Environmental Permit Variation Application - Chertsey Sewage Treatment Works

Air Quality Impact Assessment

1 | 2

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Thames Water Utilities Limited

Environmental Permit Variation Application - Chertsey Sewage Treatment Works

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2	20/05/22	Amendments following comments by the Environment Agency	D Howells	R Tait	S Byrne	M McAree

Contents

Executive Summary

Thames Water Utilities Limited (hereafter 'Thames Water') operate a STW located near the town of Chertsey, Runnymede ((TW20 8QN). These operations include two existing CHP engines (each with a thermal input capacity of 1.9 MW_{th}) and a standby generator (with a thermal input capacity of 2.6 MW_{th}). Thames Water proposed to install a new dual fuelled boiler (thermal input capacity of 4.5 MW_{th}), which is replacing the existing boiler.

Combustion Plant

Medium Combustion Plant (MCP) Information				
MCP specific identifier*	Chertsey - CHP 1 (already permitted)	Chertsey - CHP 2 (already permitted)	Standby generator (already permitted)	Chertsey - Boiler
12-digit grid reference or latitude/longitude	E 501590 N 167355 (shared stack)		E 501520 N 167471	E 501609 N 167370
Rated thermal input (MW) of the MCP	1.9	1.9	2.6	4.5
Type of MCP (diesel engine, gas turbine, other engine or other MCP)	Gas engine	Gas engine	Generator	Boiler
Type of fuels used: gas oil (diesel), natural gas, gaseous fuels other than natural gas	Biogas	Biogas	Diesel	Dual fuelled (biogas / diesel)
Date when the new MCP was first put into operation (DD/MM/YYYY)				31/08/2021
Sector of activity of the MCP or the facility in which it is applied (NACE code**)	E.37.00	E.37.00	E.37.00	E.37.00
Expected number of annual operating hours of the MCP and average load in use	8,760 (based on availability). Modelled at 100% load.	8,760 (based on availability). Modelled at 100% load.	50 (modelled operating for 150 hours per year) at 100% load.	8,760 (modelled operating all year and at 100% load).
Where the option of exemption under Article 6(8) is used the operator (as identified on Form A) should sign a declaration here that the MCP will not be operated more than	N / A			

Medium Combustion Plant (MCP) Information				
the number of hours referred to in this paragraph				

The application is collated to include the required application forms Part A, C3 and F1. As the site has CHP engines and a standby generator, the information required for application form Part B2.5, Appendix 1 is included within this document.

The Air Quality Impact Assessment presented within this report is required to support the Environmental Permit variation application and assesses the potential for significant air quality effects from the operation of the existing CHP engines, standby generator and new boiler at the Chertsey STW.

The potential impacts were determined for the following aspect:

- the potential impact on human health due to emissions of pollutants. The pollutants considered include nitrogen dioxide (NO_2); carbon monoxide (CO); sulphur dioxide (SO_2), total volatile organic compounds (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.

A range of scenarios have been modelled to represent existing and proposed operations at the site. The modelled scenarios are as follows:

- Existing scenario – two existing CHP engines (emission point reference A1 and A2) and standby generator (emission point reference A5);
- Proposed scenario (typical operations) – two existing CHP engines (emission point reference A1 and A2), standby generator (emission point reference A5) and new boiler (emission point reference A7) utilising biogas; and
- Proposed scenario (alternative operations) – two existing CHP engines (emission point reference A1 and A2), standby generator (emission point reference A5); and new boiler (emission point reference A7) utilising diesel.

Human receptors

The assessment indicates that for all modelled scenarios, with the exception of predicted 1-hour mean (99.79th percentile) NO_2 concentrations at a modelled off-site location, predicted off-site concentrations and predicted concentrations at sensitive human receptors do not exceed any relevant long-term or short-term EQSs.

Using the approach set out in Environment Agency guidance (Environment Agency, 2018), the statistical analysis found that, irrespective of the modelled scenario, the probability of exceedance of the 1-hour mean EQS at an off-site location is considered 'highly unlikely'.

For TVOCs, exceedances of the annual mean and 24-hour mean EQS for C_6H_6 were predicted. However, it is an unrealistic assumption that total TVOCs emitted by the combustion plant are C_6H_6. If present in the exhaust gases, C_6H_6 would constitute only a very small proportion of total TVOC emissions (e.g. less than 1%). Therefore, it is likely there would be no exceedance of EQSs associated with TVOC emissions and based on professional judgement, the emissions of TVOCs is considered 'not significant'.

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

The results indicate that when introducing the new boiler (i.e. Scenario 2 and 3), there are small increases in predicted long-term and short-term concentrations and nutrient nitrogen and acid deposition compared to Scenario 1. Furthermore, at H3 and H4 (tall vegetation only), the PCs are just above 1% (i.e. up to 1.05%) of the relevant critical load for acid deposition.

However, based on the conservative approach to the assessment, it is considered that no unacceptable impacts at the assessed protected conservation areas are likely to occur as a consequence of the operation of the assessed CHP engines, standby generator and new boiler (utilising biogas or diesel) with regard to ambient concentrations of NOx and SO_2 and pollutant deposition.

Summary

This assessment has been carried out on the assumption that the CHP engines and new boiler would operate continuously at maximum load all year. This is a conservative assumption as, in practice, the CHP engines and new boiler would have periods of shut-down and maintenance and may not always operate at maximum load. Furthermore, only one CHP engine is likely to operate alongside the new boiler during anticipated site operations.

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

1. Introduction

1.1 Background

Thames Water Utilities Limited (hereafter 'Thames Water') currently operates two existing biogas fuelled Jenbacher JMS 312 GS-B.L CHP engines (each with a thermal input capacity of 1.9 MW_{th}) and a Mecc Alte diesel fuelled standby generator[1] (with a thermal input capacity of 2.6 MW_{th}). Thames Water proposes to operate a new Byworth YSX6000 dual fuelled steam boiler[2] (with a thermal input capacity of 4.5 MW_{th}) at the Chertsey STW near the town of Chertsey, Runnymede (TW20 8QN) (hereafter 'the site'). Jacobs UK Limited (hereafter 'Jacobs') has carried out an Air Quality Impact Assessment (AQIA) on behalf of Thames Water to assess the potential impact of emissions from the existing CHP engines, standby generator and new boiler.

1.2 Study Outline

This AQIA is required to support the Environmental Permit (EP) variation application and assesses the likely significant air quality effects of emissions to air from the CHP engines, standby generator and new boiler (which provides heat to the digesters and the thermal hydrolysis plant (THP)) at the site. The air quality assessment has been carried out following the relevant Environment Agency guidance (Environment Agency, 2021a; 2021b). The AQIA considers:

- the potential impact on human health due to emissions of pollutants. The pollutants considered include nitrogen dioxide (NO_2); carbon monoxide (CO); sulphur dioxide (SO_2), total volatile organic compounds (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.

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

This report draws upon information provided from the following parties:

- Thames Water;
- ADM Ltd;
- INNIO Jenbacher GmbH & Co (hereafter 'Jenbacher');
- Byworth Boilers;
- Ricardo Energy & Environment (hereafter 'Ricardo');
- Department for Environment, Food and Rural Affairs (Defra); and
- Runneymede Borough Council (RBC).

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

1 Operated during triad (i.e. one of the three highest peaks of electricity demand between 1st November and the end of February).
2 Dual fuelled utilising biogas or light fuel oil (modelled as diesel).

2. Emission Sources

2.1 Emission Sources to Air

The location of the assessed existing CHP engines (emission point reference A1 and A2)[3], standby generator (emission point reference A5) and new boiler (emission point reference A7) are presented in Figure 1.

The CHP engines and new boiler (when using the primary boiler fuel type) would be fuelled by biogas generated from the site's anaerobic digestion process and emissions were modelled on this basis. The standby generator is fuelled by diesel and was modelled accordingly.

As discussed previously, the new boiler is dual fuelled[2] and has also been modelled utilising diesel in order to quantify the maximum long-term and short-term modelled concentrations for the two fuel types. The objective of the new dual fuel boiler is partly to reduce fossil fuel usage (when utilising biogas) but also provides Thames Water with operational flexibility when required. The modelling scenarios considered in this assessment are presented in Section 2.2.

The modelling only considers emissions from the existing CHP engines, standby generator and new boiler and no other emission points to air at the site have been included in the assessment.

It should be noted there is a single on-site standby generator which is only used during an emergency[4] and has been excluded from the assessment as it does not form part of the scope for the Environmental Permit variation application. Furthermore, there is currently an existing temporary long-term hire boiler (housed in a trailer) operating at the site which would be replaced by the new boiler described above. Although the existing boiler has not been included in the assessment, the likely emissions would be of a similar composition to those modelled for the new boiler. However, emissions to air from the new boiler would have improved dispersion of pollutants as emissions are released from a 9.8 m tall stack, whereas the existing boiler currently emits its exhausts gases via an aperture in the trailer roof at an approximate height of 4 m, which would have poorer dispersion.

Table 1 presents the emission sources to air considered in this assessment.

Table 1: Combustion plant to be assessed

Parameters	JMS 312 GS-B.L CHP engine (1.9 MW_{th})	JMS 312 GS-B.L CHP engine (1.9 MW_{th})	Mecc Alte standby generator (2.6 MW_{th})	Byworth YSX6000 steam boiler (4.5 MW_{th})	
Fuel	Biogas	Biogas	Diesel	Diesel	Biogas
Emission point	A1	A2	A5	A7	

During anticipated operations at the site, only one CHP engine is likely to operate alongside the new boiler and the standby generator typically operates for up to 50 hours per year for routine testing only.

In order to quantify the worst-case or maximum short-term modelled concentrations, this assessment has been carried out on the assumption that all assessed combustion plant would operate continuously at maximum load throughout the year (i.e. 8,760 hours). This is a conservative assumption as, in practice, the combustion plant would have periods of shut-down and maintenance and may not always operate at maximum load.

In order to quantify the maximum long-term (i.e. annual mean) modelled concentrations, all assessed combustion plant are assumed to operate continuously at maximum load throughout the year with the exception of the standby generator, which is assumed to operate for 150 hours per year as a conservative approach to the assessment. As discussed previously, in practice, the assessed standby generator typically

3 Combustion plant A1 and A2 share an exhaust stack.
4 The standby generator operates for less than 50 hours per year.

operates for up to 50 hours per year for routine testing only (further consideration of this is provided in Appendix A).

2.2 Modelled scenarios

A range of scenarios have been modelled to represent existing and proposed operations at the site. The modelled scenarios are as follows:

- Scenario 1 (existing scenario):- two existing CHP engines (emission point reference A1 and A2) and standby generator (emission point reference A5);
- Scenario 2 (preferred fuel type for boiler - biogas):- two existing CHP engines (emission point reference A1 and A2), standby generator (emission point reference A5) and new boiler (emission point reference A7) utilising biogas; and
- Scenario 3 (alternative fuel type for boiler - diesel):- two existing CHP engines (emission point reference A1 and A2), standby generator (emission point reference A5); and new boiler (emission point reference A7) utilising diesel.

2.3 Emissions Data

2.3.1 Emission concentrations of pollutants

For the assessed CHP engines, the NOx and CO were derived from the sites' existing Environmental Permit. The TVOCs emission concentrations were derived from the Environment Agency's guidance '*Guidance for monitoring landfill gas engine emissions'* (Environment Agency, 2010). For SO_2, in the absence of a specific emission limit value, the SO_2 emission concentration typically used in similar permit applications for biogas fuelled engines has been applied[5]. This is a conservative approach to the assessment as in practice, the CHP engines SO_2 emission concentration is likely to be lower than that applied in the model. For particulates, in the absence of a specific emission limit value, the emission concentration was derived from a previous study of landfill gas engines (Land Quality Management Ltd, 2002).

For the standby generator, the NOx, CO, PM_{10} and SO_2 emission concentrations were derived from a previous air quality modelling assessment of the Chertsey STW (Riccardo, 2020).

For the new boiler utilising biogas, the NOx and SO_2 emission concentrations were obtained from the Medium Combustion Plant Directive (MCPD) EU/2015/2193[6] (Schedule 25A of the Environmental Permitting (England and Wales) (Amendment) Regulations 2018 for new MCP other than engines and gas turbines as regulated under the MCPD[6]. For CO and particulates, in the absence of a specific emission limit value, the emission concentrations were obtained from Defra's Process Guidance Note 1/3,*'Statutory Guidance for Boilers and Furnaces 20-50MW thermal input'* (Defra, 2012). The TVOCs emission concentration was derived from the Environment Agency's '*Guidance for monitoring landfill gas engine emissions'*, (Environment Agency, 2010).

For the new boiler utilising diesel, the NOx emission concentration is based on the emission limit value for new MCP other than engines and gas turbines as regulated under the MCPD[6]. For CO and particulates, the emission concentrations are based on the new boilers' IPPC datasheet (Byworth Boilers, 2021). The SO_2 concentration is based on the size of the new boiler (MW_{th}) and volumetric normalised flow (with 0.1% sulphur content).

The emissions inventory of releases to air from the CHP engines, standby generator and new boiler is provided in Appendix A.

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5 See Permit number EPR/PB3238RK/V002 which relates to a similar site configuration owned by Thames Water Utilities Limited at the Beckton Sewage Treatment Works Combustion Facility.

6 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.

2.3.2 Other emission parameters

In the absence of information relating to the assessed CHP engines, the temperature, moisture content and exhaust gas volumetric flow rate of the CHP engines were obtained from a Jenbacher Technical Description JMS 312 GS-B.L datasheet[7] (Jenbacher, 2011). The oxygen content is based on a typical value for biogas fuelled CHP engines of a similar size.

For the standby generator, the emission parameters applied in the assessment were obtained from a previous air quality modelling assessment of the Chertsey STW (Riccardo, 2020).

For the new boiler utilising diesel, the exhaust gas volumetric flow and temperature were derived from the IPPC datasheet (Byworth Boilers, 2021) but with the thermal input reduced from 4.5 MW_{th} to 3.8 MW_{th} for the calculation of the exhaust gas volumetric flow[8]. For the new boiler utilising biogas, the volumetric flow was determined from stoichiometric calculations based on the combustion of biogas fuel at the maximum thermal input rating of the new boiler. Information regarding the temperature, oxygen and moisture content of the new boiler was provided by Thames Water (Thames Water, 2021).

The emissions inventory of releases to air from the CHP engines, standby generator and new boiler is provided in Appendix A.

7 The exhaust gas volumetric flow rate presented in the Jenbacher datasheet (for a CHP engine with a thermal input capacity of 1.2 MW_{th}) was factored accordingly based on the thermal input capacity of the assessed CHP engines (1.9 MW_{th}).

8 As instructed in communications in April 2021 between Thames Water and Eurograde Ltd (Design, manufacture and installation of combustion equipment, dual fuel biogas burners).

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

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

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

Based on these criteria; South West London Waterbodies SPA and Ramsar; Thorpe Park No 1 Gravel Pit SSSI[9]; Thursely, Ash, Pirbright & Chobham SAC; Thames Basin Heaths SPA, Windsor Forest & Great Park SAC; twenty parcels of ancient woodland and Riverside Walk, Virginia Water LNR and seven local wildlife sites have been included in the assessment.

It should be noted that the South West London Waterbodies SPA and Ramsar and Thorpe Park No 1 Gravel Pit SSSI encompass the same geographic area as do Thursely, Ash, Pirbright & Chobham SAC and Thames Basin Heaths SPA. However, for the assessment against critical loads (see Section 5.3.3), all protected conservation areas have been assessed individually for completeness.

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

3.2 Overall Methodology

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

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

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

1) Information on plant location and plant emission characteristics were supplied by Thames Water (Thames Water, 2021), Byworth Boilers (Byworth Boilers, 2021), Ricardo (Ricardo, 2020) and Jenbacher (Jenbacher, 2016).

[9] Designated for biological interest.

2) Five years of hourly sequential data recorded at the Heathrow Airport meteorological station (2015 – 2019 inclusive) were used for the assessment (ADM Ltd, 2020).

3) Information on the main buildings located on-site which could influence dispersion of emissions from the CHP engines, standby generator and new boiler stacks were estimated from Defra's environmental open-data applications and datasets (Defra, 2022a) and Google Earth (Google Earth, 2022).

4) The maximum predicted concentrations (at a modelled height of 1.5 m or 'breathing zone') at the assessed sensitive human receptor locations R1 – R21 (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 R22-R25 (representing a motocross track and PRoW), only the 1-hour mean and 15-minute mean concentrations were considered. The maximum predicted concentrations at an off-site location in the vicinity of the site were considered for the assessment of short-term (1-hour and 15-minute mean) concentrations. As discussed in Section 3.1, there is an AQMA in close proximity to the site (see Section 4.2). The AQMA was declared by RBC for elevated concentrations of annual mean NO_2 and PM_{10} and has been included in the assessment.

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

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

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

8) Modelled concentrations were processed using geographic information system (GIS) software (ArcMap 10.6.1) to produce contour plots of the model results. These are provided for illustrative purposes only; assessment of the model results was based on the numerical values outputted by the dispersion model on the model grid (see Figure 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 B.

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

Where appropriate, a conservative approach has been adopted throughout the assessment to increase the robustness of the model predictions. In addition, an analysis of various sensitivity scenarios has also been carried out (see Section 5.4) to determine how changes to model parameters (e.g. differing surface roughness values or modelling without considering buildings) may impact on predicted concentrations at sensitive human receptors and off-site locations.

3.3 Assessment Criteria

3.3.1 Environmental Quality Standards: Human Receptors

In the UK the focus on local air quality is reflected in the air quality objectives (AQOs) set out in the Defra and the Devolved Administrations *Air Quality Strategy for England, Scotland, Wales and Northern Ireland* (AQS). The AQS stipulates a number of air quality objectives for nine main air pollutants with respect to ambient levels of air quality (Defra, 2007). The AQOs are similar to the limit values that were transposed from the relevant EU directives into UK legislation by *The Air Quality Standards Regulations 2010*. The objectives are based on the current understanding of health effects of exposure to air pollutants and have been specified to control health and environmental risks to an acceptable level. They apply to places where people are regularly present over the relevant averaging period. The objectives set for the protection of human health and vegetation of relevance to the project are summarised in Table 2. Relevant Environmental Assessment Levels (EALs) set out in the Environment Agency guidance (Environment Agency, 2021a) are also included in Table 2 where these supplement the AQOs.

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

Table 2: Air quality objectives and environmental assessment levels

Pollutant	EQS (µg/m^3)	Concentration measured as
NO_2	40	Annual mean
	200	1-hour mean, not to be exceeded more than 18 times a year (99.79th percentile)
CO	10,000	Maximum daily 8 hour running mean (100th percentile)
	30,000	Maximum 1-hour mean (100th percentile)
SO_2	125	24-hour mean not to be exceeded more than 3 times a year (99.18th percentile)
	350	1-hour mean not to be exceeded more than 24 times a year (99.73rd percentile)
	266	15-minute mean not to be exceeded more than 35 times a year (99.9th percentile)
PM_{10}	40	Annual mean
	50	24-hour mean, not to be exceeded more than 35 times a year (90.41st percentile)
$PM_{2.5}$	20[3]	Annual mean
TVOC[1]	5[2]	Annual mean
	30	Maximum 24-hour mean (100th percentile)

Note 1: VOCs may contain a wide range of organic compounds and it is often difficult to determine or identify each and every compound present. The TVOCs emissions from the assessed combustion plant will largely comprise methane which is not directly harmful to human health. Therefore, there is no health-based air quality standard or guideline.
Note 2: For the purposes of this assessment, the annual mean and 24-hour mean EQSs for benzene (C_6H_6) has been applied worst-case approach for the assessment of TVOCs emissions (not all TVOCs emissions would comprise benzene).
Note 3: Amendment to the Air Quality Standards Regulations 2010 as per the Environment (Miscellaneous Amendments) (EU Exit) Regulations 2020 (UK Government, 2020).

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

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

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

- if the PC is less than 10% of the short-term EQS, this would be classed as insignificant and not representative of a significant effect (i.e. not significant) (Environment Agency, 2021b);

- if the PC is greater than 10% of the EQS but less than 20% of the headroom between the short-term background concentration and the EQS, based on professional judgement, this can also be described as not significant;
- where the PC is greater than 10% of the EQS and 20% of the headroom, professional judgement is used to determine the overall significance of the effect (i.e. whether the effect would be not significant or significant) in line with the approach specified above for long-term average concentrations.

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

3.3.2 Environmental Quality Standards: Protected Conservation Areas

Critical levels

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

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

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

Critical loads

Critical loads for pollutant deposition to statutorily designated habitat sites in the UK and for various habitat types have been published by the CEH and are available from the APIS website. Critical Loads are defined on the APIS website (Centre for Ecology and Hydrology, 2022) as:

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

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

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

Table 4: Critical loads for modelled protected conservation areas

Receptor ref	Protected conservation area	Habitat feature applied	Vegetation type (for deposition velocity)	Critical load			
				Acid deposition (kEqH+/ha/year)			Nitrogen deposition (kg N/ha/year)
				CLMaxS	CLMinN	CLMaxN	Minimum
H1	South West London Waterbodies SPA & Ramsar	Low and medium altitude hay meadows	Short	No critical loads data available			20
H2	Thorpe Park No1 Gravel Pit SSSI	no critical loads available for this feature					
H3	Thursley, Ash, Pirbright & Chobham SAC	Valley mires, poor fens and transition mires	Short	0.217	0.321	0.538	10
H4	Thames Basin Heaths SPA	Dry heaths	Short	0.240	0.642	0.882	10
		Coniferous woodland	Tall	0.773	0.285	1.058	5
H5	Windsor Forest & Great Park SAC	Acidophilous Quercus-dominated woodland	Tall	0.776	0.285	1.061	10
H6	Ancient Woodland ID 1494421	Coniferous woodland	Tall	2.570	0.142	2.712	5
H7	Ancient Woodland ID 1494091	Coniferous woodland	Tall	2.570	0.142	2.712	5
H8	Ancient Woodland ID 1494015	Coniferous woodland	Tall	2.571	0.142	2.713	5
H9	Ancient Woodland ID 1494384	Coniferous woodland	Tall	2.571	0.142	2.713	5
H10	Ancient Woodland ID 1493326	Coniferous woodland	Tall	0.742	0.285	1.027	5
H11	Ancient Woodland ID 1494192	Coniferous woodland	Tall	2.571	0.142	2.713	5
H12	Ancient Woodland ID 1494681	Coniferous woodland	Tall	0.742	0.285	1.027	5
H13	Ancient Woodland ID 1494200	Coniferous woodland	Tall	0.742	0.285	1.027	5
H14	Ancient Woodland ID 1494364	Coniferous woodland	Tall	2.571	0.142	2.713	5
H15	Ancient Woodland ID 1494363	Coniferous woodland	Tall	2.571	0.142	2.713	5
H16	Ancient Woodland ID 1493904	Coniferous woodland	Tall	0.774	0.285	1.059	5
H17	Ancient Woodland ID 1494767	Coniferous woodland	Tall	0.774	0.285	1.059	5
H18	Ancient Woodland ID 1494489	Coniferous woodland	Tall	1.154	0.357	1.511	5
H19	Ancient Woodland ID 1494338	Coniferous woodland	Tall	1.506	0.357	1.863	5
H20	Ancient Woodland ID 1494255	Coniferous woodland	Tall	1.506	0.357	1.863	5
H21	Ancient Woodland ID 1494339	Coniferous woodland	Tall	1.506	0.357	1.863	5

Receptor ref	Protected conservation area	Habitat feature applied	Vegetation type (for deposition velocity)	Critical load			
				Acid deposition (kEqH+/ha/year)			Nitrogen deposition (kg N/ha/year)
				CLMaxS	CLMinN	CLMaxN	Minimum
H22	Ancient Woodland ID 1493546	Coniferous woodland	Tall	1.506	0.357	1.863	5
H23	Ancient Woodland ID 1493550	Coniferous woodland	Tall	1.629	0.142	1.771	5
H24	Ancient Woodland ID 1493205	Coniferous woodland	Tall	1.154	0.357	1.511	5
H25	Ancient Woodland ID 1493197	Coniferous woodland	Tall	0.775	0.285	1.060	5
H26	Riverside Walk, Virginia Water LNR	Valley mires, poor fens and transition mires	Short	This habitat is not sensitive to acidity			10
		Broadleaved, Mixed and Yew Woodland	Tall	1.154	0.357	1.511	10
H27	Knowle Grove LWS	Acid grassland	Short	0.240	0.366	0.606	5
		Coniferous woodland	Tall	0.774	0.285	1.059	5
H28	Fan Grove LWS	Acid grassland	Short	0.880	0.223	1.103	5
		Coniferous woodland	Tall	2.571	0.142	2.713	5
H29	Hardwick Court Farm Fields LWS	Acid grassland	Short	0.230	0.366	0.596	5
		Coniferous woodland	Tall	0.740	0.285	1.025	5
H30	Abbey Lake Complex LWS	Acid grassland	Short	1.630	0.438	2.068	5
		Coniferous woodland	Tall	2.841	0.357	3.198	5
H31	The Dell LWS	Acid grassland	Short	0.480	0.438	0.918	5
		Coniferous woodland	Tall	1.154	0.357	1.511	5
H32	Trumps Mill LWS	Acid grassland	Short	0.480	0.438	0.918	5
		Coniferous woodland	Tall	1.154	0.357	1.511	5
H33	The Moat, Woodcock Farm LWS	Acid grassland	Short	0.880	0.223	1.103	5
		Coniferous woodland	Tall	1.628	0.142	1.770	5

Critical load functions for acid deposition are specified on the basis of both nitrogen-derived acid and sulphur derived acid. The critical load function contains a value for sulphur derived acid and two values for nitrogen derived acid deposition (a minimum and maximum value). The APIS website provides advice on how to calculate the process contribution (PC – emissions from the modelled process alone) and the predicted environmental concentrations (PEC – the PC added to the existing deposition) as a percentage of the acid critical load function and how to determine exceedances of the critical load function. This guidance was adopted for this assessment. The minimum of the range of nitrogen critical loads was used for the assessment in line with the advice on the APIS website (Centre for Ecology and Hydrology, 2022).

