Eign Sludge Treatment Centre

Air quality assessment to accompany permit application

26 April 2024

Mott MacDonald
St Vincent Plaza
319 St Vincent Street
Glasgow G2 5LD
United Kingdom

T +44 (0)141 222 4500
mottmac.com

Dŵr Cymru (Welsh Water)
Pentwyn Road
Nelson
Treharris
Mid Glamorgan
CF46 6LY

Eign Sludge Treatment Centre

Air quality assessment to accompany permit application

26 April 2024

Issue and Revision Record

Revision	Date	Originator	Checker	Approver	Description
A	April 2024	M Bell	H Cheung	A Lithgow-Dick	First version

Document reference: B16564-123532-ZZ-XX-PE-NA-DH0059 |

Information class: Standard

Contents

1	Introduction	7
1.1	Overview	7
1.2	Site description	7
1.3	Site location	7
1.4	Summary of key pollutants	8
2	Legislative context	10
2.1	Overview	10
2.2	England	10
2.3	Permitting requirements and associated guidance	11
2.4	Overview	11
3	Methodology	15
3.1	Overview	15
3.2	Modelling approach	15
3.3	Sensitive receptors	23
3.4	Effects on conservation sites	27
3.5	Significance criteria	30
4	Baseline conditions	31
4.1	Introduction	31
4.2	Review and assessment of air quality in the study area	31
4.3	Defra projected background pollutant concentrations	32
5	Results	34
5.1	Overview	34
5.2	Gridded receptors	34
5.3	Human health discrete receptors	44
5.4	Ecological receptors	48
6	Conclusions	56

1 Introduction

1.1 Overview

This Air Quality Assessment (AQA) report has been prepared to support the variation to Bespoke Installation Permit application for Eign Sludge Treatment Centre (STC). This AQA presents the results of detailed modelling of emissions from the combustion of biogas at a Combined Heat and Power (CHP) plant, auxiliary biogas boilers, and emissions from two standby diesel generators.

Commented [ALD1]: Was there a previous AQ Assessment and permit? I know we have tight timescales here, but it may be worth while requesting from the EA for future reference.

Commented [MB2R1]: There was no air quality assessment undertaken for the existing permit

The assessment has accounted for the requirements set out within the ‘Air emissions risk assessment for your environmental permit’[1] guidance. As stated in this guidance document, where existing data have not been available, either estimates based on similar operations elsewhere or worst-case estimates have been used to complete the assessment. All assumptions that have been made for these estimates are detailed in this report.

Commented [ALD3]: Where is this footnote?

Commented [MB4R3]: Added footnote

1.2 Site description

Eign is a STC (hereafter referred to as the ‘Site’) owned and operated by Dwr Cymru Welsh Water. The anaerobic digestion (AD), which is part of the STC, facility treats indigenously produced and imported sludges. Biogas produced by the AD facility is combusted by two biogas CHP engines to recover heat and electricity. The heat is used at the AD facility. If the CHP plant is not operational, biogas will be combusted via two back-up boilers and/or an on-site flare stack. The combustion plant at the Site consists of:

- Two 1.725MW_{th} CHP engines with a thermal input of each, which combusts the biogas produced by the AD facility to generate heat and electricity. All heat and electricity generated is used on site and is not exported to the National Grid.
- Two duel fuel auxiliary boilers with a thermal input of 0.57MWth each. These boilers operate on standby to provide standby heat into the hot water circuit in the event the CHP is not operating. The boilers operate on biogas but can also use diesel as a fuel in absence of sufficient levels to biogas.
- Two flares, used to burn off excess biogas.
- Two standby diesel generators for emergency use and testing with a thermal input of 2.18MWth each, operational up to 15 hours per year.

Commented [ALD5]: I think the permitting terminology dictates less than 50 hours for testing purposes. Please check and amend.

Commented [MB6R5]: That is correct, in this case the site uses them up to 15 hours a year. For the assessment I have used 40 hours because no significant effects at 40 (there are at 50). Updated to 'up to 15 hours per year'

1.3 Site location

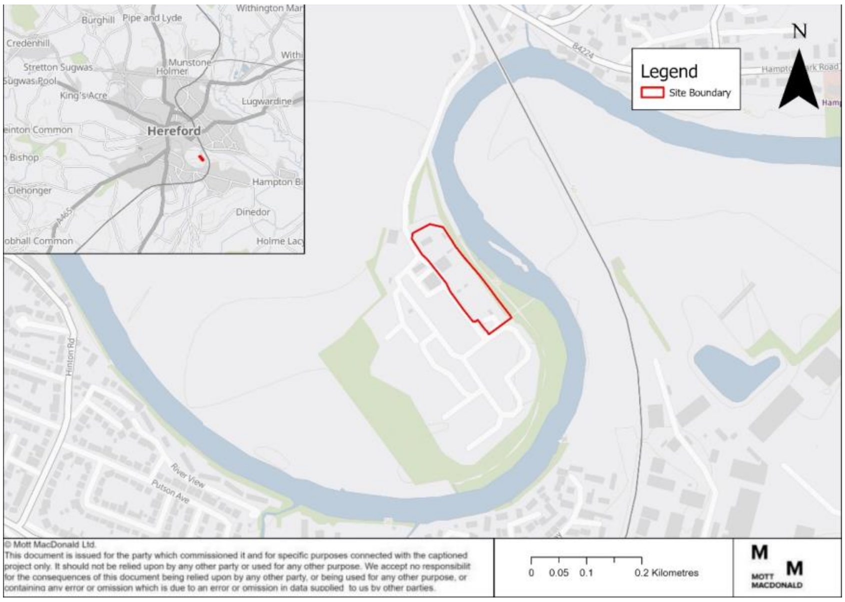
The Site address is Outfall Works Road, Hereford, Herefordshire, HR1 1RY (National Grid Reference: 352100, 238800). The Site is within the administrative area of Herefordshire Council (HC).

The nearest human health receptors to the Site are residential properties on Outfall Works Road approximately 340m to the northeast of the Site, and public footpaths either side of the River Wye the nearest of which is approximately 20m to the east the Site. The nearest ecological receptor is the River Wye Site of Special Scientific Interest (SSSI) and Special Area of

[1] Environment Agency, 2016. Air emissions risk assessment for your environmental permit. Available at: https://www.gov.uk/guidance/air-emissions-risk-assessment-for-your-environmental-permit

Conservation (SAC) which is approximately 15m to the east of the Site at the closest point. Figure 1.1 shows the location of the Site and the extent of the Site boundary.

Figure 1.1: Site location



Commented [ALD7]: Figure 1.1 should include all the receptors discussed in this paragraph. I would add Outfall road to the figure manually if not within mapping and add the sports ground; ecology sites and the footpath to the figure. Then later in the report when talking about the statistics, highlight that operation in X year indicates this was 40 hours.

Commented [ALD8]: Please give this figure it own A4 landscape page

1.4 Summary of key pollutants

This assessment has considered emissions of oxides of nitrogen (NO_x), volatile organic compounds (VOCs) and sulphur dioxide (SO_2). These are the key pollutants of potential concern, given that the main fuel used on the Site is biogas.

The following sub-sections present a brief description of the key pollutants referred to above and their behaviour in the atmosphere.

1.4.1 Oxides of nitrogen

Oxides of nitrogen is a term used to describe a mixture of nitric oxide (NO) and nitrogen dioxide (NO_2), referred to collectively as NOx. These are primarily formed from atmospheric and fuel nitrogen as a result of high temperature combustion. The most important sources in the UK are road traffic and power generation.

During the process of combustion, atmospheric and fuel nitrogen is partially oxidised via a series of complex reactions to NO. The process is dependent on the temperature, pressure, oxygen concentration and residence time of the combustion gases in the combustion zone. Most NOx exhausted from a combustion process is in the form of NO, which is a colourless and tasteless gas. It is readily oxidised to NO_2, a more harmful form of NOx, by a chemical reaction with ozone and other chemicals in the atmosphere. NO_2 is a yellowish-orange to reddish-brown gas with a pungent, irritating odour and is a strong oxidant.

1.4.2 Sulphur dioxide

SO_2 is a colourless, non-flammable gas with a penetrating odour that can irritate the eyes and air passages. It reacts on the surface of a variety of airborne solid particles, is soluble in water and can be oxidised within airborne water droplets. The most common sources of SO_2 include fossil fuel (coal and oil) combustion, smelting, manufacture of sulphuric acid, conversion of wood pulp to paper, incineration of waste and production of elemental sulphur. The most common natural source of SO_2 is volcanoes.

1.4.3 Volatile organic compounds

Volatile organic compounds (VOCs) are a collection of organic chemical compounds that have high enough vapour pressures under normal conditions to significantly vaporize and enter the atmosphere. A wide range of carbon-based molecules, such as aldehydes, ketones, and other light hydrocarbons are VOCs. Common artificial VOCs include paint thinners, dry cleaning solvents, and some constituents of fuels (e.g. petrol and natural gas).

The VOCs which are harmful to health are known as non-methane VOCs (NMVOC) as they do not contain methane (CH_4). Examples of NMVOCs include benzene, formaldehyde and acetone which can be produced during combustion, agricultural practices and from the use of solvents.

For the purpose of this assessment, only benzene has been considered as this is the VOC for which relevant Environmental Quality Standards exist.

Commented [ALD9]: For CHPs only?

Commented [MB10R9]: Yes only emissions from the CHP as discussed in the emissions section

2 Legislative context

2.1 Overview

This section summarises the relevant international and national legislation, policy and guidance in relation to air quality at the Site.

2.2 England

The Air Quality Standards Regulations 2010[2], Air Quality Standards (amendment) Regulations 2016[3], Air Quality (Amendment of Domestic Regulations) (EU Exit) Regulations 2019[4] and Environment (Miscellaneous Amendments) (EU Exit) Regulations 2020[5] implement the EU's Directive 2008/50/EC on ambient air quality.

Part IV of the Environment Act 1995[6] (as amended in Schedule 11 of the Environment Act 2021[7]) requires that every local authority shall carry out a review of air quality within its designated area. Local authorities have to consider and assess whether current and forecasted air quality levels in their areas are likely to exceed the objectives set out in the Air Quality (England) Regulations 2000[8] and the Air Quality (England) (Amendment) Regulations 2002[9].The objectives that are set out in these regulations are, in most cases, numerically synonymous with the limit values specified within the legislation, although compliance dates differ. Where an area exceeds an air quality objective, an Air Quality Management Area (AQMA) must be declared and an Air Quality Action Plan (AQAP) must be prepared to specify and implement measures to improve air quality.

The Environment Act 1995 requires the UK Government to produce a national 'Air Quality Strategy' (AQS). The AQS establishes the UK framework for air quality improvements. Measures agreed at the national and international level are the foundations on which the strategy is based. The first Air Quality Strategy was adopted in 1997.

The UK Government revised its national Air Quality Strategy[10] in 2023. This revision replaces the 2007 strategy and compliments the Clean Air Strategy 2019 (CAS). The 2023 revision sets out the actions the government expects local authorities in England to take in support of achieving the Government's long-term air quality goals.

Although the CAS does not set legally binding objectives, the CAS instead has targets for reducing total UK emissions of NOx from sectors such as road transport, domestic sources and industry.

[2] Statutory Instrument. (2010), 'The Environmental Permitting (England and Wales) Regulations', Queen's Printer of Acts of Parliament.

[3] Statutory Instrument (2016) The Air Quality Standards (Amendment) Regulations, No. 1184.

[4] Statutory Instrument (2019) Air Quality (Amendment of Domestic Regulations) (EU Exit) Regulations., No. 74.

[5] Statutory Instrument. (2020) Environment (Miscellaneous Amendments) (EU Exit) Regulations 2020, No. 1313.

[6] Department for Environment Food and Rural Affairs. (2009). Part IV of the Environment Act 1995 Local Air Quality Management Policy Guidance (PG09). London: Defra.

[7] Statutory Instrument. (2021) Chapter 30, Schedule 11 Local Air Quality Management Framework of Environment Act 2021

[8] Statutory Instrument. (2000), 'Air Quality (England) Regulations', No. 928. UK statutory instrument

[9] Statutory Instrument. (2002), 'Air Quality (England) (Amendment) Regulations', No. 3043. UK statutory instrument

[10] Draft revised Air Quality Strategy available at https://consult.defra.gov.uk/air-quality-strategy-review-team/consultation-on-the-draft-revised-air-quality-stra/ [last accessed 21st April 2023]

2.3 Permitting requirements and associated guidance

2.4 Overview

Depending on the potential level of risk to air quality, the preparation of a permit application can include the requirement for an air quality assessment. Key guidance issued by the Environment Agency to assist with undertaking an air quality assessment for an environmental permit includes:

- Air emissions risk assessment for your environmental permit[11]
- Environmental permitting: air dispersion modelling reports[12]
- Specified generators: dispersion modelling assessment guidance[13]
- Technical guidance on detailed modelling approach for an appropriate assessment for emissions to air[14]

2.4.1 Permitting requirements at the Site

Welsh Water are applying to vary their existing Environmental Permit EPR/UP3735GH into a Bespoke Installation Permit for the STC waste activity. This is because a joint Environment Agency and DEFRA decision has been made that AD treatment facilities at WTWs and STCs are covered by the Industrial Emissions Directive and can no longer operate under an Urban Waste Water Treatment Directive exclusion.

The primary permitted installation activity will be the AD treatment facility. Directly Associated Activities (DAAs) include the two standby diesel generators which provide power to the Site in the event of an emergency such as a power failure.

The Standard Rules 'SR2021 No 10: anaerobic digestion of non-hazardous sludge at a wastewater treatment works, including the use of the resultant biogas'[15] set Emission Limit Values (ELVs)[16] for boilers and other combustion plant including:

- ELVs of 250mg/Nm^3 for NO_x and 200mg/m^3 for SO_2 for existing (operational before 20 December 2018) boilers and 200mg/Nm^3 for NO_x and 100mg/m^3 for SO_2 (reference conditions at 3% O_2, 0°C, 0% H_2O) for new (operational after 20 December 2018) boilers that are medium combustion plant (MCP).
  - The Site's boilers were operational before 2018 and are less than 1MWth input therefore these ELVs are not applicable. However, for the purposes of this assessment, the higher ELVs for existing boilers have been adopted for the emissions data as a conservative assumption.
- ELVs of 500mg/Nm^3 for NO_x and 350mg/m^3 for SO_2 (reference conditions at 5% O_2, 0°C, 0% H_2O) for combustion plant burning biogas.

[11] Environment Agency, 2016. Air emissions risk assessment for your environmental permit. Available at: https://www.gov.uk/guidance/air-emissions-risk-assessment-for-your-environmental-permit

[12] Environment Agency, 2014. Environmental permitting: air dispersion modelling reports. Available at: https://www.gov.uk/guidance/environmental-permitting-air-dispersion-modelling-reports

[13] Environment Agency, 2019. Specified generators: dispersion modelling assessment. Available at: https://www.gov.uk/guidance/specified-generators-dispersion-modelling-assessment

[14] Environment Agency (2006). Technical Guidance on detailed modelling approach for an appropriate assessment for emissions to air: Habitats Directive 2004 (AQTAG 06).

