ARUP

Amazon Data Services UK Ltd

Hemel Hempstead Data Centre - Emergency Back-up Generation Facility

Air Quality Assessment – Environmental Permit Application

Reference: 284474-EP-AQA

R1 | 10 March 2023

This report takes into account the particular instructions and requirements of our client. It is not intended for and should not be relied upon by any third party and no responsibility is undertaken to any third party.

Job number 284474-00

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1. Introduction

1.1 Background

Ove Arup & Partners Ltd (Arup) has been commissioned by Amazon Data Services UK Ltd (the Operator) to prepare an Air Quality Assessment (AQA) to accompany a bespoke application for an Environmental Permit (EP) for the Hemel Hempstead Data Centre - Emergency Back-up Generation Facility (hereafter referred to as the Site).

The Site comprises 33 containerised generators for emergency back-up purposes with a combined thermal input capacity of 222 MWth. Of the 33 generators, 30 of the main back-up generators are double stacked, with two being included as secondary back-ups (redundancy). There is also a smaller ('house') generator to cover non-critical loads (e.g., office lights, office fire system) during an emergency.

Each generator has an individual flue terminating at 25m above ground. The 30 double stacked generator flues are located close to each other but are separate flues.

The generators will not be used to provide a balancing service or for demand side response operations such as triad avoidance or fast frequency response. No electricity generated from the site will be exported off-site or fed back into the National Grid.

1.2 Site Location

The Site is situated at 3A Blossom Way in the Prologis Industrial Park, located in a light industrial and commercial area in Hemel Hempstead, Hertfordshire. The application is made by Amazon Data Services UK Limited which is the legal entity that will be responsible for operating the generating installation. The Site location is shown in Figure 1.

The northern boundary of the Site consists of a Costa Coffee 'drive thru' and a fitness centre with its adjoining multi-deck car park. There are warehouses to the east; to the west there is a self-storage facility; and to the southwest there is a Travelodge Hotel, a car park and open space. Residential properties are located further to the west and south, approximately 100m from the Site boundary. Several major roads are located in proximity to the Site, including the A414 (Breakspear Way) to the south, the A4147 (Maylands Avenue) to the west. The M1 motorway is located 1.2km to the east.

1.3 Scope of Assessment

This report assesses the likely significant effects of the Site on the environment in respect to air quality. Air quality studies are concerned with the presence of airborne pollutants in the atmosphere.

The EP application is for Hemel Hempstead Data Centre - Emergency Back-up Generation Facility only and not for the whole of the data centre. As such, the main pollutants of concern related to the use of diesel generators for local air quality are oxides of nitrogen (NOx) including nitrogen dioxide (NO_2), particulate matter (PM_{10} and $PM_{2.5}$), sulphur dioxide (SO_2) and carbon monoxide (CO).

This assessment outlines relevant air quality management policy and legislation, describes the existing air quality conditions in the vicinity of the site, outlines the nature of the combustion sources and addresses any air quality issues associated with their operation.

Figure 1: Site location

2. Air Quality Legislation, Policy and Guidance

2.1 Legislation

2.1.1 Environment Act 2021

The Environment Act 2021[1] amends the Environment Act 1995[2]. It also amends the Clean Air Act 1993[3] to give local authorities more power in reducing local pollution, particularly that from domestic burning. It also amends the Environmental Protection Act 1990[4] to reduce smoke from residential chimneys by extending the system of statutory nuisance to private dwellings.

The following sections of the Environment Act 1995 have been transposed into the Environment Act 2021:

For the Secretary of State to develop, implement and maintain an Air Quality Strategy. This includes the statutory duty, also under Part IV of the Environment Act 1995, for local authorities to undergo a process of local air quality management and declare an AQMA where pollutant concentrations exceed the national air quality objectives. Where an AQMA is declared, the local authority needs to produce an Air Quality Action Plan (AQAP), which outlines the strategy for improving air quality in these areas.

The Act will implement key parts of the government's Clean Air Strategy and include targets for tackling air pollution in the UK.

The following points are relevant to air quality[5]:

- For the Secretary of State to set long-term legally binding targets on air quality. These targets must be of at least 15 years in duration, and be proposed by late 2022;
- For the Secretary of State to publish a report reviewing the Air Quality Strategy every five years;
- For the government to set two targets by October 2022: the first on the amount of $PM_{2.5}$ pollutant in the ambient air (the figure and deadline for compliance remain unspecified) and a second long-term target set at least 15 years ahead to encourage stakeholder investment;
- For the Office for Environmental Protection to be established6 to substitute the watchdog function previously exercised by the European Commission;
- For local authorities' powers to be extended under the current Local Air Quality Management framework, including responsibilities to improve local air quality and to reduce public exposure to excessive levels of air pollution;
- For "air quality partners" to have a duty to share responsibility for dealing with local air pollution among public bodies; and
- Introduces a new power for the government to compel vehicle manufacturers to recall vehicles and non-road mobile machinery if they are found not to comply with the environmental standards that they are legally required to meet.

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[1] Environment Act 2021. Available at: https://www.legislation.gov.uk/ukpga/2021/30/contents/enacted. [Accessed February 2022]

[2] Environment Act 1995, Chapter 25, Part IV Air Quality

[3] Clean Air Act 1993. Available at: https://www.legislation.gov.uk/ukpga/1993/11/contents. [Accessed February 2022]

[4] Environmental Protection Act 1990. Available at: https://www.legislation.gov.uk/ukpga/1990/43/contents. [Accessed February 2022]

[5] Environment Act 2021. Part 4 Air Quality and Environmental Recall.

[6] Environment Act 2021. Chapter 2. The Office for Environmental Protection.

2.1.2 Air Quality Standards Regulations

The Air Quality Standards Regulations 2010 (amended in 2016)[7] defines the policy framework for 12 air pollutants known to have harmful effects on human health or the natural environment. The Secretary of State for the Environment has the duty of ensuring compliance with the air quality limit values (pollutant concentrations not to be exceeded by a certain date).

Some pollutants have standards expressed as annual average concentrations due to the chronic way in which they affect health or the natural environment, i.e. effects occur after a prolonged period of exposure to elevated concentrations. Other pollutants have standards expressed as 24-hour, 1-hour or 15-minute average concentrations due to the acute way in which they affect health or the natural environment, i.e. after a relatively short period of exposure. Some pollutants have standards expressed in terms of both long and short-term concentrations. Air quality limit values and objectives are quality standards for clean air. Therefore, in this assessment, the term 'air quality standard' has been used to refer to the national limit values.

Following the UK exit from the European Union, the Air Quality Standards Regulations were retained EU-derived domestic legislation under S.2 of the European Union (Withdrawal) Act 2018[8]. Practical amendments to ensure air quality management would continue were made via the following statutory instruments:

- The Air Quality (Amendment of Domestic Regulation) (EU Exit) Regulations 2019[9];
- The Air Quality (Miscellaneous Amendment and Revocation of Retained Direct EU Legislation) (EU Exit) Regulations 2018[10]; and
- The Environment (Miscellaneous Amendments) (EU Exit) Regulations 2020[11].

Table 1 sets out the national air quality standards and objectives used in this air quality assessment. They will be referred to as Environmental Assessment Levels (EALs).

Table 1: Air quality standards for human health

Pollutant	Averaging period	Environmental standards
Nitrogen Dioxide (NO_2)	Annual mean	40µg/m^3
	1-hour mean	200µg/m^3 not to be exceeded more than 18 times a year (99.79th percentile)
Fine Particulate Matter (PM_{10})	Annual mean	40µg/m^3
	24-hour mean	50µg/m^3 not to be exceeded more than 35 times a year (90.41st percentile)
Very fine particulates ($PM_{2.5}$)	Annual mean	20µg/m^3
Carbon monoxide (CO)	8-hour mean	10,000µg/m^3
	1-hour mean	30,000µg/m^3

[7] The Air Quality Standards (Amendment) Regulations 2016, SI 2016/1184

[8] European Union (Withdrawal) Act 2018 (c. 16)

[9] The Air Quality (Amendment of Domestic Regulations) (EU Exit) Regulations 2019, SI 2019/0074

[10] The Air Quality (Miscellaneous Amendment and Revocation of Retained Direct EU Legislation) (EU Exit) Regulations 2018, SI 2018/1407

[11] The Environment (Miscellaneous Amendments) (EU Exit) Regulations 2020, SI 2020/1313

Pollutant	Averaging period	Environmental standards
Sulphide dioxide (SO_2)	15-minute	266µg/m^3 not to be exceeded more than 35 times a year (99.9th percentile)
	24-hour mean	125µg/m^3 not to be exceeded more than 3 times a year (99.18th percentile)
	1-hour mean	350µg/m^3 not to be exceeded more than 24 times a year (99.73rd percentile)

2.1.3 Ecological Legislation

European Council Directive 92/43/EEC[12] (Habitats Directive) requires member states to introduce a range of measures for the protection of habitats and species. The Conservation of Habitats and Species Regulations 2017[13] transposes the Directive into law in England and Wales, now amended by The Conservation of Habitats and Species (Amendment) (EU Exit) Regulations 2019[14].

The Habitats Directive requires the competent authority first to evaluate whether operation of the site is likely to give rise to a significant effect on the European site (Habitats Regulation Assessment screening). Where this is the case, it has to carry out an 'appropriate assessment' in order to determine whether the Project would adversely affect the integrity of the European site.

Critical Levels

There are specific objective pollutant concentrations for vegetation called 'critical levels', which are shown in Table 2. These are concentrations below which harmful effects are unlikely to occur. The critical levels apply to locations more than 20km from towns with more than 250,000 inhabitants or more than 5km from other built-up areas, industrial installations or motorways.

The objectives in the legislation are used to assess the potential impacts upon any sensitive ecosystems. They will be referred to as EALs in the remainder of this report.

Table 2: Critical levels for the protection of ecosystems

Pollutant	Averaging period	Standard
Oxides of nitrogen (NOx, as NO_2)	Annual mean	30µg/m^3
	Daily mean	75µg/m^3
SO_2 (for ecosystems where lichens and bryophytes are present)	Annual mean	10µg/m^3
SO_2 (for all other ecosystems)	Annual mean	20µg/m^3

[12] European Council Directive (92/43/EEC) of 21 May 1992, on the conservation of natural habitats and of wild fauna and flora

[13] The Conservation of Habitats and Species Regulations 2017, SI 2017/1012

[14] The Conservation of Habitats and Species (Amendment) (EU Exit) Regulations 2019, SI 2019/579

2.1.4 Industrial Emissions Directive (IED)

The Industrial Emissions Directive (IED) (2010/75/EU)[15] was transposed into UK law[16] through the Pollution Prevention and Control (PPC) system defined in The Environmental Permitting (England and Wales) Regulations 2016 (EPR)[17]. It is the regulatory regime being followed by the Environment Agency (EA). The UK government has introduced secondary legislation under the EU Withdrawal Act 2018[8], and further legislation in the devolved administrations where required, to ensure the domestic legislation that implements the IED can continue to operate.

The IED regulates pollutant emissions of NOx, dust, SO_2 and CO to the air from combustion of fuel in plants with an aggregated rated thermal input equal or greater than 50MWth.

IED emission limit value (ELVs) for liquid fuel combustion plants (e.g. diesel generators) are provided in Annex V, Part 1 of the IED. However, for each of those turbines and engines which are emergency use and operate due to testing or emergency for less than 500 hours per year, the emission limit values defined in the IED under 1.1A combustion Chapter III Annex V do not apply.

The total aggregated capacity of the generators proposed is above 50 MWth and will therefore be permitted under the IED. However, because the individual combustion is below 15 MWth the installation will be permitted as an IED Chapter II installation but not a Chapter III (Large Combustion Plant) installation. This means the installation will not be required to meet the Best Available Technique (BAT) Conclusions for the Large Combustion plant. The permit will therefore follow the guidelines set out under the Medium Combustion Plant Directive (MCPD).

2.1.5 Medium Combustion Plant Directive (MCPD)

The amended EPR[18] regulates and enacts both the IED and the MCPD in England and operators undertaking any of the activities identified under these regulations require an environmental permit to carry out these activities.

In November 2015, the European Commission published the MCPD 2015/2193[19] on the limitation of emissions of certain pollutants into the air from medium combustion plant.

The MCPD regulates pollutant emissions from the combustion of fuels in plants with a rated thermal input equal to, or greater than, 1 megawatt (MWth) and less than 50 MWth.

The MCPD regulates emissions of SO_2, NOx and dust to the air only, with the aim of reducing those emissions and the risks to human health and the environment they may cause. It also lays down rules to monitor emissions of CO but does not set an ELV for CO.

For those Medium Combustion Plant which are emergency use and operate less than 500 hours per year as a rolling average over a period of five years, the ELVs set out in the MCPD can be exempt, however an environmental permit will still be required.

2.1.6 US Acute Exposure Guideline Levels (AEGLs)

In the United States, the Superfund Amendments and Reauthorization Act[20] (SARA) of 1986 required the US Environmental Protection Agency (EPA) to identify Extremely Hazardous Substances (EHSs) and, to provide guidance for conducting health hazard assessments for the development of emergency response plans for sites where EHSs are produced, stored, transported, or used. The Agency for Toxic Substances and

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[15] Directive (EU) 2010/75/EU of the European Parliament and the Council of 24 November 2010 on industrial emissions (integrated pollution prevention and control)

[16] The Air Quality Standards Regulations 2016, SI 2010/1001

[17] Environmental Permitting (England and Wales) Regulations 2016

[18] Environmental Permitting (England and Wales) (Amendment) Regulations 2018

[19] Directive (EU) 2015/2193 of the European Parliament and the Council of 25 November 2015 on the limitation of emissions of certain pollutants into the air from medium combustion plants

[20] USEPA (1986) The Superfund Amendments and Reauthorization Act

Disease Registry (ATSDR) were also required to determine whether chemical substances identified either at hazardous waste sites or in the environment could present a public health concern.

Subsequently, Standard Operating Procedures for Developing Acute Exposure Guideline Levels for Hazardous Substances[21] was published in 2001, providing updated procedures, methodologies, and other guidelines used by the National Advisory Committee (NAC) on Acute Exposure Guideline Levels for Hazardous Substances and the Committee on Acute Exposure Guideline Levels (AEGLs) in developing the AEGL values. There are now AEGLs for more than 270 extremely hazardous substances (ESHs), which were developed using the 2001 report and input from members of EPA, various governmental organisations and sectors, the chemical industry, academia and the private sector.

AEGLs represent threshold exposure limits (exposure levels below which adverse health effects are not likely to occur) for the general public and are applicable to emergency exposures ranging from 10 minutes to 8 hours.

There are three levels of AEGL, which are defined as follows:

"*AEGL-1 is the airborne concentration (expressed as ppm [parts per million] or mg/m^3 [milligrams per cubic meter]) of a substance above which it is predicted that the general population, including susceptible individuals, could experience notable discomfort, irritation, or certain asymptomatic nonsensory effects. However, the effects are not disabling and are transient and reversible upon cessation of exposure.*

AEGL-2 is the airborne concentration (expressed as ppm or mg/m^3) of a substance above which it is predicted that the general population, including susceptible individuals, could experience irreversible or other serious, long-lasting adverse health effects or an impaired ability to escape.

AEGL-3 is the airborne concentration (expressed as ppm or mg/m^3) of a substance above which it is predicted that the general population, including susceptible individuals, could experience life-threatening adverse health effects or death."

The EA makes reference in the Data Centre Draft Industry Guidance (detailed in section 2.2.2) to including a comparison of NOx with the AEGLs, for consideration of the potential impact from any emergency operation scenarios. Therefore, these AEGLs have been considered in the assessment. The AEGLs for NOx are provided in Table 3 below for hourly mean NOx, 30-minute mean NOx and 10-minute mean NOx.

Table 3: AEGLs 1-3 for NOx

AEGL	10-minute mean	30-minute mean	Hourly mean
ppm			
AEGL 1	0.50	0.50	0.50
AEGL 2	20	15	12
AEGL 3	34	25	20
µg/m^3			
AEGL 1	956.3	956.3	956.3
AEGL 2	38,250	28,687.5	22,950
AEGL 3	65,025	47,812.5	38,250
Note: the AEGLs were converted from ppm to ug/m^3 using the Defra conversion factor for NOx			

[21] National Academies (2001) Standing Operating Procedures for Developing Acute Exposure Guideline Levels for Hazardous Chemicals

2.1.7 Clean Air Strategy

The Department for Environment, Food and Rural Affairs (Defra) Clean Air Strategy[22] was published in 2019 and sets targets for improving air quality across the country. It includes actions for reducing emissions from various sources, such as transport, domestic activities, farming and industry. There is also a long-term target for reducing population exposure to $PM_{2.5}$ concentrations to meet the World Health Organisation's (WHO) target of 10µg/m^3 as an annual mean. In particular, the Clean Air Strategy states:

"New legislation will create a stronger and a more coherent framework for action to tackle air pollution. This will be underpinned by new England-wide powers to control major sources of air pollution, in line with the risk they pose to public health and the environment, plus new local powers to take action in areas with an air pollution problem. These will support the creation of Clean Air Zones to lower emissions from all sources of air pollution, backed up with clear enforcement mechanism."

2.2 Guidance

2.2.1 Integrated Pollution Prevention and Control (IPPC) Horizontal Guidance Note H1

The IPPC H1 guidance[23] was produced by the EA for England and Wales in collaboration with the Scottish Environment Protection Agency (SEPA) and the Northern Ireland Environment and Heritage Service (EHS). The IPPC is a regulatory system that employs an integrated approach to control the environmental impacts of certain industrial activities. The purpose of the H1 guidance note is to provide supplementary information relevant to all sectors, for the appraisal of BAT and to carry out an appropriate environmental assessment of the overall impact of the emissions resulting from a proposed installation.

The EA revised the H1 guidance and has developed a web-based version[24], with the latest revision date being September 2021. The SEPA H1 guidance has been followed in the assessment and, where applicable, reference is also made to the EA air emissions risk assessment guidance. For convenience, the reference to 'H1' is retained. This guidance sets out the full process for assessing air quality for an environmental permit and has been followed in this assessment.

2.2.2 Data centre Draft Industry Guidance

The EA have published a working draft guide[25] on the approach to the permitting and regulatory aspects for Data Centre within the context of the IED and Environmental Permitting Regulations for 1.1A Combustion Activities 'Chapter II' sites aggregated to >50MWth input.

The Frequently Asked Questions (FAQs) also have relevance for Data centres which come under the MCPD specified generators. i.e. plant which is less than aggregated 50MWth but which falls under the Tranche A or Tranche B criteria for generating power (unless 'excluded generator' due to <50hours testing per year).

The draft guide makes reference to primarily assessing the NO_2 hourly mean from an emergency scenario (grid outage). This has been considered in the assessment.

The document is not presently an official release but forms the basis for discussion of a common methodology and liaison with individual operators and their industry association. The document states that it must be recognised that the document is not a legal document intending to create or modify the law as stated in statute; so ultimately data centre permitting and day to day regulation must necessarily be on a site-specific basis.

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[22] Defra (2019) Clean Air Strategy 2019

[23] IPPC H1 (2003) Environmental Assessment and Appraisal of BAT

[24] EA (2021) Air emissions risk assessment for your environmental permit Available at: https://www.gov.uk/guidance/air-emissions-risk-assessment-for-your-environmental-permit

[25] Environment Agency (2018) Data Centre FAQ Headline Approach. Available at: https://consult.environment-agency.gov.uk/psc/cr0-4td-digital-realty-uk-limited/supporting_documents/Data%20Centre%20FAQ.pdf

2.2.3 Local Air Quality Management Policy and Technical guidance

The policy guidance note, LAQM.PG(16)[26] provides additional guidance on the links between transport and air quality and the links between air quality and the land use planning system. It summarises the main ways in which the land-use planning system can help deliver compliance with the air quality objectives. This is relevant to any external organisations who may wish to engage with the local authority to assist in the delivery of their statutory duties on managing air quality.

