

# A Report on the Modelling of the Dispersion and Deposition of Ammonia from the Existing Egg Laying Chicken Houses and the Proposed Broiler Chicken Rearing Houses at Shucknall Poultry Farm, Weston Beggard Lane, Shucknall, Weston Beggard, Herefordshire

# AS Modelling & Data Ltd.

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# Introduction

AS Modelling & Data Ltd. has been instructed by Mr. Steve Raasch, on behalf of Faccenda Foods Limited, to use computer modelling to assess the impact of ammonia emissions from the existing breeder layer chicken houses and the proposed broiler chicken rearing houses at Shucknall Poultry Farm, Weston Beggard Lane, Shucknall, Weston Beggard, Herefordshire. HR1 4BJ.

Ammonia emission rates from the existing and proposed poultry houses have been derived from Environment Agency’s standard ammonia emission factors. These ammonia 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 farm 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.

# Background Details

Shucknall Poultry Farm is in a rural area, approximately 200 m to the south of the small village of Shucknall and approximately 2.2 km to the east-south-east of the village of Withington, in Herefordshire. The surrounding land use is a mixture of fodder or arable cultivation, orchards and woodland. The site is at an elevation of around 75 m with the land rising to Shucknall Hill to the north and falling gently towards the River Frome to the south, a tributary of the River Lugg, which flows into the River Wye around 5.5 km to the south-south-west.

There are four poultry houses at Shucknall Poultry Farm which are currently used to accommodate 37,118 (average over the last 5 production flocks) breeder layer hens and cockerels, these birds provid fertilised eggs that are transferred to hatcheries elsewhere. Manure collects within the poultry houses before they are cleared when the flock is replaced. Two of these poultry houses are ventilated by side fans with ridge inlets; the other two are ventilated by uncapped high speed ridge fans.

Under the proposals, rather than stocking breeder layers, the poultry houses would be used to stock up to 130,000 broiler chickens.

There is one area designated as an Ancient Woodland (AW) and four areas designated as Local Wildlife Sites (LWSs) within 2 km of Shucknall Poultry Farm. There are six Sites of Special Scientific Interest (SSSIs) within 5 km of the farm (the normal screening distance for a SSSI), one of which, The River Wye SSSI, is also designated as a Special Area of Conservation (SAC). There are a further ten areas designated as SSSIs within 10 km; however, there are no other SACs, nor Special Areas of Conservation (SPAs), nor Ramsar sites within 10 km (the normal screening distance for an internationally designated site). Some further details of the statutory wildlife sites are provided below:

* **Perton Roadside Section & Quarry SSSI** - approximately 2.0 km to the south-south-east. Geological.
* **Little Hill SSSI** - approximately 3.8 km to the south-south-east. Geological.
* **Lugg and Hampton Meadows SSSI** - approximately 4.0 km to the south-west. Species-rich neutral grasslands; traditionally managed hay meadows in the floodplain of the River Lugg - one of the oldest surviving Lammas meadows. There are also some breeding curlew *Numenius arquata* present.
* **Haugh Wood SSSI** - approximately 4.0 km to the south. A large block of woodland in a prominent position on the Woolhope Dome elevated area. There is a rich invertebrate fauna of national importance with butterflies and moths. There are also birds and mammals present - fallow deer *Dama dama*, badger *Meles meles*, dormouse *Muscardinus avellanarius* and pole cat *Putorius putorius*.
* **Woodshut Wood SSSI** - approximately 4.4 km to the south-south-west. A diverse, mixed woodland with some rare native tree species. There are also unimproved grasslands and other semi-natural habitats.
* **Scutterdine Quarry SSSI** - approximately 5.3 km to the south-south-west. Geological.
* **Sharpnage Wood SSSI** - approximately 5.2 km to the south-south-east. A diverse mixed woodland of coppice with standards with a very rich ground flora. There is also a small stream and pond supporting further interesting flora.
* **Cherry Hill Wood SSSI** - approximately 6.5 km to the south-south-west. Two blocks of diverse woodland on limestone and there is rich, diverse ground vegetation.
* **Common Hill SSSI** - approximately 7.0 km to the south. Noted for semi-natural woodland, unimproved grassland and invertebrate fauna. There is a mosaic of ancient woodland with typical ground flora and there is rich invertebrate fauna.
* **Lea & Pagets Woods SSSI** - approximately 7.6 km to the south. Locally one of the richest areas of woodland, of coppice with standards and typical ground flora.
* **Capler Wood SSSI** - approximately 9.5 km to the south. Ancient native broadleaved woodland with a good shrub layer and rich ground layer in parts, also rich in mosses and ferns.
* **Birch Wood SSSI** - approximately 9.8 km to the south-south-east. A diverse woodland with diverse ground vegetation.
* **Orchid Bank, Winslow Mill SSSI** - approximately 6.8 km to the south-south-east. A steep south facing pasture on limestone with rich vegetation.
* **Mains Wood SSSI** - approximately 6.2 km to the south-east. A remnant of ancient primary woodland unaffected by modern forestry. There is a rich flora, including ground flora and lower plant groups, particularly ferns and rare fungi.
* **Birchend SSSI** - approximately 8.2 km to the east-north-east. Two distinct ancient woodlands with extremely rich ground vegetation and there is some grassland. There are invertebrates also present including butterflies and rare moths.
* **River Wye SAC/SSSI** - approximately 4.0 km to the south-west (closest). A rare example of a near natural, large western eutrophic river which, unlike many rivers of a similar type, has not been subject to significant modification from human activities. The river is of special interest for three main aquatic plant community types - rivers on sandstone, mudstone and hard limestone, clay rivers and lowland rivers with minimal gradient, as well as for certain flowering plants and bryophytes. The SSSI incorporates adjacent areas of riparian habitat including wet woodland, marshy grassland, reed beds and topographical features which directly support the special interest of the river.

