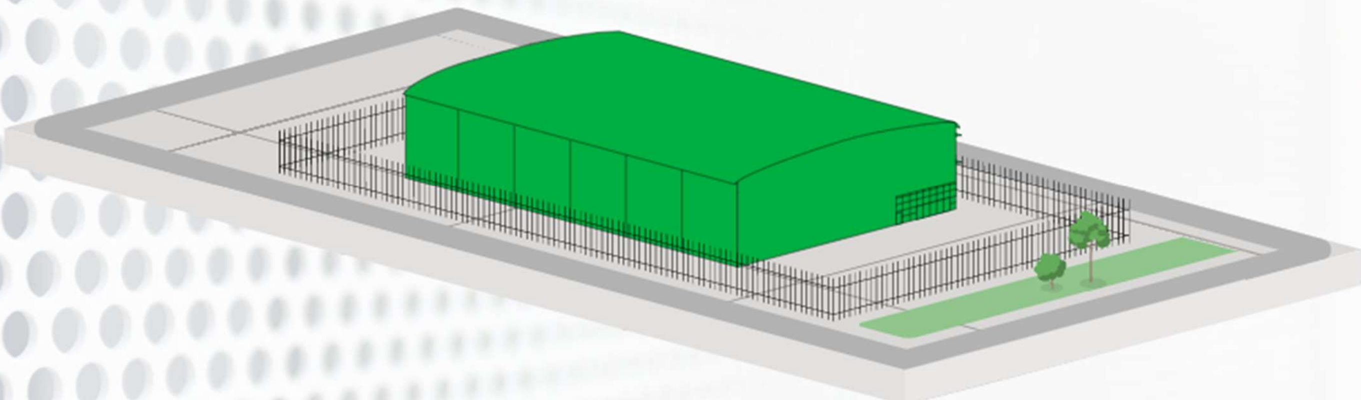
Virtus Holdco Ltd.

VIRTUS DATA CENTRE LONDON 12

Air Quality Assessment



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Virtus Holdco Ltd.

VIRTUS DATA CENTRE LONDON 12

Air Quality Assessment

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HEATHROW WINDROSES 2015-2019

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1.1.2. The assessment demonstrates that ***no significant effects*** will result from the operation of the generators due to impacts on local air quality.

Table 1-1 – Report summary

EA Requirement	Location in Report	Pages
Requirements set out in: https://www.gov.uk/guidance/specified-generators-dispersion-modelling-assessment		
Describe the site setting	Section 5.1 Study Area and Site Setting Section 6.1 SBC Air Quality Review	15 18
Define the operating envelope	Section 3.2 Assessment Scenarios	6
Characterise the emissions	**Table 3-1** Appendix C	6 63
Model the effect of buildings and terrain	Building information set out in **Table 7-1**; Terrain not included (para 7.2.25).	29
Explain the background concentration	Section 6.2 Background pollutant concentrations (Human Health) Section 6.3 Background pollutant concentrations (Ecology)	23 23
Use environmental standards for air	For human health: **Table 4-1 – Relevant air quality standards** **Table 4-2 – AEGLs for nitrogen dioxide (µg/m3, with values in ppm given in brackets)** For ecology: **Table 4-4 – Air quality critical levels used for the assessment of impacts on sensitive ecological receptors.** **Background NOx concentrations do not exceed the annual critical level of** 30µg/m3 for any of the designated sites.	10 11 12 23

EA Requirement	Location in Report	Pages
	Nitrogen deposition at every site exceeds the lower critical load (20kgN/ha/yr). Table 6-4 – Mapped background concentrations and nitrogen deposition over ecological sites	
Impact on sensitive receptors	The indicative sensitive receptors used in the modelling are set out in **Table 5-1** and **Figure 2** in **Appendix B**	15
Impact on conservation sites	The ecological receptors used in the modelling are set out in **Table 5-2** and **Figure 3** in **Appendix B**	17
NO_x to NO_2 conversion ratio	Atmospheric Chemistry	30
Results and impact Assessment	Section 8 Human health Assessment results Section 9 Ecological assessment results	36 49
Short term statistical analysis	Hypergeometric Function, para 7.3.3	31
Requirements set out in: https://www.gov.uk/guidance/air-emissions-risk-assessment-for-your-environmental-permit#detailed-modelling		
Explain your report	Section 2.1 Project Background Section 5.1 Study Area and Site Setting Section 3.2 Assessment Scenarios	4 15 6
Include a location map	**Figure 1** in **Appendix B**	
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EA Requirement	Location in Report	Pages
	Background NOx concentrations do not exceed the annual critical level of 30µg/m3 for any of the designated sites. Nitrogen deposition at every site exceeds the lower critical load (20kgN/ha/yr). Table 6-4 – Mapped background concentrations and nitrogen deposition over ecological sites	23
Work out ambient and background levels	Section 1.1 Section 6.3 Background pollutant concentrations (Ecology)	23 23
Explain the model	Section 7.1 Air Dispersion modelling	25
Explain the emission parameters	**Table 3-1** & Appendix C Emissions for LON3, LON4, LON10, LON 9 and LON11 from their respective previous air quality assessments were re-used for the emergency scenario.	6, 63
Explain the model domain and receptors	Model domain, para 7.2.31	30
Explain weather data and surface characteristics	Meteorological data, para 7.2.29 Surface parameters, para 7.2.25	30 30
Explain terrain and building treatments	Building information set out in **Table 7-1**; Terrain not included (para 7.2.25).	28
Estimate model uncertainty	Section 7.5 Limitations and Assumptions	35
Carry out sensitivity analysis	Sensitivity testing undertaken, reported throughout Section 8 and 9	
Special treatments	Set out in methodology, especially Section 7.2 model inputs & Section 7.3 Post Processing of Results	25 30
Carry out impact assessment	Section 8 Human health Assessment results Section 9 Ecological assessment results	36 49
Include input files	Included as electronic files with submission	

2. INTRODUCTION

2.1. PROJECT BACKGROUND

2.1.1. WSP has been commissioned by Virtus HoldCo Ltd (the 'Applicant') to carry out an air quality assessment in support of an application for an Environmental Permit for the site referred to as London 12 Data Centre, Slough Trading Estate, Slough, SL1 4Q2, hereafter referred to as the 'Site'. This assessment also includes two additional speculative LON4 generators.

2.1.2. The data centres referred to as London 12 (LON12) and London 4 (LON4) at Slough are connected to the local electricity transmission network via multiple grid connections. Given the nature of the data centres, and their requirement to have an available energy supply at all times, LON12 and LON4 are equipped with diesel-fired standby generators for low voltage. Each is operated independently but operates under a common management system and management structure as other Virtus Data Centres (DCs) across North London. The Site is located wholly within the administrative area of Slough Borough Council (SBC). The location of the Site and all LON12 generators are illustrated in **Figure 1** in **Appendix B**.

2.1.3. The generators will provide power to the Site in the event of an emergency situation; such as a failure of the electricity transmission network. During such events there is a potential for a delay between fault detection and initial operation of the back-up generators and the initial cover for loss of external power is provided by on-site battery arrays.

2.1.4. This document should be read in conjunction with the Environmental Permit Application[1] which contains full details of the Site's installation activities, the operating techniques and the engine emissions standards that will be implemented at the facility.

2.1.5. A glossary of terms included within this assessment and figures are provided in **Appendix A** and **Appendix B** respectively.

2.2. SCOPE

2.2.1. The scope of the air quality assessment is as follows:

- Dispersion modelling of the impact of the operation of the generators on local air quality (nitrogen oxide (NO_X), nitrogen dioxide (NO_2), ammonia (NH_3) and nitrogen deposition) at sensitive human and ecological receptor locations for the following scenarios:
  - Routine testing; and
  - A theoretical 72-hour outage scenario (including the LON3, LON4, LON9, LON10, LON11 and LON12 generators, where in a worst case 72-hour outage scenario all of these data centres would require backup power at the same time).

2.2.2. The modelling of impacts on particulate matter is scoped out of this assessment. Emissions of particulate matter from the diesel generators are typically two orders of magnitude lower than NO_x emissions at equivalent load. It can, therefore, readily be demonstrated that daily mean PM_{10} impacts from routine testing and emergency backup power generation will be negligible, and annual

[1] WSP (2025) *Virtus HoldCo Ltd – Environmental Permit Application Virtus London 12 Data Centre*. WSP UK Ltd.

mean impacts will be negligible. This is due in part to the low emissions and in part to the low operating hours in the year, and with only three days of emergency outage.

3. OPERATIONAL SCENARIOS

3.1. INSTALLED GENERATORS

3.1.1. Details of the 18 generators installed on the Site are summarised in **Table 3-1**. It is understood that all of the generators in LON12 have Selective Catalytic Reduction (SCR) fitted. The additional LON4 generators will not.

Table 3-1 – Summary of Installed Generators

Data Centre	Engine Model	No Installed	Capacity (kW)	Emission Rates at 100% (@5% O_2, dry)	SCR Fitted
LON12	20V4000G74F	16	2,670	0.18 g/s	Yes
LON4	3516C - HD	2	2,415	4.34 g/s	No
Details of the generator emissions inc O_2/H_2O content are provided in Appendix C.					

3.2. ASSESSMENT SCENARIOS

3.2.1. The operation of the generators will be limited to monthly testing and emergency situations. Consequently, the assessment of impacts presented in this report is based on the following operational scenarios:

- **Routine testing:**
  - **Virtus Test 1**: representative of a 15 minute "switch on" offload test; to be carried out on monthly basis in eleven months of the year. In reality this will be limited to approximately 5 minutes.
  - **Virtus Test 2:** representative of a full service onload test consisting of an initial 20 minutes at 100% load immediately followed by 120 minutes at 75% load; to be carried out once per year in the 12^{th} month of the year. A conservative approach was taken to model the new LON12 generators at 100% load for the full test.
- **Theoretical 72-hour Outage:**
  - **Virtus Emergency 2:** Theoretical complete mains electricity failure of 72 hours duration. In this scenario there is an initial period of 20-30 minutes where generators are required to run at 100% load, to recharge the UPS battery array before dropping to the actual building load. A conservative approach was taken to model a 100% load for the full 72-hour emergency period.

3.2.2. Emergency scenario 2 is an Environment Agency specified scenario.

3.2.3. The operator calculated average annual operation emergency scenario assumed a power outage occurs once in every five or six years for 24 hours. This was based on Ofgem grid operator outage data and on-site outage worst case estimates. Generator operation was assumed to be required for an initial 20-minute start-up load and 220-minute subsequent stable operation. The Environment

Agency's 72-hour outage is, therefore, highly conservative and should be considered a theoretical scenario only.

3.2.4. Aside from the routine monthly testing, none of the generators will be operated for any purpose other than to provide emergency back-up power generation. Virtus currently has a 100% uptime record which emphasises that the likelihood of occurrence of the theoretical 72-hour outage is very small, particularly since the incoming power system has been designed in such a way so as to ensure that only the most major power interruption event would trigger the need for the generators.

3.2.5. Furthermore, it has been assumed that planning restrictions placed on the Applicant forbid the operation of the generators for testing and maintenance purpose during peak traffic periods e.g. between 16:00 to 19:00. Nor is the simultaneous testing of two or more generator sets permitted.

4. LEGISLATION, POLICY & GUIDANCE

4.1. AIR QUALITY LEGISLATION AND POLICY

4.1.1. A summary of the air quality legislation and policy relevant to this assessment is provided below.

ENVIRONMENT ACT

4.1.2. Part IV of the Environment Act 1995[2] (as amended) required the Secretary of State to publish a national Air Quality Strategy[3,4] and set up a system of Local Air Quality Management (LAQM). An amendment, the Environment Act 2021[5], was subsequently enshrined into law in November 2021. Schedule 11 of this Act makes it clear that it remains a requirement for local authorities to periodically review and document local air quality with the aim of meeting the air quality objectives defined in the Air Quality Regulations. Where a local authority determines that one or more objective is unlikely to be achieved it is required to designate an Air Quality Management Area (AQMA). For each AQMA the local authority must produce an Air Quality Action Plan (AQAP) to secure improvements in air quality and show how it intends to work towards achieving air quality standards in the future.

AIR QUALITY REGULATIONS

4.1.3. The Air Quality (England) Regulations 2000[6] (as amended) set the objectives for ambient pollutant concentrations. The objectives apply where there is relevant exposure: *"at locations which are situated outside of buildings or other natural or man-made structures, above or below ground, and where members of the public are regularly present…".*

4.1.4. The Air Quality Standards Regulations[7] (as amended) and the Environment (Miscellaneous Amendments) (EU Exit) Regulations[8] set legally binding (mandatory) limit values for concentrations in outdoor air of major air pollutants that impact public health including NO_2 and particulate matter (PM_{10} and $PM_{2.5}$). The Regulations also include critical levels for the protection of vegetation. The limit values are numerically the same as the objectives.

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[2] The National Archives (1995) *Environment Act 1995* [online]. Available at: https://www.legislation.gov.uk/ukpga/1995/25/contents [Accessed March 2025].

[3] Defra (2007) *The Air Quality Strategy for England, Scotland, Wales and Northern Ireland (Volume 1)* [online]. Available at: https://assets.publishing.service.gov.uk/government/uploads/system/uploads/attachment_data/file/69336/pb12654-air-quality-strategy-vol1-070712.pdf [Accessed March 2025].

[4] Defra (2007) *The Air Quality Strategy for England, Scotland, Wales and Northern Ireland (Volume 2)* [online]. Available at: https://assets.publishing.service.gov.uk/government/uploads/system/uploads/attachment_data/file/69337/pb12670-air-quality-strategy-vol2-070712.pdf [Accessed March 2025].

[5] The National Archives (2021) *Environment Act 2021* [online]. Available at: https://www.legislation.gov.uk/ukpga/2021/30/contents/enacted [Accessed March 2025].

[6] The National Archives (2000) *The Air Quality (England) Regulations 2000* [online]. Available at: https://www.legislation.gov.uk/uksi/2000/928/contents/made [Accessed March 2025].

[7] The National Archives (2010) *The Air Quality Standards Regulations 2010* [online]. Available at: https://www.legislation.gov.uk/uksi/2010/1001/contents/made [Accessed March 2025].

[8] The National Archives (2020) *The Environment (Miscellaneous Amendments) (EU Exit) Regulations 2020* [online]. Available at: https://www.legislation.gov.uk/uksi/2020/1313/introduction/made [Accessed March 2025].

ENVIRONMENTAL PERMITTING (ENGLAND AND WALES) REGULATIONS (EPR), INDUSTRIAL EMISSIONS DIRECTIVE (IED)

4.1.5. Directive 2010/75/EU[9] on industrial emissions (integrated pollution prevention and control) (IED) recast seven directives related to industrial emissions, in particular Directive 2008/1/EC concerning integrated pollution prevention and control (IPPC)[10] and Directive 2001/80/EC[11] emissions from large combustion plants (LCPD), into a single legislative instrument. The aim of the IED was to improve the permitting, compliance and enforcement regimes adopted by Member States to the European Union.

4.1.6. The Environmental Permitting (England and Wales) Regulations 2016 (EPR 2016)[12], as amended, consolidated and replaced the EPR 2010 and subsequent amendments. The EPR 2016 is the main implementing regulations for the environmental permitting regime and transposed the requirements of the IED into UK legislation.

4.1.7. The Medium Combustion Plant Directive (Directive 2015/2193) (MCPD)[13] filled the regulatory gap between Large Combustion Plant (LCP) and certain small combustion plant covered by the Ecodesign Directive (2009/125/EC)[14].

4.1.8. The Environmental Permitting (England and Wales) (Amendment) Regulations 2018 SI 110 (EPR 2018)[15] transposed the requirements of the MCPD into legislation and introduced requirements for the control of emissions from 'Specified Generators'.

CONSERVATION OF HABITATS AND SPECIES REGULATIONS 2010

4.1.9. The European Habitats Directive (92/43/EEC)[16] sets out the legal framework requiring EU member states to protect habitat sites supporting vulnerable and protected species, as listed within the Directive. This Directive is transposed into UK law by the Conservation of Habitats and Species

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[9] EUR-Lex (2010) *Directive 2010/75/EU of the European Parliament and of the Council of 24 November 2010 on industrial emissions (integrated pollution prevention and control)* [online]. Available at: https://eur-lex.europa.eu/legal-content/EN/TXT/?uri=celex%3A32010L0075 [Accessed March 2025].

[10] EUR-Lex (2008) *Directive 2008/1/EC of the European Parliament and of the Council of 15 January 2008 concerning integration pollution prevention and control* [online]. Available at: https://eur-lex.europa.eu/legal-content/en/ALL/?uri=CELEX%3A32008L0001 [Accessed March 2025].

