Triton Power

Saltend Permit Variation

Air Quality Assessment

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Executive Summary

Bureau Veritas has been commissioned by Triton Power to undertake a detailed operational dispersion modelling assessment of emissions to air from a replacement boiler, which will operate alongside the three existing gas turbines and one start-up boiler at the site. The assessment will be submitted with a permit variation for the site (EPR/QP3539LE).

Detailed dispersion modelling has been undertaken for operational emissions to air from the existing plant, using ADMS dispersion modelling software. Release rates for oxides of nitrogen (NO_x (as NO_2)), carbon monoxide (CO) and sulphur dioxide (SO_2) for all relevant plant emissions included within the assessment have been derived using information provided by Triton Power.

The assessment concludes that, based on the anticipated operating profile of the plant under both Scenarios 1 and 2, all predicted air concentrations at human receptor locations are expected to be within the relevant assessment levels, with no exceedances anticipated.

For ecological receptors, the predicted concentrations in air are also anticipated to be below the relevant assessment levels. Regarding predicted deposition impacts, the assessment identified an exceedance of the nitrogen deposition assessment metric at receptor E3 which required further assessment by a qualified ecologist. Further assessment from the ecological report[1] states whilst the area slightly exceeds the 1% screening threshold typically used to identify likely significant effects, the specific environmental conditions at the Site suggest the proposals are unlikely to result in further impact from nitrogen deposition on the Humber Estuary Special Area of Conservation/Special Protection Area (SAC/SPA). Regarding acid deposition, the contribution from the plant is estimated to be small, and any exceedances are primarily due to existing background levels already exceeding the applicable thresholds.

Overall, the assessment indicates that the plant's operations are not expected to result in adverse air quality impacts for either human or ecological receptors, given the predicted concentrations and deposition levels.

It can be considered, therefore, that the air quality impacts of the plant at the Saltend Power Station site in Hull can be considered as **not significant** for both human and ecological receptors.

[1] Appendix C - Saltend Power Station – Ecological Air Quality Assessment (Reassessment July update)

1 Introduction

Triton Power proposes to install a replacement gas-fired boiler, at the Saltend Power Station site at Salt End Lane, Saltend Chemicals Park, Hull. The Site plans to operate the replacement boiler alongside the three existing gas turbines and one start-up boiler at the site.

This report has been compiled to support the requirement for modelling the operation of the replacement boiler at the Saltend Power Station site for a permit variation application. An air quality assessment is required to demonstrate that emissions from the plant's operations would not result in unacceptable pollutant levels for the surrounding human and ecological receptors.

There are five emission points to be modelled for nitrogen dioxide (NO_x as NO_2) and Carbon Monoxide (CO), and two emission points for sulphur dioxide (SO_2) have also been included in the assessment for the purpose of deriving acid deposition results at nearby ecological receptors.

1.1 Process Description

There are currently four emission points to air from the facility, comprising three gas turbines and one start up boiler. This assessment focusses on five emission points to air inclusive of the proposed replacement boiler, in order to determine air quality impacts from the Site in support of their Environmental Permit (EP) variation.

1.2 Scope of Assessment

There are five emission points to air to be modelled, as follows:

- 1 stack (reference A1) for NO_x and CO
- 1 stack (reference A2) for NO_x and CO
- 1 stack (reference A3) for NO_x and CO
- 1 stack (reference A4) for NO_x, CO and SO_2
- 1 stack (reference A5) for NO_x, CO and SO_2

The following two scenarios were used in the assessment:

- Scenario 1 – Existing (A1, A2, A3, A4)
- Scenario 2 – Proposed (A1, A2, A3, A4 and A5)

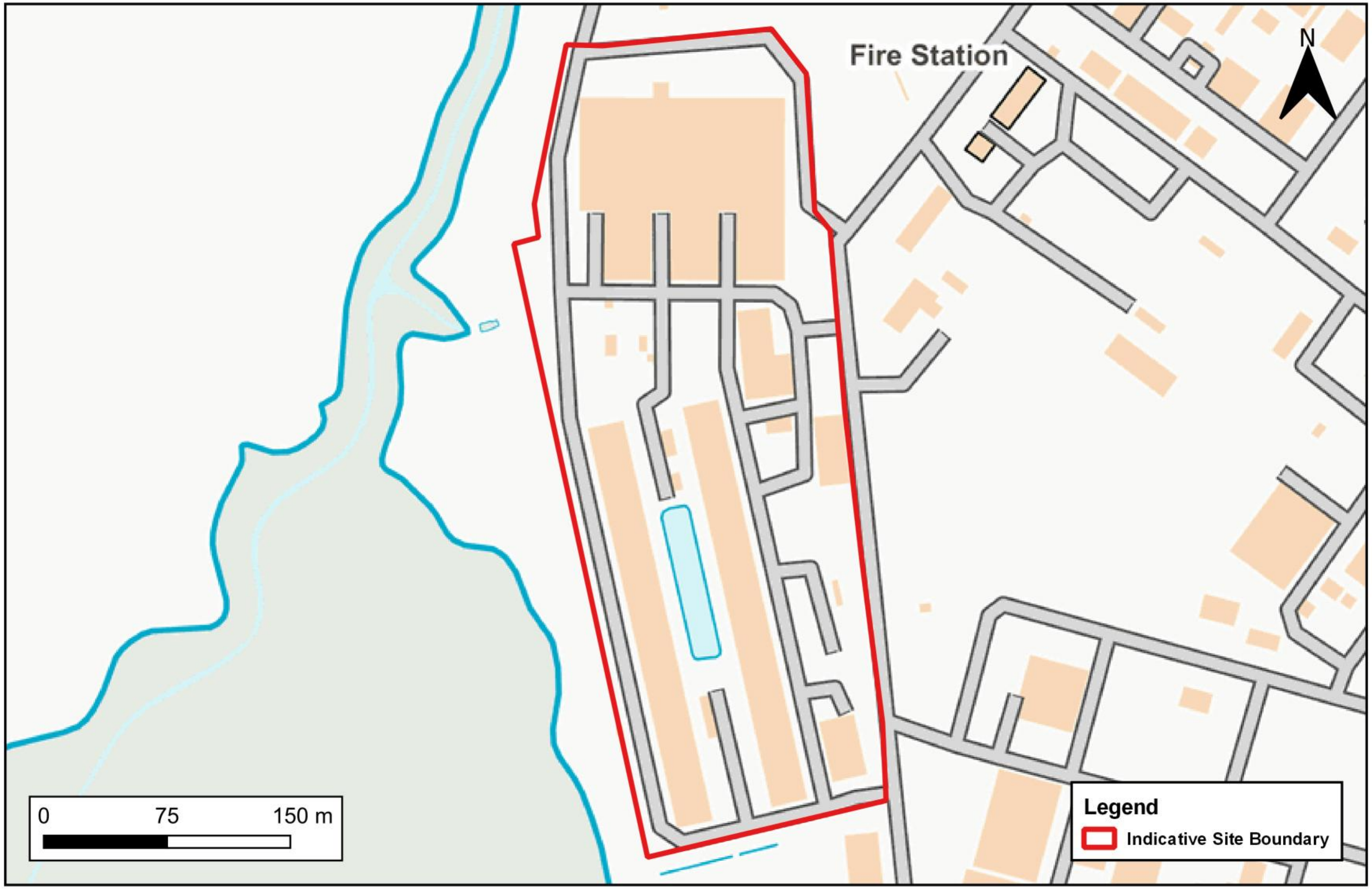
Bureau Veritas have been advised by Triton Power that the plant does not operate 24/7 throughout the year, rather, the number of operational hours changes depending on the power requirement of the site as a whole. As part of the derogation with the EA, Triton Power will be limited to 17,170 hours annually running on the Combined Cycle Gas Turbine (CCGT) units (A1 – A3). This has been averaged out between the 3 CCGT units. The models account for the expected annual operating hours for each plant.

1.3 Site Description

The Site is located on Salt End Lane, Saltend Chemicals Park, Hull, within the jurisdiction of Kingston-Upon-Hull City Council. The surrounding land use mainly compromises industrial land, with the Humber Estuary located to the South and West of site. The Site location is shown in Figure 1.1.

Within the immediate vicinity the area is comprised industrial use, located 2 km northwest of the site are residential properties which have been taken into account in this assessment. There are designated ecological receptors within 1 km of the study area. Further information on nearby sensitive receptors included in the assessment is provided in Section 2.4.

