Air Quality Assessment

Greencore, Bristol

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Executive Summary

Redmore Environmental Ltd was commissioned by EHS Projects Ltd to undertake an Air Quality Assessment in support of an Environmental Permit Application for two boilers at Greencore, Bristol.

Combustion emissions from the boilers have the potential to cause air quality impacts during normal operation. As such, an Air Quality Assessment was undertaken in order to determine baseline conditions and consider potential effects.

Dispersion modelling was undertaken in order to predict pollutant concentrations at sensitive locations as a result of emissions from the boilers. The results indicated that impacts on pollutant concentrations were not predicted to be significant at any sensitive receptor location in the vicinity of the site.

Impacts were also predicted at relevant ecological sites. The results indicated that emissions from the plant would not significantly affect existing conditions at any designation.

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1.0 INTRODUCTION

1.1 Background

1.1.1 Redmore Environmental Ltd was commissioned by EHS Projects Ltd to undertake an Air Quality Assessment in support of an Environmental Permit Application for two boilers at Greencore, Bristol.

1.1.2 Combustion emissions from the boilers have the potential to cause air quality impacts during normal operation. An Air Quality Assessment was therefore undertaken in order to determine baseline conditions and consider potential effects.

1.2 Site Location and Context

1.2.1 The site is located at Greencore, Hawkley Drive, Bristol, at National Grid Reference (NGR): 361925, 183300. Reference should be made to Figure 1 for a map of the site and surrounding area.

1.2.2 The following boilers currently operate at the site:

- One 4MW Yorkshireman Byworth Steam boiler installed in 2023; and,
- One 5MW ICI Caldaie Steam boiler installed in 2005.

1.2.3 Combustion emissions from the boilers have the potential to cause impacts at sensitive locations in the vicinity of the site. An Air Quality Assessment was therefore undertaken to define baseline conditions and quantify potential effects. The results are summarised in the following report.

2.0 LEGISLATION AND POLICY

2.1 Legislation

2.1.1 The Air Quality Standards Regulations (2010) and subsequent amendments include Air Quality Limit Values (AQLVs) for the following pollutants:

- Nitrogen dioxide (NO_2);
- Sulphur dioxide;
- Lead;
- Particulate matter with an aerodynamic diameter of less than 10µm (PM_{10});
- Particulate matter with an aerodynamic diameter of less than 2.5µm;
- Benzene; and,
- Carbon monoxide.

2.1.2 Air Quality Target Values were also provided for several additional pollutants.

2.1.3 The Air Quality Strategy (AQS) was produced by the Department for Environment, Food and Rural Affairs (DEFRA) and published on 28th April 2023[1]. The document contains standards, objectives and measures for improving ambient air quality, including a number of Air Quality Objectives (AQOs). These are maximum ambient pollutant concentrations that are not to be exceeded either without exception or with a permitted number of exceedences over a specified timescale. These are generally in line with the AQLVs, although the requirements for the determination of compliance vary.

2.1.4 Table 1 presents the AQOs for pollutants considered within this assessment.

Table 1 Air Quality Objectives

Pollutant	Air Quality Objective	
	Concentration (µg/m^3)	Averaging Period
NO_2	40	Annual mean
	200	1-hour mean, not to be exceeded on more than 18 occasions per annum

[1] The AQS: Framework for Local Authority Delivery, DEFRA, 2023.

2.1.5 Table 2 summarises the advice provided in DEFRA guidance[2] on where the AQOs for pollutants considered within this report apply.

Table 2 Examples of Where the Air Quality Objectives Apply

Averaging Period	Objective Should Apply At	Objective Should Not Apply At
Annual mean	All locations where members of the public might be regularly exposed Building façades of residential properties, schools, hospitals, care homes etc.	Building façades of offices or other places of work where members of the public do not have regular access Hotels, unless people live there as their permanent residence Gardens of residential properties Kerbside sites (as opposed to locations at the building façade), or any other location where public exposure is expected to be short term
1-hour mean	All locations where the annual mean and 24 and 8-hour mean objectives apply. Kerbside sites (for example, pavements of busy shopping streets) Those parts of car parks, bus stations and railway stations etc which are not fully enclosed, where members of the public might reasonably be expected to spend one hour or more Any outdoor locations where members of the public might reasonably be expected to spend one hour or longer	Kerbside sites where the public would not be expected to have regular access

2.2 Industrial Pollution Control Legislation

2.2.1 Atmospheric emissions from industry are controlled in the UK through the Environmental Permitting (England and Wales) Regulations (2016) and subsequent amendments. As such, the facility is required to obtain an Environmental Permit issued by the Environment Agency (EA). Conditions of operation will be stated Emission Limit Values (ELVs) for various pollutants produced by the process. Compliance with these conditions must be demonstrated through periodic monitoring requirements, which have been set in order to limit potential impacts in the surrounding area.

2 Local Air Quality Management Technical Guidance (TG22), DEFRA, 2022.

2.3 Local Air Quality Management

2.3.1 Local Authorities (LAs) are required to periodically review and assess air quality within their area of jurisdiction under the system of Local Air Quality Management (LAQM). This review and assessment of air quality involves comparing present and likely future pollutant concentrations against the AQOs. If it is predicted that levels at locations of relevant exposure, as summarised in Table 2, are likely to be exceeded, the LA is required to declare an Air Quality Management Area (AQMA). For each AQMA the LA is required to produce an Air Quality Action Plan, the objective of which is to reduce pollutant concentrations in pursuit of the AQOs.

2.4 Critical Loads and Levels

2.4.1 A critical load is defined by the UK Air Pollution Information System (APIS)[3] as:

> "A quantitative estimate of exposure to one or more pollutants below which significant harmful effects on specified sensitive elements of the environment do not occur according to present knowledge."

2.4.2 A critical level is defined as:

> "Concentrations of pollutants in the atmosphere above which direct adverse effects on receptors, such as human beings, plants, ecosystems or materials, may occur according to present knowledge."

2.4.3 A critical load refers to deposition of a pollutant, while a critical level refers to pollutant concentrations in the atmosphere (which usually have direct effects on vegetation or human health).

2.4.4 When pollutant loads (or concentrations) exceed the critical load or level it is considered that there is a risk of harmful effects. The excess over the critical load or level is termed the exceedence. A larger exceedence is often considered to represent a greater risk of damage.

3 http://www.apis.ac.uk/.

