Aldwarke Sludge Treatment Facility

Air Emissions Risk Assessment

On behalf of

YorkshireWater

Project Ref:331001762/100.2801 | Rev: Issued | Date: September 2022

Registered Office: Buckingham Court Kingsmead Business Park, London Road, High Wycombe, Buckinghamshire, HP11 1JU
Office Address: 10 Queen Square, Bristol, BS1 4NT
T: +44 (0)117 332 7840 E: PBA.Bristol@stantec.com

Document Control Sheet

Project Name: **Aldwarke Sludge Treatment Facility**

Project Ref: **331001762-100.2801-6**

Report Title: **Air Emissions Risk Assessment**

Doc Ref: **Issued**

Date: **September 2022**

	Name	Position	Signature	Date
Prepared by:	Laura Smart	Senior Air Quality Scientist	*LS*	September 2022
Reviewed by:	Philip Branchflower	Senior Associate – Air Quality	*PB*	September 2022
Approved by:	Peter Duncan	Technical Specialist – Environmental Services	*PD*	September 2022
For and on behalf of Stantec UK Limited				

Revision	Date	Description	Prepared	Reviewed	Approved
Draft	June 2022	Draft for client comment	LS	PB	PD
Issued	September 2022	Issued	LS	PB	PD

Contents

Tables

Appendices

1 Introduction

1.1 Background

1.1.1 Yorkshire Water Services Ltd has commissioned Stantec UK Ltd (Stantec) to undertake an Air Emission Risk Assessment (AERA) to support the Environmental Permit (EP) application for Anaerobic Digestion (AD) activities at Aldwarke Sludge Treatment Facility (STF).

1.1.2 The installation is located within the administrative boundary of Rotherham Borough Council (RBC). The location of the installation is shown in **Figure 1, Appendix E**.

1.1.3 The installation includes biogas combustion plant comprising two gas-fired Combined Heat and Power (CHP) plant and two gas-fired boilers.

1.2 Report Scope

1.2.1 The scope of the assessment is limited to the point source combustion emissions to air at the installation (as defined above). Consistent with Environment Agency (EA) guidance (Environment Agency, 2021), for a gas engine fired on biogas, the principal release of oxides of nitrogen (NOx) have been assessed alongside sulphur dioxide (SO_2) due to the potential sulphur content of biogas.

1.2.2 Emissions of NOx (in the form of nitrogen dioxide (NO_2)) and SO_2 have been assessed against the relevant Air Quality Standards for NO_2 and SO_2 for the protection of human health. An assessment has also been carried out against the relevant Critical Levels (C_{Le}) for NOx and SO_2, and Critical Loads (C_{Lo}) for nitrogen and acid deposition which are designed for the protection of designated ecological sites.

1.2.3 This report outlines the approach, methodology and results of the AERA that has been undertaken, utilising atmospheric dispersion modelling, to support the EP application.

1.2.4 The results of the assessment have been interpreted in accordance with the requirements of the EA to identify if impacts represent ‘significant pollution’ as required by the EA to determine an EP application.

1.2.5 The AERA has been undertaken in accordance with relevant legislation, policy and guidance.

2 Legislation and Relevant Guidance

2.1 Environmental Permitting Guidance

2.1.1 Guidance Notes produced by DEFRA provide a framework for regulation of installations and additional technical guidance produced by the EA are used to provide the basis for permit conditions.

2.1.2 Of particular relevance to the assessment is the '*Air emissions risk assessment for your environmental permit*', also known as the AERA Guidance (Environment Agency, 2022). The purpose of the AERA Guidance is to assist operators to assess risks to the environment and human health when applying for a permit under the EP Regulations. Included in the AERA guidance are:

- an approach to screening assessment;
- guidance on when detailed atmospheric dispersion modelling is required; and
- Environmental Assessment Levels (EALs) for a range of pollutants not covered by other regulations, against which impact may be assessed.

2.2 National Air Quality Legislation and Guidance

Air Quality Standards

2.2.1 The Air Quality Standards Regulations 2010 (the AQSR) transposed the Air Quality Directive (2008/50/EC) and Fourth Daughter Directive (2004/107/EC). The Regulations include Limit Values, Target Values, Objectives, Critical Levels and Exposure Reduction Targets for the protection of human health and the environment.

