



A Report on the Modelling of the Dispersion and Deposition of Ammonia from the Existing and Proposed Broiler Chicken Rearing Houses at Racecourse Farm near Pantasaph in Flintshire

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1. Introduction

AS Modelling & Data Ltd. has been instructed by Ms. Misba Tasawar, of Amber Real Estate Investments (Agriculture) Ltd., to use computer modelling to assess the impact of ammonia emissions from the existing and proposed broiler chicken rearing houses at Racecourse Farm, Pantasaph, Flintshire. CH8 8PP.

Ammonia emission rates from the poultry houses have been assessed and quantified based upon the Natural Resources Wales 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

Racecourse Farm is in a rural area approximately 500 m to the south-west of the small village of Pantasaph in Flintshire. The surrounding land is used for arable farming, grazing and fodder production and there are also some areas of semi-natural woodlands and grasslands. The farm is at an elevation of approximately 200 m in the northern Clwydian Hills.

There are currently eight broiler chicken rearing houses at Racecourse Farm, which provide accommodation for up to 114,400 broiler chickens. The poultry houses are ventilated by capped ridge mounted fans and there are gable end fans that provide increased ventilation during periods of hot weather. The chickens are reared from day old chicks to around 38 days old (with a maximum stocking density of 38 kg/m²) and there are approximately 7.5 flocks per annum.

Under the proposal, the eight existing broiler chicken rearing houses would be demolished and replaced by three new, state of the art poultry houses, which would provide accommodation for up to 132,000 broiler chickens. The proposed poultry houses would be ventilated by heat exchanger units and high-speed ridge fans and there would be gable end fans to provide supplementary ventilation during periods of hot weather. The chickens would be reared from day old chicks to around 38 days old (with a maximum stocking density of 30 kg/m²) and there would be approximately 7.5 flocks per annum.

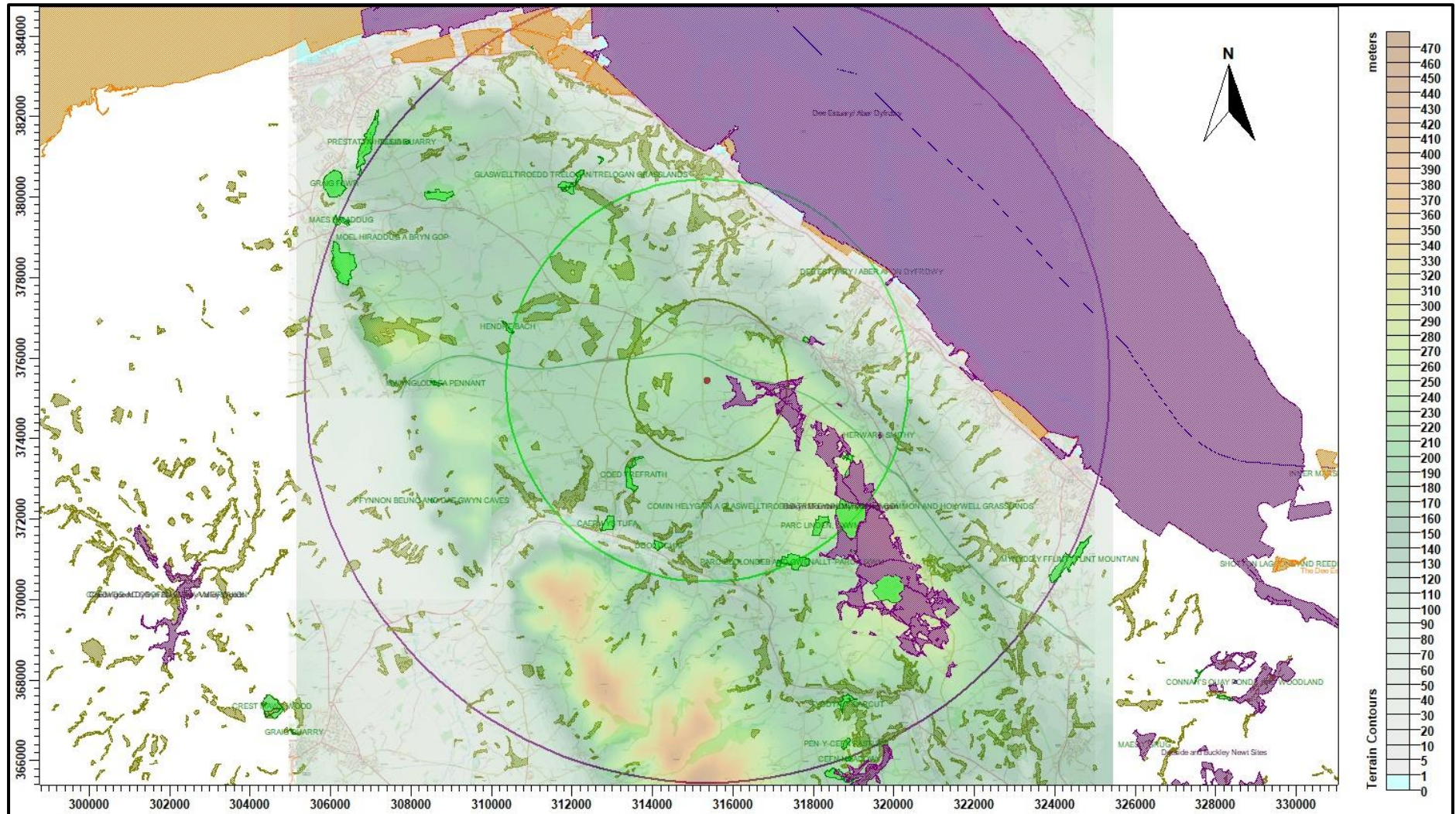
There are several areas designated as Ancient Woodlands (AWs) within 2 km (the normal screening distance for non-statutory sites) of Racecourse Farm. There are also twenty-one areas designated as Sites of Special Scientific Interest (SSSIs) within 10 km of the site. Some of the SSSIs are also designated as Special Areas of Conservation (SACs) and/or Special Protection Areas (SPAs) and/or Ramsar sites. Some further details of the statutory wildlife sites are provided below:

- **Halkyn Common and Holywell Grasslands SSSI/SAC** - Approximately 425 m to the east (closest point) - The relict industrial landscape of Halkyn Common and Holywell Grasslands supports the largest areas of heavy metal tolerant open grassland *Festuca ovina* - *Minuartia verna* (sheep's fescue - spring sandwort) Calaminarian grassland in Wales, with significant populations of the nationally scarce spring sandwort *Minuartia verna*. Halkyn Common also supports one of the largest areas of dry calcareous grassland in Wales.
- **Coed Trefraith SSSI** - Approximately 2.4 km to the south-west - One of the best examples in Clwyd of a woodland type found mainly in Wales and south-west England. The dominant tree in the wood is sessile oak *Quercus petraea* together with ash *Fraxinus excelsior* and, less commonly, wych elm *Ulmus glabra*.
- **Caerwys Tufa SSSI** - Approximately 4.0 km to the south-west - Geological.
- **Teilia Quarry SSSI** - Approximately 9.4 km to the north-west - Geological.
- **Ffynnon Beuno and Cae Gwyn Caves SSSI** - Approximately 7.3 km to the south-west - Palaeontological and bat roosting site.
- **Parc Linden, Lixwm SSSI** - Approximately 4.2 km to the south-east - The site supports unimproved calcareous grassland, acid grassland, limestone pavement, bracken and scrub.
- **Parc Bodlondeb and Gwenallt-parc, Lixwm SSSI** - Approximately 4.7 km to the south-south-east - The site supports a mosaic of unimproved calcareous, acid and neutral grasslands together with limestone heath and stands of bracken, scrub and broadleaved woodland.

- **Ddol Uchaf SSSI** - Approximately 4.1 km to the south-south-west - Geological.
- **Hendre Bach SSSI** - Approximately 4.9 km to the west-north-west - Of special interest primarily for its fen-meadow and associated soligenous mire vegetation and the population of black bog-rush *Schoenus nigricans* which it supports.
- **Mwyngloddfa Pennant SSSI** - Approximately 6.5 km to the west - Geological.
- **Glaswelltiroedd Trelogan SSSI** - Approximately 5.6 km to the north-west - Of special interest for its open vegetation on soils rich in heavy metals. The vegetation is characteristically open and typically includes heavy-metal tolerant higher plant and moss and lichen species, a number of nationally uncommon lichen species are present.
- **Moel Hiraddug a Bryn Gop SSSI** - Approximately 7.8 km to the north-west (closest point) - Of special interest for its geology, calcicolous grasslands and assemblages of nationally rare and scarce vascular and non-vascular plant species.
- **Maes Hiraddug SSSI** - Approximately 9.6 km to the west-north-west - Of special interest for its unimproved neutral grassland vegetation, which occurs in association with some small patches of woodland and scrub.
- **Graig Fawr SSSI** - Approximately 10.0 km to the north-west - A steep-sided limestone outcrop, of special interest for its range of limestone (calcicolous) grassland communities as well as its populations of vascular plants and lepidoptera. Bryophytes including *Grimmia orbicularis* and *Encalypta streptocarpa* are also abundant.
- **Prestatyn Hillside SSSI** - Approximately 10.0 km to the north-west - A steep west-facing hillside, the site supports a range of semi-natural plant communities including calcareous and acidic grassland; calcareous heath and scrub and broadleaved woodland. Limestone outcrops and disused quarries also occur.
- **Tyddyn-y-barcut SSSI** - Approximately 8.4 km to the south-south-east - A series of enclosed pastures, of special interest for stands of unimproved neutral grassland, which occur in association with broadleaved woodland, scrub and bracken.
- **Pen-y-Cefn Pasture SSSI** - Approximately 9.5 km to the south-south-east - An area of species-rich calcareous grassland. It represents one of the best-known surviving examples of a type of enclosed pasture now much reduced in area elsewhere, as a result of agricultural improvement. Additional interest is provided by calcareous scrub communities that have developed on part of the site.
- **Cefn Meadow SSSI** - Approximately 9.9 km to the south-south-east - A small, enclosed meadow developed on the Carboniferous Limestone, with a particularly rich flora, and represented a habitat declining rapidly in the county as a result of agricultural improvement.
- **Mynydd Y Fflint SSSI** - Approximately 9.8 km to the east-south-east - Of special interest for its stands of unimproved neutral grassland and semi-natural broadleaved woodland, which occur in association with scrub, fen-meadow and swamp vegetation.
- **Alyn Valley Woods and Alyn Gorge Caves SSSI/SAC** - Approximately 10.0 km to the south-south-east - The site is of special interest for its geomorphology, the Alyn Gorge Caves and its semi-natural broadleaved woodlands including their size and specific types of woodland vegetation, its calcareous and mesotrophic grasslands, its scarce plant assemblage, its population of wayfaring tree *Viburnum lantana* and its population of the grizzled skipper butterfly.
- **Herward Smithy SSSI/SAC** - Approximately 4.3 km to the east-south-east - Of special scientific interest for its open vegetation on soils rich in heavy metals. The vegetation is characteristically open and typically includes heavy metal tolerant species such as sheep's fescue *Festuca ovina*, common sorrel *Rumex acetosa* and the nationally scarce spring sandwort *Minuartia verna* together with a range of lower plants (lichens and bryophytes).
- **Dee Estuary SSSI/SAC/SPA/Ramsar site** - Approximately 4.5 km to the north-east (closest point) - Of special interest for its total populations of internationally important wintering waterfowl; its populations of individual waterfowl and tern species; its intertidal mud and sandflats, saltmarsh and transitional habitats; the hard rocky sandstone cliffs of Hilbre Island and Middle Eye with their cliff vegetation and maritime heathland and grassland; its assemblage of nationally scarce plants and its populations of sandhill rustic moth *Luperina nickerlii gueneei*, a Red Data Book species.

