Report

Air Quality Assessment for Environmental Permit Variation

CELSA Steel Cardiff Site

For Celsa Manufacturing (UK) Limited

10 December 2024

Air Quality Consultants | Part of Logika Group

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1 Introduction

1.1 This report describes the air quality assessment for the new furnace at the Celsa Manufacturing Site, located on Rover Way, Cardiff. The assessment has been prepared to support the Environmental Permit variation (permit reference EPR/TP3639BH) which is made in accordance with the Environmental Permitting (England and Wales) Regulations 2016, as amended (EPR). The assessment has been carried out by Air Quality Consultants Ltd on behalf of Celsa Manufacturing (UK) Ltd.

1.2 The new furnace will by hydrogen-ready, such that over time the emissions status of the furnace will change as it moves from operating on natural gas through to 100% hydrogen. Detailed modelling of relevant emissions from both a 100% natural gas fuelled furnace and a 100% hydrogen fuelled furnace, to cover the highest possible emissions of all potential pollutants, are described in this report.

1.3 The assessment focuses on emissions of the following pollutants for human health:

- nitrogen dioxide (NO_2);
- particulate matter (PM_{10}) ; and
- carbon monoxide (CO).

1.4 It also considers emissions of the following pollutants and their impact on ecological receptors including, where relevant, the effects of nitrogen and/or acid deposition:

- oxides of nitrogen (NO_x).

1.5 Table 1-1 summarises the site location, whilst Table 1-2 summarises the modelled scenarios and sensitivity tests that have been carried out.

1.6 The model input files have been packaged as a zip file and sent alongside this report.

Table 1-1: Site Location

Parameter	Entry
Site Name	Celsa Manufacturing
Site Address	Seawall Road, Cardiff CF24 5PH
Grid Reference (of point of release) (O.S. X,Y)	321029, 175971

Table 1-2: Summary of Model Scenarios and Sensitivity Tests

Parameter	Entry
Scenarios Assessed	Normal operation of the installation at maximum capacity fuelled by both 100% natural gas and 100% hydrogen. Both scenarios assume continuous operation throughout the year with emission parameters relevant to these operating scenarios as a worst-case assessment (see Section 6).
Year for Baseline Conditions	Most recent year of available measurements/predictions – no improvement assumed into the future (see Section 5)
Meteorological Conditions	Five years of meteorological data used. Each modelled separately. Receptor-specific maxima out of the five years are reported (see Section 6)

Parameter	Entry
Sensitivity Tests	Sensitivity has been undertaken with respect to building effects, terrain effects, surface roughness, and meteorological year. Therefore, the modelling sensitivity to the emission points modelled within this assessment is well understood.

2 Site Description

Nearby Sensitive Features

2.1 The new furnace will be located within the Celsa Manufacturing site, which lies in an industrial area approximately 2.5 km to the east of Cardiff city centre. Figure 2-1 shows the site location and identifies any designated habitats within 2 km and 10 km from the site. Figure 2-2 presents the same information but focussing on the area within 2 km of the site only. Local authority Air Quality Management Areas (AQMAs) are also shown in these figures. Table 2-1 summarises the proximity of nearby sensitive features. The locations of specified human health and ecological receptors are provided in Section 6 (Modelling Methodology).

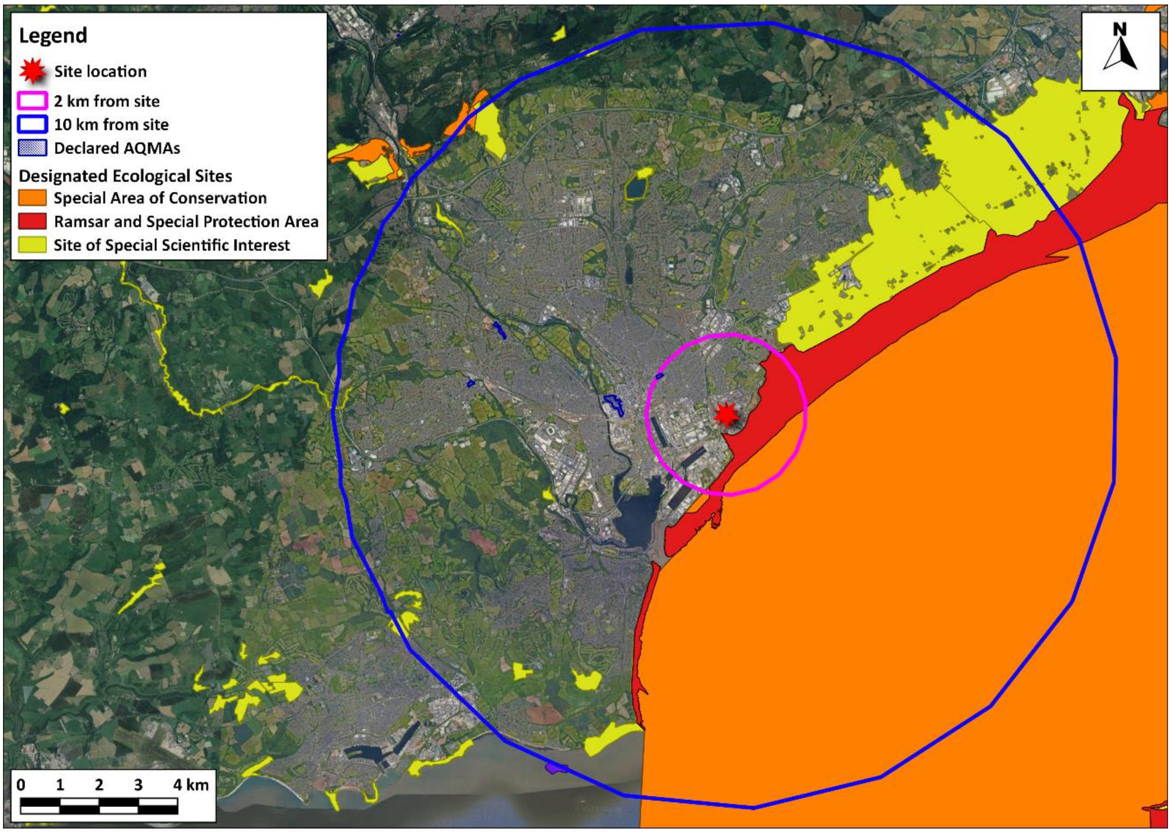

Figure 2-1: Site Location, AQMAs, SACs, SPAs, Ramsar Sites and SSSIs Within 10 km

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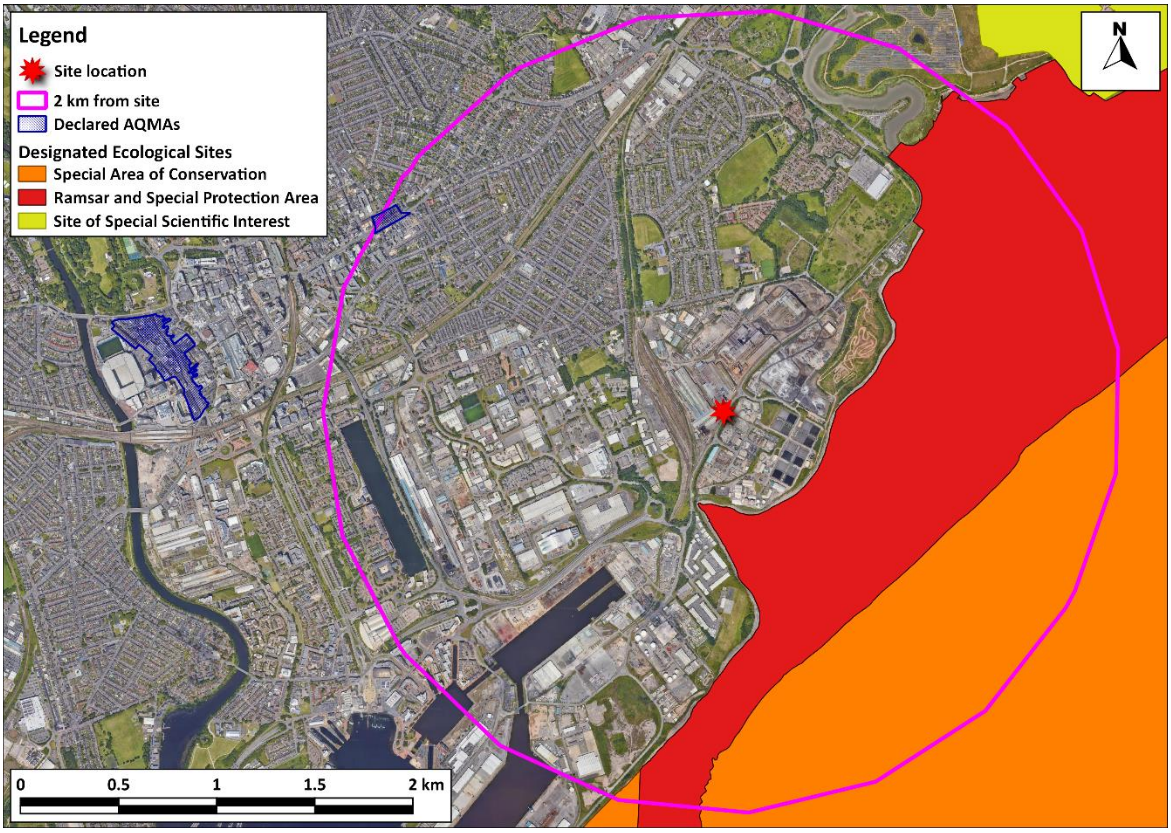

Figure 2-2: Site Location, AQMAs, SACs, SPAs, Ramsar Sites and SSSIs Within 2 km

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Table 2-1: Summary of Nearby Sensitive Features

Feature	Description	Distance from Stack
Nearest roadside human receptor	Moorland Primary School, to the northwest of the stack.	562 m
Nearest non-roadside human receptor	Residential apartments on Moorland Road, to the northwest of the stack.	482 m
Nearest SAC, SPA, Ramsar site or SSSI	Severn Estuary SAC, SPA, Ramsar and SSSI, to the south and east of the stack.	484 m
Receptors within the downwash cavity length from the nearest edge/side of the building?	There 18 residential properties to the north of the buildings within the region of potential downwash effects.	571 m
Sensitive receptor setting	Urban	n/a
Sensitive receptors within an AQMA?	No	n/a

Topography

2.2 Figure 2-3 shows the terrain across the modelled study area using Ordnance Survey (OS) Terrain 50 data. The area immediately surrounding the site is broadly flat, such that facility buildings from which the plant exhaust are approximately at the same elevation as the nearest human health receptors. However, there are areas within the wider model domain where terrain elevations exceed the site elevation by up to 290 m.

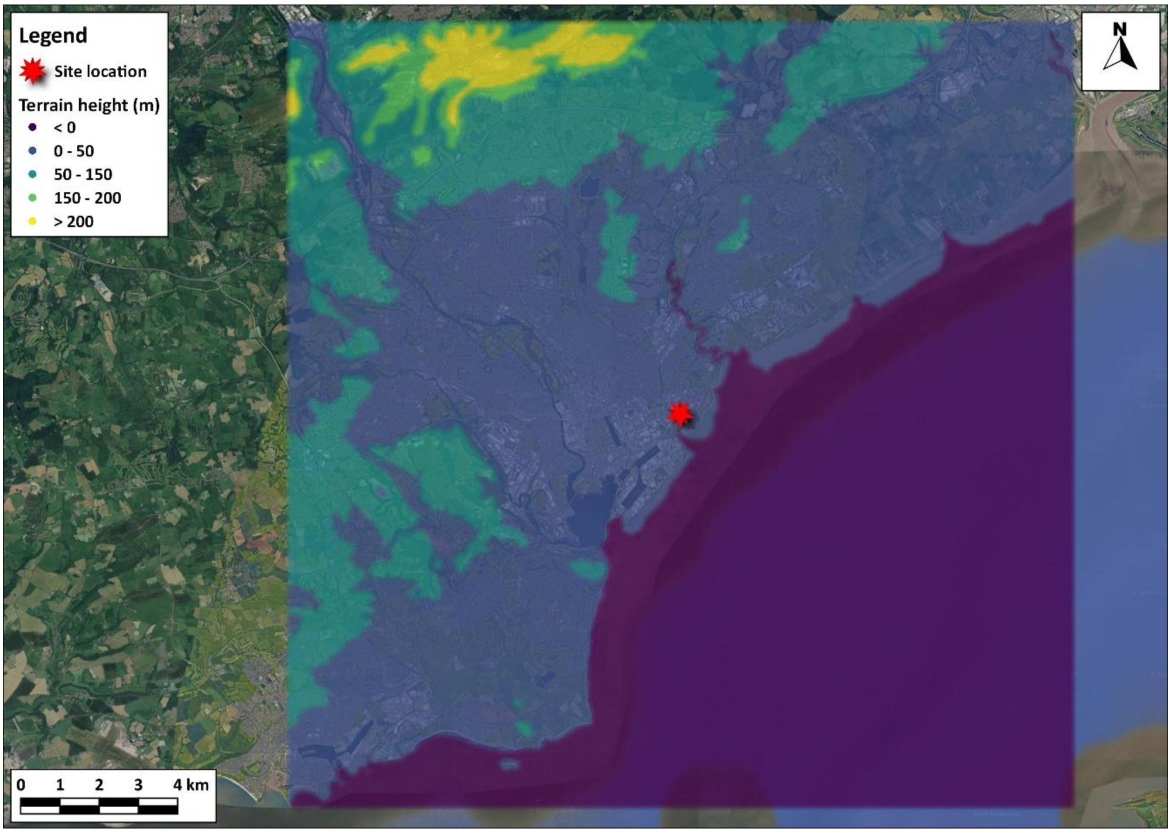

Figure 2-3: Terrain within the Modelled Area

Imagery ©2024 TerraMetrics.

3 Description of Process

3.1 The Celsa Manufacturing Site forms part of the wider Tremorfa complex, which produces steel products from scrap ferrous metal. Steel billets pass from the melt shop into the furnace, where they are reheated to approximately 1,150 C° and subsequently rolled into merchant bars.

3.2 The furnace will initially generate heat by the combustion of natural gas and will move to being solely hydrogen fuelled within two years. It will be cooled via a clean, closed-loop system with treated water.

3.3 Emissions will result solely from the combustion of the natural gas and/or hydrogen fuel. There will be no solid or liquid waste products.

3.4 Figure 3-1 provides a site plan (showing the site boundary, building locations within the site and stack location plan).

Figure 3-1: Site Boundary, Building and Stack Locations

Imagery ©2024 Airbus.

4 Environmental Standards for Air

4.1 The relevant Air Quality Standards (AQS), Air Quality Objectives (AQO) and Environmental Assessment Levels (EALs) for human health impacts are set out in Table 4-1 (EA, 2024a).

Table 4-1: Assessment Criteria for Human Health

Pollutant	Averaging Period	Designation	Metric (µg/m³)	Acceptable Exceedance Criteria
Nitrogen dioxide	Annual	AQS / AQO	40	Zero exceedances
	1-hour	AQS / AQO	200	Not to be exceeded more than 18 times a year
PM_{10}	Annual	AQS / AQO	40	Zero exceedances
	24-hour	AQS / AQO	50	Not to be exceeded more than 35 times a year
Carbon monoxide	8-hour (rolling)	AQS / AQO	10,000	Zero exceedances

4.2 The AQS and AQOs are defined within the Air Quality Standards Regulations (2010)[1] and the Air Quality (Wales) Regulations (2000) and the Air Quality (Amendment) (Wales) Regulations (2002). These regulations clarify the AQS and AQO apply at locations where members of the public are likely to be regularly present and are likely to be exposed over the averaging period of the assessment criteria. Defra explains where these criteria apply in its Local Air Quality Management Technical Guidance (Defra, 2022). Although EALs are not defined in these regulations, it is common to apply the same approach to assessing relevant exposure for EALs as AQS and AQOs.

4.3 Annual mean assessment criteria are considered to apply at the façades of residential properties, schools, hospitals etc.; they do not apply at hotels. The 24-hour mean assessment criteria are considered to apply at the same locations as the annual mean criteria, as well as in gardens of residential properties and at hotels. The 1-hour mean and 15-minute mean assessment criteria apply wherever members of the public might regularly spend 1-hour or 15-minutes or more, including outdoor eating locations and pavements of busy shopping streets. In the UK, only monitoring and modelling carried out by UK Central Government meets the specification required to assess compliance with the AQS and specific monitor and receptor siting requirements apply. None of the AQS, AQO or EAL values apply in places of work where members of the public have no free access and where relevant provisions concerning health and safety at work apply (AQC, 2016).