Maps of the surrounding area showing the positions of the poultry houses and the nearby wildlife sites are provided in Figures 1a and 1b. In these figures, AWs are shaded olive, the LWS is shaded yellow, the SSSIs are shaded green, the SAC is shaded purple and the positions of the poultry houses at Shucknall Farm are outlined in blue.

*Figure 1a. The area surrounding Shucknall Poultry Farm, with circles radii at 2.0 km (olive), 5.0 km (green) and 10.0 km (purple)*

A map of the area

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*Figure 1b. The area surrounding Shucknall Poultry Farm, a closer view*

A map with a circle in the middle

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# 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 (µg-NH3/m3) 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 2024). 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 andcannot 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 in the area around Shucknall Poultry Farm is 2.16 µg‑NH3/m3. The background nitrogen deposition rate to woodland is 32.84 kg-N/ha/y and to short vegetation is 19.38 kg-N/ha/y. The background acid deposition rate to woodland is 2.47 keq/ha/y and to short vegetation is 1.48 keq/ha/y.

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

## 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).

For ammonia concentration in air, the Critical Level for higher plants is 3.0 µg-NH3/m3 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 µg-NH3/m3 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 assumed in this study are provided in Table 1. Where the Critical Level of 1.0 µg-NH3/m3 is assumed, it is usually unnecessary to consider the Critical Load as the Critical Level provides the stricter test. Normally, the Critical Load for nitrogen deposition provides a stricter test than the Critical Load for acid deposition.

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

|  |  |  |  |
| --- | --- | --- | --- |
| Site | Critical Level  (µg-NH3/m3) | Critical Load - Nitrogen Deposition  (kg-N/ha/y) | Critical Load - Acid Deposition  (keq/ha/y) |
| AW & LWSs | 1.0 1 | - | - |
| Haugh Wood SSSI, Woodshuts Wood SSSI, Sharpnage Wood SSSI, Cherry Hill Wood SSSI, Common Hill SSSI, Lea & Pagets Woods SSSI, Capler Wood SSSI, Birch Wood SSSI, Mains Wood SSSI, Birchend SSSI | 1.0 1 & 2 | 10.0 2 & 3 | - |
| Lugg and Hampton Meadows SSSI, Orchid Bank, Winslow Hill SSSI, The River Wye SAC/SSSI | 3.0 2 | 10.0 2 & 3 | - |
| Perton Roadside Section And Quarry SSSI, Little Hill SSSI, Scutterdine Quarry SSSI | n/a 4 | n/a 4 | n/a 4 |

1. A precautionary figure used where details of the ecology of the site are unavailable or unassessed, or the citation for the site, indicates that sensitive lichens and/or bryophytes are present.
2. Based upon the citation for the site.
3. The lower bound of the range of Critical Loads for the site/species present at the site.
4. Geological.

## 3.4 Guidance on the significance of ammonia emissions

### 3.4.1 Environment Agency Criteria

The Environment Agency web-page titled “Intensive farming risk assessment for your environmental permit”, contains a set of criteria, with thresholds defined by percentages of the Critical Level or Critical Load, for: internationally designated wildlife sites (Special Protection Areas (SPAs), Special Areas of Conservation (SACs) and Ramsar sites); Sites of Special Scientific Interest (SSSIs) and other non-statutory wildlife sites. The lower and upper thresholds are: 4% and 20% for SACs, SPAs and Ramsar sites; 20% and 50% for SSSIs and 100% and 100% for non-statutory wildlife sites.

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; 4% to 20% for SACs, SPAs and Ramsar sites; 20% to 50% for SSSIs and 100% to 100% for other non-statutory wildlife sites, 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 PC of up to 100% of Critical Level or Critical Load is usually deemed acceptable for permitting purposes and therefore the upper and lower thresholds are the same (100%).

### 3.4.2 Natural England advisory criteria

Natural England are a statutory consultee at planning and usually advise that, if predicted process contributions exceed 1% (or lower in some circumstances) of Critical Level or Critical Load at a SSSI, SAC, SPA or Ramsar site, then the local authority should consider whether other farming installations1 might act in-combination or cumulatively with the farm and the sensitivities of the wildlife sites.

1. The process contribution from most farming installations is already included in the background ammonia concentrations and nitrogen and acid deposition rates. Therefore, it is normally only necessary to consider new installations and installations with extant planning permission and proposed developments when understanding the additional impact of a proposal upon nearby ecologies. However, established farms in close proximity may need to be considered given the background concentrations and deposition rates are derived as an average for a 5 km by 5 km grid.

### 3.4.3 Environment Agency and Natural England May 2022 Air Quality Risk Assessment Interim Guidance (reproduces in the Natural England letter of 21st November 2023)

Although it seems important to include a reference to this document, it appears to be primarily a discussion document about internal Environment Agency screening models and the SCAIL model and AS Modelling & Data Ltd. have been unable to draw any conclusions from the document as to what thresholds may or may not apply, nor in what circumstances the threshold may or may not apply.

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### 3.4.4 Joint Nature Conservancy Committee - Guidance on Decision-making Thresholds for Air Pollution

In December 2021, the Joint Nature Conservancy Committee (JNCC) published a report titled, “Guidance on Decision-making Thresholds for Air Pollution”. This report provides decision-making criteria to inform the assessment of air quality impacts on designated conservation sites. The criteria are intended to be applied to individual sources to identify those for which a decision can be taken without the need for further assessment effort. The Decision-making thresholds (DMT) for on-site emission sources provided in the JNCC report are reproduced below:

* For lichens and bryophytes - 0.08%, 0.20%, 0.34% and 0.75% of the Critical Level for high, medium, low and very low development density areas, respectively.
* For higher plants - 0.08%, 0.20%, 0.34% and 0.75% of the Critical Level for high, medium, low and very low development density areas, respectively.
* For nitrogen deposition to woodland (Critical Load 10 kg-N/ha/y) - 0.13%, 0.34%, 0.57% and 1.30% of the Critical Level for high, medium, low and very low development density areas, respectively.
* For nitrogen deposition to grassland (Critical Load 10 kg-N/ha/y) 0.09%, 0.24%, 0.40% and 0.88% of the Critical Level for high, medium, low and very low development density areas, respectively.

