Mr D Langford

Proposed Poultry Unit Expansion at The Gaer, Meifod, Powys

Ammonia Concentration and Deposition Assessment

442879-AQ-02

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RSK GENERAL NOTES

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Summary

RSK Environment Ltd has been commissioned by Mr David Langford, to conduct a study into the potential impact of ammonia emissions and resultant nitrogen/acid deposition for a proposed expansion of the poultry unit at The Gaer, Meifod, Powys, as part of the evidence required for a planning application. The proposal is to construct two new poultry houses of modern design on land to the south of two existing poultry houses at The Gaer. Each current and proposed new poultry house would provide accommodation for approximately 50,000 broiler chickens. The expanded poultry unit would therefore provide accommodation for a total of 200,000 broiler chickens.

The aim of the study is to focus on how ammonia emissions and resultant nitrogen/acid deposition from the proposed expansion may affect discrete ecological receptors within designated conservation sites in the surrounding area in the context of *"Intensive farming risk assessment for your environmental permit, Environment Agency 2016"* and *"Guidance Note 20 (GN 20), Assessing the impact of ammonia and nitrogen on designated sites from new and expanding intensive livestock units", Natutral Resources Wales (NRW) 2017.*

Dispersion modelling methodology

The choice of model for this study is UK Atmospheric Dispersion Modelling System (ADMS) Version 5.2. A five year weather file from the meteorological station at Shawbury for the years 2011 to 2015 has been used.

Emissions from high velocity ridge mounted fans on the existing and proposed poultry houses have been represented by six point sources per house within the model. Emissions from gable end fans, used to augment the ridge mounted fans during hot weather have also been modelled and have been represented by a single volume source at the eastern end of each of the poultry house. Emissions from the volume sources representing the gable end fans are assumed to occur when the ambient temperature equals or exceeds 22°C. When these conditions occur, the gable end fans are assumed to account for 50% of the total emission and whilst they are emitting, emissions from the point sources, representing the high velocity ridge extraction fans, are reduced by 50%.

Ammonia emissions and associated nitrogen deposition from the proposed expanded poultry unit at The Gaer have been assessed and quantified using Environment Agency standardised ammonia emission rate data. These emission rates have been used in atmospheric dispersion modelling in order to predict the potential process contribution of the proposed expanded poultry unit to ammonia concentrations and resultant nitrogen/acid deposition at nearby conservation sites. Modelling has been firstly based on an initial screening model run, and then with more detailed dispersion modelling where required, in accordance with the Environment Agency's 'Guidance on modelling the concentration and deposition of ammonia emitted from intensive farming'.

Findings

The results of the screening modelling run showed that predicted process contributions to atmospheric ammonia concentrations were below the lower threshold of 1% of the relevant Critical Level for all discrete receptor points representing the closest points of all Special Areas of Conservation and Sites of Special Scientific Interest (SACs/SSSIs) and were also below 100% of the relevant Critical Level for receptors representing all Ancient Woodlands (AWs). However, preliminary results of predicted nitrogen deposition indicated slight exceedances of the lower threshold of 1% of the Critical Load at twelve discrete receptor points representing the SACs/SSSIs, although they were appreciably below the upper threshold of 8%. With respect to the AWs, just one discrete receptor representing the closest AW to the Gaer was predicted to exceed 100% of the relevant Critical Load for nitrogen deposition. These receptors were therefore carried through from the screening assessment to detailed modelling.

The results of the detailed model run, using spatially varying deposition fields, showed that predicted process contributions to atmospheric ammonia concentrations were again all below the relevant Critical Levels for all SACs/SSSIs and AWs. With respect to predicted nitrogen deposition, very marginal exceedances of the lower threshold of 1% were predicted at two receptor points representing the Montgomery Canal SAC/SSSI, but contributions were well below the upper threshold of 8%.

These process contributions were then considered in the context of background nitrogen deposition rates to give a process environmental contribution. The predicted environmental contributions exceeded the Critical Load at both receptor points representing the Montgomery Canal SAC/SSSI due to high background levels of nutrient nitrogen, which themselves already exceed the Critical Load.

The Institute of Air Quality Management (IAQM) issued a position statement in January 2016 in response to a consultation on the NRW GN20 guidance that clarifies any impacts that are markedly greater than 1% should be considered significant or imply the risk of potential damage, whereas for impacts that are only slightly greater than 1% a degree of professional judgement should be applied when determining risk. It can therefore be reasoned that in the case of the findings of this modelling exercise the risk of adverse impacts on the designated sites as a result of the proposed expansion of the poultry unit at the Gaer are likely to be low and therefore not significant.

Abbreviations

ADMS	Atmospheric Dispersion Modelling System
APIS	Air Pollution Information System
CERC	Cambridge Environmental Research Consultants
Cle	Critical level
Clo	Critical load
Defra	Department for Environment, Food and Rural Affairs
EA	Environment Agency
EPR	Environmental Permitting Regulations
IAQM	Institute of Air Quality Management
kg N/ha/yr	Kilograms of nitrogen per hectare per year
kg NH_3/place/year	Kilograms of ammonia per place per year
LNR	Local Nature Reserve
LWS	Local Wildlife Sites
m/s	Meters per second
NH_3	Ammonia
NNR	National Nature Reserves
NRW	Natural Resources Wales
PC	Process Contribution
PEC	Process Environmental Contribution
SAC	Special Area of Conservation
SPA	Special Protection Area
SSSI	Site of Special Scientific Interest
$\mu g/m^3$	Micrograms per cubic metre of air
UNECE	United Nations Economic Commission for Europe

Contents

1 INTRODUCTION

1.1 Background

RSK Environment Ltd has been commissioned by Mr David Langford, to conduct a study to assess the potential impact of ammonia emissions and resultant nitrogen/acid deposition from a proposed expansion of the poultry unit at The Gaer, Meifod, Powys. The aim of the study is to focus on how ammonia emissions and associated nitrogen and acidic deposition from the proposed expansion may affect designated sites of conservation in the surrounding area.

Ammonia emissions and associated nitrogen/acid deposition from the proposed expanded poultry unit at The Gaer have therefore been assessed and quantified using the Environment Agency's standardised ammonia emission figures. These emission rates have been used in atmospheric dispersion modelling in order to predict the potential process contribution of the proposed expanded poultry unit to ammonia concentrations and resultant nitrogen/acid deposition at nearby conservation sites. In the first instance this was undertaken through an initial screening model run, and then with more detailed dispersion modelling where required, in accordance with the Environment Agency's 'Guidance on modelling the concentration and deposition of ammonia emitted from intensive farming'.

1.2 Proposed Development

The proposed poultry unit at the Gaer is located in a rural setting on the outskirts of the hamlet of Trefanney, approximately 5 km to the north east of Meifod. The site of the proposed development is currently laid to pasture and is at an elevation of approximately 90m. There are several isolated farmhouses and residences in the area around application site. The closest residence is The Gaer Farmhouse, which is owned and occupied by the Applicant. The closest residential property not associated with the proposed development is located in Trefanney, approximately 200 m to the west of the application site. More densely populated areas include the village of Geufford, which is located approximately 1.1 km to the south east and Sarnau, at around 2.8 km to the east. A map of the surrounding area is presented in Figure 1.1. The site of the proposed poultry unit is outlined in red.

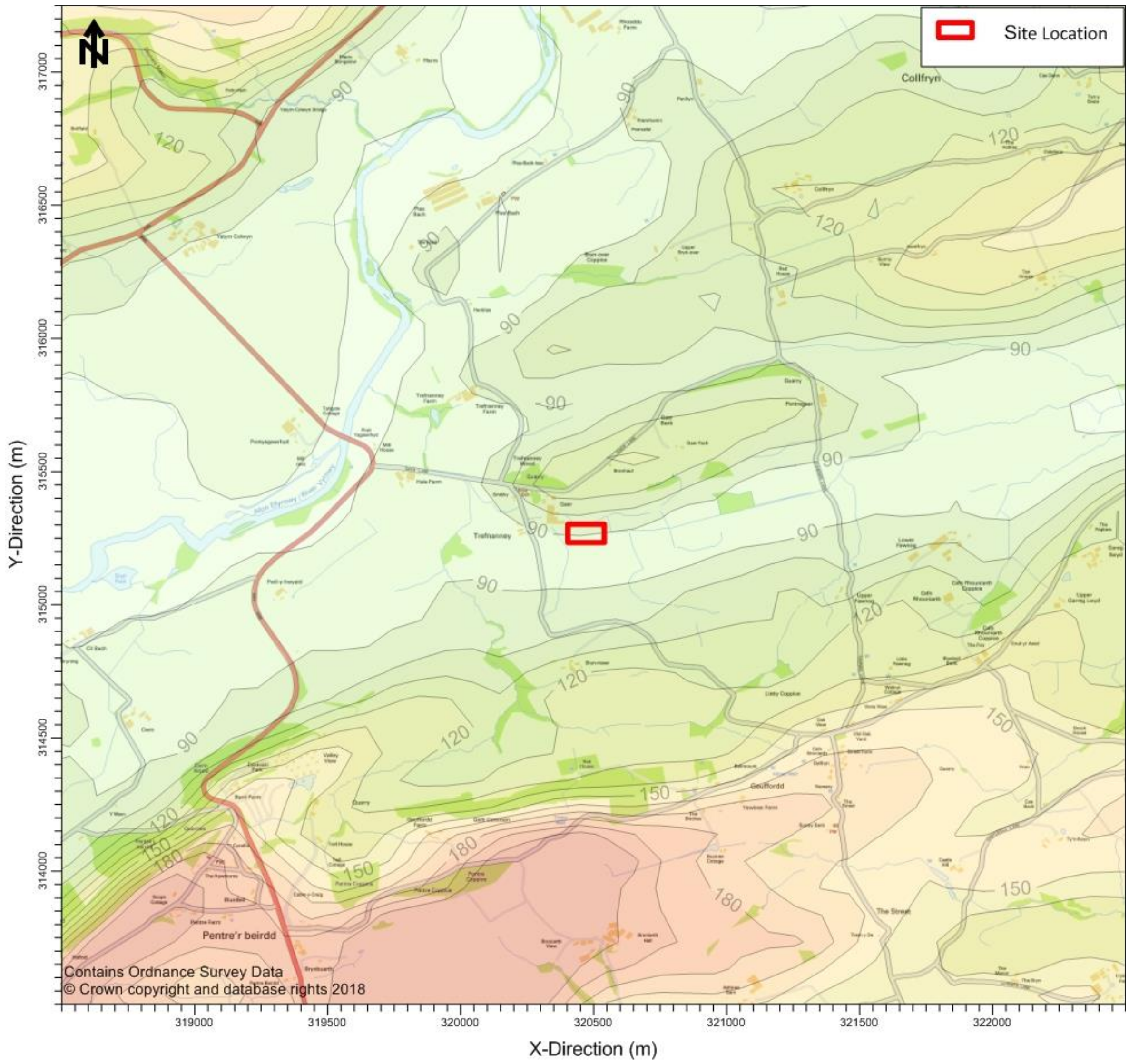
Under the proposal, two new poultry houses of modern design would be constructed on land to the south of two existing poultry houses at The Gaer, situated to the south-east of existing agricultural buildings. Each poultry house would measure 128 m x 18.5 m and each would provide accommodation for approximately 50,000 broiler chickens. The expanded poultry unit would therefore provide accommodation for a total of 200,000 broiler chickens.

