An Assessment of the Odour Impact for the Biofilter at the Proposed Thermophilic Aerobic Digester Facility at Pebble Hall Farm, Theddington, near Market Harborough, Northamptonshire

16th December 2013

Submitted to:
Mike Jordan
ADVANCED ORGANICS
Biological Nutrient Recycling
Longmoss,
Geeston Rd
Ketton,
Rutland
PE9 3RH

Prepared by:
Lauren Fieldsend & Steve Peirson
ADAS
Pendeford House
Pendeford Business Park
Wolverhampton
WV9 5AP

Reviewed by:
Phil Edgington
Met Office Rural Environment Team
Pendeford House
Pendeford Business Park
Wolverhampton
WV9 5AP
TEL: 01902 271269
# Table of Contents

Summary .........................................................................................................................3

1. Introduction ..................................................................................................................5

2. Background ..................................................................................................................5
   2.1 Geography ..................................................................................................................5
   2.2 The proposed biofilter ..............................................................................................5

3. Odour emissions and guidelines ................................................................................6
   3.1 Emissions from the proposed development ...............................................................7
   3.2 Estimation of odour emission rates ............................................................................7
   3.3 Assessment of the impact of odour ..........................................................................8
   3.4 Dispersion of odour ...................................................................................................9
   3.5 Guideline values and benchmarks ............................................................................9

4. Dispersion modelling methodology ............................................................................11
   4.1 Model description .....................................................................................................11
   4.2 Meteorology ............................................................................................................11
   4.3 Model parameters .....................................................................................................13
      4.3.1 Odour emissions .................................................................................................13
      4.3.2 Buildings ...........................................................................................................14
      4.3.3 Discrete receptors ..............................................................................................14
      4.3.4 The regular Cartesian grid ................................................................................14
      4.3.5 Terrain and roughness length ............................................................................15

5. Dispersion modelling results ......................................................................................16

6. Summary and Conclusions .........................................................................................18

APPENDIX 1 ....................................................................................................................20

   5 year minimum and maximum 98\textsuperscript{th} percentile hourly mean odour concentrations at the discrete receptors. .........................................................20
**Summary**

The Met Office Rural Environment Team and ADAS has been commissioned by Advanced Organics Nutrient Recycling to conduct a dispersion modelling study to assess the off-site impact of odour emissions from the biofilter at a proposed Thermophilic Aerobic Digester (TAD) facility at Pebble Hall Farm, Theddingworth, near Market Harborough, Northamptonshire. The objective was focus in particular upon how odour emissions from a proposed biofilter might affect residential and commercial receptors in the area surrounding the proposed development.

The TAD facility will be subject to odour extraction and abatement through a combination of a scrubber and a biofilter. Odour emission rates have been calculated based on odour concentrations and emission rates measured by ADAS at similar facilities, and ADAS experience of odour emissions and biofilter performance in organic waste treatment plants.

The calculated emission rates have then been used in an atmospheric dispersion model to assess the likely impact of odour in the area around the site. The modelling was conducted by the Met Office Rural Environment Team at ADAS Wolverhampton.

**Guideline values and benchmarks**

The Environment Agency (EA) published guidelines on odour regulation, assessment and control (H4: Odour management), in March 2011. Odours from aerobic waste processes are normally placed in the moderately offensive category. The target suggested in H4 for moderately offensive odours is an hourly mean odour concentration of $3.0 \text{ ou}_E/m^3$ at the 98th percentile.

**Dispersion modelling methodology**

The choice of model for this study is UK Atmospheric Dispersion Modelling System (ADMS) Version 5. A weather file which is derived from Numerical Weather Prediction (NWP) assimilation and short term forecast fields from the UK Met Office’s mesoscale model has been used. This data has been derived for NGR 466100, 284500, which is approximately 50 m to the south west of the biofilter at the proposed TAD facility at Pebble Hall Farm, for the years 2008 to 2012.

Emissions from the proposed biofilter have been represented by an array of 10 low velocity point sources within the model. As the open biofilter is to be constructed at a height of 2.5 m and there are other buildings in close proximity, the use of point sources allows building downwash to be modelled.

