

# Keadby Next Generation Power Station

## Environmental Permit Application

### Appendix G – Air Quality Impact Assessment

**The Environmental Permitting (England and Wales) Regulations 2016**

**Applicant: Keadby Next Generation Limited**

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## Document Version Control

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## GLOSSARY

Abbreviation	Description
APIS	Air Pollution Information Service
AQAP	Air Quality Action Plan
AQMA	Air Quality Management Area
AQS	Air Quality Standard
BAT	Best Available Techniques
BAT-AEL	BAT-Achievable Emission Level
BATc	Best Available Techniques Conclusions
BRef	BAT Reference Document
CCGT	Combined Cycle Gas Turbine
CL	Critical Level
CLd	Critical Load
CLRTAP	Convention on Long-range Transboundary Air Pollution
CO	Carbon monoxide
DC	Doncaster Council
EA	Environment Agency
EAL	Environmental Assessment Levels
EDG	Emergency Diesel Generator
EE	Electricity Efficiency
ELVs	Emission Limit Values
ERYC	East Riding of Yorkshire Council
HRSG	Heat Recovery Steam Generation
HVAC	Heating, Ventilation and Air Conditioning
IED	Industrial Emissions Directive
LCP	Large Combustion Plant
LWS	Local Wildlife Site
MCPD	Medium Combustion Plant
NH <sub>3</sub>	Ammonia
NLC	North Lincolnshire Council
NOx	Oxides of Nitrogen

<b>Abbreviation</b>	<b>Description</b>
NO <sub>2</sub>	Nitrogen Dioxide
PC	Process Contribution
PCM	Pollution Climate Mapping
PEC	Predicted Environmental Concentration
PM	Particulate Matter
SCR	Selective Catalytic Reduction
SAC	Special Area of Conservation
SCAIL	Simple Calculation of Atmospheric Impact Limits
SO <sub>2</sub>	Sulphur Dioxide
SPA	Special Protection Area
SSSI	Site of Special Scientific Interest
UNECE	United Nations Economic Commission for Europe

## CONTENTS

<b>1. Introduction</b>	<b>1</b>
1.1 Purpose of Report	1
<b>2. Assessment Criteria</b>	<b>3</b>
2.1 Air Quality Legislation	3
2.2 Environmental Permitting Regulations	5
2.3 Human Health Significance Criteria	7
2.4 Ecological Significance Criteria	8
<b>3. Assessment Methodology</b>	<b>9</b>
3.1 NO <sub>x</sub> to NO <sub>2</sub> Conversion	10
3.2 Deposition Conversion Factors	10
<b>4. Receptors and Baseline Air Quality</b>	<b>11</b>
4.1 Receptors	11
4.2 Human Health Air Quality Background Concentrations	14
4.3 Baseline Air Quality – Ecological Receptor	15
<b>5. Dispersion Modelling Parameters</b>	<b>18</b>
5.1 Emissions Inventory	18
5.2 Meteorological Data	20
5.3 Buildings and Terrain	23
5.4 Modelled Domain	24
<b>6. Predicted Results</b>	<b>25</b>
6.1 Introduction	25
6.2 Updated Keadby 2 Backgrounds	25
6.3 Human Health Receptor Results	28
6.4 Ecological Impacts	31
<b>7. In-combination Assessment</b>	<b>57</b>
<b>8. Conclusions</b>	<b>58</b>

## TABLES

Table 1: Air Quality Strategy (AQS) Objectives – Protection of Human Health	4
Table 2: Critical Levels – Protection of Vegetation and Ecosystems	5
Table 3: Environmental Assessment Levels	7
Table 4: Deposition Velocities	10
Table 5: Factors to Convert Deposition to kg/ha/yr	10
Table 6: Conversion Factor to Convert from kg of N to keq/ha/yr	10
Table 7: Identified Human Health Receptors	11
Table 8: Identified Ecological Receptors	12
Table 9: Defra Annual Average Background Concentrations	15
Table 10: APIS Background Data	16
Table 11: Modelled Emission Parameters	19
Table 12: Buildings Included with the Model Set-Up	23
Table 13: Defra Annual Average Background Concentrations with K2 Contribution	26
Table 14: APIS Background Data NO <sub>x</sub> and NH <sub>3</sub> (2020 – 2022 data) with K2 Contribution	26

Table 15: APIS Deposition Backgrounds (2020 – 2022 data) with K2 Contribution .	27
Table 16: Maximum Results 100% Hydrogen Firing – Human Health Impacts .....	29
Table 17: Maximum Results 100% Natural Gas Firing – Human Health Impacts ....	30
Table 18: NO <sub>x</sub> Dispersion Modelling Results for Ecological Receptors - 100% Hydrogen Firing.....	33
Table 19: NO <sub>x</sub> Dispersion Modelling Results for Ecological Receptors - 100% Natural Gas Firing.....	36
Table 20: NH <sub>3</sub> Dispersion Modelling Results for Ecological Receptors – 100% Hydrogen Firing.....	39
Table 21: NH <sub>3</sub> Dispersion Modelling Results for Ecological Receptors – 100% Natural Gas Firing .....	41
Table 22: Nutrient Nitrogen Deposition (Kg/Ha/Yr) Results – 100% Hydrogen Firing .....	46
Table 23: Nutrient Nitrogen Deposition (Kg/Ha/Yr) Results – 100% Natural Gas ....	49
Table 24: Acid Deposition N (Keq/Ha/Yr) Results – 100% Natural Gas Firing .....	53

## PLATES

Plate 1: Wind roses for Doncaster Robin Hood Airport – 2018 - 2022 .....	22
Plate B1: Stack Height Determination .....	62

# 1. Introduction

## 1.1 Purpose of Report

This Appendix has been prepared in support of the application for an Environmental Permit for the proposed Keadby Next Generation Power Station (the 'Proposed Installation') to be located on land adjacent to the existing Keadby Power Station site (Keadby 1 and Keadby 2) near Scunthorpe in North Lincolnshire.

The purpose of this Appendix is to detail the Air Quality Impact Assessment that has been carried out for the Proposed Installation and to demonstrate that the emissions from the Proposed Installation would not lead to the exceedance of any Air Quality Standards (AQS) objectives, Environmental Assessment Levels (EALs), Critical Levels (CLs) and Critical Loads (CLDs), as appropriate.

The pollutants included in the assessment are oxides of nitrogen (NO<sub>x</sub>), nitrogen dioxide (NO<sub>2</sub>), carbon monoxide (CO) and also ammonia (NH<sub>3</sub>) due to the potential for a Selective Catalytic Reduction (SCR) system to control NO<sub>x</sub> emissions.

The assessment has considered the requirement for the Combined Cycle Gas Turbine (CCGT) of the Proposed Installation to operate on 100% hydrogen, 100% natural gas or a blend of natural gas and hydrogen. The Proposed Installation will be designed to run on 100% hydrogen and capable of operating on 100% natural gas from the start of operations. When hydrogen becomes available and operation with hydrogen firing is commercially viable, the Proposed Installation will be upgraded to operate on a blend of natural gas and hydrogen or 100% hydrogen, as detailed in the Main Supporting Document.

In addition to the CCGT, there will be an emergency diesel generator (EDG) to provide a short-term source of electricity, in the event of a simultaneous loss of power generation and external power supply, to provide power for essential and non-essential services (heating, ventilation and air conditioning (HVAC), telecoms, emergency lighting and plant control systems) for up to 72 hours until external power can be re-established. Consideration of the impacts associated with the intermittent testing of the EDG (<12 hours per year) and the emergency power scenario are also included in the assessment.

The assessment includes:

- a summary of the air quality standards and guidance that is applicable;
- existing background air quality data;
- an outline of the assessment methodology;
- an assessment of the operation of the Proposed Installation when firing on 100% Natural Gas;
- an assessment of the operation of the Proposed Installation when firing on 100% Hydrogen;
- a Simple Calculation of Atmospheric Impact Limits (SCAIL) assessment of the operation of the EDG.

The assessment has been carried out in accordance with the Environment Agency's (EA) Risk Assessments for Specific Activities: Environmental Permits guidance (Defra and EA, 2016)<sup>1</sup> (EA's Risk Assessment Guidance).

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<sup>1</sup> [Air emissions risk assessment for your environmental permit - GOV.UK](https://www.gov.uk/guidance/air-emissions-risk-assessment-for-your-environmental-permit)

## 2. Assessment Criteria

### 2.1 Air Quality Legislation

The principal air quality legislation within the United Kingdom is the Air Quality Standards Regulations 2010<sup>2</sup> (amended 2016), which transposes the requirements of the European Ambient Air Quality Directive 2008<sup>3</sup> and the 2004 fourth Air Quality Daughter Directive<sup>4</sup>. The Air Quality Standards Regulations 2010 set air quality limits for a number of major air pollutants that have the potential to impact public health or the natural environment, such as nitrogen dioxide (NO<sub>2</sub>), carbon monoxide (CO) and oxides of nitrogen (NO<sub>x</sub>).

The Environment Act 2021<sup>5</sup> amended the Environment Act 1995, which requires the UK Government to produce a National Air Quality Strategy (AQS)<sup>6</sup>, last reviewed in 2007, containing air quality objectives and timescales to meet those objectives. The AQS objectives apply to outdoor locations where people are regularly present and do not apply to occupational, indoor or in-vehicle exposure.

Some pollutants have objectives expressed as annual average concentrations due to the chronic way in which they affect health or the natural environment, i.e., effects occur after a prolonged period of exposure to elevated concentrations. Other pollutants have objectives expressed as 24-hour or 1-hour average concentrations due to the acute way in which they affect health or the natural environment, i.e., after a relatively short period of exposure. Some pollutants have objectives expressed in terms of both long and short-term concentrations.

Air quality limit values and objectives apply to outdoor locations where people are regularly present and do not apply to occupational, indoor or in-vehicle exposure.

The current AQS objectives applicable to this assessment for the protection of human health are presented in Table 1.

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<sup>2</sup> The Air Quality Standards Regulations 2010 (SI 2010/1001). London: The Stationery Office.

<sup>3</sup> European Commission (2008) European Directive on Ambient Air Quality 2008/50/EC.

<sup>4</sup> European Commission (2004) European Fourth Daughter Directive on Ambient Air Quality. 2004/107/EC.

<sup>5</sup> The Environment Act 2021 (c. 30). Available online: [Environment Act 2021 \(legislation.gov.uk\)](https://www.legislation.gov.uk)

<sup>6</sup> Department for Environment, Food and Rural Affairs (2007). The Air Quality Strategy for England, Scotland, Wales and Northern Ireland. London: The Stationery Office.

**Table 1: Air Quality Strategy (AQS) Objectives – Protection of Human Health**

<b>Pollutant</b>	<b>NAQS Objective (µg/m<sup>3</sup>)</b>	<b>Averaging Period</b>
Nitrogen dioxide (NO <sub>2</sub> )	40	Annual mean
	200	1-hour mean, not to be exceeded more than 18 times a year (99.79 <sup>th</sup> percentile)
Carbon monoxide (CO)	10,000	Maximum daily running 8-hour mean

The impact of emissions from Proposed Installation on sensitive ecological receptors are quantified within this assessment in two ways:

- as direct impacts on plants physiology, growth and vitality arising due to increases in atmospheric pollutant concentrations, assessed against defined 'Critical Levels'; and
- as indirect impacts arising through deposition of acids and nutrient nitrogen to the ground surface, assessed against defined 'Critical Loads'.

Critical Levels (CLs) for the protection of vegetation and ecosystems have been adopted by, amongst others, the European Union and the United Nations Economic Commission for Europe (UNECE) Convention on Long-range Transboundary Air Pollution (CLRTAP).

Under the European Ambient Air Quality Directive, assessment of compliance with CLs is strictly only required at locations more than 20 km from towns with more than 250,000 inhabitants or more than 5 km from other built-up areas, industrial installations or motorways. However, in practice, assessment against CLs is frequently undertaken to inform planning and permitting processes across the country, regardless of this definition.

The annual average CL for NO<sub>x</sub> has been transposed in the Air Quality Standards Regulations 2010. Additional values for daily NO<sub>x</sub> and ammonia (NH<sub>3</sub>) are also generally used as regulatory standards, although these have not been formally adopted. The CLs applicable to this assessment for the protection of vegetation and ecosystems are presented in Table 2.

**Table 2: Critical Levels – Protection of Vegetation and Ecosystems**

Pollutant	Critical Level ( $\mu\text{g}/\text{m}^3$ )	Averaging Period	Other Information
Oxides of nitrogen (NO <sub>x</sub> )	30	Annual mean	-
	75	Daily mean	The critical level is generally considered to be $75\mu\text{g}/\text{m}^3$ , but this only applies where there are high concentrations of SO <sub>2</sub> and ozone, which is not generally the current situation in the UK. Given the low UK SO <sub>2</sub> concentrations IAQM consider the higher value of $200\mu\text{g}/\text{m}^3$ can be used as a short-term CL. <sup>7</sup>
Ammonia (NH <sub>3</sub> )	3	Annual mean	For higher plants
	1	Annual mean	For lichens and bryophytes

Critical Loads (CLDs) for the deposition of nutrient nitrogen and acidifying species are dependent on the habitat type and species present and therefore are specific to habitat types considered within the assessment. The relevant CLDs for the habitats present within the identified ecological receptors considered in this assessment are defined on the Centre for Ecology and Hydrology Air Pollution Information System (APIS) website<sup>8</sup> and are detailed in Section 4.3.

CLDs are provided as ranges of kilograms of nitrogen per hectare per year (kg N/ha/yr) or nitrogen kilogram equivalents (keq/ha/yr) for nitrogen and acid deposition respectively, which reflect the variation in ecosystem response across Europe. To ensure that a conservative assessment is carried out, it is usual for impacts to be determined against the lower end (i.e. the most stringent) of the CLD range.

## 2.2 Environmental Permitting Regulations

### Industrial Emissions Directive

The EU's Industrial Emissions Directive (IED)<sup>9</sup> provides operational limits and controls to which plant must comply, including Emission Limit Values (ELVs) for pollutant releases to air. The CCGT of the Proposed Installation falls under the Large

<sup>7</sup> IAQM (2020). A Guide to the Assessment of Air Quality Impacts on Designated Nature Conservation Sites.

<sup>8</sup> [www.apis.ac.uk](http://www.apis.ac.uk)

<sup>9</sup> 'Directive 2010/75/EU of the European Parliament and of the Council of 24 November 2010 on industrial emissions (integrated pollution prevention and control) Text with EEA relevance' (2010). *Official Journal* L334, P.17.

Combustion Plant (LCP) requirements (Chapter III) of the IED, since it will be greater than 50 MW thermal input capacity.

The operator of a plant covered by the IED is required to employ BAT for the prevention or minimisation of emissions to the environment, to ensure a high level of protection of the environment as a whole. European BAT reference documents (BRefs) are published for each industrial sector regulated under the IED, and they include BAT-Achievable Emission Levels (AELs) which are expected to be met through the application of BAT. These levels may be the same as the ELVs published in the IED, or they may be more stringent. The current version of the LCP BRef<sup>10</sup> and associated BAT Conclusions (BATc)<sup>11</sup> includes daily average and yearly average BAT-AELs for natural gas fired CCGT plant for NO<sub>x</sub> and indicative values for yearly average carbon monoxide CO, which are more stringent than the ELVs included in the IED. In the UK, IED has been implemented through the Environmental Permitting (England and Wales) Regulations 2016 (as amended) (EP Regulations).

The combustion of 100% hydrogen in a gas turbine will result in a reduction in the normalised flue gas volume (at 0°C, 1 atmosphere, dry gas and 15% O<sub>2</sub>) compared with natural gas by approximately 27%. This is due to the fundamental combustion chemistry of the respective fuels and inherent gas turbine design characteristics with respect to high excess air and means that the normalised concentration of pollutants in the flue gas when a CCGT is fired on hydrogen may be higher than when fired on natural gas. This means that the BAT-AEL for natural gas firing would not be achievable in hydrogen fired plant.

There are currently no BAT-AELs associated with hydrogen firing, however the EA has developed Guidance on Emerging Technologies for hydrogen fired combustion plant<sup>12</sup> (Hydrogen GET) to provide ELVs for hydrogen combustion within the scope of IED. The Hydrogen GET details the application of a correction factor (1.37) to be applied to the IED NO<sub>x</sub> ELV of 50 mg/Nm<sup>3</sup> for hydrogen fired plant to allow for the differing flue gas characteristics. This will result in identical mass release rates of NO<sub>x</sub> between the two fuels, based on the IED NO<sub>x</sub> ELV.

If the CCGT cannot meet the required ELVs for natural gas and/ or hydrogen firing by primary techniques alone, the exhaust gas exiting the Heat Recovery Steam Generator (HRSG) will be treated using SCR based on NH<sub>3</sub> injection, to reduce the NO<sub>x</sub> emissions of the exhaust gas to meet the required ELVs.

Where legislative ambient AQS are not specified for the pollutant species potentially released from an installation, Environmental Assessment Levels (EALs), published in

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<sup>10</sup> Best Available Techniques (BAT), Reference Document for Large Combustion Plants Industrial Emissions Directive 2010/75/EU of the European Parliament and of the Council, July 2017. Available at: [Large Combustion Plants | EU-BRITE](#)

<sup>11</sup> Commission Implementing Decision Establishing Best Available Techniques (BAT) conclusions, under Directive 2010/75/EU of the European Parliament and of the Council, for Large Combustion Plants, European IPPC Bureau, November 2021. Available at: [Large Combustion Plants | EU-BRITE](#)

<sup>12</sup> Environment Agency (2024). Guidance Hydrogen Combustion: comply with emission limit values, and the Available online: [Hydrogen combustion: comply with emission limit values - GOV.UK](#)

the EA’s Risk Assessment Guidance can be used to assess potential health effects on the general population.

For this assessment this includes an additional EAL for hourly concentrations of CO and annual average and hourly EALs for NH<sub>3</sub>.

**Table 3: Environmental Assessment Levels**

Pollutant	EAL (µg/m <sup>3</sup> )	Averaging Period
Carbon monoxide (CO)	10,000	Hourly mean as 100 <sup>th</sup> percentile
Ammonia (NH <sub>3</sub> )	180	Annual mean
	2,500	Hourly mean as 100 <sup>th</sup> percentile

### 2.3 Human Health Significance Criteria

The EA’s Risk Assessment Guidance identifies a two-stage process for determining the impact of emissions to air from a process. The stage one screening criteria compares the process contribution (PC) (i.e. the modelled ground level pollutant concentration) with the relevant AQS objective or EAL. The criteria states that an emission may be considered to have an insignificant impact where:

- Short term PC ≤10% of the AQS objective or EAL; and,
- Long term PC ≤1% of the AQS objective or EAL.

If both criteria are met, no further assessment is required, but if they are not met, the second stage of screening is applied.

The second stage of screening considers the PCs in the context of the existing background pollutant concentrations; the predicted environmental concentration (PEC) (i.e. the PC plus the background concentration) is considered acceptable where:

- Short term PC <20% of the short term AQS objective or EAL minus twice the long-term background concentration (headroom); and
- Long term PEC (PC + background concentration) <70% of the AQS objective or EAL.

The EA’s Risk Assessment Guidance indicates that where AQS objective or EAL are likely to be breached as a result of contributions from an installation, or where installation releases constitute a major proportion of the AQS or EAL, such releases are likely to be considered unacceptable.

Where the PEC is not predicted to exceed the AQS objective or EAL and the proposed emissions comply with the BAT-AEL (or equivalent requirements) the emissions may be considered acceptable by the EA.

## 2.4 Ecological Significance Criteria

For European sites (Special Protection Areas (SPA), Special Areas of Conservation (SAC) or Ramsar sites) an assessment is made as to whether the emissions from an installation are 'likely to have a significant effect', and whether this could lead to an 'adverse effect on site integrity'. Sites within 15km have been considered in the assessment, which has also included Sites of Special Scientific Interest (SSSIs).

The EA's Risk Assessment Guidance states that PCs may be considered to have an insignificant impact at the first stage of screening on these sites where:

- Short term PC  $\leq$ 10% of the CL; and,
- Long term PC  $\leq$ 1% of the CL.

If these requirements are not met for short term impacts, further assessment is required. For long term impacts, the PEC must be calculated and if it is less than 70% of the CL, the impacts are considered insignificant.

For SPAs, SACs and Ramsar sites, there is also a requirement to consider the 'in combination' (combined) impact of all permissions, plans or projects that affect the site.

For local nature sites, the assessment needs to determine whether the emissions are 'likely to damage' the site and is applicable to sites within 2km of the Proposed Installation. The EA's Risk Assessment Guidance screening criteria states that where PCs are less than 100% of the short or long term CL, the impact of emissions is insignificant at these sites.

The impact of point source emissions on ecological receptors, through deposition of nutrient nitrogen or acidity, has been evaluated using the EA's and Natural England's guidance insignificance criterion of 1% of CLd. However, it should be noted that impacts over the insignificance criterion of 1% are not consequentially significant, rather that further consideration of the impacts are required.

### 3. Assessment Methodology

The EA's Risk Assessment Guidance provides guidance on the assessment of BAT and of impacts from permitted installations, for the purposes of Environmental Permitting. The guidance also includes the consideration of risk and environmental impacts from other emissions from an installation, including visible plumes.

Emissions from the Proposed Installation have been assessed using the EA's Risk Assessment methodology in order to identify where emissions can be screened as having an insignificant impact. Detailed dispersion modelling using the atmospheric dispersion model ADMS 6 has been used to calculate the concentrations of pollutants at identified receptors. These concentrations have been compared with the AQS objectives, EALs, CLs for each pollutant species that could be released from the Proposed Installation. Dispersion modelling calculates the predicted concentrations arising from the emissions to atmosphere, based on Gaussian approximation techniques. The model employed has been developed for UK regulatory use.

