Preliminary Environmental Information Report

Volume III - Appendices

Appendix 8B: Air Quality - Operation Phase

The Infrastructure Planning (Environmental Impact Assessment) Regulations 2017 (as amended)

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8B. Air Quality – Operational Phase

8.1 Introduction

Overview

8.1.1 This report provides a technical appendix to Chapter 8: Air Quality, of the Preliminary Environmental Information (PEI) Report (Volume I).

8.1.2 AECOM has been instructed by the Applicant to assess the likely significant effects on air quality as a result of the combustion plant and the carbon capture plant for the Net Zero Teesside Project (hereafter referred to as the 'Proposed Development'). For more details about the Proposed Development, refer to Chapter 4: Proposed Development (PEI Report, Volume I).

8.1.3 Emissions associated with the combustion plant and the carbon capture process have the potential to affect human health and sensitive ecosystems, if not appropriately managed. This technical appendix identifies and proposes measures to address the potential impacts and effects of the Proposed Development on air quality during its operational phase.

8.1.4 The magnitude of air quality impacts at sensitive human and ecological receptors has been quantified for pollutants emitted from the main stacks associated with the Proposed Development. The impact of emissions on sensitive ecological receptors has been considered in the context of relevant critical levels and critical loads for Ecological receptors.

8.1.5 In addition, the dispersion modelling exercise will provide inputs to the Human Health Risk Assessment (HHRA) that quantifies the potential long-term impacts of emissions from the operation of the process on human health. The HHRA does not form part of this PEI Report but would be prepared and submitted as part of the final Environmental Statement (ES) for the DCO application.

8.1.6 The assessment has considered emissions from the Proposed Development during normal operational conditions. Non routine emissions, such as those which may occur during the commissioning process or other short-term events would typically only occur on an infrequent basis, are detected by the process control system and rectified within a short time period and are tightly regulated by the Environment Agency. For this reason, no detailed consideration of impacts associated with non-routine or emergency events has been included in this assessment.

8.2 Scope

Combustion Plant and Carbon Capture Emissions

8.2.1 The assessment has considered the impact of process emissions on local air quality, under normal operating conditions, with the power plant operational and the flue gas being abated by the carbon capture unit, and operation for

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8,760 hours per year. The assessment considers impacts in the year in which the Proposed Development is due to commence operation, 2026.

8.2.2 The Study Area for the operational Proposed Development point source emissions extends up to 15km from the PCC site, in order to assess the potential impacts on ecological receptors, in line with the Environment Agency risk assessment methodology (Defra and EA, 2016):

- Special Protection Areas (SPAs), Special Areas of Conservation (SACs), Ramsar sites and Sites of Special Scientific Interest (SSSIs) within 15 km; and
- Local Nature Sites (including ancient woodlands, Local Wildlife Sites (LWS) and National and Local Nature Reserves (NNR and LNR)) within 2 km.

8.2.3 In terms of human health receptors, impacts from the operational Proposed Development become negligible within approximately 2km and therefore sensitive receptors for the human health impacts only are concentrated within a 2 km Study Area.

8.2.4 The dispersion of emissions has been predicted using the latest version of the atmospheric dispersion model ADMS (currently version 5.2.2). The results are presented in both tabular format and as contours of predicted ground level process contributions (PCs) overlaid on mapping of the surrounding area.

8.2.5 At the PEI Report stage of the planning process, the dispersion modelling assessment has concentrated on the combustion emissions of oxides of nitrogen (NO_x) and carbon monoxide (CO) with consideration also of the impacts from ammonia (NH_3) slip (from the Selective Catalytic Reduction NO_x abatement system), and amines (from the carbon capture process).

8.2.6 Emissions from Large Combustion Plant are currently governed by Directive 2010/75/EU and the Industrial Emissions Directive (IED), which was transposed into UK law in February 2013 (originally in the Environmental Permitting (England and Wales) (Amendment) Regulations 2013, now superseded by the Environmental Permitting (England and Wales) Regulations 2016 (as amended)). The IED contains measures relating to the control of emissions, including setting limits on emissions to air from Large Combustion Plant and requires operators to monitor and report emissions.

8.2.7 The Proposed Development would be regulated under the IED and in accordance with the Large Combustion Best Available Technique (BAT) Reference document (BRef). The current BRef and associated BAT conclusion document was issued in 2017. The recommendations of the BRef are enforceable through Environmental Permits and the Environment Agency (EA) would set specific emission limits in the Environmental Permit issued to the Proposed Development, based on the BAT-associated emission levels (BAT-AELs). There is currently no BRef, or BAT reference documents relating to the carbon capture process itself, and this is currently a developing subject.

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8.2.8 A comparison has been made between predicted model output concentrations, and short-term and long-term Air Quality Assessment Levels (AQALs) as detailed in Chapter 8: Air Quality (PEI Report, Volume I).

Operational Traffic Emissions

8.2.9 No assessment of operational traffic emissions has been made, as the numbers of additional vehicles associated with the operational phase of the Proposed Development are below the DMRB and IAQM screening criteria for requiring such assessment. In addition, the predicted impacts for the construction phase traffic emissions showed that the effect of additional construction traffic was not significant at all receptors. The number of additional vehicles for the operational phase is well below the numbers assessed for the construction phase and therefore it is considered that the effect of operational traffic is also not significant, and that there will therefore be no in-combination effects with the operational traffic and operation Proposed Development.

Cumulative Impacts

8.2.10 Cumulative impacts from existing sources of pollution in the area are accounted for in the adoption of site-specific background pollutant concentrations from archive sources and a programme of project-specific baseline air quality monitoring in close proximity to the Proposed Development site. It is recognised, however, that there is a potential impact on local air quality from emission sources which have received planning permission but have yet to come into operation.

8.2.11 The full list of short-listed cumulative schemes to be considered for the Proposed Development will not be available until the final ES, as detailed within Chapter 23: Cumulative and Combined Effects of this PEI Report. The assessment for the final ES will therefore consider these schemes.

Sources of Information

8.2.12 The information that has been used within this assessment includes:

- Chapter 4: Proposed Development (PEI Report, Volume I);
- Data on emissions to atmosphere from the process, taken from IED limits, BAT-AEL values and data provided by the Applicant;
- Details on the site layout provided by the Applicant;
- Ordnance Survey mapping;
- Baseline air quality data from project specific monitoring, published sources and Local Authorities; and
- Meteorological data supplied by ADM Ltd.

8.3 Methodology

Dispersion Model Selection

8.3.1 The assessment of emissions from the Proposed Development has been undertaken using the advanced dispersion model ADMS (version V5.2.2), supplied by Cambridge Environmental Research Consultants Limited (CERC). ADMS is a modern dispersion model that has an extensive published validation history for use in the UK. This model has been extensively used throughout the UK to demonstrate regulatory compliance.

Modelled Scenarios

8.3.2 The dispersion modelling undertaken for the assessment of emissions from the operational Proposed Development main stacks includes:

- Modelling of maximum ground-level impacts at a range of release heights, between 70 m and 100 m, in order to evaluate the effect of increasing effective release height on dispersion;
- Reported impacts at selected human health and sensitive ecological receptors, at a release height of 100 m, as the main reported assessment; and,
- Modelling of impacts on a variable resolution receptor grid and at discrete sensitive human receptors for all pollutants.

Model Inputs

8.3.3 The general model conditions used in the assessment are summarised in Table 8B-1. Other more detailed data used to model the dispersion of emissions is considered below.

Table 8B-1: General ADMS 5 Model Inputs

Variable	Input
Surface roughness at source	0.3
Surface roughness at meteorological site	0.3
Receptors	Selected discrete receptors (as Tables 8B-4 and 8B-5)
	Nested receptor grid, the variable spacing
Receptor location	X,Y co-ordinates determined by GIS
	z = 1.5 m for residential receptors
	z = 0 m for ecological receptors
Source location	X,Y co-ordinates determined by GIS
Emissions	IED emission limits, BAT-AEL values and data provided by the Applicant
Sources	3 x Carbon Capture Plant Adsorber Stacks 3 x CCGT Stacks

Variable	Input
Meteorological data	5 years of meteorological data, Durham Teeside Meteorological Station (2015 - 2019)
Terrain data	Not applicable
Buildings that may cause building downwash effects	3 x Gas Turbine Halls, 3 x Steam Turbine Halls, 3 x HRSG Buildings, 3 x Adsorber Towers

Emissions Data

8.3.4 During normal operation, the carbon capture plant adsorber stacks would be the primary source of emissions from both the combustion and carbon capture processes. There would be a stack associated with each CCGT and carbon capture train (i.e. 3 carbon capture stacks in total).

