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Odour Assessment S73

Land East of A162, Low Farm, South Milford, Sherburn in Elmet, LS25 6FW

Engie Renewable Gas UK Limited

CRM.0174.006.AQ.002.R.001.P01

'Experience and expertise working in union'

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Odour Assessment

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Non-Technical Summary

i. Enzygo Limited was commissioned by Engie Renewable Gas UK Limited to undertake an Odour Assessment to support of the application for the construction and operation of an Agricultural Anaerobic Digestion (AD) Plant on agricultural land to the east of A162, Low Farm, South Milford, Sherburn in Elmet, LS25 6FW.

ii. During the operation of the plant there is the potential for impacts to occur at sensitive locations due to odour emissions from a number of sources at the plant. An Odour Assessment was therefore undertaken to consider effects in the vicinity of the site.

iii. Channelled emissions from the proposals will also be subject controls and, where applicable, emission limits as part of the operator's Environmental Permit.

iv. Potential odour emissions were defined based on the proposed plant operation and a review of literature and emissions used at similar facilities. Robust assumptions were used to consider odour emissions the manure types proposed in this facility.

v. The proposals will result in the removal or control of other odour sources in the vicinity of the site and the closest sensitive receptors. These potential improvements have not been included within the assessment to provide a robust assessment.

vi. These were represented within a dispersion model. Impacts at sensitive receptor locations in the vicinity of the site were quantified, the results compared with the appropriate odour benchmark level.

vii. Predicted odour concentrations were below the relevant benchmark level at all sensitive receptors in the vicinity of the site for all modelling years.

viii. In addition, using the IAQM guidance significance criteria, worst case impacts were slight at one receptor and negligible at all other representative sensitive receptors and overall impacts are there considered as not significant.

ix. As such, considering the results and robust assumptions made, overall potential for odour impacts generated by the AD facility can be considered as not significant and the AD facility is therefore not considered to represent a constraint to planning permission in regard to odour.

1.0 Introduction

1.1 Background

Enzygo Limited was commissioned by Engie Renewable Gas UK Limited to undertake an Odour Assessment in respect to a proposed Agricultural Anaerobic Digestion (AD) Facility on agricultural land to the Land East of A162, Low Farm, South Milford, Sherburn in Elmet, LS25 6FW.

1.1.1 The proposed AD plant will accept approximately 65,000 tonnes per annum (tpa) of feedstock from local farms. The proposed development would generate biogas which will upgraded to biomethane then connected via pipeline to be injected into the national grid directly from the site.

1.1.2 The AD process uses the principles of digestion to convert waste material into biogas. The biogas is upgraded to biomethane and exported to the national gas grid, providing sustainable, renewable gas for the county. Some biogas is used to power CHP engines for the provision of all necessary parasitic energy required on site.

1.1.3 A secondary output of the AD process is digestate, which will be used on local farms in place of raw manures and artificial fertilisers.

1.1.4 Proposed controls for odour emissions have been included in this assessment.

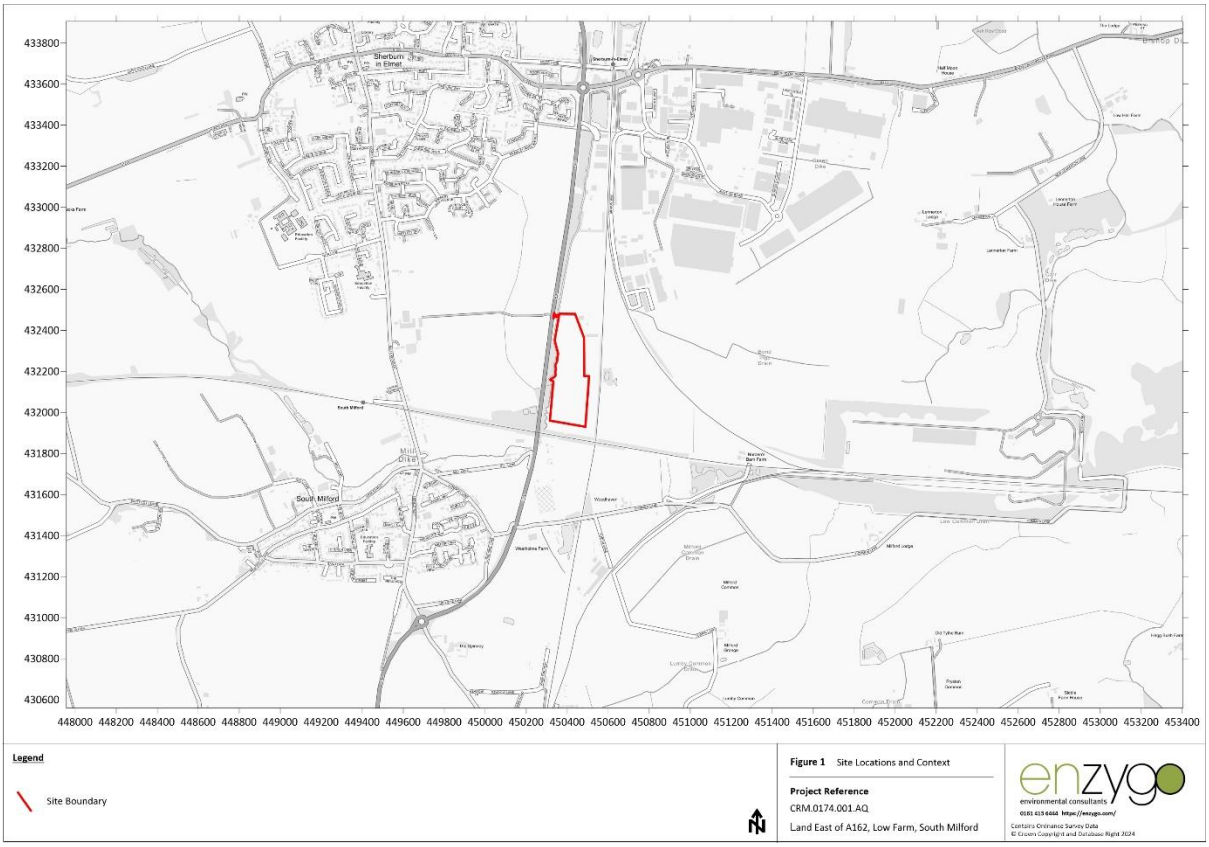
1.1.5

1.2 Site Location and Context

1.2.1 The facility is located on land east of A162, Low Farm, South Milford, Sherburn in Elmet, at approximate National Grid Reference (NGR): 450420, 432210.

1.2.2 The site is located in a predominantly agricultural area with a sparse mixture of working farms and residential properties in the vicinity of the site. The nearest residential property is a dwelling on Mill Lane, Millford 386t m south of the site. Figure 1 shows the location of the site and surrounding areas.

Figure 1: Site Location



1.2.3 It is proposed to operate an AD plant that will be fuelled by biomass feedstock in form of energy crops, straw and farmyard manures (FYM). The biogas produced by the AD process will be upgraded for injection into the gas grid.

1.2.4 The proposed AD Facility will comprise of the following primary elements:

- Agricultural manure acceptance and storage;
- Crop (such as rye, grass and maize) storage in silage clamps;
- Liquid slurry acceptance via the filling station and storage in an enclosed tanks;
- Anaerobic digestion of the feedstock;
- Biogas collection, storage and treatment;
- Small proportion of biogas combustion in boiler to provide heatr to the facility – back-up biogas boiler & emergency flare;

1.2.5

- Biogas upgrading to biomethane and injection into the gas grid; and
- Transfer of liquid digestate to storage lagoon.

