RWE

RWE Generation UK plc

Reserve Generation Site, Moody Lane, Grimsby

Planning Application

Air Quality Impact Assessment

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Planning Application

Air Quality Impact Assessment

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Summary

This assessment supports an application by RWE Generation UK plc to amend the existing planning permission for the Grimsby B gas engines development at Moody Lane, to vary the engine layout and details and to increase the operating hours for the engines to enable them to run for up to 1500 hours per year. This assessment will also support an application for a permit variation to add Grimsby B gas engines onto the existing site environmental permit. There are presently 10 gas engines on the adjacent site with a total electrical export capacity of 20MW$_e$. (shown as 'Grimsby A' in Figure 1 of this report). These existing gas engines have been operating since early 2018, and are permitted to operate for up to 1500 hours per year. The proposed development consists of 5 additional gas engines with a total electrical export capacity of 20MW$_e$ (shown as 'Grimsby B' in Figure 1 of this report). These engines will operate flexibly to generate electricity for up to 1500 hours per year at times of peak network load. The release height of the proposed Grimsby B gas engines exhaust gases is 12.5m, corresponding to stacks extending approximately 3m above the engine containers.

This assessment reports the impact of emissions to air from the 5 Grimsby B gas engines operating for up to 1500 hours per year. Due to the close proximity of the existing gas engines, modelling was also undertaken with both the 5 proposed Grimsby B gas engines and the 10 existing Grimsby A gas engines, in order to properly model the combined impact of these 15 engines. Impacts relating to human health were assessed for nitrogen dioxide (NO_2), with air emissions of other substances of potential concern judged to be insignificant. Impacts on sensitive ecosystems were assessed for NO_X and for acid and nutrient nitrogen deposition.

In quantitative terms, the following conclusions have been drawn from the results of the air quality modelling:

- NO_2 impacts on human health – the long term and short term impacts were shown to be insignificant, either alone or in-combination with other sources, at all locations where members of the public are most likely to be present;
- NO_X impacts on sensitive ecosystems – the long and short term impacts were shown not to be cause for concern, either alone or in-combination with other sources, at all designated sites;
- The acid and nutrient deposition impacts were shown to be insignificant, either alone or in-combination with other sources, at all European and Internationally designated sites.

For BAT assessment purposes, the effect of varying the stack height for the proposed Grimsby B gas engines has also been assessed. The assessment demonstrates that the proposed stack height of 12.5m for the Grimsby B gas engines provides a suitable compromise between reducing air quality impacts and reducing visual impacts and has therefore been judged to represent BAT.

Based on the low impacts and the worst-case assumptions, it can therefore confidently be concluded that the proposed Grimsby B gas engines development poses no significant effects or risks to human health and ecosystems, either alone or in-combination with other sources.

Contents

1. Introduction

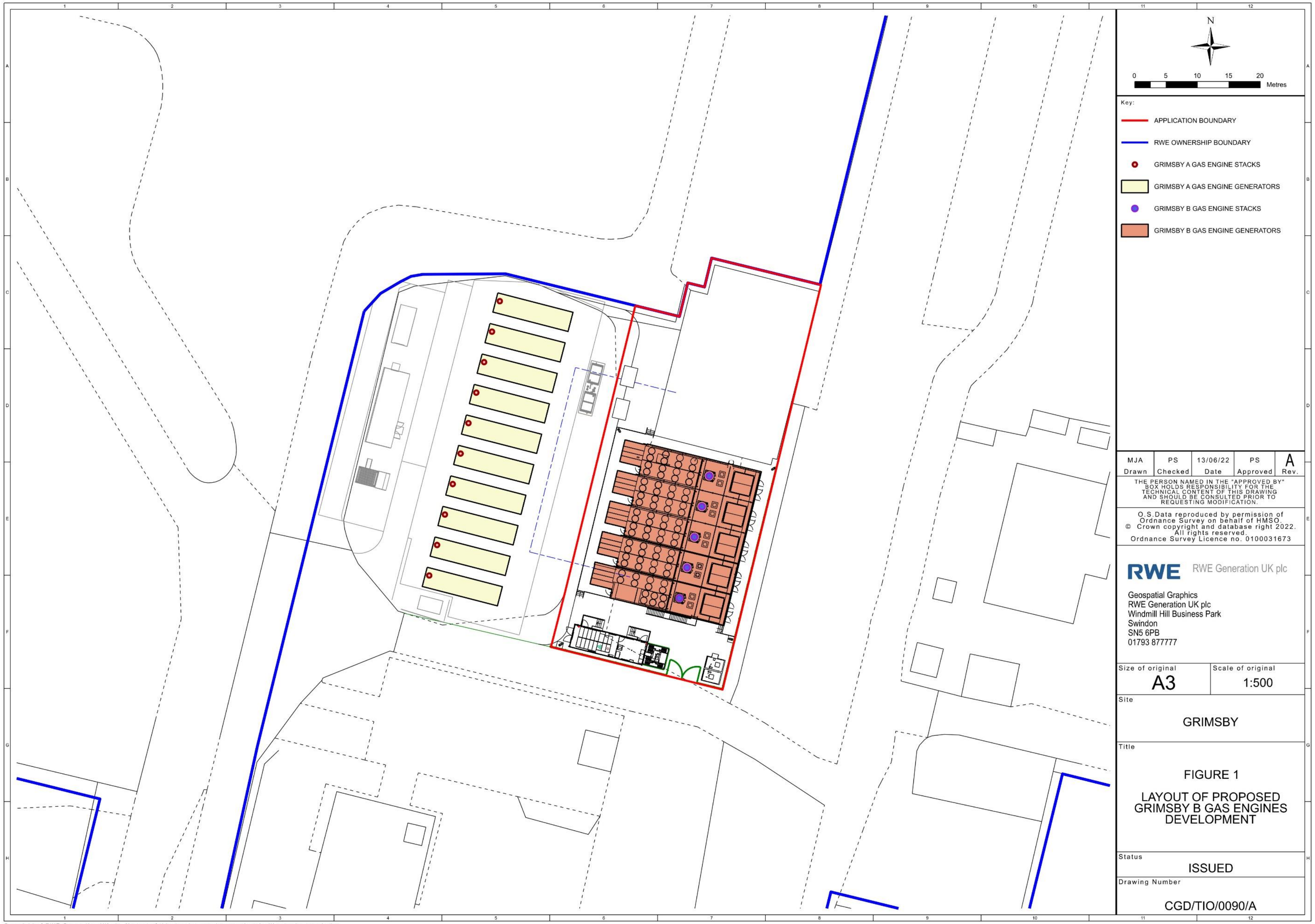
This air quality impact assessment supports an application by RWE Generation UK plc to amend the existing planning permission for the proposed Grimsby B gas engines development at Moody Lane, to vary the engine layout and details and to increase the operating hours for the engines to enable them to operate for up to 1500 hours per year. This assessment will also support an application for a permit variation to add the Grimsby B gas engines onto the existing site environmental permit. The layout of the Grimsby B gas engines is shown in Figure 1. There are presently 10 gas engines on the adjacent site ('Grimsby A'), also shown in Figure 1, with a total electrical export capacity of $20MW_e$. These existing gas engines have been operating since early 2018, and are permitted to operate for up to 1500 hours per year. The proposed development consists of 5 additional gas engines with a total electrical export capacity of $20MW_e$. These engines will operate flexibly to generate electricity for up to 1500 hours per year at times of peak network load.

Construction impacts will be insignificant and have not been assessed further. This is because the construction phase will consist of installing the pre-fabricated containerised engines on new concrete plinths, with little potential for dust generation or significant vehicle emissions.

This assessment reports the impact of emissions to air from the 5 Grimsby B gas engines operating for up to 1500 hours per year. Due to the close proximity of the existing gas engines, modelling was also undertaken with both the 5 proposed Grimsby B gas engines and the 10 existing Grimsby A gas engines, in order to properly model the combined impact of these 15 engines (see Section 5.1).

Potential in-combination impacts from additional emission sources which have only commenced operations recently, or have received planning permission but have yet to come into operation, are discussed in Section 7.

Figure 1: Layout of proposed Grimsby B gas engines development.



2. Air quality standards and policy

2.1. Local air quality and human health

The Air Quality Strategy for England, Scotland, Wales and Northern Ireland (Defra et al., 2007) establishes the policy for ambient air quality for the UK. The Strategy sets out the National Air Quality Objectives (NAQOs). Those included in the Local Air Quality Management (LAQM) regime are prescribed in the Air Quality (England) Regulations 2000 (SI 2000/928) as amended by the Air Quality (England)(Amendment) Regulations 2002 (SI 2002/3043).

The Air Quality Standards Regulations 2010 (SI 2010/1001, the "AQS Regulations") implements the European Union's Ambient Air Quality Directive (2008/50/EC) in England. It includes Limit Values (LV) for sulphur dioxide (SO_2), nitrogen dioxide (NO_2), carbon monoxide (CO) and particulate matter (PM_{10} and $PM_{2.5}$). The onus is on central government to ensure that these are met. LVs are mandatory, whereas there is no legal obligation to meet NAQOs, although local authorities must work towards their attainment within their administrative areas through a regular review, assessment and action planning process.

LAQM reviews have to consider current and future air quality and compliance with air quality objectives. Where there is or is likely to be non-compliance, the authority concerned must designate the relevant location(s) as an Air Quality Management Area (AQMA). For each AQMA, the local authority has a duty to draw up an Air Quality Action Plan (AQAP) setting out the measures it intends to introduce to deliver improvements in local air quality in pursuit of the air quality objectives.

According to the National Air Quality Strategy and associated legislation, human health NAQOs apply to outdoor locations where members of the public are regularly present, and where they might reasonably be expected to be exposed over the relevant averaging times (which vary from 15 minutes to a year). They do not apply to occupational, indoor or in-vehicle exposure. This concept is often referred to as 'relevant exposure'.

Similarly, the AQS Regulations requires that levels of relevant air pollutants in ambient air do not exceed LVs. Ambient air excludes workplaces where provisions concerning health and safety apply and locations where members of the public do not have access. Schedule 1 Part 1 of the AQS Regulations states that:

'Compliance with limit values directed at the protection of human health does not need to be assessed at the following locations:
(a) any locations situated within areas where members of the public do not have access and there is no fixed habitation;
(b) on factory premises or at industrial installations to which all relevant provisions concerning health and safety at work apply;
(c) on the carriageway of roads and on the central reservations of roads except where there is normally pedestrian access to the central reservation.'

These conditions apply to assessment by '*indicative measurement and modelling*'.

So, essentially it is necessary to assess ambient air quality for LAQM purposes at locations of 'relevant exposure' and for AQS Regulations purposes at locations where members of the public have regular access. These requirements include assessment of changes in air quality potentially arising from planned new developments, such as those outlined in this report.

The Department of Environment, Food and Rural Affairs (Defra) have published technical guidance for use by local authorities in their Review and Assessment work (Defra, 2016). This document, referred to here as LAQM.TG(16), has been used where appropriate in this assessment and includes guidance on locations where relevant exposure applies for different averaging periods.

Of the NAQO/LVs, only those for nitrogen dioxide (NO_2) impacts are likely to be relevant, due to the engines being gas-fired. Emissions and impacts of SO_2 and particulate matter are insignificant from such plant. There will be CO emissions due to incomplete natural gas combustion, but findings from similar case studies indicate that CO impacts will also be insignificant, especially noting that there has never been a failure to comply with the EU CO limit value in any EU country. The relevant standards are shown Table 1.

Table 1: Relevant National Air Quality Objective and EU limit values for the protection of human health.

