ODOUR & ENVIRONMENTAL ENGINEERING CONSULTANTS

Unit 32 De Granville Court, Dublin Rd, Trim, Co. Meath

Tel: +353 46 9437922
Mobile: +353 86 8550401
E-mail: info@odourireland.com
www.odourireland.com

BIOAEROSOL AND PARTICULATE MATTER IMPACT ASSESSMENT AT MOLAISIN COMPOSTING LTD., CAPPOQUIN, CO. WATERFORD, IRELAND

PREPARED BY: Dr. John Casey
ATTENTION: Ms. Fiona Doyle
DATE: 23rd Jan 2009
REPORT NUMBER: 2009.A75(1)
DOCUMENT VERSION: Document version 1
REVIEWERS:

TABLE OF CONTENTS

Section		Page number
TABLE OF CONTENTS		i
DOCUMENT AMENDMENT RECORD		ii
1.	**Introduction and scope**	**1**
1.1	Introduction	1
1.2	Scope of the work	1
2.	**Materials and methods**	**1**
2.1	Sampling and residential locations	1
2.2	Bioaerosols monitoring	2
2.3	Transport of bioaerosol samples	3
2.4	Particulate matter monitoring	3
2.5	Assessment criteria bioaerosols and PM_{10}	4
3.	**Results**	**5**
3.1	Ambient Bioaerosol air quality	5
3.2	Particulate matter air quality	6
4.	**Conclusions**	**6**

Document Amendment Record

Client: *Molaisin Compost Ltd*

TITLE: Bioaerosol and Particulate matter impact assessment at Molaisin Compost Ltd, Cappoquin, Co. Waterford.

Project Number: 2009.A75(1)			**Document Reference:** Bioaerosol and PM_{10} impact assessment at Molaisin Compost, Cappoquin, Co. Waterford.		
2009.A75(1)	Document for review	B.A.S.	JMC	B.A.S	23/01/2009
Revision	**Purpose/Description**	**Originated**	**Checked**	**Authorised**	**Date**

1. Introduction and scope

1.1 Introduction

Odour Monitoring Ireland was commissioned to perform a bioaerosol and particulate matter (PM_{10}) assessment in the vicinity of the operating Molaisin composting facility located in Cappoquin, Co. Waterford. The bioaerosol impact assessment was carried out in accordance with the guidance document established by the UK Composting Association "Standardised protocol for the testing and enumeration of micro organisms". The PM_{10} assessment was carried out in accordance EN1234-1:2002. Total Mesophillic bacteria and Aspergillus *fumigatus* sampling was performed using equivalent Andersen single stage impactors. Triplicate sampling was performed at each of the three identified sampling locations within and in the vicinity of Molaisin Composting facility located at Cappoquin, Co. Waterford. Bioaerosol ambient air concentrations are within the lower range of the proposed Environment Agency assessment criterion downwind of the facility (*see Table 2.4*). Ambient air concentration levels of PM_{10} were below the statutory 24-hour average ambient air concentration level of 50 $\mu g\ m^{-3}$ at the selected monitoring location (*see Table 2.5*).

1.2 Scope of the study

The main aim of the study was:

- To enumerate the ambient air concentration of two bioaerosols groups namely: Aspergillus *fumigatus* and Total Mesophillic bacteria during operation of the composting facility at Molaisin Composting Ltd, Cappoquin, Co. Waterford.
- To ascertain ambient air concentration levels of PM_{10} in the vicinity of Molaisin Composting Facility, Cappoquin, Co. Waterford.

2. Materials and methods

This section describes in detail the materials and methods used throughout the study period.

2.1 Sampling and residential locations

Figure 2.1 and *Table 2.1* illustrates the location of the proposed site in relation to local residents. Monitoring locations were (*see Table 2.1 & Figure 2.1*):

- Upwind 50m in the vicinity of the overall waste management facility,
- Downwind 50m in the vicinity of the overall waste management facility,
- At process and boundary locations around the composting facility operation.
- Centre of main facility boundary.

This allowed for the development of bioaerosol data for the operations at Molaisin Compost Ltd, Cappoquin, Co. Waterford.

Table 2.1. Monitoring locations and parameters monitored.

