A Report on the Modelling of the Dispersion and Deposition of Ammonia from the Existing and Proposed Broiler Chicken Rearing Houses at Swarbrick Hall Poultry Unit, off Singleton Road, near Weeton, in Lancashire

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1. Introduction

AS Modelling & Data Ltd. has been instructed by Mr. Steve Raasch, on behalf of Mr. John Smith, to use computer modelling to assess the impact of ammonia emissions from the existing and proposed broiler chicken rearing houses at Swarbrick Hall Poultry Unit, Singleton Lane, near Weeton, Preston in Lancashire. PR4 3JJ.

Ammonia emission rates have been assessed and quantified based upon the Environment Agency standard ammonia emission factors. The emission rates have then been used as inputs to an atmospheric dispersion and deposition model which calculates ammonia exposure levels and nitrogen and acid deposition rates in the surrounding area.

This report is arranged in the following manner:

- Section 2 provides relevant details of the site and potentially sensitive receptors in the area.

- Section 3 provides some general information on ammonia; details of the method used to estimate ammonia emissions; relevant guidelines and legislation on exposure limits and where relevant, details of likely background levels of ammonia.

- Section 4 provides some information about ADMS, the dispersion model used for this study and details the modelling procedure.

- Section 5 contains the results of the modelling.

- Section 6 provides a discussion of the results and conclusions.

2. Background Details

Swarbrick Hall Poultry Unit is in a semi-rural area, approximately 1 km to the north-east of the village of Weeton in Lancashire. The site is at an elevation of around 25 rising towards slightly higher ground to the south and falling gently to the north. The surrounding land is used for arable farming and there is a school and holiday park to the northwest of the site.

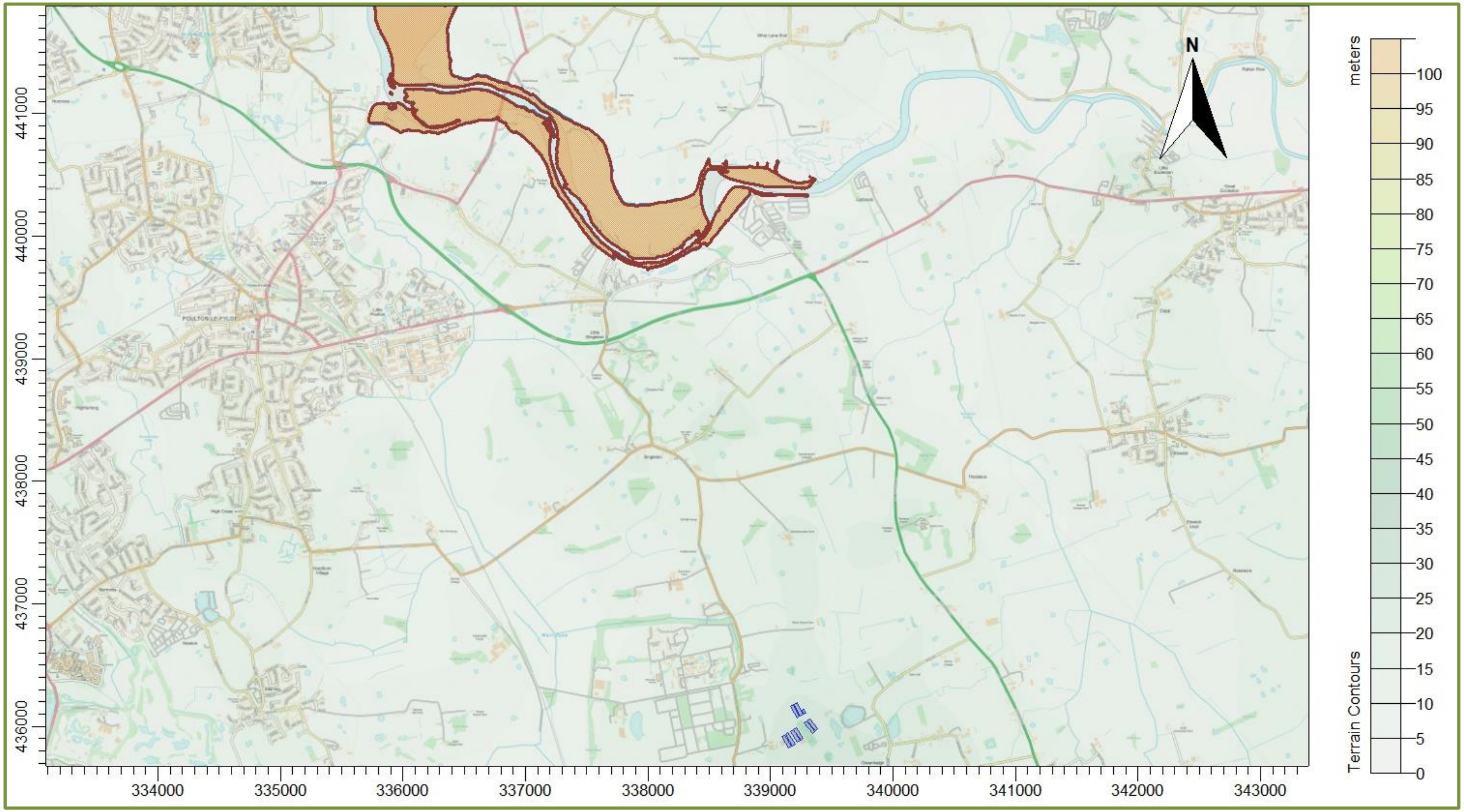
Currently, there are six existing poultry houses at Swarbrick Hall Poultry Unit. The existing poultry houses provide accommodation for up to 350,000 broiler chickens. The poultry houses are ventilated by high-speed ridge fans, each with a short chimney. The birds are raised from day old chicks to around 38 days old and there are around 7.5 crops per year.

It is proposed that two new poultry houses be constructed at Swarbrick Hall Poultry Unit. The existing and proposed poultry houses would provide accommodation for a total of 450,000 broiler chickens. The poultry houses would be ventilated by high-speed ridge fans, each with a short chimney. The birds would be raised from day old chicks to around 38 days old and there would be around 7.5 crops per year.

