MOTT MACDONALD

Millbrook Sludge Treatment Centre Environmental Permit Application

Bioaerosol risk assessment
790101_ERA_BioaRA_MIL

September 2024

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Contents

1 Introduction

1.1 Overview

Southern Water is applying to vary their existing environmental permits at the Millbrook Sludge Treatment Centre (STC) and Slowhill Copse Sludge Reception (SHCSR) ('the Site') to include the onsite sludge treatment and storage facilities. Sludge treatment activities are covered by the Environmental Permitting Regulations (EPR) 2016, which incorporates the application of the Industrial Emissions Directive (IED). The Site currently operates under a T21 exemption and has two existing environmental permits for combustion activities at Millbrook (Permit reference EPR/CP3535XU), and for the import of tankered trade waste at Slowhill Copse (Permit reference EPR/GP3792HY).

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.

The Millbrook STC accepts liquid sludge from SHCSR via a pipeline. As requested by the Environment Agency, this bioaerosol risk assessment considers the potential for impacts from bioaerosols associated with SHCSR and the Millbrook STC.

Sensitive receptors are located approximately 70m from the nearest potential source of bioaerosols at Millbrook STC. The nearest sensitive receptors to sources of bioaerosols at the SHCSR are located approximately 30m away.

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

1.2 Site location

The Site is situated on Western Avenue, at the Western Docks in Southampton. The Site is bordered by industrial land use associated with the docks to the east, south and west. To the north of the Site is the Millbrook Recreation Ground.

The SHCSR is situated on Bury Road which approximately 1.1km to southeast of the Site. The SHCSR is bordered by green spaces to the east, south, west, and River Test beyond the green spaces to the north of the SHCSR.

The layout of the sites are shown in Document reference 790101_MSD_SitelayoutPlan_MIL&SHC October 2024. Millbrook STC includes four anaerobic digesters, which are located in the western half of the site. The SHCSR includes three unscreened sludge tanks, which are located in the south of the SHCSR.

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

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

2 Methodology

2.1 Overview

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

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

2.2 Guidance

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

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

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

Nonetheless, current Environment Agency guidance[6] requires any facility which could release bioaerosols to provide a site-specific bioaerosol risk assessment if there are sensitive receptors within 250m of activities. For new permits there is also a requirement to monitor bioaerosols if the site is within 250m of a sensitive receptor[7].

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

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

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

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

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

Following a Schedule 5 notice from the Environment Agency for another similar WTW, a conservative approach has been undertaken and human receptors within 500m of the Site have been considered instead of the 250m specified in the Environment Agency guidance[8].

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*'[9], 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:

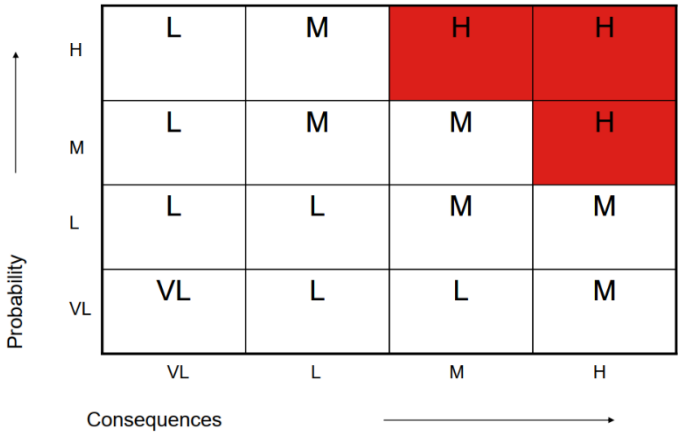
- High – exposure is probable, direct exposure likely with no/few barriers between source and receptor
- Medium – exposure is fairly probable, barriers less controllable
- Low – exposure unlikely, barriers exist to mitigate
- Very low – exposure very unlikely, effective and multiple barriers

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



[8] 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

[9] 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.

Source: Environment Agency, 2009

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

3 Source – Pathway – Receptor model

3.1 Overview

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

3.2 Sources

3.2.1 Overview

3.2.1.1 The Millbrook STC

The Millbrook STC includes the following assets which could release bioaerosols:

- Sludge reception pump house
- Cake silo
- Cake blending area
- Two sludge holding tanks (SHTs)
- Two thickened sludge storage tanks (TSSTs)
- Four anaerobic digesters
- Two post digestion sludge storage tanks (PDSTs)
- Three centrifuges within the Dryer Building (mothballed)
- Alternative cake bay
- Liquor buffer storage tank
- Gas holder
- Two Combined Heat and Power (CHP) engines
- One flare
- Two boilers

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

- Sludge/cake reception and distribution (sludge reception pump house, cake silo)
- Sludge treatment (cake blending area, SHTs, TSSTs, anaerobic digesters, PDSTs, centrifuges, alternative cake bay, liquor buffer storage tank)
- Biogas combustion (gas holder, CHP, flare and boilers)

3.2.1.2 The SHCSR

The SHCSR includes the following assets which could release bioaerosols:

- Sludge reception point
- Three unscreened sludge tanks
- Strain presses
- Two screened sludge tanks
- Grit and screening unit

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

- Sludge/cake reception and distribution (sludge reception point)
- Sludge treatment (unscreened sludge tanks, strain presses, screened sludge tanks, and grit and screening unit)

Figure 3.1 and Figure 3.2 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 then presented below.

