Green Waste Company (Abergavenny) Limited

Maindiff Court Farm
Llantilio Pertholey
Abergavenny
NP7 8AY

Bioaerosol Monitoring Report

December 2014

Cardiff Metropolitan University | Prifysgol Metropolitan Caerdydd

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Summary

Maindiff Court Farm operates a green waste composting facility, processing waste from local authority green waste collection and civic amenity sites. The Centre for Health, Safety and Environment (CHSE) / Cardiff Metropolitan University, have been requested to carry out a bioaerosol monitoring programme on behalf of Green Waste Company (Abergavenny) Limited. The principal reason for the investigation is to address the requirements of the Maindiff Court Farm Environmental Permit (EPR/BP3392LC). This report covers the sixth monitoring exercise carried out on behalf of Green Waste Company (Abergavenny) Limited.

On-site monitoring and laboratory analysis was carried out in accordance with the current Association for Organics Recycling (AfOR) protocol, 'A standard protocol for the monitoring of bioaerosols at open composting facilities' (AfOR, 2009). The intention of the protocol is to provide guidance for monitoring bioaerosols at open composting facilities and requires that levels of total mesophilic bacteria and the fungi *Aspergillus fumigatus* be monitored. The protocol notes that at enclosed or in-vessel facilities, there may be an additional requirement to monitor gram negative bacteria. The Environmental Permit for Maindiff Court Farm stipulates that monitoring should report concentrations of total mesophilic bacteria, the fungi *Aspergillus fumigatus*, and gram negative bacteria. As a result, concentrations of total mesophilic bacteria, the fungi *Aspergillus fumigatus*, and gram negative bacteria were enumerated and compared with the relevant appropriate levels for interpretation.

On the 01st April 2013, Natural Resources Wales (NRW) was formed as the regulatory authority in Wales by combination of the functions of the Environment Agency, Countryside Council for Wales and the Forestry Commission in Wales. At present, NRW has not issued specific guidance relating to bioaerosols at waste facilities. The analysis and report has therefore been prepared with reference to Environment Agency appropriate levels and guidance. References to policy and guidance from the Environment Agency within the text therefore also refer to NRW.

Monitoring was undertaken on Monday 01st December 2014. The on-site monitoring procedure and data analysis was undertaken in accordance with the current AfOR guidance, "*A Standardised Protocol for the Monitoring of Bioaerosols at Open Composting Facilities"* (2009).

Section 7.0, page 20, details the results obtained. At present, there are no statutory levels that exist in order to put the results in to a regulatory context only the guidance values set by the Environment Agency for total bacteria, gram negative bacteria and *Aspergillus fumigatus*. During the monitoring, material was turned between in-building bays. Plastic and other contaminants were removed from a deposited load of green waste for 30 minutes during the monitoring at the sensitive receptor.

Concentrations of all micro-organisms measured, mesophilic bacteria, gram negative bacteria and the fungi *Aspergillus fumigatus*, at all locations were below the acceptable levels set by the Environment Agency of 1000 cfu/m^3, 300 cfu/m^3 and 500 cfu/m^3 respectively. Concentrations of bioaerosols higher than background concentrations were recorded at the downwind monitoring location 60m from the working area and had returned to background, or near background by the monitoring location 215m from the working area. A full set of results and analysis can be found in sections 7.0 Results and 8.0 – Conclusions.

In accordance with the precautionary principle, it is recommended that practical risk mitigation measures are employed throughout the process to minimise liberation of bioaerosols as far as is reasonably practical. Practical risk mitigation measures recommended to minimise bioaerosol release, during processes such as turning, shredding and screening, are detailed in Section 9.0 – Recommendations, page 27.

1.0 Introduction

At the request of Green Waste Company (Abergavenny) Limited, the Centre for Health, Safety and Environment (CHSE) has undertaken a monitoring programme to assess levels of bioaerosol release from the composting operations at their green waste composting facility at Maindiff Court Farm, Llantilio Pertholey, Abergavenny.

As a condition of their Environmental Permit (EPR/BP3392LC), the Green Waste Company are required to monitor levels of bioaerosols at specified locations in the vicinity of the facility, on four occasions each year and submit reports of the monitoring to Natural Resources Wales (NRW).

On the 01st April 2013, NRW was formed as the regulatory authority in Wales by combination of the functions of the Environment Agency, Countryside Council for Wales and the Forestry Commission in Wales. At present, NRW has not issued specific guidance relating to bioaerosols at waste facilities. The analysis and report has therefore been prepared with reference to Environment Agency appropriate levels and guidance. References to policy and guidance from the Environment Agency within the text therefore also refer to NRW.

2.0 Potential Health Effects

Bioaerosols are defined as a collection of aerosolised biological particles including actinomycetes, bacteria, fungi protozoa and their components (Millner et al 1994, Millner, 1995, Gilbert and Ward, 1998; Van der Werf, 1996, Epstein, 1994; Fischer et al 1999, Cox and Wathes, 1995). These organisms are fundamental to the composting process. The concern regarding bioaerosols from composting activities arises because of their potential to cause adverse health effects in employees and the public living in close proximity to such facilities. These adverse effects can potentially occur in susceptible individuals from exposure to the micro-organisms associated with the composting process and can elicit an adverse response by infection, allergy or an adverse response to toxins (Environment Agency, 2005). According to Swan *et al.* (2003) the effects of exposure to organic dust on

respiratory health may lead to or exacerbate a number of distinct identifiable conditions including Aspergillosis in immuno-compromised individuals (Millner *et al*,1994, Millner 1995), Allergic Rhinitis and Asthma (Zuskin *et al*, 1994), Extrinsic allergic alveolitis (Farmers Lung) (Flannigan *et al* 1991) where prolonged (usually occupational) exposure occurs, Chronic Obstructive Pulmonary Disease (COPD) (Lacey and Crook, 1988, Matheson, 2005); Toxic Pneumonitis (Lacey and Crook,1988) and upper airway irritation/mucous membrane irritation (Dutkiewicz,1997).

Risk to the public

Whilst many measurements of airborne concentrations of organisms have been made within and in the vicinity of composting plants, which give ample evidence for a hazard especially to composting workers, there have been very few studies of health effects from which any quantitative indication of risk can be derived for members of the public (IOM, 2008). Concern has been raised by residents in the vicinity of composting sites that composting activities could increase levels of bioaerosols, such as airborne *Aspergillus fumigatus* spores. Most reports show numbers to have declined to 'background' within 200 m from a compost bioaerosol source, although some report levels above background at a greater distance. Background or typical ambient bioaerosol levels may differ by orders of magnitude depending on location, weather and season, which hinder interpretation. Few published studies exist where the health of residents near composting sites has been investigated, but where such work has been done there is little evidence of ill health compared to controls (Millner, 1995). The responses to bioaerosols are host and dose dependent; that is some individuals may respond to a dose that does not affect others (Millner et al., 1994, Millner 1995). However based on the current knowledge, the risk is impossible to quantify due to the lack of accepted dose-response relationships for bioaerosol exposure (Wheeler et al, 2001; IOM, 2008; Drew et al, 2009; EA, 2009). Bioaerosols are endemic in the environment from decomposing leaves in gardens and woods, wheat fields etc. and the body has many natural defences against them. However individual susceptibilities vary considerably and even natural levels of bioaerosols can be harmful to certain individuals. The Environment Agency

(EA), has established conservative *'acceptable levels'* for micro-organisms in air as shown in Table 1 (EA, 2010). The EA concede that other activities may lead to higher background bioaerosol levels than would normally be expected (EA, 2007).

Table 1:

Environment Agency Reference for Bioaerosol (EA, 2010)	
Reference Pollutant	CFU m^{-3}
Total Bacteria	1000
Aspergillus fumigatus	500
Gram negative Bacteria	300

3.0 Monitoring Protocol

The monitoring was undertaken in accordance with the current AfOR guidance, "*A Standardised Protocol for the Monitoring of Bioaerosols at Open Composting Facilities*" (2009).

