Environmental Permit Application – Derby Sewage Treatment Works

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Environmental Permit Application – Derby Sewage Treatment Works

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Executive summary

Under the Industrial Emissions Directive (IED) (European Union, 2010), the Medium Combustion Plant (MCP) operated by Severn Trent Water Limited (hereafter 'Severn Trent') at the Derby Sewage Treatment Works (STW), Derby (DE21 7BR) (hereafter 'the site'), require an Environmental Permit (EP). The combustion plant within the scope for EP are:

- an existing biogas fuelled Perkins Ener-g4006 combined heat and power (CHP) engine (with a thermal input capacity of 0.8 MWth);
- two existing duel fuelled Beel standby hot water boilers (each with a thermal input capacity of 0.9 MWth);
- an existing duel fuelled Eurograde ED30S/SG/3M standby hot water boiler (with a thermal input capacity of 1.3 MWth); and
- two proposed biogas fuelled Jenbacher JMS 316 GS-B.L CHP engines (each with a thermal input capacity of 2.1 MWth)

Jacobs UK Limited (hereafter 'Jacobs') has carried out an Air Quality Impact Assessment (AQIA) on behalf of Severn Trent assess the potential impact of emissions from the existing CHP engine and boilers and proposed CHP engines.

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Plant name (emission source)	NACE code	Plant manufacturer	Model name	Easting	Northing	Date operation started	Rated thermal input of the medium combustion plant or generator (MWth)	Main fuel type used	Secondary fuel type used
CHP engine 1 (A1)	5	Jenbacher	JMS 316 GS-B.L	438914	334625	Est Nov 2024	2.1	Biogas	-
CHP engine 2 (A2)	5	Jenbacher	JMS 316 GS-B.L	438926	334622	Est Nov 2024	2.1	Biogas	-
CHP engine 3 (A3)	5	Perkins	g4006	438888	334625	Pre 20th Dec 2018	0.8	Biogas	-
Boiler 1 (A4)	5	Beel	-	438900	334632	Pre 20th Dec 2018	0.9	Biogas (modelled)	Gas-oil
Boiler 2 (A5)	5	Beel	-	438898	334633	Pre 20th Dec 2018	0.9	Biogas (modelled)	Gas-oil
Boiler 3 (A6)		Eurograde	ED30S/SG/3M	438896	334634	Pre 20th Dec 2018	1.3	Biogas (modelled)	Gas-oil

The potential impacts were determined for the following aspect:

- the potential impact on human health due to emissions of pollutants, including nitrogen dioxide (NO_2); carbon monoxide (CO); sulphur dioxide (SO_2), total volatile organic compounds (TVOCs) 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 concentrations at sensitive human receptors do not exceed any relevant long-term or short-term Environmental Quality Standard (EQS).

The results indicate that for annual mean NO_2, PM_{10} and $PM_{2.5}$ and benzene concentrations, the respective process contributions (PCs), including those for the assessed Air Quality Management Areas (AQMAs), are either less than 1% of the relevant long-term EQS or where the PCs are above 1% of the relevant EQS (i.e. NO_2), the corresponding predicted environmental concentration (PEC) is less than 70% of the relevant EQS and the impacts are considered 'not significant' as per Environment Agency guidance (Environment Agency, 2024b).

For short-term NO_2, CO, SO_2, PM_{10}, toluene and benzene concentrations at a sensitive human receptor location and CO concentrations at an off-site location, the PCs are either less than 10% of the relevant EQS or where the PCs are above 10% of the relevant EQS, the respective PEC is less than 70% of the relevant EQS and the impacts are considered 'not significant'.

For 1-hour mean (99.79th percentile) NO_2 and 1-hour mean (99.73rd percentile) SO_2 concentrations at an off-site location, the respective PC is above 10% of the relevant EQS and the corresponding PEC is above 70% of the relevant EQS. The highest PCs are predicted to occur at a location which is not accessible to the public.

For 15-minute mean (99.9th percentile) SO_2 concentrations at an off-site location, an exceedance of the relevant EQS is being predicted. The highest PC is predicted to occur at a location which is not accessible to the public.

This assessment has been carried out on the assumption that for long-term concentrations, the proposed replacement Jenbacher CHP engines operate continuously at maximum load throughout the year (i.e. 8,760 hours) and the existing Perkins CHP engine and boilers operate for 4,000 hours per year. For short-term concentrations, the assessed combustion units are assumed to operate continuously. This is a conservative assumption as in practice, the Beel boilers, which are primarily used as a back-up for electricity and/or heat production when the CHP engines are undergoing routine maintenance, typically operate for less than 2,000 hours and the Eurograde boiler does not operate. The Perkins CHP engine typically operates for less than 1,000 hours per year.

Therefore, when considering the conservative approach to the assessment and based on professional judgement, the emissions of assessed pollutants at sensitive human receptor locations and modelled off-site locations is considered 'not significant'.

Protected conservation areas

For critical levels, the results indicate that at the assessed local nature sites, the annual mean NOx and SO_2 PCs are less than 100% of the relevant critical level and the effect is considered 'insignificant' as per Environment Agency guidance (Environment Agency, 2024b).

For the maximum 24-hour mean critical level for NOx, the results indicate that with the exception of H17 (River Derwent LWS) and H18 (Sewage Farm Lagoons LWS), the PCs are less than 100% of the relevant critical level and the effect is considered 'insignificant' as per Environment Agency guidance (Environment Agency, 2024b). Further analysis indicates that the PC is predicted to exceed the relevant EQS at less than 5% of the considered area at H17 and less than 1% of the considered area at H18.

For critical loads, the results indicate that with the exception of acid deposition at H17 (River Derwent LWS), the PCs are less than 100% of the relevant critical load value for acid and nutrient nitrogen deposition and the impact can be described as 'insignificant' as per Environment Agency guidance (Environment Agency,

2024b). Further analysis indicates that the PC is predicted to exceed the critical level for acid at less than 3% of the assessed area at H17.

Summary

Based on the above assessment, it is concluded that the operation of the assessed combustion plant are acceptable from an air quality perspective

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Appendices

1. Introduction

1.1 Background

Under the Industrial Emissions Directive (IED)[1] (European Union, 2010), the Medium Combustion Plant (MCP) operated by Severn Trent Water Limited (hereafter 'Severn Trent') at the Derby Sewage Treatment Works (STW), Derby (DE21 7BR) (hereafter 'the site'), require an Environmental Permit (EP). The combustion plant included within the scope for EP are:

- an existing biogas fuelled Perkins Ener-g4006 combined heat and power (CHP) engine (with a thermal input capacity of 0.8 MWth);
- two existing duel fuelled[2] Beel standby hot water boilers (each with a thermal input capacity of 0.9 MWth);
- an existing duel fuelled[2] Eurograde ED30S/SG/3M standby hot water boiler (with a thermal input capacity of 1.3 MWth); and
- two proposed replacement[3] biogas fuelled Jenbacher JMS 316 GS-B.L CHP engines (each with a thermal input capacity of 2.1 MWth).

Jacobs UK Limited (hereafter 'Jacobs') has carried out an Air Quality Impact Assessment (AQIA) on behalf of Severn Trent assess the potential impact of emissions from the existing CHP engine and boilers and proposed replacement CHP engines.

1.2 Study Outline

This AQIA is required to support the EP application and assesses the likely significant air quality effects of emissions to air from the CHP engines and boilers at the site. The air quality assessment has been carried out following the relevant Environment Agency guidance (Environment Agency; 2024a, 2024b). The AQIA considers:

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

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

This report draws upon information provided from the following parties:

- Severn Trent;
- ADM Ltd (meteorological data supplier);
- Centre for Ecology and Hydrology (CEH);
- Department for Environment, Food and Rural Affairs (Defra);
- Exova Catalyst (emissions monitoring specialists);
- INNIO Jenbacher GmbH & Co OG (Jenbacher) (engine manufacturer); and
- Derby City Council.

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

1 European Directive 2010/75/EU.

2 Biogas (primary fuel and modelled accordingly) and gas-oil (secondary fuel).

3 Replacing the two existing on-site Jenbacher CHP engines.

2. Emission Sources

2.1 Emission Sources to Air

The emission sources to air being considered in this assessment and presented in Table 2-1 and Figure 1.

The modelling only considers emissions from these sources and no other emission points to air at the site have been included in the assessment.

Table 2-1: Combustion plant considered in this assessment

Parameters	JMS 316 GS-B.L CHP engine (2.1 MWth)	JMS 316 GS-B.L CHP engine (2.1 MWth)	Perkins Ener-g4006 CHP engine (0.8 MWth)	Beel - Standby Boiler 1 (0.9 MWth)	Beel - Standby Boiler 2 (0.9 MWth)	Eurograde ED30S/SG/3M Boiler (1.3 MWth)
Status	Proposed	Proposed	Existing	Existing	Existing	Existing
Modelled fuel	Biogas	Biogas	Biogas	Biogas	Biogas	Biogas
Emission point	A1	A2	A3	A4	A5	A6

For long-term (i.e. annual mean) predicted modelled concentrations, this assessment has been carried out on the assumption that the proposed replacement Jenbacher CHP engines operate continuously at maximum load throughout the year (i.e. 8,760 hours) and the existing Perkins CHP engine and boilers operate for 4,000 hours per year. This is a conservative assumption as in practice, the Beel boilers, which are primarily used as a back-up for electricity and/or heat production when the CHP engines are undergoing routine maintenance, typically operate for less than 2,000 hours and the Eurograde boiler does not operate. The Perkins CHP engine typically operates for less than 1,000 hours per year.

For short-term predicted modelled concentrations, it is assumed the assessed combustion plant operate continuously as this approach ensures that the worst-case or maximum short-term concentrations are quantified (further consideration of this is provided in Appendix A).

2.2 Emissions Data

2.2.1 Emission concentration of pollutants

For the existing Perkins CHP engine, the NOx emission concentration was obtained from the site's existing EP (EPR/CP3638XZ)[4]. For the proposed replacement Jenbacher CHP engines, the NOx emission concentration was obtained from the Medium Combustion Plant Directive (MCPD) EU/2015/2193 (European Union, 2015) for new engines. The CO and TVOC emission concentrations applied were derived from the Environment Agency's guidance *'Guidance for monitoring landfill gas engine emissions'* (Environment Agency, 2010).

It should be noted that on behalf of Severn Trent, Exova Catalyst carried out emissions monitoring of TVOC emissions from a Biogas Plant Stack at the Severn Trent Strongford site in 2018 (Exova Catalyst, 2018). The monitoring results indicated that of the TVOC emission concentration recorded (i.e. 33.9 µg/m^3), benzene accounted for 0.12% (i.e. 0.04 µg/m^3) and toluene, which yielded the highest VOC emission concentration, accounted for 0.32% (i.e. 0.11 µg/m^3) of TVOC emissions. Therefore, for all considered emission sources, this assessment assumes 0.12% of the TVOC emissions (based on the Environment Agency's '*Guidance for monitoring landfill gas engine emissions*' (Environment Agency, 2010)) were assumed to be benzene and 0.32% were assumed to be toluene. This remains a conservative assumption as benzene emission concentrations have been factored to be 0.4 µg/m^3 (for CHP engines) and 1.3 µg/m^3 (for boilers) and toluene emission concentrations have been factored to be 1.2 µg/m^3 (for CHP engine) and 3.7 µg/m^3 (for boilers). These are a factor of ten higher than the measured emission concentrations at Strongford, to present a conservative approach.

4 Issued 5th February 2009 under regulation 13 of the Environmental Permitting (England and Wales) Regulations 2007.

The SO_2 emission concentration for the proposed replacement CHP engines was obtained from the MCPD EU/2015/2193[5] (European Union, 2015) for new engines. For the existing Perkins CHP engine, the SO_2 emission concentration applied in the assessment was derived from on-site hydrogen sulphide (H_2S))[6] monitoring of the biogas (Severn Trent, 2024). Further consideration of this is provided in Appendix B.

For the boilers, the NOx emission concentration was obtained from the MCPD EU/2015/2193[5] (European Union, 2015) for existing MCP other than engines and gas turbines, which is likely to be considerably higher than the actual NOx concentration. The SO_2 emission concentration was derived from on-site H_2S monitoring as described above.

For CO, in absence of data, the emission concentration was obtained from the value for natural gas from Defra's Process Guidance Note 1/3,'*Statutory Guidance for Boilers and Furnaces 20-50MW thermal input*' (Defra, 2012). The TVOC emission concentration was derived from the Environment Agency's guidance '*Guidance for monitoring landfill gas engine emissions*', (Environment Agency, 2010) and factored accordingly as per the findings of the TVOC monitoring at Strongford (Exova Catalyst, 2018).

2.2.2 Other emission parameters

For the proposed replacement CHP engines (emission point reference A1 & A2), the exhaust volumetric flow, exhaust gas temperature and moisture content were obtained from the Jenbacher Technical Description datasheet (Jenbacher, 2023). The oxygen content used in the model is based on professional judgement.

For the existing CHP engine (emission point reference A3) and boilers (emission point reference A4 – A6), the exhaust gas volumetric flows were determined using stoichiometric calculations based on the combustion of biogas fuel at the maximum thermal input rating of the assessed combustion plant. In the absence of information regarding exhaust gas temperature, oxygen and moisture content of the combustion plant, the data used in the model is based on professional judgment acquired from previous work involving biogas fuelled CHP engines and boilers of a similar thermal input capacity.

The emissions inventory of releases to air from the CHP engines and boilers are provided in Appendix A.

5 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 and as transposed into Schedule 25A of The Environmental Permitting (England and Wales) (Amendment) Regulations 2018 (United Kingdom (UK) Government, 2018)).

6 A maximum H_2S concentration of 811 mg/m^3 was recorded on-site between 1st January 2024 and 12th September 2024. Further information on the conversion of H_2S to SO_2 is provided in Appendix B.

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, 23 of the closest sensitive human receptors (such as residential properties, a recreational route and off-road cycle route) near the site were identified for modelling purposes. The location of these receptors are presented in Figure 2. Furthermore, the *Derby NO_2 Air Quality Management Area (AQMA) No.1 Ring Roads* and *Derby NO_2 AQMA No.2 A52* (see Section 4.2), which are in close proximity to the site, were also included in the assessment.

In line with the Environment Agency guidance '*Air emissions risk assessment for your environmental permit*' (Environment Agency, 2024b), 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)), within 2 km.

Based on these criteria, 15 LWSs and three LNRs were included in the assessment. The location of the assessed protected conservation areas are presented in Figure 3 and further details are set out in Appendix A. It should be noted there are no European sites and SSSIs within 10 km and 2 km, respectively, of the site.

3.2 Overall Methodology

The assessment was carried out using an atmospheric dispersion modelling technique. Atmospheric Dispersion Modelling System (ADMS) version 6.0.2 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 the Environment Agency.

The modelling assessment was undertaken in accordance with the Environment Agency guidance '*Air emissions risk assessment for your environmental permit*' (Environment Agency, 2024b).

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

1. Information on plant location and stack parameters were supplied by Severn Trent (Severn Trent, 2024). Information on the CHP engines and boilers were obtained from various sources as described in Section 2.2.
2. Five years of hourly sequential data recorded at Nottingham/Watnall (2016 – 2020 inclusive) were used for the assessment (ADM Ltd, 2024).
3. Information on the main buildings located on-site, that could influence dispersion of emissions from the boilers and generator stacks were estimated from Defra's environmental open-data applications and datasets (Defra, 2024a), on-site photography and Google Earth (Google Earth, 2024).
4. The maximum predicted concentrations (at a modelled height of 1.5 m or 'breathing zone') at the assessed sensitive human receptor locations R1 – R18 (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 R19-R23 (representing a recreational route and off-road cycle route), 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. The nearby AQMAs (see Section 4.2) were considered for annual mean NO_2 concentrations only.
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 4.2) 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, 2024b) document to determine the nature and extent of any potential adverse effects.
8. Modelled concentrations were processed using geographic information system (GIS) software (ArcGIS Pro 3.1.2) to produce contour plots of the model results. These are provided for illustrative purposes only; assessment of the model results was based on the numerical values outputted by the dispersion model on the model grid (see Figure 2) 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 areas. Details of the deposition assessment methodology are provided in Appendix C.

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 *Air Quality Strategy for England* (Defra, 2023). The Air Quality Strategy stipulates a number of air quality objectives for nine main air pollutants with respect to ambient levels of air quality (Defra, 2023). 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* (UK Government, 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 3-1. Relevant Environmental Assessment Levels (EALs) set out in the Environment Agency guidance (Environment Agency, 2024b) are also included in Table 3-1 where these supplement the AQOs.

