# Air Quality Assessment for Environmental Permit: Etex Bristol Substantial Permit Variation

August 2022

Experts in air quality
management & assessment

## Document Control

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| **Client** | Etex Group | **Principal Contact** | Steve Hemmings |

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| **Report Prepared By:** | Martin Peirce |

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**Air Quality Consultants Ltd**
**23 Coldharbour Road, Bristol BS6 7JT Tel: 0117 974 1086**
**24 Greville Street, Farringdon, London, EC1N 8SS Tel: 020 3873 4780**
**aqc@aqconsultants.co.uk**

Registered Office: 23 Coldharbour Road, Bristol BS6 7JT
Companies House Registration No: 2814570

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# 1 Introduction

1.1 This report describes the air quality assessment to support the substantial permit variation for the Etex Bristol site in North Somerset. The assessment has been carried out by Air Quality Consultants Ltd on behalf of Etex Building Performance (Etex).

1.2 Etex is constructing a new plasterboard production line and warehouse facility alongside their existing Bristol plasterboard plant. The new plant will be an autonomous facility but will have a symbiotic relationship between the existing and new warehouses in order to maintain the efficiency of the distribution transport load out. There will also be further interconnection with the existing plant, to allow direct supply of some elements of raw material supplied by processing workshops within the existing plant, and to allow sitewide vehicle movement and safe pedestrian access between both sites. The new plant will house a 50 million square metre per year capacity board line which will allow the combined Bristol site to double its present output capacity. The new plant is being built on a leased area of land currently owned by The Bristol Port Company and previously used as a coal stockyard.

1.3 The proposed development will increase the capacity of the facility and require new gas-fired burners to be installed to produce the energy required to manufacture the plasterboards. In addition, the process involved in the fabrication of the plasterboards leads to emissions of fine dust. There will be some additional road traffic due to the proposed development, both light and heavy vehicles.

1.4 The assessment focuses on nitrogen dioxide, $PM_{10}$ and $PM_{2.5}$ for human health, and on nitrogen oxides (NOx) and nutrient and acid nitrogen deposition for ecological impacts. Emissions of other pollutants such as carbon monoxide are considered to be small compared to the environmental standards and not warranting assessment.

1.5 Emissions from the existing facility have been modelled for completeness, acknowledging that there will be some double-counting to the extent they are included in the background concentrations.

1.6 Table 1 gives the site location. Table 2 summarises the modelled scenarios and sensitivity tests that have been carried out.

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

**Table 1: Site Location**

| Parameter | Entry |
|---|---|
| **Site Name** | Etex |
| **Site Address** | Royal Portbury Docks, Bristol |
| **Grid Reference (approximate centre of new development site) (O.S. X,Y)** | 350950, 176900 |

**Table 2: Summary of Model Scenarios and Sensitivity Tests**

| Parameter | Entry |
|---|---|
| **Year for Baseline Conditions** | 2023, the anticipated year of opening of the expanded facility (see Section 5) |
| **Operating Hours** | Assumed to operate continuously (8,760 hours per year) |
| **Meteorological Conditions** | Five years of meteorological data used. Each modelled separately. Receptor-specific maxima out of the five years are reported (see Section 6) |
| **Building Wake Effects** | Model run with and without nearby buildings. Receptor-specific maxima from the two tests are reported (see Section 6) |
| **Terrain Effects** | Model run with and without terrain. Receptor-specific maxima from the two tests are reported (see Section 6) |
| **Surface Roughness** | Model run with spatially-variable surface roughness length and fixed 0.5 m surface roughness length. Receptor-specific maxima from the two tests are reported (see Section 6) |

# 2 Site Description

## Nearby Sensitive Features

2.1 The facility is in the Royal Portbury Dock area of Bristol, south of the River Avon and close to the Severn Estuary. The land on which the new development will be built was previously used as a coal stockyard. The area around the facility is industrial and port usage, with residential areas at a greater distance. The M5 motorway runs approximately 750 m from the site. Figure 1 shows the site location and highlights the designated habitats within 2 km and 10 km distance lines from the site. Figure 2 presents the same information but focusing on the area within 2 km of the site only. Table 3 summarises the proximity of nearby sensitive features.

2.2 The following Special Area of Conservation (SAC), Special Protection Area (SPA) and Ramsar sites are within 10 km of the proposed development:

- The Severn Estuary SAC, SPA, Ramsar site and Site of Special Scientific Interest (SSSI). These designations largely overlap so are not clearly distinguished in the figures. At its closest point, the designated area of the Severn Estuary is 320 m from the nearest stack; and
- The Avon Gorge Woodlands SAC and SSSI is located approximately 4,000 m from the proposed development's stacks at its closest point.

2.3 The following ancient woodland (AW) and local nature reserves (LNR) are within 2 km of the proposed development:

- Hails Wood AW, 1,650 m from the nearest stack;
- Longlands Wood AW, 1,600 m from the nearest stack; and
- St George's Flower Bank LNR, 1,500 m from the nearest stack.

2.4 There are no national nature reserves or other SSSIs within 2 km of the proposed installation.

2.5 Local authority Air Quality Management Areas (AQMAs) are also shown in these figures. The nearest AQMA, called Bristol AQMA, is about 7,400 m from the facility at its closest point. The former Cribbs Causeway AQMA adjacent to the M5 Junction 17 roundabout was formally revoked in July 2020 as nitrogen dioxide concentrations within the AQMA have consistently been below the annual mean objective since 2010 (South Gloucestershire Council, 2021).

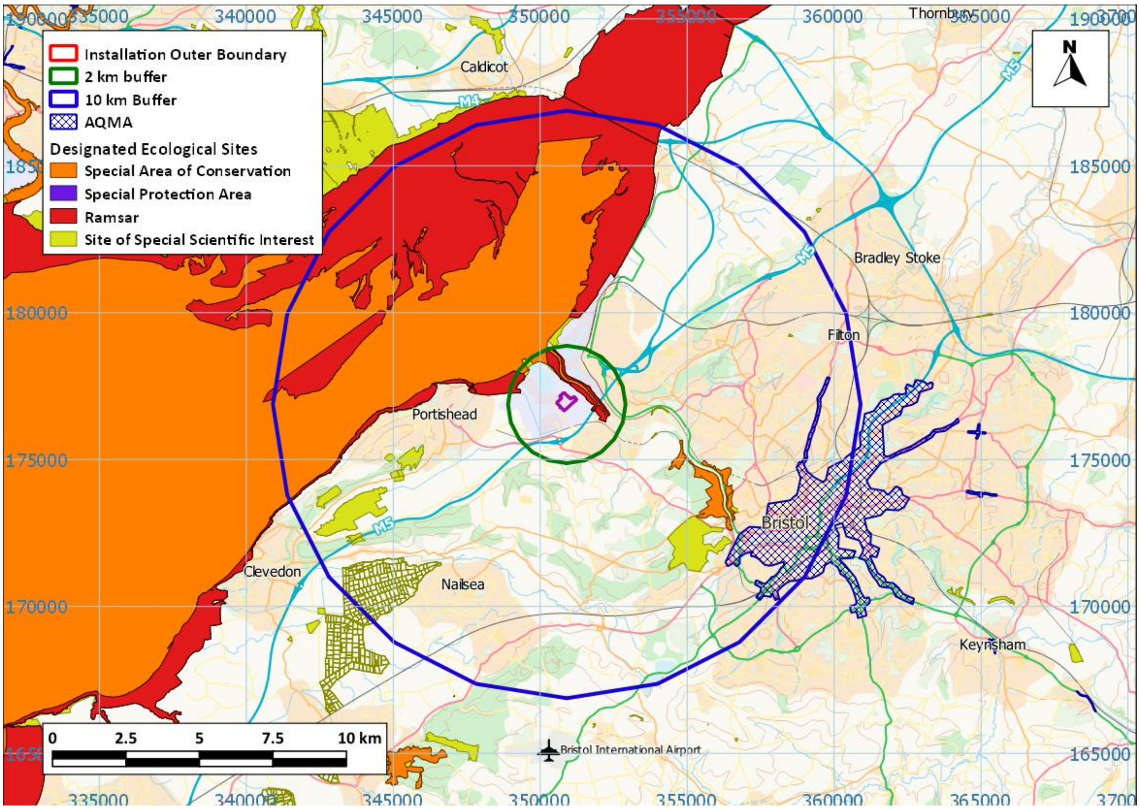


**Figure 1: Site Location, AQMAs, SACs, SPAs, Ramsar Sites and SSSIs Within 10 km**

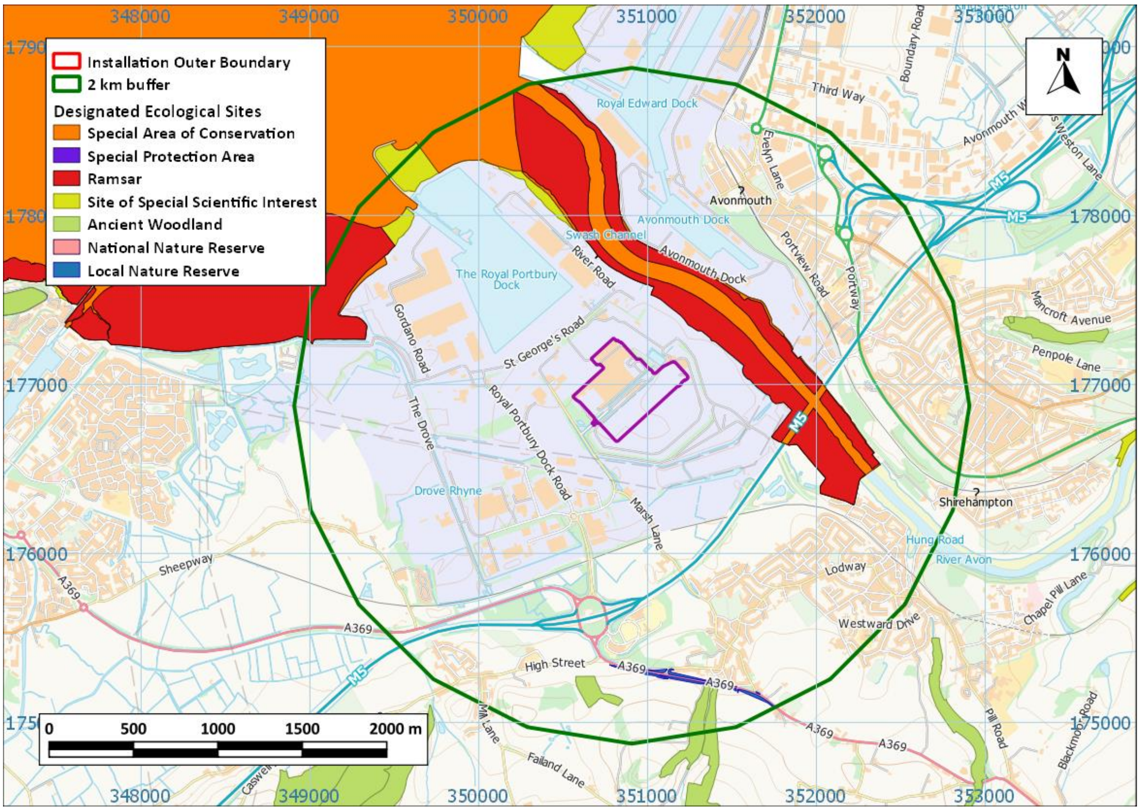


**Figure 2: Site Location, AQMAs, SACs, SPAs, Ramsar Sites, SSSIs, AW and LNRs Within 2 km**

**Table 3: Summary of Nearby Sensitive Features**

| Feature | Description | Distance from Nearest Stack |
|---|---|---|
| **Nearest roadside human receptor** | Residential properties, Marsh Lane | 900 m |
| **Nearest non-roadside human receptor** | Caravan Park, Marsh Lane | 250 m |
| **Nearest SAC, SPA, Ramsar site or SSSI** | Severn Estuary SAC, SPA, Ramsar site and SSSI | 340 m |
| **Receptors within the downwash cavity length from the nearest edge/side of the building?** | There are no receptors downwind of the building within the region of potential downwash effects | n/a |
| **Sensitive receptor setting** | Mixed | n/a |
| **Sensitive receptors near an A road or motorway network?** | Yes | 900 m |
| **Sensitive receptors within an AQMA declared for $NO_2$?** | Yes | 7,400 m |

## Topography and Terrain

2.6 Figure 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 the base of the stacks from which the plant exhausts is approximately at the same elevation as the base of the on-site buildings and nearest human health receptors.

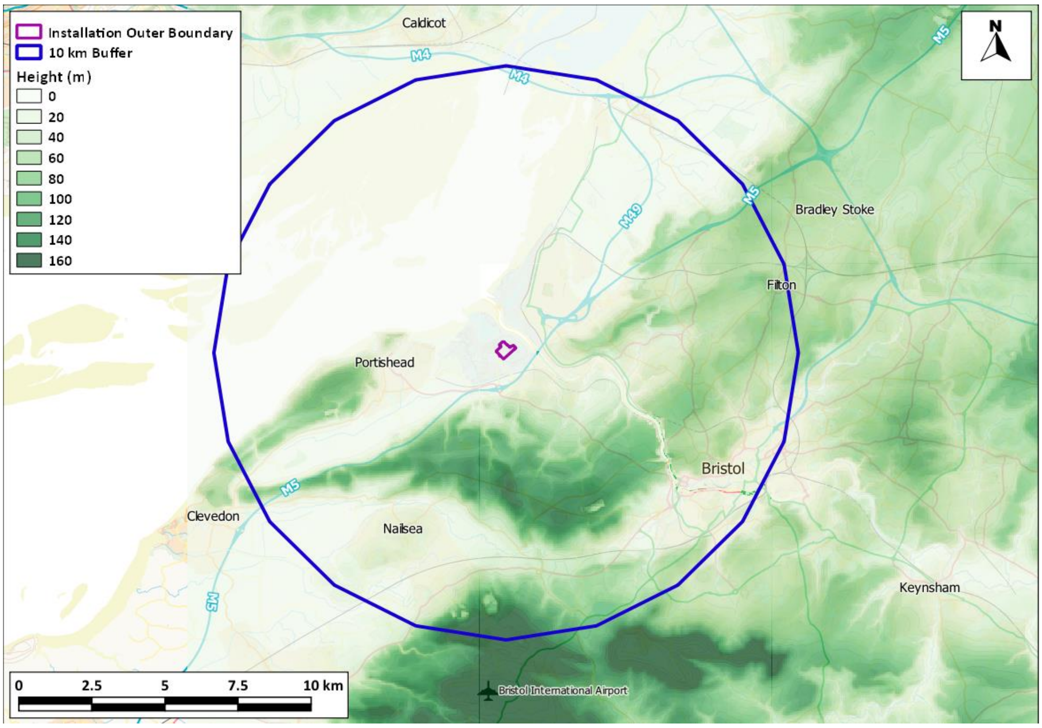


**Figure 3: Terrain across Modelled Area**

# 3 Description of Process

## Overview of Plant Requiring Permit

3.1 The proposed development will include several natural gas-fired air heater burners, venting through three main stacks: two stacks for the two-stage heat exchanger at the dryer outlet and one for the calciner.

3.2 The gypsum dryer is a combi-dryer. The first half is divided into 22 cross ventilated zones with fan-driven air circulation within each zone; 19 of them have a gas burner of 1.4 MW each to warm the air in circulation. The second half is a longitudinal fan-driven air circulation zone, which has a gas burner of 5.3 MW to warm the air in circulation within this zone. The total thermal output power which will allow evaporating the water contained in the manufactured product (plaster boards) is therefore approximately 32 MW.

3.3 The wet air is vented through a stack, after passing through a two-stage heat exchanger which warms fresh air entering the dryer and used for burner combustion. These burners are a low-NOx design. Use of selective catalytic reduction (SCR) abatement equipment is considered unsuitable, as SCR works most efficiently at temperatures above 350 °C but the process air always remains below 300 °C.

3.4 The calciner workshop is used to calcine natural gypsum with warm air. The air is warmed by a gas burner with a thermal output of 19 MW, then passed through the calciner where the gypsum is calcined (calciner inlet air temperature 600 °C , calciner outlet air temperature 165 °C). The air in the closed circuit is moved by a fan with a maximum throughput of 200,000 $m^3$/h. After the calcination process, part of this air is vented (72,000 $m^3$/h) through a stack, after passing through a heat exchanger which warms fresh air entering the calciner and used for burner combustion (35,000 $m^3$/h). These burners are a low-NOx design to avoid the need for end-of-pipe abatement.

3.5 In addition, the proposed development will also include several space extract stacks which will provide point sources of dust emissions. These are fitted with dust filters. All these sources will emit up to 10 mg/$m^3$ of fine dust, which for the purpose of this assessment has been assumed to correspond to $PM_{10}$ (particulate matter with an aerodynamic diameter less than 10 µm). To provide a worst-case assessment of $PM_{2.5}$ (particulate matter with an aerodynamic diameter less than 2.5 µm), the total fine dust emissions have also been assumed to correspond to $PM_{2.5}$. All building extracts through dust filters will operate 100% of the time, as for the combustion sources.

3.6 The assumed specifications for these point sources (thereafter collectively referred to as 'plant') are set out in Section 6.

3.7 Figure 4 shows the site plan and layout. Details of buildings and stack locations, as modelled, are shown in Figure 6.