[15] SR2021 No 10: anaerobic digestion of non-hazardous sludge at a waste water treatment works, including the use of the resultant biogas. https://www.gov.uk/government/publications/sr2021-no-10-anaerobic-digestion-of-non-hazardous-sludge-at-a-waste-water-treatment-works-including-the-use-of-the-resultant-biogas

[16] All limits are defined at a temperature of 273.15 K, a pressure of 101.3 kPa and after correction for the water vapour content of the waste gases at a standardised O_2 content of 5% for gas engines (CHP) and 3% for boilers

– These ELVs are applicable to the CHP.

Emission monitoring undertaken at the CHP plant to date demonstrates that both engines are compliant with the SR2021 No 10 combustion plant emission limits for NOx.

2.4.2 Assessment criteria

The following section presents the relevant air quality standards that are applicable to the Site. These are collectively described as the Environmental Quality Standards (EQS).

The EA's risk assessment guidance[17] provides guidelines on Ambient Air Directive (AAD) limit values, UK air quality objectives and environmental assessment levels (EALs) that the impact should be compared against. Further EQS to assess the potential impact at designated sites are available from the Air Pollution Information System[18] (APIS).

Air quality limit values and objectives

Table 2.1 summarises the AAD limit values and air quality objectives for the pollutants relevant to this assessment.

Table 2.1: Summary of relevant air quality objectives and AAD limit values

Pollutant	Averaging period	Objective / limit value ($\mu g/m^3$)	Allowance
For the protection of human health			
Nitrogen dioxide (NO_2)	1-hour	200	18 times pcy
	Annual	40	–
Sulphur dioxide (SO_2)	15-minute	266	35 times pcy
	1-hour	350	24 times pcy
	24-hour	125	3 times pcy
VOCs (as benzene)	Annual	5	–
For the protection of vegetation and ecosystems			
Nitrogen oxides (NO_X)	Annual	30	–
Sulphur dioxide (SO_2)	Annual	20	–

Notes: pcy = per calendar year

The limit values apply everywhere with the exception of:

a) Any locations situated within areas where members of the public do not have access and there is no fixed habitation.
b) In accordance with Article 2(1), on factory premises or at industrial installations to which all relevant provisions concerning health and safety at work apply
c) On the carriageway of roads, and
d) On the central reservations of roads except where there is normally pedestrian access to the central reservation.

Table 2.2 provides examples of the locations where the UK air quality objectives apply for the protection of human health. This has been used to define where the AAD limit values and air quality objectives should apply within the assessment.

[17] Environment Agency. (2016) 'Air Emissions Risk Assessment for your Environmental Permit'.
[18] UK Air Pollution Information System (APIS) www.apis.ac.uk [last accessed 09/07/2019]

Table 2.2: Locations where air quality objectives apply

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

Specified generator guidance published by the EA[19] states that the annual and hourly NO_2 objectives should be considered at sensitive receptors where "there is relevant public exposure". Relevant public exposure is defined as a location where members of the public:

- Have access
- Are regularly present, and
- Can be exposed for a significant portion of the averaging time of the standard.

Consequently, the standards do not apply where health and safety at work provisions exist and where members of the public do not have access, such as within the Site boundary.

Environmental Assessment Levels

In addition to the AAD limit values and air quality objectives, the Environment Agency risk assessment guidance[20] provides further assessment criteria in the form of Environmental Assessment Levels (EALs). The EALs cover a wide range of pollutants and specify target values for the protection of conservation areas. Any exceedances of these EALs may result in further action needing to be taken to reduce the impact on the environment. EALs applicable to the assessment (also referred to as critical levels in the context of designated sites) are presented in Table 2.3.

Table 2.3: Summary of relevant EALs/critical levels for the protection of human health and ecosystems

Pollutant	Averaging period	EAL/critical level ($\mu g/m^3$)
For the protection of human health		
VOCs (as benzene)	24 hour	30
For the protection of vegetation and ecosystems		

[19] Environment Agency, 2019. Specified generators: dispersion modelling assessment. Available at: https://www.gov.uk/guidance/specified-generators-dispersion-modelling-assessment

[20] Environment Agency. (2016) 'Air Emissions Risk Assessment for your Environmental Permit'.

Pollutant	Averaging period	EAL/critical level (µg/m³)
Nitrogen oxides (NOx)	24 hours	75
	Annual	30*

* Numerically synonymous with the annual AAD limit value

In addition to these EALs, APIS provides targets for nitrogen and acid deposition for specific habitats and species. These EALs, also known as critical loads, are provided for specific habitats within Special Areas of Conservation (SACs), Special Protection Areas (SPAs) and Sites of Special Scientific Interest (SSSI). Generic critical loads for broad habitat classes are also available on APIS.

3 Methodology

3.1 Overview

In accordance with Environment Agency risk assessment guidance[21], the approach to the air quality assessment has involved the following key elements:

- Calculation of the environmental concentration of pollutants released to the air (Process Contributions (PC) and Predicted Environmental Concentrations (PEC))
- Identification of whether the PCs and PECs have a significant environmental impact by comparing with the relevant EQS

PECs have been calculated by adding the PC to a representative value for the background concentration. Section 3.2.10 provides further details on the background concentrations used in this assessment.

Detailed modelling has been undertaken to calculate PCs and PECs to determine whether emissions from the Site are significant.

3.2 Modelling approach

3.2.1 Model selection

Commercially available dispersion models are available to predict ground level concentrations arising from emissions to air from elevated point sources.

ADMS is a “new generation” dispersion model, developed by Cambridge Environmental Research Consultants (CERC), which models a wide range of buoyant and passive releases to the atmosphere either individually or in combination. ADMS brings together the results of recent research on dispersion modelling. The model calculates the mean concentration over flat terrain, allowing for the effect of plume rise, complex terrain, buildings, radioactive decay and deposition. The model has been subject to extensive validation. ADMS comprises of a number of individual modules each representing one of the processes contributing to dispersion or an aspect of data input and output. The latest version of the model, ADMS 6.0.0.1, has been used in this assessment.

3.2.2 Buildings

The movement of air over and around buildings generates areas of flow circulation, which can lead to increased ground level concentrations in the building wakes. Where building heights are greater than about 30 - 40% of the stack height, downwash effects can be significant. ADMS includes a building effects module to calculate the dispersion of pollution from sources near large structures. The buildings likely to have a dominant effect (i.e. with the greatest dimensions likely to promote turbulence) which have been included within the model are listed in Table 3.1 and illustrated in Figure 3.1.

[21] Environment Agency. (2016) ‘Air Emissions Risk Assessment for your Environmental Permit’.

Table 3.1: Building dimensions used within the assessment

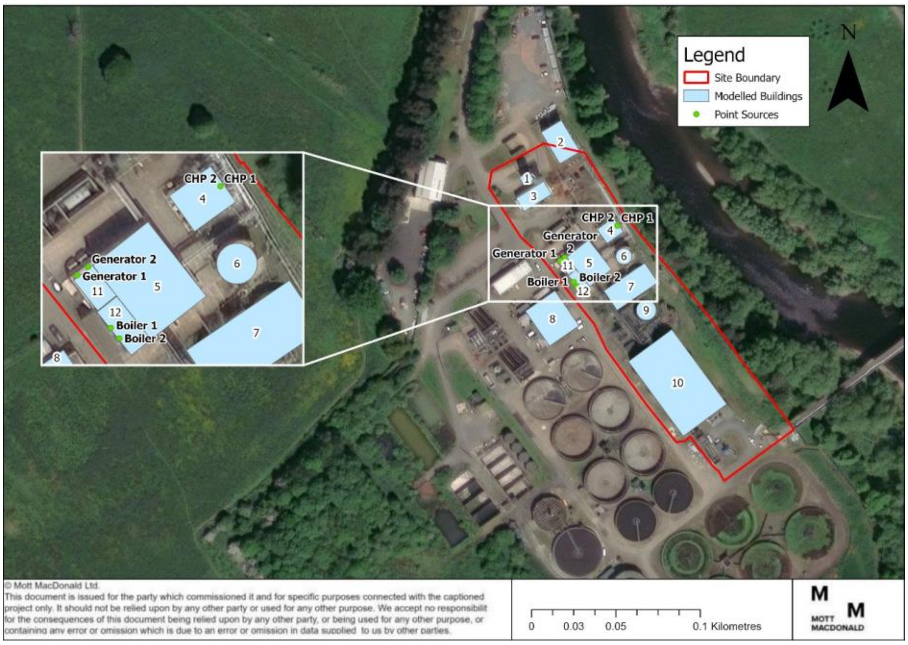
No	X (m)	Y (m)	Height (m)	Length (m)	Width (m)	Angle (°)
1	352032.1	238900.0	15.0	6.7	5.7	59
2	352052.3	238921.8	11.0	14.0	21.7	59
3	352036.5	238889.6	8.0	19.3	9.1	58
4	352081.7	238869.3	5.0	12.0	10.3	54
5	352069.3	238850.1	8.5	16.6	22.2	52
6	352089.9	238854.1	9.5	9.6	9.6	0
7	352094.0	238836.1	4.0	29.4	14.0	56
8	352047.4	238817.3	8.5	21.3	25.3	55
9	352103.1	238822.2	7.0	11.8	11.8	0
10	352121.7	238779.2	14.0	32.0	54.9	54
11	352056.4	238848.3	4.8	9.1	5.7	141
12	352063.3	238839.5	8.5	13.0	5.9	142

Commented [ALD11]: @Hazel Cheung please check that these match the models

Commented [HC12R11]: Checked. No. 4 building x coordinate need to update

Commented [MB13R11]: They match the models. No need to update

Figure 3.1: Building layout



Commented [ALD14]: Excellent figure, however I can't see the auxiliary boiler point sources. Can the figure have it's own A4 landscape page. We don't give figures enough credit.

Commented [MB15R14]: Now updated to include all sources but I prefer to have this on the same page as the buildings table

3.2.3 Meteorology

The most important meteorological parameters governing the atmospheric dispersion of pollutants are wind direction, wind speed and atmospheric stability as described below:

- Wind direction determines the sector of the compass into which the plume is dispersed.
- Wind speed affects the distance the plume travels over time and can affect plume dispersion by increasing the initial dilution of pollutants and inhibiting plume rise.

- Atmospheric stability is a measure of the turbulence of the air, and particularly of its vertical motion. It therefore affects the spread of the plume as it travels away from the source. ADMS uses a parameter known as the Monin-Obukhov length that, together with the wind speed, describes the stability of the atmosphere.

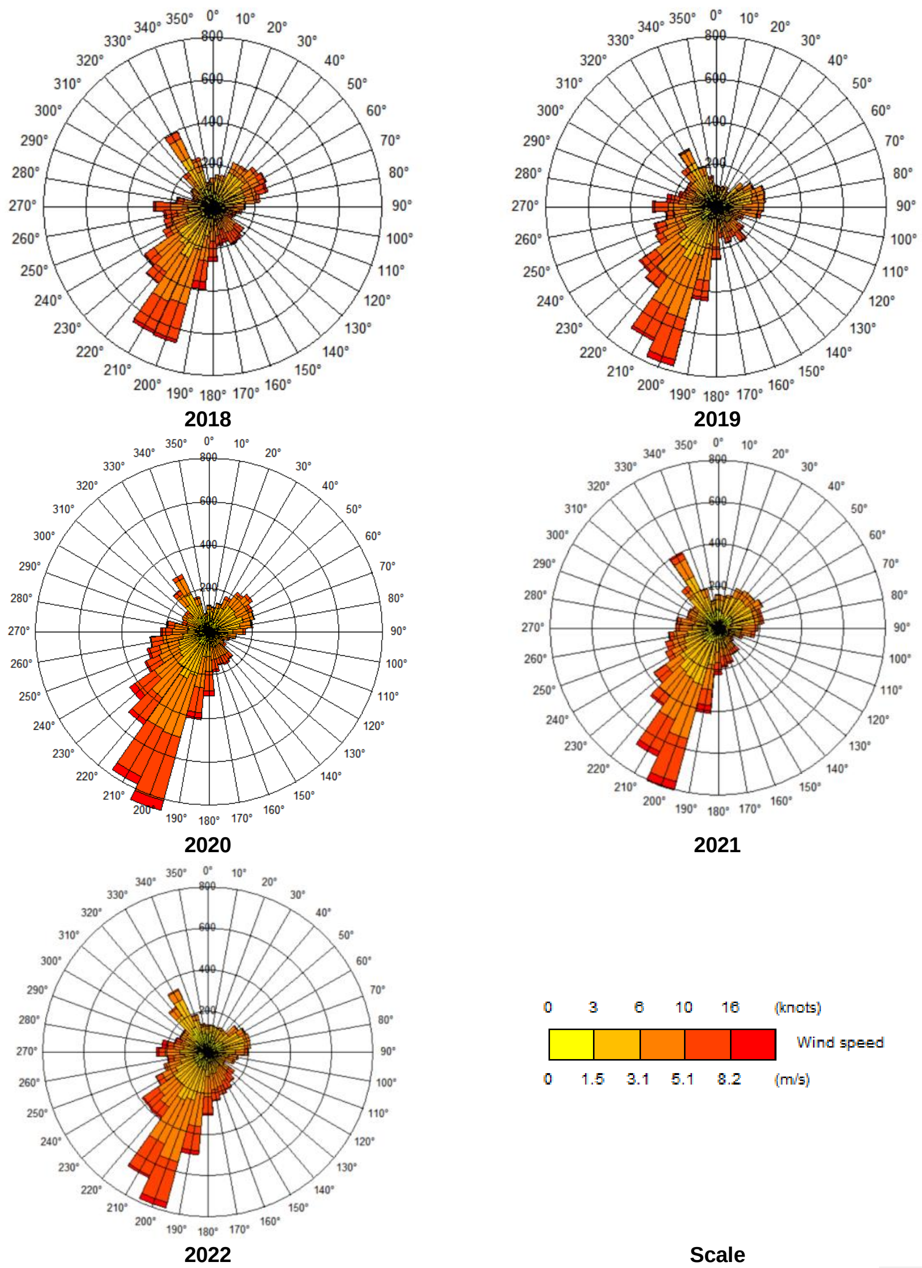
For meteorological data to be suitable for dispersion modelling purposes, parameters need to be measured on an hourly basis. These parameters include wind speed, wind direction, cloud cover and temperature. There are only a limited number of sites where the required meteorological measurements are made.

The year of meteorological data that is used for a modelling assessment can have a significant effect on source contribution concentrations. As recommended by the Environment Agency dispersion modelling guidance[22], modelling was undertaken using five years of data. Data from the Pershore Airfield meteorological station was used as this was considered the most representative station due to its proximity to the Site (approximately 48 km to the east). Five years of data from 2018 to 2022 were used.

Wind roses have been constructed for each of the five years of meteorological data used in this assessment. The wind roses presented in Figure 3.2 illustrate that in all years there is dominance in winds from the southwest and frequent winds from the north.

[22] Environment Agency, 2014. Environmental permitting: air dispersion modelling reports. Available at: https://www.gov.uk/guidance/environmental-permitting-air-dispersion-modelling-reports

Figure 3.2: Wind roses for Pershore Airfield (2018 – 2022)



Commented [ALD16]: Can all 5 be sized onto a single A4 portrait page please. 2020 also has slightly different font size or diameter. Can it match the others?

Commented [MB17R16]: Updated 2020 to match the others and now on one page

3.2.4 Terrain

The presence of elevated terrain can significantly affect ground level concentrations of pollutants emitted from elevated sources such as stacks by reducing the distance between the plume centre line and ground level and increasing turbulence and, hence, plume mixing.

