Environmental Permit Application - Leigh Wastewater Treatment Works

Air Quality Impact Assessment

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United Utilities Water Limited

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Contents

Executive Summary

Under the Industrial Emissions Directive (IED) the treatment of sewage sludge by anaerobic digestion at Leigh Wastewater Treatment Works (WwTW), requires an Environmental Permit (EP). The scope of anaerobic digestion activities includes all treatment stages and incorporates directly associated activities such as a combined heat and power (CHP) gas engines and boiler.

United Utilities Water Limited operate a wastewater treatment centre at Leigh WwTW located near the town of Leigh, Greater Manchester (WN7 3XA). These operations include two existing CHP engines (each with a thermal input capacity of 1.30 MW_{th}) and an existing dual fuelled boiler (thermal input capacity of 1.16 MW_{th}) as set out in the table below.

Combustion Plant

Medium Combustion Plant (MCP) Information			
MCP specific identifier*	Leigh - CHP 1	Leigh - CHP 2	Leigh - Boiler
12-digit grid reference or latitude/longitude	E 366351 N 398973 (shared stack)		E 366349 N 398973
Rated thermal input (MW) of the MCP	1.30	1.30	1.16
Type of MCP (diesel engine, gas turbine, other engine or other MCP)	Gas engine	Gas engine	Boiler
Type of fuels used: gas oil (diesel), natural gas, gaseous fuels other than natural gas	Biogas	Biogas	Dual fuelled (biogas / gas oil) but modelled as biogas
Date when the new MCP was first put into operation (DD/MM/YYYY)			
Sector of activity of the MCP or the facility in which it is applied (NACE code**)	E.37.00	E.37.00	E.37.00
Expected number of annual operating hours of the MCP and average load in use	8,760 (based on availability)	8,760 (based on availability)	TBC (modelled operating all year)
Where the option of exemption under Article 6(8) is used the operator (as identified on Form A) should sign a declaration here that the MCP will not be operated more than the number of hours referred to in this paragraph	N / A		

The application is collated to include the required application forms Part A, B2.5 and F1. As the site has CHP engines, the information required for application form Part B2.5, Appendix 1 is included within this document.

The Air Quality Impact Assessment presented within this report is required to support the EP application and assesses the potential for significant air quality effects from the operation of the CHP engines and boiler at the Leigh WwTW.

The potential impacts of the combustion emissions to air were determined for the following aspect:

- the potential impact on human health due to emissions of pollutants. The pollutants considered include nitrogen dioxide (NO_2); carbon monoxide (CO); sulphur dioxide (SO_2), total volatile organic compounds (TVOC's) and particulate matter (PM_{10}, particles with an aerodynamic diameter of 10 microns or less and $PM_{2.5}$, particles with an aerodynamic diameter of 2.5 microns or less); and
- the potential impact on vegetation and ecosystems due to emissions of oxides of nitrogen (NOx) and SO_2.

Human receptors

The assessment indicates that the predicted off-site concentrations and predicted concentrations at sensitive human receptors do not exceed any relevant long-term or short-term air quality objective or guideline. At sensitive human receptor locations, the predicted long-term (i.e. annual mean) NO_2 and particulate (PM_{10} and $PM_{2.5}$) contributions are considered 'not significant'. For short-term NO_2, SO_2, PM_{10} and CO concentrations at modelled off-site locations and sensitive human receptor locations, the contributions are also considered 'not significant'.

This assessment has been carried out on the assumption that the CHP engines and boiler will operate simultaneously and continuously at maximum load all year. This is a conservative assumption as, in practice, the combustion plant will have periods of shutdown and maintenance and may not always operate at maximum load.

Protected conservation areas

For critical levels, the results indicate that the respective annual mean NOx and SO_2 PCs at the assessed European designated sites and SSSI's are less than 1% of the relevant long-term environmental standard and their impact can be described as 'insignificant'. At the assessed local nature sites, the respective NOx and SO_2 PCs are less than 100% of the relevant long-term environmental standard and their impact can also be described as 'insignificant'.

For maximum 24-hour mean critical level NOx concentrations, the respective PCs at the assessed European designated sites and SSSI's are less than 10% of the relevant critical level and can be described as 'insignificant'. At the assessed local nature sites, the respective PCs are less than 100% of the relevant short-term environmental standard and their impact can be described as 'insignificant'.

For acid and nutrient nitrogen deposition, the results indicate that the respective PCs at the assessed European designated sites and SSSI's are less than 1% of the relevant critical load value and the impact can be described as 'insignificant'. At the assessed local nature sites, the respective PCs are less than 100% of the relevant long-term environmental standard and the impact can also be described as 'insignificant'.

Summary

Based on the above assessment, it is concluded that the assessed CHP engines and boiler are acceptable from an air quality perspective.

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1. Introduction

1.1 Background

Under the Industrial Emissions Directive (IED) the treatment of sewage sludge by anaerobic digestion assets at Leigh Wastewater Treatment Works (WwTW), require an Environmental Permit (EP). The scope of anaerobic digestion activities includes all treatment stages and incorporates directly associated activities such as the combined heat and power (CHP) gas engines and boiler.

United Utilities Water Limited (hereafter 'United Utilities') currently operate two biogas fuelled JMS 312 GS-BL CHP engines (each with a thermal input capacity of 1.30 MW_{th}) and one ICI Caldaire dual fuelled boiler[1] (thermal input capacity of 1.16 MW_{th}) at its sludge treatment facility at Leigh WwTW near the town of Leigh, Greater Manchester (WN7 3XA) (hereafter 'the site'). Jacobs UK Limited (hereafter 'Jacobs') has carried out an Air Quality Impact Assessment (AQIA) on behalf of United Utilities to assess the potential impact of emissions from the CHP engines and boiler.

1.2 Study Outline

This AQIA is required to support the EP application and assesses the likely significant air quality effects of emissions to air from the CHP engines and boiler (which supplies hot water/steam to the thermal hydrolysis plant) at the site. The air quality assessment has been carried out following the relevant Environment Agency guidance (Environment Agency, 2021a; 2021b). The AQIA considers:

- the potential impact on human health due to emissions of pollutants. The pollutants considered include nitrogen dioxide (NO_2); carbon monoxide (CO); sulphur dioxide (SO_2), total volatile organic compounds (TVOC's) and particulate matter (PM_{10}, particles with an aerodynamic diameter of 10 microns or less and $PM_{2.5}$, particles with an aerodynamic diameter of 2.5 microns or less); and
- the potential impact on vegetation and ecosystems due to emissions of oxides of nitrogen (NOx) and SO_2.

The site boundary (represented by the approximate site fence line) is presented in Figure 1.

This report draws upon information provided from the following parties:

- United Utilities;
- ADM Ltd;
- INNIO Jenbacher GmbH & Co (hereafter 'Jenbacher');
- Element Materials Technology Environment UK Ltd (hereafter 'Element');
- Department for Environment, Food and Rural Affairs (Defra);
- Wigan Metropolitan Borough Council (WMBC); and
- Greater Manchester Combined Authority (GMCA).

This report includes a description of the emission sources, review of the baseline conditions, description of methodology and significance criteria, an exploration of the existing environment of the site and surrounding area, an evaluation of results and the potential impact of emissions on human health and protected conservation areas during operation and, finally, conclusions of the assessment.

[1] Dual fuelled utilising biogas or gas oil.

2. Emission Sources

2.1 Emission Sources to Air

The location of the assessed CHP engines (emission point reference A1 and A2) and boiler (emission point reference A3) are presented in Figure 1.

The CHP engines are fuelled by biogas generated from the site's anaerobic digestion process. The boiler is a dual fuel design and can run on biogas or gas oil. However, for this assessment it has been modelled based on biogas as this gives a worst-case scenario for emissions of NOx, typically the pollutant of main concern. The modelling only considers emissions from the CHP engines and boiler and no other emission points to air at the site have been included in the assessment. Table 1 presents the emission sources to air considered in this assessment.

Table 1: Combustion plant to be assessed

Parameters	JMS 312 GS-B.L CHP engine (1.30 MW_{th})	JMS 312 GS-B.L CHP engine (1.30 MW_{th})	ICI Caldaire Boiler (1.16 MW_{th})
Fuel	Biogas	Biogas	Gas oil or biogas (modelled on biogas)
Emission point	A1	A2	A3

This assessment has been carried out on the assumption that the CHP engines and boiler will operate simultaneously and continuously at maximum load throughout the year. This is a conservative assumption as in practice, they will have periods of shutdown and maintenance and may not always operate at maximum load. This approach ensures that the worst-case or maximum short-term modelled concentrations are quantified (further consideration of this is provided in Appendix A).

2.2 Emissions Data

It should be noted from the 1st January 2030, certain pollutant emission concentrations from the assessed combustion plant must adhere to emission concentration limits as set out in the Medium Combustion Plant Directive (MCPD) EU/2015/2193[2] (Schedule 25A of the Environmental Permitting (England and Wales) (Amendment) Regulations 2018. Where practicable, the emission concentration limits stated in the MCPD[2] have been applied as a conservative approach to the assessment.

For the CHP engines, the NOx, CO and TVOC emission concentrations were derived from the Environment Agency's guidance '*Guidance for monitoring landfill gas engine emissions'* (Environment Agency, 2010). For SO_2, in the absence of a specific emission limit value, the SO_2 emission concentration typically used in similar permit applications for biogas fuelled engines has been applied. This is a conservative approach to the assessment as in practice, the CHP engines SO_2 emission concentration is likely to be lower than that applied in the model. For particulates, in the absence of a specific emission limit value, the emission concentration was derived from a previous study of landfill gas engines (Land Quality Management Ltd, 2002).

For the boiler, as a worst-case approach to the assessment, the NOx and SO_2 emission concentrations are based on the emission limit values for existing MCP other than engines and gas turbines as regulated under the MCPD[2]. For CO and TVOC, in the absence of a specific emission limit value, the CO emission concentration was obtained from Defra's Process Guidance Note 1/3,*'Statutory Guidance for Boilers and Furnaces 20-50MW thermal input'* (Defra, 2012) and the TVOC emission concentration was derived from the Environment Agency's guidance '*Guidance for monitoring landfill gas engine emissions'*, (Environment Agency, 2010).

2 European Parliament and the Council of the European Union, Medium Combustion Plant Directive EU/2015/2193 of 25 November 2015 on the limitation of emissions of certain pollutants into the air from medium combustion plants.

The exhaust gas volumetric flow and temperature of the CHP engines were obtained from the Jenbacher JMS 312 GS-B.L CHP engine Technical Specification (Jenbacher, 2006). The oxygen content of the CHP engines was obtained from onsite monitoring of the CHP engines undertaken by Element (Element, 2021). In the absence of information regarding moisture content, the data used in the model is based on professional judgment acquired from previous work involving CHP engines of a similar thermal input capacity.

For the boiler, the exhaust gas volumetric flow was determined using stoichiometric calculations based on the combustion of biogas at the maximum thermal input rating of the boiler. In the absence of information regarding temperature, oxygen and moisture content of the boiler, the data used in the model is based on professional judgement acquired from previous work involving biogas fuelled boilers of a similar thermal input capacity.

3. Assessment Methodology

This section presents a summary of the methodology used for the assessment of the potential impacts of the site. A full description of the study inputs and assumptions are provided in Appendix A.

3.1 Assessment Location

For this assessment, 30 of the closest sensitive human receptors (such as residential properties, schools, residential care homes and Public Rights of Way (PRoW)) near the site were identified for modelling purposes. The location of these receptors is presented in Figure 2. It should be noted there is an Air Quality Management Area (AQMA) in close proximity to the site (see Section 4.2), which has also been included in the assessment.

In line with the Environment Agency guidance *Air emissions risk assessment for your environmental permit* (Environment Agency, 2021a), it is necessary to identify protected conservation areas within the following distances from the site:

- European sites (i.e. Special Area of Conservation (SAC), Special Protection Area (SPA) and Ramsar sites) within 10 km; and
- Site of Special Scientific Interest (SSSI) and local nature sites (i.e. ancient woodlands, local wildlife sites (LWS) and national and local nature reserves (NNR and LNR), respectively, within 2 km.

Based on these criteria; Rixton Clay Pits LNR, SAC and SSSI, Manchester Mosses SAC and Risley Moss SSSI and LNR, Hope Carr Nature Reserve LWS, Pennington Flash LNR, Pennington Flash LWS, Atherton & Bedford Woods LWS and Wetland off Orchard Lane LWS have been included in the assessment.

It should be noted some of the assessed protected conservation areas encompass the same geographic area. However, for the assessment against critical loads (see Section 5.2.2), all protected conservation areas have been assessed individually for completeness.

The location of the assessed protected conservation areas are presented in Figure 3 and further details are set out in Appendix A.

3.2 Overall Methodology

The assessment was carried out using an atmospheric dispersion modelling technique. Atmospheric Dispersion Modelling System (ADMS) version 5.2.4 was used to model releases of the identified substances. The ADMS model predicts the dispersion of operational emissions from a specific source (e.g. a stack), and the subsequent concentrations over an identified area (e.g. at ground level across a grid of receptor points) or at specified points (e.g. a residential property). ADMS was selected because this model is fit for the purpose of modelling the emissions from the type of sources on-site (i.e. point source emissions from a combustion source) and is accepted as a suitable assessment tool by local authorities and the Environment Agency.

The modelling assessment was undertaken in accordance with the Environment Agency *Air emissions risk assessment for your environmental permit* guidance (Environment Agency, 2021a).

A summary of the dispersion modelling procedure is set out below.

1) Information on plant location and stack parameters were supplied by United Utilities (United Utilities, 2021). Information on the plant emission characteristics were provided by United Utilities (United Utilities, 2021), Jenbacher (Jenbacher, 2006) and Element (Element, 2021).
2) Five years of hourly sequential data recorded at the Manchester Airport meteorological station (2015 – 2019 inclusive) were used for the assessment (ADM Ltd, 2020).

3) Information on the main buildings located on-site which could influence dispersion of emissions from the CHP engines and boiler stack were estimated from Defra's environmental open-data applications and datasets (Defra, 2021a) and Google Earth (Google Earth, 2021).

4) The maximum predicted concentrations (at a modelled height of 1.5 m or 'breathing zone') at the assessed sensitive human receptor locations R1 – R13, R15 - R16 (representing long-term exposure at residential 6properties) were considered for the assessment of annual mean, 24-hour mean, 8-hour mean, 1-hour mean and 15-minute mean pollutant concentrations within the study area. For receptors R14, R17 – R30 (representing footpaths, only the 1-hour mean and 15-minute mean concentrations were considered. The maximum predicted concentrations at an off-site location in the vicinity of the site were considered for the assessment of short-term (1-hour and 15-minute mean) concentrations. As discussed in Section 3.1, there is an AQMA in close proximity to the site (see Section 4.2). The AQMA was declared by GMCA for elevated concentrations of annual mean NO_2 and has been included in the assessment.

5) The above information was entered into the dispersion model.

6) The dispersion model was run to provide the Process Contribution (PC). The PC is the estimated maximum environmental concentration of substances due to releases from the process alone. The results were then combined with baseline concentrations (see Section 4) to provide the Predicted Environmental Concentration (PEC) of the substances of interest.

7) The PECs were then assessed against the appropriate environmental standards for air emissions for each substance set out in the Environment Agency's guidance (Environment Agency, 2021a) document to determine the nature and extent of any potential adverse effects.

8) Modelled concentrations were processed using geographic information system (GIS) software (ArcMap 10.8.1) to produce contour plots of the model results. These are provided for illustrative purposes only; assessment of the model results was based on the numerical values outputted by the dispersion model on the model grid (see Figure 2 for extent of modelled grid) and at the specific receptor locations and were processed using Microsoft Excel.