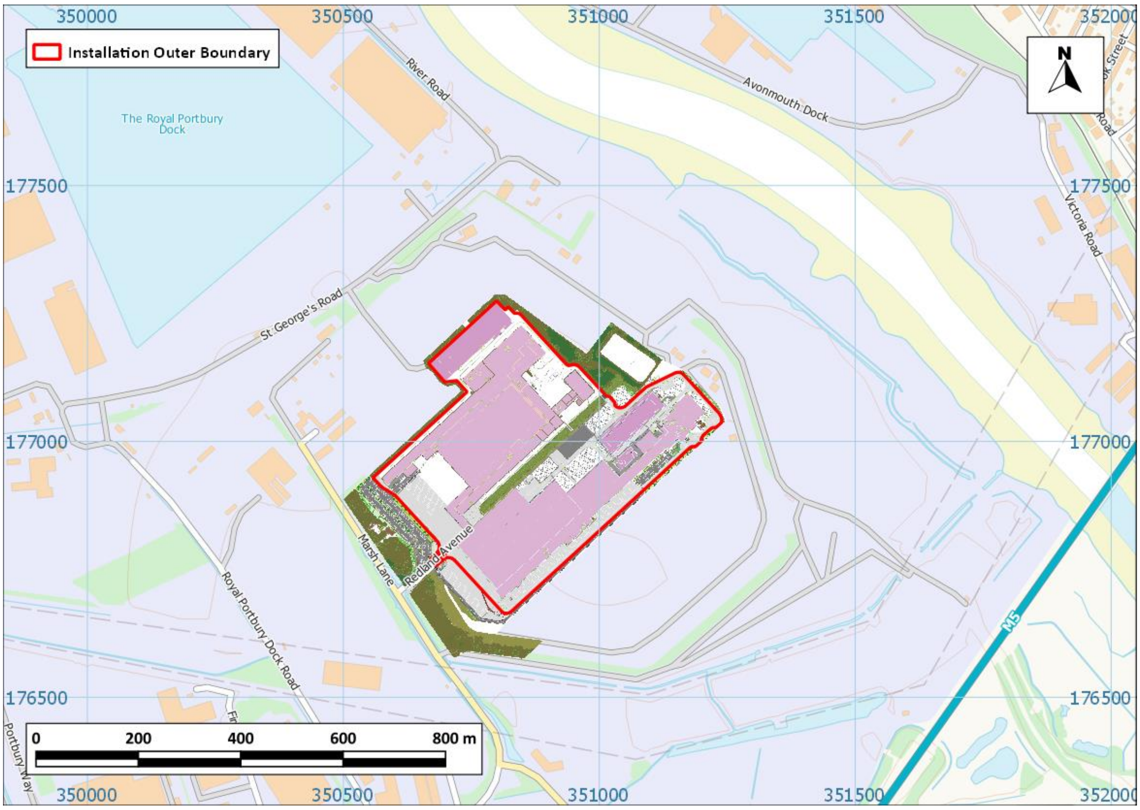


**Figure 4:** **Site Layout (Existing and Proposed)**

For clarity, the installation boundary shown is the outermost boundary only; some parts inside the boundary are excluded from the proposed installation.

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# 4 Environmental Standards

4.1 The relevant Air Quality Standards (AQS) for human health impacts are set out in Table 4 (EA, 2022).

**Table 4: AQS for Human Health**

| Pollutant | Averaging Period | AQS (µg/m$^3$) | Acceptable Exceedance Criteria |
|---|---|---|---|
| **$NO_2$** | Annual Mean | 40 | Zero exceedances |
| | 1-hour | 200 | Not to be exceeded more than 18 times a year |
| **Fine Particles ($PM_{10}$)** | 24-hour Mean | 50 | Not to be exceeded more than 35 times a year |
| | Annual Mean | 40 [a] | Zero exceedances |
| **Fine Particles ($PM_{2.5}$)** | Annual Mean | 25 | Zero exceedances |

[a] A proxy value of 32 µg/m$^3$ as an annual mean is used in this assessment to assess the likelihood of the 24-hour mean $PM_{10}$ objective being exceeded. Measurements have shown that, above this concentration, exceedances of the 24-hour mean $PM_{10}$ objective are possible (Defra, 2018b).

4.2 The AQS for $NO_2$ are defined as UK objectives within the Air Quality (England) Regulations (2000) and the Air Quality (England) (Amendment) Regulations (2002). The same numerical values are also set as European Limit values (The European Parliament and the Council of the European Union, 2008).

4.3 The objectives 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 objective. Defra explains where these objectives will apply in its Local Air Quality Management Technical Guidance (Defra, 2018). The annual mean objectives are considered to apply at the façades of residential properties, schools, hospitals etc.; they do not apply at hotels. The 1-hour mean objective for nitrogen dioxide applies wherever members of the public might regularly spend 1-hour 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 limit values and specific monitor and receptor siting requirements apply. Neither the objectives nor limit 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 Table 5 sets 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, 2021).

**Table 5: AQS for Designated Ecological Sites**

| Site | Maximum 24-hour Mean NOx (µg/m³) | Annual Mean | | | | |
|---|---|---|---|---|---|---|
| | | NOx (µg/m³) | Nutrient Nitrogen Deposition (kgN/ha/yr) | Acid Deposition (keq/ha/yr) | | |
| | | | | MaxCLminN | MaxCLmaxN | MaxCLmaxS |
| **Severn Estuary (SAC, SPA, SSSI)** | 200 | 30 | 20 | Not sensitive | Not sensitive | Not sensitive |
| **Avon Gorge Woodlands (SAC, SSSI)** | 200 | 30 | 15 | 0.142 | 1.219 | 1.077 |
| **Hails Wood (AW)** | 200 | 30 | 10 | 0.142 | 2.743 | 2.601 |
| **Longlands Wood (AW)** | 200 | 30 | 15 | 0.142 | 2.737 | 2.595 |
| **St George's Flower Bank (LNR)** | 200 | 30 | 15 | 0.856 | 4.856 | 4 |

4.5 The environment standard for daily mean NOx is 200 µg/m³ for detailed assessments where the ozone concentration is below the AOT40 critical level of 6,000 h µg/m³ and the sulphur dioxide concentration is below the lower critical level of 10 µg/m³, or 75 µg/m³ otherwise. Monitoring data from Defra's Automatic Urban and Rural Monitoring Network (AURN) from stations within 50 km of the Etex site has been reviewed to determine if ozone or sulphur dioxide are above their critical levels. Four stations measure ozone (Bristol St Paul's, Cardiff Centre, Charlton Mackrell and Cwmbran Crownbridge) and one station measures sulphur dioxide (Cardiff Centre). Data for 2019 (i.e. pre-pandemic) has been used.

4.6 Monitored annual mean concentrations of sulphur dioxide for 2019 are 1.37 µg/m³ at Cardiff Centre, less than 15% of the critical level. According to APIS (APIS, 2021), the maximum sulphur dioxide concentration anywhere across the Severn Estuary protected area is 2.61 µg m$^{-3}$ or 26% of the critical level.

4.7 Monitored AOT40 concentrations for 2019 vary widely in the range 691 h µg/m³ (at Cardiff Centre) to 3198 h µg/m³ (at Cwmbran), giving a maximum of 53% of the standard.

4.8 It is concluded that both ozone and sulphur dioxide concentrations are below their critical levels. The appropriate critical level for daily mean NOx concentrations is therefore 200 µg/m³.

# 5 Baseline Conditions

## Human Health

5.1 Figure 5 sets out the background annual mean $NO_2$ concentrations in the study area taken from Defra's published maps for 2023 (Defra, 2021a).

5.2 Annual mean $NO_2$ concentrations in the study area as measured by Bristol City Council are given in Table 6. These include both roadside and background sites, with the measurements at the roadside sites higher than those at background sites. Monitored concentrations at Receptor 16 are considerably higher than PCM concentrations, and may be influenced by a local industrial source. The other monitoring locations are located close to either the A4 or M5 roads and are likely to be influenced by local traffic conditions, or are a considerable distance from the site and likely to be influenced by other urban sources.

5.3 The monitoring closest to the site is undertaken using diffusion tubes. There are seven continuous monitors in Bristol, but the nearest is over 8.5 km from the site (501, Colston Avenue), and these are therefore considered unrepresentative of concentrations in the study area as they will be strongly influenced by other urban sources.

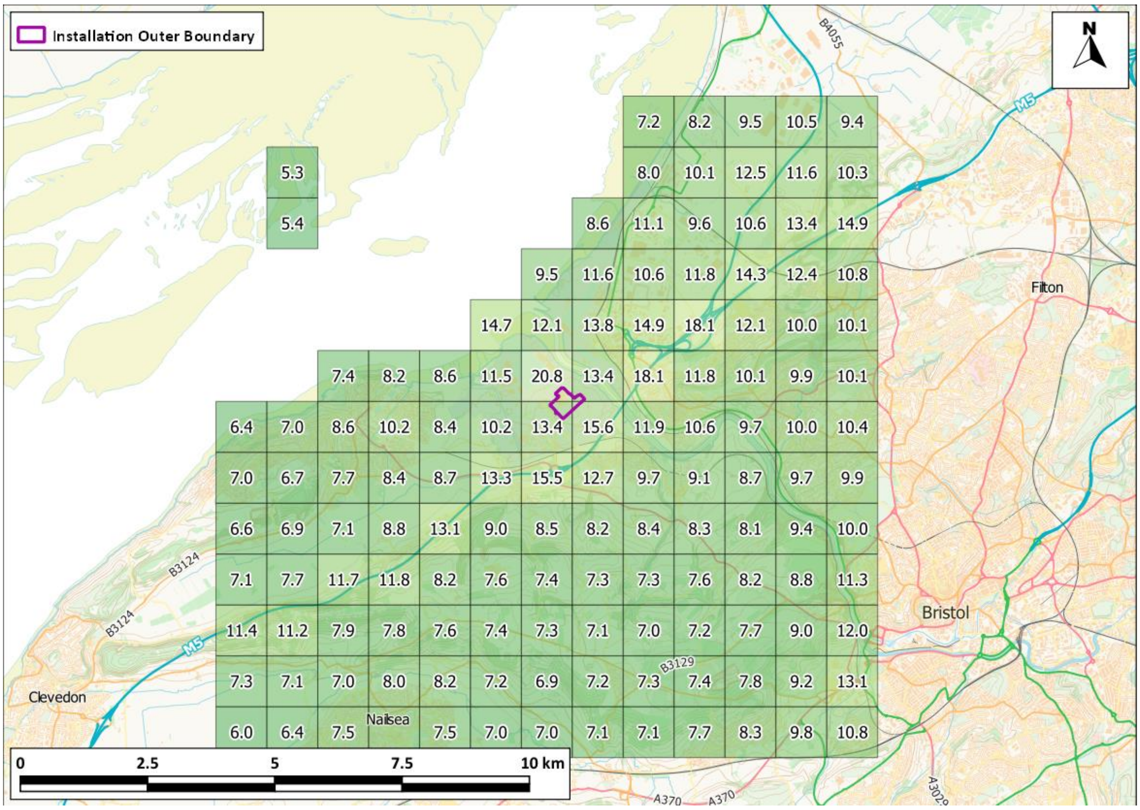



**Figure 5: Defra's Predicted $NO_2$ Background Concentrations in the Area Surrounding the Site, 2023 ($\mu g/m^3$)**

**Table 6: Summary of $NO_2$ Monitoring (2016-2020) [a]**

| Site No. | Site Type | Location | 2016 | 2017 | 2018 | 2019 | 2020 |
|---|---|---|---|---|---|---|---|
| **Diffusion Tubes - Annual Mean (µg/m³)** | | | | | | | |
| **16** | Roadside | Third Way | 35.7 | 35.2 | 32.6 | 28.6 | 23.2 |
| **489** | Roadside | Avonmouth Road No 12 | 38.6 | 37.7 | 35.5 | 28.6 | 22.8 |
| **490** | Roadside | Avon School Barrack's Lane | 32.4 | 31 | 26.8 | 22.4 | 18.6 |
| **491** | Roadside | Avonmouth Road No 76 | 36.5 | 34.4 | 33.5 | 27.3 | 22 |
| **503** | Urban Background | Sea Mills Pharmacy | – | – | 19.1 | – | – |
| **504** | Urban Background | Avonmouth Primary | – | – | 26.7 | – | – |
| **Objective** | | | 40 | | | | |

[a] Data downloaded from the Bristol City Council Annual Status Report (BCC, 2019) (BCC, 2021).

### *Summary of Baseline Concentrations*

5.4 In the absence of representative monitoring data, baseline annual mean $NO_2$, $PM_{10}$ and $PM_{2.5}$ concentrations used in this assessment have been taken from the Defra maps (Defra, 2021a). The contribution from road traffic on the M5 motorway has been modelled explicitly (as described in detail in Appendix A3).

## Designated Ecological Sites

5.5 The estimated annual mean background NOx concentrations at the designated ecological sites have been derived using Defra's background maps (Defra, 2021a). The baseline nutrient nitrogen and acid deposition fluxes have been defined using APIS (APIS, 2021) and are 1 km x 1 km grid square averages based on the three year mean between 2018 and 2020. The derived values are presented in Table 7. (Details of the receptors are given in paragraph 6.12.)

5.6 The annual mean NOx concentrations are well below the critical level of 30 µg/m³ at all receptors. Baseline nutrient nitrogen deposition fluxes are just below the site-specific critical load (see Table 5) at the Severn Estuary (E1–E9), but substantially above the respective critical loads at the Avon Gorge Woodlands SAC (E10) and at the local nature sites (E11–E13), as is the case for very many designated ecological sites across the UK.

**Table 7: Background NOx Concentrations and Deposition Fluxes at Designated Ecological Sites**

| Receptor ID | Description | NOx (µg/m³) | Nutrient Nitrogen Deposition (kgN/ha/yr) | Acid Deposition (keq/ha/yr) | |
|---|---|---|---|---|---|
| | | | | N Component | S Component |
| **E1** | Severn Estuary | 8.97 | 18.9 | 1.4 | 0.2 |

| Receptor ID | Description | NOx (µg/m³) | Nutrient Nitrogen Deposition (kgN/ha/yr) | Acid Deposition (keq/ha/yr) | |
|---|---|---|---|---|---|
| | | | | N Component | S Component |
| **E2** | Severn Estuary | 15.41 | 17.6 | 1.3 | 0.1 |
| **E3** | Severn Estuary | 20.47 | 17.6 [a] | 1.3 [a] | 0.1 [a] |
| **E4** | Severn Estuary | 31.14 | 18.1 [a] | 1.3 [a] | 0.2 [a] |
| **E5** | Severn Estuary | 18.29 | 17.6 [a] | 1.3 [a] | 0.2 [a] |
| **E6** | Severn Estuary | 18.29 | 17.6 [a] | 1.3 [a] | 0.2 [a] |
| **E7** | Severn Estuary | 18.29 | 17.6 [a] | 1.3 [a] | 0.2 [a] |
| **E8** | Severn Estuary | 21.25 | 17.6 | 1.3 | 0.2 |
| **E9** | Severn Estuary | 15.75 | 18.2 [a] | 1.3 [a] | 0.2 [a] |
| **E10** | Avon Gorge Woodlands | 10.46 | 34 | 2.4 | 0.2 |
| **E11** | Hails Wood AW | 16.85 | 29.68 | 2.12 | 0.17 |
| **E12** | Longlands Wood AW | 20.98 | 29.68 | 2.12 | 0.17 |
| **E13** | St George's Flower Bank LNR | 16.85 | 16.66 | 1.19 | 0.14 |

[a] Deposition data not available in APIS for these locations. Data for an adjacent grid square has been used instead.

# 6 Modelling Methodology

6.1 Modelling has been carried out in line with EA documents: *"Air emissions risk assessment for your environmental permit"* (EA, 2022) and *"Environmental permitting: air dispersion modelling reports"* (EA, 2019).

## Dispersion Model

6.2 Impacts from plant have been predicted using the ADMS-5.2 dispersion model developed by Cambridge Environmental Research Consultants (CERC). ADMS-5.2 is a new generation model that incorporates a state-of-the-art understanding of the dispersion processes within the atmospheric boundary layer. ADMS is widely used for assessments of this type and has been extensively validated[1]. It is considered suitable for the current assessment.

6.3 Emissions from road traffic on the M5 (used to determine baseline concentrations at receptors close to the M5) have been modelled using the ADMS-Roads dispersion model dev eloped by CERC. This is a close relative of ADMS 5.2 with optimisations for modelling road traffic (see Appendix A3 for roads modelling methodology).

## Emission Parameters: New Sources

6.4 Operational parameters have been determined from data provided by Etex. These have been used as the basis for the exhaust and pollutant emission calculations, alongside the emission limit values. The stack diameter and stack height has been provided by Etex. Emission points A35, A36 and A38–A47 have a common stack and have been combined. Emission points A32 and A52, representing the two heat exchangers, are immediately adjacent and have been treated as a single stack within the model. Emission point A51 (Emergency Stack) is not used in normal operation and have not been modelled. Stack locations, along with the existing stacks and the buildings as modelled, are shown in Figure 6.

