Breedon Cement Ltd

Hope Cement Works Sulphur Dioxide Modelling Update

Air Quality Assessment Report

February 2022

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Executive Summary

Purpose of Report

Bureau Veritas has been commissioned by Breedon Cement Ltd to undertake a detailed operational dispersion modelling assessment of sulphur dioxide emissions to air from the two cement kilns at the Hope Cement Works site.

Breedon Cement currently operate under an Environmental Permit (EP) (ref: EPR-BP3731VJ-V006), issued by the Environment Agency (EA). The Industrial Emissions Directive (IED) requires all installations to use the Best Available Techniques (BAT). Compliance with the BAT associated emission levels (BAT-AEL) is mandatory unless derogation from those BAT-AEL is justified. Breedon Cement are now seeking to apply for an extension to the site's existing derogation for emissions of SO_2. The current derogation is 695 mg/Nm^3 against a BAT-AEL of 400 mg/Nm^3.

In order to support the extension of the existing derogation for SO_2, this report presents and discusses the SO_2 modelling assessment, which has been updated for the following scenarios:

- Scenario 1: Based on actual daily average running emissions; and
- Scenario 2: Operation at the current Emission Limit Value (ELV) of 695 mg/Nm^3 (per kiln).

Summary of Conclusions

The dispersion modelling concluded that, for both scenarios, Predicted Environmental Concentrations (PECs) of sulphur dioxide did not exceed the relevant Air Quality Assessment Levels (AQALs) at any of the human receptors assessed. It is therefore unlikely that there would be any significant effects to human receptors from either modelled scenario.

For concentrations in air at the assessed ecological receptors, no exceedances were predicted in either of the modelled scenarios. The PEC was greater than 70% of the long-term AQAL in Scenario 2 at one of the sites considered (73.5%). This site is approximately 1.6 km from the stack, in Castleton SSSI. It should be noted that the PECs are based on the worst-case background concentrations, due to the use of Defra's 2001 background maps.

With regard to acid deposition, the results exceeded the critical load function at the majority of receptors in both Scenario 1 and Scenario 2. Whilst these exceedances are attributed to the background contributions, since the background levels already exceed the relevant critical loads prior to adding PC from the plant, the PC results cannot be considered insignificant.

1 Introduction

Bureau Veritas has been commissioned by Breedon Cement Ltd to undertake a detailed operational dispersion modelling assessment of sulphur dioxide emissions to air from the two cement kilns at the Hope Cement Works site.

Breedon Cement currently operate under an Environmental Permit (EP) (ref: EPR-BP3731VJ-V006), issued by the Environment Agency (EA). The Industrial Emissions Directive (IED) requires all installations to use the Best Available Techniques (BAT). Compliance with the BAT associated emission levels (BAT-AEL) is mandatory unless derogation from those BAT-AEL is justified.

Breedon Cement currently have an approved derogation of 695 mg/Nm^3 derogation for emissions of SO_2. This has been approved up to the 1st of April 2022, after which it would be required to comply with the BAT-AEL of 400 mg/Nm^3. Breedon Cement are therefore seeking to apply for an extension to the current derogation.

As such, this report presents the methodology and conclusions of the SO_2 modelling assessment, which has been updated to determine the potential impacts of daily average running emissions, and emissions at the ELV of 695 mg/Nm^3 (per kiln).

1.1 Scope of Study

Breedon cement works is located in the Hope Valley in the Peak District, Derbyshire, 20 km west of Sheffield, in the Borough of High Peak. The sites immediate surroundings are predominantly rural in character, surrounded by the villages of Hope (1 km north of the site), Castleton (1.5 km northwest) and Bradwell (1 km south of the site). To the west, the nearest urban area is Chapel-en-le-Frith, approximately 10 km from the site.

There are a number of isolated properties within 10 km of the site, which have been considered in this assessment. There are also several protected ecological sites within 10 km of the works. Further information on nearby sensitive receptors considered in the assessment is provided in Section 2.5.

In order to support an extension to the existing derogation, this study has:

- Ascertained background SO_2 levels from Defra's background mapped concentrations;
- Analysed Continuous Emission Monitoring Systems (CEMS) data from the Breedon Cement site to ascertain the daily average rate of SO_2 emissions;
- Utilised dispersion modelling to assess impacts of the following scenarios:
    - Operation at actual average daily emissions; and
    - Operation at the current Emission Limit Value (ELV) of 695 mg/Nm^3 per kiln.
- Taken into account recent feedback from the Environment Agency's Air Quality Modelling and Assessment Unit (AQMAU) on the 2017[1] modelling assessment completed by Bureau Veritas on behalf of Breedon Cement. This was regarding:
    - Meteorological year used;

[1] Bureau Veritas - Breedon Cement Improvement Conditions Air Quality Dispersion Modelling Report - September 2017

- Stack site and meteorological site surface roughness lengths applied within the model;

- Number of modelled ecological receptors; and

- Effect of buildings on dispersion of stack emissions.

The local ambient air quality impacts of SO_2 emissions have been assessed, both 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 acid deposition rates with critical levels and critical loads at key sites, excluding a formal Habitats Assessment).

2 Dispersion Modelling Methodology

Detailed dispersion modelling was undertaken to assess the pollutant emissions to air. ADMS 5 Version 5.2.4 modelling software was used for this study.

ADMS 5 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 cement kilns at the Breedon Cement 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 5 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.

2.1 Process Emissions

Details of the cement kilns at the Breedon Cement site have been provided to Bureau Veritas by Breedon Cement Ltd. There are two cement kilns on site (Kiln 1 and Kiln 2) which release pollutants generated from the combustion of kilns fuel. The emissions from each kiln are fed into a single stack located above the Preheater Tower Building.

The location of the stack included in the dispersion model is illustrated in Figure 2.1. Stack parameters and emission rates used in the assessment are summarised in Table 2.1 for the following scenarios:

- Scenario 1: Based on actual daily average running emissions; and
- Scenario 2: Operation at the current Emission Limit Value (ELV) of 695 mg/Nm^3 (per kiln).

Breedon Cement is required to report sulphur dioxide emissions data to the EA on a quarterly basis. All emissions data reported in this manner have a confidence interval applied, as detailed within the Industrial Emissions Directive (IED) Annex V[2] and the Site's Environmental Permit (Section 3.5). In line with this, sulphur dioxide emissions are reported to the EA with a 20% confidence interval applied. It is important to note that the emissions data used in this assessment do not include allowance for this confidence interval, in line with previous modelling assessments.

[2] Industrial Emissions Directive (IED) Annex V, available at: https://eur-lex.europa.eu/legal-content/EN/TXT/?uri=CELEX:32010L0075#d1e32-59-1

The assessment of sulphur dioxide emissions comprises the evaluation of concentrations in air, as well as acid deposition to land. In order to undertake a robust updated modelling assessment for emissions of sulphur dioxide, an update of the acid deposition rate calculations was also required. Nitrogen oxide and ammonia emission rates, used in these deposition calculations only, are therefore summarised in Table 2.2. Predicting the concentrations in air of these pollutants was beyond the scope of this assessment.

Table 2.1 – Model Input Parameters

Parameter	Cement Kilns	
Stack Location (XY) [a]	416490, 382450	
Stack Height (m) [a]	132.5	
Stack Diameter (m) [a]	4.4	
Efflux Velocity (m/s) [b]	9.13	
Volume Flux (m^3/s) [b]	138.4	
Efflux Temperature (°C) [c]	176.9	
Daily ELV (mg/Nm^3) per Cement Kiln	Scenario 1	Scenario 2
SO_2	453	695
Emission Rates (g/s) (Total Release from Stack)	Average Daily Emissions	ELV
SO_2 [d]	186.3	192.4

Parameters presented at reference conditions 273K, 101 kPa, 10% O_2, dry

[a] Information provided by Breedon Cement Ltd

[b] Efflux velocity calculated from actual volumetric flow rate and stack area derived from October 2021 stack monitoring reports

[c] Temperature derived from October 2021 stack monitoring reports

[d] Emission rates calculated as 3-year average of 2019 - 2021 CEMS data for Kiln 1 and Kiln 2

Table 2.2 – Nitrogen Dioxide and Ammonia Parameters (used for deposition only)

Pollutant	NO_x	NH_3
Emission Rate (g/s) (Total Release from Stack)	127.0 [a]	9.69 [b]

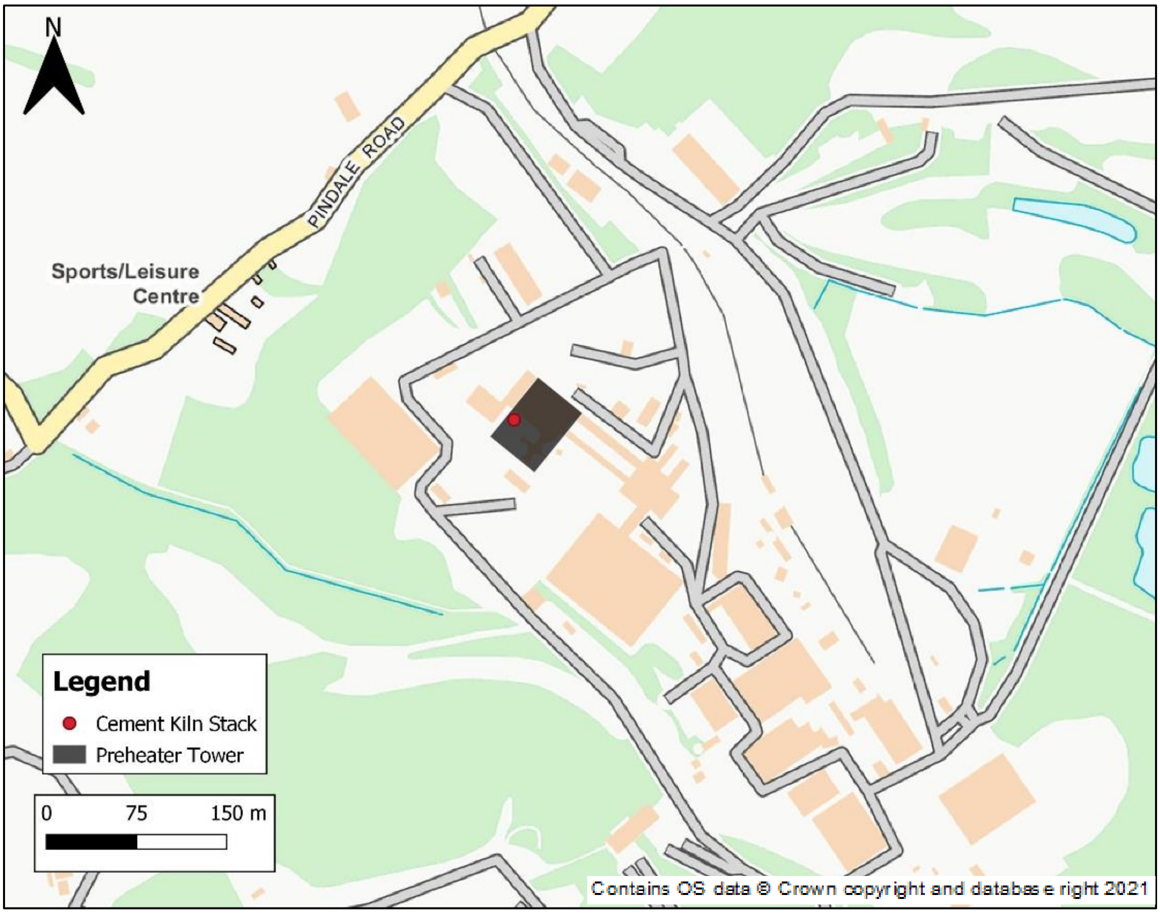
Parameters presented at reference conditions 273K, 101 kPa, 10% O_2, dry. Model uses actual values.