Figure 3.1: Potential sources of bioaerosols at the Millbrook STC

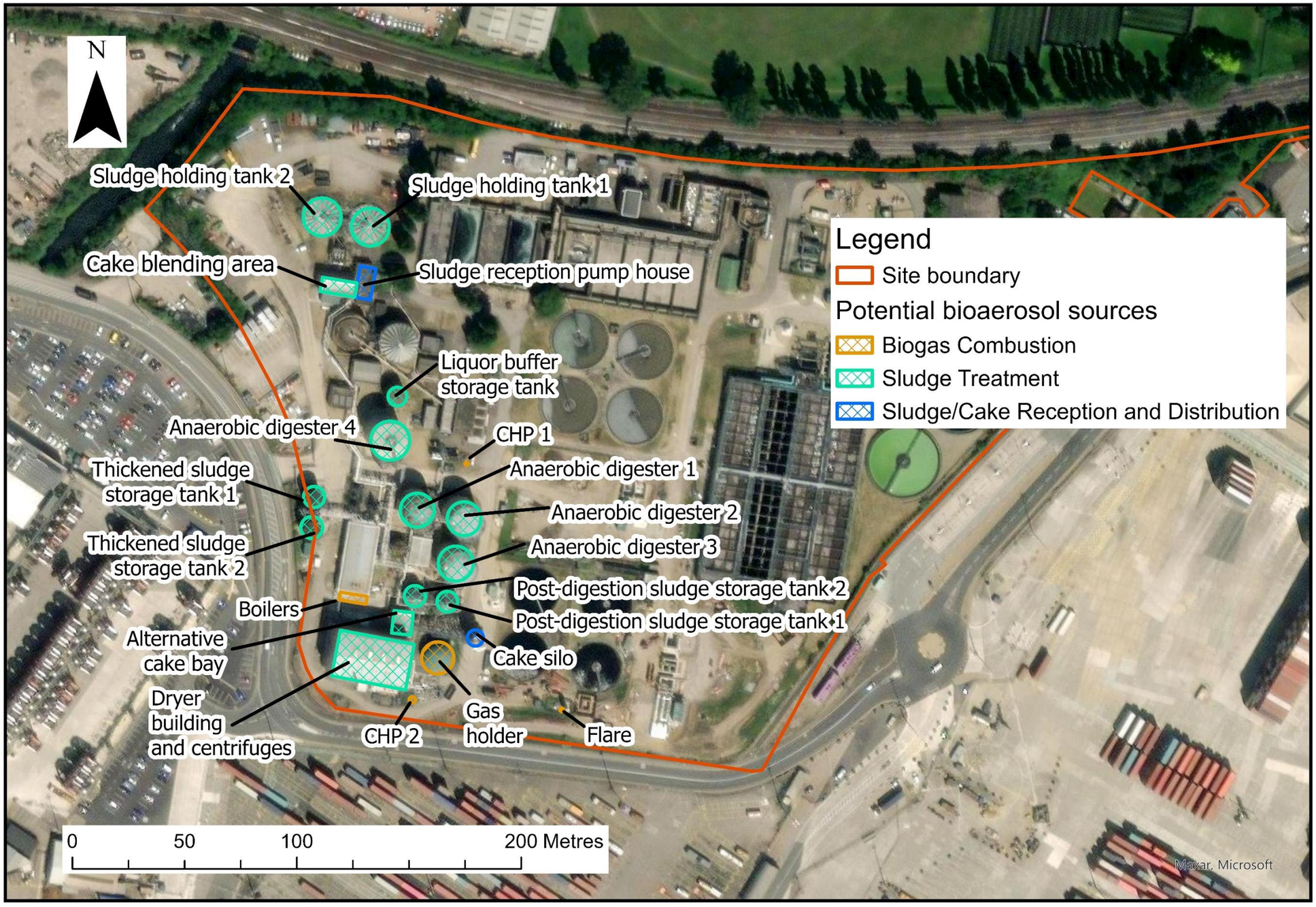
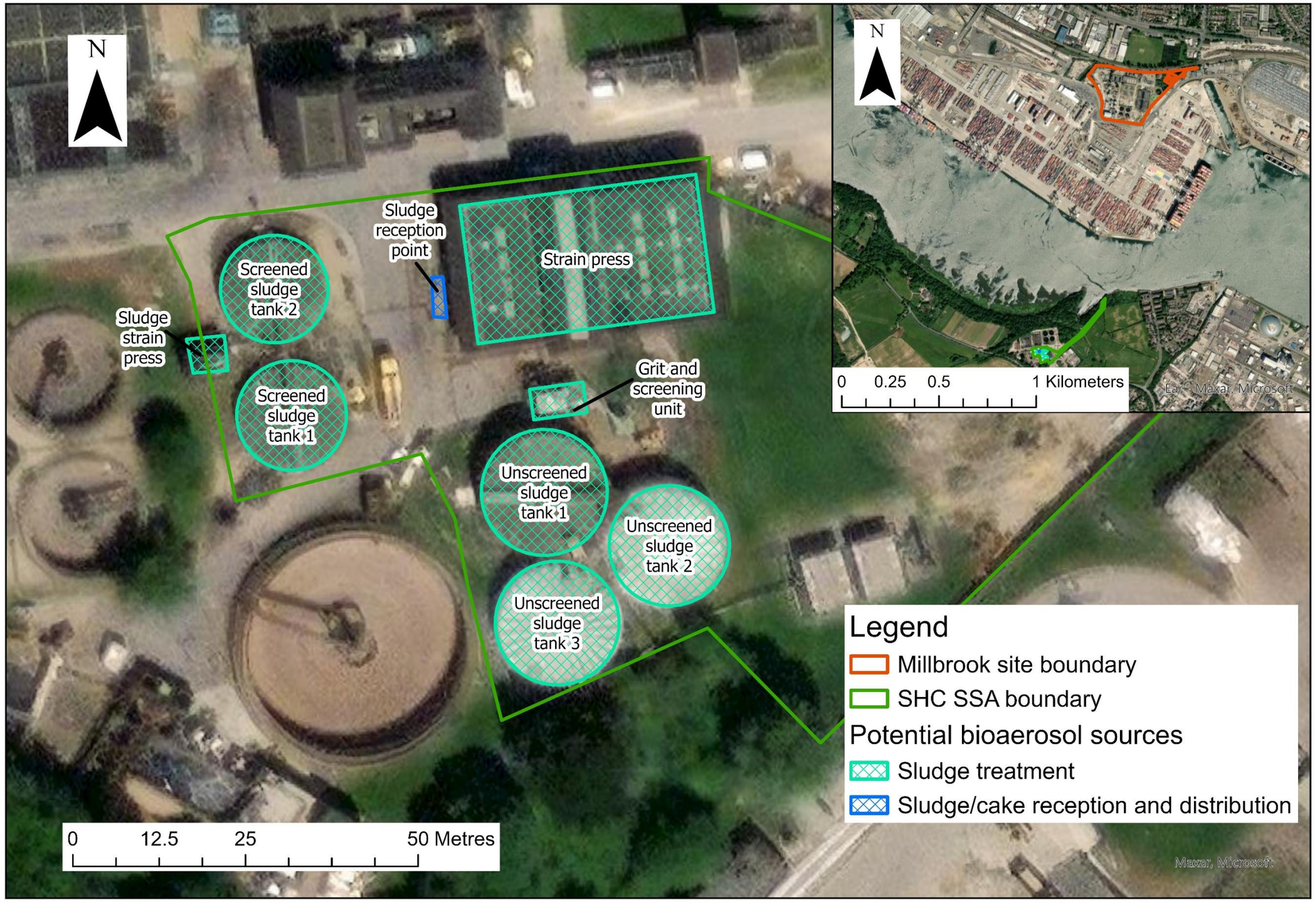


Figure 3.2: Potential sources of bioaerosols at the SHCSR



3.2.2 Activities within the Millbrook STC

3.2.2.1 Sludge/cake reception and distribution

The Millbrook STC accepts approximately five trucks a day of imported sludge cake and liquid sludge. The Millbrook STC also accepts liquid sludge from SHCSR and Marchwood WTW via a sludge main to the Millbrook STC. Daily average sludge volumes imported from SHCSR and Marchwood WTW in 2022 was 4250m^3 per week.

3.2.2.2 Sludge treatment

The Millbrook STC treats indigenous sludge (from auto de-sludging of the primary settlement tanks (PSTs) from the wastewater treatment process) as well as imported sludge from the SHCSR, Marchwood WTW, which arrives at the sludge reception pump house at the Millbrook STC via sludge main. Imported cake is blended with the imported sludge, and indigenous sludge is screened, before being stored in the sludge holding tanks.

The sludge from the sludge holding tanks is pumped and then stored within thickened sludge storage tanks (TSSTs). In the TSSTs, the sludge is mixed with imported cake. The thickened, mixed sludge is then fed into the anaerobic digesters. The anaerobic digestion process provides a controlled environment where micro-organisms, including bacteria and fungi, can grow, multiply and break-down organic material to form water, carbon dioxide and methane (biogas).

Liquors from the sludge treatment is discharged to the liquor buffer storage tank, and then pumped to the upstream of the primary settlement tanks (which are in the wastewater treatment process).

The digested sludge is stored in the post digestion sludge storage tanks (PDSTs) and dosed with lime before being fed into the centrifuges for dewatering (located in the Dryer Building). The resulting cake is then transferred to the cake silo before it is transported to a sealed Roll-on and Roll-off (RORO) skip for removal from the Millbrook STC to be deposited on agricultural land. Sludge liquors from the thickeners and centrifuges are collected at the liquor balance tank and returned to the wastewater upstream of the PSTs.

3.2.2.3 Odour control

Odour control is provided for the sludge reception tanks, sludge holding tanks, digester feed tank and centrifuges. Foul air is treated by a caustic and hypochlorite wet chemical scrubber.

3.2.2.4 Biogas combustion

Biogas produced during anaerobic digestion is transferred to the gas holder and then to the CHP and boilers where it is combusted to generate heat and electricity, which is used on-site to assist with the wastewater and sludge treatment processes. The prioritised use of the flare will be in emergencies (maintenance or breakdown of the CHPs) which is expected to be less than 10% of the year.

3.2.3 Activities within the SHCSR

3.2.3.1 Sludge/cake reception and distribution

The SHCSR accepts liquid sludge from multiple other sites around Southampton and cess waste by tankers at sludge reception point. The SHCSR also accepts cake from multiple Southampton sites. Approximately 3500m^3 of imported liquid sludge from local sites is imported weekly. Imported sludge and cess waste are held in unscreened sludge tanks.

3.2.3.2 Sludge treatment

The SHCSR treats indigenous sludge (from primary sedimentation tanks from the wastewater treatment process). Imported sludge and cess waste blended with indigenous sludge in unscreened sludge tanks, and then screened by passing it through the strain presses before being stored in screened sludge tanks. Grit and screenings from this process is passed to the grit and screenings unit and collected in a skip for removal off site. The sludge from the screened sludge tanks is pumped to the Millbrook STC via sludge main.

3.2.4 Odour control

Odour control is provided for the cess reception system, all sludge holding tanks and sludge pumping stations. Foul air is controlled by a biofilter system. Tanks are covered when making deliveries. Sludge pump building doors are also kept closed.