**Table 8: Stack Parameters for New Emissions Sources**

| Ref. | Source Description | Release Height (m) | Stack Diameter (m) | Coordinates |
|---|---|---|---|---|
| **A32,A52** | Heat Exchanger | 18 | 1.4 | 350972, 176834 |
| **A33** | Dedusting System - Stucco Silo | 27 | 0.4 | 351158, 177034 |
| **A34** | Dedusting System - Stucco Circuit | 14.5 | 0.2 | 351135, 177031 |
| **A35-A36, A38-A47** | Dedusting (combined) | 13 | 0.5 | 351160, 177029 |

1 https://www.cerc.co.uk/environmental-software/model-validation.html

| Ref. | Source Description | Release Height (m) | Stack Diameter (m) | Coordinates |
|---|---|---|---|---|
| **A37** | Dedusting Dust Collector - Bulk Bag Unloading | 13 | 0.1 | 351144, 177040 |
| **A48** | Dedusting Dust Collector - Mixer | 8 | 0.2 | 351152, 177015 |
| **A49** | Main Exhaust Air Stack | 36 | 2.8 | 351048, 176967 |
| **A50** | Dedusting System Dividing Saw | 34 | 0.6 | 351035, 176947 |

**Table 9: Emission Parameters for New Emissions Sources**

| Ref. | Volume Flux ($Am^3/s$) | Temperature (°C) | Efflux Velocity (m/s) |
|---|---|---|---|
| **A32,A52** | 171,000 | 75 | 30.9 |
| **A33** | 4,000 | Ambient | 8.8 |
| **A34** | 4,000 | Ambient | 35.4 |
| **A35-A36, A38-A47** | 7,300 | Ambient | 11.1 |
| **A37** | 300 | Ambient | 7.4 |
| **A48** | 1,200 | Ambient | 10.6 |
| **A49** | 216,900 | 72 | 9.8 |
| **A50** | 13,000 | ambient | 14.7 |

**Table 10: Emission Rates for New Emissions Sources**

| Ref. | NOx Concentration ($mg/Am^3$) | PM10 Concentration ($mg/Am^3$) | NOx Emission Rate (g/s) | $PM_{10}$ Emission Rate (g/s) |
|---|---|---|---|---|
| **A32,A52** | < 50 | – | 2.38 | 0 |
| **A33** | – | < 10 | 0 | 0.011 |
| **A34** | – | < 10 | 0 | 0.011 |
| **A35-A36, A38-A47** | – | < 10 | 0 | 0.020 |
| **A37** | – | < 10 | 0 | 0.001 |
| **A48** | – | < 10 | 0 | 0.003 |
| **A49** | 100 | < 10 | 6.03 | 0.603 |
| **A50** | – | < 10 | 0 | 0.036 |

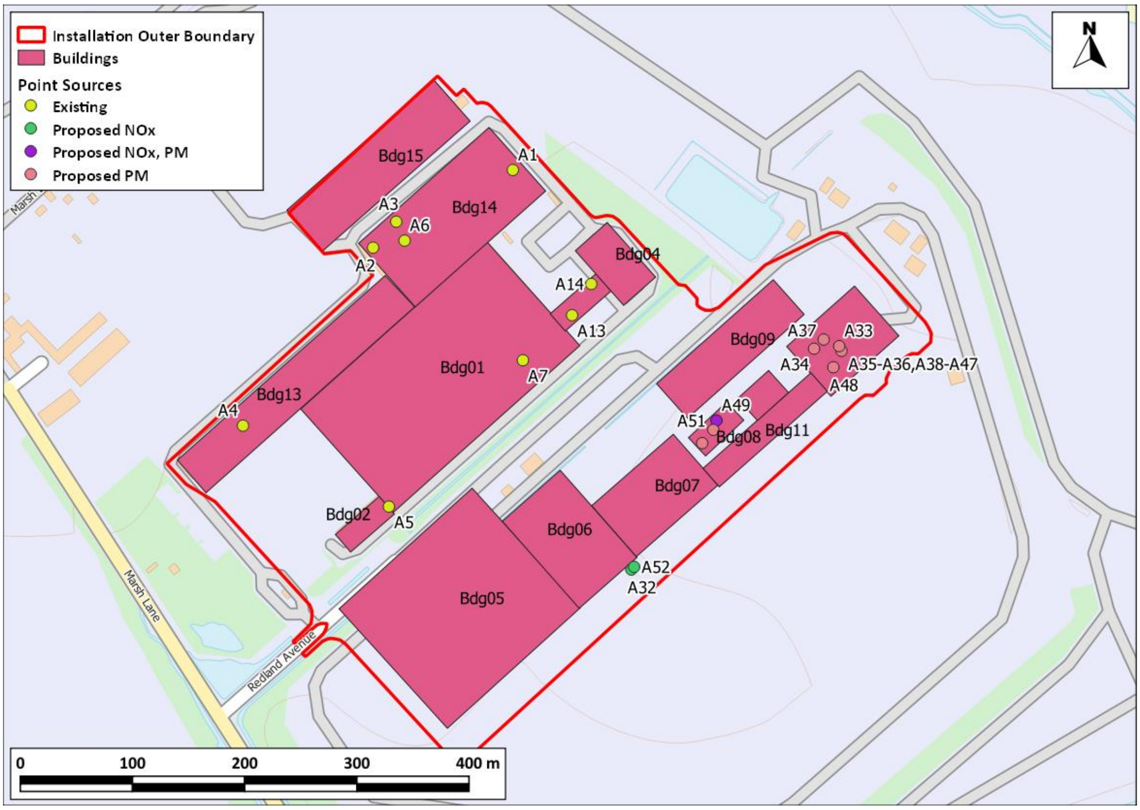



**Figure 6: Emission Points and Buildings Included in the Model**



## Emission Parameters: Existing Installation

6.5 Emission parameters for the existing Etex installation are taken from reports supporting the applications for the permit and permit variations (AECOM, 2017). Stack coordinates are taken from georeferenced aerial imagery. Parameters are given in Table 11 and Table 12.

6.6 Emission point A14 is no longer in use, but has been included in the model for completeness and consistency with the air quality assessment undertaken to support the planning application.

**Table 11: Stack Parameters for Existing Emissions Sources**

| Ref. | Source Description | Release Height (m) | Stack Diameter (m) | Coordinates |
|---|---|---|---|---|
| **A1** | Cove Line Dryer | 21.3 | 0.5 | 350867, 177191 |
| **A2** | Flash Calciner Gas Burner | 34.5 | 1.1 | 350742, 177122 |
| **A3** | Mill 1 and 2 | 35.4 | 1.1 | 350763, 177145 |
| **A4** | Line 1 Dryer | 23.6 | 1.6 | 350626, 176963 |

| Ref. | Source Description | Release Height (m) | Stack Diameter (m) | Coordinates |
|---|---|---|---|---|
| **A5** | Line 2 Dryer | 23.5 | 1.4 | 350756, 176891 |
| **A6** | Gas Burner on Kettles | 37.6 | 1.4 | 350770, 177128 |
| **A7** | Board Line 2 | 23.5 | 0.6 | 350875, 177021 |
| **A13** | Main Stack - New Calciner Burner (formerly A8) | 23.0 | 1.7 | 350919, 177061 |
| **A14** | Reclaim Burner (formerly A9) | 21.0 | 0.5 | 350936, 177089 |

**Table 12: Emission Parameters for Existing Emissions Sources**

| Ref. | Volume Flux ($Nm^3/s$) | Temperature (°C) | Efflux Velocity (m/s) |
|---|---|---|---|
| **A1** | 1.2 | 159 | 11.3 |
| **A2** | 9.5 | 149 | 15.2 |
| **A3** | 12.9 | 60 | 15.7 |
| **A4** | 20.3 | 121 | 14.3 |
| **A5** | 13.9 | 79 | 11.3 |
| **A6** | 30.8 | 170 | 13.5 |
| **A7** | 2.8 | 15 | 10.2 |
| **A13** | 13.9 | 98 | 9.5 |
| **A14** | 2 | 86 | 17.7 |

**Table 13: Emission Rates for Existing Emissions Sources**

| Ref. | NOx Emission Concentration ($mg/Nm^3$) | PM Emission Concentration ($mg/Nm^3$) | NOx Emission Rate (g/s) | PM Emission Rate (g/s) |
|---|---|---|---|---|
| **A1** | 16.1 | 8.5 | 0.019 | 0.01 |
| **A2** | 28.9 | 50 | 0.28 | 0.48 |
| **A3** | 6.5 | 50 | 0.084 | 0.64 |
| **A4** | 20.5 | 5.9 | 0.42 | 0.12 |
| **A5** | 13.9 | 20.7 | 0.19 | 0.29 |
| **A6** | 9.2 | 8.5 | 0.3 | 0.3 |
| **A7** | 0 | 14.3 | 0 | 0.04 |
| **A13** | 12.6 | 15.2 | 0.2 | 0.2 |
| **A14** | 9.9 | 0.4 | 0.02 | 0.0008 |

## Model Parameters: M5 Motorway

6.7 Concentrations have been predicted using the ADMS-Roads dispersion model, with vehicle emissions derived using Defra's Emission Factor Toolkit (EFT) (v11.0) (Defra, 2020b). Details of the model inputs, assumptions and the verification are provided in Appendix A3. Where assumptions have been made, a realistic worst-case approach has been adopted.

6.8 Markides Associates, who undertook the Transport Assessment for the proposed development, provided the increases in traffic associated with the proposed development. Baseline flows were derived from the interactive web-based map provided by DfT (2020). Further details of the traffic data used in this assessment are provided in Appendix A3.

## Receptors and Study Area

6.9 Human health impacts have been predicted over a 10 km x 10 km model domain, with the new installation at the centre. Concentrations have been predicted over this area using nested Cartesian grids (see Figure 7). These grids have a spacing of 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 5,000 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.

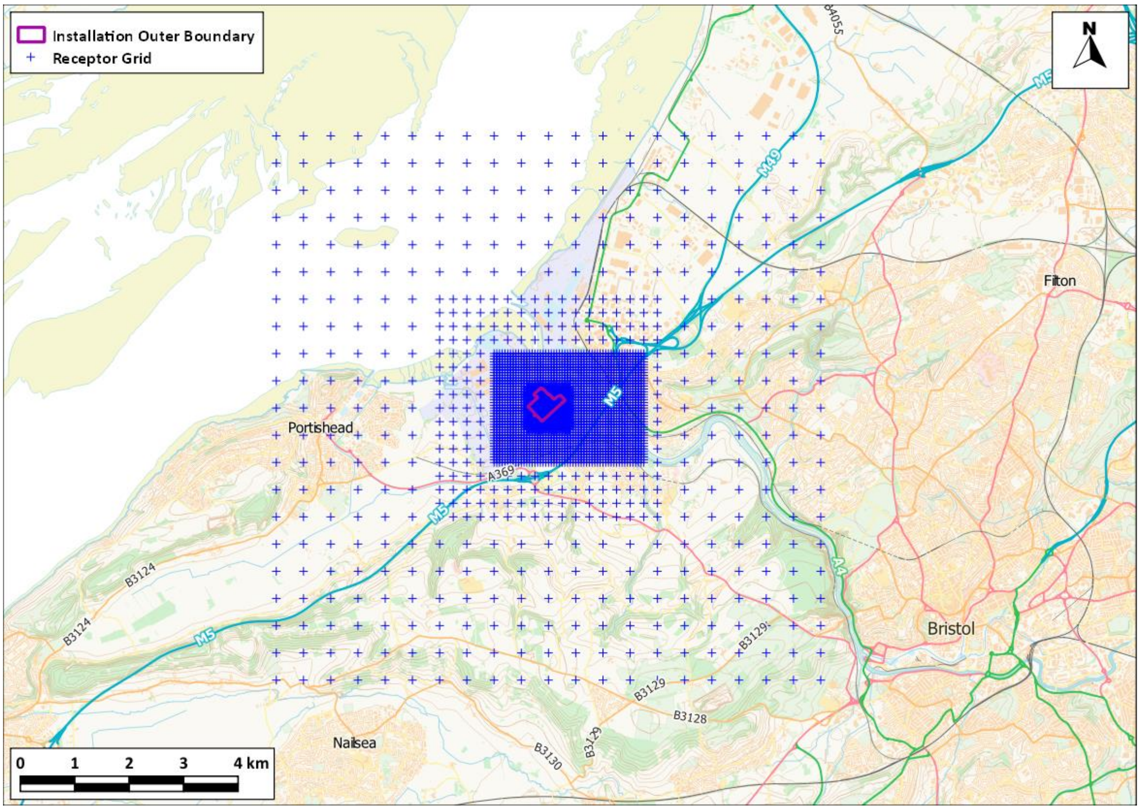



**Figure 7: Modelled Receptors (Nested Grid)**

6.10 Specific receptors have also been selected to determine impacts at locations where the AQS apply. The specific receptors identified are detailed in Table 14 and shown in Figure 8.

**Table 14: Specific Human Health Receptor Coordinates**

| Receptor ID | Description | X Coordinate | Y Coordinate |
|---|---|---|---|
| **R1** | West Town Road | 352276 | 177258 |
| **R2** | Portway | 352287 | 177371 |
| **R3** | B4054 | 352502 | 177700 |
| **R4** | B4054 | 352593 | 177674 |
| **R5** | Oakhill Lane | 355272 | 179805 |
| **R6** | B4054 | 352570 | 177644 |
| **R7** | Station Road | 349749 | 175491 |
| **R8** | Marsh Lane | 351240 | 175877 |
| **R9** | Marsh Lane | 351126 | 175945 |
| **R11** | Caravan park off Marsh Lane | 350421 | 177095 |
| **R12** | Gloucester Road | 351434 | 178128 |
| **R13** | Portview Road | 351738 | 177901 |
| **R14** | Portview Road | 351994 | 177637 |
| **R15** | Portway | 352474 | 176858 |
| **R16** | Avon Road | 352083 | 176331 |
| **R17** | The Breaches | 351753 | 176023 |
| **R18** | Beechwood Road | 351393 | 175897 |
| **R19** | St Marys School | 350274 | 175367 |
| **R20** | Sheepway | 349681 | 175898 |
| **R21** | Wharf Lane | 348841 | 176406 |
| **R22** | Wren Garden | 348257 | 177026 |

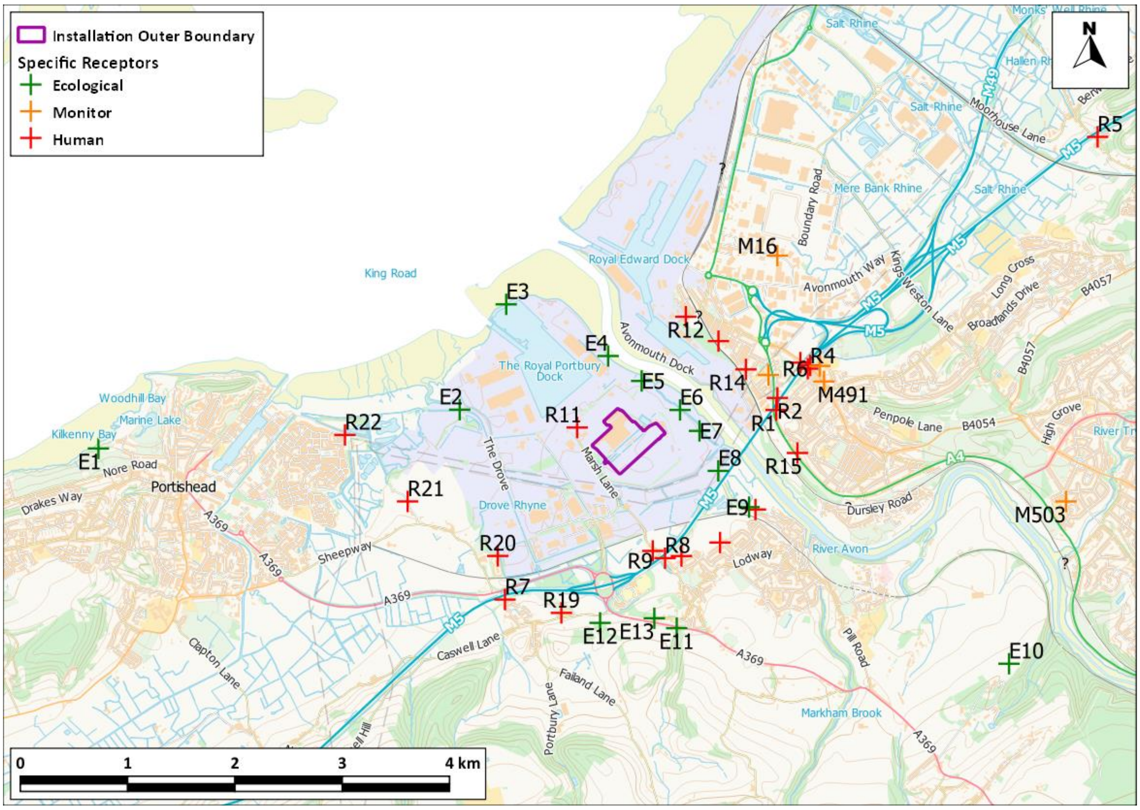



**Figure 8: Modelled Receptors (Discrete)**



6.11 Receptor ID R10 is not used in this assessment. This ID was used in the air quality assessment for the planning application to represent the Cribbs Causeway AQMA, which has since been revoked and so is not assessed here.

6.12 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 15, and their locations are shown in Figure 8.

**Table 15: Specific Ecological Receptor Coordinates**

| Receptor ID | Description | X Coordinate | Y Coordinate |
|---|---|---|---|
| **E1** | Severn Estuary | 345959 | 176900 |
| **E2** | Severn Estuary | 349326 | 177262 |
| **E3** | Severn Estuary | 349760 | 178244 |
| **E4** | Severn Estuary | 350710 | 177762 |
| **E5** | Severn Estuary | 351022 | 177529 |
| **E6** | Severn Estuary | 351380 | 177259 |

| | | | |
|---|---|---|---|
| **E7** | Severn Estuary | 351561 | 177064 |
| **E8** | Severn Estuary | 351736 | 176691 |
| **E9** | Severn Estuary | 352023 | 176353 |
| **E10** | Avon Gorge Woodlands | 354446 | 174893 |
| **E11** | Hails Wood AW | 351349 | 175224 |
| **E12** | Longlands Wood AW | 350635 | 175274 |
| **E13** | St George's Flower Bank LNR | 351140 | 175317 |

## Meteorological Data

6.13 In order 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.

6.14 Hourly sequential meteorological data from Bristol Lulsgate have been used for the years 2017–2021 inclusive. The Bristol Lulsgate meteorological monitoring station is located approximately 12 km to the south of the site. It is deemed to be the nearest monitoring station representative of meteorological conditions at the site. It is operated by the UK Meteorological Office. Raw data were provided by the Met Office, and processed by AQC for use in ADMS.