9) The predicted concentrations of NOx and SO_2 were also used to assess the potential impact on critical levels and critical loads (i.e. acid and nutrient nitrogen deposition) (see Section 3.3.2) at the assessed protected conservation area. Details of the deposition assessment methodology are provided in Appendix B.

In addition to the above, a review of existing ambient air quality in the area was undertaken to understand the baseline conditions at the site and at receptors within the study area. These existing conditions were determined by reviewing the monitoring data already available for the area and other relevant sources of information. The review of baseline air quality is set out in Section 4.

Where appropriate, a conservative approach has been adopted throughout the assessment to increase the robustness of the model predictions. In addition, an analysis of various sensitivity scenarios has also been carried out (see Section 5.3) to determine how changes to model parameters (e.g. differing surface roughness values or modelling without considering buildings) may impact on predicted concentrations at sensitive human receptors and off-site locations.

3.3 Assessment Criteria

3.3.1 Environmental Quality Standards: Human Receptors

In the UK the focus on local air quality is reflected in the air quality objectives (AQOs) set out in the Defra and the Devolved Administrations *Air Quality Strategy for England, Scotland, Wales and Northern Ireland* (AQS). The AQS stipulates a number of air quality objectives for nine main air pollutants with respect to ambient levels of air quality (Defra, 2007). The AQOs are similar to the limit values that were transposed from the relevant EU directives into UK legislation by *The Air Quality Standards Regulations 2010*. The objectives are based on the current understanding of health effects of exposure to air pollutants and have been specified to control health and environmental risks to an acceptable level. They apply to places where people are regularly present over the relevant averaging period. The objectives set for the protection of human health and vegetation of relevance

to the project are summarised in Table 2. Relevant Environmental Assessment Levels (EALs) set out in the Environment Agency guidance (Environment Agency, 2021a) are also included in Table 2 where these supplement the AQOs.

For the purposes of reporting, the AQOs and EALs have been collectively termed as Environmental Quality Standards (EQSs).

Table 2: Air quality objectives and environmental assessment levels

Pollutant	EQS ($\mu g/m^3$)	Concentration measured as
NO_2	40	Annual mean
	200	1-hour mean, not to be exceeded more than 18 times a year (99.79th percentile)
CO	10,000	Maximum daily 8 hour running mean (100th percentile)
	30,000	Maximum 1-hour mean (100th percentile)
SO_2	125	24-hour mean not to be exceeded more than 3 times a year (99.18th percentile)
	350	1-hour mean not to be exceeded more than 24 times a year (99.73rd percentile)
	266	15-minute mean not to be exceeded more than 35 times a year (99.9th percentile)
PM_{10}	40	Annual mean
	50	24-hour mean, not to be exceeded more than 35 times a year (90.41st percentile)
$PM_{2.5}$	25	Annual mean
TVOC	n/a[1]	Annual mean
		Maximum 1-hour mean (100th percentile)

Note 1: VOCs may contain a wide range of organic compounds and it is often difficult to determine or identify each and every compound present. The TVOC emissions from the assessed combustion plant will largely comprise methane which is not directly harmful to human health. Therefore, there is no health-based air quality standard or guideline.

For the assessment of long-term average concentrations (i.e. the annual mean concentrations) at human receptors, impacts were described using the following criteria:

- if the PC is less than 1% of the long-term EQS, the contribution can be considered as 'insignificant' and not representative of a significant effect (i.e. not significant) (Environment Agency, 2021b);
- if the PC is greater than 1% of the EQS but the PEC is less than 70% of the long-term air quality objective, based on professional judgement, this would be classed as 'not significant'.
- where the PC is greater than 1% of the EQS and the PEC is greater than 70% of the EQS, professional judgement is used to determine the overall significance of the effect (i.e. whether the effect would be 'not significant' or 'significant'), taking account of the following:
  - the scale of the changes in concentrations;
  - whether or not an exceedance of an EQS is predicted to arise in the study area where none existed before, or an exceedance area is substantially increased as a result of the development; and
  - uncertainty, including the influence and validity of any assumptions adopted in undertaking the assessment.

For the assessment of short-term average concentrations (e.g. the 1-hour mean NO_2 concentrations, and the 15-minute, 1-hour and 24-hour mean SO_2 concentrations etc.), impacts were described using the following criteria:

- if the PC is less than 10% of the short-term EQS, this would be classed as insignificant and not representative of a significant effect (i.e. not significant) (Environment Agency, 2021b);
- if the PC is greater than 10% of the EQS but less than 20% of the headroom between the short-term background concentration and the EQS, based on professional judgement, this can also be described as not significant;

- Where the PC is greater than 10% of the EQS and 20% of the headroom, professional judgement is used to determine the overall significance of the effect (i.e. whether the effect would be not significant or significant) in line with the approach specified above for long-term average concentrations.

Environment Agency guidance recommends that further action will not be required if proposed emissions comply with Best Available Techniques Associated Emission Levels (BAT AELs) and resulting PECs do not exceed the relevant EQS (Environment Agency, 2021a).

3.3.2 Environmental Quality Standards: Protected Conservation Areas

Critical levels

The environmental standards set for protected conservation areas of relevance to the project are summarised in Table 3 (Environment Agency, 2021a).

Table 3: Air Quality Objectives and Environmental Assessment Levels for protected conservation areas

Pollutant	EQS ($\mu g/m^3$)	Concentration measured as
NOx	30	Annual mean limit value for the protection of vegetation (referred to as the "critical level")
	75	Maximum 24-hour mean for the protection of vegetation (referred to as the "critical level")
SO_2	10	Annual mean limit value for the protection of vegetation (referred to as the "critical level") where lichens or bryophytes are present
	20	Annual mean limit value for the protection of vegetation (referred to as the "critical level") where lichens or bryophytes are not present

Critical loads

Critical loads for pollutant deposition to statutorily designated habitat sites in the UK and for various habitat types have been published by the CEH and are available from the APIS website. Critical Loads are defined on the APIS website (Centre for Ecology and Hydrology, 2021) as:

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

Compliance with these benchmarks is likely to result in no significant adverse effects on the natural environment at these locations. The critical loads for the designated habitat sites considered in this assessment are set out in Table 4. For the assessed European designated sites and SSSI's, the Site Relevant Critical Loads tool function on the APIS website was used to determine the relevant critical loads for the assessed protected conservation areas. It should be noted where both vegetation types (i.e. short or tall) are listed on the APIS website as being present at the assessed protected conservation area, the most sensitive habitat for both short and tall vegetation were applied in the assessment, irrespective of whether the vegetation is actually present at the modelled location(s).

For the assessed local nature sites, the Search by Location function on the APIS website was used. Where both short and tall vegetation type is assumed to inhabit the assessed local nature site, the acid grassland and coniferous woodland habitat feature were selected on the APIS website, which are generally the most sensitive short and tall vegetation type to nutrient nitrogen and acid deposition.

Table 4: Critical loads for modelled protected conservation areas

Recept or ref	Protected conservation area	Habitat feature applied	Vegetation type (for deposition velocity)	Critical load			
				Acid deposition (kEqH+/ha/year)			Nitrogen deposition (kg N/ha/year)
				CLMaxS	CLMinN	CLMaxN	Minimum
H1a	Rixton Clay Pits SAC, LNR and SSSI	Valley mires, poor fens and transition mires	Short	0.200	0.300	0.600	10
H1b		Valley mires, poor fens and transition mires	Short	0.200	0.300	0.600	10
H2a	Manchester Mosses SAC and Risley Moss SSSI and LNR	Raised and blanket bogs	Short	0.300	0.300	0.600	5
H2b	Manchester Mosses SAC and Holcroft Moss SSSI	Raised and blanket bogs	Short	0.300	0.300	0.600	5
H2c	Manchester Mosses SAC and Astley & Bedford Mosses SSSI	Raised and blanket bogs	Short	0.300	0.300	0.600	5
H3	Hope Carr Nature Reserve LWS	Acid grassland	Short	0.470	0.438	0.908	5
		Coniferous woodland	Tall	1.028	0.357	1.385	5
H4a	Pennington Flash LNR	Acid grassland	Short	0.870	0.438	1.308	5
		Coniferous woodland	Tall	1.511	0.357	1.868	5
H4b		Acid grassland	Short	0.870	0.438	1.308	5
		Coniferous woodland	Tall	1.509	0.357	1.866	5
H5	Pennington Flash LWS	Acid grassland	Short	0.870	0.438	1.308	5
		Coniferous woodland	Tall	1.509	0.357	1.866	5
H6	Atherton & Bedford Woods LWS and Atherton Woods (ID 1105558) Ancient Woodland	Acid grassland	Short	0.860	0.438	1.298	5
		Coniferous woodland	Tall	1.518	0.357	1.875	5
H7	Wetland off Orchard Lane LWS	Acid grassland	Short	0.860	0.438	1.298	5
		Coniferous woodland	Tall	1.522	0.357	1.879	5

Critical load functions for acid deposition are specified on the basis of both nitrogen-derived acid and sulphur-derived acid. The critical load function contains a value for sulphur derived acid and two values for nitrogen derived acid deposition (a minimum and maximum value). The APIS website provides advice on how to calculate the process contribution (PC – emissions from the modelled process alone) and the predicted environmental concentrations (PEC – the PC added to the existing deposition) as a percentage of the acid critical load function and how to determine exceedances of the critical load function. This guidance was adopted for this assessment. The minimum of the range of nitrogen critical loads was used for the assessment in line with the advice on the APIS website (Centre for Ecology and Hydrology, 2021).

Significance Criteria – European designated sites (i.e. SPAs, SACs) and SSSI's

With regard to concentrations at the assessed designated habitat sites, the Environment Agency guidance (Environment Agency, 2021a) states emissions can be described as insignificant and no further assessment is required (including the need to calculate PECs) if:

- the short-term PC is less than 10% of the short-term environmental standard for protected conservation areas; or
- the long-term PC is less than 1% of the long-term environmental standard for protected conservation areas.

Where appropriate, the significance of the predicted long-term (annual mean) concentrations or deposition at protected conservation areas were determined in line with Environment Agency guidance (Environment Agency, 2021a) summarised as set out below.

- Where the PC is less than 1% of the relevant critical level or critical load, the emission is not likely to have a significant effect alone or in combination irrespective of the existing concentrations or deposition rates.
- Where the PC is above 1%, further consideration of existing background concentrations or deposition rates is required, and where the total concentration or deposition is less than 70% of the critical level or critical load, calculated in combination with other committed projects or developments as appropriate, the emission is not likely to have a significant effect.
- Where the contribution is above 1%, and the total concentration or deposition rate is greater than 70% of the critical level or critical load, either alone or in combination with other committed projects or developments, then this may indicate a significant effect and further consideration is likely to be required.

The above approach is used to give a clear definition of what effects can be disregarded as insignificant, and which need to be considered in more detail in relation to the predicted annual mean concentrations or deposition.

For short-term mean concentrations (i.e. the 24-hour mean critical level for NOx) where the PC is less than 10% of the critical level then it would be regarded as 'insignificant'. A potentially significant effect would be identified where the short-term PC from the modelled sources would lead to the total concentration exceeding the critical level. Further consideration is likely to be required in this situation.

Significance Criteria – Local nature sites (i.e. LWS and nature reserves)

The relevant significance criteria for these protected conservation areas are set out below.

With regard to concentrations or deposition rates at local nature sites, the Environment Agency guidance (Environment Agency, 2021a) states emissions can be described as 'insignificant' and no further assessment is required (including the need to calculate PECs) if:

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

The above approach is used to give a clear definition of what effects can be disregarded as 'insignificant', and which need to be considered in more detail in relation to the predicted annual mean concentrations or deposition.

4. Existing Environment

4.1 Site Location

The site is situated approximately 1.3 km southeast from the centre of the town of Leigh, Greater Manchester. The area surrounding the site generally comprises a mixture of residential, industrial and agricultural land use. Hope Carr Nature Reserve LWS is located adjacent to the southern boundary of the site.

There are several sensitive human receptors in the vicinity of the site in respect of potential air emissions from the process. The most relevant sensitive receptors have been identified from local mapping and are summarised in Appendix A and presented in Figure 2. The nearest modelled residential property is approximately 0.26 km south-southeast of the CHP engine (based on the shared stack location NGR E 366351 N 398973). The nearest modelled receptor is a footpath approximately 20 m south-southwest of the CHP engine shared stack at its closest point.

4.2 Local Air Quality Management

A review of baseline air quality was carried out prior to undertaking the air quality assessment. This was carried out to determine the availability of baseline air quality data recorded in the vicinity of the site and also if data from other regional or national sources such as the UK Air Information Resource (UK-AIR) (Defra, 2021b) website could be used to represent background concentrations of the relevant pollutants in the vicinity of the site.

As part of the Local Air Quality Management (LAQM) process, WMBC has declared one AQMA which forms part of the Greater Manchester Combined Authority AQMA located within the Wigan Council area. The Greater Manchester Combined Authority AQMA was declared by the Greater Manchester authority in May 2016 for elevated concentrations of annual mean NO_2. The AQMA encompasses the 10 districts of Greater Manchester, including arterial routes, district centres, and Manchester airport and is approximately 0.8 km south-southeast of the site at its closest point. As this AQMA is located in close proximity to the site, it has been included in the assessment (see R31 – R33 in Figure 2).

WMBC carries out regular assessments and monitoring of air quality within the borough as part of the LAQM process. The most recent Air Quality Annual Status Report (Greater Manchester Combined Authority, 2020) was reviewed to determine the concentrations of NO_2, $PM_{2.5}$ and PM_{10} in the vicinity of the site. It should be noted none of the other assessed pollutants are monitored by WMBC. Table 5 presents information on the nearest monitoring locations to the site.

Table 5: Nearest monitoring locations

Site ID	Site name	Site type	Location	Distance and direction from CHP engines	Pollutants monitored	2019 Annual mean concentration ($\mu g/m^3$)
Automatic monitoring						
GLAZ	Glazebury	Rural	E 368758 N 396031	3.8 km, SE	NO_2	15[1]
WIG5	Wigan Centre	Urban background	E 357816, N 406024	11.1 km, NW	NO_2	19.0[1]
					PM_{10}	15.7[1]
					$PM_{2.5}$	10
Non-automatic monitoring						
WI114NO	114	Roadside	E 365115, N 400259	1.8 km, NW	NO_2	39.9
WI28NO	28	Roadside	E 366424, N 399894	1.0 km, N	NO_2	31.3
WI158NO	158	Roadside	E 365615, N 401368	2.5 km, NNW	NO_2	33.0
WI166NO	166	Kerbside	E 368414 N 399638	2.2 km, ENE	NO_2	20.2
WI167NO	167	Roadside	E 363544 N 397934	3.0 km, WSW	NO_2	26.3

Note 1: Provisional

The automatic and non-automatic monitoring locations presented in Table 5 are not considered representative of the site and surrounding area due to the monitoring location type and/or respective distance from the site.

For the assessed pollutants, information on background air quality in the vicinity of the site was obtained from Defra background map datasets (Defra, 2021b). The 2018-based background maps by Defra are estimates based upon the principal local and regional sources of emissions and ambient monitoring data. For SO_2 and CO concentrations, the 2001-based background maps were used. These background concentrations are presented in Table 6. It should be noted there are no background concentrations available for TVOC's.

As it is necessary to determine the potential impact of emissions from the site at the assessed protected conservation areas, the background concentrations of NOx and SO_2 were also identified for the assessed protected conservation areas. These background concentrations were obtained from the 2018-based and 2001-based Defra background map datasets (Defra,2021b), respectively, and are also displayed in Table 6. The concentrations for the individual assessment locations are displayed in the results tables (Table 9 – Table 11).

