

A Report on the Modelling of the Dispersion and Deposition of Ammonia from the Existing and Proposed Free Range Egg Laying Chicken Houses at Upper Esgair, Ddol, Llanbadarn Fynydd in Powys

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1. Introduction

AS Modelling & Data Ltd. has been instructed by Gail Lewis of Richard Parry & Partners LLP, on behalf of the applicants Messrs Jones of DLJ Ltd., to use computer modelling to assess the impact of ammonia emissions from the existing and proposed free range egg laying chicken houses at Upper Esgair, Ddol, Llanbadarn Fynydd, Powys. LD1 6YB.

Ammonia emission rates from the proposed poultry unit have been assessed and quantified based upon the Environment Agency's standard ammonia emission factors. The 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.

2. Background Details

The poultry unit at Upper Esgair is in an isolated mountainous rural area. The surrounding land is used primarily for livestock farming, although there are some arable fields and areas of semi-natural woodland, grassland and upland heath/moor. The site of the poultry unit is at an altitude of 400 m on a ridge extending southwards from mountains to the north with the River Ithon Valley to the west and the valley formed by the Gwenlas Brook to the south-east.

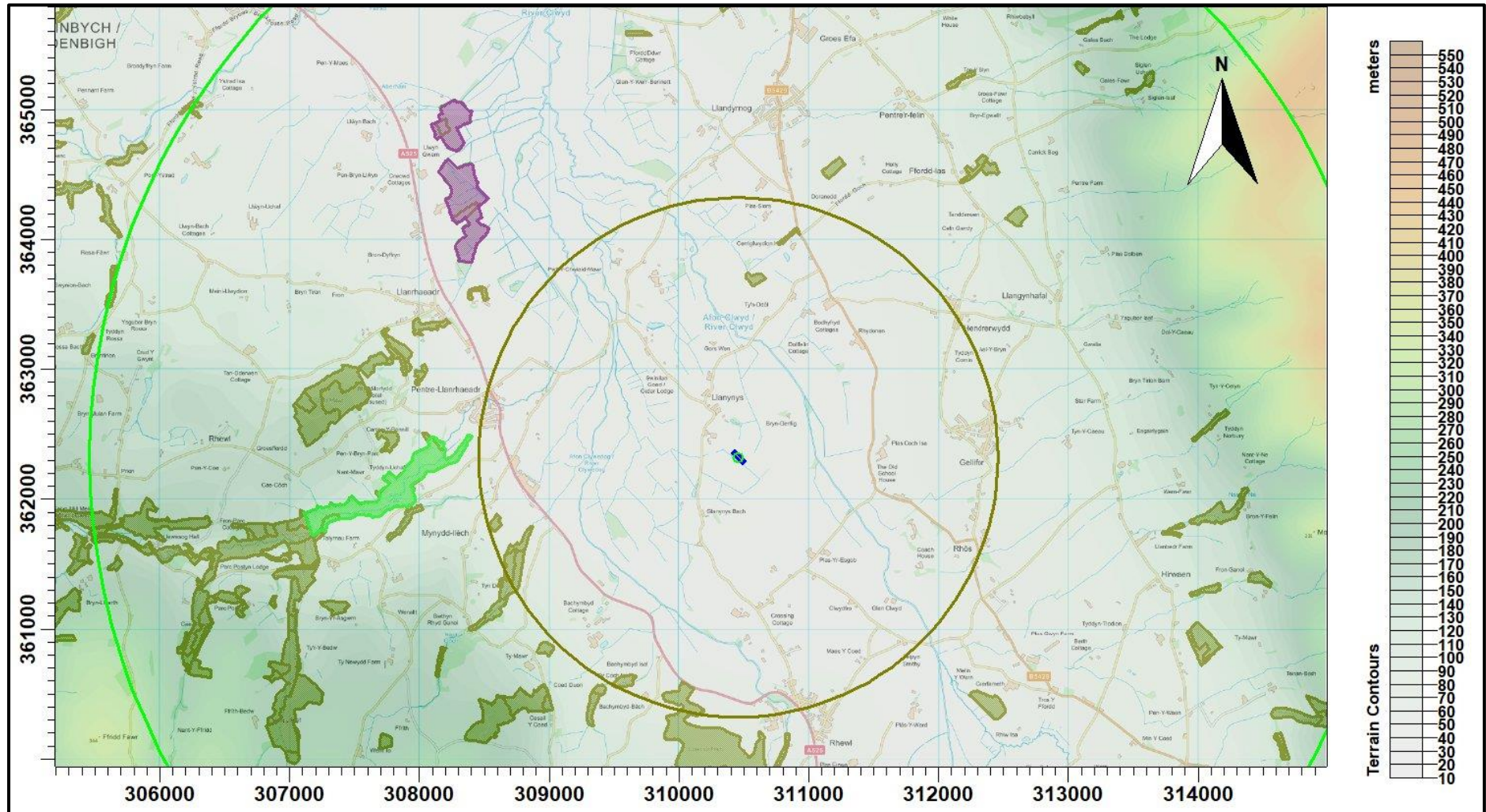
Upper Esgair currently has four poultry houses which provide accommodation for up to 100,000 egg laying chickens. The two poultry houses to the west have previously been converted into multi-tier units with a belt manure removal system, from which the manure is stored in sealed skips temporarily, prior to twice weekly removal from the site. The four existing poultry houses are ventilated by uncapped high velocity ridge mounted fans, each with a short chimney. The chickens have daytime access to outside ranging areas.

Under the proposal, the two existing poultry houses to the north and east, which are currently flat deck buildings ventilated by capped fans, would be retrofitted and upgraded to multi-tier units with a belt manure removal system, ventilated by uncapped high velocity ridge mounted fans. The chickens would have daytime access to outside ranging areas. The proposed poultry unit would then provide accommodation for up to 128,000 egg laying chickens.

There are several areas of Ancient Woodlands (AWs) within 2 km of the site of the proposed poultry houses at Upper Esgair. Parts of the River Ithon Site of Special Scientific Interest (SSSI) are within 2km of the farm, there are six other SSSIs within 5 km; namely Caeau Bryn-du SSSI, Llymwynt Brook Pastures SSSI, Rhosydd Nant-yr-Henfron SSSI, Gweunydd Esgairdraenllwyn SSSI, Gweunydd Camnant SSSI and the River Teme SSSI. AS Modelling & Data Ltd. understands that the River Ithon SSSI, as designated, does not have any flora that are likely to be affected by diffuse ammonia and consequent nitrogen and acid deposition; however, much of the River Ithon SSSI is also part of the River Wye Special Area of Conservation (SAC). The designation of the River Wye SAC is largely for its aquatic features; however, the designation includes areas of quaking mire; it has not been possible to determine where these areas of quaking mire might be and therefore, the SAC has been included for consideration as a whole. There are no other internationally designated sites within 5 km of the poultry unit.

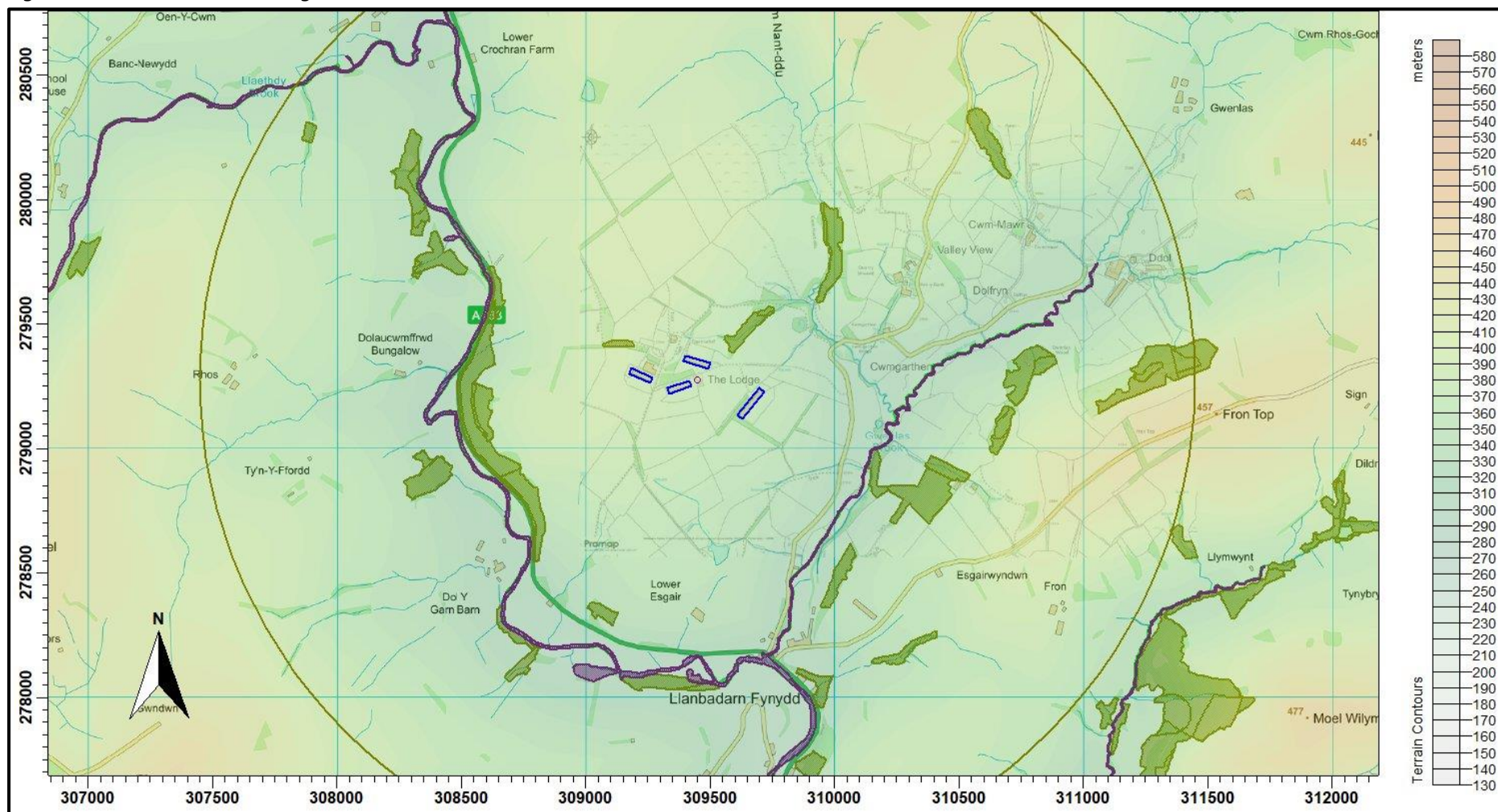
Maps of the surrounding area showing the positions of the poultry unit, the AWs, the SSSIs and the SAC are provided in Figures 1a and 1b. Figure 1a is a broad scale view, showing the positions of the SSSIs and the SAC and Figure 1b is a closer view showing the AWs. In these figures, the AWs are shaded in olive, the SSSIs are shaded in green, the SAC is shaded purple and the existing and proposed poultry buildings are outlined in blue.

Figure 1a. The area surrounding the site – a broad view, with concentric circles radii at 2 km (olive) and 5 km (green)



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Figure 1b. The area surrounding the site – a closer view



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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 ($\mu\text{g-NH}_3/\text{m}^3$) 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 background ammonia concentration (annual mean) in the area around the site of the proposed poultry unit and the wildlife sites is $1.01 \mu\text{g-NH}_3/\text{m}^3$. The background nitrogen deposition rate to woodland is 25.06 kg-N/ha/y and to short vegetation is 14.98 kg-N/ha/y . The background acid deposition rate to woodland is 1.96 keq/ha/y and to short vegetation is 1.19 keq/ha/y . The source of these background figures is the Air Pollution Information System (APIS, March 2018).

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 $3.0 \mu\text{g-NH}_3/\text{m}^3$ 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 $1.0 \mu\text{g-NH}_3/\text{m}^3$ 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 assumed in this study are provided in Table 1. N.B. Where the Critical Level of 1.0 $\mu\text{g-NH}_3/\text{m}^3$ 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.

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

Site	Critical Level ($\mu\text{g-NH}_3/\text{m}^3$)	Critical Load Nitrogen (kg-N/ha/y)	Critical Load Acid (keq/ha/y)
AWs	1.0 ¹	-	-
SSSIs	1.0 ¹	10.0 ²	-
SAC	1.0 ¹	5.0 ²	-

1. A precautionary figure used where no details of the ecology of the site are available, or the citation for the site contains reference to sensitive lichens and/or bryophytes, or in the case of the SAC, because the presence, or not, of quaking mire is an unknown.
2. Based on the citation for the site and information obtained from the APIS website (January 2018).

