Document 315160 Envar Cambridge Site Specific Bioaerosol Risk Assessment

ENVAR COMPOSTING Ltd.

In-Vessel
Composting Facility
EPR/GP3930DF/V002

Site Specific
Bioaerosols Risk Assessment

October 2024

For the
Composting Facility
at
The Heath, Woodhurst,
Huntingdon, Cambridgeshire

Prepared for:	Relates to Permit/Site:	Prepared by:
Mr James Cooper Envar Composting Ltd Stanford Bridge Farm Station Road Pluckley Ashford Kent TN27 0RU	Envar Composting Ltd Cheffins, The Heath, Woodhurst, Huntingdon, Cambridgeshire PE28 3BS	D J Baldwin BSc CEnv. MCIWM Technical Director Recogen Ltd 1 Shackleton way Shrewsbury SY3 8SW Tel: 07785 352993

Report Date: **24th October 2024**

EXECUTIVE SUMMARY

Envar Composting are proposing some minor variations to their Permit and operating plans. This report considers the relevant information including new activities, describes the likely impact of these, adds new site specific data from monitoring at the site; and provides a **Site Specific Bioaerosols Risk Assessment** (SSBRA) of the impacts that may be caused by **Envar Composting Ltd** carrying on the range of activities of composting organic waste materials at:

Cheffins, The Heath,
Woodhurst,
Huntingdon,
Cambridgeshire
PE28 3BS

The Risk Assessment takes account of and follows the guidance for undertaking such a SSBRA as described in the reference:

> **[Ref 1]:** Guidance on the Evaluation of Risk Assessments for Composting Facilities, Cranfield University (G.H. Drew et al) published by the EA August 2009 and can be found on the web-address: http://publications.environment-agency.gov.uk/pdf/GEHO0809BQUO-e-e.pdf

In taking account of information that has informed the potential for the generation of bioaerosols at this site, based on previous measurements at this and similar sites, account has been taken of the approved **M9 methodology** for undertaking such measurements; i.e.

> **[Ref 2]. M9 2018 Version 2** Technical Guidance Note (Monitoring) Environment Agency January 2018 Environmental monitoring of bioaerosols at regulated facilities

The Risk Assessment takes account of the Environment Agency Policy and Position Statement Ref 3] and several other Research and Industry Health and Safety references.

> **[Ref 3.]:** Environment Agency PS031 'Composting and potential health effects from bioaerosols: our interim guidance for permit applicants' November 2010.

Guidance from the EA has provided that because there are sensitive receptors within 250m of the site, then a full Site Specific Bioaerosols Risk Assessment is required.

Positive factors that serve to minimise risks to third parties at this site are taken into account and a number of contingencies contemplated if required. The facility continues to show acceptable levels of bioaerosols in regular monitoring and provides useful environmental protection as follows:

1. Separation distance of the principal areas of activity away from sensitive receptors
2. The primary processes (materials reception and In-Vessel Composting) are fully enclosed.
3. The IVC processes are extraction ventilated and exhaust air treated via a wet scrubber.
4. Windrow turning shall be lapsed if the wind direction is toward the NSR.
5. Harvested rainwater is used for damping down material to suppress airborne emissions.
6. Contingencies if required include: additional wetting down during windrow turning and additional dust protection/suppression measures during screening.

The SSBRA primarily considers the proximity of the Nearest Sensitive Receptor which is the **Raptor Foundation** to the north and which is **within 240m** of the main activity of the site.

With due consideration to the changes proposed and with attention to the prevailing wind and management plans in place, the report concludes that the otherwise LOW-MODERATE risks of impact to the nearby sensitive receptor may be maintained as LOW.

CONTENTS

Revisions ot the Bioaerosols Risk Assessment

Date	**Reference**	**Revision made**
24/10/24	Figure 2	Revised site plan.
	Table 1	Amendments
	Section 4	Sensitive receptors
	Section 9.10 – 9.16	New sections to provide new site specific data; for the risk assessment
	Figure 21 & 22	Revised modelling to take account of the reference data.
	Section 13	Reworked conclusions, increased emphasis on lapsing the external windrow turning when the wind is toward the NSR.
	Appendix 1	Updated to show the checks made in compiling this SSBRA
25/10/24	Appendix 2	Updated to show the key methodology for the data is EA Guide M9. 2018

QUALITY ASSURANCE for the RISK ASSESSMENT AND REPORTING

Recogen Ltd. Environmental Quality Reporting – An Independent Assessor

For the purposes of quality assurance in undertaking this risk assessment, Recogen Ltd. is a recognised organisation with appropriately trained, qualified and experienced personnel; *independent* to the composting site operator. This assessment was undertaken by D J Baldwin, BSc (Hons) CEnv. MCIWM, Technical Director with Recogen Ltd. who has over 35 years of waste and environmental management experience. David is FACTS (fertiliser advice certification) qualified, WAMITAB registered and holds the Environmental Permit Operators Certificate (EPOC).

Recogen Ltd. is registered as a Quality Environmental Consultancy on the National Business Link Register and is a supplier of Technical Consultancy to DEFRA, The Waste and Resources Action Programme (WRAP) and to The Renewable Energy Association Organic Recycling Group.

David has managed or contributed to many major projects on waste management for Government (**DEFRA, ETSU, DTI, WRAP, EA**) and The Waste Management Industry including Composting and Anaerobic Digestion processes, compost site design, product quality assurance (PAS100:2005 and 2018), The Compost Quality Protocol, ISO9001, ISO14001, COSHH and H&S Risk Assessments.

David has taken in part in Environment Agency led workshops in regard to Bioaerosols Risks and keeps abreast of EA policy and guidance. David undertakes Bioaerosols monitoring at multiple sites in England and Wales and has an excellent understanding of emissions generation and emission using the Source - Pathway - Receptor model.

For the purpose of this SSBRA, reference has been made to the guidance that is currently in place.

DEFINITIONS

Definitions – as provided in Environment Agency PS031 Nov 2010

Bioaerosols, composting and health effects. Bioaerosols are complex mixtures of airborne micro-organisms and their products, and are ubiquitous, particularly in rural environments. The most serious health problems appear to arise from *Aspergillus fumigatus*, but there are other fungal spores and bacteria that cause problems. International studies have shown that there is a wide variability in individual susceptibility to bioaerosol exposure.

Composting operations. Includes any associated waste storage and treatment operations carried out at the composting facility. Composting is the 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.

Sensitive receptors. Sensitive receptors refers to people likely to be within 250 metres of the composting operation 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 composting facilities or their staff while carrying out the composting operation as their health is covered by Health and Safety legislation.

Acceptable levels at the sensitive receptors. Refers to the concentrations of bioaerosols (as predicted or as derived from direct measurements) at the sensitive receptors which are attributable to the composting operations. The acceptable levels are 300, 1000 and 500 cfu.m^{-3} for gram-negative bacteria, total bacteria and Aspergillus Fumigatus respectively, as measured by the standardised monitoring protocol.

Maximum quantity of waste handled at any one time. Refers to the total quantity of waste being stored or treated at any one time.

Operations…likely to result in the uncontrolled release of high levels of bioaerosols. Include 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 subjected to exhaust ventilation and scrubbing/filtering.

About the SSBRA. Generally, the complexity of a risk assessment is related to the size and complexity of the proposed facility and the uncertainty of the risk posed, varying from a qualitative, largely generic approach at one extreme to a site specific quantitative risk assessment at the other.

Standard methods of determining bioaerosol levels are available. However based on our present scientific understanding of bioaerosols, the way they behave and their health impacts we now consider that there is currently no suitable methodology for carrying out adequate quantitative SSBRAs for new composting facilities. Accordingly, we believe that we need to take a precautionary approach and not normally permit those facilities where we would have expected a quantitative SSBRA until such time as a suitable methodology becomes available.

The types of new facilities affected by this are those that would have handled more than 500 tonnes of waste at any one time and would have carried out any “composting operations in the open that are likely to result in the uncontrolled release of high levels of bioaerosols”, as defined above. In practice, this would not include situations where the entire composting operation is carried out inside a building, or where composting takes place outside, but using negative aeration and without turning. However it would include compost maturation in conventional outdoor turned windrows, carried out following other treatment operations such as in-vessel composting, treatment in a dry AD (anaerobic digestion) plant and treatment in an mechanical biological treatment plant.

Associated definitions (EA Position Statement 2007)

A workplace is defined as where workers would frequently be present. This should be the boundary of land under the ownership of the business unless it is confirmed that any land within that ownership is not, and is never, going to be used by workers except for short periods of time, for example for maintenance work, animal husbandry.

Dwelling includes the boundary of the garden of the domestic property. This does not include any land such as a paddock or field in the same ownership of the domestic property.

Composting site boundary. The bioaerosol risk assessment or application should include a plan of the composting facility showing the boundary of the permitted, licensed or exempt area. We will treat this as the composting site boundary unless there is a defined area within this where waste storage, processing and other waste handling operations are to take place. If this is the case, we will treat the boundary of this smaller defined area as the composting site boundary. In all cases, we will expect the composting site boundary to be physically identifiable on the ground once composting operations start.

Appropriate levels…. were defined as bioaerosol levels not exceeding: i) those before the start of the composting process or ii) bioaerosols levels no greater than *1,000 colony forming units cfu.m^{-3} total bacteria, 500 cfu.m^{-3} Aspergillus Fumigatus and 300 cfu.m^{-3} gram-negative bacteria.* There may be other activities close by that are producing bioaerosols that mean background levels are higher than normally expected. This should not prevent the siting of a composting facility if it doesn’t present an increased risk.

Recent Guidance – Receptor Hours per day.
Exposure period for receptors within a given day. The EA have provided clarification that 6hours is the time period which for less than this, the receptor may be deemed to not be regarded as a sensitive receptor. Examples may be persons on highways, or on public footpaths, or working locally for only short periods of time.

SECTION 1.0 Introduction

1.1 Composting and Bioaerosol generation

Composting means of converting and stabilising organic biodegradable waste materials such as “green waste”, and putrescible waste. The processes rely on biological activity, notably the utilisation of bacteria and fungi in order to bio-degrade the volatile material and convert it to more stable forms of humic substance.

The overall process relies on mechanical treatment in the preparation and handling of the material, as well as specialist facilities for controlling the processes involved.

It is recognised that when any agitation of organic material occurs, especially shredding, turning, or screening, or when leachate is recirculated, elevated numbers of micro-organisms may be released into the air. Once released into the air they can remain airborne for long periods and form a ‘bioaerosol’ i.e. an aerosol of biological particles.

Systems and processes have been developed in order to minimise the movement of compost in open spaces and enclosure of the handling of the material during the initial phases of treatment and of the screening process help provide very good control of dust and emissions by reducing susceptibility to high winds across processes.

The Environment Agency regulates the Permitting of Composting Facilities and has provided a Position Statement in regard to Bioaerosols. This includes guidance and explanation in regard to where and how facilities may be permissible. The guidance strongly recommends the enclosure of such facilities to reduce the release and emission of bioaerosols and dust in strong winds.

1.2 Bioaerosols Risks to health – Dose – Response (see also Appendix 4)

Bioaerosols are small particles of biologically active material that may be carried independently in the air or otherwise may become attached to other particles of dust or moisture. Consequently the minute particles may be inhalable and also respirable (deposited in the air sacs of the lungs where gases are exchanged).

During the course of daily activities, people inhale airborne microbes. This is as much a feature of normal everyday life as eating or drinking. Most individuals' bodies are perfectly capable of coping adequately with the presence of these 'invaders' and do not suffer any ill effects. It is only when airborne microbes, such as those generated during the composting process, are present in high concentrations that they may become harmful to human health.

Everyone reacts to bioaerosols in different ways. It depends upon a variety of factors and can never be predicted: some people have worked at composting sites for many years without apparently displaying any adverse health effects.

Factors, such as prior exposure to bioaerosols, individual susceptibility, bioaerosol concentration and composition (the numbers and types of microbes present) and the length of time and frequency to which people are exposed all contribute to the way in which their bodies react. There are three main types of response:

Allergy This is an immunological response that results in the body becoming 'sensitised' following exposure. Sensitisation does not usually occur immediately; rather it is a consequence of inhaling a substance over a period of months or even years.

Inflammation This is a response of body tissues to an injury. It typically results in swelling, redness and pain.

Toxic Poisoning which is a disturbance of the normal bodily functions by a specific substance known as a toxin.

Besides from these bodily reactions it is possible that bioaerosols may lead to skin infections (spots/ boils) or else are may cause stomach sickness.

1.3 The Approach to Bioaerosols Risk Assessment

The Risk Assessment is undertaken by reference to:

[Ref 1]: Guidance on the Evaluation of Risk Assessments for Composting Facilities, Cranfield University (G.H. Drew et al) published by the EA August 2009 and can be found on the web-address: http://publications.environment-agency.gov.uk/pdf/GEHO0809BQUO-e-e.pdf

[Ref 2]. M9 2018 Version 2 Technical Guidance Note (Monitoring) Environment Agency January 2018 Environmental monitoring of bioaerosols at regulated facilities

[Ref 3.]: Environment Agency PS031 ' **Composting and potential health effects from bioaerosols: our interim guidance for permit applicants' November 2010.**

This Risk Assessment considers the 'Source,' 'Pathway' and 'Receptor', methodology for assessing Risks, i.e.

The **Source** of the bioaerosols is considered, by examination of the various activities and points within the process where bioaerosols may be generated and released. This also includes consideration of various techniques and systems for minimising those releases.

The **Pathway**, is the route by which the bioaerosols travel from the source to the receptor. Generally this is aerial, but may include vehicles or even liquid transport systems, whereby dust or similar material is carried by one medium and then by drying or exposure to the wind, becomes air-borne and travels beyond the site boundary to the receptor. The dominant wind direction and speeds are taken into account and also 'barriers' (such as topography etc.) that may serve to attenuate the concentration of bioaerosols during travel.

The **Sensitive Receptors** are identified and consideration given to the degree of sensitivity, daily period of exposure and overall duration of exposure. The context and nature of the activities that the receptors undertake are also considered as this may affect their actual exposure to the bioaerosols (in-doors, protected areas), their rate of breathing, e.g. exercising and their sensitivity (asthmatic or with weakened respiratory system).

This Risk Assessment relies upon recently published research data, sampling information from similar sites and historic data relating to this site. It takes into account of the many process controls and management procedures.

While it is appreciated that seasonal factors and day-today site operations can cause change, this report gathers together a wide range of information, data and evidence, in regard to the proposed additions and changes to the site operation.

The Bioaerosol levels have been monitored at this site for several years; and the results of monitoring have revealed that with good management procedures, suppression and the separation distance the Bioaerosol levels can be maintained at acceptable levels at the nearby receptors.

1.4 Risk Mitigation

Risk management techniques comprising technological and managerial systems shall be utilised at the site. Box 1. summarises the key features of these Risk Mitigation techniques.
Reference is made to the separation distance from the Nearest Sensitive receptor – NSR.

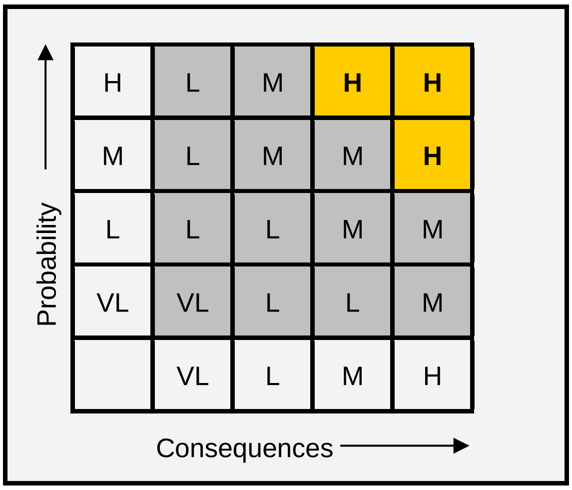
Box 1: Risk Mitigation techniques include technological processes and operational procedures including:

Technological	**Procedural**
▪ Fresh Waste Material (Feedstock) is received into an enclosed Reception Building ▪ Shredding Processes are fully enclosed ▪ In-Vessel Composting Processes are fully enclosed ▪ External Composting Processing areas are wind protected by buildings Earth Bunds and wind breaks ▪ Composting Process in accordance with PAS100 ▪ Process is very closely managed, with control of process aeration, temperature and moisture ▪ Utilises harvested clean water for suppression of dust and damping the composting material. ▪ Compost Screening is undertaken within an Enclosure	o Controls over material types received o Received material processed within set timescales. o Management of material to maintain high moisture content o Rain-water Harvesting to supply clean water damping of hard surfaces to minimise dust. o Environmental Monitoring is undertaken o Good Operator training, supervision and management o Site Cleanliness procedures

1.5 Risk Assessment Methodology

The Risks have been assessed (Section 11) using the 'Probability v Consequences' matrix published in Ref 1. Guidance on the Evaluation of Risk Assessments for Composting Facilities, Cranfield University (G.H. Drew et al) published by EA August 2009 at page 18, as follows (Box 2):

Box 2 Risk Assessment Matrix



H	L	M	**H**	**H**
M	L	M	M	**H**
L	L	L	M	M
VL	VL	L	L	M
	VL	L	M	H

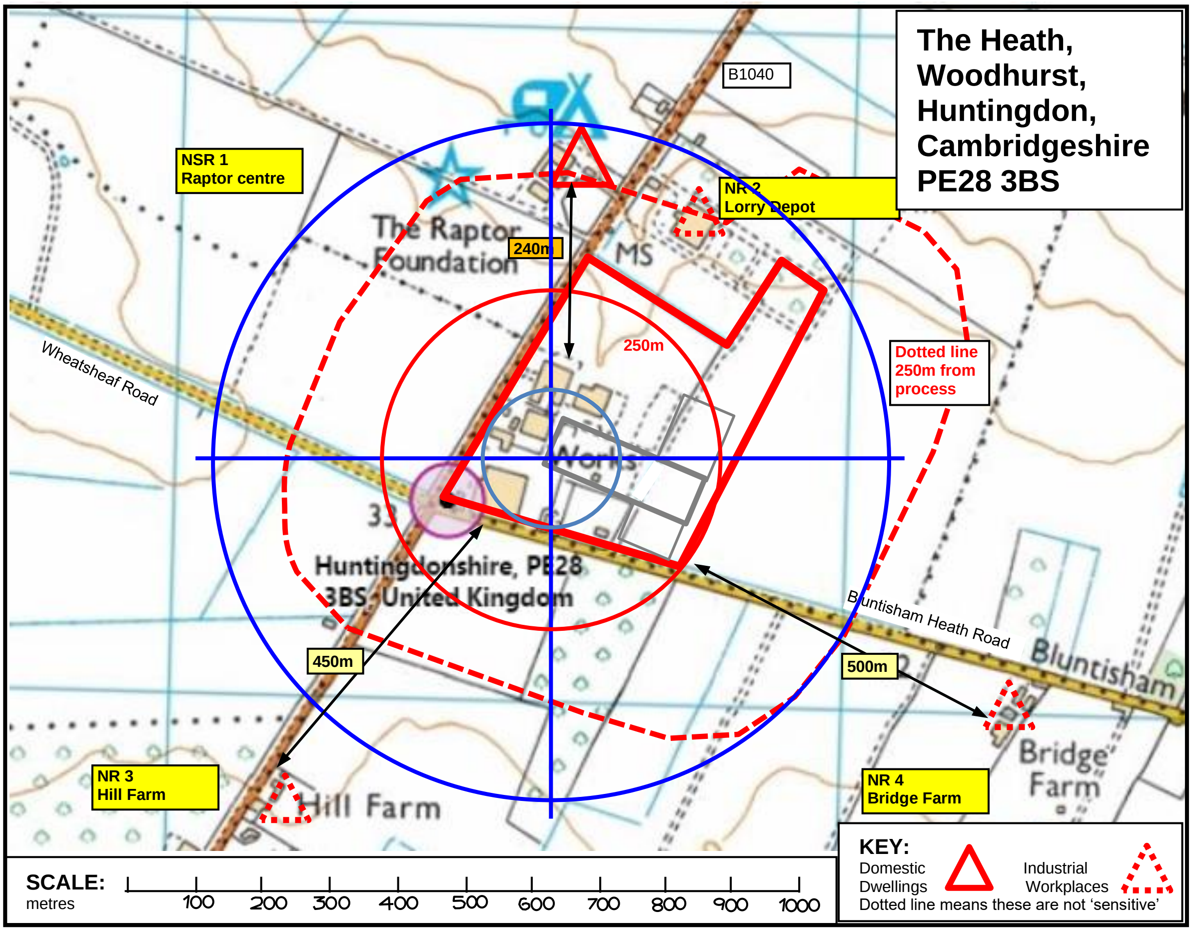
SECTION 2.0 Envar 'The Heath' – Site Location and Layout

2.1 Site Location

The site is located at the following address and grid reference. A location map and site plan is shown below at Figures 1 and 2.