[11] EUR-Lex (2001) *Directive 2001/80/EC of the European Parliament and of the Council of 23 October 2001 on the limitation of emissions of certain pollutants into the air from large combustion plants* [online]. Available at: https://eur-lex.europa.eu/legal-content/EN/TXT/?uri=CELEX:32001L0080 [Accessed March 2025].

[12] The National Archives (2016) *The Environmental Permitting (England and Wales) Regulations 2016 Statutory Instrument No. 1154* [online]. Available at: https://www.legislation.gov.uk/uksi/2016/1154/contents/made [Accessed March 2025].

[13] EUR-Lex (2015) *Directive (EU) 2015/2193 of the European Parliament and of the Council of 25 November 2015 on the limitation of emissions of certain pollutants into the air from medium combustion plants* [online]. Available at: https://eur-lex.europa.eu/legal-content/EN/TXT/?uri=CELEX%3A32015L2193 [Accessed March 2025].

[14] EUR-Lex (2009) *Directive 2009/125/EC of the European Parliament and of the Council of 21 October 2009 establishing a framework for the setting of ecodesign requirements for energy-related products* [online]. Available at: https://eur-lex.europa.eu/LexUriServ/LexUriServ.do?uri=OJ:L:2009:285:0010:0035:en:PDF [Accessed March 2025].

[15] The National Archives (2018) *The Environmental Permitting (England and Wales) (Amendment) Regulations 2018* [online]. Available at: https://www.legislation.gov.uk/uksi/2018/110/contents/made [Accessed March 2025].

[16] EUR-Lex (1992) *Council Directive 92/43/EEC of 21 May 1992 on the conservation of natural habitats and of wild fauna and flora* [online]. Available at: https://eur-lex.europa.eu/legal-content/EN/TXT/?uri=celex%3A31992L0043 [Accessed March 2025].

Regulations 2010[17] and requires protection of ecological sites including Special Areas of Conservation (SACs), Special Protection Areas (SPAs) and Sites of Special Scientific Interest (SSSIs).

4.1.10. The Ambient Air Quality Directive[18] sets mandatory ambient air quality guidelines for NO_x for the protection of ecosystems. This imposes a long-term (annual average) limit for NO_x of 30μg/m^3 (critical level). This is mirrored in the Air Quality Standards Regulations 2010[7] (as discussed above).

4.1.11. Across the UK, site-specific critical loads (which relate to deposition of materials to soils) have been set for a variety of protected habitats and species in order to allow the quantitative assessment of the condition of ecologically sensitive sites and thus the protection of such sites by the relevant competent authorities.

4.2. AIR QUALITY ASSESSMENT CRITERIA

4.2.1. This section sets out the air quality assessment criteria relevant to the assessment, and provides information on their provenance.

4.2.2. The criteria for the assessment of impacts at sensitive human receptors for NO_2 and NH_3 are given in the Air Quality (England) Regulations 2000, the Air Quality (England) (Amendment) Regulations 2002 and the Environment (Miscellaneous Amendments) (EU Exit) Regulations 2020, and the Environment Agency Air Emission Risk Assessment for Environmental Permits[19] given in **Table 4-1**.

Table 4-1 – Relevant air quality standards

Pollutant	Concentration (μg/m^3)	Measured as	Requirement
Nitrogen dioxide (NO_2)	40	Annual mean	Not to be exceeded.
	200	1-hour (hourly) mean	Not to be exceeded, more than 18 times a year (i.e. the 99.79th percentile).
Ammonia (NH_3)	180	Annual mean	Not to be exceeded.

[17] The National Archives (2010) *The Conservation of Habitats and Species Regulations 2010 Statutory Instrument No. 490* [online]. Available at: https://www.legislation.gov.uk/uksi/2010/490/contents/made [Accessed March 2025].

[18] EUR-Lex (2008) *Directive 2008/50/EC of the European Parliament and of the Council of 21 May 2008 on ambient air quality and clean air for Europe* [online]. Available at: https://eur-lex.europa.eu/legal-content/en/ALL/?uri=CELEX%3A32008L0050 [Accessed March 2025].

[19] Environment Agency (2025), Air emissions risk assessment for your environmental permit [online]. Available at: https://www.gov.uk/guidance/air-emissions-risk-assessment-for-your-environmental-permit#environmental-standards-for-air-emissions. [Accessed March 2025].

4.2.3. The United States Environmental Protection Agency publishes Acute Exposure Guideline Levels (AEGL)[20] that are applicable to emergency exposure periods and *"represent threshold exposure limits for the general public."* They 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 non-sensory 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.

4.2.4. The Environment Agency has requested that the AEGLs for NO_2 and NH_3 are considered within the assessment of impacts to human health receptors. **Table 4-2** provides the AEGL for NO_2 by severity level and period of exposure.

Table 4-2 – AEGLs for nitrogen dioxide (µg/m^3, with values in ppm given in brackets)

	Exposure Period				
	10 min	30 min	60 min	4 hour	8 hour
AEGL 1	940 (0.50)	940 (0.50)	940 (0.50)	940 (0.50)	940 (0.50)
AEGL 2	37600 (20)	28200 (15)	22560 (12)	15416 (8.2)	12596 (6.7)
AEGL 3	63920 (34)	47000 (25)	37600 (20)	26320 (14)	20680 (11)
Note: values given in brackets are in units of ppm. Converted from ppm to µg/m^3 under standard conditions (1°C and 1 atmosphere).					

[20] United States Environmental Protection Agency (2021) *About Acute Exposure Guideline Levels (AEGLs)* [online]. Available at: https://www.epa.gov/aegl/about-acute-exposure-guideline-levels-aegls#:~:text=Important%20user%20information-,Overview,which%20health%20effects%20may%20occur. [Accessed March 2025].

Table 4-3 – AEGLs for ammonia (µg/m³, with values in ppm given in brackets)

	Exposure Period				
	10 min	30 min	60 min	4 hour	8 hour
AEGL 1	20860 (30)	20860 (30)	20860 (30)	20860 (30)	20860 (30)
AEGL 2	152970 (220)	152970 (220)	111250 (160)	76480 (110)	76480 (110)
AEGL 3	1877300 (2700)	1112470 (1600)	764830 (1100)	382410 (550)	271170 (390)
Note: values given in brackets are in units of ppm. Converted from ppm to µg/m³ under standard conditions (1°C and 1 atmosphere).					

4.2.5. For ecological impacts, two metrics are assessed: critical levels (which are expressed as the concentration of a pollutant in air) and critical loads (which are expressed as the deposition of a pollutant to the surface).

4.2.6. The criteria for assessment of impacts at sensitive ecological receptors are derived as follows:

- Pollutant Concentrations (Critical Levels) derived from the UK Air Quality Strategy[3,4] and EA targets for protected conservation areas and World Health Organisation guidelines[21].
- Pollutant Deposition (Critical Loads) estimated by UNECE and others and set out on the Air Pollution Information System (APIS)[22] website.

4.2.7. Critical levels are not habitat or species specific and are the same for all sites. These are set out in **Table 4-4**. Impacts relating to nutrient nitrogen deposition are habitat and species specific; the site-specific critical loads are set out in **Background NOx** concentrations do not exceed the annual critical level of 30µg/m3 for any of the designated sites. Nitrogen deposition at every site exceeds the lower critical load (20kgN/ha/yr).

4.2.8. **Table 6-4** details the sensitive ecological receptors of interest.

Table 4-4 – Air quality critical levels used for the assessment of impacts on sensitive ecological receptors.

Pollutant	Concentration (µg/m³)	Measured as	Requirement
Nitrogen oxide (NO_x)	30	Annual mean	Critical level for the protection of sensitive vegetation and ecosystems.
	75 / 200*	24-hour (daily) mean	
Ammonia (NH_3)	3	Annual mean	Critical level for the protection of sensitive vegetation and ecosystems

[21] World Health Organisation (2021) *WHO global air quality guidelines* [online]. Available at: https://apps.who.int/iris/bitstream/handle/10665/345329/9789240034228-eng.pdf?sequence=1&isAllowed=y [Accessed March 2025].

[22] Natural England (2022) *Air Pollution Information System* [online]. Available at: https://www.apis.ac.uk/ [Accessed March 2025].

	1	Annual mean	Critical level for the protection of sensitive vegetation and ecosystems where Lichen or Bryophytes are present

*The critical level is generally considered to be 75µg/m^3, but this only applies to where there are high concentrations of SO_2 and ozone, which is not generally the current situation in the UK.[23]

4.3. GUIDANCE

4.3.1. A summary of the air quality guidance relevant to this assessment is provided below.

ENVIRONMENT AGENCY: RISK ASSESSMENTS FOR SPECIFIC ACTIVITIES: ENVIRONMENTAL PERMITS

4.3.2. The Air Emissions section of the Environment Agency (EA) guidance[24] has been referred to in the assessment of emissions to air from the generators. This guidance is intended to assist operators in assessing risks to air when applying for a permit under the Environmental Permitting Regulations. This is part of the 'Risk assessments for specific activities: environmental permits' collection. Included within the Air Emissions Risk Assessment (AERA) guidance are:

- An approach for undertaking screening assessments;
- Information on when detailed atmospheric modelling is required; and
- Environmental Assessment Levels (EALs) for a range of pollutants against which impact may be assessed.

ENVIRONMENT AGENCY: SPECIFIED GENERATORS: DISPERSION MODELLING ASSESSMENT

4.3.3. This guidance[25] provides advice on how to undertake dispersion modelling for NO_x emissions from 'specified generators', which are generators used for the purpose of generating electricity; or a group of such combustion plant located at the same site, operated by the same operator, and having the same purpose, between 1 and 50MWth. Whilst the generators assessed in this report are not specified generators, this EA guidance document details what needs to be included in the report produced to present the results of the dispersion modelling and sets out the recommended approach to the characterisation of emissions, the inclusion of buildings and terrain, and atmospheric chemistry, and the distance to which receptors (human and ecological) require consideration. The guidance also details the methods that can be used to undertake statistical analysis of short-term predictions.

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[23] IAQM (2020) A guide to the assessment of air quality impacts on designated nature conservation sites [online]. Available at: https://iaqm.co.uk/text/guidance/air-quality-impacts-on-nature-sites-2020.pdf. [Accessed March 2025].

[24] Environment Agency (2024) *Guidance – Air emissions risk assessment for your environmental permit* [online]. Available at: https://www.gov.uk/guidance/air-emissions-risk-assessment-for-your-environmental-permit [Accessed March 2025].

[25] Environment Agency (2019) *Guidance - Specified generators: dispersion modelling assessment* [online]. Available at: https://www.gov.uk/guidance/specified-generators-dispersion-modelling-assessment#explain-the-background-concentration [Accessed March 2025].

ENVIRONMENT AGENCY: ENVIRONMENTAL PERMITTING: AIR DISPERSION MODELLING REPORTS

4.3.4. This EA guidance document[26] sets out what information needs to be provided in an air quality assessment report that has been prepared in support of an environmental permit application.

[26] Environment Agency (2021) *Guidance – Environmental permitting: air dispersion modelling reports* [online]. Available at: https://www.gov.uk/guidance/environmental-permitting-air-dispersion-modelling-reports [Accessed March 2025].

5. SCOPE & METHODOLOGY

5.1. STUDY AREA AND SITE SETTING

5.1.1. The Site is located at Slough Trading Estate within the administrative area of SDC. A location map is provided in **Figure 1** in **Appendix B.**

5.1.2. The detailed study area extends 3km in all direction from the centre of the Site. This distance is sufficient to demonstrate the negligible impacts of the generators on air quality and conforms to the Environment Agency screening distances for nature conservation sites (see below).

5.1.3. The Site is located in an area of light industrial and commercial developments. Beyond the boundary of the Slough Trading Estate are residential properties, the nearest of which are over 250m to the southwest.

5.1.4. The principal source of pollution in the immediate vicinity of the Site is road traffic on the local road network; particularly on Edinburgh Avenue, Liverpool Road and Buckingham Avenue. The nearest main road is Farnham Road, which runs approximately north-south around 300m to the east. The M4 is over 1.7km to the south and the Burnham to Slough railway line runs east to west approximately 280m to the south of the Site.

5.2. SENSITIVE RECEPTORS

5.2.1. Sensitive locations are places where the public may be exposed to emissions from the generator flues. These will include places where members of the public are likely to be regularly present over the period of time prescribed in the Air Quality Strategy[3,4].

5.2.2. To complete the assessment of impacts, a number of discrete human receptor locations were selected at which pollution concentrations were predicted. The discrete receptors represent the closest residential properties, schools and healthcare facilities to the Site, at which both the long-term and short-term will objectives apply.

5.2.3. The locations of the discrete human health receptors included in ADMS 6 are summarised in **Table 5-1**.

Table 5-1 – Modelled human health receptor locations

Receptor ID	Location	X, Y	Height above ground level (m)
R1	61 Littlebrook Avenue, SL22PD	494187.2, 181685.8	1.5
R2	Residential Property, Sandown Road, SL21TU	494738.2, 181803.2	1.5
R3	1 Bodmin Avenue, SL11SL	495287.9, 181778.7	1.5
R4	Residential Property, Bodmin Avenue, SL21SL	495513.3, 181741.1	1.5
R5	20 Rowan Way, SL21EX	495678.7, 181627.3	1.5
R6	5 Montrose Avenue, SL14TN	495897.2, 181476.1	1.5

Receptor ID	Location	X, Y	Height above ground level (m)
R7	Residential Property, Farnham Road, SL14XA	496194.8, 181243.3	1.5
R8	5 Buckingham Avenue East, SL13EB	496238.2, 181038.3	1.5
R9	Residential Property, Pitts Road, SL13XG	496177.9, 180523.4	1.5
R10	7 Hayling Close, SL15DE	495554.6, 180381.4	1.5
R11	The Westgate School, Chippenham Lane, SL15AH	495329.9, 180453.1	1.5
R12	Chippenham Surgery, 261 Bath Road, SL15PP	494968.2, 180910.8	1.5
R13	Al-Madani Girls Secondary School, Bath Road SL15PR	494576.3, 181037.4	1.5
R14	1 Burnham Lane, SL16LH	494535.1, 181119.3	1.5
R15	440 Malton Avenue, SL1 4QU	495656.0, 181045.7	1.5
R16	31 Buckingham Avenue, SL1 4LU	495518.0, 181158.5	1.5

5.2.4. The EA's Air Emissions Risk Assessment Guidance[24] provides advice on which ecological sites should be considered as sensitive receptors within dispersion modelling studies. The advice recommends that the following should be included:

- SPAs, SACs or Ramsar sites within 10km of the installation; and
- SSSIs (extended to 10km for larger emitters), National Nature Reserves (NNRs), Local Nature Reserves (LNRs), Local Wildlife Sites (LWSs) and Ancient Woodland within 2km of the installation.

5.2.5. However, it should be noted that the EA guidance for dispersion modelling assessment of specified generators does not require impacts on LWSs to be considered.

5.2.6. A review of information available on Natural England's Multi-Agency Geographic Information for the Countryside (MAGIC) website[27] identified that the Southwest London Waterbodies Ramsar and SPA, Chilterns Beechwoods SAC and the Windsor Forest and Great Park SAC are all located within 10km of the Site. Given the nature of the generator emissions (short term releases from individual generators across the Site with no regular pattern), in combination effects on these sensitive ecological sites with other plans and projects cannot be accurately assessed and in any event are likely to be very small given their distance from the Site. Therefore, consideration of in-combination effects has been scoped out of this assessment.

5.2.7. Whilst there are no SSSIs within 2km of the Site, the following are within 2km of the Site:

[27] Natural England (2022) *Multi-Agency Geographic Information for the Countryside* [online]. Available at: https://magic.defra.gov.uk/ [Accessed March 2025].

- Cocksherd Wood LNR and LWS; and
- Haymill Valley LNR and LWS; and
- Railway Triangle LWS.

5.2.8. **Table 5-2** provides details regarding discrete ecological receptor points included within this assessment that are representative of the designated nature conservation sites boundary closest to the Site.

Table 5-2 – Modelled worst case ecological receptor locations

Receptor ID	Location	X, Y	Height above ground level (m)
E1	Chilterns Beechwoods SAC	486450.9, 185301.9	0
E2	Haymill Valley LNR/LWS	494320.5, 181425.4	0
E3	Haymill Valley LNR/LWS	494368.2, 181894.5	0
E4	Cocksherd Wood LNR/LWS	494624.0, 182755.2	0
E5	Burnham Beeches SAC/SSSI/NNR	495169.9, 184308.1	0
E6	Railway Triangle LWS	497178.5, 180346,2	0
E7	South West London Waterbodies & Wraysbury Reservoir Ramsar/SPA/SSSI	502329.0, 175576.4	0
E8	South West London Waterbodies & Wraysbury & Hythe End Gravel Pit Ramsar/SPA/SSSI	500727.7, 174123	0
E9	South West London Waterbodies & Wraysbury No.1 Gravel Pit Ramsar/SPA/SSSI	500249.8, 175459.5	0
E10	Windsor Forest & Great Park SAC/SSSI	495843.1, 175416.9	0
E11	Windsor Forest & Great Park SAC/SSSI	492337.6, 175565.2	0

5.2.9. In addition to the specified receptor points described above, NO_x concentrations were predicted at a height of 1.5m across a 3km x 3km cartesian grid with a 15m resolution, centred on the Site.