4.4 EU Directive 2008/50/EC (The European Parliament and the Council of the European Union, 2008) sets a limit value for annual mean concentrations of nitrogen oxides and for annual and winter mean concentrations of sulphur dioxide for the protection of vegetation and ecosystems, respectively. The same values have been set as domestic AQS within the Air Quality Standards Regulations 2010. The limit values and objectives only apply a) more than 20 km from an agglomeration (about 250,000 people), and b) more than 5 km from Part A industrial sources, motorways and built up areas of more than 5,000 people.

4.5 Critical levels (CLe) and critical loads (CLo) are the ambient concentrations and deposition fluxes below which significant harmful effects to sensitive habitats and ecosystems are unlikely to occur. Some of the CLe are set at the same concentrations as the AQS but do not have the same spatial

[1] As amended through The Air Quality Standards (Amendment) Regulations 2016 and The Environment (Miscellaneous Amendments) (EU Exit) Regulations 2020.

constraints on where they apply. Exceedances of the CLe and CLo are considered in the context of preventing harm to sites which are protected under the various designation frameworks.

4.6 Table 4-2 and Table 4-3 set out the relevant critical levels and critical loads for the designated ecological sites in the study area, as taken from the Air Pollution Information System (APIS) website (APIS, 2024) and the Environment Agency's guidance "*Air emissions risk assessment for your environmental permit*" (EA, 2024a)[2].

Table 4-2: Vegetation and Ecosystem Critical Levels

Pollutant	Averaging Period	Critical Level (µg/m^3)
Nitrogen Oxides (expressed as NO_2)	Annual	30
	24-hour	75 [a]

[a] This critical level is not an AQS and thus does not have the same legal status as the annual mean. The EA's guidance clarifies that this critical level only applies where there SO_2 and ozone exceed their respective critical levels, which is not generally the case in the UK. Where this is not the case, the applicable critical level is 200 µg/m^3.

Table 4-3: Critical Loads for Designated Ecological Sites

Site	Nutrient Nitrogen Deposition (kgN/ha/yr) [a]	Acid Deposition 'N_{max}' (keq/ha/yr) [a,b]
Severn Estuary (SAC, SPA, Ramsar, SSSI)	10	n/a
Cardiff Beech Woods (SAC)	10	1.428
Cwm Cydfin, Leckwith (SSSI)	10	1.744
Barry Woodlands (SSSI)	10	11.113
Lisvane Reservoir (SSSI)	10	n/a
Llanishen and Lisvane Reservoir Embankments (SSSI)	10	n/a
Glamorgan Canal / Long Wood (SSSI)	10	1.964
Cefn Onn (SSSI)	10	4.856
Cog Moors (SSSI)	10	n/a
Ely Valley (SSSI)	10	n/a
Gwent Levels (SSSI)	10	n/a

[a] Critical load data obtained from (APIS, 2024).
[b] Nmax is the value above which additional nitrogen deposition will lead to an exceedance of the Critical Load.

[2] The EA's guidance is relied on here in the absence of alternative, applicable guidance for Natural Resources Wales.

5 Baseline Conditions

5.1 Baseline conditions have been sourced from a combination of Defra's published background maps for 2023 (Defra, 2024a) and measurements made by Cardiff Council.

Local Air Quality Management

5.2 Under Part IV of the Environment Act 1995, Cardiff Council is required to periodically review and assess air quality within its area of jurisdiction. This process of Local Air Quality Management (LAQM) is an integral process for achieving the national AQOs.

5.3 Review and assessments of local air quality aim to identify areas where national policies to reduce vehicle and industrial emissions are unlikely to result in air quality meeting the Government's air quality objectives by the required dates.

5.4 Where the assessment indicates that some or all of the objectives may be potentially exceeded, the Local Authority has a duty to declare an Air Quality Management Area (AQMA). The declaration of an AQMA requires the Local Authority to implement an Air Quality Action Plan (AQAP) to reduce air pollution concentrations so that the required AQOs are met.

5.5 Cardiff Council has investigated air quality within its area as part of its responsibilities under the LAQM regime. In December 2000 an AQMA was declared at Ely Bridge for exceedances of the annual mean nitrogen dioxide objective. A further AQMA was declared in November 2010 at Stephenson Court, and two more were declared in April 2013 in Llandaff and in Cardiff City Centre. The closest AQMA is located 1.9 km northwest of the proposed development site. The locations of the AQMAs are shown in Figure 2-1.

5.6 In terms of PM_{10}, Cardiff Council concluded that there are no exceedances of the objectives. It is, therefore, reasonable to assume that existing PM_{10} levels will not exceed the objectives within the study area.

Local Authority Monitoring

5.7 Monitoring data of pollutants covered by the LAQM regime and reported by Cardiff Council are contained in Table 5-1, for the automatic and urban background sites within the study area, with monitoring locations shown in Figure 5-1. Monitoring data have been taken from Cardiff Council's 2023 Air Quality Progress Report (APR) (Cardiff Council, 2023).

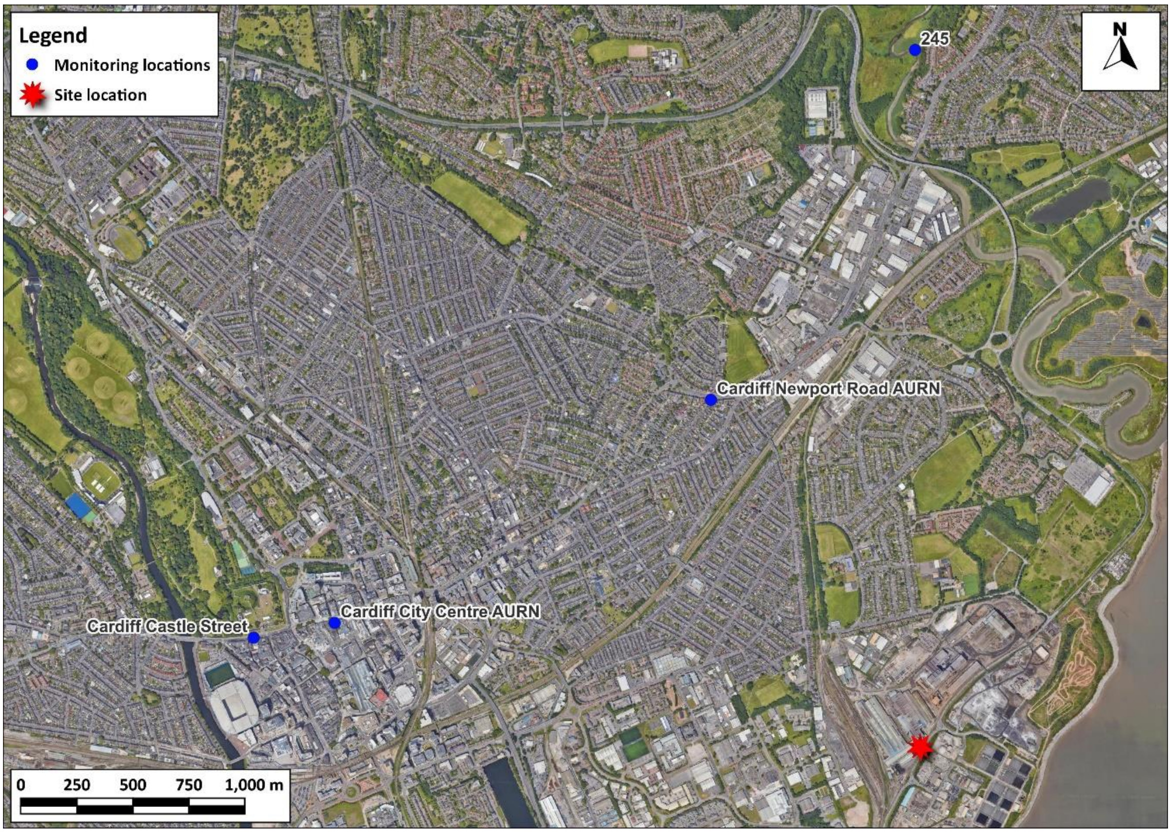

Figure 5-1: Cardiff Council Nearby Monitoring Locations.

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Table 5-1: Summary of Nitrogen Dioxide (NO_2) Monitoring (2018-2022) [a]

Site No.	Site Type	Location	2018	2019	2020	2021	2022
Automatic Monitors - Annual Mean (µg/m³)							
City Centre AURN	Urban Background	Cardiff City Centre	18	12	16	16	17
Newport Road AURN	Roadside	Newport Road, Cardiff	-	29	19	22	22
Castle Street	Roadside	Castle Street, Cardiff	-	-	-	25	34
Objective			**40**				
Automatic Monitors - No. of Hours > 200 µg/m³							
City Centre AURN	Urban Background	Cardiff City Centre	0	0	0	0	0
Newport Road AURN	Roadside	Newport Road, Cardiff	0	0	0	0	0

Site No.	Site Type	Location	2018	2019	2020	2021	2022
Castle Street	Roadside	Castle Street, Cardiff	-	-	-	0	0
Objective			**18**				
Diffusion Tubes - Annual Mean (µg/m³)							
245	Urban Background	47 Willows Avenue	-	-	14.3	15.0	15.4
Objective			**40**				

5.8 No exceedances have been recorded at the sites presented in Table 5-1.

Table 5-2: Summary of PM_{10} and $PM_{2.5}$ Monitoring (2018-2022)

Site No.	Site Type	Location	2018	2019	2020	2021	2022
PM_{10} Annual Mean (µg/m³)							
City Centre AURN	Urban Background	Cardiff City Centre	17	23	14	13	16
Newport Road AURN	Roadside	Newport Road, Cardiff	-	19	17	17	18
Castle Street	Roadside	Castle Street, Cardiff	-	-	-	12	20
Objective			**40**				
PM_{10} - No. of Days > 50 µg/m³							
City Centre AURN	Urban Background	Cardiff City Centre	-	0	0	0	0
Newport Road AURN	Roadside	Newport Road, Cardiff	-	0	0	0	0
Castle Street	Roadside	Castle Street, Cardiff	-	-	-	0	0
Objective			**35**				
$PM_{2.5}$ - Annual Mean (µg/m³)							
City Centre AURN	Urban Background	Cardiff City Centre	-	12	7	9	11
Castle Street	Roadside	Castle Street, Cardiff	-	-	-	9	10
Objective			**20**				

5.9 No exceedances of the PM_{10} or $PM_{2.5}$ objectives were recorded in any year.

5.10 The Cardiff City Centre AURN site also measures carbon monoxide concentrations. No exceedances of the 8-hour running mean were recorded in 2022.

National Background Pollution Maps

5.11 Defra maintains a nationwide model (the Pollution Climate Mapping (PCM) model) of existing and future background concentrations at a 1 km grid square resolution. The PCM model is semi-empirical in nature; it uses data from the national atmospheric emissions inventory (NAEI) to model the concentrations of pollutants at the centroid of each 1 km grid square but then calibrates these concentrations in relation to actual monitoring data

5.12 Figure 5-2 and Figure 5-3 set out the background annual mean NOx and NO_2 concentrations in the study area taken from Defra's published maps for 2021 (Defra, 2024a).

5.13 As an existing Part A(1) installation, contributions from the current furnace at the Celsa Manufacturing Site are already reflected in the modelled estimates from the PCM model.

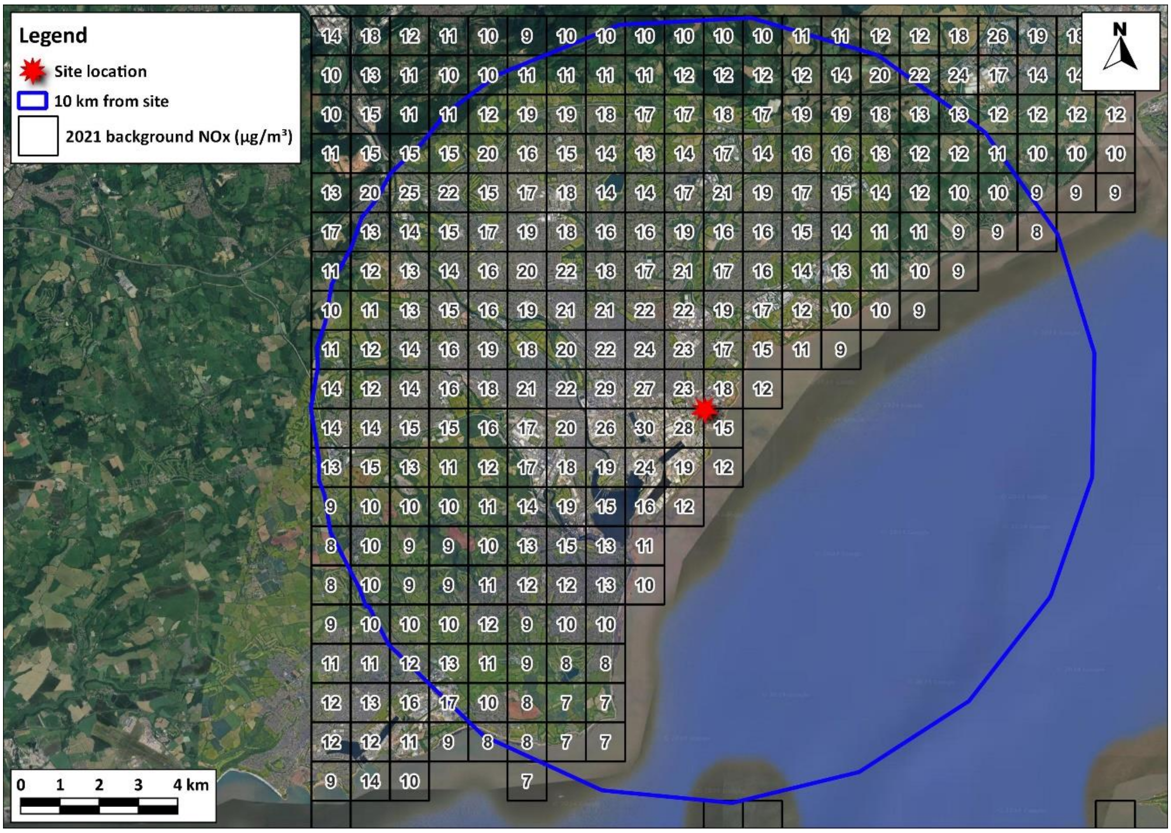

Figure 5-2: Defra's Predicted NOx Background Concentrations in the Area Surrounding the Site (μg/m³)

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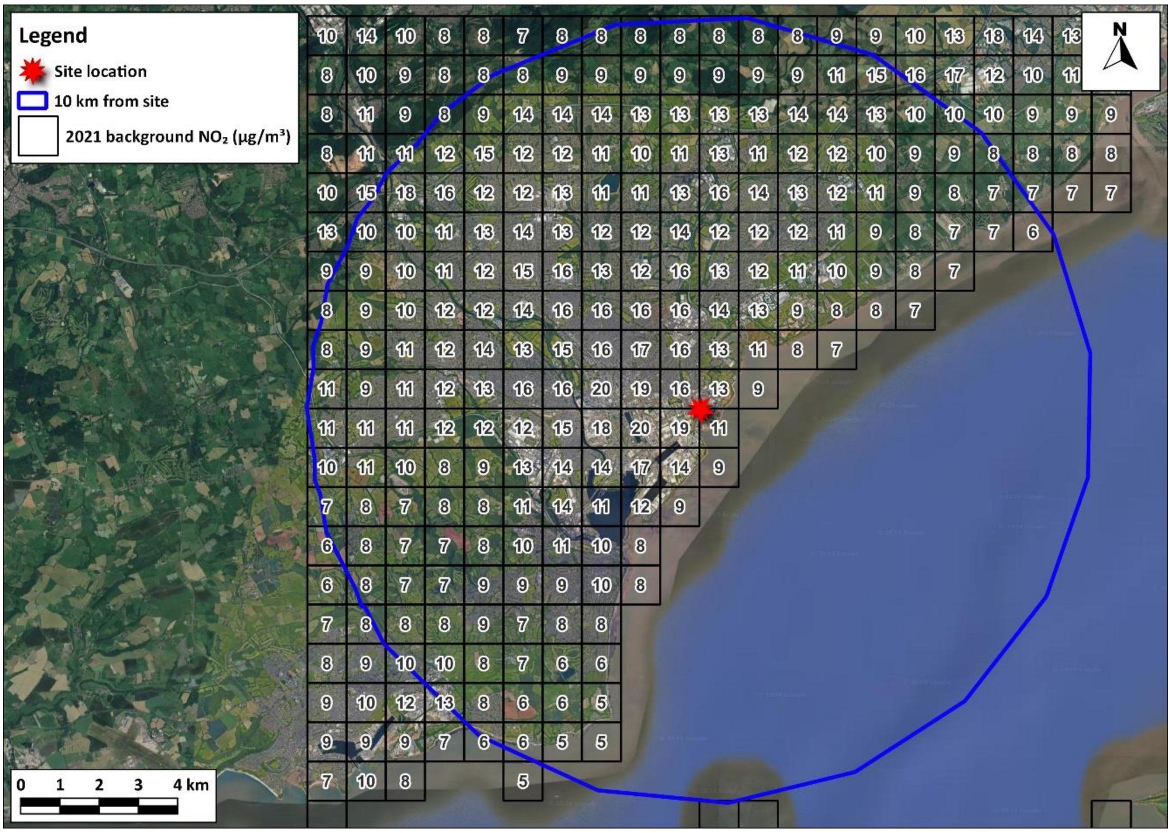

Figure 5-3: Defra's Predicted NO_2 Background Concentrations in the Area Surrounding the Site (µg/m³)

Imagery ©2024 TerraMetrics.