6.15 The meteorological parameters entered into the model are shown in Table 16. Wind roses for each year are presented in Appendix A1.

**Table 16: Meteorological Parameters Entered into the ADMS Model**

| Parameter | Modelled Receptors (including Cartesian Grids) | Meteorological Site |
|---|---|---|
| **Surface Roughness** | Variable Surface Roughness File | 0.3 m |
| **Minimum MO length** | 30 m | 30 m |
| **Surface Albedo** | 0.23[a] | 0.23[a] |
| **Priestly-Taylor Parameter** | 1[a] | 1[a] |

[a] Model default value

### *Variable Surface Roughness File*

6.16 The study area encompasses a range of land types. 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 9. The following parameters have been used regarding surface roughness and land type:

- forest – 1 m;

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

6.17 In addition, a model sensitivity test has been run using a fixed study area surface roughness length of 0.5 m (typical of suburban/low lying urban environments). The worst-case results from either sensitivity test have been used to inform the modelling.

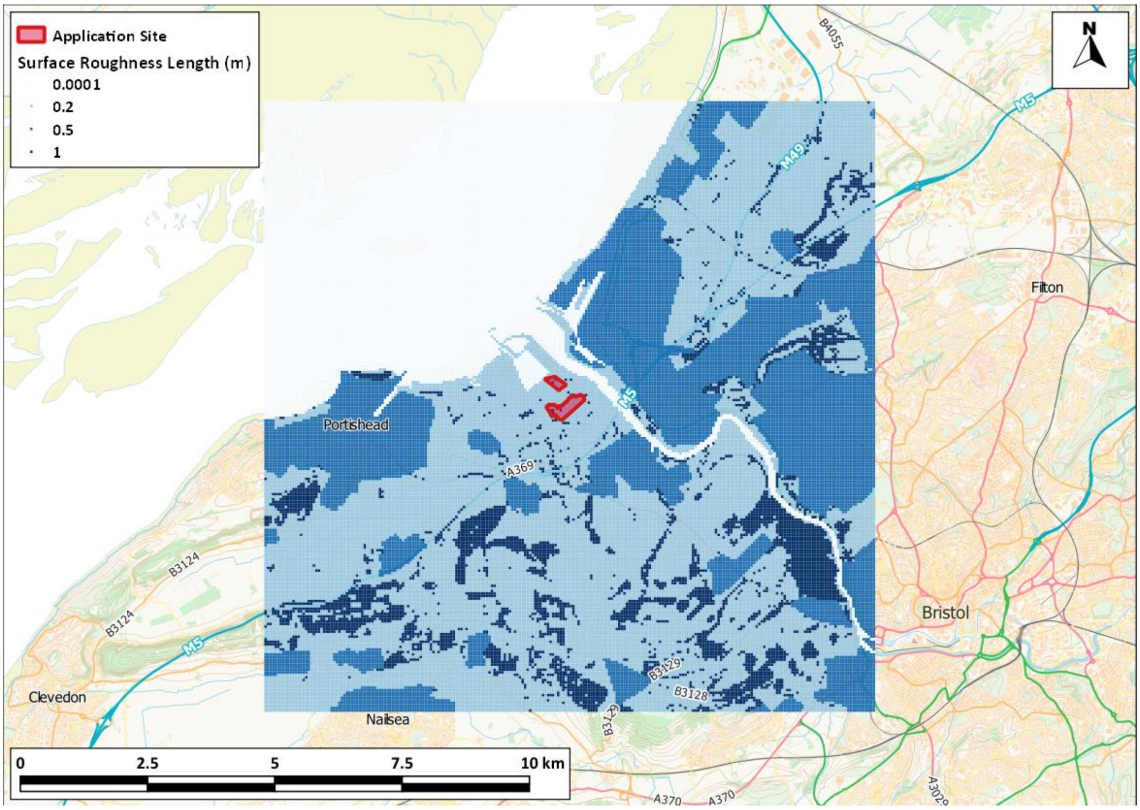



**Figure 9: Surface Roughness across Modelled Area**



## Buildings

6.18 Where buildings are a significant height relative to the stack height, building downwash effects may occur. The downwash effects should be accounted for within modelling where the stack is less than 2.5 times the height of the buildings within a distance which is five times the minimum of the stack height and the maximum projected width of the building.

6.19 The model has been run once with the adjacent buildings included, and once without, for each meteorological year. The maximum predicted concentrations from either buildings scenario, and any meteorological year, have then been determined and presented. Buildings as modelled are shown in Figure 6, and the dimensions of all buildings are given in Table 17.

**Table 17: Modelled Building Dimensions**

| Building | Height (m) | Length (m) | Width (m) | Rotation (º) |
|---|---|---|---|---|
| **Bdg01** | 9.5 | 124 | 223 | 318 |
| **Bdg02** | 9 | 21 | 52 | 319 |
| **Bdg03** | 20 | 20 | 54 | 319 |
| **Bdg04** | 17 | 65 | 38 | 319 |
| **Bdg05** | 12 | 144 | 160 | 318 |
| **Bdg06** | 12 | 104 | 69 | 319 |
| **Bdg07** | 12 | 60 | 97 | 319 |
| **Bdg08** | 33.1 | 22 | 47 | 317 |
| **Bdg09** | 20.2 | 41 | 139 | 318 |
| **Bdg10** | 12 | 59 | 81 | 318 |
| **Bdg11** | 12 | 22 | 129 | 319 |
| **Bdg12** | 36.9 | 27 | 37 | 318 |
| **Bdg13** | 9.5 | 35 | 246 | 318 |
| **Bdg14** | 9.5 | 77 | 156 | 318 |
| **Bdg15** | 9.5 | 49 | 177 | 319 |

## Terrain Effects

6.20 The model has been run with or without local terrain effects as a sensitivity test. Testing shows modelling with terrain provides worst-case results and therefore local terrain has been included within the model based on OS Terrain 50 data, as shown in Figure 3.

## $NO_X$ to $NO_2$ conversion

6.21 NOx emissions will be in the form of nitric oxide (NO) and primary $NO_2$. The primary $NO_2$ from natural gas-fuelled burners is likely to be 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 $O_3$.

6.22 The EA (2022) recommends that, as a conservative approach:

- 70% of the NOx emitted converts to $NO_2$ for the annual mean average concentrations; and
- 35% of the 1-hour mean NOx emitted converts to $NO_2$ for the 1-hour mean average concentrations.

6.23 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.

6.24 The contribution of roads to $NO_2$ concentrations has been calculated using Defra's tool for this purpose.

## Model Post-Processing

### Deposition

6.25 Deposition of $NO_2$ has not been included within the dispersion model because $NO_2$ has been calculated from NOx outside of the model. Instead, deposition has been calculated from the predicted ambient concentrations using the deposition velocity set out in Table 18. 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[2].

**Table 18: Deposition Velocities Used in This Assessment**

| Pollutant | Deposition Velocity (m/s) | Reference |
|---|---|---|
| Nitrogen Dioxide | 0.0015 m/s (Grassland) | AQTAG06 (2011) |
| | 0.003 m/s (Forest) | AQTAG06 (2011) |

6.26 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 $NO_2$ means that any scavenging of this gas will be a negligible factor.

2 i.e. 1 kg N/ha/yr = 0.071 keq/ha/yr

### Uncertainty

6.27 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.

6.28 On balance, when taking into account the assumed number of operating hours; the approach taken to meteorological conditions and the sensitivity testing for building downwash, terrain effects and surface roughness, 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.

# 7 Assessment Approach

7.1 EA guidance (EA, 2022) states that, following detailed modelling, Process Contributions (PCs) are insignificant where they are less than:

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

7.2 This is the case regardless of the total concentration or deposition flux (i.e. the PC + the local baseline, or the Predicted Environmental Concentration 'PEC').

7.3 For local nature conservation sites and ancient woodlands, the EA (2022) states that PCs are insignificant where they are less than 100% of either a long-term or short-term standard.

7.4 Where these criteria are not met following detailed modelling, the EA does not provide any specific assessment criteria but instead requires a judgement of significance based on the site-specific circumstances, taking into account the PCs and PECs. EA guidance (EA, 2022) does, however, provide a further screening criterion for long-term PECs, suggesting that where the long-term PEC is less than 70% of the long-term environmental standard then no further assessment is required.

7.5 For human health receptors, the approach has been to provide contour plots which highlight the area within which PCs cannot be considered insignificant using the criteria outlined in Paragraph 7.1. Consideration is also given to the maximum PCs at locations with relevant exposure to the AQS, and to the PECs. A judgement of significance has then reached based on the potential for the facility to cause an exceedance of the AQS.

7.6 For the designated ecological sites, the assessment has focused on the maximum PCs within the designated sites.

# 8 Results

8.1 Results in this section are given to several of significant figures. This does not necessarily reflect the accuracy of the results.

## Road traffic

8.2 Annual mean $NO_2$ concentrations increase by less than 0.05 µg/m$^3$ at all modelled receptors as a result of the increase in traffic due to the proposed development. Annual mean $PM_{10}$ and $PM_{2.5}$ concentrations increase by less than 0.01 µg/m$^3$ and 0.005 µg/m$^3$ respectively. These increases are extremely small and have therefore not been assessed further.

## Human Health Receptors

### *Nitrogen dioxide*

8.3 Figure 10 presents the area where the annual mean $NO_2$ Process Contribution (PC) is greater than 0.4 µg/m$^3$ (1% of the AQS). This covers an area which extends up to approximately 3.5 km from the exhaust flues.

8.4 Figure 11 presents the area where the PC to the 99.79$^{th}$ percentile of 1-hour mean $NO_2$ concentrations is greater than 20 µg/m$^3$ (10% of the AQS). This covers an area which extends up to approximately 2 km from the exhaust flues.

8.5 Figure 10 and Figure 11 also show the locations where the maximum PCs are predicted:

- anywhere on the nested Cartesian grids;
- at any location with relevant exposure to each AQS[3]; and
- at any busy roadside location with relevant exposure to each AQS. This is important because baseline concentrations are higher at the roadside, meaning that a smaller PC may give rise to an exceedance of the AQS.

8.6 The predicted PCs and PECs at these worst-case locations are set out in Table 19.

8.7 Predicted PCs and PECs at the specific receptors identified in Figure 8 and Table 14 are set out in Table 20.

[3] See Paragraph 4.3.

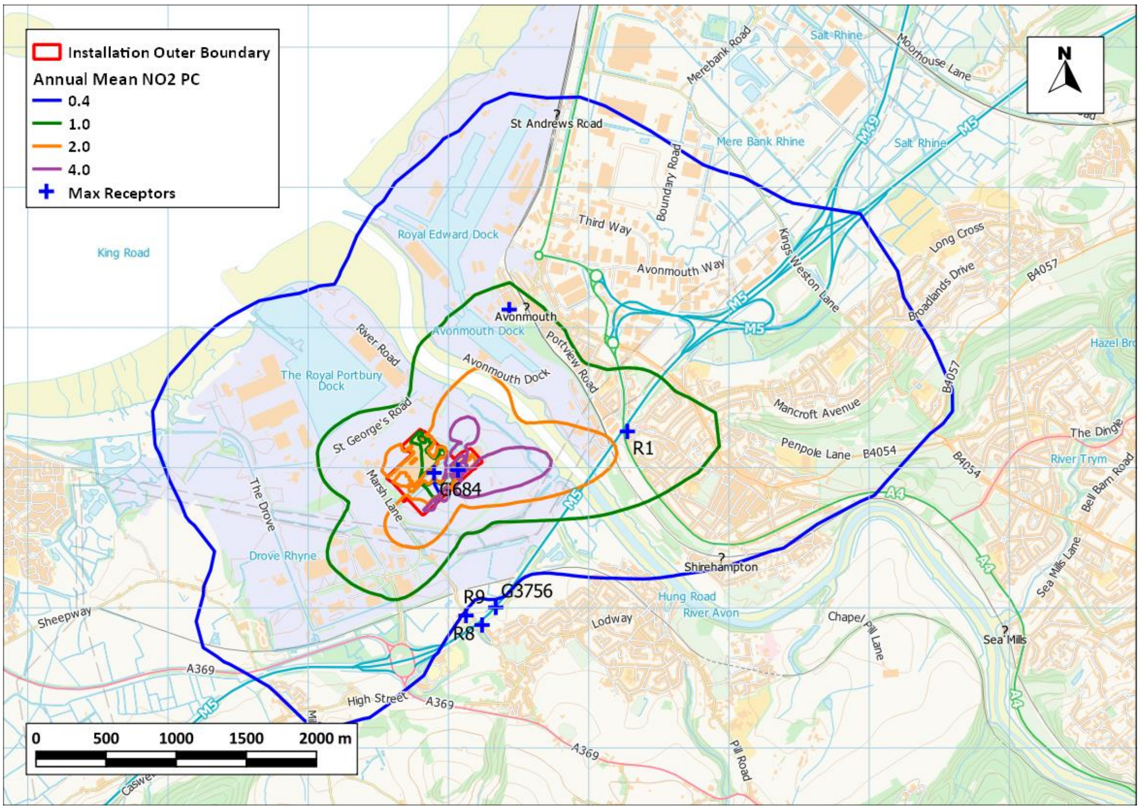



**Figure 10: Contour Plot of Annual Mean $NO_2$ PC and Locations of Maxima**

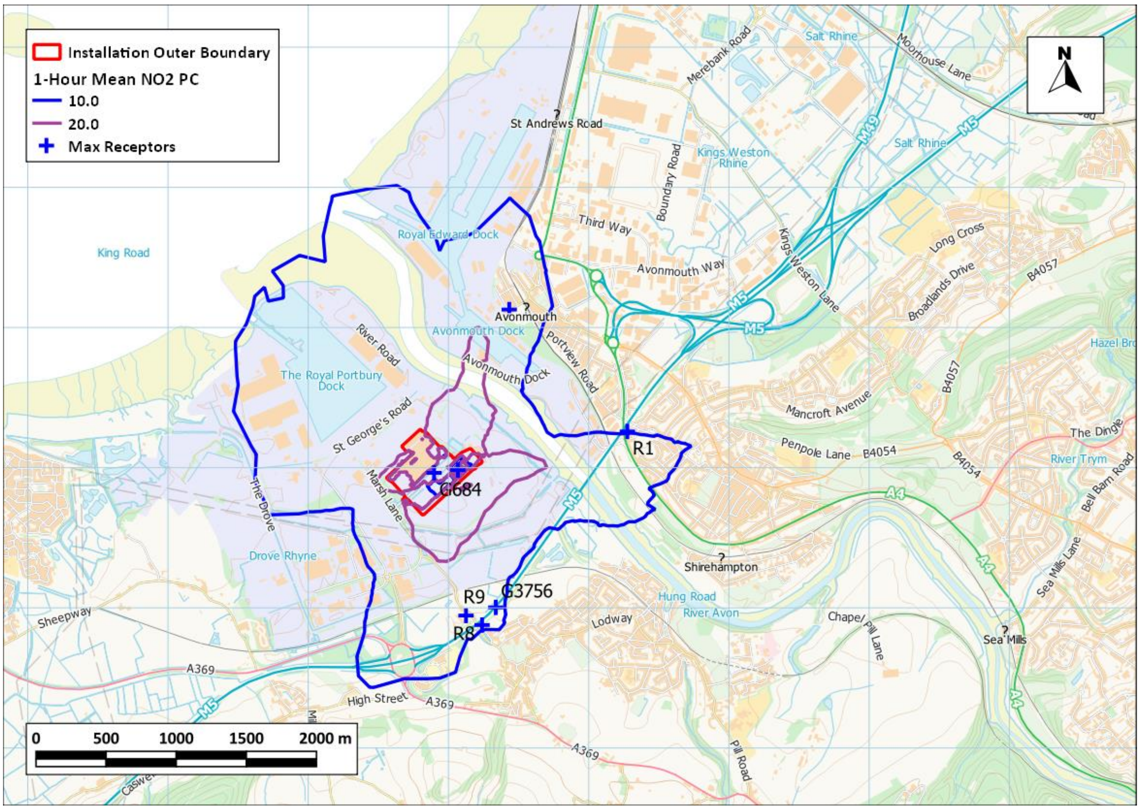



**Figure 11: Contour Plot of the 99.79th Percentile of 1-hour Mean $NO_2$ PC and Locations of Maxima**

### Table 19: Maximum $NO_2$ PCs and PECs Relevant for Human Health

| | Receptor ID | Coordinates | PC (µg/m³) | PC (% of AQS) [a] | PEC (µg/m³) [b] | PEC (% of AQS) |
|---|---|---|---|---|---|---|
| Annual Mean $NO_2$ AQS (40 µg/m³) | | | | | | |
| **Max PC on Grid [c]** | G1382 | 351068, 176983 | 21.8 | 55% | 38.8 | 97% |
| **Max PC at Relevant[3] Receptor** | R1 | 352276, 177258 | 1.7 | 4% | 22.3 | 56% |
| **Max PC at Relevant[3] Roadside Receptor** | R1 | 352276, 177258 | 1.7 | 4% | 22.3 | 56% |
| **Max PEC on Grid [c]** | G3756 | 351338, 176003 | 0.5 | 1% | 70.3 | 176% |
| **Max PEC at Relevant[3] Receptor** | R8 | 351240, 175877 | 0.4 | 1% | 36.8 | 92% |
| **Max PEC at Relevant[3] Roadside Receptor** | R8 | 351240, 175877 | 0.4 | 1% | 36.8 | 92% |
| 1-hour Mean $NO_2$ AQS (200 µg/m³) [d] | | | | | | |
| **Max PC on Grid [c]** | G684 | 350898, 176963 | 64.6 | 32% | 95.6 | 48% |
| **Max PC at Relevant[3] Receptor** | R12 | 351434, 178128 | 15.1 | 8% | 44.9 | 22% |
| **Max PC at Relevant[3] Roadside Receptor** | R9 | 351126, 175945 | 11.5 | 6% | 55.4 | 28% |
| **Max PEC on Grid [c]** | G3756 | 351338, 176003 | 11.3 | 6% | 152.0 | 76% |
| **Max PEC at Relevant[3] Receptor** | R8 | 351240, 175877 | 10.3 | 5% | 84.0 | 42% |
| **Max PEC at Relevant[3] Roadside Receptor** | R8 | 351240, 175877 | 10.3 | 5% | 84.0 | 42% |

[a] Based on unrounded numbers.