Emissions of sulphur dioxide (SO<sub>2</sub>) and particulates (PM<sub>10</sub> and PM<sub>2.5</sub>) from natural gas and hydrogen fired plant are at such low levels relative to the AQS objectives that they are considered negligible and the risk to the achievement of the PM<sub>10</sub> and SO<sub>2</sub> AQS objectives is considered negligible, therefore these have not been considered in the assessment.

An assessment of nutrient nitrogen and acidification has been undertaken by applying published deposition velocities to the predicted annual average NO<sub>2</sub> and NH<sub>3</sub> concentrations at the identified statutory habitat sites, determined through dispersion modelling, to calculate nitrogen deposition rates.

These deposition rates have then been compared to the CLDs for nitrogen published by APIS for the species present at each habitat site, taking into consideration the baseline air quality.

Increases in acidity from deposition contributions of NO<sub>2</sub> and NH<sub>3</sub> from the process contribution have also been considered. The nitrogen keq/ha/yr, have been derived from nitrogen deposition modelling values using standard conversion factors. The acidity deposition rates and baseline deposition rates have been used within the CLD Function Tool (APIS) to determine whether the contribution would result in exceedance of the defined acidity CLDs for the most sensitive feature.

The final design of the Proposed Installation will not be known until after the detailed design process has been completed. Therefore, the emission parameters assessed have been based on technology information provided by a number of CCGT suppliers, with the emissions and release parameters that lead to the worst-case impacts being used in the assessment.

The assessment of worst-case long-term and short-term emissions resulting from operation of the Proposed Installation has been undertaken assuming that the plant is operational, at full load, for 8,760 days per year, as this represents the worst case for annual average impacts and predicts the maximum short-term impacts from the worst-case meteorological data.

### 3.1 NO<sub>x</sub> to NO<sub>2</sub> Conversion

Emissions of NO<sub>x</sub> from industrial point sources are typically dominated by nitric oxide (NO), with emissions from combustion sources typically in the ratio of NO to NO<sub>2</sub> of 9:1. However, it is NO<sub>2</sub> that has specified AQS objective due to its potential impact on human health. In the ambient air, NO is oxidised to NO<sub>2</sub> by the ozone present, and the rate of oxidation is dependent on the relative concentrations of NO and ozone in the ambient air.

For the purposes of detailed modelling, and in accordance with EA technical guidance<sup>13</sup> it is assumed that 70% of emitted NO is oxidised to NO<sub>2</sub> in the long term and 35% of the emitted NO is oxidised to NO<sub>2</sub> in the local vicinity of the Proposed Installation in the short-term.

### 3.2 Deposition Conversion Factors

The dry deposition flux for each receptor has been calculated based on recommended deposition velocities<sup>14</sup>, presented in Table 4.

**Table 4: Deposition Velocities**

Parameter	Deposition velocity (m/s)	
Nitrogen Dioxide (NO <sub>2</sub> )	Grassland	0.0015
	Forest	0.003
Ammonia (NH <sub>3</sub> )	Grassland	0.02
	Forest	0.03

For nitrogen deposition, conversion factors are used to convert dry deposition flux from units of µg/m<sup>2</sup>/s to kg/ha/yr are shown in Table 5.

**Table 5: Factors to Convert Deposition to kg/ha/yr**

Parameter	Conversion factor µg/m <sup>2</sup> /s of species to kg/ha/yr	
Nitrogen Dioxide (NO <sub>2</sub> )	of N:	96
NH <sub>3</sub>	of N:	260

To convert kg/ha/yr to keq/ha/yr for acid deposition, the conversion factors shown in Table 6 are applied.

**Table 6: Conversion Factor to Convert from kg of N to keq/ha/yr**

Parameter	Conversion factor kg/ha/yr to keq/ha/yr
N	0.071428

<sup>13</sup> [https://webarchive.nationalarchives.gov.uk/20140328232919/http://www.environment-agency.gov.uk/static/documents/Conversion ratios for NO<sub>x</sub> and NO<sub>2</sub> .pdf](https://webarchive.nationalarchives.gov.uk/20140328232919/http://www.environment-agency.gov.uk/static/documents/Conversion%20ratios%20for%20NOx%20and%20NO2.pdf)

<sup>14</sup> Institute of Air Quality Management (IAQM) (2020) A guide to the assessment of air quality impacts on designated nature conservation sites.

## 4. Receptors and Baseline Air Quality

### 4.1 Receptors

Receptors potentially affected by the emissions from the Proposed Installation, including local residential and amenity receptors, have been identified through site knowledge and desk study of local mapping. Isopleth figures of pollutant dispersion have been examined to identify the receptors that will receive the highest point source contributions and these receptors have been included in the model set up as discrete receptors.

Individual receptor locations used in the model are shown in Table 7. The Thorne village receptor has been included historically as the local authority had previously expressed concerns over potential impacts, due to high background NO<sub>2</sub> concentrations in the area.

**Table 7: Identified Human Health Receptors**

Receptor I.D.	Receptor Description	Designation	Grid Reference		Distance and direction
			x	y	
R1	Holly House	Residential	483035	411880	780m northeast
R2	1 Trent Side, Keadby	Residential	483370	411285	1.2km southeast
R3	North Pilfrey Farm	Residential	480855	411405	990m southwest
R4	Keadby Grange	Residential	481565	410910	900m south
R5	Pharon-Ville - Gunness	Residential	484060	411660	1.8km east
R6	Boskeydyke Farm, Amcotts	Residential	483860	413350	2.0km northeast
R7	Grange Cottage, Gunness	Residential	484710	412315	2.5km northeast
R8	Pilfrey Farm	Residential	480770	409995	2.1km southwest
R9	Thorne Village	Residential	469570	412680	12.2km west
R10	Vazon Bridge House <sup>1</sup>	Residential/ recreational	482510	411500	455m south
R11	North Moor Farm	Residential	482875	412620	740m northwest
R12	Trent Road	Residential	483400	411620	1km east

<sup>1</sup> Taken to also be representative of the Scunthorpe Sea Cadets receptor

The Environment Act 2021 also requires local authorities to undertake an assessment of local air quality to establish whether the objectives are being achieved, and to designate air quality management areas (AQMA) if improvements are necessary to meet the objectives. Where an AQMA has been designated, the local authority must

draw up an air quality action plan (AQAP) describing the measures that will be put in place to assist in achieving the objectives. Defra has responsibility for coordinating assessments and AQAPs for the UK as a whole.

North Lincolnshire Council (NLC) has declared a single AQMA within their administrative area (approximately 6km east of the Proposed Installation), for the exceedance of the 24-hour mean PM<sub>10</sub> AQS objective. As the AQMA has not been declared for the pollutant species emitted from the Proposed Installation, it would not be impacted by its emissions.

The study area includes small parts of the administrative areas of Doncaster Council (DC) and East Riding of Yorkshire Council (ERYC). DC has declared a number of AQMAs for NO<sub>2</sub> within their administrative area, but none are within the study area; the closest being over 10km from the Proposed Installation. As the AQMAs are not within the prevailing wind direction of the operational Proposed Installation, it is considered unlikely that they would be impacted by the emissions from it. No further consideration of AQMAs has therefore been included in the assessment.

Ecological receptors potentially affected by the operation of the Proposed Installation have been identified through desk study of Defra Magic mapping and the APIS website. Statutory designated sites (including SPAs, SACs, Ramsar sites and SSSIs up to 15 km have been included in the assessment; and non-statutory designations such as Local Wildlife Sites (LWS) within 2km have been included in the assessment. Identified receptors are detailed in Table 8.

**Table 8: Identified Ecological Receptors**

Receptor I.D.	Receptor Description	Designation	Grid reference		Distance and direction
			x	y	
OE1 - 5	Humber Estuary	Ramsar, SAC, SSSI	483573 - 483951	411823 - 412817	1.3km – 1.8km east
OE6	Crowle Borrow Pits	SSSI	479102	410825	2.9km southwest
OE7	Hatfield Chase Ditches	SSSI	478769	410293	3.0km south-west
OE8	Eastoft Meadow	SSSI	478772	414311	3.6km north-west
OE9	Belshaw	SSSI	476961	406079	7.7km south-west
OE10	Thorne Moor	SAC, SPA and SSSI	475934	414720	6.3km north-west
OE11	Epworth Turbary	SSSI	475690	404195	9.8km south-west
OE12	Risby Warren	SSSI	491180	413564	9.1km east
OE13	Hatfield Moor	SAC, SPA and SSSI	471828	408178	10.4km west
OE14	Messingham Heath	SSSI	487748	403574	9.9km southeast
OE15	Tuetoes Hills	SSSI	484361	401698	10.4km south
OE16	Haxey Turbary	SSSI	475107	401866	11.9km southwest
OE17	Rush Furlong	SSSI	478141	400564	11.9km south

Receptor I.D.	Receptor Description	Designation	Grid reference		Distance and direction
			x	y	
OE18	Hewson's Field	SSSI	478493	399614	12.7km south
OE19	Messingham Sand Quarry	SSSI	491394	404065	12.0km southeast
OE20	Manton and Twigmoor	SSSI	492895	405918	12.2km southeast
OE21	Scotton and Laughton Forest Ponds	SSSI	485863	399966	12.4km south
OE22	Broughton Far Wood	SSSI	495776	410821	13.6km east
OE23	Broughton Alder Wood	SSSI	495914	409994	13.9km east
OE24	Scotton Beck Field	SSSI	487885	399177	13.9km southeast
OE25	Scotton Common	SSSI	486951	398641	14.1km south
OE26	Laughton Common	SSSI	483534	397224	14.7km south
OE27	Stainforth and Keadby Canal Corridor	LWS	482055	411529	330m south
OE28	Keadby Wetland	LWS	482773	411433	695m east
OE29	Keadby Wet Grassland	LWS	482785	411409	710m east
OE30	Three Rivers	LWS	482956	411068	1.1km south-east
OE31	Ash Tip	N/A	481797	412068	Adjacent to west
OE32	Humber Estuary (at Blacktoft Sands)	Ramsar, SAC, SPA and SSSI	486210	421275	10.3km northeast

The receptor locations are shown in Figure 1 and Figure 2 provided in Annex A.

In addition, there are two further SSSIs within 15 km of the Proposed Installation (Conesby Quarry and Manton Stone Quarry), which are designated due to their geological features. It is therefore considered that these sites will not be affected by emissions from the Proposed Installation, as the CLs and CLDs assigned to such sites are for the protection of vegetation and ecosystems only, and therefore they have been screened from further assessment.

Six LWS (Keadby Boundary Drain, South Soak Drain, Keadby Warping Drain, Hatfield Waste Drain, North Engine Drain, Belton and the River Torne) have not been included in the assessment as the relevant habitats are aquatic, and therefore not considered to be sensitive to air quality impacts from nitrogen dioxide. Guidance from the

Chartered Institute of Ecology and Environmental Management<sup>15</sup> states that *“Freshwater systems are generally phosphorus-limited....while the presence of nitrogen is not irrelevant, in most freshwater systems it is more important to control phosphorus inputs than nitrogen inputs. This is why phosphate discharge limits are often introduced on wastewater treatment works in order to protect freshwater habitats, but why nitrogen limits are rarely introduced to achieve the same objective. Phosphorus does not typically deposit from the atmosphere.”*

## 4.2 Human Health Air Quality Background Concentrations

Existing air quality conditions in the vicinity of the Proposed Installation have been evaluated through a review of local authority air quality management reports, Defra published data and other sources. The key pollutants of concern resulting from operation of the Proposed Installation, for which monitoring data on background concentration are available, are NO<sub>2</sub>, CO and NH<sub>3</sub>.

### North Lincolnshire Council Monitoring Data

NLC undertook automatic monitoring for NO<sub>2</sub> at six sites within their administrative area in 2022 and undertook NO<sub>2</sub> diffusion tube monitoring at 24 locations.

The nearest automatic monitors are located approximately 7.5km from the Proposed Installation; CM1 (Scunthorpe Town AURN) and CM3 (Low Santon), within the AQMA on the eastern side of Scunthorpe. The annual mean for NO<sub>2</sub> for 2022 at both CM1 and CM3 monitors was 13µg/m<sup>3</sup>.

The nearest NO<sub>2</sub> diffusion tube monitoring locations to the Proposed Installation are approximately 4.5km to the east, located on Doncaster Road (DT3 and DT4) and Scotter Road (DT2, near junction with Doncaster Road). Doncaster Road is a major road from the A18 and M181 into the centre of Scunthorpe. Annual mean concentrations of NO<sub>2</sub> at these locations range between 20 - 24µg/m<sup>3</sup>, well below the annual AQS objective of 40µg/m<sup>3</sup>.

Given that these monitoring locations are closer to, or within, more populated/urbanised areas than the area surrounding the Proposed Installation, it is considered that the background concentrations of NO<sub>2</sub> at these locations would be higher than those in the immediate vicinity of the Proposed Installation.

### Defra Background Data

Defra's 2021-based background maps are available at a 1x1 km resolution for the UK and are projected forward to the year 2030. These projections of pollution concentrations across England are available for NO<sub>2</sub> and NO<sub>x</sub>.

Annual average background concentrations from the Defra 2021-based background maps are presented for the year 2021 in Table 9, and have been taken for the grid

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<sup>15</sup> Chartered Institute of Ecology and Environmental Management (CIEEM) (2021). Advisory Note: Ecological Assessment of Air Quality Impacts.

square in which the Proposed Installation is located (National Grid Reference (NGR) 482500,411500) for NO<sub>2</sub> and NO<sub>x</sub>.

Recent background mapping of CO concentrations is not available for the most recent Defra maps, however Defra now advise using Pollution Climate Mapping (PCM) background maps in line with the Background Concentrations Maps User Guide<sup>16</sup>.

The background concentrations relevant to the assessment are shown in Table 9.

**Table 9: Defra Annual Average Background Concentrations**

Pollutant	Background concentration (µg/m <sup>3</sup> )
NO <sub>x</sub>	8.4
NO <sub>2</sub>	6.6
CO	114.6

A review of the background map concentrations over the study area for human health receptors shows that the concentrations presented in Table 9 for the Proposed Installation's location are also representative of the background concentrations at the receptor locations (the average NO<sub>2</sub> concentration in the grid squares with identified receptors was 6.5µg/m<sup>3</sup>).

NO<sub>2</sub> Data for 2021 has been used for the assessment to represent a conservative approach, as the typical trend shown in the Defra background mapping is that over the projected time period, concentrations of NO<sub>2</sub> and NO<sub>x</sub> are 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 Installation (earliest date 2030), is considered to represent a conservative approach, and is in line with advice from the EA on similar projects.

In line with the EA's Risk Assessment Guidance, short term background concentrations (hourly) are assumed to be twice the annual average concentration.

### 4.3 Baseline Air Quality – Ecological Receptor

The NO<sub>x</sub>, NH<sub>3</sub>, nitrogen deposition and acid deposition background concentrations are available from the APIS website for designated SAC, SPA and SSSI sites. The annual average concentrations present at the relevant habitat receptor sites are presented in Table 10.

<sup>16</sup> [2021-based-background-maps-user-guide-v1.0.pdf](#)

**Table 10: APIS Background Data**

Receptor I.D.	Ecology Site	NO <sub>x</sub> (µg/m <sup>3</sup> )	NH <sub>3</sub> (µg/m <sup>3</sup> )	Nitrogen Deposition (kg N/ha/yr)	Acid Deposition	
					(Keq N/ha/yr)	(Keq S/ha/yr)
OE1-5	Humber Estuary	8.7	1.9	16.0	1.15	0.16
OE6	Crowle Borrow Pits	8.7	1.8	28.3 woodland	2.02	0.17
				14.8 others	No critical loads	
OE7	Hatfield Chase Ditches	8.8	1.8	No comparable habitat with established critical load estimates available.		
OE8	Eastoft Meadow	7.8	1.9	14.6	1.04	0.13
OE9	Belshaw	7.8	1.7	No critical loads assigned.		
OE10	Thorne Moor	7.8	1.7	27.0 woodland	1.91	0.16
				14.1 others	1.00	0.12
OE11	Epworth Turbary	7.7	1.6	13.5	0.96	0.12
OE12	Risby Warren	11.1	1.9	17.4	1.24	0.2
OE13	Hatfield Moor	8.5	1.5	25.0 woodland	1.79	0.16
				13.0 other	0.93	0.12
OE14	Messingham Heath	8.1	2.1	16.9	No acidity critical loads	
OE15	Tuetoes Hills	7.6	2.0	15.3	No critical loads	
OE16	Haxey Turbary	7.6	1.5	13.2	0.95	0.12
OE17	Rush Furlong	7.5	1.6	13.6	0.97	0.12
OE18	Hewsons Field	7.6	1.6	13.6	0.97	0.12
OE19	Messingham Sand Quarry	8.2	2.1	32.6 woodland	2.33	0.18
				17.4 others	No critical loads	
OE20	Manton and Twigmoor	8.6	2.1	33.2 woodland	2.37	0.18
				17.7 others	No critical loads	
OE21	Scotton and Laughton forest Ponds	7.7	1.9	30.0 woodland	2.13	0.16
				15.8 others	1.12	0.12
OE22	Broughton Far Wood	9.8	2.3	35.6 woodland	2.54	0.23
				19.0 others	1.36	0.18
OE23	Broughton Alder Wood	9.9	2.3	Designated feature/ feature habitat not sensitive to eutrophication		
OE24	Scotton Beck Field	8.0	2.1	16.6	No critical loads	
OE25	Scotton Common	8.0	1.9	16.1	1.15	0.12
OE26	Laughton Common	7.5	1.7	14.7	1.02	0.12

Receptor I.D.	Ecology Site	NO <sub>x</sub> (µg/m <sup>3</sup> )	NH <sub>3</sub> (µg/m <sup>3</sup> )	Nitrogen Deposition (kg N/ha/yr)	Acid Deposition	
					(Keq N/ha/yr)	(Keq S/ha/yr)
OE27	Stainforth and Keadby Canal Corridor	8.8	1.9	15.5	1.11	0.15
OE28	Keadby Wetland	8.8	1.9	29.5	2.11	0.19
OE29	Keadby Wet Grassland	8.8	1.9	No comparable habitat with established critical load estimate available		
OE30	Three Rivers	8.9	1.9	16.0	1.14	0.15
OE31	Ash Tip	8.6	1.9	15.3	1.09	0.14
OE32	Humber Estuary (at Blacktoft Sands)	9.5	1.7	14.7	Not sensitive to acid deposition	

Although not explicitly stated in the EA's Risk Assessment Guidance, daily NO<sub>x</sub> background concentrations have been assumed to be 1.5 times the annual average concentration, as this is in line with advice provided by the EA on other projects.

## 5. Dispersion Modelling Parameters

### 5.1 Emissions Inventory

The assessment has considered two potential operational scenarios, to enable the flexible operation of the Proposed Installation, depending on the fuel source available to the Site when operation commences:

1.1.1 Proposed Installation operating on 100% hydrogen firing:

1.1.2 Proposed Installation operating on 100% natural gas

There is also potential for the Proposed Installation to operate on a blend of natural gas and hydrogen. However it is considered that the two scenarios to be assessed represents the full range of potential impacts that could occur from the Proposed Installation, as impacts associated with any interim operation on blends of natural gas and hydrogen would fall within this range.

The height of the stack has been determined based on the findings of a stack height assessment, detailed in (Annex B).

When the CCGT is 100% firing on natural gas, emission concentrations of NO<sub>x</sub> are required to be no higher than the BAT-AEL range provided in the LCP BATc (10 - 30 mg/Nm<sup>3</sup> as a yearly average and 15 - 40 mg/Nm<sup>3</sup> as a daily average). Where a CCGT has an electrical efficiency (EE) greater than 55% (as will be the case for the Proposed Installation) a correction factor can be applied to these BAT-AELs to increase the BAT-AEL to compensate for the slightly higher emission concentrations that result from improved efficiencies.

NO<sub>x</sub> has therefore been modelled at the upper end of the yearly BAT-AEL range for annual average impacts and at the upper end of the daily BAT-AEL range for hourly average impacts. The EE correction factor has been applied based on an assumed EE of 61%, as it is anticipated that the actual EE of the Proposed Development will be >61%.

For 100% hydrogen firing, the Hydrogen GET details applying a correction factor of 1.37 to the ELVs provided in the IED, which for NO<sub>x</sub> is 50 mg/Nm<sup>3</sup>. As such, the emission concentrations of NO<sub>x</sub> during 100% hydrogen firing will be required to be no higher than 68.5mg/Nm<sup>3</sup> as an annual average.

CO emissions will only occur when firing on natural gas and therefore have only been assessed for this scenario. Emissions have been modelled at the IED ELV of 100 mg/Nm<sup>3</sup>, as the LCP BATc do not contain a BAT-AEL for CO, rather details an indicative yearly emission range of 5 – 30 mg/Nm<sup>3</sup>, which is not relevant to the averaging periods set for CO AQS objective (8-hour rolling average and hourly average).

For all emissions modelling, it is considered that modelling at these maximum values represents the worst-case impacts; in practice, average emission concentrations are likely to be lower than permitted ELV concentrations.

A NOx abatement system such as SCR may be required to achieve the required NOx emission concentrations for the Proposed Installation. SCR reduces NOx concentrations by spraying NH<sub>3</sub> into the flue gas and therefore has the potential to result in ‘ammonia slip’ with a resulting emission of NH<sub>3</sub>. Emissions of NH<sub>3</sub> have therefore also been included in the assessment at the lower end of the LCP BATc BAT-AEL range of 3 – 10mg/Nm<sup>3</sup>.

It should be noted that if SCR is required, emissions of NH<sub>3</sub> would likely be less than 3mg/Nm<sup>3</sup>, which has been demonstrated by the operation of Keadby 2, which to-date has measured annual emissions of NH<sub>3</sub> below 1mg/Nm<sup>3</sup> compared to the permitted emission limit of 3.8mg/m<sup>3</sup>. It is therefore considered that the presented assessment in terms of NH<sub>3</sub> emissions and nitrogen deposition impacts is very much worst case.

