Environmental Permit Application - Burnley Wastewater Treatment Works

Air Quality Impact Assessment

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United Utilities Water Limited

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Executive Summary

Under the Industrial Emissions Directive (IED) the treatment of sewage sludge by anaerobic digestion at Burnley Wastewater Treatment Works (WwTW), requires an Environmental Permit. The scope of the permitted anaerobic digestion treatment activities includes all directly associated activities such as sludge screening and thickening and combined heat and power (CHP) gas engine and boiler.

United Utilities Water Limited operates a wastewater treatment centre at the Burnley WwTW located near the outskirts of the town of Burnley, Lancashire (BB12 9DS). These operations include an existing Combined Heat and Power engine (thermal input capacity of 1.6 MW_{th}) combusting biogas and a gas oil fuelled boiler (with a thermal input capacity of 1.3 MW_{th}).

The Air Quality Impact Assessment presented within this report is required to support the Environmental Permit application and assesses the potential for significant air quality effects from the operation of the CHP engine and boiler at the Burnley WwTW Sludge Treatment Facility.

Combustion Plant

The CHP engine is anticipated to operate for the full year and the boiler is only likely to operate when the process heat demands cannot be met when using the CHP engine. However, for this assessment the boiler has been assumed to operate for the full year (i.e. 8,760 hours).

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' and 'insignificant', respectively, as per Environment Agency guidance (Environment Agency, 2021). For short-term NO_2 concentrations at modelled off-site locations and sensitive human receptor locations, the contributions are considered 'insignificant' and 'not significant', respectively. For all predicted short-term PM_{10} and CO concentrations, the contributions are considered 'insignificant'. For 24-hour mean SO_2 concentrations, the contributions are considered 'insignificant'. For all remaining short-term SO_2 concentrations at modelled grid off-site locations and sensitive human receptor locations, the contributions are considered 'insignificant'.

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

Protected conservation areas

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

For annual mean SO_2 concentrations predicted at the assessed European designated sites, the annual mean SO_2 PCs are less than 1% of the relevant long-term environmental standard and their impact can be described as 'insignificant'. For the local nature sites, the respective PCs are less than 100% of the relevant long-term environmental standard and the impact can be described as 'insignificant'.

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

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

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

Summary

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

1. Introduction

1.1 Background

Under the Industrial Emissions Directive (IED) the treatment of sewage sludge by anaerobic digestion at Burnley Wastewater Treatment Works (WwTW), requires an Environmental Permit. The scope of the permitted anaerobic digestion activities includes all directly associated activities such as sludge screening and thickening and combined heat and power (CHP) gas engine and boiler.

United Utilities Water Limited (hereafter 'UUW') currently operates one biogas fuelled JMC 312 GS-BL CHP engine (thermal input capacity of 1.6 MW_{th}) and one Cambi gas oil fuelled boiler (with a thermal input of 1.3 MW_{th}) at its sludge treatment facility at Burnley WwTW on the outskirts of the town of Burnley, Lancashire (BB12 9DS) (hereafter 'the site'). Jacobs UK Limited (hereafter 'Jacobs') has carried out an Air Quality Impact Assessment (AQIA) on behalf of UUW to assess the potential impact of emissions from the CHP engine and boiler.

1.2 Study Outline

This AQIA is required to support the Environmental Permit (EP) application and assesses the likely significant air quality effects of emissions to air from the CHP engine and boiler (supplying 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, 2020; 2021). 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 WwTW site boundary (represented by the approximate site fence line) is presented in Figure 1.

This report draws upon information provided from the following parties:

- UUW;
- ADM Ltd;
- Department for Environment, Food and Rural Affairs (Defra); and
- Burnley Borough Council (BBC).

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.

2. Emission Sources

2.1 Emission Sources to Air

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

The CHP engine is fuelled by biogas generated from the site's anaerobic digestion process. The boiler is a dual fuel design and can run on biogas but has only ever been run on gas oil. The biogas feed line is locked off, the emissions were modelled on this basis. The modelling only considers emissions from the CHP engine 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	**JMC 312 GS-BL CHP engine (1.6 MW_{th})**	**Cambi boiler (1.3 MW_{th})**
Fuel	Biogas	Gas oil
Emission point	A1	A2

This assessment has been carried out on the assumption that the CHP engine and boiler will operate continuously at maximum load throughout the year. This is a conservative assumption as in practice, the boiler will have periods of shut-down 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[1] (Schedule 25A of the Environmental Permitting (England and Wales) (Amendment) Regulations 2018. Where practicable, the emission concentration limits stated in the MCPD[1] have been applied in this assessment as a conservative approach to the assessment.

For the CHP engine, 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 engine 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 emission concentration is based on the emission limit values for existing medium combustion plants other than engines and gas turbines as regulated under the MCPD. The SO_2 emission concentrations have been derived based on the fuel consumption and the sulphur content of the diesel fuel of 0.1%. For CO, 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).

The temperatures of the CHP engine and boiler were obtained from the spec sheet provided for the Jenbacher engine (Jenbacher, 2006) and Cambi boiler (Besa Santangelo, 2015). For the boiler, the exhaust gas volumetric

[1] 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.

flow was determined using stoichiometric calculations based on the combustion gas oil fuel at the maximum thermal input rating of the boiler. For the CHP engine, it was obtained from the technical specification sheet provided for the Jenbacher engine (Jenbacher, 2013). In the absence of information regarding oxygen and moisture content of the CHP engine and boiler, the data used in the model is based on professional judgment acquired from previous work involving biogas fuelled boilers of a similar size. The emissions inventory of releases to air from the CHP engine and boiler are provided in Appendix A.

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, 16 of the closest sensitive human receptors (such as residential properties, schools, residential care homes and public footpaths) near the site were identified for modelling purposes. The location of these receptors is presented in Figure 2.

In line with the Environment Agency guidance *Air emissions risk assessment for your environmental permit* (Environment Agency, 2020), 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 two European sites were assessed; South Pennine Moors Phase 2 SPA and South Pennine Moors SAC.

The following sites have also been identified within 2km and included in the assessment: Spurn Clough LWS, Moor Isles Clough LWS, Hagg Wood Ancient Woodland and Hagg Wood LWS, Ancient Woodland ID 1413047, Ancient Woodland ID1413046, West Close Clough and Upper Fir Trees Brook, Raven's Clough Wood Ancient Woodland and LWS, Spring Wood Ancient Woodland and LWS, Ancient Woodland ID 1413040, Oswald Street LWS, Heald Wood LWS, Barden Fields LWS, Roundwood Swamp Meadows and Swamp LWS and Leeds/Liverpool Canal Section Old Hall to M65 junction 12 LWS.

As discussed above, some of the assessed protected conservation areas encompass the same geographic area. However, for completeness, these protected conservation areas are assessed individually where relevant. 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, 2020).

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

1) Information on plant location and stack parameters were supplied by UUW (United Utilities, 2021). Information on the CHP engine and the boiler were obtained from various other sources as described in Section 2.2.
2) Five years of Numerical Weather Predication (NWP) data (2016 – 2020 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 engine and boiler stack were estimated from Defra's environmental open-data applications and datasets (Defra, 2020a) and Google Earth (Google Earth, 2020).

4) The maximum predicted concentrations (at a modelled height of 1.5 m or 'breathing zone') at the assessed sensitive human receptor locations R1 – R10 (representing long-term exposure at residential properties) 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 R11 – R16 (representing footpaths and a bridleway), 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.

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, 2020) document to determine the nature and extent of any potential adverse effects.

8) Modelled concentrations were processed using geographic information system (GIS) software (ArcMap 10.6.1) 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 1) 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, 2020) 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 (µg/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' (Environment Agency, 2021);
- 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 NO2 concentrations, and the 15-minute, 1-hour and 24-hour mean SO2 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 (Environment Agency, 2021);

- 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, 2020).

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, 2020).

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

Pollutant	EQS (µg/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, 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 sites, 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

Receptor 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
H1	South Pennine Moors Phase 2 SPA	Raised and blanket bogs	Short	1.60	0.40	2.00	5
H2	South Pennine Moors SAC	Raised and blanket bogs	Short	0.40	0.30	0.70	5
		Acidophilous Quercus-dominated woodland	Tall	3.00	0.40	3.30	10
H3	Spurn Clough LWS	Acid Grassland	Short	1.61	0.44	2.05	5
		Broadleaved, deciduous woodland	Tall	2.78	0.36	3.13	10
H4	Moor Isles Clough LWS	Acid Grassland	Short	1.61	0.44	2.05	5
		Broadleaved, deciduous woodland	Tall	2.78	0.36	3.13	10
H5	Hagg Wood (ID 1102721) Ancient Woodland and Hagg Wood LWS	Acid Grassland	Short	1.620	0.438	2.058	5
		Broadleaved, deciduous woodland	Tall	2.834	0.357	3.191	10
H6	Ancient Woodland (ID 1413047), Ancient Woodland (ID 1413046) and West Close Clough and Upper Fir Trees Brook	Acid Grassland	Short	No critical loads available			5
		Broadleaved, deciduous woodland	Tall				10
H7	Raven's Clough Wood (ID 1102723) Ancient Woodland and Raven's Clough Wood LWS	Acid Grassland	Short	1.610	0.438	2.058	5
		Broadleaved, deciduous woodland	Tall	2.778	0.357	3.135	10
H8	Spring Wood (ID 1413041) Ancient Woodland and Spring Wood LWS	Acid Grassland	Short	1.620	0.438	2.058	5
		Broadleaved, deciduous woodland	Tall	2.831	0.357	3.188	10
H9	Ancient Woodland (ID 1413040)	Acid Grassland	Short	1.620	0.438	2.058	5
		Broadleaved, deciduous woodland	Tall	2.831	0.357	3.188	10
H10	Oswald Street LWS	Acid Grassland	Short	1.620	0.438	2.058	5
		Broadleaved, deciduous woodland	Tall	2.831	0.357	3.188	10
H11	Heald Wood LWS	Acid Grassland	Short	1.620	0.438	2.058	5
		Broadleaved, deciduous woodland	Tall	2.831	0.357	3.188	10
H12	Barden Lane Fields LWS	Acid Grassland	Short	1.610	0.438	2.048	5
		Broadleaved, deciduous woodland	Tall	2.775	0.357	3.132	10
H13	Roundwood Swamp Meadows and Swamp LWS	Acid Grassland	Short	1.610	0.438	2.048	5
		Broadleaved, deciduous woodland	Tall	2.775	0.357	3.132	10