Terrain in the region of the Site is generally flat and there are no slopes with gradients more than 10% over extensive distances near the Site. Therefore, in accordance with Environment Agency guidance[23], terrain data has not been included in the dispersion model.

3.2.5 Surface roughness

The roughness of the terrain over which a plume passes can have a significant effect on dispersion by altering the velocity profile with height and the degree of atmospheric turbulence. This is accounted for by a parameter called the surface roughness length.

A roughness length of 0.5m has been used in this assessment which is consistent with the predominantly rural and residential model domain. A surface roughness length of 0.2m has been assigned to the Pershore Airfield meteorological site.

3.2.6 Modelled scenario

As detailed in Section 1.20, the combustion plant at the Site consists of a CHP plant with two engines, two backup boilers, two flares, and two emergency standby diesel generator.

During 2022 the CHP engines was operational for 6961 and 7430 hours, with the two boilers operational in duty/standby configuration when the CHP is not available. Therefore, the CHP and boilers are not in continuous operation. For the purposes of this assessment, it has been assumed that the CHP and both boilers will operate continuously year-round (8760 hours a year) and at full load, which is a conservative approach considering these combustion plant do not operate concurrently. The flares are estimated to be operational for up to 200 hours in the year, which burn off excess biogas when the CHP and boilers are offline. The flares have not been modelled because this assessment assumes the CHP and boilers are operational year-round.

Commented [ALD18]: As the operation of the CHP and Boilers would be considered worst case?

Note for later in the report: ALD to sense check these assumptions with any significant effect

Commented [MB19R18]: I haven't calculated the emissions from the flare so don't think we can confirm it's worst case

To assess the risk of standby generator emissions leading to excessively high concentrations and exceedances of the one-hour NO_2 air quality standard, the modelling has assumed continuous operation all year to capture the worst-case short-term (one hour mean) impacts. The maximum hourly PCs are therefore based on the conservative assumption that operation of the standby generators will occur at the same time as the worst-case meteorological conditions for dispersion, which is very unlikely given that Welsh Water has advised that the standby generators are not operational for more than 15 hours per year.

The more hours the generators operate in a year, the more likely that operation will coincide with the adverse meteorological conditions. Statistical testing in the form of a hypergeometric probability distribution has been carried out for NO_2 for both scenarios to determine the likelihood of exceedances of the hourly NO_2 air quality standard occurring based on 40 hours of operation, significantly more than the expected 15 hours of operation as a worst-case assumption. The level of risk then assigned to the outcome of this statistical test is based on guidance from the EA[24] which states that where the probability is:

[23] Environment Agency, 2019. Specified generators: dispersion modelling assessment. Available at: https://www.gov.uk/guidance/specified-generators-dispersion-modelling-assessment

[24] Environment Agency, 2021. Guidance: Specified generators dispersion modelling assessment. Available at: https://www.gov.uk/guidance/specified-generators-dispersion-modelling-assessment

- 1% or less - exceedances are highly unlikely
- Less than 5% - exceedances are unlikely as long as the generator plant operational lifetime is no more than 20 years
- More than or equal to 5% - there's potential for exceedances

For the assessment of annual mean PCs for the standby generators, the modelling has been undertaken based on continuous operation for an entire year and the annual mean PCs have been scaled down by a factor of 40/8760 to represent the 40 hours of operation in a year.

Commented [ALD20]: Is this based on information from the site from past years? Update paragraph to explain why you got to 40 hours?

Commented [MB21R20]: The 40 hours is a conservative assumption and explained in the paragraph above

3.2.7 Emissions data

Emissions used in this assessment are based on a plant load of 100% and assumes that exhaust gases will contain the maximum concentration of pollutants permitted. Exhaust gases from each of the CHP engines, back-up boilers and standby generators are each released from their own, individual flue.

The NO_x and SO_2 emissions modelled for the CHP are based on the SR2021 ELVs of 500mg/Nm^3 and 350 mg/Nm^3 (5% O_2, 0°C, dry), respectively. The most recent stack emissions monitoring assessments for this CHP carried out in January 2024[25] and July 2023[26] show compliance with the ELV for NO_x. The environmental permit has no monitoring requirement for SO_2.

The emissions of VOCs for the CHP engines are based on the highest monitored emissions concentration of 2582 mg/Nm^3 as there is no set ELV for VOCs emissions from the CHP. It has been assumed that 100% of the VOCs emitted from the CHP will be benzene, because this is the VOC for which a relevant EQS exists. The monitored total VOCs concentration does not speciate the VOCs so the actual benzene emission rate is not known. However, the assumption of 100% benzene emissions is likely to be a substantial overestimate and therefore highly conservative. The UK National Atmospheric Inventory (NAEI) report 'Speciation of UK emissions of non-methane volatile organic compounds'[27] provides a review of published VOC speciation profiles, the profiles relevant to this assessment have been summarised in Table 3.2 below. Although none of these are specific to combustion plant burning biogas, this range of published benzene fractions is likely to be indicative of the likely benzene fraction for the VOCs emissions from the CHP. The highest % benzene for any source listed in the table below is 9.1%. Therefore, it is likely that the assumption of 100% benzene adopted for this assessment is an overestimate of the actual benzene emissions by at least a factor of 10.

Commented [ALD22]: Can you look at these intro sentences for this paragraph again and possibly move them around a little? It is a little confusing and references itself.

Commented [MB23R22]: I have updated and removed the reference

Table 3.2: Benzene fractions from combustion sources published by the NAEI

Source	% Benzene
Domestic combustion of gas	9%
Industrial combustion of gas	9.1%
Electricity generation using gas	Nil
Internal combustion engine - natural gas	0.5%
Flares – natural gas	Nil

[25] Dwr Cymru (Welsh Water), Wign WWTW CHp Facility, Reporting of emissions to air for the period from 01/01/2023 to 31/12/2023, 26 January 2024.

[26] Environmental Compliance Limited, Wign WWTW CHp Facility, Emissions monitoring – July 2023, 25 August 2023.

[27] N R Passant, Speciation of UK emissions of non-methane volatile organic compounds, February 2002

The NOx and SO_2 emissions modelled in this assessment for the boilers are based on the Standard Rules 2021 No 10 ELVs for existing (operational before December 2018) boilers burning biogas, which are 250mg/Nm^3 for NOx and 200 mg/Nm^3 for SO_2 (3% O_2, 0°C, dry).

NOx emissions testing results for the standby generators are not currently available. For this assessment, NOx emissions for the standby generators are based on a typical emission concentration for unregulated diesel engines reported by the Environment Agency[28] of 2200 mg/Nm^3. This is a conservative high estimate.

Commented [ALD24]: Standby generators are not subject to emission limits under 50 hours of testing in accordance with Standard Rules No 7. worth while stating here.

Commented [MB25R24]: Emissions testing will be undertaken at these generators, normally it's not needed but this is a special case

Table 3.3 presents the emission parameters used in the dispersion modelling. Note that there are two of each type of combustion sources and these emissions data relate to individual sources rather than combined emissions for each source type. The data used for any calculations are included in the 'Notes' section of the table. Emission rates for NOx and SO_2 have been calculated using the equations presented below:

Emission rate = Plant emission limit x Normalised gas flow.

Correcting for water content:

Dry value = Measured value x 100 / (100 – H_2O measured concentrations [%]).

Correcting for oxygen content:

Corrected value = Measured value x (21 – O_2 Reference value [%] / 21 – O_2 Measured Value [%]).

Correcting for temperature:

Corrected value = Measured value x (Temperature of measured value [K] / 273 [K]).

Table 3.3: Stack emission parameters

Commented [ALD26]: @Hazel Cheung please check that the emissions table matches your checking.

Commented [HC27R26]: Checked. Discussed with Michael and updated

Parameter	Units	CHP Engines 1 & 2	Boilers 1 & 2	Generators 1 & 2
Thermal input	MWth	1.73	0.57	2.18
Stack location	x,y	352086, 238872	352060, 238838 & 352062, 238836	352052, 238851 & 352055, 238853
Stack height	M	15	8.5	4.2
Stack diameter	M	0.29	0.2	0.3
Stack angle (jet sources only)	Degrees	-	-	235
Exit temperature	°C	316[(a)]	200[(b)]	300[(b)]
Efflux velocity	m/s	15.29	13.69	24.79
Volumetric flow rate (actual)	Am^3/s	1.18[(a)]	0.43[(c)]	1.75[(c)]

[28] Environment Agency, Diesel generator short term NO_2 impact Assessment, 2016. COMMUNICATION BRIEF (defra.gov.uk)

Parameter	Units	CHP Engines 1 & 2	Boilers 1 & 2	Generators 1 & 2
Volumetric flow rate (normalised)	Nm^3/s	0.33(d)	0.21(e)	0.74(f)
NO_x emission	g/s	0.165(g)	0.045(h)	4.2(i)
SO_2 emission	g/s	0.12(g)	0.036(h)	-
VOCs emission	g/s	0.8(j)	-	-

Notes: (a) Worst case value (lowest reported stack temperature and the highest volumetric flow rate) for either CHP engine taken from the July 2023 CHP monitoring report
(b) Estimated from similar combustion plant
(c) Calculated from the thermal input
(d) Normalised conditions = 5% O_2, 0°C, 0% H_2O
(e) Normalised conditions = 3% O_2, 0°C, 0% H_2O
(f) Normalised conditions = 15% O_2, 0°C, 0% H_2O
(g) Calculated from the SR2021 No 10. ELVs for combustion plant burning biogas of 500 mg/Nm³ for NOx and 350 mg/Nm³ for SO_2. (Pressure of 101.3 kPA, dry, 0°C, 5% O_2) and normalised volumetric flow rate
(h) Calculated from the SR2021 No 10. ELVs for existing boilers of 250 mg/Nm³ for NOx and 200 mg/Nm³ for SO_2 (Pressure of 101.3 kPA, dry, 0°C, 3% O_2) and the thermal input of the boiler
(i) Calculated from a typical emission concentration for unregulated diesel engines reported by the Environment Agency[29] of 2200 mg/Nm^3 and the thermal input.
(j) Based on the maximum monitored VOCs emissions concentration for either CHP engine from the July 2023 CHP monitoring report of 2582 mg/Nm^3 (Pressure of 101.3 kPA, dry, 0°C, 5% O_2)

3.2.8 NOx to NO_2 relationship

The NOx emissions associated with combustion activities at the Site will typically comprise approximately 90-95% nitric oxide (NO) and 5-10% nitrogen dioxide (NO_2) at source. As described previously, the NO oxidises in the atmosphere in the presence of sunlight, ozone and volatile organic compounds to form NO_2, which is the principal concern in terms of environmental health effects.

There are various techniques available for estimating the portion of the NOx that is converted to NO_2, which will increase with distance from the source. The EA's modelling guidance[30] identifies that a 70% conversion of NOx to NO_2 should be used for calculation of annual average concentrations and a 35% conversion of NOx to NO_2 should be used for calculation of short-term concentrations. The EA's recommended conversion rates have been used in this assessment.

3.2.9 Assessment of short- and long-term concentrations

The long-term and short-term modelling undertaken assumes that the boiler and CHP will operate at full load continuously for 24 hours each day, which equates to 8760 hours a year. As discussed in Section 3.2.6, this is a very conservative approach because these combustion plant do not operate simultaneously in practice. The approach applied to modelling long term and short term concentrations for the standby generators is described in Section 3.2.6.

[29] Environment Agency, Diesel generator short term NO_2 impact
Assessment, 2016. COMMUNICATION BRIEF (defra.gov.uk)

[30] Environment Agency, 2019. Specified generators: dispersion modelling assessment. Available at: https://www.gov.uk/guidance/specified-generators-dispersion-modelling-assessment

3.2.10 Background/ambient concentrations

Background concentrations, also known as ambient concentrations (AC), are added to the PCs to determine the PEC at modelled receptors. Environment Agency dispersion modelling guidance[31] states that Defra background maps or local authority/Defra monitoring data can be used as a representative value for the background concentrations in the assessment. However, the Environment Agency specified generator guidance[32] states that low resolution grid average background values may not be suitable for receptor locations close to other sources such as busy roads or major industry. The results of air quality monitoring undertaken by HC has been reviewed for representative data that can be applied to this assessment.

As the concentrations from the background maps and diffusion tube monitoring are long-term (annual) average concentrations, short-term background concentrations have been estimated by doubling the long-term background concentrations. The short-term backgrounds are applied to the 15-minute, hourly and 24-hour averaged concentrations. This is in accordance with Environment Agency risk assessment guidance[33].

3.3 Sensitive receptors

Gridded receptors and discrete human health and ecological receptors have been considered within this assessment.

3.3.1 Gridded receptors

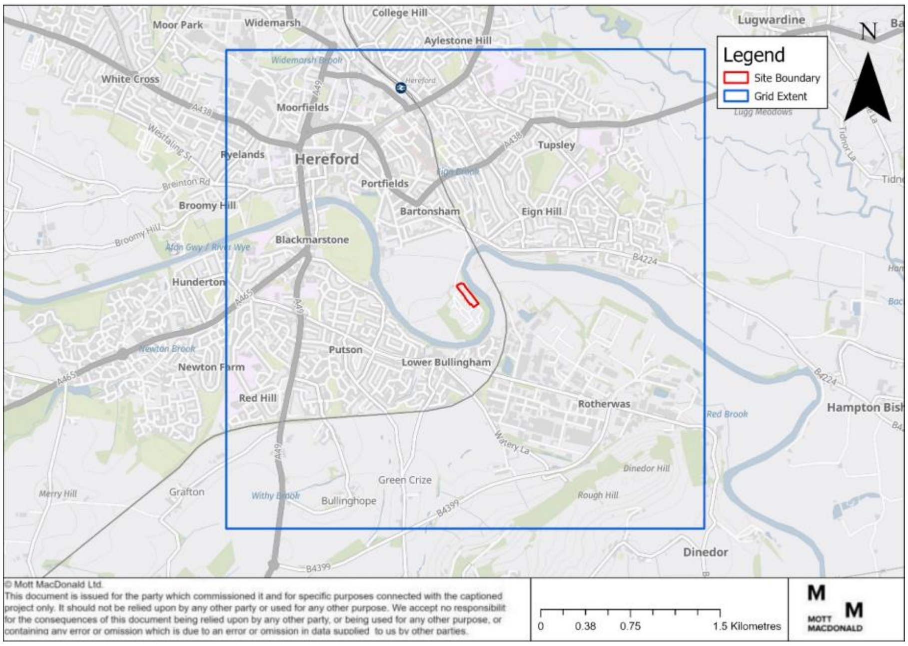
Pollutant concentrations have been modelled across a Cartesian grid with 20 metre (m) spacing up to 500m from the Site and at 100m spacing beyond this up to 2 kilometre (km) from the Site. The finer 20m resolution captures the maximum modelled impacts which fall near to the Site while the 2km grid extent is sufficient to fully cover the range of modelled concentrations in the surrounding area. The maximum predicted PCs occur within this grid extent. The extent of the grid has been presented in Figure 3.3. This assessment has not considered on-site concentrations as the EQSs would not apply at these locations as there is no relevant public exposure.