8.3.5 In addition, there would be 3 stacks associated with each CCGT train, which would only be operational when the plant is operating in an unabated mode (i.e. combustion emissions only, with no carbon capture taking place).

8.3.6 The combustion emissions associated with these two modes of operation would be subject to the same emission limits and therefore the associated release rates would be comparable. The unabated emissions from the CCGT plant only however would be released at a higher temperature (100 ºC compared with 35 ºC for the carbon capture process) and therefore would have improved thermal buoyancy, and consequentially dispersion, resulting in a lower level of impact for the unabated CCGT operation.

8.3.7 When the plant is operating with carbon capture, there are also additional emissions of amines and potentially their degradation compounds (nitrosamines and nitramines). This mode of operation therefore has been assessed as representing the worst-case mode of operation in terms of the resulting predicted impacts for the PEI Report, due to the additional species emitted and the lower release temperature resulting in reduced thermal buoyancy of the release.

8.3.8 Supplementary firing (duct burners) may be used in CCGT HRSGs to increase power output at peak demand. The gas turbine must operate with a large excess of air to modulate the temperature at the gas turbine inlet and supplementary firing uses the residual oxygen in the gas turbine exhaust with additional fuel injection to improve steam quality, thereby improving the steam cycle efficiency (although this leads to a slightly lower overall combined cycle efficiency).

8.3.9 Supplementary firing within the Proposed Development allows the power plant respond to fluctuations in energy demand but also can be used to boost steam output to compensate for steam use in the Carbon Capture process, for example in amine regeneration. The other benefits of supplementary firing for carbon capture systems include:

- A higher concentration of CO_2 in the exhaust gas from operating with lower overall excess air (closer to stoichiometric); this reduces the energy penalty from CO_2 capture by increasing the efficiency of the absorption/regeneration stages in the CC process; and

- A lower concentration of O_2 in the exhaust gas, which reduces the potential for amine oxidative degradation, and therefore improves the solvent performance and longevity.

8.3.10 The use of supplementary firing can increase the NO_x emission concentration within the flue gas, however NO_x emissions will be controlled using SCR within the flue gas treatment prior to the Carbon Capture process. The impacts from the potential use of supplementary firing within the HRSG will be assessed as part of the air quality impact assessment.

8.3.11 The main reported emissions for the Proposed Development have been modelled at a stack height of 110 m above finished ground level, with an internal stack diameter of 6.5 m. It is considered that 100m is the stack height that would result in not significant impacts at human health receptors, with the current model input parameters and therefore has been used in the assessment as a worst case. A higher stack would result in further reductions in the predicted impacts.

8.3.12 The physical properties of the three emission sources, as represented within the model, are shown in Table 8B-2.

8.3.13 The position of the stacks and the buildings included within the model are illustrated in Figure 8.4: Model Visualisation (PEI Report, Volume II).

Table 8B-2: Emissions Inventory

Parameter	Unit	Carbon adsorber stacks
Stack position	(NGR) m	CCGT and CC Train 1 = 457103, 525244 CCGT and CC Train 2 = 457049, 525118 CCGT and CC Train 3 = 456994, 524986
Stack release height	m	100
Effective internal stack diameter	m	6.5
Flue temperature	°C	35
Flue H_2O content	%	5.5
Flue O_2 content (dry)	%	11.9
Stack gas exit velocity	m/s	25.6
Stack flow (actual)	Am^3/s	849.5
Stack flow at reference conditions (STP, dry)	Nm^3/s	1,084

8.3.14 The modelled pollutant emission rates (in grams per second (g/s)) have been calculated by multiplying the emission concentration by the volumetric flow rate at normalised reference conditions. The emission limits assumed to apply to the Proposed Development are shown in Table 8B-3.

8.3.15 In order to achieve the maximum rate of carbon capture, emission concentrations of NO_x are required to be below the upper range value of the BAT-AEL provided in the Large Combustion Plant BRef (30 mg/Nm^3 as a yearly average). NO_x emissions have therefore been modelled at achievable NO_x concentrations provided by the project design engineers.

8.3.16 A NO_x abatement system such as Selective Catalytic Reduction (SCR) would be required to achieve the required NO_x emission. These systems reduce NO_x concentrations by spraying urea (or other forms of NH_3) into the flue gas and therefore have the potential to result in 'ammonia slip' with a resulting emission of ammonia. Emissions of NH_3 have therefore also been included in the assessment.

8.3.17 Likewise, the carbon capture process is likely to utilise a proprietary amine solvnet to remove the carbon dioxide from the combustion emission. Emissions of 'amine slip' can therefore also result, and this has also been modelled at emission concentrations provided by the project design engineers.

8.3.18 It is also known that some amines can potentially degrade into nitrosamines and nitramines (collectively referred to as N-amines) both during the carbon capture process itself and also in the environment following release, and therefore this has also been considered in this assessment.

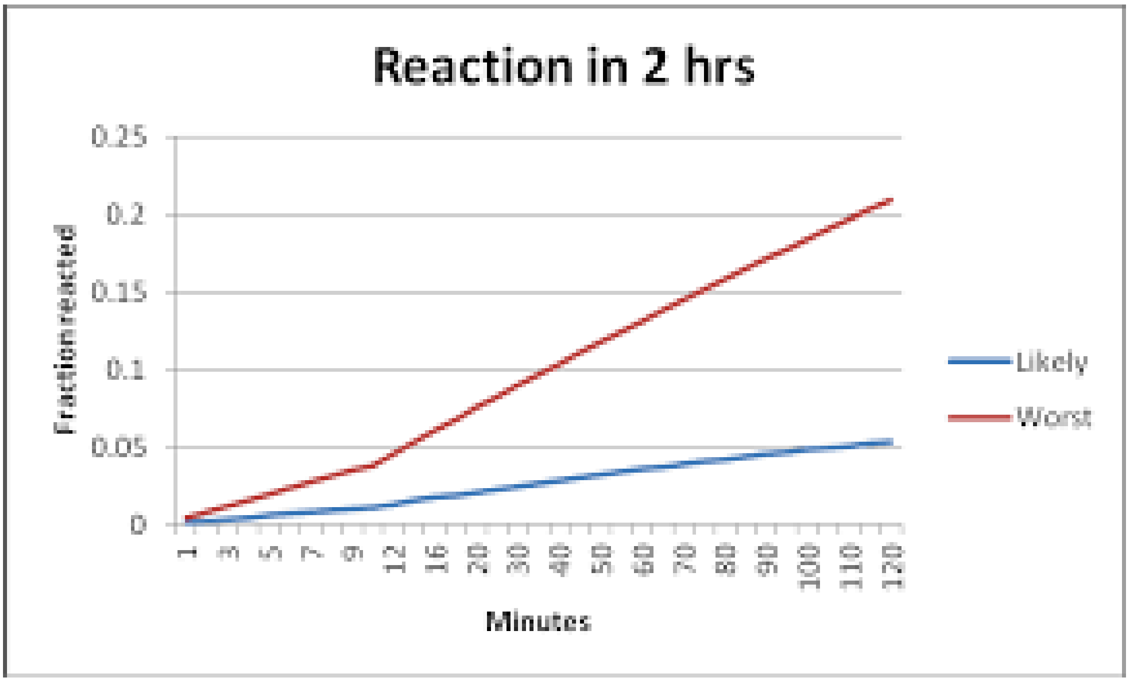
8.3.19 The ADMS model comprises a specific amine chemistry module, for the assessment of emissions of amines and their potential degradation products. The model calculates the rate of amine degradation taking into account the reaction of amines with other species present in the exhaust gas and also with hydroxyl radicals in the atmosphere. In order to generate meaningful results using the amine module, information on the specific amines present in the amine solution used in the carbon capture process is required to determine the relevant amine reaction rate constants for inclusion in the model set-up. As the specific amine solution has yet to be determined, it is therefore not possible to generate the specific model input data required at this stage of the project. Therefore, the amines module has not been used at PEI Report stage however for the assessment presented in the final ES, assessment of amine emissions and their degradation products, utilising the specific ADMS module, will be carried out. At this stage a preliminary screening approach has been taken to assess N-amine impacts, until further information is available for the final ES report.