2.4.5 Maps of critical loads and levels and their exceedences have been used to show the potential extent of pollution damage and aid in developing strategies for reducing pollution. Decreasing deposition below the critical load is seen as means for preventing the risk of damage. However, even a decrease in the exceedence may infer that less damage will occur.

2.4.6 Table 3 presents the critical levels for the protection of vegetation for pollutants considered within this assessment.

Table 3 Critical Levels for the Protection of Vegetation

Pollutant	Critical Level	
	Concentration (μg/m³)	Averaging Period
Oxides of nitrogen (NO_x)	30	Annual mean
	75	24-hour mean

2.4.7 Critical loads have been designated within the UK based on the sensitivity of the receiving habitat and have been identified for the relevant designations considered within the assessment in Section 3.5.

3.0 BASELINE

3.1 Introduction

3.1.1 Existing air quality conditions in the vicinity of the site were identified in order to provide a baseline for assessment. These are detailed in the following Sections.

3.2 Local Air Quality Management

3.2.1 As required by the Environment Act (1995), as amended by the Environment Act (2021), South Gloucester Council (SGC) has undertaken Review and Assessment of air quality within their area of jurisdiction. This process has indicated that annual mean concentrations of NO_2 are above the AQO within the district. As such, two AQMAs have been declared. The closest of the these to the site is described as follows:

> "The area incorporates the Broad Street A4175, High Street B4465, Victoria Street and Soundwell Road A4017 crossroads. It extends along Broad Street to the junction with Seymour Road, along Soundwell Road to the road linking with Seymour Road and for distances of approximately 200m along High Street and approximately 170m along Victoria Street from the centre of the crossroads. The area includes any properties that lie within the outline boundary."

3.2.2 The site is located approximately 7.7km north-west of the AQMA. It is considered unlikely the facility would cause air quality impacts over a distance of this magnitude. As such, the AQMA has not been considered further in the context of the assessment.

3.2.3 SGC has concluded that concentrations of all other pollutants considered within the AQS are currently below the relevant AQOs. As such, no further AQMAs have been designated.

3.3 Air Quality Monitoring

3.3.1 Monitoring of pollutant concentrations is undertaken by SGC throughout their area of jurisdiction. Recent NO_2 concentrations recorded in the vicinity of the site are shown in Table 4.

Table 4 Monitoring Results

Monitoring Site		Monitored NO_2 Concentration (µg/m^3)		
		2021	2022	2023
35	Bradley Stoke - Woodlands Lane (M4 East of Almondsbury Interchange)	22.0	22.9	17.5

3.3.2 As shown in Table 4, annual mean NO_2 concentrations were below the AQO of 40µg/m^3 at the monitoring location in recent years. Reference should be made to Figure 2 for a map of the survey position.

3.4 Background Pollutant Concentrations

3.4.1 Predictions of background pollutant concentrations on a 1km by 1km grid basis have been produced by DEFRA for the entire of the UK to assist Local Authorities in their Review and Assessment of air quality. The site is located in grid square NGR: 361500, 183500. Data for this location was downloaded from the DEFRA website[4] for the purpose of the assessment and is summarised in Table 5.

Table 5 Background Pollutant Concentration Predictions

Pollutant	Predicted 2025 Background Pollutant Concentration (µg/m^3)
NO_2	13.44

3.4.2 As shown in Table 5, the predicted annual mean background NO_2 concentration is below the relevant AQO at the site.

3.5 Sensitive Receptors

3.5.1 A sensitive receptor is defined as any location which may be affected by changes in air quality. These have been defined in the following Sections.

4 https://uk-air.defra.gov.uk/data/laqm-background-maps?year=2021.

Human Receptors

3.5.2 A desk-top study was undertaken in order to identify any sensitive human receptor locations in the vicinity of the site that required specific consideration during the assessment. These are summarised in in Table 6.

Table 6 Human Receptor Locations

Receptor		NGR (m)	
		X	Y
R1	Residential - Westfield Way	362011.6	183112.0
R2	Residential - Crows Grove	361913.3	183144.0
R3	Residential - Warren Close	361809.3	183149.2
R4	Residential - Foxfield Avenue	361720.7	183166.2
R5	Residential - Foxfield Avenue	361632.1	183190.5

3.5.3 Reference should be made to Figure 3 for a map of the sensitive human receptor locations.

Ecological Receptors

3.5.4 Atmospheric emissions from the facility also have the potential to impact on receptors of ecological sensitivity within the vicinity of the site. A desk-top study was undertaken to identify any sites of ecological or nature conservation importance that required consideration within the assessment. The results indicated the following for inclusion:

- Three Brooks Local Nature Reserve (LNR).

3.5.5 For the purpose of the modelling assessment, discrete receptors were placed at the closest points of the designation to the facility to ensure maximum potential impacts were predicted. These are summarised in Table 7.

Table 7 Ecological Receptor Locations

Receptor		NGR (m)	
		X	Y
E1	Three Brooks LNR	361419.1	182756.2
E2	Three Brooks LNR	361784.5	182575.5
E3	Three Brooks LNR	362167.6	182421.7

3.5.6 Reference should be made to Figure 4 for a map of the ecological receptor locations.

3.5.7 Critical loads have been designated within the UK based on the sensitivity and relevant features of the receiving habitat. A review of the APIS[5] and Multi-Agency Geographic Information for the Countryside (MAGIC)[6] websites, as well as the relevant site designations and publicly available information, was undertaken in order to identify the most relevant feature at each receptor.

3.5.8 The relevant nitrogen deposition critical loads are presented in Table 8.

Table 8 Critical Loads for Nitrogen Deposition

Receptor		APIS Habitat	Relevant Nitrogen Critical Load Class	Nitrogen Critical Load (kgN/ha/yr)	
				Low	High
E1 - E3	Three Brooks LNR	Broadleaved, Mixed and Yew Woodland	Broadleaved deciduous forest	10	15

3.5.9 The critical loads for acid deposition are presented in Table 9.

5 http://www.apis.ac.uk/.

6 Multi-Agency Geographic Information for the Countryside, www.magic.gov.uk.

Table 9 Critical Loads for Acid Deposition

Receptor		APIS Habitat	Relevant Acid Critical Load Class	Acid Critical Load (keq/ha/yr)		
				CLMinN	CLMaxS	CLMaxN
E1	Three Brooks LNR	Broadleaved, Mixed and Yew Woodland	Unmanaged woodland	0.357	2.577	2.577
E2	Three Brooks LNR	Broadleaved, Mixed and Yew Woodland	Unmanaged woodland	0.357	2.577	2.934
E3	Three Brooks LNR	Broadleaved, Mixed and Yew Woodland	Unmanaged woodland	0.357	2.578	2.935

3.5.10 Baseline pollutant concentrations and deposition rates were obtained from the APIS[7] website and are summarised in Table 10.