Cheffins,
The Heath,
Woodhurst,
Huntingdon,
Cambridgeshire,
PE28 3BS.
(Grid Ref Weighbridge on Site) **OS Map Ref: OS Grid ref. TL 33571:75362**

Figure 1. Extract from Map (1km grid) Showing location of Composting Facility and Nearby Dwellings.



2.2 Site Context

The Envar Composting facility has undertaken the Composting of mixed Food and Green Waste for the past 15 years but prior to that was a major national facility for the production of compost for the UK mushroom growing industry. The facility has been upgraded and developed to accommodate projected growth in combined green waste and food waste recycling that amounts to in excess of 165,000 tonnes per year. To service the effluent drainage requirements for the site and for the benefit of harvesting and storing rainwater, the In-Vessel and External Windrow Composting facility includes its own waste-water treatment plant and woody waste reprocessing facility.

There are now proposals to provide services for 'In-Vessel' processing of additional types of waste.

2.3 Site Operation

Currently the process includes enclosed bio-waste (and other waste) reception, shredding, and enclosed IVC treatment in multiple vessels (or tunnels) that is followed by the external compost windrowing and windrow turning, screening and product formation either according to the PAS100 'British Standard' quality assurance scheme or some other quality standard. The total material on site at any one time shall not exceed 60,000 tonnes. The facility utilises a typical external windrow composting process, capable of up to 162,500 t/yr. This provides for the external windrow composting/maturation of 30,000 tonnes of material at any one time on a concreted surface. Drainage from this is to rain-water storage lagoons to the north of the site.

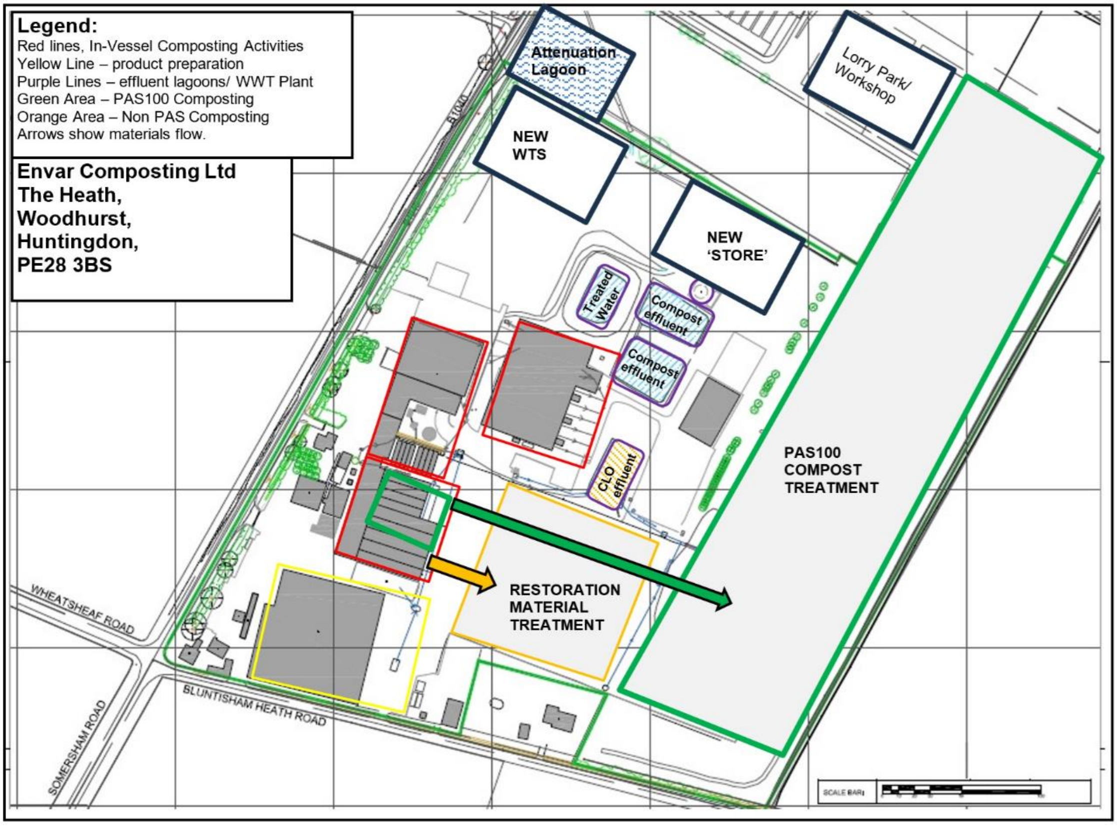
The enclosed compost processing facility has been designed to enable delivery vehicles to unload mixed food and green waste material within the large reception buildings to the north. All of the primary processing of the material is then undertaken within the buildings. The composting process takes place within any one of several enclosed bunkers (vessels/tunnels) within the buildings. The process is operated in accordance with DEFRA regulations and controls to ensure the full treatment of the material. Being contained within the building the operation has full control of any exhaust air from the composting process and this is cleaned and filtered prior to being released into the environment. Systems are in place to ensure the composting process is closely monitored, the ventilating air controlled and supplied with fresh air to maximise the quality of the compost produced. All of the IVC Processes including transfer are undertaken within the buildings.

After processing within the IVC vessels, the material if required, is transferred to one of the existing external composting areas to be further conditioned, matured and screened.

The site also includes for wood recycling and aggregates recovery activities.

The context of the facility, the vessels and the external pads are shown in Figure 2.

Figure 2. Illustration Showing Composting Facility context



SECTION 3.0 The Envar – The Heath' - Composting Facility

3.1 The composting scheme

The site currently provides composting facilities for a range of organic waste materials including 'bio-waste' (mixed food and green waste), green waste, compost oversize, food industry waste, pre-treated municipal solid waste (MSW) and other materials. Figure 2 provides the site layout plan, and Fig 3 provides a schematic of the multiple flow processes for biowaste and MSW etc.

Figure 3. Schematic of The Envar Composting Process Flows

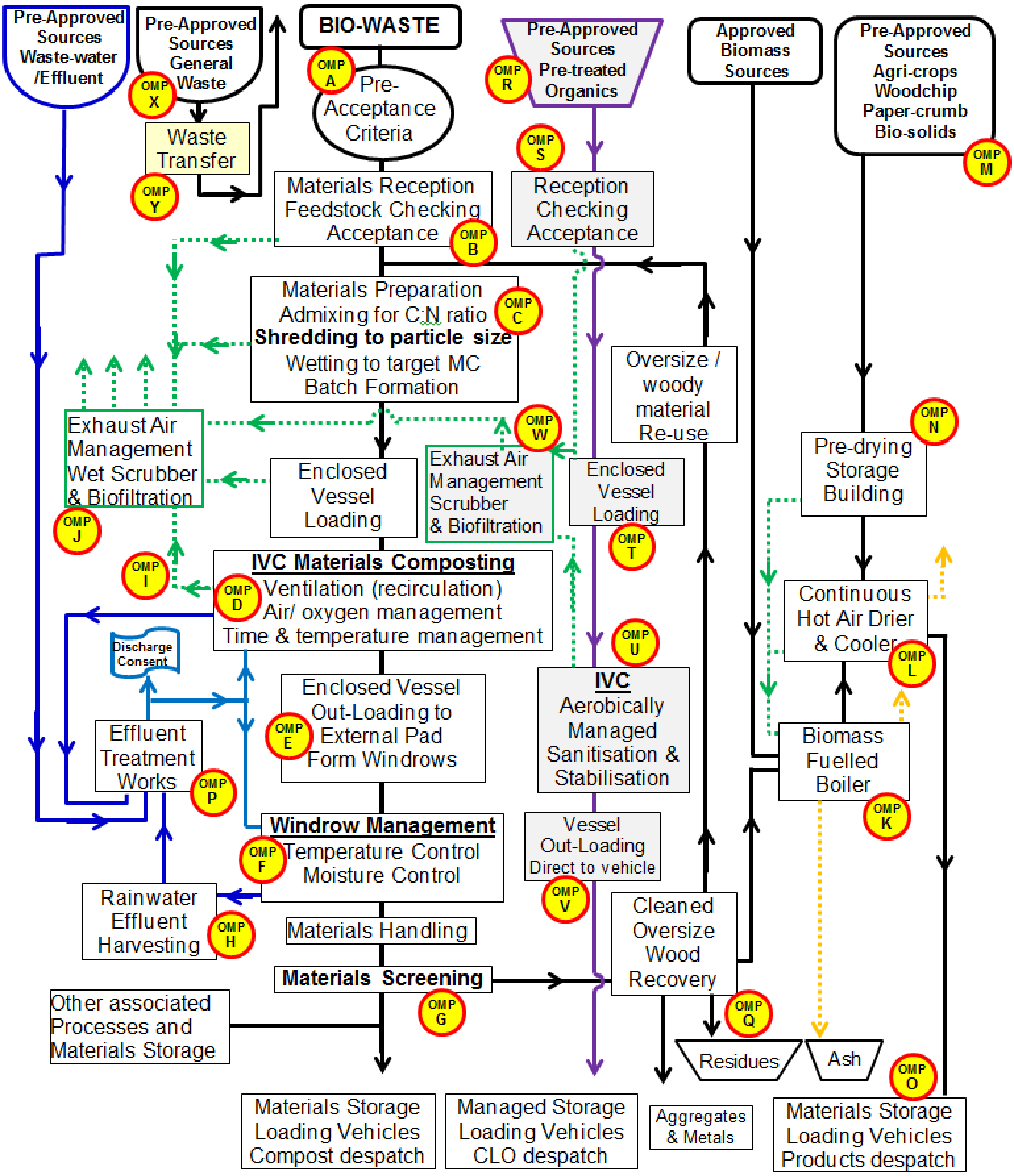
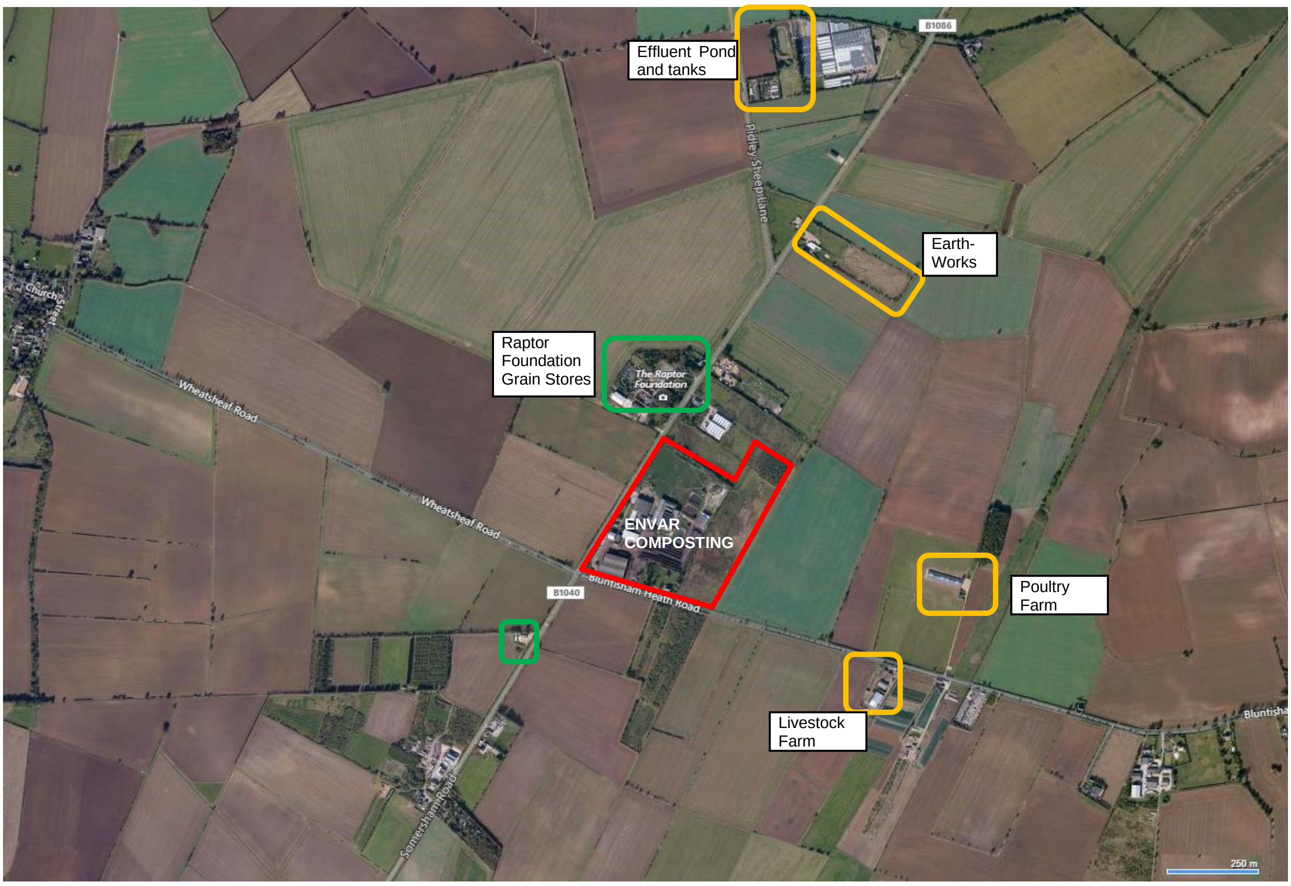


Table 1 summarises the principal points where bioaerosols may be managed and controlled.

Table 1: The Heath Composting facility's NINE Bioaerosol Control Points

1.	**WEIGHBRIDGE RECEPTION**	Material will arrive on site in high sided lorries, enclosed skips, Refuse Collection Vehicles or similarly enclosed vehicles. Feedstock deliveries shall be compliance checked for type, and dust/bioaerosol potential.
2.	**BIO- WASTE OFFLOADING (or other Waste, or Sludge)**	Vehicle Offloading for Bio-waste shall be undertaken within the enclosed reception building. Any dry, dusty or degraded bio-waste material shall be moved to the storage area and damped down immediately so as to minimise dust/bioaerosol emissions. Material shall be processed on a 'First In, First Out' Basis in order to minimise the risk of undue or prolonged bio-degradation within the Storage area.
3.	**FEEDSTOCK SHREDDING**	The material shall be prepared for composting without undue delay, so that it does not begin to decompose within the fresh waste stockpile. Material shall be treated on a first come-first processed (out) FIFO basis. The shredder can be provided with clean water dust suppression if required. The shredded material may be amended with water/treated waste-water to establish a damp state and suppress dust release. A standby shredder is available as a back-up.
4.	**ENCLOSED COMPOSTING PROCESS**	The composting process utilises the sanitisation to destroy pathogenic material (and weed seeds/plant pathogens etc.) at temperatures between approx. 65° and 75° C. This takes place within the enclosed vessels. The sanitisation phase for Bio-waste is undertaken in accordance with PAS100 and the Animal By-Products Regulations. Other wastes shall be segregated and treated to process standards and management controls within other separate and dedicated vessels. The Specific Vessel is filled as one Batch. The composting process relies on oxygen for biological processing and aeration is provided by powerful blowers. The exhaust air from the process is subjected to wet (water based) scrubbing and then biofiltration.
5.	**COMPOST OUT-LOADING FROM THE VESSELS**	The sanitised compost or processed material is out-loaded to the external Pad. Prior to this handling phase, the material is cooled down from the sanitisation temperatures by aeration and this reduces emissions during out-loading.
6.	**EXTERNAL COMPOST PROCESSING (Stabilisation/ maturation)**	The stabilisation and maturation stage maintains target temperatures that are lower circa 45° - 65° C and this reduces the generation of Aspergillus Fumigatus bioaerosol type. The composting process still relies on oxygen for biological processing and aeration is provided by turning and mixing the windrows using the large mechanical windrow turner which incorporates sprayed water irrigation during turning so that fugitive emissions are minimised. Use of specialist monitoring systems enable the need for turning (aeration) and moisture addition to be determined. Due to the precise control of the compost during the In-Vessel (Sanitisation) Phase, the material is well advanced in the composting process being less volatile and more stable. This means that the rate of oxygen requirement is reduced and so the need for turning/aeration is also reduced.
7.	**SCREENING**	Screening will be undertaken when the processed compost / material has become stabilised (e.g. 8 weeks duration) and will be undertaken when the wind and weather conditions are favourable. It may be undertaken externally, but the facility exists for it to be undertaken in the large umbrella building. The discharge of the screener is managed so that the material is damp; and the oversize where there may be litter and dusty material is retained and immediately sorted and removed. The screening machines and processes benefit from secondary enclosures. Floor surfaces are spray irrigated to suppress the raising of dust, debris and bioaerosols, especially from wheeled traffic moving around the site
8.	**PRODUCT DESPATCH**	Stabilised, cooled material is loaded to high-sided enclosed vehicles. Loading is undertaken within the building. Damping down is available in case of dusty conditions. The vehicles have canopies or tarpaulin enclosures. The yard area is regularly damped down with irrigated water and swept by a road-sweeper.
9.	**Associated Processes**	Effluent within the lagoons is kept aerobic and is quickly transferred to the Waste-water treatment works. Oversize and other materials may be stored externally. These are monitored and condition checked so that emissions are managed.

Figure 4. Location Overhead view showing where bioaerosols may arise at Off-site locations.



There are a number of locations where there may be bioaerosols generated and released; however, with the exception of the poultry farm, these are each of very low significance.

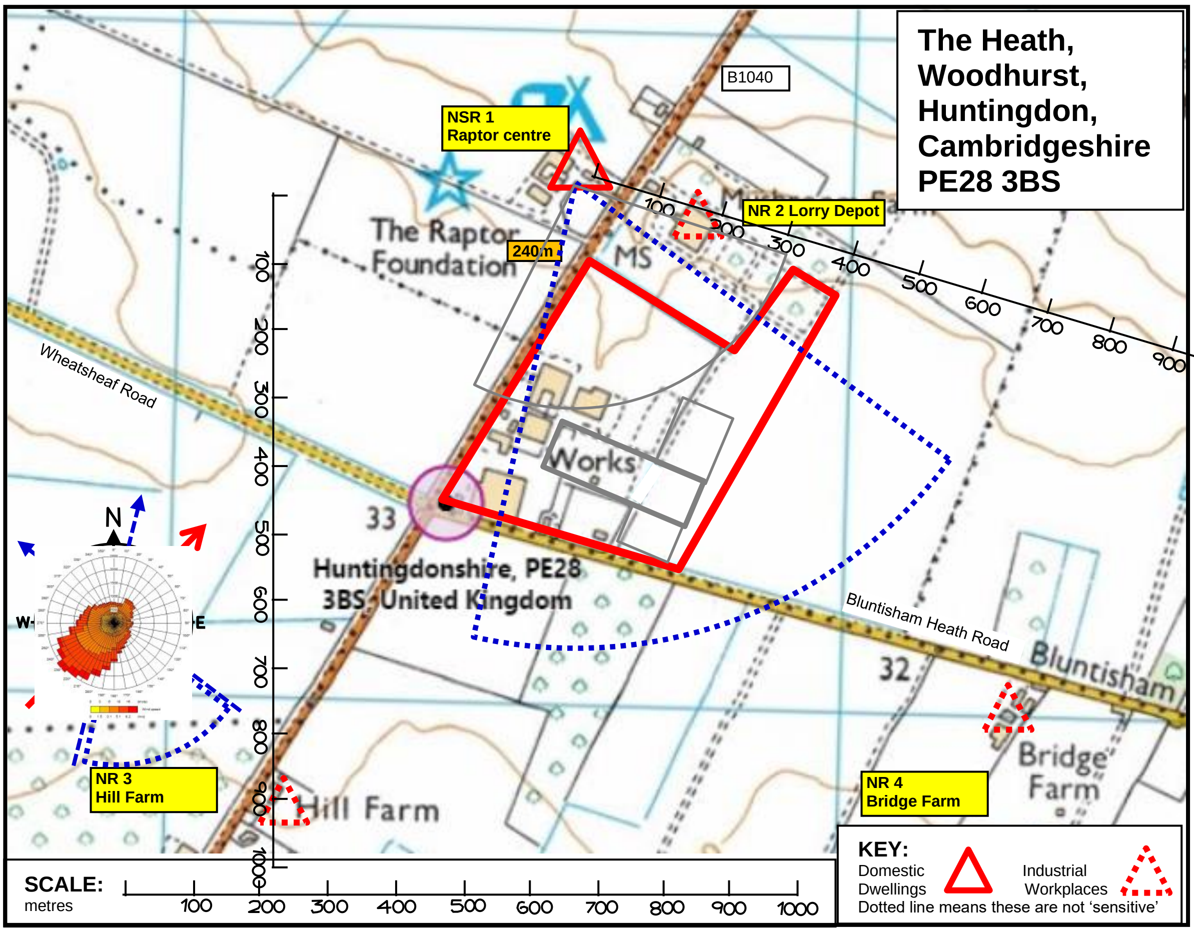
Of greater significance would be the bioaerosols generated and released a) from agricultural cropping at specific times of the year (e.g. harvest) and b) if the land areas were to be applied with livestock manure, e.g. poultry manure or other similar organic fertiliser/soil conditioner.

