# An Assessment using Dispersion Modelling of the Impact of Emissions from the Proposed Biomass Boilers at Sinkfall Farm, Rakesmore Lane, Barrow-in-Furness, Cumbria

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# 1. Introduction

AS Modelling & Data Ltd. has been instructed by Dave Baldwin of Recogen Ltd. on behalf of Mr Brian Armistead, to use computer modelling to assess the impact of emissions of nitrogen oxides, sulphur dioxide, particulate matter and carbon monoxide from the proposed biomass boiler at Sinkfall Farm, Rakesmore Lane, Barrow-in-Furness, Cumbria. LA14 4QE.

Emissions of nitrogen oxides ($NO_X$), sulphur dioxide ($SO_2$), particulate matter ($PM_{10}$) and carbon monoxide (CO) from the stacks serving the two proposed biomass boilers have been assessed and quantified based upon data supplied to AS Modelling & Data Ltd. by Recogen Ltd. The $NO_x$, $SO_2$, $PM_{10}$ and CO emission rates have then been used as the basis of inputs to an atmospheric dispersion model which calculates nitrogen oxides $NO_x$, $SO_2$, $PM_{10}$ and CO exposure levels in the surrounding area.

This report is arranged in the following manner:

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

- Section 3 provides some general information on $NO_x$, $SO_2$, $PM_{10}$ and CO and details of the method used to determine emission rates; relevant guidelines and legislation on exposure limits and where relevant, details of likely background levels of the pollutants.

- 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

Sinkfall Farm is in a rural area approximately 1.2 km to the west of Dalton-in-Furness in Cumbria. The surrounding land is used primarily for arable farming and pastoral livestock farming, although there are some isolated wooded areas. The site is at an altitude of around 65 m with the ground rising towards hill tops to the south and west and falling towards the valley of the Goldmire Brook to the east and towards the River Duddon Estuary to the north

Under the proposal, the existing biomass boiler at Sinkfall Farm which is housed in the existing waste transfer building would be upgraded to 999 kWh and the stack serving the boiler would be enlarged. In addition, a new 999 kWh boiler would be installed adjacent to the existing boiler; this boiler would be served by a new stack which would be tethered to the same support mast as the new stack serving the upgraded existing boiler

There are several potential human health receptors in the surrounding area. Excluding those at the farm, the closest residences are: those on Park Road, the closest of which are approximately 225 m to the east of the proposed biomass boiler stacks. A map of the surrounding area is provided in Figure 1a; in this figure, the position of the stacks is marked by a red crosshair symbol.

There are several areas of Ancient Woodland (AWs) and Local Wildlife Sites (LWSs) within 2 km of Sinkfall Farm. There are also two Sites of Special Scientific Interest (SSSIs) within 2 km; Elliscales Quarry SSSI to the north-east and the Dutton Estuary SSSI to the north-west. Elliscales Quarry SSSI is designated primarily for its geological features, but floral features are included in the citation. The Dutton Estuary SSSI is also designated as part of the Morecambe Bay Special Area of Conservation (SAC) and as a Special Protection Area (SPA) and Ramsar site. There is one other SSSI within 5 km of the site and there are other parts of the Morecambe Bay SAC/SPA/Ramsar site are within 10 km.

Maps of the surrounding area showing the positions of the wildlife sites are provided in Figures 1b and 1c; in these figures, the AWs and the LWSs are shaded in olive, the SSSIs are shaded in green, the SAC/SPA/Ramsar site is shaded in purple and the position of the stacks is marked by a red crosshair symbol.

*Figure 1a. The area surrounding Sinkfall Farm*

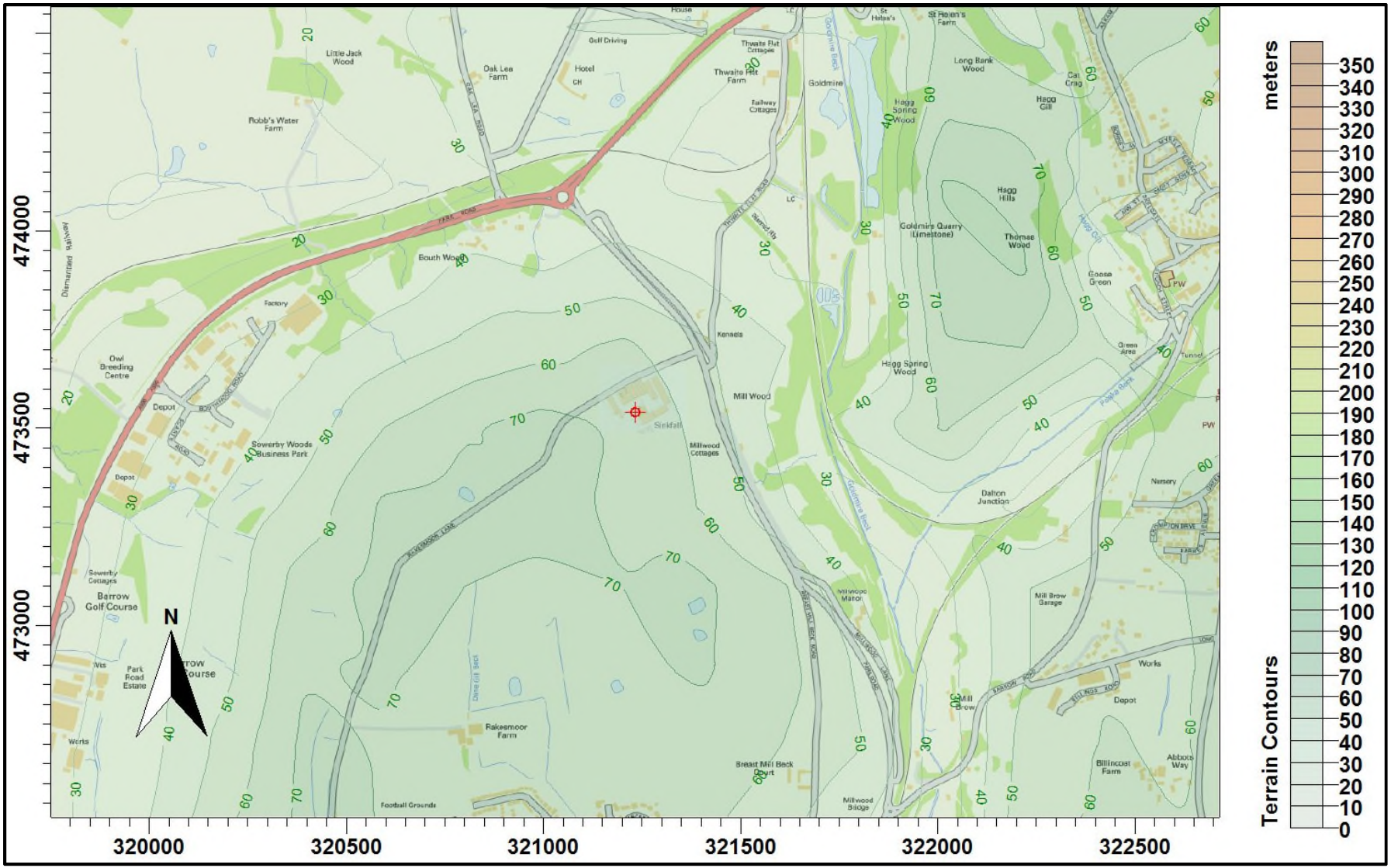


*Figure 1b. Wildlife sites in the area surrounding Sinkfall Farm – concentric circles radii 2 km (olive), 5 km (green) and 10 km (purple)*

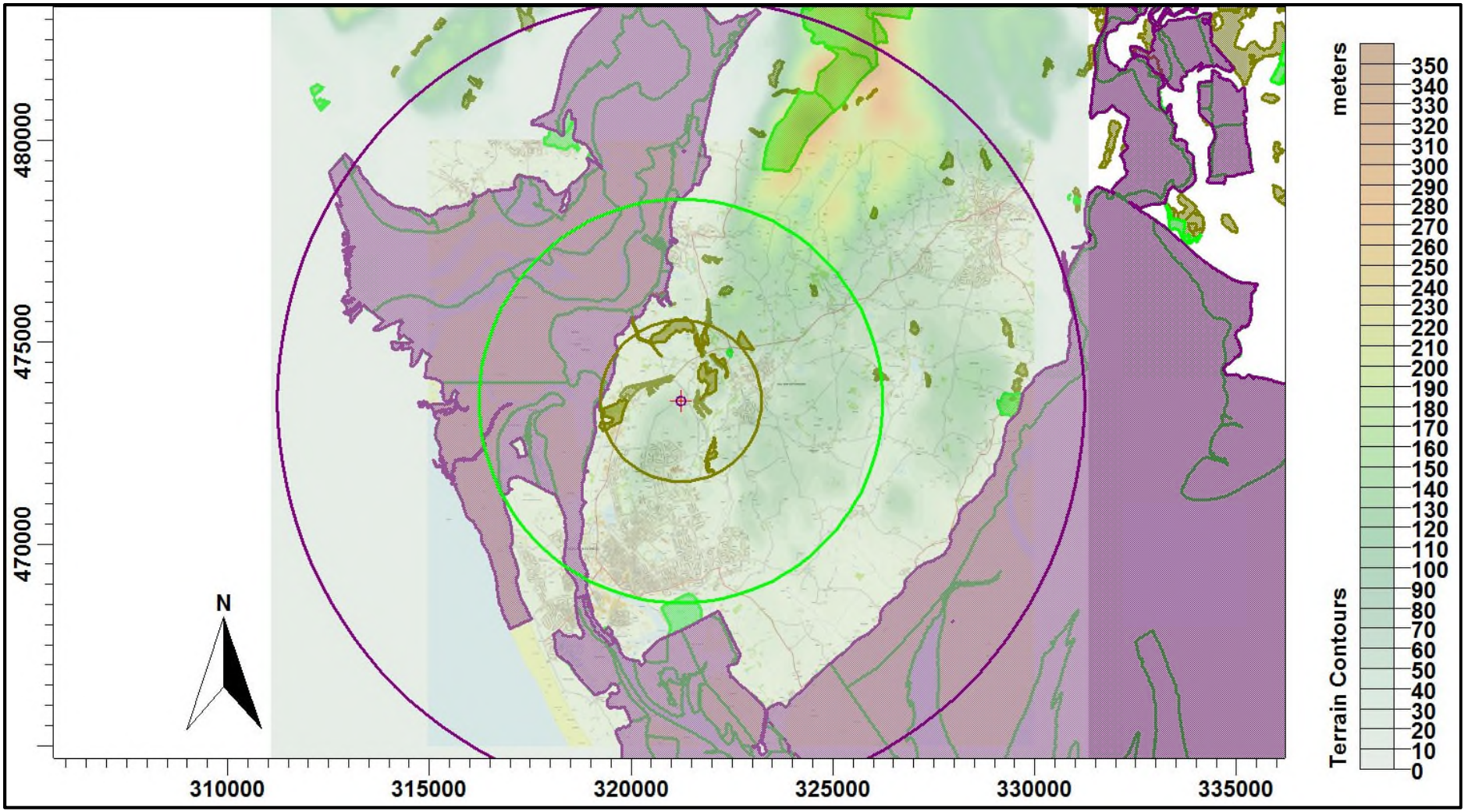
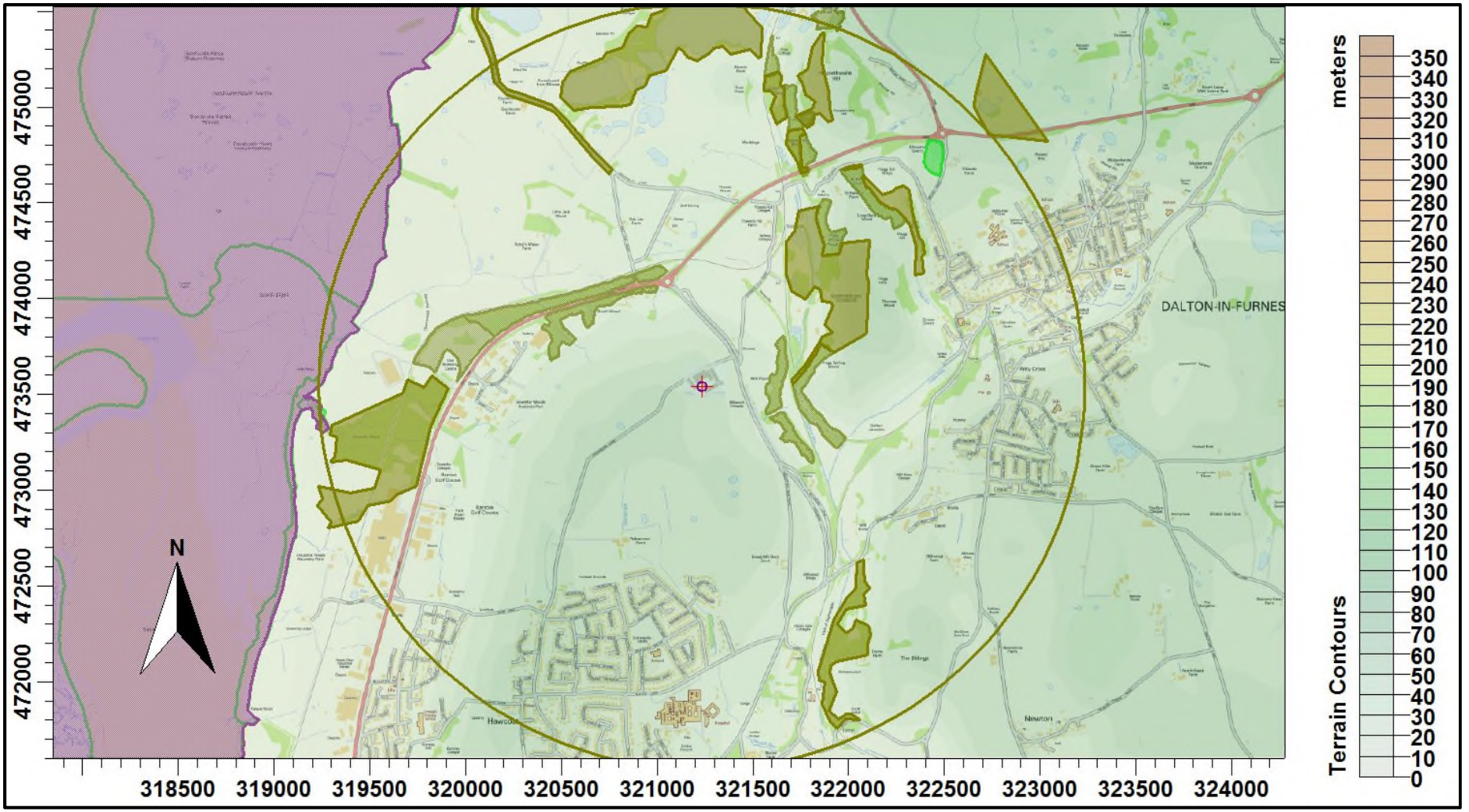


*Figure 1c. Wildlife sites in the area surrounding Sinkfall Farm – a closer view*



# 3. Air Quality Legislation, Regulation, Background Levels & Emission Rates

## 3.1 Air Quality Strategy and Air Quality Standards Regulations

The current UK Air Quality Strategy (AQS) was published in July 2007 and set out objectives for local authorities in undertaking their local air quality management duties. The AQS establishes the framework for air quality improvements. The strategy is based upon measures agreed at the national and international level. The role of the local authority review and assessment process is to identify all those areas where the air quality objectives are being, or are likely to be, exceeded.

For the purposes of this assessment, the limit values set out in the Air Quality Standards Regulations 2010 and the objective levels specified under the current UK AQS have been used. The Air Quality Standards Regulations 2010 transpose into English law the requirements of the European Directives 2008/50/EC and 2004/107/EC on ambient air quality.

The Air Quality Standards Regulations 2010 objectives levels are shown in Table 1a.