Table 10 Baseline Pollution Levels at Ecological Receptors

Receptor		Annual Mean NO_x Conc. (µg/m^3)	Baseline Deposition Rate	
			Nitrogen (kgN/ha/yr)	Acid (keq/ha/yr)
E1 & E2	Three Brooks LNR	17.27	26.73	2.02
E3	Three Brooks LNR	19.30	27.08	2.05

7 http://www.apis.ac.uk/.

4.0 METHODOLOGY

4.1 Introduction

4.1.1 Combustion emissions from the boilers have the potential to affect pollutant concentrations in the vicinity of the site. These have been quantified through dispersion modelling in accordance with the methodology outlined in the following Sections.

4.2 Dispersion Model

4.2.1 Dispersion modelling was undertaken using ADMS-6.0 (v6.0.2.0), which is developed by Cambridge Environmental Research Consultants (CERC) Ltd. ADMS-6 is a short-range dispersion modelling software package that simulates a wide range of buoyant and passive releases to atmosphere. It is a new generation model utilising boundary layer height and Monin-Obukhov length to describe the atmospheric boundary layer and a skewed Gaussian concentration distribution to calculate dispersion under convective conditions.

4.2.2 The model utilises hourly meteorological data to define conditions for plume rise, transport and diffusion. It estimates the concentration for each source and receptor combination for each hour of input meteorology and calculates user-selected long-term and short-term averages.

4.3 Modelling Scenarios

4.3.1 The scenarios considered for human receptors in the modelling assessment are summarised in Table 11.

Table 11 Assessment Scenarios: Human Receptors

Parameter	Modelled As	
	Short Term	Long Term
NO_2	99.8th percentile (%ile) 1-hour mean	Annual mean

4.3.2 Some short-term air quality criteria are framed in terms of the number of occasions in a calendar year on which the concentration should not be exceeded. As such, the %ile shown in Table 11 was selected to represent the relationship between the permitted number of exceedences of short-period concentrations and the number of periods within a calendar year.

4.3.3 The scenarios considered for ecological receptors in the modelling assessment are summarised in Table 12.

Table 12 Assessment Scenarios: Ecological Receptors

Parameter	Modelled As	
	Short Term	Long Term
NO_x	24-hour mean	Annual mean
Nitrogen deposition	-	Annual deposition
Acid deposition	-	Annual deposition

4.3.4 Predicted pollutant concentrations were summarised in the following formats:

- Process Contribution (PC) - Predicted pollutant concentration as a result of emissions from the plant; and,
- Predicted Environmental Concentration (PEC) - Total predicted pollutant concentration as a result of emissions from the plant, as well as existing background levels.

4.3.5 Predicted ground level pollutant concentrations and deposition rates were compared with the relevant AQOs, critical levels and critical loads. These criteria are collectively referred to as Environmental Quality Standards (EQSs).

4.4 Assessment Area

4.4.1 The assessment area was defined based on the site location, anticipated pollutant dispersion patterns and the positioning of sensitive receptors. Ambient concentrations were predicted over NGR: 361180, 362680 to 182555, 184055. One Cartesian grid with a resolution of 10m was used within the model to produce data suitable for contour plotting using the Surfer software package.

4.4.2 Reference should be made to Figure 5 for a graphical representation of the assessment grid extents.

4.5 Process Conditions and Emissions

4.5.1 A summary of the model inputs is provided in Table 13. These were obtained from technical data provided by the suppliers of the relevant boilers. Pollutant emission concentrations were based on the ELVs for new and existing gas-fired boilers[8].

Table 13 Process Conditions

Emission Point	Unit	Value	
		Byworth boiler	ICI boiler
Stack location	NGR (m)	361944.2, 183345.6	361945.2, 183331.6
Stack height[(a)]	m	4.74	11.20
Stack diameter	m	0.43	0.60
Exhaust gas temperature	°C	201.0	273.7
Exhaust gas flow rate	m^3/hr	4,329	9,240
Exhaust gas flow rate	Nm^3/hr	2,493	4,614
Exhaust gas efflux velocity	m/s	8.36	9.08
NO_x emission concentration	mg/Nm^3	100[(b)]	250[(b)]
NO_x emission rate	g/s	0.0693	0.3204

Note: (a) Above ground level.
(b) ELV - Dry gas, 0˚C, 3% oxygen (O_2).

4.5.2 Emissions were assumed to be constant, with the plant in operation for 24-hours per day, 365-days per year. This is considered to be a worst-case assessment scenario as plant shutdown is not reflected in the modelled emissions.

4.5.3 Reference should be made to Figure 5 for a map of the emission point locations.

8 https://www.gov.uk/guidance/medium-combustion-plant-mcp-comply-with-emission-limit-values.

4.6 NO_x to NO_2 Conversion

4.6.1 Emissions of total NO_x from combustion processes are predominantly in the form of nitric oxide (NO). Excess oxygen in the combustion gases and further atmospheric reactions cause the oxidation of NO to NO_2. Comparisons of ambient NO and NO_2 concentrations in the vicinity of point sources in recent years has indicated that it is unlikely that more than 30% of the NO_x is present at ground level as NO_2.

4.6.2 Ambient NO_x concentrations were predicted through dispersion modelling. Concentrations of NO_2 shown in the results section assume 70% conversion from NO_x to NO_2 for annual means and 35% conversion for 1-hour concentrations, based upon EA guidance[9].

4.7 Building Effects

4.7.1 The dispersion of substances released from elevated sources can be influenced by the presence of buildings close to the emission point. Structures can interrupt the wind flows and cause significantly higher ground-level concentrations close to the source than would arise in the absence of the buildings.

4.7.2 Analysis of the site layout indicated that a number of structures should be included within the model in order to take account of effects on pollutant dispersion. Input geometries are shown in Table 14.