In regard to the Poultry Farm, this is some distance away and although there may be emissions in the ventilation system, the greater emissions would be when the housing is cleaned out. Information regarding bioaerosols from livestock is mentioned in Section 7. Table 4 shows the untreated emissions can be extremely high, (100,000 cfu/m^3 bacteria and 10,000 cfu/m^3 Aspergillus Fumigatus) and the residual impact of emissions from there could affect the Nearest Sensitive receptors if the wind was from the East-south-east.

SECTION 4.0 Environmentally Sensitive Receptors

4.1 Site Situation with Regard to Environmentally Sensitive Receptors

Figure 5:* *Map (1km grid) Showing location of Composting Facility and nearby sensitive receptors Blue arc shows the range of the wind directions that cross both the site and the NSR.



There are nearby Sensitive Receptors as follows:

1. To the North there is the now redundant Mushroom Farm, which is a lorry depot (lorry overnight parking compound). The main part of this is across a grassed field beyond the land boundary that separates the composting site from the Depot. The Depot would be most affected by emissions from the composting site, if the wind was directly from the south-east; however, the Depot is unmanned and drivers/operatives are not present for more than 6 hours per day; and the site is therefore not deemed as 'sensitive'.

2. To the North there is the Raptor Foundation Site. The centre for this is directly north of the composting site. The nearest parts of the composting site to the Raptor Centre are the doors to the reception buildings to the northern end of the site. The Raptor Centre may be affected by emissions from the composting site, if the wind was directly from compass bearings **between the south and the south-east** that includes the main site and the extended area on the eastern side where external windrow composting being undertaken.

   With the exception of when the Reception doors are opened for vehicle entry and there is the risk of fugitive airborne emissions escaping; most of the infrastructure at the composting facility means that the processes closest to the Raptor Centre are fully enclosed. The next nearest activity at the site where the processed material becomes external, is when it is removed from the 'Vessels' or Tunnels after primary sanitisation treatment. This is the northern-most corner of the compost maturation pad (fig 2) and is circa 300 metres from the Raptor Centre. The separation distance of the compost screening building is 450 metres.

3. The two houses at the site; one nearest the cross roads and one along the Bluntisham Heath Road are part of the Composting Site Property and are not used as dwellings.

4. The next nearest dwellings or workplaces are the two farms: one to the south 'Hill Farm' on the main road, and one to the east 'Bridge Farm'. These are both well beyond the 250 metres distance from the site at circa 500m in each case.

5. The roads that pass by the site; the B1040 (north/south) and the Bluntisham Heath Road are both quite busy with traffic and sometimes there are short queues of traffic waiting to join the main road or turn at the crossroads. There is a speed restriction together with speed cameras on the B1040 outside the site main gates. Even so, in accordance with EA definitions, these are not regarded as sensitive receptors as the duration of any exposure is likely to be less than a minute or so and is well below the 6 hours exposure period.

6. The B1040 includes a footpath, as does the Bluntisham Road and the field to the west of the site where the path follows a double bend along the field boundary. Taking the longest length of footpath across the fields from the west, along the B1040 and then along Bluntisham Road may comprise a distance of 1200metres. At a slow walking speed of 5km/hr this would entail a walk time of approximately 15 mins duration to complete the route.

7. The fields surrounding the site are in agricultural production, typically arable crops. For these it is expected that a tractor driver (or similar machine) may be within the advised 250metre proximity while traversing the field undertaking an agricultural activity, such as cultivations, or harvesting. Again, in accordance with EA definitions, these are not regarded as sensitive receptors as the duration of any exposure is likely to be only a minute or so and is well below the 6 hours exposure period.

8. Similarly for the Historic Orchard to the south of Bluntisham Road; this is not in production. Any maintenance workers may only be present for very short periods of less than 6 hours.

9. Staff that work on the site, including the office staff are managed by company operating the Permitted composting site. The well-being of these people is covered by Health and Safety Policies and management. The EA definitions therefore, do not include these staff as being 'sensitive receptors'.

SECTION 5.0 Meteorological Conditions for the Site

An associate of the National Meteorology Unit, (Part of the UK National Meteorology office), has supplied data for this site.

This data has been provided from data accumulated over the time period (2010 – 15) and is statistically representative of the wind strength and direction averages for this grid reference.

5.1 Background

The dominant wind directions in the UK normally blow from between South and West. However, the direction of the prevailing winds can be modified by local topography. In general the more pronounced the topography, then the greater the potential influence upon local wind directions.

The Met Office maintains a network of observing stations across the UK. Wind speed and direction information is collected hourly from a number of these stations.
The provision of the data takes account of any topographic effects.

5.2 Analysis of Wind Speeds and Directions

Hourly mean wind speed and direction records were analysed over a recent period, 2011-16. This data is illustrated in Table 2. Attention is given to winds for between south and south-east

Table 2. Percentage Frequency of Wind Directions at this grid reference.

Speed\Direction	N	NNE	NE	ENE	E	ESE	SE	SSE	S	SSW	SW	WSW	W	WNW	NW	NNW	Total
<0.3	0	0.02	0.01	0.02	0	0.02	0.02	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.18
0.3 - 1.0	0.16	0.17	0.13	0.14	0.15	0.14	0.15	0.12	0.15	0.15	0.16	0.15	0.14	0.18	0.17	0.14	2.38
1.0 - 2.5	1.03	1.06	1.18	1.11	1.02	0.91	1.05	1.03	1.11	1.16	1.21	1.44	1.31	1.49	1.35	1.09	18.57
2.5 - 5.0	2.32	2.55	2.95	2.17	2.01	1.76	1.99	2.42	3.33	4.71	5.77	5.53	3.87	3.28	2.63	2.34	49.64
5.0 - 7.5	0.47	0.67	0.8	0.53	0.39	0.46	0.79	1.07	2.11	3.26	4.14	3.08	1.8	1.12	0.71	0.56	21.96
7.5 - 10.0	0.03	0.05	0.1	0.03	0.03	0.06	0.14	0.31	0.59	1.34	1.34	0.91	0.47	0.15	0.11	0.09	5.75
10.0 - 12.5	0	0	0	0	0	0	0.01	0.03	0.14	0.27	0.4	0.21	0.07	0.04	0.03	0.03	1.23
>12.5	0	0	0	0	0	0	0	0	0.03	0.04	0.11	0.05	0.01	0.03	0	0.01	0.28
Total	4.01	4.52	5.18	3.99	3.6	3.35	4.14	4.99	7.48	10.9	13.1	11.4	7.69	6.29	5.02	4.27	100.00
Total							**16.6 % of time**			**Most frequent 35.4 %**							

Table 3: Annual Average Wind Speeds at the grid reference - Percentage Frequencies

Speed/Month	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	
<0.3	0.01	0.01	0.03	0.03	0.02	0.03	0.02	0.01	0.01	0	0.02	0	
0.3 - 1.0	0.12	0.13	0.3	0.2	0.18	0.35	0.32	0.22	0.23	0.08	0.15	0.09	
1.0 - 2.5	0.92	0.82	1.78	1.72	1.6	1.96	2.69	2.13	2.22	1.21	1.11	0.42	
2.5 - 5.0	3.59	3.54	3.79	4.33	4.74	4.28	4.37	4.94	4.6	4.54	4.22	2.71	
5.0 - 7.5	2.68	2.23	1.78	1.67	1.51	1.28	0.95	1.14	1.11	2.31	1.94	3.37	
7.5 - 10.0	0.97	0.74	0.5	0.28	0.3	0.16	0.18	0.11	0.1	0.35	0.57	1.5	
10.0 - 12.5	0.19	0.23	0.11	0.03	0.05	0.03	0	0.01	0	0.01	0.22	0.35	
>12.5	0.02	0.03	0.04	0	0.02	0.01	0	0	0	0	0.05	0.11	
													100

Notes

- The above table shows the directions FROM which the winds blow.
- The NNE sector covers directions from 15 to 45 degrees and so on in 30 degree sectors.
- 100% of hours in a 30 day month = 720 ; 20.0% = 144 hours etc.

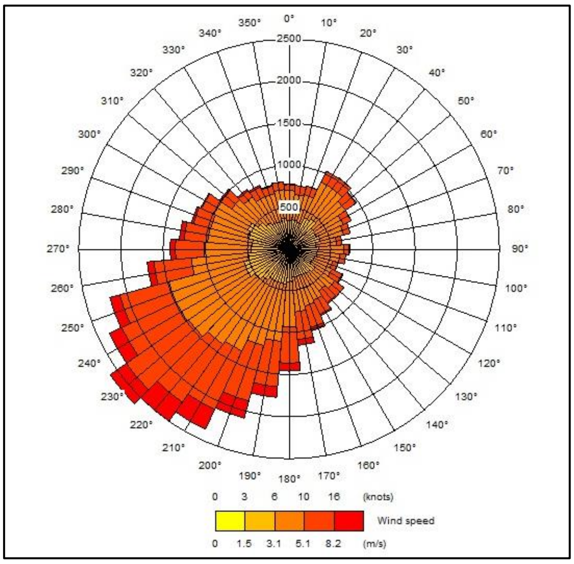
Main Features

- The prevailing winds blow from between the south-south-west and the west south-west (~35%)
- The least frequent winds blow from the easterly quarter.
- The winds from compass bearings between the **south and the south-east** is <**17% of the time**.

5.3 Frequency of Wind Direction by Speed

The distribution of wind speeds ranges to 10.0 m/s with wind-speeds in excess of 10 m/s being relatively infrequent. The strongest winds blow from the south-west - Table 3 and Fig 6.

Figure 6: Wind Rose for this grid reference (arrow denotes most frequent direction of wind)



5.4 Wind Direction in relation to The Nearest Sensitive Receptors

The wind-rose shown in Figure 4 provides a useful illustration of where the pre-dominant winds come from and therefore determine the sectors that will be downwind of the composting facility for the greater or lesser percentage of time.

In section 4.1 para 2, it was shown that the Raptor Foundation Centre would be most susceptible to winds arriving from the south and south-east (due to the extension of the eastern area).

The data taken from Table 2 determines that the frequency of winds towards the NSR may account for ~17% of time which equates to approximately 1 day per week.

SECTION 6.0 Envar – 'The Heath' Site: Bioaerosol Control Points

6.1 Hazard Analysis

It has been determined that the nearest points for emission of bioaerosols from the site will be the reception building doorways when the doors are open. The doorways are within 250metres of the nearest sensitive receptor.

The external composting pad is distanced some 300 metres from the NSR
The unloading of compost from the vessels (doorways) is distanced 250 metres from the NSR
The biofilter is 380m distant from the Raptor Centre NSR
and
The compost screening facility is 450metres distant.

Fresh Bio-waste shredding, heated compost transfer (vessel out-loading), windrow turning and compost screening are deemed to present the greatest risk of releasing bioaerosol emissions.
The shredding is undertaken within the building enclosure.
Compost within the vessels can be cooled and conditioned before removal
The enclosure and vessels are extraction ventilated with the exhaust air is treated by water scrubbing to remove dust, particulates, various soluble gases and to cool the air prior to the biofilter. The biofilter is deep, comprising specified media and is fresh water irrigated.

Storage of the effluent within the lagoons and subsequent stirring/agitation and transfer.

On the basis of these points, backed up by reference data from research and measurements undertaken at the site, and taking into account the mass of material passing through the site, it may be determined that the key control points need to comprise:

6.2 Critical Control Points

1. Doorways of the reception buildings and extraction ventilation to the reception building.
2. Air treatment by fresh water scrubbing and biofiltration
3. Vessel out-loading to the external pad area, inclusive of windrow formation.
4. Windrow turning
5. Screening
6. Vehicle movements across dusty hard surfaced areas over the whole site area.

SECTION 7.0 Bioaerosol Published Reference Data

7.1 Reference Data

Various research projects have been commissioned by the EA some of which have been joint with the H&SE and the 'The Composting Association' (latterly AfOR now REA Ltd). The following summarises some of the relevant key points from these research.

7.2 HSE Reference Regarding Occupational Exposures from Composting and Agriculture

[Ref 1] Useful information is taken from the HSE reference: 'Occupational and environmental exposure to bioaerosols from composts and potential health effects - A critical review of published data'. RESEARCH REPORT 130 Prepared by The Composting Association and Health and Safety Laboratory for the Health and Safety Executive 2003. The HSE report provides information at section 8.3 as follows [Box 3]:

Box 3: Extract from Reference- Research Report 130

> **8.3 BIOAEROSOLS GENERATED BY OTHER INDUSTRIES**
> A wide range of industries may give rise to exposure of workers to bioaerosols, either through workplace activities purposefully involving the handling of micro-organisms, e.g., biotechnology, or through incidental exposure while working with contaminated materials. Both factory-based and agricultural activities have been investigated, mostly with respect to potential respiratory sensitisation or irritation in exposed workers. Reviews of bioaerosol exposure levels in various industries are given by Crook (1995), Eduard (1997) and Crook and Swan (2001). (These are re-presented here at Table 5).

The following Table 4 presents data from that report. It is immediately obvious that bioaerosols are ubiquitous and present in many industrial processes and in the background air. Activities that involve either livestock (manure/bedding or fodder) or vegetable matter (crops/plants/vegetation) are identified as having much greater levels of bioaerosols in their working environment. These values are potentially 10 or 100 times greater than the thresholds that the EA have advised for Total bacteria (1000 $cfu.m^{-3}$) and Aspergillus Fumigatus (500 $cfu.m^{-3}$) although it will be noted that the levels shown are for Fungi, not just Aspergillus Fumigatus.

Table 4. Airborne bacteria and fungi cfu/m3 and endotoxin (ng/m3) in various workplaces - agriculture (from Crook, 1995, Eduard, 1997 and Crook and Swan, 2001)

Work activity All units are $cfu.m^{-3}$	**Bacteria**	**Fungi**	**Endotoxin (where measured)**	**Predominant organisms**
Grain stores on farms	10^5	10^4	10^3	Fungi including *Aspergillus*
Handling mouldy hay, grain on farms	10^8	10^8		*Aspergillus fumigatus*, actinomycetes
Grain harvesting	10^7– 10^8	10^5- 10^7		Fungi including *Aspergillus,* Gram positive bacteria
Animal feed mills	-	10^3	10^1-10^2	Fungi including *Aspergillus*
Cattle sheds	10^3 - 10^5	10^4– 10^5	10^3- 10^4	Fungi including *Aspergillus*
Horse stables	10^5	10^3- 10^4	10^1- 10^3	Fungi including *Aspergillus*
Pig houses	10^4- 10^6	10^4– 10^5	10^2-10^4	Gram positive and negative bacteria
Poultry houses	10^5	10^3	10^2	Fungi including *Aspergillus*
Handling mushroom compost	10^7	10^5		Actinomycetes
Picking mushrooms	10^3	10^5		Fungi (*Trichoderma*)
Wood bark composting	10^4- 10^5	10^6– 10^7		Fungi (*Paecilomyces*)

7.3 EA Cranfield University Reference - Assessment of Bioaerosol Risks from Composting

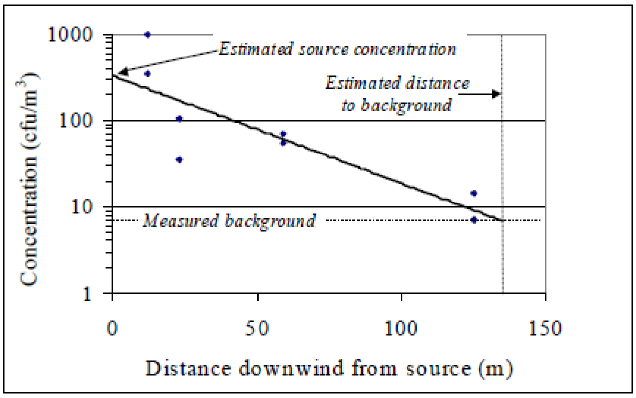
[Ref 2] Similar Data has been presented in the EA/ Cranfield University Reference: Guidance on the Evaluation of Risk Assessments for Composting Facilities, Cranfield University (G.H. Drew et al) published by the EA August 2009 and can be found on the web-address: http://publications.environment-agency.gov.uk/pdf/GEHO0809BQUO-e-e.pdf

7.4 The 'Health & Safety' and Composting Association Report

This Report considers the recent joint research findings of the **Health and Safety Executive (HSE)** and **The Composting Association (TCA).** The HSE/TCA report summarises the evidence that bioaerosols are widely present in agricultural activities as a norm; it reveals that bioaerosol levels reduce (much as dust levels reduce) with distance from the source; and concludes that the bulk of evidence suggests that bioaerosol levels reduce to background within a distance of 200m.

A review of many research and scientific articles, provided trial results data that revealed that concentrations of both culturable mesophilic bacteria and *A. Fumigatus* downwind of source activities decreased **approximately exponentially with distance** from the source, and generally attained background levels (measured and estimated from the median sampled throughout the study period) within 200 m of the source activities. The summary of this is depicted in Figure 7: and shows the rapid reduction of bioaerosol concentration in air with increased separation distance.

Figure 7: **Concentrations of culturable *Aspergillus fumigatus* measured at distances downwind from a 'turning' operation at Site A (sample code**



7.5 The Health Risks Assessment undertaken by Enviros on behalf of DEFRA. Report

The scientific reference - **Health Risks Assessment undertaken by Enviros on behalf of DEFRA,** shows there is no evidence of a link of ill health between Composting Sites and third parties. **[See Box 4.]**

Box 4: Summary Extract of Information taken from the Enviros - Health Risks Assessment

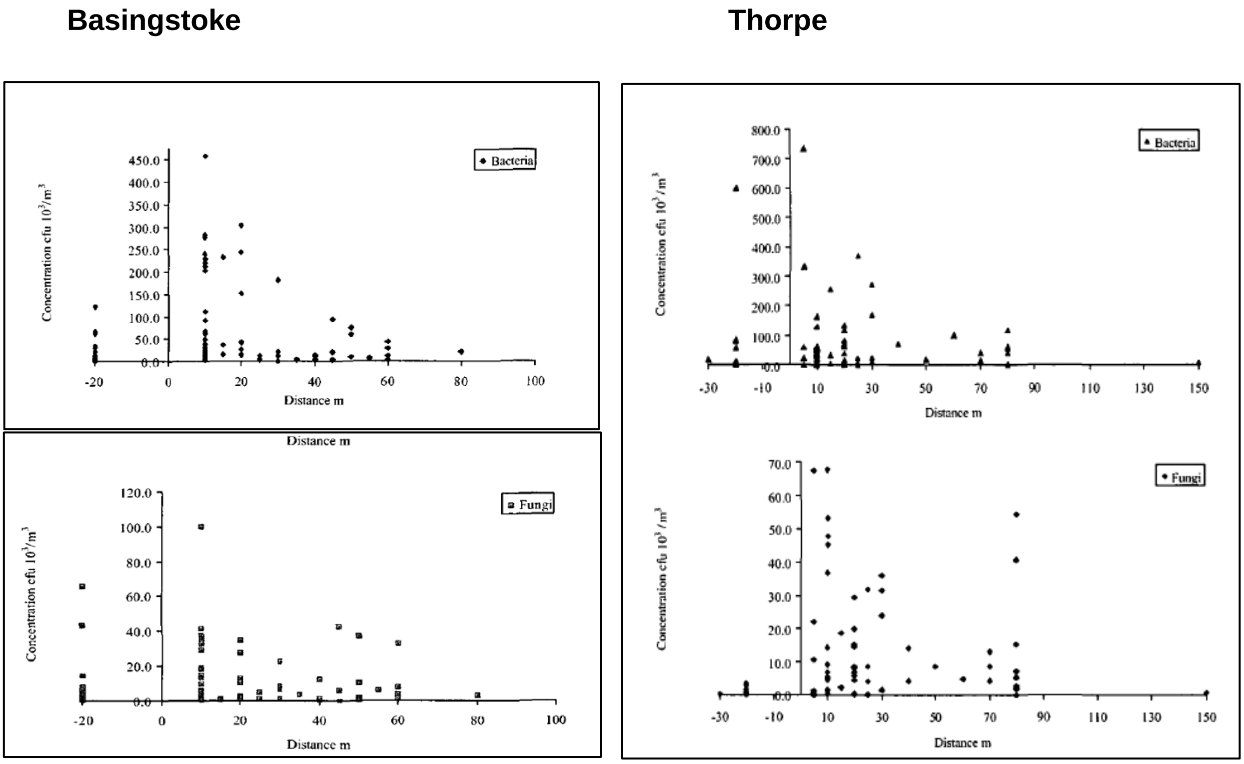
Composting on a major scale is a relatively new and rapidly expanding industry in the UK. There is little published evidence of serious/chronic disease in compost workers, although there is evidence of early ill health responses to prolonged bioaerosol exposure. e.g. there is evidence of raised antibody levels and inflammatory mediators, and evidence of progressive allergic respiratory disease in industries such as waste handling, **agriculture** and cotton mills, where similar exposure to bioaerosols may exist.

