Environmental Statement: Volume III

Appendix 6A: Air Quality Technical Appendix

April 2019

VPI Immingham OCGT Project

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The Immingham Open Cycle Gas Turbine Order

Land to the north of and in the vicinity of the VPI Immingham Power Station, Rosper Road, South Killingholme, Lincolnshire, DN40 3DZ

Environmental Statement Volume III Appendix 6A: Air Quality Technical Appendix

The Planning Act 2008
The Infrastructure Planning (Applications: Prescribed Forms and Procedure) Regulations 2009 - Regulation 5(2)(q)

Applicant: VPI Immingham B Ltd
Date: April 2019

DOCUMENT HISTORY

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GLOSSARY

Abbreviation	Description
AOD	Above Ordnance Datum
ES	Environmental Statement
ha	Hectare
HDV	Heavy Duty Vehicle
HGV	Heavy Goods Vehicle
IAQM	Institute of Air Quality Management
km	Kilometre
LAQM	Local Air Quality Management
m	metre
NAQS	National Air Quality Strategy
NELC	North East Lincolnshire Council
NLC	North Lincolnshire Council
NO	Nitrogen Oxide
NO_2	Nitrogen Dioxide
OCGT	Open Cycle Gas Turbine
PINS	The Planning Inspectorate
$PM_{2.5}$	The concentration of particles that are less than or equal to 2.5 µm.
PM_{10}	The concentration of particles that are less than or equal to 10 µm.
RMSE	Root Mean Square Error
t	Tonne

1.0 INTRODUCTION

This Technical Appendix supplements ES Volume I, Chapter 6: Air Quality and describes the full methodology for the construction dust assessment and additional details relating to the dispersion modelling carried out for the construction traffic assessment. In addition, further details for the parameters used within the dispersion modelling of point source emissions from the operational Proposed Development, as summarised in the main ES chapter (ES Volume I).

1.1 Construction Phase – Criteria for Construction Dust Assessment

The IAQM 2014 Guidance on the Assessment of Dust from Demolition and Construction details the methodology for assessing impacts from construction dust.

The following three potential construction activities have been screened as potentially leading to impacts that could be considered to be not insignificant, based on the assessment criteria detailed within Chapter 6 (ES Volume I, Section 6.4), based on the nature of construction activities proposed (as defined in the IAQM guidance):

- Earthworks (soil stripping, spoil movement and stockpiling);
- Construction (including on-site concrete batching); and,
- Trackout (HGV movements on unpaved roads and offsite mud on the highway).

Magnitude Definitions

The potential magnitude of effects for the potential dust emissions is categorised as detailed in Table 6A.1 below.

Table 6A.1: Definition of Magnitude of Construction Activities

Magnitude	Earthworks	Construction	Trackout
Large	Site area >1ha, potentially dusty soil type (e.g. clay), >10 heavy earth moving vehicles at once, bunds >8m high, total material moved >100,000t.	Total building volume >100,000m^3, on-site concrete batching, sandblasting.	>50 HDV (>3.5t) peak outward movements per day, potentially dusty surface material (e.g. high clay content), unpaved road length >100m.
Medium	Site area 0.25 - 1ha, moderately dusty soil type (e.g. silt), 5-10 heavy earth moving vehicles at once, bunds 4-8m high, total material moved 20,000-100,000t.	Total building volume 25,000-100,000m^3, potentially dusty materials e.g. concrete, on-site concrete batching.	10-50 HDV (>3.5t) peak outward movements per day, moderately dusty surface material (e.g. high clay content), unpaved road length 50-100m.
Small	Site area <0.25ha, large grain soil type (e.g. sand), <5 heavy earth moving vehicles at once, bunds <4m high, total material moved <20,000t.	Total building volume <25,000m^3, low dust potential construction materials e.g. metal/ timber.	<10 HDV (>3.5t) peak outward movements per day, surface material low dust potential, unpaved road length <50m.

Receptor Sensitivity Definitions

The assessment of construction dust has been made with respect to the receptor and area sensitivity definitions (as defined in the IAQM guidance) as outlined in Tables 6A.2-6A4 below.

Table 6A.2: Receptor Sensitivity to Construction Dust Effects

Receptor Sensitivity	Human Perception of Dust Soiling Effects	PM_{10} Health Effects	Ecological Effects
High sensitivity	Enjoy a high level of amenity; appearance/ aesthetics/ value of property would be diminished by soiling; receptor expected to be present continuously/ regularly; e.g. residential/ museums/ car showrooms/ commercial horticulture.	Public present for 8 hours per day or more, e.g. residential, schools, car homes.	Ecological receptor within 50m of source, of national or international importance including SAC, or SSSI with dust sensitive feature(s).
Moderate sensitivity	Enjoy a reasonable level of amenity; appearance/ aesthetics/ value of property could be diminished by soiling; receptor not expected to be present continuously/ regularly; e.g. parks/ places of work.	Only workforce present (no residential or high sensitivity receptors) 8 hours per day or more.	Ecological receptor within 50m of source, of national or regional importance including SSSI or CWS with features with dust sensitive features.
Low sensitivity	Enjoyment of amenity not reasonably expected; appearance/ aesthetics/ value of property not diminished by soiling; receptors are transient/ present for limited period of time; e.g. playing fields, farmland, footpaths, short term car parks* and roads - *subject to typical usage, could be high sensitivity.	Transient human exposure, e.g. footpaths, playing fields, parks.	Ecological receptor within 50m of source, of local importance (e.g. LNR) with dust sensitive features.

Table 6A.3: Sensitivity of the Area to Dust Soiling Effects on People and Property

Receptor Sensitivity	Number of Receptors	Distance from the Source (m)*			
		<20	<50	<100	<350
High	>100	High	High	Medium	Low
	10 – 100	High	Medium	Low	Low
	1 - 10	Medium	Low	Low	Low
Moderate	>1	Medium	Low	Low	Low
Low	>1	Low	Low	Low	Low

*Distance measured from source to receptor; for trackout, receptor distance measured from roadside (up to 50m), up to 500m from Site exit.

Table 6A.4: Sensitivity of the Area to Human Health Impacts

Receptor Sensitivity	Number of Receptors	Distance from the Source (m)*				
		<20	<50	<100	<200	<350
High (annual mean PM_{10} concentration <24 $\mu g/m^3$)	>100	Medium	Low	Low	Low	Low
	10 – 100	Low	Low	Low	Low	Low
	1 - 10	Low	Low	Low	Low	Low
Moderate (annual mean PM_{10} concentration <24 $\mu g/m^3$)	>100	Low	Low	Low	Low	Low
	10 – 100	Low	Low	Low	Low	Low
	1 - 10	Low	Low	Low	Low	Low

Receptor Sensitivity	Number of Receptors	Distance from the Source (m)*				
		<20	<50	<100	<200	<350
Low (annual mean PM_{10} concentration <24 $\mu g/m^3$)	>1	Low	Low	Low	Low	Low

*Distance measured from source to receptor; for trackout, receptor distance measured from roadside (up to 50m), up to 500m from Site exit.