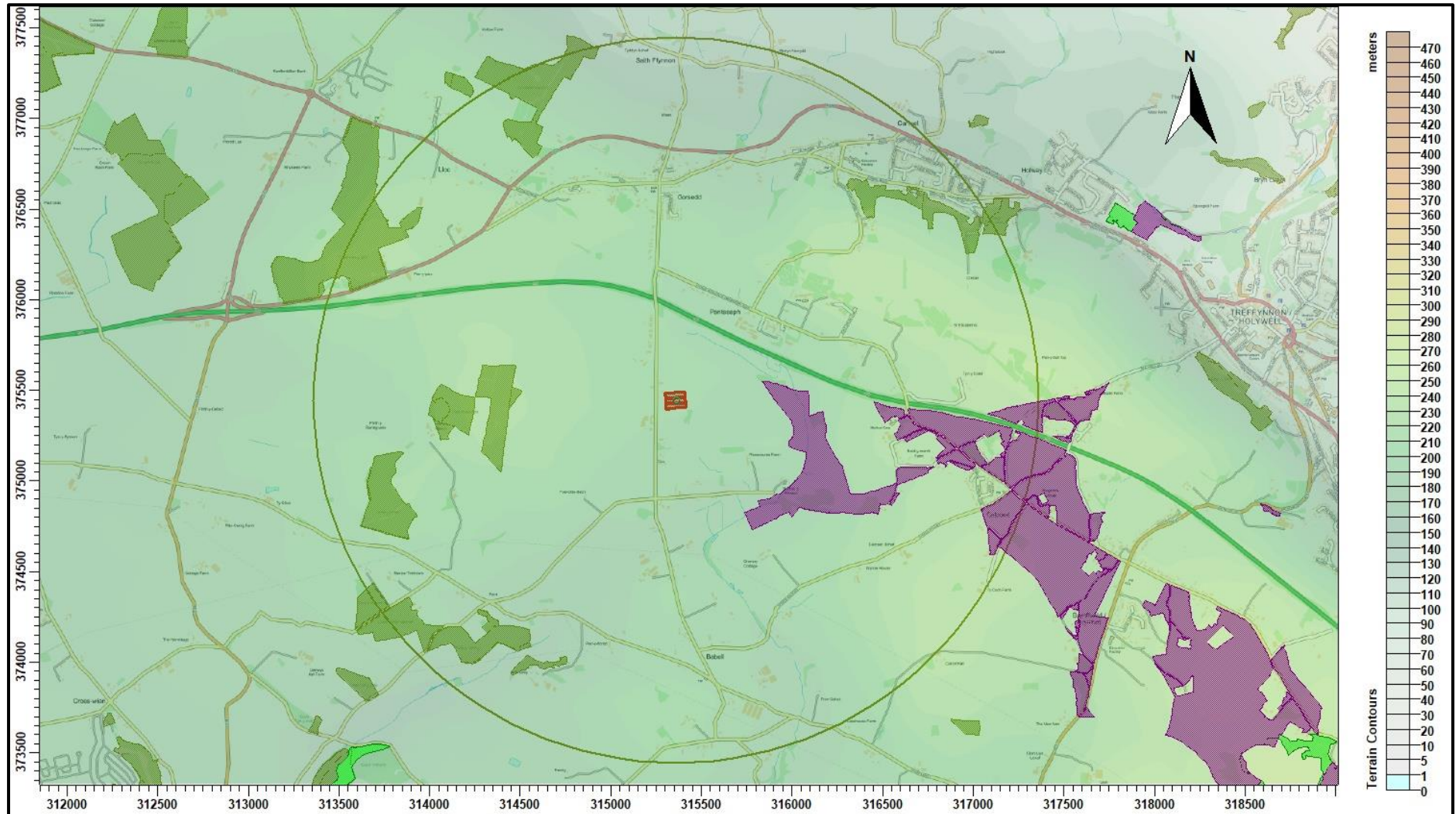
Maps of the surrounding area showing the site of Racecourse Farm, the AWs, the SSSIs, the SACs, the SPA and the Ramsar are provided in Figures 1a and 1b. In the figures, the AWs are shaded in olive, the SSSIs are shaded in green, the SACs are shaded in lilac, the SPA is shaded in orange, the Ramsar is shaded in blue and the positions of the poultry houses are outlined in red.

Figure 1a. The area surrounding Racecourse Farm – concentric circles radii 2 km (olive), 5 km (green) and 10 km (purple)



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Figure 1b. The area surrounding Racecourse Farm – 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 ($\text{kg-N}/\text{ha}/\text{y}$). Acid deposition is expressed in terms of kilograms equivalent (of H^+ ions) per hectare per year ($\text{keq}/\text{ha}/\text{y}$).

3.2 Background ammonia levels and nitrogen and acid deposition

The source of the background figures is the Air Pollution Information System (APIS, April 2025). 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 in the area around Racecourse Farm is $1.66 \mu\text{g-NH}_3/\text{m}^3$. The background nitrogen deposition rate to woodland is $28.07 \text{ kg-N}/\text{ha}/\text{y}$ and to short vegetation is $16.12 \text{ kg-N}/\text{ha}/\text{y}$. The background acid deposition rate to woodland is $2.16 \text{ keq}/\text{ha}/\text{y}$ and to short vegetation is $1.26 \text{ keq}/\text{ha}/\text{y}$.

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

3.3 Critical Levels & Critical Loads

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

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

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

For ammonia concentration in air, the Critical Level for higher plants is 3.0 $\mu\text{g-NH}_3/\text{m}^3$ 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. 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. 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 Deposition (kg-N/ha/y)	Critical Load - Acid Deposition (keq/ha/y)
LWSSs	1.0 ¹	-	-
Parc Linden, Lixwm SSSI and Parc Bodlondeb and Gwenallt-parc, Lixwm SSSI	3.0 ²	5.0 ^{2&3}	-
Coed Trefraith SSSI	3.0 ²	15.0 ^{2&3}	-
Tyddyn-y-barcut SSSI and Pen-y-Cefn Pasture SSSI	3.0 ²	10.0 ^{2&3}	-
Hendre Bach SSSI; Cefn Meadow SSSI; Mynydd Y Fflint SSSI and Herward Smithy SSSI/SAC	1.0 ^{1&2}	6.0 ^{2&3}	-
Halkyn Common and Holywell Grasslands SSSI/SAC; Graig Fawr SSSI; Prestatyn Hillside SSSI and Dee Estuary SSSI/SAC/SPA/Ramsar site	1.0 ^{1&2}	5.0 ^{2&3}	-
Ddol Uchaf SSSI; Caerwys Tufa SSSI; Mwyngloddfa Pennant SSSI; Teilia Quarry SSSI and Ffynnon Beuno and Cae Gwyn Caves SSSI	n/a ⁴	n/a ⁴	n/a ⁴

1. A precautionary figure used where details of the site are entirely unknown, or where although citations do not explicitly mention lichens or bryophytes, they are likely to be present.
2. Based upon the citation for the site and Natural Resources Wales website and APIS (note that in some cases, the APIS database contains Critical Levels/Loads for habitats/species that are not present or not present at the site/parts of the site within 10 km).
3. The lower bound of the range of Critical Loads for habitats present at the site. (please note that in some cases, the APIS database contains Critical Loads for habitats/species that are not present at the site/parts of the site within 10 km).
4. No Critical Loads for designated features.

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

The Natural Resources Wales guidance has been followed for this assessment, however it appears to apply only to statutory sites and some Ancient Woodlands deemed ammonia sensitive by Natural Resources Wales. For Local Nature Reserves (LNRs), Local Wildlife Sites (LWSs) and other Ancient Woodlands (AWs), it is assumed that the Environment Agency's "Intensive farming risk assessment for your environmental permit" is still applicable as there is no other official guidance that AS Modelling & Data Ltd. are aware of. 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 Joint Nature Conservancy Committee - Guidance on Decision-making Thresholds for Air Pollution

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

The Decision-making thresholds (DMT) for on-site emission sources provided in the JNCC report are reproduced below:

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

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

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

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

Whilst this guidance is useful for decision makers, it has not been used further in this report.

3.5 Quantification of Ammonia Emissions

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

The emission factors used for the existing and proposed broiler chicken rearing houses have been obtained from the following sources:

- It has been requested that AS Modelling & Data Ltd. uses the pre-February 2025 NRW standard ammonia emission factor of 0.034 kg-NH₃/bird place/y to estimate emissions from the aging buildings housing the existing broiler chickens.
- The post-February 2025 NRW standard ammonia emission factor of 0.024 kg-NH₃/bird place/y for birds housed in modern housing with indirect heating, has been used to estimate emissions from the proposed broiler chickens <https://naturalresources.wales/guidance-and-advice/business-sectors/farming/ammonia-assessments/emission-factors-for-poultry-for-modelling-and-reporting/?lang=en>

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

Table 2. Details of poultry numbers and ammonia emission rate

Source	Animal numbers	Type or weight	Emission factor (kg-NH ₃ /place/y)	Emission rate (g-NH ₃ /s)
Existing housing	114,400	Broiler chickens (old housing)	0.034	0.123254
Proposed housing	132,000	Broiler chickens (modern housing)	0.024	0.100388

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.

There are no observational weather data available that are likely to be representative.

The meteorological data used in this study is obtained from assimilation and short-term forecast fields of the Numerical Weather Prediction (NWP) system known as the Global Forecast System (GFS)¹.

The GFS 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 (FLOWSTAR²). The use of NWP data has advantages over traditional meteorological records because:

- Calm periods in traditional observational records may be overrepresented, 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.

A wind rose showing the distribution of wind speeds and directions in the GFS derived data is shown in Figure 2a. Wind speeds are modified by the treatment of roughness lengths (see Section 4.7) and where terrain data is included in the modelling, the raw GFS wind speeds and directions will be modified. The terrain and roughness length modified wind rose for the site is shown in Figure 2b. Please note that FLOWSTAR² is used to obtain a local flow field, not to explicitly model dispersion in complex terrain as defined in the ADMS User Guide; therefore, the ADMS default value for minimum turbulence length has been amended³.

1. The GFS data used is derived from the high-resolution operational GFS datasets, the data is not obtained from the lower resolution (0.5 degree) long-term archive.
2. Note that FLOWSTAR requirements are for meteorological data representative of the upwind flow over the modelling domain and that single site meteorological data (observational or from high resolution modelled data) that is representative of the application site is not generally suitable (personal correspondence: CERC 2019 and

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

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

Figure 2a. The wind rose. Raw GFS derived data for 53.269 N, 3.269 W, 2021-2024

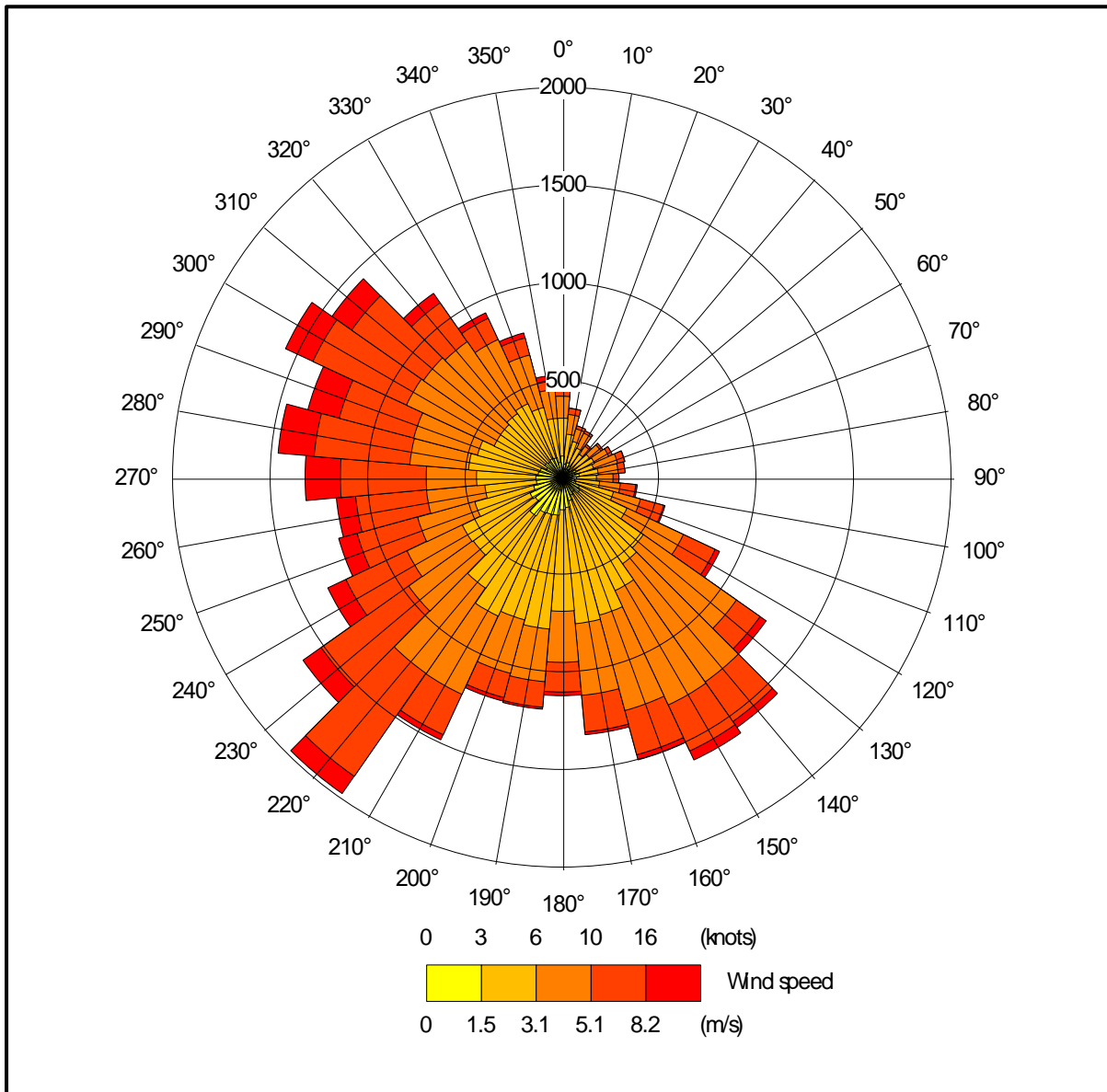
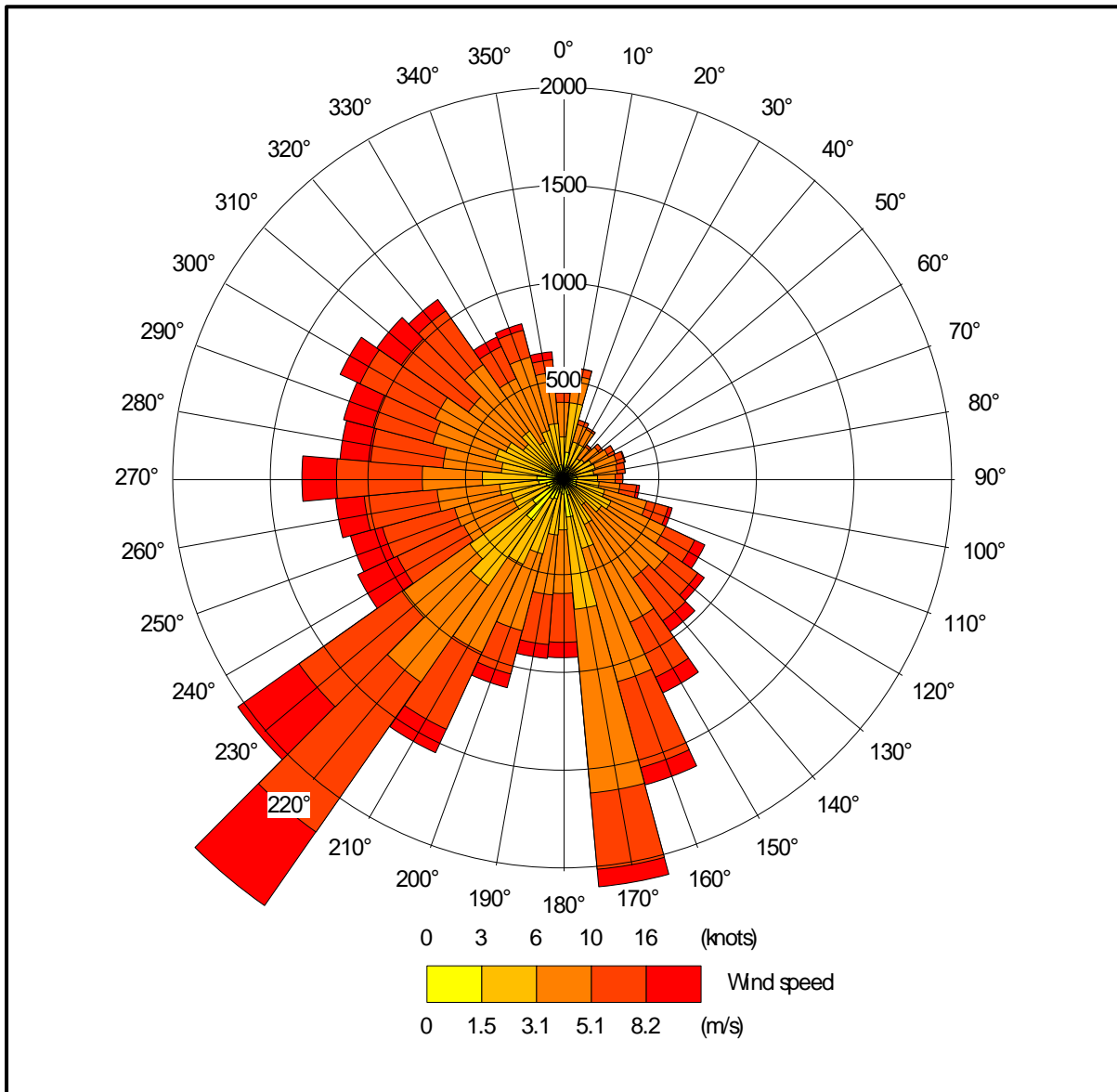