The technical guidance, LAQM.TG(16)[27] is designed to support local authorities in carrying out their duties to review and assess air quality in their area. It provides detailed guidance on how to assess the impact of measures using existing air quality tools. Where relevant, this guidance has been taken into account in this assessment.

2.2.4 EPUK/IAQM Land-use Planning and Development Control

The 2017 Land-Use Planning & Development Control guidance document[28] produced by Environmental Protection UK (EPUK) and the IAQM provides a framework for professionals operating within the planning system to provide a means of reaching sound decisions, with regard to the air quality implications of development proposals.

The document provides guidance on when air quality assessments are required by providing screening criteria regarding the size of a development, changes to traffic flows/composition energy facilities or combustion processes associated with the development.

[26] Defra (2016) Local Air Quality Management Policy Guidance PG(16)

[27] Defra (2016) Local Air Quality Management Technical Guidance TG(16)

[28] EPUK/IAQM, (2017) Land-Use Planning & Development Control: Planning for Air Quality v1.2

3. Methodology

The overall approach to the air quality assessment comprises:

- A review of the existing air quality conditions at, and in the vicinity of, the site;
- A review of human and ecological receptors in the vicinity of the site;
- Sensitivity testing of modelling options;
- An assessment of the potential impact on air quality arising from the operation of the site;
- Assessment of the significance of the potential impact; and
- Formulation of mitigation measures, where appropriate, to ensure any adverse effects on air quality are minimised.

3.1 Pollutants Assessed

The assessment of air quality effects has considered those pollutants included in the MCPD and those included within EU and UK quality standards, namely:

- Nitrogen oxides (NOx) and nitrogen dioxide (NO_2);
- Fine particulate matter (PM_{10} and $PM_{2.5}$);
- Sulphur Dioxide (SO_2); and
- Carbon Monoxide (CO).

For the assessment of impacts on sensitive habitats (ecological sites), the potential impacts of NOx and SO_2 have been assessed, both through the impacts directly to air and through deposition of acidic compounds and nutrient nitrogen.

3.2 Methodology of Baseline Assessment

Existing or baseline ambient air quality refers to the concentration of relevant substances that are already present in the environment. These are present from various sources, such as industrial processes, commercial and domestic activities, traffic and natural sources.

A desk-based review of the following data sources has been undertaken to determine baseline conditions of air quality in this assessment:

- Dacorum Borough Council (DBC) Air Quality Annual Status Report (ASR)[29];
- The EA website[30]; and
- The UK Air Information Resource website[31].

3.3 Methodology of Operational Assessment

The Site comprises 33 containerised generators for emergency purposes, 30 of which are double stacked, two of which are secondary back-ups (redundancy) and one is a smaller ('house') generator to cover non-critical loads (e.g., office lights, office fire system) during an emergency. Each generator has an individual flue terminating at 25m above ground, the locations of which are shown in Figure 2 and details provided in

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[29] Dacorum Borough Council (2020) Air Quality Annual Status Report for 2019. Available at: https://www.dacorum.gov.uk/docs/default-source/environment-health/air-quality-annual-status-report-2020.pdf?sfvrsn=cd10d9e_4 [Accessed: July 2021]

[30] Environment Agency website; https://environment.data.gov.uk/public-register/view/search-industrial-installations [Accessed February 2022]

[31] Defra, http://uk-air.defra.gov.uk [Accessed February 2022]

Appendix A, Section A.1. The 30 double stacked generator flues are located close to each other, but are separate flues. The flue height of 25m was considered following a stack height assessment looking at heights of 16m, 18m, 20m, 22m, 23m, 24m, 25m, 28m and 30m. The details of the stack height assessment are provided in Appendix C.

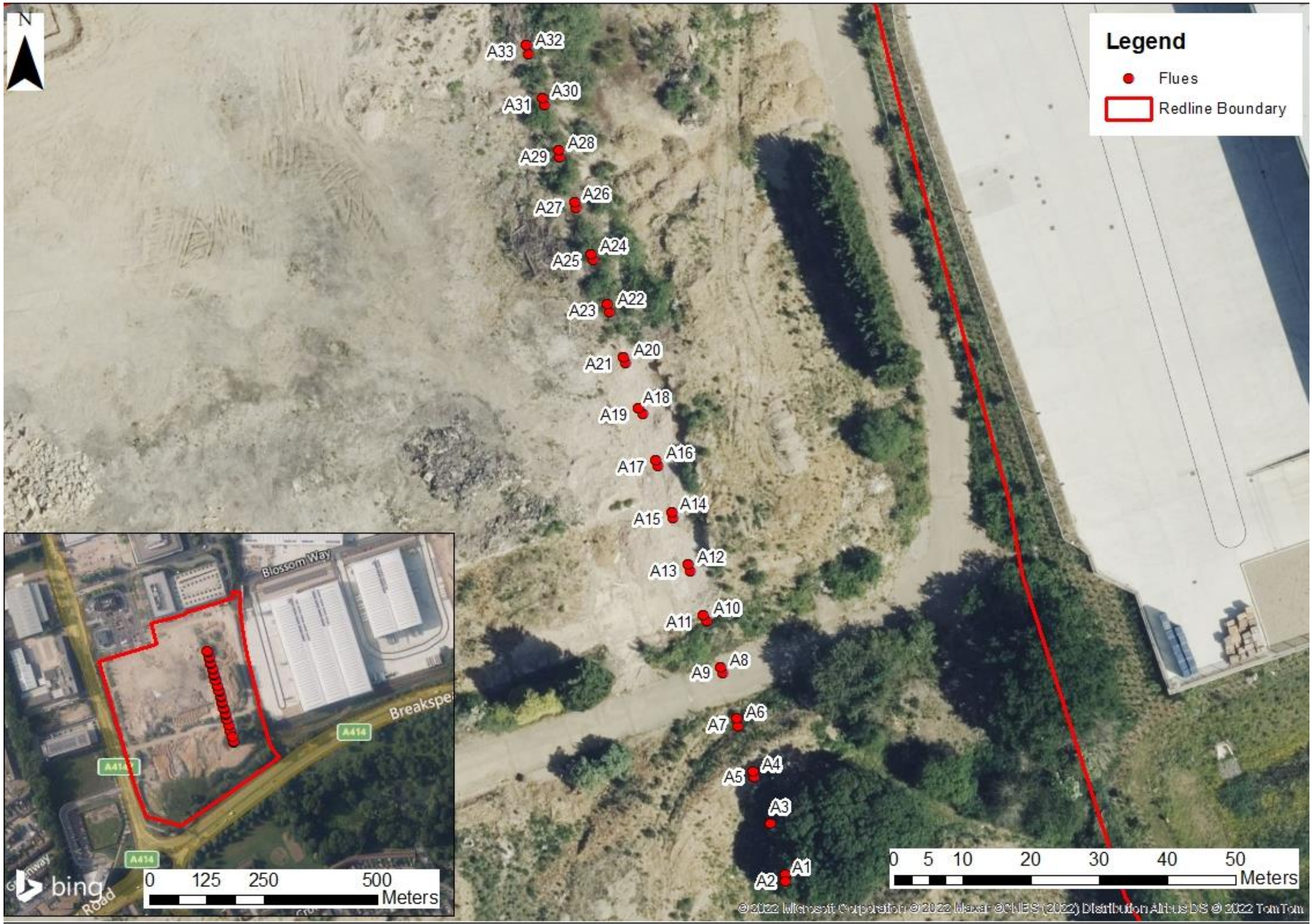

Figure 2: Generator flue locations

3.3.1 Assessment Scenarios

The following scenarios have been assessed, using the information provided by the applicant (Table 4).

Table 4: Assessment scenarios

Scenarios	Operating profile	Description
Scenario 1: Biweekly	0.5 hour runs fortnightly = 13 hours per year	Each of the 33 generators to be tested, one at a time (daytime only). Generators will be tested at 25% load (but conservatively modelled at 100%).
Scenario 2: Biannual	1.5 hour runs, twice per year = 3 hours per year	Each of the 33 generators to be tested, one at a time (daytime only). Generators will be tested at 100% load.
Scenario 3: Maintenance	3 hours of cumulative running over the course of the year	Each of the 33 generators to be tested, one at a time (daytime only). Generators will be tested at 100% load.
Scenario 4: Emergency scenario	A single (worst-case and rare) event of 68 hours of running. Preliminary modelling undertaken earlier in 2021 determined that this usage would not result in significant effects and this quantum of hours has been taken forward for formal assessment.	A single event where 30 generators plus the house generator will operate at 100% load and the two redundancy generators idling at 5% load.

Although Scenario 1 is expected to run generators at 25%, the modelling has assumed a 100% load for the generator test runs as a conservative assumption to understand any potential operational constraints (100% load is expected to result in more emission than 25% load). Using the following methodology of modelling and assessment assumes 19 hours of planned operation from the testing and maintenance Scenarios 1-3.

3.3.1.1 Modelling long-term concentrations for testing scenarios (Scenario 1-3)

The long-term air quality EALs are only relevant to planned operations (testing and maintenance). The resulting predicted annual mean concentrations was adjusted to the actual operating hours (i.e. the following factor was used to adjust the annual mean concentrations from testing, 19 ÷ 8,760 = 0.0015) following EA guidance[32].

3.3.1.2 Modelling short-term concentrations for testing scenarios (Scenario 1-3)

There are short-term air quality EALs for NO_2, PM_{10}, SO_2 and CO. Some of the EALs are given as a permitted annual number of exceedances of a threshold concentration which can be expressed as an equivalent percentile. For example, the NO_2 hourly mean EAL (200µg/m^3), not to be exceeded more than 18 times a year, can be expressed at the 99.79th percentile of the hourly mean predicted environmental concentration (PEC). PEC is the sum of the contribution from the process, process contribution (PC), and the background concentration. The PM_{10} daily mean (50µg/m^3), not to be exceeded more than 35 times a year, can be expressed as the 90.41st percentile daily mean PEC.

3.3.1.3 Modelling short-term concentrations for emergency scenario (Scenario 4)

Modelling the generators for predicting hourly mean NO_2, daily mean PM_{10}, SO_2 15-minute, hourly and daily means, CO hourly and 8-hour rolling mean concentrations for the emergency scenario is complex as the timing of an emergency scenario cannot be predetermined.

In order to estimate the absolute worst-case concentrations resulting from generators operating in an emergency, the modelling has assumed that 33 generators operate continuously throughout the year,

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[32] Environment Agency (2019) Specified generators: dispersion modelling assessment. Available at: https://www.gov.uk/guidance/specified-generators-dispersion-modelling-assessment [Accessed February 2022]

(although a 68-hour emergency operation has been considered for assessment). This allows for the emissions to coincide with all meteorological conditions that occur throughout the year and then the short-term impacts are extracted from these predictions. This approach is very pessimistic as it is highly improbable that, in the case of the NO_2 hourly mean for instance, the generators will be operating during meteorological conditions which represent the 19 hours of the year that give rise to the highest concentrations for each receptor. Therefore, a further statistical analysis was carried out using the hypergeometric distribution, following EA guidance[32], to determine the probability of exceeding the NO_2 hourly mean EAL. This is analysis is detailed in the next section.

The Summary Technical Report (Document reference 284474-EP-STR) provided as part of the EP application states that the National Grid's National Electricity Transmission System Performance Report 2020-21[33] reported the longest loss of supply incident lasted 454 minutes (7.5 hours) in Tinsley Park, Sheffield (over 190km north of the Site).

Based on this, it is unlikely that an emergency scenario will lead to an exceedance of the NOx daily, SO_2 daily and PM_{10} daily mean EALs, due to the low likelihood of a grid failure lasting 24hrs. Therefore, these impacts have not been assessed for Scenario 4. However, NOx daily concentrations have been provided on request from the EA for completeness.

3.3.1.4 Statistical analysis of the NO_2 hourly mean EAL for Scenario 4 (emergency scenario)

The hypergeometric distribution has been used to assess the likelihood of NO_2 hourly mean exceedance hours coinciding with the estimated hours of emergency operation. This makes it possible to calculate the probability of exceeding the NO_2 hourly mean EAL (not to be exceeded more than 18 times a year), taking into account the number of worst-case emergency hours (68 hours in Scenario 4). As noted in Table 4 preliminary modelling undertaken earlier in 2021 determined that this usage would not result in significant effects and this quantum of hours has been taken forward for formal assessment. 68 hours of emergency usage would comprise an exceptionally-rare event given the grid reliability in the UK.

The probability of randomly selecting 19 or more exceedance hours (failures) from the operating hours (N) is the same as selecting a non-exceedance hour within the operating hours (successes, N – 19 hours). Based on this relationship, the hypergeometric analysis calculates the probability (P) of exceedance in a year (more than 18 exceedances of the 200µg/m^3 NO_2 hourly mean EAL). The probability (P) is then multiplied by a safety factor of 2.5 following the EA guidance[32].

In this study, an emergency operational envelope of 68 hours has been deemed appropriate to use.

$$P = \sum_{i=0}^{N-19} \frac{\binom{K}{i}\binom{M-K}{N-i}}{\binom{M}{N}}$$

Where:

N= operating hours per year (i.e. 68 hours of worst-case emergency operation);

M= the operating envelope (i.e. the number of hours per year, 8,760 hours);

i= the number of sample successes required (i.e. the number of non-exceedance hours considering the total operating hours, i.e. 68 – 19 = 53 hours); and

K= The total number of non-exceedance hours in the operating envelope (i.e. 8,760 hours minus the number of hours that the limit in the model is expected to be exceeded).

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[33] Available at < https://www.nationalgrideso.com/document/211021/download> Accessed March 2022

3.3.2 Sensitive Receptors

3.3.2.1 Human Receptors

The long-term annual mean objective applies at locations where sensitive receptors are located, these would include residential properties, hospitals and schools. The short-term hourly mean objective applies at locations where members of the public may be expected to be present for more than an hour.

Pollutant concentrations have been predicted at existing sensitive receptors. Existing receptors include the properties around the proposed site. They include the most sensitive location of the residential area to the north and areas to the west and south. The closest receptor is on Barley Croft (HR6) 92m south of the Site. These receptors have been modelled at the façades of nearby existing buildings, as these are closest to the pollutant sources, and have been included at 1.5m above ground level (corresponding to the average height of human exposure).

Details of the assessed receptors are given in Table 5 below, and their locations are shown in Figure 3.

Table 5: Assessed human receptors

ID	Receptor	National Grid Reference		Heights
		X	Y	
HR1	Maddox Road	507893	207306	1.5m
HR2	27 The Flags	507866	207369	1.5m
HR3	26 The Flags	507853	207400	1.5m
HR4	17 The Flags	507806	207472	1.5m
HR5	9 Arundel Close	507779	207525	1.5m
HR6	22 Barley Croft	508159	207282	1.5m
HR7	22 Hales Park Close	508154	207768	1.5m
HR8	33 Highland Drive	507996	207208	1.5m
HR9	Holiday Inn Hemel Hempstead	508520	207432	1.5m
HR10	7 Maddox Road	507918	207225	1.5m
HR11	17 Barley Croft	508113	207244	1.5m

3.3.2.2 Ecological Receptors

Following the EA guidance, the following European level designated ecological sites within 10km of the Site:

- Special protection areas (SPAs);
- Special areas of conservation (SACs); and
- Ramsar sites (protected wetlands).

The following nationally designated ecological sites within 2km were also reviewed:

- Sites of special scientific interest (SSSIs); and
- Local nature sites:
  - Ancient woods (AW);

- Local wildlife sites (LWS);
- National nature reserves (NNR); and
- Local nature reserves (LNR).

The EA was consulted and provided a screening report listing relevant ecological sites (Document reference Appendix 05-02 of the EP Application). These included protected species and habitats using a screening distance of 500m. The list sites have been reviewed and the details are provided in Table 6.

Table 6: Ecological sites identified in the EA screening report

Ecological site	Designation	Screening details
Chilterns Beechwood	SAC	Within 10km of Site
Grand Union Canal, Two Waters to Nash Mills Lane	LWS	More than 2km away of Site – screened out
Grand Union Canal/River Gade	LWS	More than 2km away of Site – screened out
Widmore Wood	LWS, AW	Within 2km of Site
Maylands Wood	LWS, AW	Within 2km of Site
Blackwater Wood	LWS, AW	Within 2km of Site
Long Deans Meadow	LWS	More than 2km away of Site – screened out
Long Deans Wood	LWS	More than 2km away of Site – screened out
Paradise Fields Central	LWS	Within 2km of Site
Disused Railway Line, Hemel Hempstead	LWS	Within 2km of Site
Rant Meadow Wood/Bennets End Pit	LWS	Within 2km of Site
Holy Trinity Church, Leverstock Green	LWS	Within 2km of Site
Westwick Row Wood	LWS	Within 2km of Site
European Eel Anguilla migratory route	Protected species	More than 500m away of Site – screened out
Chalk rivers	Protected habitat	More than 500m away of Site – screened out

This review has identified that there is one Special Area of Conservation (SAC) within 10km, known as Chilterns Beechwoods.

Local nature sites within 2km of the Site have also been reviewed and found Ancient Woods (AW) and Local Wildlife Sites. Details are provided in Table 7 and illustrated in Figure 4.

Receptors were placed at the closest locations of the ecological designation to the proposed stacks. Ecological receptors have been modelled at a height of 0m, representative of ground level.

Table 7: Assessed ecological receptors

ID	Receptor	National Grid Reference		Heights
		X	Y	
ER1	Chilterns Beechwood SAC	500448	209977	0.0
ER2	Maylands Wood AW, LWS	507520	207861	0.0
ER3	Widmore Wood AW, LWS	507418	208561	0.0
ER4	Yewtree Wood AW	507043	208773	0.0
ER5	Rant Meadow Wood/Bennets End Pit LWS	507326	206493	0.0
ER6	Holy Trinity Church, Leverstock Green LWS	508502	206554	0.0
ER7	Westwick Row Wood LWS	509338	206429	0.0
ER8	Disused Railway Line, Hemel Hempstead LWS	506940	208808	0.0
ER9	Disused Railway Line, Hemel Hempstead LWS	507260	208943	0.0
ER10	Disused Railway Line, Hemel Hempstead LWS	507915	209515	0.0
ER11	Paradise Fields Central LWS	506073	206910	0.0
ER12	Blackwater Wood AW, LWS	509422	205831	0.0

Figure 3: Modelled human receptors

Figure 4: Modelled ecological receptors

3.3.3 Dispersion Model Setup

For the assessment of emissions from the chimney of the site, the latest ADMS atmospheric dispersion model (version 5.2.4.0) has been used. This is a well-established model originally developed on behalf of a number of UK bodies. The model can take into account the relevant information on the plant design and operations, local meteorological data, terrain and local building dimension information. ADMS has been used to predict long-term and short-term concentrations, at discrete receptors and across a gridded domain, and results have been compared with the relevant objectives.

The following sections detail the inputs and processes used in this assessment.

3.3.3.1 Meteorological Data

The meteorological data used in this assessment were measured at London Luton Airport meteorological station for the latest five years. The data were collected over the period 1st January to 31st December for years 2016 to 2020 (inclusive). London Luton is located approximately 13km north-west of the Site. This meteorological site was chosen due to its proximity to the Site.