Table 6A.5: Sensitivity of Area to Ecological Impacts

Receptor Sensitivity	Distance to Source*	
	<20m	<50m
High	High	Medium
Moderate	Medium	Low
Low	Low	Low

*Distance measured from source to receptor; for trackout, receptor distance measured from roadside (up to 50m), up to 500m from Site exit.

Risk Definitions

The potential risks from emissions from unmitigated construction activities have been defined with reference to the magnitude of the potential emission and the sensitivity of the highest receptor(s) within the effect area (as defined in the IAQM guidance), as summarised in Table 6A.6 below.

Table 6A.6: Classification of Risk of Unmitigated Impacts

Area of Sensitivity to Activity	Magnitude		
	Large	Medium	Small
Earthworks			
High	High risk	Medium risk	Low risk
Medium	Medium risk	Medium risk	Low risk
Low	Low risk	Low risk	Negligible
Construction			
High	High risk	Medium risk	Low risk
Medium	Medium risk	Medium risk	Low risk
Low	Low risk	Low risk	Negligible
Trackout			
High	High risk	Medium risk	Low risk
Medium	Medium risk	Low risk	Negligible
Low	Low risk	Low risk	Negligible

1.2 Assessment of Construction Dust

For the purpose of this assessment, the Proposed Development site is considered to be a large emissions source for fugitive dust emissions from construction related activities.

Receptor Identification

Table 6A.7: Identification of Receptors for Construction Dust Assessment

ID	Receptor Name	Receptor Type	Approximate Distance from Site Boundary or Exit	Within Screening Distance?	Receptor Sensitivity to Dust and Particulates
R1	Hazel Dene	Residences	0.3km, E	Yes	High
R2	Church Lane, North Killingholme	Residences	1.6km, W	No	-
R3	Station House	Residences	0.9km, NE	No	-
R4	Old Vicarage, North Garth	Residences	2.2km, NW	No	-
R5	Manor Farm, North Killingholme	Residences	1.9km, NW	No	-
R6	Westfield Farm, North Killingholme	Residences	1.7km, W	No	-
R7	Staple Road, South Killingholme	Residences	1.5km, SW	No	-
R8	Humber Road, South Killingholme	Residences	1.3km, SW	No	-
R9	East End Farm	School	1.3km, SW	No	-
R10	Immingham	Residences	2km, S	No	-
R11	Station Road	Residences	1.3km, NE	No	-
R12	Fairfield House, North Garth	Residences	2.3km, NW	No	-
R13	The Poplars	Residences	2.7km, W	No	-
R14	Ulceby Road	Residences	2.5km, W	No	-
R15	Craven Lane	Residences	3.9km, W	No	-
R16	Town Street	Residences	1.9km, W	No	-
R17	Primitive Chapel Lane	Residences	1.9km, W	No	-
R18	Property north of Habrough	Residences	3.7km, SW	No	-
R19	Property on Station Road in Habrough	Residences	3.5km, SW	No	-
E1	Humber Estuary	SAC, SPA, Ramsar	1.4km, NE	No	-
E2	North Killingholme Haven Pits	SSSI	2km, N	No	-
E3	Kirmington Pits	SSSI	8.3km, SW	No	-
E4	Kelsey Hill Gravel Pits	SSSI	11km, NE	No	-
E5	Swallow Wold	SSSI	12.3km, S	No	-

ID	Receptor Name	Receptor Type	Approximate Distance from Site Boundary or Exit	Within Screening Distance?	Receptor Sensitivity to Dust and Particulates
E6	Wrawby Moor	SSSI	14.6km, SW	No	-
E7	Eastfield Railway	LWS	1km, W	No	-
E8	Burkinshaws Covert	LWS	0.4km, N	Yes	Low
E9	Station Road Fields	LWS	0.4km, N	Yes	Low
E10	Rosper Road Pools	LWS	0.2km, SE	Yes	Low
E11	Chase Hill Wood	LWS	1.6km, NW	No	-
E12	Mayflower Wood Meadow	LWS	1.1km, SW	No	-
E13	Homestead Park Pond	LWS/ SINC	1.7km, SE	No	-
E14	Eastfield Road Pit	LWS	1km, W	No	-

Area Sensitivity Assessment

The receptor sensitivity to the effects of dust soiling and PM_{10} (human health) impacts has been determined for all activities, based on the closest distance from the identified receptors to those activities, as summarised in Table 6A.8. The overall area sensitivity to dust soiling, PM_{10} (human health) impacts and ecological impacts is considered to be ‘low’.

Table 6A.8: Area Sensitivity for Receptors of Construction Dust

Activity	Potential Impact	Receptor sensitivity and distance to activity	Area sensitivity
Earthworks	Dust soiling	High sensitivity <350m	Low
	Health PM_{10}	High sensitivity (1-10 receptors) <350m	Low
	Ecological	Low sensitivity <350m	Low
Construction	Dust soiling	High sensitivity <350m	Low
	Health PM_{10}	High sensitivity (1-10 receptors) <350m	Low
	Ecological	Low sensitivity <350m	Low
Trackout	Dust soiling	High sensitivity <350m	Low
	Health PM_{10}	High sensitivity (1-10 receptors) <50m	Low
	Ecological	Low sensitivity <350m	Low

The risk of impacts from unmitigated activities has been determined through a combination of the potential dust emission magnitude and the sensitivity of the area, for each activity to determine the level of mitigation that should be applied. The risk of impacts from unmitigated activities are summarised in Table 6A.9.

Table 6A.9: Risk of Impacts from Unmitigated Activities

Activity	Earthworks	Construction	Trackout
Dust Emission Magnitude	Large	Large	Large

Activity	Earthworks	Construction	Trackout
Risk of impacts from unmitigated activities			
Dust soiling (low sensitivity)	Low Risk	Low Risk	Low Risk
Health PM_{10} (low sensitivity)	Low Risk	Low Risk	Low Risk
Ecological (low sensitivity)	Low Risk	Low Risk	Low Risk

The risk assessment for construction dust indicates that there would be a low risk of dust soiling impacts, human health impacts (‘PM_{10}’) and ecological impacts from unmitigated earthworks, construction and trackout activities. These risk classifications are solely used to select the appropriate schedule of mitigation measures from IAQM guidance.