[b] After adding the relevant baseline concentrations (paragraph 5.4).

[c] This row has been greyed out as the AQS do not apply at this location.

[d] 99.79$^{th}$ percentile of 1-hour means. PCs for the 100$^{th}$ percentile of 1-hour mean concentrations are provided in Appendix A2.

### Table 20: $NO_2$ PCs and PECs at Specific Receptors

| Receptor ID | Annual Mean $NO_2$ AQS (40 µg/m³) | | | | 1-hour Mean $NO_2$ 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** | 1.7 | 4% | 22.3 | 56% | 9.5 | 5% | 51.4 | 26% |
| **R2** | 1.4 | 4% | 22.7 | 57% | 6.4 | 3% | 49.7 | 25% |
| **R3** | 1.0 | 2% | 30.3 | 76% | 6.1 | 3% | 65.5 | 33% |
| **R4** | 1.0 | 2% | 34.7 | 87% | 5.9 | 3% | 74.0 | 37% |
| **R5** | 0.2 | 1% | 13.0 | 32% | 2.9 | 1% | 28.9 | 14% |

| Receptor ID | Annual Mean $NO_2$ AQS (40 µg/m³) | | | | 1-hour Mean $NO_2$ 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] |
| **R6** | 1.0 | 3% | 33.0 | 83% | 6.1 | 3% | 70.9 | 35% |
| **R7** | 0.4 | 1% | 24.9 | 62% | 5.1 | 3% | 54.9 | 27% |
| **R8** | 0.4 | 1% | 36.8 | 92% | 10.3 | 5% | 84.0 | 42% |
| **R9** | 0.4 | 1% | 21.9 | 55% | 11.5 | 6% | 55.4 | 28% |
| **R11** | 1.6 | 4% | 23.0 | 57% | 14.2 | 7% | 58.7 | 29% |
| **R12** | 1.2 | 3% | 15.6 | 39% | 15.1 | 8% | 44.9 | 22% |
| **R13** | 1.1 | 3% | 15.4 | 39% | 6.9 | 3% | 36.5 | 18% |
| **R14** | 1.1 | 3% | 16.0 | 40% | 6.5 | 3% | 37.1 | 19% |
| **R15** | 1.1 | 3% | 14.4 | 36% | 9.7 | 5% | 37.1 | 19% |
| **R16** | 0.5 | 1% | 14.3 | 36% | 8.0 | 4% | 36.3 | 18% |
| **R17** | 0.3 | 1% | 18.1 | 45% | 7.6 | 4% | 44.0 | 22% |
| **R18** | 0.3 | 1% | 19.3 | 48% | 10.1 | 5% | 48.9 | 24% |
| **R19** | 0.5 | 1% | 17.8 | 45% | 8.6 | 4% | 44.1 | 22% |
| **R20** | 0.5 | 1% | 14.9 | 37% | 5.7 | 3% | 35.4 | 18% |
| **R21** | 0.3 | 1% | 8.9 | 22% | 5.6 | 3% | 23.7 | 12% |
| **R22** | 0.3 | 1% | 9.0 | 22% | 5.1 | 3% | 23.4 | 12% |

[a] 99.79$^{th}$ percentile of 1-hour means

[b] After adding the relevant baseline concentrations (paragraph 5.4).

[c] Based on unrounded numbers.

### *$PM_{10}$*

8.8 Figure 12 presents the area where the annual mean $PM_{10}$ PC is greater than 0.4 µg/m³ (1% of the AQS). This covers an area which extends up to approximately 800 m from the exhaust flues.

8.9 Figure 13 presents the area where the PC to the 90.4th percentile of 24-hour mean $PM_{10}$ concentrations is greater than 5 µg/m³ (10% of the AQS). This area is confined to the immediate vicinity of the exhaust flues.

8.10 Figure 12 and Figure 13 also show the locations where the maximum PCs are predicted:

- anywhere on the nested Cartesian grids;
- at any location with relevant exposure to each AQS[4]; and

[4] See Paragraph 4.3.

- at any busy roadside location with relevant exposure to each AQS. This is important because baseline concentrations are higher at the roadside, meaning that a smaller PC may give rise to an exceedance of the AQS.

8.11 The predicted PCs and PECs at these worst-case locations are set out in Table 21.

8.12 Predicted PCs and PECs at the specific receptors identified in Figure 8 and Table 14 are set out in Table 22.

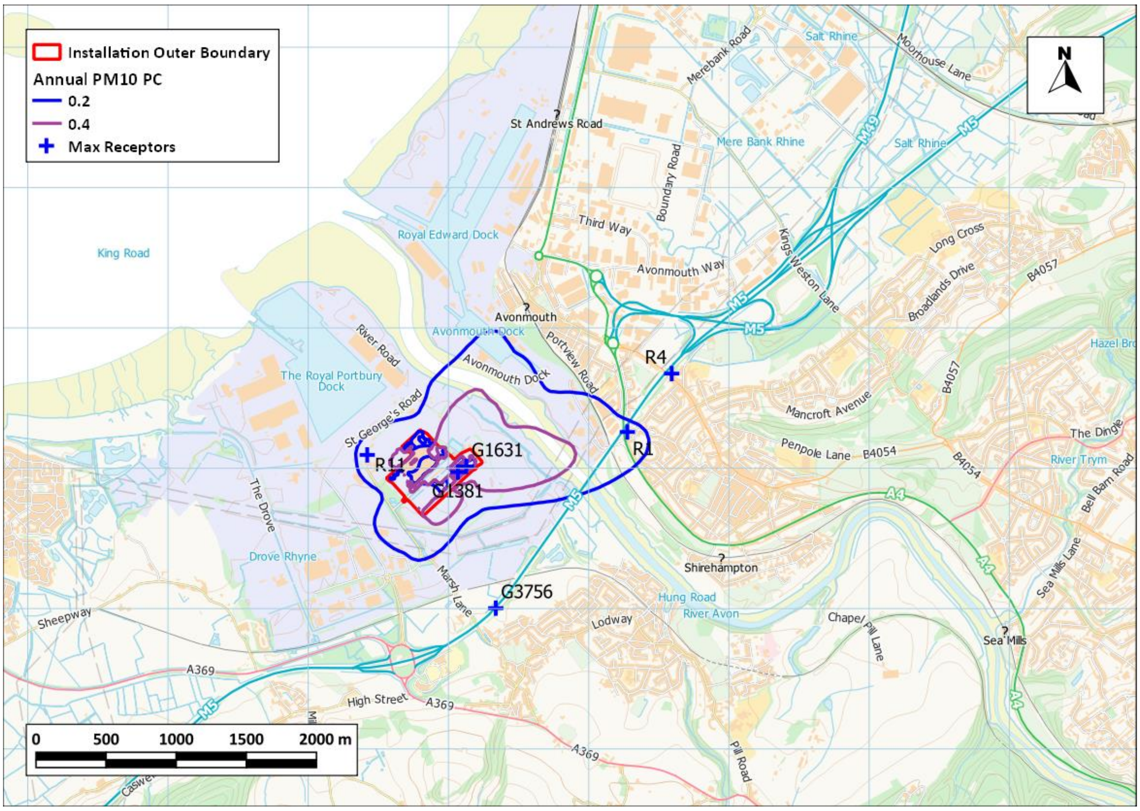



**Figure 12: Contour Plot of Annual Mean $PM_{10}$ PC and Locations of Maxima**

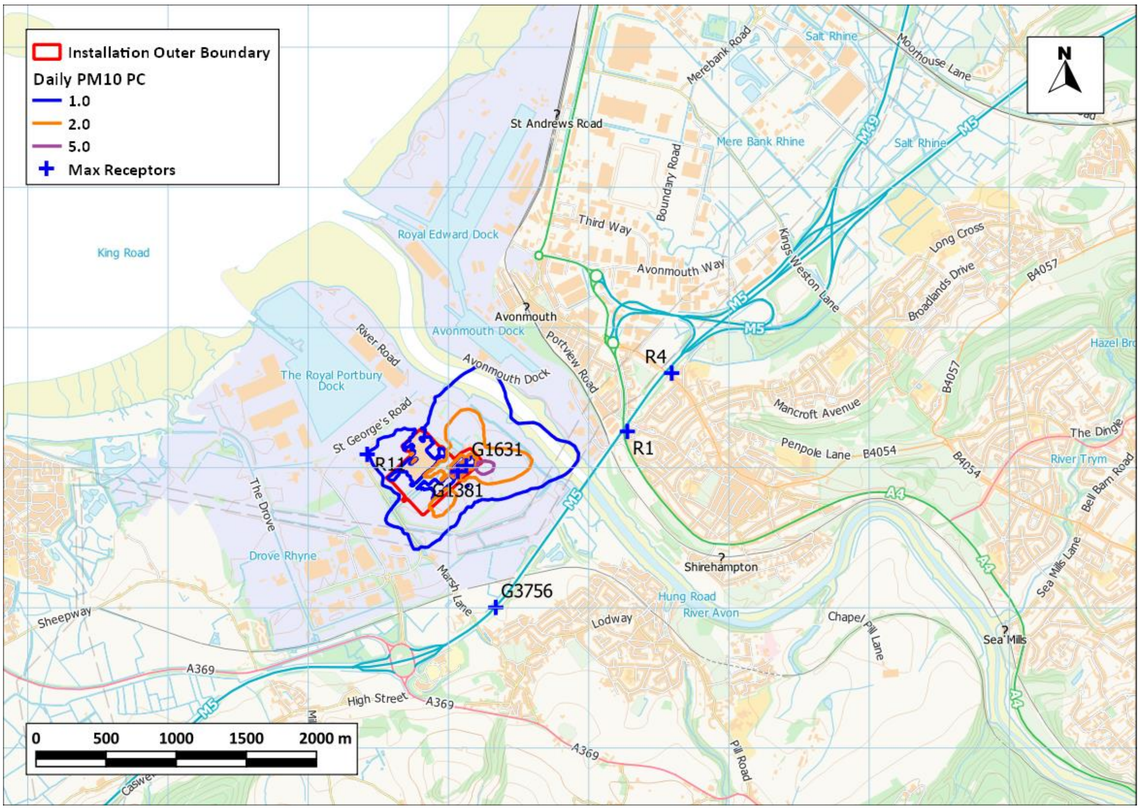



**Figure 13: Contour Plot of the 90.4th Percentile of 24-hour Mean $PM_{10}$ PC and Locations of Maxima**

**Table 21: Maximum $PM_{10}$ PCs and PECs Relevant for Human Health**

| | Receptor ID | Coordinates | PC (µg/m³) | PC (% of AQS) [a] | PEC (µg/m³) [b] | PEC (% of AQS) |
|---|---|---|---|---|---|---|
| Annual Mean $PM_{10}$ AQS (40 µg/m³) | | | | | | |
| Max PC on Grid [c] | G1381 | 351068, 176973 | 4.3 | 11% | 20.3 | 51% |
| Max PC at Relevant³ Receptor | R11 | 350421, 177095 | 0.2 | 1% | 13.2 | 33% |
| Max PC at Relevant³ Roadside Receptor | R1 | 352276, 177258 | 0.2 | 1% | 15.9 | 40% |
| Max PEC on Grid [c] | G1381 | 351068, 176973 | 4.3 | 11% | 20.3 | 51% |
| Max PEC at Relevant³ Receptor | R4 | 352593, 177674 | 0.1 | 0% | 16.6 | 42% |
| Max PEC at Relevant³ Roadside Receptor | R4 | 352593, 177674 | 0.1 | 0% | 16.6 | 42% |
| 24-hour Mean $PM_{10}$ AQS (50 µg/m³) [d] | | | | | | |
| Max PC on Grid [c] | G1631 | 351128, 177013 | 6.9 | 3% | 35.3 | 18% |
| Max PC at Relevant³ Receptor | R11 | 350421, 177095 | 1.0 | 1% | 28.0 | 14% |
| Max PC at Relevant³ Roadside Receptor | R1 | 352276, 177258 | 0.6 | 0% | 32.1 | 16% |
| Max PEC on Grid [c] | G3756 | 351338, 176003 | 0.2 | 0% | 38.8 | 19% |
| Max PEC at Relevant³ Receptor | R4 | 352593, 177674 | 0.3 | 0% | 33.5 | 17% |
| Max PEC at Relevant³ Roadside Receptor | R4 | 352593, 177674 | 0.3 | 0% | 33.5 | 17% |

[a] Based on unrounded numbers.

[b] After adding the relevant baseline concentrations (paragraph 5.4).

[c] This row has been greyed out as the AQS do not apply at this location.

[d] 99.79th percentile of 1-hour means. PCs for the 100th percentile of 1-hour mean concentrations are provided in Appendix A2.

**Table 22: $PM_{10}$ PCs and PECs at Specific Receptors**

| Receptor ID | Annual Mean $PM_{10}$ AQS (40 µg/m³) | | | | 24-hour Mean $PM_{10}$ 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 | 0.2 | 1% | 15.9 | 40% | 0.6 | 1% | 32.1 | 64% |
| R2 | 0.2 | 0% | 15.9 | 40% | 0.5 | 1% | 32.2 | 64% |
| R3 | 0.1 | 0% | 16.3 | 41% | 0.4 | 1% | 32.8 | 66% |
| R4 | 0.1 | 0% | 16.6 | 42% | 0.3 | 1% | 33.5 | 67% |
| R5 | 0.0 | 0% | 14.1 | 35% | 0.1 | 0% | 28.3 | 57% |

| Receptor ID | Annual Mean $PM_{10}$ AQS (40 µg/m³) | | | | 24-hour Mean $PM_{10}$ 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] |
| **R6** | 0.1 | 0% | 16.5 | 41% | 0.3 | 1% | 33.2 | 66% |
| **R7** | 0.0 | 0% | 14.4 | 36% | 0.2 | 0% | 29.4 | 59% |
| **R8** | 0.1 | 0% | 15.1 | 38% | 0.2 | 0% | 30.3 | 61% |
| **R9** | 0.1 | 0% | 14.0 | 35% | 0.2 | 0% | 28.3 | 57% |
| **R11** | 0.2 | 1% | 13.2 | 33% | 1.0 | 2% | 28.0 | 56% |
| **R12** | 0.2 | 0% | 14.2 | 35% | 0.6 | 1% | 29.0 | 58% |
| **R13** | 0.2 | 0% | 13.2 | 33% | 0.5 | 1% | 26.8 | 54% |
| **R14** | 0.2 | 0% | 13.3 | 33% | 0.4 | 1% | 27.0 | 54% |
| **R15** | 0.1 | 0% | 13.8 | 35% | 0.4 | 1% | 28.0 | 56% |
| **R16** | 0.1 | 0% | 13.6 | 34% | 0.2 | 0% | 27.7 | 55% |
| **R17** | 0.0 | 0% | 15.1 | 38% | 0.1 | 0% | 30.5 | 61% |
| **R18** | 0.0 | 0% | 13.8 | 35% | 0.1 | 0% | 27.9 | 56% |
| **R19** | 0.1 | 0% | 14.2 | 35% | 0.2 | 0% | 28.7 | 57% |
| **R20** | 0.1 | 0% | 13.8 | 35% | 0.3 | 1% | 28.2 | 56% |
| **R21** | 0.0 | 0% | 11.7 | 29% | 0.2 | 0% | 23.8 | 48% |
| **R22** | 0.0 | 0% | 11.0 | 28% | 0.1 | 0% | 22.4 | 45% |

[a] 99.79th percentile of 1-hour means

[b] After adding the relevant baseline concentrations (paragraph 5.4).

[c] Based on unrounded numbers.

### *$PM_{2.5}$*

8.13 Figure 14 presents the area where the annual mean $PM_{2.5}$ Process Contribution (PC) is greater than 0.25 µg/m³ (1% of the AQS). This covers an area which extends up to approximately 1,200 m from the exhaust flues.

8.14 Figure 14 also shows the locations where the maximum PCs are predicted:

- anywhere on the nested Cartesian grids;
- at any location with relevant exposure to each AQS[5]; and
- at any busy roadside location with relevant exposure to each AQS. This is important because baseline concentrations are higher at the roadside, meaning that a smaller PC may give rise to an exceedance of the AQS.

8.15 The predicted PCs and PECs at these worst-case locations are set out in Table 23.

[5] See Paragraph 4.3.