Table 6: Background concentrations: adopted for use in assessment for human receptors and protected conservation areas

Pollutant	Annual mean concentration ($\mu g/m^3$)	Description
Sensitive human receptors		
NO_2	12.0 – 14.3	Defra 1 km x 1 km background map value for the assessed sensitive human receptor locations, 2021 map concentration
CO	175.7 – 178.8	Defra 1 km x 1 km background map value for the assessed sensitive human receptor locations, scaled from 2001-based map[1] to 2021 concentration
PM_{10}	11.4 – 12.0	Defra 1 km x 1 km background map value for the assessed sensitive human receptor locations, 2021 map concentration
$PM_{2.5}$	7.4 – 7.8	Defra 1 km x 1 km background map value for the assessed sensitive human receptor locations, 2021 map concentration
SO_2	5.0 – 6.0	Defra 1 km x 1 km background map value for the assessed sensitive human receptor locations, scaled from 2001-based map[1] concentration
TVOC	n/a	
Protected conservation areas		
NOx	14.2 - 23.6	Defra 1 km x 1 km background map value for the assessed protected conservation areas, 2021 map concentration
SO2	4.9 – 7.5	Defra 1 km x 1 km background map value for the assessed protected conservation areas, scaled from 2001-based map[1] concentration

Note 1: Background maps for CO and SO_2 are based on 2001 base year mapping

The long-term background concentrations were doubled to estimate the short-term background concentrations in line with the Environment Agency guidance (Environment Agency, 2021a).

4.3 Existing Deposition Rates

Existing acid and nutrient nitrogen deposition levels were obtained from APIS (Centre for Ecology and Hydrology, 2021. As discussed previously, where both vegetation types (i.e. short or tall) are listed on the APIS website as being present at the assessed protected conservation area, the most sensitive habitat for both short and tall vegetation, where applicable, was used for the assessment to represent the differing deposition velocities for these vegetation types. As a conservative approach to the assessment, it is assumed the vegetation type selected is present at the specific modelled location within the assessed protected conservation area. The existing deposition values at the assessed habitat site are set out in Table 7.

Table 7: Existing deposition at modelled habitat sites

Receptor ref	Protected conservation area	Vegetation type (for deposition velocity)	Existing deposition rates		
			Existing acid deposition (kEqH+/ha/year)		Existing nutrient N deposition (kg N/ha/year)
			Nitrogen	Sulphur	Nitrogen
H1a	Rixton Clay Pits SAC, LNR and SSSI	Short	1.50	0.30	21.42
H1b	Rixton Clay Pits SAC, LNR and SSSI	Short	1.50	0.30	21.42
H2a	Manchester Mosses SAC and Risley Moss SSSI and LNR	Short	1.50	0.30	21.42
H2b	Manchester Mosses SAC and Holcroft Moss SSSI	Short	1.50	0.30	21.42
H2c	Manchester Mossess SAC and Astley & Bedford Mosses SSSI	Short	1.50	0.30	21.56
H3	Hope Carr Nature Reserve LWS	Short	1.5	0.26	21.56
		Tall	2.54	0.30	35.56
H4a	Pennington Flash LNR	Short	1.77	0.26	24.78
		Tall	2.95	0.30	41.30
H4b		Short	1.77	0.26	24.78
		Tall	2.95	0.30	41.30
H5	Pennington Flash LWS	Short	1.77	0.26	24.78
		Tall	2.95	0.30	41.30
H6	Atherton & Bedford Woods LWS and Atherton Woods (ID 1105558) Ancient Woodland	Short	1.59	0.27	22.26
		Tall	2.53	0.31	35.42
H7	Wetland off Orchard Lane LWS	Short	1.59	0.27	22.26
		Tall	2.53	0.31	35.42

5. Results

5.1 Human Receptors

The results presented below are the maximum modelled concentrations predicted at any of the 30 assessed sensitive human receptor locations, the considered AQMA and the maximum modelled concentration at any off-site location for the five years of meteorological data used in the study.

The results of the dispersion modelling are set out in Table 8, which presents the following information:

- EQS (i.e. the relevant air quality standard);
- estimated annual mean background concentration (see Section 4) that is representative of the baseline;
- PC, the maximum modelled concentrations due to the emissions from the assessed combustion plant;
- PEC, the maximum modelled concentration due to process emissions combined with estimated baseline concentrations;
- PC and PEC as a percentage of the EQS; and
- PC as a percentage of headroom (i.e. the PC as a percentage of the difference between the short-term background concentration and the EQS, for short-term predictions only).

The full results at assessed human receptor locations are presented in Appendix C.

Table 8: Results of detailed assessment

Pollutant	Averaging period	Assessment location	Maximum receptor	EQS ($\mu g/m^3$)	Baseline air quality level ($\mu g/m^3$)	PC ($\mu g/m^3$)	PEC ($\mu g/m^3$)	PC / EQS (%)	PEC / EQS (%)	PC as a percentage of headroom (%)
CO	Maximum 8-hour running mean	Sensitive locations	R7	10,000	351	19.5	370.9	0.2%	3.7%	0.2%
	Maximum 1-hour mean	Maximum off-site	-	30,000	356	68.8	424.7	0.2%	1.4%	0.2%
		Sensitive locations	R23	30,000	351	63.5	414.9	0.2%	1.4%	0.2%
NO_2	Annual mean	Sensitive locations	R15	40	14.3	0.7	15.0	1.7%	37.6%	-
	1-hour mean (99.79th percentile)	Maximum off-site	-	200	28.7	31.1	59.8	15.6%	29.9%	18.2%
		Sensitive locations	R23	200	25.8	11.9	37.6	5.9%	18.8%	6.8%
SO_2	24-hour mean (99.18th percentile)	Sensitive locations	R15	125	12.1	4.4	16.5	3.5%	13.2%	3.9%
	1-hour mean (99.73rd percentile)	Maximum off-site	-	350	12.1	69.5	81.6	19.9%	23.3%	20.6%
		Sensitive locations	R23	350	10.1	26.9	36.9	7.7%	10.5%	7.9%
	15-minute mean (99.9th percentile)	Maximum off-site	-	266	12.1	84.1	96.1	31.6%	36.1%	33.1%
		Sensitive locations	R23	266	10.1	32.6	42.7	12.3%	16.0%	12.7%
PM_{10}	Annual mean	Sensitive locations	R15	40	11.8	0.02	11.9	0.0%	29.6%	-
	24-hour mean (90.41st percentile)	Sensitive locations	R15	50	23.7	0.05	23.7	0.1%	47.4%	0.2%
$PM_{2.5}$	Annual mean	Sensitive locations	R15	25	7.8	0.02	7.9	0.1%	31.4%	-
TVOC	Annual mean	Sensitive locations	R15	n/a		3.3	n/a			
	Maximum 1-hour mean	Maximum off-site	-			429.8				
		Sensitive locations	R24			181.9				

Note 1: For annual mean NO_2, PM_{10} and $PM_{2.5}$ and TVOC concentrations, 24-hour mean PM_{10} and SO_2 concentrations and 8-hour mean CO concentrations, R14, R17 – R30 have been omitted from analysis as these receptor locations represent footpaths (i.e. short-term exposure only). The full results are presented in Appendix C.

The results in Table 8 indicate that the predicted off-site concentrations and predicted concentrations at sensitive human receptors do not exceed any relevant long-term or short-term air quality objective or guideline.

Table 8 indicates the maximum PC for annual mean NO_2 at a sensitive human receptor location is 0.7 µg/m^3 (equating to 1.7% of the relevant EQS) and is predicted at R15 which represents a residential property approximately 0.35 km north of the site. The PC is greater than 1% of the relevant EQS but the PEC is less than 70% of the EQS (i.e. 37.6%) and based on professional judgement, the impact can be classed as 'not significant'.

At the assessed AQMA, the maximum annual mean NO_2 PC is 0.1 µg/m^3 (predicted at R33) which equates to 0.3% of the relevant EQS.

For the assessment of 1-hour mean (99.79th percentile) NO_2 concentrations at a sensitive human receptor location, the maximum PC of 11.9 µg/m^3 (which equates to 5.9% of the relevant EQS) is predicted at R23, which, represents a footpath adjacent to the western boundary of the site. As the PC is less than 10% of the short-term EQS, as per Environment Agency guidance (Environment Agency, 2021a), the effect is considered 'insignificant' and therefore 'not significant'. For the assessment of 1-hour mean (99.79th percentile) NO_2 concentrations at a modelled off-site location, the maximum PC is 31.1 µg/m^3 which equates to 15.6% of the relevant EQS. The PC is greater than 10% of the EQS but less than 20% of the headroom between the short-term background concentration and the EQS and therefore, based on professional judgement, this can be described as 'not significant'. To note, the maximum PC is predicted at NGR E 366381 N 398973 which is adjacent to the eastern boundary of the site by the site main entrance and is not likely to be frequented by members of the public.

For long-term PM_{10} and $PM_{2.5}$ concentrations, the respective PCs are less than 1% of the relevant long-term EQS and their impact can be described as 'insignificant' and therefore 'not significant'. For 24-hour mean (90.41st percentile) PM_{10} concentrations, the PC is less than 10% of the relevant short-term EQS (i.e. 0.1%) and its impact can be described as 'insignificant' and therefore 'not significant'.

For short-term CO concentrations at both sensitive human receptor locations and modelled off-site locations, the respective PCs are less than 10% of the relevant short-term EQS and their impact is considered 'insignificant' and therefore 'not significant'.

For 24-hour mean (99.18th percentile) SO_2 concentrations at sensitive human receptor locations, the highest PC (predicted at R15) is less than 10% of the relevant EQS (i.e. 3.5%) and can be classed as 'insignificant' and therefore 'not significant'.

For 1-hour mean (99.73rd percentile) SO_2 concentrations at sensitive human receptor locations, the maximum PC of 26.9 µg/m^3 is predicted at R23. This equates to less than 10% of the relevant EQS and as per Environment Agency guidance (Environment Agency, 2021a), can be classed as 'insignificant' and therefore 'not significant'. For 1-hour mean (99.73rd percentile) SO_2 concentrations at a modelled off-site location, the maximum PC is 69.5 µg/m^3 which equates to 19.9% of the relevant EQS. As the PC is greater than 10% of the EQS and just above 20% of the headroom, based on professional judgement, the impact is considered 'not significant'. The maximum off-site PC is predicted at NGR E 366381 N 398973 which is adjacent to the eastern boundary of the site by the main entrance and is not likely to be frequented by members of the public.

For 15-minute mean (99.9th percentile) SO_2 concentrations at sensitive human receptor locations, the maximum PC of 32.6 µg/m^3 is predicted at R23. The PC is greater than 10% of the EQS but less than 20% of the headroom between the short-term background concentration and the EQS and therefore, based on professional judgement, this can be described as 'not significant'. For 15-minute mean (99.9th percentile) SO_2 concentrations at a modelled off-site location, the maximum PC is 84.1 µg/m^3 which equates to 31.6% of the relevant EQS. As the PC is greater than 10% of the EQS and above 20% of the headroom, based on professional judgement, the impact is considered 'not significant'. The maximum off-site PC is predicted at NGR E 366381 N 398973 which is adjacent to the eastern boundary of the site by the main entrance and is not likely to be frequented by members of the public.

For annual mean TVOC concentrations at sensitive human receptor locations, the highest PC of 3.3 µg/m^3 is predicted at R15. For maximum 1-hour mean TVOC concentrations at a modelled off-site location, the highest PC of 429.8 µg/m^3 is predicted at NGR E 366381 N 398973 by the site main entrance. At a sensitive human receptor location, the maximum 1-hour mean TVOC concentration of 181.9 µg/m^3 is predicted at R24 representing a footpath adjacent to the western boundary of the site. As discussed previously, the TVOCs from the assessed combustion plant will largely comprise unburnt methane gas from the biogas fuel, which is not directly harmful to human health at the concentrations predicted by the dispersion modelling.

Summary

The results in Table 8 indicate that the predicted modelled off-site concentrations and predicted concentrations at sensitive human receptors do not exceed any relevant long-term or short-term air quality objective or guideline. Furthermore, the conservative approach adopted throughout the assessment including the assumed operational hours of the plant and modelled emission concentrations, means the predicted concentrations presented in Table 8 are likely to be higher than would reasonably be expected.

Contour plots (see Figures 4 - 7) have been produced for annual mean and 1-hour mean (99.79th percentile) NO_2 concentrations, 1-hour mean (99.73rd percentile) and 15-minute mean (99.9th percentile) SO_2 concentrations. For annual mean NO_2 concentrations, the figure is based on the year of meteorological data which resulted in the highest PC at a sensitive human receptor location. For short-term concentrations, the figures are based on the year of meteorological data which resulted in the highest PC at an off-site location.

5.2 Protected Conservation Areas

5.2.1 Assessment against Critical Levels

The environmental effects of releases from the site at the assessed protected conservation areas have been determined by comparing predicted concentrations of released substances with the EQSs for the protection of vegetation (critical levels) (see Table 3). The results of the detailed modelling at the assessed protected conservation areas are shown in Table 9 to Table 11. The results presented are the maximum predicted concentration at each assessed protected conservation area for the five years of meteorological data used in the study.

For SO_2, the relevant EQS was based on the assumption that lichens and bryophytes were present at each site, therefore adopting a conservative approach.

Table 9: Results of detailed assessment at assessed protected conservation sites for annual mean NOx concentrations

Ref	Protected Conservation Area	EQS (µg/m^3)	Background concentration (µg/m^3)	PC (µg/m^3)	PEC (µg/m^3)	PC/EQS (%)	PEC/EQS (%)
H1a	Rixton Clay Pits SAC, LNR and SSSI	30	16.1	0.004	16.1	0.0%	53.7%
H1b	Rixton Clay Pits SAC, LNR and SSSI		16.1	0.003	16.1	0.0%	53.7%
H2a	Manchester Mosses SAC and Risley Moss SSSI and LNR		19.3	0.003	19.3	0.0%	64.4%
H2b	Manchester Mosses SAC and Holcroft Moss SSSI		23.6	0.006	23.6	0.0%	78.6%
H2c	Manchester Mosses SAC and Astley & Bedford Mosses SSSI		14.2	0.050	14.3	0.2%	47.6%
H3	Hope Carr Nature Reserve LWS		19.6	2.529	22.1	8.4%	73.7%
H4a	Pennington Flash LNR		15.5	0.061	15.6	0.2%	52.0%

Ref	Protected Conservation Area	EQS (µg/m^3)	Background concentration (µg/m^3)	PC (µg/m^3)	PEC (µg/m^3)	PC/EQS (%)	PEC/EQS (%)
H4b			16.5	0.069	16.5	0.2%	55.2%
H5	Pennington Flash LWS		16.5	0.090	16.6	0.3%	55.2%
H6	Atherton & Bedford Woods LWS and Atherton Woods (ID 1105558) Ancient Woodland		17.6	0.149	17.7	0.5%	59.1%
H7	Wetland off Orchard Lane LWS		18.2	0.114	18.4	0.4%	61.2%

Table 10: Results of detailed assessment at assessed protected conservation sites for maximum 24-hour mean NOx concentrations

