Burnley WwTW Sludge Treatment Facility

Bioaerosols Risk Assessment

October 2023

Burnley WwTW Sludge Treatment Facility EPR/HP3509MM

Bioaerosols Risk Assessment

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 Burnley 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:
Burnley WwTW Sludge Treatment Facility
Woodend Lane, off Barden Lane
Burnley
BB12 9DS

NGR: SD 82725 35620

United Utilities Water Limited (UUW) operates a non-hazardous wastewater treatment works at the Burnley WwTW. The works is located approximately 3 kilometres northwest of Burnley town centre and serves the town of Burnley and the neighbouring settlements of Barrowford, Brierfield and Nelson.

The works is situated in an agricultural area with the River Calder flowing approximately 90m to the west and 85m to the south east. There are several isolated farms and residential properties within 500m of the works boundary.

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

- Sludge screening (solids separation);
- Sludge thickening;
- Thermal hydrolysis;
- Anaerobic digestion;
- Sludge dewatering; and
- Storage of digestate cake.

In addition to indigenous sludge, the facility receives imported sludge from other wastewater treatment works by road tanker. The facility can treat up to 630,720m^3 of wet sludge per year (equating to approximately 630,720 wet tonnes). There is one operational digester, with a storage capacity of 2,250m^3. The sludge treatment facility has a total maximum treatment capacity of 1,728m^3 per day (equating to approximately 1,728 wet tonnes per day).

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 Burnley 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 fact that anaerobic digestion is generally a wet process undertaken in enclosed tanks and equipment,

[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

whereas composting is often undertaken using open systems such as windrows and static piles. The Burnley 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 Burnley 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 WwTW and indigenous sludges produced from Burnley WwTW (on-site). WwTW's sludge streams are well known and have been fully characterised over the years.

Indigenous sludge from the WwTW is fed from the three primary tanks automatically by three timer-controlled pumps. This is a combination of raw sludge and surplus activated sludge (SAS). The sludge is pumped into a receiving wet well. Sludge tanker imports from other wastewater treatment works are also off-loaded and pumped directly into the wet well. The wet well is below ground and covered with metal plates. The untreated sludge is then pumped to a screening plant. All transfer pipework is enclosed.

Waste Treatment

The screening plant comprises two Huber Strainpress units, operating on a duty/stand-by basis. The screening equipment is contained within enclosed units. The separated solids are deposited in skips beneath the Strainpresses. The solids skips are housed in a steel-clad enclosure fitted with a roller shutter door, which is kept shut except when the skip requires removing and replacing.

The screened sludge is then pumped via a small buffer tank into the screened sludge tank. From the screened sludge tank, the sludge passes through macerators to two centrifuges to be thickened. The centrifuges are sealed units housed in individual steel enclosures. Polyelectrolyte is automatically dosed into the centrifuges to enhance the sludge thickening process.

The thickened sludge from the centrifuges is pumped via a buffer tank into an enclosed thickened sludge silo, whilst the centrate is transferred into the thickening centrate collection tank. This tank then controls the return of centrate to the main UWWTD works flow for full treatment.

Sludge from the silo is fed into a thermal hydrolysis (TH) plant. The TH plant is housed in a dedicated building and comprises a pulper, four reactors and a flash tank. The TH process sterilises the sludge and reduces its viscosity (by breaking down gelatinous cell structures).

Leaving the flash tank, the sludge is diluted and cooled by the addition of UV treated final effluent water and use of a heat exchanger. Cooled sludge is batch fed into the digester at between 2.5 and 6.5m^3/hr. The digester is a concrete fixed roof tank with a capacity of 2,025m^3. The retention time of sludge in the digester is approximately 14 - 20 days.

Biogas generated in the digester is drawn off directly to the CHP engine for combustion. When gas production exceeds the CHP gas consumption, excess biogas is diverted to the biogas storage tank (gas holder). There are safety pressure vacuum relief valves (PVRVs) on the roof of the digester tank and the gas holder, which will operate automatically if a set pressure is exceeded.

From the digester, the digested sludge is pumped into a de-gassing tank. The purpose of the de-gassing tank is to blow compressed air into the sludge to cease the anaerobic biogas production. The de-gassing tank vents are connected to an odour control unit. The tank is protected from over pressurisation by a bursting disk.

