Industrial Compliance Solutions Ltd

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Author(s):	**Toby Campbell & Brent Kennedy**
ICS Ref:	**100860**
Client Name:	**Environmental Monitoring Solutions Ltd**
Client Address:	**7 President Buildings** **Savile Street** **Sheffield** **S4 7UQ** **United Kingdom**
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Executive Summary

Industrial Compliance Solutions Ltd (ICS) have been commissioned by Environmental Monitoring Solutions Ltd to undertake a detailed dispersion modelling assessment of emissions to air from the boilers and standby generators located at Royal Hallamshire Hospital (RHH), in Sheffield, S10 2JF. This assessment is in support of a Medium Combustion Plant Directive (MCPD) Environmental Permit Application, assessing impacts from emissions of Oxides of Nitrogen (NOx as NO_2), Carbon Monoxide (CO), and Sulphur Dioxide (SO_2).

It is understood that RHH are in the process of applying for an Environmental Permit as required by the MCPD regulations in relation to the existing medium combustion plants (MCP) on site. Currently operating MCP comprise of twelve natural gas fired boilers which continuously operate providing useful heat to the facility, as well as six diesel (gas oil) fired standby generators designed to provide emergency power in the event of an outage, hence their operational hours are minimal. The aggregated MW thermal input of the assets is 51.633. A full list of the assets, including make, model, and MW thermal input etc, are presented within this report. In line with the requirements of the MCPD there is a need to demonstrate that there are no significant air quality impacts from the operation of the boilers and standby generators.

In order to accurately quantify the impact on the surrounding area, ADMS model inputs have been prepared using measured stack emissions data, MCPD emissions limit value for NOx, and calculated concentration emissions for CO and SO_2, to determine hourly emission rates from the site. Two modelling scenarios were conducted to establish impacts linked to full and actual plant capacities:

- SC1 – Baseline/Future scenario with all 5 MCP running 24/7/365 i.e. 8760 hours/year; and
- SC2 - Vita Reali Operation scenario with MCP running at actual operational hours i.e. 3 x boilers 8760 hours/year and 2 x gensets 48 hours/year

Detailed dispersion modelling was undertaken using the dispersion model ADMS 6, Version 6.0.2. With results presented for SC1 as a worst case.

Local ambient air quality impacts of the aforementioned pollutants, in relation to human health (measured against ambient air quality standards and objectives), and impacts on sensitive vegetation/species (based on comparison of ambient pollutant concentrations and deposition rates with critical levels and critical loads at key sites, excluding a formal Habitats Assessment) have been assessed.

The dispersion modelling demonstrated that assuming the maximum emission period for NOx (SC1), the predicted environmental concentrations at human receptor locations were not significant, and consequently emissions to air from the boilers are not expected to have caused adverse effects upon the health of the local population. At all ecological sites considered, the PECs are below the NOx long-term and short-term assessment metrics, assuming the maximum emission period.

The PEDRs of nutrient nitrogen deposition was below the maximum critical load at all of the assessed ecological receptors. The PCs did not exceed the minimum critical load at any of the ecological sites and therefore can be regarded as not significant.

The PEDRs of the nitrogen component of acid deposition did not exceed the maximum critical load at all of the assessed ecological receptors. The PCs did not exceed the minimum critical load at any of the ecological sites and therefore can be regarded as not significant.

As the assessment did not conclude any significant effects to either ecological or human receptors. It should be noted that the results in Section 5 represent the impacts derived from assuming the maximum emission period for the NOx. Therefore, these results are showing the worst-case scenario at the RHH site for the period January 2019 to December 2023. The impacts derived from the average annual emission rates 2019 to 2023, for SO_2 and CO can be found in Appendix B for comparison.

1 Introduction

Industrial Compliance Solutions Ltd (ICS) have been commissioned by Environmental Monitoring Solutions Ltd to undertake a detailed dispersion modelling assessment of emissions to air from the boilers and backup generators located at Royal Hallamshire Hospital (RHH), in Sheffield, S10 2JF. This assessment is in support of a Medium Combustion Plant Directive (MCPD) Environmental Permit Application, assessing impacts from emissions of Oxides of Nitrogen (NOx as NO_2), Carbon Monoxide (CO), and Sulphur Dioxide (SO_2).

It is understood that RHH are in the process of applying for an Environmental Permit as required by the MCPD regulations in relation to the existing medium combustion plants (MCP) on site. Currently operating MCP comprise of twelve natural gas fired boilers which continuously operate providing useful heat to the facility, as well as six diesel (gas oil) fired standby generators designed to provide emergency power in the event of an outage, hence their operational hours are minimal. The aggregated MW thermal input of the assets is 51.633. A full list of the assets, including make, model, and MW thermal input etc, are presented within this report. In line with the requirements of the MCPD there is a need to demonstrate that there are no significant air quality impacts from the operation of the boilers and standby generators.

1.1 Site Location

The Royal Hallamshire Hospital (RHH) is a prominent teaching hospital located in Sheffield, South Yorkshire, England. It is part of the Sheffield Teaching Hospitals NHS Foundation Trust and provides a wide range of services, including specialized medical care, surgery, and emergency treatment. As part of the NHS Foundation Trust, RHH is recognized for delivering high-quality care and for its role in healthcare innovation within the UK. RHH is positioned between the A57 and B65647 around 1.4 km to the east of Sheffield City centre. The entire site is around 6 hectares with a blend of (but not limited to) primary care, academic medicine, research, and dental care as well as a mix of ancillary buildings.

The modelling sites (18 stacks in multiple locations), immediate surroundings consist primarily of hospital and academic buildings. Beyond the site boundary the area consists of dense residential housing estates such as Crookesmoor to the north, Broomhall to the east and south, Endcliffe and Crosspool to the southwest and west respectively, and Crookes to the northwest. Figure 1-1 provides aerial images of the site and its receiving environment.

In terms of the receiving environment beyond the RHH site boundary there are >1000 residential properties within 1.5 km. In addition to this there are schools, parks, and recreational facilities all of which have been taken into account in this assessment. In terms of land based statutory designations there are two protected sites within 10 km of the site, and four Local Nature Reserves within 2 km.

Further information on nearby sensitive receptors taken into account in the assessment is provided in Section 2.9. Figure 1-1 presents the site location (RHH pin) and boundary (highlighted in pink).

Figure 1-1 - Site Location and Boundary[1,2]

[1] Google Earth Pro, 2025 Google LLC – image Landsat/Copernicus

[2] Search by map - Search for land and property information

1.2 Description of the Process

RHH is a general and teaching hospital located in Sheffield, South Yorkshire. The assessment area of this project covers MCP within Genomic Medicine, RHH, and Charles Clifford Dental Hospital. The facilities cater for over 1 million outpatients annually, the majority of which reside within the Sheffield area. The main healthcare facility provides a holistic service (medical and educational) to the general public and students including (but not limited to) primary care, urgent and emergency care, surgery, dental, laboratory tests and radiology, and antenatal and prenatal care.

Energy demands from the hospital and ancillary buildings are ratified in the form of useful heat and steam provided by twelve existing natural gas fired boilers. The boilers discharge products of combustion via multiple flues of varying heights, details of which are presented within Section 2.4 of this report. Boilers are operational 24/7/365, hence a total of 8640 hours a year, although the system is setup as lead and lag, hence it is expected that each boiler operates at around 75% maximum continuous rate (MCR), on average, for around 75% of the year. The main boilers are supported via six standby generators, four of which were installed in 2024. The generators are diesel fired (gas oil) and designed to provide emergency power in the event of an outage, hence their operational hours are minimal at around 50 hrs per year for testing purposes.

All MCP discharge via individual flues at different locations across the site. The stacks are flanked by buildings. Details concerning stack heights and locations, as well as building heights and locations are detailed within Section 2.4 and Section 2.8 of this report respectively. A brief point source location overview is presented in Table 1.1 and annotated in Figure 2-1.

Table 1.1 – Point Source Location: Brief Overview

Plant #	Release Points					
	Name	Manufacturer	Model	Date Into Service	MW Thermal	Actual Operating Hours
1	Ruston Boiler 4	Ruston	Thermax 2	Jul. 1978	6	200
2	Ruston Boiler 5	Ruston	Thermax 2	Jul. 1979	6	200
3	Ruston Boiler 6	Ruston	Thermax 2	Jul. 1980	6	200
4	Ideal Boiler 7	Ideal	EVOJet 1450	Oct. 2022	1.45	1,500
5	Idea Boiler 8	Ideal	EVOJet 1450	Oct. 2022	1.45	1,500
6	Ideal Boiler 9	Ideal	EVOJet 1450	Oct. 2022	1.45	1,500
7	Ideal Boiler 1	Ideal	EVOJet 1450	Jul. 2019	1.45	1,500
8	Ideal Boiler 2	Ideal	EVOJet 1450	Dec. 2018	1.45	1,500
9	Ideal Boiler 3	Ideal	EVOJet 1450	Jun. 2019	1.45	1,500
10	Ideal Boiler 4	Ideal	EVOJet 1450	Jun. 2020	1.45	1,500
11	Ideal Boiler 5	Ideal	EVOJet 1450	Jul. 2019	1.45	1,500
12	Ideal Boiler 6	Ideal	EVOJet 1450	Jul. 2020	1.45	1,500
13	Standby Generator 5	Volvo	TAD1241GE	Feb. 1960	0.97	≥50
14	Standby Generator 6	Perkins	4012TAG2	Apr. 1999	3.145	≥50

Plant #	Release Points					
	Name	Manufacturer	Model	Date Into Service	MW Thermal	Actual Operating Hours
15	Standby Generator 1	Pramack	GSW3365M	May-24	5.02	≥50
16	Standby Generator 2	Pramack	GSW3365M	May-24	5.02	≥50
17	Standby Generator 3	Pramack	GSW3365M	May-24	5.02	≥50
18	Standby Generator 4	Pramack	GSW665M	Jul-24	1.408	≥50

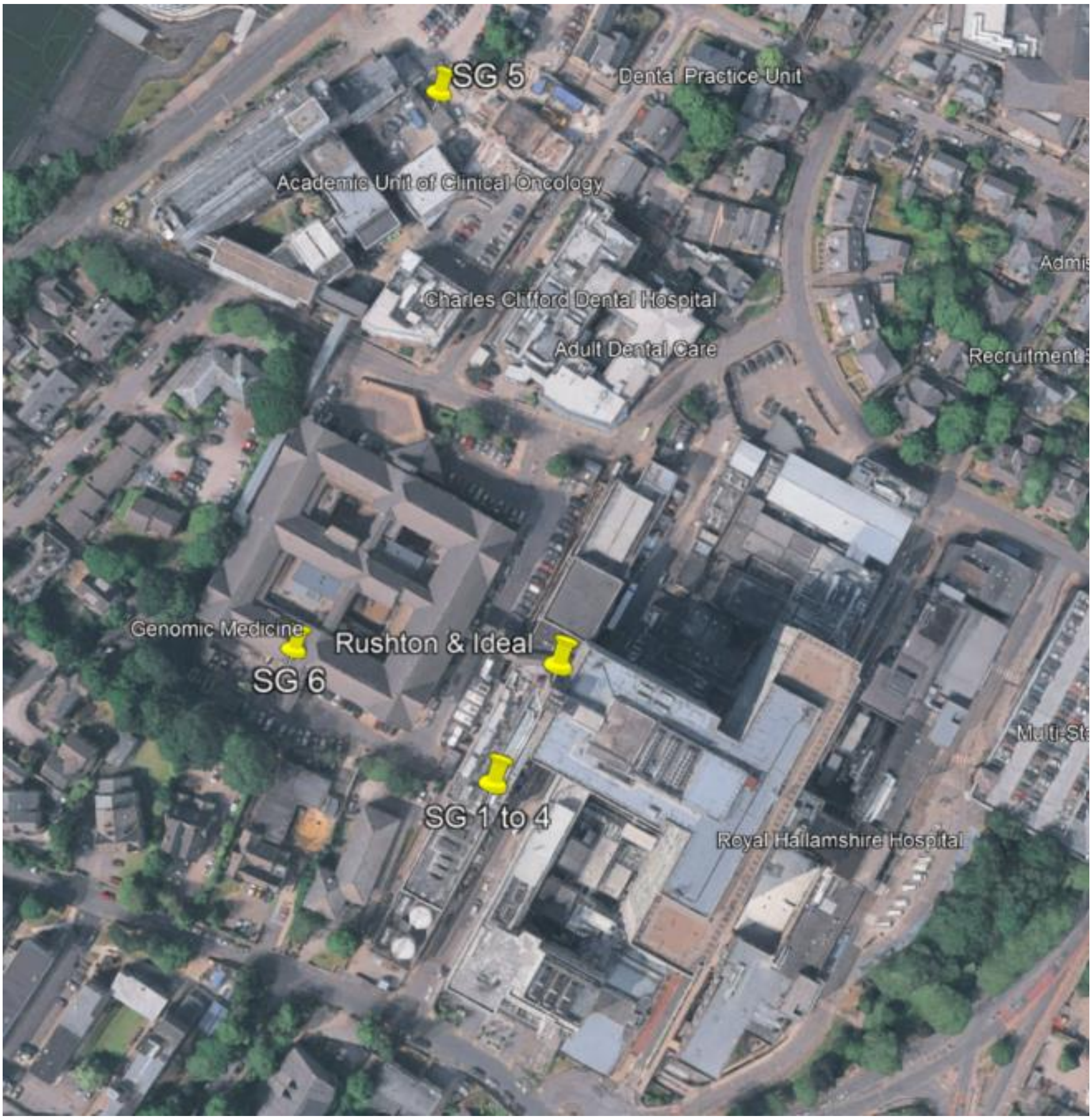


Figure 1-2 – MCP Point Source Emission Locations[3]

[3] Google Earth Pro, 2025 Google LLC – image Landsat/Copernicus

1.3 Scope of Study

In order to accurately quantify the impact on the surrounding area, the advanced dispersion model (ADMS 6) inputs have been calculated using data obtained from Environmental Monitoring Solutions Ltd , Envirocare Technical Consultancy Ltd (emissions test laboratory), as well as the statutory ELV for NOx to determine worst case hourly emission rates during the modelling years (2019-2023). Two modelling scenarios have been undertaken to ascertain the impact from emissions of Oxides of Nitrogen (NOx as NO_2), Carbon Monoxide (CO), and Sulphur Dioxide (SO_2):

- SC1 – Baseline/Future scenario with all MCP and Generators running 24/7/365 i.e. 8760 hours/year; and

- SC2 - Vita Reali Operation scenario with all MCP running at actual operational hours (refer to Table 1.1)

The local ambient air quality impacts of the above pollutants, in relation to human health, against ambient air quality standards and objectives, and impacts on sensitive vegetation/species based on comparison of ambient pollutant concentrations and deposition rates with critical levels and critical loads at key sites (excluding a formal Habitats Assessment), were assessed.

2 Dispersion Modelling Methodology

Detailed dispersion modelling was undertaken to assess the pollutant emissions to air. ADMS 6 Version 6.0.2 modelling software with Surfer Version 27.3.322 was used for this study.

2.1 Choice of Model

ADMS 6 is an advanced atmospheric dispersion model that has been developed and validated by Cambridge Environmental Research Consultants (CERC). The model was used to predict the ground level concentration of products emitted to the atmosphere from the MCPs at the RHH site. The model has been used extensively throughout the UK for regulatory compliance purposes and is accepted as an appropriate air quality modelling tool by the EA and local authorities.

ADMS 6 parameterises stability and turbulence in the atmospheric boundary layer (ABL) by the Monin-Obukhov length and the boundary layer depth. This approach allows the vertical structure of the ABL to be more accurately defined than by the stability classification methods of earlier dispersion models such as R91 or ISCST3. In ADMS, the concentration distribution follows a symmetrical Gaussian profile in the vertical and crosswind directions in neutral and stable conditions. However, the vertical profile in convective conditions follows a skewed Gaussian distribution to take account of the inhomogeneous nature of the vertical velocity distribution in the Convective Boundary Layer (CBL).

A number of complex modules, including the effects of plume rise, complex terrain, coastlines, concentration fluctuations, radioactive decay and buildings effects, are also included in the model, as well as the facility to calculate long-term averages of hourly mean concentration, dry and wet deposition fluxes, and percentile concentrations, from either statistical meteorological data or hourly average data.

A range of input parameters are required including, among others, data describing the local area, meteorological measurements and emissions data. The data used in modelling the emissions are given in the following sections of this chapter.

2.2 Pollutants of Interest

In alignment with the MCPD and based on the use of natural gas and gas oil only, the assessment considers impacts from emissions of Oxides of Nitrogen (NOx as NO_2), Carbon Monoxide (CO), and trace amounts of Sulphur Dioxide (SO_2) from operation of the boilers and standby generators.

2.3 Scenarios Modelled

In order to accurately quantify the impact on the surrounding area, two modelling scenarios have been modelled to establish impacts linked to theoretical and actual plant production capacities:

- SC1 – Baseline/Future scenario with all MCP and Generators running 24/7/365 i.e. 8760 hours/year operating at Emissions Limit Values; and
- SC2 - Vita Reali Operation scenario with all MCP running at actual operational hours (refer to Table 1.1), at measured emissions concentrations.

2.4 Point Source Parameters and Process Emissions

Details of the boilers and generators at site have been provided by Environmental Monitoring Solutions Ltd. The site will continue to operate all eighteen assets, with planned maintenance intervals scheduled into the useable life of each unit. The location of the stacks (emissions points), buildings, and sensitive receptors included in the dispersion model are illustrated in Figure 2-1 – whilst stack parameters and emission rates used in the assessment are summarised in Table 2.1. The volumetric flow rate for each asset (Nm^3/s) was calculated from the data received and applied to the emissions test results, ELVs, and/or estimated concentration data to generate hourly mass emission rates for each MCP.

Table 2.1 – Model Input Parameters

Parameter	Release Points - Table 1					
	Ruston Boiler 4	Ruston Boiler 5	Ruston Boiler 6	Ideal Boiler 7	Idea Boiler 8	Ideal Boiler 9
Stack Location (XY) [a]	433764, 386991	433764, 386991	433764, 386991	433764, 386991	433764, 386991	433764, 386991
Stack Height (m) [a]	80	80	80	80	80	80
Stack Diameter (m) [a]	0.7	0.7	0.7	0.45	0.45	0.45
Efflux Velocity (m/s) [a]	1.7	1.5	1.9	3.3	5.2	3.3
Volume Flux (Nm^3/s)	0.65	0.58	0.73	0.52	0.83	0.52
Efflux Temperature (°C) [a]	64	52	76	65	71	73
Fuel	Natural gas	Natural gas	Natural gas	Natural gas	Natural gas	Natural gas
Emission Rates (g/s unless stated)						
NO_x [b]	0.059	0.068	0.051	0.046	0.138	0.084
CO [c]	0.015	0.017	0.013	0.011	0.035	0.021
SO_2 [d]	0.00003	0.00003	0.00003	0.00002	0.00006	0.00003

Parameter	Release Points - Table 2					
	Ideal Boiler 1	Ideal Boiler 2	Ideal Boiler 3	Ideal Boiler 4	Ideal Boiler 5	Ideal Boiler 6
Stack Location (XY) [a]	433764, 386991	433764, 386991	433764, 386991	433764, 386991	433764, 386991	433764, 386991
Stack Height (m) [a]	80	80	80	80	80	80
Stack Diameter (m) [a]	0.55	0.45	0.45	0.45	0.45	0.45
Efflux Velocity (m/s) [a]	3.775	2.5	4.9	2.8	3.7	4.5
Volume Flux (Nm^3/s)	0.90	0.40	0.78	0.45	0.59	0.72
Efflux Temperature (°C) [a]	72	76	76	71	72	74
Fuel	Natural gas	Natural gas	Natural gas	Natural gas	Natural gas	Natural gas
Emission Rates (g/s unless stated)						
NO_x [b]	0.152	0.070	0.125	0.076	0.096	0.114
CO [c]	0.038	0.017	0.031	0.019	0.024	0.029

SO_2 [d]	0.00006	0.00003	0.00005	0.00003	0.00004	0.00005

Parameter	Release Points - Table 3					
	Standby Gen 5	Standby Gen 6	Standby Gen 1	Standby Gen2	Standby Gen 3	Standby Gen 4
Stack Location (XY) [a]	433736, 387174	433682, 387001	433742, 386954	433742, 386954	433742, 386954	433742, 386954
Stack Height (m) [a]	9	18	26	26	26	26
Stack Diameter (m) [a]	0.15	0.35	0.65	0.65	0.65	0.65
Efflux Velocity (m/s) [a]	6.0	9.7	23.5	23.5	23.5	23.5
Volume Flux (Nm^3/s)	0.11	0.93	7.80	7.80	7.80	7.80
Efflux Temperature (°C) [a]	128	250	545	545	545	545
Fuel	Gas oil	Gas oil	Gas oil	Gas oil	Gas oil	Gas oil
Emission Rates (g/s unless stated)						
NO_x [b]	0.011	0.139	0.519	0.519	0.519	0.519
CO [c]	0.003	0.035	0.130	0.130	0.130	0.130
SO_2 [d]	0.0004	0.006	0.021	0.021	0.021	0.021

[a] Information provided by Environmental Monitoring Solutions Ltd

[b] Boiler emissions rates based on the MCPD ELVs – existing MCP between 1 and 5 MW, natural gas:

- NOx = 250 mg/m^3 STP, 3 % O_2, Dry

Boiler emissions rates based on the MCPD ELVs – existing MCP >5 MW, natural gas:

- NOx = 200 mg/m^3 STP, 3 % O_2, Dry

Generator emissions rates based on the MCPD ELVs – engines and gas turbines, gas oil:

- NOx = 190 mg/m^3 STP, 15 % O_2, Dry

[c] no MCPD ELV, therefore assumed 25% of NOx emission rate based on relationship between NOx and CO.

[d] no MCPD ELV, therefore mass emission based on 2024 emissions test data of the unit or comparable units.

Additional notes:

Rushton boiler 4 - no emissions data, therefore averages taken from other units.
No pressure or temp data for Ideal Boiler 1, therefore taken average from other units.
No SO_2 data for Ideal boilers, therefore taken max measured on Rushton.
Winflue used for gas oil SO2 emissions
Volumetric flow for SG 1 to 4 taken from Pramack spec' sheet.

