Odour Assessment

An Assessment of the Odour Impact of a Proposed Expansion to the Poultry Unit at Ystym Colwyn Farm, near Meifod in Powys

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Version History

Version	Date	Amendments
Client First Draft	July 2018	-
Final	September 2018	Includes revised IAGM guidance

Summary

ADAS has been commissioned by Roger Parry & Partners LLP to conduct a dispersion modelling study to assess the potential impact of odour emissions from the proposed expansion to an existing poultry unit at Ystym Colwyn Farm, Meifod, Welshpool, Powys, SY22 6XT.

Odour Emissions Rates

Odour emissions from the proposed poultry unit have been assessed and quantified using an emissions 'blueprint' developed by ADAS, the Met Office and the Silsoe Research Institute. The emission figures obtained were then used in atmospheric dispersion modelling to assess the likely impact of odour in the area around the site of the poultry unit.

Guideline Values and Benchmarks

Predicted odour exposures have been compared to benchmarks of 3.0 ou_E/m^3 and 5.0 ou_E/m^3 at the annual 98th percentile. The suggested benchmark has taken account of the Newbiggin standard, the UK Water Industry Research organisation findings and the Environment Agency H4 Odour Management guidance. Results have been interpreted based on the 2018 Institute of Air Quality Management (IAQM) odour guidance.

Dispersion Modelling Methodology

The choice of model for this study is the UK Atmospheric Dispersion Modelling System (ADMS) Version 5.2. Emissions from high velocity ridge mounted fans on the proposed poultry houses have been represented by six point sources per house within the model.

Meteorological data used in this assessment was taken from a Numerical Weather Prediction (NWP) system known as the Global Forecast System (GFS), over the period 1st January 2013 to 31st December 2017 (inclusive).

An additional assessment has been added, as a sensitivity test, using meteorological data derived from the conventional Shawbury Meteorological Station. Ystym Colwyn is located between the meteorological recording stations at Lake Vyrnwy and Shawbury. Although Lake Vrynwy is located slightly closer to Ystym Colwy, the station is at a much higher elevation. Therefore, meteorological data from Shawbury was used for the sensitivity test, although it is noted that the topography area surrounding the Shawbury meteorological station and the site are different. For this reason, and because the GFS weather files better represents low wind speed conditions, the site specific GFS data is primarily relied on in evaluating odour impacts.

Findings

GFS Meteorological Data

The odour dispersion modelling predicted that the five-year maximum annual 98th percentile hourly mean odour concentrations are below the target range of 3.0 to 5.0 ou_E/m^3 and also below the EA's benchmark of 3.0 ou_E/m^3 at all of the identified discrete receptors apart from the farmhouse associated with Ystym Colwyn Farm.

Significance of Effects

The significance of the dispersion modelling results were interpreted using guidance from the IAQM.

The farmhouse associated with Ystym Colwyn Farm, is on a farm, and is therefore categorised as having "low to medium" sensitivity using the IAQM assessment methodology. Therefore **slight adverse** odour effects are predicted at receptor 1. Odour effects at all other discrete receptors are predicted to be either **negligible** or **slight adverse**.

Sensitivity Test with Shawbury Meteorological Data

A sensitivity test using Shawbury meteorological data predicted impacts which were in some cases higher and in other cases lower than the GFS data at different individual discrete receptor locations. There was an exceedance of the higher benchmark of 5.0 ou_E/m^3 at receptor 1 which would equate to a **moderate adverse** effect using the IAQM methodology. However, as a farmhouse on an existing poultry farm, there would be an expectation of some odours. There was also a small exceedance of the 3.0 ou_E/m^3 benchmark on the farm at receptor 7. Receptor 7 is a livestock farm with a farmhouse and is therefore categorised as an IAQM "low to medium" sensitivity receptor, so that the odour effects can be described as **slight adverse**. Effects at all other receptors remain either **slight adverse** or **negligible**.

1 Introduction

ADAS has been commissioned by Roger Parry & Partners LLP to conduct a dispersion modelling study to assess the potential impact of odour emissions from a proposed expansion to an existing poultry unit at Ystym Colwyn Farm, Meifod, Welshpool, Powys, SY22 6XT.

This report presents the results of the odour assessment and the subsequent atmospheric dispersion modelling and provides some commentary on the results.

2 Background

2.1 Site Location and Context

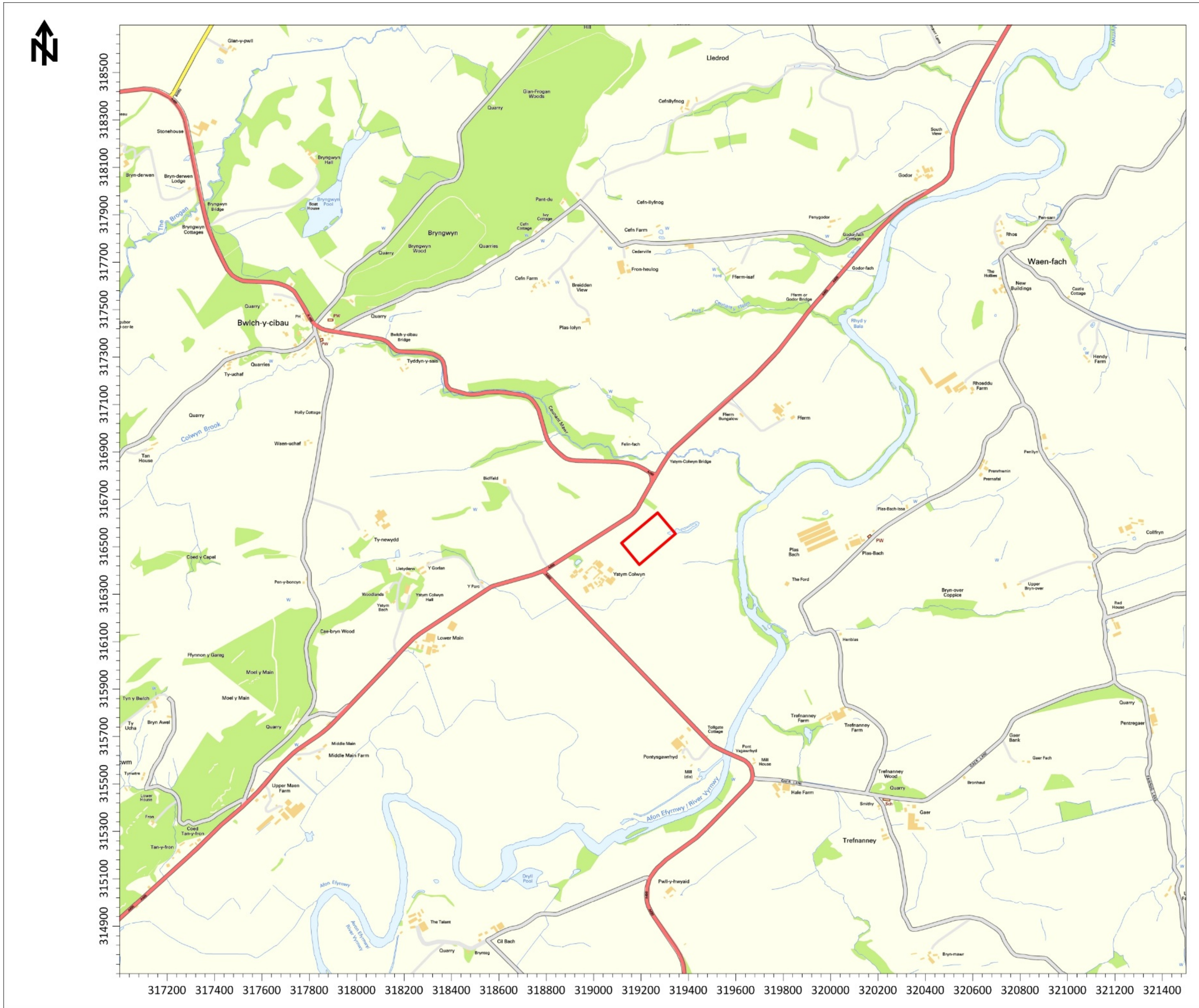
Ystym Colwyn Farm is located in a rural area approximately 4.7 km to the north-east of the village of Meifod in Powys. Ystym Colwyn farm is a large sheep, beef and poultry farm. The existing poultry unit consists of two poultry houses used to rear broilers. The application site is located directly north east of the existing poultry houses. The site is located in the River Vrnwy Valley at an elevation of approximately 87 m, with the ground rising towards the hills in the north.