Substance	NAQO/LV		Date to be achieved by and maintained thereafter
	Concentration (µg/m³)	Measured as	
Nitrogen dioxide (NO_2)	200 (not to be exceeded more than 18 times a year)	Hourly mean	31st December 2005[a] 1st January 2010[b]
	40	Annual mean	

[a]NAQO

[b]EU limit value

2.2. Regulation of emissions

2.2.1. Environmental Permitting Regulations

As the aggregate thermal input capacity of the 15 gas engines will be >50MW$_{th}$, the Environment Agency (EA) are responsible for regulating emissions from the Grimsby site as a Part A1 installation under the Environmental Permitting (England and Wales) Regulations 2016 ("EPR"). These regulations include requirements arising from the Industrial Emissions Directive (IED) and the Medium Combustion Plant Directive (MCPD) which are discussed in more detail in Sections 2.2.2 and 2.2.3. These requirements mean that the gas engines will also need to comply with obligations arising from Best Available Technique (BAT) considerations. These are discussed in more detail in Section 2.2.4.

2.2.2. Industrial Emissions Directive

The requirements of the Industrial Emissions Directive (IED) are included in the national Environmental Permitting Regulations (EPR). Under EPR, Environment Agency (EA) are responsible in England for regulating emissions from sites with combustion plant of aggregate thermal input capacity of 50MW$_{th}$ and above. Under EPR there are additional requirements for any individual combustion plant of 20-50MW$_{th}$ capacity ('Part B' process), but these do not affect the gas engines considered in this report. In practice, the permit requirements for these engines mean that they will need to comply with obligations arising from Best Available Techniques (BAT) considerations, discussed in Section 2.2.4.

2.2.3. Medium Combustion Plant Directive

Medium Combustion Plant Directive (MCPD) requirements are implemented via the Environmental Permitting Regulations (EPR); these apply to 1-50MW_{th} combustion plant. There are different requirements for plant put into operation before 20th December 2018 (classed as 'existing' plant) and after that date (classed as 'new' plant). The Grimsby A gas engines were put into operation before 20th December 2018, so are classed as 'existing'. The proposed Grimsby B gas engines would be expected to start operation in 2023, so are classed as 'new'.

As the gas engines will operate for up to 1500 hours per year, the 'new' Grimsby B gas engines would need to comply with a NO_X emission limit of 95mg/Nm^3 (dry, 15%O_2), while the 'existing' Grimsby A gas engines will continue to comply with a NO_X emission limit of 190mg/Nm^3 (dry, 15%O_2).

2.2.4. Best Available Techniques

There is a requirement that the proposed Grimsby B gas engines assessed in this report comply with the obligations arising from Best Available Techniques (BAT) to prevent or minimize emissions and environmental impacts as a whole, cost-effectively.

In terms of emissions to air, there are currently two relevant areas to consider for BAT:

- ELVs for NO_X
- Stack heights and configuration

In terms of ELVs, our understanding is that the MCPD NO_X ELV of 95mg/Nm^3 (dry,15%O_2) (see previous section), reflects the BAT conclusions for the proposed Grimsby B gas engines (flexible generators operating for up to 1500 hours per year).

In terms of stack heights and configuration, the effect of varying the stack height for the Grimsby B gas engines has been assessed. The results of this assessment are presented in Section 6.5.

2.3. National planning policy

The National Planning Policy Framework (NPPF) was revised in July 2021. It sets out the Government's planning policies for England and how these are expected to be applied. At the heart of the NPPF is a presumption in favour of sustainable development (paragraph 10). It requires Local Plans to be consistent with the principles and policies set out in the Framework with the objective of contributing to the achievement of sustainable development.

The NPPF specifies that achieving sustainable development means that the planning system has three overarching objectives: economic, social and environmental. Among other things, the environmental objective includes "minimising waste and pollution".

The NPPF identifies core planning principles that should underpin both plan-making and decision-taking, including a requirement for planning to 'contribute to conserving and enhancing the natural environment and reducing pollution'.

In relation to air quality, the NPPF states at paragraph 186 that "planning policies and decisions should sustain and contribute towards compliance with relevant limit values or national objectives for pollutants, taking into account the presence of Air Quality Management Areas and Clean Air Zones, and the cumulative impacts from individual sites in local areas" and also that: "Planning decisions should ensure that any new development in Air Quality Management Areas is consistent with the local air quality action plan".

2.4. Grimsby Council planning policy

The current local development plan for the Grimsby site is the North East Lincolnshire Council Local Plan (NELLP) 2013-2032 which was adopted in March 2018. The Local Plan contributes in several ways to air quality strategy, e.g. ensuring that land uses which might affect air quality such as industrial processes are sited appropriately and controlling land uses which are major generators of traffic and therefore exhaust fumes. Air quality is considered in Policy 5 Development boundaries where the Plan states that 'All development proposals located within or outside of the defined boundaries will be considered with regard to suitability and sustainability, having regard to … impact upon neighbouring land uses by reason of noise, air quality, disturbance or visual intrusion'.

There are no polices in the Local Plan which directly address the issue of air quality, although the plan does recognise the presence of pockets of poor Air Quality (mainly associated with air pollution from vehicle traffic) in Grimsby and Immingham. To improve environmental quality in the identified priority areas (as well as to reduce congestion and encourage more active and healthy lifestyles) measures to promote more sustainable transport choices and highway improvements are supported under "Policy 365 Promoting Sustainable Transport".

The Plan contains a number of Strategic Objectives (SO), one of which, 'SO2: Climate Change', considers air quality. SO2 seeks to address the causes and effects of climate change through the promotion of certain types of development including those which reduce pollution and promotes the appropriate distribution to development. Critical success factors of the strategic objective include addressing the issue of poor air quality and reducing the number of declared Air Quality Management Areas in the Borough.

Paragraph 12.36 of the Plan states that 'any proposed employment uses that give rise to emissions to air will be required to demonstrate they have had regard to the requirements of the Conservation of Habitats and Species Regulations 2017 (as amended) (the "Habitats Regulations"), in relation to their effect on the integrity of the Humber Estuary SAC, SPA, and Ramsar site, alone or in combination with other existing or planned sources of air pollution'.

Whilst overall North East Lincolnshire has good air quality, modelling and monitoring activities led to the identification of two key locations which exceeded European guidelines and were consequently declared Air Quality Management Areas (AQMAs). One of these, declared by the North East Lincolnshire Council on Cleethorpe Road in September 2010 - for a breach in the nitrogen dioxide, NO_2, annual mean objective - is under the administration of Grimsby Council. The second one, declared in Immingham in October 2006 for a breach in the particulate matter (PM_{10}) UK national air quality limits (mainly due to high levels of delivery vehicles in the area), was latterly revoked (in January 2016, as data collated in the AQMA for the previous few years, reflecting the implementation of the Local Air Quality Action Plan, showed a significant reduction in particulate pollution).

Paragraph 186 of the National Planning Policy Framework (NPPF) requires that new development in AQMA is consistent with the Local Air Quality Action Plan. In response to this North East Lincolnshire Council has drawn up Local Air Quality Management Action Plan (AQAP) for the AQMA. As a large fraction of the pollution in the AQMA is associated with local road traffic, the measures listed in the AQAP are predominantly traffic-related.

2.5. Vegetation and ecosystems

Certain types of vegetation and sensitive ecosystems are protected by the Habitats Regulations and the Wildlife and Countryside Act 1981 (as amended), depending on their European and/or national designations. The effect of air emissions on sensitive ecosystems and vegetation should be taken into consideration in determining planning applications, as appropriate. Impacts from gas engines considered in this report relate to any direct effects of ambient NO_X and possible eutrophication and acidification due to nitrogen deposition.

The benchmark concentration, or "critical level", for annual mean NO_X concentrations is the NAQO/LV of 30µg/m^3 (as NO_2 equivalent) for the protection of vegetation and ecosystems. Regulators also often require maximum daily mean NO_X concentrations to be assessed against a critical level of 75µg/m^3.

Table 2: Critical levels for the protection of vegetation and ecosystems.

Substances	Environmental Assessment Level	
	Level (µg/m^3)	Concentration Measured as
Nitrogen oxides	30	Annual Mean
	75	Maximum Daily Mean

For acid and nutrient nitrogen deposition at European designated sites (Special Areas of Conservation (SACs) and Special Protection Areas (SPAs)), significance is assessed by comparison with "site-relevant critical loads" obtained from the UK Air Pollution Information System (APIS) (APIS, 2021).

The standard screening distance for assessing air quality impacts from Part A1 activities is 15km for European and Internationally designated sites (Special Areas of Conservation (SACs), Special Protection Areas (SPAs) and Ramsar sites). For nationally designated sites, the standard screening distances is 15km for Sites of Special Scientific Interest (SSSIs) and 2km for National and Local Nature Reserve (NNR and LNR), Ancient Woodland (AW) and Local Wildlife Sites (LWS).

Figure 2: Location of proposed Grimsby B gas engines development and sensitive receptors.