Note that ‘development density’ is defined as, the assumed number of additional new sources below the DMT within 5 km of the proposed development over 13 years: very low density being 1 development; low 5 developments; medium 10 developments and high 30 developments.

Subject to some exceptions, where the process contribution from an on-site source is below the DMT, no further assessment is required. Where the process contribution exceeds the DMT there are two possible outcomes:

* Where site-relevant thresholds have been derived these can be applied to see if it is possible to avoid further assessment effort on the basis of site specific circumstances.
* If site-relevant thresholds have not yet been derived, further assessment in combination with other plans and projects is required.

## 3.5 Quantification of ammonia emissions

Ammonia emission rates from poultry houses depend on many factors and are likely to be rather 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 normally 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 Environment Agency provides an Intensive farming guidance note which lists standard ammonia emission factors for a variety of livestock, including egg-laying chickens and broiler chickens. The emission factor given for egg laying chickens in ventilated houses within which manure collects is 0.2 kg‑NH3/bird place/y and the emission factor for broiler chickens is 0.034 kg‑NH3/bird place/y; these figures have been used to model emissions from the existing and proposed poultry houses at Shucknall Poultry Farm.

Note, the modelling has been performed with emissions calculated for 130,000 broiler chickens with an emission factor of 0.034 kg-NH3/place/y (the proposed poultry houses). The impacts at the receptors have been adjusted by a factor of 1.68 (37,118/13,000 x 0.2/0.034) to derive impacts for the existing poultry houses.

Details of the poultry numbers and types and emission factors used and calculated ammonia emission rates are provided in Table 2.

*Table 2. Details of poultry numbers and ammonia emission rates*

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| Source | Animal numbers | Type or weight | Emission factor  (kg-NH3/place/y) | Emission rate  (g-NH3/s) |
| Existing poultry houses | 37,118 | Egg laying chickens, ventilated deep pit | 0.2 | 0.235240 |
| Proposed poultry houses | 130,000 | Broiler chickens | 0.034 | 0.140061 |

# The Atmospheric Dispersion Modelling System (ADMS) and Model Parameters

The Atmospheric Dispersion Modelling System (ADMS) ADMS 5 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 a number of model options that include: dry and wet deposition; NOx 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.

Prior to April 2019 the GFS was a spectral model, post April 2019 the 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 (FLOWSTAR2). The use of NWP data has advantages over traditional meteorological records because:

• Calm periods in traditional records may be over represented 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 and wind directions are modified during the modelling by the treatment of roughness lengths (see Section 4.7) and because terrain data is included in the modelling. The terrain and roughness length modified wind rose for the site of the poultry houses at Shucknall Poultry Farm is shown in Figure 2b; there is some modification in this case; however, elsewhere in the modelling domain the modified wind roses may differ more, or less, markedly, reflecting the local flow in that part of the domain. The resolution of FLOWSTAR is 64 by 64 grid points and the effective resolution of the wind field is approximately 340 m. Please note that FLOWSTAR2 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 amended3.

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 52.078 N, 2.601 W, 2020 - 2023*

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*Figure 2b. The wind rose. FLOWSTAR modified GFS derived data for NGR 358900, 242300, 2020 - 2023*

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## 4.2 Emission sources

Emissions from the two side fan ventilated poultry houses are represented by one volume source per house within ADMS (SH1\_v and SH2\_v). Emissions from the chimneys of the uncapped high speed ridge fans that are used to ventilate the other two poultry houses are represented by three point sources per house within ADMS (SH3 and SH4; 1, 2 and 3).

Details of the volume and point source parameters are shown in Tables 3a and 3b. The positions of the point sources may be seen in Figure 3 (point sources are marked by blue triangles and volume sources marked by red hatched rectangles).

*Table 3a. Volume source parameters*

|  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- |
| Source ID | Length (m) | Width  (m) | Depth  (m) | Base height  (m) | Emission temperature (˚C) | Emission rate per source (g-NH3/s) |
| SH1\_v & SH2\_v | 75.0 | 19.0 | 2.0 | 1.0 | Ambient | 0.035015 1 |

*Table 3b. Point source parameters*

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
| Source ID | Height (m) | Diameter (m) | Efflux velocity (m/s) | Emission temperature (˚C) | Emission rate per source (g-NH3/s) |
| SH3 & SH4; 1, 2 and 3 | 5.5 | 0.7 | 7.0 | 21.0 | 0.011672 1 |

1. *Calculated based on the poultry unit being stocked with 130,000 broiler chickens with an emission factor of 0.034 kg-NH3/place/y. Adjusted by a factor of 1.68 to derive impacts for the existing poultry houses, namely 37,118 breeder layer chickens with an emission factor of 0.2 kg-NH3/place/y.*

## 4.3 Modelled buildings

The structure of the poultry houses and other farm buildings may affect the plumes from the point sources. Therefore, these 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

Forty-seven discrete receptors have been defined at the wildlife sites. These receptors are defined at ground level within ADMS. The positions of the discrete receptors may be seen in Figure 4a and Figure 4b (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, two regular Cartesian grids have been defined within ADMS. The grid receptors are defined at ground level within ADMS. The positions of the Cartesian grid receptors may be seen in Figure 4 (marked by grey gridlines).