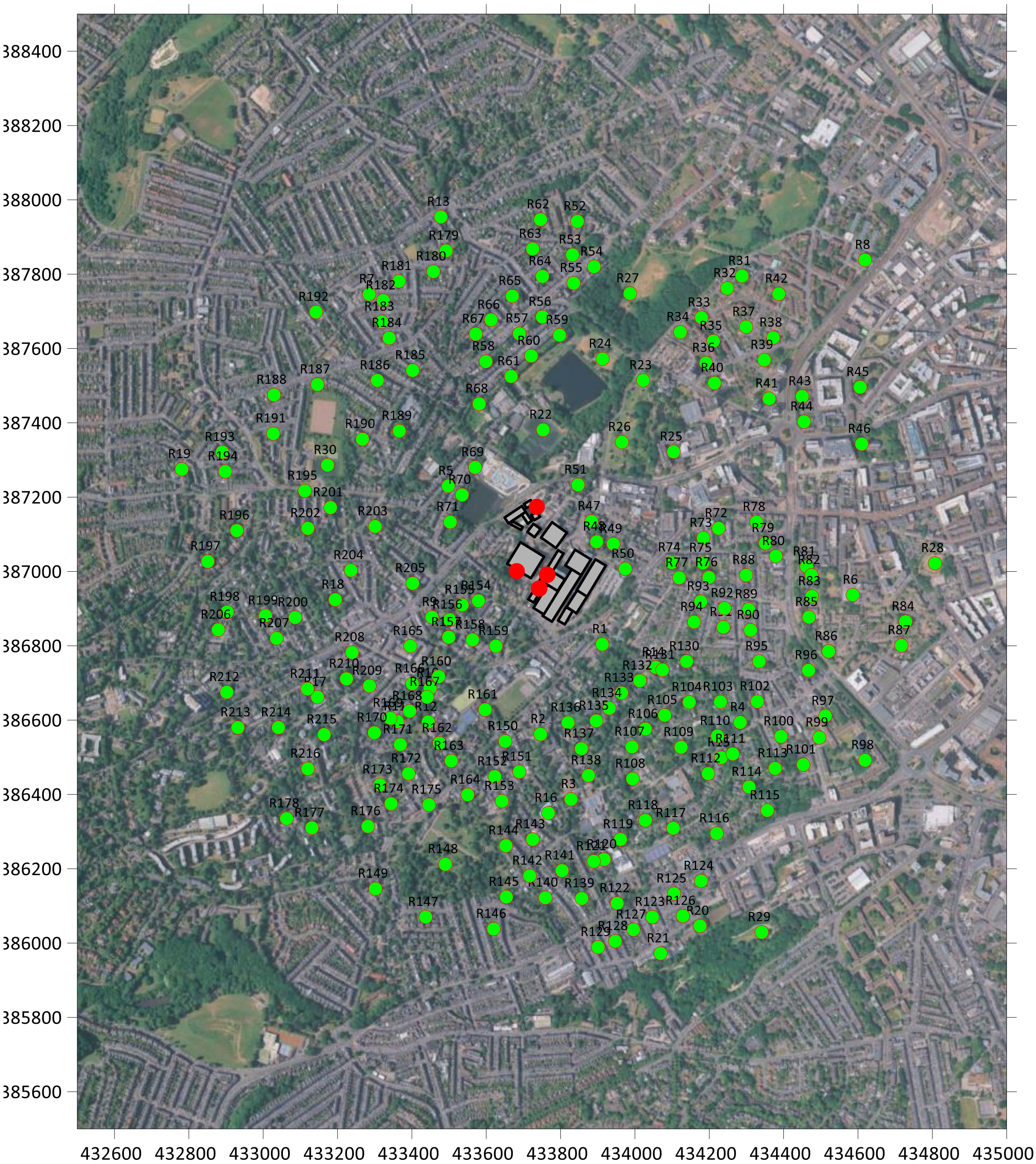


Figure 2-1 – Emissions points, buildings and sensitive receptors visualisation

2.5 Road Link Emissions

Emissions from road traffic vehicles are not included in this assessment within the model domain. Background maps will include contributions from road traffic. In terms of statutory Air Quality

Management Areas[4] (AQMA), the entire city of Sheffield has been declared as a AQMA, however the MCPs herein are not newly proposed, but existing, and should therefore already be accounted for within the AQMA.

2.6 Meteorology

For meteorological data to be suitable for dispersion modelling purposes, a number of meteorological parameters need to be measured on an hourly basis. These parameters include wind speed, wind direction, cloud cover and temperature. There are only a limited number of sites where the required meteorological measurements are made. The year of meteorological data that is used for a modelling assessment can also have a significant effect on ground level concentrations.

The meteorological stations near Royal Hallamshire Hospital collect various atmospheric parameters essential for weather monitoring and forecasting. The table below is a summary of the parameters collected at each station.

Table 2.2 – Local Meterological Data

Weston Park Weather Station: Operated by the Met Office, the United Kingdom's national weather service. Established in 1882, Weston Park is one of the UK's longest-running weather stations. It contributes both synoptic (hourly) and climate (daily) observations to the Met Office network.	Parameters Collected: • Temperature • Precipitation • Sunshine hours • Ground frost

Meteorological data was sourced from Open Weather. Open Weather utilises a sophisticated weather model that integrates multiple data sources and methodologies to provide accurate weather predictions. Numerical Weather Prediction (NWP) hourly sequential meteorological data centred at the Royal Hallamshire Hospital site has been used. NWP datasets are based on the Unified Model operated by the Open Weather for the purposes of forecasting weather conditions. There are a number of advantages in using NWP data:

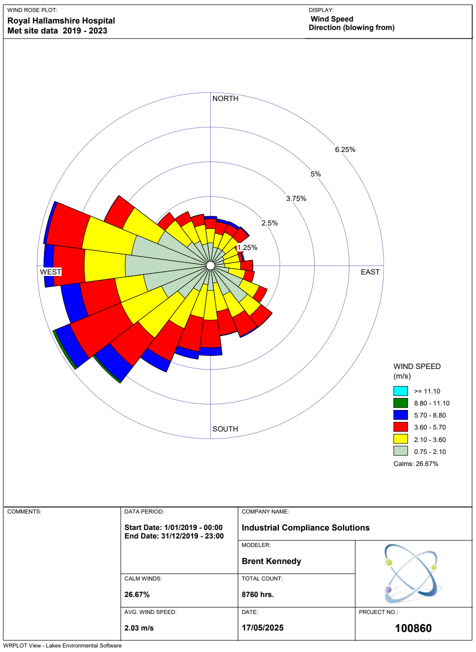
- The data is produced to site specifically representative of the location of interest, which should allow better determination of typical wind directions in an area.
- The 2019 to 2023 data has a high data capture percentage (100% data capture) which can provide a better estimation when predicting percentiles.
- The data includes the Unified Model estimates of cloud cover, sensible heat flux and boundary layer depth, which are used directly by the ADMS model. This is in contrast to using observed data, which provides only cloud cover as the minimum additional parameter (in addition to wind patterns) that the model requires to estimate heat flux and boundary layer depths.

[4] https://uk-air.defra.gov.uk/aqma/maps/

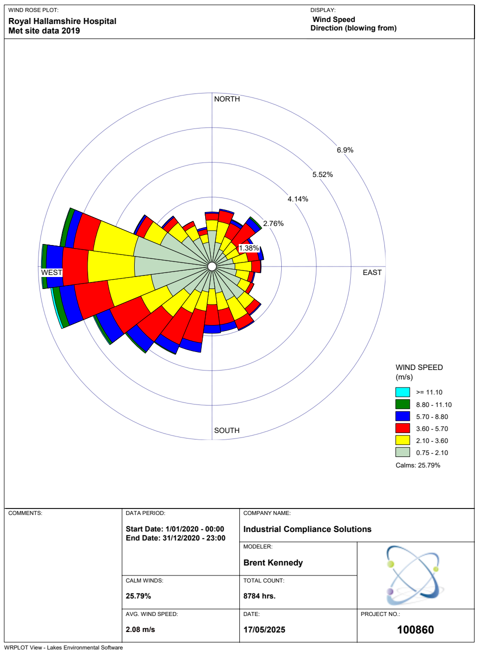
The use of NWP data is designed to allow the directional nature of the local winds to be taken into account. The study site is located in the Sheffield, and winds around the site are strongly directional, due to the influence of the surrounding terrain and the prevailing winds. The dominant wind direction at the site is from the west to southwest for 2019, 2020, and 201. For 2022 and 2023 there were noticeable increase in winds from the south to southeast direction. The wind rose for the 2019 to 2023 meteorological data is shown in Figure 2-2, where the dominant wind directions can be clearly identified.

A check on the data quality of the NWP dataset is summarised in Table 2.3. As the data are synthesised, there are no missing hours in the data set. However, the model does not include ‘calm’ meteorological data (data with wind speed at 10m, less than 0.75m/s) in the model run. As a consequence, the availability of usable hours of meteorological data is 73.33%, 74.21%, 80.14%, 74.16% and 79.3% for the 2019, 2020, 2021, 2022 and 2023 years respectively. This fulfils the minimum requirements for dispersion modelling as advised in best-practice guidance[5].

Figure 2-2 – 2019, 2020, 2021, 2022, 2023 and January 2019 to December 2023 Wind Data

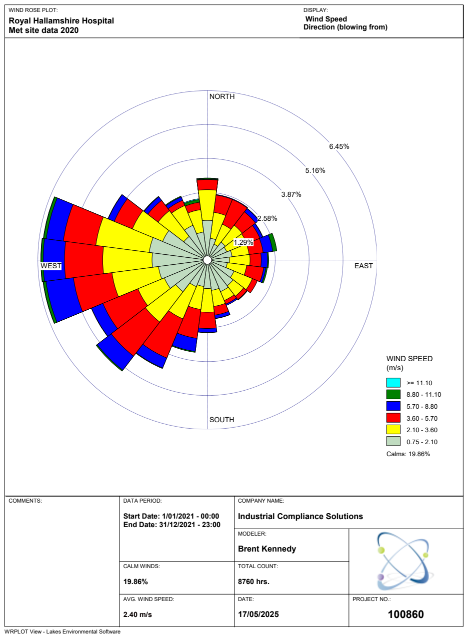


Windrose - 2019

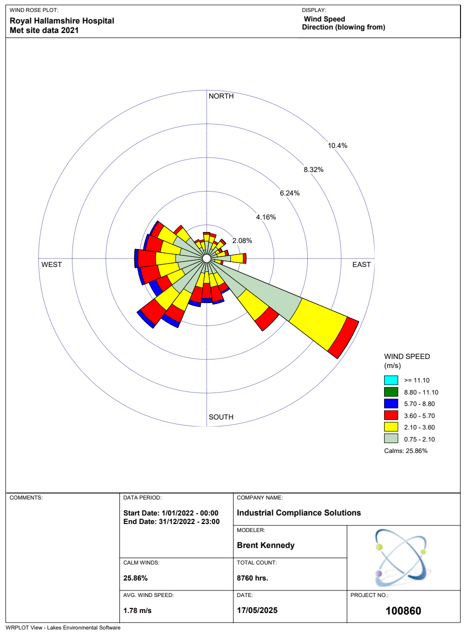


Windrose - 2020

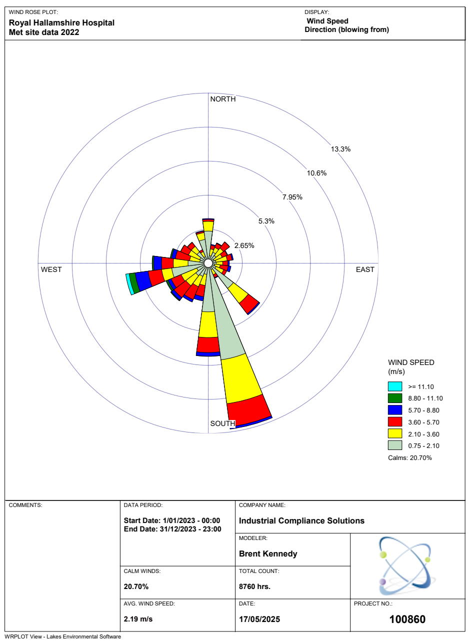
[5] Defra Technical Guidance LAQM.TG(16), 2016



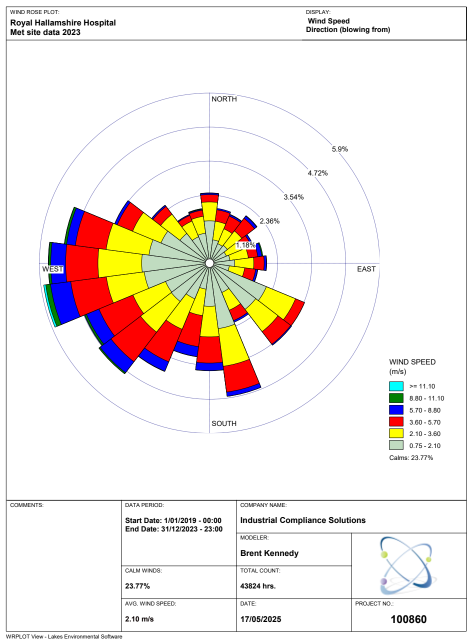
Windrose - 2021



Windrose - 2022



Windrose - 2023



Windrose – 2019 - 23

Table 2.3 – Quality Check on Meterological Data

ADMS Meteorological Input Data	2019	2020	2021	2022	2023
Number of hourly meteorological lines	8760	8784	8760	8760	8760
Number of meteorological lines with calm conditions at 10 m height) less than 0.75 m/s	2336	2265	1740	2265	1813
Number of meteorological lines with inadequate data	0	0	0	0	0
Number of non-calm meteorological lines with wind speeds (at 10 m height) greater than 0.75 m/s	6424	6519	7020	6495	6947

2.7 Surface Characteristics

The predominant surface characteristics and land use in a model domain have an important influence in determining turbulent fluxes and, hence, the stability of the boundary layer and atmospheric dispersion. Factors pertinent to this determination are detailed below.

2.7.1 Surface Roughness

Surface roughness length, z0, represents the aerodynamic effects of surface friction and is physically defined as the height at which the extrapolated surface layer wind profile tends to zero. This value is an important parameter used by meteorological pre-processors to interpret the vertical profile of wind speed and estimate friction velocities which are, in turn, used to define heat and momentum fluxes and, consequently, the degree of turbulent mixing.

The surface roughness length is related to the height of surface elements; typically, the surface roughness length is approximately 10% of the height of the main surface features. Thus, it follows that surface roughness is higher in urban and congested areas than in rural and open areas. Oke (1987) and CERC (2003) suggest typical roughness lengths for various land use categories (Table 2.4).

Table 2.4 – Typical Surface Roughness Lengths for Various Land Use Categories

Type of Surface	z_0 (m)
Ice	0.00001
Smooth snow	0.00005
Smooth sea	0.0002
Lawn grass	0.01
Pasture	0.2
Isolated settlement (farms, trees, hedges)	0.4
Parkland, woodlands, villages, open suburbia	0.5-1.0
Forests/cities/industrialised areas	1.0-1.5
Heavily industrialised areas	1.5-2.0

Increasing surface roughness increases turbulent mixing in the lower boundary layer. This can often have conflicting impacts in terms of ground level concentrations:

- The increased mixing can bring portions of an elevated plume down towards ground level, resulting in increased ground level concentrations closer to the emission source; and
- The increased mixing increases entrainment of ambient air into the plume and dilutes plume concentrations, resulting in reduced ground level concentrations further downwind from an emission source.

The overall impact on ground level concentration is, therefore, strongly correlated to the distance and orientation of a receptor from the emission source.

2.7.2 Surface Energy Budget

One of the key factors governing the generation of convective turbulence is the magnitude of the surface sensible heat flux. This, in turn, is a factor of the incoming solar radiation. However, not all solar radiation arriving at the Earth's surface is available to be emitted back to atmosphere in the form of sensible heat. By adopting a surface energy budget approach, it can be identified that, for fixed values of incoming short and long wave solar radiation, the surface sensible heat flux is inversely proportional to the surface albedo and latent heat flux.

The surface albedo is a measure of the fraction of incoming short-wave solar radiation reflected by the Earth's surface. This parameter is dependent upon surface characteristics and varies throughout the year. Oke (1987) recommends average surface albedo values of 0.6 for snow covered ground and 0.23 for non-snow-covered ground, respectively. The latent heat flux is dependent upon the amount of moisture present at the surface. The Priestly-Taylor parameter can be used to represent the amount of moisture available for evaporation:

$$\alpha = \frac{1}{S(B+1)}$$

Where:

α = Priestly-Taylor parameter (dimensionless)

$S = \frac{s}{s+\gamma}$

$s = \frac{de}{dT}$

e_s = Saturation specific humidity (kg H_2O / kg dry air)

T = Temperature (K)

$$\gamma = \frac{c_{pw}}{\lambda}$$

c_{pw} = Specific heat capacity of water (kJ/kg⁻/K)

λ = Specific latent heat of vaporisation of water (kJ/kg)

B = Bowen ratio (dimensionless)

Areas where moisture availability is greater will experience a greater proportion of incoming solar radiation released back to atmosphere in the form of latent heat, leaving less available in the form of sensible heat and, thus, decreasing convective turbulence. Holstag and van Ulden (1983) suggest values of 0.45 and 1.0 for dry grassland and moist grassland respectively.

2.7.3 Selection of Appropriate Surface Characteristic Parameters for the Site

A detailed analysis of the effects of surface characteristics on ground level concentrations by Auld et al. (2002) led them to conclude that, with respect to uncertainty in model predictions:

> *"…the energy budget calculations had relatively little impact on the overall uncertainty"*

In this regard, it is not considered necessary to vary the surface energy budget parameters spatially or temporally, and annual averaged values have been adopted throughout the model domain for this assessment.

As snow covered ground is only likely to be present for a small fraction of the year, the surface albedo of 0.23 for non-snow-covered ground advocated by Oke (1987) has been used whilst the model default α value of 1.0 has also been retained.

From examination of 1:10,000 Ordnance Survey maps, it can be seen that within the immediate vicinity of the site, land use is predominately "cities/industrialised areas". Consequently, a composite surface roughness length of 1.5m is appropriate to take account of the respective land use categories in the model domain.

2.8 Buildings

Any large, sharp-edged object has an impact on atmospheric flow and air turbulence within the locality of the object. This can result in maximum ground level concentrations that are significantly different (generally higher) from those encountered in the absence of buildings. The building 'zone of influence' is generally regarded as extending a distance of 5L (where L is the lesser of the building height or width) from the foot of the building in the horizontal plane and three times the height of the building in the vertical plane.

Inclusion of buildings within the model can lead to significant increase in predicted ground concentrations as plume dispersion is hindered by the presence of buildings and plume grounding may occur closer to the site than would otherwise be expected. Therefore, for this assessment, downwash effects were taken into account for the dominant buildings in the vicinity of the source (see Table 2.5 and Figure 2-1 –).

Table 2.5 – Modelled Buildings

Name	Centre Easting (m)	Centre Northing (m)	Height (m)	Length / Diameter (m)	Width (m)	Angle (º)
A	433706.1	387030.2	23.0	74.5	68.0	121.4
B	433781.3	386975.4	70.0	37.1	47.6	32.2
C	433803.6	386935.4	70.0	29.8	148.1	122.1
D	433760.1	386924.3	24.0	72.9	32.8	31.5
E	433847.3	387024.3	11.0	49.7	49.7	121.4
F	433677.8	387152.8	25.0	55.8	18.6	56.4
G	433713.8	387181.1	17.0	20.5	13.3	60.4
H	433709.1	387144.7	15.0	29.2	13.1	145.5
I	433681.8	387123.3	15.0	32.0	9.0	118.4
J	433728.4	387110.3	15.0	27.3	24.0	36.3
K	433732.9	387149.5	8.0	17.4	15.8	58.7
L	433782.2	387097.8	20.0	50.8	48.8	35.4
M	433760.5	386986.8	20.0	154.6	16.9	31.3
N	433882.5	386982.4	17.0	32.5	97.6	121.1
O	433843.6	386918.4	15.0	53.0	31.5	212.6
P	433812.9	386880.8	17.0	42.0	20.9	210.4

2.9 Modelled Domain and Receptors

2.9.1 Modelled Domain

A 10 km x 10 km Cartesian grid centred on the site was modelled, with a receptor resolution of 100m, to assess the impact of atmospheric emissions from the site on local air quality. The grid resolution has been selected to ensure that all local receptors are within the gridded area and the resolution is such that the maximum impact will be identified. Sensitive receptors include schools, parks, and recreational facilities. Additional residential sensitive receptors have been included in the modelling assessment to account for exposure within gardens and other outdoor private settings.

The height of all the sensitive receptors has been assumed to be 1.5m to represent inhalation exposure.

2.9.2 Sensitive Receptors

The sensitive receptors considered were chosen based on geographical locations where people may be present and subsequently judged in terms of the likely duration of their exposure to pollutants and proximity to the site (following the guidance given in Section 4). Details of the locations of sensitive receptors are given in Table 2.6 and illustrated Figure 2-3 below.

Concentrations have been predicted at 216 specific sensitive receptor locations within a radius of 1.0 km from the main stack locations (Ideal and Rushton Boiler Stacks). The majority of the sensitive specific receptor locations included are close to private residential properties (gardens), however receptors have also been included at recreational sites, schools, and play areas. Due to the high-density residential housing surrounding the project setting, individual properties have been selected to represent small areas such as a small street or cul-de-sac, rather than be fully inclusive of 1000s of homes within the area. The guidance documents are detailed in Section 5 of this report.

Table 2.6 – Assessed Human Receptors

ID	Receptor Street Name	Easting (m)	Northing (m)	Category	Distance from Central Release Points (m)
1	Fairmount Nursery	433912	386804	Nursery	238
2	Creative Kids	433746	386562	Nursery	429
3	Sheffield Hallam University Collegiate	433828	386387	Nursery	607
4	Broomhall Nursery and Children's Centre	434283	386594	Nursery	653
5	Mountford House	433498	387230	Nursery	358
6	Petre Lane	434586	386937	Nursery	824
7	Westways Primary School	433285	387746	Nursery	894
8	Netherthorpe Primary School	434619	387838	School	1204
9	Broomhill Infant School	433454	386877	School	330
10	Sheffield High School (Sixth Form)	433449	386686	School	438
11	Sheffield High School (Junior School)	433361	386596	School	564
12	Melbourne Avenue	433444	386595	School	509
13	Rajput	433478	387954	Care Home	1005
14	Elm View	434056	386742	Care Home	384
15	Broom Lawn	434232	386499	Care Home	679
16	Broomgrove Nursing Home	433767	386350	Care Home	641
17	Ashdell Cottage	433146	386662	Care Home	700
18	Spooner Road Car Park	433194	386924	Care Home	574
19	Alexander Court	432781	387275	Care Home	1023
20	Porter Croft Church of England Primary	434175	386046	Care Home	1031
21	Stalker Walk	434069	385972	School	1064
22	Goodwin Sports Centre	433753	387381	Care Home	390
23	Mushroom Lane	434022	387514	Recreation Ground	583
24	Crookes Valley Park Bowls Club	433913	387572	Recreation Ground	600
25	Western Bank	434104	387322	Recreation Ground	475
26	Mushroom Lane	433965	387348	Recreation Ground	410
27	Crookes Valley Road	433987	387748	Recreation Ground	789
28	Devonshire Street	434807	387022	Recreation Ground	1043
29	Cemetery Road	434341	386029	Recreation Ground	1122
30	Weston View	433173	387286	Recreation Ground	661
31	St Stephen's Church	434288	387795	Recreation Ground	960
32	St. Stephen's Walk	434248	387762	Residential Dwellings	910
33	Powell Street	434179	387683	Residential Dwellings	807
34	Summer Street	434122	387644	Residential Dwellings	745
35	Summer Street	434211	387620	Residential Dwellings	772
36	Summer Street	434191	387561	Residential Dwellings	712

