Coal Products Limited

Immingham Briquetting Works – Environmental Permit Application

Appendix B – Air Quality Impact Assessment

December 2023

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1 Introduction

Bureau Veritas has been commissioned by Coal Products Ltd (CPL) to undertake a detailed air quality assessment to support an Environmental Permit (EP) variation application for operations at their Immingham Briquetting Works. The variation application includes the request to operate the pyrolysis plant to process sustainable biomasses into a bio-stable char.

The introduction of the pyrolysis plant will include an additional emission point to air. The requirement for an air quality assessment was prompted based on the following the completion of an H1 risk assessment, which indicated that dispersion modelling would be required in order to evaluate the potential air quality impacts arising from emissions of nitrogen oxides (NO_x (as NO_2)), sulphur dioxide (SO_2) and particulate matter (PM_{10} and $PM_{2.5}$) from emission points to air on the Site. This report presents the methodology, input parameters and results of the dispersion modelling undertaken as part of this assessment.

In addition to the modelling of emissions to air from the pyrolysis plant, CPL have provided additional information regarding the emissions of the current operations on site.

1.1 Process Description

CPL is one of Europe's largest producers of smokeless solid fuel briquettes for use in the domestic home heating market. The Immingham Briquetting Works is capable of producing over 300,000 tonnes of briquettes each year.

The production of briquettes involves the heat treatment of coal, including blending, drying and crushing of carbonaceous materials, which are then mixed with a binder and then roll pressed. Curing of the briquettes is carried out by mild heat.

The works also regenerates 'spent activated carbon' into 'regenerated activated carbon' by thermal treatment within an indirect fired rotary kiln. The previous permit variation was to convert the hydrothermal carboniser (HTC) plant from a pilot plant to fully operation. The HTC process uses a combination of heat and pressure to chemically transform organic material into a carbon dense product. This is similar to the natural process that produces coal, however, instead of taking millennia, this process is carried out in around six hours.

The primary purpose of this variation is the introduction of the pyrolysis plant. CPL along with Nottingham University have been successful in winning the DESNZ (Department of Energy Security and Net Zero) sponsored project under the Green Gas Support scheme to build and operate a Pyrolysis Plant to process sustainable biomass into a bio-stable char. The produced biochar has been demonstrated to be chemically stable over the long term when used as soil improver therefore sequestrating the carbon back into the environment.

The process of the pyrolysis plant is to charcoal sustainable biomasses by heating in an oxygen depleted atmosphere. The pyrolysis process will result in a stable char containing the majority of the fixed carbon from the input material. This carbon is fixed and when sowed back into the ground is recognized as a significant soil improver, increasing soil fertility significantly.

There are six existing emission points to air from the facility, including vents, bag filter exhausts and boilers. This assessment focusses on all emission points to air, including new emission points associated with the pyrolysis plant, in order to determine overall air quality impacts from the Site in support of the Environmental Permit variation application.

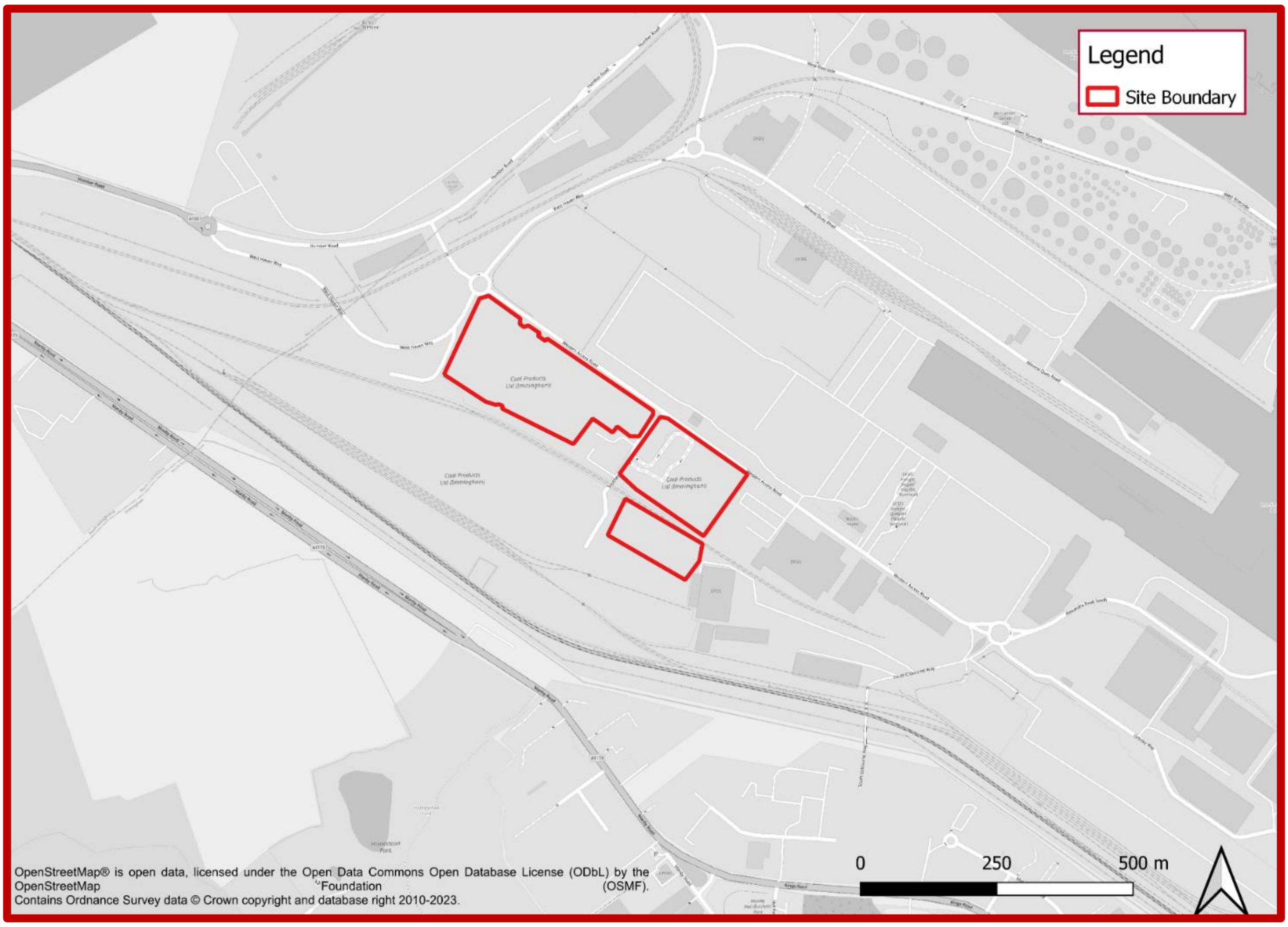
1.2 Site Description

The Site is located within the Immingham Dock, approximately 1.3 km north of the town of Immingham, Northeast Lincolnshire. The surrounding land use is primarily industrial, with the nearest sensitive receptors being residential properties in Immingham (approximately 670 m to the south) and the

Humber Estuary (approximately 1 km to the east), which is designated as a Site of Special Scientific Interest (SSSI), Special Area of Conservation (SAC) and Special Protection Area (SPA).

The Site location is shown in Figure 1.1.

Figure 1.1 – Site Location



2 Dispersion Modelling Methodology

ADMS 6.0 has been used for the dispersion modelling of process emissions from the Site. ADMS 6 is an advanced atmospheric dispersion model that has been developed and validated by Cambridge Environmental Research Consultants (CERC). 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 Environment Agency 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 is 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.

The previous Air Quality Assessments for the site have been undertaken using ADMS 5.2. ADMS 6 is considered to improve overall dispersion dynamics and is considered more representative of true conditions. There is around a +/- 5% change with ADMS 6 compared to ADMS 5.2.

2.1 Process Emissions

Details of the existing and new emission points to air to be assessed at the Site have been provided to Bureau Veritas by CPL. Appropriate emission rates and stack parameters for existing emission points A2 – A10 have been informed by stack emission testing results, from testing undertaken through 2020 as well as monitoring undertaken by CPL in 2022 for the previous permit variation[1]. A7 is currently listed within the permit but there is no requirement to provide monitoring data for this source, so there is no recent monitoring data available. Emission rates and stack parameters for the new emission points have been derived from manufacturer's information. This has been provided for emission points A2, A5 and A6.

The plant included within the assessment, defined as the Process Contribution (PC), are as follows:

- A1 (existing) – MHT 1.
- A2 (existing) – MHT 2.
- A4 (existing) – MHT 2 bag filter.
- A5 (existing) – Activated Carbon Regeneration Plant.
- A6 (existing) – Activated Carbon Regeneration Plant.

1 Application for a Variation to Environment Permit EPR/DP3134LK/V008, Bureau Veritas, 2022

- A7 (existing) – gas fired boiler (acid washing plant).
- A8 (included in existing permit but not regulated) – HTC plant scrubber.
- A9 (existing) – Impregnation drier exhaust (440 kW).
- A10 (existing) – Caustic Wash plant boiler (950 kW).
- A11 (new) – Pyrolysis Plant

Emission point A1 has been included in the modelling assessment, however, since there are currently no emissions associated with this source (nor has it run since Q4 2018) emissions from this point has not been included.

Emission Point A10 operates under two modes; high fire (3 hours per day) and low fire (remainder). As such, emissions from both operating modes have been taken into consideration into the modelling. For short-term means, such as 1-hour metrics, the high fire emissions have been assessed, however, for longer term means (24-hour and annual means) the weighted average conditions of the high fire and low fire modes have been used to derive the emission rates and exhaust parameters input to the model accordingly.

CPL have provided Bureau Veritas with the operating hours for each of the emission points which have been considered when determining the annual mean concentrations at sensitive receptors. These operating hours are based on information from all plant activities over the last 5 years and are considered representative of current operational hours.

The parameters, emissions rates and operating hours used within the assessment for each stack emission source are detailed in Table 2.1 and Table 2.2, with the locations of each of the emission points illustrated in Figure 2.6.

Table 2.1 – Model Input Parameters

Parameter	A1	A2	A4	A5	A6	A7	A8	A9	A10 (high fire)	A10 (combined low + high fire)	A11
Operating Hours (annual hours)	-	5464	8760	3639	6739	1500	4500	8760	-	400	6500
Stack Height (m)	29.8	38	9.2	18.5	18.5	7	0.45	0.3	4	4	15.0
Flue Diameter (m)	1.25	1.03	0.47	0.65	0.5	0.5	0.45	0.3	0.25	0.25	1.1
Flow Rate (Am^3/h)	-	26713	2412	3279	1332	706	5000	500	2100	508	41156
Efflux Temperature (°C)	-	195	65	107	120	200	30	300	234	205	409
Actual O_2 (%)	-	11.5	19.6	12	12	3.5	19	5	5	5	18
Moisture (%)	-	22.5	6.2	23	7	8	4	9.5	6.2	6.2	0

All input data provided by CPL. Reported at 273 K, 101.3 kPa, dry gas.

