A Report on the Modelling of the Dispersion and Deposition of Ammonia from the Existing and Proposed Free Range Egg-Laying Chicken Houses at Forest View, near Llanbister in Powys

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1. Introduction

AS Modelling & Data Ltd. has been instructed by Mr. Gerallt Davies of Roger Parry & Partners LLP, on behalf of the applicant, Ms. Zoe Edwards, to use computer modelling to assess the impact of ammonia emissions from the existing and proposed free range egg-laying chicken houses at Forest View, near Llanbister, Llandrindod Wells, Powys. LL21 9UP.

Ammonia emission rates from the poultry houses have been assessed and quantified based upon the Natural Resources Wales standard ammonia emission factors and also upon an emissions model that estimates emissions from the ammonia scrubbing equipment that would be fitted to the existing and proposed poultry houses. The emission rates have then been used as inputs to an atmospheric dispersion and deposition model which calculates ammonia exposure levels and nitrogen and acid deposition rates in the surrounding area.

This report is arranged in the following manner:

- Section 2 provides relevant details of the 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

Forest View is approximately 1.5 km to the north of Llanbister, in Powys. The site is in a rural location and the surrounding land is used mainly for pasture, although there are some isolated wooded areas nearby. The site is in a hilly area above the River Ithon, at an elevation of around 380 m.

The existing poultry house at Forest View provides accommodation for up to 16,000 egg-laying chickens and is currently ventilated using uncapped high velocity ridge or roof fans each with a short chimney. Manure is removed from the house by a belt collection system and stored temporarily on the farm, prior to removal from the site. There are pop holes along the sides of the building to provide the birds with daytime access to an outside ranging area.

It is proposed that a new poultry house would be constructed adjacent to the existing house in order to provide accommodation for a further 16,000 birds. Under the proposal, the primary ventilation of both the existing and proposed poultry houses would be provided by two air scrubber units. Backup ventilation in case of scrubber failure and supplementary ventilation, which would be required in warm weather, would be provided by high speed ridge or roof fans, each with a short chimney. Manure would be removed from the housing by a belt collection system and stored temporarily on the farm, prior to removal from the site. There would be pop holes along the sides of the building to provide the birds with daytime access to an outside ranging area.

There are several areas identified by Natural Resources Wales as Nitrogen sensitive Ancient Woodland within 5 km of the farm (the maximum screening distance required by NRW for developments proposing the use of scrubbers). There are several AWs that have not been deemed to be nitrogen sensitive by NRW within 2 km (the normal screening distance for non-statutory wildlife sites). NRW planning and permitting guidance states that it is not necessary to include these AWs in the modelling, however in this case they have been included. There are also eight Sites of Special Scientific Interest (SSSIs), one of which, The River Ithon SSSI, is also designated as a Special Area of Conservation (SAC). Some further details of the SSSIs and SAC are provided below:

- **Lower Caerfaelog Pastures SSSI** - Approximately 1 km to the south-south-west - This site comprises areas of damp pasture, fen and species-rich dry banks lying on either side of the Dorthau Brook north of Llanbister. The range of vegetation types present displays a great diversity of plant species, including some that are locally uncommon.
- **Afon Ithon SSSI/River Wye SAC** - At its closest point, approximately 1.2 km to the north-west - The site is of special interest for its populations of otter *Lutra lutra*, Atlantic salmon *Salmo salar*, bullhead *Cottus gobio*, river lamprey *Lampetra fluviatili*, brook lamprey *Lampetra planeri* and lichen species, including river jelly lichen *Collema dichotomum, Pyrencollema strontianensis, Verrucaria pachyderma* and *Dermatocarpon meiophyllizum.* The site is also of special interest for its mesotrophic and oligo-mesotrophic river types, which include communities of submerged aquatic plants containing water crowfoot *Ranunculus* spp. The headwaters support ultra-oligotrophic aquatic communities and extensive areas of seminatural riparian habitats can still be found next to the Irfon and its tributaries. These include semi-natural woodland, dry and marshy grassland, stands of tall fen and marsh vegetation and gravel banks.
- **Llymwynt Brook Pastures SSSI** - Approximately 2.2 km to the north-north-west - Of special interest for its areas of fen meadow and swamp, and associated mire, flush and fen vegetation. Along the length of the brook, broad-leaved woodland dominated by oak *Quercus* spp. with occasional downy birch *Betula pubescens* and rowan *Sorbus aucuparia*, occurs.

- **Caeau Bryn-Du SSSI** - Approximately 2.7 km to the north-west - The special interest comprises species-rich acid grassland and a mixture of fen-meadow, rush-pasture and fen vegetation, together with one of the largest populations of the locally uncommon globeflower *Trollius europaeus* known in east Wales.
- **Gweunydd Crychell SSSI** - Approximately 3.1 km to the west-south-west - The site is an excellent example of a range of marshy grassland and mire plant communities and other vegetation types, which are managed as rough pasture and small areas of woodland.
- **Coed Bryn-Person** - Approximately 3.3 km to the south-west - The site includes one of the most extensive areas of coppice beech *Fagus sylvatica* in the county. Other canopy trees include oak *Quercus petraea* and *Q. robur*, ash *Fraxinus excelsior* and elm *Ulmus glabra*. The ground flora is generally sparse with large areas dominated by bracken *Pteridium aquilinum* and grass *Deschampsia flexuosa* and *D. caespitosa* reflecting the high level of grazing.
- **Rhosydd Nant-Yr-Henfron SSSI** - Approximately 3.3 km to the west - Of special interest for its fen meadow, mire, wet heath, rush pasture and acidic flush vegetation types. The wildlife value of the site is enhanced by the presence of an abundance of broadleaved trees along field boundaries, along with patches of acidic grassland on drier banks.
- **Maelienydd SSSI** - Approximately 3.3 km to the west - The mixture of habitats of wet and freely drained acid grassland, small pools, gullies and gorse thickets enables this area to support a diverse range of breeding birds. Within Powys it is of particular significance for wader species, both as wintering and breeding habitat; species include lapwing, snipe, curlew and redshank.

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: the N sensitive AWs are shaded in blue; the AWs are shaded in olive; the SSSIs are shaded green; the SAC is shaded in purple and the positions of the existing and proposed poultry houses are outlined in blue. Where multiple designations overlap the higher designation is indicated.

Figure 1a. The area around Forest View, a broad scale view – concentric circles radii 2 km (olive) and 5 km (green)

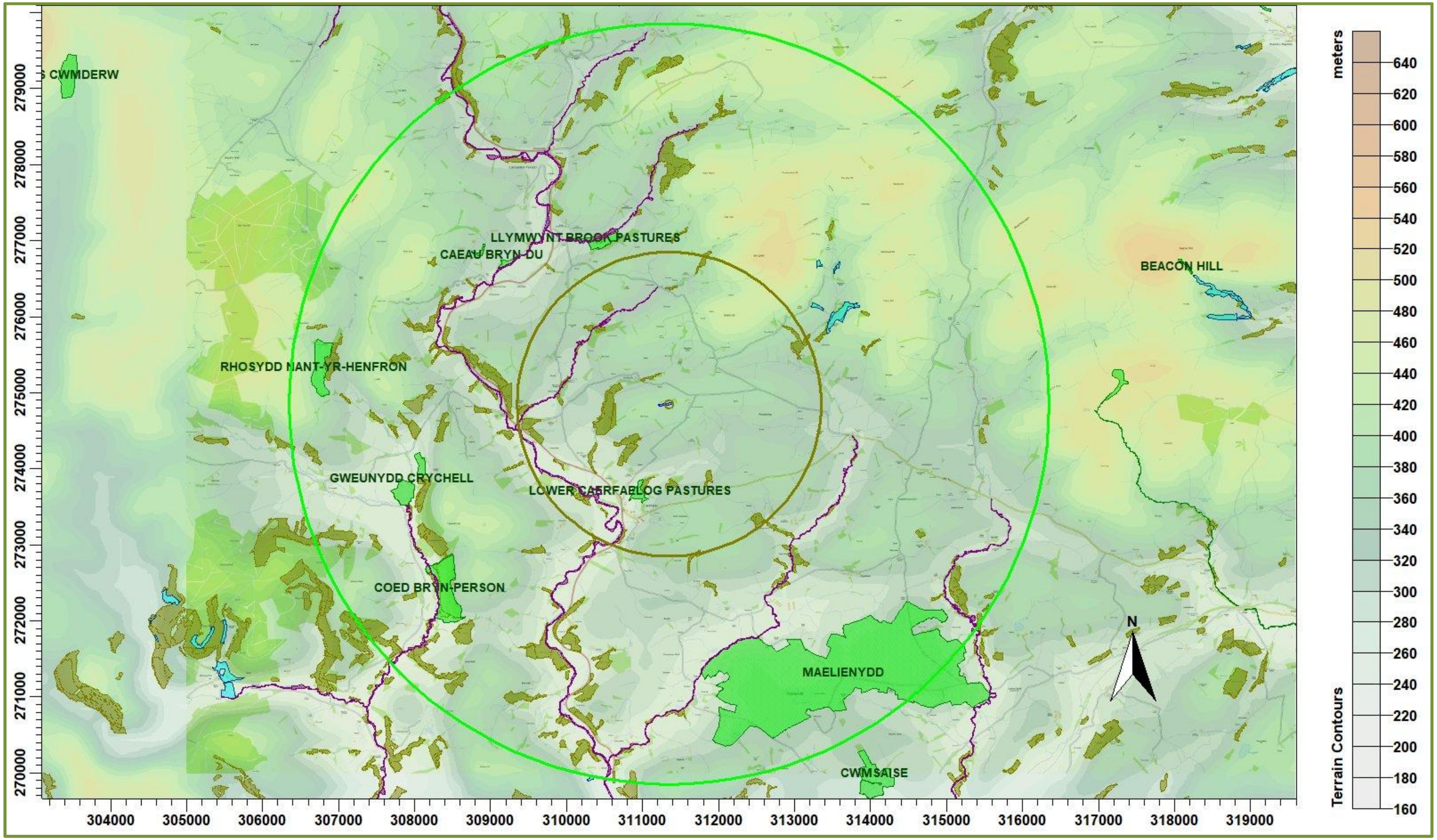
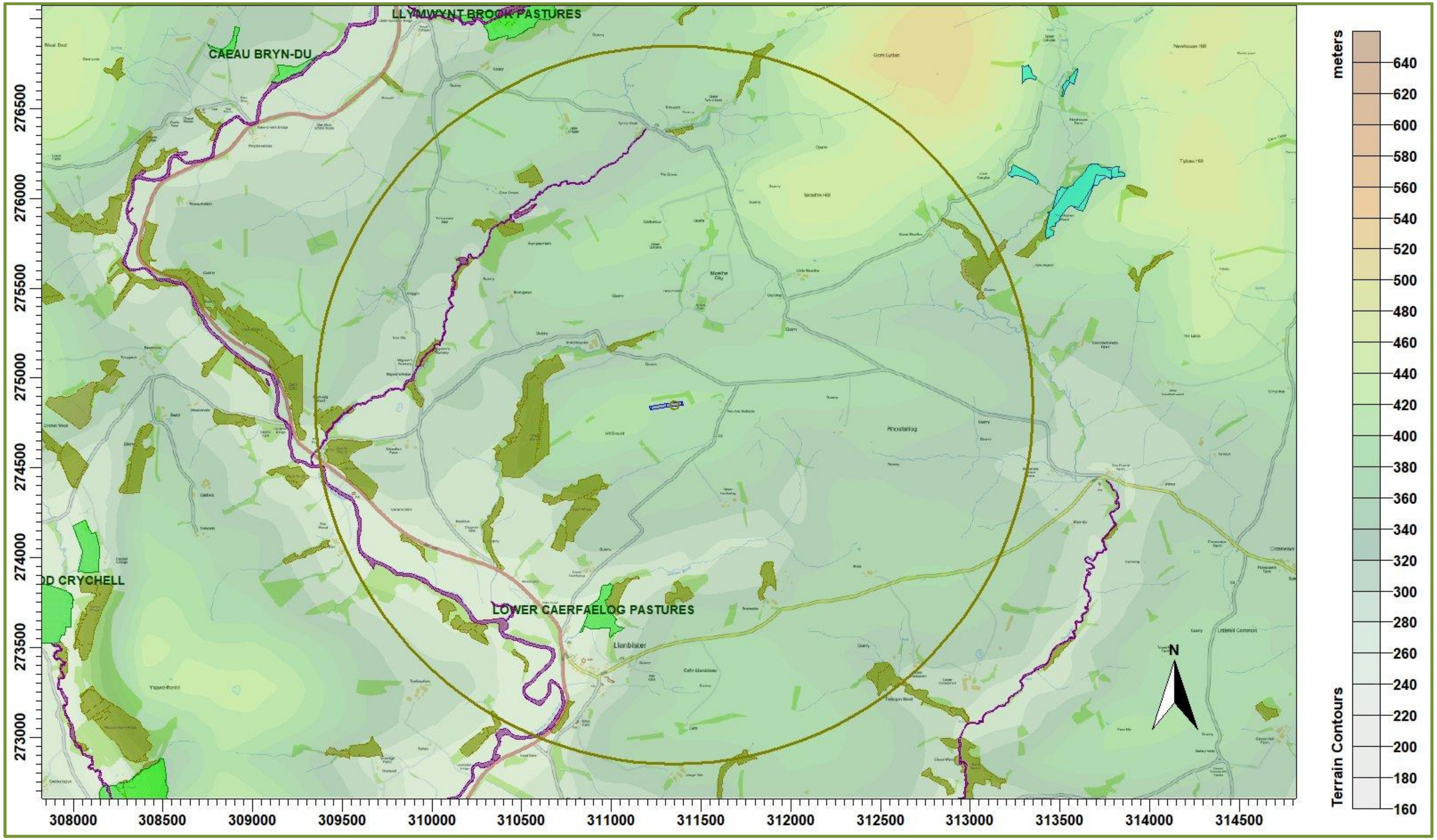