In order for the modelling exercise to be representative of local conditions and to predict long-term averages, the dispersion model requires representative meteorological data. Most dispersion models cannot make predictions during calm wind conditions, as dispersion of air pollutants is more difficult to calculate in these circumstances. The default option within ADMS for treating calm conditions has been implemented, by setting the minimum wind speed to 0.75m/s. LAQM.TG16 guidance[27] recommends that the meteorological data file is tested within a dispersion model and the relevant output log file checked to confirm the number of missing hours and calm hours that cannot be used by the dispersion model. This is important when considering predictions of high percentiles and the number of exceedances. The guidance recommends that meteorological data should only be used if the percentage of usable hours is greater than 75% and preferably 90%.

The datasets for 2016-2020 all had usable hours greater than 90% (2016: 99%; 2017: 93%; 2018: 95%; 2019: 92%; and 2020: 96%), and therefore the data meets the requirements of the Defra guidance and is adequate for use in dispersion modelling.

Figure 5 shows the London Luton Airport wind roses for 2016 to 2020. It can be seen that the predominant wind direction is south-westerly.

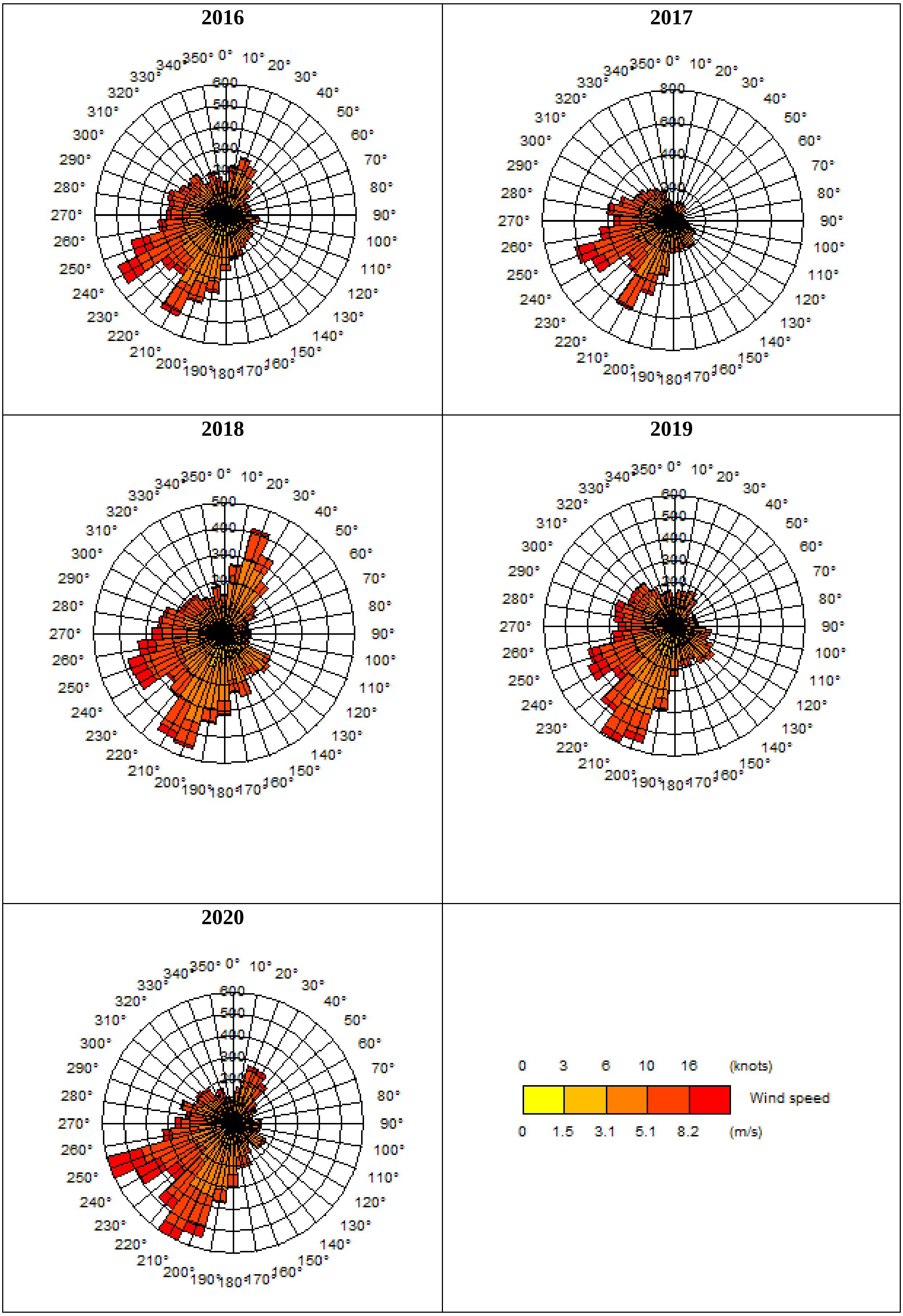

Figure 5: London Luton Airport wind roses for 2016 to 2020

3.3.3.2 Surface roughness and minimum Monin-Obukhov length

The extent of mechanical turbulence (and hence, mixing) in the atmosphere is affected by the surface/ground over which the air is passing. Typical surface roughness values range from 0.0001m (for water or sandy deserts) to 1.5 (for cities, forests and industrial areas). In this assessment, the general land use in the local study area can be described as "Cities, woodland" with a corresponding surface roughness of 1m. The surface roughness value used for the meteorological station site was also "Cities, woodland" with a corresponding surface roughness of 1m. Which is considered representative of the site.

The minimum Monin-Obukhov length is a model parameter which describes the extent to which the urban heat island effect limits stable atmospheric conditions. A Monin-Obukhov length of 30m has been used in this dispersion modelling study. It is suggested in ADMS that this length is suitable for "Cities and large towns". The same Monin-Obukhov length was used for the meteorological station site, which is considered representative of the site.

3.3.3.3 Terrain effects

Large scale terrain effects will be captured by the meteorological data. The land around the Site is fairly flat and therefore no assessment of terrain is considered to be required and it has not been included in the model.

3.3.3.4 Buildings

Buildings can have a significant effect on the dispersion of pollutants and will be included within the model. Building input geometries are shown in Table 8 and Figure 6. The complex building geometry has been simplified so as to be included within the model which only accepts rectangular or circular building shapes. The main building stands 18m above ground, but the height of 17.5m takes into consideration the curved roof of the warehouse structure.

Table 8: Building geometry details

Building ID	NGR (m)		Height (m)	Length (m)	Width (m)	Angle (°)
	X	Y				
Main Building	508063.6	207474.4	17.5	180.9	98.3	160.9
Vitabiotics	508260.4	207575.1	9.0	156.1	101.8	159.7
Chiltern Timber	508214.6	207725.0	9.0	31.9	136.8	175.7

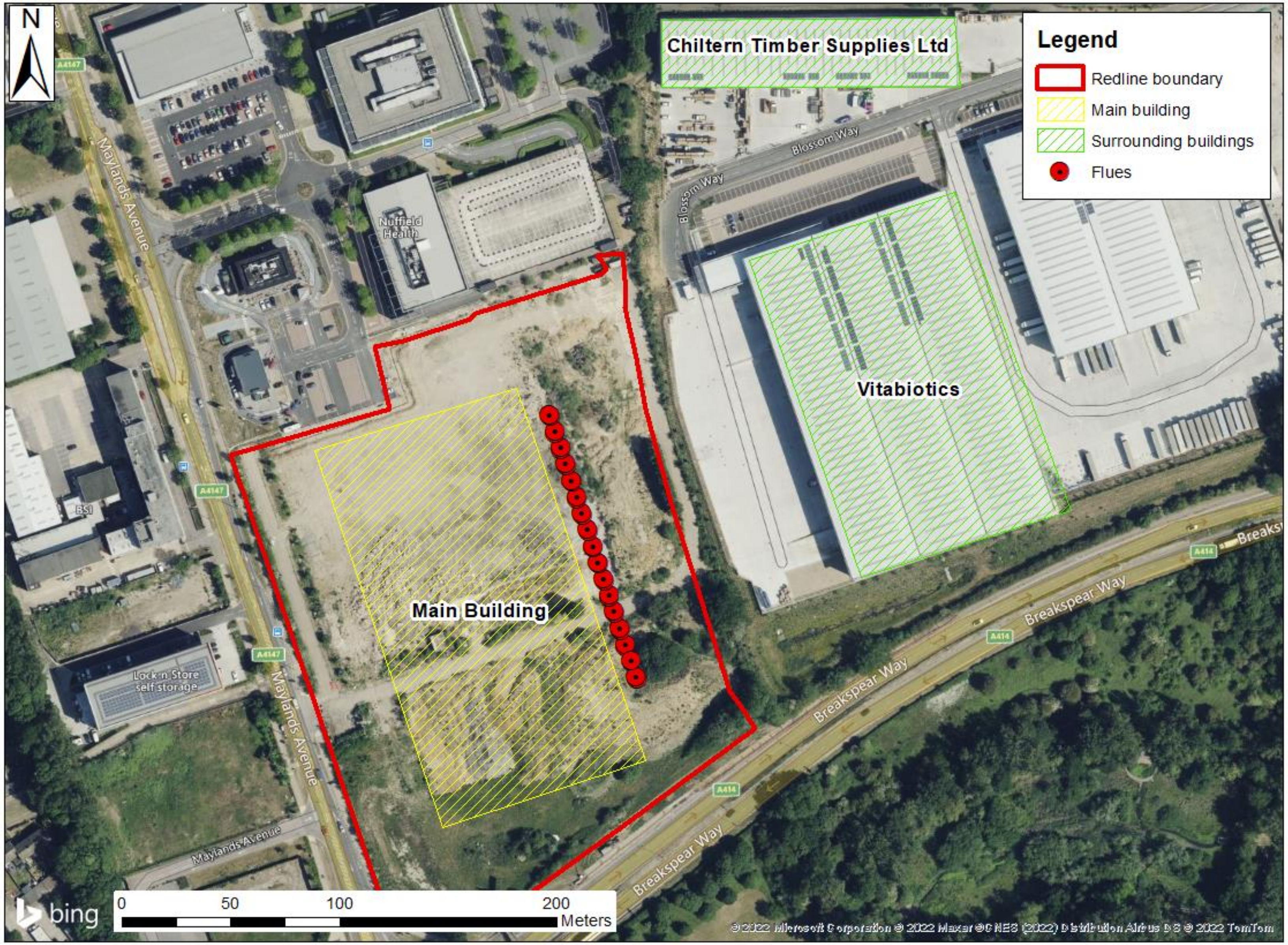

Figure 6: Modelled buildings

3.3.3.5 NOx to NO_2 Conversion

The model predicts nitrogen oxides (NOx) concentrations which comprise nitric oxide (NO) and nitrogen dioxide (NO_2). NOx is emitted from combustion processes, primarily as NO with a small percentage of NO_2. The emitted NO reacts with oxidants in the air (mainly ozone) to form NO_2.

This assessment has followed the methodology set out by the EA which states it should be assumed as a worst-case scenario that 70% of long-term and 35% of short-term NOx concentrations will convert to NO_2[34].

3.3.3.6 Total Concentrations

To calculate the total concentration, the background concentrations are added to the impact of the generators at the receptors. For long-term concentrations, the annual average background concentration has been used. For the short-term concentrations (daily mean or hourly mean), twice the annual mean will be added to the model predictions, following EA H1 guidance[24].

The total concentrations at each receptor are calculated as follows:

- Long-term total concentration or predicted environmental concentration (PEC) = long-term process contribution (PC) from the generators + annual mean background concentration
- Short-term PEC = short-term PC + 2 x annual mean background concentration

3.3.4 Nutrient Nitrogen and Acid Deposition

With regard to nitrogen and acid deposition, site and habitat specific critical loads and existing deposition rates have been taken from the APIS website[35]. Predicted deposition at ecological receptors has been compared against the lowest critical loads to provide a worst-case assessment.

The assessment has looked at the Critical Load Functions (CLFs) for acidity using the graphs on the APIS website. The CLF graphs for the most sensitive species in each designated area have been used to estimate the worst-case impact where the impacts have not been screened out as less than 1%.

The information on the critical loads and the most sensitive habitat for each designated for vegetation of nutrient nitrogen and acidity are given in Section 4.3.1.

Acid deposition is assessed in terms of the CLFs for acidity, which are a function of nitrogen (N) and sulphur (S) deposition. The critical load functions are site and feature/habitat specific. Total nitrogen (N) deposition has been derived from the addition of ammonia and nitrogen dioxide deposition results. Due to HVO fuel being used, sulphur has not been accounted for.

The CLFs comprise two lines on a graph, which represent two envelopes of safety (reflecting the present uncertainty in the scientific knowledge and evidence-base on the effects of acidic air pollution on sensitive species). If the total acid deposition rate falls above the higher 'maximum Critical Load' (maxCL) line, it is likely that there are harmful effects on the relevant habitat/features arising from the current level of acid deposition. If the total acid deposition level is below the lower 'minimum CL' (minCL) line, it is unlikely that the feature/habitat is being harmed. If the current total acid (due to both nitrogen and sulphur) deposition level lies between the lower and upper CLFs, it is not possible to be certain that harm is occurring.

The dry deposition flux for each receptor location has been calculated based on recommended deposition velocities as shown in Table 9.

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[34] Environment Agency; *Air Quality Modelling and Assessment Unit, Conversion ratios for NO_x and NO_2*

[35] APIS Air Pollution Information System www.apis.ac.uk

Table 9: Recommended dry deposition velocities

Chemical species	Recommended deposition velocity, m/s	
NO_2	Grassland	0.0015
	Forest	0.0030
SO_2	Grassland	0.0120
	Forest	0.0240

Conversion factors are used to convert dry deposition flux from units of µg/m^2/s to kg/ha/yr are shown in Table 10.

Table 10: Conversion factors to change units from µg/m^2/s of chemical species X to kg of X/ha/yr

Chemical species	Conversion factor µg m^2/s of species X to kg/ha/year	
NO_2	of N:	96
SO_2	of S:	157.7

The unit of 'equivalents' is also used for acidification purposes, rather than a unit of mass. Essentially it means 'moles of charge' i.e. it is a measure of how acidifying the chemical species can be. It is denoted by 'keq'.

To convert kg/ha/yr to keq/ha/yr, the conversion factors shown in Table 11 have been used.

Table 11: Conversion factors to alter units from kg of N or S ha/yr to keq of N or S ha/yr

Species	Conversion factor kg/ha/year to keq/ha/year
N	0.071428
S	0.0625

3.4 Assessment of Significant Effects

3.4.1 Human receptors

The EA H1 guidance[24] provides the screening criteria to determine significance of emissions associated with industrial premises. To screen out a Process Contribution (PC), the PC must meet both of the following criteria:

- The short-term PC is less than 10% of the short-term EAL; and
- The long-term PC is less than 1% of the long-term EAL.

If both criteria are met, the potential impacts are considered to be insignificant. If criteria are not met, a second stage of screening is needed to determine the impact of the Predicted Environmental Concentration (PEC).

In the second stage of screening (step 2), the potential impacts are considered to be insignificant if the following requirements are met:

- The short-term PC is less than 20% of the short-term EAL minus twice the long-term background concentration; and
- The long-term PEC is less than 70% of the long-term EAL.

Should all of these criteria be exceeded however, it does not mean that significant impacts are predicted; rather that an assessment needs to be undertaken as to whether there is the potential for significant impacts.

3.4.2 Ecological receptors

The EA H1 guidance also similarly describes how insignificant process contributions can be screened out of further analysis for ecological designated sites.

Step 1: The PC can be considered insignificant and require no further investigation if:

- The long-term PC is <1% of the long term environmental standard; and
- The short-term process contribution is <10% of the short term environmental standard.

Step 2: For those contributions not screened out, the PEC which is the sum of background concentration and PC, must be tested. Concentrations are considered potentially significant if:

- The long-term PEC is greater than 70% of the long-term standard; or
- The short-term PC is greater than 20% of the short-term standard minus twice the annual mean background concentration.

For local nature sites however (i.e. local wildlife sites and ancient woodlands), the EA uses less stringent criteria in its permitting decisions. EA policy for its permitting process is that if either the short-term or long-term PC is less than 100% of the critical level or load, they do not require further assessment. This screening criteria has been used to assess the impact on the relevant sites within 2km of the Site.

Predicted PC or PEC that meet the above criteria are deemed to be insignificant. When impacts cannot be screened out as being negligible using the thresholds above, the evaluation of the significance of results requires advice from an ecologist.

3.4.3 Emergency scenario

For Scenario 4, unplanned emergency scenario, the assessment has determined whether the relevant EAL will be exceeded. If an exceedance of the relevant EAL is not predicted as a result of an emergency scenario, the predicted impact is considered to be insignificant.

A statistical analysis has been undertaken to assess the likelihood of the NO_2 hourly mean EAL being exceeded in the modelled emergency scenario. With regards to the probability from the analysis using the hypergeometric distribution, the following criteria has been used following the EA guidance[32]. Where the probability is:

- 1% or less – exceedances are highly unlikely;
- less than 5% – exceedances are unlikely as long as the generator plant operational lifetime is no more than 20 years; and
- more than or equal to 5% – there is potential for exceedances and the regulator will consider if acceptable on a case-by-case basis.

3.5 Limitations and Assumptions

Air quality dispersion modelling has inherent areas of uncertainty, including:

- simplification in model algorithms and empirical relationships that are used to stimulate complex physical and chemical processes in the atmosphere;
- spatial variability of model background concentrations;
- spatial variability of meteorological data;
- effects of terrain; and
- emissions concentrations due to varied raw material inputs.

To reduce uncertainty, a number of conservative assumptions have been made and are detailed throughout this report. The methodology used within this assessment is designed to provide a robust assessment, reducing uncertainty caused by the above limitations.

4. Baseline Assessment

4.1 Sources of Pollution

4.1.1 Road traffic

Several major roads are located in proximity to the Site, including the A414 (Breakspear Way) to the south, the A4147 (Maylands Avenue) to the west. The M1 is located 1.2km to the east.

4.1.2 Industrial processes

Industrial air pollution sources are regulated through a system of operating permits or authorisations, requiring stringent emission limits to be met and ensuring that any releases to the environment are minimised or rendered harmless. Regulated (or prescribed) industrial processes are classified as Part A(1), A(2), Part B or Medium Combustion Plant (MCP) processes, and are regulated through the Pollution Prevention and Control (PPC) system[36,37]. The larger more polluting processes are regulated by the EA and the smaller less polluting ones by the local authorities. Local authorities regulate only for emissions to air, whereas the EA regulates emissions to air, water and land.

There are three EA regulated processes within 2km of the site according to the EA's website[38], presented in Table 12. The locations of these sites are shown in Figure 7.