5.2.10. **Figure 2** and **Figure 3** show the locations of the specified human and ecological receptor locations and the extent of the model domain.

6. BASELINE CONDITIONS

6.1. SBC AIR QUALITY REVIEW

6.1.1. SBC has declared four AQMAs within its administrative area. The closest is Slough AQMA No. 3 approximately 850m to the southeast. This AQMA was designated by the SBC in 2011 and subsequently extended due to exceedances of the annual mean NO_2 AQS[28]. The AQMA encompasses the A355 Tuns Lane from junction 6 of the M4 motorway in a northerly direction to just past its junction with the A4 Bath Road and A355 Farnham Road, known as the Three Tuns.

CONTINUOUS MONITORING DATA

6.1.2. In 2023 SBC managed seven Continuous Monitoring Sites (CMSs); of which two were within 2km of the Site boundary. **Table 6-1** shows the latest five years of data for CMSs within 2km of the Site. Data for all years recorded were compliant with the annual mean AQS (**Table 4-1**).

Table 6-1 – Monitored annual mean NO_2 concentrations at CMS within 2km of the Site (µg/m^3)

Site ID	Location	Site Type	X, Y	Distance to Site (km)	Annual mean NO_2 concentration (µg/m^3)				
					2019	2020*	2021*	2022	2023
SLH 4	Salt Hill (Slough-town-centre, A4)	Urban background	496599, 180156	1.2km southeast	26.4	-	-	-	-
SLH 12	Slough Windmill Bath Road	Roadside	496528, 180171	1.2km southeast	39.2	26.9	28.9	28.7	25.5

Data for SBD was obtained from the 2024 Air Quality Annual Status Report[29].

-indicates that the site was closed.

*2020/2021 monitoring data is not considered to be representative of normal conditions nor when making comparisons of long-term trends due to national lockdown restrictions attributed to the outbreak of the COVID-19 pandemic.

DIFFUSION TUBE MONITORING DATA

6.1.3. In 2019 SBC also managed 22 diffusion tube monitoring sites within 2km of the Site boundary (see **Table 6-2** overleaf). Annual mean NO_2 concentrations recorded at 21 of the 22 diffusion tube monitoring sites were compliant with the relevant AQS (**Table 4-1**). The maximum concentration of 42.8µg/m^3 was recorded at SLO 50 in 2019. However, this is unlikely to be representative of conditions at the Site given that SLO 50 is located kerbside to the A355 approximately 1.2km to the southeast of the Site. The closest diffusion tube monitoring location to the Site boundary is the

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[28] Defra (2024) *AQMAs Declared by Slough Borough Council* [online]. Available at: https://uk-air.defra.gov.uk/aqma/local-authorities?la_id=232 [Accessed March 2025].

[29] SBC (2024) *2024 Air Quality Annual Status Report (ASR)* [online]. Available at: https://www.slough.gov.uk/downloads/file/4398/2024-air-quality-annual-status-report-asr- [Accessed March 2025].

roadside site SLO 30 approximately 1.1km southeast. Concentrations recorded at SLO 30 were compliant with the annual mean NO_2 AQS for the five-year period from 2019 to 2023.

Table 6-2 - Monitored annual mean NO_2 concentrations at diffusion tube sites within 2km of the Site (µg/m³)

Site ID	Location	Site Type	X, Y	Distance to Site (km)	Annual mean NO_2 concentrations (µg/m³)				
					2019	2020*	2021*	2022	2023
SLO 1 Relocated	Salt Hill Park (tennis courts)	Urban Background	496904, 180187	1.3km southeast	-	19.7	18.5	19.4	16.2
SLO 2 Relocated	Salt Hill Park (footbridge)	Urban Background	496785, 180336	1.3km southeast	-	15.4	14.5	15.5	13.5
SLO 3 Relocated	Salt Hill Park (footpath)	Urban Background	496665, 180236	1.3km southeast	-	17.6	18.0	16.5	15.0
SLO 4 Relocated	Lansdowne Avenue	Roadside	497185, 180050	1.8km southeast	-	19.4	20.2	21.3	18.8
SLO 23	Tuns Lane	Urban Background	496416, 180126	1.1km southeast	30.8	22.0	21.9	22.2	20.0
SLO 24	Spackmans Way	Other	496272, 179187	1.8km southeast	33.0	22.6	20.9	21.4	18.4
SLO 25	Paxton Avenue	Other	496050, 179258	1.6km southeast	31.8	20.3	19.0	19.6	19.6
SLO 30	Farnham Road	Roadside	496397, 180341	1.0km southeast	32.0	23.2	23.9	23.4	-
SLO 31	Essex Avenue	Suburban	496200, 181900	1.1km northeast	27.0	21.9	20.9	-	-
SLO 37	Blair Road - Victoria Court	Roadside	497105, 180081	1.7km southeast	37.8	28.2	26.3	27.1	22.7

Site ID	Location	Site Type	X, Y	Distance to Site (km)	Annual mean NO_2 concentrations ($\mu g/m^3$)				
					2019	2020*	2021*	2022	2023
SLO 41	Sandringham Court	Other	493960, 181355	1.3km west	19.4	13.6	12.7	-	-
SLO 42	Walpole Rd	Other	493493, 181378	1.8km west	18.6	12.8	13.2	-	-
SLO 43	Windmill (BathRd)	Roadside	496533, 180175	1.2km southeast	33.1	25.0	25.0	25.6	23.3
SLO 50	Tuns Lane (B)	Kerbside	496377, 179929	1.2km southeast	**42.8**	30.6	30.7	32.9	27.2
SLO 57, SLO 58, SLO 59	Windmill	Kerbside	469528, 180171	1.2km southeast	38.9	27.3	28.2	28.8	27.0
SLO 66, SLO 67, SLO 68	Paxton Avenue	Other	496146, 179259	1.6km south	34.6	22.6	20.8	23.5	21.4
SLO 69, SLO 70, SLO 71	Spackmans Way	Other	496223, 179217	1.6km south	32.7	23.1	21.6	23.6	22.5
SLO 72, SLO 73, SLO 74	Spackmans Way	Other	496225, 179213	1.6km south	32.0	24.7	21.1	23.9	21.9
SLO 75, SLO 76, SLO 77	Spackmans Way	Other	496227, 179207	1.6km south	29.3	22.6	20.3	22.6	20.0
SLO 78, SLO 79, SLO 80	Spackmans Way	Other	496229, 179204	1.6km south	31.5	24.1	22.2	24.0	22.1
SLO 81, SLO 82, SLO 83	Spackmans Way	Other	496232, 179199	1.6km south	-	24.1	21.1	24.0	22.1

Site ID	Location	Site Type	X, Y	Distance to Site (km)	Annual mean NO_2 concentrations (µg/m³)				
					2019	2020*	2021*	2022	2023
SLO 84, SLO 85, SLO 86	Spackmans Way	Other	496234, 179195	1.6km south	32.9	23.3	22.0	24.6	22.4
SLO 87, SLO 88, SLO 89	Spackmans Way	Other	496236, 179191	1.6km south	33.2	23.1	21.8	23.5	20.9
SLO 90, SLO 91, SLO 92	Spackmans Way	Other	496238, 179186	1.6km south	28.7	23.1	21.5	23.8	21.5

Bold text indicates an exceedance of the annual mean NO_2 AQS.

- indicates that the monitoring site was closed.

Data for SBD was obtained from the 2024 Air Quality Annual Status Report[29].

*2020/2021 monitoring data is not considered to be representative of normal conditions nor when making comparisons of long-term trends due to national lockdown restrictions attributed to the outbreak of the COVID-19 pandemic.

6.2. BACKGROUND POLLUTANT CONCENTRATIONS (HUMAN HEALTH)

6.2.1. The Department for Environment, Food and Rural Affairs (Defra) and the Devolved Administrations provide mapped background pollutant concentrations in the UK on a 1km x 1km grid. For NO_2, the latest available data are provided as hindcasts/projections for all years from 2021 to 2040.

6.2.2. **Table 6-3** shows that the monitored concentrations at background locations near the Site are slightly lower than the mapped data. It is, therefore, appropriate to base the assessment of impacts on mapped background concentrations rather than monitoring for the assessment of human health.

6.2.3. The mapped NO_2 concentration for the Site was used as the annual mean background concentration in the calculation of risk of exceedance of the NO_2 objective for the protection of health.

Table 6-3 – Comparison of mapped and monitored background NO_2 concentrations (µg/m^3)

Site ID	Site Type	Distance to Site (km)	2023 Monitored concentration (µg/m^3)	2023 Mapped concentration (µg/m^3)	Ratio Monitored / Mapped
SLO 1	Urban background	0.8km southeast	16.2	19.4	0.8
SLO 2	Urban background	0.8km southeast	13.5	19.4	0.7
SLO 3	Urban background	0.8km southeast	15.0	19.4	0.8
SLO 23	Urban background	0.7km southeast	20.0	19.4	1.0
				Average Ratio Monitored/Mapped:	0.8

6.3. BACKGROUND POLLUTANT CONCENTRATIONS (ECOLOGY)

6.3.1. The APIS22 website provides mapped pollutant concentration and deposition data for the UK. **Background NOx** concentrations do not exceed the annual critical level of 30µg/m3 for any of the designated sites. Nitrogen deposition at every site exceeds the lower critical load (20kgN/ha/yr).

6.3.2. Table 6-4 shows the NO_x and nitrogen deposition data for the ecological sites within the study area.

6.3.3. Background NO_x concentrations do not exceed the annual critical level of 30µg/m^3 for any of the designated sites. Nitrogen deposition at every site exceeds the lower critical load (20kgN/ha/yr).

Table 6-4 – Mapped background concentrations and nitrogen deposition over ecological sites for 2023

Site	Designation	NOx Critical Level (µg/m³)	NO_X (µg/m³)	N-Dep Critical Load (kgN/ha/yr)	N-Dep (kgN/ha/yr)	NH_3 (µg/m³)	NH_3 Critical Level (µg/m³)
Chilterns Beechwoods	SAC + constituent SSSI	30	10.5	10	26.9	1.2	1.0
South West London Waterbodies	SPA/ Ramsar + constituent SSSI	30	23.7	20	22.8	1.0	3.0
Burnham Beeches	SAC + constituent SSSI	30	14.3	10	24.0	1.0	1.0
Windsor Forest and Great Park	SAC + constituent SSSI	30	14.4	10	22.3	1.0	1.0
Haymill Valley	LNR / LWS	30	22.4	10	23.4	1.2	1.0
Cocksherd Wood	LNR / LWS	30	18.2	10	23.7	1.2	1.0
Railway Triangle (off Stranraer Gdns)	LWS	30	23.5	10	22.9	1.2	1.0

7. ASSESSMENT METHODOLOGY AND SIGNIFICANCE CRITERIA

7.1. AIR DISPERSION MODELLING

7.1.1. Atmospheric dispersion modelling software (ADMS) version 6.0.1[30] developed by Cambridge Environmental Research Consultants (CERC) was used for quantifying the impact of emissions from generators on NO_x and NO_2 concentrations. ADMS uses detailed information regarding the pollutant releases, building effects and local meteorological conditions to predict pollutant concentrations at specific locations and areas as selected by the user and is approved by the EA for regulatory applications.

7.1.2. The model is a new generation Gaussian model that has been validated against both field studies and wind tunnel studies of dispersion and is widely used for air quality impact assessment in the UK.

7.2. MODEL INPUTS

STACK PARAMETERS

7.2.1. The full set of flue parameters and emissions to air used in the dispersion modelling for each scenario, together with information on their derivation and raw generator parameters (as specified by supplier technical datasheets), are provided in **Appendix C.**

Exhaust Gas Mixing

7.2.2. The generator sets for LON12 each have an air intake, driven by a fixed volume fan, which is used in part for generator cooling and in part input air to the generator combustion process. The air streams are then recombined within the individual exhaust stacks prior to emission to air and comprise a mixture:

- Generator exhaust gas, which is between 300°C and 480°C depending on the load, and
- Engine cooling air, which has been raised to around 40°C above ambient temperature

7.2.3. The air intake has an initial, fixed, volume flow rate of 35.5m^3/s (at ambient temperature), and is assumed for modelling purposes to be at a temperature of 11.9°C. This temperature is the average annual temperature at Heathrow.

7.2.4. The client has estimated that the temperature of the engine cooling air will be raised by 40°C by the cooling process. The exhaust gases therefore comprise a mixture of bypass cooling air at 51.9°C and generator exhaust gases at 290°C+ (depending on engine load). These gases are assumed to mix perfectly as ideal gases within the exhaust stack with no loss of energy through the walls and conservation of internal energy. The resulting volume and temperature of the exhaust gases are provided in **Appendix C**.

Exhaust Stack Diameter

7.2.5. The generator exhausts are rectangular in cross section, with an area of 9.42m^2. The exit is restricted by noise baffles which reduce the exhaust by 50% for an exhaust area of 4.71m^2.

[30] CERC (2023) *ADMS 6* [online]. Available at: http://www.cerc.co.uk/environmental-software/ADMS-model.html [Accessed March 2025].

7.2.6. It is a limitation of ADMS that point sources can only be represented by releases with a circular cross-section. The $4.71m^2$ area of the rectangular exhaust is equivalent to an effective 2.45m diameter circular release. Setting the exhaust diameter to 2.45m (for single generators) ensures that the exit velocity of the exhaust plume is correctly represented in the modelling.

Plume Merging

7.2.7. In the routine testing scenarios, the generators are run consecutively, with no more than a single generator operating at any time. There is, therefore, no potential for the merging of plumes.

7.2.8. In the emergency backup operations, all 16 generators are operating concurrently. With the generators arranged in two linear banks, rather than in clusters, it is unrealistic to assume that all exhaust plumes will merge. However, it is equally unrealistic to assume that there will be no plume merging since the generators are, with the exception of a few narrow gaps, located immediately adjacent to one another.

7.2.9. It was decided to model the emergency scenario of the operation of 16 generators with no plume merging. This approach was the most conservative, disregarding the beneficial impacts of plume merging.

7.2.10. Emission sources for LON12 were grouped into 4 (2 groups of 3 sources and 2 groups of 5 sources), with NO_x emissions to represent multiple generator exhausts but as a single plume with no benefits of merging. Emission sources for the additional LON4 generators were each modelled as separate point sources with no plume merging.

Routine Testing Scenarios

7.2.11. The exact sequencing of the generators during the monthly testing is unknown and may be variable, but it is possible that adjacent generators will be tested within a single hour. Offsite impacts from the use of generators that are located close to each other will be very similar, although impacts at individual receptors from generators at the extremes of the generator banks will be different.

7.2.12. Therefore, it is not possible to explicitly model any testing scenario and a pragmatic approach was adopted in which the emissions from indicative generator locations were modelled and then the output analysed to assess the statistical likelihood of exceedance of the AQS if all hours of testing were to occur at each generator location individually.

7.2.13. The indicative generator locations were taken to be those positioned on the northern and southern extremes of each of the banks of generators to ensure that the closest generators to the sensitive human health receptors were represented (**Schematic 7-1**). For each receptor, the impact was taken to be the maximum impact across the modelled locations.

7.2.14. Since the greatest impacts from a receptor are likely to occur under emissions from the closest generator, this approach is likely to overestimate the true impacts of sequential testing.

Schematic 7-1. Modelled LON12 and new LON4 Sources for All Scenarios

Virtus Test 1

7.2.15. For the routine testing in Months 1 to 11 (Virtus Test 1), all generators operate at 10% load. Further, it is assumed that the 15 minute tests are conducted immediately after one another, such that in any hour, 4 generators could potentially be tested for 15 minutes each. As will be demonstrated, even when assuming a maximum of 4 x generators, no exceedances of 200µg/m^3 (or any of the AEGLs) are modelled.