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

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

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

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

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

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

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

Significance Criteria – Local nature sites

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

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

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

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

3.3.3 Short-term statistical analysis

It may be necessary to conduct statistical analysis if short-term modelled predictions of NO_2 (i.e. the 99.79^{th} percentile of 1-hour mean concentrations) indicate that 19 or more hours per year exceed the relevant EQS value of 200 $\mu g/m^3$ at a relevant receptor based on the assessed emission source operating continuously for the year.

Using hypergeometric probability distribution, which assumes operational hours are independent and random, the probability of concentrations exceeding 200 µg/m^3 more than 18 times for an operating envelope which is less than 8,760 hours per year, can be calculated. For example, where the operating envelope is 150 hours per year for the standby generator. This is then used to determine the probability of exceedance of the EQS and is described as follows (Environment Agency, 2018):

- the probability of 1% or less indicates exceedances are 'highly unlikely';
- a probability of less than 5% indicates exceedances are 'unlikely', provided the generator plant operational lifetime is no more than 20 years;
- probabilities greater than or equal to 5% indicates there is the potential for the exceedances and may not be considered acceptable on a case-by-case basis.

A description of the statistical analysis methodology is provided in Appendix B.

4. Existing Environment

4.1 Site Location

The site is situated approximately 2.3 km west-northwest from the centre of the town of Chertsey, Runnymede. The area surrounding the site generally comprises a mixture of agricultural and isolated residential land use. Lynne motocross track is adjacent to the northern and western boundary of the site. The M3 and M25 motorways are in close proximity to the northern and eastern boundary of the site, respectively, including the interchange junction of the two motorways, and a railway line runs adjacent to the southern boundary.

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 160 m southwest of the CHP engines shared stack (National Grid Reference (NGR) E 501590 N 167355)).

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, 2022b) 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, RBC has declared three AQMAs across their administrative borough. The closest AQMA (termed the 'M25 AQMA') was declared in December 2001 (and amended in 2008 and then 2015) by RBC for exceedances of the annual mean objective for NO_2 and the annual mean and 24-hour mean objective for PM_{10}. The 'M25 AQMA' covers a length of the M25 between junction 11 and 13, which is approximately 0.3 km northeast of the CHP engines shared stack at its closest point. Due to the proximity of the 'M25 AQMA', a modelled grid encompassing a section of the AQMA closest to the site was modelled to capture the maximum long-term and short-term NO_2 and PM_{10} modelled concentrations. Further description of this is provided in Appendix A .

RBC also carries out regular assessments and monitoring of air quality within its administrative borough as part of the LAQM process. The most recent Air Quality Annual Status Report (Runnymede Borough Council, 2022) was reviewed to determine the concentrations of NO_2 in the vicinity of the site. It should be noted that none of the other assessed pollutants are monitored by RBC. Table 5 presents information on the nearest monitoring locations to the site. It should be noted Table 5 presents the 2019 monitored annual mean NO_2 concentrations as this dataset is the latest available representative data not affected by the Covid pandemic and related travel restrictions.

Table 5: Nearest monitoring locations to the site

Site ID	Site type	Location	Distance and direction from CHP engine	Pollutants monitored	2019 Annual mean concentration (µg/m^3)
Automatic monitoring					
RBC does not undertake automatic (continuous) monitoring within the Borough					
Non-automatic monitoring (diffusion tubes)					
RY21	Roadside	E 504261 N 166945	2.7 km, E	NO_2	34.3
RY39	Roadside	E 498859 N 166225	3 km, WSW	NO_2	26
RY40	Urban Background	E 502062 N 165101	2.3 km, SSE	NO_2	14.9

These monitoring locations are not considered representative of the site and surrounding area due to the roadside monitoring location type(for Site ID RY21 and RY39) and / or respective distance from the site.

For the assessed pollutants, information on background air quality in the vicinity of the site was obtained from Defra background map datasets (Defra, 2022b). 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 TVOCs concentrations, the 2010-based background maps for C_6H_6 were used. These background concentrations are presented in Table 6.

As it is necessary to determine the potential impact of emissions from the site on the assessed protected conservation areas, the background concentrations of NOx and SO_2 were also identified for the assessed protected conservation areas. These background concentrations were obtained from the Defra background map datasets (Defra,2022b), respectively, and are also displayed in Table 6.

Table 6: 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	15.6 – 23.9[1]	Defra 1 km x 1 km background map value for the assessed sensitive human receptor locations, 2022 map concentration
CO	184 - 194	Defra 1 km x 1 km background map value for the assessed sensitive human receptor locations, scaled from 2001-based map to 2022 concentration
PM_{10}	14.7 – 16.3	Defra 1 km x 1 km background map value for the assessed sensitive human receptor locations, 2022 map concentration
$PM_{2.5}$	10.0 – 10.8	Defra 1 km x 1 km background map value for the assessed sensitive human receptor locations, 2022 map concentration
SO_2	3.4 – 3.9	Defra 1 km x 1 km background map value for the assessed sensitive human receptor locations, scaled from 2001-based map to 2022 concentration
C_6H_6	0.4 – 0.5	Defra 1 km x 1 km background map value for the assessed sensitive human receptor locations, 2010 map concentration for benzene
Protected conservation areas		
NOx	15.2 – 28.6	Defra 1 km x 1 km background map value for the assessed protected conservation areas, 2022 map concentration
SO_2	3.2 – 4.0	Defra 1 km x 1 km background map value for the assessed protected conservation areas, scaled from 2001-based map[1] concentration

Note 1: For R23 – R25 (representing a PRoW adjacent to the M25 and M3 interchange), a background annual mean NO_2 concentration of 33.5 µg/m³ has been applied. The 2018 concentration was obtained from diffusion tube monitoring location RY33 (NGR E 501679 N 171676) (Runnymede Borough Council, 2021) which was situated adjacent to the M25 approximately 4.4 km north of the CHP engines shared stack. This monitoring location, which is situated to the west of the M25, is considered representative of the likely annual mean NO_2 background concentration at R23 - R25.

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

4.3 Existing Deposition Rates

Existing acid and nutrient nitrogen deposition levels were obtained from APIS (Centre for Ecology and Hydrology, 2022). As discussed previously, where both vegetation types (i.e. short or tall) are listed on the APIS website as being present at the assessed protected conservation area, the most sensitive habitat for both short and tall vegetation, where applicable, was used for the assessment to represent the differing deposition velocities for these vegetation types. As a conservative approach to the assessment, it is assumed the vegetation type selected is present at the specific modelled location within the assessed protected conservation area. The existing deposition values at the assessed habitat site are set out in Table 7.

Table 7: Existing deposition at modelled habitat sites

Receptor ref	Protected conservation area	Vegetation type (for deposition velocity)	Existing deposition rates		
			Existing acid deposition (kEqH+/ha/year)		Existing nutrient N deposition (kg N/ha/year)
			Nitrogen	Sulphur	Nitrogen
H1	South West London Waterbodies SPA & Ramsar	Short	0.6	0.2	9.04
H2	Thorpe Park No1 Gravel Pit SSSI	No critical load data available			
H3	Thursley, Ash, Pirbright & Chobham SAC	Short	1.1	0.2	15.18
H4	Thames Basin Heaths SPA	Short	1.1	0.2	15.18
		Tall	1.9	0.2	27.28
H5	Windsor Forest & Great Park SAC	Tall	2.0	0.2	27.9
H6	Ancient Woodland ID 1494421	Tall	1.9	0.2	27.16
H7	Ancient Woodland ID 1494091	Tall	1.9	0.2	27.16
H8	Ancient Woodland ID 1494015	Tall	1.9	0.2	27.16
H9	Ancient Woodland ID 1494384	Tall	1.9	0.2	27.16
H10	Ancient Woodland ID 1493326	Tall	1.9	0.2	27.16
H11	Ancient Woodland ID 1494192	Tall	1.9	0.2	27.16
H12	Ancient Woodland ID 1494681	Tall	1.9	0.2	27.16
H13	Ancient Woodland ID 1494200	Tall	1.9	0.2	27.16
H14	Ancient Woodland ID 1494364	Tall	1.9	0.2	27.16
H15	Ancient Woodland ID 1494363	Tall	1.9	0.2	27.16
H16	Ancient Woodland ID 1493904	Tall	2.0	0.2	27.58
H17	Ancient Woodland ID 1494767	Tall	2.0	0.2	27.58
H18	Ancient Woodland ID 1494489	Tall	1.9	0.2	27.16
H19	Ancient Woodland ID 1494338	Tall	1.9	0.2	27.16
H20	Ancient Woodland ID 1494255	Tall	1.9	0.2	27.16
H21	Ancient Woodland ID 1494339	Tall	1.9	0.2	27.16
H22	Ancient Woodland ID 1493546	Tall	1.9	0.2	27.16
H23	Ancient Woodland ID 1493550	Tall	1.9	0.2	27.16
H24	Ancient Woodland ID 1493205	Tall	1.9	0.2	27.16
H25	Ancient Woodland ID 1493197	Tall	2.0	0.2	27.58
H26	Riverside Walk, Virginia Water LNR	Short	This habitat is not sensitive to acidity		15.12
		Tall	1.9	0.2	27.16
H27	Knowle Grove LWS	Short	1.1	0.2	15.54
		Tall	2.0	0.2	27.58
H28	Fan Grove LWS	Short	1.1	0.2	15.12
		Tall	1.9	0.2	27.16
H29	Hardwick Court Farm Fields LWS	Short	1.1	0.2	15.12
		Tall	1.9	0.2	27.16
H30	Abbey Lake Complex LWS	Short	1.1	0.2	15.12
		Tall	1.9	0.2	27.16
H31	The Dell LWS	Short	1.1	0.2	15.12
		Tall	1.9	0.2	27.16
H32	Trumps Mill LWS	Short	1.1	0.2	15.12

Receptor ref	Protected conservation area	Vegetation type (for deposition velocity)	Existing deposition rates		
			Existing acid deposition (kEqH+/ha/year)		Existing nutrient N deposition (kg N/ha/year)
			Nitrogen	Sulphur	Nitrogen
		Tall	1.9	0.2	27.16
H33	The Moat, Woodcock Farm LWS	Short	1.1	0.2	15.12
		Tall	1.9	0.2	27.16

5. Results

5.1 Human Receptors

The results presented below are the maximum modelled concentrations predicted at any of the 25 assessed sensitive human receptor locations, the 'M25 AQMA' and the maximum modelled concentration at any off-site location for the five years of meteorological data used in the study.

The results of the dispersion modelling for the three assessed scenarios are set out in Table 8 to Table 9, 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 Appendix D.

Table 8: Results of detailed assessment for Scenario 1

Pollutant	Averaging period	Assessment location	Maximum receptor	EQS (µg/m³)	Baseline air quality level (µg/m³)	PC (µg/m³)	PEC (µg/m³)	PC / EQS (%)	PEC / EQS (%)	PC as a percentage of headroom (%)
CO	Maximum 8-hour running mean	Sensitive locations	R10	10,000	374	84.5	458.1	0.8%	4.6%	0.9%
	Maximum 1-hour mean	Maximum off-site	-	30,000	372	240.7	612.7	0.8%	2.0%	0.8%
		Sensitive locations	R10	30,000	374	103.7	477.3	0.3%	1.6%	0.3%
NO_2	Annual mean	Sensitive locations	R10	40	23.9	2.1	25.9	5.1%	64.8%	-
	Maximum 1-hour mean	Sensitive locations	R22	-	47.7	303.9	351.6	-		
	1-hour mean (99.79th percentile)	Maximum off-site	-	200	47.7	181.8	229.5	90.9%	114.8%	119.4%
		Sensitive locations	R22	200	47.7	126.8	174.6	63.4%	87.3%	83.3%
SO_2	24-hour mean (99.18th percentile)	Sensitive locations	R10	125	7.0	15.9	22.9	12.8%	18.4%	13.5%
	1-hour mean (99.73rd percentile)	Maximum off-site	-	350	7.0	56.1	63.1	16.0%	18.0%	16.3%
		Sensitive locations	R10	350	7.0	23.9	30.9	6.8%	8.8%	7.0%
	15-minute mean (99.9th percentile)	Maximum off-site	-	266	7.0	61.0	68.0	22.9%	25.6%	23.6%
		Sensitive locations	R10	266	7.0	26.1	33.1	9.8%	12.5%	10.1%
PM_{10}	Annual mean	Sensitive locations	R10	40	16.3	0.05	16.4	0.1%	40.9%	-
	24-hour mean (90.41st percentile)	Sensitive locations	R11	50	32.6	1.0	33.6	2.0%	67.2%	5.7%
$PM_{2.5}$	Annual mean	Sensitive locations	R10	20	10.8	0.05	10.9	0.2%	54.3%	-
TVOC	Annual mean	Sensitive locations	R10	5 (Benzene)	0.5	5.5	6.0	110.7%	119.8%	121.8%
	Maximum 24-hour mean	Sensitive locations	R10	30 (Benzene)	0.9	53.3	54.2	177.6%	180.6%	183.1%

Note 1: For annual mean NO_2, PM_{10} and $PM_{2.5}$ and TVOCs concentrations, 24-hour mean PM_{10} and SO_2 concentrations and 8-hour mean CO concentrations, R22 – R25 have been omitted from analysis as these receptor locations represent the Motocross track and PRoW (i.e. short-term exposure only). The full results are presented in 0.

5.1.1 Results discussion – Scenario 1

The results in Table 8 indicate that for Scenario 1 (i.e. existing operations), with the exception of predicted 1-hour mean (99.79th percentile) NO_2 concentrations at a modelled off-site location, predicted off-site concentrations and predicted concentrations at assessed sensitive human receptor locations do not exceed any relevant long-term or short-term EQSs.

For predicted 1-hour mean (99.79th percentile) NO_2 concentrations at a modelled off-site location, the maximum PC is 181.8 µg/m^3, which is predicted at NGR E 501500 N 167355. The PEC of 229.5 µg/m^3 exceeds the relevant EQS. This exceedance is predicted on the road that runs adjacent to the southern boundary of the site and is not likely to be frequented by members of the public. Further analysis indicates that the standby generator is the main contributor to the peak short-term concentrations at the modelled off-site locations when the standby generator and CHP engines are assumed to operate simultaneously. The maximum PC without the standby generator in operation is 27.1 µg/m^3.

In order to quantify the maximum short-term concentrations, the assessed combustion plant are assumed to operate at maximum load all year (i.e. 8,760 hours). As discussed previously, the standby generator typically operates for up to 50 hours per year for routine testing only. It is unlikely that the peak short-term concentrations of substances emitted from the standby generator would coincide with the worst case meteorological conditions. Therefore, the short-term concentrations presented in Table 8 are likely to be higher than would reasonably be expected.

For annual mean TVOCs concentrations at a sensitive human receptor location, the maximum PC for Scenario 1 is 5.5 µg/m^3 and is predicted at R10, which represents a residential property approximately 160 m southwest of the CHP engines shared stack. The PC and PEC exceeds the annul mean EQS for C_6H_6 when adopting a worst-case approach, which assumes all TVOCs emitted by the combustion plant are C_6H_6 in the absence of EQSs for TVOC. For maximum 24-hour mean TVOCs concentrations at a sensitive human receptor location, the maximum PC is 53.3 µg/m^3, which is predicted at R10. Therefore, the PC and PEC also exceeds the C_6H_6 24-hour mean standard when assuming all TVOCs emitted by the combustion plant are C_6H_6. This is an unrealistic assumption, and C_6H_6, if present in the exhaust gases, would constitute only a very small proportion of total TVOC emissions (e.g. less than 1%). Therefore, it is likely there would be no exceedance of EQSs associated with TVOC emissions and based on professional judgement, the emissions of TVOCs is considered 'not significant'.

Table 9: Results of detailed assessment for Scenario 1 - 3

Pollutant	Averaging period	Assessment location	Scenario 1	Scenario 2				Scenario 3			
			PC (µg/m³)	PC (µg/m³)	PC / EQS (%)	PEC (µg/m³)	PEC / EQS (%)	PC (µg/m³)	PC / EQS (%)	PEC (µg/m³)	PEC / EQS (%)
CO	Maximum 8-hour running mean	Sensitive locations	84.5	92.3	0.9%	465.9	4.7%	85.9	0.9%	459.5	4.6%
	Maximum 1-hour mean	Maximum off-site	240.7	244.1	0.8%	616.1	2.1%	241.5	0.8%	613.4	2.0%
		Sensitive locations	103.7	113.0	0.4%	486.6	1.6%	105.3	0.4%	479.0	1.6%
NO_2	Annual mean	Sensitive locations	2.1	3.0	7.6%	26.9	67.3%	2.7	6.7%	26.6	66.4%
	Maximum 1-hour mean	Sensitive locations	303.9	303.9	-	351.6	-	303.9	-	351.6	-
	1-hour mean (99.79th percentile)	Maximum off-site	181.8	181.8	90.9%	229.5	114.8%	181.8	90.9%	229.5	114.8%
		Sensitive locations	126.8	128.4	64.2%	176.1	88.1%	127.9	63.9%	175.6	87.8%
SO_2	24-hour mean (99.18th percentile)	Sensitive locations	15.9	21.8	17.4%	28.8	23.0%	22.6	18.1%	29.6	23.7%
	1-hour mean (99.73rd percentile)	Maximum off-site	56.1	63.0	18.0%	70.0	20.0%	66.2	18.9%	73.2	20.9%
		Sensitive locations	23.9	31.7	9.1%	38.7	11.1%	33.1	9.5%	40.1	11.5%
	15-minute mean (99.9th percentile)	Maximum off-site	61.0	66.3	24.9%	73.3	27.6%	69.3	26.1%	76.3	28.7%
		Sensitive locations	26.1	34.7	13.1%	41.7	15.7%	36.6	13.8%	43.6	16.4%
PM_{10}	Annual mean	Sensitive locations	0.05	0.08	0.2%	16.4	41.0%	0.21	0.5%	16.5	41.3%
	24-hour mean (90.41st percentile)	Sensitive locations	1.0	1.0	2.1%	33.7	67.3%	1.6	3.3%	34.2	68.5%
$PM_{2.5}$	Annual mean	Sensitive locations	0.05	0.08	0.4%	10.9	54.5%	0.21	1.1%	11.0	55.1%
TVOC	Annual mean	Sensitive locations	5.5	13.5	270.2%	14.0	279.3%	5.5	110.7%	6.0	119.8%
	Maximum 24-hour mean	Sensitive locations	53.3	130.0	433.5%	130.9	436.5%	53.3	177.6%	54.2	180.6%

Note 1: For annual mean NO_2, PM_{10} and $PM_{2.5}$ and TVOCs concentrations, 24-hour mean PM_{10} and SO_2 concentrations and 8-hour mean CO concentrations, R22 – R25 have been omitted from analysis as these receptor locations represent the Motocross track and PRoW (i.e. short-term exposure only). The full results are presented in 0.

5.1.2 Results discussion – Scenario 2 and 3

The results in Table 9 indicate that for all modelled scenarios, with the exception of predicted 1-hour mean (99.79th percentile) NO_2 concentrations at a modelled off-site location, the predicted off-site concentrations and predicted concentrations at sensitive human receptors do not exceed any relevant long-term or short-term EQS. The inclusion of the new boiler (i.e. Scenario 2 and Scenario 3) increases the predicted concentrations compared to Scenario 1.

Table 9 indicates that the maximum PC for annual mean NO_2 at a sensitive human receptor location for Scenario 2 (i.e. preferred fuel type for boiler - biogas) is 3.0 µg/m^3 (equating to 7.6% of the relevant EQS). For Scenario 3 (i.e. alternative fuel type for boiler - diesel), the maximum PC is 2.7 µg/m^3 (equating to 6.7% of the relevant EQS). The maximum concentration for both scenarios is predicted at R10. Although the respective PCs are greater than 1% of the relevant EQS, the corresponding PECs are less than 70% of the EQS. Based on professional judgement, the impact is considered 'not significant'. The respective PECs for Scenario 2 and Scenario 3 are only slighter higher than those predicted for Scenario 1.

At the closest relevant sensitive human receptor to the nearby 'M25 AQMA' (i.e. R5 representing a residential property), for Scenario 2, the maximum PC for annual mean NO_2 is 0.45 µg/m^3, which equates to 1.1% of the relevant EQS. For Scenario 3, the maximum PC is 0.39 µg/m^3, which equates to 1.0% of the relevant EQS. Based on professional judgement, these PCs represent a 'not significant' effect.

For the assessment of 1-hour mean (99.79th percentile) NO_2 concentrations at a sensitive human receptor location, for Scenario 2 (i.e. preferred fuel type for boiler - biogas) and Scenario 3, the maximum PCs are 128.4 µg/m^3 and 127.9 µg/m^3, respectively. The corresponding PECs equate to a maximum of 88% of the relevant EQS, and are only slightly higher than Scenario 1 where the PEC equates to 87% of the EQS.

For the assessment of 1-hour mean (99.79th percentile) NO_2 concentrations at modelled off-site locations, the maximum PEC for Scenario 2 and Scenario 3 is 229.5 µg/m^3, which exceeds the relevant EQS. For both scenarios, this concentration is predicted at NGR E 501500 N 167355, which is situated on the road that runs adjacent to the southern boundary of the site and is not likely to be frequented by members of the public. The predicted PC and PEC is identical for Scenario 1, 2 and 3 which indicates that the peak short-term concentrations at the maximum off-site location are dominated by emissions from the currently permitted standby generator (as noted in Section 5.1.1). Although emissions from the proposed boiler do not alter the maximum PC, for completeness, further statistical analysis was undertaken to determine the likelihood of the EQS to be exceeded (see Section 5.2).

For long-term PM_{10} and $PM_{2.5}$ concentrations, for both Scenario 2 and Scenario 3, the respective PCs are less than 1% of the relevant long-term EQS and their impact can be described as 'insignificant' as per Environment Agency guidance (Environment Agency, 2021a) and therefore 'not significant'.

For short-term CO, SO_2 and particulate concentrations, the PCs are less than 10% of the relevant EQS and where the PCs are above 10% of the relevant EQS, the PECs are less than 70% of the relevant EQS and the impacts are considered 'not significant'.

For annual mean TVOCs concentrations at a sensitive human receptor location, the maximum PC for Scenario 2 and Scenario 3 are 13.5 µg/m^3 and 5.5 µg/m^3, respectively, and are predicted at R10. The respective PECs exceed the annul mean EAL for C_6H_6.

For maximum 24-hour mean TVOCs concentrations at a sensitive human receptor location, the maximum PCs for Scenario 2 and Scenario 3 are 130.0 µg/m^3 and 53.3 µg/m^3, respectively, and are predicted at R10. The respective PECs exceed the C_6H_6 24-hour mean standard.

As discussed for Scenario 1, it is an unrealistic assumption that total TVOCs emitted by the combustion plant are C_6H_6. If present in the exhaust gases, C_6H_6 would constitute only a very small proportion of total TVOC emissions (e.g. less than 1%). Therefore, it is likely there would be no exceedance of EQSs associated with TVOC emissions and based on professional judgement, the emissions of TVOCs is considered 'not significant'.

5.1.3 Summary

The results in Table 9 indicate that, for all modelled scenarios, with the exception of 1-hour mean (99.79th percentile) NO_2 concentrations at a modelled off-site location, predicted off-site concentrations and predicted concentrations at sensitive human receptor locations do not exceed any relevant long-term or short-term EQS.

The results indicate that when introducing the new boiler (i.e. Scenario 2 and 3), with the exception of 1-hour mean (99.79th percentile) NO_2 concentrations at a modelled off-site location, there are increases in predicted concentrations compared to Scenario 1 but not to an extent that would lead to exceedances or indicate that there would be a significant impact. For 1-hour mean (99.79th percentile) NO_2 concentrations, adding the boiler does not change the peak 1-hour mean (99.79th percentile) NO_2 concentrations so there is no change to the existing site contributions.

Further analysis shows that the standby generator is the primary contributor to the short-term predicted concentrations at sensitive human receptor and modelled off-site locations.

The conservative approach adopted throughout the assessment means the predicted concentrations presented in Table 8 and Table 9 are likely to be higher than would reasonably be expected.

Isopleths of pollutant concentrations (see Figures 4 - 13) have been produced for the assessed scenarios. The figures are based on the year of meteorological data which resulted in the highest PC at a sensitive human receptor location.

5.2 Human Receptors – Further Statistical Analysis

A short-term statistical analysis using the hypergeometric probability distribution method was undertaken to determine the likelihood of the predicted 1-hour mean (99.79th percentile) NO_2 concentrations exceeding the EQS value of 200 $\mu g/m^3$ 19 or more times based on the modelled operating envelope of the assessed standby generator (i.e. modelled operating for 150 hours per year). This was undertaken at the modelled off-site locations where the highest concentrations (and therefore exceedances of the relevant EQS) were predicted for each year of meteorological data modelled (i.e. 2015 – 2019). As discussed previously, the highest concentrations were predicted on the road that runs adjacent to the southern boundary of the site. Table 10 presents the results of the hypergeometric probability distribution analysis. It should be noted the results presented are the same for each considered scenario.