Table 12: Regulated processes within 2km of the Site

Name	Approximate distance from Site (km)	Releases to air
Flint to Cell Limited	1.8	Tranche B special generator
UK Power Reserve Limited	1.8	Combustion; waste derived fuel =>3MW

[36] Directive 2010/75/EU of the European Parliament and of the Council of 24 November 2010 on industrial emissions (integrated pollution prevention and control)

[37] The Environmental Permitting (England and Wales) Regulations 2016, SI 2016/1154

[38] Environment Agency, Environmental Permitting Regulations – Installations. Available at: https://environment.data.gov.uk/public-register/view/search-industrial-installations [Accessed February 2022]

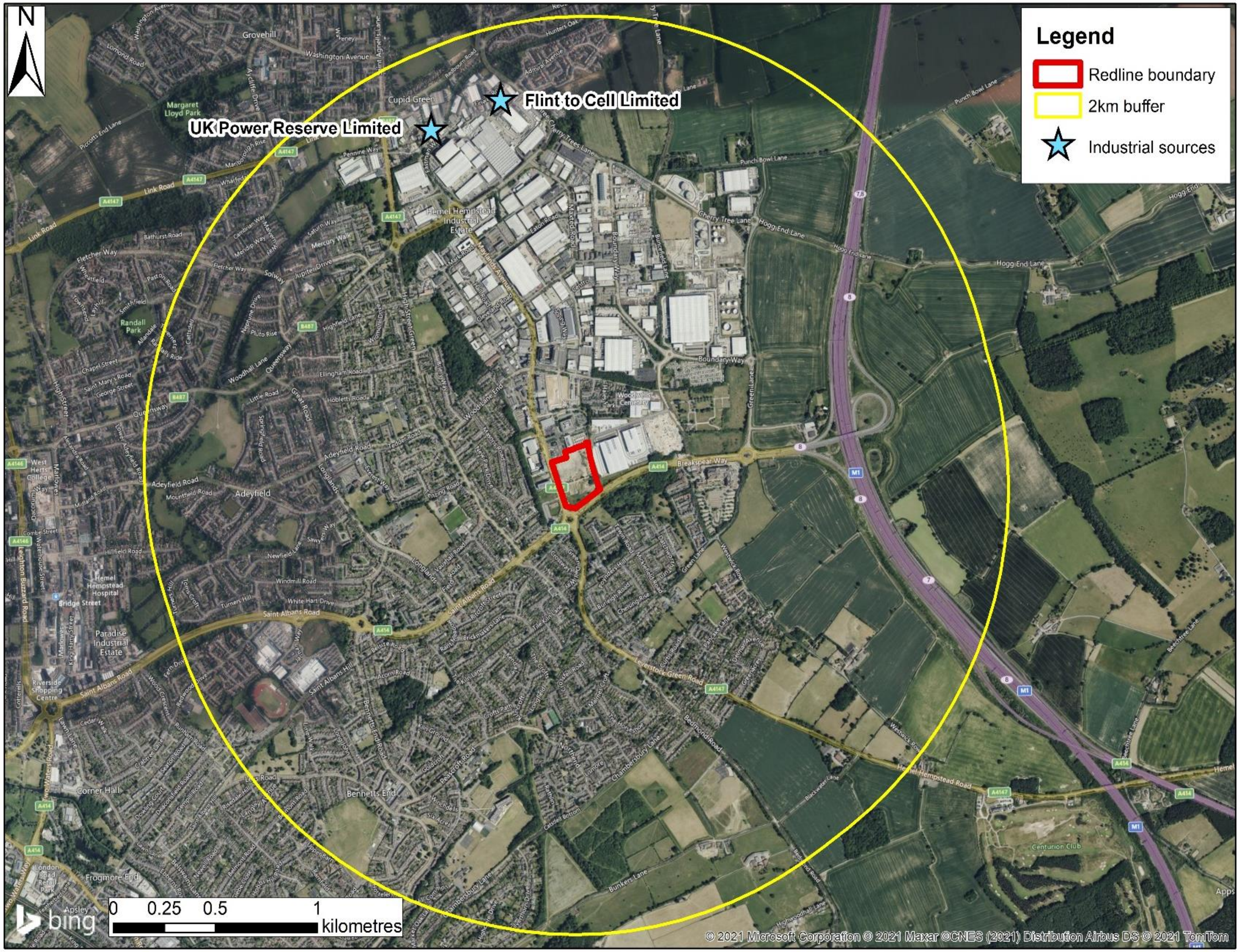

Figure 7: Industrial installations

4.2 Local Air Quality

The Environment Act 2021 requires local authorities to review and assess air quality with respect to the objectives for the pollutants specified in the National Air Quality Strategy. Where objectives are not predicted to be met, local authorities must declare the area as an AQMA. In addition, local authorities are required to produce an Air Quality Action Plan (AQAP) which includes measures to improve air quality within the AQMA.

There are no AQMAs within 2km of the site. The closest AQMA is the Hemel Hempstead AQMA No.1, which is located approximately 2.5km to the southwest and is unlikely to be affected by the proposed generators.

4.2.1 Local monitoring data

DBC undertakes both automatic and passive monitoring in the borough. A summary of the monitoring within 1km of the site is provided in the following sections.

According to the 2020 DBC's ASR, no SO_2 monitoring is being undertaken as there are no relevant sources in relation to SO_2 emission. There is no expectation that the objectives for SO_2 would be exceeded at the proposed location.

The nearest PM_{10} monitoring undertaken by DBC is located over 10km away from the site, and this is not considered to be representative. There is no expectation that the objectives for PM_{10} would be exceeded at the proposed location.

4.2.1.1 Automatic Monitoring

Automatic monitoring involves drawing air through an analyser continuously to obtain near real-time pollutant concentration data.

DBC operates one automatic site monitoring NO_2, PM_{10} and $PM_{2.5}$, which is approximately 11km west of the Site, and this is not considered to be representative. The nearest automatic monitor measuring SO_2 is Luton Airport monitoring station monitor approximately 15km northeast of the Site. The nearest automatic monitor measuring CO is London Bloomsbury monitor approximately 30km southeast of the Site.

4.2.1.2 Diffusion tube monitoring

There are six NO_2 diffusion tubes site within 2km of the site. The details of the diffusion tubes and the measured annual mean NO_2 concentrations are shown in Table 13. The locations of these diffusion tubes are shown in Figure 8.

The monitoring data show all monitoring locations recorded concentrations below the annual mean NO_2 objective of 40µg/m^3 in the last five years.

Table 13: 2015 – 2019 DBC Monitoring Data

Site ID	Site Name	Site type	Distance from site (km)	OS Grid Ref (m)		Annual mean NO_2 concentration (µg/m^3)				
				X	Y	2015	2016	2017	2018	2019
DC40	Sawyers Way HH	R	1.2	506780	207180	19.0	19.4	18.2	17.3	17.8
DC42	Wood Lane End HH	UB	0.4	508177	207934	21.0	21.5	19.4	20.8	19.6
DC58	Gammon Close HH	UB	1.3	507058	206727	24.4	33.4	23.8	24.1	22.7
DC59	Wadley Close HH	UB	1.3	506981	206829	28.9	29.2	27.8	25.7	26.7
DC60	Field Road HH	UB	0.8	507483	206898	20.9	22.4	19.2	20.3	20.8
DC61	St Agnells Lane HH	R	2.0	507121	209252	26.3	27.0	26	24.5	26.1

Note: R = Roadside; UB = Urban Background.

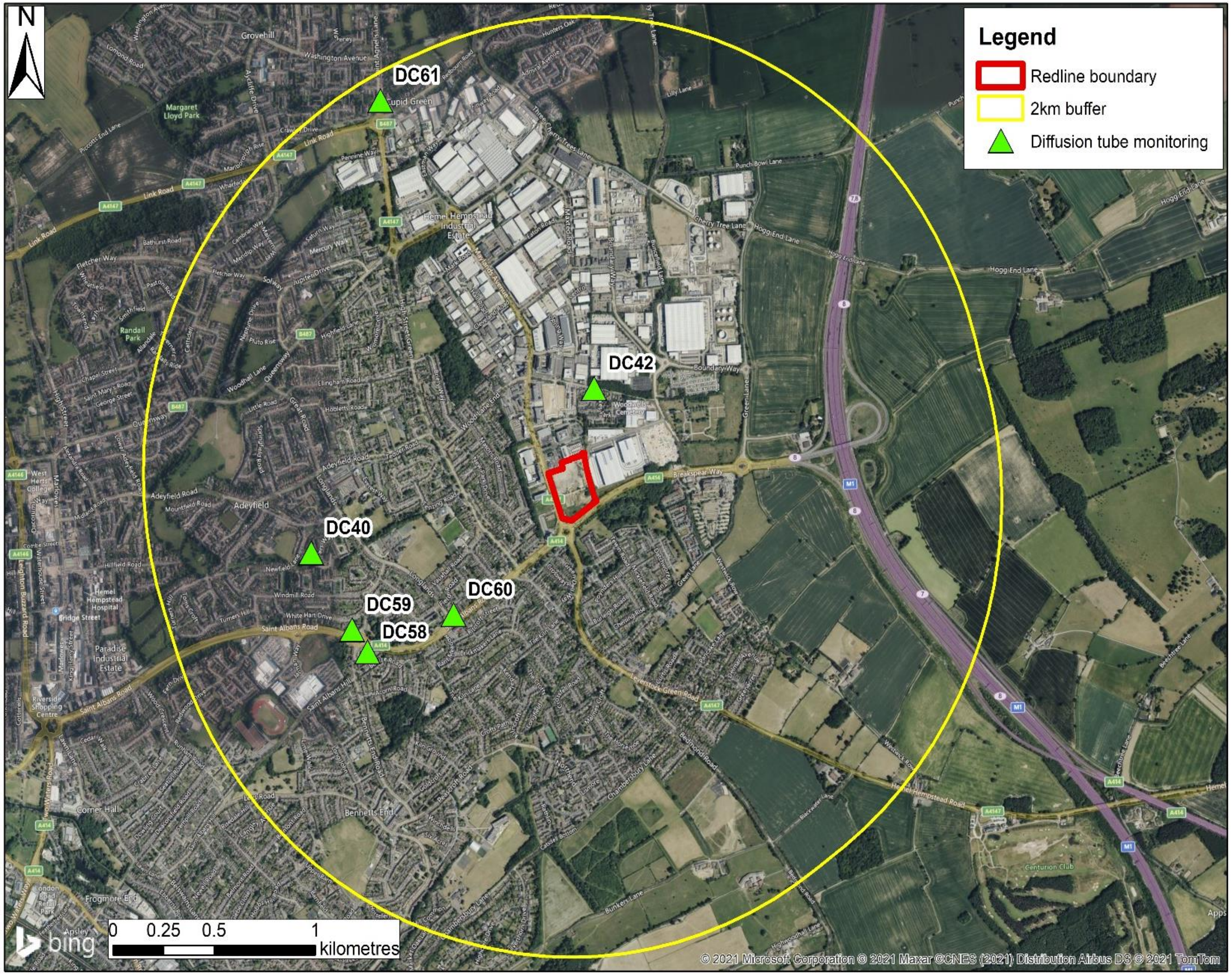

Figure 8: DBC diffusion tube monitoring sites

4.2.2 Defra predicted background concentrations

In additional to ambient monitoring, the Defra website[31] provides estimated background concentrations for NO_2, PM_{10}, $PM_{2.5}$, SO_2 and CO for each 1km-by-1km Ordnance Survey (OS) grid square. Background concentrations refer to the existing levels of pollution in the atmosphere, produced by a variety of stationary and non-stationary sources, such as roads and industrial processes.

Table 14 to Table 18 show the estimated 2018 - 2021 Defra background concentrations for relevant grid squares within the site. The CO predictions have been calculated using the year adjustment factors[39] produced by Defra, following the Defra background map user guide[40].

For SO_2, year adjustment factors are no longer provided because it is considered that away from specific locations near industrial sources or areas of high domestic coal burning, SO_2 background levels would change very little, i.e. the factor would be close to one. Therefore, Table 18 provides the 2001 predictions and assume they have not changed in the future.

The estimated background concentrations are all below the relevant objectives between 2018 and 2021.

Table 14: 2018 – 2021 Defra background pollutant concentrations for NO_2

OS Grid Square		Annual mean concentrations (µg/m³)			
X	Y	2018	2019	2020	2021
507500	207500	15.7	15.1	14.4	13.8
508500	207500	17.8	17.1	16.4	15.6

Table 15: 2018 – 2021 Defra background pollutant concentrations for PM_{10}

OS Grid Square		Annual mean concentrations (µg/m³)			
X	Y	2018	2019	2020	2021
507500	207500	15.3	15.0	14.7	14.5
508500	207500	15.6	15.3	15.0	14.8

Table 16: 2018 – 2021 Defra background pollutant concentrations for $PM_{2.5}$

OS Grid Square		Annual mean concentrations (µg/m³)			
X	Y	2018	2019	2020	2021
507500	207500	10.4	10.2	10.0	9.8
508500	207500	10.5	10.3	10.0	9.9

Table 17: 2018 – 2021 Defra background pollutant concentrations for CO

OS Grid Square		Annual mean concentrations (µg/m³)			
X	Y	2018	2019	2020	2021
507500	207500	187.05	188.77	190.49	191.78
508500	207500	187.05	188.77	190.49	191.78

[39] Defra (2021) Year Adjustment Factors https://laqm.defra.gov.uk/air-quality/air-quality-assessment/year-adjustment-factors/

[40] Defra (2020) Background Concentration Maps User Guide, August 2020

Table 18: 2018 – 2021 Defra background pollutant concentrations for SO_2

OS Grid Square		Annual mean concentrations ($\mu g/m^3$)
X	Y	2001
507500	207500	3.92
508500	207500	4.23

A comparison between the 2019 (latest year unaffected by Covid 19) urban background monitoring NO_2 concentrations and 2019 Defra predicted NO_2 concentrations in Table 19. The table suggests that Defra has underpredicted concentrations of NO_2.

Table 19: Comparison of urban background NO_2 monitoring with Defra predicted backgrounds

Site ID	Monitored ($\mu g/m^3$)	Defra predicted ($\mu g/m^3$)	% difference ((Defra–monitored)/ monitored)
DC42	19.6	17.1	-13%
DC58	22.7	14.6	-36%
DC59	26.7	15.4	-42%
DC60	20.8	14.6	-30%

Table 19 suggests that for NO_2, Defra underpredicts concentrations. This is likely due to the urban background monitors being located in proximity to roads (namely A414). The sensitive receptors assessed are nearby the A414 which monitors DC58, DC59 and DC60 are located nearby. Therefore, an average of these monitoring results for 2019 have been used for NO_2 in the assessment (23.4$\mu g/m^3$ of annual NO_2) has been used for these receptors. However, the receptor at Hales Park Close (HR7) is located in a residential area further away from the A414, near monitor DC42. Therefore, the 2019 result at DC42 (19.6$\mu g/m^3$ of annual NO_2) has been used for HR7.

For PM_{10}, $PM_{2.5}$, in the absence of relevant monitoring results, Defra predicted backgrounds have been used for the specific receptor locations.

4.3 Selection of Background Concentrations

The NO_2 annual mean background concentrations used in the assessment are described above. For PM_{10}, $PM_{2.5}$, SO_2 and CO, in the absence of relevant monitoring results, Defra predicted backgrounds for 2019 have been used for the specific receptor locations, with the exception of SO_2, which is the 2001 predicted background. Year adjustment factors have been used following guidance to calculated 2019 CO annual means, but year adjustment factors for SO_2 are no longer provided by Defra as background levels near industrial sources are not expected to change much from 2001 levels. The annual mean backgrounds used are provided in Table 20.

The short-term backgrounds are calculated as two times the annual mean background.

Table 20: Annual mean background concentrations used in assessment (µg/m^3)

Receptor	NOx	NO_2	PM_{10}	$PM_{2.5}$	SO_2	CO
HR1	20.6	23.4	14.4	10.2	3.92	189
HR2	20.6	23.4	14.4	10.2	3.92	189
HR3	20.6	23.4	14.4	10.2	3.92	189
HR4	20.6	23.4	14.4	10.2	3.92	189
HR5	20.6	23.4	14.4	10.2	3.92	189
HR6	23.8	23.4	14.4	10.3	4.23	184
HR7	23.8	19.6	14.4	10.3	4.23	184
HR8	20.6	23.4	14.4	10.2	3.92	189
HR9	23.8	23.4	14.4	10.3	4.23	184
HR10	20.6	23.4	14.4	10.2	3.92	189
HR11	23.8	23.4	14.4	10.3	4.23	184
ER1	12.5	n/a	n/a	n/a	3.37	n/a
ER2	20.6	n/a	n/a	n/a	3.92	n/a
ER3	23.6	n/a	n/a	n/a	7.69	n/a
ER4	23.6	n/a	n/a	n/a	7.69	n/a
ER5	19.9	n/a	n/a	n/a	3.77	n/a
ER6	19.8	n/a	n/a	n/a	3.79	n/a
ER7	26.2	n/a	n/a	n/a	3.55	n/a
ER8	18.5	n/a	n/a	n/a	3.64	n/a
ER9	23.6	n/a	n/a	n/a	7.69	n/a
ER10	19.2	n/a	n/a	n/a	5.22	n/a
ER11	21.2	n/a	n/a	n/a	3.68	n/a
ER12	17.9	n/a	n/a	n/a	3.42	n/a

4.3.1 Nutrient Nitrogen and Acid Deposition

The information on the backgrounds and critical loads for the most sensitive habitat for each ecological site for nutrient nitrogen and acidity are given in Table 21 and Table 22 respectively. These figures have been taken from the APIS website[35] and used in the assessment.

Table 21: Nutrient nitrogen deposition critical loads and background deposition levels

ID	Designated area	Most sensitive habitat	Critical Load (kg N/ha/yr)	Background N (kg N/ha/yr)
ER1	Chilterns Beechwood SAC	Asperulo-Fagetum (beech forests)	10-20	33.6
ER2	Maylands Wood AW, LWS	n/a	10-20	33.6
ER3	Widmore Wood AW, LWS	n/a	10-20	33.6
ER4	Yewtree Wood AW	n/a	10-20	33.6
ER5	Rant Meadow Wood/Bennets End Pit LWS	n/a	10-20	33.6
ER6	Holy Trinity Church, Leverstock Green LWS	n/a	20-30	20.44
ER7	Westwick Row Wood LWS	n/a	10-20	33.6
ER8	Disused Railway Line, Hemel Hempstead LWS	n/a	10-20	33.6
ER9	Disused Railway Line, Hemel Hempstead LWS	n/a	10-20	33.6
ER10	Disused Railway Line, Hemel Hempstead LWS	n/a	10-20	33.6
ER11	Paradise Fields Central LWS	n/a	20-30	20.44
ER12	Blackwater Wood AW, LWS	n/a	10-20	33.6

Table 22: Acid deposition critical loads and background deposition rates

ID	Most sensitive habitat	CLNmin (kg N/ha/yr)	CLNmax (kg N/ha/yr)	CLSmax (kg S/ha/yr)	Background N (kg N/ha/yr)	Background S (kg S/ha/yr)
ER1	Asperulo-Fagetum beech forests - Beech forests on neutral to rich soils	0.142	2.004	1.862	1.22	0.25
ER2	n/a	0.142	2.004	1.862	1.22	0.25
ER3	n/a	0.142	2.004	1.862	1.22	0.25
ER4	n/a	0.142	2.004	1.862	1.22	0.25
ER5	n/a	0.142	2.004	1.862	1.22	0.25
ER6	n/a	0.856	4.856	4.000	1.46	0.17
ER7	n/a	0.142	2.004	1.862	1.22	0.25
ER8	n/a	0.142	2.004	1.862	1.22	0.25
ER9	n/a	0.142	2.004	1.862	1.22	0.25
ER10	n/a	0.142	2.004	1.862	1.22	0.25
ER11	n/a	0.856	4.856	4.000	1.46	0.17
ER12	n/a	0.142	2.004	1.862	1.22	0.25

5. Assessment of Operational Effects

5.1 Human Receptors

5.1.1 Scenarios 1 to 3 (planned maintenance)

5.1.1.1 NO_2 annual mean

The largest predicted PC of NO_2 annual mean is 0.02µg/m^3 at receptor HR7 (22 Hales Park Close), which is less than 1% of the relevant EAL. The largest PEC predicted is 23.4µg/m^3 at HR11 (17 Barley Croft), less than 60% of the EAL.