7.2.16. The model parameters for Virtus Test 1 are shown in **Appendix C**.

Virtus Test 2

7.2.17. For the routine testing in Month 12 (Virtus Test 2), the concurrent operation of all sources was modelled for the previously mentioned 4 sources (16 generators) (**Schematic 7-2**). All model parameters for the LON3, LON4, LON9, LON10 and LON11 generators were taken from the respective previous assessments[31,32,33], including locations of point sources, emission rates, and exhaust flow rates

7.2.18. The generators are run at 100% for 20 minutes at the start of test, and then run for a further 120 minutes at 75% load. As a highly conservative approach the Month 12 testing is modelled with each LON12 generator remaining at 100% load for each test. The additional LON4 generators were modelled at parameters used in the previous LON4 assessment. All other parameters were taken from previous assessments[31,32,33].

7.2.19. The model parameters for Virtus Test 2 are shown in **Appendix C**.

Emergency Scenario 2

7.2.20. For the emergency scenario, the concurrent operation of all sources is modelled for the previously mentioned 4 sources (16 generators) (**Schematic 7-2**). All model parameters for the LON3, LON4, LON9, LON10 and LON11 generators were taken from the respective previous assessments[34,35,36], including locations of point sources, emission rates, and exhaust flow rates.

7.2.21. As a conservative approach to the LON12 emissions, the generators were modelled at 100% load for the full 72-hour emergency scenario along with 72-hour operations of LON3, LON4, LON9, LON10 and LON11.

7.2.22. In addition to this, the 72-hour scenario was also modelled with LON12 generators only (at 100% for the full 72 hours) and new LON4 generators (using previous assessment emergency scenario parameters from previous assessment[31]).

7.2.23. For each generator, the impacts are modelled at the specific loads set out in **Table 3-1**.

BUILDING DOWNWASH

7.2.24. ADMS 6 takes into account the effects of building downwash[37] on pollutants. Downwash is the enhanced turbulent mixing of pollutants in the lee of buildings which can result in high pollutant concentrations in the wake of the building. A summary of the buildings included within the model set up are summarised in **Table 7-1** and their positions are illustrated in **Schematics 7-1** and **7-2**, and in **Figure 1** in **Appendix B.**

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[31] WSP (2022), Virtus Slough Campus: London 3, London 4, London 10 Data Centres - Air Quality Assessment. Permit Ref. EPR/BP3945QX

[32] WSP (2022), Virtus Data Centres London 9 – Air Quality Assessment. Permit Ref. EPR/CP3347JV

[33] WSP (2022), Virtus Data Centres London 11 – Air Quality Assessment. Permit Ref. EPR/DP3348QS

[34] WSP (2022), Virtus Slough Campus: London 3, London 4, London 10 Data Centres - Air Quality Assessment. Permit Ref. EPR/BP3945QX

[35] WSP (2022), Virtus Data Centres London 9 – Air Quality Assessment. Permit Ref. EPR/CP3347JV

[36] WSP (2022), Virtus Data Centres London 11 – Air Quality Assessment. Permit Ref. EPR/DP3348QS

[37] Downwash is the enhanced turbulent mixing of pollutants in the lee of buildings which can result in high pollutant concentrations in the wake of the building.

Table 7-1 – Buildings included in the dispersion modelling

Building	Shape	Easting	Northing	Height (m)	Length (m)	Width (m)	Angle (°)
LON3	Rectangle	495731.7	181246.1	16.2	37.5	46.5	16.7
LON4	Rectangle	495731.9	181332.7	16.2	101.9	95.5	16.7
LON10	Rectangle	495764.8	181183.3	15.4	64	34	16
158 Edinburgh Ave	Rectangle	495874.8	181288.4	11.5	87.1	70.4	16.7
LON3 gantry	Rectangle	495700.5	181255.2	13.5	37.5	18.3	16.7
LON4 gantry	Rectangle	495795.1	181321.6	10	86.5	32	16.7
LON10 gantry	Rectangle	495792	181181.5	13.4	37.5	19	16
LON12-1	Rectangle	495818	181229	23	46	105	16.7
LON12-2	Rectangle	495878	181209	23	52	21	16.7
LON12-3	Rectangle	495828	181188	23	15	33	16.7
LON9-Building00	Rectangle	496013.6	180847.7	16.5	41.4	38.3	21
LON9-Building01	Rectangle	495968.2	180871.5	23	33.5	33.5	21
LON9-Building02	Rectangle	495918.3	180895.9	23	43.8	78.7	21
LON9-Building03	Rectangle	495864.5	180923.3	23	55.2	42.9	21
LON9-Building04	Rectangle	495822	180954.8	13.9	20.2	39.6	27
LON9-Building05	Rectangle	495844.4	180943.1	23	32.7	8.8	21
LON11-Building01	Rectangle	495445.7	180885.9	15.1	47.2	16.7	18.84
LON11-Building02	Rectangle	495360.1	180914.8	15.1	47.1	16.7	18.85

SURFACE ROUGHNESS AND TERRAIN

7.2.25. The area surrounding the Site is relatively flat (slope gradients <10%). Therefore, site specific terrain height data has not been included with the modelling.

7.2.26. The roughness of the terrain, over which a plume from a point source passes, can have a significant effect on dispersion by altering the velocity profile with height, and the degree of atmospheric turbulence. Within the ADMS 6 model, this can be accounted for using a parameter called 'surface roughness length'.

7.2.27. The area surrounding the Site is largely suburban in nature. A surface roughness length of 0.5m was therefore used within the modelling to represent the average surface characteristics of the study area in the model. This is the value recommended by the model developers for areas of parkland and open suburbia.

7.2.28. In addition, the model can also take into account the effect of heat generation from buildings and traffic in built up areas on pollutant dispersal. This parameter, known as the minimum Monin-Obukhov Length, was set to 30m, which represents the recommended model setting for mixed urban areas, cities and large towns.

METEOROLOGICAL DATA

7.2.29. Meteorological data, including wind speed and direction, is used by the model to determine pollutant transportation and levels of dilution by the wind. Meteorological data used in the model was obtained from the Met Office observing station at Heathrow Airport. This station is approximately 11.7km to the southeast of the Site and is considered to provide the most representative dataset for this assessment.

7.2.30. Five years of meteorological data were used in the assessment, which were for the years 2020 to 2024. Windroses for each year of meteorological data used are provided in **Appendix D**.

MODEL DOMAIN

7.2.31. The model domain extends 3km x 3km centred on the Site, with concentrations modelled on a cartesian grid with a resolution of 15m.

7.2.32. Impacts have also been modelled at indicative selected receptors. These receptors were set out in **Table 5-1** and **Table 5-2** and illustrated in **Figure 2** and **Figure 3** in **Appendix B**.

7.3. POST PROCESSING OF RESULTS

ATMOSPHERIC CHEMISTRY

7.3.1. Emissions of NO_x from combustion sources include both NO_2 and nitric oxide (NO), with the majority being in the form of NO. In ambient air, NO is oxidised to form NO_2, and it is NO_2 which has the more significant health impacts. For this assessment, the conversion of NO to NO_2 has been estimated using assumptions set out in the EA guidance[38], namely that

[38] NO_X to NO_2 conversion ratios to use – Environment Agency https://www.gov.uk/guidance/specified-generators-dispersion-modelling-assessment#nosubxsub-to-nosub2sub-conversion-ratios-to-use . Accessed September 2024

- For the assessment of long term (annual mean) impacts, at receptors 70% of NO_x is NO_2
- For the assessment of short term (hourly mean) impacts, at receptors 15% of NO_x is NO_2.

7.3.2. The oxidation of NO to NO_2 is not an instantaneous process and, where the maximum impacts occur within a few hundred metres of the stacks (as will be shown to be the case for the generators), the EA standard assumption of 35% NO_X as NO_2 for short term impacts is likely to be conservative. Therefore, following EA guidance, the impacts are modelled using 15% NO_X as NO_2 for modelling on sub-daily times.

SHORT TERM IMPACTS

7.3.3. Given the intermittent and unknown pattern of operation of the generators, short-term impacts (on daily and sub-daily timescales) were assessed using the EA's recommended statistical approach based on the hypergeometric probability distribution[25].

7.3.4. The dispersion modelling was used to assess the theoretical maximum number of hours (and 4hr and 8hr periods) in the year that the short-term AQS and AEGLs for NO_2 and NH_3, and daily mean standard for NO_X for ecological receptors, are potentially exceeded assuming continuous operation. These potential exceedance hours are combined with likely operating hours in the year to calculate the likelihood of exceedance under realistic operations.

7.3.5. Since the generators may operate in consecutive hours and days, the probability of exceedance calculated using the hypergeometric methodology was multiplied by 2.5 as prescribed by EA guidance.

ANNUAL MEAN IMPACTS

7.3.6. For the assessment of annual mean impacts on ecological and human receptors, the model outputs assuming continuous operation were scaled by the assumed hours of operation, namely:

- Virtus Test 1: 11 months with 30 minute testing of each generator: 88hrs
- Virtus Test 2: 1 month with 140 minute testing of each generator: 37.4hrs
- Virtus Emergency Scenario 2: 72hrs of running of all generators: 72hrs

POLLUTANT DEPOSITION

7.3.7. The deposition of NO_2 to ecological receptors was modelled using the following deposition velocities:

- Grassland/Meadows: 1.5mm/s
- Woodland: 3.0mm/s

SUB-HOURLY IMPACTS

7.3.8. AEGLs for NO_2 are set for 10 minute, 30 minute, 1 hour, 4 hours and 8 hours. With the ADMS model being run with hourly sequential meteorological data, the 1, 4 and 8 hour average concentrations can be modelled explicitly. However, the explicit modelling of sub-hourly timescales is less robust since the sub-hourly variation in meteorological conditions is not represented in the model input data.

7.3.9. Therefore, an empirical method linking the peak concentrations at various timescales has been used in the modelling to convert the 10 minute and 30 minute AEGLs to hourly mean concentrations for analysis. The method follows that set out in Turner[39] and is consistent with the EA guidance on modelling sub-hourly (15minute) SO_2 concentrations where:

$$C_1 = C_2 \times \left(\frac{T_2}{T_1}\right)^p$$

where C_1 and C_2 are the peak concentrations at averaging times T_1 and T_2, and the exponent p is between 0.17 and 0.2 (set to 0.2 here). Using this relationship, the peak 10 minute concentration within an hour will be a factor of 1.43 higher than the hourly concentration, and the peak 30 minute concentration will be a factor of 1.15 higher. The potential exceedances of the 10minute and 30minute AEGLS are, therefore, modelled as the potential exceedances of hourly concentrations that are factors of 1.43 and 1.15 lower.

7.3.10. For the 10 minute averages, the potential that more than one 10 minute period in the hour exceeds the AEGL is taken into account by multiplying the hourly exceedances by a factor of 3 i.e. assuming that, on average, 50% of the 10 minute average concentrations are higher than the hourly average and 50% are lower.

7.3.11. For AEGL2 and AEGL3, the resulting 'hourly equivalent AEGL is greater than the actual hourly AEGL and, therefore, the probability of exceedance of an AEGL is appropriately represented by the probability of the hourly AEGL without the need to assess the sub-hourly impacts. The above scaling is, therefore, only required for assessing the probability of exceedance of AEGL1 at sub-hourly timescales.

7.3.12. The resulting exceedance thresholds set in the modelling are set out in **Table 7-2**.

INCLUSION OF BACKGROUND CONCENTRATIONS

7.3.13. Total NOx, NO_2, NH_3 and nitrogen deposition (Predicted Environmental Concentrations (PECs)) were calculated from the relevant Process Contributions as follows:

PEC = PC + Background Concentration

7.3.14. The PECs were then compared with the relevant AQS provided in **Table 4-1**. At the ecological receptors, the NO_2 and NH_3 PCs were converted to nitrogen deposition.

7.3.15. In the calculation of the likelihood of exceedance of a short-term standard (sub-daily), the Background Concentration was assumed to be 2 x Annual Mean Background as per EA guidance.

7.3.16. Therefore, the exceedance threshold was set to:

Exceedance Threshold = AQ Standard – 2 x Annual Mean Background

where the AQ Standard is either a UK Objective or an AEGL. Furthermore, the NO_2 exceedance threshold was converted to NO_X prior to use in the modelling:

Exceedance Threshold (NO_X) = Exceedance Threshold (NO_2) / %NO_X_as_NO_2

where %NO_X_as_NO_2 is, as set out earlier, is set to 15%.

7.3.17. The resulting exceedance thresholds for modelling are set out in **Table 7-2** and **Table 7-3**.

[39] Turner, 1970, Workbook of Atmospheric Dispersion Estimates, available at https://nepis.epa.gov/

Table 7-2 – NO_2 Exceedance thresholds used for modelling. Model inputs highlighted in red cells

Metric	Standard		Averaging Time of Standard	Assessed as		Equivalent NO_2 PC after removing background[b] ($\mu g/m^3$)	Model Input Equivalent NO_X PC for modelling[c] ($\mu g/m^3$)
	ppm	$\mu g/m^3$		Conc. ($\mu g/m^3$)	Averaging Time		
UK Objective		200	1hr	200	1hr	162	1080
AEGL1	0.5	940	10min	657[a]	1hr	619	4127
AEGL1	0.5	940	30min	818[a]	1hr	780	5200
AEGL1	0.5	940	1hr	940	1hr	902	6013
AEGL1	0.5	940	4hr	940	4hr	902	6013
AEGL1	0.5	940	8hr	940	8hr	902	6013
AEGL2	12	22560	1hr	22560	1hr	22522	150147
AEGL2	8.2	15416	4hr	15416	4hr	15378	102520
AEGL2	6.7	12596	8hr	12596	8hr	12558	83720
AEGL3	20	37600	1hr	37600	1hr	37562	250413
AEGL3	14	26320	4hr	26320	4hr	26282	175213
AEGL3	11	20680	8hr	20680	8hr	20642	137613

a. **Calculated following para 7.3.9**
b. **Calculated using a background concentration of 19.0$\mu g/m^3$ following para 6.2.3**
c. **Calculated using a NO_X to NO_2 ratio of 15%, following para 7.3.1**

Table 7-3 – NH_3 Exceedance thresholds used for modelling. Model inputs highlighted in red cells

Metric	Standard		Averaging Time of Standard	Assessed as	
	ppm	$\mu g/m^3$		Conc. ($\mu g/m^3$)	Averaging Time
UK Objective		180	1hr	200	1hr
AEGL1	30	20860	10min	20858[a]	1hr
AEGL1	30	20860	30min	20858[b]	1hr

Metric	Standard		Averaging Time of Standard	Assessed as	
	ppm	µg/m^3		Conc. (µg/m^3)	Averaging Time
AEGL1	30	20860	1hr	20858	1hr
AEGL1	30	20860	4hr	20858	4hr
AEGL1	30	20860	8hr	20858	8hr
AEGL2	160	111250	1hr	111248	1hr
AEGL2	110	76480	4hr	76478	4hr
AEGL2	110	76480	8hr	76478	8hr
AEGL3	1100	764830	1hr	764828	1hr
AEGL3	550	382410	4hr	382408	4hr
AEGL3	390	271170	8hr	271168	8hr

a. **Calculated following para 7.3.9**
b. **Calculated using a background concentration of 1.0µg/m^3 following para 6.2.3**

7.4. SIGNIFICANCE CRITERIA

7.4.1. With regard to the significance of predicted long term impacts, the EA's guidance for undertaking air emissions risk assessment in support of environmental permit applications says that PC's can be screened out as insignificant at human health receptors if the following criterion is met:

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

7.4.2. Emissions that affect LWS are insignificant if they meet the following criteria:

- The short-term PC is less than 100% of the short-term environmental standard; and
- The long-term PC is less than 100% of the long-term environmental standard.

7.4.3. For the assessment of short terms effects calculated using the cumulative hypergeometric distribution, the EA's guidance on undertaking dispersion modelling for specified generators says that 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.

7.4.4. These criteria have therefore been used to determine the potential for exceedances of the hourly, 4 hourly and 8 hourly mean NO_2 AQS and AEGLs due to emissions from the generators during monthly testing and emergency outages.

7.5. LIMITATIONS AND ASSUMPTIONS

7.5.1. There are uncertainties associated with modelled pollutant concentrations. The dispersion model used in this assessment relies on input data, which also have uncertainties associated with them. The models simplify complex physical systems into a range of algorithms. In addition, local micro-climatic conditions may affect the concentrations of pollutants that the models will not take into account.

7.5.2. To reduce uncertainty associated with predicted concentrations, validated industry standard dispersion modelling software has been used in the assessment.

7.5.3. Model verification is not practical for point source models, and not possible at all in the case of the yet to be installed generators. Model uncertainty in terms of underprediction is addressed by considering the worst-case impacts in each of the five years of meteorological data and using the most conservative results to represent the impacts.