Figure 2b. The wind rose. FLOWSTAR modified GFS derived data for NGR 315350, 375450 2021-2024



4.2 Emission sources

Emissions from the capped chimneys of the ridge mounted fans on the existing houses are represented by a single point source per house within ADMS (EX1 to EX8). Emissions from the uncapped chimneys of the ridge mounted fans on the proposed houses are represented by three point sources per house within ADMS (PR1 to PR3; 1, 2 & 3). Emissions from the stacks that would serve the heat exchanger units are represented by a single point source per heat exchanger within ADMS (HEX1 to HEX3). Emissions from the gable end fans are represented by volume sources within ADMS (EX1TO4_GAB; EX5TO8_GAB and PR1TO3_GAB).

For the proposed scenario, emissions are assumed to be split as follows, 90% from the ridge fans/gable end fans and 10% from the heat exchanger units.

The positions of the point and volume sources are shown in Figure 3a and Figure 3b (marked by green circles and red shade rectangles, respectively).

Table 3a. Point source parameters

Source ID (scenario)	Height (m)	Diameter (m)	Efflux velocity (m/s)	Emission temperature (°C)	Emission rate per source (g/s)
EX1 to EX8; 1, 2 & 3 (existing)	5.0	2.0	0.1	Variable ¹	0.015407 ^{1 & 2}
PR1 to PR3 1, 2 & 3 (proposed)	6.2	0.8	11.0	Variable ¹	0.033463 ^{1 & 3}
HEX1 to HEX3 (proposed)	4.5	1.0	6.0	Variable ¹	0.033463 ^{1 & 4}

Table 3b. Volume source parameters

Source ID (scenario)	Length (m)	Width (m)	Depth (m)	Base height (m)	Emission temperature (°C)	Emission rate (g/s)
EX1TO4_GAB (existing)	10.0	105.0	3.0	0.0	Ambient	0.061627 ^{1 & 5}
EX5TO4_GA8 (existing)	10.0	105.0	3.0	0.0	Ambient	0.061627 ^{1 & 5}
PR1TO3_GAB (proposed)	83.7	10.0	3.0	0.5	Ambient	0.100388 ^{1 & 6}

1. Variable, dependant on ambient temperature.
2. Reduced by 50% when the ambient temperature exceeds 21 Celsius.
3. 90% of total emitted, reduced to 45% when the ambient temperature exceeds 23 Celsius.
4. 10% of total emitted, reduced to 5% when the ambient temperature exceeds 23 Celsius.
5. 50% emitted only when the ambient temperature exceeds 21 Celsius.
6. 50% of the total house emissions, emitted only when the ambient temperature exceeds 23 Celsius.

4.3 Modelled buildings

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

4.4 Discrete receptors

Seventy-nine discrete receptors have been defined at the nearby wildlife sites. These receptors are defined at ground level within ADMS. The positions of the discrete receptors may be seen in Figure 4a and Figure 4b (marked by enumerated pink rectangles).

4.5 Cartesian grid

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

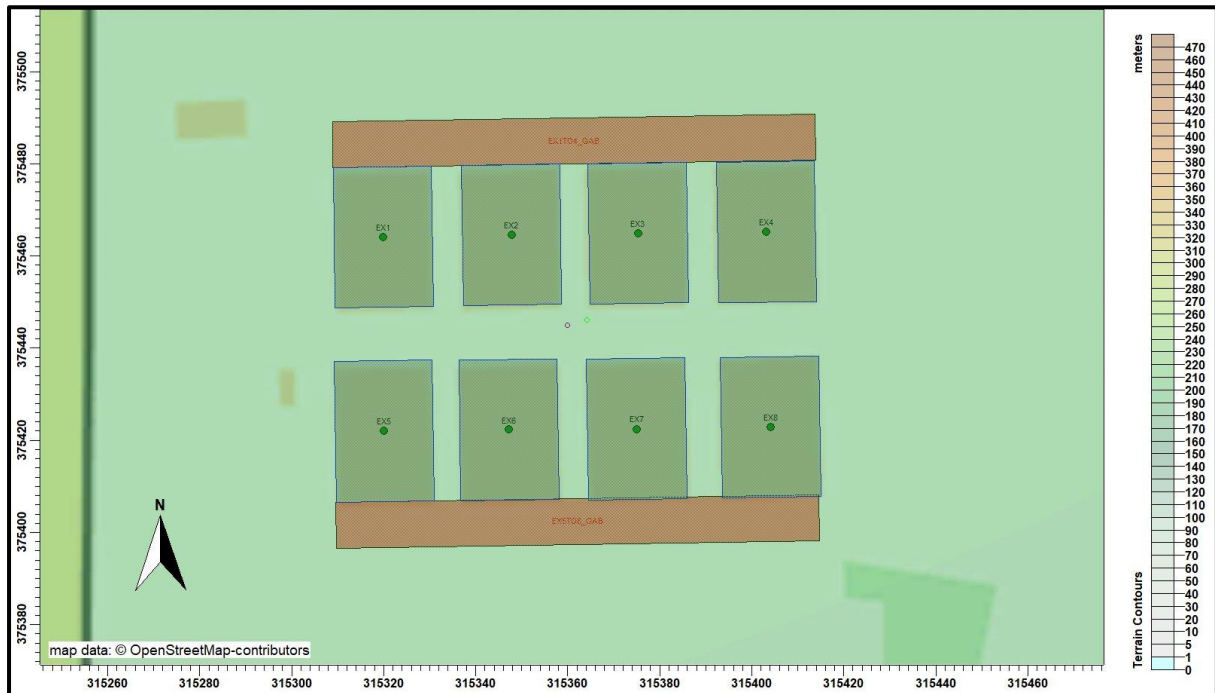
4.6 Terrain data

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

4.7 Roughness Length

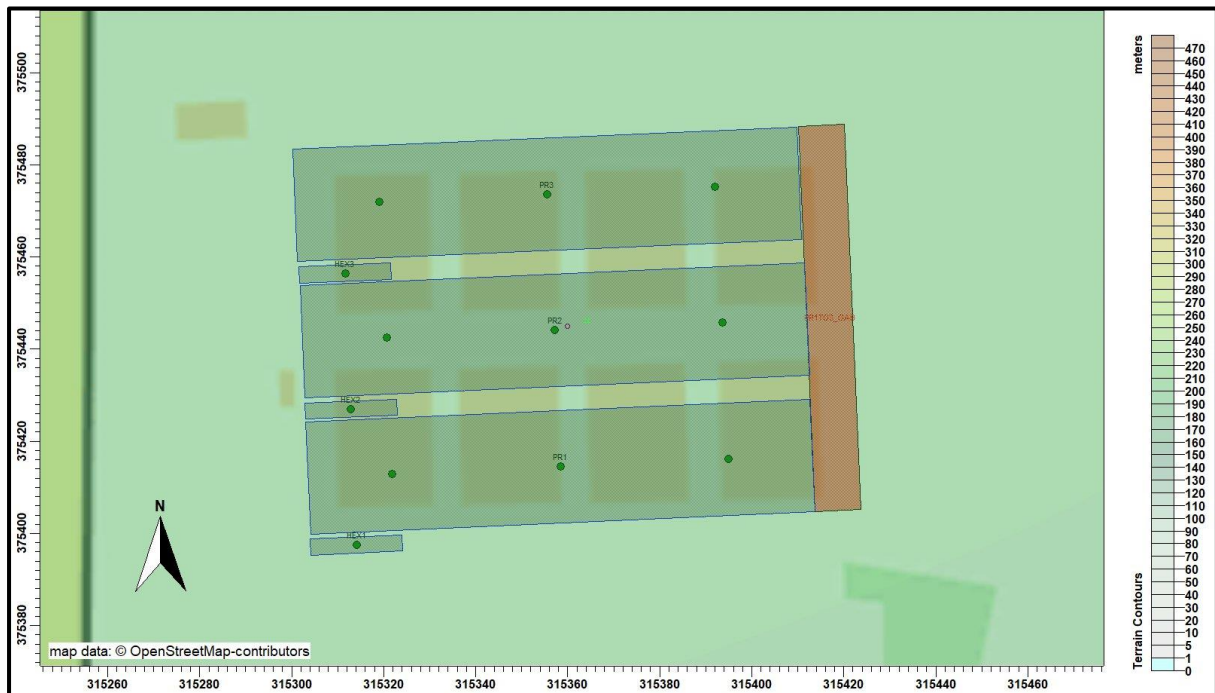
In this case, a spatially varying roughness length file has been defined, this is based upon the UK Centre for Ecology and Hydrology 25 m land use database, with permission. The GFS meteorological data is assumed to have a roughness length of 0.189 m (arithmetic average of the spatially varying roughness over the modelling domain). The sample of the central area of the spatially varying roughness length field is shown in Figure 5.

Figure 3a. The positions of the modelled buildings and sources - existing scenario



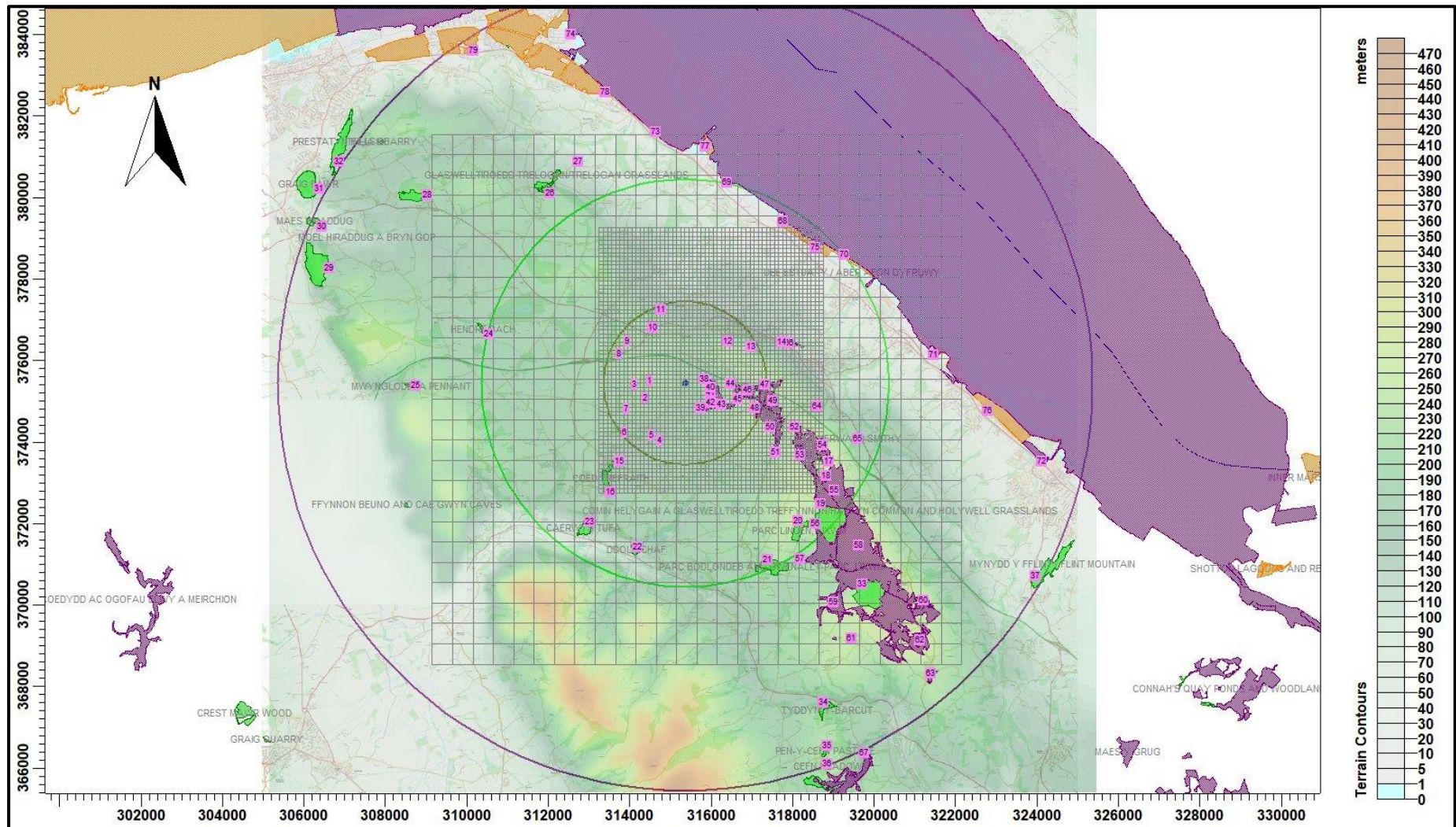
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Figure 3b. The positions of the modelled buildings and sources - proposed scenario



