Southport WwTW Sludge Treatment Facility

Permit Number EPR/XP3337QR

Bioaerosols Risk Assessment

October 2022

Contents

1. Introduction

1.1 Site Activities

The purpose of this Bioaerosols Risk Assessment is to provide supplementary information to support an environmental permit (EP) application for the screening, thickening and anaerobic digestion of indigenous and imported wastewater (sewage) sludge at Southport Wastewater Treatment Works (WwTW). The application is being made under the Environmental Permitting (England and Wales) Regulations 2016 (the EPR 2016).

The address of the installation is:
Southport WwTW Sludge Treatment Facility
Marine Drive
Crossens
Lancashire
PR9 9YL

NGR: SD36899 20620

United Utilities Water Limited (UUW) operates a non-hazardous wastewater treatment works at the Southport WwTW. The works is located approximately 4 kilometres northeast of Southport town centre.

The works is situated in close proximity to local housing estates and near to the Ribble and Alt Estuaries and Crossens Marsh. There are residential properties and a commercial property within 250m of the works boundary.

The treatment of indigenous sewage sludge arising from the wastewater treatment process at Southport comprises:

- Sludge screening;
- Macerators (x 2);
- Sludge dewatering/thickening by both GBTs (x 3) and centrifuge (x 1);
- Anaerobic digestion;
- Storage and combustion of biogas in CHP and dual fuel boiler;
- Flaring of excess biogas;
- Siloxane removal from the biogas;
- Raw material storage;
- Disposal of process liquors;
- Storage of digestate cake; and
- Odour abatement.

The facility can treat up to 525,600m^3 of wet sludge per year (equating to approximately 525,600 wet tonnes). There are two primary digesters, with a combined capacity of 4,000m^3 and four secondary digesters (combined capacity – 7,200m^3).

1.2 Regulatory Requirements

The sludge treatment activity has not previously required an environmental permit as the digested sewage sludge from the site is normally sent for recovery to land; however, a permit application has been submitted based on the Environment Agency's recent conclusion that sewage sludge is a waste and therefore the treatment of sewage sludge by anaerobic digestion for recovery is a permittable activity under Schedule 1 of the EPR 2016, specifically Chapter 5, Section 5.4, Part A 1(b)(i).

For new permits, if the site is within 250m of sensitive receptors then there is a requirement to monitor bioaerosols in accordance with the EA technical guidance[1]. The Southport Sludge Treatment Facility is within 250m of sensitive receptors; these are detailed in Section 2.3 of this report.

1.2 Bioaerosols

Bioaerosols are described in EA technical guidance note M9: environmental monitoring of bioaerosols at regulated facilities.

Bioaerosols are found naturally within the environment. They consist of airborne particles that contain living organisms, such as bacteria, fungi and viruses or parts of living organisms, such as plant pollen, spores and endotoxins from bacterial cells or mycotoxins from fungi. The components of a bioaerosol range in size from around 0.02 to 100 micrometres (µm) in diameter. The size, density and shape of a bioaerosol will affect its behaviour, survivability and ultimately its dispersion in the atmosphere. Bioaerosols are easily breathed into the human respiratory system, potentially causing allergic responses and inflammation. Bioaerosols also have the potential to cause eye irritation, gastrointestinal illness and dermatitis.

Bioaerosols are also associated with composting, anaerobic digestion and mechanical biological treatment, which are the main processes used to treat organic waste in the UK. As organic waste material breaks down it goes through different temperature dependent stages that are dominated by certain groups of bacteria and fungi. Bacteria are the most numerous group of microorganisms. *Aspergillus fumigatus* is a mesophilic fungus that is thermotolerant and is present throughout the different stages of the organic breakdown process. This fungus can cause severe respiratory infection if inhaled.

The dependence on microorganisms to degrade organic material and the way in which the material is processed make biological treatment facilities a potential source of bioaerosols. However, we note that the 2012 EA guidance note for developments requiring planning permission and environmental permits[2] states that the EA do not consider bioaerosols from anaerobic digestion to be a serious concern. This is due to the

[1] Environment Agency. July 2019. M9: Environmental monitoring of bioaerosols at regulated facilities
[2] Environment Agency. October 2012. Guidance for developments requiring planning permission and environmental permits

fact that anaerobic digestion is generally a wet process undertaken in enclosed tanks and equipment, whereas composting is often undertaken using open systems such as windrows and static piles. The Southport Sludge Treatment Facility does not undertake any composting activities.

A source-pathway-receptor risk assessment has been undertaken to appraise the potential for risk to human health at sensitive receptors from operations at the Southport Sludge Treatment Facility.