Figure 1.1 – Site Location



2 Dispersion Modelling Methodology

Detailed dispersion modelling was undertaken to assess the pollutant emissions to air. ADMS 6 Version 6.0.2.1 modelling software was used for this study.

ADMS 6 is an advanced atmospheric dispersion model that has been developed and validated by Cambridge Environmental Research Consultants (CERC). The model was used to predict the ground level concentration of products emitted to the atmosphere from the stack of the Saltend Power Station at Salt End Lane, Saltend Chemicals Park, Hull. The model has been used extensively throughout the UK for regulatory compliance purposes and is accepted as an appropriate air quality modelling tool by the EA and local authorities.

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

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

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

2.1 Process Emissions

Details of the replacement boiler stack at the Saltend Power Station has been provided to Bureau Veritas by Triton Power. The stack of the replacement boiler is an addition to the three existing gas turbines and one start-up boiler at the site. The location of the stack included in the dispersion model is illustrated in Figure 2.6. Stack Parameters and emission rates used in the assessment are summarised in Table 2.1 and Table 2.2.

To ensure a worst-case assessment, all plant has been input to the model as operating 24/7 throughout the year. Results have then been post-processed according to individual operating hours of each plant as follows:

- A1 (5723 hours) = 65.3%
- A2 (5723 hours) = 65.3%
- A3 (5723 hours) = 65.3%
- A4 (600 hours) = 6.8%
- A5 (8760 hours) = 100%

Table 2.1 – Model Input Parameters

ID	Description	X coordinate	Y coordinate	Stack Height (m)	Flue Diameter (m)	Efflux Temperature (°C)	Flow Rate (Am^3/h)	Flow Rate (Nm^3/h)	Velocity (m/s)	Reference Conditions	O_2 %	H_2O %
A1	Gas Turbine	515952	427982	65	6	120	4,597,790	1,936,112	45.2	Dry and 15% O_2	17.3	N/A
A2	Gas Turbine	515992	427983	65	6	120	3,593,757	2,014,450	35.3	Dry and 15% O_2	16.1	N/A
A3	Gas Turbine	516032	427983	65	6	120	4,469,209	1,881,967	43.9	Dry and 15% O_2	17.3*	N/A
A4	Start-up Boiler	515961	427938	45	1.5	175	50,400	30,960	7.9	Dry and 3% O_2	N/A	N/A
A5	New Gas Fired Boiler	515941	427938	46	2.31	228	181,037	86,256	12.1	Dry and 3% O_2	1.71	18.44

Data provided by Socotec, boiler manufacturer and Triton Power.
Reference conditions: 273 k, 101.3 kPa.
*Unavailable O_2% from A3 data sheet, therefore the use of A1's O_2% was used as a worst case.

Table 2.2 – Model Pollutant Emission Rates

ID	NO_x (mg/m^3)	NO_x (g/s)	CO (mg/m^3)	CO (g/s)	SO_2 (mg/m^3)	SO_2 (g/s)	Data Source
A1	40	21.51	50	26.89	-	-	Triton Power
A2	40	22.38	50	27.98	-	-	Triton Power
A3	40	20.91	50	26.14	-	-	Triton Power
A4	100	1.40	40	0.56	35	0.49	Triton Power
A5	50	2.51	15	0.75	35	1.76	Triton Power

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 calculated by the Numerical Weather Prediction (NWP), with data supported from Leconfield meteorological station across the period 2019 to 2023. The following figures illustrate the frequency of wind directions and wind speeds for the years considered.

ADMS, cannot, as standard, model calm weather conditions, since this results in a discontinuity produced by a 'divide by zero' calculation. Most Gaussian plume models simply skip lines of meteorological data where calm conditions occur. Met lines will also be skipped where any of the required meteorological input parameters are missing. The generally accepted best practice requirement is to ensure that no more than 10% of meteorological data is omitted from the model run. Table 2.3 demonstrates that this requirement is satisfied for the meteorological 'met' data years used in the assessment.

Table 2.3 – Meteorological Data Capture

Year	Number of met lines used	Number of lines with calm conditions	Number of lines with inadequate data	Percentage of lines used
2019	8759	-	1	100%
2020	8784	-	0	100%
2021	8760	-	0	100%
2022	8759	-	1	100%
2023	8759	-	1	100%

