WRM

— Make it Possible —

SITE SPECIFIC BIOAEROSOLS RISK ASSESSMENT

Environmental and sustainability solutions provided to RRS LTD

WRM-LTD.CO.UK

This report was prepared by Walker Resource Management Ltd (WRM') within the terms of its engagement and in direct response to a scope of services. This report is strictly limited to the purpose and the facts and matters stated in it and does not apply directly or indirectly and must not be used for any other application, purpose, use or matter. In preparing the report, WRM may have relied upon information provided to it at the time by other parties. WRM accepts no responsibility as to the accuracy or completeness of information provided by those parties at the time of preparing the report. The report does not take into account any changes in information that may have occurred since the publication of the report. If the information relied upon is subsequently determined to be false, inaccurate, or incomplete then it is possible that the observations and conclusions expressed in the report may have changed. WRM does not warrant the contents of this report and shall not assume any responsibility or liability for loss whatsoever to any third party caused by, related to, or arising out of any use or reliance on the report howsoever. No part of this report, its attachments or appendices may be reproduced by any process without the written consent of WRM. All enquiries should be directed to WRM.

Document Title	Site Specific Bioaerosols Risk Assessment
Client	RRS Ltd
Revision	v7.0
Date	28/03/2024
Document Reference	RRS08a
Project Reference	PR1292_J05
Author: Joel Pimm	Reviewer: Martin Ropka

REVISION LOG

Revision	Details	Date
6	Sixth Issue	12/03/2021
6.1	Update for IVC permit variation	14/12/2023
6.2	Internal review	27/02/2024
6.3	Internal review	18/03/2024
6.4	Amendments following internal review	21/03/2024
7.0	Seventh Issue	28/03/2024

CONTENTS

1.0 INTRODUCTION

This report provides an assessment of the operations of a non-hazardous green waste Open Windrow Facility at Resource Recycling Solutions Limited (RRS) in Out-Rawcliffe. The intention of this report is to carry out an independent bioaerosol risk assessment of the operations for the purposes of Environment Agency (EA) permitting requirements.

With reference to Annex II of the Waste Framework Directive 2008/98/EC, the facility will operate under R3 "Recycling/Reclamation of organic substances which are not used as solvents", R13 "Storage of waste from the R3 process" under the heading "Recovery Operations".

The results collected for this Site Specific Bioaerosols Risk Assessment (SSBRA) have been collected utilising the M9 Technical Guidance Note[1]

1.1 Consultant Competence

The sampling was undertaken by a number of members of the team at WRM Ltd. WRM staff have over a decade of experience within the industry and have been trained by microbiologists who specialise in the field of bioaerosol monitoring.

1.2 Definitions

1.2.1 Composting

"Composting is a method of waste management based in the biological degradation and stabilization of organic matter under aerobic conditions. It results in a sanitized and stabilized product rich in humic substances that can be used as fertilizer"[2].

1.2.1 Bioaerosols

"Aerosols are liquid or solid particles suspended in a gaseous medium with size ranges from 0.001 to 100µm. Bioaerosols consists of aerosols containing microorganisms (bacteria, fungi, viruses) or organic compounds derived from microorganisms (endotoxins, metabolites, toxins ad other microbial fragments)…Bioaerosols vary in size (20nm to 100µm) and composition depending on the source, aerosolization mechanisms, and environmental conditions prevailing at the site"[3].

[1] Environment Agency (2018). 'Environmental monitoring of bioaerosols at regulated facilities', M9 Technical Guidance Note, July 2018, Version 2.

[2] Wery, N. (2014) 'Bioaerosols from composting facilities – a review'. *Frontiers in Cellular and Infection Microbiology.* P1:42.

[3] Mandal, J and Brandl, H. (2011) 'Bioaerosols in Indoor Environment – A review with special reference to residential and occupational locations. *The Open Environmental & Biological Monitoring Journal.* P83:4.

1.3 Bioaerosols

Bioaerosols are defined as aerosols, aeroallergens, or particulate matter of microbiological, plant or animal origin. Bioaerosols can interact with living systems through infective, allergenic and/or toxic mechanisms. The biological agents that have been examined in relation to bioaerosol exposures associated with waste handling and treatment processes include pathogenic or non-pathogenic spores, live (viable) or dead (non-viable) bacteria, fungi, viruses, bacterial endotoxins, mycotoxins, and peptidoglycans. Although other types of biological component may also be present as airborne particles such as algal fragments, protozoa and nematodes, these have not been considered in studies of bioaerosols emitted by the waste industry[4].

The potential for particulates to be liberated from organic waste treatment sites does exist. Airborne dusts and so bioaerosols are likely to be aerosolised by the handling of the waste materials accepted on site, their storage and movement and by meteorological conditions (presence or absence of precipitation, wind, etc.). Bioaerosols are aerosolised as clumps, aggregates and attached to larger mineral particles in the TSP size range[5]. Hence, they generally settle fairly rapidly, i.e. within a minute or two and within 250m of the point of generation. Weather conditions can also affect generation and aerosolisation. Viability can deteriorate according to temperature, humidity and sunlight. Die off is generally exponential, although non-viable (dead) microorganisms may still be able to cause health effects (allergenic/toxic effects in sufficient concentrations). However, the M9 standard for England and Wales[6] and the majority of data at present utilises counts of viable microorganisms.

It is important to note other activities and environments can affect local concentrations of bioaerosols. In terms of published scientific literature, a range of authors report natural concentrations of bacteria and fungi routinely range from 1000 to 100,000 (10^3 to 10^5) cfu/m^3 air. An investigation of an anaerobic digestion site reported high measurements of fungi off-site in wet woodland comparable to on-site. Additionally, it was reported that mowing a nearby meadow also significantly affected results of viable fungi and bacteria (160 and 480 respectively prior to mowing, 15.0 x 10^3 cfu/m^3 and 17.6 x 10^3 cfu/m^3 after).

The objective of this assessment is to appraise the potential for significant risks to human health in the workplace, dwellings or other buildings within the vicinity of the existing treatment facility from the operations on the RRS site, and to demonstrate that bioaerosol risks can be maintained at acceptable levels taking into account the proposal to change tonnages accepted and stored on site.

[4] Defra (2009) *Exposure response relationships for bioaerosol emissions from waste treatment processes WR0606*.
[5] Wheeler P.A., Stewart I., Dumitrean P., Donovan B. (2001) *Health Effects of Composting: A Study of Three Compost Sites and Review of Past Data*. Environment Agency R&D Technical Report P1-315/TR.
[6] Environment Agency (2018) *Environmental monitoring of bioaerosols at regulated facilities, M9 Technical Guidance Note*. Environment Agency.

2.0 REGULATORY POSITION

Currently, Environment Agency (EA) policy requires "licence/permit applicants….to provide a site specific bioaerosol risk assessment where the [proposed] composting facility will be within 250 metres of dwellings or workplaces. These risk assessments need to demonstrate that bioaerosols from the proposed facility will not pose an unacceptable risk to human health." The statement clarifies various terms, for example noting that 'anaerobic digestion' can be limited to the actual area within the site where waste storage, processing and handling takes place. The EA's position statement firms up on permitted activities and the definitions of receptors and sources of bioaerosol – sources of bioaerosol being outdoor operations likely to result in the "uncontrolled release of high levels of bioaerosols- including shredding and turning of waste where these operations are not contained or are not subjected to exhaust ventilation and scrubbing/filtering."

This SSBRA has been updated for a new permit variation for the installation of an In-Vessel Composting (IVC) facility at the site.

RRS are operating a resource recovery facility currently processing up to 75,000 tonnes a year of non-hazardous green waste from a variety of sources, mainly from local authority kerbside collections. The green waste composting process is an 8-week process in open-air, turned windrows. Three grades of compost are produced; 0-40mm, 0-10mm and 10-60mm.

RRS have submitted a permit variation application to extend the site boundary to the south and treat green waste, comingled food and green waste or food waste only in an IVC facility, followed by open windrow composting. The waste shall be sanitised in the IVC tunnels before maturation in open windrows. The IVC tunnels will be located within a new agricultural building in which waste acceptance of the comingled food and green waste or food waste only will take place. This new building shall operate under negative aeration and the building and tunnels shall be served by a biofilter to treat the potentially odorous air. In addition to the above, RRS are also seeking permission to treat waste wood via pulverising or chipping, to screen and blend waste to produce an aggregate or soil and to use waste in construction. The total annual throughout at the site shall remain at 75,000 tonnes per year.

It should be noted that whilst there are sensitive receptors within 250m of the eastern and central portion of the site, the location of the proposed IVC building and biofilter are more than 250m from the nearest sensitive receptor.