8. HUMAN HEALTH ASSESSMENT RESULTS

8.1. INTRODUCTION

8.1.1. As set out in the methodology, the assessment of impacts from the intermittent use of the generators on the Site is based on model runs that simulate continuous operation of the generators, either as individual generators (testing scenarios) or concurrently (emergency scenario). The model outputs are then subject to statistical analysis to determine the likelihood of exceedance of standards taking into account the likely hours of operation in the year.

8.1.2. In the description of the results below, the following metrics are presented:

- 100th / 99.79th percentiles of hourly, 4 hourly or 8 hourly concentrations
  - These metrics are assessed over 5 years of meteorological data and are the theoretical maximum impacts at each receptor assuming operation of the generator(s) coincides with the worst dispersion conditions for that receptor. The associated contour plots do not, therefore, reflect the distribution of impacts in any given hour but are a composite of the theoretical impacts over all potential meteorological conditions over 5 years.
  - If the 100th percentile impact does not result in an exceedance of a standard, then the risk of exceedance of the standard is negligible.
- Annual exceedances of the standard
  - These are the maximum hours (or 4 / 8 hours) in a year that the standard (either 200µg/m^3 for the UK's objective or the AEGLs) is exceeded. The value presented is for the worst year within the 5 years of meteorological data tested.
  - The metric is used in the calculation of the probability of exceedance of the standard given the likely operating hours for a scenario and does not represent the actual hours of exceedance that would be experienced under the scenario
- Risk of exceedance of the standard
  - This is the percentage risk of exceedance of the air quality objective for hourly mean NO_2 or the AEGLs taking into account likely operating hours, as output by the statistical analysis. The metric is based on the worst year over the 5 years of meteorological data tested.
  - As for all metrics, the spatial plots of the risk percentage do not reflect the potential exceedances that would occur at the same time. That is to say, the realisation of the risk at any given receptor is dependent on the wind blowing directly from generator to that receptor. The greater the angular separation of receptors, the less likely it is that an exceedance would occur at both receptors during the same operating event.
- Annual mean concentrations
  - This metrics is assessed over 5 years of meteorological data, with impacts from each testing and emergency scenario scaled by the operating hours for that scenario.

8.1.3. In Section 8.2 the results are presented for the selected human receptors (R1 – R16) and as a maximum at any offsite location.

8.2. MODEL RESULTS

Short Term Impacts

8.2.1. The assessment has found that none of the NO_2 or NH_3 AEGLs would be exceeded in any operational scenario at any sensitive receptors. **Figure 4** and **Figure 5** show the spatial distribution of the 100th percentile of hourly NO_2 outputs for the Virtus Test 2 and 72hr Emergency Scenarios respectively. Overall, the impacts decrease with distance from the data centre, with maximum impacts occurring to the north of the LON12 and east of the LON4 housing units.

8.2.2. **Table 8-1** and **Table 8-2** show the maximum modelled concentrations across the timescales relevant to the AEGLs for Emergency Scenario 2. Maximum modelled concentrations with the testing scenarios are significantly lower again since only one generator operates at any given time, and therefore will not exceed the concentrations presented for the emergency scenario. It is immediately apparent that the AEGL1, AEGL2 and AEGL3 levels are not exceeded or at risk of being exceeded at any modelled sensitive receptor. This applies to all timescales, from 8 hrs to sub-hourly times scales. As such, ***no significant health effects are likely with the operation of the generators for backup power generation or during testing***.

8.2.3. **Table 8-3** shows the maximum hourly average modelled NO_2 concentrations for each scenario and the risk of exceedance of the associated hourly mean objective of 200μg/m^3. All risks of exceedance modelled at discrete receptor locations are negligible (i.e. 0%) for the Virtus Test 1 and Test 2 scenarios.

8.2.4. The maximum gridded 100th %ile hourly mean NO_2 concentration is predicted to be 962.7μg/m^3 for Emergency Scenario 2. The risk of exceedances of the objective is negligible at all discrete receptor locations except for R6. However, even with the extremely conservative modelling scenario of all generators on the Slough campus operating for the full 72 hours, the risk of exceedance is still only 2.3% at R6. This falls below the 5% EA threshold. Furthermore, when LON12 and the new LON4 generators only are modelled for 72 hours (still a conservative modelling scenario), the risk of exceedance is 0% at every receptor. Therefore, it is highly unlikely that the objective will be exceeded at any of the receptors in a realistic outage scenario.

Annual Mean Impacts

8.2.5. **Table 8-4** shows the combined predicted annual mean NO_2 concentrations from Virtus 1, Virtus 2 and Emergency 2 scenarios. The annual mean NO_2 concentrations are not predicted to exceed the annual mean NO_2 air quality standard (40μg/m^3) at any of the discrete receptors.

8.2.6. It is important to note that the annual mean impacts are dominated by the theoretical Emergency 2 scenario. Impacts from testing alone are <0.4μg/m^3 at all receptors and less than 2.5μg/m^3 in the immediate vicinity of the data centre where there is no relevant exposure. Furthermore, it must be noted that the Emergency 2 scenario is theoretical and highly unlikely to occur in any year and certainly not every year, and it is also unlikely that all generators at LON12, LON3, LON4, LON10, LON9 and LON11 would run concurrently for 72 hours (and that LON12 would run at 100% load for the entire 72-hour period). As such, the impacts presented in **Table 8-4** are highly conservative and realistically never likely to occur.

8.2.7. **Table 8-5** shows the combined predicted annual mean NH_3 concentrations from Virtus 1, Virtus 2 and Emergency 2 scenarios. The annual mean NH_3 concentrations are not predicted to exceed 1%

of the annual mean NH_3 air quality standard (180µg/m^3) at any of the discrete receptors. Ammonia therefore does not meet the EA's long term significance criteria and is not considered further.

Table 8-1 – Maximum modelled NO_2 impacts for Emergency Scenario 2 as a function of averaging period. The maxima are taken over 5 years of modelled meteorological data. Data in bold exceed one or more of the Standards (without the addition of background concentrations).

Receptor	100th %ile 8-Hourly Mean PC for NO_2 ($\mu g/m^3$)	100th %ile 4-Hourly Mean PC for NO_2 ($\mu g/m^3$)	100th %ile Hourly Mean PC for NO_2 ($\mu g/m^3$)	100th %ile 30min Mean PC for NO_2 ($\mu g/m^3$)[a]	100th %ile 10min Mean PC for NO_2 ($\mu g/m^3$)[a]
Standards	AEGL3 – 20680 AEGL2 – 12596 AEGL1 - 940	AEGL3 – 26320 AEGL2 – 15416 AEGL1 - 940	AEGL3 – 37600 AEGL2 – 22560 AEGL1 – 940 AQ Standard - 200	AEGL3 – 47000 AEGL2 – 28200 AEGL1 - 940	AEGL3 – 63920 AEGL2 – 37600 AEGL1 - 940
R1	36.0	51.4	97.7	112.2	139.8
R2	45.0	52.9	117.4	134.9	168.0
R3	76.0	86.4	120.2	138.1	172.0
R4	113.5	121.8	137.8	158.3	197.2
R5	186.4	190.7	**215.8**	247.8	308.7
R6	329.2	344.0	**365.0**	419.3	522.3
R7	130.3	141.2	153.1	175.9	219.1
R8	107.4	109.7	141.8	162.9	202.9
R9	76.8	80.8	125.9	144.7	180.2
R10	59.0	62.7	119.7	137.5	171.3
R11	66.0	72.0	136.5	156.8	195.3

Receptor	100th %ile 8-Hourly Mean PC for NO_2 (µg/m^3)	100th %ile 4-Hourly Mean PC for NO_2 (µg/m^3)	100th %ile Hourly Mean PC for NO_2 (µg/m^3)	100th %ile 30min Mean PC for NO_2 (µg/m^3)[a]	100th %ile 10min Mean PC for NO_2 (µg/m^3)[a]
R12	69.0	74.0	128.5	147.6	183.8
R13	46.3	71.8	122.5	140.7	175.3
R14	44.7	67.7	124.9	143.5	178.7
R15	248.9	273.9	**294.1**	337.8	420.8
R16	216.6	227.5	**254.9**	292.8	364.7
Max on Grid	895.20	909.55	**988.8**	**1135.85**	**1414.97**

a) Estimated following power law relationship from hourly concentrations, as per para 7.3.9

Table 8-2 – Maximum modelled NH_3 impacts for Emergency Scenario 2 as a function of averaging period. The maxima are taken over 5 years of modelled meteorological data. Data in bold exceed one or more of the Standards (without the addition of background concentrations).

Receptor	100th %ile 8-Hourly Mean PC for NH_3 (µg/m^3)	100th %ile 4-Hourly Mean PC for NH_3 (µg/m^3)	100th %ile Hourly Mean PC for NH_3 (µg/m^3)	100th %ile 30min Mean PC for NH_3 (µg/m^3)[a]	100th %ile 10min Mean PC for NH_3 (µg/m^3)[a]
Standards	AEGL3 – 271170 AEGL2 – 76480 AEGL1 - 20860	AEGL3 – 382410 AEGL2 – 76480 AEGL1 - 20860	AEGL3 – 764830 AEGL2 – 111250 AEGL1 – 20860	AEGL3 – 1112470 AEGL2 – 152970 AEGL1 - 20860	AEGL3 – 1877300 AEGL2 – 152970 AEGL1 - 20860
R1	0.0	0.1	0.2	0.2	0.2
R2	0.1	0.1	0.2	0.2	0.3
R3	0.1	0.2	0.2	0.3	0.3
R4	0.2	0.2	0.3	0.3	0.4
R5	0.3	0.3	0.4	0.4	0.5
R6	0.5	0.5	0.6	0.7	0.9
R7	0.5	0.5	0.6	0.7	0.8
R8	0.3	0.3	0.4	0.5	0.6
R9	0.2	0.2	0.3	0.3	0.4
R10	0.2	0.2	0.2	0.3	0.3
R11	0.1	0.2	0.2	0.3	0.3
R12	0.1	0.2	0.2	0.3	0.3

Receptor	100th %ile 8-Hourly Mean PC for NH_3 (µg/m^3)	100th %ile 4-Hourly Mean PC for NH_3 (µg/m^3)	100th %ile Hourly Mean PC for NH_3 (µg/m^3)	100th %ile 30min Mean PC for NH_3 (µg/m^3)[a]	100th %ile 10min Mean PC for NH_3 (µg/m^3)[a]
R13	0.1	0.1	0.2	0.2	0.3
R14	0.1	0.2	0.2	0.2	0.3
R15	0.6	0.7	0.8	0.9	1.1
R16	0.5	0.5	0.6	0.7	0.8
Max on Grid	1.3	1.4	1.5	1.8	2.2

a) Estimated following power law relationship from hourly concentrations, as per para 7.3.9

Table 8-3 – Maximum modelled average hourly impacts for Virtus Test 1, Virtus Test 2 and Emergency Scenario 2. The maxima are taken over 5 years of modelled meteorological data. Data in bold exceed one or more of the Standards (without the addition of background concentrations).

Receptor	Virtus Test 1		Virtus Test 2		Emergency Scenario 2		Emergency Scenario 2 (LON 12 + New LON4 Only)	
	100th %ile Hourly Mean PC for NO_2 (µg/m^3)	Risk of exceedance of objective (200µg/m^3)	100th %ile Hourly Mean PC for NO_2 (µg/m^3)	100th %ile Hourly Mean PC for NO_2 (µg/m^3)	100th %ile Hourly Mean PC for NO_2 (µg/m^3)	Risk of exceedance of objective (200µg/m^3	100th %ile Hourly Mean PC for NO_2 (µg/m^3)	Risk of exceedance of objective (200µg/m^3
R1	8.3	0%	40.8	0%	97.7	0%	5.1	0%
R2	11.0	0%	45.0	0%	117.4	0%	7.2	0%
R3	16.2	0%	65.1	0%	120.2	0%	8.6	0%
R4	18.2	0%	68.0	0%	137.8	0%	9.6	0%
R5	24.4	0%	77.0	0%	215.8	0%	15.5	0%
R6	34.2	0%	124.0	0%	365.0	2.3%	26.5	0%
R7	32.8	0%	71.4	0%	153.1	0%	11.2	0%
R8	24.8	0%	68.2	0%	141.8	0%	9.3	0%
R9	19.0	0%	58.0	0%	125.9	0%	8.7	0%
R10	16.4	0%	52.3	0%	119.7	0%	7.9	0%
R11	14.5	0%	58.9	0%	136.5	0%	8.6	0%

Receptor	Virtus Test 1		Virtus Test 2		Emergency Scenario 2		Emergency Scenario 2 (LON 12 + New LON4 Only)	
	100th %ile Hourly Mean PC for NO_2 (µg/m^3)	Risk of exceedance of objective (200µg/m^3)	100th %ile Hourly Mean PC for NO_2 (µg/m^3)	100th %ile Hourly Mean PC for NO_2 (µg/m^3)	100th %ile Hourly Mean PC for NO_2 (µg/m^3)	Risk of exceedance of objective (200µg/m^3	100th %ile Hourly Mean PC for NO_2 (µg/m^3)	Risk of exceedance of objective (200µg/m^3
R12	14.2	0%	67.0	0%	128.5	0%	7.4	0%
R13	12.0	0%	50.0	0%	122.5	0%	6.9	0%
R14	11.3	0%	51.9	0%	124.9	0%	7.0	0%
R15	40.9	0%	110.3	0%	**294.1**	0%	16.3	0%
R16	32.5	0%	82.1	0%	**254.9**	0%	14.4	0%
Max on Grid	82.8	0%	**431.4**	0%	**988.8**	100%	91.5	0%

Table 8-4 – Annual Mean NO_2 impacts at Human Receptors

Receptor	Virtus 1 – Annual Mean PC for NO_2 ($\mu g/m^3$)	Virtus 2 – Annual Mean PC for NO_2 ($\mu g/m^3$)	Emergency 2 – Annual Mean PC for NO_2 ($\mu g/m^3$)	Emergency 2 LON12 + New LON4 Only – Annual Mean PC for NO_2 ($\mu g/m^3$)	Combined (Virtus Test 1, 2 and Emergency 2) – Annual Mean PC for NO_2 ($\mu g/m^3$)	Combined (Virtus Test 1, 2 and Emergency 2) – Annual Mean PEC for NO_2 ($\mu g/m^3$)	Combined PC as % of Objective	Combined (Virtus Test 1, 2 and Emergency 2 LON12 + New LON4 Only) – Annual Mean PC for NO_2 ($\mu g/m^3$)	Combined PC as % of Objective	Combined (Virtus Test 1, 2 and Emergency 2 LON12 + New LON4 Only) – Annual Mean PEC for NO_2 ($\mu g/m^3$)
R1	0.0	0.0	0.1	0.0	0.1	19.5	0.2%	0.0	0.1%	19.4
R2	0.0	0.0	0.1	0.0	0.1	19.5	0.3%	0.0	0.1%	19.4
R3	0.0	0.1	0.2	0.0	0.2	19.6	0.6%	0.1	0.2%	19.5
R4	0.0	0.1	0.3	0.0	0.4	19.8	1.0%	0.1	0.3%	19.5
R5	0.1	0.1	0.5	0.0	0.7	20.1	1.8%	0.2	0.5%	19.6
R6	0.2	0.4	2.0	0.2	2.6	22.0	6.4%	0.7	1.9%	20.1
R7	0.1	0.2	0.6	0.0	0.9	20.3	2.3%	0.3	0.9%	19.7
R8	0.1	0.2	0.3	0.0	0.5	19.9	1.3%	0.2	0.5%	19.6
R9	0.0	0.0	0.1	0.0	0.2	19.6	0.5%	0.1	0.2%	19.5
R10	0.0	0.1	0.2	0.0	0.3	19.7	0.7%	0.1	0.2%	19.5
R11	0.0	0.1	0.2	0.0	0.3	19.7	0.8%	0.1	0.3%	19.5

Receptor	Virtus 1 – Annual Mean PC for NO_2 (µg/m^3)	Virtus 2 – Annual Mean PC for NO_2 (µg/m^3)	Emergency 2 – Annual Mean PC for NO_2 (µg/m^3)	Emergency 2 LON12 + New LON4 Only – Annual Mean PC for NO_2 (µg/m^3)	Combined (Virtus Test 1, 2 and Emergency 2) – Annual Mean PC for NO_2 (µg/m^3)	Combined (Virtus Test 1, 2 and Emergency 2) – Annual Mean PEC for NO_2 (µg/m^3)	Combined PC as % of Objective	Combined (Virtus Test 1, 2 and Emergency 2 LON12 + New LON4 Only) – Annual Mean PC for NO_2 (µg/m^3)	Combined PC as % of Objective	Combined (Virtus Test 1, 2 and Emergency 2 LON12 + New LON4 Only) – Annual Mean PEC for NO_2 (µg/m^3)
R12	0.0	0.1	0.2	0.0	0.3	19.7	0.6%	0.1	0.2%	19.5
R13	0.0	0.0	0.1	0.0	0.1	19.5	0.4%	0.0	0.1%	19.4
R14	0.0	0.0	0.1	0.0	0.1	19.5	0.3%	0.0	0.1%	19.4
R15	0.1	0.4	0.9	0.0	1.4	20.8	3.5%	0.5	1.3%	19.9
R16	0.1	0.3	0.9	0.0	1.2	20.6	3.1%	0.4	1.0%	19.8

Table 8-5 – Annual Mean NH_3 impacts at Human Receptors

Receptor	Emergency 2 – Annual Mean PC for NH_3 (µg/m^3)	Combined (Virtus Test 1, 2 and Emergency 2) – Annual Mean PC for NH_3 (µg/m^3)	Combined (Virtus Test 1, 2 and Emergency 2) – Annual Mean PEC for NH_3 (µg/m^3)
R1	<0.1	<0.1	1.0
R2	<0.1	<0.1	1.0
R3	<0.1	<0.1	1.0
R4	<0.1	<0.1	1.0
R5	<0.1	<0.1	1.0
R6	<0.1	<0.1	1.0
R7	<0.1	<0.1	1.0
R8	<0.1	<0.1	1.0
R9	<0.1	<0.1	1.0
R10	<0.1	<0.1	1.0
R11	<0.1	<0.1	1.0
R12	<0.1	<0.1	1.0
R13	<0.1	<0.1	1.0
R14	<0.1	<0.1	1.0
R15	<0.1	<0.1	1.0
R16	<0.1	<0.1	1.0

9. ECOLOGICAL ASSESSMENT RESULTS

9.1. MODEL RESULTS

9.1.1. The results of the dispersion modelling show that there is a negligible impact on annual mean NO_x concentrations, NH_3 concentrations and nitrogen deposition during both Virtus Test 1 and Virtus Test 2. Given the limited number of generators on Site, the impacts from testing on annual means are negligible and are therefore not considered further.