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

Table 3-1: 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

Pollutant	EQS (µg/m^3)	Concentration measured as
	50	24-hour mean, not to be exceeded more than 35 times a year (90.41st percentile)
$PM_{2.5}$	20	Annual mean
Benzene	5	Annual mean
	30	Maximum 24-hour mean (100th percentile)
Toluene	8,000	Maximum 1-hour mean (100th percentile)
	260	Weekly mean

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

- if the PC is less than 1% of the long-term EQS, the contribution can be considered as 'insignificant' and not representative of a significant effect (i.e. not significant) (Environment Agency, 2024b);
- 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'; and
- where the PC is greater than 1% of the EQS and the PEC is greater than 70% of the EQS, professional judgement is used to determine the overall significance of the effect (i.e. whether the effect would be 'not significant' or 'significant'), taking account of the following:
  - the scale of the changes in concentrations;
  - whether or not an exceedance of an EQS is predicted to arise in the study area where none existed before, or an exceedance area is substantially increased as a result of the development; and
  - uncertainty, including the influence and validity of any assumptions adopted in undertaking the assessment.

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

- if the PC is less than 10% of the short-term EQS, this would be classed as 'insignificant' and not representative of a significant effect (i.e. not significant) (Environment Agency, 2024b);
- 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; and
- 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, 2024b).

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 3-2 (Environment Agency, 2024b).

Table 3-2: 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

Pollutant	EQS (µg/m^3)	Concentration measured as
	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 Air Pollution Information System (APIS) website. Critical Loads are defined on the APIS website (Centre for Ecology and Hydrology, 2024) 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 3-3.

For the assessed local natures sites, the *Search by Location* function on the APIS website was used. Where the likely vegetation type inhabiting the assessed local nature site is unknown, the acid grassland (representing short vegetation type) and / or broadleaved deciduous woodland habitat feature (representing tall vegetation type) were selected on the APIS website.

The critical loads for the designated habitat sites considered in this assessment are set out in Table 3-3.

Table 3-3: Critical loads for modelled protected conservation areas

Rec 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	West Park Meadow LNR	Broadleafed/Coniferous unmanaged woodland	Tall	2.676	0.142	2.818	10
H2	The Sanctuary LNR	Broadleafed/Coniferous unmanaged woodland	Tall	1.676	0.142	1.818	10
H3	Elvaston LNR	Broadleafed/Coniferous unmanaged woodland	Tall	1.673	0.142	1.815	10
H4	Acordis Lagoons LWS	Broadleafed/Coniferous unmanaged woodland	Tall	1.674	0.142	1.816	10
H5	Accordis Effluent Beds LWS	Broadleafed/Coniferous unmanaged woodland	Tall	2.622	0.142	2.764	10
H6	Former Shardlow Sewage Works LWS	Broadleafed/Coniferous unmanaged woodland	Tall	2.622	0.142	2.764	10
H7	Former Spondon Power Station Meadow LWS	Broadleafed/Coniferous unmanaged woodland	Tall	2.622	0.142	2.764	10
H8	Alvaston Scrub LWS	Broadleafed/Coniferous unmanaged woodland	Tall	1.673	0.142	1.815	10
H9	Chaddesden Brook and Mossey Yard Plantation LWS	Broadleafed/Coniferous unmanaged woodland	Tall	2.683	0.142	2.825	10
H10	Meadow Lane Bank LWS	Broadleafed/Coniferous unmanaged woodland	Tall	1.727	0.142	1.869	10
H11	Orchard, Coleman Street LWS	Acid grassland	Short	0.900	0.223	1.123	5
H12	Elvaston Castle Country Park LWS	Broadleaved, Mixed and Yew Woodland	Tall	1.673	0.142	1.815	10
H13	Eden Street Meadow LWS	Acid grassland	Short	0.900	0.223	1.123	5
H14	Meadow Farm Marsh LWS	Broadleafed/Coniferous unmanaged woodland	Tall	1.727	0.142	1.869	10
H15	Chaddesden Sidings LWS	Broadleafed/Coniferous unmanaged woodland	Tall	1.727	0.142	1.869	10
H16	Green Lane Nature Area - aka Alvaston Community LWS	Broadleafed/Coniferous unmanaged woodland	Tall	1.673	0.142	1.815	10
H17	River Derwent LWS	Broadleafed/Coniferous unmanaged woodland	Tall	1.674	0.142	1.816	10
H18	Sewage Farm Lagoons LWS	Broadleafed/Coniferous unmanaged woodland	Tall	1.674	0.142	1.816	10

Critical load functions for acid deposition are specified on the basis of both nitrogen 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 PC (i.e. emissions from the modelled process alone) and the PEC (i.e. 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, 2024).

Significance Criteria – Local nature sites (i.e. LWSs and LNRs)

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, 2024b) 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 Location

The site is situated approximately 3.5 km east-southeast from the centre of the city of Derby. The site is surrounded by commercial/light industrial premises and residential properties with the River Derwent bordering and sometimes encroaching the site. The A6 road is adjacent to the southern and western boundary of the site.

There are several sensitive human receptors in the vicinity of the site in respect of potential air emissions from the process. The most relevant sensitive receptors have been identified from local mapping and are summarised in Appendix A and presented in Figure 2. The nearest modelled residential property is approximately 690 m northeast of the A1 emission source stack. The nearest modelled receptor represents a recreational route / off-road cycle route approximately 490 m south of the of the A1 emission source stack at its closest point.

4.2 Local Air Quality Management

A review of baseline air quality was carried out prior to undertaking the air quality assessment. This was carried out to determine the availability of baseline air quality data recorded in the vicinity of the site and also if data from other regional or national sources such as the UK Air Information Resource (UK-AIR) (Defra, 2024b) website could be used to represent background concentrations of the relevant pollutants in the vicinity of the site.

As part of the Local Air Quality Management (LAQM) process, Derby City Council have declared two AQMAs, *Derby NO_2 AQMA No.1 Ring Roads*, which is approximately 0.7 km south of the site at its closest point and *Derby NO_2 AQMA No.2 A52,* which is approximately 0.5 km northeast of the site at its closest point. Both AQMAs, which have been declared for elevated concentrations of annual mean NO_2, have been considered in the assessment accordingly.

Derby City Council carry out regular assessments and monitoring of air quality within their administrative area as part of the LAQM process. The most recent Air Quality Annual Status Reports (Derby City Council, 2023) was reviewed to determine the concentrations of NO_2 in the vicinity for the site. None of the other pollutants are monitored by Derby City Council.

Table 4-1 presents information on the nearest NO_2 monitoring locations to the site.

Table 4-1: Nearest NO_2 monitoring locations to the site

Site ID	Description	Site type	Location	Distance and direction from site centre	2022 Annual mean concentration (µg/m³)
Automatic monitoring					
AURN	St Alkmund's Way	Roadside	E 435763 N 336306	3.57 km, WNW	27.0
Non-automatic monitoring (diffusion tubes)					
DER1	198 Derby Road	Roadside	E438942 N 335864	1.24 km, N	24.8
GC1	23 Gilbert Close	Roadside	E 439776 N 335696	1.37 km, NE	18.8
HS1	16/18 Harrow Street	Roadside	E 437196 N 334410	1.73 km, W	25.8
KL1	10 Kirkleys Avenue	Roadside	E 440206 N 335650	1.65 km, NE	19.7
KL2	27 Kirkleys Avenue	Roadside	E 440198 N 335611	1.62 km, NE	17.1
LR1	938 London Road	Roadside	E 437676 N 334090	1.35 km, WSW	38.7
LR2	1178 (1170) London Road	Roadside	E 438162 N 333654	1.23 km, SW	29.2
LW1	18 Leeway	Roadside	E 439647 N 335575	1.20 km, NE	19.3
NR1	24 Nottingham Road	Roadside	E 439899 N 335348	1.22 km, NE	31.9
RW1	7 Raynesway	Roadside	E 438535 N 333508	1.18 km, SSW	25.6

Site ID	Description	Site type	Location	Distance and direction from site centre	2022 Annual mean concentration (µg/m³)
SR1	1 Station Road	Roadside	E 439789 N 335412	1.18 km, NE	20.2

The automatic and non-automatic monitoring locations presented in Table 4-1, which are located adjacent to the A6 or A6005 roads, are not considered representative of conditions experienced at the site due to their respective distance from the site.

For the assessed pollutants, information on background air quality in the vicinity of the site were obtained from Defra background map datasets (Defra, 2024b). For NO_2 and particulates, 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. For benzene concentrations, the 2010-based background maps were used. For toluene concentrations, in the absence of background map concentrations, the closest monitoring location to the site was considered in the assessment.

As it is necessary to determine the potential impact of emissions from the site at the assessed protected conservation areas, the background concentrations of NOx and SO_2 were also identified. These background concentrations were also obtained from the Defra background map datasets (Defra, 2024b) and are displayed in Table 4-2.

Table 4-2: Background concentrations: adopted for use in assessment for human receptors and protected conservation areas

Pollutant	Annual mean concentration (µg/m³)	Description
Human receptors		
NO_2	10.8 – 24.9	Defra 1 km x 1 km background map value for the assessed sensitive human receptor locations, 2024 map concentration
CO	174 - 209	Defra 1 km x 1 km background map value for the assessed sensitive human receptor locations, 2001 based map concentration
PM_{10}	11.9 – 14.3	Defra 1 km x 1 km background map value for the assessed sensitive human receptor locations, 2024 map concentration
$PM_{2.5}$	7.7 – 16.0	Defra 1 km x 1 km background map value for the assessed sensitive human receptor locations, 2024 map concentration
SO_2	5.0 – 6.9	Defra 1 km x 1 km background map value for the assessed sensitive human receptor locations, 2001 based map concentration
Benzene	0.4 – 0.6	Defra 1 km x 1 km background map value for grid squares representing the assessed sensitive human receptor locations, 2010 map concentration
Toluene	1.6	London Marylebone Road (UKA00315) (Urban Traffic site type) monitoring station, 2023 monitored concentration. The monitoring station is approximately 177 km south-southeast of the site.
Protected conservation areas		
NOx	14.4 – 39.1	Defra 1 km x 1 km background map value for the assessed protected conservation areas, 2024 map concentration
SO_2	5.0 – 11.1	Defra 1 km x 1 km background map value for the assessed sensitive human receptor locations, 2001 based map concentration

The long-term background concentrations were doubled to estimate the short-term background concentrations in line with the Environment Agency guidance (Environment Agency, 2024a).

4.3 Existing Deposition Rates

Existing acid and nutrient nitrogen deposition levels were obtained from APIS (Centre for Ecology and Hydrology, 2024). 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 ecological designations are set out in Table 4-3.

Table 4-3: Existing deposition at modelled habitat sites

Rec 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 and sulphur	Nitrogen
H1	West Park Meadow LNR	Tall	2.33	29.53
H2	The Sanctuary LNR	Tall	2.32	29.55
H3	Elvaston LNR	Tall	2.20	27.99
H4	Acordis Lagoons LWS	Tall	2.25	28.75
H5	Accordis Effluent Beds LWS	Tall	2.22	28.35
H6	Former Shardlow Sewage Works LWS	Tall	2.22	28.35
H7	Former Spondon Power Station Meadow LWS	Tall	2.22	28.35
H8	Alvaston Scrub LWS	Tall	2.23	28.36
H9	Chaddesden Brook and Mossey Yard Plantation LWS	Tall	2.41	30.47
H10	Meadow Lane Bank LWS	Tall	2.32	29.57
H11	Orchard, Coleman Street LWS	Short	1.25	15.44
H12	Elvaston Castle Country Park LWS	Tall	2.2	27.99
H13	Eden Street Meadow LWS	Short	1.27	15.53
H14	Meadow Farm Marsh LWS	Tall	2.32	29.57
H15	Chaddesden Sidings LWS	Tall	2.32	29.57
H16	Green Lane Nature Area - aka Alvaston Community LWS	Tall	2.25	28.73
H17	River Derwent LWS	Tall	2.25	28.75
H18	Sewage Farm Lagoons LWS	Tall	2.25	28.75

5. Results

5.1 Human Receptors

The results presented below are the maximum modelled concentrations predicted at any of the 23 assessed sensitive human receptor locations, the two considered AQMAs and the maximum modelled concentrations 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 5-1, 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 D.

Table 5-1: Results of detailed assessment

Pollutant	Averaging period	Assessment location	Location where maximum PC predicted	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	R7	10,000	360.6	59.7	420.3	0.6%	4.2%	0.6%
	Maximum 1-hour mean	Maximum off-site	E 438853 N 334575	30,000	387.8	663.0	1,050.7	2.2%	3.5%	2.2%
		Sensitive locations	R19	30,000	387.8	121.5	509.2	0.4%	1.7%	0.4%
NO_2	Annual mean	Sensitive locations	R7	40	16.3	1.4	17.7	3.6%	44.3%	-
		Derby NO_2 AQMA No 1: Ring Roads	-	40	14.7	0.3	15.0	0.7%	37.5%	-
		Derby NO_2 AQMA No 2: A52	-	40	16.3	0.5	16.8	1.3%	42.0%	-
	1-hour mean (99.79th percentile)	Maximum off-site	E 438853 N 334575	200	32.6	115.2	147.8	57.6%	73.9%	68.8%
		Sensitive locations	R19	200	32.6	16.2	48.8	8.1%	24.4%	9.7%
SO_2	24-hour mean (99.18th percentile)	Sensitive locations	R7	125	13.8	8.7	22.5	6.9%	18.0%	7.8%
	1-hour mean (99.73rd percentile)	Maximum off-site	E 438853 N 334575	350	11.6	311.9	323.5	89.1%	92.4%	92.2%
		Sensitive locations	R7	350	13.8	30.7	44.5	8.8%	12.7%	9.1%
	15-minute mean (99.9th percentile)	Maximum off-site	E 438853 N 334575	266	11.6	325.9	337.5	122.5%	126.9%	128.1%
		Sensitive locations	R19	266	11.6	64.5	76.0	24.2%	28.6%	25.3%
PM_{10}	Annual mean	Sensitive locations	R7	40	12.9	0.03	12.9	0.1%	32.4%	-
	24-hour mean (90.41st percentile)	Sensitive locations	R7	50	25.8	0.11	25.9	0.2%	51.9%	0.4%
$PM_{2.5}$	Annual mean	Sensitive locations	R7	20	8.4	0.03	8.5	0.1%	42.4%	-
Benzene	Annual mean	Sensitive locations	R7	5	0.5	0.01	0.5	0.1%	9.5%	-
	Maximum 24-hourly mean	Sensitive locations	R7	30	0.9	0.1	1.0	0.2%	3.3%	0.2%

Pollutant	Averaging period	Assessment location	Location where maximum PC predicted	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 (%)
Toluene	Weekly mean[2]	Sensitive locations	R7	260	3.2	0.1	3.4	0.1%	1.3%	-
	Maximum 1-hourly mean	Maximum off-site	E 438853 N 334575		3.2	3.4	6.6	<0.1%	0.1%	<0.1%
		Sensitive locations	R7	8000	3.2	0.4	3.6	<0.1%	<0.1%	<0.1%

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, R19 – R23 have been omitted from analysis as these receptor locations represent a recreational route / off-road cycle route (i.e. short-term exposure only). The full results are presented in Appendix D.

Note 2: The maximum 24-hour mean PC is presented as a conservative approach.

Bold denotes exceedance

The results in Table 5-1 indicate that the predicted concentrations at sensitive human receptors do not exceed any relevant long-term or short-term EQS.

Table 5-1 indicates that for annual mean NO_2, PM_{10}, $PM_{2.5}$ and benzene concentrations, the respective PCs, including those at the assessed AQMAs, are either less than 1% of the relevant long-term EQS or where the PC is above 1% of the relevant EQS (i.e. NO_2), the corresponding PEC is less than 70% of the relevant EQS and the impacts are considered 'not significant' as per Environment Agency guidance (Environment Agency, 2024b).

For short-term NO_2, CO, SO_2, PM_{10}, toluene and benzene concentrations at a sensitive human receptor location and CO concentrations at an off-site location, the PC is either less than 10% of the relevant EQS or where the PC is above 10% of the relevant EQS, the respective PEC is less than 70% of the relevant EQS and the impacts are considered 'not significant'.

For 1-hour mean (99.79th percentile) NO_2 and 1-hour mean (99.73rd percentile) SO_2 concentrations at an off-site location, the respective PCs are above 10% of the relevant EQS and the corresponding PECs are above 70% of the relevant EQS. The highest PCs are predicted to occur at National Grid Reference (NGR) E 438853 N 334575, which is located in an area adjacent to the southern boundary of the site, not accessible to the public. Although the PCs are elevated, for short-term concentrations this assessment assumes all considered emission sources operate simultaneously. In practice, the boilers are primarily used as a back-up for electricity and/or heat production when the CHP engines are undergoing routine maintenance and the CHP engines are unlikely to operate simultaneously.