[a] Emission rate derived from CEMS data for Kiln 1 and Kiln 2 averaged over a 3-year period (2019 – 2021)

[b] Emission rate derived as part of a prior ammonia assessment completed by Bureau Veritas on behalf of Breedon Cement[3]

[3] Bureau Veritas - Breedon Cement Ltd Ammonia Modelling Update Report - February 2022

Figure 2.1 – Emission Point Visualisation and Buildings



2.2 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.

Numerical Weather Prediction (NWP) hourly sequential meteorological data centred at the cement works has been used. NWP datasets are based on the Unified Model operated by the UK Met Office 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 data has a high data capture percentage (minimum data capture out of the five years of data used in this assessment was 8,167 lines of usable data in 2016, equating to 93%) 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.

The use of NWP data is designed to allow the directional nature of the local winds to be taken into account. The cement works are located in the Hope Valley, and winds around the site are strongly directional, due to the influence of the surrounding terrain. The dominant wind direction at the works is from the west, due to the east-west orientation of the valley.

The assessment undertaken by Bureau Veritas in 2017[1] used one year of NWP data calculated at the cement works for 2016, citing a previous study carried out in 2011[4]; however, recent feedback from the EA's AQMAU raised concerns about the appropriateness of this approach:

"It is not clear why the consultant has chosen a single year of NWP data from 2016. Environment Agency guidance states that at least 3 years of meteorological data should be used. The selected meteorological data is likely to be representative, however interannual variability has not been considered".

The modelling assessment has therefore been updated to utilise five complete years of meteorological data, in order to take the year-by-year variations within the dataset into account. The assessment has utilised NWP meteorological data across the period 2016 to 2020. Wind roses for these years are shown in Figure 2.2 to Figure 2.6, where the dominant westerly winds can be clearly identified.

The choice of NWP Hope data for the current study was informed by an earlier dispersion modelling study carried out for the Hope Cement works site[4]. There are no weather stations operated by the UK Meteorological Office in the vicinity of the site, with the nearest station, Leek Thorncliffe, approximately 27 km southwest of the works. This study concluded that the wind roses represented by the Leek Thorncliffe observational data were not representative of the wind-flows in the valley near the cement works. Moreover, the records collated by an on-site weather station at the works were found to be of inadequate quality and data capture for the purposes of air dispersion modelling.

[4] Lafarge Cement UK – UK Air Dispersion Modelling - Hope Cement Works – Report AGGX4430837/EC/2736, 2011

Figure 2.2 - 2016 NWP Hope Data

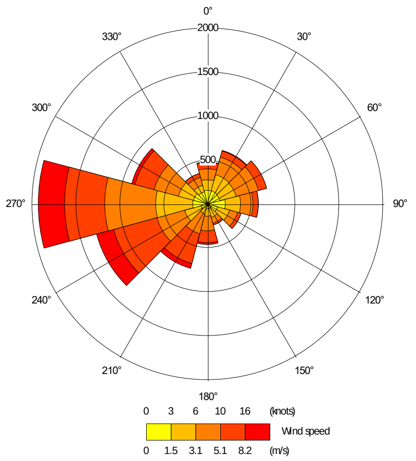


Figure 2.3 - 2017 NWP Hope Data

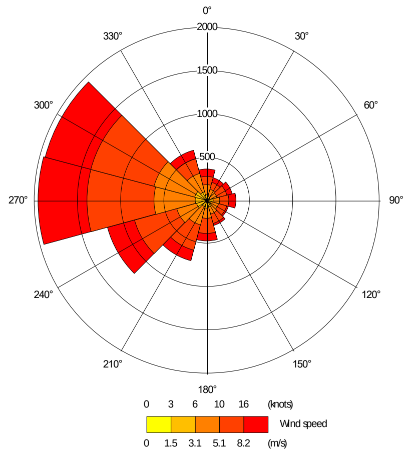


Figure 2.4 - 2018 NWP Hope Data

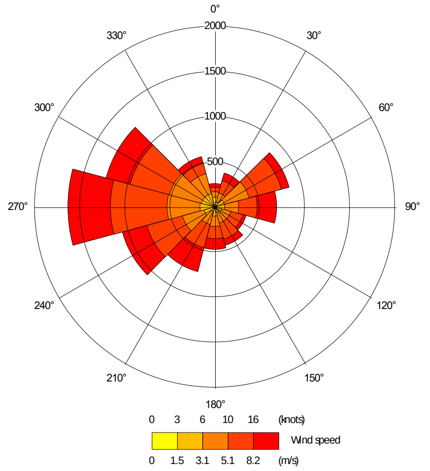


Figure 2.5 - 2019 NWP Hope Data

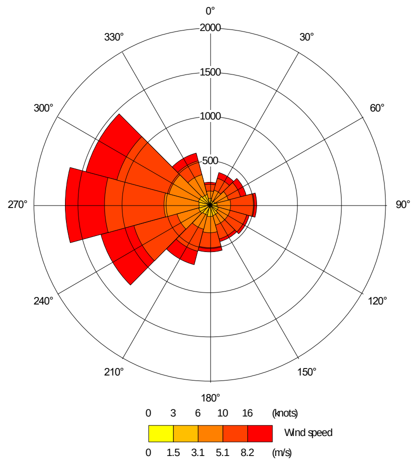
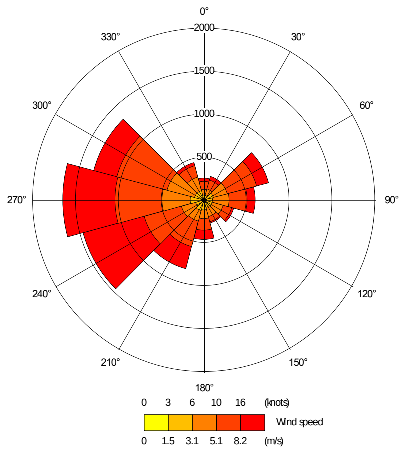


Figure 2.6 - 2020 NWP Hope Data



2.3 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.

2.3.1 Surface Roughness

Surface roughness length, z_0, 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 2.3).

Table 2.3 – 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; however; 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.

2.3.2 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.

2.3.3 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.

The assessment undertaken by Bureau Veritas in 2017[1] used a surface roughness length of 0.5 m for the dispersion site and 0.3 m for the meteorological site; however, recent feedback from the EA's AQMAU raised concerns about the appropriateness of these surface roughness lengths:

> *"We have performed sensitivity to variable surface roughness at both the dispersion and the meteorological site. Our checks consider the dispersion site with a value of 0.3 m to represent the open grassland adjacent to the river located to the south west of the site, and the meteorological site with a value of 0.2 m".*

The modelling assessment has therefore been updated to use a surface roughness length of 0.3 m (agricultural areas (max)) for the dispersion site and 0.2 m (agricultural areas (min)) for the meteorological site.

2.4 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.

Sensitivity testing carried out in previous air quality modelling for Lafarge cement works[5] (previous owners of the site) has shown that the 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 occurs closer to the site than would otherwise be expected.

For this assessment, building downwash effects were taken into account with a set of "grouped" buildings in the dispersion model (see Table 2.4 and Figure 2.1). The single "grouped" building input into the model utilised the height of the tallest of these buildings (as indicated on site plans) in order to ensure a conservative approach, allowing for smaller buildings and the complex configuration of other structures on site to be incorporated within its perimeter.

Table 2.4 – Modelled Buildings

Name	Centre Easting (m)	Centre Northing (m)	Height (m)	Length / Diameter (m)	Width (m)	Angle (º)
Preheater Tower	416509	382449	68	48	64	129

[5] Lafarge Cement UK – Dunbar Atmospheric Dispersion Modelling – Report AGGX0924/BV/2561 – September 2008

2.5 Modelled Domain and Receptors

2.5.1 Modelled Domain

In addition to the discrete receptors discussed in the sections below, a 5 km x 5 km Cartesian grid (centred on the cement works) with an approximate receptor resolution of 50 m was modelled, 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.

The height of all ecological receptors has been assumed to be 0 m and, in order to represent inhalation exposure, the height of all human receptors has been assumed to be 1.5 m.

2.5.2 Human Receptors

The receptors considered were chosen based on locations where people may be located and judged in terms of the likely duration of their exposure to pollutants and proximity to the site, following the guidance given in Section 4 of this report. Details of the locations of human receptors are given in Table 2.5 and illustrated Figure 2.7 below.

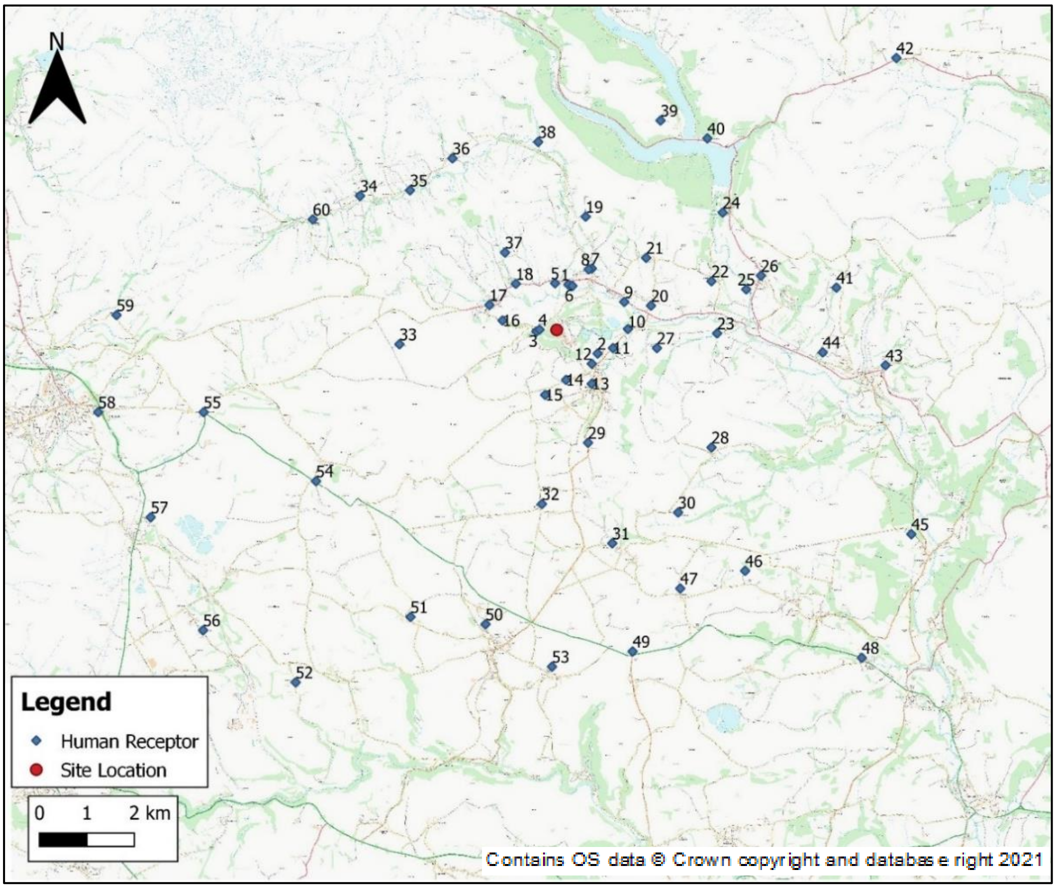
Concentrations have been predicted at 60 specific receptor locations within a radius of 10 km from the site. The majority of the human receptors included are at residential locations due to the nature of the surrounding area. Camp sites, schools and caravan parks have also been considered. The guidance documents are detailed in Section 4 of this report.