*Table 1a. Air Quality Standards Regulations 2010 - objectives levels*

| Pollutant | Air Quality Objective Concentration | Averaging period |
|---|---|---|
| Benzene (VOC) | 16.25 µg/m$^3$ | Running annual mean |
| | 5.00 µg/m$^3$ | Annual mean |
| 1,3-Butadiene (VOC) | 2.25 µg/m$^3$ | Running annual mean |
| **Carbon Monoxide (CO)** | **10.0 mg/m$^3$** | **Maximum daily running 8-hour mean** |
| Lead | 0.25 µg/m$^3$ | Annual mean |
| **Nitrogen Dioxide ($NO_2$)** | **200 µg/m$^3$ not to be exceeded more than 18 times a year** | **1-hour mean** |
| | **40 µg/m$^3$** | **Annual mean** |
| **Sulphur dioxide ($SO_2$)** | **350 µg/m$^3$, not to be exceeded more than 24 times a year** | **1-hour mean** |
| | **125 µg/m$^3$, not to be exceeded more than 3 times a year** | **24-hour mean** |
| | **266 µg/m$^3$, not to be exceeded more than 35 times a year** | **15-minute mean** |
| **Particle Matter ($PM_{10}$)** | **50 µg/m$^3$, not to be exceeded more than 35 times a year** | **Daily mean** |
| | **40 µg/m$^3$** | **Annual mean** |

## 3.2 Guidance on the Significance of the Impact of Emissions

Where comment on the significance of the impact of emission is made in this report, it is based upon guidance contained in an Environmental Protection UK publication titled Land Use Planning & Development Control: Planning For Air Quality (May 2015). It should be noted, however, that the final judgment on significance is made by the local authority's air quality specialist. The definitions of impact of magnitude for changes in pollutant concentration as a percentage of the assessment level and predicted concentration for an annual mean are provided in Table 1b.

*Table 1b. Air quality impact descriptors for changes to annual mean concentrations*

| Average concentration (as percentage of Predicted Environmental Concentration) | Change in concentration (Process Contribution as percentage of Environmental Assessment Level) | | | |
|---|---|---|---|---|
| | <1 | >=1 and <5 | >=5 and <10 | >10 |
| <75 | Negligible | Negligible | **Slight** | **Moderate** |
| >=75 to <95 | Negligible | **Slight** | **Moderate** | **Moderate** |
| >=95 to <103 | **Slight** | **Moderate** | **Moderate** | **Substantial** |
| >=103 to <110 | **Moderate** | **Moderate** | **Substantial** | **Substantial** |
| >=110 | **Moderate** | **Substantial** | **Substantial** | **Substantial** |

## 3.3 Background $NO_2$ and CO Levels

The background concentrations used in this report are obtained from the Defra website, Local Air Quality Management (LAQM) support pages. Details of the methods used to drive these background concentrations are described in the AEA report titled "UK modelling under the Air Quality Directive (2008/50/EC) for 2010 covering the following air quality pollutants: $SO_2$, $NO_x$, $NO_2$, $PM_{10}$, $PM_{2.5}$, lead, benzene, CO, and ozone".

The background concentrations of $NO_x$, $SO_2$, $PM_{10}$ and CO are provided in Tables 2a, 2b, 2c and 2d. The tables contain the concentration for the centroid of the 1 km Ordnance Survey grid square around the site and the centroid of the adjacent 1 km Ordnance Survey grid squares.

*Table 2a. Background $NO_2$ concentrations*

| $NO_2$ concentration 2013 ($\mu g/m^3$) | | | | | |
|---|---|---|---|---|---|
| OS easting & OS northing | 319500 | 320500 | 321500 | 322500 | 323500 |
| 475500 | 5.458 | 5.916 | 6.551 | 6.695 | 6.737 |
| 474500 | 6.042 | 6.823 | 8.927 | 8.167 | 7.896 |
| 473500 | 7.967 | 8.039 | 7.173 | 7.429 | 7.099 |
| 472500 | 9.282 | 8.196 | 7.549 | 7.091 | 6.729 |
| 471500 | 10.148 | 8.810 | 8.312 | 7.358 | 6.748 |

*Table 2b. Background $SO_2$ concentrations*

| $SO_2$ concentrarion 2001 (µg/m$^3$) | | | | | |
|---|---|---|---|---|---|
| OS easting & OS northing | 319500 | 320500 | 321500 | 322500 | 323500 |
| 475500 | 1.510 | 1.530 | 1.560 | 1.590 | 1.700 |
| 474500 | 1.550 | 1.650 | 1.610 | 1.800 | 1.800 |
| 473500 | 1.730 | 1.700 | 1.640 | 1.880 | n/a |
| 472500 | 2.500 | 1.830 | 1.780 | 1.840 | n/a |
| 471500 | 1.990 | 2.060 | 2.200 | 1.840 | n/a |

*Table 2c. Background $PM_{10}$ concentrations*

| $PM_{10}$ concentration 2012 (µg/m$^3$) | | | | | |
|---|---|---|---|---|---|
| OS easting & OS northing | 319500 | 320500 | 321500 | 322500 | 323500 |
| 475500 | 9.890 | 12.024 | 12.178 | 11.848 | 12.732 |
| 474500 | 10.511 | 11.370 | 12.369 | 12.995 | 13.203 |
| 473500 | 11.069 | 12.102 | 12.445 | 12.582 | 13.446 |
| 472500 | 11.228 | 10.789 | 11.251 | 12.502 | 13.494 |
| 471500 | 11.641 | 10.792 | 10.785 | 12.175 | 12.241 |

*Table 2d. Background CO concentrations*

| CO concentration 2001 (mg/m$^3$) | | | | | |
|---|---|---|---|---|---|
| OS easting & OS northing | 319500 | 320500 | 321500 | 322500 | 323500 |
| 475500 | 0.169 | 0.173 | 0.178 | 0.181 | 0.181 |
| 474500 | 0.171 | 0.176 | 0.181 | 0.187 | 0.186 |
| 473500 | 0.177 | 0.182 | 0.187 | 0.191 | n/a |
| 472500 | 0.185 | 0.190 | 0.195 | 0.194 | n/a |
| 471500 | 0.202 | 0.206 | 0.208 | 0.199 | n/a |

## 3.5 Quantification of Emissions of $NO_2$

Emissions of $NO_x$, $PM_{10}$ and CO from the proposed biomass boiler are obtained from data supplied by the manufacturers of the biomass boilers via by Recogen Ltd. The emission rates used for the modelling are provided in Table 3.

*Table 3. $NO_x$, $NO_2$, $SO_2$, $PM_{10}$ and CO emission rates*

| Source | $NO_x$ emission rate (g/s) | $NO_2$ emission rate (assuming $NO_X$ is 100% NO and all is converted to $NO_2$) (g/s) | $SO_2$ emission rate (g/s) | $PM_{10}$ emission rate (g/s) | CO emission rate (g/s) |
|---|---|---|---|---|---|
| Boiler 1 (999 kWh) | 0.07528 | 0.11542 | 0.00903 | 0.02361 | 0.07519 |
| Boiler 1 (999 kWh) | 0.07528 | 0.11542 | 0.00903 | 0.02361 | 0.07519 |

## 3.6 Choice of Receptors

Predicted pollutant levels are calculated at discrete receptor points by the dispersion model. The choice of where these receptors are defined is usually based upon guidance from the Environment Agency's H1: Environmental risk assessment for permits and its technical annexes, specifically Annex A - Amenity & accident risk from installations and waste activities.

More specific guidance on the choice of receptors is available in the Environmental Protection UK publication titled Development Control: Planning For Air Quality (2010 Update). The descriptions from Development Control: Planning For Air Quality are reproduced in Table 4.

*Table 4. Choice of receptors (Development Control: Planning For Air Quality)*

| Averaging period of objective | Where the objective should apply | Where the objective should not generally apply |
|---|---|---|
| **Annual** | All locations where members of the public might be regularly exposed. Building facades, residential properties, schools hospitals care homes etc. | Building facades of offices or other places of work where members of the public do not have regular access. Hotels, unless people live there as their permanent residence. Gardens of residential properties. Kerbside sites (as opposed to locations at the building façade), or any other location where public exposure is expected to be short term. |
| **8 hours to 24 hours** | All locations where the annual mean objectives would apply. Gardens of residential properties. | Kerbside sites (as opposed to locations at the building façade), or any other location where public exposure is expected to be short term. |
| **1 hour** | All locations where the annual mean and 24 and 8-hour mean objectives would apply. Kerbside sites (e.g. pavements of busy shopping streets). Those parts of car parks, bus stations and railway stations etc. which are not fully enclosed, where the public might reasonably be expected to spend one hour or more. Any outdoor locations at which the public may be expected to spend one hour or longer. | Kerbside sites where the public would not be expected to have regular access. |
| **15 minutes** | All locations where members of the public might reasonably be expected to spend a period of 15 minutes or longer. | |

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

## 4.1 ADMS

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.

## 4.2 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).

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

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

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

A wind rose showing the distribution of wind speeds and directions in the GFS derived data is shown in Figure 2a.

Wind speeds are modified by the treatment of roughness lengths (see Section 4.7) and because 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 is approximately 340 m.

*Figure 2a. The wind rose. Raw GFS derived data for 54.152 N, 3.206 W, 2012 – 2015*

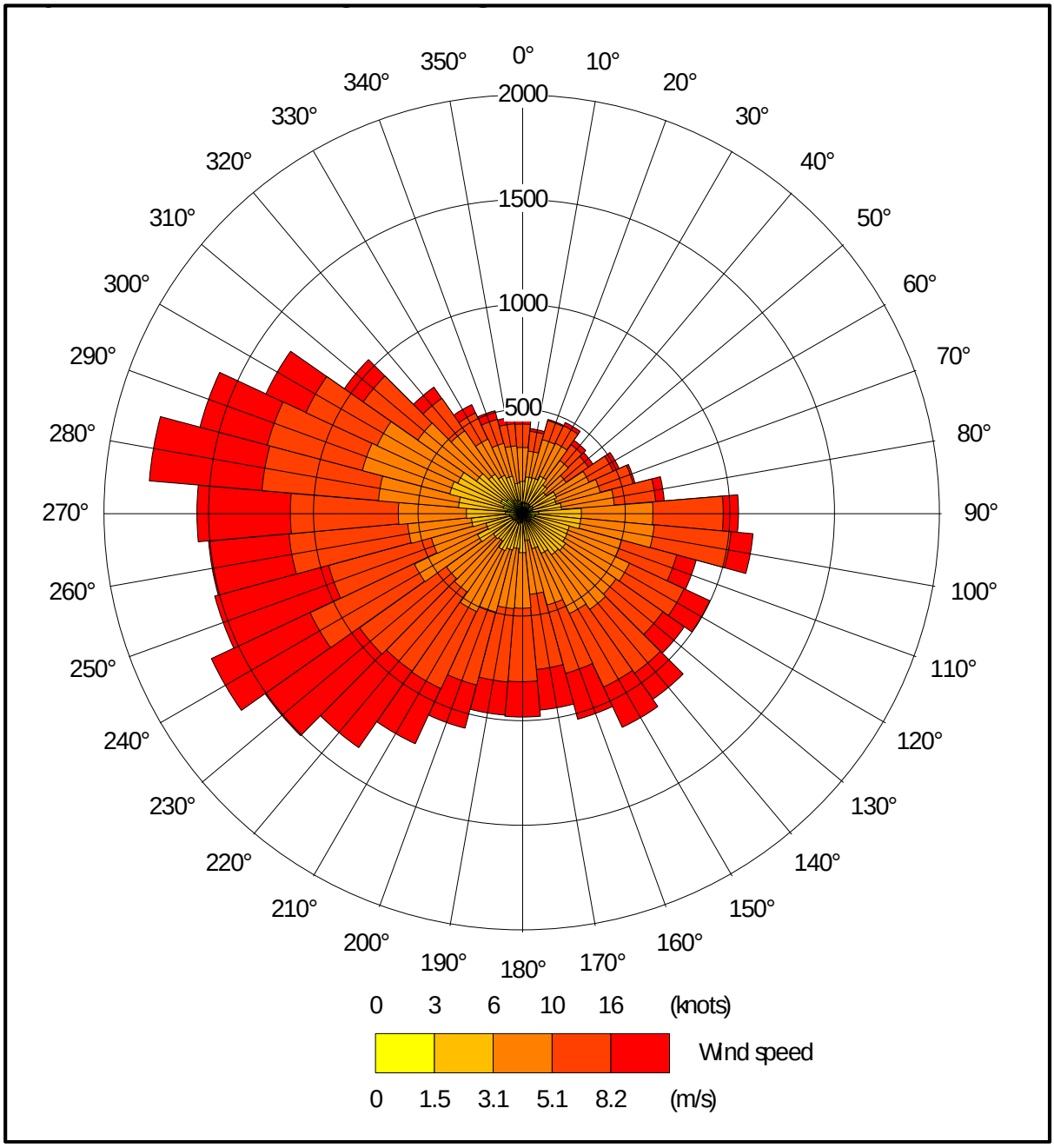
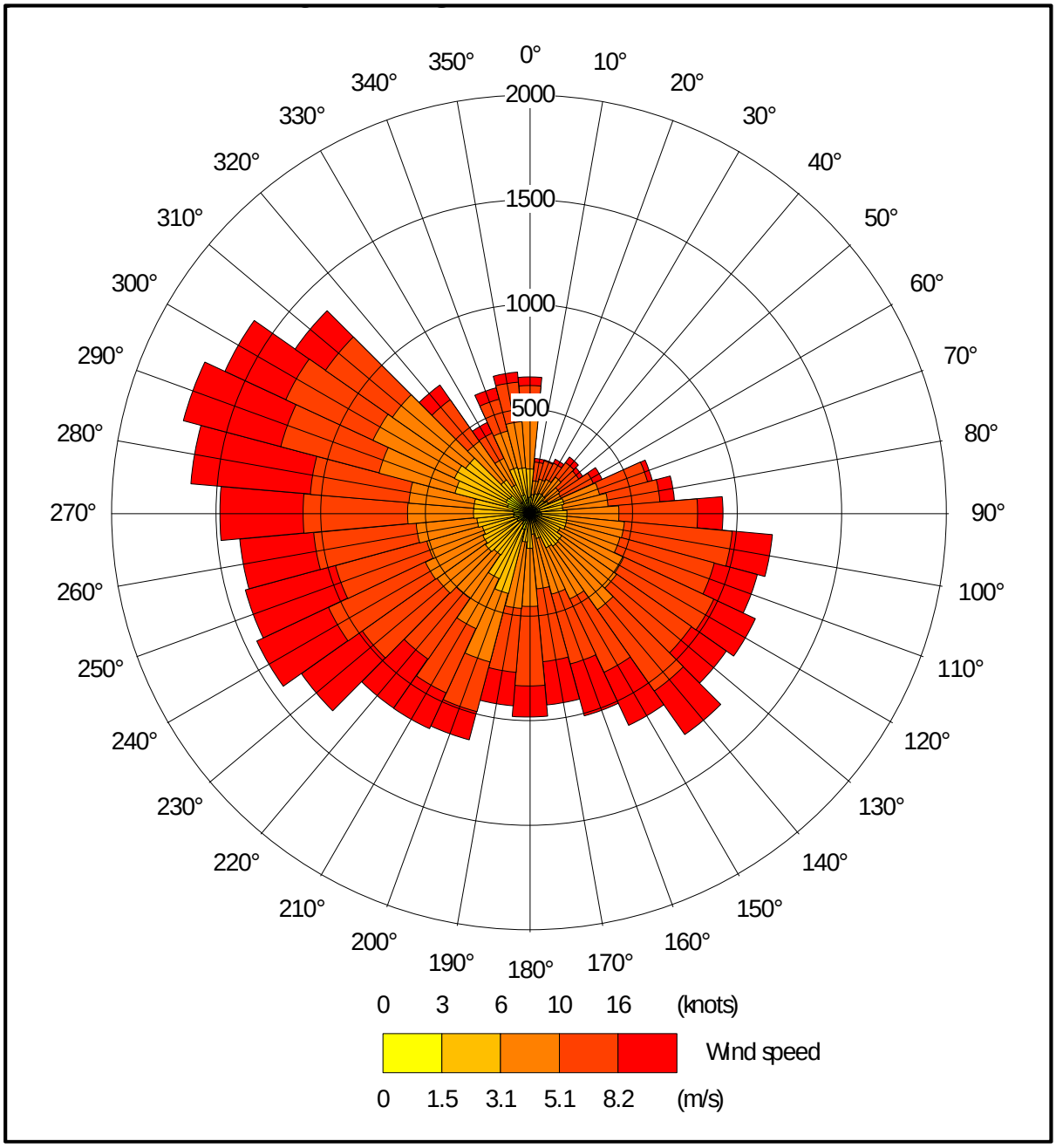


*Figure 2b. The wind rose. FLOWSTAR modified GFS data for 54.152 N, 3.206 W, 2012 – 2015*



## 4.3 Emission Sources

Emissions of $NO_x$, $SO_2$, $PM_{10}$ and CO from the stacks serving the biomass boilers are modelled using two point sources, which are combined within ADMS. The combined stacks are assumed to operate constantly; however, in reality, the boilers would only operate for a few hours per day.