Table 14 Building Geometries

Building	NGR (m)		Height (m)	Length (m)	Width (m)	Angle (°)
	X	Y				
Main Greencore Building	361925.5	183303.7	9.8	51.5	79.8	184.3
Paragon Building 1	361805.8	183306.7	15.0	66.8	95.8	184.3
Paragon Building 2	361957.0	183199.8	12.0	66.0	127.1	191.7
Byworth boiler unit	361943.7	183345.2	4.5	11.8	3.7	229.6

9 https://www.gov.uk/guidance/environmental-permitting-air-dispersion-modelling-reports.

4.7.3 Reference should be made to Figure 5 for a map of the building locations.

4.8 Meteorological Data

4.8.1 Meteorological data used in the assessment was taken from Bristol Lulsgate meteorological station over the period 1st January 2020 to 31st December 2024 (inclusive). This observation station is located at NGR: 349996, 164986, which is approximately 21.8km south-west of the site. It is anticipated that conditions would be reasonably similar over a distance of this magnitude. The data was therefore considered suitable for an assessment of this nature.

4.8.2 All meteorological files used in the assessment were provided by Atmospheric Dispersion Modelling Ltd, which is an established distributor of data within the UK. Reference should be made to Figure 6 for wind roses of utilised meteorological records.

4.9 Roughness Length

4.9.1 Roughness length (z_0) is a modelling parameter applied to allow consideration of surface height roughness elements. A value of 0.5m was used to describe the modelling extents. This is considered appropriate for the morphology of the area and is suggested within ADMS-6 as being suitable for ‘parkland, open suburbia’.

4.9.2 A z_0 of 0.3m was used to describe the meteorological site. This value is considered appropriate for the morphology of the area and is suggested within ADMS-6 as being suitable for ‘agricultural areas (max)’.

4.10 Monin-Obukhov Length

4.10.1 The Monin-Obukhov length provides a measure of the stability of the atmosphere. A minimum Monin-Obukhov length of 30m was used to describe the modelling extents. This value is considered appropriate for the nature of the area and is suggested within ADMS-6 as being suitable for 'mixed urban/industrial'.

4.10.2 A minimum Monin-Obukhov length of 10m was used to describe the meteorological site. This value is considered appropriate for the nature of the area and is suggested within ADMS-6 as being suitable for 'small towns < 50,000'.

4.11 Terrain Data

4.11.1 Ordinance Survey OS Terrain 50 data was included in the model for the site and surrounding area in order to take account of the specific flow field produced by variations in ground height throughout the assessment extents. This was pre-processed using the method suggested by CERC[10].

4.12 Nitrogen Deposition

4.12.1 Nitrogen deposition rates were calculated using the conversion factors provided within EA document 'Technical Guidance on Detailed Modelling approach for an Appropriate Assessment for Emissions to Air AQTAG 06'[11]. Predicted pollutant concentrations were multiplied by the relevant deposition velocity and conversion factor to calculate the speciated dry deposition flux. The conversion factors used for the determination of nitrogen deposition are presented within Table 15.

Table 15 Conversion Factors to Determine Dry Deposition Flux for Nitrogen Deposition

Pollutant	Deposition Velocity (m/s)		Conversion Factor (μg/m²/s to kg/ha/yr of pollutant species)
	Grassland	Forest	
NO_2	0.0015	0.003	95.9

4.12.2 The relevant deposition velocity for the ecological receptor was selected from Table 15 based on the vegetation type present within the designation.

4.13 Acid Deposition

4.13.1 Predicted ground level NO_2 concentrations were converted to kilo-equivalent ion depositions (keq/ha/yr) for comparison with the critical load for acid deposition at the identified ecological receptor. The conversion to units of equivalents, a measure of the

10 Note 105: Setting up Terrain Data for Input to CERC Models, CERC, 2016.

11 Technical Guidance on Detailed Modelling approach for an Appropriate Assessment for Emissions to Air AQTAG 06, EA, 2014.

potential acidifying effect of a species, was undertaken using the standard conversion factors shown in Table 16.

Table 16 Conversion Factors to Determine Dry Deposition Flux for Acid Deposition

Pollutant	Deposition Velocity (m/s)		Conversion Factor (μg/m²/s to keq/ha/yr of pollutant species)
	Grassland	Forest	
NO_2	0.0015	0.003	6.84

4.13.2 The following formula was used to calculate predicted PCs as a proportion of the critical load function where PECs were identified to be greater than the CLminN value.

PC as %CL function = ((PC of N deposition)/CLmaxN) x 100

4.13.3 The above formula was obtained from the APIS website[12].

4.14 Background Concentrations

4.14.1 Review of existing data in the vicinity of the site was undertaken in Section 3.0 in order to identify suitable background values for use in the assessment. This indicated that the 35 - Bradley Stoke monitor was positioned adjacent to Woodlands Way along the same road as all sensitive receptors considered in the assessment. The annual mean NO_2 concentration recorded at the monitor during 2023 of 17.5μg/m^3 was therefore utilised to represent baseline conditions at these receptors.

4.14.2 The facility is set back from Woodlands Way. As such, the background concentration predicted by DEFRA, as shown in Table 5, was utilised to represent baseline levels in the vicinity of the site and across the assessment grid.

4.14.3 Baseline pollutant levels at the ecological receptors were obtained from the APIS website[13].

12 http://www.apis.ac.uk/.

13 http://www.apis.ac.uk/.

4.14.4 It is not possible to add short-term peak baseline and process concentrations. This is because the conditions which give rise to peak ground-level concentrations of substances emitted from an elevated source at a particular location and time are likely to be different to the conditions which give rise to peak concentrations due to emissions from other sources. This point is addressed in in EA guidance 'Air emissions risk assessment for your environmental permit'[14], which advises that an estimate of the maximum combined pollutant concentration can be obtained by adding the maximum predicted short-term concentration due to emissions from the source to twice the annual mean baseline concentration. This approach was adopted throughout the assessment.

4.15 Assessment Criteria

Human Receptors

4.15.1 EA guidance 'Air emissions risk assessment for your environmental permit'[15] states that PCs can be screened as insignificant if they meet the following criteria:

- 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.

4.15.2 If these criteria are exceeded the following guidance is provided on whether PECs can be screened as insignificant:

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

4.15.3 Should these criteria be exceeded then additional consideration to potential impacts should be provided.

Ecological Receptors

14 https://www.gov.uk/guidance/air-emissions-risk-assessment-for-your-environmental-permit.

15 https://www.gov.uk/guidance/air-emissions-risk-assessment-for-your-environmental-permit.