The process can briefly be described as follows:

- Feedstock reception and storage: silage will be stored in SAFFO compliant silage clamps and will be covered except for the clamp face during removal of feedstocks. Manures will be deposited initially outside on a pad before being stored inside a feedstock reception building which will be operated under negative pressure and

have an inbuilt odour control system to control odours. Liquid feedstocks, such as, slurries will be stored in sealed reception tanks;

- The solid feedstocks will be loaded into the feed hoppers with a tele-handler or loading shovel by the site operatives, according to a pre-defined ration,

- The feeders will consist of hoppers for conveyance of bulk solids. The hoppers will have covers which can retract when filling with feedstock and close when not in use. The solids are transferred into a feeding pump, where they are mixed with liquid feedstocks, in a sealed unit, with recirculated liquid, to make an organic pumpable substrate;

- The substrate is pumped into the process. The processing vessels are high-integrity, reinforced concrete tanks, with double membrane gas dome holders as covers. The vessels are gas tight, are heated using hot water recovered from a biogas Combined Heat and Power (CHP) unit, and are mechanically mixed to ensure the substrate, bacteria and heat are well distributed around the vessel. Including the pre-treatment process, the total retention time is typically 40 days including the pre-treatment process;

- During digestion, biogas is continuously produced in the vessels, typically around 55% methane and 45% carbon dioxide;

- After digestion, the gas has been recovered from the substrate and the residual material is known as digestate. This contains indigestible fibre and nutrients. It is pumped to a separation system within a dedicated enclosed building, where the fibre is squeezed from the liquid phase. The fibre is a clean, stackable, homogenous, low odour product that is a very popular soil improver for agricultural purposes. It is temporarily stored on the silage clamps prior to being spread to land at the appropriate time;

- The liquid digestate fraction, after separation, is pumped into a purpose built, engineered lagoon or stored in a 250 m^3 tank. The lagoon will be formed from site soil and will be lined with a heavy duty liner and a cover. The liquid digestate is an excellent biofertiliser with a balanced source of nutrients and organic matter and will be spread to farmland for agricultural benefit. A minimum of 6 months digestate storage will be provided to ensure that the digestate is spread at the appropriate time of year and in line with regulations and good practice;

- Vented air from the reception and separation buildings and liquid storage tanks will pass through an odour control unit (OCU) to remove up to 99% of odours and 96% of ammonia. This is then vented to the atmosphere via an odour stack;

- A small portion of the gas produced will be combusted in a boiler unit. This will provide during cooler months of the year (approximately 24% of the time) based on the required demand;

- The remainder, and the largest portion, of the gas will be upgraded to convert it from biogas to biomethane. This is a clean renewable gas that is compliant with the gas grid specifications and regulations. The biomethane is continuously monitored and metered prior to injection into the gas grid;

- A side stream of clean, compressed carbon dioxide is produced from the upgrading of the biogas. It is intended that the carbon dioxide will be recovered and liquified before being sent off-site to end user (to displace non-renewable carbon dioxide).

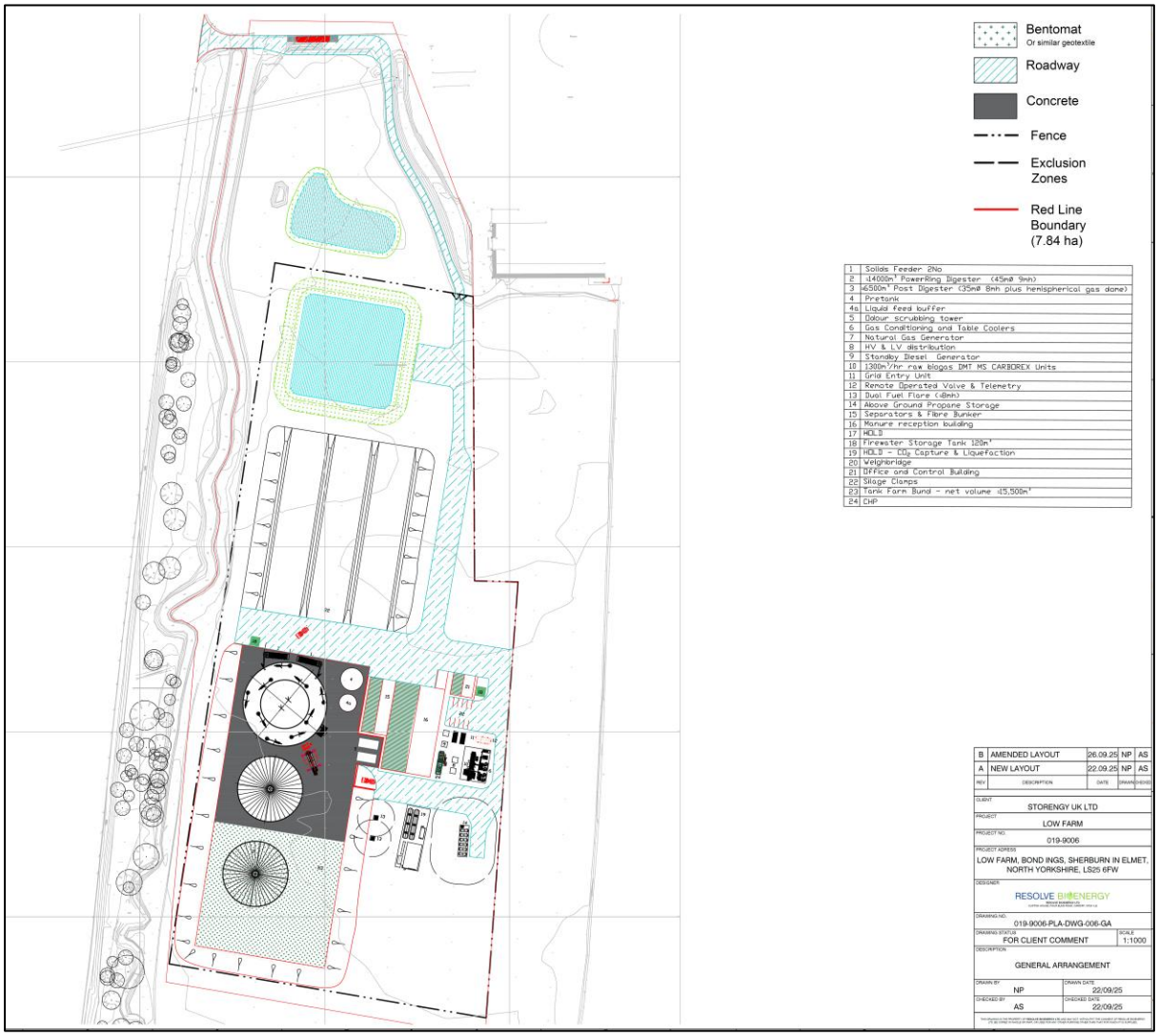
The activities associated with the proposed plant are controlled under the Environmental Permitting (England and Wales) Regulations (2016) and subsequent amendments. As such, the operator will be required to obtain an Environmental Permit from the Environment Agency (EA) as the appropriate regulator prior to operation.

1.2.6 The operation of the plant may result in odour emissions from a number of activities. These have the potential to cause impacts at sensitive locations within the vicinity of the site and have therefore been assessed within this report.

Figure 2 shows the proposal site layout.

1.2.7 **Figure 2: Site Layout**

1.2.8



2.0 Legislation Guidance and Policy

2.1 Odour Impact

The following legislation and guidance will be considered and adhered to during the preparation of the Odour Impact Assessment:

- H4: Odour Management, EA, 2011[1];
- Odour Guidance for Local Authorities (withdrawn), Department for Environment, Food and Rural Affairs (DEFRA), 2010[2];
- Guidance on the Assessment of Odour for Planning, IAQM, 2018[3];
- Industrial Emission Directive (2010/75/EU);
- Environmental Permitting (England & Wales) Regulations 2016 (as amended) – Chapter 4 Standard rules; and
- SR2021 No 6: Anaerobic digestion facility, including use of the resultant biogas – installations, EA, Updated 5th July 2022[4].

2.1.1

The magnitude of odour impact depends on a number of factors and the potential for complaints varies due to the subjective nature of odour perception. The FIDOL acronym is a useful reminder of the factors that will determine the degree of odour pollution:

2.1.2

- Frequency of Detection - frequent odour incidents are more likely to result in complaints;
- Intensity as Perceived - intense odour incidents are more likely to result in complaints;
- Duration of Exposure - prolonged exposure is more likely to result in complaints;
- Offensiveness - more offensive odours have a higher risk of resulting in complaints; and
- Location - the type of land use and nature of human activities in the vicinity of an odour source. Tolerance and expectation of the receptor. The 'Location' factor can be considered to encompass the receptor characteristics, receptor sensitivity, and socio-economic factors.

2.1.3

2.1.4

It is important to note that even infrequent emissions may cause loss of amenity if odours are perceived to be particularly intense or offensive.