Receptor 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
H14a	Leeds/Liverpool Canal Section Old Hall St to M65 junction 12	Acid Grassland	Short	1.620	0.438	2.058	5
		Broadleaved, deciduous woodland	Tall	2.831	0.357	3.188	10
H14b		Acid Grassland	Short	1.610	0.438	2.048	5
		Broadleaved, deciduous woodland	Tall	2.782	0.357	3.139	10
H14c		Acid Grassland	Short	1.610	0.438	2.048	5
		Broadleaved, deciduous woodland	Tall	2.781	0.357	3.138	10

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, 2020).

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

With regard to concentrations at the assessed designated habitat site, the Environment Agency guidance (Environment Agency, 2020) 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, 2020) summarised as follows.

- 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. ancient woodlands and local wildlife sites)

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, 2020) 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 3.3 km north northwest from the centre of the town of Burnley, Lancashire. The area surrounding the site generally comprises a mixture of residential and commercial land use. The M65 is approximately 0.4 km east of the site at its closest point.

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 1. The nearest modelled residential property is approximately 0.19 km northeast of the CHP engine (based on the stack location NGR E 382712 N 435280). The nearest modelled receptor is a footpath approximately 0.17 km southwest of the site 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, 2020b) website could be used to represent background concentrations of the relevant pollutants in the vicinity of the site.

There are no Air Quality Management Areas (AQMA) in the Burnley Borough Council (BBC) administrative area. The nearest AQMA is in Pendle Borough Council and is approximately 8.5 km northeast of the site, it is therefore not considered further in this assessment.

BBC 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 (Burnley Borough Council, 2019) was reviewed to determine the concentrations of NO_2 and PM_{10} in the vicinity of the site. It should be noted none of the other assessed pollutants are monitored by BBC.

BBC does not undertake automatic (continuous) monitoring at any locations. The nearest non-automatic monitoring locations (i.e. a NO_2 diffusion tube) to the site are three roadside locations; Site ID: DT10, NGR E 384676 N 435106 adjacent to the A682 and situated approximately 2.0 km east of the assessed CHP engine, Site ID: DT31, NGR E 384558 N 433911 near the A682 and situated approximately 2.3 km east-southeast of the assessed CHP engine and DT46, NGR E 384290 N 433609 near the A682 and situated approximately 2.3 km east southeast of the assessed CHP engine. In 2019, annual mean NO_2 concentrations of 32 µg/m^3, 34.6 µg/m^3 and 31.2 µg/m^3 were recorded at these locations, respectively. These monitoring locations are not considered representative of the site due to their close proximity to major roads.

For the assessed pollutants, information on background air quality in the vicinity of the site was obtained from Defra background map datasets (Defra, 2020b). 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 5. 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 on 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,2020b), respectively, and are displayed in Table 5. The concentrations for the individual assessment locations are displayed in the results tables (Table 8 – Table 10).

Table 5: Background concentrations: adopted for use in assessment for human receptors and protected conservation areas

Pollutant	Annual mean concentration ($\mu g/m^3$)	Description
Human receptors		
NO_2	7.7 – 11.9	Defra 1 km x 1 km background map value for the assessed sensitive human receptor locations, 2021 map concentration
CO	124.4 – 149.9	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}	9.2 – 10.6	Defra 1 km x 1 km background map value for the assessed sensitive human receptor locations, 2021 map concentration
$PM_{2.5}$	6.3 – 7.2	Defra 1 km x 1 km background map value for the assessed sensitive human receptor locations, 2021 map concentration
SO_2	3.5 – 3.9	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	8.2 – 16.8	Defra 1 km x 1 km background map value for the assessed protected conservation areas, 2021 map concentration
SO_2	3.5 – 4.5	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, 2020).

4.3 Existing Deposition Rates

Existing acid and nutrient nitrogen deposition levels were obtained from APIS (Centre for Ecology and Hydrology, 2020). 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 6.

Table 6: 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
H1	South Pennine Moors Phase 2 SPA	Short	1.80	0.30	24.78
H2	South Pennine Moors SAC	Short	1.80	0.30	24.78
		Tall	2.60	0.40	36.40
H3	Spurn Clough LWS	Short	1.82	0.29	25.48
		Tall	2.77	0.35	38.78
H4	Moor Isles Clough LWS	Short	1.82	0.29	25.48
		Tall	2.77	0.35	38.78
H5	Hagg Wood (ID 1102721) Ancient Woodland and Hagg Wood LWS	Short	1.79	0.33	25.06
		Tall	2.68	0.37	37.52
H6	Ancient Woodland (ID 1413047), Ancient Woodland (ID 1413046) and West Close Clough and Upper Fir Trees Brook	Short	1.82	0.29	25.48
		Tall	2.77	0.35	38.78
H7	Raven's Clough Wood (ID 1102723) Ancient Woodland and Raven's Clough Wood LWS	Short	1.82	0.29	25.48
		Tall	2.77	0.35	38.78
H8	Spring Wood (ID 1413041) Ancient Woodland and Spring Wood LWS	Short	1.79	0.33	25.06
		Tall	2.68	0.37	37.52
H9	Ancient Woodland (ID 1413040)	Short	1.79	0.33	25.06
		Tall	2.68	0.37	37.52
H10	Oswald Street LWS	Short	1.79	0.33	25.06
		Tall	2.68	0.37	37.52
H11	Heald Wood LWS	Short	1.79	0.33	25.06
		Tall	2.68	0.37	37.52
H12	Barden Lane Fields LWS	Short	1.82	0.29	25.48
		Tall	2.77	0.35	38.78
H13	Roundwood Swamp Meadows and Swamp LWS	Short	1.82	0.29	25.48
		Tall	2.77	0.35	38.78
H14a	Leeds/Liverpool Canal Section Old Hall St to M65 junction 12 LWS	Short	1.79	0.33	25.06
		Tall	2.68	0.37	37.52
H14b		Short	1.82	0.29	25.48
		Tall	2.77	0.35	38.78
H14c		Short	1.82	0.29	25.48
		Tall	2.77	0.35	38.78

5. Results

5.1 Human Receptors

The results presented below are the maximum modelled concentrations predicted at any of the 16 assessed sensitive human receptor locations 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 7, 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 7: Results of detailed assessment

Pollutant	Averaging period	Assessment location	Maximum receptor	EQS (µg/m^3)	Baseline air quality level (µg/m^3)	PC (µg/m^3)	PEC (µg/m^3)	PC / EQS (%)	PEC / EQS (%)	PC as a percentage of headroom (%)
CO	Maximum 8-hour running mean	Sensitive locations	1	10,000	262	53.2	315.5	0.5%	3.2%	0.5%
	Maximum 1-hour mean	Maximum off-site	-	30,000	262	163.7	425.9	0.5%	1.4%	0.6%
		Sensitive locations	R14	30,000	262	78.8	341.1	0.3%	1.1%	0.3%
NO_2	Annual mean	Sensitive locations	R1	40	17.5	1.2	10.0	3.0%	24.9%	3.8%
	1-hour mean (99.79th percentile)	Maximum off-site	-	200	17.5	10.9	19.7	5.5%	9.8%	5.7%
		Sensitive locations	R14	200	17.5	10.0	27.5	5.0%	13.8%	5.5%
SO_2	24-hour mean (99.18th percentile)	Sensitive locations	R1	125	7.8	10.2	18.0	8.1%	14.4%	8.7%
	1-hour mean (99.73rd percentile)	Maximum off-site	-	350	7.8	22.1	29.9	6.3%	8.5%	6.4%
		Sensitive locations	R14	350	7.8	19.9	27.7	5.7%	7.9%	5.8%
	15-minute mean (99.9th percentile)	Maximum off-site	-	266	7.8	25.2	33.0	9.5%	12.4%	9.8%
		Sensitive locations	R14	266	7.8	23.3	31.1	8.7%	11.7%	9.0%
PM_{10}	Annual mean	Sensitive locations	R1	40	9.2	0.14	9.3	0.4%	23.3%	0.5%
	24-hour mean (90.41st percentile)	Sensitive locations	R1	50	18.3	0.5	18.8	1.0%	37.7%	1.6%
$PM_{2.5}$	Annual mean	Sensitive locations	R1	25	6.3	0.14	6.4	0.58%	25.6%	0.8%
TVOC	Annual mean	Sensitive locations	R1	n/a		2.4	n/a			
	Maximum 1-hour mean	Maximum off-site	-			115.8				
		Sensitive locations	R14			50.4				

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, R11 – R16 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 7 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 7 indicates the maximum PC for annual mean NO_2 at a sensitive human receptor location is 1.2 µg/m^3 (equating to 3% of the relevant EQS), predicted at R1, which represents a residential property approximately 0.19 km north-northeast 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. 24.9%) and the impact can be classed as 'not significant'.