Table 10: Results of hypergeometric probability distribution analysis at modelled off-site locations for 2015 – 2019 meteorological data (Scenario 1 – 3)

Modelled off-site location (NGR)	Number of exceedances of relevant EQS	Non-exceedance total annual hours	Hypergeometric distribution	Probability of exceedance of the EQS
2015				
E 501470 N 167365	14	8746	<0.1%	<0.1%
2016				
E 501500 N 167355	14	8770	<0.1%	<0.1%
2017				
E 501500 N 167355	8	8752	<0.1%	<0.1%
2018				
E 501500 N 167355	31	8729	<0.1%	<0.1%

Modelled off-site location (NGR)	Number of exceedances of relevant EQS	Non-exceedance total annual hours	Hypergeometric distribution	Probability of exceedance of the EQS
2019				
E 501500 N167355	16	8744	<0.1%	<0.1%

Table 10 indicates that, irrespective of the modelled scenario, the hypergeometric distribution at the modelled off-site locations where the highest 1-hour mean (99.79th percentile) NO_2 concentrations are predicted is less than 0.1%, which gives a probability of exceedance of the 1-hour mean NO_2 EQS of less than 0.1%. As the short-term statistical analysis indicates that the probability of exceedance is less than 1%, based on Environment Agency guidance (Environment Agency, 2018), the probability of exceedance is 'highly unlikely'.

On this basis, the impact at modelled off-site locations is considered to be acceptable from an air quality perspective in relation to the 1-hour mean (99.79th percentile) NO_2 concentrations for the currently permitted operations and proposed new boiler.

5.3 Protected Conservation Areas

5.3.1 Assessment against Critical Levels

The environmental effects of releases from the site at the assessed protected conservation areas have been determined by comparing predicted concentrations of released substances with the EQSs for the protection of vegetation (critical levels) (see Table 3). The results of the detailed modelling at the assessed protected conservation areas are shown in Table 11 to Table 13. The results presented are the maximum predicted concentration at each assessed protected conservation area for the five years of meteorological data used in the study.

For SO_2, with the exception of South West London Waterbodies SPA & Ramsar & Thorpe Park No1 Gravel Pit SSSI where lichens and bryophytes are unlikely to be present as it is a waterbody, the relevant EQS was based on the assumption that lichens and bryophytes were present at the assessed protected conservation areas, therefore adopting the lower critical level of 10 $\mu g/m^3$ as a conservative approach.

Table 11: Results of detailed assessment at assessed protected conservation sites for annual mean NOx concentrations for Scenario 1 – Scenario 3

Ref	Protected Conservation Area	Background concentration (µg/m³)	Scenario 1				Scenario 2				Scenario 3			
			PC (µg/m³)	PEC (µg/m³)	PC/EQS (%)	PEC/EQS (%)	PC (µg/m³)	PEC (µg/m³)	PC/EQS (%)	PEC/EQS (%)	PC (µg/m³)	PEC (µg/m³)	PC/EQS (%)	PEC/EQS (%)
EQS – 30 µg/m³														
H1 & H2	South West London Waterbodies SPA & Ramsar & Thorpe Park No1 Gravel Pit SSSI	21.6	0.49	22.1	1.6%	73.6%	0.73	22.3	2.4%	74.4%	0.63	22.2	2.1%	74.0%
H3 & H4	Thursley, Ash, Pirbright & Chobham SAC & Thames Basin Heaths SPA	15.3	0.05	15.4	0.2%	51.2%	0.07	15.4	0.2%	51.3%	0.06	15.4	0.2%	51.2%
H5	Windsor Forest & Great Park SAC	15.2	0.01	15.2	0.0%	50.6%	0.02	15.2	0.1%	50.6%	0.02	15.2	0.1%	50.6%
H6	Ancient Woodland ID 1494421	28.6	0.99	29.6	3.3%	98.5%	1.48	30.0	4.9%	100.2%	1.27	29.8	4.2%	99.4%
H7	Ancient Woodland ID 1494091	28.6	0.37	28.9	1.2%	96.5%	0.54	29.1	1.8%	97.0%	0.47	29.0	1.6%	96.8%
H8	Ancient Woodland ID 1494015	18.1	0.13	18.2	0.4%	60.7%	0.18	18.3	0.6%	60.9%	0.16	18.2	0.5%	60.8%
H9	Ancient Woodland ID 1494384	18.1	0.09	18.2	0.3%	60.5%	0.13	18.2	0.4%	60.7%	0.11	18.2	0.4%	60.6%
H10	Ancient Woodland ID 1493326	17.6	0.07	17.7	0.2%	58.9%	0.10	17.7	0.3%	59.0%	0.09	17.7	0.3%	58.9%
H11	Ancient Woodland ID 1494192	18.1	0.13	18.2	0.4%	60.7%	0.19	18.3	0.6%	60.9%	0.16	18.2	0.5%	60.8%
H12	Ancient Woodland ID 1494681	17.6	0.06	17.7	0.2%	58.8%	0.09	17.7	0.3%	58.9%	0.08	17.7	0.3%	58.9%
H13	Ancient Woodland ID 1494200	17.6	0.05	17.6	0.2%	58.8%	0.08	17.7	0.3%	58.9%	0.07	17.7	0.2%	58.9%
H14	Ancient Woodland ID 1494364	18.1	0.32	17.7	1.1%	58.9%	0.47	17.7	1.6%	59.0%	0.41	17.7	1.4%	58.9%
H15	Ancient Woodland ID 1494363	18.1	0.31	18.2	1.0%	60.7%	0.46	18.3	1.5%	60.9%	0.40	18.2	1.3%	60.8%
H16	Ancient Woodland ID 1493904	25.5	0.06	17.7	0.2%	58.8%	0.09	17.7	0.3%	58.9%	0.07	17.7	0.2%	58.9%
H17	Ancient Woodland ID 1494767	25.5	0.06	17.6	0.2%	58.8%	0.09	17.7	0.3%	58.9%	0.08	17.7	0.3%	58.9%
H18	Ancient Woodland ID 1494489	23.4	0.09	17.7	0.3%	58.9%	0.14	17.7	0.5%	59.0%	0.12	17.7	0.4%	58.9%
H19	Ancient Woodland ID 1494338	18.6	0.13	18.2	0.4%	60.7%	0.19	18.3	0.6%	60.9%	0.16	18.2	0.5%	60.8%
H20	Ancient Woodland ID 1494255	18.6	0.08	17.7	0.3%	58.8%	0.12	17.7	0.4%	58.9%	0.10	17.7	0.3%	58.9%
H21	Ancient Woodland ID 1494339	18.6	0.09	17.6	0.3%	58.8%	0.13	17.7	0.4%	58.9%	0.11	17.7	0.4%	58.9%

Ref	Protected Conservation Area	Background concentration (µg/m³)	Scenario 1				Scenario 2				Scenario 3			
			PC (µg/m³)	PEC (µg/m³)	PC/EQS (%)	PEC/EQS (%)	PC (µg/m³)	PEC (µg/m³)	PC/EQS (%)	PEC/EQS (%)	PC (µg/m³)	PEC (µg/m³)	PC/EQS (%)	PEC/EQS (%)
					EQS – 30 µg/m³									
H22	Ancient Woodland ID 1493546	18.6	0.08	17.7	0.3%	58.9%	0.11	17.7	0.4%	59.0%	0.10	17.7	0.3%	58.9%
H23	Ancient Woodland ID 1493550	26.2	0.10	18.2	0.3%	60.7%	0.15	18.3	0.5%	60.9%	0.13	18.2	0.4%	60.8%
H24	Ancient Woodland ID 1493205	23.4	0.27	17.7	0.9%	58.8%	0.39	17.7	1.3%	58.9%	0.34	17.7	1.1%	58.9%
H25	Ancient Woodland ID 1493197	17.5	0.06	17.6	0.2%	58.8%	0.08	17.7	0.3%	58.9%	0.07	17.7	0.2%	58.9%
H26	Riverside Walk, Virginia Water LNR	23.4	0.07	17.7	0.2%	58.9%	0.10	17.7	0.3%	59.0%	0.09	17.7	0.3%	58.9%
H27	Knowle Grove LWS	25.5	0.06	18.2	0.2%	60.7%	0.09	18.3	0.3%	60.9%	0.07	18.2	0.2%	60.8%
H28	Fan Grove LWS	18.1	0.13	17.7	0.4%	58.8%	0.18	17.7	0.6%	58.9%	0.16	17.7	0.5%	58.9%
H29	Hardwick Court Farm Fields LWS	19.7	0.07	17.6	0.2%	58.8%	0.11	17.7	0.4%	58.9%	0.09	17.7	0.3%	58.9%
H30	Abbey Lake Complex LWS	24.3	0.26	17.7	0.9%	58.9%	0.38	17.7	1.3%	59.0%	0.33	17.7	1.1%	58.9%
H31	The Dell LWS	23.4	0.07	18.2	0.2%	60.7%	0.10	18.3	0.3%	60.9%	0.09	18.2	0.3%	60.8%
H32	Trumps Mill LWS	23.4	0.18	17.7	0.6%	58.8%	0.26	17.7	0.9%	58.9%	0.23	17.7	0.8%	58.9%
H33	The Moat, Woodcock Farm LWS	28.1	0.35	17.6	1.2%	58.8%	0.50	17.7	1.7%	58.9%	0.43	17.7	1.4%	58.9%

The results in Table 11 indicate that, with the exception of H1 and H2, the PCs at the assessed European designated sites and local nature sites are less than 1% and 100% respectively, of the relevant critical level and the impact can be described as 'insignificant'.

At H1 and H2, although the predicted annual mean NOx PCs are just above 1% (i.e. 1.6% – 2.4%) of the relevant critical level, the PECs are below the relevant critical level. It should be noted the change in PCs as a percentage of the EQS is less than 1% when comparing Scenario 2 or Scenario 3 to Scenario 1.

Table 12: Results of detailed assessment at assessed protected conservation sites for annual mean SO_2 concentrations for Scenario 1 - 3

Ref	Protected Conservation Area	Background concentration (µg/m³)	Scenario 1				Scenario 2				Scenario 3			
			PC (µg/m³)	PEC (µg/m³)	PC/EQS (%)	PEC/EQS (%)	PC (µg/m³)	PEC (µg/m³)	PC/EQS (%)	PEC/EQS (%)	PC (µg/m³)	PEC (µg/m³)	PC/EQS (%)	PEC/EQS (%)
EQS – 10 µg/m³														
H1 & H2	South West London Waterbodies SPA & Ramsar & Thorpe Park No1 Gravel Pit SSSI (EQS 20 µg/m³)	3.9	0.32	4.2	1.6%	21.0%	0.44	4.3	2.2%	21.6%	0.45	4.3	2.3%	21.7%
H3 & H4	Thursley, Ash, Pirbright & Chobham SAC & Thames Basin Heaths SPA	3.2	0.03	3.2	0.3%	32.0%	0.04	3.2	0.4%	32.1%	0.04	3.2	0.4%	32.1%
H5	Windsor Forest & Great Park SAC	3.3	0.01	3.3	0.1%	32.9%	0.01	3.3	0.1%	32.9%	0.01	3.3	0.1%	32.9%
H6	Ancient Woodland ID 1494421	3.5	0.64	4.2	6.4%	41.7%	0.89	4.4	8.9%	44.2%	0.92	4.4	9.2%	44.5%
H7	Ancient Woodland ID 1494091	3.5	0.24	3.8	2.4%	37.7%	0.33	3.9	3.3%	38.6%	0.34	3.9	3.4%	38.7%
H8	Ancient Woodland ID 1494015	3.4	0.08	3.5	0.8%	34.8%	0.11	3.5	1.1%	35.1%	0.11	3.5	1.1%	35.1%
H9	Ancient Woodland ID 1494384	3.4	0.06	3.5	0.6%	34.6%	0.08	3.5	0.8%	34.8%	0.08	3.5	0.8%	34.8%
H10	Ancient Woodland ID 1493326	3.3	0.04	3.4	0.4%	33.7%	0.06	3.4	0.6%	33.9%	0.06	3.4	0.6%	33.9%
H11	Ancient Woodland ID 1494192	3.4	0.08	3.5	0.8%	34.8%	0.12	3.5	1.2%	35.2%	0.12	3.5	1.2%	35.2%
H12	Ancient Woodland ID 1494681	3.3	0.04	3.4	0.4%	33.7%	0.06	3.4	0.6%	33.9%	0.06	3.4	0.6%	33.9%
H13	Ancient Woodland ID 1494200	3.3	0.03	3.4	0.3%	33.6%	0.05	3.4	0.5%	33.8%	0.05	3.4	0.5%	33.8%
H14	Ancient Woodland ID 1494364	3.4	0.21	3.6	2.1%	36.1%	0.28	3.7	2.8%	36.8%	0.29	3.7	2.9%	36.9%
H15	Ancient Woodland ID 1494363	3.4	0.20	3.6	2.0%	36.0%	0.27	3.7	2.7%	36.7%	0.29	3.7	2.9%	36.9%
H16	Ancient Woodland ID 1493904	3.3	0.04	3.3	0.4%	33.1%	0.05	3.3	0.5%	33.2%	0.05	3.3	0.5%	33.2%
H17	Ancient Woodland ID 1494767	3.3	0.04	3.3	0.4%	33.1%	0.05	3.3	0.5%	33.2%	0.05	3.3	0.5%	33.2%
H18	Ancient Woodland ID 1494489	3.4	0.06	3.5	0.6%	34.9%	0.08	3.5	0.8%	35.1%	0.08	3.5	0.8%	35.1%
H19	Ancient Woodland ID 1494338	3.6	0.08	3.7	0.8%	36.5%	0.11	3.7	1.1%	36.8%	0.11	3.7	1.1%	36.8%
H20	Ancient Woodland ID 1494255	3.6	0.05	3.6	0.5%	36.2%	0.07	3.6	0.7%	36.4%	0.07	3.6	0.7%	36.4%

Ref	Protected Conservation Area	Background concentration (μg/m³)	Scenario 1				Scenario 2				Scenario 3			
			PC (μg/m³)	PEC (μg/m³)	PC/EQS (%)	PEC/EQS (%)	PC (μg/m³)	PEC (μg/m³)	PC/EQS (%)	PEC/EQS (%)	PC (μg/m³)	PEC (μg/m³)	PC/EQS (%)	PEC/EQS (%)
EQS – 10 μg/m³														
H21	Ancient Woodland ID 1494339	3.6	0.06	3.6	0.6%	36.3%	0.08	3.6	0.8%	36.5%	0.08	3.7	0.8%	36.5%
H22	Ancient Woodland ID 1493546	3.6	0.05	3.6	0.5%	36.2%	0.07	3.6	0.7%	36.4%	0.07	3.6	0.7%	36.4%
H23	Ancient Woodland ID 1493550	3.7	0.06	3.8	0.6%	37.9%	0.09	3.8	0.9%	38.2%	0.09	3.8	0.9%	38.2%
H24	Ancient Woodland ID 1493205	3.4	0.17	3.6	1.7%	36.0%	0.23	3.7	2.3%	36.6%	0.24	3.7	2.4%	36.7%
H25	Ancient Woodland ID 1493197	3.5	0.04	3.5	0.4%	35.5%	0.05	3.6	0.5%	35.6%	0.05	3.6	0.5%	35.6%
H26	Riverside Walk, Virginia Water LNR	3.4	0.05	3.5	0.5%	34.8%	0.06	3.5	0.6%	34.9%	0.06	3.5	0.6%	34.9%
H27	Knowle Grove LWS	3.3	0.04	3.3	0.4%	33.1%	0.05	3.3	0.5%	33.2%	0.05	3.3	0.5%	33.2%
H28	Fan Grove LWS	3.4	0.08	3.5	0.8%	34.8%	0.11	3.5	1.1%	35.1%	0.11	3.5	1.1%	35.1%
H29	Hardwick Court Farm Fields LWS	3.8	0.05	3.8	0.5%	38.2%	0.06	3.8	0.6%	38.3%	0.07	3.8	0.7%	38.4%
H30	Abbey Lake Complex LWS	4.0	0.17	4.2	1.7%	42.1%	0.23	4.3	2.3%	42.7%	0.23	4.3	2.3%	42.7%
H31	The Dell LWS	3.4	0.04	3.5	0.4%	34.7%	0.06	3.5	0.6%	34.9%	0.06	3.5	0.6%	34.9%
H32	Trumps Mill LWS	3.4	0.12	3.5	1.2%	35.5%	0.16	3.6	1.6%	35.9%	0.16	3.6	1.6%	35.9%
H33	The Moat, Woodcock Farm LWS	3.6	0.22	3.8	2.2%	38.1%	0.30	3.9	3.0%	38.9%	0.30	3.9	3.0%	38.9%

The results in Table 12 indicate that, with the exception of H1 and H2, irrespective of the modelled scenario, the PCs at the assessed European designated sites and local nature sites are less than 1% and 100%, respectively, of the relevant critical level and the impact can be described as 'insignificant'. At H1 and H2, the predicted annual mean SO_2 PCs are just above 1% (i.e. 1.6% – 2.3%) of the relevant critical level. However, the respective PECs are well within the relevant critical level.

Table 13: Results of detailed assessment at assessed protected conservation sites for maximum 24-hour mean NOx concentrations for Scenario 1 - 3

Ref	Protected Conservation Area	Background concentration (µg/m^3)	Scenario 1				Scenario 2				Scenario 3			
			PC (µg/m^3)	PEC (µg/m^3)	PC/EQS (%)	PEC/EQS (%)	PC (µg/m^3)	PEC (µg/m^3)	PC/EQS (%)	PEC/EQS (%)	PC (µg/m^3)	PEC (µg/m^3)	PC/EQS (%)	PEC/EQS (%)
EQS – 75 µg/m^3														
H1 & H2	South West London Waterbodies SPA & Ramsar & Thorpe Park No1 Gravel Pit SSSI	43.1	17.0	60.1	22.6%	80.2%	18.0	61.1	24.0%	81.5%	17.5	60.7	23.4%	80.9%
H3 & H4	Thursley, Ash, Pirbright & Chobham SAC & Thames Basin Heaths SPA	30.6	4.0	34.6	5.3%	46.2%	4.2	34.9	5.7%	46.5%	4.1	34.8	5.5%	46.4%
H5	Windsor Forest & Great Park SAC	30.3	3.9	34.3	5.2%	45.7%	4.1	34.4	5.4%	45.9%	4.1	34.4	5.4%	45.9%
H6	Ancient Woodland ID 1494421	57.1	27.8	85.0	37.1%	113.3%	29.5	86.6	39.4%	115.5%	28.8	85.9	38.3%	114.5%
H7	Ancient Woodland ID 1494091	57.1	12.4	69.5	16.5%	92.6%	13.2	70.3	17.6%	93.8%	12.9	70.0	17.2%	93.3%
H8	Ancient Woodland ID 1494015	36.2	16.3	52.4	21.7%	69.9%	17.7	53.9	23.6%	71.8%	17.1	53.3	22.9%	71.1%
H9	Ancient Woodland ID 1494384	36.2	11.7	47.8	15.5%	63.7%	12.5	48.6	16.6%	64.8%	12.1	48.3	16.2%	64.4%
H10	Ancient Woodland ID 1493326	35.2	11.8	47.0	15.7%	62.6%	12.9	48.1	17.2%	64.1%	12.4	47.6	16.5%	63.4%
H11	Ancient Woodland ID 1494192	36.2	11.1	47.3	14.8%	63.0%	11.8	48.0	15.8%	64.0%	11.6	47.7	15.4%	63.6%
H12	Ancient Woodland ID 1494681	35.2	6.9	42.1	9.3%	56.2%	7.5	42.6	9.9%	56.9%	7.3	42.4	9.7%	56.6%
H13	Ancient Woodland ID 1494200	35.2	6.1	41.3	8.2%	55.1%	6.5	41.7	8.7%	55.6%	6.4	41.5	8.5%	55.4%
H14	Ancient Woodland ID 1494364	36.2	20.0	56.1	26.6%	74.9%	21.5	57.6	28.6%	76.8%	20.9	57.1	27.9%	76.1%
H15	Ancient Woodland ID 1494363	36.2	21.7	57.8	28.9%	77.1%	23.1	59.3	30.9%	79.1%	22.5	58.7	30.0%	78.2%
H16	Ancient Woodland ID 1493904	50.9	7.5	58.4	10.0%	77.9%	8.4	59.3	11.2%	79.1%	8.0	58.9	10.7%	78.6%
H17	Ancient Woodland ID 1494767	50.9	7.7	58.6	10.3%	78.2%	8.7	59.6	11.6%	79.4%	8.3	59.2	11.0%	78.9%
H18	Ancient Woodland ID 1494489	46.9	9.7	56.6	12.9%	75.4%	10.3	57.2	13.8%	76.3%	10.1	56.9	13.4%	75.9%
H19	Ancient Woodland ID 1494338	37.2	20.4	57.5	27.2%	76.7%	21.7	58.9	29.0%	78.5%	21.2	58.3	28.2%	77.8%
H20	Ancient Woodland ID 1494255	37.2	12.7	49.9	17.0%	66.5%	13.6	50.7	18.1%	67.6%	13.2	50.4	17.6%	67.2%
H21	Ancient Woodland ID 1494339	37.2	14.6	51.7	19.4%	69.0%	15.6	52.7	20.8%	70.3%	15.1	52.3	20.2%	69.7%

Ref	Protected Conservation Area	Background concentration (µg/m³)	Scenario 1				Scenario 2				Scenario 3			
			PC (µg/m³)	PEC (µg/m³)	PC/EQS (%)	PEC/EQS (%)	PC (µg/m³)	PEC (µg/m³)	PC/EQS (%)	PEC/EQS (%)	PC (µg/m³)	PEC (µg/m³)	PC/EQS (%)	PEC/EQS (%)
EQS – 75 µg/m³														
H22	Ancient Woodland ID 1493546	37.2	12.5	49.7	16.7%	66.3%	13.4	50.6	17.9%	67.4%	13.0	50.2	17.4%	66.9%
H23	Ancient Woodland ID 1493550	52.3	6.2	58.5	8.2%	78.0%	6.6	58.9	8.8%	78.5%	6.4	58.7	8.5%	78.3%
H24	Ancient Woodland ID 1493205	46.9	46.8	93.6	62.3%	124.8%	48.0	94.9	64.0%	126.5%	47.6	94.5	63.5%	126.0%
H25	Ancient Woodland ID 1493197	35.0	5.4	40.4	7.2%	53.9%	5.7	40.8	7.7%	54.3%	5.6	40.6	7.5%	54.2%
H26	Riverside Walk, Virginia Water LNR	46.9	6.8	53.6	9.0%	71.5%	7.2	54.1	9.6%	72.1%	7.0	53.9	9.4%	71.9%
H27	Knowle Grove LWS	50.9	7.9	58.8	10.5%	78.4%	8.8	59.7	11.8%	79.6%	8.4	59.3	11.3%	79.1%
H28	Fan Grove LWS	36.2	16.3	52.5	21.7%	70.0%	17.7	53.9	23.7%	71.9%	17.2	53.3	22.9%	71.1%
H29	Hardwick Court Farm Fields LWS	39.3	7.2	46.6	9.6%	62.1%	7.7	47.1	10.3%	62.8%	7.5	46.9	10.1%	62.5%
H30	Abbey Lake Complex LWS	48.6	11.0	59.5	14.6%	79.4%	11.7	60.3	15.6%	80.4%	11.4	60.0	15.2%	79.9%
H31	The Dell LWS	46.9	6.7	53.6	9.0%	71.5%	7.2	54.0	9.6%	72.1%	7.0	53.9	9.3%	71.8%
H32	Trumps Mill LWS	46.9	32.6	79.5	43.5%	106.0%	33.6	80.5	44.8%	107.3%	33.3	80.2	44.4%	106.9%
H33	The Moat, Woodcock Farm LWS	56.2	15.3	71.5	20.4%	95.3%	16.1	72.3	21.4%	96.4%	15.8	72.0	21.0%	95.9%

The results in Table 13 indicate that, with the exception of H1 and H2, irrespective of the modelled scenario, the PCs at the assessed European designated sites and local nature sites are less than 10% and 100%, respectively, of the relevant critical level and the impact can be described as 'insignificant'. At H1 and H2, the PECs are within the relevant critical level.

5.3.2 Summary

The results indicate that when introducing the new boiler (i.e. Scenario 2 and 3), there are increases in predicted long-term and short-term concentrations compared to Scenario 1 but not to an extent that would lead to exceedances or indicate that there would be a significant impact with regard to critical levels.

Based on the conservative approach to the assessment, it is considered that no unacceptable impacts to air quality at the assessed protected conservation areas are likely to occur as a consequence of the operation of the assessed CHP engines, standby generator and new boiler (whether utilising biogas or diesel) with regard to ambient concentrations of NOx and SO_2.

5.3.3 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, 2022). Further information on the assessment of deposition is provided in Appendix B. The full detailed modelled results are displayed in Table 14 to Table 17.