3.3 Pathways

Bioaerosols are very small and light in weight so can easily be transport by the wind from their source to a receptor. The 2019-2023 wind rose for the nearest meteorological site, Southampton Airport (located approximately 8km northeast of the Millbrook STC, and 9.2km northeast of the SHCSR), is shown in Figure 3.3. The Southampton Airport meteorological site experiences the most frequent winds from the west and southwest, although it also experiences some frequent winds from the northeast.

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

Figure 3.4 presents the wind rose generated for the Site from the Vortex model for the period from 2019-2023. The wind rose demonstrates that historically this location also experiences strong prevailing winds from the west and southwest.

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

Figure 3.3: Average wind rose for Southampton meteorological site 2019- 2023

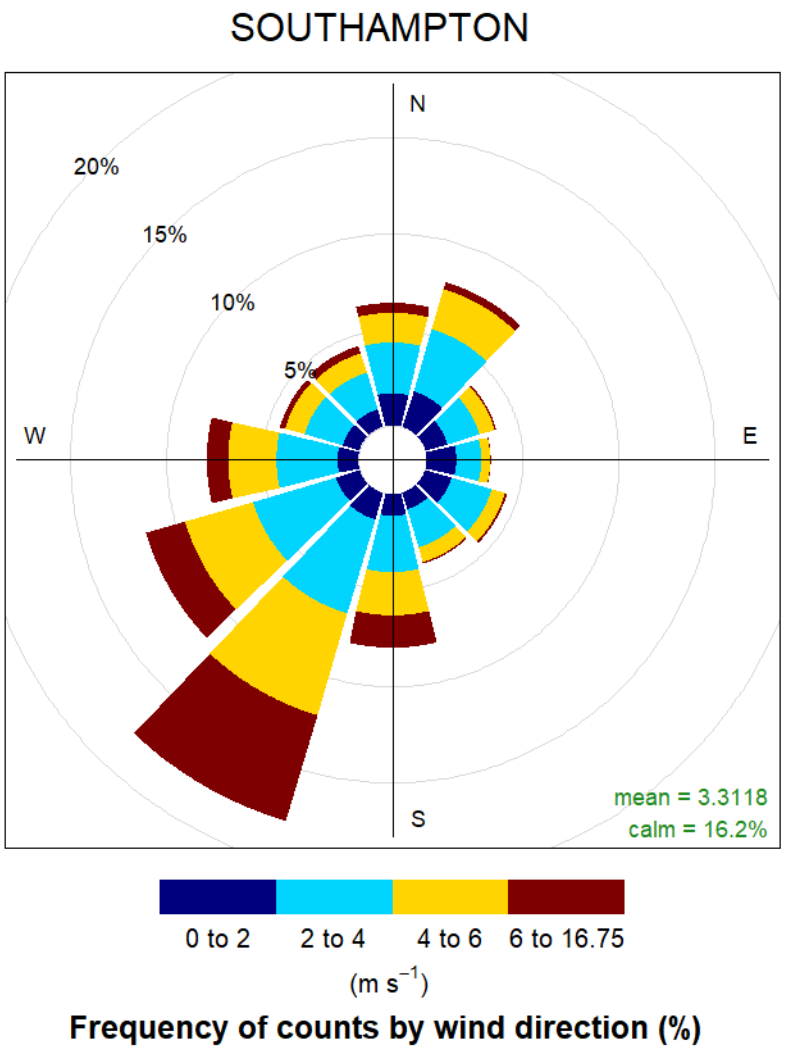
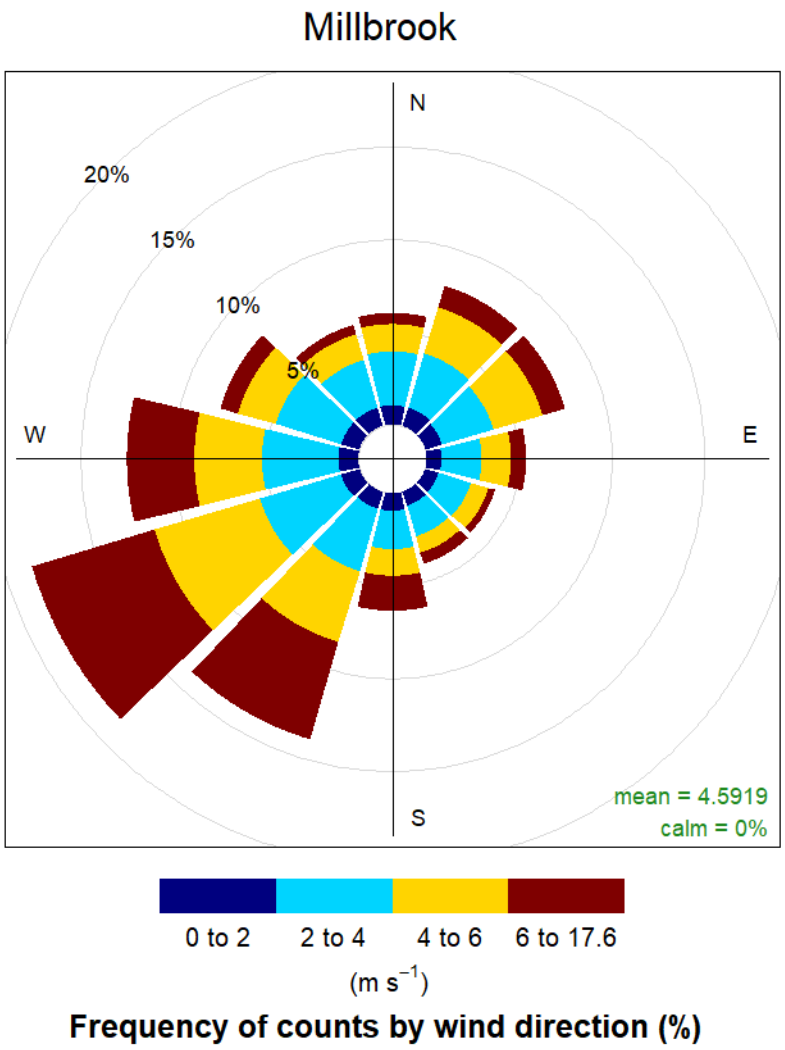


Figure 3.4: Average wind rose for the Site from the Vortex model, 2019- 2023



Concentrations of bioaerosols decline rapidly within the first 100m from a source and generally decrease to background concentrations within 250m[10,11]. The north of the Site is screened by trees and heavy vegetation. This could present a natural barrier to the transportation of bioaerosols by the wind. However, this would be dependent on the release height of bioaerosols on Site. The area surrounding the Site has relatively flat terrain.

3.4 Receptors

Although Environment Agency guidance[12] recommends a screening distance of 250m from bioaerosol emission sources to static receptor locations, a screening distance of 500m has been used as a conservative approach. Sensitive receptors are defined as:

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

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

[12] 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

"*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*."

3.4.1 The Millbrook STC

There are seven areas of sensitive receptors found within 500m of potential bioaerosol emission sources at the Millbrook STC. As demonstrated in Figure 3.5, four areas of industrial land use are located to the north, northeast, west and southwest of the Millbrook STC, whilst two areas of residential properties are located to the north and northeast of the Millbrook STC and one area of recreational land use to the north. For these seven areas of receptors, the distance and direction from each potential bioaerosol emission source on Millbrook STC to the receptors have been identified below in Table 3.1 and Table 3.3. Where multiple assets exist for the same process, such as digesters, only the closest asset to the receptors has been presented.

The receptor closest to a potential emission source is an industrial facility, which is located approximately 70m north of the sludge holding tanks.