[31] Environment Agency, 2014. Environmental permitting: air dispersion modelling reports. Available at: https://www.gov.uk/guidance/environmental-permitting-air-dispersion-modelling-reports

[32] Environment Agency, 2019. Specified generators: dispersion modelling assessment. Available at: https://www.gov.uk/guidance/specified-generators-dispersion-modelling-assessment

[33] Environment Agency, 2016. Air emissions risk assessment for your environmental permit. Available at: https://www.gov.uk/guidance/air-emissions-risk-assessment-for-your-environmental-permit

Figure 3.3: Gridded receptor model extent



3.3.2 Human health

Fourteen discrete human health receptors representing the closest sensitive receptors have been included within the model so that a comparison against the EQSs can be made. The short-term objective applies at receptors 1-4 and both the long-term and short long-term objectives apply at residential receptors 5-14 (see Table 2.2 for details). Table 3.4 and Figure 3.4 show the locations of the discrete receptors considered within this assessment.

Commented [ALD28]: 14 in the table and figure

Commented [MB29R28]: updated

Table 3.4: Modelled human health receptors

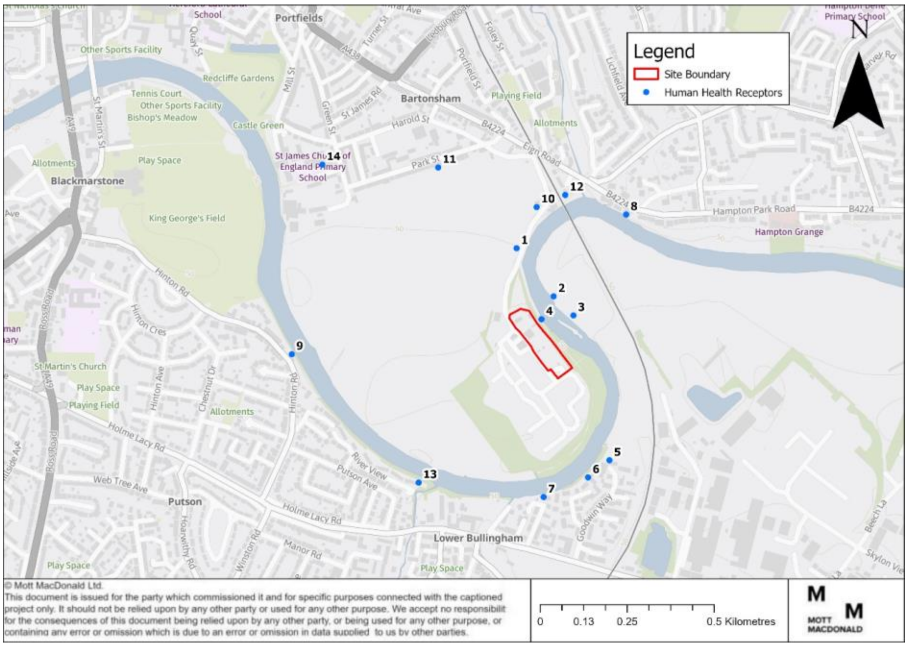
Receptor number	Receptor name	Receptor type	X	Y	Height (m)
1	Footpath 1 (ST)	Footpath	352031	239095	1.5
2	Footpath 2 (ST)	Footpath	352137	238957	1.5
3	Footpath 3 (ST)	Footpath	352194	238902	1.5
4	Footpath 4 (ST)	Footpath	352103	238891	1.5
5	Goodwin Way 1	Residential	352297	238486	1.5
6	Goodwin Way 2	Residential	352236	238437	1.5
7	Goodwin Way 3	Residential	352108	238381	1.5
8	River View	Residential	351750	238422	1.5
9	Outfall Works Road	Residential	352089	239213	1.5
10	Hampton Park Road	Residential	352346	239192	1.5

Receptor number	Receptor name	Receptor type	X	Y	Height (m)
11	Park Street	Residential	351805	239327	1.5
12	Hinton Road	Residential	351385	238791	1.5
13	St James Church of England Primary School	Primary School	351473	239335	1.5
14	Quay Cl	Residential	352171	239248	1.5

Note: Only the short-term objectives for NO_2 and SO_2 apply at modelled receptors with 'ST' included in the receptor name.

Figure 3.4: Modelled human health receptors

Commented [ALD30]: A4 Landscape



3.3.3 Ecological receptors

A review of ecological receptors has been carried out. Specific sites designated for their ecological importance need only be considered where they fall within set distances from the assessment site, as specified in the Environment Agency risk assessment guidance[34].

- Special Protection Areas (SPAs), Special Areas of Conservation (SACs) or Ramsar sites within 10km
- Sites of Special Scientific Interest (SSSIs) within 2km

[34] Environment Agency, 2016. Air emissions risk assessment for your environmental permit. Available at: https://www.gov.uk/guidance/air-emissions-risk-assessment-for-your-environmental-permit

- Other locally and nationally designated habitat sites including National Nature Reserves (NNRs), Local Nature Reserves (LNRs), Ancient Woodland sites (AWs) and Local Wildlife Sites (LWSs) within 2km.

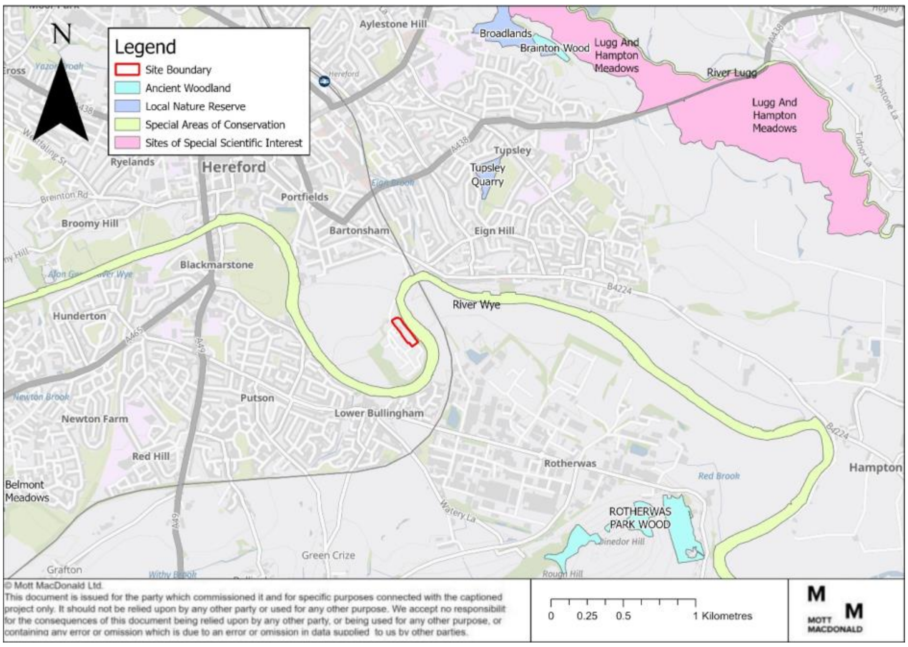
The following ecological sites are located within the above screening distances and have been considered in this assessment:

- River Wye SSSI and SAC, 8m to the east of the Site
- Lugg and Hampton Meadows, 2km to the northeast of the Site
- Tupsley Quarry LNR and AW, 1km to the northeast of the Site
- Broadlands LNR, 2km to the northeast of the Site
- Rotherwas Park Woods AW, 1.8km to the southeast of the Site
- Brainton Wood AW, 2km to the northeast of the Site

Figure 3.5 shows the locations of the ecological receptors modelled in this assessment.

Figure 3.5: Modelled ecological receptors

Commented [ALD31]: A4 Landscape



3.4 Effects on conservation sites

In accordance with the Environment Agency risk assessment guidance[35],the impact of NOx and SO_2 on conservation sites should be assessed against site relevant:

- Critical levels
- Nutrient nitrogen critical loads
- Acid deposition critical loads

3.4.1 Critical levels

Critical levels for the protection of vegetation and ecosystems are presented in Table 2.3. The contribution of NOx and SO_2 at the designated sites has been calculated for comparison against the identified critical levels presented in Section 2.4.2.

The critical levels correspond to national environmental standards for protected conservation areas and apply at all locations within the designated site boundaries. The closest point at each of the habitat sites listed above has been modelled.

3.4.2 Critical loads

Critical loads are a quantitative estimate of exposure to deposition of one or more pollutants, below which significant harmful effects on sensitive elements of the environment do not occur according to present knowledge. Critical load data are applicable to specific habitats and it may be necessary to consider the spatial distribution of various habitats present within the designation boundary of a site. For Lugg and Hampton Meadows SSSI, the most sensitive habitat listed on the APIS website has been assumed to be present at the closest point within the designation boundary to the Site. For the AW and LNR sites, site-specific habitat data from APIS are not available' however, the APIS Search by Location tool was used to determine the relevant critical load data for the 'broadleaved, mixed and yew woodland' habitat class for each of these woodland sites.

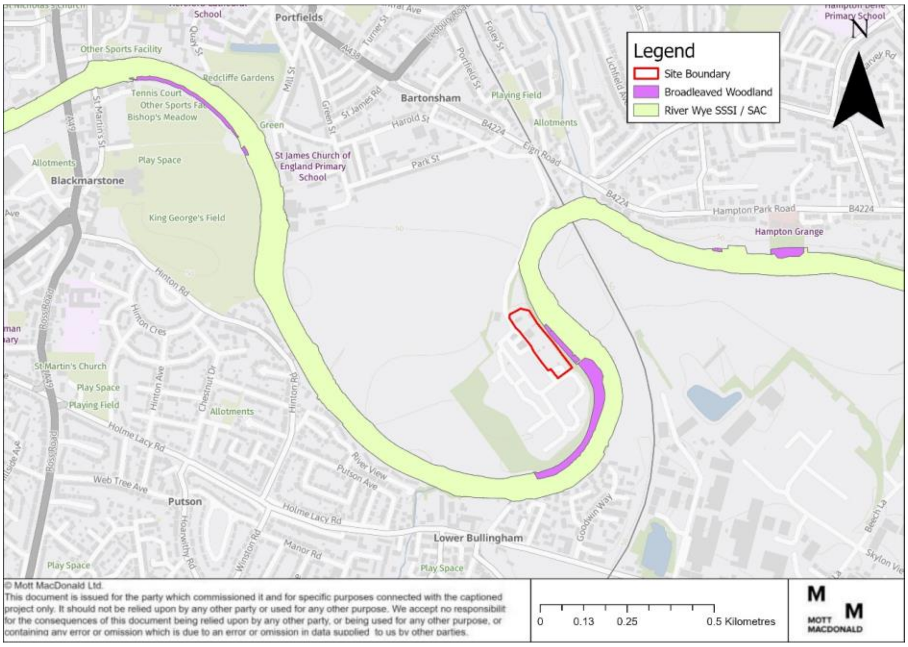
For River Wye SAC and SSSI, each grid point located within the designation boundary was attributed with a habitat type using a GIS layer from the Natural England Priority Habitats Inventory[36]. Broadleaved Woodland' is the only priority habitat within the boundary of this site that is listed as sensitive to nitrogen deposition or acid deposition, and the modelled impacts at this habitat have compared against the relevant APIS critical loads for this specific designated site and habitat. The distribution of the broadleaved woodland habitat within the River Wye SSSI is presented in Figure 3.6.

[35] Environment Agency, 2016. Air emissions risk assessment for your environmental permit. Available at: https://www.gov.uk/guidance/air-emissions-risk-assessment-for-your-environmental-permit

[36] Natural England Priority Habitats Inventory. https://www.data.gov.uk/dataset/4b6ddab7-6c0f-4407-946e-d6499f19fcde/priority-habitats-inventory-england

Figure 3.6: Broadleaved Woodland Habitat within River Wye SAC & SSSI

Commented [ALD32]: A4 landscape



The critical loads for the designated sites considered within the assessment are presented in Table 3.5.

Table 3.5: Critical loads for the modelled ecological sites

Commented [ALD33]: This could also benefit from A4 landscape

Commented [MB34R33]: This issue is as an A4 page both this table and the map above fit on one page. If we change two landscape it will be two pages so a less efficient use of space

Site name	APIS Nitrogen Critical Load Class	Modelled Location (x, y)(b)	Nitrogen deposition Lower critical load (kg/ha/yr)	Acid deposition critical loads		
				CLmaxS (keq/ha/ yr)	CLminN (keq/ha/ yr)	CLmaxN (keq/ha/ yr)
River Wye SAC and SSSI	Broadleaved deciduous woodland	352097, 238889	10	0.566	0.142	0.851
Lugg and Hampton Meadows SSSI	Low and medium altitude hay meadows	353302, 240709	10	4.000	0.856	1.123
Tupsley Quarry LNR and AW	Broadleaved deciduous woodland	352636, 239741	10	1.509	0.142	1.651
Broadlands LNR	Broadleaved deciduous woodland	352772, 240789	10	0.981	0.142	1.123

Site name	APIS Nitrogen Critical Load Class	Modelled Location (x, y)(b)	Nitrogen deposition Lower critical load (kg/ha/yr)	Acid deposition critical loads		
				CLmaxS (keq/ha/ yr)	CLminN (keq/ha/ yr)	CLmaxN (keq/ha/ yr)
Rotherwas Park Woods AW	Broadleaved deciduous woodland	353283, 237487	10	0.981	0.142	1.123
Brainton Wood AQ	Broadleaved deciduous woodland	353023, 240788	10	2.434	0.357	2.791

Source: APIS website

3.4.2.1 Critical loads – acidification

Percentage contributions to acid deposition have been derived from dispersion modelling. Deposition rates were calculated using empirical methods recommended by Environment Agency guidance[37] as follows:

- Calculate dry deposition flux. NOx: 0.0015 m/s for grassland, 0.003 m/s for forest. SO_2: 0.012m/s for grassland, 0.024 m/s for forest
- Dry deposition flux ($\mu g/m^2/s$) = ground level concentration ($\mu g/m^3$) x deposition velocity (m/s)
- Convert units from $\mu g/m^2/s$ to units of keq/ha/yr by multiplying the dry deposition flux by standard conversion factors (6.84 for NO_2 and 9.84 for SO_2)

Wet deposition in the near field is not significant compared with dry deposition and therefore for the purposes of this assessment, wet deposition has not been considered.

Predicted contributions to acid deposition have been calculated and compared with the relevant critical load function for each habitat type associated with each designated site, as derived from the APIS.

3.4.2.2 Critical loads – eutrophication

Percentage contributions to nutrient nitrogen deposition have been derived from dispersion modelling. Deposition rates were calculated using empirical methods recommended by Environment Agency guidance, as follows:

- Calculate NO_2 dry deposition flux (0.0015 m/s for grassland, 0.003 m/s for forest assumed as deposition velocity):
  - Dry deposition flux ($\mu g/m^2/s$) = ground level concentration ($\mu g/m^3$) x deposition velocity (m/s)
- Convert units from $\mu g/m^2/s$ to units of kg/ha/yr by multiplying the dry deposition flux by a standard conversion factor (95.9 for NO_2).

Wet deposition in the near field is not significant compared with dry deposition and therefore for the purposes of this assessment, wet deposition has not been considered.

Predicted contributions to nitrogen deposition have been calculated and compared with the relevant critical load range for each habitat type associated with each designated site, as derived from the APIS.

[37] Environment Agency. (2006) Technical Guidance on detailed modelling approach for an appropriate assessment for emissions to air: Habitats Directive 2004 (AQTAG 06).