Mitigation measures to be embedded within the scheme will therefore be defined according to the low risk category for these activities, according to the indicative measures listed in section 6.2 of the IAQM guidance.

1.3 Road Traffic Emissions

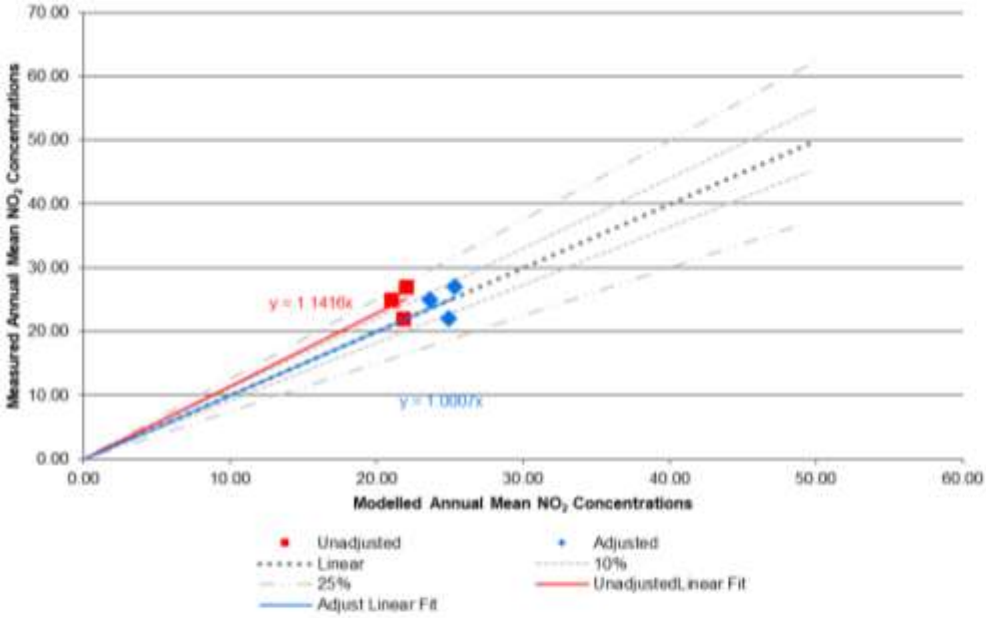
Dispersion Model Parameters

Bias Adjustment of Road Contribution of NO_x, Particulate Matter and Fine Particulate Matter

As detailed in the Chapter 6: Air Quality (Volume I), model verification is the exercise undertaken to account for dispersion model bias. In this study, data for roadside pollutant concentrations is available from diffusion tube and continuous monitoring analysis undertaken by North Lincolnshire Council (‘NLC’). NLC diffusion tubes DT14, DT16 and CM10 were identified as being appropriately close to the study area for the road traffic assessment to be used for model verification.

The factor of the difference between modelled road NO_x and measured road NO_x was calculated to be 1.75. Modelled road NO_x was then factored by this value to obtain an adjusted concentration, which was then converted to NO_2 with use of the Defra NO_x to NO_2 converter tool. A comparison of the adjusted NO_2 predictions and the measured concentrations at these locations was undertaken.

The accuracy of the adjusted model was also considered via the calculation of the Root Mean Square Error (‘RMSE’). Ideally the RMSE value should be within 10% of the NAQS objective value (i.e. 4µg/m^3), and if within 25% it is considered to be acceptable (i.e. 10µg/m^3). After adjustment the model used in this study had an RMSE of 2.1µg/m^3, which was within the RMSE ideal criteria of within 10%. As such, a correction factor of 1.75 was applied to the modelled NO_x road contributions for all receptors modelled.



In the absence of suitably located sample measurement data for the primary pollutants PM_{10} and $PM_{2.5}$, the same approach to bias adjustment has been applied to the modelled road PM_{10} and $PM_{2.5}$ contributions as to the primary road NO_x contribution, as recommended in LAQM.TG(16).

Oxides of Nitrogen to Nitrogen Dioxide Conversion

To accompany the publication of the guidance document LAQM TG(16), an oxides of nitrogen to nitrogen dioxide converter was made available by Defra as a tool to calculate the road NO_2 contribution from modelled road oxides of nitrogen contributions (Version 6.1). The tool comes in the form of an MS Excel spreadsheet and uses borough specific data to calculate annual mean concentrations of NO_2 from dispersion model output values of annual mean concentrations of NO_x. This tool was used to calculate the total NO_2 concentrations at receptors from the modelled road NO_x contribution and associated background concentration. Due to the location of the Proposed Development, NLC and North East Lincolnshire Council (‘NELC’) have been specified as the local authorities and the ‘All other UK traffic’ mix selected.

Predicting the Number of Days in which the PM_{10} 24-hour Mean NAQS Objective is Exceeded

The guidance document LAQM.TG(03) sets out the method by which the number of days in which the particulate matter 24 hour objective is exceeded can be obtained based on a relationship with the predicted particulate matter annual mean concentration. The most recent guidance LAQM.TG(16) suggests no change to this method. As such, the formula used within this assessment is:

$$No. of\ Exceedances = 0.0014\ x\ C^3 + \frac{206}{C} - 18.5$$

Where C is the annual mean concentration of PM_{10}.

Predicting the Number of Days in which the NO_2 Hourly Mean NAQS Objective is Exceeded

Research completed on behalf of Defra and the Devolved Administrations (Laxen and Marner, 2003, AEAT, 2008), have concluded that the hourly mean NO_2 objective is unlikely to be exceeded if annual mean concentrations are predicted to be less than 60µg/m^3.

In 2003, Laxen and Marner concluded:

"…local authorities could reliably base decisions on likely exceedances of the 1-hour objective for nitrogen dioxide alongside busy streets using an annual mean of 60µg/m^3 and above."

The findings presented by Laxen and Marner (2003) are further supported by AEAT (2008) who revisited the investigation to complete an updated analysis including new monitoring results and additional monitoring sites. The recommendations of this report are:

"Local authorities should continue to use the threshold of 60µg/m^3 NO_2 as the trigger for considering a likely exceedance of the hourly mean nitrogen dioxide objective."

Therefore this assessment will evaluate the likelihood of exceeding the hourly mean NO_2 objective by comparing predicted annual mean NO_2 concentrations at all receptors to an annual mean equivalent threshold of 60µg/m^3 NO_2. Where predicted concentrations are below this value, it can be concluded that the hourly mean NO_2 objective (200µg/m^3 NO_2 not to be exceeded more than 18 times per year) will be achieved.