Ref	Protected Conservation Area	EQS (µg/m^3)	Background concentration (µg/m^3)	PC (µg/m^3)	PEC (µg/m^3)	PC/EQS (%)	PEC/EQS (%)
H1a	Rixton Clay Pits SAC, LNR and SSSI	75	32.2	0.1	32.3	0.1%	43.1%
H1b	Rixton Clay Pits SAC, LNR and SSSI		32.2	0.1	32.3	0.1%	43.1%
H2a	Manchester Mosses SAC and Risley Moss SSSI and LNR		38.6	0.1	38.7	0.1%	51.6%
H2b	Manchester Mosses SAC and Holcroft Moss SSSI		47.1	0.2	47.3	0.2%	63.0%
H2c	Manchester Mosses SAC and Astley & Bedford Mosses SSSI		28.5	0.8	29.3	1.1%	39.0%
H3	Hope Carr Nature Reserve LWS		39.2	32.2	71.4	43.0%	95.2%
H4a	Pennington Flash LNR		31.1	0.9	32.0	1.2%	42.6%
H4b			33.0	1.7	34.7	2.3%	46.2%
H5	Pennington Flash LWS		33.0	1.7	34.6	2.2%	46.2%
H6	Atherton & Bedford Woods LWS and Atherton Woods (ID 1105558) Ancient Woodland		35.2	0.9	36.1	1.2%	48.1%
H7	Wetland off Orchard Lane LWS		36.5	1.0	37.5	1.3%	50.0%

Table 11: Results of detailed assessment at assessed protected conservation sites for annual mean SO_2 concentrations

Ref	Protected Conservation Area	EQS (µg/m^3)	Background concentration (µg/m^3)	PC (µg/m^3)	PEC (µg/m^3)	PC/EQS (%)	PEC/EQS (%)
H1a	Rixton Clay Pits SAC, LNR and SSSI	10	4.9	0.003	4.9	0.03%	49.0%
H1b	Rixton Clay Pits SAC, LNR and SSSI		4.9	0.002	4.9	0.02%	49.0%
H2a	Manchester Mosses SAC and Risley Moss SSSI and LNR		5.7	0.002	5.7	0.02%	57.3%
H2b	Manchester Mosses SAC and Holcroft Moss SSSI		5.0	0.005	5.0	0.05%	50.4%

Ref	Protected Conservation Area	EQS (µg/m^3)	Background concentration (µg/m^3)	PC (µg/m^3)	PEC (µg/m^3)	PC/EQS (%)	PEC/EQS (%)
H2c	Manchester Mosses SAC and Astley & Bedford Mosses SSSI		4.9	0.037	4.9	0.37%	48.9%
H3	Hope Carr Nature Reserve LWS		6.0	2.016	8.0	20.16%	80.5%
H4	Pennington Flash LNR		5.3	0.046	5.3	0.46%	53.4%
H4b			5.5	0.052	5.5	0.52%	55.0%
H5	Pennington Flash LWS		5.5	0.068	5.5	0.68%	55.2%
H6	Atherton & Bedford Woods LWS and Atherton Woods (ID 1105558) Ancient Woodland		6.7	0.110	6.8	1.10%	67.6%
H7	Wetland off Orchard Lane LWS		7.5	0.085	7.6	0.85%	75.9%

The results in Table 9 and Table 11 indicate that at the assessed European designated sites and SSSI's, the respective annual mean NOx and SO_2 PCs are less than 1% of the relevant long-term environmental standard for protected conservation areas and the impact can be described as 'insignificant' as per Environment Agency guidance (Environment Agency, 2021a). For the assessed local nature sites, the respective annual mean NOx and SO_2 PCs are less than 100% of the long-term environmental standard for protected conservation areas and their impact can also be described as 'insignificant'.

The results in Table 10 indicate that at the assessed European designated sites and SSSI's, the respective PCs for short-term mean concentrations are less than 10% of the short-term environmental standard for protected conservation areas (i.e. the 24-hour mean critical level for NOx) and can be described as 'insignificant'. For the assessed local nature sites, the short-term NOx PCs are less than 100% of the short-term environmental standard for protected conservation areas and the impact can also be described as 'insignificant'.

Therefore, no unacceptable impacts to air quality at the assessed protected conservation areas are likely to occur as a consequence of the operation of the assessed CHP engines and boiler with regard to ambient concentrations of NOx and SO_2.

5.2.2 Assessment against Critical Loads

The rate of deposition of acidic compounds and nitrogen containing species have been estimated at the assessed protected conservation areas. This allows the potential for adverse effects to be evaluated by comparison with critical loads for acid and nutrient nitrogen deposition. The assessment took account of emissions of NOx and SO_2 only.

Critical load functions for acid deposition are specified on the basis of both nitrogen-derived acid and sulphur-derived acid. This information, including existing deposition levels at habitat sites, is available from APIS (Centre for Ecology and Hydrology, 2021). Further information on the assessment of deposition is provided in Appendix B. The full detailed modelled results are displayed in Table 12 and Table 13.

Table 12: Modelled acid deposition at assessed protected conservation areas

Ref	Habitat	Vegetation type (for deposition velocity)	Critical load (CL) (kEqH+/ha/year)			Existing acid deposition (kEqH+/ha/year)					
			CLMaxS	CLMinN	CLMaxN	Existing deposition (N)	Existing deposition (S)	PC	PEC	PC/CL (%)	PEC/CL(%)
H1a	Rixton Clay Pits SAC, LNR and SSSI	Short	0.200	0.300	0.600	1.5	0.3	0.0003	1.8	0.1%	300%
H1b		Short	0.200	0.300	0.600	1.5	0.3	0.0003	1.8	0.1%	300%
H2a	Manchester Mosses SAC and Risley Moss SSSI and LNR	Short	0.300	0.300	0.600	1.5	0.3	0.0003	1.8	0.0%	300%
H2b	Manchester Mosses SAC and Holcroft Moss SSSI	Short	0.300	0.300	0.600	1.5	0.3	0.0006	1.8	0.1%	300%
H2c	Manchester Mosses SAC and Astley & Bedford Mosses SSSI	Short	0.300	0.300	0.600	1.5	0.3	0.005	1.8	0.8%	301%
H3	Hope Carr Nature Reserve LWS	Short	0.470	0.438	0.908	1.5	0.3	0.256	2.1	28.2%	226%
		Tall	1.028	0.357	1.385	2.5	0.3	0.512	3.4	37.0%	242%
H4a	Pennington Flash LNR	Short	0.870	0.438	1.308	1.8	0.3	0.006	2.0	0.5%	156%
		Tall	1.511	0.357	1.868	3.0	0.3	0.012	3.3	0.6%	175%
H4b		Short	0.870	0.438	1.308	1.8	0.3	0.007	2.0	0.5%	156%
		Tall	1.509	0.357	1.866	3.0	0.3	0.013	3.3	0.7%	175%
H5	Pennington Flash LWS	Short	0.870	0.438	1.308	1.8	0.3	0.009	2.0	0.7%	156%
		Tall	1.509	0.357	1.866	3.0	0.3	0.017	3.3	0.9%	175%
H6	Atherton & Bedford Woods LWS and Atherton Woods (ID 1105558) Ancient Woodland	Short	0.860	0.438	1.298	1.6	0.3	0.014	1.9	1.1%	144%
		Tall	1.518	0.357	1.875	2.5	0.3	0.028	2.9	1.5%	153%
H7	Wetland off Orchard Lane LWS	Short	0.860	0.438	1.298	1.6	0.3	0.011	1.9	0.8%	144%
		Tall	1.522	0.357	1.879	2.5	0.3	0.022	2.9	1.2%	152%

Table 13: Modelled nutrient nitrogen deposition at assessed protected conservation areas

Ref	Habitat	Vegetation type (for deposition velocity)	Minimal Critical Load (CL)	Existing nutrient deposition (kgN/ha-year)				
				Existing deposition	PC	PEC	PC/CL (%)	PEC/CL(%)
H1a	Rixton Clay Pits SAC, LNR and SSSI	Short	10	21.4	0.0004	21.4	0.0%	214%
H1b		Short	10	21.4	0.0003	21.4	0.0%	214%
H2a	Manchester Mosses SAC and Risley Moss SSSI and LNR	Short	5	21.4	0.0003	21.4	0.0%	428%
H2b	Manchester Mosses SAC and Holcroft Moss SSSI	Short	5	21.4	0.0007	21.4	0.0%	428%
H2c	Manchester Mosses SAC and Astley & Bedford Mosses SSSI	Short	5	21.6	0.005	21.6	0.1%	431%
H3	Hope Carr Nature Reserve LWS	Short	5	21.6	0.255	21.8	5.1%	436%
		Tall	5	35.6	0.509	36.1	10.2%	721%
H4a	Pennington Flash LNR	Short	5	24.8	0.006	24.8	0.1%	496%
		Tall	5	41.3	0.012	41.3	0.2%	826%
H4b		Short	5	24.8	0.007	24.8	0.1%	496%
		Tall	5	41.3	0.014	41.3	0.3%	826%
H6	Atherton & Bedford Woods LWS and Atherton Woods (ID 1105558) Ancient Woodland	Short	5	24.8	0.009	24.8	0.2%	496%
		Tall	5	41.3	0.018	41.3	0.4%	826%
H7	Wetland off Orchard Lane LWS	Short	5	22.3	0.015	22.3	0.3%	445%
		Tall	5	35.4	0.030	35.4	0.6%	709%
H6	Atherton & Bedford Woods LWS and Atherton Woods (ID 1105558) Ancient Woodland	Short	5	22.3	0.012	22.3	0.2%	445%
		Tall	5	35.4	0.023	35.4	0.5%	709%

The results in Table 12 and Table 13 indicate that at the assessed European designated sites and SSSI's, the respective PCs are below 1% of the relevant critical load value for acid deposition and nutrient nitrogen deposition and the impact can be described as 'insignificant' as per Environment Agency guidance (Environment Agency, 2021a). For the assessed local nature sites, the respective PCs are less than 100% of the relevant critical load value for acid deposition and nutrient nitrogen deposition and the impact can also be described as 'insignificant'.

It should be noted acid and nitrogen deposition rates currently exceed their relevant critical loads in the majority of the assessed protected conservation areas. However, this is a relatively common situation at protected conservation areas across the UK due to the high baseline deposition rates.

5.3 Sensitivity Analysis

A sensitivity study was undertaken to see how changes to the surface roughness and omission of the buildings in the 2016 model (which predicted the highest annual mean NO_2 concentrations and highest 1-hour mean NO_2 concentrations at sensitive human receptor locations), and 2019 model (which predicted the highest 1-hour mean NO_2 concentrations at a modelled off-site location) may impact on predicted concentrations at sensitive human receptors and off-site locations. The results of the sensitivity analysis are presented in Table 14, Table 15 and Table 16.

Table 14: Sensitivity analysis - fixed surface roughness of 0.1 m

Pollutant	Averaging period	Assessment location	Original PC (surface roughness 0.6 m) ($\mu g/m^3$)	Surface roughness length 0.1 m				
				PC ($\mu g/m^3$)	PEC ($\mu g/m^3$)	PC/EQS	PEC/EQS	% difference in PC/EQS compared to original
NO_2	Annual mean	Sensitive locations	0.7	0.5	14.9	1.3%	37.2%	-0.4%
	1 hour mean (99.79th percentile)	Maximum off-site	31.1	44.0	72.7	22.0%	36.4%	6.4%
		Sensitive locations	11.9	14.1	39.9	7.1%	19.9%	1.1%

The results in Table 14 indicate that the change to maximum predicted annual mean concentrations for NO_2 is slightly lower when using a surface roughness value of 0.1 m compared to the original value of 0.6 m. For 1-hour mean (99.79th percentile) NO_2 concentrations at an off-site location and sensitive human receptor location, the PCs were higher when using a reduced surface roughness value of 0.1 m. However, a surface roughness of 0.1 m (representing root crops) is not considered representative of the site and surrounding area.

Table 15: Sensitivity analysis - fixed surface roughness of 1 m

Pollutant	Averaging period	Assessment location	Original PC (surface roughness 0.6 m) ($\mu g/m^3$)	Surface roughness length 1 m				
				PC ($\mu g/m^3$)	PEC ($\mu g/m^3$)	PC/EQS	PEC/EQS	% difference in PC/EQS compared to original
NO_2	Annual mean	Sensitive locations	0.7	0.8	15.1	1.9%	37.8%	0.2%
		Maximum off-site	31.1	22.0	50.7	11.0%	25.3%	-4.6%

Pollutant	Averaging period	Assessment location	Original PC (surface roughness 0.6 m) ($\mu g/m^3$)	Surface roughness length 1 m				
				PC ($\mu g/m^3$)	PEC ($\mu g/m^3$)	PC/EQS	PEC/EQS	% difference in PC/EQS compared to original
	1 hour mean (99.79th percentile)	Sensitive locations	11.9	11.2	37.0	5.6%	18.5%	-0.3%

The results in Table 15 indicate that the change to maximum predicted annual mean concentrations of NO_2 is negligible when using a surface roughness value of 1 m compared to the original value of 0.6 m. For 1-hour mean (99.79th percentile) NO_2 concentrations at an off-site location and sensitive human receptor location, the NO_2 concentrations were lower. However, a surface roughness of 1 m (representing a large city centre location with built-up areas and tall buildings) is not considered representative of the site and surrounding area.

Table 16: Sensitivity analysis - no buildings

Pollutant	Averaging period	Assessment location	Original PC (with buildings) ($\mu g/m^3$)	No buildings				
				PC ($\mu g/m^3$)	PEC ($\mu g/m^3$)	PC/EQS	PEC/EQS	% difference in PC/EQS compared to original
NO_2	Annual mean	Sensitive locations	0.7	0.7	15.0	1.7%	37.6%	0.0%
	1 hour mean (99.79th percentile)	Maximum off-site	31.1	10.7	39.4	5.3%	19.7%	-10.2%
		Sensitive locations	11.9	10.2	35.9	5.1%	18.0%	-0.9%

The results in Table 16 indicate that the differences between the maximum predicted concentrations with and without the buildings is such that including buildings within the model is the preferred option for this study, to maintain a more realistic, and conservative, approach.

6. Conclusions

This report has assessed the potential air quality impacts associated with the operation of the biogas fuelled CHP engines and boiler at Leigh WwTW. The predicted impacts were assessed against the relevant air quality standards and guidelines for the protection of human health (referred to in the report as EQSs) and protected conservation areas (referred to as critical levels and critical loads).

Human receptors

The assessment indicates that the predicted modelled off-site concentrations and predicted concentrations at sensitive human receptors do not exceed any relevant long-term or short-term air quality objective or guideline. At sensitive human receptor locations, the predicted long-term (i.e. annual mean) NO_2 and particulate (PM_{10} and $PM_{2.5}$) contributions are considered 'not significant'. For short-term NO_2, SO_2, PM_{10} and CO concentrations at modelled off-site locations and sensitive human receptor locations, the contributions are also considered 'not significant'.

This assessment has been carried out on the assumption that the CHP engines and boiler will operate simultaneously and continuously at maximum load all year. This is a conservative assumption as, in practice, the combustion plant will have periods of shutdown and maintenance and may not always operate at maximum load.

Protected conservation areas

For critical levels, the results indicate that the respective annual mean NOx and SO_2 PCs at the assessed European designated sites and SSSI's are less than 1% of the relevant long-term environmental standard and their impact can be described as 'insignificant'. At the assessed local nature sites, the respective NOx and SO_2 PCs are less than 100% of the relevant long-term environmental standard and their impact can also be described as 'insignificant'.

For maximum 24-hour mean critical level NOx concentrations, the respective PCs at the assessed European designated sites and SSSI's are less than 10% of the relevant critical level and can be described as 'insignificant'. At the assessed local nature sites, the respective PCs are less than 100% of the relevant short-term environmental standard and their impact can also be described as 'insignificant'.

For acid and nutrient nitrogen deposition, the results indicate that the respective PCs at the assessed European designated sites and SSSI's are less than 1% of the relevant critical load value and the impact can be described as 'insignificant'. At the assessed local nature sites, the respective PCs are less than 100% of the relevant long-term environmental standard and the impact can also be described as 'insignificant'.

Summary

Based on the above assessment, it is concluded that the assessed CHP engines and boiler are acceptable from an air quality perspective.