Figure 2.1 – 2019 NWP Saltend Wind Rose

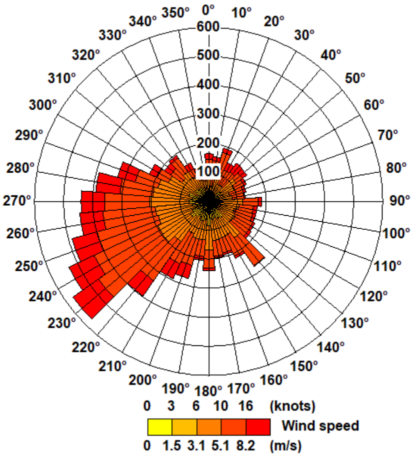


Figure 2.2 – 2020 NWP Saltend Wind Rose

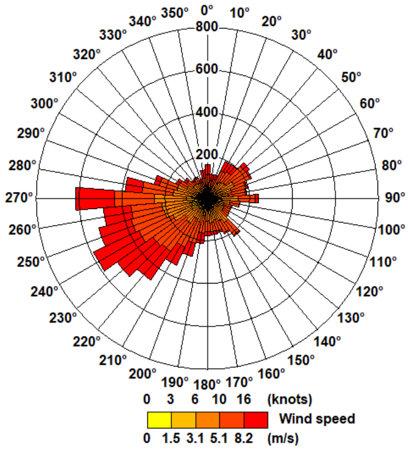


Figure 2.3 – 2021 NWP Saltend Wind Rose

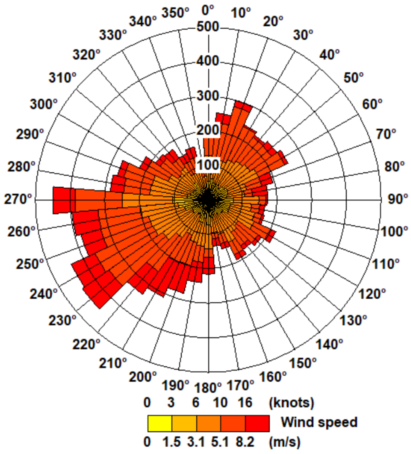


Figure 2.4 – 2022 NWP Saltend Wind Rose

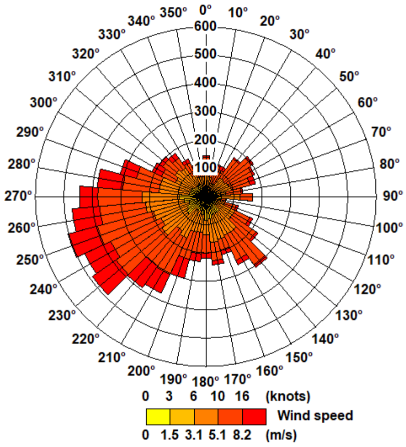


Figure 2.5 – 2023 NWP Saltend Wind Rose

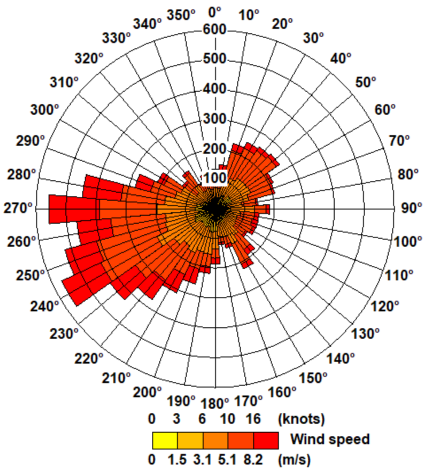
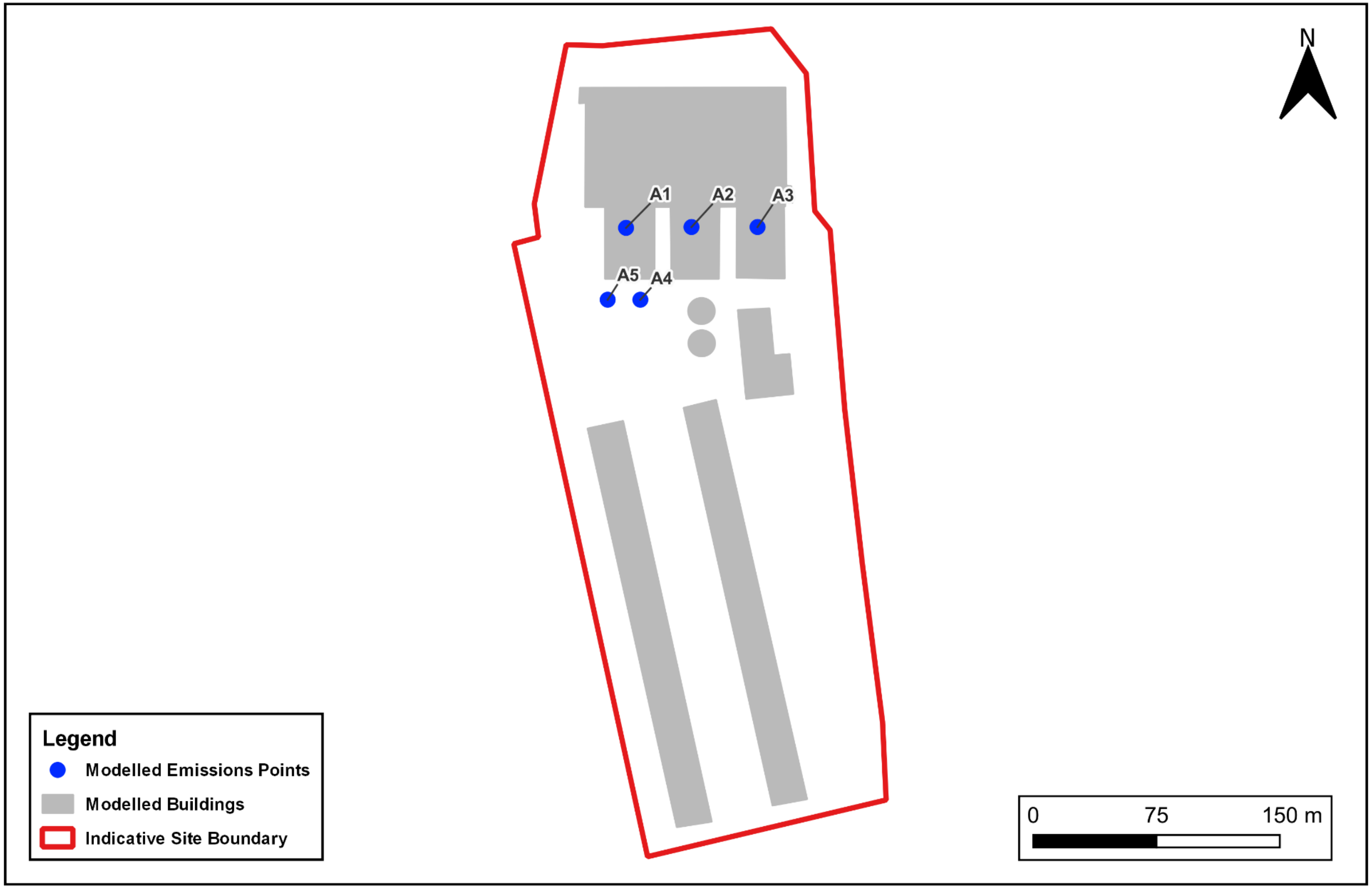


Figure 2.6 – Modelled Emission Points and Modelled Buildings Visualisation



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 2.4.

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

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

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

- The increased mixing can bring portions of an elevated plume down towards ground level, resulting in increased ground level concentrations closer to the emission source; 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 residential to the east and west with a town centre north of the Site. In addition, completing an examination of the location of the meteorological station the surrounding area is predominantly open grassland. 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 the meteorological site (since NWP data were used).

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 2.5, with the building's location presented within Figure 2.6.

Table 2.5 – Modelled Buildings

Name	Centre Easting (m)	Centre Northing (m)	Height (m)	Length / Diameter (m)	Width (m)	Angle (°)
HRSG 3	515989	428026	40.5	68	123	180
Turbine Hall	515989	427972	27.7	41.9	109.6	0
Cooling Tower West	515964	427749	19.1	21.1	247.6	7
Cooling Tower East	516021	427761	19.1	21.1	247.6	7
Demineralisation Tank - 1	515998	427930	19.0	16.5	16.5	-
Demineralisation Tank - 2	515998	427911	19.0	16.5	16.5	-
Raw Water Tank	516044	427847	19.0	10.4	10.4	-
Building 8	516032	427904	10.0	19	53.4	84
Building 9	516048	427895	10.0	10	24.7	84

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. This 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.

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 3.5 of this report. Details of the locations of human receptors are presented in Table 2.6, and illustrated in Figure 2.7 below.

Table 2.6 – Assessed Human Receptors

ID	Receptor Description	Easting (m)	Northing (m)	Height (m)
H1	Residential – HU12 8DJ	517810	428643	1.5
H2	Residential – HU12 8AW	516624	426591	1.5
H3	Residential – HU9 5JS	515457	429712	1.5
H4	Residential – HU9 1UF	511696	428669	1.5
H5	Residential – DN19 7NJ	512110	425471	1.5
H6	Residential – HU12 8TQ	517787	430426	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).

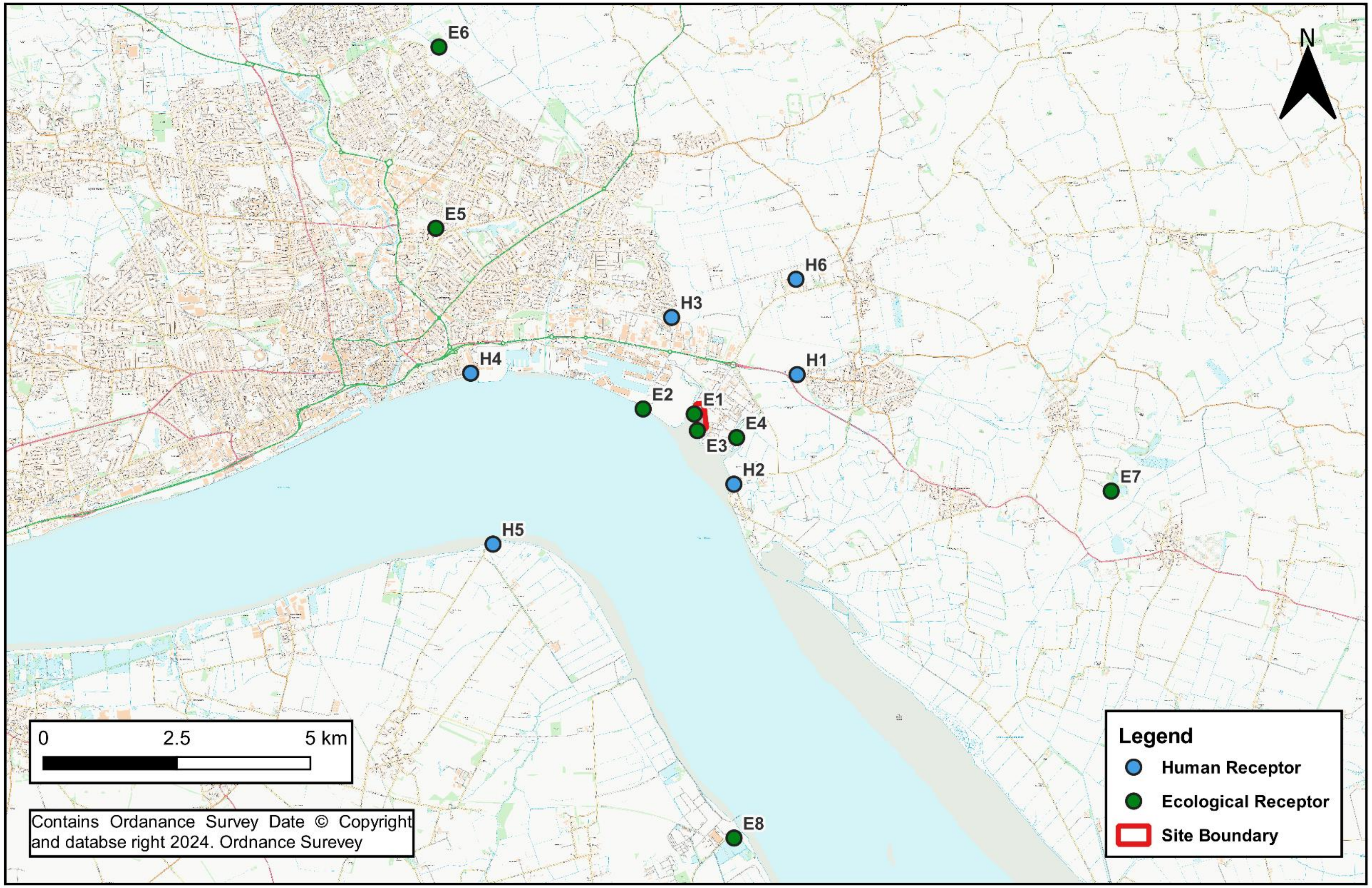
Following the above guidance, upon reviewing the Defra's MAGIC mapping website[2], the ecological receptors considered in the assessment are provided in Table 2.7 and Figure 2.7.