8.3.20 Not all amines released would convert to N-amine in the environment and the conversion of those amines that would degrade in the atmosphere to N-amine can take many hours to occur. This is described by the work carried out by Tonnesen in 2011[1], which demonstrated that less than 5% of the amines that would convert to N-amines would have do so in the first 10 minutes after release. After 2 hours, only 20% of the amines that would convert to N-amine would have done so. The work then goes on to estimate that it would take in

[1] Tonnesen. (2011). Update and improvement of dispersion calculations for emissions to air from TCMs amine plant Part II – Likely case nitrosamines, nitramines and formaldehyde.

the order of 10 hours for 100% conversion to occur. A graph showing this process is provided in Figure 8B-1.

Diagram 8B-1. Conversion of Amines to N-Amine in the Atmosphere Over Time



8.3.21 Therefore, two aspects for the preliminary screening assessment have been taken into account:

- The proportion of amine that can convert to N-amines in the atmosphere. This depends on the actual amine species released, with reported conversions of different amines being between 0.6 – 10%, based on information from Nielson et al2. Higher conversions were found in areas with particularly high background NOx concentrations, however this is not the case within the Proposed Development's Study Area, and therefore this data has been discounted. An average conversion rate of 5% has therefore been assumed for this screening assessment.
- The fraction of reacted amine that can convert to N-amines based on the time taken to reach the identified receptors. This has been based on the average wind speed in the area and the distance to the identified receptors.

8.3.22 It is considered that this screening assessment would lead to an overestimation of the potential N-amines in the atmosphere, as it assumes that all amines within the amine solvent used would have the potential to convert to N-amines, which may not be the case. It also does not take into account the destruction of N-amines within the atmosphere, which occurs following the initial conversion process by photolysis (Neilson et al.3).

[2] Nielsen et al. (2011). Atmospheric degradation of amines summary report: Photo-oxidation of methylamine, dimethylamine and trimethylamine
[3] Nielsen C J, Herrmann H and Weller C. (2012b). Atmospheric chemistry and environmental impact of the use of amines in carbon capture and storage (CCS).

8.3.23 The assessment has assumed that the Proposed Development would operate at continuous design load (8,760 hours per year). No time-based variation in emissions have therefore been accounted for within the model.

Table 8B-3: Emission Concentrations and the Assessed Emission Rates

Pollutant	Emission concentration (mg/m^3)	Emission rate (g/s) (Per Stack)
Oxides of Nitrogen ((NO_X (as NO_2))	20.5	22.2
Carbon Monoxide (CO)	11.2	12.2
Ammonia (NH_3)	3.8	4.1
Amines	5.0	5.9
N-amines[1]	0.25	0.523

[1] At PEI Report stage the screening assessment of N-amines (nitrosamine and nitramine) has assumed that an arbitrary 5% of the amine emission is capable of degrading to N-amines in the atmosphere. An additional factor to account for the time and distance the emission takes to travel from the source to the receptor has also to be applied to the results presented and this is discussed further in Section 8.7 of this appendix.

Modelled Domain – Discrete Receptors

Sensitive Human Receptors

8.3.24 Ground-level concentrations of the modelled pollutants relevant to human health have been predicted at discrete air quality sensitive receptors, as listed in Table 8B-4. The locations of these receptors are also shown in Figure 8.1: Air Quality Study Area Human Health (PEI Report, Volume II). The receptors are selected to be representative of residential dwellings, recreational areas and schools in the area around the Proposed Development. (OR = Operational Receptor).

Table 8B-4: Human Receptor Locations

Receptor reference	Receptor description	Grid reference		Distance and direction from the operational site
		X	Y	
OR1	Houses at Warrenby	457950	525045	750 m east
OR2	Cleveland Golf Links	458090	525550	880 m northeast
OR3	South Gare Fishermans Association	455680	527395	2.5 km northwest
OR4	Marine Club	455550	527345	2.5 km northwest
OR5	Caravan Park	458675	525415	1.4 km east
OR6	Houses at Dormanstown	457895	523735	1.5 km southeast
OR7	Houses at Coatham	458900	525060	1.7 km east
OR8	Dormanstown Primary School	458250	523585	1.8 km southeast
OR9	Coatham C of E School	459195	524980	2 km east

Sensitive Ecological Receptors

8.3.25 In accordance with the Environmental Agency's air emissions risk assessment guidance, the impacts associated with emissions from the combustion process on statutory sensitive ecological sites has been quantified. The assessment considers European designated sites (Special Areas of Conservation (SACs), Special Protection Areas (SPAs) and Ramsar sites) and Sites of Special Scientific Interest (SSSIs) within 15 km of the operational Proposed Development, as recommended by the EA's risk assessment guidance for "large emitters". The most notable of these sites is the Teesmouth and Cleveland Coast Ramsar, SPA and SSSI, which is adjacent to the Proposed Development site.

8.3.26 In additional, Local Wildlife Sites (LWSs) within 2km of the Proposed Development have also been included in the assessment.

8.3.27 Ground-level concentrations of the modelled pollutants relevant to sensitive ecological receptors have been predicted at locations listed in The locations of these receptors are shown in Figure 8.2: Air Quality Study Area Ecological (PEI Report, Volume II).

8.3.28 Table 8B-5. The locations of these receptors are shown in Figure 8.2: Air Quality Study Area Ecological (PEI Report, Volume II).

Table 8B-5: Ecological Receptor Locations

Receptor identification	Ecology site	Grid reference		Distance and direction from the operational site
		X	Y	
E1	Teesmouth and Cleveland Coast SPA, SSSI and Ramsar	457714	525773	700 m north
E2	North York Moors SPA, SAC and SSSI	463315	514190	11.9 km southeast
E3	Northumbria Coast SPA and Ramsar	448259	537470	14.6 km northwest
E4	Durham Coast SSSI and SAC	449520	536190	12.9 km northwest
E5	Lovell Hill Pools SSSI	459860	519100	6.3 km southeast
E6	Saltburn Gill SSSI	467000	521265	10 km southeast
E7	Coatham Marsh LWS	457860	524990	650m east
E9	Eston Pumping Station LWS	456370	523890	1.1 km southwest

N.B. E8 receptor represents Wilton Woods, which is only applicable to the construction traffic air assessment.

Modelled Domain – Receptor Grid

8.3.29 Emissions from the stacks have also been modelled on a receptor grid of variable spacing, in order to determine:

- The location and magnitude of maximum ground level impacts; and

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- To enable the generation of pollutant isopleth plots.

8.3.30 The dispersion model output has been reported at specific receptors and as a nested grid of values. The inner grid extends 500 m at a resolution of 25 m x 25 m. The middle grid extends from 500 m to 5,000 m at a resolution of 50 m x 50 m. The outer grid extends from 5,000 m to 15,000 m at a resolution of 250 m x 250 m. Details of the receptor grid are summarised in Table 8B-6**Error! Reference source not found.**.

Table 8B-6: Modelled Domain, Receptor Grid

Grid spacing (m)	Dimensions (km)	Number of nodes in each direction	National grid reference of south west corner
25	1 x 1	41	456551, 524770
50	10 x 10	201	452051, 520270
250	30 x 30	121	442051, 510270

Meteorological Data

8.3.31 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 will be 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.

8.3.32 The meteorological site that was selected for the assessment is Durham Tees Valley Airport, located approximately 22 km southwest of the Proposed Development Site, at a flat airfield in a principally agricultural area, and therefore a surface roughness of 0.3 m (representative of an agricultural area) has been selected for the meteorological site.

8.3.33 The modelling for this assessment has utilised 5 years of meteorological data for the period 2015 – 2019. Wind roses for each of the years within this period are shown in Figure 8B-2.

Building Downwash Effects

8.3.34 The buildings that make up the Proposed Development have the potential to affect the dispersion of emissions from the operational process stacks. The ADMS buildings effect module has therefore been used to incorporate building downwash effects as part of the modelling procedure. Buildings greater than one third of the range of stack heights modelled have been included within the modelling assessment.