The FIDOR factors can be further considered in conjunction with the following in regard to the potential for an odour emission to cause a nuisance:

- The rate of emission of the compound(s);
- The duration and frequency of emissions;

[1] H4: Odour Management, Environment Agency (EA), 2011

[2] Odour Guidance for Local Authorities, DEFRA, 2010

[3] Guidance on the Assessment of Odour for Planning, IAQM, 2018 – Version 1.1.

[4] https://www.gov.uk/government/publications/sr2021-no-6-anaerobic-digestion-facility-including-use-of-the-resultant-biogas-installations/sr2021-no-6-anaerobic-digestion-facility-including-use-of-the-resultant-biogas-installations

- The time of the day that this emission occurs;
- The prevailing meteorology;
- The sensitivity of receptors to the emission i.e. whether the odorous compound is more likely to cause nuisance, such as the sick or elderly, who may be more sensitive;
- The odour detection capacity of individuals to the various compound(s); and
- The individual perception of the odour (i.e. whether the odour is regarded as unpleasant). This is greatly subjective and may vary significantly from individual to individual. For example, some individuals may consider some odours as pleasant, such as petrol, paint and creosote.

2.2 Odour Measurement

2.2.1 The concentration at which an odour is just detectable to a "typical" human nose is referred to as the "threshold" concentration. This concept of a threshold concentration is the basis of olfactometry in which a quantitative sensory measurement is used to define the concentration of an odour. Standardised methods for measuring and reporting the detectability or concentration of an odour sample have been defined by European standard BS:EN 13725:2003. The concentration at which an odour is just detectable by a panel of selected human "sniffers" is defined as the detection threshold and has an odour concentration of 1 European odour unit per cubic metre (1 ou_E/m^3).

2.2.2 An odour at a strength of 1 ou_E/m^3 is in reality so weak that it would not normally be detected outside the controlled environment of an odour laboratory by the majority of people (that is individuals with odour sensitivity in the "normal" range - approximately 96% of the population). As an odour becomes more concentrated, then it gradually becomes more apparent. Some guidance as to concentrations when this occurs can be derived from laboratory measurements of intensity. The following guideline values have been stated by DEFRA2 to provide some context for discussion about exposure to odours:

- 1 ou_E/m^3 is the point of detection;
- 5 ou_E/m^3 is a faint odour; and

2.2.3
- 10 ou_E/m^3 is a distinct odour.

It is important to note that these values are based on laboratory measurements and in the general environment other factors affect our sense of odour perception, such as:

- The population is continuously exposed to a wide range of background odours at a range of different concentrations, and usually people are unaware of there being any background odours at all due to normal habituation. Individuals can also develop a tolerance to background and other specific odours. In an odour laboratory the determination of detection threshold is undertaken by comparison with non-odorous air, and in carefully controlled, odour-free, conditions. Normal background odours such as those from traffic, vegetation, grass mowings etc, can provide background odour concentrations from 5 to 60 ou_E/m^3 or more.
- The recognition threshold may be about 3 ou_E/m^3, although it might be less for offensive substances or higher if the receptor is less familiar with the odour or distracted by other stimuli; and

- An odour which fluctuates rapidly in concentration is often more noticeable than a steady odour at a low concentration.

2.3 Odour Legislative Control

The main requirement with respect to odour control from industrial activities is the Environmental Permitting (England and Wales) Regulations (2016) and subsequent amendments. If a process is deemed potentially odorous then the relevant regulator will usually include an appropriate condition in the site's Environmental Permit to restrict impacts beyond the facility boundary.

2.3.1 Enforcement of the condition is by the relevant regulator, either the EA for Part A(1) processes, or the Local Authority for Part (A2) and B processes. If the regulator is satisfied that odour from a facility is causing pollution beyond the site boundary then they can serve an improvement notice that requires remedial works to be undertaken to reduce impacts to an acceptable level.

2.3.2 The measures that are deemed appropriate will depend on the industry sector and site-specific circumstances and will take costs and benefits into account. Should appropriate actions not be taken by the operator then the regulator has a number of available options, cumulating in the revocation of the Environmental Permit and cessation of all activities on site

2.4 Odour Benchmark Levels

Environment Agency: H4

2.4.1 The H4 guidance[1] provides benchmark levels to assess relevant exposure to determine impacts from potential operations and practices regulated under the Environmental Permitting (England and Wales) Regulations (2018) and subsequent amendments.

2.4.2 Modelled concentrations above the relevant benchmark levels detailed in Table 1 would therefore indicate unacceptable odour exposure. Benchmark levels are stated as the 98th percentile (%ile) of hourly mean concentrations in ou_E over a year. This means benchmarks should not be exceeded for more than 2% of the hours in a year or approximately 175 hours per year. This takes account of a reasonable amount of tolerance that can be expected by subjects to occasional odours. EA odour benchmark levels are summarised in Table 1.

Table 1: Odour Benchmark Levels

Relative Offensiveness of Odour	Benchmark Level as 98th%ile of 1-Hour Means (ou_E/m^3)
Most Offensive Odours: Processes involving decaying animal or fish Processes involving septic effluent or sludge Biological landfill odours	1.5
Moderately Offensive Odours: Intensive livestock rearing Fat frying (food processing) Sugar beet processing Well aerated green waste composting	3.0
Less Offensive Odours: Brewery Confectionery Coffee roasting Bakery	6.0

It is considered that odours from the facility would be similar to that for 'intensive livestock' and 'well aerated green waste composting' and therefore likely be classified as 'moderately offensive', in accordance with the criteria shown in Table 1.

2.5 Institute of Air Quality Management Guidance

2.4.3 The IAQM guidance[3] specifically deals with assessing odour impacts for planning purposes, namely potential effects on amenity. The assessment methodology outlined in the guidance has been utilised in throughout this report where relevant.

2.5.1 It is therefore considered that this is the most relevant current guidance for methodology for assessment.

2.6 National Planning Policy

2.5.2 The National Planning Policy Framework (NPPF) was revised on 20 July 2021[5] and sets out the Government's core policies and principles with respect to land use planning, including air quality. The document includes the following considerations which are relevant to this

2.6.1 assessment:

"Planning policies and decisions should contribute to and enhance the natural and local environment by:

[…]

"Preventing both new and existing development from contributing to or being put at unacceptable risk from, or being adversely affected by unacceptable levels of soil, air, water or noise pollution or land instability. Development should, wherever possible, help to improve local environmental conditions such as air and water quality"

2.6.2 The implications of the NPPF have been considered during the production of this report.

[5] National Planning Policy Framework, Department for Communities and Local Government, 2021

3.0 Methodology

3.1 Scope

The operation of the AD plant will result in odour emissions during normal operations. These were assessed in accordance with the following stages:

- Identification of odour sources;
- Identification of odour emission rates;

3.1.1

- Dispersion modelling of odour emissions; and
- Comparison of modelling results with relevant criteria.

The following Sections outline the methodology and inputs used for the assessment.

3.2 Odour Sources

Potential odour sources were identified from the proposed process. These included:

3.2.1

- Air exhaust from the waste reception building, separation building and liquid storage tanks via the odour treatment plant and stack;
- Manures stored briefly outside the reception building
- Exposed crops within silage clamps;
- FYM stored with the reception building;
- Liquid slurry stored within tanks via a vent;
- Exposed crops and FYM during transfer to the feeder;
- Exposed and agitated material within the feeder hopper;
- Emissions from liquid digestate storage lagoon vents; and

3.2.2

- Emission from road tankers at liquid digestate filling points.

The AD process itself is sealed and therefore does not form a source of odour, or other emissions such as CH_4 or Hydrogen Sulphide (H_2S), under normal operation. Should releases of

3.2.3

these species occur then this would indicate a fault with the plant and immediate remedial measures would be taken to eliminate the problem to avoid seriously affecting the AD process,

3.2.4

with associated financial consequences for the operator. Odours created by the membranes themselves should not occur.

3.2.5

Liquid digestate created by the process will be transported off the site by road tankers at the collection point.

The digestate lagoon will be covered with an impermeable floating layer to control emissions. Residual emissions will be via vents surrounding the lagoons.