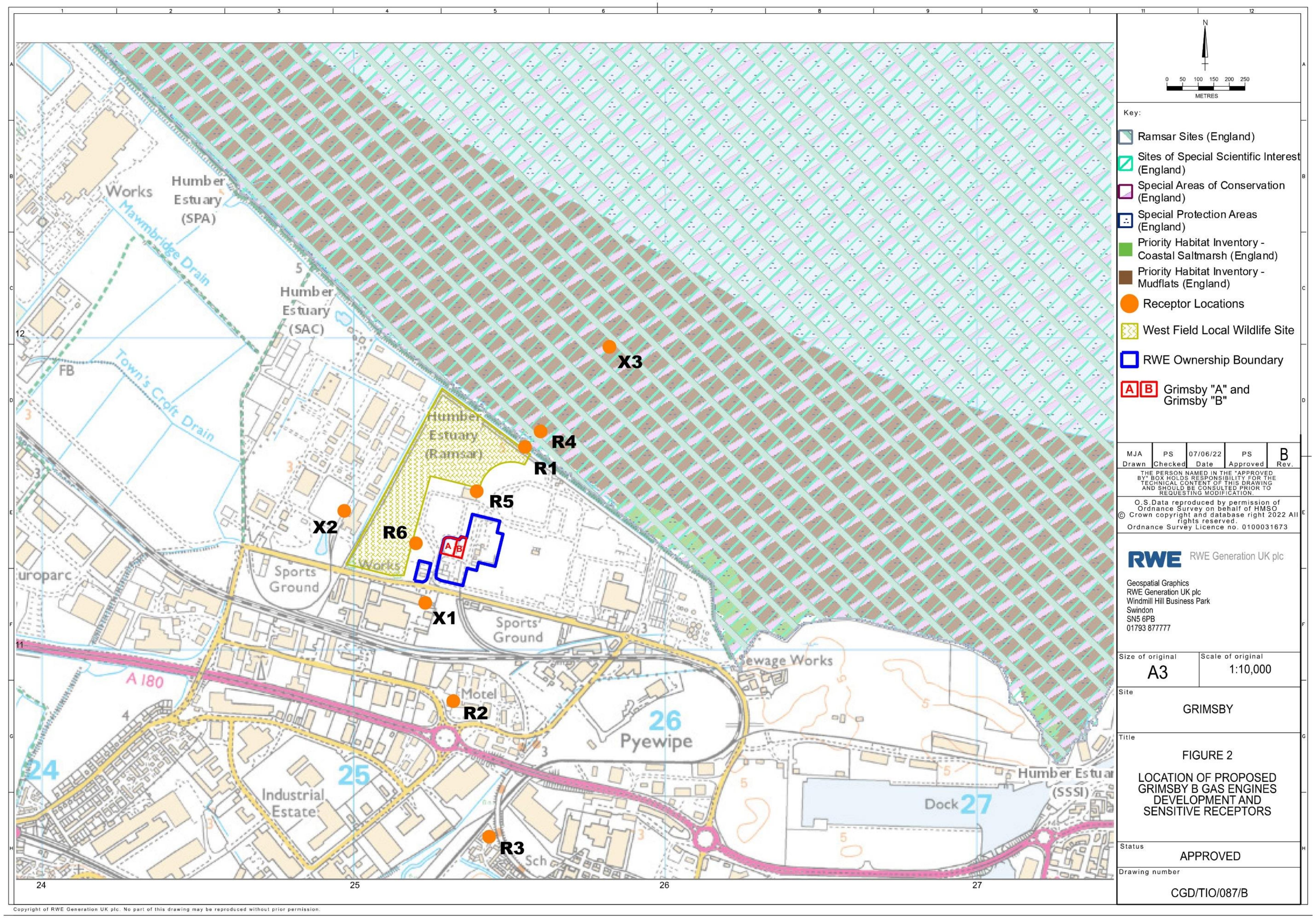
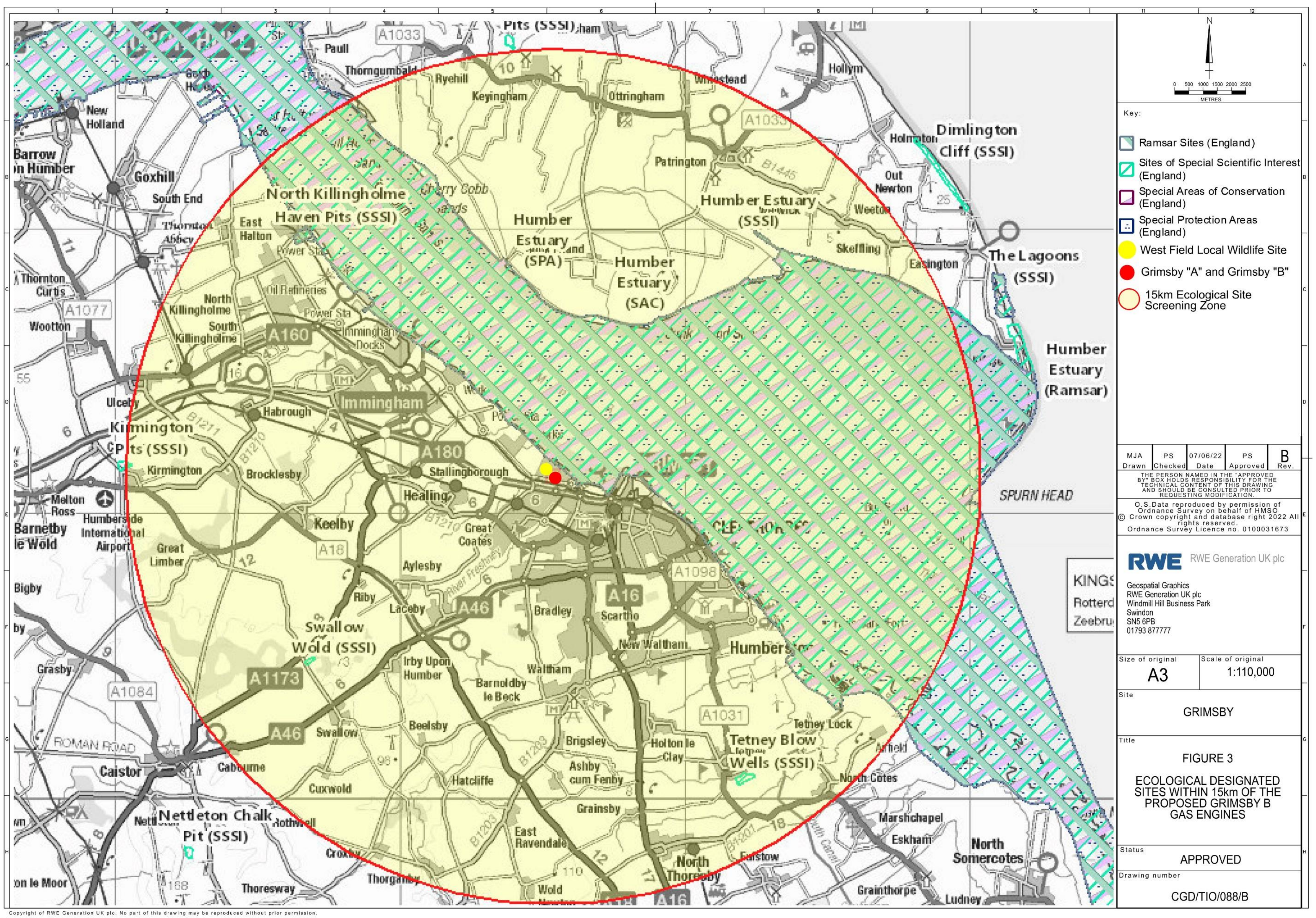


Figure 3: SPA, SAC, Ramsar and SSSI sites within screening distances (15km) of the proposed Grimsby B gas engines development.



3. The receiving environment

3.1. Identification of important receptors

The location of the proposed Grimsby B gas engines development is shown in Figure 2. The site, located to the south Humber Bank, is in an industrial area, surrounded by the former Huntsman Tioxide plant, which has been demolished and is awaiting redevelopment.

Impacts have been modelled at the human receptors, representative of locations of relevant exposure, listed in Table 3 and shown Figure 2. The nearest location that might have occasional public access is the coastal footpath along the estuary coastline to the north east of the Grimsby B gas engines. A receptor (labelled R1 in Figure 2) has been placed at the nearest point along the footpath to the proposed Grimsby B gas engines (approximately 400m from the site). The nearest dwellings are the Premier Inn Hotel (Appian Way) (labelled R2) and the houses at Haven Gardens (labelled R3) which are located, respectively, to the north and the south of the A180. The majority of the adjacent land is derelict, awaiting redevelopment or occupied by warehouses and there are no other obvious locations where members of the public are likely to have regular access and therefore where NAQOs and LVs would apply. Although, as reported in Section 2.1, compliance with limit values directed at the protection of human health does not need to be assessed *on factory premises or at industrial installations to which all relevant provisions concerning health and safety at work apply* - based on precautionary principle, two further receptors at Dunlop Oil & Marine (gatehouse and offices) and Novartis (industrial buildings) have also been considered in the assessment (labelled X1 and X2 in Figure 2, respectively).

An AQMA, on Cleethorpe Road, is under the administration of North East Lincolnshire Council. The AQMA (designated in 2010 – with a large fraction of the pollution being associated with local road traffic) is over 2.5 km from the site of the proposed Grimsby B gas engines development. For the release height of 12.5 m selected for the engine exhausts, this is too distant for local air quality in the AQMA to be affected, especially noting the limited hours of operation of the engines. No further assessment of impacts on the AQMAs has been undertaken.

Table 3: Human receptors.

Reference on Figure 2	Coordinates* (m)	Name
R1	525550, 411650	Coastal Footpath
R2	525320, 410835	Premier Inn Hotel (Appian Way)
R3	525435, 410400	Houses at Haven Gardens
X1	525230, 411150	Dunlop Oil & Marine (gatehouse and offices)
X2	524970, 411445	Novartis (industrial buildings)

* In British National Grid (BNG) – formerly known as the National Grid Reference (NGR)

Within 15km of the proposed Grimsby B gas engines development, there is one European or Internationally designated site (SPA, SAC and Ramsar). This is the Humber Estuary SAC, SPA & RAMSAR site which covers most of the adjacent estuary. This site is also designated as a SSSI. Impacts on this designated site have been modelled using the two receptors (R4 and X3) listed in Table 4 and shown in Figure 2. One receptor (labelled as R4) is located at the closest point in the Humber Estuary designated site to the proposed Grimsby B gas engines. This receptor is approximately 400m from the Grimsby B gas engines. Another receptor (labelled as X3) is located 350m out from the coast to assess the decrease in NO_X emission impacts with distance from the estuary coastline.

Four additional SSSIs are located within 15km of the proposed Grimsby B gas engines: Kirmington Pits, Tetney Blow Wells, Swallow Wold and North Killingholme Haven Pits (see Figure 3). Impacts have been modelled at the closest points in the four additional SSSIs to the Grimsby B gas engines, and the contribution of the Grimsby B gas engines to long term and short term ecological impacts on these SSSIs were found to be less than 0.1% and 0.3% of the respective critical levels. Given the extremely small magnitude of these values, impacts at the four additional SSSIs can be screened out and will therefore not be considered further in this assessment.

There are no National Nature Reserves (NNR), Local Nature Reserves (LNR) or Ancient Woodland (AW) sites within 2km of the proposed Grimsby B gas engines. One Local Wildlife Site (LWS) was identified within 2km of the Grimsby B gas engines. This is the West Field LWS which arcs around the north and west sides of the Grimsby B gas engines. Impacts have been modelled at the two receptors (R5 and R6) placed in the LWS listed in Table 4 and shown in Figure 2. These receptors are located at the nearest points to the north and west (labelled as R5 and R6 in Figure 2 in respectively) of the Grimsby B gas engines and are approximately 200m and 150m from the engines, respectively.

Table 4: Ecological receptors.

Reference on Figure 2	Designation type	Coordinates* (m)	Name
R4	SAC/SPA /RAMSAR/SSSI	525600, 411700	Humber Estuary
X3		525821, 411971	
R5	LWS	525395, 411508	West Field
R6		525200, 411341	

* In British National Grid (BNG) – formerly known as the National Grid Reference (NGR)

3.2. Features of 'Humber Estuary' designated site

As mentioned above, the Humber Estuary SPA/SAC/Ramsar site (SPA Site Code: UK9006111, SAC Site Code: UK0030170 & Ramsar Site Code: UK11031) is the only European or Internationally designated site (SPA, SAC and Ramsar) within 15km of the proposed Grimsby B gas engines development. A map of the site can be found on the Natural England "Designated Sites View" website (Natural England, 2021). The site extends about 70km from the mouth of the Humber up to the limit of saline intrusion on the rivers Ouse and Trent.

The site supports a rich variety of habitats and species. Its qualifying features, which can be found on the Natural England "Designated Sites View" website (Natural England, 2021), are:

SPA

A021. Botaurus stellaris; Great bittern (Non-breeding)
A021. Botaurus stellaris; Great bittern (Breeding)
A048. Tadorna tadorna; Common shelduck (Non-breeding)
A081. Circus aeruginosus; Eurasian marsh harrier (Breeding)
A082. Circus cyaneus; Hen harrier (Non-breeding)
A132. Recurvirostra avosetta; Pied avocet (Non-breeding)
A132. Recurvirostra avosetta; Pied avocet (Breeding)
A140. Pluvialis apricaria; European golden plover (Non-breeding)
A143. Calidris canutus; Red knot (Non-breeding)

A149. Calidris alpina alpina; Dunlin (Non-breeding)
A151. Philomachus pugnax; Ruff (Non-breeding)
A156. Limosa limosa islandica; Black-tailed godwit (Non-breeding)
A157. Limosa lapponica; Bar-tailed godwit (Non-breeding)
A162. Tringa totanus; Common redshank (Non-breeding)
A195. Sterna albifrons; Little tern (Breeding)
Waterbird assemblage

SAC
H1110. Sandbanks which are slightly covered by sea water all the time; Subtidal sandbanks
H1130. Estuaries
H1140. Mudflats and sandflats not covered by seawater at low tide; Intertidal mudflats and sandflats
H1150. Coastal lagoons
H1310. Salicornia and other annuals colonising mud and sand; Glasswort and other annuals colonising mud and sand
H1330. Atlantic salt meadows (Glauco-Puccinellietalia maritimae)
H2110. Embryonic shifting dunes
H2120. Shifting dunes along the shoreline with Ammophila arenaria ("white dunes"); Shifting dunes with marram
H2130. Fixed dunes with herbaceous vegetation ("grey dunes"); Dune grassland
H2160. Dunes with Hippophae rhamnoides; Dunes with sea-buckthorn
S1095. Petromyzon marinus; Sea lamprey
S1099. Lampetra fluviatilis; River lamprey
S1364. Halichoerus grypus; Grey seal

Ramsar
Bar-tailed godwit, Limosa lapponica - Wintering
Black-tailed godwit, Limosa limosa - Passage
Black-tailed godwit, Limosa limosa - Wintering
Dunlin, Calidris alpina - Passage
Dunlin, Calidris alpina - Wintering
Estuary
Golden plover, Pluvialis apricaria - Passage
Golden plover, Pluvialis apricaria - Wintering
Grey seal, Halichoerus grypus
Knot, Calidris canutus - Passage
Knot, Calidris canutus - Wintering
Natterjack toad, Epidalea calamita
Redshank, Tringa totanus - Passage
Redshank, Tringa totanus - Wintering
River lamprey, Lampetra fluviatilis - Passage
Sea lamprey, Petromyzon marinus - Passage
Shelduck, Tadorna tadorna - Wintering
Waterbird assemblage - Wintering

The site features have been assessed to be predominantly (by area) in unfavourable recovering condition.