Table 2.2 – Model Pollutant Emission Rates

Parameter	A1	A2	A4	A5	A6	A7	A8	A9	A10 (high fire)	A10 (combined low + high fire)	A11
NO_x (mg/m^3)	-	136.0	-	126.5	31	475	414	0.12 (g/kWh)*	192	123	300
NO_x (g/s)	-	0.240	-	0.032	0.004	0.093	0.053	0.014	0.069	0.011	0.223
PM (mg/m^3)	-	57.2	20.0	1.5	24.0	-	176	-	-	-	40
PM** (g/s)	-	0.101	0.001	0.0004	0.003	-	0.022	-	-	-	0.030
SO_2 (mg/m^3)	-	19.9	-	1.0	19.0	-	14	-	2.62	2.62	50
SO_2 (g/s)	-	0.035	-	0.00024	0.002	-	0.002	-	0.0009	0.0002	0.0372

Reported at 273 K, 101.3 kPa, dry gas.
*Data from technical specification sheet reported in g/kWh.
**No data available on particle size analysis, so total particulate matter data used to assess against the relevant air quality limits for PM_{10} and $PM_{2.5}$.

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, including wind speed, wind direction, cloud cover and temperature. In addition to meteorological parameters effecting predicted concentrations, the year of meteorological data that is used for a modelling assessment can also have a significant effect on ground level concentrations.

Five complete years of meteorological data have been utilised within the modelling of pollutants to take the year-by-year variations within the dataset into account. This assessment has utilised meteorological data recorded at Humberside meteorological station across the period 2016 to 2020.

The Humberside station is located approximately 9.7 km to the east of the Site and is considered representative of the meteorological conditions experienced at the Site. The following figures illustrate the frequency of wind directions and wind speeds for the years considered.

Figure 2.1 – 2016 Humberside Wind Rose

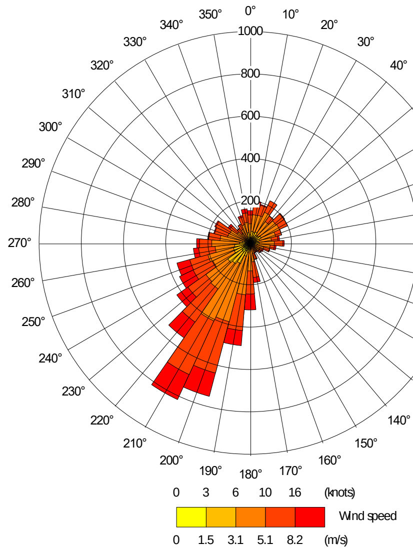


Figure 2.2 – 2017 Humberside Wind Rose

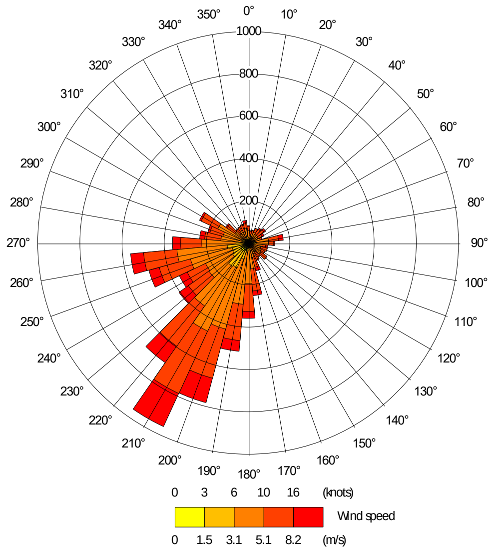


Figure 2.3 – 2018 Humberside Wind Rose

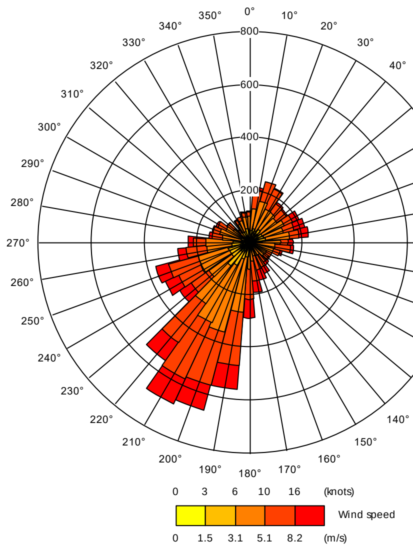


Figure 2.4 – 2019 Humberside Wind Rose

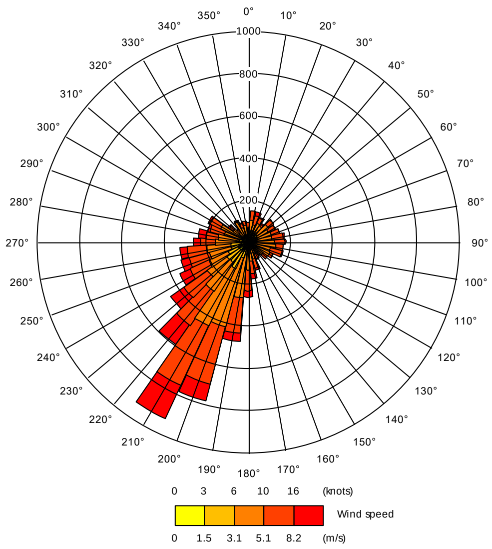


Figure 2.5 – 2020 Humberside Wind Rose

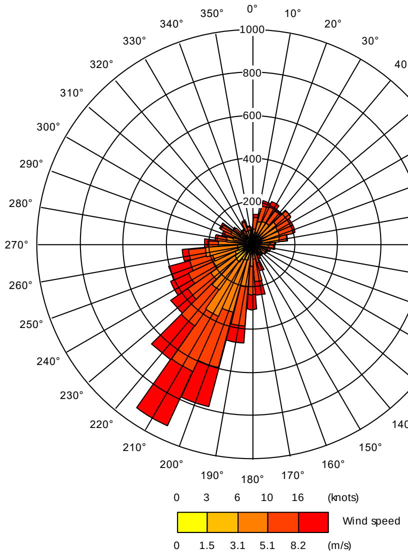
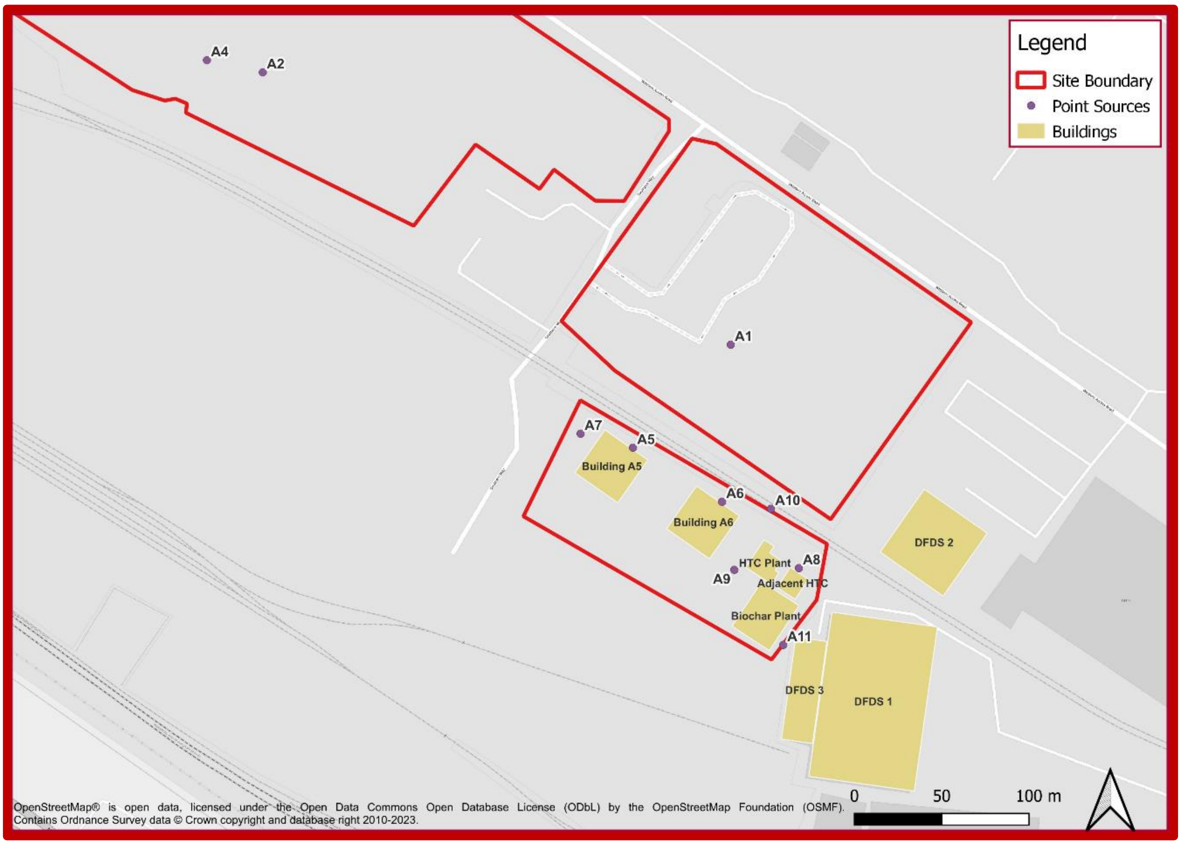


Figure 2.6 – Modelled Emission Points and Modelled Buildings Visualisation



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

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 as presented within 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;
- 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^{-1} K^{-1})

λ = Specific latent heat of vaporisation of water (kJ kg^{-1})

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 to a conclusion, 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 and satellite imagery, it can be seen that within the immediate vicinity of the site, land use is predominately industrial, with open land to the west and north. In addition, completing an examination of the location of the Humberside meteorological station the surrounding area is predominantly agricultural pasture. Consequently, a composite surface roughness length of 0.5 m was used in the model to account for the different surface roughness lengths within the model domain and a surface roughness length of 0.2 m around 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.

The inclusion of buildings within the model can lead to a 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. Details of the building included within the model are presented within Table 2.4, with the building's location presented within Figure 2.6.

Table 2.4 – Modelled Buildings

Name	Centre Easting (m)	Centre Northing (m)	Height (m)	Length / Diameter (m)	Width (m)	Angle (º)
Building A5	518478	416071	12	30	30	35
Building A6	518530	416039	12	30	30	35
HTC Plant	518561	416008	10	12	9	20
DFDS 1	518628	415937	12	95	61	8
DFDS 2	518662	416028	12	44	44	35
DFDS 3	518588	415943	12	59	18	8
Biochar Plant	518564	415985	12	30	25	20

2.5 Model Domain and Receptors

2.5.1 Model Domain

To assess the impact of atmospheric emissions from the site on local air quality, pollutant concentrations were output to a 2 km x 2 km Cartesian grid centred on the site, with an approximate receptor resolution of 10 m.

2.5.2 Human Receptors

The discrete receptors considered were chosen based on 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 2.6 of this report. Details of the locations of human receptors are presented in Table 2.5, and illustrated in Figure 2.7 below.