Table 3.1: Receptors within 500m of potential emission sources at the Millbrook STC

Nearest potential emission source to receptor	Process	Distance (m) and direction of different receptors[a] from nearest potential emission source [b]						
		Industrial land use to north of the Millbrook STC	Industrial land use to northeast of the Millbrook STC	Industrial land use to west of the Millbrook STC	Industrial land use to southwest of the Millbrook STC	Residential properties to north of the Millbrook STC	Residential properties to northeast of the Millbrook STC	Recreational land use to north of the Millbrook STC
Sludge reception pump house	Sludge/cake reception and distribution	**100**, **north**	295, east	145, west	260, southwest	340, north	310, east	115, northeast
Cake silo	Sludge/cake reception and distribution	250, north	295, northeast	195, west	**170**, **southwest**	480, north	330, northeast	250, north
Cake blending area	Sludge treatment	**105, north**	300, east	130, west	260, southwest	350, north	320, east	125, northeast
Sludge holding tanks	Sludge treatment	**70, north**	290, east	145, west	285, southwest	315, north	305, east	95, northeast
Thickened sludge storage tanks (TSSTs)	Sludge treatment	200, north	335, northeast	**105, west**	155, southwest	440, north	355, northeast	210, north
Anaerobic digesters	Sludge treatment	160, north	270, northeast	**130, west**	180, southwest	430, north	295, northeast	165, north
Post digestion sludge storage tanks (PDSTs)	Sludge treatment	240, north	300, northeast	**145, west**	155, southwest	475, north	325, northeast	235, north
Alternative cake bay	Sludge treatment	250, north	320, northeast	155, west	**140, southwest**	485, north	345, northeast	245, north
Liquor buffer storage tank	Sludge treatment	150, north	285, northeast	**140, west**	225, southwest	385, north	305, northeast	150, northeast
Gas holder	Biogas combustion	265, north	310, northeast	180, west	**145, southwest**	495, north	340, northeast	255, north
CHP	Biogas combustion	175, north	265, northeast	175, west	**130, southwest**	410, north	290, northeast	175, north

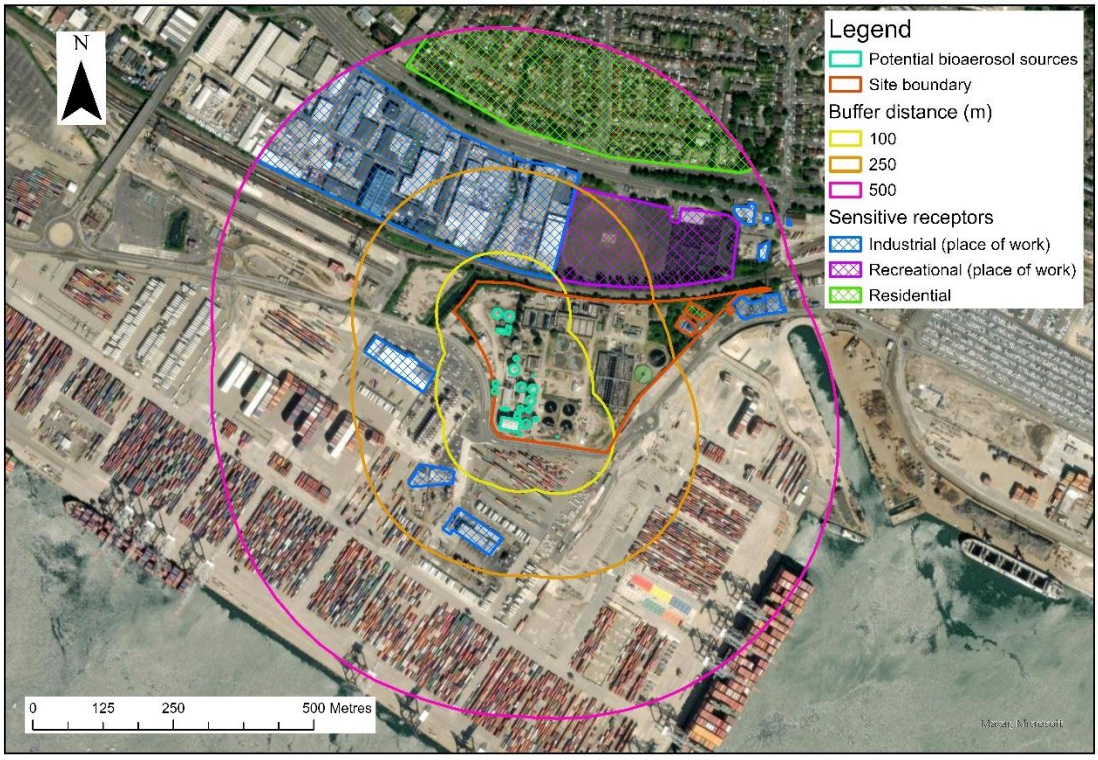
Nearest potential emission source to receptor	Process	Distance (m) and direction of different receptors[a] from nearest potential emission source [b]						
		Industrial land use to north of the Millbrook STC	Industrial land use to northeast of the Millbrook STC	Industrial land use to west of the Millbrook STC	Industrial land use to southwest of the Millbrook STC	Residential properties to north of the Millbrook STC	Residential properties to northeast of the Millbrook STC	Recreational land use to north of the Millbrook STC
Flare	Biogas combustion	300, north	290, northeast	245, west	**195, southwest**	>500, north	315, northeast	280, north
Boilers	Biogas combustion	245, north	330, northeast	**135, west**	140, southwest	480, north	360, northeast	245, north

Note: (a) Refers to the receptors presented within Figure 3.5.

(b) Distance from source to receptor is rounded to the nearest 5m

Value in bold represents the nearest potential emission source for each process which is closest to a sensitive receptor

Figure 3.5: Sensitive receptors within 500m of the Millbrook STC



3.4.2 The Slowhill Copse Sludge Reception

There are six areas of sensitive receptors found within 500m of potential bioaerosol emission sources at SHCSR. Three areas of industrial land use are located to the southeast, west and northwest of the SHCSR, whilst two areas of residential properties are located to the southeast and west. One recreational land use is located to the southeast. The locations of these sensitive receivers present in Figure 3.6.

For these six areas of receptors, the distance and direction from each potential bioaerosol emission source on the SHCSR to the receptors have been identified below in Table 3.2 and Table 3.4. Where multiple assets exist for the same process, such as screened sludge tanks, only the closest asset to the receptors has been presented.

The receptor closest to a potential emission source is an industrial facility, which is located approximately 30m southeast of the unscreened sludge tanks.

Table 3.2: Receptors within 500m of potential emission sources at the SHCSR

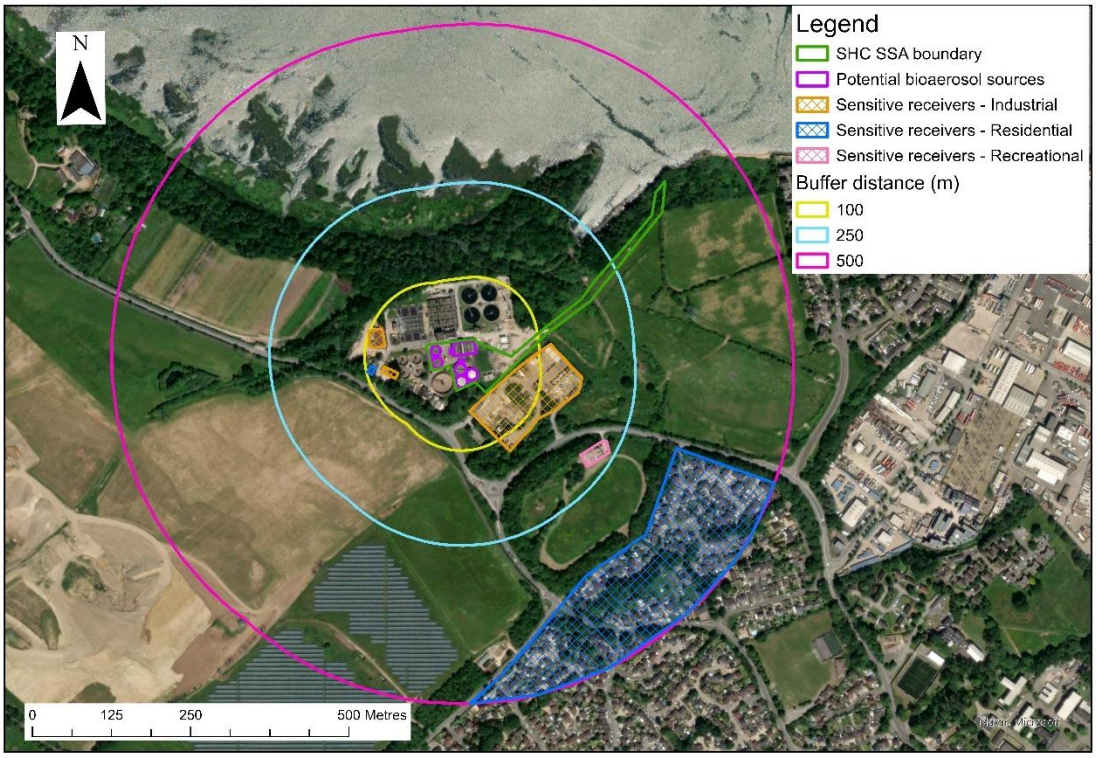
Nearest potential emission source to receptor	Process	Distance (m) and direction of different receptors[a] from nearest potential emission source [b]					
		Industrial land use to southeast of the SHCSR	Industrial land use to west of the SHCSR	Industrial land use to northwest of the SHCSR	Residential properties to southeast of the SHCSR	Residential properties to west of the SHCSR	Recreation land use to southeast of the SHCSR
Sludge reception point	Sludge/cake reception and distribution	**85, southeast**	90, west	100, northwest	385, southeast	120, west	260, southeast
Unscreened sludge tanks	Sludge treatment	**30, southeast**	90, west	115, northwest	335, southeast	125, west	215, southeast
Strain presses	Sludge treatment	60, southeast	**50, west**	70, northwest	350, southeast	85, west	230, southeast
Screened sludge tanks	Sludge treatment	80, southeast	**55, west**	75, northwest	395, southeast	90, west	260, southeast
Grit and screening unit	Sludge treatment	**60, southeast**	95, west	120, northwest	360, southeast	130, west	235, southeast