Although Keadby 1 and Keadby 2 Power Stations are both operational, Keadby 2 only became commercially operational in March 2023, and therefore it is considered that this is not included in the baseline monitoring available for the study area, unlike the Keadby 1 Power Station, which has been operational since 1996. As such, emissions from the Keadby 2 Power Station have been modelled and added to the baseline data to provide a “modified baseline” including the Keadby 2 process contributions (PC).

The indicative emissions to air from the Proposed Installation and Keadby 2 are summarised in Table 11.

**Table 11: Modelled Emission Parameters**

Model Parameters		Keadby 2 Power Station	Proposed Installation	
			100% Natural Gas Firing	100% Hydrogen Firing
Stack height (m above finished ground level)		75	85	
Assessed stack locations (OS Grid reference)		482720, 411640	482064, 411945	
Average efflux velocity (m/s)		20.7	19.1	19.7
Volumetric flow at stack exit parameters (Am <sup>3</sup> /s)		1,040	1,058	1,091
Volumetric flow (Nm <sup>3</sup> /s) <sup>1</sup>		1,129	1,176	860
Average stack exit conditions	Temp (°C)	80.0	75.0	75.0
	O <sub>2</sub> (% dry)	9.8	11.5	13.8
	Moisture (%)	11.8	10.1	16.0
Approx. flue diameter (m)		8.0	8.4	
Assumed maximum operating hours / year for assessment purposes		8,760		
Annual Oxides of nitrogen (NO <sub>x</sub> ) ELV (mg/Nm <sup>3</sup> )		34 <sup>1</sup>	34 <sup>1</sup>	68.5

Model Parameters	Keadby 2 Power Station	Proposed Installation	
		100% Natural Gas Firing	100% Hydrogen Firing
Annual Oxides of nitrogen (NO <sub>x</sub> ) emission rate (g/s)	38.5	40.1	58.9
Daily Oxides of nitrogen (NO <sub>x</sub> ) ELV (mg/Nm <sup>3</sup> )	45 <sup>2</sup>	45 <sup>2</sup>	-
Daily Oxides of nitrogen (NO <sub>x</sub> ) emission rate (g/s)	51.2	53.4	-
Carbon monoxide (CO) ELV (mg/Nm <sup>3</sup> )	100	100	-
Carbon monoxide (CO) emission rate (g/s)	112.9	117.6	-
Ammonia (NH <sub>3</sub> ) ELV (mg/Nm <sup>3</sup> )	3.8	3.0	3.0
Ammonia (NH <sub>3</sub> ) emission rate (g/s)	4.3	3.5	2.6
<sup>1</sup> Correction factor applied to the BAT-AEL based on 30 × 61/55 – (assuming 61% net electrical efficiency) <sup>2</sup> Correction factor applied to the BAT-AEL based on 40 × 61/55 – (assuming 61% net electrical efficiency)			

In addition to the CCGT emission point (A1) there will also be an additional emission point associated with the EDG (A2).

Although the diesel generator has yet to be selected, it is envisaged that this will be a unit that is approximately 3MWth. As such, the EDG would fall under the Medium Combustion Plant Directive (MCPD) requirements of the EP Regulations.

The EDGs purpose is to provide a short-term source of electricity, in the event of a simultaneous loss of power generation and external power supply, for up to 72 hours until external power can be re-established. Such emergency operations are excluded from the MCPD, however in order to ensure that the EDG remains fit for purpose monthly testing will be carried out for up to 1 hour per month (i.e. <12 hours per year). As the annual operation will be <50 hours per year, the EDG will be exempt from compliance with the MCPD ELVs.

It is considered that due to the small size of the EDG and the low annual running hours it is unlikely that it would have a discernible impact at the receptor locations. However, the SCAIL tool has been used to undertake an assessment of the EDG to demonstrate this. The details of the SCAIL assessment are provided in Annex C.

## 5.2 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.

Keadby Next Generation Power Station Project

Environmental Permit Application

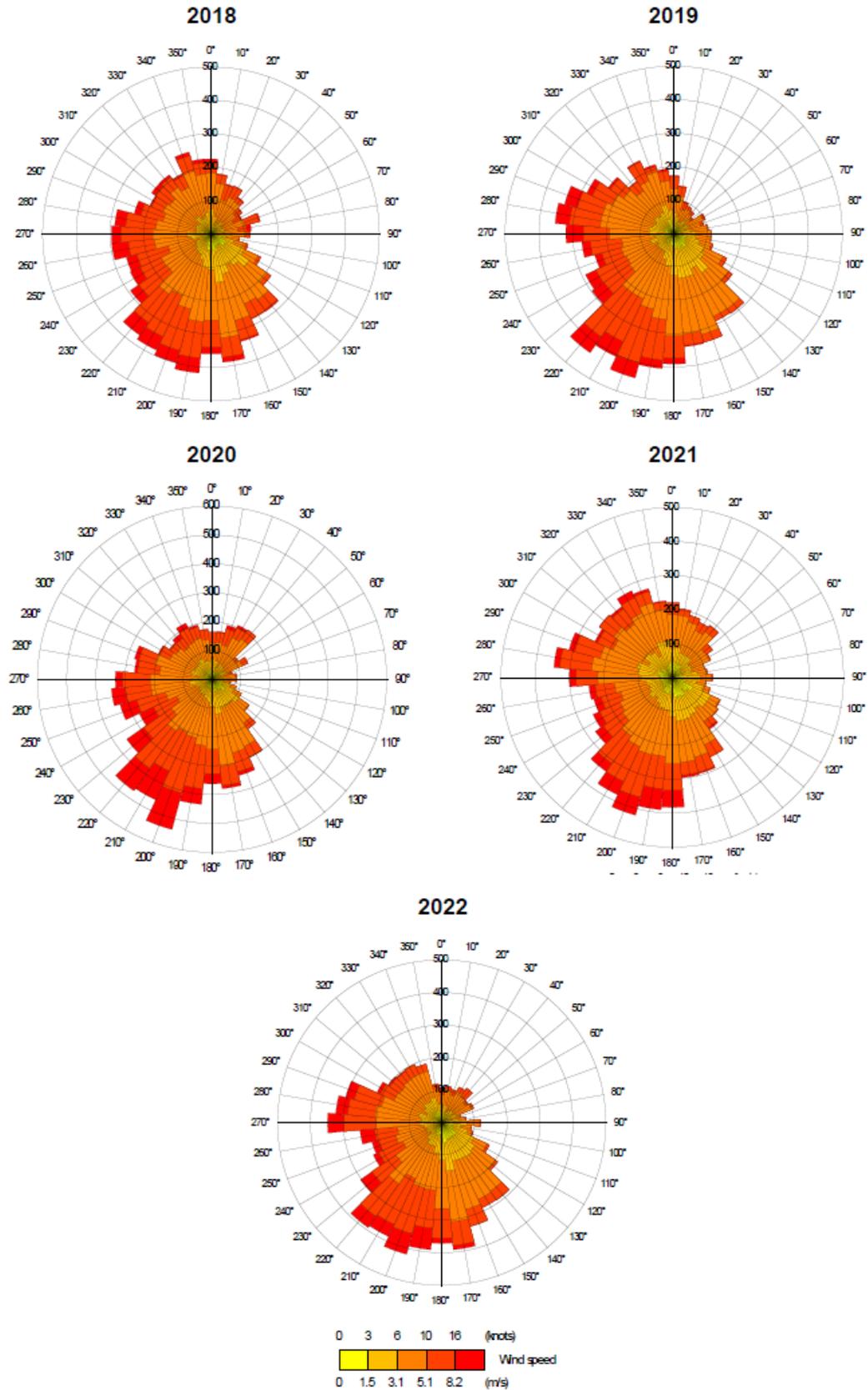
Appendix G – Air Quality Impact Assessment

The meteorological site that was selected for the assessment is Doncaster Robin Hood Airport, located approximately 21 km southwest of the Proposed Installation, 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 within the model.

The modelling for this assessment has utilised five years of meteorological data for the period 2018 - 2022, and the worst-case impacts from all years modelled has been used in the assessment. The wind roses for Doncaster Robin Hood Airport are provided in Plate 1.

Sensitivity of the model to the different years of meteorological data used is provided in Annex D.

**Plate 1: Wind roses for Doncaster Robin Hood Airport – 2018 - 2022**



### 5.3 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 Installation that have been considered to be of sufficient height and volume to potentially impact on the dispersion of emission stacks are shown in Table 12. The dimensions of the buildings included in the model are the maximum measurements that could potentially be required and have been provided by the Design Engineers.

The buildings associated with the Keadby 2 CCGT have also been included in the model.

A plan showing the buildings layout used in the ADMS simulation is shown in Figure 3 (Annex A).

**Table 12: Buildings Included with the Model Set-Up**

Building	Building Centre Grid Reference (x,y)	Height (m)	Length (m)	Width (m)	Angle <sup>1</sup>
Keadby 2 Power Station HRSG	482720, 411640	40	26	46	92
Keadby 2 Power Station Gas Turbine	482720, 411676	30	47	20	92
Keadby 2 Power Station Building	482660, 411640	30	46	46	91
Keadby Next Generation HRSG	482105, 411925	58	74	33	91
Keadby Next Generation Gas Turbine	482115, 411940	32	23	53	91
Keadby Next Generation Power Station Building	482105, 411995	39	61	58	91
<sup>1</sup> Angle to grid north					

The local area immediate to the Proposed Installation is flat agricultural land, with the urban area of Scunthorpe (including the industrial area on the east side) approximately 4.1km to the east. The Proposed Installation is situated near to the River Trent and River Humber. A surface roughness of 0.2m, corresponding to the minimum value

associated with the terrain type, has therefore been selected to represent the local terrain.

Sensitivity of the model to the different surface roughness is provided in Annex D.

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. There are no potentially significant changes in gradient within the study area.

## 5.4 Modelled Domain

Emissions have been modelled on a receptor grid that is 4km by 4km centred on the area containing the Proposed Installation. The grid spacing is 44m, which is considered appropriate for an 85m stack. The receptors detailed in Table 7 and Table 8 have been included as specified points within the model and therefore are unaffected by grid spacing.

In order to produce isopleths for ecological receptors, a larger grid with variable grid spacing has been used, this included an inner grid extending 500m at a resolution of 25m x 25m. A middle grid extending from 500m to 5,000m at a resolution of 50m x 50m. An outer grid extending from 5,000m to 15,000m at a resolution of 250m x 250m.

## 6. Predicted Results

### 6.1 Introduction

The process contributions (PCs) of pollutants from the dispersion modelling of both the 100% hydrogen and 100% natural gas operational scenarios for human health impacts, and for impacts at designated statutory and non-statutory ecological receptors, are presented in this Section, and are compared against the relevant AQS objectives, EALs, CLs and CLDs and screening criteria, as per EA's Risk Assessment Guidance.

Isopleth figures showing the maximum predicted annual mean and short-term process contributions of NO<sub>2</sub> and NO<sub>x</sub> for the worst-case impacts from the two scenarios modelled are provided in Figures 4 - 8 (Annex A).

The dispersion modelling includes several conservative assumptions in combination, including:

- Modelling of emissions from the Keadby 2 CCGT at the ELV concentrations to update the background concentrations used in the assessment, in practice actual emissions will be below the ELVs, particularly NH<sub>3</sub>, which has been monitored at an annual average of <1mg/Nm<sup>3</sup>;
- Emission concentrations for the Proposed Installation are calculated based on the use of IED limits, the upper BAT-AELs, or the Hydrogen GET ELVs; in practice annual average emissions rates would be below this to enable continued compliance with Environmental Permit requirements;
- Maximum annual operation for the plant configuration assessed (8,760 hours, assuming the plant is used for baseloading as a worst case);
- Reporting of the worst-case results from the five years of meteorological data modelled;
- Conservative estimates of background concentrations for the commencement of operation at the receptor locations.

### 6.2 Updated Keadby 2 Backgrounds

The additional contribution from the Keadby 2 (K2) power station, together with the modified background concentration for use in the assessment, are shown in Table 13.

**Table 13: Defra Annual Average Background Concentrations with K2 Contribution**

Pollutant	Defra Background Concentration (µg/m <sup>3</sup> )	K2 Process Contribution (µg/m <sup>3</sup> )	K2 Modified Background Concentration (µg/m <sup>3</sup> )
NOx	8.4	1.0	9.4
NO <sub>2</sub>	6.6	0.7	7.3
CO	114.6	142.6	257.2

The NOx and NH<sub>3</sub> background concentrations for designated SAC, SPA and SSSI sites have also been modified to include the modelled PCs from the Keadby 2 power station (shown in parenthesis). The modified backgrounds are provided in Table 14.

**Table 14: APIS Background Data NO<sub>x</sub> and NH<sub>3</sub> (2020 – 2022 data) with K2 Contribution**

Receptor I.D.	Ecology Site	APIS Backgrounds		K2 Modified Background Concentration (µg/m <sup>3</sup> )	
		NO <sub>x</sub> (µg/m <sup>3</sup> )	NH <sub>3</sub> (µg/m <sup>3</sup> )	NO <sub>x</sub> (µg/m <sup>3</sup> )	NH <sub>3</sub> (µg/m <sup>3</sup> )
OE1-5	Humber Estuary	8.7	1.9	(0.7) 9.3	(0.07) 2.0
OE6	Crowle Borrow Pits	8.7	1.8	(0.1) 8.7	(0.01) 1.8
OE7	Hatfield Chase Ditches	8.8	1.8	(0.1) 8.9	(0.01) 1.8
OE8	Eastoft Meadow	7.8	1.9	(0.1) 7.8	(0.01) 1.9
OE9	Belshaw	7.8	1.7	(0.1) 7.8	(0.01) 1.7
OE10	Thorne Moor	7.8	1.7	(0.1) 7.9	(0.01) 1.7
OE11	Epworth Turbary	7.7	1.6	(0.1) 7.8	(0.01) 1.6
OE12	Risby Warren	11.1	1.9	(0.1) 11.3	(0.01) 1.9
OE13	Hatfield Moor	8.5	1.5	(0.0) 8.5	(0.00) 1.5
OE14	Messingham Heath	8.1	2.1	(0.1) 8.2	(0.01) 2.1
OE15	Tuetoes Hills	7.6	2.0	(0.1) 7.7	(0.01) 2.0
OE16	Haxey Turbary	7.6	1.5	(0.1) 7.7	(0.01) 1.5
OE17	Rush Furlong	7.5	1.6	(0.1) 7.6	(0.01) 1.6
OE18	Hewsons Field	7.6	1.6	(0.1) 7.7	(0.01) 1.6
OE19	Messingham Sand Quarry	8.2	2.1	(0.1) 8.3	(0.01) 2.1
OE20	Manton and Twigmoor	8.6	2.1	(0.1) 8.7	(0.01) 2.1
OE21	Scotton and Laughton Forest Ponds	7.7	1.9	(0.1) 7.8	(0.01) 1.9
OE22	Broughton Far Wood	9.8	2.3	(0.1) 9.9	(0.01) 2.3
OE23	Broughton Alder Wood	9.9	2.3	(0.1) 10.0	(0.01) 2.3
OE24	Scotton Beck Field	8.0	2.1	(0.1) 8.1	(0.01) 2.1
OE25	Scotton Common	8.0	1.9	(0.1) 8.0	(0.01) 1.9

Receptor I.D.	Ecology Site	APIS Backgrounds		K2 Modified Background Concentration ( $\mu\text{g}/\text{m}^3$ )	
		NOx ( $\mu\text{g}/\text{m}^3$ )	NH <sub>3</sub> ( $\mu\text{g}/\text{m}^3$ )	NOx ( $\mu\text{g}/\text{m}^3$ )	NH <sub>3</sub> ( $\mu\text{g}/\text{m}^3$ )
OE26	Laughton Common	7.5	1.7	(0.1) 7.6	(0.01) 1.7
OE27	Stainforth and Keadby Canal Corridor	8.8	1.9	(0.0) 8.8	(0.00) 1.9
OE28	Keadby Wetland	8.8	1.9	(0.0) 8.8	(0.00) 1.9
OE29	Keadby Wet Grassland	8.8	1.9	(0.0) 8.8	(0.00) 1.9
OE30	Three Rivers	8.9	1.9	(0.2) 9.1	(0.03) 1.9
OE31	Ash Tip	8.6	1.9	(0.1) 8.7	(0.01) 1.9
OE32	Humber Estuary (at Blacktoft Sands)	9.5	1.7	(0.2) 9.7	(0.02) 1.7

Table 15 shows the modelled PCs from the Keadby 2 power station (shown in parenthesis), and the modified background deposition concentrations (N.B. only the nitrogen acid deposition baseline has been modified as there are no emissions of sulphur species).

**Table 15: APIS Deposition Backgrounds (2020 – 2022 data) with K2 Contribution**

Receptor I.D.	APIS Backgrounds			K2 Modified Background Concentration ( $\mu\text{g}/\text{m}^3$ )	
	Nitrogen Deposition (kg N/Ha/Yr)	Acid Deposition		Nitrogen Deposition (kg N/Ha/Yr)	Acid Deposition (Keq N/Ha/Yr)
		(Keq N/Ha/Yr)	(Keq S/Ha/Yr)		
OE1-5	16.0	1.15	0.16	(0.45) 16.4	(0.032) 1.182
OE6	28.3 woodland 14.8 others	2.02	0.17	(0.09) 28.4 (0.06) 14.9	(0.007) 2.027
OE7	No comparable habitat with established critical load estimate available				
OE8	14.6	1.04	0.13	(0.05) 14.6	(0.004) 1.044
OE9	No Critical Load Assigned				
OE10	27.0 woodland 14.1 other	1.91 1.00	0.16 0.12	(0.06) 27.0 (0.04) 14.1	(0.004) 1.914 (0.003) 1.003
OE11	13.5	0.96	0.12	(0.04) 13.5	(0.003) 0.963
OE12	17.4	1.24	0.2	(0.08) 17.5	(0.006) 1.246
OE13	25.0 woodland 13.0 other	1.79 0.93	0.16 0.12	(0.04) 25.0 (0.03) 13.0	(0.003) 1.793 (0.002) 0.932
OE14	16.9	No acidity critical loads		(0.07) 17.0	NA

Receptor I.D.	APIS Backgrounds			K2 Modified Background Concentration ( $\mu\text{g}/\text{m}^3$ )	
	Nitrogen Deposition (kg N/Ha/Yr)	Acid Deposition		Nitrogen Deposition (kg N/Ha/Yr)	Acid Deposition (Keq N/Ha/Yr)
		(Keq N/Ha/Yr)	(Keq S/Ha/Yr)		
OE15	15.3	No acidity critical loads		(0.05) 15.4	NA
OE16	13.2	0.95	0.12	(0.04) 13.3	(0.003) 0.953
OE17	13.6	0.97	0.12	(0.04) 13.7	(0.003) 0.973
OE18	13.6	0.97	0.12	(0.04) 13.6	(0.003) 0.973
OE19	32.6 woodland 17.4 other	2.33 N/A	0.18 N/A	(0.08) 32.7 (0.05) 17.5	(0.006) 2.336
OE20	33.2 woodland 17.7 other	2.37	0.18	(0.07) 33.3 (0.04) 17.8	(0.006) 2.376
OE21	30.0 woodland 15.8 other	2.13 1.12	0.16 0.12	(0.08) 30.0 (0.05) 15.8	(0.005) 2.085 (0.003) 1.093
OE22	35.6 woodland 19.0 other	2.54 1.36	0.23 0.18	(0.09) 35.7 (0.06) 19.1	(0.006) 2.546 (0.004) 1.364
OE23	Designated feature/ feature habitat not sensitive to eutrophication				
OE24	16.6	No acidity critical loads		(0.05) 16.7	N/A
OE25	16.1	1.15	0.12	(0.05) 16.2	(0.004) 1.154
OE26	14.7	1.02	0.12	(0.04) 14.7	(0.003) 1.023
OE27	15.5	1.11	0.15	(0.00) 15.5	(0.002) 1.112
OE28	29.5	2.11	0.19	(0.03) 29.5	(0.001) 2.111
OE29	No comparable habitat with established critical load estimate available				
OE30	16.0	1.14	0.15	(0.12) 16.1	(0.008) 1.148
OE31	15.3	1.09	0.14	(0.06) 15.4	(0.001) 1.091
OE32	14.7	Not sensitive to acid deposition		(0.11) 14.8	N/A

### 6.3 Human Health Receptor Results

The impact of the Proposed Installation's PCs at human health receptors, has been determined from the maximum model output which occurs anywhere.

Table 16 shows the maximum results for human health receptors for the 100% hydrogen firing scenario, with Table 17 showing the results for the 100% natural gas firing scenario.