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8. Figures

Figure 1: Approximate site fence line, modelled stack locations and modelled buildings

N

A3

A1 & A2

0 0.025 0.05 0.1 Kilometers

Legend

- Approximate site fenceline
- Modelled stack locations
- Modelled buildings

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0	02/07/2021	Initial Issue	DH	GW	GW	MM

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Drawing Title
APPROXIMATE SITE FENCELINE,MODELLED STACK LOCATIONS AND MODELLED BUILDINGS

Drawing Status: FINAL

Scale @ A3	1:1,500	DO NOT SCALE
Jacobs No.	B27030BQ	Rev 0
Client No.		

Drawing Number
FIGURE 1

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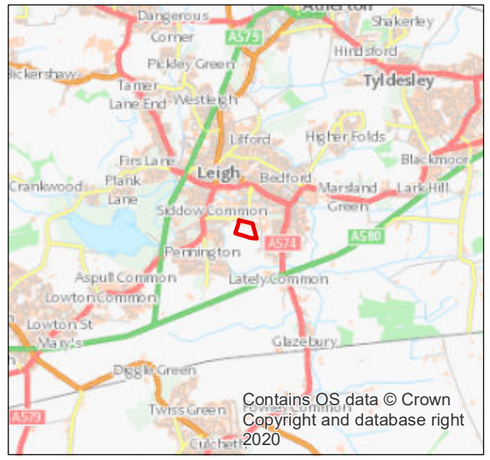
Figure 2: Sensitive human receptor locations, AQMA and extent of modelled grid

Legend

- Approximate site fenceline
- Modelled stack locations
- Greater Manchester Combined Authority AQMA
- Extent of modelled grid
- R1 Sensitive human receptor locations



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Drawing Title: SENSITIVE HUMAN RECEPTOR LOCATIONS, AQMA AND EXTENT OF MODELLED GRID

Drawing Status: FINAL

Scale @ A3	1:7,000	DO NOT SCALE
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Drawing Number: FIGURE 2

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Figure 3: Protected conservation areas

N

H1 H1a H1b H2a H2b H2c H3 H4a H4b H5 H6 H7

0 1 2 4 Kilometers

Legend

- Approximate site fenceline
- Special Area of Conservation (SAC)
- Site of Special Scientific Interest (SSSI)
- Local Wildlife Site (LWS)
- Local Nature Reserves (LNR)
- H1 Protected conservation area locations

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Drawing Title: PROTECTED CONSERVATION AREAS

Drawing Status: FINAL

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Drawing Number: FIGURE 3

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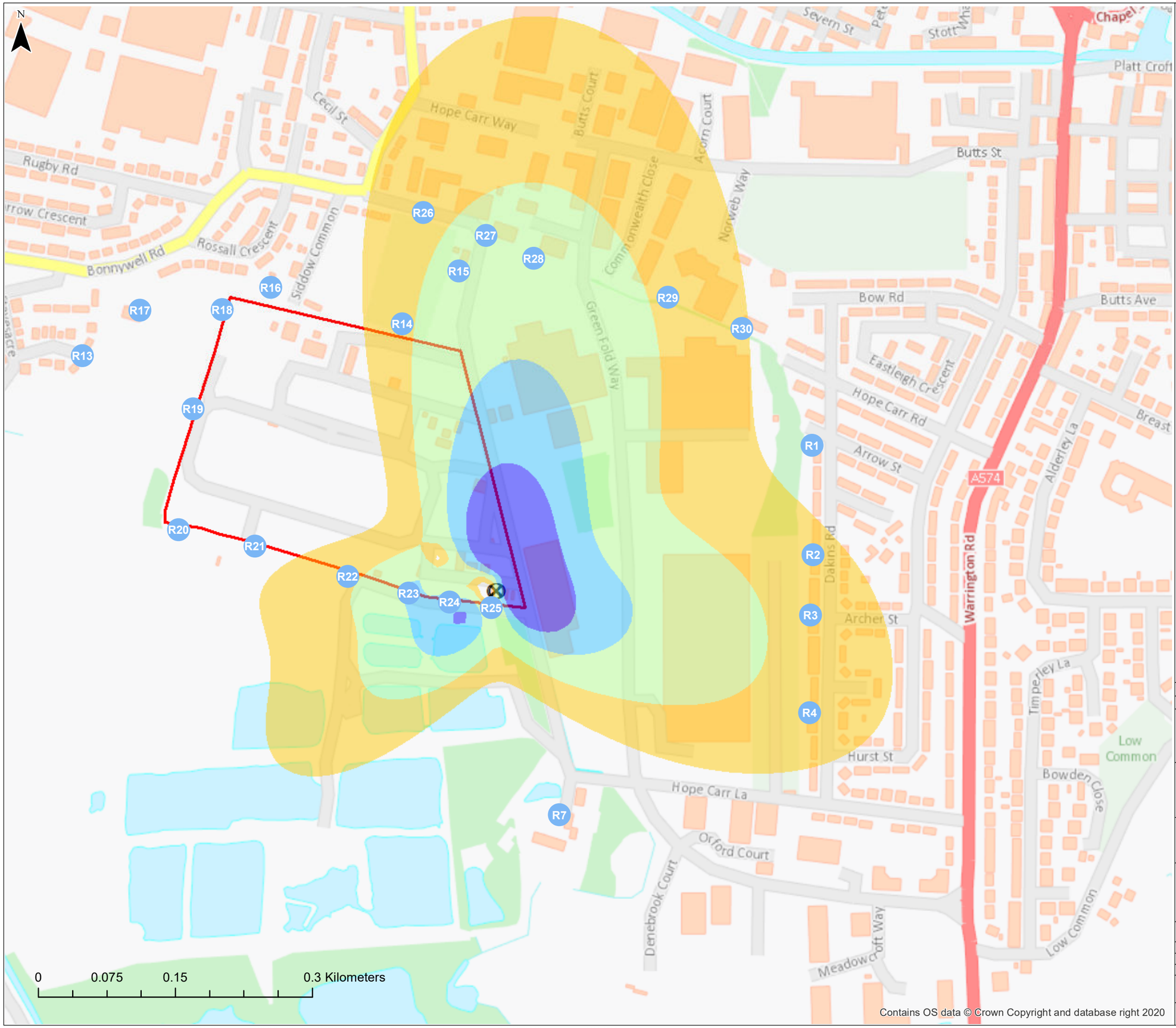
Figure 4: Annual mean nitrogen dioxide process contributions, 2016 meteorological data



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Drawing Title: ANNUAL MEAN NITROGEN DIOXIDE PROCESS CONTRIBUTIONS, 2016 METEOROLOGICAL DATA

Drawing Status: FINAL

Scale @ A3	1:4,000	DO NOT SCALE
Jacobs No.	B27030BQ	Rev 0
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Drawing Number: FIGURE 4

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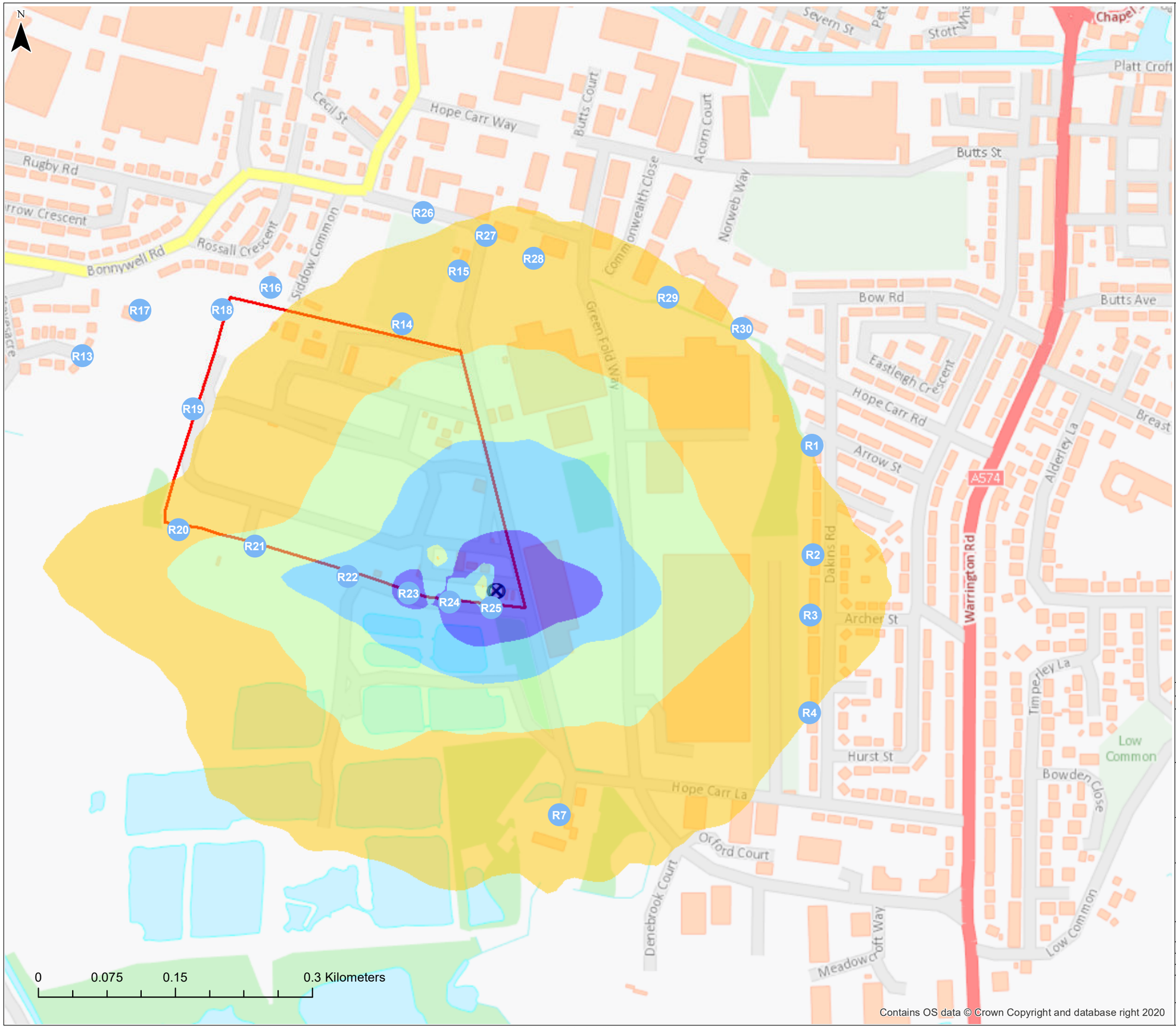
Figure 5: 1-hour mean (99.79th percentile) nitrogen dioxide process contributions, 2019 meteorological data



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Drawing Title: 1-HOUR MEAN (99.79th PERCENTILE) NITROGEN DIOXIDE PROCESS CONTRIBUTIONS, 2019 METEOROLOGICAL DATA

Drawing Status: FINAL

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Drawing Number: FIGURE 5

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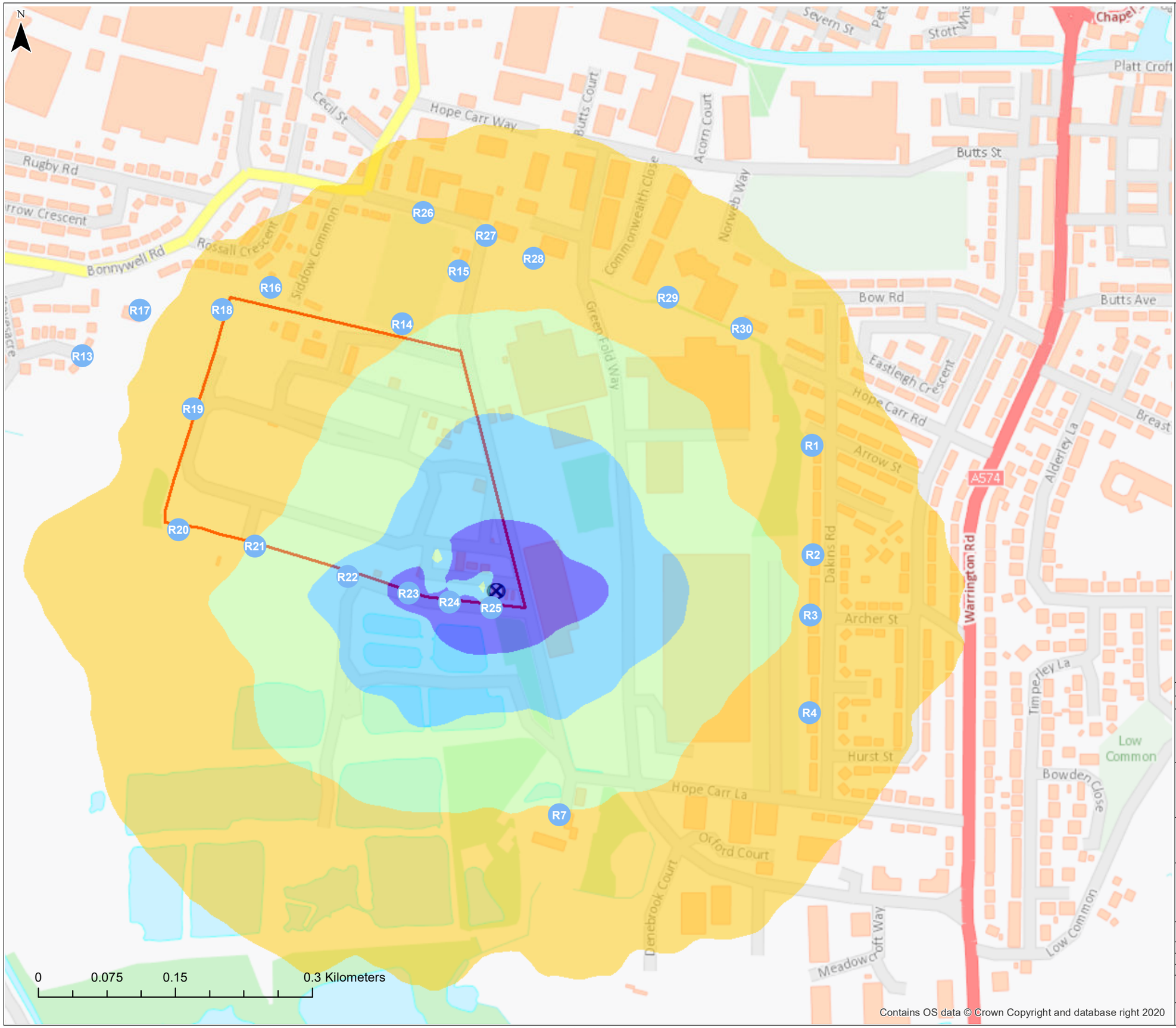
Figure 6: 1-hour mean (99.73rd percentile) sulphur dioxide process contributions, 2018 meteorological data



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Drawing Title: 1-HOUR MEAN (99.73rd PERCENTILE) SULPHUR DIOXIDE PROCESS CONTRIBUTIONS, 2018 METEOROLOGICAL DATA

Drawing Status: FINAL

Scale @ A3	1:4,000	DO NOT SCALE
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Drawing Number: FIGURE 6