3.4 Guidance on the significance of ammonia emissions

3.4.1 Natural Resources Wales criteria

In March 2017, Natural Resources Wales (Regulation and Permitting Department, EPP) published Operational Guidance Note 41 (OGN 41), "Assessment of ammonia and nitrogen impacts from livestock units when applying for an Environmental Permit or Planning Permission". This guidance was intended to update the way Natural Resources Wales (NRW) assessed emissions, in particular by changing the thresholds of insignificance and the upper threshold process contributions for designated sites. These designated sites include European sites, such as Special Areas of Conservation (SACs), Special Protection Areas (SPAs) and Ramsar sites as well as Sites of Special Scientific Interest (SSSIs).

Table 1 in OGN 41 describes the revised screening distance and thresholds for livestock developments; the threshold of insignificant percentage of the designated site Critical Level or Load is given as 1%; the upper threshold percentage of the designated site Critical Level or Load is given as 8%.

Table 2 in OGN 41 describes the possible outcomes of assessment and for detailed modelling of the application alone, where process contributions, considered in isolation, are up to 1% of the designated site Critical Level or Load, then it should be determined that there is no significant environmental effect/no likely significant effect/damage to scientific interest.

Where process contributions, considered in isolation, are between 1% and 8% of the designated site Critical Level or Load, an in-combination assessment is required. Should the in-combination process contributions be between 1% and 8% of the designated site Critical Level or Load then it should be determined that the application would cause no significant environmental effect/likely significant effect/damage to scientific interest.

When considering process contributions, in isolation or in-combination, if they exceed 8% of the designated site Critical Level or Load it is necessary to consider background concentrations and whether the designated site Critical Level or Load is breached and whether additional controls may be necessary. The application will then be determined based on whether there will be significant environmental effect/adverse effect/damage to scientific interest.

For Local Nature Reserves (LNRs), Local Wildlife Sites (LWSs) and Ancient Woodlands (AWs), the current assessment procedure usually applied is based on the Environment Agency's horizontal guidance, H1 Environmental Risks Assessment, H1 Annex B - Intensive Farming. The following are taken from this document.

"An emission is insignificant where Process Contribution (PC) is <50% for local and national nature reserves (LNRs & NNRs), ancient woodland and local wildlife sites." And "Where modelling predicts a process contribution >100% at a NNR, LNR, ancient woodland or local wildlife site, your proposal may not be considered acceptable. In such cases, your assessment should include proposals to reduce ammonia emissions."

This document was withdrawn February 1st 2016 and replaced with a web-page titled "Intensive farming risk assessment for your environmental permit", which contains essentially the same criteria. It is assumed that the upper threshold and lower threshold on the web-page refers to the levels that were previously referred to as levels of insignificance and acceptability in Annex B– Intensive Farming.

Within the range between the lower and upper thresholds, whether or not the impact is deemed acceptable is at the discretion of the Environment Agency. N.B. 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 Environment Agency criteria

The following are obtained from the Environment Agency's horizontal guidance, H1 Environmental Risks Assessment, H1 Annex B - Intensive Farming.

"An emission is insignificant where Process Contribution (PC) is <4% of Critical Levels for SACs, SPAs and Ramsars, <20% for SSSIs, and <50% for local and national nature reserves (LNRs & NNRs), ancient woodland and local wildlife sites." And, "Where modelling predicts a process contribution >20% of the Critical Level/Load at a SAC, SPA or Ramsar, >50% at a SSSI or >100% at a NNR, LNR, ancient woodland or local wildlife site, your proposal may not be considered acceptable. In such cases, your assessment should include proposals to reduce ammonia emissions."

This document was withdrawn February 1st 2016 and replaced with a web-page titled "Intensive farming risk assessment for your environmental permit", which contains essentially the same criteria. It is assumed that the upper threshold and lower threshold on the web-page refers to the levels that were previously referred to as levels of insignificance and acceptability in Annex B— Intensive Farming.

Within the range between the lower and upper thresholds; 4% to 20% for SACs, SPAs and Ramsars; 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. N.B. 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%).

3.5 IAQM Position Statement on the use of the 1% criterion

A Position Statement issued by the Institute of Air Quality Management (IAQM) in January 2016 further clarifies the use of the 1% criterion for the determination of an '*insignificant*' effect of air quality impacts on sensitive habitats. The Position Statement states: "*the use of a criterion of 1% of an environmental standard or 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.*" Furthermore, if the impacts are plainly above 1% then this should be regarded as potentially significant; where impacts are just slightly greater than 1% then a degree of professional judgement should be applied with regards to the theoretical risk.

3.6 Quantification of ammonia emissions

Ammonia emission rates from poultry houses, ranging areas and manure spreading 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.

3.6.1 Proposed chicken housing ammonia emissions

The Environment Agency provides an Intensive Farming guidance note which lists standard ammonia emission factors for a variety of livestock, including poultry. For free-range egg laying chickens, in an aviary system, where manure is removed frequently using a belt system, the Environment Agency figure is 0.08 kg-NH₃/bird place/year (for the existing flat deck housing the Environment Agency/BREF figure of 0.21 kg-NH₃/bird place/year is assumed).

3.6.2 Proposed ranging area ammonia emissions

As the birds would have access to outdoor ranging areas, some of the birds' droppings, which is the source of the ammonia, would be deposited on these ranging areas. For modelling purposes, it is assumed that 12%¹ of the droppings are deposited on the ranging areas; this assumption is based upon figures from "Ammonia emission factors for UK agriculture" (Misselbrook *et al*). To estimate the ammonia emissions from the ranges, it has been assumed that laying hens produce 0.8 kg-N/y (Misselbrook) in their droppings and that 35% of ammoniacal nitrogen is emitted as ammonia (Misselbrook and Defra). This equates to an emission factor of 0.34 kg-NH₃/bird/y.

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

1. A figure of 20% is sometimes assumed. However, it should be noted that this figure is probably based primarily upon the widely accepted figure of 80% of dropping occurring at night when birds are housed and a single report; however, because, even under optimal conditions, not all of the birds go outside (50% is considered a high percentage), this does not imply that 20% of droppings occur outside the house.

Table 2. Details of poultry numbers and ammonia emission rates

Source	Animal numbers	Type or weight	Emission factor (kg-NH ₃ /place/y)	Emission rate (g-NH ₃ /s)
Existing Houses 1 & 2	64,000 (x 0.88)	Egg laying chickens, aviary system	0.08 (EA/BREF figure)	0.142774
Existing Houses 3 & 4	31,500 (x 0.88)	Egg laying chickens, flat deck system	0.21 (EA/BREF figure)	0.184463
Existing Ranges 1 & 2	64,000 (x 0.12)	Ranging Area	0.34 (AS Modelling & Data figure)	0.082744
Existing Ranges 3 & 4	31,500 (x 0.12)	Ranging Area	0.34 (AS Modelling & Data figure)	0.040726
Proposed Houses 3 & 4	64,000 (x 0.88)	Egg laying chickens, aviary system	0.08 (EA/BREF figure)	0.142774
Proposed Ranges 3 & 4	64,000 (x 0.12)	Ranging Area	0.34 (AS Modelling & Data figure)	0.082744

4. 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 including: 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) and from the closest observation meteorological station at Sennybridge.

The GFS is a spectral model and data are archived at a horizontal resolution of 0.25 degrees, which is approximately 25 km over the UK (formerly 0.5 degrees, or approximately 50 km). The GFS resolution adequately captures major topographical features and the broad-scale characteristics of the weather over the UK. Smaller scale topological features may be included in the dispersion modelling by using the flow field module of ADMS (FLOWSTAR). The use of NWP data has advantages over traditional meteorological records because:

- Calm periods in traditional observational records may be over represented, this is because the instrumentation used may not record wind speeds 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.

The wind rose for the raw GFS data is shown in Figure 2a.

Wind speeds are modified by the treatment of roughness lengths (see Section 4.7) and where terrain data is included in the modelling, wind speeds and directions will be modified. The terrain and roughness length modified wind rose for the site of the proposed poultry house is shown in Figure 2b. Note that elsewhere in the modelling domain, modified wind roses may differ markedly, particularly in more sheltered valleys, and that the resolution of the wind field in the terrain runs is 150 m. Please also note that FLOWSTAR 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.

The wind rose for Sennybridge is shown in Figure 2c. Please note that data from Sennybridge, although the closest observational dataset available for the area around Upper Esgair, has a steep slope directly to the east of the station and therefore is unlikely to represent an exposed ridge such as at Upper Esgair, it is included purely to demonstrate that, in general, the use of GFS data does not lead to marked under or over prediction of ground level concentrations compared to observational data.

Figure 2a. The wind rose. Raw GFS derived data, for 52.403 N, 3.331 W, 2014-2017

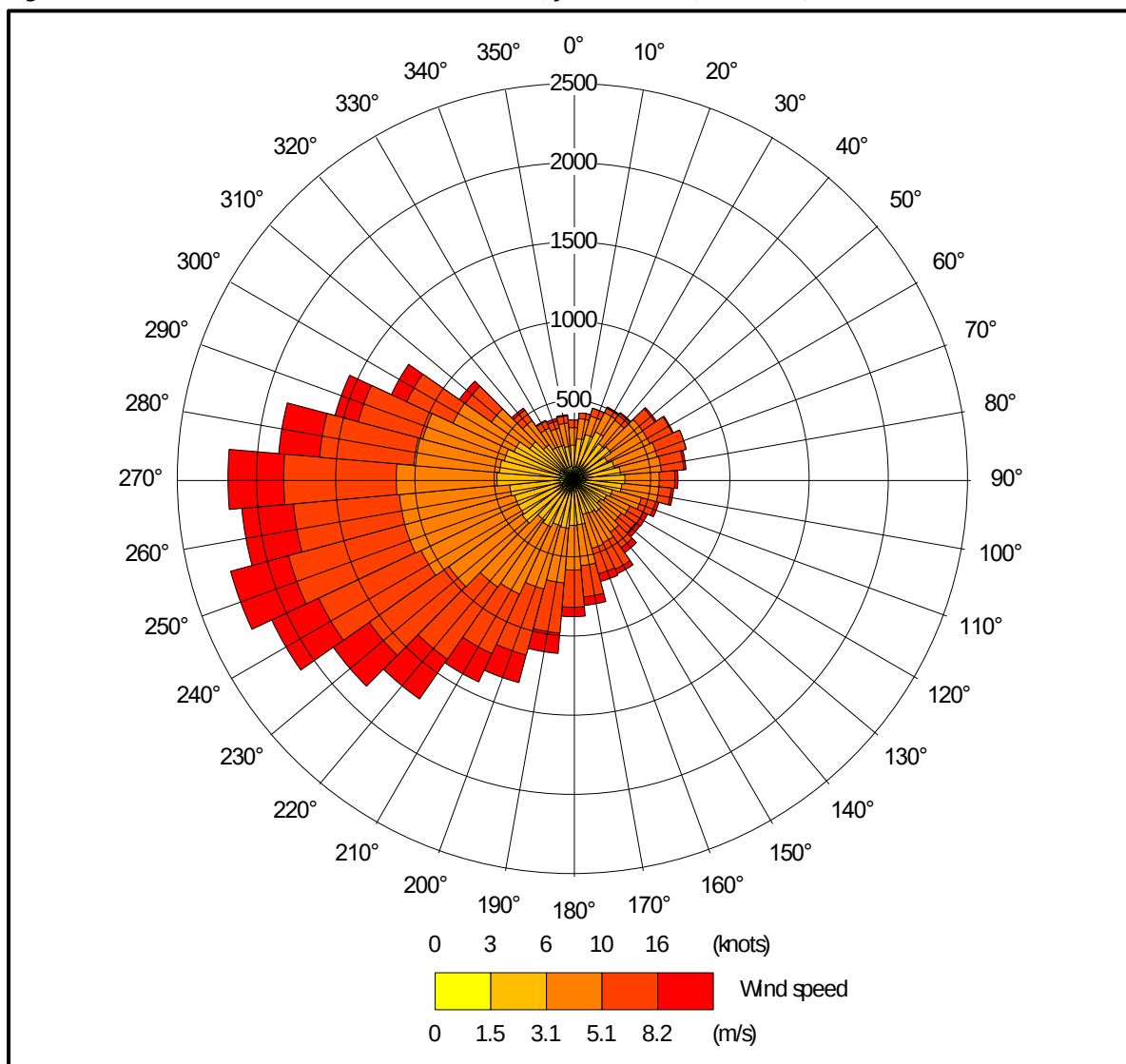


Figure 2b. The wind rose. FLOWSTAR modified GFS derived data for NGR 309450, 279250