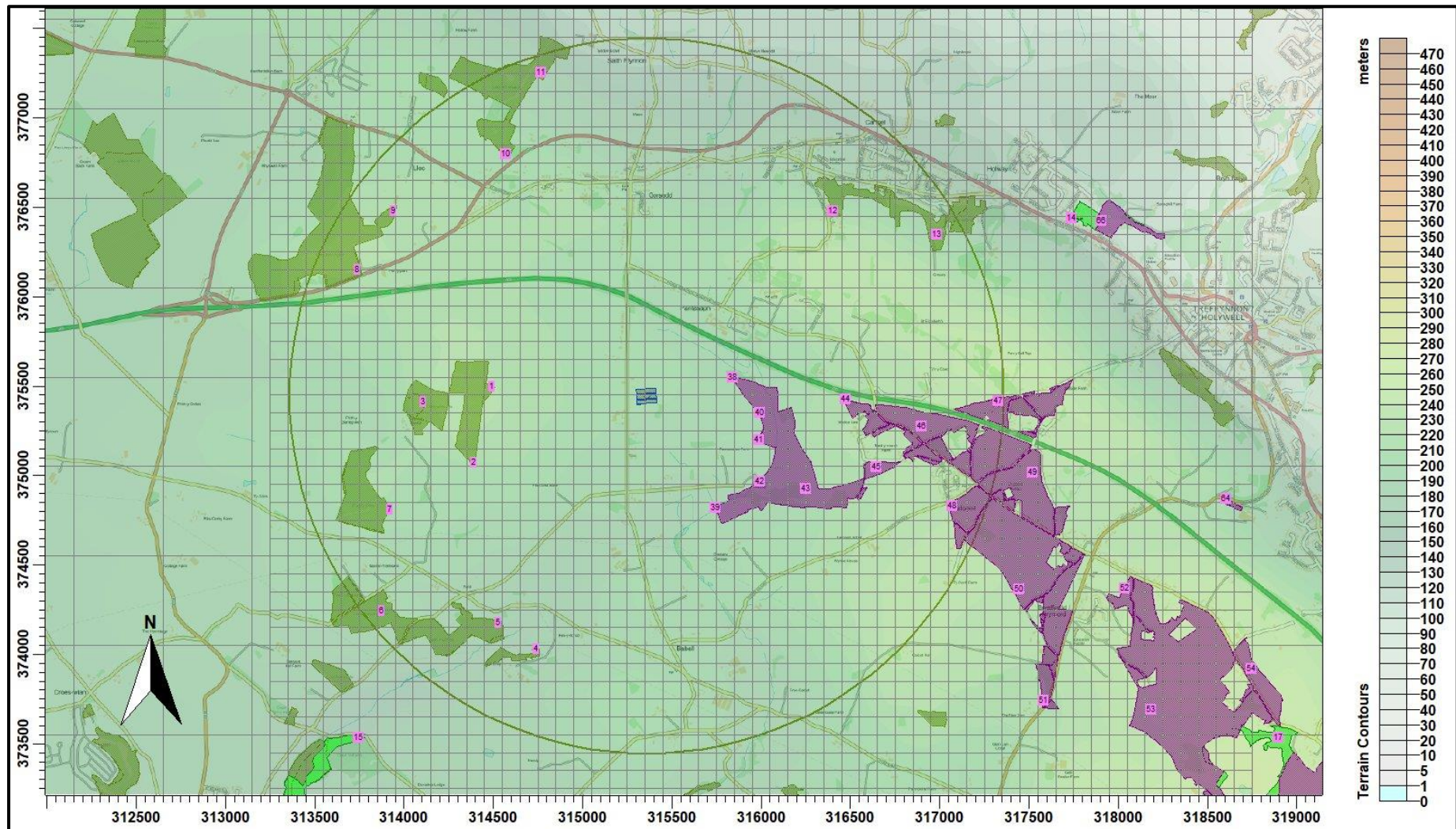
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Figure 4a. The discrete receptors and regular Cartesian grid - a broad scale view



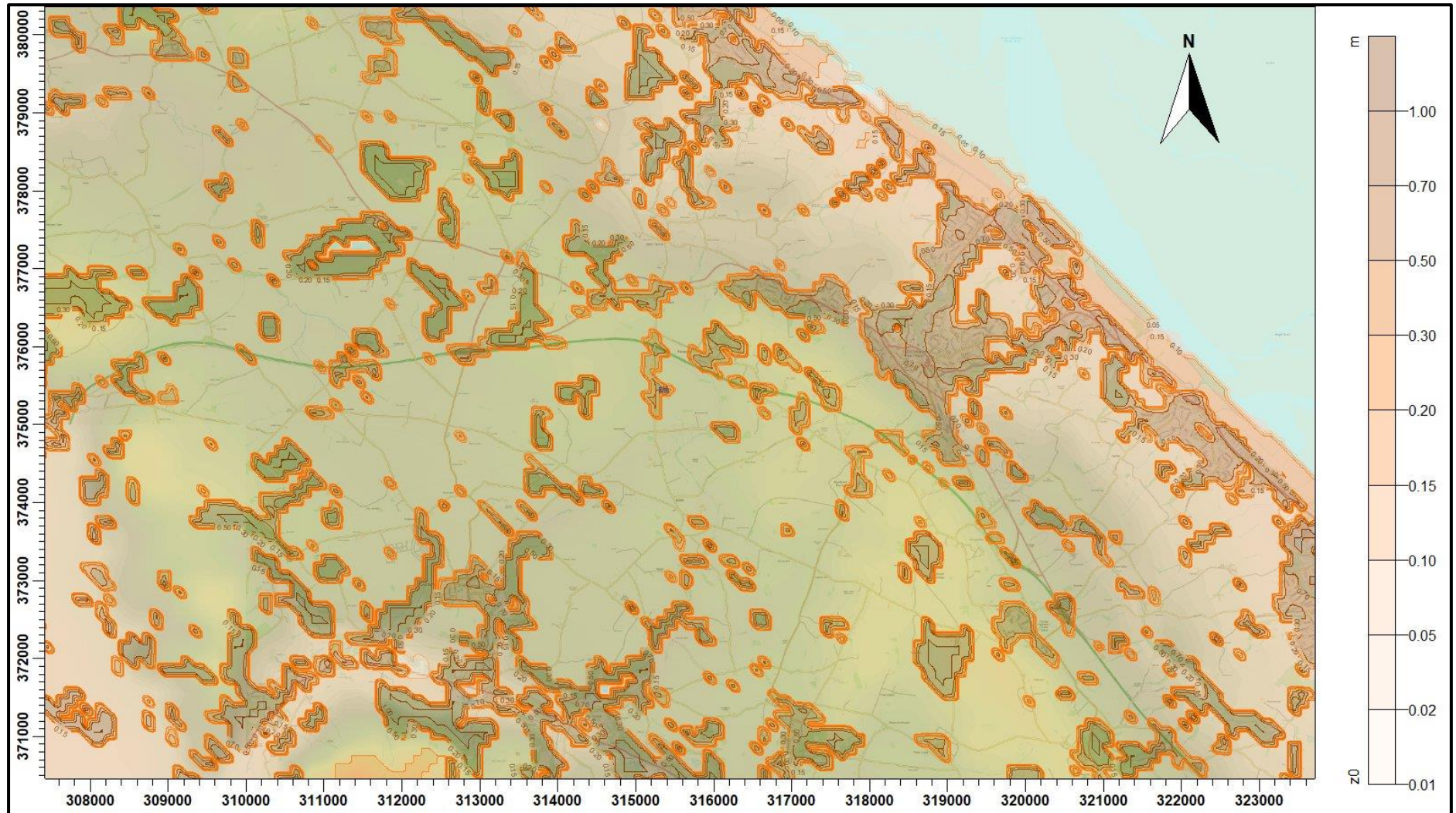
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Figure 4b. The discrete receptors and regular Cartesian grid - a closer scale view



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



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4.8 Deposition

The method used to model deposition of ammonia and consequent plume depletion is based primarily upon figures obtained from 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 rye-grass 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 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 two deposition velocity fields. The deposition velocities used are provided in Table 4.

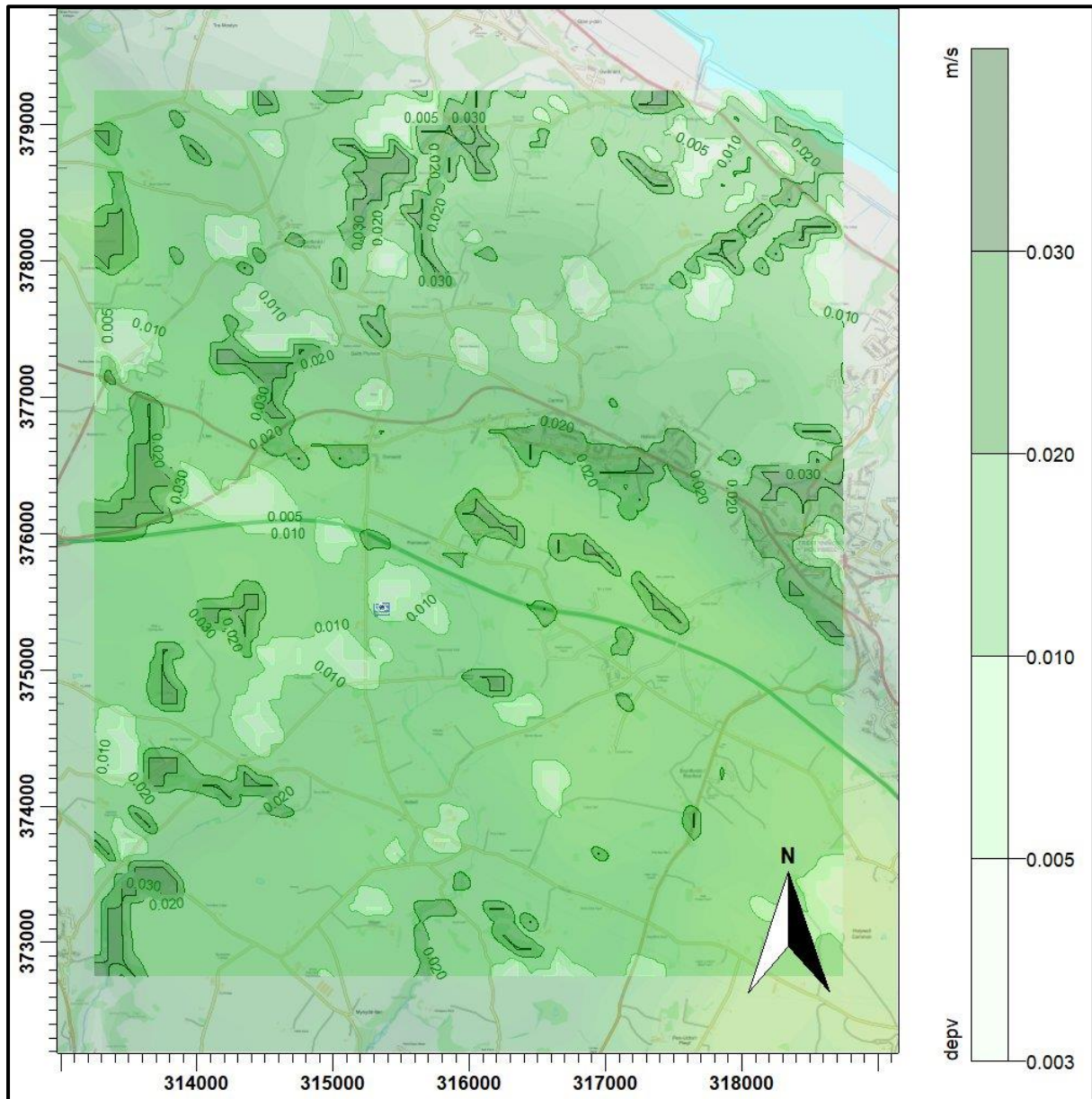
Table 4. Deposition velocities

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 (0.010 to 0.015 over heavily grazed grassland)	0.015	0.01	0.005	0.003
Deposition velocity - arable farmland/rye grass (m/s)	0.005	0.005	0.005	0.005	0.003

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

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

Figure 5. The spatially varying deposition field



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5. Details of the Model Runs and Results