The modelled and adjusted annual mean concentrations of NO_2, PM_{10} and $PM_{2.5}$, and the number of exceedances of the PM_{10} 24-hour mean NAQS objective, at the selected receptors during the 2017 baseline scenario used for the traffic assessment are listed in Table 6A.10.

Table 6A.10: Air Quality Statistics Predicted for Traffic Model Verification 2017

ID	Receptor Name	Annual Mean Pollutant Concentration			Number of Days of exceedance of 24-hour Mean PM_{10} of 50µg/m^3 (days)
		NO_2 (µg/m^3)	PM_{10} (µg/m^3)	$PM_{2.5}$ (µg/m^3)	
R1	Hazel Dene	18.3	15.8	10.8	<1
R8	Humber Road, South Killingholme	20.8	16.6	11.1	<1
R13	The Poplars	19.9	16.4	11.0	<1
R14	Ulceby Road	21.6	16.7	11.1	<1
R15	Craven Lane	17.6	16.0	10.7	<1
R16	Town Street	23.6	17.2	11.4	<1
R17	Primitive Chapel Lane	21.8	16.8	11.2	<1
R18	Property north of Habrough	17.5	16.0	10.7	<1
R19	Property on Station Road in Habrough	17.6	16.0	10.7	<1

1.4 Point Source Emissions

Dispersion Model Parameters

The emissions inventory modelled for the assessment of impacts from the operational Proposed Development is detailed in Chapter 6: Air Quality and the additional model input parameters are provided in the sections below.

NO_X to NO_2 Conversion – Combustion Plant

Emissions of nitrogen oxides from industrial point sources are typically dominated by nitric oxide ('NO'), with emissions from combustion sources typically in the ratio of nitric oxide to nitrogen dioxide of 9:1. However, it is nitrogen dioxide that has specified NAQS objectives due to its potential impact on human health. In the ambient air, nitric oxide is oxidised to nitrogen dioxide by the ozone present, and the rate of oxidation is dependent on the relative concentrations of nitric oxide and ozone in the ambient air.

For the purposes of detailed modelling, and in accordance with Environment Agency technical guidance it is assumed that 70% of emitted nitric oxide is oxidised to nitrogen dioxide in the long term and 35% of the emitted nitric oxide is oxidised to nitrogen dioxide in the local vicinity of the site in the short-term.

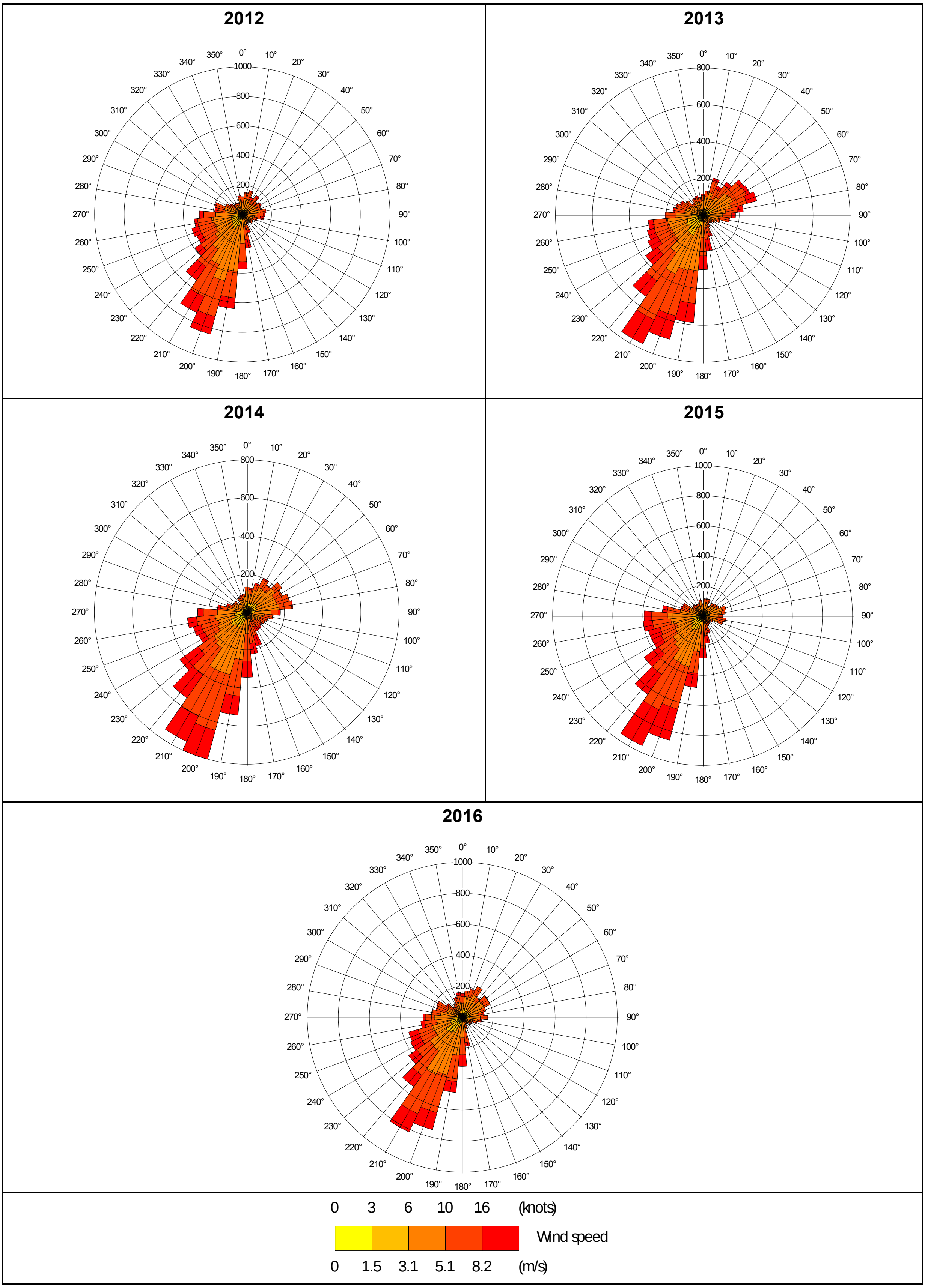
Meteorological Data

Actual measured hourly-sequential meteorological data is available for input into dispersion models, and it is important to select data as representative as possible for the site that is modelled. This is usually achieved by selecting a meteorological station as close to the site as possible, although other stations may be used if the local terrain and conditions vary considerably, or if the station does not provide sufficient data.

The meteorological site that was selected for the assessment is Humberside Airport, located approximately 9.5km southwest of the Proposed Development, at a flat airfield in a principally agricultural area, and therefore a surface roughness of 0.2m (representative of agricultural areas) has been selected for the meteorological site.