From the de-gassing tank, the digested sludge is passed into one of two digested sludge (holding) tanks (only one tank in operation at any given time. As and when one is required for cleaning and maintenance, the alternate tank is brought back online to allow work on the other tank). Following storage in this tank, the sludge is fed through a final de-watering process. This is undertaken in a dedicated building and comprises three macerators, three dewatering centrifuges and a polyelectrolyte make up system.

Liquid separated by the centrifuge process (centrate) may be passed through a dissolved air flotation (DAF) unit for solids removal. This tank is a covered tank. Separated solids are pumped to the digested sludge tanks. Treated centrate from the DAF unit is gravity fed to a collection tank and then pumped to the centrate storage tank. The DAF unit can be by-passed with the centrate being pumped directly into the storage tank.

Centrate discharged from the centrifuges is discharged into a buffer tank outside the building. The liquor from both the thickening and dewatering centrifuges is returned to the inlet of the WwTW for full biological treatment.
De-watered digestate cake is carried by a conveyor and deposited in a concrete surfaced and walled storage bay. The cake is transferred onto trucks using an excavator and loading shovel and removed off site for agricultural land spreading.

2.3. Sources

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

- A1 - CHP biogas engine;
- A2 – Steam boiler;
- A3 – Flare;
- A4 – the Odour Control Unit (OCU) serving the serving the sludge screen press enclosure, screened sludge tank, thickening centrifuges, thickened sludge silo, degassing tank, digested sludge tanks, dewatering building (centrifuges/conveyors), dewatering centrate buffer tank, DAF tank (not currently operational) and treated centrate tank (not currently operational);
- A5 and A6 – Digester pressure vacuum relief valves (PVRVs); and
- A7 – Gas holder pressure vacuum relief valve (PVRV).

The location of these discharge points is shown on the site layout plan at Appendix A.

The CHP engine, boiler and flare combust biogas at high temperatures (in excess of 100^0C) and as such can be discounted as sources of bioaerosols emissions.

The odour control unit is a potential sources of bioaerosols as it receives air extracted from various tanks and sludge treatment areas.

The OCU comprises two stages of treatment; two dual bed trickling biofilters operating in parallel followed by an activated carbon adsorption. The first stage biofilters are predominately designed for ammonia, and hydrogen sulphide removal, but are expected to remove approximately 50% of incoming VOCs. Each biofilter has two different layers of media comprising of pumice stone followed by coir fibre. The filter media is wetted with final effluent to maintain biological activity. Spent effluent is discharged to the site's drainage system. The final stage of treatment (adsorption) uses copper impregnated carbon to treat residual sulphide odours as well as VOCs. A dehumidifier (heater unit) is fitted prior to the carbon to enhance the units performance with regard to VOC removal. Treated air discharges via a stack (emission point A4).

PVRVs are fitted on the digester and gas holder. The PVRVs 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 risk of fugitive bioaerosol emissions from the treatment process is considered to be very low, given that all storage tanks, treatment tanks and associated pipework are enclosed apart from a small unscreened buffer tank. The wet well used to receive incoming sludge is below ground and covered with metal grates. Sludge screening and dewatering takes place in enclosed units.

The only open storage of solid waste is the digestate cake. De-watered digestate cake is carried by a conveyor and deposited in a concrete surfaced and walled storage bay. The cake is transferred onto trucks using an excavator and loading shovel and removed off site for agricultural land spreading. The digested cake storage bay is bounded by concrete walls that are approximately 3.5m in height and will provide some protection from the prevailing westerly winds. There is a sensor on the cake conveyor that ensures the height of the cake pile does not exceed the height of the walls.

Photo 1: Digestate cake storage bay

Typically, around 100 tonnes of digestate cake is stored on the concrete pad within the cake storage bay, for a maximum duration of 1 week. However, cake storage amounts vary depending upon production and availability of the land bank for spreading. The water/wastewater industry understands that there is a low level of risk of bioaerosols from this material.

The movement and storage of biosolids (digested cake sludge) is coordinated across the region by the Agricultural Services Teams. Digested cake, which is to be used in accordance with the Sludge (Use in Agriculture) Regulations (SUiAR) and BAS, is tracked using ‘Business Collaborator’, an excel-based tracking database which records: quantities per load and source; and the receiving site’s details.

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. The primary settlement tanks, aeration tanks and final settlement tanks are all uncovered and are in closer proximity to the identified receptors (see Section 2.5).