Engie Renewable Gas UK Limited has advised that the number of tanker removals will be approximately as follows:

- Out of spreading season (from on-site lagoon to off-site lagoon) – 16 tonne loads (tractor and tanker) – 97 loads per calendar month (c. 3 loads per day)

- Spreading campaigns during spring and late summer (from on site lagoon to field) – 29 tonne loads – 677 loads per month (c. 23 loads per day)

During tanker filling there is the potential for short term odour emissions from displaced air within the tanker. These emissions have been included within this assessment as they have the potential to affect the immediate locality over a short period although the contribution to annual mean concentrations will be very low.

3.2.6 Solid digestate will be stored within the separation building before removal from the site. These odours have therefore been accounted for within the building.

3.2.7 Additional emissions such as Carbon Dioxide (CO_2), H_2S and Particulate Matter (PM), Engie Renewable Gas UK Limited have confirmed the plant Includes a raw gas treatment unit to remove such species from the system. The treatment plant effectively captures CO_2 emissions and scrubs both H_2S and PM emissions within the raw gas via adsorption methods, activated carbon and particulate filters. It should be noted that only H_2S is a potentially odourous emission.

3.2.8

3.2.9 Following the capture of CO_2 the raw gas in compressed and fed into the adsorption column where it passes through a bed of activated carbon, ensuring the complete removal of H_2S, and then to a downstream filter, which ensures a complete removal of PM matter. The remaining CO_2 is then condensed and enters a liquefier where it is cooled and enclosed within the collection vessel to the transfer pump.

3.2.10 Similarly, the engines, generators , boilers and flare will only emit products of combustion which do not typically have any associated odour. As such, they have not been considered as potential sources in the context of this assessment. Reference should be made to SHF.0174.006.AQ.R.001.P01 for the assessment of associated on-site pollutant emissions.

3.2.11 Feedstock delivery of crops, will only be undertaken for short-periods, with materials quickly compacted, covered and sealed once deposited in the clamps. Odour emissions from these sources are therefore likely to be short in duration and controlled effectively once the relevant materials are contained. As such, they are not anticipated to be significant in the context of the other sources considered with the assessment and were not included within the dispersion model.

3.2.12 Delivery of FYM will be deposited outside the waste reception building. This will be pushed into the building on arrival and the assessment has assumed a worst case of 30 minutes storage outside. The building will be kept under negative pressure to ensure no fugitive emissions when the doors are open. All extracted air within the building will be passed through the OCU and emitted via the 14 m high odour stack.

3.2.13

3.2.14

3.2.15 Feedstock will be transferred from the clamps by loader into the feeding unit for 2 hourly periods each day.

Liquid slurries will be stored within 2 enclosed tanks which will vent to the OCU.

3.3.1 Figure 3 shows the modelled emission locations and buildings included within the model.

Figure 3: Emission Locations

3.3 Odour Stack

The air extracted from the reception building will also be emitted through dedicated stack following treatment for odours and ammonia. Air will be extracted from the reception building

at a rate of 4 air exchanges per hour. The process conditions associated with the odour stack, as provided by Engie Renewable Gas UK Limited , are detailed in Table 2.

Table 2: Odour Stack Process Conditions

Parameter	Unit	Value
Approx. Stack Location	NGR	450429, 432091
Stack Height	m	14.0
Stack Exit diameter	m	0.8
Exit Temperature	˚C	15 (ambient)
Volumetric flow rate	m^3/s	7.866
Flue gas efflux velocity	m/s	15.649

a: Referenced wet gas flow rate from technical data sheets

3.4 Dispersion Modelling

3.4.1 Dispersion modelling was undertaken using ADMS 6 (v6.0.0.1), which is developed by Cambridge Environmental Research Consultants (CERC) Ltd which is widely accepted by the EA and local authorities across the UK.

3.5 Modelling Scenarios

3.5.1 The scenarios considered in the modelling assessment are summarised in Table 3.

Table 3: Dispersion Modelling Scenarios

Pollutant	Modelled As	
	Short Term	Long Term
Odour	98th%ile 1-hour mean	n/a

3.5.2 Since the facility is not operational, it was not possible to monitor site specific emissions. In the absence of such information for specific odour sources, these were based on a review of existing literature and odour monitoring data reported at similar AD plants and are therefore considered to provide representative inputs for an assessment of this nature.

3.5.3 Odour emission rates are summarised in Table 4. Where a variation in odour rates was researched, the higher rate was used to provide a robust assessment, these are highlighted in **bold.**

Table 4: Odour Emission Rates

Source	Odour Emission Rate	Unit	Reference
Maize Silage	20.0	$ou_E/m^2/s$	Odournet UK Ltd(1)
Maize	18.7	$ou_E/m^2/s$	REC Ltd(2)
Maize, rye, barley, sugar beet, fodder beet, grass and other whole crops	**20.0**	$ou_E/m^2/s$	ADAS(3)
Chicken	**77.0**	$ou_E/m^2/s$	Sniffer (4)
Chicken	75.0	$ou_E/m^2/s$	Odournet UK Ltd(5)
Duck manure	20.0	$ou_E/m^2/s$	Sniffer (4)
Cattle manure	0.8	$ou_E/m^2/s$	Odournet UK Ltd(5)
Pig manure	1.35	$ou_E/m^2/s$	Odournet UK Ltd(5)
Slurry Pit (Winter)	1.83	$ou_E/m^2/s$	AMEC (8)

Source	Odour Emission Rate	Unit	Reference
Slurry Pit (Summer)	3.62	$ou_E/m^2/s$	AMEC (8)
Dewatered Digestate	2.8	$ou_E/m^2/s$	Odournet UK Ltd(6)
Dewatered Digestate	**10.0**	$ou_E/m^2/s$	Odournet UK Ltd(5)
Liquid Digestate	**1.0**	$ou_E/m^2/s$	University of Liège and Universidad Politécnica de Valencia(7)
Liquid digestate tanker vehicle	**10,000**	ou_E/m^3	Odournet UK Ltd(6)

Notes:

(1) Odour Impact Assessment for a proposed Crop CHP Plant at Stoke Bardolph, Nottinghamshire, Odournet UK Ltd;

(2) Odour Assessment Biomass Renewable Energy Unit Spring Farm, Taverham, Resource and Environmental Consultants Ltd.

(3) An Odour Impact Study for a Proposed Agricultural Anaerobic Digester at Cleat Hill Farm, Haunton,ADAS;

(4) Sniffer ER26: Final Report March / 2014, SCAIL-Agriculture update;

(5) Odour Impact Assessment for a proposed Anaerobic Digestion facility near Kenninghall, Norfolk, Odournet UK Ltd

(6) Odour Impact Assessment for a proposed Anaerobic Digestion facility in Chatteris, Cambridgeshire, Odournet UK Ltd

(7) Multi-method Monitoring of Odor Emissions in Agricultural Biogas Facilities, Jacques Nicolas, Gilles Adam, Yolanda Ubeda, Anne-Claude Romain, University of Liège and Universidad Politécnica de Valencia

(8) Residential Development Odour Assessment, High Harrington, AMEC

3.5.4 As indicated in Table 3 the maximum odour emissions would be derived from chicken manure. FYMs are proposed to be a mix of manures. As shown in Table 4 the odour emission rate for cattle, pig and duck manure is much lower than that for chicken manure. However to ensure a robust assessment, all odour emissions from the manures from the outside pad, transfer route and feeder were assumed to be that from chicken manure. Actual emissions are likely to be much less than this.

3.5.5 To use a highly conservative approach an emission of 77 $ou_E/m^2/s$ has been used to represent manure odour emissions and in this assessment.

3.5.6 Emissions from the reception buildings, separator building and liquid slurry and liquid digestate tanks will be passed through the OCU and vented via the dedicated odour stack. The environmental permit will have an emission limit of 1,000 ou_E/Nm^3 and all emissions from these

3.5.7 sources were assumed to be at this maximum to provide a worst case assessment.

3.5.8 Table 4 shows that maize, grass and rye and similar feedstocks are likely to have comparable odour generating characteristics. As such, an emission rate of 20 $ou_E/m^2/s$ was applied to all energy crops in the dispersion model.

3.5.9 The feeders would cause increased emissions due to agitation and, as such, a factor of 10 was applied to these area emissions.