These results have been scaled to reflect operation over 19 hours of the year, but still provide a conservative approach assuming the generators operate at 100% load.

There are no predicted exceedances of the EAL, and the PC is <1% of the EAL. Therefore, the impact of the generators on the NO_2 annual mean EAL is considered to be **insignificant** for scenarios 1-3.

These results are presented in Appendix B.

5.1.1.2 NO_2 hourly mean

The largest predicted PC in NO_2 99.79th percentile hourly mean is 30.2µg/m^3 at receptor HR7, which is approximately 15% of the EAL. The largest PEC predicted is 73.9µg/m^3 at HR11, less than 74% of the EAL.

As the first screening step was not passed at all receptors (where some short term PCs were greater than 10% of the air quality standard), step 2 was considered. All short term NO_2 PCs were less than 20% of the EAL minus twice the long-term background. No exceedances of the air quality standard were predicted. Therefore, the impact from the generators on the NO_2 hourly mean EAL is considered to be **insignificant** for scenarios 1-3.

These results are presented in Appendix B.

5.1.1.3 PM_{10} annual mean

The largest predicted PC in PM_{10} annual mean is <0.01µg/m^3 at receptor HR7, which is less than 1% of the EAL. The largest PEC predicted is 14.4µg/m^3 at HR7, which is less than 36% of the EAL.

These results have been scaled to reflect operation over 19 hours of the year, but still provide a conservative approach assuming the generators operate at 100% load.

There are no predicted exceedances of the EAL, and the PCs are <1% of the EAL. Therefore, the impact of the generators on the PM_{10} annual mean EAL is considered to be **insignificant** for scenarios 1-3.

These results are presented in Appendix B.

5.1.1.4 PM_{10} daily mean

The largest predicted PC in PM_{10} 90.41st percentile daily mean is 1.2µg/m^3 at receptor HR11, which is less than 3% of the EAL of 50µg/m^3. The largest PEC predicted is 30.0µg/m^3 and also at HR11, which is approximately 60% of the EAL.

The first screening step was passed at all receptors as all short term PCs were less than 10% of the EAL. No exceedances of the EAL were predicted. Therefore, the impact from the generators on the PM_{10} daily mean objective at the sensitive receptors is considered to be **insignificant** for scenarios 1-3.

These results are presented in Appendix B.

5.1.1.5 $PM_{2.5}$ annual mean

The largest predicted PC of $PM_{2.5}$ annual mean is <0.01µg/m^3 at receptor HR7, which is less than 1% of the EAL of 20µg/m^3. The largest PEC predicted is 10.3µg/m^3 at HR7, which is less than 52% of the EAL.

These results have been scaled to reflect operation over 19 hours of the year, but still provide a conservative approach assuming the generators operate at 100% load.

There are no predicted exceedances of the EAL, and the PCs are <1% of the EAL. Therefore, the impact from the generators on the $PM_{2.5}$ annual mean EAL at the sensitive receptors is considered to be **insignificant** for scenarios 1-3.

These results are presented in Appendix B.

5.1.1.6 SO_2 15-minute mean

The largest predicted PC of SO_2 99.9th percentile 15-minute mean is 36.5µg/m^3 at receptor HR11, which is less than 15% of the EAL of 266µg/m^3. The largest PEC predicted is 45.0µg/m^3 also at HR11, which is approximately 17% of the EAL.

For scenario 1, a conservative approach was taken with the generators running at 100% load and these results are also therefore applicable to scenarios 2 and 3.

As the first screening step was not passed at all receptors (some short-term PCs were greater than 10% of the EAL), step 2 was considered. All 15-minute mean short-term SO_2 PCs were less than 20% of the EAL minus twice the long-term background. There were no exceedances of the EAL. Therefore, the impact from the generators on the SO_2 15-minute mean EAL is considered to be **insignificant** for scenarios 1-3.

These results are presented in Appendix B.

5.1.1.7 SO_2 hourly mean

The largest predicted PC of SO_2 99.73rd percentile hourly mean is 32.1µg/m^3 at receptor HR11, which is 9% of the EAL of 350µg/m^3. The largest PEC predicted is 40.6µg/m^3 also at HR11, which is approximately 12% of the EAL.

For scenario 1, a conservative approach was taken with the generators running at 100% load and these results are also therefore applicable to scenarios 2 and 3.

The first screening step was passed at all receptors as all short-term PCs were less than 10% of the EAL. There were no exceedances of the EAL. Therefore, the impact from the generators on the SO_2 hourly mean objective is considered to be **insignificant** for scenarios 1-3.

These results are presented in Appendix B.

5.1.1.8 SO_2 daily mean

The largest predicted PC of SO_2 99.18th percentile daily mean is 21.0µg/m^3 at receptor HR11, which is less than 18% of the EAL of 125µg/m^3. The largest PEC predicted is 29.4µg/m^3 also at HR11, which is approximately 24% of the EAL.

For scenario 1, a conservative approach was taken with the generators running at 100% load and these results are also therefore applicable to scenarios 2 and 3.

As the first screening step was not passed at all receptors (some short-term PCs were greater than 10% of the EAL), step 2 was considered. All daily mean short-term SO_2 PCs were less than 20% of the EAL minus twice the long-term background. There were no exceedances of the EAL. Therefore, the impact from the generators on the SO_2 daily mean EAL is considered to be **insignificant** for scenarios 1-3.

These results are presented in Appendix B.

5.1.1.9 CO hourly mean

The largest predicted PC of CO hourly mean is 91.6µg/m^3 at receptor HR6, which is less than 1% of the EAL of 30,000µg/m^3. The largest PEC predicted is 460µg/m^3 also at HR6, which is less than 2% of the EAL.

For scenario 1, a conservative approach was taken with the generators running at 100% load and these results are also therefore applicable to scenarios 2 and 3.

The first screening step was passed at all receptors as all short-term PCs were less than 10% of the EAL. There were no exceedances of the EAL. Therefore, the impact from the generators on the CO hourly mean EAL is considered to be **insignificant** for scenarios 1-3.

These results are presented in Appendix B.

5.1.1.10 CO 8-hour rolling mean

The largest predicted PC of 8 hour rolling CO is 64.4µg/m^3 at receptor HR11, which is less than 2% of the EAL of 10,000µg/m^3. The largest PEC predicted is 65.3µg/m^3 also at HR11, which is less than 1% of the EAL.

For scenario 1, a conservative approach was taken with the generators running at 100% load and these results are also therefore applicable to scenarios 2 and 3.

The first screening step was passed at all receptors as all short-term PCs were less than 10% of the EAL. There were no exceedances of the EAL. Therefore, the impact from the generators on the CO 8-hour rolling mean objective is considered to be **insignificant** for scenarios 1-3.

These results are presented in Appendix B.

5.1.2 Scenario 4

5.1.2.1 NO_2 hourly mean

The largest predicted PC in NO_2 99.79th percentile hourly mean is 716µg/m^3 at receptor HR7. The largest PEC predicted is 755µg/m^3, well above the EAL.

Therefore, the impact from the generators on the NO_2 hourly mean objective at the sensitive receptors, in Scenario 4 cannot be screened out as insignificant.

However, the above result includes the overly conservative assumption that the generators will operate for all hours of the year, in order to calculate the 99.79th percentile. Therefore, following guidance from the EA, statistical analysis using the hypergeometric distribution was undertaken to determine the potential likelihood of these exceedances occurring. The analysis found the maximum probability of exceeding the EAL, assuming 68 hours of emergency running, was 4.92% at receptor HR7, which suggests the NO_2 hourly mean objective is unlikely to be exceeded (falling below the 5% criterion for unlikely effects). The next highest probability occurs at receptor HR8 and drops to 0.33%, well below the 5% criterion.

All other modelled receptors resulted in predicted impacts having probabilities <0.4% of exceeding the NO_2 hourly mean EAL, which is less than the criterion of 1% considered to be **'highly unlikely' to exceed the EAL.**

5.1.2.2 SO_2 15-minute mean

The largest predicted PC of SO_2 99.9th percentile 15-minute mean is 83.1µg/m^3 at receptor HR6, which is 31% of the EAL of 266µg/m^3. The largest PEC predicted is 91.6µg/m^3 also at HR6, which is approximately 34% of the EAL. Therefore, the impact from the generators cannot be screened out.

However, the above result includes the overly conservative assumption that the generators will operate for all hours of the year, in order to calculate the 99.9th percentile. It is predicted to be unlikely the SO_2 15-minute mean EAL will be exceeded and as this scenario is unlikely to occur, this is considered to be **insignificant.**

These results are presented in Appendix B.

5.1.2.3 SO_2 hourly mean

The largest predicted PC of SO_2 99.73rd percentile hourly mean is 74.2µg/m^3 at receptor HR6, which is 21% of the EAL of 350µg/m^3. The largest PEC predicted is 82.6µg/m^3 also at HR6, which is approximately 24% of the EAL.

The above result includes the overly conservative assumption that the generators will operate for all hours of the year, in order to calculate the 99.73rd percentile. Therefore, it is predicted to be unlikely the SO_2 hourly mean EAL will be exceeded and is considered to be **insignificant.**

These results are presented in Appendix B.

5.1.2.4 CO hourly mean

The largest predicted PC of CO hourly mean is 395.4µg/m^3 at receptor HR6, which is 1.3% of the EAL of 30,000µg/m^3. The largest PEC predicted is 764.2µg/m^3 also at HR6, which is 2.6% of the EAL.

The above result includes the overly conservative assumption that the generators will operate for all hours of the year, in order to calculate the maximum concentration. Therefore, it is predicted to be unlikely the CO hourly mean EAL will be exceeded and is considered to be **insignificant.**

These results are presented in Appendix B.

5.1.2.5 CO 8-hour rolling mean

The largest predicted PC of 8-hour rolling CO is 296.3µg/m^3 at receptor HR7, which is less than 3% of the EAL of 10,000µg/m^3. The largest PEC predicted is 665.1µg/m^3 also at HR7, which is 6.7% of the EAL.

The above result includes the overly conservative assumption that the generators will operate for all hours of the year, in order to calculate the maximum concentration. Therefore, it is predicted to be unlikely the CO 8-hour rolling mean EAL will be exceeded and is considered to be **insignificant.**

These results are presented in Appendix B.

5.1.2.6 USEPA AEGLs

The results for hourly mean NO_2, 30-minute mean NO_2 and 10 minute mean NO_2 have also been predicted and compared with the USA AEGLs. AEGL 1 has been used for comparison as this is the most stringent limit.

***NO_2* hourly mean**

The highest hourly mean NO_2 PEC for the testing scenarios (which is a conservative approach assuming running all hours of the year) was predicted at HR7 and was 780.8µg/m^3. This is equivalent of approximately 82% of AEGL 1 (956.3µg/m^3). Since this is less than AEGL 1, it is therefore considered **insignificant** and it was not necessary to compare further with AEGLs 2 and 3.

***NO_2* 30-minute mean**

The highest 30-minute mean NO_2 PEC for the emergency scenarios was predicted at HR7 and was 840.2µg/m^3. This is equivalent of approximately 88% of AEGL 1 (956.3µg/m^3). Since this is less than AEGL 1, it is therefore considered **insignificant** and it was not necessary to compare further with AEGLs 2 and 3.

***NO_2* 10-minute mean**

The highest 10-minute mean NO_2 PEC for the emergency scenario was predicted at HR7 and was 891.5µg/m^3. This is equivalent of approximately 93% of AEGL 1 (956.3µg/m^3). Since this is less than AEGL 1, it is therefore considered **insignificant** and it was not necessary to compare further with AEGLs 2 and 3.

5.2 Ecological Receptors

5.2.1 Scenario 1 to 3 (planned maintenance)

5.2.1.1 NOx annual mean

The largest predicted PC in NO_x annual mean is <0.01µg/m^3 at receptor ER2, which is less than 1% of the Critical Level (CLe) of 30µg/m^3 (which is only applicable to ecological receptors). The largest PEC predicted is 26.2µg/m^3 at ER7, which is less than 88% of the CLe.

These results have been scaled to reflect operation over 19 hours of the year, but still provide a conservative approach assuming the generators operate at 100% load.

There were no predicted exceedances of the CLe. Neither of the screening criteria for ecological sites were exceeded, as the PC for the SAC (ER1) was less than 1%, and the PCs for all other local nature sites were less than 100%. Therefore, the impact from the generators on the NOx annual mean CLe at the sensitive receptors is considered to be **insignificant.**

These results are presented in Appendix B.

5.2.1.2 NOx daily mean

The largest predicted PC in NOx daily mean is 1.1µg/m^3 at receptor ER2, which is 1% of the CLe of 75µg/m^3 (which is only applicable to ecological receptors). The largest PEC predicted is 52.9µg/m^3 at ER7, which is approximately 70% of the CLe.

There were no predicted exceedances of the CLe. Neither of the screening criteria for ecological sites were exceeded, as the PC for the SAC (ER1) was less than 10%, and the PCs for all other local nature sites were less than 100%. Therefore, the impact from the generators on the NOx daily mean CLe at the sensitive receptors is considered to be **insignificant.**

These results are presented in Appendix B.

5.2.1.3 SO_2 annual mean

The largest predicted PC in SO_2 annual mean is <0.01µg/m^3 at receptor ER2, which is less than 1% of the CLe of 20µg/m^3 (which is only applicable to ecological receptors). The largest PEC predicted is 7.7µg/m^3 at ER3, which is 38% of the CLe.

These results have been scaled to reflect operation over 19 hours of the year, but still provide a conservative approach assuming the generators operate at 100% load.

There were no predicted exceedances of the CLe . Neither of the screening criteria for ecological sites were exceeded, as the PC for the SAC (ER1) was less than 1%, and the PCs for all other local nature sites were less than 100%. Therefore, the impact from the generators on the SO_2 annual mean CLe at the sensitive receptors is considered to be **insignificant.**

These results are presented in Appendix B.

5.2.1.4 Nutrient nitrogen deposition

With regard to nutrient nitrogen, the PC at the ecological receptors were predicted to be < 1% and the PEC > 70% of the relevant critical loads. However, in all cases the background already exceeds the relevant critical load used in the assessment.

These results are presented in Appendix B.

5.2.1.5 Acid deposition

For acid deposition, the PC for each ecological receptor was less than the critical load and no exceedances of the critical load function were recorded using the APIS critical load function tool. As such, the impacts of acid deposition can be considered **not significant.**

These results are presented in Appendix B.

5.2.2 Scenario 4

5.2.2.1 NO_x daily mean

The largest predicted PC in NOx daily mean is 440.6µg/m^3 at receptor ER2, which is 588% of the CLe of 75µg/m^3 (which is only applicable to ecological receptors). The largest PEC predicted is 481.9µg/m^3 at ER2, which is 642% of the CLe.

This provides a conservative approach assuming the back-up generators operate at 100% load for a continuous period of 24 hours, in the event of grid failure.

Exceedances of the CLe are predicted at all but one identified ecological receptor (ER1), and therefore the impacts of Scenario 4 on ecological receptors cannot be screened out as insignificant.

The primary objective for any Data Centre is ensuring an uninterrupted supply of power to the host servers. The likelihood of this scenario ever occurring in reality however is considered to be highly unlikely, based on the electrical design and in-built resilience measures at the Site (as set out in the accompanying Summary Technical Report (Document reference 284474-EP-STR) provided as part of the EP application.

This STR supporting document also states that the National Grid's National Electricity Transmission System Performance Report 2020-21 reported the longest loss of supply incident lasted 454 minutes (7.5 hours) in Tinsley Park, Sheffield (over 190km north of the Site), further suggesting that a continuous complete grid failure of more than 24 hours is highly unlikely.

These results are presented in Appendix B and illustrated in Appendix D.

6. Mitigation and Enhancement

Mitigation has been embedded into the design for the Site. This has resulted in no significant effects in the assessment. These embedded measures include:

- Determining an appropriate stack height for the generator exhausts, which was found to be 25m (see stack height assessment in Appendix C); and
- The choice of high market generators and flue design (parameters affecting exit velocity and temperature which influence dispersion). Further information is provided below.

As part of the AQA, consideration has also been given to the design of the plant, equipment and infrastructure, particularly in how to demonstrate relevant BAT will be met. This includes consideration for the MCPD.

A comprehensive stand-alone BAT assessment has been completed as part of the EP Application for the Site (Document reference 284474-EP-STR).

In relation to emissions to air (and the AQA) however, the below responses to the quoted EA text provide a summary to demonstrate that the engines are specified to be BAT. This is for emergency standby diesel generators with a net rated thermal input above 1 MW, which are exempted from MCPD emission limits because they operate for less than 500 hours per year.

- *"Emissions optimised engines specified to TA-Luft 2g, or US EPA Tier 2 standard or equivalent NOx emission levels in the range of 2000 mg/m^3 of NOx at 5% oxygen and reference conditions*"

Response – the assessment has been based on back-up emergency generators with NOx emission concentrations of 2091 mg/m^3 at 5% oxygen and reference conditions (100% load standby mode).

- "*Dispersion of flue gases optimised through vertical stacks, no caps and cowls impediments";*

Response – Individual 25m vertical stacks, clear of impediments, are proposed to be installed. A stack height determination study has been undertaken to show how the height of the flues has been optimized - see Appendix C

- "*Maintenance testing minimised and kept to less than 50 hours per year";*

Response - Maintenance testing will be kept to less than 50 hours per year – see Table 4

- *"Provision of flue gases sampling ports to allow for monitoring of NOx and Carbon Monoxide in line with web guidance 'Monitoring stack emissions: low risk MCPs and specified generators'".*

Response – Sampling ports will be included for flue gas monitoring.

As a result, no other mitigation measures are considered necessary.

7. Conclusions

The operational effects from the generator emissions were assessed for planned testing scenarios, which would be the planned normal operation of the Site.

The generator and flue design found **no significant impacts** with regards to the NO_2, PM_{10}, $PM_{2.5}$, SO_2, CO and nutrient nitrogen and acid deposition Environmental Assessment Levels (EALs).

A worst-case emergency scenario representing a grid outage, assuming generators operating for 68 hours, was also assessed for short term impacts of NO_2, SO_2 and CO. The results found that the EALs for SO_2 and CO were not predicted to be exceeded. A statistical analysis using the hypergeometric distribution was used to assess the probability of exceeding the NO_2 hourly mean EAL and the resulting probability indicated that **exceedance would be unlikely**.

Exceedances of the 24-hour NOx critical level are also predicted at sensitive ecological receptors under the emergency scenario. The likelihood of a complete grid failure for a continuous 24-hour period however is considered to be **highly unlikely**, based on in-built electrical design resilience measures at the Site, together with published grid reliability data for the National Grid network.

There are **no significant impacts predicted from the Site** at sensitive receptors with no likely exceedances of air quality EALs predicted.

Therefore, no mitigation is recommended other than those embedded in the design of the generators and related flues.

Appendix A

Model Inputs

A.1 Generator Parameters

The proposed combustion plant comprises 33 generators (including 2 redundancy generators and a smaller house generator) with the parameters detailed in Table 23. The redundancy generators operating at 5% load is only relevant for the emergency scenario (Scenario 4), all other parameters are given at 100%. The emission rates used are taken for the more conservative generator options considered. The generators are proposed to have individual stack exhausts. The coordinates of the stacks for the generators are detailed in

Table 24.