2.2.2 Following the Transition Period after the UK's departure from the EU in January 2020, the Air Quality (Amendment of Domestic Regulations) (EU Exit) Regulations 2019 (and subsequent amendments for the devolved administrations) have amended the AQ Standards Regulations 2010 to reflect the fact that the UK has left the EU, but do not change the pollutants assessed or the numerical thresholds.

National Air Pollution Plan for NO_2 in the UK

2.2.3 The national Air Quality Plan for NO_2 (DEFRA, 2018) sets out how the Government plans to deliver reductions in NO_2 throughout the UK, with a focus on reducing concentrations to below the EU Limit Values throughout the UK within the 'shortest possible time'.

2.2.4 The plan requires all Local Authorities (LAs) in England which DEFRA identified as having exceedances of the Limit Values in their areas past 2020 to develop local plans to improve air quality and identify measures to deliver reduced emissions, with the aim of meeting the Limit Values within their area within "*the shortest time possible*". Potential measures include changing road layouts, encouraging public and private ultra-low emission vehicle (ULEV) uptake, the use of retrofitting technologies and new fuels and encouraging public transport. In cases where these measures are not sufficient to bring about the required change within 'the shortest time possible' then LAs may consider implementing access restrictions on more polluting vehicles (e.g. Clean Air Zones (CAZs)).

Air Quality Strategy

2.2.5 The Air Quality Strategy (AQS) 2007 for England, Scotland, Wales and Northern Ireland sets out a comprehensive strategic framework within which air quality policy will be taken forward in the short to medium term, and the roles that Government, industry, the Environment Agency, local government, business, individuals and transport have in protecting and improving air quality (DEFRA, 2007). The AQS contains Air Quality Objectives (AQOs) based on the protection of both human health and vegetation (ecosystems). The AQOs are maximum ambient pollutant concentrations that are not to be exceeded, either without exception or with a permitted number of exceedances allowable over a specified timescale. The AQOs are generally in accordance with the Limit Values specified in the AQSRs, however requirements for compliance differ slightly.

2.2.6 The Clean Air Strategy (2019) aims to lower national emissions of pollutants, thereby reducing background pollution and minimising human exposure to harmful concentrations of pollution. The Strategy aims to create a stronger and more coherent framework for action to tackle air pollution (DEFRA, 2019).

2.2.7 The Environment Agency's role in relation to the AQS is as follows:

"The Environment Agency is committed to ensuring that any industrial installation or waste operation we regulate will not contribute significantly to breaches of an AQS objective.

It is a mandatory requirement of EPR legislation that we ensure that no single industrial installation or waste operation we regulate will be the sole cause of a breach of an EU air quality limit value. Additionally, we have committed that no installation or waste operation will contribute significantly to a breach of an EU air quality limit value." (Environment Agency, 2008)

2.3 Standards for Air Quality

2.3.1 The standards applied in this assessment are taken from the AERA Guidance (Environment Agency, 2021) which are in accordance with the AQS and AQSR. The EALs that have been applied in this assessment are provided in **Table 2-1**.

Table 2-1 Applied EALs

Pollutant	Averaging Period	EAL (µg/m^3)	Source
Nitrogen dioxide (NO_2)	Annual Mean	40	AQS and AQSR
	1-hour Mean	200 (1-hour) not to be exceeded more than 18 times per year	AQS and AQSR
Sulphur Dioxide (SO_2)	15 minutes	266 µg/m^3 not to be exceeded more than 35 times a year	AQS
	1-hour	350 µg/m^3 not to be exceeded more than 24 times a year	AQS and AQSR
	24-hour	125 µg/m^3 not to be exceeded more than 3 times a year	AQS and AQSR

2.3.2 DEFRA has published technical guidance for use in Local Air Quality Management (LAQM). According to LAQM.TG (16), air quality strategy objectives should only apply to locations where "*members of the public are likely to be regularly present and are likely to be exposed for a period of time appropriate to the averaging period of the objective*". Authorities should not consider exceedances of the objectives at any location where relevant public exposure would not be realistic. Thus, short term objectives such as the 1-hour objective should apply to footpaths and other areas which may be regularly frequented by the public even for a short period of time. Longer term objectives such as annual means, should apply at houses or other locations which the public can be expected to occupy on a continuous basis. These objectives do not apply to exposure at the workplace.