**Findings**

The model results predict that there would not be any exceedances of the Environment Agency’s $3.0 \text{ ou}_E/m^3$ benchmark, chosen for this study, at any of the discrete receptors. It therefore follows that there would not be any loss of residential amenity at these residences.
The modelled impacts are also well below the stricter “most offensive” odours H4 benchmark of 1.5 ouE/m³.

The model outputs show that with good odour management, and with typical biofilter odour loadings and abatement performance, the proposed plant can be operated with very low risk of any off-site odour impact on local amenity.

Furthermore the modelling results show that there is appreciable tolerance or headroom for higher emissions that those used in the modelling without causing any adverse offsite impact.
1. Introduction
The Met Office Rural Environment Team and ADAS has been commissioned by Advanced Organics Nutrient Recycling to conduct a dispersion modelling study to assess the off-site impact of odour emissions from the biofilter at a proposed Thermophillic Aerobic Digester (TAD) facility at Pebble Hall Farm, Theddingworth, near Market Harborough, Northamptonshire. The objective was focus in particular upon how odour emissions from a proposed biofilter might affect residential and commercial receptors in the area surrounding the TAD proposed development.

The facility will be subject to odour extraction and abatement through a combination of a scrubber (as pre-treatment for drier emissions) and a biofilter (for all emissions). Odour emission rates have been calculated based on odour concentrations and emission rates measured by ADAS at similar facilities, and ADAS experience of organic waste treatment odour emissions and biofilter performance.

The calculated emission rates were then used in an atmospheric dispersion model to assess the likely impact of odour in the area around the site. The modelling was conducted by the Met Office Rural Environment Team at ADAS Wolverhampton.

This report presents the results of the odour dispersion modelling for the proposed TAD development at Pebble Hall.

2. Background

2.1 Geography
Pebble Hall Farm is in a rural area at an altitude of around 125 m. The nearest residences to the proposed TAD facility are approximately 500 m to the south west. There are also residences to the north of the proposed facility, along the A4304 Theddingworth Road, and Hothorpe Hall is situated approximately 900 m to the north east. Further afield there are isolated residences and denser residential areas in the village of Theddingworth, approximately 1 km to the north east.

A map of the surrounding area is presented in Figure 1. The site of the proposed TAD facility at Pebble Hall Farm, including the biofilter, is highlighted by a red box.

2.2 The proposed biofilter
Under the proposal, the TAD facility would be constructed at Pebble Hall Farm, including a multi-compartment open biofilter, which will be used to control air emissions. This report models the emissions from the biofilter. There will also be an associated scrubber to pre-treat drier emissions.
3. Odour emissions and guidelines

Odour emission rates are expressed as European Odour Units per second (ouE/s) and odour concentration as European Odour Units per metre cubed of air (ouE/m³). The following descriptions of how odour might be perceived under certain concentration may be helpful:

- 1.0 ouE/m³ – This is defined as the detection limit in laboratory conditions.
- 2.0 - 3.0 ouE/m³ – A particular odour might become just detectable against normal background odour.
- 3.0 - 5.0 ouE/m³ – Odour is detectable and identifiable, but most observers would only describe it as feint.
- 5.0 - 10.0 ouE/m³ – Odour levels in this range may become annoying, if persistent and/or unpleasant.
- 10+ ouE/m³ – Most observers would describe the odour intensity as moderate or strong.
3.1 Emissions from the proposed development

A full description of the process is set out in the Design and Access Statement, but this report also takes account of a revised biofilter odour abatement system, with an open biofilter, rather than the “Ag-bag” system previously proposed. Open biofilters have been proposed in preference as they can be more effectively irrigated to ensure that the media remains moist.

The following brief description deals with key parts of the plant and their potential to generate odours. The magnitude of potential odour emissions from those areas which may generate odours has been predicted for use in the dispersion model.

Odour Control Measures

The processing and reception building will be constructed from insulated “cold store” type panels and will fitted with high speed roller shutter doors to control odour emissions. The doors will be fitted with alarms to ensure that they are kept closed when not in use.

The waste reception building and digestion hall will be subject to extraction at a rate of two air changes per hour to prevent fugitive odour emissions, which is at an airflow rate of 5.5 m$^3$/s.