2. Bioaerosols Risk Assessment

2.1. Introduction

This risk assessment follows a standardised approach, namely:

- Hazard identification: what sources of bioaerosols are present;
- Exposure assessment: what are the mechanisms or pathways allowing bioaerosols to migrate off site and reach a receptor; and
- Risk evaluation: who is potentially exposed to bioaerosols; what is the probability, magnitude and duration of exposure.

The assessment describes:

- The processing techniques and equipment used;
- Feedstock, tonnages processed and any seasonal variations;
- Sources of bioaerosols;
- The site layout, including any screens, bunds, or trees around the site;
- What is beyond the site boundaries and the location of sensitive receptors;
- Local wind direction data; and
- Other sources of bioaerosols in the vicinity.

2.2. Processing techniques and equipment

Waste Reception

The wastewater sludge received for treatment consists of sludges imported from other WwTWs and indigenous sludges produced from Southport WwTW (on-site). WwTW's sludge streams are well known and have been fully characterised over the years.

Southport's indigenous sludge is bled off from the return activated sludge (RAS) system and enters the surplus activated sludge (SAS) wet well. From here it is pumped to the Gravity Belt Thickener (GBT) building, where it enters the GBT feed tank before passing through one of two macerators. Polyelectrolyte is then added before the sludge is passed into one of three GBTs, the filtrate which is produced from this process is fed into the liquor return pumping station where it is pumped into the UWWT flow. The processed sludge passes from the GBT into the thickened sludge hopper and from here it is pumped into the mixing and balancing tank, where it joins the screened imported tanker sludge. Imported tanker sludge is pumped by tanker into the import break tank (connected to an Odour Control Unit (OCU)). The untreated sludge is then pumped to a screening plant. From here the screened imported sludge joins the SAS in the mixing and balancing tank, which is connected to an OCU. All transfer pipework is enclosed.

Waste Treatment

Indigenous SAS sludge is pre-treated using one of two macerators prior to thickening by GBT. Polyelectrolyte is automatically dosed into the GBT to enhance the sludge thickening process. The filtrate returns to the liquor return pumping station and is then pumped to the discharge to the flow to full treatment. The macerators and GBTs are located within an enclosed building.

Imported sludge is screened prior to the anaerobic digestion treatment. The screening equipment is contained within an enclosed unit. The separated solids are deposited in a skip beneath the Strainpress. The solids skip is housed in a steel-clad enclosure fitted with a roller shutter door which is kept shut except when the skip requires removing and replacing.

Screened imported sludge joins the thickened SAS in the closed mixing and balancing tank. The thickened indigenous sludge within the mixing and balancing tank is mixed with the imported sludge via an air mixing system. The mixing and balancing tank is served by an OCU.

From the mixing and balancing tank, the sludge is pumped to one of two primary digesters. The required flows to the primary digesters are calculated based upon the required retention period of 12 days. Upon completion of the primary digestion process the sludge is pumped to four secondary digesters. Secondary digestion is achieved by holding the displaced primary digester sludge for a minimum of 12 days in one of the four secondary digesters. After the 12 days retention has lapsed an automatic valve will open and discharge the sludge to the centrifuge. The valve can be manually operated, if required.

The digested sludge passes through a mobile containerised centrifuge unit. This has its own polyelectrolyte make up building. The polyelectrolyte is in the form of powder and is mixed with potable water to make it up into a solution that is added to the sludge.

The centrifuge is a sealed unit housed in an individual steel enclosure. Polyelectrolyte is automatically dosed into the centrifuge to enhance the sludge thickening process. From here the cake is conveyed directly to a wagon container and taken off site. The centrate from the centrifuge is pumped back to the head of the works via the liquor return pumping station.

Biogas produced by the Anaerobic Digestion (AD) process is stored within a gas bag. From here it is passed to the CHP engine for consumption on site. An enclosed flare is used to manage excess gas if required.

2.3. Sources

There are nine point-source emissions to air from the process at the following locations:

- A1 - CHP exhaust
- A2 - Odour control unit (OCU) serving the import break tank
- A3 - Odour control unit (OCU) serving the mixing and balancing tank
- A4 - Primary digester tank PVRV (dual unit operating duty/standby)

- A5 - Primary digester tank PVRV (dual unit operating duty/standby)
- A6 - Gas bag PVRV
- A7 - Flare stack
- A8 - Dual fuel boiler flue
- A9 – A20 – Secondary digester tank vents

The location of these discharge points is shown on the emissions point plan at Appendix A.

The CHP engine and flare combust biogas at high temperatures (in excess of 100^0C) and as such can be discounted as sources of bioaerosols emissions. The boiler normally combusts natural gas, but if burning biogas can be discounted as sources for the same reason.