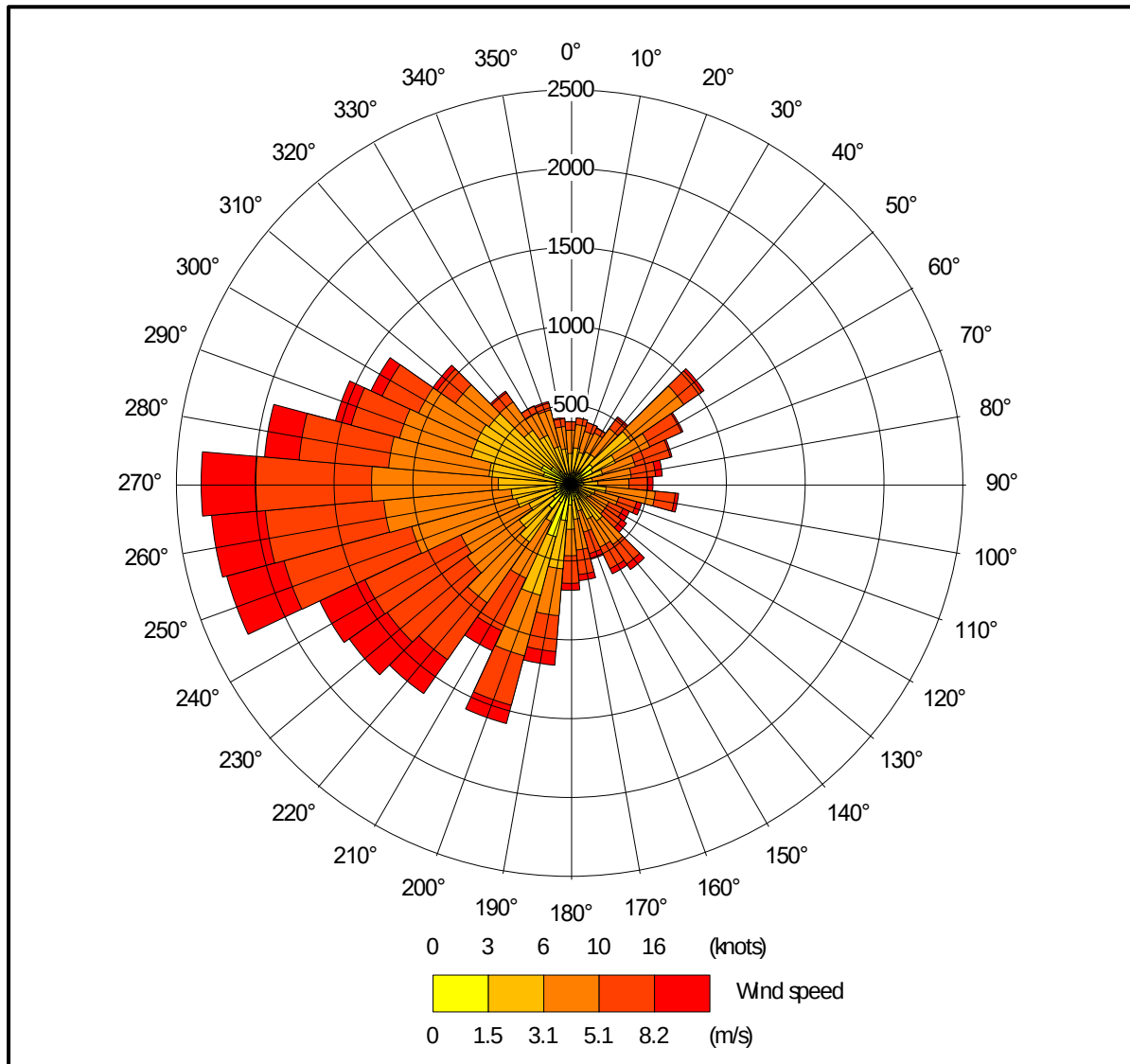
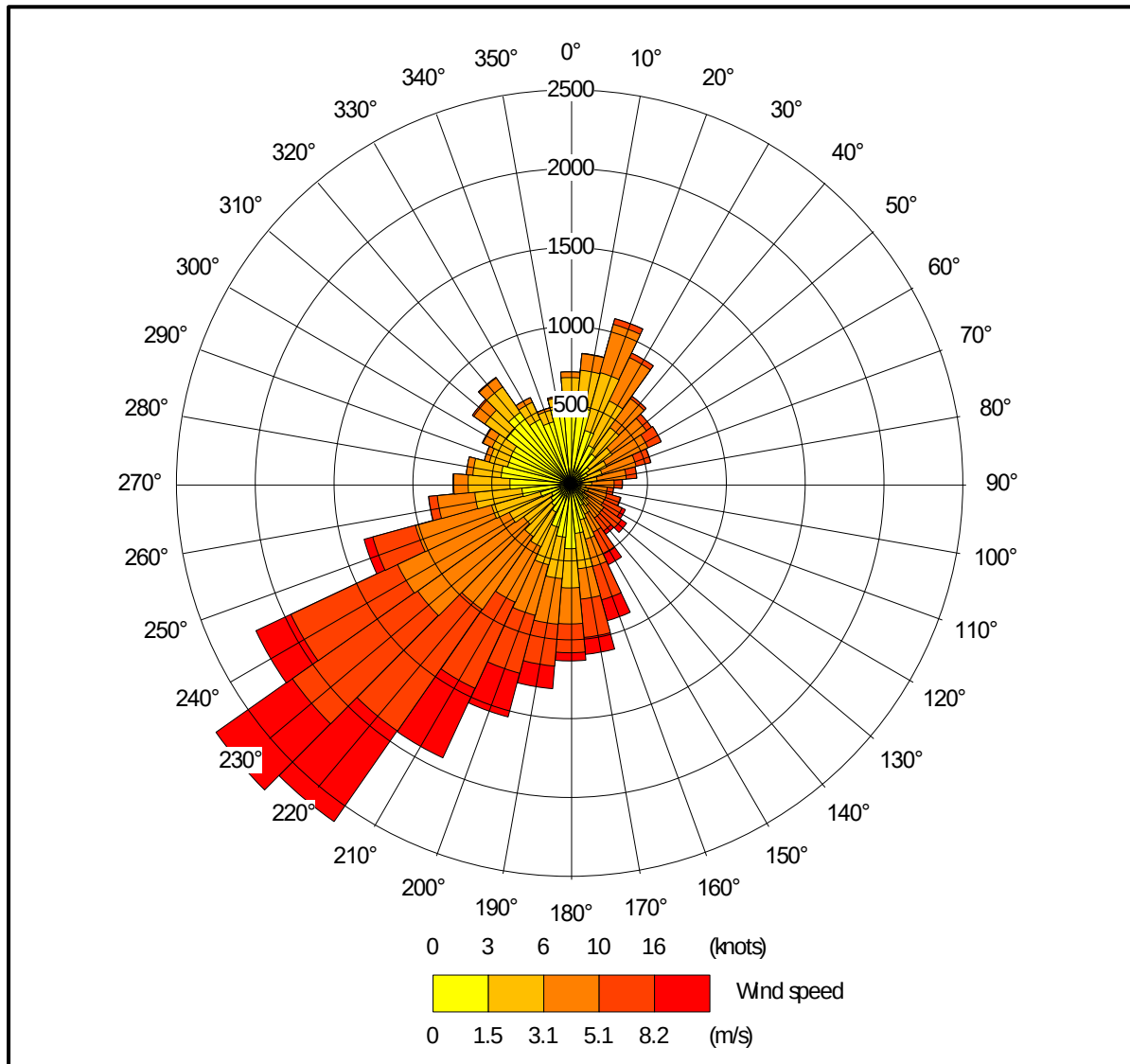


Figure 2c. The wind rose for Sennybridge, 2014 - 2017.



4.2 Emission sources

Emissions from the capped roof fans and high velocity roof fans that are/would be used to ventilate the existing and proposed poultry houses are represented by three point sources per house within ADMS (EX1 a, b & c; EX2 a, b & c; EX3 a, b & c; EX4 a, b & c; PR3 a, b & c and PR4 a, b & c). Details of the point source parameters are shown in Table 3a. The positions of the point sources may be seen in Figure 3, where they are indicated by red star symbols.

Table 3a. Point source parameters

Source ID	Height (m)	Diameter (m)	Efflux velocity (m/s)	Emission temperature (°C)	Emission rate per source (g-NH ₃ /s)
EX1 a, b & c and EX2 a, b & c	6.0	0.8	10.0	21.0	0.023796
EX3 a, b & c	5.2	2	0.01	21.0	0.026352
EX4 a, b & c	5.2	2	0.01	21.0	0.035136
PR3 a, b & c	6.0	0.8	10.0	21.0	0.023796
PR4 a, b & c	6.0	0.8	10.0	21.0	0.023796

The poultry houses would each have a ranging area, which are represented by six area sources within ADMS (EX1_RAN; EX2_RAN; EX3_RAN; EX4_RAN; PR3_RAN and PR4_RAN). Note that the area sources cover the parts of the range most likely to be used frequently and not the whole ranging area.

Details of the area source parameters are provided in Table 3b. The positions of the area sources are shown in Figure 3.

Table 3b. Area source parameters

Source ID	Area (m ²)	Base height (m)	Emission temperature (°C)	Emission rate (g-NH ₃ /s)
EX1_RAN	5418.84	0.0	Ambient	0.041372
EX2_RAN	5608.50	0.0	Ambient	0.041372
EX3_RAN	5453.69	0.0	Ambient	0.017454
EX4_RAN	6985.75	0.0	Ambient	0.023272
PR3_RAN	5453.69	0.0	Ambient	0.041372
PR4_RAN	6985.75	0.0	Ambient	0.041372

4.3 Modelled buildings

The structure of the poultry houses and nearby farm buildings 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, where they are marked by grey rectangles.

4.4 Discrete receptors

Forty-nine discrete receptors have been defined: twenty-eight at the AWs (1 to 28), seven at the SSSIs (29 to 35) and fourteen at the SSSI/SAC (36 to 49). These receptors are defined at ground level within ADMS. The positions of the discrete receptors may be seen in Figures 4a and 4b, where they are 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 field used in the detailed modelling, a regular Cartesian grid has been defined at ground level within ADMS. The position of the Cartesian grid may be seen in Figures 4a and 4b, where it is marked by grey lines.

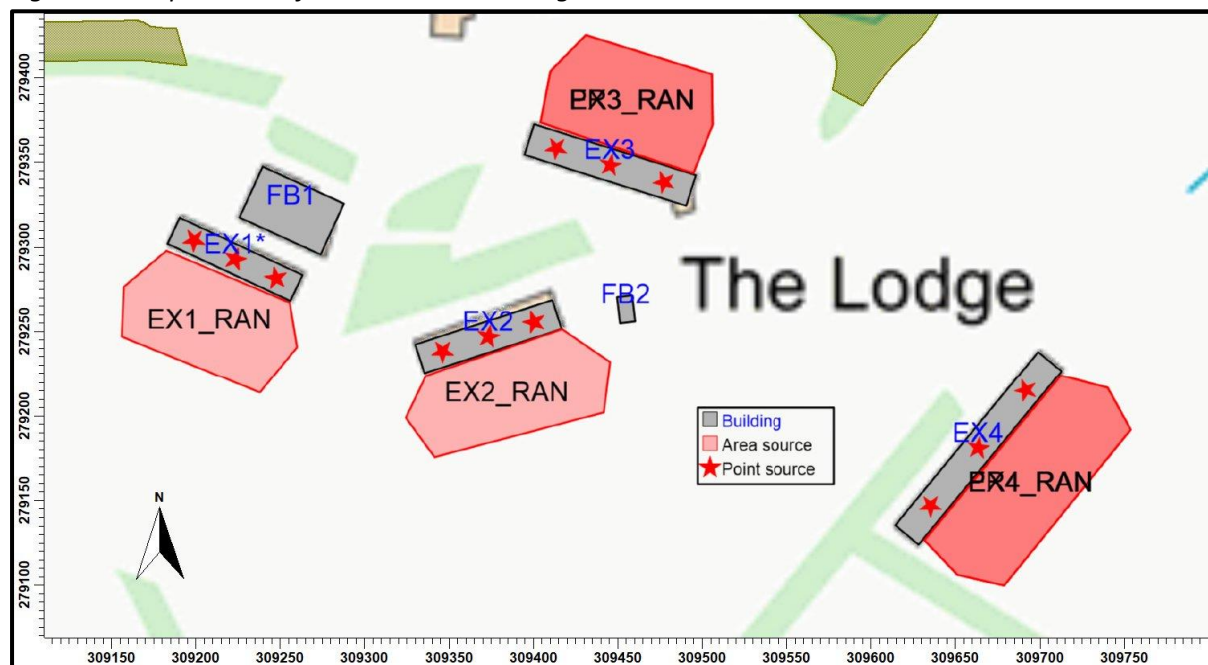
4.6 Terrain data

Terrain has been considered in the modelling. The terrain data are based upon the Ordnance Survey 50 m Digital Elevation Model. A 10.0 km x 10.0 km domain has been resampled at 100 m horizontal resolution for use within ADMS for the preliminary modelling and low resolution detailed modelling runs and a 6.4 km x 6.4 km domain has been resampled at 50 m horizontal resolution for use within ADMS for the high resolution detailed modelling runs. N.B. The resolution of FLOWSTAR is 64 x 64 grid points; therefore, the effective resolution of the wind field is approximately 150 m in the preliminary and low resolution detailed modelling and 100 m in the high resolution detailed modelling.