Air from the drying system will be pre-treated by a scrubber to remove ammonia and the pre-treated air stream off the scrubber will then be mixed with lower temperature air streams from the reception building and the digestion hall to provide a total flow for abatement by a biofilter of 7 m$^3$/s.

The combined flow will be treated by an open biofilter situated alongside the processing building with a generous air residence time of 60 seconds to ensure effective treatment. The biofilter will be filled with wood based compost over-size material, and it will be constructed in two by two modular sections so that a proportion of abatement capacity can be retained during media maintenance/replacement in each of the four individual sections.

The biofilter will be equipped with a fixed water “sprinkler” irrigation system, with the water distribution pipes just covered with media to provide frost protection.

3.2 Estimation of odour emission rates

There are two main components of the airflow to the biofilter, those from the drier via the scrubber (at 1.5 m$^3$/s) and those from the reception building and digester hall (5.5 m$^3$/s combined).

Reception Building and Digester Hall

Odour concentrations in air extracted from the reception building can be estimated from analogous food waste reception buildings at anaerobic
digestion plants. ADAS have undertaken odour concentration measurements in a number of such plants including those operated by Shanks, Biogen, Biogen Greenfinch and Scottish Water. This experience shows that typically internal odour concentrations are in a range from 1.500 to 15,000 ouE/m$^3$ with variations caused primarily by ambient temperature, the period over which waste is held on-site prior to processing, and the composition of the food wastes.

The TAD process will take place in vessels within a digester hall and is an aerobic process. Measurements by ADAS of odour concentrations at an analogous plant in Norfolk suggest that odour concentrations in the building headspace around these digesters will be in the low thousands of odour units per cubic metre (<5,000 ouE/m$^3$).

Taking this date into account suggests that untreated air odour concentrations are unlikely to exceed 15,000 ouE/m$^3$ in the combined air flow to the biofilter from the reception and digester areas. Thus, with an airflow rate of 5.5 m$^3$/s the untreated odour emission contribution to the biofilter is predicted to be no more than 82,500 ouE/s.

**Drier Emission**
ADAS experience of high temperature bio-drying and composting operations at In-Vessel Composting sites suggests that the proposed aerobic drying process is unlikely to generate untreated odour concentrations any higher than 50,000 ouE/m$^3$ even before any treatment or abatement by the scrubber. It is therefore suggested that if this concentration is assumed in air off the scrubber to the biofilter (i.e. after scrubber treatment), then the untreated odour emission load to the biofilter from the proposed drier and scrubber would equate to around 75,000 ouE/s.

**Net Biofilter Emissions.**
Combining emission from the buildings and the drier provides a total odour load to the biofilter of 157,500 ouE/s.

If the biofilter achieves a reduction of 95% in odour emissions, then the biofilter emissions would be 7,875 ouE/s, that is at an outlet concentration of 1,125 ouE/m$^3$. At a lower level of 90% abatement, emissions would be around 15,750 ouE/s, that is at an outlet odour concentrations of 2,250 ouE/m$^3$.

Taking a reasonably cautious approach, treated emissions have been assumed to be at a concentration of 2,000 ouE/m$^3$. Thus, using an odour concentration of 2,000 ouE/m$^3$ and a ventilation rate of 7 m$^3$/s, an emission rate of 14,000 ouE/m$^3$ has been used in ADMS to model the odour impact of the biofilter at the proposed TAD facility.

**3.3 Assessment of the impact of odour**
It is important when assessing the potential impact of odours on a local community to study both the concentration of odours and their frequency of occurrence. This approach forms part of the most recent guidance from the Environment Agency (EA). In adopting the FIDOR (Frequency, Intensity,
Duration, Offensiveness and Receiver) protocol, the EA is advocating an objective methodology for the assessment of odour nuisance. The probability of off-site impact from odour sources depends on:-

- **Frequency of exposure**: Complaints are more likely if the frequency of exposure increases.
- **Intensity of the odour**: There is a greater probability of complaint when the odour concentration exceeds a threshold or guideline.
- **Duration of odour events**: Short or fleeting odour events are less likely to cause a nuisance than is a prolonged exposure.
- **Offensiveness of the odour**: More offensive odours have a higher risk of causing complaint.
- **Receptor sensitivity**: In particular, the sensitivity of an individual as influenced by their context. As an example, people who live or work in suburban areas (large villages or towns) may be relatively intolerant of “countryside” odours.