The local area is predominately rural with a number of ruminant livestock and poultry farms in the area, as well as a number of residential properties scattered around the area. The closest residential property is the Ystym Colwyn farmhouse which is directly associated with the poultry unit. The closest residences not associated with the poultry unit include The Ford, located within 500 m of the application site.

A map of the area surrounding the farm is presented in Figure 1 below.

2.2 The Proposed Development

The proposal involves the construction of four additional poultry houses adjacent to the existing poultry houses. The proposed poultry houses are to be identical to the existing poultry houses, measuring 109.73 x 24.38 m with a ridge height of 5.17m. With the proposed development, the poultry unit would provide accommodation for up to 340,000 birds. The birds would be reared from day old chicks to up to around 38 days old. It is envisaged that approximately 25% of the birds would be removed at day 33 with the remainder removed at day 38. Following depopulation and cleaning out of the poultry houses, there would be an empty period of approximately 10 days.



Legend

Site Location

Title

Figure 1 Site Location

Project

Odour Impact Assessment
Proposed Expansion to the
Poultry Unit at Ystym Colwyn

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3 Odour Emissions and Guidelines

Odour emission rates are expressed as European Odour Units per second (ou_E/s) and odour concentration as European Odour Units per cubic metre of air (ou_E/m^3).

The following descriptions of how odour of certain concentrations might be perceived may be helpful:

- 1.0 ou_E/m^3 – This is defined as the detection limit in the controlled, odour free, conditions of an odour laboratory;
- 2.0 - 3.0 ou_E/m^3 – A particular odour may become just detectable against normal background odour;
- 3.0 - 5.0 ou_E/m^3 – Odour is likely to be detectable and identifiable, but most observers would only describe it as faint;
- 5.0 - 10.0 ou_E/m^3 – Odour levels in this range may start to become annoying, if persistent and/or unpleasant; and
- >10 ou_E/m^3 – Most observers would describe the odour intensity as moderate or strong.

Odour emission rates from poultry houses depend upon the odour concentration within the building and the ventilation rate to the outside atmosphere. Internal odour concentrations depend on many factors including the number of birds housed, building design and management, methods of provision of drinking water, age of the birds and manure management techniques. The minimisation of odour production is addressed by Defra in Section 4 of its Code of Good Agricultural Practice (Defra, 2009) in which paragraphs 229 and 319-328 are especially relevant.

3.1 Sources of Odour from the Proposed Poultry Unit

The proposed poultry houses would be ventilated by uncapped, high velocity, ridge mounted extraction fans, and these fans will therefore be the primary source of odour emissions from the proposed buildings. Since emissions from the high velocity roof fans would not be obstructed by any caps or any other obstacles, this arrangement, with vertical discharge, will optimise dispersion of odours from the proposed poultry houses, especially under low wind speed conditions.

Modern, well-insulated, poultry houses such as those proposed help to minimise odour generation at source through good temperature control and even internal temperature distribution which facilitates good litter management and dry litter conditions. Drinking water would be supplied through low spillage nipple drinkers which have been shown to maintain low litter moisture levels and, as a consequence, to minimise odour emission rates.

No spent litter/manure would be stored on the site as this would be taken away off-site immediately following the poultry house clear out.

3.2 Peak Odour Emissions and Mitigation Measures

Odour emissions can increase during the period when the poultry houses are being cleared of spent floor litter, unless good management practices are deployed. Under the proposal, the poultry houses would be cleared of manure once at the completion of each flock cycle (of 38 days). The time taken to complete the task would normally be less than four hours per house so that any elevated odour emissions are transitory and relatively infrequent. No manure would be stored on site.

Little publicised information exists on the magnitude of odour emission rates during clearing out, and because of the short term duration of these activities it is not feasible to model them and relate the results to accepted odour impact standards. The emissions will be transitory and infrequent in nature, and therefore the output of modelling could not be assessed against conventional 98th percentile impact benchmarks and guidance. For these reasons, it has been concluded that it is not feasible to model odour emissions during the cleaning out of poultry houses. This approach has been supported by planning appeals, in particular the Mapleton Farm appeal (at Horsington in Lincolnshire), where the Planning Inspector considered that modelling emissions during cleaning out was not appropriate. We have seen no guidance or scientific evidence that suggests that the planning and assessment criteria have changed since this planning appeal decision.

Emissions rates are dependent upon management of litter throughout the bird growth cycle so that the litter has low odour potential when it is cleaned out, because good litter management means dry litter which is inherently less odorous than high moisture content litter, and careful management of the cleaning out operation.

Odour management controls should include restricting cleaning out to one poultry house at a time, and using only sufficient ridge fan extract ventilation on that house to draw air inwards through the open doorway so that emissions are dispersed to atmosphere at high level, rather than escaping at low level through the doorway.

The evidence for this recommendation came from odour emission measurements carried out by ADAS on a farm in Worcestershire in June 2014. The measurements were carried out at the end of the crop just two days before de-stocking, and then two days later when one of the sheds was being cleaned out. The shed were of identical size and the findings were:

a) Emission measurements on 18th June 2014 with two buildings fully stocked were 55,200 ou_E/s and 68,000 ou_E/s for sheds 1 and 2 respectively.

b) Odour emissions from Shed 1 were measured two day later on 20th June during cleaning out and emissions were 75,700 ou_E/s with a limited number of ridge fans providing the ventilation.

These measurements demonstrated that, with controlled extraction of the building which is being cleaned out, odour emissions are comparable with those from a single fully stocked shed, and certainly no higher than from two fully stocked sheds.

From these observation it can be concluded that odour emissions during the few hours when cleaning out is being undertaken can be controlled to levels no higher than with normal stocking where there are at least three buildings, and if the following steps are taken:

a) No sheds should cleaned out until at least two sheds have been de-populated of chickens.

b) “Empty” sheds awaiting cleaning out should be ventilated at minimal rates. This is feasible because there is no need to control temperatures for the benefit of chickens when sheds are empty.

c) De-stocked sheds which are being cleaned out should be ventilated only through a controlled number of ridge extraction fans (likely to be around half the total fan capacity) and doors should be kept closed.

Such measures can be readily written into an Odour Management Plan (OMP) and will ensure that total site emissions during cleaning out do not exceed total emissions from the site when the buildings are fully stocked.

With management of cleaning out based on guidance in the Code of Good Agricultural Practice (Defra, 2009) and adoption of an appropriate OMP, odour emissions can be mitigated and minimised during clearing out. In addition to the steps set out above a list of best management practices is included at Appendix 1 of this report, based on the Defra Code of Good Agricultural Practice and additional comment from specialists.

3.3 Estimation of Odour Emission Rates

ADAS, in conjunction with the Silsoe Research Institute and the Met Office, developed an emission 'blueprint' which predicts odour emissions from a wide range of agricultural sources, including poultry farms, that is based on many years of research and measurement.

Emissions from very young birds are insignificant and any odour emitted will be dominated by the smell of wood shavings (from the floor litter). As both the internal odour concentration and the ventilation rate increases with flock age then emissions increase rapidly over time. The rate of odour emission is the product of the ventilation rate and the internal odour concentration.

Internal odour concentrations and emission rates to the outside atmosphere also vary depending on the season of the year. Temperature fluctuations occur between night and day. Therefore, for example, winter night time odour emissions are calculated to be substantially lower than those during the summer.

For broiler chickens, the average summer daytime emission rate in this case, with the proposed stocking regime is estimated to be 0.47 European odour units per bird place per second (ou_E/bird/s). The total average summer daytime odour emission rate from 340,000 broiler chickens at the proposed expanded poultry unit is thus calculated to be approximately 160,004 ou_E/s (approximately 26,667 ou_E/s per house).