4.7 Roughness Length

A fixed surface roughness length of 0.225 m has been applied over the entire modelling domain. As a precautionary measure, the GFS meteorological data is assumed to have a roughness length of 0.2 m. The effect of the difference in roughness length is precautionary as it increases the frequency of low wind speeds and stability and therefore increases predicted ground level concentrations.

Figure 3. The positions of the modelled buildings and sources

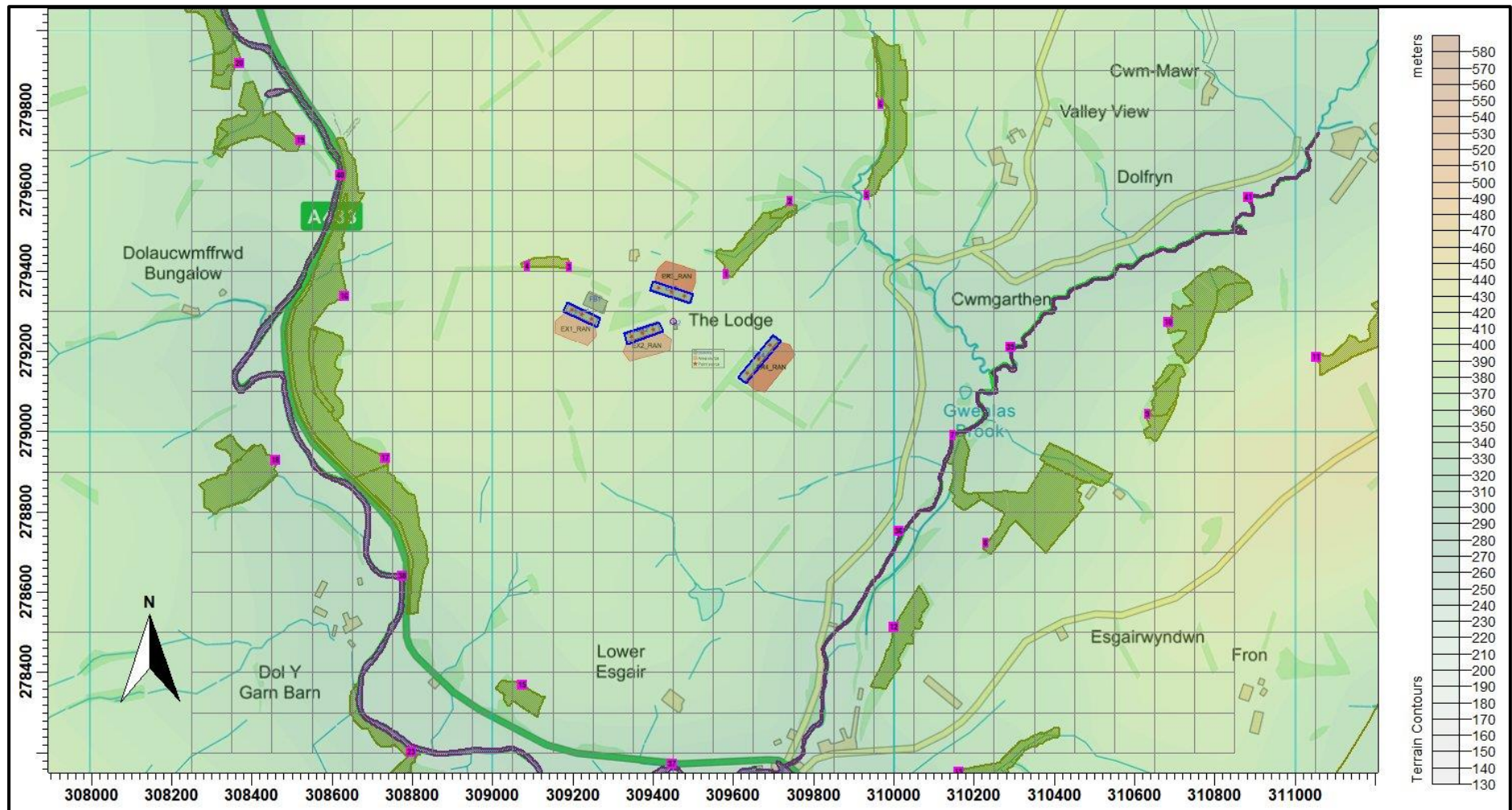


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Topographic map of the study area showing terrain contours, a grid, and a network of points and lines. The map includes a north arrow and a scale bar. The terrain is color-coded by elevation, with a legend on the right showing a range from 130 to 580 meters. The map is overlaid with a grid and a network of points and lines, likely representing a sampling or monitoring network. The map is titled 'Topographic map of the study area'.

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Figure 4b. The discrete receptors and high resolution regular Cartesian grid – a closer view



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4.8 Deposition

The method used to model deposition of ammonia and consequent plume depletion is based on a document titled “Guidance on modelling the concentration and deposition of ammonia emitted from intensive farming” from the Environment Agency’s Air Quality Modelling and Assessment Unit, 22 November 2010. N.B. 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 0.015 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 high and low resolution deposition velocity fields. The deposition velocities used are provided in Table 4.

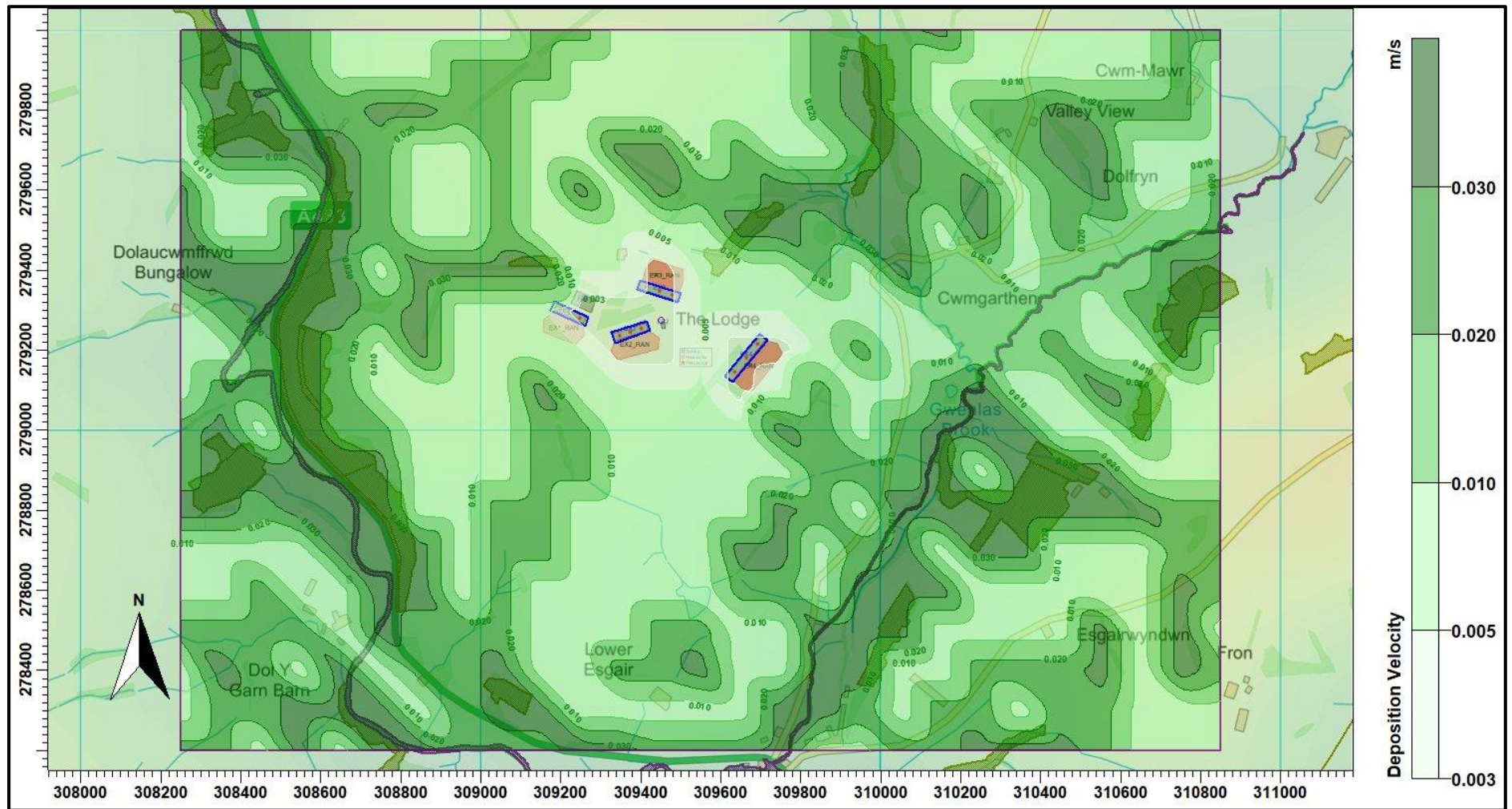
Table 4. Deposition velocities

NH ₃ concentration (PC + background) (µg/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 (0.015 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 at high and low resolution.

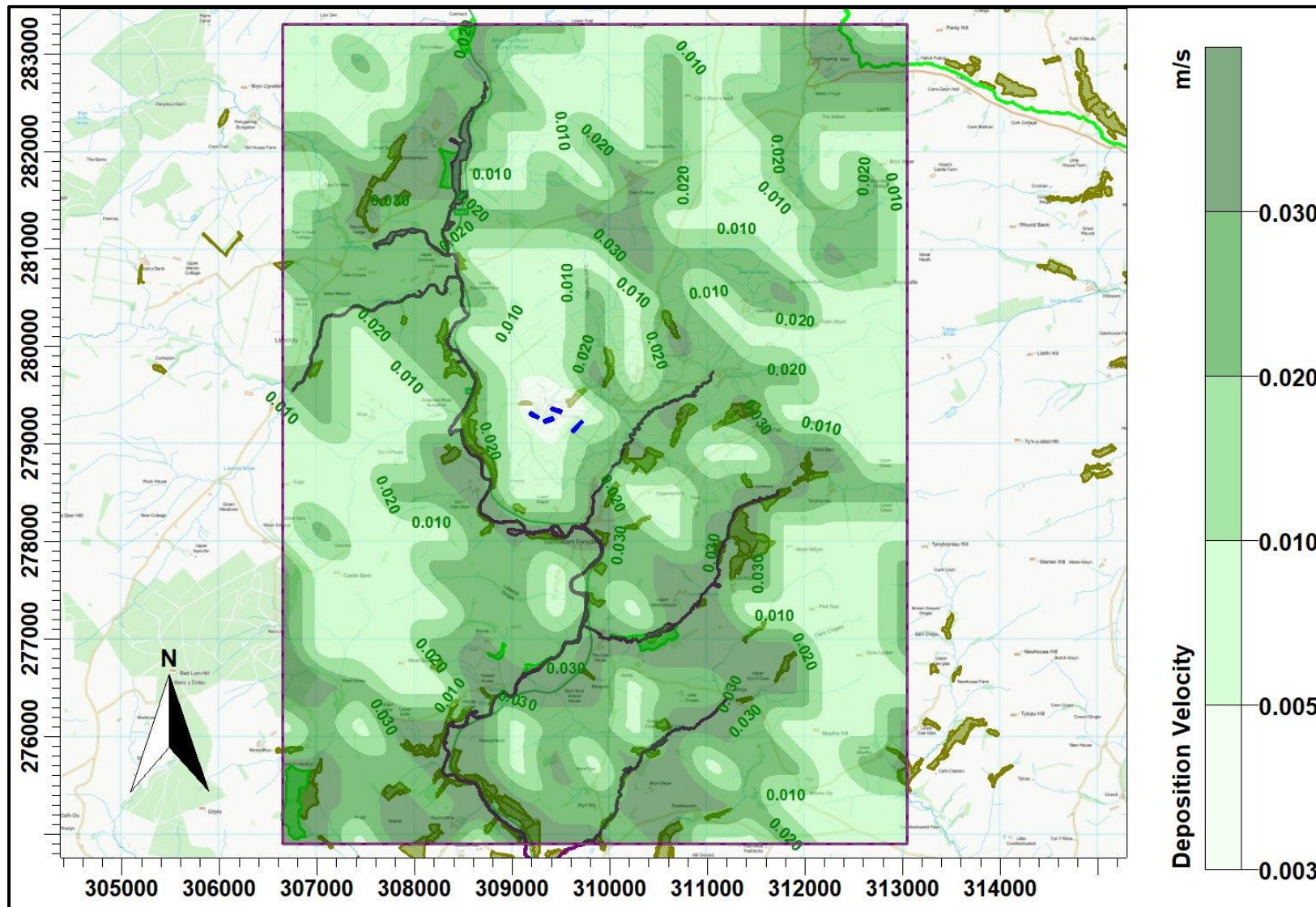
Contour plots of the high and low resolution spatially varying deposition fields are provided in Figures 5a and 5b, respectively.