3.5 Significance criteria

Several approaches can be used to determine whether the potential air quality effects of a development are significant. However, there remains no universally recognised definition of what constitutes 'significance'.

Guidance is available from a range of regulatory authorities and advisory bodies on how best to determine and present the significance of effects within an air quality assessment. It is generally considered good practice that, where possible, an assessment should communicate effects both numerically and descriptively.

Definitions of significance have been adopted from the EA's air dispersion modelling guidance[38]. This guidance provides criteria for the screening out of insignificant PCs however does not provide explicit criteria regarding the significance of PECs. This guidance advises that an assessment must explain how significance has been judged and base this on site specific circumstances. For this assessment, the conservative assumptions regarding the operational load for the combustion plant and the emissions data adopted for NOx and SO_2 will strongly bias the modelled concentrations towards the worst-case, where it is highly likely that the actual concentrations would be lower than reported. Therefore, it is considered appropriate for the Site to judge that the PECs are insignificant where they do not exceed the EQS.

Table 3.6 provides a summary of criteria used to screen out insignificant impacts.

Table 3.6: Summary of assessment criteria

Parameter	Long-term standards	Short-term standards
Screen out insignificant emissions (PCs)	Emissions can be seen as insignificant where: PC long-term <= 1% of standard	Emissions can be seen as insignificant where: PC short-term <= 10% of standard
Screening for SPAs, SACs, Ramsar and SSSIs	The long-term PC is less than 1% of the long-term environmental standard for protected conservation areas	The short-term PC is less than 10% of the short-term environmental standard for protected conservation areas
Screening for local wildlife sites*	The short term PC is less than 100% of the short term environmental standard for protected conservation areas	The long term PC is less than 100% of the long term environmental standard for protected conservation areas
Screen out insignificant PECs	Resulting PEC does not exceed the relevant EQS	

Note: PC = Process Contribution; PEC = Predicted Environmental Concentration (PC + Ambient Concentration, AC)
*Local wildlife sites include Ancient Woodlands, NNRs, LNRs and other non-statutory wildlife sites

[38] Environment Agency, 2014. Environmental permitting: air dispersion modelling reports. Available at: https://www.gov.uk/guidance/environmental-permitting-air-dispersion-modelling-reports

4 Baseline conditions

4.1 Introduction

Information on air quality in the UK can be obtained from a variety of sources including local authorities, national network monitoring sites and other published sources. For the purpose of this assessment, data has been obtained from HC[39]. Data from the most recent year of monitoring data, 2022, has been used in this assessment.

4.2 Review and assessment of air quality in the study area

HC has declared two AQMAs within its boundary due to exceedances of the annual mean objective for NO_2. The AQMA's include A49 Road through Hereford and Bargates Road junction in Leominster. These AQMAs are not considered representative of the Site or surrounding sensitive receptors.

4.2.1 Local authority automatic monitoring

HC undertakes automatic monitoring at the HRD1 site on Victoria Street in Hereford city centre. This automatic station is not near to or considered representative of the Site or the surrounding receptors.

4.2.2 Local authority diffusion tube monitoring

HC undertakes diffusion tube monitoring at 45 locations across its administrative boundary, one of which is considered representative of the Site and the surrounding receptors. Table 4.1 below presents the annual mean NO_2 concentrations monitored at the locations considered representative of the Site.

HC reported no exceedances of the annual mean objective for NO_2 during 2022 and there have been no exceedances at any location since the year 2018.

Figure 4.1 presents the locations of the representative diffusion tube monitoring sites in relation to the Site.

Table 4.1: Annual mean NO_2 diffusion tube monitoring data

Site ID	Site	Coordinates (x, y)	Distance from Site (km)	Type	NO_2 annual mean concentrations (µg/m^3)				
					2018	2019	2020	2021	2022
92	Rotherwas Industrial Estate Hfd	352919, 237840	1.2	Urban Background	13.9	13.5	9.8	10.6	10.2

Source: HC Annual Status Report 2022 & nitrogen dioxide monitoring data 2022
Note: Data capture for both sites has been 100% for the period from 2018-2022

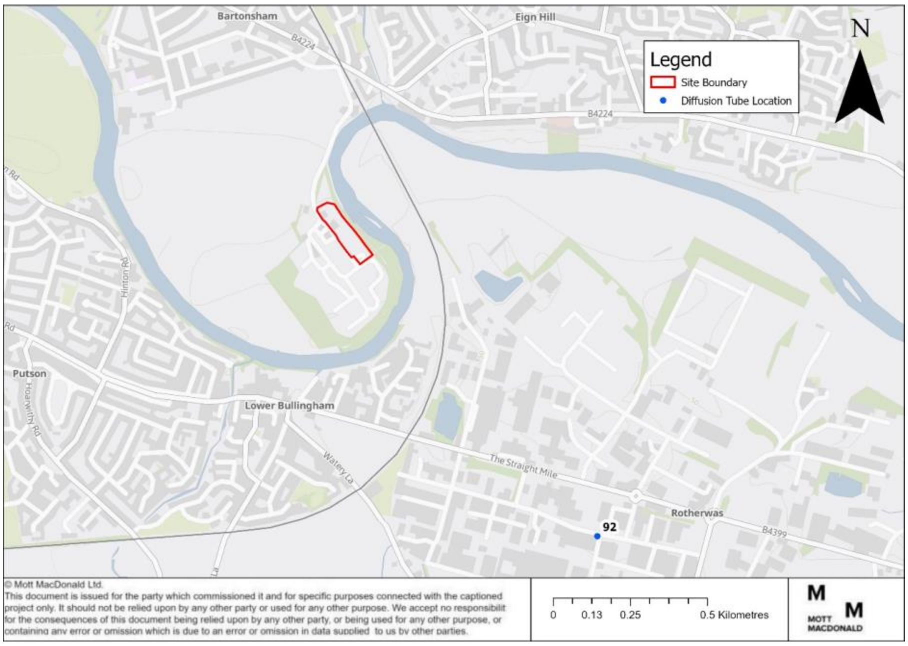
Commented [ALD35]: This is a bit squashed, move to A4 landscape page

Commented [MB36R35]: I have adjusted the columns to make it less squished

[39] Hertfordshire Council, 2022. 2022 Air Quality Annual Status Report.

Commented [ALD37]: A4 landscape

Figure 4.1: Representative monitoring site locations



4.3 Defra projected background pollutant concentrations

Defra provides estimates of background pollution concentrations for NO_X and NO_2 across the UK for each 1km grid square for every year from 2018 to 2030. Data is also available from Defra on SO_2 concentrations, however the most recent year of data available for SO_2 and VOCs is 2022.

Data from these sources has been collected for the grid square containing the Site and the grid squares containing the discrete human health receptors.

The Defra projected background concentrations for the grid square containing the Site for 2023 are presented in Table 4.2. These ACs have been added to the PCs to determine the PEC at the gridded receptors. The ACs used for the human health receptors correspond to the concentrations for the grid square the receptor is located within.

As discussed in Section 3.2.10, short-term background concentrations have been assumed to be twice the annual mean concentrations in line with Environment Agency guidance.[40]

[40] Environment Agency, 2016. Air emissions risk assessment for your environmental permit. Available at: https://www.gov.uk/guidance/air-emissions-risk-assessment-for-your-environmental-permit

Table 4.2: 2024 Defra projected background concentrations for the Site (µg/m³)

Pollutant	Long-term	Short-term
NO_X	8.0	16.1
NO_2	6.3	12.6
SO_2	2.5	5.0
VOCs	0.3	0.6

Notes: Results rounded to 1 decimal place
Pollutant concentrations for OS grid square 352500, 238500 is presented
Background concentrations of SO_2 and VOCs presented for 2022, which is the most recent year of data presented on Defra's website https://uk-air.defra.gov.uk/data/pcm-data

Commented [ALD38]: @Hazel Cheung does data in this table match your checking
Commented [HC39R38]: Checked and no issue

4.3.1 Summary

A review of air quality monitoring undertaken by HC has been undertaken to determine baseline air quality levels in the vicinity of the Site. There have been no exceedances of the annual mean NO_2 objective in Herefordshire since the year 2018 and background concentrations in the vicinity of the Site are low. There is one diffusion tube monitoring location considered representative of the Site and surrounding receptors. The monitored annual mean NO_2 concentration at this site for 2022 is applicable as the background concentration for the Site and modelled human health receptors.

5 Results

5.1 Overview

The results of modelling atmospheric emissions from the Site at gridded and human health receptors are summarised and interpreted below. The model results are presented in tabular form and as contour plots. The PCs and PECs have been compared against the EQSs and assessment criteria stated within EA's risk assessment guidance[41], as presented in Table 3.6, to assess the significance of the air quality impacts from the Site.

This conservative modelling assessment has assumed that the CHP and boilers operate continuously at full load, continuously all year. In practice, these combustion plant do not operate concurrently. The modelling of VOCs assumes the fraction of benzene in the VOCs emitted from the CHP is 100%. As discussed in Section 3.2.7, this is likely to lead to an overestimation of the actual benzene emissions by at least a factor of 10. The modelled impacts for VOCs below are therefore highly conservative and not a realistic prediction of the actual benzene concentrations.

For the assessment of hourly impacts for NO_2, the modelled PECs are based on continuous operation of the standby generators for all hours (8760) in the year, and the maximum modelled hourly concentrations allowing for 18 exceedances of the objective (99.79th percentile) are presented. Typical operation of these standby generators is only 15 hours in the year, therefore there is a very small probability that the operation of the generators will coincide with the worst meteorological conditions for dispersion. In addition, public exposure at the footpaths in the vicinity of the Site is transient, where a member of public using the footpath would likely be in the vicinity of the Site for less than one hour.

5.2 Gridded receptors

Table 5.1 presents the maximum predicted NO_2 SO_2 and VOCs PCs at offsite locations across the modelled grid. Table 5.1 shows that all of the predicted PCs for NO_2, SO_2 and VOCs are above 1% of the long-term EQS and above 10% of the short-term EQS. Therefore, these impacts cannot be screened out according to the Environment Agency significance criteria[42] so the PECs have also been considered. Table 5.2 presents the predicted PCs for NO_2, SO_2 and VOCs at offsite locations across the modelled grid.

Contour plots of all modelled PECs, in the worst-case meteorological years, are presented in Figure 5.1 to Table 5.9.

[41] Environment Agency, 2016. Air emissions risk assessment for your environmental permit. Available at: https://www.gov.uk/guidance/air-emissions-risk-assessment-for-your-environmental-permit

[42] the PCs are greater than 1% of the long-term standards, and the 10% of the short-term standards

Commented [ALD40]: A4 landscape

Table 5.1: Maximum NO_2, SO_2 and VOCs process contributions (PCs) (µg/m³) – Gridded receptors

Pollutant	Averaging period	Max PC	Max PC as % of EQS	EQS (µg/m³)
NO_2	99.79 %'ile of hourly averages	3686.7	**1843%**	200
	Annual average	8.1	**20%**	40
SO_2	99.9 %'ile of 15-minute averages	93.3	**35%**	266
	99.73 %'ile of hourly averages	77.4	**22%**	350
	99.18 %'ile of 24-hour averages	36.9	**30%**	125
VOCs	100 %'ile of 24-hour averages	97.2	**324%**	30
	Annual average	12.1	**241%**	5

Notes: Results rounded to 1 decimal place
PC = Process Contribution; EQS = Environmental Quality Standard, equivalent to the ambient air quality objectives
The results in **bold** are those that cannot be screened out as insignificant according to Environment Agency criteria

Commented [ALD41]: A4 landscape

Table 5.2: Maximum NO_2 and SO_2 predicted environmental concentration (PECs) (µg/m³) – Gridded receptors

Pollutant	Averaging period	EQS	AC	Max PC	Max PEC	Max PEC as % of EQS
NO_2	99.79 %'ile of hourly averages	200	20.4	3686.7	3707.1	**1854%**
	Annual average	40	10.2	8.1	18.3	46%
SO_2	99.9 %'ile of 15-minute averages	266	5.0	93.3	98.3	37%
	99.73 %'ile of hourly averages	350	5.0	77.4	82.4	24%
	99.18 %'ile of 24-hour averages	125	5.0	36.9	41.9	34%
VOCs	100 %'ile of 24-hour averages	30	0.6	97.2	97.8	**326%**
	Annual average	5	0.3	12.1	12.4	**247%**

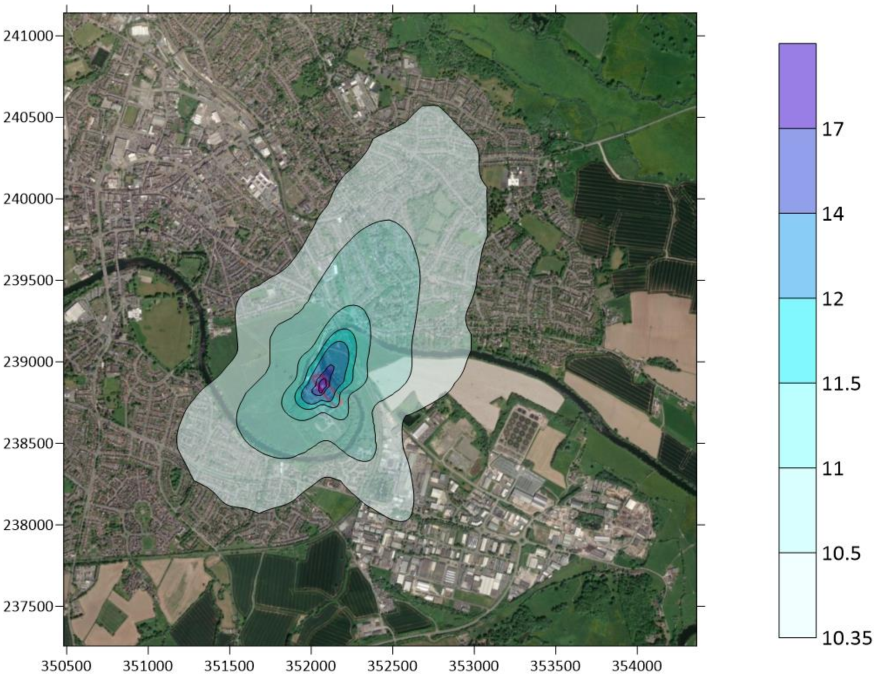
Notes: Results rounded to 1 decimal place
AC= Ambient Concentration (2023 Defra background concentration); PC = Process Contribution; PEC = Predicted Environmental Concentration (AC+PC=PEC); EQS = Environmental Quality Standard, equivalent to the ambient air quality objectives
The results in bold are those that cannot be screened out as insignificant according to Environment Agency criteria

The PECs for the pollutants and averaging periods which have not be screened out are shown in Table 5.2. The maximum hourly PEC for NO_2 and the daily and annual PECs for VOCs are above the relevant EQSs and have been reviewed further. The PECs for annual mean NO_2 and SO_2 are below the relevant EQSs and therefore considered insignificant.