Table 2.5 – Assessed Human Receptors

ID	Receptor Description	Easting (m)	Northing (m)	Height (m)
R1	2 Pelham Road	519157	415282	1.5
R2	4 Pelham Road	518976	415252	1.5
R3	4 Manby Road	518789	415176	1.5

ID	Receptor Description	Easting (m)	Northing (m)	Height (m)
R4	42 Manby Road	518683	415314	1.5
R5	26 Manby Road	518755	415260	1.5
R6	36 Kings Road	519248	415165	1.5
R7	169 Woodlands Avenue	518558	415243	1.5
R8	89 Woodlands Avenue	518308	415137	1.5
R9	59 Woodlands Avenue	518205	415250	1.5
R10	12 Ash Tree Close	518426	415158	1.5
R11	39 Woodlands Avenue	518113	415330	1.5
R12	13 Woodlands Avenue	517994	415277	1.5
R13	8 Church Lane	517831	415260	1.5
R14	Westfield House, Church Lane	517688	415164	1.5
R15	5 Stansfield Gardens	517511	415154	1.5
R16	1 Church Lane	517863	415389	1.5
R17	Hazel Dene, Marsh Lane	517340	417306	1.5
R18	East End Farm	516361	415690	1.5
R19	Highfield House, Baptist Chapel Lane	515833	415718	1.5
R20	1 N Moss Lane	521286	413113	1.5
R21	Poplar Farm	521600	413015	1.5
R22	Elm Tree Farm	515232	416158	1.5
R23	Old Vicarage, Chase Hill Road	514435	418193	1.5
R24	Fairfield House, Brick Lane	514653	418803	1.5
R25	Warneford House, Brick Lane	514527	418681	1.5
R26	4 Church Lane	514756	417334	1.5
SCH1	Allerton Primary School	518026	414926	1.5
SCH2	Briggs Primary School	517391	414510	1.5
SCH3	Canon Peter Hall Ce Primary School	518618	414776	1.5
SCH4	Oasis Academy	518457	414656	1.5
SCH5	Eastfield County Junior & Infants School	518303	414066	1.5

2.5.3 Ecological Receptors

The Environment Agency's AER Guidance 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).

Following the above guidance, and request from the Environment Agency (EA) the following additional ecological receptors were considered in the assessment, shown in Table 2.6 and Figure 2.7

Two local wildlife sites were included as part of this addendum:

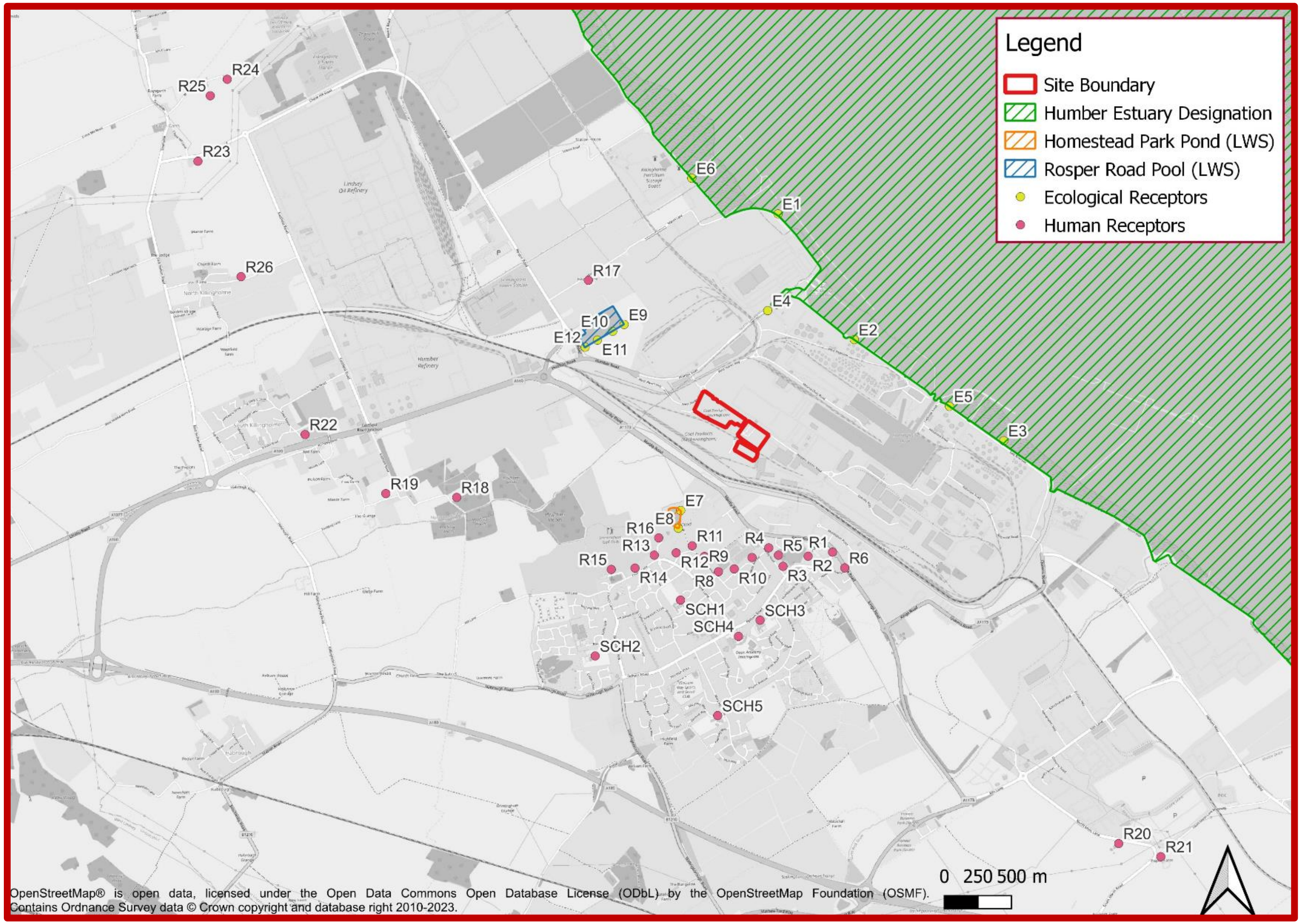
- **Homestead Park Pond** – This local wildlife site is mostly semi-improved grassland with some scatter scrub with standing water. For this assessment the habitat is defined as semi-improved grassland.

- **Rosper Road Pool** – Designated for birds of interest, however the ecological site for this assessment is based on the marshy grassland used by some species of bird.

Table 2.6 – Assessed Ecological Receptors

ID	Receptor Description	Easting (m)	Northing (m)	Height (m)
E1	Humber Estuary SSSI/SPA/SAC	518752	417801	0
E2	Humber Estuary SSSI/SPA/SAC	519319	416865	0
E3	Humber Estuary SSSI/SPA/SAC	520431	416112	0
E4	Humber Estuary SSSI/SPA/SAC	518675	417081	0
E5	Humber Estuary SSSI/SPA/SAC	520027	416368	0
E6	Humber Estuary SSSI/SPA/SAC	518110	418067	0
E7	Homestead Park Pond (LWS)	518028	415593	0
E8	Homestead Park Pond (LWS)	518010	415460	0
E9	Rosper Road Pool (LWS)	517606	416978	0
E10	Rosper Road Pool (LWS)	517521	416927	0
E11	Rosper Road Pool (LWS)	517408	416861	0
E12	Rosper Road Pool (LWS)	517317	416809	0

Figure 2.7 – Location of Modelled Receptors



2.6 Deposition

2.6.1 Nitrogen and Acid Deposition

The predominant route by which emissions will affect land in the vicinity of a process is by deposition of atmospheric emissions. Ecological receptors can potentially be sensitive to the deposition of pollutants, particularly nitrogen compounds, 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 m^{-2} s^{-1})

v_d = deposition velocity (m s^{-1})

$C(x, y, 0)$ = 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^{-1})

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[2] 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^{-1})	
	Short Vegetation	Long Vegetation/Forest
NO_x	0.0015	0.003
SO_2	0.012	0.024

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 Air Pollution Information System (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 (kg N ha^{-1} y^{-1}) and kilo equivalents deposited per hectare per year (keq ha^{-1} y^{-1}). To enable a direct comparison against the critical loads, the modelled total wet and dry deposition flux (µg m^{-2} s^{-1}) 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 (kg N ha^{-1} y^{-1})

K_2 = Conversion factor for m^2 to ha (= 1x104 m^2 ha^{-1})

K_3 = Conversion factor for µg to kg (= 1x109 µg kg^{-1})

t = Number of seconds in a year (= 3.1536x107 s y^{-1})

i = 1,2,3…….T

T = Total number of nitrogen containing compounds

F = Modelled deposition flux of nitrogen containing compound (µg m^{-2} s^{-1})

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

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/m2/s [of Pollutant] → kg/ha/yr [of Chemical Element]
NO_x (as NO_2)	Nitrogen (N)	95.9

Table 2.9 – Acidification Conversion Factors

Chemical Element	Conversion Factor µg/m2/s [of Pollutant] → keq/ha/yr [of Chemical Element]
Nitrogen (N)	6.84
Sulphur (S)	9.84

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 'long vegetation' deposition velocities (as detailed in Table 2.7) to the modelled annual mean concentrations of NO_x. Wet deposition has not been assessed 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	Background Nitrogen Deposition (kg N ha^{-1} y^{-1})	Background Acid N Deposition (keq ha^{-1} y^{-1})	Background Acid S Deposition (keq ha^{-1} y^{-1})
E1	28.9	2.11	0.47
E2	28.9	2.11	0.47
E3	28.9	2.11	0.47
E4	28.9	2.11	0.47
E5	28.9	2.11	0.47
E6	28.9	2.11	0.47
E7	16.58	1.18	0.33
E8	16.58	1.18	0.33
E9	16.58	1.18	0.33
E10	16.58	1.18	0.33
E11	16.58	1.18	0.33

E12	16.58	1.18	0.33

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

2.7 Other Treatments

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

2.8 Conversion of NO to NO_2

Emissions of NO_x 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). NO_x 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 NO_2 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 R_1 and R_2 produce no net change in O_3 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 NO_2:NO_x ratio.

However, at night, the photolysis of NO_2 ceases, allowing reaction R_2 to promote the production of NO_2, at the expense of O_3, with a corresponding increase in the NO_2:NO_x ratio. Similarly, near to an emission source of NO, the result is a net increase in the rate of reaction R_2, 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 NO_x 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 NO_2 which dispersion model practitioners can use in their detailed assessments[3]. The AQMAU guidance advises that the source term should be modelled as NO_x (as NO_2) and then suggests a tiered approach when considering ambient NO_2:NO_x 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 NO_x 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.

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

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 and AER guidance, this assessment has therefore used a NO_x to NO_2 ratio of 70% for long term average concentrations and 35% for short term concentrations.

3 Relevant Legislation and Guidance

3.1 UK Legislation

3.1.1 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. Although the UK has now left the EU and, therefore, technically this directive no longer directly applies, it has been transposed 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."*

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

The 2023 Air Quality Strategy for England provides a framework for improving air quality at a national and local level and supersedes the previous strategy published in 2007 for England.

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.

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.

3.1.3 Air Quality Strategy: framework for local authority delivery

The 2023 Air Quality Strategy for England provides a framework for improving air quality at a national and local level and supersedes the previous strategy published in 2007 for England.

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.