Buildings associated with the Proposed Development that have been considered to be of sufficient height and volume to potentially impact on the dispersion of emission stacks are shown in Table 8B-7. A plan showing the buildings layout used in the ADMS simulation is illustrated in **Error! Reference source not found.**8.4: Model Visualisation (PEI Report, Volume II).The

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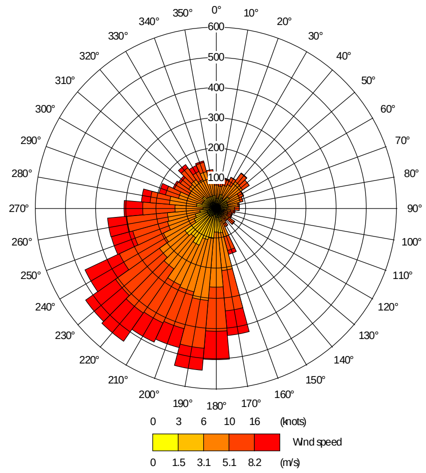
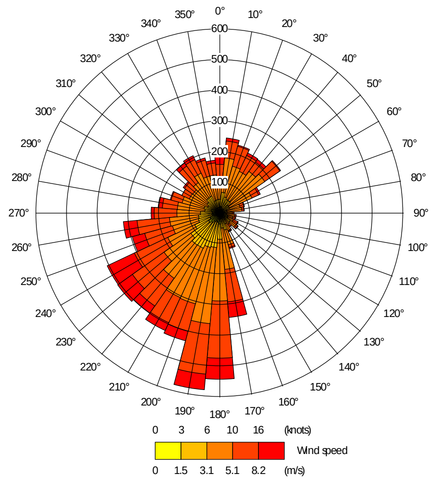
dimensions of the buildings are understood to be the maximum measurements that could potentially be required (as defined in the Rochdale Envelope), and have been provided by the Design Engineers.

Diagram 8B-2: Wind Roses for Durham Tees Valley Airport, 2015 To 2019

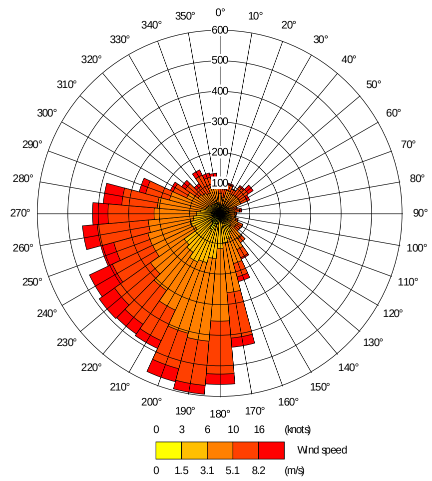
2015



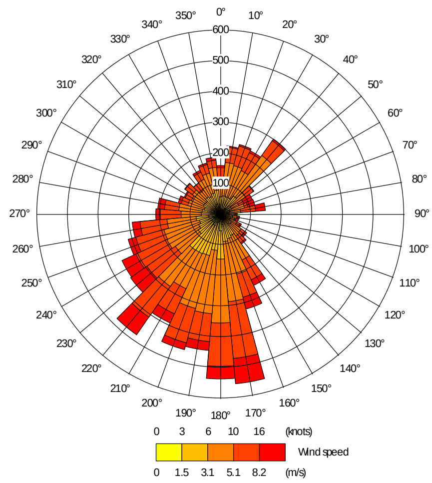
2016



2017



2018



2019

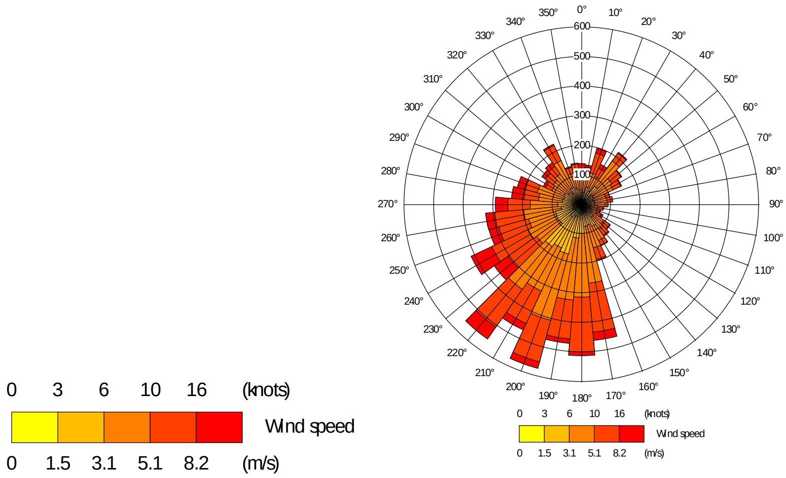


Table 8B-7: Buildings Incorporated into the Modelling Assessment

Building	Building centre grid reference (x,y)	Height (m)	Length (m)	Width (m)	Angle (º)
HRSG 1	457168, 525218	50	63	28	112
Gas Turbine Hall 1	457231, 525191	30	76	76	22
Steam Turbine Hall 1	457257, 525250	30	64	54	112
CC Adsorber Tower 1	457100, 525245	62	35	24	112
HRSG 2	457117, 525090	50	63	28	112
Gas Turbine Hall 2	457182, 525063	30	76	76	22
Steam Turbine Hall 2	457206, 525123	30	64	54	112
CC Adsorber Tower 2	457049, 525119	62	35	24	112
HRSG 3	457061, 524959	50	63	28	112
Gas Turbine Hall 3	457125, 524993	30	76	76	22
Steam Turbine Hall 3	457151, 524993	30	64	54	112
CC Adsorber Tower 3	456994, 524984	62	35	24	112

8.3.35 The immediate local area downwind of the Proposed Development is flat and undeveloped land followed by the coast and North Sea. Upwind of the Proposed Development Site is dominated by industrial land uses and relatively flat. The Site is adjacent to the River Tees Estuary to the west. A surface roughness of 0.3 m, corresponding to the minimum value associated with the terrain type, has therefore been selected to represent the local terrain.

8.3.36 Site-specific terrain data has not been used in the model, as there are no potentially significant changes in gradient within the study area.

NO_X To NO_2 Conversion

8.3.37 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 environmental standards 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.

8.3.38 For the purposes of detailed modelling, and in accordance with Environment Agency technical guidance it is assumed that 70% of nitric oxide emitted from the stack 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.

Calculation of Deposition at Sensitive Ecological Receptors

8.3.39 The deposition of nutrient nitrogen and acid at sensitive ecological receptors has been calculated, using the modelled process contribution predicted at the receptor points. The deposition rates are determined using conversion rates and factors contained within Environment Agency guidance, which account for variations deposition mechanisms in different types of habitat.

8.3.40 The conversion rates and factors used in the assessment are detailed in Table 8B-8**Error! Reference source not found.** and Table 8B-9.

Table 8B-8: Conversion Factors – Calculation of Nutrient Nitrogen Deposition

Pollutant	Deposition velocity grassland (m/s)	Deposition velocity woodland (m/s)	Conversion factor (μg/m³/s to kg/ha/yr)
NO_X as NO_2	0.0015	0.003	96
NH_3	0.02	0.03	259.7

Table 8B-9: Conversion Factors – Calculation of Acid Deposition

Pollutant	Deposition velocity grassland (m/s)	Deposition velocity woodland (m/s)	Conversion factor (μg/m³/s to keq/ha/yr)
NO_2	0.0015	0.003	6.84
NH_3	0.02	0.03	18.5

Specialised Model Treatments

8.3.41 Emissions have been modelled such that they are not subject to dry and wet deposition or depleted through chemical reactions. The assumption of continuity of mass is likely to result in an over-estimation of impacts at receptors, and therefore is considered to be conservative.

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8.4 Baseline Air Quality

Overview

8.4.1 This section presents the information used to evaluate the background and baseline ambient air quality in the area surrounding the Proposed Development. The following steps have been taken in the determination of background values. Where appropriate, the study focuses on data gathered in the vicinity of the site:

- Identification of Air Quality Management Areas;
- Review of Redcar and Cleveland Borough Council (RCBC) ambient monitoring data;
- Review of data from Defra's background mapping database;
- AECOM monitoring undertaken in the area around the application site; and
- Review of background data and site relevant critical loads from the APIS website.

Air Quality Management Areas

8.4.2 Redcar and Cleveland Borough Council (RCBC) and Stockton on Tees Borough Council (STBC) have not declared any AQMAs within their administrative area, and there are no AQMAs declared by other Local Authorities within the study area.

Local Authority Ambient No_x and NO_2 Monitoring Data

Redcar And Cleveland Borough Council

8.4.3 RCBC currently operate one automatic monitoring site, located at Dormanstown Primary School, approximately 1.5 km to the south east of the operational Proposed Development. The site was chosen in order to monitor roadside and industrial emissions. Data for 2018 was available at the time of writing with annual concentrations of NO_x and NO_2 of 15.0 µg/m^3 and 10 µg/m^3 respectively.

8.4.4 In addition, NO_x diffusion tube monitoring is carried out at 16 locations within the borough. The nearest NO_2 diffusion tubes are again located at Dormanstown Primary School. At the time of writing, the most recent monitoring data available from RCBC diffusion tube monitoring is for 2018 and the average measured annual NO_2 concentration was 17.6 µg/m^3.