5.14 Defra's maps (Defra, 2024b) of roadside concentrations for the baseline year 2022 can also be used to determine approximate concentrations at the roadside. Figure 5-4 shows the roads in Cardiff that are included in the PCM model, labelled with the annual mean NO_2 concentrations, equivalent to a concentration at 4 m from the kerbside and 2 m height, along these roads in 2022. The highest predicted roadside concentration in the study area is 39.1 µg/m³. This is along the A48 Eastern Avenue, a busy dual-carriageway road, and so concentrations are not representative of the majority of roadside receptors in the study area.

Figure 5-4: PCM Mapped Roadside Annual Mean NO_2 Concentrations in 2022

Imagery ©2024 TerraMetrics.

Summary of Baseline Concentrations for Human Health Receptors

5.15 Table 5-3 sets out the baseline annual mean concentrations used in this assessment.

5.16 It is not rigorous to add predicted short term or percentile concentrations from different emission sources, since peak contributions from different sources would not necessarily coincide in time or space. For the purposes of estimating short-term baseline concentrations (averaging periods of 24-hours or less), a factor of two has been applied to the annual mean baseline concentration in Table 5-3 in accordance with the Environment Agency's "*Air emissions risk assessment for your environmental permit*" guidance (EA, 2024a).

Table 5-3: Baseline Annual Mean Concentrations Used in the Assessment

Location [a]	Value (µg/m³)	Derivation
Nitrogen Dioxide		
Receptor R1	13.3	Mapped concentration in grid square 321500, 176500
Receptors R2 to R4	16.5	Mapped concentration in grid square 320500, 176500
Grid Maximum	20.3	Highest mapped concentration across the study area
PM_{10}		
Receptor R1	13.0	Mapped concentration in grid square 321500, 176500

Location [a]	Value (µg/m³)	Derivation
Receptors R2 to R4	14.5	Mapped concentration in grid square 320500, 176500
Grid Maximum	15.6	Highest mapped concentration across the study area
Carbon Monoxide		
Receptor R1	134.7	Mapped concentration in grid square 321500, 176500
Receptors R2 to R4	155.2	Mapped concentration in grid square 320500, 176500
Grid Maximum	186.0	Highest mapped concentration across the study area

[a] See Table 6-3 and Figure 6-3 for specific receptor locations.

Designated Ecological Sites

5.17 Background concentrations of NOx, and nitrogen and acid nitrogen deposition fluxes, have been taken from the APIS website (APIS, 2024) and are set out in Table 5-4. These data represent 3-year mean 1 km x 1 km averages centred on the calendar year of 2021.

5.18 The NOx concentrations are well below the critical level of 30 µg/m³. Baseline nutrient nitrogen deposition fluxes are above the critical loads at all sites where a critical load is defined; this is the case for very many designated ecological sites across the UK. Baseline acid nitrogen deposition fluxes are above the critical loads at the Cardiff Beech Woods SAC, but are below the critical loads at all other sites where a critical load is defined.

5.19 The baseline values used in this assessment have been taken to be those in Table 5-4 for annual means and twice those in Table 5-4 for short term concentrations.

Table 5-4: Background Concentrations and Deposition Fluxes at Designated Ecological Sites

	NOx (µg/m³)		Nutrient Nitrogen Deposition (kgN/ha/yr)		Acid Deposition (keq/ha/yr)	
	Conc.	Critical Level	Deposition Flux	Critical Load	Deposition Flux	Critical Load
Severn Estuary (SAC, SPA, Ramsar, SSSI)	15.62	30	-	10	-	n/a [a]
Cardiff Beech Woods (SAC)	10.69		23.22		1.9	1.428
Cwm Cydfin, Leckwith (SSSI)	14.56		21.46		1.74	1.744
Barry Woodlands (SSSI)	9.55		20.53		1.62	11.113

	NOx (µg/m³)		Nutrient Nitrogen Deposition (kgN/ha/yr)		Acid Deposition (keq/ha/yr)	
	Conc.	Critical Level	Deposition Flux	Critical Load	Deposition Flux	Critical Load
Glamorgan Canal / Long Wood (SSSI)	14.36		22.89		1.9	1.964
Cefn Onn (SSSI)	10.11		13.21		1.11	4.856
Cog Moors (SSSI)	10.71		10.49		-	n/a [a]
Lisvane Reservoir	15.21		13.32	n/a [a]	-	
Llanishen and Lisvane Reservoir Embankments (SSSI)					-	
Ely Valley (SSSI)	12.21		-		-	
Gwent Levels (SSSI)	13.3		-		-	

[a] not applicable

6 Modelling Methodology

6.1 Modelling has been carried out using the following Environment Agency guidance: "*Air emissions risk assessment for your environmental permit*" (EA, 2024a) and "*Environmental permitting: air dispersion modelling reports*" (EA, 2024b)[2].

6.2 The modelling approach was also outlined and agreed with Natural Resources Wales via email correspondence between Karl Shepherd (Senior Specialist Advisor – Radioactivity and Industrial Policy at Natural Resources Wales) and Dr Imogen Heard (Air Quality Consultants) on 27th August 2024. Specifically, it was agreed that a conversion factor of 1.37 should be used to calculate NOx emissions from the hydrogen fuelled plant, resulting in a value of 137 mg/m^3 (see Table 6-2).

Dispersion Model

6.3 There are two primary dispersion models which are used extensively throughout the UK for assessments of this nature and accepted as appropriate air quality modelling tools by the Regulators and local planning authorities alike:

- The ADMS model, developed in the UK by Cambridge Environmental Research Consultants (CERC) in collaboration with the Met Office, National Power and the University of Surrey; and
- The AERMOD model, developed in the United States by the American Meteorological Society (AMS)/United States Environmental Protection Agency (EPA) Regulatory Model Improvement Committee (AERMIC).

6.4 Both models are termed 'new generation' Gaussian plume models, parameterising stability and turbulence in the planetary boundary layer (PBL) by the Monin-Obukhov length and the boundary layer depth. This approach allows the vertical structure of the PBL to be more accurately defined than by the stability classification methods of earlier dispersion models. Like these earlier models, ADMS and AERMOD adopt a symmetrical Gaussian profile of the concentration distribution in the vertical and crosswind directions in neutral and stable conditions. However, unlike earlier models, the ADMS and AERMOD vertical concentration profile in convective conditions adopts a skewed Gaussian distribution to take account of the heterogeneous nature of the vertical velocity distribution in the Convective Boundary Layer (CBL).

6.5 Numerous model inter-comparison studies have demonstrated little difference between the output of ADMS and AERMOD, except in certain scenarios, such as in areas of complex terrain (Carruthers and Seaton, 2011). For the purposes of this study, the use of the ADMS model (version 6) is adopted. ADMS is widely used for assessments of this type and has been extensively validated. Consequently, it is considered suitable for the current assessment.

Emission Scenarios

6.6 The assessment considers two emission scenarios:

- Scenario 1 - 100% natural gas fuelled operation; and
- Scenario 2 - 100% hydrogen fuelled operation.

6.7 It is assumed as a conservative approach that operation occurs continuously throughout the year.

Stack and Emission Parameters

6.8 Figure 6-1 presents the location of the modelled stack. The associated stack physical parameters and emission parameters are presented in Table 6-1 and Table 6-2, respectively.

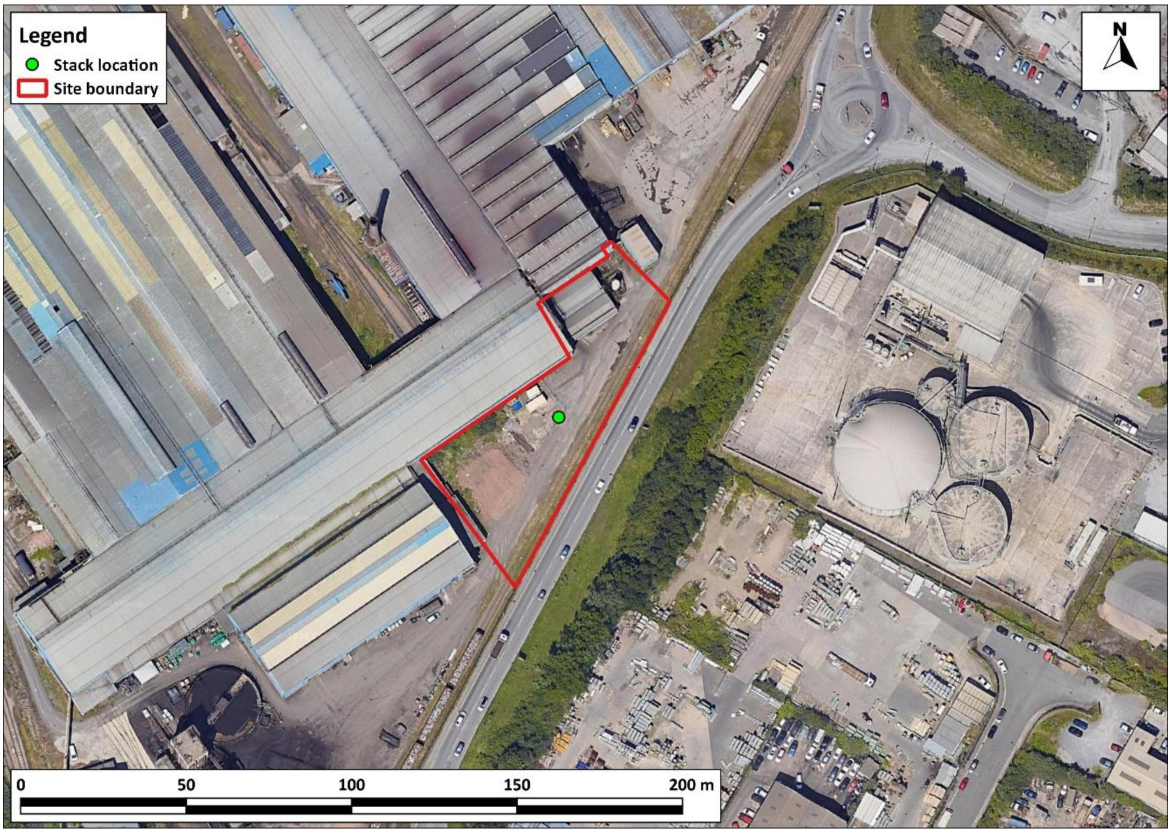

Figure 6-1: Stack Location

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Table 6-1: Modelled Physical Release Parameters for the Facility

Parameter	Value
Permit Emission Point Reference Number	EPR/TP3639BH
Source Type	Point
X-Coordinate	321029
Y-Coordinate	175971
Discharge Height Above Ground (m)	60
Discharge Diameter (m)	2.4

Table 6-2: Modelled Emission Parameters for the Facility

Parameter	Scenario 1 (Natural Gas)	Scenario 2 (Hydrogen)
Discharge Temperature (°C)	229	229
Discharge Velocity (m/s)	7.1	7.7
Volumetric Flowrate at Discharge Conditions (Am^3/s)	32.1	34.8
Volumetric Flowrate at Normalised Conditions (Nm^3/s)	58.4 [a]	63.1 [a]
Oxygen Content (%v/v)	3.0	3.0
Moisture Content (%v/v)	0.0	0.0
NOx Emission Concentration (mg/Nm^3)	100 [a]	137 [a]
NOx Emission Rate (g/s)	5.84	8.64
PM_{10} Emission Concentration (mg/Nm^3)	---	---
PM_{10} Emission Rate (g/s)	0.3	0.3
CO Emission Concentration (mg/Nm^3)	50	- [b]
CO Emission Rate (g/s)	0.8	- [b]

[a] Reference conditions of 273K, 101.3 kPa, 3% oxygen, dry gas.

[b] There are no CO emissions from a 100% hydrogen fuelled plant.

6.9 Stack physical parameters have been provided by EAME.

6.10 Emission parameters, including emission concentrations, volumetric flow rates and discharge temperatures have been obtained from tests using the proposed burners performed by the supplier. It has been assumed that emissions occur at these monitored parameters continuously throughout the year, with the exception of NOx emissions which have been modelled at the Emission Limit Value (ELV). A correction factor of 1.37 has been applied to the NOx emission in the 100% hydrogen fuelled scenario as recommended by the EA (EA, 2024c).

6.11 It is assumed the combustion plant is operating at the full load conditions continuously throughout the year.

Receptors and Study Area

6.12 Both human health and ecological impacts have been predicted over an 18 km x 18 km model domain, with the stack at the centre. Concentrations have been predicted over this area using nested Cartesian grids (see Figure 6-2). These grids have a spacing of 5 m x 5 m within 200 m of the facility, 25 m x 25 m within 400 m of the facility, 50 m x 50 m within 1,000 m of the facility, 250 m x 250 m within 2,000 m of the facility and 500 m x 500 m within 9,000 m of the facility. This grid is considered to provide a sufficiently high resolution to enable the identification of worst-case impacts throughout the study area. The receptor grid has been modelled at a height of 1.5 m above ground level.

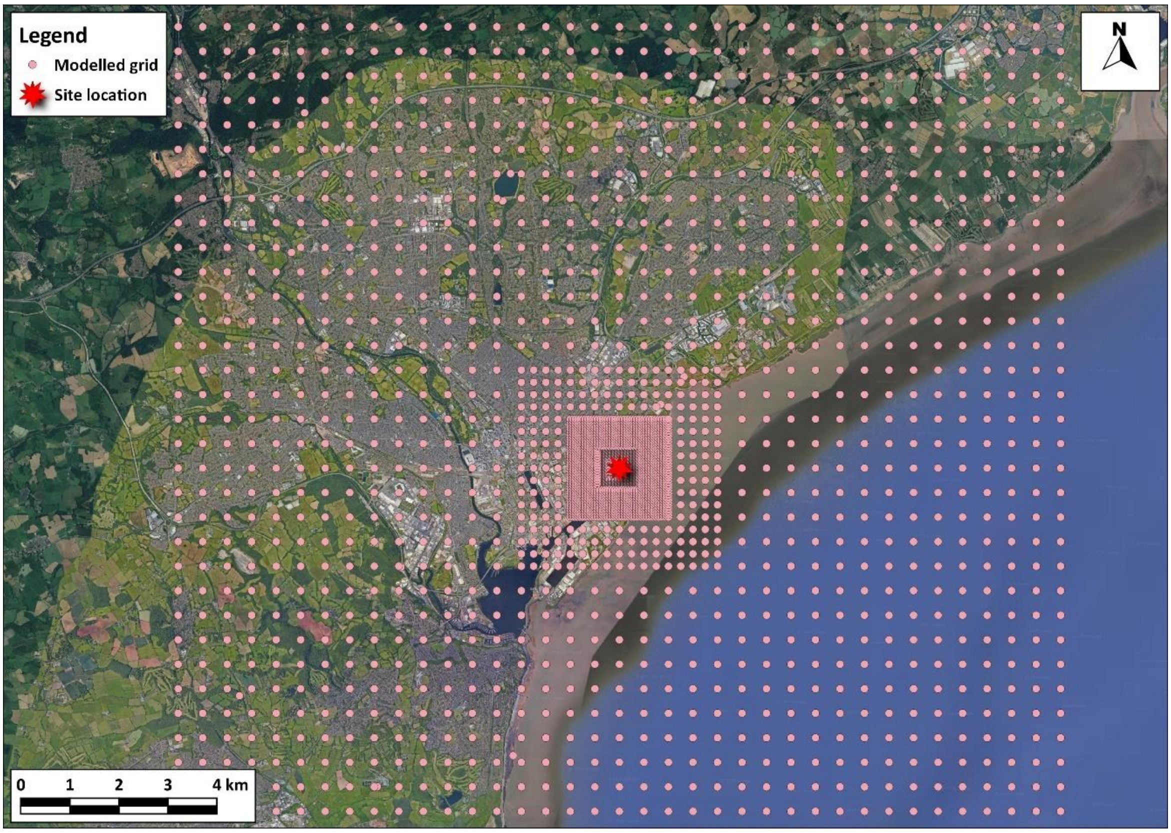

Figure 6-2: Modelled Receptors (Nested Grid)

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6.13 Specific receptors have also been selected to determine impacts at locations where the assessment criteria apply. In some cases, these may have been determined based on initial results across the nested Cartesian grids. The specific receptors identified are detailed in Table 6-3 and shown in Figure 6-3.

