MOTT MACDONALD

Motney Hill Sludge Treatment Centre Environmental Permit Application

Bioaerosol risk assessment
790101_ERA_BioaRA_MOT

March 2021

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Contents

1 Introduction

1.1 Overview

Southern Water is applying for a new environmental permit to operate their sludge treatment facility at Motney Hill Wastewater Treatment Works (WTW) and Sludge Treatment Centre (STC) ('the Site'). Sludge treatment activity is covered by the Environmental Permitting Regulations (EPR) 2016, which incorporates the application of the Industrial Emissions Directive (IED). The site currently operates under a T21 exemption and does not have an environmental permit.

Regulatory Position Statement 209[1], issued 23 January 2018 by the Environment Agency (EA), states that all sites that have a permit for the treatment of biological waste within 250 metres of a sensitive receptor (a place where people live or work for more than 6 hours at a time) must carry out a site-specific bioaerosol risk assessment. Four sensitive receptors are found within 250m of a potential source of bioaerosols at the Site therefore a bioaerosol risk assessment has been undertaken to accompany the permit application for this site.

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

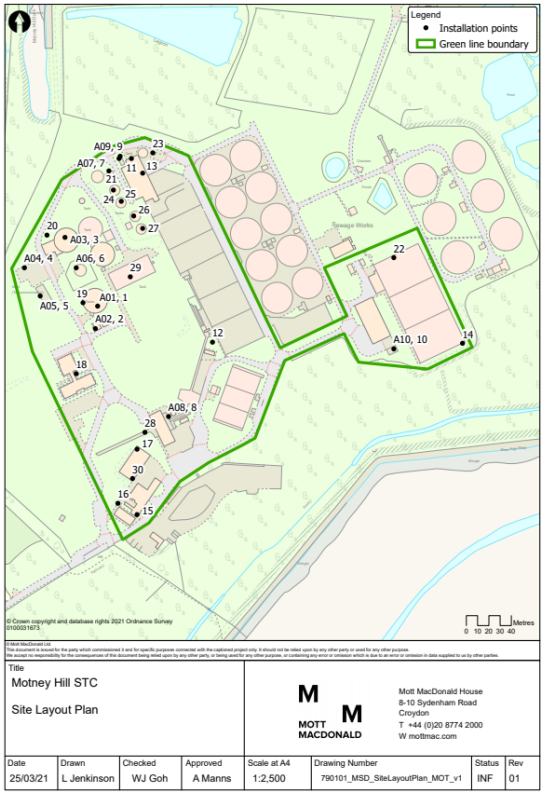
1.2 Site location

The Site is situated on Motney Hill, north of Rainham in Kent. The layout of the Site is shown in Figure 1.1. The site includes two anaerobic digestors which are located on the western half of the site.

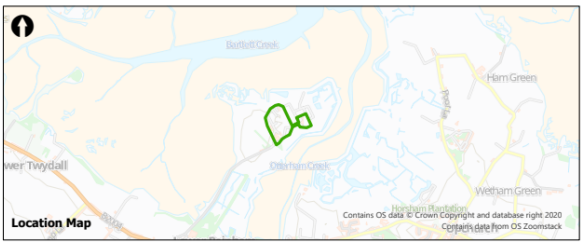
[1] Environment Agency (2018) Bioaerosol monitoring at regulated facilities - use of M9: RPS 209. Available online at: https://www.gov.uk/government/publications/bioaerosol-monitoring-at-regulated-facilities-use-of-m9-rps-209/bioaerosol-monitoring-at-regulated-facilities-use-of-m9-rps-209

[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 layout and location plan



Emissions Ref	Emissions Points	Assets Ref	Assets	X	Y
A01	Whessoe Valve 1	1	Anaerobic Digester 1	582883	168458
A02	Flue 1	2	Boiler 1	582881	168438
A03	Whessoe Valve 2 & Flue 2	3	Anaerobic Digester 2 and boiler 2	582854	168519
A04	CHP Exhaust Stack & CHP Exhaust Emission Monitoring Point	4	Combined Heat and Power Engine	582818	168492
A05	Flare Stack	5	Flare	582832	168467
A06	Whessoe Valve 3	6	Gas Holder	582864	168492
A07	Odour Control Unit 1	7	Odour Control Unit 1	582893	168578
A08	Odour Control Unit 2	8	Odour Control Unit 2	582946	168360
A09	Sludge Treatment Centre Generator	9	Sludge Treatment Centre Generator	582903	168591
A10	Wastewater Treatment Works Generator	10	Wastewater Treatment Works Generator	583146	169420
		11	Polymer Storage Area	582913	168589
		12	Ferric Chemical Store	582985	168426
		13	Centrifuges and thickeners	582923	168576
		14	Gas oil, kerosene, grease and oil storage 1	583207	168425
		15	Gas oil, kerosene, grease and oil storage 2	582918	168273
		16	Gas oil, kerosene, grease and oil storage 3	582901	168283
		17	Gas oil, kerosene, grease and oil storage 4 and WEEE storage	582918	168331
		18	Gas oil, kerosene, grease and oil storage 5 and general waste bins	582864	168398
		19	Gas oil, kerosene, grease and oil storage 6	582870	168461
		20	Gas oil, kerosene, grease and oil storage 7	582838	168521
		21	Gas oil, kerosene, grease and oil storage 8	582902	168589
		22	Gas oil, kerosene, grease and oil storage 9	583146	168501
		23	Sludge Reception Building	582932	168594
		24	Sludge Storage Tank 1	582897	168561
		25	Sludge Storage Tank 2	582904	168551
		26	Sludge Storage Tank 3	582915	168538
		27	Sludge Storage Tank 4	582923	168527
		28	Emergency cess inlet	582925	168346
		29	Emergency sludge tank	582912	168484
		30	General waste bins and scrap metal skip	582914	168305



Source: Southern Water

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 any sensitive receptors within 250m of activities. For new permits there is also a requirement to monitor bioaerosols if the site is within 250m of a sensitive receptor[7].