Table 2.7 – Assessed Ecological Receptors

ID	Receptor Description	Easting (m)	Northing (m)	Height (m)
E1	SSSI, SAC, SPC and Ramsar Site – Humber Estuary	515872	427902	0
E2	SSSI, SAC, SPC and Ramsar Site – Humber Estuary	514921	427999	0
E3	SSSI, SAC, SPC and Ramsar Site – Humber Estuary	515938	427593	0
E4	SSSI, SAC, SPC and Ramsar Site – Humber Estuary	516674	427462	0
E5	Local Nature Reserve – Rockford Fields	511017	431383	0
E6	Local Nature Reserve – Noddle Hill	511091	434785	0
E7	SSSI – Kelsey Hill Gravel Pits	523684	426459	0
E8	SSSI – North Killingholme Haven Pits	516618	419973	0

[2] MAGIC website - https://magic.defra.gov.uk/home.htm

Figure 2.7 – Location of Modelled Receptors (Human and Ecological)



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[3] recommends deposition velocities for various pollutants, according to land use classification (Table 2.8).

Table 2.8 – Recommended Deposition Velocities

Pollutant	Deposition Velocity (m s^{-1})	
	Short Vegetation/Grassland	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

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

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

M_N = Molecular mass of nitrogen (kg)

M = Molecular mass of nitrogen containing compound (kg)

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

Table 2.9 – Deposition Conversion Factors

Pollutant	Chemical Element	Conversion Factor µg/m²/s [of Pollutant] → kg/ha/yr [of Chemical Element]
NO_x (as NO_2)	Nitrogen (N)	95.9
SO_2	Sulphur (S)	157.7

Table 2.10 – Acidification Conversion Factors

Chemical Element	Conversion Factor µg/m²/s [of Pollutant] → keq/ha/yr [of Chemical Element]
Nitrogen (N)	6.84
Sulphur	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 2.8) 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 2.11 provides the estimated deposition rates for the ecological receptors considered in this study, as obtained from the APIS website. It should be noted that the level of uncertainty associated with these modelled estimates is relatively high and the results are presented from the model across the UK on a coarse 5 km grid square resolution.

Table 2.11 – 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	14.98	1.07	0.17
E2	14.98	1.07	0.17
E3	14.98	1.07	0.17
E4	14.98	1.07	0.17
E5	16.13	1.15	0.26
E6	16.26	1.16	0.24
E7	14.80	1.06	0.17
E8	16.64	1.19	0.26

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[4]. 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:

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

- **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.

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 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."*

3.1.2 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 AQS objectives, 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 AQS objectives 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.

3.2 Local Air Quality Management

Part IV of the Environment Act 1995 (as amended 2021) requires that Local Authorities periodically review air quality within their individual areas. 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)[5], 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.

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

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 receptors. In the absence of data pertaining to the species contained within the VOCs emissions, these have been treated as 100% benzene within the assessment, as per Environment Agency guidance[6].

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

Pollutant	AQS/AQO/EAL	Averaging Period	Value ($\mu g\ m^{-3}$)
Nitrogen dioxide (NO_2)	AQS	Annual mean	40
	AQS	1-hour mean, not more than 18 exceedances a year (equivalent of 99.79 Percentile)	200
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
	AQS	15-min mean, not to be exceeded more than 35 times a year (equivalent to 99.9 percentile)	266
Carbon Monoxide (CO)	AQS	Maximum 8 hour running mean in any daily period	10,000
	EAL	1-hour mean	30,000

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

A summary of the relevant AQS and EAL that apply to the emissions from the plant and their impact on ecological receptors are given in Table 3.2.

6 https://www.gov.uk/guidance/air-emissions-risk-assessment-for-your-environmental-permit

Table 3.2 – Relevant Air Quality Standards and Environmental Assessment Levels for Ecological Receptors

Pollutant	AQS/EAL	Averaging Period	Value ($\mu g/m^3$)
Oxides of nitrogen (NO_x)	AQS	Annual mean	30
	Target	Daily mean	75
Sulphur dioxide (SO_2)	AQS	Annual mean	20

The Air Pollution Information System (APIS) website[7] 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 3.3.

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

Table 3.3 – Typical Habitat and Species Information Concerning Nitrogen Deposition from APIS

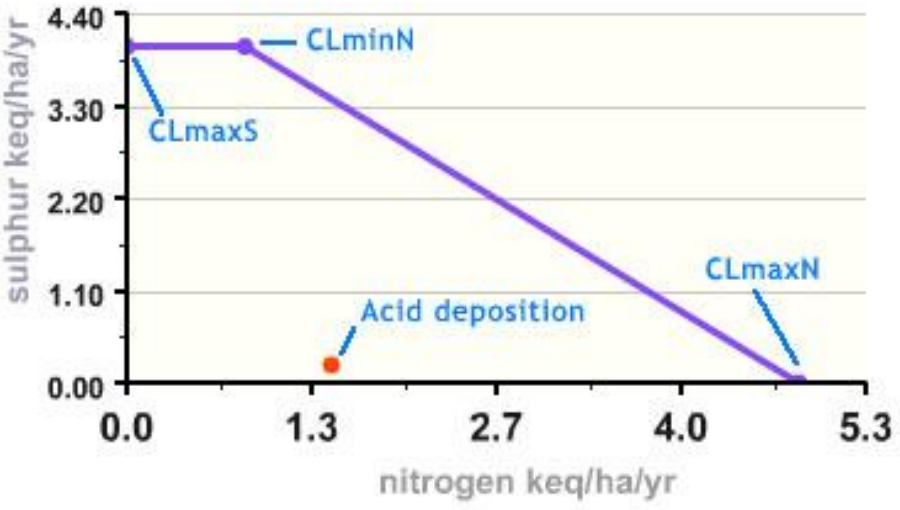
Habitat and Species Specific Information	Critical Load (kg N ha^{-1} yr^{-1})	Specific Information Concerning Nitrogen Deposition
Saltmarsh	30-40	Many saltmarshes receive large nutrient loadings from river and tidal inputs. It is unknown whether other types of species-rich saltmarsh would be sensitive 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 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

Triton power has been in contact with the with Habitat Regulations Assessment (HRA) Team at the Environment Agency to discuss the appropriate Critical Loads to be used in the assessment. The Critical Load (CLo) for the saltmarsh of 10 kg/N/ha/yr has been used based on the recently published Saltmarsh Extent Tool[8]. This new tool reclassified the saltmarsh zone from mid-low to upper marsh, which necessitates a more conservative nitrogen deposition limit. The change reflects the latest ecological classification and ensures a more stringent approach to environmental protection. The Clo of 10 kg/N/ha/yr is used in this assessment to align with the most current understanding of the saltmarsh habitat.

[8] https://www.data.gov.uk/dataset/0e9982d3-1fef-47de-9af0-4b1398330d88/saltmarsh-extent-zonation

4 Existing Ambient Data

4.1 Local Air Quality Management

The Site is located within the jurisdiction of Kingston Upon Hull City Council. The most recent publicly available monitoring data in is provided in the 2023 Annual Status Report (ASR)[9]. The ASR shows that Hull has declared one Air Quality Management Areas (AQMA), declared for exceedances of the NO_2 annual mean (Air Quality Strategy) AQS. The AQMA is located approximately 5.7 km west of Saltend Power Station site boundary.

In 2022, Kingston Upon Hull City Council undertook automatic monitoring at 3 sites, non-automatic (passive) monitoring was undertaken at 142 sites for NO_2. The closest monitoring station to the Saltend Power Station is located on A1033 Hedon Road, approximately 1.9 km northwest of the site boundary at its closest point.