8.4.5 All monitoring locations within the study area are below the annual mean nitrogen dioxide objective of 40µg/m^3 in 2018.

Defra Background Data

8.4.6 Defra's 2017-based background maps are available at a 1x1 km resolution for the UK for the year 2017 and are projected forward to the year 2030. These projections of pollution concentrations across England are available for NO_2 and NO_x.

8.4.7 Background concentrations from the Defra 2017-based background maps are presented for the year 2017 in Table 8B-10 taken for the grid square in which the operational Proposed Development is located (456500, 525500) for NO_x and NO_2. Background concentrations for CO are not available for the most recent Defra maps, but data for 2001-based background concentrations are available and this has been adjusted for 2017 using the Defra published year adjustment factors.

8.4.8 Data for 2017 has been presented, as the typical trend shown in the Defra background mapping is that over the projected time period, concentrations of NO_2 and NO_x are shown to be decreasing. This corresponds to a reduction overtime of vehicle emissions as newer, cleaner vehicles replace older ones. Therefore, assuming no reduction occurs until the opening year of the Proposed Development (2025), is considered to represent a conservative approach.

8.4.9 A review of the background map concentrations over the study area for human health receptors shows that the concentration presented in Table 8B-10 for the Site location is also representative of the background concentrations at the receptor locations (the average NO_2 concentration in the grid squares with identified receptors was 15.4 µg/m^3).

Table 8B-10: Defra Background Concentrations (NGR 456500, 525500)

Pollutant	Background concentration (µg/m^3)
NO_X	22.6
NO_2	15.6
CO	110.4

AECOM Monitoring Data

8.4.10 A diffusion tube monitoring survey of the study area commenced in December 2019, in order to gather data on the ambient concentrations of NO_2 at representative human health and ecological receptor locations. At the time of writing, none of the monitoring data was available, however it is envisaged that this data would help inform the background concentrations applied in the assessment reported in the final ES.

8.4.11 Additional ammonia monitoring at the Teesmouth and Cleveland Coast ecological receptor (E1), commenced in June 2020.

Ecological Site Background Data

8.4.12 The NO_x and NH_3 background concentrations are available from the APIS website for designated SAC, SPA and SSSI sites. The average concentrations present at the relevant habitat receptor sites are presented in Table 8B-11.

Table 8B-11: APIS Background Data No_x And NH_3

Receptor I.D.	Ecology site	NO_x (µg/m^3)	Ammonia (µg/m^3)
E1	Teesmouth and Cleveland Coast SPA, SSSI and Ramsar	19.36	0.64
E2	North York Moors SPA, SAC and SSSI	8.97	1.14
E3	Northumbria Coast SPA and Ramsar	9.98	1.23
E4	Durham Coast SAC and SSSI	11.15	1.23
E5	Lovell Hill Pools SSSI	13.93	2.21
E6	Saltburn Gill SSSI	10.22	0.84
E7	Coatham Marsh LWS	28.54	1.26
E9	Eston Pumping Station LWS	21.55	1.26

8.4.13 In addition, the APIS website provides information on the relevant critical loads for the assessment of depositional impacts, as well as background nitrogen deposition and acid deposition loads. This data has been presented in Table 8B-12.

Table 8B-12: APIS Background Deposition Information

Receptor I.D.	Ecology site	N-Deposition	Acid Deposition	
		(kg N/ha/yr)	(keq N/ha/yr)	(keq S/ha/yr)
E1	Teesmouth and Cleveland Coast SPA, SSSI and Ramsar	10.19	0.73	0.26
E2	North York Moors SPA, SAC and SSSI	18.50	1.32	0.23
E3	Northumbria Coast SPA and Ramsar	13.60	1.00	0.20
E4	Durham Coast SAC and SSSI	13.58	0.70	0.20
E5	Lovell Hill Pools SSSI	No information available on relevant critical loads for assessment		
E6	Saltburn Gill SSSI	18.2	1.30	0.20
E7	Coatham Marsh LWS	13.86	1.10	0.24
E9	Eston Pumping Station LWS	13.86	1.10	0.24

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8.5 Summary of Background Air Quality

8.5.1 For human health receptors, the background concentration for nitrogen dioxide, and CO has been taken from the Defra background mapping, as presented in Table 8-10. Although the diffusion tube data for Dormanstown indicates slightly higher NO_2 concentrations, it is considered that as the Defra data and the automatic monitoring data at the same location show good correlation, this is most appropriate for use in the assessment. This will be reviewed for the final ES following the collation of additional data from the AECOM monitoring campaign.

8.5.2 The background NO_x and NH_3 concentrations for ecological receptors were sourced from APIS using the specific location for the relevant ecological receptor, as detailed in Table 8B-12.

8.5.3 There is little data on background amine and nitrosamine concentrations in the UK. It is proposed that AECOM will carry out monitoring of these species in order to collate some data for the final ES, however the monitoring methodology is currently undergoing review with the Environment Agency and other interested parties prior to monitoring commencing.

8.5.4 Where no short-term concentrations are available, short-term background concentrations have been calculated by multiplying the selected annual mean background concentration by a factor of two, in accordance with the Environment Agency Risk Assessment methodology.

8.5.5 In order to represent a conservative approach, it has been assumed that background concentrations would not decrease in future years. Therefore, the current background concentrations have been assumed to apply to the projected opening year of 2026.

8.6 Operational Emissions Modelling Results

Evaluation of Stack Height

8.6.1 The selection of an appropriate stack release height requires a number of factors to be taken into account, the most important of which is the need to balance a release height sufficient to achieve adequate dispersion of pollutants against other constraints such as the visual impact of tall stacks.

8.6.2 Emissions from the main carbon capture stacks have been modelled at heights between 70 m and 110 m, at 10 m increments. Graphs, showing the predicted ground level concentrations for the annual mean and maximum 1-hour NO_2 concentrations are presented in Diagram 8B-8B-3. The purpose of the graphs is to evaluate the optimum release height in terms of the dispersion of pollutants which would occur, against the visual constraints of further increases in release height, with the ‘elbow’ of the resulting curve showing where the reductions in ground level concentrations become disproportionate to the increasing height.

8.6.3 Analysis of the curves shows that the benefit of incremental increases in release heights between 70 m and 90 m are relatively pronounced. At heights

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above 100 m, the air quality benefit of increasing release height further is reduced.

8.6.4 Although the graph suggests that a stack height of 80 – 90 m represents the optimum stack height for maximum ground level concentrations of NO_2, following further analysis of the results, especially those at the habitat receptors, it has been concluded that an 100 m stack is more appropriate for ensuring that impacts of atmospheric pollutants at these receptors can be considered to be acceptable. The reported results are therefore based on an 100 m stack.