At the Environment Agency's request, only wildlife sites identified in the pre-application report (EPR/XP3330VH/P001) have been considered.

A map of the surrounding area showing the positions of the poultry houses (outlined in blue) and the SPA/Ramsar site (shaded in orange) is provided in Figure 1.

Figure 1. The area surrounding the Swarbrick Hall Poultry Unit



3. Ammonia, Background Levels, Critical Levels & Loads & Emission Rates

3.1 Ammonia concentration and nitrogen and acid deposition

When assessing potential impact on ecological receptors, ammonia concentration is usually expressed in terms of micrograms of ammonia per metre cubed of air ($\mu g\text{-}NH_3/m^3$) as an annual mean. Ammonia in the air may exert direct effects on the vegetation or indirectly affect the ecosystem through deposition which causes both hyper-eutrophication (excess nitrogen enrichment) and acidification of soils. Nitrogen deposition, specifically in this case the nitrogen load due to ammonia deposition/absorption, is usually expressed in kilograms of nitrogen per hectare per year (kg-N/ha/y). Acid deposition is expressed in terms of kilograms equivalent (of H^+ ions) per hectare per year (keq/ha/y).

3.2 Background ammonia levels and nitrogen and acid deposition

The source of the background figures is the Air Pollution Information System (APIS, July 2026). It should be noted that the 1 km APIS database background levels are extrapolated from 5 km modelled data. Ammonia levels may vary markedly over relatively short distances and the APIS website itself notes that, the background values should be used only to assist the user in obtaining a broad indication of the likely pollutant impact at a specific location and cannot be considered representative of any particular location within the 5 km grid square; extrapolation to a 1 km grid does not alter this.

The APIS figures for background ammonia concentration (2023) in the area around the site is 2.41 $\mu g\text{-}NH_3/m^3$. The background nitrogen deposition rate to woodland is 30.54 kg-N/ha/y and to short vegetation is 18.2 kg-N/ha/y. The background acid deposition rate to woodland is 2.29 keq/ha/y and to short vegetation is 1.39 keq/ha/y.

The APIS background figures are subject to correction and revision and appear to change fairly frequently, the latest figures can be obtained at https://www.apis.ac.uk/app.

In most cases, the APIS background figures, which are modelled, extrapolated and statistically manipulated figures, nevertheless, are the only figures available and although it is noted that the background values should be used only to assist in obtaining a broad indication of the likely pollutant impact, it is also noted that across the majority of the UK the lower bounds of the Critical Level and Critical Load are already exceeded.

3.3 Critical Levels & Critical Loads

Critical Levels and Critical Loads are a benchmark for assessing the risk of air pollution impacts to ecosystems. It is important to distinguish between a Critical Level and a Critical Load. The Critical Level is the gaseous concentration of a pollutant in the air, whereas the Critical Load relates to the quantity of pollutant deposited from air to the ground.

Critical Levels are defined as, "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" (UNECE).

Critical Loads are 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" (UNECE). However, AS Modelling & Data Ltd. would note that effects have been shown to occur at loads that are well below existing Critical Loads (as currently defined) and that these effects are likely to adversely impact the most sensitive species first. Furthermore, recent research suggests that responses are far from linear and where background levels are high and sensitive species that may be associated with the habitat have already been negatively impacted, or indeed are now absent, responses to changes in nitrogen load (in terms of biodiversity) are relatively limited compared to where background levels are low. Therefore, what is deemed significant (in terms of a percentage of Critical Load), where background levels are low, is not necessarily significant where background levels are high.

For ammonia concentration in air, the Critical Level for higher plants is 3.0 $\mu g\text{-}NH_3/m^3$ as an annual mean. For sites where there are sensitive lichens and bryophytes present, or where lichens and bryophytes are an integral part of the ecosystem, the Critical Level is 1.0 $\mu g\text{-}NH_3/m^3$ as an annual mean.

Critical Loads for nutrient nitrogen are set under the Convention on Long-Range Transboundary Air Pollution. They are based on empirical evidence, mainly observations from experiments and gradient studies. Critical Loads are given as ranges (e.g. 10-20 kg-N/ha/y); these ranges reflect variation in ecosystem response across Europe.

The Critical Levels and Critical Loads at the wildlife sites used as the assessment criteria at the relevant receptor locations are provided in Table 1. N.B. Where the Critical Level of 1.0 $\mu g\text{-}NH_3/m^3$ is assumed, it is usually unnecessary to consider the Critical Load as the Critical Level provides the stricter test. However, it may be necessary to consider nitrogen deposition should a Critical Load of 5.0 kg-N/ha/y be appropriate.

Normally, the Critical Load for nitrogen deposition provides a stricter test than the Critical Load for acid deposition, therefore acid deposition has not been considered further.

Please note that the assessment requirement is to use the lower bound of the range of Critical Loads for habitats that are present; however, the APIS database (https://www.apis.ac.uk/app) may contain Critical Levels and Critical Loads for species/habitats that are not present at the site or not present at the parts of the site under consideration.

Table 1. Critical Levels and Critical Loads at the wildlife sites

Site	Critical Level ($\mu g\text{-}NH_3/m^3$)	Critical Load Nitrogen (kg-N/ha/y)	Critical Load Acid (keq/ha/y)
Morecambe Bay and Duddon Estuary SPA/Morecambe Bay Ramsar	1.0 [1&2]	5.0 [1 & 2]	-

1. Natural England have previously advised that a Critical Level of 3.0 ug/m^3 and Critical Load of 8.0 kg/ha should be applied across the Morecambe Bay SPA/Ramsar site (EPR/XP3330VH/V002). Whilst the Environment Agency have not provided evidence of when and why this advice was superseded, they have provided a new Critical Level of 1.0 ug/m^3 and Critical Load of 5.0 kg/ha to be applied.
2. Based upon APIS (https://www.apis.ac.uk/search-habitat-impacts) and the citation for the site. Note that the APIS database may contain entries habitats/species that are not present at the site or part of the site under consideration.
3. The lower bound of the range of Critical Load for habitats/species present at the site (https://www.apis.ac.uk/search-habitat-impacts) and Review and revision of empirical critical loads of nitrogen for Europe, 2022. Note that the APIS database may contain entries habitats/species that are not present at the site or part of the site under consideration.