Note: (a) Refers to the receptors presented within Figure 3.6.

(b) Distance from source to receptor is rounded to the nearest 5m

Value in bold represents the nearest potential emission source for each process which is closest to a sensitive receptor

Figure 3.6: Sensitive receptors within 500m of the SHCSR



3.5 Summary

Table 3.3 below summarises the potential sources of bioaerosol emissions at the Millbrook STC, the sensitive receptors most at risk and the pathways through which the bioaerosols could travel from source to receptor.

Table 3.3: Source-Pathway-Receptor model – the Millbrook STC

Source process	Potential emission source	Pathway	Nearest receptor
Sludge/cake reception and distribution	Sludge reception pump house	Air transport then: • Inhalation (through nose or mouth) • Ingestion (eating or swallowing) • Absorption/contact (through skin or eyes) • Injection (by high pressure equipment/ contaminated sharp objects)	Industrial land use - 100m north
	Cake silo		Industrial land use - 170m southwest
Sludge treatment	Cake blending area		Industrial land use - 105m north
	Sludge holding tanks (SHTs)		Industrial land use - 70m north
	Thickened sludge storage tanks (TSSTs)		Industrial land use - 105m west
	Anaerobic digesters		Industrial land use - 130m west
	Post digestion sludge storage tanks (PDSSTs)		Industrial land use - 145m west

Source process	Potential emission source	Pathway	Nearest receptor
	Alternative cake bay		Industrial land use - 140m southwest
	Liquor buffer storage tank		Industrial land use – 140m west
Biogas combustion	Gas holder		Industrial land use - 145m southwest
	CHP		Industrial land use - 130m southwest
	Flare		Industrial land use - 195m southwest
	Boilers		Industrial land use - 135m west

Table 3.4 below summarises the potential sources of bioaerosol emissions at the SHCSR, the sensitive receptors most at risk and the pathways through which the bioaerosols could travel from source to receptor.

Table 3.4: Source-Pathway-Receptor model – the SHCSR

Source process	Potential emission source	Pathway	Nearest receptor
Sludge/cake reception and distribution	Sludge reception point	Air transport then: • Inhalation (through nose or mouth) • Ingestion (eating or swallowing) • Absorption/contact (through skin or eyes) • Injection (by high pressure equipment/ contaminated sharp objects)	Industrial land use - 85m southeast
Sludge treatment	Unscreened sludge tanks		Industrial land use - 30m southeast
	Strain press		Industrial land use - 50m west
	Screened sludge tanks		Industrial land use - 55m west
	Grit and screening unit		Industrial land use - 60m southeast

4 Control measures

4.1 Overview

The three primary ways to mitigate emissions of bioaerosols[13] is to:

- Reduce emissions
- Contain emissions
- Enhance dispersion

The sections below outline the different control measures in place at the Site. At the Site these cover sludge reception cake and distribution, sludge treatment and biogas combustion processes. At SHCSR these cover sludge reception cake and distribution, and sludge treatment. These control measures aim to reduce and contain emissions of bioaerosols to prevent the source-pathway-receptor link associated with each of the potential emission sources identified in Section 3.5.

4.2 Control measures

4.2.1 The Millbrook STC

4.2.1.1 Sludge reception and distribution

During normal operation, the Millbrook STC receives up to five trucks a day of cake imports. These imports of cake arrive to the Millbrook STC via covered lorries and are deposited directly within the cake silo in the cake blending area. Unloading of cake from the trucks has a short duration so the potential for release of bioaerosols is minimal.

If a spillage of sludge/cake occurs, operators will carry out clean up as soon as possible (using disinfectant where necessary). If the spillage is caused by a lorry, the driver is responsible for cleaning up the spill before leaving the Millbrook STC. If a lorry 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 Millbrook STC immediately to clean up. Significant spillage incidents will be recorded in the Site diary.

Appropriate wash up facilities are also provided for drivers to clean the vehicles after loading or unloading in sludge storage bays and loading points. Lorry drivers are required to hose down any spillage after each loading or unloading and clean contaminated wheels before leaving the Millbrook STC.

Liquid sludge is also imported from the SHCSR Marchwood WTW and arrives at the sludge reception pump house onsite via a sludge main.

4.2.1.2 Containment of emissions from sludge treatment

To contain emissions of bioaerosols during sludge treatment, all sludge tanks and processes associated with sludge treatment are sealed and covered or contained within a sealed building. The doors and covers for sludge treatment processes are kept closed at all times except when access is required. When access is required for operation and maintenance, the doors and

[13] 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.

covers 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, additional mitigation measures are implemented to minimise the impact associated with bioaerosols. This includes using suppressants on-site to limit odour.

4.2.1.3 Reducing emissions from sludge treatment

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

To further reduce potential bioaerosol emissions associated with sludge treatment, sludge produced on-site is processed immediately. This prevents processing of old sludge which is more odorous and difficult to process. Liquid sludge arriving on-site is also processed immediately to help minimise bioaerosol emissions.

Further to this, odorous air from sludge treatment processes (including sludge reception tanks, sludge holding tanks, TSSTs, centrifuges and cake blending area) is extracted and treated by a wet scrubber Odour Control Unit (OCU) at the Millbrook STC to remove odorous compounds. This OCU has an odour removal efficiency of >95% (average and peak) and total flow rate of 9,650 m^3/hour. Filtered odour streams are discharged into the environment through the OCU stack as shown by A09 in 790101_SiteLayourPlan_MIL and are monitored hourly to ensure the absence of odorous compounds.

4.2.1.4 Biogas combustion

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

4.2.2 The SHCSR

4.2.2.1 Sludge reception and distribution

During normal operation, the SHCSR receives approximately 3500m^3 of liquid sludge from multiple Southampton sites. These imports of liquid sludge arrive to the SHCSR via covered tanker and are deposited directly within sludge reception point. Unloading of liquid sludge from the tanker has a short duration so the potential for release of bioaerosols is considered minimal.

If the spillage of sludge/cake occurs, the handling procedures will be the same as presented in Section 4.2.1.1.

Appropriate wash up facilities are also provided for drivers to clean the vehicles after loading or unloading in sludge storage bays and loading points. Lorry drivers are required to hose down any spillage after each loading or unloading and clean contaminated wheels before leaving the this site.

4.2.2.2 Containment of emissions from sludge treatment

To contain emissions of bioaerosols during sludge treatment, all sludge tanks and processes associated with sludge treatment are sealed and covered or contained within a sealed building. The doors and covers for sludge treatment processes are kept closed at all times except when access is required. When access is required for operation and maintenance, the strategy of getting access to tanks and processes associated with sludge treatment will be the same as shown in Section 4.2.1.2.

4.2.2.3 Reducing emissions from sludge treatment

At SHCSR, a biofilter OCU system is used to remove odorous compounds from the cess reception system, all sludge holding tanks and sludge pumping stations. This OCU has an odour removal efficiency of >95% (average and peak) and total flow rate of 9,650m^3/hour. This biofilter system reduces the risk of bioaerosol emissions from these processes.