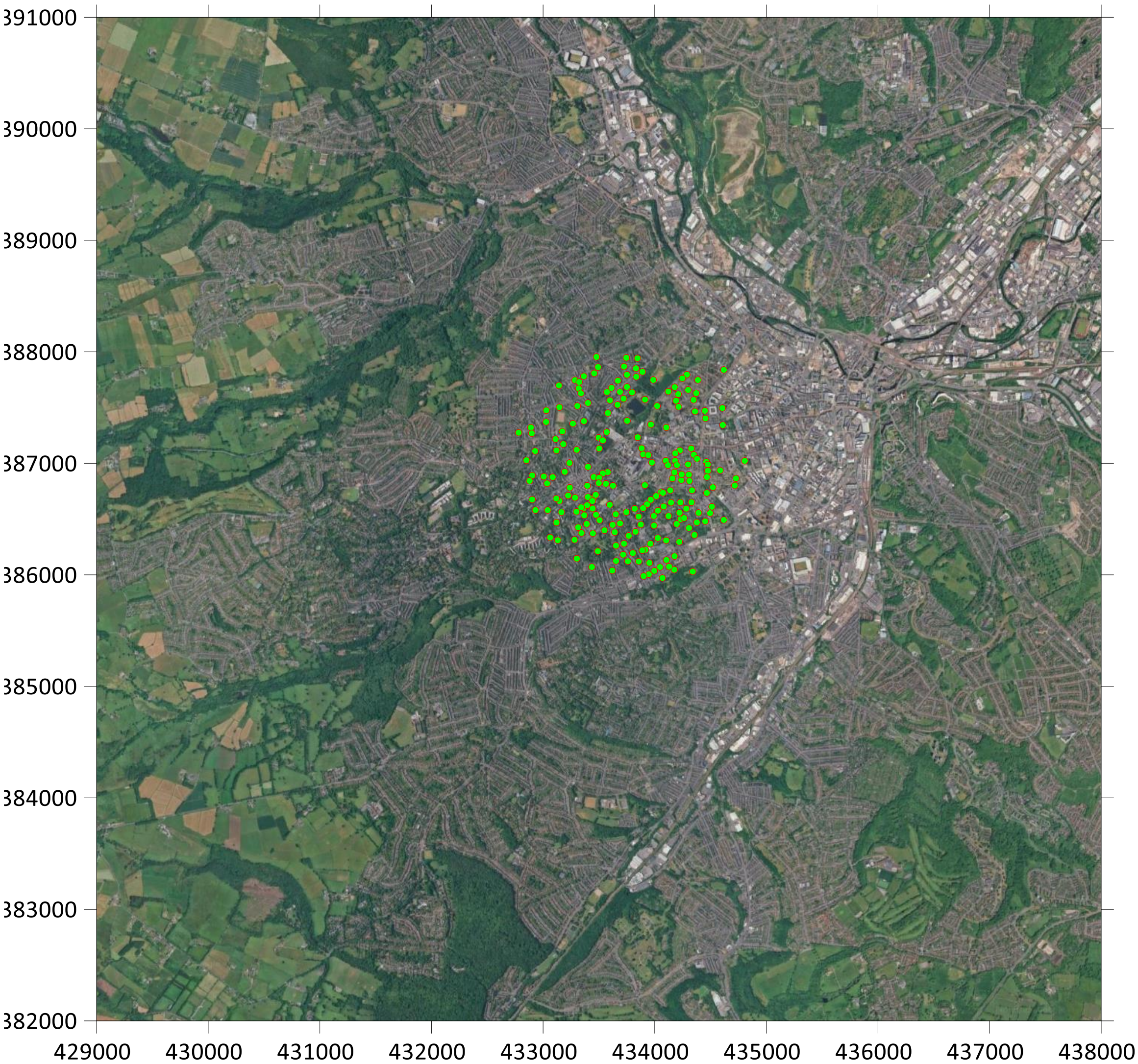
ID	Receptor Street Name	Easting (m)	Northing (m)	Category	Distance from Central Release Points (m)
37	Bramwell Drive	434299	387658	Residential Dwellings	855
38	Bramwell Close	434372	387629	Residential Dwellings	881
39	Weston Street	434348	387569	Residential Dwellings	822
40	Weston Street	434214	387507	Residential Dwellings	685
41	Robertshaw	434361	387465	Residential Dwellings	762
42	Daisy Bank	434387	387747	Residential Dwellings	980
43	iQ Knight House	434450	387471	Residential Dwellings	837
44	Brook Hill	434455	387403	Residential Dwellings	805
45	Upper Allen Arch	434606	387496	Residential Dwellings	982
46	Mappin Street	434610	387343	Residential Dwellings	916
47	Bealby & Jones	433883	387135	Residential Dwellings	187
48	Royal Hallamshire Hospital	433897	387080	Residential Dwellings	160
49	Shearwood Mount	433942	387074	Residential Dwellings	196
50	Claremont Place	433974	387007	Residential Dwellings	211
51	Mushroom View	433847	387233	Residential Dwellings	256
52	Roebuck Road	433845	387942	Residential Dwellings	954
53	Roebuck Road	433832	387852	Residential Dwellings	864
54	Oxford Street	433890	387820	Residential Dwellings	839
55	Oxford Street	433835	387776	Residential Dwellings	788
56	Second Hand Centre	433751	387685	Residential Dwellings	694
57	Crookesmoor Road	433689	387640	Residential Dwellings	653
58	Crookesmoor Road	433599	387565	Residential Dwellings	597
59	Harcourt Road	433797	387636	Residential Dwellings	646
60	Harcourt Road	433721	387580	Residential Dwellings	591
61	Harcourt Road	433667	387525	Residential Dwellings	543
62	Burns Road	433746	387947	Residential Dwellings	956
63	Roebuck Road	433725	387868	Residential Dwellings	878
64	Barber Road	433751	387794	Residential Dwellings	803
65	Ivy Grove	433670	387741	Residential Dwellings	756
66	The Coach Houses	433613	387677	Residential Dwellings	702
67	Moorgate Avenue	433572	387639	Residential Dwellings	676
68	Goodwin Sports Centre	433581	387451	Residential Dwellings	495
69	James Smith House	433570	387280	Residential Dwellings	348
70	Whitham Road	433535	387206	Residential Dwellings	314
71	Marlborough Road	433503	387133	Residential Dwellings	297
72	Peel Terrace	434225	387116	Residential Dwellings	478
73	University of Sheffield	434184	387090	Residential Dwellings	432
74	Broomspring House	434099	387024	Residential Dwellings	337
75	Elton House	434183	387023	Residential Dwellings	420
76	Albion Place	434199	386984	Residential Dwellings	435
77	Broomspring Lane Car Park	434119	386983	Residential Dwellings	355
78	SK:N- Courthouse Clinic	434327	387133	Residential Dwellings	581
79	Mount Albion	434351	387076	Residential Dwellings	593
80	Wilkinson Street	434379	387041	Residential Dwellings	617
81	Conway Street	434462	387013	Residential Dwellings	698
82	Conway Street	434475	386990	Residential Dwellings	711
83	Broomspring Lane	434476	386933	Residential Dwellings	714
84	Egerton Walk	434728	386865	Residential Dwellings	972
85	Broomspring Close	434468	386877	Residential Dwellings	713
86	Headford Gardens	434521	386785	Residential Dwellings	785
87	Broom Green	434717	386801	Residential Dwellings	972
88	Brunswick Street	434299	386990	Residential Dwellings	535
89	Broomspring Lane	434306	386898	Residential Dwellings	550
90	Filey Street	434311	386842	Residential Dwellings	567
91	Holberry Gardens	434238	386850	Residential Dwellings	495

ID	Receptor Street Name	Easting (m)	Northing (m)	Category	Distance from Central Release Points (m)
92	Havelock Street	434241	386901	Residential Dwellings	485
93	Broomspring Lane	434177	386919	Residential Dwellings	419
94	Holberry Gardens	434159	386864	Residential Dwellings	415
95	Holberry Close	434334	386758	Residential Dwellings	616
96	Holberry Playground	434467	386734	Residential Dwellings	749
97	Hanover Street	434512	386611	Residential Dwellings	839
98	Hanover Tower	434619	386492	Residential Dwellings	990
99	Exeter Place	434496	386553	Residential Dwellings	853
100	Broom Street	434393	386556	Residential Dwellings	765
101	Clinton Place	434453	386480	Residential Dwellings	858
102	Sandon Place	434329	386650	Residential Dwellings	660
103	Oakfield House	434230	386649	Residential Dwellings	578
104	The Elms	434146	386648	Residential Dwellings	513
105	Beech Dell	434080	386613	Residential Dwellings	493
106	Clifton Villas	434028	386576	Residential Dwellings	492
107	Ashleigh/ Park Elms	433992	386528	Residential Dwellings	516
108	Oakburn	433994	386442	Residential Dwellings	595
109	Park Lane	434124	386527	Residential Dwellings	587
110	Broomhall Road	434222	386557	Residential Dwellings	631
111	Green Bank	434263	386509	Residential Dwellings	694
112	Victoria Road	434197	386456	Residential Dwellings	688
113	Sunnybank House	434377	386470	Residential Dwellings	804
114	Weston Lodge	434307	386420	Residential Dwellings	788
115	Clarendon Villas	434356	386357	Residential Dwellings	867
116	Langholm Villas	434220	386295	Residential Dwellings	832
117	Victoria Road	434103	386309	Residential Dwellings	762
118	Sheffield Hallam University Collegiate	434028	386330	Residential Dwellings	712
119	Sheffield Hallam University Collegiate	433961	386279	Residential Dwellings	739
120	Sheffield Hallam University Collegiate	433917	386225	Residential Dwellings	781
121	Broomgrove Road	433889	386220	Residential Dwellings	781
122	Sheffield Hallam University Collegiate	433952	386107	Residential Dwellings	904
123	Harlequins	434047	386070	Residential Dwellings	963
124	Copa Caffè	434178	386167	Residential Dwellings	922
125	Conrad Blandford	434105	386133	Residential Dwellings	923
126	Stalker Lees Road	434129	386073	Residential Dwellings	988
127	Denham Road	433996	386036	Residential Dwellings	983
128	Cemetery Avenue	433947	386005	Residential Dwellings	1003
129	Harefield Road	433901	385989	Residential Dwellings	1011
130	Havelock Place	434139	386758	Residential Dwellings	441
131	Gloucester Cottage	434074	386735	Residential Dwellings	402
132	Lynwood/ Birchcliffe	434013	386706	Residential Dwellings	378
133	Collegiate Villa	433964	386673	Residential Dwellings	376
134	The Knowle	433931	386632	Residential Dwellings	396
135	Sheffield Hallam University Collegiate	433896	386598	Residential Dwellings	415
136	Park Lane	433820	386593	Residential Dwellings	402
137	Sheffield Hallam University Collegiate	433856	386523	Residential Dwellings	477
138	Sheffield Hallam University Collegiate	433875	386451	Residential Dwellings	551
139	Southgrove Road	433857	386120	Residential Dwellings	876
140	Southgrove Road	433759	386122	Residential Dwellings	869
141	Southgrove Road	433804	386195	Residential Dwellings	797
142	Southgrove Road	433717	386181	Residential Dwellings	811
143	East Grove Road	433725	386279	Residential Dwellings	713
144	Southgrove Road	433653	386262	Residential Dwellings	737
145	Sheffield Botanical Gardens	433654	386124	Residential Dwellings	874
146	Walton Road	433620	386038	Residential Dwellings	964

ID	Receptor Street Name	Easting (m)	Northing (m)	Category	Distance from Central Release Points (m)
147	Water Villa	433437	386070	Residential Dwellings	977
148	Sheffield Botanical Gardens	433490	386212	Residential Dwellings	826
149	Brocco Bank	433302	386146	Residential Dwellings	963
150	Clarkegrove Road	433651	386543	Residential Dwellings	462
151	Broomgrove Terrace	433689	386461	Residential Dwellings	535
152	Clarkegrove Road	433623	386448	Residential Dwellings	561
153	Birkdale School (Preparatory School)	433642	386382	Residential Dwellings	621
154	Oaklege	433579	386921	Residential Dwellings	198
155	Beech Hill Mount	433535	386910	Residential Dwellings	243
156	Broomhill Infant School	433502	386870	Residential Dwellings	289
157	Lea Hurst	433499	386823	Residential Dwellings	314
158	Hallamshire Physiotherapy	433563	386816	Residential Dwellings	267
159	The Rutland Hotel	433626	386799	Residential Dwellings	236
160	Sheffield High School (Sixth Form)	433472	386717	Residential Dwellings	400
161	Sheffield High School (Senior School)	433597	386628	Residential Dwellings	400
162	Sheffield High School (Senior School)	433474	386538	Residential Dwellings	538
163	Thorn Hurst	433506	386490	Residential Dwellings	564
164	Birkdale School (Pre-Prep)	433550	386399	Residential Dwellings	629
165	Mount Terrace	433396	386799	Residential Dwellings	415
166	West Mount House	433401	386698	Residential Dwellings	466
167	Sheffield High School (Junior School)	433441	386662	Residential Dwellings	461
168	Sheffield High School (Junior School)	433394	386624	Residential Dwellings	521
169	Melbourne Avenue	433342	386605	Residential Dwellings	572
170	Westbourne School	433299	386566	Residential Dwellings	630
171	Oak View	433369	386534	Residential Dwellings	604
172	Beech Grove	433391	386456	Residential Dwellings	652
173	The Hollies	433314	386426	Residential Dwellings	722
174	Westbrook Cottage	433344	386375	Residential Dwellings	746
175	Moorwood Bank	433446	386372	Residential Dwellings	696
176	Fern Villa	433282	386314	Residential Dwellings	831
177	Oakholme Lodge 20-18	433131	386310	Residential Dwellings	930
178	Oakholme Lodge 14	433063	386335	Residential Dwellings	960
179	Moorend Place	433492	387863	Residential Dwellings	913
180	Hands Road	433458	387807	Residential Dwellings	871
181	Hands Road	433365	387781	Residential Dwellings	885
182	Warwick Street	433323	387729	Residential Dwellings	860
183	Spring View Road	433319	387672	Residential Dwellings	814
184	Spring View Road	433339	387628	Residential Dwellings	766
185	Ainsley Road	433402	387541	Residential Dwellings	658
186	Conduit Road	433307	387514	Residential Dwellings	695
187	School Road	433146	387503	Residential Dwellings	803
188	School Road Dental Surgery	433029	387475	Residential Dwellings	880
189	Conduit Road	433366	387378	Residential Dwellings	555
190	Reservoir Road	433267	387356	Residential Dwellings	617
191	Coombe Road	433027	387371	Residential Dwellings	829
192	Sandhurst Place	433142	387698	Residential Dwellings	942
193	Elgin Street	432890	387321	Residential Dwellings	934
194	Bute Street	432898	387269	Residential Dwellings	910
195	Crookes Road	433112	387217	Residential Dwellings	690
196	Mary Tozer House	432929	387110	Residential Dwellings	843
197	Hallamgate Road	432851	387027	Residential Dwellings	914
198	Tapton Mount Close	432903	386891	Residential Dwellings	867
199	Lawson Road	433006	386881	Residential Dwellings	766
200	Taptonville Road	433086	386876	Residential Dwellings	688
201	Crookes Road	433181	387172	Residential Dwellings	610

ID	Receptor Street Name	Easting (m)	Northing (m)	Category	Distance from Central Release Points (m)
202	Hawthorne Mews	433120	387116	Residential Dwellings	656
203	Crookesmoor Road	433301	387121	Residential Dwellings	481
204	Hoole Lane	433236	387003	Residential Dwellings	528
205	Parkers Road	433402	386968	Residential Dwellings	363
206	Tapton Mount Close	432879	386843	Residential Dwellings	897
207	Clifton Court	433036	386820	Residential Dwellings	748
208	Boulevardier	433239	386782	Residential Dwellings	565
209	Clifton Cottage	433286	386692	Residential Dwellings	564
210	Summerfield	433224	386711	Residential Dwellings	608
211	Ashdell Mount	433119	386684	Residential Dwellings	714
212	Chesterwood Drive	432902	386675	Residential Dwellings	918
213	Birkdale School	432932	386580	Residential Dwellings	928
214	Ashcroft	433041	386580	Residential Dwellings	832
215	Westbourne School (Senior School)	433164	386561	Residential Dwellings	738
216	Birkdale School	433120	386469	Residential Dwellings	829

Figure 2-3 – Modelling domain and location of modelled human receptors



2.9.3 Ecological Receptors

The Environment Agency's Air Emissions Risk (AER) Guidance provides the following detail regarding consideration of ecological receptors:

- Check if there are any of the following within 10km of your site (within 15km if you operate a large electric power station or refinery):
    - Special Protection Areas (SPAs)
    - Special Areas of Conservation (SACs)
    - Ramsar Sites (protected wetlands)
- Check if there are any of the following within 2 km of your site:
    - Sites of Special Scientific Interest (SSSIs)
    - Local Nature Sites (ancient woods, local wildlife sites, Sites of Nature Conservation Importance (SNCIs) and national/local nature reserves (NNR/LNR).

Following the above guidance, Table 2.7 provides details of ecological receptors which should be considered within this assessment. There is one SPA and one SAC site within 10 km of the site, and four LNR within 2 km of the site. There are no Ramsar sites within 10 km of the site.

Table 2.7 – Details of Modelled Ecological Receptors

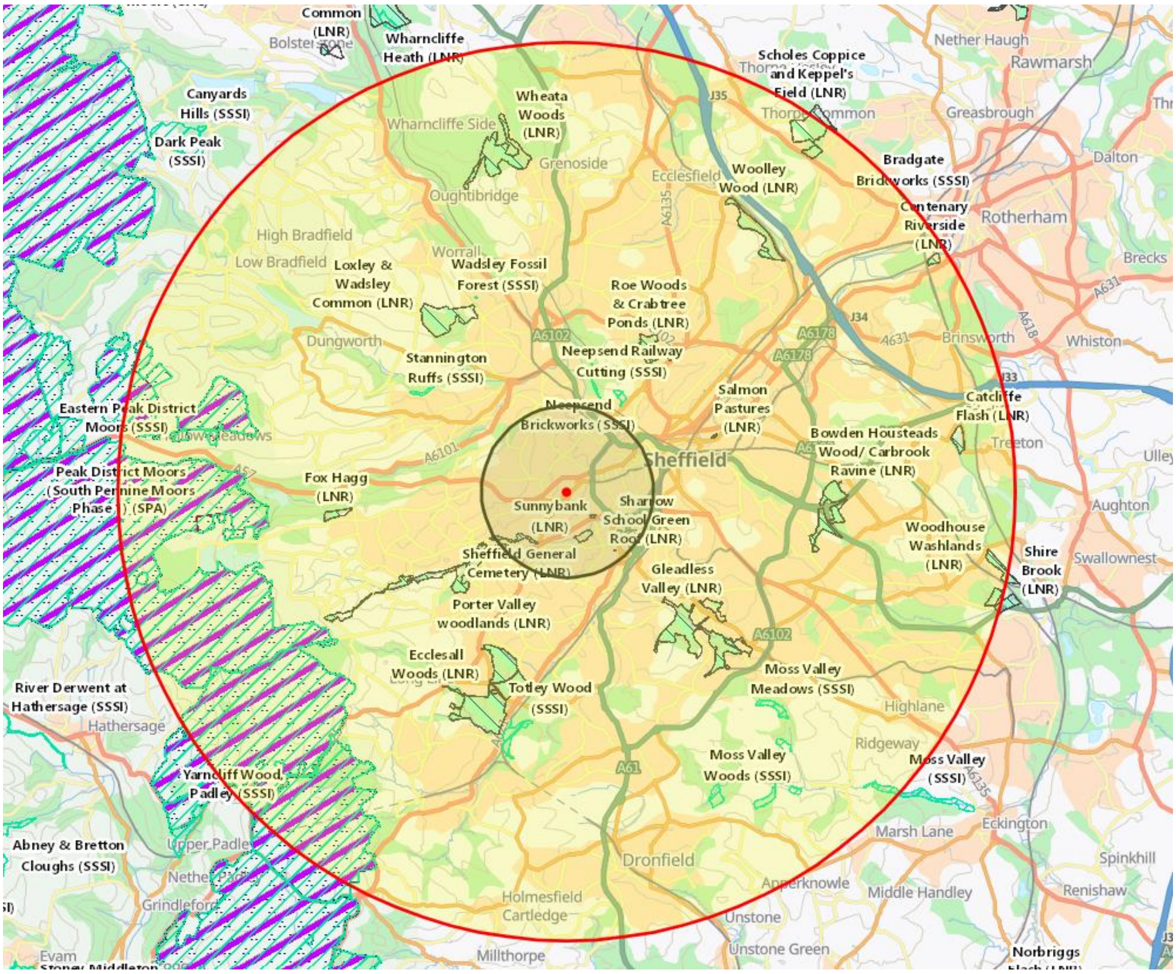
ID	Receptor Name	Type	Easting (m)	Northing (m)	Distance from the site (km)
E1	Peak District Moors (South Pennine Moors phase 1)	SPA	428025	385982	>2 but <10
E2	South Pennine Moors	SAC	428025	385982	>2 but <10
E3	Porter Valley Woodlands	LNR	432847	385978	<2
E4	Sheffield General Cemetery	LNR	434316	386061	<2
E5	Sharrow School Green Roof	LNR	434921	385641	<2
E6	Sunnybank	LNR	434375	386431	<2
E7	Lynwood Gardens	LNR	433945	386756	>2 but <10
E8	Botanical Gardens	LNR	433492	386237	>2 but <10
E9	Lower Porter	LNR	434156	385920	>2 but <10
E10	Endcliffe Park	LNR	432695	385858	>2 but <10
E11	Blake Street Nature Park	LNR	434015	388341	>2 but <10
E12	Bole Hills	LNR	432632	388240	>2 but <10
E13	Oak Brook	LNR	432307	386235	>2 but <10
E14	The Reaps	LNR	432250	388241	>2 but <10
E15	Clough Fields	LNR	432002	387667	>2 but <10
E16	Milestone Edge Rough & Fields	LNR	431134	387578	>2 but <10
E17	Lower Rivelin Valley	LNR	431496	388093	>2 but <10
E18	Middle River Don	LNR	434312	388769	>2 but <10
E19	Wardsend Cemetery	LNR	434837	388416	>2 but <10
E20	Kelham Island	LNR	435134	388273	>2 but <10
E21	Sharrow School Green Roof	LNR	434926	385629	>2 but <10
E22	River Sheaf	LNR	435731	386328	>2 but <10
E23	Bingham Park	LNR	431781	385383	>2 but <10
E24	Parkwood Springs	LNR	435137	389195	>2 but <10
E25	Walkley Bank Plantation	LNR	432417	388832	>2 but <10
E26	Cattle Dock Sidings	LNR	435618	388293	>2 but <10
E27	Smith Wood (Ancient Woodland)	LNR	432302	386115	>2 but <10

Note: Coordinates represent the location of the closest point of the ecological receptor to the site, and therefore the location of the predicted maximum impact. E1 and E2 closest points are within the same location.

Receptors E3 to E27 do not have any habitat interest features listed in the UK Air Pollution Information System (APIS) database and there are no Critical Loads (CL) available for these sites. Therefore, to ensure a conservative approach, this assessments has assumed the CL associated with Broadleaved, Mixed and Yew Woodland (10-20).

For each ecological receptor the predicted concentration and deposition at the closest point of the ecological receptor to the site was compared against relevant Critical Levels and Critical Loads. The location of designated sites considered in this assessment is shown in Figure 2-4.

Figure 2-4 – Location of Modelled Ecological Receptors (10km and 2km radius from site)



2.10 Terrain

The concentrations of an emitted pollutant found in elevated, complex terrain differ from those found in simple level terrain. There have been numerous studies on the effects of topography on atmospheric flows. A summary of the main effects of terrain on atmospheric flow and dispersion of pollutants are summarised below:

- **Plume interactions with windward facing terrain features**
  - Plume interactions with terrain features whereby receptors on hills at a similar elevation to the plume experience elevated concentrations.
  - Direct impaction of the plume on hill slopes in stable conditions.