### 3.4 Dispersion of odour

A plume of odour naturally disperses through the turbulent motion of the atmosphere as it moves downwind from the point of release. Due to this turbulent mixing process, odour concentrations downwind from a source will not be uniform. Characteristically, in any given hour, there are short duration peaks in concentration that last for a few seconds, separated by longer periods, when the concentrations are low or zero. Consequently, it is necessary to predict the frequency of particular odour concentrations at various points around an odour source.

Once released to the atmosphere, the direction of spread of odours is entirely dependent upon the direction of the wind. The rate of dispersion depends mainly on the wind speed, but other meteorological parameters such as air temperature also influence dispersion rates. The stability of the atmosphere also plays an important role in atmospheric dispersion.

There are also non-meteorological factors which influence downwind odour concentrations.

- **Distance from odour source**: The closer a receptor is to an odour source; the higher the likely odour concentration at that location and the greater the probability of odour impact or detection.
- **The height of release**: Generally, the higher the point of release; the lower the odour concentration in the vicinity of the odour source.
- **Emission characteristics**: Stronger odour sources tend to affect a larger area than weaker sources.
- **Building downwash**: Pollutant emissions may be subject to highly turbulent wind flows in the wake of buildings.

### 3.5 Guideline values and benchmarks

Minimising waste and pollution is a key component of the National Planning Policy Framework. There is no specific guidance for odour; however, odour is defined as pollution within the framework. It is stated in the framework that planning decisions must reflect and where appropriate promote relevant obligations and statutory requirements, for example, the Pollution Prevention
and Control Act and Environmental Permitting (England and Wales) Regulations 2010 (as amended).

The Environment Agency (EA) published draft guidelines on odour regulation, assessment and control (IPPC H4: Horizontal Odour Guidance Parts 1 & 2) in 2002. The 2002 documents have now been withdrawn and various updated versions, for consultation purposes, have been produced in the interim period. The final version (H4: Odour management) was published in March 2011.

Odour detection thresholds and consideration of whether or not an odour is offensive are discussed in Appendix 2 of the updated H4. In Appendix 3, modelled odour concentration benchmark levels are presented for odours of varying degrees of offensiveness. Expressed as a 98th percentile of the hourly mean odour concentrations over a one year period, a threshold value of 6.0 European Odour Units per cubic metre of air (ouE/m³) is suggested in H4 as being appropriate for the least offensive odours. This means that a situation should be acceptable, provided that the value of 6.0 ouE/m³ is not exceeded on more than 2% of occasions. For moderately offensive and highly offensive odours, the threshold values are 3.0 ouE/m³ and 1.5 ouE/m³ respectively.

The EA, in the H4 guidance, recommends that a minimum of three years, and preferably five years, should be used to calculate the 98th percentile of the hourly mean odour concentrations, in order to represent conditions for an “average year”. Comparisons of single yearly statistics will show the range, or sensitivity, of the modelled 98th percentile odour concentrations to meteorological data. For example, a particular year may have a number of periods where dispersion conditions are very poor, leading to higher annual 98th percentile values. ADAS has used the mean 98th percentile of the hourly mean odour concentrations over a five year period to provide statistically robust results, smoothing out inter-annual variations. The modelled minimum and maximum 98th percentiles are reported in Appendix 1, giving an indication of the sensitivity of the results to the meteorological data used in the modelling. This satisfies the EA requirement within H4 that “worst case” scenarios should be considered.

ADAS has generally found that a range of odours, including those from organic waste processing are unlikely to cause unacceptable off-site impacts with annual 98th percentile odour concentrations of less than 5.0 ouE/m³ over a five year period. However, once exposure exceeds 5.0 ouE/m³ at the annual 98th percentile, there is an increasing risk of annoyance and above 10.0 ouE/m³ (at the annual 98th percentile), some complaints would normally be expected. These observations are consistent with an empirical standard of 5.0 ouE/m³ at the annual 98th percentile, used in the landfill and wastewater industries in the UK and elsewhere, to assess the likelihood of community annoyance.