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Table 14: Modelled acid deposition at assessed protected conservation areas for Scenario 1 (existing operations)

Ref	Habitat	Vegetation type (for deposition velocity)	Critical load (CL) (kEqH+/ha/year)			Existing acid deposition (kEqH+/ha/year)		PC	PEC	PC/CL (%)	PEC/CL (%)
			CLMaxS	CLMinN	CLMaxN	Existing deposition (N)	Existing deposition (S)				
H1	South West London Waterbodies SPA & Ramsar	No critical load data available				0.6	0.2	0.083	0.9	-	
H2	Thorpe Park No1 Gravel Pit SSSI	No critical load data available				1.2	0.2	0.083	1.5	-	
H3	Thursley, Ash, Pirbright & Chobham SAC	Short	0.217	0.321	0.538	1.1	0.2	0.004	1.2	0.7%	231%
H4	Thames Basin Heaths SPA	Short	0.240	0.642	0.882	1.1	0.2	0.004	1.2	0.5%	141%
		Tall	0.773	0.285	1.058	1.9	0.2	0.008	2.1	0.8%	203%
H5	Windsor Forest & Great Park SAC	Tall	0.776	0.285	1.061	2.0	0.2	0.002	2.2	0.2%	206%
H6	Ancient Woodland ID 1494421	Tall	2.570	0.142	2.712	1.9	0.2	0.166	2.3	6.1%	85%
H7	Ancient Woodland ID 1494091	Tall	2.570	0.142	2.712	1.9	0.2	0.063	2.2	2.3%	81%
H8	Ancient Woodland ID 1494015	Tall	2.571	0.142	2.713	1.9	0.2	0.021	2.2	0.8%	80%
H9	Ancient Woodland ID 1494384	Tall	2.571	0.142	2.713	1.9	0.2	0.014	2.2	0.5%	79%
H10	Ancient Woodland ID 1493326	Tall	0.742	0.285	1.027	1.9	0.2	0.012	2.2	1.1%	210%
H11	Ancient Woodland ID 1494192	Tall	2.571	0.142	2.713	1.9	0.2	0.022	2.2	0.8%	80%
H12	Ancient Woodland ID 1494681	Tall	0.742	0.285	1.027	1.9	0.2	0.011	2.2	1.0%	209%
H13	Ancient Woodland ID 1494200	Tall	0.742	0.285	1.027	1.9	0.2	0.009	2.1	0.9%	209%
H14	Ancient Woodland ID 1494364	Tall	2.571	0.142	2.713	1.9	0.2	0.054	2.2	2.0%	81%
H15	Ancient Woodland ID 1494363	Tall	2.571	0.142	2.713	1.9	0.2	0.053	2.2	1.9%	81%
H16	Ancient Woodland ID 1493904	Tall	0.774	0.285	1.059	2.0	0.2	0.010	2.2	0.9%	205%
H17	Ancient Woodland ID 1494767	Tall	0.774	0.285	1.059	2.0	0.2	0.010	2.2	0.9%	205%
H18	Ancient Woodland ID 1494489	Tall	1.154	0.357	1.511	1.9	0.2	0.016	2.2	1.0%	143%
H19	Ancient Woodland ID 1494338	Tall	1.506	0.357	1.863	1.9	0.2	0.021	2.2	1.1%	116%
H20	Ancient Woodland ID 1494255	Tall	1.506	0.357	1.863	1.9	0.2	0.014	2.2	0.7%	116%
H21	Ancient Woodland ID 1494339	Tall	1.506	0.357	1.863	1.9	0.2	0.015	2.2	0.8%	116%

Ref	Habitat	Vegetation type (for deposition velocity)	Critical load (CL) (kEqH+/ha/year)			Existing acid deposition (kEqH+/ha/year)		PC	PEC	PC/CL (%)	PEC/CL (%)
			CLMaxS	CLMinN	CLMaxN	Existing deposition (N)	Existing deposition (S)				
H22	Ancient Woodland ID 1493546	Tall	1.506	0.357	1.863	1.9	0.2	0.013	2.2	0.7%	116%
H23	Ancient Woodland ID 1493550	Tall	1.629	0.142	1.771	1.9	0.2	0.017	2.2	0.9%	122%
H24	Ancient Woodland ID 1493205	Tall	1.154	0.357	1.511	1.9	0.2	0.044	2.2	2.9%	145%
H25	Ancient Woodland ID 1493197	Tall	0.775	0.285	1.060	2.0	0.2	0.010	2.2	0.9%	205%
H26	Riverside Walk, Virginia Water LNR	Short	This habitat is not sensitive to acidity			1.2	0.2	0.006	1.3	-	-
		Tall	1.154	0.357	1.511	1.9	0.2	0.012	2.2	0.8%	142%
H27	Knowle Grove LWS	Short	0.240	0.366	0.606	1.1	0.2	0.005	1.3	0.8%	209%
		Tall	0.774	0.285	1.059	2.0	0.2	0.010	2.2	0.9%	205%
H28	Fan Grove LWS	Short	0.880	0.223	1.103	1.1	0.2	0.011	1.3	1.0%	113%
		Tall	2.571	0.142	2.713	1.9	0.2	0.021	2.2	0.8%	80%
H29	Hardwick Court Farm Fields LWS	Short	0.230	0.366	0.596	1.1	0.2	0.006	1.2	1.0%	209%
		Tall	0.740	0.285	1.025	1.9	0.2	0.012	2.2	1.2%	210%
H30	Abbey Lake Complex LWS	Short	1.630	0.438	2.068	1.1	0.2	0.022	1.3	1.1%	61%
		Tall	2.841	0.357	3.198	1.9	0.2	0.044	2.2	1.4%	68%
H31	The Dell LWS	Short	0.480	0.438	0.918	1.1	0.2	0.006	1.2	0.6%	136%
		Tall	1.154	0.357	1.511	1.9	0.2	0.011	2.2	0.8%	142%
H32	Trumps Mill LWS	Short	0.480	0.438	0.918	1.1	0.2	0.015	1.3	1.6%	137%
		Tall	1.154	0.357	1.511	1.9	0.2	0.030	2.2	2.0%	144%
H33	The Moat, Woodcock Farm LWS	Short	0.880	0.223	1.103	1.1	0.2	0.028	1.3	2.6%	115%
		Tall	1.628	0.142	1.770	1.9	0.2	0.056	2.2	3.2%	124%

Table 15: Modelled acid deposition at assessed protected conservation areas for Scenario 2 and Scenario 3

Ref	Habitat	Vegetation type (for deposition velocity)	Acid deposition rate (kEqH+/ha/year)									
			Scenario 1		Scenario 2				Scenario 3			
			PC	PEC	PC	PEC	PC/CL (%)	PEC/CL (%)	PC	PEC	PC/CL (%)	PEC/CL (%)
H1	South West London Waterbodies SPA & Ramsar	Short	0.083	0.9	0.115	0.9	-		0.116	0.9	-	
H2	Thorpe Park No1 Gravel Pit SSSI	Short	0.083	1.5	0.115	1.5	-		0.116	1.5	-	
H3	Thursley, Ash, Pirbright & Chobham SAC	Short	0.004	1.2	0.005	1.2	1.0%	231%	0.006	1.2	1.0%	231%
H4	Thames Basin Heaths SPA	Short	0.004	1.2	0.005	1.2	0.6%	141%	0.006	1.2	0.6%	141%
		Tall	0.008	2.1	0.011	2.2	1.0%	203%	0.011	2.2	1.0%	203%
H5	Windsor Forest & Great Park SAC	Tall	0.002	2.2	0.003	2.2	0.3%	206%	0.003	2.2	0.3%	206%
H6	Ancient Woodland ID 1494421	Tall	0.166	2.3	0.231	2.4	8.5%	87%	0.235	2.4	8.7%	88%
H7	Ancient Woodland ID 1494091	Tall	0.063	2.2	0.085	2.2	3.1%	82%	0.086	2.2	3.2%	82%
H8	Ancient Woodland ID 1494015	Tall	0.021	2.2	0.028	2.2	1.0%	80%	0.029	2.2	1.1%	80%
H9	Ancient Woodland ID 1494384	Tall	0.014	2.2	0.020	2.2	0.7%	80%	0.020	2.2	0.7%	80%
H10	Ancient Woodland ID 1493326	Tall	0.012	2.2	0.016	2.2	1.5%	210%	0.016	2.2	1.6%	210%
H11	Ancient Woodland ID 1494192	Tall	0.022	2.2	0.030	2.2	1.1%	80%	0.030	2.2	1.1%	80%
H12	Ancient Woodland ID 1494681	Tall	0.011	2.2	0.015	2.2	1.4%	210%	0.015	2.2	1.5%	210%
H13	Ancient Woodland ID 1494200	Tall	0.009	2.1	0.012	2.2	1.2%	210%	0.012	2.2	1.2%	210%
H14	Ancient Woodland ID 1494364	Tall	0.054	2.2	0.073	2.2	2.7%	82%	0.075	2.2	2.8%	82%
H15	Ancient Woodland ID 1494363	Tall	0.053	2.2	0.071	2.2	2.6%	82%	0.073	2.2	2.7%	82%
H16	Ancient Woodland ID 1493904	Tall	0.010	2.2	0.013	2.2	1.3%	205%	0.014	2.2	1.3%	205%
H17	Ancient Woodland ID 1494767	Tall	0.010	2.2	0.013	2.2	1.3%	205%	0.014	2.2	1.3%	205%
H18	Ancient Woodland ID 1494489	Tall	0.016	2.2	0.021	2.2	1.4%	143%	0.022	2.2	1.4%	143%
H19	Ancient Woodland ID 1494338	Tall	0.021	2.2	0.029	2.2	1.5%	116%	0.029	2.2	1.6%	116%
H20	Ancient Woodland ID 1494255	Tall	0.014	2.2	0.019	2.2	1.0%	116%	0.019	2.2	1.0%	116%

Ref	Habitat	Vegetation type (for deposition velocity)	Acid deposition rate (kEqH+/ha/year)									
			Scenario 1		Scenario 2				Scenario 3			
			PC	PEC	PC	PEC	PC/CL (%)	PEC/CL (%)	PC	PEC	PC/CL (%)	PEC/CL (%)
H21	Ancient Woodland ID 1494339	Tall	0.015	2.2	0.020	2.2	1.1%	116%	0.021	2.2	1.1%	116%
H22	Ancient Woodland ID 1493546	Tall	0.013	2.2	0.018	2.2	1.0%	116%	0.018	2.2	1.0%	116%
H23	Ancient Woodland ID 1493550	Tall	0.017	2.2	0.023	2.2	1.3%	122%	0.023	2.2	1.3%	122%
H24	Ancient Woodland ID 1493205	Tall	0.044	2.2	0.060	2.2	4.0%	146%	0.061	2.2	4.1%	146%
H25	Ancient Woodland ID 1493197	Tall	0.010	2.2	0.013	2.2	1.2%	205%	0.013	2.2	1.2%	205%
H26	Riverside Walk, Virginia Water LNR	Short	0.006	1.2	0.008	1.2	-	-	0.008	1.2	-	-
		Tall	0.012	2.2	0.016	2.2	1.1%	143%	0.016	2.2	1.1%	143%
H27	Knowle Grove LWS	Short	0.005	1.3	0.007	1.3	1.1%	209%	0.007	1.3	1.1%	209%
		Tall	0.010	2.2	0.013	2.2	1.2%	205%	0.013	2.2	1.3%	205%
H28	Fan Grove LWS	Short	0.011	1.3	0.014	1.3	1.3%	114%	0.014	1.3	1.3%	114%
		Tall	0.021	2.2	0.028	2.2	1.0%	80%	0.029	2.2	1.1%	80%
H29	Hardwick Court Farm Fields LWS	Short	0.006	1.2	0.008	1.2	1.4%	209%	0.009	1.2	1.4%	209%
		Tall	0.012	2.2	0.017	2.2	1.6%	210%	0.017	2.2	1.7%	210%
H30	Abbey Lake Complex LWS	Short	0.022	1.3	0.030	1.3	1.4%	61%	0.030	1.3	1.4%	61%
		Tall	0.044	2.2	0.059	2.2	1.8%	69%	0.060	2.2	1.9%	69%
H31	The Dell LWS	Short	0.006	1.2	0.008	1.2	0.8%	136%	0.008	1.2	0.9%	136%
		Tall	0.011	2.2	0.016	2.2	1.0%	143%	0.016	2.2	1.0%	143%
H32	Trumps Mill LWS	Short	0.015	1.3	0.020	1.3	2.2%	137%	0.021	1.3	2.3%	137%
		Tall	0.030	2.2	0.041	2.2	2.7%	144%	0.041	2.2	2.7%	144%
H33	The Moat, Woodcock Farm LWS	Short	0.028	1.3	0.039	1.3	3.5%	116%	0.039	1.3	3.5%	116%
		Tall	0.056	2.2	0.077	2.2	4.4%	125%	0.078	2.2	4.4%	125%

Table 16: Modelled nitrogen deposition at assessed protected conservation areas for Scenario 1

Ref	Habitat	Vegetation type (for deposition velocity)	Nutrient nitrogen deposition (kgN/ha-year)					
			Minimal Critical Load (CL)	Existing deposition	PC	PEC	PC/CL (%)	PEC/CL(%)
H1	South West London Waterbodies SPA & Ramsar	Short	20	9.0	0.050	9.1	0.2%	45%
H2	Thorpe Park No1 Gravel Pit SSSI	no critical load data available			0.100	-		
H3	Thursley, Ash, Pirbright & Chobham SAC	Short	10	15.2	0.005	15.2	0.0%	152%
H4	Thames Basin Heaths SPA	Short	10	15.2	0.005	15.2	0.0%	152%
		Tall	5	27.3	0.010	27.3	0.2%	546%
H5	Windsor Forest & Great Park SAC	Tall	10	27.9	0.003	27.9	0.0%	279%
H6	Ancient Woodland ID 1494421	Tall	5	27.2	0.200	27.4	4.0%	547%
H7	Ancient Woodland ID 1494091	Tall	5	27.2	0.075	27.2	1.5%	545%
H8	Ancient Woodland ID 1494015	Tall	5	27.2	0.025	27.2	0.5%	544%
H9	Ancient Woodland ID 1494384	Tall	5	27.2	0.017	27.2	0.3%	544%
H10	Ancient Woodland ID 1493326	Tall	5	27.2	0.014	27.2	0.3%	543%
H11	Ancient Woodland ID 1494192	Tall	5	27.2	0.026	27.2	0.5%	544%
H12	Ancient Woodland ID 1494681	Tall	5	27.2	0.013	27.2	0.3%	543%
H13	Ancient Woodland ID 1494200	Tall	5	27.2	0.011	27.2	0.2%	543%
H14	Ancient Woodland ID 1494364	Tall	5	27.2	0.065	27.2	1.3%	545%
H15	Ancient Woodland ID 1494363	Tall	5	27.2	0.063	27.2	1.3%	544%
H16	Ancient Woodland ID 1493904	Tall	5	27.6	0.012	27.6	0.2%	552%
H17	Ancient Woodland ID 1494767	Tall	5	27.6	0.012	27.6	0.2%	552%
H18	Ancient Woodland ID 1494489	Tall	5	27.2	0.019	27.2	0.4%	544%
H19	Ancient Woodland ID 1494338	Tall	5	27.2	0.026	27.2	0.5%	544%
H20	Ancient Woodland ID 1494255	Tall	5	27.2	0.017	27.2	0.3%	544%
H21	Ancient Woodland ID 1494339	Tall	5	27.2	0.018	27.2	0.4%	544%
H22	Ancient Woodland ID 1493546	Tall	5	27.2	0.016	27.2	0.3%	544%

Ref	Habitat	Vegetation type (for deposition velocity)	Nutrient nitrogen deposition (kgN/ha-year)					
			Minimal Critical Load (CL)	Existing deposition	PC	PEC	PC/CL (%)	PEC/CL(%)
H23	Ancient Woodland ID 1493550	Tall	5	27.2	0.020	27.2	0.4%	544%
H24	Ancient Woodland ID 1493205	Tall	5	27.2	0.054	27.2	1.1%	544%
H25	Ancient Woodland ID 1493197	Tall	5	27.6	0.012	27.6	0.2%	552%
H26	Riverside Walk, Virginia Water LNR	Short	10	15.1	0.007	15.1	0.1%	151%
		Tall	10	27.2	0.014	27.2	0.1%	272%
H27	Knowle Grove LWS	Short	5	15.5	0.006	15.5	0.1%	311%
		Tall	5	27.6	0.012	27.6	0.2%	552%
H28	Fan Grove LWS	Short	5	15.1	0.013	15.1	0.3%	303%
		Tall	5	27.2	0.025	27.2	0.5%	544%
H29	Hardwick Court Farm Fields LWS	Short	5	15.1	0.007	15.1	0.1%	303%
		Tall	5	27.2	0.015	27.2	0.3%	543%
H30	Abbey Lake Complex LWS	Short	5	15.1	0.026	15.1	0.5%	303%
		Tall	5	27.2	0.053	27.2	1.1%	544%
H31	The Dell LWS	Short	5	15.1	0.007	15.1	0.1%	303%
		Tall	5	27.2	0.014	27.2	0.3%	543%
H32	Trumps Mill LWS	Short	5	15.1	0.018	15.1	0.4%	303%
		Tall	5	27.2	0.037	27.2	0.7%	544%
H33	The Moat, Woodcock Farm LWS	Short	5	15.1	0.035	15.2	0.7%	303%
		Tall	5	27.2	0.070	27.2	1.4%	545%

Table 17: Modelled nitrogen deposition at assessed protected conservation areas for Scenario 2 and Scenario 3

Ref	Habitat	Vegetation type (for deposition velocity)	Nutrient nitrogen deposition (kgN/ha-year)									
			Minimal Critical Load (CL)	Scenario 1	Scenario 2				Scenario 3			
				PC	PC	PEC	PC/CL (%)	PEC/CL(%)	PC	PEC	PC/CL (%)	PEC/CL(%)
H1	South West London Waterbodies SPA & Ramsar	Short	20	0.050	0.074	9.1	0.4%	46%	0.063	9.1	0.3%	46%
H2	Thorpe Park No1 Gravel Pit SSSI	no critical load data available		0.100	0.148	-			0.127	-		
H3	Thursley, Ash, Pirbright & Chobham SAC	Short	10	0.005	0.007	15.2	0.1%	152%	0.006	15.2	0.1%	152%
H4	Thames Basin Heaths SPA	Short	10	0.005	0.007	15.2	0.1%	152%	0.006	15.2	0.1%	152%
		Tall	5	0.010	0.014	27.3	0.3%	546%	0.012	27.3	0.2%	546%
H5	Windsor Forest & Great Park SAC	Tall	10	0.003	0.004	27.9	0.0%	279%	0.003	27.9	0.0%	279%
H6	Ancient Woodland ID 1494421	Tall	5	0.200	0.299	27.5	6.0%	549%	0.256	27.4	5.1%	548%
H7	Ancient Woodland ID 1494091	Tall	5	0.075	0.109	27.3	2.2%	545%	0.094	27.3	1.9%	545%
H8	Ancient Woodland ID 1494015	Tall	5	0.025	0.036	27.2	0.7%	544%	0.032	27.2	0.6%	544%
H9	Ancient Woodland ID 1494384	Tall	5	0.017	0.025	27.2	0.5%	544%	0.022	27.2	0.4%	544%
H10	Ancient Woodland ID 1493326	Tall	5	0.014	0.020	27.2	0.4%	544%	0.018	27.2	0.4%	544%
H11	Ancient Woodland ID 1494192	Tall	5	0.026	0.038	27.2	0.8%	544%	0.033	27.2	0.7%	544%
H12	Ancient Woodland ID 1494681	Tall	5	0.013	0.019	27.2	0.4%	544%	0.016	27.2	0.3%	544%
H13	Ancient Woodland ID 1494200	Tall	5	0.011	0.016	27.2	0.3%	544%	0.014	27.2	0.3%	543%
H14	Ancient Woodland ID 1494364	Tall	5	0.065	0.094	27.3	1.9%	545%	0.082	27.2	1.6%	545%
H15	Ancient Woodland ID 1494363	Tall	5	0.063	0.092	27.3	1.8%	545%	0.080	27.2	1.6%	545%
H16	Ancient Woodland ID 1493904	Tall	5	0.012	0.017	27.6	0.3%	552%	0.015	27.6	0.3%	552%
H17	Ancient Woodland ID 1494767	Tall	5	0.012	0.017	27.6	0.3%	552%	0.015	27.6	0.3%	552%
H18	Ancient Woodland ID 1494489	Tall	5	0.019	0.028	27.2	0.6%	544%	0.024	27.2	0.5%	544%
H19	Ancient Woodland ID 1494338	Tall	5	0.026	0.037	27.2	0.7%	544%	0.033	27.2	0.7%	544%
H20	Ancient Woodland ID 1494255	Tall	5	0.017	0.024	27.2	0.5%	544%	0.021	27.2	0.4%	544%
H21	Ancient Woodland ID 1494339	Tall	5	0.018	0.027	27.2	0.5%	544%	0.023	27.2	0.5%	544%

Ref	Habitat	Vegetation type (for deposition velocity)	Nutrient nitrogen deposition (kgN/ha-year)									
			Minimal Critical Load (CL)	Scenario 1	Scenario 2				Scenario 3			
				PC	PC	PEC	PC/CL (%)	PEC/CL(%)	PC	PEC	PC/CL (%)	PEC/CL(%)
H22	Ancient Woodland ID 1493546	Tall	5	0.016	0.023	27.2	0.5%	544%	0.020	27.2	0.4%	544%
H23	Ancient Woodland ID 1493550	Tall	5	0.020	0.029	27.2	0.6%	544%	0.025	27.2	0.5%	544%
H24	Ancient Woodland ID 1493205	Tall	5	0.054	0.079	27.2	1.6%	545%	0.068	27.2	1.4%	545%
H25	Ancient Woodland ID 1493197	Tall	5	0.012	0.017	27.6	0.3%	552%	0.015	27.6	0.3%	552%
H26	Riverside Walk, Virginia Water LNR	Short	10	0.007	0.010	15.1	0.1%	151%	0.009	15.1	0.1%	151%
		Tall	10	0.014	0.021	27.2	0.2%	272%	0.018	27.2	0.2%	272%
H27	Knowle Grove LWS	Short	5	0.006	0.009	15.5	0.2%	311%	0.008	15.5	0.2%	311%
		Tall	5	0.012	0.017	27.6	0.3%	552%	0.015	27.6	0.3%	552%
H28	Fan Grove LWS	Short	5	0.013	0.018	15.1	0.4%	303%	0.016	15.1	0.3%	303%
		Tall	5	0.025	0.036	27.2	0.7%	544%	0.032	27.2	0.6%	544%
H29	Hardwick Court Farm Fields LWS	Short	5	0.007	0.011	15.1	0.2%	303%	0.009	15.1	0.2%	303%
		Tall	5	0.015	0.022	27.2	0.4%	544%	0.019	27.2	0.4%	544%
H30	Abbey Lake Complex LWS	Short	5	0.026	0.038	15.2	0.8%	303%	0.033	15.2	0.7%	303%
		Tall	5	0.053	0.076	27.2	1.5%	545%	0.066	27.2	1.3%	545%
H31	The Dell LWS	Short	5	0.007	0.010	15.1	0.2%	303%	0.009	15.1	0.2%	303%
		Tall	5	0.014	0.020	27.2	0.4%	544%	0.018	27.2	0.4%	544%
H32	Trumps Mill LWS	Short	5	0.018	0.027	15.1	0.5%	303%	0.023	15.1	0.5%	303%
		Tall	5	0.037	0.053	27.2	1.1%	544%	0.046	27.2	0.9%	544%
H33	The Moat, Woodcock Farm LWS	Short	5	0.035	0.051	15.2	1.0%	303%	0.044	15.2	0.9%	303%
		Tall	5	0.070	0.101	27.3	2.0%	545%	0.088	27.2	1.8%	545%

For acid deposition, the results in Table 14 indicate that for Scenario 1, at the assessed European designated sites and local nature sites, the corresponding PCs are less than 1% and 100%, respectively, of the critical loads and the impact can also be described as ‘insignificant’ as per Environment Agency guidance (Environment Agency, 2021a).

For Scenario 2 and Scenario 3, the results in Table 15 indicate that at H3 and H4 (tall vegetation only), the PCs are just above 1% (i.e. up to 1.05%) of the relevant critical load for acid deposition and the corresponding PECs exceed the relevant critical load. However, this assessment assumes the CHP engines and new boiler operate continuously all year. In practice, only one CHP engine is likely to operate alongside the new boiler. Therefore, based on the conservative approach adopted, the impact is considered ‘not significant’.

At the remaining European designated site and local nature sites, the corresponding PCs are less than 1% and 100%, respectively, of the critical load and the impact can be described as ‘insignificant’.

For nutrient nitrogen deposition, irrespective of the modelled scenario, the results in Table 16 and Table 17 indicate that at the assessed European designated sites and local nature sites, the predicted PCs are less than 1% and 100%, respectively, of the relevant critical load value and the impact can be described as ‘insignificant’ as per Environment Agency guidance (Environment Agency, 2021a).

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

5.3.4 Summary

The results indicate that when introducing the new boiler (i.e. Scenario 2 and 3), there are small increases in predicted nutrient nitrogen and acid deposition compared to Scenario 1. Furthermore, at H3 and H4 (tall vegetation only), the PCs are just above 1% of the relevant critical load for acid deposition.

However, based on the conservative approach to the assessment, it is considered that no unacceptable impacts at the assessed protected conservation areas are likely to occur as a consequence of the operation of the assessed CHP engines, standby generator and new boiler (utilising biogas or diesel) with regard to pollutant deposition.

5.4 Sensitivity Analysis – Scenario 2 (i.e. preferred fuel type for boiler - biogas)

A sensitivity study for Scenario 2 (i.e. preferred fuel type for boiler - biogas) was undertaken to see how changes to the surface roughness and omission of the buildings in the 2018 model (which predicted the highest annual mean NO_2 concentrations at a sensitive human receptor location and highest 1-hour mean NO_2 concentrations at a modelled off-site location), and 2019 model (which predicted the highest 1-hour mean NO_2 concentrations at a sensitive human receptor location) may impact on predicted concentrations at sensitive human receptors and off-site locations. The results of the sensitivity analysis are presented in Table 18, Table 19 and Table 20.

Table 18: 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	3.0	2.3	26.1	5.6%	65.3%	-2.0%

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
	1 hour mean (99.79th percentile)	Maximum off-site	181.8	253.5	301.3	126.8%	150.6%	35.9%
		Sensitive locations	128.4	159.8	207.5	79.9%	103.8%	15.7%

The results in Table 18 indicate that the maximum predicted annual mean concentrations for NO_2 is lower 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 an off-site location and sensitive human receptor location, the PCs were higher when using a reduced surface roughness value of 0.1 m. However, a surface roughness of 0.1 m (representing root crops) is not considered representative of the site and surrounding area.