3.4 Guidance on the Significance of Ammonia Emissions

3.4.1 Environment Agency Criteria

The Environment Agency and Department for Environment, Food & Rural Affairs published guidance "Intensive farming risk assessment for your environmental permit" (last updated August 2025) applies to ammonia emitting developments requiring a permit. The Environment Agency ammonia screening thresholds for designated nature conservation sites are given in Table 2.

Table 2. Environment Agency Screening Thresholds

Nature conservation site designation	Distance from site (km)	Lower threshold %	Upper threshold %
Special Protection Areas (SPAs), Special Areas of Conservation (SACs), Ramsar sites	5	1	No upper threshold
Sites of Special Scientific Interest (SSSIs)	5	20	50
Local nature sites (National Nature Reserves, Local Nature Reserves, Local Wildlife Sites, Ancient Woodlands)	2	100	100

If the predicted process contributions to Critical Level or Critical Load are below the lower threshold percentage, the impact is usually deemed acceptable.

If the predicted process contributions to Critical Level or Critical Load are in the range between the lower and upper thresholds, whether or not the impact is deemed acceptable is at the discretion of the Environment Agency. In making their decision, the Environment Agency will consider whether other farming installations might act in-combination with the farm and the sensitivities of the wildlife sites. In the case of LWSs and AWs, the Environment Agency do not usually consider other farms that may act in-combination and therefore a Process Contribution of up to 100% of Critical Level and/or Critical Load is usually deemed acceptable for permitting purposes and therefore the upper and lower thresholds are the same (100%).

3.5 Quantification of Ammonia Emissions

Ammonia emission rates from poultry housing depend on many factors and are likely to be highly variable. However, the benchmarks for assessing impacts of ammonia and nitrogen deposition are framed in terms of an annual mean ammonia concentration and annual nitrogen deposition rates. To obtain relatively robust figures for these statistics, it is not necessary to model short term temporal variations and a steady continuous emission rate can be assumed. In fact, modelling short term temporal variations might introduce rather more uncertainty than modelling continuous emissions.

The emission factor used for the broiler chicken rearing houses has been obtained from: https://www.gov.uk/guidance/ammonia-emission-factors-for-pig-and-poultry-screening-modelling-and-reporting#ammonia-emission-factors-for-poultry.

Details of the poultry numbers and type, emission factor used and calculated ammonia emission rates are provided in Table 3.

Table 3. Details of poultry numbers and ammonia emission rates

Housing	Bird numbers (broilers)	Emission Factor (kg-NH_3/place/y)	Emission rate (g-NH_3/s)
Existing Scenario	350,000	0.024	0.266180
Proposed Scenario	450,000	0.024	0.342231

4. The Atmospheric Dispersion Modelling System (ADMS) and model parameters

The Atmospheric Dispersion Modelling System (ADMS) ADMS 6 is a new generation Gaussian plume air dispersion model, which means that the atmospheric boundary layer properties are characterised by two parameters: the boundary layer depth, and the Monin-Obukhov length rather than in terms of the single parameter Pasquill-Gifford class.

Dispersion under convective meteorological conditions uses a skewed Gaussian concentration distribution (shown by validation studies to be a better representation than a symmetrical Gaussian expression).

ADMS has several model options, that include dry and wet deposition; NO_x chemistry; impacts of hills, variable roughness, buildings and coastlines; puffs; fluctuations; odours; radioactivity decay (and γ-ray dose); condensed plume visibility; time varying sources and inclusion of background concentrations.

ADMS has an in-built meteorological pre-processor that allows flexible input of meteorological data both standard and more specialist. Hourly sequential and statistical data can be processed, and all input and output meteorological variables are written to a file after processing.

The user defines the pollutant, the averaging time (which may be an annual average or a shorter period), which percentiles and exceedance values to calculate, whether a rolling average is required or not and the output units. The output options are designed to be flexible to cater for the variety of air quality limits, which can vary from country to country and are subject to revision.

4.1 Meteorological data

Computer modelling of dispersion requires hourly sequential meteorological data and to provide robust statistics the record should be of a suitable length; preferably four years or longer.

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)[1].

The GFS physics are discrete. The physics/dynamics model has a resolution or had an equivalent resolution of approximately 7 km over the UK; terrain is understood to be resolved at a resolution of approximately 2 km, with sub-7 km terrain effects parameterised. Site specific data may be extrapolated from nearby archive grid points or a most representative grid point chosen. The GFS resolution adequately captures major topographical features and the broad-scale characteristics of the weather over the UK. Smaller scale topological features may be included in the dispersion modelling by using the flow field module of ADMS (FLOWSTAR[2]). The use of NWP data has advantages over traditional meteorological records because:

- Calm periods in traditional records may be overrepresented because the instrumentation used may not record wind speed below approximately 0.5 m/s and start up wind speeds may be greater than 1.0 m/s. In NWP data, the wind speed is continuous down to 0.0 m/s, allowing the calms module of ADMS to function correctly.

- Traditional records may include very local deviations from the broad-scale wind flow that would not necessarily be representative of the site being modelled; these deviations are difficult to identify and remove from a meteorological record. Conversely, local effects at the site being modelled are relatively easy to impose on the broad-scale flow and provided horizontal resolution is not too great, the meteorological records from NWP data may be expected to represent well the broad-scale flow.

- Information on the state of the atmosphere above ground level which would otherwise be estimated by the meteorological pre-processor may be included explicitly.

A wind rose showing the distribution of wind speeds and directions in the GFS derived data is shown in Figure 2a. Wind speeds are modified by the treatment of roughness lengths (see Section 4.7) and because terrain data is included in the modelling, the raw GFS wind speeds and directions will be modified. The terrain and roughness length modified wind rose for the site is shown in Figure 2b. Please note that FLOWSTAR[2] is used to obtain a local flow field, not to explicitly model dispersion in complex terrain as defined in the ADMS User Guide; therefore, the ADMS default value for minimum turbulence length has been amended[3].

As discussed above, the use of NWP data (suitably processed and quality controlled), removes the usual uncertainties and gross errors associated with using "representative" data from a remote meteorological station.