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 –*
>
> c) *which are situated outside of buildings or other natural or man-made structures above or below ground; and*
>
> d) *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.

3.1.4 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 3.2) 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 $PM_{2.5}$.

3.2 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 has 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 Local Air Quality Management (LAQM) is an integral part of delivering the Government's AQS objectives.

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 AQS objectives.

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 AQS 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 AQS 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 AQS objectives are met.

3.3 Environmental Permitting Regulations (EPR)

The Environmental Permitting Regulations (England and Wales)[4], 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.

3.4 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.

3.4.1 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) 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 and EQS are equivalent to the objectives set in force by the AQS for England, Scotland, Wales and Northern Ireland.

3.5 Criteria Appropriate to the Assessment

Table 3.1 sets out those air quality standards and objectives that are relevant to the assessment with regard to human and ecological receptors. Collectively, these standards and objective are termed 'Air Quality Assessment Levels' (AQAL) within this assessment.

Table 3.1 – Air Quality Standards and Objectives appropriate to the Assessment

Pollutant	Averaging Period	Value ($\mu g\ m^{-3}$)
Nitrogen oxides (NO_x) – ecological receptors	Annual mean	30
	24-hour mean	75

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

Nitrogen dioxide (NO_2) – human receptors	Annual mean	40
	1-hour mean, not more than 18 exceedances a year (equivalent of 99.79 Percentile)	200
Particulate Matter (PM_{10})	Annual mean	40
	24-hour mean, not more than 35 exceedances per year (equivalent of 90.41 Percentile)	50
Particulate Matter ($PM_{2.5}$)	Annual mean	20
Sulphur Dioxide (SO_2) – human receptors	1-hour mean not to be exceeded more than 24 times a year (equivalent to 99.73 percentile)	350
	24-hour mean, not to be exceeded more than 3 times a year (equivalent to 99.18 percentile)	125
	15-min mean, not to be exceeded more than 35 times a year (equivalent to 99.9 percentile)	266
Sulphur Dioxide (SO_2) – ecological receptors	Annual mean	20

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

The Air Pollution Information System (APIS) website[5] 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 3.2.

Table 3.2 - Typical Habitat and Species Information Concerning Nitrogen Deposition from APIS

Habitat and Species Specific Information	Critical Load (kg N ha^{-1} yr^{-1})	Specific Information Concerning Nitrogen Deposition
Saltmarsh	30-40	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.
Littoral Sediments	20 - 30	Increase late successional species, increase productivity increase in dominance of graminoids.
Coastal Stable Dune Grasslands	10-20	Foredunes receive naturally high nitrogen inputs. Key concerns of the deposition of nitrogen in these habitats relate to changes in species composition.
Alkaline Fens and Reed beds	10-35	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

[5] http://www.apis.ac.uk/

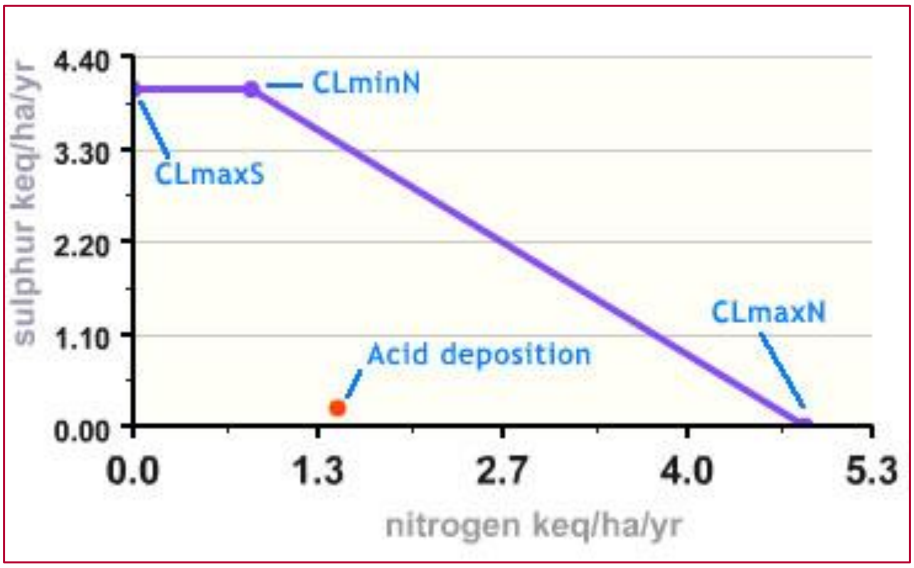
		species diversity. The overall threat from competition will also depend on the availability of propagules
Acid Grasslands	10-25	Nitrogen deposition provides fertilization to acid grasslands, this increase robust grass growth that may limit other species reducing diversity.
Raised bog and blanket bog	5-10	Nitrogen deposition provides fertilization, this increase robust vegetation growth that may limit other species reducing diversity
Oak Woodland	10-15	Increased nitrogen deposition in Oak forests increases susceptibility to secondary stresses such as drought and frost, can cause reduced crown growth

Information relating specifically to acid deposition is provided 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 3.1. 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 3.1 - Critical Load Function (sourced from APIS)



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

4 Existing Ambient Data

4.1 Local Air Quality Management

The Site is located within the jurisdiction of North East Lincolnshire Council ('the Council'). The Council currently has one Air Quality Management Area (AQMA), located in Grimsby, approximately 10 km away from the Site. Due to this distance from the Site, it is not anticipated that emissions from the Site would impact on this AQMA.

The most recent publicly available monitoring data from the Council is provided in the 2023 Annual Status Report (ASR)[6], which includes data up to 2022. In 2022, the Council undertook automatic monitoring at two sites (one of which is incorporated into the Automatic Urban and Rural Network (AURN)), and non-automatic (passive) monitoring at 30 sites. The closest monitoring to the Site is located in Immingham itself, approximately 1 km south. There are three diffusion tube sites, all categorised as roadside/kerbside sites and one automatic analyser (AURN), classed as an urban background site. The annual mean NO_2 concentrations from the diffusion tube sites for 2022 were between 14.6 – 21.7µg/m^3, significantly below the annual mean limit of 40µg/m^3. The annual mean NO_2 concentration for the AURN site was 11.7 µg/m^3 and no exceedances of the 1-hour mean NO_2 objective were observed.

Due to the nature of the Site, the Council's passive monitoring data cannot be considered representative of concentrations in the vicinity of the site. However, where applicable, the urban background data collected at the AURN site in Immingham has been used for nitrogen dioxide. Where not applicable (i.e., at those receptors some distance away from the AURN site) and for other pollutants, background-mapped concentrations have been used in the assessment, as detailed below.

4.2 Background Concentrations used in the Assessment.

Defra maintains a nationwide model of existing and future background air quality concentrations on a 1 km grid square resolution. The datasets include annual average concentration estimates for NO_x, 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.

Annual mean background concentrations of NO_x, NO_2 and PM_{10}/$PM_{2.5}$ have been obtained from the Defra 2018-based background maps[7], for the assessment year of 2023, based on the 1 km grid squares which cover the modelled area.

The modelled concentrations are 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 standard/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 objective. 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 within the AER Guidance. The annual mean background concentrations used in the assessment are detailed in Table 4.1.

[6] https://www.nelincs.gov.uk/assets/uploads/2022/07/North-East-Lincolnshire_2023_ASR_V2.pdf
[7] Defra Background Maps (2021). http://laqm.defra.gov.uk/review-and-assessment/tools/background-maps.html

Table 4.1 – 2021 Background Annual Mean Concentrations used in the Assessment

Grid square (E, N)	Annual Mean Pollutant Concentrations (µg m^{-3})					
	NO_x	NO_2	PM_{10}	$PM_{2.5}$	SO_2	CO
518500,416500	19.1	13.8	12.8	7.8	7.4	740
518500,417500	20.7	14.8	14.0	8.1	10.0	999
519500,416500	42.5	26.1	13.0	8.4	8.3	829
520500,416500	34.7	22.4	12.3	7.8	10.0	999
518500,418500	28.4	19.2	12.5	7.8	10.0	999
519500,415500	27.5	18.7	13.1	8.1	8.1	808
518500,415500	17.9	13.1	13.1	8.0	8.3	825
517500,415500	14.5**	11.7*	13.0	7.8	7.0	700
517500,417500	16.4	12.1	14.3	8.1	9.8	982
516500,415500	13.3	10.0	14.8	8.2	7.6	759
515500,415500	13.2	10.0	15.2	8.3	7.5	749
521500,413500	14.9	11.1	15.3	8.3	14.5	1450
515500,416500	13.8	10.4	14.1	8.3	12.6	1260
514500,418500	13.4	10.1	16.7	8.2	11.9	1190
514500,417500	12.7	9.6	14.2	8.0	8.8	876
518500,414500	16.6**	11.7*	13.6	8.2	7.9	790
517500,414500	15.1**	11.7*	13.7	8.1	7.2	722

*NO_2 background from Immingham Woodlands Avenue AURN Site.
**NO_x directly from background maps

4.3 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 AQS objectives.

Sensitivity analysis has been undertaken for a number of model input parameters to investigate the results of the model with respect to changes in buildings and surface roughness.

4.3.1 Buildings

A sensitivity analysis has been undertaken to investigate the impact of modelling with and without buildings on the modelled results. Results 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 4.2.

Table 4.2 – Building Inclusion Sensitivity Analysis

Buildings	Normalised Maximum Ground Level Concentration	
	NO_x Annual Mean	NO_x 24-Hour Mean
With buildings	1.00	1.00
Without buildings	1.02	0.55

From the above predicted ground level concentrations, it can be seen that the inclusion of buildings in the model results in higher concentrations for short-term means, but not long-term means. Given the presence of buildings at the site, the model used in this assessment has included buildings in order to demonstrate a robust assessment.

4.3.2 Surface Roughness

A sensitivity analysis has been undertaken to investigate the impact of modelling different surface roughness lengths at the dispersion site of 0.2 m, 0.3 m, and 0.5 m. These are composite surface roughness lengths averaged over the entire model domain.

Results have been normalised by the value obtained from the surface roughness length resulting in the highest ground level process contribution at any modelled receptor location and are presented in Table 4.3 below.

Table 4.3 – Surface Roughness Sensitivity Analysis

Surface Roughness (m)	Normalised Maximum Ground Level Concentration	
	NO_x Annual Mean	NO_x 24-Hour Mean
0.2	0.99	0.41
0.3	1.02	0.45
0.5	1.00	1.00

The model used in this assessment has used a composite roughness length of 0.5 m. Whilst the sensitivity analysis has shown there is only marginal difference in concentration due to the differing surface roughness lengths, for long-terms means, there is a greater difference with 24-hour means. Therefore, a roughness length of 0.5 m has shown to be a sensible input to the model on the basis of both the sensitivity analysis and the surrounding land use within the model domain.

4.3.3 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.

5 Assessment of Impact

This section sets out the results of the dispersion modelling and compares predicted pollutant concentrations to ambient air quality standards or objectives. The predicted concentrations resulting from the process are presented with background concentrations and the percentage contribution that the predicted environmental concentrations would make towards the relevant Air Quality Assessment Level (AQAL).

Results 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 the section below.