$NO_x$ chemistry is modelled as described by the Environment Agency Guidance note "CONVERSION RATIOS FOR NOX AND NO2". The $NO_x$ emitted from combustion sources is a mixture of nitrogen oxides, primarily NO and conversion to $NO_2$ occurs in the atmosphere at various rates, dependant on a variety of factors. Whilst this process can be modelled by ADMS, the uncertainties involved are considered too great for robust results to be obtained. Therefore, in this case and as per the Environment Agency guidance, for modelling purposes, the $NO_x$ is assumed to be all NO which is converted to $NO_2$ at source. For short term objectives (less than 24 hours) it is assumed that 35% of the NO is converted to $NO_2$. For long term objectives (greater than 24 hours) it is assumed that 70% of the NO is converted to $NO_2$. For ecological receptors it is assumed that 100% of the NO is converted to $NO_2$.

Details of the modelled stack parameters are provided in Table 5. The position of the combined stacks may be seen in Figure 3, where they are marked by a red star symbol.

*Table 5. Point source emission parameters*

| Stack ID | X (m) | Y (m) | Height (m) [1] | Diameter (m) | Efflux velocity (m/s) | Efflux temp-erature (°C) | 100% $NO_2$ (g/s) | 70% $NO_2$ (g/s) | 35% $NO_2$ (g/s) | $SO_2$ (g/s) | $PM_{10}$ (g/s) | CO g/s) |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| BB1s | 321234 | 473541 | 14.778 | 0.28 | 11.28 | 117 | 0.11542 | 0.08079 | 0.04040 | 0.00903 | 0.02361 | 0.07519 |
| BB2s | 321234 | 473541 | 14.778 | 0.28 | 11.28 | 117 | 0.11542 | 0.08079 | 0.04040 | 0.00903 | 0.02361 | 0.07519 |

## 4.4 Modelled Buildings

The structure of the various buildings at and around the site may affect the plumes from the point sources. Therefore, the major buildings are modelled within ADMS. The positions of the modelled buildings may be seen in Figure 3 where they are marked by grey rectangles.

## 4.5 Discrete receptors

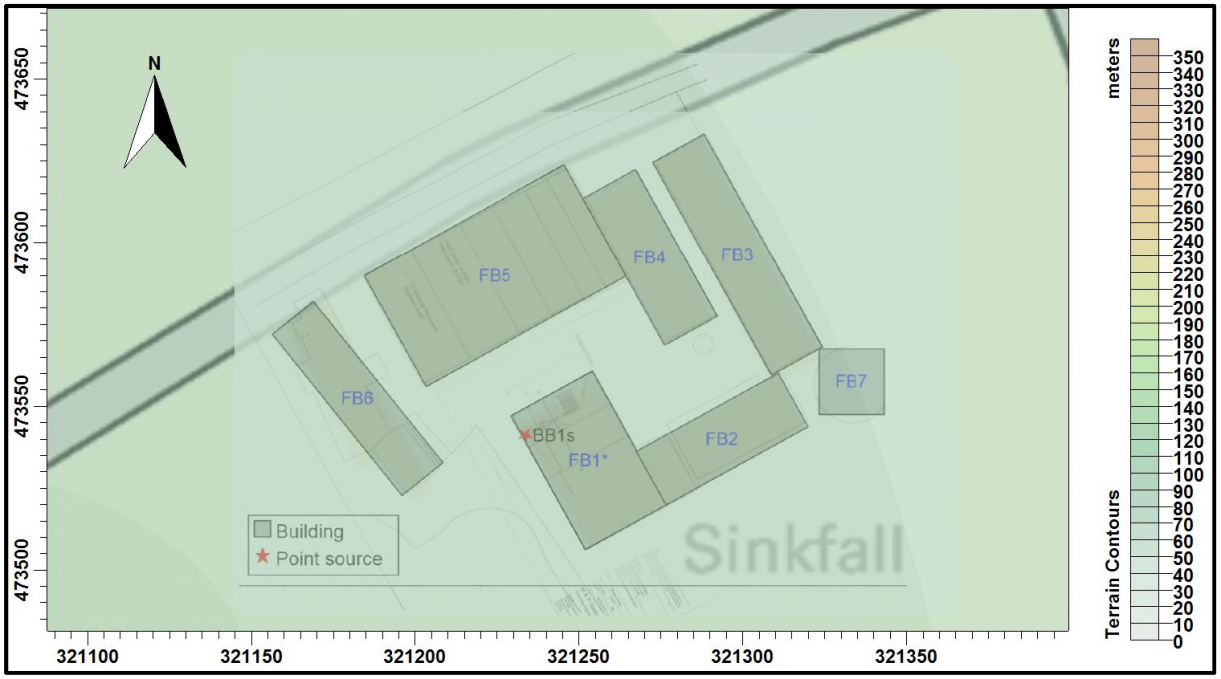
### 4.5.1 Human health receptors

Thirty discrete receptors have been defined at a selection of nearby residences, commercial and industrial premises and amenity areas. The receptors are defined at 1.5 m above ground level within ADMS. The positions of the discrete receptors may be seen in Figure 4a where they are marked by enumerated pink rectangles.

### 4.5.2 Ecological Receptors

Fifty-nine discrete receptors have been defined: twenty-eight at the AWs and the LWSs (1 to 28); two at the SSSIs (29 and 30) and twenty-nine at the SAC/SPA/Ramsar site (31 to 59). These receptors are defined at ground level within ADMS. The positions of the discrete receptors may be seen in Figures 4b and 4c, where they are marked by enumerated pink rectangles.

*Figure 3. The positions of modelled point source and buildings*






## 4.6 The Nested Cartesian Grid

To produce the contour plots presented in this report and to obtain the maximum predicted concentrations, a nested regular Cartesian grid has been defined within ADMS. The individual grid receptors are defined at a height of 1.5 m above ground level within ADMS. The position of the individual grid points of the nested Cartesian grid may be seen in Figure 4a, where they are marked by green crosses.

## 4.7 Terrain Data

Terrain has been considered in the modelling. The terrain data are based upon the Ordnance Survey 50 m Digital Elevation Model. A 22.0 km x 22.0 km domain has been resampled at 100 m horizontal resolution for use within ADMS for use in the modelling. N.B. The resolution of FLOWSTAR is 64 x 64 grid points; therefore, the effective resolution of the wind field is approximately 340 m.

## 4.8 Roughness Length

A fixed surface roughness length of 0.25 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 0.225 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.

## 4.9 Deposition

In this case it proves unnecessary to model deposition explicitly and where deposition figures are quoted, these are obtained by multiplying the predicted $NO_2$ or $SO_2$ concentration by an appropriate deposition velocity, a factor of 315.576 to convert units and a factor of 14/46 to convert $NO_2$ to N and 32/64 to convert $SO_2$ to S. Acid deposition assumes that the H+ deposition is $1/14^{th}$ of the N deposition plus $1/16^{th}$ of the S deposition. Please note that, because deposition of $NO_2$ or $SO_2$ and the consequent plume depletion are not accounted for, this is a precautionary approach. Therefore, predicted 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 nested Cartesian grid and human health discrete receptors*

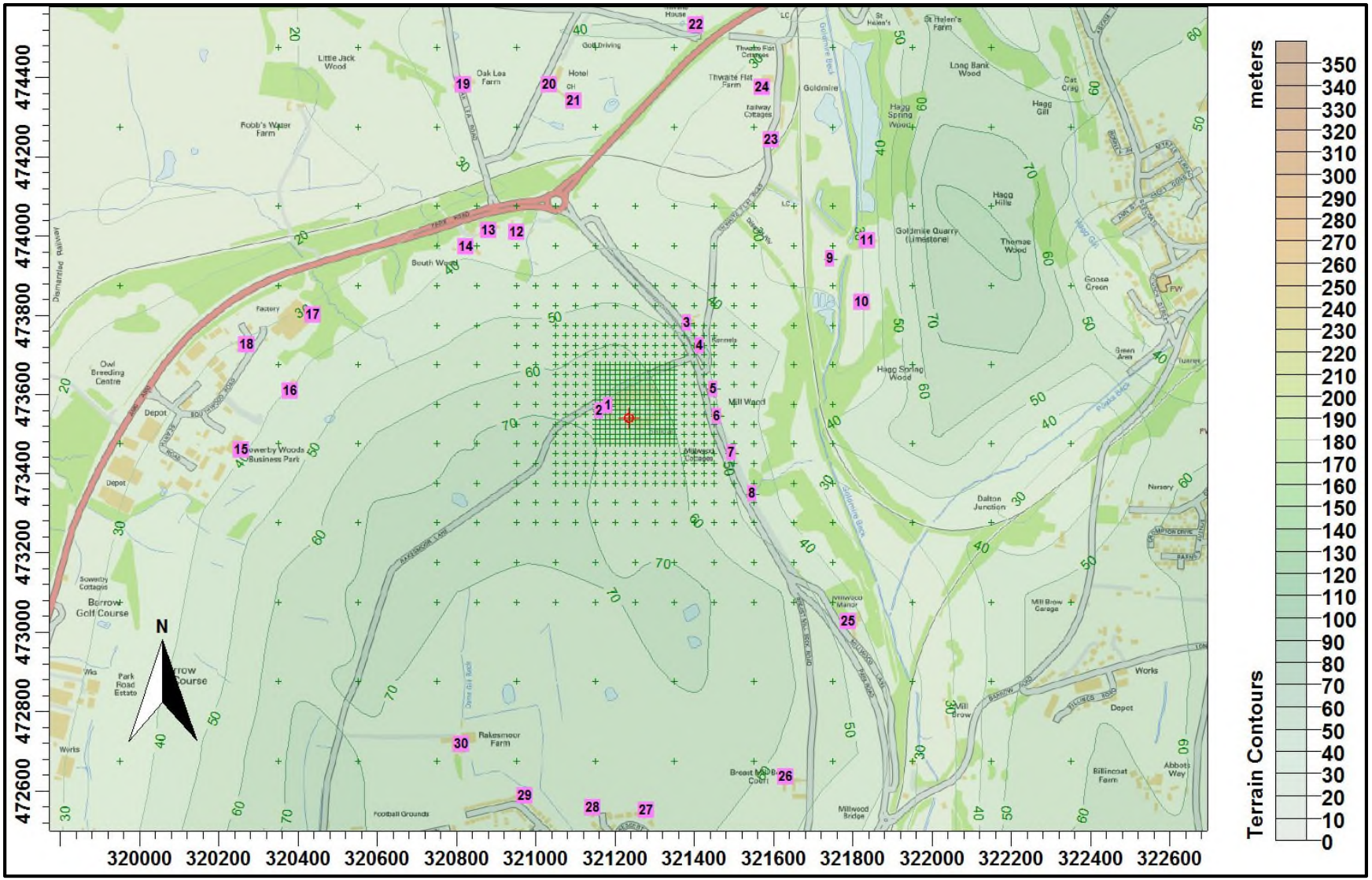


*Figure 4b. The discrete receptors at the AWs/LWSs, the SSSIs and the SAC/SPA/Ramsar site*

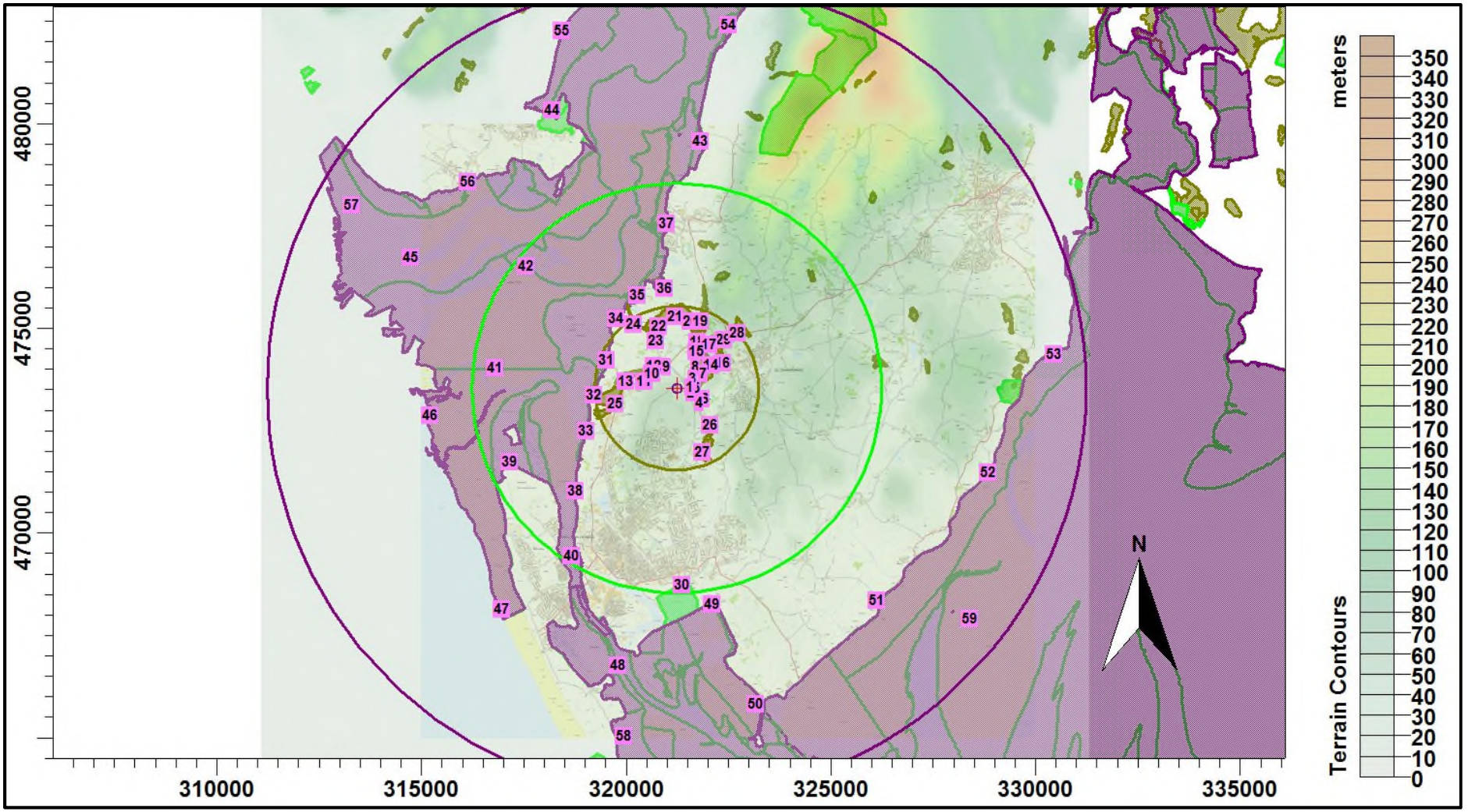
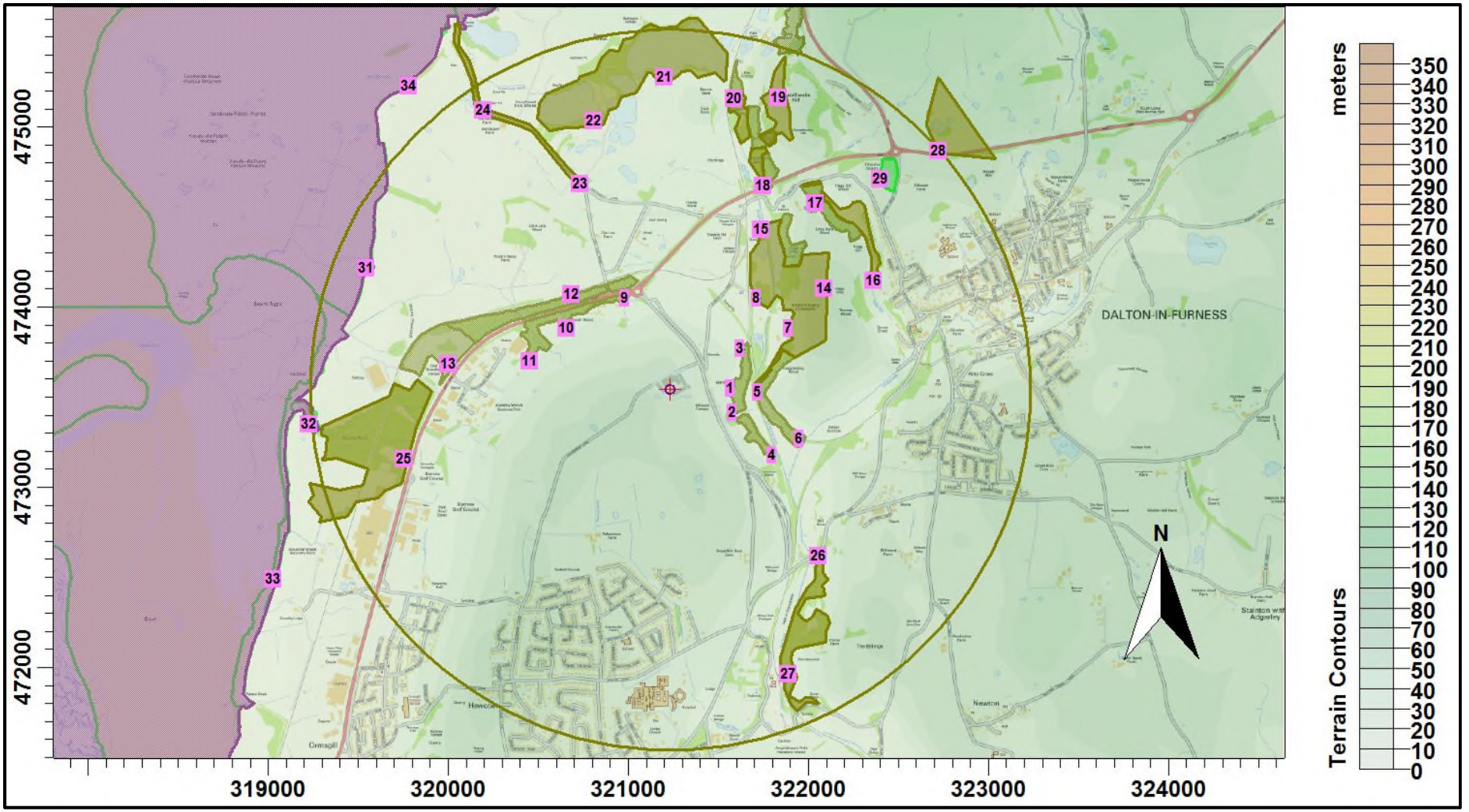