For 15-minute mean (99.9th percentile) SO_2 concentrations at an off-site location, an exceedance of the relevant EQS is predicted. The highest PC is again predicted to occur at NGR E 438853 N 334575, adjacent to the southern boundary of the site. As described above, the conservative approach adopted throughout this assessment means the predicted concentrations presented in Table 5-1 are likely to be higher than would reasonably be expected.

Isopleths (see Figures 4 and 7) have been produced for annual mean and 1-hour mean (99.79th percentile) NO_2 concentrations and 1-hour mean (99.73rd percentile) and 15 minute mean (99.9th percentile) SO_2 concentrations. The figures are 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 has been determined by comparing predicted concentrations of released substances with the EQSs for the protection of vegetation (critical levels) (see Table 3-2). The results of the detailed modelling at the assessed protected conservation areas are shown in Table 5-2. The results presented are the maximum predicted concentrations at the modelled locations for the five years of meteorological data used in the study area.

For SO_2 PCs, the relevant EQS was based on the assumption that lichens and bryophytes were not present at the assessed protected conservation areas, therefore adopting the critical level of 20 µg/m^3.

Table 5-2: Results of detailed assessment at assessed protected conservation sites for annual mean NOx and SO_2 concentrations and for maximum 24-hour mean NOx concentrations

Rec 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 (%)
Annual mean NOx concentrations							
H1	West Park Meadow LNR	30	17.4	0.27	17.6	0.9%	58.8%
H2	The Sanctuary LNR		39.1	0.15	39.3	0.5%	130.9%
H3	Elvaston LNR		14.4	0.18	14.5	0.6%	48.5%

Rec 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 (%)
H4	Acordis Lagoons LWS		16.0	1.82	17.8	6.1%	59.3%
H5	Accordis Effluent Beds LWS		15.3	0.36	15.6	1.2%	52.1%
H6	Former Shardlow Sewage Works LWS		15.3	0.71	16.0	2.4%	53.3%
H7	Former Spondon Power Station Meadow LWS		15.3	0.34	15.6	1.1%	52.1%
H8	Alvaston Scrub LWS		16.2	0.26	16.4	0.9%	54.8%
H9	Chaddesden Brook and Mossey Yard Plantation LWS		19.7	0.09	19.8	0.3%	65.9%
H10	Meadow Lane Bank LWS		27.1	0.17	27.3	0.6%	90.9%
H11	Orchard, Coleman Street LWS		21.7	0.23	21.9	0.8%	73.0%
H12	Elvaston Castle Country Park LWS		14.4	0.14	14.5	0.5%	48.3%
H13	Eden Street Meadow LWS		22.8	0.79	23.6	2.6%	78.8%
H14	Meadow Farm Marsh LWS		27.1	0.35	27.4	1.2%	91.5%
H15	Chaddesden Sidings LWS		27.1	0.22	27.3	0.7%	91.0%
H16	Green Lane Nature Area - aka Alvaston Community LWS		20.2	0.38	20.6	1.3%	68.7%
H17	River Derwent LWS		16.0	25.18	41.2	83.9%	**137.2%**
H18	Sewage Farm Lagoons LWS		16.0	7.19	23.2	24.0%	77.3%
Annual mean SO_2 concentrations							
H1	West Park Meadow LNR	20	11.1	0.13	11.2	0.7%	56.2%
H2	The Sanctuary LNR		6.2	0.07	6.3	0.4%	31.3%
H3	Elvaston LNR		5.0	0.08	5.1	0.4%	25.3%
H4	Acordis Lagoons LWS		5.3	0.83	6.1	4.2%	30.5%
H5	Accordis Effluent Beds LWS		5.2	0.17	5.4	0.8%	26.8%
H6	Former Shardlow Sewage Works LWS		5.2	0.32	5.5	1.6%	27.6%
H7	Former Spondon Power Station Meadow LWS		5.2	0.16	5.4	0.8%	26.8%
H8	Alvaston Scrub LWS		5.3	0.13	5.4	0.6%	27.2%
H9	Chaddesden Brook and Mossey Yard Plantation LWS		5.4	0.04	5.4	0.2%	27.2%
H10	Meadow Lane Bank LWS		5.5	0.08	5.5	0.4%	27.7%
H11	Orchard, Coleman Street LWS		5.8	0.11	5.9	0.6%	29.7%
H12	Elvaston Castle Country Park LWS		5.0	0.07	5.0	0.3%	25.2%
H13	Eden Street Meadow LWS		5.8	0.38	6.2	1.9%	30.8%
H14	Meadow Farm Marsh LWS		5.5	0.17	5.6	0.8%	28.1%
H15	Chaddesden Sidings LWS		5.5	0.10	5.6	0.5%	27.8%
H16	Green Lane Nature Area - aka Alvaston Community LWS		6.5	0.18	6.7	0.9%	33.5%

Rec ref	Protected Conservation Area	EQS (µg/m³)	Background concentration (µg/m³)	PC (µg/m³)	PEC (µg/m³)	PC/EQS (%)	PEC/EQS (%)
H17	River Derwent LWS		5.3	11.21	16.5	56.1%	82.4%
H18	Sewage Farm Lagoons LWS		5.3	3.58	8.8	17.9%	44.2%
Maximum 24-hour mean NOx concentrations							
H1	West Park Meadow LNR	75	34.7	3.8	38.5	5.0%	51.3%
H2	The Sanctuary LNR		78.2	2.8	81.1	3.8%	108.1%
H3	Elvaston LNR		28.7	4.0	32.8	5.4%	43.7%
H4	Acordis Lagoons LWS		32.0	15.3	47.3	20.4%	63.1%
H5	Accordis Effluent Beds LWS		30.6	3.8	34.4	5.1%	45.9%
H6	Former Shardlow Sewage Works LWS		30.6	5.9	36.5	7.9%	48.6%
H7	Former Spondon Power Station Meadow LWS		30.6	3.3	33.9	4.4%	45.2%
H8	Alvaston Scrub LWS		32.3	5.7	38.0	7.6%	50.7%
H9	Chaddesden Brook and Mossey Yard Plantation LWS		39.4	2.8	42.2	3.8%	56.2%
H10	Meadow Lane Bank LWS		54.2	5.2	59.4	6.9%	79.2%
H11	Orchard, Coleman Street LWS		43.3	5.0	48.3	6.6%	64.4%
H12	Elvaston Castle Country Park LWS		28.7	3.0	31.7	4.0%	42.3%
H13	Eden Street Meadow LWS		45.7	10.6	56.3	14.1%	75.0%
H14	Meadow Farm Marsh LWS		54.2	6.2	60.4	8.2%	80.5%
H15	Chaddesden Sidings LWS		54.2	7.2	61.4	9.6%	81.9%
H16	Green Lane Nature Area - aka Alvaston Community LWS		40.4	7.3	47.7	9.7%	63.6%
H17	River Derwent LWS		32.0	145.2	177.1	**193.6%**	**236.2%**
H18	Sewage Farm Lagoons LWS		32.0	96.1	128.1	**128.1%**	**170.7%**

Bold denotes exceedance

The results in Table 5-2 indicate that at the assessed local nature sites, the annual mean NOx and SO_2 PCs are less than 100% of the relevant critical level and the effect is considered 'insignificant' as per Environment Agency guidance (Environment Agency, 2024b). It is noted that the annual mean NOx PEC at H17 (River Derwent LWS) exceeds the relevant EQS. As discussed previously, the conservative nature of the assessment means the predicted concentrations presented in Table 5-2 are likely to be higher than would reasonably be expected.

For the maximum 24-hour mean critical level for NOx, the results indicate that with the exception of H17 (River Derwent LWS) and H18 (Sewage Farm Lagoons LWS), the PCs are less than 100% of the relevant critical level and the effect is considered 'insignificant' as per Environment Agency guidance (Environment Agency, 2024b).

5.2.1.1 River Derwent LWS and Sewage Farm Lagoons LWS

The River Derwent LWS borders and in some instances encroaches the site and Sewage Farm Lagoons LWS is adjacent to the eastern and southern boundary of the site. As such, a modelled grid (at ground level) with calculation points every 10 m, was applied in the assessment to represent the two LWSs to ensure the maximum PCs were quantified (see Appendix A, Section A.3.2 for further description and Figure 5-1).

Figure 5-1. Modelled grid points to represent H17 and H18 for 24-hour mean critical level for NOx

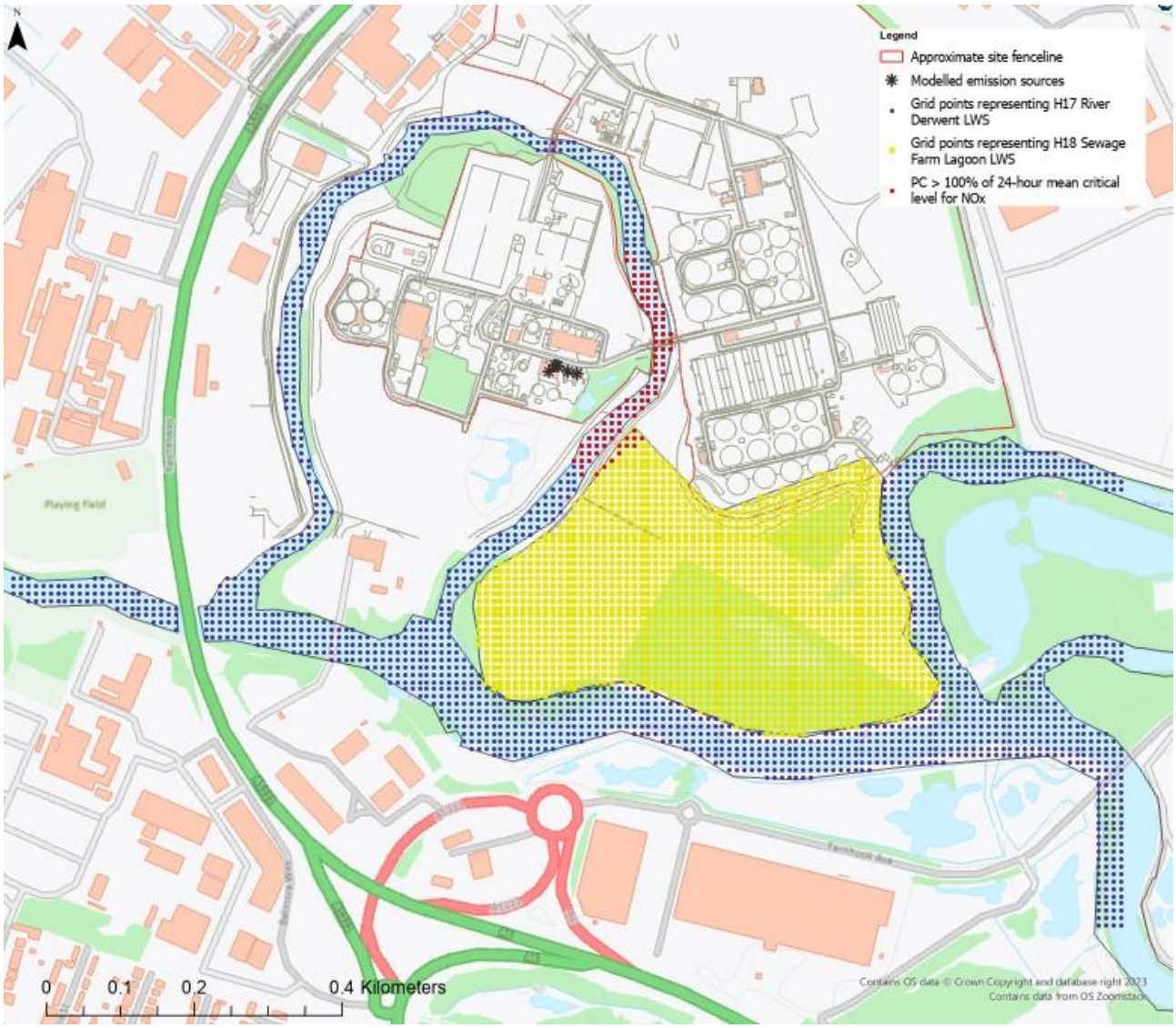

Table 5-3 presents the number of grid points considered in the assessment for H17 and H18 and percentage of assessed area where the PC exceeds the 24-hour mean critical level for NOx.

Table 5-3. Maximum 24-hour mean critical level for NOx at H17 and H18

Rec ref	Protected conservation area	Number of grid points considered for LWS[1]	Number of grid points where PC > 100%[1] of EQS	Percentage of area considered where PC > 100% of EQS
H17	River Derwent LWS	1,808	86	4.8%
H18	Sewage Farm Lagoons LWS	1,709	11	0.6%

Note 1: Calculation points every 10 m

Further analysis indicates that the PC exceeds the relevant EQS at less than 5% of the assessed area at H17 (River Derwent LWS) and less than 1% of the assessed area at H18 (Sewage Farm Lagoons LWS).

For short-term concentrations, this assessment assumes all considered emission sources operate simultaneously. In practice, the boilers are primarily used as a back-up for electricity and/or heat production when the CHP engines are undergoing routine maintenance and the CHP engines are unlikely to operate simultaneously. Therefore, the predicted concentrations presented are likely to be higher than would reasonably be expected and based on professional judgement, the impact is considered to be not significant.

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, 2024). Further information on the assessment of deposition is provided in Appendix B. The full detailed modelled results are displayed in Table 5-4 and Table 5-5.

Table 5-4: 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) (S)	PC	PEC	PC/CL (%)	PEC/CL (%)
H1	West Park Meadow LNR	Tall	2.676	0.142	2.818	2.33	0.035	2.37	1.2%	84%
H2	The Sanctuary LNR	Tall	1.676	0.142	1.818	2.32	0.019	2.34	1.0%	**129%**
H3	Elvaston LNR	Tall	1.673	0.142	1.815	2.20	0.023	2.22	1.2%	**122%**
H4	Acordis Lagoons LWS	Tall	1.674	0.142	1.816	2.25	0.222	2.47	12.2%	**136%**
H5	Accordis Effluent Beds LWS	Tall	2.622	0.142	2.764	2.22	0.045	2.26	1.6%	82%
H6	Former Shardlow Sewage Works LWS	Tall	2.622	0.142	2.764	2.22	0.087	2.31	3.1%	83%
H7	Former Spondon Power Station Meadow LWS	Tall	2.622	0.142	2.764	2.22	0.042	2.26	1.5%	82%
H8	Alvaston Scrub LWS	Tall	1.673	0.142	1.815	2.23	0.033	2.26	1.8%	**125%**
H9	Chaddesden Brook and Mossey Yard Plantation LWS	Tall	2.683	0.142	2.825	2.41	0.012	2.42	0.4%	86%
H10	Meadow Lane Bank LWS	Tall	1.727	0.142	1.869	2.32	0.022	2.34	1.2%	**125%**
H11	Orchard, Coleman Street LWS	Short	0.900	0.223	1.123	1.25	0.015	1.26	1.3%	**113%**
H12	Elvaston Castle Country Park LWS	Tall	1.673	0.142	1.815	2.20	0.018	2.22	1.0%	**122%**
H13	Eden Street Meadow LWS	Short	0.900	0.223	1.123	1.27	0.050	1.32	4.5%	**118%**
H14	Meadow Farm Marsh LWS	Tall	1.727	0.142	1.869	2.32	0.045	2.37	2.4%	**127%**
H15	Chaddesden Sidings LWS	Tall	1.727	0.142	1.869	2.32	0.028	2.35	1.5%	**126%**
H16	Green Lane Nature Area - aka Alvaston Community LWS	Tall	1.673	0.142	1.815	2.25	0.047	2.30	2.6%	**127%**
H17	River Derwent LWS	Tall	1.674	0.142	1.816	2.25	3.010	5.26	**165.8%**	**290%**
H18	Sewage Farm Lagoons LWS	Tall	1.674	0.142	1.816	2.25	0.948	3.20	52.2%	**176%**

Bold denotes exceedance

Table 5-5: 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	West Park Meadow LNR	Tall	10	29.53	0.055	29.59	0.6%	**296%**
H2	The Sanctuary LNR	Tall	10	29.55	0.030	29.58	0.3%	**296%**
H3	Elvaston LNR	Tall	10	27.99	0.036	28.03	0.4%	**280%**
H4	Acordis Lagoons LWS	Tall	10	28.75	0.366	29.12	3.7%	**291%**
H5	Accordis Effluent Beds LWS	Tall	10	28.35	0.072	28.42	0.7%	**284%**
H6	Former Shardlow Sewage Works LWS	Tall	10	28.35	0.144	28.49	1.4%	**285%**
H7	Former Spondon Power Station Meadow LWS	Tall	10	28.35	0.069	28.42	0.7%	**284%**
H8	Alvaston Scrub LWS	Tall	10	28.36	0.053	28.41	0.5%	**284%**
H9	Chaddesden Brook and Mossey Yard Plantation LWS	Tall	10	30.47	0.018	30.49	0.2%	**305%**
H10	Meadow Lane Bank LWS	Tall	10	29.57	0.034	29.60	0.3%	**296%**
H11	Orchard, Coleman Street LWS	Short	5	15.44	0.023	15.46	0.5%	**309%**
H12	Elvaston Castle Country Park LWS	Tall	10	27.99	0.028	28.02	0.3%	**280%**
H13	Eden Street Meadow LWS	Short	5	15.53	0.080	15.61	1.6%	**312%**
H14	Meadow Farm Marsh LWS	Tall	10	29.57	0.071	29.64	0.7%	**296%**
H15	Chaddesden Sidings LWS	Tall	10	29.57	0.044	29.61	0.4%	**296%**
H16	Green Lane Nature Area - aka Alvaston Community LWS	Tall	10	28.73	0.077	28.81	0.8%	**288%**
H17	River Derwent LWS	Tall	10	28.75	5.072	33.82	50.7%	**338%**
H18	Sewage Farm Lagoons LWS	Tall	10	28.75	1.448	30.20	14.5%	**302%**

Bold denotes exceedance

The results in Table 5-4 and Table 5-5 indicate that, with the exception of acid deposition at H17 (River Derwent LWS), the PCs are less than 100% of the relevant critical load value for acid and nutrient nitrogen deposition and the impact can be described as 'insignificant' as per Environment Agency guidance (Environment Agency, 2024b).