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

2.4. Pathways

The main pathway for bioaerosols transport is air movement and wind. Wind rose data from 2016-2020 for the site is shown in Appendix B.

Numerical Weather Prediction (NWP) data was sourced from ADM Ltd. for the location of the site (NGR E 382723 N 435292) as it is considered the most representative meteorological data for the site. NWP data was used as it is a site-specific location. The closest alternative meteorological stations to the site were Manchester airport (approximately 52 km from the site), which is not representative due to the distance from the site, and Bingley, which is also not representative due to distance (approximately 29 km from the site) and an elevation difference.

The wind rose data shows that the site experiences strong prevailing west-south-westerly winds, predominantly in excess of 6 knots. Infrequently, the site experiences strong easterly winds. The Burnley 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 some screening along the north eastern boundary of the site, adjacent to the closest residential property.

There are no residential properties that have been identified within 150m of potential bioaerosols sources at the main site. However, there are two residential properties that are approximately 200m distance from the Digester and Gas Holder PVRVs. 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. Given that the potential source is considered to represent a low magnitude risk of release, the intervening distance and the screening provided by the vegetation bund, it is considered that

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

the risk of exposure to occupants of these properties from bioaerosols emitted from the site is likely to be negligible.

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 2.5.1 below provides details of static receptors within 250m of potential bioaerosol sources from the permitted processes. There are two open (uncovered) sources; this being the digestate cake storage bay and the unscreened sludge buffer tank. The location of these receptors is shown on the plan at Appendix C.

Table 2.5.1: Static Receptors within 250m of Potential Bioaerosol Sources

Receptor	Description	Distance from closest source (m)	Source	Grid Reference	Direction from the site
R1	Residential property at Wood End Barn Farm	200	Digester and gas holder PVRVs	SD 82723 35251 SD 82768 35249	NNE
		235	Cake storage bay	SD 82801 35218	N
		240	Unscreened sludge buffer tank	SD 82707 35230	NNE
		250	Odour control unit stack	SD 82740 53209	NNE
R2	Commercial property at Wood End Barn Farm	200	Digester and gas holder PVRVs	SD 82723 35251 SD 82768 35249	NNE
		230	Cake storage bay	SD 82801 35218	NNE
		245	Unscreened sludge buffer tank	SD 82707 35230	NNE
		250	Odour control unit stack	SD 82740 53209	NNE
R3	Residential property at Wood End Barn Farm	250	Digester and gas holder PVRVs	SD 82723 35251 SD 82768 35249	NNE

2.6. Magnitude of Risk

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

- Unscreened sludge buffer tank;
- Emission point A4 – odour control unit;
- Emission points A5 and A6 - the digester and gas holder PVRVs; and
- The digestate cake storage bay.

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

The odour control unit receives airflow from the majority of tanks that are not connected to the biogas system, along with the centrifuges and sludge screen presses. The OCU comprises two stages of treatment; two dual bed trickling biofilters operating in parallel followed by an activated carbon adsorption unit. A dehumidifier (heater unit) is fitted prior to the carbon to enhance the unit's performance with regard to VOC removal. The carbon filter may remove a proportion of any bioaerosols present but there has not been studied sufficiently to draw a scientific conclusion. Treated air discharges via a 15m high stack (emission point A4). This is approximately 250m from the closest receptors (R1 and R2).

There is one open topped sludge tank; the unscreened sludge buffer tank. This an above ground tank but is relatively small (37m^3 capacity) with a small surface area and is not agitated and thus the potential for bioaerosol release is considered to be low.

The digester and gas holder 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 condition and performance of the PVRVs will be monitored via a 2-yearly service and calibration programme carried out by a specialist contractor in accordance with design specifications and regular site tours by operational staff which include inspection of the PVRVs to ensure they are operating at the correct set points. This is in conjunction with a check of SCADA pressure related information and trends available for the previous 24 hours.

Digestate sludge cake is stored on an open concrete pad situated approximately 200m from the nearest occupied building (to the north-north-east). The risk of bioaerosols being generated from the digestate cake are considered to be low. Prior to anaerobic digestion, the sludge is passed through a thermal hydrolysis plant which operates at high temperatures and pressures and acts to sterilise the sludge and reduce its viscosity. Following digestion, the waste is centrifuged to reduce its water content to between

25-30% dry solids, although it remains relatively damp and does not give rise to dust readily. The cake storage bay is bounded by concrete walls that are approximately 3.5m in height and will provide some protection from the prevailing westerly winds. There is a sensor on the cake conveyor that ensures the height of the cake pile does not exceed the height of the walls. Typically, around 100 tonnes of digestate cake is stored on the concrete pad.