There are four monitoring sites located on A1033 Hedon Road, , all sites are classified as 'Roadside' sites, with annual mean NO_2 concentrations in 2022 of 31.4 µg/m^3 at ID 51, 35.8 µg/m^3 at ID 50, 27.8 µg/m^3 at ID 49 and 22.9 µg/m^3 at ID 65/66/67, below the annual mean limit of 40 µg/m^3.

Due to the site classes of the Council's monitoring sites and the fact that only NO_2 is monitored, background data for this assessment has been taken from the Defra background maps, 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 and NO_2 have been obtained from the Defra 2021-based background maps[10], for the assessment year of 2025 (based on the current year), using the 1 km grid squares which cover the modelled area.

Annual mean background concentrations of SO_2 and CO have been obtained from the Defra 2001-based background maps, using the 1 km grid squares which cover the modelled area. For ecological receptors located in proximity to the Humber Estuary, background concentration data from the nearest available location were used.

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

[9] https://www.hull.gov.uk/downloads/file/3743/AnnualStatusReport2023.pdf

[10] Defra Background Maps (2021). http://laqm.defra.gov.uk/review-and-assessment/tools/background-maps.html

as per the recommendation within the AER Guidance[11]. The annual mean background concentrations used in the assessment are detailed in Table 4.1.

Table 4.1 – 2025 Background Annual Mean Concentrations used in the Assessment

Grid square (E, N)	Annual Mean Pollutant Concentrations (µg m^{-3})			
	NO_x	NO_2	SO_2 (2001)	CO (2001)
517500,428500	14.6	11.0	7.7	313
516500,426500	13.7	10.4	25.3	313
515500,429500	20.8	15.1	7.4	333
511500,428500	15.4	11.6	6.4	348
512500,425500	10.2	8.0	6.9	278
517500,430500	13.6	10.3	6.5	316
515500,427500	17.1	12.7	7.3	325
514500,427500	17.1	12.7	7.3	325
515500,427500	17.1	12.7	9.7	318
516500,427500	14.8	11.1	9.7	318
511500,431500	15.9	11.9	6.3	361
511500,434500	11.8	9.1	5.4	303
523500,426500	9.5	7.4	6.8	257
516500,419500	14.8	11.1	7.8	263
517500,428500	14.6	11.0	7.7	313

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 99.79 Percentile of 1-Hour Mean
With buildings	1.00	0.85
Without buildings	0.89	1.00

[11] https://www.gov.uk/guidance/air-emissions-risk-assessment-for-your-environmental-permit

From the above predicted ground level concentrations, it can be seen that the inclusion of buildings in the model results in higher concentrations for the NO_x annual mean averaging period, but has the opposite effect for short-term means. On balance, given that the site includes multiple large buildings, the model used in this assessment included buildings in order to demonstrate a realistic 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 0.3 m, 0.5 m, and 1.0 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 99.79 Percentile of 1-Hour Mean
0.3	0.77	1.00
0.5	0.87	0.95
1.0	1.00	0.88

The model utilised a composite surface roughness length of 0.5 meters as the primary input parameter. Sensitivity analyses were conducted to evaluate the impacts of varying this roughness length, which demonstrated that a value of 1.0 metre resulted in the highest predicted long-term average concentrations, while a roughness length of 0.3 metres produced the peak 1-hour maximum concentrations. Considering both the sensitivity analysis findings and the surrounding land use characteristics within the model domain, a composite roughness length of 0.5 metres was determined to be a reasonable and representative input parameter for this assessment.

4.3.3 Terrain

The site is situated in an area characterised by relatively level topography. It is unlikely that the terrain will significantly influence the dispersion of pollutants. Therefore, no terrain file has been incorporated into the dispersion model, which is consistent with the approach adopted in the previous modelling assessments conducted at the Saltend Power Station[12,13] .

4.3.4 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.

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[12] Gair Consulting. Air Quality Assessment To Support Ppc Permitting Of The Congeneration Plant, Saltend Power Station. 2005

[13] RAS Environmental Permit Variation Detailed Dispersion Modelling. Triton Power, Saltend Power Station. 2019

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 standards or objectives.

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 for each receptor location for each pollutant, thus the worst-case data has been reported within the section below.

As described in section 1.2, two scenarios were assessed using the following annual operational hours to capture realistic operating conditions for each emission point and were used to adjust the results:

- A1 (5723 hours)
- A2 (5723 hours)
- A3 (5723 hours)
- A4 (500 hours)
- A5 (3807 hours)

Table 5.1 below shows the inter-year variability of met conditions at the worst-case human receptors. It demonstrates that 2020 provides the worst-case conditions for long-term concentrations at receptor H1, and 2021 provides the worst-case short-term 1-hour concentrations at receptor H2. However, the worst-case met year does vary by receptor.

Table 5.1 – Inter-year variability of met conditions and modelled concentrations

Receptor	Annual Mean					1-hour Mean				
	2019	2020	2021	2022	2023	2019	2020	2021	2022	2023
H1	0.99	1.00	0.67	0.89	0.99	-	-	-	-	-
H2	-	-	-	-	-	0.87	0.93	1.00	0.97	0.87

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
Scenario 1 – Existing Plant								
H1	0.60	10.99	1.51%	27.5%	7.54	28.31	3.8%	14.2%
H2	0.16	9.99	0.40%	25.0%	8.71	28.37	4.4%	14.2%
H3	0.15	14.36	0.38%	35.9%	7.10	35.51	3.5%	17.8%
H4	0.06	10.85	0.16%	27.1%	2.48	24.06	1.2%	12.0%

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
H5	0.09	7.60	0.22%	19.0%	2.59	17.62	1.3%	8.8%
H6	0.32	10.13	0.81%	25.3%	3.87	23.48	1.9%	11.7%
Scenario 2 – Existing and Proposed Plant								
H1	0.72	11.10	1.80%	27.8%	7.97	28.74	4.0%	14.4%
H2	0.20	10.04	0.51%	25.1%	9.28	28.95	4.6%	14.5%
H3	0.20	14.41	0.51%	36.0%	7.47	35.88	3.7%	17.9%
H4	0.08	10.87	0.19%	27.2%	2.64	24.22	1.3%	12.1%
H5	0.11	7.62	0.27%	19.0%	2.71	17.73	1.4%	8.9%
H6	0.38	10.18	0.95%	25.5%	4.07	23.67	2.0%	11.8%
AQAL = Air Quality Assessment Level; PC = Process Contribution; PEC = Predicted Environmental Concentration (PC + Background)								

The above table compares the predicted environmental concentrations (PECs) for both the existing conditions scenario and the proposed scenario. The results indicate that the long-term and short-term PECs for NO_2 are below the respective assessment metrics at all applicable human receptor locations under both scenarios.

While there is a minor increase in PECs observed between the two scenarios, the model has predicted that for the proposed Scenario 2, the highest PEC results will occur at receptor location H3, located north of the site. At this location, the PEC concentrations are estimated to be 36.0% of the air quality assessment metric for the annual mean NO_2, and 17.9% of the metric for the 1-hour mean NO_2.

A concentration isopleth for the 99.79th percentile of the 1-hour mean NO_2 process contribution for Scenario 2 is presented in Appendix A.

5.1 SO_2 Impacts at Human Receptors

Table 5.3 details the results of the impact assessment for SO_2 against the 99.73rd percentile 1-hour mean (350 µg/m³), 99.18th percentile 24-hour mean (125 µg/m³) AQALs and the 99.9th percentile 15-minute mean (266 µg/m³) AQALs.