Table 2.5 – Assessed Human Receptors

ID	Receptor Name	Easting (m)	Northing (m)	Category	Distance from Site (km)
1	College 1	416737.9	383407.5	School	1.0
2	Caravan Park	417354.5	381952.0	Home	1.0
3	Pindale Farm 1	416066.3	382417.6	Home	0.4
4	Pindale Farm 2	416128.3	382457.4	Home	0.4
5	Hope Valley 1	416455.3	383435.6	Home	1.0
6	Hope Valley 2	416822.7	383379.4	Home	1.0
7	Hope Valley 3	417233.9	383745.9	Home	1.5
8	Hope Valley School	417165.7	383728.3	School	1.4
9	Laneside Farm	417916.3	383041.5	Home	1.5
10	Brough Farm	417993.3	382469.2	Home	1.5
11	Stretfield	417678.6	382067.5	Home	1.2
12	Bradwell	417231.7	381736.2	Home	1.4
13	Bradwell School	417231.7	381314.7	School	1.0
14	Bradwell 2	416686.9	381395.0	Home	1.1
15	Paradise Farm	416247.8	381079.1	Home	1.4
16	Castleton	415348.6	382649.2	Home	1.2
17	Castleton School	415072.3	382976.0	School	1.5
18	Caravan Castleton	415628.7	383424.0	Caravan Park	1.3
19	Fullwood Farm	417101.3	384839.4	Home	2.5
20	Borough Caravan Park	418479.3	382961.7	Caravan Park	2.0
21	Aston	418376.9	383971.0	Home	2.4
22	Thornhill	419754.9	383477.9	Home	3.4

ID	Receptor Name	Easting (m)	Northing (m)	Category	Distance from Site (km)
23	Shatton	419873.8	382377.3	Home	3.4
24	Parkin Clough	419991.5	384926.3	Home	4.3
25	Bamford	420487.9	383306.2	Home	4.1
26	Bamford School	420799.4	383595.7	School	4.4
27	Elmore Hill Farm	418604.7	382066.9	Home	2.1
28	Abney	419756.0	379971.4	Home	4.1
29	Hazelbadge	417151.9	380070.4	Home	2.5
30	Grange Farm	419051.6	378598.3	Home	4.6
31	Great Hucklow	417663.7	377947.9	Home	4.7
32	Little Hucklow	416179.0	378777.7	home	3.7
33	Camp site	413174.3	382147.8	Camp site	3.3
34	Vale of Edale	412342.2	385278.0	Home	5.0
35	Edale Mill	413396.6	385395.8	Home	4.3
36	Nether Booth	414291.4	386070.4	Home	4.2
37	Fields Farm	415400.8	384083.8	Home	2.0
38	Upper Fullwood Farm	416099.7	386416.0	Home	4.0
39	Crookhill Farm	418680.7	386868.4	Home	4.9
40	Ashopten	419669.0	386492.0	Home	5.1
41	Crookhill Farm	422389.8	383342.0	Home	6.0
42	Moscar	423655.5	388186.9	Home	9.2
43	Hathersage School	423426.5	381704.3	School	7.0
44	Hathersage	422102.5	381976.1	Home	5.6
45	Grindleford	423971.4	378141.6	Home	8.6
46	Eyam	420464.8	377367.8	Home	6.4
47	Foolow	419096.7	376995.8	Home	6.0
48	Stoney Middleton	422925.8	375533.1	Home	9.4
49	Wardlow	418091.9	375667.4	Home	7.0
50	Tideswell	414990.3	376241.9	Home	6.4
51	Wheston	413407.6	376396.0	Home	6.8
52	Wormhill	410985.2	375015.8	Home	9.2
53	Litton	416391.4	375346.0	Home	7.1
54	Peak Forest	411414.4	379259.8	School	6.0
55	Sparrowpit	409043.7	380714.8	Home	7.6
56	Upperend	409032.7	376114.2	Home	9.8
57	Doveholes	407928.7	378498.2	Home	9.4
58	Chapel-en-le-Frith	406819.3	380714.8	Home	9.8
59	Malcoff	407207.8	382763.1	Home	9.3
60	Barber Booth	411346.1	384782.7	Home	5.6

Figure 2.7 – Location of Modelled Human Receptors



2.5.3 Ecological Receptors

The Environment Agency's Air Emissions Risk (AER) Guidance[6] provides the following detail regarding consideration of ecological receptors:

- Check if there are any of the following within 10 km of your site (within 15 km 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 and local nature reserves).

[6] Environment Agency's Air Emissions Risk (AER) Guidance available at https://www.gov.uk/guidance/air-emissions-risk-assessment-for-your-environmental-permit

The assessment undertaken by Bureau Veritas in 2017[1] identified seven ecological receptors within the relevant screening distances; however, recent feedback from the EA's AQMAU raised concerns about the number of these receptors. The modelling assessment has therefore been updated to include additional receptors within the Peak District Moors SPA, South Pennine Moors SAC and Castleton SSSI, as well as adding receptors at the closest point of the Lower Hollins SSSI and Hallam Barn Grasslands SSSI to the site.

Table 2.6 provides details of ecological receptors which should be considered within this assessment.

Table 2.6 – Details of Modelled Ecological Receptors

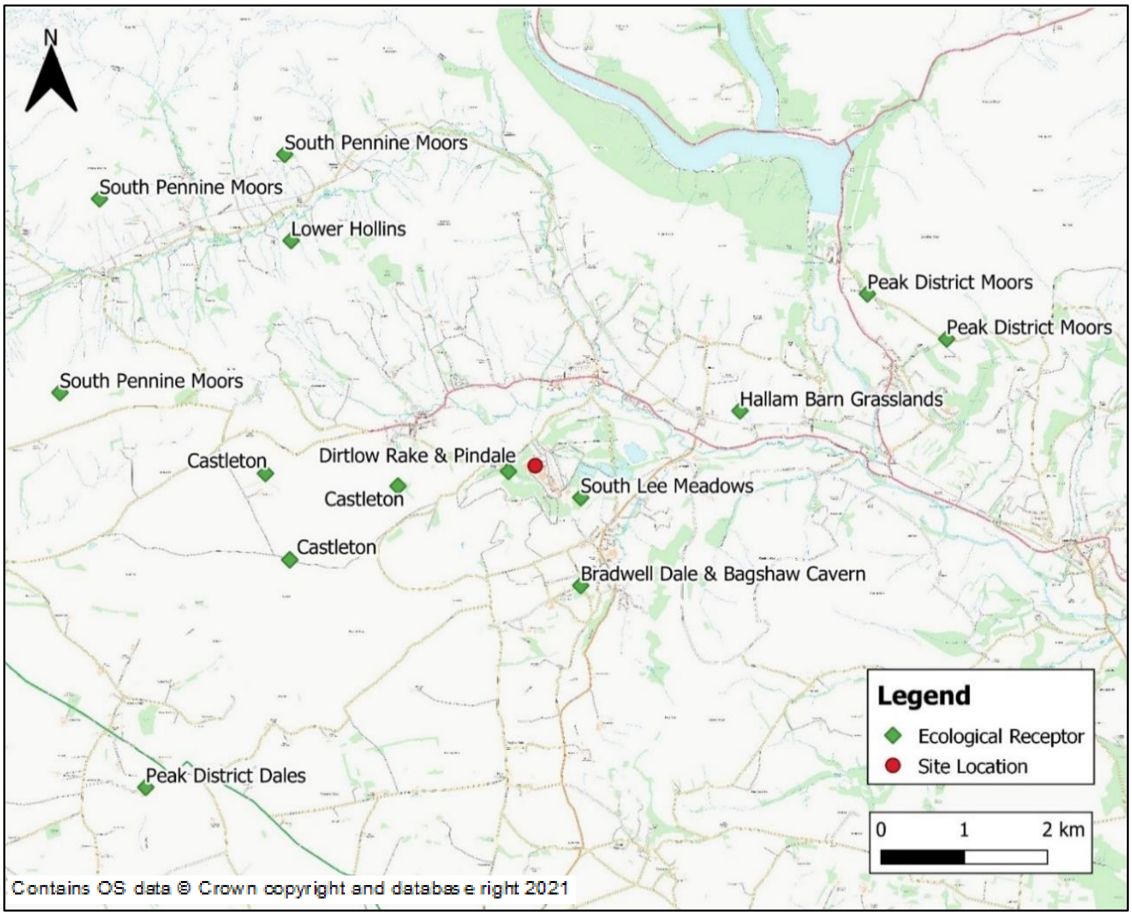
ID	Receptor Name	Type	Easting (m)	Northing (m)	Distance from the site (km)
A	Peak District Moors	SPA	420482	384514	4.5
B			421435	383972	5.0
C	South Pennine Moors	SAC	410777	383329	5.6
D			413478	386190	4.7
E			411253	385656	6.0
F	Peak District Dales	SAC	411809	378587	6.1
G	Castleton	SSSI	413247	382357	3.1
H			414840	382205	1.6
I			413539	381319	3.1
J	South Lee Meadows	SSSI	417036	382067	0.2
K	Bradwell Dale & Bagshaw Cavern	SSSI	417036	381011	1.2
L	Dirtlow Rake & Pindale	SSSI	416168	382382	0.4
M	Lower Hollins	SSSI	413556	385154	3.8
N	Hallam Barn Grasslands	SSSI	418950	383109	2.5

Note: The closest point of each ecological receptor to the site has been represented, and therefore the location of the predicted maximum impact has been taken into consideration.

Bradwell Dale & Bagshaw Cavern and Dirtlow Rake & Pindale SSSIs do not have any habitat interest features listed in the UK Air Pollution Information System (APIS) database and there are no Critical Loads available for these sites. Therefore, they have not been taken into account in this assessment.

For each conservation area 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 2.8.