Bioaerosols were sampled at a position 1.5m above ground level using a single stage Anderson sampler during normal site operations. Monitoring was conducted in parallel at each of the monitoring locations. Additional passive samples, i.e. no air drawn through the sampler, were taken at the locations downwind of the working area.

4.0 Sample Collection

Composting operations, at Maindiff Court Farm, are carried out in two locations within the working area detailed in the Environmental Permit:

- an in-building composting area. Windrows are housed within bays of an agricultural building. After shredding, material is formed in to piles within bays. The East facing side of the building is open.
- an open concrete pad area, used for delivery and short-term storage of green waste and for maturation of the output of the in-building bays.

Table 2 details the distances and bearing of the closest receptors to the working area.

Table 2: – Sensitive Receptors

Receptor	From working area		Description
	Distance	Bearing	
Maindiff Court Farm cottages	60m	270°	Residential buildings adjacent to Maindiff Court Farm.
Maindiff Court Hospital grounds	250m +	0^{o} to 60^{o}	Community hospital grounds.
Maindiff Court Hospital buildings	275m +	10° to 50^{o}	Community hospital buildings.
A465	250m	270°	Trunk Road. Linear feature N – S to west of facility.
Green Acres Farm	425m	197^{o}	Agricultural buildings.
Wern Ddu Golf Club	450m	90^{o}	Recreational.
Ross Road, Abergavenny	450m	270°	Residential street.
Tredilion Park	550m	125°	Residential.
Wern Ddu	575m	80°	Residential house.
Blossom Holiday Park	625m	52°	Touring caravan site/Tourism.

In accordance with the Association for Organics Recycling protocol, monitoring locations are adjusted on each monitoring occasion, to account for changes in the prevailing wind direction, site access and other practical issues. The actual monitoring locations utilised are included in Appendix 2, page 31, and indicated as:-

- Up-wind
- Downwind – 60m
- Downwind – 215m
- Sensitive Receptor

4.1. Selection of Monitoring Locations

On arrival at the site on the day of monitoring the weather station was erected on top of an earth bund forming the southern boundary of the working area, away from buildings and trees that may affect meteorological data. From gathered data, a working plan was proposed and monitoring locations selected. The meteorological data was consulted between each monitoring location to ensure that selected monitoring locations were still valid, prior to setting up equipment.

On the day of monitoring, the prevailing wind direction was generally from the North East.

Monitoring was carried out at four locations:

- a point 50m upwind of the working area (Upwind),
- a point 60m downwind of the working area (Downwind – 60m),
- a point downwind of the working area a similar distance from the working areas as the boundary of Maindiff Court Hospital (Downwind 215m) and
- A point in the most suitable location adjacent to the closest sensitive receptor, Maindiff Farm Cottages (Sensitive Receptor).

Upwind – Samples were collected from a monitoring location approximately 50m north east of the working area in an open field.

Downwind – 60m. - A location 60m south west of the border of the working area was selected for the downwind monitoring location. Samples were collected in an open field used for livestock grazing. On the day of monitoring, the field was being used for grazing sheep. During monitoring, sheep clustered around the monitoring equipment and had to be moved away from the equipment on several occasions.

The topography between the site and the monitoring location was open grassland. This does not replicate the land between the site and sensitive receptor, which is screened by buildings. The concentrations recorded at the downwind location therefore may over represent the concentration that would be found at the sensitive receptor.

Photograph 1: Downwind – 60m. open ground between monitoring location and working area.

Downwind – 215m. – The Environment Permit for the Maindiff Court Farm requires a monitoring location on the boundary of Maindiff Court Hospital. As Maindiff Court Hospital was not downwind on the day of monitoring, a location was chosen a similar distance downwind from the working area as the distance between working area and hospital boundary, i.e. approximately 250m. A location was chosen in the south west corner of an open field, used for grazing sheep, to the south of the working area. The open terrain between the working area and monitoring location corresponds to the terrain between the working area and Maindiff Court Hospital.

The monitoring location was as far away from the working area as the field would allow, 215m from the working area. This was slightly closer to the working area than the equivalent distance to the hospital boundary at 250m. A location a greater distance to the south would have placed the monitoring location behind a tree screen surrounding the field and would not have reflected the topography between the site and the hospital receptor.

Photograph 2: Downwind - 215m, view south to tree screening at boundary of field:

Photograph 3. Downwind 210m. Open ground between monitoring location and working area.

Sensitive Receptor – Samples were collected from a monitoring location, approximately 60m from the working area, at the edge of a field adjacent to Maindiff Court cottages. The monitoring location was close to trees and buildings, however the location chosen provided the most open and suitable area of available ground adjacent to the sensitive receptor. The choice of location was limited by the access road, perimeter wall and buildings.

4.2. Site Activity

During monitoring at the upwind, downwind and downwind 215m locations on 01st December 2014, material was turned between in-building bays. Material was also turned during the *Aspergillus fumigatus* samples at the sensitive receptor. During the mesophilic bacteria and gram negative bacteria samples at the sensitive receptor, plastics and other contaminants were removed from a load of deposited green waste.

Exposure times for each sample were reduced from 20 minutes to 15 minutes to ensure that work was being undertaken throughout the monitoring period.

5.0 Meteorological Data

Meteorological data was logged with a Davis Instruments wireless Vantage Pro2 with associated 'Weatherlink' software throughout the monitoring period. The full meteorological data has been omitted from the report due to the large volume that is generated. However, supplementary meteorological data that provides a general overview is listed in Appendix 4 and 5.

The weather during monitoring was overcast with a light north easterly breeze. There was no precipitation during the monitoring period. The average wind speed was 0.6 m/s over the monitoring period. Temperatures were stable throughout the monitoring period varying between 7.9 ^{o}C to 8.3 ^{o}C throughout the day. Humidity was stable throughout the monitoring period, ranging between 79% and 82%.

Weather conditions for the 24 hours prior to the monitoring exercise were:
Cloudy once early morning fog had lifted, dry. The wind was predominantly from the North West.

6.0 Analysis

Analysis was carried out for total mesophilic bacteria, the fungi *Aspergillus fumigatus*, and gram negative bacteria using standard 'Cardiff Met Laboratory Protocol' and in line with BS EN ISO 7218:2007 + A1:2013 – "Microbiology of

food and animal feeding stuffs. General requirements and guidance for microbiological examinations."

This method is taken from the protocol, "A Standardised Protocol for the Monitoring of Bioaerosols at Open Composting Facilities" (AFOR, 2009).

6.1 Selective Media

All laboratory media preparation and sterilisation was carried out in accordance with the standard procedures as set out in the Cardiff School of Health Sciences Laboratory Manual (volume 2, section 5) in line with BS EN ISO 7218:2007 + A1:2013 – "Microbiology of food and animal feeding stuffs. General requirements and guidance for microbiological examinations." and ISO 11133-1:2009 (ISO, 2009).

Half-strength nutrient agar medium is used to culture mesophilic bacteria; malt extract medium was used to culture *Aspergillus fumigatus* and MacConkey No.3 agar was used to culture Gram Negative bacteria.

The mesophilic bacterial count derives from the AfOR protocol (2009) and HPA standard methodology. The count for *Aspergillus fumigatus* follows the AfOR protocol (2009). The total gram negative count method is not covered by the AfOR protocol, but is based on reference by Drew et al (2009).

6.2 Sampling

The sampling at the composting site follows the procedures laid out in the guidance, "A Standardised Protocol for the Monitoring of Bioaerosols at Open Composting Facilities" (AFOR, 2009).

The exposure time for each sample were reduced from 20 minutes to 15 minutes on the day of monitoring, to ensure that composting activity, i.e. turning, took place during sampling at each monitoring location.