Table 23: Generator stack exhaust parameters

Description	Units	Main and redundancy generators at 100% load	Redundancy generators at 5% load (Scenario 4)	House generator
Power capacity	hp	3403	170	1200
Actual volumetric flow rate#	Am^3/s	9.03	0.45	2.46
Exit diameter	m	0.6	0.6	0.6
Efflux velocity	m/s	31.9	1.6†	8.71
Exit temperature	°C	481	381‡	543
Emission Data				
Emission concentration data (at 5% O_2 and reference conditions - not used in emission calculations – see footnotes)				
NOx	mg/Nm^3	2091	1663 (at 25% load)	-
PM_{10}	mg/Nm^3	23	66 (at 25% load)	-
$PM_{2.5}$	mg/Nm^3	23	66 (at 25% load)	-
SO_2	mg/Nm^3	38	38 (at 25% load)	-
CO	mg/Nm^3	263	283 (at 25% load)	-
Manufacturer emission factors used in emission calculations				
NOx	g/hp-hr	4.9	4.9	6.9
PM_{10}	g/hp-hr	0.06	0.06	0.40
$PM_{2.5}$	g/hp-hr	0.06	0.06	0.4
SO_2	g/hp-hr	0.11	0.11	3.7*
CO	g/hp-hr	0.62	0.62	8.5
Emission rates used in modelling				
NOx	g/s	4.63	0.22†	2.3
PM_{10}	g/s	0.06	0.06††	0.13
$PM_{2.5}$	g/s	0.06	0.06††	0.13
SO_2	g/s	0.10	0.10††	1.22*
CO	g/s	0.6	0.6††	2.8

Notes:

Actual conditions data (oxygen and moisture) not available for the Site and therefore emission data calculated based on emissions per power rating data provided by manufacturer.

-House generator emission concentration data not available and therefore modelling undertaken based on emissions per power rating data provided

† The emission rate and efflux velocity was extrapolated using a linear regression from data of the 25%, 50%, 75% and 100% load parameters, provided by manufacturer.

†† Emission rates assumed as 100% load to be conservative.

‡ The exit temperature was not linear and therefore the temperature running at 25% load was used to represent 5% load.

* The SO_2 emission rate for the house generator was calculated using USEPA AP-42 methodology[41], assuming the Sulphur content of heavy oil is 1% following EU directive[42].

[41] US Environmental Protection Agency (1996) AP 42, Fifth Edition, Volume I Chapter 3: Stationary Internal Combustion Sources, 3.4 Large Stationary Diesel and All Stationary Dual-fuel Engines. [Accessed Feb 2022] Available at: https://www.epa.gov/air-emissions-factors-and-quantification/ap-42-fifth-edition-volume-i-chapter-3-stationary-0

[42] Ricardo-AEA (2012) Implementation of the EC Sulphur Content of Liquid Fuels Directive 1999/32/EC (as amended by 2005/33/EC) in the UK

Table 24: Flue locations

Source ID	X (m)	Y (m)	Height above ground (m)
A1 (House Generator)	508137	207445	25
A2 (Redundancy Generator)	508137	207446	25
A3 (Redundancy Generator)	508135	207453	25
A4	508133	207460	25
A5	508132	207461	25
A6	508130	207467	25
A7	508130	207468	25
A8	508128	207475	25
A9	508128	207476	25
A10	508125	207483	25
A11	508125	207484	25
A12	508123	207490	25
A13	508123	207491	25
A14	508121	207498	25
A15	508120	207499	25
A16	508118	207505	25
A17	508118	207506	25
A18	508116	207513	25
A19	508116	207514	25
A20	508114	207520	25
A21	508113	207521	25
A22	508111	207528	25
A23	508111	207529	25
A24	508109	207536	25
A25	508109	207536	25
A26	508106	207543	25
A27	508106	207544	25
A28	508104	207551	25
A29	508104	207552	25
A30	508102	207558	25
A31	508101	207559	25
A32	508099	207566	25
A33	508099	207567	25

Appendix B

Assessment Results

B.1 Human Receptors Results

B.1.1 Scenario 1 to 3 (planned testing)

B.1.1.1 NO_2 annual mean

Table 25: Scenario 1 to 3, NO_2 annual mean results

Receptor	Max Year[43]	PC (µg/m³)	PC% of EAL	PEC (µg/m³)	PEC% of EAL	Significance
HR1	2018	<0.01	0.02%	23.4	59%	Insignificant
HR2	2018	<0.01	0.01%	23.4	59%	Insignificant
HR3	2018	<0.01	0.01%	23.4	59%	Insignificant
HR4	2019	<0.01	<0.01%	23.4	59%	Insignificant
HR5	2019	<0.01	<0.01%	23.4	59%	Insignificant
HR6	2018	<0.01	0.02%	23.4	59%	Insignificant
HR7	2019	0.02	0.04%	19.6	49%	Insignificant
HR8	2018	<0.01	0.02%	23.4	59%	Insignificant
HR9	2017	<0.01	0.02%	23.4	59%	Insignificant
HR10	2018	<0.01	0.02%	23.4	59%	Insignificant
HR11	2018	<0.01	0.02%	23.4	59%	Insignificant

B.1.1.2 NO_2 hourly mean

Table 26: Scenario 1 to 3, NO_2 99.79th percentile hourly mean results

Receptor	Max Year	PC (µg/m³)	PC% of EAL	PEC (µg/m³)	PEC% of EAL	Significance
HR1	2018	60.0	10.5%	67.8	34%	Insignificant
HR2	2016	60.8	10.6%	68.1	34%	Insignificant
HR3	2016	60.2	10.5%	67.9	34%	Insignificant
HR4	2020	56.0	9.8%	66.4	33%	Insignificant
HR5	2020	52.7	9.2%	65.2	33%	Insignificant
HR6	2018	71.1	12.4%	71.7	36%	Insignificant
HR7	2019	86.3	15.1%	69.4	35%	Insignificant
HR8	2016	64.6	11.3%	69.4	35%	Insignificant
HR9	2016	46.2	8.1%	63.0	31%	Insignificant
HR10	2018	55.5	9.7%	66.2	33%	Insignificant
HR11	2018	77.4	13.6%	73.9	37%	Insignificant

[43] Meteorological data year resulting in the maximum process contribution.

B.1.1.3 PM_{10} annual mean

Table 27: Scenario 1 to 3, PM_{10} annual mean results

Receptor	Max Year	PC (µg/m^3)	PC% of EAL	PEC (µg/m^3)	PEC% of EAL	Significance
HR1	2018	<0.01	<0.01%	14.4	36%	Insignificant
HR2	2018	<0.01	<0.01%	14.4	36%	Insignificant
HR3	2018	<0.01	<0.01%	14.4	36%	Insignificant
HR4	2016	<0.01	<0.01%	14.4	36%	Insignificant
HR5	2019	<0.01	<0.01%	14.4	36%	Insignificant
HR6	2018	<0.01	<0.01%	14.4	36%	Insignificant
HR7	2020	<0.01	0.02%	14.4	36%	Insignificant
HR8	2018	<0.01	0.01%	14.4	36%	Insignificant
HR9	2017	<0.01	<0.01%	14.4	36%	Insignificant
HR10	2018	<0.01	0.01%	14.4	36%	Insignificant
HR11	2018	<0.01	0.01%	14.4	36%	Insignificant

B.1.1.4 PM_{10} daily mean

Table 28: Scenario 1 to 3, PM_{10} 90.41st percentile daily mean results

Receptor	Max Year	PC (µg/m^3)	PC% of EAL	PEC (µg/m^3)	PEC% of EAL	Significance
HR1	2018	0.47	0.95%	29.3	59%	Insignificant
HR2	2016	0.43	0.86%	29.2	58%	Insignificant
HR3	2016	0.41	0.82%	29.2	58%	Insignificant
HR4	2019	0.40	0.80%	29.2	58%	Insignificant
HR5	2019	0.42	0.84%	29.2	58%	Insignificant
HR6	2018	0.85	1.69%	29.6	59%	Insignificant
HR7	2020	0.56	1.13%	29.3	59%	Insignificant
HR8	2018	1.09	2.18%	29.9	60%	Insignificant
HR9	2017	0.45	0.91%	29.2	58%	Insignificant
HR10	2018	0.69	1.37%	29.5	59%	Insignificant
HR11	2018	1.21	2.42%	30.0	60%	Insignificant

B.1.1.5 $PM_{2.5}$ annual mean

Table 29: Scenario 1 to 3, $PM_{2.5}$ annual mean results

Receptor	Max Year	PC (µg/m^3)	PC% of EAL	PEC (µg/m^3)	PEC% of EAL	Significance
HR1	2018	<0.01	0.35%	10.2	51%	Insignificant
HR2	2018	<0.01	0.24%	10.2	51%	Insignificant
HR3	2018	<0.01	0.21%	10.2	51%	Insignificant
HR4	2016	<0.01	0.18%	10.2	51%	Insignificant
HR5	2019	<0.01	0.19%	10.2	51%	Insignificant
HR6	2018	<0.01	0.34%	10.3	51%	Insignificant
HR7	2020	<0.01	0.65%	10.3	51%	Insignificant
HR8	2018	<0.01	0.50%	10.2	51%	Insignificant
HR9	2017	<0.01	0.40%	10.3	51%	Insignificant
HR10	2018	<0.01	0.41%	10.2	51%	Insignificant
HR11	2018	<0.01	0.43%	10.3	51%	Insignificant

B.1.1.6 SO_2 15-minute mean

Table 30: Scenario 1 to 3, SO_2 99.9th percentile 15-minute mean results

Receptor	Max Year	PC (µg/m^3)	PC% of EAL	PEC (µg/m^3)	PEC% of EAL	Significance
HR1	2018	26.5	10.0%	34.4	12.9%	Insignificant
HR2	2019	27.4	10.3%	35.2	13.2%	Insignificant
HR3	2016	27.8	10.5%	35.7	13.4%	Insignificant
HR4	2016	25.9	9.7%	33.7	12.7%	Insignificant
HR5	2016	25.7	9.7%	33.5	12.6%	Insignificant
HR6	2018	33.6	12.6%	42.1	15.8%	Insignificant
HR7	2016	24.2	9.1%	32.7	12.3%	Insignificant
HR8	2019	31.9	12.0%	39.8	14.9%	Insignificant
HR9	2020	23.4	8.8%	31.8	12.0%	Insignificant
HR10	2018	26.8	10.1%	34.7	13.0%	Insignificant
HR11	2016	36.5	13.7%	45.0	16.9%	Insignificant

B.1.1.7 SO_2 hourly mean

Table 31: Scenario 1 to 3, SO_2 99.73rd percentile hourly mean results

Receptor	Max Year	PC (µg/m^3)	PC% of EAL	PEC (µg/m^3)	PEC% of EAL	Significance
HR1	2018	22.0	6.3%	29.9	8.5%	Insignificant
HR2	2019	23.0	6.6%	30.8	8.8%	Insignificant
HR3	2016	22.8	6.5%	30.6	8.7%	Insignificant
HR4	2016	21.3	6.1%	29.2	8.3%	Insignificant
HR5	2020	19.3	5.5%	27.1	7.7%	Insignificant
HR6	2017	29.2	8.3%	37.6	10.8%	Insignificant
HR7	2019	20.0	5.7%	28.5	8.1%	Insignificant
HR8	2016	25.8	7.4%	33.6	9.6%	Insignificant
HR9	2016	17.0	4.8%	25.4	7.3%	Insignificant
HR10	2018	21.5	6.1%	29.3	8.4%	Insignificant
HR11	2018	32.1	9.2%	40.6	11.6%	Insignificant

B.1.1.8 SO_2 daily mean

Table 32: Scenario 1 to 3, SO_2 99.18th percentile daily mean results

Receptor	Max Year	PC (µg/m^3)	PC% of EAL	PEC (µg/m^3)	PEC% of EAL	Significance
HR1	2016	11.0	8.8%	18.9	15.1%	Insignificant
HR2	2020	10.4	8.4%	18.3	14.6%	Insignificant
HR3	2019	10.8	8.6%	18.6	14.9%	Insignificant
HR4	2016	11.0	8.8%	18.8	15.1%	Insignificant
HR5	2016	9.2	7.4%	17.0	13.6%	Insignificant
HR6	2016	16.3	13.1%	24.8	19.8%	Insignificant
HR7	2018	10.3	8.2%	18.8	15.0%	Insignificant
HR8	2018	16.2	13.0%	24.0	19.2%	Insignificant
HR9	2018	7.4	5.9%	15.8	12.7%	Insignificant
HR10	2018	11.9	9.5%	19.7	15.8%	Insignificant
HR11	2018	21.0	16.8%	29.4	23.6%	Insignificant

B.1.1.9 CO hourly mean

Table 33: Scenario 1 to 3, CO hourly mean results

Receptor	Max Year	PC (µg/m^3)	PC% of EAL	PEC (µg/m^3)	PEC% of EAL	Significance
HR1	2019	60.8	0.20%	438	1.46%	Insignificant
HR2	2018	61.6	0.21%	439	1.46%	Insignificant
HR3	2019	58.8	0.20%	436	1.45%	Insignificant
HR4	2020	56.8	0.19%	434	1.45%	Insignificant
HR5	2016	55.4	0.18%	433	1.44%	Insignificant
HR6	2018	91.6	0.31%	460	1.53%	Insignificant
HR7	2017	52.2	0.17%	421	1.40%	Insignificant
HR8	2016	65.7	0.22%	443	1.48%	Insignificant
HR9	2020	45.0	0.15%	414	1.38%	Insignificant
HR10	2016	57.3	0.19%	435	1.45%	Insignificant
HR11	2019	83.5	0.28%	452	1.51%	Insignificant

B.1.1.10 CO 8-hour rolling mean

Table 34: Scenario 1 to 3, CO 8-hour rolling mean results

Receptor	Max Year	PC (µg/m^3)	PC% of EAL	PEC (µg/m^3)	PEC% of EAL	Significance
HR1	2020	55.2	0.55%	433	4.33%	Insignificant
HR2	2017	47.5	0.48%	425	4.25%	Insignificant
HR3	2017	47.6	0.48%	425	4.25%	Insignificant
HR4	2019	42.7	0.43%	420	4.20%	Insignificant
HR5	2017	39.2	0.39%	417	4.17%	Insignificant
HR6	2018	62.0	0.62%	431	4.31%	Insignificant
HR7	2019	38.4	0.38%	407	4.07%	Insignificant
HR8	2020	52.8	0.53%	430	4.30%	Insignificant
HR9	2016	33.9	0.34%	403	4.03%	Insignificant
HR10	2018	42.7	0.43%	420	4.20%	Insignificant
HR11	2018	64.4	0.64%	433	4.33%	Insignificant

B.1.2 Scenario 4

B.1.2.1 NO_2 hourly mean

Table 35: Scenario 4, NO_2 99.79th percentile hourly mean results

Receptor	Max Year	PC (µg/m^3)	PC% of EAL	PEC (µg/m^3)	PEC% of EAL	Significance
HR1	2016	558.7	279%	605.5	303%	See Table 36
HR2	2018	566.5	283%	613.3	307%	See Table 36
HR3	2016	562.1	281%	608.9	304%	See Table 36
HR4	2016	529.6	265%	576.4	288%	See Table 36
HR5	2019	513.2	257%	560.0	280%	See Table 36
HR6	2018	686.7	343%	733.5	367%	See Table 36
HR7	2018	715.7	358%	754.9	377%	See Table 36
HR8	2016	581.5	291%	628.3	314%	See Table 36
HR9	2018	421.8	211%	468.6	234%	See Table 36
HR10	2018	524.2	262%	571.0	285%	See Table 36
HR11	2018	656.6	328%	703.4	352%	See Table 36

B.1.2.2 NO_2 hourly mean statistical analysis

Table 36: Scenario 4, NO_2 hourly mean statistical analysis results

Receptor	N	M	K	Max Year	P	Exceedance likelihood
HR1	68	8,760	7,900	2018	<0.01%	Highly unlikely
HR2	68	8,760	8,159	2018	<0.01%	Highly unlikely
HR3	68	8,760	8,249	2018	<0.01%	Highly unlikely
HR4	68	8,784	8,302	2016	<0.01%	Highly unlikely
HR5	68	8,760	8,276	2019	<0.01%	Highly unlikely
HR6	68	8,784	8,058	2016	<0.01%	Highly unlikely
HR7	68	8,784	7,261	2020	4.92%	Unlikely
HR8	68	8,760	7,573	2018	0.33%	Highly unlikely
HR9	68	8,760	7,576	2017	0.32%	Highly unlikely
HR10	68	8,760	7,677	2018	0.10%	Highly unlikely
HR11	68	8,760	7,856	2018	<0.01%	Highly unlikely

N= operating hours per year;

M= the operating envelope (i.e. the number of hours per year, 8,760 hours or 8,784 for a leap year);

K= The total number of non-exceedance hours in the operating envelope (i.e. 8,760 hours minus the number of hours that the limit in the model is expected to be exceeded);

P = Probability of exceedance of the standard.

B.1.2.3 SO_2 15-minute mean

Table 37: Scenario 4, SO_2 99.9th percentile 15-minute mean results

Receptor	Max Year	PC (µg/m^3)	PC% of EAL	PEC (µg/m^3)	PEC% of EAL	Significance
HR1	2016	60.2	23%	68.0	26%	Insignificant
HR2	2020	57.6	22%	65.5	25%	Insignificant
HR3	2020	57.0	21%	64.8	24%	Insignificant
HR4	2020	55.3	21%	63.2	24%	Insignificant
HR5	2016	55.1	21%	62.9	24%	Insignificant
HR6	2018	83.1	31%	91.6	34%	Insignificant
HR7	2019	72.8	27%	81.3	31%	Insignificant
HR8	2016	69.1	26%	77.0	29%	Insignificant
HR9	2017	46.3	17%	54.8	21%	Insignificant
HR10	2018	57.5	22%	65.3	25%	Insignificant
HR11	2018	79.5	30%	87.9	33%	Insignificant

B.1.2.4 SO_2 hourly mean

Table 38: Scenario 4, SO_2 99.73rd percentile hourly mean results

Receptor	Max Year	PC (µg/m^3)	PC% of EAL	PEC (µg/m^3)	PEC% of EAL	Significance
HR1	2016	54.8	16%	62.6	18%	Insignificant
HR2	2020	53.3	15%	61.1	17%	Insignificant
HR3	2016	52.7	15%	60.5	17%	Insignificant
HR4	2020	49.8	14%	57.6	16%	Insignificant
HR5	2019	47.0	13%	54.8	16%	Insignificant
HR6	2018	74.2	21%	82.6	24%	Insignificant
HR7	2018	63.0	18%	71.5	20%	Insignificant
HR8	2016	60.5	17%	68.3	20%	Insignificant
HR9	2017	40.2	11%	48.6	14%	Insignificant
HR10	2018	51.8	15%	59.7	17%	Insignificant
HR11	2018	73.0	21%	81.4	23%	Insignificant

B.1.2.5 CO hourly mean

Table 39: Scenario 4, CO hourly mean results

Receptor	Max Year	PC (µg/m^3)	PC% of EAL	PEC (µg/m^3)	PEC% of EAL	Significance
HR1	2016	276.1	0.9%	653.7	2.2%	Insignificant
HR2	2016	270.5	0.9%	648.0	2.2%	Insignificant
HR3	2016	269.2	0.9%	646.7	2.2%	Insignificant
HR4	2017	250.0	0.8%	627.6	2.1%	Insignificant
HR5	2017	245.3	0.8%	622.8	2.1%	Insignificant
HR6	2019	395.4	1.3%	764.2	2.5%	Insignificant
HR7	2017	340.3	1.1%	709.0	2.4%	Insignificant
HR8	2018	290.4	1.0%	668.0	2.2%	Insignificant
HR9	2019	211.9	0.7%	580.6	1.9%	Insignificant
HR10	2018	258.5	0.9%	636.1	2.1%	Insignificant
HR11	2020	355.2	1.2%	724.0	2.4%	Insignificant