Odours from aerobic wastes are normally placed in the moderately offensive category. The target suggested in H4 for moderately offensive odours is an hourly mean odour concentration of 3.0 ouE/m³ at the 98th percentile. As a precautionary measure, particularly so if the maximum, or “worst year” of five is considered, an hourly mean odour concentration of 3.0 ouE/m³ at the 98th percentile is used in this study as a guideline to assess the point above which some loss of residential amenity may occur.
It should be noted that the prediction that a particular property lies above the guideline concentration does not necessarily imply that a loss of residential amenity (or a nuisance) will follow. However, it is suggested that the probability of such an occurrence is increased in proportion to the exceedence of the guideline.

4. Dispersion modelling methodology

4.1 Model description

The choice of model for this study is UK Atmospheric Dispersion Modelling System (ADMS) Version 5. ADMS is a steady-state atmospheric dispersion model that is based on modern atmospheric physics. It can include treatment of both surface and elevated sources and both simple and complex terrain. ADMS is one of the few models capable of simulating all the important atmospheric processes. Importantly, ADMS 5 can take into account spatially varying deposition of pollutants and consequent plume depletion. The model calculates downwind pollutant concentration in the surrounding area for each hour of the day and night over an appropriate period. Statistics on the frequency and concentration of pollutants at the receptor sites are based upon the hourly calculations. A grid referencing system within the computer model allows the location of both sources and receptors to be specified to an accuracy of within 1m. If necessary, the model also incorporates the effects of buildings on the pollutant plume, known as building downwash.

ADMS has been chosen because it is “fitted for the purpose of the modelling procedure” as defined by the guidelines published by the Royal Meteorological Society (Britter et al, 1995 and Ireland et al, 2006). The group that leads the development of ADMS is Cambridge Environmental Research Consultants (CERC), but the UK Met Office and others have made additional contributions. The model has been extensively validated against site measurements. Details of these validation studies and the formulation of the ADMS are available on the CERC website.

Published studies have shown that atmospheric dispersion models are reliable at predicting the pattern of downwind pollutant concentrations and deposition rates (as statistical distributions) over a period of time (H.R. Olesen, 1997). The ADAS modelling study reported here is based on calculations made over a period of 43,800 hours (5 years) and represents a suitably long period for such a statistical study.

4.2 Meteorology

A statistical dispersion modelling run requires hourly meteorological records, over a minimum of three but preferably over five years. There is a requirement to limit the amount of missing records through station selection and pre-processing the weather file (Defra, 2009). Where only a small number of missing records arise, Defra recommends a procedure of ‘in-fill’ by interpolation or near-neighbour substitution. The occurrence of calm conditions must be considered so that they are not unnecessarily excluded from the modelling study. NB. ADMS considers wind speeds less than 0.75 m/s as ‘calms’.
In this case a weather file which is derived from Numerical Weather Prediction (NWP) assimilation and short term forecast fields from the UK Met Office’s mesoscale model. The location for this data is NGR 466100, 284500, which is approximately 50 m to the south west of the biofilter at the proposed TAD facility at Pebble Hall Farm, for the years 2008 to 2012. From comparison of the NWP data and nearby traditional climatological records and due to the inclusion of information about the state of the atmosphere above ground level, we have formed the opinion that the use of NWP data provides better results.

If traditional climatological data were used then the ADAS/Met Office method of dealing with calm periods in the modelled weather files is to set a wind speed of 1.0 m/s and use the last known “good” wind direction (or set to the direction of known katabatic winds if appropriate). However, many of the periods of calms reported in traditional climatological data are not true calms, but represent wind speeds below the minimum recording capabilities of the anemometers, or below the start up speed of the anemometers (typically 1.0 - 1.5 m/s). This is part of the justification for our standard treatment of calms. Atmospheric dispersion models have internal procedures for dealing with calm periods; however our experience has been that the ADAS method results in the prediction of a larger exposure footprint in the surrounding area the model’s calms procedures. The ADAS/Met Office calms treatment also produces more cautious outcomes than “ignoring” calms by not modelling for hours when there is a calm recorded.