For the assessment of 1-hour mean (99.79th percentile) NO_2 concentrations at a sensitive human receptor location, the maximum PC of 10.0 µg/m^3 (which equates to 5.0% of the relevant EQS) is predicted at R14 which, represents a footpath approximately 0.17 km north-northeast of the modelled CHP engine. As the PC is less than 10% of the short-term EQS, as per Environment Agency guidance (Environment Agency, 2021 the effect is considered 'insignificant'. For the assessment of 1-hour mean (99.79th percentile) NO_2 concentrations at the modelled grid off-site locations, the maximum PC is 10.9 µg/m^3, which equates to 5.5% of the relevant EQS. As the PC is less than 10% of the EQS, this impact can be described as 'insignificant'.

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'. For 24-hour mean (90.41st percentile) PM_{10} concentrations, the PC is less than 10% of the relevant short-term EQS (i.e. 1%) and its impact can be described as 'insignificant'.

For short-term CO concentrations at both sensitive human receptor locations and the modelled grid off-site locations, the respective PCs are less than 10% of the relevant short-term EQS and their impact is considered 'insignificant'.

For 24-hour mean (99.18th percentile) SO_2 concentrations at sensitive human receptor locations, the highest PC (predicted at R1) is less than 10% of the relevant EQS (i.e. 8.1%) and can be classed as 'insignificant'.

For 1-hour mean (99.73rd percentile) SO_2 concentrations at sensitive human receptor locations, the maximum PC of 19.9 µg/m^3 is predicted at R14 (representing a footpath receptor). This equates to less than 10% of the relevant EQS and can be classed as 'insignificant'. For 1-hour mean (99.73rd percentile) SO_2 concentrations at a modelled off-site location, the highest off-site concentration is 22.1 µg/m^3 which equates to 6.3% of the relevant EQS. This is less than 10% of the relevant EQS and can be classed as 'insignificant'.

For 15-minute mean (99.9th percentile) SO_2 concentrations at sensitive human receptor locations, the maximum PC of 23.3 µg/m^3 is predicted at R14 representing a footpath receptor. This equates to less than 10% of the relevant EQS and can be classed as 'insignificant'. For 15-minute mean (99.9th percentile) SO_2 concentrations at a modelled off-site location, the highest off-site concentration is 25.2 µg/m^3 which equates to 9.5% of the relevant EQS. The PC is less than 10% of the relevant EQS and can be classed as 'insignificant'.

For annual mean TVOC concentrations at sensitive human receptor locations, the highest PC of 2.4 µg/m^3 is predicted at R1. For maximum 1-hour mean TVOC concentrations at a modelled off-site location, the highest PC of 115.8 µg/m^3 was predicted at NGR E 382213 N 435512, which is situated near a river, to the northwest of the boundary of the site. At a sensitive human receptor location, the maximum 1-hour mean TVOC concentration of 50.4 µg/m^3 was predicted at R14. 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 7 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, due to the conservative approach adopted throughout the assessment including the assumed operational hours of the plant and modelled emission concentrations, the predicted concentrations presented in Table 7 are likely to be higher than would reasonably be expected.

A contour plot (see Figures 4) has been produced for. annual mean NO_2 concentrations, as the annual mean PC was greater than 1% of the EQS, the figure is based on the year of meteorological data which resulted in the highest PC at a sensitive human receptor 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 8 to Table 10. 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 8: Results of detailed assessment at assessed protected conservation sites for annual mean NOx concentrations

Ref	Protected Conservation Area	EQS (µg/m³)	Background concentration (µg/m³)	PC (µg/m³)	PEC (µg/m³)	PC/EQS (%)	PEC/EQS (%)
H1	South Pennine Moors Phase 2 SPA	30	8.2	0.012	8.2	0.04%	27.4%
H2	South Pennine Moors SAC		8.2	0.012	8.2	0.04%	27.4%
H3	Spurn Clough LWS		11.4	0.953	12.3	3.2%	41.1%
H4	Moor Isles Clough LWS		11.4	0.723	12.1	2.4%	40.4%
H5	Hagg Wood (ID 1102721) Ancient Woodland and Hagg Wood LWS		10.2	0.081	10.2	0.3%	34.1%
H6	Ancient Woodland (ID 1413047), Ancient Woodland (ID 1413046) and West Close Clough and Upper Fir Trees Brook		9.7	0.038	9.7	0.1%	32.3%
H7	Raven's Clough Wood (ID 1102723) Ancient Woodland and Raven's Clough Wood LWS		12.8	0.056	12.8	0.2%	42.8%
H8	Spring Wood (ID 1413041) Ancient Woodland and Spring Wood LWS		15.8	0.097	15.9	0.3%	53.0%
H9	Ancient Woodland (ID 1413040)		15.8	0.082	15.9	0.3%	52.9%
H10	Oswald Street LWS		15.8	0.047	15.8	0.2%	52.8%
H11	Heald Wood LWS		15.8	0.219	16.0	0.7%	53.4%
H12	Barden Lane Fields LWS		14.5	0.259	14.7	0.9%	49.1%
H13	Roundwood Swamp Meadows and Swamp LWS		14.5	0.358	14.8	1.2%	49.4%
H14a	Leeds/Liverpool Canal Section Old Hall St to M65 junction 12		15.8	0.129	15.9	0.4%	53.1%
H14b			14.1	0.192	14.3	0.6%	47.5%
H14c			16.8	0.090	16.9	0.3%	56.2%

Table 9: 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 (%)
H1	South Pennine Moors Phase 2 SPA	75	16.4	0.18	16.6	0.2%	22.2%
H2	South Pennine Moors SAC		16.4	0.18	16.6	0.2%	22.2%
H3	Spurn Clough LWS		22.8	10.8	33.6	14.4%	44.8%
H4	Moor Isles Clough LWS		22.8	10.2	33.0	13.6%	44.0%
H5	Hagg Wood (ID 1102721) Ancient Woodland and Hagg Wood LWS		20.3	1.39	21.7	1.9%	29.0%
H6	Ancient Woodland (ID 1413047), Ancient Woodland (ID 1413046) and West Close Clough and Upper Fir Trees Brook		19.3	0.73	20.1	1.0%	26.7%
H7	Raven's Clough Wood (ID 1102723) Ancient Woodland and Raven's Clough Wood LWS		25.6	0.60	26.1	0.8%	34.9%
H8	Spring Wood (ID 1413041) Ancient Woodland and Spring Wood LWS		31.6	1.78	33.4	2.4%	44.5%
H9	Ancient Woodland (ID 1413040)		31.6	1.57	33.2	2.1%	44.2%
H10	Oswald Street LWS		31.6	0.91	32.5	1.2%	43.3%
H11	Heald Wood LWS		31.6	2.20	33.8	2.9%	45.0%
H12	Barden Lane Fields LWS		29.0	1.94	30.9	2.6%	41.2%
H13	Roundwood Swamp Meadows and Swamp LWS		29.0	3.97	32.9	5.3%	43.9%
H14a	Leeds/Liverpool Canal Section Old Hall St to M65 junction 12		31.6	1.64	33.2	2.2%	44.3%
H14b			28.1	1.20	29.3	1.6%	39.1%
H14c			33.5	1.42	35.0	1.9%	46.6%

Table 10: Results of detailed assessment at assessed protected conservation sites for annual mean SO_2 concentrations

Ref	Protected Conservation Area	EQS (µg/m³)	Background concentration (µg/m³)	PC (µg/m³)	PEC (µg/m³)	PC/EQS (%)	PEC/EQS (%)
H1	South Pennine Moors Phase 2 SPA	10	3.5	0.01	3.5	0.1%	35.3%
H2	South Pennine Moors SAC		3.5	0.01	3.5	0.1%	35.3%
H3	Spurn Clough LWS		3.9	0.68	4.6	6.8%	45.9%
H4	Moor Isles Clough LWS		3.9	0.52	4.4	5.2%	44.3%
H5	Hagg Wood (ID 1102721) Ancient Woodland and Hagg Wood LWS		3.7	0.06	3.8	0.6%	37.6%
H6	Ancient Woodland (ID 1413047), Ancient Woodland (ID 1413046) and West Close Clough and Upper Fir Trees Brook		3.6	0.03	3.6	0.3%	35.8%
H7	Raven's Clough Wood (ID 1102723) Ancient Woodland and Raven's Clough Wood LWS		3.9	0.04	3.9	0.4%	38.9%
H8	Spring Wood (ID 1413041) Ancient Woodland and Spring Wood LWS		3.9	0.07	3.9	0.7%	39.4%
H9	Ancient Woodland (ID 1413040)		3.9	0.06	3.9	0.6%	39.3%
H10	Oswald Street LWS		3.9	0.03	3.9	0.3%	39.0%
H11	Heald Wood LWS		3.9	0.16	4.0	1.6%	40.3%
H12	Barden Lane Fields LWS		3.9	0.19	4.1	1.9%	41.0%
H13	Roundwood Swamp Meadows and Swamp LWS		3.9	0.26	4.2	2.6%	41.7%
H14a	Leeds/Liverpool Canal Section Old Hall St to M65 junction 12		3.9	0.09	4.0	0.9%	39.6%
H14b			3.9	0.14	4.0	1.4%	40.4%
H14c			4.5	0.06	4.6	0.6%	45.9%

The results in Table 8 and Table 10 indicate that at the assessed European designated sites, 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'. For the assessed local nature sites, the 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 9 indicate that at the assessed European designated sites, 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 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 engine 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, 2020). Further information on the assessment of deposition is provided in Appendix B. The full detailed modelled results are displayed in Table 11 and Table 12.