4.3 Maintenance of control measures

4.3.1 The Millbrook STC

Daily checks, measurements and sampling are conducted of the treatment processes on-site to ensure the equipment is working correctly. The parameters measured include: sludge blanket thickness, turbidity, temperature and methane production (full list of parameters monitored are found within the operating plan for the Millbrook STC). 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 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 are also performed on key equipment across the Millbrook STC by Southern Water staff and specialist contractors. Southern Water has also issued generic maintenance task manuals for use across all their sites which include protocols for the maintenance of equipment such as absorbers, biological filters, fresh air supply ducting, wet scrubber (cleaning, pre-winter service, pH probe calibration, redox probe calibration), direct driven fan, belt driven fan and dryer exhaust ducting.

Currently bioaerosols are not directly monitored, however, future monitoring will be accordance with Environment Agency's Technical Guidance Note (TGN) M9[14] requirements to monitor effectiveness of control measures, where appropriate. Alternatively, the Odour Management Plan requires routine sniff tests and mitigation to odours, and therefore the Plan will indirectly aid the prevention and monitoring of bioaerosol.

The OCU to reduce emissions from the sludge treatment processes is maintained in accordance with manufacturer's requirements to ensure treatment of bioaerosols and odours are effective.

All sludge treatment processes are covered or enclosed. Nonetheless, to minimise odour nuisance, it is important to ensure that the Millbrook STC is operating as designed. Covers and hatches are replaced to maintain the integrity of enclosures provided to collect odorous air.

[14] 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

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

Stocks of chemicals on-site 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.

4.3.2 The SHCSR

All assets and processes associated with sludge treatment within the permitted boundary are sealed and covered or contained within a sealed building. Therefore, no monitoring will be conducted within the SHCSR.

Currently bioaerosols are not directly monitored, however, future monitoring will be accordance with Environment Agency's Technical Guidance Note (TGN) M9[15] requirements to monitor effectiveness of control measures, where appropriate. Alternatively, the Odour Management Plan requires routine sniff tests and mitigation to odours, and therefore the Plan will indirectly aid the prevention and monitoring of bioaerosol.

The OCU to reduce emissions from the sludge treatment processes is maintained in accordance with manufacturer's requirements to ensure treatment of bioaerosols and odours are effective.

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

4.4 Emergency procedures

4.4.1 The Millbrook STC

In the event of plant failures or emergency situations, an alarm would be raised on the Millbrook STC SCADA or telemetry systems, which will be reacted to by Site Manager and Process Scientist. Depending upon the nature of the fault or emergency, Site Manager and Process Scientist would be contacted and would attend the Site as soon as practicable if required. Where the on-call technicians are already engaged upon other response work, there is the facility to access staff from other Southern Water geographic divisions, coordinated by the Duty Manager. All faults, breakdowns and emergencies are logged electronically together with records of the action taken and the solutions reached.

In the event of an emergency/failure of equipment on-site, there are various contingency measures in place. For example, a failure of the flare stack and/or CHP would result in releases of biogas from the Whessoe Valves located on the roofs of the digesters, PDSTs and gas holder, 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 by 50%.

[15] 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

4.4.2 The SHCSR

In the event of plant failures or emergency situations, an alarm would be raised on the Site SCADA or telemetry systems, which will be reacted to by Site Manager and Process Scientist. The handling of emergency procedures will be the same as presented in Section 4.4.1.

4.5 Monitoring

4.5.1 Overview

Bioaerosol emissions associated with the operation of the Site will be monitored in line with the Environment Agency Technical Guidance Note (TGN) M9[16] requirements to monitor effectiveness of control measures.

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

4.5.2 Monitoring Locations

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

Figure 4.1 and Figure 4.2 present the indicative sampling locations identified for the Site and SHCSR. For the Millbrook STC, locations 1, 2 and 3 represent the proposed locations for the three downwind samplers and are located at the same distance as the closest sensitive receptor (70m) from the nearest source of bioaerosols. For SHCSR, locations 5, 6 and 7 represent the proposed locations for the three downwind samplers and are located at the same distance as the closest sensitive receptor (30m) from the nearest source of bioaerosols. The downwind samplers are arranged in a fan shape to ensure the maximum concentrations of bioaerosols are captured and variable wind directions will be accounted for.

The indicative monitoring location 4 and 8 represents the upwind sampler of the Millbrook STC and the SHCSR respectively. These are positioned approximately 50m from the nearest bioaerosol sources. This location will provide a baseline concentration of bioaerosols, representative of background concentrations and any neighbouring sources of bioaerosols, such as agricultural activities, without contributions from the Millbrook STC.

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

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

Figure 4.1: Indicative bioaerosol monitoring locations at the Millbrook STC

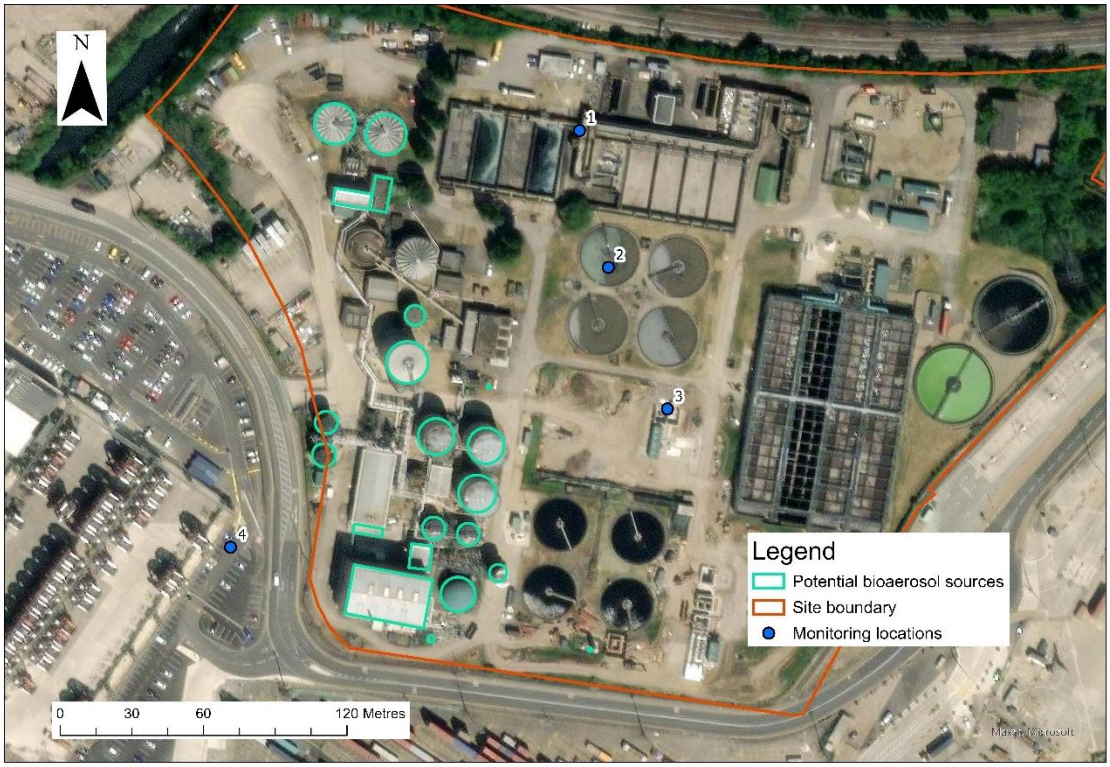
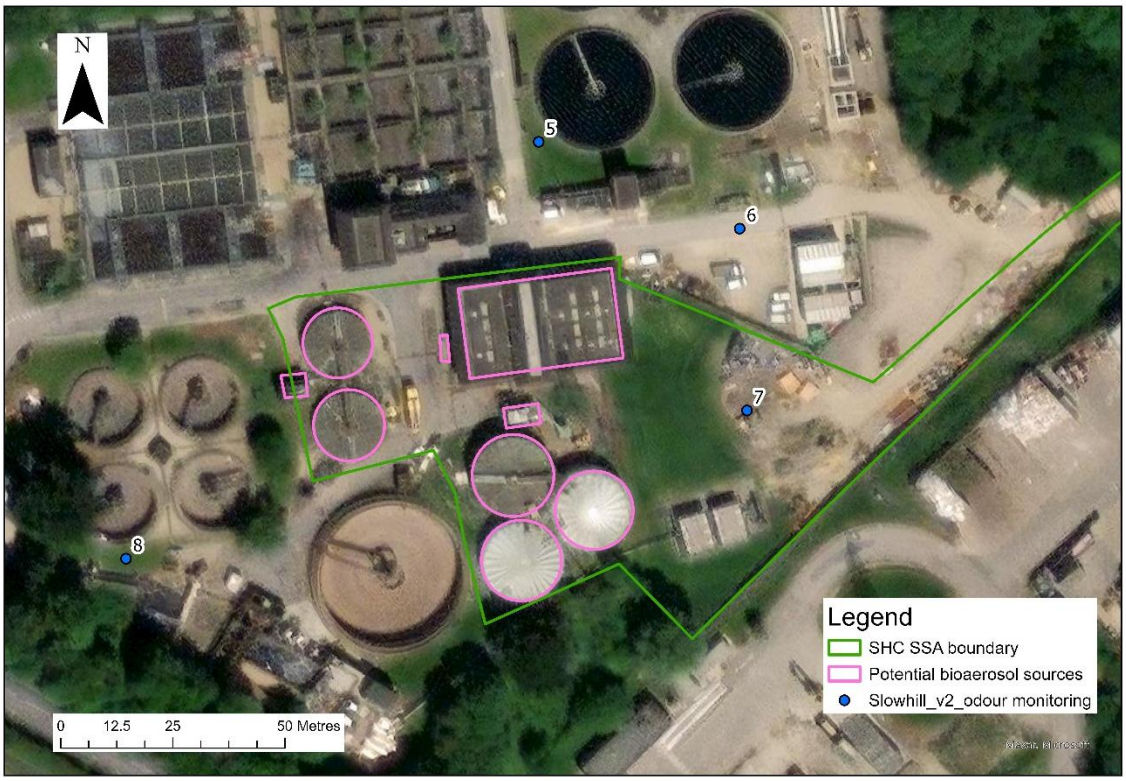