1. The GFS data used is derived from the high-resolution operational GFS datasets, the data is not obtained from the lower resolution (0.5 degree) long-term archive.
2. Note that FLOWSTAR requirements are for meteorological data representative of the upwind flow over the modelling domain and that single site meteorological data (observational or from high resolution modelled

data) that is representative of the application site is not generally suitable (personal correspondence: CERC 2019 and UK Met O 2015). If data are deemed representative of a particular application site, either wholly or partially, then these data cannot also be representative of the upstream flow over the modelling domain. Furthermore, it would be extremely poor practice to use such data as the boundary conditions for a flow-solver, such as FLOWSTAR.

3. When modelling complex terrain with ADMS, by default, the minimum turbulence length has 0.1 m added to the flat terrain value (calculated from the Monin-Obukhov length). Whilst this might be appropriate over hill/mountain tops in terrain with slopes > 1:10 (and quite possibly only in certain wind directions) in lesser terrain it introduces model behaviour that is not desirable where FLOWSTAR is simply being used to modify the upwind flow. Specifically, the parameter sigma z of the Gaussian plume model is overly constrained, which for elevated point sources emissions, may on occasion cause over prediction of ground level concentrations in stable weather conditions and light winds (Steven R. Hanna & Biswanath Chowdhury, 2013), conversely for low level emission sources, this will cause gross under prediction. Note that this becomes particularly important overnight and if calm and light wind conditions are not being ignored, as they often are when using traditional observational meteorological datasets. To reduce this behaviour, where terrain is modelled, AS Modelling & Data Ltd. have set a minimum turbulence length of 0.025 m in ADMS. This approximates the normal behaviour of ADMS with flat terrain.

Figure 2a. The wind rose. Raw GFS derived data for 53.818 N, 2.923 W, 2022-2025

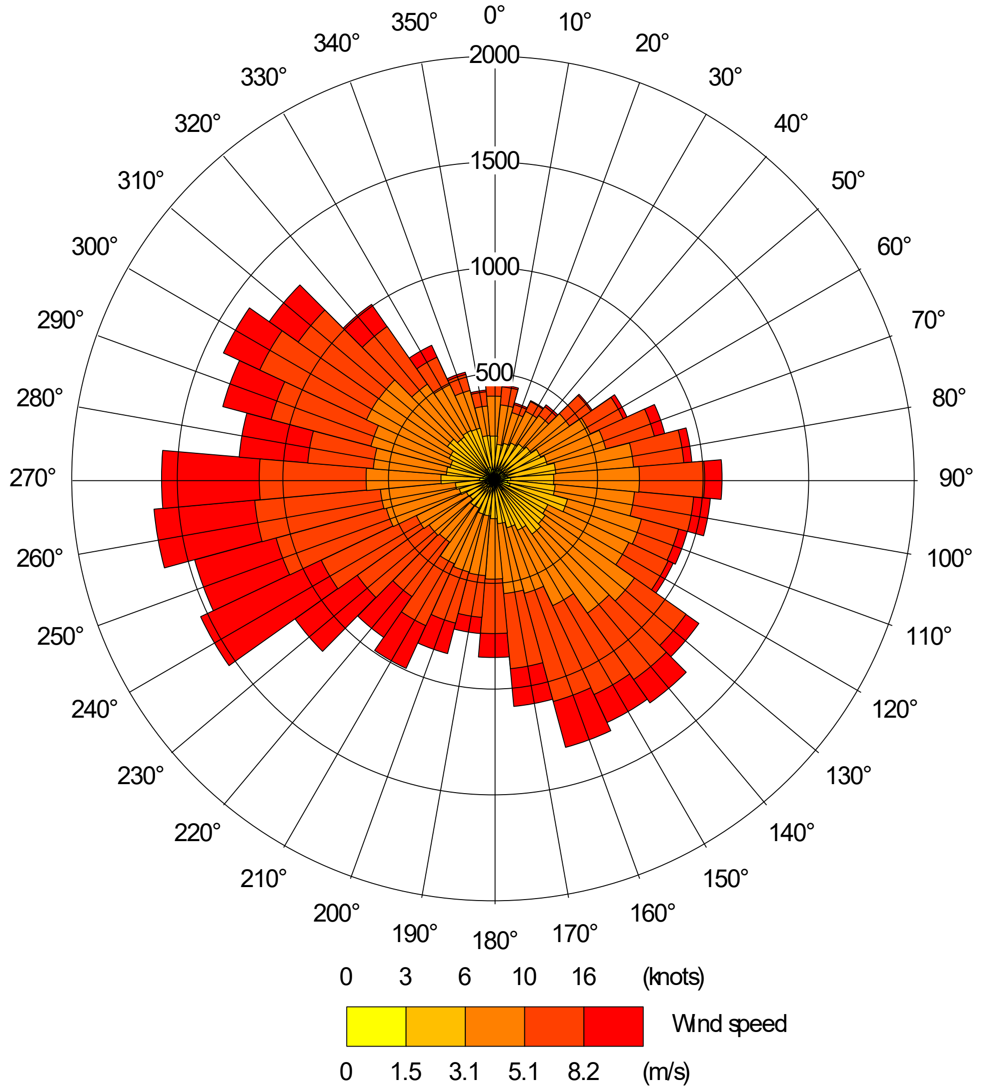
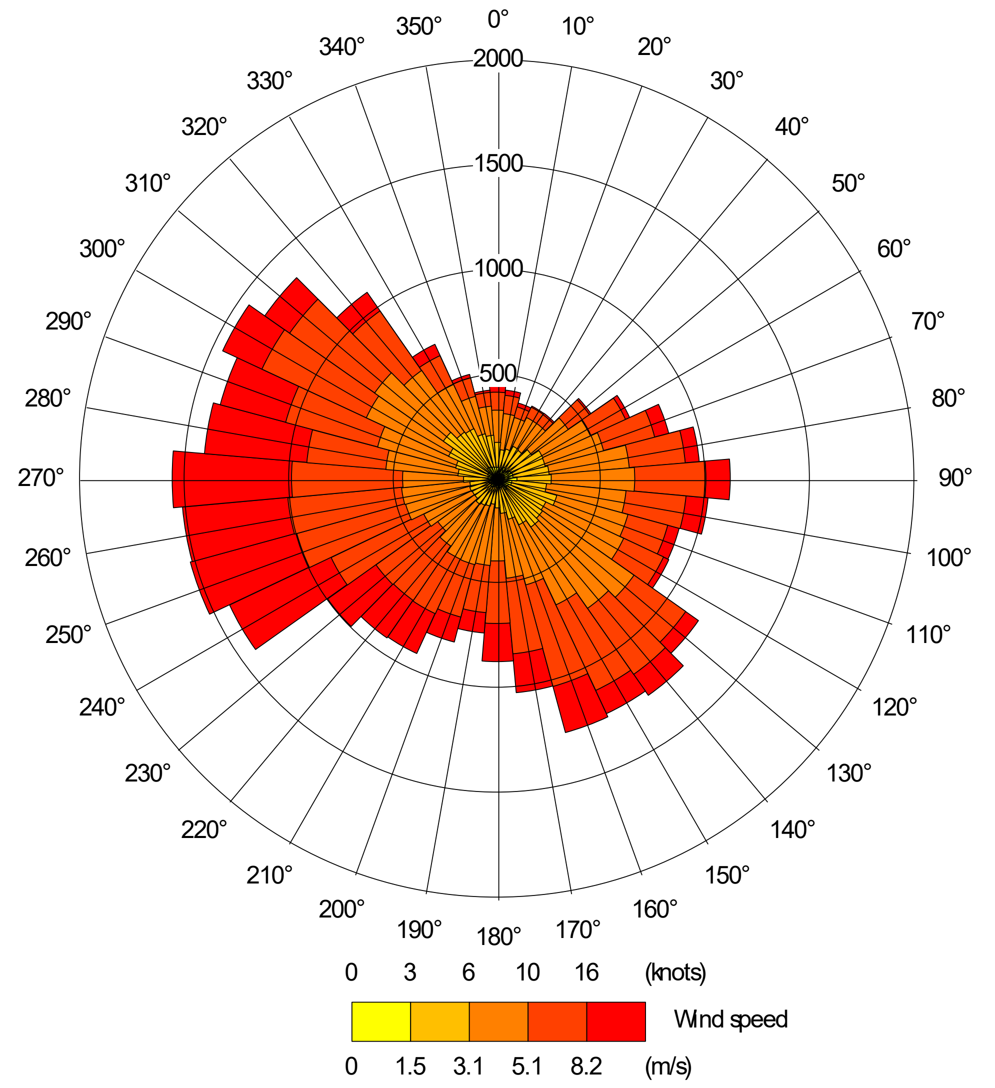