*Figure 4c. The discrete receptors at the AWs/LWSs, the SSSIs and the SAC/SPA/Ramsar site - a closer view*



# 5. Details of the Model Runs and Results

ADMS was run four times, once for each year of the meteorological dataset, using the calms and terrain modules of ADMS.

From the model output, the following statistics for each grid point (discrete and nested Cartesian) were calculated for each configuration:

- Maximum annual mean $NO_2$ concentration
- Maximum 1 hour mean $NO_2$ concentration
- Maximum 24 hour mean $SO_2$ concentration
- Maximum 1 hour mean $SO_2$ concentration
- Maximum 15 minute mean $SO_2$ concentration
- Maximum annual mean $PM_{10}$ concentration
- Maximum 24 hour mean $PM_{10}$ concentration
- Maximum running 8 hour mean CO concentration

Summaries of the maximum predicted concentrations for each of these statistics for the human health receptors (at any receptor point, discrete or nested Cartesian) are presented in Table 6. Further details of the predicted concentration for each pollutant and averaging period at each of the discrete receptors, assuming constant emission from the biomass boiler stack, are shown in Annex 1 of this report in Tables A1a through to A1h.

Contour plots of the predicted concentration for each pollutant and averaging period in the surrounding area, assuming constant emission from the biomass boiler, are shown in Annex 2 of this report in Figures A2a through to A2h.

The results of the modelling for the ecological receptors are provided in Table 7.

*Table 6. Maximum predicted concentrations of $NO_2$, $SO_2$, $PM_{10}$ and CO – constant emissions*

| Statistic | Maximum Point | | PC | Background | EAL | PEC | PC as %age of EAL | %age change from background levels | Air quality impact descriptors | Exceedances of EAL predicted |
|---|---|---|---|---|---|---|---|---|---|---|
| | X(m) | Y(m) | | | | | | | | |
| Maximum annual mean $NO_2$ concentration ($\mu g/m^3$) | 321225 | 473538 | 5.21 | 7.17 | 40.00 | 12.38 | 13.02 | 72.61 | Moderate | No |
| Maximum 1 hour mean $NO_2$ concentration ($\mu g/m^3$) | 321213 | 473513 | 94.10 | 14.35 | 200.00 | 108.45 | **47.05** | 655.98 | - | 0.00 |
| Maximum 24 hour mean $SO_2$ concentration ($\mu g/m^3$) | 321175 | 473500 | 1.74 | 3.28 | 125.00 | 5.02 | 1.39 | 52.99 | - | 0.00 |
| Maximum 1 hour mean $SO_2$ concentration ($\mu g/m^3$) | 321213 | 473513 | 21.03 | 3.28 | 350.00 | 24.31 | 6.01 | 641.25 | - | 0.00 |
| Maximum 15 minute mean $SO_2$ concentration ($\mu g/m^3$) | 321213 | 473513 | 21.29 | 3.28 | 266.00 | 24.57 | 8.01 | 649.20 | - | 0.00 |
| Maximum annual mean $PM_{10}$ concentration ($\mu g/m^3$) | 321225 | 473538 | 1.52 | 12.45 | 40.00 | 13.97 | 3.81 | 12.23 | Negligible | No |
| Maximum 24 hour mean $PM_{10}$ concentration ($\mu g/m^3$) | 321175 | 473500 | 4.54 | 24.89 | 50.00 | 29.43 | 9.09 | 18.26 | - | 0.00 |
| Maximum running 8 hour mean CO concentration ($mg/m^3$) | 321175 | 473500 | 0.04 | 0.37 | 10.00 | 0.41 | 0.39 | 10.30 | - | 0.00 |

*Table 7. Maximum predicted concentrations of $NO_2$, $SO_2$ N deposition and H+ deposition at the ecological receptors*

| Receptor Number | X (m) | Y (m) | Nitrogen Dioxide | | | | | | | Sulphur Dioxide | | | | | Acid Deposition | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | Max ann conc. (µg/m$^3$) | Cle (µg/m3) | %of Cle | depv (m/s) | N depo (kg/ha/y) | Clo (kg/ha/y) | % of Clo | Max ann conc. (µg/m$^3$) | Cle (µg/m$^3$) | %of Cle | depv (m/s) | S depo (kg/ha/y) | H+ depo (keq/ha/y) | Clo (keq/ha/y) | % of Clo |
| 1 | 321566 | 473544 | 0.565 | 30.0 | **1.88** | 0.0015 | 0.081 | 10.0 | **0.81** | 0.044 | 20.0 | **0.22** | 0.012 | 0.084 | 0.011 | 2.0 | **0.55** |
| 2 | 321580 | 473411 | 0.522 | 30.0 | **1.74** | 0.0015 | 0.075 | 10.0 | **0.75** | 0.041 | 20.0 | **0.20** | 0.012 | 0.077 | 0.010 | 2.0 | **0.51** |
| 3 | 321622 | 473765 | 0.323 | 30.0 | **1.08** | 0.0015 | 0.047 | 10.0 | **0.47** | 0.025 | 20.0 | **0.13** | 0.012 | 0.048 | 0.006 | 2.0 | **0.32** |
| 4 | 321797 | 473177 | 0.192 | 30.0 | **0.64** | 0.0015 | 0.028 | 10.0 | **0.28** | 0.015 | 20.0 | **0.08** | 0.012 | 0.029 | 0.004 | 2.0 | **0.19** |
| 5 | 321717 | 473527 | 0.320 | 30.0 | **1.07** | 0.0015 | 0.046 | 10.0 | **0.46** | 0.025 | 20.0 | **0.13** | 0.012 | 0.047 | 0.006 | 2.0 | **0.31** |
| 6 | 321948 | 473264 | 0.169 | 30.0 | **0.56** | 0.0015 | 0.024 | 10.0 | **0.24** | 0.013 | 20.0 | **0.07** | 0.012 | 0.025 | 0.003 | 2.0 | **0.17** |
| 7 | 321888 | 473877 | 0.142 | 30.0 | **0.47** | 0.0015 | 0.021 | 10.0 | **0.21** | 0.011 | 20.0 | **0.06** | 0.012 | 0.021 | 0.003 | 2.0 | **0.14** |
| 8 | 321713 | 474049 | 0.151 | 30.0 | **0.50** | 0.0015 | 0.022 | 10.0 | **0.22** | 0.012 | 20.0 | **0.06** | 0.012 | 0.022 | 0.003 | 2.0 | **0.15** |
| 9 | 320981 | 474045 | 0.197 | 30.0 | **0.66** | 0.0015 | 0.028 | 10.0 | **0.28** | 0.015 | 20.0 | **0.08** | 0.012 | 0.029 | 0.004 | 2.0 | **0.19** |
| 10 | 320659 | 473881 | 0.157 | 30.0 | **0.52** | 0.0015 | 0.023 | 10.0 | **0.23** | 0.012 | 20.0 | **0.06** | 0.012 | 0.023 | 0.003 | 2.0 | **0.15** |
| 11 | 320456 | 473698 | 0.143 | 30.0 | **0.48** | 0.0015 | 0.021 | 10.0 | **0.21** | 0.011 | 20.0 | **0.06** | 0.012 | 0.021 | 0.003 | 2.0 | **0.14** |
| 12 | 320687 | 474070 | 0.144 | 30.0 | **0.48** | 0.0015 | 0.021 | 10.0 | **0.21** | 0.011 | 20.0 | **0.06** | 0.012 | 0.021 | 0.003 | 2.0 | **0.14** |
| 13 | 320007 | 473681 | 0.073 | 30.0 | **0.24** | 0.0015 | 0.011 | 10.0 | **0.11** | 0.006 | 20.0 | **0.03** | 0.012 | 0.011 | 0.001 | 2.0 | **0.07** |
| 14 | 322091 | 474101 | 0.082 | 30.0 | **0.27** | 0.0015 | 0.012 | 10.0 | **0.12** | 0.006 | 20.0 | **0.03** | 0.012 | 0.012 | 0.002 | 2.0 | **0.08** |
| 15 | 321745 | 474427 | 0.071 | 30.0 | **0.24** | 0.0015 | 0.010 | 10.0 | **0.10** | 0.006 | 20.0 | **0.03** | 0.012 | 0.010 | 0.001 | 2.0 | **0.07** |
| 16 | 322367 | 474144 | 0.058 | 30.0 | **0.19** | 0.0015 | 0.008 | 10.0 | **0.08** | 0.005 | 20.0 | **0.02** | 0.012 | 0.009 | 0.001 | 2.0 | **0.06** |
| 17 | 322042 | 474576 | 0.046 | 30.0 | **0.15** | 0.0015 | 0.007 | 10.0 | **0.07** | 0.004 | 20.0 | **0.02** | 0.012 | 0.007 | 0.001 | 2.0 | **0.05** |
| 18 | 321752 | 474668 | 0.048 | 30.0 | **0.16** | 0.0015 | 0.007 | 10.0 | **0.07** | 0.004 | 20.0 | **0.02** | 0.012 | 0.007 | 0.001 | 2.0 | **0.05** |
| 19 | 321839 | 475157 | 0.025 | 30.0 | **0.08** | 0.0015 | 0.004 | 10.0 | **0.04** | 0.002 | 20.0 | **0.01** | 0.012 | 0.004 | 0.000 | 2.0 | **0.02** |
| 20 | 321592 | 475153 | 0.028 | 30.0 | **0.09** | 0.0015 | 0.004 | 10.0 | **0.04** | 0.002 | 20.0 | **0.01** | 0.012 | 0.004 | 0.001 | 2.0 | **0.03** |
| 21 | 321206 | 475272 | 0.030 | 30.0 | **0.10** | 0.0015 | 0.004 | 10.0 | **0.04** | 0.002 | 20.0 | **0.01** | 0.012 | 0.004 | 0.001 | 2.0 | **0.03** |
| 22 | 320810 | 475030 | 0.035 | 30.0 | **0.12** | 0.0015 | 0.005 | 10.0 | **0.05** | 0.003 | 20.0 | **0.01** | 0.012 | 0.005 | 0.001 | 2.0 | **0.03** |
| 23 | 320736 | 474681 | 0.052 | 30.0 | **0.17** | 0.0015 | 0.008 | 10.0 | **0.08** | 0.004 | 20.0 | **0.02** | 0.012 | 0.008 | 0.001 | 2.0 | **0.05** |
| 24 | 320199 | 475090 | 0.033 | 30.0 | **0.11** | 0.0015 | 0.005 | 10.0 | **0.05** | 0.003 | 20.0 | **0.01** | 0.012 | 0.005 | 0.001 | 2.0 | **0.03** |
| 25 | 319757 | 473151 | 0.035 | 30.0 | **0.12** | 0.0015 | 0.005 | 10.0 | **0.05** | 0.003 | 20.0 | **0.01** | 0.012 | 0.005 | 0.001 | 2.0 | **0.03** |
| 26 | 322058 | 472614 | 0.051 | 30.0 | **0.17** | 0.0015 | 0.007 | 10.0 | **0.07** | 0.004 | 20.0 | **0.02** | 0.012 | 0.008 | 0.001 | 2.0 | **0.05** |
| 27 | 321890 | 471957 | 0.024 | 30.0 | **0.08** | 0.0015 | 0.003 | 10.0 | **0.03** | 0.002 | 20.0 | **0.01** | 0.012 | 0.004 | 0.000 | 2.0 | **0.02** |
| 28 | 322729 | 474862 | 0.024 | 30.0 | **0.08** | 0.0015 | 0.003 | 10.0 | **0.03** | 0.002 | 20.0 | **0.01** | 0.012 | 0.004 | 0.000 | 2.0 | **0.02** |