**Table 16: Maximum Results 100% Hydrogen Firing – Human Health Impacts**

Species	AQS (µg/m <sup>3</sup> )	PC (µg/m <sup>3</sup> )	PC/AQS %	1 <sup>st</sup> Stage Screened as Insignificant?	K2 Modified BC (µg/m <sup>3</sup> )	PEC (µg/m <sup>3</sup> )	PEC/AQS %	PC/(AQS – 2 x BC)	2 <sup>nd</sup> Stage Screened as Insignificant?
NO <sub>2</sub> hourly mean (as the 99.79 <sup>th</sup> percentile)	200	36.6	18.3%	<b>No</b>	14.6	51.3	-	19.8%	<b>Yes</b> PC <20% of the AQS objective minus twice the long-term background concentration.
NO <sub>2</sub> annual mean	40	1.8	4.6%	<b>No</b>	7.3	9.2	22.9%	-	<b>Yes</b> Yes PEC <70% AQS objective
NH <sub>3</sub> 1-hour mean	2,500	5.7	0.2%	<b>Yes</b>	-	-	-	-	-
NH <sub>3</sub> annual mean	180	0.1	0.1%	<b>Yes</b>	-	-	-	-	-
PC = Process Contribution, AQS = Air Quality Standard objective or EAL, BC = Background Concentration (modified with the addition of Keadby 2 annual average impacts), PEC = Predicted Environmental Concentration									

**Table 17: Maximum Results 100% Natural Gas Firing – Human Health Impacts**

Species	AQS ( $\mu\text{g}/\text{m}^3$ )	PC ( $\mu\text{g}/\text{m}^3$ )	PC/AQS %	1 <sup>st</sup> Stage Screened as Insignificant?	K2 Modified BC ( $\mu\text{g}/\text{m}^3$ )	PEC ( $\mu\text{g}/\text{m}^3$ )	PEC/AQS %	PC / (AQS – 2 x BC)	2 <sup>nd</sup> Stage Screened as Insignificant?
NO <sub>2</sub> hourly mean (as the 99.79 <sup>th</sup> percentile)	200	35.0	17.5%	<b>No</b>	14.6	49.6	-	18.9%	<b>Yes</b> PC <20% of the AQS objective minus twice the long-term background concentration.
NO <sub>2</sub> annual mean	40	1.3	3.3%	<b>No</b>	7.3	8.7	21.7%	-	<b>Yes</b> Yes PEC <70% AQS objective
CO 1-hour mean (as the 100 <sup>th</sup> percentile)	30,000	265	0.9%	<b>Yes</b>	-	-	-	-	-
CO 8-hour rolling mean	10,000	220	2.2%	<b>Yes</b>	-	-	-	-	-
NH <sub>3</sub> 1-hour mean	2,500	8.0	0.3%	<b>Yes</b>	-	-	-	-	-
NH <sub>3</sub> annual mean	180	0.2	0.1%	<b>Yes</b>	-	-	-	-	-
PC = Process Contribution, AQS = Air Quality Standard objective or EAL, BC = Background Concentration (modified with the addition of Keadby 2 annual average impacts), PEC = Predicted Environmental Concentration									

### Nitrogen Dioxide Impacts

The maximum annual mean NO<sub>2</sub> concentration that occurs anywhere within the study area as a result of the Proposed Installation occurs during the 100% hydrogen firing scenario, and results in a predicted PC of 1.8 µg/m<sup>3</sup>, which represents 4.6% of the AQS objective. This occurs approximately 700m to the northeast of the Emission Point A1.

The annual mean NO<sub>2</sub> PEC is 9.2 µg/m<sup>3</sup> and represents 22.9% of the AQS objective and therefore is well below the second stage of screening criteria 70%. NO<sub>2</sub> emissions from the Proposed Installation are therefore not predicted to lead to a risk of the annual mean AQS objective being exceeded anywhere within the vicinity of the Site.

The maximum predicted hourly mean NO<sub>2</sub> concentration (as the 99.79<sup>th</sup> percentile of hourly averages) that occurs anywhere as a result of the Proposed Installation occurs as a result of the 100% hydrogen firing scenario, and results in a PC of 36.6µg/m<sup>3</sup>. This occurs approximately 500m to the northeast of the Proposed Installation. This represent 18.3% of the hourly mean NO<sub>2</sub> AQS objective of 200 µg/m<sup>3</sup> and therefore is over the first stage screening criteria of 10% for short term impacts. The PC represents 19.8% of the short term AQS minus twice the long-term background concentration and therefore is below the second stage screening criteria of 20%. The Proposed Installation is therefore not predicted to lead to a risk of the hourly mean NO<sub>2</sub> AQS objective being exceeded.

### Carbon Monoxide

Carbon monoxide emissions are only released if the Proposed Installation is fired on natural gas. If required to operate on 100% natural gas, the maximum hourly and 8-hour running mean PCs that occur anywhere as a result of the Proposed Installation are well below the first screening criteria of 10% of the relevant AQS objective and therefore can be considered to be insignificant at all receptor locations.

### Ammonia

The maximum annual and hourly average PCs of NH<sub>3</sub> occur when firing on 100% natural gas, due to the higher mass release rate of NH<sub>3</sub> that results from this mode of operation. The predicted PCs that occur anywhere as a result of the Proposed Installation represent less than 1% of the relevant EALs and therefore can be considered to be insignificant at all receptor locations. In addition, when added to the background concentrations in the study area, the PEC remains less than 1% of the relevant EAL for both averaging periods.

## **6.4 Ecological Impacts**

The results of the dispersion modelling of predicted impacts on sensitive ecological receptors are presented in Table 18 to Table 24. The tables set out the predicted PC to atmospheric concentrations of NO<sub>x</sub> and NH<sub>3</sub> and also nutrient nitrogen and acid deposition.

### Oxides of Nitrogen – Critical Levels

The assessment results show that the predicted annual average and daily average NO<sub>x</sub> impacts are below the criteria for insignificance at the majority of the ecological receptors assessed for the operating scenario that resulted in the highest impacts at receptors (100% hydrogen firing).

PCs of more than 1% of the annual average CL for NO<sub>x</sub> occur at the adjacent Humber Estuary SAC, SSSI and Ramsar, Keadby Wetland LWS, Keadby Wet grassland and Three Rivers LWSs, however in combination with the K2 modified background concentrations, all sites are well below 70% of the critical level threshold for insignificance, therefore no exceedances of the annual CL are predicted.

The daily CL is below the 10% screening threshold for insignificance at all the statutory designated sites except for the Humber Estuary. In combination with the K2 modified background concentration at the Humber Estuary, the impacts are 34% of the daily CL and therefore indicate that no exceedance of the daily CL is predicted as a result of the operational Proposed Installation.

Five of the LWS have impacts over the 10% daily CL, however again with the K2 modified background concentrations taken into account, the impacts are well below the daily critical level at all these sites, and therefore no exceedance of the daily CL is predicted at any non-statutory nature conservation site.

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 Proposed Installation.

### Ammonia – Critical Levels

The assessment results show that the predicted annual average NH<sub>3</sub> impacts at all the ecological receptors for the worst case operating scenario (100% Natural Gas firing) are below the criteria for insignificance (<1% of the CL) for all but two habitat receptors and therefore can be considered insignificant. When combined with the K2 modified background concentrations, the impacts at the Humber Estuary SSSI, SAC and Ramsar and the Keadby Wetland LWS are both less than 70% of the CL and therefore can be considered to be insignificant.

**Table 18: NO<sub>x</sub> Dispersion Modelling Results for Ecological Receptors - 100% Hydrogen Firing**

Receptor I.D.	Site	CL (µg/m <sup>3</sup> )	PC (µg/m <sup>3</sup> )	PC % of CL	1 <sup>st</sup> Stage Screened as Insignificant?	K2 Modified BC (µg/m <sup>3</sup> )	PEC (µg/m <sup>3</sup> )	PEC % of CL	2 <sup>nd</sup> Stage Screened as Insignificant?
OE1-5	Humber Estuary Ramsar/ SAC/ SSSI	30	0.8	2.7%	No	9.4	10.2	34%	Yes
		75	16.4	21.8%	No	14.0	30.4	41%	No exceedance of the CL predicted
OE6	Crowle Borrow Pits SSSI	30	0.18	0.6%	Yes	-	-	-	-
		75	8.9	12%	No	13.1	22.0	29%	No exceedance of the CL predicted
OE7	Hatfield Chase Ditches SSSI	30	0.15	0.5%	Yes	-	-	-	-
		75	7.4	10%	Yes	-	-	-	-
OE8	Eastoft Meadow SSSI	30	0.13	0.4%	Yes	-	-	-	-
		75	3.4	4%	Yes	-	-	-	-
OE9	Belshaw SSSI	30	0.13	0.4%	Yes	-	-	-	-
		75	2.8	4%	Yes	-	-	-	-
OE10	Thorne Moor SAC	30	0.08	0.3%	Yes	-	-	-	-
		75	2.4	3%	Yes	-	-	-	-
OE11	Epworth Turbary SSSI	30	0.11	0.4%	Yes	-	-	-	-
		75	2.4	3%	Yes	-	-	-	-
OE12	Risby Warren SSSI	30	0.16	0.5%	Yes	-	-	-	-
		75	2.0	3%	Yes	-	-	-	-
OE13	Hatfield Moor SAC	30	0.06	0.2%	Yes	-	-	-	-
		75	1.8	2%	Yes	-	-	-	-

Receptor I.D.	Site	CL (µg/m <sup>3</sup> )	PC (µg/m <sup>3</sup> )	PC % of CL	1 <sup>st</sup> Stage Screened as Insignificant?	K2 Modified BC (µg/m <sup>3</sup> )	PEC (µg/m <sup>3</sup> )	PEC % of CL	2 <sup>nd</sup> Stage Screened as Insignificant?
OE14	Messingham Heath SSSI	30	0.13	0.4%	Yes	-	-	-	-
		75	2.0	3%	Yes	-	-	-	-
OE15	Tuetoos Hills SSS	30	0.11	0.4%	Yes	-	-	-	-
		75	1.6	2%	Yes	-	-	-	-
OE16	Haxey Turbary SSSI	30	0.10	0.3%	Yes	-	-	-	-
		75	2.2	3%	Yes	-	-	-	-
OE17	Rush Furlong SSSI	30	0.10	0.3%	Yes	-	-	-	-
		75	1.7	2%	Yes	-	-	-	-
OE18	Hewsons Field SSSI	30	0.09	0.3%	Yes	-	-	-	-
		75	1.6	2%	Yes	-	-	-	-
OE19	Messingham Sand Quarry SSSI	30	0.11	0.4%	Yes	-	-	-	-
		75	1.4	2%	Yes	-	-	-	-
OE20	Manton and Twigmoor SSSI	30	0.12	0.4%	Yes	-	-	-	-
		75	1.9	2%	Yes	-	-	-	-
OE21	Scotton and Laughton Forest Ponds SSSI	30	0.11	0.4%	Yes	-	-	-	-
		75	1.5	2%	Yes	-	-	-	-
OE22	Broughton Far Wood SSSI	30	0.12	0.4%	Yes	-	-	-	-
		75	1.2	2%	Yes	-	-	-	-
OE23	Broughton Alder Wood SSSI	30	0.12	0.4%	Yes	-	-	-	-
		75	1.3	2%	Yes	-	-	-	-
OE24	Scotton Beck Fields SSSI	30	0.10	0.3%	Yes	-	-	-	-
		75	1.5	2%	Yes	-	-	-	-

Receptor I.D.	Site	CL (µg/m <sup>3</sup> )	PC (µg/m <sup>3</sup> )	PC % of CL	1 <sup>st</sup> Stage Screened as Insignificant?	K2 Modified BC (µg/m <sup>3</sup> )	PEC (µg/m <sup>3</sup> )	PEC % of CL	2 <sup>nd</sup> Stage Screened as Insignificant?
OE25	Scotton Common SSSI	30	0.10	0.3%	Yes	-	-	-	-
		75	1.4	2%	Yes	-	-	-	-
OE26	Laughton Common SSSI	30	0.08	0.3%	Yes	-	-	-	-
		75	1.1	2%	Yes	-	-	-	-
OE27	Stainforth and Keadby Canal Corridor LWS	30	0.3	1.0%	Yes - PC <100% for LWS	-	-	-	-
		75	22.3	30%		-	-	-	-
OE28	Keadby Wetland LWS	30	0.57	1.9%		-	-	-	-
		75	24.9	33%		-	-	-	-
OE29	Keadby Wet Grassland LWS	30	0.46	1.5%		-	-	-	-
		75	22.8	30%		-	-	-	-
OE30	Three Rivers LWS	30	0.38	1.3%		-	-	-	-
		75	11.4	15%		-	-	-	-
OE31	Ash tip	30	0.09	0.3%		-	-	-	-
		75	11.5	15%		-	-	-	-
OE32	Humber Estuary (at Blacktoft Sands) Ramsar, SAC, SPA and SSSI	30	0.23	0.8%	Yes	-	-	-	-
		75	1.9	3%	Yes	-	-	-	-

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

**Table 19: NO<sub>x</sub> Dispersion Modelling Results for Ecological Receptors - 100% Natural Gas Firing**

Receptor I.D.	Site	CL (µg/m <sup>3</sup> )	PC (µg/m <sup>3</sup> )	PC % of CL	1 <sup>st</sup> Stage Screened as Insignificant?	K2 Modified BC (µg/m <sup>3</sup> )	PEC (µg/m <sup>3</sup> )	PEC % of CL	2 <sup>nd</sup> Stage Screened as Insignificant?
OE1-5	Humber Estuary Ramsar/ SAC/ SSSI	30	0.57	1.9%	No	9.4	9.9	33%	Yes
		75	14.9	20%	No	14.8	29.7	40%	No exceedance of the CL predicted
OE6	Crowle Borrow Pits SSSI	30	0.13	0.4%	Yes	-	-	-	-
		75	8.2	11%	No	13.1	21.3	28%	No exceedance of the CL predicted
OE7	Hatfield Chase Ditches SSSI	30	0.10	0.3%	Yes	-	-	-	-
		75	6.8	9%	Yes	-	-	-	-
OE8	Eastoft Meadow SSSI	30	0.09	0.3%	Yes	-	-	-	-
		75	3.1	4%	Yes	-	-	-	-
OE9	Belshaw SSSI	30	0.09	0.3%	Yes	-	-	-	-
		75	2.6	3%	Yes	-	-	-	-
OE10	Thorne Moor SAC	30	0.06	0.2%	Yes	-	-	-	-
		75	2.2	3%	Yes	-	-	-	-
OE11	Epworth Turbary SSSI	30	0.08	0.3%	Yes	-	-	-	-
		75	2.2	3%	Yes	-	-	-	-
OE12	Risby Warren SSSI	30	0.11	0.4%	Yes	-	-	-	-
		75	1.8	2%	Yes	-	-	-	-
OE13	Hatfield Moor SAC	30	0.04	0.1%	Yes	-	-	-	-
		75	1.6	2%	Yes	-	-	-	-

Receptor I.D.	Site	CL (µg/m <sup>3</sup> )	PC (µg/m <sup>3</sup> )	PC % of CL	1 <sup>st</sup> Stage Screened as Insignificant?	K2 Modified BC (µg/m <sup>3</sup> )	PEC (µg/m <sup>3</sup> )	PEC % of CL	2 <sup>nd</sup> Stage Screened as Insignificant?
OE14	Messingham Heath SSSI	30	0.09	0.3%	Yes	-	-	-	-
		75	1.8	2%	Yes	-	-	-	-
OE15	Tuetoos Hills SSS	30	0.08	0.3%	Yes	-	-	-	-
		75	1.4	2%	Yes	-	-	-	-
OE16	Haxey Turbary SSSI	30	0.07	0.2%	Yes	-	-	-	-
		75	2.1	3%	Yes	-	-	-	-
OE17	Rush Furlong SSSI	30	0.07	0.2%	Yes	-	-	-	-
		75	1.5	2%	Yes	-	-	-	-
OE18	Hewsons Field SSSI	30	0.06	0.2%	Yes	-	-	-	-
		75	1.5	2%	Yes	-	-	-	-
OE19	Messingham Sand Quarry SSSI	30	0.08	0.3%	Yes	-	-	-	-
		75	1.3	2%	Yes	-	-	-	-
OE20	Manton and Twigmoor SSSI	30	0.08	0.3%	Yes	-	-	-	-
		75	1.7	2%	Yes	-	-	-	-
OE21	Scotton and Laughton Forest Ponds SSSI	30	0.07	0.2%	Yes	-	-	-	-
		75	1.4	2%	Yes	-	-	-	-
OE22	Broughton Far Wood SSSI	30	0.08	0.3%	Yes	-	-	-	-
		75	1.1	%	Yes	-	-	-	-
OE23	Broughton Alder Wood SSSI	30	0.08	0.3%	Yes	-	-	-	-
		75	1.2	2%	Yes	-	-	-	-
OE24	Scotton Beck Fields SSSI	30	0.07	0.2%	Yes	-	-	-	-
		75	1.3	2%	Yes	-	-	-	-

Receptor I.D.	Site	CL (µg/m <sup>3</sup> )	PC (µg/m <sup>3</sup> )	PC % of CL	1 <sup>st</sup> Stage Screened as Insignificant?	K2 Modified BC (µg/m <sup>3</sup> )	PEC (µg/m <sup>3</sup> )	PEC % of CL	2 <sup>nd</sup> Stage Screened as Insignificant?
OE25	Scotton Common SSSI	30	0.07	0.2%	Yes	-	-	-	-
		75	1.3	2%	Yes	-	-	-	-
OE26	Laughton Common SSSI	30	0.06	0.2%	Yes	-	-	-	-
		75	1.0	1%	Yes	-	-	-	-
OE27	Stainforth and Keadby Canal Corridor LWS	30	0.22	0.7%	Yes - PC <100% for LWS	-	-	-	-
		75	21.6	29%		-	-	-	-
OE28	Keadby Wetland LWS	30	0.41	1.4%		-	-	-	-
		75	23.2	31%		-	-	-	-
OE29	Keadby Wet Grassland LWS	30	0.33	1.1%		-	-	-	-
		75	21.5	29%		-	-	-	-
OE30	Three Rivers LWS	30	0.27	0.9%		-	-	-	-
		75	10.5	14%		-	-	-	-
OE31	Ash tip	30	0.07	0.2%		-	-	-	-
		75	13.4	18%		-	-	-	-
OE32	Humber Estuary (at Blacktoft Sands) Ramsar, SAC, SPA and SSSI	30	0.16	0.5%	Yes	-	-	-	-
		75	1.5	2%	Yes	-	-	-	-

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

**Table 20: NH<sub>3</sub> Dispersion Modelling Results for Ecological Receptors – 100% Hydrogen Firing**

Receptor I.D.	Site	CL (µg/m <sup>3</sup> )	PC (µg/m <sup>3</sup> )	PC % of CL	1 <sup>st</sup> Stage Screened as Insignificant?	K2 Modified as BC (µg/m <sup>3</sup> )	PEC (µg/m <sup>3</sup> )	PEC % of CL	2 <sup>nd</sup> Stage Screened as Insignificant?
OE1-5	Humber Estuary SSSI, SAC, Ramsar	3	0.04	1.2%	No	2.0	2.0	67%	Yes
OE6	Crowle Borrow Pits SSSI	3	0.01	0.3%	Yes	-	-	-	-
OE7	Hatfield Chase Ditches SSSI	No features listed							
OE8	Eastoft Meadow SSSI	3	0.01	0.2%	Yes	-	-	-	-
OE9	Belshaw SSSI	3	0.01	0.2%	Yes	-	-	-	-
OE10	Thorne Moor SAC	1	0.004	0.4%	Yes	-	-	-	-
OE11	Epworth Turbary SSSI	1	0.005	0.5%	Yes	-	-	-	-
OE12	Risby Warren SSSI	1	0.007	0.7%	Yes	-	-	-	-
OE13	Hatfield Moor SAC	1	0.003	0.3%	Yes	-	-	-	-
OE14	Messingham Heath SSSI	1	0.006	0.6%	Yes	-	-	-	-
OE15	Tuetoes Hills SSSI	1	0.005	0.6%	Yes	-	-	-	-
OE16	Haxey Turbary SSSI	1	0.004	0.4%	Yes	-	-	-	-
OE17	Rush Furlong SSSI	3	0.004	0.1%	Yes	-	-	-	-
OE18	Hewsons Field SSSI	3	0.004	0.1%	Yes	-	-	-	-
OE19	Messingham Sand Quarry SSSI	1	0.005	0.5%	Yes	-	-	-	-
OE20	Manton and Twigmoor SSSI	1	0.005	0.5%	Yes	-	-	-	-

Receptor I.D.	Site	CL (µg/m <sup>3</sup> )	PC (µg/m <sup>3</sup> )	PC % of CL	1 <sup>st</sup> Stage Screened as Insignificant?	K2 Modified BC (µg/m <sup>3</sup> )	PEC (µg/m <sup>3</sup> )	PEC % of CL	2 <sup>nd</sup> Stage Screened as Insignificant?
OE21	Scotton and Laughton Forest Ponds SSSI	1	0.005	0.5%	Yes	-	-	-	-
OE22	Broughton Far Wood SSSI	3	0.01	0.2%	Yes	-	-	-	-
OE23	Broughton Alder Wood SSSI	3	0.01	0.2%	Yes	-	-	-	-
OE24	Scotton Beck Fields SSSI	1	0.004	0.4%	Yes	-	-	-	-
OE25	Scotton Common SSSI	1	0.004	0.4%	Yes	-	-	-	-
OE26	Laughton Common SSSI	1	0.004	0.4%	Yes	-	-	-	-
OE27	Stainforth and Keadby Canal Corridor LWS	3	0.01	0.4%	Yes	-	-	-	-
OE28	Keadby Wetland LWS	3	0.03	0.8%	Yes	-	-	-	-
OE29	Keadby Wet Grassland LWS	3	0.02	0.7%	Yes	-	-	-	-
OE30	Three Rivers LWS	3	0.02	0.6%	Yes	-	-	-	-
OE31	Ash tip	1	0.004	0.4%	Yes	-	-	-	-
OE32	Humber Estuary (at Blacktoft Sands) Ramsar, SPA, SAC and SSSI	3	0.01	0.3%	Yes	-	-	-	-

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

**Table 21: NH<sub>3</sub> Dispersion Modelling Results for Ecological Receptors – 100% Natural Gas Firing**

Receptor I.D.	Site	CL (µg/m <sup>3</sup> )	PC (µg/m <sup>3</sup> )	PC % of CL	1 <sup>st</sup> Stage Screened as Insignificant?	K2 Modified BC (µg/m <sup>3</sup> )	PEC (µg/m <sup>3</sup> )	PEC % of CL	2 <sup>nd</sup> Stage Screened as Insignificant?
OE1-5	Humber Estuary SSSI, SAC, Ramsar	3	0.05	1.7%	No	2.0	2.0	67%	Yes
OE6	Crowle Borrow Pits SSSI	3	0.01	0.4%	Yes	-	-	-	-
OE7	Hatfield Chase Ditches SSSI	No features listed							
OE8	Eastoft Meadow SSSI	3	0.01	0.3%	Yes	-	-	-	-
OE9	Belshaw SSSI	3	0.01	0.3%	Yes	-	-	-	-
OE10	Thorne Moor SAC	1	0.005	0.5%	Yes	-	-	-	-
OE11	Epworth Turbary SSSI	1	0.007	0.7%	Yes	-	-	-	-
OE12	Risby Warren SSSI	1	0.01	1.0%	Yes	-	-	-	-
OE13	Hatfield Moor SAC	1	0.004	0.4%	Yes	-	-	-	-
OE14	Messingham Heath SSSI	1	0.008	0.8%	Yes	-	-	-	-
OE15	Tuetoes Hills SSSI	1	0.007	0.7%	Yes	-	-	-	-
OE16	Haxey Turbary SSSI	1	0.006	0.6%	Yes	-	-	-	-
OE17	Rush Furlong SSSI	3	0.01	0.2%	Yes	-	-	-	-
OE18	Hewsons Field SSSI	3	0.01	0.2%	Yes	-	-	-	-
OE19	Messingham Sand Quarry SSSI	1	0.007	0.7%	Yes	-	-	-	-
OE20	Manton and Twigmoor SSSI	1	0.007	0.7%	Yes	-	-	-	-

Receptor I.D.	Site	CL (µg/m <sup>3</sup> )	PC (µg/m <sup>3</sup> )	PC % of CL	1 <sup>st</sup> Stage Screened as Insignificant?	K2 Modified BC (µg/m <sup>3</sup> )	PEC (µg/m <sup>3</sup> )	PEC % of CL	2 <sup>nd</sup> Stage Screened as Insignificant?
OE21	Scotton and Laughton Forest Ponds SSSI	1	0.007	0.7%	Yes	-	-	-	-
OE22	Broughton Far Wood SSSI	3	0.01	0.3%	Yes	-	-	-	-
OE23	Broughton Alder Wood SSSI	3	0.01	0.2%	Yes	-	-	-	-
OE24	Scotton Beck Fields SSSI	1	0.006	0.6%	Yes	-	-	-	-
OE25	Scotton Common SSSI	1	0.006	0.6%	Yes	-	-	-	-
OE26	Laughton Common SSSI	1	0.005	0.5%	Yes	-	-	-	-
OE27	Stainforth and Keadby Canal Corridor LWS	3	0.02	0.6%	Yes	-	-	-	-
OE28	Keadby Wetland LWS	3	0.04	1.2%	Yes	-	-	-	-
OE29	Keadby Wet Grassland LWS	3	0.03	1.0%	Yes	-	-	-	-
OE30	Three Rivers LWS	3	0.02	0.8%	Yes	-	-	-	-
OE31	Ash tip	1	0.007	0.7%	Yes	-	-	-	-
OE32	Humber Estuary (at Blacktoft Sands) Ramsar, SPA, SAC and SSSI	3	0.01	0.5%	Yes	-	-	-	-

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

## Nitrogen Deposition

The EA and Natural England have agreed that depositional impacts that are below 1% of the relevant CLd a site can be regarded as insignificant.