8.16 Predicted PCs and PECs at the specific receptors identified in Figure 8 and Table 14 are set out in Table 24.

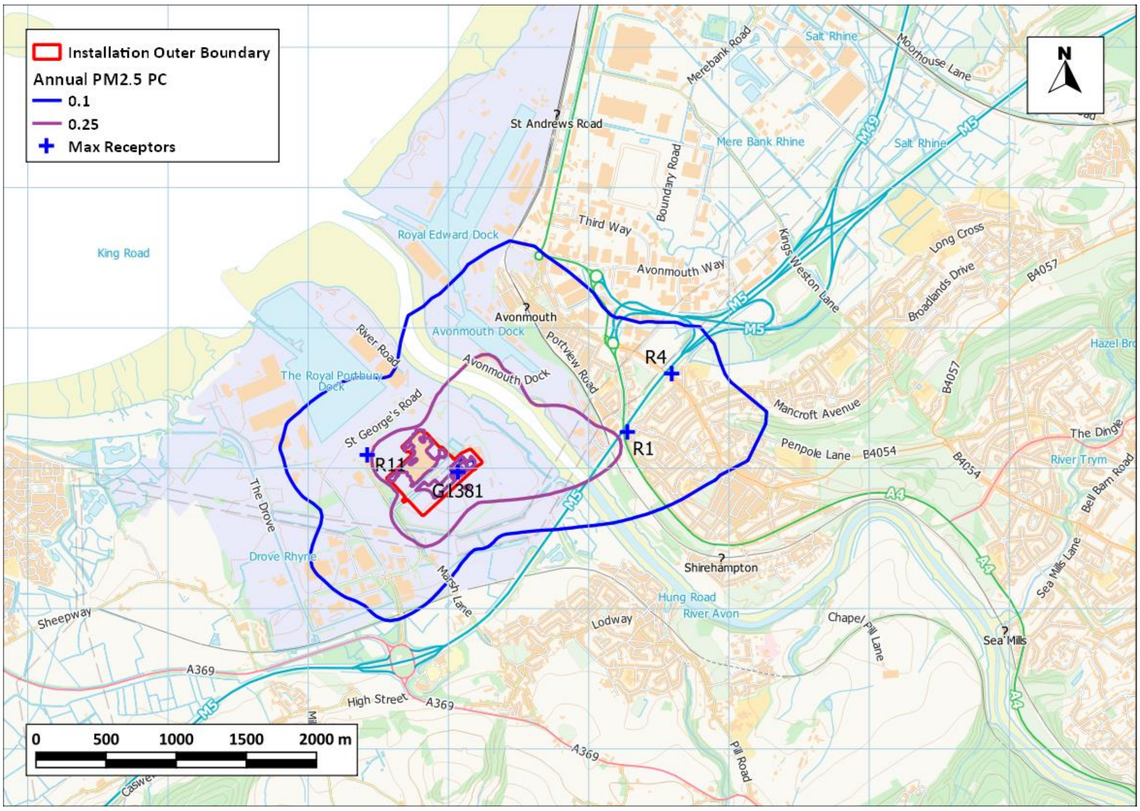



**Figure 14: Contour Plot of Annual Mean $PM_{2.5}$ PC and Locations of Maxima**

**Table 23: Maximum $PM_{2.5}$ PCs and PECs Relevant for Human Health**

| | Receptor ID | Coordinates | PC (µg/m³) | PC (% of AQS) [a] | PEC (µg/m³) [b] | PEC (% of AQS) |
|---|---|---|---|---|---|---|
| Annual Mean $PM_{2.5}$ AQS (25 µg/m³) | | | | | | |
| **Max PC on Grid** [c] | G1381 | 351068, 176973 | 4.3 | 17% | 14.4 | 57% |
| **Max PC at Relevant[3] Receptor** | R11 | 350421, 177095 | 0.2 | 1% | 8.6 | 35% |
| **Max PC at Relevant[3] Roadside Receptor** | R1 | 352276, 177258 | 0.2 | 1% | 10.3 | 41% |
| **Max PEC on Grid** [c] | G1381 | 351068, 176973 | 4.3 | 17% | 14.4 | 57% |
| **Max PEC at Relevant[3] Receptor** | R4 | 352593, 177674 | 0.1 | 1% | 10.6 | 43% |
| **Max PEC at Relevant[3] Roadside Receptor** | R4 | 352593, 177674 | 0.1 | 1% | 10.6 | 43% |

[a] Based on unrounded numbers.

[b] After adding the relevant baseline concentrations (paragraph 5.4).

[c] This row has been greyed out as the AQS do not apply at this location.

[d] 99.79th percentile of 1-hour means. PCs for the 100th percentile of 1-hour mean concentrations are provided in Appendix A2.

**Table 24: $PM_{2.5}$ PCs and PECs at Specific Receptors**

| Receptor ID | Annual Mean $PM_{2.5}$ AQS (25 µg/m³) | | | |
|---|---|---|---|---|
| | PC | | PEC [a] | |
| | µg/m³ | % AQS [b] | µg/m³ | % AQS [b] |
| **R1** | 0.2 | 1% | 10.3 | 41% |
| **R2** | 0.2 | 1% | 10.3 | 41% |
| **R3** | 0.1 | 1% | 10.4 | 42% |
| **R4** | 0.1 | 1% | 10.6 | 43% |
| **R5** | 0.0 | 0% | 8.9 | 36% |
| **R6** | 0.1 | 1% | 10.6 | 42% |
| **R7** | 0.0 | 0% | 9.1 | 36% |
| **R8** | 0.0 | 0% | 9.6 | 38% |
| **R9** | 0.1 | 0% | 9.0 | 36% |
| **R11** | 0.2 | 1% | 8.6 | 35% |
| **R12** | 0.2 | 1% | 8.9 | 36% |
| **R13** | 0.2 | 1% | 8.5 | 34% |
| **R14** | 0.2 | 1% | 8.6 | 35% |
| **R15** | 0.1 | 1% | 9.0 | 36% |
| **R16** | 0.1 | 0% | 8.8 | 35% |

| Receptor ID | Annual Mean $PM_{2.5}$ AQS (25 µg/m³) | | | |
|---|---|---|---|---|
| | PC | | PEC [a] | |
| | µg/m³ | % AQS [b] | µg/m³ | % AQS [b] |
| **R17** | 0.0 | 0% | 9.2 | 37% |
| **R18** | 0.0 | 0% | 8.8 | 35% |
| **R19** | 0.1 | 0% | 8.9 | 36% |
| **R20** | 0.1 | 0% | 8.7 | 35% |
| **R21** | 0.0 | 0% | 7.6 | 30% |
| **R22** | 0.0 | 0% | 7.3 | 29% |

[a] After adding the relevant baseline concentrations (paragraph 5.4).

[b] % rounded to nearest whole number and based on unrounded PCs.

## Designated Ecological Sites

8.17 Figure 15 and Figure 16 present contours of annual mean NOx and daily mean NOx concentrations respectively. Contours of nitrogen deposition and acid deposition are not presented, since these depend on the type of vegetation present.

8.18 Table 25, Table 26, Table 27 and Table 28 present the maximum PCs and PECs at any of the designated ecological sites for annual mean NOx, daily mean NOx, annual mean nitrogen deposition and annual mean acid deposition respectively.

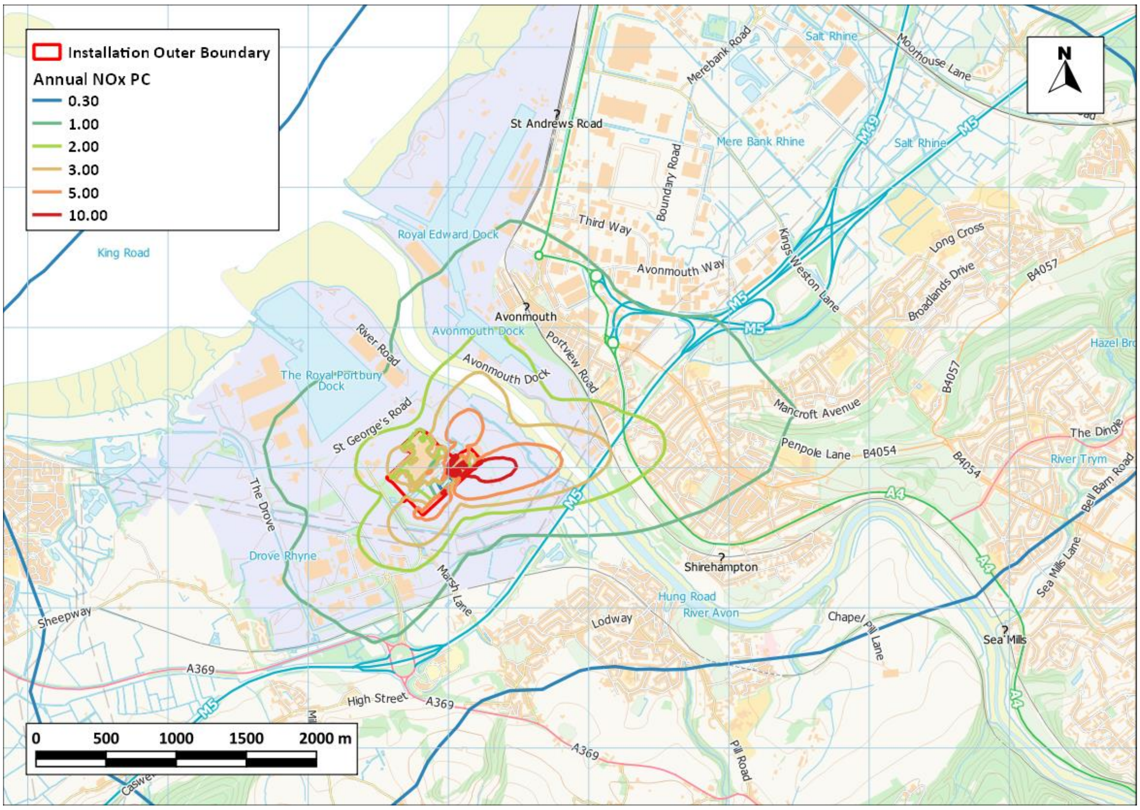
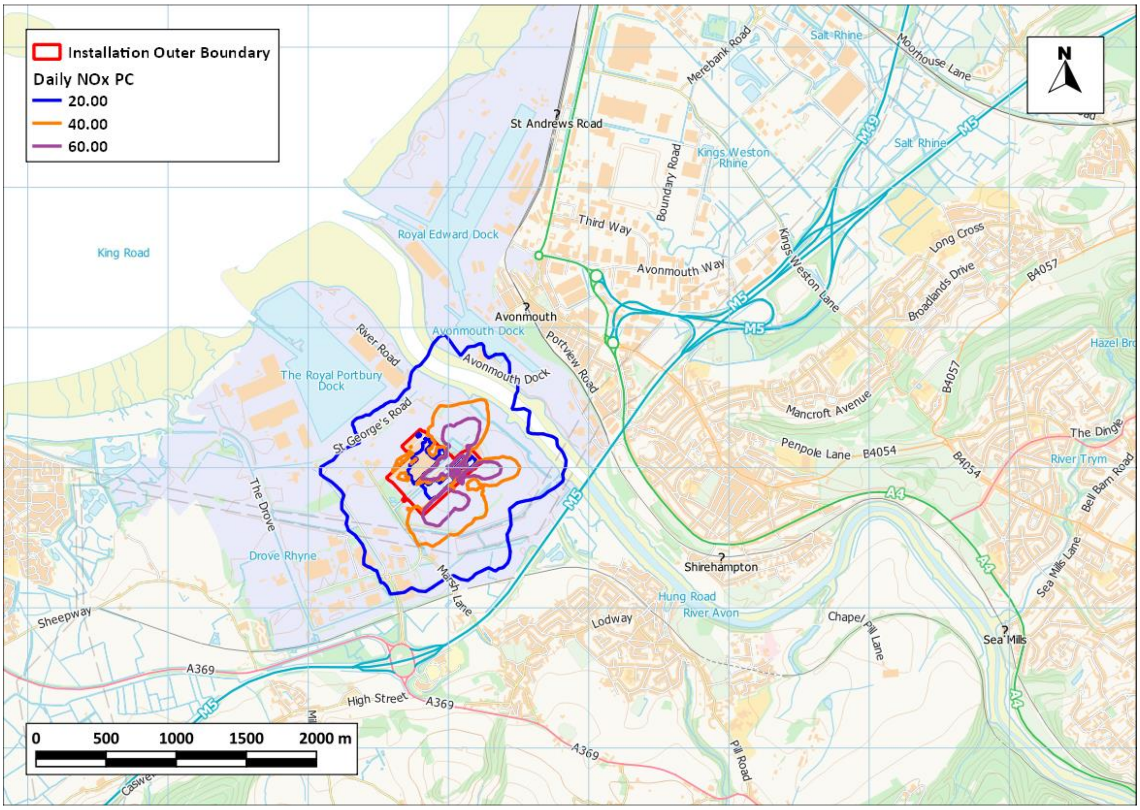



**Figure 15: Contour Plot of Annual Mean NOx PC and Locations of Maxima**




## Figure 16: Contour Plot of Daily Mean NOx PC and Locations of Maxima



### Table 25: Annual Mean NOx PCs and PECs at Specific Receptors

| Receptor ID | Description | Annual Mean NOx AQS (30 µg/m³) | | | |
|---|---|---|---|---|---|
| | | PC | | PEC [a] | |
| | | µg/m³ | % AQS [b] | µg/m³ | % AQS [b] |
| **E1** | Severn Estuary | 0.2 | 1% | 9.2 | 31% |
| **E2** | Severn Estuary | 0.8 | 3% | 16.6 | 55% |
| **E3** | Severn Estuary | 0.6 | 2% | 21.4 | 71% |
| **E4** | Severn Estuary | 1.3 | 4% | 33.4 | 111% |
| **E5** | Severn Estuary | 3.1 | 10% | 22.8 | 76% |
| **E6** | Severn Estuary | 3.4 | 11% | 24.1 | 80% |
| **E7** | Severn Estuary | 7.8 | 26% | 28.8 | 96% |
| **E8** | Severn Estuary | 1.8 | 6% | 27.2 | 91% |
| **E9** | Severn Estuary | 0.7 | 2% | 20.4 | 68% |
| **E10** | Avon Gorge Woodlands | 0.2 | 1% | 10.9 | 36% |
| **E11** | Hails Wood AW | 0.3 | 1% | 18.0 | 60% |
| **E12** | Longlands Wood AW | 0.5 | 2% | 23.3 | 78% |

| Receptor ID | Description | Annual Mean NOx AQS (30 µg/m³) | | | |
|---|---|---|---|---|---|
| | | PC | | PEC [a] | |
| | | µg/m³ | % AQS [b] | µg/m³ | % AQS [b] |
| **E13** | St George's Flower Bank LNR | 0.3 | 1% | 18.4 | 61% |

[a] After adding the relevant baseline concentrations (paragraph 5.4).

[b] % rounded to nearest whole number and based on unrounded PCs.

**Table 26: Daily Mean NOx PCs and PECs at Specific Receptors**

| Receptor ID | Description | 24-hour Mean NOx AQS (200 µg/m³) | | | |
|---|---|---|---|---|---|
| | | PC | | PEC [a] | |
| | | µg/m³ | % AQS [b] | µg/m³ | % AQS [b] |
| **E1** | Severn Estuary | 8.3 | 4% | 28.0 | 14% |
| **E2** | Severn Estuary | 25.3 | 13% | 60.5 | 30% |
| **E3** | Severn Estuary | 27.3 | 14% | 73.7 | 37% |
| **E4** | Severn Estuary | 45.1 | 23% | 113.9 | 57% |
| **E5** | Severn Estuary | 60.3 | 30% | 104.8 | 52% |
| **E6** | Severn Estuary | 42.6 | 21% | 87.4 | 44% |
| **E7** | Severn Estuary | 63.0 | 32% | 108.1 | 54% |
| **E8** | Severn Estuary | 33.2 | 17% | 86.8 | 43% |
| **E9** | Severn Estuary | 23.1 | 12% | 65.0 | 32% |
| **E10** | Avon Gorge Woodlands | 9.3 | 5% | 32.2 | 16% |
| **E11** | Hails Wood AW | 19.6 | 10% | 57.4 | 29% |
| **E12** | Longlands Wood AW | 24.3 | 12% | 72.1 | 36% |
| **E13** | St George's Flower Bank LNR | 21.6 | 11% | 60.2 | 30% |

[a] After adding the relevant baseline concentrations (paragraph 5.4).

[b] % rounded to nearest whole number and based on unrounded PCs.

**Table 27: Nitrogen Deposition PCs and PECs at Specific Receptors**

| Receptor ID | Description | Minimum critical load (kgN/ha/y) | Annual Mean Nitrogen Deposition Rate | | | |
|---|---|---|---|---|---|---|
| | | | PC | | PEC [a] | |
| | | | µg/m³ | % AQS [b] | µg/m³ | % AQS [b] |
| **E1** | Severn Estuary | 20 | 0.02 | 0% | 18.92 | 95% |
| **E2** | Severn Estuary | 20 | 0.08 | 0% | 17.68 | 88% |
| **E3** | Severn Estuary | 20 | 0.06 | 0% | 17.66 | 88% |
| **E4** | Severn Estuary | 20 | 0.13 | 1% | 18.23 | 91% |
| **E5** | Severn Estuary | 20 | 0.31 | 2% | 17.91 | 90% |
| **E6** | Severn Estuary | 20 | 0.34 | 2% | 17.94 | 90% |

| Receptor ID | Description | Minimum critical load (kgN/ha/y) | Annual Mean Nitrogen Deposition Rate | | | |
|---|---|---|---|---|---|---|
| | | | PC | | PEC [a] | |
| | | | µg/m³ | % AQS [b] | µg/m³ | % AQS [b] |
| **E7** | Severn Estuary | 20 | 0.79 | 4% | 18.39 | 92% |
| **E8** | Severn Estuary | 20 | 0.18 | 1% | 17.78 | 89% |
| **E9** | Severn Estuary | 20 | 0.07 | 0% | 18.27 | 91% |
| **E10** | Avon Gorge Woodlands | 15 | 0.03 | 0% | 34.03 | 227% |
| **E11** | Hails Wood AW | 10 | 0.05 | 1% | 29.73 | 297% |
| **E12** | Longlands Wood AW | 10 | 0.10 | 1% | 29.78 | 298% |
| **E13** | St George's Flower Bank LNR | 5 | 0.03 | 1% | 16.69 | 334% |

[a] After adding the relevant baseline concentrations (paragraph 5.4).