The birds would be reared from 1 day old chicks to an age of 37 days, with approximately 50% of each flock thinned at 30 days. The proposed poultry unit would operate 7 to 7.5

flock cycles per year, which includes an allowance of approximately 12 days between each flock to clean out the houses and to prepare them for re-stocking.

The proposed new poultry houses would be primarily ventilated by uncapped high velocity ridge mounted extraction fans, with additional ventilation provided by gable end wall extract fans during hot weather, as with the two existing poultry buildings.

Figure 1.1: Site Location



2 BACKGROUND TO AMMONIA AND NITROGEN DEPOSITION

2.1 Airborne Ammonia Emissions and Nitrogen Deposition

Ammonia is produced by the breakdown of urea in animal manures or uric acid in poultry manure and litter. Ammonia which escapes as gas to the atmosphere from animal housing and/or associated manure storage can lead to adverse environmental impacts (**Ref. 1**).

Exposure to high concentrations of ammonia can lead to direct damage to woodlands, for example, leaf scorching and loss. Severe damage has been found in woodland edges adjacent to fields with high slurry applications in the Netherlands and Belgium (**Ref. 2 and Ref. 3**) and damage to trees has been reported in the immediate vicinity of farms in the United Kingdom (**Ref. 4 and Ref. 5**). There may also be changes in plant morphology, physiology and biochemistry which can increase growth and also increase sensitivity to other environmental factors such as wind, frost, drought and pests.

Certain species are also more sensitive to ammonia and nitrogen deposition than others. Lower plants, namely lichens and mosses, are the most sensitive group, with ammonia having an effect on them at much lower concentrations than others, such as grasses and flowering plants.

Ammonia concentrations are usually expressed in terms of micrograms of ammonia per cubic metre of air ($\mu g\text{-}NH_3/m^3$) expressed as an annual mean.

The nitrogen component of ammonia “settles” out (known as 'nitrogen deposition’). Excessive nitrogen deposition can lead to acidification and eutrophication of soils. In addition, species richness can be compromised, especially for slow growing species which suffer from increased competition from invasive species (**Ref. 4 and Ref. 5**). Nitrogen deposition is usually expressed in kilograms of nitrogen per hectare per year (kg-N/ha/y).

2.2 Critical Levels and Loads

The United Nations Economic Commission for Europe (UNECE) has set environmental criteria known as critical levels for the protection of vegetation from direct effects and critical loads to protect against the indirect effects of deposition of pollutants. Critical loads and levels are generally defined as: “*a quantitative estimate of exposure to one or more pollutants below which significant harmful effects on specified sensitive elements of the environment do not occur according to present knowledge*” (**Ref. 6**).

It is important to distinguish between a critical load and a critical level. The critical load relates to the quantity of pollutant deposited from air to the ground, whereas the critical level refers to the gaseous concentration of a pollutant in the air.

Critical levels and loads are defined by the UNECE (**Ref. 7**) as:

- **Critical Levels:** "*concentrations of pollutants in the atmosphere above which direct adverse effects on receptors, such as human beings, plants, ecosystems or materials, may occur according to present knowledge*."
- **Critical Loads:** "*a quantitative estimate of exposure to one or more pollutants below which significant harmful effects on specified sensitive elements of the environment do not occur according to present knowledge*."

When pollutant loads (or concentrations) exceed the critical level or critical load it is considered that there is a risk of harmful effects. The excess over the critical level or load is termed the exceedance. A larger exceedance is often considered to represent a greater risk of damage.

Critical levels and loads have been designated within the UK based on the sensitivity and qualifying features of the receiving habitat. Critical levels are set at 1 micrograms per cubic metre of air (µg/m^3) where lichens or bryophytes are present as a key part of the ecosystem integrity and at 3 µg/m^3 for all other vegetation. Critical loads for nutrient nitrogen and acid deposition are set under the Convention on Long-Range Transboundary Air Pollution and are based on empirical evidence, mainly observations from experiments, and gradient studies (**Ref. 8**).

2.3 Guidance on the Significance of Ammonia Emissions

Guidance on the significance of ammonia emissions from farming installations can be found in the Environment Agency's Environmental Management Guidance, Intensive Farming Risk Assessment for your Environmental Permit (2016) (**Ref 9**) with respect to Local and National Nature Reserves (LNRs and NNRs), Ancient Woodland (AW) and Local Wildlife Sites (LWSs). Upper significance thresholds are set at 100% for LNRs, NNRs, AW and LWSs.

In March 2017, Natural Resources Wales (NRW) (Regulation and Permitting Department, EPP) published Guidance Note 20 (GN 20), "*Assessing the impact of ammonia and nitrogen on designated sites from new and expanding intensive livestock units*" when applying for an Environmental Permit or Planning Permission (**Ref 10**). This guidance note has updated the approach that NRW take to assessing ammonia emission impacts and in particular has changed the thresholds of insignificance and the upper threshold process contributions for European designated sites, such as Special Areas of Conservation (SACs), Special Protection Areas (SPAs) and Ramsar sites as well as Sites of Special Scientific Interest (SSSIs). In GN 20 the threshold of insignificant percentage of the designated site Critical Level or Load is given as 1%; while the upper threshold percentage of the designated site Critical Level or Load is given as 8%.

GN20 states that where process contributions (PC), considered in isolation, are between 1% and 8% of the designated site Critical Level or Load, in-combination effects may need to be considered further. When considering process contributions from a poultry unit, whether in isolation or in-combination, if they fall between 1 – 8% or above 8%, they would then need to be considered in the context of background ammonia concentrations and nitrogen deposition at the sensitive receptor. This is referred to as the process environmental contribution (PEC) and includes the addition of the PC of the unit being assessed with other sources (sumPCs) and with background levels. Then, where the PEC is between 1-8% or above 8%, control measures may need to be considered to reduce emissions.

As further guidance, a position statement issued by the Institute of Air Quality Management (IAQM) in January 2016 (**Ref. 11**) clarifies the use of the 1% insignificance criterion for determining air quality impacts on European designated sites. The position statement states "*the use of a criterion of 1% of an assessment level in the context of habitats should be used only to screen out impacts that will have an insignificant effect. It should not be used as a threshold above which damage is implied"*. The statement clarifies further to the effect that where any impacts that are markedly greater than 1% then they should be considered significant, whereas for impacts that are only slightly greater than 1% a degree of professional judgement should be applied when determining risk.

2.4 Overall Approach

The approach of the assessment has been based on 'Guidance on modelling the concentration and deposition of ammonia emitted from intensive farming' (Air Quality Modelling and Assessment Unit, 2010) (**Ref. 1**). The approach taken for assessing the potential impacts of ammonia from the proposal may be summarised as follows:

- baseline characterisation that included a desktop search for designated sites;
- determination of ammonia emission rates for each poultry building;
- screening dispersion modelling to predict annual average ammonia concentrations in air without deposition;
- detailed dispersion modelling using a spatially varying deposition field;
- recommendation of mitigation measures, where appropriate, to ensure any adverse effects on air quality are minimised; and
- identification of residual impacts resulting from the proposed development.

3 BASELINE CHARACTERISATION

Baseline or background air quality refers to the concentrations of relevant substances that are already present in ambient air. These substances are emitted by various sources, including road traffic, industrial, domestic, agricultural and natural sources. Background ammonia concentrations and background nitrogen/acid deposition rates for the area around the poultry unit at The Gaer and around the designated conservation sites were obtained from the UK Air Pollution Information System (APIS) website using either the 'search by location' function (**Ref. 12**) or ‘search by relevant site critical load’ function (**Ref. 13**). This data is based on resolutions of 1 to 5 km.

3.1 Designated Site Search

As required by the Environment Agency Air Emissions Risk Assessment Guidance for Environmental Permitting (2016) (**Ref. 9**) and NRW’s “*Assessing the impact of ammonia and nitrogen on designated sites from new and expanding intensive livestock units*” (2017) (**Ref 10**) a desktop study was undertaken to identify Special Areas of Conservation (SACs), Special Protection Areas (SPAs) Ramsar Sites and Sites of Special Scientific Interest (SSSIs) within 5 km of The Gaer. Locally designated sites such as Local Wildlife Sites (LWS), Ancient Woodland (AW) and Local/National Nature Reserves (LNR/NNR) were identified within 2 km of the site.

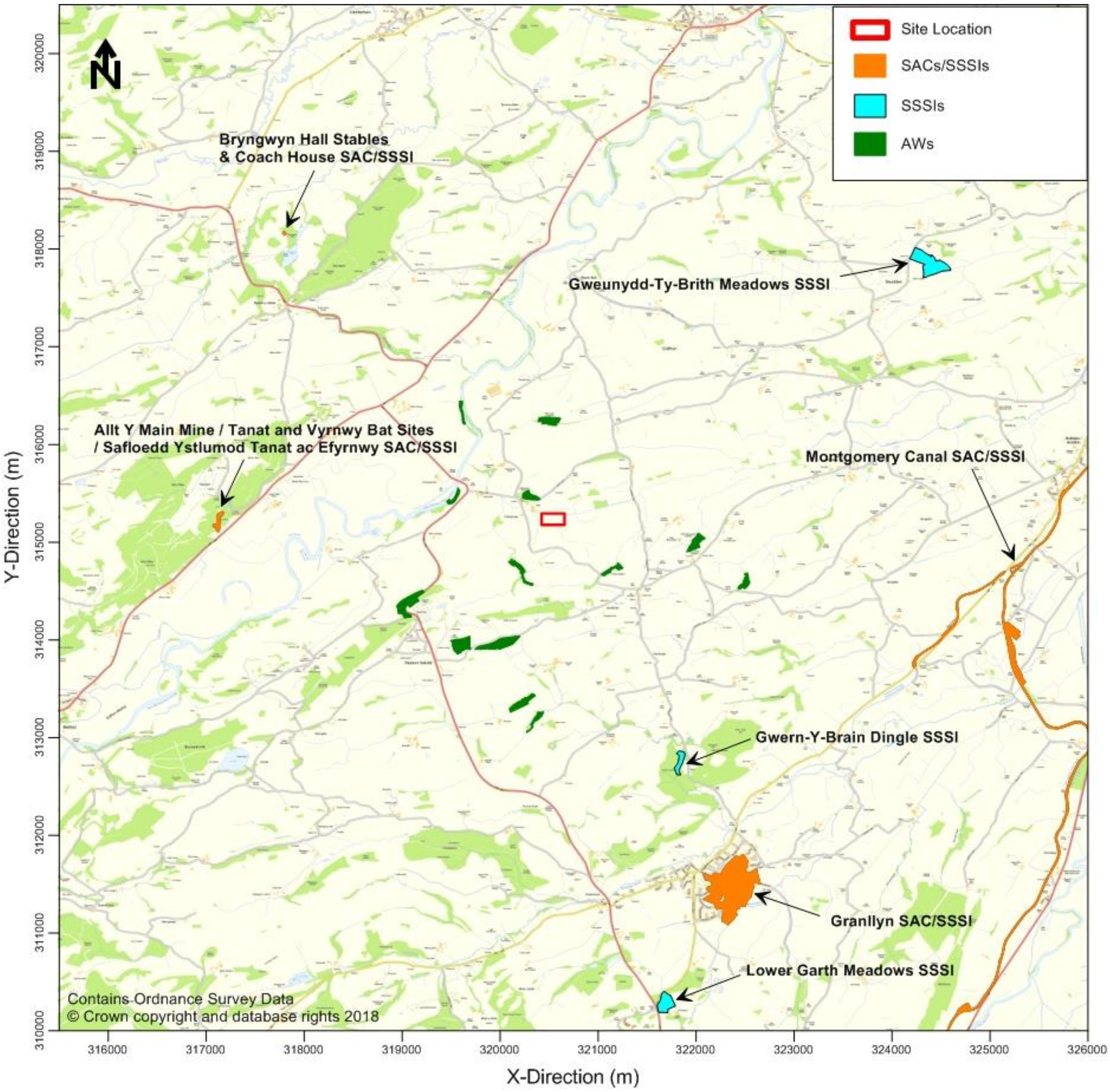
The study was undertaken using the Multi-Agency Geographic Information for the Countryside (MAGIC) web-based interactive mapping service (**Ref 14**), which draws together information on key environmental schemes and designations for any statutory designations although it should be noted that not all locally designated sites appear on MAGIC, notably AWs and LWSs. A further request was made to the Powys and BBNP Biodiversity Information Service (BIS) to obtain details of any LWSs and AWs within 2km of The Gaer.