2.1 Reference Levels

Based on open windrow composting systems, the EA has set reference levels for micro-organisms in air derived from values for an 8-hour working day. These levels are given as follows in Table 1 below.

Table 1 - EA set Reference Levels for Micro-organisms

Reference Pollutant	Threshold Level (cfu/m^3)	Result if dose-response exceeded
Bacteria	10,000	Not stated
	1,000	Not stated
Fungi	5 x 10^4	Work related respiratory disorders at cont. exposures over 10^5
	Background	Not stated
	1,000	Not stated
Actinomycetes	2 x 10^4	Work related respiratory disorders at cont. exposures over 10^5
Aspergillus fumigatus	10^5 - 10^6	Sensitisation if exposed repeatedly
	10^8	Hypersensitivity Pneumonitis
Gram-negative Bacteria	300	Not stated
	1 x 10^3	Work related respiratory disorders at cont. exposures over 10^5
	2 x 10^4	Work related respiratory disorders at cont. exposures over 10^5
Endotoxins	1-2 x 10^2 (ng/m^3)	Not stated
	50 (eu/m^3)	Based on no-effect-level of 90 eu/m^3 in clinical trials
	1,000-2,000 (ng/m^3)	Organic dust toxic syndrome
	100-200	Bronchorestriction
	20-50	Mucous membrane irritation

2.2 Health Impacts

Bioaerosols are a mixture of micro-organisms which generate products ubiquitous in rural environments. Bioaerosols can be disrupted during screening, shredding and turning events on composting sites and when they can travel downwind towards sensitive receptors they can cause some health problems. Bioaerosols can travel up to 250m due to their small size of generally less than 10μm (fungi, bacteria and actinomycetes) and are not filtered out by specialised nose cells lining the nose and nose hairs thus penetrating deep into the lungs. These bioaerosols can cause diseases relating to the respiratory system (coughs and fevers), eye irritation, dermatitis and gastro-intestinal symptoms.

Aspergillus fumigatus is of particular concern at composting facilities and it can cause severe infections which can be fatal particularly for people with immune-suppressed diseases[7]. Another acute disease is Organic Dust Toxic Syndrome (ODTS) with symptoms including acute irritation of the airways and eyes[8].

High concentrations and long exposure times can affect the health of an individual who is vulnerable with lower natural defences. Bioaerosols and toxins could overwhelm an individual's immune system and cause some of the symptoms mentioned above. However, in a normal healthy person there is no increased health risk in the natural environment. There is no evidence to suggest that occupiers who live in proximity to waste sites have suffered ill health. However, one report by Dehghani et al., (2012) states that distances of composting sites to residential properties must be observed as 600 species of Aspergillus fungus is enough to cause infections of the internal organs and skin, and can damage human eye, ear and fingernails[9].

[7] Wery, N. (2014) 'Bioaerosols from composting facilities – a review'. *Frontiers in Cellular and Infection Microbiology.* P4:42.

[8] Eduard, W., et al. (2012) 'Bioaerosols exposure assessment in the workplace: the past, present and recent advances. *Journal of Environmental Monitoring.* P334:14.

[9] Dehghani, R., Ali Asadi, M., Charkhloo, E., Mostafaie, G., Saffari, M., Abbas Mousavi, G and Pourbabaei, M. (2012) 'Identification of fungal communities in producing compost by windrow method. *Journal of Environmental Protection.* P61:3.

3.0 RISK ASSESSMENT METHODOLOGY

The starting point for every risk assessment is to identify the different aspects, namely the hazards, sources of those hazards, sensitive receptors and the pathways between the source and the receptors. Figure 1 identifies the risk assessment framework[10] with each tier of risk assessment presented to which the methodology within this SSBRA is based.

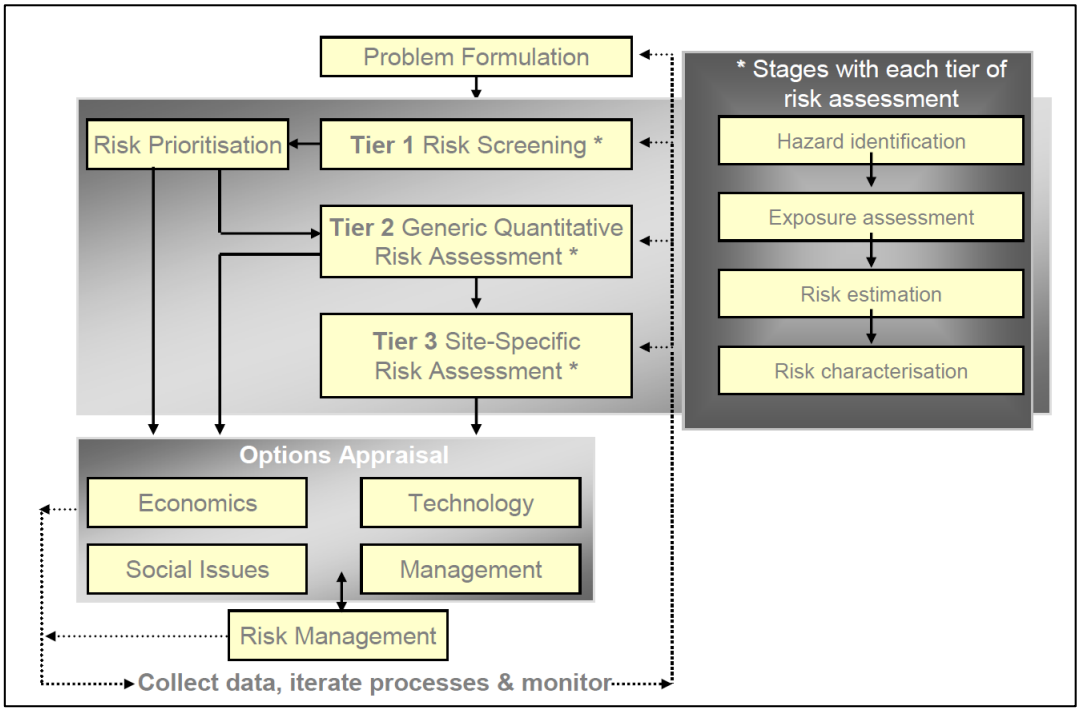


Figure 1 - The Environmental Risk Assessment Framework

The four stages within each tier of risk assessment are identified below.

Hazard identification: The situation that could lead to harm. Including what sources of hazard(s) are present and what are their properties/what data is available? Is this substance toxic (or situation hazardous) and how toxic (hazardous) is it?

Exposure assessment: Evaluate the plausibility of the hazard being realised at the receptor - by which mechanisms, allowing an assessment of the probability, magnitude and duration of exposure. Who (or what) is exposed, how long and often?

[10] Environment Agency (2009) *Guidance on the evaluation of bioaerosol risk assessments for composting facilities.* Environment Agency for England and Wales.

Risk estimation: Of what relative scale is the probability and extent of possible harm? How big a risk is this? This includes the probability and frequency of a hazard being present, potential pathways and possible harm, e.g. dose-response relationships. (Dose-response relationships in turn depend on duration and concentration of exposure).

Risk characterisation: How significant is the risk and what are the uncertainties? Is this something I need to worry about and if so, how much should I worry? The probability and magnitude of consequences are placed in context and an evaluative judgement is made in response to the data that is available currently.

4.0 SITE DESCRIPTION AND INFORMATION

Iron House Farm is located off Lancaster Road, 17km south of Lancaster and 9km west of the M6. The main village of Out Rawcliffe is situated 3km to the southwest. The site is situated within an area that is of agricultural use with some residential. The site is also surrounded by fields in all directions and two forests; one to the north called Tarn Wood and the one to the south called Williamson's Wood. There are properties directly to the north of the site, mainly dealing in farming and horses. There are other farming properties surrounding the site at a greater distance away of at least 300m.

The nearby sensitive receptors include Moss Cottage, a residential property approximately 130m north of the eastern portion of the site. There is also a light industrial unit approximately 165m north of the eastern portion of the site.

Under the current Permit, RRS are operating a resource recovery facility currently processing up to 75,000 tonnes a year of non-hazardous green waste from a variety of sources, mainly from local authority kerbside collections, via open windrow composting. The green waste composting process is an 8-week process in open-air, turned windrows. Three grades of compost are produced; 0-40mm, 0-10mm and 10-60mm.

Green waste material is delivered and placed on a designated reception area where shredding takes place. The material is then moved across to the sanitisation area to the west of the reception area where the material is formed into static windrows. Material is then moved along to the stabilisation area in static turned windrows on the western side of the site.