[b] % rounded to nearest whole number and based on unrounded PCs.

**Table 28: Acid Deposition PCs and PECs at Specific Receptors**

| Receptor ID | Description | Annual Mean Acid Deposition Rate | | | |
|---|---|---|---|---|---|
| | | PC | | PEC [b] | |
| | | keq/ha/y | % AQS [c] | keq/ha/y | % AQS [c] |
| **E1** | Severn Estuary [a] | 0.001 | N/A | 1.60 | N/A |
| **E2** | Severn Estuary [a] | 0.005 | N/A | 1.41 | N/A |
| **E3** | Severn Estuary [a] | 0.004 | N/A | 1.40 | N/A |
| **E4** | Severn Estuary [a] | 0.009 | N/A | 1.51 | N/A |
| **E5** | Severn Estuary [a] | 0.022 | N/A | 1.52 | N/A |
| **E6** | Severn Estuary [a] | 0.025 | N/A | 1.52 | N/A |
| **E7** | Severn Estuary [a] | 0.056 | N/A | 1.56 | N/A |
| **E8** | Severn Estuary [a] | 0.013 | N/A | 1.51 | N/A |
| **E9** | Severn Estuary [a] | 0.005 | N/A | 1.51 | N/A |
| **E10** | Avon Gorge Woodlands | 0.002 | 0% | 2.60 | 214% |
| **E11** | Hails Wood AW | 0.004 | 0% | 2.29 | 84% |
| **E12** | Longlands Wood AW | 0.007 | 0% | 2.30 | 84% |
| **E13** | St George's Flower Bank LNR | 0.002 | 0% | 1.33 | 27% |

[a] Not sensitive to acidity.

[b] After adding the relevant baseline concentrations (paragraph 5.4).

[c] Percent of critical load function. Based on unrounded numbers.

# 9 Discussion

## Human Health Receptors

### *Annual Mean $NO_2$*

9.1 Figure 10 shows that the PC exceeds 1% of the long-term $NO_2$ AQS across a broad area of Avonmouth and west Bristol. Table 19 shows that the PEC is exceeded at some modelled grid receptors, but this is because the grid covers the carriageway of the M5 motorway which is not a location of relevant exposure, and the high concentrations are due to the existing road traffic. Table 19 and Table 20 show that the PEC is below the AQS at all modelled receptors with relevant exposure, although it is close to the AQS at some locations close to the M5 motorway, e.g. receptor R8 where Marsh Lane passes under the motorway; this is predominantly due to the existing road traffic, and the extra contribution from the Proposed Development (including additional road traffic) is less than 1% of the AQS at this location. The greatest PC at a receptor with relevant exposure is 1.7 $\mu g/m^3$ or 4% of the AQS at receptor R1, where the PEC is 22 $\mu g/m^3$ or 56% of the AQS. Considering that the assessment makes a number of conservative and worst-case assumptions, it is unlikely that the proposed development would result in an exceedance of the AQS at any relevant location.

### *1-hour Mean $NO_2$*

9.2 Figure 11 shows that the PC exceeds 10% of the short-term $NO_2$ AQS across an area around the Proposed Development, but this area is confined to the industrial site with limited public access. Table 19 shows that the PEC will remain well below the AQS, even where there is no relevant exposure and including within the carriageway of the M5 motorway. There is thus no risk that the AQS will be exceeded as a result of the facility.

### *Annual Mean $PM_{10}$*

9.3 Figure 12 shows that the PC exceeds 1% of the long-term $PM_{10}$ AQS close to the facility, but this is confined to an area of the industrial estate around the facility. Table 21 shows that the PEC remains well below the AQS at all modelled locations, including within the carriageway of the motorway. There is therefore no risk that the AQS will be exceeded as a result of the facility.

### *24-hour Mean $PM_{10}$*

9.4 Figure 13 shows that the PC exceeds 10% of the short-term $PM_{10}$ AQS in a small area very close to the Proposed Development. The PEC will remain well below the AQS, even where there is no relevant exposure. There is thus no risk that the AQS will be exceeded as a result of the facility.

### *Annual Mean $PM_{2.5}$*

9.5 Figure 14 shows that the PC exceeds 1% of the long-term $PM_{2.5}$ AQS across an area of the industrial estate around the facility. Table 23 shows that the PEC remains well below the AQS at all modelled locations, including within the carriageway of the motorway. There is therefore no risk that the AQS will be exceeded as a result of the facility.

## Designated Ecological Sites

### *Annual Mean NOx*

9.6 Figure 15 shows that the PC exceeds 1% of the long-term NOx AQS across a large area. Table 25 shows that the greatest PC at any relevant ecological receptor is 7.8 $\mu g/m^3$ or 26% of the AQS at receptor E7, representing the River Avon east of the facility (within the Severn Estuary designated area); the PEC here is 29 $\mu g/m^3$ or 96% of the AQS and this is therefore considered to be not significant.

9.7 The highest PEC is 33.4 $\mu g\ m^{-3}$ or 111% of the AQS at receptor E4, representing the Severn Estuary nearer to the mouth of the River Avon, where the PC is 1.3 $\mu g/m^3$ or 4% of the AQS. The PEC exceeds the critical level at this location, even without the PC. This issue was identified during the planning application for the new installation and was subject to protracted dialogue with both local and national officers within Natural England. A shadow Habitats Regulations Appropriate Assessment was undertaken by ecological consultants on behalf of Etex, which concluded that the contribution of NOx from the Etex facility on the Severn Estuary SAC would be not significant. Comments from Natural England's air quality lead Lydia Knight corroborated these conclusions:

*"there is a compelling argument that the expansion is unlikely to be of high risk due to the specifics of the situation. We do generally advise that tidal saltmarsh is not highly sensitive to air pollution due to the regular influx of nutrients from the water. This is considered on a case by case site specific basis however currently this is not addressed within the appropriate assessment as reason for no adverse effect. The area team have agreed that if this evidence was to be included within the air pollution section on page 21 of the appropriate assessment then we can agree no adverse effect to the designated sites affected and advise no objection to the application to North Somerset Local Authority."*

9.8 It is therefore considered that the impacts of NOx PCs to the Severn Estuary SAC (including at Receptor E4) are not significant.

### *24-hour Mean NOx*

9.9 Figure 16 shows that the PC exceeds 10% of the short-term AQS across a 1.3 km length of the River Avon (within the Severn Estuary designated area). However, Table 26 shows that the PEC is at most 57% of the AQS at any receptor, and there is therefore no risk of the AQS being exceeded. At all other ecological receptors, the PC is less than 10% of the AQS and EA guidance is that these PCs are insignificant.

### Nitrogen deposition

9.10 Table 27 shows that the maximum PCs exceed 1% of the long-term AQS at some receptors along the River Avon (within the Severn Estuary designated area), but the PEC at these receptors remains below the AQS. The maximum PEC at a Severn Estuary receptor is 18.9 kg N/ha/y or 95% of the AQS of 20 kg N/ha/y for this habitat at receptor E1, where the PC is 0.02 kg N/ha/y or 0.1% of the AQS. Considering that the assessment makes a number of conservative and worst-case assumptions, it is unlikely that the proposed development would result in an exceedance of the AQS at any receptor on the Severn Estuary.

9.11 At the Avon Gorge Woodlands SAC (receptor E10), the PEC is at exceedance due to the existing background deposition. However, the PC from the proposed facility is less than 1% of the long-term AQS. The EA guidance is thus that the impact is insignificant regardless of the PEC.

9.12 The other receptors representing ecological sites are local designations (ancient woodland and LNR). Although the PECs at these receptors is at exceedance due to the existing background deposition, the PC at these receptors is at most 1% (rounded) of the long-term AQS. Since this is less than 100% of the long-term AQS, the EA guidance is that these PCs are insignificant regardless of the PEC.

### Acid deposition

9.13 The Severn Estuary is not sensitive to acidity, according to APIS. At the remaining receptors, Table 28 shows that the PC is less than 1% of the long-term AQS (i.e. the site-specific critical load function). The EA guidance is thus that these PCs are insignificant regardless of the PEC.

# 10 Conclusions

10.1 There is no risk that any of the AQS for the protection of human health will be exceeded as a result of the facility at any relevant receptor. On this basis, the impacts are judged to be not significant.

10.2 The impacts at designated ecological sites are either insignificant or will not cause an exceedance of any AQS, with the exception of one location within the Severn Estuary SAC where the AQS for annual mean NOx is exceeded with or without the PC from the installation. The NOx impacts were subject to a shadow HRA Appropriate Assessment at planning stage and agreed with Natural England to be not significant.

10.3 The assessment includes a number of conservative assumptions. It also takes account of the maximum predicted impacts across several sensitivity tests. In particular:

- the assessment of short-term impacts assumes constant operation of the plant;
- 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;
- the results presented are the maxima from modelling both with and without including terrain effects within the dispersion model;
- the results presented are the maxima from modelling both with and without including spatially-varying surface roughness lengths 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.

10.4 It is thus concluded that the air quality impacts of the proposed facility will be not significant.

### Table 29: EA Checklist for Dispersion Modelling Report for Installations

| Item | Included | Comment |
|---|---|---|
| Location map | ✓ | See Figure 1 and Figure 2 |
| Site plan | ✓ | See Figure 4 |
| List of emissions modelled | ✓ | See Paragraph 1.4 |
| Details of modelled scenarios | ✓ | See Table 2 and Section 6 |
| Details of relevant ambient concentrations used | ✓ | See Section 5 |
| Model description and justification | ✓ | See Paragraph 6.2 |
| Special model treatments used | ✓ | See Section 6 |
| Table of emission parameters used | ✓ | See Table 8–Table 13 |
| Details of modelled domain receptors | ✓ | See Figure 7, Figure 8 and Paragraph 6.9 |
| Details of meteorological data used (including origin) and justification | ✓ | See Paragraphs 6.13 to 6.15 |
| Details of terrain treatment | ✓ | See Paragraph 6.20 |
| Details of building treatment | ✓ | See Paragraphs 6.18 and 6.19 |
| Sensitivity analysis | ✓ | See Table 2 and Section 6 |
| Assessment of impacts | ✓ | See Sections 9 and 10 |
| Model input files | ✓ | Sent electronically |

# 11 References

AECOM. (2017). *Environmental permit support: Revised H1 impact assessment following burner replacement.*

APIS. (2021). *APIS.* Retrieved from Air Pollution Information System Database: http://www.apis.ac.uk/

APIS. (2021). *APIS.* Retrieved from Air Pollution Information System Database: http://www.apis.ac.uk/

AQC. (2016). *Relationship between the UK Air Quality Objectives and Occupational Air Quality Standards.* Retrieved from http://www.aqconsultants.co.uk/AQC/media/Reports/Relationship-between-the-UK-Air-Quality-Objectives-and-Occupational-Air-Quality-Standards.pdf

AQC. (2020a). Calculator for Road Emissions of Ammonia V1A. https://www.aqconsultants.co.uk/resources.

AQTAG. (2011). *AQTAG06 - Technical guidance on detailed modelling approach for an appropriate assessment for emissions to air.*

BCC. (2019). *2019 Air Quality Annual Status Report (ASR).*

BCC. (2021). *2021 Air Quality Annual Status Report (ASR).*

Bristol City Council. (2019). *Air Quality Annual Status Report.*

Defra. (2018). *Review & Assessment: Technical Guidance LAQM.TG16 February 2018 Version.* Defra. Retrieved from https://laqm.defra.gov.uk/documents/LAQM-TG16-February-18-v1.pdf

Defra. (2018b). *Review & Assessment: Technical Guidance LAQM.TG16 February 2018 Version.* Defra. Retrieved from https://laqm.defra.gov.uk/documents/LAQM-TG16-February-18-v1.pdf

Defra. (2020b). *Local Air Quality Management (LAQM) Support Website.* Retrieved from http://laqm.defra.gov.uk/

Defra. (2021a). *Background Mapping data for local authorities.* Retrieved from https://uk-air.defra.gov.uk/data/laqm-background-home

DfT. (2017). *TEMPro (Version 7.2) Software.* Retrieved from https://www.gov.uk/government/collections/tempro

DfT. (2019). *DfT Road traffic statistics (TRA03).* Retrieved from https://www.gov.uk/government/statistical-data-sets/road-traffic-statistics-tra

DfT. (2020). *Road traffic statistics.* Retrieved from http://www.dft.gov.uk/matrix/

EA. (2019). *Environmental permitting: air dispersion modelling reports.* Retrieved from https://www.gov.uk/guidance/environmental-permitting-air-dispersion-modelling-reports?utm_source=4101c1a1-65a0-4299-99f3-

d50dc8cd5823&utm_medium=email&utm_campaign=govuk-notifications&utm_content=immediate

EA. (2022). *Air emissions risk assessment for your environmental permit*, Updated 5 July 2022. Retrieved from https://www.gov.uk/guidance/air-emissions-risk-assessment-for-your-environmental-permit

North Somerset Council. (2019). *Air Quality Annual Status Report.*

South Gloucestershire Council. (2019). *Air Quality Annual Status Report.*

South Gloucestershire Council. (2021). *2020 Air Quality Annual Status Report (ASR).*

*The Air Quality (England) (Amendment) Regulations 2002, Statutory Instrument 3043.* (2002). HMSO. Retrieved from https://www.legislation.gov.uk/uksi/2002/3043/contents/made

*The Air Quality (England) Regulations 2000 Statutory Instrument 928.* (2000). HMSO. Retrieved from http://www.legislation.gov.uk/uksi/2000/928/contents/made

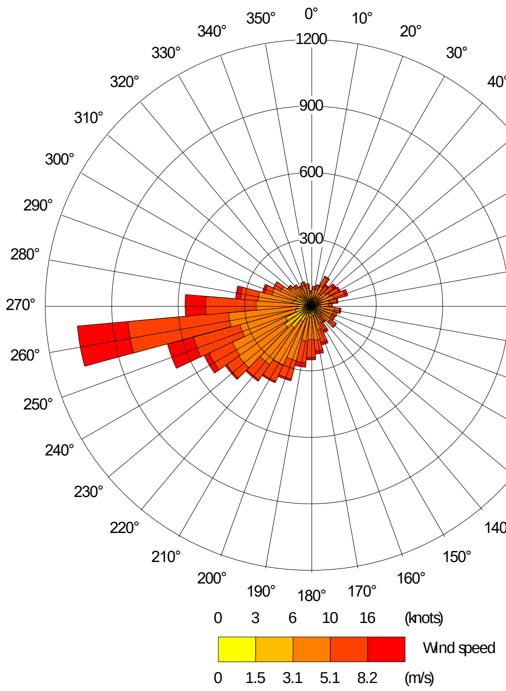
*The Environmental Permitting (England and Wales) (Amendment) Regulations 2018 Statutory Instrument 2018 No.110.* (2018). Retrieved from http://www.legislation.gov.uk/uksi/2018/110/contents/made

The European Parliament and the Council of the European Union. (2008). *Directive 2008/50/EC of the European Parliament and of the Council.* Retrieved from http://eur-lex.europa.eu/legal-content/EN/TXT/?uri=celex%3A32008L0050