Petri dishes were stored in a cooled container (at approximately 4°C) following sampling, until all remaining samples had been collected. All dishes

were then inverted and placed in an appropriate microbiological incubator at the same time. This is carried out no later than 12 hours after sampling. The nutrient agar medium, selecting for mesophilic bacteria and the MacConkey No. 3 agar medium, culturing for total Gram Negative bacteria were incubated at 37°C. Colonies growing on these media were enumerated after two and three days respectively. The malt extract medium, culturing for *Aspergillus fumigatus*, were incubated at 42°C and enumerated after 2 days.

6.3 Enumeration

Mesophilic Bacteria:

The number of colonies on each nutrient agar medium plate was counted after incubation of the sample for two days at 37°C.

If 399 or more colonies are counted on any single plate, this is recorded as "Too Numerous To Count" (TNTC).

Gram Negative Bacteria:

The number of colonies of Gram Negative bacteria growing on each MacConkey No. 3 agar plate after incubation of the sample for three days at 37°C were counted and recorded.

If 399 or more colonies are counted on any single plate, this is recorded as "Too Numerous To Count" (TNTC).

Aspergillus fumigatus:

The number of colonies of *A. fumigatus* growing on each malt extract agar medium plate after incubation of the sample for two days at 40°C were counted and recorded. Identification is based upon gross colony colour and morphology plus spore bearing structures according to standard texts.

Identification was confirmed by low magnification bright field light microscopy where necessary.

If enumeration of *Aspergillus fumigatus* is not possible because of the large number of colonies, this is recorded as "Too Numerous To Count" (TNTC). Where spreading colonies of other fungi obscure less than half of a Petri dish, then colonies of *A. fumigatus* were enumerated on the un-obscured half, as

long as this appears to be representative of the entire sample. This is recorded and the number of colonies adjusted as if the whole dish were enumerated.

Only colonies that fall at the impaction sites of the sampler were counted and recorded. Satellite colonies growing adjacent to larger colonies at the impaction site and colonies growing around the perimeter of the medium are ignored.

If spreading colonies obscured more than half of one Petri dish, this was recorded as “No results, spreaders”. If 399 or more colonies are counted on any single plate, this is recorded as “Too Numerous To Count” (TNTC).

Where spreading colonies obscure less than half of a Petri dish, then colonies were enumerated on the un-obscured half, as long as this appears to be representative of the entire sample. This is recorded and the number of colonies adjusted as if the whole dish were enumerated.

6.4 Data Recording

Laboratory – prior to sampling:

- Date and time of media preparation (media preparation log file)
- Batch numbers of the media components (media preparation log file)
- Laboratory personnel (media preparation log file)
- Trace of the sterilisation temperature profiles (refer to Cardiff Met Laboratory Manual volume 2, section 5.6 “Media Autoclaving” and section 9.22 “Osprey Multicycle Autoclave”)
- Storage conditions of the prepared media (media preparation log file)

Laboratory -post sampling:

For each Petri dish the following was recorded,

- Unique sample number
- Sampling date
- Date and time Petri dishes were placed in incubators
- Date and time Petri dishes were removed from incubators

- Number of colonies on the plate
- Corrected number of colonies (using the Positive Hole Correction Table supplied by the Andersen sampler manufacturer)

7.0 Results

The data interpretation has been conducted and presented in accordance with the AFOR guidance, "*A Standardised Protocol for the Monitoring of Bioaerosols at Open Composting Facilities*" (2009).

In the tabulated results below;

- *'UW' refers to the upwind sample location*
- *'DW' refers to the Downwind sample location*
- *'DHR' refers to a location downwind at the same distance from the working area as the Maindiff Court Hospital receptor*
- *'SR' refers to the sensitive receptor location*
- '½Str Nutrient' refers to the ½ strength nutrient agar media
- 'MacConkey' refers to the MacConkey No. 3 agar media
- 'Malt extract' refers to the Malt extract media
- *'AF' refers to Aspergillus fumigatus*
- *'MB' refers to Mesophilic Bacteria*
- *'GN' refers to Gram Negative Bacteria*
- *'Passive' refers to a sample left in the sampler but with no vacuum applied*
- *'Control' refers to a sample not exposed to the atmosphere before analysis*
- *TNTC is indicated when enumeration is not possible because of the large numbers of colonies. This is greater than 399 colonies or greater than 2427 cfu m^{-3}*
- *'No Count – Spreaders' is indicated when spreading fungal growth, other than A. fumigatus, has obscured greater than 50% of the plate.*
- *cfu m^{-3} refers to Colony forming units per cubic meter of air*
- *'Corrected Number of colonies' refers to the number of colonies per plate adjusted using the Positive Hole Correction Table*

The results presented below are for each organism for the monitoring exercise undertaken on 01st December 2014. A graphical overview of the results can be found in Appendix 1, page 29.

Mesophilic Bacteria Counts – 01st December 2014

Sample Reference Number	Media	Incubation Period		Identification	Date Completed	Presumptive count (colonies per plate)	Sample Duration	Flow Rate	Corrected Number of colonies*	**Colony forming units per cubic meter of air (cfu m-3)**
		IN	OUT							
DW MB Passive	½Str Nutrient	01/12/2014	03/12/2014	n/a	03/12/2014	0	15	0	0	n/a
DHR MB Passive	½Str Nutrient	01/12/2014	03/12/2014	n/a	03/12/2014	0	15	0	0	n/a
Control 1	½Str Nutrient	01/12/2014	03/12/2014	n/a	03/12/2014	0	n/a	n/a	n/a	n/a
Control 2	½Str Nutrient	01/12/2014	03/12/2014	n/a	03/12/2014	0	n/a	n/a	n/a	n/a
DW MB 1	½Str Nutrient	01/12/2014	03/12/2014	n/a	03/12/2014	84	15	0.0283	94	**221**
DW MB 2	½Str Nutrient	01/12/2014	03/12/2014	n/a	03/12/2014	101	15	0.0283	116	**273**
DHR MB 1	½Str Nutrient	01/12/2014	03/12/2014	n/a	03/12/2014	20	15	0.0283	21	**49**
DHR MB 2	½Str Nutrient	01/12/2014	03/12/2014	n/a	03/12/2014	16	15	0.0283	16	**38**
SR MB 1	½Str Nutrient	01/12/2014	03/12/2014	n/a	03/12/2014	30	15	0.0283	31	**73**
SR MB 2	½Str Nutrient	01/12/2014	03/12/2014	n/a	03/12/2014	29	15	0.0283	30	**71**
UW MB 1	½Str Nutrient	01/12/2014	03/12/2014	n/a	03/12/2014	5	15	0.0283	5	**12**
UW MB 2	½Str Nutrient	01/12/2014	03/12/2014	n/a	03/12/2014	6	15	0.0283	6	**14**

Total Gram Negative Bacteria Counts – 01st December 2014

Sample Reference Number	Media	Incubation Period		Identification	Date Completed	Presumptive count (colonies per plate)	Sample Duration	Flow Rate	Corrected Number of colonies*	**Colony forming units per cubic meter of air (cfu m-3)**
		IN	OUT							
DW GN Passive	MacConkey	01/12/2014	04/12/2014	n/a	04/12/2014	0	15	0	0	n/a
DHR GN Passive	MacConkey	01/12/2014	04/12/2014	n/a	04/12/2014	0	15	0	0	n/a
Control 1	MacConkey	01/12/2014	04/12/2014	n/a	04/12/2014	0	n/a	n/a	n/a	n/a
Control 2	MacConkey	01/12/2014	04/12/2014	n/a	04/12/2014	0	n/a	n/a	n/a	n/a
DW GN 1	MacConkey	01/12/2014	04/12/2014	13 G -ve	04/12/2014	13	15	0.0283	13	**31**
DW GN 2	MacConkey	01/12/2014	04/12/2014	9 G -ve	04/12/2014	9	15	0.0283	9	**21**
DHR GN 1	MacConkey	01/12/2014	04/12/2014	1 G -ve	04/12/2014	1	15	0.0283	1	**2**
DHR GN 2	MacConkey	01/12/2014	04/12/2014	0 G -ve	04/12/2014	0	15	0.0283	0	**0**
SR GN 1	MacConkey	01/12/2014	04/12/2014	0 G -ve	04/12/2014	0	15	0.0283	0	**0**
SR GN 2	MacConkey	01/12/2014	04/12/2014	0 G -ve	04/12/2014	0	15	0.0283	0	**0**
UW GN 1	MacConkey	01/12/2014	04/12/2014	1 G -ve	04/12/2014	1	15	0.0283	1	**2**
UW GN 2	MacConkey	01/12/2014	04/12/2014	0 G -ve	04/12/2014	0	15	0.0283	0	**0**