RRS have submitted a permit variation application to extend the site boundary to the south and treat green waste, comingled food and green waste or food waste only in an IVC facility, followed by open windrow composting. The waste shall be sanitised in 4No. IVC tunnels before maturation in open windrows. The IVC tunnels will be located within a new agricultural building in which waste acceptance of the green waste, comingled food and green waste or food waste only will take place. This new building shall operate under negative aeration and the building and tunnels shall be served by a biofilter to treat the potentially odorous air. In addition to the above, RRS are also seeking permission to treat waste wood via pulverising or chipping, to screen and blend waste to produce an aggregate or soil and to use waste in construction. The total annual throughout at the site shall remain at 75,000 tonnes per year.

Any rejected load or part-load is kept separate from loads awaiting inspection or those accepted for composting.

Table 2a - Feedstock Variation and Management Controls

Waste Source	Seasonal Variation	Odour Implication	Management Controls	Age and Source of Material
Kerbside collected green waste.	**April – September:** Increasing grass clippings content (typically peaking at 40%+ in May-June from experience). Short, sharp, tonnage surges possible (e.g. collections around bank holiday weekends) Accordingly, loads increasingly compacted due to material density.	Degradation could begin rapidly. Excess nitrogen will form ammonia and odorous compounds.	Source additional "woody" / carbonaceous material in anticipation of warm, wet, weather when possible. In the event of sudden summer green waste "surge" overwhelming treatment capacity, broker material to other local compost facility.	Local Authority collections undertake on a bi-weekly basis. Material up to 14 days old.
	October - March: Increase in "woody" type materials (branches etc), resulting in higher C:N ratios.	Material unlikely likely to compost rapidly, so odour potential is decreased, but still present if stored too long.	Green waste loads from October to March containing large amounts of "woody" type materials (branches etc) may need to be blended together to improve C:N ratio.	
Civic amenity green waste.	**April – September:** Increasing grass clippings content (peaking at 40%+ in May - June). Short, sharp, tonnage surges possible over bank holiday	Degradation could begin rapidly. Excess nitrogen will form ammonia and odorous compounds. Increased risk of evaporation.	Source additional "woody" / carbonaceous material in anticipation of warm, wet, weather when possible.	Local Authority sites where material is stored between 1 and 2 weeks before arriving on site.

Waste Source	Seasonal Variation	Odour Implication	Management Controls	Age and Source of Material
	weekends. Accordingly, loads increasingly compacted due to material density, and contractors desire to maximise bin weights / payloads. Potential for waste to be kept in warm conditions prior to delivery (waste exposed to direct sunlight in site bins).		In the event of sudden summer green waste "surge" overwhelming treatment capacity, leading to green stockpile in reception building longer than 2 days, broker material to other local compost facility.	Material up to 14 days old.
	October - March: Increase in "woody" type materials (branches etc), resulting in higher C:N ratios. Potential for significant "spike" post-Christmas (disposal of Christmas trees).	Material unlikely likely to compost rapidly, so odour potential is decreased, but still present if stored too long.	Adjust green to "woody" green waste ratios during October – March to meet desired C:N ratio. Green wastes loads may need to be blended together to improve C:N ratio.	
Commercial green waste.	**April – September:** Increasing grass clippings content (typically peaking at 40%+ in May –	Degradation could begin rapidly. Excess nitrogen will form ammonia and odorous compounds.	Source additional "woody" / carbonaceous material in anticipation of warm,	Sourced from a variety of local landscape contractors typically within a day of cutting,

Waste Source	Seasonal Variation	Odour Implication	Management Controls	Age and Source of Material
	June from experience). Accordingly, loads increasingly compacted due to material density. Potential for waste to be kept in warm conditions prior to delivery (waste exposed to direct sunlight prior to delivery).	Increased risk of evaporation.	wet, weather when possible. In the event of sudden summer green waste "surge" overwhelming treatment capacity, leading to green stockpile in reception building longer than 2 days, broker material to other local compost facility.	but potentially up to a week. Material up to 7 days old.
	October to March: Increase in "woody" type materials (branches etc), resulting in higher C:N ratios.	Material unlikely likely to compost rapidly, so odour potential is decreased, but still present if stored too long.	Adjust green waste to "woody" green waste ratios during October – March to meet desired C:N ratio. Green wastes loads may need to be blended together to improve C:N ratio.	
Kerbside collected comingled food and green waste.	Seasonal variation is minimal. Waste produced over public holidays could be greater in amount and older / more compacted due to collection round disruptions.	The low C:N ratio of this waste (approx. 15) means it is highly susceptible to degradation with age. Treatment as soon as possible is crucial to prevent / minimise nitrogen volatilisation in the form of ammonia and other odours.	Ensure food waste is processed immediately after it is accepted on site. Food waste blended with less odorous \ carbonaceous prior to treatment. If material significantly odorous	Local Authority collections undertake on a bi-weekly basis. Material up to 14 days old.

Waste Source	Seasonal Variation	Odour Implication	Management Controls	Age and Source of Material
			consider rejection or disposal.	
Kerbside collected food waste.	Seasonal variation is minimal. Waste produced over public holidays could be greater in amount and older / more compacted due to collection round disruptions.	The low C:N ratio of this waste (approx. 15) means it is highly susceptible to degradation with age. Treatment as soon as possible is crucial to prevent / minimise nitrogen volatilisation in the form of ammonia and other odours.	Ensure food waste is processed as soon as delivered to site. Food waste blended with less odorous \ carbonaceous material immediately following shredding. All food waste material to be processed and loaded into vessels on same day – no storage in reception building overnight. If material significantly odorous consider alternative disposal: landfill or other local composting facility.	Local Authority collections undertake on a bi-weekly basis. Material up to 14days old.
Commercial food waste.	Waste produced over public holidays could be variable: offices may produce less waste due to low staff levels, whilst pubs and restaurants could produce more due to increased business.	The low C:N ratio of this waste (approx. 15) means it is highly susceptible to degradation with age. Treatment as soon as possible is crucial to prevent / minimise nitrogen volatilisation in the	Ensure food waste is processed as soon as delivered to site. Food waste blended with less odorous \ carbonaceous material immediately following shredding. All food waste material to be	Sourced from a variety of local food processing facilities. Material delivered as past sell/use by date.

Waste Source	Seasonal Variation	Odour Implication	Management Controls	Age and Source of Material
		form of ammonia and other odours.	processed and loaded into vessels on same day – no storage in reception building overnight. If material significantly odorous consider alternative disposal: landfill or other local composting facility.	Material up to 7 days old.

Due to seasonal variations and contract specifications, it is difficult to say the exact amounts of certain wastes that will come through the site. The total annual throughput of waste at the site shall be 75,000 tonnes.

Under IED the tonnages per day will not exceed 357tpd.

Table 2b – Waste Activities and Operational Limits

Activity	Specified Waste Management Operation	Permitted Waste Category	Limits on Specified Waste Operation
Open Windrow and IVC Composting	**R13** Storage of waste materials to be subject to category R operations numbered R1 to R12 (excluding temporary storage, pending collection on the site where it is produced).	All	i) Storage of waste prior to shredding shall take place on area of impermeable pavement. ii) All shredding and composting operations shall be carried out on areas of impermeable pavement. iii) Storage time prior to commencement of process limited to 7 days for OWC and 3 days for IVC.

Activity	Specified Waste Management Operation	Permitted Waste Category	Limits on Specified Waste Operation
	R3 Recycling or reclamation of organic substances which are not used as solvents.		iv) Storage of waste prior to shredding shall not be stockpiled in a quantity that exceeds 1,000 tonnes. v) The total quantity of waste being composted and stored shall not exceed 15,000 tonnes at any one time. vi) The quantity of finished compost shall not exceed 2,500 tonnes at any one time.

4.1 Description of Process

4.1.1 Waste Reception

On entering site, the waste carrying vehicles drive to the weighbridge, where the driver must have the waste transfer documentation with the correct details of the waste on board.

The site operative will inspect the waste transfer documentation. When the site operative is satisfied that the documentation is in order the driver will be instructed to enter the designated waste reception area, where the weights will be documented from the waste transfer note from the site where the waste has come from.

The driver will then be instructed to proceed to the appropriate waste reception area for the waste type. The site operative will then inspect the load to ensure that it is to the correct standard that is acceptable under the operational procedures; if acceptable the driver will be instructed to tip the waste onto the reception area. The driver will then proceed back to the office area and be provided with a copy of the ticket for his records.

Green and wood waste will be deposited in the reception area on the composting pad. Comingled food and green waste or food waste only will be deposited in the northern portion of the IVC building. RRS will also deposit green waste in the IVC building when necessary. Waste soils and aggregates will be deposited in the southeast portion of the site. Once tipped, a site operative shall inspect each load deposited at the designated storage area.