Figure 2b. The wind rose. FLOWSTAR modified GFS derived data for NGR 339200, 436150, 2022-2025



4.2 Emission sources

Emissions from the chimneys of the uncapped high-speed ridge fans that would be used for the ventilation of the poultry houses are characterised by three point sources per house within ADMS (EX1 to EX6; 1, 2 & 3, and PR1 to PR2; 1, 2 & 3).

Details of the emissions source parameters are shown in Table 4. The positions of the point sources used are shown in Figure 3, marked by green circles.

Table 4. Point source parameters

Source ID	Height (m)	Diameter (m)	Efflux velocity (m/s)	Emission temperature (˚C)	Baseline Emission rate per source (g-NH_3/s)
EX1 to EX6; 1, 2 & 3	5.5	0.8	11.0	22.0	0.014260 [1]
PR1 to PR2; 1, 2 & 3	5.5	0.8	11.0	22.0	0.014260

1. The baseline emission rate per source given is based on the proposed scenario of 56,250 broilers per house. For the results of the existing scenario the figures have been scaled to represent 58,333 broilers per house.

4.3 Modelled buildings

The structure of the poultry houses may affect the plumes from the point sources. Therefore, the buildings are modelled within ADMS. The positions of the modelled buildings may be seen in Figure 3 (marked by grey rectangles).

4.4 Discrete receptors

Thirteen discrete receptors have been defined at nearby wildlife sites, however the results at only four are reported as requested. These receptors are defined at ground level within ADMS. The positions of the discrete receptors may be seen in Figure 4 (marked by enumerated pink rectangles).

4.5 Cartesian grid

To produce the contour plots presented in Section 5 of this report and to define the spatially varying deposition velocity field, a regular Cartesian grid has been defined within ADMS. The individual grid receptors are defined at ground level within ADMS. The position of the Cartesian grid may be seen in Figure 4 (marked by grey lines).

4.6 Terrain data

Terrain has been considered in the modelling. The terrain data are based upon the Ordnance Survey 50 m Digital Elevation Model. A 20.0 km by 20.0 km domain has been resampled at 100 m horizontal resolution for use within ADMS for the modelling. The resolution of FLOWSTAR is 64 x 64 grid points; therefore, the effective resolution of the wind field for the terrain runs is approximately 300 m.

4.7 Roughness Length

In this case, a spatially varying roughness length file has been defined, this is based upon the Defra Living England 25 m land use database. The GFS meteorological data is assumed to have a roughness length of 0.19 m (arithmetic average of the spatially varying roughness over the modelling domain). The sample of the central area of the spatially varying roughness length field is shown in Figure 5.