Aspergillus fumigatus **Counts – 01st December 2014**

Sample Reference Number	Media	Incubation Period		Identification	Date Completed	Presumptive count (colonies per plate)	Sample Duration	Flow Rate	Corrected Number of colonies*	**Colony forming units per cubic meter of air (cfu m-3)**
		IN	OUT							
DW AF Passive	Malt Extract	01/12/2014	03/12/2014	n/a	03/12/2014	0	15	0	0	n/a
DHR AF Passive	Malt Extract	01/12/2014	03/12/2014	n/a	03/12/2014	0	15	0	0	n/a
Control 1	Malt Extract	01/12/2014	03/12/2014	n/a	03/12/2014	0	n/a	n/a	n/a	n/a
Control 2	Malt Extract	01/12/2014	03/12/2014	n/a	03/12/2014	0	n/a	n/a	n/a	n/a
DW AF 1	Malt Extract	01/12/2014	03/12/2014	112 +ve *A. fumigatus*	03/12/2014	112	15	0.0283	131	**309**
DW AF 2	Malt Extract	01/12/2014	03/12/2014	100 +ve *A. fumigatus*	03/12/2014	100	15	0.0283	115	**271**
DHR AF 1	Malt Extract	01/12/2014	03/12/2014	17 +ve *A. fumigatus*	03/12/2014	17	15	0.0283	17	**40**
DHR AF 2	Malt Extract	01/12/2014	03/12/2014	14 +ve *A. fumigatus*	03/12/2014	14	15	0.0283	14	**33**
SR AF 1	Malt Extract	01/12/2014	03/12/2014	4 +ve *A. fumigatus*	03/12/2014	4	15	0.0283	4	**9**
SR AF 2	Malt Extract	01/12/2014	03/12/2014	2 +ve *A. fumigatus*	03/12/2014	2	15	0.0283	2	**5**
UW AF 1	Malt Extract	01/12/2014	03/12/2014	1 +ve *A. fumigatus*	03/12/2014	1	15	0.0283	1	**2**
UW AF 2	Malt Extract	01/12/2014	03/12/2014	5 +ve *A. fumigatus*	03/12/2014	5	15	0.0283	5	**12**

During monitoring at the upwind, downwind and downwind 215m locations on 01st December 2014, material was turned between in-building bays. Material was also turned during the Aspergillus fumigatus samples at the sensitive receptor. During the mesophilic bacteria and gram negative bacteria samples at the sensitive receptor, plastics and other contaminants were removed from a load of deposited green waste. Exposure times for each sample were reduced from 20 minutes to 15 minutes to ensure that composting activities were being undertaken throughout the monitoring period.

All concentrations of bioaerosols measured on 01st December 2014 at Maindiff Court Farm were below guidance levels suggested by the Environment Agency of 1000 cfu/m^3 for mesophilic bacteria, 500 cfu/m^3 for *Aspergillus fumigatus* and 300 cfu/m^3 for gram negative bacteria.

The wind direction during sampling was relatively stable, blowing from a generally North Easterly direction throughout the period. As a result, the sampling locations used provide good representations of the concentrations at each location.

The North Easterly prevailing wind placed the downwind monitoring location in an open field to the south of the working area. The open ground between the monitoring location and the working area does not represent the same conditions between the working area and sensitive area, which consist of buildings which would act to screen the sensitive receptor from bioaerosols. As a result, the results from the current monitoring may overestimate the likely concentrations experienced at the sensitive receptor. Concentrations at the downwind location were above background levels (mesophilic bacteria: mean 247 cfu/m^3, gram negative bacteria: mean 26 cfu/m^3, *Aspergillus fumigatus*: mean 290 cfu/m^3) but were below guidance levels suggested by the Environment Agency.

In order to represent monitoring at the boundary of the Maindiff Court Hospital grounds, monitoring at approximately 250m from the working area is undertaken during each monitoring exercise. During the current monitoring, a location was chosen in an open field to the south west of the site 215m from the working area. This is closer to the working area than the hospital boundary. A location 250m from

the working area would have placed the monitoring point behind a tree screen that would not have been representative of the ground between the working area and hospital boundary. As the selected monitoring location is closer to the working area than the hospital boundary, the concentrations measured may over estimate concentrations at the boundary of the hospital grounds.

Concentrations of mesophilic bacteria (mean 44 cfu/m^3) and Aspergillus fumigatus (mean 37 cfu/m^3) at the location 215m downwind of the working area were slightly above background concentrations but had decreased significantly from the concentrations observed at the downwind location and were in the same order of magnitude as background concentrations. Concentrations of gram negative bacteria had returned to background levels at this location (mean 1 cfu/m^3). The concentrations recorded at the location 215m from the working area suggest that concentrations for all micro-organisms measured on the day would have returned to background concentration within 250m of the site boundary.

Concentrations of mesophilic bacteria at the sensitive receptor were above background levels (mean 72 cfu/m^3: background mean 13 cfu/m^3). During monitoring, the sensitive receptor was perpendicular to the prevailing wind direction. This suggests that a secondary source of bioaerosol in the vicinity of the sensitive receptor may have contributed to the concentration of mesophilic bacteria recorded.

Concentrations of Aspergillus fumigatus (mean 7 cfu/m^3) and gram negative bacteria (not detected) were at background levels at the sensitive receptor location.

Suggested risk mitigation measures can be found in section 9.0 – Recommendations.

8.0 Conclusions

In conclusion, the CHSE / Cardiff Met have completed ambient air monitoring of bioaerosols in accordance with Association for Organics Recycling approved methodology. Selective media has been used to enumerate mesophilic bacteria, the fungus *Aspergillus fumigatus* and gram negative bacteria.

During the monitoring, material was turned between in-building bays. Plastic and other contaminants were removed from a deposited load of green waste for 30 minutes during the monitoring at the sensitive receptor.

During the monitoring exercises on 01st December 2014, levels of mesophilic bacteria, gram negative bacteria and the fungi *Aspergillus fumigatus* were all below the appropriate levels set by the Environment Agency of 1000 cfu/m^3, 300 cfu/m^3 and 500 cfu/m^3 respectively, at all locations monitored.

Concentrations for all the micro-organisms measured showed higher concentrations at the location 60m downwind of the working area than background (mesophilic bacteria: mean 247 cfu/m^3, *Aspergillus fumigatus*: mean 290 cfu/m^3 and gram negative: mean 26 cfu/m^3). The ground between the working area and monitoring location was open and as a result may overestimate concentrations at the sensitive receptor which is screened from the working area by buildings. The concentrations of mesophilic bacteria, gram negative bacteria and the fungi *Aspergillus fumigatus* measured at the downwind location 215m from the working area were slightly higher than background concentrations but were significantly lower than those at the downwind location. This suggests that bioaerosol levels 250m from the working area would have dropped to background levels.

Practical control measures are provided in Section 9.0 – Recommendations.