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*Table 7. (continued)*

| Receptor Number | X (m) | Y (m) | Nitrogen Dioxide | | | | | | | Sulphur Dioxide | | | | | Acid Deposition | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | Max ann conc. ($\mu g/m^3$) | Cle ($\mu g/m3$) | %of Cle | depv (m/s) | N depo (kg/ha/y) | Clo (kg/ha/y) | % of Clo | Max ann conc. ($\mu g/m^3$) | Cle ($\mu g/m^3$) | %of Cle | depv (m/s) | S depo (kg/ha/y) | H+ depo (keq/ha/y) | Clo (keq/ha/y) | % of Clo |
| 29 | 322404 | 474708 | 0.032 | 30.0 | **0.11** | 0.0015 | 0.005 | 10.0 | **0.05** | 0.003 | 20.0 | **0.01** | 0.012 | 0.005 | 0.001 | 1.0 | **0.06** |
| 30 | 321387 | 468720 | 0.010 | 30.0 | **0.03** | 0.0015 | 0.001 | 10.0 | **0.01** | 0.001 | 20.0 | **0.00** | 0.012 | 0.001 | 0.000 | 1.0 | **0.02** |
| 31 | 319548 | 474213 | 0.035 | 30.0 | **0.12** | 0.0015 | 0.005 | 10.0 | **0.05** | 0.003 | 20.0 | **0.01** | 0.012 | 0.005 | 0.001 | 0.2 | **0.31** |
| 32 | 319232 | 473347 | 0.027 | 30.0 | **0.09** | 0.0015 | 0.004 | 10.0 | **0.04** | 0.002 | 20.0 | **0.01** | 0.012 | 0.004 | 0.001 | 0.2 | **0.24** |
| 33 | 319029 | 472488 | 0.015 | 30.0 | **0.05** | 0.0015 | 0.002 | 10.0 | **0.02** | 0.001 | 20.0 | **0.01** | 0.012 | 0.002 | 0.000 | 0.2 | **0.13** |
| 34 | 319783 | 475226 | 0.026 | 30.0 | **0.09** | 0.0015 | 0.004 | 10.0 | **0.04** | 0.002 | 20.0 | **0.01** | 0.012 | 0.004 | 0.001 | 0.2 | **0.23** |
| 35 | 320285 | 475785 | 0.017 | 30.0 | **0.06** | 0.0015 | 0.003 | 10.0 | **0.03** | 0.001 | 20.0 | **0.01** | 0.012 | 0.003 | 0.000 | 0.2 | **0.15** |
| 36 | 320965 | 475966 | 0.017 | 30.0 | **0.06** | 0.0015 | 0.003 | 10.0 | **0.03** | 0.001 | 20.0 | **0.01** | 0.012 | 0.003 | 0.000 | 0.2 | **0.15** |
| 37 | 321007 | 477551 | 0.009 | 30.0 | **0.03** | 0.0015 | 0.001 | 10.0 | **0.01** | 0.001 | 20.0 | **0.00** | 0.012 | 0.001 | 0.000 | 0.2 | **0.08** |
| 38 | 318772 | 471018 | 0.005 | 30.0 | **0.02** | 0.0015 | 0.001 | 10.0 | **0.01** | 0.000 | 20.0 | **0.00** | 0.012 | 0.001 | 0.000 | 0.2 | **0.05** |
| 39 | 317174 | 471716 | 0.007 | 30.0 | **0.02** | 0.0015 | 0.001 | 10.0 | **0.01** | 0.001 | 20.0 | **0.00** | 0.012 | 0.001 | 0.000 | 0.2 | **0.06** |
| 40 | 318695 | 469419 | 0.004 | 30.0 | **0.01** | 0.0015 | 0.001 | 10.0 | **0.01** | 0.000 | 20.0 | **0.00** | 0.012 | 0.001 | 0.000 | 0.2 | **0.03** |
| 41 | 316817 | 474029 | 0.010 | 30.0 | **0.03** | 0.0015 | 0.001 | 10.0 | **0.01** | 0.001 | 20.0 | **0.00** | 0.012 | 0.001 | 0.000 | 0.2 | **0.09** |
| 42 | 317577 | 476496 | 0.008 | 30.0 | **0.03** | 0.0015 | 0.001 | 10.0 | **0.01** | 0.001 | 20.0 | **0.00** | 0.012 | 0.001 | 0.000 | 0.2 | **0.07** |
| 43 | 321838 | 479549 | 0.004 | 30.0 | **0.01** | 0.0015 | 0.001 | 10.0 | **0.01** | 0.000 | 20.0 | **0.00** | 0.012 | 0.001 | 0.000 | 0.2 | **0.04** |
| 44 | 318211 | 480322 | 0.004 | 30.0 | **0.01** | 0.0015 | 0.001 | 10.0 | **0.01** | 0.000 | 20.0 | **0.00** | 0.012 | 0.001 | 0.000 | 0.2 | **0.03** |
| 45 | 314763 | 476725 | 0.005 | 30.0 | **0.02** | 0.0015 | 0.001 | 10.0 | **0.01** | 0.000 | 20.0 | **0.00** | 0.012 | 0.001 | 0.000 | 0.2 | **0.04** |
| 46 | 315238 | 472860 | 0.005 | 30.0 | **0.02** | 0.0015 | 0.001 | 10.0 | **0.01** | 0.000 | 20.0 | **0.00** | 0.012 | 0.001 | 0.000 | 0.2 | **0.04** |
| 47 | 316992 | 468133 | 0.002 | 30.0 | **0.01** | 0.0015 | 0.000 | 10.0 | **0.00** | 0.000 | 20.0 | **0.00** | 0.012 | 0.000 | 0.000 | 0.2 | **0.02** |
| 48 | 319817 | 466765 | 0.007 | 30.0 | **0.02** | 0.0015 | 0.001 | 10.0 | **0.01** | 0.001 | 20.0 | **0.00** | 0.012 | 0.001 | 0.000 | 0.2 | **0.06** |
| 49 | 322106 | 468252 | 0.007 | 30.0 | **0.02** | 0.0015 | 0.001 | 10.0 | **0.01** | 0.001 | 20.0 | **0.00** | 0.012 | 0.001 | 0.000 | 0.2 | **0.06** |
| 50 | 323176 | 465814 | 0.004 | 30.0 | **0.01** | 0.0015 | 0.001 | 10.0 | **0.01** | 0.000 | 20.0 | **0.00** | 0.012 | 0.001 | 0.000 | 0.2 | **0.03** |
| 51 | 326149 | 468341 | 0.005 | 30.0 | **0.02** | 0.0015 | 0.001 | 10.0 | **0.01** | 0.000 | 20.0 | **0.00** | 0.012 | 0.001 | 0.000 | 0.2 | **0.05** |
| 52 | 328855 | 471462 | 0.006 | 30.0 | **0.02** | 0.0015 | 0.001 | 10.0 | **0.01** | 0.000 | 20.0 | **0.00** | 0.012 | 0.001 | 0.000 | 0.2 | **0.05** |
| 53 | 330460 | 474346 | 0.004 | 30.0 | **0.01** | 0.0015 | 0.001 | 10.0 | **0.01** | 0.000 | 20.0 | **0.00** | 0.012 | 0.001 | 0.000 | 0.2 | **0.04** |
| 54 | 322522 | 482403 | 0.002 | 30.0 | **0.01** | 0.0015 | 0.000 | 10.0 | **0.00** | 0.000 | 20.0 | **0.00** | 0.012 | 0.000 | 0.000 | 0.2 | **0.02** |
| 55 | 318449 | 482255 | 0.003 | 30.0 | **0.01** | 0.0015 | 0.000 | 10.0 | **0.00** | 0.000 | 20.0 | **0.00** | 0.012 | 0.000 | 0.000 | 0.2 | **0.03** |
| 56 | 316160 | 478568 | 0.005 | 30.0 | **0.02** | 0.0015 | 0.001 | 10.0 | **0.01** | 0.000 | 20.0 | **0.00** | 0.012 | 0.001 | 0.000 | 0.2 | **0.04** |
| 57 | 313306 | 478003 | 0.004 | 30.0 | **0.01** | 0.0015 | 0.001 | 10.0 | **0.01** | 0.000 | 20.0 | **0.00** | 0.012 | 0.001 | 0.000 | 0.2 | **0.03** |
| 58 | 319971 | 465025 | 0.005 | 30.0 | **0.02** | 0.0015 | 0.001 | 10.0 | **0.01** | 0.000 | 20.0 | **0.00** | 0.012 | 0.001 | 0.000 | 0.2 | **0.05** |
| 59 | 328409 | 467895 | 0.006 | 30.0 | **0.02** | 0.0015 | 0.001 | 10.0 | **0.01** | 0.000 | 20.0 | **0.00** | 0.012 | 0.001 | 0.000 | 0.2 | **0.05** |

# 6. Summary and Conclusions

AS Modelling & Data Ltd. has been instructed by Dave Baldwin of Recogen Ltd. on behalf of Mr Liam Armistead, to use computer modelling to assess the impact of emissions of nitrogen oxides, sulphur dioxide, particulate matter and carbon monoxide from the proposed biomass boiler at Sinkfall Farm, Rakesmore Lane, Barrow-in-Furness, Cumbria. LA14 4QE.

Emissions of nitrogen oxides ($NO_X$), sulphur dioxide ($SO_2$), particulate matter ($PM_{10}$) and carbon monoxide (CO) from the stacks serving the two proposed biomass boilers have been assessed and quantified based upon data supplied to AS Modelling & Data Ltd. by Recogen Ltd. The $NO_x$, $SO_2$, $PM_{10}$ and CO emission rates have then been used as the basis of inputs to an atmospheric dispersion model which calculates nitrogen oxides $NO_x$, $SO_2$, $PM_{10}$ and CO exposure levels in the surrounding area.

Note that the modelling assumes continuous emissions from the stack. Therefore, although the maximum predicted values for short term averaging periods for 1 hour $NO_2$, 1 hour $SO_2$ and 15 minute $SO_2$ may be realistic; in reality, for the longer term statistics, the real values would be considerably lower than those predicted by the modelling of continuous emissions.

## 6.1 $NO_2$

There are no predicted exceedances of the EAL of 40 µg/m$^3$ for $NO_2$ as an annual mean. Assuming continuous emissions, at the maximum point the magnitude of the PC is 13.0% of the EAL; the change is greater than 10% of the EAL and the PEC is less than 75% of the EAL; therefore, the impact would be described as Moderate using the Land Use Planning & Development Control: Planning For Air Quality criteria. At all residential receptors, the impact would be described as Negligible using the Land Use Planning & Development Control: Planning For Air Quality criteria.

There are no predicted exceedances of the EAL of 200 µg/m$^3$, for 1 hour mean $NO_2$.

## 6.2 $SO_2$

There are no predicted exceedances of the EAL of 125 µg/m$^3$, for 24 hour mean $SO_2$.

There are no predicted exceedances of the EAL of 350 µg/m$^3$, for 1 hour mean $SO_2$.

There are no predicted exceedances of the EAL of 266 µg/m$^3$, for 15 minute mean $SO_2$.

## 6.3 $PM_{10}$

Assuming continuous emissions, there are no predicted exceedances of the EAL of 40 µg/$m^3$ for $PM_{10}$ as an annual mean. Assuming continuous emissions, at the maximum point the magnitude of the PC is 3.8% of the EAL; the change is less than 10% of the EAL and the PEC is below 75 % of the EAL; therefore, the impact would be described as Negligible using the Land Use Planning & Development Control: Planning For Air Quality criteria.

There are no predicted exceedances of the EAL of 50 µg/$m^3$, for 24 hour mean $PM_{10}$.

## 6.3 CO

There are no predicted exceedances of the EAL of 10mg/$m^3$, for 8 hour running mean CO.

## 6.4 Ecological Receptors

There are three receptors at Mill Wood AW (receptors 1, 2 and 3) and one receptor at Hagg Spring Wood AW (receptor 5) to the west of the site, where there is a very small predicted exceedance of 1% of the Critical Level for $NO_2$. At all other receptors considered, all measures of impact; $NO_2$ concentration, $SO_2$ concentration, N deposition and H+ deposition, are below 1% of the relevant Critical Level or Critical Load and therefore would normally be deemed insignificant.

# 7. References

Cambridge Environmental Research Consultants (CERC) (website).
http://www.cerc.co.uk/environmental-software/ADMS-model.html

Environment Agency H1 Risk Assessment (website).
http://www.environment-agency.gov.uk/business/topics/permitting/36414.aspx

Environment Agency. CONVERSION RATIOS FOR NOX AND NO2
http://www.environment-agency.gov.uk/static/documents/Conversion_ratios_for__NOx_and_NO2_.pdf

Environmental Protection UK. Development Control: Planning For Air Quality (2010 Update)

Environmental Protection UK. Land Use Planning & Development Control: Planning For Air Quality (2015 Update)

UK Air Pollution Information System (APIS) (website).
http://www.apis.ac.uk/

# Annex 1 – Predicted concentrations at the discrete receptors

*Table A1a. Maximum annual mean $NO_2$ concentration*

| Receptor Number | X(m) | Y(m) | Maximum annual $NO_2$ concentration (µg/m$^3$) | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| | | | PC | Background | EAL | PEC | PC as %age of EAL | %age change from background levels | Air quality impact descriptors | Exceedances of EAL predicted |
| Maximum | 321225 | 473537.5 | 5.2 | 7.2 | 40.0 | 12.4 | 13.0 | 72.6 | Moderate | None |
| Max Exceedances | - | - | - | - | - | - | - | - | - | - |
| 1 | 321183 | 473572 | 0.8 | 7.2 | 40.0 | 8.0 | 2.0 | 11.4 | Negligible | None |
| 2 | 321161 | 473557 | 1.1 | 7.2 | 40.0 | 8.3 | 2.8 | 15.5 | Negligible | None |
| 3 | 321383 | 473779 | 0.4 | 7.2 | 40.0 | 7.6 | 1.1 | 6.0 | Negligible | None |
| 4 | 321414 | 473723 | 0.6 | 7.2 | 40.0 | 7.7 | 1.4 | 7.8 | Negligible | None |
| 5 | 321449 | 473613 | 0.6 | 7.2 | 40.0 | 7.8 | 1.6 | 8.8 | Negligible | None |
| 6 | 321459 | 473546 | 0.7 | 7.2 | 40.0 | 7.9 | 1.7 | 9.7 | Negligible | None |
| 7 | 321495 | 473450 | 0.6 | 7.2 | 40.0 | 7.7 | 1.4 | 7.8 | Negligible | None |
| 8 | 321547 | 473347 | 0.3 | 7.2 | 40.0 | 7.5 | 0.9 | 4.8 | Negligible | None |
| 9 | 321744 | 473942 | 0.1 | 7.2 | 40.0 | 7.3 | 0.3 | 1.7 | Negligible | None |
| 10 | 321826 | 473833 | 0.1 | 7.2 | 40.0 | 7.3 | 0.3 | 1.7 | Negligible | None |
| 11 | 321839 | 473987 | 0.1 | 7.2 | 40.0 | 7.3 | 0.2 | 1.3 | Negligible | None |
| 12 | 320953 | 474008 | 0.1 | 6.8 | 40.0 | 7.0 | 0.4 | 2.2 | Negligible | None |
| 13 | 320882 | 474012 | 0.1 | 6.8 | 40.0 | 7.0 | 0.4 | 2.2 | Negligible | None |
| 14 | 320826 | 473971 | 0.1 | 8.0 | 40.0 | 8.2 | 0.4 | 1.9 | Negligible | None |
| 15 | 320259 | 473457 | 0.1 | 8.0 | 40.0 | 8.1 | 0.1 | 0.7 | Negligible | None |
| 16 | 320382 | 473608 | 0.1 | 8.0 | 40.0 | 8.1 | 0.2 | 1.1 | Negligible | None |
| 17 | 320438 | 473799 | 0.1 | 8.0 | 40.0 | 8.1 | 0.2 | 1.1 | Negligible | None |
| 18 | 320272 | 473724 | 0.1 | 8.0 | 40.0 | 8.1 | 0.2 | 0.9 | Negligible | None |
| 19 | 320819 | 474381 | 0.1 | 6.8 | 40.0 | 6.9 | 0.1 | 0.9 | Negligible | None |
| 20 | 321035 | 474382 | 0.1 | 8.9 | 40.0 | 9.0 | 0.2 | 0.7 | Negligible | None |
| 21 | 321097 | 474339 | 0.1 | 8.9 | 40.0 | 9.0 | 0.2 | 0.8 | Negligible | None |
| 22 | 321407 | 474531 | 0.0 | 8.9 | 40.0 | 9.0 | 0.1 | 0.5 | Negligible | None |
| 23 | 321597 | 474243 | 0.1 | 8.9 | 40.0 | 9.0 | 0.2 | 0.9 | Negligible | None |
| 24 | 321572 | 474374 | 0.1 | 8.9 | 40.0 | 9.0 | 0.1 | 0.7 | Negligible | None |
| 25 | 321790 | 473026 | 0.1 | 7.2 | 40.0 | 7.3 | 0.2 | 1.2 | Negligible | None |
| 26 | 321632 | 472634 | 0.0 | 7.5 | 40.0 | 7.6 | 0.1 | 0.5 | Negligible | None |
| 27 | 321280 | 472549 | 0.1 | 7.5 | 40.0 | 7.6 | 0.2 | 0.9 | Negligible | None |
| 28 | 321145 | 472557 | 0.1 | 7.5 | 40.0 | 7.6 | 0.1 | 0.7 | Negligible | None |
| 29 | 320973 | 472588 | 0.0 | 8.2 | 40.0 | 8.2 | 0.1 | 0.3 | Negligible | None |
| 30 | 320815 | 472717 | 0.0 | 8.2 | 40.0 | 8.2 | 0.1 | 0.3 | Negligible | None |