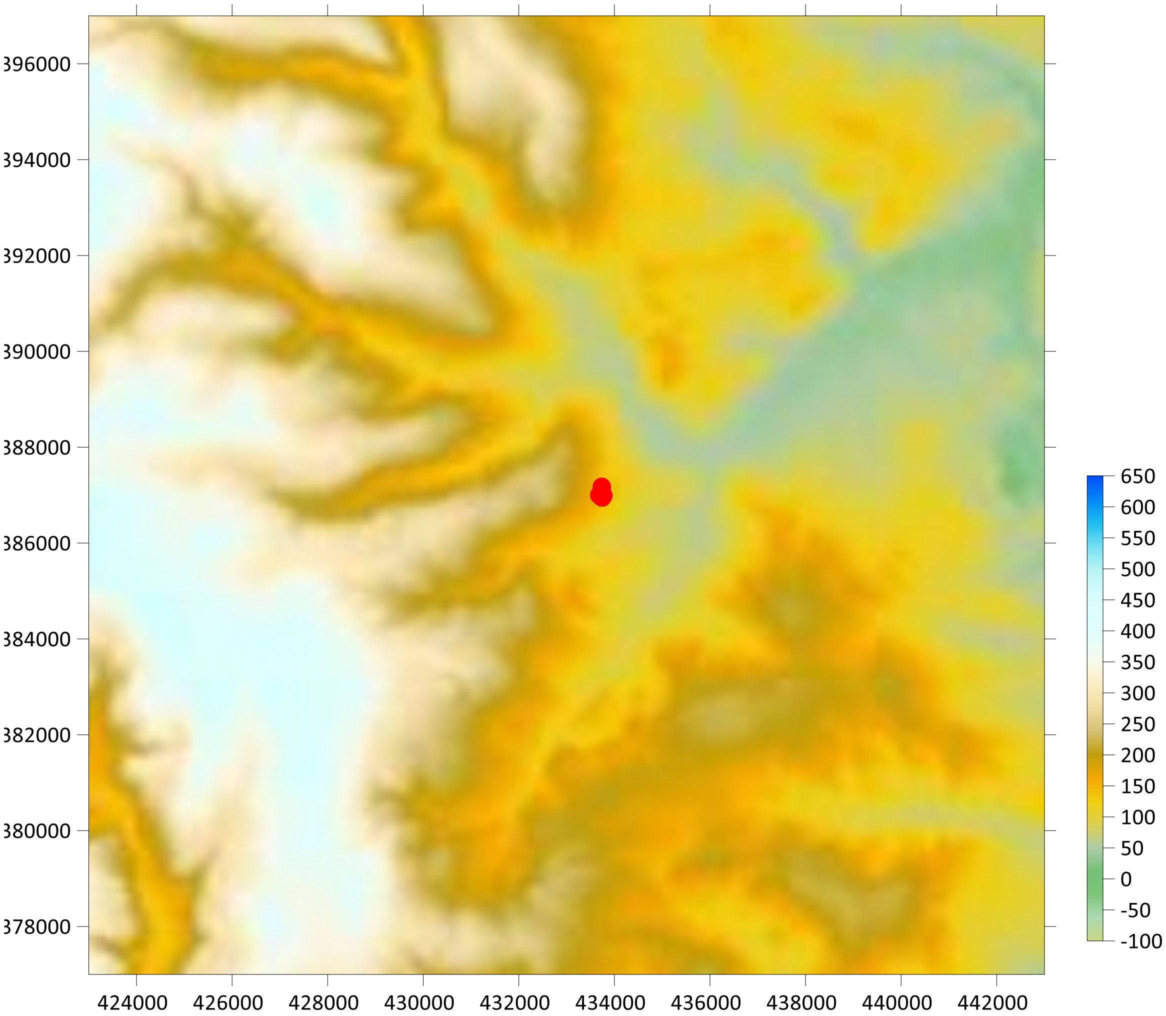
- Flow over hills in neutral conditions can experience deceleration forces on the upwind slope, reducing the rate of dispersion and increasing concentrations.
- Recirculation regions on the upwind side of a hill can cause partial or complete entrainment of the plume, resulting in elevated pollutant concentrations.

- **Plume interactions with lee sides of terrain features**
    - Regions of recirculation behind steep terrain features can rapidly advect pollutants towards the ground culminating in elevated concentrations.
    - As per the upwind case, releases into the lee of a hill in stable conditions can also be recirculated, resulting in increased pollutant concentrations.
- **Plume interactions within valleys**
    - Releases within steep valleys experience restricted lateral dispersion due to the valley sidewalls. During stable overnight conditions, inversion layers develop within the valley essentially trapping all emitted pollutants. Following sunrise and the erosion of the inversion, elevated pollutant concentrations can result during fumigation events.
    - Convective circulations in complex terrain due to differential heating of the valley side walls can lead to the impingement of plumes due to crossflow onto the valley sidewalls and the subsidence of plume centrelines, both having the impact of increasing pollutant concentrations.

These effects are most pronounced when the terrain gradients exceed 1 in 10 i.e. a 100m change in elevation per 1km step in the horizontal plane. The gradients surrounding the site do exceed this criterion and, consequently, terrain data will be included in the model.

The site is located on land at an elevation of approximately 127 m. Terrain rises to the west increasing to above 400m approximately 15 km from site. To the east the terrain decreases to approximately 50m. Residential properties surrounding the have a similar elevation ranging from 115 to 175 m. The nature of the terrain could have a significant effect on the dispersion of pollutants, hence the terrain module operated within ADMS 6 has been used to generate a high-resolution terrain file. Topographical data for the surrounding area has been obtained from Ordnance Survey (OS) OpenData, covering an area of approximately 20km × 20km centred on the site. The resulting terrain grid is shown is shown below in Figure 2-5.

Figure 2-5 – Terrain Data Input to the ADMS 6 Model



2.11 Deposition

The predominant route by which emissions will affect land in the vicinity of a process is by deposition of atmospheric emissions. Potential ecological receptors can be sensitive to the deposition of pollutants, particularly nitrogen and sulphur compounds as well as minor pollutants such as HCl, which can affect the character of the habitat through eutrophication and acidification.

Deposition processes in the form of dry and wet deposition remove material from a plume and alter the plume concentration. Dry deposition occurs when particles are brought to the surface by gravitational settling and turbulence. They are then removed from the atmosphere by deposition on the land surface. Wet deposition occurs due to rainout (within cloud) scavenging and washout (below cloud) scavenging of the material in the plume. These processes lead to a variation with downwind distance of the plume strength and may alter the shape of the vertical concentration profile as dry deposition only occurs at the surface.

Near to sources of pollutants (< 2 km), dry deposition is the predominant removal mechanism (Fangmeier et al. 1994). Dry deposition may be quantified from the near-surface plume concentration and the deposition velocity (Chamberlin and Chadwick, 1953);

$$F_d = v_d C(x, y, 0)$$

where:

F_d = dry deposition flux (µg/m²/s)

v_d = deposition velocity (m/s)

$C(x, y, 0)$ = ground level concentration (µg/m³)

Assuming irreversible uptake, the total wet deposition rate is found by integrating through a vertical column of air;

$$F_w = \int_0^z \Lambda C \, dz$$

where;

F_w = wet deposition flux (µg/m²/s)

Λ = washout co-efficient (s^{-1})

C = local airborne concentration (µg/m³)

z = height (m)

The washout co-efficient is an intrinsic function of the rate of rainfall.

Environment Agency guidance AQTAG06 (Environment Agency, 2014) recommends deposition velocities for various pollutants, according to land use classification (Table 2.8).

Table 2.8 – Recommended Deposition Velocities

Pollutant	Deposition Velocity (m/s)	
	Short Vegetation	Long Vegetation/Forest
NO_x	0.0015	0.003
SO_2	0.012	0.024
NH_3	0.020	0.030
HCl	0.025	0.060

Source: Environment Agency (2014) 'Technical Guidance on Detailed Modelling Approach for an Appropriate Assessment for Emissions to Air', AQTAG06 Updated Version (March 2014)'

In order to assess the impacts of deposition, habitat-specific critical loads and critical levels have been created. These are generally defined as (e.g., Nilsson and Grennfelt, 1988):

> *"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"*

It is important to distinguish between a critical load and a critical level. The critical load relates to the quantity of a material deposited from air to the ground, whilst critical levels refer to the concentration of a material in air. The UK APIS provides critical load data for ecological sites in the UK.

The critical loads used to assess the impact of compounds deposited to land which result in eutrophication and acidification are expressed in terms of kilograms of nitrogen deposited per hectare per year (kgN/ha/yr) and kilo equivalents deposited per hectare per year (keq/ha/yr). To enable a direct comparison against the critical loads, the modelled total wet and dry deposition flux (µg/m2/s) must be converted into an equivalent value.

For a continuous release, the annual deposition flux of nitrogen can be expressed as:

$$F_{NTot} = \left(\frac{K_2}{K_3}\right) \cdot t \cdot \sum_{i=1}^{T} F_i \left(\frac{M_N}{M_i}\right)$$

where:

F_{NYot} = Annual deposition flux of nitrogen (kgN/ha/yr)

K_2 = Conversion factor for m^2 to ha (= 1x10^4 m^2/ha)

K_3 = Conversion factor for µg to kg (= 1x10^9 µg/kg)

t = Number of seconds in a year (= 3.1536x10^7 s/yr)

i = 1,2,3…….T

T = Total number of nitrogen containing compounds

F = Modelled deposition flux of nitrogen containing compound (µg/m^2/s)

M_N = Molecular mass of nitrogen (kg)

M = Molecular mass of nitrogen containing compound (kg)

The unit eq (1 keq ≡ 1,000 eq) refers to molar equivalent of potential acidity resulting from e.g. sulphur, oxidised and reduced nitrogen, as well as base cations. Conversion units are provided in AQTAG(06).

Table 2.9 – Deposition Conversion Factors

Pollutant	Chemical Element	Conversion Factor µg/m²/s [of Pollutant] → kg/ha/yr [of Chemical Element]
NO_x (as NO_2)	Nitrogen (N)	96.0
NH_3	Nitrogen (N)	259.7
SO_2	Sulphur (S)	157.7
HCl	Chlorine (Cl)	306.7

Table 2.10 – Acidification Conversion Factors

Chemical Element	Conversion Factor kg/ha/yr →keq/ha/yr
Nitrogen (N)	0.07143
Sulphur (S)	0.06250
Chlorine (Cl)	0.02857

For the purposes of this assessment, dry deposition rates of nitrogen and acidic equivalents at the identified ecological receptors have been calculated by applying the 'short vegetation' deposition velocities (as detailed in Table 2.8) to the modelled annual mean concentrations of NOx and SO_2. Wet deposition has not been assessed for NOx since this is not a significant contributor to total deposition over shorter ranges (Fangmeier et al. 1994; Environment Agency, 2006).

Estimated background deposition rates of nutrient nitrogen and total acid deposition for the UK are available via the Air Pollution Information Service (APIS) website (http://www.apis.ac.uk). Table 2.11 provides the estimated deposition rates for the ecological receptors considered in this study, as obtained from the APIS website. It should be noted that the level of uncertainty associated with these modelled estimates is relatively high and the results are presented from the model across the UK on a 1 km grid square resolution.

Table 2.11 – Estimated Background Deposition Rates 2021

ID	Background Nitrogen Deposition (grid average kgN/ha/yr)	Background Acid Deposition (grid average keq/ha/yr)
E1	1.22	0.23
E2	1.22	0.23
E3	0.99	0.26
E4	0.95	0.26
E5	0.95	0.25
E6	0.95	0.26

2.12 Other Treatments

Specialised model treatments, for short-term (puff) releases, fluctuations or photochemistry were not used in this assessment.

2.13 Conversion of NO to NO_2

Emissions of NOx from combustion processes are predominantly in the form of nitric oxide (NO). Excess oxygen in the combustion gases and further atmospheric reactions cause the oxidation of NO to nitrogen dioxide (NO_2). NOx chemistry in the lower troposphere is strongly interlinked in a complex chain of reactions involving Volatile Organic Compounds (VOCs) and Ozone (O_3). Two of the key reactions interlinking NO and NO2 are detailed below:

$$NO_2 + hv \xrightarrow{O_2} NO + O_3 \qquad (R_1)$$

$$NO + O_3 \longrightarrow NO_2 + O_2 \qquad (R_2)$$

Where hv is used to represent a photon of light energy (i.e., sunlight).

Taken together, reactions R1 and R2 produce no net change in O3 concentrations, and NO and NO_2 adjust to establish a near steady state reaction (photo-equilibrium). However, the presence of VOCs and CO in the atmosphere offer an alternative production route of NO_2 for photolysis, allowing O_3 concentrations to increase during the day with a subsequent decrease in the NO2:NOx ratio.

However, at night, the photolysis of NO_2 ceases, allowing reaction R2 to promote the production of NO_2, at the expense of O_3, with a corresponding increase in the NO_2:NOx ratio. Similarly, near to an emission source of NO, the result is a net increase in the rate of reaction R2, suppressing O_3 concentrations immediately downwind of the source, and increasing further downwind as the concentrations of NO begin to stabilise to typical background levels (Gillani and Pliem 1996).

Given the complex nature of NOx chemistry, the Environment Agency's Air Quality Modelling and Assessment Unit (AQMAU) have adopted a pragmatic, risk-based approach in determining the conversion rate of NO to NO2 which dispersion model practitioners can use in their detailed assessments6. The AQMAU guidance advises that the source term should be modelled as NOx (as NO2) and then suggests a tiered approach when considering ambient NO_2:NOx ratios:

- **Screening Scenario:** 50 % and 100 % of the modelled NO_x process contributions should be used for short-term and long-term average concentration, respectively. That is, 50 % of the predicted NO_x concentrations should be assumed to be NO_2 for short-term assessments and 100 % of the predicted NO_x concentrations should be assumed to be NO_2 for long-term assessments;
- **Worst Case Scenario:** 35 % and 70 % of the modelled NOx process contributions should be used for short-term and long-term average concentration, respectively. That is, 35 % of the predicted NO_x concentrations should be assumed to be NO_2 for short-term assessments and 70 % of the predicted NO_x concentrations should be assumed to be NO_2 for long-term assessments; and
- **Case Specific Scenario:** Operators are asked to justify their use of percentages lower than 35 % for short-term and 70 % for long-term assessments in their application reports.

In addition, AER guidance for air dispersion modelling reports states that worst case scenario conversion ratios of 35% for short-term average concentrations and 70% for long-term average concentrations should be applied for combustion processes.

In line with the AQMAU guidance, this assessment will therefore use a NOx to NO2 ratio of 70% for long term average concentrations, 35% for short term concentrations.

[6] http://www.environment-agency.gov.uk/static/documents/Conversion_ratios_for__NOx_and_NO2_.pdf

3 Background Pollutant Concentrations

3.1 Local Air Quality Management

In 2010 Sheffield City Council, as part of their duties under Local Air Quality Management (LAQM), declared a districtwide Air Quality Management Area (AQMA) for failure to meet short-term (hourly) and long term (annual) Air Quality Limit Values for Nitrogen Dioxide (NO2) gas. At that time, in accordance with LAQM, the council also declared a districtwide AQMA for breach of short-term (24 Hourly mean) Particulate Matter PM10 limits. Data for 2022 indicates that the Sheffield AQMA is still in breach of Air Quality Limit Values for Nitrogen Dioxide (NO2) gas.

The the main sources of nitrogen dioxide (NO_2) pollution in the area is from road traffic. Sheffield City Council monitor for the pollutant NO_2 via a network of 235 diffusion tubes sites. NO_2 is considered the main pollutant of concern for road vehicles and is particularly linked to heavy goods vehicles (HGVs) and other diesel vehicles. Sheffield City Council also undertake automatic (continuous) monitoring at 6 sites during 2021 along with 3 DEFRA monitoring sites within the Sheffield City Council area.

3.2 Monitoring Data

The Council operates a pollutant monitoring network consisting of passive NO_2 diffusion tube monitoring locations. In terms of monitoring locations, operated by the Council, which are close to the Site there are six diffusion tubes within 0.5 km of the site boundary, details of which are provided in Table 3.1. A fully interactive map including 2023 data is available at Diffusion Tubes.

Table 3.1 – NO_2 Diffusion Tube Monitoring Close to the Site

Site ID	Site Location	Site Type	OS Grid Ref (E, N)	Within an AQMA	Distance to Site (m)	Height (m)	2023 Annual Mean NO_2 Concentration ($\mu g/m^3$)
110	12 Town Street Comm	Roadside	439943, 390948	Yes - SCC City Wide	<500m	2	35.6
112	Greasebro Road Comm	Roadside	439813, 390743	Yes - SCC City Wide	<500m	2	27.9
198	Whitham Road / Crookes	Roadside	433328, 386864	Yes - SCC City Wide	<500m	2	35.0
200	Crookes Valley Road/Crookesm	Roadside	433750 387724	Yes - SCC City Wide	<500m	2	36.8
195	Western Bank / Northumberland Road	Roadside	433752, 387232	Yes - SCC City Wide	<500m	2	N/A
194	Hunter's Bar School	Urban Background	433267, 385684	Yes - SCC City Wide	<500m	2	18.4
The 2023 monitoring results presented above were obtained from the Council LAQM 2023 ASR[7]							

[7] https://www.sheffield.gov.uk/sites/default/files/2024-02/2023-air-quality-annual-status-report_0.pdf

3.3 Background Concentrations used in the Assessment

The dispersion model has been used to predict the contribution of the MCP emissions, or Process Contribution (PC), to ambient air concentrations. Existing background concentrations have then been added to the Process Contribution in order to report total pollutant concentrations or Predicted Environmental Concentration (PEC) at specific sites and on the grid of receptors. The total concentration can then be compared against the relevant Air Quality Standard/Objective (AQS/O) or Environmental Assessment Limit (EAL) and the likelihood of an exceedance determined. In order to determine background concentration levels, local monitoring sites and the UK background maps have been considered.

The closest urban background ambient air monitoring station is located 1.0 km to the east of the site in Devonshire Green and is part of the Automatic Urban and Rural Network (AURN)[8]. Urban Background data from the continuous monitoring site has been used to determine the annual average NO_2 and NOx concentrations for the individual assessment years. Background annual mean concentrations obtained at this site are detailed in Table 3.2, and provide an insight into local background air quality.

Table 3.2 – Background Annual Mean Concentrations used in the Assessment

Pollutant	2020 Background Annual Mean	2021 Background Annual Mean	2022 Background Annual Mean	2023 Background Annual Mean	2024 Background Annual Mean	Units
NO_x as NO_2	26.6	32.0	26.4	22.8	21.5	$\mu g/m^3$
NO_2	17.8	21.0	17.6	16.2	15.4	$\mu g/m^3$

In addition to the AURN data, Defra maintains a nationwide model of existing and future background air quality concentrations on a 1km grid square resolution. The datasets include annual average concentration estimates for PM_{10}, $PM_{2.5}$, CO, NOx, NO_2 and SO_2. The model used is empirical in nature: it uses the national atmospheric emissions inventory (NAEI) emissions to model the concentrations of pollutants at the centroid of each 1 km grid square but then calibrates these concentrations in relation to actual monitoring data.

Annual mean background concentrations have been obtained from the Defra published background maps[9], based on the 1 km grid squares which cover the modelled area. No adjustment for background concentration variability with height will be made. The modelled concentrations are subsequently added to the annual average background concentration to give a total concentration at

[8] https://uk-air.defra.gov.uk/networks/index

[9] Defra Background Maps. http://laqm.defra.gov.uk/review-and-assessment/tools/background-maps.html

each receptor location. This total concentration can then be compared against the relevant AQS objective, and the likelihood of an exceedance determined.

It is not technically rigorous to add predicted short-term or percentile concentrations to ambient background concentrations not measured over the same averaging period, since peak contributions from different sources would not necessarily coincide in time or location. Without hourly ambient background monitoring data available it is difficult to make an assessment against the achievement or otherwise of the short-term AQS/O. For the current assessment, conservative short-term ambient levels have been derived by applying a factor of two to the annual mean background data as per the recommendation in EA AER Guidance for NOx. This is comparable to the 2024 AURN Urban Background data.

Background annual mean concentrations used in the assessment are detailed in Table 3.2.

Table 3.3 – Background Annual Mean Concentrations

Pollutant	2024 Background Annual Mean (reference year of 2021)	Units
NO_x	9.9 (x2 = 19.8)	$\mu g/m^3$
NO_2	7.6 (x2 = 15.2)	$\mu g/m^3$
CO[1]	0.34 (x2 = 0.68)	mg/m^3
SO_2[1]	5.08 (x2 = 10.16)	$\mu g/m^3$
[1]Data for CO and SO_2 are obtained from Defra 2001-based background maps for the Borough of St Edmundsbury which became West Suffolk District in 2019[10]		

4 Sensitivity Analysis and Uncertainty

4.1 Sensitivity Analysis

Wherever possible, this assessment has used worst-case scenarios, which will exaggerate the impact of the emissions on the surrounding area, including mass emissions, operational profile, ambient concentrations, meteorology, and surface roughness.

4.2 Model Uncertainty

Dispersion modelling is inherently uncertain but is nonetheless a useful tool in plume footprint visualisation and prediction of ground level concentrations. The use of dispersion models has been widely used in the UK for both regulatory and compliance purposes for a number of years and is an accepted approach for this type of assessment.

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[10] https://uk-air.defra.gov.uk/data/laqm-background-maps?year=2001

This assessment has incorporated a number of worst-case assumptions, as described above, which will result in an overestimation of the predicted ground level concentrations from the process. Therefore, the actual predicted ground level concentrations would be expected to be lower than this and, in some cases, significantly lower.

The model is well validated with observed concentrations for a number of scenarios; however, as the complexity of the modelled domain increases, modelled concentrations deviate from observed concentrations.

5 Relevant Legislation and Guidance

5.1 EU Legislation

5.1.1 Directive 2008/50/EC on Ambient Air Quality and Cleaner Air for Europe

Directive 2008/50/EC (the 'Directive'), which came into force in June 2008, consolidates existing EU-wide air quality legislation (with the exception of Directive 2004/107/EC) and provides a new regulatory framework for PM2.5.

The Directive sets limits, or target levels, for selected pollutants that are to be achieved by specific dates and details procedures EU Member States should take in assessing ambient air quality. The limit and target levels relate to concentrations in ambient air. At Article 2(1), the Directive defines ambient air as:

> *"…outdoor air in the troposphere, excluding workplaces as defined by Directive 89/654/EEC where provisions concerning health and safety at work apply and to which members of the public do not have regular access."*

In accordance with Article 2(1), Annex III, Part A, paragraph 2 details locations where compliance with the limit values does not need to be assessed:

> *"Compliance with the limit values directed at the protection of human health shall not be assessed at the following locations:*
>
> *a) any locations situated within areas where members of the public do not have access and there is no fixed habitation;*
>
> *b) in accordance with Article 2(1), on factory premises or at industrial installations to which all relevant provisions concerning health and safety at work apply;*
>
> *c) on the carriageway of roads; and on the central reservation of roads except where there is normally pedestrian access to the central reservation.*

5.2 UK Legislation

5.2.1 The Air Quality Standards Regulations 2010

The Air Quality Standards Regulations 2010 (the 'Regulations') came into force on the 11th of June 2010 and transpose Directive 2008/50/EC into UK legislation. The Directive's limit values are transposed into the Regulations as 'Air Quality Standards' (AQS) with attainment dates in line with the Directive.

These standards are legally binding concentrations of pollutants in the atmosphere which can broadly be taken to achieve a certain level of environmental quality. The standards are based on the assessment of the effects of each pollutant on human health including the effects of sensitive groups or on ecosystems.

Similar to Directive 2008/50/EC, the Regulations define ambient air as;

> *"…outdoor air in the troposphere, excluding workplaces where members of the public do not have regular access."*

With direction provided in Schedule 1, Part 1, Paragraph 2 as to where compliance with the AQS' does not need to be assessed:

> *"Compliance with the limit values directed at the protection of human health does not need to be assessed at the following locations:*
>
> *a) any location situated within areas where members of the public do not have access and there is no fixed habitation;*
>
> *b) on factory premises or at industrial locations to which all relevant provisions concerning health and safety at work apply;*
>
> *c) on the carriageway of roads and on the central reservation of roads except where there is normally pedestrian access to the central reservation."*

5.2.2 The Air Quality Strategy for England, Scotland, Wales and Northern Ireland

The 2007 Air Quality Strategy for England, Scotland Wales and Northern Ireland provides a framework for improving air quality at a national and local level and supersedes the previous strategy published in 2000.