The OCUs are potential sources of bioaerosols as they receive air extracted from sludge storage tanks. There are two OCUs for the sludge process, one connected to the import break tank (A2) and the second connected to the mixing and balancing tank (A3). The OCUs have force-vented activated carbon filters.

The OCUs are designed to continuously remove odours from the malodorous air passed through them. This is achieved by the passing the air through dry carbon to allow natural adsorption to take place (this technology typically offers the lowest outlet concentration of any odour control technology).

Non-soluble VOCs and other odorous compounds are adsorbed onto the carbon and are thus removed from the gaseous phase. The main odour control extraction fans are used to extract air out of the odour control units and push it up the stack. The OCUs are contained units so only treated air is discharged to atmosphere.

Pressure vacuum relief valves (PVRVs) are fitted on the primary digesters and gas bag. Each digester has two PVRVs that operate on a Duty/Stand-by configuration to protect against over/under pressurisation of the tank. The PVRVs are maintained, monitored, inspected and calibrated on a periodic basis to ensure correct operation of the valves.

The small vents (300mm diameter, complete with integral fly screen) on the four secondary digester tanks are potential sources of bioaerosols release. There are three vents in the roof of each tank that currently vent to atmosphere. Given the small size of these openings, most air remains in the digester headspace. Once connected to an OCU, the OCU extractor fan(s) will draw the air through the system from the tanks, and as such the existing three number roof mounted vents on each secondary digester will allow “clean air” to be drawn into the tank to prevent negative pressures and allow the atmosphere to be exchanged. The digested sludge is also wet, with a low risk of dust emissions. The potential for bioaerosols release from the vents is therefore considered to be low.

The risk of fugitive bioaerosol emissions from the treatment process is considered to be low, given that the majority of storage tanks, treatment tanks and associated pipework are enclosed. The wet well used to receive incoming sludge is below ground and within a building. Sludge screening and dewatering takes place in enclosed units.

The only open storage of waste is the digestate cake. Dewatered digestate cake is carried by an open conveyor and deposited directly into a trailer prior to being removed off site for agricultural land spreading. Under normal operations, loading a trailer typically takes 3 to 4 hours, before it is sheeted and removed from site. Storage duration within trailer prior to removal is typically less than 24 hours. The water/wastewater industry understands that there is a low level of risk of bioaerosols from this material. The potential sources of bioaerosols at the sludge treatment facility should be taken in context of the wider wastewater treatment works where there are open tanks for the treatment of urban wastewater.

2.4. Pathways

The main pathway for bioaerosols transport is air movement and wind. Wind rose data from 2015-2019 for the site is shown in Appendix B recorded at Blackpool meteorological station. Blackpool meteorological station is located approximately 11.5 km to the north-northeast of the site and is considered the closest most representative meteorological monitoring station to the site.

The wind rose data shows that the site experiences strong prevailing west-south-westerly winds, Infrequently, the site experiences strong easterly winds. The Southport Sludge Treatment Facility and surrounding area has a relatively flat topography with few natural barriers to the transportation of bioaerosols by the wind. However, there is an earth bund and a line of mature trees that provide screening along the boundaries of the site in the direction of the nearby residential and commercial properties.

Because of the dilution effect in the open air, bioaerosol concentrations fall away rapidly with distance from the source. It has been shown by research (RR786 - Bioaerosol emissions from waste composting and the potential for workers' exposure[3]) that by 100 to 200m away, the bioaerosol concentration has mostly returned to background levels. By 50m and 100m distances downwind of the process, bioaerosol concentrations were substantially reduced by comparison to those level measurements at source. RR786 confirmed previous published studies which showed that at a distance of 250m from composting activity, in most cases, the bioaerosol concentrations will be reduced to background levels.

2.5. Receptors

EA guidance indicates that sensitive receptors are considered to be people likely to be within 250 metres of the operational area (source of release) for prolonged or frequent periods. This term would therefore apply to dwellings (including any associated gardens) and to workplaces where workers would frequently be present. It does not apply to the operators of the facility as their health is covered by Health and Safety legislation.

Table 1 below provides details of static receptors within 250m of potential bioaerosol sources from the permitted processes. There is only one open (uncovered) source; this being the digestate cake wagon container; and point source emissions from OCU’s, tank vents and tank PVRVs. The location of these receptors is shown on the plan at Appendix C.