Figure 2.8 – Location of Modelled Ecological Receptors

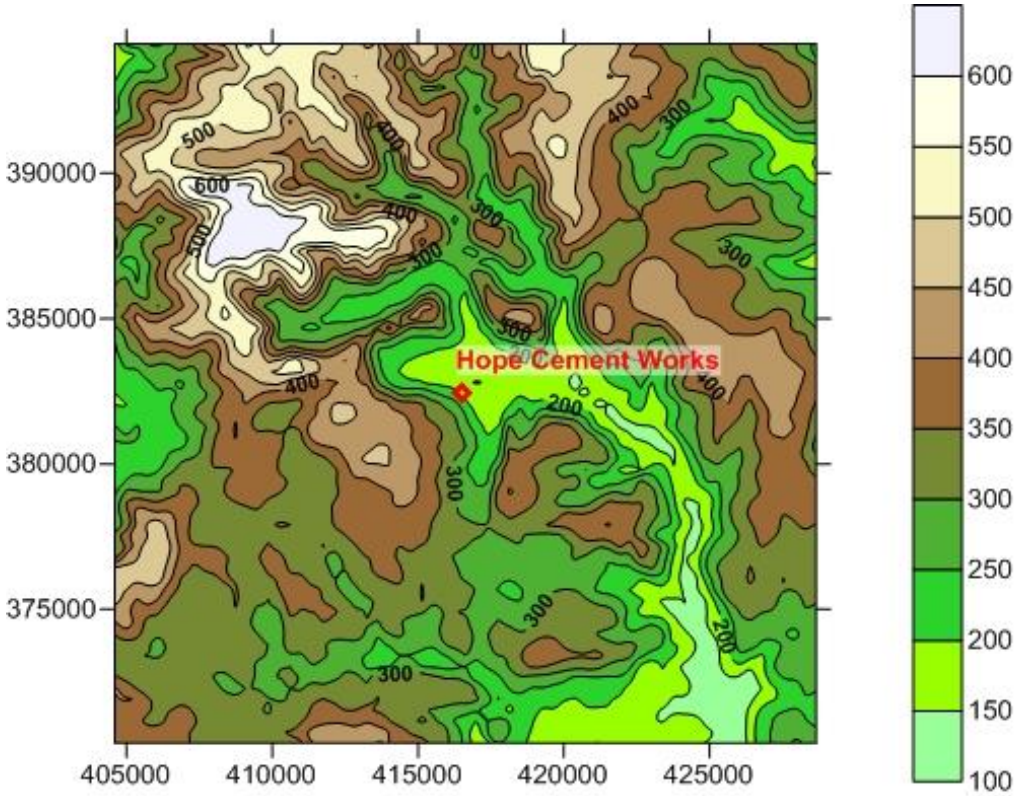


2.6 Terrain

Complex terrain can have a significant effect on the dispersion of a stack plume. As a result, pollutant concentrations at ground level may be higher or lower than on a flat area, depending on the topography. This effect can be taken into account by the dispersion model.

As the cement works are located in a valley the local terrain could have a significant effect on the dispersion of pollutants, the terrain module operated within ADMS 5 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 25 km × 25 km centred on the cement works. The resulting terrain grid is shown is shown below in Figure 2.9.

Figure 2.9 – Terrain Data Input to the ADMS 5 Model



2.7 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/m^3)

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/m^2/s)

Λ = washout co-efficient (s^{-1})

C = local airborne concentration (µg/m^3)

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 2.7).

Table 2.7 – 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

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/m^2/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 (= 1x104 m^2/ha)

K_3 = Conversion factor for µg to kg (= 1x109 µg/kg)

t = Number of seconds in a year (= 3.1536x107 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 2.8 – Deposition Conversion Factors

Pollutant	Chemical Element	Conversion Factor µg/m^2/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

Table 2.9 – Acidification Conversion Factors

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

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 2.7) to the modelled annual mean concentrations of NO_x, SO_2, HCl and NH_3. Wet deposition has not been assessed for NO_x, SO_2 and NH_3 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 2.10 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 coarse 5 km grid square resolution.

Table 2.10 – Estimated Background Deposition Rates

ID	Receptor Name	Background Nitrogen Deposition (kgN/ha/yr)	Background Nitric Acid Deposition (keq/ha/yr)	Background Sulphuric Acid Deposition (keq/ha/yr)
A	Peak District Moors	33.7	1.5	0.3
B				
C	South Pennine Moors	33.7	1.5	0.3
D				
E				
F	Peak District Dales	35.0	1.8	0.3
G	Castleton	29.2	1.8	0.4
H				
I				
J	South Lee Meadows	25.5	1.8	0.4
M	Lower Hollins	26.6	1.9	0.4
N	Hallam Barn Grasslands	25.5	1.8	0.4

Source: Air Pollution Information Service (APIS) website (http://www.apis.ac.uk)

2.8 Other Treatments

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

3 Defra Mapped Background Pollutant Concentrations

Defra maintains a nationwide model of existing and future background air quality concentrations at a 1 km grid square resolution. The datasets include annual average concentration estimates for NOx, NO_2, PM_{10}, $PM_{2.5}$, CO and SO_2 and benzene. 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.

3.1 Background Concentrations used in the Assessment

The Ladybower continuous rural background monitoring site, part of the Automatic Urban and Rural Network (AURN), is located 7 km north of the works. Annual data from this site was considered for use in this assessment. However, annual mean background concentrations have instead been derived from the Defra background maps for the 1 km grid square in which the assessed receptors are located. This is to ensure the assessment has considered the most conservative estimates of background concentrations.

The annual average process contribution is added to the annual average background concentration to give a total concentration at each receptor location. This total concentration can then be compared against the relevant Air Quality Assessment Level (AQAL) 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 AQALs. 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 Environment Agency guidance[6]. Those background annual mean concentrations used in the assessment are detailed in Table 3.1.

Table 3.1 – Background Annual Mean Concentrations used in the Assessment

Grid square (E, N)	Annual Mean SO_2 Concentrations (µg/m^3) [a]	Grid square (E, N)	Annual Mean SO_2 Concentrations (µg/m^3) [a]
416500, 383500	5.0	422500, 383500	5.1
417500, 381500	5.3	423500, 388500	5.1
416500, 382500	5.0	423500, 381500	5.0
417500, 383500	5.6	422500, 381500	5.0
417500, 382500	5.5	423500, 378500	4.8
416500, 381500	5.1	420500, 377500	4.8
415500, 382500	5.1	419500, 376500	4.8
415500, 383500	5.1	422500, 375500	5.5
417500, 384500	5.5	418500, 375500	4.8
418500, 382500	5.7	414500, 376500	5.1
418500, 383500	5.5	413500, 376500	5.0
419500, 383500	5.5	410500, 375500	4.9
419500, 382500	5.5	416500, 375500	5.0
419500, 384500	5.4	411500, 379500	4.8
420500, 383500	5.6	409500, 380500	4.8

419500, 379500	4.9	409500, 376500	5.0
417500, 380500	5.1	407500, 378500	5.2
419500, 378500	4.8	406500, 380500	5.2
417500, 377500	4.9	407500, 382500	5.0
416500, 378500	5.0	411500, 384500	4.9
413500, 382500	5.0	420500, 384500	5.5
412500, 385500	5.1	421500, 383500	5.4
413500, 385500	5.0	410500, 383500	4.9
414500, 386500	5.1	413500, 386500	5.0
415500, 384500	5.0	411500, 385500	4.9
416500, 386500	5.0	411500, 378500	5.2
418500, 386500	5.5	414500, 382500	5.0
419500, 386500	5.4	413500, 381500	5.1

[a] Background concentration of SO_2 taken from Defra's UK Air Quality Archive (1 km x 1 km grid squares) 2001 background maps.

3.2 Local Air Quality Management

High Peak Borough Council, under its LAQM obligations, continually reviews and assesses concentrations of key air pollutants in the borough to ascertain the requirement, or otherwise, to declare an Air Quality Management Area (AQMA). The Hope Cement site is not located within an AQMA and, furthermore, there are no AQMAs declared within the entire modelled domain. Since the assessment undertaken by Bureau Veritas in 2017[1] High Peak Borough Council have declared two AQMAs. The Dinting Vale and Tintwistle AQMAs were declared during 2019 for exceedances of the annual mean NO_2 objective and are located 18.5 km and 20 km, respectively, from the site. Due to the distance of these AQMAs from the site, it is not likely that they would be affected by the emissions from the Breedon Site. The AQMAs are also declared for exceedances of the NO_2 objective, whilst the focus of this updated assessment is on the impacts of sulphur dioxide emissions from the site.

4 Sensitivity Analysis and Uncertainty

Wherever possible, this assessment has used worst-case scenarios, which will exaggerate the impact of the emissions on the surrounding area, including emissions, operational profile, ambient concentrations, meteorology and surface roughness. This assessment has considered the years predicting the highest ground-level concentrations at the nearest sensitive receptor for comparison with the relevant AQAL.

Sensitivity analysis has been undertaken to investigate the results of the model with respect to changes in buildings and meteorological years.

4.1.1 Buildings

For the assessment undertaken by Bureau Veritas in 2017[1], building downwash effects were taken into account with a set of "grouped" buildings in the dispersion model. The single "grouped" building input into the model utilised the height of the tallest of these buildings (as indicated on site plans) in order to ensure a conservative approach, allowing for smaller buildings and the complex configuration of other structures on site (which cannot be included individually into the model set-up) to be incorporated within its perimeter.

Recent feedback from the EA's AQMAU raised concerns about the appropriateness of the building input:

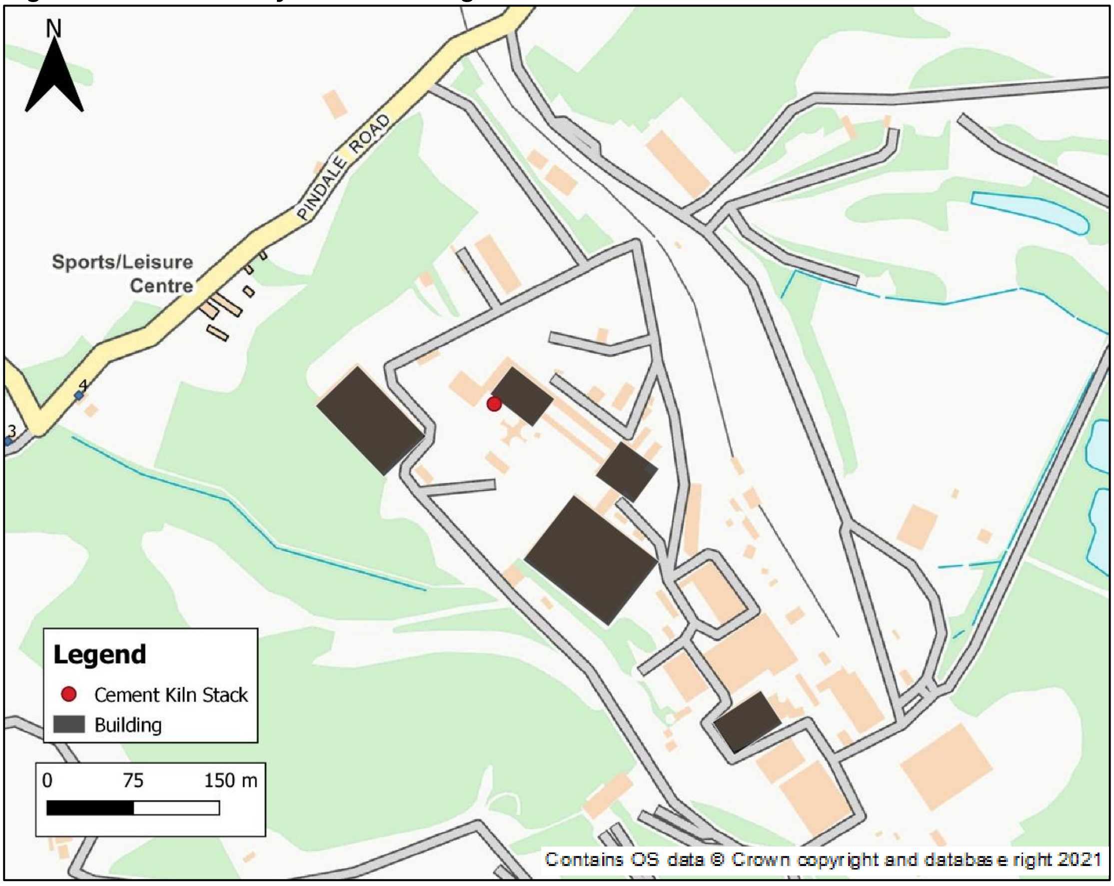
> *"The consultant has not appropriately modelled the effect of buildings on the dispersion of stack emissions. The consultant has included a single building within their modelling which is representative of a set of 'grouped' buildings in the vicinity of the cement kilns stack. Their single building is somewhat larger than in reality. Sensitivity has been considered with and without buildings and more representative buildings to evaluate the influence of building downwash effects on predictions".*

As a result, sensitivity analysis has been undertaken to investigate the impact on the modelled results with:

1. The single "grouped" building, as included in the 2017 assessment; and
2. A revised "grouped" building that excludes the stack, plus inclusion of all dominant buildings for which data was available from the site plan.