The conservation objectives for this site can be obtained from the Natural England "Designated Sites View" website (Natural England, 2021):

SPA

Ensure that the integrity of the site is maintained or restored as appropriate, and ensure that the site contributes to achieving the aims of the Wild Birds Directive, by maintaining or restoring;

- *The extent and distribution of the habitats of the qualifying features*
- *The structure and function of the habitats of the qualifying features*
- *The supporting processes on which the habitats of the qualifying features rely*
- *The population of each of the qualifying features, and,*
- *The distribution of the qualifying features within the site.*

SAC

Ensure that the integrity of the site is maintained or restored as appropriate, and ensure that the site contributes to achieving the Favourable Conservation Status of its Qualifying Features, by maintaining or restoring;

- *The extent and distribution of qualifying natural habitats and habitats of qualifying species*
- *The structure and function (including typical species) of qualifying natural habitats*
- *The structure and function of the habitats of qualifying species*
- *The supporting processes on which qualifying natural habitats and habitats of qualifying species rely*
- *The populations of qualifying species, and,*
- *The distribution of qualifying species within the site.*

As can be seen from Figure 2, the region of the Humber Estuary designated site closest to the proposed Grimsby B gas engines is classified as tidal mudflats. The mudflats extend 3km to the NW along the coast from the engines and 2km to the SE along the coast from the engines. The tidal mudflats area extends about 1km out from the coast. About 1km to the SE along the coast (see Figure 2) is a small area of coastal saltmarsh which extends about 600m along the coast and extends about 100m out from the coast.

Critical load values are site and feature dependent. Using information obtained from the UK Air Pollution Information System (APIS), the tidal mudflats and coastal saltmarshes are not sensitive to acid deposition and the nutrient nitrogen deposition critical load value for these habitats is 20kgN/ha/yr. APIS also gives the same critical levels for NO_x concentration for the Humber Estuary designated site as for any other designated sites (long term: 30 $\mu g/m^3$; short term: 75 $\mu g/m^3$).

3.3. Background NO_2 concentrations

North East Lincolnshire Council operates one real time air quality monitoring station which is located at Cleethorpe Road in Grimsby (Bureau Veritas, 2020). A second real time air quality monitoring station, which is run by the Environment Agency, is located on Woodlands Avenue in Immingham. There is, therefore, no local background air quality monitoring site appropriate for use in this assessment, as measurements at the Grimsby air quality monitoring station are dominated by emissions from local traffic. The nearest monitoring of 'urban background' is the Immingham air quality monitoring station but this is too far away from the proposed Grimsby B gas engines development to be relevant for this assessment.

The Council also operates a passive air quality monitoring network, consisting of 32 nitrogen dioxide diffusion tubes (intentionally located where potential pollution problems may occur, for example busy roads/junctions or narrow streets). NO_2 annual mean concentrations reported in Grimsby at the locations of the diffusion tubes (in 2019) vary between: 17.4μg/m^3 ('Toll Bar Roundabout') and 37.8μg/m^3 ('Cleethorpe Road'). The measured NO_2 concentrations nearest to the site of interest are those from the diffusion tube at 'Pyewipe Road', a roadside location (and therefore not appropriate for use in this assessment) some 1.4km south-east of the Grimsby B gas engines. The NO_2 annual mean concentration reported at this location for 2019 is 25.2μg/m^3.

Consistently with the approach used by Local Authorities in modelling air quality at Cleethorpe Road, (NELC, 2012), background NO_2 and NO_X concentrations have been obtained from the UK pollutant background maps. Projections of annual mean NO_2 and NO_X concentrations are produced by Defra, for LAQM purposes, across 1km grid squares (Defra, 2021). The figures most relevant for the location of this assessment are those for the 1km grid squares centred at BNG coordinates (525500, 411500) and (525500, 410500). The predicted background annual mean NO_2 and NO_X concentrations for 2023 for the (525500, 411500) square are 12.0μg/m^3 and 16.2μg/m^3 respectively. The predicted background annual mean NO_2 and NO_X concentrations for 2023 for the (525500, 410500) square are 14.2μg/m^3 and 19.6μg/m^3 respectively. For 2019, the annual mean NO_2 concentration reported by Defra for (525500, 411500) and (525500, 410500) squares are 13.4μg/m^3 and 16.1μg/m^3 respectively. As might be expected these values are lower than the ones reported under the passive air quality monitoring, as the diffusion tubes are intentionally positioned in locations where potential pollution problems may occur.

The background annual nutrient nitrogen deposition has been obtained from APIS. Maps of the mean annual nutrient nitrogen depositions over the three year period 2017-2019 are provided at 5km grid square resolution. The figures most relevant for the location of this assessment are those for the 5km grid square closest to the R4 & X3 receptors, for which there is nutrient nitrogen deposition data for the tidal mudflats and coastal saltmarsh habitat types. The background annual nutrient nitrogen deposition for this square for the required habitat types is 17.7kgN/ha.

4. Operational scenario and emissions

The proposed Grimsby B gas engines will be required to achieve a NO_X emission concentration of 95mg/Nm^3 (dry, 15% O_2). The modelling of the Grimsby B gas engines has, therefore, assumed 95mg/Nm^3 (dry, 15% O_2). The existing Grimsby A gas engines have been permitted for 190mg/Nm^3 (dry, 15% O_2). The modelling of the Grimsby A gas engines has, therefore, assumed NO_X emissions of 190mg/Nm^3 (dry, 15% O_2). As the Grimsby A gas engines achieve lower NO_X emission concentrations than this during normal operation, this is a conservative scenario, unlikely to represent the normal operational scenario of that plant.

The engines are expected to run up to 1500 hours per year, and maximum impacts at locations of relevant exposure will occur in a scenario where all 15 engines (i.e. the 5 proposed Grimsby B gas engines and the 10 existing Grimsby A gas engines) are assumed to be running simultaneously at full load.

It is worth noting that the upper bound of the combined NO_X annual mass emissions of the Grimsby A and Grimsby B gas engines (operated up to 1500 hours and at the NO_X emission concentrations reported above) will only be around 45% of the NO_X emissions released by the previous CHP site, which operated continuously (except for shut down periods) for at least 8000 hours per year (and assuming, for the CHP, the same NO_X emission rate as an open cycle GT).

The release height of the proposed Grimsby B gas engines exhaust gases will be 12.5m, corresponding to stacks extending approximately 3m above the engine containers. As mentioned in Section 2.2.4, the effect of varying the stack height for the Grimsby B gas engines has been assessed for BAT. The assessment demonstrates that the proposed stack height of 12.5m for the Grimsby B gas engines provides a suitable compromise between reducing air quality impacts and reducing visual impacts and has therefore been judged to be BAT-compliant. The results of this assessment are presented in Section 6.5.

Representative site, emission and modelling parameters for the Grimsby A and Grimsby B gas engines are provided in Appendix A.

Potential in-combination impacts from additional emission sources which have only commenced operations recently, or have received planning permission but have yet to come into operation, are discussed in Section 7.

5. Assessment methodology

5.1. Modelled impacts

The impacts of the proposed Grimsby B gas engines on short and long term NO_X concentrations have been predicted using the ADMS dispersion model (see Appendix A). The quantities which have been modelled for this assessment are defined below:

- **Process Contribution (PC)**
  To assess the process contribution (PC) impact of the proposed Grimsby B gas engines, ADMS runs were performed for the 5 proposed Grimsby B gas engines alone.
- **Combined Contribution (CC)**
  Due to the close proximity of the existing Grimsby A gas engines, the background concentrations projected by Defra would not be expected to properly represent the background concentrations for use in this assessment. ADMS runs were therefore performed which included both the 5 proposed Grimsby B gas engines and the 10 existing Grimsby A gas engines. The combined impact of the 15 Grimsby gas engines will be referred to as the "combined contribution" (CC) impact in this assessment. The next bullet point describes how the CC impacts were used in this assessment.
- **Predicted Environmental Concentration (PEC)**
  The Predicted Environmental Contributions (PEC), which take into account the projected background concentrations, have been calculated by combining the modelled combined contributions (CC) with the background concentrations projected by Defra, in order to properly model the combined impact of the 15 Grimsby gas engines. It should be noted that these projected background concentrations are based on measured 2018 data. As the existing Grimsby A gas engines have been operating since early 2018, there will be a degree of double counting of the existing Grimsby A gas engines impacts, which are directly modelled but also already taken into account in the background projected by Defra. The PEC figures reported in this assessment are, therefore, very conservative.

The PC and PEC impacts are the modelled quantities which have been assessed against the relevant air quality standards in this report.

More specifically, to estimate the long term human health PC impacts, annual mean NO_X concentrations for continuous operation of the proposed Grimsby B gas engines at full load have been modelled and scaled by a factor of 1500/8760 to reflect the maximum 1500hrs generation during the year. The modelled NO_X impacts are then multiplied by a factor of 0.7 (representing the proportion of NO_X in the form of NO_2) to give an estimate of NO_2 PC impacts. This conversion factor is consistent with EA guidance.

The human health PC impact of short term NO_X concentrations has been estimated by modelling the 99.79th and 98.80th percentile of hourly mean NO_X concentrations for continuous operation of the proposed Grimsby B gas engines at full load, thus capturing all possible weather conditions. For 1500 hours generation per year, the use of the 98.80th percentile gives a more realistic assessment (than the use of the 99.79th percentile) of the risk of having more than 18 exceedances a year. This is explained in more detail in Appendix B. The modelled NO_X impacts are then multiplied by a factor of 0.35 (representing the proportion of NO_X in the form of NO_2) to give an estimate of NO_2 PC impacts. This conversion factor is consistent with EA guidance.

To estimate the ecological PC impact of long term NO_X concentration, annual mean NO_X concentrations for continuous operation of the proposed Grimsby B gas engines at full load have been modelled and scaled by a factor of 1500/8760 to reflect the maximum 1500hrs generation during the year. The ecological PC impact of long term nutrient nitrogen deposition have been calculated from these scaled modelled annual mean NO_X concentrations as described in Appendix A.

The ecological PC impact of short term NO_X concentrations has been estimated by modelling the 100.00th and 98.40th percentile of daily mean NO_X impacts for continuous operation of the proposed Grimsby B gas engines at full load, to capture all possible weather conditions. The 100.00th percentile corresponds to the day with the greatest modelled daily mean NO_X concentration. This corresponds to the engines being run for the whole 24 hours on the day which has the weather conditions which produce the greatest daily mean NO_X concentration. For engines which only run for up to 1500 hours per year, the probability of this happening is very low and a more realistic prediction is obtained by conservatively considering that the engines will always run for the whole 24 hours of a day, but these days are assumed to be randomly distributed throughout the year. The highest daily mean NO_X concentration is then given by the 98.40th percentile (see Appendix B).

Guidance on assessing the short term air quality impact of a proposed development which will only operate for a limited number of hours per year, is provided by Environment Agency (2018). Following this guidance, the short term human health PEC impacts have been assessed by determining if the 99.32th percentile of PEC hourly mean NO_2 concentrations is less than the short term NO_2 limit value of 200µg/m^3. This corresponds to there being <1% chance of human health PEC impact of short term NO_2 concentrations being non-complaint with the short term NO_2 NAQO/LV. The guidance states that probabilities of 1% or less indicate exceedances are highly unlikely. The basis of the assessment is explained further in Appendix B.