Figure 1b. The area surrounding Forest View, a closer view



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

3.1 Ammonia concentration and nitrogen and acid deposition

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

3.2 Background ammonia levels and nitrogen and acid deposition

The source of the background figures is the Air Pollution Information System (APIS, 14th February 2026). It should be noted that the 1 km APIS database background levels are extrapolated from 5 km modelled data. Ammonia levels may vary markedly over relatively short distances and the APIS website itself notes that, the background values should be used only to assist the user in obtaining a broad indication of the likely pollutant impact at a specific location and cannot be considered representative of any particular location within the 5 km grid square; extrapolation to a 1 km grid does not alter this.

The APIS figures for background ammonia concentration (2021) in the area around Forest View is 1.19 $\mu g\text{-}NH_3/m^3$. The background nitrogen deposition rate to woodland is 31.31 kg-N/ha/y and to short vegetation is 19.48 kg-N/ha/y. The background acid deposition rate to woodland is 2.35 keq/ha/y and to short vegetation is 1.46 keq/ha/y.

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

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

3.3 Critical Levels & Critical Loads

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

Critical Levels are defined as: "concentrations of pollutants in the atmosphere above which direct adverse effects on receptors, such as human beings, plants, ecosystems or materials, may occur according to present knowledge" (UNECE).

Critical Loads are defined as: "a quantitative estimate of exposure to one or more pollutants below which significant harmful effects on specified sensitive elements of the environment do not occur according to present knowledge" (UNECE).

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

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

The Critical Levels and Critical Loads at the wildlife sites assumed in this study are provided in Table 1. Where the Critical Level of 1.0 $\mu g\text{-}NH_3/m^3$ is assumed, it is usually unnecessary to consider the Critical Load as the Critical Level provides the stricter test. Normally, the Critical Load for nitrogen deposition provides a stricter test than does the Critical Load for acid deposition.

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

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

Site	Critical Level ($\mu g\text{-}NH_3/m^3$)	Critical Load Nitrogen (kg-N/ha/y)	Critical Load Acid (keq/ha/y)
AWs	1.0 [1]	-	-
N sensitive AWs	1.0 [1 & 2]	-	-
Afon Ithon SSSI/River Wye SAC; Coed Bryn-Person SSSI and Maelienydd SSSI	1.0 [1 & 2]	10.0 [3]	-
Lower Caerfaelog Pastures SSSI and Caeau Bryn-Du SSSI	3.0 [2]	10.0 [3]	-
Llymwynt Brook Pastures SSSI and Gweunydd Crychell SSSI	3.0 [2]	15.0 [3]	-
Rhosydd Nant-Yr-Henfron SSSI	1.0 [1 & 2]	15.0 [3]	-

1. A precautionary figure used where no details of the ecology of the site are available, or the citation for the site indicates that sensitive lichens and/or bryophytes are/may be present.
2. Based upon APIS (https://www.apis.ac.uk/search-habitat-impacts) and/or the citation for the site and information from the Natural resources Wales website (https://nrw.maps.arcgis.com/apps/MapSeries/index.html?appid=c7770d2881394c899123bae210afe370). Note that the APIS database may contain entries habitats/species that are not present at the site or part of the site under consideration.
3. The lower bound of the range of Critical Load for habitats/species present at the site (https://www.apis.ac.uk/search-habitat-impacts) and Review and revision of empirical critical loads of nitrogen for Europe, 2022. Note that the APIS database may contain entries habitats/species that are not present at the site or part of the site under consideration.

3.4 Guidance on the significance of ammonia emissions

3.4.1 Natural Resources Wales guidance

In May 2021, Natural Resources Wales published web-based guidance for the assessment of ammonia emissions from intensive livestock farming. The guidance includes the following:

- Ammonia assessments for developments that require a permit or planning permission
- Ammonia assessments: initial screening and evidence gathering (GN 020)
- How to carry out detailed modelling of ammonia emissions (GN 036)
- Detailed modelling of ammonia emissions stage 1 (GN 036)
- Detailed modelling of ammonia emissions stage 2 (GN 036)
- How to interpret the results from your screening or modelling exercise for Ammonia Emissions (GN 020)
- Ammonia scrubber design and use
- Applications that reduce the impact or risk of pollution (GN 020)
- Emission factors for poultry for modelling and reporting
- Emission factors for pigs for modelling and reporting
- Emission factors for cattle for modelling and reporting
- Reducing ammonia emissions from agriculture

3.4.2 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 NH_3 - both sites with lichens and bryophytes or 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 - 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

3.5.1 Existing house

The Natural Resources Wales emission factor for free range egg laying birds with manure belt removal is 0.066 kg-NH_3/bird-place/y.

3.5.2 Existing & Proposed houses - scrubber and bypass emissions

The ventilation rates used in the calculations are based on industry standard practices. For the calculations, the minimum ventilation rate is set at 1.0 m^3-air/bird/h and the maximum ventilation rate is 7.5 m^3-air/bird/h. If the external temperature is 13 Celsius, or lower, minimum ventilation only is assumed for the calculation. If the external temperature is 23 Celsius, or more, then the maximum ventilation rate is assumed. A transitional ventilation rate is calculated between these extremes. Based upon these principles, an ammonia emission rate for each hour of the period modelled is calculated by multiplying the outlet concentration by the ventilation rate.

The capacity of each of the air scrubbers would be 100,000 m^3/h (27.778 m^3/s), which is approximately 70% of the maximum ventilation rate that would ever be required, if the modelled ventilation rate exceeds the scrubber capacity, additional ventilation would be provided by the ridge mounted fans.

For the calculation of the emission rates from the air scrubber, the outlet ammonia concentration is assumed to be constant at 2 ppm (~1,400 µg/m^3). AS Modelling & Data Ltd. would note that to guarantee this maximum outlet concentration, a maintenance contract would normally be required and also that this report and results presented are applicable only to air scrubbers of similar specification as described here and elsewhere in this report. An ammonia emission rate for each hour of the period modelled is calculated by multiplying the outlet concentration by the ventilation rate.

If the modelled ventilation rate exceeds the scrubber capacity, additional ventilation would be provided by the ridge mounted fans. The ammonia concentration is assumed to be approximately 8.5 ppm for the existing and proposed housing; this figure is assumed because it approximates the regulatory ammonia emission factor. Similarly, to the scrubber emissions, an emission rate from the bypass ventilation system is calculated by multiplying the internal concentration by the ventilation rate.

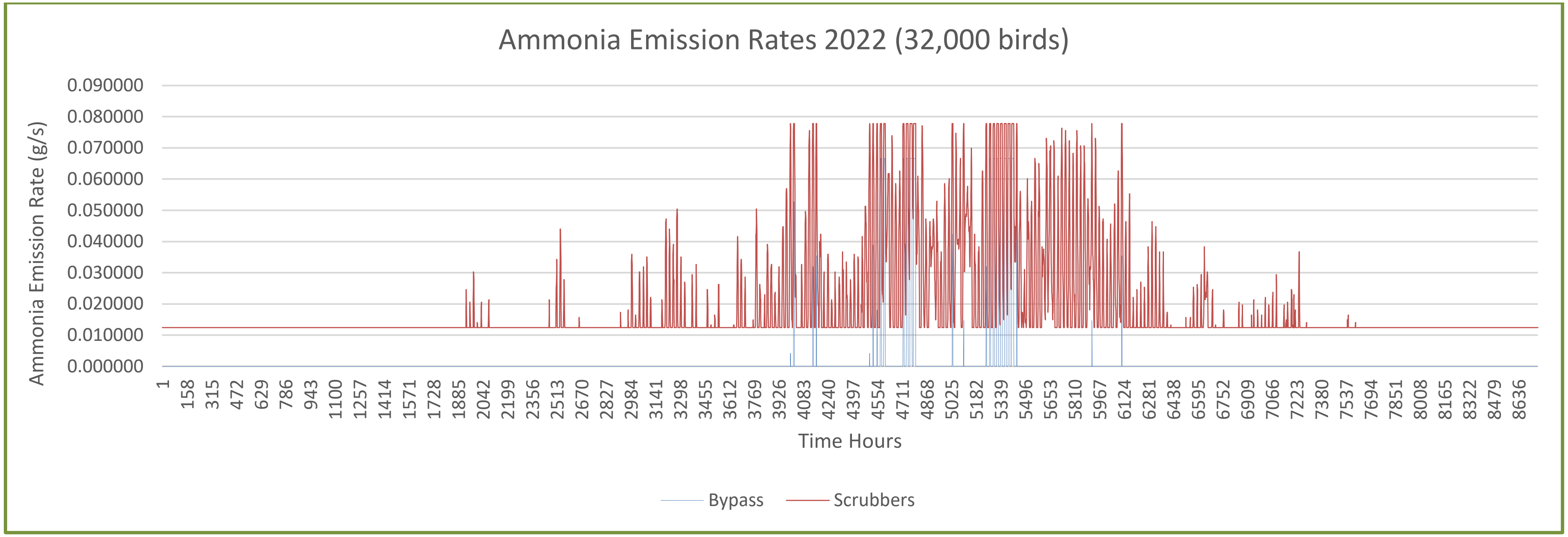
Please note that because the ammonia emissions are defined by ventilation rate, scrubber outlet concentrations and bypass ventilation, the regulatory emission factor is not considered, nor has there been any adjustment made to reflect occupancy of the houses.