In the NWP data, the winds are “theoretical”, and therefore not subject to limitations of instrumentation. Also, the wind speed in the NWP data more correctly represents a true hourly mean, whereas from a traditional recording station the wind speed is usually a mean derived from the 10 minutes preceding the observation. Therefore, the NWP data has less variance in wind speed and calm periods, or wind speeds below the models default minimum (0.3 m/s), are less frequent. In this case the few wind speeds in the data below this default minimum have been ignored.

The wind rose for the weather file, derived from data from UK Met Office’s mesoscale model (2008 - 2012) is shown in Figure 2. This illustrates the relative frequency of wind directions and wind speeds used in the modelling study.
4.3 Model parameters

4.3.1 Odour emissions
The proposed biofilter at the TAD facility have been modelled as an open biofilter, and emissions from the surface of the biofilter have been represented as an array of 10 low velocity point sources within the model. These low velocity point sources have been modelled at a height of 2.5 m to enable the effect of building downwash to be modelled. The positions of the point sources used to represent the emissions from the biofilter are shown in Figure 3, where they are depicted as red stars, and the source parameters are detailed in Table 1 (all 10 point sources have the same parameters).

Table 1. Point source parameters

<table>
<thead>
<tr>
<th>Height (m)</th>
<th>Diameter (m)</th>
<th>Efflux Velocity (m/s)</th>
<th>Temperature (°C)</th>
<th>Emission Rate (per source) (ouE/s)</th>
</tr>
</thead>
<tbody>
<tr>
<td>2.5</td>
<td>1</td>
<td>0.1</td>
<td>25</td>
<td>1400</td>
</tr>
</tbody>
</table>
4.3.2 Buildings

The structure of the proposed buildings at the TAD facility will have a significant effect on the behaviour of the plumes from the point sources representing emissions from the biofilter. Therefore, the buildings are modelled as rectangular blocks within ADMS, with heights representative of the type of building. The position of the modelled buildings can be seen in Figure 3, where they are marked by grey rectangles.

Figure 3. The modelled buildings and sources

4.3.3 Discrete receptors

Fourteen discrete receptor points have been defined within the model to represent local residences. These discrete receptors are defined at height of 1.5 m and their positions are shown in Figure 4, marked by enumerated blue rectangles. The exact positions of the discrete receptors are given in Table 2, in Section 5.

4.3.4 The regular Cartesian grid

A nested grid has been used to produce the contour maps presented in the results of this study. In this case an 80 m by 80 m area around the TAD facility
was defined at 20 m resolution, a 50 m grid extends 50 m from the central grid, a 100 m grid extends a further 100 m and beyond this the resolution is reduced to 200 m, and then 500 m. The nested grid points are defined at a height of 1.5 m above ground level within ADMS. Details of the nested grid can be seen in Figure 4, where the grid points are marked by green crosses.

4.3.5 Terrain and roughness length
The land in the vicinity of the proposed TAD facility contains some slopes that may affect wind flow and the dispersion of odour. Consequently, terrain data have been incorporated within ADMS. These data are based on the SRTM3 data which is derived from Space Shuttle mission RADAR measurements and has a resolution of approximately 90 m. These data have been re-sampled at a horizontal resolution of 200 m for use within ADMS. A fixed roughness length of 0.25 m is used over the entire modelling domain.

Figure 4. The regular Cartesian grids and discrete receptors
5. Dispersion modelling results

ADMS calculates average odour concentrations at the grid points and the discrete receptor points for each hour over a five-year period. From these calculations, statistics have been produced of the predicted five year mean annual 98\textsuperscript{th} percentile hourly average odour concentrations. That is, the odour concentration which is exceeded for only 2\% of all hours (around 14 hours per month, on average).

The ADMS run made for this study included emissions from an array of 10 low velocity point sources used to represent the emissions from the open biofilter. Five runs, one for each year in the five year meteorological record (2008 to 2012) were performed, and the mean annual predicted 98\textsuperscript{th} percentile hourly odour concentrations from these five years is shown in Figure 5.