For the hourly NO_2 objective, the maximum PECs exceed 200 µg/m^3 up to approximately 230m from the site boundary. Within this area up to 230m from the Site there are public footpaths running either side of the River Wye where the hourly objective for NO_2 may apply. However, as discussed in Section 5.1, these modelled maximum PECs are based on continuous operation of the standby generators for all hours in the year. Figure 5.3 presents the results of statistical testing in the form of a hypergeometric probability distribution to determine the areas in which the probability of exceedances of the hourly NO_2 objective exceed 1% and 5% based on 40 hours of annual operation. The area in which the probability of exceedance is >5%, where there is a potential for exceedances, includes a very small area up to 10m to the northeast of the site boundary, where there is no public footpath and therefore there is no relevant exposure for the hourly objective. The area where the probability of exceedances is more than 1% and less than 5% extends up to 40m to the northeast of the site boundary and includes approximately 50m of the public footpath. This area signifies that exceedances are unlikely as long as the generator plant operational lifetime is no more than 20 years. Furthermore, members of the public would not be expected to be present within this small area for more than an hour. On that basis, the hourly impacts for NO_2 are considered insignificant.

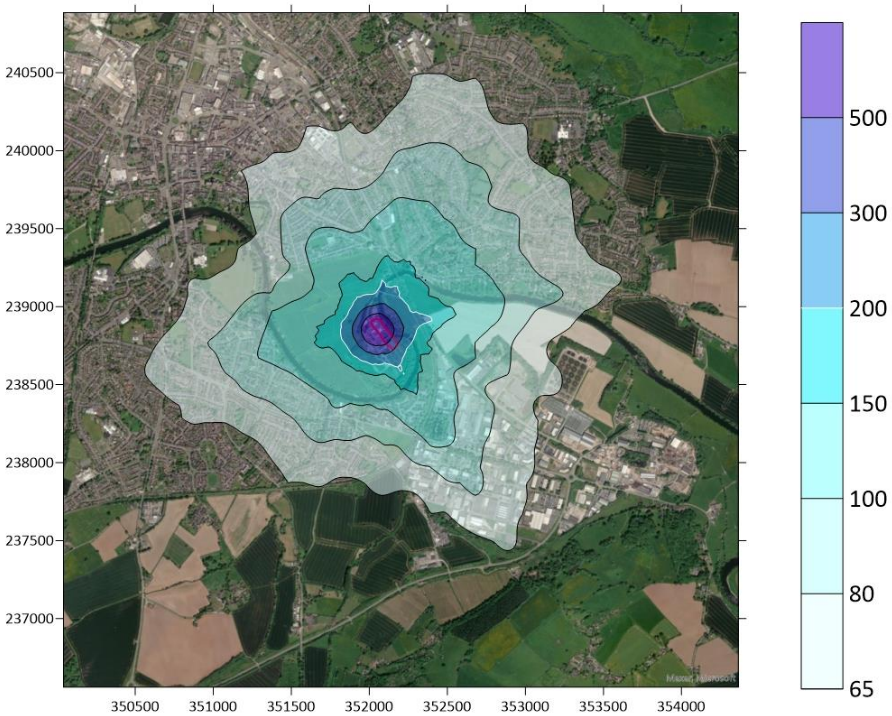
For the daily and annual EQSs for VOCs, contour plots presented in Figure 5.7 and Figure 5.8 show that the daily and annual mean PECs are above the EQS at the land surrounding the site boundary up to a distance of approximately 200 - 240m from the site. The area of exceedance for the annual mean EQS includes one residential property at Quay Close where the where the annual and daily EQSs apply, while the area of exceedance for the daily EQS does not include any receptors where the daily objective applies. Considering the highly conservative assumptions regarding the fraction of benzene for the modelled VOCs, as discussed in Section 5.1, exceedances of the EQS for benzene are considered highly unlikely on the basis of these modelled PECs. The modelled VOCs impacts which are therefore considered insignificant.

Figure 5.1: Annual mean NO_2 PEC (µg/m^3)



Note: Results presented for the worst case meteorological year of 2020. The worst case meteorological year is determined by calculating the year with the maximum offsite concentration modelled across the gridded receptors. Site boundary is outlined in red. The 2022 monitored concentration at Hereford diffusion tube 92 has been assumed for the ambient concentrations for all gridded receptors. This 2022 diffusion tube concentration is 10.2 µg/m^3.

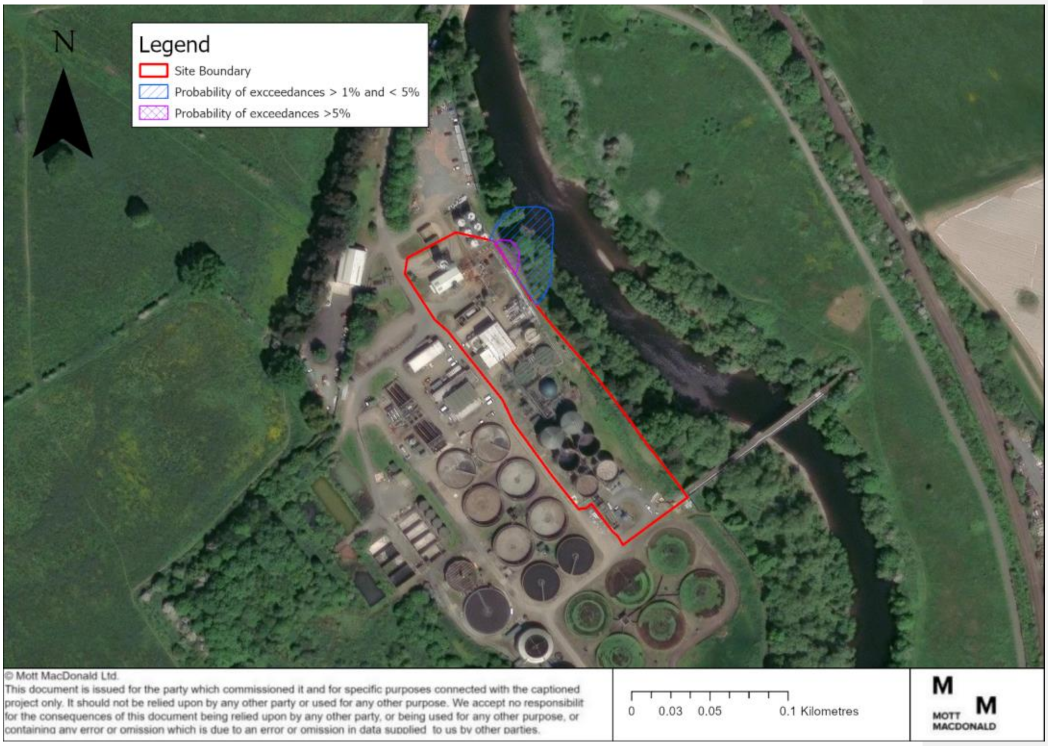
Figure 5.2: Hourly mean (99.79th percentile) NO_2 PEC (µg/m^3)



Note: Results presented for the worst case meteorological year of 2021. The worst case meteorological year is determined by calculating the year with the maximum offsite concentration modelled across the gridded receptors. Site boundary and modelled stacks are outlined in red. The 2022 monitored concentration at Hereford diffusion tube 92 (multiplied by 2) has been assumed for the ambient concentrations for all gridded receptors. This 2022 diffusion tube concentration multiplied by 2 is 20.4 µg/m^3. The EQS of 200µg/m^3 is indicated by the white contour line.

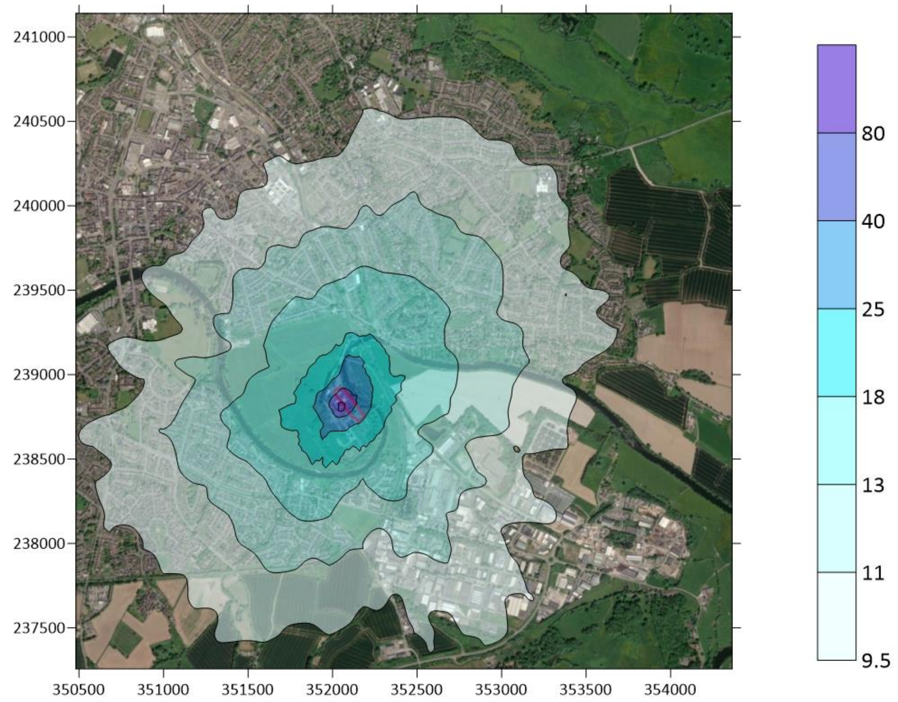
Commented [ALD42]: Above you mention that there are sports facilities to the west. Does the 200ug/m3 contour cross into that receptor? That could be another factor to it not being significant.

Figure 5.3: Probability of exceedances of the hourly NO_2 objective based on 40 hours of annual operation for the standby generators and continuous operation for the CHP and boilers



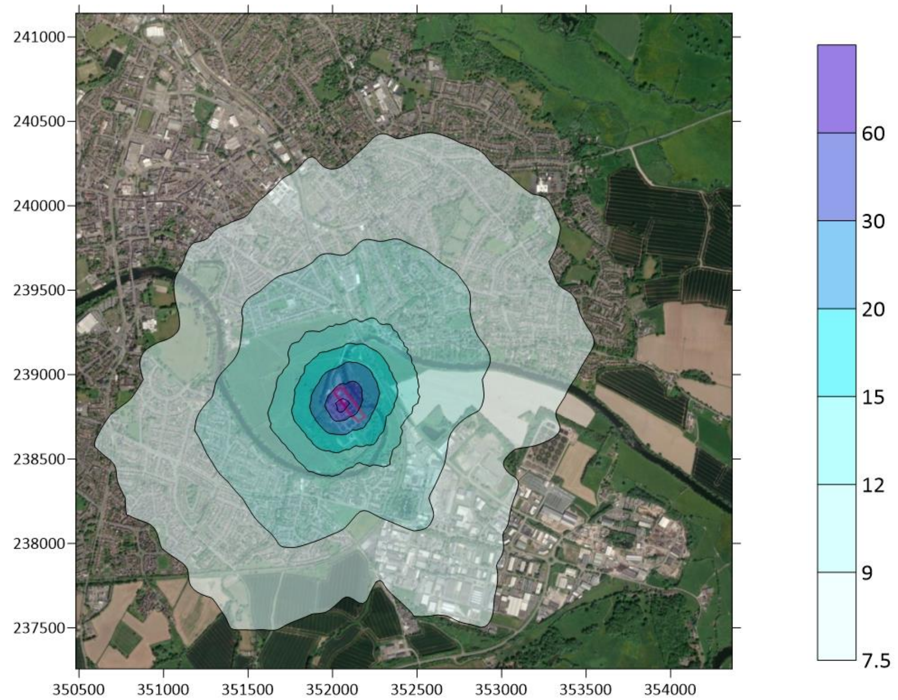
Note: The statistical testing behind this analysis is described in Section 3.2.6
The area outside of the shaded zones indicate that the risk of exceedance is <1% and are highly unlikey
The blue shaded area indicates that the risk of exceedance is <5% and unlikely as long as the generator plant operational lifetime is no more than 20 years
The purple area indicates a risk of exceedance that is >5% and there is a potential for exceedances

Figure 5.4: 15-minute mean (99.9th percentile) SO_2 PEC (µg/m³)



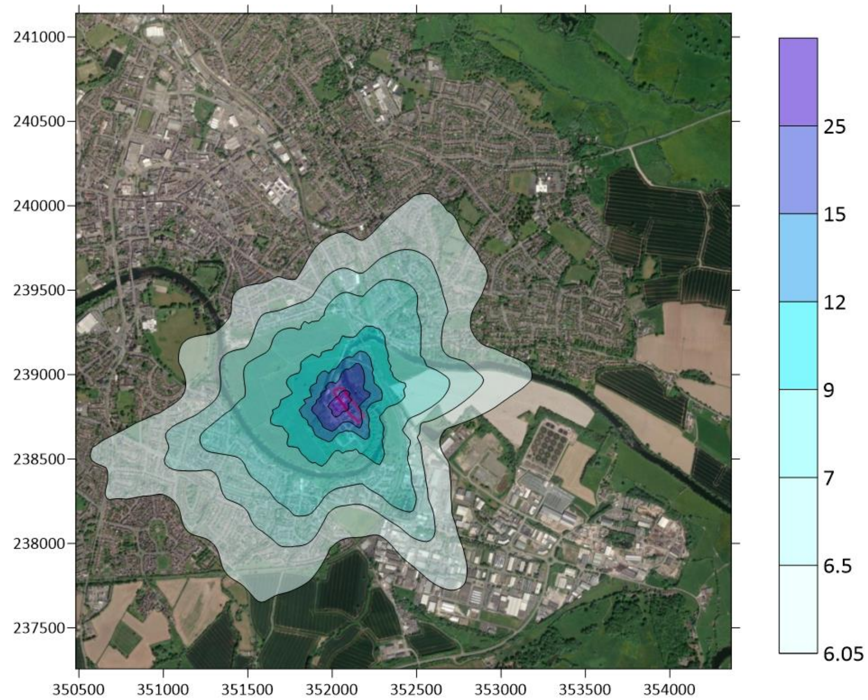
Note: Results presented for the worst case meteorological year of 2018. The worst case meteorological year is determined by calculating the year with the maximum offsite concentration modelled across the gridded receptors. Site boundary and modelled stacks are outlined in red. The 2022 Defra background concentration for the grid square of the maximum PC (multiplied by 2) has been assumed for the ambient concentrations for all gridded receptors. This 2022 Defra background concentration is 5.0 µg/m³.

Figure 5.5: Hourly mean (99.73rd percentile) SO_2 PEC (µg/m³)



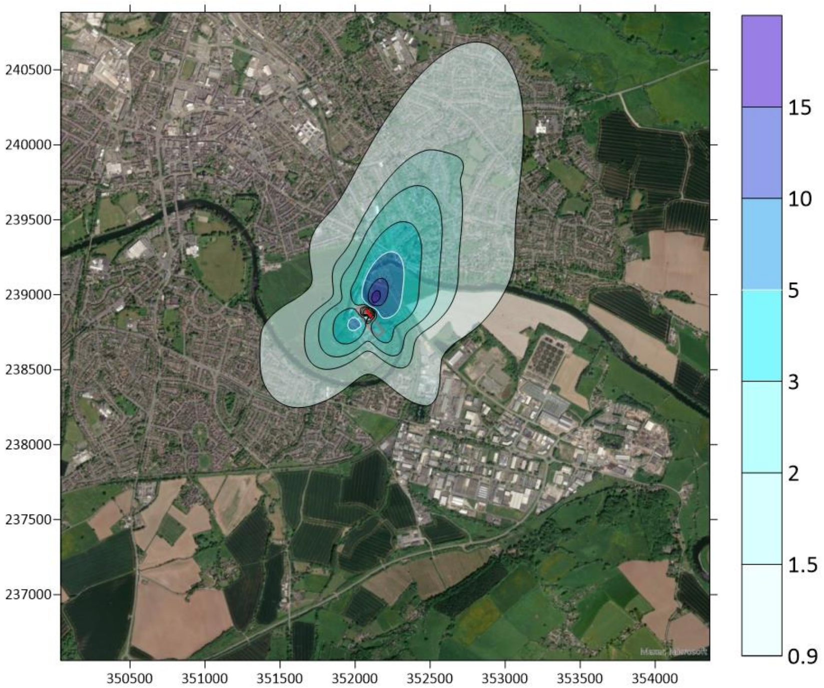
Note: Results presented for the worst case meteorological year of 2018. The worst case meteorological year is determined by calculating the year with the maximum offsite concentration modelled across the gridded receptors. Site boundary and modelled stacks are outlined in red. The 2022 Defra background concentration for the grid square of the maximum PC (multiplied by 2) has been assumed for the ambient concentrations for all gridded receptors. This 2022 Defra background concentration is 5.0 µg/m³.