As an example, ammonia emission rates over 2022 (the warmest year) are shown in Figure 2.

3.5.3 Existing & Proposed ranging area 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. The Natural Resources Wales emission factor for ranging chickens is 0.024 kg-NH_3/bird-place/y.

Figure 2. Ammonia emission rates over 2022 (House 1, 41,500 birds stocked)



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

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

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

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

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

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

4.1 Meteorological data

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

The meteorological data used in this study is obtained from assimilation and short-term forecast fields of the Numerical Weather Prediction (NWP) system known as the Global Forecast System (GFS)[1]. There are no observational datasets that are at all likely to be representative of the area, nor any that would be suitable for driving FLOWSTAR[2].

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

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

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

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

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

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

1. The GFS data used is derived from the high-resolution operational GFS datasets, the data is not obtained from the lower resolution (0.5 degree) long-term archive.
2. Note that FLOWSTAR requirements are for meteorological data representative of the upwind flow over the modelling domain and that single site meteorological data (observational or from high resolution modelled data) that is representative of the application site is not generally suitable (personal correspondence: CERC 2019 and UK Met O 2015). If data are deemed representative of a particular application site, either wholly or partially, then these data cannot also be representative of the upstream flow over the modelling domain. Furthermore, it would be extremely poor practice to use such data as the boundary conditions for a flow-solver, such as FLOWSTAR.
3. When modelling complex terrain with ADMS, by default, the minimum turbulence length has up to 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 may 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 3a. Raw GFS derived data, for 52.364 N, 3.302 W, 2022 – 2025

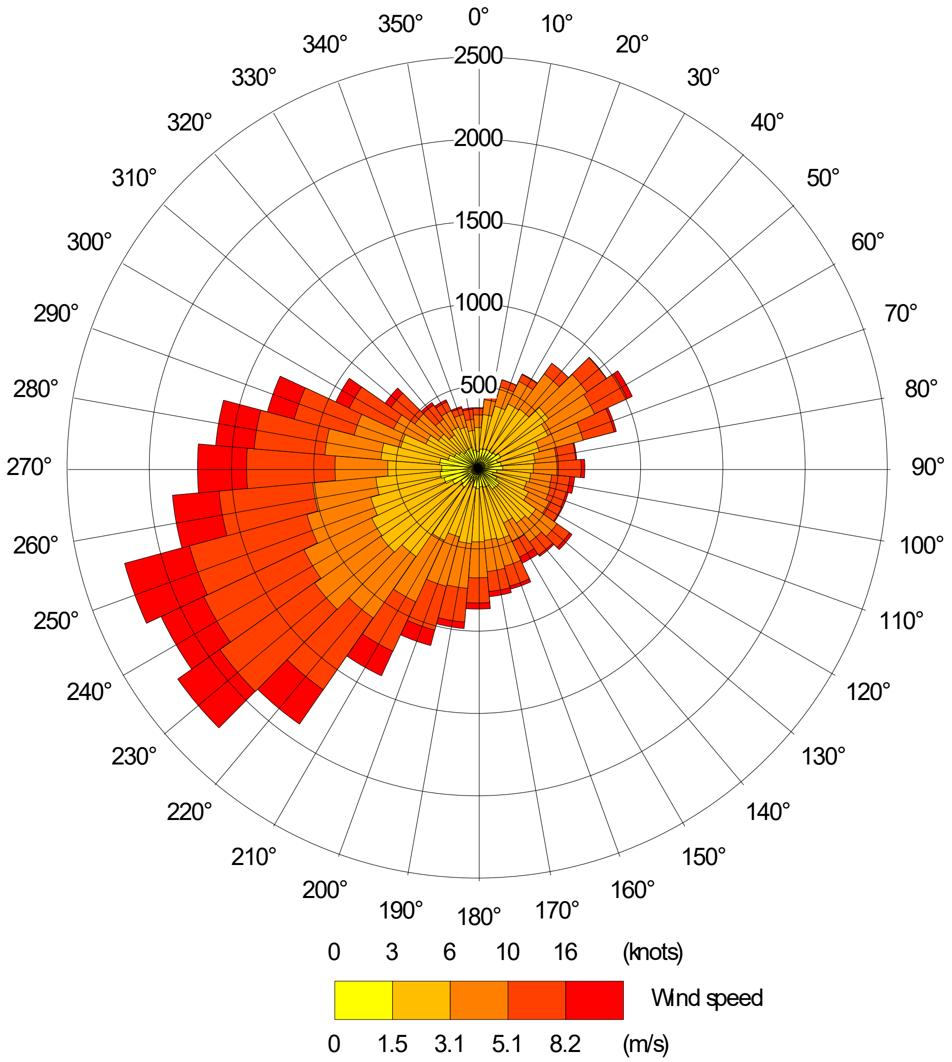
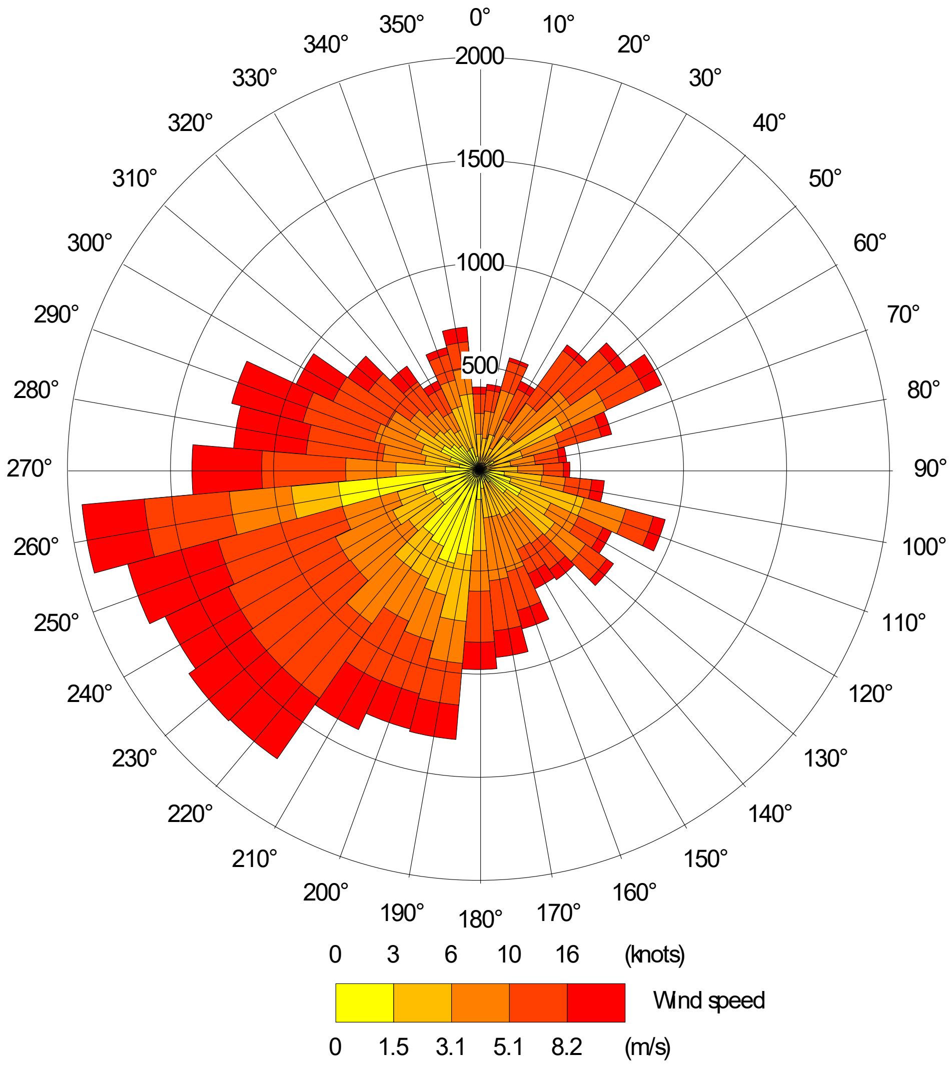


Figure 3b. FLOWSTAR modified GFS derived data for NGR 311350, 274850, 2022 -2025



4.2 Emission sources

Emissions from the high speed ridge fans used to ventilate the existing poultry house in the existing scenario are represented by three point sources per house within ADMS (EX1; 1, 2 &3).

Emissions from the air scrubber emission control equipment and the high speed ridge fans that serve the bypass system on the existing and proposed poultry houses in the proposed scenario are represented by six point sources per house within ADMS (EX1_BYP 1, 2 & 3 and EX1_SCR 1, 2 & 3 and PR1_BYP 1, 2 & 3 and PR1_SCR 1, 2 & 3). Details of the point source parameters are shown in Table 2a.

The positions of the point sources may be seen in Figures 4a and 4b (marked by green circles).

Table 2. Point source parameters

Source ID (Scenario)	Height (m)	Diameter (m)	Efflux velocity (m/s)	Emission temperature (˚C)	Emission rate per source ($g-NH_3/s$)
EX1; 1, 2 & 3 (Existing)	6.0	0.8	11.0	21.0	0.011154
EX1_BYP 1, 2 & 3 (Proposed)	6.0	0.8	11.0	Variable [1]	Variable [1]
EX1_SCR 1, 2 & 3 (Proposed)	6.0	1.0	7.0	Variable [1]	Variable [1]
PR1_BYP 1, 2 & 3 (Proposed)	6.0	0.8	11.0	Variable [1]	Variable [1]
PR1_SCR1, 2 & 3 (Proposed)	6.0	1.0	7.0	Variable [1]	Variable [1]

1. Dependent on ambient temperature.

The poultry houses have/would have ranging areas, which are represented by two area sources within ADMS (EX_RAN and PR_RAN). Note that the area sources cover the parts of the ranges 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 Figures 4a and 4b (marked by red shaded polygons).

Table 3b. Area source parameters

Source ID (Scenario)	Area (m^2)	Base height (m)	Emission temperature (°C)	Emission rate ($g-NH_3/s$)
EX_RAN (Existing & Proposed)	4,014.8	0.0	Ambient	0.12168
PR_RAN (Proposed)	4,050.0	0.0	Ambient	0.12168

4.3 Modelled buildings

The structure of the existing and proposed poultry houses and the scrubber units may affect the plumes from the point sources. Therefore, these structures are modelled within ADMS. The positions of the modelled buildings may be seen in Figures 4a and 4b (marked by grey rectangles).

4.4 Discrete receptors

Sixty-four discrete receptors have been defined: twenty-two at the AWs (1 to 22), fifteen at the SSSIs (23 to 37); twenty-two at the SAC (38 to 59) and five (60 to 64) at the N sensitive AWs. These receptors are defined at ground level within ADMS. The positions of the discrete receptors may be seen in Figures 5a and 5b (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, two regular Cartesian grids have been defined at ground level within ADMS. The position of the Cartesian grids may be seen in Figures 5a and 5b (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 12.0 km x 12.0 km domain has been resampled at 100 m horizontal resolution for use within ADMS. The resolution of FLOWSTAR is 64 x 64 grid points; therefore, the effective resolution of the wind field for the terrain runs is approximately 180 m.

4.7 Roughness Length

In this case, a spatially varying roughness length file has been defined, this is based upon the UK Centre for Ecology and Hydrology 25m resolution land use database, with permission. The GFS meteorological data is assumed to have a roughness length of 0.167 m (the average over the modelling domain). A sample of the central area of the spatially varying roughness length field is shown in Figure 6.