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

5.2.2.1 River Derwent LWS

Table 5-3 presents the number of grid points considered in the assessment to represent the River Derwent LWS and percentage of the respective area where the PC exceeds the relevant critical load value.

Figure 5-2. Modelled grid points to represent H17 for acid deposition

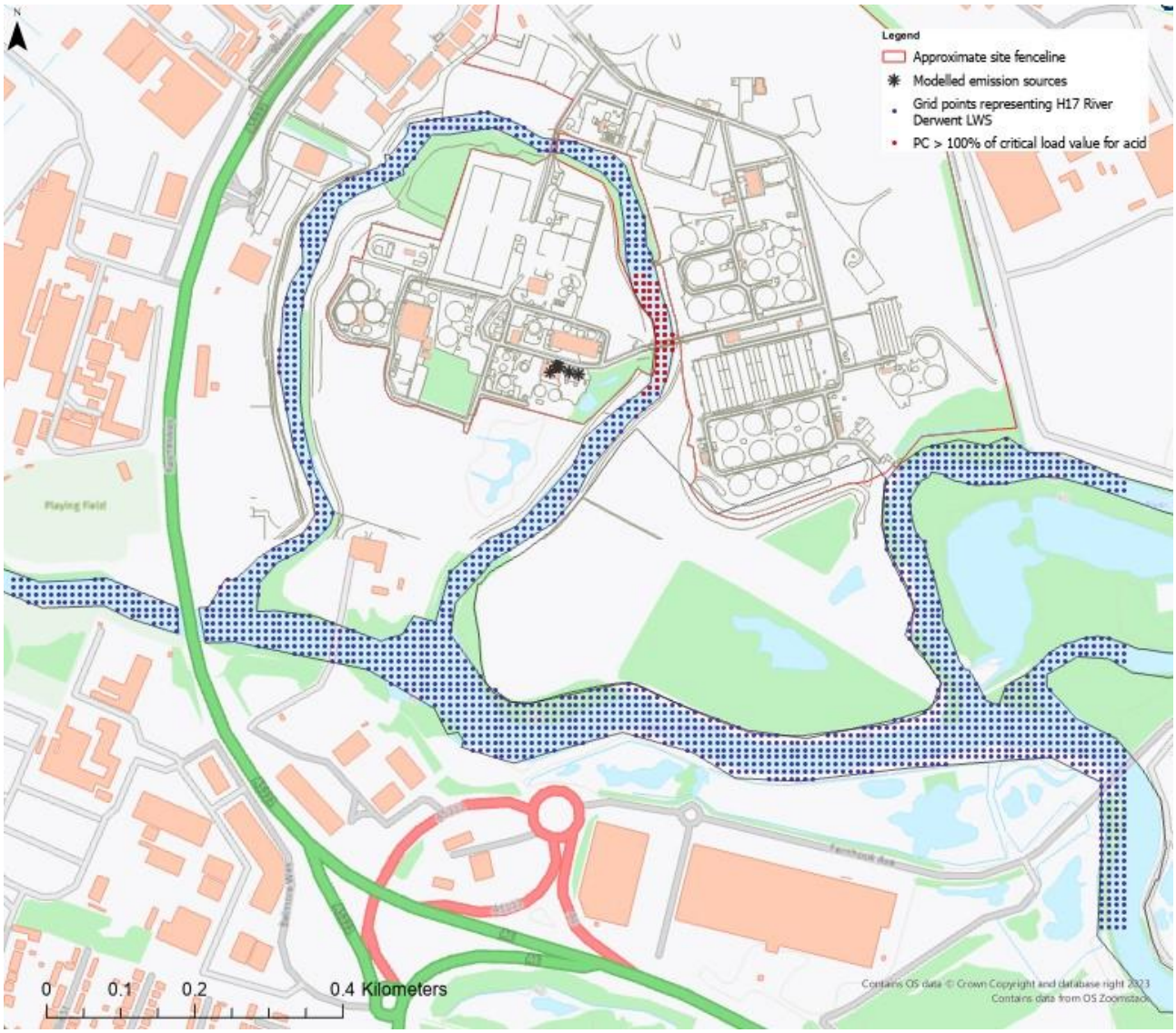

Table 5-6. Modelled acid deposition at H17 (River Derwent LWS)

Rec ref	Protected conservation area	Number of grid points considered with LWS[1]	Number of grid points where PC > 100%[1] of CL value	Percentage of area where PC > 100% of CL value
H17	River Derwent LWS	1,808	44	2.4%

Note 1: Calculation points every 10 m

Further analysis indicates that the PC is predicted to exceed the relevant critical level for acid at less than 3% of the assessed area at H17 (River Derwent LWS).

For critical loads, this assessment has been carried out on the assumption that the assessed replacement Jenbacher CHP engines operate continuously at maximum load throughout the year (i.e. 8,760 hours) and the existing Perkins CHP engine and boilers operate for 4,000 hours per year. This is a conservative assumption as in practice, the Beel boilers, which are primarily used as a back-up for electricity and/or heat production when the CHP engines are undergoing routine maintenance, typically operate for less than 2,000 hours and the Eurograde boiler does not operate. The Perkins CHP engine typically operates for less than 1,000 hours per year. Therefore, the predicted concentrations presented are likely to be higher than would reasonably be expected and based on professional judgement, the impact is considered to be not significant.

5.3 Sensitivity Analysis

A sensitivity study was undertaken to see how changes to the surface roughness and omission of the buildings in the 2016 model (which predicted the highest annual mean and 1-hour mean NO_2 concentrations at sensitive human receptor locations concentrations) may impact on predicted concentrations at sensitive human receptors and off-site locations. The results of the sensitivity analysis are presented in Table 5-7 to Table 5-9.

Table 5-7: Sensitivity analysis - fixed surface roughness of 0.1 m

Pollutant	Averaging period	Assessment location	Original PC (surface roughness 0.5 m) (µg/m³)	Surface roughness length 0.1 m				
				PC (µg/m³)	PEC (µg/m³)	PC/EQS	PEC/EQS	% difference in PC/EQS compared to original
NO_2	Annual mean	Sensitive locations	1.4	1.4	17.7	3.6%	44.3%	<0.1%
	1 hour mean (99.79th percentile)	Maximum off-site	115.2	101.0	133.6	50.5%	66.8%	-7.1%
		Sensitive locations	16.2	16.6	49.2	8.3%	24.6%	0.2%

The results in Table 5-7 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 0.5 m. For 1-hour mean (99.79th percentile) NO_2 concentrations at a sensitive human receptor location, the PC is marginally higher. At an off-site location, the PC is considerably lower. However, a surface roughness of 0.1 m (representing root crops) is not considered representative of the site and surrounding area.

Table 5-8: Sensitivity analysis - fixed surface roughness of 1 m

Pollutant	Averaging period	Assessment location	Original PC (surface roughness 0.5 m) (µg/m³)	Surface roughness length 1 m				
				PC (µg/m³)	PEC (µg/m³)	PC/EQS	PEC/EQS	% difference in PC/EQS compared to original
NO_2	Annual mean	Sensitive locations	1.4	1.4	17.7	3.6%	44.3%	<0.1%
	1 hour mean (99.79th percentile)	Maximum off-site	115.2	118.5	151.1	59.3%	75.6%	1.6%
		Sensitive locations	16.2	14.6	47.2	7.3%	23.6%	-0.8%

The results in Table 5-8 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 0.5 m. For 1-hour mean (99.79th percentile) NO_2 concentrations at a sensitive human receptor location, the PC is marginally lower when modelling with an increased surface roughness value of 1 m. At an off-site location, the PC is slightly higher. 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 5-9: Sensitivity analysis - no buildings

Pollutant	Averaging period	Assessment location	Original PC (with buildings) (µg/m³)	No buildings				
				PC (µg/m³)	PEC (µg/m³)	PC/EQS	PEC/EQS	% difference in PC/EQS compared to original
NO_2	Annual mean	Sensitive locations	1.4	1.4	17.7	3.5%	44.2%	0.0%
	1 hour mean (99.79th percentile)	Maximum off-site	115.2	71.7	104.3	35.9%	52.2%	-21.8%
		Sensitive locations	16.2	13.1	45.7	6.6%	22.9%	-1.6%

The results in Table 5-9 indicate that the differences between the maximum predicted concentrations with and without the buildings is such that including buildings within the model is the preferred option for this study, to maintain a more realistic, and conservative, approach.

6. Conclusions

This report has assessed the potential air quality impacts associated with the operation of the biogas fuelled existing CHP engine and boilers and proposed replacement CHP engines at the Derby STW. The predicted impacts were assessed against the relevant air quality standards and guidelines for the protection of human health and protected conservation areas.

6.1 Human receptors

The assessment indicates that the predicted concentrations at sensitive human receptors do not exceed any relevant long-term or short-term EQSs.

The results indicate that for annual mean NO_2, PM_{10}, $PM_{2.5}$ and benzene concentrations, the respective PC including those for the assessed AQMAs, is either less than 1% of the relevant long-term EQS or where the PC is above 1% of the relevant EQS (i.e. NO_2), the corresponding PEC is less than 70% of the relevant EQS and the impacts are considered 'not significant' as per Environment Agency guidance (Environment Agency, 2024b).

For short-term NO_2, CO, SO_2, PM_{10}, toluene and benzene concentrations at a sensitive human receptor location and CO concentrations at an off-site location, the PC is either less than 10% of the relevant EQS or where the PC is above 10% of the relevant EQS, the respective PEC is less than 70% of the relevant EQS and the impacts are considered 'not significant'.

For 1-hour mean (99.79th percentile) NO_2 and 1-hour mean (99.73rd percentile) SO_2 concentrations at an off-site location, the respective PC is above 10% of the relevant EQS and the corresponding PEC is above 70% of the relevant EQS. The highest PCs are predicted to occur at a location which is not accessible to the public.

For 15-minute mean (99.9th percentile) SO_2 concentrations at an off-site location, an exceedance of the relevant EQS is being predicted. The highest PC is predicted to occur at a location which is not accessible to the public.

This assessment has been carried out on the assumption that for long-term concentrations, the proposed replacement Jenbacher CHP engines operate continuously at maximum load throughout the year (i.e. 8,760 hours) and the existing Perkins CHP engine and boilers operate for 4,000 hours per year. For short-term concentrations, the assessed combustion units are assumed to operate continuously. This is a conservative assumption as in practice, the Beel boilers, which are primarily used as a back-up for electricity and/or heat production when the CHP engines are undergoing routine maintenance, typically operate for less than 2,000 hours and the Eurograde boiler does not operate. The Perkins CHP engine typically operates for less than 1,000 hours per year.

Therefore, when considering the conservative approach to the assessment and based on professional judgement, the emissions of assessed pollutants at sensitive human receptor locations and modelled off-site locations is considered 'not significant'.

6.2 Protected conservation areas

For critical levels, the results indicate that at the assessed local nature sites, the annual mean NOx and SO_2 PCs are less than 100% of the relevant critical level and the effect is considered 'insignificant' as per Environment Agency guidance (Environment Agency, 2024b).

For the maximum 24-hour mean critical level for NOx, the results indicate that with the exception of H17 (River Derwent LWS) and H18 (Sewage Farm Lagoons LWS), the PCs are less than 100% of the relevant critical level and the effect is considered 'insignificant' as per Environment Agency guidance (Environment Agency, 2024b). Further analysis indicates that the PC is predicted to exceed the relevant EQS at less than 5% of the considered area at H17 and less than 1% of the considered area at H18.

For critical loads, the results indicate that with the exception of acid deposition at H17 (River Derwent LWS), the PCs are less than 100% of the relevant critical load value for acid and nutrient nitrogen deposition and the impact can be described as 'insignificant' as per Environment Agency guidance (Environment Agency, 2024b). Further analysis indicates that the PC is predicted to exceed the critical level for acid at less than 3% of the assessed area at H17.

6.3 Summary

Based on the above assessment, it is concluded that the operation of the assessed combustion plant are acceptable from an air quality perspective.

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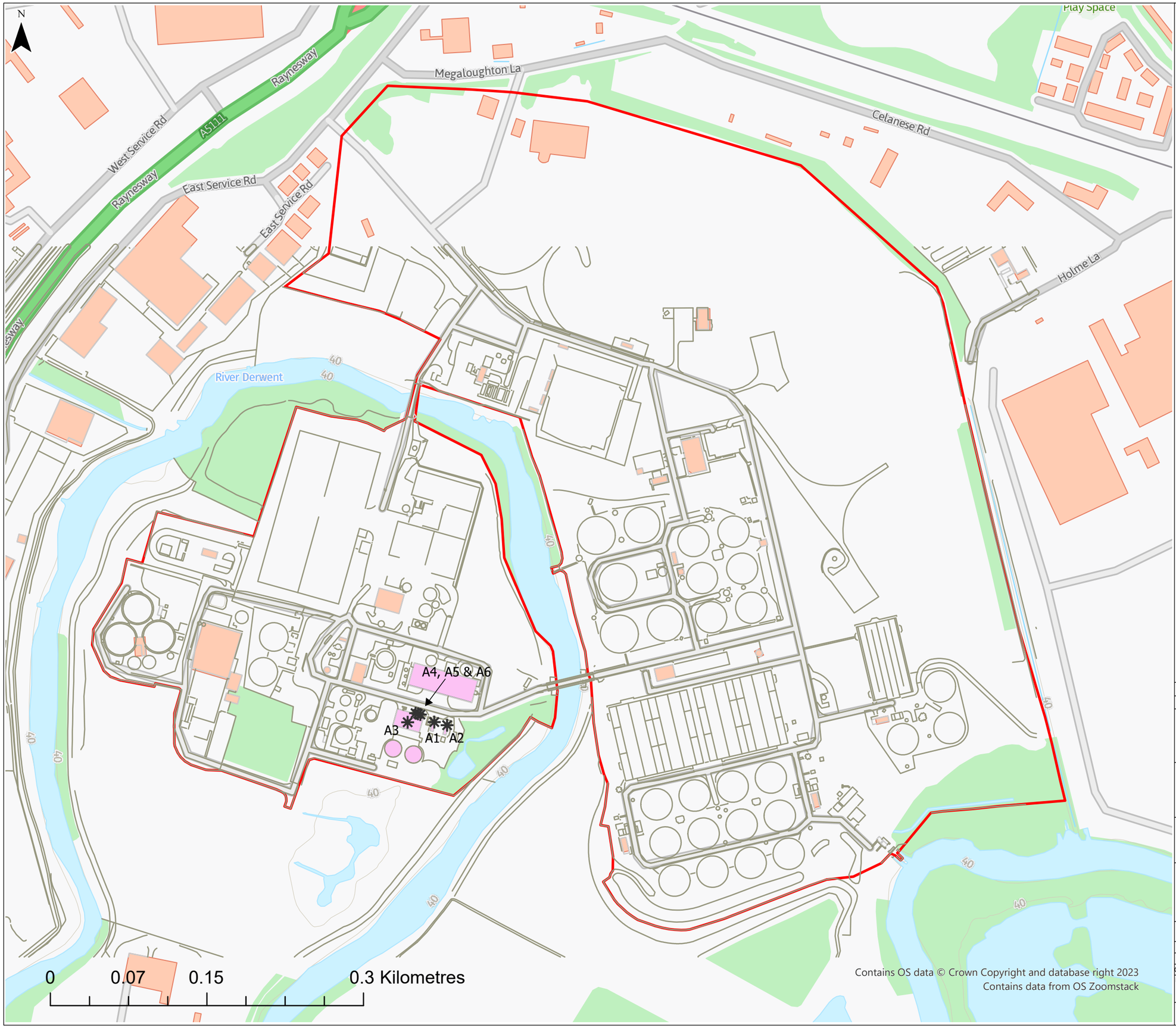
8. Figures



Legend

- Approximate site fenceline
- Modelled emission sources
- Modelled buildings

Rev.	Date	Purpose of revision	Drawn	Check'd	Rev'd	Appr'd
0	23/09/2024	Initial Issue	DH	GW	GW	MM

Jacobs

Client: SEVERN TRENT

Project: ENVIRONMENTAL PERMIT APPLICATION - DERBY SEWAGE TREATMENT WORKS

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

Drawing Status: FINAL

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Jacobs No.	B19589DB	Rev 0
Client No.		