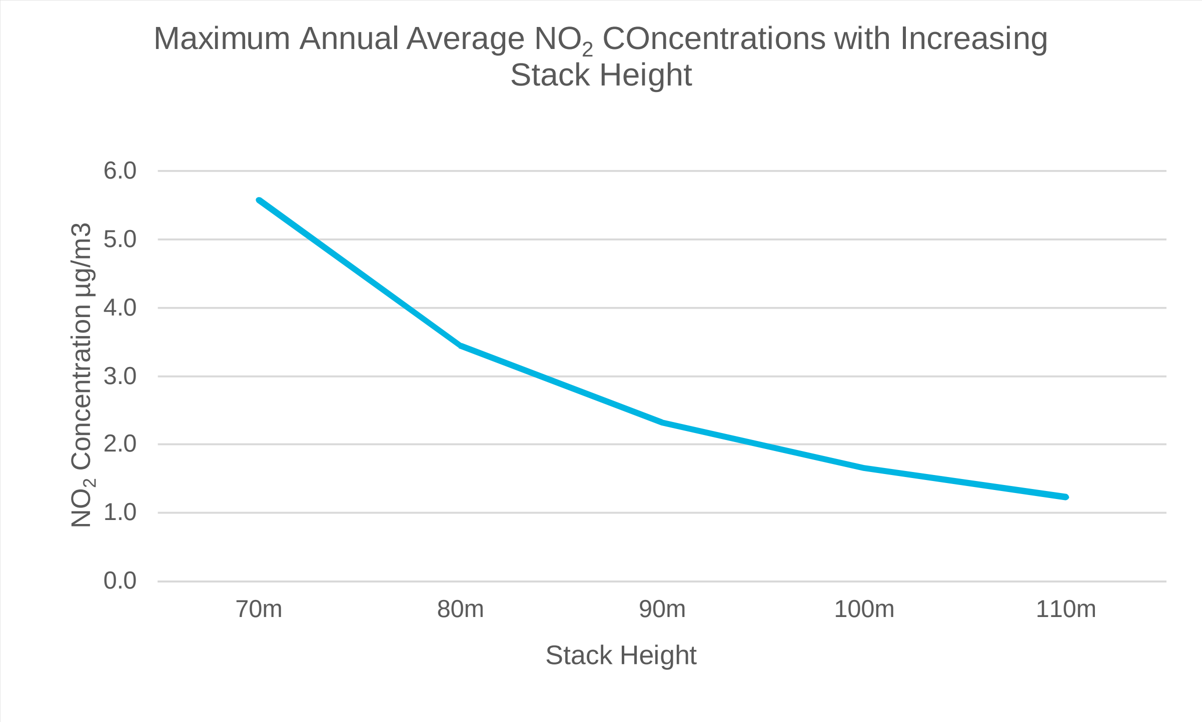
Human Health Receptor Results

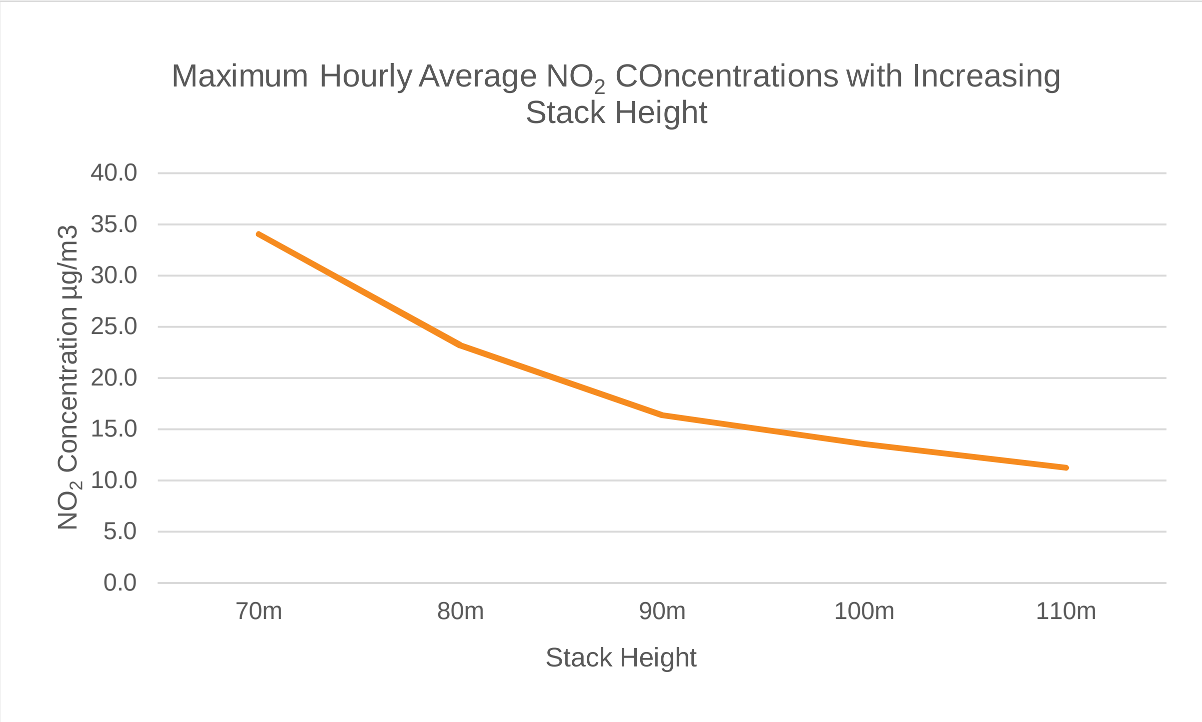
Nitrogen dioxide emissions

8.6.5 The predicted change in annual mean NO_2 concentrations that would occur during the operation of the Proposed Development, at the identified human health receptors, are presented in Table 8B-13. The results presented represents the highest (worst case) result from all five years of the meteorological data used in the model.

8.6.6 The maximum predicted annual mean NO_2 concentration that occurs anywhere within the study area as a result of the Proposed Development is 1.7 µg/m^3, and this occurs at the coast at Coatham, just to the north of the operational Proposed Development, in the vicinity of the Cleveland Links Golf Course. The hourly mean NO_2 predicted environmental concentration (i.e. the process contribution and the existing background concentration) is 17.3 µg/m^3 and therefore is below the annual mean NO_2 AQAL of 40 µg/m^3. NO_2 emissions from the Proposed Development are therefore not predicted to lead to a risk of the annual mean AQALs being exceeded anywhere within the study area.

Diagram 8B-3: Predicted Maximum Process Contribution to Ground Level NO_2 Concentrations at Stack Release Heights of 70 M - 110m





8.6.7 The discrete receptor most affected by emissions from the Proposed Development is receptor OR2 the Cleveland Links Golf Course, with a predicted annual mean NO_2 concentration as a result of the Proposed Development of 1.4 µg/m^3, representing 4% of the AQAL.

8.6.8 The significance of the predicted change in annual mean NO_2 concentrations in planning terms is discussed in Chapter 8: Air Quality (PEI Report, Volume I).

Table 8B-13: Predicted Change in Annual Mean NO_2 Concentrations

Receptor	AQAL (µg/m^3)	Predicted Concentration (PC) (µg/m^3)	PC/AQAL %	Background Concentration (BC) (µg/m^3)	Predicted Environmental Concentration (PEC) (µg/m^3)	PEC/ AQAL %
Max anywhere	40	1.7	4%	15.6	17.3	43%
OR1		0.9	2%		16.6	41%
OR2		1.4	4%		17.0	43%
OR3		0.3	0.8%		15.9	40%
OR4		0.3	0.6%		15.9	40%
OR5		1.1	3%		16.7	42%
OR6		0.4	0.9%		16.0	40%
OR7		0.9	2%		16.5	41%
OR8		0.3	0.9%		16.0	40%
OR9		0.8	2%		16.4	41%

PC = Process Contribution, AQAL = Air Quality Assessment Level, BC = Background Concentration, PEC = Predicted Environmental Concentration

8.6.9 The maximum predicted hourly mean NO_2 concentration (as the 99.79th percentile of hourly averages) that occurs anywhere within the study area as a result of the Proposed Development is 13.6 µg/m^3, and this occurs again just to the north of the operational Proposed Development, and also to a small area to the south of the operational Proposed Development. The predicted environmental concentration (i.e. the process contribution and the existing background concentration) is 44.8 µg/m^3 and therefore is below the hourly mean NO_2 AQAL of 200 µg/m^3. NO_2 emissions from the Proposed Development are therefore not predicted to lead to a risk of the hourly mean air quality standard being exceeded anywhere within the study area.

8.6.10 The discrete receptor most affected by emissions from the Proposed Development is receptor OR1 Houses at Warrenby, with a predicted hourly mean NO_2 concentration as a result of the Proposed Development of 12.8 µg/m^3.

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Table 8B-14: Predicted Change in Hourly Mean NO_2 Concentrations (as the 99.79th Percentile of Hourly Averages

Receptor	AQAL (µg/m^3)	PC (µg/m^3)	PC/AQAL %	BC (µg/m^3)	PEC (µg/m^3)	PEC/ AQAL %
Max anywhere	200	13.6	7%	31.2	44.8	22%
OR1		12.8	6%		44.0	22%
OR2		12.1	6%		43.4	22%
OR3		6.5	3%		37.8	19%
OR4		6.1	3%		37.4	19%
OR5		9.8	5%		41.0	21%
OR6		9.0	5%		40.3	20%
OR7		9.6	5%		40.8	20%
OR8		8.1	4%		39.3	20%
OR9		8.3	4%		39.5	20%

PC = Process Contribution, AQAL = Air Quality Assessment Level, BC = Background Concentration, PEC = Predicted Environmental Concentration

Carbon monoxide emissions

8.6.11 The maximum hourly and 8 hour running mean predicted concentrations that occur anywhere as a result of the Proposed Development represent less than 1% of the relevant AQALs and therefore can be considered to be insignificant/ negligible at all receptor locations. In addition, in combination with the background concentrations in the study area, the predicted environmental concentration remains less than 1% of the relevant AQALs for both averaging periods. The results at individual receptors have therefore not been presented.