Table 11: 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(%)
H1	South Pennine Moors Phase 2 SPA	Short	1.600	0.400	2.000	1.8	0.3	0.001	2.1	0.1%	105%
H2	South Pennine Moors SAC	Short	0.400	0.300	0.700	1.8	0.3	0.001	2.1	0.2%	300%
		Tall	3.000	0.400	3.300	2.6	0.4	0.002	3.0	0.1%	91%
H3	Spurn Clough LWS	Short	1.610	0.438	2.048	1.8	0.3	0.088	2.2	4.3%	107%
		Tall	2.776	0.357	3.133	2.8	0.4	0.175	3.3	5.6%	105%
H4	Moor Isles Clough LWS	Short	1.610	0.438	2.048	1.8	0.3	0.066	2.2	3.2%	106%
		Tall	2.776	0.357	3.133	2.8	0.4	0.133	3.3	4.2%	104%
H5	Hagg Wood (ID 1102721) Ancient Woodland and Hagg Wood LWS	Short	1.620	0.438	2.058	1.8	0.3	0.007	2.1	0.4%	103%
		Tall	2.834	0.357	3.191	2.7	0.4	0.015	3.1	0.5%	96%
H6	Ancient Woodland (ID 1413047), Ancient Woodland (ID 1413046) and West Close Clough and Upper Fir Trees Brook	Short	No critical loads			1.8	0.3	0.003	2.1	N/A	N/A
		Tall	No critical loads			2.8	0.4	0.007	3.1	N/A	N/A
H7	Raven's Clough Wood (ID 1102723) Ancient Woodland and Raven's Clough Wood LWS	Short	1.610	0.438	2.048	1.8	0.3	0.005	2.1	0.3%	103%
		Tall	2.778	0.357	3.135	2.8	0.4	0.010	3.1	0.3%	100%
H8	Spring Wood (ID 1413041) Ancient Woodland and Spring Wood LWS	Short	1.620	0.438	2.058	1.8	0.3	0.009	2.1	0.4%	103%
		Tall	2.831	0.357	3.188	2.7	0.4	0.018	3.1	0.6%	96%
H9	Ancient Woodland (ID 1413040)	Short	1.620	0.438	2.058	1.8	0.3	0.007	2.1	0.4%	103%
		Tall	2.831	0.357	3.188	2.7	0.4	0.015	3.1	0.5%	96%
H10	Oswald Street LWS	Short	1.620	0.438	2.058	1.8	0.3	0.004	2.1	0.2%	103%

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(%)
		Tall	2.831	0.357	3.188	2.7	0.4	0.009	3.1	0.3%	96%
H11	Heald Wood LWS	Short	1.620	0.438	2.058	1.8	0.3	0.020	2.1	1.0%	104%
		Tall	2.831	0.357	3.188	2.7	0.4	0.040	3.1	1.3%	97%
H12	Barden Lane Fields LWS	Short	1.610	0.438	2.048	1.8	0.3	0.024	2.1	1.2%	104%
		Tall	2.775	0.357	3.132	2.8	0.4	0.047	3.2	1.5%	101%
H13	Roundwood Swamp Meadows and Swamp LWS	Short	1.610	0.438	2.048	1.8	0.3	0.033	2.1	1.6%	105%
		Tall	2.775	0.357	3.132	2.8	0.4	0.066	3.2	2.1%	102%
H14a	Leeds/Liverpool Canal Section Old Hall St to M65 junction 12	Short	1.620	0.438	2.058	1.8	0.3	0.011	2.1	0.5%	104%
		Tall	2.831	0.357	3.188	2.7	0.4	0.023	3.1	0.7%	96%
H14b		Short	1.610	0.438	2.048	1.8	0.3	0.017	2.1	0.8%	104%
		Tall	2.782	0.357	3.139	2.8	0.4	0.034	3.2	1.1%	100%
H14c		Short	1.610	0.438	2.048	1.8	0.3	0.009	2.1	0.4%	103%
		Tall	2.781	0.357	3.138	2.8	0.4	0.018	3.1	0.6%	100%

Table 12: Modelled 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(%)
H1	South Pennine Moors Phase 2 SPA	Short	5	24.8	0.001	24.8	0.02%	496%
H2	South Pennine Moors SAC	Short	5	24.8	0.001	24.8	0.02%	496%
		Tall	10	36.4	0.002	36.4	0.02%	364%
H3	Spurn Clough LWS	Short	5	25.5	0.096	25.6	1.9%	512%
		Tall	10	38.8	0.192	39.0	1.9%	390%
H4	Moor Isles Clough LWS	Short	5	25.5	0.073	25.6	1.5%	511%

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(%)
		Tall	10	38.8	0.146	38.9	1.5%	389%
H5	Hagg Wood (ID 1102721) Ancient Woodland and Hagg Wood LWS	Short	5	25.1	0.008	25.1	0.2%	501%
		Tall	10	37.5	0.016	37.5	0.2%	375%
H6	Ancient Woodland (ID 1413047), Ancient Woodland (ID 1413046) and West Close Clough and Upper Fir Trees Brook	Short	5	25.5	0.004	25.5	0.1%	510%
		Tall	10	38.8	0.008	38.8	0.1%	388%
H7	Raven's Clough Wood (ID 1102723) Ancient Woodland and Raven's Clough Wood LWS	Short	5	25.5	0.006	25.5	0.1%	510%
		Tall	10	38.8	0.011	38.8	0.1%	388%
H8	Spring Wood (ID 1413041) Ancient Woodland and Spring Wood LWS	Short	5	25.1	0.010	25.1	0.2%	501%
		Tall	10	37.5	0.019	37.5	0.2%	375%
H9	Ancient Woodland (ID 1413040)	Short	5	25.1	0.008	25.1	0.2%	501%
		Tall	10	37.5	0.016	37.5	0.2%	375%
H10	Oswald Street LWS	Short	5	25.1	0.005	25.1	0.1%	501%
		Tall	10	37.5	0.010	37.5	0.1%	375%
H11	Heald Wood LWS	Short	5	25.1	0.022	25.1	0.4%	502%
		Tall	10	37.5	0.044	37.6	0.4%	376%
H12	Barden Lane Fields LWS	Short	5	25.5	0.026	25.5	0.5%	510%
		Tall	10	38.8	0.052	38.8	0.5%	388%
H13	Roundwood Swamp Meadows and Swamp LWS	Short	5	25.5	0.036	25.5	0.7%	510%
		Tall	10	38.8	0.072	38.9	0.7%	389%
H14a	Leeds/Liverpool Canal Section Old Hall St to M65 junction 12 LWS	Short	5	25.1	0.006	25.1	0.1%	501%
		Tall	10	37.5	0.011	37.5	0.1%	375%
H14b		Short	5	25.5	0.013	25.5	0.3%	510%
		Tall	10	38.8	0.026	38.8	0.3%	388%
H14c		Short	5	25.5	0.019	25.5	0.4%	510%

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(%)
		Tall	10	38.8	0.039	38.8	0.4%	388%

The results in Table 11 indicate that at the assessed European designated sites, the respective PCs at modelled locations are below 1% of the relevant critical load value for acid deposition and therefore, the impact of the acid deposition is considered to be 'insignificant'. For the assessed local nature sites, the respective PCs are less than 100% of the long-term environmental standard for protected conservation areas and the impact can be described as 'insignificant'.

For nutrient nitrogen deposition, the results in Table 12 indicate that at the assessed European designated sites, the respective PCs are less than 1% of the relevant critical load value and the impact can be described as 'insignificant' as per Environment Agency guidance (Environment Agency, 2020). For the assessed local nature sites, the respective PCs are less than 100% of the long-term environmental standard for protected conservation areas and the impact can also be described as 'insignificant'.

Summary

The results in Table 11 indicate that at the assessed European designated sites, the respective PCs are below 1% of the relevant critical load value for acid deposition, therefore, the likely impact from the site is 'insignificant'.

5.3 Sensitivity Analysis

A sensitivity study was undertaken to see how changes to the surface roughness, omission of the buildings and an alternative meteorological station in the 2019 model (which predicted the highest annual mean NO_2 concentrations at sensitive human receptor locations), 2019 model (which predicted the highest 1-hour mean NO_2 concentrations at sensitive human receptor locations) and 2016 model (which predicted the highest 1-hour mean NO_2 concentrations at the modelled grid off-site locations) may impact on predicted concentrations at sensitive human receptors and off-site locations. The results of the sensitivity analysis are presented in Table 13, Table 14, Table 15 and Table 16.