The modelling for this assessment has utilised 5 years of meteorological data for the period 2012 - 2016, and the worst case impacts from all years modelled has been used in the assessment. The sensitivity of the model results to the data from the five meteorological years is provided in the Sensitivity Analysis in this appendix. The wind roses for Humberside for 2012 to 2016 are provided in Figure 6A.1.

Figure 6A.1: Windrose for Humberside Airport 2012 - 2016



Buildings and Terrain

The presence of buildings or structures near to the emission points can have a significant effect on the dispersion of emissions. The wind field can become entrained into the wake of buildings, which causes the wind to be directed to ground level more rapidly than in the absence of a building. If an emission is entrained into this deviated wind field, this can give rise to elevated ground-level concentrations. Building effects are typically considered where a structure of height greater than 40% of the stack height is situated within 8 - 10 stack heights of the emissions source.

Buildings associated with the Proposed Development that are considered to be of sufficient height and volume to potentially impact on the dispersion of emissions from the OCGT Power Station stack include the OCGT Power Station building and air intakes.

At this stage, the air quality assessment is conservatively based on the maximum (worst-case) building dimensions as outlined in ES Volume I, Chapter 4: The Proposed Development (Application Document Ref 6.2). In reality, the building dimensions may be smaller than the ones used in the assessment, and this would be expected to reduce the significance of building impacts on the dispersion of emissions from the OCGT stack and therefore reduce the maximum predicted ground level concentrations; the results presented in ES Volume I, Chapter 6: Air Quality are therefore considered to be conservative with respect to building effects. The sensitivity of the model results to the building dimensions is provided in the Sensitivity Analysis in this Appendix.

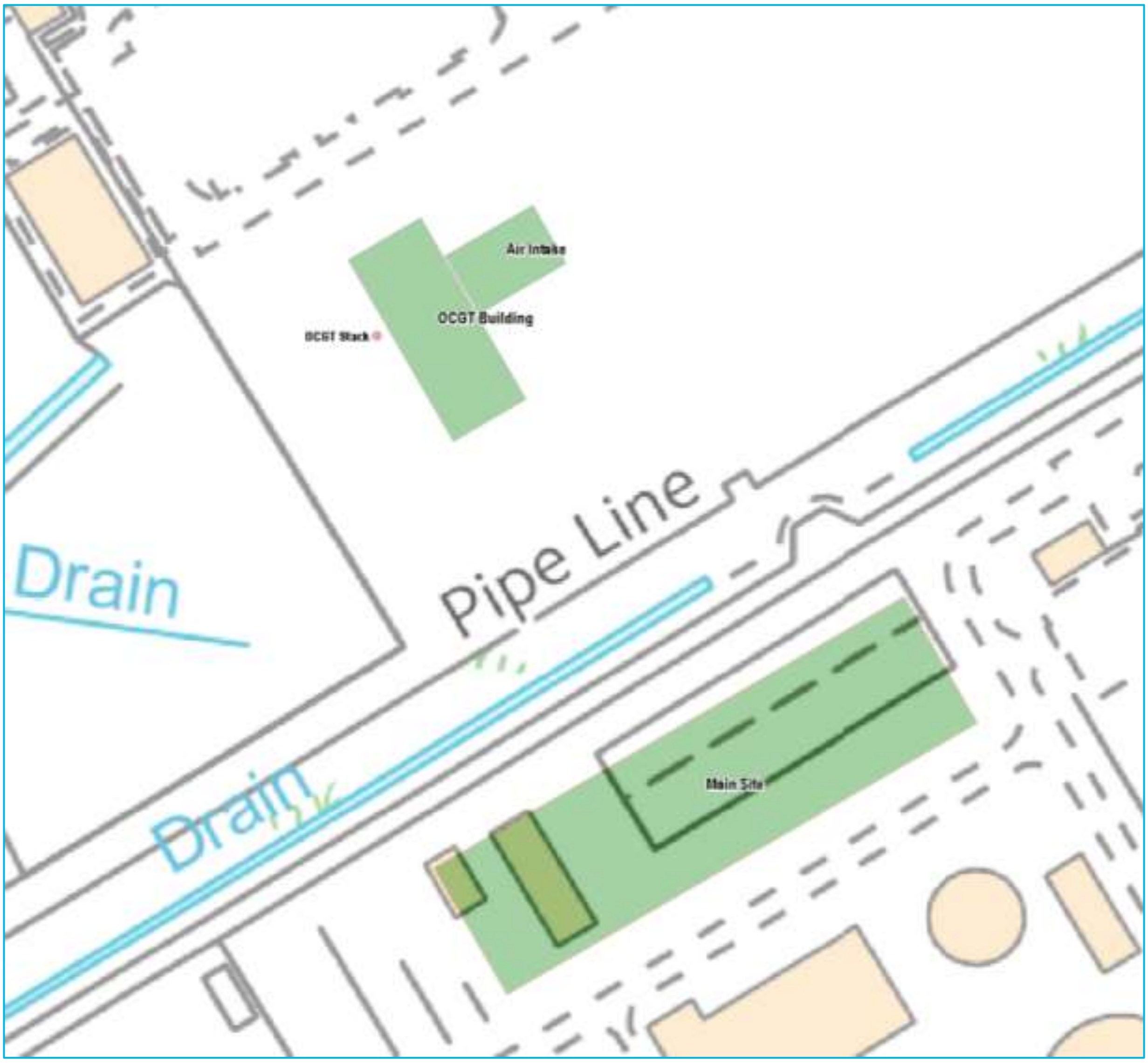
Parameters representing the buildings included in the model are shown in Table 6A.11 and a plan showing the worst-case buildings used in the ADMS simulations is illustrated in Figure 6A.2 below.

Table 6A.11: Buildings Incorporated into the Modelling Assessment

Building	Building Centre Grid Reference (x,y)	Height (m)[1]	Length (m)	Width (m)	Angle (°)[2]
VPI CHP Building	516718, 417296	22	130	35	60
OCGT Building	516653, 417408	23	25	46	60
Air Intake	516670, 417424	34	16	24	150

[1] Height of building above the finished ground level of the Proposed Development site.
[2] Angle of the building from North

Figure 6A.2: Building Visualisation



The local area upwind and downwind of the OCGT Power Station is flat, and predominantly industrial to the west, and agricultural to the north, south and east. A surface roughness of 0.5m, corresponding to Parkland and Open Suburbia, has therefore been selected to represent the local terrain.

Site-specific terrain data has not been used in the model, as typically terrain data will only have a marked effect on predicted concentrations where hills with gradient of more than 1 in 10 are present in the vicinity of the source, which is not the case at the OCGT Power Station.