3.5.10 The slurry tank emissions used the higher (summer) value as a constant emission from the surface area within the tank to use a conservative estimate. The almost complete enclosure within the tank would provide a high level of odour control and a minimum 50% reduction was

3.5.11 assumed for this source. Residual gases are emitted ambiently into the OCU.

Liquid digestate in the lagoons will be completely covered by impermeable floating plastic sheets which will reduce emissions considerably by avoiding exposure to meteorological conditions. Again, to use a robust assessment this was considered to give a reduction of 50%.

To avoid over pressurisation, residual gases will be released via vents around the perimeter of the lagoons. The lagoon is estimated to provide twelve 0.15 m diameter vents. The emissions were therefore based on an emission rate of 0.5 $ou_E/m^2/s$ over the measured lagoon areas and then divided equally as point source emissions from the vents.

Following separation to solid portion of the digestate remains in a clamp within the reception building and whose emissions are vented via the odour control unit and stack. The digestate is regularly removed from the site by tractor/trailer.

The emission rates shown in Table 4 were utilised with additional information provided by Engie Renewable Gas UK Limited to define emissions within the dispersion model. These are summarised in Table 5.

3.5.12

Table 5: Emissions

3.5.1

Source	Odour Emission	Unit	Characteristics
Silage Clamps	20.0	$ou_E/m^2/s$	c. 152 m^2 of silage exposed constantly within clamp
Reception Building	Maximum ELV via OCU Stack		
Manure Pad	77.0	$ou_E/m^2/s$	50 m^2 stored for 30 minutes on arrival
Transfer from Silage Clamps to Feed Hoppers	20.0	$ou_E/m^2/s$	1 hour transfer from clamps to feeder twice per day
Transfer from Reception Building to Feed Hoppers	77.0	$ou_E/m^2/s$	1 hour transfer from clamps to feeder twice per day
Agitated material within Feeder Hopper	200.0	$ou_E/m^2/s$	c. 25 m^2 agitated exposed material in each feeder for 2 hour period per day
Agitated material within Feeder Hopper	770.0	$ou_E/m^2/s$	c. 25 m^2 agitated exposed material in each feeder for 2 hour period per day
Slurry and liquid digestate within tanks	Maximum ELV via OCU Stack		
Liquid digestate lagoon vents	0.5	$ou_E/m^2/s$	c. 3,000 m^2 lagoon area emitted as 125 ou/s per vent (assumed 12 vents)
Liquid digestate tanker filling point	88.89	ou_E/s	16 m^3 tank air expelled over 1800 seconds.
OCU Stack	1,000	ou_E/Nm^3	Assumed at 0°C = 1,055 at 15°C Flow based on 3 air exchanges from reception and separation buildings = 7.866 m^3/s = **8298 ou_E/s**

3.5.14

The emission characteristics summarised within Table 5 include the following assumptions:

- The area of the silage clamp constantly uncovered represents an exposed face of the silage along its entire length. The uncovered clamp area will vary throughout operation depending on the levels and type of stored feedstock. As such, the assumption that three clamps will be exposed at all times is considered to provide a conservative over estimation;
- The emissions for FYMs are given for pure and raw manures and based on 100% poultry manure.
- The feedstock transfer routes from the proposed clamps to the dry feeder was modelled as a c. 2 m wide area source;
- The liquid digestate collection points cause emissions as air expelled from the tankers when filled. Tankers are assumed to be 16 m^3 capacity and a filling time of 30 minutes

has been used to calculate an air flow rate from the tanker of 29 m^3 / 1800 s = 0.0089 m^3/s; and

- All odour emissions were at ambient velocity and temperature as a robust assumption.

It is important to note that the operation of the proposed facility would result in the removal or control of other odour sources in the vicinity of the site where silage and manures are currently stored.

The removal of these sources has not been considered in this assessment and provides a further
3.5.15 indication that the findings of this assessment can be considered as robust.

3.6 Time Varied Emissions

3.5.16

Emissions for the silage and manures were assumed to be constant at full capacity, with the plant in operation 24-hours per day, 365-days per year. Emission releases from the slurry tanks were also assumed to be constant from all three vents.

3.6.1

The filling of the feeder unit, as well as the transfer of feedstock from the silage and FYM is understood to occur for approximately twice and for a maximum of 2 hours per day. A time-
3.6.2 varied file was therefore applied to represent these conditions.

The collection of liquid digestate from the designated points will occur for approximately 18
3.6.3 times per day in March and August and twice per day at other times of the year.

3.6.4 Storage on the outside pad was assumed as a worst case of for a 30 minute period. For the majority of the year waste will be brought to the site once 2 or 3 days per week. For robustness this was assumed to be one deposit 5 days per week. During July and October the amount of materials are greater than with on average 2.7 daily trips in July and 1.7 in October. During these periods it was assumed that 3 trips would be made on 7 days per week (21 trips in total). These
3.6.5 are considered conservative assumptions based on material masses.

Modelling of all sources is therefore considered to provide conservative short-term pollutant concentration predictions which do not account for periods of reduced workload.

3.7.1

3.7 Assessment Extents

Ambient concentrations were modelled over the following area using the gridded output
3.7.2 function with ADMS-6 model:

3.7.3
- NGR: 449040, 431300 to 452360, 434040.

3.7.4 Results were subsequently used to produce contour plots within the Surfer® visualisation software package.

Sensitive receptor locations in the vicinity of the AD plant were identified following a desk top survey and assigned a relevant sensitivity based on the appropriate land use category.

The IAQM document Guidance on the Assessment of Odour for Planning[3] provides descriptions of relevant sensitivity as summarised in Table 6.

Table 6: Odour Receptor Sensitivity

Sensitivity	Description
High	**Surrounding land where:** • Users can reasonably expect enjoyment of a high level of amenity; and

Sensitivity	Description
	• People would reasonably be expected to be present here continuously, or at least regularly for extended periods, as part of the normal pattern of use of the land • Examples may include residential dwellings, hospitals, schools/education and tourist/cultural
Medium	**Surrounding land where:** • Users would expect to enjoy a reasonable level of amenity, but would not reasonably expect to enjoy the same level of amenity as in their home; or • People would not reasonably be expected to be present here continuously or regularly for extended periods as part of the normal pattern of use of the land • Examples may include places of work, commercial/retail premises and playing/recreation fields
Low	**Surrounding land where:** • The enjoyment of amenity would not reasonably be expected; or • There is transient exposure, where the people would reasonably be expected to present only for limited periods of time as part of the normal pattern of use of the land. • Examples may include industrial use, farms, footpaths and roads