Figure 4a. The positions of the modelled buildings and sources – Existing Scenario

Figure 4b. The positions of the modelled buildings and sources – Proposed Scenario

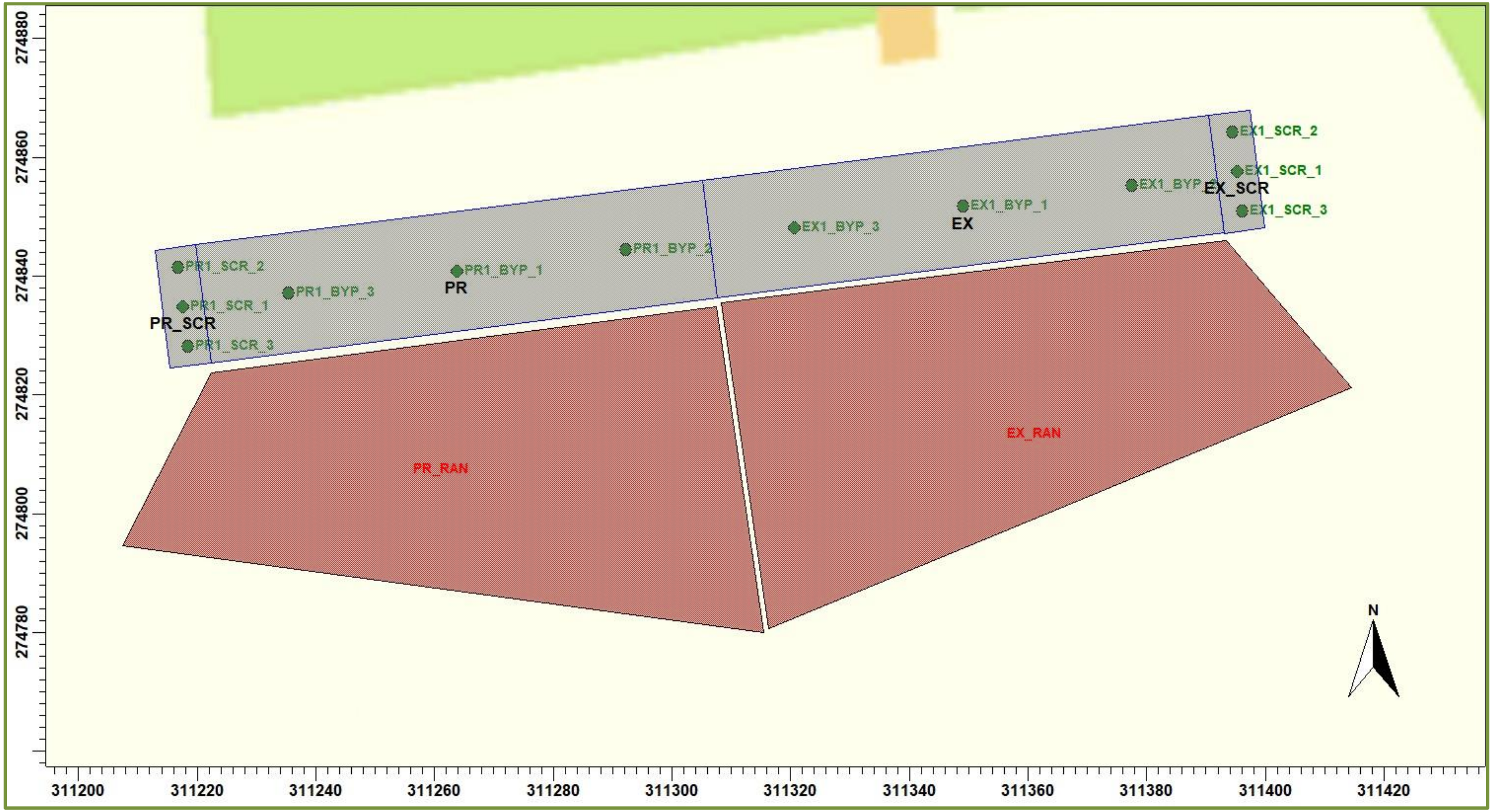


Figure 5a. The discrete receptors and regular Cartesian grids – a broadscale view