The ecological PEC impact of short term NO_X concentrations have been conservatively assessed by modelling the 100.00th percentile of PEC daily mean NO_X concentrations for continuous operation of the proposed Grimsby B gas engines and the existing Grimsby A gas engines at full load. If the 100.00th percentile of PEC daily mean NO_X concentrations is less than the short term NO_X critical level then the risk of non-compliance with the short term NO_X critical level is negligible.

As mentioned above, the PEC impacts were obtained in a very conservative way by combining the CC impacts (i.e. the impacts of the proposed Grimsby B gas engines and the existing Grimsby A gas engines) with the background concentrations projected by Defra. The long term human health CC impact of NO_2 concentrations and long term ecological CC impacts of NO_X concentrations and nutrient nitrogen deposition for engines running for the maximum 1500 hours per year were modelled in exactly the same way as the corresponding PC impact. The short term human health CC impact has been estimated by modelling the 99.32^{th} percentile of hourly mean NO_X concentrations for continuous operation of the Grimsby A and Grimsby B gas engines at full load and then multiplying by a factor of 0.35 to give an estimate of NO_2 CC impact, as was done for the short term human health NO_2 PC impact. The short term ecological CC impact has been estimated by modelling the 100.00^{th} percentile of daily mean NO_X concentrations for continuous operation of the Grimsby A and Grimsby B gas engines at full load.

PECs for long term concentration impacts have been calculated by summing the annual mean concentration CC impacts with annual mean background. The same approach is used for the daily mean used for assessing the ecological short term impacts. For short term impacts on human health, the PEC is instead obtained by summing the hourly mean CC with twice the annual mean background, in line with Environment Agency (2016) guidance:

- total hourly mean impact (PEC) =
  hourly mean process impact (CC) + 2 x annual mean background concentration

- total daily mean impact (PEC) =
  daily mean process impact (CC) + annual mean background concentration

- total annual mean impact (PEC) =
  annual mean process impact (CC) + annual mean background concentration

The ecological PEC impact of long term nutrient nitrogen deposition have been estimated using the following approach from Environment Agency (2016):

- total annual deposition impact (PEC) =
  annual deposition process impact (CC) + annual background deposition

In the absence of suitable monitoring data, Defra predicted annual mean background concentrations and background annual nutrient nitrogen deposition from APIS (as described in Section 3.3) have been used in the calculation.

5.2. Impact descriptors and significance

In determining the significance of impacts for the pollutants released to air, reference has been made to Moorcroft and Barrowcliffe et al. (2017), which presents descriptors for the magnitude of impacts. These descriptors are adapted in Table 5 below for the annual mean NO_2 limit value ($40 \mu g/m^3$) as the Air Quality Assessment Level (AQAL). Additionally, it should be noted that impacts below 1% of a long term AQAL are regarded by the Environment Agency (2016) as insignificant.

Table 5: Air quality impact significance descriptors for changes in NO_2 annual mean concentrations at individual receptors.

Long term average concentration at receptor in assessment year (µg/m³)	Change in concentration with development (µg/m³)				
	<0.2	0.2-0.5	0.5-2	2-4	>4
<30	Negligible	Negligible	Negligible	Slight	Moderate
30-38		Negligible	Slight	Moderate	Moderate
38-41		Slight	Moderate	Moderate	Substantial
41-44		Moderate	Moderate	Substantial	Substantial
>44		Moderate	Substantial	Substantial	Substantial

Changes in short term concentrations, are generally described in terms of the magnitude of the process-only impact, because short term background and process impacts are not additive. Bandings in Table 6 are as proposed in Moorcroft and Barrowcliffe (2017), adapted for the hourly mean NO_2 limit value (200µg/m³) as the AQAL. Additionally, it should be noted that impacts below 10% of a short term AQAL are regarded by the Environment Agency (2016) as insignificant.

Table 6: Air quality impact descriptors for short-term NO_2 process impacts.

Maximum process impact (µg/m³)	Magnitude descriptor	Severity descriptor
<20	Insignificant	
20-40	Small	Slight
40-100	Medium	Moderate
>100	Large	Substantial

The overall severity of air quality impacts for a development depends on a number of other factors including the number of receptors affected.

Moorcroft and Barrowcliffe (2017) does not provide impact descriptors for the assessment of ecological impacts. The following significance criteria, applicable to both critical loads and critical levels, are specified in Environment Agency (2016):

- For SPAs, SACs, Ramsar sites and SSSIs, impacts may be considered insignificant where both of the following criteria are met:
    - the long-term PC is less than 1% of the long-term environmental standard for protected conservation areas.
    - the short-term PC is less than 10% of the short-term environmental standard for protected conservation areas.

  Where impacts as not classed as insignificant, the PEC should be compared to the standard for protected conservation areas.

- For local nature sites (Ancient Woods, Local Wildlife Sites and National and Local Nature Reserves) impacts may be considered insignificant where both of the following criteria are met:
    - the long-term PC is less than 100% of the long-term environmental standard.
    - the short-term PC is less than 100% of the short-term environmental standard.

6. Results and assessment of impacts

6.1. Modelling results for human health impacts

The maximum modelled impacts from the proposed Grimsby B gas engines at relevant locations of NO_2 exposure (from five separate years of meteorological data, presented in Appendix C) are summarised in Table 7. Results are reported for:

- PC annual mean NO_2 concentrations. These figures have been derived from the PC annual mean NO_X concentrations reported in Appendix C, converted to NO_2 concentrations and appropriately scaled for 1500 hours per annum generation as described in Section 5.1.
- CC annual mean NO_2 concentrations. These figures have been derived from the CC annual mean NO_X concentrations reported in Appendix C, converted to NO_2 concentrations and appropriately scaled for 1500 hours per annum generation as described in Section 5.1.
- PEC annual mean NO_2 concentrations. These figures have been derived from the CC annual mean NO_2 concentrations reported in the table by adding the annual mean background concentrations given in Section 3.3 as described in Section 5.1. (As already noted, this introduces an element of double counting of the existing Grimsby A gas engines' impacts.)
- 99.79th and 98.80th percentiles of PC hourly mean NO_2 concentrations. These figures have been derived from the corresponding percentiles of PC hourly mean NO_X concentrations reported in Appendix C, converted to NO_2 concentrations as described in Section 5.1.
- 99.32th percentiles of CC hourly mean NO_2 concentrations. These figures have been derived from the 99.32th percentiles of PC hourly mean NO_X concentrations reported in Appendix C, converted to NO_2 concentrations as described in Section 5.1.
- 99.32th percentiles of PEC hourly mean NO_2 concentrations. These figures have been derived from 99.32th percentiles of CC hourly mean NO_2 concentrations reported in this table by adding twice the annual mean background given in Section 3.3 as described in Section 5.1. (As already noted, this introduces an element of double counting of the existing Grimsby A gas engines' impacts.)

Table 7: Maximum modelled NO_2 impacts for the proposed Grimsby B gas engines at the selected human health receptors.

Air quality statistics	Maximum modelled impact		
	Coastal Footpath (R1)	Premier Inn (R2)	Haven Gardens (R3)
PC annual mean NO_2 concentration (µg/m^3) (Assuming 1500 hours per annum generation)	0.8	0.2	0.1
CC annual mean NO_2 concentration (µg/m^3) (Assuming 1500 hours per annum generation)	2.9	0.8	0.3
PEC annual mean NO_2 concentration (µg/m^3) (Assuming 1500 hours per annum generation)	14.9	15.0	14.5
99.79th percentile of PC hourly mean NO_2 concentrations (µg/m^3) (If plant assumed to operate all year)	17.2	11.7	4.7
98.80th percentile of PC hourly mean NO_2 concentrations (µg/m^3) (Representative of short term impacts if operating for 1500 hours per year)	15.5	9.1	3.6
99.32th percentile of CC hourly mean NO_2 concentrations (µg/m^3) (Corresponds to <1% chance of non-compliance of PEC with the short term NO_2 NAQO/LV)	55.9	35.6	14.3
99.32th percentile of PEC hourly mean NO_2 concentrations (µg/m^3) (Corresponds to <1% chance of non-compliance of PEC with the short term NO_2 NAQO/LV)	80.0	64.0	42.7

6.2. Modelling results for ecological impacts

The maximum modelled impacts from the proposed Grimsby B gas engines at the selected ecological receptors (from five separate years of meteorological data, presented in Appendix C) are summarised in Table 8. Results are reported for:

- PC annual mean NO_X concentrations. These figures have been derived from the PC annual mean NO_X concentrations reported in Appendix C, appropriately scaled for 1500 hours per annum generation as described in Section 5.1.
- CC annual mean NO_X concentrations. These figures have been derived from the CC annual mean NO_X concentrations reported in Appendix C, appropriately scaled for 1500 hours per annum generation as described in Section 5.1.
- PEC annual mean NO_X concentrations. These figures have been derived from the CC annual mean NO_X concentrations reported in the table by adding the annual mean background concentrations given in Section 3.3 as described in Section 5.1. (As already noted, this introduces an element of double counting of the existing Grimsby A gas engines' impacts.)
- 100.00th and 98.40th percentiles of PC daily mean NO_X concentrations. These figures have been taken from Appendix C.
- 100.00th percentiles of CC daily mean NO_X concentrations. These figures have been taken from Appendix C.
- 100.00th percentiles of PEC daily mean NO_X concentrations. These figures have been derived from 100.00th percentiles of CC daily mean NO_X concentrations reported in this table by adding the annual mean background given in Section 3.3 as described in Section 5.1. (As already noted, this introduces an element of double counting of the existing Grimsby A gas engines' impacts.)

- PC annual nutrient nitrogen deposition. These figures have been derived from the PC annual mean NO_x concentrations reported in Appendix C as described in Section 5.1.
- CC annual nutrient nitrogen deposition. These figures have been derived from the CC annual mean NO_x concentrations reported in Appendix C as described in Section 5.1.
- PEC annual nutrient nitrogen deposition. These figures have been derived from the CC annual nutrient nitrogen depositions reported in the table by adding the annual background depositions given in Section 3.3 as described in Section 5.1. (As already noted, this introduces an element of double counting of the existing Grimsby A gas engines' impacts.)

Table 8: Maximum modelled impacts for the proposed Grimsby B gas engines at the selected ecological receptors.

Air quality statistics	Maximum modelled impact			
	Humber Estuary SAC/SPA /RAMSAR/SSSI		West Field LWS	
	R4	X3	R5	R6
PC annual mean NO_x concentration (µg/m^3) (Assuming 1500 hours per annum generation)	0.9	0.4	2.9	1.4
CC annual mean NO_x concentration (µg/m^3) (Assuming 1500 hours per annum generation)	3.2	1.3	10.9	8.3
PEC annual mean NO_x concentration (µg/m^3) (Assuming 1500 hours per annum generation)	19.4	17.6	27.1	24.5
100.00th percentile of PC daily mean NO_x concentrations (µg/m^3) (If plant assumed to operate all year)	30.5	14.6	94.8	119.0
98.40th percentile of PC daily mean NO_x concentrations (µg/m^3) (Representative of short term impacts if operating for 1500 hours per year and 24 hours per day)	21.8	9.3	71.4	75.2
100.00th percentile of CC daily mean NO_x concentrations (µg/m^3) (Corresponds to 0% chance of non-compliance of PEC with the short term NO_x critical level)	108.0	50.6	319.7	607.8
100.00th percentile of PEC hourly mean NO_x concentrations (µg/m^3) (Corresponds to 0% chance of non-compliance of PEC with the short term NO_x critical level)	140.5	83.1	352.2	640.3
PC annual nutrient nitrogen deposition (kgN/ha) (Assuming 1500 hours per annum generation)	0.13	0.05	Not-applicable	
CC annual nutrient nitrogen deposition (kgN/ha) (Assuming 1500 hours per annum generation)	0.46	0.19		
PEC annual nutrient nitrogen deposition (kgN/ha) (Assuming 1500 hours per annum generation)	18.1	17.8		

6.3. Assessment of human health impacts

The long term process contribution (annual mean NO_2 concentration) at receptor R1 (coastal footpath) is 0.8μg/m^3 (see Table 7). This corresponds to 1.9% of the AQAL of 40μg/m^3. Lower values are modelled at the two sensitive receptors located at dwellings (R2 and R3: 0.6% and 0.2% of the AQAL, respectively). The highest long term PEC is modelled at the receptor R1: 14.9μg/m^3 (see Table 7). This corresponds to 37.2% of the AQAL. Such impacts at all the receptors are classed as 'negligible' using the Moorcroft, Barrowcliffe et al. (2017) descriptors in Table 5 and therefore are judged not to lead to adverse health effects at any of the sensitive receptors.