*Table A1b. Maximum 1 hour mean $NO_2$ concentration*

| Receptor Number | X(m) | Y(m) | Maximum 1hr $NO_2$ concentration ($\mu g/m^3$) | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| | | | PC | Background | EAL | PEC | PC as %age of EAL | %age change from background levels | Air quality impact descriptors | Exceedances of EAL predicted |
| Maximum | 321212.5 | 473512.5 | 94.1 | 14.3 | 200.0 | 108.4 | 47.1 | 656.0 | | 0.0 |
| Max Exceedances | | | | | | | | | | |
| 1 | 321183 | 473572 | 12.4 | 14.3 | 200.0 | 26.8 | 6.2 | 86.7 | | 0.0 |
| 2 | 321161 | 473557 | 11.6 | 14.3 | 200.0 | 26.0 | 5.8 | 81.0 | | 0.0 |
| 3 | 321383 | 473779 | 4.0 | 14.3 | 200.0 | 18.4 | 2.0 | 28.2 | | 0.0 |
| 4 | 321414 | 473723 | 4.2 | 14.3 | 200.0 | 18.5 | 2.1 | 29.3 | | 0.0 |
| 5 | 321449 | 473613 | 4.4 | 14.3 | 200.0 | 18.7 | 2.2 | 30.7 | | 0.0 |
| 6 | 321459 | 473546 | 4.4 | 14.3 | 200.0 | 18.7 | 2.2 | 30.6 | | 0.0 |
| 7 | 321495 | 473450 | 3.6 | 14.3 | 200.0 | 17.9 | 1.8 | 24.8 | | 0.0 |
| 8 | 321547 | 473347 | 2.9 | 14.3 | 200.0 | 17.2 | 1.4 | 20.0 | | 0.0 |
| 9 | 321744 | 473942 | 2.1 | 14.3 | 200.0 | 16.4 | 1.0 | 14.4 | | 0.0 |
| 10 | 321826 | 473833 | 2.0 | 14.3 | 200.0 | 16.3 | 1.0 | 13.8 | | 0.0 |
| 11 | 321839 | 473987 | 1.8 | 14.3 | 200.0 | 16.2 | 0.9 | 12.6 | | 0.0 |
| 12 | 320953 | 474008 | 1.7 | 13.6 | 200.0 | 15.4 | 0.9 | 12.5 | | 0.0 |
| 13 | 320882 | 474012 | 1.9 | 13.6 | 200.0 | 15.5 | 0.9 | 13.7 | | 0.0 |
| 14 | 320826 | 473971 | 1.6 | 16.1 | 200.0 | 17.7 | 0.8 | 10.1 | | 0.0 |
| 15 | 320259 | 473457 | 1.0 | 16.1 | 200.0 | 17.1 | 0.5 | 6.5 | | 0.0 |
| 16 | 320382 | 473608 | 1.1 | 16.1 | 200.0 | 17.1 | 0.5 | 6.6 | | 0.0 |
| 17 | 320438 | 473799 | 1.2 | 16.1 | 200.0 | 17.2 | 0.6 | 7.2 | | 0.0 |
| 18 | 320272 | 473724 | 1.0 | 16.1 | 200.0 | 17.0 | 0.5 | 6.0 | | 0.0 |
| 19 | 320819 | 474381 | 1.2 | 13.6 | 200.0 | 14.9 | 0.6 | 9.0 | | 0.0 |
| 20 | 321035 | 474382 | 1.3 | 17.9 | 200.0 | 19.2 | 0.7 | 7.5 | | 0.0 |
| 21 | 321097 | 474339 | 1.5 | 17.9 | 200.0 | 19.3 | 0.7 | 8.2 | | 0.0 |
| 22 | 321407 | 474531 | 1.2 | 17.9 | 200.0 | 19.1 | 0.6 | 6.7 | | 0.0 |
| 23 | 321597 | 474243 | 1.6 | 17.9 | 200.0 | 19.5 | 0.8 | 9.1 | | 0.0 |
| 24 | 321572 | 474374 | 1.4 | 17.9 | 200.0 | 19.2 | 0.7 | 7.7 | | 0.0 |
| 25 | 321790 | 473026 | 1.6 | 14.3 | 200.0 | 15.9 | 0.8 | 11.0 | | 0.0 |
| 26 | 321632 | 472634 | 1.3 | 15.1 | 200.0 | 16.4 | 0.7 | 8.6 | | 0.0 |
| 27 | 321280 | 472549 | 9.7 | 15.1 | 200.0 | 24.8 | 4.8 | 64.0 | | 0.0 |
| 28 | 321145 | 472557 | 9.1 | 15.1 | 200.0 | 24.2 | 4.6 | 60.3 | | 0.0 |
| 29 | 320973 | 472588 | 2.7 | 16.4 | 200.0 | 19.1 | 1.4 | 16.6 | | 0.0 |
| 30 | 320815 | 472717 | 1.1 | 16.4 | 200.0 | 17.5 | 0.5 | 6.7 | | 0.0 |

*Table A1c. Maximum 24 hour mean $SO_2$ concentration*

| Receptor Number | X(m) | Y(m) | Maximum 24hr $SO_2$ concentration ($\mu g/m^3$) | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| | | | PC | Background | EAL | PEC | PC as %age of EAL | %age change from background levels | Air quality impact descriptors | Exceedances of EAL predicted |
| Maximum | 321175 | 473500 | 1.7 | 3.3 | 125.0 | 5.0 | 1.4 | 53.0 | | 0.0 |
| Max Exceedances | | | | | | | | | | |
| 1 | 321183 | 473572 | 0.8 | 3.3 | 125.0 | 4.1 | 0.7 | 25.1 | | 0.0 |
| 2 | 321161 | 473557 | 1.0 | 3.3 | 125.0 | 4.3 | 0.8 | 31.0 | | 0.0 |
| 3 | 321383 | 473779 | 0.4 | 3.3 | 125.0 | 3.7 | 0.3 | 13.3 | | 0.0 |
| 4 | 321414 | 473723 | 0.4 | 3.3 | 125.0 | 3.7 | 0.3 | 12.9 | | 0.0 |
| 5 | 321449 | 473613 | 0.6 | 3.3 | 125.0 | 3.8 | 0.4 | 16.9 | | 0.0 |
| 6 | 321459 | 473546 | 0.5 | 3.3 | 125.0 | 3.8 | 0.4 | 16.8 | | 0.0 |
| 7 | 321495 | 473450 | 0.4 | 3.3 | 125.0 | 3.7 | 0.3 | 11.7 | | 0.0 |
| 8 | 321547 | 473347 | 0.4 | 3.3 | 125.0 | 3.6 | 0.3 | 10.8 | | 0.0 |
| 9 | 321744 | 473942 | 0.2 | 3.3 | 125.0 | 3.4 | 0.1 | 4.6 | | 0.0 |
| 10 | 321826 | 473833 | 0.1 | 3.3 | 125.0 | 3.4 | 0.1 | 3.6 | | 0.0 |
| 11 | 321839 | 473987 | 0.1 | 3.3 | 125.0 | 3.4 | 0.1 | 3.8 | | 0.0 |
| 12 | 320953 | 474008 | 0.2 | 3.3 | 125.0 | 3.5 | 0.2 | 6.6 | | 0.0 |
| 13 | 320882 | 474012 | 0.2 | 3.3 | 125.0 | 3.5 | 0.2 | 6.9 | | 0.0 |
| 14 | 320826 | 473971 | 0.2 | 3.4 | 125.0 | 3.6 | 0.2 | 7.2 | | 0.0 |
| 15 | 320259 | 473457 | 0.1 | 3.4 | 125.0 | 3.5 | 0.1 | 2.9 | | 0.0 |
| 16 | 320382 | 473608 | 0.1 | 3.4 | 125.0 | 3.5 | 0.1 | 3.5 | | 0.0 |
| 17 | 320438 | 473799 | 0.1 | 3.4 | 125.0 | 3.5 | 0.1 | 3.4 | | 0.0 |
| 18 | 320272 | 473724 | 0.1 | 3.4 | 125.0 | 3.5 | 0.1 | 3.0 | | 0.0 |
| 19 | 320819 | 474381 | 0.1 | 3.3 | 125.0 | 3.4 | 0.1 | 2.6 | | 0.0 |
| 20 | 321035 | 474382 | 0.1 | 3.2 | 125.0 | 3.3 | 0.1 | 3.3 | | 0.0 |
| 21 | 321097 | 474339 | 0.1 | 3.2 | 125.0 | 3.3 | 0.1 | 3.1 | | 0.0 |
| 22 | 321407 | 474531 | 0.1 | 3.2 | 125.0 | 3.3 | 0.1 | 2.0 | | 0.0 |
| 23 | 321597 | 474243 | 0.1 | 3.2 | 125.0 | 3.3 | 0.1 | 3.0 | | 0.0 |
| 24 | 321572 | 474374 | 0.1 | 3.2 | 125.0 | 3.3 | 0.1 | 2.9 | | 0.0 |
| 25 | 321790 | 473026 | 0.1 | 3.3 | 125.0 | 3.4 | 0.1 | 3.4 | | 0.0 |
| 26 | 321632 | 472634 | 0.1 | 3.6 | 125.0 | 3.6 | 0.1 | 2.4 | | 0.0 |
| 27 | 321280 | 472549 | 0.2 | 3.6 | 125.0 | 3.7 | 0.1 | 5.2 | | 0.0 |
| 28 | 321145 | 472557 | 0.2 | 3.6 | 125.0 | 3.8 | 0.2 | 6.3 | | 0.0 |
| 29 | 320973 | 472588 | 0.1 | 3.7 | 125.0 | 3.7 | 0.1 | 2.1 | | 0.0 |
| 30 | 320815 | 472717 | 0.1 | 3.7 | 125.0 | 3.7 | 0.1 | 2.2 | | 0.0 |

*Table A1d. Maximum 1 hour mean $SO_2$ concentration*

| Receptor Number | X(m) | Y(m) | Maximum 1hr $SO_2$ concentration ($\mu g/m^3$) | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| | | | PC | Background | EAL | PEC | PC as %age of EAL | %age change from background levels | Air quality impact descriptors | Exceedances of EAL predicted |
| Maximum | 321212.5 | 473512.5 | 21.0 | 3.3 | 350.0 | 24.3 | 6.0 | 641.3 | | 0.0 |
| Max Exceedances | - | - | - | - | - | - | - | - | - | - |
| 1 | 321183 | 473572 | 2.8 | 3.3 | 350.0 | 6.1 | 0.8 | 84.8 | | 0.0 |
| 2 | 321161 | 473557 | 2.6 | 3.3 | 350.0 | 5.9 | 0.7 | 79.2 | | 0.0 |
| 3 | 321383 | 473779 | 0.9 | 3.3 | 350.0 | 4.2 | 0.3 | 27.6 | | 0.0 |
| 4 | 321414 | 473723 | 0.9 | 3.3 | 350.0 | 4.2 | 0.3 | 28.6 | | 0.0 |
| 5 | 321449 | 473613 | 1.0 | 3.3 | 350.0 | 4.3 | 0.3 | 30.0 | | 0.0 |
| 6 | 321459 | 473546 | 1.0 | 3.3 | 350.0 | 4.3 | 0.3 | 29.9 | | 0.0 |
| 7 | 321495 | 473450 | 0.8 | 3.3 | 350.0 | 4.1 | 0.2 | 24.2 | | 0.0 |
| 8 | 321547 | 473347 | 0.6 | 3.3 | 350.0 | 3.9 | 0.2 | 19.5 | | 0.0 |
| 9 | 321744 | 473942 | 0.5 | 3.3 | 350.0 | 3.7 | 0.1 | 14.1 | | 0.0 |
| 10 | 321826 | 473833 | 0.4 | 3.3 | 350.0 | 3.7 | 0.1 | 13.5 | | 0.0 |
| 11 | 321839 | 473987 | 0.4 | 3.3 | 350.0 | 3.7 | 0.1 | 12.3 | | 0.0 |
| 12 | 320953 | 474008 | 0.4 | 3.3 | 350.0 | 3.7 | 0.1 | 11.6 | | 0.0 |
| 13 | 320882 | 474012 | 0.4 | 3.3 | 350.0 | 3.7 | 0.1 | 12.7 | | 0.0 |
| 14 | 320826 | 473971 | 0.4 | 3.4 | 350.0 | 3.8 | 0.1 | 10.7 | | 0.0 |
| 15 | 320259 | 473457 | 0.2 | 3.4 | 350.0 | 3.6 | 0.1 | 6.8 | | 0.0 |
| 16 | 320382 | 473608 | 0.2 | 3.4 | 350.0 | 3.6 | 0.1 | 7.0 | | 0.0 |
| 17 | 320438 | 473799 | 0.3 | 3.4 | 350.0 | 3.7 | 0.1 | 7.6 | | 0.0 |
| 18 | 320272 | 473724 | 0.2 | 3.4 | 350.0 | 3.6 | 0.1 | 6.3 | | 0.0 |
| 19 | 320819 | 474381 | 0.3 | 3.3 | 350.0 | 3.6 | 0.1 | 8.3 | | 0.0 |
| 20 | 321035 | 474382 | 0.3 | 3.2 | 350.0 | 3.5 | 0.1 | 9.3 | | 0.0 |
| 21 | 321097 | 474339 | 0.3 | 3.2 | 350.0 | 3.5 | 0.1 | 10.2 | | 0.0 |
| 22 | 321407 | 474531 | 0.3 | 3.2 | 350.0 | 3.5 | 0.1 | 8.3 | | 0.0 |
| 23 | 321597 | 474243 | 0.4 | 3.2 | 350.0 | 3.6 | 0.1 | 11.2 | | 0.0 |
| 24 | 321572 | 474374 | 0.3 | 3.2 | 350.0 | 3.5 | 0.1 | 9.5 | | 0.0 |
| 25 | 321790 | 473026 | 0.4 | 3.3 | 350.0 | 3.6 | 0.1 | 10.8 | | 0.0 |
| 26 | 321632 | 472634 | 0.3 | 3.6 | 350.0 | 3.9 | 0.1 | 8.2 | | 0.0 |
| 27 | 321280 | 472549 | 2.2 | 3.6 | 350.0 | 5.7 | 0.6 | 60.6 | | 0.0 |
| 28 | 321145 | 472557 | 2.0 | 3.6 | 350.0 | 5.6 | 0.6 | 57.2 | | 0.0 |
| 29 | 320973 | 472588 | 0.6 | 3.7 | 350.0 | 4.3 | 0.2 | 16.6 | | 0.0 |
| 30 | 320815 | 472717 | 0.2 | 3.7 | 350.0 | 3.9 | 0.1 | 6.7 | | 0.0 |

*Table A1e. Maximum 15 minute mean $SO_2$ concentration*

| Receptor Number | X(m) | Y(m) | Maximum 15 min $SO_2$ concentration ($\mu g/m^3$) | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| | | | PC | Background | EAL | PEC | PC as %age of EAL | %age change from background levels | Air quality impact descriptors | Exceedances of EAL predicted |
| Maximum | 321212.5 | 473512.5 | 21.3 | 3.3 | 266.0 | 24.6 | 8.0 | 649.2 | | 0.0 |
| Max Exceedances | - | - | - | - | - | - | - | - | - | - |
| 1 | 321183 | 473572 | 2.8 | 3.3 | 266.0 | 6.1 | 1.1 | 86.0 | | 0.0 |
| 2 | 321161 | 473557 | 2.8 | 3.3 | 266.0 | 6.1 | 1.0 | 84.6 | | 0.0 |
| 3 | 321383 | 473779 | 1.1 | 3.3 | 266.0 | 4.3 | 0.4 | 32.4 | | 0.0 |
| 4 | 321414 | 473723 | 1.1 | 3.3 | 266.0 | 4.4 | 0.4 | 33.3 | | 0.0 |
| 5 | 321449 | 473613 | 1.1 | 3.3 | 266.0 | 4.4 | 0.4 | 34.8 | | 0.0 |
| 6 | 321459 | 473546 | 1.2 | 3.3 | 266.0 | 4.4 | 0.4 | 35.4 | | 0.0 |
| 7 | 321495 | 473450 | 0.9 | 3.3 | 266.0 | 4.2 | 0.4 | 28.4 | | 0.0 |
| 8 | 321547 | 473347 | 0.8 | 3.3 | 266.0 | 4.1 | 0.3 | 25.0 | | 0.0 |
| 9 | 321744 | 473942 | 0.7 | 3.3 | 266.0 | 4.0 | 0.3 | 21.0 | | 0.0 |
| 10 | 321826 | 473833 | 0.7 | 3.3 | 266.0 | 3.9 | 0.2 | 19.9 | | 0.0 |
| 11 | 321839 | 473987 | 0.6 | 3.3 | 266.0 | 3.9 | 0.2 | 18.9 | | 0.0 |
| 12 | 320953 | 474008 | 0.5 | 3.3 | 266.0 | 3.8 | 0.2 | 16.5 | | 0.0 |
| 13 | 320882 | 474012 | 0.6 | 3.3 | 266.0 | 3.9 | 0.2 | 19.1 | | 0.0 |
| 14 | 320826 | 473971 | 0.5 | 3.4 | 266.0 | 3.9 | 0.2 | 15.3 | | 0.0 |
| 15 | 320259 | 473457 | 0.4 | 3.4 | 266.0 | 3.8 | 0.1 | 10.6 | | 0.0 |
| 16 | 320382 | 473608 | 0.4 | 3.4 | 266.0 | 3.8 | 0.1 | 11.5 | | 0.0 |
| 17 | 320438 | 473799 | 0.4 | 3.4 | 266.0 | 3.8 | 0.2 | 11.8 | | 0.0 |
| 18 | 320272 | 473724 | 0.3 | 3.4 | 266.0 | 3.7 | 0.1 | 10.2 | | 0.0 |
| 19 | 320819 | 474381 | 0.4 | 3.3 | 266.0 | 3.7 | 0.2 | 13.0 | | 0.0 |
| 20 | 321035 | 474382 | 0.4 | 3.2 | 266.0 | 3.7 | 0.2 | 13.9 | | 0.0 |
| 21 | 321097 | 474339 | 0.5 | 3.2 | 266.0 | 3.7 | 0.2 | 15.2 | | 0.0 |
| 22 | 321407 | 474531 | 0.4 | 3.2 | 266.0 | 3.7 | 0.2 | 13.8 | | 0.0 |
| 23 | 321597 | 474243 | 0.5 | 3.2 | 266.0 | 3.7 | 0.2 | 16.4 | | 0.0 |
| 24 | 321572 | 474374 | 0.5 | 3.2 | 266.0 | 3.7 | 0.2 | 14.5 | | 0.0 |
| 25 | 321790 | 473026 | 0.5 | 3.3 | 266.0 | 3.8 | 0.2 | 16.3 | | 0.0 |
| 26 | 321632 | 472634 | 0.5 | 3.6 | 266.0 | 4.0 | 0.2 | 13.6 | | 0.0 |
| 27 | 321280 | 472549 | 3.9 | 3.6 | 266.0 | 7.5 | 1.5 | 110.7 | | 0.0 |
| 28 | 321145 | 472557 | 3.1 | 3.6 | 266.0 | 6.7 | 1.2 | 87.6 | | 0.0 |
| 29 | 320973 | 472588 | 0.6 | 3.7 | 266.0 | 4.2 | 0.2 | 15.6 | | 0.0 |
| 30 | 320815 | 472717 | 0.4 | 3.7 | 266.0 | 4.0 | 0.1 | 10.5 | | 0.0 |