Table 13: Sensitivity analysis - fixed surface roughness of 0.1 m

Pollutant	Averaging period	Assessment location	Original PC (surface roughness 0.6 m) (µg/m^3)	Surface roughness length 0.1 m				
				PC (µg/m^3)	PEC (µg/m^3)	PC/EQS	PEC/EQS	% difference in PC/EQS compared to original
NO_2	Annual mean	Sensitive locations	1.2	1.1	9.9	2.8%	24.7%	-0.2%
	1 hour mean (99.79th percentile)	Maximum off-site	10.9	12.3	21.1	6.2%	10.5%	0.7%
		Sensitive locations	10.0	11.5	29.0	5.7%	14.5%	0.7%

The results in Table 13 indicate that the change to maximum predicted annual mean concentrations for NO_2 is negligible when using a surface roughness value of 0.1 m compared to the original value of 1.2 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 14: Sensitivity analysis - fixed surface roughness of 1 m

Pollutant	Averaging period	Assessment location	Original PC (surface roughness 0.6 m) (µg/m^3)	Surface roughness length 1 m				
				PC (µg/m^3)	PEC (µg/m^3)	PC/EQS	PEC/EQS	% difference in PC/EQS compared to original
NO_2	Annual mean	Sensitive locations	1.2	1.2	10.0	3.0%	24.9%	0.0%
	1 hour mean (99.79th percentile)	Maximum off-site	10.9	10.1	18.8	5.0%	9.4%	-0.4%
		Sensitive locations	10.0	8.9	26.5	4.5%	13.2%	-0.5%

The results in Table 14 indicate that the change to maximum predicted annual mean concentrations for NO_2 is negligible when using a surface roughness value of 1 m compared to the original value of 1.2 m. For 1-hour mean (99.79th percentile) NO_2 concentrations at an off-site location and sensitive human receptor location, the PC was lower when modelling with an increased surface roughness value of 1 m. 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 15: Sensitivity analysis - no buildings

Pollutant	Averaging period	Assessment location	Original PC (with buildings) (µg/m^3)	No buildings				
				PC (µg/m^3)	PEC (µg/m^3)	PC/EQS	PEC/EQS	% difference in PC/EQS compared to original
NO_2	Annual mean	Sensitive locations	1.2	1.2	10.0	3.0%	24.9%	0.0%
	1 hour mean (99.79th percentile)	Maximum off-site	10.9	10.9	19.7	5.5%	9.9%	0.0%
		Sensitive locations	10.0	9.9	27.4	4.9%	13.7%	-0.1%

The results in Table 15 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.

Table 16: Sensitivity analysis - Manchester met data

Pollutant	Averaging period	Assessment location	Original PC (with buildings) (µg/m^3)	No buildings				
				PC (µg/m^3)	PEC (µg/m^3)	PC/EQS	PEC/EQS	% difference in PC/EQS compared to original
NO_2	Annual mean	Sensitive locations	1.2	2.2	10.0	5.6%	25.1%	2.6%
	1 hour mean (99.79th percentile)	Maximum off-site	10.9	11.1	19.9	5.6%	9.9%	0.1%
		Sensitive locations	10.0	10.2	27.7	5.1%	13.8%	0.1%

The results in Table 16 indicate that the change to maximum predicted annual mean concentrations for NO_2 increases slightly when using Manchester meteorological data compared to the original value of 1.2 m. For 1-hour mean (99.79th percentile) NO_2 concentrations at an off-site location and sensitive human receptor location, the PCs were slightly higher when using this data.

6. Conclusions

This report has assessed the potential air quality impacts associated with the operation of the biogas fuelled CHP engine and a gas oil fired boiler at Burnley 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 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' and 'insignificant', respectively, as per Environment Agency guidance (Environment Agency, 2021). For short-term NO_2 concentrations at modelled off-site locations and sensitive human receptor locations, the contributions are considered 'insignificant' and 'not significant', respectively. For all predicted short-term PM_{10} and CO concentrations, the contributions are considered 'insignificant'. For 24-hour mean SO_2 concentrations, the contributions are considered 'insignificant'. For all remaining short-term SO_2 concentrations at modelled grid off-site locations and sensitive human receptor locations, the contributions are considered 'insignificant'.

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

Protected conservation areas

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

For annual mean SO_2 concentrations predicted at the assessed European designated sites, the annual mean SO_2 PCs are less than 1% of the relevant long-term environmental standard and their impact can be described as 'insignificant'. For the assessed local nature sites, the respective PCs are less than 100% of the relevant long-term environmental standard and the impact can be described as 'insignificant'.

For maximum 24-hour mean critical level NOx concentrations, the respective PCs at the assessed European designated sites are less than 10% of the relevant critical level and can be described as 'insignificant'. For the 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 nitrogen deposition, the results indicate that the respective PCs at the assessed European designated sites are less than 1% of the relevant critical load value and the impact can be described as 'insignificant'. For 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'.

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

Summary

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

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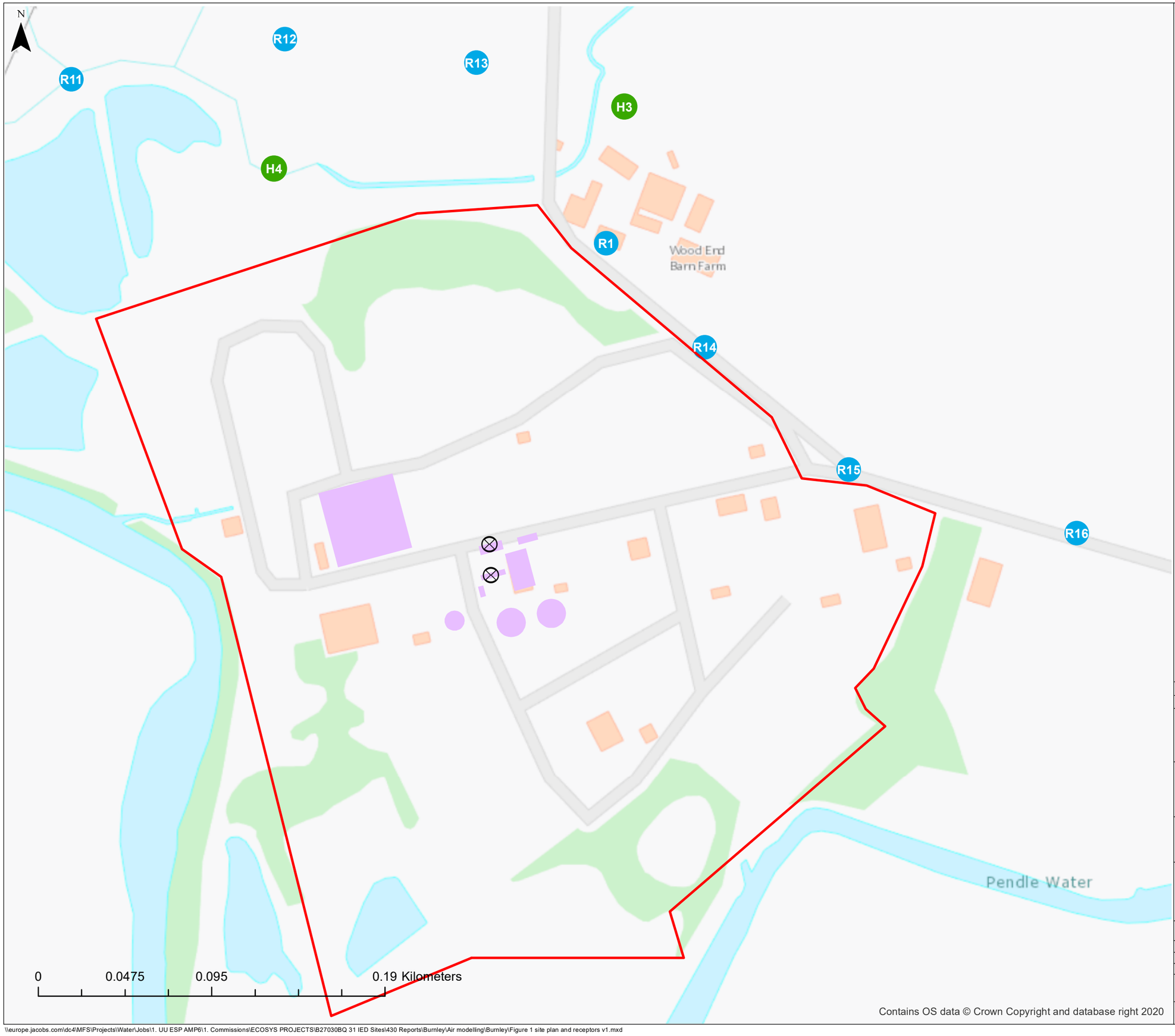
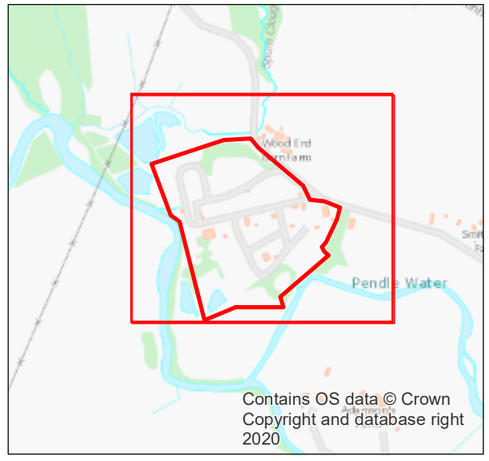
8. Figures

Figure 1: Approximate WwTW site fenceline, modelled stack locations and modelled buildings



Legend

- Approximate site fenceline
- Modelled stack locations
- Modelled buildings
- Sensitive human receptors
- Protected conservation areas



Rev.	Date	Purpose of revision	Drawn	Check'd	Rev'd	Appr'd
0	20/04/2021	Initial Issue	BT	GW	GW	HS

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BURNLEY WASTEWATER TREATMENT WORKS

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

Drawing Status: FINAL

Scale @ A3	1:2,000	DO NOT SCALE
Jacobs No.	B27030BQ	Rev 0
Client No.		