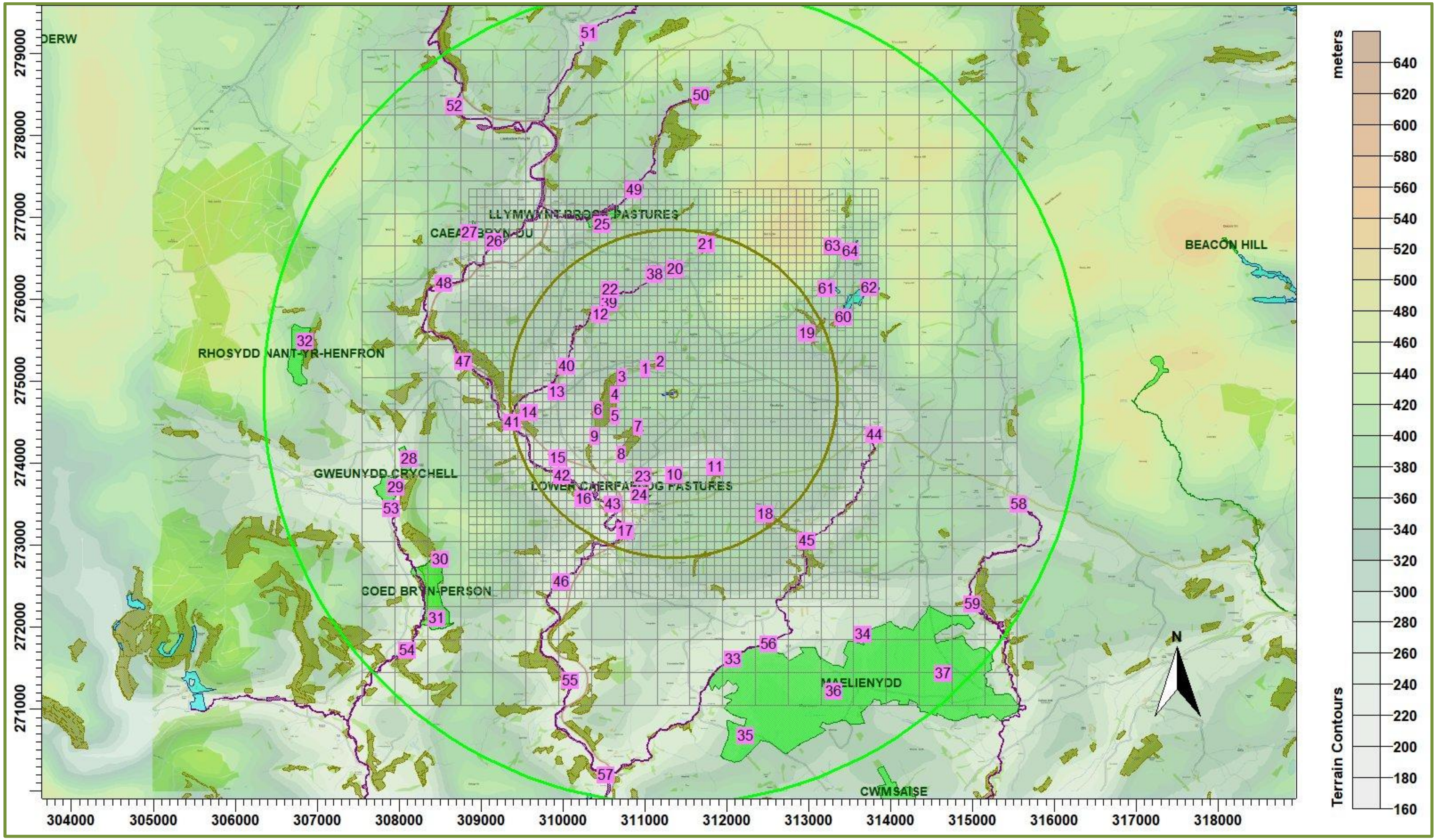


Figure 5b. The discrete receptors and regular Cartesian grids – a closer view

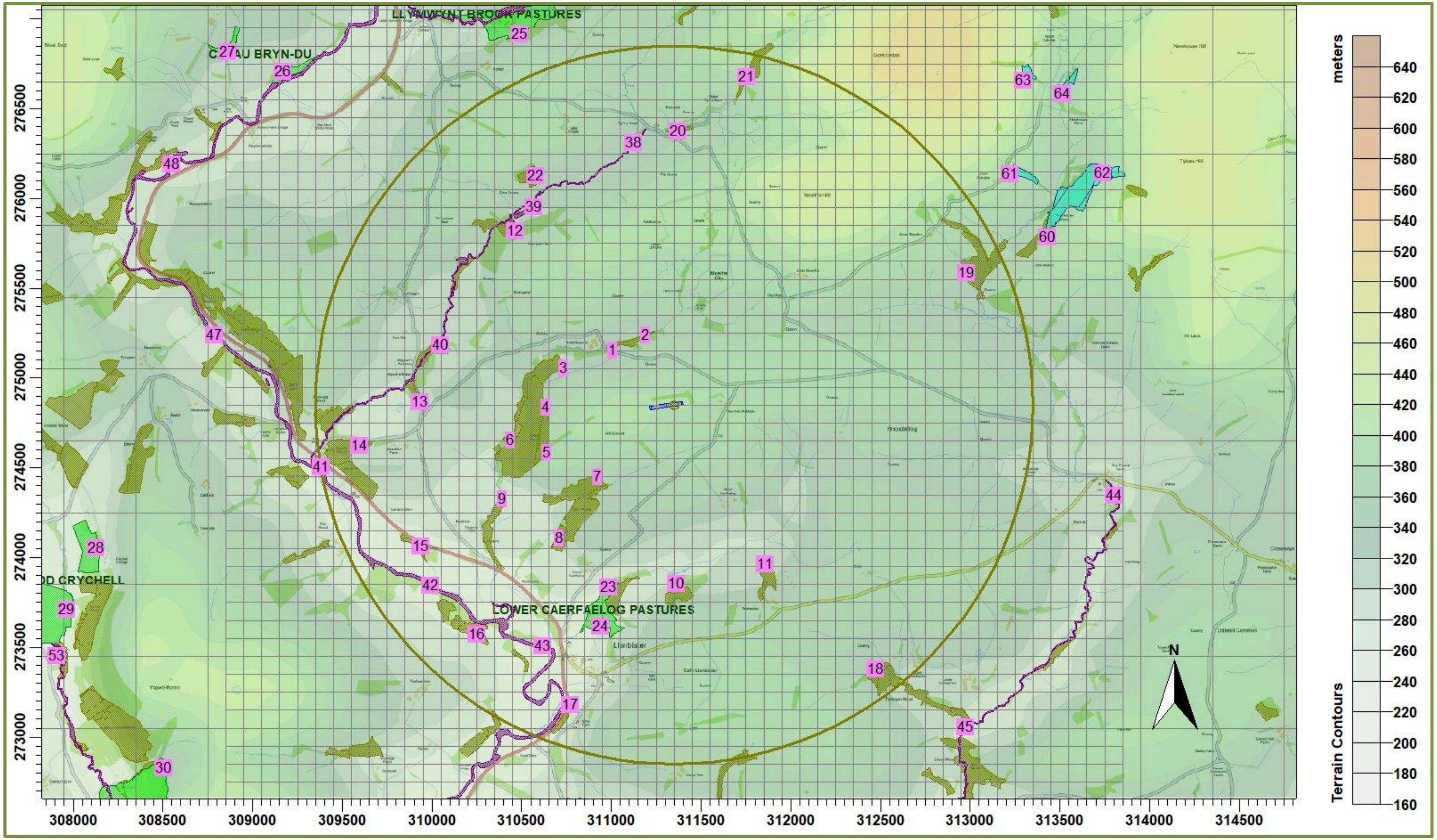
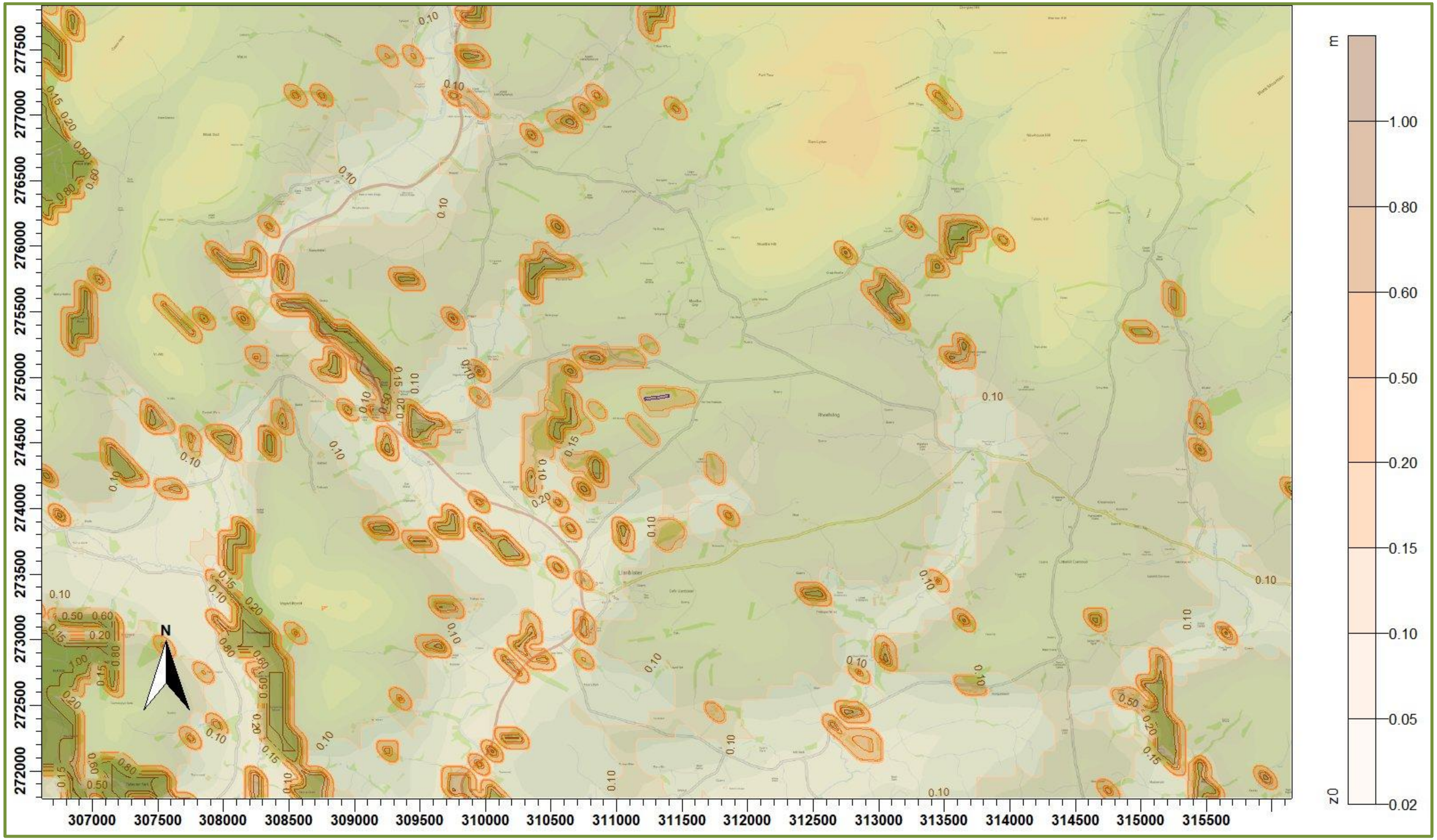


Figure 6. The spatially varying roughness length (z_0) field (central area)



4.8 Deposition

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

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.

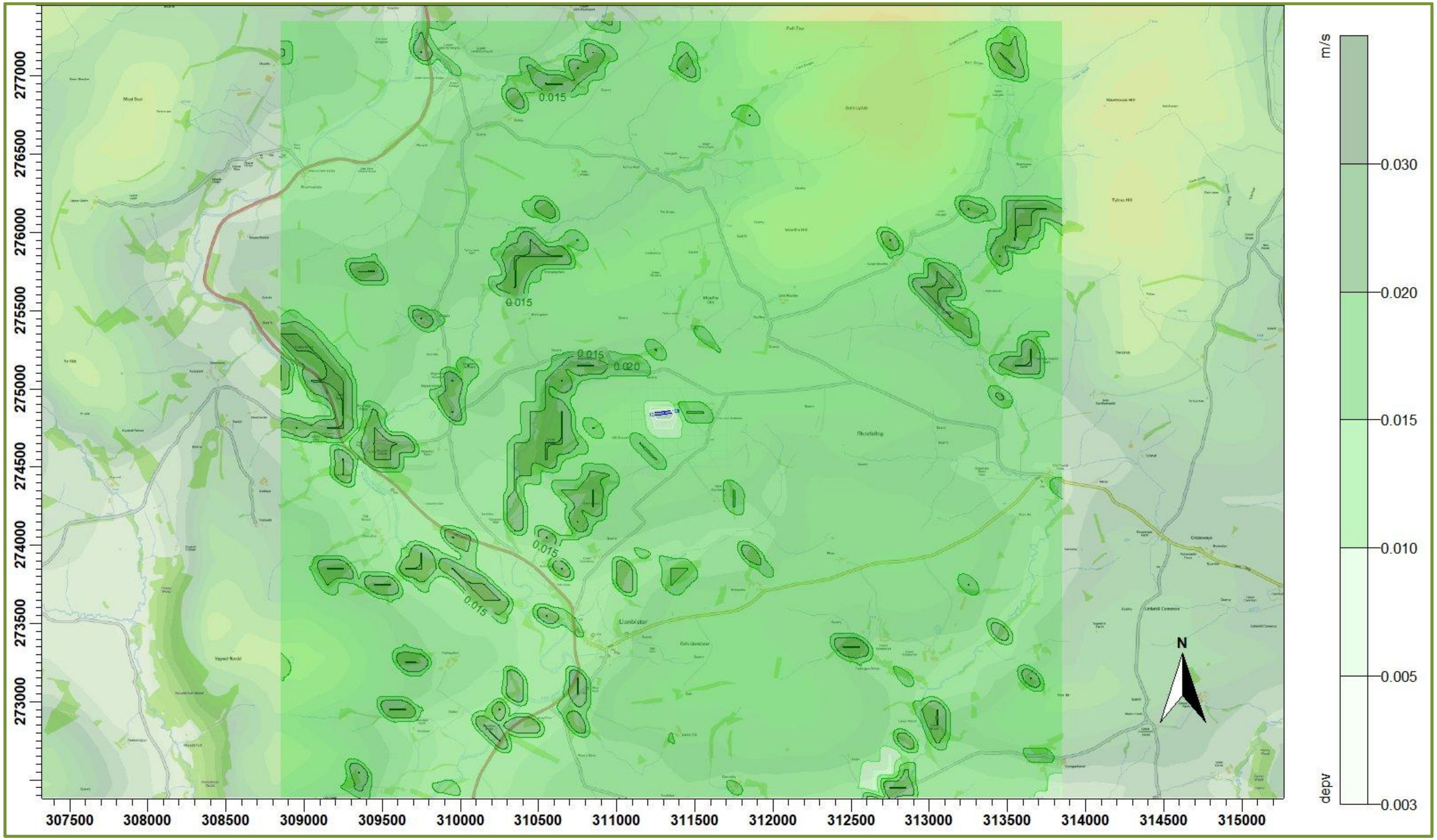
Table 4. Deposition velocities

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 (0.010 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 plots of the spatially varying deposition field is provided in Figure 7.

Figure 7. The spatially varying deposition field



5. Details of the Model Runs and Results

5.1 Preliminary modelling and model sensitivity tests

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

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

For each mode, statistics for the maximum annual mean ammonia concentration at each receptor were compiled. Details of the predicted annual mean ammonia concentrations at each receptor are provided in Table 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 concentration at the discrete receptors - preliminary modelling (Proposed scenario shown)

Receptor number	X(m)	Y(m)	Name/Designation	Maximum annual mean ammonia concentration (µg/m³)	
				GFS No Calms No Terrain	GFS Calms No Terrain
1	311008	275156	AW	0.067	0.066
2	311189	275239	AW	0.073	0.072
3	310731	275058	AW	0.037	0.036
4	310634	274839	AW	0.035	0.034
5	310641	274584	AW	0.042	0.041
6	310437	274654	AW	0.025	0.025
7	310923	274454	AW	0.059	0.058
8	310710	274111	AW	0.023	0.022
9	310390	274327	AW	0.023	0.023
10	311359	273857	AW	0.013	0.013
11	311858	273965	AW	0.013	0.013
12	310462	275819	AW	0.013	0.012
13	309933	274870	AW	0.011	0.011
14	309594	274627	AW	0.009	0.009
15	309937	274065	AW	0.013	0.013
16	310252	273574	AW	0.010	0.010
17	310768	273180	AW	0.008	0.008
18	312470	273381	AW	0.007	0.007
19	312977	275590	AW	0.014	0.014
20	311369	276377	AW	0.010	0.010
21	311755	276677	AW	0.009	0.008
22	310575	276126	AW	0.011	0.010
23	310983	273838	LOWER CAERFAELOG PASTURES SSSI	0.015	0.015
24	310940	273617	LOWER CAERFAELOG PASTURES SSSI	0.012	0.011
25	310487	276916	LLYMWYNT BROOK PASTURES SSSI	0.007	0.007
26	309167	276707	CAEAU BRYN-DU SSSI	0.005	0.005
27	308862	276820	CAEAU BRYN-DU SSSI	0.004	0.004
28	308129	274055	GWEUNYDD CRYCHELL SSSI	0.004	0.004
29	307962	273712	GWEUNYDD CRYCHELL SSSI	0.004	0.004
30	308503	272828	COED-Y-PERSON SSSI	0.004	0.004
31	308461	272111	COED-Y-PERSON SSSI	0.003	0.003
32	306850	275489	RHOSYDD NANT-YR-HENFRON SSSI	0.002	0.002
33	312079	271612	MAELIENYDD SSSI	0.003	0.003