The waste load shall be rejected if, by subjective assessment, it contains more than 5% litter/contrary material unsuitable for the activity to which it relates. The biodegradable wastes will be shredded as required within the respective waste reception area to <400mm in order to comply with CQP regulations.

4.1.2 Open Windrow Sanitisation

For green waste stream, material will be shredded and then moved across to the sanitisation area west of the reception area where the material is formed into static windrows. This phase typically occurs in the first 2 weeks of the 8-week composting process, but on occasion the temperatures and turning may occur later in the process.

4.1.3 Open Windrow Stabilisation

Following the sanitisation phase, the sanitised compost undergoes stabilisation which takes place in open windrows for 6 weeks. The dimensions of each windrow are approximately 4 metres high, 8 metres wide and between 24 to 45 metres long depending on which part of the site they are located. Gaps of a suitable width to enable turning/monitoring and litter picking will be left between the windrows.

At the end of the stabilisation phase the compost will be screened and sampled, on achieving all the criteria for the PAS 100 & QCP the compost will be moved to the storage area to await dispatch.

Table 2c - Operational Activities on Site – Green Waste

Activity	Description
Reception	Material is delivered to the designated reception area having been signed in. The contents are unloaded onto the green waste . Waste material is inspected. green material is blended as required to obtain the required C:N ratio.
Shredding	Material is shredded to <400mm on the reception area prior to formation of windrows typically at 1000 tonnes max.
Mixing	Feedstocks are blended to create as even and clean a feedstock as possible. This includes blending kerbside, oversize and civic amenity wastes. Where possible an open structure is implemented due to the high rainfall area.
Windrow Formation	After shredding and mixing, material is moved by front loader for formation into open windrows.
Sanitisation	Windrows are sanitised for 7 non consecutive days to achieve critical limits: one turn for core zones to reach 65-85°C and moisture to reach 50 - 65 % m/m / Grip test 3-4. Phase duration: 14 days
Stabilisation	Windrows are stabilised for 6 weeks on the composting pad to achieve critical limits: one turn for core zones to reach 45-85 °C and moisture to reach 50 – 65 % m/m / Grip test 3-4.

Activity	Description
	Phase duration: 42 days
Windrow Turning	Windrows are turned approximately once during the sanitisation phase and once during the stabilisation phase by mechanically lifting and aerating material with a front loader or excavator.
Screening	The screened compost shall be inspected by a site operative, in particular for physical contaminants and to remove any oversize. 0-10mm, soil improver, certified to PAS100:2018 & CQP 0-40mm, soil improver, certified to PAS100:2018 & CQP 10-60mm, Mulch, certified to PAS100:2018 & CQP
Storage	Each product batch shall be identifiable in its storage location by a marker that displays its unique product batch code, or on a site diagram. Each product batch shall contain compost from no greater than 6 windrows and may be stored for a maximum of 12 months before dispatch to the customer.
Product Movements	Prior to dispatch, each load shall be checked to ensure information supplied to the recipient and kept on record by the composter is correct. Compost from this composting process is supplied for use in the following markets: **0 - 40 mm grade -** agriculture, soil-grown horticulture, soft landscape, land restoration, sports turfs; **0 - 10 mm grade -** soft landscape, sports turfs; **10 – 60mm grade -** mulch or biomass.

4.1.4 IVC Sanitisation

The green waste, comingled food and green waste or food waste only will be deposited in the reception hall at the IVC facility on the west of the site and a site operative shall spread and inspect each load deposited at the storage area. The load shall be rejected if, by subjective assessment, it contains more than 5% litter/contrary material unsuitable for composting. The waste will be shredded as required within the reception hall to <400mm in order to comply with ABPR regulations. The waste shall then be loaded into an IVC tunnel for sanitisation. Continuous temperature logging is recorded to comply with ABPR requirements that are for a 2-stage food waste process. The waste shall be sanitised at more than 60°C for 48 hours twice, with one turn. Therefore, sanitisation in the IVC vessels shall take up to 7 days.

4.1.5 IVC Maturation

Following the sanitisation phase, the sanitised material is removed from the IVC tunnels and undergoes maturation which takes place in open windrows for 8 weeks. The dimensions of each windrow are approximately 4 metres high, 8 metres wide and between 24 to 45 metres long depending on which part of the site they are located. Gaps of a suitable width to enable turning/monitoring and litter picking will be left between the windrows.

At the end of the stabilisation phase the compost will be screened and sampled, on achieving all the criteria for the PAS 100 & QCP the compost will be moved to the storage area to await dispatch.

Table 2d - Operational Activities on Site – Comingled Food/Green Waste

Activity	Description
Reception	Material is delivered to the designated reception in the IVC building having been signed in. The contents are unloaded onto the floor of the northern end of the IVC building. Waste material is inspected.
Shredding	Material is shredded to <400mm within the IVC building prior loading into an IVC tunnel.
Sanitisation (Food waste)	Critical limits: >60°C+ 48 hours x 2 (per barrier) Critical limits: 1 turn between ABP barrier 7 days
Windrow Formation	After sanitisation, material is removed from the IVC tunnel and moved by front loader for formation into open windrows on the external composting pad.
Maturation	Windrows are stabilised for 8 weeks on the composting pad to achieve critical limits: one turn for core zones to reach 45-85 °C and moisture to reach 50 – 65 % m/m / Grip test 3-4. Phase duration: 56 days
Windrow Turning	Windrows are turned approximately once during the maturation phase by mechanically lifting and aerating material with a front loader or excavator.
Screening	The screened compost shall be inspected by a site operative, in particular for physical contaminants and to remove any oversize. 0-10mm, soil improver, certified to PAS100:2018 & CQP 0-40mm, soil improver, certified to PAS100:2018 & CQP

Activity	Description
Storage	Each product batch shall be identifiable in its storage location by a marker that displays its unique product batch code, or on a site diagram. Each product batch shall contain compost from no greater than 6 windrows and may be stored for a maximum of 12 months before dispatch to the customer.
Product Movements	Prior to dispatch, each load shall be checked to ensure information supplied to the recipient and kept on record by the composter is correct. Compost from this composting process is supplied for use in the following markets: **0 - 40 mm grade -** agriculture, soil-grown horticulture, soft landscape, land restoration, sports turfs; **0 - 10 mm grade -** soft landscape, sports turfs.

4.2 Climate Data

The following section identifies the prevailing weather conditions on site, in particular the wind direction, in order to predict the path of likely aerial dispersion of bioaerosols generated on site. Information on wind direction has been derived from Garstang over the last 30 years. This data is illustrated by the wind rose in Figure 2. Wind data is collected daily as part of the routine monitoring on site. 8-point wind directions are provided below, note that calm days are also included to provide a complete data record.

Table 3 - Wind Direction and Occurrence on Site

Wind Direction (from)	N	NE	E	SE	S	SW	W	NW
% Occurrence	6	11	9	9	16	28	16	5

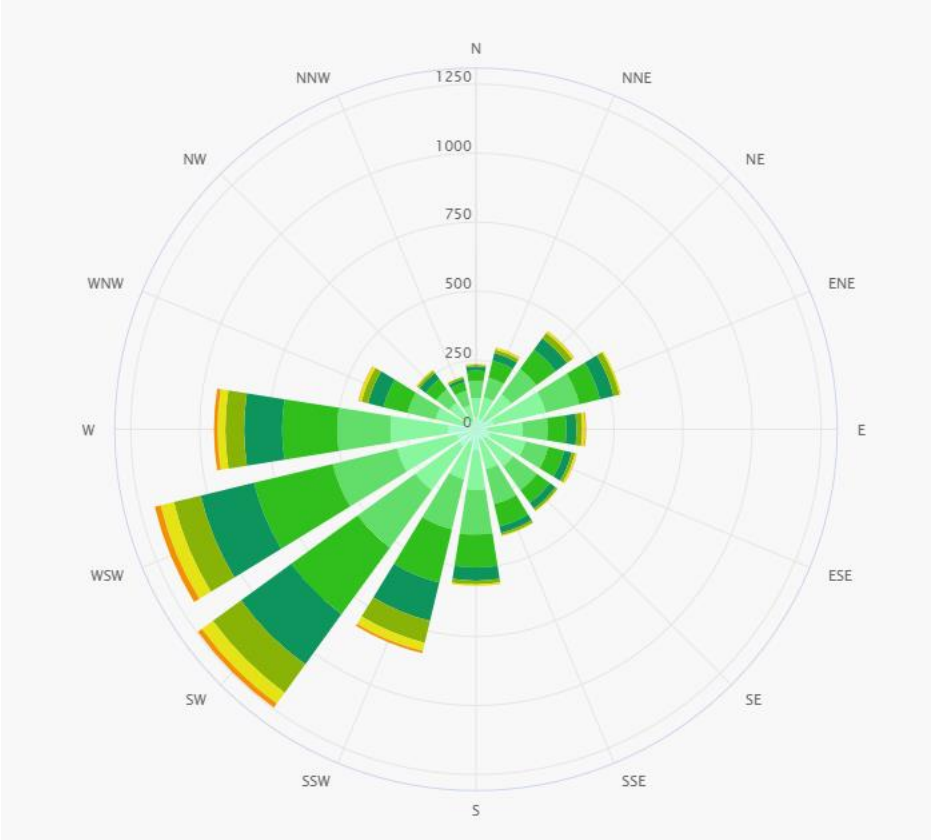


Figure 2 - Windrose for Garstang

The site uses an on-site weather vane to provide an instant visual guide as to the wind strength and direction to assist site operative carrying out daily operations on site. As a result, the site is able to determine what activities should be undertaken. For instance, screening and shredding will not take place when the wind blows in the direction of the sensitive receptor. There are several operatives on site which are equipped with changing roles on site at a moment's notice. If there is no rain predicted but then it does start to rain, then the operatives understand that they will have to change the job they are doing. Operations on site are determined by the weather conditions at that point in time.