Only few published studies exist where the health of residents near to composting facilities has been investigated, **but where this has been done there is no evidence of significant ill health compared to unexposed controls**.

7.6 Environment Agency Health Effects of Composting - A Study of Three Compost Sites and Review of Past Data, 2001. Report

One of the first main scientific research documents published in the UK was by the Environment Agency *Health Effects of Composting - A Study of Three Compost Sites and Review of Past Data*, 2001 (researcher AEAT). This focussed on three composting sites, including two open air turned windrow and one in-vessel unit. Many different emissions were measured from the sites, with bioaerosols being a leading part of the investigations. The research looked at levels for total bacteria, total fungi and gram-negative bacteria, and following the sampling, modelling and review of past data, the Environment Agency's reference levels of 1,000 cfu.m^{-3}, 1,000 cfu.m^{-3} and 300 cfu.m^{-3} respectively, were derived and have since been revised. The results from the overall work, which mainly focussed on the shredding, turning and screening operations on the open windrow sites, showed some variations in results. The rate in decline of bioaerosols from the source was however quite well defined, with most of the results showing a clear and rapid fall in concentrations, as shown in Figure 8 below and as depicted in Figure 12 of Section 8 'Bioaerosols Dispersal'. For most of the results, the concentrations had significantly fallen back by about 100-150 metres from the source, and most were either back to the background level or below the reference level by 250 metres.

Figure 8: Results from Environment Agency Health Effects of Composting - A Study of Three Compost Sites and Review of Past Data, 2001.



7.8 Bioaerosol Monitoring and Dispersal from Composting Sites, 2005 (researcher ADAS)

A Landfill Tax Credit Scheme (LTCS) funded research project also looked at the rate of decline of bioaerosols from composting sites. The report publish by SWIC-EB *Bioaerosol Monitoring and Dispersal from Composting Sites*, 2005 (researcher ADAS) focused on three composting sites, including two in-vessel technologies and one open-windrow system. Sampling for bioaerosols was conducted on a wide range of composting activities, including shredding, turning, loading, unloading and screening. Sampling also took place while different materials were being composted, including municipal waste, agricultural waste and kitchen waste. The results of this study show that **91% of all micro-organisms sampled across all three sites were below 1,000 cfu.m^{-3} at 125 metres downwind from the boundary**. The specific summary data for the open windrow system is shown in an extract at Figures 8, 9 and 10, and clearly shows the decline in concentrations. Although 125 metres downwind of the facility boundary was the greatest sampling distance in this study, it would appear likely that upwind concentrations would more or less be achieved in the majority of cases at separation distance of 200 metres downwind.

Extract from SWICEB Bioaerosol Monitoring and Dispersal from Composting Sites, 2005

Concentration (cfu.m^{-3}) - Totals by micro-organism type
The sampling data has also been analysed in terms of the distribution of each of the groups of micro- organisms. The following figures show the concentration of each group in each of the sampling positions. The data used to generate each figure represents a combination of the data collected for each group over all of the visits to Site B.

Figure 9: Concentration (cfu.m^{-3}) - combined total bacteria count – (SWIC-EB data)

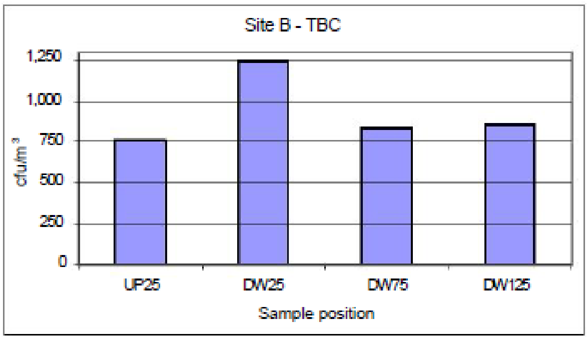
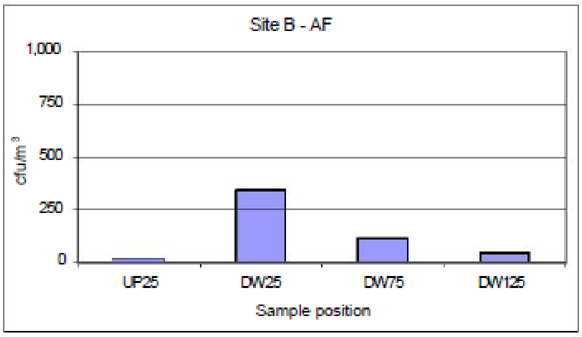


Figure 10: Concentration (cfu.m^{-3}) - combined *Aspergillus Fumigatus* – (SWIC-EB data)



The combined data (Figure 9.) shows the expected distribution for Total Bacteria (viable) Count with levels at 125m downwind of the boundary is almost returned back to the upwind result.

The combined data (Figure 10.) shows the expected distribution for *Aspergillus Fumigatus* with levels at 125m downwind of the boundary only very slightly higher than the upwind result.

7.9 Measurement and Modelling of Emissions from Three Composting Sites, 2007 (researcher Cranfield University)

Following this research, SNIFFER/SEPA published a report *Measurement and Modelling of Emissions from Three Composting Sites*, 2007 (researcher Cranfield University). Again, this research included two in-vessel technologies and one open windrow system and was mainly looking at measuring the source concentration and modelling the dispersion. There was a seasonal variation of *Aspergillus Fumigatus* at all the three sites, with concentrations being the highest in the autumn. When composting material was agitated (i.e. shredding, turning, moving, screening), the model predictions of downwind concentrations were within the same order of magnitude as the sampled concentrations, suggesting that the major contribution to downwind emissions was from "disturbance" activities, as shown by other researchers. The majority of the sampled concentrations were shown to be reduced to below the suggested threshold limit values by 250 m downwind of the sites.

7.10 Bioaerosols in waste composting: deriving source terms and characterising profiles, 2008

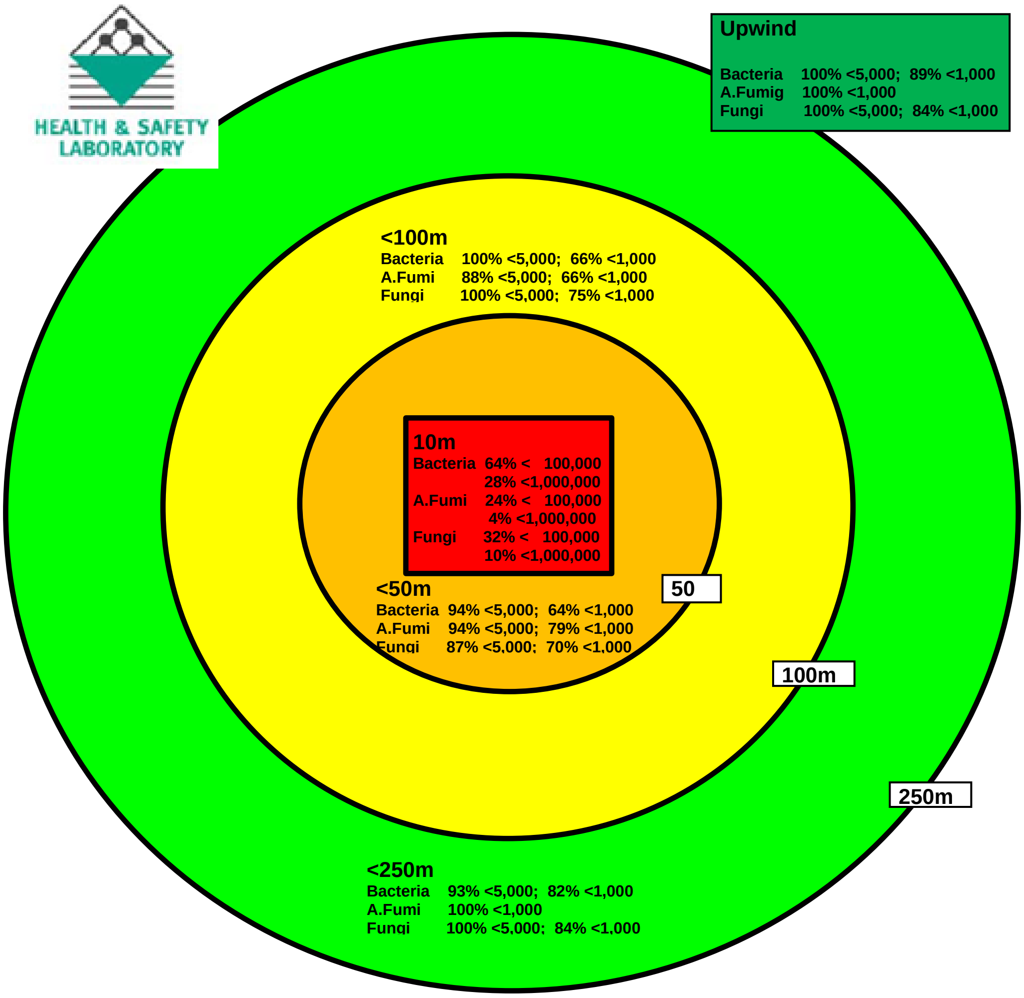
More recently, another report published by the Environment Agency, *Bioaerosols in waste composting: deriving source terms and characterising profiles*, 2008 (researcher Health & Safety Laboratory) looks at four sites representative of commercial composting activities in the UK. The sites again look at both in-vessel composting systems and open windrow composting. The results from the study showed that compost handling operations can release high concentrations of bacteria and fungi into the air in the immediate surroundings. Samples did show, however, that concentrations of bioaerosols tended to decrease as distance from the original source increased. **At distances of 50m and 100m downwind of composting activities, bioaerosols concentrations were significantly lower than in the immediate vicinity of the composting**

activity. The report authors also stated that there was no evidence that the composting operations visited made major contributions to the overall environmental bioaerosol burden at a distance of 250m from activities, and therefore no evidence to suggest that the Environment Agency's 250m trigger limit should be revised (increased).

7.11 Bioaerosol emissions from waste composting and the potential for workers' exposure Health and Safety Executive, 2010 (researcher Health & Safety Laboratory).

The most recent report was an extension to the above research, ***Bioaerosol emissions from waste composting and the potential for workers' exposure*** as published by the Health and Safety Executive, 2010 (researcher Health & Safety Laboratory). The dispersion of bioaerosols from compost handling activities was estimated by collecting bioaerosol samples at several points downwind increasing in distance from the emission site up to 250m. Upwind background samples were used as a benchmark.

Figure 11: Health and Safety Laboratory – Risk Zones
(showing how bioaerosol concentration changes with distance from the source)



Close to compost handling activities, if workers are not protected from exposure, they may be exposed to concentrations of airborne bacteria and fungi that frequently exceed 100,000 cfu.m^{-3} and occasionally (28% of bacterial samples and 10% of fungal samples) exceed 1 million cfu.m^{-3} air sampled. Downwind of compost handling activities, although at some sites the bioaerosol levels at times were higher than upwind even at 100 to 250m distance, still the majority of samples yielded fewer than 1,000 cfu.m^{-3} air.

At least 93% of bacteria and 98% of *Aspergillus Fumigatus* bioaerosol concentrations were less than 5,000 cfu.m^{-3} air, and could be considered to be within the range of 'typical' background levels. There was therefore little evidence that the composting operations studied made a major contribution to the overall bioaerosol burden by a distance of 250m from activities. Figure 10 provides a summary diagram of the findings from the research, showing how bioaerosol concentration changes with distance from the source, as denoted by the concentration zones.

7.12 Conclusions from research data

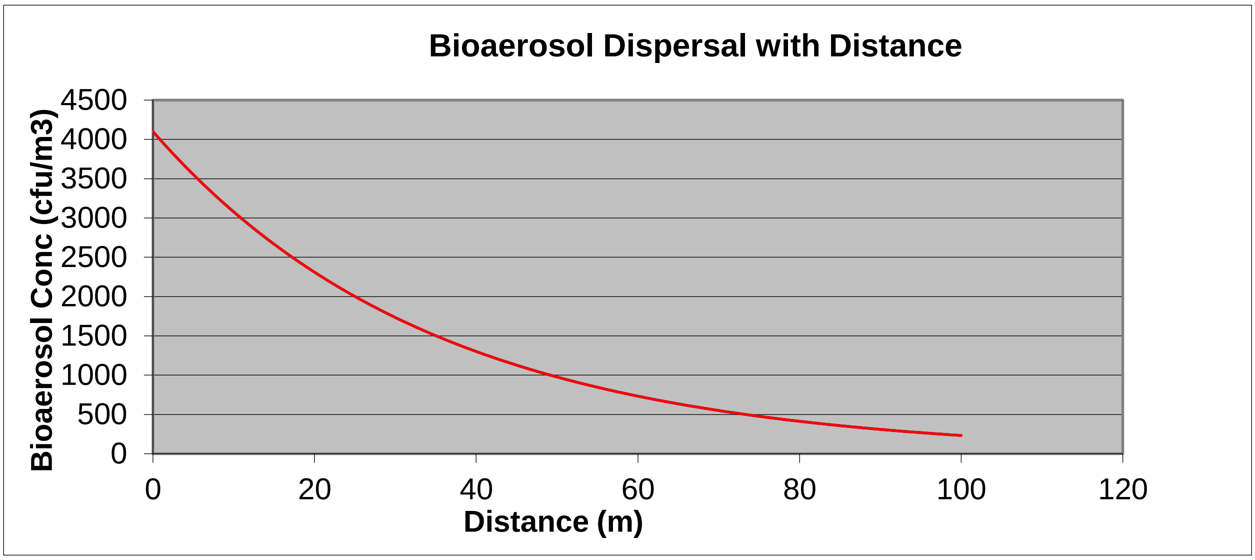
The greatest concentration of bioaerosols release is when composting material is disturbed or agitated, which mainly occurs during shredding, turning, and screening. It is apparent that in many cases very high levels of micro-organisms are released when these activities take place, but the concentrations quickly decline, typically within a range of 50 to 150 metres from the source. Local conditions do however have an impact on the concentrations, whether it is from elevated background levels, process conditions or windbreaks which either reduce the source emission or help disperse the emission.

All the research indicates that either background levels or the reference levels are achieved in the majority of cases by a separation distance of 250 metres, although mitigating measures could be used to reduce this distance.

SECTION 8.0 Bioaerosol Dispersal

As with any other type of emission (smoke, odour or noise), the emission will disperse in a three dimensional pattern around the source and particulate emissions will be highly influenced by wind and local topography. With increasing distance from the source, the volume of air into which the emission becomes mixed, increases in a semi-cubic relationship. In high wind speeds there is a greater element of mixing, turbulence and vertical lift; however in low wind-speeds the emission is not well mixed and will form a more definite plume, drifting away from the source.

Figure 12: Consideration of the Modelling for Bioaerosol Dispersal in regard to Wind and Distance.



In higher wind-speeds there is greater dispersal. In lower wind-speeds there is reduced release.

Factors such as ground rise, trees, hedges and buildings, have an effect on the shape of the plume, and weather conditions have an effect on the degree of vertical rise, mixing and attenuation e.g. in rain or moist air conditions.

Dispersions may be modelled, taking in to account these variables and local topography. Figure 12 illustrates this exponential decay in concentration:

The Figure shows the typical exponential dispersion of bioaerosols from a typical turned windrow system and may be used as an aid to indicate the levels of dispersal from a process that is not enclosed or protected by a scrubber/bio-filter system.

SECTION 9.0 Reference Site Bioaerosol Data

9.1 Introduction

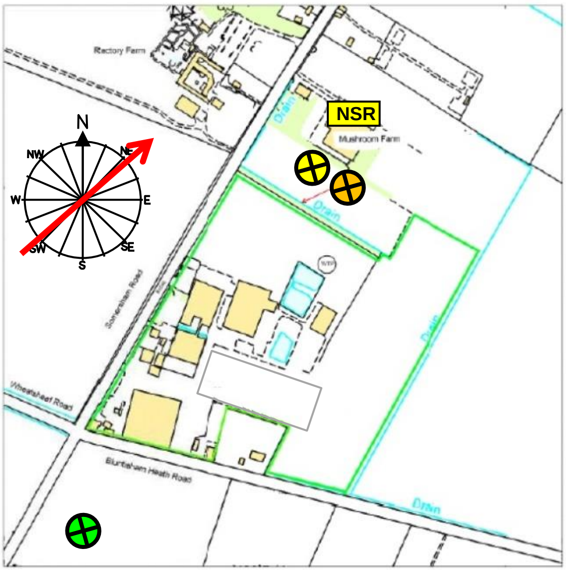
The Envar 'The Heath' composting site has previously been monitored to determine the bioaerosol levels under different operating conditions through 2015 to current date. Over this time there have been various developments and changes at the site and of course the site will have been undertaking different tasks and with varying degrees of capacity being utilised. Consideration is also given to the time of the seasons and potential off-site effects.

The following reviews the data and attempts to draw out and interpret these data. For ease of use, the data has been presented in a simplified way that provides the context and the results. While the interpretation of the data considers that within the original reports, the interpretation here brings in fresh expertise and experience in order to draw this to a summary.

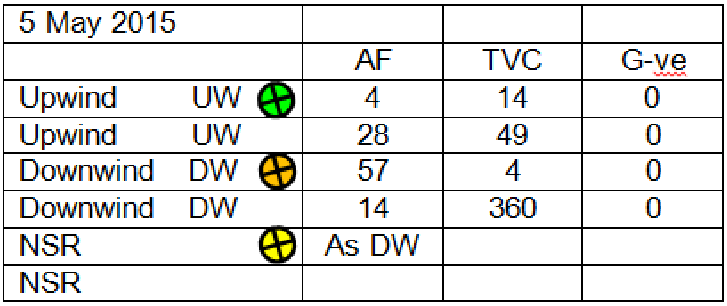
AF=Aspergillus Fumigatus; TVC = Total Viable Count of Bacteria (Total Bacteria)
G-ve = Gram negative bacteria (often associated with animals)
UW = Upwind; DW = Downwind; NSR = Nearest sensitive Receptor
Units are cfu.m^{-3} meaning colony forming units per cubic metre of air
Red arrow denotes average wind direction during sampling session.