9.0 Recommendations

Practical risk mitigation measures are recommended to minimise bioaerosol exposure through processes such as turning, shredding and screening. The Environment Agency Technical Guidance on Composting Operations (October 2001 – Draft for External Consultation) recommends the following;

- The moisture content within all stages of the composting process should be monitored to avoid the waste and materials drying out and potentially forming dusts.
- The formation or turning of windrows or piles should be avoided if possible on windy days. Screening and shredding should also be undertaken when wind speeds are calm or wind direction is away from sensitive receptors.
- Site surfaces such as roads and tracks and the piles or windrows themselves should be regularly dampened down and/or regularly swept to suppress dust.
- Plant and machinery should be well maintained to avoid dust generation. The use of enclosures for screens and hoppers can be useful.
- Physical barriers such as mounds or walls can prevent dust leaving a site. Site construction and specific landscaping techniques can contain dusts that are generated on site.
- The composting of waste within buildings can provide excellent containment for the control of dust.

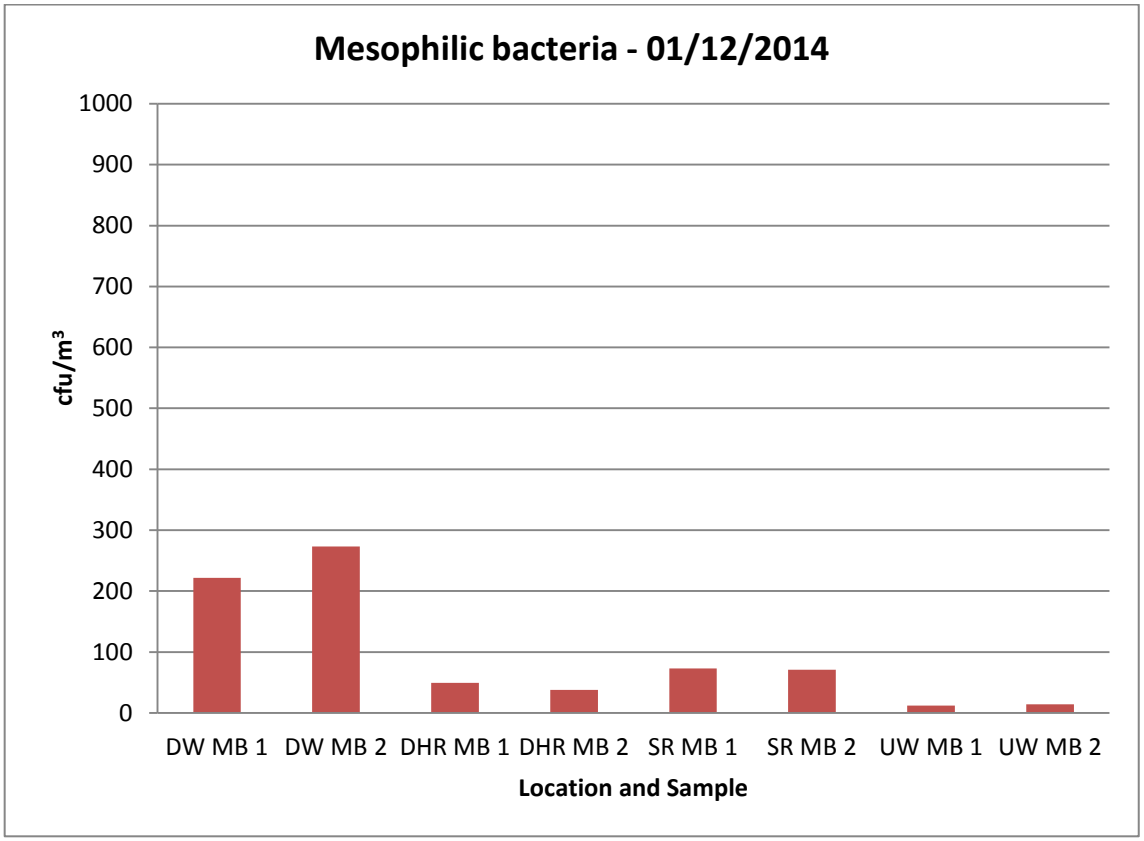
In addition to the recommendations in the Technical Guidance note, it is recommended that:

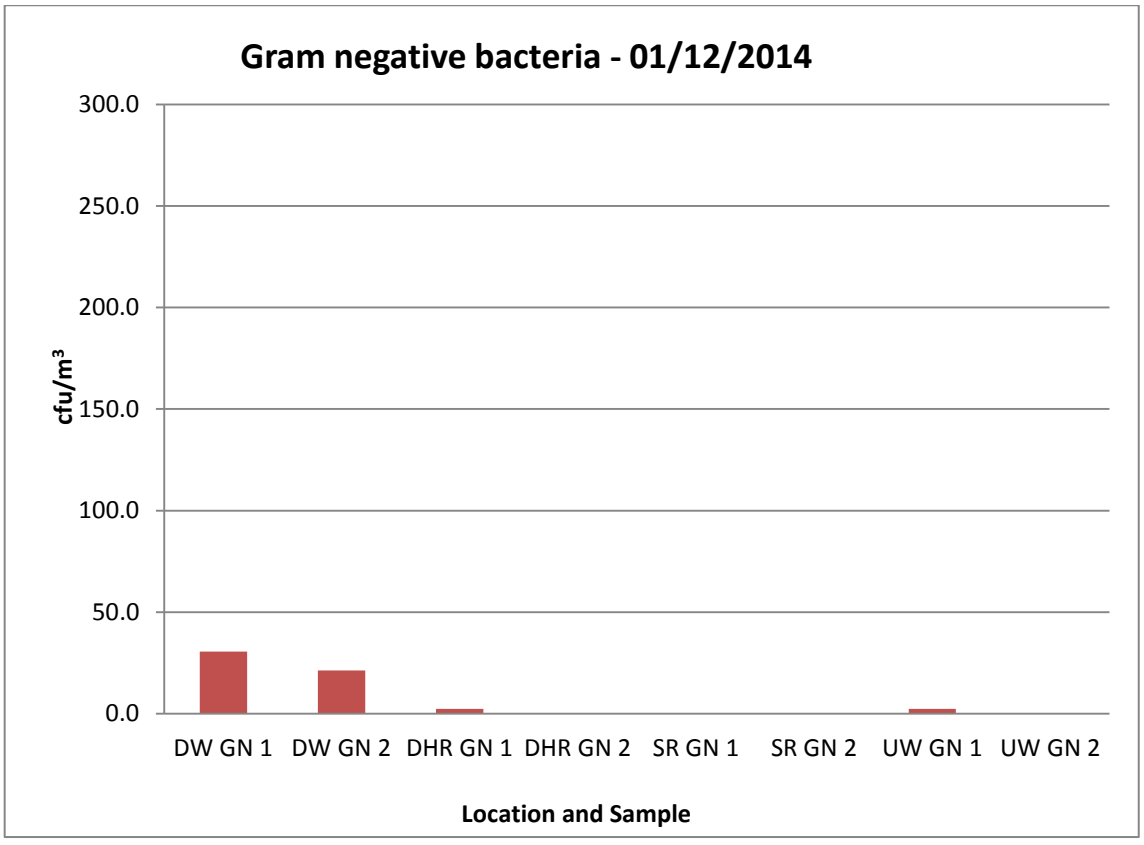
- Stockpiling of material before shredding should be minimised. This would reduce the potential for decomposition to begin before shredding takes place. The early stages of decomposition see a proliferation in the numbers of micro-organisms on the more readily available sources of nutrients.
- Drop heights should be minimised, to reduce the agitation of the material when being moved.