4.3 Potentially Sensitive Receptors

The EA refers to Receptors as a 'workplace' or a 'dwelling'. A dwelling includes a garden boundary, and a workplace is where workers are frequently present (a workplace does not normally include areas where workers are present for short periods). The EA does not explicitly class transient receptors including footpaths, recreational open spaces, bridleways, highways, roads, railways or livestock as potentially sensitive receptors to bioaerosols.

DEFRA ranks the sensitivity of potential receptors to general waste management activities as given in Table 4. There are minor differences in sensitivity categories to bioaerosols and dust. In the latest EA position statement duration of exposure was also mentioned as:

'Sensitive receptors refer 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'.

Table 4 - Ranking of Sensitive Receptors

Sensitivity Ranking	Category of Receptor
High Individuals living and/or working in the vicinity for prolonged frequent periods.	Houses and residents (schools, hospitals etc.).
Medium Individuals working in the vicinity for prolonged frequent periods.	Trade premises and factories (offices, industrial premises).
Medium/Low Individuals in the area for frequent periods.	Public footpaths (local environmental areas).
Low Individuals unlikely to be in the area of direct exposure for prolonged or frequent periods.	Other amenities (minor roads and open public spaces).

4.4 Site Specific Sensitive Receptors

Site specific sensitive receptors that are located within 250m of the site boundary are identified in Table 5 below. Distances to receptors are given from the composting area within the site boundary.

Table 5 - Sensitive Receptors to the Site Boundary

Receptor	OW site		Details
	Occurrence % (wind blowing from)	Distance from site (m)	
Moss Cottage	South 16%	~130m	Residential
Light Industrial Unit	South 16%	~168m	Commercial

Conditions and factors that may affect bioaerosol releases and release pathways have also been given although the full mitigating effects of topography (height) or screening (buildings trees etc.) are not fully considered in this assessment. Mitigating factors may be used during

subsequent estimations or evaluations if and as appropriate. The frequency of the wind direction blowing towards each receptor has been calculated from the wind rose diagram given in section 4.2, and a map of the prominent wind direction and the site's spatial proximity to nearby sensitive receptors is provided in Figure 3.

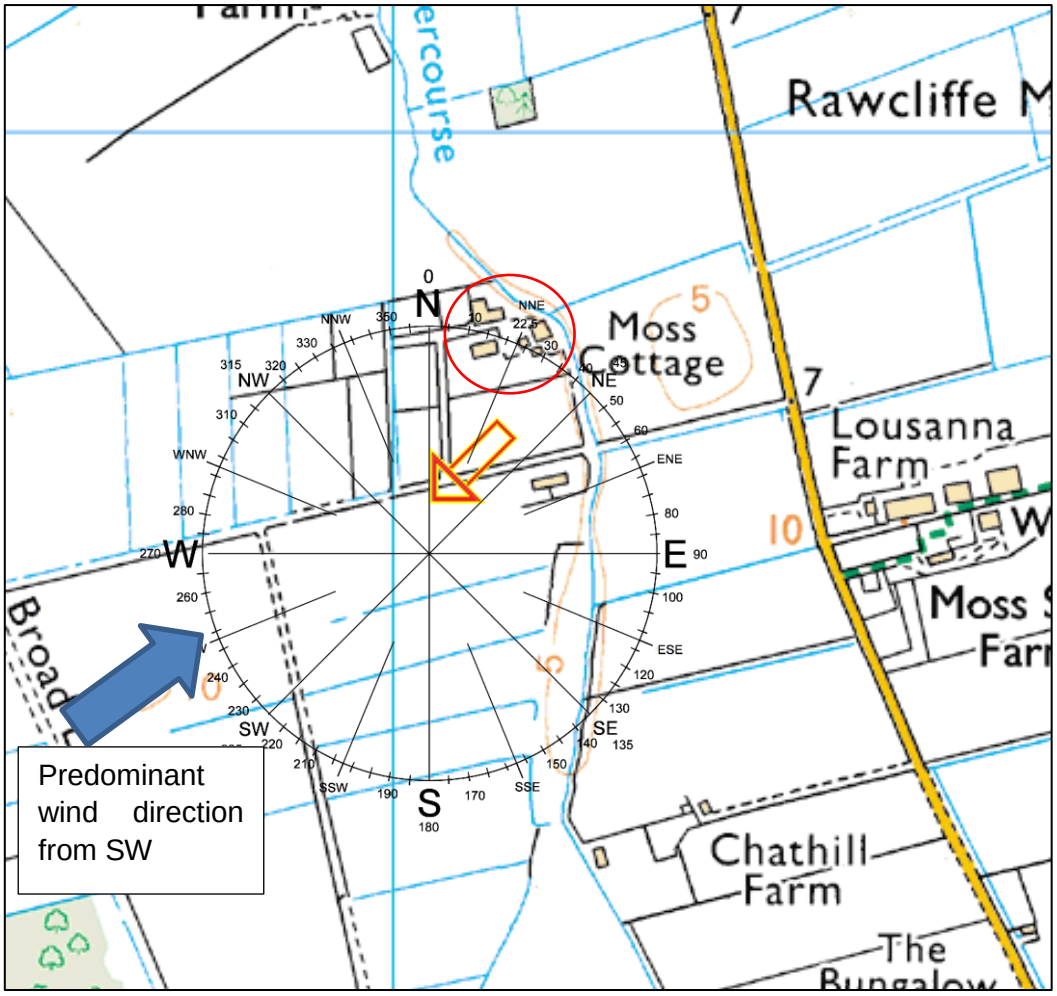


Figure 3 - Map of Predominant Wind Direction and Sensitive Receptors

5.0 RISK ASSESSMENT

The process on site is a biological process that is predominantly moist and aerobic. If oxygen levels are depleted due to high moisture levels, some processes could become anaerobic. High levels of micro-organisms will be present during periods of activity and bioaerosols may be dispersed via material movement, screening, natural evaporation (during the drying process) or by wind influences. If process temperatures are sufficiently high, bioaerosols may also be dispersed via steam plumes.

This risk assessment has considered the staged risk assessment techniques presented in the guidance 'An Environmental Risk Management Framework for Composting Facilities in England & Wales', and the iterative risk assessment techniques described by DEFRA as the best available risk assessment model to apply to the biological process.

5.1 Hazard Identification

Section 1.1 outlines the hazard to be evaluated, in this case bioaerosols which may be released from the process that takes place at the site. In order to assess the potential risks from bioaerosols, emission sources need to be considered. Table 6 sets out the source-pathway-receptor linkages for exposure of local sensitive receptors to emissions from airborne bioaerosols at the site.

Table 6 - Source-Pathway-Receptors Identified for Bioaerosol Emissions

Primary Source	Hazard	Transportation	Exposure Medium	Receptor
Windrow turning and screening.	Chronic or acute illness due to bioaerosol exposure.	Atmospheric dispersion.	Aerial deposition.	Those within 250m of the site.
Roadways and vehicles, material transportation and storage.	Irritation/nuisance due to deposition of larger particles.	Fugitive emissions.	Re-aerosolised material.	Localised to within 50m of the activity.
Reception of material.	Chronic or acute illness due to bioaerosol exposure.	Atmospheric dispersion.	Aerial deposition.	Those within 250m of the site.
Shredding of material.	Chronic or acute illness due to bioaerosol exposure.	Atmospheric dispersion.	Aerial deposition.	Those within 250m of the site.