B.1.2.6 CO 8-hour rolling mean

Table 40: Scenario 4, CO 8-hour rolling mean results

Receptor	Max Year	PC ($\mu g/m^3$)	PC% of EAL	PEC ($\mu g/m^3$)	PEC% of EAL	Significance
HR1	2016	231.6	2.3%	609.1	6.1%	Insignificant
HR2	2018	257.8	2.6%	635.3	6.4%	Insignificant
HR3	2019	231.9	2.3%	609.5	6.1%	Insignificant
HR4	2016	217.6	2.2%	595.2	6.0%	Insignificant
HR5	2019	217.1	2.2%	594.7	5.9%	Insignificant
HR6	2018	291.1	2.9%	659.9	6.6%	Insignificant
HR7	2017	291.1	2.9%	659.9	6.6%	Insignificant
HR8	2018	261.6	2.6%	639.1	6.4%	Insignificant
HR9	2018	161.9	1.6%	530.6	5.3%	Insignificant
HR10	2020	222.1	2.2%	599.6	6.0%	Insignificant
HR11	2019	296.3	3.0%	665.1	6.7%	Insignificant

B.2 Ecological Receptor Results

B.2.1 Scenario 1, 2 and 3

B.2.1.1 NOx annual mean

Table 41: Scenario 1 to 3, NOx annual mean results

Receptor	Max Year	PC (µg/m^3)	PC% of EAL	PEC (µg/m^3)	PEC% of EAL	Significance
ER1	2016	<0.01	<0.01%	12.5	42%	Insignificant
ER2	2019	<0.01	<0.01%	20.6	69%	Insignificant
ER3	2018	<0.01	<0.01%	23.6	79%	Insignificant
ER4	2019	<0.01	<0.01%	23.6	79%	Insignificant
ER5	2018	<0.01	<0.01%	19.9	66%	Insignificant
ER6	2017	<0.01	<0.01%	19.8	66%	Insignificant
ER7	2017	<0.01	<0.01%	26.2	87%	Insignificant
ER8	2019	<0.01	<0.01%	18.5	62%	Insignificant
ER9	2018	<0.01	<0.01%	23.6	79%	Insignificant
ER10	2018	<0.01	<0.01%	19.2	64%	Insignificant
ER11	2016	<0.01	<0.01%	21.2	71%	Insignificant
ER12	2019	<0.01	<0.01%	17.9	60%	Insignificant

B.2.1.2 NOx daily mean

Table 42: Scenario 1 to 3, NOx daily mean results

Receptor	Max Year	PC ($\mu g/m^3$)	PC% of EAL	PEC ($\mu g/m^3$)	PEC% of EAL	Significance
ER1	2016	0.03	0.04%	25.0	33%	Insignificant
ER2	2019	1.06	1.42%	42.3	56%	Insignificant
ER3	2018	0.46	0.61%	47.6	63%	Insignificant
ER4	2019	0.34	0.45%	47.5	63%	Insignificant
ER5	2018	0.59	0.79%	40.4	54%	Insignificant
ER6	2017	0.59	0.79%	40.3	54%	Insignificant
ER7	2017	0.39	0.52%	52.9	70%	Insignificant
ER8	2019	0.32	0.43%	37.3	50%	Insignificant
ER9	2018	0.33	0.44%	47.5	63%	Insignificant
ER10	2018	0.36	0.47%	38.8	52%	Insignificant
ER11	2016	0.14	0.19%	42.5	57%	Insignificant
ER12	2019	0.23	0.30%	36.1	48%	Insignificant

B.2.1.3 SO_2 annual mean

Table 43: Scenario 1 to 3, SO_2 annual mean results

Receptor	Max Year	PC ($\mu g/m^3$)	PC% of EAL	PEC ($\mu g/m^3$)	PEC% of EAL	Significance
ER1	2018	0.14	0.11%	6.9	5.5%	Insignificant
ER2	2018	4.09	3.27%	11.9	9.5%	Insignificant
ER3	2016	1.70	1.36%	17.1	13.7%	Insignificant
ER4	2019	1.17	0.94%	16.6	13.2%	Insignificant
ER5	2018	1.51	1.21%	9.1	7.2%	Insignificant
ER6	2019	1.92	1.54%	9.5	7.6%	Insignificant
ER7	2016	1.19	0.95%	8.3	6.6%	Insignificant
ER8	2019	1.18	0.95%	8.5	6.8%	Insignificant
ER9	2018	1.27	1.01%	16.6	13.3%	Insignificant
ER10	2016	0.91	0.73%	11.3	9.1%	Insignificant
ER11	2019	0.60	0.48%	8.0	6.4%	Insignificant
ER12	2018	0.75	0.60%	7.6	6.1%	Insignificant

B.2.1.4 Nutrient Nitrogen Deposition

Table 44: Scenario 1 to 3, Nutrient nitrogen deposition results

ID	Background (kg N/ha/yr)	PC (kg N/ha/yr)	PC% of Critical Load	PEC (kg N/ha/yr)	PEC% of Critical Load	Significance
ER1	33.6	0.00001	<0.01	33.6	336	Insignificant
ER2	33.6	0.00047	<0.01	33.6	336	Insignificant
ER3	33.6	0.00020	<0.01	33.6	336	Insignificant
ER4	33.6	0.00015	<0.01	33.6	336	Insignificant
ER5	33.6	0.00026	<0.01	33.6	336	Insignificant
ER6	20.44	0.00013	<0.01	20.4	102	Insignificant
ER7	33.6	0.00017	<0.01	33.6	336	Insignificant
ER8	33.6	0.00014	<0.01	33.6	336	Insignificant
ER9	33.6	0.00014	<0.01	33.6	336	Insignificant
ER10	33.6	0.00016	<0.01	33.6	336	Insignificant
ER11	20.44	0.00003	<0.01	20.4	102	Insignificant
ER12	33.6	0.00010	<0.01	33.6	336	Insignificant

B.2.1.5 Acid Deposition: APIS Critical Load Function

B.2.1.5.1 Receptor ER1

Critical Load Function

CLmaxS:	1.862
CLminN:	0.142
CLmaxN:	2.004

Deposition data

Source	keq/ha/yr		
	Sulphur Deposition	Nitrogen Deposition	Total Acid Deposition (S+N)
Process Contribution (PC)	0.000004	0.000001	0
Background	0.25	1.22	1.47
Predicted Environmental Concentration (PEC)	0.25	1.22	1.47

Results - exceedance and deposition as a proportion of the CL function

Source	Exceedance (keq/ha/yr)	% of CL function*
Process Contribution (PC)	no exceedance of CL function	0
Background	no exceedance of CL function	73.4
Predicted Environmental Concentration (PEC)	no exceedance of CL function	73.4

* % of CL function is calculated after the value of PEC relative to CLminN is taken into account. See detailed explanation for further information and justification.

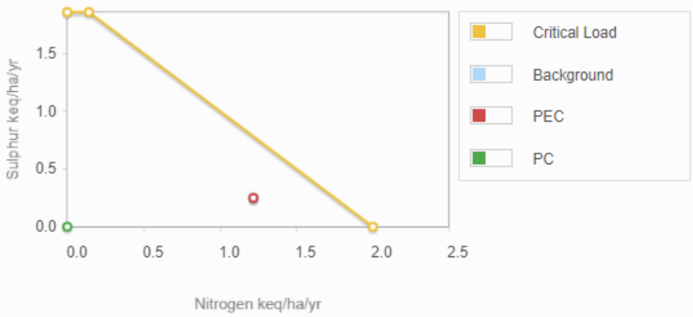

Figure 9 Screenshot from the APIS website of the acid critical load function tool for receptor ER1

B.2.1.5.2 Receptor ER2

Critical Load Function

CLmaxS:	1.862
CLminN:	0.142
CLmaxN:	2.004

Deposition data

Source	keq/ha/yr		
	Sulphur Deposition	**Nitrogen Deposition**	**Total Acid Deposition (S+N)**
Process Contribution (PC)	0.000205	0.000033	0
Background	0.25	1.22	1.47
Predicted Environmental Concentration (PEC)	0.25	1.22	1.47

Results - exceedance and deposition as a proportion of the CL function

Source	**Exceedance (keq/ha/yr)**	**% of CL function***
Process Contribution (PC)	no exceedance of CL function	0
Background	no exceedance of CL function	73.4
Predicted Environmental Concentration (PEC)	no exceedance of CL function	73.4

* % of CL function is calculated after the value of PEC relative to CLminN is taken into account. See detailed explanation for further information and justification.

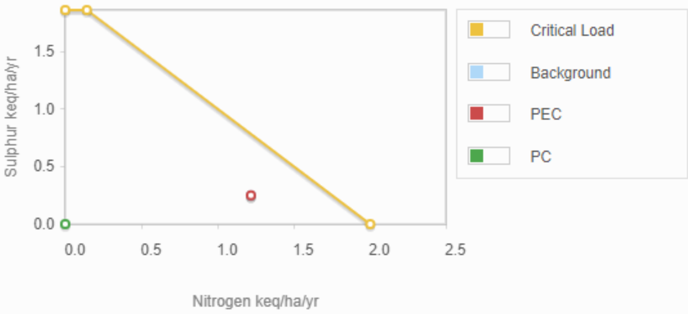

Figure 10: Screenshot from the APIS website of the acid critical load function tool for receptor ER2

B.2.1.5.3 Receptor ER3

Critical Load Function

CLmaxS:	1.862
CLminN:	0.142
CLmaxN:	2.004

Deposition data

Source	**keq/ha/yr**		
	Sulphur Deposition	**Nitrogen Deposition**	**Total Acid Deposition (S+N)**
Process Contribution (PC)	0.000084	0.000014	0
Background	0.25	1.22	1.47
Predicted Environmental Concentration (PEC)	0.25	1.22	1.47

Results - exceedance and deposition as a proportion of the CL function

Source	**Exceedance (keq/ha/yr)**	**% of CL function***
Process Contribution (PC)	no exceedance of CL function	0
Background	no exceedance of CL function	73.4
Predicted Environmental Concentration (PEC)	no exceedance of CL function	73.4

* % of CL function is calculated after the value of PEC relative to CLminN is taken into account. See detailed explanation for further information and justification.

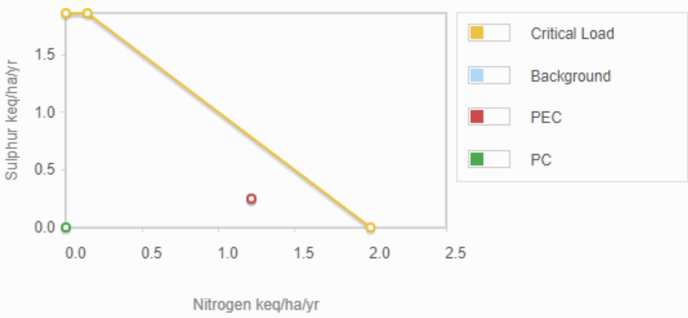

Figure 11: Screenshot from the APIS website of the acid critical load function tool for receptor ER3

B.2.1.5.4 Receptor ER4

Critical Load Function

CLmaxS:	1.862
CLminN:	0.142
CLmaxN:	2.004

Deposition data

Source	keq/ha/yr		
	Sulphur Deposition	Nitrogen Deposition	Total Acid Deposition (S+N)
Process Contribution (PC)	0.000057	0.000010	0
Background	0.25	1.22	1.47
Predicted Environmental Concentration (PEC)	0.25	1.22	1.47

Results - exceedance and deposition as a proportion of the CL function

Source	Exceedance (keq/ha/yr)	% of CL function*
Process Contribution (PC)	no exceedance of CL function	0
Background	no exceedance of CL function	73.4
Predicted Environmental Concentration (PEC)	no exceedance of CL function	73.4

* % of CL function is calculated after the value of PEC relative to CLminN is taken into account. See detailed explanation for further information and justification.

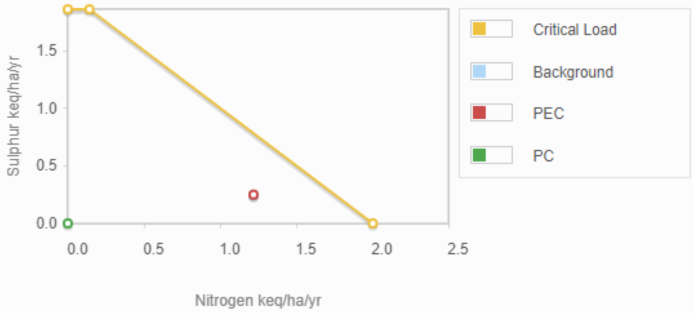

Figure 12: Screenshot from the APIS website of the acid critical load function tool for receptor ER4

B.2.1.5.5 Receptor ER5

Critical Load Function

CLmaxS:	1.862
CLminN:	0.142
CLmaxN:	2.004

Deposition data

Source	keq/ha/yr		
	Sulphur Deposition	Nitrogen Deposition	Total Acid Deposition (S+N)
Process Contribution (PC)	0.000095	0.000018	0
Background	0.25	1.22	1.47
Predicted Environmental Concentration (PEC)	0.25	1.22	1.47

Results - exceedance and deposition as a proportion of the CL function

Source	Exceedance (keq/ha/yr)	% of CL function*
Process Contribution (PC)	no exceedance of CL function	0
Background	no exceedance of CL function	73.4
Predicted Environmental Concentration (PEC)	no exceedance of CL function	73.4

* % of CL function is calculated after the value of PEC relative to CLminN is taken into account. See detailed explanation for further information and justification.

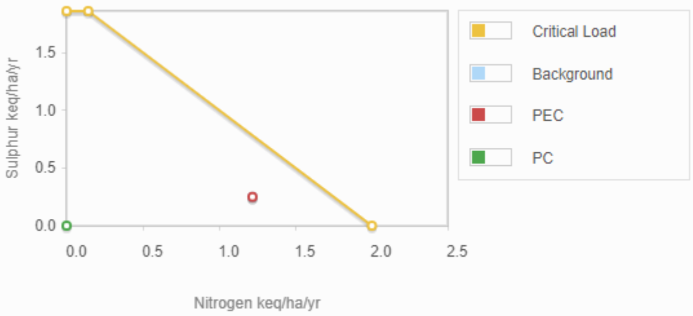

Figure 13: Screenshot from the APIS website of the acid critical load function tool for receptor ER5

B.2.1.5.6 Receptor ER6

Critical Load Function

CLmaxS:	4
CLminN:	0.856
CLmaxN:	4.856

Deposition data

Source	keq/ha/yr		
	Sulphur Deposition	Nitrogen Deposition	Total Acid Deposition (S+N)
Process Contribution (PC)	0.000052	0.000009	0
Background	0.17	1.46	1.63
Predicted Environmental Concentration (PEC)	0.17	1.46	1.63

Results - exceedance and deposition as a proportion of the CL function

Source	Exceedance (keq/ha/yr)	% of CL function*
Process Contribution (PC)	no exceedance of CL function	0
Background	no exceedance of CL function	33.6
Predicted Environmental Concentration (PEC)	no exceedance of CL function	33.6

* % of CL function is calculated after the value of PEC relative to CLminN is taken into account. See detailed explanation for further information and justification.

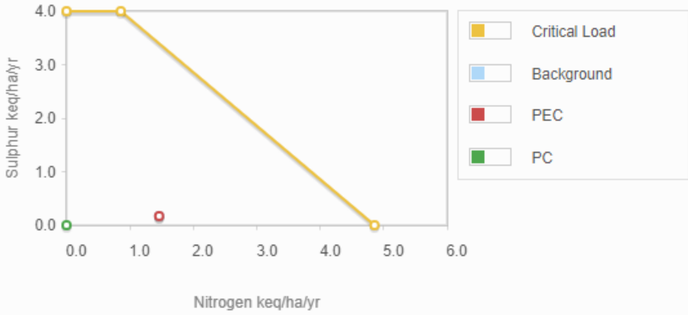

Figure 14: Screenshot from the APIS website of the acid critical load function tool for receptor ER6

B.2.1.5.7 Receptor ER7

Critical Load Function

CLmaxS:	1.862
CLminN:	0.142
CLmaxN:	2.004

Deposition data

Source	keq/ha/yr		
	Sulphur Deposition	**Nitrogen Deposition**	**Total Acid Deposition (S+N)**
Process Contribution (PC)	0.000063	0.000012	0
Background	0.25	1.22	1.47
Predicted Environmental Concentration (PEC)	0.25	1.22	1.47

Results - exceedance and deposition as a proportion of the CL function

Source	**Exceedance (keq/ha/yr)**	**% of CL function***
Process Contribution (PC)	no exceedance of CL function	0
Background	no exceedance of CL function	73.4
Predicted Environmental Concentration (PEC)	no exceedance of CL function	73.4

* % of CL function is calculated after the value of PEC relative to CLminN is taken into account. See detailed explanation for further information and justification.

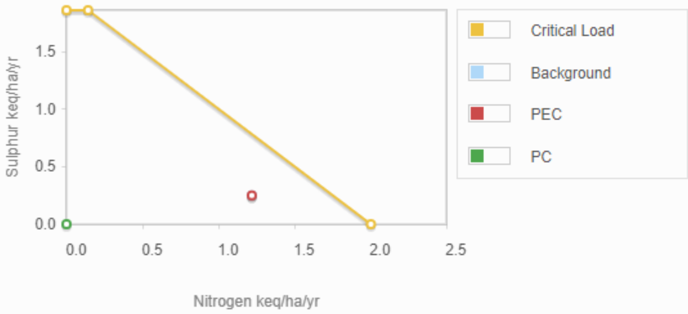

Figure 15: Screenshot from the APIS website of the acid critical load function tool for receptor ER7

B.2.1.5.8 Receptor ER8

Critical Load Function

CLmaxS:	1.862
CLminN:	0.142
CLmaxN:	2.004

Deposition data

Source	keq/ha/yr		
	Sulphur Deposition	**Nitrogen Deposition**	**Total Acid Deposition (S+N)**
Process Contribution (PC)	0.000054	0.000010	0
Background	0.25	1.22	1.47
Predicted Environmental Concentration (PEC)	0.25	1.22	1.47

Results - exceedance and deposition as a proportion of the CL function

Source	Exceedance (keq/ha/yr)	% of CL function*
Process Contribution (PC)	no exceedance of CL function	0
Background	no exceedance of CL function	73.4
Predicted Environmental Concentration (PEC)	no exceedance of CL function	73.4

* % of CL function is calculated after the value of PEC relative to CLminN is taken into account. See detailed explanation for further information and justification.

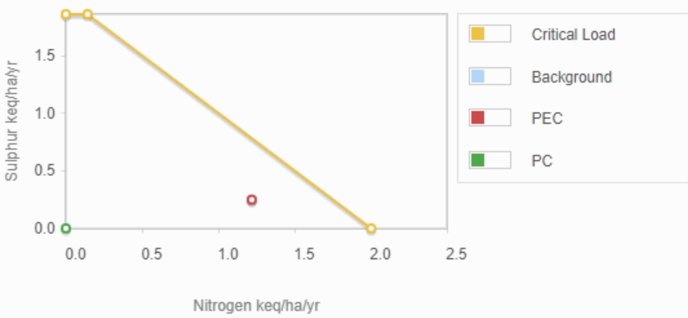

Figure 16: Screenshot from the APIS website of the acid critical load function tool for receptor ER8

B.2.1.5.9 Receptor ER9

Critical Load Function

CLmaxS:	1.862
CLminN:	0.142
CLmaxN:	2.004

Deposition data

Source	**keq/ha/yr**		
	Sulphur Deposition	**Nitrogen Deposition**	**Total Acid Deposition (S+N)**
Process Contribution (PC)	0.000058	0.000010	0
Background	0.25	1.22	1.47
Predicted Environmental Concentration (PEC)	0.25	1.22	1.47

Results - exceedance and deposition as a proportion of the CL function

Source	**Exceedance (keq/ha/yr)**	**% of CL function***
Process Contribution (PC)	no exceedance of CL function	0
Background	no exceedance of CL function	73.4
Predicted Environmental Concentration (PEC)	no exceedance of CL function	73.4

* % of CL function is calculated after the value of PEC relative to CLminN is taken into account. See detailed explanation for further information and justification.