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

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

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

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

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

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

2.3 Methodology

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

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

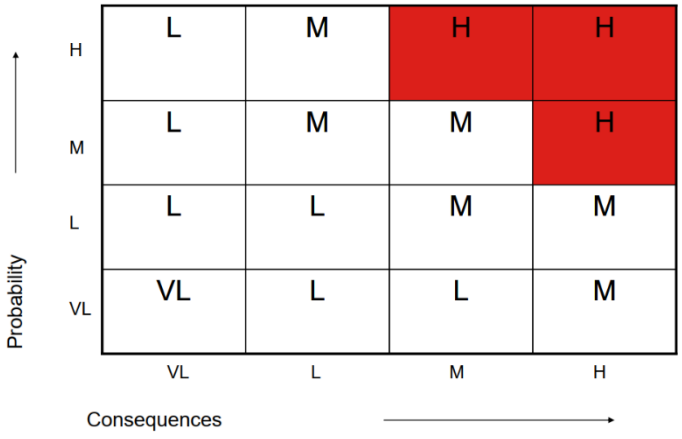
- High – exposure is probable, direct exposure likely with no/few barriers between source and receptor
- Medium – exposure is fairly probable, barriers less controllable
- Low – exposure unlikely, barriers exist to mitigate
- Very low – exposure very unlikely, effective and multiple barriers

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

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

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

Figure 2.1: Magnitude of risk matrices



Source: Environment Agency, 2009

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

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

3 Source – Pathway – Receptor model

3.1 Overview

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

3.2 Sources

The Site includes the following assets which could release bioaerosols:

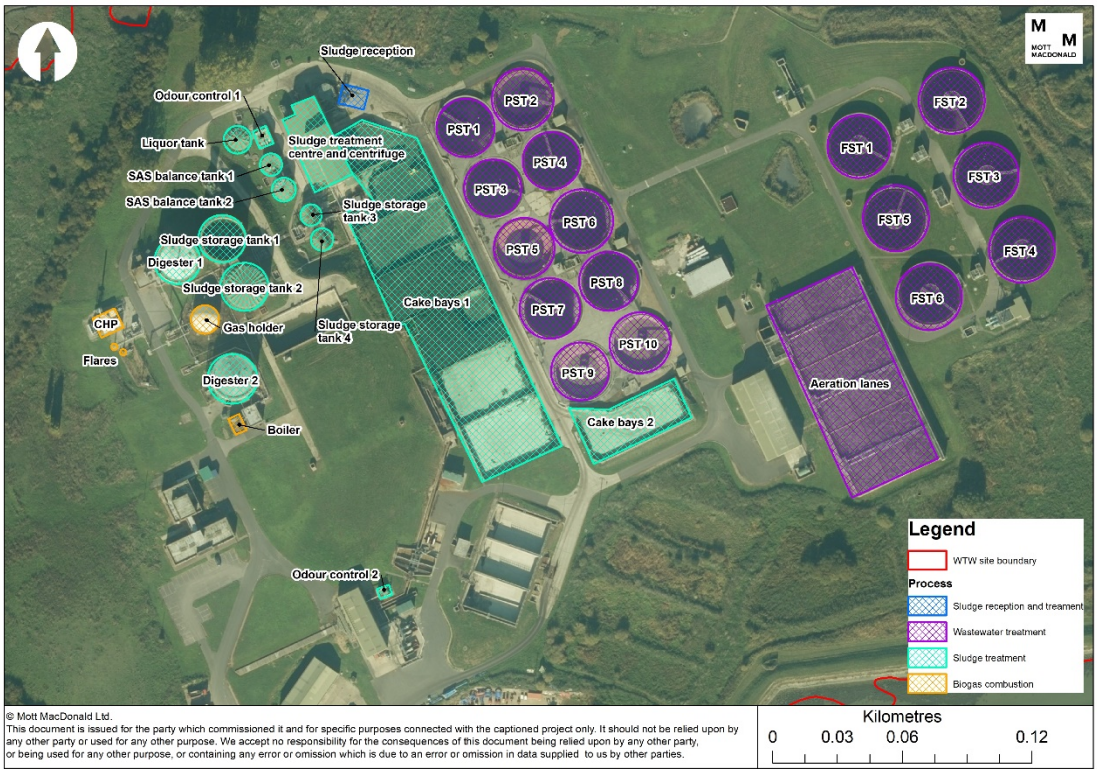
- Ten Primary Settlement Tanks (PSTs)
- Six aeration lanes
- Six final settlement tanks (FSTs)
- One sludge treatment centre with two centrifuges
- Two anaerobic digesters
- Four sludge storage tanks
- Two odour control units
- One liquor tank
- Two Surplus Activated Sludge (SAS) balance tanks
- Seven cake bays
- One gas holder
- One Combined Heat and Power (CHP) unit (2.5 MWth)
- Four boilers
- Two flares

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

- Sludge reception and distribution
- Wastewater treatment (settlement tanks and aeration lanes)
- Sludge treatment (sludge treatment, digestors and cake bays)
- Biogas combustion

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

Figure 3.1: Potential sources of bioaerosols at the Site



3.2.1 Sludge reception and distribution

The Site does not regularly receive sludge imports. If liquid sludge arrives onsite, it arrives via tanker where it is pumped directly into the sludge reception tank before passing to the sludge storage tank where it is subsequently screened and thickened by the gravity belt thickeners.

3.2.2 Wastewater treatment and sludge treatment

3.2.2.1 Wastewater

The Site receives wastewater from 31 pumping stations across the catchment area. Wastewater arriving at the site is screened before entering the inlet works where wastewater is sent to the PSTs after being dosed with ferric and passing through the detritor tanks for grit removal. The PSTs are then de-sludged and the sludge produced is screened and stored in the sludge holding tanks where it is subsequently thickened by the gravity belt thickeners (see 3.2.2.2 for further details).

Settled sewage is pumped from the PSTs to the intermediate pumping station for the activated sludge process. During this secondary biological treatment process, wastewater passes through aeration lanes and mixes with biologically active sludge to remove organic pollutants (a process which releases carbon dioxide and water). The treated wastewater then passes to the FSTs where mixed liquor settles out and Return Activated Sludge (RAS) and Surplus Activated Sludge (SAS) is removed. The RAS is returned to the intermediate pumping station to be reused in the activated sludge process while the SAS passes to the SAS balance tank to be thickened. Secondary treated effluent from the FSTs is then discharged to the estuarial waters of the River Medway.