Figure 5.6: 24-hour mean (99.18th percentile) SO_2 PEC (µg/m^3)



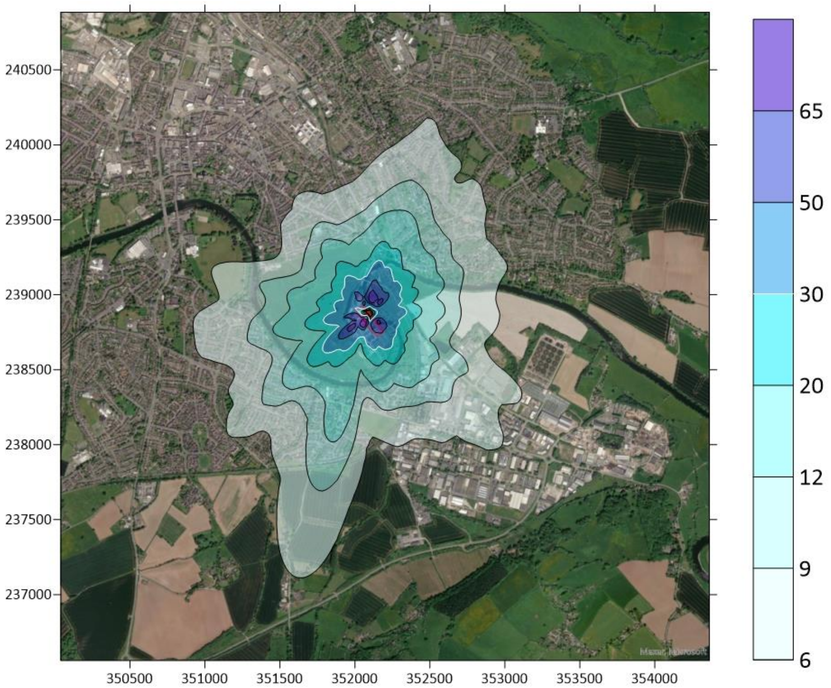
Note: Results presented for the worst case meteorological year of 2018. The worst case meteorological year is determined by calculating the year with the maximum offsite concentration modelled across the gridded receptors. Site boundary and modelled stacks are outlined in red. The 2023 Defra background concentration for the grid square of the maximum PC (multiplied by 2) has been assumed for the ambient concentrations for all gridded receptors. This 2023 Defra background concentration is 5.0 µg/m^3.

Figure 5.7 Annual mean VOCs (benzene) PEC (µg/m³)



Note: Results presented for the worst case meteorological year of 2020. The worst case meteorological year is determined by calculating the year with the maximum offsite concentration modelled across the gridded receptors. Site boundary and modelled stacks are outlined in red. The 2022 Defra background concentration for the grid square of the maximum PC has been assumed for the ambient concentrations for all gridded receptors. This 2022 Defra background concentration is 0.3 µg/m³. The EQS of 5µg/m³ is indicated by the white contour line.

Figure 5.8 24-hour mean (100th percentile) VOCs (benzene) PEC (µg/m³)



Note: Results presented for the worst case meteorological year of 2022. The worst case meteorological year is determined by calculating the year with the maximum offsite concentration modelled across the gridded receptors. Site boundary and modelled stacks are outlined in red. The 2022 Defra background concentration for the grid square of the maximum PC (multiplied by 2) has been assumed for the ambient concentrations for all gridded receptors. This 2022 Defra background concentration is 0.6 µg/m³. The EAL of 30µg/m³ is indicated by the white contour line.

5.3 Human health discrete receptors

5.3.1 NO_2 concentrations

The PCs and PECs for hourly and annual NO_2 at discrete human health receptors are summarised in Table 5.3 and Table 5.4.

The predicted hourly NO_2 PCs exceed 10% of the EQS at all receptors, and the PECs exceed the EQS at receptors 1-4 which are at public footpaths in the vicinity of the Site. As discussed in Sections 5.1 and 5.2, these modelled impacts are based on maximum hourly concentrations from 8760 hours of operation, while the generators are in practice operational for up to 15 hours in the year. As shown in Figure 5.3 and discussed in Section 5.2, statistical testing of the hourly impacts assuming 40 hours of annual operation has shown that the probability of exceedances at these footpaths are unlikely and the hourly impacts for NO_2 are therefore considered insignificant.

For the annual mean, the predicted PC is above 1% of the EQS at receptors 5, 9 and 10, but the PECs are well below the EQS. Therefore, the annual mean impacts for NO_2 are considered insignificant.

Table 5.3: Maximum process contributions (PCs) (µg/m³) – 99.79 %'ile of hourly averages - Discrete human health receptors

Receptor	EQS (µg/m³)	Max PC	Max PC as % of EQS	AC	Max PEC	Max PEC as % of EQS
1	200	192.3	**96.1**	20.4	212.7	**106.3**
2	200	343.8	**171.9**	20.4	364.2	**182.1**
3	200	327.0	**163.5**	20.4	347.4	**173.7**
4	200	838.5	**419.2**	20.4	858.9	**429.4**
5	200	133.7	**66.9**	20.4	154.1	77.1
6	200	116.6	**58.3**	20.4	137.0	68.5
7	200	80.1	**40.0**	20.4	100.5	50.2
8	200	91.6	**45.8**	20.4	112.0	56.0
9	200	173.9	**87.0**	20.4	194.3	97.2
10	200	131.9	**66.0**	20.4	152.3	76.2
11	200	102.2	**51.1**	20.4	122.6	61.3
12	200	95.1	**47.6**	20.4	115.5	57.8
13	200	67.0	**33.5**	20.4	87.4	43.7
14	200	160.3	**80.2**	20.4	180.7	90.4

Notes: PC = Process Contribution
EQS = Environmental Quality Standard, equivalent to the ambient air quality objectives
Results rounded to 1 decimal place

Table 5.4: Maximum process contributions (PCs) (µg/m³) – Annual average - Discrete human health receptors

Receptor	EQS (µg/m³)	Max PC	Max PC as % of EQS	AC	Max PEC	Max PEC as % of EQS
5	40	0.4	**1.1**	10.2	10.6	26.6
6	40	0.3	0.8	10.2	10.5	26.3
7	40	0.2	0.5	10.2	10.4	26.0
8	40	0.3	0.8	10.2	10.5	26.3
9	40	1.1	**2.7**	10.2	11.3	28.2
10	40	1.0	**2.5**	10.2	11.2	28.0
11	40	0.3	0.6	10.2	10.5	26.1
12	40	0.2	0.5	10.2	10.4	26.0
13	40	0.1	0.3	10.2	10.3	25.8
14	40	1.2	**3.1**	10.2	11.4	28.6

Notes: PC = Process Contribution;
EQS = Environmental Quality Standard, equivalent to the ambient air quality objectives
AC= Ambient Concentration (2023 Defra background concentration)
PEC = Predicted Environmental Concentration (AC+PC=PEC)
Results rounded to 1 decimal place
The PCs in **bold** are those that cannot be screened out as insignificant
Modelled impacts at only the receptors where the annual mean EQS is applicable are presented.

5.3.2 SO_2 concentrations

The PCs and PECs for 15-minute, hourly and daily SO_2 at discrete human health receptors are summarised in Table 5.5 to Table 5.7.

The hourly and daily PCs are below 10% of the EQS at all receptors. The 15-minute PCs exceed 10% of the EQS at receptors 2 and 4. All PECs are below the relevant EQSs. On that basis, all short term impacts for SO_2 are considered insignificant.

Table 5.5: Maximum SO_2 process contributions (PCs) (µg/m³) – 99.9 %'ile of 15-minute averages - Discrete human health receptors

Receptor	EQS (µg/m^3)	Max PC	Max PC as % of EQS	AC	Max PEC	Max PEC as % of EQS
1	266	18.5	6.9	3.2	21.6	8.1
2	266	28.3	**10.6**	5.0	33.3	12.5
3	266	25.5	9.6	5.0	30.5	11.5
4	266	37.6	**14.1**	5.0	42.6	16.0
5	266	10.3	3.9	5.0	15.3	5.8
6	266	10.2	3.8	5.0	15.2	5.7
7	266	10.5	4.0	5.0	15.5	5.8
8	266	9.9	3.7	3.1	13.0	4.9
9	266	14.7	5.5	3.2	17.9	6.7
10	266	12.2	4.6	3.2	15.4	5.8
11	266	9.3	3.5	3.0	12.3	4.6
12	266	8.6	3.2	3.1	11.6	4.4
13	266	6.5	2.5	3.0	9.5	3.6
14	266	12.8	4.8	3.2	16.0	6.0

Notes: PC = Process Contribution
EQS = Environmental Quality Standard, equivalent to the ambient air quality objectives
AC= Ambient Concentration (2023 Defra background concentration)
PEC = Predicted Environmental Concentration (AC+PC=PEC)
Results rounded to 1 decimal place

Table 5.6: Maximum SO_2 process contributions (PCs) (µg/m³) – 99.73 %'ile of hourly averages - Discrete human health receptors

Receptor	EQS (µg/m^3)	Max PC	Max PC as % of EQS
1	350	13.0	3.7
2	350	25.1	7.2
3	350	22.5	6.4
4	350	34.2	9.8
5	350	7.4	2.1
6	350	6.8	1.9
7	350	6.3	1.8
8	350	6.1	1.7
9	350	9.2	2.6
10	350	7.9	2.3
11	350	5.9	1.7
12	350	5.0	1.4

Receptor	EQS (µg/m³)	Max PC	Max PC as % of EQS
13	350	4.0	1.1
14	350	8.4	2.4

Notes: PC = Process Contribution
EQS = Environmental Quality Standard, equivalent to the ambient air quality objectives
AC= Ambient Concentration (2023 Defra background concentration)
PEC = Predicted Environmental Concentration (AC+PC=PEC)
Results rounded to 1 decimal place

Table 5.7: Maximum SO_2 process contributions (PCs) (µg/m³) – 99.18 %'ile of 24-hour averages - Discrete human health receptors

Receptor	EQS (µg/m³)	Max PC	Max PC as % of EQS
5	125	4.4	3.5
6	125	3.7	2.9
7	125	2.7	2.1
8	125	3.4	2.7
9	125	4.4	3.6
10	125	3.8	3.0
11	125	1.8	1.5
12	125	2.4	1.9
13	125	1.2	0.9
14	125	4.9	3.9

Notes: PC = Process Contribution
EQS = Environmental Quality Standard, equivalent to the ambient air quality objectives
AC= Ambient Concentration (2023 Defra background concentration)
PEC = Predicted Environmental Concentration (AC+PC=PEC)
Results rounded to 1 decimal place
The PCs in **bold** are those that cannot be screened out as insignificant

5.3.3 VOCs (benzene) concentrations

The PCs and PECs for daily and annual VOCs at discrete human health receptors are summarised in Table 5.8 to Table 5.9.

The 24-hour PCs are predicted to be above 10% of the EQS at all receptors while the PECs are all below the EQS. Therefore, the daily mean impacts for VOCs are considered insignificant.

For the annual mean, the PCs are predicted to be above 1% of the EQS at all modelled receptors while the PECs exceed the EQS at receptor 14. Considering the highly conservative assumption regarding the fraction of benzene in the VOCs emissions, exceedances of the EQS for benzene are unlikely and the annual mean impacts for VOCs are considered insignificant.

Table 5.8: Maximum VOCs (benzene) process contributions (PCs) (µg/m³) – 100 %'ile of 24-hour averages - Discrete human health receptors

Receptor	EQS (µg/m³)	Max PC	Max PC as % of EQS	AC	Max PEC	Max PEC as % of EQS
5	30	21.2	**70.7%**	0.6	21.8	72.7%
6	30	16.7	**55.7%**	0.6	17.3	57.7%
7	30	20.4	**68.1%**	0.6	21.0	70.1%
8	30	15.9	**52.9%**	0.5	16.4	54.8%
9	30	25.6	**85.5%**	0.6	26.2	87.4%

Receptor	EQS ($\mu g/m^3$)	Max PC	Max PC as % of EQS	AC	Max PEC	Max PEC as % of EQS
10	30	20.9	**69.8%**	0.6	21.5	71.7%
11	30	12.5	**41.7%**	0.6	13.1	43.5%
12	30	11.8	**39.2%**	0.5	12.3	41.1%
13	30	7.7	**25.6%**	0.6	8.2	27.4%
14	30	27.6	**91.9%**	0.6	28.1	93.8%

Notes: PC = Process Contribution
EQS = Environmental Quality Standard, equivalent to the ambient air quality objectives
AC= Ambient Concentration (2023 Defra background concentration)
PEC = Predicted Environmental Concentration (AC+PC=PEC)
Results rounded to 1 decimal place
The PCs in **bold** are those that cannot be screened out as insignificant

Table 5.9: Maximum VOCs (benzene) process contributions (PCs) ($\mu g/m^3$) – annual average - Discrete human health receptors

Receptor	EQS ($\mu g/m^3$)	Max PC	Max PC as % of EQS	AC	Max PEC	Max PEC as % of EQS
5	5	1.5	**30.0%**	0.3	1.8	36.0%
6	5	1.1	**21.6%**	0.3	1.4	27.6%
7	5	0.6	**12.7%**	0.3	0.9	18.8%
8	5	1.1	**21.8%**	0.3	1.4	27.3%
9	5	4.0	**79.0%**	0.3	4.2	84.7%
10	5	4.2	**83.4%**	0.3	4.5	89.1%
11	5	1.0	**20.6%**	0.3	1.3	26.1%
12	5	0.7	**14.6%**	0.3	1.0	20.0%
13	5	0.5	**10.4%**	0.3	0.8	16.0%
14	5	5.0	**99.7%**	0.3	5.3	**105.4%**

Notes: PC = Process Contribution
EQS = Environmental Quality Standard, equivalent to the ambient air quality objectives
AC= Ambient Concentration (2023 Defra background concentration)
Results rounded to 1 decimal place

5.4 Ecological receptors

This section presents the maximum PCs and PECs for comparison with the relevant daily and annual NOx EQS (critical levels) and relevant nitrogen deposition and acid critical loads at nearby ecological sites.

The PCs and PECs modelled at the closest point at the boundaries of ecological sites to the Site are presented.