Drawing Number
FIGURE 1

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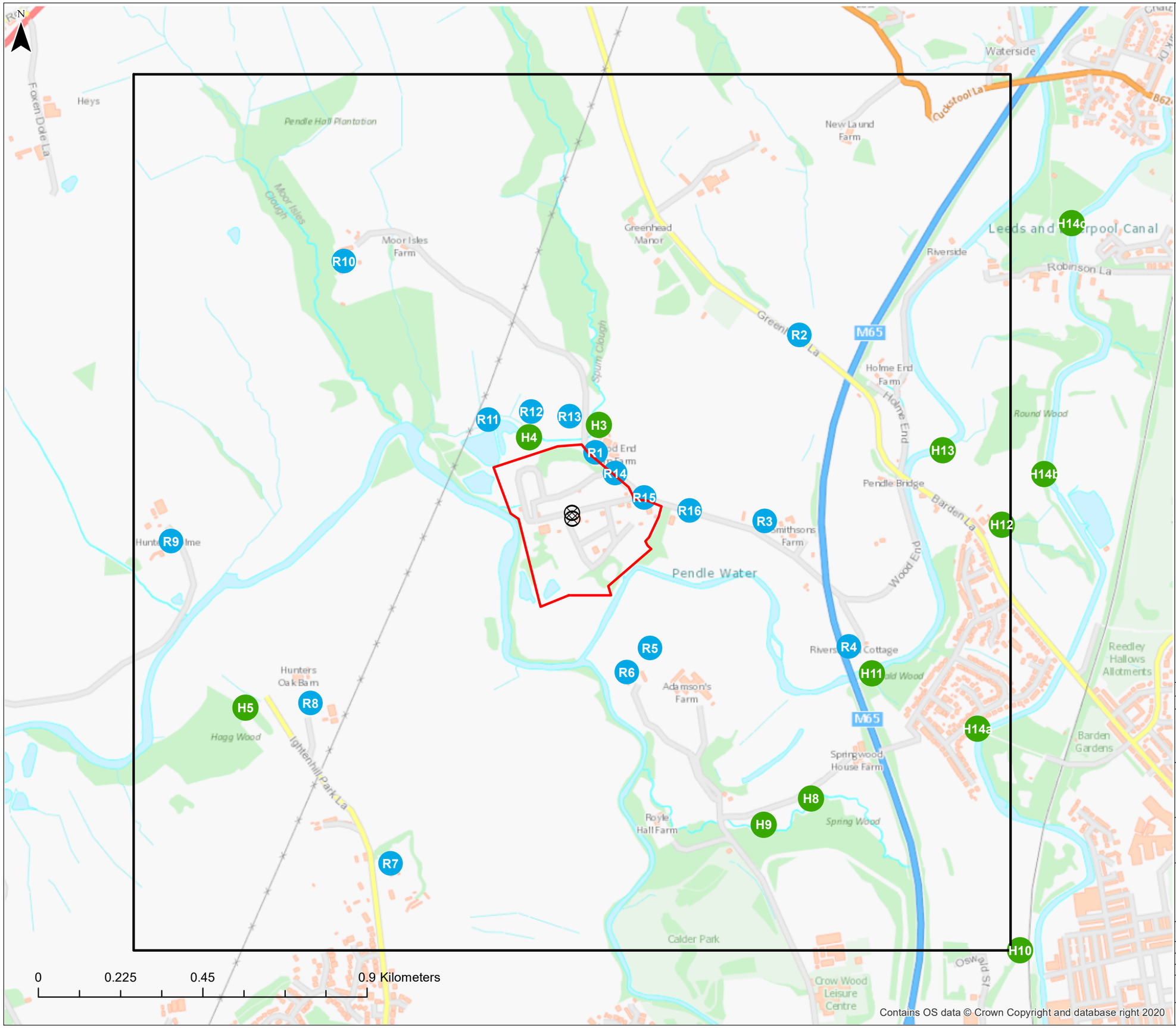
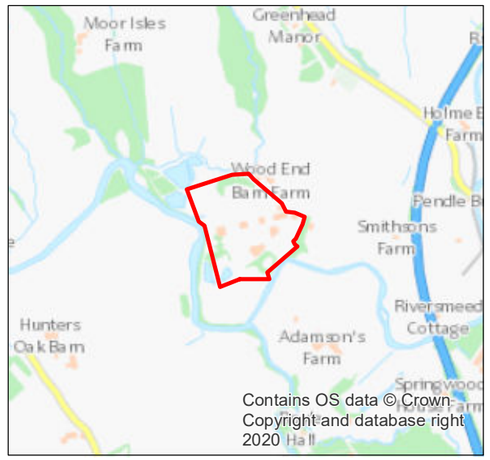
Figure 2: Approximate WwTW site fenceline, sensitive human receptors and modelled grid



Legend

- Approximate site fenceline
- Modelled stack locations
- Extent of modelled grid
- Sensitive human receptor locations
- Protected conservation areas



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Drawing Title: APPROXIMATE SITE FENCELINE, SENSITIVE HUMAN RECEPTOR LOCATIONS AND MODELLED GRID

Drawing Status: FINAL

Scale @ A3	1:10,000	DO NOT SCALE
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Drawing Number: FIGURE 2

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Figure 3: Protected conservation areas

N

H1 H3 H4 H5 H6 H7 H8 H9 H10 H11 H12 H13 H14a H14b H14c

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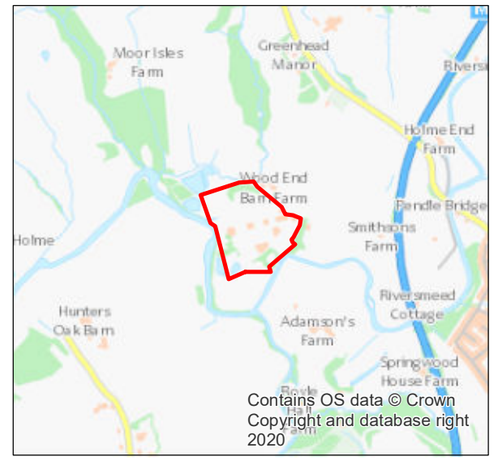
Legend

- Approximate site fenceline
- Extent of modelled grid
- Protected conservation areas
- Special Areas of Conservation
- Special Protection Areas



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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, 2019 meteorological data

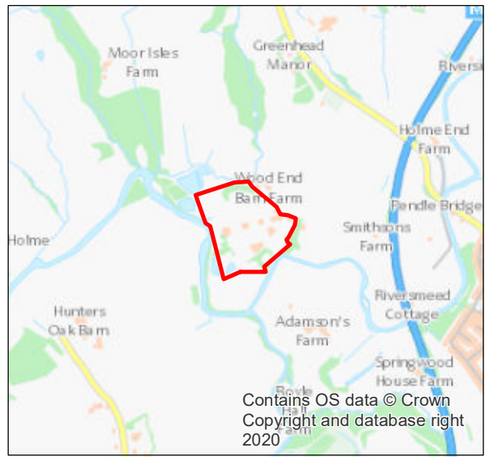
N

Legend

- Approximate site fenceline
- Modelled stack locations
- Sensitive human receptor locations
- Protected conservation areas

Annual mean nitrogen dioxide process contributions (µg/m^3)

- 0 - 0.4
- 0.4 - 0.8
- 0.8 - 1.4
- 1.4 - 3.4
- 3.4 - 6.4
- >6.4



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Drawing Title: ANNUAL MEAN NITROGEN DIOXIDE PROCESS CONTRIBUTIONS, 2019 METEOROLOGICAL DATA

Drawing Status: FINAL

Scale @ A3	1:10,365	DO NOT SCALE
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Drawing Number: FIGURE 4

0 0.25 0.5 1 Kilometers

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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[1] for existing combustion plant are also presented in Table 17 where relevant.

Table 17: Dispersion modelling parameters

Parameters	Unit	JMC 312 GS-BL CHP engine (1.6 MW_{th})	Cambi boiler (1.3 MW_{th})
Fuel	-	Biogas	Gas oil
Emission point	-	A1	A2
Assessed annual operation hours	Hours	8,760	8,760
Stack location	m	E 382712 N 435280	E 382711 N 435297
Stack height	m	7	7
Stack diameter	m	0.35	0.40
Flue gas temperature	°C	180	197
Efflux velocity	m/s	12.7	7.8
Moisture content of exhaust gas	%	13.0	11.0
Oxygen content of exhaust gas (dry)	%	8.6	6.4
Volumetric flow rate (actual)	m^3/s	1.224	0.982
Volumetric flow rate (normal)[1]	Nm^3/s	1.336	0.411
NOx emission concentration[1,]	mg/Nm^3	186 (190 after 1st January 2030)	200 (200 after 1st January 2030)
NOx emission rate	g/s	0.248	0.082
CO emission concentration[1]	mg/Nm^3	519	150
CO emission rate	g/s	0.694	0.062
PM_{10} / $PM_{2.5}$ emission concentration[1]	mg/Nm^3	2.7	50.0
PM_{10} / $PM_{2.5}$ emission rate	g/s	0.004	0.021
SO_2 emission concentration[1]	mg/Nm^3	130 (60 after 1st January 2030)	153
SO_2 emission rate	g/s	0.173	0.063
TVOC emission concentration[1]	mg/Nm^3	371	n/a
TVOC emission rate	g/s	0.496	n/a

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

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. The buildings are also 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
Boiler housing	Rectangular	5.0	13.0	3.1	345	382712	435295
CHP housing	Rectangular	2.9	13.7	2.9	345	382713	435280
Building 3	Rectangular	4.0	11.0	2.3	345	382732	435300
Building 4	Rectangular	21.0	12.0	5.8	345	382728	435283
Building 5	Rectangular	6.0	3.0	2.3	345	382707	435271
Sludge screen feed tank	Circular	11.0	-	6.9	-	382692	435255
Primary digester 1	Circular	16.0	-	9.2	-	382723	435254
Primary digester 2	Circular	16.0	-	9.2	-	382745	435259
Nitrifying filters	Rectangular	42.0	42.0	7.7	345	382643	435310