Primary Source	Hazard	Transportation	Exposure Medium	Receptor
Construction of windrows.	Chronic or acute illness due to bioaerosol exposure.	Atmospheric dispersion.	Aerial deposition.	Those within 250m of the site.
Biofilter	Chronic or acute illness due to bioaerosol exposure.	Atmospheric dispersion.	Aerial deposition.	Those within 250m of the site.

Fugitive dusts are likely to be liberated by the handling of the materials accepted on site, their storage and movement and by meteorological conditions (presence or absence of precipitation, but particularly wind). Vehicles on site may exacerbate this situation at sites with hard-standing where surfaces dry out.

Mostly, bioaerosols are likely to be released when materials are agitated or processed; current guidance indicates that turning is likely to generate the highest concentrations of bioaerosols. Although little data is available re: specific material types, green waste has the potential to be biologically active at this point, hence it is likely to be the point source likely to generate the most bioaerosols at the site (risk will be discussed in more detail below).

It should be noted that there are some agricultural activities surrounding the site, e.g. crop harvesting, that have previously been identified as significant sources of bioaerosols, specifically 105cfu/m^3 of bacteria and 103cfu/m^3 of fungi, including *Aspergillus fumigatus*[11]. In addition, activities at neighbouring waste facilities must be considered along with agricultural activities when assessing the facility.

5.2 Exposure Assessment

An assessment necessarily requires the consideration of potential routes of exposure of individuals to bioaerosols should they escape from the site. Potential pathways of exposure are:

- **Inhalation:** breathing via nose or mouth;
- **Ingestion:** eating or swallowing;
- **Absorption:** through skin or via the eyes (directly or indirectly;
- **Contact:** with the surface of the skin or eyes; and
- **Injection:** by high pressure equipment/contaminated sharp objects.

[11] Swan J.R.M., Kelsey A., Crook B., Gilbert E.J. (2003) *Occupational and environmental exposure to bioaerosols from composts and potential health effects – A critical review of published data*. HSE Research Report 130 ISBN 0 7176 2707

It is assumed the most important potential route of any exposure for a sensitive receptor in the vicinity of a site will be airborne inhalation as other routes would involve direct contact with the material (which is more of an occupational issue). The conceptual model for the exposure assessment is outlined in Figure 4:

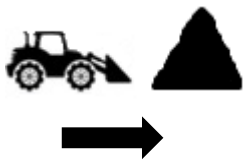
SOURCE	PATHWAY	RECEPTOR
		
Release of bioaerosols during, windrow forming, windrow turning, screening and transportation.	Airborne transportation.	Nearby sensitive receptors identified in section 4.4.
HAZARD		
Mucous Membrane; Irritation; Systemic symptoms e.g. fever, headache; Sensitisation; Allergic reaction; Infection e.g. *Aspergillus fumigatus*.		

Figure 4 - Site Conceptual Model for Pollutant Exposure

The conceptual model requires further refinement in terms of the duration of exposure and other issues such as whether effects are likely to be acute (short-term) or chronic (long-term) i.e. the consequences, which will be explored below. However, the differing volumes of material on site are not assumed to be a significant factor affecting the source, as machinery processing rates will not alter, although duration may increase.

5.2.1 Emissions Classification

In terms of reported concentrations at composting sites, many reports specify that concentrations are elevated during agitation only, and during periods of little to no activity concentrations are similar to background. Indeed, the EA state that bioaerosol release is episodic with reception movement potentially generating the highest releases. An emissions classification can therefore be drawn from the identified site activities as identified in Table 2c. Table 7 below presents the classification and comments regarding each class and activity.

Table 7 - Emissions Classification for Site Activities

Emission Class	Site Activities	Comments	Hours/Week
Low	Vehicle movements	Constant activities but low level of material agitation.	50
	Site maintenance		
	Material storage		
Low to Medium	Waste reception	Activities take place on designated unloading then composting area or within IVC building.	30
	Sanitisation		
	Maturation	No maturation.	
Medium	Shredding	Medium release from waste degrading prior to arriving on site	30
	Vehicle loading and transportation of finished products	Limited quantities of mature low potential materials.	15
	Stabilisation	Low release from undisturbed windrows.	
High	Screening	High instantaneous release of bioaerosols in immediacy of activities which are actively agitating materials.	12
	Windrow formation		
	Windrow turning		
Very High	Accidents leading to elevated release events.	Rare due to management systems and processes.	<1

5.3 Monitoring Results

WRM conducted monitoring events at RRS on the 17th May 2023 and 12th October 2023. This section presents the results of these monitoring events in order to provide an overview of bioaerosol levels at the site during the time monitoring was undertaken.

Bioaerosol monitoring was undertaken in accordance with the M9 Technical Guidance Note.

5.4 Mesophilic Bacteria

Table 8 presents the monitoring results for Mesophilic Bacteria (MB) at RRS for May 2023 and October 2023.

Table 8- Median monitoring MB results at RRS in line with the M9 Technical Guidance Note

Date	UW 50m	DW -30 180m	DW 180m	DW +30 180m
17/05/2023	<139	1,665	555	139
12/10/2023	555	139	278	278

NB: The University of Hertfordshire uses 139 cfu/m^3 as the limit of detection.

The median UW results for May 2023 and October 2023 (<139 cfu/m^3 and 555 cfu/m^3) both fall below the EA Suggested Threshold (1,000 cfu/m^3).

The median DW -30 (139 cfu/m^3), DW +30 (<139 cfu/m^3 and 278 cfu/m^3) and DW (555 cfu/m^3 and 278 cfu/m^3) monitoring results for May 2023 and October 2023 all fall below the EA suggested threshold (1,000 cfu/m^3).

The median result at the DW -30 location (1,665 cfu/m^3) in the May round of monitoring is slightly elevated above the EA Suggested Threshold. This is also the maximum medium result of the of the six downwind locations considered in this SSBRA. However, the May 2023 DW-30 monitoring location was situated next to an access track to a field. It was noted during the monitoring that a farm vehicle was travelling up and down this track to enter and exit the field on more than one occasion. The track was dusty and entrained dust into the atmosphere and is a probable cause of the elevated bacteria concentration at that monitoring location. The monitoring location could not have been closer to site due to a larger bank that would have potentially obstructed the flow of air from the site. The monitoring location could not have been further from the site due to the presence of a stream and an inaccessible field.

5.5 Aspergillus fumigatus

Table 9 presents the monitoring results for *Aspergillus fumigatus* (*Af)* at RRS for May 2023 and October 2023.

Table 9- Median monitoring *Af* results at RRS in line with the M9 Technical Guidance Note

Date	UW 50m	DW -30 130m	DW 130m	DW +30 130m
17/05/2023	<139	<139	<139	<139
12/10/2023	<139	<139	<139	<139

NB: The University of Hertfordshire uses 139 cfu/m^3 as the limit of detection.

The median UW results for May 2023 and October 2023 (<139 cfu/m^3) both fall below the EA Suggested Threshold (500 cfu/m^3).

The median DW -30 (<139 cfu/m^3), DW +30 (<139 cfu/m^3) and DW (<139cfu/m^3) results for May 2023 and October 2023 all fall below the EA Suggested Threshold (500 cfu/m^3).

5.6 Risk Estimation

Site specific data is available that permits a more detailed, or at least a 'semi-quantitative' risk assessment. To overcome potential difficulties with the uncertainty of information such as source emission rates or micro-organism decay, conservative assumptions have been made. Risk estimation uses deterministic and probabilistic techniques that offer a way of dealing with the inherent variability and uncertainties in exposure estimation.

The risk estimation calculated within this SSBRA is based upon a calculation of the probability of exposure and the magnitude of the consequence. Semi-quantitative scoring is assigned to each factor and combined in order to score the risk to each potential receptor from operations on site due to bioaerosol release.

5.6.1 Magnitude of Consequences

Table 10 indicates the magnitude of consequences based on DEFRA (Negligible to Mild) and Environment Agency (Moderate to Extremely Severe) categories and their descriptions. These broad categories provide a mechanism for comparative assessment. The category of consequence is therefore assigned to the magnitude of risk for assessment based upon levels of micro-organisms monitored at or adjacent to the source. WRM has also classified each of these categories, to ensure consistency with the classifications presented in Tables 11, 14 and 15, respectively.

Table 10 - Magnitude of Consequences from Source Emissions

WRM Classification	Category	Indicative Range	Category and Consequence	Level of Consequences compared to natural levels
Low	Negligible	<300	No observable effect on individuals or populations. No effect on the local ecosystem, individual species or local features.	Low range of natural environmental levels.