4.15.4 EA guidance 'Air emissions risk assessment for your environmental permit'[16] states that PCs at LNRs can be screened as insignificant if they meet the following criteria:

- The short-term PC is less than 100% of the short-term environmental standard for protected conservation areas;
- The long-term PC is less than 100% of the long-term environmental standard for protected conservation areas.

4.15.5 Predicted PCs have been compared to the relevant EQSs and the criteria stated above. Where the impact is within these parameters, the EA concludes that impacts associated with an installation are acceptable.

4.16 Modelling Uncertainty

4.16.1 Uncertainty in dispersion modelling predictions can be associated with a variety of factors, including:

- Model uncertainty - due to model limitations;
- Data uncertainty - due to errors in input data, including emission estimates, operational procedures, land use characteristics and meteorology; and,
- Variability - randomness of measurements used.

4.16.2 Potential uncertainties in the model results were minimised as far as practicable and worst-case inputs used in order to provide a robust assessment. This included the following:

- Choice of model - ADMS-6 is a commonly used atmospheric dispersion model and results have been verified through a number of studies to ensure predictions are as accurate as possible;
- Meteorological data - Modelling was undertaken using five annual meteorological data sets from an observation station local to the site. The analysis was based on the worst-case year for each averaging period to ensure maximum concentrations were considered;

16 https://www.gov.uk/guidance/air-emissions-risk-assessment-for-your-environmental-permit.

- Surface characteristics - The z_0 and Monin-Obukhov length were determined for both the dispersion and meteorological sites based on the surrounding land uses and guidance provided by CERC;
- Plant operating conditions - Operational parameters for the plant were obtained from the boiler manufacturers. As such, these are considered to be representative of normal operating conditions;
- Emission rates - The emission rates for the boilers were derived from the relevant ELVs. These were assumed to be constant throughout the modelling period, which does not allow for plant shut down. This assumption is likely to overestimate actual emissions and therefore result in a worst-case assessment;
- Background concentrations - Background pollutant levels were obtained from local monitoring results, as well as the DEFRA and APIS websites. These are considered representative of baseline air quality conditions at sensitive locations within the vicinity of the site;
- Receptor locations - A Cartesian Grid was included in the model in order to provide suitable data for contour plotting. Receptor points were also included at sensitive locations to provide additional consideration of these areas; and,
- Variability - All model inputs were as accurate as possible and worst-case conditions were considered as necessary in order to ensure a robust assessment of potential pollutant concentrations.

4.16.3 Results were considered in the context of the relevant EQSs and EA significance criteria. It is considered that the use of the stated measures to reduce uncertainty and the use of worst-case assumptions when necessary has resulted in model accuracy of an acceptable level.

5.0 RESULTS

5.1 Introduction

5.1.1 Dispersion modelling was undertaken with the inputs described in Section 4.0. The results are outlined in the following Sections.

5.1.2 Reference should be made to Figure 7 and Figure 8 for graphical representations of predicted PECs, inclusive of background levels, throughout the assessment extents. It should be noted that the values shown in the Figures are predictions from the meteorological data set which resulted in the maximum pollutant concentration for that averaging period. For example, the maximum annual mean NO_2 concentration was predicted using the 2020 meteorological data set. As such, the contours shown in Figure 7 were produced from the 2020 model outputs.

5.2 Maximum Off-Site Pollutant Concentrations

5.2.1 Maximum predicted off-site pollutant concentrations for any meteorological data set are summarised in Table 17.

Table 17 Maximum Predicted Off-Site Pollutant Concentrations

Pollutant	Averaging Period	EQS (μg/m^3)	PC (μg/m^3)	PC Proportion of EQS (%)	PEC (μg/m^3)	PEC Proportion of EQS (%)
NO_2	Annual	40	31.86	79.65	45.30	113.25
	99.8th %ile 1-hour	200	88.92	44.46	115.80	57.90

5.2.2 As shown in Table 17, off-site annual mean NO_2 concentrations are predicted to exceed the EQS of 40μg/m^3. However, these exceedences are confined to the east of the site boundary as shown in Figure 7. This area consists of vegetation between the facility and the M4. The public would not be expected to have access to this area. As such, the AQO for annual mean NO_2 would not apply in accordance with Table 2.

5.2.3 There were no predicted off-site exceedences of the EQS for 1-hour mean NO_2 throughout the grid extents.

5.3 Human Receptors

5.3.1 Predicted annual mean NO_2 concentrations at the human receptors, inclusive of background levels, are summarised in Table 18.

Table 18 Predicted Annual Mean NO_2 Concentrations

Receptor		Predicted Annual Mean NO_2 PEC (µg/m³)				
		2020	2021	2022	2023	2024
R1	Residential - Westfield Way	17.75	17.81	17.85	17.83	17.79
R2	Residential - Crows Grove	17.97	18.26	18.23	18.20	18.04
R3	Residential - Warren Close	18.28	18.53	18.12	18.08	18.15
R4	Residential - Foxfield Avenue	18.19	18.23	18.07	18.06	18.03
R5	Residential - Foxfield Avenue	17.98	17.97	18.02	17.97	17.88

5.3.2 As indicated in Table 18, annual mean NO_2 concentrations were below the EQS of 40µg/m³ at all human receptors for all meteorological data sets.

5.3.3 The significance of predicted impacts on annual mean NO_2 concentrations at the human receptors are summarised in Table 19. These consider the maximum predicted change in concentration from the five meteorological datasets as a worst-case.

Table 19 Predicted Impacts on Annual Mean NO_2 Concentrations

Receptor		Maximum Predicted Annual Mean NO_2 Concentration (µg/m³)		Proportion of EQS (%)	
		PC	PEC	PC	PEC
R1	Residential - Westfield Way	0.35	17.85	0.88	44.63
R2	Residential - Crows Grove	0.76	18.26	1.89	45.64
R3	Residential - Warren Close	1.03	18.53	2.58	46.33
R4	Residential - Foxfield Avenue	0.73	18.23	1.81	45.56
R5	Residential - Foxfield Avenue	0.52	18.02	1.29	45.04

5.3.4 As indicated in Table 19, PECs were below 70% of the EQS at all human receptors. As such, predicted effects on annual mean NO_2 concentrations are not considered to be significant.

5.3.5 Predicted 99.8th %ile 1-hour mean NO_2 concentrations at the receptors, inclusive of background levels, are summarised in Table 20.

