A Report on the Modelling of the Dispersion and Deposition of Ammonia from the Proposed Pullet Rearing Houses at Gaufron Farm, Howey, Llandrindod Wells, Powys

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1. Introduction

AS Modelling & Data Ltd. has been instructed by Steve Raasch, on behalf of the applicant Sun Valley Foods Ltd. to use computer modelling to assess the impact of ammonia emissions from the proposed pullet rearing houses at Gaufron Farm, Howey, Llandrindod Wells, Powys. LD1 5RG.

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

This report is arranged in the following manner:

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

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

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

- Section 5 contains the results of the modelling.

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

2. Background Details

The site of the proposed poultry houses at Gaufron Farm is in a rural area. The surrounding land is used primarily as pasture for livestock farming although there are also some arable fields and some wooded areas. The site is at an altitude of around 202 m with the land falling towards the River Ithon Valley to the west and rising towards hills and mountains to the east.

It is proposed that two new chicken rearing houses be constructed at Gaufron Farm; these houses would replace the five existing poultry houses. The new houses would provide accommodation for up to 56,000 pullets, which would be reared from day old chicks up to the age of around 18 weeks old, prior to transfer to egg laying units elsewhere. The new houses would be ventilated by uncapped high speed ridge mounted fans, each with a short chimney.

There are several areas of Ancient Woodlands (AWs) within 2 km of Gaufron Farm, the closest of these are approximately 210 m to the north-west. There are also seven areas designated as Sites of Special Scientific Interest (SSSIs) within 2 km: Neuadd and Tylelo Mires SSSI, approximately 900 m to the south-south-west and approximately 940 m to the south; Trecoed/Castle Crab SSSI, approximately 1.7 km to the south-east; Coed-Mawr Quarry SSSI, approximately 1.95 km to the south-south-east; Rhos Penhiw SSSI, approximately 1.85 km to the north and parts of the River Wye SSSI which are approximately 1.0 km to the north-west and 1.1 km to the south-east. There are several other SSSIs within 5 km of the site. The River Wye SSSI is also designated as a Special Area of Conservation (SAC) and there are several other parts and tributaries of the River Wye SAC within 10 km of the farm and a small part of the Ellenydd Mallaen SAC and Special Protection Area (SPA) is just within 10 km of the farm.

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

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

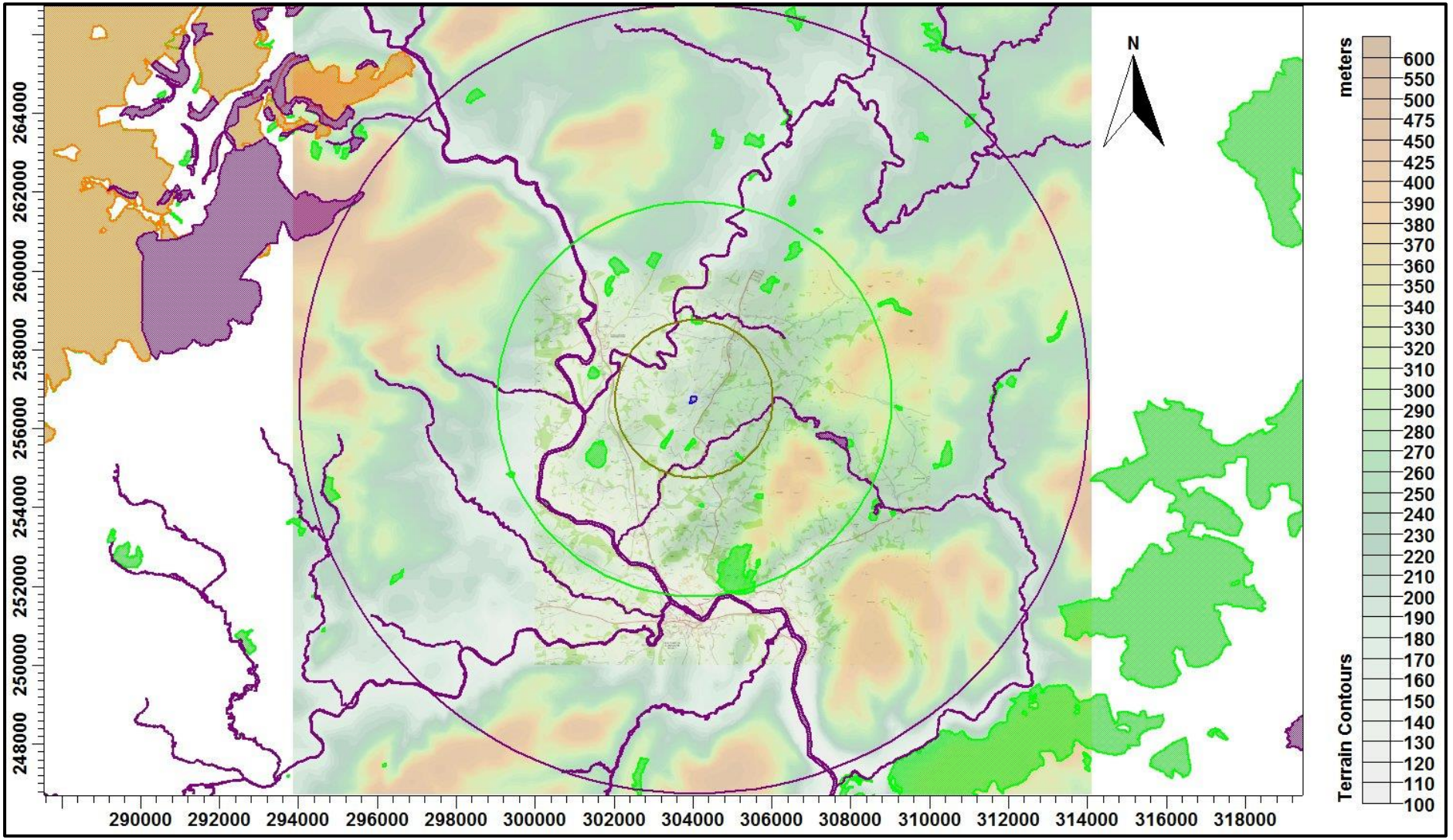
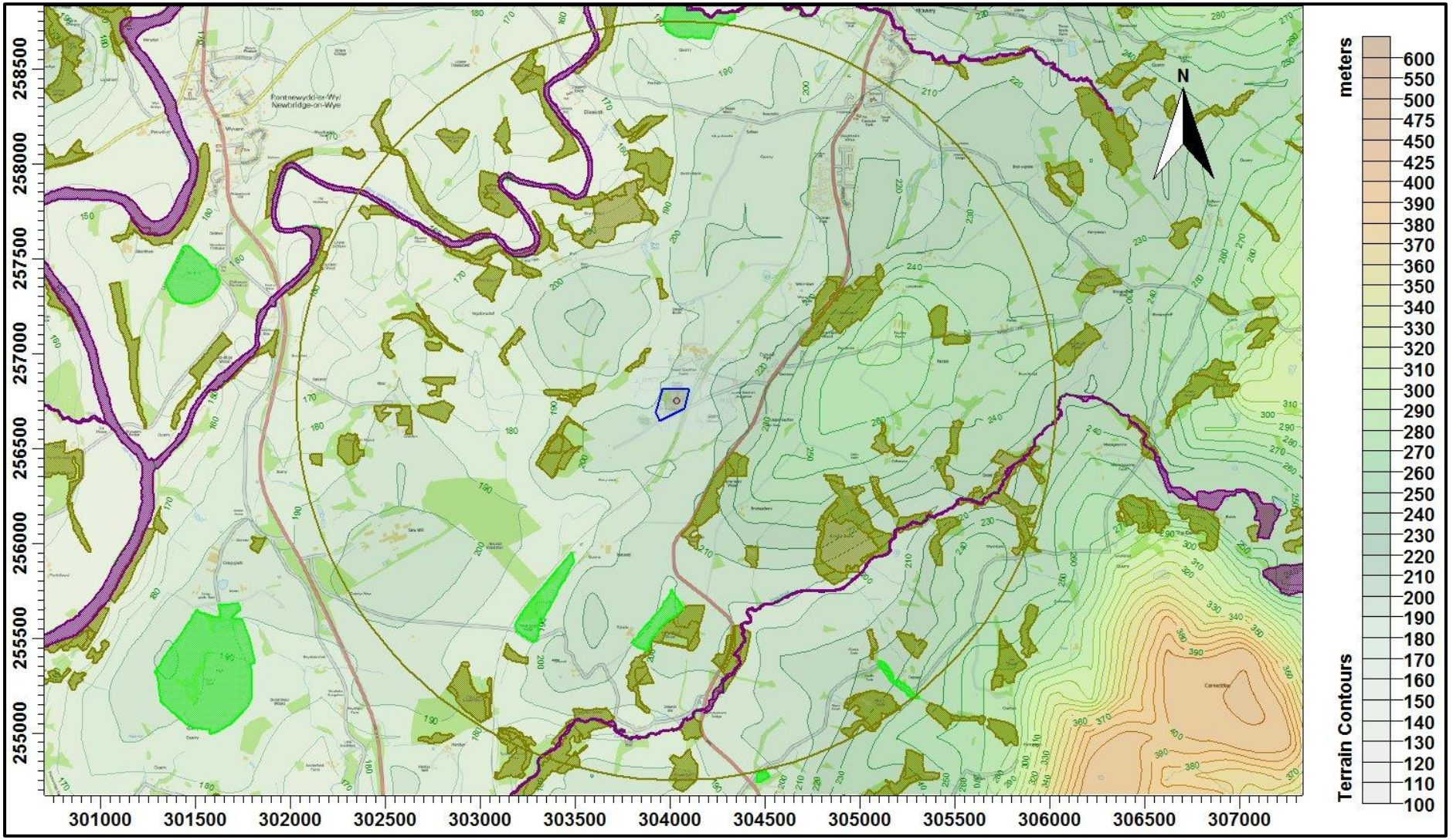