Table 6-3: Specific Human Health Receptor Coordinates

Receptor ID	Description	X Coordinate	Y Coordinate	Receptor Height (m)	Approx. Distance to Site boundary (m)
R1	Residential Property on Balloon Estate	321861	176754	1.5	1,094
R2	Residential Property on Moorland Road	320585	176159	1.5	450
R3	Moorland Primary School	320525	176220	1.0	532
R4	Residential Property on Willows Avenue	320894	176519	1.5	517

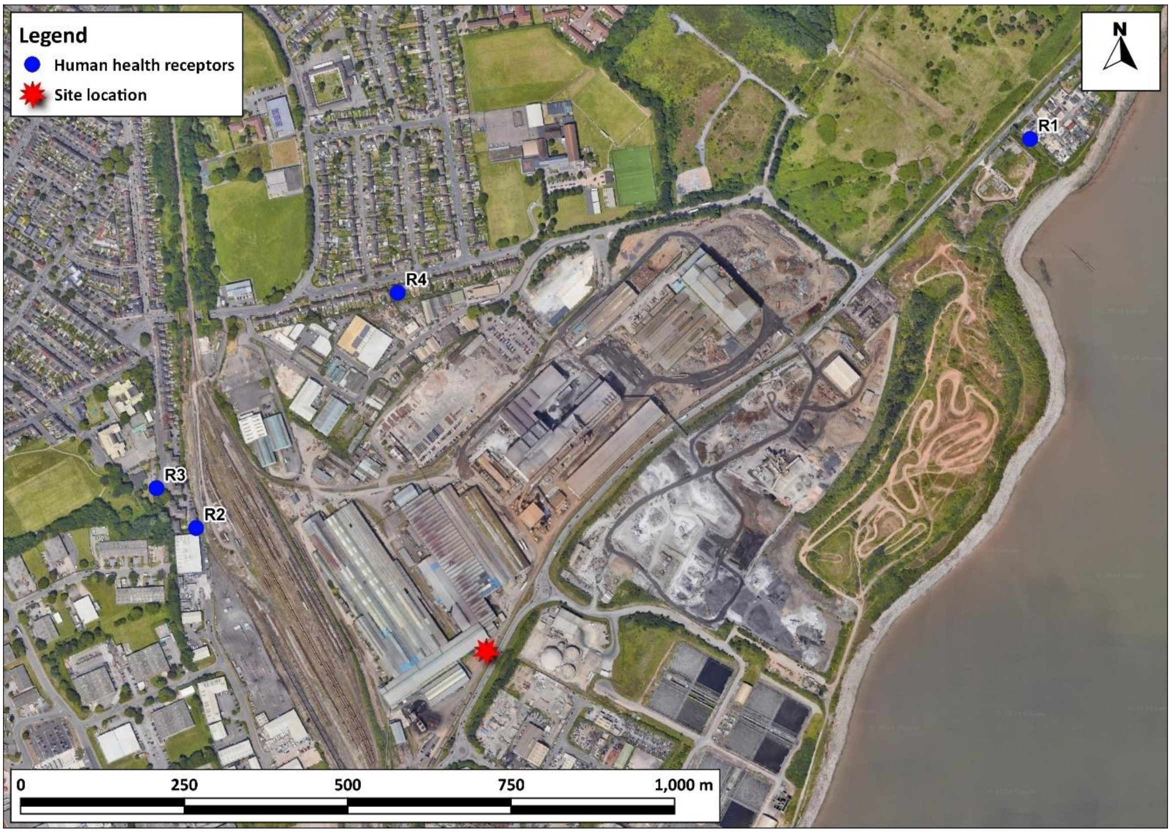

Figure 6-3: Modelled Receptors (Human Health)

Imagery ©2024 Airbus, Bluesky, Infoterra Ltd & COWI A/S, Maxar Technologies.

6.14 In addition, specific receptors have been modelled at the boundaries of the designated ecological sites closest to the facility. Receptors have been modelled at 1.5 m above ground level to be consistent with Defra's national modelling of ecosystem impacts. The grid references for these specific locations are presented in Table 6-4, and their locations are shown in Figure 6-4.

Table 6-4: Specific Ecological Receptor Coordinates

Receptor ID	Designated Ecological Site	X Coordinate	Y Coordinate
E1	Severn Estuary (SAC, SPA, Ramsar, SSSI)	320906	175502
E2	Severn Estuary (SAC, SPA, Ramsar, SSSI)	321571	175854
E3	Severn Estuary (SAC, SPA, Ramsar, SSSI)	321605	175972
E4	Severn Estuary (SAC, SPA, Ramsar, SSSI)	321840	176568
E5	Severn Estuary (SAC, SPA, Ramsar, SSSI)	321998	176938
E6	Severn Estuary (SAC, SPA, Ramsar, SSSI)	321870	177268

E7	Cardiff Beech Woods (SAC, SSSI)	314608	183216
E8	Cardiff Beech Woods (SSSI)	315276	182480
E9	Glamorgan Canal / Long Wood (SSSI)	314340	180369
E10	Llanishen and Lisvane Reservoir Embankments (SSSI)	318648	181419
E11	Lisvane Reservoir / Llanishen and Lisvane Reservoir Embankments (SSSI)	318808	181979
E12	Gwent Levels - Rumney and Peterstone (SSSI)	322348	177835
E13	Cwm Cydfin, Leckwith (SSSI)	316574	173954
E14	Barry Woodlands (SSSI)	313280	171328
E15	Cog Moors (SSSI)	316089	169473
E16	Severn Estuary (SAC, SPA, Ramsar, SSSI)	318862	170108
E17	Ely Valley (SSSI)	311490	176682
E18	Cefn Onn (SSSI)	317540	185115
E19	Gwent Levels - Rumney and Peterstone / St Brides (SSSI)	326631	181686

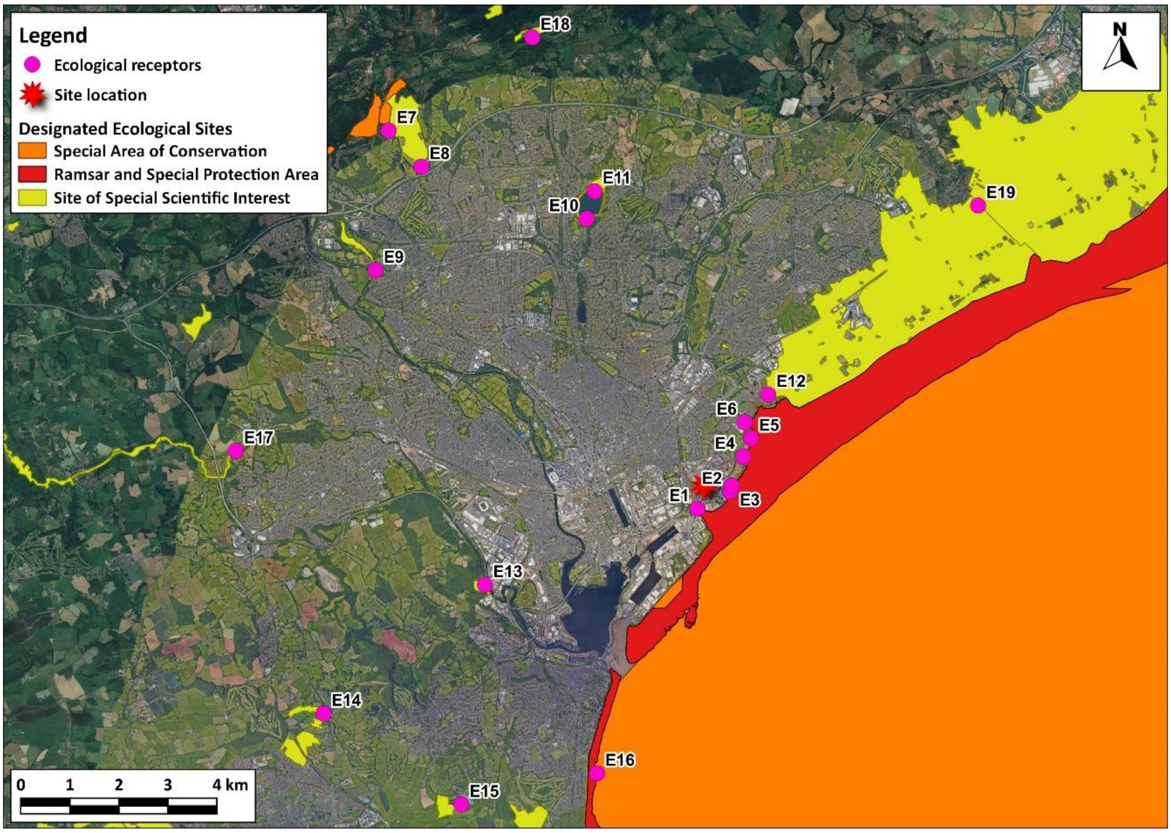

Figure 6-4: Modelled Receptors (Ecological)

Imagery ©2024 TerraMetrics.

Meteorological Data

6.15 To allow for uncertainties in local and future-year conditions, the dispersion model has been run five times, with each run using a different full year of hour-by-hour meteorological data from the nearest appropriate meteorological site. For each individual receptor point on the nested Cartesian grids, the maximum predicted concentration across any of the five meteorological datasets has then been determined. It is these maxima which are presented.

6.16 Hourly sequential meteorological data from Rhoose have been used for the years 2019-2023 inclusive. The Rhoose meteorological monitoring station is located at Cardiff Airport, approximately 17 km to the southwest of the site. It is considered to be the nearest monitoring station representative of meteorological conditions at the site. The Rhoose meteorological station is operated by the UK Meteorological Office. Raw data were provided by the Met Office, and processed by AQC for use in ADMS.

6.17 The model parameters entered into ADMS are shown in Table 6-5. Wind roses for each year are presented in Appendix A1.

Table 6-5: Model Parameters Entered into the ADMS Model

Parameter	Modelled Receptors (including Cartesian Grids)	Meteorological Site
Surface Roughness	Variable Surface Roughness File	0.2 m

Parameter	Modelled Receptors (including Cartesian Grids)	Meteorological Site
Minimum MO length	30 m	1 m
Surface Albedo	0.23[a]	0.23[a]
Priestly-Taylor Parameter	1[a]	1[a]

[a] Model default value. An analysis of the effects of surface characteristics on ground level concentrations by the UK Atmospheric Dispersion Modelling Liaison Committee (Auld et al., 2003) concluded surface energy budget parameters such as albedo and the Priestly-Taylor parameter have "*relatively little impact on model uncertainty*". Consequently, it is considered appropriate to retain the model default values which are applicable for moist ground that is not snow covered (representative of typical UK conditions).

Surface Roughness

6.18 The roughness length represents the aerodynamic effects of surface friction and is defined as the height at which the extrapolated surface layer wind profile tends to zero. This value is an important parameter used by meteorological pre-processors to interpret the vertical profile of wind speed and estimate friction velocities which are, in turn, used to define heat and momentum fluxes and, consequently, the degree of turbulent mixing in the boundary layer.

6.19 The surface roughness length is related to the height of surface elements; typically, the surface roughness length is approximately 10% of the height of the main surface features. Consequently, it follows that surface roughness is greater in urban, congested areas than in rural, open areas.

6.20 (CERC, 2023) and (Oke, 1987) suggest typical roughness lengths for various land use categories as summarised in Table 6-6.

Table 6-6: Typical Surface Roughness Lengths of Different Land Use Types

Type of Surface	Surface Roughness Length (m)
Ice	0.00001
Smooth snow	0.00005
Smooth sea / water	0.0001 - 0.0002
Lawn grass	0.01
Pasture	0.2
Isolated settlement (farms, trees, hedges)	0.4
Parkland, woodlands, villages, open suburbia	0.5-1.0
Forests/cities/industrialised areas	1.0-1.5
Heavily industrialised areas	1.5-2.0

6.21 The study area encompasses a range of land types. Consequently, a variable surface roughness file has been used to represent the spatial variation of the surface roughness over each land type as shown in Figure 6-5. The following parameters have been used to define the surface roughness length and land type:

- forest – 1 m;

- built-up area – 0.5 m;
- grassland – 0.2 m; and
- water – 0.0001 m.

6.22 The variable surface roughness file was generated for a 50 m resolution gridded area covering the model domain by assigning appropriate representative surface roughness values based on the underlying land use categories. The land use categories were derived by combining those defined in the Meridian 2 and VectorMap District datasets available from Ordnance Survey.

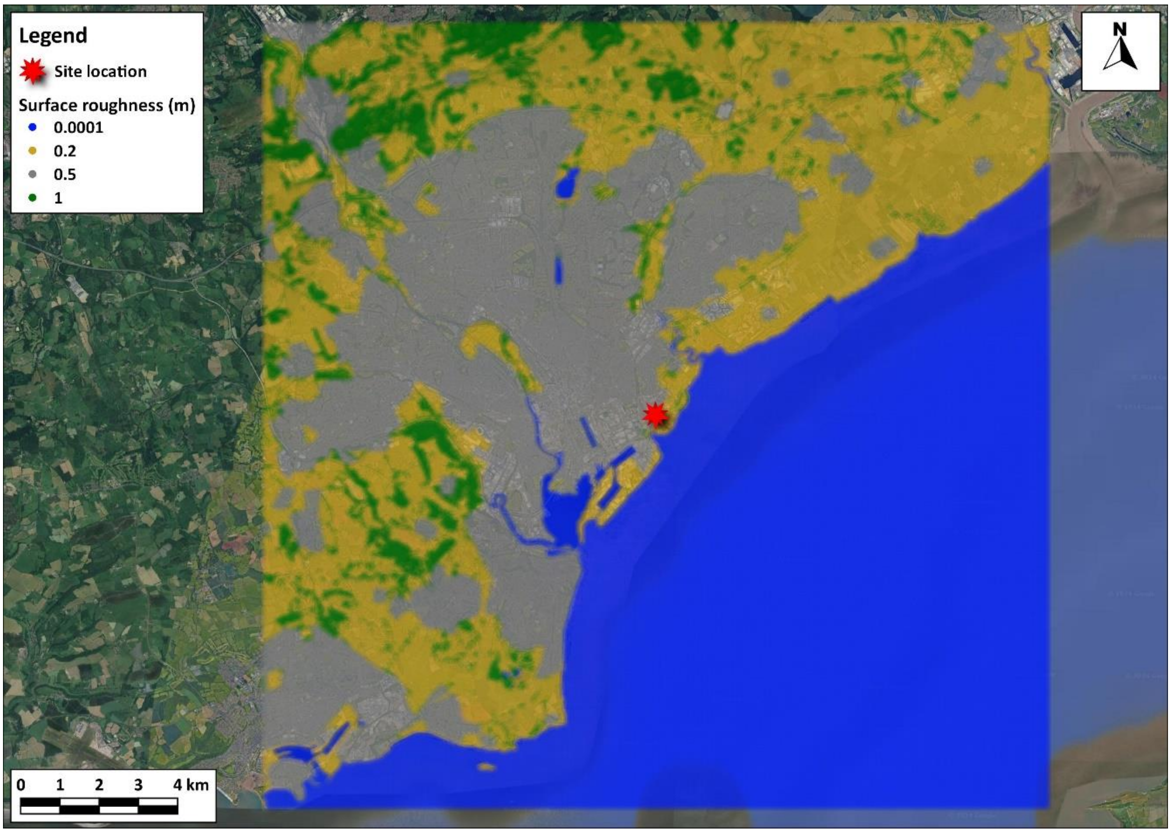

Figure 6-5: Surface Roughness across Modelled Area

Imagery ©2024 TerraMetrics.