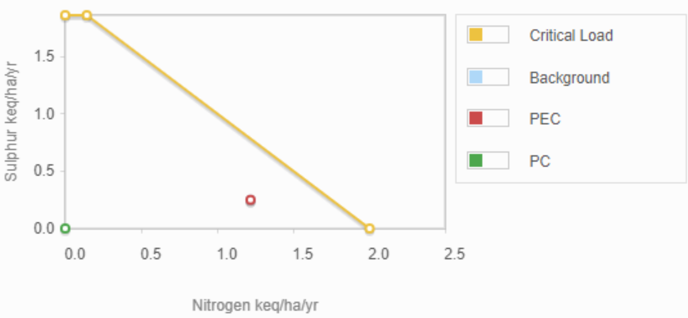

Figure 17: Screenshot from the APIS website of the acid critical load function tool for receptor ER9

B.2.1.5.10 Receptor ER10

Critical Load Function Deposition data

CLmaxS:	1.862
CLminN:	0.142
CLmaxN:	2.004

Source	**keq/ha/yr**		
	Sulphur Deposition	**Nitrogen Deposition**	**Total Acid Deposition (S+N)**
Process Contribution (PC)	0.000058	0.000011	0
Background	0.25	1.22	1.47
Predicted Environmental Concentration (PEC)	0.25	1.22	1.47

Results - exceedance and deposition as a proportion of the CL function

Source	**Exceedance (keq/ha/yr)**	**% of CL function***
Process Contribution (PC)	no exceedance of CL function	0
Background	no exceedance of CL function	73.4
Predicted Environmental Concentration (PEC)	no exceedance of CL function	73.4

* % of CL function is calculated after the value of PEC relative to CLminN is taken into account. See detailed explanation for further information and justification.

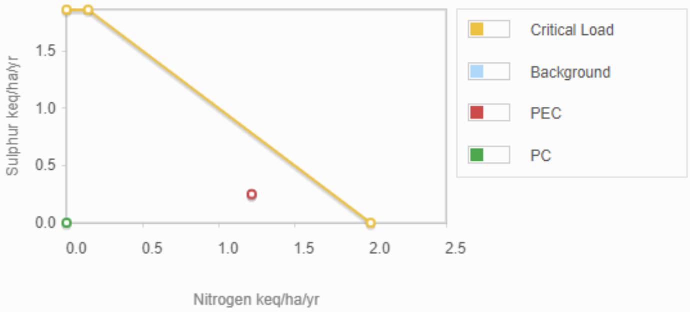

Figure 18: Screenshot from the APIS website of the acid critical load function tool for receptor ER10

B.2.1.5.11 Receptor ER11

Critical Load Function Deposition data

CLmaxS:	4
CLminN:	0.856
CLmaxN:	4.856

Source	**keq/ha/yr**		
	Sulphur Deposition	**Nitrogen Deposition**	**Total Acid Deposition (S+N)**
Process Contribution (PC)	0.000012	0.000002	0
Background	0.17	1.46	1.63
Predicted Environmental Concentration (PEC)	0.17	1.46	1.63

Results - exceedance and deposition as a proportion of the CL function

Source	**Exceedance (keq/ha/yr)**	**% of CL function***
Process Contribution (PC)	no exceedance of CL function	0
Background	no exceedance of CL function	33.6
Predicted Environmental Concentration (PEC)	no exceedance of CL function	33.6

* % of CL function is calculated after the value of PEC relative to CLminN is taken into account. See detailed explanation for further information and justification.

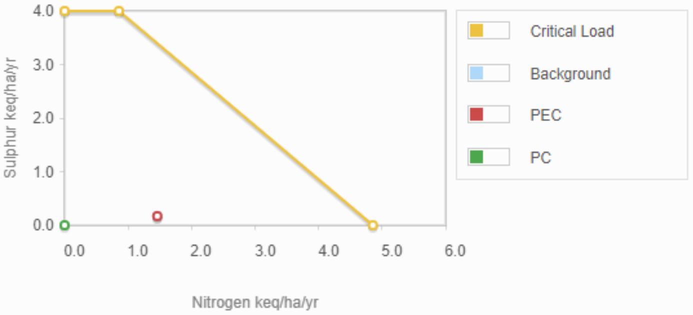

Figure 19: Screenshot from the APIS website of the acid critical load function tool for receptor ER11

B.2.1.5.12 Receptor ER12

Critical Load Function

CLmaxS:	1.862
CLminN:	0.142
CLmaxN:	2.004

Deposition data

Source	keq/ha/yr		
	Sulphur Deposition	Nitrogen Deposition	Total Acid Deposition (S+N)
Process Contribution (PC)	0.000037	0.000007	0
Background	0.25	1.22	1.47
Predicted Environmental Concentration (PEC)	0.25	1.22	1.47

Results - exceedance and deposition as a proportion of the CL function

Source	Exceedance (keq/ha/yr)	% of CL function*
Process Contribution (PC)	no exceedance of CL function	0
Background	no exceedance of CL function	73.4
Predicted Environmental Concentration (PEC)	no exceedance of CL function	73.4

* % of CL function is calculated after the value of PEC relative to CLminN is taken into account. See detailed explanation for further information and justification.

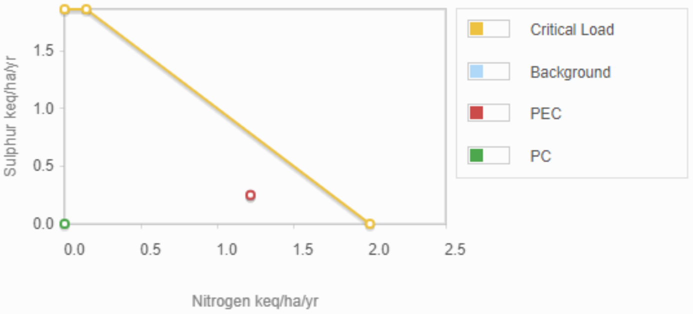

Figure 20: Screenshot from the APIS website of the acid critical load function tool for receptor ER12

B.2.2 Scenario 4

B.2.2.1 NO_x daily mean

Table 45: Scenario 4 NOx daily mean results

Receptor	Max Year	PC (µg/m^3)	PC% of CLe	PEC (µg/m^3)	PEC% of CLe	Significance
ER1	2016	22.3	30%	47.2	63%	Insignificant
ER2	2018	441	588%	481.9	642%	Significant but highly unlikely to occur
ER3	2018	181	241%	227.8	304%	Significant but highly unlikely to occur
ER4	2018	137	182%	184.0	245%	Significant but highly unlikely to occur
ER5	2016	198	264%	238.2	318%	Significant but highly unlikely to occur
ER6	2016	246	328%	285.5	381%	Significant but highly unlikely to occur
ER7	2018	315	420%	367.7	490%	Significant but highly unlikely to occur
ER8	2019	133	177%	169.6	226%	Significant but highly unlikely to occur
ER9	2016	137	182%	183.8	245%	Significant but highly unlikely to occur
ER10	2016	153	204%	191.6	256%	Significant but highly unlikely to occur
ER11	2018	107	143%	149.3	199%	Significant but highly unlikely to occur
ER12	2020	88.4	118%	124.3	166%	Significant but highly unlikely to occur

Appendix C

Stack Height Assessment

C.1 Stack Height Assessment Results

The emergency scenario (Scenario 4) was considered to be the most sensitive scenario to determine the flue heights, because it has the most potential for impact (NO_2 hourly impacts), as seen in the results in Section 5.1.2. Therefore, Scenario 4 was tested for the following generator stack heights:16m, 18m, 20m, 22m, 23m, 24m, 25m, 28m and 30m. The statistical analysis using the hypergeometric distribution was used to determine the stack height needed to mitigate against a potential exceedance of the NO_2 hourly mean EAL in the instance of an emergency operation of 68 hours.

Figure 21 shows that, when assuming an emergency operation of 68 hours, a 25m stack provided sufficient beneficial dispersion to result in an unlikely exceedance of the NO_2 hourly objective (a probability of >5%). Therefore, this design parameter was taken forward for the flue heights.

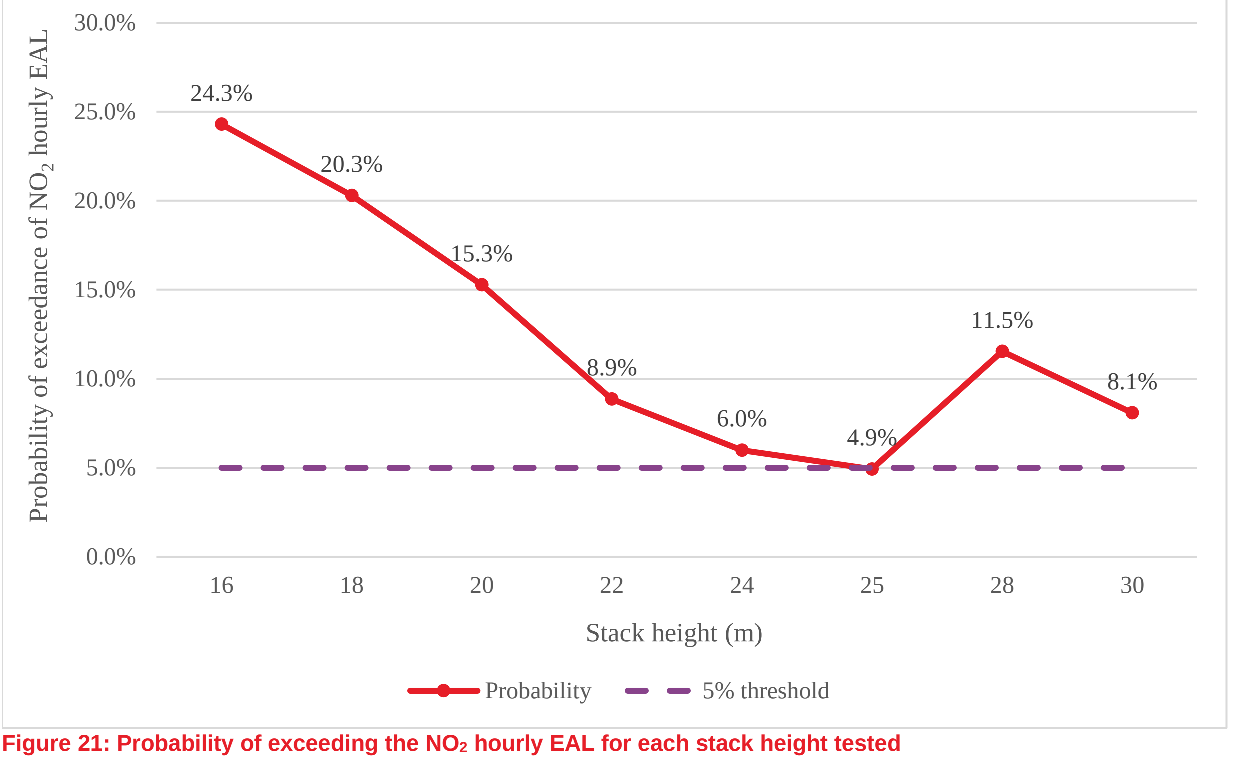

Figure 21: Probability of exceeding the NO_2 hourly EAL for each stack height tested

Appendix D

Contour Plots

D.1 Scenario 4 Contour Plots

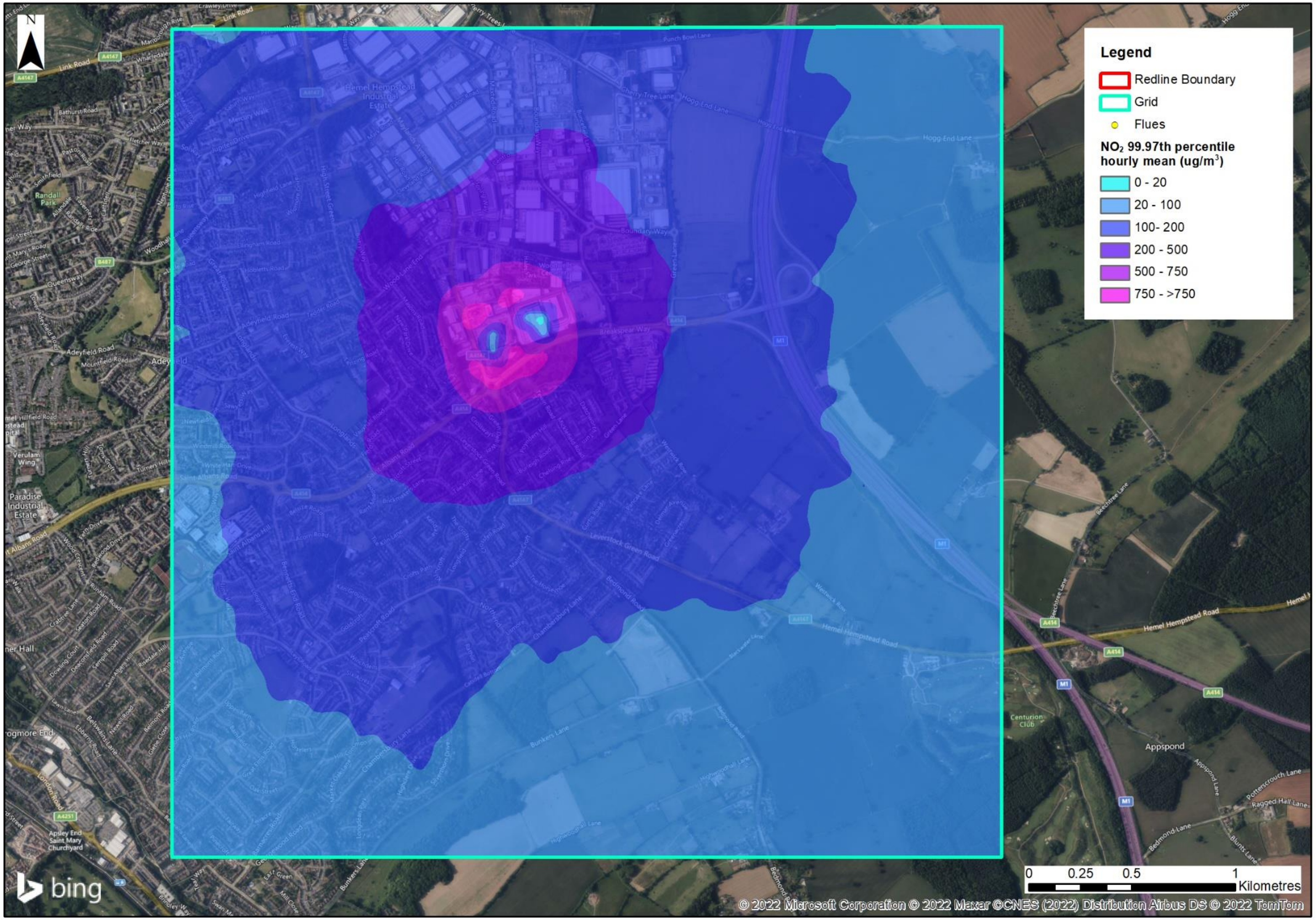

Figure 22: Contour plot of NO_2 hourly concentrations in Scenario 4, using 2018 meteorological data (worst year)

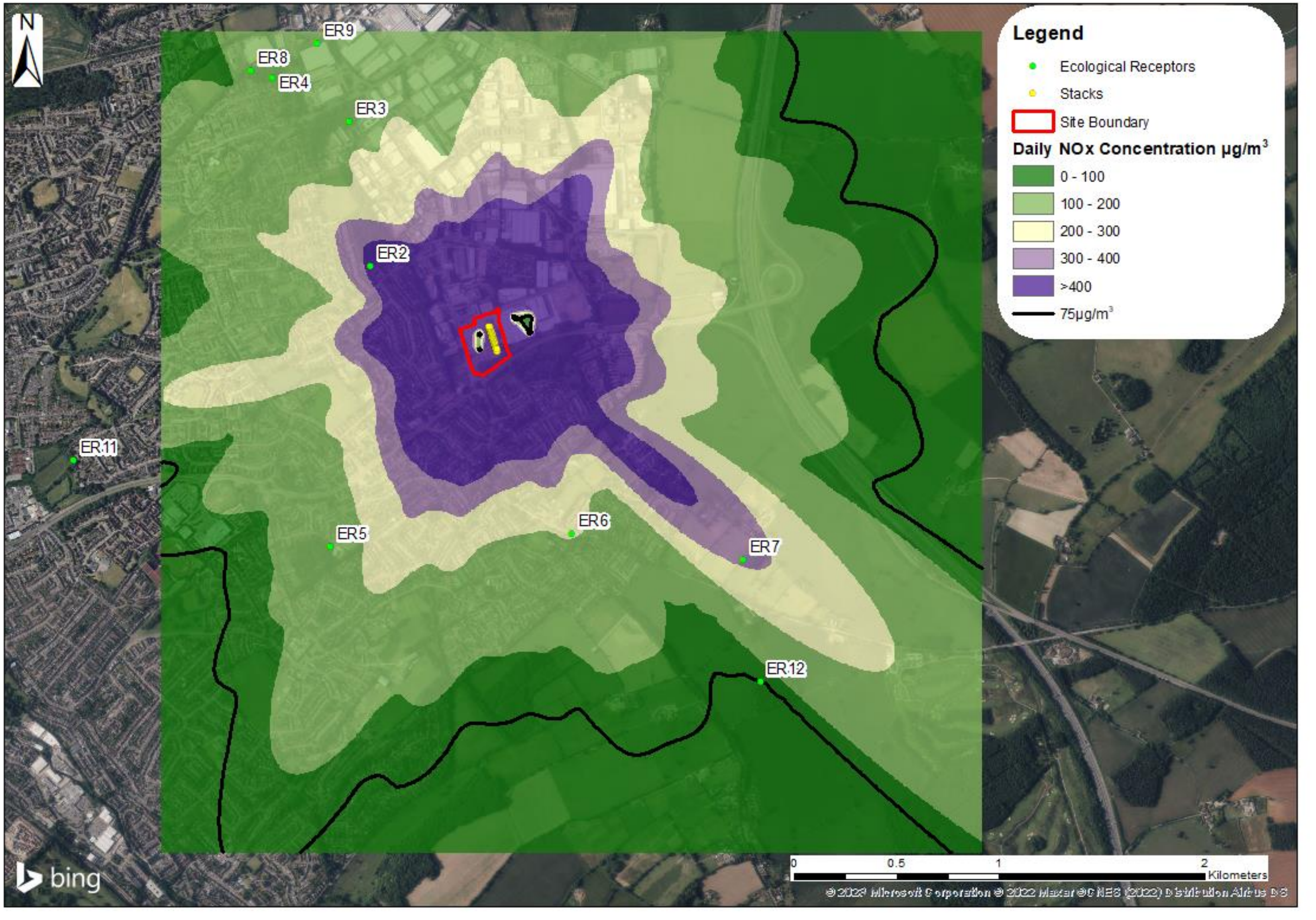

Figure 23: Contour plot of NOx daily concentrations in Scenario 4, using 2018 meteorological data (worst year)