The following sites were identified as part of this study:

- Bryngwyn Hall Stables and Coach House SAC/SSSI, approximately 3.8 km to the north-west;
- Allt Y Main Mine/Tanat and Vyrnwy Bat Sites/Safloedd Ystlumod Tanat ac Efyrnwy SAC/SSSI, approximately 3.2 km to the west;
- Montgomery Canal SAC/SSSI approximately 3.8 km at its closest point to the south-east;
- Granllyn SAC/SSSI, approximately 3.8 km to the south-south-east;
- Gwern-Y-Brain Dingle SSSI, approximately 2.5 km to the south-south-east;
- Lower Garth Meadows SSSI, approximately 4.9 km to the south;
- Gweunydd-Ty-Brith Meadows SSSI, approximately 4.3 km to the north-east;
- 13 x Ancient Woodland sites with no fixed name within 2 km of The Gaer

The location of The Gaer in relation to the above identified designated sites is shown below in Figure 2.1.

Figure 2.1: Site Location



3.2 Background Levels of Ammonia and Nitrogen & Acid Deposition

The background ammonia concentration in the vicinity of The Gaer is 1.79 µg/m^3 (**Ref. 12**). The background nitrogen deposition rate is 20.02 kg N/ha/yr and the background acid deposition rate is 1.55 keq/ha/yr (**Ref. 13**).

The background ammonia concentration at both Bryngwyn Hall Stables & Coach House SAC/SSSI and the Allt Y Main Mine/Tanat and Vyrnwy Bat Sites/Safloedd Ystlumod Tanat ac Efyrnwy SAC/SSSI is 1.78 µg/m^3 and the background nitrogen deposition rate is 28.14 kg N/ha/yr, while the background acid deposition rate is 2.13 keq/ha/yr (**Ref. 12**).

The background ammonia concentration for the Montgomery Canal SAC/SSSI is 2.17 µg/m^3 and the background nitrogen deposition rate is 19.6 kg N/ha/yr, while the background acid deposition rate is 1.51 keq/ha/yr (**Ref. 12**).

The background ammonia concentration at Granllyn SAC/SSSI, Gwern-Y-Brain Dingle SSSI and Lower Garth Meadows SSSI is 2.17 µg/m^3 and the background nitrogen deposition rate is also 31.64 kg N/ha/yr, while the background acid deposition rate is in the range 2.32 to 2.37 keq/ha/yr (**Ref. 12**).

The background ammonia concentration for the Gweunydd-Ty-Brith Meadows SSSI is 2.46 µg/m^3 and the background nitrogen deposition rate is 21.14 kg N/ha/yr, while the background acid deposition rate is 1.23 keq/ha/yr (**Ref. 12**).

The background ammonia concentrations at the thirteen Ancient Woodland sites is in the range 1.78 to 2.46 µg/m^3, the background nitrogen deposition rate is in the range 28.14 to 34.3 kg N/ha/yr and the background acid deposition rate is in the range 2.12 to 2.55 keq/ha/yr (**Ref. 12**).

3.3 Ecology of the Conservation Sites and Critical Levels and Loads

The Bryngwyn Hall Stables and Coach House SAC/SSSI is designated as the buildings themselves provide roosting space for Lesser Horsehoe Bats (**Ref. 14**). No site relevant critical loads/levels are assigned. However, the search by location function on APIS for the surrounding wood-pasture & parkland which provides vital feeding grounds for the Bats gives an ammonia Critical Level of 3 µg/m^3 and a nutrient nitrogen Critical Load of 10 kg N/ha/yr (**Ref. 12**).

The Allt Y Main Mine/Tanat and Vyrnwy Bat Sites / Safloedd Ystlumod Tanat ac Efyrnwy SAC/SSSI is also designated with respect to Lesser Horsehoe Bats (**Ref. 14**). The search by location function on APIS for the surrounding semi-natural mixed woodland which provides feeding grounds for the Bats also gives an ammonia Critical Level of 3 µg/m^3 and a nutrient nitrogen Critical Load of 10 kg N/ha/yr (**Ref. 12**).

With respect to the Montgomery Canal SAC/SSSI, at least 75% of the canal lengths have open water that supports a rich assemblage of floating-leaved, emergent and submerged plants at a cover of 30% or greater. Most important is floating water-plantain (Luronium natans). This together with other species of floating and submerged plants in turn help support more than 10 species of dragonfly (**Ref. 14**). The site relevant critical loads function on APIS gives an ammonia Critical Level of 1 to 3 µg/m³ and nutrient nitrogen Critical Load in the range of 3 to 10 kg N/ha/yr (**Ref. 13**). For the purpose of this exercise the lower Critical Level/Load has been applied and therefore represents the worst case scenario.

The Granllyn SAC/SSSI covers an approximate area of 20.9 ha (**Ref. 14**). At least 5% of this SAC/SSSI is aquatic habitat that is suitable for breeding Great Crested Newts. There are two main water bodies, that contain plenty of weed cover but at least 40% of these water bodies is open water at all times. These water bodies are not polluted or subject to excessive nutrient inputs from surrounding land and predatory fish are absent. The pool margins are shallow and there is sufficient tall marginal vegetation and woodland to provide cover for newts entering and leaving the water. Scrub, grasslands, hedgerows and other habitats provide conditions suitable for dispersing, foraging, sheltering and hibernating amphibians. At least 5% of the site is broadleaved woodland. The pasture and amenity grassland have a sward that is suitable for foraging newts and there are plenty of suitable sites, such as fallen logs, large stones, hedge bottoms or manmade structures for them to hide during the day or hibernate. At its closest point to the Gaer Granllyn SAC/SSSI is predominantly woodland. The search by location function in APIS gives an ammonia Critical Level of 3 µg/m³ and nutrient nitrogen Critical Load of 10 kg N/ha/yr (**Ref. 12**).

Gwern-Y-Brain Dingle SSSI is designated largely for its geological interest for fossiliferous Nod Glas shales of Onnian age (**Ref. 14**). The surrounding habitat is broadleaved mixed woodland. The search by location function in APIS gives an ammonia Critical Level of 3 µg/m³ and nutrient nitrogen Critical Load of 10 kg N/ha/yr (**Ref. 12**). However, the fossils themselves are not sensitive to ammonia.

Lower Garth Meadows SSSI covers an approximate area of 2.5 ha (**Ref. 14**). This designated site is a good example of an unimproved, herb-rich grassland on a more base-rich soil than is typical of most of Montgomeryshire. The site consists of two damp fields on fairly level ground, containing a number of ditches and the remains of an old pond, with a neutral soil loam. The larger field is used for summer grazing and the smaller one is more lightly grazed. Grazing stock may include sheep, cattle, ducks and geese. The grassland comprises of bents, fescues and sweet vernal-grass (Agrostis/ Festuca/Anthoxanthum odoratum), as well as crested dog's-tail Cynosurus cristatus and some perennial rye-grass Lolium perenne. Tufted hair-grass Deschampsia cespitosa is found in some damper areas and locally quaking-grass Briza media also occurs. In the less well grazed areas a varied tall-herb vegetation has developed, with common knapweed Centaurea nigra, meadowsweet Filipendula ulmaria and greater bird's-foot-trefoil Lotus uliginosus prominent components. There is also a good representation of marsh orchids Dactylorhiza spp., and autumn lady's-tresses Spiranthes spiralis, a rare orchid in Montgomeryshire. The search by location function in APIS gives an ammonia Critical Level of 3 µg/m³ and nutrient nitrogen Critical Load of 20 kg N/ha/yr (**Ref. 12**).

The Gweunydd-Ty-Brith Meadows SSSI covers an approximate area of 5.5 ha (**Ref. 16**). It represents an area of unimproved lowland mesotrophic grassland managed as traditional hay meadow. The site comprises four fields on ground that slopes gently to the north-east. Three of the fields support fairly uniform dry grassland plant communities, but the central field shows a graduation from dry grassland through to a damper more acidic community, to a central marshy area associated with a small watercourse. The dry grassland is largely dominated by common bent Agrostis capillaris, crested dog's-tail Cynosurus cristatus and Yorkshire-fog Holcus lanatus, with frequent sweet vernal-grass Anthoxanthum odoratum, red fescue Festuca rubra, common knapweed Centaurea nigra, meadow vetchling Lathyrus pratensis, ribwort plantain Plantago lanceolata, meadow buttercup Ranunculus acris, common sorrel Rumex acetosa and red clover Trifolium pratense. Other locally prominent species include yellow oat-grass Trisetum flavescens, yellow-rattle Rhinanthus minor and tufted vetch Vicia cracca. The damper grassland is characterised by the presence of glaucous sedge Carex flacca, jointed rush Juncus articulatus, compact rush J. conglomerates and devil's-bit scabious Succisa pratensis. This grades into a much wetter community dominated by sharp-flowered rush Juncus acutiflorus. Associated species here include carnation sedge Carex panicea, marsh-marigold Caltha palustris, common spotted-orchid Dactylorhiza fuchsii, meadowsweet Filipendula ulmaria, square-stalked St. John's-wort Hypericum tetrapterum, ragged-robin Lychnis flos-cuculi and water mint Mentha aquatica. For the dry grassland part of this site, APIS gives an ammonia Critical Level of 3 µg/m³ and nutrient nitrogen Critical Load of 15 kg N/ha/yr (**Ref. 14**). Meanwhile, for the moist and wet oligotrophic grassland area of this site, APIS gives a stricter ammonia Critical Level of 1 µg/m³ and nutrient nitrogen Critical Load of 10 kg N/ha/yr (**Ref. 13**). On this basis, discrete receptors representing the varying habitats of this designated site have been considered in this assessment, see Section 4.3.6 for more details.

The thirteen unnamed ancient woodland sites comprise of a mixture of ancient restored woodland, semi-natural woodland or NRW Priority Area Woodlands (PAWS). No lichens, bryophytes, sphagnum mosses or other particularly sensitive lower plant species have been identified to be present. Using the search by location function in APIS an ammonia Critical Level of 3 µg/m³ and nutrient nitrogen critical load of 10 kg N/ha/yr have been assigned to these sites (**Ref. 12**).

4 METHODOLOGY

4.1 Guidance

This assessment has taken into account the following guidance:

- Intensive farming risk assessment for your environmental permit, Environment Agency 2016;
- Guidance Note 20 (GN 20), Assessing the impact of ammonia and nitrogen on designated sites from new and expanding intensive livestock units, NRW 2017;
- Guidance on modelling the concentration and deposition of ammonia emitted from intensive farming, Air Quality Modelling and Assessment Unit, Environment Agency, 2010.
- Position Statement: Use of a Criterion for the Determination of an Insignificant Effect of Air Quality Impacts on Sensitive Habitats. IAQM (January 2016).