Figure 5. Modelled five year mean annual 98\textsuperscript{th} percentile hourly mean odour concentration (2008 to 2012)

The predicted five year mean annual 98\textsuperscript{th} percentile hourly average odour concentrations at the specified receptor points are shown in Table 2, where values in less than the Environment Agency’s benchmark of 3 ouE/m\textsuperscript{3} are shown in black, any in excess of this benchmark are shown highlighted in blue, and those in excess of 5 ouE/m\textsuperscript{3} are shown highlighted in orange, and those in
excess of 10 ouₑ/m³, where adverse impact would be expected, are shown highlighted in red.

The predicted five year minimum and maximum values (2008 to 2012) are presented in Appendix 1.

Table 2. Predicted maximum annual mean odour concentrations at the discrete receptors

<table>
<thead>
<tr>
<th>Rec</th>
<th>X (m)</th>
<th>Y (m)</th>
<th>Name</th>
<th>Mean 98th percentile hourly mean odour concentration (ouₑ/m³)</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>466825</td>
<td>284967</td>
<td>'The Bungalow'</td>
<td>0.24</td>
</tr>
<tr>
<td>2</td>
<td>466896</td>
<td>285063</td>
<td>Hothorpe Hall</td>
<td>0.20</td>
</tr>
<tr>
<td>3</td>
<td>466094</td>
<td>285096</td>
<td>Pebble Hall</td>
<td>0.30</td>
</tr>
<tr>
<td>4</td>
<td>465885</td>
<td>285138</td>
<td>Dene Lodge</td>
<td>0.17</td>
</tr>
<tr>
<td>5</td>
<td>465728</td>
<td>285028</td>
<td>Residence at Woodside Farm</td>
<td>0.16</td>
</tr>
<tr>
<td>6</td>
<td>464754</td>
<td>284381</td>
<td>Bosworth Hall</td>
<td>0.05</td>
</tr>
<tr>
<td>7</td>
<td>467005</td>
<td>285299</td>
<td>Residences on Hothorpe Road</td>
<td>0.14</td>
</tr>
<tr>
<td>8</td>
<td>466473</td>
<td>285449</td>
<td>Residences on Bosworth Road</td>
<td>0.13</td>
</tr>
<tr>
<td>9</td>
<td>466826</td>
<td>285667</td>
<td>Residences at Manor Farm</td>
<td>0.07</td>
</tr>
<tr>
<td>10</td>
<td>467298</td>
<td>285276</td>
<td>Quiet Fields</td>
<td>0.11</td>
</tr>
<tr>
<td>11</td>
<td>467490</td>
<td>285458</td>
<td>Welland Paddocks</td>
<td>0.09</td>
</tr>
<tr>
<td>12</td>
<td>467697</td>
<td>285137</td>
<td>Residence at Home Farm</td>
<td>0.08</td>
</tr>
<tr>
<td>13</td>
<td>465690</td>
<td>284399</td>
<td>Residence</td>
<td>0.44</td>
</tr>
<tr>
<td>14</td>
<td>467280</td>
<td>285348</td>
<td>Buckle Hill</td>
<td>0.11</td>
</tr>
</tbody>
</table>

The modelling results show that predicted impact are all well below the selected 3.0 ouₑ/m³ benchmark, and indeed are also well below the stricter H4 benchmark of 1.5 ouₑ/m³ that can be used for more offensive odours.

These results show that with representative odour loadings and biofilter abatement performance the proposed plant could be operated with no significant off-site odour impact on local amenity. The modelling results also show that there is appreciable tolerance or headroom for higher emissions without causing any adverse offsite impact, for example if the modelled odour concentration or biofilter abatement predictions are optimistic.
6. Summary and Conclusions

The Met Office Rural Environment Team and ADAS has been commissioned by Advanced Organics Nutrient Recycling to conduct a dispersion modelling study to assess the off-site impact of odour emissions from the biofilter at the proposed Thermophillic Aerobic Digester (TAD) facility at Pebble Hall Farm, Theddingworth, near Market Harborough, Northamptonshire.

Odour emissions from the proposed biofilter at the TAD facility have been calculated based on odour concentrations and emission rates measured by ADAS at similar facilities, and ADAS experience of organic waste treatment odour emissions and biofilter performance.