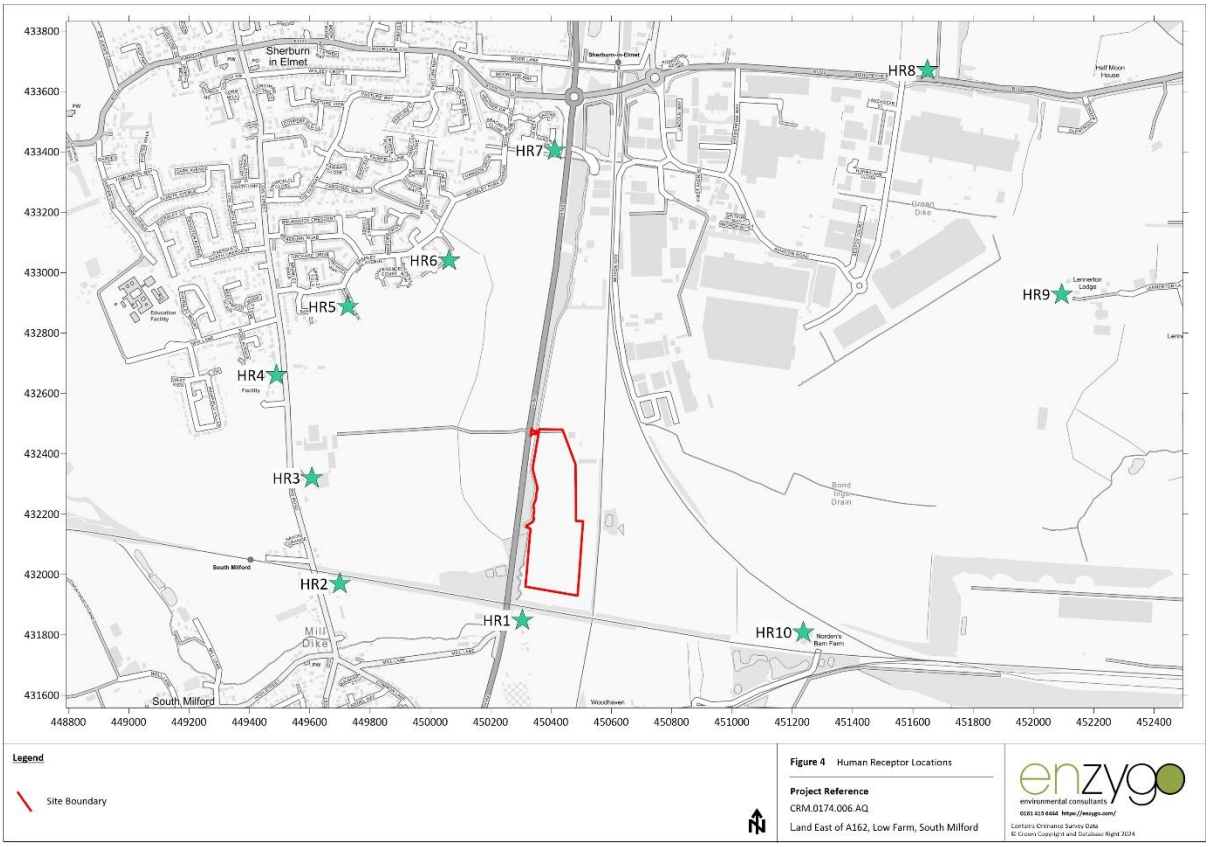
3.7.5 Sensitive receptor locations surrounding the facility were identified from a desk-top study. These were modelled at the minimum height of relevant exposure. The modelled receptors are summarised in Table 7.

Table 7: Sensitive Human Receptors

Receptor		Use	NGR (m)		Distance from Centre of Site (m)	Height (m)
			X	Y		
HR1	Mill Lane, South Millford	Residential	450305.1	431848.1	386	1.5
HR2	Craglands, South Millford	Residential	449699.2	431969.0	765	1.5
HR3	Home Lea Cottage	Residential	449607.5	432319.2	823	1.5
HR4	22 Milford Road/Primary School	Residential/ School	449489.4	432659.7	1,034	1.5
HR5	10 Bartlett View, Sherburn in Elmet	Residential	449726.1	432886.8	968	1.5
HR6	25 Egremont Place, Sherburn in Elmet	Residential	450062.1	433040.2	900	1.5
HR7	Saxon Mews, Sherburn in Elmet	Residential	450412.9	433404.5	1,189	1.5
HR8	Ashfield	Residential	451647.9	433670.0	1,901	1.5
HR9	Lennerton Lodge	Residential	452093.9	432927.7	1,816	1.5
HR10	Norden's Barn Farm	Residential	451236.8	431807.9	910	1.5

3.7.6 The sensitive locations identified in Table 7 represent worst-case locations, i.e., the locations at which air quality impacts from the proposals are expected to be the greatest. Figure 4 shows the location of sensitive human receptors.

Figure 4: Human Receptor Locations



3.7.7 It should be noted that surrounding land use is predominantly agricultural so silage and FYM odours and a higher level of tolerance would reasonably be expected. Many of the receptors are working farms however some receptors represent a group of properties and range of uses and have therefore been classified as the highest sensitivity in that group.

3.8.1

3.8 Terrain Data

3.8.2 Areas of complex terrain have potential to affect the dispersion of pollutants which vary dependent on the height and location of modelled emission sources.

3.9.1 Ordnance Survey Landform Panorama terrain data processed within the ADMS-6 model and covers the AD plant and surround receptor locations.

3.9 Building Effects

Buildings can influence the dispersion of pollutant and may lead to increases to ground level concentrations. A review of adjacent buildings was therefore undertaken and subsequently included within the model and are summarised in Onsite building heights were provided by the project architect and considered to an accurate representation.

Table 8: Building Geometries.

Building		NGR (m)		Height (m)	Length/ Diameter (m)	Width (m)	Angle (°)
		X	Y				
1	Main Digester	450379.1	432115.7		45.0	Circular	N/A
2	Post Digester	450370.9	432070.2		35.0	Circular	N/A
3	Post Digester	450363.0	432023.9		35.0	Circular	N/A

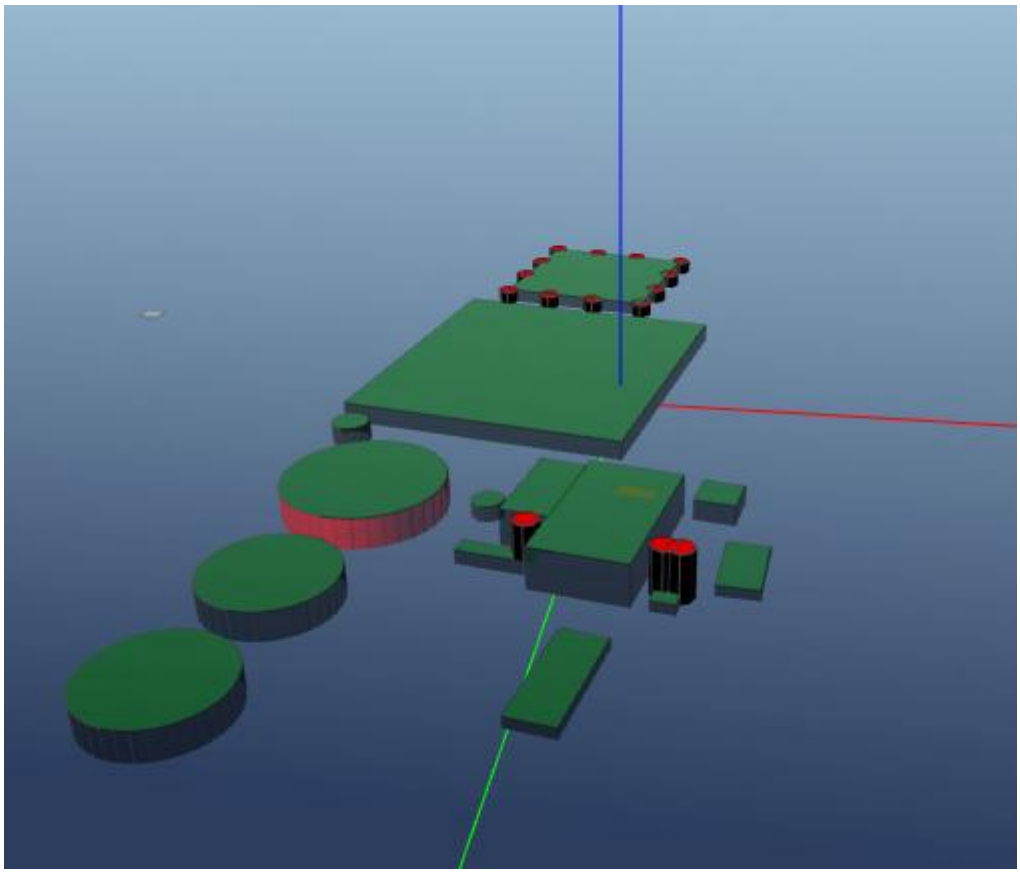
Building		NGR (m)		Height (m)	Length/ Diameter (m)	Width (m)	Angle (°)
		X	Y				
1	Power RIng Tank	450379.1	432115.7	9.0	45.0	Circular	N/A
2	Post Digester 1	450371.5	432068.2	8.0	35.0	Circular	N/A
3	Post Digester 2	450364.1	432025.3	8.0	35.0	Circular	N/A
4	Effluent Tank	450361.3	432155.7	6.1	11.1	Circular	N/A
5	Separation Liquid Tank	450412.9	432116.6	4.5	9.0	Circular	N/A
6	Silage Clamps	450407.8	432210.1	6.0	99.9	90.42	189.5
7	Separator Building	450429.3	432114.7	10.5	29.8	13.92	189.9
8	Feedstock Reception	450448.0	432102.4	12.0	47.6	26.68	189.9
9	Office and Control Building	450474.7	432126.0	6.0	11.7	11.55	189.1
10	NG Generators	450465.8	432081.4	3.0	12.1	6.51	189.2
11	CO2 Capture	450445.8	432044.3	3.0	33.2	12.35	190.3
12	Odour Control System	450421.4	432091.2	4.0	5.0	21.04	189.4
13	Biomethane Upgrading Plant	450482.9	432094.7	3.0	20.7	11.18	184.1
14	Digestate Lagoon	450374.3	432141.9	4.5	54.1	53.80	189.7

3.9.2 Figure 5 shows a graphical representation of the modelled building layout and the ADMS 6 model input. A 3D image of the model inputs is also shown in Figure 6.