Figure 5a. The high resolution spatially varying deposition field



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Figure 5b. The low resolution spatially varying deposition field



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5. Details of the Model Runs and Results

5.1 Preliminary modelling

ADMS was run a total of twenty times; once for each year of the meteorological record and in the following five modes:

- In basic mode without calms or terrain – GFS data.
- With calms and without terrain – GFS data.
- Without calms and with terrain – GFS data.
- In basic mode without calms or terrain – Sennybridge observational data.
- Without calms, with terrain and with a fixed deposition velocity of 0.003 m/s – 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. In the Table, predicted ammonia concentrations, including those that would lead to a nitrogen deposition rate, that are in excess of the Natural Resources Wales upper threshold (8% of Critical Level or Load for a SSSI/SAC and 100% of a Critical Level or Load for an AW) are coloured red. Concentrations in the range between the Natural Resources Wales upper threshold and lower threshold (1% to 8% for a SSSI/SAC and 50%¹ to 100% for an AW) are coloured blue. For convenience, cells referring to the SAC are shaded purple, cells referring to the SSSI are shaded green and cells referring to the AWs are shaded olive.

1. The Pre-February 2016 figure is retained.

Table 5. Predicted maximum annual mean ammonia concentration at the discrete receptors

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 Terrain	Sennybridge No Calms No terrain	GFS No Calms Terrain Fixed Depo	GFS No Calms No terrain	GFS Calms No Terrain	GFS No Calms Terrain	Sennybridge No Calms No terrain	GFS No Calms Terrain Fixed Depo
1	309582	279393	Unnamed AW	10.903	10.841	12.269	14.490	9.552	10.823	10.799	11.990	13.537	8.472
2	309741	279573	Unnamed AW	2.884	2.881	3.113	5.701	2.142	2.375	2.364	2.683	4.262	1.773
3	309192	279409	Unnamed AW	5.881	5.838	5.910	8.990	3.978	6.030	5.983	6.631	9.321	4.514
4	309086	279411	Unnamed AW	3.476	3.452	3.573	3.068	2.258	3.301	3.265	3.739	3.073	2.363
5	309933	279588	Cwm Nant-ddu AW	1.995	2.001	1.891	3.316	1.181	1.560	1.557	1.874	2.425	1.299
6	309967	279816	Cwm Nant-ddu AW	1.169	1.194	1.170	2.258	0.665	0.935	0.932	1.038	1.670	0.638
7	310147	278992	Unnamed AW	2.024	2.017	2.643	2.091	1.693	1.487	1.470	1.641	1.464	0.927
8	310230	278723	Unnamed AW	0.952	0.956	1.102	1.305	0.622	0.744	0.734	0.785	0.909	0.416
9	310632	279043	Unnamed AW	0.906	0.916	1.298	0.921	0.566	0.680	0.675	0.606	0.639	0.286
10	310685	279272	Gwenlas Wood AW	0.812	0.824	1.329	0.837	0.598	0.627	0.624	0.581	0.596	0.304
11	311053	279185	Ddol Wood AW	0.539	0.551	0.717	0.551	0.288	0.422	0.420	0.370	0.397	0.160
12	310000	278514	Unnamed AW	0.582	0.614	0.718	1.581	0.429	0.455	0.453	0.572	1.085	0.333
13	310161	278153	Unnamed AW	0.320	0.346	0.336	0.899	0.179	0.232	0.234	0.286	0.631	0.162
14	309854	278116	Unnamed AW	0.342	0.374	0.395	0.881	0.214	0.252	0.255	0.312	0.599	0.149
15	309073	278369	Unnamed AW	0.701	0.723	0.916	1.394	0.498	0.526	0.522	0.594	1.097	0.286
16	308631	279338	Berth y Bi AW	1.103	1.117	1.615	0.398	0.931	0.953	0.940	1.328	0.358	0.740
17	308734	278934	Berth y Bi AW	0.937	0.968	1.323	0.846	0.791	0.792	0.792	1.161	0.787	0.650
18	308459	278929	Unnamed AW	0.628	0.656	1.592	0.423	0.831	0.532	0.532	1.161	0.386	0.637
19	308521	279726	Unnamed AW	0.504	0.519	0.768	0.355	0.435	0.431	0.422	0.517	0.301	0.285
20	308370	279917	Unnamed AW	0.339	0.355	0.408	0.287	0.217	0.292	0.286	0.339	0.233	0.184
21	308330	280171	Unnamed AW	0.260	0.277	0.323	0.270	0.184	0.220	0.217	0.295	0.209	0.170
22	309332	278089	Unnamed AW	0.416	0.441	0.497	1.121	0.265	0.291	0.292	0.335	0.787	0.165
23	308798	278202	Unnamed AW	0.491	0.511	0.732	0.839	0.356	0.390	0.386	0.483	0.680	0.220
24	309913	277784	Unnamed AW	0.231	0.257	0.249	0.604	0.121	0.173	0.176	0.200	0.398	0.093

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 Terrain	Sennybridge No Calms No terrain	GFS No Calms Terrain Fixed Depo	GFS No Calms No terrain	GFS Calms No Terrain	GFS No Calms Terrain	Sennybridge No Calms No terrain	GFS No Calms Terrain Fixed Depo
25	310629	280154	Coed Cwm Mawr AW	0.418	0.440	0.361	0.649	0.194	0.340	0.339	0.370	0.498	0.230
26	308519	280800	Unnamed AW	0.203	0.218	0.234	0.297	0.131	0.167	0.165	0.225	0.241	0.140
27	307894	280230	Unnamed AW	0.182	0.196	0.193	0.159	0.088	0.156	0.153	0.648	0.126	0.085
28	309793	277470	Unnamed AW	0.170	0.192	0.195	0.520	0.097	0.130	0.133	0.158	0.344	0.079
29	308910	276954	Caeau Bryn-du SSSI	0.159	0.172	0.145	0.394	0.065	0.120	0.120	0.123	0.301	0.056
30	309191	276747	Caeau Bryn-du SSSI	0.117	0.131	0.115	0.360	0.056	0.088	0.089	0.114	0.266	0.055
31	310225	277035	Llymwynt Brook Pastures SSSI	0.122	0.138	0.154	0.293	0.070	0.094	0.096	0.107	0.212	0.044
32	306914	275653	Rhosydd Nant-yr-Henfron SSSI	0.069	0.075	0.054	0.113	0.019	0.059	0.060	0.039	0.097	0.016
33	308363	281626	Gweunydd Esgairdraenllwyn SSSI	0.116	0.126	0.155	0.221	0.072	0.097	0.096	0.137	0.180	0.069
34	308540	283015	Gweunydd Camnant SSSI	0.070	0.076	0.091	0.188	0.044	0.060	0.060	0.080	0.154	0.041
35	312561	282882	River Teme SSSI	0.055	0.061	0.046	0.112	0.026	0.048	0.049	0.050	0.093	0.030
36	310014	278751	River Ithon SSSI / River Wye SAC	1.112	1.116	1.400	2.194	0.900	0.885	0.877	1.068	1.500	0.617
37	309446	278172	River Ithon SSSI / River Wye SAC	0.437	0.466	0.511	1.228	0.269	0.311	0.313	0.359	0.849	0.179
38	308775	278639	River Ithon SSSI / River Wye SAC	0.707	0.734	1.104	0.953	0.626	0.590	0.586	0.725	0.828	0.355
39	310291	279210	River Ithon SSSI / River Wye SAC	1.659	1.666	2.221	1.666	1.403	1.222	1.215	1.314	1.154	0.770
40	308621	279638	River Ithon SSSI / River Wye SAC	0.660	0.673	1.059	0.427	0.641	0.565	0.553	0.654	0.370	0.362
41	310884	279584	River Ithon SSSI / River Wye SAC	0.516	0.529	0.840	0.573	0.473	0.417	0.415	0.460	0.436	0.279
42	308552	280322	River Ithon SSSI / River Wye SAC	0.275	0.293	0.369	0.342	0.239	0.235	0.233	0.348	0.270	0.222
43	307757	281068	River Ithon SSSI / River Wye SAC	0.105	0.116	0.177	0.126	0.062	0.090	0.090	0.137	0.095	0.066
44	306924	279797	River Ithon SSSI / River Wye SAC	0.159	0.169	0.201	0.057	0.070	0.133	0.131	0.151	0.046	0.054

Receptor number	X(m)	Y(m)	Designation	Maximum annual mean ammonia concentration ($\mu\text{g}/\text{m}^3$)									
				Existing					Proposed				
				GFS No Calms No terrain	GFS Calms No Terrain	GFS No Calms Terrain	Sennybridge No Calms No terrain	GFS No Calms Terrain Fixed Depo	GFS No Calms No terrain	GFS Calms No Terrain	GFS No Calms Terrain	Sennybridge No Calms No terrain	GFS No Calms Terrain Fixed Depo
45	308639	282454	River Ithon SSSI / River Wye SAC	0.088	0.096	0.112	0.234	0.057	0.075	0.075	0.100	0.189	0.052
46	311272	278305	River Ithon SSSI / River Wye SAC	0.312	0.319	0.566	0.353	0.252	0.249	0.246	0.283	0.253	0.123
47	308608	276255	River Ithon SSSI / River Wye SAC	0.110	0.119	0.099	0.259	0.044	0.087	0.087	0.079	0.206	0.034
48	310729	276101	River Ithon SSSI / River Wye SAC	0.070	0.081	0.093	0.174	0.035	0.056	0.058	0.062	0.135	0.026
49	309095	275028	River Ithon SSSI / River Wye SAC	0.050	0.057	0.073	0.166	0.029	0.040	0.042	0.053	0.130	0.025

5.2 Detailed deposition modelling

The detailed modelling was carried out over high and low resolution restricted domains where the preliminary modelling indicated that annual mean ammonia concentrations could potentially exceed the relevant lower threshold percentage of the Critical Level of $1.0 \mu\text{g-NH}_3/\text{m}^3$. The low resolution domain covers the poultry houses and ranges at Upper Esgair and all receptors, whereas the high resolution domain focuses on the poultry houses and ranges and closer receptors including; several unnamed AWs, Cwm Nant-ddu AW, Gwenlas Wood AW, Berth y Bi AW, River Ithon SSSI and River Wye SAC.

The predicted maximum annual mean ground level ammonia concentrations and nitrogen deposition rates at the discrete receptors over high and low resolution domains are shown in Tables 6a and 6b respectively. In the tables, predicted ammonia concentrations or nitrogen deposition rates that are in excess of the Natural Resources Wales upper threshold (8% of Critical Level or Load for a SSSI/SAC and 100% of Critical Level or Load for an AW) are coloured red. Concentrations that are in the range between the Natural Resources Wales lower and upper thresholds (1% to 8% for a SSSI/SAC and 50%¹ to 100% for an AW) are coloured blue.

Contour plots of the predicted ground level maximum annual mean ammonia and maximum nitrogen deposition rates at high and low resolution for existing and proposed scenarios are shown in Figures 6a to 6h.