Location ID	Parameter monitored	Location description
Cappo 1	Total Mesophillic bacteria and Aspergillus fumigatus	Upwind of site (approx 50m)
Cappo 2	Total Mesophillic bacteria and Aspergillus fumigatus	Downwind of site (approx 50m)
Cappo 3	Total Mesophillic bacteria and Aspergillus fumigatus	Within site downwind (approx 1 m from biofilter wall)
Cappo 4	PM_{10}	Centre of main facility boundary

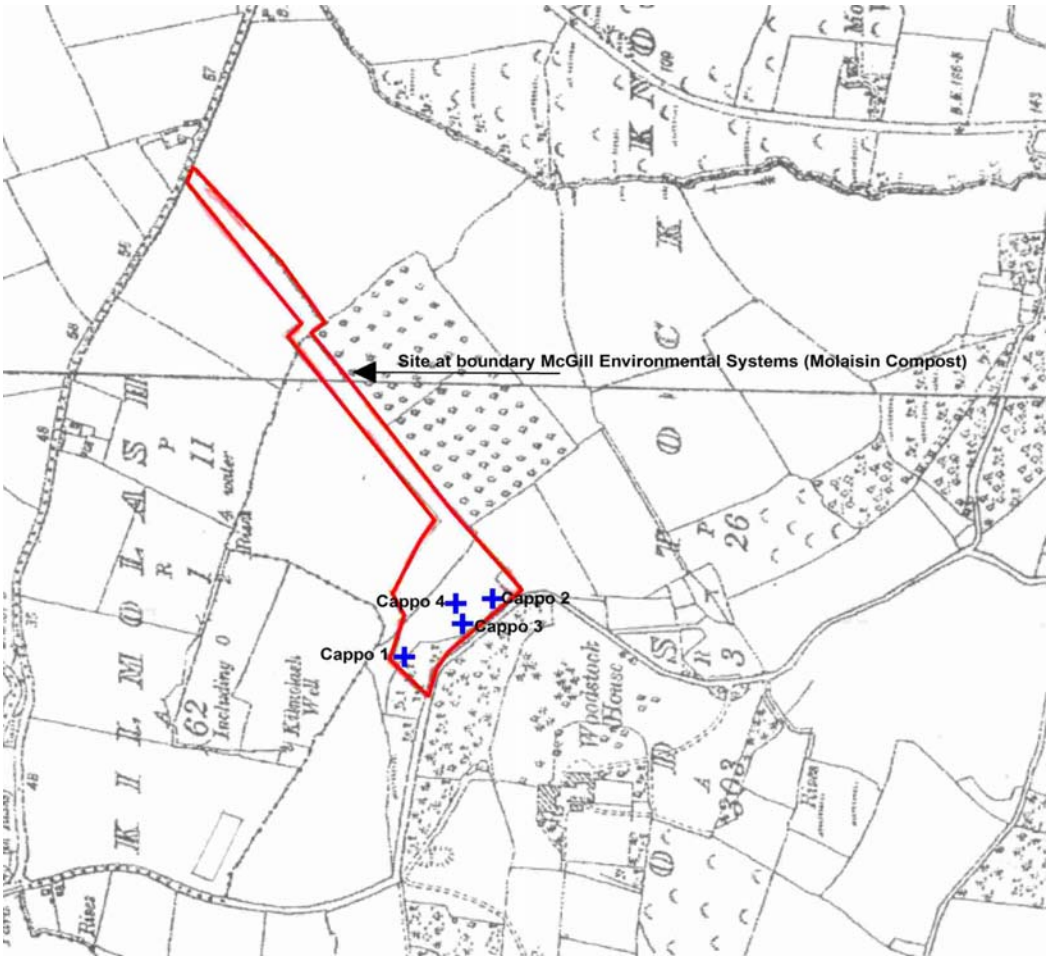

Figure 2.1. Schematic overview of Bioaerosol and PM_{10} monitoring locations.

2.2 Bioaerosols monitoring

Monitoring of bioaerosols was performed in strict accordance with available information and advice including the sources:

1. Standardised Protocol for the Sampling and Enumeration of Airborne Micro-organisms at Composting Facilities. (1999). The UK Composting Association.
2. Macher, J. (1999). Bioaerosol assessment and control. American Conference of Government Industrial Hygienists, Kemper Woods Centre, 1330 Kemper Meadow Drive, Cincinnati, OH.
3. Direct Laboratories, (formerly ADAS), Woodthorne, Wergs Road, Wolverhampton, WV6 8QT.
4. SKC Inc, 863 Valley View Road, Eighty-four, PA, 15330.