Figure 5: Modelled Building Layout

TBC

Figure 6: 3D Image of Modelled Buildings and Point Sources



3.10 Meteorological Data

3.10.1 Hourly sequential data used in this assessment was obtained from Leeds/Bradford Airport meteorological station, located 30 km northwest of the AD facility at approximate NGR: 423110, 441590. Figure 7 shows the wind roses of utilised meteorological data.

3.10.2 **Figure 7: Meteorological Data**

3.10.3 The application site and meteorological station, both sites are located within similar rural contexts. The choice of this parameter therefore provides a suitable representative of metrological conditions across the modelled domain.

3.11.1 Maximum emissions across the five years of meteorological data (2019 – 2023) were utilised to account for varying meteorological conditions. All meteorological data used in the assessment was provided by ADM Ltd.

3.11 Roughness Length

3.11.2 The specific roughness length (z_0) values specified with ADMS-6 are summarised in Table 9.

Table 9: Utilised Roughness Length

Location	Roughness length (m)	ADMS Description
Application Site and Meteorological Station	0.2	Agricultural (min)

Both the AD facility and meteorological station are located within rural locations and surrounded by agricultural fields. Given the surrounding area is void of significant building

structures, which could increase turbulence, a value of 0.2 m is considered appropriate for the morphology of the assessment area.

3.12 Monin-Obukhov Length

The Monin-Obukhov length values are summarised in Table 10.

Table 10: Utilised Monin-Obukhov Lengths

Location	Monin-Obukhov length (m)	ADMS Description
Application Site and Meteorological Station	10	Small Towns <50,000

3.12.2 The application of Monin-Obukhov values considers the effect of heat production in populated areas which will influence atmospheric stability. The rural context of both the AD facility and meteorological site suggest a stable conditions and a value of 10 m is deemed appropriate.

3.13 Roughness Length

The specific roughness length (z_0) values specified with ADMS-6 are summarised in Table 11.

Table 11: Utilised Roughness Length

Location	Roughness length (m)	ADMS Description
Application Site and Meteorological Station	0.2	Agricultural (max)

3.13.2 Both the AD facility and meteorological station are located within rural locations and surrounded by agricultural fields. Given the surrounding area is void of significant building structures, which could increase turbulence, a value of 0.2 m is considered appropriate for the morphology of the assessment area.

3.14 Monin-Obukhov Length

The Monin-Obukhov length values are summarised in Table 12:.

Table 12: Utilised Monin-Obukhov Lengths

Location	Monin-Obukhov length (m)	ADMS Description
Application Site and Meteorological Station	10	Small Towns <50,000

3.14.3 The application of Monin-Obukhov values considers the effect of heat production in populated areas which will influence atmospheric stability. The rural context of both the AD facility and meteorological site suggest a stable conditions and a value of 10 m is deemed appropriate.

All meteorological data used in the assessment was provided by ADM Ltd.

3.15 Significance of Odour Impacts

The significance of impacts was assessed through the interaction of the predicted 98th%ile of 1-hour mean odour concentrations and receptor sensitivity, as outlined in the IAQM guidance[3]. The relevant assessment matrix for “moderately offensive odours” as defined in Section 2.4 is summarised in Table 10.

Table 13: Odour Impact Descriptors

Odour Exposure Level as 98th%ile of 1-Hour Means (ou_E/m^3)	Receptor Sensitivity		
	Low	Medium	High
Greater than 10	Moderate	Substantial	Substantial

Odour Exposure Level as 98th%ile of 1-Hour Means (ou_E/m^3)	Receptor Sensitivity		
	Low	Medium	High
5 - 10	Slight	Moderate	Moderate
3 - 5	Negligible	Slight	Moderate
1.5 - 3	Negligible	Negligible	Slight
0.5 - 1.5	Negligible	Negligible	Negligible
Less than 0.5	Negligible	Negligible	Negligible

The IAQM guidance states that an assessment must reach a conclusion on the likely significance of the predicted impact. Where the overall effect is moderate or substantial, the effect is likely to be considered significant, whilst if the impact is slight or negligible, the impact is likely to be considered not significant.

3.15.2 It should be noted that this is a binary judgement of either it is significant or it is not significant. This has been considered to determine the overall magnitude of potential odour impacts associated with the facility.

3.15.3

3.16 Modelling Uncertainties

3.16.1 Uncertainty in dispersion modelling predictions can be associated with a variety of factors, including:

- Model uncertainty - due to model limitations;
- Data uncertainty - due to errors in input data, including emission estimates, operational procedures, land use characteristics and meteorology; and
- Variability - randomness of measurements used.

3.16.2 Whilst uncertainty in the model inputs and parameters cannot be fully reduced, the analysis of maximum emissions across the five years of meteorological data (2017 – 2021) provides sensitivity analysis which sufficiently accounts for variations in modelled predictions. Additionally, worse case assumptions regarding the application of emission rates within the model also minimise podetial uncertainties. As such, a sufficient degree of confidence can be placed in the results.

3.17.1

3.17 Dispersion Modelling Report Requirements

Table 14 provides the checklist of dispersion modelling report requirements.

Table 14: Dispersion Modelling Report Requirements

Item	Location within Report
Location map	Figure 1
List of odours modelled and relevant odour guidelines	Section 3.2, Section 2.3 and Section 2.4
Details of modelled scenarios	Section 3.5
Model description and justification	Section 3.3
Special model treatments used	Section 3.0
Table of emission parameters used	Table 4; Table 5
Details of modelled domain and receptors	Section 3.7, Figure 4
Details of meteorological data used	Section 3.10

Item	Location within Report
Details of terrain treatment	Section 3.8
Details of building treatment	Section 3.9, Table 8

4.0 Assessment

4.1 Sensitive Receptor Results

Predicted odour concentrations at receptor locations are summarised in Table 15. Odour concentrations are presented as a 98th%ile of 1-hour mean values over the relevant assessment year. The maximum concentration over the 5 year meteorological dataset has been used to determine the overall assessment significance.

4.1.1 **Table 15: Predicted Odour Concentrations Digestate**

Receptor		Predicted 98th%ile 1-hour Mean Concentration (ou_E/m^3)					
		2019	2020	2021	2022	2023	5-Year Max
HR1	Mill Lane, South Millford	1.31	1.40	1.96	1.81	1.97	1.97
HR2	Craglands, South Millford	0.23	0.19	0.26	0.29	0.28	0.29
HR3	Home Lea Cottage	0.13	0.14	0.14	0.12	0.11	0.14
HR4	22 Milford Road/Primary School	0.10	0.11	0.11	0.09	0.09	0.11
HR5	10 Bartlett View, Sherburn in Elmet	0.22	0.25	0.26	0.22	0.17	0.26
HR6	25 Egremont Place, Sherburn in Elmet	0.37	0.23	0.29	0.34	0.28	0.37
HR7	Saxon Mews, Sherburn in Elmet	0.13	0.12	0.15	0.14	0.15	0.15
HR8	Ashfield	0.07	0.07	0.08	0.07	0.07	0.08
HR9	Lennerton Lodge	0.13	0.10	0.13	0.12	0.15	0.15
HR10	Norden's Barn Farm	0.22	0.18	0.29	0.22	0.21	0.29