Central to the Air Quality Strategy are health-based criteria for certain air pollutants; these criteria are based on medical and scientific reports on how and at what concentration each pollutant affects human health. The objectives derived from these criteria are policy targets often expressed as a maximum ambient concentration not to be exceeded, without exception or with a permitted number of exceedences, within a specified timescale. At paragraph 22 of the 2007 Air Quality Strategy, the point is made that the objectives are:

> *"…a statement of policy intentions or policy targets. As such, there is no legal requirement to meet these objectives except where they mirror any equivalent legally binding limit values…"*

The AQOs, based on a selection of the objectives in the Air Quality Strategy, were incorporated into UK legislation through the Air Quality Regulations 2000, as amended.

Paragraph 4(2) of The Air Quality (England) Regulations 2000 states:

> *"The achievement or likely achievement of an air quality objective prescribed by paragraph (1) shall be determined by reference to the quality of air at locations –*
>
> *a) which are situated outside of buildings or other natural or man-made structures above or below ground; and*
>
> *b) where members of the public are regularly present*

Consequently, compliance with the AQOs should focus on areas where members of the general public are present over the entire duration of the concentration averaging period specific to the relevant objective.

5.2.3 Clean Air Strategy

The Clean Air Strategy[11] (CAS) was published on 14th January 2019 outlining how the UK will meet international commitments to significantly reduce emissions of five damaging air pollutants by 2020 and 2030 under the adopted revised National Emissions Ceiling Directive (NECD).

The strategy states that it:

> *…sets out the comprehensive action that is required from across all parts of government and society to meet these goals. New legislation will create a stronger and more coherent framework for action to tackle air pollution. This will be underpinned by new England-wide powers to control major sources of air pollution, in line with the risk they pose to public health and the environment, plus new local powers to take action in areas with an air pollution problem. These will support the creation of Clean Air Zones to lower emissions from all sources of air pollution, backed up with clear enforcement mechanisms.*

Chapter 8 of the CAS addresses action to reduce emissions from industry outlining the following key actions:

- *Maintain the longstanding policy of continuous improvement in relation to industrial emissions, building on existing good practice to deliver a stable and predictable regulatory environment for business as part of a world leading clean green economy.*
- *Improve the current framework to make it work better for both the environment, the public and UK industry by:*
    - *Working with industry to develop a series of ambitious sector roadmaps to make UK industry world leaders in clean technology and to secure further emissions reductions from industry by 2030 and beyond;*
    - *Ensuring there is a clear process for determining future UK Best Available Techniques for industrial sectors. The future UK BAT regime will continue to endorse the collaborative approach of the current system;*
    - *Reviewing existing guidance to support effective emission controls at smaller industrial sites and consider whether further action is needed to strengthen the current regulatory framework;*
    - *Considering the case for tighter emissions standards on emissions from medium combustion plants and generators;*
    - *Considering closing the regulatory gap between the current eco-design and medium combustion plant regulations to tackle emissions from plants in the 500kW to 1MW thermal input range while being mindful of the impact on small and medium sized businesses; and*

[11] Department for Environment, Food and Rural Affairs – Clean Air Strategy (2019)

- *Considering the need to exempt generators used for research and development from emissions control.*

5.3 Local Air Quality Management

Part IV of the Environment Act 1995 requires that Local Authorities periodically review air quality within their individual areas. This process of LAQM is an integral part of delivering the Government's AQOs.

To carry out an air quality Review and Assessment under the LAQM process, the Government recommends a three-stage approach. This phased review process uses initial simple screening methods and progresses through to more detailed assessment methods of modelling and monitoring in areas identified to be at potential risk of exceeding the objectives in the Regulations.

Review and assessments of local air quality aim to identify areas where national policies to reduce vehicle and industrial emissions are unlikely to result in air quality meeting the Government's air quality objectives by the required dates.

For the purposes of determining the focus of Review and Assessment, Local Authorities should have regard to those locations where members of the public are likely to be regularly present and are likely to be exposed over the averaging period of the objective.

Where the assessment indicates that some or all of the objectives may be potentially exceeded, the Local Authority has a duty to declare an AQMA. The declaration of an AQMA requires the Local Authority to implement an Air Quality Action Plan (AQAP), to reduce air pollution concentrations so that the required AQOs are met.

5.4 Environmental Permitting Regulations (EPR) and MCPD

The Environmental Permitting Regulations (EPR) 2018 were published in January 2018 to transpose the requirements of the Medium Combustion Plant Directive (MCPD) of 25 November 2015 and to control emissions from the operation of Specified Generators (SG). The MCPD sets out rules to control emissions of sulphur dioxide (SO2), nitrogen oxides (NOx), and fine particulate matter into the air (depending on the fuel used within the MCP). The SG regulations in EPR also control emission to air, primarily NOx, from generators that would not be otherwise captured by the MCPD. Together the directives aim to protect the environment by securing reductions of these pollutants.

Within EPR the requirements for MCPs are set out in Schedule 25A and for SG in Schedule 25B. The schedules include significant dates for submitting a permit application. The Environment

Agency (EA) administers and regulates the scheme for England. The other UK regulators include: Scottish Environment Protection Agency (SEPA), Northern Ireland Environment Agency (NIEA) and Natural Resources Wales (NRW The Industrial Emissions Directive (2010/75/EU)[12] came into force on 6 January 2011.

Emissions limit values (ELVs) to air are set out by the regulator in the Environmental Permit as permit conditions. Although ELVs are based on limit values prescribed in the relevant Directives (IPPC, WID, LCPD, MCPD), they can be different from site to site due to a variety of site-specific factors such as geographical location, mineralogy variations and local environmental conditions, but also technical and economic considerations. As specified in Article 6 of the MCPD, the ELV applicable to RHH will only cover NOx as per

Table 5.2 and Table 5.2 below.

Table 5.1 – Article 6 MCPD ELVs for MCPs other than Engines or Gas Turbines

Pollutant	Reference Conditions	Natural Gas Fired - ELVs mg/Nm^3
Nitrogen dioxide	STP, Dry, 3% O_2	250 (between 1 MW and 5 MW), 200 (>5 MW)
Carbon Monoxide		-
Sulphur Dioxide		-

Table 5.2 – Article 6 MCPD ELVs for Existing MCPs - Engines or Gas Turbines

Pollutant	Reference Conditions	Gas Oil Fired - ELVs mg/Nm^3
Nitrogen dioxide	STP, Dry, 15% O_2	190 (Engines)
Carbon Monoxide		-
Sulphur Dioxide		-

5.5 Other Guideline Values

In the absence of statutory standards for the other prescribed substances that may be found in the emissions, there are several sources of applicable air quality guidelines.

5.5.1 Air Quality Guidelines for Europe, the World Health Organisation (WHO)

The aim of the WHO Air Quality Guidelines for Europe (WHO, 2000) is to provide a basis for protecting public health from adverse effects of air pollutants and to eliminate or reduce exposure

[12] Directive 2010/75/EU of the European Parliament and of the Council of 24 November 2010 on industrial emissions (integrated pollution prevention and control) (Recast)

to those pollutants that are known or likely to be hazardous to human health or well-being. These guidelines are intended to provide guidance and information to international, national and local authorities making risk management decisions, particularly in setting air quality standards.

5.5.2 Environmental Assessment Levels (EALs)

The Environment Agency's AER Guidance provides methods for quantifying the environmental impacts of emissions to all media. The AER guidance contains long and short-term Environmental Assessment Levels (EALs), Ambient Air Directive (AAD) Limit Values and Environmental Quality Standards (EQS) for releases to air derived from a number of published UK and international sources. For the pollutants considered in this study, these EALs, AAD Limit Values and EQS are equivalent to the AQS and AQOs set in force by the Air Quality Strategy for England, Scotland Wales and Northern Ireland.

5.6 Criteria Appropriate to the Assessment

Table 5.3 sets out those AQS that are relevant to the assessment with regard to human receptors.

Table 5.3 – Air Quality Standards

Pollutant	AQS / EAL	Averaging Period	Value ($\mu g/m^3$)
Nitrogen dioxide	AQS	Annual	40
	AQS	1 hour mean, not more than 18 exceedances a year (equivalent of 99.79 Percentile)	200
Carbon Monoxide	AQS	8 hour running average across a 24 hour period	10,000
	EAL	1-hour	30,000
Sulphur Dioxide	AQS	24-hour, not more than 3 exceedances a year	125
	AQS	1-hour, not more than 24 exceedances a year	350

5.7 Critical Levels and Critical Loads Relevant to the Assessment of Ecological Receptors

A summary of the relevant AQS and EAL that apply to the emissions from the plant and their impact on ecological receptors are given in Table 5.4.

Table 5.4 – Summary of Relevant Air Quality Standards and Environmental Assessment Levels for Ecological Receptors

Pollutant	AQS / EAL	Averaging Period	Value ($\mu g/m^3$)
Oxides of nitrogen (NO_x) all receptors	AQS	Annual mean	30
	EAL	Daily mean	75
Sulphur Dioxide (SO_2) Forests and natural Vegetation	EAL	Annual mean	20

The APIS website provides specific information on the potential effects of nitrogen deposition on various habitats and species. This information, relevant to habitats of some of the ecological receptors considered in this assessment, is presented in Table 5.5.

Table 5.5 – Typical Habitat and Species Information Concerning Deposition

Habitat and Species Specific Information	Nitrogen Deposition Critical Load (kgN/ha/yr)	Specific Information Concerning Nitrogen Deposition
Coastal Saltmarsh	20 - 30	Many saltmarshes receive large nutrient loadings from river and tidal inputs. It is unknown whether other types of species-rich saltmarsh would be sensitive to nitrogen deposition. Increase in late-successional species, increased productivity but only limited information available for this type of habitat.
Dunes, Shingle & Machair	5 - 15	Foredunes receive naturally high nitrogen inputs. Key concerns of the deposition of nitrogen in these habitats relate to changes in species composition.
Fen, Marsh and Swamp	10 - 30	Nitrogen deposition provides fertilization. Increase in tall graminoids (grasses or Carex species) resulting in loss of rare species and decrease in diversity of subordinate plant species.
Temperate and boreal forests	10-20	Increased nitrogen deposition in mixed forests increases susceptibility to secondary stresses such as drought and frost, can cause reduced crown growth. Also can reduce the diversity of species due to increased growth rates of more robust plants.
Hay Meadow	20-30	The key concerns are related to changes in species composition following enhanced nitrogen deposition. Indigenous species will have evolved under conditions of low nitrogen availability. Enhanced nitrogen deposition will favour those species that can increase their growth rates and competitive status e.g. rough grasses such as false brome grass (Brachypodium pinnatum) at the expense of overall species diversity. The overall threat from competition will also depend on the availability of propagules
Acid Grasslands	10-25	Nitrogen deposition provides fertilization to acid grasslands, this increase robust grass growth that may limit other species reducing diversity.
Calcareous grassland	10 - 20	Nitrogen deposition provides fertilization, this increase robust vegetation growth that may limit other species reducing diversity
Broadleaved, Mixed and Yew Woodland	10-20	Increased nitrogen deposition in forests increases susceptibility to secondary stresses such as drought and frost, can cause reduced crown growth

6 Dispersion Modelling Results

This section sets out the results of the dispersion modelling and compares predicted ground level concentrations to ambient air quality standards or environmental assessment levels, if available. The predicted concentrations resulting from the process are presented with background concentrations, where possible, and the percentage contribution that the predicted environmental concentrations would make towards the relevant AQS/AQO/EAL. Ground level concentrations based on the average and maximum emission rates of each pollutant, as described in Section 2, have been modelled.

Air Quality impacts derived from the calculated maximum emission rate scenario (SC1), as shown in Table 2.1, were predicted in order to ascertain compliance with the relevant standards. As the maximum emission rate typically result in the greater impact, the results below only detail the air quality concentrations predicted based on the maximum emission rate scenario.

The results for SC1 in relation to CO and SO_2 can be found in Appendix B for completeness.

6.1 Human Receptors

6.1.1 Nitrogen Dioxide Impacts

Table 6.1 details the predicted annual and 99.79th percentile of the one hour mean NO2 concentrations at human receptors assuming the SC1 scenario.

Table 6.1 – NO_2 Impacts at Human Receptors SC1 Scenario

ID	Annual Mean (µg/m^3)				99.79th percentile 1 Hour Mean (µg/m^3)			
	AQS	PC	PEC	% PEC of AQS	AQS	PC	PEC	% PEC of AQS
R1	40	2.4	10.0	25.1%	200	27.9	43.1	21.5%
R2	40	1.2	8.8	22.1%	200	12.9	28.1	14.1%
R3	40	0.8	8.4	21.0%	200	9.6	24.8	12.4%
R4	40	0.9	8.5	21.2%	200	8.0	23.2	11.6%
R5	40	2.1	9.7	24.3%	200	14.0	29.2	14.6%
R6	40	1.1	8.7	21.7%	200	7.7	22.9	11.4%
R7	40	1.1	8.7	21.8%	200	6.4	21.6	10.8%
R8	40	0.5	8.1	20.1%	200	4.7	19.9	10.0%
R9	40	1.7	9.3	23.3%	200	16.9	32.1	16.1%
R10	40	1.1	8.7	21.7%	200	12.1	27.3	13.7%
R11	40	0.7	8.3	20.9%	200	9.3	24.5	12.2%
R12	40	0.8	8.4	21.1%	200	9.7	24.9	12.4%
R13	40	1.4	9.0	22.5%	200	6.6	21.8	10.9%
R14	40	1.8	9.4	23.4%	200	12.7	27.9	13.9%
R15	40	0.7	8.3	20.8%	200	8.2	23.4	11.7%

ID	Annual Mean (µg/m³)				99.79th percentile 1 Hour Mean (µg/m³)			
	AQS	PC	PEC	% PEC of AQS	AQS	PC	PEC	% PEC of AQS
R16	40	0.7	8.3	20.9%	200	9.0	24.2	12.1%
R17	40	0.6	8.2	20.5%	200	8.2	23.4	11.7%
R18	40	0.8	8.4	20.9%	200	10.0	25.2	12.6%
R19	40	0.3	7.9	19.8%	200	5.9	21.1	10.6%
R20	40	0.4	8.0	19.9%	200	6.3	21.5	10.7%
R21	40	0.4	8.0	19.9%	200	6.0	21.2	10.6%
R22	40	2.6	10.2	25.6%	200	12.7	27.9	14.0%
R23	40	1.1	8.7	21.7%	200	8.1	23.3	11.7%
R24	40	1.1	8.7	21.7%	200	8.3	23.5	11.8%
R25	40	1.6	9.2	23.0%	200	10.0	25.2	12.6%
R26	40	1.7	9.3	23.3%	200	10.6	25.8	12.9%
R27	40	0.7	8.3	20.7%	200	6.6	21.8	10.9%
R28	40	0.8	8.4	20.9%	200	6.7	21.9	11.0%
R29	40	0.4	8.0	19.9%	200	5.7	20.9	10.4%
R30	40	0.6	8.2	20.4%	200	8.0	23.2	11.6%
R31	40	0.6	8.2	20.4%	200	5.2	20.4	10.2%
R32	40	0.6	8.2	20.5%	200	5.4	20.6	10.3%
R33	40	0.7	8.3	20.8%	200	5.9	21.1	10.6%
R34	40	0.8	8.4	20.9%	200	6.5	21.7	10.8%
R35	40	0.8	8.4	21.0%	200	6.1	21.3	10.6%
R36	40	0.9	8.5	21.2%	200	6.6	21.8	10.9%
R37	40	0.7	8.3	20.7%	200	5.7	20.9	10.5%
R38	40	0.7	8.3	20.7%	200	5.8	21.0	10.5%
R39	40	0.8	8.4	20.9%	200	6.3	21.5	10.7%
R40	40	1.0	8.6	21.4%	200	7.0	22.2	11.1%
R41	40	0.9	8.5	21.1%	200	6.9	22.1	11.1%
R42	40	0.6	8.2	20.4%	200	5.2	20.4	10.2%
R43	40	0.8	8.4	20.9%	200	6.5	21.7	10.8%
R44	40	0.8	8.4	21.1%	200	6.9	22.1	11.0%
R45	40	0.6	8.2	20.6%	200	6.1	21.3	10.6%
R46	40	0.8	8.4	20.9%	200	7.1	22.3	11.1%
R47	40	3.1	10.7	26.6%	200	23.0	38.2	19.1%
R48	40	3.5	11.1	27.8%	200	31.5	46.7	23.4%
R49	40	3.4	11.0	27.5%	200	28.9	44.1	22.0%
R50	40	4.5	12.1	30.1%	200	34.8	50.0	25.0%
R51	40	2.5	10.1	25.3%	200	16.4	31.6	15.8%
R52	40	0.8	8.4	20.9%	200	5.8	21.0	10.5%
R53	40	0.9	8.5	21.2%	200	6.3	21.5	10.8%
R54	40	0.8	8.4	21.1%	200	6.3	21.5	10.7%
R55	40	1.0	8.6	21.4%	200	6.7	21.9	10.9%
R56	40	1.3	8.9	22.1%	200	7.8	23.0	11.5%

ID	Annual Mean (µg/m³)				99.79th percentile 1 Hour Mean (µg/m³)			
	AQS	PC	PEC	% PEC of AQS	AQS	PC	PEC	% PEC of AQS
R57	40	1.6	9.2	22.9%	200	8.0	23.2	11.6%
R58	40	2.2	9.8	24.6%	200	8.6	23.8	11.9%
R59	40	1.3	8.9	22.2%	200	8.0	23.2	11.6%
R60	40	1.7	9.3	23.1%	200	8.9	24.1	12.0%
R61	40	2.3	9.9	24.7%	200	9.1	24.3	12.2%
R62	40	0.9	8.5	21.1%	200	6.4	21.6	10.8%
R63	40	1.0	8.6	21.4%	200	6.6	21.8	10.9%
R64	40	1.0	8.6	21.6%	200	6.9	22.1	11.1%
R65	40	1.3	8.9	22.2%	200	7.1	22.3	11.1%
R66	40	1.8	9.4	23.4%	200	7.5	22.7	11.3%
R67	40	2.0	9.6	23.9%	200	7.9	23.1	11.6%
R68	40	2.7	10.3	25.8%	200	10.8	26.0	13.0%
R69	40	3.7	11.3	28.3%	200	14.3	29.5	14.8%
R70	40	2.6	10.2	25.4%	200	15.5	30.7	15.3%
R71	40	1.9	9.5	23.8%	200	15.6	30.8	15.4%
R72	40	1.9	9.5	23.8%	200	11.3	26.5	13.3%
R73	40	2.2	9.8	24.6%	200	12.4	27.6	13.8%
R74	40	3.1	10.7	26.7%	200	15.3	30.5	15.3%
R75	40	2.5	10.1	25.2%	200	12.7	27.9	13.9%
R76	40	2.4	10.0	25.1%	200	12.0	27.2	13.6%
R77	40	3.0	10.6	26.6%	200	14.3	29.5	14.8%
R78	40	1.5	9.1	22.8%	200	9.8	25.0	12.5%
R79	40	1.5	9.1	22.9%	200	9.7	24.9	12.5%
R80	40	1.5	9.1	22.8%	200	9.3	24.5	12.3%
R81	40	1.3	8.9	22.3%	200	8.4	23.6	11.8%
R82	40	1.3	8.9	22.2%	200	8.2	23.4	11.7%
R83	40	1.3	8.9	22.2%	200	8.2	23.4	11.7%
R84	40	0.9	8.5	21.1%	200	6.9	22.1	11.0%
R85	40	1.3	8.9	22.2%	200	8.1	23.3	11.7%
R86	40	1.1	8.7	21.7%	200	7.4	22.6	11.3%
R87	40	0.9	8.5	21.1%	200	6.8	22.0	11.0%
R88	40	1.9	9.5	23.7%	200	10.2	25.4	12.7%
R89	40	1.8	9.4	23.6%	200	9.8	25.0	12.5%
R90	40	1.7	9.3	23.2%	200	9.4	24.6	12.3%
R91	40	2.0	9.6	24.0%	200	10.5	25.7	12.9%
R92	40	2.1	9.7	24.3%	200	10.9	26.1	13.0%
R93	40	2.6	10.2	25.4%	200	12.2	27.4	13.7%
R94	40	2.4	10.0	25.1%	200	12.0	27.2	13.6%
R95	40	1.4	9.0	22.4%	200	8.7	23.9	11.9%
R96	40	1.1	8.7	21.7%	200	7.6	22.8	11.4%
R97	40	0.8	8.4	21.0%	200	6.8	22.0	11.0%

ID	Annual Mean (µg/m³)				99.79th percentile 1 Hour Mean (µg/m³)			
	AQS	PC	PEC	% PEC of AQS	AQS	PC	PEC	% PEC of AQS
R98	40	0.6	8.2	20.4%	200	6.0	21.2	10.6%
R99	40	0.7	8.3	20.7%	200	6.6	21.8	10.9%
R100	40	0.7	8.3	20.9%	200	7.0	22.2	11.1%
R101	40	0.6	8.2	20.5%	200	6.5	21.7	10.9%
R102	40	1.0	8.6	21.5%	200	7.9	23.1	11.5%
R103	40	1.1	8.7	21.7%	200	8.9	24.1	12.0%
R104	40	1.2	8.8	21.9%	200	10.1	25.3	12.6%
R105	40	1.1	8.7	21.8%	200	11.0	26.2	13.1%
R106	40	1.0	8.6	21.5%	200	11.4	26.6	13.3%
R107	40	0.9	8.5	21.3%	200	11.1	26.3	13.2%
R108	40	0.7	8.3	20.9%	200	9.8	25.0	12.5%
R109	40	0.8	8.4	21.1%	200	9.7	24.9	12.4%
R110	40	0.8	8.4	21.1%	200	8.5	23.7	11.9%
R111	40	0.7	8.3	20.8%	200	7.9	23.1	11.6%
R112	40	0.7	8.3	20.7%	200	8.2	23.4	11.7%
R113	40	0.6	8.2	20.6%	200	6.8	22.0	11.0%
R114	40	0.6	8.2	20.5%	200	7.2	22.4	11.2%
R115	40	0.5	8.1	20.3%	200	6.7	21.9	10.9%
R116	40	0.5	8.1	20.3%	200	7.1	22.3	11.1%
R117	40	0.5	8.1	20.3%	200	7.8	23.0	11.5%
R118	40	0.6	8.2	20.5%	200	8.4	23.6	11.8%
R119	40	0.6	8.2	20.4%	200	8.1	23.3	11.7%
R120	40	0.5	8.1	20.4%	200	7.6	22.8	11.4%
R121	40	0.6	8.2	20.4%	200	7.6	22.8	11.4%
R122	40	0.5	8.1	20.1%	200	6.6	21.8	10.9%
R123	40	0.4	8.0	20.0%	200	6.5	21.7	10.9%
R124	40	0.4	8.0	20.1%	200	6.7	21.9	11.0%
R125	40	0.4	8.0	20.1%	200	6.8	22.0	11.0%
R126	40	0.4	8.0	20.0%	200	6.5	21.7	10.8%
R127	40	0.4	8.0	20.0%	200	6.4	21.6	10.8%
R128	40	0.4	8.0	20.0%	200	6.1	21.3	10.7%
R129	40	0.4	8.0	20.0%	200	6.3	21.5	10.7%
R130	40	1.8	9.4	23.4%	200	11.1	26.3	13.1%
R131	40	1.7	9.3	23.3%	200	12.1	27.3	13.7%
R132	40	1.6	9.2	22.9%	200	13.5	28.7	14.4%
R133	40	1.4	9.0	22.5%	200	14.2	29.4	14.7%
R134	40	1.3	8.9	22.2%	200	14.0	29.2	14.6%
R135	40	1.2	8.8	22.0%	200	13.9	29.1	14.6%
R136	40	1.3	8.9	22.2%	200	14.2	29.4	14.7%
R137	40	1.0	8.6	21.6%	200	12.2	27.4	13.7%
R138	40	0.9	8.5	21.2%	200	10.7	25.9	12.9%