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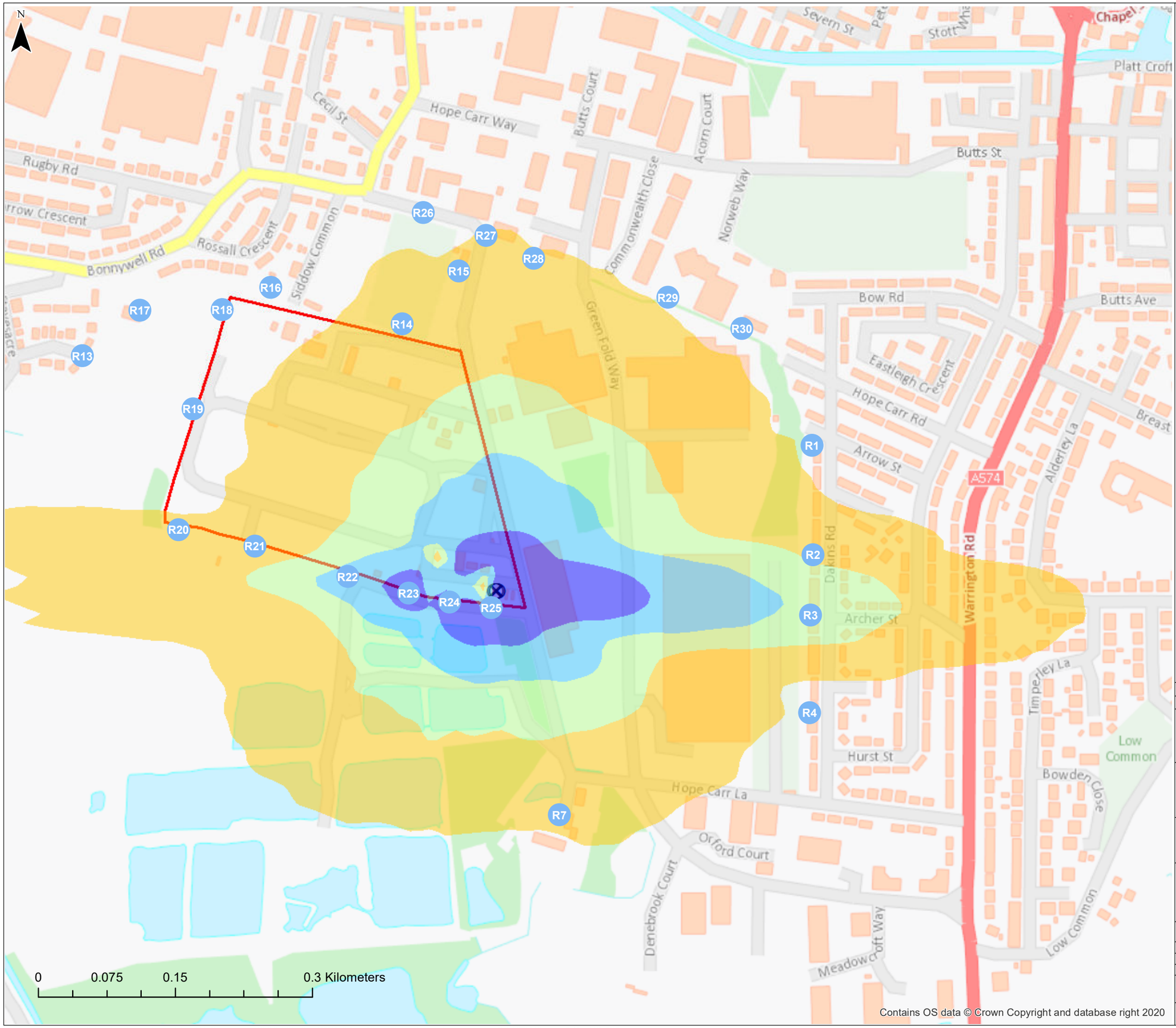
Figure 7: 15-minute mean (99.9th percentile) sulphur dioxide process contributions, 2017 meteorological data



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LEIGH WASTEWATER TREATMENT WORKS

Drawing Title: 15-MINUTE MEAN (99.9th PERCENTILE)
SULPHUR DIOXIDE PROCESS CONTRIBUTIONS,
2017 METEOROLOGICAL DATA

Drawing Status: FINAL

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Drawing Number: FIGURE 7

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Appendix A. Dispersion Model Input Parameters

A.1 Emission Parameters

The emissions data used to represent the site for the scenario described in Section 2 is set out in Table 17. Emission limits as set out in the MCPD[2] for existing combustion plant are also presented in Table 17 where relevant.

Table 17: Dispersion modelling parameters

Parameters	Unit	JMS 312 GS-BL CHP engine (1.30 MW_{th})	JMS 312 GS-BL CHP engine (1.30 MW_{th})	ICI Caldaire Boiler (1.16 MW_{th})
Fuel	-	Biogas	Biogas	Gas oil or biogas (modelled on biogas)
Emission point	-	A1	A2	A3
Assessed annual operation hours	Hours	8,760	8,760	8,760
Stack location	m	E 366351 N 398973 (shared stack)[2]		E 366349 N 398973
Stack height	m	35	35	7
Stack diameter	m	0.23	0.23	0.27
Flue gas temperature	°C	180	180	180
Efflux velocity	m/s	31.2	29.6	23.0
Moisture content of exhaust gas	%	11.9	11.9	8.1
Oxygen content of exhaust gas (dry)	%	8.1	7.4	6.4
Volumetric flow rate (actual)	m^3/s	1.242	1.176	1.317
Volumetric flow rate (normal)[1]	Nm^3/s	1.434	1.434	0.591
NOx emission concentration[1,]	mg/Nm^3	186 (190 after 1st January 2030)	186 (190 after 1st January 2030)	250 (200 after 1st January 2030)
NOx emission rate	g/s	0.266	0.266	0.148
CO emission concentration[1]	mg/Nm^3	519	519	100
CO emission rate	g/s	0.745	0.745	0.059
PM_{10} / $PM_{2.5}$ emission concentration[1]	mg/Nm^3	2.7	2.7	5
PM_{10} / $PM_{2.5}$ emission rate	g/s	0.004	0.004	0.003
SO_2 emission concentration[1]	mg/Nm^3	130 (60 after 1st January 2030)	130 (200 after 1st January 2030)	200 (200 after 1st January 2030)
SO_2 emission rate	g/s	0.186	0.186	0.118
TVOC emission concentration[1]	mg/Nm^3	371	371	1,126
TVOC emission rate	g/s	0.532	0.532	0.665

Note 1: Normalised flows and concentrations presented at 273 K, 101.3 kPa, dry gas and oxygen content of 15% (CHP engines) or 3% (boiler).

Note 2: As the CHP engines exhaust gases exit via a shared stack, an aai file was used in the model to represent the effects of a single plume.

A.2 Dispersion Model Inputs

A.2.1 Structural influences on dispersion

The main structures within the site which have been included in the model to reflect the existing site layout are identified within Table 18 and shown on Figure 1. A sensitivity study has been carried out to assess the sensitivity of the model to using the buildings module.

Table 18: Building parameters

Building	Modelled building shapes	Length / diameter (m)	Width (m)	Height (m)	Angle of length to north	Centre point co-ordinates	
						Easting	Northing
Gas holder	Circular	19.0	-	7.8		366290	399012
Digested Sludge Tank	Circular	15.0	-	7.3	-	366279	398978
Primary Digester	Circular	16.0	-	18.8	-	366305	398974
Sludge Storage Tank	Circular	9.0	-	12.8	-	366357	399009
Sludge Storage Silo	Circular	9.0	-	11.4	-	366357	398996
Gen housing	Rectangular	11.8	5.5	3.4	6	366347	398971

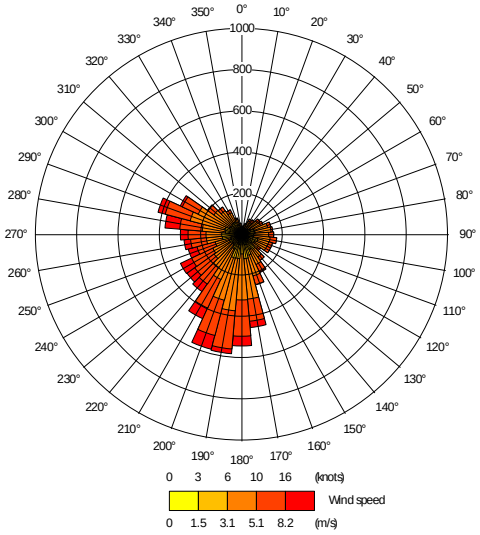
A.2.2 Other model inputs

Parameter	Value used	Comments
Surface roughness length for dispersion site	0.6 m	This is appropriate for the dispersion site which is area where the local land-use ranges from open suburbia to towns. A sensitivity study has been carried out with fixed surface roughness values of 0.1 m and 1.0 m.
Surface roughness length at meteorological station site	0.5 m	This is appropriate for an area where the local land-is relatively flat such as Manchester airport.
Minimum Monin-Obukhov Length	1 m	Typical values for the dispersion site
Surface Albedo	0.23 m	Typical values for the dispersion site
Priestley-Taylor Parameter	1 m	Typical values for the dispersion site
Terrain	Not included	Guidance for the use of the ADMS model suggests that terrain is normally incorporated within a modelling study when the gradient exceeds 1:10. As the gradient in the vicinity of the site does not exceed 1:10, a terrain file was not included in the modelling.
Meteorological data	Manchester Airport meteorological station, 2015 - 2019	Manchester Airport meteorological station is located approximately 21.4 km southeast of the site and is considered the closest most representative meteorological monitoring station to the site.
Combined flue option	Yes	As the CHP engines exhaust gases exit via a shared stack, an aai file was used in the model to represent the effects of a single plume.

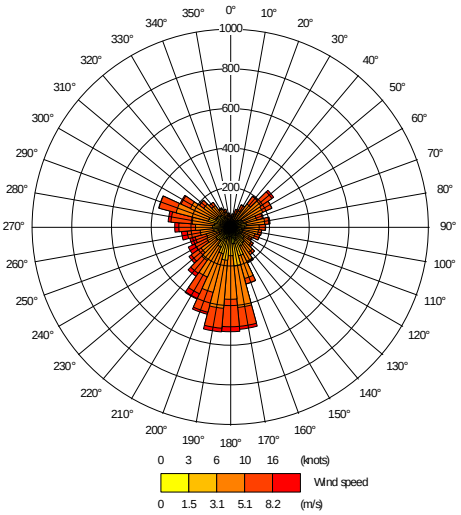
A.2.3 Meteorological Data – Wind Roses

The wind roses for each year of meteorological data utilised in the assessment are shown below.

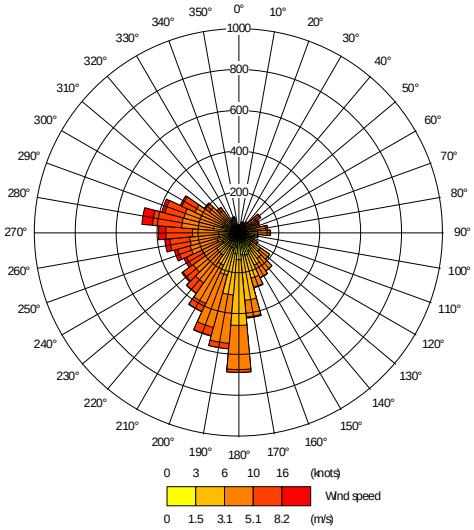
Manchester Airport meteorological station, 2015



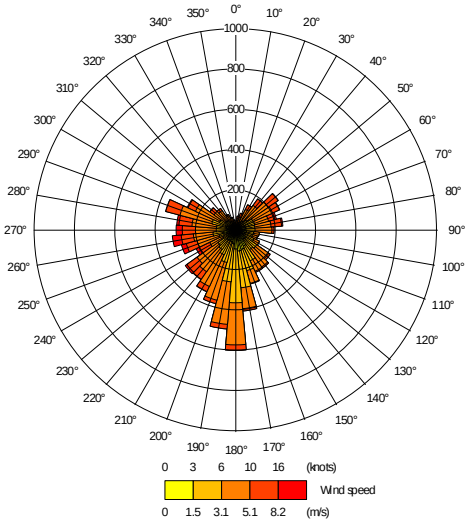
Manchester Airport meteorological station, 2016



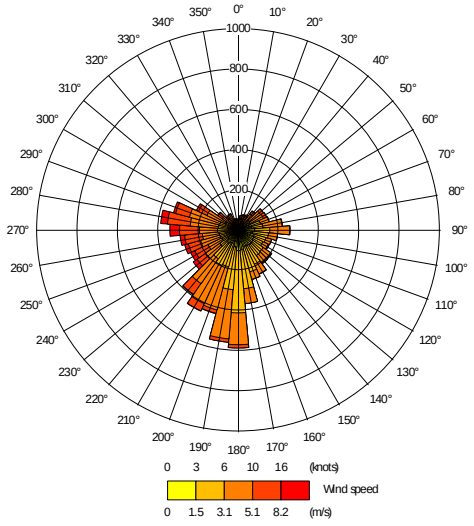
Manchester Airport meteorological station, 2017



Manchester Airport meteorological station, 2018



Manchester Airport meteorological station, 2019



A.2.4 Model Domain/Study Area

The ADMS model calculates the predicted concentrations based on a user defined grid system. Generally, the larger the study area, the greater the distance between the grid calculation points and the lower the resolution of the dispersion model predictions. This is to be offset against the need to encompass an appropriately wide area within the dispersion modelling study to capture the dispersion of the stack emissions.

The modelled grid was specified as a 1.5 km x 1.5 km grid with calculation points every 10 m (i.e. 151 points along each grid axis) with a grid height of 1.5 m. This size of grid was selected to provide a good grid resolution and also encompass a sufficient area so that the maximum predicted concentrations would be determined. The area within the site boundary was excluded from the modelled grid as it is not accessible to the general public. The modelled grid parameters are presented in Table 19.

Table 19: Modelled grid parameters

	Start	Finish	Number of grid points	Grid spacing (m)
Easting	365601	367101	151	10
Northing	398223	399723	151	10
Grid height	1.5	1.5	1	-

Due to the close proximity of Hope Carr Nature Reserve LWS, those grid points detailed above which encompass the LWS were used to quantify the highest long-term and short-term concentrations at ground level.

As well as the modelled grid, the potential impact at 30 sensitive human receptors (e.g. exposure locations such as residential properties and footpaths), Greater Manchester Combined Authority AQMA and 7 protected conservation areas within the required study area were assessed. The receptor locations are shown in Figure 2 and Figure 3 and further details of the receptor locations are provided in Table 20 and Table 21.