Figure 4.2: Indicative bioaerosol monitoring locations in the SHCSR



4.5.3 Sampling methodology and frequency

The following sampling methodology and frequency protocols cover monitoring at both the Millbrook STC and SHCSR.

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

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

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

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

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

4.6 Summary

As discussed above, there are a number of control measures in place at 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 risk of significant bioaerosol emissions from the Site is associated with emergency situations, which could result in uncontrolled emissions of bioaerosols. However, such an emergency event would be unlikely, temporary, and infrequent due to the extensive monitoring and maintenance programmes undertaken at the Site as well as the emergency procedures and warning systems in place.

5 Risk assessment

5.1 Overview

This section assesses the probability of exposure and consequence of the hazard associated with potential emissions of bioaerosols at the Site to determine the overall magnitude of risk. The descriptors used ('very low' to 'high') are based on the descriptors outlined in the Environment Agency guidance[17], 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:

The Millbrook STC

- Sludge/cake reception and distribution (sludge reception pump house, cake silo)
- Sludge treatment (cake blending area, sludge holding tanks, TSSTs, anaerobic digesters, PDSTs, centrifuges, alternative cake bay, liquor buffer storage tank)
- Biogas combustion (gas holder, CHP, flare, and boilers)

The SHCSR

- Sludge/cake reception and distribution (sludge reception point)
- Sludge treatment (unscreened sludge tanks, strain presses, screened sludge tanks, and grit and screening unit)

These processes have the potential to emit bioaerosols, which are transported through the air by the wind and could cause harm to nearby human health receptors. However, as discussed in Section 4, there are multiple control measures in place at the Site which restrict the Source-Pathway-Receptor link by reducing and containing emissions of bioaerosols from these processes. Therefore, across all potential bioaerosol sources at the Site, the overall probability of exposure is '**very low**'.

The final probability of exposures to bioaerosols assessed for each emission source at the Millbrook STC is presented below in Table 5.1.

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

Process	Potential source of bioaerosols	Probability of exposure	Justification
Sludge/cake reception and distribution	Sludge reception pump house	Very Low	Pump house within sealed building, process monitored and regularly maintained – uncontrolled release of bioaerosols very unlikely
	Cake silo	Very Low	Silo sealed. Stringent loading and unloading procedures process monitored and regularly maintained – uncontrolled release of bioaerosols very unlikely
Sludge treatment	Cake blending area	Very Low	All processes within the building are sealed. – uncontrolled release of bioaerosols very unlikely

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

Process	Potential source of bioaerosols	Probability of exposure	Justification
	Sludge holding tanks	Very Low	Tanks covered, process monitored and regularly maintained. Odorous air from the tanks is extracted and treated by the OCU – uncontrolled release of bioaerosols very unlikely
	Thickened sludge storage tanks (TSSTs)	Very Low	Tanks sealed, process monitored and regularly maintained. Odorous air from the tank is extracted and treated by the OCU – uncontrolled release of bioaerosols very unlikely
	Anaerobic digesters	Very Low	Digesters covered, process monitored and regularly maintained – uncontrolled release of bioaerosols very unlikely
	Post digestion sludge storage tanks (PDSTs)	Very Low	Tanks covered, process monitored and regularly maintained – uncontrolled release of bioaerosols very unlikely
	Alternative cake bay	Very Low	Cake bay covered. Cake within bays at the end of treatment process so bioaerosol concentrations would be very low/de minimis (any exposure would not result in “significant” consequences). No disturbance of cake once placed in bays except to remove from Millbrook STC to disposed on agricultural land – uncontrolled release of bioaerosols very unlikely
	Liquor buffer storage tank	Very Low	Tank covered, process monitored and regularly maintained – uncontrolled release of bioaerosols very unlikely
Biogas combustion	Gas holder	Very Low	Gas holder sealed to prevent uncontrolled release of bioaerosols – uncontrolled release of bioaerosols very unlikely
	CHP	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
	Boilers	Very Low	Combustion of biogas at very high temperatures which would destroy bioaerosols – uncontrolled release of bioaerosols very unlikely

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

Table 5.2: Probability of exposure to bioaerosols from different sources at the SHCSR

Process	Potential source of bioaerosols	Probability of exposure	Justification
Sludge/cake reception and distribution	Sludge reception point	Very Low	Sludge reception point within sealed building, process monitored and regularly maintained – uncontrolled release of bioaerosols very unlikely
Sludge treatment	Unscreened sludge tanks	Very Low	Tanks sealed, process monitored and regularly maintained. Odorous air from the tank is extracted and treated by the OCU – uncontrolled release of bioaerosols very unlikely
	Strain presses	Very Low	Processes covered, process monitored and regularly maintained – uncontrolled release of bioaerosols very unlikely

Process	Potential source of bioaerosols	Probability of exposure	Justification
	Screened sludge tanks	Very Low	Tanks sealed, process monitored and regularly maintained. Odorous air from the tank is extracted and treated by the OCU – uncontrolled release of bioaerosols very unlikely
	Grit and screening unit	Very Low	Processes covered, process monitored and regularly maintained – uncontrolled release of bioaerosols very unlikely

5.3 Consequence of hazard

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

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

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

The consequence of the hazard at sensitive receptors (i.e. the severity of impacts on human health) is largely determined by the proximity of the receptor to the emission source; concentrations of bioaerosols decline rapidly within the first 50-100m from a source (and generally decrease to background concentrations within 250m) [18,19]. Therefore, receptors within 100m of bioaerosol emission sources will experience a greater hazard consequence than those more than 100m from the emission source.

For the purpose of this assessment, receptors within 50m of bioaerosol sources and downwind of the prevailing wind direction are considered to be '**high**' consequence of hazard. This is because within 50m of a source, consequences could be "severe", and "exposure may result in significant damage", as being downwind of the prevailing wind direction also increases the likelihood of exposure. Receptors within 50m of bioaerosols that are upwind of the prevailing wind direction are considered to have a '**medium**' consequence of hazard, as though they are in close proximity to a bioaerosol source, they are less likely to be exposed due to the prevailing wind direction.

Sources of bioaerosols within 50-100m of receptors are also considered to have a '**medium**' consequence of hazard, irrespective of whether they are upwind or downwind of the emission source. This is because within 50-100m of the source, concentrations of bioaerosols would

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

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

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. Beyond 500m, the consequence is not applicable (n/a).

The final consequence of hazard assessed for each emission source at the Site are presented below in Table 5.3 and Table 5.4. Across all potential bioaerosol emission sources at the Site, the consequence of hazard is ‘**low**’ or ‘**medium’** for the Millbrook STC, and **‘medium’** for the SHCSR.