5.1 Preliminary modelling and model sensitivity tests

ADMS was effectively run a total of sixteen times: once for each year of the meteorological record; for both the existing and proposed scenarios 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 runs

Receptor number	X(m)	Y(m)	Name/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 No Terrain	GFS Calms No Terrain
1	314490	375497	AW	0.140	0.136	0.024	0.024
2	314390	375073	AW	0.088	0.088	0.018	0.018
3	314106	375410	AW	0.081	0.080	0.014	0.015
4	314740	374030	AW	0.045	0.046	0.010	0.010
5	314529	374175	AW	0.048	0.049	0.010	0.010
6	313875	374241	AW	0.029	0.031	0.007	0.007
7	313921	374809	AW	0.048	0.049	0.010	0.010
8	313736	376149	AW	0.078	0.078	0.016	0.016
9	313941	376480	AW	0.109	0.109	0.029	0.029
10	314568	376797	AW	0.135	0.134	0.054	0.054
11	314766	377252	AW	0.131	0.129	0.040	0.039
12	316404	376480	AW	0.282	0.271	0.051	0.050
13	316985	376348	AW	0.166	0.161	0.032	0.032
14	317739	376437	Halkyn Common and Holywell Grasslands SSSI	0.097	0.096	0.021	0.021
15	313745	373532	Coed Trefraith SSSI	0.022	0.024	0.005	0.005
16	313526	372780	Coed Trefraith SSSI	0.016	0.018	0.004	0.004
17	318895	373534	Halkyn Common and Holywell Grasslands SSSI	0.029	0.031	0.011	0.010
18	318822	373162	Halkyn Common and Holywell Grasslands SSSI	0.026	0.028	0.010	0.010
19	318686	372472	Halkyn Common and Holywell Grasslands SSSI	0.021	0.023	0.008	0.008
20	318141	372054	Parc Linden, Lixwm SSSI	0.021	0.023	0.008	0.008
21	317387	371101	Parc Bodlondeb and Gwennallt-parc, Lixwm SSSI	0.016	0.018	0.006	0.006
22	314182	371410	Ddol Uchaf SSSI	0.009	0.011	0.003	0.003
23	313010	372045	Caerwys Tufa SSSI	0.011	0.013	0.003	0.003
24	310531	376648	Hendre Bach SSSI	0.014	0.016	0.004	0.004
25	308749	375377	Mwyngloddfa Pennant SSSI	0.008	0.009	0.003	0.003
26	312037	380097	Glaswelltiroedd Trelogan SSSI	0.018	0.020	0.009	0.009
27	312738	380872	Glaswelltiroedd Trelogan SSSI	0.020	0.021	0.009	0.009
28	309041	380053	Moel Hiraddug a Bryn Gop SSSI	0.012	0.013	0.005	0.005
29	306615	378270	Moel Hiraddug a Bryn Gop SSSI	0.006	0.007	0.003	0.003
30	306440	379293	Maes Hiraddug SSSI	0.006	0.007	0.003	0.003

Receptor number	X(m)	Y(m)	Name/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 No Terrain	GFS Calms No Terrain
31	306367	380214	Graig Fawr SSSI	0.007	0.008	0.003	0.003
32	306863	380872	Prestatyn Hillside SSSI	0.008	0.008	0.004	0.004
33	319708	370505	Halkyn Common and Holywell Grasslands SSSI	0.011	0.013	0.005	0.005
34	318765	367599	Tyddyn-y-barcut SSSI	0.007	0.008	0.003	0.003
35	318854	366542	Pen-y-Cefn Pasture SSSI	0.005	0.007	0.003	0.003
36	318841	366096	Cefn Meadow SSSI	0.005	0.006	0.002	0.002
37	323964	370722	Mynydd Y Fflint SSSI	0.007	0.009	0.004	0.004
38	315840	375546	Halkyn Common and Holywell Grasslands SSSI/SAC	0.847	0.814	0.164	0.162
39	315745	374820	Halkyn Common and Holywell Grasslands SSSI/SAC	0.289	0.278	0.077	0.076
40	315991	375349	Halkyn Common and Holywell Grasslands SSSI/SAC	0.516	0.499	0.124	0.122
41	315987	375198	Halkyn Common and Holywell Grasslands SSSI/SAC	0.446	0.429	0.121	0.119
42	315991	374967	Halkyn Common and Holywell Grasslands SSSI/SAC	0.305	0.293	0.095	0.094
43	316248	374926	Halkyn Common and Holywell Grasslands SSSI/SAC	0.223	0.215	0.064	0.064
44	316471	375425	Halkyn Common and Holywell Grasslands SSSI/SAC	0.241	0.235	0.051	0.051
45	316645	375047	Halkyn Common and Holywell Grasslands SSSI/SAC	0.165	0.161	0.045	0.044
46	316899	375274	Halkyn Common and Holywell Grasslands SSSI/SAC	0.145	0.142	0.036	0.035
47	317326	375417	Halkyn Common and Holywell Grasslands SSSI/SAC	0.105	0.105	0.026	0.025
48	317069	374828	Halkyn Common and Holywell Grasslands SSSI/SAC	0.104	0.103	0.030	0.029
49	317523	375017	Halkyn Common and Holywell Grasslands SSSI/SAC	0.083	0.083	0.024	0.024
50	317443	374366	Halkyn Common and Holywell Grasslands SSSI/SAC	0.067	0.067	0.020	0.020
51	317583	373742	Halkyn Common and Holywell Grasslands SSSI/SAC	0.045	0.046	0.015	0.015
52	318037	374370	Halkyn Common and Holywell Grasslands SSSI/SAC	0.051	0.052	0.016	0.016
53	318185	373689	Halkyn Common and Holywell Grasslands SSSI/SAC	0.037	0.039	0.013	0.013
54	318743	373921	Halkyn Common and Holywell Grasslands SSSI/SAC	0.034	0.036	0.012	0.012
55	319021	372808	Halkyn Common and Holywell Grasslands SSSI/SAC	0.022	0.024	0.009	0.008
56	318563	371990	Halkyn Common and Holywell Grasslands SSSI/SAC	0.019	0.021	0.007	0.007
57	318188	371129	Halkyn Common and Holywell Grasslands SSSI/SAC	0.016	0.018	0.006	0.006
58	319618	371462	Halkyn Common and Holywell Grasslands SSSI/SAC	0.014	0.016	0.006	0.006
59	318674	369852	Halkyn Common and Holywell Grasslands SSSI/SAC	0.011	0.013	0.005	0.005
60	321214	370116	Halkyn Common and Holywell Grasslands SSSI/SAC	0.009	0.010	0.004	0.004
61	319451	369172	Halkyn Common and Holywell Grasslands SSSI/SAC	0.009	0.011	0.004	0.004
62	321116	369131	Halkyn Common and Holywell Grasslands SSSI/SAC	0.008	0.009	0.004	0.004
63	321380	368326	Halkyn Common and Holywell Grasslands SSSI/SAC	0.007	0.008	0.003	0.003
64	318604	374869	Halkyn Common and Holywell Grasslands SSSI/SAC	0.046	0.047	0.015	0.015
65	319599	374072	Herward Smithy SSSI/SAC	0.027	0.029	0.010	0.010
66	317907	376426	Halkyn Common and Holywell Grasslands SSSI/SAC	0.088	0.087	0.020	0.020
67	319759	366365	Alyn Valley Woods and Alyn Gorge Caves SSSI/SAC	0.005	0.007	0.003	0.003
68	317750	379425	Dee Estuary SSSI/SAC/SPA/Ramsar site	0.052	0.052	0.017	0.017
69	316379	380379	Dee Estuary SSSI/SAC/SPA/Ramsar site	0.038	0.039	0.014	0.014
70	319259	378593	Dee Estuary SSSI/SAC/SPA/Ramsar site	0.043	0.044	0.014	0.014
71	321461	376130	Dee Estuary SSSI/SAC/SPA/Ramsar site	0.021	0.022	0.008	0.008
72	324115	373528	Dee Estuary SSSI/SAC/SPA/Ramsar site	0.010	0.011	0.005	0.005
73	314628	381610	Dee Estuary SSSI/SAC/SPA/Ramsar site	0.024	0.025	0.010	0.010
74	312564	384004	Dee Estuary SSSI/SAC/SPA/Ramsar site	0.013	0.014	0.006	0.006
75	318548	378766	Dee Estuary SSSI/SPARamsar site	0.053	0.054	0.017	0.017
76	322778	374775	Dee Estuary SSSI/SPARamsar site	0.014	0.015	0.006	0.006
77	315859	381264	Dee Estuary SSSI/SPARamsar site	0.028	0.029	0.012	0.011
78	313396	382593	Dee Estuary SSSI/SPARamsar site	0.018	0.020	0.008	0.008
79	310152	383610	Dee Estuary SSSI/SPARamsar site	0.008	0.010	0.005	0.005

5.2 Detailed deposition modelling

In this case, detailed modelling has been carried out over a high resolution 5.5 km x 6.5 km domain surrounding Racecourse Farm. 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, but also to provide results should any LWSs be identified. Outside of the 5.5 km x 6.5 km 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. The results of the preliminary modelling indicate that the effects of calms are significant in the case of the existing scenario and therefore a correction, based on the preliminary modelling results has been applied to the existing scenario results.

The predicted maximum annual mean ground level ammonia concentrations and annual nitrogen deposition rates at the discrete receptors are shown in Tables 6a (Existing Scenario) and 6b (Proposed Scenario). The predicted changes are shown in Table 7.

In these Tables, there are no predicted ammonia concentrations at AWs that are in excess of 100% of the precautionary Critical Level. Predicted ammonia concentrations and nitrogen deposition rates exceeding 1% of the relevant Critical Level or Critical Load at a statutory site are highlighted with bold text.

Contour plots of the predicted ground level maximum annual mean ammonia concentration and maximum annual nitrogen deposition rates for the Proposed Scenario are shown in Figures 7a and 7b. Contour plots for other scenarios can be made available upon 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 ammonia concentration		Maximum annual nitrogen deposition rate	
				Deposition Velocity	Critical Level ($\mu\text{g}/\text{m}^3$)	Critical Load (kg/ha)	Process Contribution ($\mu\text{g}/\text{m}^3$)	%age of Critical Level	Process Contribution (kg/ha)	%age of Critical Load
1	314490	375497	AW	0.03	1.0	10.0	0.066	6.56	0.51	5.11
2	314390	375073	AW	0.03	1.0	10.0	0.044	4.37	0.34	3.41
3	314106	375410	AW	0.03	1.0	10.0	0.033	3.33	0.26	2.59
4	314740	374030	AW	0.03	1.0	10.0	0.023	2.33	0.18	1.81
5	314529	374175	AW	0.03	1.0	10.0	0.023	2.25	0.18	1.75
6	313875	374241	AW	0.03	1.0	10.0	0.011	1.09	0.08	0.85
7	313921	374809	AW	0.03	1.0	10.0	0.020	1.99	0.16	1.55
8	313736	376149	AW	0.03	1.0	10.0	0.026	2.63	0.20	2.05
9	313941	376480	AW	0.03	1.0	10.0	0.044	4.38	0.34	3.41
10	314568	376797	AW	0.03	1.0	10.0	0.061	6.13	0.48	4.78
11	314766	377252	AW	0.03	1.0	10.0	0.049	4.87	0.38	3.79
12	316404	376480	AW	0.03	1.0	10.0	0.110	11.02	0.86	8.58
13	316985	376348	AW	0.03	1.0	10.0	0.053	5.30	0.41	4.13
14	317739	376437	Halkyn Common and Holywell Grasslands SSSI	0.02	1.0	5.0	0.025	2.53	0.13	2.62
15	313745	373532	Coed Trefraith SSSI	0.03	3.0	15.0	0.008	0.25	0.06	0.39
16	313526	372780	Coed Trefraith SSSI	0.03	3.0	15.0	0.005	0.16	0.04	0.25
17	318895	373534	Halkyn Common and Holywell Grasslands SSSI	0.02	1.0	5.0	0.007	0.72	0.04	0.75
18	318822	373162	Halkyn Common and Holywell Grasslands SSSI	0.02	1.0	5.0	0.006	0.64	0.03	0.66
19	318686	372472	Halkyn Common and Holywell Grasslands SSSI	0.02	1.0	5.0	0.005	0.55	0.03	0.57
20	318141	372054	Parc Linden, Lixwm SSSI	0.02	3.0	5.0	0.005	0.18	0.03	0.55
21	317387	371101	Parc Bodlondeb and Gwenallt-parc, Lixwm SSSI	0.02	3.0	5.0	0.005	0.16	0.03	0.51
22	314182	371410	Ddol Uchaf SSSI	0.03	n/a	n/a	0.003	-	0.02	-
23	313010	372045	Caerwys Tufa SSSI	0.03	n/a	n/a	0.003	-	0.02	-
24	310531	376648	Hendre Bach SSSI	0.02	1.0	6.0	0.004	0.38	0.02	0.33
25	308749	375377	Mwyngloddfa Pennant SSSI	0.03	n/a	n/a	0.002	-	0.01	-
26	312037	380097	Glaswelltiroedd Trelogan SSSI	0.03	1.0	10.0	0.006	0.56	0.04	0.44
27	312738	380872	Glaswelltiroedd Trelogan SSSI	0.03	1.0	10.0	0.006	0.58	0.05	0.45
28	309041	380053	Moel Hiraddug a Bryn Gop SSSI	0.02	1.0	10.0	0.003	0.29	0.01	0.15