9.1.2. **Table 9-1** shows that annual average impacts on NO_X concentrations and nitrogen deposition are negligible for Emergency Scenario 2 (even with all generators in the Slough campus active for 72 hours).

Table 9-1 – Annual mean NO_X impacts over designated ecological sites for Emergency Scenario 2

ID	Site	Annual mean nitrogen deposition (N-dep) (kgN/ha/yr)	N-dep as % of Critical Load	Annual mean PC for NOx (µg/m³)	Annual mean as % of Critical Level (30µg/m³)	Annual mean PC for NH_3 (µg/m³)	Annual mean as % of Critical Level (
E1	Chilterns Beechwoods SAC	<0.1	<0.1%	0.01	<0.1%	<0.1	<0.1%
E2	Haymill Valley LNR	<0.1	0.1%	0.1	0.3%	<0.1	<0.1%
E3	Haymill Valley LNR	<0.1	<0.1%	0.1	0.3%	<0.1	<0.1%
E4	Cocksherd Wood LNR	<0.1	<0.1%	0.1	0.3%	<0.1	<0.1%
E5	Cocksherd Wood LNR	<0.1	<0.1%	0.1	0.2%	<0.1	<0.1%
E6	Railway Triangle LWS	<0.1	0.1%	0.1	0.4%	<0.1	<0.1%
E7	South West London Waterbodies Ramsar/SPA	<0.1	<0.1%	0.03	0.1%	<0.1	<0.1%
E8	South West London Waterbodies Ramsar/SPA	<0.1	<0.1%	<0.1	0.1%	<0.1	<0.1%
E9	South West London Waterbodies Ramsar/SPA	<0.1	<0.1%	<0.1	0.1%	<0.1	<0.1%
E10	Windsor Forest and Great Park SAC	<0.1	<0.1%	<0.1	0.1%	<0.1	<0.1%
E11	Windsor Forest and Great Park SAC	<0.1	<0.1%	0.1	0.2%	<0.1	<0.1%

9.1.3. **Table 9-2** shows that in the Emergency Scenario 2, the risk of exceedance of the daily mean critical level at international ecological sites when assuming that an outage occurs every year is above 5% at receptors E2, while negligible at all other ecological sites assessed. It should be noted that this scenario is highly unlikely, as it is based on power outage every year for all generators across the Slough campus for the full 72-hour emergency period. When an outage is assumed to occur every 5 years, the risk of exceedance at every site falls to 0%.

9.1.4. **Table 9-2** also shows that in the Virtus Test 1 sand Virtus Test 2 scenarios, the risk of exceedance of the daily mean critical level at all ecological sites modelled is negligible, even with an assumed outage every year.

Table 9-2 – Daily mean NO_X impacts over designated ecological sites for all modelled scenarios

ID	Site	Virtus Test 1 Scenario		Virtus Test 2 Scenario		Emergency Scenario 2		Emergency Scenario 2 (LON12 Only)	
		100th %ile Daily mean PC for NOx ($\mu g/m^3$)	Probability of Exceedance of Critical Level with Outage Every Year	100th %ile Daily mean PC for NOx ($\mu g/m^3$)	Probability of Exceedance of Critical Level with Outage Every Year	100th %ile Daily mean PC for NOx ($\mu g/m^3$)	Probability of Exceedance of Critical Level with Outage Every Year	100th %ile Daily mean PC for NOx ($\mu g/m^3$)	Probability of Exceedance of Critical Level with Outage Every Year
E1	Chilterns Beechwoods SAC	1.5	0%	10.4	0%	24.9	0%	1.0	0%
E2	Haymill Valley LNR	19.3	0%	71.5	0%	182.6	4%	11.2	0%
E3	Haymill Valley LNR	12.7	0%	65.1	0%	141.4	0%	7.6	0%
E4	Cocksherd Wood LNR	11.7	0%	50.8	0%	122.8	0%	7.0	0%
E5	Cocksherd Wood LNR	5.8	0%	33.3	0%	86.9	0%	4.1	0%
E6	Railway Triangle LWS	19.5	0%	75.6	0%	174.1	0%	8.2	0%
E7	South West London Waterbodies Ramsar/SPA	2.6	0%	17.2	0%	43.1	0%	1.9	0%

ID	Site	Virtus Test 1 Scenario		Virtus Test 2 Scenario		Emergency Scenario 2		Emergency Scenario 2 (LON12 Only)	
		100th %ile Daily mean PC for NOx ($\mu g/m^3$)	Probability of Exceedance of Critical Level with Outage Every Year	100th %ile Daily mean PC for NOx ($\mu g/m^3$)	Probability of Exceedance of Critical Level with Outage Every Year	100th %ile Daily mean PC for NOx ($\mu g/m^3$)	Probability of Exceedance of Critical Level with Outage Every Year	100th %ile Daily mean PC for NOx ($\mu g/m^3$)	Probability of Exceedance of Critical Level with Outage Every Year
E8	South West London Waterbodies Ramsar/SPA	2.4	0%	14.4	0%	37.2	0%	1.7	0%
E9	South West London Waterbodies Ramsar/SPA	2.8	0%	20.5	0%	47.0	0%	1.9	0%
E10	Windsor Forest and Great Park SAC	3.5	0%	25.1	0%	55.1	0%	2.6	0%
E11	Windsor Forest and Great Park SAC	3.8	0%	24.1	0%	54.6	0%	2.4	0%

10. ASSESSMENT SUMMARY

10.1. HUMAN HEALTH

10.1.1. ***No significant health effects are likely with the operation of the generators on the London 12 Data Centre***.

10.1.2. With the proposed routine generator testing regime for the Site, there is an insignificant risk of exceedance of either the UK's air quality objective for hourly mean NO_2 or the AEGLs 1 – 3.

10.1.3. With the emergency power outage scenario, the risk of exceedance of AEGLs 1 - 3 is also negligible. Average exposure at longer timescales (30mins, 1hr, 4hr, 8hr) does not exceed AEGL-1.

10.1.4. For almost all residential properties, the risk of exceedance of the UK's air quality objectives for annual mean and hourly mean NO_2 is negligible. One residential property has a risk of exceedance in Emergency Scenario 2 (R6, 2.3%). However, this scenario is highly conservative and unlikely to occur in reality, as all generators on the Slough Campus were modelled to be active for the full 72-hour period. When the LON12 and new LON4 generators only are at emergency loads for the full 72-hour emergency period (still a very conservative scenario), the risk of exceedance falls to 0% at this receptor. Therefore, it is highly unlikely that there is a risk of exceedance of the UK's air quality objectives for annual and hourly mean NO_2.

10.2. ECOLOGY

10.2.1. ***No significant effects on ecological sites are likely***.

10.2.2. The risk of exceedances of the daily mean NO_x objective in Emergency Scenario 2 is below 5% at all ecological sites. Only receptor E2 shows a non-negligible risk of exceedance (4%). However, this is only where an outage is assumed every year. This scenario is highly conservative and unlikely to occur in reality, as all generators on the Slough Campus were modelled to be active for the full 72-hour period. When the LON12 and new LON4 generators are at emergency loads for the full 72-hour emergency period (still a very conservative scenario), the risk of exceedance falls to 0% at all ecological receptors. Therefore, it is highly unlikely that there will be any significant effects.

10.2.3. Annual average impacts on NO_X concentrations and nitrogen deposition are negligible for all scenarios (routine testing and emergency outage).

Appendix A

GLOSSARY

Table A-1 – Glossary of terms

Term	Definition
ADMS	Atmospheric Dispersion Modelling Software
AEGL	Acute Exposure Guideline Level
AERA	Air Emissions Risk Assessment
Air quality objective	Policy target generally expressed as a maximum ambient concentration to be achieved, either without exception or with a permitted number of exceedances within a specific timescale (see also air quality standard).
Air quality standard	The concentrations of pollutants in the atmosphere which can broadly be taken to achieve a certain level of environmental quality. The standards are based on the assessment of the effects of each pollutant on human health include the effects on sensitive subgroups (see also air quality objective).
Ambient air	Outdoor air in the troposphere, excluding workplace air.
Annual mean	The average (mean) of the concentrations measured for each pollutant for one year.
AQAP	Air Quality Action Plan
AQMA	Air Quality Management Area
AQS	Air Quality Standards
CMS	Continuous Monitoring Site
Conservative	Tending to over-predict the impact rather than under-predict.
Defra	Department for Environment, Food and Rural Affairs
EA	Environment Agency
EAL	Environmental Assessment Level
Emission rate	The quantity of a pollutant released from a source over a given period of time.
Exceedance	A period of time where the concentration of a pollutant is greater than the appropriate air quality standard.
LAQM	Local Air Quality Management
LNR	Local Nature Reserve
LWS	Local Wildlife Site
MAGIC	Multi-Agency Geographic Information for the Countryside
NNR	National Nature Reserve

Term	Definition
NO_2	Nitrogen dioxide
NO_x	Nitrogen oxides
PC	Process Contribution
PEC	Predicted Environmental Concentration
PM_{10}	Particulate matter with an aerodynamic diameter of less than 10 micrometres.
$PM_{2.5}$	Particulate matter with an aerodynamic diameter of less than 2.5 micrometres.
SAC	Special Area of Conservation
SBC	Slough Borough Council
SPA	Special Protection Area
SSSI	Site of Special Scientific Interest
$\mu g/m^3$ micrograms per cubic metre	A measure of concentration in terms of mass per unit volume. A concentration of $1\mu g/m^3$ means that one cubic metre of air contains one microgram (millionth of a gram) of pollutant.