4.2 Sources of Ammonia from the Poultry Unit

As with the existing houses, the proposed poultry houses at The Gaer would be primarily ventilated by uncapped high velocity, vertical discharge, ridge mounted extraction fans, which will be the primary source of ammonia emissions from these buildings. Since the outflow from the high velocity ridge fans would not be obstructed by any caps or any other obstacles, this arrangement will optimise dispersion of ammonia from the proposed poultry houses, especially under low wind speed conditions. However, to provide additional ventilation during hot weather, gable end wall fans would also be fitted and therefore, some lower level ammonia emissions are also expected.

Modern, well-insulated poultry houses such as those proposed will help to minimise ammonia production at source through good temperature control and good 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 poultry litter moisture levels and, as a consequence, to minimise ammonia and odour emission rates.

No spent litter or manure would be stored on the site as this would be taken away off-site immediately following the poultry house clear out and stored in field stockpiles before being spread onto agricultural land as organic manure.

Part of the Environment Agency's Pollution Inventory Guidance, entitled 'Intensive farming guidance note' (Environment Agency, 2013) (**Ref. 15**) provides standardised ammonia emission factors for a variety of poultry housing types and other sources. The figure given for broilers that are naturally ventilated, fan ventilated or tunnel ventilated with a fully littered floor and non-leaking drinkers is 0.034 kilograms of ammonia per animal place per year (kg NH_3/animal place/year). This emission factor was used in this assessment.

To provide a worst case assessment of ammonia impact and resultant nitrogen/acid deposition "empty" periods (approximately 87 days per year), when the birds are not stocked, have not been taken into account in the calculation of gross ammonia emissions for the poultry unit at The Gaer. Therefore the overall ammonia emission rate for 100,000 birds is calculated to be 0.1077 g/s under the existing modelled scenario. The total ammonia emission rate for an increase to 200,000 bird numbers as part of the proposal to construct two new poultry buildings to the south-east of the existing ones is calculated to be 0.2155 g/s.

A summary of bird numbers per house and associated ammonia emissions for both the existing modelled baseline scenario and the proposed scenario of constructing two additional poultry buildings to accommodate increased bird numbers is provided in Table 4.1a and Table 4.1b respectively below.

Table 4.1a: Sources of Ammonia and Emission Rates for Housing (Existing Scenario)

Poultry Building ID.	No. of broiler places	No. of days of occupancy	Empty periods per cycle	NH_3 emission factor ($kgNH_3$/place/year)	NH_3 emission rate per building (g/s)
P1 (existing)	50,000	278	12	0.034	0.0539
P2 (existing)	50,000	278	12	0.034	0.0539
Total	100,000				0.1077

Table 4.1b: Sources of Ammonia and Emission Rates for Housing (Proposed Scenario)

Poultry Building ID.	No. of broiler places	No. of days of occupancy	Empty periods per cycle	NH_3 emission factor ($kgNH_3$/place/year)	NH_3 emission rate per building (g/s)
P1 (existing)	50,000	278	12	0.034	0.0539
P2 (existing)	50,000	278	12	0.034	0.0539
P1 (proposed)	50,000	278	12	0.034	0.0539
P2 (proposed)	50,000	278	12	0.034	0.0539
Total	200,000				0.2155

4.3 Dispersion Modelling Methodology

4.3.1 Modelling Software

Dispersion modelling was undertaken using the 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 is one of the few models capable of simulating all the important atmospheric processes. Importantly, ADMS 5.2 can take into account spatially varying deposition of pollutants and consequent plume depletion. The model calculates downwind pollutant concentrations 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.

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 (**Ref. 16 and Ref. 17**). The group that leads the development of ADMS is Cambridge Environmental Research Consultants (CERC), but the UK Met Office and others have made additional contributions. The model has been extensively validated against site measurements. Details of these validation studies and the formulation of the ADMS are available on the CERC website.

Published studies have shown that atmospheric dispersion models are reliable at predicting the pattern of downwind pollutant concentrations and deposition rates (as statistical distributions) over a period of time (**Ref. 18**).

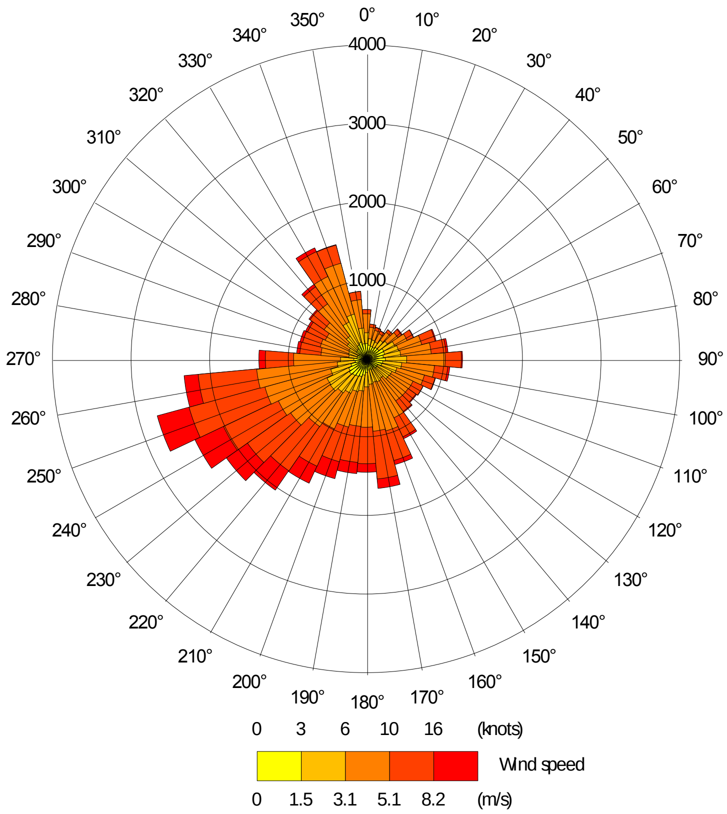
4.3.2 Meteorology

The closest meteorological station to the proposed development that regularly records all the elements required for dispersion modelling to a suitable standard is at Lake Vrynwy, approximately 20 km to the north west of the application site. However, this station is at an elevation of 360 m, which is significantly higher than the proposed site and therefore is not considered to be wholly representative of meteorological conditions in the area around the application site.

The next closest meteorological station that regularly records all the elements required for dispersion modelling and with similar exposure to the poultry unit is at Shawbury, approximately 34 km to the north east of the application site at an elevation of 72 m.

The wind rose for the weather file, derived from data from Shawbury (2011 to 2015 inclusive), is shown in Figure 4.1. This shows the direction FROM which winds blows and illustrates the relative frequency of wind directions and wind speeds used in the modelling study.

Figure 4.1: Wind Rose, derived from Data from Shawbury (2011 - 2015)



4.3.3 Source Parameters and Buildings

Emissions from the high velocity ridge mounted fans on all four houses are represented by six point sources per house within ADMS. Emissions from the gable end fans, used to augment the high velocity ridge fans during periods of hot weather are represented by one volume source per house, at the eastern end of the existing and proposed new poultry houses.

Emissions from the volume sources representing the gable end fans are assumed to occur when the ambient temperature equals or exceeds 22°C. When these conditions do occur, the gable end fans are assumed to account for 50% of the total emission and whilst they are emitting, emissions from the point sources, representing the high velocity roof fans, are reduced by 50%.

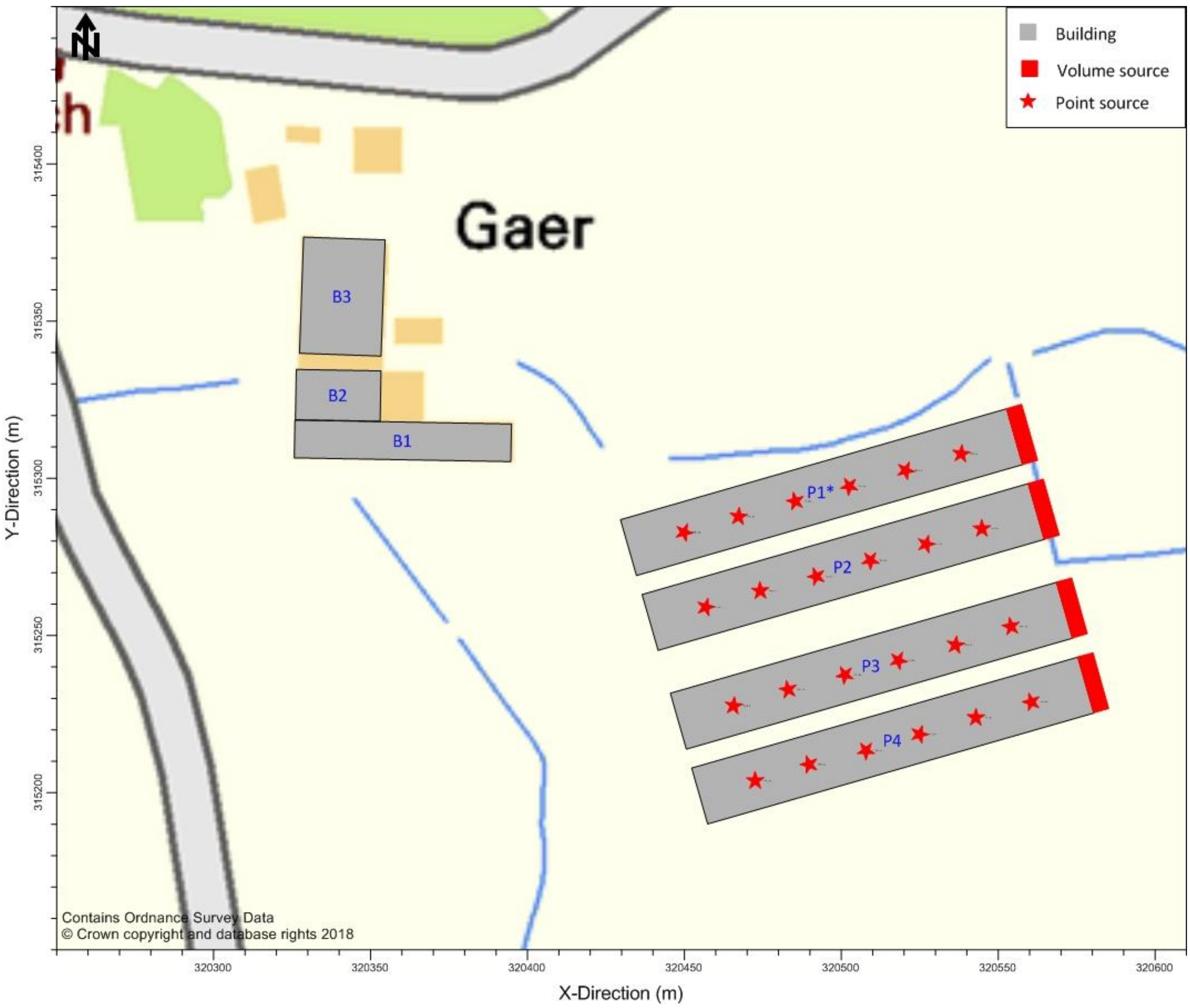
Further details of the point source and volume source parameters are provided in Appendix A. The positions of the modelled sources are shown in Figure 4.2.