Figure 3. The positions of modelled buildings and sources

Figure 4. The discrete receptors and regular Cartesian grids

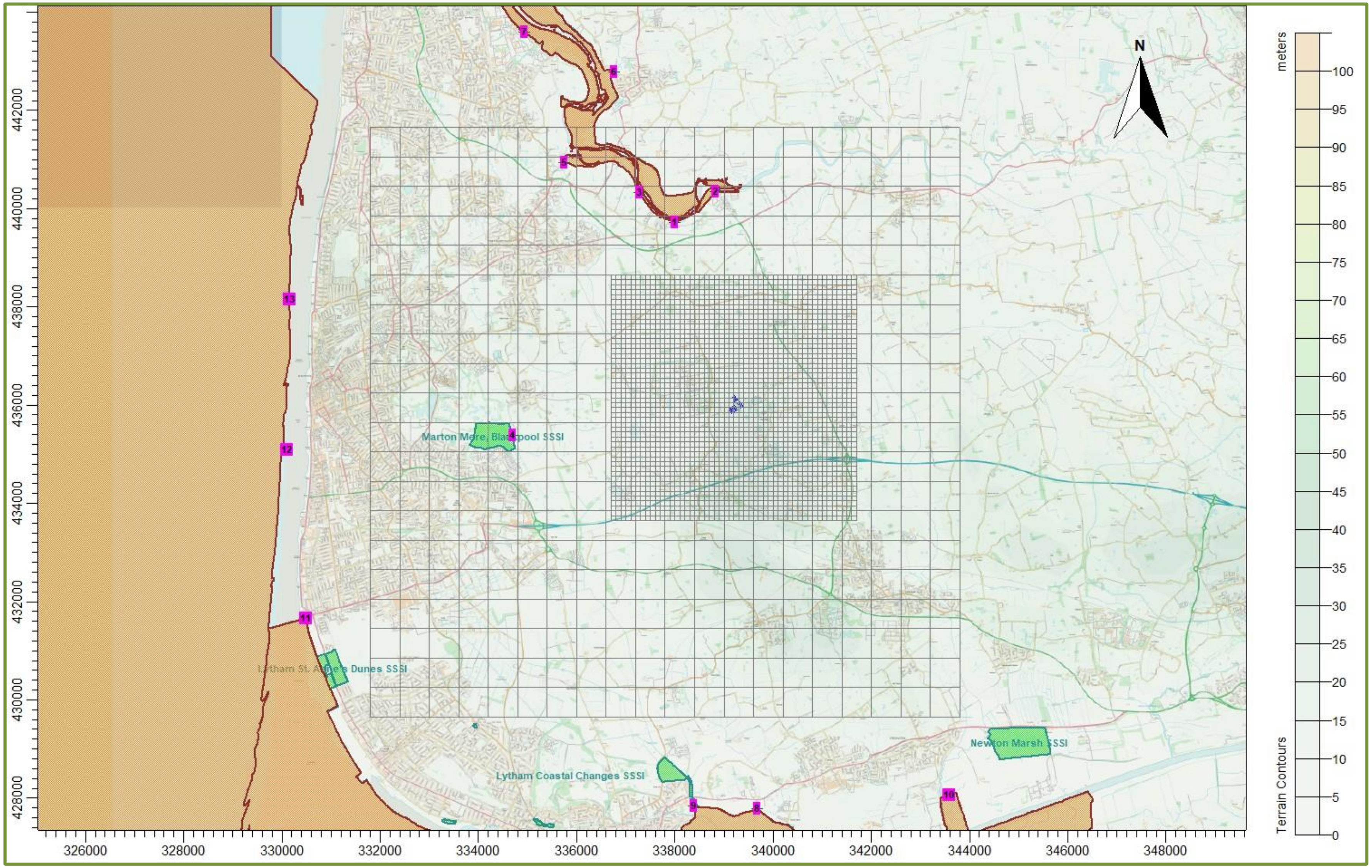
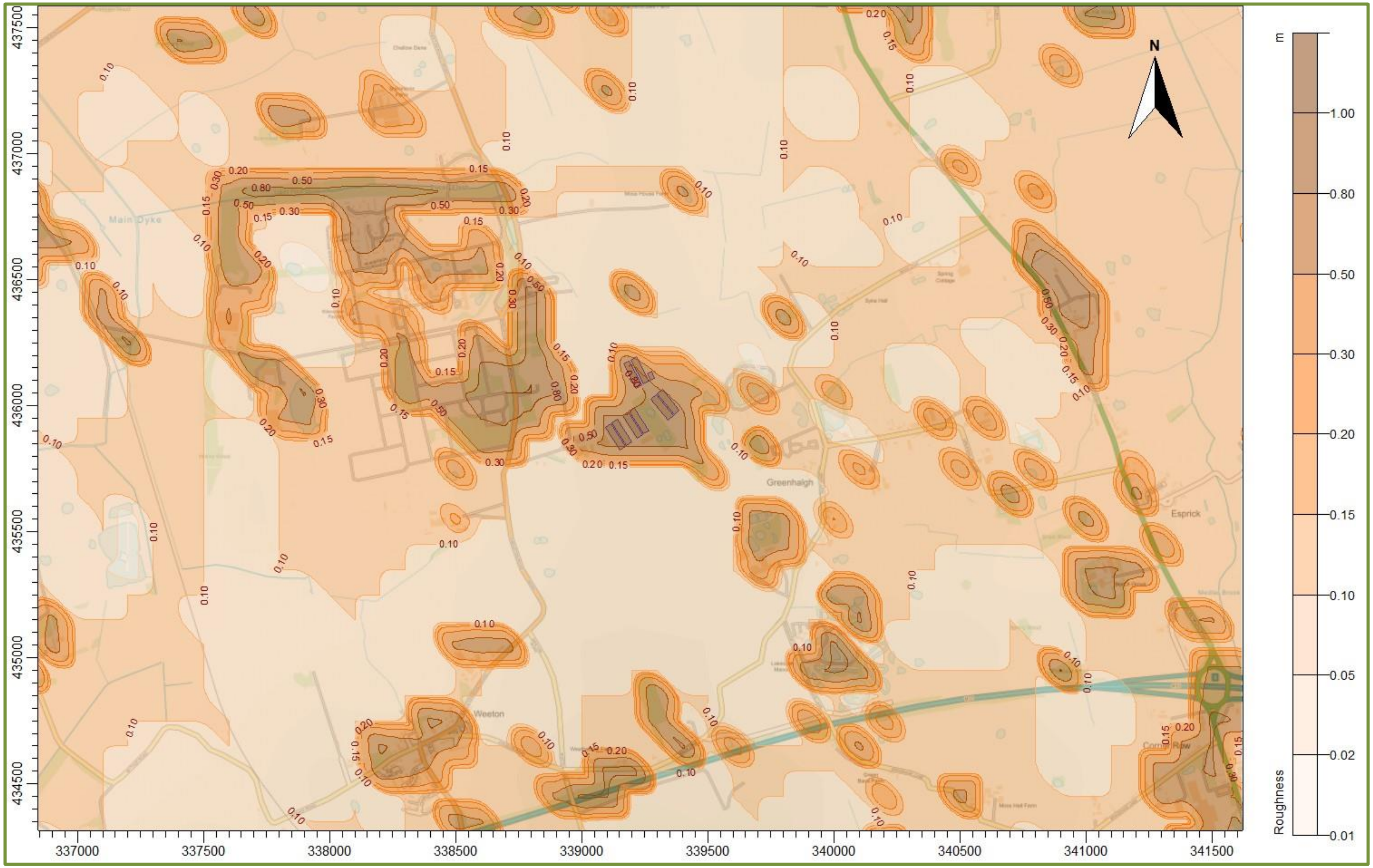


