industrial estate | Low | Nearest receptor >100m away from potential source, not downwind of prevailing wind direction |
| | Post digestion tank | 105m east, industrial estate | Low | Nearest receptor >100m away from potential source, not downwind of prevailing wind direction |
| | Anaerobic digesters | 115m south east, industrial estate | Low | Nearest receptor >100m away from potential source, not downwind of prevailing wind direction |
| | SAS and raw holding tanks | 160m west, offices | Low | Nearest receptor >100m away from potential source, not downwind of prevailing wind direction |
| | Thickening plant SAS indigenous and import | 155m west, offices | Low | Nearest receptor >100m away from potential source, not downwind of prevailing wind direction |
| | EEH tanks | 200m south east, industrial estate | Low | Nearest receptor >100m away from potential source, not downwind of prevailing wind direction |
| | Blended sludge tank | 190m south east, industrial estate | Low | Nearest receptor >100m away from potential source, not downwind of prevailing wind direction |

| Process | Potential source of bioaerosols | Nearest receptor | Consequence of exposure | Justification |
|---|---|---|---|---|
| | Thickening plant SAS D stream | 160m south east, industrial estate | Low | Nearest receptor >100m away from potential source, not downwind of prevailing wind direction |
| Biogas combustion | Gas holder | 155m south, industrial estate | Low | Nearest receptor >100m away from potential source, not downwind of prevailing wind direction |
| | Boiler house | 100m south, industrial estate | Low | Nearest receptor >100m away from potential source, not downwind of prevailing wind direction |
| | CHPs | 125m south, industrial estate | Low | Nearest receptor >100m away from potential source, not downwind of prevailing wind direction |
| | Flare | 140m south east, industrial estate | Low | 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. Receptors which are downwind (north east of the sources) are all located over 250m 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 and WRC. 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 Environment Agency guidance[15], across all potential bioaerosol emission sources, the magnitude of risk is described as '**low**' or '**medium**' and therefore operation of the Site and WRC is unlikely to lead to significant impacts at nearby sensitive receptors from bioaerosol emissions.

Nonetheless, due to the proximity of the Site and WRC to sensitive receptors, monitoring of bioaerosols should be undertaken at the Site[16]. 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.

**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 |
|---|---|---|---|---|---|
| Wastewater treatment | Storm tanks | Low | Medium | Medium | Nearest receptor <50m away from potential source, not downwind of prevailing wind direction. Uncovered, 'wet' process - uncontrolled release of bioaerosols unlikely |

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

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

| Process | Potential source of bioaerosols | Probability of exposure | Consequence of exposure | Magnitude of risk | Justification |
|---|---|---|---|---|---|
| | Primary settlement tanks | Low | Medium | Medium | Nearest receptor <50m away from potential source, not downwind of prevailing wind direction. Uncovered, 'wet' process - uncontrolled release of bioaerosols unlikely |
| | Inlet | Low | Medium | Medium | Nearest receptor <100m away from potential source, not downwind of prevailing wind direction. Uncovered, 'wet' process - uncontrolled release of bioaerosols unlikely |
| | Aeration lanes D works | Low | Low | Low | Nearest receptor >100m away from potential source, not downwind of prevailing wind direction. Uncovered, 'wet' process - uncontrolled release of bioaerosols unlikely |
| | Final settlement tanks D works | Low | Low | Low | Nearest receptor >100m away from potential source, not downwind of prevailing wind direction. Uncovered, 'wet' process - uncontrolled release of bioaerosols unlikely |
| | Aeration lanes C works | Low | Medium | Medium | Nearest receptor <100m away from potential source, not downwind of prevailing wind direction. Uncovered, 'wet' process - uncontrolled release of bioaerosols unlikely |
| | Final settlement tanks C works | Low | Medium | Medium | Nearest receptor <100m away from potential source, not downwind of prevailing wind direction. Uncovered, 'wet' process - uncontrolled release of bioaerosols unlikely |
| Sludge reception and distribution | Head of works | Low | Medium | Medium | Nearest receptor <100m away from potential source, not downwind of prevailing wind direction. Uncovered, 'wet' process - uncontrolled release of bioaerosols unlikely |
| | Treated cake pad | Very Low | Low | Low | Nearest receptor >100m away from potential source, not 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 |
| | Primary sludge import tank | Low | Low | Low | Nearest receptor >100m away from potential source, not downwind of prevailing wind direction. Uncovered, 'wet' process - uncontrolled release of bioaerosols unlikely |
| Sludge treatment | Thickening plant primary | Very Low | Low | Low | Nearest receptor >100m away from potential source, not downwind of prevailing wind direction. Covered process – uncontrolled release of bioaerosols very unlikely |

| Process | Potential source of bioaerosols | Probability of exposure | Consequence of exposure | Magnitude of risk | Justification |
|---|---|---|---|---|---|
| | Centrifuge building | Low | Low | Low | Nearest receptor >100m away from potential source, not downwind of prevailing wind direction. Partially uncovered, 'wet' process - uncontrolled release of bioaerosols unlikely |
| | Post digestion tank | Very Low | Low | Low | Nearest receptor >100m away from potential source, not downwind of prevailing wind direction. Covered process – uncontrolled release of bioaerosols very unlikely |
| | Anaerobic digesters | Very Low | Low | Low | Nearest receptor >100m away from potential source, not downwind of prevailing wind direction. Covered, process monitored and regularly maintained – uncontrolled release of bioaerosols very unlikely |
| | SAS and raw holding tanks | Very Low | Low | Low | Nearest receptor >100m away from potential source, not downwind of prevailing wind direction. Covered process – uncontrolled release of bioaerosols very unlikely |
| | Thickening plant SAS indigenous and import | Very Low | Low | Low | Nearest receptor >100m away from potential source, not downwind of prevailing wind direction. Covered process – uncontrolled release of bioaerosols very unlikely |
| | EEH tanks | Very Low | Low | Low | Nearest receptor >100m away from potential source, not downwind of prevailing wind direction. Covered process – uncontrolled release of bioaerosols very unlikely |
| | Blended sludge tank | Very Low | Low | Low | Nearest receptor >100m away from potential source, not downwind of prevailing wind direction. Covered process – uncontrolled release of bioaerosols very unlikely |
| | Thickening plant SAS D stream | Very Low | Low | Low | Nearest receptor >100m away from potential source, not downwind of prevailing wind direction. Covered process – uncontrolled release of bioaerosols very unlikely |
| Biogas combustion | Gas holder | Very Low | Low | Low | Nearest receptor >100m away 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 |
| | Boiler house | Very Low | Low | Low | Nearest receptor >100m away from potential source, not downwind of prevailing wind direction. Combustion of biogas at very high temperatures which would destroy bioaerosols – |

| Process | Potential source of bioaerosols | Probability of exposure | Consequence of exposure | Magnitude of risk | Justification |
|---|---|---|---|---|---|
| | | | | | uncontrolled release of bioaerosols very unlikely |
| | CHPs | Very Low | Low | Low | Nearest receptor >100m away 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 away 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 |

# 6 Summary

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

- Wastewater treatment
- 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 and WRC, resulting in adverse health effects. As these sensitive human health receptors are within 250m of potential emission sources at the Site and WRC, a bioaerosol risk assessment has been undertaken in accordance with Environment Agency 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 and WRC.

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