The dispersion of substances released from elevated point sources can be influenced by the presence of buildings close to the emission point. Structures can interrupt the wind flows and cause higher ground-level concentrations close to the source than would arise in the absence of the buildings. The only buildings likely to affect dispersion are the four poultry houses themselves and the nearby farm buildings, which have all been modelled as rectangular blocks within ADMS 5.2. The locations and heights of these buildings/structures are listed in Table 4.2. The position of the modelled buildings are shown in Figure 4.2, where they are marked by grey rectangles.

Table 4.2: Buildings Details included in the Model

ID	Building	Grid Ref, X	Grid Ref, Y	Height, m
P1	Poultry house 1 (existing)	320493.7	315295.6	5
P2	Poultry house 2 (existing)	320500.6	315271.8	5
P3	Poultry house 3 (proposed)	320509.6	315240.4	5
P4	Poultry house 4 (proposed)	320516.4	315216.6	5
B1	Farm building	320360.3	315311.9	6
B2	Farm building	320339.7	315326.4	9
B3	Farm building	320341.0	315357.8	7

Figure 4.2: Modelled Sources and Buildings



4.3.4 Terrain and Roughness Length

The land in the vicinity of the proposed expanded poultry unit contains some slopes and topographical features that may affect wind flow and the dispersion of odours. Therefore, terrain data have been used within ADMS. This data is based on Ordnance Survey Land-Form PANORAMA. A fixed roughness length of 0.25 m is used over the entire modelling domain.

4.3.5 Monin-Obukhov Length

The Monin-Obukhov length provides a measure of the stability of the atmosphere. The CERC guidance advises that in "*in very stable conditions in a rural areas its value would typically be 2 to 20 m*". A minimum Monin-Obukhov length of 10 m was used in the dispersion modelling study.

4.3.6 Receptor Locations and Model Domain

Twenty seven discrete receptor points have been defined within the model to represent the designated conservation sites. Details of all discrete receptors included in the modelling study are listed in Table 4.3. These discrete receptors are taken to be at ground level and their locations are shown in Figure 4.3.

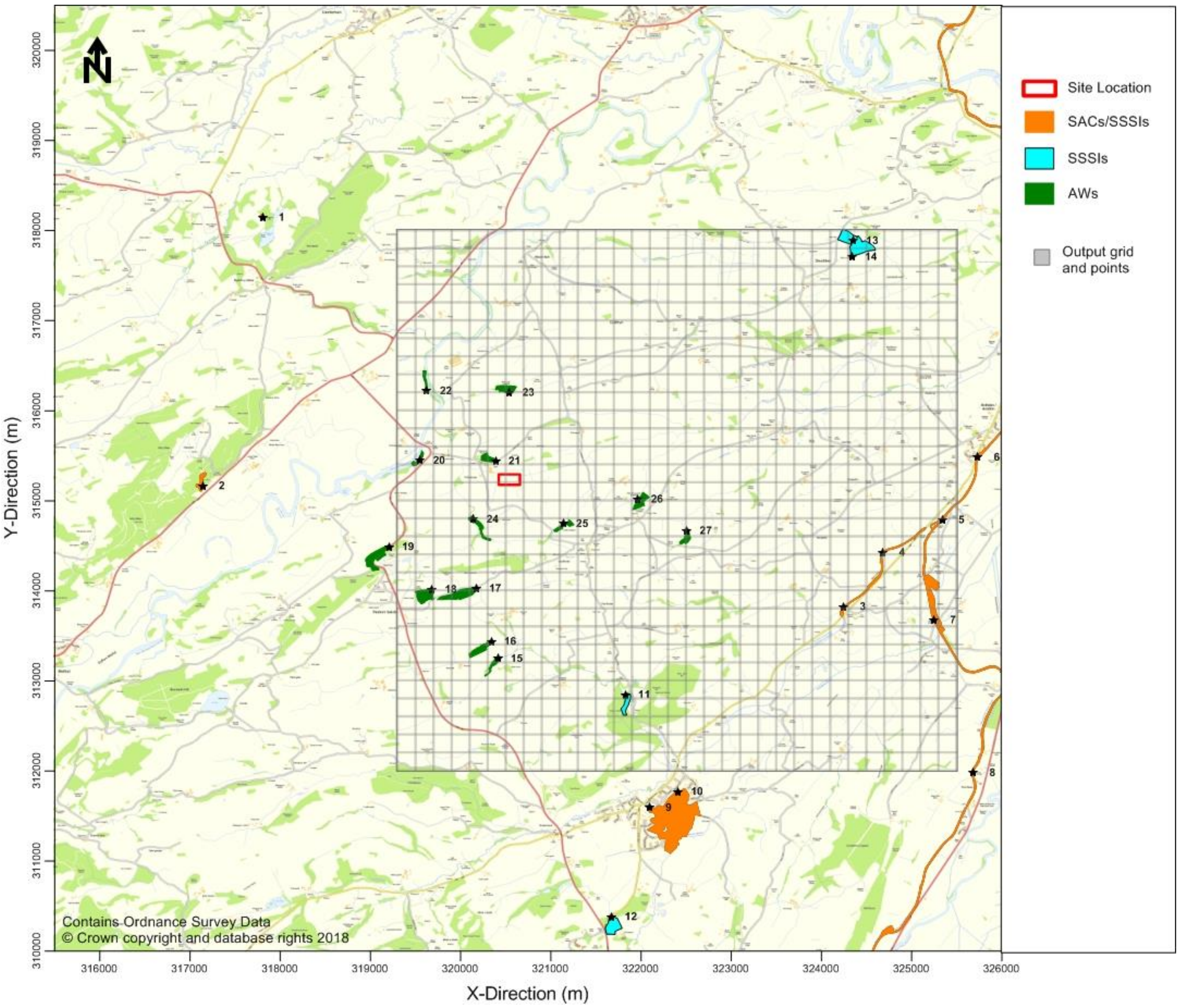
A 6.2 km by 6 km regular Cartesian grid at 200 m resolution has been used to produce the contour map presented in the results of this study, as shown in Figure 4.3.

Table 4.3: Receptors Included in the Dispersion Modelling Assessment

Receptor ID	Receptor Location	Grid Reference	
		X	Y
1	Bryngwyn Hall Stables and Coach House SAC/SSSI	317808	318147
2	Allt Y Main Mine / Tanat and Vyrnwy Bat Sites / Safleoedd Ystlumod Tanat ac Efyrnwy SAC/SSSI	317141	315165
3	Montgomery Canal SAC/SSSI	324247	313824
4	Montgomery Canal SAC/SSSI	324683	314427
5	Montgomery Canal SAC/SSSI	325340	314789
6	Montgomery Canal SAC/SSSI	325734	315484
7	Montgomery Canal SAC/SSSI	325248	313677
8	Montgomery Canal SAC/SSSI	325684	311981
9	Granllyn SAC/SSSI	322096	311594
10	Granllyn SAC/SSSI	322409	311772
11	Gwern-Y-Brain Dingle SSSI	321825	312847
12	Lower Garth Meadows SSSI	321678	310383
13	Gweunydd-Ty-Brith (Ty-Brith Meadows) SSSI	324352	317885
14	Gweunydd-Ty-Brith (Ty-Brith Meadows) SSSI	324339	317708
15	Ancient Woodland (Unknown Name)	320412	313247
16	Ancient Woodland (Unknown Name)	320338	313437
17	Ancient Woodland (Unknown Name)	320172	314027
18	Ancient Woodland (Unknown Name)	319681	314015
19	Ancient Woodland (Unknown Name)	319208	314488
20	Ancient Woodland (Unknown Name)	319552	315447

Receptor	Receptor Location	Grid Reference	
21	Ancient Woodland (Unknown Name)	320387	315440
22	Ancient Woodland (Unknown Name)	319625	316221
23	Ancient Woodland (Unknown Name)	320541	316202
24	Ancient Woodland (Unknown Name)	320142	314795
25	Ancient Woodland (Unknown Name)	321137	314746
26	Ancient Woodland (Unknown Name)	321967	315016
27	Ancient Woodland (Unknown Name)	322507	314666

Figure 4.3: Discrete Ecological Receptors



4.3.7 Ammonia Deposition

The methods used to model deposition of ammonia and consequent plume depletion are based on Environment Agency guidance from the document entitled 'Guidance on modelling the concentration and deposition of ammonia emitted from intensive farming' (**Ref. 1**).

1. Annual mean ammonia concentrations in each of the five separate years of the meteorological record were calculated using ADMS without deposition. As deposition results in depletion of ammonia in the plume, this tends to overestimate the concentration in air.
2. Based on the maxima of the annual concentrations obtained in step one, values for deposition velocity suggested by the Environment Agency (see Table 4.4) and land usage around the farm, a spatially varying deposition field was defined. This is shown in Figure 4.4.
3. Using the spatially varying deposition field obtained in step two, ADMS was re-run for all five years in the meteorological record for completeness.

Table 4.4: Environment Agency Recommended Ammonia Dry Deposition Velocity at Different Long Term Average Concentration to be used in an Impact Assessment

NH_3 Concentration (Farm(s) Contribution + Background) (µg/m^3)	< 10	10 - 20	20 – 30	30 – 80	> 80
Deposition velocity (m/s)	0.02 - 0.03*	0.015	0.01	0.005	0.003

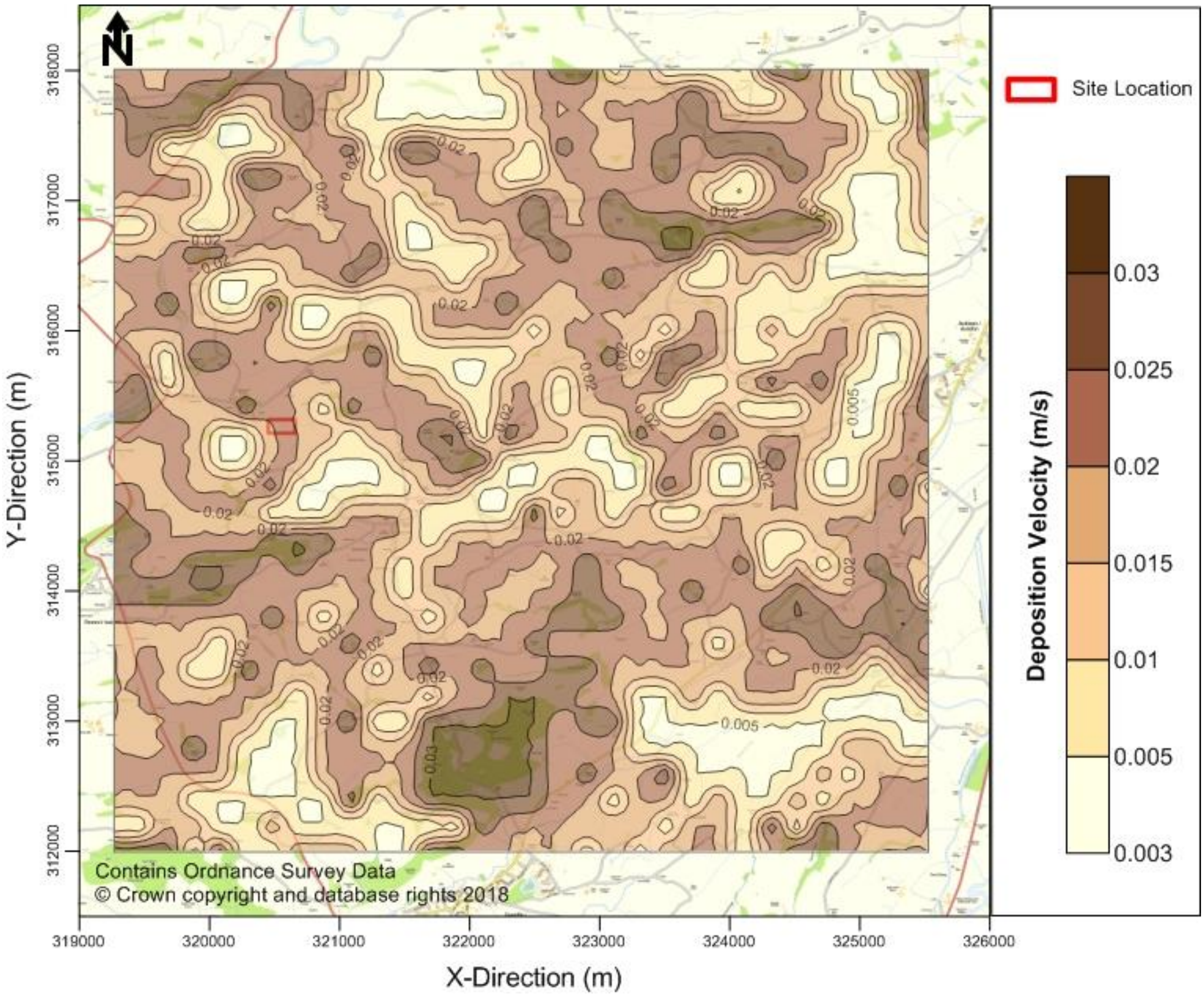
* 0.02 m/s for short vegetation, and 0.03 m/s for tall vegetation.