Table 5.1 below shows the inter-year variability of met conditions at the worst-case human receptor. It demonstrates that 2017 provides the worst-case conditions for long-term concentrations and short-term concentrations, however, this does vary by receptor.

Table 5.1 – NO_x Impacts at the Worst-Case Receptor

Receptor	Annual Mean					24-hour Mean				
	2016	2017	2018	2019	2020	2016	2017	2018	2019	2020
E4	0.17	0.18	0.17	0.18	0.17	-	-	-	-	-
E2	-	-	-	-	-	0.13	0.15	0.12	0.14	0.14

5.1 NO_2 Impacts at Human Receptors

Table 5.2 details the results of the impact assessment for NO_2, with an assessment against both the long-term annual mean (40 µg/m^3), and the short term 99.79th Percentile 1-hour mean (200 µg/m^3) Air Quality Assessment Levels.

Table 5.2 – NO_2 Impacts at Human Receptors

Receptor	Annual Mean				99.79th Percentile of 1-Hour Mean			
	PC µg/m^3	PEC µg/m^3	% PC of AQAL	% PEC of AQAL	PC µg/m^3	PEC µg/m^3	% PC of AQAL	% PEC of AQAL
R1	0.02	18.76	0.1%	46.9%	1.79	39.27	0.9%	19.6%
R2	0.03	13.10	0.1%	32.7%	2.48	28.61	1.2%	14.3%
R3	0.04	13.10	0.1%	32.8%	2.95	29.09	1.5%	14.5%
R4	0.05	13.12	0.1%	32.8%	3.38	29.51	1.7%	14.8%
R5	0.05	13.11	0.1%	32.8%	3.35	29.48	1.7%	14.7%
R6	0.02	18.76	<0.01%	46.9%	1.49	38.97	0.7%	19.5%
R7	0.05	13.12	0.1%	32.8%	2.99	29.12	1.5%	14.6%
R8	0.05	13.12	0.1%	32.8%	2.70	28.83	1.3%	14.4%
R9	0.06	13.13	0.2%	32.8%	2.97	29.10	1.5%	14.6%
R10	0.05	13.12	0.1%	32.8%	2.57	28.70	1.3%	14.3%
R11	0.06	13.13	0.2%	32.8%	3.13	29.26	1.6%	14.6%
R12	0.05	10.90	0.1%	27.2%	2.81	24.50	1.4%	12.2%
R13	0.05	10.89	0.1%	27.2%	2.45	24.14	1.2%	12.1%
R14	0.04	10.88	0.1%	27.2%	2.10	23.79	1.1%	11.9%
R15	0.03	10.88	0.1%	27.2%	1.82	23.50	0.9%	11.8%
R16	0.05	10.90	0.1%	27.2%	2.72	24.41	1.4%	12.2%
R17	0.01	12.10	<0.01%	30.3%	1.44	25.62	0.7%	12.8%
R18	0.02	10.05	<0.01%	25.1%	1.26	21.33	0.6%	10.7%

Receptor	Annual Mean				99.79th Percentile of 1-Hour Mean			
	PC µg/m³	PEC µg/m³	% PC of AQAL	% PEC of AQAL	PC µg/m³	PEC µg/m³	% PC of AQAL	% PEC of AQAL
R19	0.01	10.02	<0.01%	25.0%	0.98	21.00	0.5%	10.5%
R20	<0.01	11.13	<0.01%	27.8%	0.27	22.53	0.1%	11.3%
R21	0.00	11.13	<0.01%	27.8%	0.24	22.49	0.1%	11.2%
R22	0.01	10.44	<0.01%	26.1%	0.98	21.83	0.5%	10.9%
R23	<0.01	10.10	<0.01%	25.3%	0.58	20.78	0.3%	10.4%
R24	<0.01	10.10	<0.01%	25.3%	0.51	20.70	0.3%	10.4%
R25	<0.01	10.10	<0.01%	25.3%	0.46	20.65	0.2%	10.3%
R26	0.01	9.64	<0.01%	24.1%	0.61	19.88	0.3%	9.9%
SCH1	0.04	12.27	0.1%	30.7%	2.06	26.53	1.0%	13.3%
SCH2	0.02	11.29	0.1%	28.2%	1.39	23.94	0.7%	12.0%
SCH3	0.03	12.26	0.1%	30.7%	2.03	26.50	1.0%	13.3%
SCH4	0.03	12.26	0.1%	30.7%	1.88	26.36	0.9%	13.2%
SCH5	0.02	12.25	<0.01%	30.6%	1.38	25.85	0.7%	12.9%

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

The above table indicates that long and short-term Predicted Environmental Concentrations (PECs) of NO_2 are comfortably below the respective assessment metric at all applicable human receptors. The model has predicted that the highest PC will occur at R11 for the annual mean and at R4 for the hourly mean. Both receptors are located to the south of the Site, in the town of Immingham.

Concentration isopleths for the 99.79th percentile of the one-hour mean NO_2 process contribution, and the annual mean NO_2 process contribution are presented in Appendix A.

5.2 PM_{10} Impacts at Human Receptors

Table 5.3 details the results of the impact assessment for PM_{10} against both the long-term annual mean (40 µg/m³), and the short-term 90.41 percentile 24-hour mean (50 µg/m³) Air Quality Assessment Level (AQAL).

Table 5.3 – PM_{10} Impacts at Human Receptors

Receptor	Annual Mean PM_{10}				90.41 percentile 24-hour mean PM_{10}			
	PC µg/m³	PEC µg/m³	% PC of AQAL	% PEC of AQAL	PC µg/m³	PEC µg/m³	% PC of AQAL	% PEC of AQAL
R1	0.01	13.14	<0.01%	32.9%	0.05	26.32	0.1%	52.6%
R2	0.01	13.07	<0.01%	32.7%	0.06	26.18	0.1%	52.4%
R3	0.01	13.07	<0.01%	32.7%	0.08	26.20	0.2%	52.4%
R4	0.01	13.07	<0.01%	32.7%	0.10	26.23	0.2%	52.5%
R5	0.01	13.07	<0.01%	32.7%	0.09	26.21	0.2%	52.4%
R6	0.01	13.14	<0.01%	32.8%	0.04	26.31	0.1%	52.6%
R7	0.01	13.07	<0.01%	32.7%	0.10	26.22	0.2%	52.4%
R8	0.01	13.08	<0.01%	32.7%	0.11	26.23	0.2%	52.5%
R9	0.02	13.08	<0.01%	32.7%	0.14	26.26	0.3%	52.5%
R10	0.01	13.07	<0.01%	32.7%	0.11	26.23	0.2%	52.5%
R11	0.02	13.08	<0.01%	32.7%	0.15	26.28	0.3%	52.6%
R12	0.02	13.05	<0.01%	32.6%	0.13	26.19	0.3%	52.4%

Receptor	Annual Mean PM_{10}				90.41 percentile 24-hour mean PM_{10}			
	PC µg/m³	PEC µg/m³	% PC of AQAL	% PEC of AQAL	PC µg/m³	PEC µg/m³	% PC of AQAL	% PEC of AQAL
R13	0.02	13.04	<0.01%	32.6%	0.11	26.17	0.2%	52.3%
R14	0.01	13.04	<0.01%	32.6%	0.09	26.15	0.2%	52.3%
R15	0.01	13.04	<0.01%	32.6%	0.08	26.14	0.2%	52.3%
R16	0.02	13.05	<0.01%	32.6%	0.13	26.19	0.3%	52.4%
R17	<0.01	14.30	<0.01%	35.7%	0.03	28.61	0.1%	57.2%
R18	0.01	14.81	<0.01%	37.0%	0.04	29.66	0.1%	59.3%
R19	<0.01	15.24	<0.01%	38.1%	0.03	30.50	0.1%	61.0%
R20	<0.01	15.26	<0.01%	38.1%	0.01	30.52	<0.01%	61.0%
R21	<0.01	15.26	<0.01%	38.1%	0.01	30.52	<0.01%	61.0%
R22	<0.01	14.14	<0.01%	35.4%	0.02	28.30	<0.01%	56.6%
R23	<0.01	16.71	<0.01%	41.8%	0.01	33.42	<0.01%	66.8%
R24	<0.01	16.71	<0.01%	41.8%	0.01	33.42	<0.01%	66.8%
R25	<0.01	16.71	<0.01%	41.8%	0.01	33.42	<0.01%	66.8%
R26	<0.01	14.20	<0.01%	35.5%	0.01	28.41	<0.01%	56.8%
SCH1	0.01	13.59	<0.01%	34.0%	0.09	27.26	0.2%	54.5%
SCH2	0.01	13.74	<0.01%	34.3%	0.05	27.52	0.1%	55.0%
SCH3	0.01	13.59	<0.01%	34.0%	0.05	27.22	0.1%	54.4%
SCH4	0.01	13.59	<0.01%	34.0%	0.05	27.22	0.1%	54.4%
SCH5	<0.01	13.59	<0.01%	34.0%	0.04	27.20	0.1%	54.4%

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

Table 5.2 indicates that long and short term Predicted Environmental Concentrations (PECs) of PM_{10} are comfortably below the respective assessment metric at all applicable human receptors. The model has predicted that the highest PC for both the long and short term will occur at R11 (located to the south of the Site), and the highest PEC will occur at R23 (located to the northwest of Site), although the PEC is influenced by the higher background in that area.

5.3 $PM_{2.5}$ Impacts at Human Receptors

Table 5.4 details the results of the impact assessment for annual mean $PM_{2.5}$ AQAL (20 µg/m³). All results are below the relevant assessment metrics. Long term Predicted Environmental Concentrations (PECs) of $PM_{2.5}$ are comfortably below the respective assessment metric at all applicable human receptors. The model has predicted that the highest PC will occur at R11 (located to the south of the Site), and the highest PEC will occur at R23 (located to the northwest of Site) with concentrations at 42% of the AQAL for annual mean $PM_{2.5}$.

Table 5.4 – $PM_{2.5}$ Impacts at Human Receptors

Receptor	Annual Mean $PM_{2.5}$			
	PC µg/m³	PEC µg/m³	% PC of AQAL	% PEC of AQAL
R1	0.01	8.14	0.1%	40.7%
R2	0.02	8.06	0.1%	40.3%
R3	0.02	8.06	0.1%	40.3%
R4	0.03	8.07	0.1%	40.4%
R5	0.02	8.07	0.1%	40.3%

Receptor	Annual Mean $PM_{2.5}$			
	PC µg/m³	PEC µg/m³	% PC of AQAL	% PEC of AQAL
R6	0.01	8.14	0.1%	40.7%
R7	0.03	8.07	0.1%	40.3%
R8	0.03	8.07	0.1%	40.4%
R9	0.03	8.08	0.2%	40.4%
R10	0.03	8.07	0.1%	40.3%
R11	0.04	8.08	0.2%	40.4%
R12	0.03	7.80	0.2%	39.0%
R13	0.03	7.80	0.1%	39.0%
R14	0.02	7.79	0.1%	39.0%
R15	0.02	7.79	0.1%	38.9%
R16	0.03	7.80	0.2%	39.0%
R17	0.01	8.08	<0.01%	40.4%
R18	0.01	8.16	<0.01%	40.8%
R19	0.01	8.29	<0.01%	41.4%
R20	<0.01	8.28	<0.01%	41.4%
R21	<0.01	8.28	<0.01%	41.4%
R22	0.01	8.30	<0.01%	41.5%
R23	<0.01	8.19	<0.01%	41.0%
R24	<0.01	8.19	<0.01%	41.0%
R25	<0.01	8.19	<0.01%	41.0%
R26	<0.01	7.95	<0.01%	39.8%
SCH1	0.02	8.20	0.1%	41.0%
SCH2	0.01	8.15	0.1%	40.8%
SCH3	0.01	8.19	0.1%	41.0%
SCH4	0.01	8.19	0.1%	41.0%
SCH5	0.01	8.19	<0.01%	40.9%
AQAL = Air Quality Assessment Level; PC = Process Contribution; PEC = Predicted Environmental Concentration (PC + Background)				

5.4 SO2 Impacts at Human Receptors

Table 5.5 details the results of the impact assessment for SO_2, with an assessment against both the 99.18 percentile 24-hour mean (125 µg/m³), and the 99.73 percentile 1-hour mean (350 µg/m³) AQALs.