Guidance from the Institute of Air Quality Management (IAQM)<sup>17</sup> clarifies that the 1% threshold is not intended to be precise to a set number of decimal places but to the nearest whole number is relevant.

The majority of sites have impacts that can be screened as being insignificant as they are less than 1% of the CLd for the worst case operating scenario (100% natural gas firing).

Although a number of sites have impacts that are over the 1% screening level for determining insignificance, this does not mean that the impacts are therefore considered to be significant. Impacts at the Humber Estuary are predicted to be 1.6% of the lower CLd for the worst case 100% natural gas firing scenario, reducing to 1.3% for the 100% hydrogen fired scenario. The background deposition at this site is not exceeding the lower end of the relevant CLd range (representing 82%) and therefore the lower end of the CLd is not exceeded as a result of the Proposed Installation.

Although the Humber Estuary locations OE1 – OE5 show a PC representing 1.6% of the lower CLd range applied to the assessment for the worst gas firing scenario, it should be noted that the Pioneer saltmarsh habitat type used in the assessment for which the SAC is designated for is not present at these locations, with only very narrow stands of common reed on the banks of the River Trent at the high water line. Adjacent to this at low tide there are exposed marginal mudflats in the river. The vegetation closest to the Proposed Installation is therefore considered to be transitional reedbed.

The SAC qualifying saltmarsh is specifically “Salicornia and other annuals colonising mud and sand” which is a pioneer community that would occur within the main Humber Estuary area. The community of relevance is therefore only considered to occur at the estuary proper<sup>18</sup>, at the mouth of the River Trent. This is closer to the location of the Humber receptor OE32, which has a PC of 0.10kg N/ha/yr, which represents 0.5% of the Pioneer saltmarsh lower CLd and therefore would be screened as being insignificant.

The Broadleaved deciduous woodland habitat type at the Crowle Borrow Pits receptor OE6 has a PC representing 1.1% of the lower CLd value for the worst case operating scenario (100% natural gas firing). For the 100% hydrogen firing scenario, which will be the main mode of operation once hydrogen becomes available to the site, the PC

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<sup>17</sup> Institute of Air Quality Management (2020). *A Guide to the Assessment of Air Quality Impacts on Designated Nature Conservation Sites, Version 1.1* [Online]. Available from: <https://iaqm.co.uk/text/guidance/air-quality-impacts-on-nature-sites-2020.pdf>

<sup>18</sup> Mapping showing the location of the relevant saltmarsh habitat can be found <https://environment.data.gov.uk/explore/6da82900-d465-11e4-8cc3-f0def148f590?download=true> – the relevant community is coloured red.

reduces to represent 1.0% of the lower CLd value. The background deposition at the site is already 284% of the lower Critical Load value.

The woodland at Crowle Borrow Pit is currently in an unfavourable condition, due to ash dieback and lack of regeneration of trees, which are factors that are likely to be unrelated to nitrogen deposition. In addition, the woodland is floodplain wet woodland and the identified ground flora is already, and likely naturally, eutrophic in character. It is therefore considered that the 1.1% increase associated with the natural gas firing scenario, would be unlikely to impact the unfavourable condition of the site, given the very high background nitrogen deposition at the site. Additionally, air quality is not an identified pressure on this site.

The only other site that has a PC that represents more than 1% of the lower CLd is Risby Warren (OE12) at 1.1%. Against the upper CLd for the Inland sanddrift and dune with siliceous grassland habitat type, the PC would represent 0.4% and therefore would be significantly less than the 1% screening criteria. For the hydrogen firing scenario, the PC is also 1.1% of the lower CLd.

The background deposition at Risby Warren is already 350% of the lower CL value and therefore it is highly unlikely the predicted additional deposition from the Proposed Installation would impact the site further, given that it represents only 0.3% of the existing nitrogen deposition at the site.

Although nitrogen deposition is recognised as a barrier to recovery of the designated interest (lichen heath/ acid grassland) a significant reduction would be required to recover the interest feature, and the impacts associated with the Proposed Installation could be considered inconsequential.

As stated previously, emissions of NH<sub>3</sub> are only as a result of SCR abatement, which may not be needed in order to meet the BAT-AELs and Hydrogen GET ELVs, depending on the final CCGT selection. If SCR were needed, it is likely that the actual annual emissions would be less than 3mg/Nm<sup>3</sup>, which has been demonstrated by the operation of Keadby 2, which to-date has measured annual emissions of NH<sub>3</sub> below 1mg/Nm<sup>3</sup> compared to the permitted emission limit of 3.8mg/Nm<sup>3</sup>. However, it is unlikely that an Original Equipment Manufacturer would guarantee that such low emissions could be achieved, especially in the light of the early development of hydrogen technology.

Due to the higher conversion factors for nitrogen deposition for NH<sub>3</sub> compared to NO<sub>2</sub>, even very small changes in NH<sub>3</sub> emission concentrations can have a large effect on nitrogen deposition. For example, if an annual NH<sub>3</sub> emission concentration of 2mg/Nm<sup>3</sup> was achieved, nitrogen deposition impacts at Crowle Barrow Pits (OE6) and Risby Warren (OE12) would be reduced to 0.8% and 0.6% of the relevant CLds respectively. Likewise, if annual operational hours were modelled as 8,000 rather than 8,760 the impacts at both sites would reduce to 1.0% and 0.8% of the respective CLds. Although it would not be proposed to restrict operating hours to less than 8,760 hours per year, this does not represent a realistic operational scenario, as the Proposed Installation will need to undergo maintenance outages and is also likely to operate as a dispatchable plant. Therefore, even a slight reduction in annual operational hours

would reduce the nitrogen deposition impacts to a level that could be considered insignificant.

It is therefore considered that the presented assessment in terms of NH<sub>3</sub> emissions and nitrogen deposition impacts is very much worst case and that the nitrogen deposition impacts from the Proposed Installation would not result in any significant impacts on the identified ecological sites.

Further consideration of the impacts is provided in Appendix B of the Main Supporting Document (ES Volume I, Chapter 11 Biodiversity and Nature Conservation).

**Table 22: Nutrient Nitrogen Deposition (Kg/Ha/Yr) Results – 100% Hydrogen Firing**

Recept or ID	Site Name	K2 Modified Background Nitrogen Deposition (kg N/ha/yr)	Lowest CLd Class Applicable	Lower Value of CLd Range	PC (kg N/ha/yr)	PC % CLd	PEC (kg N/ha/yr)	PEC % CLd
OE1-5	Humber Estuary Ramsar, SSSI, SAC	16.4	Pioneer saltmarsh	20	0.27	1.3%	16.7	83%
OE6	Crowle Borrow Pits SSSI	28.4	Broad-leaved, mixed and yew woodland	10	0.10	1.0%	28.5	285%
		14.9	Rich fens	15	0.07	0.4%	14.9	100%
OE7	Hatfield Chase Ditches SSSI	No comparable habitat with established critical load estimate available						
OE8	Eastoft Meadow SSSI	14.6	Low and medium altitude hay meadows	10	0.04	0.4%	14.7	147%
OE9	Belshaw SSSI	No critical loads assigned						
OE10	Thorne Moor SAC	27.0	Temperate mountain Picea forest, Temperate mountain Abies forest	10	0.05	0.5%	27.1	271%
		14.1	Raised and blanket bogs	5	0.03	0.6%	14.2	283%
OE11	Epworth Turbary SSSI	13.5	Raised and blanket bogs	5	0.04	0.7%	13.6	272%
OE12	Risby Warren SSSI	17.5	Inland sanddrift and dune with siliceous grassland	5	0.05	1.1%	17.5	350%
OE13	Hatfield Moor SSSI	25.0	Temperate mountain Picea forest, Temperate mountain Abies forest	10	0.04	0.4%	25.1	251%
		13.0	Raised and blanket bogs	5	0.02	0.5%	13.1	261%

Recept or ID	Site Name	K2 Modified Background Nitrogen Deposition (kg N/ha/yr)	Lowest CLd Class Applicable	Lower Value of CLd Range	PC (kg N/ha/yr)	PC % CLd	PEC (kg N/ha/yr)	PEC % CLd
OE14	Messingham Heath SSSI	17.0	Non-mediterranean dry acid and neutral closed grassland	6	0.04	0.7%	17.0	283%
OE15	Tuetoos Hills SSSI	15.4	Inland sanddrift and dune with siliceous grassland	5	0.04	0.7%	15.4	309%
OE16	Haxey Turbary SSSI	13.3	Raised and blanket bogs	5	0.03	0.6%	13.3	266%
OE17	Rush Furlong SSSI	13.7	Low and medium altitude hay meadows	10	0.03	0.3%	13.7	137%
OE18	Hewsons Field SSSI	13.6	Low and medium altitude hay meadows	10	0.03	0.3%	13.6	136%
OE19	Messingham Sand Quarry SSSI	32.7	Broadleaved deciduous woodland	10	0.06	0.6%	32.7	327%
		17.5	Rich fens	15	0.04	0.2%	17.5	117%
OE20	Manton and Twigmoor SSSI	33.3	Broadleaved deciduous woodland	10	0.07	0.7%	33.3	333%
		17.8	Inland sanddrift and dune with siliceous grassland	5	0.04	0.8%	17.8	356%
OE21	Scotton and Laughton Forest Ponds SSSI	30.0	Broadleaved deciduous woodland	10	0.06	0.6%	30.1	301%
		15.8	Valley mires, poor fens and transition mires	5	0.04	0.7%	15.8	317%
OE22	Broughton Far Wood SSSI	35.7	Carpinus and Quercus mesic deciduous forest	15	0.07	0.5%	35.8	238%

Recept or ID	Site Name	K2 Modified Background Nitrogen Deposition (kg N/ha/yr)	Lowest CLd Class Applicable	Lower Value of CLd Range	PC (kg N/ha/yr)	PC % CLd	PEC (kg N/ha/yr)	PEC % CLd
		19.1	Semi-dry Perennial calcareous grassland (basic meadow steppe).	10	0.04	0.4%	19.1	191%
OE23	Broughton Alder Wood SSSI	Designated feature/ feature habitat not sensitive to eutrophication						
OE24	Scotton Beck Fields SSSI	16.7	Dry heath	5	0.04	0.7%	16.7	334%
OE25	Scotton Common SSSI	16.2	Dry heath	5	0.04	0.7%	16.2	324%
OE26	Laughton Common SSSI	14.7	Dry heath	5	0.03	0.6%	14.8	296%
OE27	Stainforth and Keadby Canal Corridor LWS	15.5	Neutral grassland	20	0.11	0.6%	15.6	78%
OE28	Keadby Wetland LWS	29.5	Broadleaved deciduous woodland	10	0.36	3.6%	29.9	299%
OE29	Keadby Wet Grassland LWS	15.5	Coastal and floodplain grazing marsh	20	0.17	0.9%	15.7	78%
OE30	Three Rivers LWS	16.2	Coastal and floodplain grazing marsh	20	0.14	0.7%	16.3	81%
OE31	Ash tip	15.4	Acid grassland	10	0.03	0.3%	15.4	154%
OE32	Humber Estuary at Blacktoft Sands (Ramsar, SAC, SPA and SSSI)	14.8	Rich Fens	15	0.09	0.6%	14.9	99%

**Table 23: Nutrient Nitrogen Deposition (Kg/Ha/Yr) Results – 100% Natural Gas**

Recept or ID	Site Name	K2 Modified Background Nitrogen Deposition (kg N/ha/yr)	Lowest CLd Class Applicable	Lower Value of CLd Range	PC (kg N/ha/yr)	PC % CLd	PEC (kg N/ha/yr)	PEC % CLd
OE1-5	Humber Estuary Ramsar, SSSI, SAC	16.4	Pioneer saltmarsh	20	0.32	1.6%	16.7	84%
OE6	Crowle Borrow Pits SSSI	28.4	Broad-leaved, mixed and yew woodland	10	0.11	1.1%	28.5	285%
		14.9	Rich fens	15	0.07	0.5%	14.9	100%
OE7	Hatfield Chase Ditches SSSI	No comparable habitat with established critical load estimate available						
OE8	Eastoft Meadow SSSI	14.6	Low and medium altitude hay meadows	10	0.05	0.5%	14.7	147%
OE9	Belshaw SSSI	No critical loads assigned						
OE10	Thorne Moor SAC	27.0	Temperate mountain Picea forest, Temperate mountain Abies forest	10	0.05	0.5%	27.1	271%
		14.1	Raised and blanket bogs	5	0.03	0.7%	14.2	283%
OE11	Epworth Turbary SSSI	13.5	Raised and blanket bogs	5	0.04	0.9%	13.6	272%
OE12	Risby Warren SSSI	17.5	Inland sanddrift and dune with siliceous grassland	5	0.06	1.1%	17.5	351%
OE13	Hatfield Moor SSSI	25.0	Temperate mountain Picea forest, Temperate mountain Abies forest	10	0.04	0.4%	25.1	251%
		13.0	Raised and blanket bogs	5	0.02	0.5%	13.1	261%

Recept or ID	Site Name	K2 Modified Background Nitrogen Deposition (kg N/ha/yr)	Lowest CLd Class Applicable	Lower Value of CLd Range	PC (kg N/ha/yr)	PC % CLd	PEC (kg N/ha/yr)	PEC % CLd
OE14	Messingham Heath SSSI	17.0	Non-mediterranean dry acid and neutral closed grassland	6	0.05	0.9%	17.0	284%
OE15	Tuetoos Hills SSSI	15.4	Inland sanddrift and dune with siliceous grassland	5	0.04	0.9%	15.4	309%
OE16	Haxey Turbary SSSI	13.3	Raised and blanket bogs	5	0.04	0.7%	13.3	266%
OE17	Rush Furlong SSSI	13.7	Low and medium altitude hay meadows	10	0.04	0.4%	13.7	137%
OE18	Hewsons Field SSSI	13.6	Low and medium altitude hay meadows	10	0.04	0.4%	13.6	136%
OE19	Messingham Sand Quarry SSSI	32.7	Broadleaved deciduous woodland	10	0.07	0.7%	32.7	327%
		17.5	Rich fens	15	0.04	0.3%	17.5	117%
OE20	Manton and Twigmoor SSSI	33.3	Broadleaved deciduous woodland	10	0.07	0.7%	33.3	333%
		17.8	Inland sanddrift and dune with siliceous grassland	5	0.05	0.9%	17.8	356%
OE21	Scotton and Laughton Forest Ponds SSSI	30.0	Broadleaved deciduous woodland	10	0.07	0.7%	30.1	301%
		15.8	Valley mires, poor fens and transition mires	5	0.04	0.8%	15.9	317%
OE22	Broughton Far Wood SSSI	35.7	Carpinus and Quercus mesic deciduous forest	15	0.08	0.5%	35.8	238%

Recept or ID	Site Name	K2 Modified Background Nitrogen Deposition (kg N/ha/yr)	Lowest CLd Class Applicable	Lower Value of CLd Range	PC (kg N/ha/yr)	PC % CLd	PEC (kg N/ha/yr)	PEC % CLd
		19.1	Semi-dry Perennial calcareous grassland (basic meadow steppe).	10	0.05	0.5%	19.1	191%
OE23	Broughton Alder Wood SSSI	Designated feature/ feature habitat not sensitive to eutrophication						
OE24	Scotton Beck Fields SSSI	16.7	Dry heath	5	0.04	1.0%	16.7	335%
OE25	Scotton Common SSSI	16.2	Dry heath	5	0.04	1.0%	16.2	324%
OE26	Laughton Common SSSI	14.7	Dry heath	5	0.03	0.8%	14.8	296%
OE27	Stainforth and Keadby Canal Corridor LWS	15.5	Neutral grassland	20	0.13	0.7%	15.6	78%
OE28	Keadby Wetland LWS	29.5	Broadleaved deciduous woodland	10	0.40	4.0%	29.9	299%
OE29	Keadby Wet Grassland LWS	15.5	Coastal and floodplain grazing marsh	20	0.20	1.0%	15.7	79%
OE30	Three Rivers LWS	16.2	Coastal and floodplain grazing marsh	20	0.16	0.8%	16.3	81%
OE31	Ash tip	15.4	Acid grassland	10	0.04	0.4%	15.4	154%
OE32	Humber Estuary at Blacktoft Sands (Ramsar, SAC, SPA and SSSI)	14.8	Rich Fens	15	0.10	0.6%	14.9	99%

### Acid Deposition

The results for acid deposition for Natural Gas firing are presented in Table 24. The acid deposition at all sites are less than the 1% screening threshold for insignificance, for the worst case scenario of 100% natural gas firing. As all impacts are insignificant, the results for 100% Hydrogen Firing have not been presented.

It is therefore considered that the acid deposition impacts from the Proposed Installation would not result in any significant impacts on the identified ecological sites.