Figure 1b. The area surrounding Gaufron Farm – a closer view with AWs



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 (µg-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 background ammonia concentration (annual mean) in the area around Little Hales and the wildlife sites is 1.20 µg-NH_3/m^3. The background nitrogen deposition rate to woodland is 24.64 kg-N/ha/y and to short vegetation is 16.36 kg-N/ha/y. The background acid deposition rate to woodland is 1.95 keq/ha/y and to short vegetation is 1.34 keq/ha/y. The source of these background figures is the Air Pollution Information System (APIS, February 2017).

3.3 Critical Levels & Critical Loads

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

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

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

For ammonia concentration in air, the Critical Level for higher plants is 3.0 µg-NH_3/m^3 as an annual mean. For sites where there are sensitive lichens and bryophytes present, or where lichens and bryophytes are an integral part of the ecosystem, the Critical Level is 1.0 µg-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. N.B. Where the Critical Level of 1.0 µg-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 the Critical Load for acid deposition.

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

Site	Critical Level (µg-NH_3/m^3)	Critical Load - Nitrogen Deposition (kg-N/ha/y)	Critical Load - Acid Deposition (keq/ha/y)
AWs	1.0 [1]	-	-
SSSIs	1.0 [1]	-	-
SACs & SPA	1.0 [1]	-	

1. A precautionary figure, used where details of the site are unavailable, or citations indicate that sensitive lichens and bryophytes may be present.

3.4 Guidance on the significance of ammonia emissions

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

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

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

Within the range between the lower and upper thresholds; 4% to 20% for SACs, SPAs and Ramsars; 20% to 50% for SSSIs and 100% to 100% for other non-statutory wildlife sites, whether or not the impact is deemed acceptable is at the discretion of the Environment Agency. In making their decision, the Environment Agency will consider whether other farming installations might act in combination with the farm and the sensitivities of the wildlife sites. N.B. In the case of LWSs and AWs, the Environment Agency do not usually consider other farms that may act in combination and therefore a PC of up to 100% of Critical Level or Critical Load is usually deemed acceptable for permitting purposes and therefore the upper and lower thresholds are the same (100%).

3.5 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 Environment Agency provided an Intensive farming guidance note which lists standard ammonia emission factors for a variety of livestock, including pullets (rearing). The emission factor for pullets (rearing) is 0.06 kg-NH_3/bird place/y; this figure is used to calculate the emissions from the proposed poultry houses.

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

Table 2. Details of poultry numbers and ammonia emission rates

Source	Animal numbers	Type or weight	Emission factor (kg-NH_3/place/y)	Emission rate (g-NH_3/s)
Proposed Housing	56,000	Pullet Chickens (rearing)	0.06	0.106472

4. The Atmospheric Dispersion Modelling System (ADMS) and Model Parameters

The Atmospheric Dispersion Modelling System (ADMS) ADMS 5 is a new generation Gaussian plume air dispersion model, which means that the atmospheric boundary layer properties are characterised by two parameters; the boundary layer depth and the Monin-Obukhov length rather than in terms of the single parameter Pasquill-Gifford class.

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

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

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

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

4.1 Meteorological data

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

The meteorological data used in this study is obtained from assimilation and short term forecast fields of the Numerical Weather Prediction (NWP) system known as the Global Forecast System (GFS). Traditional observational meteorological datasets from Sennybridge and Shobdon, which are the two closest recording stations have also been considered.