## 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 23.0 km by 23.0 km domain has been resampled at 100 m horizontal resolution for use within ADMS. The resolution of FLOWSTAR is 64 by 64 grid points; therefore, the effective resolution of the wind field is approximately 340 m.

*Figure 3. The positions of the modelled sources and buildings*

A map of poultry houses

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## 4.7 Roughness Length

In this case, a spatially varying roughness length file has been defined, this is based upon the Defra Living Landscapes land use database. The GFS meteorological data is assumed to have a roughness length of 0.189 m (arithmetic average of the spatially varying roughness over the modelling domain). A sample of the central area of the spatially varying roughness length field is shown in Figure 5.

*Figure 4a. The discrete receptors and regular Cartesian grids - a broadscale view*

*A map of the north pole

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*Figure 4b. The discrete receptors - a closer view*

*A map of land with green and yellow circles

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

A green map with a blue circle

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## 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 4.

*Table 4. Deposition velocities*

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
| NH3 concentration  (PC + background) (µg/m3) | < 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. Please note that the spatially varying deposition field does account for effects of the poultry houses at Shucknall Poultry Farm and other nearby poultry rearing farms.

*Figure 6. The spatially varying deposition field*

*A map of land with a red square

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# Details of the Model Runs and Results

## 5.1 Preliminary modelling and sensitivity tests

ADMS was effectively run a totalof sixteen times, once for each year of the meteorological record and in the following four modes for the existing and proposed poultry houses:

* 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 5.

The primary purpose of the preliminary modelling is to assess the effect of calms on the results.

*Table 5. Predicted maximum annual mean ammonia concentrations at the discrete receptors - preliminary modelling*

| Receptor number | X(m) | Y(m) | Designation | Maximum annual mean ammonia concentration - (µg/m3) | | | |
| --- | --- | --- | --- | --- | --- | --- | --- |
| Existing | | Proposed | |
| GFS No calms No terrain | GFS Calms No terrain | GFS No calms No terrain | GFS Calms No terrain |
| 1 | 358655 | 242662 | Woodland on Shucknall LWS | 1.828 | 2.349 | 1.088 | 1.399 |
| 2 | 358899 | 242723 | Woodland on Shucknall LWS | 2.555 | 3.077 | 1.521 | 1.832 |
| 3 | 359211 | 242937 | Woodland on Shucknall LWS | 1.211 | 1.408 | 0.721 | 0.838 |
| 4 | 359625 | 243223 | Woodland on Shucknall LWS | 0.586 | 0.663 | 0.349 | 0.395 |
| 5 | 359832 | 243629 | Woodland on Shucknall LWS | 0.337 | 0.382 | 0.201 | 0.227 |
| 6 | 359418 | 243824 | Woodland on Shucknall LWS | 0.293 | 0.344 | 0.175 | 0.205 |
| 7 | 357764 | 242764 | Woodland on Shucknall LWS | 0.223 | 0.295 | 0.133 | 0.175 |
| 8 | 358847 | 242941 | Unnamed AW | 1.131 | 1.369 | 0.673 | 0.815 |
| 9 | 359249 | 243313 | Unnamed AW | 0.574 | 0.677 | 0.342 | 0.403 |
| 10 | 358241 | 242918 | Unnamed AW | 0.500 | 0.631 | 0.297 | 0.376 |
| 11 | 357674 | 242568 | Unnamed AW | 0.190 | 0.269 | 0.113 | 0.160 |
| 12 | 358963 | 243568 | Unnamed AW | 0.387 | 0.459 | 0.231 | 0.273 |
| 13 | 358429 | 243238 | Unnamed AW | 0.330 | 0.438 | 0.196 | 0.261 |
| 14 | 357426 | 243012 | Unnamed AW | 0.144 | 0.188 | 0.086 | 0.112 |
| 15 | 359705 | 240373 | Perton Roadside Section & Quarry SSSI | 0.183 | 0.213 | 0.109 | 0.127 |
| 16 | 359395 | 239921 | Perton Roadside Section & Quarry SSSI | 0.150 | 0.173 | 0.089 | 0.103 |
| 17 | 360300 | 238648 | Little Hill SSSI | 0.072 | 0.083 | 0.043 | 0.049 |
| 18 | 361240 | 238125 | Little Hill SSSI | 0.052 | 0.059 | 0.031 | 0.035 |
| 19 | 356195 | 239065 | Lugg and Hampton Meadows SSSI | 0.052 | 0.062 | 0.031 | 0.037 |
| 20 | 354577 | 240326 | Lugg and Hampton Meadows SSSI | 0.038 | 0.045 | 0.023 | 0.027 |
| 21 | 352769 | 241682 | Lugg and Hampton Meadows SSSI | 0.022 | 0.028 | 0.013 | 0.016 |
| 22 | 358721 | 238350 | Haugh Wood SSSI | 0.067 | 0.077 | 0.040 | 0.046 |
| 23 | 359913 | 237444 | Haugh Wood SSSI | 0.052 | 0.059 | 0.031 | 0.035 |
| 24 | 358394 | 237042 | Haugh Wood SSSI | 0.042 | 0.049 | 0.025 | 0.029 |
| 25 | 359048 | 235871 | Haugh Wood SSSI | 0.034 | 0.038 | 0.020 | 0.023 |
| 26 | 358040 | 237914 | Woodshuts Wood SSSI | 0.054 | 0.062 | 0.032 | 0.037 |
| 27 | 357747 | 236885 | Scutterdine Quarry SSSI | 0.039 | 0.045 | 0.024 | 0.027 |
| 28 | 360234 | 237097 | Sharpnage Wood SSSI | 0.046 | 0.052 | 0.027 | 0.031 |
| 29 | 357516 | 235700 | Cherry Hill Wood SSSI | 0.030 | 0.034 | 0.018 | 0.020 |
| 30 | 358183 | 235108 | Common Hill SSSI | 0.027 | 0.031 | 0.016 | 0.018 |
| 31 | 359205 | 234604 | Common Hill SSSI | 0.026 | 0.030 | 0.016 | 0.018 |
| 32 | 359729 | 234699 | Lea & Pagets Woods SSSI | 0.027 | 0.031 | 0.016 | 0.018 |
| 33 | 358742 | 232778 | Capler Wood SSSI | 0.019 | 0.021 | 0.011 | 0.013 |
| 34 | 360928 | 232540 | Birch Wood SSSI | 0.019 | 0.021 | 0.011 | 0.013 |
| 35 | 362453 | 236222 | Orchid Bank, Winslow Mill SSSI | 0.029 | 0.033 | 0.017 | 0.020 |
| 36 | 364320 | 238842 | Main's Wood SSSI | 0.040 | 0.044 | 0.024 | 0.026 |
| 37 | 366980 | 244512 | Birchend SSSI | 0.031 | 0.034 | 0.019 | 0.020 |
| 38 | 355047 | 240401 | River Wye SSSI/SAC | 0.044 | 0.053 | 0.026 | 0.032 |
| 39 | 355604 | 239184 | River Wye SSSI/SAC | 0.042 | 0.051 | 0.025 | 0.031 |
| 40 | 356999 | 237979 | River Wye SSSI/SAC | 0.050 | 0.058 | 0.030 | 0.034 |
| 41 | 353443 | 242659 | River Wye SSSI/SAC | 0.021 | 0.028 | 0.012 | 0.017 |
| 42 | 352757 | 245373 | River Wye SSSI/SAC | 0.017 | 0.020 | 0.010 | 0.012 |
| 43 | 351729 | 247802 | River Wye SSSI/SAC | 0.013 | 0.016 | 0.008 | 0.009 |
| 44 | 354986 | 238059 | River Wye SSSI/SAC | 0.031 | 0.038 | 0.019 | 0.022 |
| 45 | 351186 | 239516 | River Wye SSSI/SAC | 0.017 | 0.020 | 0.010 | 0.012 |
| 46 | 356300 | 235316 | River Wye SSSI/SAC | 0.026 | 0.029 | 0.015 | 0.018 |
| 47 | 356729 | 233088 | River Wye SSSI/SAC | 0.018 | 0.021 | 0.011 | 0.012 |