Other Surface Parameters

The dispersion model can incorporate additional site-specific parameters relating to surface effects on dispersion of emissions. These include:

- Surface albedo – the ratio of reflected to incident shortwave solar radiation, in particular this is affected by ground snow cover;
- Minimum Monin-Obukhov length – this is a measure of atmospheric stability not represented by meteorological data and allows for urban heat-island effects, typically associated with large towns and cities; and
- Priestly-Taylor parameter – representing surface moisture that can evaporate.

The area in the immediate vicinity of the OCGT Power Station is considered to be similar to the meteorological site with respect to the above characteristics, and therefore the model has been run assuming that these site surface parameters are the same.

Modelled Domain and Receptors

The main model results have been based on a grid extending 4km from the point source with a grid resolution output at 148m intervals from the source. The nearest sensitive receptor to the source is located approximately 350m from the source, therefore this resolution is considered appropriate. Discrete receptor locations, including residential properties and ecological receptors up to 15km from the Proposed Development, have also been included in the model, as detailed Chapter 6: Air Quality (ES Volume I (Application Document Ref. 6.2). These discrete receptors are not affected by the grid resolution selected in the model. Ecological receptor grid references have been determined through identification of the nearest receptor boundary to the Proposed Development. Modelled receptor locations are shown in Figures 6.1 and 6.2 (ES Volume II, Application Document Ref. 6.3).

Stack Height Determination

The proposed stack height for the OCGT Power Station has been optimised following screening modelling using conservative emission parameters, followed by detailed dispersion modelling and assessment to identify the appropriate stack height. A screening stack height range of 35 – 55m was selected based on professional experience of typical OCGT plant stack heights and considering the height of the buildings associated with the OCGT plant. It can be seen from Table 6A.12 that the impacts at the worst case human health and ecological receptors at all stack heights are considered to be imperceptible, and therefore a stack height of 35m (above finished ground level) could be acceptable.

At a stack height of 40m, the impacts increase slightly over those predicted for the 35m stack. It is therefore considered that the 35m stack results in lower impacts due to increased building downwash effects, bringing the plume to ground closer to the stack, resulting in poor dispersion of the plume (and hence lower predicted concentrations at receptors further away). A 45m stack was considered to lead to better dispersion of the emission from the Proposed Development than a 35m or 40m stack, and it would also result in lower visual impacts than a higher stack, say of 50m or 55m and therefore has been selected as the potentially suitable stack height. Although a higher stack would reduce the Process Contributions at receptors further, as the impacts are already considered to be negligible at all the lower stack heights assessed, it is not considered necessary to install a higher stack.

Table 6A.12: Max Long Term PCs at Worst Case Receptor at Assessed Stack Heights

Main plant stack height	Annual mean NO_2 PC at HH receptor / NAQS	Magnitude of change	Effect	Annual mean NO_X PC at Ecological receptor/ CL	Magnitude of change	Effect
35m	0.23%	Imperceptible	Negligible	0.32%	Imperceptible	Negligible
40m	0.30%	Imperceptible	Negligible	0.34%	Imperceptible	Negligible
45m	0.18%	Imperceptible	Negligible	0.32%	Imperceptible	Negligible
50m	0.16%	Imperceptible	Negligible	0.29%	Imperceptible	Negligible
55m	0.14%	Imperceptible	Negligible	0.27%	Imperceptible	Negligible

The 45m stack height has been selected as the optimum stack height for the purposes of the ES air quality assessment, and these are the results that have been reported in the assessment. This has been referenced to Ordnance Datum (mAOD), with the assumed made ground of the Site estimated to be 6mAOD, such that a fixed emission release point of a maximum of 51mAOD is assumed.

1.5 Likely Impacts and Effects

The predicted impacts from the worst case scenario assessed and based on conservative assumptions as outlined in Chapter 6 are presented in Tables 6A.13 to 6A.17.

Construction Traffic Emissions

Table 6A.13: Long Term NO_2 PCs at Human Health Receptors for the Peak Construction Traffic

Receptor ID	2021 NO_2 baseline ($\mu g/m^3$)[1]	Magnitude of change due to construction traffic ($\mu g/m^3$)	2022 NO_2 with construction traffic[2] ($\mu g/m^3$)	Annual mean NO_2 PEC[3]/NAQS	Effect
R1	18.6	<0.1	18.6	47%	Negligible
R8	20.7	<0.1	20.7	52%	Negligible
R13	19.7	<0.1	19.7	49%	Negligible
R14	21.5	<0.1	21.5	54%	Negligible
R15	17.2	<0.1	17.2	43%	Negligible
R16	23.7	<0.1	23.7	59%	Negligible
R17	21.8	<0.1	21.8	54%	Negligible
R18	17.2	<0.1	17.2	43%	Negligible
R19	17.2	<0.1	17.2	43%	Negligible

[1] 2022 Baseline is 2015 background + future emissions due to normal traffic growth for 2022
[2] 2022 with construction is 2015 background + emissions from Proposed Development construction traffic
[3] PEC= predicted environmental concentration (PC + background)

Table 6A.14: Annual Mean NO_x PCs at Ecological Receptors for the Peak Construction Traffic

Receptor ID	Annual mean NO_x baseline ($\mu g/m^3$)	Annual mean NO_x PC ($\mu g/m^3$)	Annual mean PC/ Critical Level	Annual mean NO_x PEC ($\mu g/m^3$)	Annual mean PEC/ Critical Level	Effect
E1	30.0	<0.01	<0.1%	30.0	100%	Negligible adverse
E2	24.4	<0.01	<0.1%	24.4	81%	Negligible adverse
E3	19.9	<0.01	<0.1%	19.9	66%	Negligible adverse
E4	19.4	<0.01	<0.1%	19.4	65%	Negligible adverse
E5	18.8	<0.01	<0.1%	18.8	63%	Negligible adverse
E6	20.2	<0.01	<0.1%	20.2	67%	Negligible adverse
E7	21.9	<0.01	<0.1%	21.9	73%	Negligible adverse
E8	23.4	0.01	<0.1%	23.4	78%	Negligible adverse
E9	23.4	0.02	0.1%	23.4	78%	Negligible adverse
E10	28.1	0.10	0.3%	28.2	94%	Negligible adverse
E11	21.8	<0.01	<0.1%	21.8	73%	Negligible adverse
E12	22.3	<0.01	<0.1%	22.3	74%	Negligible adverse
E13	24.2	<0.01	<0.1%	24.2	81%	Negligible adverse
E14	21.9	0.01	<0.1%	21.9	73%	Negligible adverse