3.2.2.2 Sludge treatment

Thickened indigenous and imported sludge from the thickened sludge holding tanks is fed to 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, releasing water, carbon dioxide and methane (biogas). After AD, digested sludge is stored in a digested sludge storage tank before being dewatered by the centrifuges. The dewatered sludge cake produced is then stored cake bays prior to being collected by covered trucks to be transported off site to be used on farmland.

3.2.2.3 Odour control

Odour control systems are attached to sludge treatment centre and centrifuge. The control system extracts odorous air and treats the air using a filter to remove odorous compounds and bioaerosols. Treated air is released to the atmosphere via stacks to assist dispersion.

3.2.3 Biogas combustion

Biogas produced during AD 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 onsite to assist with the wastewater and sludge treatment processes. When more biogas is produced onsite than can be combusted within the CHP and boilers and there is insufficient space in the gas holder to store surplus biogas, excess biogas is sent to one of the flares to be burned.

3.3 Pathways

Bioaerosols are very small and light in weight so can easily be transport by the wind from their source to a receptor. The 2015-2019 wind rose for the nearest meteorological site, Southend (located approximately 21km north of the Site), is shown in Figure 3.2. This monitoring site experiences strong prevailing winds from the south west, with occasional strong winds from the west. However, as this meteorological site is more than 20km from the Site, an atmospheric hindcast model (Vortex) has also been used to assess the wind conditions at the Site.

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

Figure 3.3 presents the wind rose generated for the Site from the Vortex model for the period from 2015-2019. The wind rose demonstrates that historically this location experiences strong prevailing winds from the south west, demonstrating that both datasets are in agreement with each other. This suggests that sensitive receptors located to the north east of the site would be at the greatest risk from bioaerosol emissions from the Site as they would be downwind of the prevailing wind direction.

Figure 3.2: Average wind rose for Southend meteorological site, 2015- 2019

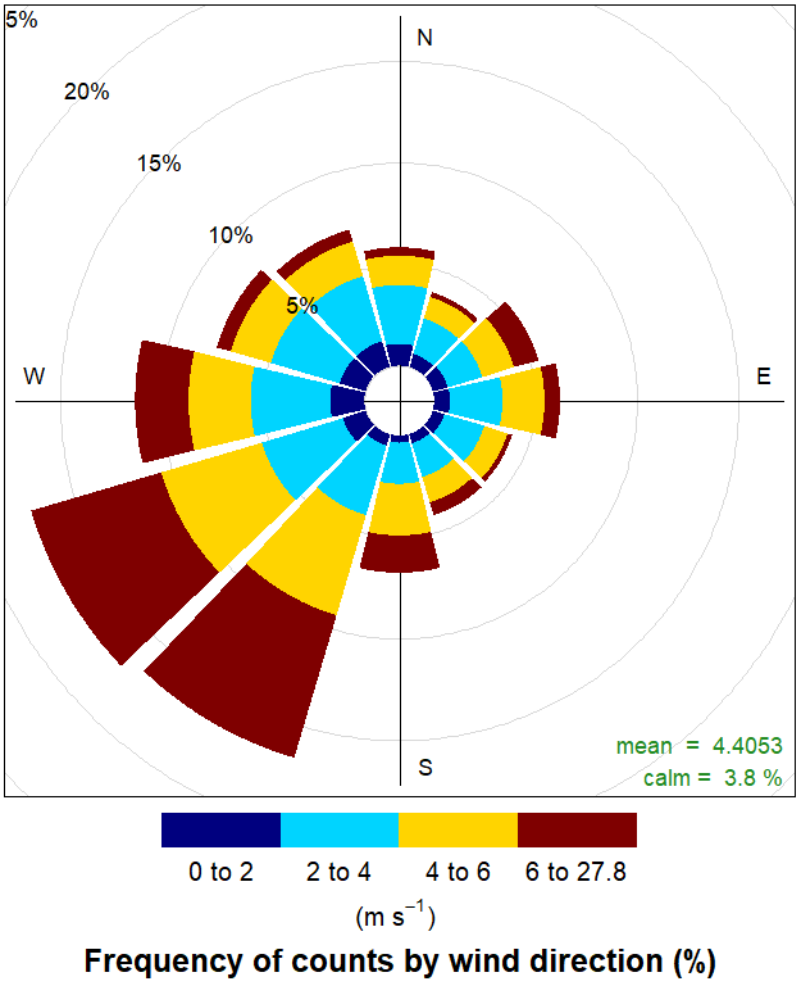
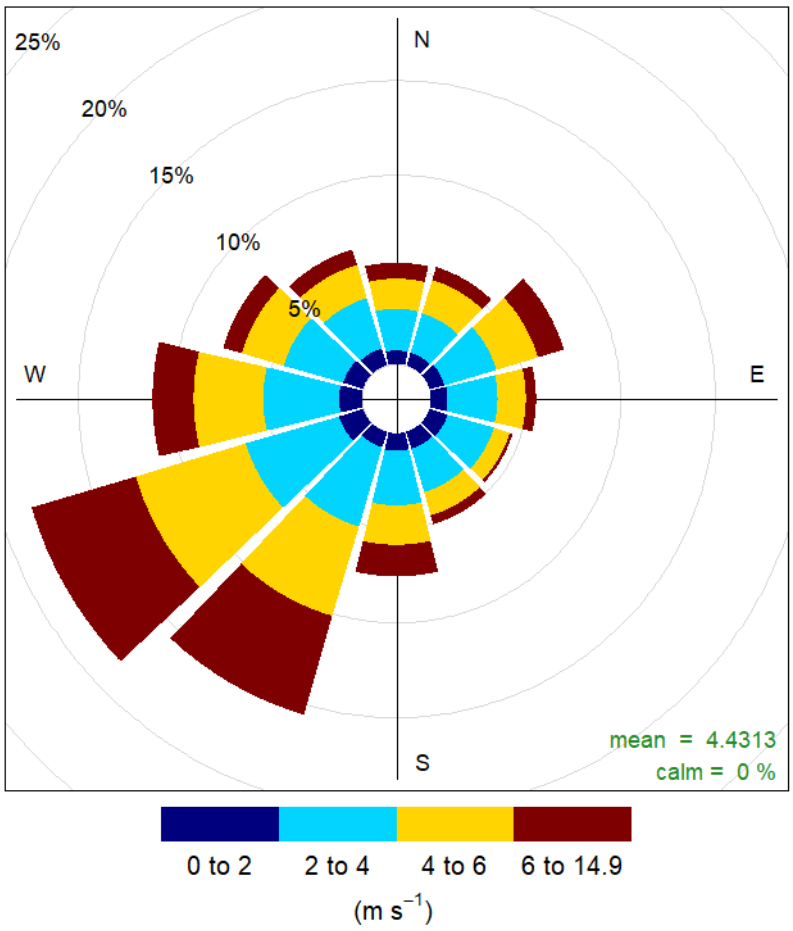


Figure 3.3: Average wind rose for the Site from the Vortex model, 2015- 2019



Concentrations of bioaerosols decline rapidly within the first 100m from a source and generally decrease to background concentrations within 250m[9,10]. The local terrain in the 250m area surrounding the Site is flat and surrounded on most sides by water so there would be few obstacles to inhibit the pathway between source and receptor.