## 5.2 Detailed deposition modelling

In this case, detailed modelling has been carried out over a 5.0 km x 5.0 km domain at 100 m horizontal resolution. 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. Outside of the 5.0 km x 5.0 km domain a fixed deposition velocity of 0.003 m/s is assumed (with appropriate deposition velocities applied post-modelling at the discrete receptors).

The predicted process contributions to maximum annual mean ground level ammonia concentrations and nitrogen deposition rates at the discrete receptors are shown in Table 6a, for the existing poultry houses and in Table 6b, for the proposed poultry houses. Calms cannot be modelled with spatially varying deposition and calms corrections are not applied; therefore, it should be noted that the preliminary modelling does suggest that calms may lead to significant increases in predicted results at closer receptors.

In these Tables, percentages of the predicted ammonia concentrations or nitrogen deposition rates that are in excess of the Environment Agency’s upper threshold for the site (20% of Critical Level/Load for a SAC, 50% for a SSSI and 100% for a non-statutory site) are coloured red. Percentages that are in the range between the Environment Agency’s upper threshold and lower threshold of the Critical Level or Critical Load for the site (4% and 20% for a SAC, 20% and 50% for a SSSI and 100% and 100% for a non-statutory site) are coloured blue. Additionally, percentages that exceed 1% of the relevant Critical Level or Critical Load at a statutory wildlife site are highlighted with bold text.

Contour plots of the process contribution to annual mean ammonia concentrations and nitrogen deposition rates are shown in Figures 7a and 7b for the existing poultry houses and in Figures 8a and 8b for the proposed poultry houses.

*Table 6a. Predicted process contribution to maximum annual mean ammonia and nitrogen deposition at the discrete receptors – existing poultry houses*