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

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

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

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

The wind rose for the raw GFS data at the site of the poultry unit is shown in Figure 2a.

Wind speeds are modified by the treatment of roughness lengths (see Section 4.7) and where terrain data is included in the modelling, wind speeds and directions will be modified. The terrain and roughness length modified wind rose is shown in Figure 2b. Note that elsewhere in the modelling domain modified wind roses may differ more markedly and that the resolution of the wind field in terrain runs is approximately 600 m.

Gaufron Farm is approximately central to the meteorological recording stations at Sennybridge and Shobdon. However, neither Sennybridge nor Shobdon has an aspect that in any way could be considered similar to Gaufron Farm. Therefore, it should be noted that the frequency of winds from a particular direction in the Sennybridge or Shobdon data may be either high or low in comparison to what might occur at Gaufron Farm, which means mean concentrations downwind may be either over or under predicted. In particular, note that Shobdon is a station that is located in a valley bottom and as such is likely to have a considerable greater frequency of light or calm winds than a hillside location such as Gaufron Farm. Therefore, it is the opinion of AS Modelling & Data Ltd. that the results obtained using the GFS data, particularly when modified by using FLOWSTAR, should be given considerably more weight when interpreting the results of the modelling and furthermore that results obtained using Sennybridge and Shobdon meteorological data are rather more likely to be subject to gross errors than are the GFS/FLOWSTAR results.

The wind roses for Sennybridge and Shobdon are provided in Figures 2c and 2d and should serve to demonstrate how different the wind regime from relatively close observing sites in complex terrain can be and how unlikely it is that a remote observational dataset could in any way be representative of the wind regime around Gaufron Farm.

Figure 2a. The wind rose. GFS derived data for 52.200 N, 3.405 W 2013 – 2016

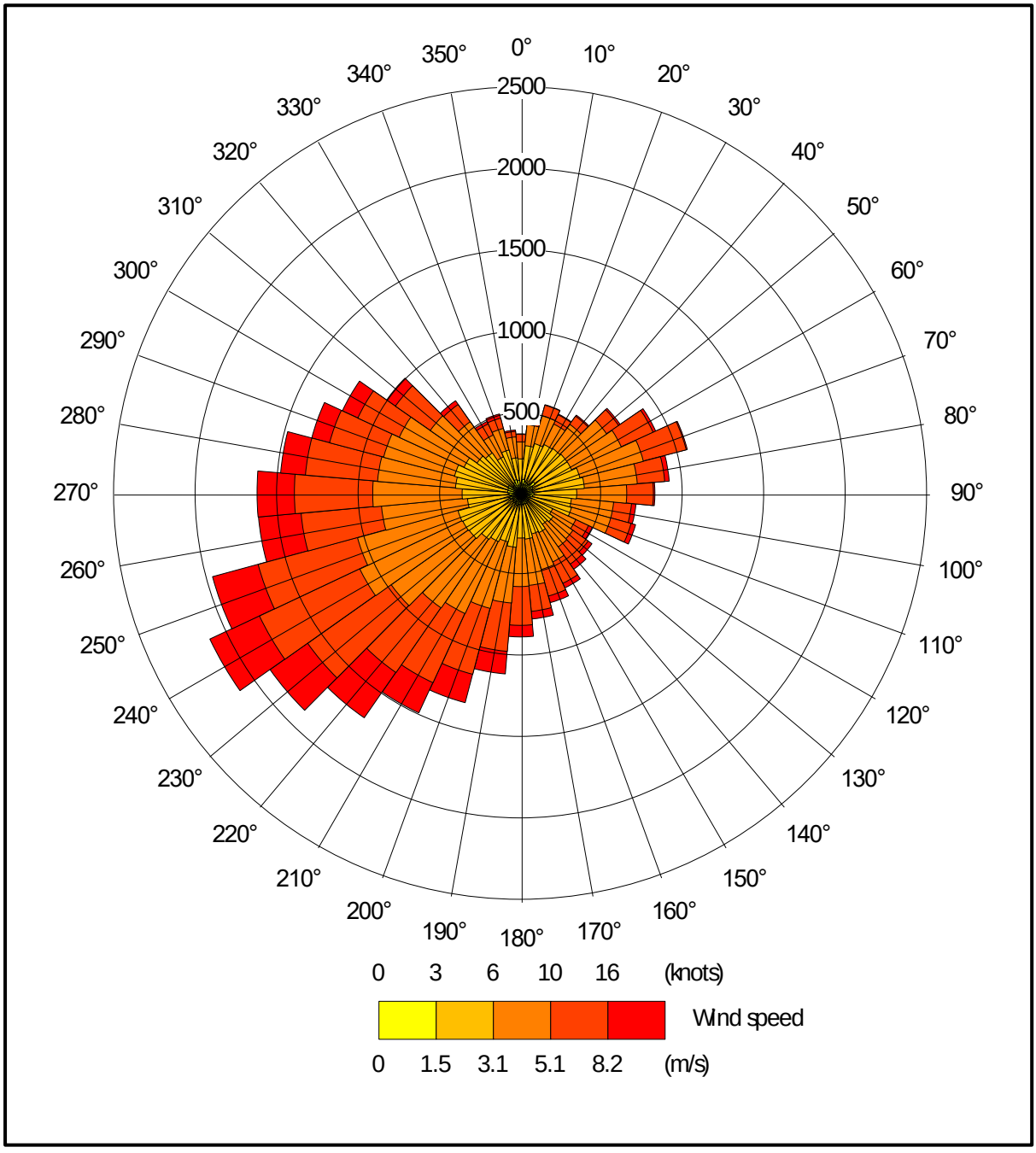


Figure 2b. The wind rose. FLOWSTAR modified GFS data for the site of the poultry unit NGR 304000, 256750)