9.2 Reference Data May 2015

Figure 13: Site Plan, stations and wind direction



Sample Results (cfu.m^{-3})

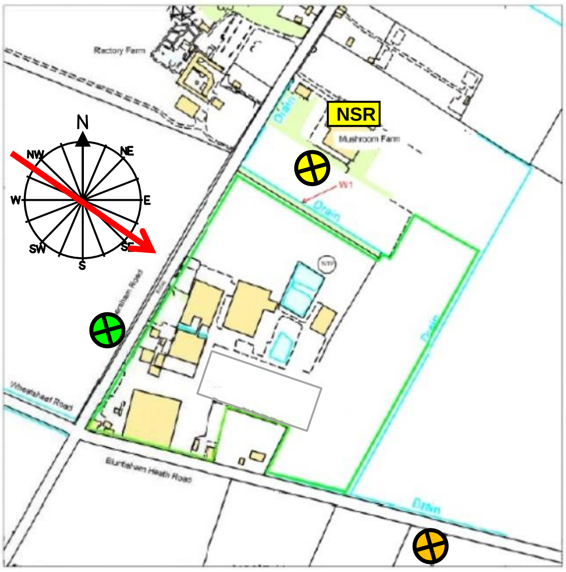


5 May 2015			
	AF	TVC	G-ve
Upwind UW ⊕	4	14	0
Upwind UW	28	49	0
Downwind DW ⊕	57	4	0
Downwind DW	14	360	0
NSR ⊕	As DW		
NSR			

Benchmarks	EA Thresholds= TVC 1000, AF 500 G-ve 300 cfu.m^{-3} Background AF typical 50
Interpretation	TVC LOW in UW, variable but LOW DW. G-ve absent.
Conclusion	Results suggest LOW contribution from the site. Variability noted and presence of AF noted while G-ve absent. (NOTE this characteristic is seen to change later)

9.3 Reference Data Sept 2015

Figure 14: Site Plan, stations and wind direction (red arrow)



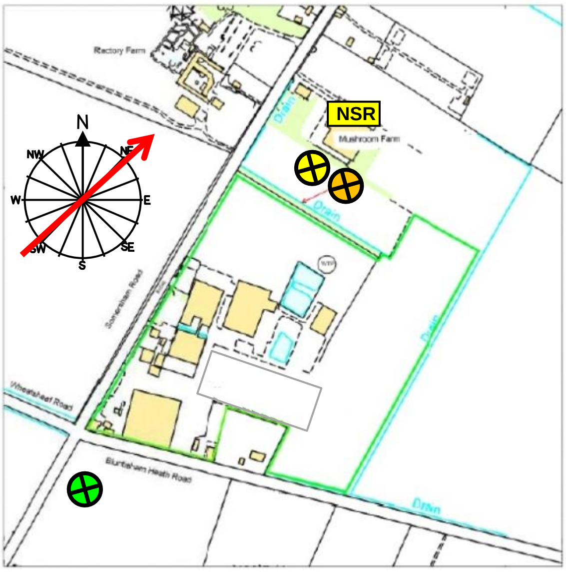
Sample Results (cfu.m^{-3})

Sept 2015			
	AF	TVC	G-ve
Upwind UW ⊕	0	0	0
Upwind UW	4	32	0
Downwind DW ⊕	>8576	290	0
Downwind DW			
NSR ⊕	11	18	
NSR			

Benchmarks	EA Thresholds= TVC 1000, AF 500 G-ve 300 cfu.m^{-3} Background AF typical 50
Interpretation	Low AF & TVC in UW. Excessive AF in DW with some TVC. G-ve absent. The excessive AF value is given due to the plate colonies being 'too numerous to count. Windrow turning was ongoing. There may have been a technical problem with the plates, or some other factor such as car/ vehicle movement on the road near to the sampling station. More recent results have shown (surprisingly) LOW levels of AF around the site
Conclusion	Results raise the concerns over AF as this is a health hazard; however, it is yet more surprising that the LOW TVC has been recorded because if it was the windrow turning, then both Bioaerosol types would have been elevated. Similarly, G-ve was absent. (NOTE this characteristic is seen to change later)

9.4 Reference Data Jan 2016

Figure 15: Site Plan, stations and wind direction (red arrow)



Sample Results (cfu.m^{-3})

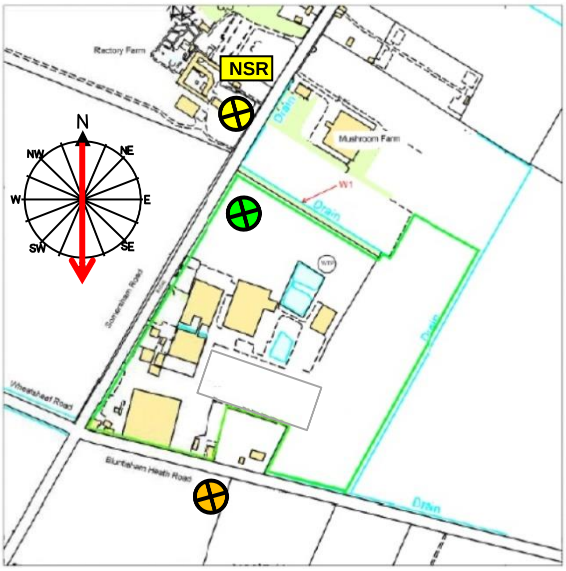
Jan 2016			
	AF	TVC	G-ve
Upwind UW ⊕	0	14	0
Upwind UW	7	0	0
Downwind DW ⊕	18	965	0
Downwind DW	14	587	0
NSR ⊕	As DW		
NSR			

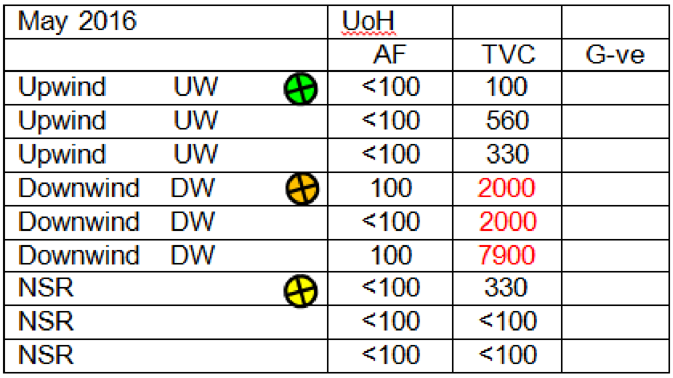
Benchmarks	EA Thresholds= TVC 1000, AF 500 G-ve 300 cfu.m^{-3} Background AF typical 50
Interpretation	Again, Very Low AF & TVC in UW. The results for the DW are more as would be expected with one of the results a little higher than may be expected. G-ve absent. The AF in DW is LOW and so the focus is on the TVC. The high TVC value may be a result of the sources being the Reception building doorways, the biofilter exhaust, the lagoons the windrows or the screening activities.
Conclusion	These results raise the concerns over TVC and on this occasion are contrary to the previous results where AF was flagged. It is strange that the G-ve are not elevated to reflect the high TVC and seems to suggest that the source is Bacteria that do not include G-ve and there-fore suggest the source is treated material.

9.5 Reference Data May 2016

NOTE: The Technicians and the Technique for Monitoring and Sampling Bioaerosols was changed and at the same time the characteristics within the results has changed.

Figure 16: Site Plan, stations and wind direction (red arrow) Sample Results (cfu.m^{-3})



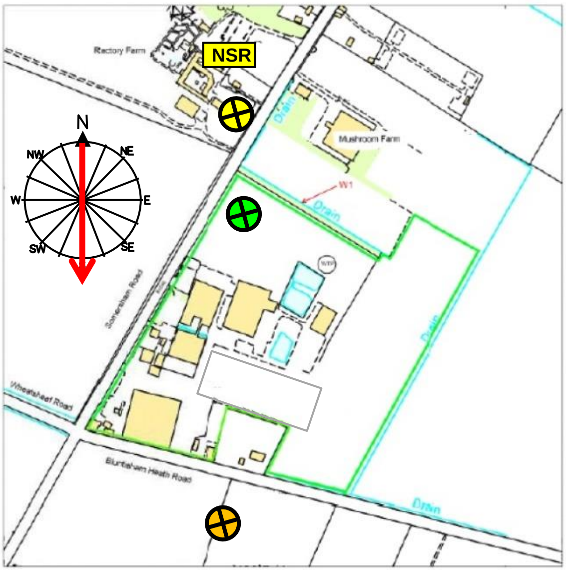


May 2016	UoH		
	AF	TVC	G-ve
Upwind UW ⊕	<100	100	
Upwind UW	<100	560	
Upwind UW	<100	330	
Downwind DW ⊕	100	2000	
Downwind DW	<100	2000	
Downwind DW	100	7900	
NSR ⊕	<100	330	
NSR	<100	<100	
NSR	<100	<100	

Benchmarks	EA Thresholds= TVC 1000, AF 500 G-ve 300 cfu.m^{-3} Background AF typical 50
Interpretation	Low to Moderate AF and TVC in the UW. (G-ve not done) The results for the DW reveal no contribution to the AF, BUT the TVC become excessive. Unfortunately the reporting of the AF as <100 is not useful, as this could mean AF were absent or Low to moderate, however they are reported at 100 cfu.m^{-3} in the DW. The sampling station was located very close to the Screening Building and for the time of year, traffic movements would account for the raised levels as dust raining from the concreted ground surfaces.
Conclusion	These results point towards the vehicle activities in and around the product screening as being the more likely sources of the raised AF and elevated TVC.

9.6 Reference Data July 2016

Figure 17: Site Plan, stations and wind direction (red arrow) Sample Results (cfu.m^{-3})

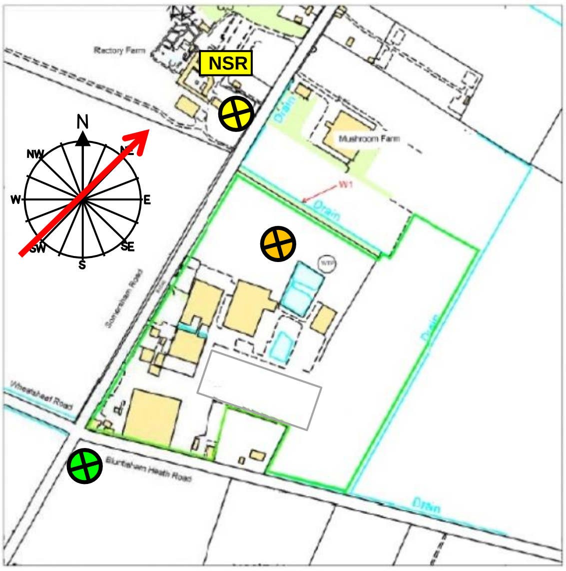


July 2016			UoH		
			AF	**TVC**	**G-ve**
Upwind	UW	⊕	**<100**	**1110**	**<100**
Upwind	UW		**<100**	**670**	**<100**
Upwind	UW		**<100**	**670**	**220**
Downwind	DW	⊕	**100**	**220**	**<100**
Downwind	DW		**<100**	**1670**	**<100**
Downwind	DW		**100**	**2440**	**<100**
NSR		⊕	**<100**	**220**	**<100**
NSR			**<100**	**440**	**<100**
NSR			**<100**	**110**	**<100**

Benchmarks	EA Thresholds= TVC 1000, AF 500 G-ve 300 cfu.m^{-3} Background AF typical 50
Interpretation	Low to Moderate AF and some HIGH TVC in the UW. G-ve LOW to Moderate in the UW. It is July and this is in agricultural harvest season. The very HIGH UW levels may be subtracted from the DW levels to gain an idea of the level of contribution from the site and despite some variability, this suggests that the TVC are elevated and may be excessively so. Two results for the DW AF show actual values are Low to Moderate and so as with the May data this suggests that the contribution may be associated with dust raising from traffic movements on the site. The DW sampling station was located very close to the Screening Building and therefore does not provide readily useful data that accounts for dispersion.
Conclusion	These results point towards the vehicle activities in and around the product screening as being the more likely sources of the raised AF and elevated TVC.

9.7 Reference Data Sept 2016

Figure 18: Site Plan, stations and wind direction (red arrow) Sample Results (cfu.m^{-3})

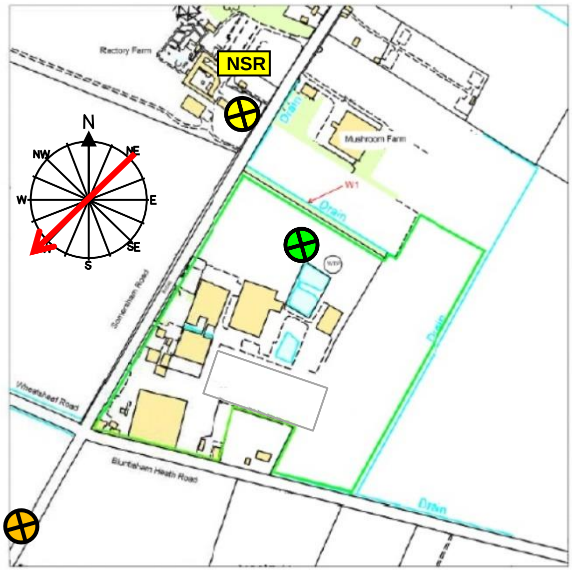


Sept 2016			UoH		
			AF	TVC	G-ve
Upwind	UW	⊕	<100	780	<100
Upwind	UW		<100	440	<100
Upwind	UW		<100	110	220
Downwind	DW	⊕	110	1220	110
Downwind	DW		110	1220	<100
Downwind	DW		<100	1440	110
NSR		⊕	<100	<100	<100
NSR			<100	<100	<100
NSR			<100	220	<100

Benchmarks	EA Thresholds= TVC 1000, AF 500 G-ve 300 cfu.m^{-3} Background AF typical 50
Interpretation	Potentially Low AF and some variable and HIGH TVC in the UW. G-ve now revealed in the UW. It is September and late into the agricultural harvest and into the field cultivations season. The results show excessively HIGH levels in the DW although if the UW is subtracted, these become typical for the DW levels expected. It is interesting to note the G-ve showing as Moderate levels…. Previously these were absent (This could be a quirk in the sampling technique between the use of Plates versus tubes as used in this instance.) The results for the DW TVC could now be seen as relating to the reception building as the G-ve are evident. HOWEVER the DW sampling station was located quite close to the Reception Building and therefore does not provide readily useful data that accounts for dispersion. It is notable that the levels at the NSR are so LOW compared to the UW and when the proximity of the High levels at the DW station are taken into consideration, suggesting that the source was quite specific rather than diffuse.
Conclusion	On the basis of there being HIGH TVC together with MODERATE G-ve these results point towards emissions from the doorways of the reception building and/or the lagoons or IVC biofilter exhaust.

9.8 Reference Data Dec 2016

Figure 19: Site Plan, stations and wind direction (red arrow)



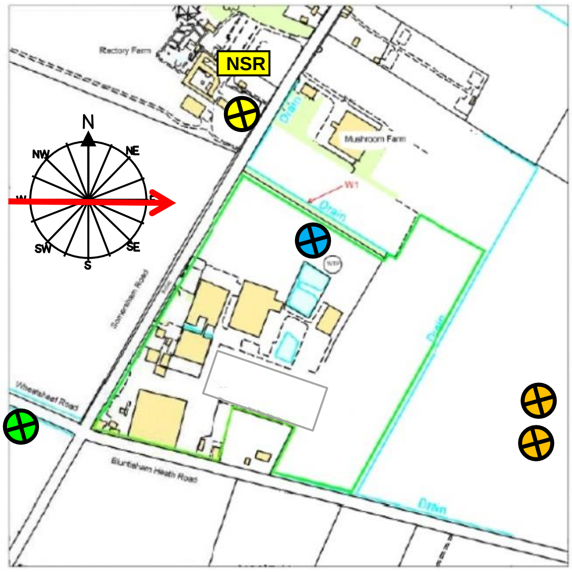
Sample Results (cfu.m^{-3})

Dec 2016			UoH		
			AF	TVC	G-ve
Upwind	UW	⊕	<100	<100	<100
Upwind	UW		<100	110	<100
Upwind	UW		<100	110	<100
Downwind	DW	⊕	<100	1887	<100
Downwind	DW		<100	2553	<670
Downwind	DW		<100	1110	<100
NSR		⊕	<100	<100	<100
NSR			<100	<100	<100
NSR			<100	220	<100

Benchmarks	EA Thresholds= TVC 1000, AF 500 G-ve 300 cfu.m^{-3} Background AF typical 50
Interpretation	Potentially Low AF and some variable and HIGH TVC in the UW. There is an excessively HIGH level of G-ve now revealed in the DW. Otherwise, these data provide a very similar picture to the data found for September although the DW station was located further away from the site and very much further away from the Reception Building doors. This seems to point toward the IVC Biofilter as a potential specific source to which is being added diffuse contributions.
Conclusion	On the basis of there being HIGH TVC together with MODERATE G-ve and an investigation of the biofilter revealing airflow performance and leakage issues a number of measures for site improvement were discussed and are being developed and implemented.

9.9 Reference Data March 2017

Figure 20: Site Plan, stations and wind direction (red arrow) Sample Results (cfu.m^{-3})



March 2017	UoH		
	AF	TVC	G-ve
Upwind UW ⊕	Avg 2	Avg 2	Avg 2
Downwind DWn ⊕	0	164	79
Downwind DWn	0	286	100
Downwind DWn	0	86	71
Downwind DWn	0	86	43
Downwind DWs	0	479	279
Downwind DWs	0	286	171
Downwind DWs	0	314	164
Downwind DWs	0	171	221
DW of Reception ⊕	14	50	279
DW of Reception	43	14	143
NSR ⊕	Avg 2	Avg 4	Avg 9

Benchmarks	EA Thresholds= TVC 1000, AF 500 G-ve 300 cfu.m^{-3} Background AF typical 50
Interpretation	NOTE: The measurement technique used **Plates** rather than tubes. These results follow development works that have been undertaken at site, including attention to the biofilter and dust suppression systems. UW bioaerosols were either VERY LOW or absent. The DW bioaerosols revealed nil AF. This may be a reflection of the time of year, however AF were present in samples to the NE of the site where there is no bund. The levels DW are what may be expected for March weather and time of season and site level of activity not at its highest. At the time of sampling, the main activity was Vessel Outloading. This may be the reason why the levels of TVC and G-ve were very similar. During Outloading, the vessel eastern door is opened and some air off compost nearest the door escapes from the vessel.
Conclusion	It is remarkable that the AF were near absent in the DW. On the basis of this one instance, it rather renders the Sept 2015 (para 9.3) AF result as spurious. The results appear to show that with dispersion, the DW levels of Bioaerosols can be manged to levels within the EA thresholds.

9.10 Summary and Conclusions from Historic (pre-June 2017) Data (AfOR Method)

Given the history of the site and the way it has developed, changed management and the techniques for monitoring bioaerosols have been implemented and have changed, it is difficult to draw absolutely robust conclusions from the data.

However, with the exception of one spurious result for Aspergillus Fumigatus and some elevated Total Bacteria results that may be explained by attention to some very specific aspects of the site; the results do show that the site can be operated and managed so that the emissions of bioaerosols are LOW or at Least LOW to MODERATE.

The Risk Assessment in section 10 takes these findings into account and the level of residual risk is predicted on the basis that the new management and improved procedures will continue.

9.11 Recent History (2017-2024) of Monitoring – extended site in operation

The following sections relate to more recent data, the majority of which was compiled based on monitoring using the M9 Method. Due to the volume of data, the information is provided in Tabular form with only brief descriptions.

The Data has been collected based on the twice per year requirement as required by the Permit. The M9 Method (see Appendix 2) requires that a 'Fan-Tail' arrangement of samplers are used in the Downwind Direction to take account of small changes in wind direction. Attention is given to the Maximum Mean value derived from the Data.

The full Data is available within the archive of Reports submitted to the Environment Agency. Much of this data was captured by Recogen Ltd of Shrewsbury, and the laboratory work undertaken by D&F Associates of Widnes.

9.12 Bioaerosols Monitoring June to November 2017 – Envar St. Ives. (AfOR Method)

June 2017. Wind from the SW towards NSR. Stations near the Mushroom Farm and NSR

Sampler location	Total Bacteria cfu.m-3	Aspergillus Fumigatus cfu.m-3	Gram Negative Bacteria cfu.m-3
(Average UW-South)	(13)	(10)	(13)
(Average NSR-North-West)	(37)	(1)	(9)
(Average DW-North)	(651)	(16)	(46)

Sept 2017. Wind from the West towards fields. Stations in field to the East

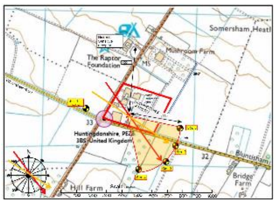
Sampler location	Total Bacteria cfu.m-3	Aspergillus Fumigatus cfu.m-3	Gram Negative Bacteria cfu.m-3
(Average UW-West)	(81)	(8)	(8)
(Average NSR--North)	(37)	(9)	(10)
(Average DW-East)	(198)	(7)	(84)

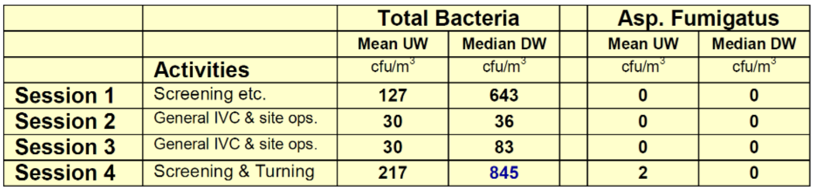
Nov 2017. Wind from the WSW towards fields. Stations in field to the NE

Sampler location	Total Bacteria cfu.m-3	Aspergillus Fumigatus cfu.m-3	Gram Negative Bacteria cfu.m-3
(Average UW-WSW)	(45)	(25)	(4)
(Average NSR--North)	(5)	(9)	(4)
(Average DW-ENE)	(71)	(24)	(27)

9.13 Bioaerosols Monitoring 2018 onwards – Envar St. Ives. (M9 Method)

March 2018

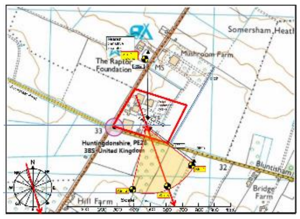


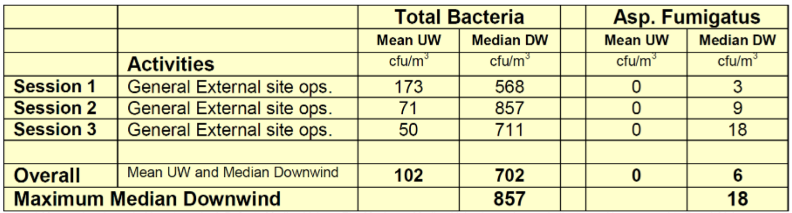


		Total Bacteria			Asp. Fumigatus	
		Mean UW	Median DW		Mean UW	Median DW
	Activities	cfu/m^3	cfu/m^3		cfu/m^3	cfu/m^3
Session 1	Screening etc.	**127**	**643**		**0**	**0**
Session 2	General IVC & site ops.	**30**	**36**		**0**	**0**
Session 3	General IVC & site ops.	**30**	**83**		**0**	**0**
Session 4	Screening & Turning	**217**	**845**		**2**	**0**

* Mean value downwind is not required. Refer to Median Values. The Maximum Median Value is used as an indicator and is compared to Permit Values.