3.4 Receptors

Environment Agency guidance[11] recommends a screening distance of 250m from bioaerosol emission sources to static receptor locations. Sensitive receptors are defined as:

"*permitted activities where people are likely to be for prolonged periods. This term would therefore apply to dwellings (including any associated gardens) and to many types of workplaces. We would not normally regard a place where people are likely to be present for less than 6 hours at one time as being a sensitive receptor. The term does not apply to those*

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

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

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

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 four sensitive receptors found within 250m of a potential bioaerosol emission source at the Site. As demonstrated in Figure 3.4, these receptors (residential properties) are found to the south west of the site, upwind of the prevailing wind direction. No sensitive receptors are found to the north east of the site, downwind of the prevailing wind direction.

Table 3.1 below has identified the distance and direction from each potential bioaerosol emission source to the closest sensitive receptor. Where multiple assets exist for the same process, such as digesters or settlement tanks, only the closest asset has been presented.

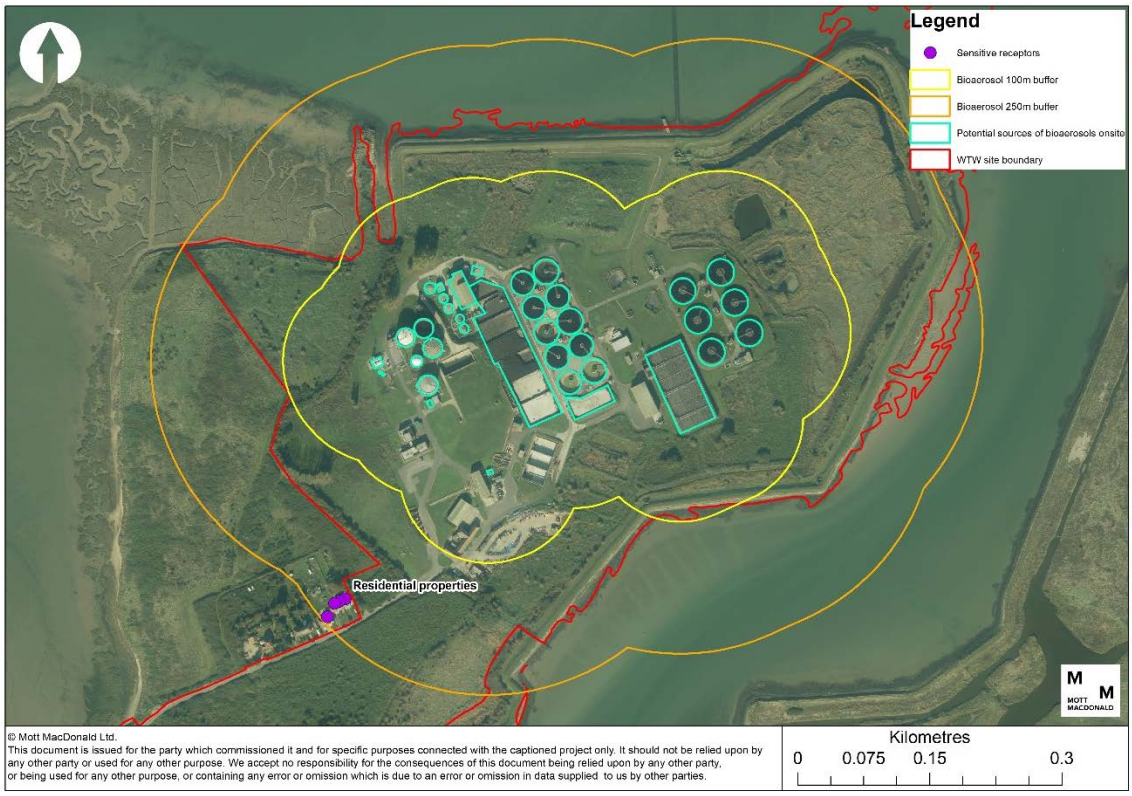
The potential bioaerosol emission source closest to a residential property is an odour control unit. The potential emission source located the furthest away from the sensitive receptor is the FSTs.

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

Receptor	Nearest potential emission source to receptor	Process	Distance (m) from nearest potential emission source [(a)]	Direction of receptor from closest emission source
Residential property	Sludge reception	Sludge reception and distribution	395	South west
	Primary settlement tanks	Wastewater treatment	340	South west
	Aeration lanes	Wastewater treatment	430	South west
	Final settlement tanks	Wastewater treatment	485	South west
	Sludge treatment centre and centrifuge	Sludge treatment	355	South west
	Sludge storage tank	Sludge treatment	290	South west
	Digester	Sludge treatment	250	South west
	Liquor tank	Sludge treatment	360	South west
	SAS balance tank	Sludge treatment	345	South west
	Cake bays	Sludge treatment	285	South west
	Odour control unit	Sludge treatment	215	South west
	Gas holder	Biogas combustion	275	South west
	CHP	Biogas combustion	265	South west
	Boiler	Biogas combustion	245	South west
	Flare	Biogas combustion	260	South west

Source: (a) Distance from source to receptor is rounded to the nearest 5m

Figure 3.4: Sensitive receptors within 250m



3.5 Summary

Table 3.2 below summarises the potential sources of bioaerosol emissions at The Site, the sensitive receptor 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 sensitive receptor (residential property)
Sludge reception and distribution	Sludge reception	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)	395m
Wastewater treatment	Primary settlement tanks		340m
	Aeration lanes		430m
	Final settlement tanks		485m
Sludge treatment	Sludge treatment centre and centrifuge		355m
	Sludge storage tank		290m
	Digester		250m
	Liquor tank		360m
	SAS balance tank		345m
	Cake bays		285m

Source process	Potential emission source	Pathway	Distance to nearest sensitive receptor (residential property)
	Odour control unit		215m
Biogas combustion	Gas holder		275m
	CHP		265m
	Boiler		245m
	Flare		260m

4 Control measures

4.1 Overview

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

- Reduce emissions
- Contain emissions
- Enhance dispersion

The sections below outline the different control measures in place at the Site. These control measures aim to reduce and contain emissions of bioaerosols to prevent the source-pathway-receptor link associated with each of the potential emission sources identified in Section 3.2.5.