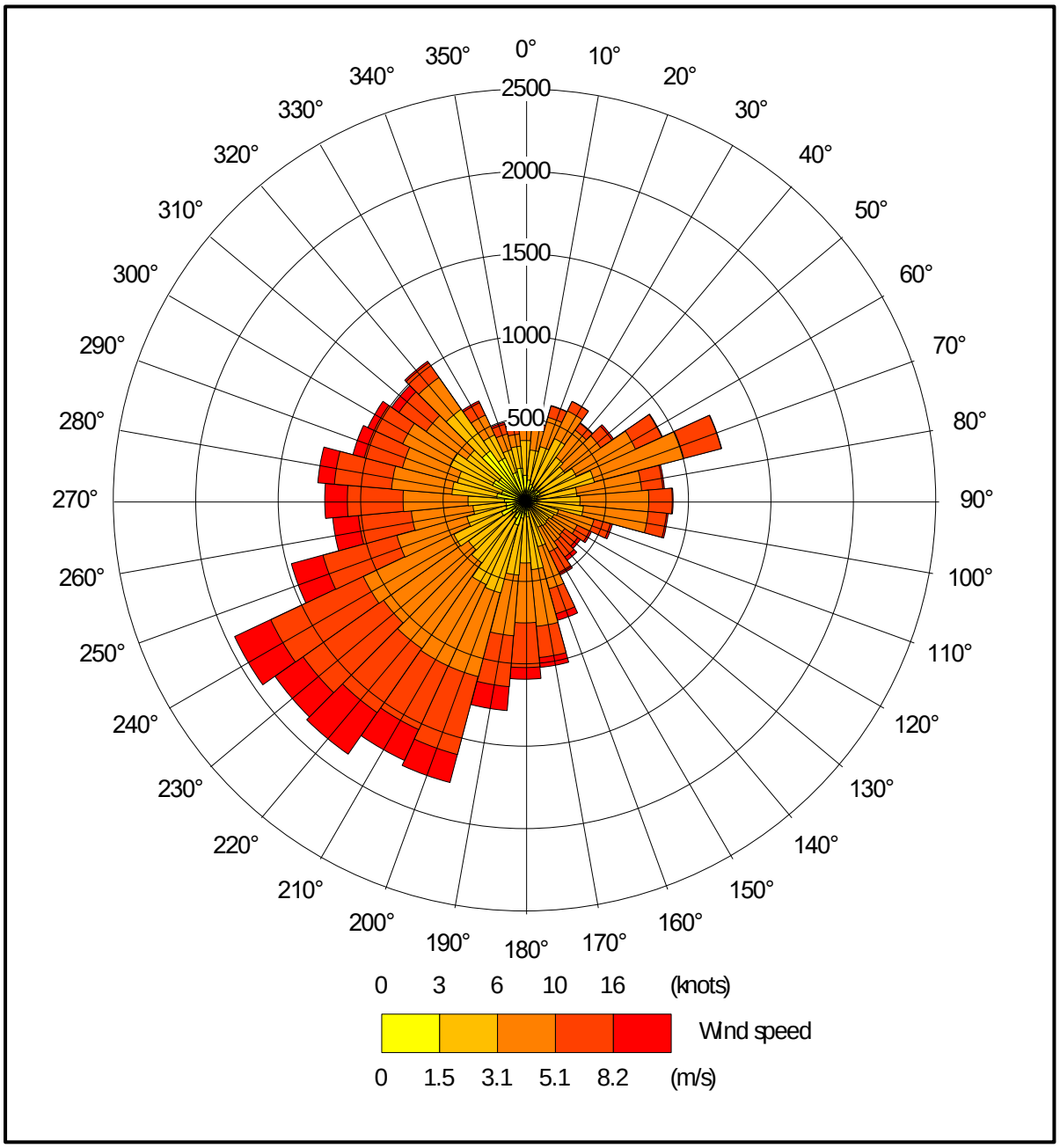


Figure 2c. The wind rose. Sennybridge data 2013 – 2016

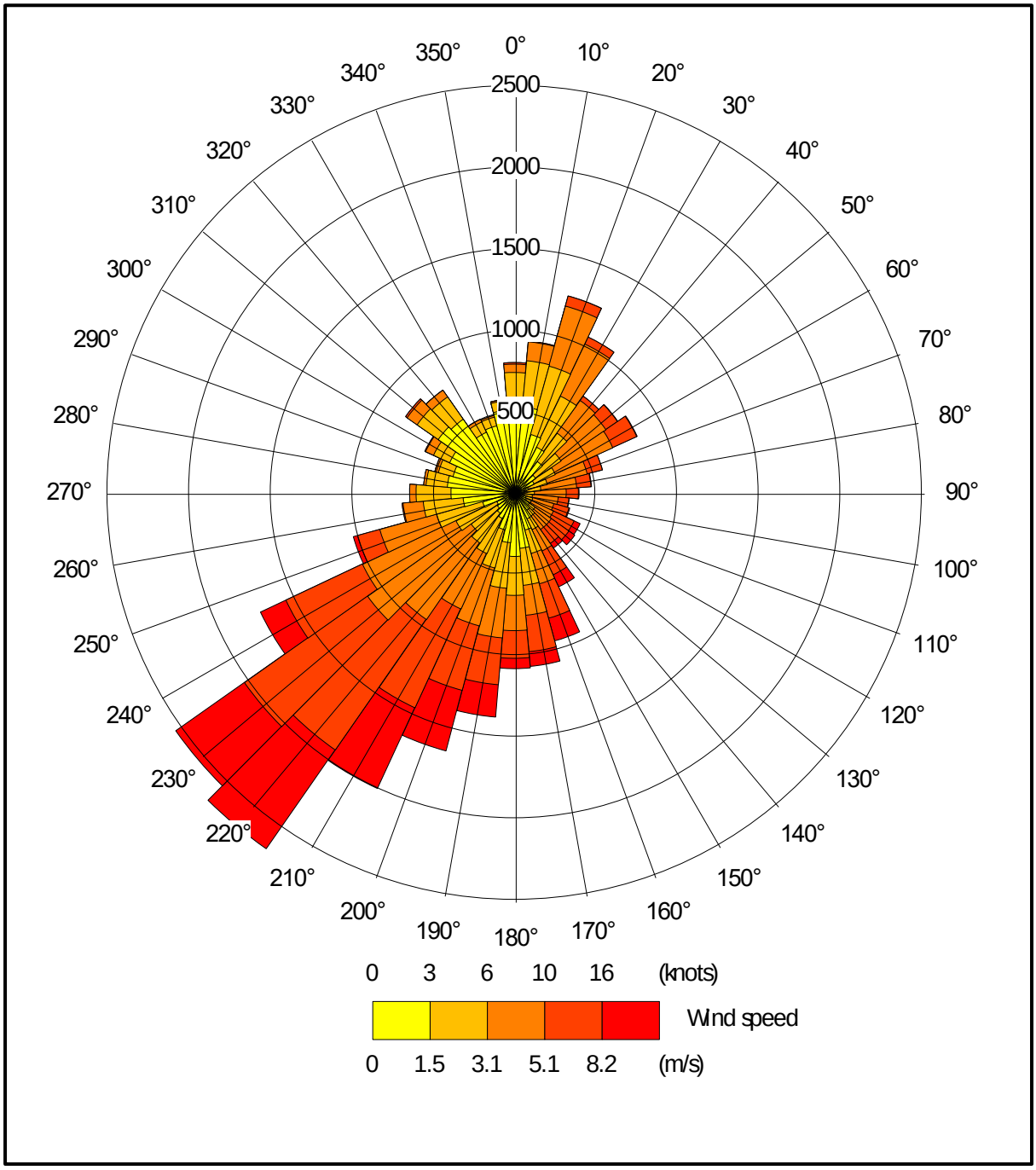
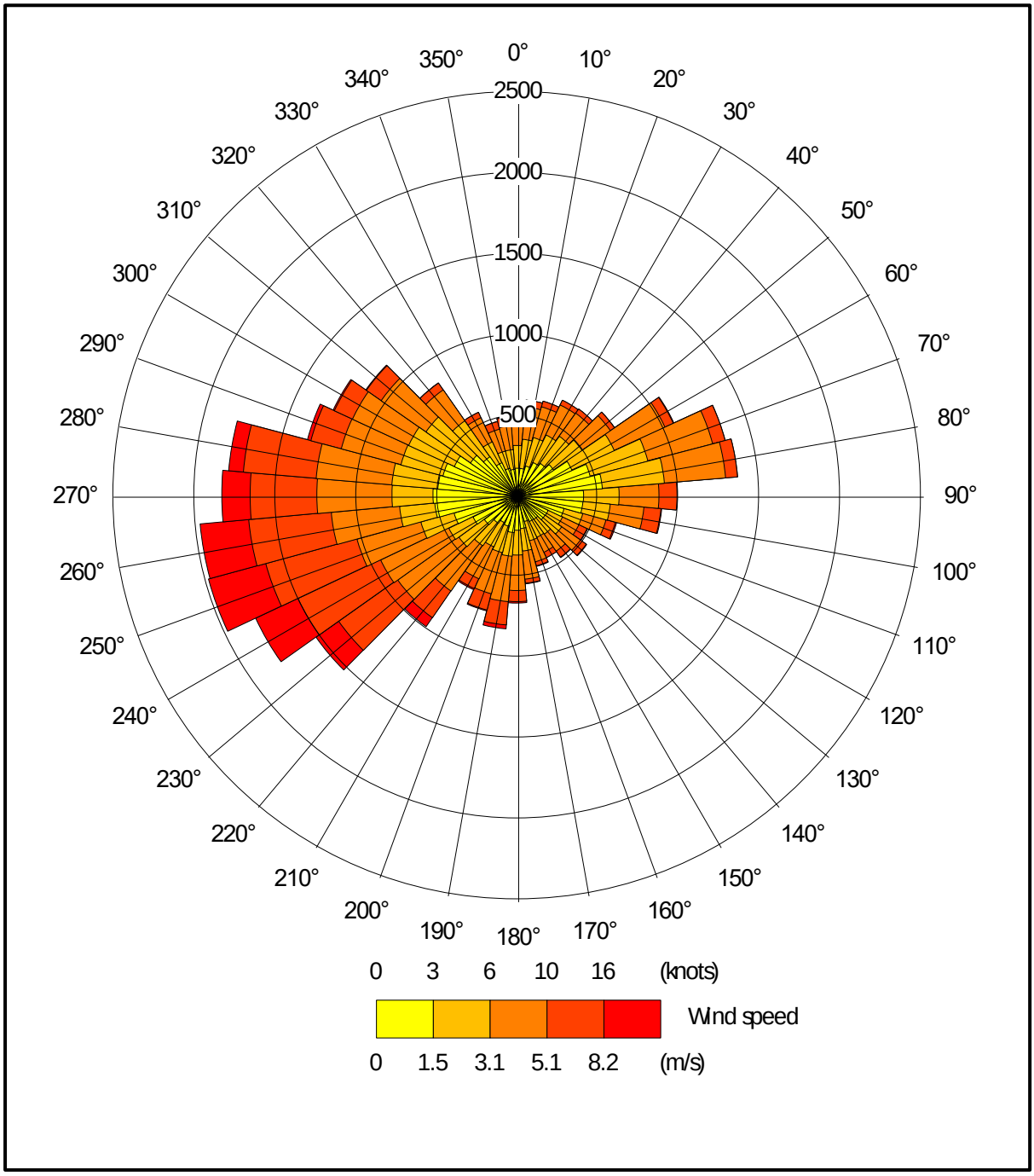


Figure 2d. The wind rose. Shobdon data 2013 – 2016



4.2 Emission sources

Emissions from the chimneys of the uncapped high speed ridge mounted fans on the proposed poultry houses are represented by three point sources per house within ADMS (PR1 a, b & c and PR2 a, b & c). Details of the point source parameters are shown in Table 3. The positions of the point sources may be seen in Figure 3.

Table 3. Point source parameters

Source ID	Height (m)	Diameter (m)	Efflux velocity (m/s)	Emission temperature (˚C)	Emission rate per source (g-NH_3/s)
PR1 a, b & c	6.5	0.8	11.0	21.0	0.017745
PR2 a, b & c	6.5	0.8	11.0	21.0	0.017745

4.3 Modelled buildings

The structure of the proposed poultry houses and other farm buildings may affect the odour plumes from the point sources; therefore, the buildings are modelled within ADMS. The positions of the modelled buildings may be seen in Figure 3 where they are marked by grey rectangles.

Figure 3. The positions of modelled buildings & sources

4.4 Discrete receptors

Ninty-nine discrete receptors have been defined: thirty-one at the AWs (1 to 31); twenty-one at the SSSIs (32 to 52) and forty-seven at the SACs (53 to 99). These receptors are defined at ground level within ADMS. The positions of the discrete receptors may be seen in Figures 4a and 4b, where they are marked by enumerated pink rectangles.

4.5 Cartesian grid

Not modelled.