The modelled short term PC (99.79th percentiles of hourly mean NO_2 concentrations for continuous generation) at all three receptors are reported in Table 7. The highest value is 17.2μg/m^3, at receptor R1. This corresponds to 8.6% of the AQAL of 200μg/m^3 and is therefore classed as 'negligible' using the Moorcroft, Barrowcliffe et al. (2017) descriptors in Table 6. Using the 98.80th percentile, which should be more representative of generation for the maximum 1500 hrs/yr, the impact at receptor R1 further reduces to 15.5μg/m^3 (see Table 7). The impacts at all the receptors can therefore be judged to be no cause for concern.

As noted in Section 5.1, if the 99.32th percentile of PEC hourly mean NO_2 concentrations is less than the short term AQAL of 200μg/m^3 then the risk of non-compliance with the short term AQAL is below 1%. The modelled short term PEC (99.32th percentiles of hourly mean NO_2 concentrations for continuous generation) is well below the AQAL at all the receptors (see Table 7). Environment Agency (2018) states that probabilities of non-compliance with the short term AQAL of 1% or less indicate exceedances are highly unlikely.

A further screening of the impacts at the two additional receptors at X1 and X2 shows that the PC annual mean NO_2 concentrations are, respectively, 2.2% and 0.6% of the long term AQAL. The long term impacts at both receptors are classed as 'negligible' using Moorcroft, Barrowcliffe et al. (2017) descriptors in Table 5. Using the 98.80th percentile of hourly mean NO_2 concentrations for continuous operation, the short term PC impacts at receptors X1 and X2 are classed as 'small' magnitude and 'insignificant' respectively, using Moorcroft, Barrowcliffe et al. (2017) descriptors in Table 6. The modelled short term PEC (99.32th percentiles of hourly mean NO_2 concentrations for continuous generation) is well below the AQAL at receptors X1 and X2. Non-compliance with the short term AQAL is, therefore, considered highly unlikely at both receptors. The impact at these receptors is therefore also judged to be no cause for concern.

6.4. Assessment of ecological impacts

For the receptors located in the Humber Estuary designated site, the long term process contribution (annual mean NO_X concentration) at receptors R4 and X3 are 0.9μg/m^3 and 0.4μg/m^3 respectively (see Table 8). These correspond, respectively, to 2.9% and 1.2% of the critical level (CL) of 30μg/m^3. This shows that the long term impacts of the proposed Grimsby B gas engines only extend over a small region (few hundred meters) of the Humber Estuary designated site. As can be seen from Figure 2, this small region predominantly consists of tidal mudflats. Although, under the highly conservative assumptions used in this assessment, the long term PC impacts at the receptors in the tidal mudflats can exceed the 1% potentially significant effects threshold, the risk of impact on this small region of the mudflats would be expected to be very low as they will contain little vegetation and the inter-tidal nature of the estuary will limit exposure of the tidal mudflats to atmospheric NO_X. The long term PEC modelled at the receptors R4 and X3 are 19.4μg/m^3 and 17.6μg/m^3 respectively (see Table 8). These correspond to 64.8%

and 58.6% of the CL respectively. Following the criteria summarized in Section 5.2, taking into account both the PC and PEC long term impacts, the effect of the air concentrations of NO_X on all the Humber Estuary designated site was therefore judged to be insignificant.

The modelled short term PC (100.00th percentiles of daily mean NO_X concentrations for continuous generation) at receptors R4 and X3 are 30.5µg/m^3 and 14.6µg/m^3 respectively (see Table 8). These correspond to 40.7% and 19.4% of the CL of 75µg/m^3. However, this is an extremely pessimistic representation of short-term impacts, as the periods of generation are unlikely to coincide with periods of adverse meteorology and are unlikely to last for a full day. Using the 98.40th percentile, which still gives a very conservative but more representative estimate of the short-term impacts of the proposed Grimsby B gas engines operating for up to 1500 hrs/yr, the impacts at receptors R4 and X3 are 21.8µg/m^3 and 9.3µg/m^3 respectively (see Table 8). These correspond to 29.1% and 12.4% of the CL respectively. This shows that the short term impacts of the Grimsby B gas engines also only extend over a small region (few hundred meters) of the tidal mudflats. Although, under the highly conservative assumptions used in this assessment, the short term PC impacts at the receptors in the tidal mudflats can be above the 10% potentially significant effects threshold, the risk of impact on this small region of the mudflats would be expected to be very low as they will contain little vegetation and the inter-tidal nature of the estuary will limit exposure of the tidal mudflats to atmospheric NO_X. The modelled short term PEC (100.00th percentile of daily mean NO_X concentrations for continuous generation) at R4 and X3 are 140.5µg/m^3 and 83.1µg/m^3 respectively (see Table 8). As already noted, these short term PEC values will be highly conservative as they also include an element of double counting. These short term PEC figures for R4 and X3 shows that the chance of non-compliance with the short term NO_X critical level is also limited to only a small region (few hundred meters) of the tidal mudflats. (As noted in Section 5.1, there can't be any risk of non-compliance with the short term NO_X critical level if the 100.00th percentile of PEC daily mean NO_X concentration is less than the short term NO_X critical level of 75µg/m^3). Consequently, following the criteria summarized in Section 5.2, taking into account both the PC and PEC short term impacts, the effect of the air concentrations of NO_X on all the Humber Estuary designated site was judged to be insignificant.

For the receptors located in the Humber Estuary designated site, the modelled PC annual nutrient nitrogen deposition at receptors R4 and X3 are 0.13kgN/ha and 0.05kgN/ha respectively (see Table 8). These correspond to 0.6% and 0.3% of the critical load of 20kgN/ha. The long term PEC is modelled at the receptors R4 and X3 to be 18.1kgN/ha and 17.8kgN/ha respectively (see Table 8). These correspond to 90.5% and 89.2% of the CL respectively. As the long term PC impacts at the receptors are below the 1% potentially significant effects threshold, the effect of the nutrient nitrogen depositions on all the Humber Estuary designated site was judged to be insignificant.

For the receptors located in the West Field Local Wildlife Site, the long term process contribution (annual mean NO_X concentration) at receptors R5 and R6 are 2.9µg/m^3 and 1.4µg/m^3 respectively (see Table 8). These correspond to 9.7% and 4.8% of the CL of 30µg/m^3 respectively. Following the criteria summarized in Section 5.2, as the long term PC impacts at the receptors are below the 100% potentially significant effects threshold, the effect of the air concentrations of NO_X on all the West Field Local Wildlife Site was judged to be insignificant. The short term PC impacts at the receptors R5 and R6, modelled using the 98.40th percentile, are 71.4µg/m^3 and 75.2µg/m^3, respectively (see Table 8). These correspond to 95.1% and 100.3% of the CL respectively. As the short term PC impacts at the receptors are below or on the 100% threshold of potentially significant effects (see Section 5.2), they were also judged to be insignificant due to the conservative use of the 98.40th percentile and due to the extremely low associated long term PC impacts.

6.5. BAT assessment

As mentioned in Section 2.2.4, IED requires plants to use BAT which is defined as: 'the most effective and advanced stage in the development of activities and their methods of operation which indicates the practical suitability of particular techniques for providing the basis for emission limit values and other permit conditions designed to prevent and, where that is not practicable, to reduce emissions and the impact on the environment as a whole'. A BAT assessment was carried out by modelling the effect of varying the stack height on the air quality impacts for the proposed Grimsby B gas engines. The air quality impacts were modelled for three alternative stack heights: 11.0m, 12.5m and 14.0m.

The proposed stack height selected on the basis of this BAT assessment is 12.5m. The results of the modelling and an assessment of the impacts for the proposed stack height of 12.5m are given in Sections 6.1, 6.2, 6.3 and 6.4. The results for the two other stack heights of 11.0m and 14.0m (i.e. a change in stack height of +/-1.5m with respect to the proposed 12.5m) are shown in Table 9, which reports the change in the modelled long term and short term PC impacts at the selected human health receptors. Changes in the modelled long term and short term PC impacts at the selected ecological receptors are similarly summarized in Table 10. As can be seen, variations in stack height of +/-1.5m have relatively small effects on the results of the assessment: around -/+4.0% on the impacts at the selected human health receptors, -/+6.0% for the receptors located in the Humber Estuary designated site (R4 and X3) and -/+13.0% for those in the West Field Local Wildlife Site (R5 and R6)). These results show therefore that the stack height of the proposed Grimsby B gas engines would have to be varied by several metres to result in appreciable changes in the impacts on air quality.

The proposed stack height of 12.5m for the Grimsby B gas engines has been judged to be represent BAT as:

- It ensures the absence of likely significant adverse effect on human health and sensitive ecosystems (as demonstrated in the assessment undertaken in the previous sections).
- It provides a suitable compromise between reducing air quality impacts and reducing visual impacts (therefore reducing the impact on the environment as a whole).

Table 9: Change in the modelled PC impacts for the proposed Grimsby B gas engines at the selected human health receptors corresponding to a change in stack height of +/-1.5m.

Air quality statistics	Change in stack height (m)	Change in modelled impact (%)		
		Coastal Footpath (R1)	Premier Inn (R2)	Haven Gardens (R3)
PC annual mean NO_2 concentration (µg/m^3) (Assuming 1500 hours per annum generation)	-1.5	+3.5	+1.7	+0.9
	+1.5	-3.6	-1.8	-0.9
99.79th percentile of PC hourly mean NO_2 concentrations (µg/m^3) (If plant assumed to operate all year)	-1.5	+5.3	+2.7	+1.6
	+1.5	-4.0	-2.4	-1.6
98.80th percentile of PC hourly mean NO_2 concentrations (µg/m^3) (Representative of short term impacts if operating for 1500 hours per year)	-1.5	+3.8	+0.8%	+0.7%
	+1.5	-3.1	-1.2%	-1.8%

Table 10: Change in the modelled PC impacts for the proposed Grimsby B gas engines at the selected ecological receptors corresponding to a change in stack height of +/- 1.5m.