[3] HSE. 2010. RR786 Research Report. Bioaerosol emissions from waste composting and the potential for workers’ exposure

Table 1: Static Receptors within 250m of Potential Bioaerosol Sources

Receptor	Description	Distance from closest source (m)	Source	Grid Reference	Direction from the site
R1	Residential properties at Treen Close	55	Secondary digester vents	SD 36814 20567	WSW
		70	Cake wagon container	SD 36816 20591	WSW
		100	Odour Control Units	SD 36838 20625 and SD 36831 20639	WSW
		130	Primary digester PVRVs	SD 36892 20593	WSW
		215	Gas bag PVRV	SD 36949 20655	WSW
R2	Commercial property at Marine Drive	160	Gas bag PVRV	SD 36949 20655	SE
		200	Digester PVRVs	SD 36892 20593	E
		250	Secondary digester vents	SD 36814 20567	E
R3	Residential properties at Ferryside Lane and Eamont Avenue	210	Primary digester PVRVs	SD 36892 20593	SE
		210	Secondary digester vents	SD 36814 20567	SE
		225	Gas bag PVRV	SD 36949 20655	SE

2.6. Magnitude of Risk

There are five potential sources of bioaerosols release within 250m of static receptors:

- Emission Points A4 & A5 - the Primary digester tank PVRVs;
- A6 – the Gas bag PVRV;
- A2 & A3 - the Odour Control Units serving the import break tank and mixing and balancing tank;
- Secondary digester tank vents (A9 – A20); and
- The digestate cake trailer.

The receptors are situated to the west-south west and south east of the release points and the prevailing wind direction is from the west. Whilst the receptors are not situated immediately down-wind of these sources, there is potential for wind-borne transportation of bioaerosols.

The import break tank and mixing and balancing tanks are enclosed and are linked to activated carbon OCU's. Given that adsorption of micro-organisms onto the activated carbon would be expected, the likelihood of bioaerosol release is anticipated to be minimal. The closest receptor to the OCUs is 100m away.

The primary digester and gas bag PVRVs only activate to release biogas when the pressure or vacuum operating set conditions (or set points) in the tank are exceeded. These valves are safety devices to ensure

the tank is not subjected to over or under pressurisation. As such, they only operate infrequently and are not a constant source of bioaerosol release. The valves are only open for a short period of time and thus the potential for bioaerosol release is considered to be very low. The closest receptor to the PVRVs is 130m away.

The pressure vacuum relief valves are calibrated on an annual basis to ensure they are operating at the correct set points. The valves are visually checked daily to ensure there is no unplanned biogas releasing to atmosphere. This is in conjunction with a check of SCADA pressure related information and trends available for the previous 24 hours.

The secondary digester tank vents are situated approximately 55m from the nearest residential properties. The potential for bioaerosols release from the vents is considered to be minimal as most air remains in the digester headspace. Once connected to an OCU, there will be no emissions from these vents, as they will operate to allow clean air to flow into the tanks. In addition, partially digested sludge stored in the secondary digesters is wet and therefore has a low risk of dust emissions.

The risk of bioaerosols being generated from the digestate cake is also considered to be low. Following digestion, the waste is centrifuged to reduce its water content to around 30% dry solids, although it remains relatively damp and does not give rise to dust readily. Under normal operations, loading a trailer typically takes 3 to 4 hours, before it is sheeted and removed from site. Storage duration within containers (trailers) prior to removal is typically less than 24 hours.

Overall, the probability of bioaerosols being released from the sludge treatment process and the identified potential sources is considered to be very low to low. The potential duration of release of bioaerosols varies from infrequent to frequent. The magnitude of release is considered to be very low to low.

There are residential properties that are approximately 55m distance from the secondary digester vents and 70m from the cake wagon container. However, given the wet nature of the digested sludge material this is considered to be a very low risk for bioaerosol emissions. Residential properties and a commercial property are located between 100m and 250m of other identified potential bioaerosol sources. Because of the dilution effect in the open air, research has shown that bioaerosol concentrations fall away rapidly with distance from the source. It has been shown (RR786 - Bioaerosol emissions from waste composting and the potential for workers' exposure[4]) that by 100 to 200m away the bioaerosol concentration has mostly returned to background levels. Given that the identified potential sources are considered to represent a low risk, the intervening distance and the screening provided by the vegetation bund, it is considered that the risk of exposure to occupants of these properties from bioaerosols emitted from the site is likely to be negligible. However, to validate this bioaerosols sampling is proposed (see Section 3.2).

The overall magnitude of the risk is summarised in Table 2 below.