Figure 5. The spatially varying surface roughness field (central area)



4.8 Deposition

The method used to model deposition of ammonia and consequent plume depletion is based primarily upon Frederik Schrader and Christian Brümmer. Land Use Specific Ammonia Deposition Velocities: a Review of Recent Studies (2004-2013). AS Modelling & Data Ltd. has restricted deposition over arable farmland and heavily grazed and fertilised pasture; this is to compensate for possible saturation effects due to fertilizer application and to allow for periods when fields are clear of crops (Sutton), the deposition is also restricted over areas with little or no vegetation and the deposition velocity is set to 0.002 m/s where grid points are over the poultry housing and 0.010 m/s to 0.015 m/s over heavily grazed grassland. Where deposition over water surfaces is calculated, a deposition velocity of 0.005 m/s is used.

In summary, the method is as follows:

- A preliminary run of the model without deposition is used to provide an ammonia concentration field.
- The preliminary ammonia concentration field, along with land usage, has been used to define a deposition velocity field. The deposition velocities used are provided in Table 5.

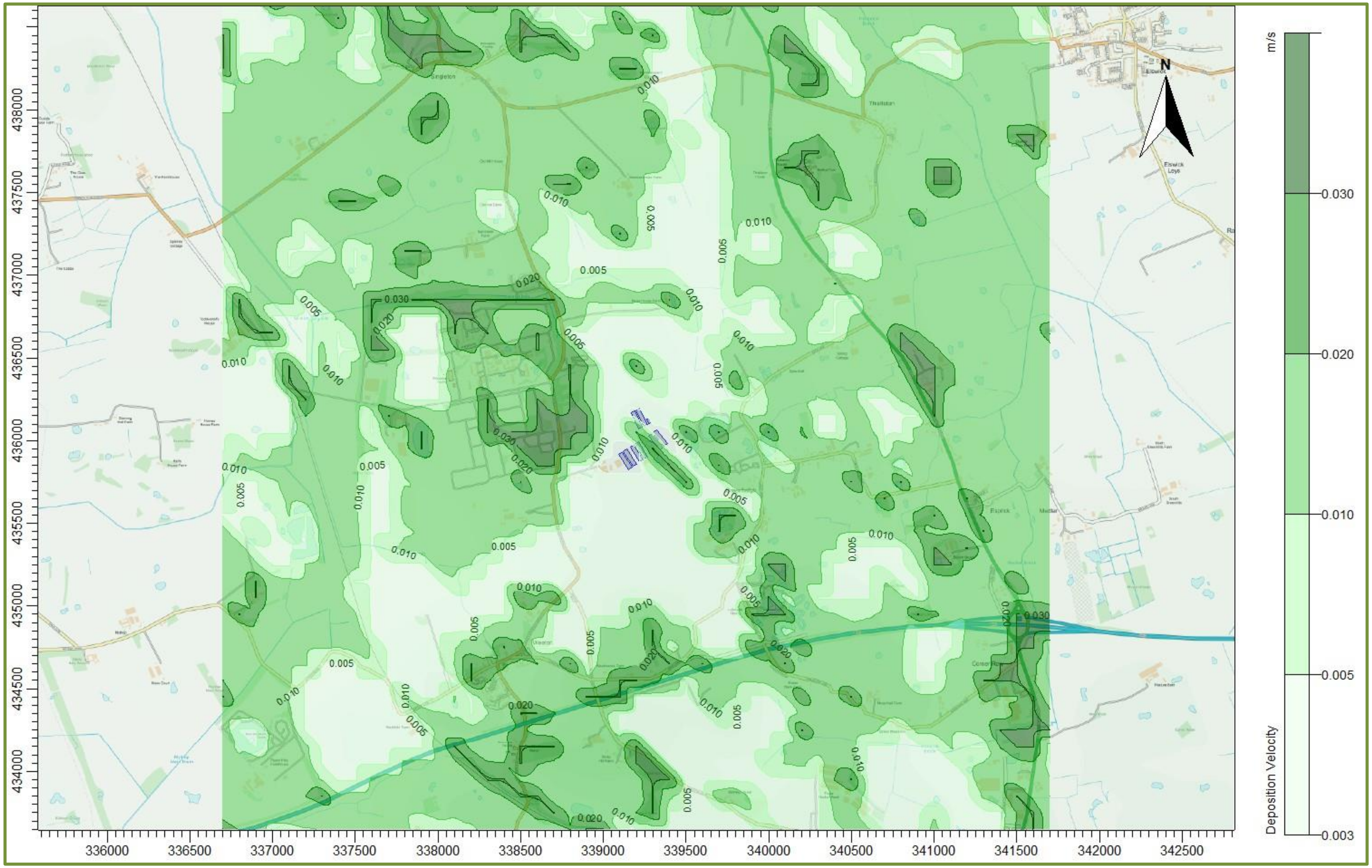
Table 5. Deposition velocities

NH_3 concentration (PC + background) ($\mu g/m^3$)	< 10	10 - 20	20 - 30	30 - 80	> 80
Deposition velocity - woodland (m/s)	0.03	0.015	0.01	0.005	0.003
Deposition velocity - short vegetation (m/s)	0.02 (0.010 to 0.015 over heavily grazed grassland)	0.015	0.01	0.005	0.003
Deposition velocity - arable farmland/rye grass (m/s)	0.005	0.005	0.005	0.005	0.003

- The model is then rerun with the spatially varying deposition module.

A contour plot of the spatially varying deposition field is provided in Figure 6.

Figure 6. The spatially varying deposition field



5. Details of the Model Runs and Results

5.1 Preliminary modelling and model sensitivity tests

ADMS was effectively run a total of eight times: once for each year of the meteorological record and in the following modes:

- In basic mode without calms, or terrain – GFS data.
- With calms and without terrain – GFS data.