The buildings included in the sensitivity test are demonstrated in Figure 4.1 below.

Figure 4.1 – Sensitivity Test: Buildings



Results for the annual and 1-hour mean periods have been normalised by the value obtained from the parameter resulting in the highest ground level process contribution at any modelled receptor location and are presented in Table 4.1.

Table 4.1 – Building Sensitivity Analysis

Building Scenario	Normalised Maximum Ground Level Concentration	
	Annual Mean	1-Hour Mean
1	1.00	1.00
2	0.75	1.00

From the above predicted ground level concentrations, it can be seen that revision of the main "grouped" building and inclusion of additional buildings in the model results in less conservative concentrations for the long-term averaging period, and a negligible difference for the short-term averaging period. The model used in this updated assessment therefore included only the original size "grouped" pre-heater building, in order to represent the more conservative scenario and remain consistent with the 2017 assessment[1].

4.1.2 Meteorological Year

Results in this assessment are presented for the meteorological year resulting in the highest concentrations at any receptor location, as a worst-case assumption. The worst-case meteorological year was determined separately for long and short term concentrations at the worst-case receptor location for each pollutant, thus the worst-case data has been reported within Section 5.

For information, a table showing the inter-year variability of met conditions at the worst-case receptor is provided below. The results have been normalised against the maximum value. At the worst-case receptor, it demonstrates that 2018 and 2016 provide the worst-case conditions for the annual and 1-hour means, respectively. However, this can vary by receptor, hence the consideration of the worst-case meteorological year by receptor, as described above.

Table 4.2 – Inter-Year Variability in Concentration (Normalised)

Receptor	Annual Mean					1-hour Mean				
	2016	2017	2018	2019	2020	2016	2017	2018	2019	2020
H/11	0.42	0.49	1.00	0.46	0.73	1.00	0.95	0.96	0.91	0.94

4.1.3 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.

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 UK Legislation

5.1.1 The Air Quality Standards Regulations 2010

The Air Quality Standards Regulations 2010 (the 'Regulations') came into force on the 11th June 2010 and transpose EU 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."*

5.1.2 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 exceedances, 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.

5.1.3 The Environment Act 2021

The Environment Act 2021 came into force on 9th November 2021, with Part 4 of the Act (and associated Schedules 11 and 12) reserved for matters pertaining to air quality.

The Environment Act 2021 includes amendments to Environment Act 1995 (further detail in Section 4.2) the Clean Air Act 1993 to give Local Authorities more power. It also requires the Secretary of State to set at least one long-term target in relation to air quality and, in addition, a short-term legally binding target to reduce PM2.5.

5.2 Local Air Quality Management

Part IV of the Environment Act 1995 requires that Local Authorities periodically review air quality within their individual areas. As previously discussed, this Act has now been amended and supplemented by the Environment Act 2021 Schedule 11. Defra have said: "Responsibility for tackling local air pollution will now be shared with designated relevant public authorities, all tiers of local government and neighbouring authorities."

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.

5.3 Environmental Permitting Regulations (EPR)

The Environmental Permitting Regulations (England and Wales)[7], which came into force on 6 April 2010 (replacing the 2007 Regulations), was amended in 2017 to include the Medium Combustion Plant Directive (MCPD). The MCPD forms part of the European Union's Clean Air Policy Package (2013) for medium sized combustion plants with emissions of between 1 and 50 MW_{th} input. Through regulating emissions of SO_2, NO_x and dust into the air, the MCPD aims to reduce air pollution and lessen the risks to human health and the environment that they may cause.

The EPR provides a single regulatory framework transposing EU Directives (Industrial Emissions Directive and Medium Combustion Plant Directive) into UK legislation, by defining the permitting and compliance system for industry and regulators.

5.4 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.

5.4.1 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 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.

5.4.2 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

[7] The Environmental Permitting Regulations (England and Wales) 2010, Statutory Instrument No 675, The Stationary Office Limited

equivalent to the AQS and AQOs set in force by the Air Quality Strategy for England, Scotland Wales and Northern Ireland.

5.5 Criteria Appropriate to the Assessment

Table 5.1 sets out those AQS and AQOs (referred to in this report as Air Quality Assessment Levels (AQALs)) that are relevant to this assessment with regard to human receptors.

Table 5.1 –Air Quality Assessment Levels

Pollutant	AQALs	Averaging Period	Value (µg/m³)
Sulphur Dioxide (SO_2)	AQS	1-hour mean, not to be exceeded more than 24 times a year (equivalent to 99.73 percentile)	350
	AQS	24-hour mean, not to be exceeded more than 3 times a year (equivalent to 99.18 percentile)	125
	AQO	15-min mean, not to be exceeded more than 35 times a year (equivalent to 99.9 percentile)	266

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

A summary of the relevant EALs (also known as AQALs) that apply to the emissions from the plant and their impact on ecological receptors are given in Table 5.2.

Table 5.2 – Summary of Relevant Air Quality Assessment Levels for Ecological Receptors

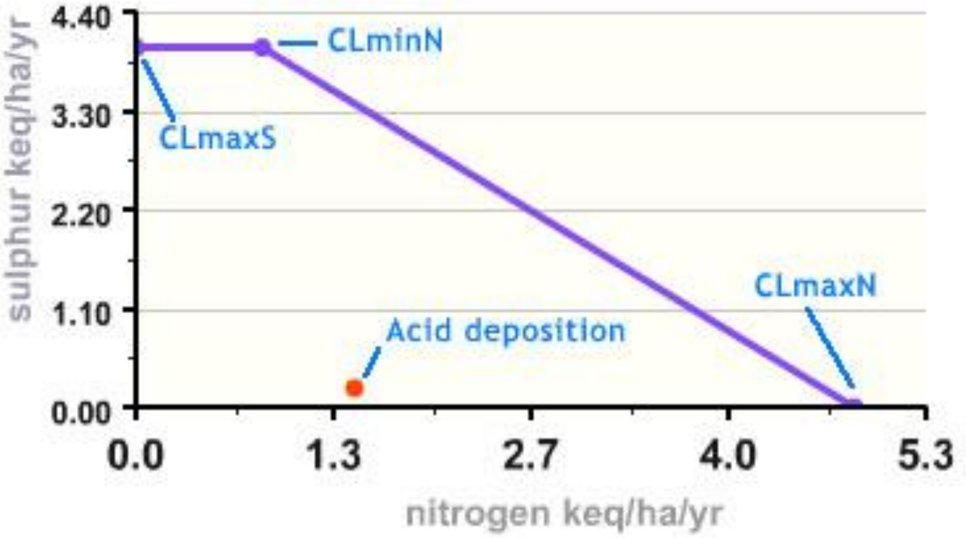
Pollutant	AQAL	Averaging Period	Value (µg/m³)
Sulphur Dioxide (SO_2)	Environmental Assessment Level (EAL)	Annual mean	10 (Sensitive lichen communities & bryophytes and ecosystems where lichens & bryophytes are an important part of the ecosystem's integrity)
			20 (All other vegetation)

The APIS website provides information relating specifically to acid deposition using three critical load parameters:

- $CL_{max}S$: the maximum critical load of sulphur, above which sulphur alone would be considered to cause an exceedance;
- $CL_{min}N$: a measure of the ability of the habitat/ecosystem to 'consume' deposited nitrogen; and
- $CL_{max}N$: the maximum critical load of nitrogen, above which nitrogen alone would be considered to cause an exceedance.

These three parameters define the critical load function, as illustrated in Figure 5.1. The region under the three-node line represents results where critical loads are not exceeded, whereas combinations of deposition above this line would be considered an exceedance

Figure 5.1 - Critical Load Function (sourced from APIS)



Source: http://www.apis.ac.uk/clf-guidance

6 Dispersion Modelling Results

This section sets out the results of the dispersion modelling and compares predicted ground level sulphur dioxide concentrations to AQALs. 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 AQAL.

Ground level concentrations based on the average (Scenario 1) and ELV (Scenario 2) emission rates of SO_2, as described in Section 2, have been modelled. Results are presented for the meteorological year resulting in the highest concentrations at any receptor location, as a worst-case assumption, as detailed in Section 4. The worst-case meteorological year was determined separately for long and short-term concentrations at the worst-case receptor location for each pollutant, thus the worst-case data has been reported within the sections below.

Pollutant concentration isopleths for Scenario 2 results are also provided in Appendix A.

6.1 Human Receptors

Table 6.1 details the annual mean predicted impacts of SO_2 on human receptors assuming the two emission rates assessed.

Table 6.1 – SO_2 Impacts at Human Receptors – 1-Hour Mean AQAL

ID	EAL (µg/m^3)	99.73rd Percentile 1-Hour Mean (µg/m^3)							
		Scenario 1				Scenario 2			
		PC	PEC	%PC of EAL	% PEC of EAL	PC	PEC	%PC of EAL	% PEC of EAL
1	350	49.9	69.9	14.2	20.0	76.4	96.5	21.8	27.6
2	350	49.7	70.9	14.2	20.3	76.2	97.4	21.8	27.8
3	350	27.6	47.6	7.9	13.6	42.3	62.3	12.1	17.8
4	350	8.8	28.8	2.5	8.2	13.4	33.4	3.8	9.6
5	350	53.6	73.7	15.3	21.1	82.2	102.3	23.5	29.2
6	350	50.6	70.6	14.4	20.2	77.5	97.6	22.1	27.9
7	350	41.8	64.3	11.9	18.4	64.1	86.6	18.3	24.7
8	350	44.0	66.5	12.6	19.0	67.4	89.9	19.3	25.7
9	350	48.4	70.9	13.8	20.3	74.2	96.7	21.2	27.6
10	350	51.1	73.2	14.6	20.9	78.3	100.4	22.4	28.7
11	350	55.6	77.7	15.9	22.2	85.2	107.3	24.3	30.7
12	350	43.1	64.3	12.3	18.4	66.1	87.3	18.9	24.9
13	350	43.8	65.0	12.5	18.6	67.1	88.3	19.2	25.2
14	350	52.1	72.5	14.9	20.7	79.9	100.3	22.8	28.7
15	350	52.8	73.2	15.1	20.9	80.9	101.3	23.1	28.9
16	350	45.4	65.7	13.0	18.8	69.7	89.9	19.9	25.7
17	350	41.1	61.4	11.8	17.5	63.1	83.3	18.0	23.8
18	350	45.0	65.2	12.9	18.6	69.0	89.2	19.7	25.5
19	350	29.1	51.2	8.3	14.6	44.6	66.6	12.7	19.0
20	350	38.5	61.3	11.0	17.5	59.0	81.8	16.9	23.4
21	350	32.4	54.4	9.3	15.6	49.6	71.7	14.2	20.5
22	350	25.8	47.7	7.4	13.6	39.6	61.4	11.3	17.6
23	350	25.0	46.8	7.1	13.4	38.3	60.1	10.9	17.2
24	350	19.3	41.1	5.5	11.7	29.6	51.4	8.5	14.7
25	350	24.0	46.2	6.9	13.2	36.8	59.0	10.5	16.9
26	350	23.1	45.3	6.6	13.0	35.4	57.7	10.1	16.5
27	350	38.6	61.3	11.0	17.5	59.1	81.9	16.9	23.4
28	350	21.1	40.6	6.0	11.6	32.3	51.8	9.2	14.8