Buildings

6.23 Atmospheric flow is disrupted by aerodynamic forces in the immediate vicinity of structures. These disruptions generate an area of stagnation behind the structure known as the cavity region. The flow within this region is highly turbulent and can be visualised as circulating eddies of air. The area beyond the cavity region is known as the building wake, where turbulence generated by the structure gradually decays to background levels. The entire area covered by the cavity region and turbulent wake is known as the 'building envelope'.

6.24 The above phenomena can cause a plume to be drawn downwards towards the ground in the building envelope, resulting in elevated ground level concentrations; this effect is known as building induced downwash. The building envelope is generally regarded as extending to a height of three times the height of the structure in the vertical plane, and a distance of 5L (where L is the lesser of the building width or height) from the foot of the building in the horizontal plane. Consequently, stacks within these extents should be identified and the corresponding building included in the dispersion model. The location of the modelled buildings relative to the stacks are shown in Figure 6-6 with their dimensions provided in Table 6-7. Building heights have been derived using 2 m DSM and DTM Lidar Data provided by the Environment Agency.

6.25 Sensitivity analysis to understand the effects of assumptions related to the treatment of buildings within the model is provided in Table 6-9.

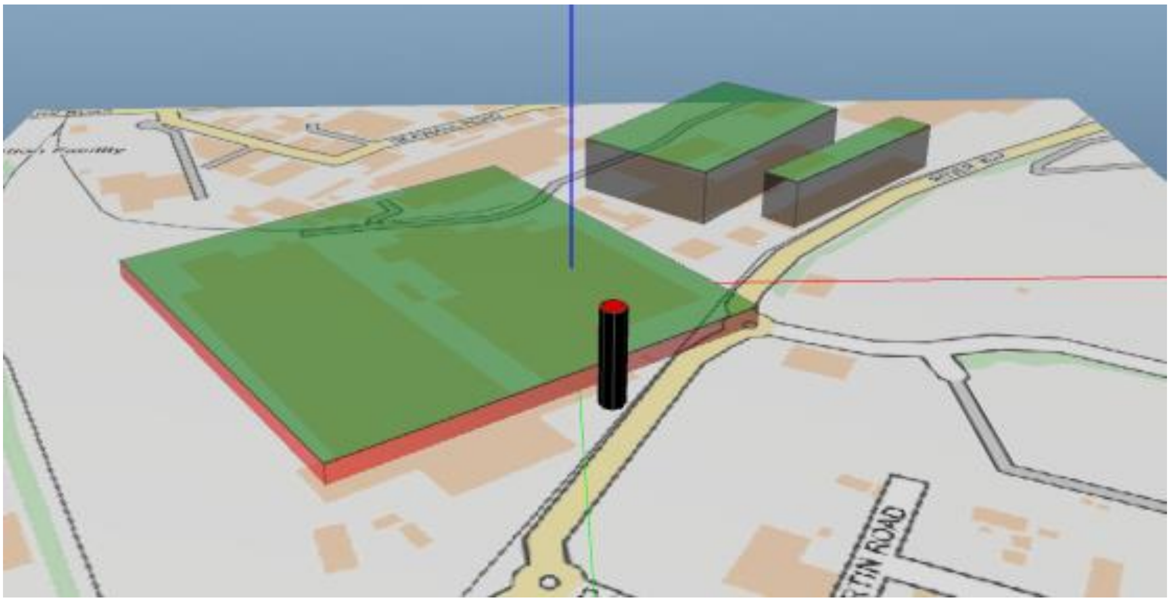

Figure 6-6: Buildings Included in the Model (Green-topped Objects) and Modelled Stack (Red-topped Cylinder)

Additional data sourced from third parties, including public sector information licensed under the Open Government Licence v3.0.

Table 6-7: Modelled Building Dimensions

Building	X (m)	Y (m)	Width (m)	Rotation (º)	Height (m)	Length / Diameter (m)	Main building?
Building 1	320920	176101	294.0	235.8	12.6	292.8	Yes
Building 2	321129	176321	108.9	221.6	40.0	183.6	No
Building 3	321226	176277	29.2	227.0	35.0	171.3	No

Terrain Effects

6.26 Figure 2-3 shows the terrain across the modelled study area using Ordnance Survey (OS) Terrain 50 data. The ADMS User Guide recommends terrain data should be included in the model set up where terrain gradients exceed 1 in 10. Terrain gradients do not exceed this criterion across the majority of the study area and, consequently, terrain data has not been included in the core model set up. However, sensitivity analysis with respect to the treatment of terrain is provided in Table 6-9.

NO_X to NO_2 conversion

6.27 NOx emissions will be in the form of nitric oxide (NO) and primary NO_2. The primary NO_2 from most combustion plant is typically in the region of 5-12% of the total NOx. Over time, the NO emissions will react with available ozone (O_3) to form NO_2. In close proximity to the source, the ratio will be similar to the primary NO_2 proportion; with increasing distance from the source the ratio will increase, depending on the availability of O_3.

6.28 The Environment Agency's "Environmental permitting: air dispersion modelling reports" guidance (EA, 2024b) states: "For combustion processes where no more than 10% of nitrogen oxides are emitted as nitrogen dioxide, you can assume worst case conversion ratios to nitrogen dioxide of 35% for short-term average concentrations and 70% for long-term average concentrations."

6.29 Given the size of the furnace and its fuel, it is likely that the primary NO_2:NOx ratio will be 10% or less; therefore, the 70% (long-term) and 35% (short-term) conversion ratios used represent a conservative approach.

Model Post-Processing

Annual Mean PCs

6.30 The model has been run assuming constant operation. Annual mean Process Contributions (PCs) have been obtained from the raw model output using this assumption.

Short-term PCs

6.31 Short-term PCs have been predicted assuming continuous operation with the model configured to produce output for the relevant averaging period and percentile based on the acceptable number of exceedances as defined by the AQS / AQO / EAL. This provides a worst-case assessment.

Deposition

6.32 Deposition has not been included within the dispersion model. Instead, deposition has been calculated from the predicted ambient concentrations using the deposition velocity set out in Table 6-8. This means that depletion effects are ignored, resulting in a worst-case assessment. Deposition velocities refer to a height above ground, typically 1 or 2 m, although in practice the precise height makes little difference and here they have been applied to concentrations predicted at a height of 1.5 m above ground, which is the average height of the monitors which underpin the Concentration Based Estimated Deposition (CBED) model which generates predictions used by UK Government. The velocities are applied simply by multiplying a concentration (µg/m^3) by the velocity (m/s) to predict a deposition flux (µg/m^2/s). Subsequent calculations required to present the data as kg/ha/yr of nitrogen as keq/ha/yr for acidity follow basic chemical and mathematical rules[3].

Table 6-8: Deposition Velocities used in this Assessment

Pollutant	Deposition Velocity (m/s)	Reference
Nitrogen Dioxide	0.0015 m/s (Grassland)	AQTAG06 (2014)
	0.003 m/s (Forest)	AQTAG06 (2014)

[3] i.e. 1 kg N/ha/yr = 0.071 keq/ha/yr

6.33 Wet deposition of emissions from the facility has been discounted. Wet deposition of the emitted pollutants this close to the emission source will be restricted to wash-out, or below cloud scavenging. For this to occur, rain droplets must come into contact with the gas molecules before they hit the ground. Falling raindrops displace the air around them, effectively pushing gasses away. The low solubility of the pollutants modelled means that any scavenging of the gases will be a negligible factor. As a result, AQTAG06 (2014) advises wet deposition of NO_2 is not significant within a short range.

Special Model Treatments

6.34 Special model treatments for e.g., short-term (puff) releases, coastal effects, fluctuations or photochemistry have not been used in this assessment.

Model Uncertainty

6.35 The point source dispersion model used in the assessment is dependent upon emission rates, flow rates, exhaust temperatures and other parameters for each source, all of which are both variable and uncertain. There are then additional uncertainties, as models are required to simplify real-world conditions into a series of algorithms. These uncertainties cannot be easily quantified and it is not possible to verify the point-source model outputs. Where these parameters have been estimated the approach has been to use reasonable worst-case assumptions.

6.36 On balance, when taking into account the assumption that emissions occur continuously throughout the year, the approach taken to meteorological conditions and the sensitivity testing for building downwash, the assessment can be expected to over-predict the impacts of the facility. The approach has been designed to provide a robust and conservative assessment.

6.37 The use of dispersion models has been widely used in the UK for both regulatory and compliance purposes for many years and is an accepted approach for this type of assessment. The model used has also undergone extensive validation.

Sensitivity Analysis

6.38 As discussed at paragraph 6.35, the point source dispersion model used in this assessment is required to simplify real-world conditions into a series of algorithms. Consequently, sensitivity analysis is an important component of any model assessment, since it helps to identify the potential magnitude of uncertainty in model predictions and the associated impacts on the conclusions of the assessment. Various sensitivity analyses have been undertaken in relation to the following inputs:

- Meteorological data
- Buildings
- Terrain
- Surface roughness

6.39 The aim of the sensitivity analysis is not necessarily to find a model setup that obtains the maximum possible prediction from the model, but to provide greater understanding of how assumptions on key input variables may affect the assessment, so that these factors can be considered when evaluating the significance of potential effects and determining the conclusions of the assessment.

6.40 Sensitivity tests have been undertaken by establishing a ‘core’ model that is considered to best represent the actual site characteristics and emission scenarios. This is the model from which the results in Section 8 are obtained. This model is then run in different configurations to quantify the impact certain model options or assumptions may have on predicted concentrations. For buildings and terrain, this is simply a case of running one version of the model with these aspects included, and a second version with them excluded. In the case of the surface roughness sensitivity, the model has been run with a variable surface roughness file and a fixed surface roughness value (0.5 m) across the model domain.

6.41 The results of the sensitivity test at the worst-case receptor location have been compared and presented as a ratio to the 'core' model. For example, a value of 0.8 indicates the maximum result from the sensitivity test is 20% smaller than the 'core' model, whilst a value of 1.2 indicates the maximum result from the sensitivity test is 20% greater than the 'core' model.

6.42 Table 6-9 presents the sensitivity tests for the annual mean, the 99.79th percentile of hourly means, the 100th and 90.40th percentiles of 24-hour means, and the 100th percentile of 8-hour rolling means at the location of maximum concentration for each run.

Table 6-9: Model Sensitivity Results

Model Sensitivity Test	Annual Mean	1-hour 99.79 %ile	24-hour 100 %ile	24-hour 90.40 %ile	8-hour Rolling Mean 100 %ile
Core model (buildings included, variable surface roughness file)	1.00	1.00	1.00	1.00	1.00
Terrain included (as per Core model but with terrain file included)	1.04	1.01	1.01	1.03	1.01
No buildings (as per Core model but buildings excluded from model set up)	1.00	0.55	0.73	1.00	0.49
Uniform surface roughness length of 0.5 m (as per Core model but with a uniform roughness length rather than a variable roughness file)	1.04	1.01	0.94	1.02	0.78

6.43 The sensitivity analysis indicates model predictions are relatively insensitive to the treatment of terrain. This is likely a consequence of the uniform nature of terrain across much of the model domain. Greater sensitivity is observed in the treatment of buildings, particularly for shorter-term averaging periods, which reflects the presence of the buildings and their associated downwash effects. Assumptions on surface roughness length have more sensitivity on the 8-hour rolling mean predictions than they do on the other averaging periods.

6.44 Table 8-5 presents normalised results (ratio of the maximum impact at any receptor for a given year to the maximum impact at any receptor from any year) from the meteorological year sensitivity test and displays the typical range in outcomes that could be expected for any given year.

Table 6-10: Meteorological Year Sensitivity Results (Core Model Scenario)

Year	Annual Mean	1-hour 99.79 %ile	24-hour 100 %ile	24-hour 90.40 %ile	8-hour Rolling Mean 100 %ile
2019	0.95	0.88	0.94	0.90	0.50
2020	0.94	0.95	1.00	0.99	1.00

2021	0.73	1.00	0.74	0.85	0.57
2022	0.82	0.83	0.76	0.97	0.52
2023	1.00	0.74	0.73	1.00	0.62

7 Assessment Approach

7.1 The Environment Agency's "*Air emissions risk assessment for your environmental permit*" guidance (EA, 2023) (previously Horizontal Guidance Note H1) provides methods for quantifying the environmental impacts of emissions to air. This compares predicted process contributions (PC) and predicted environmental concentrations (PEC, i.e., PC in addition to background) to both long and short term environmental standards. These standards include guideline EALs and statutory AQS.

7.2 Air emission risk assessments for environmental permits require a three-tiered approach to assessing the significance of emissions to atmosphere. The first stage is to 'screen out' insignificant emissions to air using the H1 screening tool; these are emissions which are emitted in such small quantities that they are unlikely to cause a significant impact on ground level concentrations. The Environment Agency's guidance suggests that emissions are insignificant where PCs are less than:

- 1% of a long-term environmental standard; or
- 10% of a short-term environmental standard

7.3 For those emissions that cannot be screened out as insignificant using the H1 software tool, the guidance indicates that further modelling of emissions may be appropriate for long term effects where the PEC is greater than 70% of the long-term environmental benchmark. For short-term effects, further modelling of emissions is required where the PC is more than 20% of the difference between twice the (long term) background concentration and the relevant short term environmental benchmark (i.e., more than 20% of the model 'headroom').

7.4 The above criteria apply to human receptors and Special Protection Areas (SPAs), Special Areas of Conservation (SACs), Sites of Special Scientific Interest (SSSIs) and Ramsar sites. For local nature sites, emissions can be screened as insignificant where the short-term and long-term PC is less than 100% of the relevant environmental benchmark with modelling required where this metric is exceeded.

7.5 In any resultant modelling assessment, the EA guidance explains no further action is required where the assessment shows that both of the following apply:

- Emissions comply with Best Available Technique Associated Emission Levels (BAT-AELs) or the equivalent requirements where there is no BAT-AEL; and
- The resulting PECs will not exceed environmental standards.

7.6 Consequently, in this modelling study, the assessment of impacts is primarily made with respect to the PEC. Where the PEC is exceeded and BAT-AELs are being met, an assessment of the significance of the installation's impact towards the exceedance is made using the H1 software tool first tier insignificance criteria and/or professional judgment taking into account other mitigating factors, e.g., the probability of exceedance. Although the insignificance criteria technically apply to PCs predicted using the H1 software tool, they are considered suitable proxies for determining the significance of an installation's modelled contribution to a PEC.

7.7 This assessment models all relevant pollutants emitted from the various emission sources, including those that may have been screened out as insignificant using the H1 software tool, to provide a more robust prediction of the installation's impact on local air quality.

8 Results

Natural Gas Fuelled

Human Health Receptors

8.1 Table 8-1 presents the maximum PCs and PECs at any receptor for the pollutants modelled in this assessment. Predicted PCs and PECs at the specific receptors identified in Figure 6-3 and Table 6-3 are set out in Table 8-2 through Table 8-4.

Table 8-1: Maximum PCs and PECs Relevant for Human Health – Natural Gas

	X Coord.	Y Coord.	PC (µg/m³)	PC (% of assessment level) [a]	PEC (µg/m³) [b]	PEC (% of assessment level)
Annual Mean NO_2 AQS (40 µg/m³)						
Max on Grid	321779	176021	**1.1**	**2.7**	21.4	53.6
Max at Relevant Receptor	321861	176754	0.2	0.6	13.5	33.8
1-hour Mean NO_2 AQS (200 µg/m³)						
Max on Grid	321204	176296	13.6	6.8	54.3	27.2
Max at Relevant Receptor	320894	176519	5.2	2.6	38.1	19.1
Annual Mean PM_{10} AQS (40 µg/m³)						
Max on Grid	321779	176021	0.1	0.2	15.6	39.1
Max at Relevant Receptor	321861	176754	0.02	0.04	13.0	32.4
24-hour Mean PM_{10} AQS (50 µg/m³)						
Max on Grid	321729	176021	0.2	0.5	31.4	62.7
Max at Relevant Receptor	321861	176754	0.06	0.11	26.0	52.0
8-hour Rolling Mean CO AQS (10,000 µg/m³)						
Max on Grid	321179	176271	5.3	0.05	422.3	4.2
Max at Relevant Receptor	320894	176519	1.5	0.02	349.5	3.5

[a] Based on unrounded numbers.