Appendix B

FIGURES

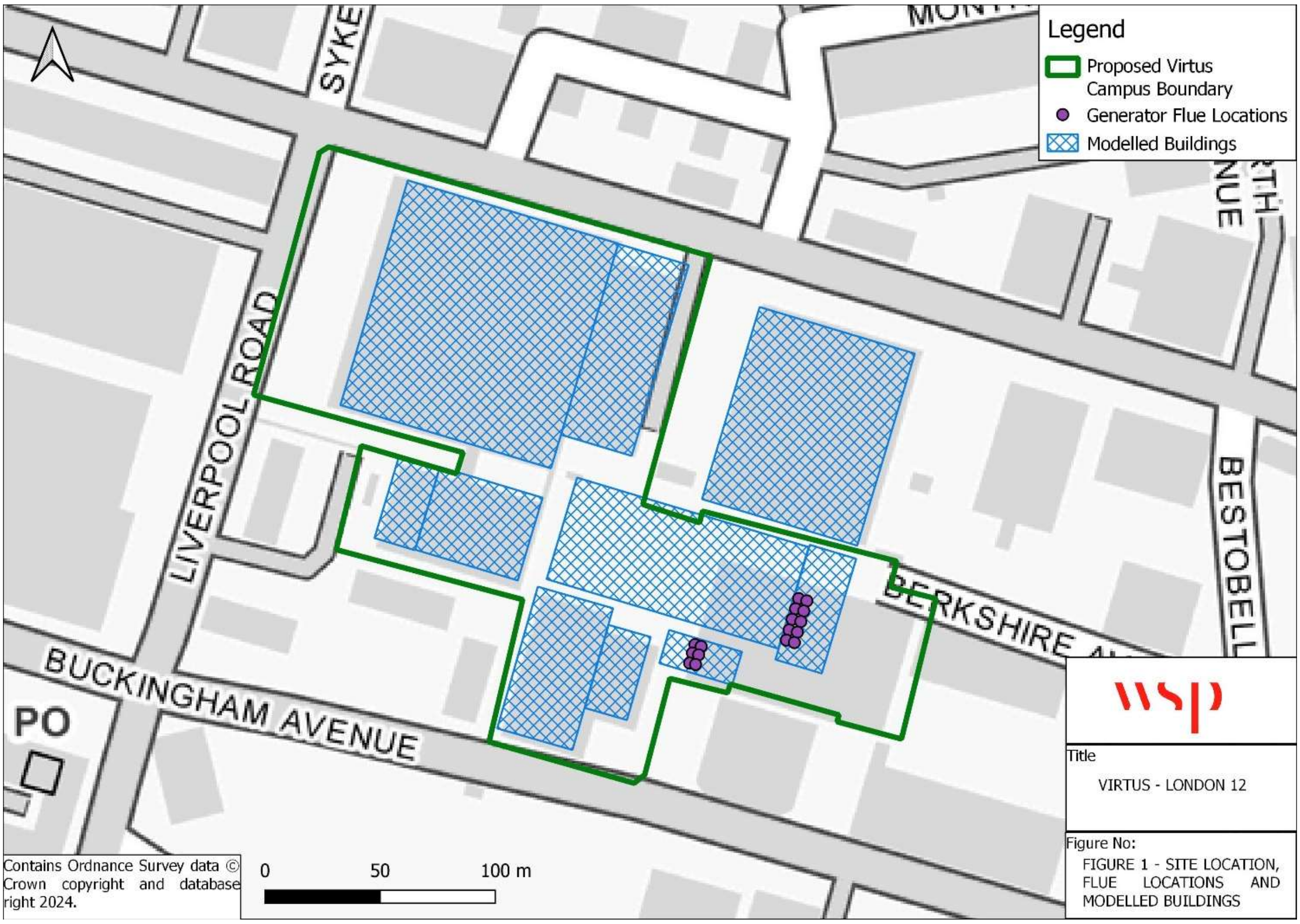


Figure 1 – Site Location, LON12 Flue Locations and Modelled Buildings

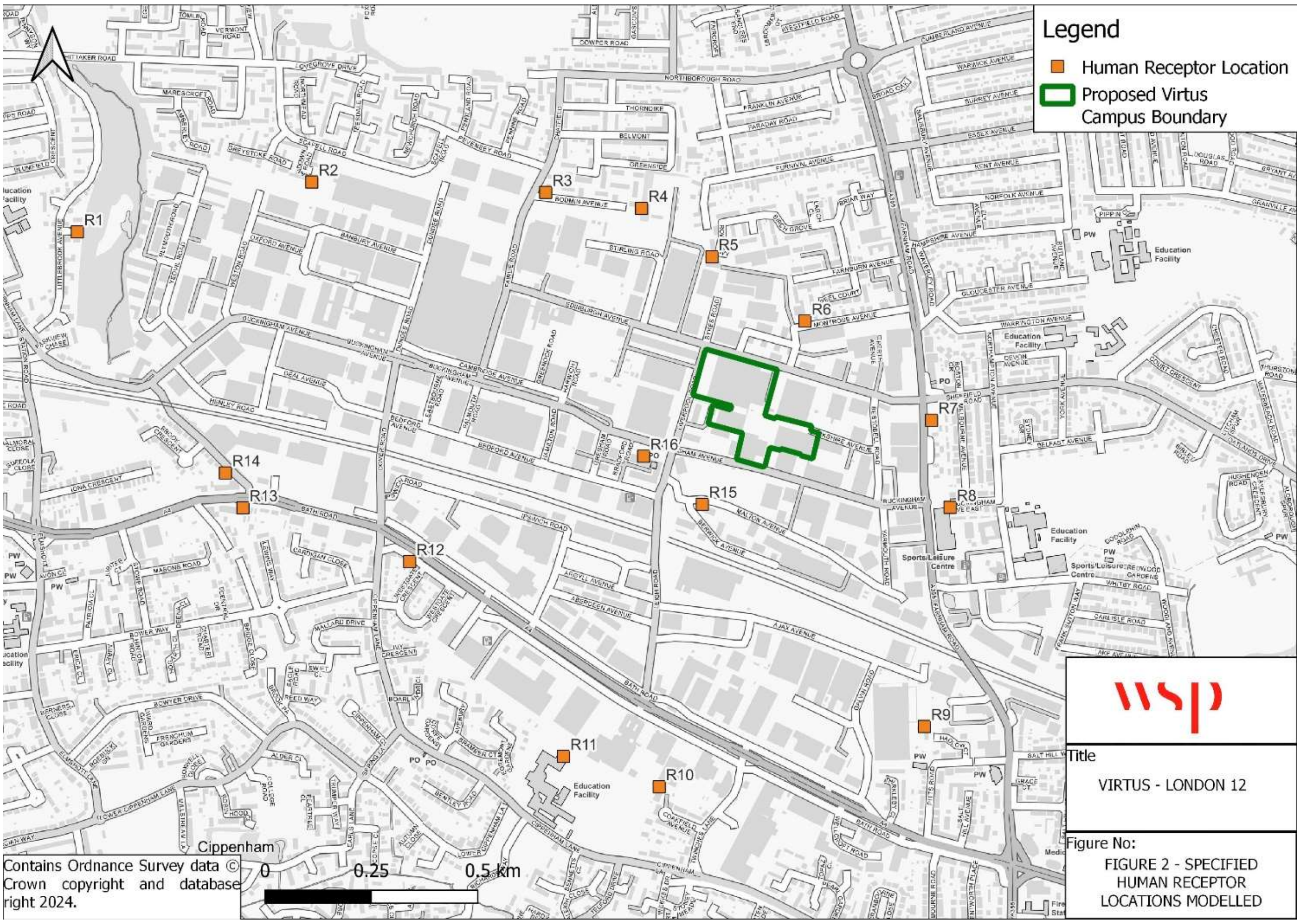


Figure 2 – Specified Human Receptor Locations Modelled

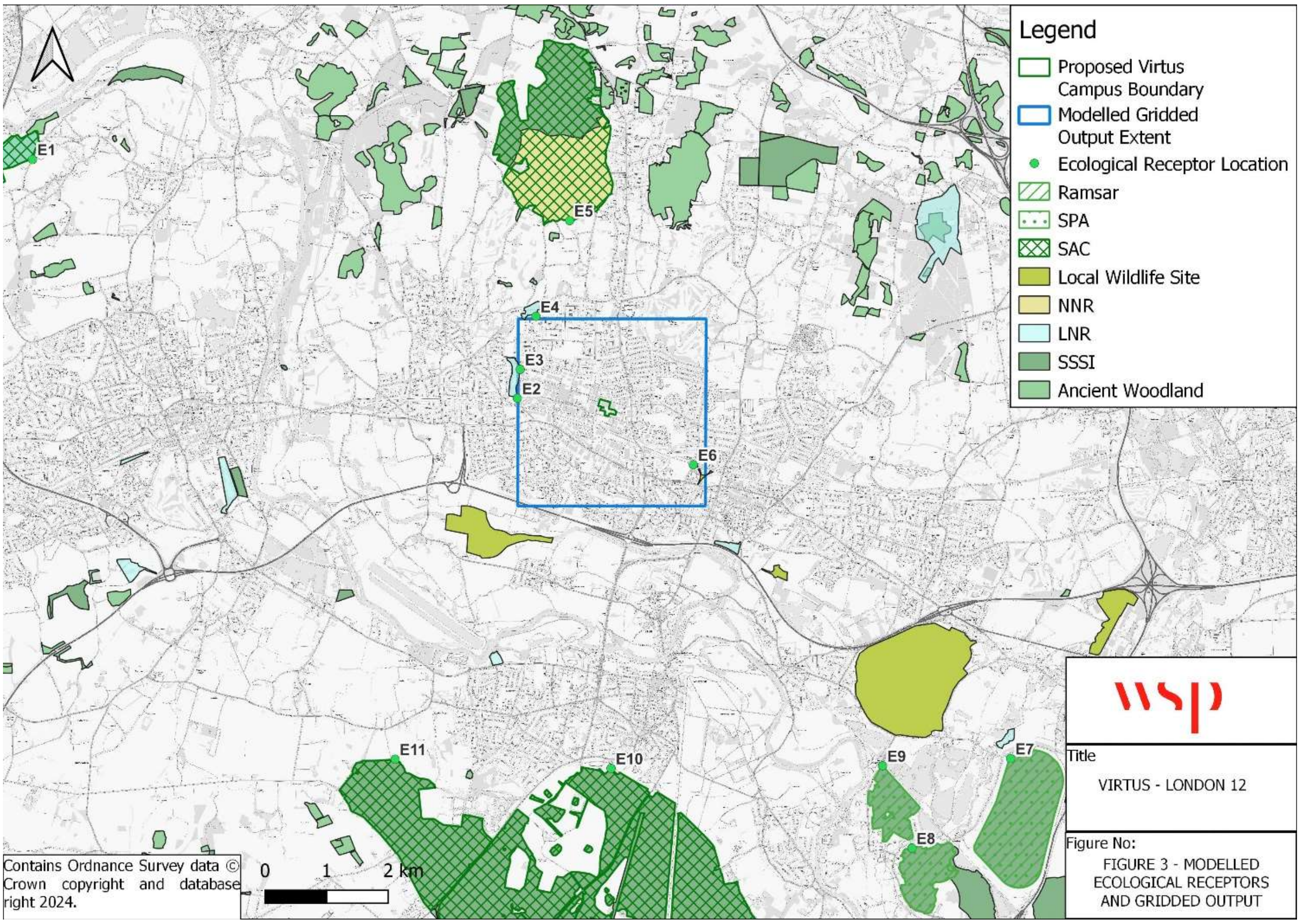


Figure 3 – Modelled Ecological Receptors and Gridded Output

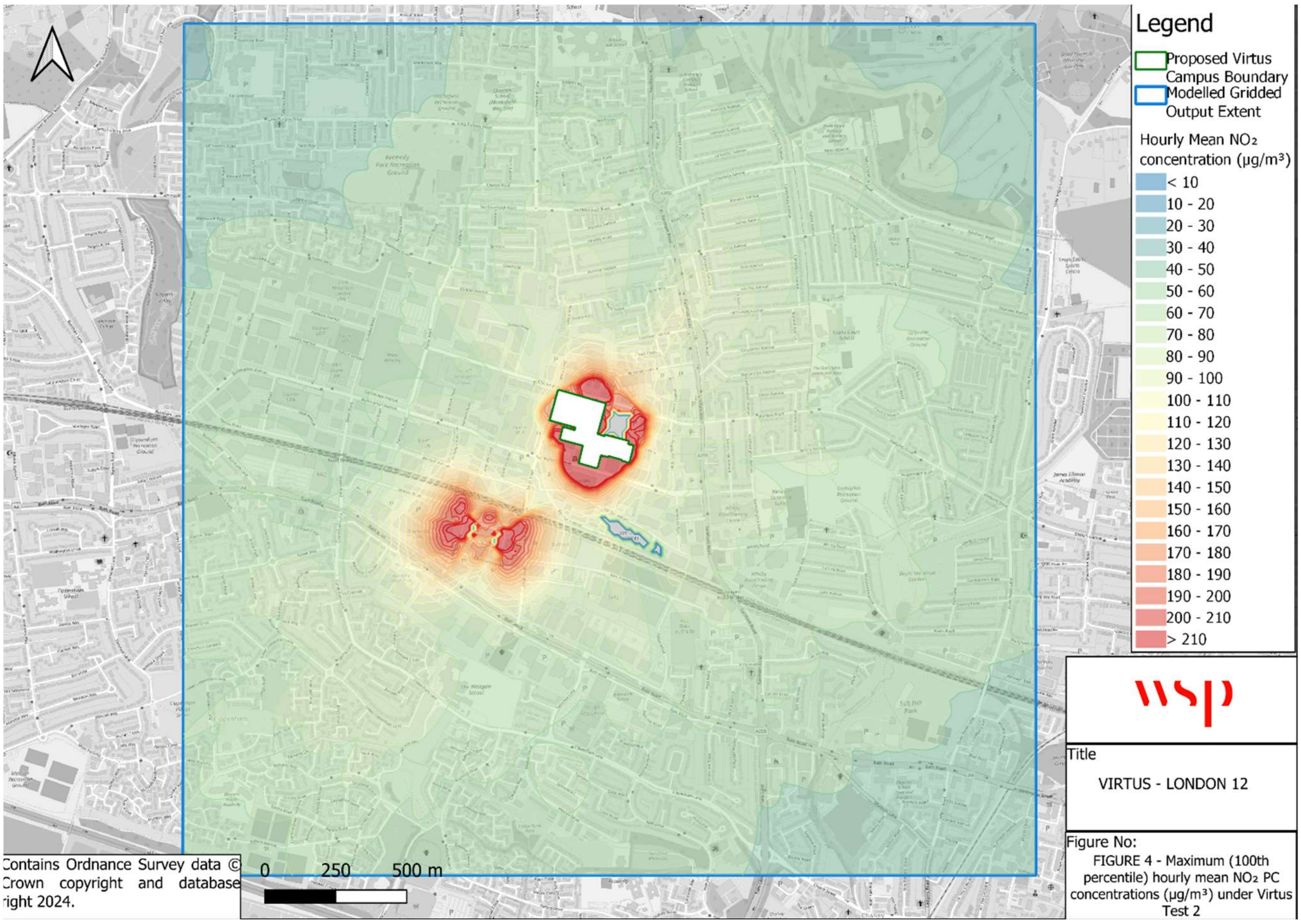


Figure 4 – Maximum (100th percentile) hourly mean NO_2 PC concentrations (µg/m³) over 5 years of meteorological data under the Virtus Test 2 Scenario.

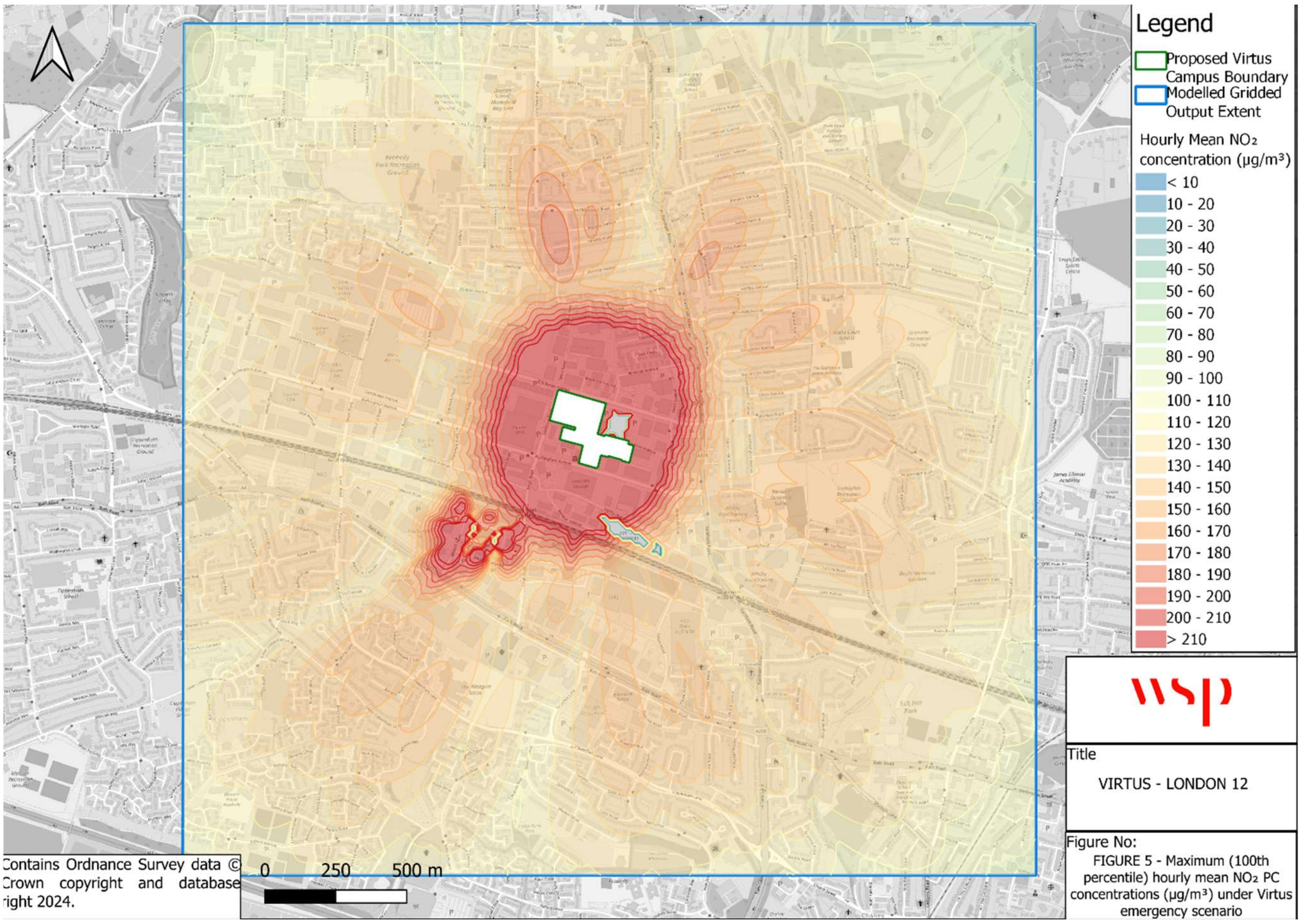


Figure 5 – Maximum (100th percentile) hourly mean NO_2 PC concentrations (µg/m³) over 5 years of meteorological data under Virtus Emergency 2 Scenario. Contour interval is 10µg/m³.

Appendix C

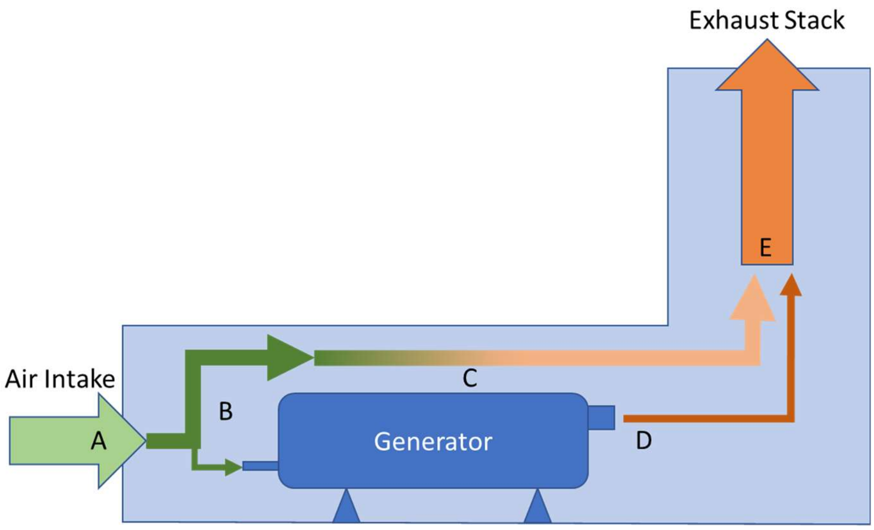
GENERATOR FLUE PARAMETERS

CALCULATION OF EMISSIONS PARAMETERS

Emissions parameters for the new LON4 generators were taken from the previous air quality assessment for LON4 (see Section 7.2).

The generators for LON12 are arranged as set out in the schematic below

1) There is a fixed volume ambient air intake to the generator housing unit (A)
2) The air intake serves two purposes, namely the air intake for the generator (B) and the generator cooling air (C)
3) The exhaust gases from the generator (D) merges with the cooling air (C) prior to exhaust from the stack (E)



The generator exhaust parameters, as presented in technical data sheets, are representative of conditions at location D.

The parameters used in the modelling of impacts i.e. for the bulk exhaust gases, are those representing the conditions at the stack exit (E).

Air Intake (A).

The air intake is via a fixed volume fan with a capacity of 35.5m^3/s. For the calculation of exhaust parameters, this intake is assumed to be at an approximate ambient temperature of 10°C.