1. The pre-February 2016 figure is retained.

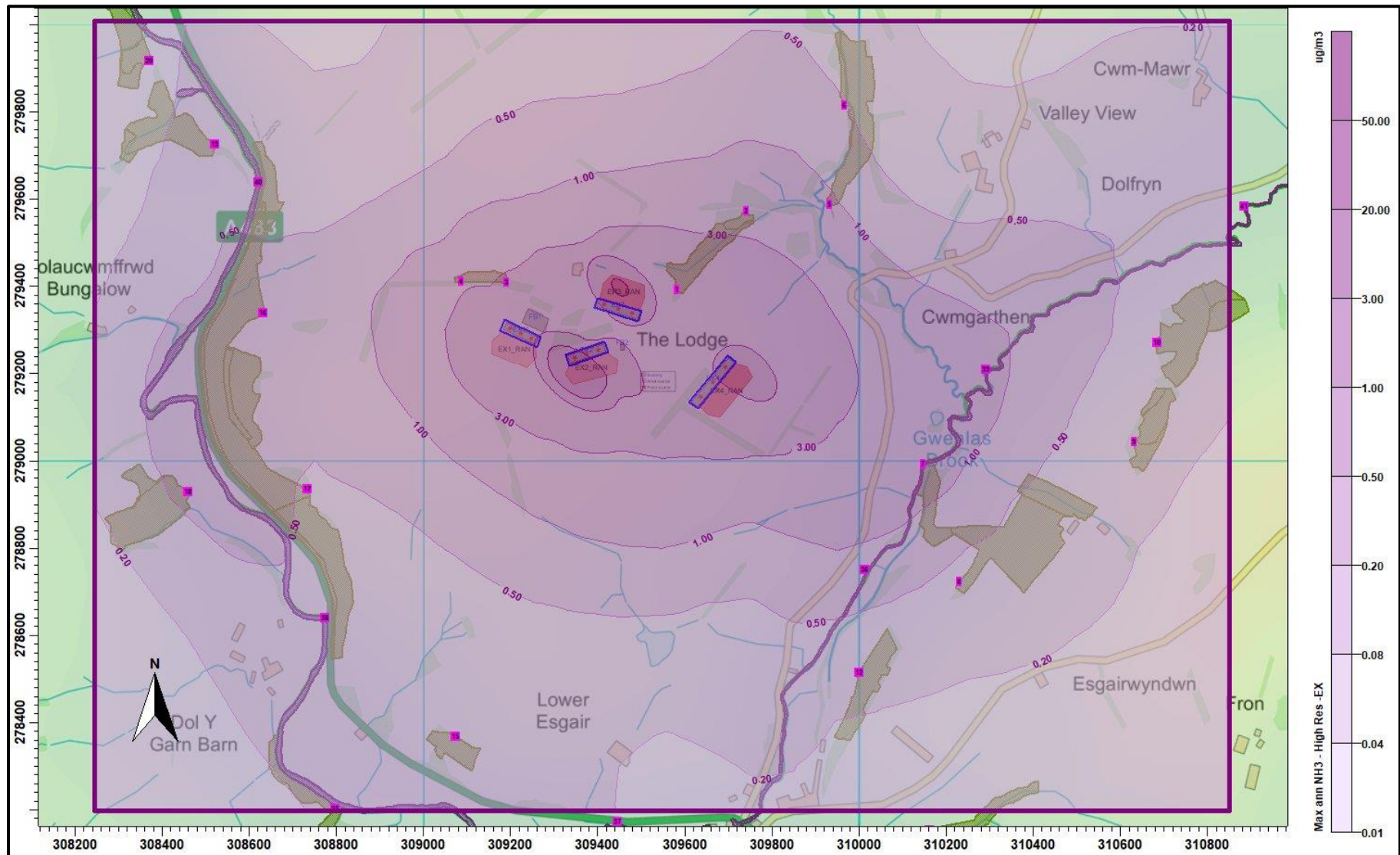
Table 6a. Predicted maximum annual mean ammonia concentrations and nitrogen deposition at the discrete receptors – high resolution

Rec. Num.	X (m)	Y (m)	Site	Site Parameters			Maximum annual mean ammonia concentration				Maximum annual mean ammonia concentration			
				Critical Level (µg/m³)	Deposition velocity (m/s)	Critical Load (kg/ha)	Existing Process Contribution (µg/m³)	%age of Critical Level	Proposed Process Contribution (µg/m³)	%age of Critical Level	Existing Process Contribution (kg/ha)	%age of Critical Level	Proposed Process Contribution (kg/ha)	%age of Critical Level
1	309582	279393	Unnamed AW	1.0	-	-	10.161	1016.1	9.034	903.4	-	-	-	-
2	309741	279573	Unnamed AW	1.0	-	-	2.071	207.1	1.286	128.6	-	-	-	-
3	309192	279409	Unnamed AW	1.0	-	-	3.474	347.4	3.992	399.2	-	-	-	-
4	309086	279411	Unnamed AW	1.0	-	-	1.904	190.4	1.901	190.1	-	-	-	-
5	309933	279588	Cwm Nant-ddu AW	1.0	-	-	1.124	112.4	0.634	63.4	-	-	-	-
6	309967	279816	Cwm Nant-ddu AW	1.0	-	-	0.505	50.5	0.319	31.9	-	-	-	-
7	310147	278992	Unnamed AW	1.0	-	-	1.441	144.1	0.933	93.3	-	-	-	-
8	310230	278723	Unnamed AW	1.0	-	-	0.397	39.7	0.295	29.5	-	-	-	-
9	310632	279043	Unnamed AW	1.0	-	-	0.283	28.3	0.193	19.3	-	-	-	-
10	310685	279272	Gwenlas Wood AW	1.0	-	-	0.359	35.9	0.243	24.3	-	-	-	-
12	310000	278514	Unnamed AW	1.0	-	-	0.268	26.8	0.239	23.9	-	-	-	-
15	309073	278369	Unnamed AW	1.0	-	-	0.359	35.9	0.238	23.8	-	-	-	-
16	308631	279338	Berth y Bi AW	1.0	-	-	0.584	58.4	0.557	55.7	-	-	-	-
17	308734	278934	Berth y Bi AW	1.0	-	-	0.460	46.0	0.592	59.2	-	-	-	-
18	308459	278929	Unnamed AW	1.0	-	-	0.619	61.9	0.499	49.9	-	-	-	-
19	308521	279726	Unnamed AW	1.0	-	-	0.298	29.8	0.262	26.2	-	-	-	-
20	308370	279917	Unnamed AW	1.0	-	-	0.164	16.4	0.133	13.3	-	-	-	-
23	308798	278202	Unnamed AW	1.0	-	-	0.258	25.8	0.138	13.8	-	-	-	-
36	310014	278751	River Ithon SSSI / River Wye SAC	1.0	0.03	5.0	0.752	75.2	0.500	50.0	5.861	117.2	3.897	77.9
38	308775	278639	River Ithon SSSI / River Wye SAC	1.0	0.03	5.0	0.455	45.5	0.339	33.9	3.542	70.8	2.638	52.8
39	310291	279210	River Ithon SSSI / River Wye SAC	1.0	0.03	5.0	1.220	122.0	0.786	78.6	9.505	190.1	6.122	122.4
40	308621	279638	River Ithon SSSI / River Wye SAC	1.0	0.02	5.0	0.397	39.7	0.389	38.9	20.059	41.2	2.022	40.4

Table 6b. Predicted maximum annual mean ammonia concentrations and nitrogen deposition at the discrete receptors – low resolution

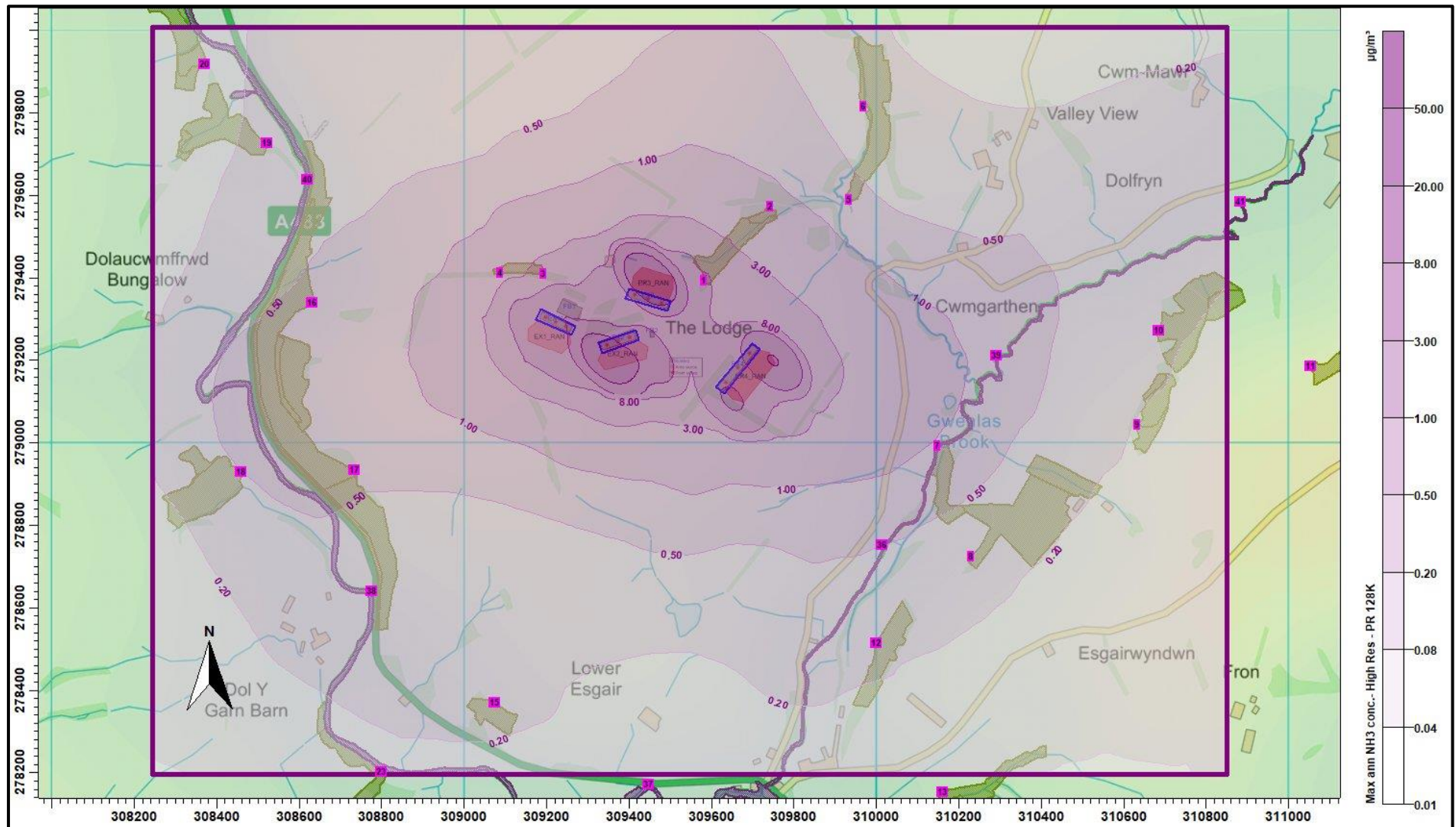
Receptor Number	X (m)	Y (m)	Site	Site Parameters			Maximum annual mean ammonia concentration				Maximum annual mean nitrogen deposition			
				Critical Level (µg/m³)	Deposition Velocity (m/s)	Critical Load (kg/ha)	Existing Process Contribution (µg/m³)	%age of Critical Level	Proposed Process Contribution (µg/m³)	%age of Critical Level	Existing Process Contribution (kg/ha)	%age of Critical Load	Proposed Process Contribution (kg/ha)	%age of Critical Load
29	308910	276954	Caeau Bryn-du SSSI	1.0	0.03	10.0	0.035	3.5	0.026	2.6	0.271	2.7	0.200	2.0
30	309191	276747	Caeau Bryn-du SSSI	1.0	0.03	10.0	0.032	3.2	0.026	2.6	0.247	2.5	0.200	2.0
31	310225	277035	Llymwynt Brook Pastures SSSI	1.0	0.03	10.0	0.031	3.1	0.022	2.2	0.242	2.4	0.171	1.7
32	306914	275653	Rhosydd Nant-yr-Henfron SSSI	1.0	0.03	10.0	0.008	0.8	0.007	0.7	0.065	0.6	0.056	0.6
33	308363	281626	Gweunydd Esgairdraenllwyn SSSI	1.0	0.03	10.0	0.049	4.9	0.051	5.1	0.385	3.9	0.397	4.0
34	308540	283015	Gweunydd Camnant SSSI	1.0	0.03	10.0	0.029	2.9	0.028	2.8	0.223	2.2	0.216	2.2
35	312561	282882	River Teme SSSI	1.0	0.03	10.0	0.017	1.7	0.016	1.6	0.132	1.3	0.127	1.3
36	310014	278751	River Ithon SSSI / River Wye SAC	1.0	0.03	5.0	0.623	62.3	0.478	47.8	4.853	97.1	3.723	74.5
37	309446	278172	River Ithon SSSI / River Wye SAC	1.0	0.03	5.0	0.190	19.0	0.115	11.5	1.479	29.6	0.900	18.0
38	308775	278639	River Ithon SSSI / River Wye SAC	1.0	0.03	5.0	0.466	46.6	0.376	37.6	3.632	72.6	2.927	58.5
39	310291	279210	River Ithon SSSI / River Wye SAC	1.0	0.02	5.0	1.046	104.6	0.763	76.3	5.432	108.6	3.965	79.3
40	308621	279638	River Ithon SSSI / River Wye SAC	1.0	0.02	5.0	0.483	48.3	0.430	43.0	2.509	50.2	2.231	44.6
41	310884	279584	River Ithon SSSI / River Wye SAC	1.0	0.02	5.0	0.309	30.9	0.236	23.6	1.605	32.1	1.226	24.5
42	308552	280322	River Ithon SSSI / River Wye SAC	1.0	0.02	5.0	0.194	19.4	0.209	20.9	1.010	20.2	1.085	21.7
43	307757	281068	River Ithon SSSI / River Wye SAC	1.0	0.02	5.0	0.038	3.8	0.040	4.0	0.200	4.0	0.207	4.1
44	306924	279797	River Ithon SSSI / River Wye SAC	1.0	0.02	5.0	0.037	3.7	0.028	2.8	0.191	3.8	0.145	2.9
45	308639	282454	River Ithon SSSI / River Wye SAC	1.0	0.02	5.0	0.039	3.9	0.038	3.8	0.203	4.1	0.196	3.9
46	311272	278305	River Ithon SSSI / River Wye SAC	1.0	0.03	5.0	0.114	11.4	0.086	8.6	0.887	17.7	0.673	13.5
47	308608	276255	River Ithon SSSI / River Wye SAC	1.0	0.02	5.0	0.021	2.1	0.017	1.7	0.110	2.2	0.086	1.7
48	310729	276101	River Ithon SSSI / River Wye SAC	1.0	0.03	5.0	0.013	1.3	0.012	1.2	0.102	2.0	0.095	1.9
49	309095	275028	River Ithon SSSI / River Wye SAC	1.0	0.03	5.0	0.013	1.3	0.011	1.1	0.100	2.0	0.087	1.7