For each mode, statistics for the maximum annual mean ammonia concentration at each receptor were compiled. Details of the predicted annual mean ammonia concentrations at each receptor are provided in Table 6. The primary purpose of the preliminary modelling is to assess the effect of calms on the results. In this case, the preliminary modelling shows that calms is not significant.

Table 6. Predicted maximum annual mean ammonia concentration at the discrete receptors – preliminary modelling

Receptor number	X(m)	Y(m)	Name/Designation	Maximum annual mean ammonia concentration ($\mu g/m^3$)			
				Existing Scenario		Proposed Scenario	
				GFS No Calms No Terrain	GFS Calms No Terrain	GFS No Calms No Terrain	GFS Calms No Terrain
1	338000.7	439727	Morecambe Bay and Duddon Estuary SPA/Morecambe Bay Ramsar	0.020	0.020	0.027	0.027
2	338830.6	440339	Morecambe Bay and Duddon Estuary SPA/Morecambe Bay Ramsar	0.015	0.015	0.020	0.020
3	337277.4	440320	Morecambe Bay and Duddon Estuary SPA/Morecambe Bay Ramsar	0.018	0.017	0.024	0.024
5	335737.9	440933	Morecambe Bay and Duddon Estuary SPA/Morecambe Bay Ramsar	0.015	0.015	0.020	0.020

5.2 Detailed modelling

In this case, detailed modelling has been carried out over a high resolution 5.0 km x 5.0 km domain surrounding the site of the poultry houses. The primary purpose is to determine the magnitude of deposition of ammonia and consequent plume depletion close to the sources where it is of the greatest importance.

The predicted maximum annual mean ground level ammonia concentrations and maximum nitrogen deposition rates at the discrete receptors are shown in Tables 7a (existing scenario) and 7b (proposed scenario). In the Tables, the predicted ammonia concentrations or nitrogen deposition rates that are in excess of the Environment Agency lower threshold of 1% for internationally designated wildlife sites are coloured blue.

Table 7a. Predicted maximum annual mean ammonia concentrations and maximum annual nitrogen deposition – Existing Scenario

Receptor number	X(m)	Y(m)	Name	Site Parameters			Maximum annual ammonia concentration		Maximum annual nitrogen deposition rate	
				Deposition Velocity	Critical Level (µg/m³)	Critical Load (kg/ha)	Process Contribution (µg/m³)	%age of Critical Level	Process Contribution (kg/ha)	%age of Critical Load
1	338001	439727	Wyre Estuary SSSI/Morecambe Bay and Duddon Estuary SPA/Morecambe Bay Ramsar	0.005	1.0	5.0	0.013	**1.28**	0.017	0.33
2	338831	440339	Wyre Estuary SSSI/Morecambe Bay and Duddon Estuary SPA/Morecambe Bay Ramsar	0.005	1.0	5.0	0.009	0.91	0.012	0.24
3	337277	440320	Wyre Estuary SSSI/Morecambe Bay and Duddon Estuary SPA/Morecambe Bay Ramsar	0.005	1.0	5.0	0.010	**1.03**	0.013	0.27
5	335738	440933	Morecambe Bay and Duddon Estuary SPA/Morecambe Bay Ramsar	0.005	1.0	5.0	0.008	0.78	0.010	0.20

Table 7b. Predicted maximum annual mean ammonia concentrations and maximum annual nitrogen deposition – Proposed Scenario

Receptor number	X(m)	Y(m)	Name	Site Parameters			Maximum annual ammonia concentration		Maximum annual nitrogen deposition rate	
				Deposition Velocity	Critical Level (µg/m³)	Critical Load (kg/ha)	Process Contribution (µg/m³)	%age of Critical Level	Process Contribution (kg/ha)	%age of Critical Load
1	338001	439727	Wyre Estuary SSSI/Morecambe Bay and Duddon Estuary SPA/Morecambe Bay Ramsar	0.005	1.0	5.0	0.018	**1.76**	0.023	0.46
2	338831	440339	Wyre Estuary SSSI/Morecambe Bay and Duddon Estuary SPA/Morecambe Bay Ramsar	0.005	1.0	5.0	0.012	**1.23**	0.016	0.32
3	337277	440320	Wyre Estuary SSSI/Morecambe Bay and Duddon Estuary SPA/Morecambe Bay Ramsar	0.005	1.0	5.0	0.014	**1.40**	0.018	0.36
5	335738	440933	Morecambe Bay and Duddon Estuary SPA/Morecambe Bay Ramsar	0.005	1.0	5.0	0.011	**1.06**	0.014	0.28

6. Summary and Conclusions

Ammonia emission rates have been assessed and quantified based upon the Environment Agency standard ammonia emission factors. The emission rates have then been used as inputs to an atmospheric dispersion and deposition model which calculates ammonia exposure levels and nitrogen and acid deposition rates in the surrounding area.

The modelling predicts that:

- Process contributions to maximum annual mean ammonia concentrations and annual nitrogen deposition rates currently exceed the Environment Agency threshold of 1% of the relevant Critical Level/Load at Morecambe Bay and Duddon Estuary SPA/Morecambe Bay Ramsar site.
- Should the development at Swarbrick Hall Poultry Unit proceed, process contributions would increase at Morecambe Bay and Duddon Estuary SPA/Morecambe Bay Ramsar site by less than 1%.

7. References

Cambridge Environmental Research Consultants (CERC) (website).

Chapman, C. and Kite, B. Joint Nature Conservation Committee. Guidance on Decision-making Thresholds for Air Pollution.

Environment Agency and Department for Environment, Food & Rural Affairs “Intensive farming risk assessment for your environmental permit”, last updated August 2025 (website).

Steven R Hanna, & Biswanath Chowdhury. Minimum turbulence assumptions and u* and L estimation for dispersion models during low-wind stable conditions.

M. A. Sutton *et al*. Measurement and modelling of ammonia exchange over arable croplands.

Frederik Schrader and Christian Brümmer. Land Use Specific Ammonia Deposition Velocities: a Review of Recent Studies (2004-2013).

United Nations Economic Commission for Europe (UNECE) (website).

UK Air Pollution Information System (APIS) (website).