ID	Annual Mean (µg/m³)				99.79th percentile 1 Hour Mean (µg/m³)			
	AQS	PC	PEC	% PEC of AQS	AQS	PC	PEC	% PEC of AQS
R139	40	0.5	8.1	20.2%	200	7.0	22.2	11.1%
R140	40	0.5	8.1	20.3%	200	6.9	22.1	11.1%
R141	40	0.6	8.2	20.4%	200	7.5	22.7	11.3%
R142	40	0.5	8.1	20.4%	200	7.2	22.4	11.2%
R143	40	0.6	8.2	20.6%	200	8.1	23.3	11.6%
R144	40	0.6	8.2	20.5%	200	7.3	22.5	11.2%
R145	40	0.5	8.1	20.2%	200	6.6	21.8	10.9%
R146	40	0.4	8.0	20.0%	200	5.8	21.0	10.5%
R147	40	0.4	8.0	19.9%	200	5.5	20.7	10.3%
R148	40	0.5	8.1	20.2%	200	6.3	21.5	10.8%
R149	40	0.4	8.0	19.9%	200	5.0	20.2	10.1%
R150	40	1.1	8.7	21.8%	200	11.7	26.9	13.5%
R151	40	0.9	8.5	21.4%	200	10.3	25.5	12.7%
R152	40	0.9	8.5	21.2%	200	9.5	24.7	12.3%
R153	40	0.8	8.4	20.9%	200	8.6	23.8	11.9%
R154	40	2.7	10.3	25.9%	200	27.0	42.2	21.1%
R155	40	2.4	10.0	24.9%	200	21.8	37.0	18.5%
R156	40	2.0	9.6	24.0%	200	18.7	33.9	16.9%
R157	40	1.8	9.4	23.5%	200	16.7	31.9	16.0%
R158	40	2.0	9.6	24.1%	200	19.0	34.2	17.1%
R159	40	2.2	9.8	24.6%	200	19.1	34.3	17.2%
R160	40	1.2	8.8	22.1%	200	13.4	28.6	14.3%
R161	40	1.3	8.9	22.3%	200	13.5	28.7	14.4%
R162	40	0.8	8.4	21.0%	200	8.9	24.1	12.1%
R163	40	0.8	8.4	21.0%	200	9.1	24.3	12.1%
R164	40	0.7	8.3	20.8%	200	8.3	23.5	11.7%
R165	40	1.3	8.9	22.2%	200	13.7	28.9	14.4%
R166	40	1.0	8.6	21.6%	200	11.4	26.6	13.3%
R167	40	1.0	8.6	21.5%	200	11.3	26.5	13.3%
R168	40	0.8	8.4	21.1%	200	10.1	25.3	12.6%
R169	40	0.7	8.3	20.8%	200	9.2	24.4	12.2%

ID	Annual Mean (µg/m³)				99.79th percentile 1 Hour Mean (µg/m³)			
	AQS	PC	PEC	% PEC of AQS	AQS	PC	PEC	% PEC of AQS
R170	40	0.6	8.2	20.6%	200	8.4	23.6	11.8%
R171	40	0.7	8.3	20.6%	200	8.2	23.4	11.7%
R172	40	0.6	8.2	20.5%	200	7.2	22.4	11.2%
R173	40	0.5	8.1	20.3%	200	6.7	21.9	11.0%
R174	40	0.5	8.1	20.2%	200	6.2	21.4	10.7%
R175	40	0.6	8.2	20.4%	200	7.2	22.4	11.2%
R176	40	0.4	8.0	20.0%	200	5.6	20.8	10.4%
R177	40	0.3	7.9	19.9%	200	5.5	20.7	10.4%
R178	40	0.3	7.9	19.9%	200	5.6	20.8	10.4%
R179	40	1.5	9.1	22.8%	200	7.0	22.2	11.1%
R180	40	1.6	9.2	23.1%	200	7.6	22.8	11.4%
R181	40	1.6	9.2	22.9%	200	7.4	22.6	11.3%
R182	40	1.3	8.9	22.3%	200	6.7	21.9	10.9%
R183	40	1.2	8.8	22.0%	200	6.7	21.9	11.0%
R184	40	1.3	8.9	22.2%	200	7.1	22.3	11.1%
R185	40	1.6	9.2	23.0%	200	8.0	23.2	11.6%
R186	40	1.1	8.7	21.7%	200	7.6	22.8	11.4%
R187	40	0.7	8.3	20.8%	200	6.9	22.1	11.0%
R188	40	0.5	8.1	20.2%	200	5.9	21.1	10.6%
R189	40	1.3	8.9	22.2%	200	9.5	24.7	12.4%
R190	40	0.9	8.5	21.3%	200	8.3	23.5	11.7%
R191	40	0.4	8.0	20.0%	200	6.8	22.0	11.0%
R192	40	0.7	8.3	20.9%	200	6.3	21.5	10.8%
R193	40	0.3	7.9	19.8%	200	6.8	22.0	11.0%
R194	40	0.4	8.0	19.9%	200	6.8	22.0	11.0%
R195	40	0.5	8.1	20.3%	200	8.2	23.4	11.7%
R196	40	0.4	8.0	20.0%	200	6.6	21.8	10.9%
R197	40	0.4	8.0	19.9%	200	6.5	21.7	10.8%
R198	40	0.4	8.0	20.0%	200	7.0	22.2	11.1%
R199	40	0.5	8.1	20.2%	200	7.7	22.9	11.4%
R200	40	0.6	8.2	20.4%	200	8.5	23.7	11.9%
R201	40	0.6	8.2	20.5%	200	8.9	24.1	12.1%
R202	40	0.6	8.2	20.4%	200	8.1	23.3	11.7%
R203	40	0.8	8.4	21.1%	200	10.9	26.1	13.1%

ID	Annual Mean (µg/m³)				99.79th percentile 1 Hour Mean (µg/m³)			
	AQS	PC	PEC	% PEC of AQS	AQS	PC	PEC	% PEC of AQS
R204	40	0.8	8.4	21.0%	200	10.4	25.6	12.8%
R205	40	1.4	9.0	22.5%	200	14.7	29.9	14.9%
R206	40	0.4	8.0	20.0%	200	6.8	22.0	11.0%
R207	40	0.5	8.1	20.3%	200	8.1	23.3	11.7%
R208	40	0.8	8.4	21.0%	200	10.8	26.0	13.0%
R209	40	0.8	8.4	21.0%	200	9.5	24.7	12.4%
R210	40	0.7	8.3	20.8%	200	9.6	24.8	12.4%
R211	40	0.6	8.2	20.4%	200	8.4	23.6	11.8%
R212	40	0.4	8.0	20.0%	200	6.9	22.1	11.0%
R213	40	0.4	8.0	20.0%	200	6.6	21.8	10.9%
R214	40	0.5	8.1	20.2%	200	7.0	22.2	11.1%
R215	40	0.5	8.1	20.3%	200	7.3	22.5	11.2%
R216	40	0.4	8.0	20.1%	200	6.4	21.6	10.8%
AQS = Air Quality Standard (µg/m³); PC = Process Contribution; PEC = Predicted Environmental Concentration (PC + Background)								

Table 6.1 indicates that long-term PECs of NO_2 are below the respective assessment metric at all applicable human receptors. The highest predicted NO_2 annual mean (PEC) was at receptor R50, approximately 211 m to the east of the site, along Claremont Place. Based on the maximum emission rate period for January 2019 to December 2023, the predicted concentration was 30.1% of the AQS objective of 40µg/m3. The direct contribution from the site's exhaust stacks (PC) at this receptor was 4.5µg/m3.

Short-term PECs of NO_2 are below the respective assessment metric at all applicable human receptors. The highest predicted 99.79th percentile of the hourly mean (PEC), assuming the maximum emission rate period for January 2019 to December 2023, was also at receptor R50 along Claremont Place. The predicted concentration was 25.0% of the AQS objective of 200µg/m3. The direct contribution from the site exhaust stacks (PC) at this receptor was 34.8µg/m3.

Consequently, it is not considered any exceedances of the air quality objectives were of likely to have occurred as a result of emissions of NO_2 from the site boilers and generators during the period from January 2019 to December 2023.

NO_2 process contribution (PC) isopleths for the annual mean and 99.79th percentile of the one hour mean are presented in

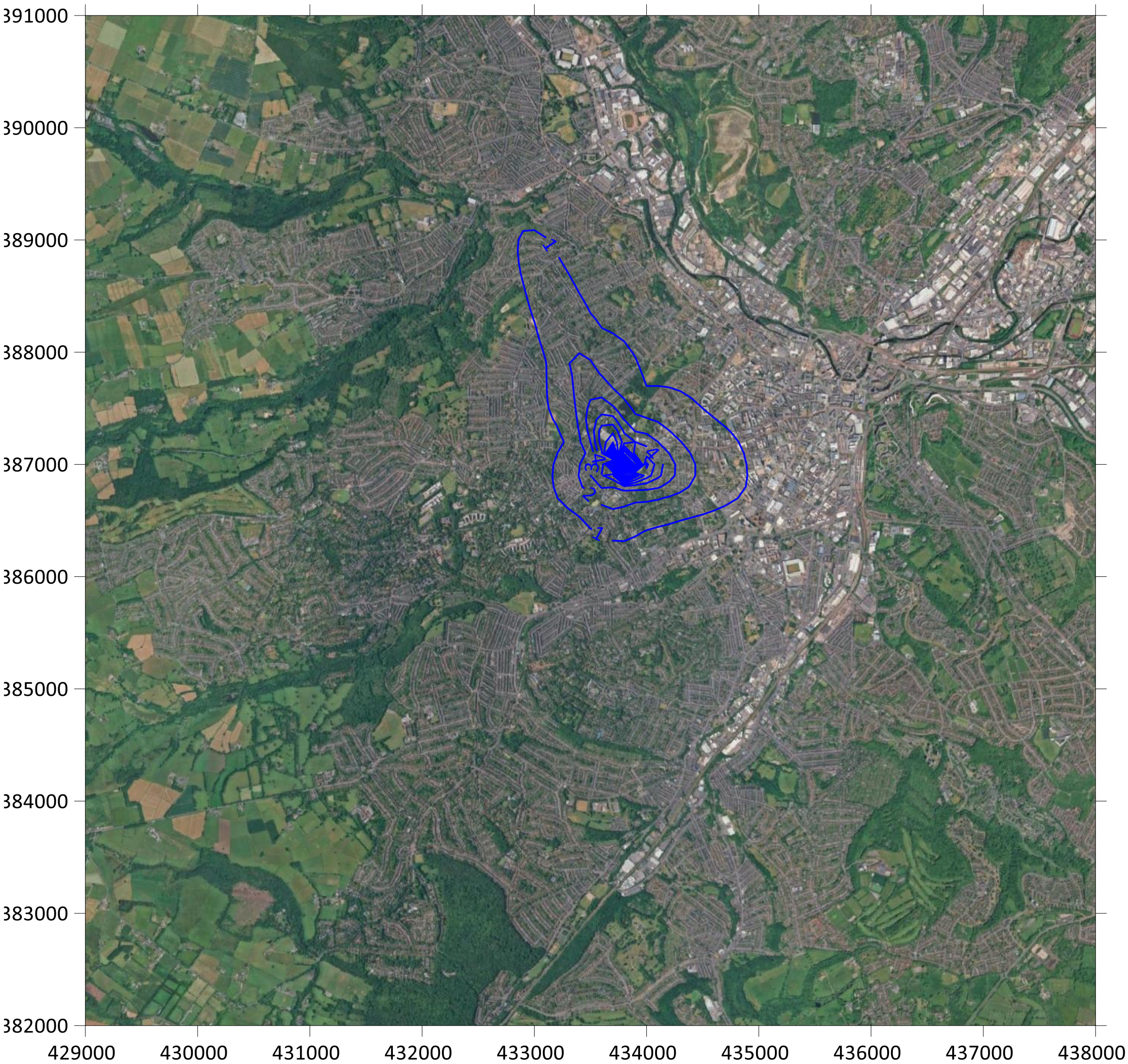

Figure A.1 and

Figure A.2 of Appendix A respectively.

6.1.2 Carbon Monoxide and Sulphur Dioxide Impacts

Appendix B presents the maximum ground level concentrations for all modelled receptors in relation to SO_2 and CO.

Firstly, considering SO_2, the PEC for the 24 hour mean and 1 hour mean is less than 5.26% and 3.64% of the respective AQS, and can therefore be considered de minimis.

In relation to CO, the PEC for the 8-hour average and 1 hour mean is less than 3.46% and 2.60% of the respective AQS and can therefore be considered de minimis.

6.2 Ecological Receptors

6.2.1 Nitrogen Oxides Impacts

Table 6.2 details the results of the impact assessment for NO_x assuming the maximum emission period from January 2019 to December 2023.

Table 6.2 – NO_x Impacts at Ecological Receptors – Maximum Emission Period

Receptor ID	Annual Mean (µg/m^3)				24-hour Mean (µg/m^3)			
	AQS	PC	PEC	% PEC OF AQS	EAL	PC	PEC	% PEC of EAL
E1	30	0.05	9.9	33.2%	75	1.31	21.1	28.1%
E2	30	0.29	10.2	34.0%	75	4.97	24.8	33.0%
E3	30	0.53	10.4	34.8%	75	7.21	27.0	36.0%
E4	30	0.31	10.2	34.0%	75	3.39	23.2	30.9%
E5	30	0.83	10.7	35.8%	75	11.12	30.9	41.2%
E6	30	0.84	10.7	35.8%	75	18.73	38.5	51.4%
E7	30	2.83	12.7	42.4%	75	50.24	70.0	93.4%
E8	30	0.71	10.6	35.4%	75	8.62	28.4	37.9%
E9	30	0.48	10.4	34.6%	75	24.41	44.2	58.9%
E10	30	0.24	10.1	33.8%	75	4.23	24.0	32.0%
E11	30	0.58	10.5	34.9%	75	6.62	26.4	35.2%
E12	30	0.54	10.4	34.8%	75	11.03	30.8	41.1%
E13	30	0.25	10.2	33.8%	75	3.86	23.7	31.5%
E14	30	0.37	10.3	34.2%	75	9.01	28.8	38.4%
E15	30	0.20	10.1	33.7%	75	7.62	27.4	36.6%
E16	30	0.13	10.0	33.4%	75	2.97	22.8	30.4%
E17	30	0.15	10.0	33.5%	75	5.30	25.1	33.5%
E18	30	0.30	10.2	34.0%	75	6.66	26.5	35.3%
E19	30	0.36	10.3	34.2%	75	6.54	26.3	35.1%
E20	30	0.36	10.3	34.2%	75	7.38	27.2	36.2%
E21	30	0.31	10.2	34.0%	75	11.59	31.4	41.9%
E22	30	0.40	10.3	34.3%	75	11.35	31.1	41.5%
E23	30	0.13	10.0	33.4%	75	1.23	21.0	28.0%
E24	30	0.21	10.1	33.7%	75	4.93	24.7	33.0%
E25	30	0.40	10.3	34.3%	75	10.14	29.9	39.9%
E26	30	0.29	10.2	34.0%	75	6.68	26.5	35.3%
E27	30	0.24	10.1	33.8%	75	3.51	23.3	31.1%

AQS = Air Quality Standard ; EAL = Environmental Assessment Level; PC = Process Contribution; PEC = Predicted Environmental Concentration (PC + Background)

Table 6.2 indicates that at all ecological sites considered assuming the maximum emission period, long and short-term NOx PECs are below the relevant AQS. Consequently, NOx emissions from the boilers are not expected to cause adverse effects upon local ecological sites.

6.2.2 Nitrogen Deposition Rates

Table 6.3 contains the results of the deposition analysis for nitrogen at ecological receptors based on the maximum calculated emission period. The contribution of the boilers to the total nutrient nitrogen deposition has been estimated following the cited methodology, based on predicted deposition of NOx.

Table 6.3 – Nitrogen Deposition Rates at Ecological Receptors

Receptor ID	CL (kgN/ha/yr)	PC (kgN/ha/yr)	%PC of Clave	Background Deposition rate (kgN/ha/yr)	PEDR (kgN/ha/yr)	%PEDR of Cl_{ave}
E1	5-15	0.014	0.14%	1.22	1.234	24.7%
E2	5-15	0.084	0.84%	0.99	1.074	21.5%
E3	5-15	0.152	1.52%	0.95	1.102	22.0%
E4	5-15	0.091	0.91%	0.95	1.041	20.8%
E5	5-15	0.240	2.40%	0.95	1.190	23.8%
E6	5-15	0.242	2.42%	0.95	1.192	23.8%
E7	5-15	0.815	8.15%	0.95	1.765	35.3%
E8	5-15	0.205	2.05%	0.95	1.155	23.1%
E9	5-15	0.137	1.37%	0.95	1.087	21.7%
E10	5-15	0.070	0.70%	0.95	1.020	20.4%
E11	5-15	0.168	1.68%	0.95	1.118	22.4%
E12	5-15	0.154	1.54%	0.95	1.104	22.1%
E13	5-15	0.073	0.73%	0.95	1.023	20.5%
E14	5-15	0.106	1.06%	0.95	1.056	21.1%
E15	5-15	0.058	0.58%	0.95	1.008	20.2%
E16	5-15	0.037	0.37%	0.95	0.987	19.7%
E17	5-15	0.042	0.42%	0.95	0.992	19.8%
E18	5-15	0.086	0.86%	0.95	1.036	20.7%
E19	5-15	0.104	1.04%	0.95	1.054	21.1%
E20	5-15	0.104	1.04%	0.95	1.054	21.1%
E21	5-15	0.090	0.90%	0.95	1.040	20.8%
E22	5-15	0.115	1.15%	0.95	1.065	21.3%
E23	5-15	0.038	0.38%	0.95	0.988	19.8%
E24	5-15	0.060	0.60%	0.95	1.010	20.2%
E25	5-15	0.114	1.14%	0.95	1.064	21.3%
E26	5-15	0.084	0.84%	0.95	1.034	20.7%
E27	5-15	0.069	0.69%	0.95	1.019	20.4%

CL = Critical load – *the CL selected for each designated site relates to its most N-sensitive habitat (or a similar surrogate) listed on the site citation for which data on Critical Loads are available and is also based on a precautionary approach using professional judgement.*

PC = Process contribution

PEDR = Predicted environmental deposition rate (= PC + background)

Emission rates based on the maximum calculated emission rate for NO_x.

The NOx PC towards nutrient nitrogen deposition is below the minimum critical load at all sites. Furthermore, the background rate alone exceeds the minimum critical load at all sites assessed. These results are based on the maximum calculated emission period for NOx and therefore represent worst case out of the modelled scenarios. Nutrient nitrogen deposition can therefore be regarded as not significant.

6.2.3 Acid Deposition Rates

Table 6.4 contains details of nitrogen component of the acid deposition based on predicted deposition of NO_x calculated from the maximum emission period at ecological receptors.

Table 6.4 – Nitrogen Component of Acid Deposition Rates at Ecological Receptors – Maximum Emission Rate

Receptor ID	CL (keq/ha/yr)	N PC (keq/ha/yr)	%N PC of Cl_{ave}	Background Acid Deposition (keq/ha/yr)	N PEDR (keq/ha/yr)	%N PEDR of Cl_{ave}
E1	1.45	0.0010	0.07%	0.23	0.23	16%
E2	1.25	0.0060	0.48%	0.26	0.27	21%
E3	1.21	0.0108	0.89%	0.26	0.27	22%
E4	1.21	0.0065	0.54%	0.26	0.27	22%
E5	1.21	0.0172	1.42%	0.26	0.28	23%
E6	1.21	0.0173	1.43%	0.26	0.28	23%
E7	1.21	0.0582	4.81%	0.26	0.32	26%
E8	1.21	0.0146	1.21%	0.26	0.27	23%
E9	1.21	0.0098	0.81%	0.26	0.27	22%
E10	1.21	0.0050	0.42%	0.26	0.27	22%
E11	1.21	0.0120	0.99%	0.26	0.27	22%
E12	1.21	0.0110	0.91%	0.26	0.27	22%
E13	1.21	0.0052	0.43%	0.26	0.27	22%
E14	1.21	0.0076	0.63%	0.26	0.27	22%
E15	1.21	0.0042	0.34%	0.26	0.26	22%
E16	1.21	0.0027	0.22%	0.26	0.26	22%
E17	1.21	0.0030	0.25%	0.26	0.26	22%
E18	1.21	0.0061	0.51%	0.26	0.27	22%
E19	1.21	0.0074	0.61%	0.26	0.27	22%
E20	1.21	0.0074	0.61%	0.26	0.27	22%
E21	1.21	0.0064	0.53%	0.26	0.27	22%

E22	1.21	0.0082	0.68%	0.26	0.27	22%
E23	1.21	0.0027	0.22%	0.26	0.26	22%
E24	1.21	0.0043	0.35%	0.26	0.26	22%
E25	1.21	0.0081	0.67%	0.26	0.27	22%
E26	1.21	0.0060	0.49%	0.26	0.27	22%
E27	1.21	0.0049	0.40%	0.26	0.26	22%

CL = Critical load – *the CL selected for each designated site relates to its most N-sensitive habitat (or a similar surrogate) listed on the site citation for which data on Critical Loads are available and is also based on a precautionary approach using professional judgement.*

PC = Process contribution

PEDR = Predicted environmental deposition rate (= PC + background)

The PC towards the nitrogen component of acid deposition is less than the minimum critical load at all the ecological sites considered, and the background rate alone exceeds the minimum critical load at most sites. These results are based on the maximum calculated emission period for NOx and therefore represent worst case. The nitrogen component of acid deposition can therefore be regarded as not significant.

7 Conclusions

Industrial Compliance Solutions Ltd (ICS) have been commissioned by Environmental Monitoring Solutions Ltd to undertake a detailed dispersion modelling assessment of emissions to air from the boilers and standby generators located at Royal Hallamshire Hospital (RHH), in Sheffield, S10 2JF. This assessment is in support of a Medium Combustion Plant Directive (MCPD) Environmental Permit Application, assessing impacts from emissions of Oxides of Nitrogen (NOx as NO_2), Carbon Monoxide (CO), and Sulphur Dioxide (SO_2).

It is understood that RHH are in the process of applying for an Environmental Permit as required by the MCPD regulations in relation to the existing medium combustion plants (MCP) on site. Currently operating MCP comprise of twelve natural gas fired boilers which continuously operate providing useful heat to the facility, as well as six diesel (gas oil) fired standby generators designed to provide emergency power in the event of an outage, hence their operational hours are minimal. The aggregated MW thermal input of the assets is 51.633. A full list of the assets, including make, model, and MW thermal input etc, are presented within this report. In line with the requirements of the MCPD there is a need to demonstrate that there are no significant air quality impacts from the operation of the boilers and standby generators.

In order to accurately quantify the impact on the surrounding area, ADMS model inputs have been prepared using measured stack emissions data, MCPD emissions limit value for NOx, and calculated concentration emissions for CO and SO_2, to determine hourly emission rates from the site.

7.1 Dispersion Modelling Results

Detailed dispersion modelling was undertaken for the boilers and generators emissions to air from the RHH site using the dispersion model ADMS 6.

The dispersion modelling demonstrated that assuming the maximum emission period for NOx (SC1), the predicted environmental concentrations at human receptor locations were not significant, and consequently emissions to air from the boilers are not expected to have caused adverse effects upon the health of the local population. At all ecological sites considered, the PECs are below the NOx long-term and short-term assessment metrics, assuming the maximum emission period.