Receptor number	X(m)	Y(m)	Name/Designation	Maximum annual mean ammonia concentration (µg/m³)	
				GFS No Calms No Terrain	GFS Calms No Terrain
34	313670	271913	MAELIENYDD SSSI	0.003	0.003
35	312235	270676	MAELIENYDD SSSI	0.002	0.002
36	313306	271217	MAELIENYDD SSSI	0.002	0.002
37	314647	271435	MAELIENYDD SSSI	0.002	0.002
38	311125	276311	AFON ITHON SSSI/River Wye SAC	0.011	0.011
39	310565	275957	AFON ITHON SSSI/River Wye SAC	0.012	0.012
40	310049	275185	AFON ITHON SSSI/River Wye SAC	0.011	0.011
41	309383	274505	AFON ITHON SSSI/River Wye SAC	0.008	0.007
42	309992	273847	AFON ITHON SSSI/River Wye SAC	0.011	0.011
43	310615	273507	AFON ITHON SSSI/River Wye SAC	0.010	0.010
44	313804	274346	AFON ITHON SSSI/River Wye SAC	0.007	0.007
45	312975	273056	AFON ITHON SSSI/River Wye SAC	0.005	0.005
46	309980	272562	AFON ITHON SSSI/River Wye SAC	0.005	0.005
47	308786	275238	AFON ITHON SSSI/River Wye SAC	0.004	0.004
48	308547	276194	AFON ITHON SSSI/River Wye SAC	0.004	0.004
49	310872	277341	AFON ITHON SSSI/River Wye SAC	0.005	0.005
50	311685	278488	AFON ITHON SSSI/River Wye SAC	0.003	0.003
51	310315	279253	AFON ITHON SSSI/River Wye SAC	0.003	0.003
52	308674	278361	AFON ITHON SSSI/River Wye SAC	0.003	0.003
53	307909	273454	AFON ITHON SSSI/River Wye SAC	0.004	0.004
54	308101	271718	AFON ITHON SSSI/River Wye SAC	0.003	0.003
55	310092	271351	AFON ITHON SSSI/River Wye SAC	0.003	0.003
56	312513	271797	AFON ITHON SSSI/River Wye SAC	0.003	0.003
57	310522	270204	AFON ITHON SSSI/River Wye SAC	0.002	0.002
58	315572	273502	AFON ITHON SSSI/River Wye SAC	0.004	0.004
59	314998	272291	AFON ITHON SSSI/River Wye SAC	0.003	0.003
60	313427	275787	NH3 sensitive AW	0.010	0.010
61	313222	276137	NH3 sensitive AW	0.010	0.010
62	313736	276144	NH3 sensitive AW	0.008	0.008
63	313296	276659	NH3 sensitive AW	0.008	0.008
64	313516	276585	NH3 sensitive AW	0.008	0.008

5.2 Detailed modelling

In this case, detailed modelling has been carried out over a high resolution 5.0 km x 5.0 km domain surrounding Forest View. 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 this domain a fixed deposition velocity of 0.005 m/s is assumed (with appropriate deposition velocities applied post-modelling at the discrete receptors).

The detailed deposition run was made with terrain. Calms cannot be used with terrain or spatially varying deposition; therefore, calms have not been included in the detailed modelling. However, the results of the preliminary modelling indicate that the effects of calms are not significant.

The predicted process contribution to maximum annual mean ground level ammonia concentrations and nitrogen deposition rates at the discrete receptors are shown in Tables 6a (Existing Scenario) and 6b (Proposed scenario). The predicted change in process contributions is shown in Table 7 (Proposed Scenario minus Existing Scenario).

It has been noted previously that background levels Critical Levels and Loads that available background levels are suitable only to provide a broad indication of likely pollutant impact at a specific location; therefore, Predicted Environmental Concentrations (PECs) are not presented in the Tables.

Contour plots of the predicted process contribution to maximum annual mean ground level ammonia concentrations and nitrogen deposition rates of the Proposed Scenario are provided in Figures 8a and 8b. Contour plots for other scenarios, or partial scenarios, are available on request.

Table 6a. Predicted maximum annual mean ammonia concentrations and nitrogen deposition rates at the discrete receptors – Existing Scenario

Receptor number	X(m)	Y(m)	Name	Site Parameters			Maximum annual mean ammonia concentration		Maximum annual nitrogen deposition rate	
				Deposition Velocity	Critical Level ($\mu g/m^3$)	Critical Load (kg/ha)	Process Contribution ($\mu g/m^3$)	%age of Critical Level	Process Contribution (kg/ha)	%age of Critical Load
1	311008	275156	AW	0.03	1.0	10.0	0.060	6.00	0.47	4.67
2	311189	275239	AW	0.03	1.0	10.0	0.075	7.47	0.58	5.82
3	310731	275058	AW	0.03	1.0	10.0	0.038	3.78	0.29	2.95
4	310634	274839	AW	0.03	1.0	10.0	0.025	2.53	0.20	1.97
5	310641	274584	AW	0.03	1.0	10.0	0.032	3.16	0.25	2.46
6	310437	274654	AW	0.03	1.0	10.0	0.018	1.80	0.14	1.41
7	310923	274454	AW	0.03	1.0	10.0	0.057	5.65	0.44	4.40
8	310710	274111	AW	0.03	1.0	10.0	0.018	1.82	0.14	1.42
9	310390	274327	AW	0.03	1.0	10.0	0.025	2.53	0.20	1.97
10	311359	273857	AW	0.03	1.0	10.0	0.010	0.95	0.07	0.74
11	311858	273965	AW	0.03	1.0	10.0	0.011	1.06	0.08	0.83
12	310462	275819	AW	0.03	1.0	10.0	0.010	1.02	0.08	0.80
13	309933	274870	AW	0.03	1.0	10.0	0.007	0.73	0.06	0.57
14	309594	274627	AW	0.03	1.0	10.0	0.005	0.54	0.04	0.42
15	309937	274065	AW	0.03	1.0	10.0	0.016	1.62	0.13	1.26
16	310252	273574	AW	0.03	1.0	10.0	0.007	0.73	0.06	0.57
17	310768	273180	AW	0.03	1.0	10.0	0.004	0.44	0.03	0.34
18	312470	273381	AW	0.03	1.0	10.0	0.005	0.49	0.04	0.38
19	312977	275590	AW	0.03	1.0	10.0	0.020	1.99	0.15	1.55
20	311369	276377	AW	0.03	1.0	10.0	0.012	1.16	0.09	0.90
21	311755	276677	AW	0.03	1.0	10.0	0.008	0.85	0.07	0.66
22	310575	276126	AW	0.03	1.0	10.0	0.007	0.71	0.06	0.55
23	310983	273838	LOWER CAERFAELOG PASTURES SSSI	0.02	3.0	10.0	0.011	0.37	0.06	0.58
24	310940	273617	LOWER CAERFAELOG PASTURES SSSI	0.02	3.0	10.0	0.008	0.25	0.04	0.39
25	310487	276916	LLYMWYNT BROOK PASTURES SSSI	0.02	3.0	15.0	0.004	0.13	0.02	0.14
26	309167	276707	CAEAU BRYN-DU SSSI	0.02	3.0	10.0	0.005	0.15	0.02	0.24
27	308862	276820	CAEAU BRYN-DU SSSI	0.02	3.0	10.0	0.003	0.10	0.02	0.16
28	308129	274055	GWEUNYDD CRYCHELL SSSI	0.02	3.0	15.0	0.003	0.09	0.01	0.09
29	307962	273712	GWEUNYDD CRYCHELL SSSI	0.02	3.0	15.0	0.003	0.10	0.02	0.10
30	308503	272828	COED-Y-PERSON SSSI	0.03	1.0	10.0	0.003	0.25	0.02	0.20
31	308461	272111	COED-Y-PERSON SSSI	0.03	1.0	10.0	0.002	0.22	0.02	0.17

32	306850	275489	RHOSYDD NANT-YR-HENFRON SSSI	0.03	1.0	15.0	0.001	0.12	0.01	0.06
33	312079	271612	MAELIENYDD SSSI	0.02	1.0	10.0	0.003	0.26	0.01	0.13
34	313670	271913	MAELIENYDD SSSI	0.02	1.0	10.0	0.002	0.23	0.01	0.12
35	312235	270676	MAELIENYDD SSSI	0.02	1.0	10.0	0.002	0.18	0.01	0.09
36	313306	271217	MAELIENYDD SSSI	0.02	1.0	10.0	0.002	0.15	0.01	0.08
37	314647	271435	MAELIENYDD SSSI	0.02	1.0	10.0	0.002	0.15	0.01	0.08
38	311125	276311	AFON ITHON SSSI/River Wye SAC	0.03	1.0	10.0	0.010	0.95	0.07	0.74
39	310565	275957	AFON ITHON SSSI/River Wye SAC	0.03	1.0	10.0	0.009	0.89	0.07	0.69
40	310049	275185	AFON ITHON SSSI/River Wye SAC	0.03	1.0	10.0	0.013	**1.26**	0.10	0.98
41	309383	274505	AFON ITHON SSSI/River Wye SAC	0.03	1.0	10.0	0.007	0.70	0.05	0.55
42	309992	273847	AFON ITHON SSSI/River Wye SAC	0.03	1.0	10.0	0.014	**1.41**	0.11	**1.10**
43	310615	273507	AFON ITHON SSSI/River Wye SAC	0.03	1.0	10.0	0.008	0.76	0.06	0.59
44	313804	274346	AFON ITHON SSSI/River Wye SAC	0.03	1.0	10.0	0.007	0.69	0.05	0.54
45	312975	273056	AFON ITHON SSSI/River Wye SAC	0.03	1.0	10.0	0.004	0.44	0.03	0.34
46	309980	272562	AFON ITHON SSSI/River Wye SAC	0.03	1.0	10.0	0.003	0.31	0.02	0.24
47	308786	275238	AFON ITHON SSSI/River Wye SAC	0.03	1.0	10.0	0.003	0.31	0.02	0.24
48	308547	276194	AFON ITHON SSSI/River Wye SAC	0.03	1.0	10.0	0.004	0.43	0.03	0.33
49	310872	277341	AFON ITHON SSSI/River Wye SAC	0.03	1.0	10.0	0.004	0.38	0.03	0.30
50	311685	278488	AFON ITHON SSSI/River Wye SAC	0.03	1.0	10.0	0.003	0.26	0.02	0.20
51	310315	279253	AFON ITHON SSSI/River Wye SAC	0.03	1.0	10.0	0.002	0.18	0.01	0.14
52	308674	278361	AFON ITHON SSSI/River Wye SAC	0.03	1.0	10.0	0.002	0.17	0.01	0.13
53	307909	273454	AFON ITHON SSSI/River Wye SAC	0.03	1.0	10.0	0.003	0.33	0.03	0.26
54	308101	271718	AFON ITHON SSSI/River Wye SAC	0.03	1.0	10.0	0.002	0.17	0.01	0.13
55	310092	271351	AFON ITHON SSSI/River Wye SAC	0.03	1.0	10.0	0.002	0.21	0.02	0.16
56	312513	271797	AFON ITHON SSSI/River Wye SAC	0.03	1.0	10.0	0.002	0.22	0.02	0.17
57	310522	270204	AFON ITHON SSSI/River Wye SAC	0.03	1.0	10.0	0.002	0.18	0.01	0.14
58	315572	273502	AFON ITHON SSSI/River Wye SAC	0.03	1.0	10.0	0.003	0.28	0.02	0.22
59	314998	272291	AFON ITHON SSSI/River Wye SAC	0.03	1.0	10.0	0.002	0.22	0.02	0.17
60	313427	275787	NH3 sensitive AW	0.03	1.0	10.0	0.011	**1.07**	0.08	0.83
61	313222	276137	NH3 sensitive AW	0.03	1.0	10.0	0.008	0.81	0.06	0.63
62	313736	276144	NH3 sensitive AW	0.03	1.0	10.0	0.006	0.64	0.05	0.50
63	313296	276659	NH3 sensitive AW	0.03	1.0	10.0	0.005	0.53	0.04	0.41
64	313516	276585	NH3 sensitive AW	0.03	1.0	10.0	0.006	0.63	0.05	0.49

Table 6b. Predicted maximum annual mean ammonia concentrations and nitrogen deposition rates at the discrete receptors – Proposed Scenario