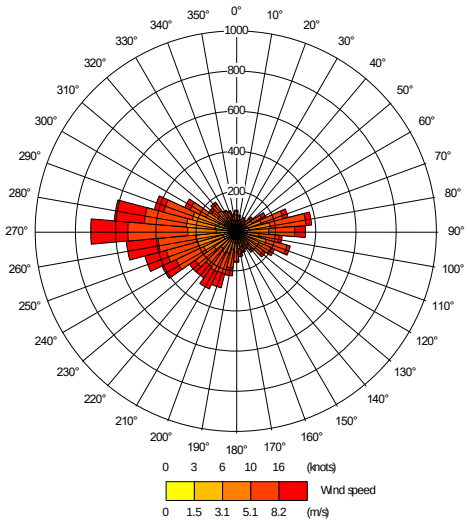
A.2.2 Other model inputs

Parameter	Value used	Comments
Surface roughness length for dispersion site	0.4 m	This is appropriate for the dispersion site which is area where the local land-use is primarily agricultural areas and suburbia. 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	0.4 m	NWP data has been used based on the site location itself so the roughness length is the same as that used for the dispersion site.
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	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. The gradients experienced in the vicinity of the Burnley exceeds this threshold. In line with ADMS guidelines, terrain influences have therefore been included within the dispersion model. The terrain data were obtained from the Ordnance Survey (Ordnance Survey, 2019). The terrain grid was created using the terrain tool within ADMS, with a 3.5 km x 3.5 km (approximate) extent at. 64 points along each grid axis.
Meteorological data	NWP data, 2016- 2020	NWP data is based on the location of the site (NGR E 382723 N 435292) and is considered the most representative meteorological data for the site. NWP data was used as it is a site-specific location, the closest alternative meteorological stations to the site were Manchester airport (approx. 52 km from the site), not representative due to the distance from the site, and Bingley, which was not representative due to distance (approx. 29 km from the site) and the elevation difference. Further information on this data can be found in Appendix D.

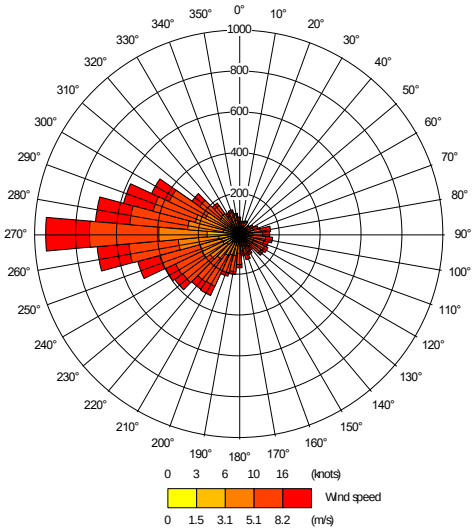
A.2.3 Meteorological Data – Wind Roses

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

NWP data, 2016

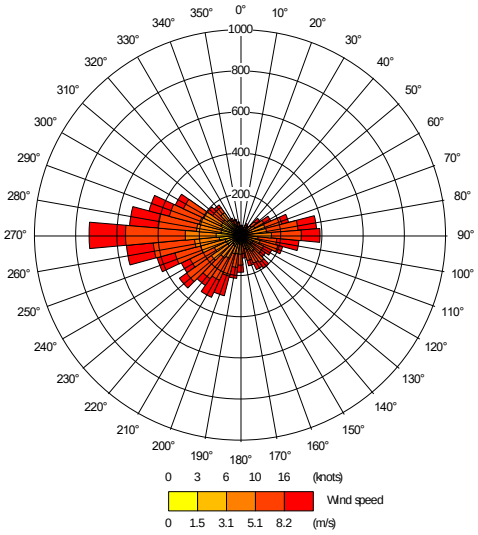


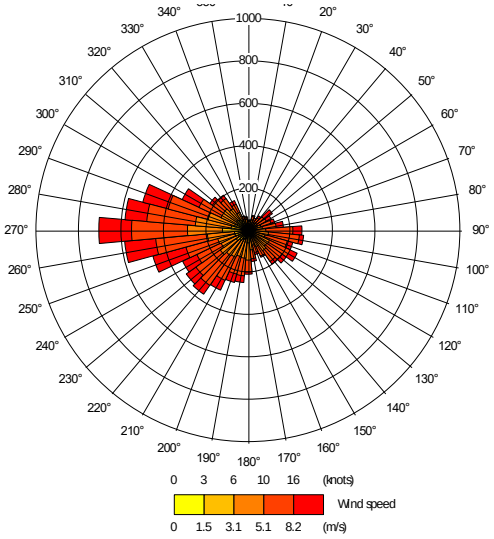
NWP data, 2017



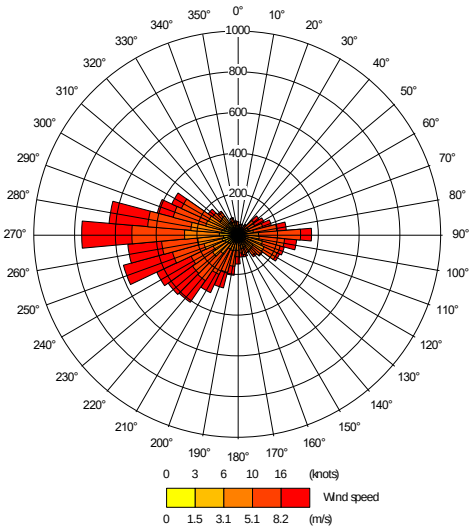
NWP data, 2018

NWP data, 2019





NWP data, 2020



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 and the extent is shown on Figure 2.

Table 19: Modelled grid parameters

	Start	Finish	Number of grid points	Grid spacing (m)
Easting	381511	383911	240	10
Northing	434097	436497	240	10
Grid height	1.5	1.5	1	-

As well as the modelled grid, the potential impact at 16 sensitive human receptors (e.g. exposure locations such as residential properties and footpaths) and fourteen 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 engine (km)	Direction from the site
		Easting	Northing		
R1	Residential property	382775	435462	0.18	NNE
R2	Residential property	383334	435786	0.79	NE
R3	Residential property	383238	435274	0.53	E
R4	Residential property	383469	434930	0.84	ESE
R5	Residential property	382924	434926	0.43	SSE

Receptor	Description	Grid reference		Distance from the CHP engine (km)	Direction from the site
		Easting	Northing		
R6	Residential property	382861	434860	0.46	SSE
R7	Residential property	382214	434336	1.08	SSW
R8	Residential property	381995	434775	0.89	SW
R9	Residential property	381613	435219	1.10	W
R10	Residential property	382086	435986	0.93	NW
R11	Bridleway/PRoW	382482	435552	0.34	NW
R12	Bridleway/PRoW	382599	435574	0.30	NNW
R13	Bridleway/PRoW	382704	435561	0.26	N
R14	PRoW	382829	435405	0.16	NE
R15	PRoW	382910	435342	0.20	ENE
R16	PRoW	383033	435303	0.32	E

Table 21: Assessed protected conservation area locations

Receptor	Description	Grid reference		Distance from combustion plant (km)	Direction from the site
		Easting	Northing		
H1	South Pennine Moors Phase 2 SPA	388958	433032	6.64	ESE
H2	South Pennine Moors SAC	388958	433032	6.64	ESE
H3	Spurn Clough LWS	382785	435537	0.25	NNE
H4	Moor Isles Clough LWS	382593	435503	0.24	NNW
H5	Hagg Wood (ID 1102721) Ancient Woodland and Hagg Wood LWS	381817	434763	1.04	WSW
H6	Ancient Woodland (ID 1413047), Ancient Woodland (ID 1413046) and West Close Clough and Upper Fir Trees Brook	380859	435915	1.95	WNW
H7	Raven's Clough Wood (ID 1102723) Ancient Woodland and Raven's Clough Wood LWS	383782	436741	1.80	NE
H8	Spring Wood (ID 1413041) Ancient Woodland and Spring Wood LWS	383365	434514	1.02	SE
H9	Ancient Woodland (ID 1413040)	383236	434442	1.00	SSE
H10	Oswald Street LWS	383938	434098	1.72	SE
H11	Heald Wood LWS	383532	434857	0.93	ESE
H12	Barden Lane Fields LWS	383888	435264	1.18	E
H13	Roundwood Swamp Meadows and Swamp LWS	383726	435468	1.03	E
H14a	Leeds/Liverpool Canal Section Old Hall St to M65 junction 12	383821	434705	1.26	ESE
H14b		384004	435403	1.30	E
H14c		384079	436090	1.58	ENE

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, 2021). 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, 2020), 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 engine and boiler were assumed to operate for 8,760 hours each calendar year but in practice, both the CHP engine and boiler will have periods of shut-down 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, 2020a). 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 ($\mu g/m^2/s$) = ground level concentration ($\mu g/m^3$) 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 $\mu g/m^2/s$ (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