Impactor plate sampling was carried out in accordance with the document “Sampling Protocol for the Sampling and Enumeration of Airborne Micro-organisms at Composting facilities, The Composting Association, UK.

One sampling technique was employed namely:

- Biostage single stage 400 hole impactor (SKC Inc, PA)- This is a direct equivalent to the Andersen N6 single stage impactor and meets the requirements of NIOSH 0800 and NIOSH 0801 biological sampling standards (i.e. this impactor is a direct copy of the Andersen N6 impactor with added benefits including the Surelok system which prevents any air leakages. This was an inherent problem of the Andersen N6 single stage impactor).

Generally, sampling times of 10 minutes were used to assess ambient levels using the impactor plates as longer sampling times can lead to desiccation of the plate and impacted microbes.

The Biostage (i.e. Andersen N 6 equivalent impactor) was calibrated using a Bios Primary flow calibrator to a volumetric flow rate of 28.3 *litres* min^{-1} and Hi Flow 30 battery operated automatically timed pumps were used for suction airflow.

The Biostage impactors were fixed to tripods ensuring an adjustable sampling height of between 0.40 to 1.9 metres. The sampling height was fixed at 1.50 metres. Two Biostage impactors were used throughout the study period. The use of correctly designed sampling equipment ensured correct operation at all times throughout the study period.

The Irish Equine Centre (ISO 17025 accredited) tested two medias including Malt Extract Agar media (MEA) for Aspergillus *fumigatus*, and standard plate count agar (TVC) for total Mesophillic bacteria. MEA media facilitates the sporulation of Aspergillus *fumigatus*, which is used to identify the species. Sterile fresh 90mm plates were supplied by Cruinn Diagnostics accredited laboratory services and placed in sealed coolers. Fresh plates were used to eliminate the formation of a skin upon the plate upper surface (i.e. develops with age). It was thought that this may cause problems while using an impaction method (i.e. particle bounce off).

2.3. Transport of bioaerosol samples

All sampling plates during monitoring were allowed to equilibrate to ambient temperature before sampling. This allowed for the development of less harsh conditions upon impacted bioaerosols. It was also noticed that cooled plates (approximately 5^0C) formed an outer “skin” which could facilitate particle bounce. Following equilibration, it was apparent from observation, better “knitting” of impactor plates occurred. Before each sampling event, the Biostage impactors were sterilised using cotton wool and 70% iso-proponal. The impactors were autoclaved for complete sterilisation before sampling. Once sampled, all agar plates were inverted, sealed with parafilm, placed within a flexible plastic container, and neatly stacked within a mobile cooler for delivery to Irish Equine Centre laboratory located in Kill, Co. Kildare. Once received, they were incubated at the appropriate temperatures of 30^0C for Total viable counts (i.e. Mesophillic bacteria) and 37^0C for Aspergillus *fumigatus* by the laboratory technician. Results were received within 10 to 15 working days following sampling.

2.4 Particulate matter monitoring

Major sources of particulates include industrial/residential combustion and processing, energy generation, vehicular emissions and construction projects. The particulate matter created by these processes is responsible for many adverse environmental conditions including reduced visibility, contamination and soiling, but also recognised as a contributory factor to many respiratory medical conditions such as asthma, bronchitis and lung cancer. PM_{10} (Particulate Matter 10) refers to particulate matter with an aerodynamically diameter of 10 μm. Generally, such particulate matter remains in the air due to low deposition rates. It is the main particulate matter of concern in Europe and has existing air quality limits. In order to obtain ambient air PM_{10} concentration levels for the Molaisin Composting Ltd site, a battery operated gravimetric Particulate sampler (Partisol) was used. One fixed monitoring location (i.e. Cappo 4) was used to perform gravimetric monitoring over the sampling period. The monitoring locations and results are presented in *Figure 2.1* and *Table 2.4*.