Receptor number	X(m)	Y(m)	Name	Site Parameters			Maximum annual ammonia concentration		Maximum annual nitrogen deposition rate	
				Deposition Velocity	Critical Level (µg/m³)	Critical Load (kg/ha)	Process Contribution (µg/m³)	%age of Critical Level	Process Contribution (kg/ha)	%age of Critical Load
29	306615	378270	Moel Hiraddug a Bryn Gop SSSI	0.02	1.0	10.0	0.001	0.12	0.01	0.06
30	306440	379293	Maes Hiraddug SSSI	0.02	3.0	10.0	0.001	0.04	0.01	0.06
31	306367	380214	Graig Fawr SSSI	0.02	1.0	5.0	0.001	0.13	0.01	0.13
32	306863	380872	Prestatyn Hillside SSSI	0.02	1.0	5.0	0.001	0.15	0.01	0.15
33	319708	370505	Halkyn Common and Holywell Grasslands SSSI	0.02	1.0	5.0	0.003	0.26	0.01	0.27
34	318765	367599	Tyddyn-y-barcut SSSI	0.02	3.0	10.0	0.002	0.05	0.01	0.08
35	318854	366542	Pen-y-Cefn Pasture SSSI	0.02	3.0	10.0	0.001	0.04	0.01	0.06
36	318841	366096	Cefn Meadow SSSI	0.02	3.0	6.0	0.001	0.04	0.01	0.09
37	323964	370722	Mynydd Y Fflint SSSI	0.02	1.0	6.0	0.002	0.16	0.01	0.14
38	315840	375546	Halkyn Common and Holywell Grasslands SSSI/SAC	0.02	1.0	5.0	0.497	49.74	2.58	51.67
39	315745	374820	Halkyn Common and Holywell Grasslands SSSI/SAC	0.02	1.0	5.0	0.177	17.73	0.92	18.42
40	315991	375349	Halkyn Common and Holywell Grasslands SSSI/SAC	0.02	1.0	5.0	0.311	31.06	1.61	32.27
41	315987	375198	Halkyn Common and Holywell Grasslands SSSI/SAC	0.02	1.0	5.0	0.279	27.85	1.45	28.93
42	315991	374967	Halkyn Common and Holywell Grasslands SSSI/SAC	0.02	1.0	5.0	0.182	18.20	0.95	18.91
43	316248	374926	Halkyn Common and Holywell Grasslands SSSI/SAC	0.02	1.0	5.0	0.112	11.23	0.58	11.67
44	316471	375425	Halkyn Common and Holywell Grasslands SSSI/SAC	0.02	1.0	5.0	0.112	11.19	0.58	11.62
45	316645	375047	Halkyn Common and Holywell Grasslands SSSI/SAC	0.02	1.0	5.0	0.075	7.45	0.39	7.74
46	316899	375274	Halkyn Common and Holywell Grasslands SSSI/SAC	0.02	1.0	5.0	0.061	6.06	0.31	6.29
47	317326	375417	Halkyn Common and Holywell Grasslands SSSI/SAC	0.02	1.0	5.0	0.035	3.49	0.18	3.63
48	317069	374828	Halkyn Common and Holywell Grasslands SSSI/SAC	0.02	1.0	5.0	0.041	4.07	0.21	4.23
49	317523	375017	Halkyn Common and Holywell Grasslands SSSI/SAC	0.02	1.0	5.0	0.028	2.80	0.15	2.91
50	317443	374366	Halkyn Common and Holywell Grasslands SSSI/SAC	0.02	1.0	5.0	0.024	2.38	0.12	2.48
51	317583	373742	Halkyn Common and Holywell Grasslands SSSI/SAC	0.02	1.0	5.0	0.014	1.42	0.07	1.48
52	318037	374370	Halkyn Common and Holywell Grasslands SSSI/SAC	0.02	1.0	5.0	0.015	1.53	0.08	1.59
53	318185	373689	Halkyn Common and Holywell Grasslands SSSI/SAC	0.02	1.0	5.0	0.010	1.01	0.05	1.05
54	318743	373921	Halkyn Common and Holywell Grasslands SSSI/SAC	0.02	1.0	5.0	0.009	0.85	0.04	0.89
55	319021	372808	Halkyn Common and Holywell Grasslands SSSI/SAC	0.02	1.0	5.0	0.005	0.55	0.03	0.57
56	318563	371990	Halkyn Common and Holywell Grasslands SSSI/SAC	0.02	1.0	5.0	0.005	0.47	0.02	0.48
57	318188	371129	Halkyn Common and Holywell Grasslands SSSI/SAC	0.02	1.0	5.0	0.004	0.43	0.02	0.44

Receptor number	X(m)	Y(m)	Name	Site Parameters			Maximum annual ammonia concentration		Maximum annual nitrogen deposition rate	
				Deposition Velocity	Critical Level ($\mu\text{g}/\text{m}^3$)	Critical Load (kg/ha)	Process Contribution ($\mu\text{g}/\text{m}^3$)	%age of Critical Level	Process Contribution (kg/ha)	%age of Critical Load
58	319618	371462	Halkyn Common and Holywell Grasslands SSSI/SAC	0.02	1.0	5.0	0.003	0.32	0.02	0.33
59	318674	369852	Halkyn Common and Holywell Grasslands SSSI/SAC	0.02	1.0	5.0	0.003	0.29	0.02	0.30
60	321214	370116	Halkyn Common and Holywell Grasslands SSSI/SAC	0.02	1.0	5.0	0.002	0.19	0.01	0.19
61	319451	369172	Halkyn Common and Holywell Grasslands SSSI/SAC	0.02	1.0	5.0	0.002	0.21	0.01	0.21
62	321116	369131	Halkyn Common and Holywell Grasslands SSSI/SAC	0.02	1.0	5.0	0.001	0.14	0.01	0.15
63	321380	368326	Halkyn Common and Holywell Grasslands SSSI/SAC	0.02	1.0	5.0	0.001	0.12	0.01	0.13
64	318604	374869	Halkyn Common and Holywell Grasslands SSSI/SAC	0.02	1.0	5.0	0.012	1.22	0.06	1.27
65	319599	374072	Herward Smithy SSSI/SAC	0.02	1.0	6.0	0.007	0.69	0.04	0.60
66	317907	376426	Halkyn Common and Holywell Grasslands SSSI/SAC	0.02	1.0	5.0	0.022	2.22	0.12	2.30
67	319759	366365	Alyn Valley Woods and Alyn Gorge Caves SSSI/SAC	0.02	1.0	10.0	0.001	0.11	0.01	0.06
68	317750	379425	Dee Estuary SSSI/SAC/SPA/Ramsar site	0.02	1.0	5.0	0.008	0.77	0.04	0.80
69	316379	380379	Dee Estuary SSSI/SAC/SPA/Ramsar site	0.02	1.0	5.0	0.012	1.15	0.06	1.20
70	319259	378593	Dee Estuary SSSI/SAC/SPA/Ramsar site	0.02	1.0	5.0	0.006	0.62	0.03	0.65
71	321461	376130	Dee Estuary SSSI/SAC/SPA/Ramsar site	0.02	1.0	5.0	0.004	0.37	0.02	0.38
72	324115	373528	Dee Estuary SSSI/SAC/SPA/Ramsar site	0.02	1.0	5.0	0.002	0.21	0.01	0.22
73	314628	381610	Dee Estuary SSSI/SAC/SPA/Ramsar site	0.02	1.0	5.0	0.008	0.75	0.04	0.78
74	312564	384004	Dee Estuary SSSI/SAC/SPA/Ramsar site	0.02	1.0	5.0	0.004	0.41	0.02	0.43
75	318548	378766	Dee Estuary SSSI/SPARamsar site	0.02	1.0	5.0	0.007	0.69	0.04	0.71
76	322778	374775	Dee Estuary SSSI/SPARamsar site	0.02	1.0	5.0	0.003	0.29	0.02	0.30
77	315859	381264	Dee Estuary SSSI/SPARamsar site	0.02	1.0	5.0	0.009	0.92	0.05	0.95
78	313396	382593	Dee Estuary SSSI/SPARamsar site	0.02	1.0	5.0	0.005	0.54	0.03	0.56
79	310152	383610	Dee Estuary SSSI/SPARamsar site	0.02	1.0	5.0	0.003	0.27	0.01	0.29

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 ammonia concentration		Maximum annual nitrogen deposition rate	
				Deposition Velocity	Critical Level ($\mu\text{g}/\text{m}^3$)	Critical Load (kg/ha)	Process Contribution ($\mu\text{g}/\text{m}^3$)	%age of Critical Level	Process Contribution (kg/ha)	%age of Critical Load
1	314490	375497	AW	0.03	1.0	10.0	0.019	1.87	0.15	1.46
2	314390	375073	AW	0.03	1.0	10.0	0.015	1.50	0.12	1.17
3	314106	375410	AW	0.03	1.0	10.0	0.011	1.07	0.08	0.84
4	314740	374030	AW	0.03	1.0	10.0	0.009	0.90	0.07	0.70
5	314529	374175	AW	0.03	1.0	10.0	0.007	0.74	0.06	0.58
6	313875	374241	AW	0.03	1.0	10.0	0.005	0.48	0.04	0.38
7	313921	374809	AW	0.03	1.0	10.0	0.008	0.81	0.06	0.63
8	313736	376149	AW	0.03	1.0	10.0	0.011	1.10	0.09	0.86
9	313941	376480	AW	0.03	1.0	10.0	0.018	1.77	0.14	1.38
10	314568	376797	AW	0.03	1.0	10.0	0.028	2.82	0.22	2.20
11	314766	377252	AW	0.03	1.0	10.0	0.027	2.69	0.21	2.10
12	316404	376480	AW	0.03	1.0	10.0	0.051	5.07	0.40	3.95
13	316985	376348	AW	0.03	1.0	10.0	0.019	1.88	0.15	1.46
14	317739	376437	Halkyn Common and Holywell Grasslands SSSI	0.02	1.0	5.0	0.010	1.03	0.05	1.07
15	313745	373532	Coed Trefraith SSSI	0.03	3.0	15.0	0.003	0.11	0.03	0.17
16	313526	372780	Coed Trefraith SSSI	0.03	3.0	15.0	0.002	0.08	0.02	0.12
17	318895	373534	Halkyn Common and Holywell Grasslands SSSI	0.02	1.0	5.0	0.006	0.55	0.03	0.57
18	318822	373162	Halkyn Common and Holywell Grasslands SSSI	0.02	1.0	5.0	0.004	0.44	0.02	0.46
19	318686	372472	Halkyn Common and Holywell Grasslands SSSI	0.02	1.0	5.0	0.003	0.34	0.02	0.35
20	318141	372054	Parc Linden, Lixwm SSSI	0.02	3.0	5.0	0.003	0.10	0.02	0.31
21	317387	371101	Parc Bodlondeb and Gwenallt-parc, Lixwm SSSI	0.02	3.0	5.0	0.003	0.09	0.01	0.28
22	314182	371410	Ddol Uchaf SSSI	0.03	n/a	n/a	0.003	-	0.02	-
23	313010	372045	Caerwys Tufa SSSI	0.03	n/a	n/a	0.002	-	0.01	-
24	310531	376648	Hendre Bach SSSI	0.02	1.0	6.0	0.003	0.27	0.01	0.23
25	308749	375377	Mwyngloddfa Pennant SSSI	0.03	n/a	n/a	0.001	-	0.01	-
26	312037	380097	Glaswelltiroedd Trelogan SSSI	0.03	1.0	10.0	0.003	0.31	0.02	0.24
27	312738	380872	Glaswelltiroedd Trelogan SSSI	0.03	1.0	10.0	0.004	0.44	0.03	0.34
28	309041	380053	Moel Hiraddug a Bryn Gop SSSI	0.02	1.0	10.0	0.002	0.20	0.01	0.10