Ammonia emissions

8.6.12 The annual and hourly average predicted concentrations of ammonia that occur anywhere as a result of the Proposed Development represent less than 1% of the relevant AQALs and therefore can be considered to be insignificant/ negligible at all receptor locations. In addition, in combination with the background concentrations in the study area, the predicted environmental concentration remains less than 1% of the relevant AQALs for both averaging periods. The results at individual receptors have therefore not been presented.

Amine emissions

8.6.13 The annual average predicted concentration of amines that occurs anywhere as a result of the Proposed Development represent less than 1% of the relevant AQAL at all locations and therefore can be considered to be insignificant/ negligible.

8.6.14 The hourly average concentrations at the maximum impacted location is 14.6 µg/m^3, representing 3.7.4% of the AQALs. The results at other receptors are shown in Table 8B-15.

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Table 8B-15: Predicted Change in Hourly Average Amine Concentrations

Receptor	AQAL (µg/m³)	PC (µg/m³)	PC/AQAL %
Max anywhere	400	14.6	3.7%
OR1		11.6	2.9%
OR2		11.9	3.0%
OR3		8.48	2.1%
OR4		8.5	2.1%
OR5		10.4	2.6%
OR6		8.8	2.2%
OR7		8.74	2.2%
OR8		8.8	2.2%
OR9		7.4	1.8%

Additional Consideration of N-Amine Degradation Products

8.6.15 As stated previously, it has been assumed that an arbitrary 5% of the amine release could degrade into N-amines following release from the emission stacks.

8.6.16 Additional consideration needs to be taken into account of the time (and therefore distance from the emission source) that this conversion takes place over. The specified receptors included in the model are between 800 m and 2 km from the emission sources, and therefore considering that the average wind speed in the study area is approximately 4.5 m/s, the pollutants released from the stacks would take approximately 3 – 7.5 minutes to reach these receptors. Due to the slow rate of the degradation of amine to N-amine in the atmosphere (especially in an area with low background NO_2 concentrations) it is considered that less than 1% of the amine that could degrade to N-amine would have done so by the time it reaches the identified receptors (based on the work carried out by Tonnesen1).

8.6.17 Obviously over a greater distance, further degradation would occur, and therefore this could result in N-amine concentrations increasing with distance from the stacks, although this would be countered to some extent by the additional dispersion of the plume over the greater distance.

8.6.18 All these factors are taken into account in the amines module of the ADMS modelling software, however without data on the specific amines to be used, it is not possible to carry out the assessment to this level of detail at PEI Report stage.

8.6.19 Taking the outlined assumptions into account, the N-amine concentrations at the identified receptors are shown in Table 8B-16.

8.6.20 Although these results show a possible exceedance of the AQAL for N-amines at the maximum impact location, it should be noted that the conversion factors applied in this assessment are based on conservative assumptions, in order to carry out a screening assessment only, and that it is considered that use of the amines module in ADMS would result in significantly lower predicted concentrations, when the appropriate data to carry out this assessment is available for the final ES.

Table 8B-16: Predicted Change in Annual Average N-Amine Concentrations

Receptor	AQAL (ng/m^3)	PC (ng/m^3)	PC/AQAL %
Max anywhere	0.3	0.32	105%
OR1		0.181	59%
OR2		0.27	89%
OR3		0.06	19%
OR4		0.05	16%
OR5		0.20	66%
OR6		0.07	24%
OR7		0.17	58%
OR8		0.06	22%
OR9		0.15	49%

PC = Process Contribution, AQAL = Air Quality Assessment Level

Ecological Receptors Results

8.6.21 The results of the dispersion modelling of predicted impacts on sensitive ecological receptors are presented in Table 8B-17 to Table 8B-20. The tables set out the predicted PC to atmospheric concentrations of NO_x and NH_3 and also nutrient nitrogen and acid deposition.

8.6.22 Specific significance criteria relating to impacts on sensitive designated ecological receptors are set out within the Environmental Agency air emissions risk assessment guidance. The impact of stack emissions can be regarded as insignificant at sites with statutory designations if:

- The long-term PC is less than 1% of the critical level, or if greater than 1% then the PEC is less than 70% of the critical level.
- The short-term PC is less than 10% of the critical level.

8.6.23 The impact of stack emissions can be regarded as insignificant at sites of local importance if:

- The long-term PC is less than 100% of the critical level;
- The short-term PC is less than 100% of the critical level

8.6.24 The effect of atmospheric NO_x concentrations, nitrogen deposition rates and acid deposition rates on the modelled receptor locations would be considered in detail in the report to inform the Habitats Regulations Assessment (HRA) within the final ES. Further discussion on the significance of the impact on sensitive ecological receptors is provided in Chapter 12: Terrestrial Ecology and Nature Conservation (PEI Report, Volume I).

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Oxides of nitrogen emissions – Critical Levels

8.6.25 The assessment results show that the predicted annual average and daily average NO_x impacts are below the criteria for insignificance at five of the eight receptors.

8.6.26 PCs of more than 1% of the long-term critical level and 10% of the daily critical level for NO_x occur at the adjacent Teesmouth and Cleveland Coast SPA, SSSI and Ramsar, the Coatham Marsh LWS and also the Eston Pumping Station LWS.

8.6.27 The annual average PEC at the Teesmouth and Cleveland Coast site is 72% of the annual average critical level and 76% of the daily average critical level respectively. Although the annual average value is just over the 70% of the critical level threshold for insignificance, no exceedance of the critical level is predicted. There is also no exceedance of the daily average critical level predicted.

8.6.28 Annual average impacts at the Coatham Marsh LWS represent 4% of the critical level, however as the background NO_x concentration at the site represents 95% of the critical level without the contribution from the Proposed Development, the PEC represents 99% of the annual critical level. This is just below the level of insignificance for LWSs. The daily PC represents 22% of the critical level, and again with the high background concentration at the site the PEC represents 79% of the daily average critical level.

8.6.29 Due to the worst-case assumptions used in the assessment, it is considered that the predicted impacts are conservative and that an exceedance of the critical level is unlikely to occur as a result of the emissions from the operational development.

Ammonia – Critical Levels

8.6.30 The assessment results show that the predicted annual average NH_3 impacts are below the criteria for insignificance (<1% of the critical level) at four of the eight receptors. The PECs at all but one of the ecological receptors however are below 70% of the critical level and therefore can be considered to be not significant.

8.6.31 The PC for the E5 – Lovell Hill Pools receptor is 1.3% of the annual average critical level and the PEC is 75%. Although this is over the 70% threshold for insignificance, due to the worst-case assumptions used in the assessment, it is considered that the predicted impacts are conservative and that an exceedance of the critical level is unlikely to occur as a result of the emissions from the operational development.

Nitrogen deposition – Critical Loads

8.6.32 The Environment Agency and Natural England have agreed that depositional impacts that are below 1% of the relevant critical load for a site can be regarded as insignificant. Further interpretation of the significance of the depositional results is provided in Chapter 12: Terrestrial Ecology and Nature Conservation (PEI Report, Volume I).

Table 8B-17: NO_x Dispersion Modelling Results for Ecological Receptors

Receptor ID	Site Name	Annual average (µg/m³)						24 hour average (µg/m³)					
		CL	BC (µg/m³)	PC (µg/m³)	PC % of CL	PEC (µg/m³)	PEC % of CL	Critical level (CL)	BC (µg/m³)	PC (µg/m³)	PC % of CL	PEC (µg/m³)	PEC % of CL
E1	Teesmouth and Cleveland Coast SPA, SSSI and Ramsar	30	19.36	2.2	7.3%	21.6	72%	75	29.04	27.8	37.0%	56.8	75.8%
E2	North York Moors SPA, SAC and SSSI		8.97	0.1	0.4%	9.1	30%		13.46	2.0	2.6%	15.4	20.6%
E3	Northumbria Coast SPA and Ramsar		9.98	0.08	0.3%	10.1	34%		14.97	1.4	1.9%	16.4	21.9%
E4	Durham Coast SAC and SSSI		11.15	0.09	0.3%	11.2	37%		16.73	1.7	2.3%	18.4	24.6
E5	Lovell Hill		13.93	0.2	0.7%	14.1	47%		20.90	3.4	4.5%	24.3	32.4%

Receptor ID	Site Name	Annual average (µg/m³) CL	BC (µg/m³)	PC (µg/m³)	PC % of CL	PEC (µg/m³)	PEC % of CL	24 hour average (µg/m³) Critical level (CL)	BC (µg/m³)	PC (µg/m³)	PC % of CL	PEC (µg/m³)	PEC % of CL
	Pools SSSI												
E6	Saltburn Gill SSSI		10.22	0.1	0. 5%	10.4	35%		15.33	1.9	2.5%	17.2	22.9%
E7	Coatham Marsh LWS		28.54	1.1	4%	29.6	99%		42.81	16.8	22.4%	59.6	79.5%
E9	Eston Pumping Station LWS		21.55	1.0	3%	22.6	75%		32.3	14.4	19.2%	46.7	62.3%