Table 20: Assessed sensitive human receptor locations

Receptor	Description	Grid reference		Distance from the CHP engines stack (km)	Direction from the site
		Easting	Northing		
R1	Residential property off Dakins Rd	366696	399132	0.38	ENE
R2	Residential property off Dakins Rd	366697	399012	0.35	E
R3	Residential property off Dakins Rd	366694	398946	0.34	E
R4	Residential property off Dakins Rd	366693	398839	0.37	ESE
R5	Residential property off East Lancashire Rd	366542	398245	0.75	SSE
R6	Residential property off East Lancashire Rd	366352	398163	0.81	S
R7	Residential property Green Fold Way	366419	398727	0.26	SSE
R8	Residential property off Fallow Brook	365831	398486	0.71	SW
R9	Residential property off Chestnut Drive South	365718	398719	0.68	WSW
R10	Residential property off Meynell Drive	365748	398822	0.62	WSW
R11	Residential property off Chestnut Lane	365780	399008	0.57	W
R12	Residential property off Birchwood Close	365720	399142	0.65	WNW
R13	Residential property off Charlock Close	365897	399230	0.52	WNW
R14	Siddow Park Playing Fields	366247	399265	0.31	NNW
R15	Claycroft Bungalow	366309	399323	0.35	N
R16	Residential property off Siddow Common	366103	399305	0.41	NW
R17	Footpath	365960	399280	0.50	NW
R18	Footpath	366060	399278	0.42	NW
R19	Footpath	366018	399172	0.39	WNW
R20	Footpath	366007	399054	0.35	WNW
R21	Footpath	366088	399029	0.27	WNW
R22	Footpath	366192	398999	0.16	W
R23	Footpath	366259	398979	0.09	W
R24	Footpath	366300	398964	0.05	W
R25	Footpath	366345	398959	0.02	SSW
R26	Footpath	366270	399387	0.42	N
R27	Footpath	366339	399362	0.39	N
R28	Footpath	366391	399337	0.37	N
R29	Footpath	366538	399294	0.37	NNE
R30	Footpath	366619	399260	0.39	NE
R31	Greater Manchester Combined Authority AQMA	366695	398250	0.80	SSE
R32		365745	399915	1.12	NNW
R33		367266	399930	1.32	NE

Table 21: Assessed protected conservation area locations

Receptor	Description	Grid reference		Distance from combustion plant (km)	Direction from the site
		Easting	Northing		
H1a	Rixton Clay Pits SAC, LNR and SSSI	368432	390718	8.51	SSE
H1b		368382	390389	8.82	SSE
H2a	Manchester Mosses SAC and Risley Moss SSSI and LNR	366885	392263	6.73	S
H2b	Manchester Mosses SAC and Holcroft Moss SSSI	368351	393456	5.87	SSE
H2c	Manchester Mosses SAC and Astley & Bedford Mosses SSSI	368271	397739	2.28	ESE
H3	Hope Carr Nature Reserve LWS	Modelled grid		Adjacent to southern boundary of the site	
H4a	Pennington Flash LNR	364513	399221	1.85	W
H4b		364633	398793	1.73	W
H5	Pennington Flash LWS	364915	398987	1.44	W
H6	Atherton & Bedford Woods LWS and Atherton Woods (ID 1105558) Ancient Woodland	366761	400967	2.04	NNE
H7	Wetland off Orchard Lane LWS	365966	401256	2.32	N

A.2.5 Treatment of oxides of nitrogen

It was assumed that 70% of NOx emitted from the assessed combustion plant will be converted to NO_2 at ground level in the vicinity of the site, for determination of the annual mean NO_2 concentrations, and 35% of emitted NO_x will be converted to NO_2 for determination of the hourly mean NO_2 concentrations, in line with guidance provided by the Environment Agency (Environment Agency, 2021b). This approach is likely to overestimate the annual mean NO_2 concentrations considerably at the most relevant assessment locations close to the site.

A.2.6 Calculation of PECs

In the case of long-term mean concentrations, it is relatively straightforward to combine modelled process contributions with baseline air quality levels, as long-term mean concentrations due to plant emissions could be added directly to long-term mean baseline concentrations.

It is not possible to add short-period peak baseline and process concentrations directly. This is because the conditions which give rise to peak ground-level concentrations of substances emitted from an elevated source at a particular location and time are likely to be different to the conditions which give rise to peak concentrations due to emissions from other sources.

As described in the Environment Agency guidance (Environment Agency, 2021a), for most substances the short-term peak PC values are added to twice the long-term mean baseline concentration to provide a reasonable estimate of peak concentrations due to emissions from all sources.

A.2.7 Modelling Uncertainty

There are always uncertainties in dispersion models, in common with any environmental modelling study, because a dispersion model is an approximation of the complex processes which take place in the atmosphere. Some of the key factors which lead to uncertainty in atmospheric dispersion modelling are as follows.

- The quality of the model output depends on the accuracy of the input data enter the model. Where model input data are a less reliable representation of the true situation, the results are likely to be less accurate.

- The meteorological data sets used in the model are not likely to be completely representative of the meteorological conditions at the site. However, the most suitable available meteorological data was chosen for the assessment.
- Models are generally designed on the basis of data obtained for large scale point sources and may be less well validated for modelling emissions from smaller scale sources.
- The dispersion of pollutants around buildings is a complex scenario to replicate. Dispersion models can take account of the effects of buildings on dispersion; however, there will be greater uncertainty in the model results when buildings are included in the model.
- Modelling does not specifically take into account individual small-scale features such as vegetation, local terrain variations and off-site buildings. The roughness length (z_o) selected is suitable to take general account of the typical size of these local features within the model domain.
- To take account of these uncertainties and to ensure the predictions are more likely to be over-estimates than under-estimates, the conservative assumptions described below have been used for this assessment.

A.2.8 Conservative Assumptions

The conservative assumptions adopted in this study are summarised below.

- The CHP engines and boiler were assumed to operate for 8,760 hours each calendar year but in practice, both the CHP engines and boiler will have periods of shutdown and maintenance and may not always operate at maximum load.
- The study is based on emissions being continuously at the emission limits and calculated emissions specified.
- The maximum predicted concentrations at any residential areas as well as off-site locations were considered for the assessment of short-term concentrations and the maximum predicted concentrations at any residential areas were considered for assessment of annual mean concentrations within the air quality study area. Concentrations at other locations will be less than the maximum values presented.
- The highest predicted concentrations obtained using any of the five different years of meteorological data have been used in this assessment. During a typical year the ground level concentrations are likely to be lower.
- It was assumed that 100% of the particulate matter emitted from the plant is in the PM_{10} size fraction. The actual proportion will be less than 100%.
- It was assumed that 100% of the particulate matter emitted from the plant is in the $PM_{2.5}$ size fraction. The actual proportion will be less than 100%.
- It was assumed the vegetation type selected for each assessed protected conservation area is present at the specific modelled location.

Appendix B. Calculating Acid and Nitrogen Deposition

B.1 Methodology

Nitrogen and acid deposition have been predicted using the methodologies presented in the Air Quality Technical Advisory Group (AQTAG) guidance note: AQTAG 06 "*Technical Guidance on Detailed Modelling Approach for an Appropriate Assessment for Emissions to Air"* (AQTAG, 2014).

When assessing the deposition of nitrogen, it is important to consider the different deposition properties of nitric oxide and nitrogen dioxide. It is generally accepted that there is no wet or dry deposition arising from nitric oxide in the atmosphere. Thus, it is normally necessary to distinguish between nitric oxide (NO) and nitrogen dioxide in a deposition assessment. In this case, the conservative assumption that 70% of the oxides of nitrogen are in the form of nitrogen dioxide was adopted.

Information on the existing nitrogen and acid deposition was obtained from the APIS database (Centre for Ecology and Hydrology, 2021). Information on the deposition critical loads for each habitat site was also obtained from the APIS database using the Site Relevant Critical Load function.

The annual dry deposition flux can be obtained from the modelled annual average ground level concentration via use of the formula:

- Dry deposition flux (µg/m^2/s) = ground level concentration (µg/m^3) x deposition velocity (m/s)

(where µg refers to µg of the chemical species under consideration).

The deposition velocities for various chemical species recommended for use (AQTAG, 2014) are shown below in Table 22.

Table 22: Recommended dry deposition velocities

Chemical species	Recommended deposition velocity (m/s)	
NO_2	Grassland (short)	0.0015
	Forest (tall)	0.003
SO_2	Grassland (short)	0.012
	Forest (tall)	0.024

To convert the dry deposition flux from units of µg/m^2/s (where µg refers to µg of the chemical species) to units of kg N/ha/yr (where kg refers to kg of nitrogen) multiply the dry deposition flux by the conversion factors shown in Table 23. To convert dry deposition flux to acid deposition multiply by factors shown in Table 25.

Table 23: Dry deposition flux conversion factors for nutrient nitrogen deposition

µg/m^2/s of species	Conversion factor to kg N/ha/yr
NO_2	95.9

Table 24: Dry deposition flux conversion factors for acidification

µg/m^2/s of species	Conversion factor to keq/ha/yr
NO_2	6.84
SO_2	9.84

Appendix C. Results at Sensitive Human Locations

Table 25: Results of detailed assessment at sensitive human receptor locations for maximum 8-hour mean and 1-hour mean CO predicted concentrations

Receptor ID	Baseline air quality level (µg/m³)	Maximum 8-hour running mean					Maximum 1-hour mean				
		EQS (µg/m³)	PC (µg/m³)	PEC (µg/m³)	PC/EQS (%)	PEC/EQS (%)	EQS (µg/m³)	PC (µg/m³)	PEC (µg/m³)	PC/EQS (%)	PEC/EQS (%)
R1	356	10,000	16.7	373	0.2%	3.7%	30,000	22.6	379	0.1%	1.3%
R2	356		17.8	374	0.2%	3.7%		24.0	380	0.1%	1.3%
R3	351		17.0	368	0.2%	3.7%		24.0	375	0.1%	1.3%
R4	351		15.1	367	0.2%	3.7%		23.0	374	0.1%	1.2%
R5	351		6.5	358	0.1%	3.6%		10.9	362	0.0%	1.2%
R6	351		4.7	356	0.0%	3.6%		10.8	362	0.0%	1.2%
R7	351		19.5	371	0.2%	3.7%		29.4	381	0.1%	1.3%
R8	355		8.6	364	0.1%	3.6%		14.9	370	0.0%	1.2%
R9	355		7.5	363	0.1%	3.6%		14.9	370	0.0%	1.2%
R10	355		8.6	364	0.1%	3.6%		14.7	370	0.0%	1.2%
R11	358		10.2	368	0.1%	3.7%		14.6	372	0.0%	1.2%
R12	358		11.0	369	0.1%	3.7%		15.1	373	0.1%	1.2%
R13	358		10.3	368	0.1%	3.7%		18.1	376	0.1%	1.3%
R14	356		18.7	375	0.2%	3.7%		26.7	383	0.1%	1.3%
R15	356		17.8	374	0.2%	3.7%		23.1	379	0.1%	1.3%
R16	356		14.1	370	0.1%	3.7%		20.3	376	0.1%	1.3%
R17	358		12.1	370	0.1%	3.7%		17.0	375	0.1%	1.2%
R18	356		13.8	370	0.1%	3.7%		20.3	376	0.1%	1.3%
R19	356		13.9	370	0.1%	3.7%		21.0	377	0.1%	1.3%
R20	356		19.6	376	0.2%	3.8%		23.0	379	0.1%	1.3%
R21	356		22.1	378	0.2%	3.8%		30.1	386	0.1%	1.3%
R22	351		25.4	377	0.3%	3.8%		44.2	396	0.1%	1.3%
R23	351		25.6	377	0.3%	3.8%		63.5	415	0.2%	1.4%
R24	351		15.0	366	0.2%	3.7%		54.4	406	0.2%	1.4%
R25	351		3.1	355	0.0%	3.5%		6.7	358	0.0%	1.2%
R26	356		15.1	371	0.2%	3.7%		20.6	377	0.1%	1.3%

Receptor ID	Baseline air quality level (µg/m³)	Maximum 8-hour running mean					Maximum 1-hour mean				
		EQS (µg/m³)	PC (µg/m³)	PEC (µg/m³)	PC/EQS (%)	PEC/EQS (%)	EQS (µg/m³)	PC (µg/m³)	PEC (µg/m³)	PC/EQS (%)	PEC/EQS (%)
R27	356		16.9	373	0.2%	3.7%		21.5	377	0.1%	1.3%
R28	356		17.7	374	0.2%	3.7%		23.1	379	0.1%	1.3%
R29	356		16.5	372	0.2%	3.7%		23.2	379	0.1%	1.3%
R30	356		14.0	370	0.1%	3.7%		21.9	378	0.1%	1.3%

Table 26: Results of detailed assessment at sensitive human receptor locations for annual mean and 1-hour mean (99.79th percentile) NO_2 predicted concentrations

Receptor ID	Annual mean						99.79th percentile of 1-hour mean					
	Baseline air quality level (µg/m³)	EQS (µg/m³)	PC (µg/m³)	PEC (µg/m³)	PC/EQS (%)	PEC/EQS (%)	EQS (µg/m³)	Baseline air quality level (µg/m³)	PC (µg/m³)	PEC (µg/m³)	PC/EQS (%)	PEC/EQS (%)
R1	14.3	40	0.5	14.8	1.2%	37.1%	200	28.7	3.0	31.7	1.5%	15.9%
R2	14.3		0.6	15.0	1.5%	37.4%		28.7	3.6	32.3	1.8%	16.2%
R3	12.9		0.7	13.6	1.7%	33.9%		25.8	3.8	29.6	1.9%	14.8%
R4	12.9		0.6	13.4	1.4%	33.6%		25.8	3.1	28.8	1.5%	14.4%
R5	12.9		0.1	12.9	0.1%	32.3%		25.8	1.4	27.2	0.7%	13.6%
R6	12.9		0.0	12.9	0.1%	32.3%		25.8	1.2	27.0	0.6%	13.5%
R7	12.9		0.2	13.1	0.5%	32.7%		25.8	4.1	29.8	2.0%	14.9%
R8	12.0		0.2	12.1	0.4%	30.4%		24.0	1.7	25.6	0.8%	12.8%
R9	12.0		0.2	12.1	0.4%	30.4%		24.0	1.7	25.7	0.9%	12.9%
R10	12.0		0.2	12.2	0.4%	30.4%		24.0	1.9	25.8	0.9%	12.9%
R11	13.6		0.2	13.8	0.5%	34.5%		27.2	2.5	29.8	1.3%	14.9%
R12	13.6		0.1	13.7	0.3%	34.4%		27.2	1.8	29.0	0.9%	14.5%
R13	13.6		0.1	13.8	0.3%	34.4%		27.2	2.2	29.4	1.1%	14.7%
R14	14.3		0.5	14.9	1.4%	37.2%		28.7	3.9	32.5	1.9%	16.3%
R15	14.3		0.7	15.0	1.7%	37.6%		28.7	3.4	32.1	1.7%	16.1%
R16	14.3		0.3	14.6	0.6%	36.5%		28.7	2.8	31.5	1.4%	15.7%
R17	13.6		0.2	13.8	0.4%	34.5%		27.2	2.3	29.6	1.2%	14.8%
R18	14.3		0.2	14.6	0.6%	36.5%		28.7	2.7	31.4	1.4%	15.7%
R19	14.3		0.2	14.5	0.5%	36.3%		28.7	2.8	31.5	1.4%	15.8%
R20	14.3		0.3	14.6	0.7%	36.5%		28.7	3.5	32.2	1.8%	16.1%
R21	14.3		0.4	14.7	0.9%	36.7%		28.7	4.9	33.6	2.5%	16.8%
R22	12.9		0.6	13.5	1.5%	33.7%		25.8	7.7	33.5	3.8%	16.7%
R23	12.9		1.1	14.0	2.9%	35.1%		25.8	11.9	37.6	5.9%	18.8%
R24	12.9		1.4	14.2	3.4%	35.6%		25.8	11.4	37.1	5.7%	18.6%
R25	12.9		0.1	13.0	0.2%	32.4%		25.8	2.1	27.9	1.1%	13.9%
R26	14.3		0.5	14.9	1.3%	37.2%		28.7	2.9	31.6	1.5%	15.8%

Receptor ID	Annual mean						99.79th percentile of 1-hour mean					
	Baseline air quality level (µg/m³)	EQS (µg/m³)	PC (µg/m³)	PEC (µg/m³)	PC/EQS (%)	PEC/EQS (%)	EQS (µg/m³)	Baseline air quality level (µg/m³)	PC (µg/m³)	PEC (µg/m³)	PC/EQS (%)	PEC/EQS (%)
R27	14.3		0.7	15.0	1.8%	37.6%		28.7	3.2	31.9	1.6%	16.0%
R28	14.3		0.8	15.2	2.0%	37.9%		28.7	3.4	32.1	1.7%	16.0%
R29	14.3		0.7	15.0	1.7%	37.5%		28.7	3.2	31.9	1.6%	16.0%
R30	14.3		0.5	14.9	1.3%	37.2%		28.7	3.0	31.7	1.5%	15.8%
R31 (AQMA)	-		0.1	-	0.2%	-		-				
R32 (AQMA)			0.1		0.2%							
R33 (AQMA)			0.1		0.3%							