As similar control measures are used at the Site for wastewater and sludge treatment, control measures for both emission sources have been considered together below.

4.2 Control measures

4.2.1 Sludge reception and distribution

The Site does not regularly receive sludge imports. Unloading tankers is therefore infrequent and has a short duration.

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 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.

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 and tanker drivers are required to hose down any spillage after each loading or unloading and clean contaminated wheels before leaving site.

4.2.2 Wastewater and sludge treatment

4.2.2.1 Containment of emissions

To contain emissions of bioaerosols during wastewater and sludge treatment, the digesters, pre-digestion storage tanks, liquor tank and SAS balance tank are covered and linked to odour control where appropriate. While the PSTs, FSTs, aeration lanes, post-digestion storage tank and cake bays are uncovered, additional mitigation measures are in place to reduce emissions from these sources (see below).

4.2.2.2 Reduce emissions

Throughout the sludge treatment process, biological material which could give rise to emissions of bioaerosols is broken down. This primarily occurs during AD, with subsequent processes

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

such as liming being undertaken to further remove microorganisms by raising the pH and temperature. Therefore, at each stage of the sludge treatment process, the quantity of bioaerosols decreases; the concentration of bioaerosols that could potentially be emitted from the cake bays (at the end of the sludge treatment process) is much lower than from the sludge treatment works (pre-AD).

While the cake bays themselves are not covered, once the cake is deposited within the bays, it is not handled further until it is loaded into trucks to be transported offsite to farmland. This reduces the risk of bioaerosol emissions as agitation of cake could facilitate the resuspension of any remaining bioaerosols into the air. Samples of cake are also tested before being transported offsite to confirm that levels of bacteria (which could result in emissions of bioaerosols) are low enough to safely apply to farmland.

To 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. The sludge treatment centre and centrifuge are also odour controlled; odorous air is treated with a bio-scrubber to remove odour and bioaerosols before it is released to the atmosphere. While the bio-scrubber is unable to remove 100% of bioaerosols, any bioaerosol emissions from odour control are anticipated to be negligible.

4.2.3 Biogas combustion

Biogas produced during AD is stored within the gas holder before being combusted at high temperatures within the CHP/boiler 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.

4.3 Maintenance of control measures

Daily checks, measurements and sampling is conducted of the treatment processes on site to ensure the equipment is working correctly. The parameters measured include: sludge blanket thickness, dissolved oxygen content, turbidity, temperature, pH and alkalinity (full list of parameters monitored are found within the operating plan for the Site). Where desired operating parameters are not met, various corrective actions and operating procedures are in place to rectify the problem. Performance issues and equipment problems are also reported promptly 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 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, biofilters, odour extraction, fresh air supply ducting, wet scrubber (cleaning, pre-winter service, pH probe calibration, redox probe calibration), direct driven fan, belt driven fan and dryer exhaust ducting.

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

4.4 Emergency procedures

In the event of plant failures or emergency situations, an alarm would be raised on the site Supervisory Control and Data Acquisition (SCADA) or telemetry systems, which will be reacted to by on-site or regional control room operators and Duty Managers. Depending upon the nature of the fault or emergency, a mechanical or electrical technician, both of whom are on-call 24-

hours, would be contacted and would attend site as soon as practicable if required. Where the on-call technicians are already engaged upon other response work, there is the facility to access staff from other Southern Water geographic divisions, coordinated by the Duty Manager. All faults, break-downs and emergencies are logged electronically together with records of the action taken and the solutions reached.

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

4.5 Summary

As discussed above, there are a number of control measures in place at the Site to reduce and contain emissions of bioaerosols. These control measures are regularly maintained to sustain their efficacy and reduce the risk of equipment failure. The greatest risk associated with emissions of bioaerosols from the site is associated with uncovered operations such as the PSTs, FSTs, aeration lanes and post digestion sludge tanks as well as from emergency situations such as a failure of the flare or CHP/boiler, which could result in uncontrolled emissions of bioaerosols. However, such events would be temporary and infrequent due to the extensive monitoring and maintenance programmes undertaken at the site as well as the emergency procedures and warning systems in place. The uncovered processes are also ‘wet’ processes so the risk of resuspension of bioaerosols is minimised.

5 Risk assessment

5.1 Overview

This section assesses the probability of exposure and consequence of the hazard associated with potential emissions of bioaerosols at the Site to determine the overall magnitude of risk. The descriptors used ('very low' to 'high') are based on the descriptors outlined in the Environment Agency guidance[13], as summarised in Section 2.3.

5.2 Probability of exposure

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

- Sludge reception and distribution
- Wastewater treatment (settlement tanks and aeration lanes)
- Sludge treatment (sludge treatment, digestors, centrifuge and cake bays)
- 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 250m from the digestors. However, as discussed in Section 4, there are multiple control measures in place at the Site which restrict the Source-Pathway-Receptor link by reducing and containing emissions of bioaerosols from these processes. The overall probability of exposure of sensitive receptors to bioaerosols at the majority of bioaerosol sources at the Site is therefore considered to be '**very low**' as exposure of the receptors to bioaerosols is "very unlikely" due to the "effective and multiple barriers" (control measures) in place.

The exception to this are the PSTs, FSTs, aeration lanes and post-digestion sludge tanks, which are not covered. However, all of these are wet processes so the probability of exposure is considered to be '**low**'; exposure of the receptors to bioaerosols is "unlikely" as receptors are not downwind of the prevailing wind direction and some "barriers exist to mitigate".