The highest PC during the 24-hour mean is at R4 (located south of the site) and the highest PEC is at R20 (located southeast of the site). The highest PC during the 1-hour mean is at R11 (located southwest of the site) and the highest PEC is at R21 (located southeast of the site).

Overall, the results for the 24-hour mean and 1-hour mean are comfortably below the relevant assessment metrics.

Table 5.6 details the results for the 99.9 percentile 15-minute mean SO_2 (AQAL of 266 µg/m³). The highest PC during the 15-minute mean is at R4 (located south of the site) and the highest PEC is at R20 (located southeast of the site). Results at all receptors are comfortably below the relevant assessment metrics.

Table 5.5 – SO_2 Impacts at Human Receptors (24-hour and 1-hour)

Receptor	99.18th Percentile of 24-hour Mean				99.73th Percentile of 1-Hour Mean			
	PC µg/m³	PEC µg/m³	% PC of AQAL	% PEC of AQAL	PC µg/m³	PEC µg/m³	% PC of AQAL	% PEC of AQAL
R1	0.10	16.26	0.1%	13.0%	0.26	16.42	0.1%	4.7%
R2	0.11	16.61	0.1%	13.3%	0.36	16.86	0.1%	4.8%
R3	0.13	16.63	0.1%	13.3%	0.33	16.83	0.1%	4.8%
R4	0.19	16.69	0.2%	13.4%	0.44	16.94	0.1%	4.8%
R5	0.15	16.65	0.1%	13.3%	0.39	16.89	0.1%	4.8%
R6	0.08	16.24	0.1%	13.0%	0.21	16.37	0.1%	4.7%
R7	0.17	16.67	0.1%	13.3%	0.39	16.89	0.1%	4.8%
R8	0.16	16.66	0.1%	13.3%	0.40	16.90	0.1%	4.8%
R9	0.17	16.67	0.1%	13.3%	0.45	16.95	0.1%	4.8%
R10	0.16	16.66	0.1%	13.3%	0.37	16.87	0.1%	4.8%
R11	0.18	16.68	0.1%	13.3%	0.46	16.96	0.1%	4.8%
R12	0.15	14.15	0.1%	11.3%	0.41	14.41	0.1%	4.1%
R13	0.14	14.14	0.1%	11.3%	0.36	14.36	0.1%	4.1%
R14	0.11	14.11	0.1%	11.3%	0.34	14.34	0.1%	4.1%
R15	0.10	14.10	0.1%	11.3%	0.27	14.27	0.1%	4.1%
R16	0.16	14.16	0.1%	11.3%	0.41	14.41	0.1%	4.1%
R17	0.06	19.70	<0.01%	15.8%	0.19	19.83	0.1%	5.7%
R18	0.05	15.23	<0.01%	12.2%	0.17	15.35	<0.01%	4.4%
R19	0.04	15.02	<0.01%	12.0%	0.13	15.11	<0.01%	4.3%
R20	0.01	29.01	<0.01%	23.2%	0.05	29.05	<0.01%	8.3%
R21	0.01	29.01	<0.01%	23.2%	0.05	29.05	<0.01%	8.3%
R22	0.03	25.23	<0.01%	20.2%	0.11	25.31	<0.01%	7.2%
R23	0.02	23.82	<0.01%	19.1%	0.08	23.88	<0.01%	6.8%
R24	0.01	23.81	<0.01%	19.1%	0.07	23.87	<0.01%	6.8%
R25	0.01	23.81	<0.01%	19.1%	0.07	23.87	<0.01%	6.8%
R26	0.02	17.54	<0.01%	14.0%	0.08	17.60	<0.01%	5.0%
SCH1	0.11	15.91	0.1%	12.7%	0.33	16.13	0.1%	4.6%
SCH2	0.06	14.50	<0.01%	11.6%	0.23	14.67	0.1%	4.2%
SCH3	0.09	15.89	0.1%	12.7%	0.27	16.07	0.1%	4.6%
SCH4	0.09	15.89	0.1%	12.7%	0.24	16.04	0.1%	4.6%
SCH5	0.05	15.85	<0.01%	12.7%	0.20	16.00	0.1%	4.6%

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

Table 5.6 – SO_2 Impacts at Human Receptors (15-minute)

Receptor	99.9th Percentile of 15-minute Mean			
	PC µg/m³	PEC µg/m³	% PC of AQAL	% PEC of AQAL
R1	0.41	16.57	0.2%	6.2%
R2	0.65	17.15	0.2%	6.4%
R3	0.60	17.10	0.2%	6.4%
R4	0.76	17.26	0.3%	6.5%
R5	0.66	17.16	0.2%	6.5%

Receptor	99.9th Percentile of 15-minute Mean			
	PC µg/m³	PEC µg/m³	% PC of AQAL	% PEC of AQAL
R6	0.36	16.52	0.1%	6.2%
R7	0.67	17.17	0.3%	6.5%
R8	0.65	17.15	0.2%	6.4%
R9	0.67	17.17	0.3%	6.5%
R10	0.64	17.14	0.2%	6.4%
R11	0.73	17.23	0.3%	6.5%
R12	0.68	14.68	0.3%	5.5%
R13	0.61	14.61	0.2%	5.5%
R14	0.58	14.58	0.2%	5.5%
R15	0.47	14.47	0.2%	5.4%
R16	0.65	14.65	0.2%	5.5%
R17	0.35	19.99	0.1%	7.5%
R18	0.30	15.48	0.1%	5.8%
R19	0.29	15.27	0.1%	5.7%
R20	0.12	29.12	<0.01%	10.9%
R21	0.08	29.08	<0.01%	10.9%
R22	0.22	25.42	0.1%	9.6%
R23	0.16	23.96	0.1%	9.0%
R24	0.14	23.94	0.1%	9.0%
R25	0.12	23.92	<0.01%	9.0%
R26	0.18	17.70	0.1%	6.7%
SCH1	0.57	16.37	0.2%	6.2%
SCH2	0.40	14.84	0.2%	5.6%
SCH3	0.48	16.28	0.2%	6.1%
SCH4	0.40	16.20	0.2%	6.1%
SCH5	0.36	16.16	0.1%	6.1%
AQAL = Air Quality Assessment Level; PC = Process Contribution; PEC = Predicted Environmental Concentration (PC + Background)				

5.5 NOX Impacts at Ecological Receptors

Table 5.7 details the results of the impact assessment for NO_x, with an assessment against both the long-term annual mean (30 µg/m³), and the short term 24-hour mean (75 µg/m³) Critical Levels (CL_e) for ecological receptors.

Table 5.7 – NO_x Impacts at Ecological Receptors

Receptor	Annual Mean				24-hour Mean			
	PC µg/m³	PEC µg/m³	% PC of CL_e	% PEC of CL_e	PC µg/m³	PEC µg/m³	% PC of CL_e	% PEC of CL_e
E1	0.08	20.78	0.3%	69.3%	0.92	42.32	1.2%	56.4%
E2	0.15	42.63	0.5%	142.1%	2.04	87.00	2.7%	116.0%
E3	0.05	34.71	0.2%	115.7%	1.01	70.35	1.4%	93.8%
E4	0.18	20.88	0.6%	69.6%	1.87	43.26	2.5%	57.7%
E5	0.08	34.75	0.3%	115.8%	2.09	71.42	2.8%	95.2%
E6	0.03	28.41	0.1%	94.7%	0.74	57.49	1.0%	76.7%
E7	0.12	17.98	0.4%	59.9%	3.00	38.72	4.0%	51.6%

Receptor	Annual Mean				24-hour Mean			
	PC µg/m³	PEC µg/m³	% PC of CL_e	% PEC of CL_e	PC µg/m³	PEC µg/m³	% PC of CL_e	% PEC of CL_e
E8	0.10	17.95	0.3%	59.8%	2.98	38.69	4.0%	51.6%
E9	0.03	15.82	0.1%	52.7%	1.32	32.90	1.8%	43.9%
E10	0.03	15.82	0.1%	52.7%	1.39	32.97	1.8%	44.0%
E11	0.03	15.82	0.1%	52.7%	1.49	33.07	2.0%	44.1%
E12	0.03	15.82	0.1%	52.7%	1.51	33.10	2.0%	44.1%

CL_e = Critical Level; PC = Process Contribution; PEC = Predicted Environmental Concentration (PC + Background)

The above tables indicate there may be some exceedances at nearby ecological receptors.

However, for annual mean NO_x, all PC result are below 1% of the CL_e and, as such, in line with EA guidance, these results can be regarded as not significant, as the exceedance is caused by the existing background levels.

In addition, for short-term, 24-hour mean NO_x, all PC results are below 10% of the CL_e and, as such, again in line with relevant EA guidance, these results can be regarded as not significant.

A concentration isopleth for the Annual Mean and 24-hour mean NO_x process contribution presented in Appendix A.

5.6 SO2 Impacts at Ecological Receptors

Table 5.8 details the results of the impact assessment for SO_2, with an assessment against the long-term annual mean (20 µg/m³) CL_e for ecological receptors.

Table 5.8 – SO_2 Impacts at Ecological Receptors

Receptor	Annual Mean			
	PC µg/m³	PEC µg/m³	% PC of CL_e	% PEC of CL_e
E1	0.01	10.00	0.1%	50.0%
E2	0.02	8.31	0.1%	41.5%
E3	0.01	10.00	0.0%	50.0%
E4	0.02	10.01	0.1%	50.1%
E5	0.01	10.00	0.0%	50.0%
E6	0.00	9.99	0.0%	50.0%
E7	0.01	8.26	0.1%	41.3%
E8	0.01	8.26	0.1%	41.3%
E9	0.00	7.14	0.0%	35.7%
E10	0.00	7.14	0.0%	35.7%
E11	0.00	7.14	0.0%	35.7%
E12	0.00	7.14	0.0%	35.7%

CL_e = Critical Level; PC = Process Contribution; PEC = Predicted Environmental Concentration (PC + Background)

The above table indicates that long term Predicted Environmental Concentrations (PECs) of SO_2 are comfortably below the respective assessment metric at all ecological receptors considered in the assessment, with results no more than 50.1% of the CL_e for the annual mean.