| Receptor number | X(m) | Y(m) | Designation | 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 | 358655 | 242662 | Woodland on Shucknall LWS | 0.03 | 1.0 | 10.0 | 0.621 | 62.1 | 4.84 | 48.4 |
| 2 | 358899 | 242723 | Woodland on Shucknall LWS | 0.03 | 1.0 | 10.0 | 1.057 | **105.7** | 8.23 | 82.3 |
| 3 | 359211 | 242937 | Woodland on Shucknall LWS | 0.03 | 1.0 | 10.0 | 0.479 | 47.9 | 3.73 | 37.3 |
| 4 | 359625 | 243223 | Woodland on Shucknall LWS | 0.03 | 1.0 | 10.0 | 0.174 | 17.4 | 1.36 | 13.6 |
| 5 | 359832 | 243629 | Woodland on Shucknall LWS | 0.03 | 1.0 | 10.0 | 0.087 | 8.7 | 0.68 | 6.8 |
| 6 | 359418 | 243824 | Woodland on Shucknall LWS | 0.03 | 1.0 | 10.0 | 0.074 | 7.4 | 0.58 | 5.8 |
| 7 | 357764 | 242764 | Woodland on Shucknall LWS | 0.03 | 1.0 | 10.0 | 0.068 | 6.8 | 0.53 | 5.3 |
| 8 | 358847 | 242941 | Unnamed AW | 0.03 | 1.0 | 10.0 | 0.356 | 35.6 | 2.77 | 27.7 |
| 9 | 359249 | 243313 | Unnamed AW | 0.03 | 1.0 | 10.0 | 0.161 | 16.1 | 1.25 | 12.5 |
| 10 | 358241 | 242918 | Unnamed AW | 0.03 | 1.0 | 10.0 | 0.104 | 10.4 | 0.81 | 8.1 |
| 11 | 357674 | 242568 | Unnamed AW | 0.03 | 1.0 | 10.0 | 0.063 | 6.3 | 0.49 | 4.9 |
| 12 | 358963 | 243568 | Unnamed AW | 0.03 | 1.0 | 10.0 | 0.107 | 10.7 | 0.83 | 8.3 |
| 13 | 358429 | 243238 | Unnamed AW | 0.03 | 1.0 | 10.0 | 0.083 | 8.3 | 0.65 | 6.5 |
| 14 | 357426 | 243012 | Unnamed AW | 0.03 | 1.0 | 10.0 | 0.037 | 3.7 | 0.29 | 2.9 |
| 15 | 359705 | 240373 | Perton Roadside Section & Quarry SSSI | - | - | - | 0.068 | - | - | - |
| 16 | 359395 | 239921 | Perton Roadside Section & Quarry SSSI | - | - | - | 0.034 | - | - | - |
| 17 | 360300 | 238648 | Little Hill SSSI | - | - | - | 0.008 | - | - | - |
| 18 | 361240 | 238125 | Little Hill SSSI | - | - | - | 0.004 | - | - | - |
| 19 | 356195 | 239065 | Lugg and Hampton Meadows SSSI | 0.02 | 3.0 | 10.0 | 0.016 | 0.5 | 0.08 | 0.8 |
| 20 | 354577 | 240326 | Lugg and Hampton Meadows SSSI | 0.02 | 3.0 | 10.0 | 0.008 | 0.3 | 0.04 | 0.4 |
| 21 | 352769 | 241682 | Lugg and Hampton Meadows SSSI | 0.02 | 3.0 | 10.0 | 0.007 | 0.2 | 0.04 | 0.4 |
| 22 | 358721 | 238350 | Haugh Wood SSSI | 0.03 | 1.0 | 10.0 | 0.009 | 0.9 | 0.07 | 0.7 |
| 23 | 359913 | 237444 | Haugh Wood SSSI | 0.03 | 1.0 | 10.0 | 0.006 | 0.6 | 0.04 | 0.4 |
| 24 | 358394 | 237042 | Haugh Wood SSSI | 0.03 | 1.0 | 10.0 | 0.006 | 0.6 | 0.04 | 0.4 |
| 25 | 359048 | 235871 | Haugh Wood SSSI | 0.03 | 1.0 | 10.0 | 0.003 | 0.3 | 0.02 | 0.2 |
| 26 | 358040 | 237914 | Woodshuts Wood SSSI | 0.03 | 1.0 | 10.0 | 0.008 | 0.8 | 0.07 | 0.7 |
| 27 | 357747 | 236885 | Scutterdine Quarry SSSI | - | - | - | 0.006 | - | - | - |
| 28 | 360234 | 237097 | Sharpnage Wood SSSI | 0.03 | 1.0 | 10.0 | 0.005 | 0.5 | 0.04 | 0.4 |
| 29 | 357516 | 235700 | Cherry Hill Wood SSSI | 0.03 | 1.0 | 10.0 | 0.004 | 0.4 | 0.03 | 0.3 |
| 30 | 358183 | 235108 | Common Hill SSSI | 0.03 | 1.0 | 10.0 | 0.003 | 0.3 | 0.02 | 0.2 |
| 31 | 359205 | 234604 | Common Hill SSSI | 0.03 | 1.0 | 10.0 | 0.002 | 0.2 | 0.02 | 0.2 |
| 32 | 359729 | 234699 | Lea & Pagets Woods SSSI | 0.03 | 1.0 | 10.0 | 0.002 | - | 0.02 | - |
| 33 | 358742 | 232778 | Capler Wood SSSI | 0.03 | 1.0 | 10.0 | 0.002 | 0.2 | 0.018 | 0.2 |
| 34 | 360928 | 232540 | Birch Wood SSSI | 0.03 | 1.0 | 10.0 | 0.002 | 0.2 | 0.015 | 0.1 |
| 35 | 362453 | 236222 | Orchid Bank, Winslow Mill SSSI | 0.02 | 3.0 | 10.0 | 0.002 | 0.1 | 0.012 | 0.1 |
| 36 | 364320 | 238842 | Main's Wood SSSI | 0.03 | 1.0 | 10.0 | 0.007 | 0.7 | 0.051 | 0.5 |
| 37 | 366980 | 244512 | Birchend SSSI | 0.03 | 1.0 | 10.0 | 0.008 | 0.8 | 0.066 | 0.7 |
| 38 | 355047 | 240401 | River Wye SSSI/SAC | 0.03 | 3.0 | 10.0 | 0.010 | 0.3 | 0.079 | 0.8 |
| 39 | 355604 | 239184 | River Wye SSSI/SAC | 0.03 | 3.0 | 10.0 | 0.013 | 0.4 | 0.103 | **1.0** |
| 40 | 356999 | 237979 | River Wye SSSI/SAC | 0.03 | 3.0 | 10.0 | 0.011 | 0.4 | 0.084 | 0.8 |
| 41 | 353443 | 242659 | River Wye SSSI/SAC | 0.03 | 3.0 | 10.0 | 0.007 | 0.2 | 0.057 | 0.6 |
| 42 | 352757 | 245373 | River Wye SSSI/SAC | 0.03 | 3.0 | 10.0 | 0.004 | 0.1 | 0.031 | 0.3 |
| 43 | 351729 | 247802 | River Wye SSSI/SAC | 0.03 | 3.0 | 10.0 | 0.002 | 0.1 | 0.017 | 0.2 |
| 44 | 354986 | 238059 | River Wye SSSI/SAC | 0.03 | 3.0 | 10.0 | 0.010 | 0.3 | 0.074 | 0.7 |
| 45 | 351186 | 239516 | River Wye SSSI/SAC | 0.03 | 3.0 | 10.0 | 0.003 | 0.1 | 0.027 | 0.3 |
| 46 | 356300 | 235316 | River Wye SSSI/SAC | 0.03 | 3.0 | 10.0 | 0.005 | 0.2 | 0.038 | 0.4 |
| 47 | 356729 | 233088 | River Wye SSSI/SAC | 0.03 | 3.0 | 10.0 | 0.003 | 0.1 | 0.026 | 0.3 |