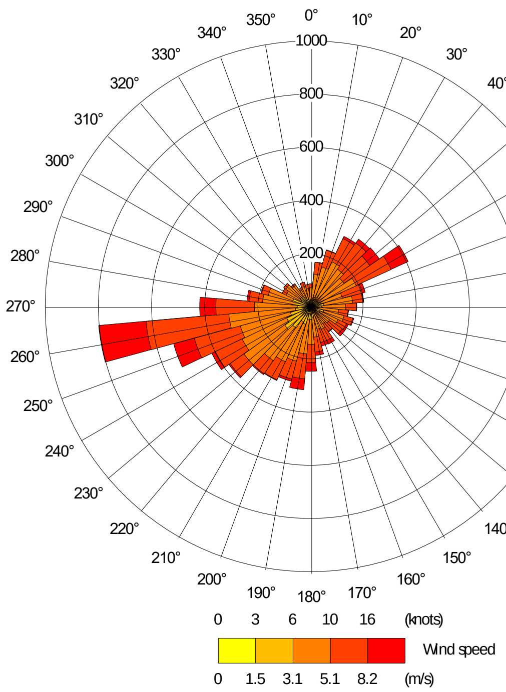
# 12 Appendices

# A1 Wind Roses for Bristol Lulsgate

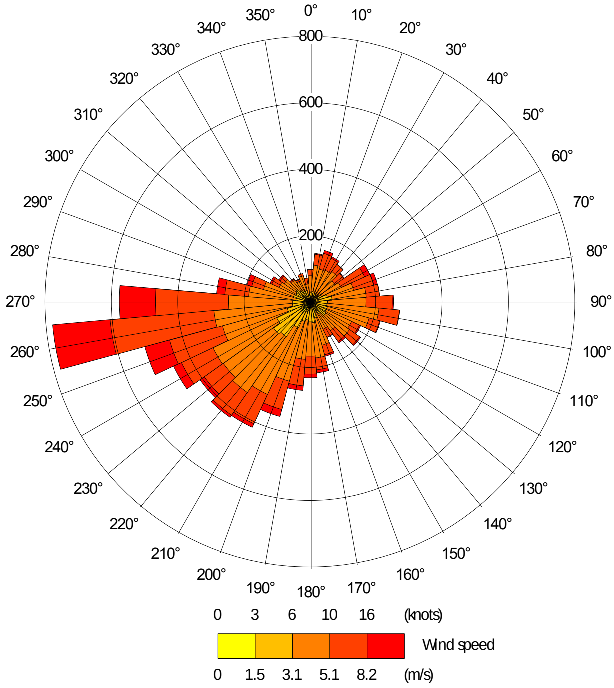
## 2017




## 2018



## 2019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Wind speed
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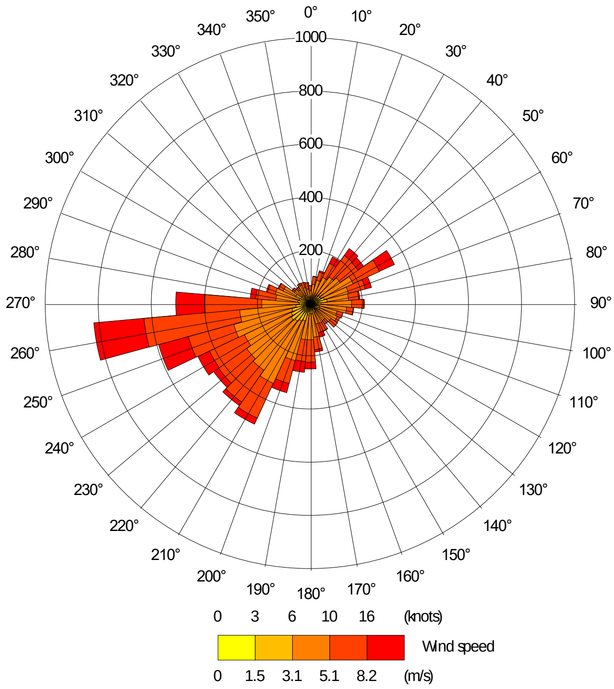
## 2020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Wind speed
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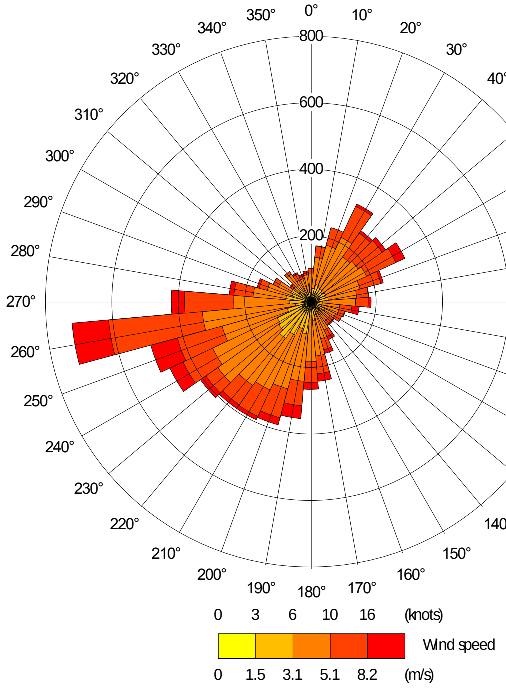
## 2021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0 3 6 10 16 (knots)
Wind speed
0 1.5 3.1 5.1 8.2 (m/s)

# A2 100th Percentile of 1-hour Mean PCs

A3.1 Table A2.1 presents the maximum 100th percentile of 1-hour Mean $NO_2$ PCs and PECs at different receptors, while Figure A2.1 presents a contour plot of these PCs. The AQS for 1-hour mean $NO_2$ concentrations allows 18 exceedances of 200 µg/m$^3$ in each calendar year. The 100th percentile of 1-hour means (i.e. the maximum in any hour of the year) is thus not comparable with the AQS. Results are provided here for information only.

**Table A2.1: Maximum 100th Percentile of 1-hour Mean $NO_2$ PCs and PECs**

| | Receptor ID | Coordinates | PC (µg/m$^3$) | PC (% of AQS) | PEC (µg/m$^3$) | PEC (% of AQS) |
|---|---|---|---|---|---|---|
| **Max PC on Grid** | G2530 | 351068, 176983 | 73.9 | N/A | 116.6 | N/A |
| **Max PC at Relevant[a] Receptor** | R12 | 352276, 177258 | 25.6 | N/A | 54.1 | N/A |
| **Max PC at Relevant[a] Roadside Receptor** | R9 | 352276, 177258 | 23.9 | N/A | 69.1 | N/A |
| **Max PEC on Grid** | G3756 | 351338, 176003 | 20.3 | N/A | 172.1 | N/A |
| **Max PEC at Relevant[a] Receptor** | R8 | 351240, 175877 | 21.3 | N/A | 100.0 | N/A |
| **Max PEC at Relevant[a] Roadside Receptor** | R8 | 351240, 175877 | 21.3 | N/A | 100.0 | N/A |

a See Paragraph 4.3.

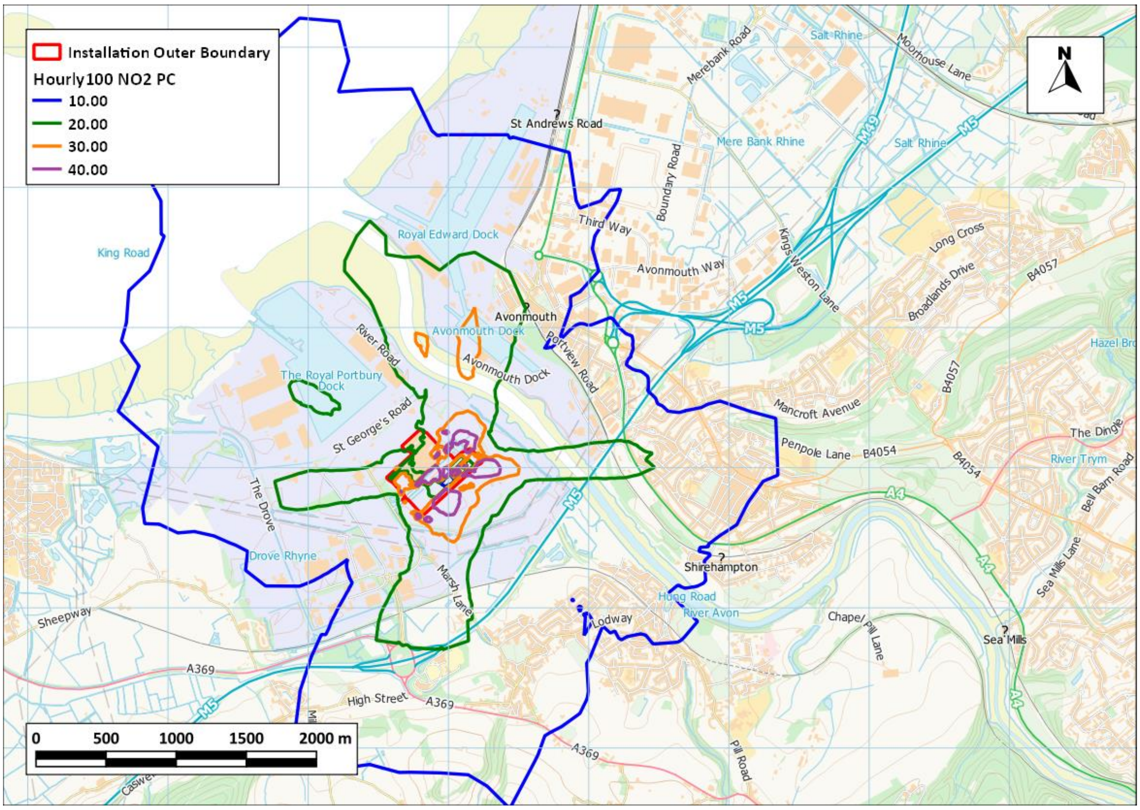


**Figure A2.1: Contour Plot of the 100th Percentile of 1-hour Mean $NO_2$ PCs**

# A3 Roads Modelling Methodology

## Model Inputs

A3.1 Predictions have been carried out using the ADMS-Roads dispersion model (v5). The model requires the user to provide various input data, including emissions from each section of road and the road characteristics (including road width and height where applicable). Vehicle emissions have been calculated based on vehicle flow, composition and speed data using the EFT (Version 11.0) published by Defra (2020b).

A3.2 Hourly sequential meteorological data from Bristol for 2018 have been used in the model. The Bristol meteorological monitoring station is located at Bristol Airport, approximately 11.5 km to the south of the proposed development site. It is deemed to be the nearest monitoring station representative of meteorological conditions in the vicinity of the proposed development site; both the development site and the Bristol meteorological monitoring station are located in the southwest of England, close to the Severn Estuary where they will be influenced by the effects of coastal meteorology over urban topography.

A3.3 Development generated AADT flows and vehicle fleet composition data have been provided by Markides Associates, who have undertaken the transport assessment work for the proposed development. Baseline AADT flows, and the proportions of HDVs, for the M5 adjacent to the proposed development site have been determined from the interactive web-based map provided by DfT (2020). The 2018 AADT flows have been factored forwards to the assessment year of 2023 using growth factors derived using the TEMPro System v7.2 (DfT, 2017). Traffic speeds have been estimated based on professional judgement, taking account of the road layout, speed limits and the proximity to a junction. The traffic data used in this assessment are summarised in Table A3.1. Diurnal and monthly flow profiles for the traffic have been derived from the national profiles published by DfT (2019).

A3.4 No adjustments have been made for effects of the Covid-19 pandemic on road traffic. This is expected to be conservative.

**Table A3.1: Summary of Traffic Data used in the Assessment (AADT Flows)**

| Road Link | 2018 | | 2023 (Without Scheme) | | 2023 (With Scheme) | |
|---|---|---|---|---|---|---|
| | AADT | %HDV | AADT | %HDV | AADT | %HDV |
| M5 between Junctions 18 and 19 | 131,812 | 8.2 | 143,187 | 8.2 | 143,555 | 8.3 |
| M5 between Junctions 18 and 18A | 98,461 | 6.1 | 106,958 | 6.1 | 107,262 | 6.2 |
| M5 between Junctions 17 and 18 | 123,874 | 9.7 | 134,564 | 9.7 | 134,868 | 9.8 |
| B4054 | 11,268 | 0.9 | 12,240 | 0.9 | 12,263 | 0.9 |
| B4055 | 5,405 | 1.1 | 5,871 | 1.1 | 5,871 | 1.1 |
| M5 South of Junction 19 | 103,275 | 9.9 | 112,188 | 9.9 | 112,282 | 9.9 |

A3.5 Figure A3.1 shows the road network included within the model, along with the speed at which each link was modelled, and defines the study area.

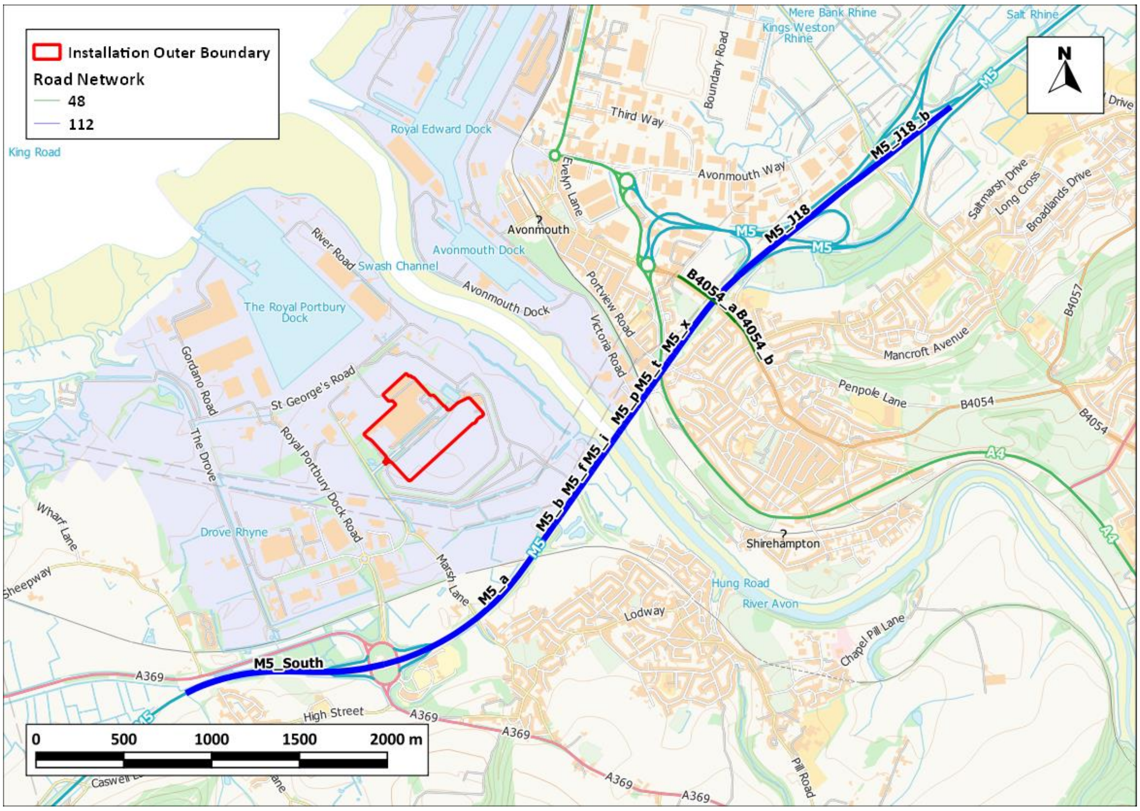


**Figure A3.1: Modelled Road Network & Speed**

## Model Verification

A3.6 In order to ensure that ADMS-Roads accurately predicts local concentrations of NOx, it is necessary to verify the model against local measurements. It is not practical, nor usual, to verify the ADMS-5 model, and, because ADMS-5 does not rely on estimated road-vehicle emission factors, the adjustment used for ADMS-Roads cannot be applied to ADMS-5. Predictions made using ADMS-5 have thus not been verified.

### *Background Concentrations*

A3.7 The 2018 background $NO_2$ concentrations for the monitoring sites have been derived from the national maps, and are presented in Table A3.2.

**Table A3.2: Annual Mean Background Concentrations used in the Verification for 2018**

| Diffusion Tube | $NO_2$ (µg/m$^3$) |
|---|---|
| **489** | 23.63 |
| **491** | 23.63 |
| **Objective** | **40** |

### *Traffic Data*

A3.8 2018 AADT flows, and the proportions of HDVs, for the roads adjacent to the monitoring sites, have been determined from the interactive web-based map provided by the DfT (2020). The 2009 AADT flows for the B4054 have been factored forwards to 2018 for model verification purposes using growth factors derived using the TEMPro System v7.0 (DfT, 2017) (a growth factor of 1.1097 for the years 2011 to 2018 has been applied, in the absence of a 2009-2018 factor). Traffic data used in the model verification are summarised in Table A3.3.

**Table A3.3: 2018 AADT Traffic Data used in the Model Verification**

| Road Link | AADT | %HDV |
|---|---|---|
| **M5 between Junctions 18 and 19** | 131,812 | 8.2 |
| **M5 between Junctions 17 and 18** | 123,874 | 9.7 |
| **B4054** | 11,268 | 0.9 |
| **B4055** | 5,405 | 1.1 |

### *Nitrogen Dioxide*

A3.9 Most nitrogen dioxide ($NO_2$) is produced in the atmosphere by reaction of nitric oxide (NO) with ozone. It is therefore most appropriate to verify the model in terms of primary pollutant emissions of nitrogen oxides ($NOx = NO + NO_2$). The model has been run to predict the annual mean NOx concentrations during 2018 at the 489 and 490 diffusion tube monitoring sites. Concentrations have been modelled at the height of the monitors as displayed in the relevant annual status reports (BCC, 2021).

A3.10 The model output of road-NOx (i.e. the component of total NOx coming from road traffic) has been compared with the ‘measured’ road-NOx.  Measured road-NOx has been calculated from the measured $NO_2$ concentrations and the predicted background $NO_2$ concentration using the NOx from $NO_2$ calculator (Version 8.1) available on the Defra LAQM Support website (Defra, 2020b).

A3.11 The unadjusted model has under predicted the road-NOx contribution; this is a common experience with this and most other road traffic emissions dispersion models.  An adjustment factor has been determined as the slope of the best-fit line between the ‘measured’ road contribution and the model derived road contribution, forced through zero.  The calculated adjustment factor of 2.1 has been applied to the modelled road-NOx concentration for each receptor to provide adjusted modelled road-NOx concentrations.

A3.12 The total nitrogen dioxide concentrations have then been determined by combining the adjusted modelled road-NOx concentrations with the predicted background $NO_2$ concentration within the NOx to $NO_2$ calculator.

### *$PM_{10}$ and $PM_{2.5}$*

A3.13 There are no nearby $PM_{10}$ or $PM_{2.5}$ monitors.  It has therefore not been possible to verify the model for $PM_{10}$ or $PM_{2.5}$.  The model outputs of road-$PM_{10}$ and road-$PM_{2.5}$ have therefore been adjusted by applying the adjustment factor calculated for road NOx.

## Model Post-processing

A3.14 The model predicts road-NOx concentrations at each receptor location.  These concentrations have been adjusted using the adjustment factor set out above, which, along with the background $NO_2$, has been processed through the NOx to $NO_2$ calculator available on the Defra LAQM Support website (Defra, 2020b).  The traffic mix within the calculator has been set to “All UK traffic”, which is considered suitable for the study area.  The calculator predicts the component of $NO_2$ based on the adjusted road-NOx and the background $NO_2$.