Figure 6a. Maximum annual ammonia concentration – high resolution – existing scenario



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Figure 6b. Maximum annual ammonia concentration – high resolution – proposed scenario

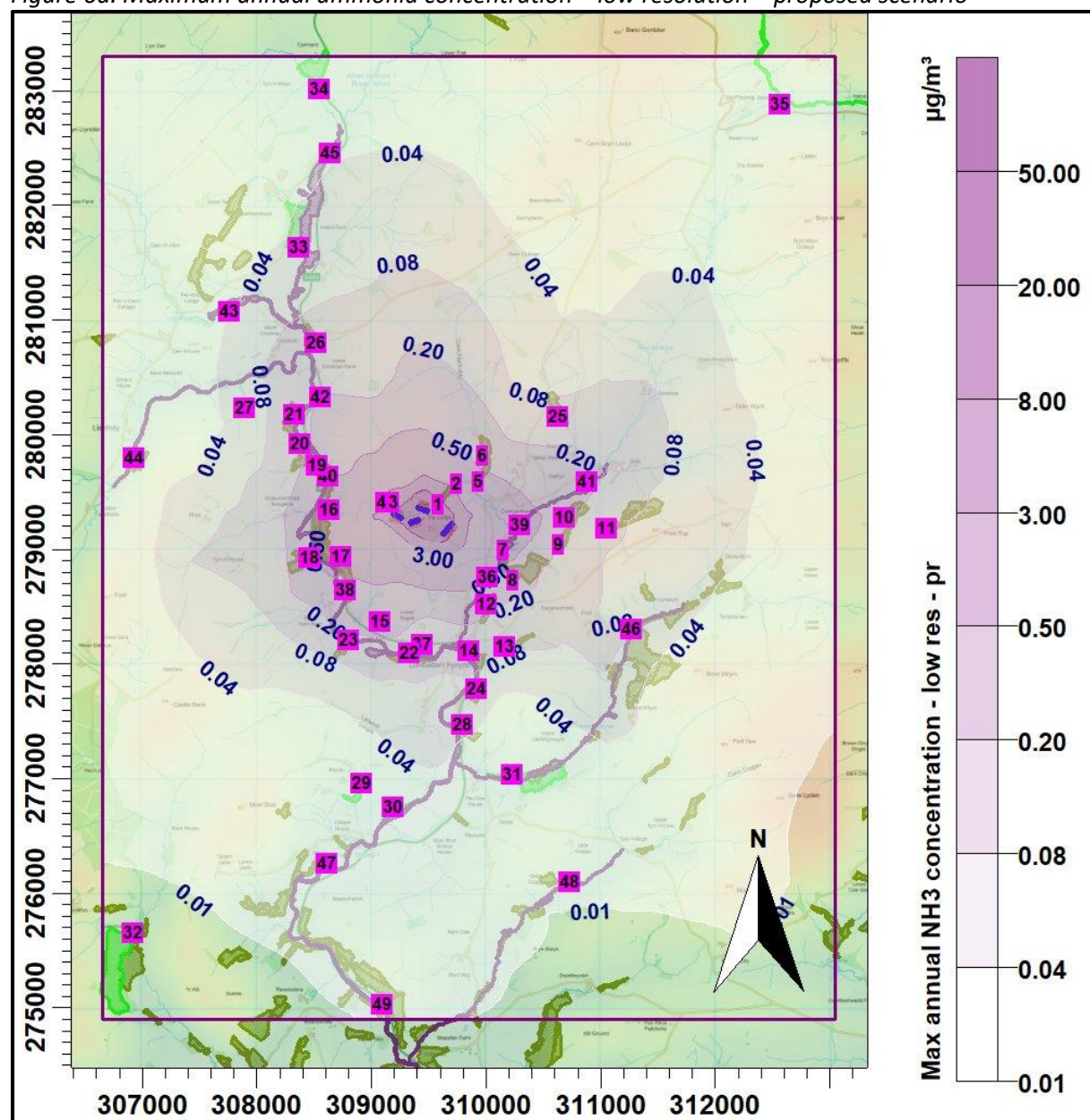


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The map illustrates the spatial distribution of predicted maximum annual NH₃ concentration in the atmosphere over the Liffey catchment area. The concentration is highest in the central urban area, reaching up to 50.00 ug/m³, and decreases as distance from the urban center increases. The map includes a coordinate grid and a north arrow.

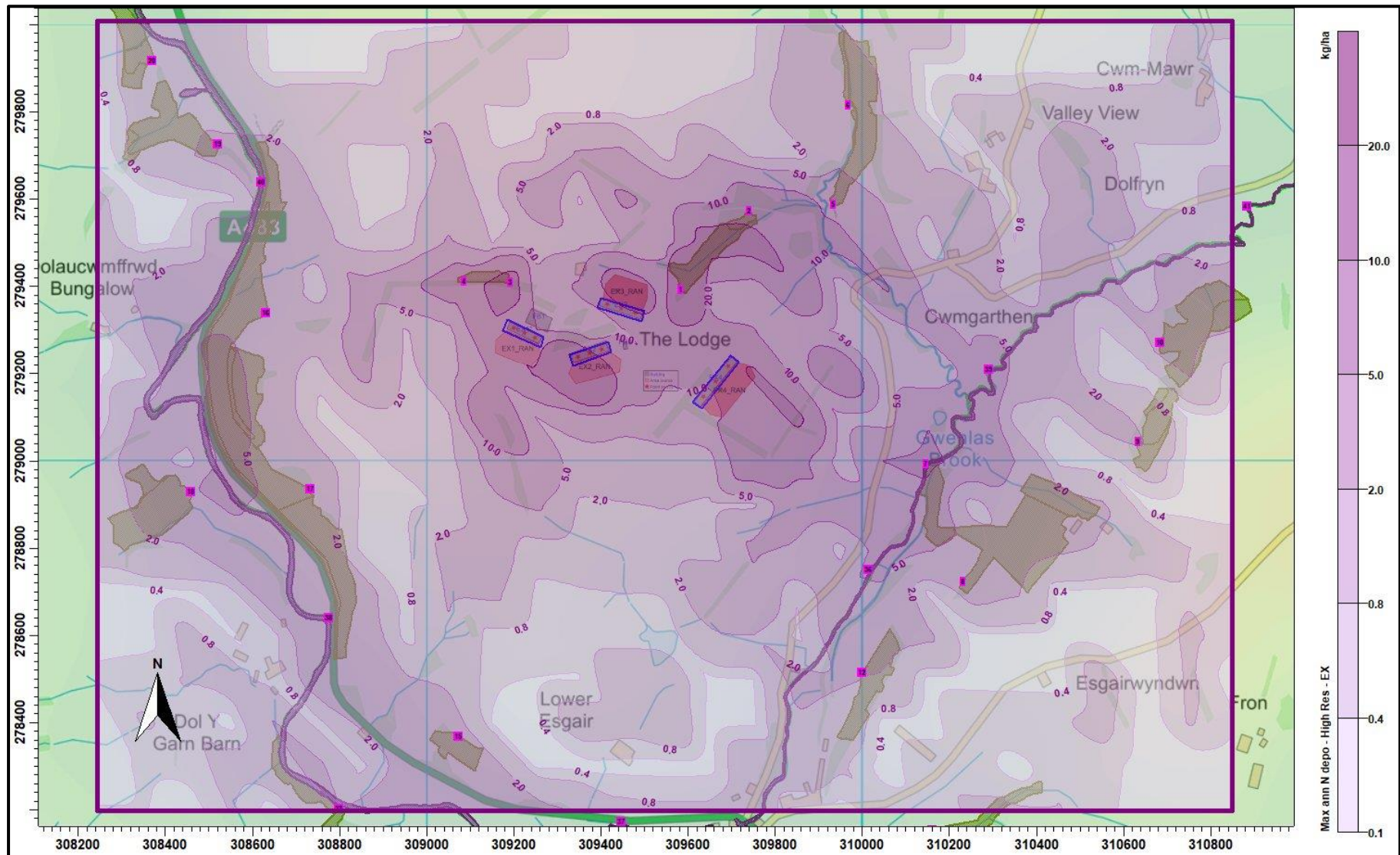
32

Figure 6d. Maximum annual ammonia concentration – low resolution – proposed scenario



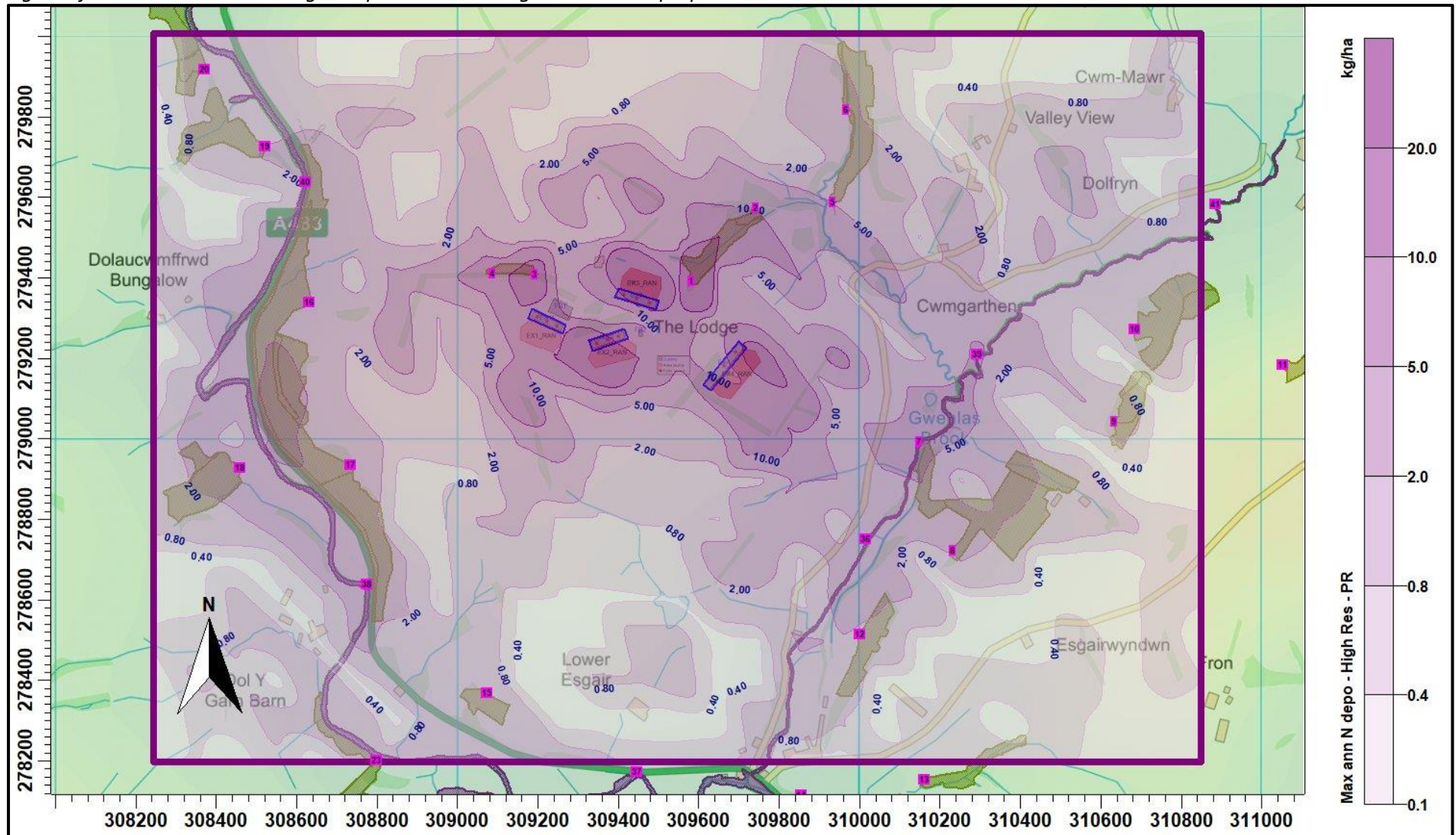
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Figure 6e. Maximum annual nitrogen deposition rate – high resolution – existing scenario