$\mu g/m^2/s$ of species	Conversion factor to kg N/ha/yr
NO_2	95.9

Table 24: Dry deposition flux conversion factors for acidification

$\mu g/m^2/s$ 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	262	10,000	53.2	315	0.5%	3.2%	30,000	66.2	328	0.2%	1.1%
R2	281		10.6	292	0.1%	2.9%		21.5	303	0.1%	1.0%
R3	281		21.6	303	0.2%	3.0%		31.9	313	0.1%	1.0%
R4	300		11.0	311	0.1%	3.1%		19.7	319	0.1%	1.1%
R5	287		25.9	313	0.3%	3.1%		32.1	319	0.1%	1.1%
R6	287		21.5	309	0.2%	3.1%		30.6	318	0.1%	1.1%
R7	287		6.7	294	0.1%	2.9%		11.5	299	0.0%	1.0%
R8	269		13.8	283	0.1%	2.8%		17.4	287	0.1%	1.0%
R9	249		8.5	257	0.1%	2.6%		14.1	263	0.0%	0.9%
R10	262		6.9	269	0.1%	2.7%		11.6	274	0.0%	0.9%
R11	262		25.1	287	0.3%	2.9%		48.2	310	0.2%	1.0%
R12	262		32.0	294	0.3%	2.9%		50.6	313	0.2%	1.0%
R13	262		30.4	293	0.3%	2.9%		49.3	312	0.2%	1.0%
R14	262		59.1	321	0.6%	3.2%		78.8	341	0.3%	1.1%
R15	262		51.6	314	0.5%	3.1%		72.2	334	0.2%	1.1%
R16	281		32.0	313	0.3%	3.1%		44.8	326	0.1%	1.1%

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	8.8	40	1.2	10.0	3.0%	24.9%	200	17.5	8.5	26.1	4.3%	13.0%
R2	11.0		0.2	11.2	0.4%	27.9%		22.0	2.2	24.2	1.1%	12.1%
R3	11.0		0.7	11.7	1.7%	29.2%		22.0	3.7	25.7	1.8%	12.8%
R4	11.9		0.2	12.1	0.5%	30.2%		23.8	2.1	25.9	1.1%	13.0%
R5	8.6		0.2	8.8	0.5%	21.9%		17.1	3.7	20.8	1.8%	10.4%
R6	8.6		0.1	8.7	0.3%	21.7%		17.1	3.3	20.4	1.7%	10.2%
R7	8.6		0.0	8.6	0.0%	21.4%		17.1	0.7	17.8	0.3%	8.9%
R8	7.9		0.1	8.0	0.1%	19.9%		15.8	1.6	17.4	0.8%	8.7%
R9	7.7		0.1	7.8	0.2%	19.4%		15.3	1.3	16.7	0.7%	8.3%
R10	8.8		0.1	8.8	0.1%	22.0%		17.5	0.9	18.5	0.5%	9.2%
R11	8.8		0.4	9.1	0.9%	22.8%		17.5	4.5	22.0	2.2%	11.0%
R12	8.8		0.3	9.1	0.8%	22.7%		17.5	4.6	22.1	2.3%	11.0%
R13	8.8		0.5	9.2	1.2%	23.1%		17.5	5.4	23.0	2.7%	11.5%
R14	8.8		1.8	10.6	4.6%	26.5%		17.5	10.0	27.5	5.0%	13.8%
R15	8.8		2.2	11.0	5.6%	27.5%		17.5	8.2	25.8	4.1%	12.9%
R16	11.0		1.4	12.4	3.6%	31.1%		22.0	5.5	27.5	2.7%	13.7%

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	7.8	125	10.2	18.0	8.1%	14.4%	350	7.8	17.2	25.0	4.9%	7.2%
R2	7.8		1.1	8.9	0.9%	7.1%		7.8	4.1	11.9	1.2%	3.4%
R3	7.8		2.8	10.6	2.2%	8.5%		7.8	7.3	15.1	2.1%	4.3%
R4	7.7		1.2	9.0	1.0%	7.2%		7.7	3.8	11.6	1.1%	3.3%
R5	7.7		2.7	10.4	2.2%	8.3%		7.7	7.1	14.8	2.0%	4.2%
R6	7.7		2.2	9.9	1.8%	7.9%		7.7	6.2	13.9	1.8%	4.0%
R7	7.7		0.4	8.1	0.3%	6.5%		7.7	1.3	9.0	0.4%	2.6%
R8	7.4		1.0	8.4	0.8%	6.7%		7.4	2.8	10.2	0.8%	2.9%
R9	7.0		0.9	8.0	0.7%	6.4%		7.0	2.6	9.6	0.7%	2.7%
R10	7.8		0.6	8.5	0.5%	6.8%		7.8	1.8	9.6	0.5%	2.7%
R11	7.8		3.9	11.7	3.1%	9.4%		7.8	8.7	16.5	2.5%	4.7%
R12	7.8		3.6	11.4	2.8%	9.1%		7.8	8.9	16.8	2.6%	4.8%
R13	7.8		5.2	13.1	4.2%	10.4%		7.8	10.8	18.7	3.1%	5.3%
R14	7.8		11.0	18.8	8.8%	15.0%		7.8	19.9	27.7	5.7%	7.9%
R15	7.8		8.6	16.5	6.9%	13.2%		7.8	16.5	24.3	4.7%	6.9%
R16	7.8		5.6	13.4	4.5%	10.7%		7.8	10.8	18.6	3.1%	5.3%

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 (µg/m³)	EQS (µg/m³)	PC (µg/m³)	PEC (µg/m³)	PC/EQS (%)	PEC/EQS (%)
R1	7.8	266	20.8	28.6	7.8%	10.8%
R2	7.8		8.3	16.2	3.1%	6.1%
R3	7.8		11.7	19.6	4.4%	7.4%
R4	7.7		6.8	14.5	2.6%	5.5%
R5	7.7		10.7	18.4	4.0%	6.9%
R6	7.7		9.8	17.5	3.7%	6.6%
R7	7.7		2.4	10.1	0.9%	3.8%
R8	7.4		6.2	13.6	2.3%	5.1%
R9	7.0		5.2	12.3	2.0%	4.6%
R10	7.8		3.5	11.3	1.3%	4.3%
R11	7.8		13.2	21.0	5.0%	7.9%
R12	7.8		12.1	20.0	4.6%	7.5%
R13	7.8		13.9	21.7	5.2%	8.2%
R14	7.8		23.3	31.1	8.7%	11.7%
R15	7.8		20.4	28.2	7.7%	10.6%
R16	7.8		15.2	23.0	5.7%	8.7%

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	9.2	40	0.14	9.3	0.4%	23.3%	50	18.3	0.51	18.8	1.0%	37.7%
R2	10.0		0.02	10.0	0.0%	25.0%		20.0	0.06	20.0	0.1%	40.0%
R3	10.0		0.08	10.1	0.2%	25.1%		20.0	0.19	20.1	0.4%	40.3%
R4	10.6		0.02	10.6	0.1%	26.5%		21.2	0.06	21.3	0.1%	42.5%
R5	9.4		0.02	9.5	0.1%	23.7%		18.9	0.09	19.0	0.2%	38.0%
R6	9.4		0.02	9.5	0.0%	23.7%		18.9	0.05	19.0	0.1%	37.9%
R7	9.4		0.00	9.5	0.0%	23.6%		18.9	0.01	18.9	0.0%	37.8%
R8	9.4		0.01	9.4	0.0%	23.5%		18.8	0.02	18.8	0.0%	37.6%
R9	9.3		0.01	9.3	0.0%	23.3%		18.6	0.05	18.7	0.1%	37.3%
R10	9.2		0.01	9.2	0.0%	22.9%		18.3	0.02	18.3	0.0%	36.7%
R11	9.2		0.04	9.2	0.1%	23.0%		18.3	0.15	18.5	0.3%	36.9%
R12	9.2		0.04	9.2	0.1%	23.0%		18.3	0.16	18.5	0.3%	37.0%
R13	9.2		0.06	9.2	0.1%	23.0%		18.3	0.21	18.5	0.4%	37.1%
R14	9.2		0.22	9.4	0.6%	23.5%		18.3	0.72	19.0	1.4%	38.1%
R15	9.2		0.27	9.4	0.7%	23.6%		18.3	0.67	19.0	1.3%	38.0%
R16	10.0		0.16	10.1	0.4%	25.3%		20.0	0.39	20.3	0.8%	40.7%

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 (µg/m³)	EQS (µg/m³)	PC (µg/m³)	PEC (µg/m³)	PC/EQS (%)	PEC/EQS (%)
R1	6.3	25	0.14	6.4	0.6%	25.6%
R2	6.8		0.02	6.8	0.1%	27.3%
R3	6.8		0.08	6.9	0.3%	27.6%
R4	7.2		0.02	7.2	0.1%	28.9%
R5	6.5		0.02	6.6	0.1%	26.2%
R6	6.5		0.02	6.6	0.1%	26.2%
R7	6.5		0.00	6.5	0.0%	26.2%
R8	6.4		0.01	6.4	0.0%	25.7%
R9	6.3		0.01	6.3	0.0%	25.4%
R10	6.3		0.01	6.3	0.0%	25.1%
R11	6.3		0.04	6.3	0.2%	25.2%
R12	6.3		0.04	6.3	0.1%	25.2%
R13	6.3		0.06	6.3	0.2%	25.3%
R14	6.3		0.22	6.5	0.9%	26.0%
R15	6.3		0.27	6.5	1.1%	26.1%
R16	6.8		0.16	7.0	0.6%	27.9%

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		2.4	n/a			n/a		43.0	n/a		
R2			0.3						14.0			
R3			1.5						20.6			
R4			0.4						12.8			
R5			0.4						20.9			
R6			0.3						19.9			
R7			0.0						7.5			
R8			0.1						11.3			
R9			0.2						9.2			
R10			0.1						7.5			
R11			0.7						31.3			
R12			0.7						32.9			
R13			1.0						32.0			
R14			3.7						50.4			
R15			4.6						47.7			
R16			3.0						29.3			

Appendix D. ADM Ltd Verification of NWP data