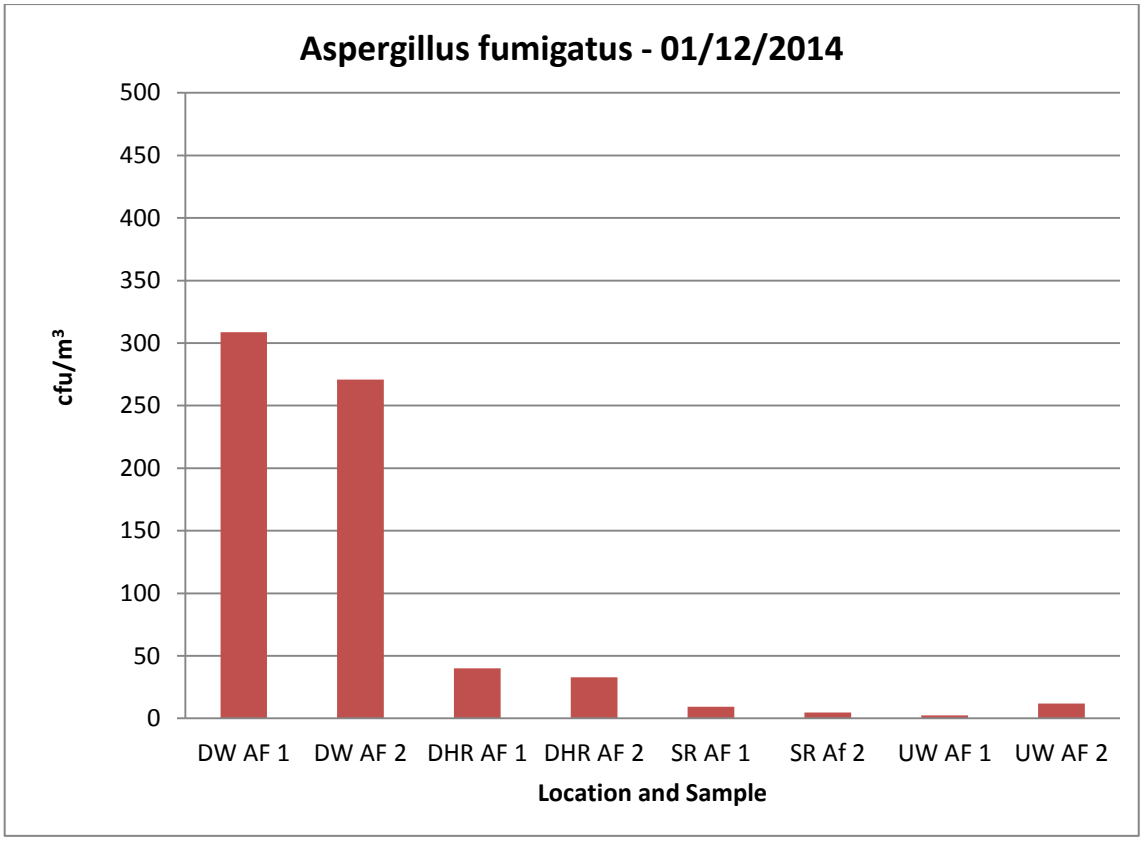
Appendices

Appendix 1 – Variation in monitored levels of specific micro-organisms

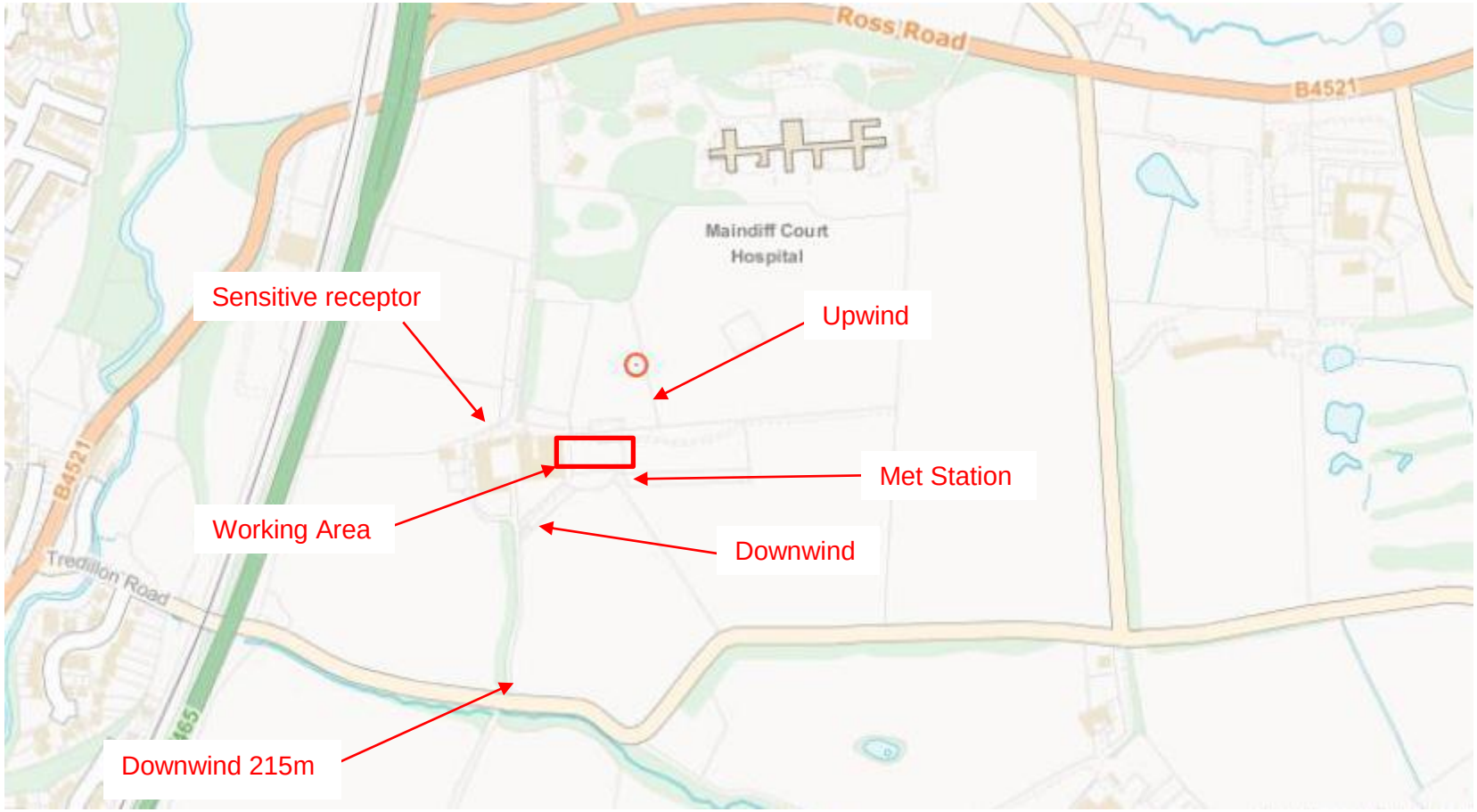
01st December 2014






Aspergillus fumigatus - 01/12/2014
500
450
400
350
300
250
200
150
100
50
0
cfu/m³
DW AF 1
DW AF 2
DHR AF 1
DHR AF 2
SR AF 1
SR Af 2
UW AF 1
UW AF 2
Location and Sample

Appendix 2 Monitoring Location Plan – 01st December 2014



Appendix 3 – Location Specific Site Data

Upwind location – 01st December 2014

Upwind

Site: Maindiff Court Farm, Abergavenny
Site Operator: Mr Andrew Lewis
Sampling Date: 01st December 2014
Commissioning Laboratory: Cardiff Met, Western Avenue, Llandaff, Cardiff
Estimated Mass of Material:
Type of Material Processed on site: Green Waste

Location:	Sampling Reference Number:	Difference from boundary of operational area or tuning / screening operation (m)	Difference in bearing location of samplers from boundary / source and mean direction wind blows to (o)	Sampling time: (hh:mm)	Sampling duration (min)	Microbial type	Site activity	Material processed	Calculated concentration of airborne micro-organisms (cfu m-3)	Arithmetic mean of parallel samples (cfu m-3)	Comments relating to any activities occurring during the sampling period that might affect the concentration of airborne micro-organisms
Upwind	AF UW 1	50.0	135	14.10	15	AF	Turning material between in-building bays	Green waste	2	7	
Upwind	AF UW 2	50.0	135	14.10	15	AF			12		
Upwind	MB UW 1	50.0	175	14.27	15	MB			12	13	
Upwind	MB UW 2	50.0	175	14.27	15	MB			14		
Upwind	GN UW 1	50.0	203	14.45	15	GN			2	1	
Upwind	GN UW 2	50.0	203	14.45	15	GN			0		

Downwind – 01st December 2014

Downwind.