A further restriction to deposition velocity of 0.005 m/s has been applied where there is fertilised arable cropland. This is to account for possible restricted deposition over crops and open ground. It is a precautionary approach which can only result in higher predictions of ammonia concentration and deposition at sensitive sites.

Deposition rates were calculated using the conversion factors provided within the Environment Agency guidance. Predicted ammonia concentrations were multiplied by the deposition velocity and conversion factor to calculate the dry deposition flux.

The spatially varying deposition field includes the area surrounding The Gaer and most of the ancient woodland sites. A contour map of the spatially varying deposition velocity field is shown in Figure 4.4. The contouring software "smooths" any abrupt changes in deposition velocity at woodland/field boundaries.

Figure 4.4: Spatially Varying Deposition Velocity



4.4 Uncertainties and Assumptions

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

- There will be uncertainties introduced because the modelling has simplified real-world processes into a series of algorithms. For example, it has been assumed that wind conditions measured at Shawbury weather station (in 2011 to 2015) were representative of wind conditions at the site. Furthermore, it has been assumed that the subsequent dispersion of ammonia 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 best possible estimates.
- For modelling purposes, deposition velocity is temporally fixed. However, in reality it will vary seasonally and diurnally and it is also dependent on meteorological conditions and the state of vegetation. Model sensitivity to such effects is currently unknown. Nevertheless, higher rates of deposition and plume depletion in summer probably compensate for lower rates in winter.

5 DISPERSION MODELLING RESULTS

Five screening runs, one for each year in the five year meteorological record (2011 to 2015) were performed to assess the impact of emissions from the proposed expansion of the poultry unit at The Gaer on ammonia concentrations at the discrete receptor points representing nearby conservation sites.

The maximum annual mean ammonia concentration figures, from this preliminary modelling run were used along with land usage data to define the spatially varying deposition field required in the detailed modelling run. Detailed modelling was then conducted by re-running the model using the deposition and plume depletion module for all five years for those receptors exceeding the relevant screening thresholds.

The results of the modelling runs are presented below in Section 5.1 with respect to the screening run and 5.2 with respect to the detailed run.

5.1 Screening Model Run

The predicted maximum annual mean ammonia concentrations at the discrete receptor points representing all identified designated conservation sites are shown in Table 5.1. Nutrient nitrogen and acid deposition rates have also been calculated for all receptor points, based on the predicted atmospheric ammonia concentration for each discrete receptor point and an assumed deposition velocity of 0.03 m/s for tall vegetation and a deposition velocity of 0.02 m/s for short vegetation, as shown in Table 5.1 for nitrogen deposition and Table 5.2 for acid deposition.

5.1.1 Ammonia Concentrations

The NRW's GN 20 guidance states that if a simple screening run predicts that process contributions to atmospheric ammonia concentrations are less than the lower insignificance threshold (i.e. 1%) of the relevant Critical Level for SACs/SSSIs then detailed modelling is not required. However if the simple screening predicts ammonia process contributions to be between 1-8%, or above 8% of the relevant Critical Level, then more detailed modelling would be required, with some consideration of background ammonia levels and in-combination effects. For AWs, NRW's GN 20 guidance and the EA 2016 guidance states that if a simple screening run predicts that process contributions to atmospheric ammonia concentrations are less than 100% of the relevant Critical Level then detailed modelling is not required. However if the simple screening predicts ammonia process contributions to be above 100%, of the relevant Critical Level, then more detailed modelling would be required.

The results of the screening model run show that predicted process contributions to atmospheric ammonia concentrations are below 1% at all receptor points representing the SAC's and SSSIs. The predicted process contributions are also below 100% of the relevant Critical Level for all receptor points representing the AWs. In accordance with the criteria set out in the Environment Agency's latest intensive farming risk assessment guidance (2016) and NRWs GN20 guidance (2017), the predicted process contributions at all designated conservation sites should therefore be considered to be insignificant and acceptable for the purposes of planning permission/permitting.

5.1.2 Nitrogen Deposition

The NRW's GN 20 guidance states that if a simple screening run predicts that process contributions to nutrient nitrogen deposition is less than 1% of the relevant Critical Load for SACs/SSSIs then detailed modelling is not required. However if the simple screening predicts nitrogen deposition process contributions to be between 1-8%, or above 8% of the relevant Critical Load, then more detailed modelling would be required, with some consideration of background nitrogen deposition rates and in-combination effects.

For AWs, NRW's GN 20 guidance and the EA 2016 guidance states that if a simple screening run predicts that process contributions to resultant nitrogen deposition is less than 100% of the relevant Critical Load then detailed modelling is not required. However if the simple screening predicts nitrogen deposition process contributions to be above 100%, of the relevant Critical Load, then more detailed modelling would be required.

The preliminary modelling results show that predicted process contributions to nutrient nitrogen deposition rates at discrete receptor points are slightly above 1% of the relevant Critical Load at 12 discrete receptor points representing the SACs/SSSIs, but appreciably below the upper 8% threshold. The highest maximum annual mean nitrogen deposition process contribution is predicted at receptor point 6 (3.14%). This receptor point represents the Montgomery Canal SAC/SSSI, where the lowest Critical Load of 3 kg N/ha/yr has been applied as a precautionary measure. For the AW sites, the predicted process contributions to nutrient nitrogen deposition rates are below 100% of the relevant Critical Load for all but one receptor point, which is at receptor point 21.

In accordance with NRW's GN 20 guidance, the discrete receptors representing the SACs/ SSSIs exceeding 1% of the Critical Load are taken forward for detailed modelling.

In accordance with NRW's GN 20 guidance and the EA 2016 guidance, discrete receptor point 21 representing an AW site where 100% of the Critical Load is exceeded is also taken forward for detailed modelling.

5.1.3 Acid Deposition

The NRW's GN 20 guidance states that if a simple screening run predicts that process contributions to acid deposition is less than 1% of the relevant Critical Load for SACs/SSSIs then detailed modelling is not required. However if the simple screening predicts acid deposition process contributions to be between 1-8%, or above 8% of the relevant Critical Load, then more detailed modelling would be required, with some consideration of background acid deposition rates and in-combination effects.

For AWs, NRW's GN 20 guidance and the EA 2016 guidance states that if a simple screening run predicts that process contributions to acid deposition is less than 100% of the relevant Critical Load then detailed modelling is not required. However if the simple screening predicts acid deposition process contributions to be above 100%, of the relevant Critical Load, then more detailed modelling would be required.

The results of the screening model run show that predicted process contributions to acid deposition are below 1% at all receptor points representing the SAC's and SSSIs. The predicted acid deposition process contributions are also below 100% of the relevant Critical Load for all receptor points representing the AWs. In accordance with the criteria set out in the Environment Agency's latest intensive farming risk assessment guidance (2016) and NRWs GN 20 guidance (2017), the predicted process contributions at all designated conservation sites should therefore be considered to be insignificant.

Table 5.1: Predicted Maximum Process Contribution to Annual Mean Ammonia Concentrations and Nitrogen Deposition – Screening Run

Receptor	X (m)	Y (m)	Receptor Location	Maximum Annual Mean Ammonia Concentration (2011 – 2015)			Maximum Annual Mean Nitrogen Deposition (2011 – 2015)		
				Cle (µg/m³)	PC (µg/m³)	% of Cle	Clo (kg N/ha/yr)	PC (kg N/ha/yr)	% of Clo
1	317807.6	318146.7	Bryngwyn Hall Stables and Coach House	3	0.010	0.34	10	0.079	0.79
2	317141.4	315165.1	Allt Y Main Mine / Tanat and Vyrnwy Bat Sites / Safleoedd Ystlumod Tanat ac Efyrnwy	3	0.023	0.76	10	0.178	**1.78**
3	324246.5	313824.3	Montgomery Canal	3	0.011	0.38	3	0.088	**2.93**
4	324682.8	314426.6	Montgomery Canal	3	0.009	0.30	3	0.071	**2.35**
5	325340.4	314789.1	Montgomery Canal	3	0.009	0.30	3	0.070	**2.32**
6	325733.6	315483.5	Montgomery Canal	3	0.012	0.40	3	0.094	**3.14**
7	325248.2	313676.9	Montgomery Canal	3	0.009	0.28	3	0.067	**2.22**
8	325684.5	311980.8	Montgomery Canal	3	0.006	0.21	3	0.048	**1.60**
9	322095.8	311593.7	Granllyn	3	0.020	0.67	10	0.155	**1.55**
10	322409.2	311771.9	Granllyn	3	0.019	0.62	10	0.144	**1.44**
11	321825.4	312847.3	Gwern-Y-Brain Dingle	3	0.027	0.90	10	0.210	**2.10**
12	321677.9	310383.1	Lower Garth Meadows	3	0.013	0.42	20	0.097	0.49
13	324352.1	317885.1	Gweunydd-Ty-Brith (Ty-Brith Meadows)	3	0.021	0.69	10	0.161	**1.61**
14	324338.7	317708.0	Gweunydd-Ty-Brith (Ty-Brith Meadows)	3	0.022	0.74	15	0.173	**1.15**
15	320412.0	313246.7	Ancient Woodland (Unknown Name)	3	0.020	0.68	10	0.160	1.60
16	320338.3	313437.2	Ancient Woodland (Unknown Name)	3	0.021	0.71	10	0.167	1.67
17	320172.4	314027.1	Ancient Woodland (Unknown Name)	3	0.033	1.11	10	0.259	2.59
18	319680.8	314014.8	Ancient Woodland (Unknown Name)	3	0.031	1.03	10	0.240	2.40
19	319207.6	314488.0	Ancient Woodland (Unknown Name)	3	0.042	1.40	10	0.327	3.27
20	319551.7	315446.6	Ancient Woodland (Unknown Name)	3	0.180	6.00	10	1.402	14.02
21	320387.4	315440.5	Ancient Woodland (Unknown Name)	3	1.332	44.38	10	10.374	**103.74**
22	319625.5	316220.9	Ancient Woodland (Unknown Name)	3	0.081	2.70	10	0.631	6.31
23	320541.1	316202.5	Ancient Woodland (Unknown Name)	3	0.155	5.16	10	1.206	12.06