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 two residential properties that are approximately 200m to 250m distance from identified potential 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.

One commercial property has been identified, approximately 200m to 240m distance from the identified potential sources. The exact nature of activities at the property is not known but is likely to be associated with farming and could involve people being present for extended periods of time, including working outdoors. However, given that the identified potential sources are considered to represent a low risk and the intervening distance, it is considered that the risk of exposure to workers at this property from bioaerosols emitted from the site is also negligible.

The overall magnitude of the risk is summarised in Table 2.6.1 below.

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

Table 2.6.1: 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
Odour control unit (A4)	Low	Inhalation via wind-borne transportation	R1 & R2 - residential and commercial properties at Wood End Barn Farm	The odour control unit is monitored using a telemetry system, which allows plant operations personnel to be notified by alarm of faults or readings that are out of range. This includes the carbon filter differential pressure. Site staff also carry out daily checks and inspections of the OCU. This includes checking all monitors are within their ranges.	Low	Very Low
Uncovered unscreened sludge buffer tank	Low	Inhalation via wind-borne transportation	R1 & R2 - residential and commercial properties at Wood End Barn Farm	Ambient bioaerosol monitoring will be undertaken as per Section 3.2. One round of monitoring will be undertaken in accordance with EA Technical Guidance Note (Monitoring) M9: Regulatory Position Statement (RPS) 209 – Bioaerosol monitoring at regulated facilities.	Low	Very Low

Source	Magnitude of Release	Pathway	Receptor	Control Measures	Probability of Exposure	Magnitude of Risk
Digester and Gas Holder PVRVs (A5 & A6)	Very low – infrequent operation	Inhalation via wind-borne transportation	R1, R2 & R3 - residential and commercial properties at Wood End Barn Farm	PVRVs are safety devices; they are designed to operate infrequently for short periods of time. The valves are calibrated 2-yearly to ensure operation at the correct set points. 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
Cake storage bay	Low	Inhalation via wind-borne transportation	R1 & R2 - residential and commercial properties at Wood End Barn Farm	The cake stockpile is managed so that under normal operating conditions it does not exceed the height of the surrounding bund wall. If weather conditions are excessively dry for a prolonged period and there is a risk of dust generation, a water bowser is used to dampen down.	Low	Negligible

Source	Magnitude of Release	Pathway	Receptor	Control Measures	Probability of Exposure	Magnitude of Risk
				Drainage from the storage area is maintained so that it is free flowing and does not allow ponding of surface water run-off. The drainage is directed back to the head of the works for full biological treatment.		

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 Burnley 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 for the treatment of urban wastewater. The primary settlement tanks, aeration tanks and final settlement tanks are all uncovered and are in closer proximity to the identified receptors.

3.2. Recommendations

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

- B1 – 50m upwind of the OCU, 60m upwind of the unscreened sludge buffer tank, 90m upwind of the cake storage bay;
- B2 – downwind of all sources, 60m to closest source (digester and gas holder PVRVs);
- B3 – downwind of all sources, 55m to closest source (the cake storage bay); and
- B4 – downwind of all sources, 90m to closest source (the cake storage bay).

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 Boundary and Emission Point Plan

KEY:

Emission Points

A1 – CHP biogas engine

A2 – Steam boiler

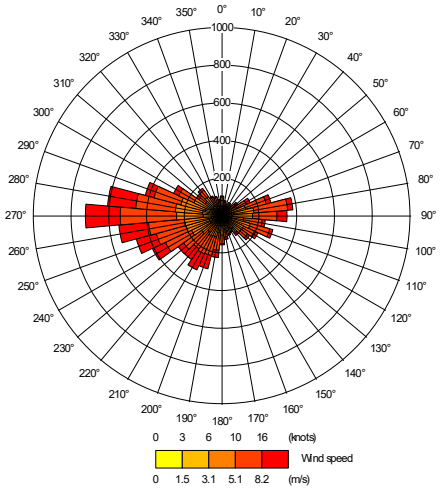
A3 - Flare

A4 – Odour Control Unit

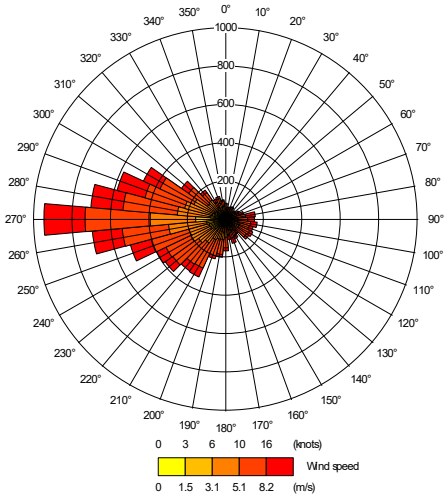
A5 & A6 – Digester PVRVs

A7 – Gas holder PVRV

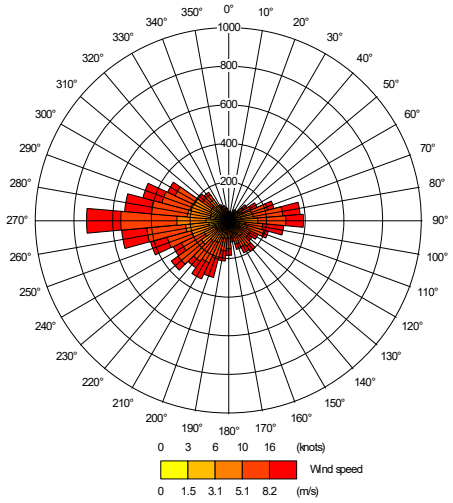
Appendix B: Meteorological Data – Wind Roses



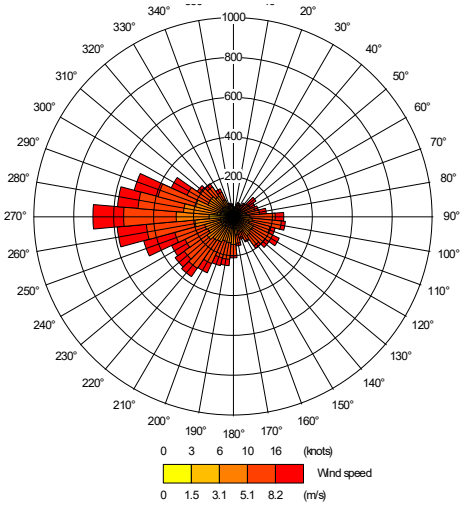
NWP data, 2016



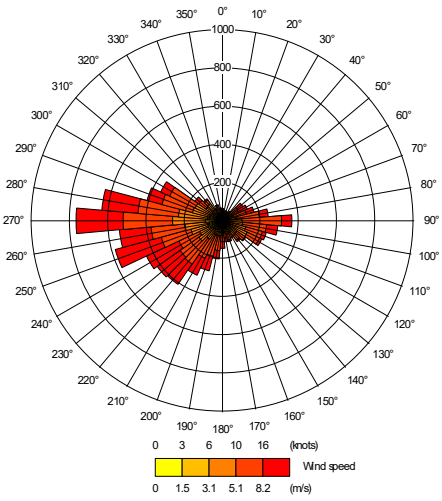
NWP data, 2017



NWP data, 2018



NWP data, 2019



NWP data, 2020

Appendix C: Location of Receptors

Location of Receptors within 250m of Potential Bioaerosols Sources

Receptor	Description	Distance from closest source (m)	Source	Grid Reference	Direction from the site
R1	Residential property at Wood End Barn Farm	200	Digester and gas holder PVRVs	SD 82723 35251 SD 82768 35249	NNE
		235	Cake storage bay	SD 82801 35218	N
		240	Unscreened sludge buffer tank	SD 82707 35230	NNE
		250	Odour control unit stack	SD 82740 53209	NNE

Receptor	Description	Distance from closest source (m)	Source	Grid Reference	Direction from the site
R2	Commercial property at Wood End Barn Farm	200	Digester and gas holder PVRVs	SD 82723 35251 SD 82768 35249	NNE
		230	Cake storage bay	SD 82801 35218	NNE
		245	Unscreened sludge buffer tank	SD 82707 35230	NNE
		250	Odour control unit stack	SD 82740 53209	NNE
R3	Residential property at Wood End Barn Farm	250	Digester and gas holder PVRVs	SD 82723 35251 SD 82768 35249	NNE

Appendix D: Bioaerosol Monitoring Locations

Bioaerosol Monitoring Locations Burnley Sludge Treatment Operations