Table 5.3 – SO_2 Impacts at Human Receptors

Receptor	99.73rd Percentile 1-hour SO_2				99.18th Percentile 24-hour Mean SO_2				99.9th Percentile 15-minute Mean SO_2			
	PC µg/m³	PEC µg/m³	% PC of AQAL	% PEC of AQAL	PC µg/m³	PEC µg/m³	% PC of AQAL	% PEC of AQAL	PC µg/m³	PEC µg/m³	% PC of AQAL	% PEC of AQAL
Scenario 1 – Existing Plant												
H1	0.85	16.29	0.2%	4.7%	0.29	15.73	0.2%	12.6%	1.50	16.94	0.6%	6.4%
H2	1.10	51.70	0.3%	14.8%	0.27	50.87	0.2%	40.7%	1.78	52.38	0.7%	19.7%
H3	0.92	15.80	0.3%	4.5%	0.28	15.16	0.2%	12.1%	1.49	16.37	0.6%	6.2%
H4	0.27	13.05	0.1%	3.7%	0.10	12.88	0.1%	10.3%	0.53	13.31	0.2%	5.0%
H5	0.30	14.16	0.1%	4.0%	0.08	13.94	0.1%	11.2%	0.65	14.51	0.2%	5.5%
H6	0.46	13.42	0.1%	3.8%	0.12	13.08	0.1%	10.5%	0.92	13.88	0.3%	5.2%
Scenario 2 – Existing and Proposed Plant												
H1	2.59	18.03	0.7%	5.2%	1.12	16.56	0.9%	13.3%	4.07	19.51	1.5%	7.3%
H2	2.41	53.01	0.7%	15.1%	0.96	51.56	0.8%	41.2%	3.12	53.72	1.2%	20.2%
H3	2.24	17.12	0.6%	4.9%	0.79	15.67	0.6%	12.5%	3.47	18.35	1.3%	6.9%
H4	0.88	13.66	0.3%	3.9%	0.26	13.04	0.2%	10.4%	1.64	14.42	0.6%	5.4%
H5	1.14	15.00	0.3%	4.3%	0.28	14.14	0.2%	11.3%	2.33	16.19	0.9%	6.1%
H6	1.67	14.63	0.5%	4.2%	0.47	13.43	0.4%	10.7%	3.38	16.34	1.3%	6.1%

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

The results indicate that the long-term and short-term PECs for SO_2 are below the respective assessment metrics at all applicable human receptor locations under both scenarios.

While there is a minor increase in PECs observed between the two scenarios, the model has predicted that for the proposed Scenario 2, the highest PEC results will occur at receptor location H2, located south of the site. At this location, the PEC concentrations are estimated to be 15.1% of the air quality assessment AQAL for the 1-hour mean SO_2, 41.2% of the AQAL for the 24-hour mean SO_2 and 20.2% of the AQAL for the 15-minute mean SO_2.

A concentration isopleth for the 99.73rd percentile of the 1-hour mean SO_2 process contribution for Scenario 2 is presented in Appendix A.

5.2 CO Impacts at Human Receptors

Table 5.4 details the results of the impact assessment for CO against Maximum 8 hour running mean in any daily period (10,000 µg/m³) and the 1-hour mean (30,000 µg/m³).

Table 5.4 – CO Impacts at Human Receptors

Receptor	Maximum 8 hour running mean in any daily period				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
Scenario 1 – Existing Plant								
H1	25.00	651.00	0.25%	6.5%	28.72	654.72	0.10%	2.2%
H2	30.79	656.79	0.31%	6.6%	35.65	661.65	0.12%	2.2%
H3	25.87	691.87	0.26%	6.9%	27.68	693.68	0.09%	2.3%
H4	7.53	703.53	0.08%	7.0%	12.26	708.26	0.04%	2.4%
H5	8.39	564.39	0.08%	5.6%	24.09	580.09	0.08%	1.9%
H6	13.08	645.08	0.13%	6.5%	25.25	657.25	0.08%	2.2%
Scenario 2 – Existing and Proposed Plant								
H1	25.37	651.37	0.25%	6.5%	29.11	655.11	0.10%	2.2%
H2	31.28	657.28	0.31%	6.6%	36.20	662.20	0.12%	2.2%
H3	26.23	692.23	0.26%	6.9%	28.03	694.03	0.09%	2.3%
H4	7.65	703.65	0.08%	7.0%	12.59	708.59	0.04%	2.4%
H5	8.51	564.51	0.09%	5.6%	24.39	580.39	0.08%	1.9%
H6	13.24	645.24	0.13%	6.5%	25.69	657.69	0.09%	2.2%
AQAL = Air Quality Assessment Level; PC = Process Contribution; PEC = Predicted Environmental Concentration (PC + Background)								

The above table compares the predicted environmental concentrations (PECs) for both the existing conditions scenario and the proposed scenario that includes the replacement boiler. The results indicate that the long-term and short-term PECs for CO are below the respective assessment metrics at all applicable human receptor locations under both scenarios.

While there is a minor increase in PECs observed between the two scenarios, the model has predicted that for the proposed Scenario 2, the highest PEC results will occur at receptor location H4, located west of the site. At this location, the PEC concentrations are estimated to be 7.0% of the air quality assessment AQAL for the maximum 8 hour running mean CO, and 2.4% of the AQAL for the 1-hour mean CO.

5.1 NO_X Impacts at Ecological Receptors

Table 5.5 details the results of the impact assessment for NO_x, with an assessment against both the long-term annual mean (30 µg/m^3), and the short term 24-hour mean (75 µg/m^3), collectively termed Critical Levels (CL_e), for ecological receptors.

Table 5.5 – NO_x Impacts at Ecological Receptors

Receptor	Annual Mean				24-hour Mean			
	PC µg/m^3	PEC µg/m^3	% PC of CL_e	% PEC of CL_e	PC µg/m^3	PEC µg/m^3	% PC of CL_e	% PEC of CL_e
Scenario 1 – Existing Plant								
E1	0.03	15.96	0.10%	53.2%	9.81	41.68	13.1%	55.6%
E2	0.34	16.27	1.12%	54.2%	21.76	53.63	29.0%	71.5%
E3	0.22	16.16	0.74%	53.9%	37.82	69.69	50.4%	92.9%
E4	0.45	14.26	1.48%	47.5%	28.06	55.69	37.4%	74.2%
E5	0.09	14.79	0.31%	49.3%	3.26	32.66	4.3%	43.5%
E6	0.09	11.08	0.30%	36.9%	2.94	24.93	3.9%	33.2%
E7	0.15	9.13	0.49%	30.4%	3.11	21.06	4.1%	28.1%
E8	0.05	14.19	0.17%	47.3%	2.01	30.29	2.7%	40.4%
Scenario 2 – Existing and Proposed Plant								
E1	0.07	16.00	0.22%	53.3%	10.99	42.86	14.7%	57.1%
E2	0.48	16.41	1.58%	54.7%	23.69	55.55	31.6%	74.1%
E3	1.08	17.01	3.59%	56.7%	42.05	73.92	56.1%	98.6%
E4	0.61	14.42	2.03%	48.1%	30.05	57.67	40.1%	76.9%
E5	0.11	14.81	0.37%	49.4%	3.46	32.86	4.6%	43.8%
E6	0.10	11.10	0.34%	37.0%	3.09	25.08	4.1%	33.4%
E7	0.17	9.15	0.56%	30.5%	3.32	21.28	4.4%	28.4%
E8	0.06	14.20	0.20%	47.3%	2.15	30.43	2.9%	40.6%
CL_e = Critical Level; PC = Process Contribution; PEC = Predicted Environmental Concentration (PC + Background)								

The above table indicates the long-term annual mean Predicted Environmental Concentrations (PECs) of NO_x are comfortably below the annual mean assessment metric at all ecological receptors considered in the assessment under both scenarios, with results no more than 56.7% of CL_e of the annual mean. The impacts at all receptors for the annual mean can be considered not significant and no further assessment is required.

The predicted short-term mean PECs of NO_x are below the 24-hour mean assessment metric at all ecological receptors considered in the assessment under both scenarios. Ecological receptor E3 has a PEC that is close to the 24-hour metric, with the PEC representing 98.6% of the critical level (CLe) for the 24-hour mean, respectively. The impacts at all receptors for the 24-hour mean are under the 24-hour mean metric.

5.2 SO_2 Impacts at Ecological Receptors

Table 5.6 details the results of the impact assessment for SO_2, with an assessment against the long-term annual mean (20 µg/m^3) CL_e for ecological receptors.

Table 5.6 – SO_2 Impacts at Ecological Receptors

Receptor	Annual Mean			
	PC µg/m^3	PEC µg/m^3	% PC of CL_e	% PEC of CL_e
Scenario 1 – Existing Plant				
E1	0.01	7.34	0.04%	36.7%
E2	<0.01	7.33	0.01%	36.7%
E3	0.02	9.67	0.08%	48.3%
E4	<0.01	9.65	0.02%	48.3%
E5	<0.01	6.32	<0.01%	31.6%
E6	<0.01	5.42	<0.01%	27.1%
E7	<0.01	6.82	<0.01%	34.1%
E8	<0.01	7.83	<0.01%	39.2%
Scenario 2 – Existing and Proposed Plant				
E1	0.04	7.37	0.18%	36.8%
E2	0.10	7.43	0.50%	37.2%
E3	0.62	10.27	3.08%	51.3%
E4	0.12	9.77	0.59%	48.8%
E5	0.01	6.33	0.06%	31.7%
E6	0.01	5.43	0.05%	27.1%
E7	0.01	6.83	0.07%	34.2%
E8	0.01	7.84	0.03%	39.2%
CL_e = Critical Level; PC = Process Contribution; PEC = Predicted Environmental Concentration (PC + Background)				

The above table indicates that annual term Predicted Environmental Concentrations (PECs) of SO_2 are comfortably below the respective assessment metric at all ecological receptors considered in the assessment under both scenarios, with results no more than 51.3% of the Cl_e.