[b] After adding the relevant baseline concentrations from Table 5-3.

Table 8-2: Nitrogen Dioxide PCs and PECs at Specific Receptors – Natural Gas

Receptor ID	Annual Mean NO_2 AQS (40 µg/m³)				1-hour Mean AQS (200 µg/m³) a			
	PC		PEC b		PC		PEC b	
	µg/m³	% AQS c	µg/m³	% AQS c	µg/m³	% AQS c	µg/m³	% AQS c
R1	0.2	0.6	13.5	33.8	3.1	1.5	29.7	14.8
R2	0.1	0.3	16.6	41.5	4.4	2.2	37.3	18.6
R3	0.1	0.4	16.6	41.6	4.7	2.3	37.6	18.8
R4	0.1	0.3	16.6	41.5	5.2	2.6	38.1	19.1

a 99.79th percentile of 1-hour means
b After adding the relevant baseline concentrations from Table 5-3.
c Based on unrounded numbers

Table 8-3: PM_{10} PCs and PECs at Specific Receptors – Natural Gas

Receptor ID	Annual Mean PM_{10} AQS (40 µg/m³)				24-hour Mean AQS (50 µg/m³) a			
	PC		PEC b		PC		PEC b	
	µg/m³	% AQS c	µg/m³	% AQS c	µg/m³	% AQS c	µg/m³	% AQS c
R1	0.02	0.04	13.0	32.4	0.06	0.11	26.0	52.0
R2	0.01	0.02	14.5	36.2	0.03	0.06	28.9	57.9
R3	0.01	0.03	14.5	36.2	0.04	0.08	28.9	57.9
R4	0.01	0.02	14.5	36.2	0.04	0.08	28.9	57.9

a 90.40th percentile of 24-hour means
b After adding the relevant baseline concentrations from Table 5-3.
c Based on unrounded numbers

Table 8-4: Carbon Monoxide PCs and PECs at Specific Receptors – Natural Gas

Receptor ID	1-hour Rolling Mean CO AQS (10,000 µg/m³)			
	PC		PEC b	
	µg/m³	% AQS c	µg/m³	% AQS c
R1	1.0	0.01	303.0	3.0
R2	1.3	0.01	349.3	3.5
R3	1.4	0.01	349.4	3.5
R4	1.5	0.02	349.5	3.5

a 100th percentile of 8-hour rolling means
b After adding the relevant baseline concentrations from Table 5-3.
c Based on unrounded numbers

8.2 Figure 8-1 presents the isopleth of the modelled process contributions for NO_2. The isopleths depict the area where the long-term PC is greater than 1% the assessment criterion. The isopleth also shows the locations where the maximum PCs are predicted at any location on the modelled grid and at any location with relevant exposure.

Figure 8-1: Contour Plot of Annual Mean NO_2 PC and Locations of Maxima on Entire Grid and at a Relevant Receptor – Natural Gas

Imagery ©2024 Airbus, Bluesky, Infoterra Ltd & COWI A/S, Maxar Technologies.

Designated Ecological Sites

8.3 Table 8-5 presents the maximum PCs and PECs at the designated ecological sites.

Table 8-5: Maximum PCs at Designated Ecological Sites– Natural Gas

Pollutant and Averaging period		X Coord.	Y Coord.	PC	PC (% of CLe / CLo [b]	PEC [a]	PEC (% of CLe / CLo) [b]	CLe / CLo
Severn Estuary SAC, SPA, Ramsar and SSSI								
NOx (µg/m³)	Annual Mean	321605	175972	1.38	**4.61**	17.0	56.7	30
	24-hour	320906	175502	11.8	**15.8**	43.1	57.4	75
Nutrient Nitrogen (kg-N/ha/yr)	Annual Mean	321605	175972	0.14	**1.40**	0.14	1.40	10
Acid Nitrogen (keq/ha/yr)		Annual Mean				n/a		
Cardiff Beech Woods SAC and SSSI								

NOx (µg/m³)	Annual Mean	315276	182480	0.03	0.10	10.7	35.7	30
	24-hour	315276	182480	0.68	0.91	22.1	29.4	75
Nutrient Nitrogen (kg-N/ha/yr)	Annual Mean	315276	182480	0.01	0.06	23.2	232.3	10
Acid Nitrogen (keq/ha/yr)	Annual Mean	315276	182480	0.0004	0.03	1.90	133.1	1.428
Glamorgan Canal / Long Wood SSSI								
NOx (µg/m³)	Annual Mean	314340	180369	0.04	0.13	14.4	48.0	30
	24-hour	314340	180369	0.76	1.01	29.5	39.3	75
Nutrient Nitrogen (kg-N/ha/yr)	Annual Mean	314340	180369	0.01	0.08	22.9	229.0	10
Acid Nitrogen (keq/ha/yr)	Annual Mean	314340	180369	0.0006	0.03	1.90	96.8	1.964
Lisvane Reservoir / Llanishen and Lisvane Reservoir Embankments SSSI								
NOx (µg/m³)	Annual Mean	318648	181419	0.04	0.14	15.3	50.8	30
	24-hour	318808	181979	0.59	0.79	31.0	41.4	75
Nutrient Nitrogen (kg-N/ha/yr)	Annual Mean	n/a						
Acid Nitrogen (keq/ha/yr)	Annual Mean	n/a						
Gwent Levels - Rumney and Peterstone / St Brides SSSI								
NOx (µg/m³)	Annual Mean	322348	177835	0.18	0.61	13.5	45.0	30
	24-hour	322348	177835	2.34	3.11	28.9	38.6	75
Nutrient Nitrogen (kg-N/ha/yr)	Annual Mean	n/a						

Acid Nitrogen (keq/ha/yr)	Annual Mean	n/a						
Cwm Cydfin, Leckwith SSSI								
NOx (µg/m³)	Annual Mean	316574	173954	0.11	0.38	14.7	48.9	30
	24-hour	316574	173954	1.04	1.38	30.2	40.2	75
Nutrient Nitrogen (kg-N/ha/yr)	Annual Mean	316574	173954	0.02	0.23	21.5	214.8	10
Acid Nitrogen (keq/ha/yr)	Annual Mean	316574	173954	0.002	0.09	1.74	99.9	1.744
Barry Woodlands SSSI								
NOx (µg/m³)	Annual Mean	313280	171328	0.06	0.19	9.61	32.0	30
	24-hour	313280	171328	0.63	0.84	19.7	26.3	75
Nutrient Nitrogen (kg-N/ha/yr)	Annual Mean	313280	171328	0.01	0.11	20.5	205.4	10
Acid Nitrogen (keq/ha/yr)	Annual Mean	313280	171328	0.001	0.01	1.62	14.6	11.113
Cog Moors SSSI								
NOx (µg/m³)	Annual Mean	316089	169473	0.05	0.17	10.8	35.9	30
	24-hour	316089	169473	0.88	1.17	22.3	29.7	75
Nutrient Nitrogen (kg-N/ha/yr)	Annual Mean	316089	169473	0.01	0.05	10.5	105.0	10
Acid Nitrogen (keq/ha/yr)	Annual Mean	n/a						
Ely Valley SSSI								

NOx (µg/m³)	Annual Mean	311490	176682	0.04	0.14	12.3	40.8	30
	24-hour	311490	176682	0.85	1.13	25.3	33.7	75
Nutrient Nitrogen (kg-N/ha/yr)		Annual Mean			n/a			
Acid Nitrogen (keq/ha/yr)	Annual Mean	n/a						
Cefn Onn SSSI								
NOx (µg/m³)	Annual Mean	317540	185115	0.03	0.09	10.14	33.79	30
	24-hour	317540	185115	0.50	0.67	20.72	27.63	75
Nutrient Nitrogen (kg-N/ha/yr)	Annual Mean	317540	185115	0.0027	0.03	13.21	132.13	10
Acid Nitrogen (keq/ha/yr)	Annual Mean	317540	185115	0.0002	0.004	1.11	22.86	4.856

[a] After adding the relevant baseline values from Table 5-4.
[b] Based on unrounded numbers.

8.4 Figure 8-2 through Figure 8-4 present isopleths of the modelled process contributions for annual mean and 24-hour mean NOx and nutrient nitrogen deposition[4]. The isopleths depict the area where the long-term PCs are greater than 1% of the respective assessment criteria and the short-term PCs are greater than 10%.

[4] No exceedances of 1% of the PC for acid deposition have been predicted, therefore isopleths are not presented for this pollutant.

Figure 8-2: Contour Plot of Annual Mean NOx PC – Natural Gas

Imagery ©2024 Airbus, Bluesky, Infoterra Ltd & COWI A/S, Landsat / Copernicus, Maxar Technologies.

Figure 8-3: Contour Plot of 24-hour Mean NOx PC – Natural Gas

Imagery ©2024 Airbus, Bluesky, Infoterra Ltd & COWI A/S, Maxar Technologies.

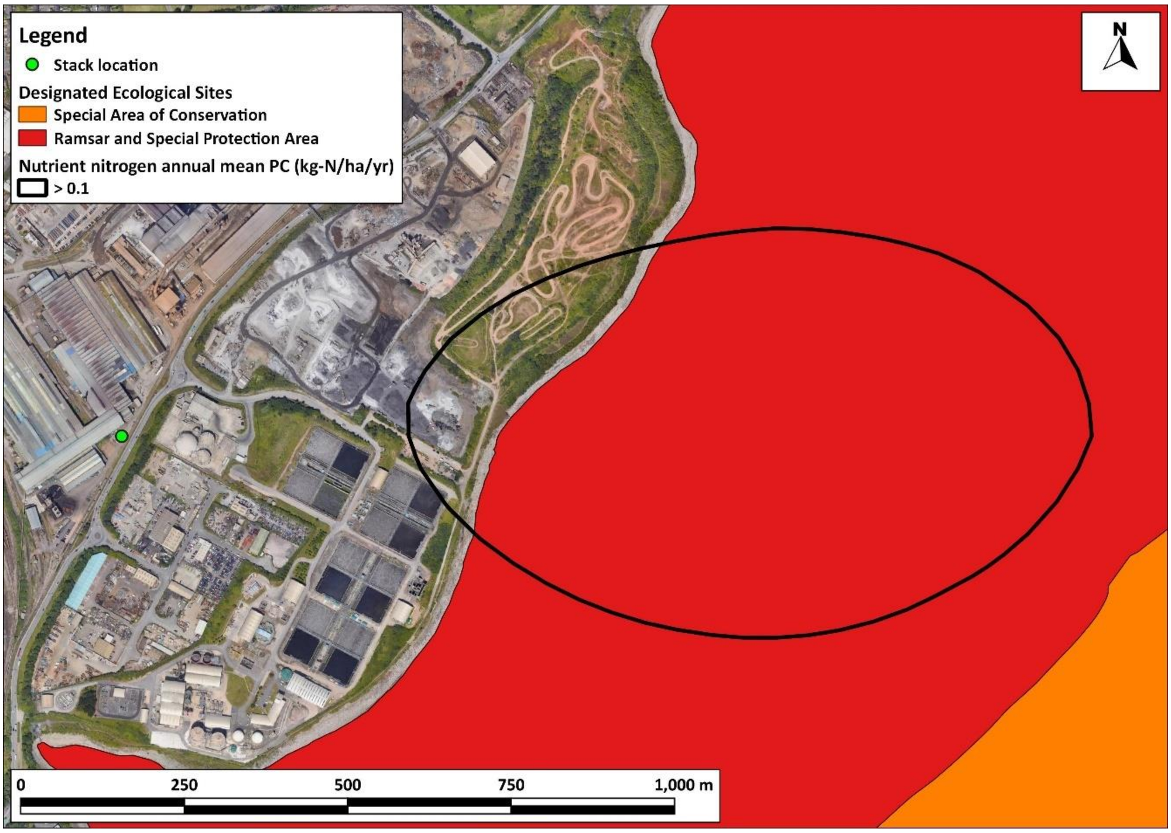

Figure 8-4: Contour Plot of Annual Mean Nutrient Nitrogen Deposition PC– Natural Gas

Imagery ©2024 Airbus, Bluesky, Infoterra Ltd & COWI A/S, Maxar Technologies.

Hydrogen Fuelled

Human Health Receptors

8.5 Table 8-6 presents the maximum PCs and PECs at any receptor for the pollutants modelled in this assessment. Predicted PCs and PECs at the specific receptors identified in Figure 6-3 and Table 6-3 are set out in Table 8-6 through Table 8-8.

Table 8-6: Maximum PCs and PECs Relevant for Human Health - Hydrogen

	X Coord.	Y Coord.	PC (µg/m³)	PC (% of assessment level) [a]	PEC (µg/m³) [b]	PEC (% of assessment level)
Annual Mean NO_2 AQS (40 µg/m³)						
Max on Grid	321779	176021	1.5	**3.8**	21.9	54.7
Max at Relevant Receptor	321861	176754	0.3	0.9	13.6	34.1
1-hour Mean NO_2 AQS (200 µg/m³)						
Max on Grid	321204	176296	19.3	9.7	60.0	30.0

	X Coord.	Y Coord.	PC (µg/m³)	PC (% of assessment level) [a]	PEC (µg/m³) [b]	PEC (% of assessment level)
Max at Relevant Receptor	320894	176519	7.4	3.7	40.3	20.2
Annual Mean PM_{10} AQS (40 µg/m³)						
Max on Grid	321779	176021	0.1	0.2	15.6	39.1
Max at Relevant Receptor	321861	176754	0.02	0.04	13.0	32.4
24-hour Mean PM_{10} AQS (50 µg/m³)						
Max on Grid	321729	176021	0.2	0.4	31.3	62.7
Max at Relevant Receptor	321861	176754	0.05	0.11	26.0	52.0

a Based on unrounded numbers.
b After adding the relevant baseline concentrations from Table 5-3.

Table 8-7: Nitrogen Dioxide PCs and PECs at Specific Receptors - Hydrogen

Receptor ID	Annual Mean NO_2 AQS (40 µg/m³)				1-hour Mean AQS (200 µg/m³) [a]			
	PC		PEC [b]		PC		PEC [b]	
	µg/m³	% AQS [c]	µg/m³	% AQS [c]	µg/m³	% AQS [c]	µg/m³	% AQS [c]
R1	0.3	0.9	13.6	34.1	4.4	2.2	31.0	15.5
R2	0.2	0.4	16.6	41.6	6.0	3.0	39.0	19.5
R3	0.2	0.5	16.7	41.7	6.7	3.3	39.6	19.8
R4	0.2	0.4	16.6	41.6	7.4	3.7	40.3	20.2

a 99.79th percentile of 1-hour means
b After adding the relevant baseline concentrations from Table 5-3.
c Based on unrounded numbers

Table 8-8: PM_{10} PCs and PECs at Specific Receptors - Hydrogen

Receptor ID	Annual Mean PM_{10} AQS (40 µg/m³)				24-hour Mean AQS (50 µg/m³) [a]			
	PC		PEC [b]		PC		PEC [b]	
	µg/m³	% AQS [c]	µg/m³	% AQS [c]	µg/m³	% AQS [c]	µg/m³	% AQS [c]
R1	0.02	0.04	13.0	32.4	0.05	0.11	26.0	52.0
R2	0.01	0.02	14.5	36.2	0.03	0.05	28.9	57.9
R3	0.01	0.03	14.5	36.2	0.04	0.07	28.9	57.9
R4	0.01	0.02	14.5	36.2	0.04	0.08	28.9	57.9

a 90.40th percentile of 24-hour means
b After adding the relevant baseline concentrations from Table 5-3.
c Based on unrounded numbers

8.6 Figure 8-1 presents the isopleth of the modelled process contributions for NO_2. The isopleth depicts the area where the long-term PC is greater than 1% of the assessment criterion. The isopleths also show the locations where the maximum PCs are predicted at any location on the modelled grid and the location of maximum PCs at any location with relevant exposure.