May 2018





		Total Bacteria			Asp. Fumigatus	
		Mean UW	Median DW		Mean UW	Median DW
	Activities	cfu/m^3	cfu/m^3		cfu/m^3	cfu/m^3
Session 1	General External site ops.	173	568		0	3
Session 2	General External site ops.	71	857		0	9
Session 3	General External site ops.	50	711		0	18
Overall	Mean UW and Median Downwind	**102**	**702**		**0**	**6**
Maximum Median Downwind			**857**			**18**

* Mean value downwind is not required. Refer to Median Values. The Maximum Median Value is used as an indicator and is compared to Permit Values.

September 2018

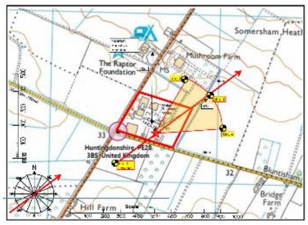
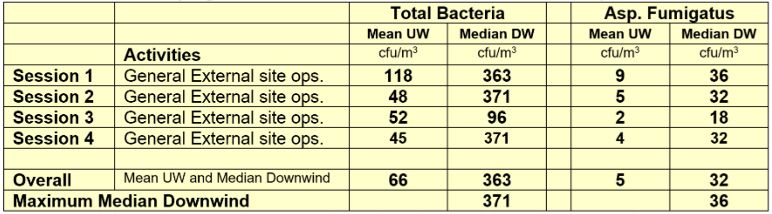


Table 5: SUMMARY TABLE - Sampling Results – Bioaerosols - Envar Ltd – The Heath - 13th September 2018



		Total Bacteria			Asp. Fumigatus	
		Mean UW	Median DW		Mean UW	Median DW
	Activities	cfu/m^3	cfu/m^3		cfu/m^3	cfu/m^3
Session 1	General External site ops.	**118**	**363**		**9**	**36**
Session 2	General External site ops.	**48**	**371**		**5**	**32**
Session 3	General External site ops.	**52**	**96**		**2**	**18**
Session 4	General External site ops.	**45**	**371**		**4**	**32**
Overall	Mean UW and Median Downwind	**66**	**363**		**5**	**32**
Maximum Median Downwind			**371**			**36**

* Mean value downwind is not required. Refer to Median Values. The Maximum Median Value is used as an indicator and is compared to Permit Values.

November 2018

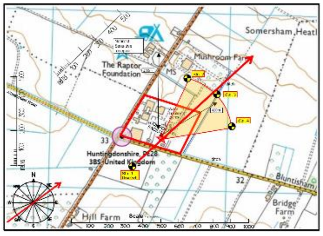
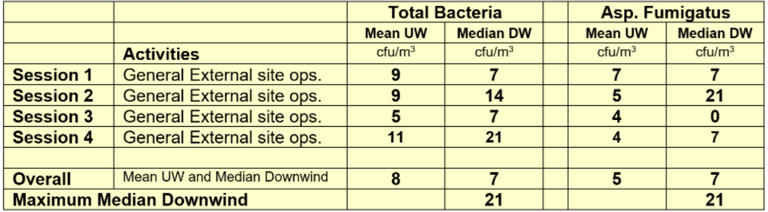


Table 5: SUMMARY TABLE - Sampling Results – Bioaerosols - Envar Ltd – The Heath - 14th November 2018



		Total Bacteria			Asp. Fumigatus	
		Mean UW	Median DW		Mean UW	Median DW
	Activities	cfu/m^3	cfu/m^3		cfu/m^3	cfu/m^3
Session 1	General External site ops.	**9**	**7**		**7**	**7**
Session 2	General External site ops.	**9**	**14**		**5**	**21**
Session 3	General External site ops.	**5**	**7**		**4**	**0**
Session 4	General External site ops.	**11**	**21**		**4**	**7**
Overall	Mean UW and Median Downwind	**8**	**7**		**5**	**7**
Maximum Median Downwind			**21**			**21**

* The Maximum Median Value is used as an indicator and is compared to Permit Values.

June 2019

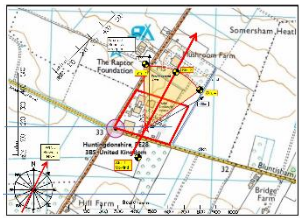
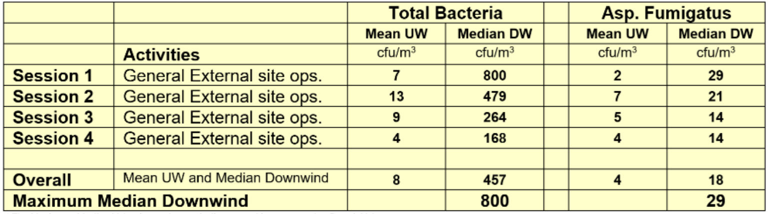


Table 5: SUMMARY TABLE - Sampling Results – Bioaerosols - Envar Ltd – The Heath - 17th June 2019



		Total Bacteria			Asp. Fumigatus	
		Mean UW	Median DW		Mean UW	Median DW
	Activities	cfu/m^3	cfu/m^3		cfu/m^3	cfu/m^3
Session 1	General External site ops.	**7**	**800**		**2**	**29**
Session 2	General External site ops.	**13**	**479**		**7**	**21**
Session 3	General External site ops.	**9**	**264**		**5**	**14**
Session 4	General External site ops.	**4**	**168**		**4**	**14**
Overall	Mean UW and Median Downwind	**8**	**457**		**4**	**18**
Maximum Median Downwind			**800**			**29**

* The Maximum Median Value is used as an indicator and is compared to Permit Values.

December 2019

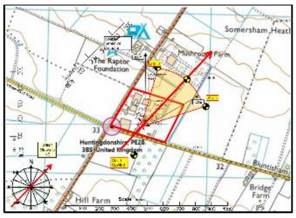
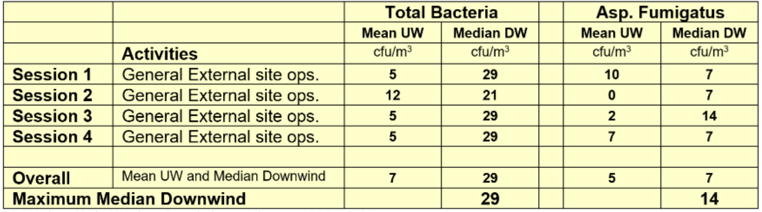


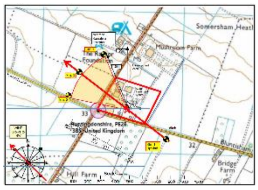
Table 5: SUMMARY TABLE - Sampling Results – Bioaerosols - Envar Ltd – The Heath - 11th December 2019



		Total Bacteria			Asp. Fumigatus	
		Mean UW	Median DW		Mean UW	Median DW
	Activities	cfu/m^3	cfu/m^3		cfu/m^3	cfu/m^3
Session 1	General External site ops.	**5**	**29**		**10**	**7**
Session 2	General External site ops.	**12**	**21**		**0**	**7**
Session 3	General External site ops.	**5**	**29**		**2**	**14**
Session 4	General External site ops.	**5**	**29**		**7**	**7**
Overall	Mean UW and Median Downwind	**7**	**29**		**5**	**7**
Maximum Median Downwind			**29**			**14**

* The Maximum Median Value is used as an indicator and is compared to Permit Values.

March 2020



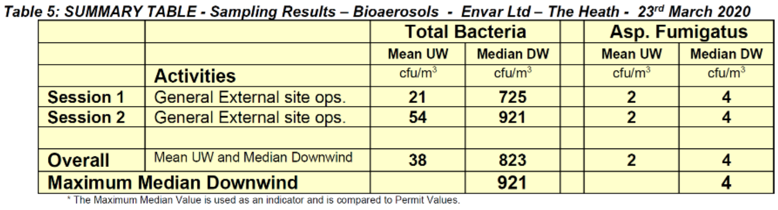
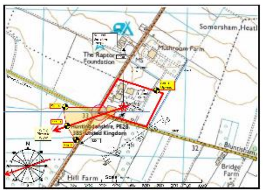


Table 5: SUMMARY TABLE - Sampling Results – Bioaerosols - Envar Ltd – The Heath - 23rd March 2020

		Total Bacteria			Asp. Fumigatus	
		Mean UW	Median DW		Mean UW	Median DW
	Activities	cfu/m^3	cfu/m^3		cfu/m^3	cfu/m^3
Session 1	General External site ops.	21	725		2	4
Session 2	General External site ops.	54	921		2	4
Overall	Mean UW and Median Downwind	38	823		2	4
Maximum Median Downwind			921			4

* The Maximum Median Value is used as an indicator and is compared to Permit Values.

October 2020



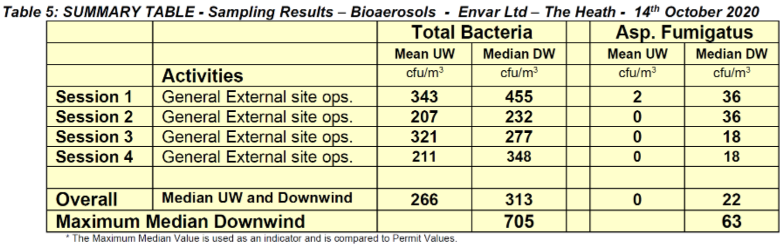
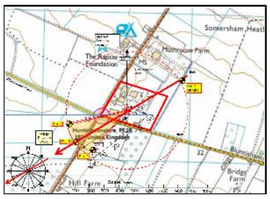


Table 5: SUMMARY TABLE - Sampling Results – Bioaerosols - Envar Ltd – The Heath - 14th October 2020

		Total Bacteria			Asp. Fumigatus	
		Mean UW	Median DW		Mean UW	Median DW
	Activities	cfu/m^3	cfu/m^3		cfu/m^3	cfu/m^3
Session 1	General External site ops.	343	455		2	36
Session 2	General External site ops.	207	232		0	36
Session 3	General External site ops.	321	277		0	18
Session 4	General External site ops.	211	348		0	18
Overall	Median UW and Downwind	266	313		0	22
Maximum Median Downwind			705			63

* The Maximum Median Value is used as an indicator and is compared to Permit Values.

April 2021



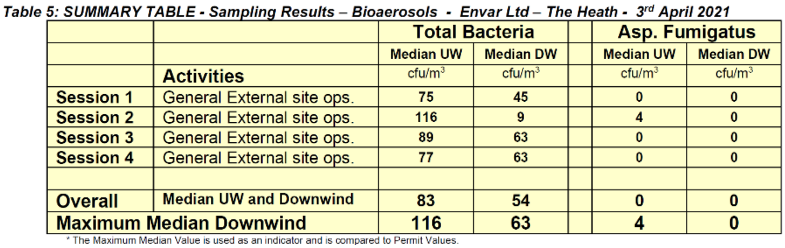
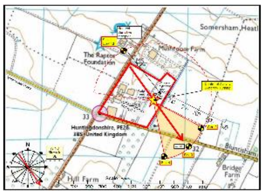


Table 5: SUMMARY TABLE - Sampling Results – Bioaerosols - Envar Ltd – The Heath - 3rd April 2021

		Total Bacteria			Asp. Fumigatus	
		Median UW	Median DW		Median UW	Median DW
	Activities	cfu/m^3	cfu/m^3		cfu/m^3	cfu/m^3
Session 1	General External site ops.	75	45		0	0
Session 2	General External site ops.	116	9		4	0
Session 3	General External site ops.	89	63		0	0
Session 4	General External site ops.	77	63		0	0
Overall	Median UW and Downwind	83	54		0	0
Maximum Median Downwind		116	63		4	0

* The Maximum Median Value is used as an indicator and is compared to Permit Values.

October 2021



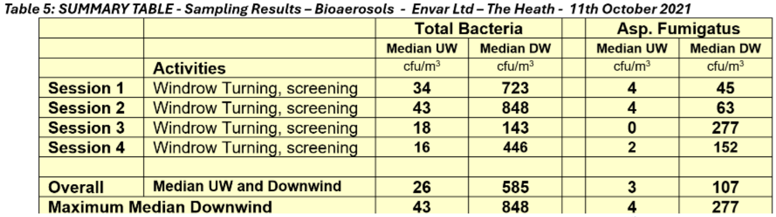
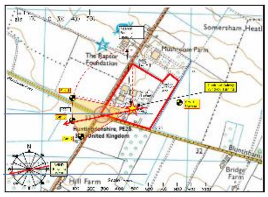


Table 5: SUMMARY TABLE - Sampling Results – Bioaerosols - Envar Ltd – The Heath - 11th October 2021

		Total Bacteria			Asp. Fumigatus	
		Median UW	Median DW		Median UW	Median DW
	Activities	cfu/m^3	cfu/m^3		cfu/m^3	cfu/m^3
Session 1	Windrow Turning, screening	34	723		4	45
Session 2	Windrow Turning, screening	43	848		4	63
Session 3	Windrow Turning, screening	18	143		0	277
Session 4	Windrow Turning, screening	16	446		2	152
Overall	Median UW and Downwind	26	585		3	107
Maximum Median Downwind		43	848		4	277

March 2022



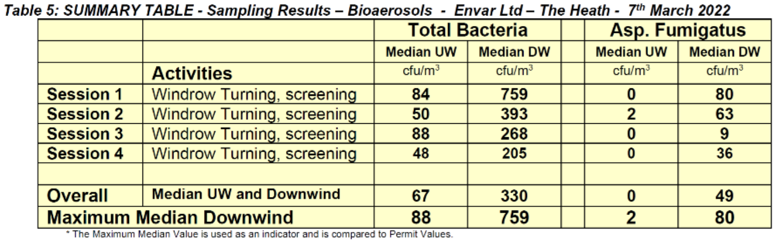
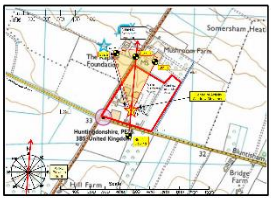


Table 5: SUMMARY TABLE - Sampling Results – Bioaerosols - Envar Ltd – The Heath - 7th March 2022

		Total Bacteria			Asp. Fumigatus	
		Median UW	Median DW		Median UW	Median DW
	Activities	cfu/m^3	cfu/m^3		cfu/m^3	cfu/m^3
Session 1	Windrow Turning, screening	84	759		0	80
Session 2	Windrow Turning, screening	50	393		2	63
Session 3	Windrow Turning, screening	88	268		0	9
Session 4	Windrow Turning, screening	48	205		0	36
Overall	Median UW and Downwind	67	330		0	49
Maximum Median Downwind		88	759		2	80

* The Maximum Median Value is used as an indicator and is compared to Permit Values.

October 2022



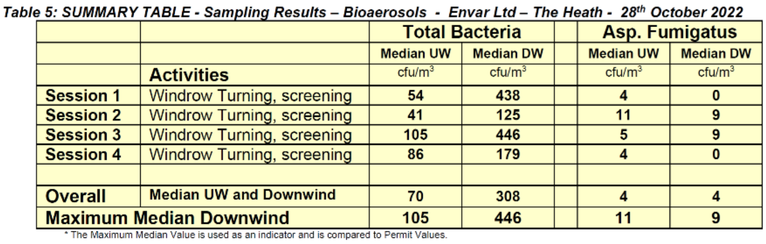
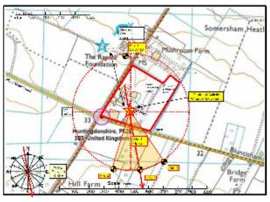


Table 5: SUMMARY TABLE - Sampling Results – Bioaerosols - Envar Ltd – The Heath - 28th October 2022

		Total Bacteria			Asp. Fumigatus	
		Median UW	Median DW		Median UW	Median DW
	Activities	cfu/m^3	cfu/m^3		cfu/m^3	cfu/m^3
Session 1	Windrow Turning, screening	54	438		4	0
Session 2	Windrow Turning, screening	41	125		11	9
Session 3	Windrow Turning, screening	105	446		5	9
Session 4	Windrow Turning, screening	86	179		4	0
Overall	Median UW and Downwind	70	308		4	4
Maximum Median Downwind		105	446		11	9

* The Maximum Median Value is used as an indicator and is compared to Permit Values.

March 2023



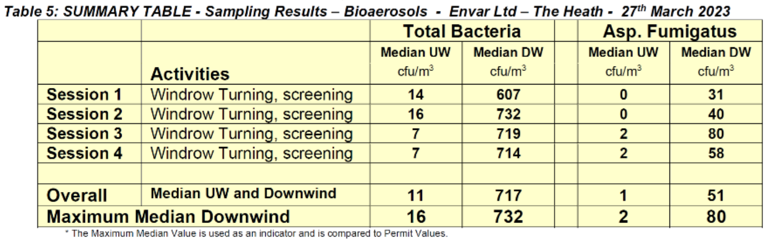


Table 5: SUMMARY TABLE - Sampling Results – Bioaerosols - Envar Ltd – The Heath - 27th March 2023

		Total Bacteria			Asp. Fumigatus	
	Activities	Median UW cfu/m^3	Median DW cfu/m^3		Median UW cfu/m^3	Median DW cfu/m^3
Session 1	Windrow Turning, screening	14	607		0	31
Session 2	Windrow Turning, screening	16	732		0	40
Session 3	Windrow Turning, screening	7	719		2	80
Session 4	Windrow Turning, screening	7	714		2	58
Overall	Median UW and Downwind	11	717		1	51
Maximum Median Downwind		16	732		2	80

* The Maximum Median Value is used as an indicator and is compared to Permit Values.

October 2023

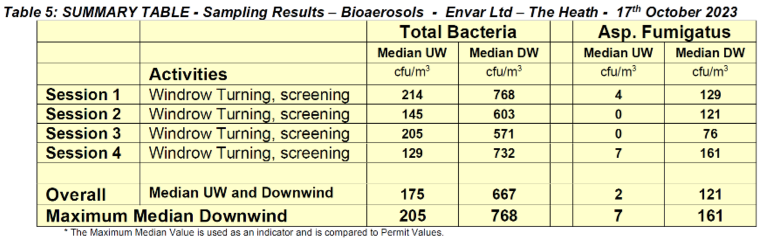


Table 5: SUMMARY TABLE - Sampling Results – Bioaerosols - Envar Ltd – The Heath - 17th October 2023

		Total Bacteria			Asp. Fumigatus	
		Median UW	Median DW		Median UW	Median DW
	Activities	cfu/m^3	cfu/m^3		cfu/m^3	cfu/m^3
Session 1	Windrow Turning, screening	214	768		4	129
Session 2	Windrow Turning, screening	145	603		0	121
Session 3	Windrow Turning, screening	205	571		0	76
Session 4	Windrow Turning, screening	129	732		7	161
Overall	Median UW and Downwind	175	667		2	121
Maximum Median Downwind		205	768		7	161

* The Maximum Median Value is used as an indicator and is compared to Permit Values.

March 2024

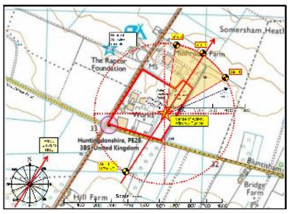
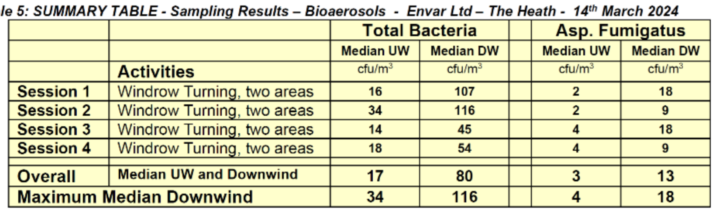


Table 5: SUMMARY TABLE - Sampling Results – Bioaerosols - Envar Ltd – The Heath - 14th March 2024



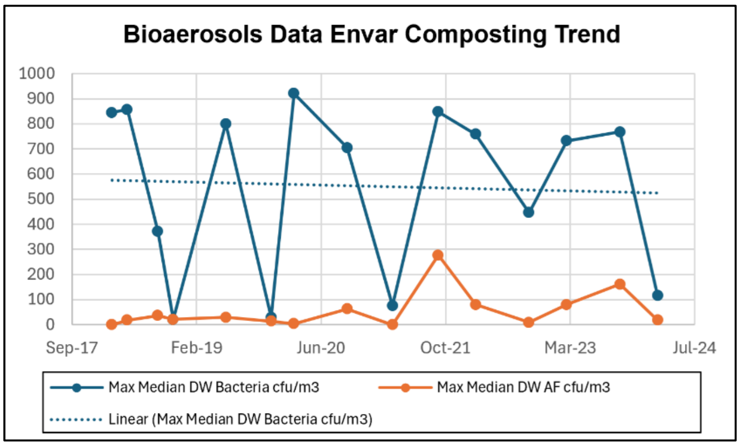
		Total Bacteria			Asp. Fumigatus	
		Median UW	Median DW		Median UW	Median DW
	Activities	cfu/m^3	cfu/m^3		cfu/m^3	cfu/m^3
Session 1	Windrow Turning, two areas	16	107		2	18
Session 2	Windrow Turning, two areas	34	116		2	9
Session 3	Windrow Turning, two areas	14	45		4	18
Session 4	Windrow Turning, two areas	18	54		4	9
Overall	**Median UW and Downwind**	**17**	**80**		**3**	**13**
Maximum Median Downwind		**34**	**116**		**4**	**18**

* The Maximum Median Value is used as an indicator and is compared to Permit Values.