5.4.1 Assessment of critical levels

Table 5.10 and Table 5.11 present the maximum predicted annual and daily NOx PC and PECs at ecological receptors.

The maximum predicted annual NOx PC exceeds 1% of the EQS at River Wye SSSI & SAC and Tupsley Quarry LNR, but the PECs are below the EQS at all modelled sites. The impact is therefore considered insignificant.

The maximum daily NOx PCs exceed 10% of the EQS at River Wye SSSI & SAC and Lugg And Hampton Meadows SSSI, and the PECs exceed the EQS at River Wye SSSI & SAC. The modelled PCs are below 100% of the EQS at the AW and LNR sites and are therefore considered insignificant. The modelled maximum PCs and PECs at River Wye SSSI & SAC are based on 8760 hours of annual operation and are therefore highly conservative based upon the actual operational hours for the generators which are not expected for more than 15 hours in the year. However, based on professional judgement and the conservative assumptions applied to this assessment, it is considered that exceedances of the daily NOx EQS are possible at River Wye SSSI & SAC within the area indicated on Figure 5.9. It is It is therefore not possible to rule out a significant impact for the 24 hour NOx EQS at River Wye SSSI & SAC. The significance of the daily NOx impact at River Wye SSSI & SAC will be determined in a separate Ecological Impact Assessment that will follow this AQA.

Table 5.10: Maximum annual NOx critical level results

Receptor	EQS ($\mu g/m^3$)	Max PC ($\mu g/m^3$)	% PC of EQS	AC	PEC	% PEC of EQS
River Wye SSSI & SAC	30	11.5	**38.5%**	8.0	19.6	65%
Lugg And Hampton Meadows SSSI	30	0.2	0.6%	7.2	7.3	24%
Tupsley Quarry LNR	30	0.5	1.6%	7.6	8.0	27%
Broadlands LNR	30	0.2	0.7%	8.7	8.9	30%
Brainton Wood AW	30	0.2	0.7%	7.2	7.4	25%
Rotherwas Park Woods AW	30	0.1	0.3%	7.2	7.3	24%

Note: PC = Process Contribution; PEC=Predicted Environmental Concentration; AC=Ambient Concentration (2023 Defra NOx backgrounds); EQS = Environment Quality Standards
Arithmetic discrepancies may occur due to rounding of results, and due to differences in worst-case meteorological years

Table 5.11: Maximum daily NOx critical level results

Receptor	EQS (µg/m3)	Max PC (µg/m3)	% PC of EQS	AC	PEC	% PEC of EQS
River Wye SSSI & SAC	75	2239.7	**2986.3%**	16.1	2255.8	**3008%**
Lugg And Hampton Meadows SSSI	75	36.5	**48.7%**	14.4	50.9	68%

Receptor	EQS (µg/m3)	Max PC (µg/m3)	% PC of EQS	AC	PEC	% PEC of EQS
Tupsley Quarry LNR	75	64.2	85.6%	15.2	79.3	106%
Broadlands LNR	75	40.3	53.7%	17.3	57.6	77%
Brainton Wood AW	75	40.5	54.0%	14.4	54.8	73%
Rotherwas Park Woods AW	75	38.8	51.7%	14.4	53.2	71%

Note: PC = Process Contribution; PEC=Predicted Environmental Concentration; AC=Ambient Concentration (2023 Defra NOx backgrounds); EQS = Environment Quality Standards
Arithmetic discrepancies may occur due to rounding of results, and due to differences in worst-case meteorological years

Figure 5.9: Area of potential exceedances of 24 hour NOx EQS

Table 5.12 presents the maximum annual SO_2 PC and PECs. The maximum predicted annual SO_2 PC exceed 1% of the EQS at River Wye SSSI & SAC, but the PECs are below the EQS. The modelled PCs are below 100% of the EQS at the AQ and LNR sites and are below 1% of the EQS at Lugg And Hampton Meadows SSSI. The modelled impacts are therefore considered insignificant.

Table 5.12: Maximum annual SO_2 critical level results

Receptor	EQS (µg/m3)	Max PC (µg/m3)	% PC of EQS	% PC of EQS	AC	PEC
River Wye SSSI & SAC	20	7.1	**35.6%**	2.5	9.6	48%
Lugg And Hampton Meadows SSSI	20	0.1	0.6%	1.4	1.5	7%
Tupsley Quarry LNR	20	0.3	1.5%	1.6	1.9	9%
Broadlands LNR	20	0.1	0.7%	1.5	1.6	8%
Brainton Wood AW	20	0.1	0.6%	1.4	1.5	7%
Rotherwas Park Woods AW	20	0.1	0.3%	3.1	3.2	16%

Note: PC = Process Contribution; PEC=Predicted Environmental Concentration; AC=Ambient Concentration (2022 Defra SO_2 backgrounds); EQS = Environment Quality Standards
PC presented to two decimal places to show concentrations are not zero
Arithmetic discrepancies may occur due to rounding of results, and due to differences in worst-case meteorological years

5.4.2 Assessment of critical loads

5.4.2.1 Critical loads – eutrophication

Table 5.13 presents the predicted nitrogen deposition rates at ecological sites, which have been calculated from dispersion modelling and compared with the lower nitrogen critical load for each habitat.

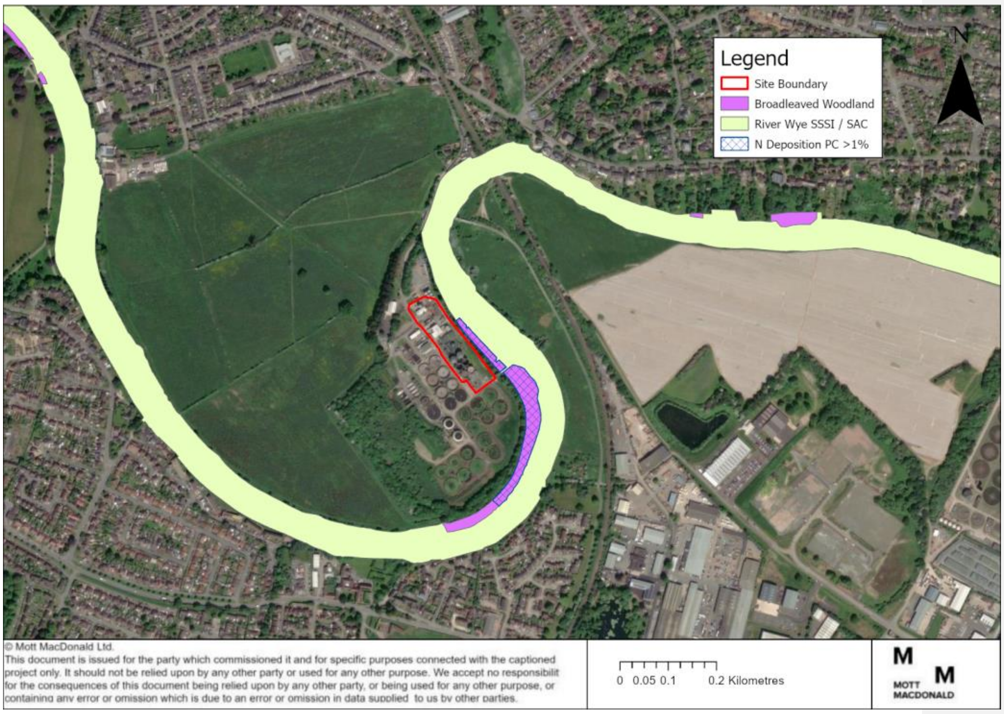
The results show that the maximum predicted PC for nitrogen deposition exceeds 1% of the relevant minimum critical load at the broadleaved woodland habitat at River Wye SSSI & SAC. The areas of this woodland habitat where the PC exceeds 1% of the minimum CL are presented in Figure 5.10. It should be noted that the background nitrogen deposition rate is well above the minimum CL for the broadleaved woodland, and the contribution from the Site is only a maximum of approximately 5% of this background level. The AD facilities at the Site have also been operational for several years and can be considered part of the effective background. Therefore, its continued operation may not be expected to cause adverse ecological changes. However, specialist ecological opinion should be sought to determine the potential for adverse ecological changes at the impacted area of broadleaved woodland and whether this affects the integrity of the River Wye SSSI & SAC. It is therefore not possible to rule out a significant impact for the nitrogen deposition at the broadleaved woodland habitat at River Wye SSSI & SAC. The significance of the nitrogen deposition impact at River Wye SSSI & SAC will be determined in a separate Ecological Impact Assessment that will follow this AQA.

Table 5.13: Critical load results - nitrogen deposition

Designated site	APIS Habitat[(a)]	Minimum nitrogen deposition critical load[(b)]	Maximum ground level concentration of NO_2 (PC) (µg/m^3)	Total nitrogen deposition from the Site (PC) (kg/ha/yr)	% PC of minimum nitrogen deposition critical load	Background Ndep (kg/ha/year)	PEC Ndep (kg/ha/year)	PEC as % Ndep CL
River Wye SSSI & SAC	Broadleaved deciduous woodland	10	3.7	1.1	**10.6%**	21.0	24.7	247.0%
Lugg And Hampton Meadows SSSI	Low and medium altitude hay meadows	10	0.1	0.0	0.2%	21.0	21.1	211.3%
Tupsley Quarry LNR	Broadleaved deciduous woodland	10	0.3	0.1	0.9%	30.9	31.2	312.2%
Broadlands LNR	Broadleaved deciduous woodland	10	0.1	0.0	0.4%	31.1	31.2	312.4%
Brainton Wood AW	Broadleaved deciduous woodland	10	0.1	0.0	0.4%	31.3	31.4	314.5%
Rotherwas Park Woods AW	Broadleaved deciduous woodland	10	0.1	0.0	0.2%	31.5	31.6	315.9%

Note: PC = Process Contribution; PC presented to more than one decimal places to demonstrate change and is not an indication of model accuracy
[(a)]Each habitat has been classified as either “grassland” or “forest” to determine which conversion factor should be used to calculate dry deposition flux (see Section 3.4.2.2)
[(b)]The lower critical load for the ‘fen, marsh and swamp’ nitrogen critical load class from APIS has been applied
Arithmetic discrepancies may occur due to rounding of results, and due to differences in worst-case meteorological years

Figure 5.10: Area where N deposition PCs exceed 1% of the minimum CL at the broadleaved woodland habitat at River Wye SSSI & SAC



5.4.2.2 Critical loads - acidification

Table 5.14 presents the predicted acid deposition rates at ecological receptors, which have been calculated from dispersion modelling and compared with the relevant acidity critical load.

The results show that the maximum PCs exceed 1% of the lower CLmaxN critical load for acid deposition at the broadleaved woodland habitat at River Wye SSSI & SAC, and the PEC exceeds the CLmaxN for this habitat. The PCs are below 1% of the lower CLmaxN at Lugg and Hampton Meadows SSSI and below 100% of the EQS at the AW and LNR sites. These PCs are therefore considered insignificant.

At River Wye SSSI & SAC, it should be noted that the background acid deposition rate exceeds the minimum CLmaxN for the by considerable margin. It should also be noted that the PCs contribution for SO_2 is considerably higher than the PC contribution for NO_2, and these SO_2 PCs are based on assumed SO_2 ELVs for the CHP and boilers which may be considerably higher than the actual SO_2 emissions concentrations. However, this conservative assessment indicates that exceedances of 1% of the lower CLmaxN are possible for the broadleaved woodland habitat at River Wye SSSI & SAC which is indicated in Figure 3.6. Specialist ecological opinion should be sought to determine the potential for adverse ecological changes at broadleaved woodland due to acid deposition and whether this affects the integrity of the River Wye SSSI & SAC. It is therefore not possible to rule out a significant impact for the acid deposition at the broadleaved woodland habitat at River Wye SSSI & SAC. The significance of the acid deposition impact at River Wye SSSI & SAC will be determined in a separate Ecological Impact Assessment that will follow this AQA.

Table 5.14: Critical load results - acid deposition*

Designated site	APIS Habitat[(a)]	Minimum CLmaxN (keq N/ha/yr)	Maximum ground level concentration of NO_2 (PC) (µg/m^3)	Maximum ground level concentration of SO_2 (PC) (µg/m^3)	NO_2 acid deposition PC (keq/ha/yr)	SO_2 acid deposition PC (keq/ha/yr)	Total acid deposition PC (keq/ha/yr)	% PC of minimum CLmaxN	Acid deposition AC (keq/ha/yr)	Acid deposition PEC (keq/ha/yr)	% PEC of minimum CLmaxN
River Wye SSSI & SAC	Unmanaged Broadleafed/Coniferous Woodland	0.851	3.7	3.1	0.076	0.723	0.799	**93.9%**	2.519	3.318	389.9%
Lugg And Hampton Meadows SSSI	Alopecurus pratensis - Sanguisorba officinalis Grassland	4.856	0.1	0.1	0.001	0.013	0.014	0.3%	1.370	1.384	28.5%
Tupsley Quarry LNR	Broadleafed/Coniferous unmanaged woodland	1.651	0.3	0.3	0.007	0.073	0.080	4.8%	2.290	2.370	143.5%
Broadlands LNR	Broadleafed/Coniferous unmanaged woodland	1.123	0.1	0.1	0.003	0.031	0.034	3.1%	2.300	2.334	207.9%
Brainton Wood AW	Broadleafed/Coniferous unmanaged woodland	1.123	0.1	0.1	0.003	0.030	0.033	2.9%	2.310	2.343	208.6%
Rotherwas Park Woods AW	Broadleafed/Coniferous unmanaged woodland	2.791	0.1	0.1	0.001	0.015	0.017	0.6%	2.260	2.277	81.6%

Note: PC = Process Contribution; PC presented to more than one decimal places to demonstrate change and is not an indication of model accuracy
(a) Each habitat has been classified as either “grassland” or “forest” to determine which conversion factor should be used to calculate dry deposition flux (see Section 3.4.2.1).
Arithmetic discrepancies may occur due to rounding of results, and due to differences in worst-case meteorological years
N/A indicates that no critical load data for this habitat is available on APIS.

6 Conclusions

An assessment has been undertaken to determine the effect of emissions from the combustion of biogas at the CHP and auxiliary boilers and operation of standby generators at the Site on air quality in the surrounding area using advanced dispersion modelling. For gridded and human health receptors, the emissions of NOx, SO_2 and VOCs have been considered in accordance with Environment Agency guidance. Emissions of NOx and SO_2 and their contribution to nitrogen deposition has also been considered in terms of their impact on nearby ecological sites. The method of the assessment has taken a conservative approach by assuming worst-case conditions for factors such as emission characteristics, the operational hours and meteorological conditions. The modelled concentrations forecast in this assessment are likely to be higher than in reality, due to the worst-case assumptions regarding the combustion operating continuously at full load. The modelled impacts for VOCs assume a fraction of 100% benzene which is likely to overestimate the modelled benzene concentrations by at least a factor of 10 and is therefore highly conservative.

No exceedances of the EQSs for NO_2, SO_2 or VOCs (benzene) for human health receptors are predicted at locations of relevant public exposure. The air quality effects at human health receptors are considered insignificant in accordance with Environment Agency guidance.

Modelled impacts at the River Wye SAC & SSSI relating to 24-hour NOx concentrations and nitrogen and acid deposition cannot be ruled out as insignificant. The significance of these impacts will be determined in a separate Ecological Impact Assessment that will follow this AQA.

mottmac.com