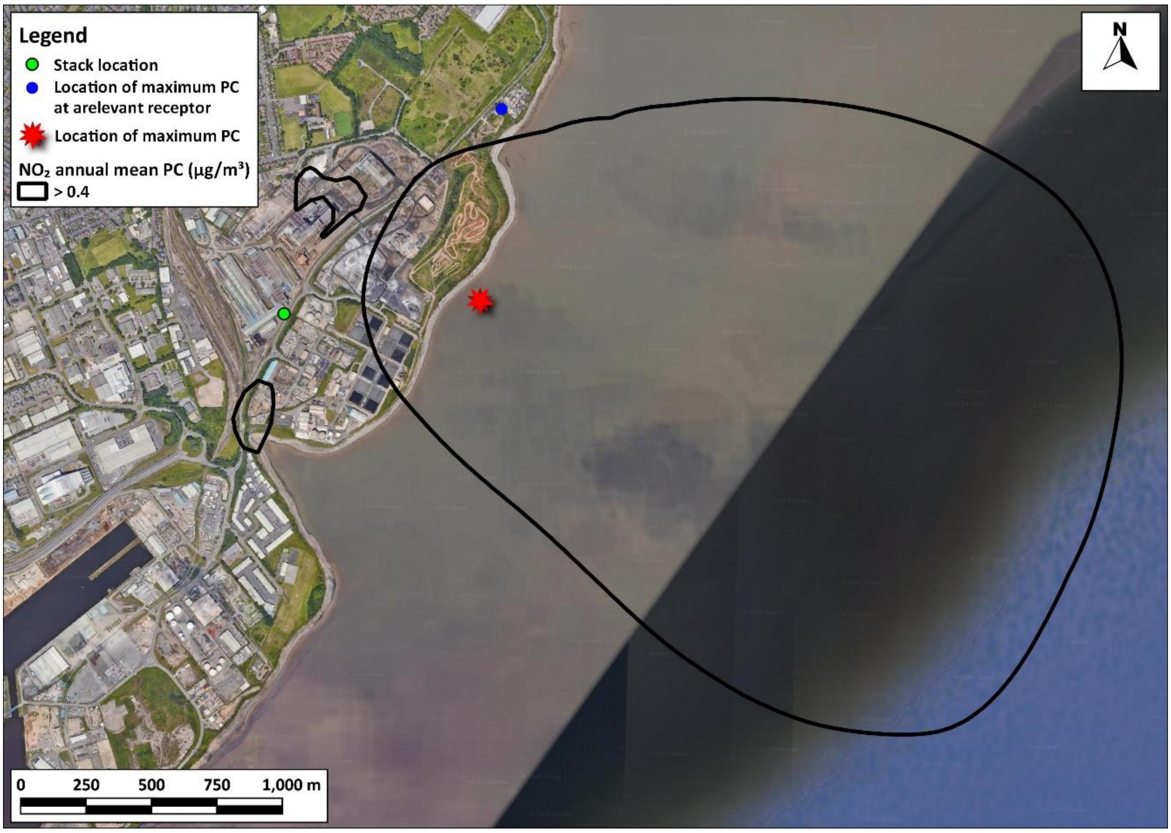

Figure 8-5: Contour Plot of Annual Mean NO_2 PC and Locations of Maxima on Entire Grid and at a Relevant Receptor - Hydrogen

Imagery ©2024 Airbus, Bluesky, Infoterra Ltd & COWI A/S, Maxar Technologies.

Designated Ecological Sites

8.7 Table 8-9 presents the maximum PCs and PECs at the designated ecological sites.

Table 8-9: Maximum PCs at Designated Ecological Sites - Hydrogen

Pollutant and Averaging period		X Coord.	Y Coord.	PC	PC (% of CLe / CLo [b]	PEC [a]	PEC (% of CLe / CLo) [b]	CLe / CLo
Severn Estuary SAC, SPA, Ramsar and SSSI								
NOx (µg/m³)	Annual Mean	321605	175972	1.93	**6.45**	17.6	58.5	30
	24-hour	320906	175502	17.0	**22.6**	48.2	64.3	75
Nutrient Nitrogen (kg-N/ha/yr)	Annual Mean	321605	175972	0.19	**1.95**	0.19	1.95	10

Pollutant and Averaging period		X Coord.	Y Coord.	PC	PC (% of CLe / CLo [b]	PEC [a]	PEC (% of CLe / CLo) [b]	CLe / CLo
Acid Nitrogen (keq/ha/yr)	Annual Mean	n/a						
Cardiff Beech Woods SAC and SSSI								
NOx (µg/m³)	Annual Mean	315276	182480	0.04	0.15	10.7	35.8	30
	24-hour	315276	182480	0.99	1.32	22.4	29.8	75
Nutrient Nitrogen (kg-N/ha/yr)	Annual Mean	315276	182480	0.01	0.09	23.2	232.3	10
Acid Nitrogen (keq/ha/yr)	Annual Mean	315276	182480	0.0006	0.04	1.90	133.1	1.428
Glamorgan Canal / Long Wood SSSI								
NOx (µg/m³)	Annual Mean	314340	180369	0.06	0.19	14.4	48.1	30
	24-hour	314340	180369	1.10	1.47	29.8	39.8	75
Nutrient Nitrogen (kg-N/ha/yr)	Annual Mean	314340	180369	0.01	0.12	22.9	229.0	10
Acid Nitrogen (keq/ha/yr)	Annual Mean	314340	180369	0.0008	0.04	1.90	96.8	1.964
Lisvane Reservoir / Llanishen and Lisvane Reservoir Embankments SSSI								
NOx (µg/m³)	Annual Mean	318648	181419	0.06	0.20	15.3	50.9	30
	24-hour	318808	181979	0.85	1.13	31.3	41.7	75
Nutrient Nitrogen (kg-N/ha/yr)	Annual Mean	n/a						
Acid Nitrogen (keq/ha/yr)	Annual Mean	n/a						
Gwent Levels - Rumney and Peterstone / St Brides SSSI								
NOx (µg/m³)	Annual Mean	322348	177835	0.26	0.88	13.6	45.2	30
	24-hour	322348	177835	3.33	4.44	29.9	39.9	75
Nutrient Nitrogen (kg-N/ha/yr)	Annual Mean	n/a						
Acid Nitrogen (keq/ha/yr)	Annual Mean	n/a						
Cwm Cydfin, Leckwith SSSI								
NOx (µg/m³)	Annual Mean	316574	173954	0.16	0.54	14.7	49.1	30

Pollutant and Averaging period		X Coord.	Y Coord.	PC	PC (% of CLe / CLo [b]	PEC [a]	PEC (% of CLe / CLo) [b]	CLe / CLo
	24-hour	316574	173954	1.51	2.01	30.6	40.8	75
Nutrient Nitrogen (kg-N/ha/yr)	Annual Mean	316574	173954	0.03	0.33	21.5	214.9	10
Acid Nitrogen (keq/ha/yr)	Annual Mean	316574	173954	0.002	0.13	1.74	99.9	1.744
Barry Woodlands SSSI								
NOx (µg/m³)	Annual Mean	313280	171328	0.08	0.27	9.63	32.1	30
	24-hour	313280	171328	0.91	1.21	20.0	26.7	75
Nutrient Nitrogen (kg-N/ha/yr)	Annual Mean	313280	171328	0.02	0.17	20.6	205.5	10
Acid Nitrogen (keq/ha/yr)	Annual Mean	313280	171328	0.001	0.01	1.62	14.6	11.113
Cog Moors SSSI								
NOx (µg/m³)	Annual Mean	316089	169473	0.07	0.24	10.8	35.9	30
	24-hour	316089	169473	1.26	1.68	22.7	30.2	75
Nutrient Nitrogen (kg-N/ha/yr)	Annual Mean	316089	169473	0.01	0.07	10.5	105.0	10
Acid Nitrogen (keq/ha/yr)	Annual Mean	n/a						
Ely Valley SSSI								
NOx (µg/m³)	Annual Mean	311490	176682	0.06	0.20	12.3	40.9	30
	24-hour	311490	176682	1.24	1.65	25.7	34.2	75
Nutrient Nitrogen (kg-N/ha/yr)	Annual Mean	n/a						
Acid Nitrogen (keq/ha/yr)	Annual Mean	n/a						
Cefn Onn SSSI								
NOx (µg/m³)	Annual Mean	317540	185115	0.04	0.13	10.15	33.83	30
	24-hour	317540	185115	0.73	0.97	20.95	27.93	75
Nutrient Nitrogen (kg-N/ha/yr)	Annual Mean	317540	185115	0.004	0.04	13.21	132.14	10
Acid Nitrogen (keq/ha/yr)	Annual Mean	317540	185115	0.0003	0.006	1.11	22.86	4.856

[a] After adding the relevant baseline values from Table 5-4.

[b] Based on unrounded numbers.

8.8 Figure 8-6 through Figure 8-8 present isopleths of the modelled process contributions for annual mean and 24-hour NOx and nutrient nitrogen deposition[5]. The isopleths depict the area where the long-term PCs are greater than 1% of the respective assessment criteria and the short-term PCs are greater than 10%.

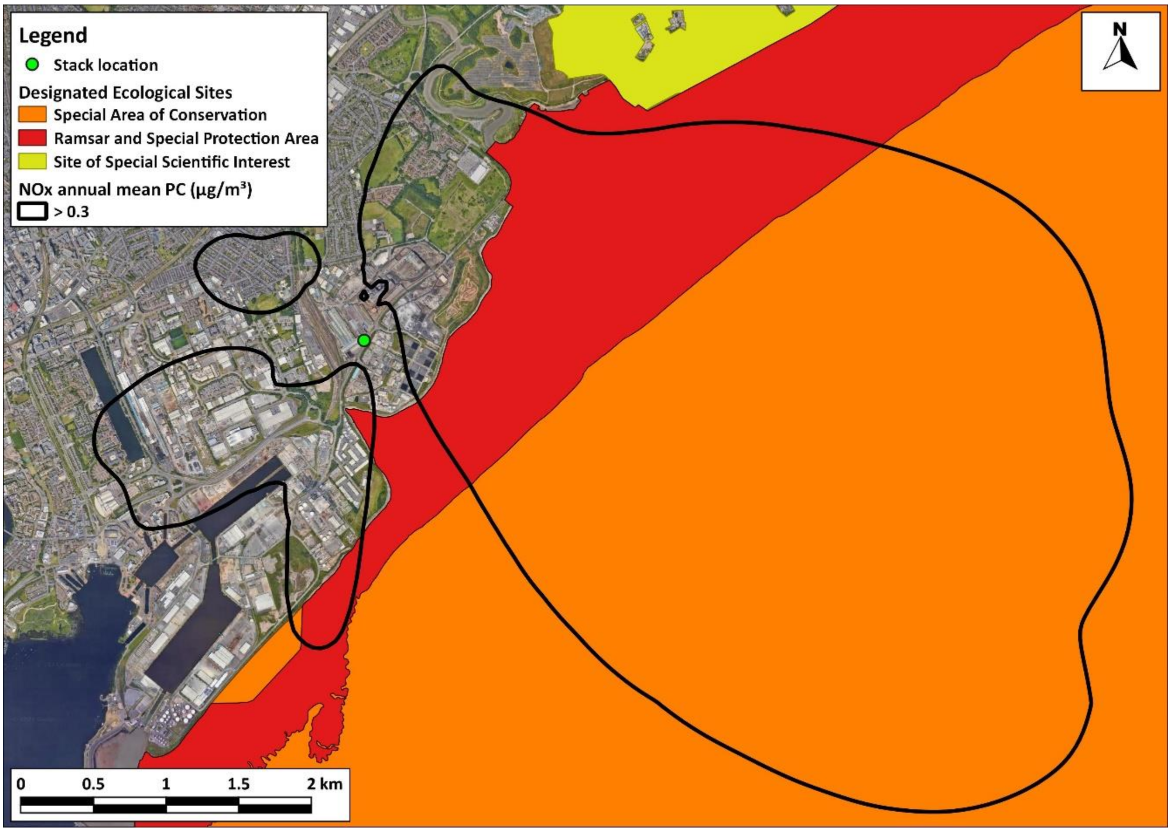

Figure 8-6: Contour Plot of Annual Mean NOx PC - Hydrogen

Imagery ©2024 Airbus, Bluesky, Infoterra Ltd & COWI A/S, Landsat / Copernicus, Maxar Technologies.

[5] No exceedances of 1% of the PC for acid deposition have been predicted, therefore isopleths are not presented for this pollutant.

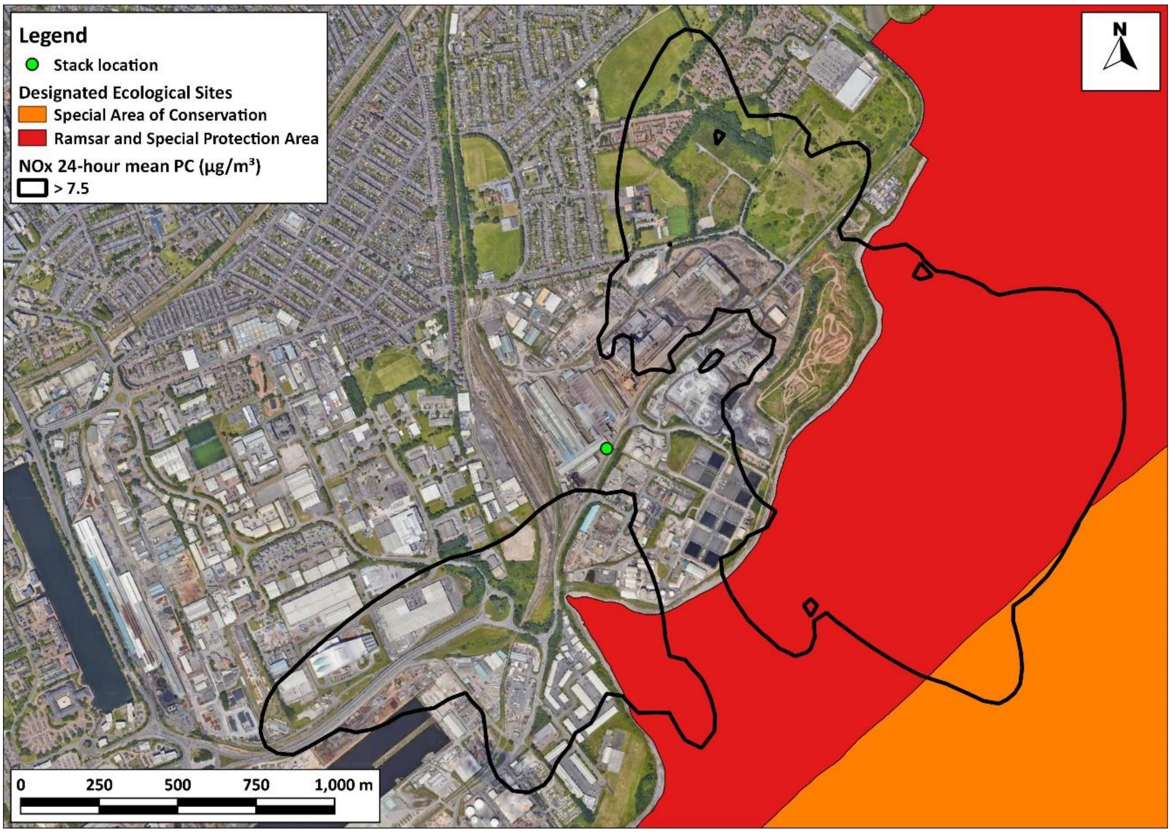

Figure 8-7: Contour Plot of 24-hour Mean NOx PC - Hydrogen

Imagery ©2024 Airbus, Bluesky, Infoterra Ltd & COWI A/S, Maxar Technologies.