Table 19: 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	3.0	3.4	27.3	8.6%	68.3%	1.0%
	1 hour mean (99.79th percentile)	Maximum off-site	181.8	150.8	198.5	75.4%	99.3%	-15.5%
		Sensitive locations	128.4	117.8	165.6	58.9%	82.8%	-5.3%

The results in Table 19 indicate that the change to maximum predicted annual mean concentrations for NO_2 is marginally higher 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 an off-site location and sensitive human receptor location, the PCs were lower. However, a surface roughness of 1 m (representing a large city centre location with built up areas and tall buildings) is not considered representative of the site and surrounding area.

Table 20: 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	3.0	3.0	26.9	7.5%	67.2%	-0.1%
	1 hour mean (99.79th percentile)	Maximum off-site	181.8	142.7	190.4	71.3%	95.2%	-19.6%
		Sensitive locations	128.4	103.5	151.2	51.8%	75.6%	-12.4%

The results in Table 20 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 existing CHP engines, standby generator and new boiler at the Chertsey 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 for all modelled scenarios, with the exception of predicted 1-hour mean (99.79th percentile) NO_2 concentrations at a modelled off-site location, predicted off-site concentrations and predicted concentrations at sensitive human receptors do not exceed any relevant long-term or short-term EQSs.

Using the approach set out in Environment Agency guidance (Environment Agency, 2018), the statistical analysis found that, irrespective of the modelled scenario, the probability of exceedance of the 1-hour mean EQS at an off-site location is considered 'highly unlikely'.

For TVOCs, exceedances of the annual mean and 24-hour mean EQS for C_6H_6 were predicted. However, it is an unrealistic assumption that total TVOCs emitted by the combustion plant are C_6H_6. If present in the exhaust gases, C_6H_6 would constitute only a very small proportion of total TVOC emissions (e.g. less than 1%). Therefore, it is likely there would be no exceedance of EQSs associated with TVOC emissions and based on professional judgement, the emissions of TVOCs is considered 'not significant'.

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

The results indicate that when introducing the new boiler (i.e. Scenario 2 and 3), there are small increases in predicted long-term and short-term concentrations and nutrient nitrogen and acid deposition compared to Scenario 1. Furthermore, at H3 and H4 (tall vegetation only), the PCs are just above 1% (i.e. up to 1.05%) of the relevant critical load for acid deposition.

However, based on the conservative approach to the assessment, it is considered that no unacceptable impacts at the assessed protected conservation areas are likely to occur as a consequence of the operation of the assessed CHP engines, standby generator and new boiler (utilising biogas or diesel) with regard to ambient concentrations of NOx and SO_2 and pollutant deposition.

6.3 Summary

This assessment has been carried out on the assumption that the CHP engines and new boiler would operate continuously at maximum load all year. This is a conservative assumption as, in practice, the CHP engines and new boiler would have periods of shut-down and maintenance and may not always operate at maximum load. Furthermore, only one CHP engine is likely to operate alongside the new boiler during anticipated site operations.

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

7. References

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8. Figures

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

Figure 2: Approximate site fenceline, modelled stack locations, AQMA, extent of modelled grid and sensitive human receptor locations

Figure 3: Protected conservation areas

Figure 4: Scenario 1 – Annual mean nitrogen dioxide process contributions, 2018 meteorological data

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

Figure 6: Scenario 2 – Annual mean nitrogen dioxide process contributions, 2018 meteorological data

Figure 7: Scenario 2 - 1-hour mean (99.79th percentile) nitrogen dioxide process contributions, 2019 meteorological data

Figure 8: Scenario 2 - 1-hour mean (99.73rd percentile) sulphur dioxide process contributions, 2018 meteorological data

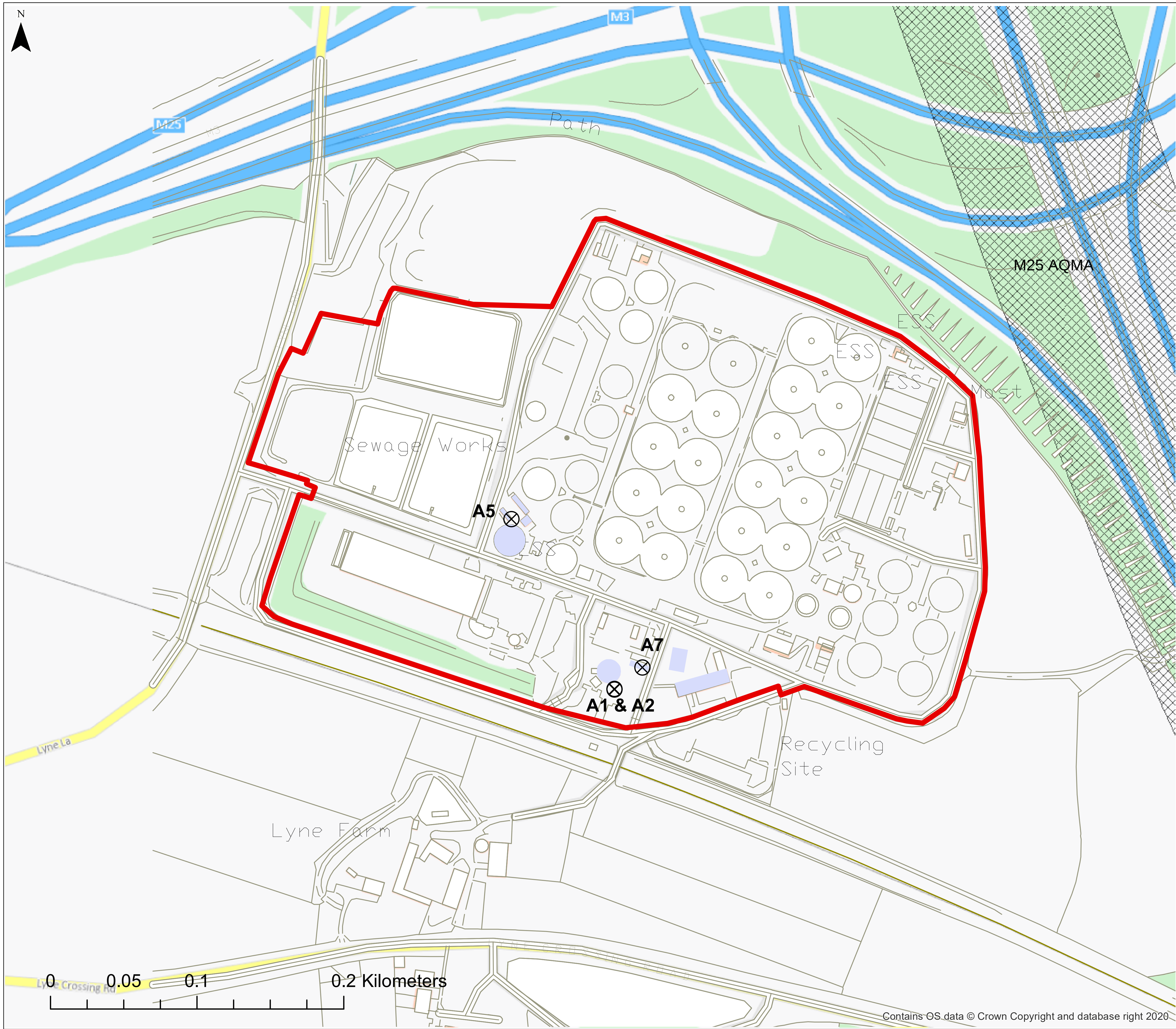
Figure 9: Scenario 2 - 15-minute mean (99.9th percentile) sulphur dioxide process contributions, 2018 meteorological data

Figure 10: Scenario 3 – Annual mean nitrogen dioxide process contributions, 2018 meteorological data

Figure 11: Scenario 3 - 1-hour mean (99.79th percentile) nitrogen dioxide process contributions, 2019 meteorological data

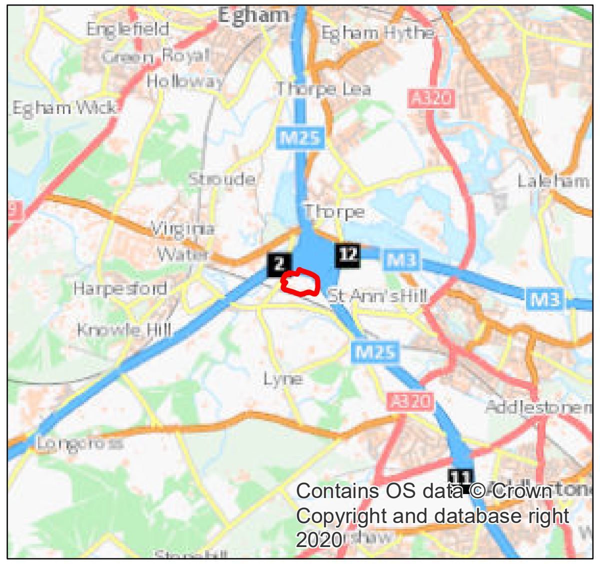
Figure 12: Scenario 3 - 1-hour mean (99.73rd percentile) sulphur dioxide process contributions, 2018 meteorological data

Figure 13: Scenario 3 - 15-minute mean (99.9th percentile) sulphur dioxide process contributions, 2018 meteorological data



Legend

- Approximate site fenceline
- Modelled stack locations
- Modelled buildings
- Air Quality Management Area (AQMA)



Rev.	Date	Purpose of revision	Drawn	Check'd	Rev'd	Appr'd
0	16/05/2022	Initial Issue	DH	GW	GW	MM

Jacobs

Client: Thames Water

Project: ENVIRONMENTAL PERMIT APPLICATION - CHERTSEY SEWAGE TREATMENT WORKS AIR QUALITY IMPACT ASSESSMENT

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

Drawing Status: FINAL

Scale @ A3	1:2,500	DO NOT SCALE	
Jacobs No.	B22849AM	Rev	0
Client No.			

Drawing Number: FIGURE 1

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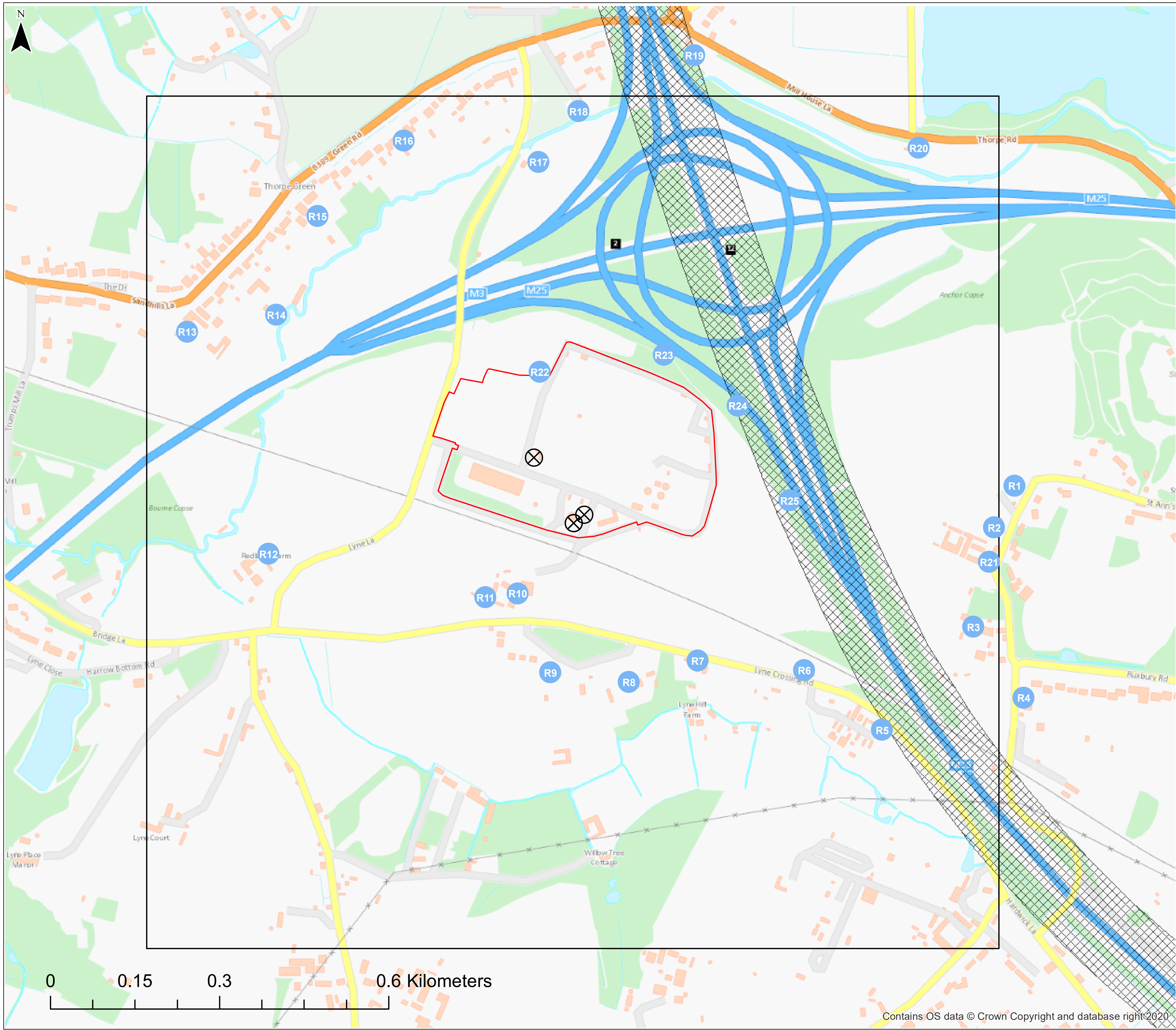


Legend

- Approximate site fenceline
- Modelled stack locations
- Air Quality Management Area (AQMA)
- Extent of modelled grid
- R1 Sensitive human receptor locations

Rev.	Date	Purpose of revision	Drawn	Check'd	Rev'd	Appr'd
0	16/05/2022	Initial Issue	DH	GW	GW	MM

Jacobs

Client: Thames Water

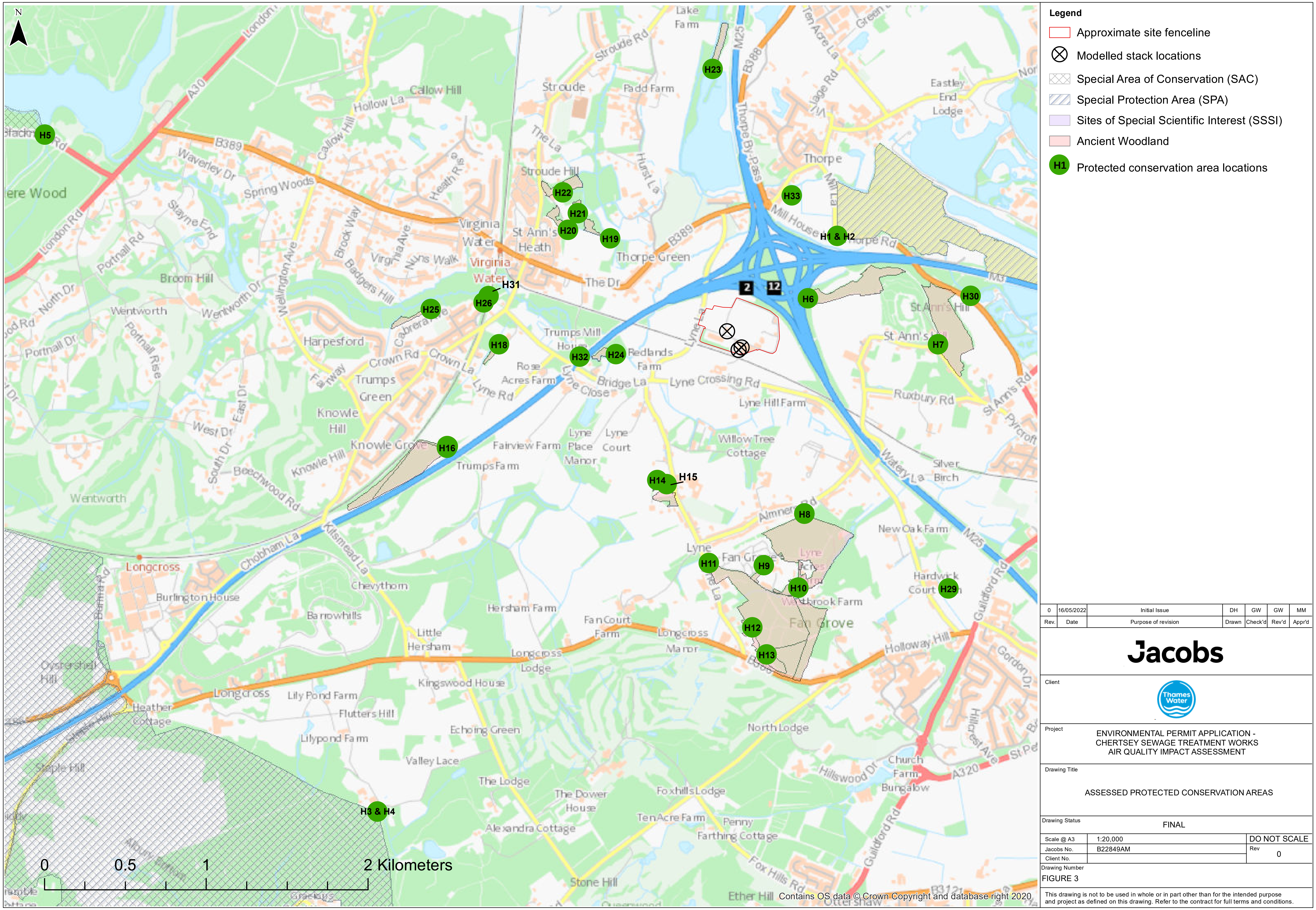
Project: ENVIRONMENTAL PERMIT APPLICATION - CHERTSEY SEWAGE TREATMENT WORKS AIR QUALITY IMPACT ASSESSMENT

Drawing Title: APPROXIMATE SITE FENCELINE, MODELLED STACK LOCATIONS, AQMA, EXTENT OF MODELLED GRID AND SENSITIVE HUMAN RECEPTOR LOCATIONS

Drawing Status: FINAL

Scale @ A3	1:6,500	DO NOT SCALE	
Jacobs No.	B22849AM	Rev	0
Client No.			

Drawing Number: FIGURE 2



Rev.	Date	Purpose of revision	Drawn	Check'd	Rev'd	Appr'd
0	16/05/2022	Initial Issue	DH	GW	GW	MM

Jacobs

Client

Thames Water

Project

ENVIRONMENTAL PERMIT APPLICATION - CHERTSEY SEWAGE TREATMENT WORKS AIR QUALITY IMPACT ASSESSMENT

Drawing Title

ASSESSED PROTECTED CONSERVATION AREAS

Drawing Status

FINAL

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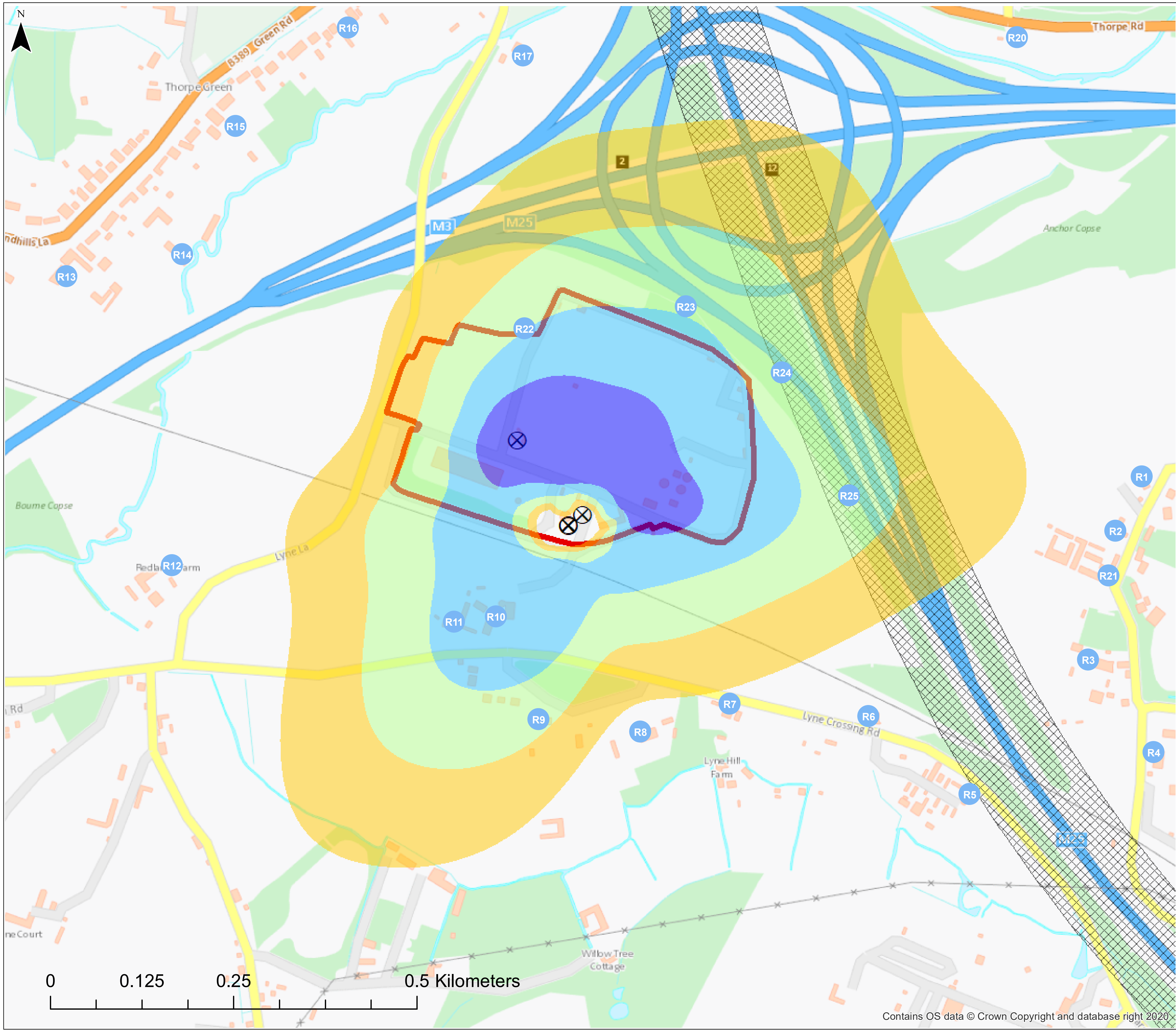
Jacobs No.	B22849AM	Rev 0
Client No.		

Drawing Number

FIGURE 3

J:\B22849AM Stc ied permit\Chertsey\Updated assessment to include gen\GIS\B22849AM_Figure3_protected_conservation_area_v2.mxd



Legend

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

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

- 0 - 0.5
- 0.5 - 0.8
- 0.8 - 1.3
- 1.3 - 2.4
- 2.4 - 307.5

Rev.	Date	Purpose of revision	Drawn	Check'd	Rev'd	Appr'd
0	16/05/2022	Initial Issue	DH	GW	GW	MM

Jacobs

Client: Thames Water

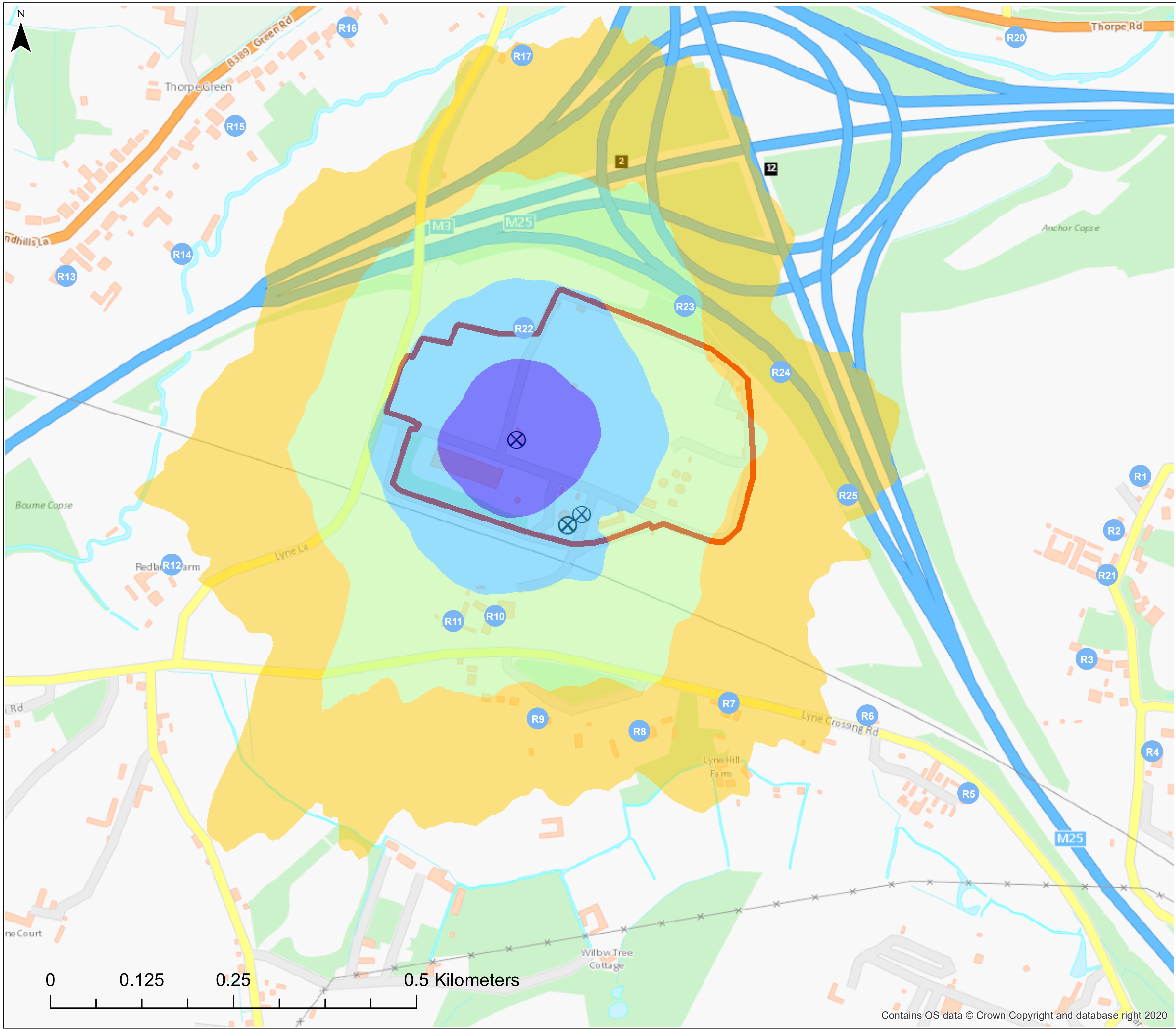
Project: ENVIRONMENTAL PERMIT VARIATION APPLICATION - CHERTSEY SEWAGE TREATMENT WORKS AIR QUALITY IMPACT ASSESSMENT

Drawing Title: SCENARIO 1 - ANNUAL MEAN NITROGEN DIOXIDE PROCESS CONTRIBUTIONS, 2018 METEOROLOGICAL DATA

Drawing Status: FINAL

Scale @ A3	1:5,000	DO NOT SCALE
Jacobs No.	B22849AM	Rev 0
Client No.		