Receptor number	X(m)	Y(m)	Name	Site Parameters			Maximum annual mean ammonia concentration		Maximum annual nitrogen deposition rate	
				Deposition Velocity	Critical Level ($\mu g/m^3$)	Critical Load (kg/ha)	Process Contribution ($\mu g/m^3$)	%age of Critical Level	Process Contribution (kg/ha)	%age of Critical Load
1	311008	275156	AW	0.03	1.0	10.0	0.033	3.33	0.26	2.59
2	311189	275239	AW	0.03	1.0	10.0	0.039	3.86	0.30	3.00
3	310731	275058	AW	0.03	1.0	10.0	0.021	2.13	0.17	1.66
4	310634	274839	AW	0.03	1.0	10.0	0.014	1.37	0.11	1.06
5	310641	274584	AW	0.03	1.0	10.0	0.016	1.56	0.12	1.22
6	310437	274654	AW	0.03	1.0	10.0	0.009	0.88	0.07	0.69
7	310923	274454	AW	0.03	1.0	10.0	0.019	1.89	0.15	1.47
8	310710	274111	AW	0.03	1.0	10.0	0.007	0.70	0.05	0.54
9	310390	274327	AW	0.03	1.0	10.0	0.011	1.07	0.08	0.83
10	311359	273857	AW	0.03	1.0	10.0	0.003	0.29	0.02	0.23
11	311858	273965	AW	0.03	1.0	10.0	0.005	0.55	0.04	0.43
12	310462	275819	AW	0.03	1.0	10.0	0.006	0.55	0.04	0.43
13	309933	274870	AW	0.03	1.0	10.0	0.004	0.40	0.03	0.31
14	309594	274627	AW	0.03	1.0	10.0	0.003	0.28	0.02	0.22
15	309937	274065	AW	0.03	1.0	10.0	0.007	0.70	0.05	0.54
16	310252	273574	AW	0.03	1.0	10.0	0.003	0.29	0.02	0.23
17	310768	273180	AW	0.03	1.0	10.0	0.002	0.17	0.01	0.13
18	312470	273381	AW	0.03	1.0	10.0	0.002	0.25	0.02	0.19
19	312977	275590	AW	0.03	1.0	10.0	0.008	0.82	0.06	0.63
20	311369	276377	AW	0.03	1.0	10.0	0.006	0.60	0.05	0.47
21	311755	276677	AW	0.03	1.0	10.0	0.004	0.40	0.03	0.32
22	310575	276126	AW	0.03	1.0	10.0	0.004	0.41	0.03	0.32
23	310983	273838	LOWER CAERFAELOG PASTURES SSSI	0.02	3.0	10.0	0.004	0.13	0.02	0.20
24	310940	273617	LOWER CAERFAELOG PASTURES SSSI	0.02	3.0	10.0	0.003	0.09	0.01	0.14
25	310487	276916	LLYMWYNT BROOK PASTURES SSSI	0.02	3.0	15.0	0.002	0.08	0.01	0.08
26	309167	276707	CAEAU BRYN-DU SSSI	0.02	3.0	10.0	0.003	0.08	0.01	0.13
27	308862	276820	CAEAU BRYN-DU SSSI	0.02	3.0	10.0	0.002	0.06	0.01	0.09
28	308129	274055	GWEUNYDD CRYCHELL SSSI	0.02	3.0	15.0	0.001	0.04	0.01	0.04
29	307962	273712	GWEUNYDD CRYCHELL SSSI	0.02	3.0	15.0	0.001	0.04	0.01	0.04
30	308503	272828	COED-Y-PERSON SSSI	0.03	1.0	10.0	0.001	0.10	0.01	0.07
31	308461	272111	COED-Y-PERSON SSSI	0.03	1.0	10.0	0.001	0.08	0.01	0.06
32	306850	275489	RHOSYDD NANT-YR-HENFRON SSSI	0.03	1.0	15.0	0.001	0.07	0.01	0.03
33	312079	271612	MAELIENYDD SSSI	0.02	1.0	10.0	0.001	0.11	0.01	0.06
34	313670	271913	MAELIENYDD SSSI	0.02	1.0	10.0	0.001	0.11	0.01	0.06
35	312235	270676	MAELIENYDD SSSI	0.02	1.0	10.0	0.001	0.08	0.00	0.04

Receptor number	X(m)	Y(m)	Name	Site Parameters			Maximum annual mean ammonia concentration		Maximum annual nitrogen deposition rate	
				Deposition Velocity	Critical Level ($\mu g/m^3$)	Critical Load (kg/ha)	Process Contribution ($\mu g/m^3$)	%age of Critical Level	Process Contribution (kg/ha)	%age of Critical Load
36	313306	271217	MAELIENYDD SSSI	0.02	1.0	10.0	0.001	0.09	0.00	0.04
37	314647	271435	MAELIENYDD SSSI	0.02	1.0	10.0	0.001	0.07	0.00	0.04
38	311125	276311	AFON ITHON SSSI/River Wye SAC	0.03	1.0	10.0	0.005	0.48	0.04	0.37
39	310565	275957	AFON ITHON SSSI/River Wye SAC	0.03	1.0	10.0	0.005	0.53	0.04	0.42
40	310049	275185	AFON ITHON SSSI/River Wye SAC	0.03	1.0	10.0	0.007	0.71	0.06	0.55
41	309383	274505	AFON ITHON SSSI/River Wye SAC	0.03	1.0	10.0	0.004	0.35	0.03	0.27
42	309992	273847	AFON ITHON SSSI/River Wye SAC	0.03	1.0	10.0	0.005	0.55	0.04	0.43
43	310615	273507	AFON ITHON SSSI/River Wye SAC	0.03	1.0	10.0	0.003	0.30	0.02	0.23
44	313804	274346	AFON ITHON SSSI/River Wye SAC	0.03	1.0	10.0	0.003	0.27	0.02	0.21
45	312975	273056	AFON ITHON SSSI/River Wye SAC	0.03	1.0	10.0	0.002	0.20	0.02	0.16
46	309980	272562	AFON ITHON SSSI/River Wye SAC	0.03	1.0	10.0	0.001	0.13	0.01	0.10
47	308786	275238	AFON ITHON SSSI/River Wye SAC	0.03	1.0	10.0	0.002	0.17	0.01	0.14
48	308547	276194	AFON ITHON SSSI/River Wye SAC	0.03	1.0	10.0	0.002	0.21	0.02	0.16
49	310872	277341	AFON ITHON SSSI/River Wye SAC	0.03	1.0	10.0	0.002	0.19	0.01	0.15
50	311685	278488	AFON ITHON SSSI/River Wye SAC	0.03	1.0	10.0	0.001	0.12	0.01	0.10
51	310315	279253	AFON ITHON SSSI/River Wye SAC	0.03	1.0	10.0	0.001	0.08	0.01	0.07
52	308674	278361	AFON ITHON SSSI/River Wye SAC	0.03	1.0	10.0	0.001	0.08	0.01	0.06
53	307909	273454	AFON ITHON SSSI/River Wye SAC	0.03	1.0	10.0	0.001	0.13	0.01	0.10
54	308101	271718	AFON ITHON SSSI/River Wye SAC	0.03	1.0	10.0	0.001	0.07	0.01	0.05
55	310092	271351	AFON ITHON SSSI/River Wye SAC	0.03	1.0	10.0	0.001	0.09	0.01	0.07
56	312513	271797	AFON ITHON SSSI/River Wye SAC	0.03	1.0	10.0	0.001	0.11	0.01	0.09
57	310522	270204	AFON ITHON SSSI/River Wye SAC	0.03	1.0	10.0	0.001	0.11	0.01	0.09
58	315572	273502	AFON ITHON SSSI/River Wye SAC	0.03	1.0	10.0	0.001	0.11	0.01	0.09
59	314998	272291	AFON ITHON SSSI/River Wye SAC	0.03	1.0	10.0	0.001	0.09	0.01	0.07
60	313427	275787	NH3 sensitive AW	0.03	1.0	10.0	0.004	0.45	0.03	0.35
61	313222	276137	NH3 sensitive AW	0.03	1.0	10.0	0.004	0.36	0.03	0.28
62	313736	276144	NH3 sensitive AW	0.03	1.0	10.0	0.003	0.29	0.02	0.22
63	313296	276659	NH3 sensitive AW	0.03	1.0	10.0	0.002	0.24	0.02	0.19
64	313516	276585	NH3 sensitive AW	0.03	1.0	10.0	0.003	0.29	0.02	0.23

Table 7. Predicted changes in maximum annual mean ammonia concentrations and nitrogen deposition rates – Proposed Scenario minus Existing Scenario

Receptor number	X(m)	Y(m)	Name	Maximum annual mean ammonia concentration		Maximum annual nitrogen deposition rate	
				Process Contribution (μg/m³)	%age of Critical Level	Process Contribution (kg/ha)	%age of Critical Load
1	311008	275156	AW	-0.027	3.27	0.20	2.53
2	311189	275239	AW	-0.021	3.80	0.24	2.94
3	310731	275058	AW	-0.039	2.07	0.11	1.60
4	310634	274839	AW	-0.046	1.31	0.05	1.00
5	310641	274584	AW	-0.044	1.50	0.06	1.16
6	310437	274654	AW	-0.051	0.82	0.01	0.63
7	310923	274454	AW	-0.041	1.83	0.09	1.41
8	310710	274111	AW	-0.053	0.64	-0.01	0.48
9	310390	274327	AW	-0.049	1.01	0.02	0.77
10	311359	273857	AW	-0.057	0.23	-0.04	0.17
11	311858	273965	AW	-0.055	0.49	-0.02	0.37
12	310462	275819	AW	-0.054	0.49	-0.02	0.37
13	309933	274870	AW	-0.056	0.34	-0.03	0.25
14	309594	274627	AW	-0.057	0.22	-0.04	0.16
15	309937	274065	AW	-0.053	0.64	-0.01	0.48
16	310252	273574	AW	-0.057	0.23	-0.04	0.17
17	310768	273180	AW	-0.058	0.11	-0.05	0.07
18	312470	273381	AW	-0.058	0.19	-0.04	0.13
19	312977	275590	AW	-0.052	0.76	0.00	0.57
20	311369	276377	AW	-0.054	0.54	-0.01	0.41
21	311755	276677	AW	-0.056	0.34	-0.03	0.26
22	310575	276126	AW	-0.056	0.35	-0.03	0.26
23	310983	273838	LOWER CAERFAELOG PASTURES SSSI	-0.056	0.07	-0.04	0.14
24	310940	273617	LOWER CAERFAELOG PASTURES SSSI	-0.057	0.03	-0.05	0.08
25	310487	276916	LLYMWYNT BROOK PASTURES SSSI	-0.058	0.02	-0.05	0.02
26	309167	276707	CAEAU BRYN-DU SSSI	-0.057	0.02	-0.05	0.07
27	308862	276820	CAEAU BRYN-DU SSSI	-0.058	0.00	-0.05	0.03
28	308129	274055	GWEUNYDD CRYCHELL SSSI	-0.059	-0.02	-0.05	-0.02
29	307962	273712	GWEUNYDD CRYCHELL SSSI	-0.059	-0.02	-0.05	-0.02
30	308503	272828	COED-Y-PERSON SSSI	-0.059	0.04	-0.05	0.01
31	308461	272111	COED-Y-PERSON SSSI	-0.059	0.02	-0.05	0.00
32	306850	275489	RHOSYDD NANT-YR-HENFRON SSSI	-0.059	0.01	-0.05	-0.03
33	312079	271612	MAELIENYDD SSSI	-0.059	0.05	-0.05	0.00
34	313670	271913	MAELIENYDD SSSI	-0.059	0.05	-0.05	0.00
35	312235	270676	MAELIENYDD SSSI	-0.059	0.02	-0.06	-0.02
36	313306	271217	MAELIENYDD SSSI	-0.059	0.03	-0.06	-0.02
37	314647	271435	MAELIENYDD SSSI	-0.059	0.01	-0.06	-0.02
38	311125	276311	AFON ITHON SSSI/River Wye SAC	-0.055	0.42	-0.02	0.31
39	310565	275957	AFON ITHON SSSI/River Wye SAC	-0.055	0.47	-0.02	0.36
40	310049	275185	AFON ITHON SSSI/River Wye SAC	-0.053	0.65	0.00	0.49
41	309383	274505	AFON ITHON SSSI/River Wye SAC	-0.056	0.29	-0.03	0.21
42	309992	273847	AFON ITHON SSSI/River Wye SAC	-0.055	0.49	-0.02	0.37
43	310615	273507	AFON ITHON SSSI/River Wye SAC	-0.057	0.24	-0.04	0.17
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46	309980	272562	AFON ITHON SSSI/River Wye SAC	-0.059	0.07	-0.05	0.04
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50	311685	278488	AFON ITHON SSSI/River Wye SAC	-0.059	0.06	-0.05	0.04