3.4 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, as well as local circumstances. This approach forms part of guidance from the Environment Agency (EA) (EA, 2011). In adopting the FIDOR (Frequency, Intensity, Duration, Offensiveness and Receptor) protocol, the EA is recommending an objective methodology for the assessment of odour nuisance. The probability of adverse impacts from odour sources depends on:

- **F**requency of exposure: Complaints are more likely if the frequency of exposure increases.
- **I**ntensity of the odour: There is a greater probability of adverse impact when the odour concentration or impact exceeds a threshold or guideline.
- **D**uration of odour events: Short or fleeting odour events are less likely to cause adverse impact than is a prolonged exposure.
- **O**ffensiveness of the odour: More offensive odours have a higher risk of causing off-site impact.
- **R**eceptor 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, whereas residents of rural areas are more likely to accept agricultural activities and odours as part of their environment. The courts have accepted the principle that sensitivity varies depending on land use (e.g. Hirose Electrical vs Peak Ingredients) to the extent that, for example, industrial areas are accepted to be less sensitive than residential areas. In this specific case a number of the surrounding properties are farms or linked to agricultural businesses.

The implications of the FIDOR criterion have been recognised in the Institute of Air Quality Management (IAQM) "Guidance on the assessment of odour for planning" and particularly in the latest revision (version 1.1, July 2018). This guidance, which has been prepared by a group of air and odour quality specialists, is based on industry experience and research findings and currently represents the most authoritative guidance in relation to the interpretation of odour modelling.

3.5 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 dependent on 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 lapse rate, or 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:** Generally 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.

3.6 Odour Impact Standards or Benchmarks

Minimising waste and pollution is a key component of the National Planning Policy Framework (DLGC, 2012). There is no specific guidance for odour; however, odour is defined as pollution within the framework and cited as a potential planning concern in the Planning Practice Guidance (DLGC, 2014). 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).

Since the early 1990s the technique of odour dispersion modelling has become well established as a means of assessing the off-site odour impact of a very wide range of odorous activities and particularly sewage/wastewater and intensive livestock farming (poultry and pigs). Odour impact benchmark levels have been developed as a matter of “custom and practice”, of which the best established is the so-called “Newbiggin” standard.

The widely accepted convention in the UK is that odour impacts are expressed as 98th percentile hourly means, and these standards have been based on “dose-response” relationships which take account of normal temporal and metrological variations in downwind/off-site odour impacts.

3.6.1 The Newbiggin Standard

This empirical standard, of 5.0 ou/m^3 at the 98th percentile, has been widely used in the intensive livestock and wastewater (sewage) sectors in the UK and elsewhere, to assess the likelihood of community annoyance. This standard was derived from an early 1990’s planning appeal decision relating to an appeal by Northumberland Water for the construction of a wastewater treatment facility at Newbiggin-by-the-Sea in Northumberland in which evidence on potential off-site odour impacts was presented using odour dispersion modelling. The decision in this appeal case was the origin of the now well-established “Newbiggin” criterion that has been used, and it is still used to this day, for odour impact assessments, although there is more recent guidance provided by the EA for larger pig and poultry farming installations.

3.6.2 UKWIR Research

In 2001 the UK Water industry Research (UKWIR) organisation undertook research into correlations between (dispersion) modelled odour impact and the distribution of odour complaints around wastewater (sewage) treatment works. The findings of this work were concisely summarised in a Chartered Institute of Water and Environmental Management (CIWEM) document:

> *"The main source of research into odour impacts in the UK has been the wastewater industry and the most in-depth study published study in the UK of the correlation between of modelled odour impacts and human response (dose-effect) was published by UK Water industry Research (UKWIR) in 2001. This was based on a review of the correlation between reported odour complaints and modelled odour impacts in relation to 9 wastewater treatment works in the UK with ongoing odour complaints. The findings of this research (and subsequent UKWIR research) indicated the following:*
>
> *At modelled exposures of below C98, 1-hour 5ou_E/m^3, complaints are relatively rare, at only 3% of the total registered;*
>
> *At modelled exposures between C98, 1-hour 5ou_E/m^3 and C98, 1-hour 10ou_E/m^3, a significant proportion of total registered complaints occur; 38% of the total;*
>
> *The majority of complaints occur in areas of modelled exposure greater than C98, 1-hour 10ou_E/m^3, 59% of the total." (CIWEM, 2012)*

In effect these findings demonstrated that with appropriate modelling, potential odour impact and annoyance is effectively controlled at 98th percentile hourly mean odour impacts of 5.0 ou_E/m^3 or less. These findings are consistent with the Newbiggin standard and ADAS experience of correlating odour impacts/complaints (and the absence of complaints) with dispersion modelling results.

3.6.3 H4 Odour Guidance

The EA published guidelines on odour regulation, assessment and control (H4: Odour Management) in March 2011. This EA guidance is specifically aimed at Environmental Permitting Regulations (EPR) permitted installations. Natural Resources Wales (NRW) adopted the guidance to NRW in 2014 although it seems that this version did not include the appendices.

Odour detection thresholds and consideration of whether or not an odour is offensive are discussed in Appendix 2 of the H4 guidance. In Appendix 3 (of H4), 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 ou_E/m^3 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 ou_E/m^3 is not exceeded on more than 2% of occasions. For moderately offensive and highly offensive odours, the equivalent threshold values are 3.0 ou_E/m^3 and 1.5 ou_E/m^3 respectively.

Odours from livestock housing are placed in the moderately offensive category and the target suggested in H4 for moderately offensive odours is an hourly mean odour concentration of 3.0 ou_E/m^3 at the 98th percentile. The H4 guidance only recognises 98th percentile guideline values and this document provides the most relevant and authoritative guidance on the use of percentile values.

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". ADAS has used the 98th percentile of the hourly mean odour concentrations over a five year period to provide statistically robust results, smoothing out inter-annual variations as set out in H4, as well as presenting data for individual years.

3.6.4 IAQM Odour Guidance

Section 5 of the latest revision (version 1.1, July 2018) of the IAQM "Guidance on the assessment of odour for planning" provides a review of odour impact benchmarks and concludes this review with two tables setting out odour effect descriptors for most offensive odours and moderately offensive odours. In accordance with the H4 guidance, Table 7 is most relevant to intensive farming odours and it is reproduced below. This table takes account of the sensitivity of the receptors as well as the predicted impacts, as suggested in the H4 guidance under the FIDOR acronym.

Table 7: Proposed odour effect descriptors for impacts predicted by modelling – "Moderately Offensive" odours

Odour Exposure Level C_{98}, ou_E/m^3	Receptor Sensitivity		
	Low	Medium	High
≥10	Moderate	Substantial	Substantial
5-<10	Slight	Moderate	Moderate
3-<5	Negligible	Slight	Moderate
1.5-<3	Negligible	Negligible	Slight
0.5-<1.5	Negligible	Negligible	Negligible
<0.5	Negligible	Negligible	Negligible

It should be noted that the Table applies equally to cases where there are increases and decreases in odour exposure as a result of this development, in which case the appropriate terms "adverse" or "beneficial "should be added to the descriptors.

3.6.5 Suggested Odour Benchmarks

ADAS has generally found that a range of "biological" odours, including those from livestock housing, are unlikely to cause unacceptable off-site impacts with annual 98th percentile odour concentrations of less than 5 ou_E/m^3. However, as exposure exceeds 5 ou_E/m^3 at the annual 98th percentile, there is an increasing risk of annoyance, and above 10 ou_E/m^3 (at the annual 98th percentile), some adverse impact might be expected. These observations are consistent with an empirical standard of 5 ou_E/m^3 at the annual 98th percentile, used in the landfill and wastewater industries in the UK and elsewhere, to assess the likelihood of community annoyance.

When assessing the impact of odours it is important to take account of the nature of receptors in the area. For example, it has been accepted by the Courts that industrial areas are less "sensitive" to odours than residential areas (for example as in Hirose Electrical vs Peak Ingredients). It is therefore suggested that taking account of the Newbiggin standard, the UKWIR research findings and the H4 guidance, it is reasonable to assess odour impacts against a benchmark range of 3.0 ou_E/m^3 to 5.0 ou_E/m^3 in predominantly agricultural areas. In this specific case a number of the surrounding properties are farms or are linked to agricultural businesses and this has been taken account of in the assessment of the significance of odour impacts in Table 5 below using the IAQM methodology (and specifically the IAQM Table 7 as reproduced above).

It should be noted that the prediction that any particular property lies above the guideline concentrations 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 exceedance of the guideline.