[4] HSE. 2010. RR786 Research Report. Bioaerosol emissions from waste composting and the potential for workers' exposure

Table 2: Risk of Exposure to Receptors within 250m of Potential Bioaerosols Sources

Source	Magnitude of Release	Pathway	Receptor	Control Measures	Probability of Exposure	Magnitude of Risk
Primary Digesters and Gas Bag PVRVs	Very low – infrequent operation	Inhalation via wind-borne transportation	R1, R2 & R3 - residential and commercial properties	PVRVs are safety devices; they are designed to operate infrequently for short periods of time. The valves are calibrated every 2 years by a specialist contractor to ensure safe and effective operation within design parameters. Operation of the valves is checked visually by the operators and the SCADA pressure related information and trends are checked to ensure the valves are not leaking.	Very Low	Negligible
Odour Control Units	Low	Inhalation via wind-borne transportation	R1 - residential properties at Treen Close	The air stream is treated via a carbon adsorption filter. Scheduled maintenance is undertaken in accordance with UUW's Mobile Asset Resource Scheduling (MARS).	Low	Negligible
Secondary Digester vents	Low	Inhalation via wind-borne transportation	R1, R2 & R3 - residential and commercial properties	Partially digested sludge stored in the secondary digesters is wet and therefore	Low	Negligible

Source	Magnitude of Release	Pathway	Receptor	Control Measures	Probability of Exposure	Magnitude of Risk
				has a low risk of dust emissions. The release from the vents is also minimal as most air remains in the digester headspace. Once connected to an OCU, there will be no emissions from these vents, as they will operate to allow clean air to flow into the tanks.		
Cake wagon container	Low	Inhalation via wind-borne transportation	R1 - residential properties at Treen Close	Loading of digested sludge cake is typically conducted over a 3 to 4 hour period before it is sheeted and removed from site within 24 hours.	Low	Negligible

3. Conclusions and Recommendations

3.1. Conclusions

A source-pathway-receptor risk assessment has been undertaken to appraise the potential for risk to human health in dwellings and other nearby buildings from bioaerosols arising from operations at the Southport Sludge Treatment Facility. The risk assessment followed a standardised approach, namely:

- Hazard identification: what sources of bioaerosols are present;
- Exposure assessment: what are the mechanisms or pathways allowing bioaerosols to migrate off site and reach a receptor; and
- Risk evaluation: what is the probability, magnitude and duration of exposure. This considered control measures in place to reduce the probability or magnitude of release.

The overall bioaerosol risk to receptors within 250m of potential sources of the sludge treatment process is considered to be negligible.

Potential sources of bioaerosols at the sludge treatment facility should also be taken in context of the wider wastewater treatment works where there are open tanks (primary settlement tanks, aeration tanks and final settlement tanks) for the treatment of urban wastewater.

3.2. Recommendations

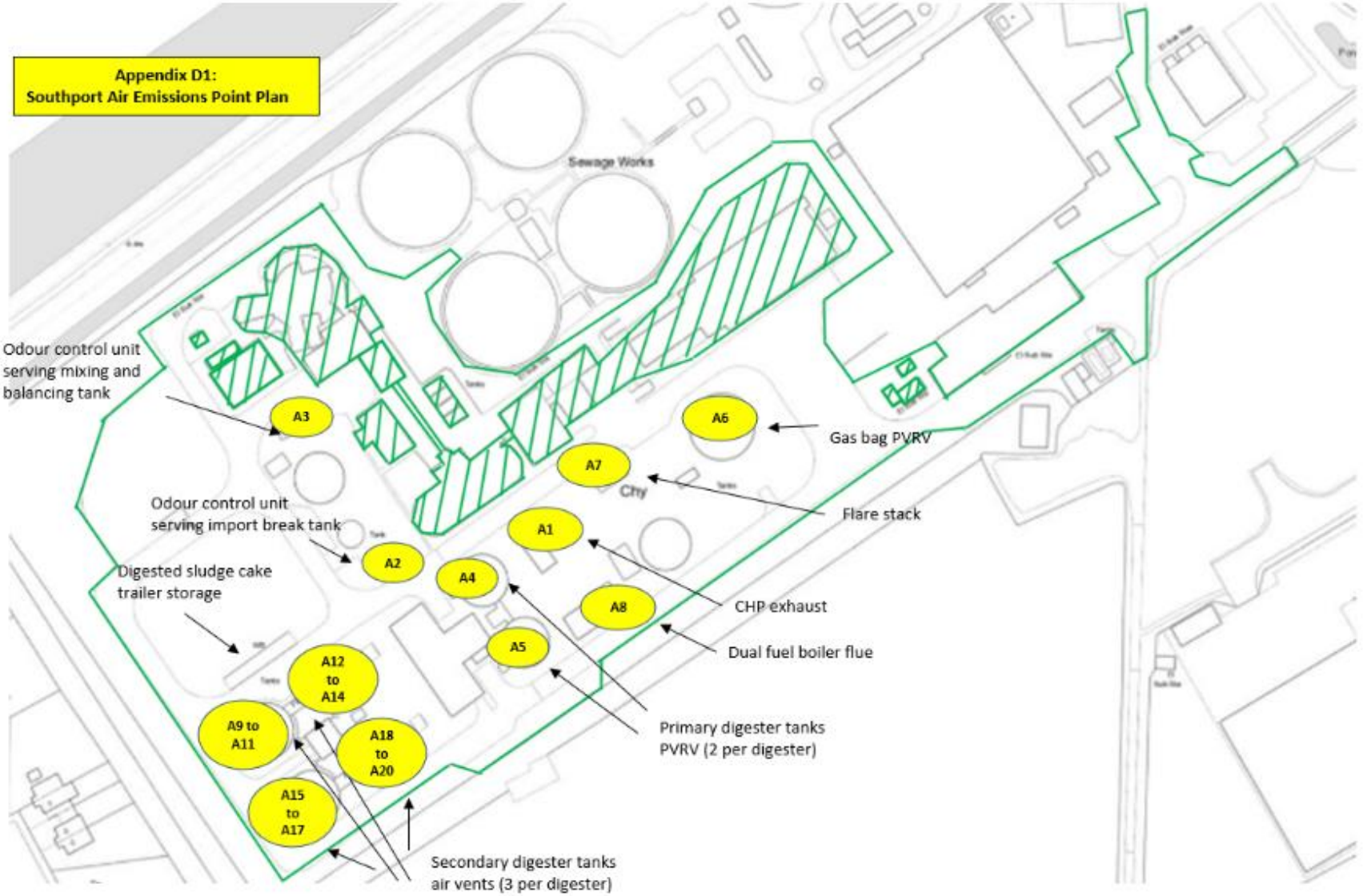
To confirm that the bioaerosol risk to receptors is negligible, UUW will undertake the following ambient monitoring[5] at Southport:

- B1 – 25m upwind of the operational sludge treatment area (located by R1);
- B2 – downwind of the sludge treatment area, but in line with upwind monitoring location (between R2 and the bioaerosol source);
- B3 – downwind. Approximately 45 degrees to the right from the central point (at R3); and
- B4 – downwind. Approximately 45 degrees to the left from the central point.

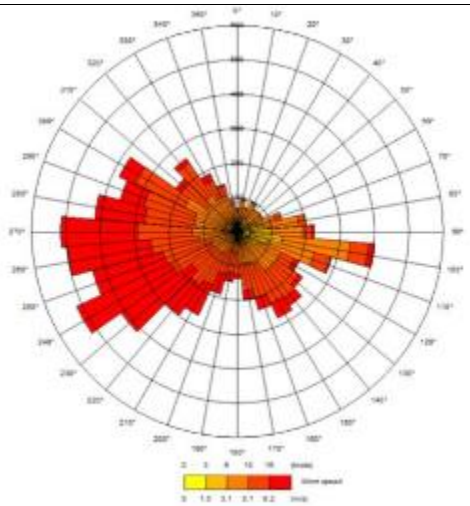
The monitoring locations are shown on Appendix D. The monitoring will be undertaken in accordance with EA Technical Guidance Note (Monitoring) M9: Regulatory Position Statement (RPS) 209 – Bioaerosol monitoring at regulated facilities.

[5] The monitoring locations assume that the prevailing wind direction is in occurrence at the time of the monitoring. Should wind conditions be different on the day of sampling the monitoring locations may vary. In any event they will follow the M9 guidance of one monitoring location upwind and three monitoring locations downwind.

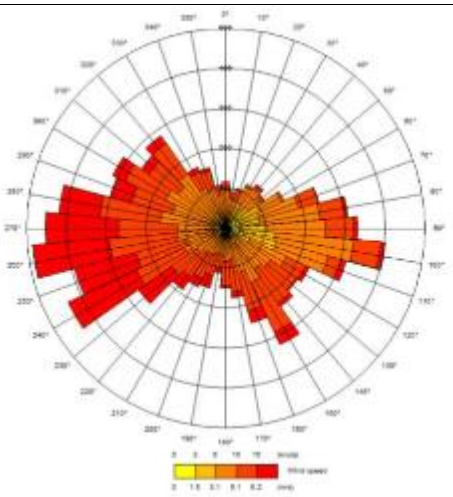
Appendix A: Site Layout and Emission Point Plan


Appendix D1:
Southport Air Emissions Point Plan
Sewage Works
Odour control unit serving mixing and balancing tank
A3
A6
Gas bag PVRV
A7
CHP
Flare stack
Odour control unit serving import break tank
A1
A2
A4
Digested sludge cake trailer storage
A8
CHP exhaust
A5
Dual fuel boiler flue
A12 to A14
A9 to A11
A18 to A20
Primary digester tanks PVRV (2 per digester)
A15 to A17
Secondary digester tanks air vents (3 per digester)