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 x 20.0 km domain has been resampled at 100 m horizontal resolution for use within ADMS. N.B. The resolution of FLOWSTAR is 32 x 32 grid points; therefore, the effective resolution of the wind field is approximately 600 m.

4.7 Roughness Length

A fixed surface roughness length of 0.3 m has been applied over the entire modelling domain. As a precautionary measure, the GFS meteorological data is assumed to have a roughness length of 0.275 m. The effect of the difference in roughness length is precautionary as it increases the frequency of low wind speeds and the stability and therefore increases predicted ground level concentrations.

4.8 Deposition

The method used to model deposition of ammonia and consequent plume depletion is based on a document titled “Guidance on modelling the concentration and deposition of ammonia emitted from intensive farming” from the Environment Agency’s Air Quality Modelling and Assessment Unit, 22 November 2010. In this case, it proves unnecessary to model deposition of ammonia explicitly and where deposition figures are quoted, these are obtained by multiplying the predicted ammonia concentration by an appropriate deposition velocity and a factor of 259.7 to convert units. Please note that, because deposition of ammonia and the consequent plume depletion are not accounted for, this is a precautionary approach. Therefore, predicted ammonia concentrations (and nitrogen and acid deposition rates) are always higher than if deposition were modelled explicitly, particularly where there is some distance between the source and a receptor.