Drawing Number: FIGURE 1

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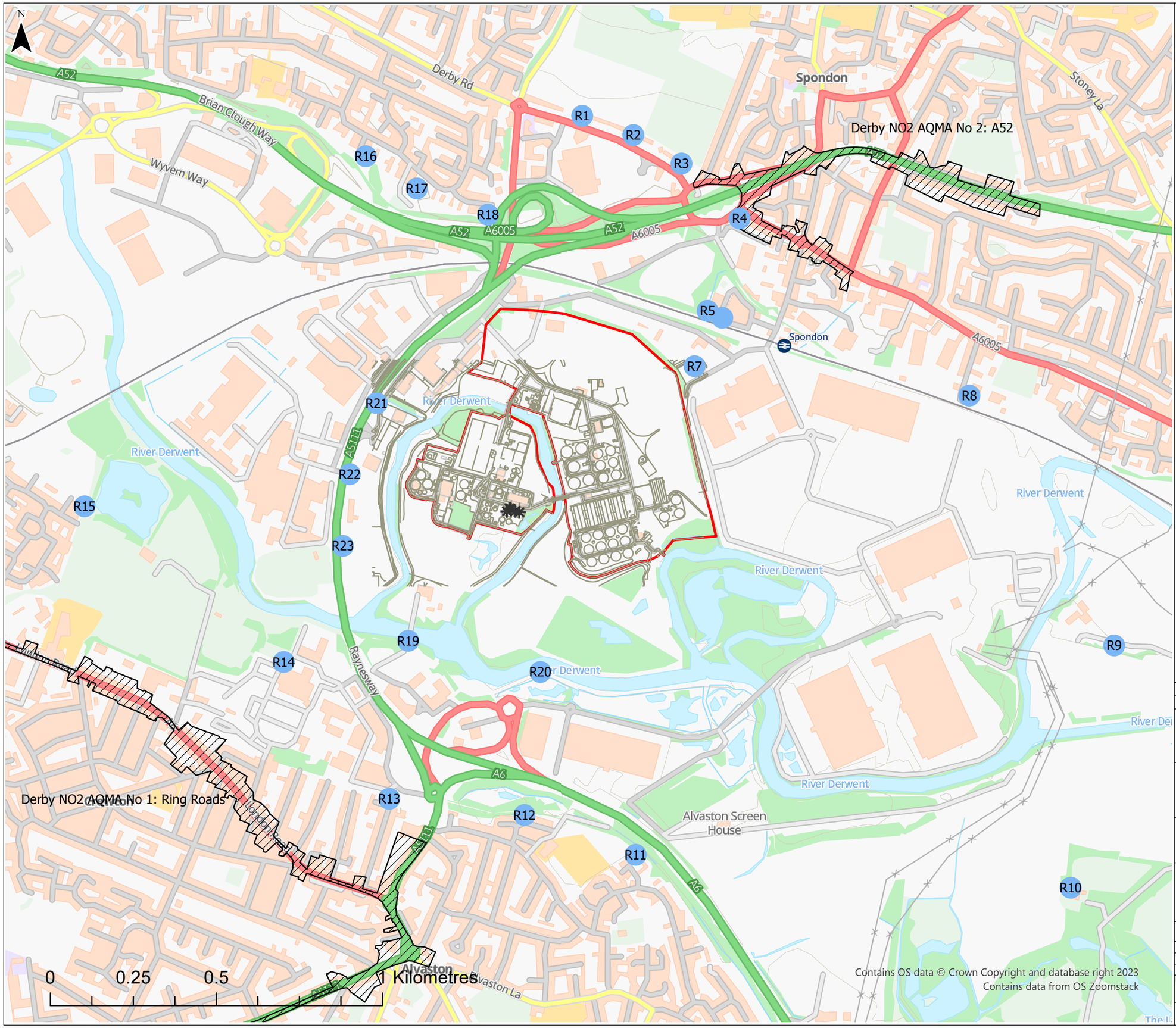

Legend

- Approximate site fenceline
- Modelled emission sources
- R1 Sensitive human receptor locations
- Air Quality Management Area (AQMA)

Rev.	Date	Purpose of revision	Drawn	Check'd	Rev'd	Appr'd
0	23/09/2024	Initial Issue	DH	GW	GW	MM

Jacobs

Client: SEVERN TRENT

Project: ENVIRONMENTAL PERMIT APPLICATION - DERBY SEWAGE TREATMENT WORKS

Drawing Title: SENSITIVE HUMAN RECEPTOR LOCATIONS

Drawing Status: FINAL

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Drawing Number: FIGURE 2

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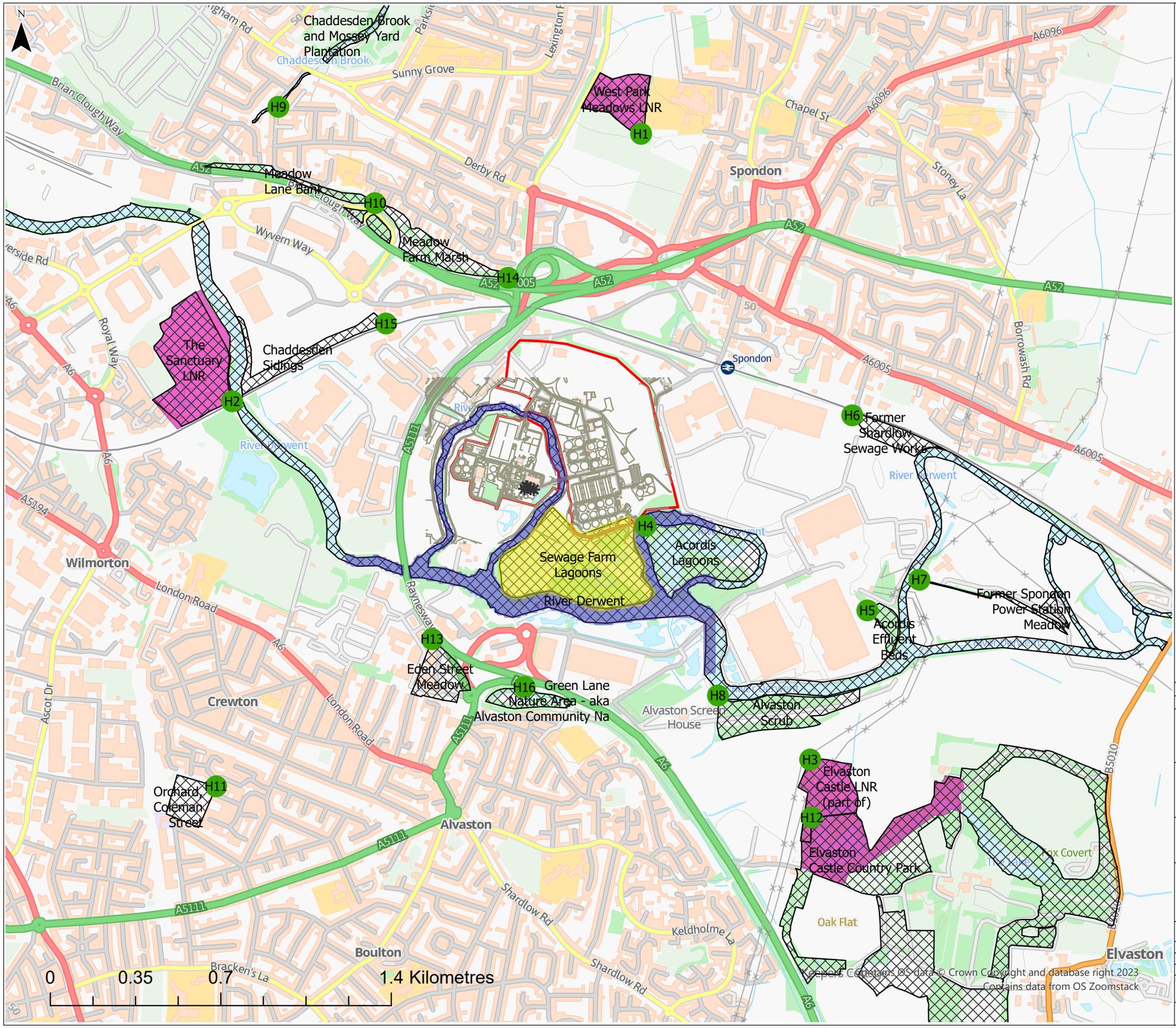

Legend

- Approximate site fenceline
- Modelled emission sources
- Grid points representing H17 River Derwent LWS
- Grid points representing H18 Sewage Farm Lagoon LWS
- Local Wildlife Site (LWS)
- Local Nature Reserve (LNR)
- H1 Protected conservation area

Rev.	Date	Purpose of revision	Drawn	Check'd	Rev'd	Appr'd
0	23/09/2024	Initial Issue	DH	GW	GW	MM

Jacobs

Client: SEVERN TRENT

Project: ENVIRONMENTAL PERMIT APPLICATION - DERBY SEWAGE TREATMENT WORKS

Drawing Title: PROTECTED CONSERVATION AREAS

Drawing Status: FINAL

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Jacobs No.	B19589DB	Rev 0
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Drawing Number: FIGURE 3

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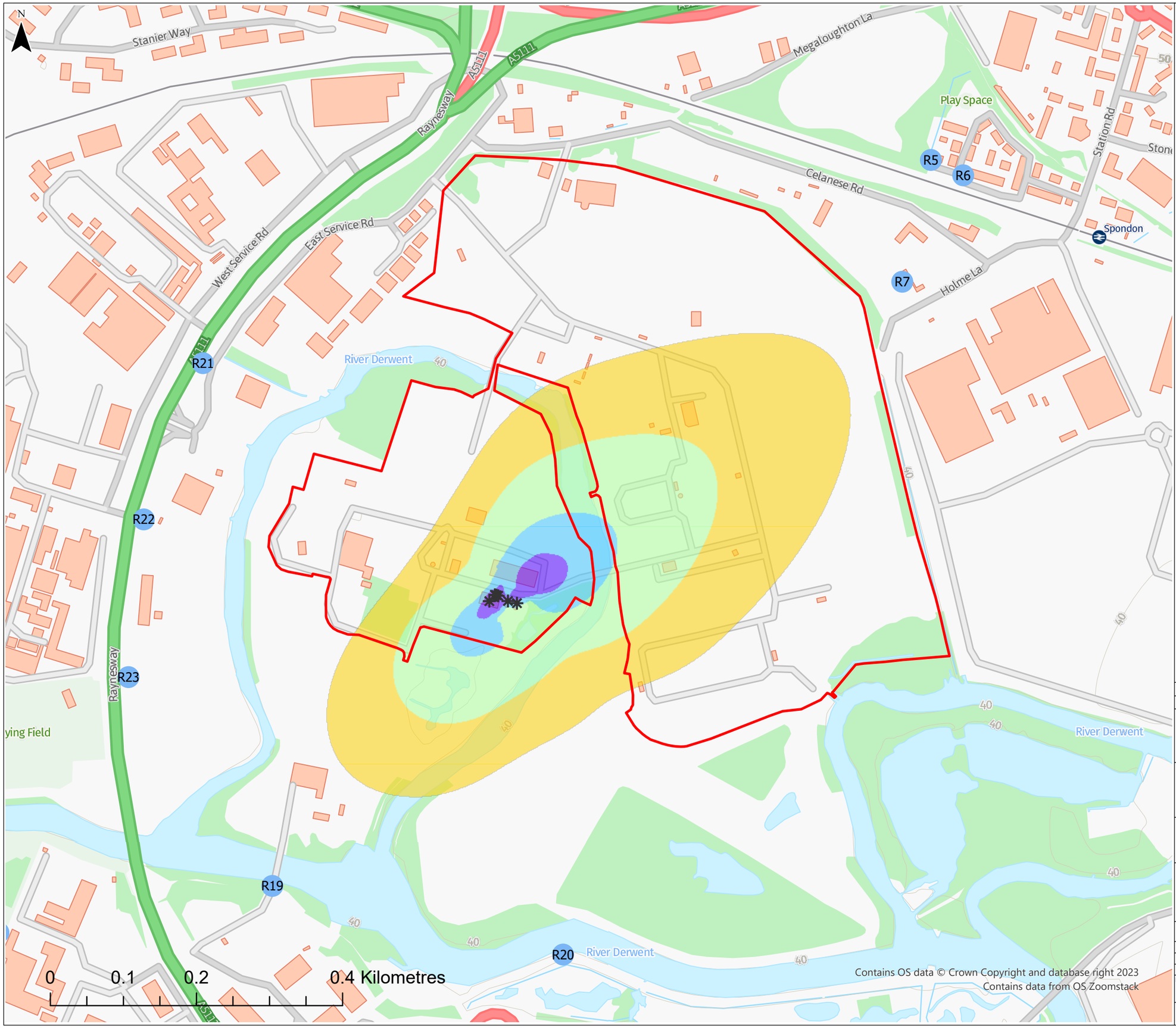

Legend

- Approximate site fenceline
- Modelled emission sources
- R1 Sensitive human receptor locations

Annual mean NO_2 process contributions ($\mu g/m^3$),

- 0 - 2
- 2 - 4
- 4 - 10
- 10 - 20
- 20 - 38

Rev.	Date	Purpose of revision	Drawn	Check'd	Rev'd	Appr'd
0	23/09/2024	Initial Issue	DH	GW	GW	MM

Jacobs

Client: SEVERN TRENT

Project: ENVIRONMENTAL PERMIT APPLICATION - DERBY SEWAGE TREATMENT WORKS

Drawing Title: ANNUAL MEAN NITROGEN DIOXIDE PROCESS CONTRIBUTIONS ($\mu g/m^3$), 2016 METEOROLOGICAL DATA

Drawing Status: FINAL

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Jacobs No.	B19589DB	Rev 0
Client No.		