PM_{10} monitoring in Ireland is limited to continuous monitoring stations operated by the Local Authorities and the Irish EPA, mainly in large urban centres. The dominant source of PM_{10} in the area appears to be HGV emissions, boilers (i.e. Home heating and Industrial heating), traffic, wind blown dust and construction activities.

2.5 Assessment criteria bioaerosols and PM_{10}

Table 2.2 and 2.3 illustrates the assessment criteria is used for comparison of monitoring results during operation to ascertain ambient bioaerosol and PM_{10} air quality in the vicinity of the Molaisin Composting Ltd, Cappoquin, Co. Waterford. Bioaerosol impact criteria are derived from those limits proposed by the UK Environmental Agency.

Table 2.2. Assessment criteria for the ambient bioaerosol air quality in the vicinity of Molaisin Compost, Cappoquin, Co. Waterford, Ireland.

Assessment criteria	Reference concentration range	Notes	Reference
Total fungi (includes Aspergillus *fumigatus*)[1]	1000 to 5,000 CFU m^{-3}	Environment Agency proposed concentration level, Reported concentration range in Swan, 2003 & Sheridan et al., 2004	McNeel et al., 1999 Wheeler et al., 2001, Swan et al., 2003 Sheridan et al., 2004
Mesophillic bacteria[1]	5,000 to 10,000 CFU m^{-3}	Environment Agency proposed concentration level, Reported concentration range in Swan, 2003 and Sheridan et al., 2004	Gorny and Dutkiewicz (2002) Wheeler et al., 2001 Swan et al., 2003 Dutch Occupational Health Association NWA 1989. Sheridan et al., 2004

Notes: [1] denotes the values of CFU m^{-3} refers to Colony Forming Unit per cubic metre of air sampled.

For PM_{10} the EU has introduced several measures to address the issue of air quality management. In 1996, Environmental Ministers agreed a Framework Directive on ambient air quality assessment and management (Council Directive 96/62/EC). As part of the measures to improve air quality, the European Commission has adopted proposals for daughter legislation under Directive 96/62/EC. The first of these directives to be enacted, 1999/30/EC, has set limit values which replaced existing limit values under Directives 80/779/EEC, 82/884/EEC and 85/203/EEC in April 2001. The new directive, as relating to limit values for PM_{10}, is detailed in *Table 2.3.*

The National Air Quality Standards Regulations 2002 (S.I. No. 271 of 2002) transpose those parts of the "Framework" Directive 92/30/EC on ambient air quality assessment and management not transposed by Environment Protection Agency Act 1992 (Ambient Air Quality Assessment and Management) Regulations 1999 (S.I. No. 33 of 1999). The 2002 Regulations also transpose, in full, the 1st two "Daughter" Directives 1999/30/EC relating to limit values for sulphur dioxide, nitrogen dioxide and oxides of nitrogen, particulate matter and lead in ambient air and 2000/69/EC relating to limit values for benzene and carbon monoxide in ambient air.

Table 2.3. PM_{10} Irish and EU Ambient Air Standard SI 271 of 2002 and 1999/30/EC.

Particulate Matter Stage 1	1999/30/EC SI 271 of 2002	24-hour limit for protection of human health - not to be exceeded more than 35 times/year-24 hour average	50% until 2001 reducing linearly to 0% by 2005 for 1999/30/EC 30% from the date of entry into force of these Regulations, reducing on 1 January 2003 and every 12 months thereafter by equal annual percentages to reach 0% by 1 January 2005 for SI 271 of 2002	50 µg/m^3 PM_{10}
		Annual limit for protection of human health-Annual	20% until 2001 reducing linearly to 0% by 2005 for 1999/30/EC 12% from the date of entry into force of these Regulations, reducing on 1 January 2003 and every 12 moths thereafter by equal annual percentages to reach 0% by 1 January 2005	40 µg/m^3 PM_{10}
Particulate Matter Stage 2	1999/30/EC SI 271 of 2002	24-hour limit for protection of human health - not to be exceeded more than 7 times/year-24 hour average	To be derived from data and to be equivalent to Stage 1 limit value for 1999/30/EC Not to be exceeded more than 28 times by 1 January 2006, 21 times by 1 January 2007, 14 times by 1 January 2008, 7 times by 1 January 2009 and zero times by 1 January 2010 for SI 271 of 2002	50 µg/m^3 PM_{10}
		Annual limit for protection of human health-Annual	50% until 2005 reducing linearly to 0% by 2010 for 1999/30/EC and SI 271 of 2002	20 µg/m^3 PM_{10}

3. Results

This section presents the results obtained during the study period.