3.7 Assessment of Significance

In accordance with the IAQM guidance (Bull et. al, v1.1, July 2018) on the assessment of odour, the significance of odour effects can be assessed in relation to the magnitude of the impact and the sensitivity of the receptor. The magnitude scale has been developed based on the suggested odour benchmarks above for odours in the moderately offensive category. The magnitude is combined with the receptor sensitivity to determine the significance of the impact as shown in Table 1.

It is important to note, however, that there is relatively limited evidence of the dose related odour impact in the community and therefore assigning significance is not as straightforward as simply following the matrix in Table 1. Although the matrix acts as a guide, professional judgement still needs to be used to take into account various factors such as a community's existing tolerance of odours.

Table 1. Matrix for Assessing the Significance of Impacts Predicted by Modelling

Odour Exposure Level C_{98}, ou_E/m^3	Receptor Sensitivity		
	Low	Medium	High
>10	Moderate	Substantial	Substantial
5 – 10	Slight	Moderate	Moderate
3 – 5	Negligible	Slight	Moderate
1.5 – 3	Negligible	Negligible	Slight
0.5 – 1.5	Negligible	Negligible	Negligible
<0.5	Negligible	Negligible	Negligible

4 Dispersion Modelling Methodology

4.1 Model Description

The choice of model used in this study is UK Atmospheric Dispersion Modelling System (ADMS) Version 5.2. 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 5.2 is one of the few models capable of simulating all the important atmospheric processes. 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 1 m. If necessary, the model also incorporates the effects of buildings on the pollutant plume, known as building downwash, and that effect has been included in this study.

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[1].

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 (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

It is acknowledged that there are difficulties in sourcing representative weather data for this area using conventional weather recording stations. The meteorological data used in this study is obtained from assimilation and short term forecast fields of the Numerical Weather Prediction (NWP) system known as the Global Forecast System (GFS).

The GFS is a spectral model and data are archived at a horizontal resolution of 0.25 degrees, which is approximately 25 km over the UK (formerly 0.5 degrees, or approximately 50 km). The GFS resolution adequately captures major topographical features and the broad-scale characteristics of the weather over the UK. Smaller scale topographical features may be included in the dispersion modelling by using the flow field module of ADMS (FLOWSTAR). The wind rose for the weather file, derived from data from the GFS data is shown in Figure 2a. This shows the direction FROM which winds blows and illustrates the relative frequency of wind directions and wind speeds used in the modelling study.

In addition, a sensitivity test was carried out using meteorological data from a conventional Met Office weather recording station. Ystym Colwyn is located between the meteorological recording stations at Lake Vyrnwy and Shawbury. Although Lake Vrynwy is located slightly closer to Ystym Colwy, the station is at a much higher elevation. Therefore, meteorological data from Shawbury was used for the sensitivity test, although it is noted that the topography area surrounding the Shawbury meteorological station and the site are different. For this reason, and because the GFS weather files better represents low wind speed conditions, the site specific GFS data is primarily relied on in evaluating odour impacts The wind rose for the weather file, derived from data from Shawbury (2013 - 2017), is shown in Figure 2b.

[1] http://www.cerc.co.uk/environmental-software/model-validation.html

Figure 2a. Wind Rose Derived from GFS Data 52.740 N, -3.198 W (2013 - 2017)

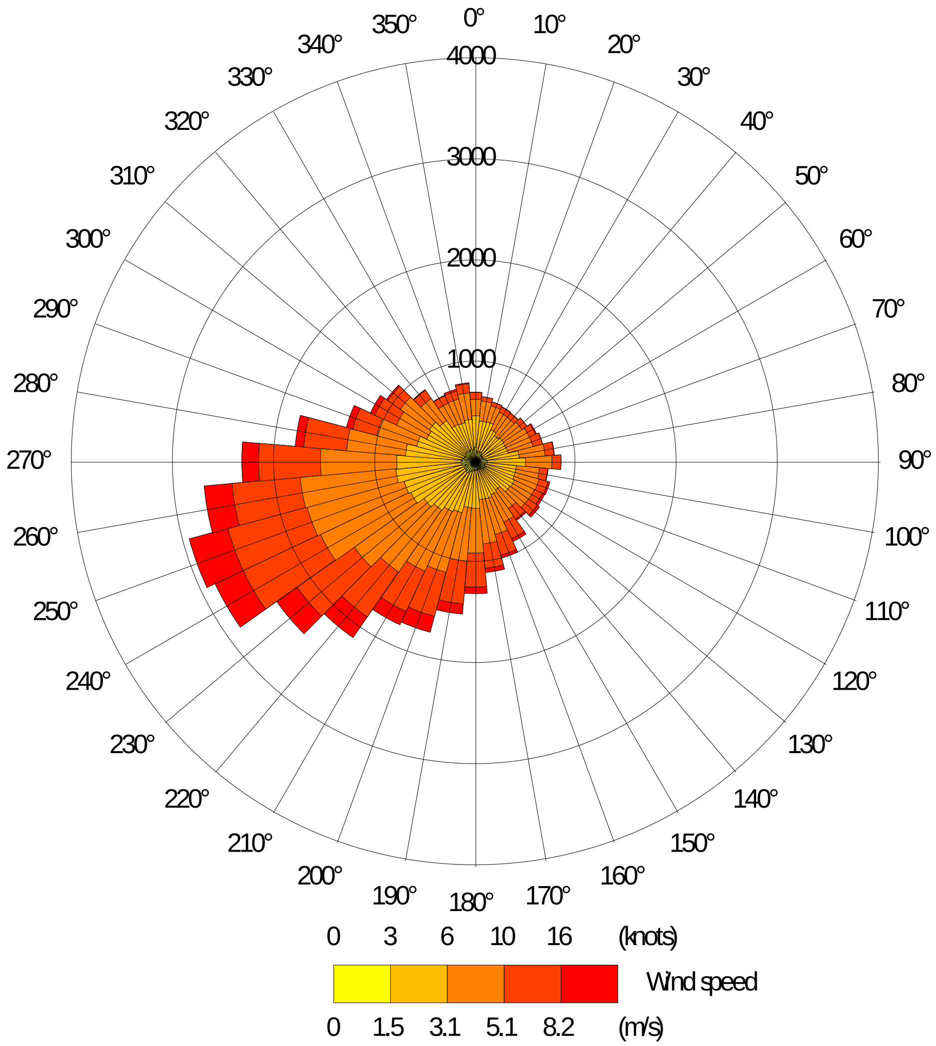
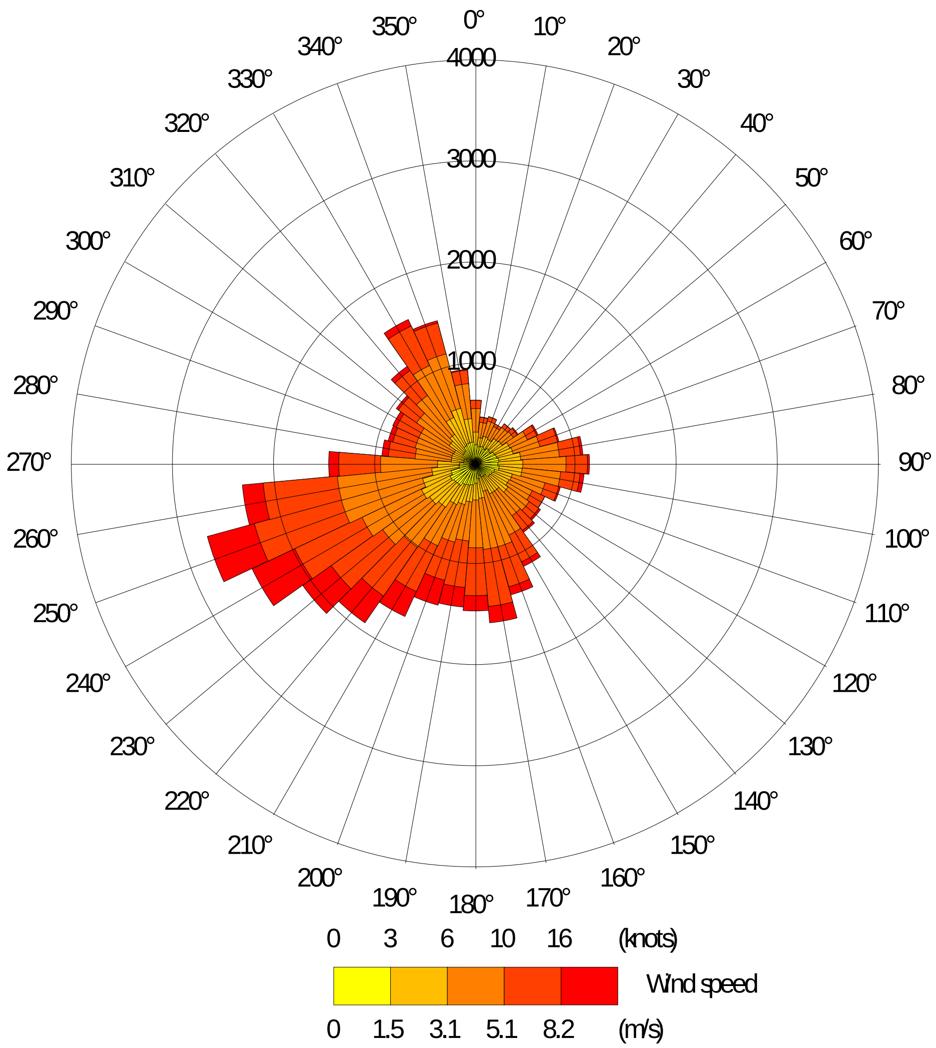