Drawing Number: FIGURE 4

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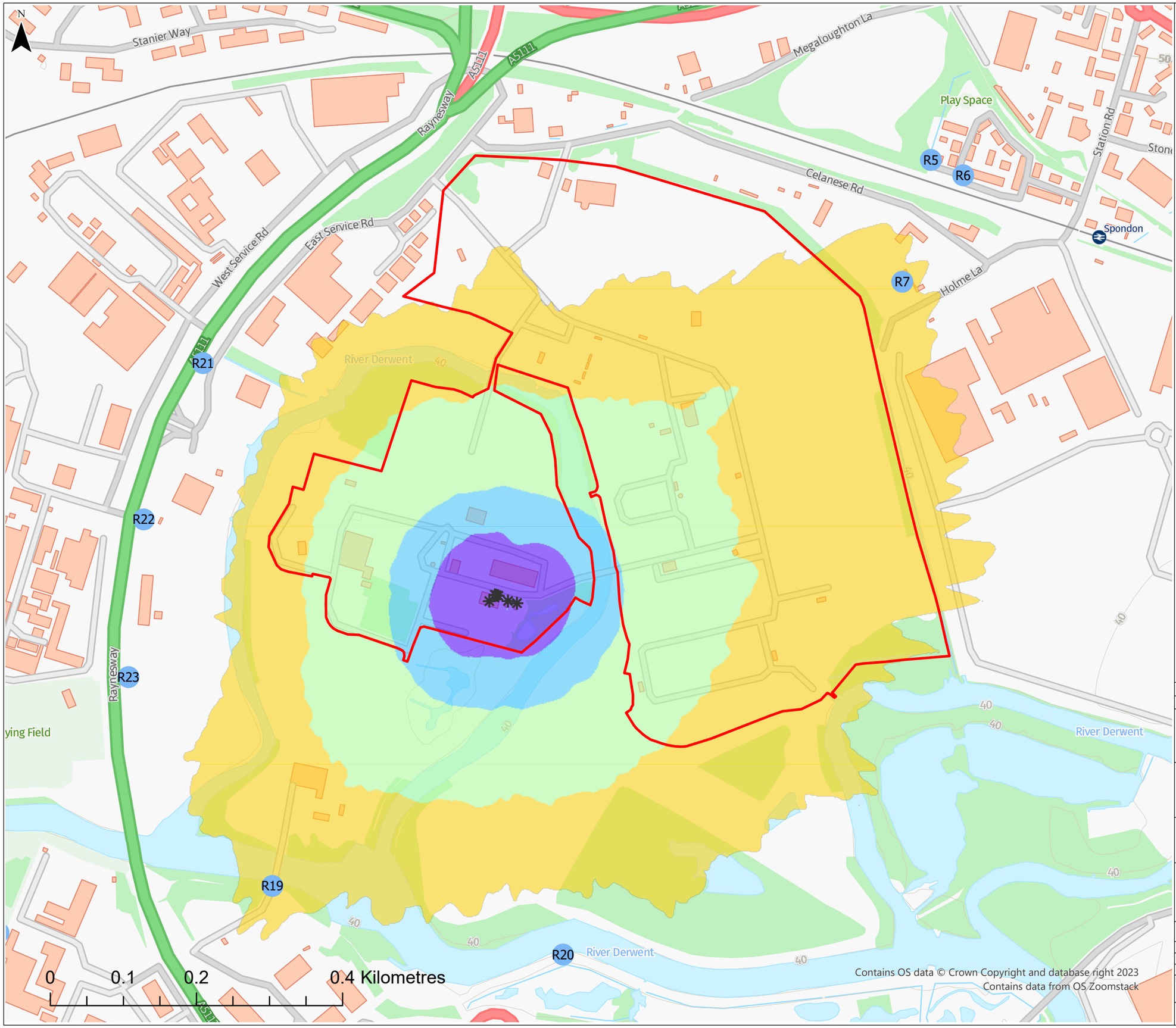

Legend

- Approximate site fenceline
- Modelled emission sources
- R1 Sensitive human receptor locations

1-hour mean (99.79th percentile) NO_2 process contributions ($\mu g/m^3$)

- 0 - 40
- 40 - 60
- 60 - 120
- 120 - 200
- 200 - 511

Rev.	Date	Purpose of revision	Drawn	Check'd	Rev'd	Appr'd
0	23/09/2024	Initial Issue	DH	GW	GW	MM

Jacobs

Client: SEVERN TRENT

Project: ENVIRONMENTAL PERMIT APPLICATION - DERBY SEWAGE TREATMENT WORKS

Drawing Title: 1-HOUR MEAN (99.79th PERCENTILE) NITROGEN DIOXIDE PROCESS CONTRIBUTIONS ($\mu g/m^3$), 2016 METEOROLOGICAL DATA

Drawing Status: FINAL

Scale @ A3	1:5,000	DO NOT SCALE
Jacobs No.	B19589DB	Rev 0
Client No.		

Drawing Number: FIGURE 5

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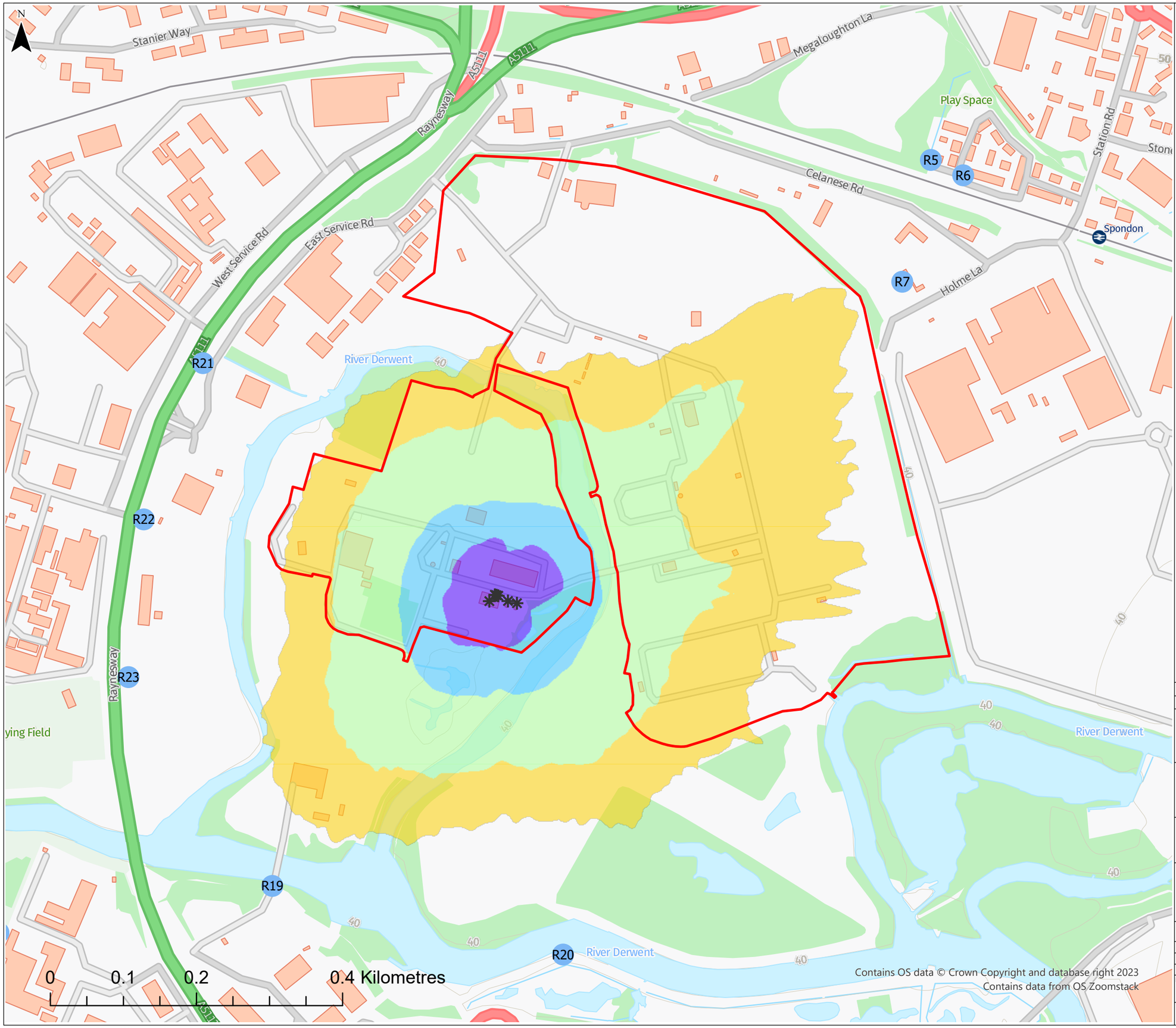

Legend

- Approximate site fenceline
- Modelled emission sources
- R1 Sensitive human receptor locations

1-hour mean (99.73rd percentile) SO_2 process contributions ($\mu g/m^3$)

- 0 - 35
- 35 - 50
- 50 - 100
- 100 - 200
- 200 - 405

Rev.	Date	Purpose of revision	Drawn	Check'd	Rev'd	Appr'd
0	23/09/2024	Initial Issue	DH	GW	GW	MM

Jacobs

Client: SEVERN TRENT

Project: ENVIRONMENTAL PERMIT APPLICATION - DERBY SEWAGE TREATMENT WORKS

Drawing Title: 1-HOUR MEAN (99.73rd PERCENTILE) SULPHUR DIOXIDE PROCESS CONTRIBUTIONS ($\mu g/m^3$), 2016 METEOROLOGICAL DATA

Drawing Status: FINAL

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Client No.		

Drawing Number: FIGURE 6

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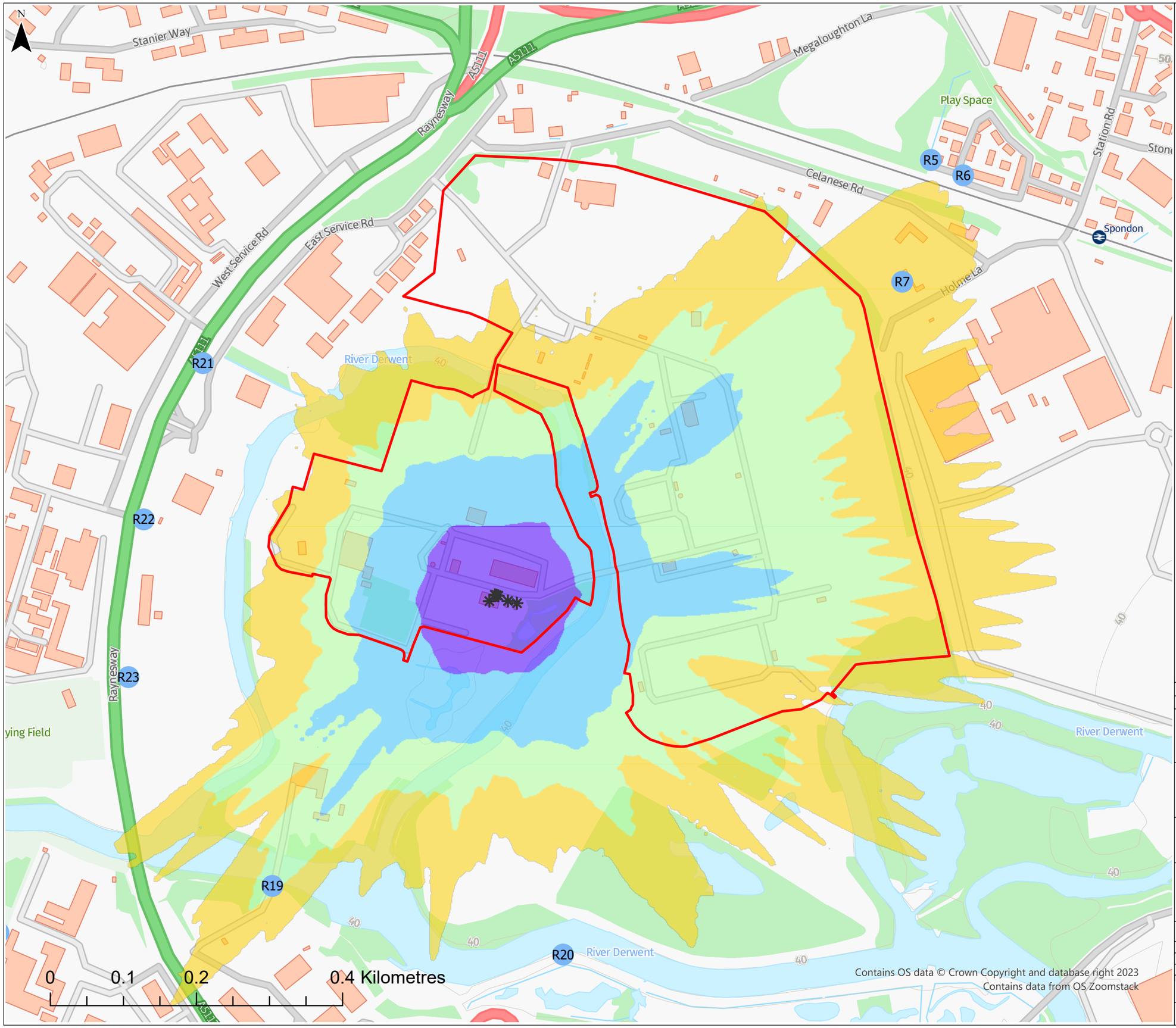

Legend

- Approximate site fenceline
- Modelled emission sources
- R1 Sensitive human receptor locations

15-minute mean (99.9th percentile) SO_2 process contributions (µg/m^3)

- 0 - 45
- 45 - 60
- 60 - 80
- 80 - 150
- 150 - 423

Rev.	Date	Purpose of revision	Drawn	Check'd	Rev'd	Appr'd
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Jacobs

Client: SEVERN TRENT

Project: ENVIRONMENTAL PERMIT APPLICATION - DERBY SEWAGE TREATMENT WORKS

Drawing Title: 15-MINUTE MEAN (99.9th PERCENTILE) SULPHUR DIOXIDE PROCESS CONTRIBUTIONS (µg/m^3), 2016 METEOROLOGICAL DATA

Drawing Status: FINAL

Scale @ A3	1:5,000	DO NOT SCALE
Jacobs No.	B19589DB	Rev 0
Client No.		

Drawing Number: FIGURE 7

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Appendix A. Dispersion Model Input Parameters

A.1 Emission Parameters

The emissions data used to represent the site for the scenario described in Section 2 are set out in Table A-1.

Table A-1. Dispersion modelling parameters

Parameters	Unit	JMS 316 GS-B.L CHP engine (2.1 MWth)	JMS 316 GS-B.L CHP engine (2.1 MWth)	Perkins Ener-g4006 CHP engine (0.8 MWth)	Beel - Standby Boiler 1 (0.9 MWth)	Beel - Standby Boiler 2 (0.9 MWth)	Eurograde ED30S/SG/3M Boiler (1.3 MWth)
Modelled fuel	-	Biogas	Biogas	Biogas	Biogas	Biogas	Biogas
Emission point	-	A1	A2	A3	A4	A5	A6
Assessed annual operation hours	Hours	8,760	8,760	4,000	4,000	4,000	4,000
Stack location	m	E 438914 N 334625	E 438926 N 334622	E 438888 N 334625	E 438900 N 334632[2]	E 438898 N 334633[2]	E 438896 N 334634
Stack height	m	7.00	7.00	8.40	8.50	8.50	11.70
Stack diameter	m	0.40	0.40	0.40	0.40	0.40	0.40
Flue gas temperature	°C	180	180	180	126	126	126
Efflux velocity	m/s	16.8	16.8	8.2	8.5	8.5	12.0
Moisture content of exhaust gas	%	11.5	11.5	11.5	6.3	6.3	6.3
Oxygen content of exhaust gas (dry)	%	8.4	8.4	8.4	8.8	8.8	8.8
Volumetric flow rate (actual)	m^3/s	2.114	2.114	1.025	1.063	1.063	1.506
Volumetric flow rate (normal)[1]	Nm^3/s	2.389	2.389	1.159	0.462	0.462	0.655
NOx emission concentration[1]	mg/Nm^3	190	190	186	250	250	250
NOx emission rate	g/s	0.454	0.454	0.215	0.116	0.116	0.164
CO emission concentration[1]	mg/Nm^3	519	519	519	100	100	100
CO emission rate	g/s	1.241	1.241	0.602	0.046	0.046	0.065
PM_{10} / $PM_{2.5}$ emission concentration[1]	mg/Nm^3	2.7	2.7	2.7	5.0	5.0	5.0

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Parameters	Unit	JMS 316 GS-B.L CHP engine (2.1 MWth)	JMS 316 GS-B.L CHP engine (2.1 MWth)	Perkins Ener-g4006 CHP engine (0.8 MWth)	Beel - Standby Boiler 1 (0.9 MWth)	Beel - Standby Boiler 2 (0.9 MWth)	Eurograde ED30S/SG/3M Boiler (1.3 MWth)
PM_{10} / $PM_{2.5}$ emission rate	g/s	0.006	0.006	0.003	0.002	0.002	0.003
SO_2 emission concentration[1]	mg/Nm^3	40	40	271	271	271	271
SO_2 emission rate	g/s	0.096	0.096	0.315	0.125	0.125	0.178
Benzene emission concentration[1]	mg/Nm^3	0.4	0.4	0.4	1.3	1.3	1.3
Benzene emission rate	g/s	0.001	0.001	0.001	0.001	0.001	0.001
Toluene emission concentration[1]	mg/Nm^3	1.2	1.2	1.2	3.7	3.7	3.7
Toluene emission rate	g/s	0.003	0.003	0.001	0.002	0.002	0.002

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

Note 2: As the stacks for the Beel boilers are in close proximity, an aai file was used in the model to represent a single plume.