Drawing Number: FIGURE 4



Legend

Approximate site fenceline

Modelled stack locations

Sensitive human receptor locations

1-hour mean (99.79th percentile) nitrogen dioxide process contributions (µg/m³)

- 0 - 30
- 30- 45
- 45 - 80
- 80 - 200
- 200 - 94,942

Rev.	Date	Purpose of revision	Drawn	Check'd	Rev'd	Appr'd
0	16/05/2022	Initial Issue	DH	GW	GW	MM

Jacobs

Client: Thames Water

Project: ENVIRONMENTAL PERMIT VARIATION APPLICATION - CHERTSEY SEWAGE TREATMENT WORKS AIR QUALITY IMPACT ASSESSMENT

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

Drawing Status: FINAL

Scale @ A3	1:5,000	DO NOT SCALE
Jacobs No.	B22849AM	Rev 0
Client No.		

Drawing Number: FIGURE 5

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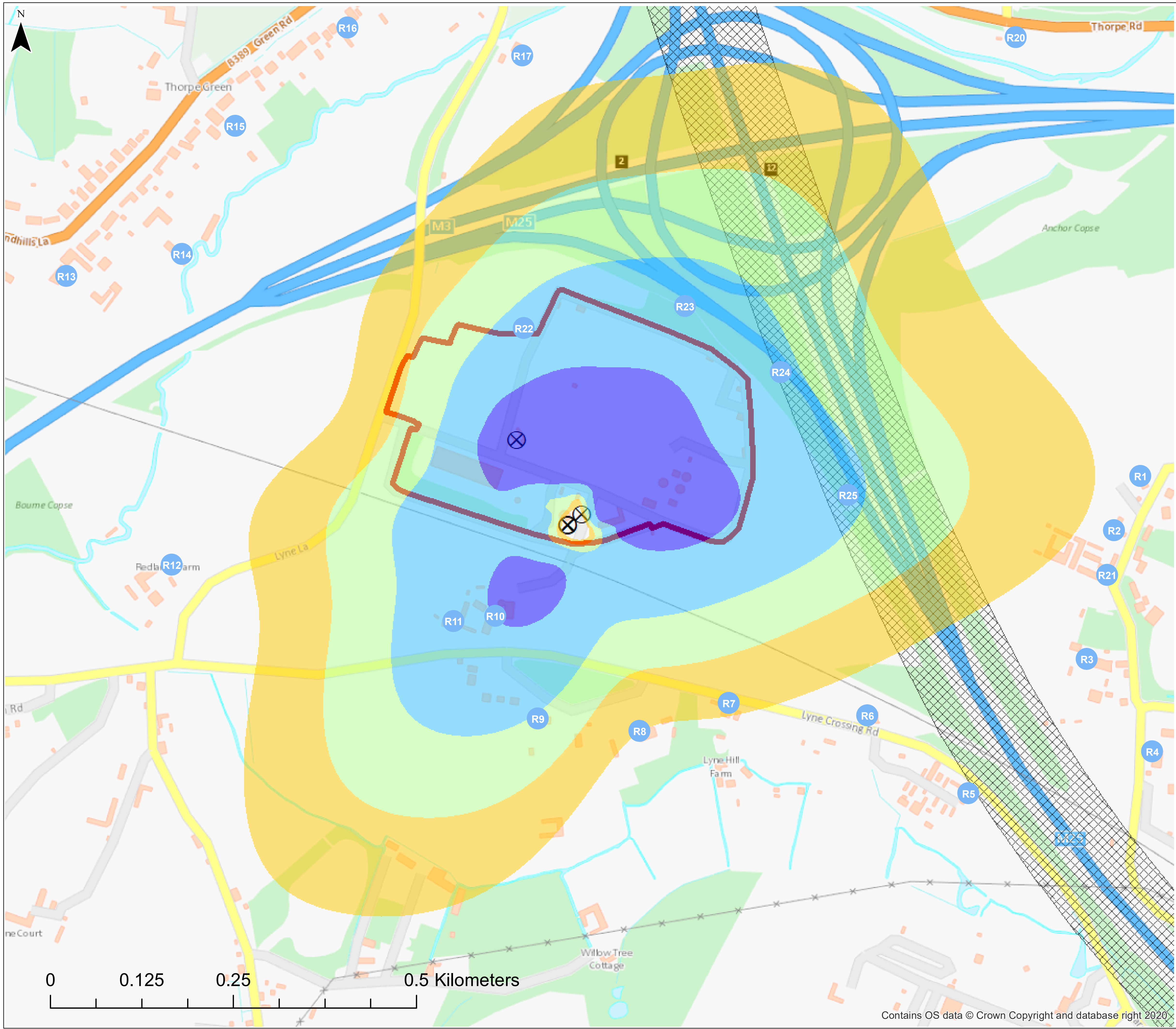


Legend

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

Annual mean nitrogen dioxide process contributions (µg/m³)

- 0- 0.6
- 0.6 - 0.9
- 0.9 - 1.4
- 1.4 - 3.0
- 3.0 - 308.2

Rev.	Date	Purpose of revision	Drawn	Check'd	Rev'd	Appr'd
0	16/05/2022	Initial Issue	DH	GW	GW	MM

Jacobs

Client: Thames Water

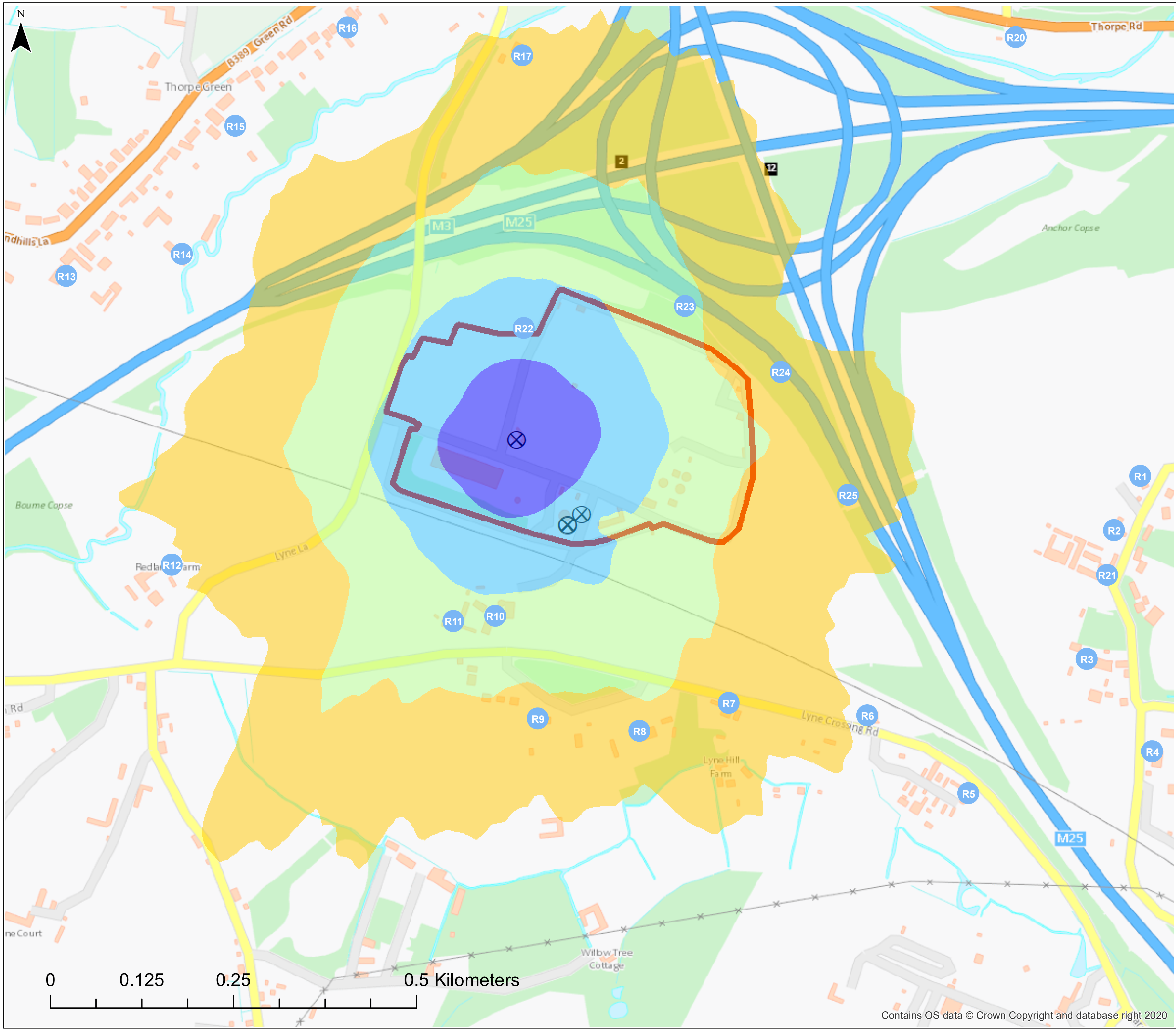
Project: ENVIRONMENTAL PERMIT VARIATION APPLICATION - CHERTSEY SEWAGE TREATMENT WORKS AIR QUALITY IMPACT ASSESSMENT

Drawing Title: SCENARIO 2 - ANNUAL MEAN NITROGEN DIOXIDE PROCESS CONTRIBUTIONS, 2018 METEOROLOGICAL DATA

Drawing Status: FINAL

Scale @ A3	1:5,000	DO NOT SCALE	
Jacobs No.	B22849AM	Rev	0
Client No.			

Drawing Number: FIGURE 6



Legend

- Approximate site fenceline
- Modelled stack locations
- Sensitive human receptor locations

1-hour mean (99.79th percentile) nitrogen dioxide process contributions (µg/m³)

- 0 - 30
- 30 - 45
- 45 - 80
- 80 - 200
- 200 - 94,942

Rev.	Date	Purpose of revision	Drawn	Check'd	Rev'd	Appr'd
0	16/05/2022	Initial Issue	DH	GW	GW	MM

Jacobs

Client: Thames Water

Project: ENVIRONMENTAL PERMIT VARIATION APPLICATION - CHERTSEY SEWAGE TREATMENT WORKS AIR QUALITY IMPACT ASSESSMENT

Drawing Title: SCENARIO 2 - 1-HOUR MEAN (99.79th PERCENTILE) NITROGEN DIOXIDE PROCESS CONTRIBUTIONS, 2019 METEOROLOGICAL DATA

Drawing Status: FINAL

Scale @ A3	1:5,000	DO NOT SCALE	
Jacobs No.	B22849AM	Rev	0
Client No.			

Drawing Number: FIGURE 7

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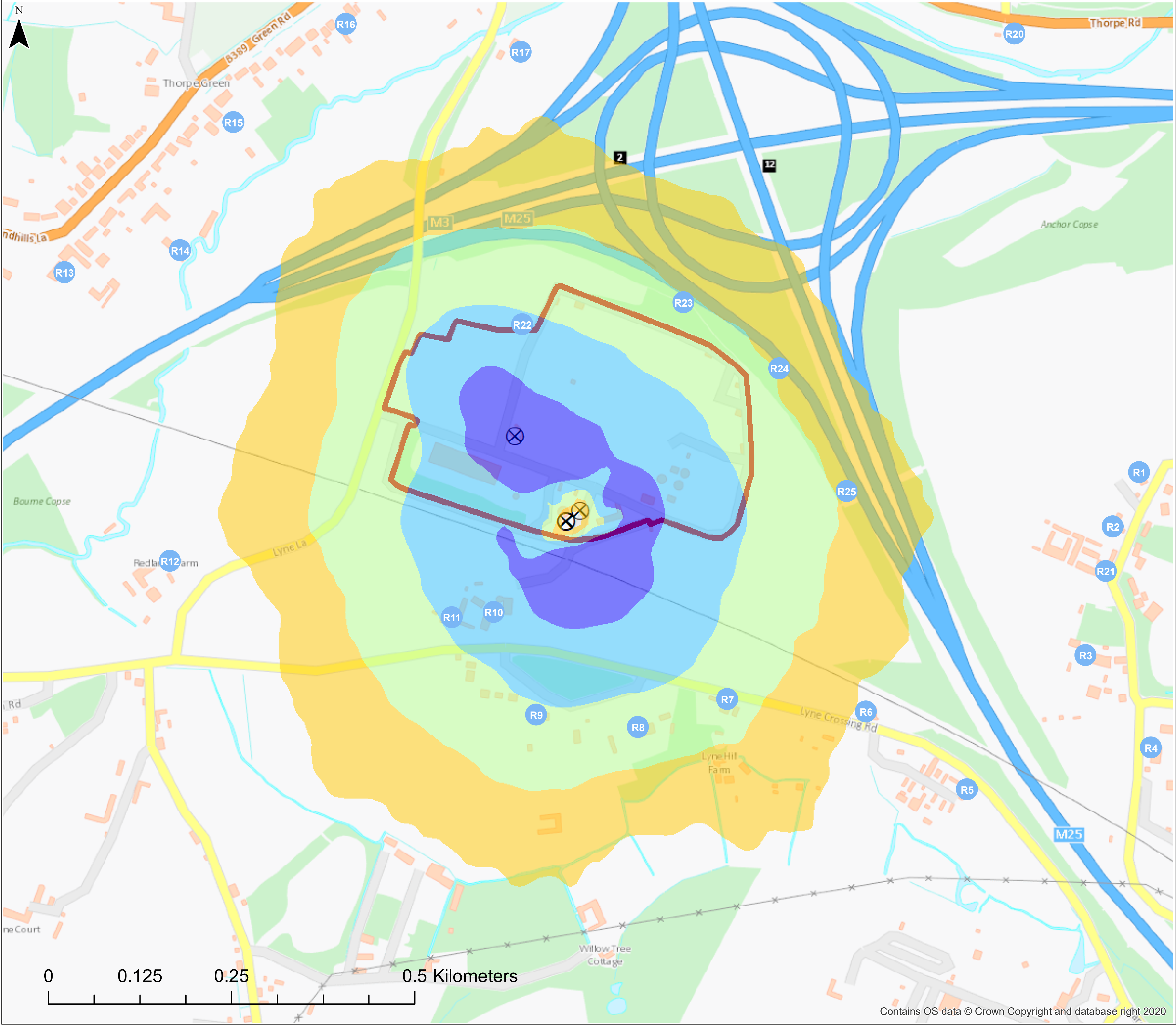


Legend

- Approximate site fenceline
- Modelled stack locations
- R1 Sensitive human receptor locations

1-hour mean (99.73rd percentile) sulphur dioxide process contributions (µg/m³)

- 0 - 12
- 12 - 16
- 16 - 24
- 24 - 40
- 40 - 8,030

Rev.	Date	Purpose of revision	Drawn	Check'd	Rev'd	Appr'd
0	16/05/2022	Initial Issue	DH	GW	GW	MM

Jacobs

Client: Thames Water

Project: ENVIRONMENTAL PERMIT VARIATION APPLICATION - CHERTSEY SEWAGE TREATMENT WORKS AIR QUALITY IMPACT ASSESSMENT

Drawing Title: SCENARIO 2 - 1-HOUR MEAN (99.73rd PERCENTILE) SULPHUR PROCESS CONTRIBUTIONS, 2018 METEOROLOGICAL DATA

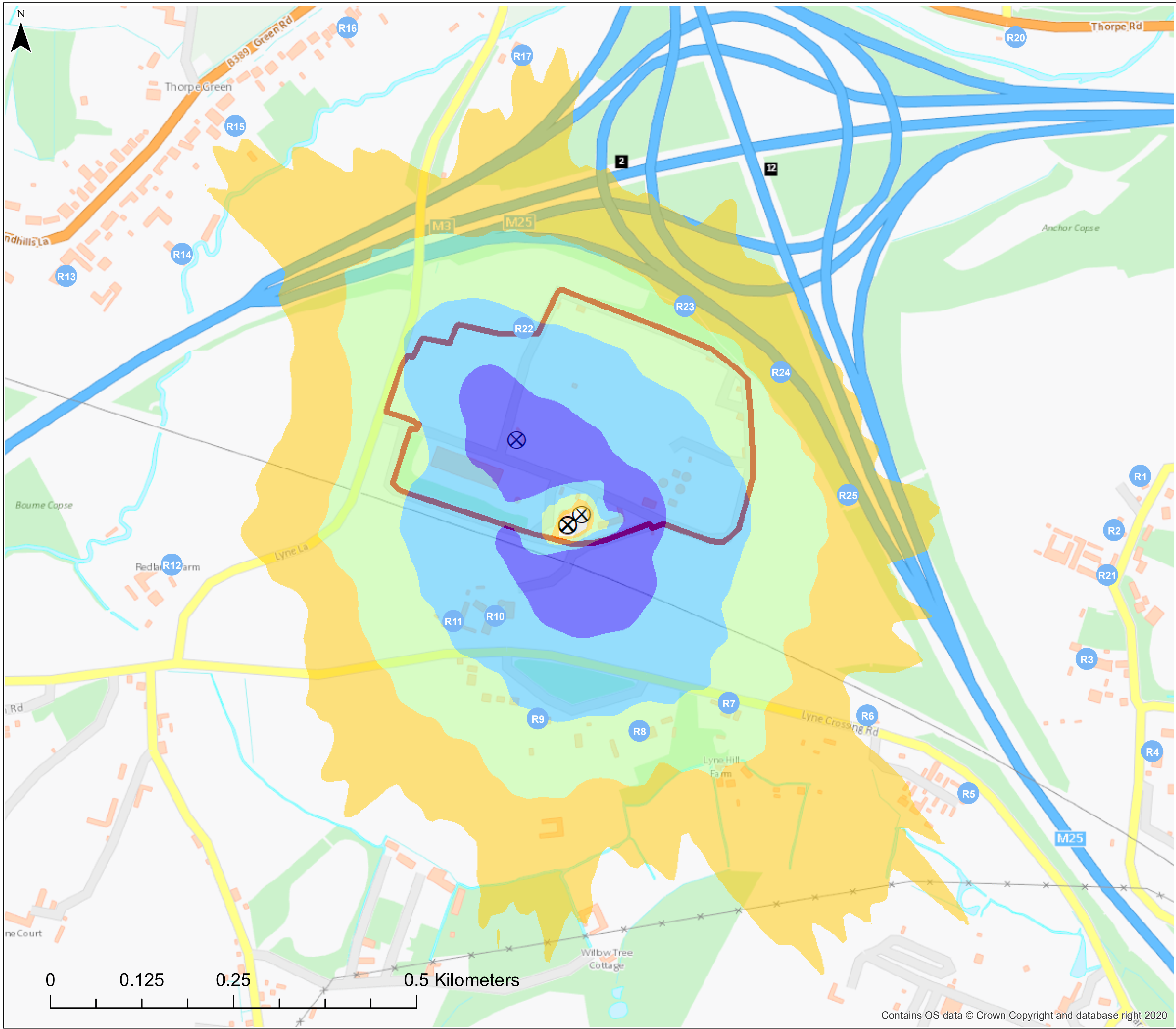
Drawing Status: FINAL

Scale @ A3	1:5,000	DO NOT SCALE
Jacobs No.	B22849AM	Rev 0
Client No.		

Drawing Number: FIGURE 8

This drawing is not to be used in whole or in part other than for the intended purpose and project as defined on this drawing. Refer to the contract for full terms and conditions.

J:\B22849AM Stc ied permit\Chertsey\Updated assessment to include gen\GIS\B22849AM_Figure8_Sc2_1h_SO2_2018_v2.mxd



Legend

- Approximate site fenceline
- Modelled stack locations
- R1 Sensitive human receptor locations

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

- 0 - 16
- 16 - 20
- 20 - 27
- 27 - 43
- 43 - 9,713

Rev.	Date	Purpose of revision	Drawn	Check'd	Rev'd	Appr'd
0	16/05/2022	Initial Issue	DH	GW	GW	MM

Jacobs

Client: Thames Water

Project: ENVIRONMENTAL PERMIT VARIATION APPLICATION - CHERTSEY SEWAGE TREATMENT WORKS AIR QUALITY IMPACT ASSESSMENT

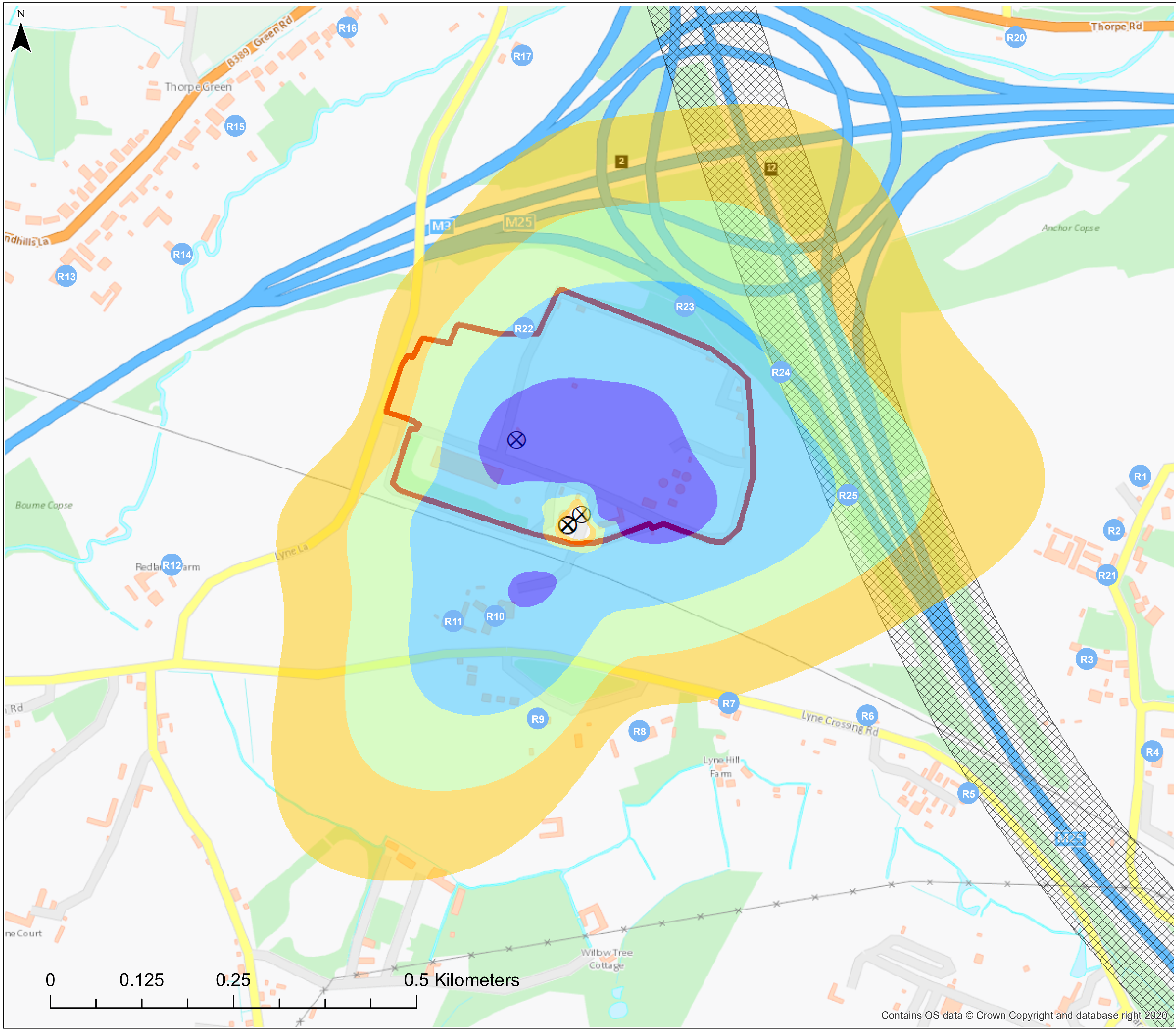
Drawing Title: SCENARIO 2 - 15-MINUTE MEAN (99.9th PERCENTILE) SULPHUR PROCESS CONTRIBUTIONS, 2018 METEOROLOGICAL DATA

Drawing Status: FINAL

Scale @ A3	1:5,000	DO NOT SCALE	
Jacobs No.	B22849AM	Rev	0
Client No.			