The PEDRs of nutrient nitrogen deposition was below the maximum critical load at all of the assessed ecological receptors. The PCs did not exceed the minimum critical load at any of the ecological sites and therefore can be regarded as not significant.

The PEDRs of the nitrogen component of acid deposition did not exceed the maximum critical load at all of the assessed ecological receptors. The PCs did not exceed the minimum critical load at any of the ecological sites and therefore can be regarded as not significant.

As the assessment did not conclude any significant effects to either ecological or human receptors. It should be noted that the results in Section 5 represent the impacts derived from assuming the maximum emission period for the NOx. Therefore, these results are showing the worst-case scenario at the Royal Hallamshire Hospital site for the period January 2019 to December 2023. The impacts derived from the average annual emission rates 2019 to 2023, for SO_2 and CO can be found in Appendix B for comparison.

Appendices

Appendix A:
Pollutant Concentration Isopleths

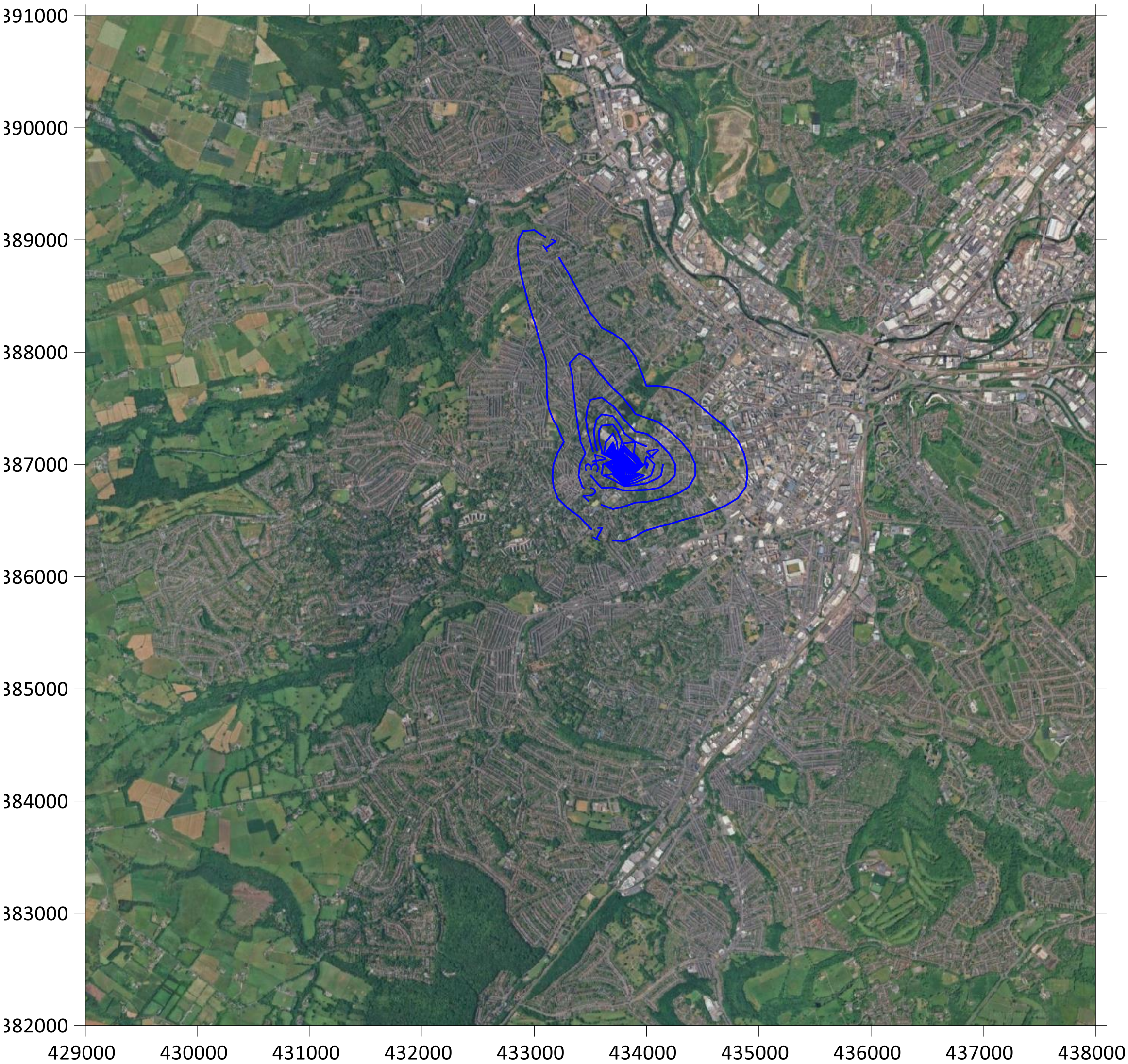

Figure A.1 – Annual Mean NO_2 process contribution isopleth for SC1 (µg/m^3)

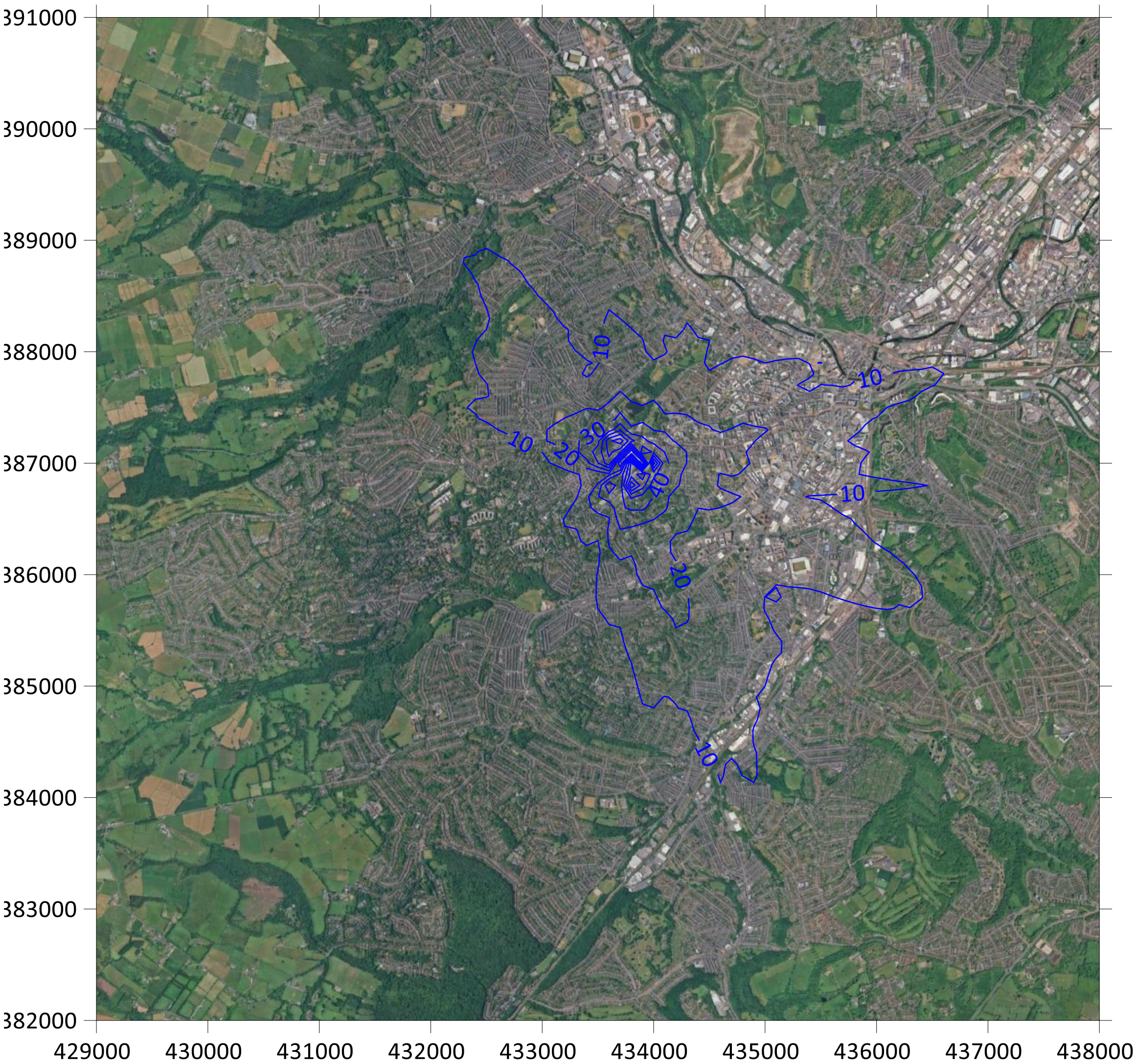

Figure A.2 – 99.79th Percentile of 1 Hour Mean NO_2 process contribution isopleth for SC1 (µg/m^3)

Appendix B:
SO_2 and CO Maximum Emissions Rate Ground Level Concentration Results

Table B1 – Sulphur Dioxide Results – Maximum Emission Rate

ID	24 hour Mean (µg/m³)				99.79th percentile 1 Hour Mean (µg/m³)			
	AQS	PC	PEC	% PEC of AQS	AQS	PC	PEC	% PEC of AQS
R1	125	0.8	5.9	4.7%	350	1.8	12.0	3.4%
R2	125	0.4	5.5	4.4%	350	1.0	11.1	3.2%
R3	125	0.2	5.3	4.3%	350	0.7	10.8	3.1%
R4	125	0.2	5.3	4.2%	350	0.6	10.7	3.1%
R5	125	0.5	5.6	4.5%	350	1.1	11.3	3.2%
R6	125	0.2	5.3	4.2%	350	0.6	10.7	3.1%
R7	125	0.1	5.2	4.2%	350	0.4	10.5	3.0%
R8	125	0.1	5.2	4.2%	350	0.3	10.5	3.0%
R9	125	0.7	5.8	4.6%	350	1.4	11.6	3.3%
R10	125	0.4	5.5	4.4%	350	1.0	11.2	3.2%
R11	125	0.3	5.4	4.3%	350	0.7	10.9	3.1%
R12	125	0.3	5.4	4.3%	350	0.7	10.9	3.1%
R13	125	0.1	5.2	4.2%	350	0.4	10.5	3.0%
R14	125	0.5	5.6	4.5%	350	1.0	11.2	3.2%
R15	125	0.2	5.3	4.2%	350	0.6	10.7	3.1%
R16	125	0.2	5.3	4.3%	350	0.6	10.8	3.1%
R17	125	0.2	5.3	4.2%	350	0.6	10.8	3.1%
R18	125	0.3	5.4	4.3%	350	0.8	10.9	3.1%
R19	125	0.2	5.3	4.2%	350	0.4	10.6	3.0%
R20	125	0.1	5.2	4.1%	350	0.4	10.5	3.0%
R21	125	0.1	5.2	4.1%	350	0.4	10.5	3.0%
R22	125	0.5	5.6	4.5%	350	1.0	11.2	3.2%
R23	125	0.3	5.3	4.3%	350	0.6	10.8	3.1%
R24	125	0.3	5.3	4.3%	350	0.6	10.8	3.1%
R25	125	0.4	5.5	4.4%	350	0.8	10.9	3.1%
R26	125	0.4	5.5	4.4%	350	0.8	11.0	3.1%
R27	125	0.2	5.3	4.2%	350	0.5	10.6	3.0%
R28	125	0.2	5.3	4.2%	350	0.5	10.7	3.0%
R29	125	0.1	5.2	4.1%	350	0.3	10.5	3.0%
R30	125	0.3	5.4	4.3%	350	0.6	10.7	3.1%
R31	125	0.1	5.2	4.2%	350	0.4	10.5	3.0%
R32	125	0.1	5.2	4.2%	350	0.4	10.6	3.0%
R33	125	0.2	5.3	4.2%	350	0.4	10.6	3.0%
R34	125	0.2	5.3	4.2%	350	0.5	10.6	3.0%
R35	125	0.2	5.3	4.2%	350	0.4	10.6	3.0%
R36	125	0.2	5.3	4.2%	350	0.5	10.6	3.0%
R37	125	0.2	5.2	4.2%	350	0.4	10.6	3.0%
R38	125	0.2	5.3	4.2%	350	0.4	10.6	3.0%
R39	125	0.2	5.3	4.2%	350	0.5	10.6	3.0%
R40	125	0.2	5.3	4.2%	350	0.5	10.7	3.0%

ID	24 hour Mean (µg/m³)				99.79th percentile 1 Hour Mean (µg/m³)			
	AQS	PC	PEC	% PEC of AQS	AQS	PC	PEC	% PEC of AQS
R41	125	0.2	5.3	4.2%	350	0.5	10.7	3.0%
R42	125	0.1	5.2	4.2%	350	0.4	10.5	3.0%
R43	125	0.2	5.3	4.2%	350	0.5	10.6	3.0%
R44	125	0.2	5.3	4.2%	350	0.5	10.6	3.0%
R45	125	0.2	5.2	4.2%	350	0.4	10.6	3.0%
R46	125	0.2	5.2	4.2%	350	0.5	10.7	3.0%
R47	125	1.0	6.1	4.9%	350	2.1	12.3	3.5%
R48	125	1.3	6.3	5.1%	350	2.5	12.7	3.6%
R49	125	1.2	6.2	5.0%	350	2.4	12.5	3.6%
R50	125	1.5	6.6	5.3%	350	2.6	12.7	3.6%
R51	125	0.8	5.8	4.7%	350	1.4	11.6	3.3%
R52	125	0.1	5.2	4.2%	350	0.4	10.6	3.0%
R53	125	0.2	5.2	4.2%	350	0.4	10.6	3.0%
R54	125	0.2	5.2	4.2%	350	0.4	10.6	3.0%
R55	125	0.2	5.3	4.2%	350	0.5	10.6	3.0%
R56	125	0.2	5.3	4.2%	350	0.6	10.7	3.1%
R57	125	0.2	5.3	4.3%	350	0.6	10.7	3.1%
R58	125	0.3	5.3	4.3%	350	0.6	10.7	3.1%
R59	125	0.2	5.3	4.3%	350	0.6	10.7	3.1%
R60	125	0.3	5.4	4.3%	350	0.6	10.8	3.1%
R61	125	0.3	5.4	4.3%	350	0.6	10.8	3.1%
R62	125	0.1	5.2	4.2%	350	0.5	10.6	3.0%
R63	125	0.2	5.2	4.2%	350	0.5	10.6	3.0%
R64	125	0.2	5.3	4.2%	350	0.5	10.7	3.0%
R65	125	0.2	5.3	4.2%	350	0.5	10.7	3.0%
R66	125	0.2	5.3	4.2%	350	0.5	10.7	3.0%
R67	125	0.2	5.3	4.2%	350	0.5	10.7	3.1%
R68	125	0.3	5.4	4.3%	350	0.8	10.9	3.1%
R69	125	0.6	5.6	4.5%	350	1.1	11.3	3.2%
R70	125	0.7	5.7	4.6%	350	1.2	11.4	3.3%
R71	125	0.8	5.9	4.7%	350	1.3	11.5	3.3%
R72	125	0.4	5.5	4.4%	350	0.8	11.0	3.1%
R73	125	0.5	5.6	4.5%	350	0.9	11.1	3.2%
R74	125	0.7	5.8	4.6%	350	1.2	11.4	3.2%
R75	125	0.5	5.6	4.5%	350	1.0	11.1	3.2%
R76	125	0.5	5.6	4.5%	350	0.9	11.1	3.2%
R77	125	0.6	5.7	4.6%	350	1.1	11.3	3.2%
R78	125	0.3	5.4	4.3%	350	0.7	10.9	3.1%
R79	125	0.3	5.4	4.3%	350	0.7	10.9	3.1%
R80	125	0.3	5.4	4.3%	350	0.7	10.9	3.1%
R81	125	0.3	5.4	4.3%	350	0.6	10.8	3.1%

ID	24 hour Mean (μg/m³)				99.79th percentile 1 Hour Mean (μg/m³)			
	AQS	PC	PEC	% PEC of AQS	AQS	PC	PEC	% PEC of AQS
R82	125	0.3	5.3	4.3%	350	0.6	10.8	3.1%
R83	125	0.3	5.4	4.3%	350	0.6	10.8	3.1%
R84	125	0.2	5.3	4.2%	350	0.5	10.7	3.1%
R85	125	0.3	5.4	4.3%	350	0.6	10.8	3.1%
R86	125	0.2	5.3	4.3%	350	0.6	10.7	3.1%
R87	125	0.2	5.3	4.2%	350	0.5	10.7	3.0%
R88	125	0.4	5.5	4.4%	350	0.8	10.9	3.1%
R89	125	0.4	5.5	4.4%	350	0.8	10.9	3.1%
R90	125	0.4	5.4	4.4%	350	0.7	10.9	3.1%
R91	125	0.4	5.5	4.4%	350	0.8	11.0	3.1%
R92	125	0.5	5.5	4.4%	350	0.9	11.0	3.1%
R93	125	0.6	5.6	4.5%	350	1.0	11.1	3.2%
R94	125	0.6	5.7	4.5%	350	1.0	11.1	3.2%
R95	125	0.3	5.4	4.3%	350	0.7	10.8	3.1%
R96	125	0.3	5.3	4.3%	350	0.6	10.7	3.1%
R97	125	0.2	5.3	4.2%	350	0.5	10.7	3.0%
R98	125	0.1	5.2	4.2%	350	0.4	10.6	3.0%
R99	125	0.2	5.3	4.2%	350	0.5	10.6	3.0%
R100	125	0.2	5.3	4.2%	350	0.5	10.7	3.0%
R101	125	0.1	5.2	4.2%	350	0.4	10.6	3.0%
R102	125	0.3	5.3	4.3%	350	0.6	10.7	3.1%
R103	125	0.3	5.4	4.3%	350	0.7	10.8	3.1%
R104	125	0.3	5.4	4.3%	350	0.7	10.9	3.1%
R105	125	0.3	5.4	4.3%	350	0.8	10.9	3.1%
R106	125	0.3	5.4	4.3%	350	0.8	10.9	3.1%
R107	125	0.3	5.4	4.3%	350	0.7	10.9	3.1%
R108	125	0.2	5.3	4.2%	350	0.6	10.8	3.1%
R109	125	0.3	5.4	4.3%	350	0.6	10.8	3.1%
R110	125	0.2	5.3	4.2%	350	0.6	10.7	3.1%
R111	125	0.2	5.3	4.2%	350	0.5	10.7	3.1%
R112	125	0.2	5.3	4.2%	350	0.5	10.7	3.1%
R113	125	0.2	5.2	4.2%	350	0.5	10.6	3.0%
R114	125	0.2	5.3	4.2%	350	0.5	10.6	3.0%
R115	125	0.2	5.2	4.2%	350	0.4	10.6	3.0%
R116	125	0.2	5.2	4.2%	350	0.4	10.6	3.0%
R117	125	0.2	5.2	4.2%	350	0.5	10.6	3.0%
R118	125	0.2	5.2	4.2%	350	0.5	10.7	3.0%
R119	125	0.2	5.2	4.2%	350	0.5	10.7	3.0%
R120	125	0.2	5.2	4.2%	350	0.5	10.6	3.0%
R121	125	0.2	5.3	4.2%	350	0.5	10.6	3.0%
R122	125	0.1	5.2	4.2%	350	0.4	10.6	3.0%

ID	24 hour Mean (µg/m³)				99.79th percentile 1 Hour Mean (µg/m³)			
	AQS	PC	PEC	% PEC of AQS	AQS	PC	PEC	% PEC of AQS
R123	125	0.1	5.2	4.2%	350	0.4	10.5	3.0%
R124	125	0.1	5.2	4.2%	350	0.4	10.6	3.0%
R125	125	0.1	5.2	4.2%	350	0.4	10.6	3.0%
R126	125	0.1	5.2	4.2%	350	0.4	10.5	3.0%
R127	125	0.1	5.2	4.2%	350	0.4	10.5	3.0%
R128	125	0.1	5.2	4.2%	350	0.4	10.5	3.0%
R129	125	0.1	5.2	4.2%	350	0.4	10.6	3.0%
R130	125	0.5	5.5	4.4%	350	0.9	11.0	3.2%
R131	125	0.5	5.6	4.4%	350	0.9	11.1	3.2%
R132	125	0.5	5.6	4.5%	350	1.0	11.2	3.2%
R133	125	0.5	5.6	4.5%	350	1.1	11.2	3.2%
R134	125	0.4	5.4	4.4%	350	1.0	11.2	3.2%
R135	125	0.4	5.5	4.4%	350	1.0	11.1	3.2%
R136	125	0.4	5.5	4.4%	350	1.0	11.2	3.2%
R137	125	0.3	5.4	4.3%	350	0.8	11.0	3.1%
R138	125	0.3	5.4	4.3%	350	0.7	10.9	3.1%
R139	125	0.1	5.2	4.2%	350	0.5	10.6	3.0%
R140	125	0.1	5.2	4.2%	350	0.5	10.6	3.0%
R141	125	0.2	5.2	4.2%	350	0.5	10.7	3.0%
R142	125	0.2	5.2	4.2%	350	0.5	10.7	3.0%
R143	125	0.2	5.3	4.2%	350	0.6	10.7	3.1%
R144	125	0.2	5.3	4.2%	350	0.5	10.7	3.1%
R145	125	0.2	5.2	4.2%	350	0.4	10.6	3.0%
R146	125	0.1	5.2	4.2%	350	0.4	10.6	3.0%
R147	125	0.1	5.2	4.2%	350	0.4	10.5	3.0%
R148	125	0.2	5.3	4.2%	350	0.5	10.6	3.0%
R149	125	0.1	5.2	4.2%	350	0.4	10.5	3.0%
R150	125	0.4	5.5	4.4%	350	0.9	11.1	3.2%
R151	125	0.3	5.4	4.3%	350	0.8	10.9	3.1%
R152	125	0.3	5.4	4.3%	350	0.7	10.9	3.1%
R153	125	0.3	5.3	4.3%	350	0.6	10.8	3.1%
R154	125	1.2	6.3	5.0%	350	2.4	12.5	3.6%
R155	125	1.0	6.1	4.9%	350	1.9	12.1	3.5%
R156	125	0.8	5.9	4.7%	350	1.7	11.8	3.4%
R157	125	0.7	5.8	4.6%	350	1.5	11.6	3.3%