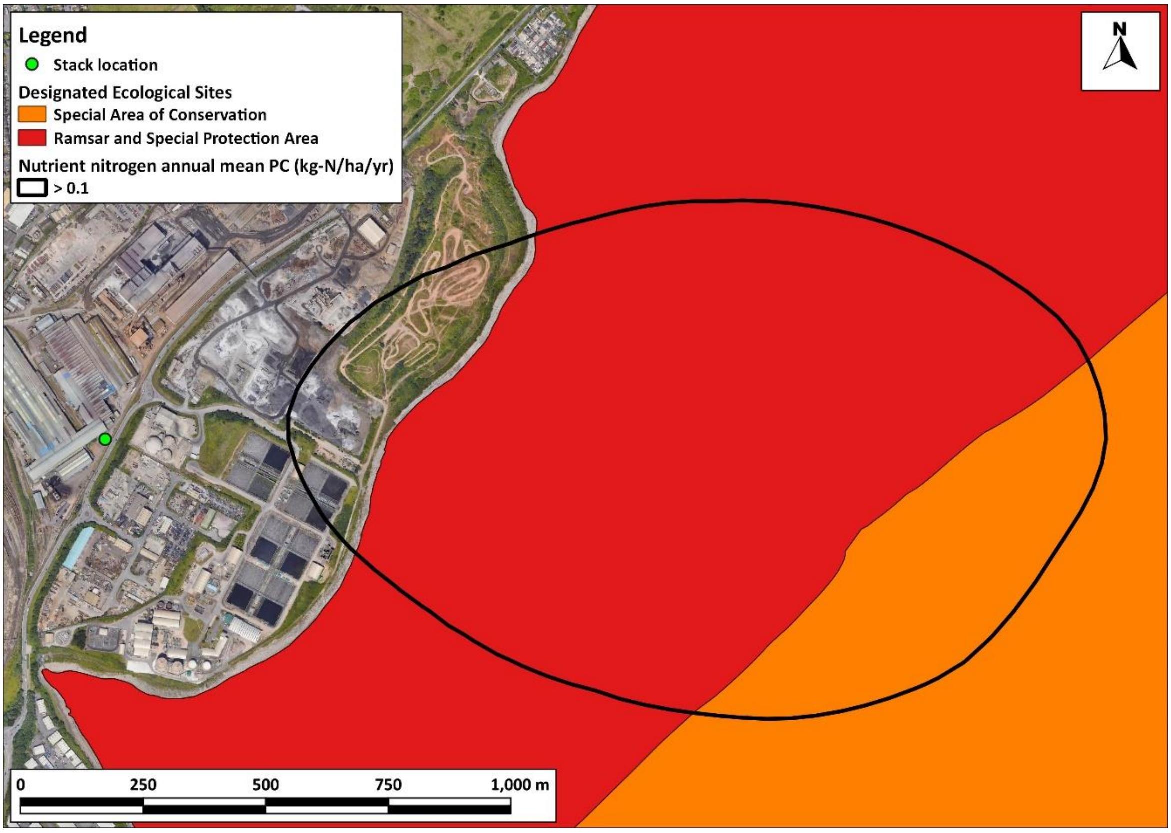

Figure 8-8: Contour Plot of Annual Mean Nutrient Nitrogen Deposition PC- Hydrogen

Imagery ©2024 Airbus, Bluesky, Infoterra Ltd & COWI A/S, Maxar Technologies.

9 Discussion

9.1 The modelling approach was agreed with Natural Resources Wales in advance of the study.

Natural Gas Fuelled

Human Health Receptors

9.2 Table 8-1 demonstrates that the maximum PECs of all pollutants are less than the respective assessment levels. This is the case even at the point of maximum impact anywhere across the modelled grid. Accounting for the worst-case assumptions adopted within this assessment, there is a negligible risk that emissions from the installation will cause an exceedance of any assessment level and, consequently, impacts are assessed as not significant.

Designated Ecological Sites

9.3 Table 8-5 demonstrates that nutrient nitrogen deposition exceeds the critical load at Cardiff Beech Woods SAC and SSSI, Glamorgan Canal / Long Wood SSSI, Cwm Cydfin SSSI, Barry Woodlands SSSI, Cog Moors SSSI and Cefn Onn SSSI. In addition, acid nitrogen deposition exceeds the critical load at Cardiff Beech Woods SAC and SSSI. PECs at all other locations and of all other pollutants are less than the respective assessment levels. At all locations where the PEC is exceeded, the PC remains below 1% of the AQS and is, therefore, considered insignificant. Accounting for the worst-case assumptions adopted within this assessment, impacts are assessed as not significant.

Hydrogen Fuelled

Human Health Receptors

9.4 Table 8-6 demonstrates that the maximum PECs of all pollutants are less than the respective assessment levels. This is the case even at the point of maximum impact anywhere across the modelled grid. Accounting for the worst-case assumptions adopted within this assessment, there is a negligible risk that emissions from the installation will cause an exceedance of any assessment level and, consequently, impacts are assessed as not significant.

Designated Ecological Sites

9.5 Table 8-9 demonstrates that nutrient nitrogen deposition exceeds the critical load at Cardiff Beech Woods SAC and SSSI, Glamorgan Canal / Long Wood SSSI, Cwm Cydfin SSSI, Barry Woodlands SSSI, Cog Moors SSSI and Cefn Onn SSSI. In addition, acid nitrogen deposition exceeds the critical load at Cardiff Beech Woods SAC and SSSI. PECs at all other locations and of all other pollutants are less than the respective assessment levels. At all locations where the PEC is exceeded, the PC remains below 1% of the AQS and is, therefore, considered insignificant. Accounting for the worst-case assumptions adopted within this assessment, impacts are assessed as not significant.

10 Conclusions

10.1 The assessment uses dispersion modelling to predict the impacts on local air quality associated with emissions to air from the new furnace at the Celsa Manufacturing Site, located on Rover Way, Cardiff. The new furnace will move from operating on natural gas through to 100% hydrogen over time; emissions from both a 100% natural gas fuelled furnace and a 100% hydrogen fuelled furnace have been assessed.

10.2 For human health receptors, modelled PECs of all pollutants are less than the respective assessment levels at all locations where there is relevant exposure, in both emissions scenarios.

10.3 For designated ecological sites, although modelled PECs exceed the critical loads at some locations, the corresponding PCs remain below 1% of the AQS in both emissions scenarios and are, therefore, considered insignificant.

10.4 The assessment includes a number of conservative assumptions. It also uses sensitivity analysis to investigate the sensitivity of the model to certain assumptions and model treatments. These conservative assumptions include:

- the assessment of impacts assumes continuous operation of the installation throughout the year at its maximum capacity;
- NOx emissions have been modelled at the respective emission limit values whilst, in actual operation, they are expected to be less than the emission limit values;
- the results presented are the maxima from modelling with five separate years of meteorological data;
- the results presented are the maxima from modelling both with and without including surrounding buildings within the dispersion model;
- depletion has not been included in the model. This will cause a tendency for impacts to be over-predicted; and
- a conservative approach has been taken to calculating NO_2 concentrations from modelled NOx concentrations.

10.5 It is, therefore, concluded that the air quality impacts of the proposed installation will be not significant.

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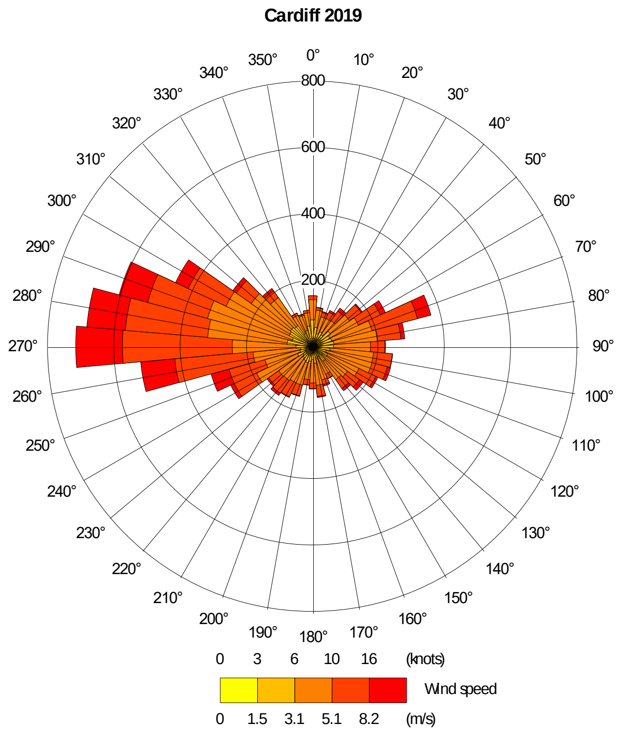
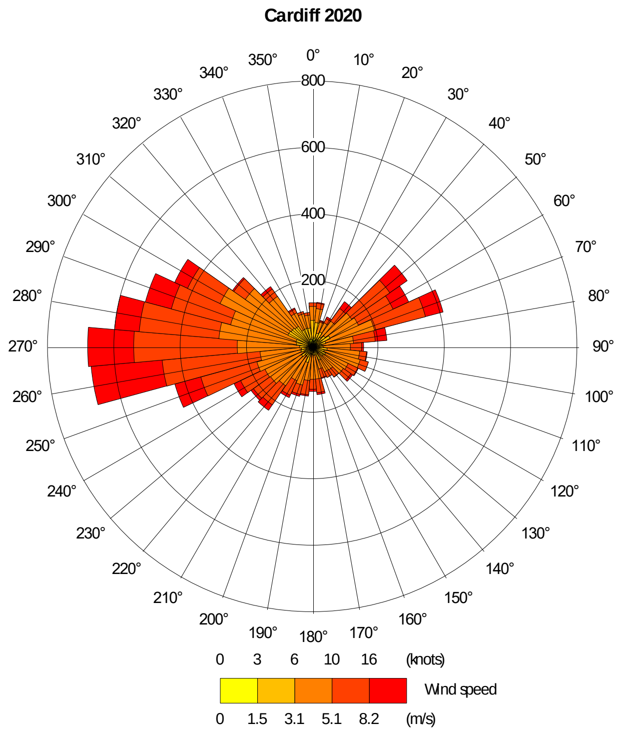
12 Appendices

A1 Wind Roses for Cardiff

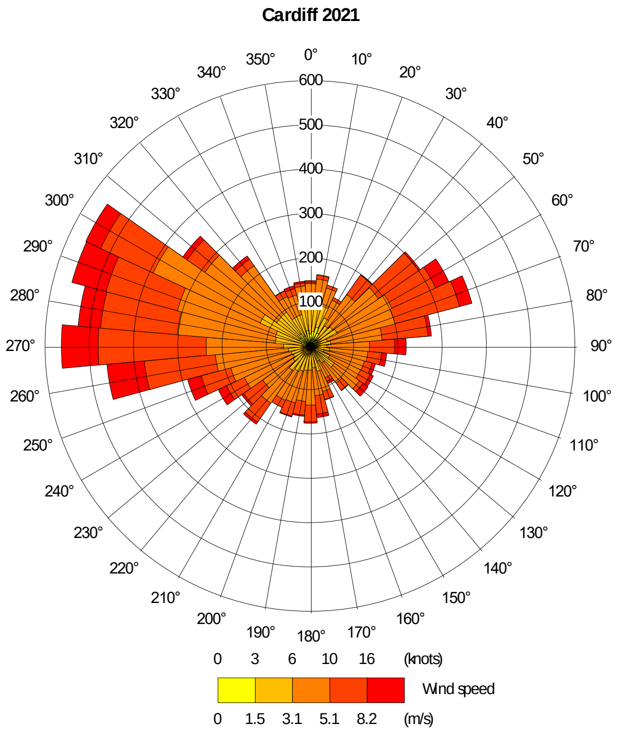
2019



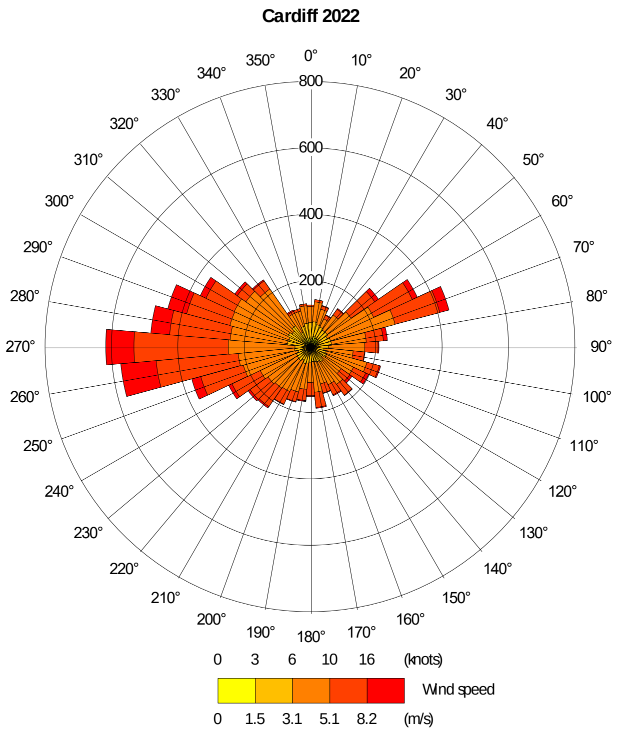
2020



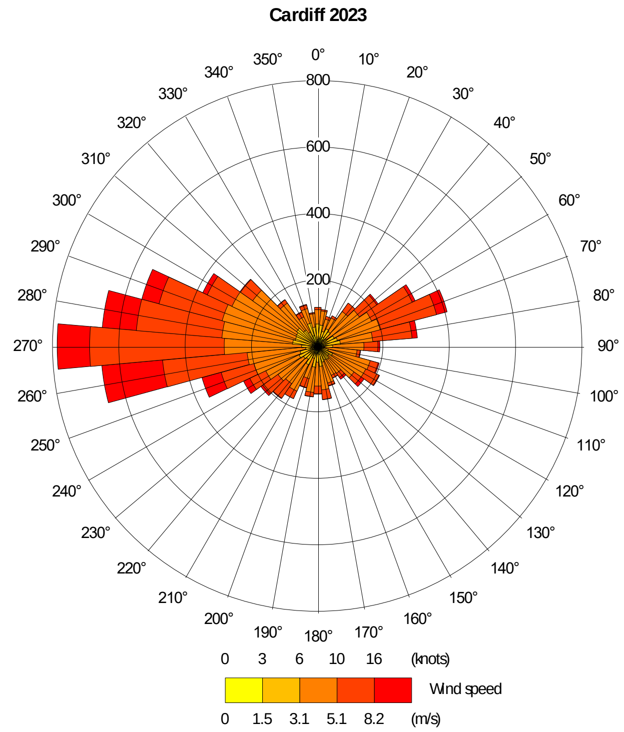
2021


Cardiff 2021
0°
10°
20°
30°
40°
50°
60°
70°
80°
90°
100°
110°
120°
130°
140°
150°
160°
170°
180°
190°
200°
210°
220°
230°
240°
250°
260°
270°
280°
290°
300°
310°
320°
330°
340°
350°
100
200
300
400
500
600
0 3 6 10 16 (knots)
Wind speed
0 1.5 3.1 5.1 8.2 (m/s)

2022


Cardiff 2022
0°
10°
20°
30°
40°
50°
60°
70°
80°
90°
100°
110°
120°
130°
140°
150°
160°
170°
180°
190°
200°
210°
220°
230°
240°
250°
260°
270°
280°
290°
300°
310°
320°
330°
340°
350°
200
400
600
800
0 3 6 10 16 (knots)
Wind speed
0 1.5 3.1 5.1 8.2 (m/s)

2023


Cardiff 2023
0°
10°
20°
30°
40°
50°
60°
70°
80°
90°
100°
110°
120°
130°
140°
150°
160°
170°
180°
190°
200°
210°
220°
230°
240°
250°
260°
270°
280°
290°
300°
310°
320°
330°
340°
350°
200
400
600
800
0 3 6 10 16 (knots)
Wind speed
0 1.5 3.1 5.1 8.2 (m/s)

A2 EA Checklist for Dispersion Modelling Report for Installations

Table A2-1: EA Checklist for Dispersion Modelling Report for Installations

Item	Included	Comment
Location map	✓	See Figure 2-1 and Figure 2-2
Site plan	✓	See Figure 3-1
List of emissions modelled	✓	See Paragraph 1.3
Details of modelled scenarios	✓	See Table 1-2 and Section 6
Details of relevant ambient concentrations used	✓	See Section 5
Model description and justification	✓	See Paragraph 6.3 through 6.5
Special model treatments used	✓	See Section 6.34
Table of emission parameters used	✓	See Table 6-1 and Table 6-2
Details of modelled domain and receptors	✓	See Figure 2-2 and Paragraph 6.12
Details of meteorological data used (including origin) and justification	✓	See Paragraphs 6.15 to 6.17
Details of terrain treatment	✓	See Paragraph 6.26
Details of building treatment	✓	See Paragraphs 6.23 through 6.25 and Table 6-7
Sensitivity analysis	✓	See Section 6 and Table 6-9
Assessment of impacts	✓	See Sections 8 and 9
Model input files	✓	Sent electronically

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