Drawing Number: FIGURE 9

J:\B22849AM Stc ied permit\Chertsey\Updated assessment to include gen\GIS\B22849AM_Figure9_Sc2_15m_SO2_2018_v2.mxd



Legend

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

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

- 0 - 0.6
- 0.6 - 0.9
- 0.9 - 1.4
- 1.4 - 3.0
- 3.0 - 307.9

Rev.	Date	Purpose of revision	Drawn	Check'd	Rev'd	Appr'd
0	16/05/2022	Initial Issue	DH	GW	GW	MM

Jacobs

Client: Thames Water

Project: ENVIRONMENTAL PERMIT VARIATION APPLICATION - CHERTSEY SEWAGE TREATMENT WORKS AIR QUALITY IMPACT ASSESSMENT

Drawing Title: SCENARIO 3 - ANNUAL MEAN NITROGEN DIOXIDE PROCESS CONTRIBUTIONS, 2018 METEOROLOGICAL DATA

Drawing Status: FINAL

Scale @ A3: 1:5,000 — DO NOT SCALE

Jacobs No.: B22849AM — Rev: 0

Client No.:

Drawing Number: FIGURE 10

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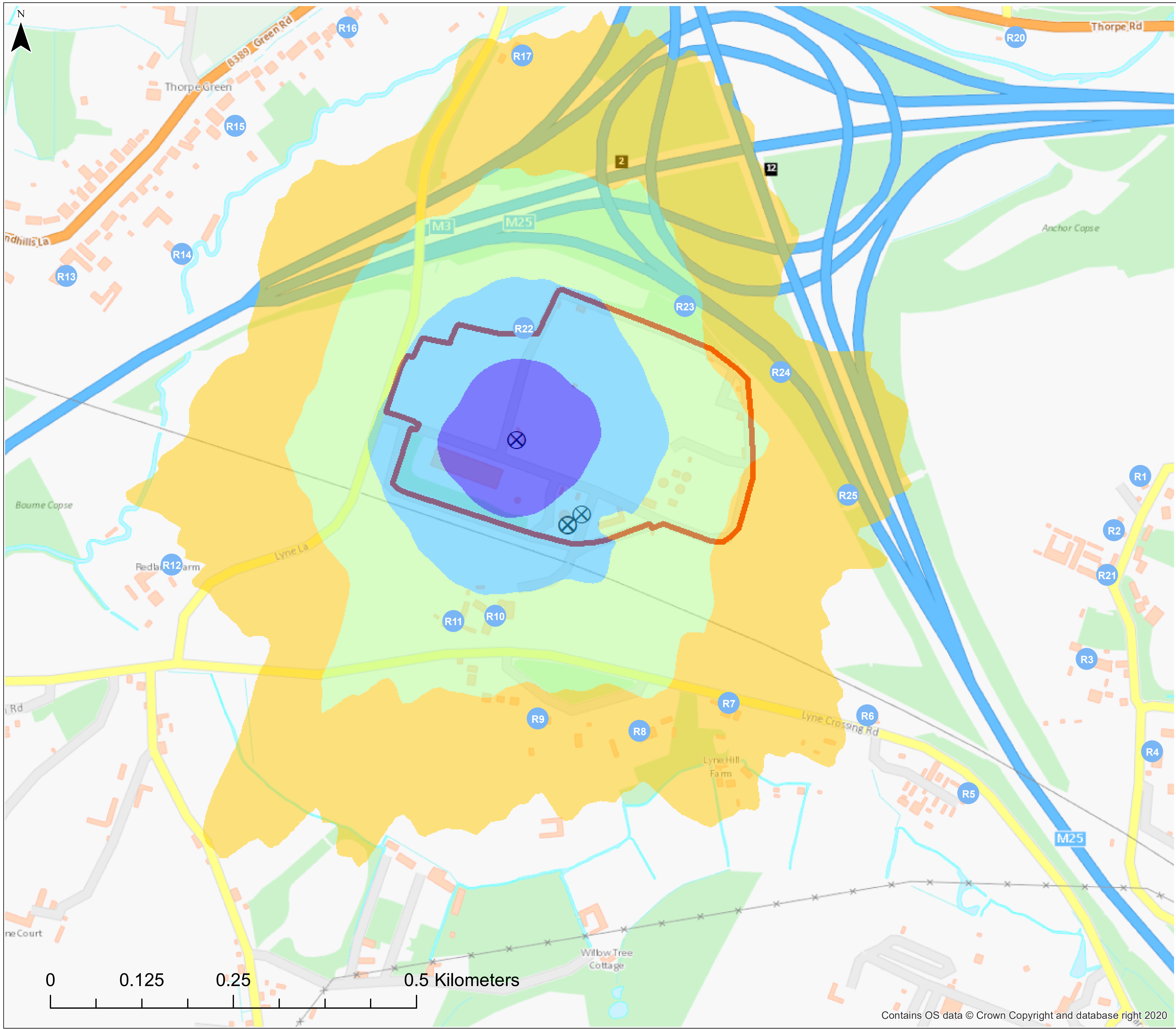
J:\B22849AM Stc ied permit\Chertsey\Updated assessment to include gen\GIS\B22849AM_Figure10_Sc3_AM_NO2_2018_v2.mxd



Legend

- Approximate site fenceline
- Modelled stack locations
- Sensitive human receptor locations

1-hour mean (99.79th percentile) nitrogen dioxide process contributions (μg/m^3)

- 0 - 30
- 30 - 45
- 45 - 80
- 80 - 200
- 200 - 94,942

Rev.	Date	Purpose of revision	Drawn	Check'd	Rev'd	Appr'd
0	16/05/2022	Initial Issue	DH	GW	GW	MM

Jacobs

Client

Thames Water

Project

ENVIRONMENTAL PERMIT VARIATION APPLICATION - CHERTSEY SEWAGE TREATMENT WORKS AIR QUALITY IMPACT ASSESSMENT

Drawing Title

SCENARIO 3 - 1-HOUR MEAN (99.79th PERCENTILE) NITROGEN DIOXIDE PROCESS CONTRIBUTIONS, 2019 METEOROLOGICAL DATA

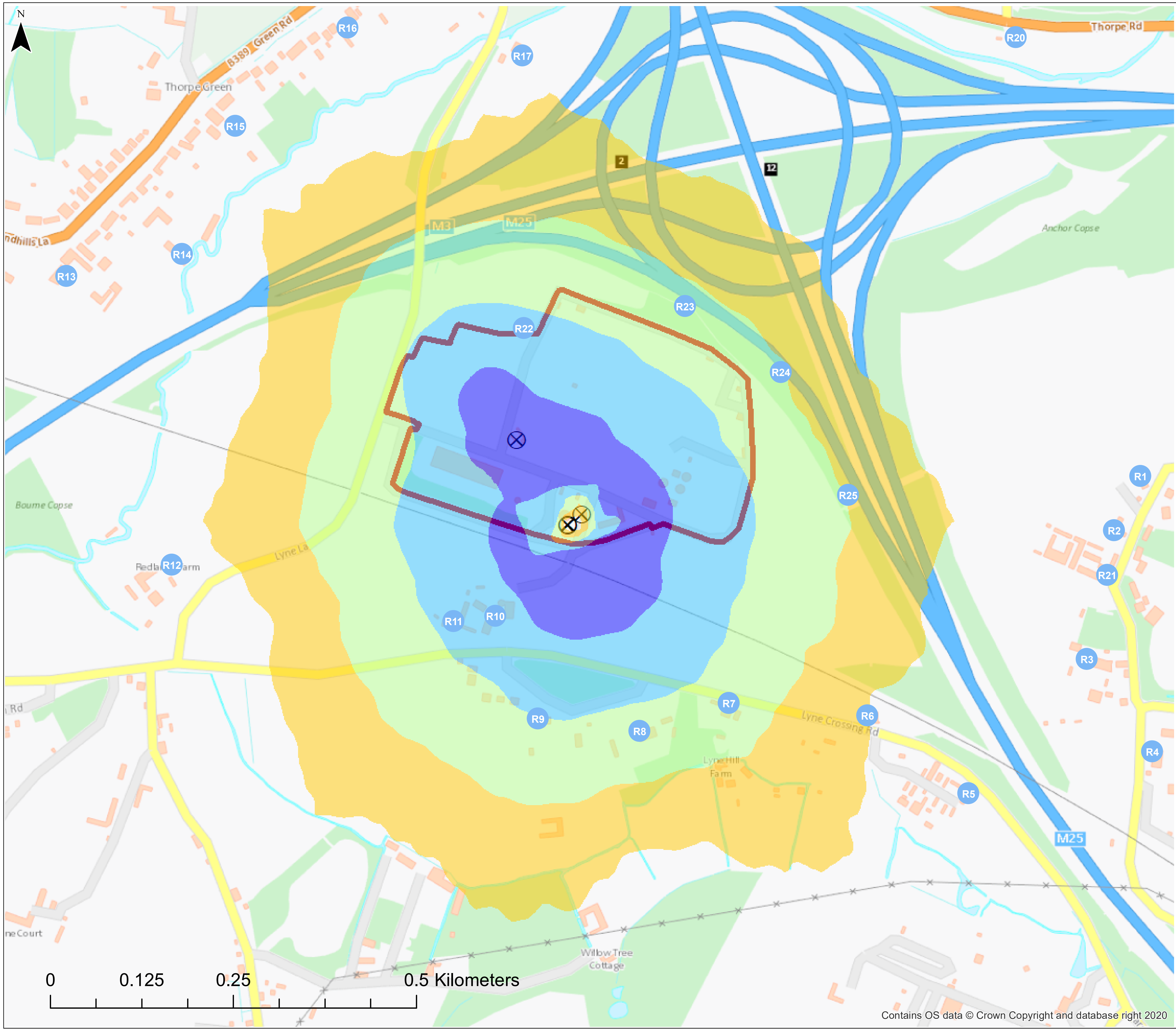
Drawing Status

FINAL

Scale @ A3	1:5,000	DO NOT SCALE	
Jacobs No.	B22849AM	Rev	0
Client No.			

Drawing Number

FIGURE 11



Legend

Approximate site fenceline

Modelled stack locations

Sensitive human receptor locations

1-hour mean (99.73rd percentile) sulphur dioxide process contributions (µg/m^3)

0 - 12

12 - 16

16 - 24

24 - 40

40 - 8,030

Rev.	Date	Purpose of revision	Drawn	Check'd	Rev'd	Appr'd
0	16/05/2022	Initial Issue	DH	GW	GW	MM

Jacobs

Client

Thames Water

Project

ENVIRONMENTAL PERMIT VARIATION APPLICATION - CHERTSEY SEWAGE TREATMENT WORKS AIR QUALITY IMPACT ASSESSMENT

Drawing Title

SCENARIO 3 - 1-HOUR MEAN (99.73rd PERCENTILE) SULPHUR PROCESS CONTRIBUTIONS, 2018 METEOROLOGICAL DATA

Drawing Status

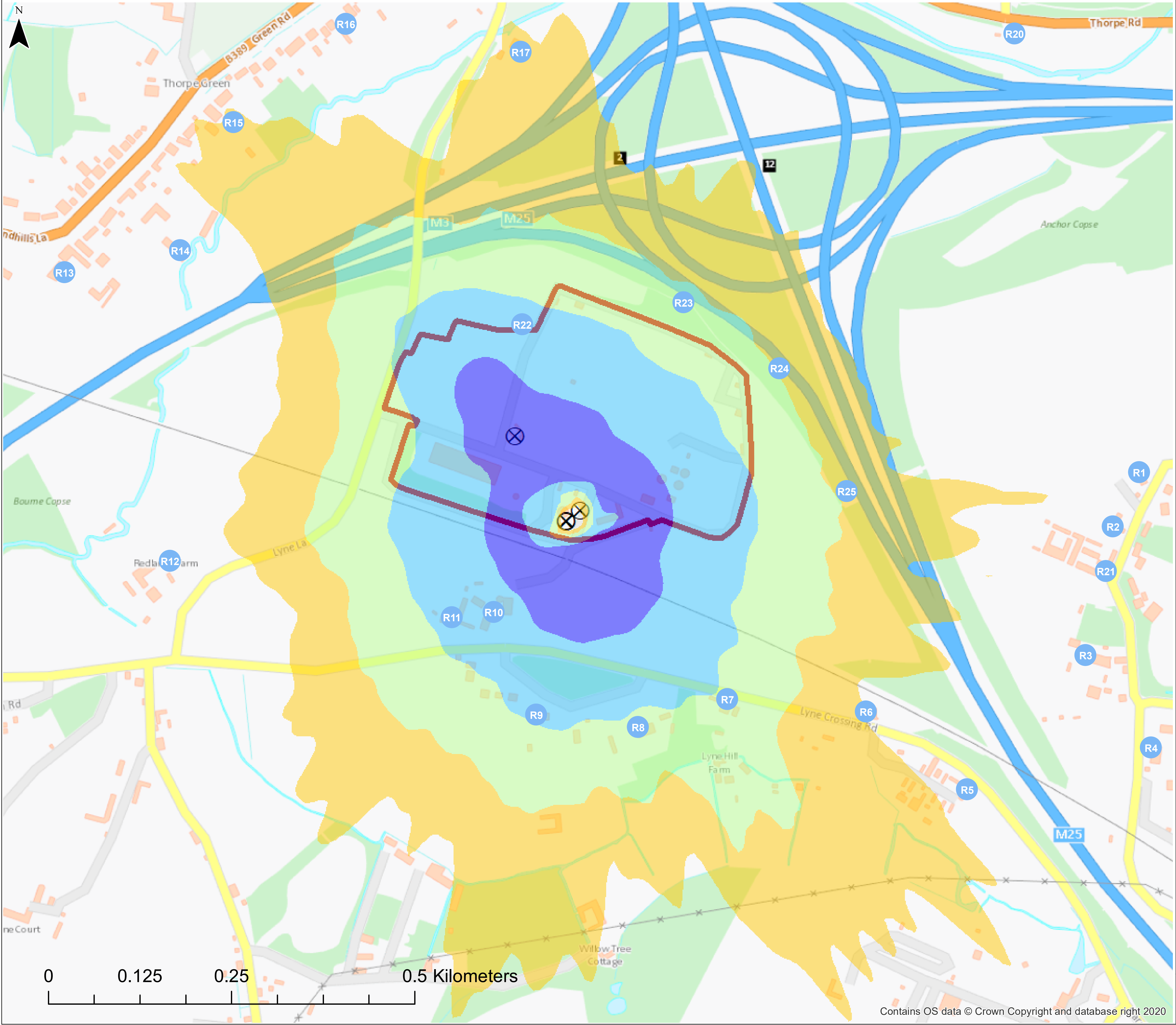
FINAL

Scale @ A3	1:5,000	DO NOT SCALE	
Jacobs No.	B22849AM	Rev	0
Client No.			

Drawing Number

FIGURE 12

J:\B22849AM Stc ied permit\Chertsey\Updated assessment to include gen\GIS\B22849AM_Figure12_Sc3_1h_SO2_2018_v2.mxd



Legend

- Approximate site fenceline
- Modelled stack locations
- Sensitive human receptor locations

15-minute mean (99.9th percentile) sulphur dioxide process contributions (µg/m³)

- 0 - 16
- 16 - 20
- 20 - 27
- 27 - 43
- 43 - 9,713

Rev.	Date	Purpose of revision	Drawn	Check'd	Rev'd	Appr'd
0	16/05/2022	Initial Issue	DH	GW	GW	MM

Jacobs

Client: Thames Water

Project: ENVIRONMENTAL PERMIT VARIATION APPLICATION - CHERTSEY SEWAGE TREATMENT WORKS AIR QUALITY IMPACT ASSESSMENT

Drawing Title: SCENARIO 3 - 15-MINUTE MEAN (99.9th PERCENTILE) SULPHUR PROCESS CONTRIBUTIONS, 2018 METEOROLOGICAL DATA

Drawing Status: FINAL

Scale @ A3	1:5,000	DO NOT SCALE	
Jacobs No.	B22849AM	Rev	0
Client No.			

Drawing Number: FIGURE 13

J:\B22849AM Stc ied permit\Chertsey\Updated assessment to include gen\GIS\B22849AM_Figure13_Sc3_15m_SO2_2018_v2.mxd

Appendix A. Dispersion Model Input Parameters

A.1 Emission Parameters

The emissions data used to represent the site for the scenario described in Section 2 is set out in Table 21. Emission limits as set out in the MCPD[6] for existing combustion plant are also presented in Table 21 where relevant.

Table 21: Dispersion modelling parameters

Parameters	Unit	JMS 312 GS-B.L CHP engine (1.9 MW_{th})	JMS 312 GS-B.L CHP engine (1.9 MW_{th})	Mecc Alte standby generator (2.6 MW_{th})	Byworth YSX6000 Steam Boiler (4.5 MW_{th})	
Fuel	-	Biogas	Biogas	Diesel	Biogas	Diesel
Emission point	-	A1	A2	A5	A7	
Assessed annual operation hours	Hours	8,760	8,760	8,760[2]	8,760 (Scenario 2)	8,760 (Scenario 3)
Stack location	m	E 501590 N 167355 (shared stack)		E 501520 N 167471	E 501609 N 167370	
Stack position	-	Vertical		Horizontal	Vertical	
Stack height	m	13.00		3.40	9.80	
Stack diameter	m	0.35 (individual)	0.35 (individual)	0.25	0.50	
Effective stack diameter	m	-	-	6.73[3]	-	
Flue gas temperature	°C	180	180	350	200	235
Efflux velocity	m/s	19.5	19.5	72.6	20.7	12.7
Moisture content of exhaust gas	%	11.6	11.6	12.0	10.0	10.4
Oxygen content of exhaust gas (dry)	%	8.5	8.5	13.3	5.0	6.0
Volumetric flow rate (actual)	m^3/s	1.881	1.881	3.562	4.139	2.525
Volumetric flow rate (normal)[1]	Nm^3/s	2.106	2.106	1.770	1.910	1.012
NOx emission concentration[1,]	mg/Nm^3	186 (190 after 1st January 2030)	186 (190 after 1st January 2030)	2,127	200	200
NOx emission rate	g/s	0.391	0.391	3.766	0.382	0.202
CO emission concentration[1]	mg/Nm^3	519	519	150	100	30
CO emission rate	g/s	1.094	1.094	0.266	0.191	0.030
PM_{10} / $PM_{2.5}$ emission concentration[1]	mg/Nm^3	2.7	2.7	37.8	5.0	37.0
PM_{10} / $PM_{2.5}$ emission rate	g/s	0.006	0.006	0.067	0.010	0.037
SO_2 emission concentration[1]	mg/Nm^3	130 (60 after 1st January 2030)	130 (60 after 1st January 2030)	68	100	196

Parameters	Unit	JMS 312 GS-B.L CHP engine (1.9 MW_{th})	JMS 312 GS-B.L CHP engine (1.9 MW_{th})	Mecc Alte standby generator (2.6 MW_{th})	Byworth YSX6000 Steam Boiler (4.5 MW_{th})	
SO_2 emission rate	g/s	0.274	0.274	0.121	0.191	0.198
TVOCs emission concentration[1]	mg/Nm^3	371	371	-	1,126	-
TVOCs emission rate	g/s	0.782	0.782		2.150	

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

Note 2: For long-term (i.e. annual mean) predicted concentrations, the standby generator was assumed to operate for 150 hours per year as a conservative approach to the assessment. In practice, the standby generator typically operates for up to 50 hours per year for routine testing only.

Note 3: As the standby generator emits waste gas via a horizontal stack, an effective stack diameter was applied in the model based on the volumetric flow rate (actual) divided by an assumed efflux velocity of 0.1 m/s.

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 22. A sensitivity study has been carried out to assess the sensitivity of the model to using the buildings module.

Table 22: Building parameters

Building	Modelled building shapes	Length / diameter (m)	Width (m)	Height (m)	Angle of length to north	Centre point co-ordinates	
						Easting	Northing
Tank 1 (Sludge reception tank)	Circular	16.50	-	9.60	-	501586	167367
Building 1 (Office)	Rectangular	36.70	9.50	4.17	254	501650	167360
Building 2	Rectangular	15.70	10.50	4.17	10	501634	167375
Building 3 (Housing for new boiler)	Rectangular	13.40	3.80	3.00	109	501607	167371
Tank 2	Circular	21.46	-	9.86	-	501519	167457
Generator housing	Rectangular	9.40	2.70	4.09	141.00	501516	167474
Building 4	Rectangular	15.10	3.10	4.84	140.1	501526	167481
Building 5	Rectangular	5.30	6.10	4.65	140.5	501530	167470

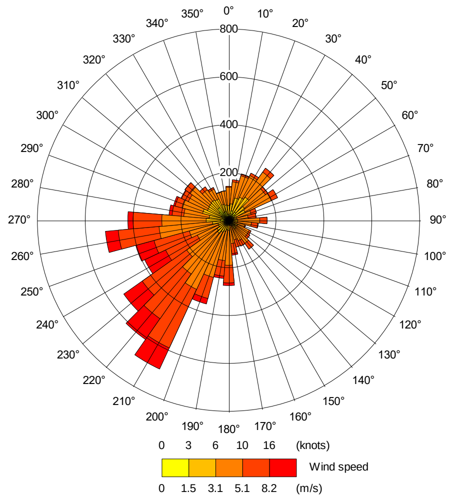
A.2.2 Other Model Inputs

Parameter	Value used	Comments
Surface roughness length for dispersion site	0.5 m	This is appropriate for the dispersion site which is area where the local land-use ranges from parkland to open suburbia. A sensitivity study has been carried out with fixed surface roughness values of 0.1 m and 1.0 m.
Surface roughness length at meteorological station site	0.6 m	This is appropriate for an area at Heathrow Airport 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	Heathrow Airport meteorological station, 2015 - 2019	Heathrow Airport meteorological station is located approximately 10.7 km northeast of the site and is considered the closest most representative meteorological monitoring station to the site.
Combined flue option	Yes	As the CHP engines exhaust gases exit via a shared stack, an aai file was used in the model to represent the effects of a single plume.

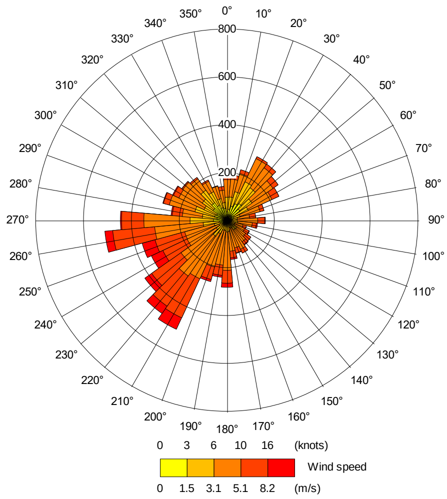
A.2.3 Meteorological Data – Wind Roses

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

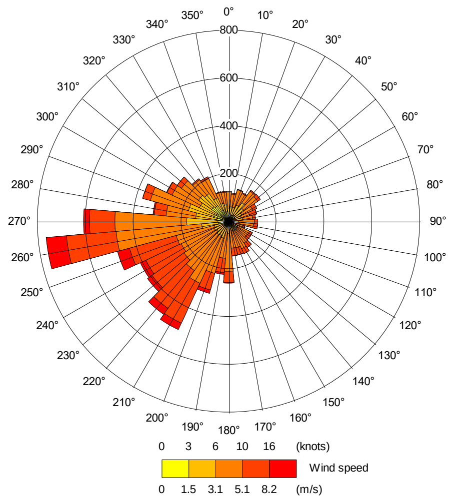
Heathrow meteorological station, 2015



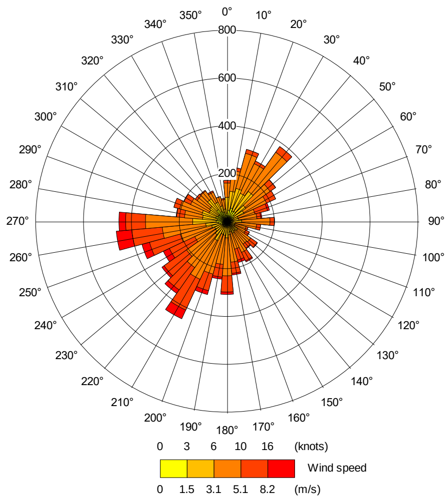
Heathrow meteorological station, 2016



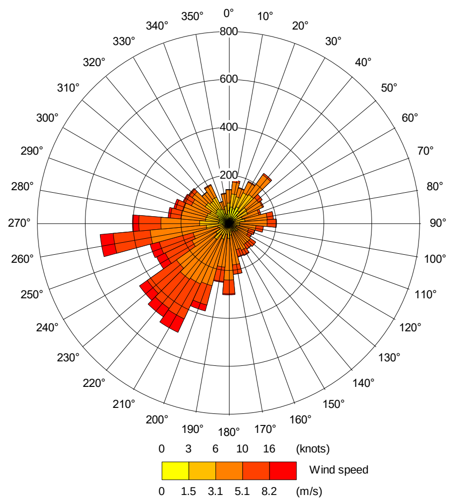
Heathrow meteorological station, 2017



Heathrow meteorological station, 2018



Heathrow meteorological station, 2019



A.2.4 Model Domain/Study Area

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

The modelled grid was specified as a 1.5 km x 1.5 km grid with calculation points every 10 m (i.e. 151 points along each grid axis) with a grid height of 1.5 m. This size of grid was selected to provide a good grid resolution and also encompass a sufficient area so that the maximum predicted concentrations would be determined. The area within the site boundary was excluded from the modelled grid as it is not accessible to the general public. The modelled grid parameters are presented in Table 23.