Figure 2b. Wind Rose Derived from Data from Shawbury (2013 - 2017)



4.3 Model Parameters

4.3.1 Odour Emissions

Emissions from the high velocity ridge mounted fans are represented by six point sources per poultry house within ADMS. Details of the point sources are provided in Table 2 below. The figures presented represent the average of summer daytime emission rates through the growing cycle, and they are varied seasonally and diurnally within ADMS.

The positions of the modelled sources can be seen in Figure 3, where the point sources are depicted as red stars.

Table 2. Point Source Parameters

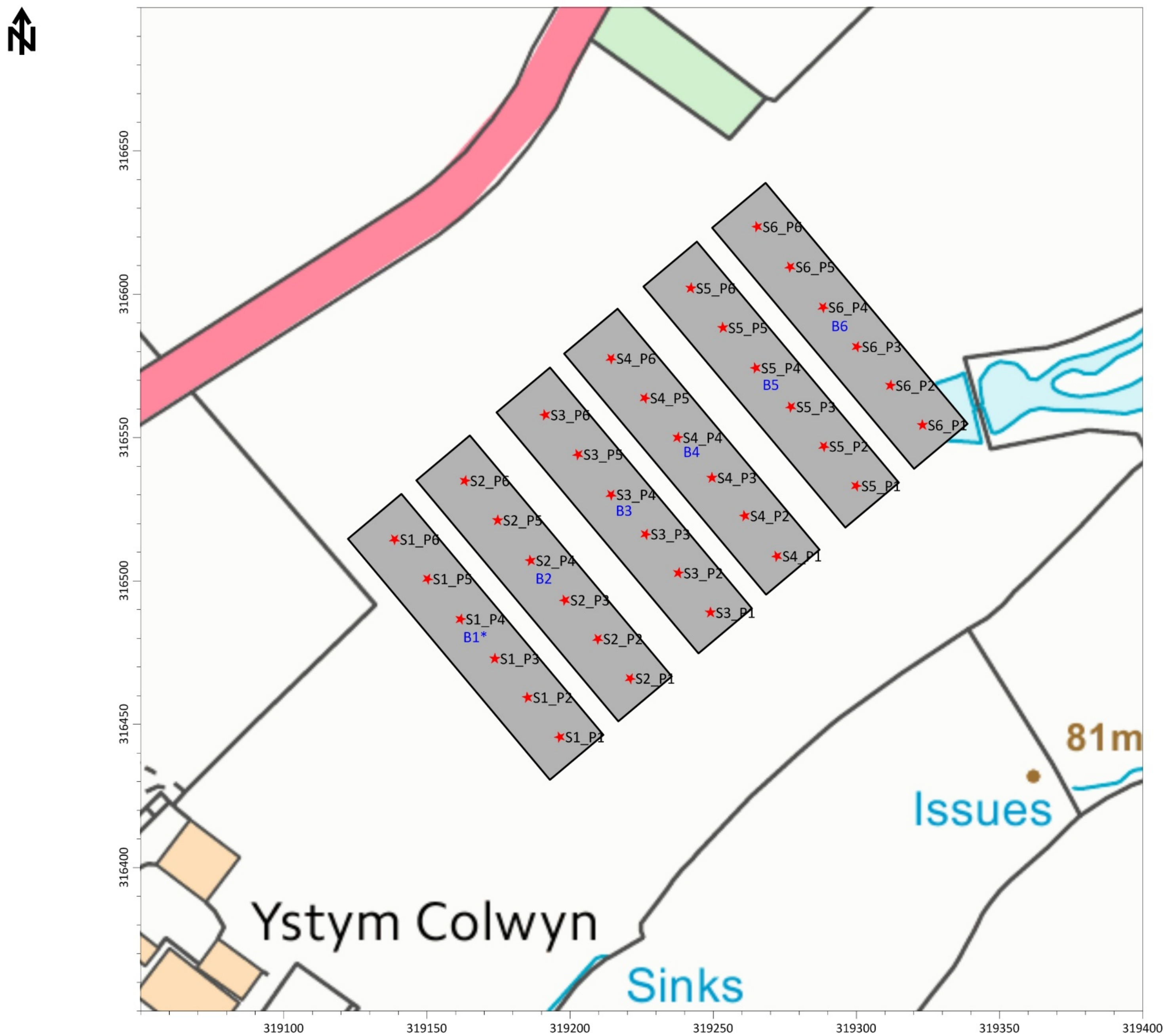
Poultry House	Source ID	Height (m)	Diameter (m)	Efflux Velocity (m/s)	Temperature	Specific Emission (per fan) (ou_E/s)
Poultry house 1 (existing)	S1_P1, S1_P2, S1_P3, S1_P4, S1_P5, S1_P6	5.5	0.8	10	22	4,444.58
Poultry house 2 (existing)	S2_P1, S2_P2, S2_P3, S2_P4, S2_P5, S2_P6	5.5	0.8	10	22	4,444.58
Poultry house 3 (proposed)	S3_P1, S3_P2, S3_P3, S3_P4, S3_P5, S3_P6	5.5	0.8	10	22	4,444.58
Poultry house 4 (proposed)	S4_P1, S4_P2, S4_P3, S4_P4, S4_P5, S4_P6	5.5	0.8	10	22	4,444.58
Poultry house 5 (proposed)	S5_P1, S5_P2, S5_P3, S5_P4, S5_P5, S5_P6	5.5	0.8	10	22	4,444.58
Poultry house 6 (proposed)	S6_P1, S6_P2, S6_P3, S6_P4, S6_P5, S6_P6	5.5	0.8	10	22	4,444.58

4.3.2 Buildings

The structure of the poultry houses will have some effect on the behaviour of the odour plumes from the point sources representing the high velocity ridge extraction fans. Therefore, the proposed poultry houses are modelled as rectangular blocks within ADMS. The building details are provided in Table 3 and the location of the modelled buildings is shown in Figure 3, where they are marked by grey rectangles.

Table 3. Building Details included in the Model

Building	Building ID	Grid Ref.	Length (m)	Width (m)	Height (m)	Angle (°)
Poultry house 1 (existing)	B1	319167.0, 316480.5	109.73	24.38	5.17	230
Poultry house 2 (existing)	B2	319190.9, 316500.9	109.73	24.38	5.17	230
Poultry house 3 (proposed)	B3	319218.9, 316524.6	109.73	24.38	5.17	230
Poultry house 4 (proposed)	B4	319242.5, 316545.1	109.73	24.38	5.17	230
Poultry house 5 (proposed)	B5	319270.2, 316568.5	109.73	24.38	5.17	230
Poultry house 6 (proposed)	B6	319294.2, 316589.0	109.73	24.38	5.17	230



Legend

★ Point Source

Building

Title

Figure 3 Position of Modelled Sources and Buildings

Project

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Client

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4.3.1 Terrain and Surface Roughness Length

The surrounding areas include slopes greater than 1:10 so that these features could affect local wind flows. Therefore terrain data has been used within ADMS. The terrain data is based on Ordnance Survey OS Terrain 50, a 50 m resolution Digital Terrain Model.