Site: Maindiff Court Farm, Abergavenny
Site Operator: Mr Andrew Lewis
Sampling Date: 01st December 2014
Commissioning Laboratory: Cardiff Met, Western Avenue, Llandaff, Cardiff
Estimated Mass of Material:
Type of Material Processed on site: Green Waste

Location:	Sampling Reference Number:	Difference from boundary of operational area or tuning / screening operation (m)	Difference in bearing location of samplers from boundary / source and mean direction wind blows to (o)	Sampling time: (hh:mm)	Sampling duration (min)	Microbial type	Site activity	Material processed	Calculated concentration of airborne micro-organisms (cfu m-3)	Arithmetic mean of parallel samples (cfu m-3)	Comments relating to any activities occurring during the sampling period that might affect the concentration of airborne micro-organisms
Downwind	AF DW 1	60m	4	10.04	15	AF	Turning material between in-building bays.	Green waste	309	290	
Downwind	AF DW 2	60m	4	10.04	15	AF			271		
Downwind	MB DW 1	60m	8	10.21	15	MB			221	247	
Downwind	MB DW 2	60m	8	10.21	15	MB			273		
Downwind	GN DW 1	60m	1	10.40	15	GN			31	26	
Downwind	GN DW 2	60m	1	10.40	15	GN			21		
Downwind	AF DW Passive	60m	4	10.04	15	AF	Turning material between in-building bays.	Green waste	0*	n/a	*Presumptive count per plate
Downwind	MB DW Passive	60m	8	10.21	15	MB			0*	n/a	
Downwind	GN DW Passive	60m	1	10.40	15	GN			0*	n/a	

Downwind Hospital Receptor – 01st December 2014

Downwind - Distance equivalent to hospital boundary

Site: Maindiff Court Farm, Abergavenny
Site Operator: Mr Andrew Lewis
Sampling Date: 01/12/2014
Commissioning Laboratory: Cardiff Met, Western Avenue, Llandaff, Cardiff
Estimated Mass of Material:
Type of Material Processed on site: Green Waste

Location:	Sampling Reference Number:	Difference from boundary of operational area or tuning / screening operation (m)	Difference in bearing location of samplers from boundary / source and mean direction wind blows to (o)	Sampling time: (hh:mm)	Sampling duration (min)	Microbial type	Site activity	Material processed	Calculated concentration of airborne micro-organisms (cfu m-3)	Arithmetic mean of parallel samples (cfu m-3)	Comments relating to any activities occurring during the sampling period that might affect the concentration of airborne micro-organisms
Downwind - 215m	AF DHR 1	215.0	8	11.25	15	AF	Turning material between indoor bays	Green waste	40	37	
Downwind - 215m	AF DHR 2	215.0	8	11.25	15	AF			33		
Downwind - 215m	MB DHR 1	215.0	17	11.40	15	MB			49	44	
Downwind - 215m	MB DHR 2	215.0	17	11.44	15	MB			38		
Downwind - 215m	GN DHR 1	215.0	20	12.01	15	GN			2	1	
Downwind - 215m	GN DHR 2	215.0	20	12.01	15	GN			0		
Downwind - 215m	AF DW Passive	215.0	8	11.25	15	AF	Turning material between indoor bays	Green waste	0*	n/a	*Presumptive count per plate
Downwind - 215m	MB DW Passive	215.0	17	11.40	15	MB			0*	n/a	
Downwind - 215m	GN DW Passive	215.0	20	12.01	15	GN			0*	n/a	

Sensitive Receptor – 01st December 2014

Sensitive Receptor

Site: Maindiff Court Farm, Abergavenny
Site Operator: Mr Andrew Lewis
Sampling Date: 01st December 2014
Commissioning Laboratory: Cardiff Met, Western Avenue, Llandaff, Cardiff
Estimated Mass of Material:
Type of Material Processed on site: Green Waste

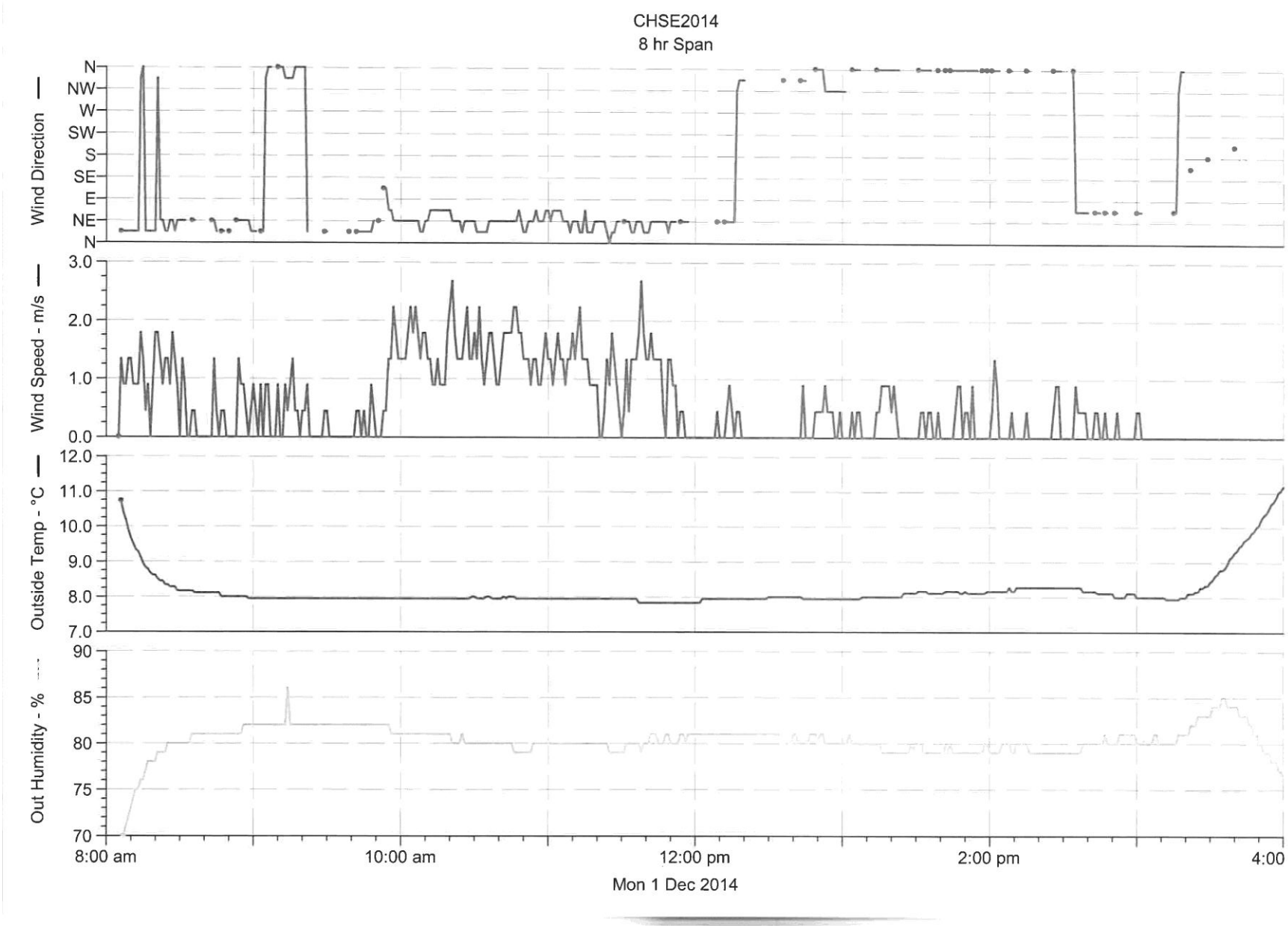
Location:	Sampling Reference Number:	Difference from boundary of operational area or tuning / screening operation (m)	Difference in bearing location of samplers from boundary / source and mean direction wind blows to (o)	Sampling time: (hh:mm)	Sampling duration (min)	Microbial type	Site activity	Material processed	Calculated concentration of airborne micro-organisms (cfu m-3)	Arithmetic mean of parallel samples (cfu m-3)	Comments relating to any activities occurring during the sampling period that might affect the concentration of airborne micro-organisms
Sensitive Receptor	AF SR 1	60.0	95	13.10	15	AF	Turning material between in-building bays.	Green waste	9	7	
Sensitive Receptor	AF SR 2	60.0	95	13.10	15	AF			5		
Sensitive Receptor	MB SR 1	60.0	95	13.27	15	MB	Removing plastic from deposited material.		73	72	
Sensitive Receptor	MB SR 2	60.0	95	13.27	15	MB			71		
Sensitive Receptor	GN SR 1	60.0	95	13.45	15	GN			0	0	
Sensitive Receptor	GN SR 2	60.0	95	13.45	15	GN			0		