5.3 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 5.7 whilst the results for acid deposition are shown in Table 5.8.

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[14]. 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.

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

The assessment has determined that the nitrogen deposition at ecological receptor E3 is above 1% for the %PC of CLmin of the relevant critical load, therefore requiring further assessment. This indicates the need for further detailed assessment of the potential impacts on sensitive habitats and species at these locations. Where exceedances of the PEDR occur, these are due to the existing background concentrations.

Based on the detailed ecological assessment[1], the nitrogen deposition exceedance has been deemed acceptable because only 1.25% of the total mudflat area within the Humber Estuary SAC/SPA will be affected, and the estuary's macro-tidal nature with regular brackish water flushing significantly limits the potential for atmospheric nitrogen accumulation. It is key to note these are conservative modelling assumptions.

The ecological report[1] contains isopleth maps showing the spatial extent of predicted impacts. *Figure 3* within Appendix C[1] displays the nitrogen deposition impact isopleth, showing areas that are within the zone of influence. Whilst the areas slightly exceed the 1% screening threshold typically used to identify likely significant effects, the specific environmental conditions at the Site suggest the proposals are unlikely to result in further impact from nitrogen deposition on the Humber Estuary SAC/SPA. On this basis, no likely significant effect is anticipated.

Table 5.7 – 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}
Scenario 1 – Existing Plant						
E1	10	0.00	0.04%	14.98	15.0	149.8%
E2	10	0.05	0.48%	14.98	15.0	150.3%
E3	10	0.03	0.32%	14.98	15.0	150.1%
E4	10	0.06	0.64%	14.98	15.0	150.4%
E5	10	0.01	0.13%	29.83	29.8	298.4%
E6	10	0.01	0.13%	16.26	16.3	162.7%
E7	10	0.02	0.21%	14.80	14.8	148.2%
E8	10	0.01	0.07%	16.64	16.6	166.5%
Scenario 2 – Existing and Proposed Plant						
E1	10	0.01	0.10%	14.98	15.0	149.9%
E2	10	0.07	0.68%	14.98	15.0	150.5%
E3	10	0.15	1.55%	14.98	15.1	151.3%
E4	10	0.09	0.88%	14.98	15.1	150.7%
E5	10	0.02	0.16%	29.83	29.8	298.5%
E6	10	0.01	0.15%	16.26	16.3	162.7%
E7	10	0.02	0.24%	14.80	14.8	148.2%
E8	10	0.01	0.09%	16.64	16.6	166.5%
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, the contribution from the Site is very low and no exceedances are predicted in terms of the PC. Where exceedances occur, these are due to the existing background. Ecological receptor E8 was not assessed for potential impacts due to the lack of available data on the critical load for the habitat type. The habitat associated with receptor E8 is not considered sensitive to acidification impacts, and therefore a critical load value was not established for this receptor.

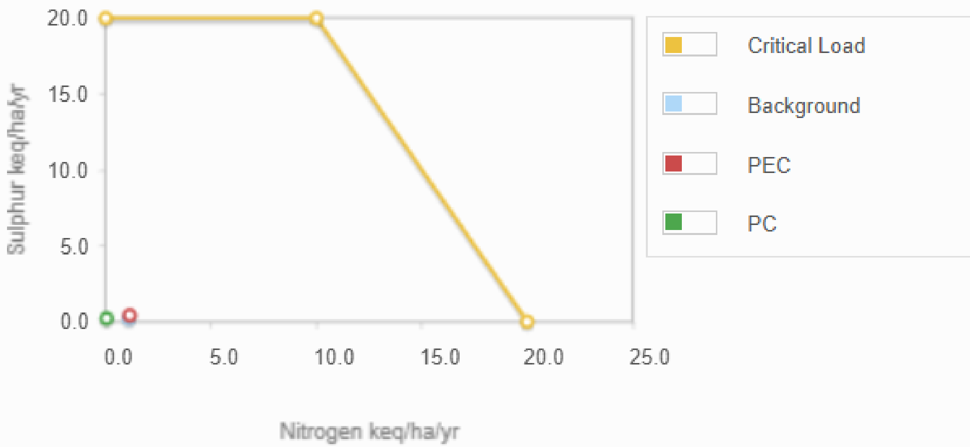
Table 5.8 – Acid Deposition Rates at Ecological Receptors

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
Scenario 1 – Existing Plant										
E1	0.00105	0.00030	0.2	1.1	0.2	1.1	0.005	0.9	0.9	Not significant
E2	0.00032	0.00346	0.2	1.1	0.2	1.1	0.002	0.9	0.9	Not significant
E3	0.00197	0.00228	0.2	1.1	0.2	1.1	0.010	0.9	0.9	Not significant
E4	0.00049	0.00458	0.3	2.1	0.3	2.1	0.002	1.7	1.7	Not significant
E5	0.00003	0.00096	0.2	1.2	0.2	1.2	0.011	16.1	16.1	Not significant
E6	0.00003	0.00092	0.2	1.2	0.2	1.2	0.019	27.6	27.6	Not significant
E7	0.00004	0.00152	0.2	1.1	0.2	1.1	0.032	25.3	25.4	Not significant
E8	0.00002	0.00053	0.3	1.2	0.3	1.2	-	-	-	-
Scenario 2 – Existing and Proposed Plant										
E1	0.00426	0.00069	0.2	1.1	0.2	1.1	0.021	0.9	0.9	Not significant
E2	0.01183	0.00489	0.2	1.1	0.2	1.1	0.059	0.9	0.9	Not significant
E3	0.07286	0.01107	0.2	1.1	0.2	1.1	0.364	0.9	1.2	Not significant
E4	0.01404	0.00626	0.3	2.1	0.3	2.1	0.070	1.7	1.7	Not significant
E5	0.00135	0.00113	0.2	1.2	0.2	1.2	0.028	16.1	16.1	Not significant
E6	0.00115	0.00106	0.2	1.2	0.2	1.2	0.044	27.6	27.7	Not significant
E7	0.00173	0.00173	0.2	1.1	0.2	1.1	0.071	25.3	25.4	Not significant
E8	0.00067	0.00061	0.3	1.2	0.3	1.2	-	-	-	-
CL = Critical Load PEC = Predicted environmental concentration (PC + background) Notes: Ecological receptor E8 has a habitat not sensitive to acidity										

Figure 5.1 – Critical Load Function Output for Worst-Case Receptor, E3

Source	Exceedance (keq/ha/yr)	% of CL function*
Process Contribution (PC)	no exceedance of CL function	1.1
Background	no exceedance of CL function	1
Predicted Environmental Concentration (PEC)	no exceedance of CL function	2.1

* % 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.



6 Conclusions

Bureau Veritas has been commissioned by Triton Power to undertake a detailed air quality assessment to support a new EP variation application for operations at their Saltend Power Station facility in Hull.

Detailed dispersion modelling has been undertaken for operational emissions to air from the existing and proposed plant, using ADMS dispersion modelling software. Release rates for NO_x, CO and SO_2 for five emission points to air have been included within the assessment, which have been derived using information provided by Triton Power.

The assessment concludes that, under the anticipated operating profile of the plant, all concentrations in air at human receptors are predicted to be below the relevant assessment level and no exceedances are predicted under both Scenario 1 and 2.

For ecological receptors, with regard to concentrations in air, results at all of the receptors are predicted to be below the relevant assessment level for the annual and daily mean metrics under both scenarios. Regarding deposition impacts, the ecological assessment identified an exceedance of the nitrogen deposition metric at receptor E3, with levels surpassing 1% of the critical load minimum.

As such, further analysis of deposition impacts was undertaken by a qualified ecologist. The ecological assessment[1] reveals that while background levels exceed lower critical loads of nitrogen deposition, the proposed permit's impact is minimal.