Receptor	X (m)	Y (m)	Receptor Location	Maximum Annual Mean Ammonia Concentration (2011 – 2015)			Maximum Annual Mean Nitrogen Deposition (2011 – 2015)		
				Cle ($\mu g/m^3$)	PC ($\mu g/m^3$)	% of Cle	Clo (kg N/ha/yr)	PC (kg N/ha/yr)	% of Clo
24	320141.6	314795.3	Ancient Woodland (Unknown Name)	3	0.165	5.50	10	1.286	12.86
25	321137.1	314746.1	Ancient Woodland (Unknown Name)	3	0.133	4.43	10	1.036	10.36
26	321966.7	315016.5	Ancient Woodland (Unknown Name)	3	0.051	1.69	10	0.396	3.96
27	322507.5	314666.2	Ancient Woodland (Unknown Name)	3	0.030	0.98	10	0.230	2.30

Cle – Critical Level

Clo – Critical Load

PC – Process Contribution

Table 5.2: Predicted Maximum Process Contribution to Annual Mean Acid Deposition – Screening Run

Receptor	X (m)	Y (m)	Receptor Location	Maximum Annual Mean Acid Deposition Rate (2011 – 2015)		
				Clo (keq N/ha/yr)	PC (keq N/ha/yr)	% of Clo
1	317807.6	318146.7	Bryngwyn Hall Stables and Coach House	3	0.010	0.34
2	317141.4	315165.1	Allt Y Main Mine / Tanat and Vyrnwy Bat Sites / Safleoedd Ystlumod Tanat ac Efyrnwy	3	0.023	0.76
3	324246.5	313824.3	Montgomery Canal	3	0.011	0.38
4	324682.8	314426.6	Montgomery Canal	3	0.009	0.30
5	325340.4	314789.1	Montgomery Canal	3	0.009	0.30
6	325733.6	315483.5	Montgomery Canal	3	0.012	0.40
7	325248.2	313676.9	Montgomery Canal	3	0.009	0.28
8	325684.5	311980.8	Montgomery Canal	3	0.006	0.21
9	322095.8	311593.7	Granllyn	3	0.020	0.67
10	322409.2	311771.9	Granllyn	3	0.019	0.62

Receptor	X (m)	Y (m)	Receptor Location	Maximum Annual Mean Acid Deposition Rate (2011 – 2015)		
				Clo (keq N/ha/yr)	PC (keq N/ha/yr)	% of Clo
11	321825.4	312847.3	Gwern-Y-Brain Dingle	3	0.027	0.90
12	321677.9	310383.1	Lower Garth Meadows	3	0.013	0.42
13	324352.1	317885.1	Gweunydd-Ty-Brith (Ty-Brith Meadows)	3	0.021	0.69
14	324338.7	317708.0	Gweunydd-Ty-Brith (Ty-Brith Meadows)	3	0.022	0.74
15	320412.0	313246.7	Ancient Woodland (Unknown Name)	3	0.020	0.68
16	320338.3	313437.2	Ancient Woodland (Unknown Name)	3	0.021	0.71
17	320172.4	314027.1	Ancient Woodland (Unknown Name)	3	0.033	1.11
18	319680.8	314014.8	Ancient Woodland (Unknown Name)	3	0.031	1.03
19	319207.6	314488.0	Ancient Woodland (Unknown Name)	3	0.042	1.40
20	319551.7	315446.6	Ancient Woodland (Unknown Name)	3	0.180	6.00
21	320387.4	315440.5	Ancient Woodland (Unknown Name)	3	1.332	44.38
22	319625.5	316220.9	Ancient Woodland (Unknown Name)	3	0.081	2.70
23	320541.1	316202.5	Ancient Woodland (Unknown Name)	3	0.155	5.16
24	320141.6	314795.3	Ancient Woodland (Unknown Name)	3	0.165	5.50
25	321137.1	314746.1	Ancient Woodland (Unknown Name)	3	0.133	4.43
26	321966.7	315016.5	Ancient Woodland (Unknown Name)	3	0.051	1.69
27	322507.5	314666.2	Ancient Woodland (Unknown Name)	3	0.030	0.98

5.2 Detailed Modelling, Including Deposition

The predicted maximum annual mean ammonia concentrations and nitrogen deposition rates from the detailed modelling run for all five years in the meteorological record are shown in Table 5.3 for 12 receptor points representing the SACs/SSSIs and one receptor point representing an AW site only. The detailed modelling results also takes into account background ammonia concentrations and nitrogen deposition to determine the process environmental contribution (PEC) where the process contribution from the Gaer alone exceeds the lower insignificance threshold. Acid deposition impacts have also been screened out and are not considered in the detailed assessment. The results from the detailed modelling are shown graphically as contour plots in Figure 5.1 and Figure 5.2 respectively for ammonia and nitrogen deposition.

5.2.1 Ammonia Concentrations

The results of the detailed model run show that predicted process contributions to atmospheric ammonia concentrations are below 1% at all receptor points representing the SAC's and SSSIs. The predicted process contributions are also below 100% of the relevant Critical Level for receptor point 21 representing the nearest AW site. In accordance with the criteria set out in the Environment Agency's latest intensive farming risk assessment guidance (2016) and NRWs GN20 guidance (2017), the predicted process contributions at all designated conservation sites should therefore be considered to be insignificant.

5.2.2 Nitrogen Deposition

The detailed modelling results show that predicted process contributions to nutrient nitrogen deposition rates at discrete receptor point 21 which represents the closest AW site to the poultry unit is below 100% of the relevant Critical Load. In accordance with the criteria set out in the Environment Agency's latest intensive farming risk assessment guidance (2016) and NRWs GN20 guidance (2017), the predicted process contributions for all AW sites should therefore be considered to be insignificant.

The detailed modelling results show that predicted process contributions to nitrogen deposition at receptor points 3 and 6 representing the Montgomery Canal SAC/SSSI are at or slightly above 1% of the precautionary relevant Critical Load of 3 kg/N/ha/yr, but significantly below the upper 8% threshold. The highest maximum annual mean nitrogen deposition process contribution is predicted at receptor point 6 (1.1%). In accordance with NRW's GN 20 guidance, where an exceedance of the lower (1%) threshold of the relevant Critical Load has been predicted, there is a requirement to consider process contributions in the context of background nitrogen deposition at the sensitive receptor. Table 5.4 provides the predicted environmental concentration, which is the addition of the process contribution with the background levels of nutrient nitrogen for receptor points 3 and 6 that represent the Montgomery Canal SAC/SSSI.

The predicted environmental concentration exceeds the Critical Load at both receptor points representing the Montgomery Canal SAC/SSSI because the background levels of nutrient nitrogen (19.6kg/N/yr) already exceeds the Critical Load.

It is important to note that empty periods, which amount to approximately 87 days per year were not factored into the calculation of gross ammonia emissions for the poultry unit at The Gaer, therefore both the initial screening and detailed model results represent overly pessimistic-predictions of the actual ammonia impacts and resultant nitrogen/acid deposition at sensitive receptors. Had empty days been taken into account the highest maximum annual mean nitrogen deposition process contribution predicted at receptor point 6 would have been well below 1% of the Critical Load.

Furthermore the lower Critical Load of 3 kg/N/yr was used to represent the worst case scenario with respect to receptors representing the Montgomery Canal SAC/SSSI. Had the upper Critical Load of 10 kg/N/yr been applied the process contributions to nitrogen deposition would have all been below 1%.

Table 5.3: Predicted Maximum Process Contribution to Annual Mean Ammonia Concentrations and Nitrogen Deposition – Detailed Model Run

Receptor	X (m)	Y (m)	Receptor Location	Maximum Annual Mean Ammonia Concentration (2011 – 2015)			Maximum Annual Mean Nitrogen Deposition (2011 – 2015)		
				Cle (µg/m³)	PC (µg/m³)	% of Cle	Clo (kg N/ha/yr)	PC (kg N/ha/yr)	% of Clo
2	317141.4	315165.1	Allt Y Main Mine / Tanat and Vyrnwy Bat Sites / Safleoedd Ystlumod Tanat ac Efyrnwy	3	0.0090	0.3	10	0.07	0.7
3	324246.5	313824.3	Montgomery Canal	3	0.0061	0.2	3	0.03	**1.1**
4	324682.8	314426.6	Montgomery Canal	3	0.0049	0.2	3	0.03	0.8
5	325340.4	314789.1	Montgomery Canal	3	0.0048	0.2	3	0.02	0.8
6	325733.6	315483.5	Montgomery Canal	3	0.0065	0.2	3	0.03	**1.1**
7	325248.2	313676.9	Montgomery Canal	3	0.0043	0.1	3	0.02	0.7
8	325684.5	311980.8	Montgomery Canal	3	0.0029	0.1	3	0.02	0.5
9	322095.8	311593.7	Granllyn	3	0.0089	0.3	10	0.07	0.7
10	322409.2	311771.9	Granllyn	3	0.0089	0.3	10	0.07	0.7
13	324352.1	317885.1	Gweunydd-Ty-Brith (Ty-Brith Meadows)	3	0.0097	0.3	10	0.05	0.5
14	324338.7	317708.0	Gweunydd-Ty-Brith (Ty-Brith Meadows)	3	0.0104	0.3	15	0.05	0.4
21	320387.4	315440.5	Ancient Woodland (Unknown Name)	3	1.0913	36.4	10	8.50	85.0

Cle – Critical Level

Clo – Critical Load

PC – Process Contribution

Table 5.4: Predicted Maximum Process Environmental Contribution to Annual Nitrogen Deposition – Detailed Model Run

Receptor	X (m)	Y (m)	Receptor Location	Maximum Annual Mean Nitrogen Deposition (2011 – 2015)				
				Clo (kg N/ha/yr)	PC (kg N/ha/yr)	Background Nitrogen (kg N/ha/yr)	PEC (kg N/ha/yr)	% of Clo
3	324246.5	313824.3	Montgomery Canal	3	0.03	19.6	19.63	**654.36**
6	325733.6	315483.5	Montgomery Canal	3	0.03	19.6	19.63	**654.44**

Clo – Critical Load

PC – Process Contribution

PEC – Process Environmental Contribution

Figure 5.1: Predicted Maximum Annual Mean Ammonia Concentration - Detailed Modelling