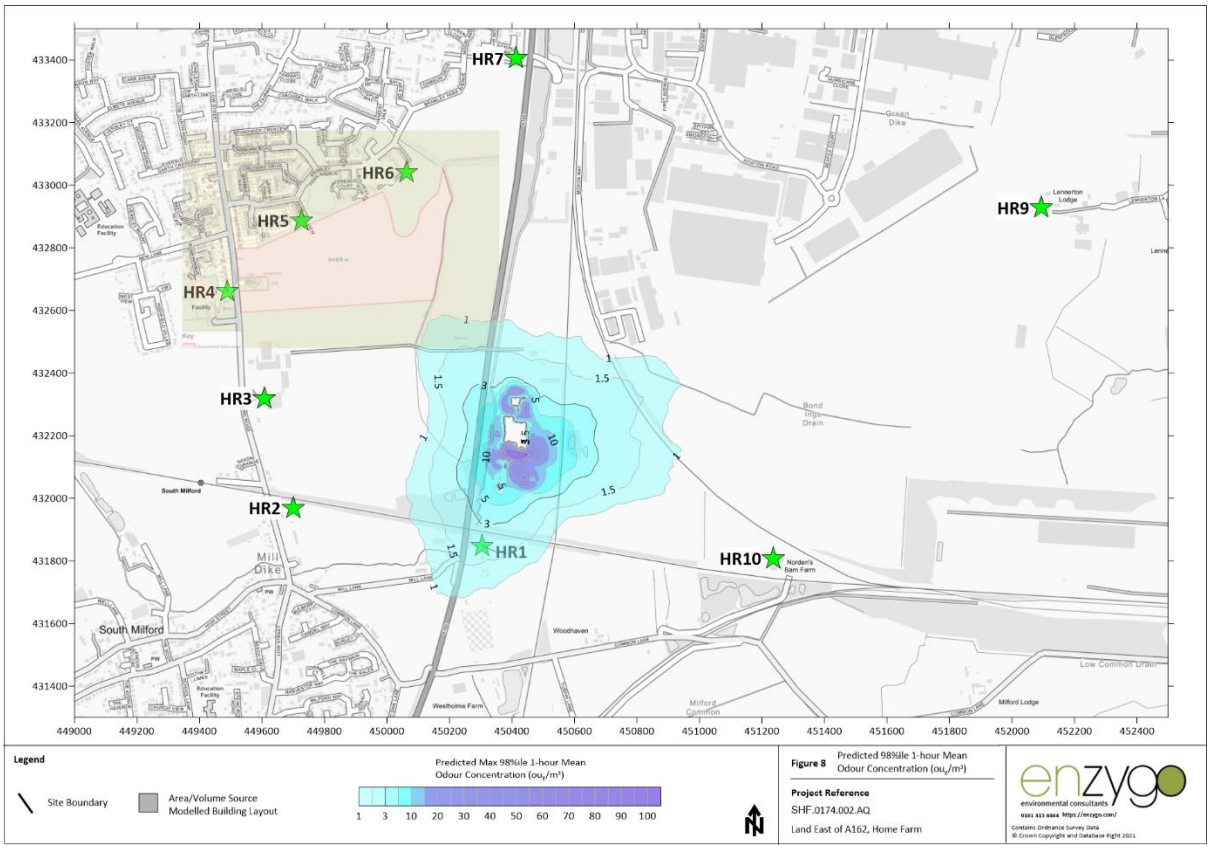
4.1.2 As indicated in Table 15, predicted odour concentrations were below the appropriate odour benchmark of 3.0 ou_E/m^3 at all highly sensitive receptor locations throughout the considered modelling years.

4.1.3 The highest predicted odour concentration was also below 1.97 ou_E/m^3 at Mill Lane South
4.1.4 Milford.

4.1.5 In addition, as robust assumptions have been used for the odour emissions from materials and a maximum 5 year impact produced it is considered that actual odour impacts will normally be less than those predicted in Table 15.

Predicted 5 year maximum 98th %ile odour contours over the study area are represented in Figure 8 and shows that all sensitive locations are not within the maximum 3 ou_E/m^3 contour and no adverse odours would impact on the commercial/industrial areas to the north east of the site.

Figure 8: Predicted Maximum Odour Concentrations



Impact Significance

4.1.6 The significance of predicted odour impacts at the sensitive receptors based on 5-year maximum concentrations is summarised in Table 16. It should be noted that the IAQM guidance[3] has been compiled on the assumption that the odour in question is deemed moderately offensive. As shown in Table 1, odours from the proposed facility would be categorised within the 'moderately offensive' category.

Table 16 Predicted Impact Significance at Receptors

Receptor		Maximum Concentration (ou_E/m^3)	Odour Exposure Range (ou_E/m^3)	Receptor Sensitivity	Significance of Impact
HR1	Mill Lane, South Millford	1.97	1.5 – 3.0	High	Slight
HR2	Craglands, South Millford	0.29	Less than 0.5	High	Negligible
HR3	Home Lea Cottage	0.14	Less than 0.5	High	Negligible
HR4	22 Milford Road/Primary School	0.11	Less than 0.5	High	Negligible
HR5	10 Bartlett View, Sherburn in Elmet	0.26	Less than 0.5	High	Negligible
HR6	25 Egremont Place, Sherburn in Elmet	0.37	Less than 0.5	High	Negligible
HR7	Saxon Mews, Sherburn in Elmet	0.15	Less than 0.5	High	Negligible
HR8	Ashfield	0.08	Less than 0.5	High	Negligible
HR9	Lennerton Lodge	0.15	Less than 0.5	High	Negligible
HR10	Norden's Barn Farm	0.29	Less than 0.5	High	Negligible

As indicated in Table 16, the significance of odour impacts as a result of the AD facility was predicted to be negligible at all sensitive receptor locations. All impacts are also predicted to be below the most sensitive odour benchmark of 1.5 ou_E/m^3.

4.1.7 Based on the assessment results, the overall odour impact associated with the proposed activities are **not significant**, in accordance with the stated methodology and the IAQM impact descriptors listed in Table 13.

4.1.8 In addition, as robust assumptions have been used for the odour emissions from materials and in particular manure, and that some odour sources closest to those most affected will be removed, better contained or moved it is considered that actual maximum odour impacts will be less than those predicted.

4.1.9

5.0 Conclusions

Enzygo Limited was commissioned by Engie Renewable Gas UK Limited to undertake an Odour Assessment to support of the application for the construction and operation of an Agricultural Anaerobic Digestion (AD) Plant on agricultural land to the land east of A162, Low Farm, South Milford, Sherburn in Elmet.

5.1.1 During the operation of the plant there is the potential for impacts at sensitive locations due to odour emissions from a number of sources at the plant. An Odour Assessment was undertaken to consider effects in the vicinity of the site. The emissions from the operation of the proposals will be subject to required controls and emissions limits within the Environmental Permitting regime.

5.1.2 Potential odour emissions were defined based on the proposed plant operation and a review of literature and emissions used at similar facilities. Where appropriate robust assumptions were made to give an increased confidence in the results.

5.1.3 These were represented within a dispersion model produced using ADMS 6 and using 5 years' meteorological data. Impacts at sensitive receptor locations in the vicinity of the site were

5.1.4 quantified, the maximum predicted results compared with the appropriate odour benchmark level.

5.1.5 The proposals will result in the removal or control of other odour sources in the vicinity of the site and the closest sensitive receptors. These potential improvements have not been included within the assessment to provide a robust assessment.

5.1.6 Predicted odour concentrations were below the relevant benchmark level of 3.0 ou_E/m^3 at all sensitive receptors in the vicinity of the site for all modelling years.

5.1.7 In addition, using the IAQM guidance[3] significance criteria, worst case impacts were negligible at all representative sensitive receptors.

5.1.8 As such, given the robust assumptions made for odour emissions, the overall potential for odour impacts generated by the AD facility can be considered as **not significant**, and the AD facility is therefore not considered to represent a constraint to planning permission with regard to odour.

6.0 Abbreviations

%ile	Percentile
AD	Anaerobic Digestion
ADM	Atmospheric Dispersion Modelling
CERC	Cambridge Environmental Research Consultants
CH_4	Methane
CO_2	Carbon Dioxide
CHP	Combined Heating and Power
DEFRA	Department for Environment, Food and Rural Affairs
EA	Environment Agency
EPUK	Environmental Protection UK
FYM	Farmyard Manure
H_2S	Hydrogen Sulphide
IAQM	Institute of Air Quality Management
NGR	National Grid Reference
ou_E	European Odour Unit
z_0	Roughness Length

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