**Table 24: Acid Deposition N (Keq/Ha/Yr) Results – 100% Natural Gas Firing**

Receptor ID	Site Name	Acid Deposition				PC Acid Deposition (keq/ha/yr)		
		CLd (keq/ha/yr)	K2 Modified Baseline (keq/ha/yr)	Lowest CLd Class Applicable	Baseline % of CLd	PC	PC % of CLd	PEC% of CLd
OE1-5	Humber Estuary Ramsar/SAC/ SSSI	Min CL Min N: 0.856 Min CL Max N: 4.856 Min CL Max S: 4.00	N: 1.182 S: 0.16	Calcareous grassland (using base cation)	27.6%	0.023	0.4%	28.2%
OE6	Crowle Borrow Pits SSSI	Min CL Min N: 0.142 Min CL Max N: 10.908 Min CL Max S: 10.766	N: 2.027 S: 0.17	Unmanaged Broadleaved/ Coniferous Woodland	20.2%	0.008	0.1%	20.2%
OE7	Hatfield Chase Ditches SSSI	Not sensitive to acidity						
OE8	Eastoft Meadow SSSI	Min CL Min N: 1.071 Min CL Max N: 5.071 Min CL Max S: 4.000	N: 1.044 S: 0.13	Calcareous grassland (using base cation)	3.3%	0.003	0.0%	3.3%
OE9	Belshaw SSSI	No critical load assigned						
OE10	Thorne Moor SAC	Min CL Min N: 0.142 Min CL Max N: 0.498 Min CL Max S: 0.213	N: 1.924 S: 0.16	Unmanaged Broadleaved/ Coniferous Woodland	418.5%	0.004	0.8%	419.3%
OE11	Epworth Turbary SSSI	Min CL Min N: 0.321 Min CL Max N: 0.478 Min CL Max S: 0.157	N: 0.963 S: 0.12	Bogs	226.4%	0.003	0.4%	227.0%

Receptor ID	Site Name	Acid Deposition				PC Acid Deposition (keq/ha/yr)		
		CLd (keq/ha/yr)	K2 Modified Baseline (keq/ha/yr)	Lowest CLd Class Applicable	Baseline % of CLd	PC	PC % of CLd	PEC% of CLd
OE12	Risby Warren SSSI	Min CL Min N: 0.856 Min CL Max N: 4.856 Min CL Max S: 4.00	N: 1.246 S: 0.20	Acid grassland	29.8%	0.004	0.1%	29.9%
OE13	Hatfield Moor SAC	Min CL Min N: 0.285 Min CL Max N: 0.475 Min CL Max S: 0.154	N: 1.813 S: 0.16	Unmanaged Broadleaved/ Coniferous Woodland	386.9%	0.003	0.6%	3.87.5%
OE14	Messingham Heath SSSI	No acidity critical loads available for this site						
OE15	Tuetoos Hills SSSI	No critical loads assigned						
OE16	Haxey Turbary SSSI	Min CL Min N: 0.321 Min CL Max N: 0.486 Min CL Max S: 0.165	N: 0.953 S: 0.12	Bogs	224.9%	0.003	0.6%	225.6%
OE17	Rush Furlong SSSI	Min CL Min N: 1.071 Min CL Max N: 5.071 Min CL Max S: 4.000	N: 0.973 S: 0.12	Calcareous grassland (using base cation)	3.0%	0.003	<0.1%	3.0%
OE18	Hewsons Field SSSI	Min CL Min N: 1.071 Min CL Max N: 5.07 Min CL Max S: 4.00	N: 0.973 S: 0.12	Calcareous grassland (using base cation)	3.0%	0.003	0.0%	3.0%
OE19	Messingham Sand Quarry SSSI	Min CL Min N: 0.142 Min CL Max N: 1.214 Min CL Max S: 1.016	N: 2.336 S: 0.18	Unmanaged Broadleaved/ Coniferous Woodland	207.2%	0.005	0.4%	207.7%

Receptor ID	Site Name	Acid Deposition				PC Acid Deposition (keq/ha/yr)		
		CLd (keq/ha/yr)	K2 Modified Baseline (keq/ha/yr)	Lowest CLd Class Applicable	Baseline % of CLd	PC	PC % of CLd	PEC% of CLd
OE20	Manton and Twigmoor SSSI	Min CL Min N: 0.142 Min CL Max N: 1.002 Min CL Max S: 0.717	N: 2.376 S: 0.18	Unmanaged Broadleaved/Coniferous Woodland	255.1%	0.005	0.5%	255.6%
OE21	Scotton and Laughton Forest Ponds SSSI	Min CL Min N: 0.321 Min CL Max N: 0.484 Min CL Max S: 0.163	N: 1.093 S: 0.12	Bogs	250.6%	0.003	0.6%	251.2%
OE22	Broughton Far Wood SSSI	Min CL Min N: 0.285 Min CL Max N: 0.989 Min CL Max S: 0.704	N: 2.546 S: 0.23	Unmanaged Broadleaved/Coniferous Woodland	280.7%	0.005	0.5%	281.2%
OE23	Broughton Alder Wood SSSI	No critical loads assigned						
OE24	Scotton Beck Fields SSSI	No critical load assigned						
OE25	Scotton Common SSSI	Min CL Min N: 1.035 Min CL Max N: 1.225 Min CL Max S: 0.19	N: 1.154 S: 0.12	Dwarf shrub heath	103.7%	0.003	0.8%	104.5%
OE26	Laughton Common SSSI	Min CL Min N: 0.892 Min CL Max N: 5.002 Min CL Max S: 4.11	N: 1.024 S: 0.12	Dwarf shrub heath	22.8%	0.002	0.2%	23.0%

Receptor ID	Site Name	Acid Deposition				PC Acid Deposition (keq/ha/yr)		
		CLd (keq/ha/yr)	K2 Modified Baseline (keq/ha/yr)	Lowest CLd Class Applicable	Baseline % of CLd	PC	PC % of CLd	PEC% of CLd
OE27	Stainforth and Keadby Canal Corridor LWS	Min CL Min N: 0.856 Min CL Max N: 4.856 Min CL Max S: 4.000	N: 1.112 S: 0.15	Neutral grassland	25.9%	0.009	0.2%	26.2%
OE28	Keadby Wetland LWS	Min CL Min N: 0.142 Min CL Max N: 10.923 Min CL Max S: 10.781	N: 2.111 S: 0.19	Unmanaged Broadleaved/ Coniferous Woodland	21.1%	0.028	0.3%	21.3%
OE29	Keadby Wet Grassland LWS	No comparable critical load class for which the CL function is calculated.						
OE30	Three Rivers LWS	Min CL Min N: 0.856 Min CL Max N: 4.856 Min CL Max S: 4.000	N: 1.14 S: 0.15	Neutral grassland	26.8%	0.013	0.2%	27.0%
OE31	Ash tip	Min CL Min N: 0.223 Min CL Max N: 4.303 Min CL Max S: 4.08	N: 1.09 S: 0.15	Acid grassland	28.6%	0.002	0%	28.6%
OE32	Humber Estuary at Blacktoft Sands (Ramsar, SAC, SPA and SSSI)	Fen, Marsh and Swamp - Not sensitive to acidity						

## 7. In-combination Assessment

For SPAs, SACs and Ramsar sites, there is also a requirement to consider the 'in combination' (combined) impact of all permissions, plans or projects that affect the site. The only SPAs, SACs and Ramsar sites are the Humber Estuary, Thorne Moor and Hatfield Moor.

The ES carried out for the DCO application included a Cumulative and Combined Effects assessment (Appendix B of the Main Supporting Document (ES Volume I, Chapter 21), which identified the following developments for potential operational in-combination effects:

- North Lincolnshire Green Energy Park (DCO EN10116); and
- Scunthorpe Electric Arc Furnace Planning Application (PA/2024/12)

North Lincolnshire Green Energy Park is 4km southeast of the Proposed Development and Scunthorpe Electric Arc Furnace is located 9.5km east.

The DCO application for the North Lincolnshire Green Energy considered the cumulative impacts with Keadby 3, for which the Proposed Installation is an alternative for. The only potential for cumulative likely significant effects identified were ammonia and nitrogen deposition at the Risby Warren SSSI, with no in-combination impacts being predicted at European Designated Sites.

Although the Planning Application for the Scunthorpe Electric Arc Furnace has been approved, there is currently large uncertainty over the development of the site, and therefore it is recognised that there may be changes to current plans which would require further planning updates to be sought. The current assessment considered two potential future operational scenarios for the site. One scenario assumes that the existing blast furnaces continue operation with the proposed Electric Arc Furnace, with a further scenario assuming that the blast furnaces cease operation. The former scenario is assumed to only be in place for 12 months and therefore the scenario with just the EAF operational is most relevant for cumulative impacts.

On the whole, the operation of the EAF only will result in a decrease in the mass emissions of NO<sub>x</sub> from the British Steel site over existing operations, which will lead to a reduction in the predicted impacts at receptors. Additionally, due to the distance from the Proposed Installation (>9km) the potential for in-combination impacts is considered to be minimal.

## 8. Conclusions

This Appendix has been prepared in support of the application for an Environmental Permit for the Proposed Installation, to detail the Air Quality Impact Assessment that has been carried out to demonstrate that the emissions from the Proposed Installation would not lead to the exceedance of any AQS objectives, EALs, CLs and CLDs, as appropriate.

The pollutants included in the assessment were NO<sub>x</sub>, NO<sub>2</sub>, CO and also NH<sub>3</sub> due to the potential for a SCR system to control NO<sub>x</sub> emissions.

The assessment considered the requirement for the CCGT aspect of the Proposed Installation to be permitted to operate on 100% hydrogen, 100% natural gas or a blend of natural gas and hydrogen, as detailed in the Main supporting Document.

The assessment demonstrated that impacts on Human Health receptors could all be screened as insignificant at the first stage of assessment for CO and NH<sub>3</sub> and at the second screening stage for NO<sub>2</sub>. The results presented in the assessment are those at the maximum point of impact, and therefore the impacts at actual receptor locations are actually lower than those presented.

Ecological impacts against the CLs can largely be screened as insignificant at the first level of screening for annual NO<sub>x</sub>, daily NO<sub>x</sub> and NH<sub>3</sub>.

PCs of more than 1% of the annual average CL for NO<sub>x</sub> occur at the adjacent Humber Estuary SAC, SSSI and Ramsar, Keadby Wetland LWS, Keadby Wet grassland and Three Rivers LWSs, however in combination with the K2 modified background concentrations, all sites are well below 70% of the critical level threshold for insignificance, therefore no exceedances of the annual CL are predicted.

The daily CL is predicted to be over the first screening threshold for insignificance at only the Humber Estuary. However again, in combination with the K2 modified background concentration the impacts are well below the daily CL and therefore indicate that no exceedance would be likely to occur as a result of the operational Proposed Installation.

For NH<sub>3</sub>, only two habitat receptors had impacts over the first level of screening, however when combined with the K2 modified background concentrations, the impacts at the Humber Estuary SSSI, SAC and Ramsar and the Keadby Wetland LWS are both less than 70% of the CL and therefore can be considered to be insignificant.

For nitrogen deposition, the majority of sites have impacts that can be screened as being insignificant as they are less than 1% of the CLd for the worst case operating scenario (100% natural gas firing).

There are three sites with impacts over the 1% screening level for determining insignificance. Impacts at the Humber Estuary are predicted to be 3.2% of the lower CLd for the worst case 100% natural gas firing scenario, reducing to 2.7% for the 100%

hydrogen fired scenario. However, this impact occurs in an area where the Atlantic upper-mid & mid-low salt marshes habitat type used in the assessment is not present.

The community of relevance is considered to occur at the estuary proper, at the mouth of the River Trent. This is closer to the location of the Humber receptor OE32, which has a PC of 0.10kg N/ha/yr, which represents 1.0% of the Atlantic upper-mid & mid-low salt marshes lower CLd and therefore would be screened as being insignificant.

Crowle Borrow Pits (OE6) and Risby Warren (OE12) both have impacts that are slightly over the 1% screening threshold for the worst case scenario, however it is considered that the woodland at Crowle Borrow Pit is currently in an unfavourable condition due to ash dieback and lack of regeneration of trees, which are factors that are likely to be unrelated to nitrogen deposition.

The background deposition at Risby Warren is already 350% of the lower CL value and therefore it is highly unlikely the predicted additional deposition from the Proposed Installation would impact the site further, given that it represents only 0.3% of the existing nitrogen deposition at the site.

Although nitrogen deposition is recognised as a barrier to recovery of the designated interest (lichen heath/ acid grassland) a significant reduction would be required to recover the interest feature, and the impacts associated with the Proposed Installation could be considered inconsequential.

Emissions of NH<sub>3</sub> are only as a result of SCR abatement, which may not be needed in order to meet the BAT-AELs and Hydrogen GET ELVs, depending on the final CCGT selection. If SCR were needed, it is likely that the actual annual emissions would be less than 3mg/Nm<sup>3</sup>, which has been demonstrated by the operation of Keadby 2, which to-date has measured annual emissions of NH<sub>3</sub> below 1mg/Nm<sup>3</sup> compared to the permitted emission limit of 3.8mg/Nm<sup>3</sup>. However, it is unlikely that an Original Equipment Manufacturer would guarantee that such low emissions could be achieved, especially in the light of the early development of hydrogen technology.

Due to the higher conversion factors for nitrogen deposition for NH<sub>3</sub> compared to NO<sub>2</sub>, even very small changes in NH<sub>3</sub> emission concentrations can have a large effect on nitrogen deposition. For example, if an annual NH<sub>3</sub> emission concentration of 2mg/Nm<sup>3</sup> was achieved, nitrogen deposition impacts at Crowle Barrow Pits (OE6) and Risby Warren (OE12) would be reduced to 0.8% and 0.6% of the relevant CLds respectively. Likewise, if annual operational hours were modelled as 8,000 rather than 8,760 the impacts at both sites would reduce to 1.0% and 0.8% of the respective CLds. Although it would not be proposed to restrict operating hours to less than 8,760 hours per year, this does not represent a realistic operational scenario, as the Proposed Installation will need to undergo maintenance outages and is also likely to operate as a dispatchable plant. The point being made is that even, a slight reduction in annual operational hours would reduce the nitrogen deposition impacts to a level that could be considered insignificant.

It is therefore considered that the presented assessment in terms of NH<sub>3</sub> emissions and nitrogen deposition impacts is very much worst case and that the nitrogen

deposition impacts from the Proposed Installation would not result in any significant impacts on the identified ecological sites.

Impacts associated with acid deposition are insignificant at all sites.

## **ANNEX A: FIGURES**

Figure 1 – Human Health Receptors

Figure 2 – Ecological Receptors

Figure 3 – ADMS Buildings Visualisation

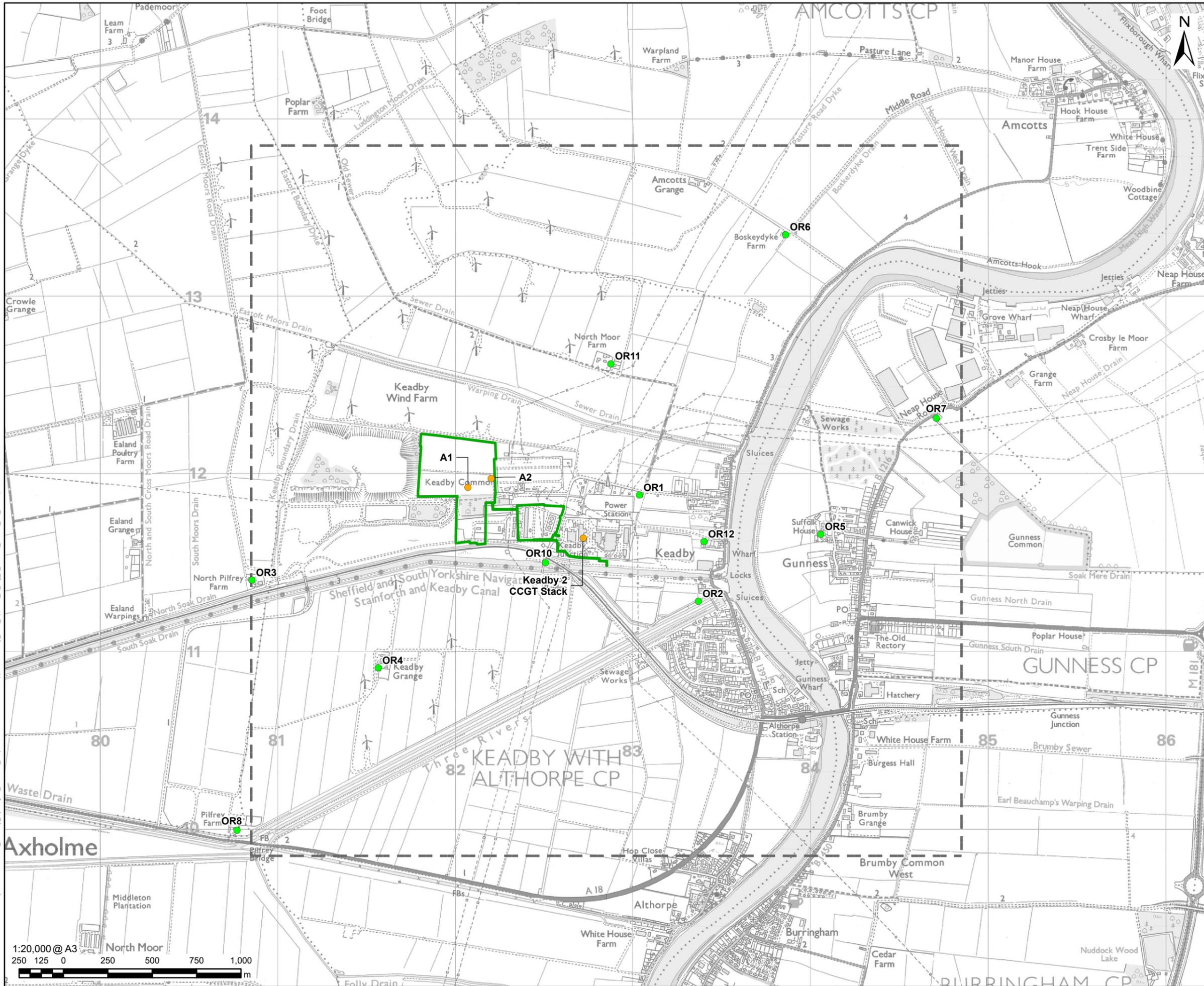
Figure 4 – Annual Average NO<sub>2</sub> Process Contributions

Figure 5 – Hourly Average NO<sub>2</sub> Process Contributions

Figure 6 – Annual Average NO<sub>x</sub> Process Contributions

Figure 7 – Daily Average NO<sub>x</sub> Process Contributions

Figure 8 – Nitrogen Deposition



OR9 Thorne is located approximately 11km west of the Proposed Development Site

Keadby 1 Power Station Stack is not shown as was not modelled due to it being part of the background already

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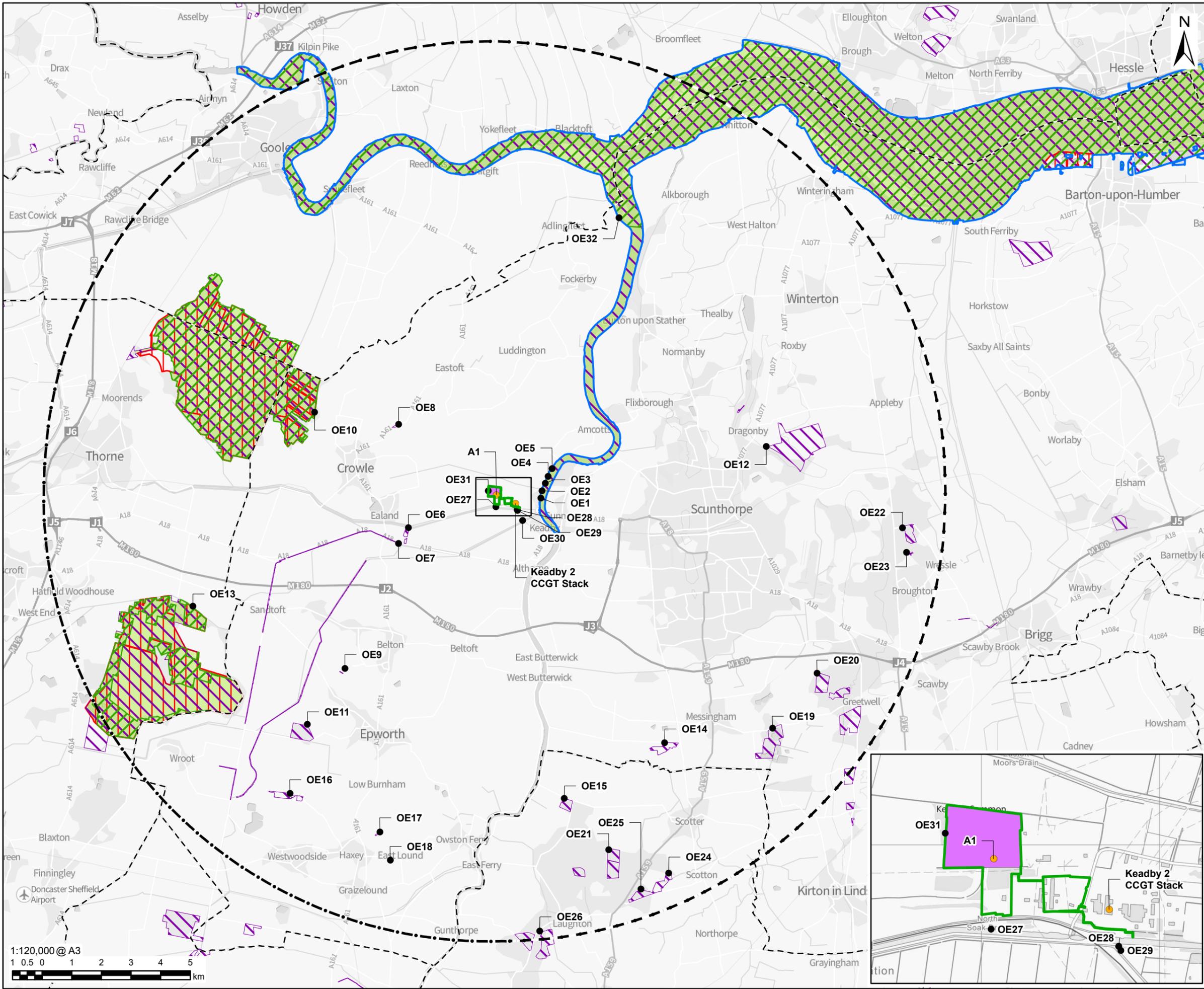
**FIGURE TITLE**

Operational Study Area - Human Health Receptors

**FIGURE NUMBER**

Appendix G Figure 1

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**LEGEND**

- Main Site
- Keadby Next Generation Power Station Installation Boundary
- 15km Study Area from the Main Site
- National Nature Reserve (NNR)
- Ramsar Site
- Site of Special Scientific Interest (SSSI)
- Special Area of Conservation (SAC)
- Special Protection Area (SPA)
- Operational Ecological Receptor
- Emission Source

Keadby 1 Power Station Stack is not shown as it was not modelled due to it being part of the background already