ID	24 hour Mean (µg/m³)				99.79th percentile 1 Hour Mean (µg/m³)			
	AQS	PC	PEC	% PEC of AQS	AQS	PC	PEC	% PEC of AQS
R158	125	0.8	5.9	4.7%	350	1.7	11.9	3.4%
R159	125	1.0	6.1	4.9%	350	1.8	12.0	3.4%
R160	125	0.5	5.6	4.5%	350	1.1	11.3	3.2%
R161	125	0.6	5.6	4.5%	350	1.1	11.3	3.2%
R162	125	0.3	5.4	4.3%	350	0.7	10.9	3.1%
R163	125	0.3	5.4	4.3%	350	0.7	10.9	3.1%
R164	125	0.3	5.4	4.3%	350	0.6	10.8	3.1%
R165	125	0.5	5.6	4.5%	350	1.1	11.3	3.2%
R166	125	0.4	5.5	4.4%	350	0.9	11.1	3.2%
R167	125	0.4	5.5	4.4%	350	0.9	11.1	3.2%
R168	125	0.3	5.4	4.3%	350	0.8	10.9	3.1%
R169	125	0.3	5.4	4.3%	350	0.7	10.9	3.1%
R170	125	0.3	5.3	4.3%	350	0.6	10.8	3.1%
R171	125	0.3	5.3	4.3%	350	0.6	10.8	3.1%
R172	125	0.2	5.3	4.3%	350	0.5	10.7	3.1%
R173	125	0.2	5.3	4.2%	350	0.5	10.6	3.0%
R174	125	0.2	5.3	4.2%	350	0.5	10.6	3.0%
R175	125	0.2	5.3	4.2%	350	0.5	10.7	3.1%
R176	125	0.2	5.2	4.2%	350	0.4	10.6	3.0%
R177	125	0.1	5.2	4.2%	350	0.4	10.5	3.0%
R178	125	0.1	5.2	4.2%	350	0.4	10.6	3.0%
R179	125	0.2	5.2	4.2%	350	0.4	10.6	3.0%
R180	125	0.2	5.3	4.2%	350	0.4	10.6	3.0%
R181	125	0.2	5.3	4.2%	350	0.4	10.6	3.0%
R182	125	0.2	5.2	4.2%	350	0.4	10.6	3.0%
R183	125	0.2	5.2	4.2%	350	0.4	10.6	3.0%
R184	125	0.2	5.3	4.2%	350	0.4	10.6	3.0%
R185	125	0.2	5.3	4.2%	350	0.5	10.7	3.1%
R186	125	0.2	5.3	4.2%	350	0.5	10.7	3.0%
R187	125	0.2	5.3	4.2%	350	0.5	10.6	3.0%
R188	125	0.1	5.2	4.2%	350	0.4	10.6	3.0%

ID	24 hour Mean (µg/m³)				99.79th percentile 1 Hour Mean (µg/m³)			
	AQS	PC	PEC	% PEC of AQS	AQS	PC	PEC	% PEC of AQS
R189	125	0.3	5.4	4.3%	350	0.7	10.8	3.1%
R190	125	0.3	5.3	4.3%	350	0.6	10.7	3.1%
R191	125	0.2	5.3	4.2%	350	0.5	10.6	3.0%
R192	125	0.1	5.2	4.2%	350	0.4	10.5	3.0%
R193	125	0.2	5.3	4.2%	350	0.5	10.6	3.0%
R194	125	0.2	5.3	4.2%	350	0.5	10.6	3.0%
R195	125	0.3	5.4	4.3%	350	0.6	10.8	3.1%
R196	125	0.2	5.2	4.2%	350	0.5	10.6	3.0%
R197	125	0.1	5.2	4.2%	350	0.5	10.6	3.0%
R198	125	0.2	5.2	4.2%	350	0.5	10.7	3.0%
R199	125	0.2	5.3	4.2%	350	0.6	10.7	3.1%
R200	125	0.2	5.3	4.2%	350	0.6	10.8	3.1%
R201	125	0.3	5.4	4.3%	350	0.7	10.8	3.1%
R202	125	0.3	5.4	4.3%	350	0.6	10.8	3.1%
R203	125	0.4	5.5	4.4%	350	0.9	11.0	3.1%
R204	125	0.3	5.4	4.3%	350	0.8	11.0	3.1%
R205	125	0.6	5.7	4.5%	350	1.2	11.4	3.3%
R206	125	0.2	5.2	4.2%	350	0.5	10.6	3.0%
R207	125	0.2	5.3	4.2%	350	0.6	10.7	3.1%
R208	125	0.3	5.4	4.3%	350	0.8	11.0	3.1%
R209	125	0.3	5.4	4.3%	350	0.7	10.9	3.1%
R210	125	0.3	5.4	4.3%	350	0.7	10.9	3.1%
R211	125	0.2	5.3	4.2%	350	0.6	10.8	3.1%
R212	125	0.2	5.2	4.2%	350	0.5	10.6	3.0%
R213	125	0.2	5.2	4.2%	350	0.5	10.6	3.0%
R214	125	0.2	5.3	4.2%	350	0.5	10.6	3.0%
R215	125	0.2	5.3	4.2%	350	0.5	10.7	3.1%
R216	125	0.2	5.2	4.2%	350	0.5	10.6	3.0%
AQS = Air Quality Standard (µg/m³); PC = Process Contribution; PEC = Predicted Environmental Concentration (PC + Background)								

Table B2 – Carbon Monoxide results – Maximum Emission Rate

ID	8 hour rolling average (µg/m³)				1 Hour Mean (µg/m³)			
	AQS	PC	PEC	% PEC of AQS	AQS	PC	PEC	% PEC of AQS
R1	10000	3.5	343.5	3.4%	30000	79.6	759.6	2.5%
R2	10000	1.8	341.8	3.4%	30000	36.9	716.9	2.4%
R3	10000	1.1	341.1	3.4%	30000	27.3	707.3	2.4%
R4	10000	1.3	341.3	3.4%	30000	22.8	702.8	2.3%
R5	10000	3.0	343.0	3.4%	30000	40.0	720.0	2.4%
R6	10000	1.5	341.5	3.4%	30000	21.9	701.9	2.3%
R7	10000	1.6	341.6	3.4%	30000	18.2	698.2	2.3%
R8	10000	0.6	340.6	3.4%	30000	13.5	693.5	2.3%
R9	10000	2.5	342.5	3.4%	30000	48.3	728.3	2.4%
R10	10000	1.5	341.5	3.4%	30000	34.6	714.6	2.4%
R11	10000	1.1	341.1	3.4%	30000	26.4	706.4	2.4%
R12	10000	1.2	341.2	3.4%	30000	27.6	707.6	2.4%
R13	10000	2.0	342.0	3.4%	30000	18.9	698.9	2.3%
R14	10000	2.5	342.5	3.4%	30000	36.3	716.3	2.4%
R15	10000	1.0	341.0	3.4%	30000	23.4	703.4	2.3%
R16	10000	1.1	341.1	3.4%	30000	25.8	705.8	2.4%
R17	10000	0.9	340.9	3.4%	30000	23.4	703.4	2.3%
R18	10000	1.1	341.1	3.4%	30000	28.7	708.7	2.4%
R19	10000	0.4	340.4	3.4%	30000	16.9	696.9	2.3%
R20	10000	0.5	340.5	3.4%	30000	17.9	697.9	2.3%
R21	10000	0.5	340.5	3.4%	30000	17.1	697.1	2.3%
R22	10000	3.8	343.8	3.4%	30000	36.4	716.4	2.4%
R23	10000	1.5	341.5	3.4%	30000	23.2	703.2	2.3%
R24	10000	1.5	341.5	3.4%	30000	23.8	703.8	2.3%
R25	10000	2.3	342.3	3.4%	30000	28.5	708.5	2.4%
R26	10000	2.5	342.5	3.4%	30000	30.4	710.4	2.4%
R27	10000	1.0	341.0	3.4%	30000	18.9	698.9	2.3%
R28	10000	1.1	341.1	3.4%	30000	19.2	699.2	2.3%
R29	10000	0.5	340.5	3.4%	30000	16.2	696.2	2.3%
R30	10000	0.8	340.8	3.4%	30000	22.9	702.9	2.3%
R31	10000	0.8	340.8	3.4%	30000	14.9	694.9	2.3%
R32	10000	0.9	340.9	3.4%	30000	15.5	695.5	2.3%
R33	10000	1.0	341.0	3.4%	30000	17.0	697.0	2.3%
R34	10000	1.1	341.1	3.4%	30000	18.5	698.5	2.3%
R35	10000	1.1	341.1	3.4%	30000	17.3	697.3	2.3%
R36	10000	1.3	341.3	3.4%	30000	18.8	698.8	2.3%
R37	10000	1.0	341.0	3.4%	30000	16.4	696.4	2.3%
R38	10000	1.0	341.0	3.4%	30000	16.6	696.6	2.3%
R39	10000	1.1	341.1	3.4%	30000	17.9	697.9	2.3%
R40	10000	1.4	341.4	3.4%	30000	19.9	699.9	2.3%

ID	8 hour rolling average (µg/m³)				1 Hour Mean (µg/m³)			
	AQS	PC	PEC	% PEC of AQS	AQS	PC	PEC	% PEC of AQS
R41	10000	1.2	341.2	3.4%	30000	19.8	699.8	2.3%
R42	10000	0.8	340.8	3.4%	30000	15.0	695.0	2.3%
R43	10000	1.1	341.1	3.4%	30000	18.6	698.6	2.3%
R44	10000	1.2	341.2	3.4%	30000	19.6	699.6	2.3%
R45	10000	0.9	340.9	3.4%	30000	17.4	697.4	2.3%
R46	10000	1.1	341.1	3.4%	30000	20.2	700.2	2.3%
R47	10000	4.4	344.4	3.4%	30000	65.8	745.8	2.5%
R48	10000	5.0	345.0	3.5%	30000	90.1	770.1	2.6%
R49	10000	4.9	344.9	3.4%	30000	82.5	762.5	2.5%
R50	10000	6.4	346.4	3.5%	30000	99.4	779.4	2.6%
R51	10000	3.6	343.6	3.4%	30000	46.8	726.8	2.4%
R52	10000	1.1	341.1	3.4%	30000	16.5	696.5	2.3%
R53	10000	1.3	341.3	3.4%	30000	18.0	698.0	2.3%
R54	10000	1.2	341.2	3.4%	30000	17.9	697.9	2.3%
R55	10000	1.4	341.4	3.4%	30000	19.0	699.0	2.3%
R56	10000	1.8	341.8	3.4%	30000	22.3	702.3	2.3%
R57	10000	2.2	342.2	3.4%	30000	22.9	702.9	2.3%
R58	10000	3.2	343.2	3.4%	30000	24.5	704.5	2.3%
R59	10000	1.8	341.8	3.4%	30000	22.8	702.8	2.3%
R60	10000	2.4	342.4	3.4%	30000	25.4	705.4	2.4%
R61	10000	3.3	343.3	3.4%	30000	26.0	706.0	2.4%
R62	10000	1.2	341.2	3.4%	30000	18.4	698.4	2.3%
R63	10000	1.4	341.4	3.4%	30000	18.9	698.9	2.3%
R64	10000	1.5	341.5	3.4%	30000	19.8	699.8	2.3%
R65	10000	1.9	341.9	3.4%	30000	20.2	700.2	2.3%
R66	10000	2.5	342.5	3.4%	30000	21.3	701.3	2.3%
R67	10000	2.8	342.8	3.4%	30000	22.6	702.6	2.3%
R68	10000	3.9	343.9	3.4%	30000	30.8	710.8	2.4%
R69	10000	5.3	345.3	3.5%	30000	40.9	720.9	2.4%
R70	10000	3.6	343.6	3.4%	30000	44.2	724.2	2.4%
R71	10000	2.8	342.8	3.4%	30000	44.6	724.6	2.4%
R72	10000	2.8	342.8	3.4%	30000	32.3	712.3	2.4%
R73	10000	3.2	343.2	3.4%	30000	35.3	715.3	2.4%
R74	10000	4.4	344.4	3.4%	30000	43.7	723.7	2.4%
R75	10000	3.5	343.5	3.4%	30000	36.3	716.3	2.4%
R76	10000	3.5	343.5	3.4%	30000	34.4	714.4	2.4%
R77	10000	4.3	344.3	3.4%	30000	40.9	720.9	2.4%
R78	10000	2.2	342.2	3.4%	30000	27.9	707.9	2.4%
R79	10000	2.2	342.2	3.4%	30000	27.8	707.8	2.4%
R80	10000	2.2	342.2	3.4%	30000	26.6	706.6	2.4%
R81	10000	1.9	341.9	3.4%	30000	23.9	703.9	2.3%

ID	8 hour rolling average (µg/m³)				1 Hour Mean (µg/m³)			
	AQS	PC	PEC	% PEC of AQS	AQS	PC	PEC	% PEC of AQS
R82	10000	1.8	341.8	3.4%	30000	23.5	703.5	2.3%
R83	10000	1.9	341.9	3.4%	30000	23.4	703.4	2.3%
R84	10000	1.2	341.2	3.4%	30000	19.6	699.6	2.3%
R85	10000	1.8	341.8	3.4%	30000	23.2	703.2	2.3%
R86	10000	1.6	341.6	3.4%	30000	21.3	701.3	2.3%
R87	10000	1.2	341.2	3.4%	30000	19.5	699.5	2.3%
R88	10000	2.7	342.7	3.4%	30000	29.1	709.1	2.4%
R89	10000	2.6	342.6	3.4%	30000	27.9	707.9	2.4%
R90	10000	2.4	342.4	3.4%	30000	26.8	706.8	2.4%
R91	10000	2.8	342.8	3.4%	30000	30.0	710.0	2.4%
R92	10000	3.1	343.1	3.4%	30000	31.1	711.1	2.4%
R93	10000	3.7	343.7	3.4%	30000	34.9	714.9	2.4%
R94	10000	3.5	343.5	3.4%	30000	34.4	714.4	2.4%
R95	10000	1.9	341.9	3.4%	30000	24.8	704.8	2.3%
R96	10000	1.5	341.5	3.4%	30000	21.7	701.7	2.3%
R97	10000	1.1	341.1	3.4%	30000	19.5	699.5	2.3%
R98	10000	0.8	340.8	3.4%	30000	17.1	697.1	2.3%
R99	10000	1.0	341.0	3.4%	30000	18.9	698.9	2.3%
R100	10000	1.1	341.1	3.4%	30000	20.1	700.1	2.3%
R101	10000	0.9	340.9	3.4%	30000	18.6	698.6	2.3%
R102	10000	1.4	341.4	3.4%	30000	22.6	702.6	2.3%
R103	10000	1.6	341.6	3.4%	30000	25.4	705.4	2.4%
R104	10000	1.7	341.7	3.4%	30000	28.8	708.8	2.4%
R105	10000	1.6	341.6	3.4%	30000	31.5	711.5	2.4%
R106	10000	1.5	341.5	3.4%	30000	32.5	712.5	2.4%
R107	10000	1.3	341.3	3.4%	30000	31.8	711.8	2.4%
R108	10000	1.1	341.1	3.4%	30000	28.1	708.1	2.4%
R109	10000	1.2	341.2	3.4%	30000	27.6	707.6	2.4%
R110	10000	1.2	341.2	3.4%	30000	24.4	704.4	2.3%
R111	10000	1.0	341.0	3.4%	30000	22.6	702.6	2.3%
R112	10000	1.0	341.0	3.4%	30000	23.4	703.4	2.3%
R113	10000	0.9	340.9	3.4%	30000	19.5	699.5	2.3%
R114	10000	0.8	340.8	3.4%	30000	20.5	700.5	2.3%
R115	10000	0.7	340.7	3.4%	30000	19.1	699.1	2.3%
R116	10000	0.7	340.7	3.4%	30000	20.2	700.2	2.3%
R117	10000	0.8	340.8	3.4%	30000	22.3	702.3	2.3%
R118	10000	0.8	340.8	3.4%	30000	24.0	704.0	2.3%
R119	10000	0.8	340.8	3.4%	30000	23.2	703.2	2.3%
R120	10000	0.8	340.8	3.4%	30000	21.6	701.6	2.3%
R121	10000	0.8	340.8	3.4%	30000	21.7	701.7	2.3%
R122	10000	0.6	340.6	3.4%	30000	19.0	699.0	2.3%

ID	8 hour rolling average (µg/m³)				1 Hour Mean (µg/m³)			
	AQS	PC	PEC	% PEC of AQS	AQS	PC	PEC	% PEC of AQS
R123	10000	0.6	340.6	3.4%	30000	18.7	698.7	2.3%
R124	10000	0.6	340.6	3.4%	30000	19.2	699.2	2.3%
R125	10000	0.6	340.6	3.4%	30000	19.6	699.6	2.3%
R126	10000	0.6	340.6	3.4%	30000	18.5	698.5	2.3%
R127	10000	0.6	340.6	3.4%	30000	18.2	698.2	2.3%
R128	10000	0.6	340.6	3.4%	30000	17.5	697.5	2.3%
R129	10000	0.6	340.6	3.4%	30000	18.0	698.0	2.3%
R130	10000	2.5	342.5	3.4%	30000	31.7	711.7	2.4%
R131	10000	2.4	342.4	3.4%	30000	34.7	714.7	2.4%
R132	10000	2.2	342.2	3.4%	30000	38.7	718.7	2.4%
R133	10000	2.0	342.0	3.4%	30000	40.5	720.5	2.4%
R134	10000	1.8	341.8	3.4%	30000	40.1	720.1	2.4%
R135	10000	1.7	341.7	3.4%	30000	39.7	719.7	2.4%
R136	10000	1.8	341.8	3.4%	30000	40.6	720.6	2.4%
R137	10000	1.5	341.5	3.4%	30000	35.0	715.0	2.4%
R138	10000	1.2	341.2	3.4%	30000	30.5	710.5	2.4%
R139	10000	0.7	340.7	3.4%	30000	19.9	699.9	2.3%
R140	10000	0.7	340.7	3.4%	30000	19.7	699.7	2.3%
R141	10000	0.8	340.8	3.4%	30000	21.4	701.4	2.3%
R142	10000	0.8	340.8	3.4%	30000	20.5	700.5	2.3%
R143	10000	0.9	340.9	3.4%	30000	23.1	703.1	2.3%
R144	10000	0.9	340.9	3.4%	30000	20.9	700.9	2.3%
R145	10000	0.7	340.7	3.4%	30000	18.7	698.7	2.3%
R146	10000	0.6	340.6	3.4%	30000	16.6	696.6	2.3%
R147	10000	0.5	340.5	3.4%	30000	15.6	695.6	2.3%
R148	10000	0.7	340.7	3.4%	30000	18.1	698.1	2.3%
R149	10000	0.5	340.5	3.4%	30000	14.3	694.3	2.3%
R150	10000	1.6	341.6	3.4%	30000	33.5	713.5	2.4%
R151	10000	1.3	341.3	3.4%	30000	29.4	709.4	2.4%
R152	10000	1.2	341.2	3.4%	30000	27.1	707.1	2.4%
R153	10000	1.1	341.1	3.4%	30000	24.5	704.5	2.3%
R154	10000	3.9	343.9	3.4%	30000	77.0	757.0	2.5%
R155	10000	3.4	343.4	3.4%	30000	62.3	742.3	2.5%
R156	10000	2.9	342.9	3.4%	30000	53.4	733.4	2.4%
R157	10000	2.6	342.6	3.4%	30000	47.8	727.8	2.4%

ID	8 hour rolling average (µg/m³)				1 Hour Mean (µg/m³)			
	AQS	PC	PEC	% PEC of AQS	AQS	PC	PEC	% PEC of AQS
R158	10000	2.9	342.9	3.4%	30000	54.3	734.3	2.4%
R159	10000	3.2	343.2	3.4%	30000	54.7	734.7	2.4%
R160	10000	1.8	341.8	3.4%	30000	38.4	718.4	2.4%
R161	10000	1.9	341.9	3.4%	30000	38.6	718.6	2.4%
R162	10000	1.2	341.2	3.4%	30000	25.6	705.6	2.4%
R163	10000	1.1	341.1	3.4%	30000	26.0	706.0	2.4%
R164	10000	1.0	341.0	3.4%	30000	23.7	703.7	2.3%
R165	10000	1.8	341.8	3.4%	30000	39.1	719.1	2.4%
R166	10000	1.5	341.5	3.4%	30000	32.6	712.6	2.4%
R167	10000	1.4	341.4	3.4%	30000	32.4	712.4	2.4%
R168	10000	1.2	341.2	3.4%	30000	28.7	708.7	2.4%
R169	10000	1.1	341.1	3.4%	30000	26.3	706.3	2.4%
R170	10000	0.9	340.9	3.4%	30000	23.9	703.9	2.3%
R171	10000	0.9	340.9	3.4%	30000	23.4	703.4	2.3%
R172	10000	0.9	340.9	3.4%	30000	20.6	700.6	2.3%
R173	10000	0.7	340.7	3.4%	30000	19.2	699.2	2.3%
R174	10000	0.7	340.7	3.4%	30000	17.8	697.8	2.3%
R175	10000	0.8	340.8	3.4%	30000	20.5	700.5	2.3%
R176	10000	0.6	340.6	3.4%	30000	16.1	696.1	2.3%
R177	10000	0.5	340.5	3.4%	30000	15.7	695.7	2.3%
R178	10000	0.5	340.5	3.4%	30000	16.1	696.1	2.3%
R179	10000	2.2	342.2	3.4%	30000	20.1	700.1	2.3%
R180	10000	2.3	342.3	3.4%	30000	21.6	701.6	2.3%
R181	10000	2.3	342.3	3.4%	30000	21.0	701.0	2.3%
R182	10000	1.9	341.9	3.4%	30000	19.1	699.1	2.3%
R183	10000	1.7	341.7	3.4%	30000	19.2	699.2	2.3%
R184	10000	1.8	341.8	3.4%	30000	20.2	700.2	2.3%
R185	10000	2.3	342.3	3.4%	30000	22.9	702.9	2.3%
R186	10000	1.6	341.6	3.4%	30000	21.8	701.8	2.3%
R187	10000	1.0	341.0	3.4%	30000	19.6	699.6	2.3%
R188	10000	0.7	340.7	3.4%	30000	17.0	697.0	2.3%

ID	8 hour rolling average (µg/m³)				1 Hour Mean (µg/m³)			
	AQS	PC	PEC	% PEC of AQS	AQS	PC	PEC	% PEC of AQS
R189	10000	1.8	341.8	3.4%	30000	27.2	707.2	2.4%
R190	10000	1.3	341.3	3.4%	30000	23.7	703.7	2.3%
R191	10000	0.6	340.6	3.4%	30000	19.3	699.3	2.3%
R192	10000	1.1	341.1	3.4%	30000	18.0	698.0	2.3%
R193	10000	0.5	340.5	3.4%	30000	19.4	699.4	2.3%
R194	10000	0.5	340.5	3.4%	30000	19.4	699.4	2.3%
R195	10000	0.7	340.7	3.4%	30000	23.4	703.4	2.3%
R196	10000	0.6	340.6	3.4%	30000	18.9	698.9	2.3%
R197	10000	0.5	340.5	3.4%	30000	18.5	698.5	2.3%
R198	10000	0.6	340.6	3.4%	30000	20.0	700.0	2.3%
R199	10000	0.7	340.7	3.4%	30000	21.9	701.9	2.3%
R200	10000	0.8	340.8	3.4%	30000	24.3	704.3	2.3%
R201	10000	0.9	340.9	3.4%	30000	25.5	705.5	2.4%
R202	10000	0.8	340.8	3.4%	30000	23.3	703.3	2.3%
R203	10000	1.2	341.2	3.4%	30000	31.3	711.3	2.4%
R204	10000	1.2	341.2	3.4%	30000	29.8	709.8	2.4%
R205	10000	2.0	342.0	3.4%	30000	41.9	721.9	2.4%
R206	10000	0.6	340.6	3.4%	30000	19.3	699.3	2.3%
R207	10000	0.7	340.7	3.4%	30000	23.2	703.2	2.3%
R208	10000	1.2	341.2	3.4%	30000	30.8	710.8	2.4%
R209	10000	1.2	341.2	3.4%	30000	27.2	707.2	2.4%
R210	10000	1.0	341.0	3.4%	30000	27.3	707.3	2.4%
R211	10000	0.8	340.8	3.4%	30000	23.9	703.9	2.3%
R212	10000	0.6	340.6	3.4%	30000	19.6	699.6	2.3%
R213	10000	0.6	340.6	3.4%	30000	18.9	698.9	2.3%
R214	10000	0.7	340.7	3.4%	30000	20.0	700.0	2.3%
R215	10000	0.8	340.8	3.4%	30000	20.8	700.8	2.3%
R216	10000	0.6	340.6	3.4%	30000	18.4	698.4	2.3%
AQS = Air Quality Standard (µg/m³); PC = Process Contribution; PEC = Predicted Environmental Concentration (PC + Background)								