Long-term significance criteria: Insignificant / imperceptible<1% of long-term Critical Level

Operational Emissions

Table 6A.15: Long Term NO_2 PCs at Human Health Receptors for the 2022 Operational Scenario

Receptor I.D.	Annual Average PC ($\mu g/m^3$)	PC/ NAQS	Magnitude of Change	Annual Average AC ($\mu g/m^3$)	PEC/ NAQS	Effect Descriptor
R1	0.03	0.1%	Imperceptible	17.0	43%	Negligible adverse
R2	0.01	<0.1%	Imperceptible		43%	Negligible adverse
R3	0.1	0.3%	Imperceptible		43%	Negligible adverse
R4	0.005	<0.1%	Imperceptible		43%	Negligible adverse
R5	0.009	<0.1%	Imperceptible		43%	Negligible adverse
R6	0.02	0.1%	Imperceptible		43%	Negligible adverse
R7	0.02	<0.1%	Imperceptible		43%	Negligible adverse
R8	0.02	<0.1%	Imperceptible		43%	Negligible adverse
R9	0.01	<0.1%	Imperceptible		43%	Negligible adverse
R10	0.005	<0.1%	Imperceptible		43%	Negligible adverse
R11	0.06	0.2%	Imperceptible		43%	Negligible adverse
R12	0.004	<0.1%	Imperceptible		43%	Negligible adverse

EA long-term significance criteria: insignificant if <1% of long term NAQS objective.

Table 6A.16: Short Term NO_2 PCs at Human Health Receptors for the 2022 Operational Scenario

Receptor ID	Hourly NO_2 PC (µg/m^3)	PC/ NAQS	Magnitude of Change	NO_2 baseline (µg/m^3)	PEC/ NAQS	Effect Descriptor
R1	3.6	2%	Imperceptible	34.0	19%	Negligible adverse
R2	2.1	1%	Imperceptible		18%	Negligible adverse
R3	4.4	2%	Imperceptible		19%	Negligible adverse
R4	1.0	<1%	Imperceptible		17%	Negligible adverse
R5	1.8	1%	Imperceptible		18%	Negligible adverse
R6	2.2	1%	Imperceptible		18%	Negligible adverse
R7	2.1	1%	Imperceptible		18%	Negligible adverse
R8	2.1	1%	Imperceptible		18%	Negligible adverse
R9	2.0	1%	Imperceptible		18%	Negligible adverse
R10	1.1	1%	Imperceptible		18%	Negligible adverse
R11	3.2	2%	Imperceptible		19%	Negligible adverse
R12	0.7	1%	Imperceptible		17%	Negligible adverse

Short-term baseline assumed to be twice the annual average baseline; EA short-term significance criteria: insignificant if <10% of short-term NAQS Objective

Table 6A.17: Daily Mean NO_X PCs at Ecological Receptors for the 2022 Operational Scenario

Receptor ID	NO_x short-term baseline (µg/m^3)	Daily mean NO_x PC (µg/m^3)	Daily mean PC/ Critical Level	Daily mean NO_x PEC (µg/m^3)	Daily mean PEC/ Critical Level	Effect
E1	44.9	7.4	10%	52.3	70%	Negligible adverse
E2	36.6	3.7	5%	40.3	54%	Negligible adverse
E3	29.8	1.0	1%	30.8	41%	Negligible adverse
E4	29.0	0.6	1%	29.6	39%	Negligible adverse
E5	28.1	0.4	1%	28.6	38%	Negligible adverse
E6	30.3	0.5	1%	30.8	41%	Negligible adverse
E7	32.8	6.3	8%	39.0	52%	Negligible adverse
E8	35.1	3.7	5%	38.8	52%	Negligible adverse
E9	35.1	8.2	11%	43.3	58%	Minor adverse
E10	42.2	3.1	4%	45.3	60%	Negligible adverse
E11	32.8	3.1	4%	35.8	48%	Negligible adverse
E12	33.4	4.1	6%	37.5	50%	Negligible adverse
E13	36.3	1.2	2%	37.6	50%	Negligible adverse
E14	32.8	6.9	9%	39.7	53%	Negligible adverse

Short-term baseline assumed to be one and a half times the annual average baseline; EA short-term significance criteria: insignificant if <10% of short-term Critical Level

Table 6A.18: Maximum Annual Mean NO_X PCs at Ecological Receptors for the 2022 Operational Scenario

Receptor ID	Annual mean NO_x baseline ($\mu g/m^3$)	Annual mean NO_x PC ($\mu g/m^3$)	Annual mean PC/ Critical Level	Annual mean NO_x PEC ($\mu g/m^3$)	Annual mean PEC/ Critical Level	Effect
E1	30.0	0.14	0.5%	30.0	100%	Negligible adverse
E2	24.4	0.06	0.2%	24.4	82%	Negligible adverse
E3	19.9	0.01	<0.1%	19.9	66%	Negligible adverse
E4	19.4	0.02	0.1%	19.4	65%	Negligible adverse
E5	18.8	0.005	<0.1%	18.8	63%	Negligible adverse
E6	20.2	0.009	<0.1%	20.2	67%	Negligible adverse
E7	21.9	0.04	0.1%	21.9	73%	Negligible adverse
E8	23.4	0.03	0.1%	23.4	78%	Negligible adverse
E9	23.4	0.06	0.2%	23.5	78%	Negligible adverse
E10	28.1	0.01	<0.1%	28.1	94%	Negligible adverse
E11	21.8	0.02	0.1%	21.9	73%	Negligible adverse
E12	22.3	0.02	<0.1%	22.3	74%	Negligible adverse
E13	24.2	0.006	<0.1%	24.2	81%	Negligible adverse
E14	21.9	0.04	0.1%	21.9	73%	Negligible adverse

Long-term significance criteria: Insignificant/ imperceptible <1% of long-term Critical Level

Table 6A.19: Maximum Predicted Nutrient Nitrogen Deposition to Land at Ecological Receptors

ID	Critical Load Class	Critical Load Range (kg N/ha/hr)	Baseline (kgN/ha/yr) [as % lower Critical Load]	Annual mean PC (kgN/ha/yr)	PC / Critical Load (lower)	Effect
E1 Humber Estuary SPA, SAC and SSSI	*Rich Fens*	15 - 30	100%	0.0003	<0.1%	Insignificant
	Low and medium altitude hay meadows	20 - 30	75%	0.01	<0.1%	Insignificant
	Pioneer, low-mid, mid-upper saltmarshes	20 – 30	75%	0.01	<0.1%	Insignificant
	Coastal stable dune grassland - acid type	8 - 10	188%	0.0003	<0.1%	Insignificant
	Coastal stable dune grassland - calcareous type	10 – 15	150%	0.0003	<0.1%	Insignificant
	Coastal shifting dunes	10 - 20	150%	0.0003	<0.1%	Insignificant
	Northern wet heath	10 - 20	150%	0.0003	<0.1%	Insignificant
E2 North Killingholme Haven Pits SSSI	*Pioneer, low-mid, mid-upper saltmarshes*	20 - 30	81%	0.006	<0.1%	Insignificant
E3 Kirmington Pits SSSI	No information listed within APIS					
E4 Kelsey Hill Gravel Pits SSSI	No features listed within APIS					
E5 Swallow Wold SSSI	*Calcareous grassland*	15 - 25	125%	0.0005	<0.1%	Insignificant