Table 27: Results of detailed assessment at sensitive human receptor locations for 24-mean (99.18th percentile) and 1-hour mean (99.73rd percentile) SO_2 predicted concentrations

Receptor ID	99.18th percentile of 24-hour mean						99.73rd percentile of 1-hour mean					
	Baseline air quality level (µg/m³)	EQS (µg/m³)	PC (µg/m³)	PEC (µg/m³)	PC/EQS (%)	PEC/EQS (%)	EQS (µg/m³)	Baseline air quality level (µg/m³)	PC (µg/m³)	PEC (µg/m³)	PC/EQS (%)	PEC/EQS (%)
R1	12.1	125	2.5	14.5	2.0%	11.6%	350	12.1	6.2	18.3	1.8%	5.2%
R2	12.1		2.9	15.0	2.4%	12.0%		12.1	7.5	19.6	2.2%	5.6%
R3	10.1		3.4	13.5	2.8%	10.8%		10.1	7.7	17.7	2.2%	5.1%
R4	10.1		3.5	13.5	2.8%	10.8%		10.1	6.4	16.5	1.8%	4.7%
R5	10.1		0.8	10.9	0.7%	8.7%		10.1	3.0	13.0	0.8%	3.7%
R6	10.1		0.8	10.9	0.6%	8.7%		10.1	2.4	12.4	0.7%	3.6%
R7	10.1		2.6	12.7	2.1%	10.1%		10.1	8.4	18.5	2.4%	5.3%
R8	10.6		1.8	12.4	1.4%	9.9%		10.6	3.5	14.1	1.0%	4.0%
R9	10.6		1.5	12.1	1.2%	9.7%		10.6	3.6	14.2	1.0%	4.1%
R10	10.6		1.9	12.5	1.5%	10.0%		10.6	3.9	14.5	1.1%	4.1%
R11	11.5		2.3	13.8	1.8%	11.0%		11.5	5.6	17.1	1.6%	4.9%
R12	11.5		1.6	13.1	1.3%	10.5%		11.5	3.7	15.2	1.1%	4.3%
R13	11.5		2.1	13.6	1.7%	10.9%		11.5	4.6	16.1	1.3%	4.6%
R14	12.1		3.5	15.5	2.8%	12.4%		12.1	7.9	20.0	2.3%	5.7%
R15	12.1		4.4	16.5	3.5%	13.2%		12.1	7.2	19.2	2.0%	5.5%
R16	12.1		3.4	15.5	2.7%	12.4%		12.1	5.8	17.8	1.6%	5.1%
R17	11.5		3.1	14.6	2.5%	11.7%		11.5	4.8	16.3	1.4%	4.7%
R18	12.1		3.6	15.6	2.9%	12.5%		12.1	5.6	17.7	1.6%	5.1%
R19	12.1		2.8	14.9	2.3%	11.9%		12.1	5.8	17.9	1.7%	5.1%
R20	12.1		3.5	15.5	2.8%	12.4%		12.1	7.4	19.5	2.1%	5.6%
R21	12.1		4.6	16.7	3.7%	13.3%		12.1	10.0	22.0	2.9%	6.3%
R22	10.1		7.2	17.2	5.7%	13.8%		10.1	16.5	26.6	4.7%	7.6%
R23	10.1		14.5	24.5	11.6%	19.6%		10.1	26.9	36.9	7.7%	10.5%
R24	10.1		19.8	29.9	15.9%	23.9%		10.1	25.5	35.5	7.3%	10.1%
R25	10.1		1.8	11.9	1.5%	9.5%		10.1	4.8	14.8	1.4%	4.2%

Receptor ID	99.18th percentile of 24-hour mean						99.73rd percentile of 1-hour mean					
	Baseline air quality level (µg/m³)	EQS (µg/m³)	PC (µg/m³)	PEC (µg/m³)	PC/EQS (%)	PEC/EQS (%)	EQS (µg/m³)	Baseline air quality level (µg/m³)	PC (µg/m³)	PEC (µg/m³)	PC/EQS (%)	PEC/EQS (%)
R26	12.1		3.2	15.3	2.6%	12.2%		12.1	6.0	18.1	1.7%	5.2%
R27	12.1		4.5	16.5	3.6%	13.2%		12.1	6.7	18.8	1.9%	5.4%
R28	12.1		4.3	16.3	3.4%	13.1%		12.1	7.0	19.1	2.0%	5.5%
R29	12.1		3.1	15.2	2.5%	12.2%		12.1	6.6	18.6	1.9%	5.3%
R30	12.1		2.7	14.8	2.2%	11.8%		12.1	6.2	18.2	1.8%	5.2%

Table 28: Results of detailed assessment at sensitive human receptor locations for 15-minute mean (99.9th percentile) SO_2 predicted concentrations

Receptor ID	99.9th percentile of 15-minute mean					
	Baseline air quality level ($\mu g/m^3$)	EQS ($\mu g/m^3$)	PC ($\mu g/m^3$)	PEC ($\mu g/m^3$)	PC/EQS (%)	PEC/EQS (%)
R1	12.1	266	7.7	19.7	2.9%	7.4%
R2	12.1		14.2	26.3	5.3%	9.9%
R3	10.1		14.6	24.7	5.5%	9.3%
R4	10.1		7.7	17.7	2.9%	6.7%
R5	10.1		4.3	14.4	1.6%	5.4%
R6	10.1		3.8	13.8	1.4%	5.2%
R7	10.1		9.8	19.9	3.7%	7.5%
R8	10.6		4.8	15.4	1.8%	5.8%
R9	10.6		5.6	16.2	2.1%	6.1%
R10	10.6		5.8	16.4	2.2%	6.2%
R11	11.5		9.1	20.6	3.4%	7.8%
R12	11.5		5.7	17.2	2.1%	6.5%
R13	11.5		5.8	17.3	2.2%	6.5%
R14	12.1		9.6	21.7	3.6%	8.1%
R15	12.1		8.5	20.5	3.2%	7.7%
R16	12.1		7.6	19.6	2.9%	7.4%
R17	11.5		6.7	18.2	2.5%	6.8%
R18	12.1		7.5	19.6	2.8%	7.4%
R19	12.1		7.2	19.3	2.7%	7.3%
R20	12.1		9.4	21.5	3.5%	8.1%
R21	12.1		14.3	26.3	5.4%	9.9%
R22	10.1		22.8	32.9	8.6%	12.4%
R23	10.1		32.6	42.7	12.3%	16.0%
R24	**10.1**		27.7	37.8	10.4%	14.2%
R25	10.1		5.9	16.0	2.2%	6.0%
R26	12.1		7.7	19.7	2.9%	7.4%
R27	12.1		8.0	20.1	3.0%	7.6%

Receptor ID	99.9th percentile of 15-minute mean					
	Baseline air quality level (µg/m³)	EQS (µg/m³)	PC (µg/m³)	PEC (µg/m³)	PC/EQS (%)	PEC/EQS (%)
R28	12.1		8.3	20.3	3.1%	7.6%
R29	12.1		7.9	20.0	3.0%	7.5%
R30	12.1		7.5	19.6	2.8%	7.4%

Table 29: Results of detailed assessment at sensitive human receptor locations for annual mean and 24-hour mean (90.41st) percentile) PM_{10} predicted concentrations

Receptor ID	Annual mean						90.41st percentile of 24-hour mean					
	Baseline air quality level (µg/m³)	EQS (µg/m³)	PC (µg/m³)	PEC (µg/m³)	PC/EQS (%)	PEC/EQS (%)	EQS (µg/m³)	Baseline air quality level (µg/m³)	PC (µg/m³)	PEC (µg/m³)	PC/EQS (%)	PEC/EQS (%)
R1	11.8	40	0.012	11.8	0.0%	29.6%	50	23.7	0.03	23.7	0.1%	47.4%
R2	11.8		0.015	11.9	0.0%	29.6%		23.7	0.04	23.7	0.1%	47.4%
R3	12.0		0.017	12.0	0.0%	30.1%		24.0	0.05	24.1	0.1%	48.2%
R4	12.0		0.014	12.0	0.0%	30.1%		24.0	0.04	24.1	0.1%	48.2%
R5	12.0		0.001	12.0	0.0%	30.0%		24.0	0.00	24.0	0.0%	48.1%
R6	12.0		0.001	12.0	0.0%	30.0%		24.0	0.00	24.0	0.0%	48.1%
R7	12.0		0.005	12.0	0.0%	30.1%		24.0	0.02	24.1	0.0%	48.1%
R8	11.4		0.004	11.4	0.0%	28.5%		22.8	0.02	22.8	0.0%	45.7%
R9	11.4		0.004	11.4	0.0%	28.5%		22.8	0.02	22.8	0.0%	45.7%
R10	11.4		0.004	11.4	0.0%	28.5%		22.8	0.02	22.8	0.0%	45.7%
R11	11.8		0.005	11.8	0.0%	29.5%		23.6	0.02	23.6	0.0%	47.2%
R12	11.8		0.003	11.8	0.0%	29.5%		23.6	0.01	23.6	0.0%	47.2%
R13	11.8		0.003	11.8	0.0%	29.5%		23.6	0.01	23.6	0.0%	47.2%
R14	11.8		0.014	11.9	0.0%	29.6%		23.7	0.05	23.7	0.1%	47.4%
R15	11.8		0.017	11.9	0.0%	29.6%		23.7	0.05	23.7	0.1%	47.4%
R16	11.8		0.006	11.8	0.0%	29.6%		23.7	0.02	23.7	0.0%	47.4%
R17	11.8		0.004	11.8	0.0%	29.5%		23.6	0.01	23.6	0.0%	47.2%
R18	11.8		0.006	11.8	0.0%	29.6%		23.7	0.02	23.7	0.0%	47.4%
R19	11.8		0.005	11.8	0.0%	29.6%		23.7	0.02	23.7	0.0%	47.4%
R20	11.8		0.007	11.8	0.0%	29.6%		23.7	0.03	23.7	0.1%	47.4%
R21	11.8		0.009	11.8	0.0%	29.6%		23.7	0.04	23.7	0.1%	47.4%
R22	12.0		0.017	12.0	0.0%	30.1%		24.0	0.06	24.1	0.1%	48.2%
R23	12.0		0.033	12.1	0.1%	30.1%		24.0	0.13	24.2	0.3%	48.3%
R24	12.0		0.039	12.1	0.1%	30.1%		24.0	0.17	24.2	0.3%	48.4%
R25	12.0		0.002	12.0	0.0%	30.1%		24.0	0.01	24.0	0.0%	48.1%
R26	11.8		0.013	11.8	0.0%	29.6%		23.7	0.04	23.7	0.1%	47.4%

Receptor ID	Annual mean						90.41st percentile of 24-hour mean					
	Baseline air quality level (µg/m³)	EQS (µg/m³)	PC (µg/m³)	PEC (µg/m³)	PC/EQS (%)	PEC/EQS (%)	EQS (µg/m³)	Baseline air quality level (µg/m³)	PC (µg/m³)	PEC (µg/m³)	PC/EQS (%)	PEC/EQS (%)
R27	11.8		0.018	11.9	0.0%	29.6%		23.7	0.05	23.7	0.1%	47.4%
R28	11.8		0.021	11.9	0.1%	29.6%		23.7	0.06	23.7	0.1%	47.5%
R29	11.8		0.016	11.9	0.0%	29.6%		23.7	0.05	23.7	0.1%	47.4%
R30	11.8		0.013	11.8	0.0%	29.6%		23.7	0.04	23.7	0.1%	47.4%

Table 30: Results of detailed assessment at sensitive human receptor locations for annual mean $PM_{2.5}$ predicted concentrations

Receptor ID	Annual mean					
	Baseline air quality level ($\mu g/m^3$)	EQS ($\mu g/m^3$)	PC ($\mu g/m^3$)	PEC ($\mu g/m^3$)	PC/EQS (%)	PEC/EQS (%)
R1	7.8	25	0.012	7.8	0.0%	31.4%
R2	7.8		0.015	7.9	0.1%	31.4%
R3	7.6		0.017	7.6	0.1%	30.5%
R4	7.6		0.014	7.6	0.1%	30.5%
R5	7.6		0.001	7.6	0.0%	30.5%
R6	7.6		0.001	7.6	0.0%	30.5%
R7	7.6		0.005	7.6	0.0%	30.5%
R8	7.4		0.004	7.4	0.0%	29.6%
R9	7.4		0.004	7.4	0.0%	29.6%
R10	7.4		0.004	7.4	0.0%	29.6%
R11	7.8		0.005	7.8	0.0%	31.4%
R12	7.8		0.003	7.8	0.0%	31.4%
R13	7.8		0.003	7.8	0.0%	31.4%
R14	7.8		0.014	7.8	0.1%	31.4%
R15	7.8		0.017	7.9	0.1%	31.4%
R16	7.8		0.006	7.8	0.0%	31.4%
R17	7.8		0.004	7.8	0.0%	31.4%
R18	7.8		0.006	7.8	0.0%	31.4%
R19	7.8		0.005	7.8	0.0%	31.4%
R20	7.8		0.007	7.8	0.0%	31.4%
R21	7.8		0.009	7.8	0.0%	31.4%
R22	7.6		0.017	7.6	0.1%	30.5%
R23	7.6		0.033	7.6	0.1%	30.6%
R24	7.6		0.039	7.7	0.2%	30.6%
R25	7.6		0.002	7.6	0.0%	30.5%
R26	7.8		0.013	7.8	0.1%	31.4%
R27	7.8		0.018	7.9	0.1%	31.4%

Receptor ID	Annual mean					
	Baseline air quality level ($\mu g/m^3$)	EQS ($\mu g/m^3$)	PC ($\mu g/m^3$)	PEC ($\mu g/m^3$)	PC/EQS (%)	PEC/EQS (%)
R28	7.8		0.021	7.9	0.1%	31.4%
R29	7.8		0.016	7.9	0.1%	31.4%
R30	7.8		0.013	7.8	0.1%	31.4%

Table 31: Results of detailed assessment at sensitive human receptor locations for annual mean and maximum 1-hour mean TVOC predicted concentrations

Receptor ID	Annual mean						100th percentile of 1-hour mean					
	Baseline air quality level (µg/m³)	EQS (µg/m³)	PC (µg/m³)	PEC (µg/m³)	PC/EQS (%)	PEC/EQS (%)	EQS (µg/m³)	Baseline air quality level (µg/m³)	PC (µg/m³)	PEC (µg/m³)	PC/EQS (%)	PEC/EQS (%)
R1	n/a		2.1	n/a			n/a		30.3	n/a		
R2			2.7						57.3			
R3			3.0						58.7			
R4			2.5						38.8			
R5			0.2						18.4			
R6			0.2						17.6			
R7			1.0						41.1			
R8			0.7						20.1			
R9			0.7						20.4			
R10			0.7						27.8			
R11			0.9						48.0			
R12			0.6						28.4			
R13			0.6						26.2			
R14			2.7						35.7			
R15			3.3						32.8			
R16			1.2						30.4			
R17			0.8						27.0			
R18			1.1						30.3			
R19			0.9						31.2			
R20			1.3						59.6			
R21			1.8						80.1			
R22			3.5						107.0			
R23			7.2						178.6			
R24			8.7						181.9			
R25			0.5						75.3			
R26			2.4						30.1			

Receptor ID	Annual mean						100th percentile of 1-hour mean					
	Baseline air quality level (µg/m³)	EQS (µg/m³)	PC (µg/m³)	PEC (µg/m³)	PC/EQS (%)	PEC/EQS (%)	EQS (µg/m³)	Baseline air quality level (µg/m³)	PC (µg/m³)	PEC (µg/m³)	PC/EQS (%)	PEC/EQS (%)
R27			3.4						31.0			
R28			3.9						32.2			
R29			3.0						30.4			
R30			2.4						31.6			