Receptor number	X(m)	Y(m)	Name	Site Parameters			Maximum annual ammonia concentration		Maximum annual nitrogen deposition rate	
				Deposition Velocity	Critical Level ($\mu\text{g}/\text{m}^3$)	Critical Load (kg/ha)	Process Contribution ($\mu\text{g}/\text{m}^3$)	%age of Critical Level	Process Contribution (kg/ha)	%age of Critical Load
29	306615	378270	Moel Hiraddug a Bryn Gop SSSI	0.02	1.0	10.0	0.001	0.10	0.01	0.05
30	306440	379293	Maes Hiraddug SSSI	0.02	3.0	10.0	0.001	0.04	0.01	0.06
31	306367	380214	Graig Fawr SSSI	0.02	1.0	5.0	0.001	0.11	0.01	0.12
32	306863	380872	Prestatyn Hillside SSSI	0.02	1.0	5.0	0.001	0.11	0.01	0.12
33	319708	370505	Halkyn Common and Holywell Grasslands SSSI	0.02	1.0	5.0	0.002	0.16	0.01	0.17
34	318765	367599	Tyddyn-y-barcut SSSI	0.02	3.0	10.0	0.001	0.04	0.01	0.06
35	318854	366542	Pen-y-Cefn Pasture SSSI	0.02	3.0	10.0	0.001	0.04	0.01	0.06
36	318841	366096	Cefn Meadow SSSI	0.02	3.0	6.0	0.001	0.04	0.01	0.09
37	323964	370722	Mynydd Y Fflint SSSI	0.02	1.0	6.0	0.001	0.14	0.01	0.12
38	315840	375546	Halkyn Common and Holywell Grasslands SSSI/SAC	0.02	1.0	5.0	0.136	13.57	0.70	14.09
39	315745	374820	Halkyn Common and Holywell Grasslands SSSI/SAC	0.02	1.0	5.0	0.059	5.85	0.30	6.08
40	315991	375349	Halkyn Common and Holywell Grasslands SSSI/SAC	0.02	1.0	5.0	0.094	9.39	0.49	9.76
41	315987	375198	Halkyn Common and Holywell Grasslands SSSI/SAC	0.02	1.0	5.0	0.090	9.00	0.47	9.35
42	315991	374967	Halkyn Common and Holywell Grasslands SSSI/SAC	0.02	1.0	5.0	0.066	6.60	0.34	6.86
43	316248	374926	Halkyn Common and Holywell Grasslands SSSI/SAC	0.02	1.0	5.0	0.041	4.09	0.21	4.25
44	316471	375425	Halkyn Common and Holywell Grasslands SSSI/SAC	0.02	1.0	5.0	0.035	3.53	0.18	3.67
45	316645	375047	Halkyn Common and Holywell Grasslands SSSI/SAC	0.02	1.0	5.0	0.028	2.78	0.14	2.89
46	316899	375274	Halkyn Common and Holywell Grasslands SSSI/SAC	0.02	1.0	5.0	0.022	2.21	0.11	2.29
47	317326	375417	Halkyn Common and Holywell Grasslands SSSI/SAC	0.02	1.0	5.0	0.014	1.45	0.08	1.50
48	317069	374828	Halkyn Common and Holywell Grasslands SSSI/SAC	0.02	1.0	5.0	0.017	1.70	0.09	1.76
49	317523	375017	Halkyn Common and Holywell Grasslands SSSI/SAC	0.02	1.0	5.0	0.013	1.29	0.07	1.34
50	317443	374366	Halkyn Common and Holywell Grasslands SSSI/SAC	0.02	1.0	5.0	0.013	1.26	0.07	1.31
51	317583	373742	Halkyn Common and Holywell Grasslands SSSI/SAC	0.02	1.0	5.0	0.008	0.77	0.04	0.80
52	318037	374370	Halkyn Common and Holywell Grasslands SSSI/SAC	0.02	1.0	5.0	0.010	0.96	0.05	0.99
53	318185	373689	Halkyn Common and Holywell Grasslands SSSI/SAC	0.02	1.0	5.0	0.007	0.67	0.03	0.70
54	318743	373921	Halkyn Common and Holywell Grasslands SSSI/SAC	0.02	1.0	5.0	0.007	0.67	0.03	0.70
55	319021	372808	Halkyn Common and Holywell Grasslands SSSI/SAC	0.02	1.0	5.0	0.004	0.37	0.02	0.38
56	318563	371990	Halkyn Common and Holywell Grasslands SSSI/SAC	0.02	1.0	5.0	0.003	0.29	0.02	0.30
57	318188	371129	Halkyn Common and Holywell Grasslands SSSI/SAC	0.02	1.0	5.0	0.002	0.22	0.01	0.23

Receptor number	X(m)	Y(m)	Name	Site Parameters			Maximum annual ammonia concentration		Maximum annual nitrogen deposition rate	
				Deposition Velocity	Critical Level ($\mu\text{g}/\text{m}^3$)	Critical Load (kg/ha)	Process Contribution ($\mu\text{g}/\text{m}^3$)	%age of Critical Level	Process Contribution (kg/ha)	%age of Critical Load
58	319618	371462	Halkyn Common and Holywell Grasslands SSSI/SAC	0.02	1.0	5.0	0.002	0.21	0.01	0.22
59	318674	369852	Halkyn Common and Holywell Grasslands SSSI/SAC	0.02	1.0	5.0	0.002	0.16	0.01	0.16
60	321214	370116	Halkyn Common and Holywell Grasslands SSSI/SAC	0.02	1.0	5.0	0.001	0.14	0.01	0.15
61	319451	369172	Halkyn Common and Holywell Grasslands SSSI/SAC	0.02	1.0	5.0	0.001	0.14	0.01	0.14
62	321116	369131	Halkyn Common and Holywell Grasslands SSSI/SAC	0.02	1.0	5.0	0.001	0.11	0.01	0.11
63	321380	368326	Halkyn Common and Holywell Grasslands SSSI/SAC	0.02	1.0	5.0	0.001	0.09	0.00	0.09
64	318604	374869	Halkyn Common and Holywell Grasslands SSSI/SAC	0.02	1.0	5.0	0.008	0.77	0.04	0.80
65	319599	374072	Herward Smithy SSSI/SAC	0.02	1.0	6.0	0.006	0.56	0.03	0.49
66	317907	376426	Halkyn Common and Holywell Grasslands SSSI/SAC	0.02	1.0	5.0	0.009	0.95	0.05	0.98
67	319759	366365	Alyn Valley Woods and Alyn Gorge Caves SSSI/SAC	0.02	1.0	10.0	0.001	0.10	0.01	0.05
68	317750	379425	Dee Estuary SSSI/SAC/SPA/Ramsar site	0.02	1.0	5.0	0.007	0.73	0.04	0.76
69	316379	380379	Dee Estuary SSSI/SAC/SPA/Ramsar site	0.02	1.0	5.0	0.007	0.74	0.04	0.77
70	319259	378593	Dee Estuary SSSI/SAC/SPA/Ramsar site	0.02	1.0	5.0	0.005	0.52	0.03	0.54
71	321461	376130	Dee Estuary SSSI/SAC/SPA/Ramsar site	0.02	1.0	5.0	0.003	0.28	0.01	0.29
72	324115	373528	Dee Estuary SSSI/SAC/SPA/Ramsar site	0.02	1.0	5.0	0.001	0.15	0.01	0.16
73	314628	381610	Dee Estuary SSSI/SAC/SPA/Ramsar site	0.02	1.0	5.0	0.007	0.67	0.03	0.70
74	312564	384004	Dee Estuary SSSI/SAC/SPA/Ramsar site	0.02	1.0	5.0	0.003	0.35	0.02	0.36
75	318548	378766	Dee Estuary SSSI/SPARamsar site	0.02	1.0	5.0	0.006	0.63	0.03	0.66
76	322778	374775	Dee Estuary SSSI/SPARamsar site	0.02	1.0	5.0	0.002	0.21	0.01	0.22
77	315859	381264	Dee Estuary SSSI/SPARamsar site	0.02	1.0	5.0	0.007	0.67	0.03	0.69
78	313396	382593	Dee Estuary SSSI/SPARamsar site	0.02	1.0	5.0	0.005	0.46	0.02	0.48
79	310152	383610	Dee Estuary SSSI/SPARamsar site	0.02	1.0	5.0	0.002	0.20	0.01	0.21

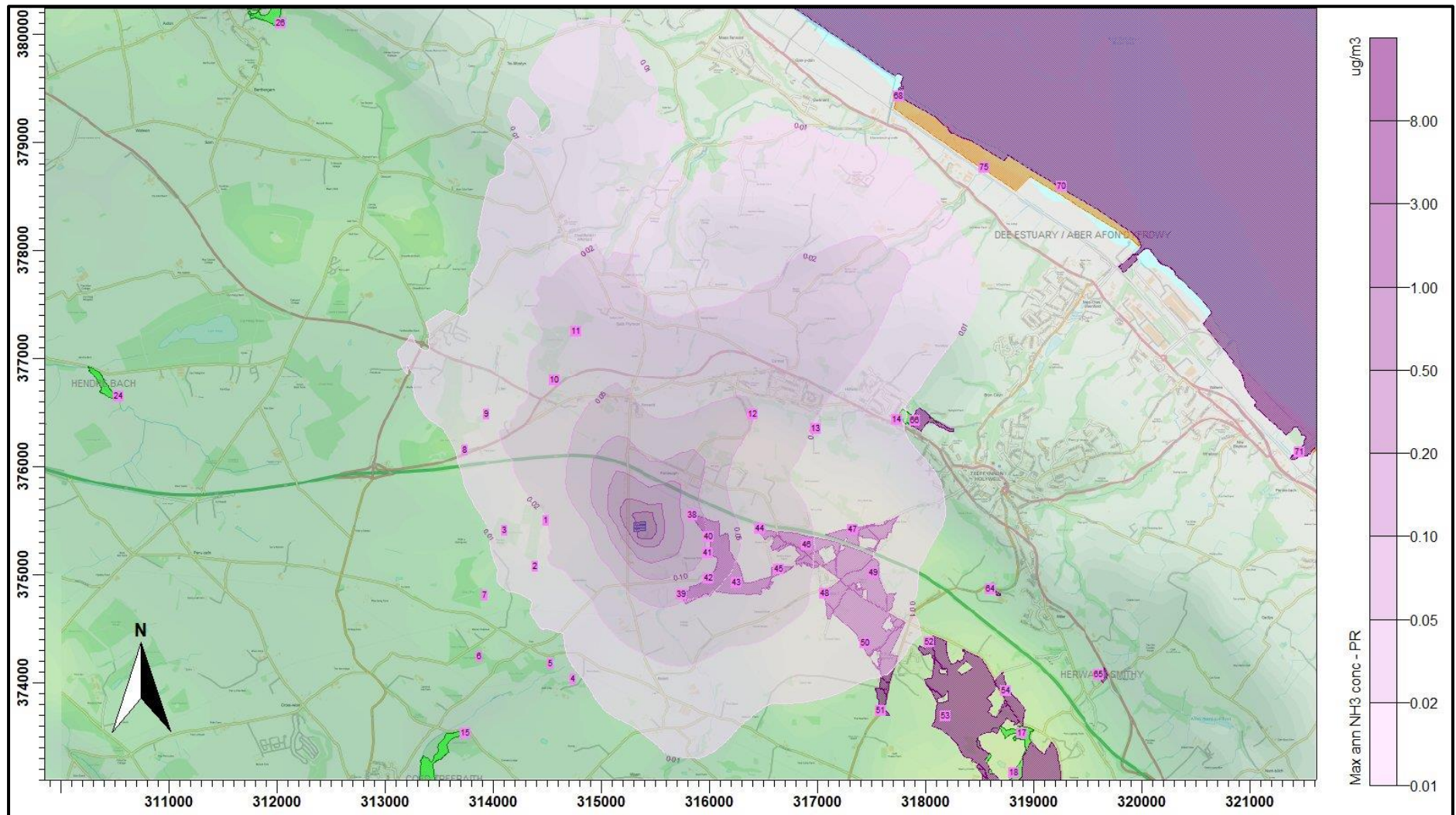
Table 7. Predicted changes in maximum annual mean ammonia concentrations and nitrogen deposition rates at the discrete receptors

Receptor number	X(m)	Y(m)	Name	Site Parameters			Maximum annual ammonia concentration		Maximum annual nitrogen deposition rate	
				Deposition Velocity	Critical Level ($\mu\text{g}/\text{m}^3$)	Critical Load (kg/ha)	Process Contribution ($\mu\text{g}/\text{m}^3$)	%age of Critical Level	Process Contribution (kg/ha)	%age of Critical Load
1	314490	375497	AW	0.03	1.0	10.0	-0.047	-4.69	-0.37	-3.65
2	314390	375073	AW	0.03	1.0	10.0	-0.029	-2.87	-0.22	-2.24
3	314106	375410	AW	0.03	1.0	10.0	-0.023	-2.25	-0.18	-1.76
4	314740	374030	AW	0.03	1.0	10.0	-0.014	-1.43	-0.11	-1.11
5	314529	374175	AW	0.03	1.0	10.0	-0.015	-1.51	-0.12	-1.18
6	313875	374241	AW	0.03	1.0	10.0	-0.006	-0.60	-0.05	-0.47
7	313921	374809	AW	0.03	1.0	10.0	-0.012	-1.18	-0.09	-0.92
8	313736	376149	AW	0.03	1.0	10.0	-0.015	-1.53	-0.12	-1.19
9	313941	376480	AW	0.03	1.0	10.0	-0.026	-2.61	-0.20	-2.03
10	314568	376797	AW	0.03	1.0	10.0	-0.033	-3.31	-0.26	-2.58
11	314766	377252	AW	0.03	1.0	10.0	-0.022	-2.17	-0.17	-1.69
12	316404	376480	AW	0.03	1.0	10.0	-0.059	-5.95	-0.46	-4.63
13	316985	376348	AW	0.03	1.0	10.0	-0.034	-3.43	-0.27	-2.67
14	317739	376437	Halkyn Common and Holywell Grasslands SSSI	0.02	1.0	5.0	-0.015	-1.49	-0.08	-1.55
15	313745	373532	Coed Trefraith SSSI	0.03	3.0	15.0	-0.004	-0.14	-0.03	-0.22
16	313526	372780	Coed Trefraith SSSI	0.03	3.0	15.0	-0.002	-0.08	-0.02	-0.12
17	318895	373534	Halkyn Common and Holywell Grasslands SSSI	0.02	1.0	5.0	-0.002	-0.17	-0.01	-0.18
18	318822	373162	Halkyn Common and Holywell Grasslands SSSI	0.02	1.0	5.0	-0.002	-0.20	-0.01	-0.20
19	318686	372472	Halkyn Common and Holywell Grasslands SSSI	0.02	1.0	5.0	-0.002	-0.21	-0.01	-0.21
20	318141	372054	Parc Linden, Lixwm SSSI	0.02	3.0	5.0	-0.002	-0.08	-0.01	-0.24
21	317387	371101	Parc Bodlondeb and Gwenallt-parc, Lixwm SSSI	0.02	3.0	5.0	-0.002	-0.07	-0.01	-0.23
22	314182	371410	Ddol Uchaf SSSI	0.03	n/a	n/a	0.000	-	0.00	-
23	313010	372045	Caerwys Tufa SSSI	0.03	n/a	n/a	-0.001	-	-0.01	-
24	310531	376648	Hendre Bach SSSI	0.02	1.0	6.0	-0.001	-0.11	-0.01	-0.10
25	308749	375377	Mwyngloddfa Pennant SSSI	0.03	n/a	n/a	0.000	-	0.00	-
26	312037	380097	Glaswelltiroedd Trelogan SSSI	0.03	1.0	10.0	-0.003	-0.25	-0.02	-0.20
27	312738	380872	Glaswelltiroedd Trelogan SSSI	0.03	1.0	10.0	-0.001	-0.14	-0.01	-0.11
28	309041	380053	Moel Hiraddug a Bryn Gop SSSI	0.02	1.0	10.0	-0.001	-0.09	0.00	-0.05