Appendix 4 – Location Specific Meteorological Data – 01st December 2014

Site: Maindiff Court Farm, Abergavenny					Site Operator: Mr Andrew Lewis				
Sampling Date: 01st December 2014					Commissioning Laboratory: Cardiff Met, Western Avenue, Llandaff, Cardiff				
Estimated Mass of Material:					Type of Material Processed on site: Green waste				
Location:	Sampling Reference Number:	Bearing of samplers from boundary of operational area or turning / screening operation (o from true north)	Mean direction the wind blows **from** during the sampling period (each individual sample) (o from true north)	Mean direction the wind blows **to** during the sampling period (each individual sample) (o from true north)	Difference in bearing between location of samplers from boundary / source and mean direction wind blows to (o)	Mean wind speed during sampling (m s-1)	Arithmetic mean of air temperature (^{o}C)	Arithmetic mean of relative humidity (%)	Prevailing weather conditions (cloud cover in eighths)
Up Wind	AF UW 1	45	0	180	135	0.03	8.3	79	8/8
Up Wind	AF UW 2	45	0	180	135	0.03	8.3	79	8/8
Up Wind	MB UW 1	45	40	220	175	0.2	8.3	79	8/8
Up Wind	MB UW 2	45	40	220	175	0.2	8.3	79	8/8
Up Wind	GN UW 1	45	68	248	203	0.1	8.1	81	8/8
Up Wind	GN UW 2	45	68	248	203	0.1	8.1	81	8/8
Down Wind	AF DW 1	225	49	229	4	1.4	7.9	81	8/8
Down Wind	AF DW 2	225	49	229	4	1.4	7.9	81	8/8
Down Wind	AF DW Passive	225	49	229	4	1.4	7.9	81	8/8
Down Wind	MB DW 1	225	37	217	8	1.6	7.9	80	8/8
Down Wind	MB DW 2	225	37	217	8	1.6	7.9	80	8/8
Down Wind	MB DW Passive	225	37	217	8	1.6	7.9	80	8/8
Down Wind	GN DW 1	225	44	224	1	1.5	7.9	79	8/8
Down Wind	GN DW 2	225	44	224	1	1.5	7.9	79	8/8
Down Wind	GN DW Passive	225	44	224	1	1.5	7.9	79	8/8

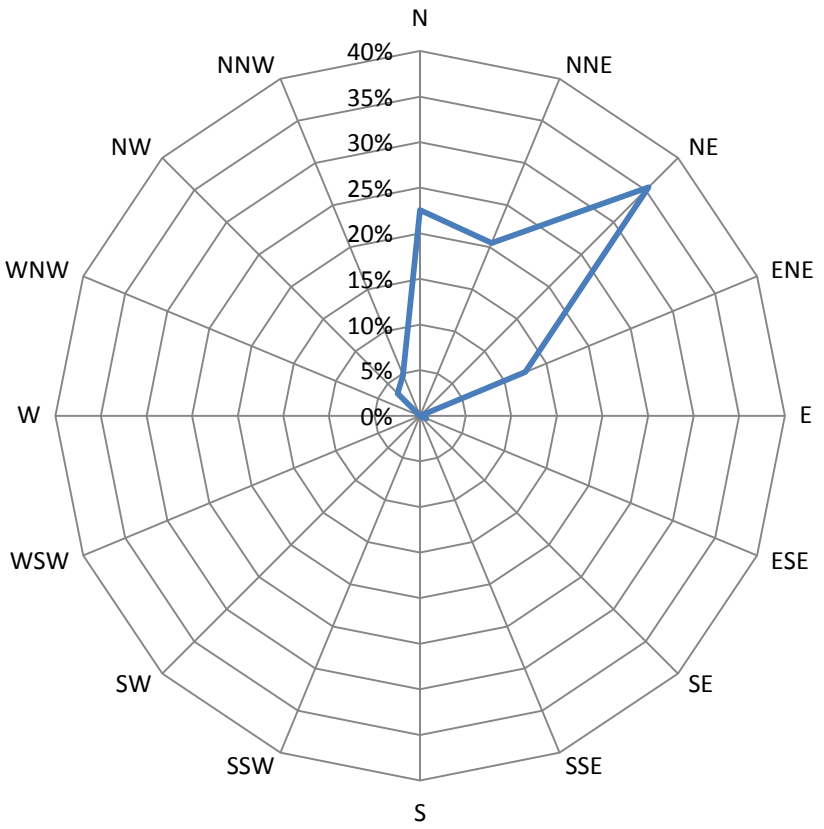
Location:	Sampling Reference Number:	Bearing of samplers from boundary of operational area or turning / screening operation (o from true north)	Mean direction the wind blows **from** during the sampling period (each individual sample) (o from true north)	Mean direction the wind blows **to** during the sampling period (each individual sample) (o from true north)	Difference in bearing between location of samplers from boundary / source and mean direction wind blows to (o)	Mean wind speed during sampling (m s-1)	Arithmetic mean of air temperature (^{o}C)	Arithmetic mean of relative humidity (%)	Prevailing weather conditions (cloud cover in eighths)
Down Wind 215m	AF DHR 1	205	33	213	8	1.1	7.9	79	8/8
Down Wind 215m	AF DHR 2	205	33	213	8	1.1	7.9	79	8/8
Down Wind 215m	AF DHR Passive	205	33	213	8	1.1	7.9	79	8/8
Down Wind 215m	MB DHR 1	205	42	222	17	0.6	7.8	80	8/8
Down Wind 215m	MB DHR 2	205	42	222	17	0.6	7.8	80	8/8
Down Wind 215m	MB DHR Passive	205	42	222	17	0.6	7.8	80	8/8
Down Wind 215m	GN DHR 1	205	45	225	20	0.1	7.9	81	8/8
Down Wind 215m	GN DHR 2	205	45	225	20	0.1	7.9	81	8/8
Down Wind 215m	GN DHR Passive	205	45	225	20	0.1	7.9	81	8/8
Sensitive Receptor	AF SR 1	275	0	180	95	0.4	8.0	79	8/8
Sensitive Receptor	AF SR 2	275	0	180	95	0.4	8.0	79	8/8
Sensitive Receptor	MB SR 1	275	0	180	95	0.1	8.1	79	8/8
Sensitive Receptor	MB SR 2	275	0	180	95	0.1	8.1	79	8/8
Sensitive Receptor	GN SR 1	275	0	180	95	0.3	8.1	79	8/8
Sensitive Receptor	GN SR 2	275	0	180	95	0.3	8.1	79	8/8

Appendix 5 –Meteorological Strip Chart – 01st December 2014



Appendix 6

Wind Rose covering time on site (8am – 3.15pm) - 01st December 2014



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