9.14 Summary Bioaerosols Monitoring 2018 - 2024 – Envar St. Ives. (M9 Method)

Date	Max Median DW Bacteria cfu/m^3	Max Median DW AF cfu/m^3	Comment
March 2018	845	0	Moderate-High bacteria, low AF
May 2018	857	18	Moderate-High bacteria, low AF
Sept 2018	371	36	Low-Moderate bacteria, low AF
Nov 2018	21	21	Low bacteria, low AF
June 2019	800	29	Moderate-High bacteria, low AF
December 2019	29	14	Low bacteria, low AF
March 2020	921	4	Moderate-High bacteria, low AF
October 2020	705	63	Moderate-High bacteria, low AF
April 2021	76	0	Low bacteria, low AF
October 2021	848	277	Moderate-High bacteria, low AF
March 2022	759	80	Moderate-High bacteria, low AF
October 2022	446	9	Moderate-High bacteria, low AF
March 2023	732	80	Moderate-High bacteria, low AF
October 2023	768	161	Moderate-High bacteria, low AF
March 2024	116	18	Low bacteria, low AF

9.15 Trend Bioaerosols Monitoring 2018 - 2024 – Envar St. Ives.



The data shows the maximum mean bioaerosols. Clearly the Aspergillus Fumigatus is maintained at low levels throughout, with only one instance where these were elevated, and even then the level was only 55% of the permitted threshold.

9.16 Summary Bioaerosols Monitoring - Site Specific Data – Envar St. Ives.

The bacteria type bioaerosols are generally elevated when the windrow activities are undertaken, but there is evidence that at other times the levels are low to moderate at the equivalent distance of the NSR to the centre of activity. An excel generated trendline has been added and this shows a slight downward trend as the site has got better at suppressing the bioaerosols and managing the windrows. Windrow turning using the large self propelled machine is fast and therefore the timing of its use can be planned for when the wind is away from the NSR, which it is for 83% of the time.

SECTION 10.0 Envar 'The Heath' - Bioaerosol Risk Assessment

10.1 The Critical Control Points

The Critical Control Points were summarised in Table 1. Based on information gathered in the monitoring sessions, additional requirements are added to the Controls listed here.

Table 5: The Heath Composting facility's NINE Bioaerosol Control Points

1.	**WEIGHBRIDGE RECEPTION**	To control the types of Waste arriving for reception and rejecting any that may cause significant increase in bioaerosol potential.
2.	**BIO- WASTE OFFLOADING**	To ensure that the offloading of Bio-waste shall be undertaken within an enclosed reception building. **AND Reception Building Door control- doors to be closed when not required for vehicle movements.**
3.	**FEEDSTOCK SHREDDING**	Must be within an enclosed building
4.	**ENCLOSED COMPOSTING PROCESS**	Must be well managed, to control temperature and moisture content and determination of completion of that phase of the process. **Due regard to the impact of thermophilic and mesophilic conditions to minimise harmful bioaerosols. Excessive drying of the material to be avoided.**
5.	**COMPOST OUT-LOADING FROM THE VESSELS**	The sanitised compost is out-loaded to the external Pad. Prior to this handling phase, the material is cooled down from the sanitisation temperatures by aeration and this reduces emissions during out-loading. **Due consideration to the time during which the compost material continues to produce emissions while awaiting out-loading from the vessels, AND the periods, timing and weather conditions during out-loading.**
6.	**EXTERNAL COMPOST PROCESSING (Stabilisation/ maturation)**	Critical that this phase is managed and controlled. Turning of windrows is undertaken by specialist machinery. Systems for watering the windrows have been improved. Operatives should be trained and monitoring for this activity undertaken. **Due consideration to the weather conditions and especially the wind-direction is required, and ideally there shall be no wind-row turning when the wind is toward the North to north west sector.**
7.	**SCREENING**	Critical that this phase is managed and controlled. Screening of composted material is undertaken by specialist machinery in enclosures and in a wind protected environment. Systems for dust suppression and damping down have been developed. Operatives should be trained and monitoring for this activity undertaken.
8.	**PRODUCT DESPATCH**	Undertaken within the enclosed building. Operatives should be trained for using loading shovels etc. without causing undue dust emission.
9.	**Associated Processes**	The agitation and surface disturbance of the lagoon effluent needs to be monitored to ensure that this is not a source of bioaerosol emissions. Site development has included the improvement of the main bio-filter. Staff should be trained in regard to the performance of this and the critical management of the air clean-up system including the wet-(water-based) scrubber and the irrigation system on the biofilter.

SECTION 10.2 Bioaerosol Risk Assessment – Envar 'The Heath' Composting Site

Table 6a. Risk Assessment Table

Hazard		**Hazard (Risk Potential)**			**Mitigation**	**RISK ASSESSMENT**		
Critical Control Point		**Hazard Description**	**Magnitude & Frequency**	**Pathway & Sensitive Receptors**	**Control Measures**	**Impact Magnitude (Consequences)**	**Probability**	**RISK**
1.	**WEIGHBRIDGE RECEPTION**	Material to arrive on site in enclosed lorries, and checked for type, and dust/ bioaerosol issues.	Enclosed Vehicles with minimal emission; Rear ejector type for minimal disturbance during off-loading.	Dust/ emissions may travel in the air, but should be contained by the enclosure providing doors are closed.	Check Source and type of Feedstock. Only approved materials to be accepted. Dusty or spore laden materials not accepted. Roadways damped down during dry weather. Emissions shall be contained by the reception building enclosure providing doors are closed.	Avoided high bioaerosol laden materials. Dust is damped down. Reception Building is fully enclosed. Magnitude LOW	Probability of difficult materials arising at site is low, Emissions are contained and extracted by suction ventilation system Probability is LOW	**LOW**
2.	**BIO- WASTE OFFLOADING**	Fresh material offloaded and if required is damped down with spray irrigation immediately so as to avoid dust/ bioaerosol emissions.	Large magnitude but short period exposure time as material is treated within 48 hours.	Stored in enclosed area. Volatile materials within building. Enclosures contain emissions.	Bio-waste storage bunkers Fresh non-dusty bio- waste, material is stacked and stored ready for shredding Storage of volatile materials within enclosed building; contains emissions. Storage quantity throughput rate mean there is a short term of storage and means material is processed quickly, often within the same day it arrives.	Benefit of enclosed storage area and building with negative ventilation reduces emissions; therefore Magnitude is LOW	Probability of risk materialising is LOW	**LOW**
3.	**FEEDSTOCK SHREDDING**	Shredding generates fragments and air movement. Hazards may include bacteria, and Fungi.	Magnitude potentially large due to the high tonnage through the site. 50 – 100t/hr of material	Possible release and emission. Irrigation system over shredder may be used to damp down the material as it exits the shredder.	Shredder has enclosed rotor and discharges via a grate and a conveyor belt to avoid particles becoming airborne. Shredding undertaken within the building. Irrigation system is utilised. Shredding takes place within the fully enclosed extraction ventilated buildings with air filtration exhaust.	Potentially presents a high risk; when material being loaded to shredder, and from shredder discharge. Magnitude retained as MEDIUM	High potential for emissions from the material, but damped and fully contained. The full enclosure is essential and the doors of the building should be closed	**LOW (Caveat: Building doors to be kept closed so that extraction ventilation functions correctly)**

Table 6b. Risk Assessment Table

Hazard		Hazard (Risk Potential)			Mitigation	RISK ASSESSMENT		
Critical Control Point		Hazard Description	Magnitude & Frequency	Pathway & Sensitive Receptors	Control Measures	Impact Magnitude (Consequences)	Probability	RISK
4.	**ENCLOSED COMPOSTING PROCESS**	Composting (sanitisation phase) is undertaken within enclosed vessels. All materials handling into the vessels is within fully enclosed environment with suction extract ventilation system operating. The vessels are state-of-the-art for process control, oxygen management and process temperature control.	High capacity site requires high tonnage movements per day. May entail circa 500 t/day. .	Emissions during In Vessel Composting are fully contained within the enclosed environment until some portion of the air volume is sent to the exhaust system. This comprises a wet (water-based) scrubber followed by wetted wood media biofilter. The scrubber helps remove dust spores and soluble gases and cools the airflow.	Trained operator/supervisor must be present to oversee the In-Vessel composting to ensure control is appropriate to minimise excessive drying of inappropriate temperatures. Air exhaust system to be carefully managed; including the wet-scrubber and The Biofilter. Clean water mist spray scrubbing system to be used when required. Wet scrubber water quality to be controlled. Biofilter system has ability to provide additional water damping (irrigation) to surface of biofilter, to suppress dust and emissions. Irrigation is important for suppression of Aspergillus when biofilter environment is retained at >60% moisture content.	Releases of exhaust from the IVC can be managed by care in operation. Releases from the biofilter can be managed by attention to the wet scrubber and biofilter moisture content. Being an enclosed system, the exhaust emissions from the system can be managed and controlled.	There is a possibility of bioaerosol release from the IVC process but this is minimised by enclosure and then air exhaust treatment. The final emissions from the biofilters are along way distant from the edge of the site and from nearby sensitive receptors. Consequently the Risks are regarded as LOW	**LOW**
5.	**COMPOST OUT-LOADING FROM THE VESSELS**	Compost out-loading from the vessels allows warmed steaming material releases emissions to the external environment.	High capacity site requires high tonnage movements per day. May entail circa 500 t/day.	Emissions during Vessel Outloading cannot be contained, but can be mitigated by attention to compost condition.	This phase relies on trained operators and supervision to ensure that the warmed compost does not release undue emissions. The control of the process is capable of providing a target temperature that will minimise specific types of bioaerosol.	The out-loading of the vessels is a critical point in the process; therefore the control of the temperature and condition of the material just prior to Outloading is critical. Material should be cooled and should be maintained damp.	There is a possibility of bioaerosol release from the IVC Outloading. Consequently the Risks are regarded as MEDIUM	**MEDIUM**

Table 6c. Risk Assessment Table

Hazard		**Hazard (Risk Potential)**			**Mitigation**	**RISK ASSESSMENT**		
Critical Control Point		**Hazard Description**	**Magnitude & Frequency**	**Pathway & Sensitive Receptors**	**Control Measures**	**Impact Magnitude (Consequences)**	**Probability**	**RISK**
6.	**EXTERNAL COMPOST PROCESSING (Stabilisation/ maturation)**	Compost turning allows warmed steaming material to release emissions to the external environment.	High capacity site requires high tonnage movements per day. May entail circa 500 t/day.	Emissions during windrow turning cannot be contained, but can be mitigated by compost moisture control, turning technique and damping down.	This phase relies on trained operators and supervision to ensure that the controls are in place to minimise the release of emissions. The control of the process is provides the target moisture content of compost within the windrows and so minimise specific types of bioaerosol. The turning equipment to be used now has the capability for water irrigation during turning. The turner technology enables thorough turning without undue vertical elevation of the material.	The windrow turning of the material externally is a critical point in the process; therefore the control of the moisture and temperatures and condition of the material during this phase of stabilisation is critical. Material should be carefully monitored and should be maintained damp.	There is a possibility and high probability of bioaerosol release from windrows. Consequently the Risks are regarded as MEDIUM	**MEDIUM**
7.	**SCREENING**	Screening is within an enclosed building. The screener system is wind protected by secondary enclosure. There is a dust suppression system and floor damping down and use of road sweepers.	High capacity site requires high tonnage movements per day. May entail circa 500 t/day.	New techniques and emissions controls have been installed.. These focus on Minimising dust releases, i.e. Enclosures and containment Water based suppression on road surfaces. Driver training and site speed restrictions.	System has ability to provide additional water damping (irrigation) to surface of roads and paved areas to suppress dust and emissions. Irrigation also suppresses the Aspergillus when compost is retained at >60% moisture content.	Screening timing can be selected based on weather conditions. Use of irrigation system and dust suppression systems to minimise Aspergillus bioaerosol.	Probability of bioaerosol release from process is LOW to Medium during screening, however, by good management and use of the emissions control techniques then the probability of risk is LOW	**LOW**
8.	**PRODUCT DESPATCH**	Cooled material is loaded to vehicles. Hazards may include bacteria, and Fungi	May entail circa 500 t/day.	Environment is partially enclosed with dust suppression systems..	Material is cooled screened and stabilised. Opportunity for damping down any dust by using irrigation or spray misting system available..	Low Magnitude	LOW Probability	**LOW**

SECTION 11.0 Scientific and Evidence Based Risk Assessment

11.1 Summary of the Scientific Information

11.1.1 EA advised acceptable levels at the sensitive receptors

The EA Position Statement PS031 advises that the concentrations of bioaerosols (as predicted or as derived from direct measurements) at the sensitive receptors which are attributable to any composting operations, that are deemed acceptable are as follows at Table 7.

Table 7. The acceptable (appropriate) levels (given as colony forming units per cubic metre of air).

Bioaerosol type	**Threshold value**	**units**
total bacteria	1000	cfu.m^{-3}
Aspergillus Fumigatus	500	cfu.m^{-3}

11.1.2 EA advised Separation Distance

Sensitive receptors. Sensitive receptors refers to people likely to be within 250 metres of the composting operation for prolonged or frequent periods. This does not include employees.

11.1.3 Separation Distance based on Research

The consensus from various studies is that bioaerosols from composting activities decline rapidly within the first 100 metres from a site and generally decline to background levels within 250m

The Health and Safety Executive (HSE) and The Composting Association (TCA) report . summarises the evidence that bioaerosols are widely present in agricultural activities as a norm; it reveals that bioaerosol levels reduce (much as dust levels reduce) with distance from the source; and concludes that the bulk of evidence suggests that bioaerosol levels reduce to background within a distance of 200m.

A review of many research and scientific articles, provided trial results data that revealed that concentrations of both culturable mesophilic bacteria and *A. Fumigatus* downwind of source activities decreased **approximately exponentially with distance** from the source, and generally attained background levels (measured and estimated from the median sampled throughout the study period) within 200 m of the source activities. The summary of this is depicted in Figure 11: and shows the rapid reduction of bioaerosol concentration in air with increased separation distance.

11.1.4 Background Levels of Bioaerosols in Rural Environments Section 7 Table 5.

Research shows that bioaerosols are ubiquitous and present in high concentrations in activities that involve either livestock (manure/bedding or fodder) or vegetable matter (crops/plants/vegetation) are identified as having much greater levels of bioaerosols in their working environment. These values are potentially as high as 10,000,000 cfu.m^{-3} Total bacteria in grain harvesting or handling mouldy hay.

FOR THIS SITE multiple sessions of sampling have been undertaken and the results reported and summarised at section 9.16. The results have indicated that the worst case scenarios – compost windrow turning may result in mean levels of bioaerosols downwind at a distance equal to the distance to the nearest sensitive receptor are on average 600 cfu.m^{-3} Total Bacteria, where-as the Aspergillus Fumigatus was typically less than 100 cfu.m^{-3}

11.1.5 Dispersal Calculation

Section 9.4 shows how the bioaerosol dispersions may be modelled, and has revealed that for elevated concentrations at the boundary of the site, then with increasing distance away from the site, the concentrations are projected to fall exponentially and in most instances should fall to concentrations of below 600 cfu.m^{-3}.

The Bioaerosol Dispersal Model utilises the emission data at 240m from the facility for the instance of compost turning i.e. a Trend average Maximum mean 600 cfu.m^{-3} Total Bacteria. The projection of the attenuated Bioaerosol concentration downwind of the facility is then mathematically projected as Figure 21. A similar projection is shown for the Aspergillus Fumigatus at Figure 22. Based on a Trend average of 100 cfu.m^{-3}.

Figure 21: Modelling for Bioaerosol Dispersal with Distance for Emissions from the Composting Facility

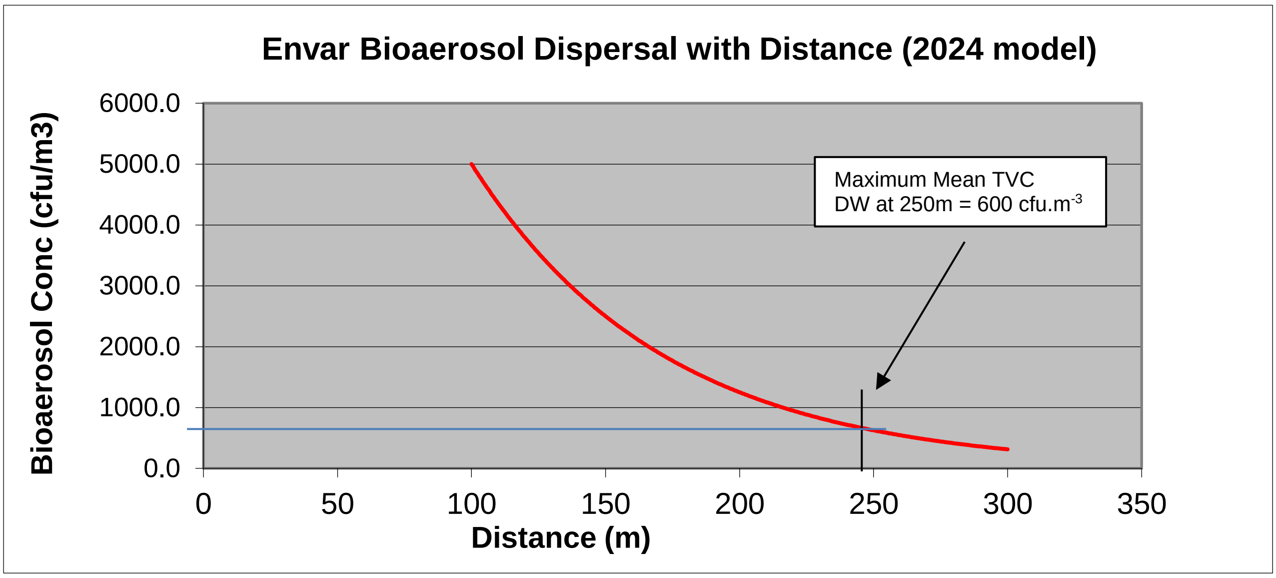
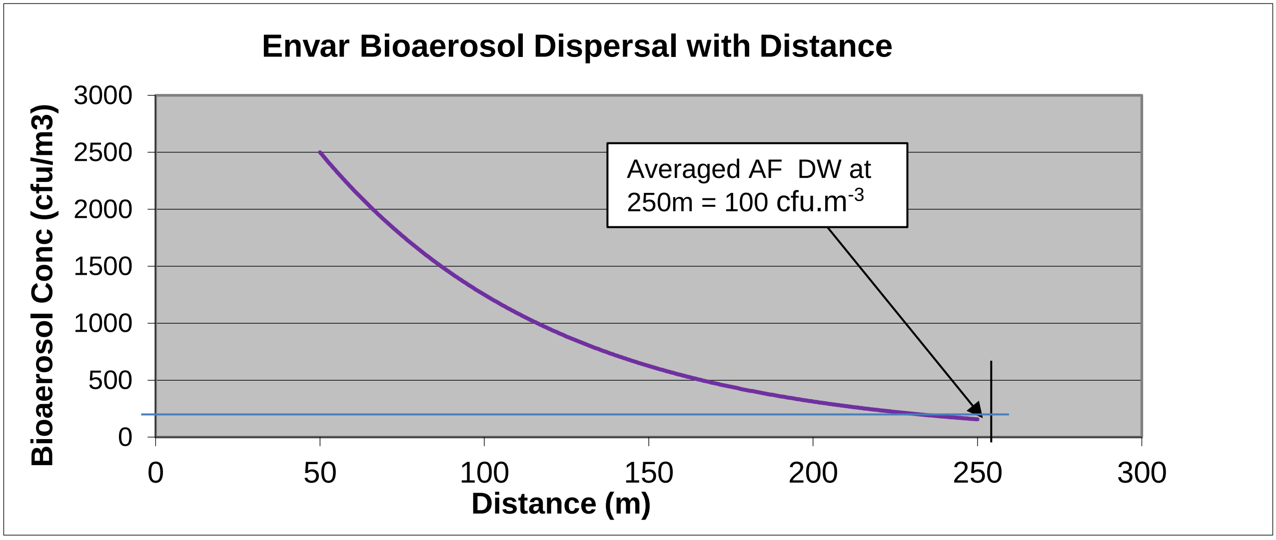


Figure 22: Modelling for Bioaerosol Dispersal with Distance for Emissions from the Facility



This model is based on a lower rate of dispersion than previous models, to account for the size of the area of the source of the emissions. This the dispersion curves are shallower and show a lesser reduction within the initial separation distance. This model provides a better correlation with the sampled values.

SECTION 12.0 Overall Risk Assessment

12.1 Summary of the Risk Assessment Facts and Evidence

The Mathematical Modelling based on the real-life Baseline and Background monitoring agrees with the Research Data and third party site reference data. All of the scientific information show that bioaerosols from composting decline rapidly within the first 100 metres. For this site, due to the large area of the source, a more realistic model has been applied, with a slower rate of dispersal.