WRM Classification	Category	Indicative Range	Category and Consequence	Level of Consequences compared to natural levels
Low/Medium	Mild	300 - 1000	No observable effect on health of individuals. No observable effect at the population level or on the local ecosystem.	Mid-range of natural environmental levels.
Medium	Moderate	1000 - 3000	Health effects generally not noted. Short term: no significant impacts on robust individuals, populations or ecosystems. Potential minor health or nuisance impacts for vulnerable individuals (frail/elderly/sick). Continuous long term: robust individuals unaffected. Potential health effects on vulnerable individuals (frail/elderly/sick). No observable effect on local ecosystem.	Upper-range natural environmental levels.
High	High	3000 - 10,000	Short-term: no significant impacts on robust individuals. Vulnerable individuals affected including welfare and nuisance. Continuous long term: vulnerable individuals affected including health, welfare and nuisance. Potential effects on population structure or size and local ecosystem impacts possibly detectable. Equivalent to occupational exposure levels.	High range of natural environmental levels.
Very High	Severe	10,000 - 30,000	Short term and long term: some robust individuals affected including health, welfare, and nuisance. Local dysfunction of communities if continuous.	Short term highest natural environmental levels

WRM Classification	Category	Indicative Range	Category and Consequence	Level of Consequences compared to natural levels
			Local ecosystem changes detectable.	for specific events e.g. harvesting.
Very High	Very Severe	30,000 - 100,000	Probable effects on robust individuals. Widespread effects on the functioning of communities and ecosystems.	Rare natural environmental levels.
Very High	Extremely Severe	>100,000	Widespread health effects. Impacts on the functioning of regionally important ecosystems.	Maximum of natural environmental events.

It is difficult to ascribe a consistent source emission rate as values quoted are highly variable and masked by variations in ambient concentrations. Detailed estimation would require the use of dispersion models with appropriate modules for calculation of airborne and deposited particulate. The EA indicates that there are 'numerous uncertainties' with air quality modelling and refers to the use of deterministic or probabilistic models. The EA uses a simple straight-line fit to estimate the downwind distance to meet the reference level.

5.6.2 Mesophilic Bacteria

Section 5.4 demonstrates that the median results for Mesophilic Bacteria (UW: <139 cfu/m^3 and 555 cfu/m^3, DW -30: 139 cfu/m3, DW +30: <139 cfu/m3 and 278 cfu/m3, and DW: 555 cfu/m3 and 278 cfu/m3) for May 2023 and October 2023 are generally considered to be Low to Low/Medium using WRM's classification in Table 10. The median result at the DW -30 location (1,665 cfu/m3) in the May round of monitoring would be classified as Medium.

5.6.3 Aspergillus fumigatus

Section 5.4 demonstrates that the median results for *A. fumigatus* (UW <139 cfu/m^3, DW-30 <139 cfu/m^3 and DW <139 cfu/m^3) are generally considered to be Low using WRM's classification in Table 10.

Based on the analysis of these results, Table 11 demonstrates how varying emission levels impact upon the magnitude of consequences. Whilst it is clear that an emission event labelled as 'Very High' would cause a high magnitude of consequences, a very high emission event is

unlikely based on the results presented within this SSBRA. Low to Medium emissions – which are more typical of the RRS site – would result in a Low to Medium magnitude of consequences.

The worst case, and anomalous, result for bacteria has been used in this risk assessment as a worst-case scenario.

Table 11 – Risk Assessment Factor A – Magnitude of Consequence

Receptor	Emission Classification				
	Low	Low/Medium	Medium	High	Very High
Moss Cottage			X		

5.6.4 Probability of Exposure

Simple factors can be used to generate indicative probabilities of an event occurring. Each can be the product of several variables. For example, the fraction of the time that the wind blows towards a receptor multiplied by fraction of time that material is disturbed. Conservative (i.e. 'worst case' conditions) probability factors for the occurrence of a release event have been derived and are described in Table 12 below.

Table 12 – Factor Determining the Probability of Exposure

Factor	Description
Receptor	*The proportion of time that a receptor is present at the identified location.* The receptor is only affected when present. In Residential property and Hospitals, a value of 1 is assumed; equivalent to continual occupancy. At commercial/school properties, a value of 0.25 is equivalent to slightly more than a 40-hour week. At amenity and other facilities, a value of 0.01 is equivalent to 2 hours a week for any individual.
Wind Direction	*The proportion of time averaged over 1 year that wind blows towards the receptor – no modification is made for wind speed.* Probability factors are calculated as the proportion of the time that the wind blows to the receptor from any part of the biological activity for all release cases. Average climatic data is used to calculate wind direction probabilities.
Activity Classification	*Classification as to the frequency of bioaerosol release from each identified site activity.*

Factor	Description
	Classification as identified within Table 4 with hours per week of operations for each site activity.

Criteria for probability as a function of frequency and duration are defined below in Table 13. These are conservative and are based upon site activity duration as identified in Table 7.

Table 13 – Criteria for Probability of Exposure Occurrence

Probability Criteria	Description of Probability
Negligible	Exposure of less than 25 hours per year (½ hour per week).
Low	Exposure of 25-100 hours per year (<2 hours per week).
Medium	Exposure of 100-250 hours per year (<5 hours per week).
High	Exposure of >250 hours per year (>5 hours per week).

Based on these factors, the probability of conditions occurring to affect each receptor has been estimated for the probability criteria defined above. The results are shown in Table 14 for possible exposure to emissions from operations on site. The number of hours of potential bioaerosol exposure at the receptors has been determined by multiplying the site activity operational hours (Table 7) by the percentage of time the wind blows to each receptor (Table 3) and the receptor occupancy factor (Table 12). These factors have been used to determine the likely probability criteria applicable for each receptor and bioaerosol emission case. The potential probability of consequences is given in Table 14 below based on criteria as identified in Table 9.

Table 14 – Risk Assessment Factor B – Probability of Consequence

Receptor	Emission Classification				
	Low	Low/Medium	Medium	High	Very High
Residential Property			X		

5.6.5 Significance of Risk

In order to provide an estimation of the risk of bioaerosol release on site, an assessment combining the following risk assessment factors are required:

- Risk Assessment Factor A: Magnitude of Consequence – Table 11

- Risk Assessment Factor B: Probability of Consequence – Table 14

There is no single formula for combining the frequency and magnitude of exposure and simple intuitive methods are therefore employed. A risk matrix is generally considered to be an accepted method of identifying the magnitude and probability of the potential risk. A general matrix to estimate the magnitude and the probability of a potential risk is given in Table 15.

Table 15 – Risk Estimation Matrix

Probability (Factor B)	Magnitude (Factor A)				
	Low	Low/Medium	Medium	High	Very High
Low	1	2	3	4	5
Low/Medium	2	4	6	8	10
Medium	3	6	9	12	15
High	4	8	12	16	20
Very High	5	10	14	18	25

Applying the above risk estimation matrix to the combined risk assessment factors for RRS, the significance of the risk to sensitive receptors located near to the site are calculated as below in Table 16 under each emission classification event. Table 11 shows, the magnitude of consequence is 'Medium,' while Table 14 shows that the probability of consequence is 'Medium'. When combined in the risk estimation matrix (Table 15), this yields a score of 9. The result and classification of risk significance from site operations (Low/Medium) is displayed in Table 16, below.

Table 16 – Significance of Risk from Site Operations

Receptor	Emission Classification				
	Low (Less than 5)	Low/Medium (Less than 10)	Medium (Less than 15)	High (Less than 20)	Very High (20 or above)
Moss Cottage		9			

5.7 Risk Characterisation

Having calculated the significance of the risk from site operations, it is possible to assign categories of tolerability to the scores based on the position in the risk estimation matrix (Table 15). These are not definitive categories but indicate the likely degree of risk acceptability from the risk assessment calculations and site management requirements. Table 17 provides a tolerability criterion (based on DEFRA classifications) for bioaerosol risk assessment scores.

Table 17 - Tolerability Criterion

Tolerability Level	Criteria
Acceptable	Risks are in the low range and are likely to be acceptable in all circumstances.
Tolerable	Risks are in the medium range and are likely to be acceptable where best available techniques (BAT) are employed to mitigate risks.
Unacceptable	Risks are unlikely to be acceptable under any circumstances.

The risk assessment carried out indicates that the potential risk of bioaerosol exposure from the aerobic biological process and associated activities at RRS are likely to be as follows:

- The risks to potentially sensitive receptors are low to medium in most cases.
- The tolerability of site operations is considered to be acceptable in most circumstances.

RRS will use best practice techniques to reduce any residual risk to as low as reasonably practicable (see Section 7). RRS will focus on reducing the potential for bioaerosol emissions during unfavourable conditions, and during direct disturbance activities that may include material movement, windrow turning, shredding and screening of reclaimed /recycled solids (as applicable).