Table 20 Predicted 99.8th %ile 1-hour Mean NO_2 Concentrations

Receptor		Predicted 99.8th %ile 1-hour Mean NO_2 PEC (μg/m³)				
		2020	2021	2022	2023	2024
R1	Residential - Westfield Way	40.09	40.30	40.47	40.33	40.22
R2	Residential - Crows Grove	41.48	41.57	41.77	41.76	41.65
R3	Residential - Warren Close	42.02	42.11	41.47	41.68	41.66
R4	Residential - Foxfield Avenue	40.37	40.43	40.12	39.97	39.93
R5	Residential - Foxfield Avenue	39.04	39.14	39.30	39.42	38.86

5.3.6 As indicated in Table 20, 1-hour mean NO_2 concentrations were below the EQS of 200μg/m³ at all human receptors for all meteorological data sets.

5.3.7 Maximum predicted 99.8th %ile 1-hour mean NO_2 concentrations at the human receptor locations are summarised in Table 21.

Table 21 Predicted Impacts on 99.8th %ile 1-hour Mean NO_2 Concentrations

Receptor		Maximum Predicted 99.8th %ile 1-hour Mean NO_2 Concentration (μg/m³)		PC Proportion of EQS (%)	PC Proportion of EQS Headroom (%)[a]
		PC	PEC		
R1	Residential - Westfield Way	5.47	40.47	2.74	3.16
R2	Residential - Crows Grove	6.77	41.77	3.39	3.91
R3	Residential - Warren Close	7.11	42.11	3.55	4.11
R4	Residential - Foxfield Avenue	5.43	40.43	2.71	3.13

Receptor		Maximum Predicted 99.8th %ile 1-hour Mean NO_2 Concentration (µg/m³)		PC Proportion of EQS (%)	PC Proportion of EQS Headroom (%)[a]
		PC	PEC		
R5	Residential - Foxfield Avenue	4.42	39.42	2.21	2.56

Note: (a) PC proportion of AQO minus twice the long-term background concentration.

5.3.8 As shown in in Table 21, PCs were below 10% of the EQS at all human receptors. As such, predicted effects on 1-hour mean NO_2 concentrations are not considered to be significant.

5.4 Ecological Receptors

Nitrogen Oxides

5.4.1 Predicted annual mean NO_x PECs at the ecological receptor locations, inclusive of background levels, are summarised in Table 22.

Table 22 Predicted Annual Mean NO_x Concentrations

Receptor		Predicted Annual Mean NO_x PEC (µg/m³)				
		2020	2021	2022	2023	2024
E1	Three Brooks LNR	17.44	17.48	17.40	17.38	17.41
E2	Three Brooks LNR	17.36	17.43	17.42	17.41	17.38
E3	Three Brooks LNR	19.35	19.36	19.38	19.37	19.36

5.4.2 As indicated in Table 22, annual mean NO_x PECs were below the EQS of 30µg/m³ at all ecological receptor locations.

5.4.3 Maximum predicted annual mean NO_x concentrations at the ecological receptor locations are summarised in Table 23.

Table 23 Maximum Predicted Annual Mean NO_x Concentrations

Receptor		Maximum Predicted Annual Mean NO_x Concentration (µg/m³)		Proportion of EQS (%)	
		PC	PEC	PC	PEC
E1	Three Brooks LNR	0.21	17.48	0.69	58.26
E2	Three Brooks LNR	0.16	17.43	0.53	58.09
E3	Three Brooks LNR	0.08	19.38	0.25	64.58

5.4.4 As shown in Table 23, PECs were below 100% of the annual mean EQS at all locations. As such, predicted effects on annual mean NO_x concentrations are not considered to be significant.

5.4.5 Predicted 24-hour mean NO_x PECs at the ecological receptor locations, inclusive of background levels, are summarised in Table 24.

Table 24 Predicted 24-hour Mean NO_x Concentrations

Receptor		Predicted 24-hour Mean NO_x PEC (µg/m³)				
		2020	2021	2022	2023	2024
E1	Three Brooks LNR	36.22	36.52	36.15	36.29	35.86
E2	Three Brooks LNR	36.20	36.34	37.11	36.84	36.69
E3	Three Brooks LNR	39.69	39.86	39.94	39.83	39.37

5.4.6 As indicated in Table 23, 24-hour mean NO_x PECs were below the EQS of 75µg/m³ at all ecological receptor locations.

5.4.7 Maximum predicted 24-hour mean NO_x concentrations at the ecological receptor locations are summarised in Table 25.

Table 25 Maximum Predicted 24-hour Mean NO_x Concentrations

Receptor		Maximum Predicted 24-hour Mean NO_x Concentration (μg/m³)		Proportion of EQS (%)	
		PC	PEC	PC	PEC
E1	Three Brooks LNR	1.98	36.52	2.64	48.70
E2	Three Brooks LNR	2.57	37.11	3.43	49.48
E3	Three Brooks LNR	1.34	39.94	1.79	53.26

5.4.8 As indicated in Table 25, PCs were below 100% at all receptors. As such, predicted effects on 24-mean NO_x concentrations are not considered to be significant, in accordance with the EA criteria.

Nitrogen Deposition

5.4.9 Predicted annual nitrogen PC deposition rates at the ecological receptor locations are summarised in Table 26.

Table 26 Predicted Annual Nitrogen Deposition Rates

Receptor		Predicted Annual PC Nitrogen Deposition Rate (kgN/ha/yr)				
		2020	2021	2022	2023	2024
E1	Three Brooks LNR	0.035	0.042	0.027	0.023	0.027
E2	Three Brooks LNR	0.018	0.032	0.030	0.028	0.022
E3	Three Brooks LNR	0.010	0.013	0.015	0.014	0.012

5.4.10 Maximum predicted annual nitrogen deposition rates at the ecological receptor locations are summarised in Table 27.

Table 27 Maximum Predicted Annual Nitrogen Deposition Rates

Receptor		Maximum Predicted Annual PC Nitrogen Deposition Rate (kgN/ha/yr)	Proportion of EQS (%)	
			Low EQS	High EQS
E1	Three Brooks LNR	0.042	0.42	0.28
E2	Three Brooks LNR	0.032	0.32	0.21
E3	Three Brooks LNR	0.015	0.15	0.10

5.4.11 As shown in Table 27, PCs were below 100% of the EQS at all receptors. As such, predicted effects on nitrogen deposition are not considered to be significant, in accordance with the EA criteria.