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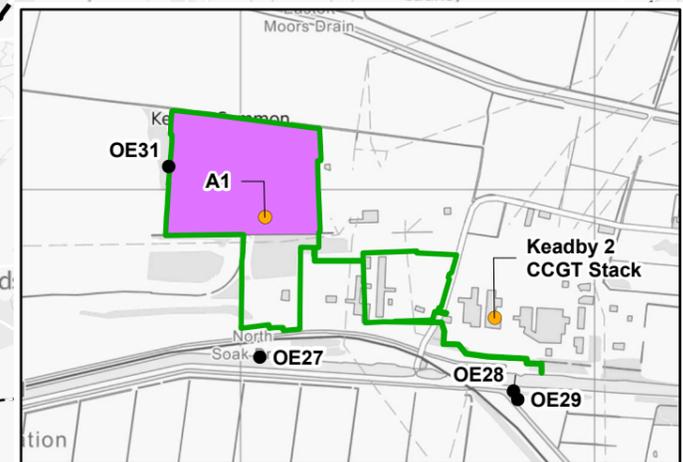
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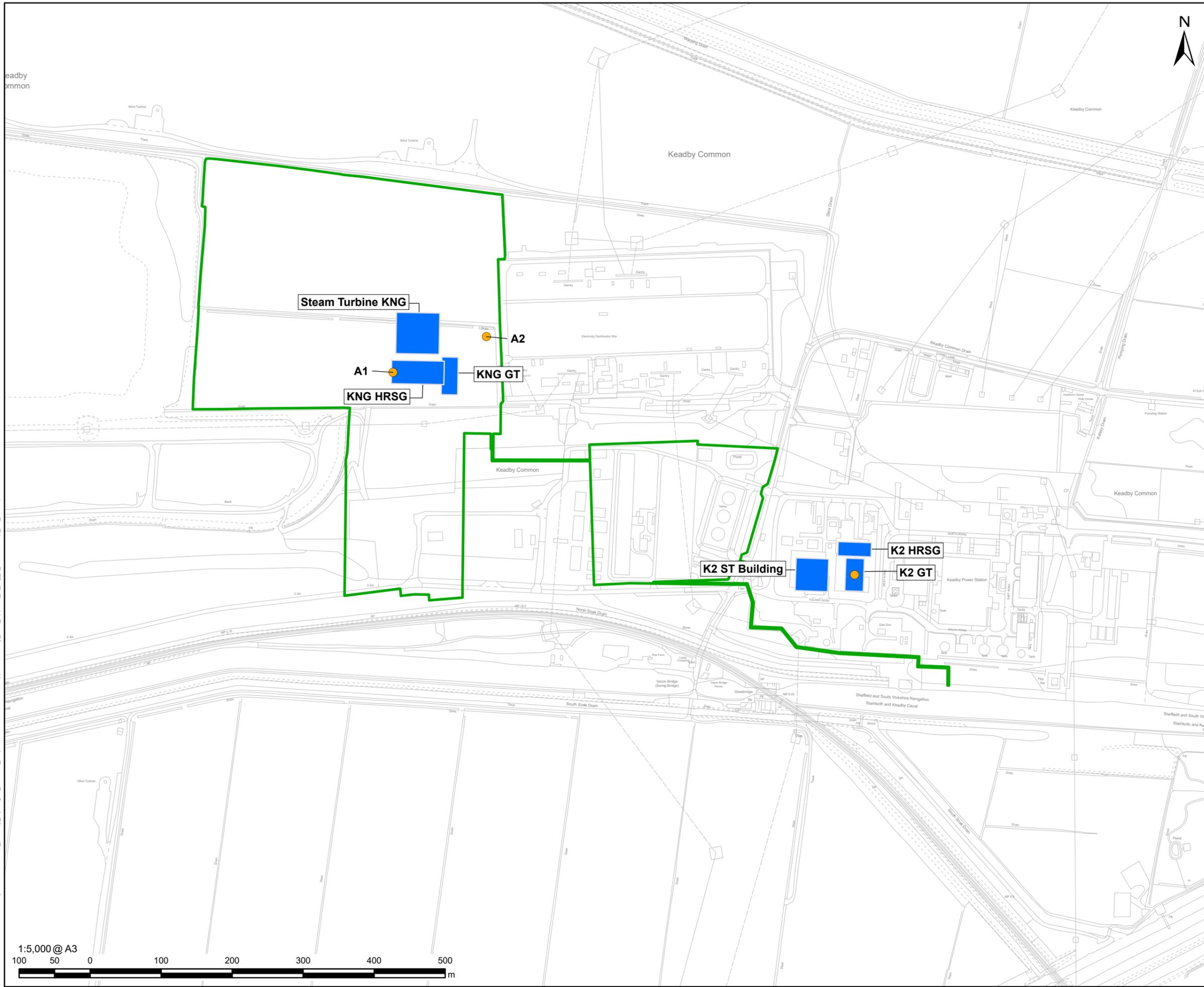
**FIGURE TITLE**

Ecological Receptor Locations

**FIGURE NUMBER**

Appendix G Figure 2





- ▭ Keadby Next Generation Power Station Installation Boundary
- ▭ Modelled Building
- Emission Source

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**FIGURE TITLE**

Model Set-up

**FIGURE NUMBER**

Appendix G Figure 3

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**LEGEND**

- Keadby Next Generation Power Station Installation Boundary
- 4 x 4km Modelled Domain Area
- Annual Mean NO<sub>2</sub> PC (µg/m<sup>3</sup>)
- Emission Source
- Operational Human Health Receptor

Keadby 1 Power Station Stack is not shown as was not modelled due to it being part of the background already

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**FIGURE TITLE**

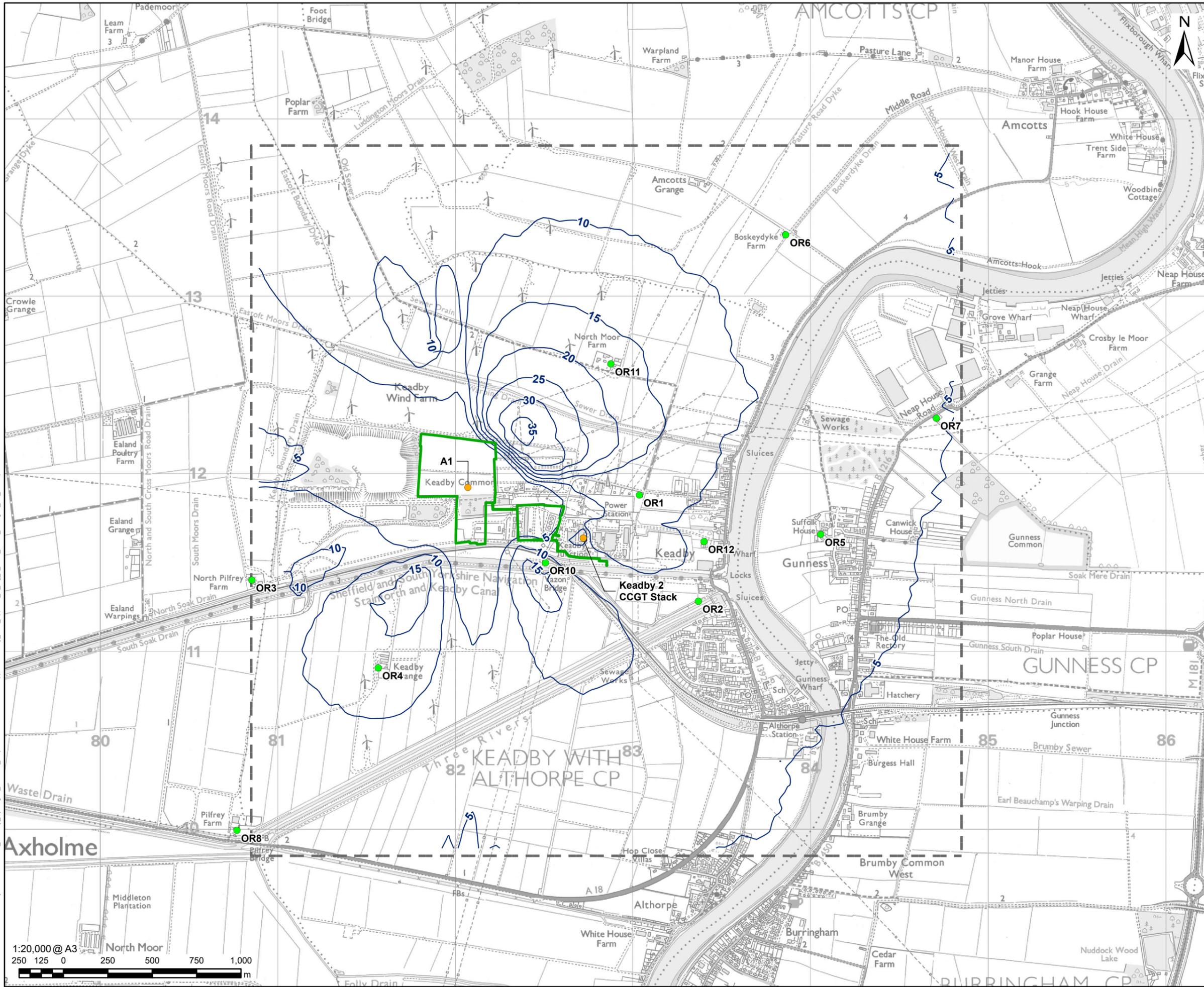
Annual Mean Nitrogen Dioxide Process Contribution - Hydrogen Firing 2020 Isopleths

**FIGURE NUMBER**

Appendix G Figure 4



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- Keadby Next Generation Power Station Installation Boundary
- 4 x 4km Modelled Domain Area
- 99.79<sup>th</sup> Percentile 1hr Mean NO<sub>2</sub> PC (µg/m<sup>3</sup>)
- Emission Source
- Operational Human Health Receptor

Keadby 1 Power Station Stack is not shown as was not modelled due to it being part of the background already

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**FIGURE TITLE**

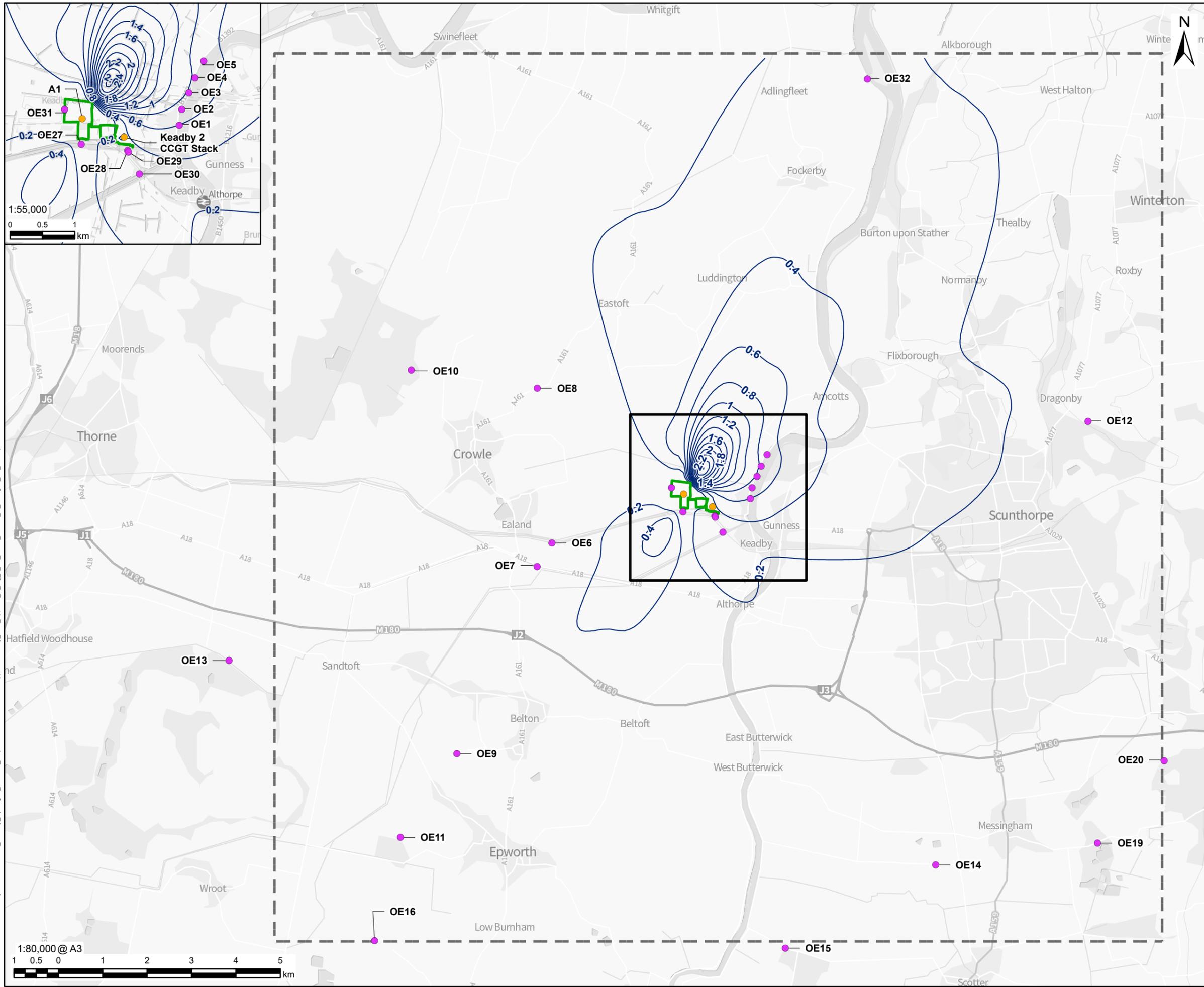
99.79<sup>th</sup> Percentile 1 hour Mean Nitrogen Dioxide – Hydrogen Firing 2020 Isopleths

**FIGURE NUMBER**

Appendix G Figure 5



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**KEADBY  
NEXT GENERATION  
POWER STATION**  
Hydrogen-enabled flexible power

A collaboration between SSE Thermal and Equinor

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**LEGEND**

- Keadby Next Generation Power Station Installation Boundary
  - 20 x 20km Modelled Domain Area
  - Annual Mean NOx PC (µg/m<sup>3</sup>)
  - Operational Ecological Receptor
  - Emission Source
- Keadby 1 Power Station Stack is not shown as was not modelled due to it being part of the background already

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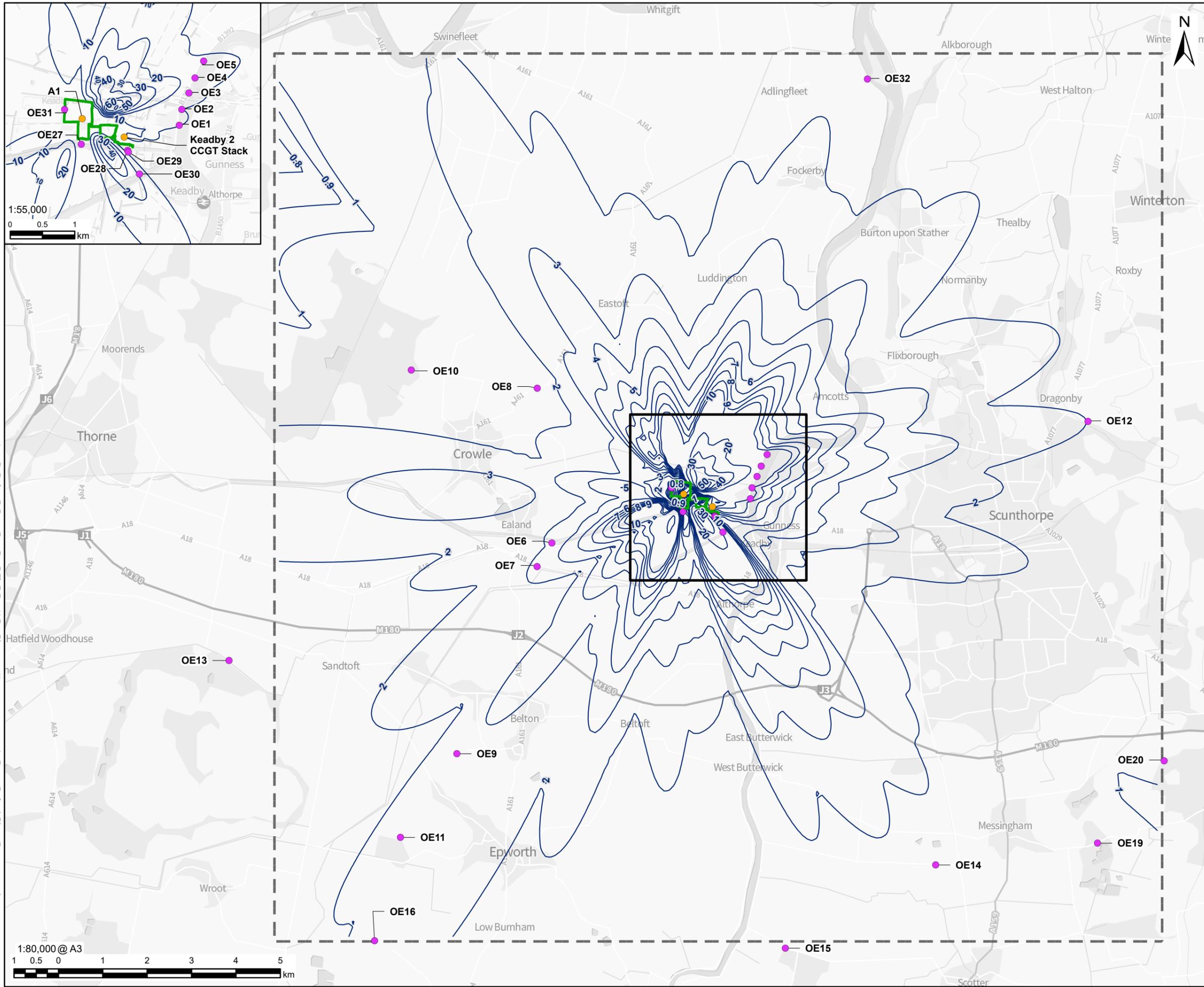
**FIGURE TITLE**

Annual Mean Oxides of Nitrogen Process Contribution – Hydrogen Firing 2020 Isopleths

**FIGURE NUMBER**

Appendix G Figure 6

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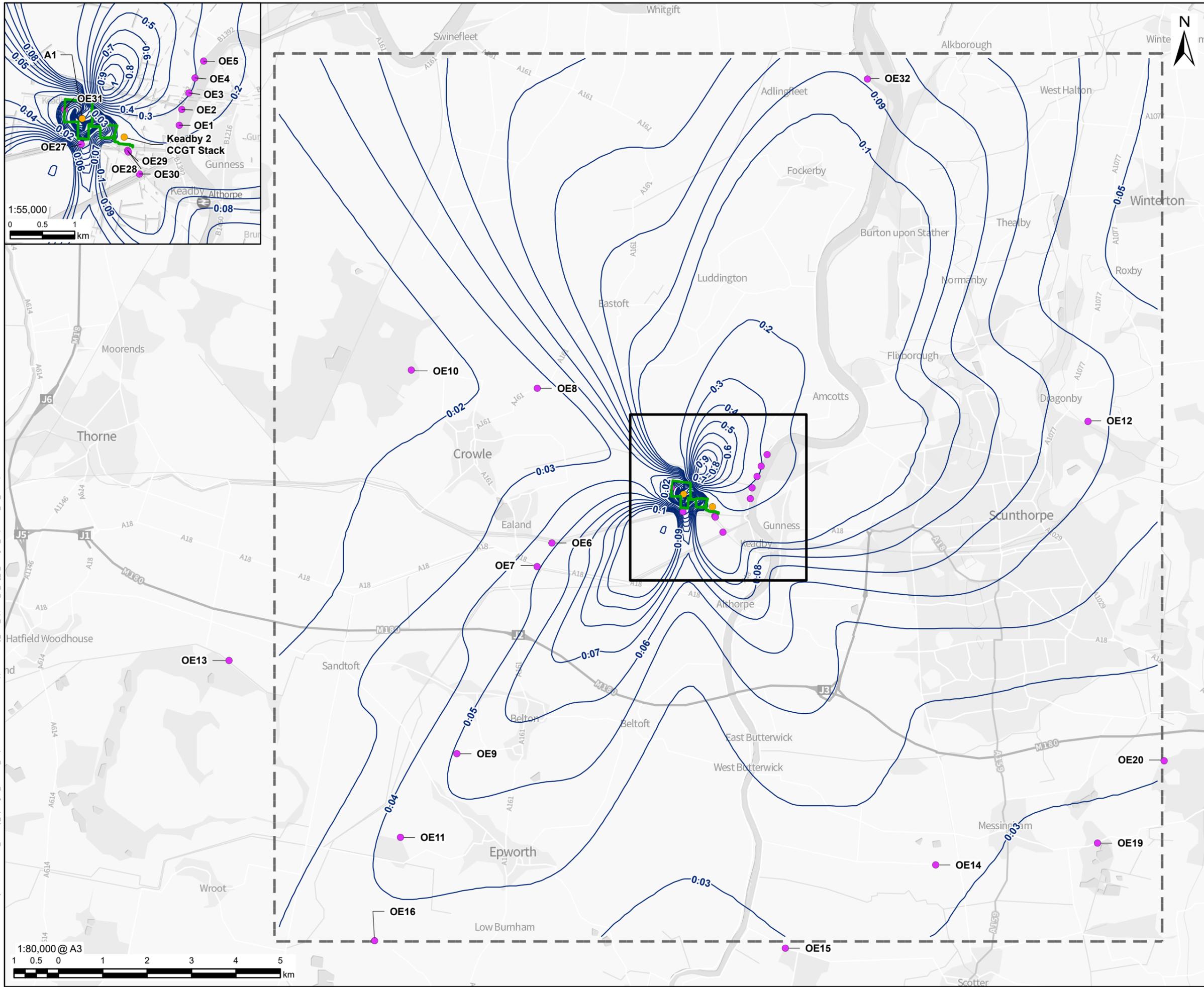
**ISSUE PURPOSE**  
 ENVIRONMENTAL PERMIT APPLICATION

**PROJECT NUMBER**  
 60721867

**FIGURE TITLE**  
 Maximum 24 Hour Mean Oxides of Nitrogen – Hydrogen Firing 2020 Isoleths

**FIGURE NUMBER**  
 Appendix G Figure 7

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- LEGEND**
- Keadby Next Generation Power Station Installation Boundary
  - 20 x 20km Modelled Domain Area
  - Nitrogen Deposition (short vegetation) kg N/ha/yr
  - Operational Ecological Receptor
  - Emission Source

Keadby 1 Power Station Stack is not shown as was not modelled due to it being part of the background already

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**ISSUE PURPOSE**

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**FIGURE TITLE**

Nitrogen Deposition (short vegetation) kg N/ha/yr - Natural Gas Firing 2020 Isopleths

**FIGURE NUMBER**

Appendix G Figure 8

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## ANNEX B: STACK HEIGHT ASSESSMENT

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.