A.2 Dispersion Model Inputs

A.2.1 Structural influences on dispersion

The main structures within the site which have been included in the model to reflect the existing site layout are identified within Table A-2. A sensitivity study has been carried out to assess the sensitivity of the model to using the buildings module.

Table A-2. Building parameters

Building	Modelled building shapes	Length (m)	Width / diameter (m)	Height (m)	Angle of length to north	Centre point co-ordinates	
						Easting	Northing
Plant Boiler House	Rectangular	26.20	16.20	7.90	106	438889	334627
Building 2	Rectangular	63.20	21.70	10.50	106	438922	334663
Digestion tank 1	Circular	-	16.40	18.10	-	438874	334600
Digestion tank 2	Circular	-	16.40	18.10	-	438894	334594
CHP engine housing	Rectangular	12.19	3.00	3.12	16	438913	334623
CHP engine housing	Rectangular	12.19	3.00	3.12	16	438925	334619

A.3 Other model inputs

Other model input parameters are presented in Table A-3.

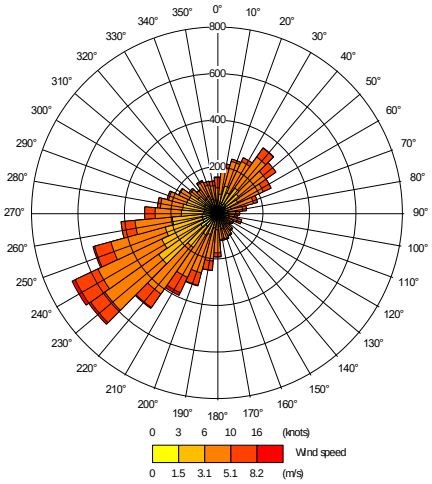
Table A-3. Other model inputs

Parameter	Value used	Comments
Surface roughness length for dispersion site	0.5 m	This is appropriate for the dispersion site where the surrounding local land-use is a mixture of residential and commercial premises. A sensitivity study has been carried out with fixed surface roughness values of 0.1 m and 1.0 m.
Surface roughness length at meteorological station site	0.5 m	This is appropriate for Nottingham / Watnall meteorological station.
Minimum Monin-Obukhov Length	1 m	Typical values for the dispersion site
Surface Albedo	0.23 m	Typical values for the dispersion site
Priestley-Taylor Parameter	1 m	Typical values for the dispersion site
Terrain	Not included	Guidance for the use of the ADMS model suggests that terrain is normally incorporated within a modelling study when the gradient exceeds 1:10. As the gradient in the vicinity of the site does not exceed 1:10, a terrain file was not included in the modelling.
Meteorological data	Nottingham / Watnall meteorological station, 2016 - 2020	RAF Benson meteorological station is located approximately 20.7 km northwest of the site and is considered the closest most representative meteorological monitoring station to the site.
Combined flue option	Yes	As the stacks for the Beel boilers are in close proximity, an aai file was used in the model to represent a single plume.

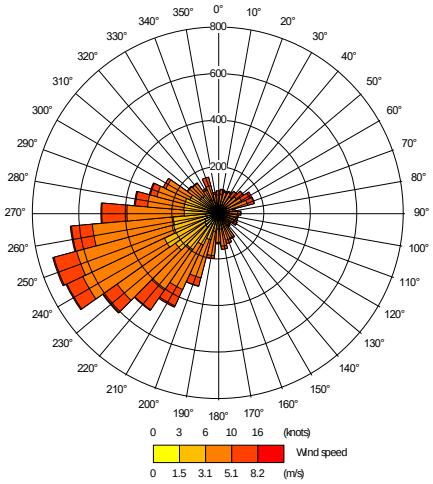
A.3.1 Meteorological Data

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

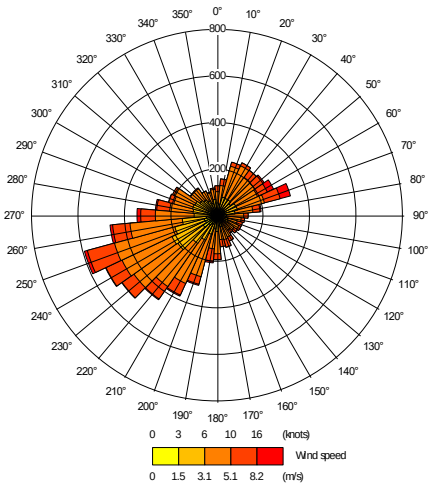
Nottingham/ Watnall meteorological station, 2016



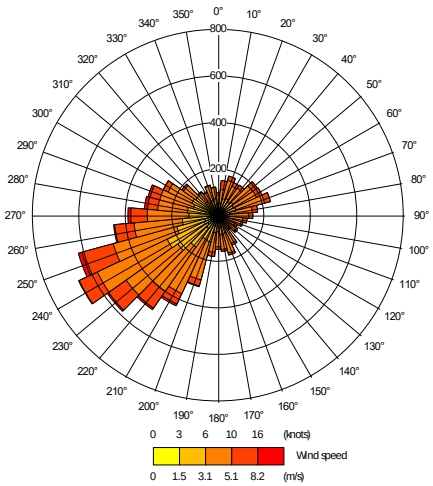
Nottingham/ Watnall meteorological station, 2017



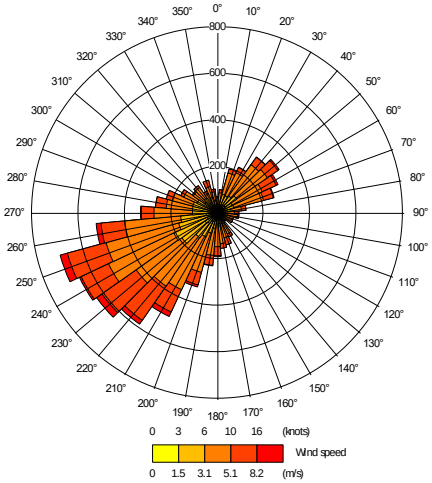
Nottingham/ Watnall meteorological station, 2018



Nottingham/ Watnall meteorological station, 2019



Nottingham/ Watnall meteorological station, 2020



A.3.2 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 A-4.

Table A-4. Modelled grid parameters

	Start	Finish	Number of grid points	Grid spacing (m)
Easting	438164	439664	151	10
Northing	333875	335375	151	10
Grid height	1.5	1.5	1	-

As well as the modelled grid, the potential impact at 23 sensitive human receptors (e.g. exposure locations such as residential properties, a recreational route and off-road cycle route), and 18 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 human receptor locations and protected conservation areas are provided in Table A-5 and Table A-6 respectively. For River Derwent LWS and Sewage Farm Lagoons LWS, those grid points (at ground level) presented in Table A-4, which encompass the respective LWS, were used to quantify the maximum PCs.

Table A-5. Assessed sensitive human receptor

Receptor	Description	Grid reference		Distance from the Jenbacher (A1) CHP engine stack (km)	Direction from the Jenbacher (A1) CHP engine stack
		Easting	Northing		
R1	Residential property on Derby Road	439115	335817	1.21	N
R2	Residential property on Derby Road	439269	335759	1.19	NNE
R3	Residential property on Derby Road	439414	335673	1.16	NNE
R4	Residential property on A6005	439589	335508	1.11	NE
R5	Residential property on Bridgeside Way	439493	335229	0.84	NE
R6	Residential property on Bridgeside Way	439537	335208	0.85	NE
R7	Residential property on Holme Lane	439453	335063	0.69	NE
R8	Residential property on Anglers' Lane	440281	334974	1.41	ENE
R9	Residential property off B5010	440717	334221	1.85	ESE
R10	Home Farm	440586	333491	2.02	SE
R11	Residential property on Halstock Drive	439276	333590	1.10	SSE
R12	Residential property on Manifold Drive	438941	333710	0.92	S
R13	Residential property on Eden Street	438534	333759	0.95	SSW
R14	Residential property on Leeside	438216	334171	0.83	WSW
R15	Residential property on Persian Close	437616	334640	1.30	W
R16	Residential property on Waterford Drive	438463	335695	1.16	NNW
R17	Residential property on Waterford Drive	438617	335598	1.02	NNW
R18	Residential property on Galway Avenue	438831	335519	0.90	N
R19	Recreational route / off-road cycle route	438591	334235	0.51	SW
R20	Recreational route / off-road cycle route	438989	334141	0.49	S
R21	Off-road cycle route	438496	334951	0.53	NW
R22	Off-road cycle route	438415	334737	0.51	WNW
R23	Off-road cycle route	438394	334521	0.53	WSW
AQMA No.1	Derby NO2 AQMA No 1: Ring Roads	438561	333658	1.03	SSW
AQMA No.2	Derby NO2 AQMA No 2: A52	439574	335485	1.08	NE

Table A-6. Assessed protected conservation area locations

Receptor	Description	Grid reference		Distance from the Jenbacher (A1) CHP engine stack (km)	Direction from the Jenbacher (A1) CHP engine stack
		Easting	Northing		
H1	West Park Meadow LNR	439367	336084	1.53	NNE
H2	The Sanctuary LNR	437688	334985	1.28	WNW

Receptor	Description	Grid reference		Distance from the Jenbacher (A1) CHP engine stack (km)	Direction from the Jenbacher (A1) CHP engine stack
		Easting	Northing		
H3	Elvaston LNR	440061	333513	1.60	SE
H4	Acordis Lagoons LWS	439386	334473	0.50	ESE
H5	Accordis Effluent Beds LWS	440296	334126	1.47	ESE
H6	Former Shardlow Sewage Works LWS	440234	334927	1.35	ENE
H7	Former Spondon Power Station Meadow LWS	440510	334251	1.64	ESE
H8	Alvaston Scrub LWS	439682	333776	1.15	SE
H9	Chaddesden Brook and Mossey Yard Plantation LWS	437878	336195	1.88	NNW
H10	Meadow Lane Bank LWS	438274	335799	1.34	NNW
H11	Orchard, Coleman Street LWS	437622	333403	1.78	SW
H12	Elvaston Castle Country Park LWS	440068	333275	1.78	SE
H13	Eden Street Meadow LWS	438509	334007	0.74	SSW
H14	Meadow Farm Marsh LWS	438821	335492	0.87	N
H15	Chaddesden Sidings LWS	438319	335304	0.90	NW
H16	Green Lane Nature Area - aka Alvaston Community LWS	438888	333811	0.82	S
H17	River Derwent LWS	Modelled grid		Adjacent	
H18	Sewage Farm Lagoons LWS	Modelled grid		Adjacent	

A.3.3 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 NOx 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.3.4 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, 2024a), 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 assessed sources.

A.3.5 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 (zo) 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.3.6 Conservative Assumptions

The conservative assumptions adopted in this study are summarised below.

- The proposed replacement CHP engines were assumed to operate for 8,760 hours each calendar year and the existing Perkins CHP engine and boilers were assumed to operate for 4,000 hours each calendar year. This is a conservative assumption as in practice, the Beel boilers, which are primarily used as a back-up for electricity and/or heat production when the CHP engines are undergoing routine maintenance, typically operate for less than 2,000 hours and the Eurograde boiler does not operate. The Perkins CHP engine typically operates for less than 1,000 hours per year.
- 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 the respective protected conservation areas is present at the specific modelled location where the highest PC was predicted.

Appendix B. Biogas H_2S concentration and conversion to SO_2

When biogas is combusted in the assessed CHP engine and boilers, H_2S is oxidised to water and sulphur oxides (SOx). The mass balance equation published in US EPA AP-42 guidance (EPA, 1995), can be used to calculate the input of sulphur on the basis of the molecular ratio between the daughter and parent species. Where SO_2 is the daughter spies of the parent species (i.e. the sulphur containing compounds in the raw gas H_2S).

Figure B-1. Biogas H2S conversion to SO2 (SLR, 2010)

$$Mass_D\ (mg) = Mass_P\ (mg) * MM * (DE\%/100\%)$$

$Mass_D$	is the mass of Daughter Species (mg)
$Mass_P$	is the mass of Parent Species (mg)
MM	is the ratio of molecular mass e.g. SO_2 : H_2S
DE%	is the destruction efficiency of the emitted gas

In order to calculate the SO_2 concentration in the engine emissions, the equation must consider mass flow of AD gas and a dilution factor to account for combustion air in engine emissions, hence the calculation is:

$$Eng_{Emis}\ Conc_D\ (mg/m^3) = Conc_P\ (mg/m^3) * MM * (DE\%/100\%) / DF$$

Eng_{Emi} $Conc_D$	is the engine emission concentration of Daughter Species (mg/Nm^3)
$Conc_P$	is the mass of Parent Species (mg/m^3)
DF	is the dilution factor (for the Jenbacher 320 of 6.9 at 50% methane)
MM	is the ratio of molecular mass (for SO_2 : H_2S this is 1.88)
DE%	is the destruction efficiency of the emitted gas (99%)

Note: the dilution factor (DF) of 6.9 has been applied for the assessed CHP engine and boilers.

Comparison of calculated SO_2 concentrations against measured SO_2 concentrations was undertaken for the Severn Trent site at Wanlip (SLR, 2010). The greatest underprediction of calculated SO_2 against measured SO_2 concentrations was 24% and therefore this value has been incorporated into the calculation shown above as follows:

Figure B-2. Incorporation of 24% underprediction between calculated and measured SO2 concentrations

$$Eng_{Emis}\ Conc_D\ (mg/m^3) = Conc_P\ (mg/m^3) * MM * (DE\%/100\%) / DF * 1.24$$

This provides a conservative approach to the estimation of SO_2 with emission rates around 1.24 times that of the average trend.

Appendix C. Calculating Acid and Nitrogen Deposition

C.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, 2024). Information on the deposition critical loads for the European designated sites and SSSI and were 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 C-1.

Table C-1. 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 C-2. To convert dry deposition flux to acid deposition multiply by factors shown in Table C-3.

Table C-2. 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 C-3. 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 D. Results at Sensitive Human Locations

Table D-1. 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	361	10,000	23.3	384	0.2%	3.8%	30,000	53.2	414	0.2%	1.4%
R2	361		23.5	384	0.2%	3.8%		54.5	415	0.2%	1.4%
R3	361		29.2	390	0.3%	3.9%		54.7	415	0.2%	1.4%
R4	361		27.4	388	0.3%	3.9%		57.8	418	0.2%	1.4%
R5	361		45.0	406	0.4%	4.1%		77.0	438	0.3%	1.5%
R6	361		44.9	406	0.4%	4.1%		75.6	436	0.3%	1.5%
R7	361		59.7	420	0.6%	4.2%		89.8	450	0.3%	1.5%
R8	357		21.2	378	0.2%	3.8%		48.0	405	0.2%	1.3%
R9	357		16.3	373	0.2%	3.7%		35.6	393	0.1%	1.3%
R10	348		16.6	365	0.2%	3.6%		32.3	380	0.1%	1.3%
R11	354		36.5	391	0.4%	3.9%		59.6	414	0.2%	1.4%
R12	375		29.4	405	0.3%	4.0%		66.8	442	0.2%	1.5%
R13	375		34.7	410	0.3%	4.1%		63.4	438	0.2%	1.5%
R14	388		35.5	423	0.4%	4.2%		75.2	463	0.3%	1.5%
R15	418		16.5	434	0.2%	4.3%		50.5	468	0.2%	1.6%
R16	382		23.2	406	0.2%	4.1%		54.9	437	0.2%	1.5%
R17	382		25.5	408	0.3%	4.1%		62.7	445	0.2%	1.5%
R18	382		31.8	414	0.3%	4.1%		68.7	451	0.2%	1.5%
R19	388		66.1	454	0.7%	4.5%		121.5	509	0.4%	1.7%
R20	388		67.0	455	0.7%	4.5%		118.9	507	0.4%	1.7%
R21	388		45.5	433	0.5%	4.3%		112.4	500	0.4%	1.7%
R22	388		55.9	444	0.6%	4.4%		115.5	503	0.4%	1.7%
R23	388		49.0	437	0.5%	4.4%		107.8	496	0.4%	1.7%