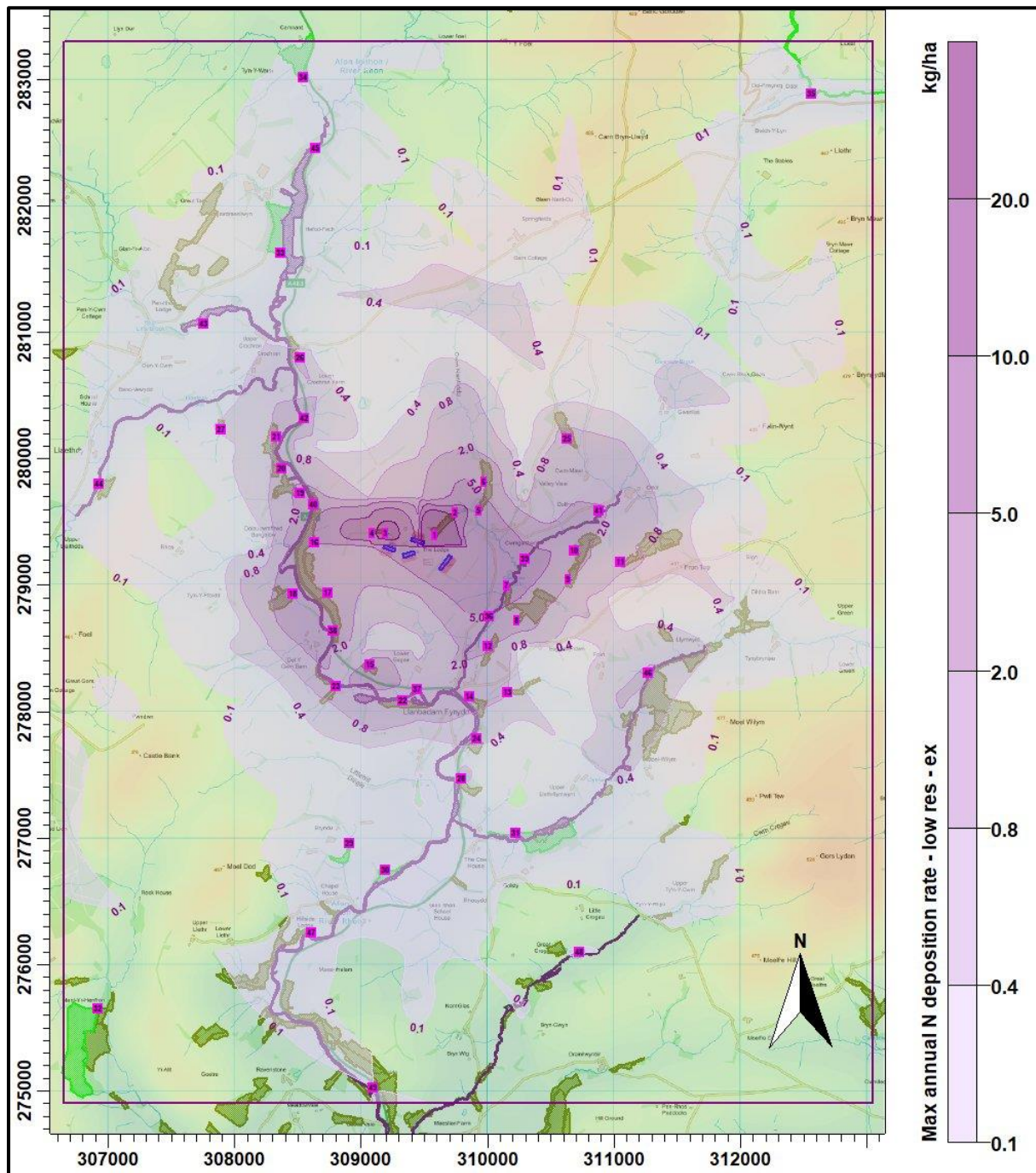
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Figure 6f. Maximum annual nitrogen deposition rate – high resolution – proposed scenario



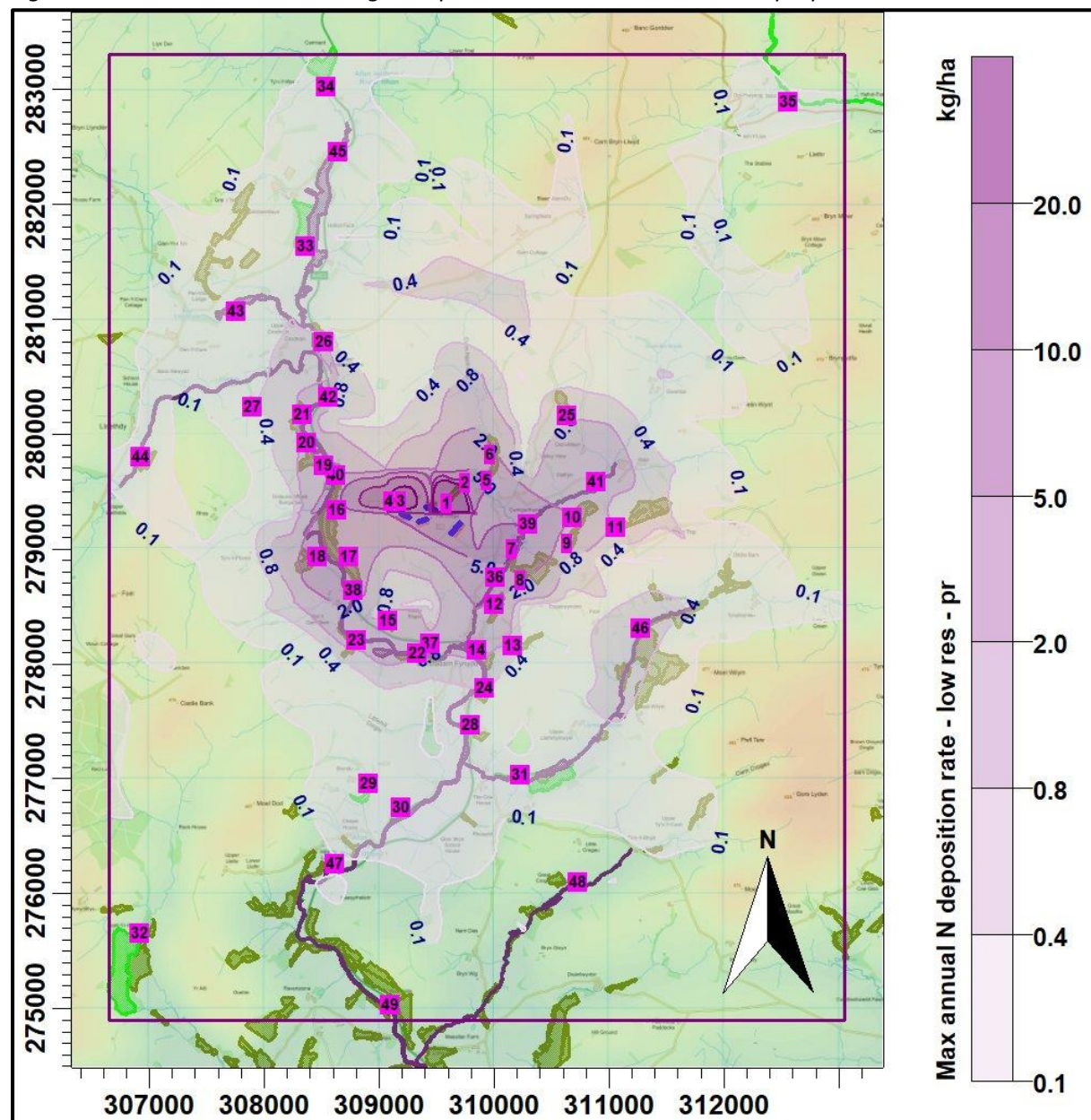
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Figure 6g. Maximum annual nitrogen deposition rate – low resolution – existing scenario



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Figure 6h. Maximum annual nitrogen deposition rate – low resolution – proposed scenario



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6. Summary and Conclusions

AS Modelling & Data Ltd. has been instructed by Gail Lewis of Richard Parry & Partners LLP, on behalf of the applicants Messrs Jones of DLJ Ltd., to use computer modelling to assess the impact of ammonia emissions from the free range egg laying chicken houses at Upper Esgair, Ddol, Llanbadarn Fynydd, Powys. LD1 6YB.

Ammonia emission rates from the proposed poultry unit have been assessed and quantified based upon the Environment Agency's standard ammonia emission factors. The 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.

Preliminary modelling

The preliminary modelling of the existing and proposed scenarios predicts that the process contribution to ammonia at several AWs, Caeau Bryn-du SSSI, Llymwynt Brook Pastures SSSI, Gweunydd Esgairdraenllwyn SSSI, Gweunydd Camnant SSSI, River Ithon SSSI and the River Wye SAC would potentially exceed Natural Resources Wales upper threshold (8% for a SSSI/SAC and 100% for non-statutory sites) of the precautionary Critical Level of $1.0 \mu\text{g-NH}_3/\text{m}^3$.

At a further five AWs, Rhosydd Nant-yr-Henfron SSSI, and the River Teme SSSI the preliminary modelling of the existing and proposed scenarios predicts that the process contribution to ammonia would potentially exceed Natural Resources Wales lower threshold (1% for a SSSI/SAC and 50% for non-statutory sites) of the precautionary Critical Level of $1.0 \mu\text{g-NH}_3/\text{m}^3$.

At all other sites considered, the preliminary modelling predicts that the process contribution to the annual ammonia concentration and the nitrogen deposition rate would be below Natural Resources Wales lower threshold percentage of Critical Level for the site (50% for non-statutory sites).

Detailed deposition modelling

The detailed modelling, which was undertaken over both high and low resolution domains, predicts that, when deposition and consequent plume depletion are considered:

- At the closest surrounding unnamed AWs the process contribution to ammonia concentration would exceed the Natural Resources Wales upper threshold percentage (100%) of the Critical Level of $1.0 \mu\text{g-NH}_3/\text{m}^3$. However, in general, predicted ammonia levels are lower in the proposed scenario than in the existing scenario.
- Low resolution modelling predicts that at Caeau Bryn-du SSSI, Llymwynt Brook Pastures SSSI, Gweunydd Esgairdraenllwyn SSSI, Gweunydd Camnant SSSI and the River Teme SSSI the process contribution to ammonia concentration would be below the Natural Resources Wales upper threshold percentage (8%) of the Critical Level of $1.0 \mu\text{g-NH}_3/\text{m}^3$, but above the upper threshold percentage (1%). However, in general, predicted ammonia levels are lower in the proposed scenario than in the existing scenario.

- At Rhosydd Nant-yr-Henfron SSSI the process contribution to ammonia concentration is predicted to be below the Natural Resources Wales lower threshold percentage (1%) of the Critical Level of $1.0 \mu\text{g-NH}_3/\text{m}^3$
- Along approximately 7.0 km of the River Ithon SSSI and the River Wye SAC in the existing scenario and 6.7 km in the proposed scenario, the process contribution to nitrogen deposition is predicted to exceed the Natural Resources Wales upper threshold percentage (8%) of the precautionary Critical Level of $1.0 \mu\text{g-NH}_3/\text{m}^3$. However, in general, predicted ammonia levels are lower in the proposed scenario than in the existing scenario.

The designation of the River Wye SAC is largely for its aquatic features; however, the designation includes areas of quaking mire; it has not been possible to determine where these areas of quaking mire might be and therefore, the SAC has been included for consideration as a whole. If the strictest Critical Level of $1.0 \mu\text{g-NH}_3/\text{m}^3$ and a Critical Load of 10.0 kg-N/ha are assumed, then there are predicted exceedances of 8% of both the Critical Level and the Critical Load along a stretch of approximately 7.0 km and 6.7 km in the existing and proposed scenarios respectively, of the river surrounding the proposed poultry unit. However, if as appears to be likely, this section of the river does not have any features likely to be highly susceptible to either nitrogen deposition or the direct effects of ammonia then: either; higher Critical Levels and Critical Loads would be applicable, in which case the predicted process contribution would be at significantly lower levels; or, if the features are purely aquatic, there would normally be no requirement for assessment of the effects of nitrogen deposition or the direct effects of ammonia.

Where exceedances of the lower threshold percentage of Critical Level or Critical Load at a SSSI/SAC are predicted, further assessment may be required. This assessment should take into account background levels of ammonia and nitrogen deposition, the sensitivity of the parts of the site in question and if it is deemed necessary, also the presence, or not, of other developments in the area that may act in combination with the proposed development.

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