A fixed surface roughness length of 0.25 m has been assumed for the entire modelling domain to reflect the agricultural land surrounding the site. This value is considered appropriate for the morphology of the assessment area and is between the values suggested within ADMS 5.2 for 'agricultural areas (min)' and 'agricultural areas (max)'. The GFS meteorological data is assumed to have a roughness length of 0.225 m. The effect of the difference in roughness length is precautionary as it increases the frequency of low wind speeds and the stability and therefore increases predicted ground level concentrations.

4.3.2 Discrete Receptor Points

Sixteen receptor points have been defined within the model to represent a selection of nearby residential properties. These discrete receptors are defined at 1.5 m above ground level and their positions are shown in Figure 4. The exact positions of the discrete receptors are given, as national grid coordinates, in Table 4, in Section 5.

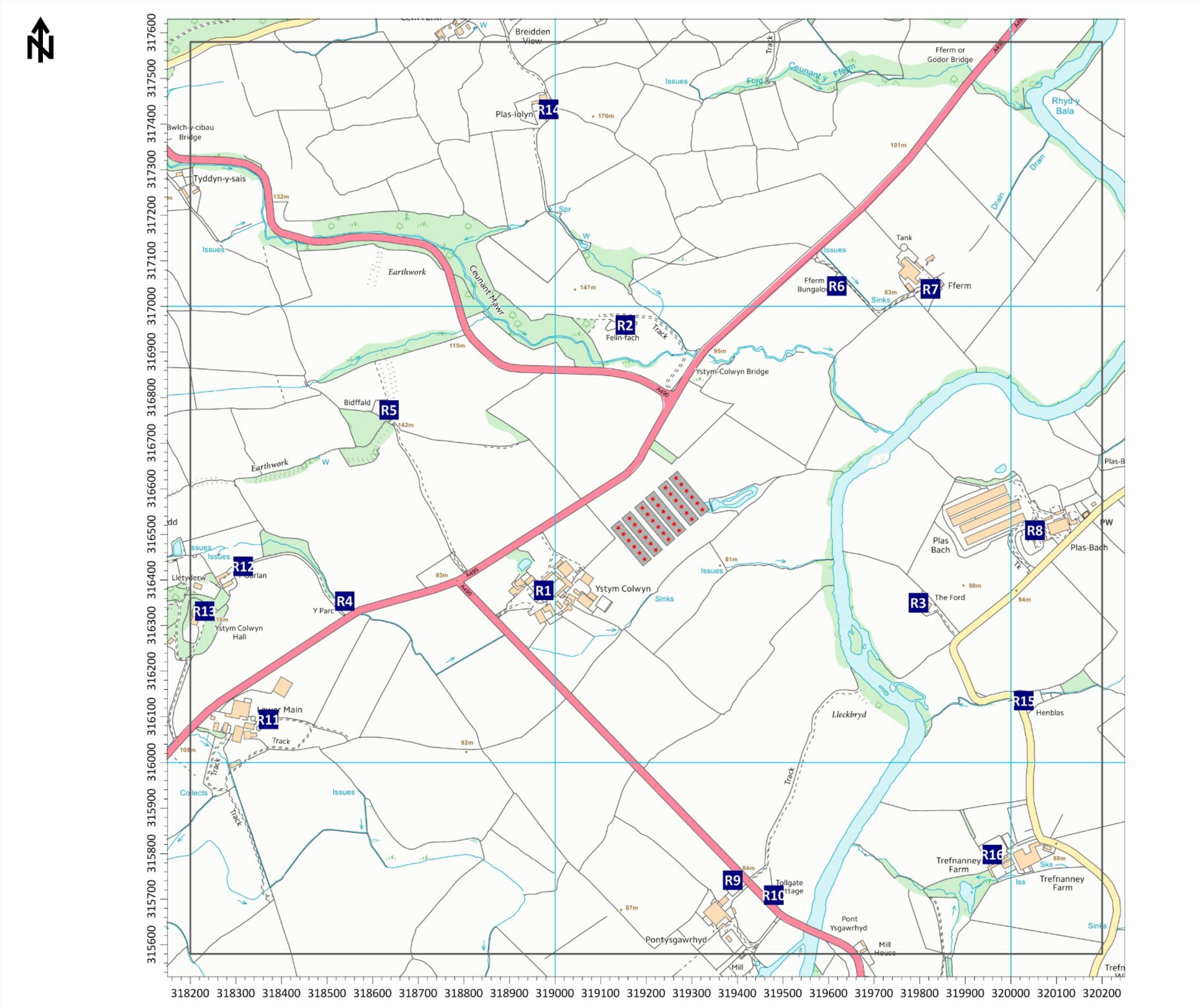
4.3.3 The Regular Cartesian Grid

A 2 km by 2 km regular Cartesian grid at 10 m resolution has been used to produce the contour map presented in the results of this study. The grid points are defined at a height of 1.5 m above ground level within ADMS 5.2. The extent of the grid is shown in Figure 4.

4.4 Uncertainties and Assumptions

The following uncertainties and assumptions have been made in the odour assessment:

- There will be uncertainties introduced because the modelling has simplified real-world processes into a series of algorithms. Furthermore, it has been assumed that the subsequent dispersion of odour will conform to a Gaussian distribution in order to simplify the real-world dilution and dispersion conditions; and,
- There is an element of uncertainty in all measured and modelled data. All values presented in this report are based on "best" estimates.



Title

Figure 4 Discrete Receptor Points and the Regular Cartesian Grid used in ADMS

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5 Modelling Results

ADMS calculates hourly mean odour concentrations at the regular Cartesian 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 maximum annual 98th percentile hourly mean odour concentrations. That is, the odour concentration which is exceeded for only 2% of all hours (around 14 hours per month on average).

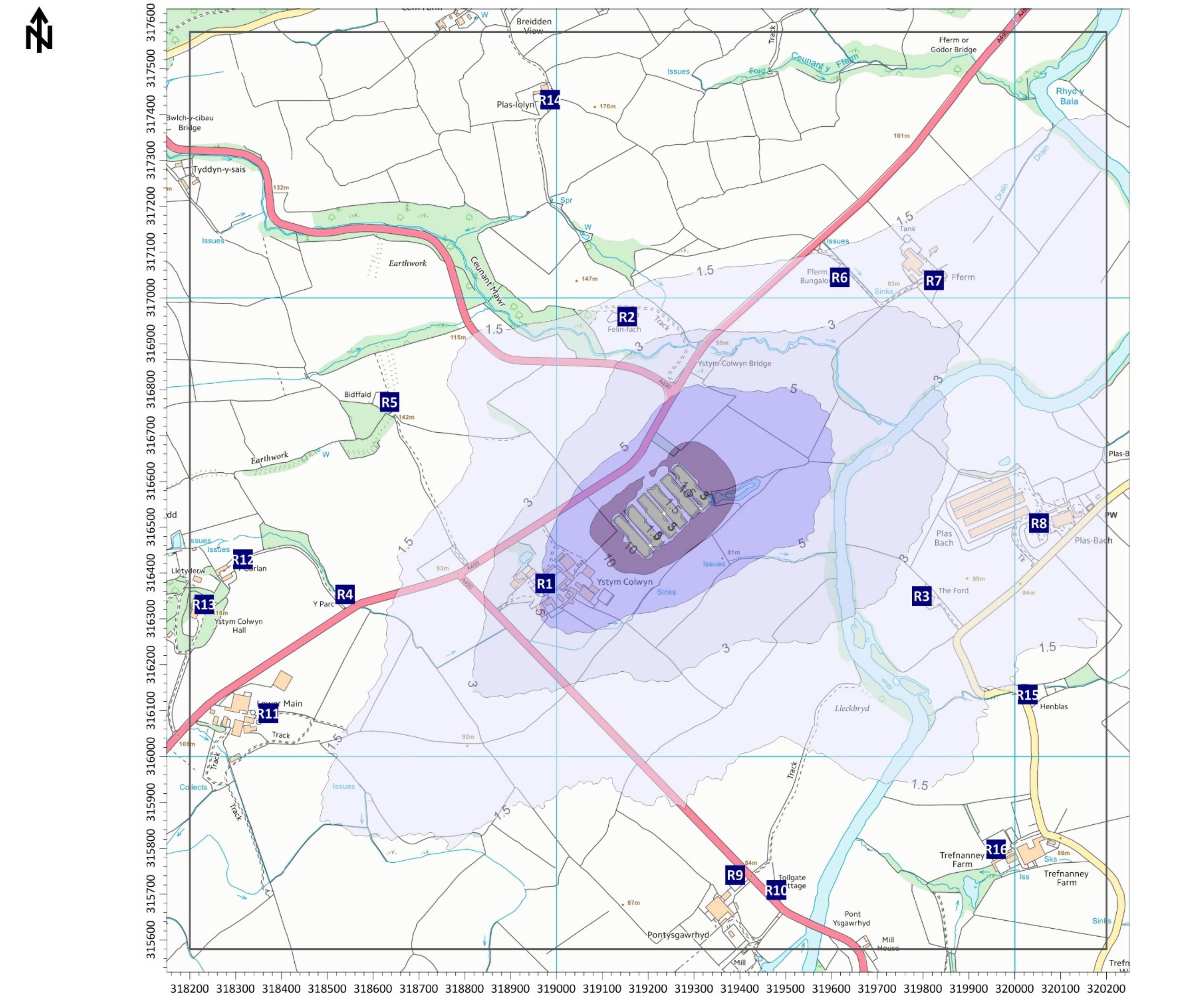
Five runs, one for each year in the meteorological record (2013 – 2017) were performed for both the GFS meteorological data and for the sensitivity test with the Shawbury meteorological data. For each discrete receptor, the predicted five-year maximum annual 98th percentile hourly mean odour concentrations are shown in Table 4. A contour plot of the predicted five-year maximum 98th percentile concentrations at all grid points in the area surrounding the farm is shown in Figure 5a. The annual 98th percentile hourly mean odour concentrations for each year of the meteorological file are provided in Appendix 1.