Receptor number	X(m)	Y(m)	Name	Site Parameters			Maximum annual ammonia concentration		Maximum annual nitrogen deposition rate	
				Deposition Velocity	Critical Level (µg/m³)	Critical Load (kg/ha)	Process Contribution (µg/m³)	%age of Critical Level	Process Contribution (kg/ha)	%age of Critical Load
29	306615	378270	Moel Hiraddug a Bryn Gop SSSI	0.02	1.0	10.0	0.000	-0.01	0.00	-0.01
30	306440	379293	Maes Hiraddug SSSI	0.02	3.0	10.0	0.000	0.00	0.00	0.00
31	306367	380214	Graig Fawr SSSI	0.02	1.0	5.0	0.000	-0.02	0.00	-0.02
32	306863	380872	Prestatyn Hillside SSSI	0.02	1.0	5.0	0.000	-0.03	0.00	-0.03
33	319708	370505	Halkyn Common and Holywell Grasslands SSSI	0.02	1.0	5.0	-0.001	-0.10	-0.01	-0.10
34	318765	367599	Tyddyn-y-barcut SSSI	0.02	3.0	10.0	0.000	-0.01	0.00	-0.02
35	318854	366542	Pen-y-Cefn Pasture SSSI	0.02	3.0	10.0	0.000	0.00	0.00	0.00
36	318841	366096	Cefn Meadow SSSI	0.02	3.0	6.0	0.000	0.00	0.00	0.00
37	323964	370722	Mynydd Y Fflint SSSI	0.02	1.0	6.0	0.000	-0.02	0.00	-0.02
38	315840	375546	Halkyn Common and Holywell Grasslands SSSI/SAC	0.02	1.0	5.0	-0.362	-36.17	-1.88	-37.58
39	315745	374820	Halkyn Common and Holywell Grasslands SSSI/SAC	0.02	1.0	5.0	-0.119	-11.88	-0.62	-12.34
40	315991	375349	Halkyn Common and Holywell Grasslands SSSI/SAC	0.02	1.0	5.0	-0.217	-21.67	-1.13	-22.51
41	315987	375198	Halkyn Common and Holywell Grasslands SSSI/SAC	0.02	1.0	5.0	-0.189	-18.85	-0.98	-19.58
42	315991	374967	Halkyn Common and Holywell Grasslands SSSI/SAC	0.02	1.0	5.0	-0.116	-11.60	-0.60	-12.05
43	316248	374926	Halkyn Common and Holywell Grasslands SSSI/SAC	0.02	1.0	5.0	-0.071	-7.14	-0.37	-7.42
44	316471	375425	Halkyn Common and Holywell Grasslands SSSI/SAC	0.02	1.0	5.0	-0.077	-7.66	-0.40	-7.95
45	316645	375047	Halkyn Common and Holywell Grasslands SSSI/SAC	0.02	1.0	5.0	-0.047	-4.67	-0.24	-4.85
46	316899	375274	Halkyn Common and Holywell Grasslands SSSI/SAC	0.02	1.0	5.0	-0.039	-3.85	-0.20	-4.00
47	317326	375417	Halkyn Common and Holywell Grasslands SSSI/SAC	0.02	1.0	5.0	-0.020	-2.05	-0.11	-2.13
48	317069	374828	Halkyn Common and Holywell Grasslands SSSI/SAC	0.02	1.0	5.0	-0.024	-2.38	-0.12	-2.47
49	317523	375017	Halkyn Common and Holywell Grasslands SSSI/SAC	0.02	1.0	5.0	-0.015	-1.51	-0.08	-1.57
50	317443	374366	Halkyn Common and Holywell Grasslands SSSI/SAC	0.02	1.0	5.0	-0.011	-1.12	-0.06	-1.16
51	317583	373742	Halkyn Common and Holywell Grasslands SSSI/SAC	0.02	1.0	5.0	-0.007	-0.65	-0.03	-0.68
52	318037	374370	Halkyn Common and Holywell Grasslands SSSI/SAC	0.02	1.0	5.0	-0.006	-0.57	-0.03	-0.60
53	318185	373689	Halkyn Common and Holywell Grasslands SSSI/SAC	0.02	1.0	5.0	-0.003	-0.34	-0.02	-0.36
54	318743	373921	Halkyn Common and Holywell Grasslands SSSI/SAC	0.02	1.0	5.0	-0.002	-0.18	-0.01	-0.19
55	319021	372808	Halkyn Common and Holywell Grasslands SSSI/SAC	0.02	1.0	5.0	-0.002	-0.18	-0.01	-0.18
56	318563	371990	Halkyn Common and Holywell Grasslands SSSI/SAC	0.02	1.0	5.0	-0.002	-0.18	-0.01	-0.18
57	318188	371129	Halkyn Common and Holywell Grasslands SSSI/SAC	0.02	1.0	5.0	-0.002	-0.21	-0.01	-0.22

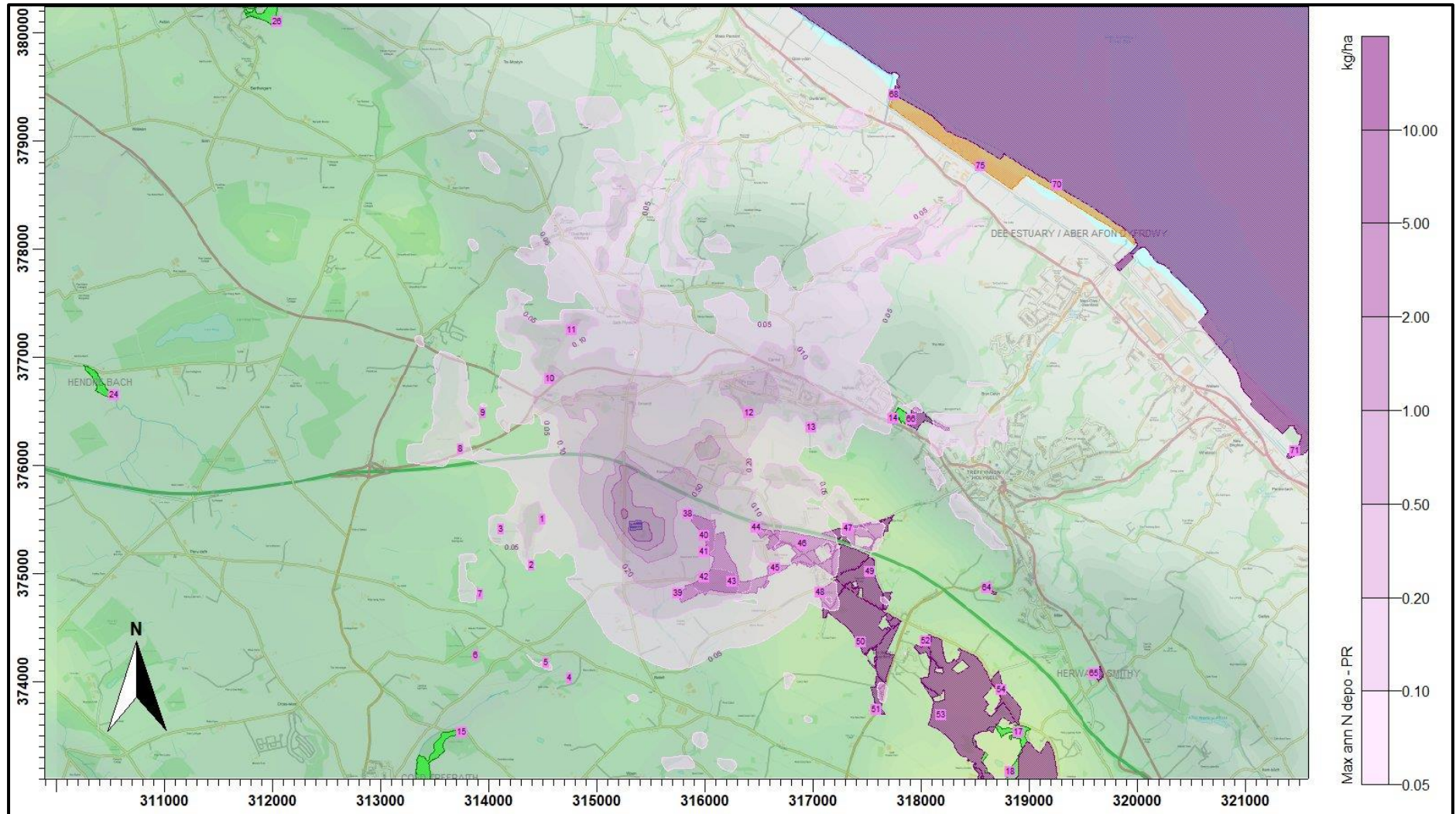
Receptor number	X(m)	Y(m)	Name	Site Parameters			Maximum annual ammonia concentration		Maximum annual nitrogen deposition rate	
				Deposition Velocity	Critical Level ($\mu\text{g}/\text{m}^3$)	Critical Load (kg/ha)	Process Contribution ($\mu\text{g}/\text{m}^3$)	%age of Critical Level	Process Contribution (kg/ha)	%age of Critical Load
58	319618	371462	Halkyn Common and Holywell Grasslands SSSI/SAC	0.02	1.0	5.0	-0.001	-0.11	-0.01	-0.11
59	318674	369852	Halkyn Common and Holywell Grasslands SSSI/SAC	0.02	1.0	5.0	-0.001	-0.14	-0.01	-0.14
60	321214	370116	Halkyn Common and Holywell Grasslands SSSI/SAC	0.02	1.0	5.0	0.000	-0.05	0.00	-0.05
61	319451	369172	Halkyn Common and Holywell Grasslands SSSI/SAC	0.02	1.0	5.0	-0.001	-0.07	0.00	-0.07
62	321116	369131	Halkyn Common and Holywell Grasslands SSSI/SAC	0.02	1.0	5.0	0.000	-0.04	0.00	-0.04
63	321380	368326	Halkyn Common and Holywell Grasslands SSSI/SAC	0.02	1.0	5.0	0.000	-0.03	0.00	-0.03
64	318604	374869	Halkyn Common and Holywell Grasslands SSSI/SAC	0.02	1.0	5.0	-0.004	-0.45	-0.02	-0.46
65	319599	374072	Herward Smithy SSSI/SAC	0.02	1.0	6.0	-0.001	-0.13	-0.01	-0.11
66	317907	376426	Halkyn Common and Holywell Grasslands SSSI/SAC	0.02	1.0	5.0	-0.013	-1.27	-0.07	-1.32
67	319759	366365	Alyn Valley Woods and Alyn Gorge Caves SSSI/SAC	0.02	1.0	10.0	0.000	-0.01	0.00	-0.01
68	317750	379425	Dee Estuary SSSI/SAC/SPA/Ramsar site	0.02	1.0	5.0	0.000	-0.04	0.00	-0.04
69	316379	380379	Dee Estuary SSSI/SAC/SPA/Ramsar site	0.02	1.0	5.0	-0.004	-0.41	-0.02	-0.43
70	319259	378593	Dee Estuary SSSI/SAC/SPA/Ramsar site	0.02	1.0	5.0	-0.001	-0.10	-0.01	-0.11
71	321461	376130	Dee Estuary SSSI/SAC/SPA/Ramsar site	0.02	1.0	5.0	-0.001	-0.09	0.00	-0.09
72	324115	373528	Dee Estuary SSSI/SAC/SPA/Ramsar site	0.02	1.0	5.0	-0.001	-0.06	0.00	-0.06
73	314628	381610	Dee Estuary SSSI/SAC/SPA/Ramsar site	0.02	1.0	5.0	-0.001	-0.08	0.00	-0.08
74	312564	384004	Dee Estuary SSSI/SAC/SPA/Ramsar site	0.02	1.0	5.0	-0.001	-0.06	0.00	-0.07
75	318548	378766	Dee Estuary SSSI/SPARamsar site	0.02	1.0	5.0	-0.001	-0.05	0.00	-0.06
76	322778	374775	Dee Estuary SSSI/SPARamsar site	0.02	1.0	5.0	-0.001	-0.08	0.00	-0.09
77	315859	381264	Dee Estuary SSSI/SPARamsar site	0.02	1.0	5.0	-0.003	-0.25	-0.01	-0.26
78	313396	382593	Dee Estuary SSSI/SPARamsar site	0.02	1.0	5.0	-0.001	-0.08	0.00	-0.08
79	310152	383610	Dee Estuary SSSI/SPARamsar site	0.02	1.0	5.0	-0.001	-0.07	0.00	-0.07

Figure 7a. Process contribution to maximum annual mean ammonia concentrations – Proposed Scenario



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Figure 7b. Process contribution to maximum annual mean nitrogen deposition rates – Proposed Scenario



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6. Summary and Conclusions

AS Modelling & Data Ltd. has been instructed by Ms. Misba Tasawar, of Amber Real Estate Investments (Agriculture) Ltd., to use computer modelling to assess the impact of ammonia emissions from the existing and proposed broiler chicken rearing houses at Racecourse Farm, Pantasaph, Flintshire. CH8 8PP.

Ammonia emission rates from the poultry houses have been assessed and quantified based upon the Natural Resources Wales 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.

The model predicts that, should the proposed redevelopment of Racecourse Farm proceed, then at all wildlife sites that have been identified for this modelling study, there would be a reduction in ammonia concentrations and nitrogen deposition rates. The reductions are predicted to be significant in some cases, particularly at closer parts of Halkyn Common and Holywell Grasslands SSSI/SAC.

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