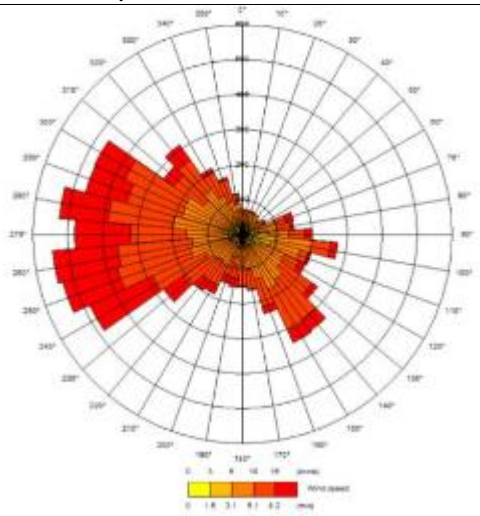
Appendix B: Meteorological Data – Wind Roses



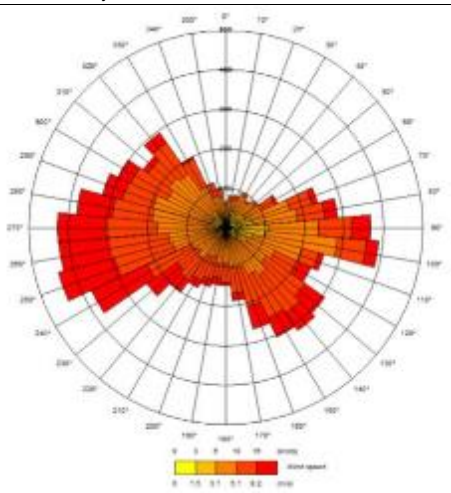
Blackpool Station, 2015



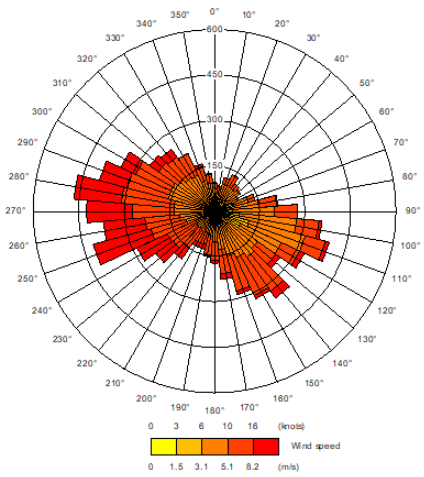
Blackpool Station, 2016



Blackpool Station, 2017



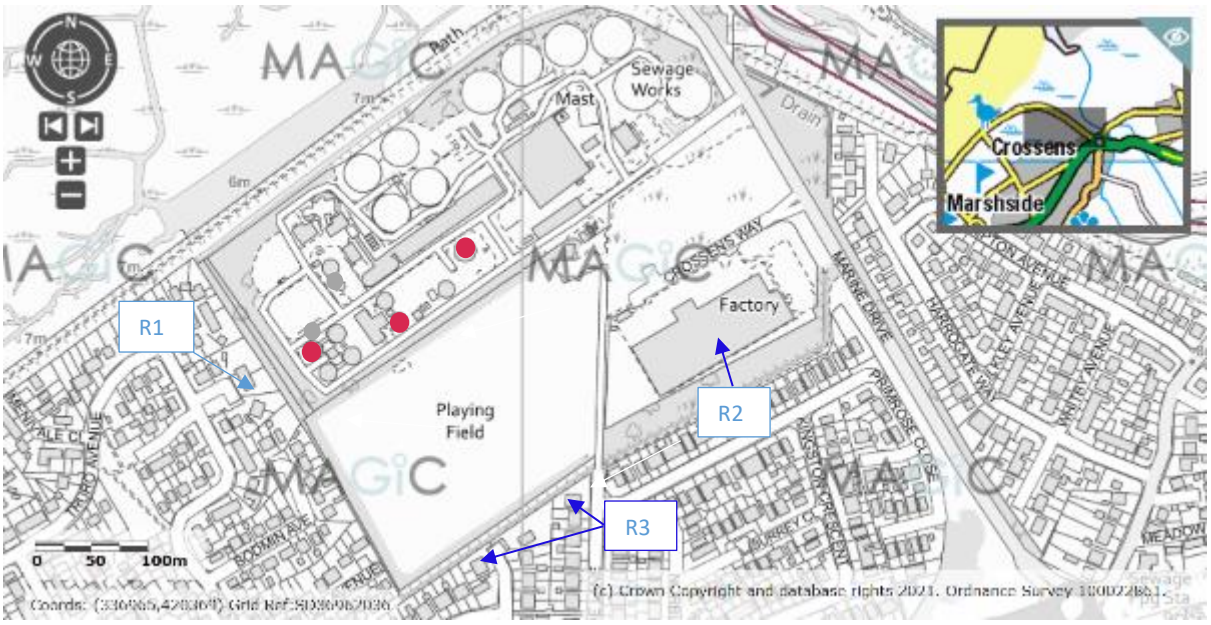
Blackpool Station, 2018



Blackpool, 2019

Appendix C: Location of Receptors

Location of Receptors within 250m of Potential Bioaerosols Sources

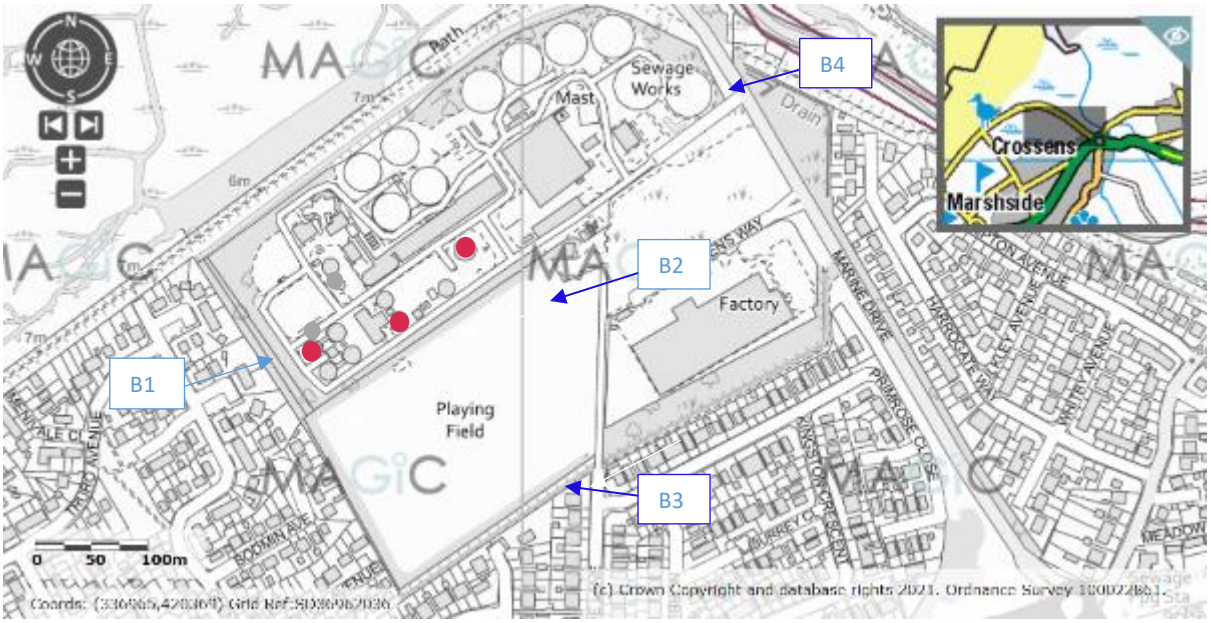


● = Source

Receptor	Description	Distance from closest source (m)	Source	Direction from the site
R1	Residential properties at Treen Close	55	Secondary digester vents	WSW
		70	Cake wagon container	WSW
		100	Odour Control Units	WSW
		130	Digester PVRVs	WSW
		215	Gas bag PVRV	WSW
R2	Commercial property at Marine Drive	160	Gas bag PVRV	SE
		200	Digester PVRVs	E
		250	Secondary digester vents	E
R3	Residential properties at Ferryside Lane and Eamont Avenue	210	Digester PVRVs	SE
		210	Secondary digester vents	SE
		225	Gas bag PVRV	SE

Appendix D: Bioaerosol Monitoring Locations

Bioaerosol Monitoring Locations



● = Source

Emission Points*	National Grid Reference
B1 - 25m upwind of the operational sludge treatment area (located by R1)	SD 3620 7756
B2 - downwind of the sludge treatment area, but in line with upwind monitoring location (between R2 and the bioaerosol source)	SD 3720 0260
B3 - downwind. Approximately 45 degrees to the right from the central point (at R3)	SD 3704 2044
B4 - downwind. Approximately 45 degrees to the left from the central point	SD 3717 2078

* The monitoring locations are expected to be as above, however should wind conditions be different on the day of sampling the monitoring locations may vary.