Acid Deposition

5.4.12 Predicted annual acid PC deposition rates are summarised in Table 28.

Table 28 Maximum Predicted Annual Acid Deposition Rates

Receptor		Predicted Annual PC Acid Deposition Rate (keq/ha/yr)				
		2020	2021	2022	2023	2024
E1	Three Brooks LNR	0.0025	0.0030	0.0019	0.0016	0.0019
E2	Three Brooks LNR	0.0013	0.0023	0.0022	0.0020	0.0016
E3	Three Brooks LNR	0.0007	0.0009	0.0011	0.0010	0.0008

5.4.13 Maximum predicted annual acid deposition rates at the ecological receptor locations are summarised in Table 29.

Table 29 Maximum Predicted Annual Acid Deposition Rates

Receptor		Maximum Predicted Annual Acid PC Deposition Rate (keq/ha/yr)	Proportion of EQS (%)
E1	Three Brooks LNR	0.0030	0.00

Receptor		Maximum Predicted Annual Acid PC Deposition Rate (keq/ha/yr)	Proportion of EQS (%)
E2	Three Brooks LNR	0.0023	0.00
E3	Three Brooks LNR	0.0011	0.00

5.4.14 As shown in Table 29, PCs were below 100% of the EQS at all receptors. As such, predicted effects on acid deposition are not considered to be significant, in accordance with the stated criteria.

5.5 Sensitivity Analysis

5.5.1 Dispersion model outputs can be affected by a number of variables, including:

- Meteorological data;
- Emission parameters;
- Receptor grid resolution;
- Treatment of terrain and buildings; and,
- Special model treatments.

5.5.2 As shown previously, maximum NO_2 concentrations at the human receptors were below the relevant EQSs. The results indicate a significant difference between the predictions and the values required to result in an impact at the relevant receptors. As such, there is sufficient headroom to account for model uncertainty without affecting the assessment conclusions. Further Sensitivity Analysis of specific variables is therefore not warranted for the project.

6.0 CONCLUSION

6.1.1 Redmore Environmental Ltd was commissioned by EHS Projects Ltd to undertake an Air Quality Assessment in support of an Environmental Permit Application for two boilers at Greencore, Bristol.

6.1.2 Combustion emissions from the boilers have the potential to cause air quality impacts during normal operation. As such, an Air Quality Assessment was undertaken in order to determine baseline conditions and consider potential effects.

6.1.3 Dispersion modelling was undertaken using ADMS-6 in order to predict NO_2 and NO_x concentrations, as well as nitrogen and acid deposition, at sensitive locations as a result of emissions from the boilers.

6.1.4 The results of the assessment indicated that the operation of the facility is not predicted to result in exceedences of the relevant EQSs at any sensitive human receptor within the vicinity of the installation. Impacts were classified as not significant in accordance with the relevant methodology.

6.1.5 Impacts were also predicted at relevant ecological sites. The results indicated that emissions from the proposed plant would not significantly affect existing conditions at any designation.

7.0 ABBREVIATIONS

APIS	Air Pollution Information System
AQLV	Air Quality Limit Value
AQMA	Air Quality Management Area
AQO	Air Quality Objective
AQS	Air Quality Strategy
CERC	Cambridge Environmental Research Consultants
DEFRA	Department for Environment, Food and Rural Affairs
EA	Environment Agency
ELV	Emissions Limit Value
EQS	Environmental Quality Standard
LAQM	Local Air Quality Management
MAGIC	Multi-Agency Geographic Information for the Countryside
NGR	National Grid Reference
NO	Nitric oxide
NO_2	Nitrogen dioxide
NO_x	Oxides of nitrogen
PC	Process Contribution
PEC	Predicted Environmental Concentration
PM_{10}	Particulate matter with an aerodynamic diameter of less than 10µm
SGC	South Gloucester Council
z_0	Roughness length
%ile	Percentile

Figures

Legend

Site Boundary

Title
Figure 1 - Site Location Plan

Project
Air Quality Assessment
Greencore, Bristol

Project Reference
9850

Client
EHS Projects Ltd

Redmore environmental

www.red-env.co.uk | 0161 7060075

Legend

Site Boundary

Human Receptor

Title
Figure 2 - Human Receptor Locations

Project
Air Quality Assessment
Greencore, Bristol

Project Reference
9850

Client
EHS Projects Ltd

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Legend

Site Boundary

Ecological Receptor

Title

Figure 3 - Ecological Receptor Locations

Project

Air Quality Assessment
Greencore, Bristol

Project Reference

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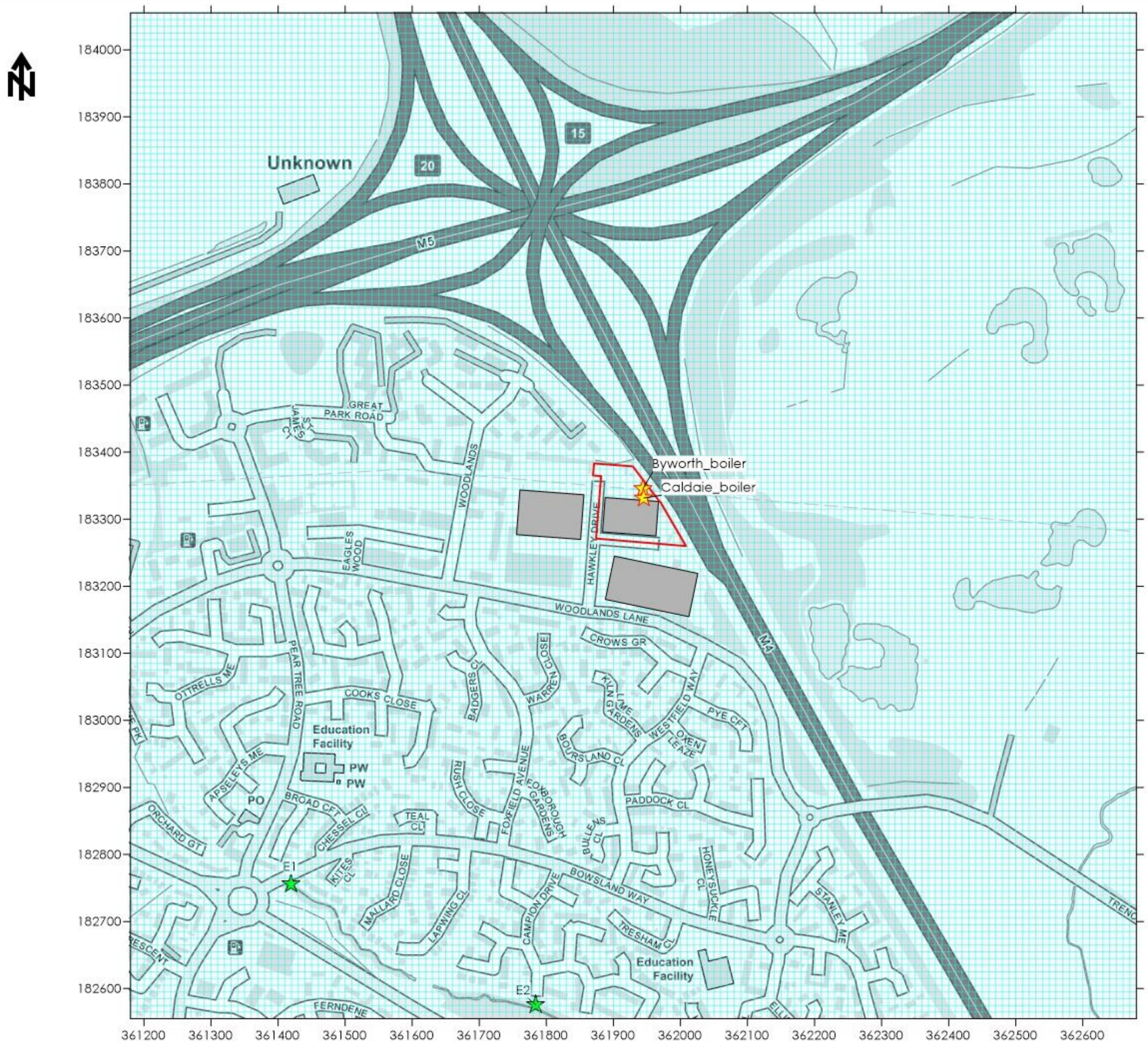