ID	Critical Load Class	Critical Load Range (kg N/ha/hr)	Baseline (kgN/ha/yr) [as % lower Critical Load]	Annual mean PC (kgN/ha/yr)	PC / Critical Load (lower)	Effect
E6 Wrawby Wold SSSI	*Acid grassland*	10 - 15	253%	0.0010	<0.1%	Insignificant
	Broadleaved and mixed yew woodland	15 - 20	283%	0.002	<0.1%	Insignificant

Notes:
PC/ Critical Load <1% is described as insignificant or 'imperceptible'
1 = Critical Loads and existing baseline levels taken from APIS
2 = "Rich Fens" and "Northern Wet Heath" habitat are not considered to occur in the vicinity of the Proposed Development Site. The annual PC has therefore been assessed at a location to the west of the Humber Bridge, which is considered to be the closest location where such habitat could occur.
3 = There are not considered to be any "Dune" type habitats within the vicinity of the Proposed Development Site. The annual PC has therefore been assessed at known dune locations, namely south of Cleethorpes and at Spurn Point.

Table 6A.20: Maximum Predicted Acid Deposition to Land at Ecological Receptors

ID	Receptor name (Critical Load Class: most sensitive species)	Critical Load (keqN/ha/yr)	Critical Load (keqS/ha/yr)	Total Background (N:S keq/ha/yr)	Process contribution of N to Acid Deposition[12]	PC/ Critical Load (CLMaxN)	PEC/ Critical Load (CLMaxN)	Effect
E1 Humber Estuary SPA, SAC and SSSI	*Acid Grassland*	0.223 – 0.643	0.420	1.07:0.32	0.0006	<0.1%	216%	Insignificant
	Calcareous grassland	0.856 – 4.856	4.000	1.07:0.32	0.0006	<0.1%	29%	Insignificant
	Dwarf Shrub and Heath	0.499 – 1.312	0.420	1.07:0.32	0.00002	<0.1%	106%	Insignificant
E2 North Killingholme Haven Pits SSSI	Not sensitive to acid deposition							
E3	No information listed within APIS							

ID	Receptor name (Critical Load Class: most sensitive species)	Critical Load (keqN/ha/yr)	Critical Load (keqS/ha/yr)	Total Background (N:S keq/ha/yr)	Process contribution of N to Acid Deposition[12]	PC/ Critical Load (CLMaxN)	PEC/ Critical Load (CLMaxN)	Effect
Kirmington Pits SSSI								
E4 Kelsey Hill Gravel Pits SSSI	No features listed within APIS							
E5 Swallow Wold SSSI	*Calcareous grassland*	0.856 – 4.856	4.000	1.34:0.27	0.00003	<0.1%	33%	Insignificant
E6 Wrawby Wold SSSI	*Acid grassland*	0.366 – 0.536	0.170	1.81:0.31	0.00005	<0.1%	396%	Insignificant
	Broadleaved and mixed yew woodland	0.285 – 1.333	0.748	3.04:0.35	0.00009	<0.1%	254%	Insignificant

[1] Sulphur contribution from Proposed Development assumed to be zero.
[2] PC/ Critical Load <1% is described as insignificant or 'imperceptible'

Operational Scenario Model Sensitivity Analysis

The assessment has taken into consideration the sensitivity of predicted results to dispersion model input variables, to identify the realistic worst-case process contributions at sensitive receptor locations. These variables include:

- Meteorological data, for which five years' recent data from a representative meteorological station (Humberside Airport) have been used;
- Buildings, structures and local topography that could affect dispersion from the source; and
- Surface Roughness – both a higher and lower surface roughness have been assessed.

The maximum predicted concentration of NO_2 at the worst-affected human health receptors, and NO_x at the worst-affected statutory designated ecological receptor, associated with the variable input parameters are presented in Table 6A.21 as the percentage of maximum reported values used in determining whether effects are significant or not significant.

Table 6A.21: Operation Point Source Dispersion Model Sensitivity Analysis

Model Input Variable	Human Health Receptor		Statutory Ecological Receptor	
	Short term	Long term	Short term	Long term
Meteorological data (5-year min-max)	81% - 100%	39 – 100%	51 – 100%	55 – 100%
Buildings representation (no buildings)	69% - 100%	89% - 100%	92 – 100%	95% - 100%
Stack location moved by 10m	81% - 100%	100 – 101%	100% - 102%	100%
Surface roughness representation (0.3m)	79% - 100%	92% - 100%	100 – 102%	94% - 100%
Surface roughness representation (0.1m)	84% - 100%	100% - 111%	95 – 100%	100 – 109%

The main uncertainty associated with the model is considered to be meteorological data, with a variation of 39% in the annual average NO_2 PC at human health receptors and 55% variation at the worst case statutory ecological receptor. This is equivalent to an overall uncertainty associated with the annual average mean PC at the worst-affected human health receptor of -0.02µg/m^3 (or -0.05% of the NAQS) and -0.07µg/m^3 (or -0.2% of the Critical Level at the statutory ecological receptor.

The short term impacts have a variation of 81% in the NO_2 PC at human health receptors and 51% variation at the worst case statutory ecological receptor. This is equivalent to an overall uncertainty associated with the hourly mean PC at the worst-affected human health receptor of -0.8µg/m^3 (or -2% of the NAQS) and -3.6µg/m^3 (or -4.8% of the Critical Level at the statutory ecological receptor).

The variation in surface roughness resulted in 2 - 5% change in the short-term PC at the worst-affected ecological receptor and at the modelled receptor. The long term impacts were more marked, especially for the increased surface roughness, however as a surface roughness of 1m is typically used to represent city locations, it is not considered appropriate to represent the roughness within the Study Area.

The overall worst-case input parameters have been used to generate the PCs used in the assessment presented in Chapter 6, ES Volume I (Application Document Ref. 6.2). Application of the above sensitivity results to PCs does not significantly alter the predicted effects assessment reported in the Chapter 6.