*Table A1f. Maximum annual mean $PM_{10}$ concentration*

| Receptor Number | X(m) | Y(m) | Maximum annual $PM_{10}$ concentration ($\mu g/m^3$) | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| | | | PC | Background | EAL | PEC | PC as %age of EAL | %age change from background levels | Air quality impact descriptors | Exceedances of EAL predicted |
| Maximum | 321225 | 473537.5 | 1.5 | 12.4 | 40.0 | 14.0 | 3.8 | 12.2 | Negligible | No |
| Max Exceedances | - | - | - | - | - | - | - | - | - | - |
| 1 | 321183 | 473572 | 0.2 | 12.4 | 40.0 | 12.7 | 0.6 | 1.9 | Negligible | None |
| 2 | 321161 | 473557 | 0.3 | 12.4 | 40.0 | 12.8 | 0.8 | 2.6 | Negligible | None |
| 3 | 321383 | 473779 | 0.1 | 12.4 | 40.0 | 12.6 | 0.3 | 1.0 | Negligible | None |
| 4 | 321414 | 473723 | 0.2 | 12.4 | 40.0 | 12.6 | 0.4 | 1.3 | Negligible | None |
| 5 | 321449 | 473613 | 0.2 | 12.4 | 40.0 | 12.6 | 0.5 | 1.5 | Negligible | None |
| 6 | 321459 | 473546 | 0.2 | 12.4 | 40.0 | 12.6 | 0.5 | 1.6 | Negligible | None |
| 7 | 321495 | 473450 | 0.2 | 12.4 | 40.0 | 12.6 | 0.4 | 1.3 | Negligible | None |
| 8 | 321547 | 473347 | 0.1 | 12.4 | 40.0 | 12.5 | 0.3 | 0.8 | Negligible | None |
| 9 | 321744 | 473942 | 0.0 | 12.4 | 40.0 | 12.5 | 0.1 | 0.3 | Negligible | None |
| 10 | 321826 | 473833 | 0.0 | 12.4 | 40.0 | 12.5 | 0.1 | 0.3 | Negligible | None |
| 11 | 321839 | 473987 | 0.0 | 12.4 | 40.0 | 12.5 | 0.1 | 0.2 | Negligible | None |
| 12 | 320953 | 474008 | 0.0 | 11.4 | 40.0 | 11.4 | 0.1 | 0.4 | Negligible | None |
| 13 | 320882 | 474012 | 0.0 | 11.4 | 40.0 | 11.4 | 0.1 | 0.4 | Negligible | None |
| 14 | 320826 | 473971 | 0.0 | 12.1 | 40.0 | 12.1 | 0.1 | 0.4 | Negligible | None |
| 15 | 320259 | 473457 | 0.0 | 12.1 | 40.0 | 12.1 | 0.0 | 0.1 | Negligible | None |
| 16 | 320382 | 473608 | 0.0 | 12.1 | 40.0 | 12.1 | 0.1 | 0.2 | Negligible | None |
| 17 | 320438 | 473799 | 0.0 | 12.1 | 40.0 | 12.1 | 0.1 | 0.2 | Negligible | None |
| 18 | 320272 | 473724 | 0.0 | 12.1 | 40.0 | 12.1 | 0.1 | 0.2 | Negligible | None |
| 19 | 320819 | 474381 | 0.0 | 11.4 | 40.0 | 11.4 | 0.0 | 0.2 | Negligible | None |
| 20 | 321035 | 474382 | 0.0 | 12.4 | 40.0 | 12.4 | 0.0 | 0.2 | Negligible | None |
| 21 | 321097 | 474339 | 0.0 | 12.4 | 40.0 | 12.4 | 0.1 | 0.2 | Negligible | None |
| 22 | 321407 | 474531 | 0.0 | 12.4 | 40.0 | 12.4 | 0.0 | 0.1 | Negligible | None |
| 23 | 321597 | 474243 | 0.0 | 12.4 | 40.0 | 12.4 | 0.1 | 0.2 | Negligible | None |
| 24 | 321572 | 474374 | 0.0 | 12.4 | 40.0 | 12.4 | 0.0 | 0.1 | Negligible | None |
| 25 | 321790 | 473026 | 0.0 | 12.4 | 40.0 | 12.5 | 0.1 | 0.2 | Negligible | None |
| 26 | 321632 | 472634 | 0.0 | 11.3 | 40.0 | 11.3 | 0.0 | 0.1 | Negligible | None |
| 27 | 321280 | 472549 | 0.0 | 11.3 | 40.0 | 11.3 | 0.0 | 0.2 | Negligible | None |
| 28 | 321145 | 472557 | 0.0 | 11.3 | 40.0 | 11.3 | 0.0 | 0.1 | Negligible | None |
| 29 | 320973 | 472588 | 0.0 | 10.8 | 40.0 | 10.8 | 0.0 | 0.1 | Negligible | None |
| 30 | 320815 | 472717 | 0.0 | 10.8 | 40.0 | 10.8 | 0.0 | 0.1 | Negligible | None |

*Table A1g. Maximum 24 hour mean $PM_{10}$ concentration*

| Receptor Number | X(m) | Y(m) | Maximum 24hr $PM_{10}$ concentration ($\mu g/m^3$) | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| | | | PC | Background | EAL | PEC | PC as %age of EAL | %age change from background levels | Air quality impact descriptors | Exceedances of EAL predicted |
| Maximum | 321175 | 473500 | 4.5 | 24.9 | 50.0 | 29.4 | 9.1 | 18.3 | | 0.0 |
| Max Exceedances | 321183.44 | 473571.59 | 2.15677 | 24.9 | 50.0 | 27.0 | 4.3 | 8.7 | | 0.0 |
| 1 | 321183 | 473572 | 2.2 | 24.9 | 50.0 | 27.0 | 4.3 | 8.7 | | 0.0 |
| 2 | 321161 | 473557 | 2.7 | 24.9 | 50.0 | 27.6 | 5.3 | 10.7 | | 0.0 |
| 3 | 321383 | 473779 | 1.1 | 24.9 | 50.0 | 26.0 | 2.3 | 4.6 | | 0.0 |
| 4 | 321414 | 473723 | 1.1 | 24.9 | 50.0 | 26.0 | 2.2 | 4.4 | | 0.0 |
| 5 | 321449 | 473613 | 1.4 | 24.9 | 50.0 | 26.3 | 2.9 | 5.8 | | 0.0 |
| 6 | 321459 | 473546 | 1.4 | 24.9 | 50.0 | 26.3 | 2.9 | 5.8 | | 0.0 |
| 7 | 321495 | 473450 | 1.0 | 24.9 | 50.0 | 25.9 | 2.0 | 4.0 | | 0.0 |
| 8 | 321547 | 473347 | 0.9 | 24.9 | 50.0 | 25.8 | 1.9 | 3.7 | | 0.0 |
| 9 | 321744 | 473942 | 0.4 | 24.9 | 50.0 | 25.3 | 0.8 | 1.6 | | 0.0 |
| 10 | 321826 | 473833 | 0.3 | 24.9 | 50.0 | 25.2 | 0.6 | 1.2 | | 0.0 |
| 11 | 321839 | 473987 | 0.3 | 24.9 | 50.0 | 25.2 | 0.7 | 1.3 | | 0.0 |
| 12 | 320953 | 474008 | 0.6 | 22.7 | 50.0 | 23.3 | 1.1 | 2.5 | | 0.0 |
| 13 | 320882 | 474012 | 0.6 | 22.7 | 50.0 | 23.3 | 1.2 | 2.6 | | 0.0 |
| 14 | 320826 | 473971 | 0.6 | 24.2 | 50.0 | 24.8 | 1.3 | 2.6 | | 0.0 |
| 15 | 320259 | 473457 | 0.3 | 24.2 | 50.0 | 24.5 | 0.5 | 1.1 | | 0.0 |
| 16 | 320382 | 473608 | 0.3 | 24.2 | 50.0 | 24.5 | 0.6 | 1.3 | | 0.0 |
| 17 | 320438 | 473799 | 0.3 | 24.2 | 50.0 | 24.5 | 0.6 | 1.2 | | 0.0 |
| 18 | 320272 | 473724 | 0.3 | 24.2 | 50.0 | 24.5 | 0.5 | 1.1 | | 0.0 |
| 19 | 320819 | 474381 | 0.2 | 22.7 | 50.0 | 23.0 | 0.4 | 1.0 | | 0.0 |
| 20 | 321035 | 474382 | 0.3 | 24.7 | 50.0 | 25.0 | 0.6 | 1.1 | | 0.0 |
| 21 | 321097 | 474339 | 0.3 | 24.7 | 50.0 | 25.0 | 0.5 | 1.1 | | 0.0 |
| 22 | 321407 | 474531 | 0.2 | 24.7 | 50.0 | 24.9 | 0.3 | 0.7 | | 0.0 |
| 23 | 321597 | 474243 | 0.3 | 24.7 | 50.0 | 25.0 | 0.5 | 1.0 | | 0.0 |
| 24 | 321572 | 474374 | 0.2 | 24.7 | 50.0 | 25.0 | 0.5 | 1.0 | | 0.0 |
| 25 | 321790 | 473026 | 0.3 | 24.9 | 50.0 | 25.2 | 0.6 | 1.2 | | 0.0 |
| 26 | 321632 | 472634 | 0.2 | 22.5 | 50.0 | 22.7 | 0.4 | 1.0 | | 0.0 |
| 27 | 321280 | 472549 | 0.5 | 22.5 | 50.0 | 23.0 | 1.0 | 2.2 | | 0.0 |
| 28 | 321145 | 472557 | 0.6 | 22.5 | 50.0 | 23.1 | 1.2 | 2.6 | | 0.0 |
| 29 | 320973 | 472588 | 0.2 | 21.6 | 50.0 | 21.8 | 0.4 | 0.9 | | 0.0 |
| 30 | 320815 | 472717 | 0.2 | 21.6 | 50.0 | 21.8 | 0.4 | 1.0 | | 0.0 |

*Table A1h. Maximum running 8 hour mean CO concentration*

| Receptor Number | X(m) | Y(m) | Maximum 8hr CO concentration (mg/m$^3$) | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| | | | PC | Background | EAL | PEC | PC as %age of EAL | %age change from background levels | Air quality impact descriptors | Exceedances of EAL predicted |
| Maximum | 321175 | 473500 | 0.039 | 0.374 | 10.000 | 0.413 | 0.4 | 10.3 | | 0.0 |
| Max Exceedances | - | - | - | - | - | - | - | - | - | - |
| 1 | 321183 | 473572 | 0.016 | 0.374 | 10.000 | 0.390 | 0.2 | 4.2 | | 0.0 |
| 2 | 321161 | 473557 | 0.017 | 0.374 | 10.000 | 0.391 | 0.2 | 4.5 | | 0.0 |
| 3 | 321383 | 473779 | 0.006 | 0.374 | 10.000 | 0.380 | 0.1 | 1.5 | | 0.0 |
| 4 | 321414 | 473723 | 0.007 | 0.374 | 10.000 | 0.381 | 0.1 | 1.8 | | 0.0 |
| 5 | 321449 | 473613 | 0.008 | 0.374 | 10.000 | 0.382 | 0.1 | 2.1 | | 0.0 |
| 6 | 321459 | 473546 | 0.007 | 0.374 | 10.000 | 0.381 | 0.1 | 1.9 | | 0.0 |
| 7 | 321495 | 473450 | 0.006 | 0.374 | 10.000 | 0.380 | 0.1 | 1.5 | | 0.0 |
| 8 | 321547 | 473347 | 0.004 | 0.374 | 10.000 | 0.378 | 0.0 | 1.1 | | 0.0 |
| 9 | 321744 | 473942 | 0.003 | 0.374 | 10.000 | 0.377 | 0.0 | 0.7 | | 0.0 |
| 10 | 321826 | 473833 | 0.002 | 0.374 | 10.000 | 0.376 | 0.0 | 0.5 | | 0.0 |
| 11 | 321839 | 473987 | 0.002 | 0.374 | 10.000 | 0.376 | 0.0 | 0.6 | | 0.0 |
| 12 | 320953 | 474008 | 0.003 | 0.352 | 10.000 | 0.355 | 0.0 | 0.8 | | 0.0 |
| 13 | 320882 | 474012 | 0.002 | 0.352 | 10.000 | 0.354 | 0.0 | 0.7 | | 0.0 |
| 14 | 320826 | 473971 | 0.003 | 0.364 | 10.000 | 0.367 | 0.0 | 0.7 | | 0.0 |
| 15 | 320259 | 473457 | 0.002 | 0.364 | 10.000 | 0.366 | 0.0 | 0.4 | | 0.0 |
| 16 | 320382 | 473608 | 0.002 | 0.364 | 10.000 | 0.366 | 0.0 | 0.4 | | 0.0 |
| 17 | 320438 | 473799 | 0.002 | 0.364 | 10.000 | 0.366 | 0.0 | 0.5 | | 0.0 |
| 18 | 320272 | 473724 | 0.001 | 0.364 | 10.000 | 0.365 | 0.0 | 0.4 | | 0.0 |
| 19 | 320819 | 474381 | 0.001 | 0.352 | 10.000 | 0.353 | 0.0 | 0.4 | | 0.0 |
| 20 | 321035 | 474382 | 0.001 | 0.362 | 10.000 | 0.363 | 0.0 | 0.4 | | 0.0 |
| 21 | 321097 | 474339 | 0.002 | 0.362 | 10.000 | 0.364 | 0.0 | 0.5 | | 0.0 |
| 22 | 321407 | 474531 | 0.001 | 0.362 | 10.000 | 0.363 | 0.0 | 0.3 | | 0.0 |
| 23 | 321597 | 474243 | 0.002 | 0.362 | 10.000 | 0.364 | 0.0 | 0.5 | | 0.0 |
| 24 | 321572 | 474374 | 0.002 | 0.362 | 10.000 | 0.364 | 0.0 | 0.5 | | 0.0 |
| 25 | 321790 | 473026 | 0.002 | 0.374 | 10.000 | 0.376 | 0.0 | 0.7 | | 0.0 |
| 26 | 321632 | 472634 | 0.002 | 0.390 | 10.000 | 0.392 | 0.0 | 0.4 | | 0.0 |
| 27 | 321280 | 472549 | 0.005 | 0.390 | 10.000 | 0.395 | 0.0 | 1.2 | | 0.0 |
| 28 | 321145 | 472557 | 0.006 | 0.390 | 10.000 | 0.396 | 0.1 | 1.4 | | 0.0 |
| 29 | 320973 | 472588 | 0.002 | 0.380 | 10.000 | 0.382 | 0.0 | 0.5 | | 0.0 |
| 30 | 320815 | 472717 | 0.002 | 0.380 | 10.000 | 0.382 | 0.0 | 0.4 | | 0.0 |