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 or the nature of processes on site, there is still a risk that nearby receptors could be exposed bioaerosols, for example if there is a failure of the control equipment. Should this occur, any exposure to bioaerosols would likely be temporary as the fault would be detected by the SCADA system and the emergency protocols would be undertaken to rectify the fault as soon as possible.

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

- Respiratory infections and inflammation of the respiratory system
- Reduced lung function
- Allergic reactions

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

- Gastro-intestinal disorders
- Dermatitis
- Eye irritation

The consequence of the hazard at sensitive receptors (i.e. the severity of impacts on human health) is largely determined by the proximity of the receptor to the emission source; concentrations of bioaerosols decline rapidly within the first 50-100m from a source (and generally decrease to background concentrations within 250m) [14],[15]. Therefore, receptors within 100m of bioaerosol emission sources will experience a greater hazard consequence than those more than 100m from the emission source.

For the purpose of this assessment, sources of bioaerosols within 100m of receptors are therefore considered to have a '**medium**' consequence of hazard. This is because within 100m of the source, concentrations of bioaerosols would be greatest so temporary exposure could result in "significant consequences" and potentially result in "damage that is not severe and is reversible". Between 100-250m, 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 from a bioaerosol emission source, concentrations of bioaerosols generally decreases to the same levels as background concentrations and therefore the consequence of the hazard is considered to be '**very low**' as exposure would result in "negligible consequences" where there is "no evidence for adverse changes".

The final consequence of hazard assessed for each emission source is presented below in Table 5.1.

5.4 Magnitude of risk

Table 5.1 below summarises the probability of exposure, consequence of hazard and resulting magnitude of risk for each potential bioaerosol emission source at the Site. Across all sources, there is a 'very low' or 'low' probability of exposure due to the nature of the processes and control measures in place which would prevent uncontrolled releases of bioaerosols. The consequence of exposure is described as 'very low' to 'low' depending on the potential emission source due to their proximity to sensitive receptors.

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

Nonetheless, as there are sensitive receptors within 250m of a potential bioaerosol source at the site, monitoring of bioaerosols should be undertaken at the Site[17]. The requirements for bioaerosol monitoring at the Site will need to be agreed with the Environment Agency within the Environmental Permit issued for the site.

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

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

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

[17] 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 5.1: Magnitude of risk from bioaerosols at the Site

Process	Potential source of bioaerosols	Probability of exposure	Consequence of exposure	Magnitude of risk	Justification
Sludge reception and distribution	Sludge reception	Very Low	Very Low	Very Low	Nearest receptor >250m away from potential source, not downwind of the prevailing wind direction Stringent loading and unloading procedures – uncontrolled release of bioaerosols unlikely
Wastewater treatment	Primary settlement tanks	Low	Very Low	Low	Nearest receptor >250m away from potential source, not downwind of the prevailing wind direction Uncovered, 'wet' process - exposure to bioaerosol emissions unlikely
	Aeration lanes	Low	Very Low	Low	Nearest receptor >250m away from potential source, not downwind of the prevailing wind direction Uncovered, 'wet' process - exposure to bioaerosol emissions unlikely
	Final settlement tanks	Low	Very Low	Low	Nearest receptor >250m away from potential source, not downwind of the prevailing wind direction Uncovered, 'wet' process - exposure to bioaerosol emissions unlikely
Sludge treatment	Sludge treatment centre	Very Low	Very Low	Very Low	Nearest receptor >250m away from potential source, not downwind of the prevailing wind direction Sludge treatment covered, enclosed and odour controlled, process monitored and regularly maintained – uncontrolled release of bioaerosols unlikely
	Sludge storage tank	Low	Very Low	Low	Nearest receptor >250m away from potential source, not downwind of the prevailing wind direction Uncovered, 'wet' process - exposure to bioaerosol emissions unlikely
	Digester	Very Low	Low	Low	Nearest receptor >100m away from potential source, not downwind of the prevailing wind direction Digestor covered, process monitored and regularly maintained – uncontrolled release of bioaerosols unlikely.
	Liquor tank	Very Low	Very Low	Very Low	Nearest receptor >250m away from potential source, not downwind of the prevailing wind direction Liquor tanks covered, process monitored and regularly maintained – uncontrolled release of bioaerosols unlikely.
	SAS balance tank	Very Low	Very Low	Very Low	Nearest receptor >250m away from potential source, not downwind of the prevailing wind direction Balance tanks covered, process monitored and regularly maintained – uncontrolled release of bioaerosols unlikely.
	Cake bays	Very Low	Very Low	Very Low	Nearest receptor >250m away from potential source, not downwind of the prevailing wind direction While uncovered, cake within bays at the end of treatment process so bioaerosol concentrations would be at very low/de minimis (any exposure would not result in "significant" consequences).

Process	Potential source of bioaerosols	Probability of exposure	Consequence of exposure	Magnitude of risk	Justification
					No disturbance of cake while in bays except for removal.
	Odour control unit	Low	Very Low	Low	Nearest receptor >100m away from potential source, not downwind of the prevailing wind direction Odour control unit treats air to remove bioaerosols, process monitored and regularly maintained –uncontrolled release of bioaerosols unlikely
Biogas combustion	Gas holder	Very Low	Very Low	Very Low	Nearest receptor >250m away from potential source, not downwind of the prevailing wind direction Gas holder air-tight to prevent uncontrolled release of bioaerosols. SCADA system in place to detect leaks.
	CHP	Very Low	Very Low	Very Low	Nearest receptor >250m away from potential source, not downwind of the prevailing wind direction Combustion of biogas at very high temperatures which would destroy bioaerosols
	Boiler	Low	Very Low	Low	Nearest receptor >100m away from potential source, not downwind of the prevailing wind direction Combustion of biogas at very high temperatures which would destroy bioaerosols
	Flare	Very Low	Very Low	Very Low	Nearest receptor >250m away from potential source, not downwind of the prevailing wind direction Combustion of biogas at very high temperatures which would destroy bioaerosols

6 Summary

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

- Sludge reception and distribution
- Wastewater treatment (settlement tanks and aeration lanes)
- Sludge treatment (sludge treatment, digestors, centrifuge and cake bays)
- Biogas combustion

Bioaerosol emissions associated with these processes could be transported by the wind to nearby sensitive human health receptors bordering the site, resulting in adverse health effects. As there are four sensitive human health receptors within 250m of a potential emission source at the Site, 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.