5.7 Deposition Impacts at Ecological Receptors

The impact assessment for ecological receptors also includes an assessment of pollutants deposited to land in the form of nitrogen deposition and acid deposition. Nitrogen deposition results are shown in Table 5.9 whilst the results for acid deposition are shown in Table 5.10.

The results for acid deposition are presented in line with the Critical Load Function Tool as contained on the Air Pollution Information System (APIS) website[8]. As described on APIS: "the Critical Load Function is a three-node line on a graph representing the acidity critical load. Combinations of deposition above this line would exceed the critical load, while all areas below or on the line represent an "envelope of protection" where critical loads are not exceeded". Therefore, where 'no exceedance' is stated with regards to acid deposition, it denotes no exceedance of the critical load function.

The results for nitrogen deposition show that, whilst exceedances are predicted at each receptor point, this is due to the existing background deposition rate which is already in exceedance. The PC makes up less than 0.53% at the worst-case ecological receptors considered, so the contribution from the plant can be considered not significant.

Table 5.9 – Nitrogen Deposition Rates at Ecological Receptors

Receptor ID	CL (kg N ha^{-1} yr^{-1})	PC (kg N ha^{-1} yr^{-1})	%PC of CL_{min}	Background Deposition rate (kg N ha^{-1} yr^{-1})	PEDR (kg N ha^{-1} yr^{-1})	%PEDR of CL_{min}	Impact
E1	5	0.012	0.24%	28.9	28.9	578.2%	Not significant
E2	5	0.022	0.44%	28.9	28.9	578.4%	Not significant
E3	5	0.007	0.14%	28.9	28.9	578.1%	Not significant
E4	5	0.027	0.53%	28.9	28.9	578.5%	Not significant
E5	5	0.012	0.24%	28.9	28.9	578.2%	Not significant
E6	5	0.004	0.09%	28.9	28.9	578.1%	Not significant
E7	10	0.018	0.18%	16.60	16.61	166.0%	Not significant
E8	10	0.014	0.14%	16.59	16.60	165.9%	Not significant
E9	10	0.004	0.04%	16.58	16.58	165.8%	Not significant
E10	10	0.004	0.04%	16.58	16.58	165.8%	Not significant
E11	10	0.005	0.05%	16.58	16.58	165.8%	Not significant
E12	10	0.005	0.05%	16.58	16.58	165.8%	Not significant

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)

With regards to acid deposition results, again the contribution from the Site is very low at all receptors. The PC expressed as a % of the critical load function (as provided on APIS) is less than 0.6% at all ecological receptors. These results can therefore be described as not significant.

[8] http://www.apis.ac.uk/critical-load-function-tool

Table 5.10 – Acid Deposition Rates at Ecological Receptors

Receptor ID	PC (kg N+S ha^{-1} yr^{-1})	Background (kg N+S ha^{-1} yr^{-1})	PEC (kg N+S ha^{-1} yr^{-1})	PC (% of CL function)	Background (% of CL function)	PEC (% of CL function)	Impact
E1	0.0015	2.1	2.1	0.3	507.9	508.2	Not significant
E2	0.0026	2.1	2.1	0.5	507.9	508.4	Not significant
E3	0.0008	2.1	2.1	0.2	507.9	508.0	Not significant
E4	0.0033	2.1	2.1	0.6	507.9	508.5	Not significant
E5	0.0014	2.1	2.1	0.3	507.9	508.2	Not significant
E6	0.0006	2.1	2.1	0.1	507.9	508.0	Not significant
E7	0.0021	1.5	1.5	0.0	29.8	29.8	Not significant
E8	0.0017	1.5	1.5	0.0	29.8	29.8	Not significant
E9	0.0005	1.5	1.5	0.0	29.8	29.8	Not significant
E10	0.0005	1.5	1.5	0.0	29.8	29.8	Not significant
E11	0.0005	1.5	1.5	0.0	29.8	29.8	Not significant
E12	0.0005	1.5	1.5	0.0	29.8	29.8	Not significant
CL = Critical load PEC = Predicted environmental concentration (PC + background) No exceedance as per the output of the critical load function tool available on APIS							

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6 Conclusions

Bureau Veritas has been commissioned by Coal Products Ltd (CPL) to undertake a detailed air quality assessment to support an Environmental Permit (EP) variation application for operations at their Immingham Briquetting Works. The variation application includes the request to operate the pyrolysis plant to process sustainable biomasses into a bio-stable char.

An initial screening of emissions to air was carried out using the EA risk assessment H1 software tool as part of the EA guidance; Air Emissions Risk (AER) assessment for your environmental permit. For those operational emissions not screened out by the H1 assessment as being either insignificant or not significant, detailed dispersion modelling requires undertaking in order to determine their significance more precisely. The H1 assessment concluded the need for dispersion modelling of nitrogen oxides, sulphur dioxide and particulate matter emissions from the new plant to assess the impacts more precisely from activities on sensitive human and ecological receptors located around the Site.

Detailed dispersion modelling has been undertaken for operational emissions to air from the existing plant, using ADMS 6 dispersion modelling software. Release rates for NO_x, SO_x and PM for all plant emissions included within the assessment have been derived using information provided by CPL, this includes updated information on emissions monitoring data and operating hours.

The assessment concludes that, under the anticipated operating profile of the plant, all concentrations in air at human receptors are projected to be below the relevant assessment level and no exceedances are predicted.

For concentrations in air at ecological receptors, although exceedances have been redacted, these are due to the existing background levels and the process contribution from the site can be described as not significant.

For deposition results at ecological receptors no exceedances of the critical load is observed.

It can be considered, therefore, that the air quality impacts of the existing and new biochar plant at the Immingham Briquetting Works can be considered as not significant for concentrations in air. With regard to deposition results, nitrogen deposition and acid deposition results can also be described as not significant.

Appendices

Appendix A: Contour Plots

Figure A.1 - 99.79th Percentile 1-Hour Mean NO_2 Process Contribution Isopleth (µg/m^3) for 2018