Figure 4a. The discrete receptors – a broad scale view

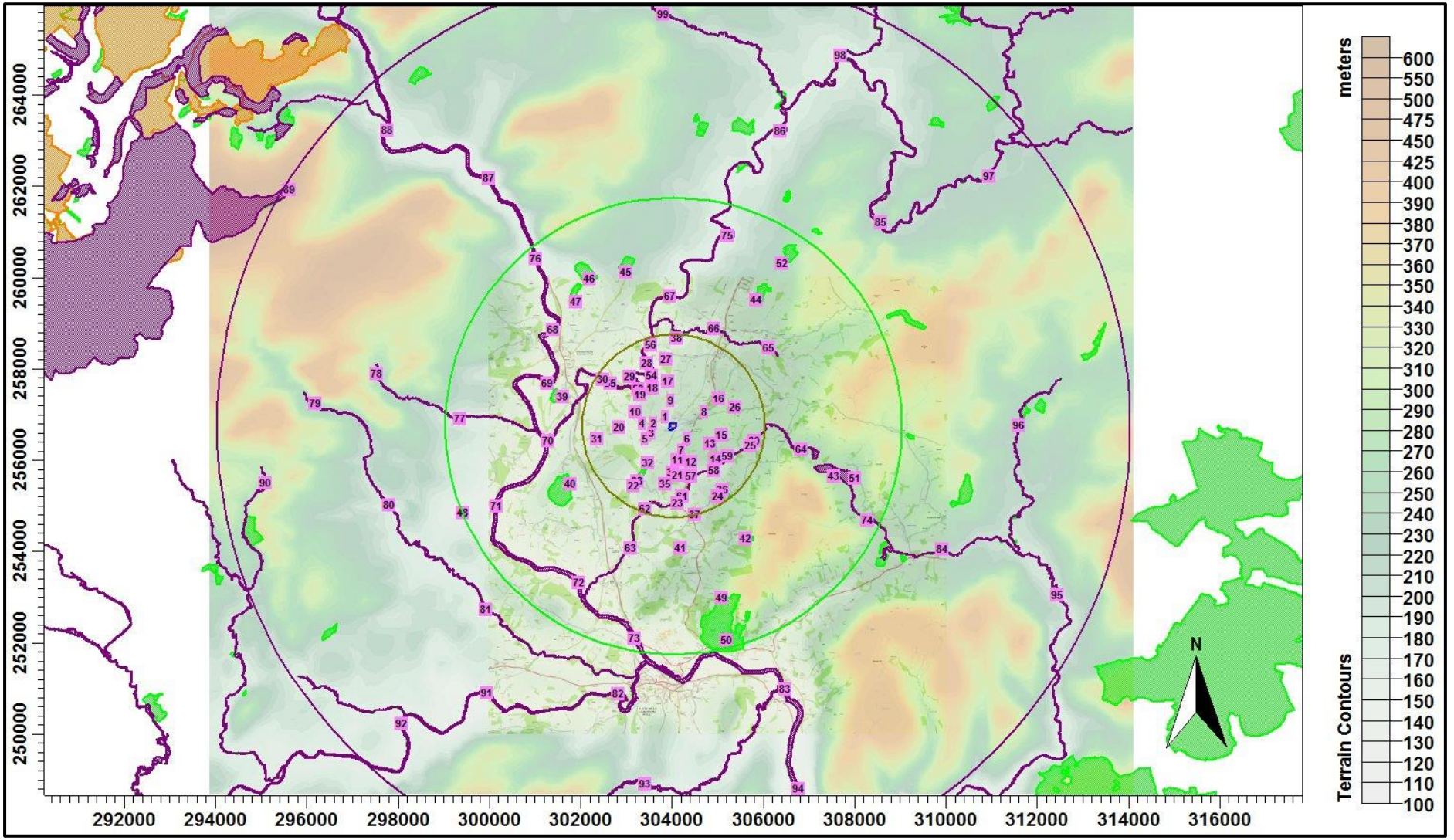
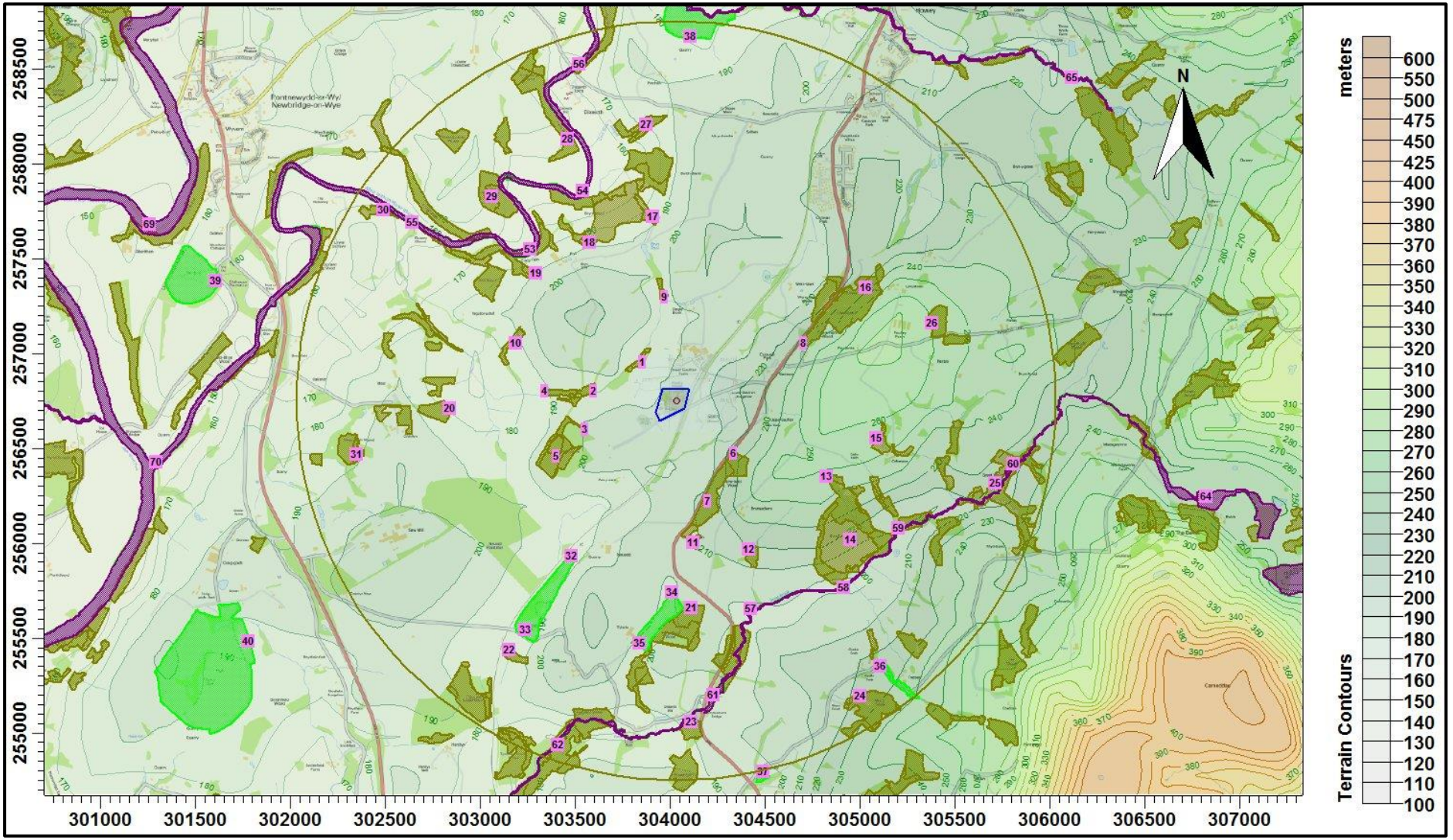