## Annex 2 – Contour plots of predicted concentrations in the area surrounding the farm

*Figure A2a. Maximum annual mean $NO_2$ concentration (process contribution)*

*Figure A2b. Maximum 1 hour mean $NO_2$ concentration (process contribution)*

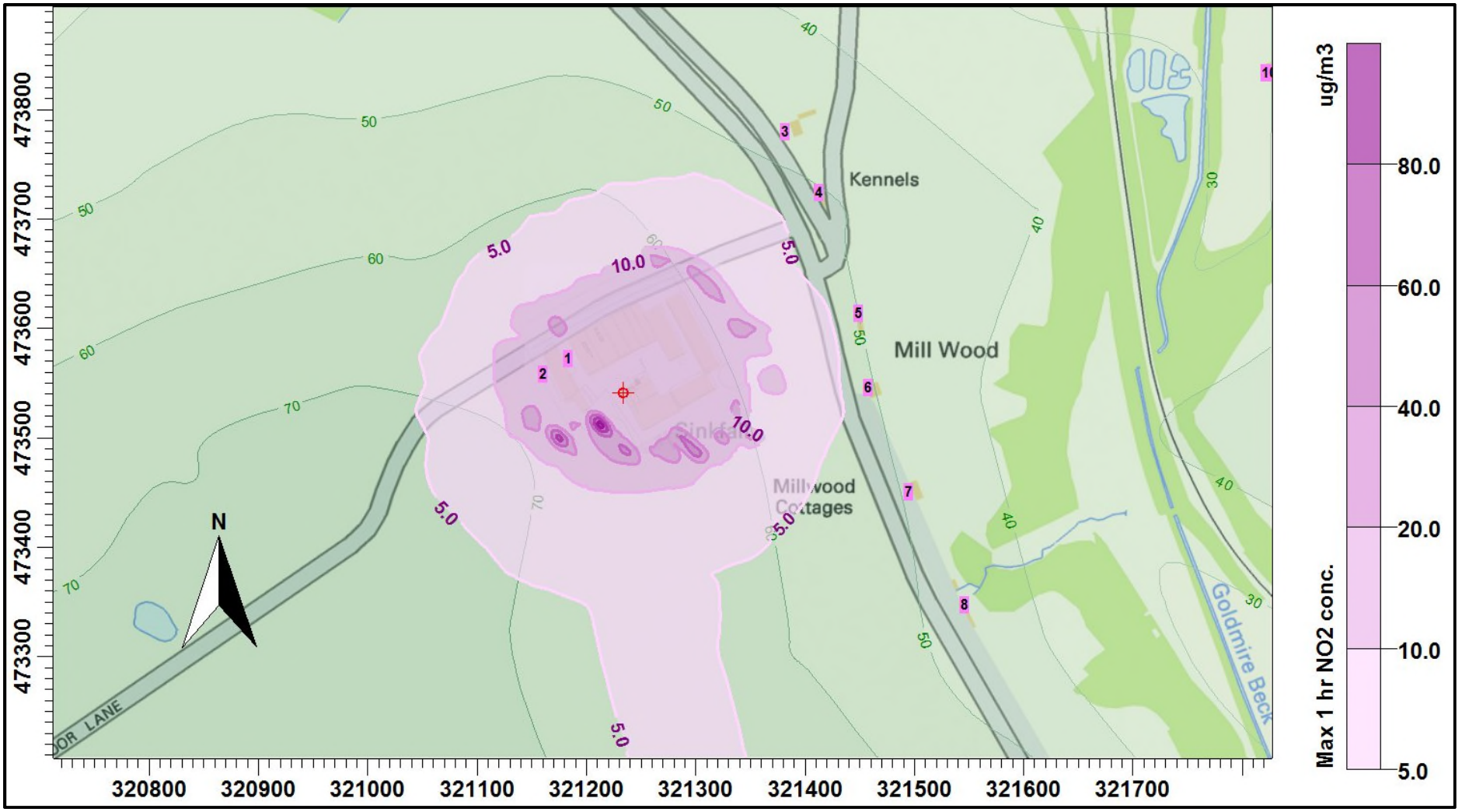

*Figure A2c. Maximum 24 hour mean $SO_2$ concentration (process contribution)*

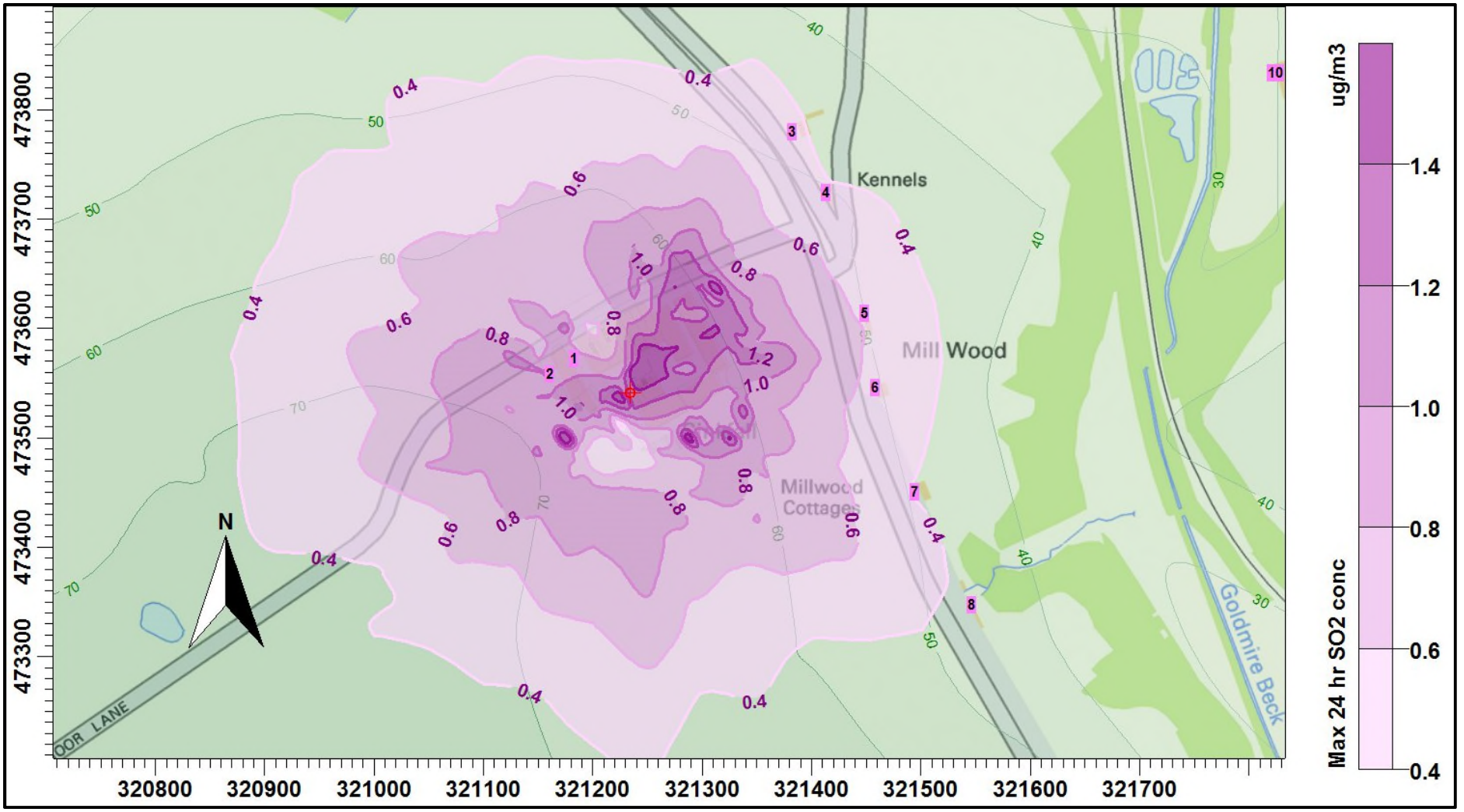

*Figure A2d. Maximum 1 hour mean $SO_2$ concentration (process contribution)*

*Figure A2e. Maximum 15 minute mean $SO_2$ concentration (process contribution)*

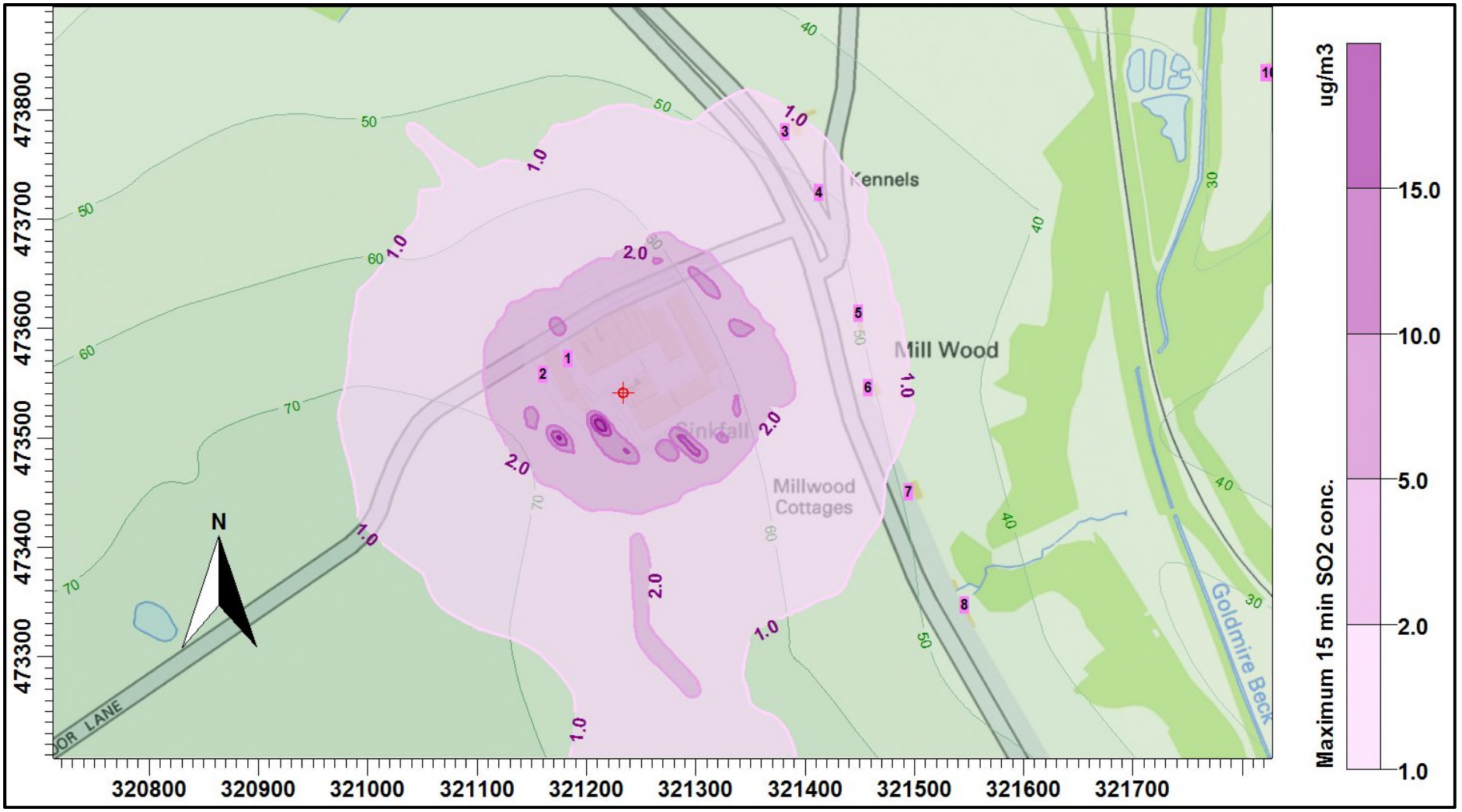

*Figure A2f. Maximum annual mean $PM_{10}$ concentration (process contribution)*

*Figure A2g. Maximum 24 hour mean $PM_{10}$ concentration (process contribution)*

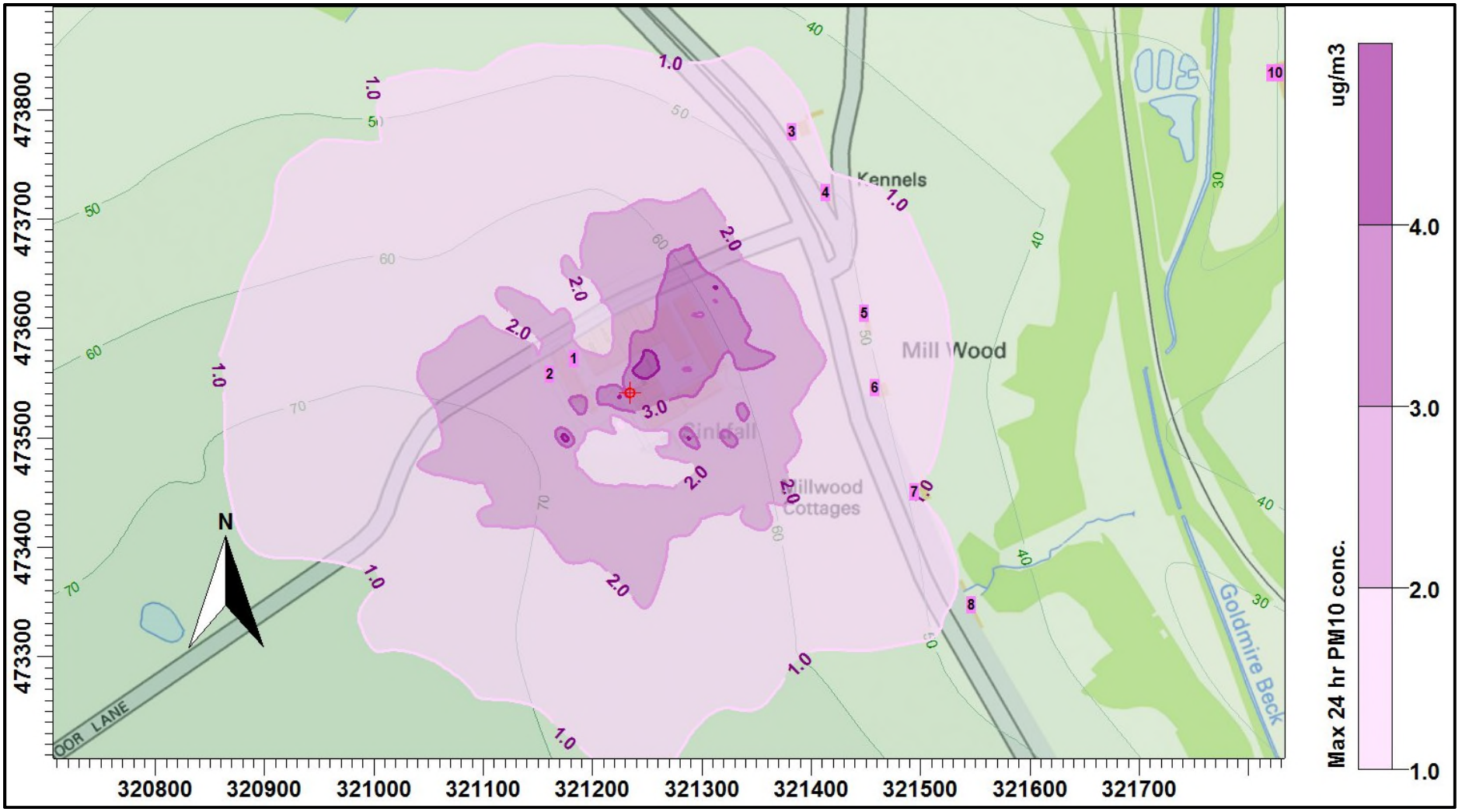

*Figure A2h. Maximum 8 hour mean CO concentration (process contribution)*