CL = Critical Level, PC = Process Contribution, BC = Background Concentration (assumed to be 1.5 times the annual average for daily concentrations), PEC = Predicted Environmental Concentration

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Table 8B-18: Dispersion Modelling Results for Ecological Receptors – NH_3

Receptor ID	Site Name	Annual Average (µg/m³)					
		CL (µg/m³)	BC (µg/m³)	PC	PC % of CL	PEC (µg/m³)	PEC % of CL
E1	Teesmouth and Cleveland Coast SPA, SSSI and Ramsar	3	0.64	0.4	13.3%	1.0	35%
E2	North York Moors SPA, SAC and SSSI		1.14	0.02	0.7%	1.2	39%
E3	Northumbria Coast SPA and Ramsar		1.23	0.01	0.5%	1.2	41%
E4	Durham Coast SAC		1.23	0.02	0.6%	1.2	42%
E5	Lovell Hill Pools SSSI		2.21	0.04	1.3%	2.2	75%
E6	Saltburn Gill SSSI		0.84	0.03	0.9%	0.9	29%
E7	Coatham Marsh LWS		1.26	0.2	6.5%	1.5	49%
E8	Eston Pumping Station LWS		1.26	0.2	6.4%	1.5	48%

CL = Critical Level, PC = Process Contribution, BC = Background Concentration, PEC = Predicted Environmental Concentration

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Table 8B-19: Dispersion Modelling Results for Ecological Receptors – Nutrient Nitrogen Deposition (Kg/Ha/Yr)

Receptor ID	Site name	Background nitrogen deposition (kg N/ha/yr)	Most stringent Critical Load class applicable for the site	Lower value of applicable Critical Load range	PC (kg N/ha/yr)	PC % Critical Load	PEC (µg/m³)	PEC % Critical Load
E1	Teesmouth and Cleveland Coast SPA, SSSI and Ramsar	10.2	Coastal stable dune grassland (acid type)	8	2.3	28.8%	12.5	157%
E2	North York Moors SPA, SAC and SSSI	18.5	Dry Heath	10	0.12	1.2%	18.6	186%
E3	Northumbria Coast SPA and Ramsar	13.6	Coastal stable dune grassland (acid type)	8	0.07	1.0%	13.7	171%
E4	Durham Coast SAC and SSSI	13.6	Sub-atlantic semi-dry calcareous grassland	15	0.10	0.7%	13.7	91%
E5	Lovell Hill Pools SSSI	No comparable habitat with established critical load for estimate available.						
E6	Saltburn Gill SSSI	18.2	Broad-leaved, mixed and yew woodland	15	0.24	1.6%	18.4	123%
E7	Coatham Marsh LWS	13.9	Sub-atlantic semi-dry calcareous grassland	15	1.1	7.5%	15.0	100%
E9	Eston Pumping Station LWS	13.9	Sub-atlantic semi-dry calcareous grassland	15	1.1	5.5%	15.0	75%

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Table 8B-20: Dispersion Modelling Results for Ecological Receptors – Acid Deposition N (Keq/Ha/Yr)

Receptor ID	Site name	Acid deposition (keq/ha/yr)[4]				PC acid deposition (keq/ha/yr)[5]		
		Critical Load[6]	Baseline	Lowest Critical Load class applicable	Baseline % of Critical Load	PC	PC % of Critical Load	PEC% of Critical Load
E1	Teesmouth and Cleveland Coast SPA, SSSI and Ramsar	Min CL Min N 0.223 Min CL Max N 1.998 Min CL Max S 1.560	N: 0.7 S: 0.3	Acid grassland	50.1%	0.164	8.0%	58.1%
E2	North York Moors SPA, SAC and SSSI	Min CL Min N 0.321 Min CL Max N 0.504 Min CL Max S 0.183	N: 1.3 S: 0.2	Dwarf shrub heath	189.4%	0.008	1.3%	190.7%
E3	Northumbria Coast SPA and Ramsar	Min CL Min N 0.223 Min CL Max N 0.786 Min CL Max S 0.420	N: 1.0 S: 0.2	Acid grassland	152.7%	0.006	1.3%	153.9%
E4	Durham Coast SAC and SSSI	Min CL Min N 0.856 Min CL Max N 4.856	N: 0.7 S: 0.2	Calcareous grassland	5.0%	0.007	0%	5.0%

[4] Acid Deposition Critical Loads
[5] Process Contribution and Process Environmental Contribution as percentages of the relevant Critical Load have been calculated using the Min CL Max N
[6] Critical Load (as obtained from APIS, July 2018)

Receptor ID	Site name	Acid deposition (keq/ha/yr)[4]				PC acid deposition (keq/ha/yr)[5]		
		Critical Load[6]	Baseline	Lowest Critical Load class applicable	Baseline % of Critical Load	PC	PC % of Critical Load	PEC% of Critical Load
		Min CL Max S 4.00						
E5	Lovell Hill Pools SSSI	No critical loads assigned for the features present.						
E6	Saltburn Gill SSSI	Min CL Min N 0.142 Min CL Max N 2.639 Min CL Max S 2.448	N: 0.1.3 S: 0.2	Unmanaged Broadleafed/Coniferous Woodland	56.8%	0.017	0.8%	57.6%
E7	Coatham Marsh LWS	Min CL Min N 1.07 Min CL Max N 4.00 Min CL Max S 5.07	N: 1.1 S: 0.24	Calcareous grassland	33.5%	0.123	3.3%	36.8%
E9	Eston Pumping Station	Min CL Min N 1.07 Min CL Max N 4.00 Min CL Max S 5.07	N: 1.1 S: 0.24	Calcareous grassland	33.5%	0.125	3.3%	36.8%

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8.7 Assessment of Limitations and Assumptions

8.7.1 This section outlines the potential limitations associated with the dispersion modelling assessment. Where assumptions have been made, this is also detailed here.

8.7.2 The greatest uncertainty associated with any dispersion modelling assessment arises through the inherent uncertainty of the dispersion modelling process itself. Despite this, the use of dispersion modelling is a widely applied and accepted approach for the prediction of impacts from industrial sources.

8.7.3 In order to minimise the likelihood of under-estimating the PC to ground level concentrations from the main stack, the following conservative assumptions have been made within the assessment:

- The operational Proposed Development has been assumed to operate on a continuous basis i.e. for 8,760 hour per year, although in practice the plant would require routine maintenance periods;
- The modelling predictions are based on the use of five full years of meteorological data from Durham Teesside meteorological station for the years 2015 to 2019 inclusive, with the highest result being reported for all years assessed;
- The largest possible building sizes within the Rochdale Envelope have been included; and
- Emission concentrations for the process are calculated based on the use of IED limits, BAT-AEL concentrations, or maximum envisaged emission rates when annual average rates would be below this.

8.7.4 The following assumptions have been made in the preparation of the assessment:

- 70% NO_x to NO_2 conversion rate has been assumed in predicting the long-term process contribution, and 35% for the short-term process contribution respectively; and
- The screening assessment of N-amines is considered to be deliberately conservative at this stage, and further work for the final ES is planned to take into account specific amine species and the amines specific module within ADMS.

8.8 Conclusions

8.8.1 This report has assessed the impact on local air quality of the operation of the Proposed Development. The assessment has used the dispersion model ADMS to predict the increases in pollutant species released from the operational Development to the local study area.

8.8.2 An evaluation of release height for the main stacks has shown that a release height of 80 m or greater is capable of mitigating the short-term and long-term

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impacts of emissions to an acceptable level, with regard to existing air quality and ambient air quality standards with regards to human health receptors.

8.8.3 Emissions from the main stacks would result in small increases in ground-level concentrations of the modelled pollutants. Taking into account available information on background concentrations within the modelled domain, predicted operational concentrations of the modelled pollutants would be within current environmental standards for the protection of human health.

8.8.4 The modelling of impacts at designated ecological sites (SACs / Ramsar / SPAs and SSSIs) has predicted that emissions would give rise to no impacts with regard to increases in atmospheric concentrations of NO_x and NH_3, however depositional impacts of nutrient nitrogen and acid are considered to be significant. Further interpretation and discussion of these impacts is provided in Appendix 15E, Habitats Regulations Assessment – Least Significant Effects (PEI Report, Volume III).