*Table 6b. Predicted process contribution to maximum annual mean ammonia and nitrogen deposition at the discrete receptors – proposed poultry houses*

| Receptor number | X(m) | Y(m) | Designation | 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 | 358655 | 242662 | Woodland on Shucknall LWS | 0.03 | 1.0 | 10.0 | 0.370 | 37.0 | 2.88 | 28.8 |
| 2 | 358899 | 242723 | Woodland on Shucknall LWS | 0.03 | 1.0 | 10.0 | 0.629 | 62.9 | 4.90 | 49.0 |
| 3 | 359211 | 242937 | Woodland on Shucknall LWS | 0.03 | 1.0 | 10.0 | 0.285 | 28.5 | 2.22 | 22.2 |
| 4 | 359625 | 243223 | Woodland on Shucknall LWS | 0.03 | 1.0 | 10.0 | 0.104 | 10.4 | 0.81 | 8.1 |
| 5 | 359832 | 243629 | Woodland on Shucknall LWS | 0.03 | 1.0 | 10.0 | 0.052 | 5.2 | 0.41 | 4.1 |
| 6 | 359418 | 243824 | Woodland on Shucknall LWS | 0.03 | 1.0 | 10.0 | 0.044 | 4.4 | 0.35 | 3.5 |
| 7 | 357764 | 242764 | Woodland on Shucknall LWS | 0.03 | 1.0 | 10.0 | 0.040 | 4.0 | 0.31 | 3.1 |
| 8 | 358847 | 242941 | Unnamed AW | 0.03 | 1.0 | 10.0 | 0.212 | 21.2 | 1.65 | 16.5 |
| 9 | 359249 | 243313 | Unnamed AW | 0.03 | 1.0 | 10.0 | 0.096 | 9.6 | 0.75 | 7.5 |
| 10 | 358241 | 242918 | Unnamed AW | 0.03 | 1.0 | 10.0 | 0.062 | 6.2 | 0.48 | 4.8 |
| 11 | 357674 | 242568 | Unnamed AW | 0.03 | 1.0 | 10.0 | 0.037 | 3.7 | 0.29 | 2.9 |
| 12 | 358963 | 243568 | Unnamed AW | 0.03 | 1.0 | 10.0 | 0.063 | 6.3 | 0.49 | 4.9 |
| 13 | 358429 | 243238 | Unnamed AW | 0.03 | 1.0 | 10.0 | 0.050 | 5.0 | 0.39 | 3.9 |
| 14 | 357426 | 243012 | Unnamed AW | 0.03 | 1.0 | 10.0 | 0.022 | 2.2 | 0.17 | 1.7 |
| 15 | 359705 | 240373 | Perton Roadside Section & Quarry SSSI | - | - | - | 0.040 | - | - | - |
| 16 | 359395 | 239921 | Perton Roadside Section & Quarry SSSI | - | - | - | 0.021 | - | - | - |
| 17 | 360300 | 238648 | Little Hill SSSI | - | - | - | 0.004 | - | - | - |
| 18 | 361240 | 238125 | Little Hill SSSI | - | - | - | 0.002 | - | - | - |
| 19 | 356195 | 239065 | Lugg and Hampton Meadows SSSI | 0.02 | 3.0 | 10.0 | 0.009 | 0.3 | 0.05 | 0.5 |
| 20 | 354577 | 240326 | Lugg and Hampton Meadows SSSI | 0.02 | 3.0 | 10.0 | 0.005 | 0.2 | 0.03 | 0.3 |
| 21 | 352769 | 241682 | Lugg and Hampton Meadows SSSI | 0.02 | 3.0 | 10.0 | 0.004 | 0.1 | 0.02 | 0.2 |
| 22 | 358721 | 238350 | Haugh Wood SSSI | 0.03 | 1.0 | 10.0 | 0.006 | 0.6 | 0.04 | 0.4 |
| 23 | 359913 | 237444 | Haugh Wood SSSI | 0.03 | 1.0 | 10.0 | 0.003 | 0.3 | 0.03 | 0.3 |
| 24 | 358394 | 237042 | Haugh Wood SSSI | 0.03 | 1.0 | 10.0 | 0.003 | 0.3 | 0.03 | 0.3 |
| 25 | 359048 | 235871 | Haugh Wood SSSI | 0.03 | 1.0 | 10.0 | 0.002 | 0.2 | 0.01 | 0.1 |
| 26 | 358040 | 237914 | Woodshuts Wood SSSI | 0.03 | 1.0 | 10.0 | 0.005 | 0.5 | 0.04 | 0.4 |
| 27 | 357747 | 236885 | Scutterdine Quarry SSSI | - | - | - | 0.004 | - | - | - |
| 28 | 360234 | 237097 | Sharpnage Wood SSSI | 0.03 | 1.0 | 10.0 | 0.003 | 0.3 | 0.02 | 0.2 |
| 29 | 357516 | 235700 | Cherry Hill Wood SSSI | 0.03 | 1.0 | 10.0 | 0.002 | 0.2 | 0.02 | 0.2 |
| 30 | 358183 | 235108 | Common Hill SSSI | 0.03 | 1.0 | 10.0 | 0.002 | 0.2 | 0.01 | 0.1 |
| 31 | 359205 | 234604 | Common Hill SSSI | 0.03 | 1.0 | 10.0 | 0.001 | 0.1 | 0.01 | 0.1 |
| 32 | 359729 | 234699 | Lea & Pagets Woods SSSI | 0.03 | 1.0 | 10.0 | 0.001 | - | 0.01 | - |
| 33 | 358742 | 232778 | Capler Wood SSSI | 0.03 | 1.0 | 10.0 | 0.001 | 0.1 | 0.011 | 0.1 |
| 34 | 360928 | 232540 | Birch Wood SSSI | 0.03 | 1.0 | 10.0 | 0.001 | 0.1 | 0.009 | 0.1 |
| 35 | 362453 | 236222 | Orchid Bank, Winslow Mill SSSI | 0.02 | 3.0 | 10.0 | 0.001 | 0.0 | 0.007 | 0.1 |
| 36 | 364320 | 238842 | Main's Wood SSSI | 0.03 | 1.0 | 10.0 | 0.004 | 0.4 | 0.030 | 0.3 |
| 37 | 366980 | 244512 | Birchend SSSI | 0.03 | 1.0 | 10.0 | 0.005 | 0.5 | 0.039 | 0.4 |
| 38 | 355047 | 240401 | River Wye SSSI/SAC | 0.03 | 3.0 | 10.0 | 0.006 | 0.2 | 0.047 | 0.5 |
| 39 | 355604 | 239184 | River Wye SSSI/SAC | 0.03 | 3.0 | 10.0 | 0.008 | 0.3 | 0.061 | 0.6 |
| 40 | 356999 | 237979 | River Wye SSSI/SAC | 0.03 | 3.0 | 10.0 | 0.006 | 0.2 | 0.050 | 0.5 |
| 41 | 353443 | 242659 | River Wye SSSI/SAC | 0.03 | 3.0 | 10.0 | 0.004 | 0.1 | 0.034 | 0.3 |
| 42 | 352757 | 245373 | River Wye SSSI/SAC | 0.03 | 3.0 | 10.0 | 0.002 | 0.1 | 0.018 | 0.2 |
| 43 | 351729 | 247802 | River Wye SSSI/SAC | 0.03 | 3.0 | 10.0 | 0.001 | 0.0 | 0.010 | 0.1 |
| 44 | 354986 | 238059 | River Wye SSSI/SAC | 0.03 | 3.0 | 10.0 | 0.006 | 0.2 | 0.044 | 0.4 |
| 45 | 351186 | 239516 | River Wye SSSI/SAC | 0.03 | 3.0 | 10.0 | 0.002 | 0.1 | 0.016 | 0.2 |
| 46 | 356300 | 235316 | River Wye SSSI/SAC | 0.03 | 3.0 | 10.0 | 0.003 | 0.1 | 0.022 | 0.2 |
| 47 | 356729 | 233088 | River Wye SSSI/SAC | 0.03 | 3.0 | 10.0 | 0.002 | 0.1 | 0.015 | 0.2 |