<table>
<tr><th rowspan="3">Air quality statistics</th><th rowspan="3">Change in stack height (m)</th><th colspan="4">Change in modelled impact (%)</th></tr>
<tr><th colspan="2">Humber Estuary SAC/SPA /RAMSAR /SSSI</th><th colspan="2">West Field LWS</th></tr>
<tr><th>R4</th><th>X3</th><th>R5</th><th>R6</th></tr>
<tr><td rowspan="2">PC annual mean NO_x concentration ($\mu g/m^3$)
(Assuming 1500 hours per annum generation)</td><td>-1.5</td><td>+3.0</td><td>+2.1</td><td>+7.6</td><td>+12.7</td></tr>
<tr><td>+1.5</td><td>-3.1</td><td>-2.1</td><td>-8.0</td><td>-13.2</td></tr>
<tr><td rowspan="2">100.00th percentile of PC daily mean NO_x concentrations ($\mu g/m^3$)
(If plant assumed to operate all year)</td><td>-1.5</td><td>+4.8</td><td>+2.1</td><td>+1.8</td><td>+10.4</td></tr>
<tr><td>+1.5</td><td>-5.8</td><td>-2.8</td><td>-2.9</td><td>-6.5</td></tr>
<tr><td rowspan="2">98.40th percentile of PC daily mean NO_x concentrations ($\mu g/m^3$)
(Representative of short term impacts if operating for 1500 hours per year and 24 hours per day)</td><td>-1.5</td><td>+2.3</td><td>+2.2</td><td>+3.7</td><td>+8.9</td></tr>
<tr><td>+1.5</td><td>-1.6</td><td>-2.2</td><td>-4.5</td><td>-10.5</td></tr>
<tr><td rowspan="2">PC annual nutrient nitrogen deposition (kgN/ha)
(Assuming 1500 hours per annum generation)</td><td>-1.5</td><td>+3.0</td><td>+2.1</td><td colspan="2" rowspan="2">Not-applicable</td></tr>
<tr><td>+1.5</td><td>-3.1</td><td>-2.1</td></tr>
</table>

7. Cumulative impacts

Cumulative impacts from existing sources of pollution in the area are accounted for in the use of the latest projections for annual mean NO_2 and NO_x background concentrations, released by Defra for LAQM purposes (see Section 3.3). There are however potentially local emission sources from developments which are proposed, consented or in the development pipeline but which have yet to come into operation. These emission sources could potentially give rise to in-combination effects but their impact on local air quality would not have been captured by the background concentrations projected by Defra and used in this report. Consequently, a review has been carried out to identify other developments, either proposed, consented or in the development pipeline, within 15km of the proposed Grimsby B gas engines, which could significantly affect the background air quality in the local area. Table 11 lists the developments identified. The planning list for North East Lincolnshire Council (NELC, 2022) and the National Infrastructure Planning website (NIP, 2022), which lists Nationally Significant Infrastructure projects, were examined.

Table 11: Developments, either proposed, consented or in the development pipeline, within 15km of the proposed Grimsby B gas engines, which could significantly affect the background air quality in the local area.

Development	Location and distance from the proposed Grimsby B gas engines	Status	Details
Nationally significant infrastructure project: South Humber Bank Energy Centre EN010107	Approx. 3km north west	DCO granted November 2021	Energy from waste plant of up to 95MW
Nationally significant infrastructure project: VPI Immingham OCGT EN010097	Approx. 11km north west	DCO granted August 2020	299MW OCGT
Immingham Railfreight Terminal waste to energy facility DM/0628/18/FUL	Approx. 5km north west	Under construction	20MW waste to energy power plant
Youngs Seafood CHP plants DM/0045/21/FUL	Approx. 3km east	Permission granted August 2021	2 x 2.5MW_e CHP plants
Nationally significant infrastructure project: V Net Zero Pipeline	Approx. 7km west	Application is expected to be submitted Q1 2023.	A CO_2 pipeline from Immingham to Threddlethorpe

In-combination effects with another development have to be assessed at those locations where the impacts of the proposed Grimsby B gas engines are above the threshold for potentially significant effect (for human health or ecological impacts at SPAs, SACs, Ramsar sites and SSSIs). If the impacts from the other development at these locations are below the threshold for potentially significant effect, in-combination effects can be screened out. Impacts from the other developments have, therefore, been assessed in-combination at the R1 human health receptor and the R4 Humber Estuary receptor.

While the first two developments in Table 11 are sufficiently large and close to the proposed Grimsby B gas engines to require in-combination effects to be investigated in more detail. The next two developments in the table are too far (for their size) from the proposed Grimsby B gas engines for any potential for in-combination impacts to be of significance. The final development in the table is not expected to have any significant impacts resulting from NO_X emissions. The last three developments in the table are therefore not further considered.

Air quality assessments are available for both the South Humber Bank Energy Centre (EP Waste Management Ltd, 2020) and VPI Immingham OCGT (VPI Immingham B Ltd, 2019) developments.

The VPI Immingham OCGT air quality assessment found the impacts are below the potentially significant effect threshold at all the human health receptors modelled for both the operational and construction phases. It also found the impacts are below the potentially significant effect threshold at all the Humber Estuary receptors modelled for both the operational and construction phases. In-combination effects with the VPI Immingham OCGT development can, therefore, be screened out.

The South Humber Bank Energy Centre air quality assessment only found impacts above the potentially significant effect threshold at the human health and Humber Estuary receptors modelled during the operational phase. All the modelled human health receptors for which the impacts were above the potentially significant effect threshold, were over 3.5km away from the R1 receptor. All the modelled Humber Estuary receptors for which the impacts were above the potentially significant effect threshold, were over 2km from the R4 receptor. The impacts from the South Humber Bank Energy Centre development will therefore be below the potentially significant effect threshold at human health, SPAs, SACs, Ramsar sites and SSSIs receptors where the proposed Grimsby B gas engines impacts are above the potentially significant effect threshold and, consequently, in-combination effects with the South Humber Bank Energy Centre development can be screened out.

Consequently, the conclusions of the present air quality assessments with respect to both human health and ecological impacts are not altered by in-combination impacts.

8. Conclusions

This assessment considers air quality impacts associated with the operation of the proposed Grimsby B gas engines at Moody Lane, Grimsby.

The assessment demonstrates that the air quality impact of the proposed Grimsby B gas engines has no likely significant adverse effect on human health and sensitive ecosystems, either alone or in-combination. More specifically:

- **Human Health Impacts**
  - Long term NO_2 impacts are insignificant at all locations of relevant exposure for members of the public.
  - Short term NO_2 impacts are insignificant at all locations of relevant exposure for members of the public. At all receptors the risk of non-compliance of the PEC impact with the short term AQAL has been modelled to be substantially below 1%. Environment Agency (2018) states that probabilities of non-compliance with the short term AQAL of 1% or less indicate exceedances are highly unlikely.
- **Ecological Impacts**
  - Long term NO_X impacts on sensitive ecosystems were shown to be insignificant, apart from a small region (limited to a region within few hundred meters from the proposed Grimsby B gas engines) of mudflats in the Humber Estuary designated site. The modelled PC impact (annual mean NO_X concentration) is 2.9% of the long term CL (30µg/m^3) at the closest point in the Humber Estuary designated site to the proposed Grimsby B gas engines. This is considered no cause for concern as: 1) the assessment relies on a number of worst-case assumptions highly unlikely to correspond to the real operating scenario of the proposed Grimsby B gas engines; 2) the PC impacts are only marginally above the screening criteria (1% of long term CL) and this occurs only over a small region of the designated site; 3) this small region is classified as mudflats and will contain little vegetation; 4) the inter-tidal nature of the estuary will limit exposure of the tidal mudflats to atmospheric NO_X; 5) at all receptors the PEC impact is well below the long term CL.

- Short term NO_X impacts on the sensitive ecological receptors were shown to be insignificant, apart from a small region (limited to a region within few hundred meters from the proposed Grimsby B gas engines) of mudflats in the Humber estuary designated site and at the West Field LWS.

  The modelled PC impact (98.40th percentiles of daily mean NO_X concentrations for continuous generation) is 29.1% of the short term CL (75μg/m^3) at the closest point in the Humber Estuary designated site to the proposed Grimsby B gas engines. This is considered no cause for concern as: 1) the assessment relies on a number of worst-case assumptions highly unlikely to correspond to the real operating scenario of the proposed Grimsby B gas engines; 2) the PC impacts are only marginally above the screening criteria (10% of short term CL) and only over a small region; 3) the mudflats will contain little vegetation and the inter-tidal nature of the estuary will limit exposure of the tidal mudflats to atmospheric NO_X.

  The modelled PC impacts (98.40th percentiles of daily mean NO_X concentrations for continuous generation) at the two receptors located in the West Field LWS are 95.1% and 100.3% of the short term CL (75μg/m^3). This is considered no cause for concern as: 1) the assessment relies on a number of worst-case assumptions highly unlikely to correspond to the real operating scenario of the proposed Grimsby B gas engines; 2) the PC impacts are below or on the 100% of the short term CL threshold of potentially significant effects.

- Acid and nutrient nitrogen deposition impacts are insignificant at all European and Internationally designated sites.

For BAT assessment purposes, the effect of varying the stack height for the proposed Grimsby B gas engines has been assessed. The assessment demonstrates that the proposed stack height of 12.5m for the Grimsby B gas engines provides a suitable compromise between reducing air quality impacts and reducing visual impacts and has therefore been judged to represent BAT.

Thus, considering the precautionary nature of the assessment, the use of worst-case assumptions, double counting of background emissions and the general very low levels of impacts, it can confidently be concluded that the proposed Grimsby B gas engines development will not result in any significant impacts on human health and ecological sites due to emission to air, either alone or in-combination with other sources.

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Appendix A Modelling methodology

Model application details

ADMS version 5.2 has been used (CERC, 2016). ADMS is a well-established dispersion model, which has been employed extensively for industrial power stations and has undergone several validation studies (see for example: JEP, 2004 and 2008).

Stack locations

The locations (British National Grid (BNG) coordinates) of the existing Grimsby A gas engines' stacks (1 to 10) and the proposed Grimsby B gas engines' stacks (11 to 15) defined for modelling purposes are shown in Table A1.

Table A1: Stack locations as used in modelling

Stack	X(m)	Y(m)
Stack 1	525311.6	411355.1
Stack 2	525310.3	411350.2
Stack 3	525309.1	411345.4
Stack 4	525307.9	411340.5
Stack 5	525306.6	411335.7
Stack 6	525305.4	411330.8
Stack 7	525304.1	411326.0
Stack 8	525302.9	411321.2
Stack 9	525301.6	411316.3
Stack 10	525300.4	411311.5
Stack 11	525344.9	411327.3
Stack 12	525343.8	411322.4
Stack 13	525342.6	411317.6
Stack 14	525341.4	411312.7
Stack 15	525340.2	411307.9

Input conditions

Table A2 summarises the emission parameters used in modelling impacts for each of the stacks for the existing Grimsby A gas engines and each of the stacks for the proposed Grimsby B gas engines. There are two types of gas engine used for Grimsby B; stacks 11 to 14 are for 'Type 1' gas engines and stack 15 is for a 'Type 2' gas engine. The modelling of the Grimsby A gas engines has been done for 190mg/Nm^3 (dry, 15% O_2) as a conservative scenario (see section 4). The proposed Grimsby B gas engines will be required to achieve a NO_X emission concentration of 95mg/Nm^3 (dry, 15% O_2). The modelling of the Grimsby B gas engines has, therefore, been done for 95mg/Nm^3 (dry, 15% O_2).

Table A2: Model input parameters

Parameter	Grimsby A Gas Engines	Grimsby B Gas Engines (Type 1)	Grimsby B Gas Engines (Type 2)
Exhaust gas release height (m)	8.0	12.5	12.5
Internal exhaust diameter (m)	0.50	0.68	0.54
Exit temperature of exhaust gas (°C)	451	348	362
Exhaust gas volume flux at full load (Am^3/s)	6.80	12.36	7.85
Exit velocity of exhaust gas (m/s)	34.6	34.0	34.3
Molecular weight of exhaust gas (g)[1]	28.966		
Specific heat capacity of exhaust gas at constant pressure (J/kg/K)[1]	1012		
%O_2 in dry exhaust gas	9.4	9.4	9.3
% moisture in exhaust gas	11.5	10.8	11.0
NO_X emission concentration (mg/Nm^3; NO_2-equivalent)[2]	190	95	95
NO_X emission rate (g/s; NO_2-equivalent)	0.84	0.80	0.49

[1] ADMS default values

[2] @15%O_2 dry

Topography

Variations in local topography where sustained gradients greater than 1:10 exist can have a significant effect on the dispersion of emissions. Gradients in the vicinity of the Grimsby site are less than 1:10 and so for modelling purposes the terrain has been assumed to be flat.