Based on the ‘very low’ to ‘low’ probability of exposure and consequence of hazards associated with different processes at the Site, the overall magnitude of the risk associated with bioaerosols emissions from the Site is considered to be ‘very low’ to ‘low’. This is primarily because the majority of potential bioaerosol emission sources are more than 250m away from a sensitive receptor. It is also due to the ‘wet’ nature of the processes undertaken at the Site 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.

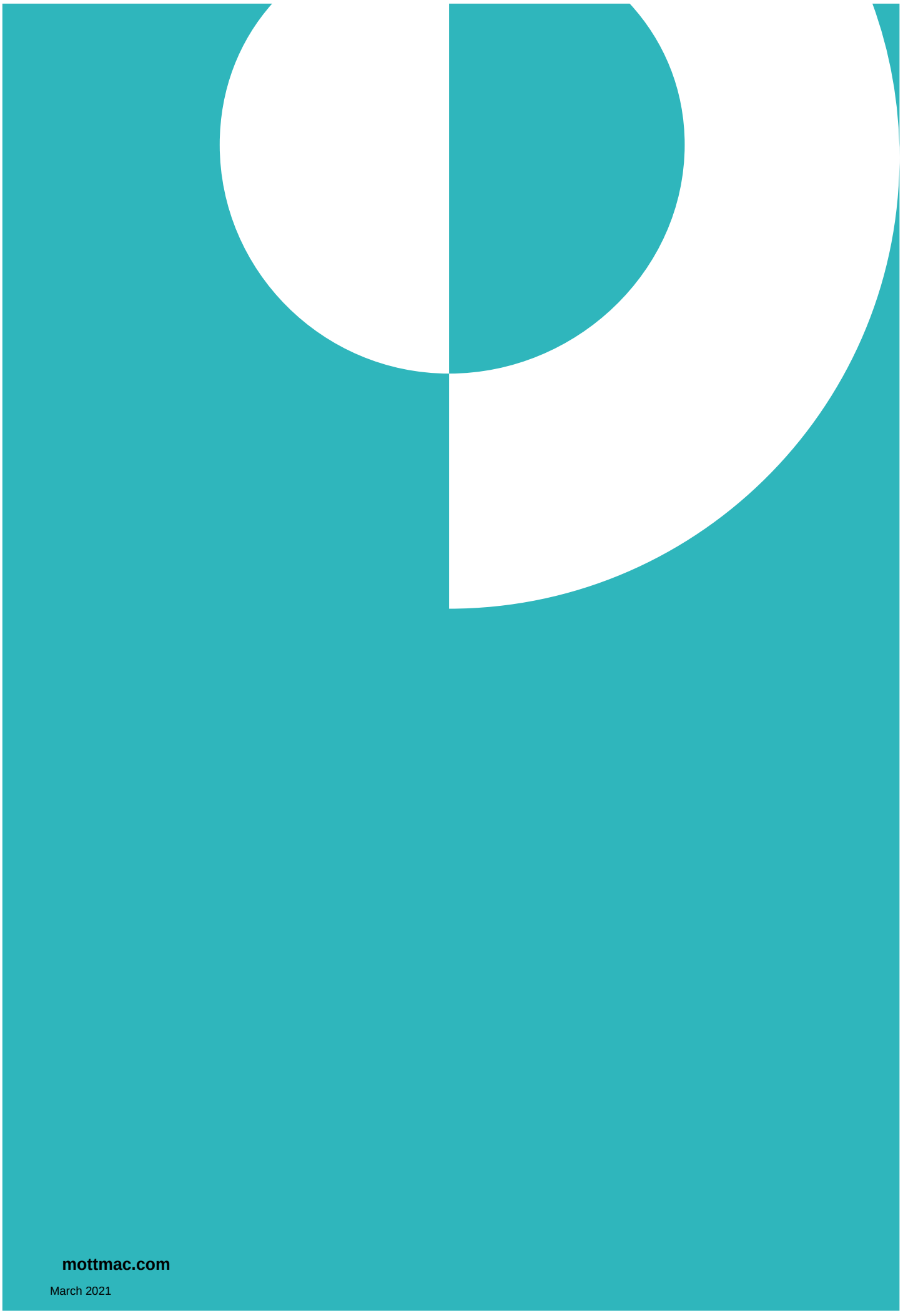


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Figure B.1: Statutory designated habitat sites within 10km of the Site