For the **Envar 'The Heath' Composting Site**, where there are high quantities of material to be stored and handled each day but the fresh material and shredding are protected from the wind by the buildings then the emissions are attenuated. Similarly the screening is provided with an enclosure. Therefore, the key area of emission is windrow turning.

The 'new' additional waste types have been predicted to be unlikely to add to the emissions loading, because the main activity for these is within the vessels, and where the material is processed externally, then it is simply utilising area that would have otherwise previously have been taken up with composting biowaste.

The projection is that the resultant emissions will fall to be below the Permitted levels within the separation distance available; however, based on the results, then a firm **Policy of NOT turning the windrows, when the wind is directly toward the NSR** should be enforced.

The Data shows that the fugitive emissions (other than when windrow turning is taking place) shall be liable to dispersion, reduction and fall out and therefore residual levels of bioaerosols will disperse to below the appropriate levels.

12.2 Summary of the Process using the Risk Assessment Matrix

Table 8. Composting Site - Risk Assessment Matrix Summary Table

Hazard		**RISK ASSESSMENT**		
Critical Control Point		**Impact Magnitude (Consequences)**	**Probability**	**RISK**
1.	**WEIGHBRIDGE RECEPTION**	Low potential	Low Probability	LOW RISK
2.	**BIO WASTE STORAGE**	Low potential	Low Probability	LOW RISK
3.	**FEEDSTOCK SHREDDING**	Low potential	Low Probability	LOW RISK
4.	**COMPOSTING IVC PROCESSES**	Low potential	Low Probability	LOW RISK
5.	**OUTLOADING THE VESSELS**	Medium potential	Medium Probability	**MEDIUM- RISK***
6.	**WINDROW TURNING**	Medium potential	Medium Probability	**MEDIUM- RISK****
7.	**SCREENING**	Medium potential	Low Probability	**MEDIUM- RISK*****
8.	**COMPOST DESPATCH**	Low potential	Low Probability	LOW- RISK

*Need to carefully manage the process in regard compost moisture and temperature.

** To enforce a Policy of not Turning Windrows when the wind is blowing toward the NSR.

** Need to carefully manage dust emissions from paved areas by damping down and dust suppression..

SECTION 13.0 Overall Conclusions

1. The nearest third party sensitive receptor (NSR) is located at the Rectory Farm – Raptor Foundation Centre which are at least 240 metres from the main activities.

2. The centre is distanced ~300m from the extension area (on the east of the compost site).

3. A key factor is the prevailing wind directions which is predominantly from the South-West. Wind crossing the compost site towards the NSR occurs for ~ 17% of time.

4. This Risk Assessment strongly recommends that Management shall be careful to avoid or minimise windrow turning if the wind is from the south to south-east sector.

5. Bioaerosol emission from the reception, shredding, primary processing and screening of the material is either enclosed (buildings and In-vessel) or else protected from the wind and therefore present lesser risk.

6. The External Windrowing activity presents the greater risk because of the, size of the area (of emission) the nature of the activity and the volume (repeat activity) of material that is processed. Bioaerosol emission from the this activity is attenuated by the use of a specialist machine and suppression system, including a water spray irrigation system over the compost during turning when conditions dictate. None-the-less, the monitoring data suggests this activity should be suspended if the wind is directly toward the NSR.

7. By accounting for bioaerosol dispersal and fall-out and based on mathematical projections, the air quality of fugitive emissions can be maintained with low bioaerosol concentrations. The data suggests that the levels may be projected as <600 cfu.m^{-3} (Total Bacteria maximum mean) and <100 cfu.m^{-3} Aspergillus Fumigatus. The level of confidence in the values will depend on circumstances, but recent trend data have shown these levels are possible. With a margin for fugitive external emissions this means that the levels are well within the Environment Agency guideline values for Bioaerosols maxima at the nearest sensitive receptor.

8. Contingencies are available, including the use of additional water suppression systems.

9. The risk assessment is dependent upon the enclosures being properly utilised, the raw material storage and shredding building doors being closed when no vehicle movements are required so that the extraction ventilation system can work properly.

10. The ‘new’ additional materials planned for composting or bio-drying are not deemed as representing a significant addition to the emissions, because a) these are in place of the previous bio-waste which they are replacing, and b) because the processes to be used for these are to be undertaken within the vessels with minimal external activity.

11. Use of the extension area for composting is deemed unlikely to be significant, because of the separation distance, and the low frequency of easterly wind from that area to the NSR.

12. Persons using the footpath are not deemed to be at risk due to the distance from the active activities, and the short duration of exposure (less than 15 minutes.) near to the site.

Taking these factors into account and in particular the prevailing wind directions, and pausing windrow turning in specified conditions; then the otherwise LOW-MODERATE risks of impact to the nearby sensitive receptor may be maintained as LOW.

APPENDIX 1: Checklist of Contents for Risk Assessment Compliance

Cranfield University / EA Bioaerosols Risk Assessment Checklist.

Taken from: Guidance on the Evaluation of Risk Assessments for Composting Facilities, Cranfield University (G.H. Drew et al) published by the EA August 2009

Essential attributes		**Yes/No**
1	Has the operator or consultant described Environment Agency policy on bioaerosols and risk assessment?	YES
2	Has the operator or consultant demonstrated that they understand what bioaerosols are	YES
3	Does the operator or consultant provide a summary of health risks from bioaerosols	YES
4	Has the operator or consultant described other sources of bioaerosols in vicinity	YES
5	Has the operator or consultant shown they understand the uncertainties and the lack of dose-response relationships associated with bioaerosols?	YES
6	Has the operator or consultant discussed any other potential emissions, e.g. odour, from their activities?	YES (separate Doc.)
7	Has the operator or consultant described the processing technology and equipment that is or will be used on the site?	YES
8	Has the operator or consultant described the feedstock that they will process and the tonnages?	YES
9	Has the operator or consultant described the site layout and included a scaled diagram?	YES
10	Does this description cover details of any screens, bunds, misting sprays or trees around the site?	YES
11	Has the operator or consultant described the pathways between the source and receptors, e.g. the prevailing winds?	YES
12	Has the operator or consultant provided local wind direction data?	YES
13	Has the operator or consultant described what is beyond the site boundaries?	YES
14	Does this include the location of and distance to sensitive receptors? Is there a scaled map that shows this?	YES O.S. Map copy with scale is included
	Desirable attributes	
16	Is all information site specific and relevant?	YES
17	Has the operator or consultant described their own competencies or qualifications for undertaking a bioaerosol risk assessment?	YES
18	Has the operator or consultant consulted any receptors (stakeholders)?	This has been done via Planning Local Liaison

Essential attributes	**Yes/No**
Has the operator or consultant described what is at risk (sensitive receptors, e.g. offices, schools homes)?	YES
Has the operator or consultant described what it is at risk from (the hazard)?	YES
Has the operator or consultant described what might happen (the consequences)?	YES
Has the operator or consultant described how it might happen (pathways)?	YES
Has the operator or consultant described how large the consequences might be?	YES by reference to Site specific data and inclusion of dispersion model.
Has the operator or consultant described how probable the consequences are?	YES
Has the operator or consultant described the significance of the probabilities and consequences?	YES Appendix 4.
Has the operator or consultant described the criteria used to assess their significance?	YES reference to EA Cranfield matrix

Has the operator or consultant described the certainty of the assessment?	YES
Has the operator or consultant described the most significant risk?	YES
Has the operator or consultant described their assumptions and justified these?	YES
Is all information site specific and relevant?	YES

Checklist 3: Bioaerosols

Essential attributes		Yes/No
1	Has the operator or consultant listed the sources of bioaerosols from their composting process?	YES Section 4
2	Has the operator or consultant explained the causes of variation?	YES Section 4
3	Has the operator or consultant identified other sources of bioaerosols in the vicinity	YES
4	Has the operator or consultant discussed bioaerosol dispersal?	YES Figure 7 and references to EA Information
5	Has the operator or consultant used the Association for Organics Recycling standard protocol for sampling? If not, please contact the Human Health Advisory Service advice on alternative methods.	YES Appendices 2 & 3 and case study data Using The M9 Method.
6	Has the operator or consultant monitored background concentrations?	YES
7	Is background either upwind for an existing site or pre-operations for a new site?	YES
8	How far upwind (greater than 25m)?	YES
9	Has the operator or consultant stated the local conditions during sampling (sampling location, including height and relationship to buildings, activities on-site, and weather conditions)?	YES
10	Has the operator or consultant taken these into account in designing their sampling strategy?	YES
11	Has the operator or consultant provided details of equipment used and sampling times	YES
12	Has the operator or consultant provided details of the calibration of equipment?	YES
13	Has the operator or consultant provided details of the storage of samples, transport method, time of transport, and any delays in analysis?	YES
14	Has the operator or consultant provided details of laboratory procedures, including agar used and culture techniques)	YES
15	Has the operator or consultant provided details of the laboratory certification?	YES
16	Has the operator or consultant provided details of the level of replication of sampling, variability between samples, or a statement of errors or error bars?	YES
17	Has the operator or consultant stated the uncertainties associated with the data?	YES
18	Is all information site specific and relevant?	YES

APPENDIX 2. The M9 Technical Guidance Monitoring Bioaerosols

The Composting Association Protocol was replaced in 2018 and so the current reference and basis of methodology for sampling and monitoring bioaerosols as referenced within this assessment is:

Technical Guidance Note (Monitoring)

M9

Environmental monitoring of bioaerosols at regulated facilities

Environment Agency January 2018 Version 2

Sampling bioaerosols

Bioaerosols can be measured using a number of different techniques. This technical note describes the following techniques for sampling bioaerosols:

Impaction

The impaction method uses a single stage Andersen sampler, loaded with a Petri dish of appropriate media. This method uses inertial forces to collect microorganisms in the air. Air is drawn through the perforated holes in the sampling head at a constant rate, using a vacuum pump. The velocity of the air is determined by the diameter of the holes in the sampling head. When the air hits the collection surface it is forced to change direction. The inertia of the microorganisms prevents them from changing direction, which causes them to become impacted onto the Petri dish media. When a sufficient volume of air has been collected, the Petri dish is removed and incubated, without further treatment.

5.2 Sample location strategy

The principle of this specification is to compare the concentrations in air unaffected by the activities of the facility (that is the background air sampled upwind of the plant) with the concentration of bioaerosols in air downwind of the plant. This comparison enables an assessment of the plant related contribution over a specified area to be made. The difference between the upwind and downwind concentration caused by bioaerosol emissions from the site is known as the process contribution. It uses sampling locations that form a fan like shape, which helps to ensure that variable wind directions are taken account of during the sampling period.

5.2.2 Sample locations upwind of the site

Sampling should be carried out upwind of the site. Upwind data should provide information on the concentration of specified bioaerosols that are present in the air blowing onto the operational area of the site. This should reflect either the background concentration at that time, or the effects of neighbouring operations, such as agricultural activities.

Upwind data indicates the concentration of bioaerosols that would be present, irrespective of whether the facility was there or not. The sample location of the upwind concentration measurement should be measured at a distance of 50m from the centre of the active operational area.

5.2.3 Sample locations downwind of the site

Sampling should be carried out downwind of the site, using a fan like shape arrangement to detect the position of the plume. The orientation of the measurement area is determined by the prevailing mean wind direction.

This approach is used to ensure that measurements are made in the emission plume, during the sampling campaign. If there are any buildings, installations or structures between the downwind location(s) and the centre of the active operational area, then sampling should be carried out *upwind of that structure or installation, at a distance greater than twice its height*.

Figure 5.1 shows this approach applied to a facility with a single point source. Topography or vegetation may restrict the line of sight required to locate sample traverses. This may make it difficult to determine the angle for locating the sample points. The restriction should be noted in the sample strategy and final monitoring report. For area sources, the orientation of the fan like shape sampling arrangement is selected by determining the centre point of the sources in the site.

Each impaction sampler should be mounted onto a tripod, or other suitable structure, so that the top of the inlet cone is held **between 1.5 and 1.8m above the ground**. Each single stage impaction sampler fitted with a cone should be fitted with a **hemi-cylindrical baffle** extending in height at least 15 centimetres (cm) above the top of the inlet of the cone, to ensure stagnation point sampling.

Figure 5.2: Simplified fan like shape sampling arrangement for area sources (based on CEN TS 16115-2)

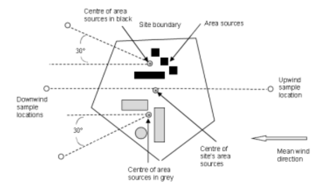
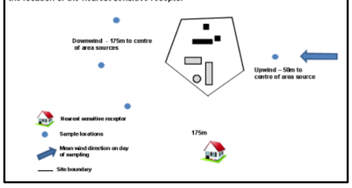


Figure 5.3: Example application of fan like shape sampling arrangements related to the location of the nearest sensitive receptor



Photograph 5.1: Single stage impaction sampler (Andersen) set up in the field

5.6.2 Sampling procedure

A single Petri dish (with the lid removed) should be loaded into each sampler immediately prior to use, in accordance with the manufacturer's instructions. Once loaded, the sampler should be kept upright, to prevent the Petri dish from dislodging. A single sample of *Aspergillus fumigatus* (1 Petri dish containing selective medium) should be collected at each of the specified locations using a single stage impaction sampler. The same procedure should be repeated for mesophilic bacteria using Petri dishes containing selective medium specific for the culturing of mesophilic bacteria.

APPENDIX 3. The Sampling procedure Used: Andersen samplers

	A single Petri dish (with the lid removed) should be loaded into each sampler immediately prior to use, in accordance with the manufacturer's instructions. Due consideration must be given to potential sources of microbial contamination (Chapter 5.4) during this procedure. Once loaded, the sampler should be kept upright, to prevent the Petri dish from dislodging.	
	A *minimum* of two samples of *Aspergillus fumigatus* (two Petri dishes containing selective medium) should be collected in parallel at each of the specified locations (Chapter 7) using two single stage Andersen samplers. Samples are considered to have been collected in parallel if the onset and cessation of the sampling periods do not differ by more than 30 seconds. The same procedure should be repeated for mesophilic bacteria.	
	Additional replicate samples should be collected whenever possible. Samples should be considered replicates if they have been collected at the same location but in a different time frame. The start and stop times when the vacuum is applied and shut off should be recorded (Chapter 10.3) using the synchronised digital watch (Chapter 5.1).	
	The sampling times should be such that no more than 300 bacterial colonies grow on each Petri dish containing nutrient agar medium and no more than 300 colonies of *A. fumigatus* grow on each Petri dish containing malt extract agar medium. It is recommended that sampling times reflect the likelihood of overloading of the plates; initially a guideline of 20 minutes is suggested for the bacterial and *A. fumigatus* samples. However, shorter sampling times should be used if it is likely that local concentrations of airborne micro-organisms will be high and cause overloading of the plates (>399 colonies), as low as one minute in highly contaminated environments, for example (Swan *et al., 2003).*	
	Petri dishes should be stored in a refrigerated or cooled container (preferably at 4°C) following sampling, until the remaining samples have been collected.	
	In the laboratory, all dishes should then be inverted and placed in an appropriate microbiological incubator at the same time. This should be carried out no longer than 12 hours after sampling. The nutrient agar medium, selecting for total mesophilic bacteria, should be incubated at 37C; the malt extract medium, culturing A. *fumigatus,* should be incubated at 40°C. Colonies growing on both media should be enumerated after two days.	
	Control Petri dishes containing both types of media should also be included in the sampling programme. At least two Petri dishes containing both types of media should be kept in re-sealable bags in the work station during the entire working day. At least one Petri dish containing each of the sampling media should be placed in a sampler at the downwind location and exposed for the same time period as the respective samples, except the vacuum pump should not be switched on. All control dishes should be handled, incubated and enumerated in an identical manner to the samples collected with the pumps operational.	

APPENDIX 4. Bioaerosol Types, Descriptions And Health Effects

A4.1 Description of Bioaerosol Types

Actinomycetes	A specific group of bacteria that are capable of forming very small spores, Actinomycetes are Gram-positive bacteria, but they are distinguished from other bacteria by their distinct role in decomposition. They have a filamentous (thread-like) morphology and grow slower than other bacteria, making them more of an intermediate between fungi and bacteria. Actinomycetes prefer moist and aerobic conditions, with a neutral to slightly alkaline pH. They are most easily seen in the early stages of composting, when the self-heating process has begun. They form long grey strands that resemble spider webs and give the compost a soil-like odour. They are therefore a useful indication of the stage of the composting process.
Bacteria	A group of micro-organisms with a primitive cellular structure, in which the hereditary genetic material is not retained within an internal membrane (nucleus), Bacteria are usually between 1 and 5 µm in size, and are divided into Gram-negative bacteria (predominantly of animal origin) and Gram-positive bacteria (predominantly of plant origin).
Fungi	A group of micro-organisms with a more complicated cellular structure than bacteria, in which the hereditary genetic material is retained within an internal membrane forming a nucleus,
Micro-Organisms	Microscopic organisms that are capable of living on their own, Often called 'MICROBES',
Spore	A general term describing a bacterial or fungal cell that is in a dormant form, They are a potential risk to health because they can be inhaled.
Gram-Negative Bacteria	Gram-negative bacteria are more abundant in the mesophilic phases of composting. The pathogenic Gram-negative bacteria, *Salmonella* species and *Escherichia coli*, can also be found in composting facilities. However, adequate process control during composting should produce temperatures high enough to kill these bacteria.

A4.2 Health impacts

People who work with composting materials, or those who are in close proximity to the agitated compost, can potentially inhale significant concentrations of bioaerosols. The human respiratory system can adequately filter out larger dust particles through a combination of hairs that line the nose and specialised cells in the upper parts of our airways. Unfortunately, the smaller bioaerosol particles escape capture by these mechanisms and can penetrate deep into the lungs. As our lungs have a very large surface area and carry out a specialised function, they can easily be affected by bioaerosols.

During the course of daily activities, people inhale airborne microbes. This is as much a feature of normal everyday life as eating or drinking. Most individuals' bodies are perfectly capable of coping adequately with the presence of these 'invaders' and do not suffer any ill effects. It is only when airborne microbes, such as those generated during the composting process, are present in high concentrations that they may become harmful to human health.

Composting results in the formation of bioaerosols and utilises certain types of microbes that tend to produce very tiny spores. However without even being close to composting activities, third parties may continually encounter these same microbes in their everyday lives at low concentrations. They are present naturally and are essential in the 'recycling' of nutrients in our gardens, parks and countryside.

Everyone reacts to bioaerosols in different ways. It depends upon a variety of factors and can never be predicted: some people have worked at composting sites for many years without apparently displaying *any* adverse health effects.

Factors, such as prior exposure to bioaerosols, individual susceptibility, bioaerosol concentration and composition (the numbers and types of microbes present) and the length of time and frequency to which people are exposed all contribute to the way in which their bodies react. There are three main types of response:

Allergy

This is an immunological response that results in the body becoming 'sensitised' following exposure. The next time the body encounters the substance it 'over-reacts', even if the substance

is present in extremely low concentrations. When such a substance affects a person's lungs in this way it is referred to as a 'respiratory sensitiser'.
Sensitisation does not usually occur immediately; rather it is a consequence of inhaling a substance over a period of months or even years.

Inflammation

This is a response of body tissues to an injury. It typically results in swelling, redness and pain.

Toxin Poisoning

This is a disturbance of the normal bodily functions by a specific substance known as a toxin. It differs from both the allergic and inflammatory responses.

These bodily reactions may manifest themselves in various ways. These conditions are not due to infections, which are caused by microbes that invade the body tissue and cause skin infections or else are ingested (such as E. Coli) and may cause stomach sickness.

A4.3 Dose Response

Threshold of Risk
Bioaerosols are small particles of biologically active material that may be carried independently in the air, or otherwise may become attached to other particles of dust or moisture. Consequently, these small particles may be inhalable and the very small particles may be respirable (deposited in the air sacs of the lungs where gases are exchanged). The small particle size of bioaerosols means that they are not typically filtered out by the hairs and cells which line the human nose, and can therefore penetrate deeply into the lungs.

There is a limited scientific evidence base of the human health impacts of bioaerosols, and of dose-response relationships. Previous research (CIWEM, 2002 & Enviros, 2004) has identified associations between bioaerosol exposure and respiratory and gastro-intestinal illness, in particular inflammation of the respiratory system, coughs, fevers and exacerbation of existing respiratory illnesses. Possible links have also been established between bioaerosols and Organic Dust Toxic Syndrome (ODTS) (Rylander, 1997).

Aspergillosis caused by *Aspergillus Fumigatus*, a micro-organism species often associated with composting sites, can give rise to a severe infection of the respiratory system and can be fatal. There are, however, no documented cases of fatalities occurring specifically due to exposure of *A. Fumigatus* as a result of commercial composting or waste handling despite the widespread adoption of commercial composting.