Generator Parameters (B & D).

The generator intake (location B) and exhaust parameters (location D), as provided by the technical data sheet[40] are shown in **Table C-1**. The intake air is assumed to be at Normal Temperature and Pressure (0°C, 1atm. Exhaust gas conditions are provided in the table as a function of engine load. The water and oxygen content of the exhaust gases were not provided directly in the datasheet but, as set out in **Table 1**, can be calculated from the parameters provided.

[40] Performance Number EM2883, Model CAT 3516C, October 14 2021

Table C-1 – Generator Inlet and Exhaust Parameters for 20V4000G74F Engine.

Engine Power inc Fan	% Load	Inlet Air Volume m^3/s (Actual)	Exhaust Volume (Actual) m^3/s	Exhaust Temp-erature (°C)	NOx (mg/Nm^3 @5%O_2, dry)	Exhaust Volume (dry, 0C, 1atm, 5% O_2) m^3/s	%H_2O	%O_2 (Actual)	NOx emission rate (g/s)	NH_3 emission rate (g/s)
2670	100	3.1	8.1	528.1	85.0 (with SCR)	1.9	8.9%	7.4%	0.175 (with SCR)	0.016
267	10	1.2	1.8	223.9	2390.0	0.3	4.0%	15.3%	0.706	N/A

Cooling Air Intake (B)

The cooling air intake is calculated as the difference between the fixed volume intake and the engine inlet flow and is, therefore, dependent on engine load. The results of the calculation are shown in **Table 2**. Note: the calculation assumes that the mass flow rate of air to the generator intake is fixed and all calculation of volumes are undertaken at STP (15°C, 1atm).

Cooling Air (C)

It is assumed that the cooling air temperature is increased by 40°C as it passes over the generator (independent of the generator load). With an assumed air intake temperature of 10°C, this results in the temperature of the cooling air, just prior to merging with the generator exhaust, of 50°C.

Merged Plume within Exhaust Stack (E)

The cooling air and generator exhaust are assumed to mix within the exhaust stack whilst preserving internal energy, U, such that

$$U_{Combined\ Exhau} = U_{Generator\ Exhau} + U_{Cooling\ Air} \quad (1)$$

where

$$U = \frac{3}{2}nRT \qquad (2)$$

and n is the number of moles, R is the universal gas constant and T is the gas temperature. With the molecular weight of the cooling air and the generator exhaust approximately equal (~28.9), the number of moles in a given volume of air is proportional to the volume of the gas. Equation 1 can then be rearranged to give

$$T_{Combined\ Exhaust} = \frac{((T_{Gen} \times n_{Gen}) + (T_{C.Air} \times n_{C.Air}))}{(n_{Gen} + n_{C.Air})} \qquad (3)$$

Where Gen is the Generator Exhaust and C.Air is the Cooling Air.

The calculation of the combined exhaust parameters for the testing and emergency scenarios is shown in **Table C-2**.

Table C-2 – Calculation of combined exhaust parameters for LON12 after merging of generator cooling air and exhaust streams.

Scenario	Load %	Air Intake (Ambient Temp, 11.9C) m^3/s	Cooling Air at STP m^3/s	Cooling Air Temperature (degC) - Ambient+ 40C	Exhaust Vol Flow (STP) m^3/s	Exhaust Temperature (degC)	Combined Air Temp (degC)	Combined Exhaust Volume (Actual) m^3/s	NOx Emission Rate (g/s)	NH_3 emission rate (g/s)
Emergency	100	35.5	32.4	60	2.8	528.1	104.2	40.6	0.175	0.016
Test 2	100	35.5	32.4	60	2.8	528.1	104.2	40.6	0.175	0.016
Test 1	10	35.5	34.3	60	1.0	223.9	65.5	37.0	0.706	N/A

CALCULATION OF EXHAUST VELOCITY

It is not possible to explicitly represent the exact conditions at the point of exit from the stacks at LON12 in the ADMS model due to the presence of ‘fins’ within the stack that reduce the effective release area.

The plume rise of the exhaust gases is determined both by the momentum of the plume, which is dependent on the exit velocity, and also the buoyancy of the plume. The overall plume rise is dependent on the exit temperature, the volume flow rate, the exit velocity and the stack diameter. As stated above, all of these parameters cannot be simultaneously represented in the ADMS model.

As such, a pragmatic approach was adopted in which the initial, momentum driven plume rise was appropriately reproduced by reducing the effective diameter of the stack to represent the true ‘open’ area of the stack. The trade off using this approach is that in the later stages of plume rise, the buoyancy of the plume will reduce more quickly than in reality since the plume diameter will be underrepresented.

In reality, the stacks have a rectangular cross -section, with an area of approximately 9.42m^2. This would give an effective diameter of 3.46m.

The noise baffles (‘fins’) occupy approximately 50% of the area, leaving an open area of 4.71m^2. This open area gives an effective diameter of 2.45m.

The latter diameter has been used to ensure the correct exit velocity, and hence momentum plume rise, was represented in the modelling.

Emissions parameters for the new LON4 generators were taken from the previous air quality assessment for LON4 (see Section 7.2).

Table C-3 - Flue parameters and emissions used in the Virtus Test 1 modelled scenario (Off-load, Based on Worst Case at 10% load)

Model ID	X, Y	Generators Represented	Stack Height (m)	Effective Stack Diameter (m)*	Stack efflux velocity (m/s)	Efflux temperature (˚C)	Exhaust actual volumetric flow rate (m^3/s)	NO_x emissions per generator (g/s)
LON12_ Source001	495828.2, 181192.8	A33, A34, A35	23	2.45	7.9	65.5	37.0	2.1
LON12_ Source002	495825.8, 181185.0	A36, A37, A38	23	2.45	7.9	65.5	37.0	2.1
LON12_ Source003	495874.1, 181212.6	A39, A40, A41, A42, A43	23	2.45	7.9	65.5	37.0	3.5
LON12_ Source004	495868.7, 181194.5	A44, A45, A46, A47, A48	23	2.45	7.9	65.5	37.0	3.5
LON4_19a	495790.3, 181287.3	19a	10.1	2.8	13.1	58.1	82.5	1.10
LON4_20	495807.2, 181354.490378	20	10.1	2.8	13.1	58.1	82.5	1.10

* All generator flue stacks are an approximate square with 50% of the area taken up by noise attenuation baffles. This has been used to calculate the internal diameter for a circular flue in ADMS 6.

The effective emissions represent multiple generator exhausts for LON12.

Table C-4 - Flue parameters and emissions used in the Virtus Test 2 modelled scenario (On-load, each generator at 100% load for 120 minutes). Emission sources from previous LON3, LON4, LON10, LON 9 and LON11 assessments[34,35,36] were also modelled for the scenario.

Model ID	X, Y	Generators Represented	Stack Height (m)	Effective Stack Diameter (m)*	Stack efflux velocity (m/s)	Efflux temperature (˚C)	Exhaust actual volumetric flow rate (m^3/s)	NO_x emissions per generator (g/s)
LON12_ Source001	495828.2, 181192.8	A33, A34, A35	23	2.5	8.6	104	40.6	17.0
LON12_ Source002	495825.8, 181185.0	A36, A37, A38	23	2.5	8.6	104	40.6	17.0
LON12_ Source003	495874.1, 181212.6	A39, A40, A41, A42, A43	23	2.5	8.6	104	40.6	28.4
LON12_ Source004	495868.7, 181194.5	A44, A45, A46, A47, A48	23	2.5	8.6	104	40.6	28.4
LON4_19a	495790.3, 181287.3	19a	10.1	2.8	14.1	81.5	88.5	5.7627
LON4_20	495807.2, 181354.490378	20	10.1	2.8	14.1	81.5	88.5	5.7627

* All generator flue stacks are an approximate square with 50% of the area taken up by noise attenuation baffles. This has been used to calculate the internal diameter for a circular flue in ADMS 6.

The effective emissions represent multiple generator exhausts for LON12.

Table C-5 – Flue parameters and emissions used in the Virtus Emergency 2 Scenario, with LON12 at 100% load for 72 hours (See Above, Section 7.2 and Table 3-1 for assumptions used in calculating emissions). In addition to LON12, emission sources From previous LON3, LON4, LON10, LON 9 and LON11 assessments[34,35,36] were also modelled to provide a highly conservative worst case emergency scenario.

Model ID	X, Y	Generators Represented	Stack Height (m)	Effective Stack Diameter (m)*	Stack efflux velocity (m/s)	Efflux temperature (˚C)	Exhaust actual volumetric flow rate (m^3/s)	NO_x emissions per generator (g/s)
LON12_ Source001	495828.2, 181192.8	A33, A34, A35	23	2.5	8.6	104	40.6	17.0
LON12_ Source002	495825.8, 181185.0	A36, A37, A38	23	2.5	8.6	104	40.6	17.0
LON12_ Source003	495874.1, 181212.6	A39, A40, A41, A42, A43	23	2.5	8.6	104	40.6	28.4
LON12_ Source004	495868.7, 181194.5	A44, A45, A46, A47, A48	23	2.5	8.6	104	40.6	28.4
LON4_19a	495790.3, 181287.3	19a	10.1	2.83	14.07	81,49	88.5	7.35
LON4_20	495807.2, 181354.490378	20	10.1	2.83	14.07	81,49	88.5	7.35

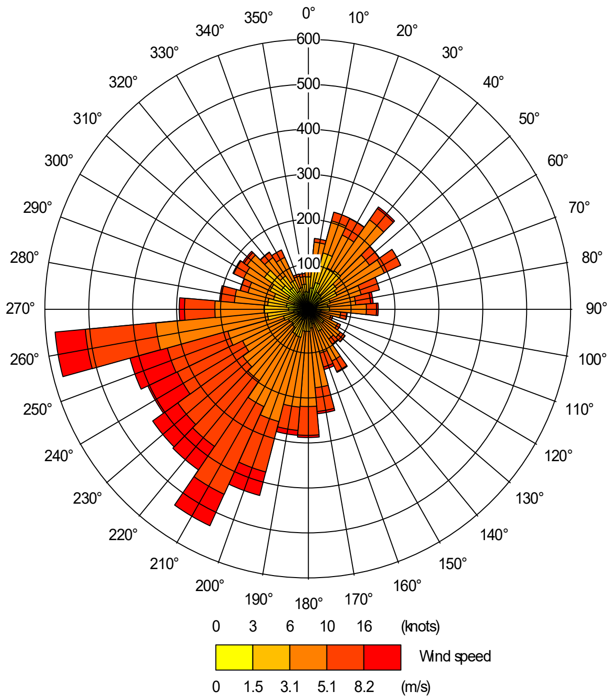
* All generator flue stacks are an approximate square with 50% of the area taken up by noise attenuation baffles. This has been used to calculate the internal diameter for a circular flue in ADMS 6.

The effective emissions represent multiple generator exhausts for LON12.

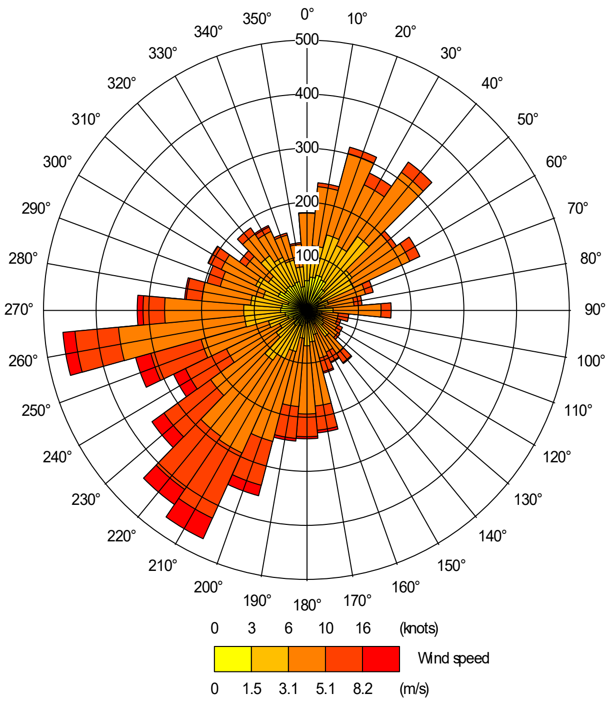
Appendix D

HEATHROW METEOROLOGICAL STATION WINDROSES 2020 - 2024

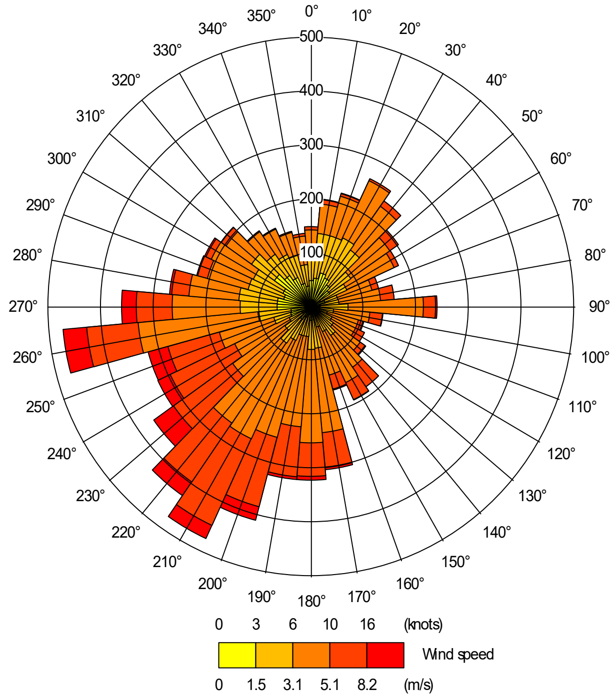
2020 Heathrow Meteorological Station Windrose



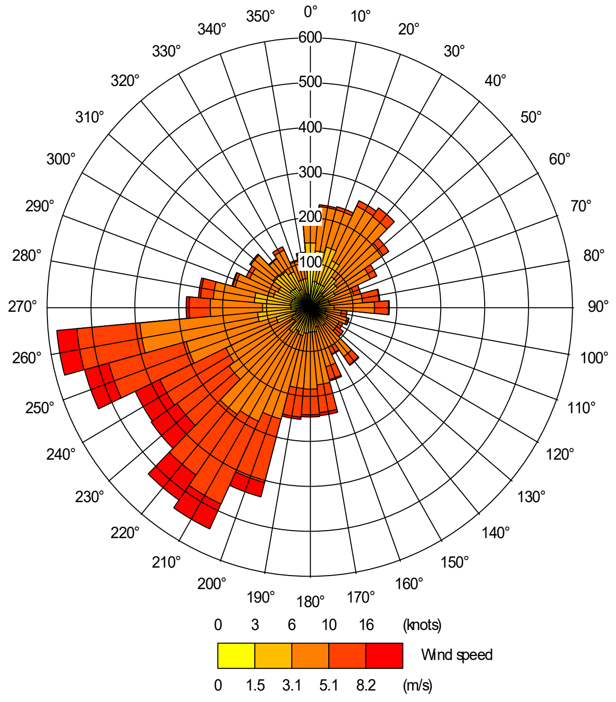
2021 Heathrow Meteorological Station Windrose



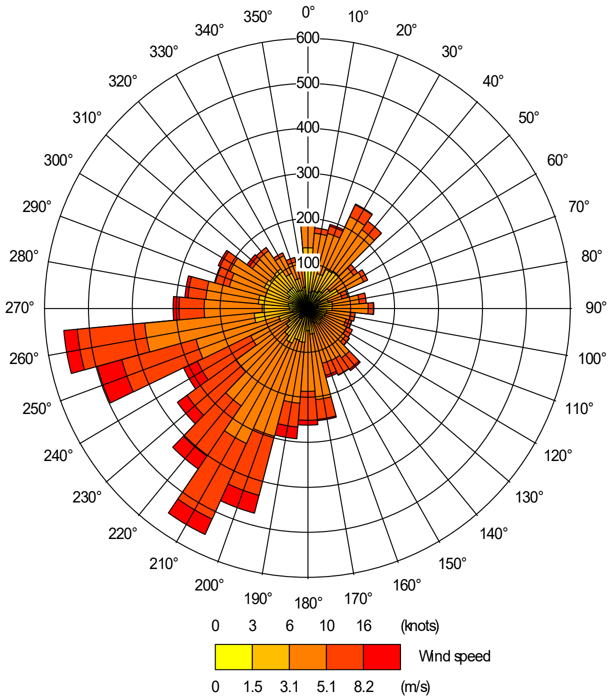
2022 Heathrow Meteorological Station Windrose



2023 Heathrow Meteorological Station Windrose



2024 Heathrow Meteorological Station Windrose



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