ID	EAL (µg/m^3)	99.73rd Percentile 1-Hour Mean (µg/m^3)							
		Scenario 1				Scenario 2			
		PC	PEC	%PC of EAL	% PEC of EAL	PC	PEC	%PC of EAL	% PEC of EAL
29	350	29.5	49.7	8.4	14.2	45.2	65.4	12.9	18.7
30	350	19.4	38.7	5.5	11.1	29.7	49.0	8.5	14.0
31	350	17.2	36.9	4.9	10.5	26.3	46.1	7.5	13.2
32	350	23.6	43.4	6.7	12.4	36.2	56.0	10.3	16.0
33	350	34.5	54.5	9.9	15.6	52.9	72.9	15.1	20.8
34	350	19.1	39.3	5.4	11.2	29.2	49.5	8.4	14.1
35	350	17.7	37.9	5.1	10.8	27.2	47.3	7.8	13.5
36	350	17.9	38.1	5.1	10.9	27.4	47.7	7.8	13.6
37	350	34.7	54.8	9.9	15.6	53.2	73.3	15.2	20.9
38	350	18.9	39.0	5.4	11.1	29.0	49.0	8.3	14.0
39	350	18.0	39.9	5.2	11.4	27.7	49.5	7.9	14.2
40	350	17.2	38.9	4.9	11.1	26.3	48.1	7.5	13.7
41	350	19.8	40.0	5.6	11.4	30.3	50.5	8.7	14.4
42	350	11.5	32.0	3.3	9.1	17.7	38.1	5.0	10.9
43	350	19.0	39.1	5.4	11.2	29.1	49.2	8.3	14.1
44	350	21.4	41.5	6.1	11.8	32.8	52.8	9.4	15.1
45	350	25.4	44.7	7.3	12.8	38.9	58.2	11.1	16.6
46	350	14.7	34.0	4.2	9.7	22.6	41.9	6.5	12.0
47	350	16.9	36.1	4.8	10.3	26.0	45.1	7.4	12.9
48	350	16.1	38.3	4.6	10.9	24.7	46.9	7.1	13.4
49	350	15.2	34.4	4.4	9.8	23.4	42.5	6.7	12.1
50	350	19.7	39.9	5.6	11.4	30.1	50.4	8.6	14.4
51	350	24.1	44.1	6.9	12.6	37.0	57.0	10.6	16.3
52	350	17.9	37.3	5.1	10.7	27.4	46.8	7.8	13.4
53	350	16.7	36.7	4.8	10.5	25.6	45.6	7.3	13.0
54	350	22.9	42.1	6.5	12.0	35.1	54.3	10.0	15.5
55	350	20.1	39.3	5.7	11.2	30.7	49.9	8.8	14.3
56	350	15.8	35.9	4.5	10.2	24.3	44.3	6.9	12.7
57	350	16.5	37.2	4.7	10.6	25.3	46.0	7.2	13.1
58	350	16.3	36.9	4.7	10.5	25.0	45.6	7.1	13.0
59	350	23.3	43.1	6.7	12.3	35.7	55.5	10.2	15.9
60	350	22.9	42.5	6.6	12.1	35.2	54.7	10.0	15.6

EAL = Environmental Assessment Level
ELV = Emission Limit Value
PC = Process Contribution (modelled)
PEC = Predicted Environmental Concentration (PC + background)

Table 6.1 indicates that the 1-hour mean PECs of SO_2 are below the respective assessment metric at all applicable human receptors assuming both modelled scenarios. The highest predicted SO_2 1-hour PEC was at receptor 11, approximately 1.5 km ESE (East-Southeast) from the stack, along Stretfield Road in Brough. Based on the Scenario 2 emission rate, the predicted concentration was 30.7% of the 1-hour mean AQAL of 350 µg/m^3. The direct contribution from the kilns exhaust stack (PC) at this receptor was 85.2 µg/m^3.

Table 6.2 – SO_2 Impacts at Human Receptors – 24-Hour Mean AQAL

ID	EAL ($\mu g/m^3$)	99.18th Percentile 24-Hour Mean ($\mu g/m^3$)							
		Scenario 1				Scenario 2			
		PC	PEC	%PC of EAL	% PEC of EAL	PC	PEC	%PC of EAL	% PEC of EAL
1	125	21.8	41.9	17.4	33.5	33.4	53.5	26.7	42.8
2	125	27.1	48.3	21.7	38.7	41.6	62.8	33.3	50.2
3	125	10.8	30.8	8.7	24.7	16.6	36.6	13.3	29.3
4	125	3.7	23.7	3.0	19.0	5.7	25.7	4.6	20.6
5	125	16.8	36.9	13.5	29.5	25.8	45.9	20.6	36.7
6	125	20.8	40.9	16.7	32.7	31.9	52.0	25.5	41.6
7	125	24.1	46.6	19.3	37.3	37.0	59.5	29.6	47.6
8	125	24.1	46.6	19.3	37.3	36.9	59.5	29.5	47.6
9	125	32.9	55.4	26.3	44.3	50.4	72.9	40.3	58.3
10	125	30.0	52.1	24.0	41.7	46.0	68.1	36.8	54.5
11	125	33.6	55.7	26.9	44.6	51.5	73.6	41.2	58.9
12	125	16.6	37.8	13.2	30.2	25.4	46.6	20.3	37.3
13	125	17.5	38.7	14.0	30.9	26.8	48.0	21.4	38.4
14	125	18.2	38.6	14.6	30.9	27.9	48.3	22.3	38.6
15	125	19.7	40.1	15.8	32.1	30.2	50.6	24.2	40.5
16	125	30.7	50.9	24.6	40.8	47.1	67.3	37.7	53.9
17	125	14.8	35.0	11.8	28.0	22.6	42.9	18.1	34.3
18	125	15.3	35.5	12.2	28.4	23.4	43.7	18.7	34.9
19	125	11.1	33.2	8.9	26.6	17.0	39.1	13.6	31.3
20	125	24.7	47.4	19.7	37.9	37.8	60.6	30.2	48.4
21	125	14.9	37.0	12.0	29.6	22.9	44.9	18.3	36.0
22	125	15.1	36.9	12.1	29.6	23.2	45.0	18.5	36.0
23	125	12.4	34.2	9.9	27.4	19.0	40.8	15.2	32.7
24	125	8.8	30.5	7.0	24.4	13.5	35.2	10.8	28.2
25	125	10.1	32.3	8.1	25.8	15.4	37.7	12.3	30.1
26	125	9.7	32.0	7.8	25.6	14.9	37.1	11.9	29.7
27	125	22.0	44.8	17.6	35.8	33.7	56.5	27.0	45.2
28	125	9.4	28.9	7.5	23.1	14.4	33.9	11.5	27.1
29	125	11.7	31.9	9.4	25.6	17.9	38.2	14.4	30.6
30	125	7.2	26.5	5.7	21.2	11.0	30.3	8.8	24.3
31	125	6.0	25.7	4.8	20.5	9.1	28.9	7.3	23.1
32	125	8.1	27.9	6.5	22.3	12.4	32.2	9.9	25.8
33	125	11.1	31.1	8.8	24.8	17.0	37.0	13.6	29.6
34	125	6.0	26.2	4.8	21.0	9.2	29.4	7.3	23.5
35	125	6.2	26.3	4.9	21.0	9.4	29.6	7.6	23.7
36	125	6.5	26.7	5.2	21.4	9.9	30.2	7.9	24.1
37	125	14.7	34.7	11.8	27.8	22.5	42.6	18.0	34.1
38	125	7.2	27.2	5.8	21.8	11.0	31.1	8.8	24.9
39	125	6.0	27.9	4.8	22.3	9.2	31.1	7.4	24.9
40	125	6.9	28.6	5.5	22.9	10.5	32.3	8.4	25.8
41	125	6.1	26.3	4.8	21.0	9.3	29.5	7.4	23.6
42	125	3.2	23.7	2.6	18.9	5.0	25.4	4.0	20.3
43	125	5.4	25.5	4.3	20.4	8.3	28.4	6.7	22.7
44	125	6.4	26.5	5.2	21.2	9.9	30.0	7.9	24.0
45	125	6.8	26.1	5.5	20.9	10.4	29.7	8.4	23.8
46	125	5.4	24.6	4.3	19.7	8.2	27.5	6.6	22.0
47	125	5.9	25.1	4.8	20.0	9.1	28.2	7.3	22.6

ID	EAL (µg/m³)	99.18th Percentile 24-Hour Mean (µg/m³)							
		Scenario 1				Scenario 2			
		PC	PEC	%PC of EAL	% PEC of EAL	PC	PEC	%PC of EAL	% PEC of EAL
48	125	5.1	27.2	4.0	21.8	7.8	29.9	6.2	23.9
49	125	3.9	23.0	3.1	18.4	6.0	25.1	4.8	20.1
50	125	5.8	26.1	4.7	20.9	8.9	29.2	7.2	23.3
51	125	6.4	26.4	5.1	21.1	9.8	29.8	7.8	23.8
52	125	5.1	24.5	4.1	19.6	7.8	27.2	6.3	21.8
53	125	4.3	24.4	3.5	19.5	6.6	26.7	5.3	21.3
54	125	7.2	26.4	5.8	21.1	11.0	30.2	8.8	24.2
55	125	4.6	23.8	3.7	19.1	7.1	26.3	5.7	21.1
56	125	4.4	24.4	3.5	19.5	6.7	26.7	5.3	21.4
57	125	4.4	25.1	3.5	20.1	6.8	27.5	5.4	22.0
58	125	3.7	24.4	3.0	19.5	5.7	26.3	4.6	21.1
59	125	5.8	25.6	4.6	20.5	8.9	28.7	7.1	23.0
60	125	5.8	25.3	4.6	20.2	8.8	28.4	7.1	22.7

EAL = Environmental Assessment Level
ELV = Emission Limit Value
PC = Process Contribution (modelled)
PEC = Predicted Environmental Concentration (PC + background)

Table 6.2 indicates that the 24-hour PECs of SO_2 are below the respective assessment metric at all applicable human receptors assuming both modelled scenarios. The highest predicted SO_2 24-hour PEC was again at receptor 11. Based on the Scenario 2 emission rate, the predicted concentration was 58.9% of the 24-hour EAL of 125 µg/m³. The direct contribution from the kilns exhaust stack (PC) at this receptor was 51.5 µg/m³.