Table 5.3: Consequence of hazard from bioaerosols at the Millbrook STC

Source process	Potential source of bioaerosols	Nearest receptor	Consequence of hazard	Justification
Sludge/cake reception and distribution	Sludge reception pump house	100m north	Low	Nearest receptor <250m from potential source
	Cake silo	170m southwest	Low	Nearest receptor <250m from potential source
Sludge treatment	Cake blending area	105m north	Low	Nearest receptor <250m from potential source
	Sludge holding tanks	70m north	Medium	Nearest receptor <100m from potential source
	Thickened sludge storage tanks (TSSTs)	105m west	Low	Nearest receptor <250m from potential source
	Anaerobic digesters	130m west	Low	Nearest receptor <250m from potential source
	Post digestion sludge storage tanks (PDSTs)	145m west	Low	Nearest receptor <250m from potential source
	Alternative cake bay	140m southwest	Low	Nearest receptor <250m from potential source
	Liquor buffer storage tank	140m west	Low	Nearest receptor <250m from potential source
Biogas combustion	Gas holder	145m southwest	Low	Nearest receptor <250m from potential source
	CHP	130m southwest	Low	Nearest receptor <250m from potential source
	Flare	195m southwest	Low	Nearest receptor <250m from potential source
	Boilers	140m southwest	Low	Nearest receptor <250m from potential source

Table 5.4: Consequence of hazard from bioaerosols at the SHCSR

Source process	Potential source of bioaerosols	Nearest receptor	Consequence of hazard	Justification
Sludge/cake reception and distribution	Sludge reception point	85m southeast	Medium	Nearest receptor <100m from potential source
Sludge treatment	Unscreened sludge tanks	30m southeast	Medium	Nearest receptor <50m from potential source, upwind of potential source
	Strain presses	50m west	Medium	Nearest receptor <100m from potential source
	Screened sludge tanks	55m west	Medium	Nearest receptor <100m from potential source
	Grit and screening unit	60m southeast	Medium	Nearest receptor <100m from potential source

5.4 Magnitude of risk

Table 5.5 and Table 5.6 below summarises the probability of exposure, consequence of hazard and resulting magnitude of risk for each potential bioaerosol emission source at the Site. Across all sources, there is a 'very low' probability of exposure due to the nature of the processes and control measures in place which would prevent uncontrolled releases of bioaerosols at the Site. The consequence of hazard is described as 'low' to 'medium' at the Millbrook STC and 'medium' at the SHCSR depending on the proximity of the potential emission source to a sensitive receptor.

In accordance with Environment Agency guidance[20], across all potential bioaerosol emission sources, the magnitude of risk is described as '**low**' at the Site. Therefore, the 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 Millbrook STC to sensitive receptors, monitoring of bioaerosols should be undertaken[21] at the Site. 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.

[20] 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.

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

Table 5.5: Magnitude of risk from bioaerosols at the Millbrook STC

Process	Potential source of bioaerosols	Probability of exposure	Consequence of Hazard	Magnitude of risk	Justification
Sludge/cake reception and distribution	Sludge reception pump house	Very Low	Low	Low	Pump house within sealed building, process monitored and regularly maintained – uncontrolled release of bioaerosols very unlikely Nearest receptor <250m from potential source
	Cake silo	Very Low	Low	Low	Silo sealed. Stringent loading and unloading procedures process monitored and regularly maintained – uncontrolled release of bioaerosols very unlikely Nearest receptor <250m from potential source
Sludge treatment	Cake blending area	Very Low	Low	Low	All processes within the building are sealed. – uncontrolled release of bioaerosols very unlikely Nearest receptor <250m from potential source
	Sludge holding tanks	Very Low	Medium	Low	Tanks covered, process monitored and regularly maintained. Odorous air from the tank is extracted and treated by the OCU – uncontrolled release of bioaerosols very unlikely Nearest receptor <100m from potential source
	Thickened sludge storage tanks (TSSTs)	Very Low	Low	Low	Tanks sealed, process monitored and regularly maintained. Odorous air from the tank is extracted and treated by the OCU – uncontrolled release of bioaerosols very unlikely Nearest receptor <250m from potential source, upwind of the prevailing wind direction
	Anaerobic digesters	Very Low	Low	Low	Digesters covered, process monitored and regularly maintained – uncontrolled release of bioaerosols very unlikely Nearest receptor <250m from potential source
	Post digestion sludge storage tanks (PDSTs)	Very Low	Low	Low	Tanks covered, process monitored and regularly maintained – uncontrolled release of bioaerosols very unlikely Nearest receptor <250m from potential source
	Alternative cake bay	Very Low	Low	Low	Cake bay covered. Cake within bays at the end of treatment process so bioaerosol concentrations would be very low/de minimis (any exposure would not result in “significant” consequences). No disturbance of cake once placed

Process	Potential source of bioaerosols	Probability of exposure	Consequence of Hazard	Magnitude of risk	Justification
					in bays except to remove from Millbrook STC to disposed on agricultural land – uncontrolled release of bioaerosols very unlikely Nearest receptor <250m from potential source
	Liquor buffer storage tank	Very Low	Low	Low	Tank covered, process monitored and regularly maintained – uncontrolled release of bioaerosols very unlikely Nearest receptor <250m from potential source
Biogas combustion/	Gas holder	Very Low	Low	Low	Gas holder sealed to prevent uncontrolled release of bioaerosols – uncontrolled release of bioaerosols very unlikely Nearest receptor <250m from potential source
	CHP	Very Low	Low	Low	Combustion of biogas at very high temperatures which would destroy bioaerosols – uncontrolled release of bioaerosols very unlikely Nearest receptor <250m from potential source
	Flare	Very Low	Low	Low	Combustion of biogas at very high temperatures which would destroy bioaerosols – uncontrolled release of bioaerosols very unlikely Nearest receptor <250m from potential source
	Boilers	Very Low	Low	Low	Combustion of biogas at very high temperatures which would destroy bioaerosols – uncontrolled release of bioaerosols very unlikely Nearest receptor <250m from potential source, upwind of the prevailing wind direction

Table 5.6: Magnitude of risk from bioaerosols at the SHCSR

Process	Potential source of bioaerosols	Probability of exposure	Consequence of Hazard	Magnitude of risk	Justification
Sludge/cake reception and distribution	Sludge reception point	Very Low	Medium	Low	Sludge reception point within sealed building, process monitored and regularly maintained – uncontrolled release of bioaerosols very unlikely Nearest receptor <100m from potential source

Process	Potential source of bioaerosols	Probability of exposure	Consequence of Hazard	Magnitude of risk	Justification
Sludge treatment	Unscreened sludge tanks	Very Low	Medium	Low	Tanks sealed, process monitored and regularly maintained. Odorous air from the tank is extracted and treated by the OCU – uncontrolled release of bioaerosols very unlikely Nearest receptor <50m from potential source, upwind of potential source
	Strain press	Very Low	Medium	Low	Processes covered, process monitored and regularly maintained – uncontrolled release of bioaerosols very unlikely Nearest receptor <100m from potential source
	Screened sludge tanks	Very Low	Medium	Low	Tanks sealed, process monitored and regularly maintained. Odorous air from the tank is extracted and treated by the OCU – uncontrolled release of bioaerosols very unlikely Nearest receptor <100m from potential source
	Grit and screening unit	Very Low	Medium	Low	Processes covered, process monitored and regularly maintained – uncontrolled release of bioaerosols very unlikely Nearest receptor <100m from potential source

6 Summary

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

- Sludge/cake reception and distribution (sludge reception pump house, cake silo)
- Sludge treatment (cake blending area, sludge holding tanks, TSSTs, anaerobic digesters, PDSTs, centrifuges, alternative cake bay, liquor buffer storage tank)
- Biogas combustion (gas holder, CHP, flare and boilers)

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

- Sludge/cake reception and distribution (sludge reception point)
- Sludge treatment (unscreened sludge tanks, strain presses, screened sludge tanks, and grit and screening unit)

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

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

The probability of exposure is determined to be ‘very low’ at the Site. The consequences of hazards is ‘low’ to ‘medium’ at the Millbrook STC and ‘medium’ at SHCSR. The overall magnitude of the risk associated with bioaerosols emissions is considered to be ‘low’ for the Site. Bioaerosol emissions from the Site are therefore unlikely to lead to significant impacts nearby sensitive receptors. This is primarily due to the ‘wet’ nature of several processes undertaken 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.