- Only 1.25% of the total mudflat area within the Humber Estuary SAC/SPA will experience an increase over 0.1 kgN/ha/yr.
- The Humber Estuary's macro-tidal characteristics, characterised by regular brackish water flushing, significantly mitigate the potential accumulation of atmospheric nitrogen.
- Waterborne nutrient inputs are considered a more substantial pressure on mudflat habitats compared to atmospheric deposition.
- For all other sensitive habitats, less than 1% of the total SAC/SPA area will be impacted, rendering the nitrogen deposition effect statistically and ecologically insignificant.

With regards to acid deposition, contribution from the plant is extremely small and exceedances occur due to existing background levels already being in exceedance.

It can be considered, therefore, that the air quality impacts of the plant at the Saltend Power Station site in Hull can be considered as not significant for both human and ecological receptors.

Appendices

Appendix A: Contour Plots (Scenario 2)

Contour plots have been provided for those pollutants and averaging periods which appear to be the most onerous in terms of compliance for Scenario 2.

Figure A.1 – 99.79th Percentile 1-Hour Mean NO_2 Process Contribution Isopleth (µg/m^3) for 2021

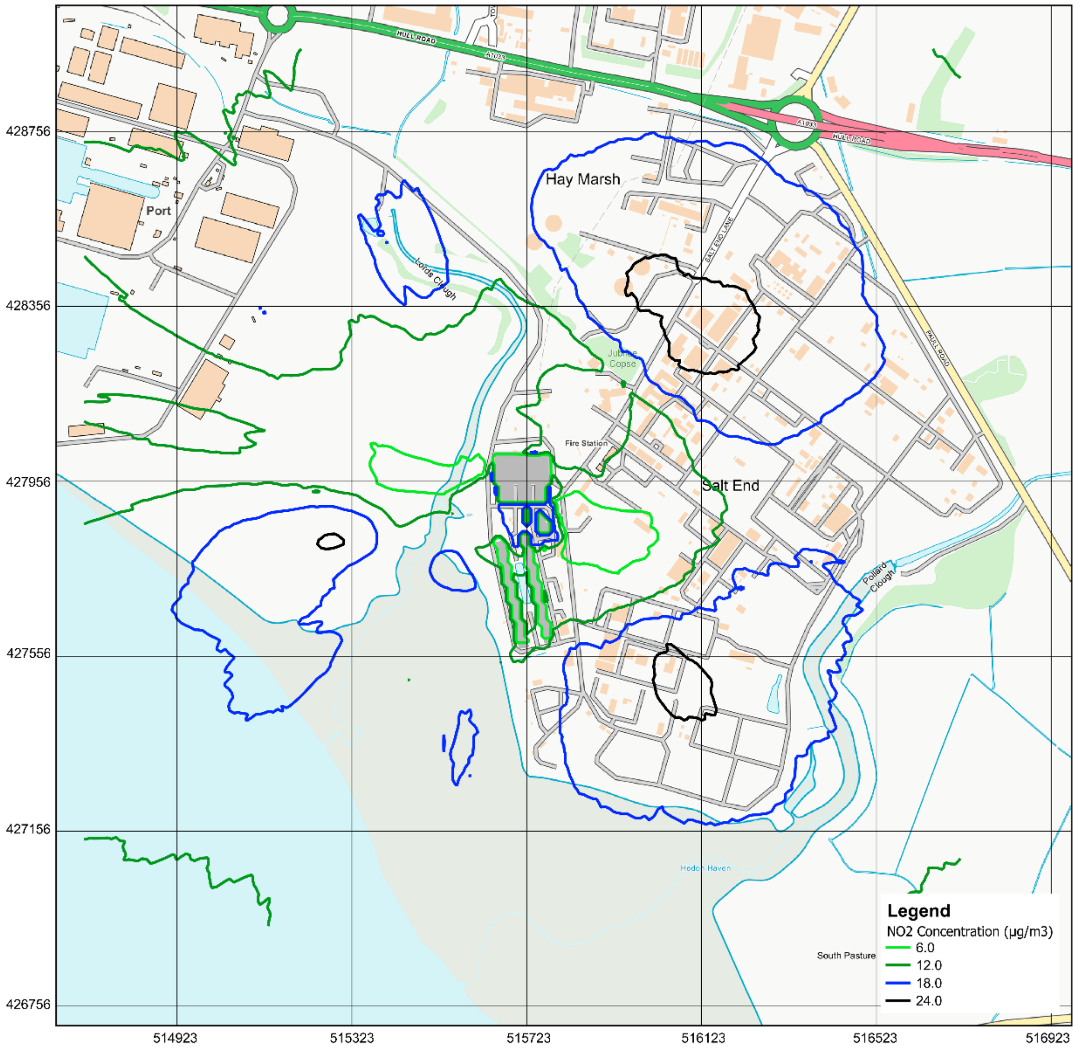
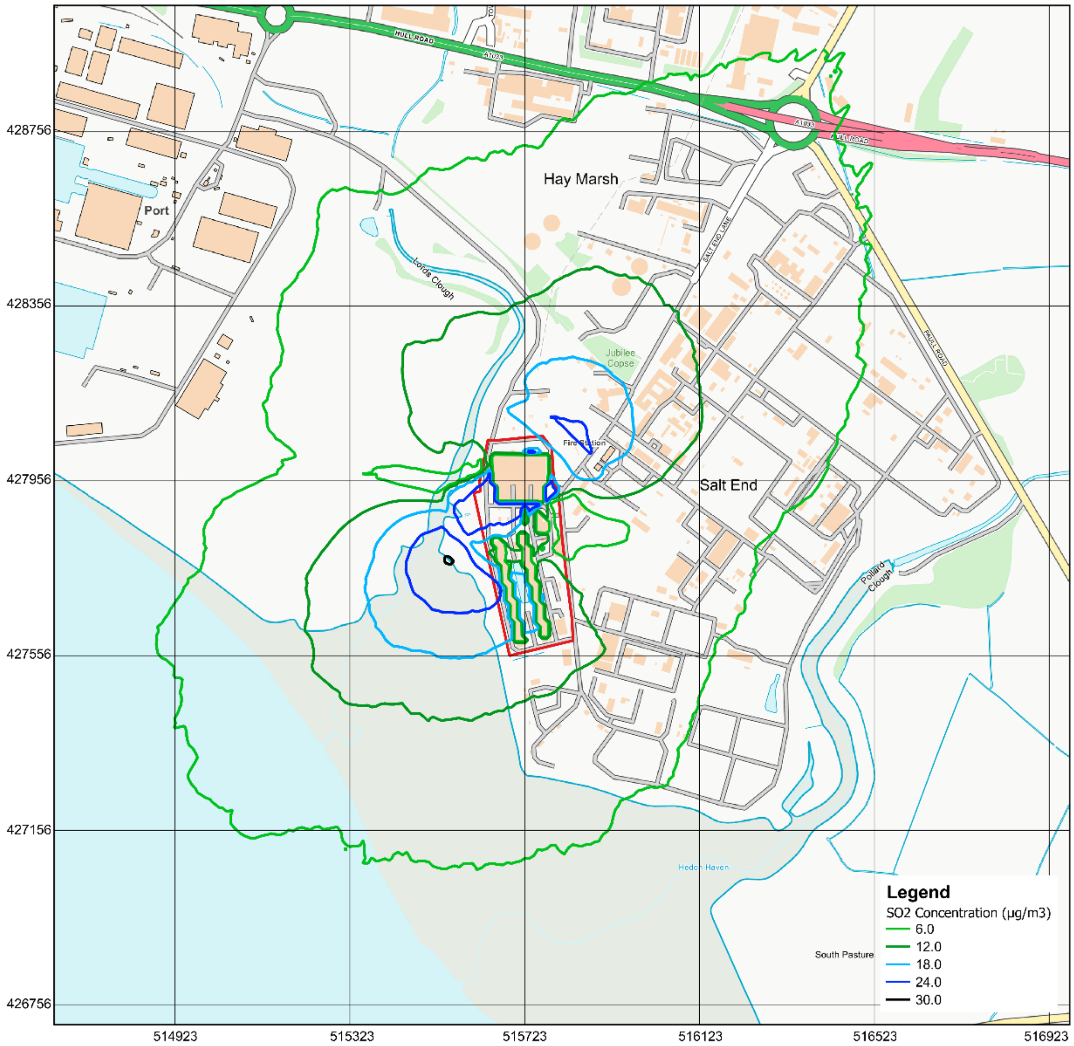


Figure A.2 – 99.73rd Percentile 1-Hour Mean SO_2 Process Contribution Isopleth (µg/m³) for 2021



Appendix B:
Model Files

Appendix C:
Ecological Report