The calculated emission rates were then used in an atmospheric dispersion model to assess the likely impact of odour in the area around the site. The modelling was conducted by the Met Office Rural Environment Team at ADAS Wolverhampton.

The model results predict that there would not be any exceedances of the Environment Agency’s 3.0 $\text{ou}_E/\text{m}^3$ benchmark, chosen for this study, at any of a number of discrete receptors around the plant.

The modelled impacts are also well below the stricter H4 benchmark of 1.5 $\text{ou}_E/\text{m}^3$ that can be used for more offensive odours.

These results show that with good odour management, and with typical biofilter odour loadings and abatement performance, the proposed plant can be operated with very low risk of any off-site odour impact on local amenity.

The modelling results also show that there is appreciable tolerance or headroom for higher emissions, for example if the odour concentration or biofilter abatement predictions used in the modelling are optimistic, without causing any adverse offsite impact.
7. References

Air Quality Modelling and Assessment Unit, 2010. Guidance (from the Environment Agency) on modelling the concentration and deposition of ammonia emitted from intensive farming.

APIS. Air Pollution Information System. http://www.apis.ac.uk/index.html


CERC website. Cambridge Environmental Research Consultants http://www.cerc.co.uk/


Environment Agency H1. H1 Environmental Risk Assessment, Annex b (Intensive Farming)


APPENDIX 1

5 year minimum and maximum 98th percentile hourly mean odour concentrations at the discrete receptors.

Values in excess of the Environment Agency’s guideline (> 3.0 ouE/m³) are coloured blue and those that are in the range where ADAS has previously found that there is an increasing risk of complaint (> 5.0 ouE/m³) are coloured orange and those above this range (> 10.0 ouE/m³) are coloured red.

Table A1. 5 year minimum annual 98th percentile hourly mean odour concentration at the discrete receptors

<table>
<thead>
<tr>
<th>Rec</th>
<th>X (m)</th>
<th>Y (m)</th>
<th>Name</th>
<th>98th percentile hourly mean odour concentration (ouE/m³)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td>Minimum</td>
</tr>
<tr>
<td>1</td>
<td>46825</td>
<td>284967</td>
<td>‘The Bungalow’</td>
<td>0.20</td>
</tr>
<tr>
<td>2</td>
<td>46896</td>
<td>285063</td>
<td>Hothorpe Hall</td>
<td>0.18</td>
</tr>
<tr>
<td>3</td>
<td>46094</td>
<td>285096</td>
<td>Pebble Hall</td>
<td>0.27</td>
</tr>
<tr>
<td>4</td>
<td>45885</td>
<td>285138</td>
<td>Dene Lodge</td>
<td>0.14</td>
</tr>
<tr>
<td>5</td>
<td>45728</td>
<td>285028</td>
<td>Residence at Woodside Farm</td>
<td>0.14</td>
</tr>
<tr>
<td>6</td>
<td>44754</td>
<td>284381</td>
<td>Bosworth Hall</td>
<td>0.04</td>
</tr>
<tr>
<td>7</td>
<td>47005</td>
<td>285299</td>
<td>Residences on Hothorpe Road</td>
<td>0.12</td>
</tr>
<tr>
<td>8</td>
<td>46473</td>
<td>285449</td>
<td>Residences on Bosworth Road</td>
<td>0.12</td>
</tr>
<tr>
<td>9</td>
<td>46826</td>
<td>285667</td>
<td>Residences at Manor Farm</td>
<td>0.07</td>
</tr>
<tr>
<td>10</td>
<td>467298</td>
<td>285276</td>
<td>Quiet Fields</td>
<td>0.09</td>
</tr>
<tr>
<td>11</td>
<td>467490</td>
<td>285458</td>
<td>Welland Paddocks</td>
<td>0.08</td>
</tr>
<tr>
<td>12</td>
<td>46797</td>
<td>285137</td>
<td>Residence at Home Farm</td>
<td>0.07</td>
</tr>
<tr>
<td>13</td>
<td>46590</td>
<td>284399</td>
<td>Residence</td>
<td>0.33</td>
</tr>
<tr>
<td>14</td>
<td>467280</td>
<td>285348</td>
<td>Buckle Hill</td>
<td>0.10</td>
</tr>
</tbody>
</table>