*Figure 7a. Process contribution to maximum annual mean ammonia concentration - existing poultry houses*

*A map of a storm

Description automatically generated with medium confidence*

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*Figure 7b. Process contribution to maximum annual nitrogen deposition rates - existing poultry houses*

A map of land with green and purple colors

Description automatically generated

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*Figure 8a. Process contribution to maximum annual mean ammonia concentration - proposed poultry houses*

*A map of the area

Description automatically generated with medium confidence*

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*Figure 8b. Process contribution to maximum annual nitrogen deposition rates - proposed poultry houses*

A map of land with green and purple spots

Description automatically generated

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# Summary and Conclusions

AS Modelling & Data Ltd. has been instructed by Mr. Steve Raasch, on behalf of Faccenda Foods Limited, to use computer modelling to assess the impact of ammonia emissions from the existing breeder layer chicken houses and the proposed broiler chicken rearing houses at Shucknall Poultry Farm, Weston Beggard Lane, Shucknall, Weston Beggard, Herefordshire. HR1 4BJ.

Ammonia emission rates from the existing and proposed poultry houses have been derived from Environment Agency’s standard ammonia emission factors. These ammonia 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.

## Existing poultry houses

The modelling predicts that:

* At one discrete receptor 2, located at Woodland on Shucknall LWS, process contributions of the existing poultry houses to ammonia concentrations marginally exceed the precautionary Critical Level of 1.0 µg/m³.
* At the other discrete receptors located at the non-statutory sites, process contributions to ammonia concentrations and nitrogen deposition rates are less than the Environment Agency’s lower threshold percentage of the precautionary Critical Level of 1.0 µg/m³ and the Critical Load of 10.0 kg/ha.
* At the SSSIs and the SAC considered, the process contribution of the existing poultry house to ammonia concentrations and nitrogen deposition rates are below the Environment Agency lower threshold percentage of the relevant Critical Level and Critical Load.
* At the SSSIs and the SAC considered, the process contributions are below 1% of the relevant Critical Level and Critical Load.

## Proposed poultry houses

The modelling predicts that:

* At the discrete receptors located at the non-statutory sites, process contributions of the proposed poultry houses to ammonia concentrations and nitrogen deposition rates are below the Environment Agency’s lower threshold percentage of the precautionary Critical Level of 1.0 µg/m³ and the Critical Load of 10.0 kg/ha.
* At the SSSIs and the SAC considered, the process contributions to ammonia concentrations and nitrogen deposition rates are below the Environment Agency lower threshold percentage of the relevant Critical Level and Critical Load.
* At the SSSIs and the SAC considered, the process contributions to ammonia concentrations and nitrogen deposition rates are below 1% of the relevant Critical Level and Critical Load.
* Should the proposals be undertaken and the poultry houses at Shucknall Poultry Farm be used to rear broiler chickens instead of breeder layer chickens, there would be a reduction in ammonia concentrations and nitrogen deposition rates at all receptors.

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