5.8 Most Significant Risks

1) The most significant risk is from the actual composting operation on site:
    a. Shredding Area: There is a dedicated green waste shredding area in the reception; this is currently designed to handle up to 75,000 tonnes of waste per annum. The shredding of waste can produce high levels of emissions but good housekeeping and cleaning will reduce dust and bioaerosol agitation later on. Comingled food and green waste or food waste only takes place within the IVC building which operates under negative aeration and is served by a biofilter.
    b. Sanitisation and Stabilisation Area: The material will be sanitised to prevent pathogens. The material will be wetted if required; this will be determined by monitoring the compost. Green waste is sanitised on the open composting pad. Comingled food and green waste or food waste only is sanitised in IVC

tunnels which are served by a biofilter. All stabilisation takes place on the OWC pad.

c. Screening Area: Screening can generate moderate to high releases of bioaerosols which is in an open setting. The waste will be screened after stabilisation, this activity is undertaken in the central section of the waste reception area.

2) The second most significant risk will be a high exposure event with high winds in the direction of a sensitive receptor. Wind direction in the pathway of the sensitive receptor is low at 16% (from the south) and bioaerosol dispersal usually drops at 250m. There is only one residential building within 250m of the site, approximately 130m away. There is a light industrial unit approximately 167m from the site. As a result, drop off will be fairly high at this distance. Nevertheless, when the wind is blowing from a southerly direction, towards the sensitive receptor, no shredding, screening or turning activity shall take place on site in order to protect the sensitive receptor.

3) Another significant risk includes deliveries of waste. When deliveries are made on site the waste shall be inspected to see how much has been degrading, if the waste looks as if it has been degrading for longer than two weeks producing foul odours then the waste will be rejected as this can cause high bioaerosol release on tipping in the waste reception. Comingled food and green waste or food waste only is deposited within the IVC building which is served by the biofilter.

4) The biofilter is another possible source of bioaerosols should it not be functioning appropriately. The biofilter has been appropriately sized for the volume of air that it shall be treating. Regular monitoring shall be undertaken on the biofilter media to ensure optimal working conditions are maintained. This includes monitoring the moisture content, temperature and back pressure. The biofilter media shall be changed at regular intervals.

Table 18 below outlines the increased risks associated with the tonnage through the site.

Table 18 – Sources and Hazards Associated with Bioaerosols and Dust

Primary Source	Secondary Source	Hazard	Transport Mechanism	Pathway	Medium of Exposure	Receptor
Waste - Release of breakdown products, micro-organisms, biological particles.	Disturbed materials – unloading, storage, preparations, treatment, sorting. Abatement, plant, vents, filters, etc.	Lung disease, allergies, irritation of mucus membranes; asthma	Carried with airborne dust	Inhalation via nose or mouth	Air	Humans: Residents, occupiers and users of facilities
		Fever, headache, diarrhoea, systemic infection		Ingestion – eating or swallowing	Air & deposited materials	
		Irritation of eye and mucus membranes, skin infection		Absorption: Direct contact with airborne bioaerosol	Air & deposited materials	
				Indirect contact via clothing or surfaces		
		Skin infection, irritation of mucus membranes		Contact with skin or eyes	Air	
		Tissue damage, skin infection, systemic infection		Injection by puncture, HP equipment or sharps	Deposited materials.	

6.0 CONCLUSIONS

In conclusion, a variety of studies have shown different dispersal distances and have used differing reference values for estimating effects on health to local populations. The results in this report indicate that the magnitude of consequence and the probability of consequence are both medium as a worst case. Therefore, the current activities being carried out on site are acceptable in terms of risk tolerability.

Although there are potentially emissive operations on site, the low to moderate occurrence of wind being in the direction of sensitive receptors reduces the overall exposure potential. When the wind does blow towards sensitive receptors then composting activity will be reduced and shredding and screening operations will cease for the duration that the wind is blowing towards the sensitive receptors. This makes the risk posed to the sensitive receptor as low as it possibly can be, without ceasing composting activity altogether.

7.0 RISK MITIGATION MEASURES

The Organics Recycling Group (ORG) provides a Code of Good Practice for the management of composting facilities. The following good practice operation and mitigation measures are currently adopted in order to control activities that may generate or affect the release of bioaerosols.

a) The moisture content within all stages of the composting process will be monitored to avoid the waste and materials drying out and potentially forming dusts.

b) The shredding and formation or turning of windrows is avoided if possible on windy days, and shredding, screening and turning is avoided when wind is blowing towards the sensitive receptor. Screening is also undertaken when wind speeds are calm or wind direction is away from sensitive receptors. Shredding of comingled food and green waste or food waste only shall take place within the IVC building.

c) The composting of waste at the sanitisation phase is carried out within the dedicated area. Sanitisation of comingled food and green waste or food waste only takes place within IVC tunnels within the IVC building.

d) Inspections of the buildings and infrastructure are undertaken to ensure that requisite maintenance is regularly undertaken. Checks include fencing, gates, building facilities and the foul and surface water drainage systems.

e) The site is swept and kept clear of all loose material on a regular basis.

f) An Accident Management Plan is in place in order to prevent and manage potential fire risks on site.

g) Plant and machinery are well maintained in line with a maintenance schedule to avoid dust generation.

h) An onsite weather data collector collects the required data every day (for wind direction and wind speed) to identify conditions of high winds blowing towards the receptor(s).

i) A windsock is located just offsite to provide a visual indication of the wind direction to site workers and third parties.

j) Material transportation from the shredding area to the composting area, and for final product out of site, takes place under sheeted vehicles.

k) Composting process and controls are inline within industry best practice, being PAS100 and QP certified.

7.1 Recommended Measures

The site will also implement the following measures in order to further mitigate the aerosolisation of bioaerosols:

1) Site surfaces such as roads and tracks will be regularly dampened down and/or regularly swept to suppress dust and bioaerosols. Roads will be swept when there is no wind blowing, on a daily basis. Water will be used when dust starts to show as there is an increased possibility of the liberalisation of dust and bioaerosols from the roads and tracks when they are drier. Drier roads and tracks also increase the production and abundance of spore forming micro-organisms which can survive more environmentally challenging conditions.

    a. The dampening and sweeping of dusts will reduce bioaerosols at the increased throughput as the bioaerosols will bond to the surface of the tracks and roads.
    b. Lower relative humidity and higher temperatures will also be monitored as the drying of roads and tracks relates to release of bioaerosols and dust emissions.

2) The compost piles or windrows themselves will also be regularly dampened down and swept around the piles / windrows. Temperature and moisture readings will determine when the windrows need additional dampening.

    a. The dampening of compost piles will take place on a regular basis or depending on relative humidity and temperature inside and outside the compost pile.

    b. Bioaerosols can bond to the surface of compost when they are wet which reduces the number of spore forming micro-organisms which can be released.

The bioaerosols are able to travel with the wind in the atmosphere, the wet bioaerosols will be too heavy to travel which will ensure they do not pose harm or risk to the wider population.

c. Moisture readings will determine how wet the compost is inside the pile. Turning of the waste will not take place if the compost is too dry, additional liquid will be added the pile and allowed to percolate through the pile before the turning commences. The compost will then be dropped to the ground slowly so reduce the amount of aerosolisation of particles.

d. The screening/shredding of compost will not take place when the wind blows towards the direction of identified sensitive receptors. The compost will be monitored to ensure the material is moist enough prior to the activity taking place. This will reduce the amount of dust and bioaerosols available for exposure.

3) Operatives are instructed to minimise the drop height of material from loaders to the floor in order to mitigate the potential for aerolisation of bioaerosols.

4) Daily housekeeping measure will be employed to keep the site levels of dust and other loose-materials as low as possible. Site Management will frequently tour the site to check the site's condition. If the site is not up to suitable standards operatives will be instructed to perform further housekeeping work.

5) The site monitors weather continuously. This monitoring will be incorporated into decisions pertaining to composting activities on site. For example, if the wind is blowing towards the sensitive receptor, then certain composting activities such as screening, shredding or the turning of windrows will not be carried out.

7.2 Contingency Measures

As detailed in earlier parts of this section, RRS have a number of robust measures in place to minimise the aerosolisation of bioaerosols. Where bioaerosol levels have been exceeded previously, no specific activity taking place on site has been identified as a principal cause of elevated bioaerosol levels. Consequently, RRS will continue to take all reasonable steps to ensure that the measures taken to minimise bioaerosol release continue to be implemented effectively.

In the event that bioaerosol concentrations exceed the EA Suggested Threshold, the cause of the exceedance would be investigated, reasons stated, and, if applicable, action taken to minimise bioaerosol concentrations to a level as is reasonably practical. Where bioaerosol levels are above the permitted threshold, RRS shall complete further monitoring.