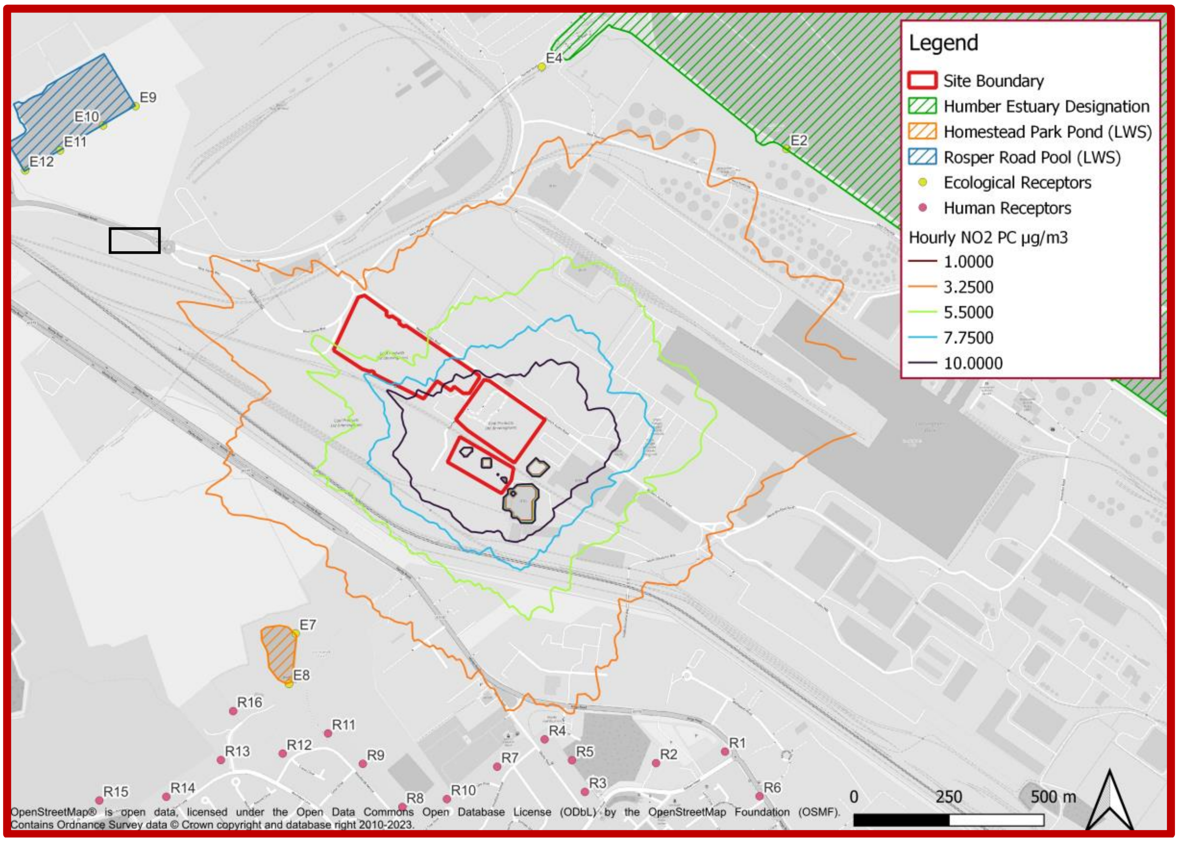


Figure A.2 - Annual Mean NO_2 Process Contribution Isopleth (µg/m³) for 2017

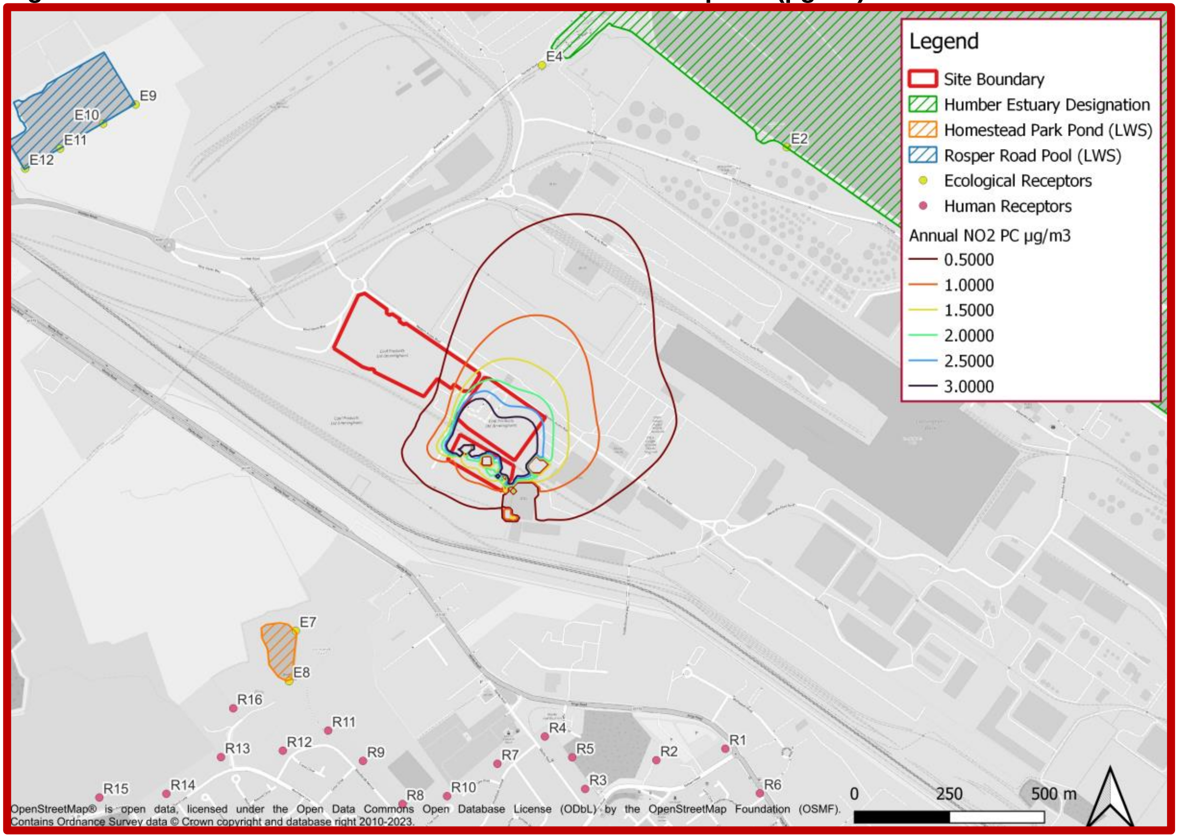


Figure A.2 - Annual Mean NOx Process Contribution Isopleth (µg/m³) for 2017

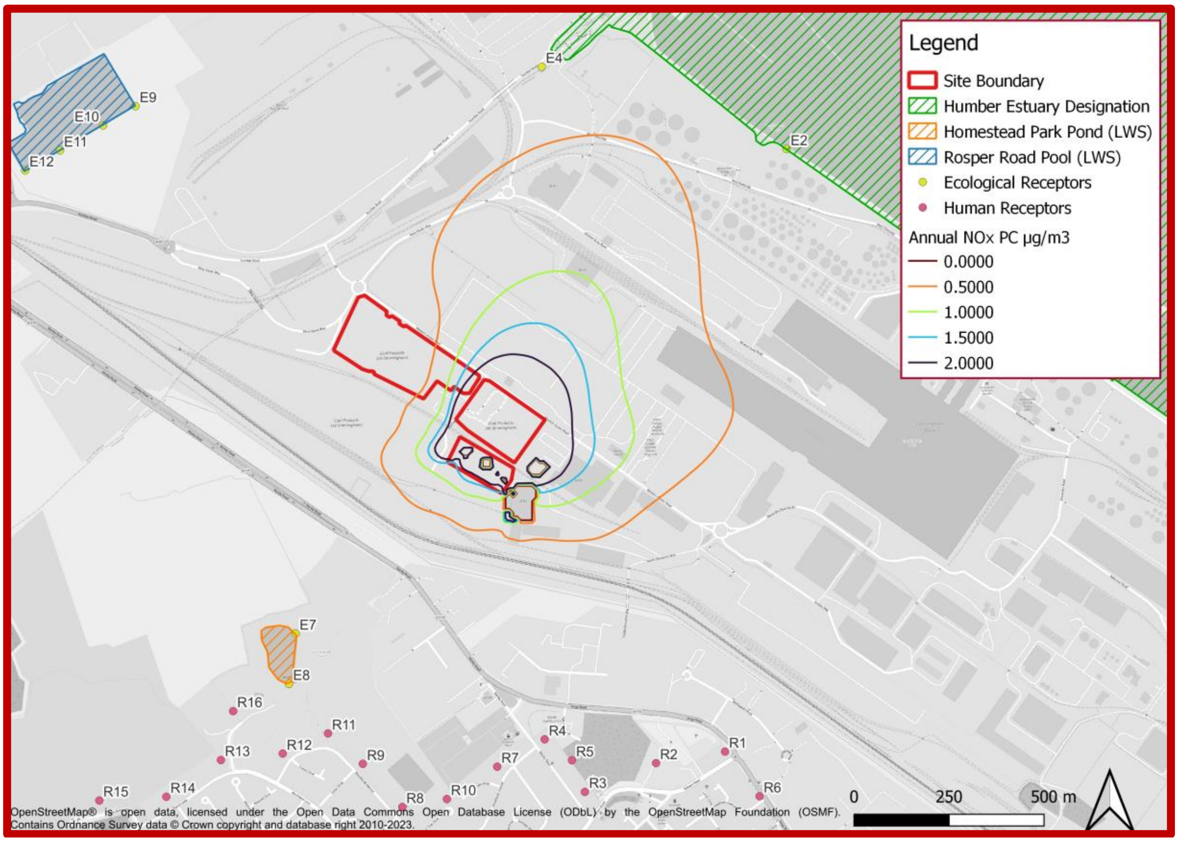
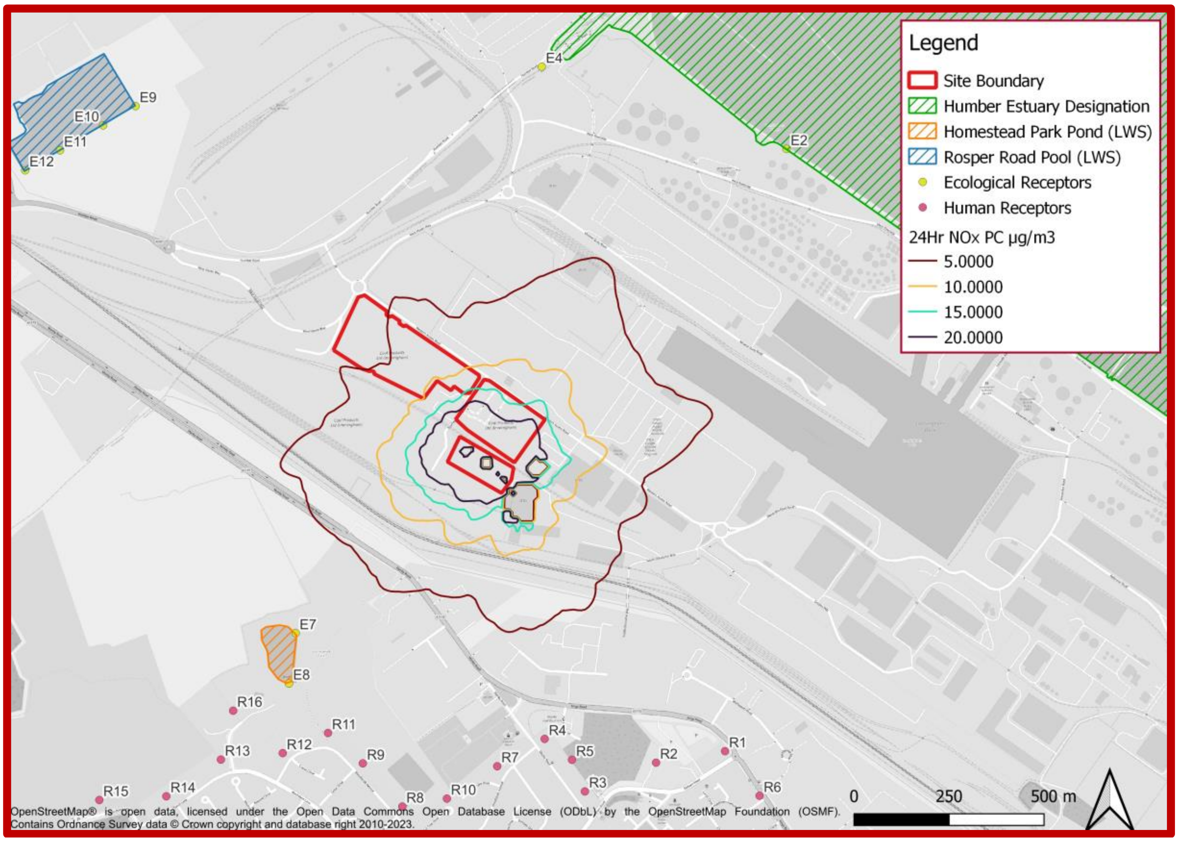


Figure A.3 – 100 Percentile 24-hour mean NO_x Process Contribution Isopleth (µg/m^3) for 2018



Appendix B: H1 Air Impact Screening Output

Figure B.1 – H1 Tool Screening Output - PC

Substance	Long term EAL (ug/m3)	Long term PC (ug/m3)	%PC of EAL (long term)	>1% of EAL? (long term)	Short term EAL (ug/m3)	Short term PC (ug/m3)	%PC of EAL (short term)	>10% of EAL? (short term)
Nitrogen Dioxide	40	24.49	61.23%	fail	200	870	435.00%	fail
Nitrogen Dioxide (Ecological - Daily Mean)	30	4.0809	13.60%	fail	75	513	684.00%	fail
Particulates (PM10) (Annual Mean)	40	3.3	8.25%	fail	0	11.0162		
Particulates (PM10) (24 hr Mean)	0	0.54412			50	69.03	138.06%	fail
Particulates (PM2.5)	20	3.3	16.50%	fail	0	11.0162		
Sulphur Dioxide (Other Ecology)	20	4.08	20.40%	fail	0	13.77025		
Sulphur Dioxide (24 Hour Mean)	0	0.68015			125	85.6	68.48%	fail
Sulphur Dioxide (1 Hour Mean)	0	0.68015			350	145.08	41.45%	fail
Sulphur Dioxide (15 Min Mean)	0	0.68015			266	194.41	73.09%	fail

Figure B.2 – H1 Tool Screening Output - PEC

Substance	Long term EAL (ug/m3)	Long term PC (ug/m3)	Air Background conc (ug/m3)	%PC of headroom (long term)	PEC Long term (µg/m3)	%PEC of EAL% (Long term)	%PEC of EAL>70%? (long	Short term EAL (ug/m3)	Short term PC (ug/m3)	%PC of the EAL-2*background	%PC of headroom >=20%? (short
Nitrogen Dioxide	40	24.49	14.8	97%	39.29	98.23%	fail	200	870	510.56%	fail
Nitrogen Dioxide (Ecological - Daily Mean)	30	4.0809	20.7	44%	24.78	82.60%	fail	75	513	1526.79%	fail
Particulates (PM10) (Annual Mean)	40	3.3	14	13%	17.30	43.25%	pass	0	11.0162	-39.34%	pass
Particulates (PM10) (24 hr Mean)	0	0.54412	14	-4%	14.54			50	69.03	313.77%	fail
Particulates (PM2.5)	20	3.3	8.2	28%	11.50	57.50%	pass	0	11.0162	-67.17%	pass
Sulphur Dioxide (Other Ecology)	20	4.08	10	41%	14.08	70.40%	fail	0	13.77025	-68.85%	pass
Sulphur Dioxide (24 Hour Mean)	0	0.68015	20	-3%	20.68			125	85.6	100.71%	fail
Sulphur Dioxide (1 Hour Mean)	0	0.68015	20	-3%	20.68			350	145.08	46.80%	fail
Sulphur Dioxide (15 Min Mean)	0	0.68015	20	-3%	20.68			266	194.41	86.02%	fail