Table D-2. 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	16.3	40	0.2	16.5	0.5%	41.2%	200	32.6	5.3	37.9	2.7%	19.0%
R2	16.3		0.3	16.6	0.7%	41.4%		32.6	5.6	38.1	2.8%	19.1%
R3	16.3		0.4	16.6	0.9%	41.6%		32.6	6.3	38.9	3.1%	19.4%
R4	16.3		0.5	16.8	1.3%	42.0%		32.6	7.7	40.2	3.8%	20.1%
R5	16.3		1.0	17.2	2.4%	43.1%		32.6	11.9	44.4	5.9%	22.2%
R6	16.3		1.0	17.3	2.5%	43.2%		32.6	12.1	44.7	6.1%	22.3%
R7	16.3		1.4	17.7	3.6%	44.3%		32.6	14.7	47.3	7.4%	23.6%
R8	11.4		0.5	11.9	1.2%	29.8%		22.9	6.4	29.3	3.2%	14.6%
R9	11.4		0.2	11.6	0.5%	29.1%		22.9	4.4	27.3	2.2%	13.7%
R10	10.8		0.1	11.0	0.3%	27.4%		21.7	3.5	25.2	1.7%	12.6%
R11	12.1		0.2	12.2	0.4%	30.6%		24.2	6.1	30.2	3.0%	15.1%
R12	14.7		0.2	14.9	0.5%	37.4%		29.5	6.2	35.7	3.1%	17.8%
R13	14.7		0.3	15.1	0.8%	37.7%		29.5	7.0	36.5	3.5%	18.2%
R14	16.3		0.4	16.7	1.1%	41.8%		32.6	8.4	41.0	4.2%	20.5%
R15	24.9		0.1	25.0	0.3%	62.5%		49.8	3.7	53.5	1.9%	26.7%
R16	18.8		0.2	19.0	0.4%	47.5%		37.6	5.6	43.3	2.8%	21.6%
R17	18.8		0.2	19.0	0.5%	47.6%		37.6	6.5	44.1	3.2%	22.1%
R18	18.8		0.2	19.1	0.6%	47.7%		37.6	6.6	44.2	3.3%	22.1%
R19	16.3		1.0	17.3	2.5%	43.3%		32.6	16.2	48.8	8.1%	24.4%
R20	16.3		0.5	16.8	1.3%	42.1%		32.6	13.3	45.9	6.7%	23.0%
R21	16.3		0.4	16.7	0.9%	41.6%		32.6	9.9	42.5	5.0%	21.3%
R22	16.3		0.4	16.7	1.1%	41.8%		32.6	10.7	43.3	5.4%	21.7%
R23	16.3		0.7	17.0	1.7%	42.4%		32.6	12.0	44.6	6.0%	22.3%
Derby NO_2 AQMA No 1:	14.7		0.3	15.0	0.7%	37.5%	-					

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 (%)
Derby NO_2 AQMA No 2: A52	16.3		0.5	16.8	1.3%	42.0%						

Table D-3. 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	13.8	125	2.4	16.2	1.9%	12.9%	350	13.8	10.1	23.9	2.9%	6.8%
R2	13.8		2.6	16.4	2.1%	13.2%		13.8	10.6	24.4	3.0%	7.0%
R3	13.8		2.8	16.6	2.3%	13.3%		13.8	11.3	25.1	3.2%	7.2%
R4	13.8		3.6	17.4	2.9%	13.9%		13.8	13.5	27.3	3.8%	7.8%
R5	13.8		6.6	20.4	5.3%	16.3%		13.8	22.6	36.4	6.5%	10.4%
R6	13.8		7.0	20.8	5.6%	16.6%		13.8	24.6	38.4	7.0%	11.0%
R7	13.8		8.7	22.5	6.9%	18.0%		13.8	30.7	44.5	8.8%	12.7%
R8	10.4		2.7	13.1	2.2%	10.5%		10.4	11.0	21.4	3.1%	6.1%
R9	10.4		1.6	12.0	1.3%	9.6%		10.4	7.4	17.8	2.1%	5.1%
R10	9.9		1.5	11.5	1.2%	9.2%		9.9	7.2	17.1	2.1%	4.9%
R11	10.6		3.0	13.6	2.4%	10.9%		10.6	11.0	21.6	3.1%	6.2%
R12	13.0		3.0	16.1	2.4%	12.9%		13.0	11.1	24.1	3.2%	6.9%
R13	13.0		3.7	16.7	3.0%	13.4%		13.0	12.7	25.7	3.6%	7.3%
R14	11.6		5.0	16.6	4.0%	13.3%		11.6	15.7	27.2	4.5%	7.8%
R15	12.4		1.9	14.3	1.5%	11.4%		12.4	6.8	19.1	1.9%	5.5%
R16	10.9		2.3	13.2	1.8%	10.5%		10.9	10.9	21.8	3.1%	6.2%

Receptor ID	99.18th percentile of 24-hour mean						99.73rd percentile of 1-hour mean					
	Baseline air quality level (µg/m³)	EQS (µg/m³)	PC (µg/m³)	PEC (µg/m³)	PC/EQS (%)	PEC/EQS (%)	EQS (µg/m³)	Baseline air quality level (µg/m³)	PC (µg/m³)	PEC (µg/m³)	PC/EQS (%)	PEC/EQS (%)
R17	10.9		2.7	13.6	2.2%	10.9%		10.9	12.0	23.0	3.4%	6.6%
R18	10.9		3.6	14.5	2.9%	11.6%		10.9	11.8	22.7	3.4%	6.5%
R19	11.6		10.6	22.1	8.5%	17.7%		11.6	27.2	38.7	7.8%	11.1%
R20	11.6		8.8	20.4	7.0%	16.3%		11.6	24.0	35.6	6.9%	10.2%
R21	11.6		7.1	18.6	5.6%	14.9%		11.6	17.3	28.8	4.9%	8.2%
R22	11.6		6.2	17.8	5.0%	14.2%		11.6	19.2	30.8	5.5%	8.8%
R23	11.6		7.3	18.9	5.8%	15.1%		11.6	22.5	34.1	6.4%	9.7%

Table D-4. 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	13.8	266	20.6	34.4	7.7%	12.9%
R2	13.8		23.6	37.4	8.9%	14.1%
R3	13.8		22.4	36.2	8.4%	13.6%
R4	13.8		28.9	42.7	10.9%	16.1%
R5	13.8		41.7	55.5	15.7%	20.9%
R6	13.8		43.2	57.0	16.2%	21.4%
R7	13.8		52.1	65.9	19.6%	24.8%
R8	10.4		21.2	31.6	8.0%	11.9%
R9	10.4		15.2	25.6	5.7%	9.6%
R10	9.9		14.9	24.9	5.6%	9.4%
R11	10.6		25.1	35.7	9.4%	13.4%
R12	13.0		22.1	35.2	8.3%	13.2%
R13	13.0		23.1	36.2	8.7%	13.6%
R14	11.6		33.8	45.4	12.7%	17.1%

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 (%)
R15	12.4		16.4	28.8	6.2%	10.8%
R16	10.9		22.3	33.2	8.4%	12.5%
R17	10.9		23.4	34.3	8.8%	12.9%
R18	10.9		22.6	33.5	8.5%	12.6%
R19	11.6		64.5	76.0	24.2%	28.6%
R20	11.6		41.0	52.6	15.4%	19.8%
R21	11.6		27.9	39.5	10.5%	14.8%
R22	11.6		29.9	41.4	11.2%	15.6%
R23	11.6		38.6	50.2	14.5%	18.9%

Table D-5. 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	12.9	40	0.00	12.9	0.01%	32.3%	50	25.8	0.02	25.9	0.0%	51.7%
R2	12.9		0.01	12.9	0.01%	32.3%		25.8	0.03	25.9	0.1%	51.7%
R3	12.9		0.01	12.9	0.02%	32.3%		25.8	0.03	25.9	0.1%	51.7%
R4	12.9		0.01	12.9	0.03%	32.3%		25.8	0.04	25.9	0.1%	51.7%
R5	12.9		0.02	12.9	0.05%	32.3%		25.8	0.08	25.9	0.2%	51.8%
R6	12.9		0.02	12.9	0.05%	32.3%		25.8	0.08	25.9	0.2%	51.8%
R7	12.9		0.03	12.9	0.07%	32.4%		25.8	0.11	25.9	0.2%	51.9%
R8	11.9		0.01	11.9	0.02%	29.7%		23.8	0.03	23.8	0.1%	47.6%
R9	11.9		0.00	11.9	0.01%	29.7%		23.8	0.02	23.8	0.0%	47.6%
R10	13.2		0.00	13.2	0.01%	33.0%		26.4	0.01	26.4	0.0%	52.8%
R11	12.8		0.00	12.8	0.01%	31.9%		25.5	0.02	25.5	0.0%	51.1%

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 (%)
R12	13.5		0.00	13.5	0.01%	33.9%		27.1	0.03	27.1	0.1%	54.2%
R13	13.5		0.01	13.6	0.02%	33.9%		27.1	0.04	27.1	0.1%	54.2%
R14	13.1		0.01	13.1	0.02%	32.7%		26.1	0.05	26.2	0.1%	52.4%
R15	14.3		0.00	14.3	0.01%	35.7%		28.6	0.01	28.6	0.0%	57.2%
R16	13.0		0.00	13.0	0.01%	32.6%		26.1	0.02	26.1	0.0%	52.2%
R17	13.0		0.00	13.1	0.01%	32.6%		26.1	0.02	26.1	0.0%	52.2%
R18	13.0		0.00	13.1	0.01%	32.6%		26.1	0.03	26.1	0.1%	52.2%
R19	13.1		0.02	13.1	0.05%	32.7%		26.1	0.13	26.3	0.3%	52.5%
R20	13.1		0.01	13.1	0.03%	32.7%		26.1	0.05	26.2	0.1%	52.4%
R21	13.1		0.01	13.1	0.02%	32.7%		26.1	0.04	26.2	0.1%	52.4%
R22	13.1		0.01	13.1	0.02%	32.7%		26.1	0.05	26.2	0.1%	52.4%
R23	13.1		0.01	13.1	0.03%	32.7%		26.1	0.08	26.2	0.2%	52.4%

Table D-6. 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	8.4	25	0.00	8.5	0.0%	42.3%
R2	8.4		0.01	8.5	0.0%	42.3%
R3	8.4		0.01	8.5	0.0%	42.3%
R4	8.4		0.01	8.5	0.1%	42.3%
R5	8.4		0.02	8.5	0.1%	42.3%
R6	8.4		0.02	8.5	0.1%	42.3%
R7	8.4		0.03	8.5	0.1%	42.4%
R8	7.7		0.01	7.7	0.0%	38.4%
R9	7.7		0.00	7.7	0.0%	38.3%
R10	16.0		0.00	16.0	0.0%	80.1%
R11	8.3		0.00	8.3	0.0%	41.3%
R12	9.0		0.00	9.0	0.0%	45.0%
R13	9.0		0.01	9.0	0.0%	45.0%
R14	8.4		0.01	8.4	0.0%	42.1%
R15	9.3		0.00	9.3	0.0%	46.4%
R16	8.5		0.00	8.5	0.0%	42.7%
R17	8.5		0.00	8.5	0.0%	42.7%
R18	8.5		0.00	8.5	0.0%	42.7%
R19	8.4		0.02	8.4	0.1%	42.2%
R20	8.4		0.01	8.4	0.1%	42.1%
R21	8.4		0.01	8.4	0.0%	42.1%
R22	8.4		0.01	8.4	0.0%	42.1%
R23	8.4		0.01	8.4	0.1%	42.1%

Table D-7. Results of detailed assessment at sensitive human receptor locations for annual mean and maximum 24-hour mean benzene predicted concentrations

Receptor ID	Annual mean						100th percentile of maximum 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	0.5	5	0.001	0.5	0.0%	9.3%	30	0.9	0.02	0.9	0.1%	3.2%
R2	0.5		0.001	0.5	0.0%	9.3%		0.9	0.02	1.0	0.1%	3.2%
R3	0.5		0.002	0.5	0.0%	9.4%		0.9	0.02	1.0	0.1%	3.2%
R4	0.5		0.002	0.5	0.0%	9.4%		0.9	0.02	1.0	0.1%	3.2%
R5	0.5		0.005	0.5	0.1%	9.4%		0.9	0.05	1.0	0.2%	3.3%
R6	0.5		0.005	0.5	0.1%	9.4%		0.9	0.05	1.0	0.2%	3.3%
R7	0.5		0.007	0.5	0.1%	9.5%		0.9	0.07	1.0	0.2%	3.3%
R8	0.5		0.002	0.5	0.0%	9.2%		0.9	0.03	0.9	0.1%	3.1%
R9	0.5		0.001	0.5	0.0%	9.1%		0.9	0.01	0.9	0.0%	3.1%
R10	0.4		0.001	0.4	0.0%	8.7%		0.9	0.01	0.9	0.0%	2.9%
R11	0.5		0.001	0.5	0.0%	9.1%		0.9	0.02	0.9	0.1%	3.1%
R12	0.5		0.001	0.5	0.0%	9.7%		1.0	0.03	1.0	0.1%	3.3%
R13	0.5		0.002	0.5	0.0%	9.8%		1.0	0.03	1.0	0.1%	3.3%
R14	0.5		0.002	0.5	0.0%	10.3%		1.0	0.04	1.1	0.1%	3.6%
R15	0.6		0.001	0.6	0.0%	11.5%		1.1	0.01	1.2	0.0%	3.9%
R16	0.5		0.001	0.5	0.0%	10.1%		1.0	0.03	1.0	0.1%	3.4%
R17	0.5		0.001	0.5	0.0%	10.1%		1.0	0.03	1.0	0.1%	3.4%
R18	0.5		0.001	0.5	0.0%	10.1%		1.0	0.02	1.0	0.1%	3.4%
R19	0.5		0.005	0.5	0.1%	10.3%		1.0	0.08	1.1	0.3%	3.7%
R20	0.5		0.002	0.5	0.0%	10.3%		1.0	0.08	1.1	0.3%	3.7%
R21	0.5		0.002	0.5	0.0%	10.3%		1.0	0.06	1.1	0.2%	3.6%
R22	0.5		0.002	0.5	0.0%	10.3%		1.0	0.05	1.1	0.2%	3.6%
R23	0.5		0.003	0.5	0.1%	10.3%		1.0	0.05	1.1	0.2%	3.6%

Table D-8. Results of detailed assessment at sensitive human receptor locations for weekly mean and maximum 1-hour mean toluene predicted concentrations

Receptor ID	Weekly mean						Maximum 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	3.2	260	0.03	3.3	0.0%	1.3%	8,000	3.2	0.2	3.5	0.0%	0.0%
R2	3.2		0.05	3.3	0.0%	1.3%		3.2	0.2	3.5	0.0%	0.0%
R3	3.2		0.05	3.3	0.0%	1.3%		3.2	0.2	3.5	0.0%	0.0%
R4	3.2		0.05	3.3	0.0%	1.3%		3.2	0.3	3.5	0.0%	0.0%
R5	3.2		0.10	3.3	0.0%	1.3%		3.2	0.3	3.6	0.0%	0.0%
R6	3.2		0.10	3.3	0.0%	1.3%		3.2	0.3	3.6	0.0%	0.0%
R7	3.2		0.14	3.4	0.1%	1.3%		3.2	0.4	3.6	0.0%	0.0%
R8	3.2		0.05	3.3	0.0%	1.3%		3.2	0.2	3.4	0.0%	0.0%
R9	3.2		0.02	3.3	0.0%	1.3%		3.2	0.1	3.4	0.0%	0.0%
R10	3.2		0.02	3.3	0.0%	1.3%		3.2	0.1	3.4	0.0%	0.0%
R11	3.2		0.05	3.3	0.0%	1.3%		3.2	0.2	3.5	0.0%	0.0%
R12	3.2		0.05	3.3	0.0%	1.3%		3.2	0.3	3.5	0.0%	0.0%
R13	3.2		0.05	3.3	0.0%	1.3%		3.2	0.3	3.5	0.0%	0.0%
R14	3.2		0.09	3.3	0.0%	1.3%		3.2	0.3	3.6	0.0%	0.0%
R15	3.2		0.03	3.3	0.0%	1.3%		3.2	0.2	3.4	0.0%	0.0%
R16	3.2		0.06	3.3	0.0%	1.3%		3.2	0.2	3.5	0.0%	0.0%
R17	3.2		0.06	3.3	0.0%	1.3%		3.2	0.3	3.5	0.0%	0.0%
R18	3.2		0.05	3.3	0.0%	1.3%		3.2	0.3	3.5	0.0%	0.0%
R19	3.2		0.17	3.4	0.1%	1.3%		3.2	0.6	3.8	0.0%	0.0%
R20	3.2		0.16	3.4	0.1%	1.3%		3.2	0.5	3.8	0.0%	0.0%
R21	3.2		0.12	3.3	0.0%	1.3%		3.2	0.5	3.7	0.0%	0.0%
R22	3.2		0.10	3.3	0.0%	1.3%		3.2	0.5	3.7	0.0%	0.0%
R23	3.2		0.11	3.3	0.0%	1.3%		3.2	0.5	3.7	0.0%	0.0%