Table 6.3 - SO_2 Impacts at Human Receptors – 15-Minute Mean AQAL

ID	EAL (µg/m³)	99.9th Percentile 15-Minute Mean (µg/m³)							
		Scenario 1				Scenario 2			
		PC	PEC	%PC of EAL	% PEC of EAL	PC	PEC	%PC of EAL	% PEC of EAL
1	266	56.2	76.2	21.1	28.7	86.1	106.2	32.4	39.9
2	266	58.9	80.1	22.2	30.1	90.3	111.5	34.0	41.9
3	266	41.8	61.8	15.7	23.2	64.1	84.1	24.1	31.6
4	266	24.0	44.0	9.0	16.6	36.8	56.8	13.8	21.4
5	266	62.3	82.4	23.4	31.0	95.6	115.6	35.9	43.5
6	266	58.6	78.7	22.0	29.6	89.8	109.9	33.8	41.3
7	266	46.9	69.4	17.6	26.1	71.8	94.4	27.0	35.5
8	266	49.1	71.6	18.5	26.9	75.2	97.8	28.3	36.7
9	266	55.3	77.8	20.8	29.2	84.7	107.3	31.9	40.3
10	266	59.0	81.1	22.2	30.5	90.4	112.5	34.0	42.3
11	266	61.1	83.2	23.0	31.3	93.7	115.8	35.2	43.5
12	266	50.4	71.6	18.9	26.9	77.3	98.5	29.0	37.0
13	266	50.3	71.5	18.9	26.9	77.1	98.3	29.0	37.0
14	266	66.2	86.6	24.9	32.5	101.4	121.8	38.1	45.8
15	266	63.0	83.4	23.7	31.3	96.5	116.9	36.3	44.0
16	266	53.8	74.1	20.2	27.8	82.5	102.7	31.0	38.6
17	266	52.2	72.5	19.6	27.3	80.1	100.3	30.1	37.7
18	266	53.2	73.4	20.0	27.6	81.5	101.7	30.6	38.2
19	266	35.1	57.2	13.2	21.5	53.8	75.9	20.2	28.5
20	266	47.6	70.3	17.9	26.4	72.9	95.7	27.4	36.0
21	266	40.5	62.6	15.2	23.5	62.1	84.2	23.4	31.6

ID	EAL (µg/m³)	99.9th Percentile 15-Minute Mean (µg/m³)							
		Scenario 1				Scenario 2			
		PC	PEC	%PC of EAL	% PEC of EAL	PC	PEC	%PC of EAL	% PEC of EAL
22	266	33.2	55.0	12.5	20.7	50.9	72.7	19.1	27.3
23	266	34.5	56.4	13.0	21.2	52.9	74.7	19.9	28.1
24	266	29.8	51.5	11.2	19.4	45.6	67.4	17.1	25.3
25	266	41.6	63.8	15.6	24.0	63.8	86.0	24.0	32.3
26	266	35.3	57.6	13.3	21.6	54.2	76.4	20.4	28.7
27	266	44.1	66.9	16.6	25.1	67.6	90.4	25.4	34.0
28	266	40.0	59.5	15.0	22.4	61.3	80.8	23.0	30.4
29	266	36.1	56.4	13.6	21.2	55.4	75.6	20.8	28.4
30	266	36.7	56.1	13.8	21.1	56.3	75.6	21.2	28.4
31	266	26.2	45.9	9.9	17.3	40.2	59.9	15.1	22.5
32	266	39.6	59.4	14.9	22.3	60.7	80.5	22.8	30.3
33	266	60.0	80.0	22.5	30.1	91.9	111.9	34.6	42.1
34	266	28.5	48.7	10.7	18.3	43.6	63.9	16.4	24.0
35	266	32.0	52.1	12.0	19.6	49.0	69.2	18.4	26.0
36	266	26.7	47.0	10.0	17.7	40.9	61.2	15.4	23.0
37	266	43.6	63.6	16.4	23.9	66.8	86.8	25.1	32.6
38	266	26.1	46.2	9.8	17.4	40.0	60.1	15.1	22.6
39	266	29.4	51.3	11.0	19.3	45.1	66.9	16.9	25.2
40	266	31.3	53.0	11.8	19.9	47.9	69.7	18.0	26.2
41	266	31.5	51.7	11.8	19.4	48.2	68.5	18.1	25.7
42	266	21.4	41.9	8.1	15.7	32.8	53.3	12.3	20.0
43	266	32.0	52.1	12.0	19.6	49.1	69.2	18.5	26.0
44	266	35.4	55.5	13.3	20.9	54.3	74.3	20.4	27.9
45	266	55.7	74.9	20.9	28.2	85.3	104.6	32.1	39.3
46	266	33.9	53.2	12.8	20.0	52.0	71.3	19.6	26.8
47	266	34.5	53.6	13.0	20.2	52.9	72.0	19.9	27.1
48	266	21.7	43.8	8.2	16.5	33.2	55.4	12.5	20.8
49	266	25.6	44.8	9.6	16.8	39.3	58.4	14.8	22.0
50	266	31.6	51.9	11.9	19.5	48.5	68.7	18.2	25.8
51	266	47.1	67.1	17.7	25.2	72.2	92.2	27.2	34.7
52	266	32.6	52.0	12.2	19.5	49.9	69.3	18.8	26.1
53	266	25.5	45.6	9.6	17.1	39.2	59.2	14.7	22.3
54	266	45.1	64.2	16.9	24.2	69.1	88.3	26.0	33.2
55	266	35.5	54.7	13.3	20.6	54.4	73.6	20.5	27.7
56	266	27.8	47.9	10.5	18.0	42.6	62.7	16.0	23.6
57	266	30.3	51.0	11.4	19.2	46.4	67.1	17.4	25.2
58	266	27.5	48.2	10.3	18.1	42.2	62.8	15.9	23.6
59	266	56.2	76.1	21.1	28.6	86.2	106.0	32.4	39.9
60	266	40.0	59.5	15.0	22.4	61.3	80.8	23.0	30.4

EAL = Environmental Assessment Level
ELV = Emission Limit Value
PC = Process Contribution (modelled)
PEC = Predicted Environmental Concentration (PC + background)

Table 6.3 indicates that the 15-minute PECs of SO_2 are below the respective assessment metric at all applicable human receptors assuming both modelled scenarios. The highest predicted SO_2 15-minute PEC was at receptor 14, approximately 1 km from the stack, along Creswellpart Lane in Bradwell. Based on the Scenario 2 emission rate, the predicted concentration was 45.8% of the 15-minute EAL of 266 µg/m³. The direct contribution from the kilns exhaust stack (PC) at this receptor was 101.4 µg/m³.

6.2 Ecological Receptors

6.2.1 Concentrations in Air

Table 6.4 details the results of the impact assessment for SO_2. Bradwell Dale & Bagshaw Cavern and Dirtlow Rake & Pindale SSSIs (Receptor IDs K and L) do not have any habitat interest features listed in the UK Air Pollution Information System (APIS) database and there are no Critical Loads available for these sites. Therefore, they have not been taken into account in this assessment.

Table 6.4 – SO_2 Impacts at Ecological Receptors

Receptor ID	AQAL (µg/m³)	Annual Mean (µg/m³)							
		Scenario 1				Scenario 2			
		PC	PEC	%PC of EAL	%PEC of EAL	PC	PEC	%PC of EAL	% PEC of EAL
A	20	1.1	6.5	5.3	32.7	1.6	7.1	8.1	35.5
B	20	0.9	6.3	4.5	31.4	1.4	6.8	6.9	33.8
C	10	0.6	5.5	5.9	54.5	0.9	5.8	9.1	57.7
D	10	0.3	5.3	2.6	52.8	0.4	5.4	3.9	54.1
E	10	0.2	5.1	2.2	50.8	0.3	5.2	3.3	51.9
F	10	0.5	5.7	5.1	57.5	0.8	6.0	7.8	60.2
G	10	0.7	5.7	7.3	57.3	1.1	6.1	11.2	61.2
H	10	1.5	6.5	15.1	65.5	2.3	7.3	23.1	73.5
I	10	0.8	5.9	8.2	58.8	1.3	6.3	12.6	63.2
J	20	0.8	6.3	3.8	31.4	1.2	6.7	5.8	33.4
M	20	0.3	5.3	1.5	26.6	0.5	5.5	2.3	27.4
N	20	2.3	7.8	11.4	38.9	3.5	9.0	17.4	44.9

EAL = Environmental Assessment Level
ELV = Emission Limit Value
PC = Process Contribution (modelled)
PEC = Predicted Environmental Concentration (PC + background)

Table 6.4 indicates that there are no exceedances of the relevant long-term AQAL at any of the assessed ecological sites. The PEC is greater than 70% of the AQAL at only Receptor H in Scenario 2. This site is approximately 1.6 km from the stack, in Castleton SSSI. Based on the Scenario 2 emission rate, the predicted concentration was 73.5% of the long-term EAL of 10 µg/m³. The direct contribution from the kilns exhaust stack (PC) at this receptor was 2.3 µg/m³ (23.1 %).

6.2.2 Acid Deposition Rates

Table 6.5 and Table 6.6 contain details of the nitrogen component of the acid deposition at ecological receptors. These have been updated based on the ammonia emission rate calculated in the recent assessment undertaken by Bureau Veritas on behalf of Breedon Cement[3], the nitrogen dioxide emission rate for the annual average daily emissions, and the sulphur dioxide emission rates for Scenarios 1 and 2 within this assessment.

Table 6.5 – Acid Deposition Rates at Ecological Receptors: Scenario 1

Receptor ID	S PC	N PC	S Background	N Background	S PEC	N PEC	PC (% of CL function)	Background (% of CL function)	PEC (% of CL function)	Impact
A	0.12	0.06	0.4	2.5	0.5	2.6	4.0	65.0	69.0	Not significant
B	0.11	0.05	0.4	2.5	0.5	2.6	3.4	65.0	68.4	Not significant
C	0.07	0.03	0.4	2.5	0.5	2.6	8.5	249.8	258.3	Further assessment required
D	0.03	0.01	0.4	2.5	0.5	2.5	3.7	249.8	253.5	Further assessment required
E	0.03	0.01	0.4	2.5	0.4	2.5	3.2	249.8	253.0	Further assessment required
F	0.06	0.03	0.4	2.6	0.4	2.6	1.8	61.0	62.9	Not significant
G	0.09	0.04	0.4	2.1	0.5	2.1	21.6	430.3	451.9	Further assessment required
H	0.18	0.08	0.4	2.1	0.6	2.2	44.7	430.3	475.0	Further assessment required
I	0.10	0.04	0.4	2.1	0.5	2.1	24.3	430.3	454.6	Further assessment required
J	0.09	0.05	0.4	1.8	0.5	1.9	5.7	92.2	97.9	Further assessment required
M	0.04	0.02	0.4	1.9	0.4	1.9	2.2	99.2	101.5	Further assessment required
N	0.27	0.12	0.4	1.8	0.7	1.9	16.2	92.2	108.4	Further assessment required

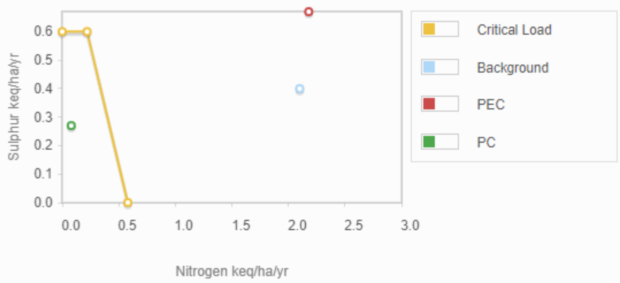
Table 6.6 – Acid Deposition Rates at Ecological Receptors: Scenario 2