The predicted five-year maximum annual 98th percentile hourly mean odour concentrations are below the target range of 3.0 to 5.0 ou_E/m^3 and also below the EA's benchmark of 3.0 ou_E/m^3 at all of the identified discrete receptors apart from receptor 1, which is the farmhouse associated with Ystym Colwyn Farm.

The sensitivity test using the Shawbury meteorological data predicted impacts which were in some cases higher and in other cases lower than the GFS data at different individual discrete receptor locations. There was an exceedance of the higher benchmark of 5.0 ou_E/m^3 at receptor 1 and a small exceedance of the EA's benchmark of 3.0 ou_E/m^3 at receptor 7.

Table 4. Predicted Five-Year Maximum Annual 98th Percentile Hourly Mean Odour Concentrations at the Discrete Receptors

Receptor number	Receptors	National Grid Coordinates		5-Year Maximum Annual 98th Percentile Hourly Mean Odour Concentration (ou_E/m^3)	
		X (m)	Y (m)	GFS	Shawbury
R1	Ystym Colwyn Farmhouse	318975	316377	4.95	8.91
R2	Felin-Fach	319154	316959	2.01	2.36
R3	The Ford	319797	316350	2.38	1.41
R4	Y Parc	318539	316354	1.10	1.58
R5	Bidffold	318636	316773	0.98	0.99
R6	Fferm Bungalow	319618	317045	2.03	2.90
R7	Fferm	319824	317038	2.59	3.43
R8	Plas Bach	320053	316509	2.03	1.14
R9	Pontysgawrhyd	319390	315742	1.02	1.84
R10	Tollgate Cottage	319480	315709	0.87	1.77
R11	Lower Main	318371	316094	0.86	1.27
R12	Y Gorlan	318316	316430	0.70	0.83
R13	Ystym Colwyn Hall	318231	316332	0.58	0.71
R14	Plas-Lolyn	318986	317432	0.53	0.58
R15	Henblas	320028	316135	1.46	0.97
R16	Trefnanney Farm	319959	315798	1.18	0.85



Legend

Receptors

Predicted Maximum 98th Percentile Hourly Mean Odour Concentration (ou_E/m^3)

10
5
3
1.5

Title

Figure 5a Five-Year Maximum Annual 98th Percentile Hourly Mean Odour Concentrations (2013 - 2017)
GFS

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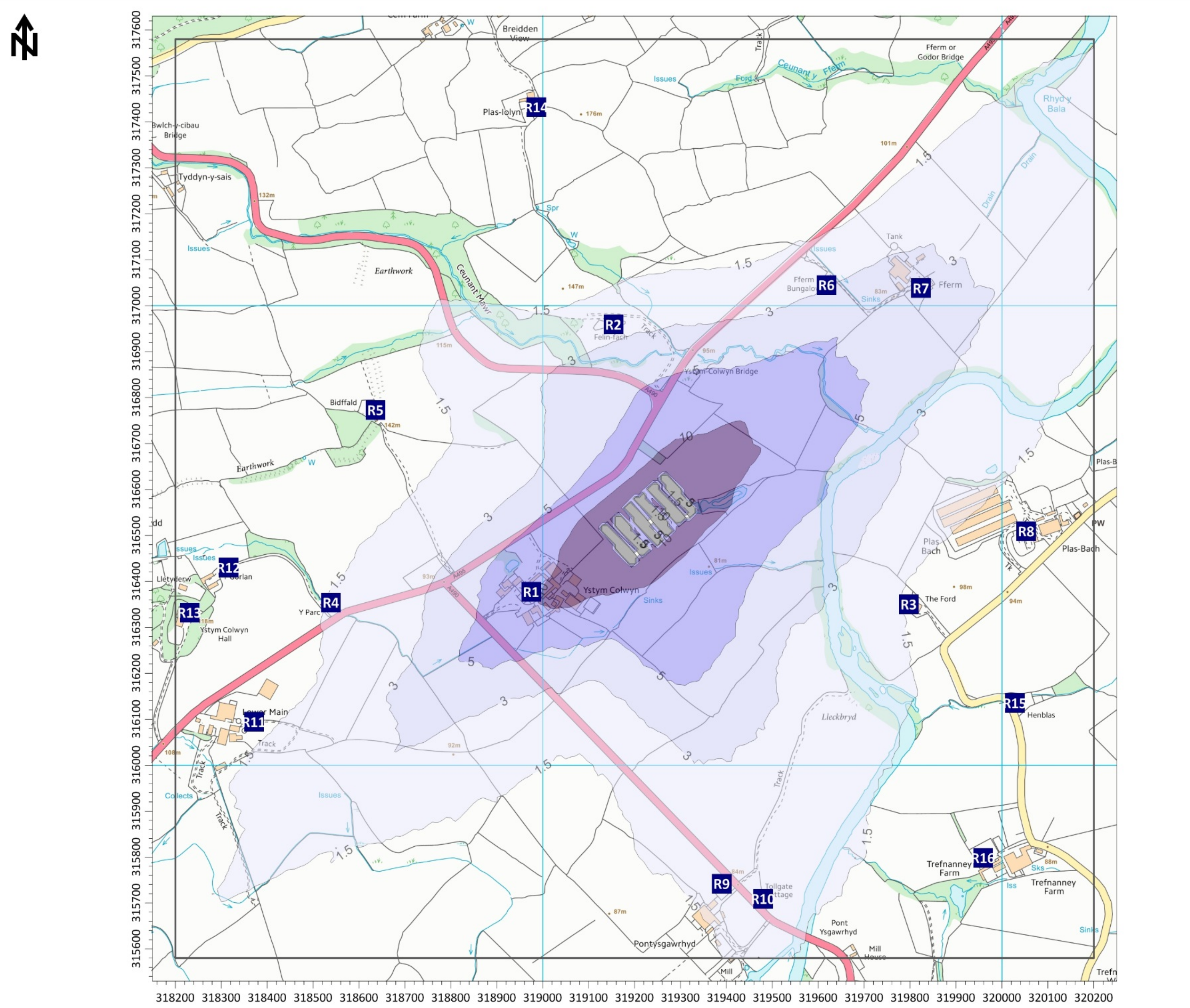

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Receptors

Predicted Maximum 98th Percentile Hourly Mean Odour Concentration (ou_E/m^3)

10
5
3
1.5

Title

Figure 5b Five-Year Maximum Annual 98th Percentile Hourly Mean Odour Concentrations (2013 - 2017) Shawbury

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6 Assessment of the Significance of Odour Impact

An assessment of the significance of the odour impact at each receptor using the IAQM criterion and modelling results from the GFS weather file modelling is included below in Table 5. This assessment is based on the "sensitivity" descriptors derived in Table 6, which has been complied based on evidence provided by the client and using the guidance in Table 2 of the IAQM guidance.