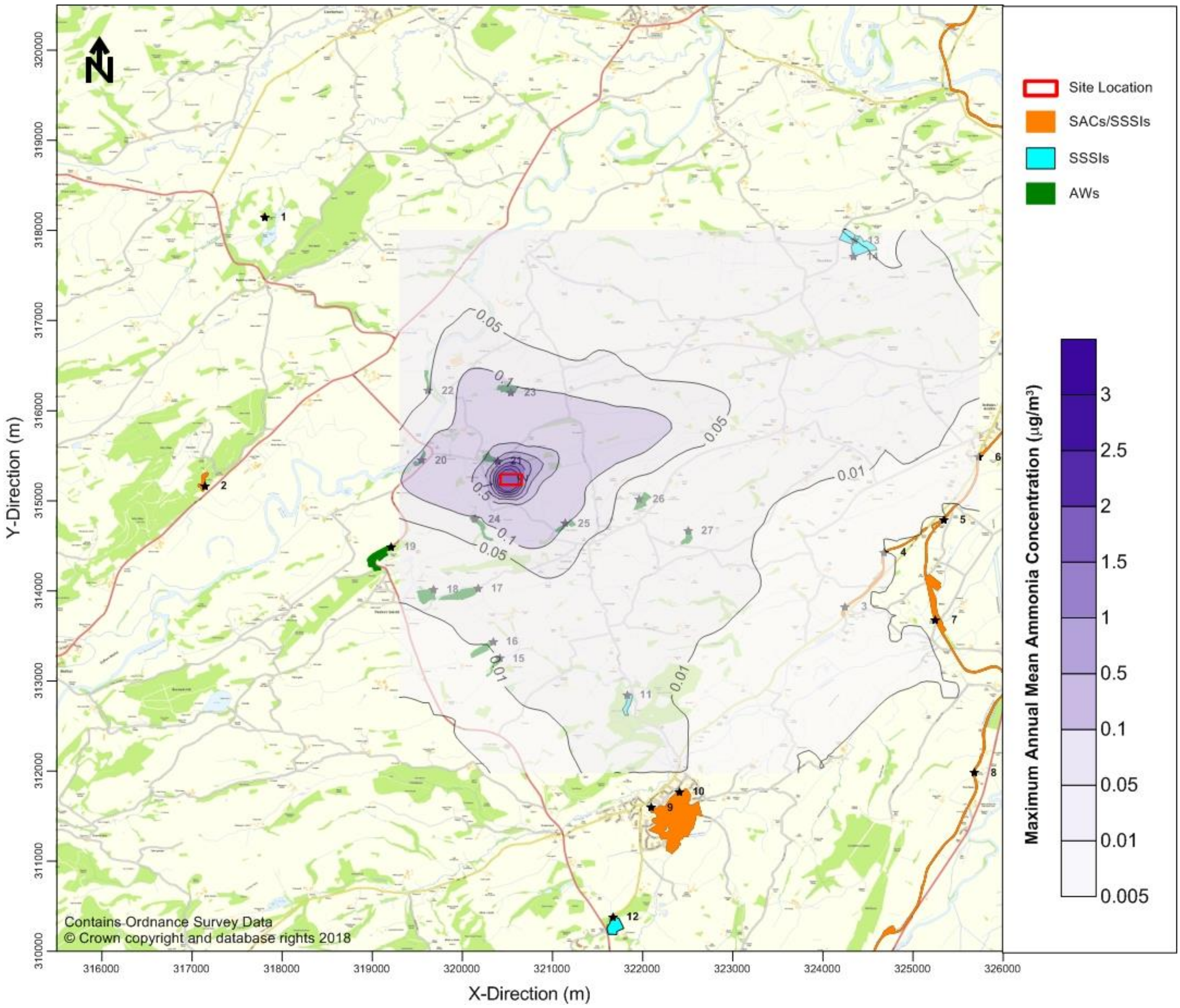
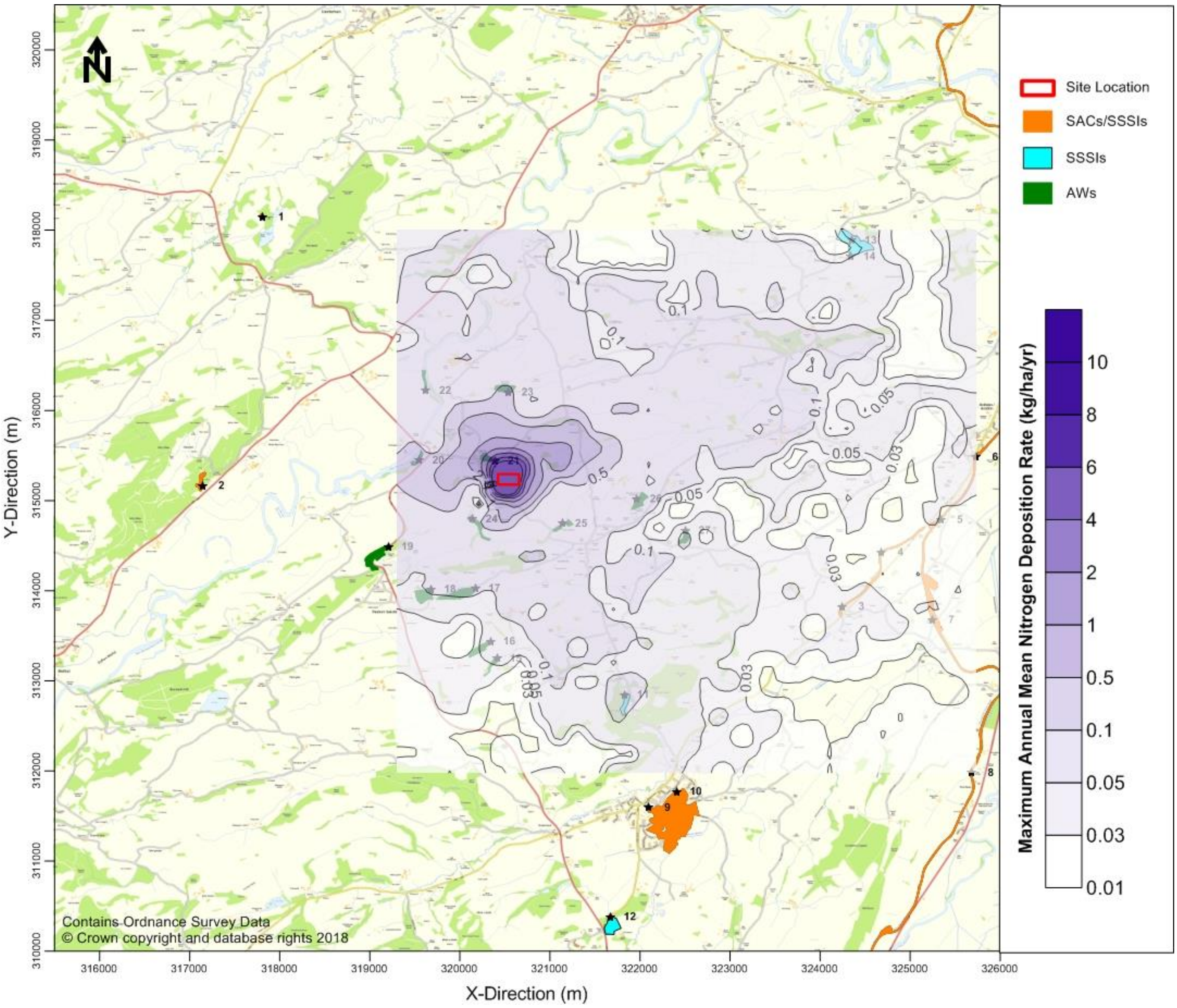


Figure 5.2: Predicted Maximum Annual Mean Nitrogen Deposition Rates - Detailed Modelling



6 CONCLUSIONS

RSK Environment Ltd has been commissioned by Mr David Langford, to conduct a study to assess the potential impact of ammonia emissions and resultant nitrogen and acid deposition from a proposed expansion of the poultry unit at The Gaer, Meifod, Powys. The aim of the study is to focus on how ammonia emissions and resultant deposition from the proposed expansion may affect discrete ecological receptors within designated conservation sites in the surrounding area.

Ammonia emissions and associated nitrogen deposition from the proposed expanded poultry unit at The Gaer have therefore been assessed and quantified using the EA standardised ammonia emission figures. These emission rates have been used in atmospheric dispersion modelling in order to predict the potential process contribution of the proposed expanded poultry unit to ammonia concentrations and resultant nitrogen/acid deposition at nearby conservation sites, firstly through an initial screening model run, and then with detailed dispersion modelling where required, in accordance with the EA's 'Guidance on modelling the concentration and deposition of ammonia emitted from intensive farming'.

The results of the screening modelling run, with a precautionary assumption of no "empty days" in the poultry buildings, show that predicted process contributions to atmospheric ammonia concentrations were below the lower threshold of 1% of the relevant Critical Level for all discrete receptor points representing the closest points of all SACs/SSSIs and are also below 100% of the relevant Critical Level for receptors representing all AWs. In contrast, preliminary results of predicted nitrogen deposition rates indicated slight exceedances of the lower threshold of 1% of the Critical Load at 12 discrete receptor points representing the SACs/SSSIs. However, the predicted nitrogen deposition rates were appreciably below the upper threshold of 8%. With respect to the AWs, just one discrete receptor representing the closest AW to the Gaer was predicted to exceed 100% of the relevant Critical Load. These receptors were therefore carried through to detailed modelling.

The results of the subsequent detailed model run, again with a precautionary assumption of no "empty days" in the poultry buildings, using spatially varying deposition fields, showed that predicted process contributions to atmospheric ammonia concentrations were again all below the relevant Critical Levels for all SACs/SSSIs and AWs.

With respect to predicted nitrogen deposition rates, very marginal exceedances of the lower threshold of 1% were predicted at two receptor points representing the Montgomery Canal SAC/SSSI, but were well below the upper threshold of 8%. Had empty days been taken into account, then the highest maximum annual mean nitrogen deposition process contribution predicted at the most critical location (receptor point 6) would have been below 1% of the Critical Load.

These process contributions were then considered in the context of background nitrogen deposition rates to give a process environmental contribution. However, the predicted environmental contribution exceeded the Critical Load at both receptor points representing the Montgomery Canal SAC/SSSI because the background levels of nutrient nitrogen already exceed the Critical Load.

It is important to note that empty periods, which amount to approximately 87 days per year were not factored in to the calculation of gross ammonia emissions for the poultry unit at The Gaer, therefore both the initial screening and detailed model results represent over-estimates of the actual ammonia impact and resultant nitrogen/acid deposition at sensitive receptors.

In terms of context, the IAQM (January 2016) position statement clarifies that any impacts that are markedly greater than 1% should be considered significant or imply damage, whereas for impacts that are only slightly greater than 1% a degree of professional judgement should be applied when determining risk. The contour plot in Figure 5.2 shows that most of the Montgomery Canal SAC/SSSI is below the 0.03 kg/ha/yr contour that would correspond to the 1% exceedance threshold.

It can therefore be reasoned that in this case the risk of adverse impacts on the designated sites as a result of the proposed expansion of the poultry unit at the Gaer are low and the effects on the designated sites are likely to not be significant.

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APPENDIX A
SOURCE PARAMETERS

Table A.1: Point Source Parameters

Source ID	Height (m)	Diameter (m)	Efflux velocity (m/s)	Temperature (°C)
Existing				
P1a	5.5	0.8	8.0	22
P1b	5.5	0.8	8.0	22
P1c	5.5	0.8	8.0	22
P1d	5.5	0.8	8.0	22
P1e	5.5	0.8	8.0	22
P1f	5.5	0.8	8.0	22
P2a	5.5	0.8	8.0	22
P2b	5.5	0.8	8.0	22
P2c	5.5	0.8	8.0	22
P2d	5.5	0.8	8.0	22
P2e	5.5	0.8	8.0	22
P2f	5.5	0.8	8.0	22
Proposed				
P3a	5.5	0.8	8.0	22
P3b	5.5	0.8	8.0	22
P3c	5.5	0.8	8.0	22
P3d	5.5	0.8	8.0	22
P3e	5.5	0.8	8.0	22
P3f	5.5	0.8	8.0	22
P4a	5.5	0.8	8.0	22
P4b	5.5	0.8	8.0	22
P4c	5.5	0.8	8.0	22
P4d	5.5	0.8	8.0	22
P4e	5.5	0.8	8.0	22
P4f	5.5	0.8	8.0	22

Table A.2: Volume Source Parameters

Source ID	Base height (m)	Depth (m)	Volume (m^3)
Existing			
P1v	0	4	370
P2v	0	4	370
Proposed			
P3v	0	4	370
P4v	0	4	370