Receptor ID	S PC	N PC	S Background	N Background	S PEC	N PEC	PC (% of CL function)	Background (% of CL function)	PEC (% of CL function)	Impact
A	0.19	0.06	0.4	2.5	0.6	2.6	5.4	65.0	70.4	Further assessment required
B	0.16	0.05	0.4	2.5	0.6	2.6	4.6	65.0	69.6	Not significant
C	0.11	0.03	0.4	2.5	0.5	2.6	11.7	249.8	261.5	Further assessment required
D	0.05	0.01	0.4	2.5	0.5	2.5	5.1	249.8	254.9	Further assessment required
E	0.04	0.01	0.4	2.5	0.5	2.5	4.3	249.8	254.1	Further assessment required
F	0.09	0.03	0.4	2.6	0.5	2.6	2.5	61.0	63.5	Not significant
G	0.13	0.04	0.4	2.1	0.5	2.1	29.6	430.3	459.9	Further assessment required
H	0.27	0.08	0.4	2.1	0.7	2.2	61.1	430.3	491.4	Further assessment required
I	0.15	0.04	0.4	2.1	0.5	2.1	33.2	430.3	463.5	Further assessment required
J	0.14	0.05	0.4	1.8	0.5	1.9	7.7	92.2	99.9	Further assessment required
M	0.05	0.02	0.4	1.9	0.4	1.9	3.1	99.2	102.3	Further assessment required
N	0.41	0.12	0.4	1.8	0.8	1.9	22.1	92.2	114.3	Further assessment required

Figure 6.1 - Critical Load Function Output for Worst-Case Receptor (Receptor H) assuming Scenario 2

Source	Exceedance (keq/ha/yr)	% of CL function*
Process Contribution (PC)	no exceedance of CL function	60.3
Background	1.92	431
Predicted Environmental Concentration (PEC)	2.27	491.4

* % of CL function is calculated after the value of PEC relative to CLminN is taken into account. See detailed explanation for further information and justification.



Whilst the acid deposition critical load function is exceeded at eight ecological receptors in both Scenarios, in these instances the background rate alone is extremely close to, or exceeds, even before the addition of the PC. However, despite the PC being relatively small in comparison to the background contribution, it is still above the 1% threshold at all receptors and is therefore unable to be considered insignificant.

7 Conclusions

Bureau Veritas has been commissioned by Breedon Cement Ltd to undertake a detailed operational dispersion modelling assessment of sulphur dioxide emissions to air from the two cement kilns at the Hope Cement Works site.

The Industrial Emissions Directive (IED) requires all installations to use the Best Available Techniques (BAT). Compliance with the BAT associated emission levels (BAT-AEL) is mandatory unless derogation from those BAT-AEL is justified. Breedon Cement are now seeking to apply for an extension to the site's existing derogation for emissions of SO_2. The current derogation is 695 mg/Nm^3 against a BAT-AEL of 400 mg/Nm^3.

In order to support the extension of the existing derogation for SO_2, this report has assessed two scenarios.

Considering operation at daily average running emissions (Scenario 1), and emissions at the ELV of 695 mg/Nm^3 (per kiln) (Scenario 2), the dispersion modelling has demonstrated that sulphur dioxide concentrations did not exceed the relevant AQALs at any of the human receptors assessed. Therefore, it is predicted that emissions from the plant would not cause significant impacts to the surrounding sensitive human receptors.

When considering concentrations in air at the assessed ecological receptors, no exceedances were predicted in either of the modelled scenarios. The predicted environmental concentration was greater than 70% of the long-term AQAL at one of the sites considered (73.5%) in Scenario 2. It should be noted that the PECs are based on the worst-case background concentrations, due to the use of Defra's 2001 background maps.

With regard to acid deposition, the results exceeded the critical load function at the majority of receptors in both Scenario 1 and Scenario 2. Whilst these exceedances are attributed to the background contributions, since the background levels already exceed the relevant critical loads prior to adding PC from the plant, the PC results cannot be considered insignificant.

Appendices

Appendix A:
Pollutant Concentration Isopleths

Figure A. 1 – 2016 1-Hour Mean SO_2 process contribution isopleth assuming Scenario 2 (µg/m^3)

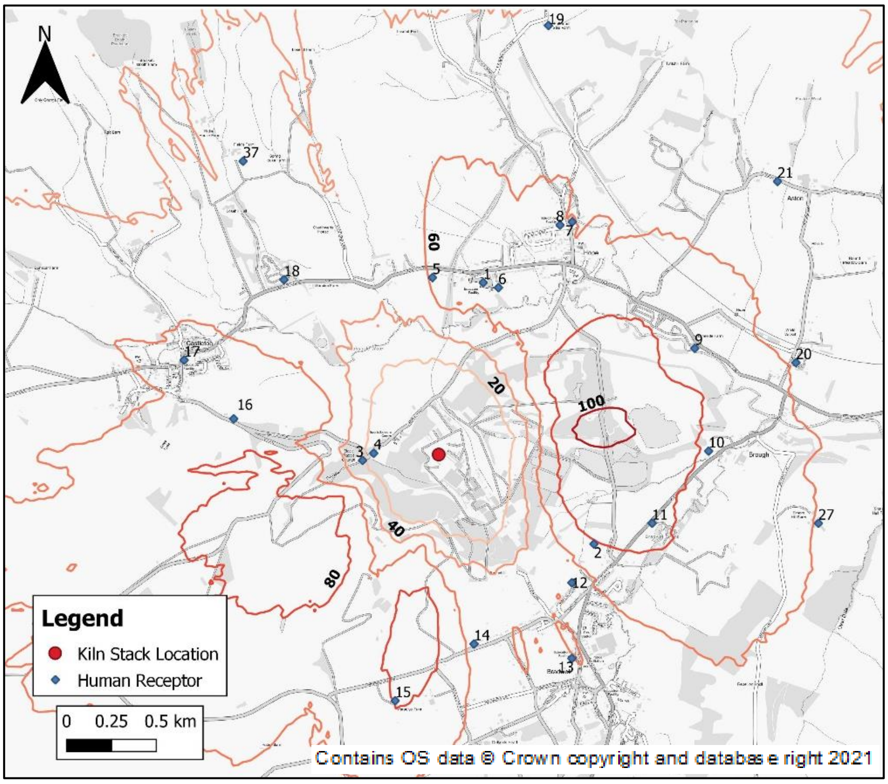


Figure A. 2 – 2017 24-Hour Mean SO_2 process contribution isopleth assuming Scenario 2 (µg/m^3)

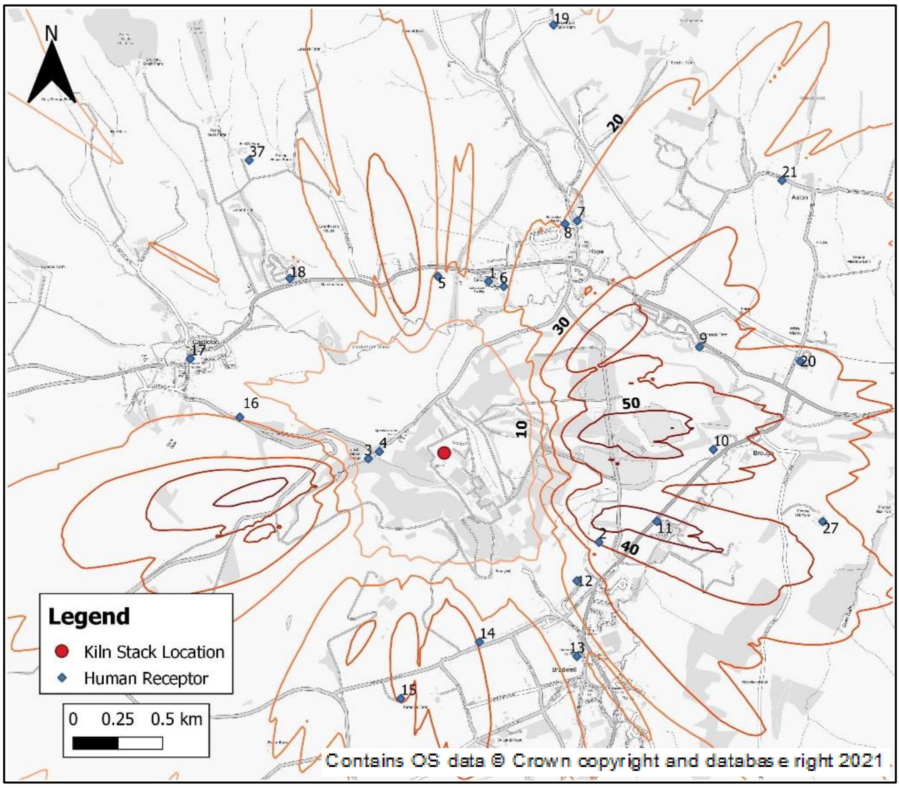


Figure A. 3 - 2017 15-Minute Mean SO_2 process contribution isopleth assuming Scenario 2 (µg/m^3)

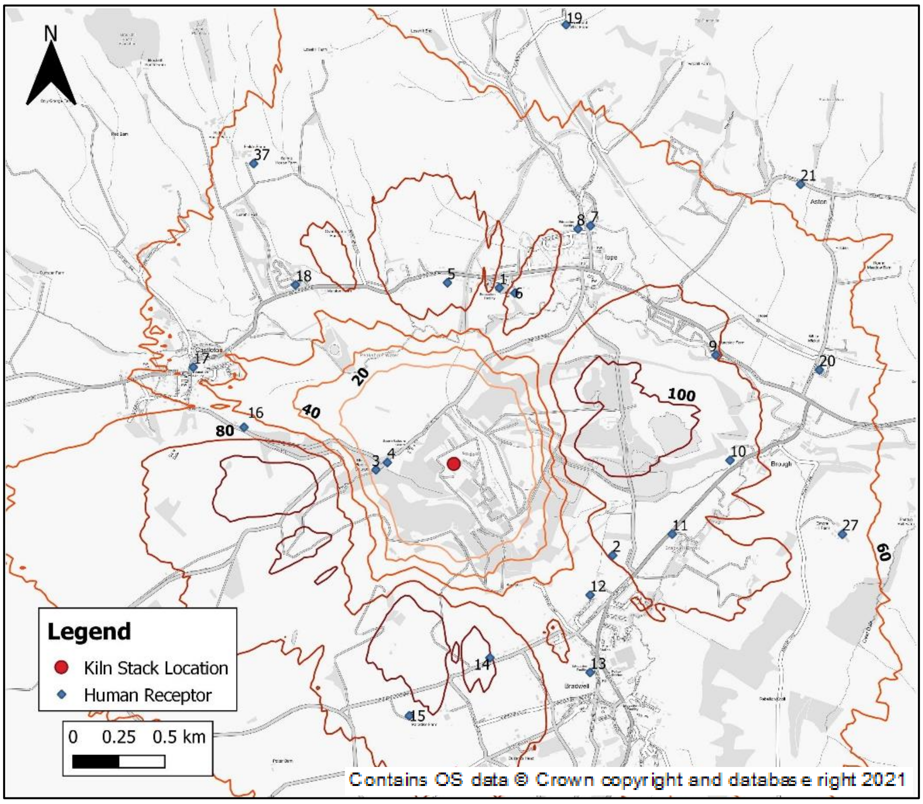


Figure A. 4 - 2018 Annual Mean SO_2 process contribution isopleth assuming Scenario 2 (µg/m^3)