Table 23: Modelled grid parameters

	Start	Finish	Number of grid points	Grid spacing (m)
Easting	500840	502340	151	10
Northing	166605	168105	151	10
Grid height	1.5	1.5	1	-

As well as the modelled grid, the potential impact at 25 sensitive human receptors (e.g. exposure locations such as residential properties and a PRoW) and 33 protected conservation areas within the required study area were assessed. The receptor locations are shown in Figure 2 and Figure 3 and further details of the receptor locations are provided in Table 24 and Table 25.

Table 24: Assessed sensitive human receptor locations

Receptor	Description	Grid reference		Distance from the CHP engines shared stack (km)	Direction from the CHP engines shared stack (km)
		Easting	Northing		
R1	Residential property on St Anne's Hill Road	502372	167421	0.78	E
R2	Residential property on St Anne's Hill Road	502336	167347	0.75	E
R3	Residential property on St Anne's Hill Road	502299	167171	0.73	ESE
R4	Residential property on Almners Road	502388	167045	0.86	ESE
R5	Residential property on Lyne Crossing Road	502137	166988	0.66	SE
R6	Residential property on Lyne Crossing Road	501999	167094	0.49	ESE
R7	Residential property on Lyne Crossing Road	501810	167111	0.33	SE
R8	Residential property on Lyne Crossing Road	501688	167073	0.30	SSE
R9	Residential property on Lyne Crossing Road	501549	167090	0.27	S
R10	Residential property on Lyne Crossing Road	501491	167230	0.16	SW
R11	Residential property on Lyne Crossing Road	501434	167223	0.20	SW
R12	Residential property on Lyne Lane	501049	167300	0.54	W
R13	Residential property on Sandhills Lane	500905	167694	0.76	WNW
R14	Residential property on Sandhills Lane	501063	167724	0.64	NW
R15	Residential property on Sandhills Lane	501136	167899	0.71	NW
R16	Residential property on Green Road	501289	168033	0.74	NNW

Receptor	Description	Grid reference		Distance from the CHP engines shared stack (km)	Direction from the CHP engines shared stack (km)
		Easting	Northing		
R17	Residential property on Green Road	501528	167995	0.64	N
R18	Residential property on Green Road	501599	168085	0.73	N
R19	Residential property on Millhouse Lane	501804	168184	0.86	NNE
R20	Residential property on Thorpe Road	502202	168020	0.90	NE
R21	Residential property on St Anne's Hill Road	502327	167286	0.74	E
R22	Motocross track	501530	167623	0.27	NNW
R23	PRoW	501750	167653	0.34	NNE
R24	PRoW	501881	167563	0.36	NE
R25	PRoW	501973	167395	0.39	E

Table 25: Assessed protected conservation area locations

Receptor	Description	Grid reference		Distance from combustion plant (km)	Direction from the site
		Easting	Northing		
H1 & H2	South West London Waterbodies SPA & Ramsar & Thorpe Park No1 Gravel Pit SSSI	502201	168057	0.93	NE
H3 & H4	Thursley, Ash, Pirbright & Chobham SAC & Thames Basin Heaths SPA	499358	164497	3.63	SW
H5	Windsor Forest & Great Park SAC	497302	168685	4.49	WNW
H6	Ancient Woodland ID 1494421	502020	167672	0.53	NE
H7	Ancient Woodland ID 1494091	502825	167388	1.24	E
H8	Ancient Woodland ID 1494015	501998	166339	1.09	SSE
H9	Ancient Woodland ID 1494384	501748	166021	1.34	S
H10	Ancient Woodland ID 1493326	501961	165882	1.52	SSE
H11	Ancient Woodland ID 1494192	501407	166034	1.33	S
H12	Ancient Woodland ID 1494681	501676	165637	1.72	S
H13	Ancient Woodland ID 1494200	501765	165469	1.89	S
H14	Ancient Woodland ID 1494364	501089	166548	0.95	SSW
H15	Ancient Woodland ID 1494363	501146	166522	0.94	SSW
H16	Ancient Woodland ID 1493904	499788	166748	1.90	WSW
H17	Ancient Woodland ID 1494767	499793	166755	1.89	WSW
H18	Ancient Woodland ID 1494489	500110	167387	1.48	W
H19	Ancient Woodland ID 1494338	500797	168042	1.05	NW
H20	Ancient Woodland ID 1494255	500536	168095	1.29	NW
H21	Ancient Woodland ID 1494339	500598	168198	1.30	NW
H22	Ancient Woodland ID 1493546	500505	168328	1.46	NW
H23	Ancient Woodland ID 1493550	501431	169091	1.74	N

Receptor	Description	Grid reference		Distance from combustion plant (km)	Direction from the site
		Easting	Northing		
H24	Ancient Woodland ID 1493205	500834	167326	0.76	W
H25	Ancient Woodland ID 1493197	499688	167606	1.92	W
H26	Riverside Walk, Virginia Water LNR	500016	167646	1.60	W
H27	Knowle Grove LWS	499790	166758	1.90	WSW
H28	Fan Grove LWS	501998	166340	1.09	SSE
H29	Hardwick Court Farm Fields LWS	502889	165877	1.97	SE
H30	Abbey Lake Complex LWS	503026	167688	1.47	ENE
H31	The Dell LWS	500046	167686	1.58	WNW
H32	Trumps Mill LWS	500609	167312	0.98	W
H33	The Moat, Woodcock Farm LWS	501920	168308	1.01	NNE

A.2.5 Treatment of oxides of nitrogen

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

A.2.6 Calculation of PECs

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

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

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

A.2.7 Modelling Uncertainty

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

- The quality of the model output depends on the accuracy of the input data enter the model. Where model input data are a less reliable representation of the true situation, the results are likely to be less accurate.
- The meteorological data sets used in the model are not likely to be completely representative of the meteorological conditions at the site. However, the most suitable available meteorological data was chosen for the assessment.
- Models are generally designed on the basis of data obtained for large scale point sources and may be less well validated for modelling emissions from smaller scale sources.

- The dispersion of pollutants around buildings is a complex scenario to replicate. Dispersion models can take account of the effects of buildings on dispersion; however, there will be greater uncertainty in the model results when buildings are included in the model.
- Modelling does not specifically take into account individual small-scale features such as vegetation, local terrain variations and off-site buildings. The roughness length (z_o) selected is suitable to take general account of the typical size of these local features within the model domain.
- To take account of these uncertainties and to ensure the predictions are more likely to be over-estimates than under-estimates, the conservative assumptions described below have been used for this assessment.

A.2.8 Conservative Assumptions

The conservative assumptions adopted in this study are summarised below.

- The CHP engines and new boiler were assumed to operate for 8,760 hours each calendar year but in practice, the CHP engines and new boiler will have periods of shut-down and maintenance and may not always operate at maximum load. Furthermore, only one CHP engine is likely to operate simultaneously with the new boiler during site operations. To quantify short-term modelled concentrations, the standby generator was assumed to operate for 8,760 hours each calendar year but in practice, the standby generator typically operates for up to 50 hours per year for routine testing only.
- The study is based on emissions being continuously at the emission limits and calculated emissions specified.
- The maximum predicted concentrations at any residential areas as well as off-site locations were considered for the assessment of short-term concentrations and the maximum predicted concentrations at any residential areas were considered for assessment of annual mean concentrations within the air quality study area. Concentrations at other locations will be less than the maximum values presented.
- The highest predicted concentrations obtained using any of the five different years of meteorological data have been used in this assessment. During a typical year the ground level concentrations are likely to be lower.
- It was assumed that 100% of the particulate matter emitted from the plant is in the PM_{10} size fraction. The actual proportion will be less than 100%.
- It was assumed that 100% of the particulate matter emitted from the plant is in the $PM_{2.5}$ size fraction. The actual proportion will be less than 100%.
- It was assumed the vegetation type selected for each assessed protected conservation area is present at the specific modelled location.

Appendix B. Short-term Statistical Analysis

As per Environment Agency guidance (Environment Agency, 2018), where the modelling assuming continuous operation of periodic sources predicts an exceedance of the EQS, the probability of an exceedance has been calculated using cumulative hypergeometric probability distribution as follows:

$$\sum_{i=0}^{N-19} \frac{\binom{K}{i}\binom{M-K}{N-i}}{\binom{M}{N}}$$

Where:

- N denotes the sample size (i.e. operational hours or days);
- M denotes the operating envelope of 8,760 hours or 365 days; and
- K denotes the non-exceedance hours or days.

Once the hypergeometric distribution is calculated, this probability is multiplied by 2.5 to provide the probability of exceedance of the EQS taking into account that the operation will include consecutive hours and not random single-hour operation throughout the year.

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, 2022). Information on the deposition critical loads for each habitat site was also obtained from the APIS database using the Site Relevant Critical Load function.

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

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

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

The deposition velocities for various chemical species recommended for use (AQTAG, 2014) are shown below in Table 26.

Table 26: Recommended dry deposition velocities

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

To convert the dry deposition flux from units of μg/m^2/s (where μg refers to μg of the chemical species) to units of kg N/ha/yr (where kg refers to kg of nitrogen) multiply the dry deposition flux by the conversion factors shown in Table 27. To convert dry deposition flux to acid deposition multiply by factors shown in Table 29.

Table 27: Dry deposition flux conversion factors for nutrient nitrogen deposition

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

Table 28: Dry deposition flux conversion factors for acidification

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

Appendix D. Results at Sensitive Human Locations

Table 29: Results of detailed assessment at sensitive human receptor locations (Scenario 1, 2 and 3) for maximum 8-hour mean and 1-hour mean CO process contributions

Receptor ID	Baseline air quality level (µg/m³)	Maximum 8-hour running mean				Maximum 1-hour mean			
		EQS (µg/m³)	PC (Sc1) (µg/m³)	PC (Sc2) (µg/m³)	PC (Sc3) (µg/m³)	EQS (µg/m³)	PC (Sc1) (µg/m³)	PC (Sc2) (µg/m³)	PC (Sc3) (µg/m³)
R1	383	10,000	18.7	20.3	19.0	30,000	28.4	31.4	28.9
R2	383		20.1	22.0	20.4		29.3	31.9	29.7
R3	383		19.3	21.0	19.6		29.7	32.1	30.1
R4	383		18.1	19.5	18.3		27.6	29.9	28.1
R5	387		29.1	31.5	29.5		38.4	41.4	38.9
R6	374		38.1	41.3	38.7		51.4	55.8	52.2
R7	374		47.6	50.9	48.2		64.4	68.2	65.2
R8	374		58.5	63.2	59.4		74.8	78.7	75.6
R9	374		60.6	64.4	61.3		75.3	79.8	76.3
R10	374		84.5	92.3	85.9		103.7	113.0	105.3
R11	374		69.8	75.9	70.9		83.9	90.8	85.1
R12	374		28.2	31.1	28.8		37.5	40.4	38.0
R13	367		15.5	16.7	15.7		34.5	37.5	35.0
R14	374		22.3	24.0	22.6		40.0	43.2	40.6
R15	374		27.1	28.9	27.4		39.0	41.4	39.5
R16	377		27.5	29.1	27.8		40.0	42.2	40.5
R17	374		26.4	28.1	26.7		40.5	42.7	41.0
R18	377		23.4	25.0	23.7		37.0	39.6	37.6
R19	377		14.3	15.5	14.5		30.6	32.8	31.0
R20	384		18.1	19.7	18.4		26.2	28.5	26.6
R21	383		18.3	20.2	18.6		30.9	33.6	31.4
R22	374		67.0	71.6	67.8		83.0	87.5	83.8
R23	374		42.0	45.7	42.7		54.6	59.5	55.5
R24	374		45.8	50.3	46.7		53.8	59.0	54.6
R25	374		37.4	40.9	38.0		46.0	50.8	46.7

Table 30: Results of detailed assessment at sensitive human receptor locations (Scenario 1, 2 and 3) for annual mean and 1-hour mean (99.79th percentile) NO_2 process contributions

Receptor ID	Annual mean					99.79th percentile of 1-hour mean				
	Baseline air quality level (µg/m³)	**EQS (µg/m³)**	**PC (Sc1) (µg/m³)**	**PC (Sc2) (µg/m³)**	**PC (Sc3) (µg/m³)**	**EQS (µg/m³)**	**Baseline air quality level (µg/m³)**	**PC (Sc1) (µg/m³)**	**PC (Sc2) (µg/m³)**	**PC (Sc3) (µg/m³)**
R1	20.1	40	0.5	0.8	0.7	200	40.2	24.5	26.3	25.5
R2	20.1		0.5	0.8	0.7		40.2	25.1	27.4	26.5
R3	20.1		0.4	0.6	0.5		40.2	27.1	28.7	28.3
R4	20.1		0.3	0.4	0.4		40.2	20.3	21.7	21.3
R5	17.8		0.3	0.45	0.4		35.6	21.8	23.2	22.7
R6	23.9		0.5	0.7	0.6		47.7	28.6	30.3	29.6
R7	23.9		0.6	0.9	0.8		47.7	39.1	41.8	41.2
R8	23.9		0.5	0.7	0.6		47.7	42.6	42.9	42.9
R9	23.9		0.9	1.3	1.2		47.7	43.4	44.2	43.9
R10	23.9		2.1	3.0	2.7		47.7	72.1	72.1	72.1
R11	23.9		1.6	2.3	2.0		47.7	65.6	65.6	65.6
R12	23.9		0.3	0.4	0.4		47.7	30.5	31.5	31.2
R13	16.9		0.1	0.2	0.2		33.8	18.0	19.0	18.6
R14	23.9		0.2	0.2	0.2		47.7	24.0	25.3	24.8
R15	23.9		0.2	0.3	0.2		47.7	26.8	28.3	27.8
R16	19.8		0.2	0.3	0.2		39.6	21.1	22.1	21.6
R17	23.9		0.3	0.5	0.4		47.7	31.2	32.2	32.2
R18	19.8		0.3	0.4	0.4		39.6	26.7	27.5	27.1
R19	19.8		0.3	0.4	0.4		39.6	22.1	22.5	22.5
R20	15.6		0.4	0.5	0.5		31.3	16.2	16.9	16.6
R21	20.1		0.5	0.7	0.6		40.2	26.2	26.7	26.6
R22	23.9		1.3	1.7	1.5		47.7	126.8	128.4	127.9
R23	33.5		1.6	2.5	2.1		67.0	49.1	49.2	49.1
R24	33.5		1.3	2.0	1.7		67.0	38.8	38.8	38.8
R25	33.5		1.5	2.2	1.9		67.0	39.1	41.5	41.0

Table 31: Results of detailed assessment at sensitive human receptor locations (Scenario 1, 2 and 3) for 24-mean (99.18th percentile) and 1-hour mean (99.73rd percentile) SO_2 process contributions

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 (Sc1) (µg/m³)	PC (Sc2) (µg/m³)	PC (Sc3) (µg/m³)	EQS (µg/m³)	Baseline air quality level (µg/m³)	PC (Sc1) (µg/m³)	PC (Sc2) (µg/m³)	PC (Sc3) (µg/m³)
R1	7.1	125	2.5	3.2	3.2	350	7.1	6.6	9.2	9.6
R2	7.1		2.8	3.6	3.7		7.1	7.3	10.0	10.2
R3	7.1		2.7	3.5	3.7		7.1	7.1	9.6	10.4
R4	7.1		2.0	2.6	2.7		7.1	6.4	8.3	9.1
R5	6.9		2.8	3.6	3.8		6.9	7.3	9.6	10.1
R6	7.0		4.0	5.3	5.5		7.0	9.2	12.0	12.6
R7	7.0		6.5	8.6	8.8		7.0	14.7	18.6	19.4
R8	7.0		7.1	9.0	9.3		7.0	16.3	20.6	21.4
R9	7.0		9.7	12.6	13.1		7.0	17.9	22.5	23.6
R10	7.0		15.9	21.8	22.6		7.0	23.9	31.7	33.1
R11	7.0		13.6	18.3	18.9		7.0	19.2	25.4	26.6
R12	7.0		4.2	5.4	5.5		7.0	7.7	10.5	11.0
R13	6.9		1.8	2.3	2.4		6.9	5.4	6.9	7.1
R14	7.0		2.7	3.4	3.5		7.0	7.2	9.2	9.6
R15	7.0		2.6	3.3	3.4		7.0	7.6	9.7	10.1
R16	7.2		1.9	2.4	2.4		7.2	6.3	7.8	8.0
R17	7.0		3.2	3.9	4.1		7.0	8.6	10.7	11.2
R18	7.2		2.6	3.4	3.5		7.2	7.5	9.1	9.7
R19	7.2		2.0	2.6	2.7		7.2	6.1	8.0	8.3
R20	7.8		1.9	2.5	2.6		7.8	5.6	7.4	7.8
R21	7.1		2.6	3.4	3.4		7.1	6.7	9.5	9.9
R22	7.0		11.4	13.4	13.7		7.0	22.1	26.1	27.1
R23	7.0		7.3	9.8	10.1		7.0	12.5	17.1	17.9
R24	7.0		6.5	8.8	9.1		7.0	11.4	15.7	16.6
R25	7.0		6.3	8.4	8.7		7.0	11.1	15.5	16.0

Table 32: Results of detailed assessment at sensitive human receptor locations (Scenario 1, 2 and 3) for 15-minute mean (99.9th percentile) SO_2 process contributions

Receptor ID	99.9th percentile of 15-minute mean				
	Baseline air quality level (µg/m³)	EQS (µg/m³)	PC (Sc1) (µg/m³)	PC (Sc2) (µg/m³)	PC (Sc3) (µg/m³)
R1	7.1	266	9.6	14.3	15.2
R2	7.1		10.0	14.9	15.7
R3	7.1		10.4	13.8	15.5
R4	7.1		9.8	13.0	14.4
R5	6.9		10.9	14.3	15.6
R6	7.0		12.3	15.8	16.7
R7	7.0		19.1	24.4	25.7
R8	7.0		21.9	26.3	27.4
R9	7.0		20.9	26.4	28.1
R10	7.0		26.1	34.7	36.6
R11	7.0		21.3	28.6	30.2
R12	7.0		10.3	14.6	15.7
R13	6.9		7.7	10.0	10.7
R14	7.0		10.7	14.0	14.5
R15	7.0		12.8	15.7	16.6
R16	7.2		11.1	13.9	14.3
R17	7.0		13.0	16.3	17.0
R18	7.2		11.5	14.4	15.3
R19	7.2		9.4	12.1	12.6
R20	7.8		8.3	11.2	11.8
R21	7.1		10.1	13.7	14.6
R22	7.0		24.4	29.3	30.6
R23	7.0		14.6	20.0	21.2
R24	7.0		13.6	18.9	20.3
R25	7.0		13.3	18.7	19.6

Table 33: Results of detailed assessment at sensitive human receptor locations (Scenario 1, 2 and 3) for annual mean and 24-hour mean (90.41st) percentile) PM_{10} process contributions

Receptor ID	Annual mean					90.41st percentile of 24-hour mean				
	Baseline air quality level (µg/m³)	EQS (µg/m³)	PC (Sc1) (µg/m³)	PC (Sc2) (µg/m³)	PC (Sc3) (µg/m³)	EQS (µg/m³)	Baseline air quality level (µg/m³)	PC (Sc1) (µg/m³)	PC (Sc2) (µg/m³)	PC (Sc3) (µg/m³)
R1	15.9	40	0.01	0.02	0.05	50	31.8	0.18	0.20	0.28
R2	15.9		0.01	0.02	0.05		31.8	0.18	0.21	0.29
R3	15.9		0.01	0.02	0.04		31.8	0.15	0.17	0.24
R4	15.9		0.01	0.01	0.03		31.8	0.11	0.13	0.18
R5	15.8		0.01	0.01	0.03		31.7	0.14	0.16	0.22
R6	16.3		0.01	0.02	0.05		32.6	0.20	0.23	0.34
R7	16.3		0.01	0.02	0.06		32.6	0.25	0.29	0.40
R8	16.3		0.01	0.02	0.05		32.6	0.21	0.24	0.36
R9	16.3		0.02	0.04	0.09		32.6	0.30	0.36	0.55
R10	16.3		0.05	0.08	0.21		32.6	0.90	1.04	1.63
R11	16.3		0.04	0.06	0.15		32.6	0.98	1.03	1.42
R12	16.3		0.01	0.01	0.03		32.6	0.24	0.25	0.31
R13	15.4		0.00	0.00	0.01		30.9	0.09	0.10	0.13
R14	16.3		0.00	0.01	0.02		32.6	0.12	0.13	0.16
R15	16.3		0.00	0.01	0.02		32.6	0.13	0.14	0.18
R16	16.0		0.00	0.01	0.02		32.0	0.14	0.15	0.19
R17	16.3		0.01	0.01	0.03		32.6	0.24	0.26	0.31
R18	16.0		0.01	0.01	0.03		32.0	0.19	0.20	0.26
R19	16.0		0.01	0.01	0.03		32.0	0.16	0.17	0.22
R20	14.7		0.01	0.01	0.03		29.4	0.12	0.14	0.18
R21	15.9		0.01	0.02	0.05		31.8	0.16	0.18	0.25
R22	16.3		0.03	0.05	0.10		32.6	1.65	1.68	1.81
R23	16.3		0.04	0.07	0.16		32.6	0.73	0.82	1.03
R24	16.3		0.03	0.05	0.13		32.6	0.65	0.71	0.86
R25	16.3		0.03	0.06	0.15		32.6	0.42	0.50	0.73

Table 34: Results of detailed assessment at sensitive human receptor locations (Scenario 1, 2 and 3) for annual mean $PM_{2.5}$ process contributions

Receptor ID	Annual mean				
	Baseline air quality level (µg/m³)	EQS (µg/m³)	PC (Sc1) (µg/m³)	PC (Sc2) (µg/m³)	PC (Sc3) (µg/m³)
R1	10.6	25	0.01	0.02	0.05
R2	10.6		0.01	0.02	0.05
R3	10.6		0.01	0.02	0.04
R4	10.6		0.01	0.01	0.03
R5	10.5		0.01	0.01	0.03
R6	10.8		0.01	0.02	0.05
R7	10.8		0.01	0.02	0.06
R8	10.8		0.01	0.02	0.05
R9	10.8		0.02	0.04	0.09
R10	10.8		0.05	0.08	0.21
R11	10.8		0.04	0.06	0.15
R12	10.8		0.01	0.01	0.03
R13	10.4		0.00	0.00	0.01
R14	10.8		0.00	0.01	0.02
R15	10.8		0.00	0.01	0.02
R16	10.7		0.00	0.01	0.02
R17	10.8		0.01	0.01	0.03
R18	10.7		0.01	0.01	0.03
R19	10.7		0.01	0.01	0.03
R20	10.0		0.01	0.01	0.03
R21	10.6		0.01	0.02	0.05
R22	10.8		0.03	0.05	0.10
R23	10.8		0.04	0.07	0.16
R24	10.8		0.03	0.05	0.13
R25	10.8		0.03	0.06	0.15

Table 35: Results of detailed assessment at sensitive human receptor locations (Scenario 1, 2 and 3) for annual mean and maximum 24-hour mean TVOCs process contributions

Receptor ID	Annual mean					100th percentile of 24-hour mean				
	Baseline air quality level (µg/m³)	EQS (µg/m³)	PC (Sc1) (µg/m³)	PC (Sc2) (µg/m³)	PC (Sc3) (µg/m³)	EQS (µg/m³)	Baseline air quality level (µg/m³)	PC (Sc1) (µg/m³)	PC (Sc2) (µg/m³)	PC (Sc3) (µg/m³)
R1	0.5	5 (Benzene)	1.4	3.4	1.4	30 (Benzene)	1.0	7.5	18.6	7.5
R2	0.5		1.4	3.4	1.4		1.0	7.1	16.7	7.1
R3	0.5		1.0	2.5	1.0		1.0	8.3	22.0	8.3
R4	0.5		0.7	1.8	0.7		1.0	7.6	18.5	7.6
R5	0.5		0.8	1.9	0.8		1.0	7.7	19.3	7.7
R6	0.5		1.3	3.1	1.3		0.9	10.8	27.7	10.8
R7	0.5		1.7	4.0	1.7		0.9	19.0	42.9	19.0
R8	0.5		1.4	3.2	1.4		0.9	26.8	59.2	26.8
R9	0.5		2.5	5.9	2.5		0.9	33.4	77.3	33.4
R10	0.5		5.5	13.5	5.5		0.9	53.3	130.0	53.3
R11	0.5		4.1	9.8	4.1		0.9	41.6	99.2	41.6
R12	0.5		0.8	1.9	0.8		0.9	12.5	29.2	12.5
R13	0.4		0.3	0.7	0.3		0.9	6.4	14.4	6.4
R14	0.5		0.4	1.0	0.4		0.9	8.7	19.5	8.7
R15	0.5		0.5	1.1	0.5		0.9	7.2	18.4	7.2
R16	0.5		0.5	1.2	0.5		0.9	8.2	17.1	8.2
R17	0.5		0.9	2.1	0.9		0.9	8.0	19.1	8.0
R18	0.5		0.8	1.9	0.8		0.9	6.2	15.3	6.2
R19	0.5		0.7	1.8	0.7		0.9	5.4	13.0	5.4
R20	0.5		0.9	2.3	0.9		1.0	5.1	12.9	5.1
R21	0.5		1.3	3.1	1.3		1.0	7.3	17.3	7.3
R22	0.5		2.7	6.4	2.7		0.9	24.4	55.6	24.4
R23	0.5		4.2	10.7	4.2		0.9	20.4	54.5	20.4
R24	0.5		3.4	8.8	3.4		0.9	22.0	56.3	22.0
R25	0.5		3.9	10.0	3.9		0.9	18.5	45.8	18.5