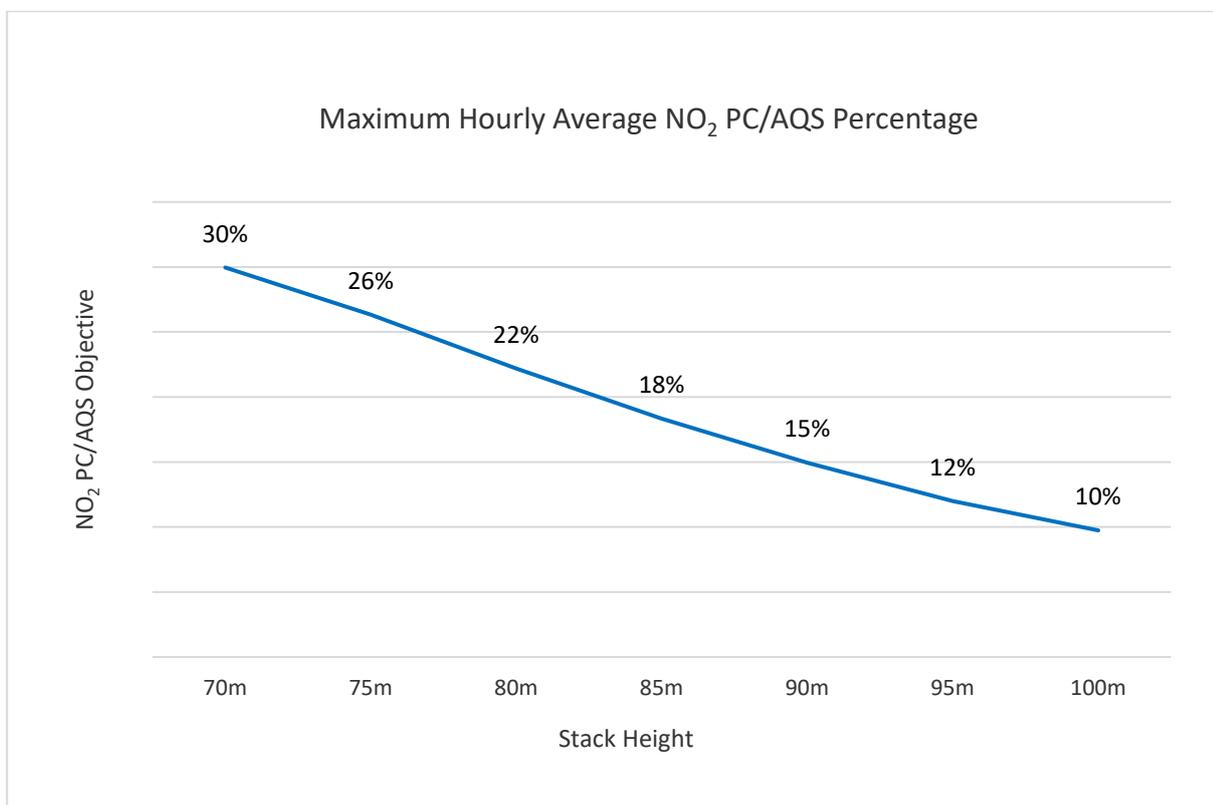
The emissions from the operational Proposed Installation occur from a stack adjacent to the HRSG Building. The HRSG building has been included in the model at a maximum height of 58m AGL.

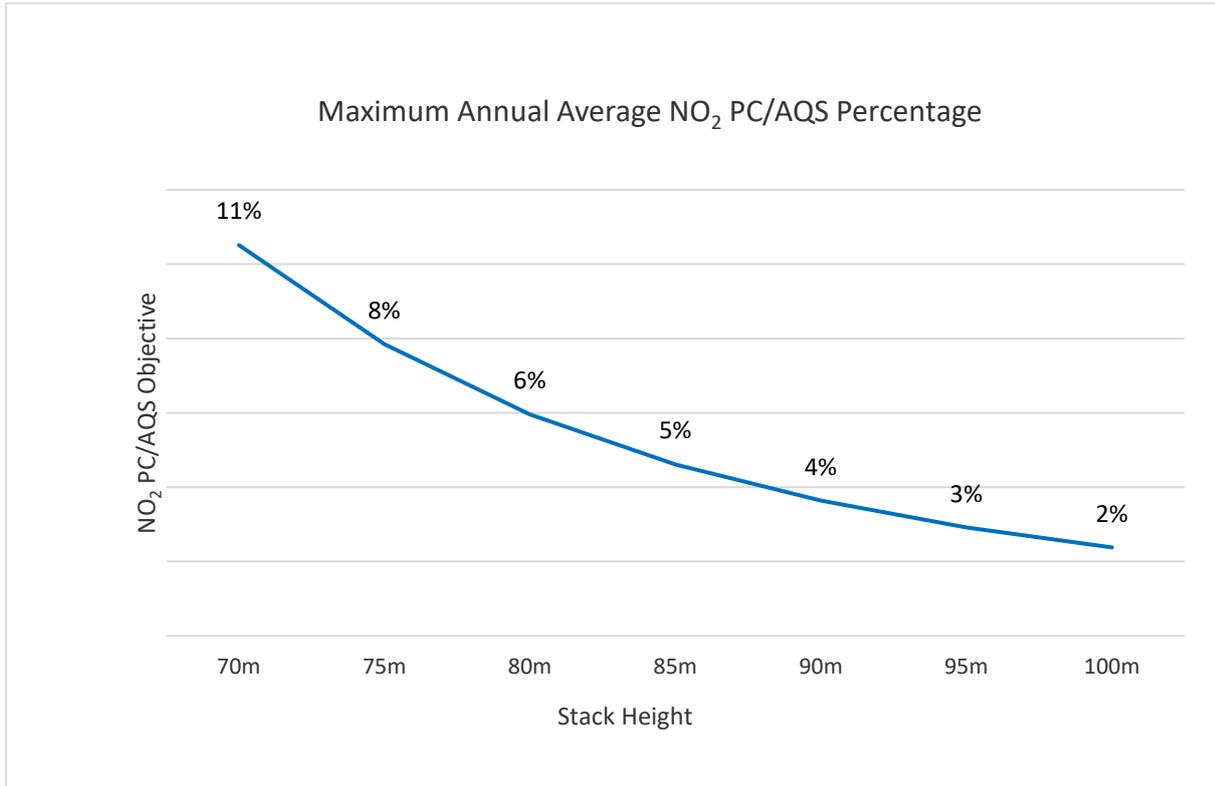
The CCGT stack has been modelled at heights between 70m and 100m, at 5m increments for the hydrogen firing scenario, as this was found to lead to the worst-case impacts for NO<sub>2</sub> and NO<sub>x</sub> and will be the long-term mode of operation.

A graph showing the percentage PC against the relevant AQS objective for the maximum annual mean and maximum 1-hour NO<sub>2</sub> concentrations is presented in Plate B1. The purpose of the graph 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, regarded as the stack height that represents BAT for the emission source.

Analysis of the curves shows that there is no obvious “elbow” to the curve, however after a stack height of 85m the reduction in the impacts becomes less pronounced with each 5m increase. The reported results are therefore based on an 85m AGL stack.

**Plate B1: Stack Height Determination**





## ANNEX C: SCAIL ASSESSMENT OF THE EDG

### SCAIL Methodology

The SCAIL combustion tool has been used to assess the potential for air quality impacts to occur as a result of the operation of the proposed EDG (Emission Point A2) to be installed as part of the Proposed Installation.

SCAIL is a screening tool that uses the atmospheric dispersion model AERMOD to predict impacts of emissions from small and medium combustion sources. The model estimates the impacts of emissions on sensitive habitat sites and can also be used to assess impacts at human receptors.

The final EDG has yet to be selected, however data available for the comparably sized EDGs has been used to carry out the assessment. Based on the fact that EDGs run for a maximum of 12 hours per year it is unlikely that any substantial impacts will occur.

### Receptors

For ecological receptors, the SCAIL tool determines relevant ecological receptors within a given radius dependent on the plant capacity and fuel type. For the proposed EDG a search radius of 2km was determined by the SCAIL tool.

The Humber Estuary SSSI and SAC were the only ecological receptors identified by the tool, at 1.9km from the EDG location. An additional LWS receptor was added to the tool, to represent the closest LWS site to the EDG, given the close proximity of a number of these sites to the Proposed Installation.

A human health receptor was also added to the SCAIL tool, in line with the closest receptor to the Proposed Installation identified for the main assessment.

The identified receptors included are detailed below in Table C1.

**Table C1: Receptors included in the SCAIL tool**

Receptor Name	Receptor Type	X	Y
Humber Estuary SAC	Ecological receptor - SAC	483554	411901
Humber Estuary SSSI	Ecological receptor - SSSI	483554	411901
OE27 Stainforth and Keadby Canal Corridor	Ecological receptor – user defined - LWS		
R10 Vazon Bridge House	Human health receptor - residential	482510	411500

### Significance Criteria

The SCAIL assessment tool uses the same EA Risk Assessment Guidance significance criteria as described in the main assessment.

## Emission Parameters

The parameters outlined in Table C2 were used in the SCAIL tool for the EDG. Only emissions of NO<sub>x</sub> have been included in the assessment, as the combustion of low sulphur gas oil is not anticipated to lead to significant emissions of SO<sub>2</sub> or particulates, which is why there are no emission limits applied for these pollutants from gas oil engines in the MCPD. It is assumed that the EDG will comply with BAT for emergency backup diesel engines<sup>19</sup>, achieving 2g TA Luft and United States Environment Protection Agency (EPA) Tier 2 (or equivalent) standards (i.e. approximately 750mg per m<sup>3</sup> NO<sub>x</sub> (as NO<sub>2</sub>) at 15% O<sub>2</sub> standard temperature and pressure, dry, 273K and 101.3kPa).

**Table C2: SCAIL Input Parameters for the EDG**

Parameters	Data
Emission Point Reference	A2
Stack location	481640,412225
Stack height (m)	5.0
Stack diameter (m)	0.35
Flues (No#)	1
Exhaust temp (°C)	470
Flow rate (Am <sup>3</sup> /s)	4.3
Exhaust velocity (m/s)	44.6
Operating hours	12 hours (testing)/ 72 hours (emergency)
Plant capacity	4.125MWth
NO mg/Nm <sup>3</sup>	750
NO <sub>x</sub> (g/s)	4.2

## Meteorological Data

The SCAIL tool uses meteorological data from nearby weather stations and can be run in one of three modes.

The conservative mode uses the source to receptor bearing that will rotate the habitat site so that it is in the prevailing wind direction and hence receives the highest amount of pollutant concentrations.

The hybrid mode provides concentrations from the conservative method with an arc of +/- 40 to +/- 10 at the receptor.

The realistic mode uses the actual position of the receptor and bearing to the source. It is most suitable for sources spread across a wide geographical area.

<sup>19</sup> [Emergency backup diesel engines on installations: best available techniques \(BAT\) - GOV.UK](#)

In order to provide a conservative assessment, only the conservative mode has been used to assess the impacts of the EDG, as it is considered that this would be most likely to lead to the highest predicted impacts.

### Assessment Scenarios

The SCAIL assessment was carried out for both a general maintenance and testing scenario for the EDG and for a potential emergency scenario.

The EDG is intended for emergency use only and as such will not be in continuous operation. It is only intended to undergo periodic testing for maintenance procedures. It is anticipated that the generator will operate for a maximum of 12 hours per year for testing.

There is no specific guidance for an emergency operating window for emergency generators. Best practice guidance has been drawn on from the data centre sector, whereby a 72-hour operating window is recommended to be used by the EA<sup>20</sup>. This provides a highly conservative assessment due to national grid reliability and in-built design resilience. For this assessment, a period of 72 hours has been used for the emergency scenario.

### SCAIL Results

The SCAIL screening assessment has been undertaken to determine any potential exceedances at human and ecological receptors surrounding the Proposed Installation from the operation of the EDG.

#### **Human Receptors**

The results for NO<sub>2</sub> for the testing and emergency scenarios are shown below in Table C3. The annual mean PC was less than 1% of the AQS objective for both scenarios and therefore can be considered to be insignificant according to the EA screening criteria and therefore no further assessment is required.

The hourly mean NO<sub>2</sub> PCs for the testing and emergency scenarios are both 0.1% or less of the hourly mean NO<sub>2</sub> AQS objective. The impacts are therefore below the screening threshold of 10% for short term impacts and can therefore be considered insignificant.

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<sup>20</sup> Environment Agency, 2022. working draft BAT guidance document specifically for data centres: 'Data Centre FAQ Headline Approach v21' (November 2022)

**Table C3: SCAIL Results for Testing and Emergency Scenarios - NO<sub>2</sub> Impacts at Closest Human Receptor**

AQS (µg/m <sup>3</sup> )	NO <sub>2</sub> background (µg/m <sup>3</sup> )	Testing Scenario				Emergency Scenario			
		PC (µg/m <sup>3</sup> )	PC % of AQS	Screening	PEC (µg/m <sup>3</sup> )	PC (µg/m <sup>3</sup> )	PC % of AQS	Screening	PEC (µg/m <sup>3</sup> )
40	7.75	0.003	<0.1%	Insignificant	7.75	0.02	<0.1%	Insignificant	7.76
200	15.5	0.03	<0.1%	Insignificant	15.53	0.2	0.1%	Insignificant	15.67

## Ecological Receptors - Atmospheric NOx Impacts

For the testing scenario, the PC is less than 1% of the Critical Level and the PEC is below the AQS (30µg/m<sup>3</sup>) for annual mean NOx at both receptors assessed. As a result, this is considered to be insignificant. The results are shown below in Table C4.

**Table C4: NOx Concentrations for the Ecological Receptors for the Testing Scenario**

Receptor	Critical Level (µg/m <sup>3</sup> )	Background concentration (µg/m <sup>3</sup> )	PC (µg/m <sup>3</sup> )	PC % of Critical Level	PEC (µg/m <sup>3</sup> )
OE1 Humber Estuary SAC and SSSI	30	9.98	0.002	<0.1%	9.98
OE27 Stainforth and Keadby Canal Corridor		10.11	0.006	<0.1%	10.12

For the emergency scenario, the PC is less than 1% of the Critical Level and the PEC is below for annual mean NOx for both sites and therefore the impacts can be considered to be insignificant. The results are shown below in Table C5.

**Table C5: NOx Concentrations for the Ecological Receptors for the Emergency Scenario**

Receptor	Critical Level (µg/m <sup>3</sup> )	Background concentration (µg/m <sup>3</sup> )	PC (µg/m <sup>3</sup> )	PC % of Critical Level	PEC (µg/m <sup>3</sup> )
OE1 Humber Estuary SAC and SSSI	30	9.98	0.01	<0.1%	9.99
OE27 Stainforth and Keadby Canal Corridor		10.11	0.03	0.1%	10.14

## Ecological Receptors - Deposition Impacts

The results for nitrogen deposition for the testing scenario at ecological receptors are shown in Table C6 and Table C7 shows the emergency scenario.

The percentage of the PC of the relevant critical loads is less than 1% at both receptors for both nitrogen and acid deposition for both the testing and the emergency scenarios and therefore can be considered to be insignificant.

**Table C6: Nitrogen and Acid deposition for the Testing Scenario**

Receptor	N deposition (kg N/ha/yr)					Acid deposition (keq H/ha/yr)				
	PC	Background concentration	PEC	Critical Load	PC % of Critical Load	PC	Background concentration	PEC	Critical Load	PC % of Critical Load
OE1 Humber Estuary SAC and SSSI	0.0003	15.95	15.95	5	<0.1%	0	1.26	1.26	0.453	0%
OE27 Stainforth and Keadby Canal Corridor	0.0008	15.51	15.51	10	<0.1%	0	1.26	1.26	4.7	0%

**Table C7: Nitrogen and Acid Deposition for the Emergency Scenario**

Receptor	N deposition (kg N/ha/yr)					Acid deposition (keq H/ha/yr)				
	PC	Background concentration	PEC	Critical Load	PC % of Critical Load	PC	Background concentration	PEC	Critical Load	PC % of Critical Load
OE1 Humber Estuary SAC and SSSI	0.002	15.95	15.95	5	<0.1%	0	1.26	1.26	0.453	0%
OE27 Stainforth and Keadby Canal Corridor	0.005	15.51	15.51	10	<0.1%	0	1.26	1.26	4.7	0%

## Summary and Conclusions

A screening assessment has been undertaken using the SCAIL tool for the proposed EDG to be installed as part of the Proposed Installation for emergency use. The assessment has considered both testing and potential emergency scenarios.

Following the methodology set out in the EA risk assessment guidance, the impact on human receptors is considered to be insignificant.

For ecological receptors, the results in terms of the critical level and critical loads can all be considered to be insignificant. The overall effect of the EDG in relation to air quality is therefore considered to be insignificant.

## ANNEX D: SENSITIVITY TESTING OF MODEL INPUTS

The maximum PC of NO<sub>2</sub> at the worst-affected human health receptors and NO<sub>x</sub> at the worst-affected statutory designated ecological receptor associated with the variable input parameters, are presented in Table D1 as the percentage of maximum reported values in Table 16 and Table 18, above.

**Table D1: Point Source Dispersion Model Sensitivity Analysis**

Model Input Variable	Human Health Receptor		Ecological Receptor	
	Short-term	Long-term	Short-term	Long-term
<b>Reported Results (µg/m<sup>3</sup>)</b>	<b>17.8</b>	<b>1.3</b>	<b>24.9</b>	<b>0.81</b>
Meteorological data (5-year min-max)	92%	54%	21%	60%
Surface roughness representation (0.3m)	96%	100%	96%	103%
Surface roughness representation (0.1m)	107%	100%	105%	95%

The main uncertainty associated with the model is considered to be the meteorological data, with the lowest NO<sub>2</sub> process contribution resulting in a PC that is 92% of the hourly mean NO<sub>2</sub> result at the worst-case human health receptor; this is equivalent to an overall uncertainty at the worst-affected receptor of -1.4 µg/m<sup>3</sup> (or -0.7% of the relevant AQS objective).

The lowest annual average NO<sub>2</sub> process contribution was 54%, equivalent to an overall uncertainty at the worst-affected receptor of - 0.6 µg/m<sup>3</sup> (or -1.5% of the relevant AQS objective).

The surface roughness representation in the main model has been assessed at 0.2m, representative of the lowest surface roughness associated with agricultural land. This is consistent with modelling carried out for the Keadby 2 Power Station Section 36 Consent and Environmental Permit application, and the Keadby 3 DCO application and Environmental Permit application therefore is considered to be the most appropriate surface roughness to represent the Proposed Installation Site. The surface roughness has been varied and it was found that a higher surface roughness (0.3m), resulted in higher short-term impacts at the worst case receptor, with the lower surface roughness (0.1m) resulting in higher long-term impacts.

## ANNEX E: VISIBLE PLUMES

### HRSG STACK VISIBLE PLUMES

There is potential for visible plumes to occur from the HRSG Stack, and due to the increased water content of the flue gas when firing on hydrogen, there is increased potential for visible plumes to occur when firing in this mode. The potential for visible plumes to occur from the HRSG Stack for both firing modes has therefore been modelled in ADMS as shown in Table E1.

**Table E1: HRSG Plume Model Inputs**

Parameter	Hydrogen Firing	Natural Gas Firing
Water ratio (kg/kg, dry)	0.12	0.07

The results for the HRSG Stack modelling are shown in Table E2. The results predict that when firing on hydrogen, a visible plume is likely to be present for approximately twice as frequently as when firing on natural gas. Similarly, the approximate visible plume length is predicted to be twice as long for hydrogen firing than for natural gas firing.

**Table E2: HRSG Visible Plumes**

Met Year	Percentage of Time Plume is Visible	Longest Visible Plume Length (m)	Average Visible Plume Length (m)
<b>Natural Gas Firing</b>			
2018	37%	1,693m	147m
2019	42%	1,361m	118m
2020	47%	1,416m	117m
2021	42%	1,361m	127m
2022	38%	1,361m	110m
<b>Hydrogen Firing</b>			
2018	75%	5,728m	207m
2019	79%	2,614m	196m
2020	85%	3,153m	197m
2021	82%	6,045m	197m
2022	87%	4,366m	163m

## COOLING TOWER VISIBLE PLUMES

There is potential for visible plumes to occur from the hybrid cooling towers, although these are plume abated in order to reduce the potential for visible plumes to form. The indicative cooling infrastructure design shows 16 cooling cells positioned in a single block, 2 cells wide and 8 cells in length. The potential for visible plumes to occur from the cooling cells has therefore been modelled in ADMS as shown in Table E3.

**Table E3: Cooling Cell Visible Plume Model Inputs**

Parameter	Wet Cooling System
Number of vents	16
Release height (m)	20
Vent diameter (m)	12
Flow rate per vent	1,050 kg/s
Water ratio (kg/kg, dry)	0.0064
Temperature (°C)	Ambient

The results for the cooling tower modelling are shown in Table E4. Although the results indicate that a short visible plume may be present for up to 24% of the time once the Proposed Installation becomes operational, the average length of visible plumes is less than 1m, with a maximum length of 241m predicted for only one year of the meteorological data.

**Table E4: Cooling Cell Visible Plumes**

Met Year	Percentage of Time Plume is Visible	Longest Visible Plume Length (m)	Average Visible Plume Length (m)
2018	20.8%	216m	<1m
2019	20.3%	63m	<1m
2020	22.7%	53m	<1m
2021	24.2%	241m	<1m
2022	18.4%	65m	<1m