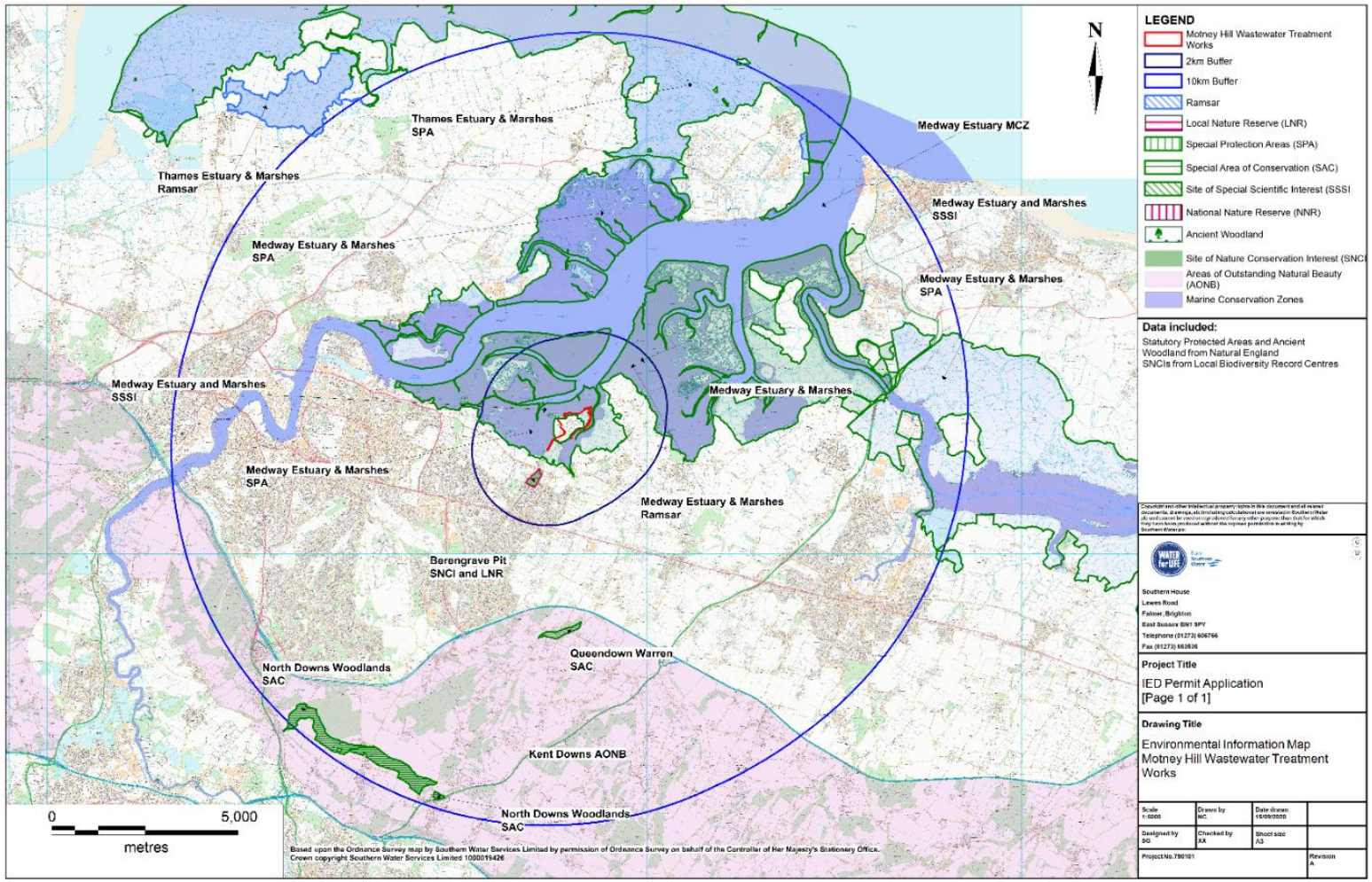

Figure B.2: Non-statutory designated habitat sites within 2km of the Site

Figure B.3: Designated heritage sites within 1km of the Site

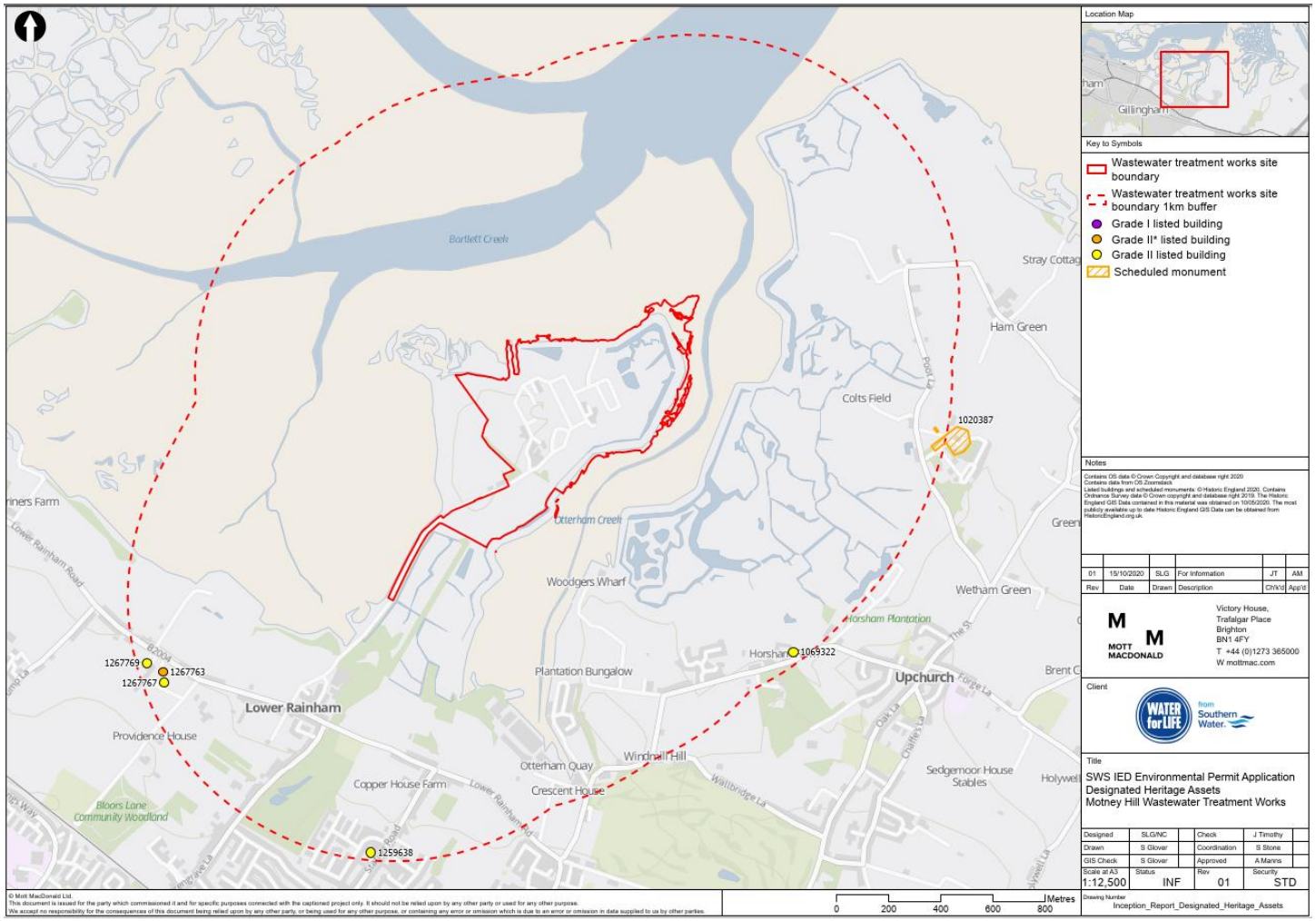

Figure B.4: Sensitive receptors within 250m of the Site