Figure 4b. The discrete receptors – a closer view



5. Details of the Model Runs and Results

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

- In basic mode without calms, or terrain – GFS data.
- With calms and without terrain – GFS data.
- Without calms and with terrain – GFS data.
- In basic mode without calms, or terrain – Sennybridge data.
- In basic mode without calms, or terrain – Shobdon 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 4. In the Table, predicted ammonia concentrations that are in excess of the Environment Agency's upper percentage threshold of the stricter Critical Level of 1.0 μg-NH_3/m^3 (20% for a SAC/SPA, 50% for a SSSI and 100% for an AW) are coloured red. Predicted ammonia concentrations that are in the range between the Environment Agency's upper threshold and lower threshold (4% to 20% for a SAC/SPA, 20% to 50% for a SSSI and 50% [1] to 100% for an AW) are coloured blue. For convenience, cells referring to AWs are shaded olive, cells referring to the SSSIs are shaded green and cells referring to the SACs are shaded purple.

1. The pre-February 2016 value is used.

Table 4. Predicted maximum annual mean ammonia concentration rate at the discrete receptors

Receptor number	X(m)	Y(m)	Name	Maximum annual mean ammonia concentration (µg/m³)				
				GFS No Calms No terrain	GFS Calms No Terrain	GFS No Calms Terrain	Sennybridge No Calms No Terrain	Shobdon No Calms No Terrain
1	303855	256954	Un-named AW	0.259	0.256	0.259	0.180	0.234
2	303594	256802	Un-named AW	0.158	0.157	0.158	0.089	0.170
3	303551	256598	Neuadd Birches	0.164	0.162	0.164	0.108	0.228
4	303340	256800	Un-named AW	0.080	0.080	0.080	0.045	0.095
5	303397	256458	Neuadd Birches	0.095	0.094	0.095	0.077	0.139
6	304335	256471	Erw-Bant Woods	0.208	0.207	0.208	0.119	0.228
7	304199	256220	Erw-Bant Woods	0.075	0.075	0.075	0.051	0.076
8	304702	257056	Cae-Wingol Wood	0.136	0.134	0.136	0.124	0.145
9	303968	257299	Un-named AW	0.125	0.123	0.125	0.157	0.094
10	303187	257054	Un-named AW	0.048	0.047	0.048	0.027	0.042
11	304121	256002	Brynsadwrn Wood	0.043	0.043	0.043	0.045	0.052
12	304412	255969	Un-named AW	0.049	0.049	0.049	0.031	0.047
13	304826	256352	Coed y Bedw	0.071	0.070	0.071	0.038	0.101
14	304951	256017	Coed y Bedw	0.047	0.047	0.047	0.031	0.071
15	305084	256555	Un-named AW	0.070	0.069	0.070	0.033	0.086
16	305029	257349	llwynbrain	0.066	0.066	0.066	0.071	0.066
17	303911	257722	Un-named AW	0.050	0.049	0.050	0.080	0.041
18	303578	257585	Un-named AW	0.039	0.039	0.039	0.040	0.033
19	303291	257423	Un-named AW	0.037	0.037	0.037	0.020	0.033
20	302838	256713	Un-named AW	0.041	0.040	0.041	0.022	0.056
21	304113	255659	Forty Acre Wood	0.028	0.027	0.028	0.034	0.033
22	303151	255437	Un-named AW	0.026	0.025	0.026	0.039	0.028
23	304113	255058	Un-named AW	0.017	0.017	0.017	0.026	0.019
24	305002	255197	Wern Coed	0.020	0.020	0.020	0.018	0.024
25	305711	256314	Great Wood	0.035	0.034	0.035	0.018	0.051
26	305381	257162	Un-named AW	0.047	0.046	0.047	0.037	0.060
27	303872	258207	Un-named AW	0.027	0.027	0.027	0.054	0.024
28	303458	258129	Bank Wood	0.024	0.024	0.024	0.031	0.019
29	303061	257829	Castle Plantation	0.020	0.020	0.020	0.013	0.019
30	302490	257757	Un-named AW	0.018	0.018	0.018	0.009	0.017
31	302346	256471	Rhos-goch Wood	0.030	0.029	0.030	0.016	0.047

Table 4. (continued)