Legend

Site Boundary

Building

Output Grid

Source

Title

Figure 4 - ADMS-6 Inputs

Project

Air Quality Assessment
Greencore, Bristol

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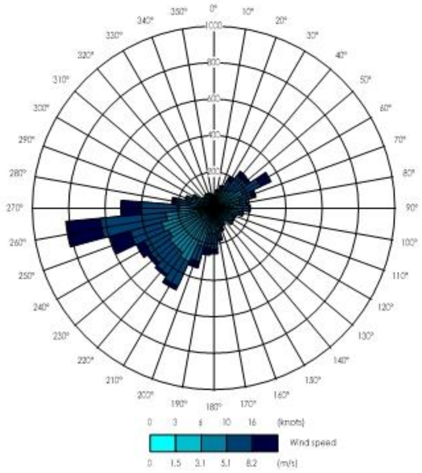
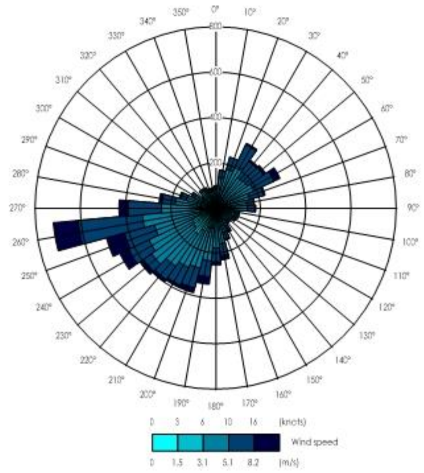
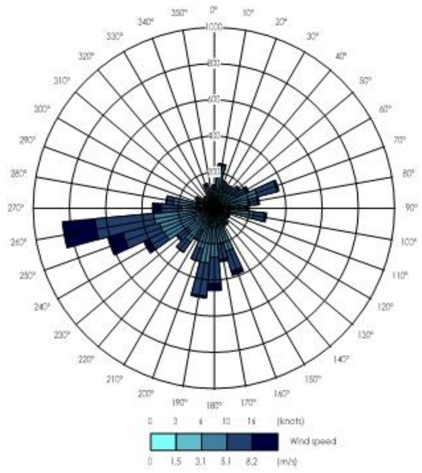


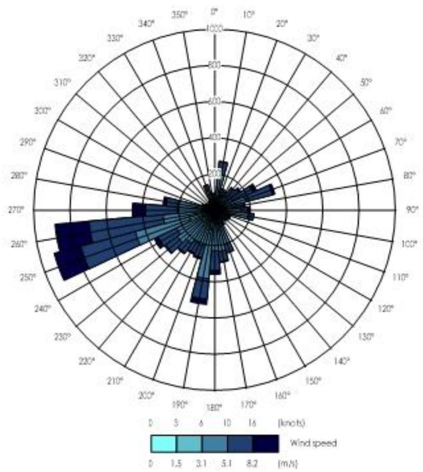
2020 Meteorological Data



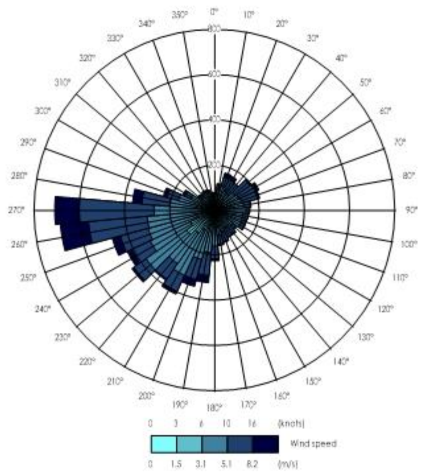
2021 Meteorological Data



2022 Meteorological Data



2023 Meteorological Data



2024 Meteorological Data

Legend

Title

Figure 5 - Wind Roses of 2020 to 2024 Bristol Lulsgate Meteorological Station Data

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Legend

Site Boundary

Annual Mean NO_2 Concentration (µg/m³)

15, 25, 35, 40, 45, 55

Title

Figure 6 - Predicted Annual Mean NO_2 Concentrations (µg/m³) 2020 Meteorological Data

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Air Quality Assessment
Greencore, Bristol

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Site Boundary

99.8th %ile 1-hour Mean NO_2 Concentration (µg/m³)

35, 55, 75, 95, 115, 135

Title

Figure 7 - Predicted 99.8th %ile 1-hour Mean NO_2 Concentrations (µg/m³)
2022 Meteorological Data

Project

Air Quality Assessment
Greencore, Bristol

Project Reference

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