Buildings and other structures

Buildings and other structures in the vicinity of discharge stacks have the potential to increase ground level concentrations by causing the plume to 'downwash' into the building wakes. The gas engines are the only buildings on the site. For modelling purposes, the 10 Grimsby A gas engines have been grouped together into a single block, 'Building A', and the 5 Grimsby B gas engines have been grouped together into a single block, 'Building B'. The building parameters used in the modelling for this study are summarised in Table A3.

Table A3: Buildings and structures included in modelling

Building	Shape	Centroid coordinates		Height (m)	Length (m)	Width (m)	Angle (°)
Building A	Rectangular	525311.2	411331.5	6.5	48.2	12.4	14.4
Building B	Rectangular	525339.4	411318.3	9.5	25.2	22.3	13.6

Meteorological data and surface roughness

Five years of hourly sequential meteorological data (2010-2014 inclusive) from the Met Office observing site at 'Donna Nook' have been used. A surface roughness length of 0.5m, suggested by ADMS 5.2 (CERC, 2016) as representative of parkland or open suburbia, has been assumed for the gas engine site. A surface roughness length of 0.2m, suggested by ADMS 5.2 as representative of agricultural areas, has been assumed for the meteorological site. Since the gas engine site is at the mouth of the River Humber it may experience some coastal dispersion phenomena. The location of the observing site at 'Donna Nook' (a flat coastal site at approximately 25km from the site of interest) ensures that sea breeze events will have been captured appropriately in the meteorological data, including changes in wind direction and near surface air temperature.

Deposition

Nutrient nitrogen deposition is composed of wet and dry deposition. It is considered that wet deposition is not significant within a short range of the gas engines. All the NO_X is taken to be NO_2 for the purpose of calculating the modelled nutrient nitrogen deposition. The annual dry nutrient nitrogen deposition is obtained by multiplying the modelled annual mean NO_X concentration by the deposition velocity for NO_2 corresponding to the land-use type to which the deposition is occurring. Grassland is the appropriate land-use type for the tidal mudflats and coastal saltmarsh habitats types considered in this assessment. The deposition velocity for NO_2 for grassland is 0.0015m/s.

Appendix B Modelling short term NO_X/NO_2 impacts for 1500hrs/yr generation

The NO_2 short term NAQO/LV to protect human health prescribes that the hourly mean value must not exceed 200µg/m³ more than 18 times in a year. For a combustion plant which continuously generates for all 8760 hours in a year, this is equivalent to the 100x(1-18/8760) = 99.79th percentile of modelled hourly impacts over the whole year. For low generating hours combustion plant, the local air quality impacts cannot be modelled deterministically as the generating schedule is intrinsically unpredictable. There is a low probability that the plant will be generating in any particularly adverse hour for ground-level impacts and an exceedingly low probability that it will be generating in all 18 hours corresponding to the NO_2 short term NAQO/LV. For 1500hrs/yr generation, and where the hours are representative of the range of meteorological conditions occurring at the site throughout the year, the 18th highest hourly mean impact corresponds to the 18x8760/1500 (i.e. 105th) highest impact over all hours in the year. This is equivalent to the 100x(1-105/8760) = 98.80th percentile of modelled hourly impacts for continuous generation over the whole year.

For the maximum daily mean concentration, if it is assumed the engines run for the whole 24 hours on the day, then the engines will run for 1500/24 days in a year. There is a low probability that the plant will be generating in any particularly adverse 24 hour period for ground-level impacts. Where the days are representative of the range of meteorological conditions occurring at the site throughout the year, the highest daily impact corresponds to the 365x24/1500 (i.e. 6th) highest impact over all days in the year. This is equivalent to the 100x(1-24/1500) = 98.40th percentile of modelled daily impacts for continuous generation over the whole year.

Guidance on assessing the short term air quality impact of a proposed development which will only operate for a limited number of hours per year, is provided by Environment Agency (2018). It suggests the use of the hypergeometric probability distribution which computes the probability of *x* or more successes in a randomly selected sample, size *n*, from a population *N* without replacement, where in the population there are *k* successes. This can be used to calculate the probability of the short term NO_2 concentration PEC impact for the proposed gas engines exceeding the limit value (200µg/m^3) 19 or more hours in a year when the gas engines operate for 1500 hours per year, if the short term NO_2 concentration PEC impact for the proposed gas engines exceeding the limit value *k* hours in a year for continuous generation. Alternatively, this method can be used to calculate the percentile of PEC hourly mean NO_2 concentrations for continuous generation for which there is a 1% chance of the short term NO_2 concentration PEC impact for the proposed gas engines exceeding the limit value 19 or more hours in a year when the gas engines operate for 1500 hours per year. The hypergeometric probability distribution method assumes the hours of operation are randomly distributed throughout the year. In reality the gas engines will usually be operated for several consecutive hours, not for just one hour. To account for this, Environment Agency (2018) recommends that the probability obtained from the hypergeometric probability distribution method is multiplied by 2.5. This recommendation was based on a study done for a plant operating for 500 hours per year. This report has assumed that the same factor should be used for a plant operating for 1500 hours per year. Using the hypergeometric probability distribution method and the factor of 2.5, a percentile value of 99.32th was obtained for the assessment of the short term NO_2 concentration PEC impact of a proposed gas engines. I.e. if the 99.32th percentile of PEC hourly mean NO_2 concentrations is less than the short term NO_2 limit value then there is <1% chance of non-compliance with the short term NO_2 NAQO/LV. Environment Agency (2018) states that probabilities of 1% or less indicate exceedances are highly unlikely.

Appendix C Full modelling results

The results presented in the Tables below are the direct outputs for NO_X from ADMS dispersion modelling. There are two sets of results:

- The 'process contribution' (PC) results where the impacts of the 5 proposed Grimsby B gas engines alone were modelled.
- The 'combined contribution' (CC) results where the impacts of the both the 5 proposed Grimsby B gas engines and the 10 existing Grimsby A gas engines were modelled.

Both sets of results are for continuous operation at full load of the gas engines throughout the year, to account for all possible weather conditions. Both sets of results are for the modelling performed for the proposed stack height of 12.5m for the Grimsby B gas engines. The two sets of model runs are explained further in Section 5.1.

Further processing and discussion of the impacts for each air quality statistic is presented in Section 6 of the main body of the report.

Modelled NO_X impacts (μg/m^3)

Table C1: Receptor R1

Air quality statistic	Year modelled					Maximum impact
	2010	2011	2012	2013	2014	
PC annual mean concentration	3.6	6.4	6.0	5.1	5.7	6.4
CC annual mean concentration	13.3	23.8	22.2	18.2	19.6	23.8
99.79th percentile of PC hourly mean concentrations	48.6	48.9	49.0	48.0	48.8	49.0
98.80th percentile of PC hourly mean concentrations	40.2	44.3	43.4	43.0	43.0	44.3
99.32th percentile of CC hourly mean concentrations	149.3	158.9	159.8	156.0	157.0	159.8

Table C2: Receptor R2

Air quality statistic	Year modelled					Maximum impact
	2010	2011	2012	2013	2014	
PC annual mean concentration	1.9	1.0	1.3	1.5	1.4	1.9
CC annual mean concentration	6.5	3.6	4.6	5.3	5.2	6.5
99.79th percentile of PC hourly mean concentrations	33.3	29.7	30.8	31.2	33.3	33.3
98.80th percentile of PC hourly mean concentrations	25.9	22.1	23.3	25.5	26.1	26.1
99.32th percentile of CC hourly mean concentrations	101.1	87.1	92.1	96.8	101.6	101.6

Table C3: Receptor R3

Air quality statistic	Year modelled					Maximum impact
	2010	2011	2012	2013	2014	
PC annual mean concentration	0.6	0.4	0.5	0.5	0.5	0.6
CC annual mean concentration	2.1	1.3	1.7	1.8	1.9	2.1
99.79th percentile of PC hourly mean concentrations	12.9	11.7	13.4	12.9	13.3	13.4
98.80th percentile of PC hourly mean concentrations	9.2	8.0	8.5	9.6	10.4	10.4
99.32th percentile of CC hourly mean concentrations	36.1	31.9	36.4	39.1	40.8	40.8

Table C4: Receptor X1

Air quality statistic	Year modelled					Maximum impact
	2010	2011	2012	2013	2014	
PC annual mean concentration	7.2	3.0	4.1	6.4	3.8	7.2
CC annual mean concentration	28.5	12.4	17.0	24.7	15.9	28.5
99.79th percentile of PC hourly mean concentrations	106.3	103.5	101.3	107.1	104.7	107.1
98.80th percentile of PC hourly mean concentrations	91.9	78.2	83.3	91.5	84.8	91.9
99.32th percentile of CC hourly mean concentrations	355.3	318.8	322.1	341.6	333.4	355.3

Table C5: Receptor X2

Air quality statistic	Year modelled					Maximum impact
	2010	2011	2012	2013	2014	
PC annual mean concentration	1.9	2.1	1.9	2.0	1.7	2.1
CC annual mean concentration	8.1	8.6	8.0	8.3	7.0	8.6
99.79th percentile of PC hourly mean concentrations	42.8	42.9	43.3	43.2	42.2	43.3
98.80th percentile of PC hourly mean concentrations	33.5	35.2	34.3	35.1	33.6	35.2
99.32th percentile of CC hourly mean concentrations	150.8	151.2	154.3	154.5	148.6	154.5

Table C6: Receptor R4

Air quality statistic	Year modelled					Maximum impact
	2010	2011	2012	2013	2014	
PC annual mean concentration	2.8	5.1	4.7	4.0	4.3	5.1
CC annual mean concentration	10.4	18.6	17.4	14.0	15.0	18.6
100.00th percentile of PC daily mean concentrations	22.8	22.0	25.3	26.2	30.5	30.5
100.00th percentile of CC daily mean concentrations	73.7	80.5	89.1	84.9	108.0	108.0
98.40th percentile of PC daily mean concentrations	16.7	19.3	20.7	19.5	21.8	21.8

Table C7: Receptor X3

Air quality statistic	Year modelled					Maximum impact
	2010	2011	2012	2013	2014	
PC annual mean concentration	1.2	2.2	2.1	1.7	1.8	2.2
CC annual mean concentration	4.7	7.9	7.6	6.0	6.6	7.9
100.00th percentile of PC daily mean concentrations	9.6	10.6	10.7	11.2	14.6	14.6
100.00th percentile of CC daily mean concentrations	31.5	38.5	37.4	37.2	50.6	50.6
98.40th percentile of PC daily mean concentrations	6.6	8.8	9.0	7.8	9.3	9.3

Table C8: Receptor R5

Air quality statistic	Year modelled					Maximum impact
	2010	2011	2012	2013	2014	
PC annual mean concentration	8.9	14.1	12.9	13.0	17.0	17.0
CC annual mean concentration	36.1	62.0	56.8	53.3	63.5	63.5
100.00th percentile of PC daily mean concentrations	72.5	77.2	83.2	94.8	81.4	94.8
100.00th percentile of CC daily mean concentrations	280.5	296.6	308.3	319.7	311.1	319.7
98.40th percentile of PC daily mean concentrations	64.9	66.3	69.1	65.6	71.4	71.4

Table C9: Receptor R6

Air quality statistic	Year modelled					Maximum impact
	2010	2011	2012	2013	2014	
PC annual mean concentration	7.3	7.0	7.0	8.4	6.2	8.4
CC annual mean concentration	40.8	40.0	38.9	48.4	35.3	48.4
100.00th percentile of PC daily mean concentrations	117.3	113.9	111.8	119.0	87.3	119.0
100.00th percentile of CC daily mean concentrations	607.8	594.7	513.4	551.0	466.5	607.8
98.40th percentile of PC daily mean concentrations	64.1	75.2	70.0	72.8	68.0	75.2