Receptor number	X(m)	Y(m)	Name	Maximum annual mean ammonia concentration (µg/m³)				
				GFS No Calms No terrain	GFS Calms No Terrain	GFS No Calms Terrain	Sennybridge No Calms No Terrain	Shobdon No Calms No Terrain
32	303478	255933	Neuadd & Tylelo Mires	0.045	0.045	0.045	0.068	0.047
33	303238	255545	Neuadd & Tylelo Mires	0.029	0.028	0.029	0.043	0.031
34	304009	255739	Neuadd & Tylelo Mires	0.032	0.032	0.032	0.046	0.038
35	303841	255474	Neuadd & Tylelo Mires	0.028	0.027	0.028	0.047	0.030
36	305108	255353	Trecoed/Castle Crab	0.023	0.023	0.023	0.023	0.033
37	304490	254797	Coed-Mawr Quarry	0.015	0.015	0.015	0.016	0.015
38	304107	258668	Rhos Penhiw	0.021	0.021	0.021	0.043	0.021
39	301604	257383	Aberith & Bedw Turbaries	0.013	0.013	0.013	0.006	0.015
40	301777	255483	Cors y Llyn	0.015	0.015	0.015	0.014	0.029
41	304183	254067	Pen-Cerrig Stream Section	0.011	0.011	0.011	0.018	0.011
42	305611	254286	Newmead	0.011	0.011	0.011	0.013	0.016
43	307542	255653	Colwn Brook Marshes	0.013	0.013	0.013	0.009	0.025
44	305835	259513	Pentrosfa Mire	0.012	0.012	0.012	0.018	0.011
45	302991	260109	Gweunydd Dwfnant	0.008	0.008	0.008	0.017	0.008
46	302179	259974	Rhos Dwfnant	0.007	0.007	0.007	0.010	0.006
47	301894	259459	Aberith & Bedw Turbaries	0.006	0.006	0.006	0.006	0.007
48	299419	254847	Cae Comin Coch	0.008	0.008	0.008	0.005	0.017
49	305092	252983	Llanelwedd Rocks	0.008	0.008	0.008	0.010	0.008
50	305188	252059	Llanelwedd Rocks	0.006	0.006	0.006	0.009	0.006
51	308008	255612	Colwn Brook Marshes	0.011	0.011	0.011	0.009	0.022
52	306399	260313	Lake Wood	0.008	0.008	0.008	0.013	0.008

Table 4. (continued)

Receptor number	X(m)	Y(m)	Name	Maximum annual mean ammonia concentration ($\mu g/m^3$)				
				GFS No Calms No terrain	GFS Calms No Terrain	GFS No Calms Terrain	Sennybridge No Calms No Terrain	Shobdon No Calms No Terrain
53	303263	257548	River Wye	0.031	0.030	0.031	0.018	0.028
54	303542	257855	River Wye	0.031	0.031	0.031	0.037	0.025
55	302641	257691	River Wye	0.021	0.020	0.021	0.010	0.019
56	303522	258524	River Wye	0.018	0.018	0.018	0.033	0.015
57	304422	255655	River Wye	0.030	0.030	0.030	0.022	0.029
58	304917	255768	River Wye	0.037	0.037	0.037	0.030	0.051
59	305202	256078	River Wye	0.039	0.039	0.039	0.025	0.065
60	305810	256418	River Wye	0.034	0.033	0.034	0.019	0.049
61	304229	255198	River Wye	0.019	0.019	0.019	0.022	0.020
62	303408	254938	River Wye	0.019	0.019	0.019	0.039	0.020
63	303098	254073	River Wye	0.012	0.012	0.012	0.026	0.013
64	306825	256244	River Wye	0.019	0.019	0.019	0.012	0.032
65	306119	258453	River Wye	0.019	0.019	0.019	0.023	0.019
66	304916	258885	River Wye	0.019	0.019	0.019	0.030	0.018
67	303961	259591	River Wye	0.011	0.011	0.011	0.029	0.013
68	301399	258859	River Wye	0.008	0.008	0.008	0.005	0.008
69	301255	257682	River Wye	0.010	0.010	0.010	0.005	0.012
70	301294	256427	River Wye	0.017	0.016	0.017	0.008	0.026
71	300143	255001	River Wye	0.009	0.009	0.009	0.006	0.019
72	301961	253315	River Wye	0.009	0.009	0.009	0.015	0.010
73	303183	252094	River Wye	0.006	0.006	0.006	0.015	0.007
74	308287	254682	River Wye	0.008	0.008	0.008	0.008	0.019
75	305210	260908	River Wye	0.007	0.007	0.007	0.016	0.009
76	301011	260419	River Wye	0.004	0.004	0.004	0.004	0.005
77	299346	256908	River Wye	0.008	0.008	0.008	0.003	0.012

Table 4. (continued)

Receptor number	X(m)	Y(m)	Name	Maximum annual mean ammonia concentration ($\mu g/m^3$)				
				GFS No Calms No terrain	GFS Calms No Terrain	GFS No Calms Terrain	Sennybridge No Calms No Terrain	Shobdon No Calms No Terrain
78	297537	257885	River Wye	0.004	0.004	0.004	0.002	0.007
79	296179	257234	River Wye	0.004	0.004	0.004	0.002	0.007
80	297790	255026	River Wye	0.006	0.006	0.006	0.003	0.013
81	299925	252727	River Wye	0.005	0.005	0.005	0.007	0.009
82	302822	250889	River Wye	0.005	0.005	0.005	0.012	0.005
83	306463	250995	River Wye	0.004	0.004	0.004	0.007	0.005
84	309912	254040	River Wye	0.006	0.006	0.006	0.006	0.014
85	308571	261215	River Wye	0.005	0.005	0.005	0.008	0.007
86	306357	263196	River Wye	0.004	0.004	0.004	0.009	0.005
87	299990	262174	River Wye	0.003	0.003	0.003	0.004	0.003
88	297755	263217	River Wye	0.002	0.002	0.002	0.002	0.003
89	295626	261918	Ellenydd Mallaen	0.002	0.002	0.002	0.002	0.003
90	295093	255509	River Wye	0.004	0.004	0.004	0.002	0.008
91	299948	250910	River Wye	0.004	0.004	0.004	0.007	0.006
92	298074	250229	River Wye	0.003	0.003	0.003	0.005	0.005
93	303397	248909	River Wye	0.003	0.003	0.003	0.008	0.003
94	306765	248798	River Wye	0.003	0.003	0.003	0.005	0.003
95	312440	253043	River Wye	0.004	0.004	0.004	0.004	0.009
96	311586	256755	River Wye	0.005	0.005	0.005	0.006	0.012
97	310946	262217	River Wye	0.004	0.004	0.004	0.005	0.005
98	307682	264862	River Wye	0.003	0.003	0.003	0.006	0.004
99	303800	265758	River Wye	0.002	0.002	0.002	0.009	0.004

6. Summary and Conclusions

AS Modelling & Data Ltd. has been instructed by Steve Raasch, on behalf of the applicant Sun Valley Foods Ltd. to use computer modelling to assess the impact of ammonia emissions from the proposed pullet rearing houses at Gaufron Farm, Howey, Llandrindod Wells, Powys. LD1 5RG.

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

The modelling predicts that, at all the AWs, SSSIs and SAC/SPAs considered, the process contribution to maximum annual ammonia concentrations and nitrogen and acid deposition rates would be below the Environment Agency's lower threshold percentage of Critical Level or Critical Load for the designation of the sites (4% for a SAC, 20% for a SSSI and 100% for an AW).

7. References

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