'Slight' adverse effects are predicted at receptor 1 and at two other receptors. Effects at all other receptors are predicted to be negligible.

Table 5. Significance of Estimated Odour Emissions at Surrounding Receptors with GFS Weather Data

Receptor number	Receptors	Sensitivity	5-Year Maximum Annual 98th Percentile Hourly Mean Odour Concentration (ou_E/m^3) with GFS	Significance
R1	Ystym Colwyn Farmhouse	Low/Medium	4.95	Slight
R2	Felin-Fach	Low	2.01	Negligible
R3	The Ford	High	2.38	Slight
R4	Y Parc	Medium/High	1.10	Negligible
R5	Bidffold	High	0.98	Negligible
R6	Fferm Bungalow	High	2.03	Slight
R7	Fferm	Low/Medium	2.59	Negligible
R8	Plas Bach	Low	2.03	Negligible
R9	Pontysgawrhyd	High	1.02	Negligible
R10	Tollgate Cottage	High	0.87	Negligible
R11	Lower Main	Low/Medium	0.86	Negligible
R12	Y Gorlan	High	0.70	Negligible
R13	Ystym Colwyn Hall	High	0.58	Negligible
R14	Plas-Lolyn	High	0.53	Negligible
R15	Henblas	High	1.46	Negligible
R16	Trefnanney Farm	Low/Medium	1.18	Negligible

Table 6. Sensitivity Allocations of Surrounding Receptors

Receptor number	Receptors	Allocated Sensitivity	Comments/Justification
R1	Ystym Colwyn Farmhouse	Low/Medium	Farmhouse with occupier managing the poultry unit
R2	Felin-Fach	Low	Field barn with no consent for residential development
R3	The Ford	High	Dwelling
R4	Y Parc	Medium/High	Dwelling with agricultural occupancy condition
R5	Bidffold	High	Dwelling
R6	Fferm Bungalow	High	Agricultural workers bungalow
R7	Fferm	Low/Medium	Farmhouse on farm with slurry & silage facilities
R8	Plas Bach	Low	Established poultry farm
R9	Pontysgawrhyd	High	Dwelling adjacent to farm
R10	Tollgate Cottage	High	Dwelling adjacent to farm
R11	Lower Main	Low/Medium	Farm and farmhouse
R12	Y Gorlan	High	Dwelling
R13	Ystym Colwyn Hall	High	Dwelling
R14	Plas-Lolyn	High	Dwelling
R15	Henblas	High	Dwelling
R16	Trefnanney Farm	Low/Medium	Livestock Farm and farmhouse

7. Summary and Conclusions

ADAS has been commissioned by Roger Parry & Partners LLP to conduct a dispersion modelling study to assess the potential impact of odour emissions from a proposed expansion to an existing poultry unit at Ystym Colwyn Farm, Meifod, Welshpool, Powys, SY22 6XT.

The odour dispersion modelling using site specific GFS weather files predicted that the five-year maximum annual 98th percentile hourly mean odour concentrations are below the target range of 3.0 to 5.0 ou_E/m^3 and also below the EA's benchmark of 3.0 ou_E/m^3 at all of the identified discrete receptors apart from receptor 1, which is the farmhouse associated with Ystym Colwyn Farm. This property is on a farm, and can therefore be categorised as having "low to medium" sensitivity using the IAQM assessment methodology. Therefore slight adverse odour effects are predicted at receptor 1 with all other odour effects at discrete receptors predicted to be either negligible or slight adverse.

A sensitivity test using Shawbury meteorological data predicted impacts which were in some cases higher and in other cases lower than the GFS data at different individual discrete receptor locations. There was an exceedance of the higher benchmark of 5.0 ou_E/m^3 at receptor 1 which would equate to a moderate adverse effect using the IAQM methodology. However, as a farmhouse on an existing poultry farm, there would be an expectation of some odours. There is also a small exceedance of the 3.0 ou_E/m^3 benchmark on a farm at receptor 7. Receptor 7 is a livestock farm with a farmhouse and is therefore categorised as an IAQM "low to medium" sensitivity receptor, so that the odour effects can be described as slight adverse. Effects at all other receptors remain either slight adverse or negligible.

7 References

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Appendix 1: Predicted Annual 98th Percentile Hourly Mean Odour Concentrations for Each Year of the Met File

GFS Meteorological Data

Receptor number	Receptor	National Grid Coordinates		Annual 98th Percentile Hourly Mean Odour Concentration (ou_E/m^3)				
		X (m)	Y (m)	2013	2014	2015	2016	2017
R1	Ystym Colwyn Farmhouse	318975	316377	3.95	4.95	4.58	4.85	2.97
R2	Felin-Fach	319154	316959	1.93	2.01	1.63	1.96	1.80
R3	The Ford	319797	316350	1.75	1.41	1.48	1.96	2.38
R4	Y Parc	318539	316354	1.10	1.09	0.88	0.94	0.51
R5	Bidffold	318636	316773	0.91	0.98	0.80	0.82	0.64
R6	Fferm Bungalow	319618	317045	2.00	2.03	1.67	1.95	1.99
R7	Fferm	319824	317038	2.42	2.56	1.55	1.99	2.59
R8	Plas Bach	320053	316509	1.27	1.24	1.09	1.77	2.03
R9	Pontysgawrhyd	319390	315742	1.02	0.83	0.91	0.81	0.64
R10	Tollgate Cottage	319480	315709	0.87	0.65	0.78	0.73	0.58
R11	Lower Main	318371	316094	0.67	0.86	0.80	0.83	0.35
R12	Y Gorlan	318316	316430	0.70	0.60	0.43	0.50	0.29
R13	Ystym Colwyn Hall	318231	316332	0.58	0.52	0.37	0.44	0.23
R14	Plas-Lolyn	318986	317432	0.50	0.53	0.40	0.52	0.48
R15	Henblas	320028	316135	1.26	1.15	0.78	1.20	1.46
R16	Trefnanney Farm	319959	315798	1.18	0.92	0.53	0.71	0.84

Shawbury Meteorological Data

Receptor number	Receptor	National Grid Coordinates		Annual 98th Percentile Hourly Mean Odour Concentration (ou_E/m^3)				
		X (m)	Y (m)	2013	2014	2015	2016	2017
R1	Ystym Colwyn Farmhouse	318975	316377	6.93	8.91	8.10	8.38	4.71
R2	Felin-Fach	319154	316959	2.36	2.13	2.23	2.31	2.31
R3	The Ford	319797	316350	1.41	1.10	1.11	1.33	1.35
R4	Y Parc	318539	316354	1.48	1.58	1.26	1.53	0.99
R5	Bidffold	318636	316773	0.98	0.99	0.95	0.93	0.94
R6	Fferm Bungalow	319618	317045	2.83	2.61	2.35	2.54	2.90
R7	Fferm	319824	317038	3.19	3.35	2.69	3.27	3.43
R8	Plas Bach	320053	316509	0.86	0.84	0.86	1.14	1.10
R9	Pontysgawrhyd	319390	315742	1.10	1.69	1.34	1.84	0.87
R10	Tollgate Cottage	319480	315709	1.21	1.74	1.32	1.77	0.86
R11	Lower Main	318371	316094	0.93	1.27	0.96	1.17	0.60
R12	Y Gorlan	318316	316430	0.78	0.83	0.65	0.75	0.49
R13	Ystym Colwyn Hall	318231	316332	0.679	0.71	0.58	0.66	0.44
R14	Plas-Lolyn	318986	317432	0.580	0.52	0.55	0.55	0.58
R15	Henblas	320028	316135	0.967	0.71	0.73	0.85	0.94
R16	Trefnanney Farm	319959	315798	0.836	0.85	0.81	0.82	0.70