3.1 Ambient Bioaerosol air quality

Table 2.4 illustrates the results from bioaerosol air quality monitoring. Both Aspergillus *fumigatus* and Total Mesophillic bacteria were assessed on the day of sampling namely 10th December 2008.

Table 2.4. Bioaerosols concentration levels within and in the vicinity of the recycling facility on 10th December 2008.

Location ID	Average Aspergillus *fumigatus* concentration (CFU m^{-3})[1]	Average Mesophillic bacteria concentration (CFU m^{-3})[1]	Sample count[2]
Cappo 1	<12	31	6
Cappo 2	<12	42	6
Cappo 3	<15	183	6

Note: [1] denote a total of 3 blanks (2 plate and 1 impactor blanks for the monitored bioaerosol) were incorporated into the sampling exercise. All blanks were negative CFU m^{-3}.
[2] denote total number of sample counts for each parameter monitored at each location.

Table 2.4 illustrates the ambient bioaerosol air quality within and in the vicinity of the composting facility. As can be observed, Aspergillus *fumigatus* concentrations are low in

close proximity and downwind of the facility. Total Mesophillic bacteria ambient air concentration levels were elevated close to the facility biofilter while downwind concentrations decreased rapidly at 50 metres of the facility boundary (see *Table 2.2*).

Following a review of literature, it is reported that concentration levels of bioaerosols in ambient environment range from 0 to 400 CFU m^{-3} for Aspergillus *fumigatus*, 0 to 15,673 CFU m^{-3} for Total fungi and 79 to 3204 CFU m^{-3} for Total bacteria. Monitoring of bioaerosols is important due to the complexities in monitoring once a facility is in operation. The main reasons for monitoring include:

- Microbes are ubiquitous in the environment and air or surface samples will always contain some bacteria or fungi.
- Microbes grow and are released at irregular intervals and depend on some sort of air turbulence to be transported from their original source.
- Bioaerosols vary greatly in size and therefore some remain in ambient air for longer periods of time in comparison to larger, heavier particles that fall quickly to the ground. This is explained with Stokes law.
- Meteorological factors such as relative humidity, temperature and wind speed greatly effect ambient air concentrations.
- Due to the variety of size and sensitivity, the sampling methodology will greatly affect the measured concentration.
- Seasonal effects can increase of decrease ambient bioaerosol concentrations.

In accordance with the assessment criteria reported in *Table 2.2*, bioaerosol concentrations levels are within the lower end of the range for Aspergillus *fumigatus* and *Total mesophillic bacteria*.

3.2 Particulate matter air quality

Table 2.5 illustrates the results from PM_{10} air quality monitoring.

Table 2.5. Average ambient PM_{10} concentrations for one fixed monitoring location at the Molaisin Compost, Cappoquin, Co. Waterford, Ireland on the 10th December 2008

Monitoring locations	Sample number	Average concentration value (µg/m3)
Cappo 4	038399	11

PM_{10} monitoring in Ireland is limited to continuous monitoring stations operated by the Local Authorities and the Irish EPA, mainly in large urban centres. The dominant source of PM_{10} in this area would appear to be HGV emissions, boilers (i.e. Home heating and Industrial heating), traffic, wind blown dust, composting and construction activities. The average ambient PM_{10} concentrations are in the range of those monitored in other rural locations. The results presented herein demonstrate that PM_{10} air quality is good at monitoring locations Cappo 4 (i.e. Air Quality Index rating, www.epa.ie).

4. Conclusions

The following conclusions were drawn during the study:

1. The bioaerosol concentration levels were determined at each sampling location in triplicate. Three sampling locations were chosen to include upwind, downwind and within the facility boundary.
2. Currently, there are no significant bioaerosol impacts in the vicinity of Molaisin Composting facility located at Cappoquin, Co. Waterford with all reported bioaerosol ambient air concentrations within the range of the proposed bioaerosol assessment criterion.
3. Ambient air concentration levels of PM_{10} were below the statutory 24-hour average ambient air concentration level of 50 µg m^{-3}.