Receptor number	X(m)	Y(m)	Name	Maximum annual mean ammonia concentration		Maximum annual nitrogen deposition rate	
				Process Contribution ($\mu g/m^3$)	%age of Critical Level	Process Contribution (kg/ha)	%age of Critical Load
51	310315	279253	AFON ITHON SSSI/River Wye SAC	-0.059	0.02	-0.05	0.01
52	308674	278361	AFON ITHON SSSI/River Wye SAC	-0.059	0.02	-0.05	0.00
53	307909	273454	AFON ITHON SSSI/River Wye SAC	-0.059	0.07	-0.05	0.04
54	308101	271718	AFON ITHON SSSI/River Wye SAC	-0.059	0.01	-0.05	-0.01
55	310092	271351	AFON ITHON SSSI/River Wye SAC	-0.059	0.03	-0.05	0.01
56	312513	271797	AFON ITHON SSSI/River Wye SAC	-0.059	0.05	-0.05	0.03
57	310522	270204	AFON ITHON SSSI/River Wye SAC	-0.059	0.05	-0.05	0.03
58	315572	273502	AFON ITHON SSSI/River Wye SAC	-0.059	0.05	-0.05	0.03
59	314998	272291	AFON ITHON SSSI/River Wye SAC	-0.059	0.03	-0.05	0.01
60	313427	275787	NH3 sensitive AW	-0.056	0.39	-0.03	0.29
61	313222	276137	NH3 sensitive AW	-0.056	0.30	-0.03	0.22
62	313736	276144	NH3 sensitive AW	-0.057	0.23	-0.04	0.16
63	313296	276659	NH3 sensitive AW	-0.058	0.18	-0.04	0.13
64	313516	276585	NH3 sensitive AW	-0.057	0.23	-0.04	0.17

Figure 8a. Maximum annual mean ammonia concentration

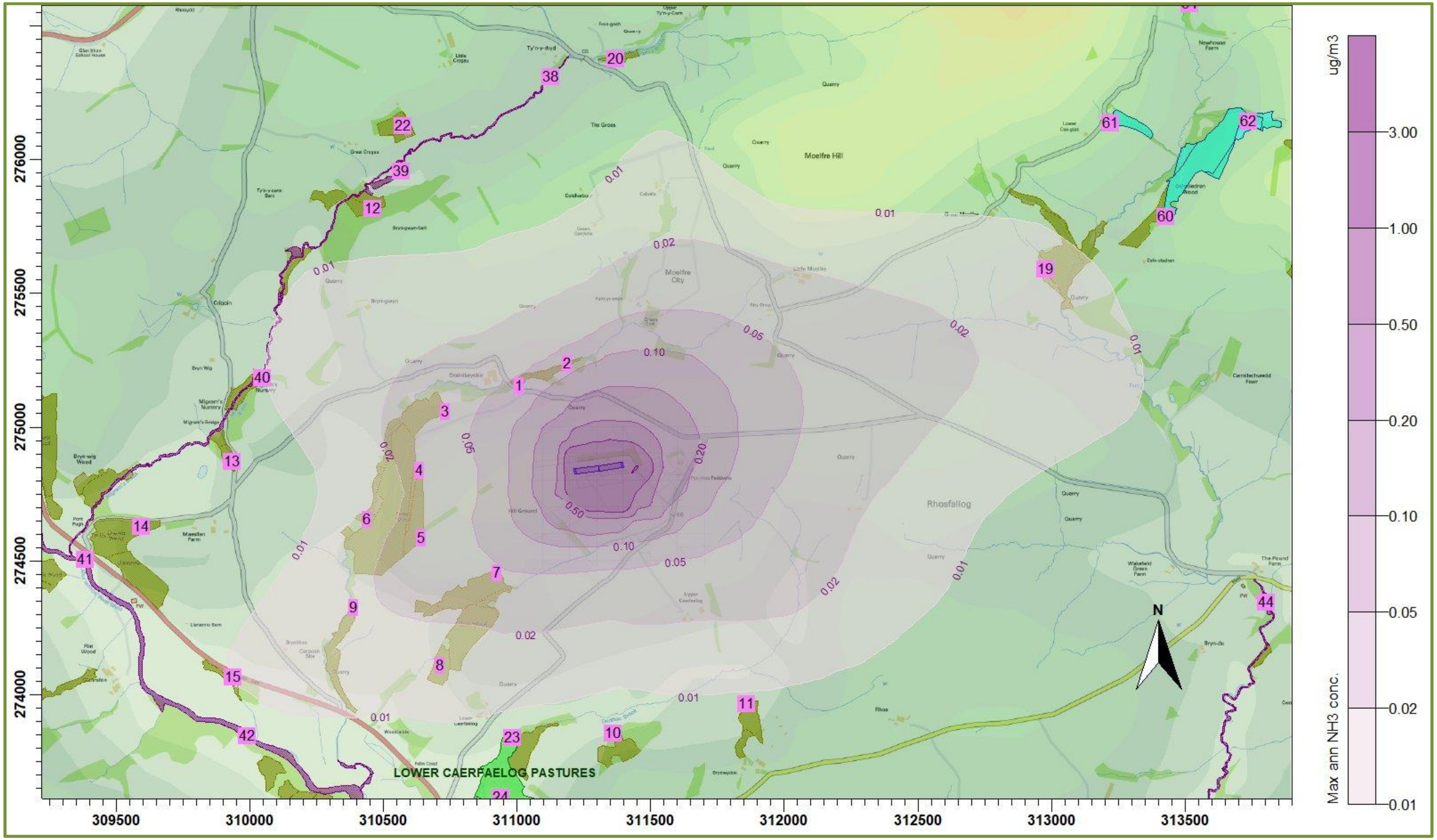
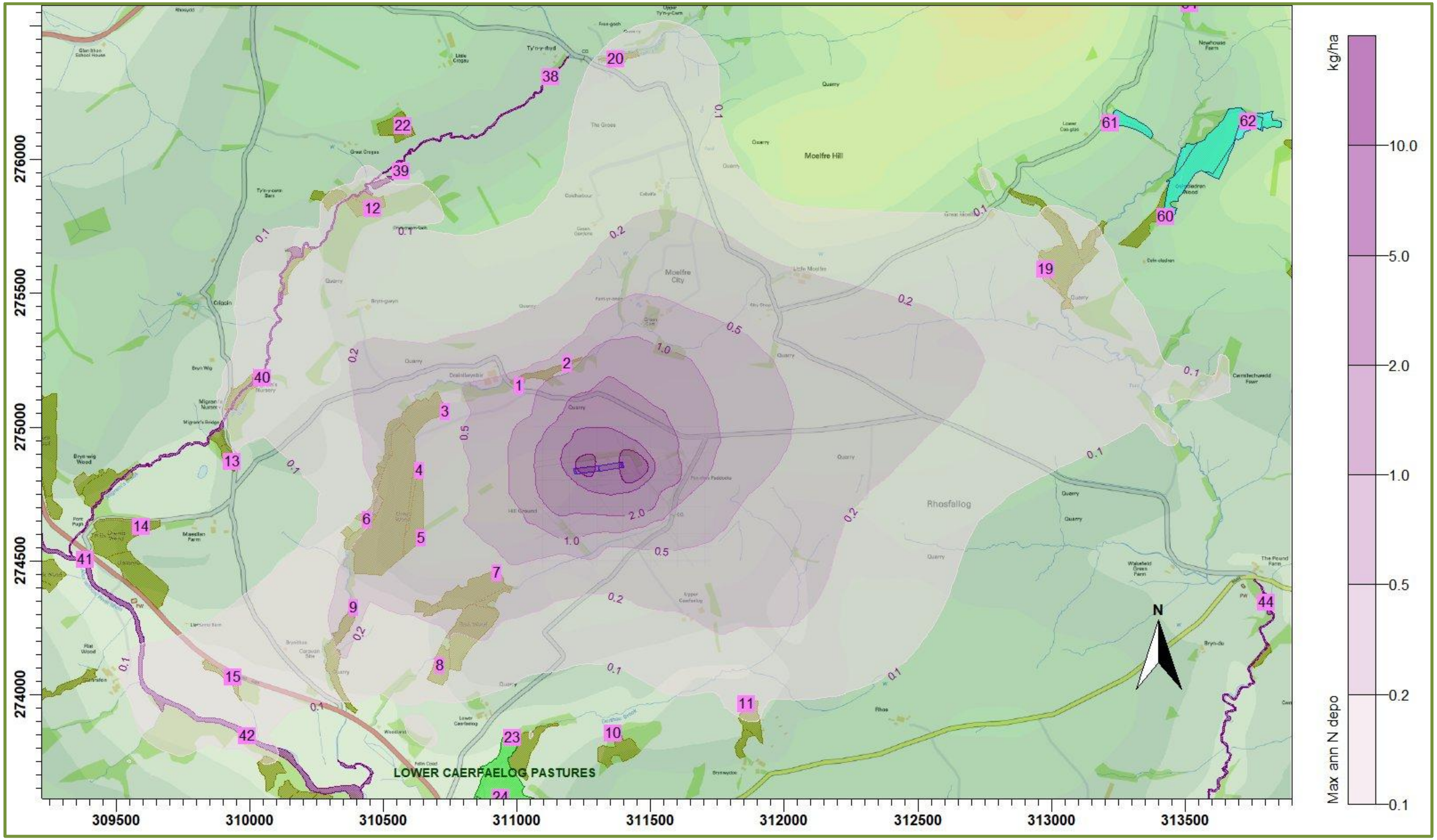


Figure 8b. Maximum annual nitrogen deposition rates



6. Summary and Conclusions

Ammonia emission rates from the poultry houses have been assessed and quantified based upon the Natural Resources Wales standard ammonia emission factors and also upon an emissions model that estimates emissions from the ammonia scrubbing equipment that would be fitted to the existing and proposed poultry houses. The emission rates have then been used as inputs to an atmospheric dispersion and deposition model which calculates ammonia exposure levels and nitrogen and acid deposition rates in the surrounding area.

It should be noted that the modelling is for scrubbing equipment of a design and specification as described in this report and is unlikely to be applicable to other scrubber designs and specifications.

The modelling predicts that:

- The process contribution to the annual ammonia concentration is currently/would be well below 100% of the precautionary Critical Level of 1.0 $\mu g\text{-}NH_3/m^3$ at all non-statutory AWs considered.

- The predicted annual ammonia concentrations over small parts of the Afon Ithon SSSI/River Wye SAC and a small part of the closest N sensitive AW, currently exceed 1% of the relevant Critical Level and/or Load. Under the proposal, these exceedances would be reduced to well below 1%.

- There would be reductions, some of which would be significant, at all wildlife sites considered should the proposal proceed.

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