Table 2-2 Relevant Public Exposure

Averaging Period	Air quality objectives should apply at:	Air quality objectives don't apply at:
Annual mean	All locations where members of the public might be regularly exposed. Building façades of residential properties, schools, hospitals, care homes etc.	Building façades of offices or other places of work where members of the public do not have regular access. Hotels, unless people live there as their permanent residence. Gardens of residential properties. Kerbside sites (as opposed to locations at the building façade), or any other location where public exposure is expected to be short term.
24-hour and 8-hour mean	All locations where the annual mean AQO would apply, together with hotels and gardens of residences.	Kerbside sites Any other location where public exposure is expected to be short term.
1-hour mean	Any outdoor locations where members of the public might reasonably be expected to spend one hour or longer.	Kerbside sites where public would not be expected to have regular access
15-minute mean	All locations where members of the public might reasonably be regularly exposed for a period of 15 minutes or longer.	Locations where members of the public would not reasonably be expected to be regularly exposed for a period of 15 minutes or longer.

2.4 Protection of Ecological Receptors

2.4.1 Sites of nature conservation importance at a national and local level, are provided environmental protection from developments, including from atmospheric emissions. EALs for the protection of ecological receptors are known as Critical Levels (C_{Le}) for airborne concentrations and Critical Loads (C_{Lo}) for deposition to land from air.

2.4.2 The AERA Guidance requires that ecological habitats should be screened against relevant standards if they are located within the following set distances from the facility:

- Special Protection Areas (SPAs), Special Areas of Conservation (SACs) or Ramsar sites within 10km of the Installation; and
- Sites of Special Scientific Interest (SSSIs), National Nature Reserves (NNR), Local Nature Reserves (LNR), Local Wildlife Sites (LWS) and Ancient Woodland (AW) within 2km of the Installation.

Critical Levels (C_{Le})

2.4.3 C_{Le} are a quantitative estimate of exposure to one or more airborne pollutants in gaseous form, below which significant harmful effects on sensitive elements of the environment do not occur, according to present knowledge. The relevant C_{Le} for the protection of vegetation and ecosystems are specified within the UK Air Quality Regulations and AERA Guidance (see **Table 2-3**).

Table 2-3 Relevant C_{Le} for the Protection of Vegetation and Ecosystems

Pollutant	Concentration (µg/m^3)	Habitat and Averaging Period	Source
Nitrogen Oxides (NOx)	30	Annual mean (all ecosystems)	AQSR
	75[a]	Daily mean (all ecosystems)	AERA
Sulphur Dioxide (SO_2)	10	Annual Mean (lichens and bryophytes)	AERA
	20	Annual Mean	AQSR

[a] 200 µg/m^3 where ozone (O_3) is below the AOT40 critical level and SO_2 is below the lower critical level of 10 µg/m^3.

Critical Loads (C_{Lo})

2.4.4 C_{Lo} are a quantitative estimate of exposure to deposition of one or more pollutants, below which significant harmful effects on sensitive elements of the environment do not occur, according to present knowledge. Critical loads are set for the deposition of various substances to sensitive ecosystems. In relation to combustion emissions critical loads for eutrophication and acidification are relevant which can occur via both wet and dry deposition; however, on a local scale only dry (direct deposition) is considered significant.

2.4.5 Empirical C_{Lo} for eutrophication (derived from a range of experimental studies) are assigned based for different habitats, including grassland ecosystems, mire, bog and fen habitats, freshwaters, heathland ecosystems, coastal and marine habitats, and forest habitats and can be obtained from the UK Air Pollution Information System (APIS) website (APIS, 2022).

2.4.6 C_{Lo} for acidification have been set in the UK using an empirical approach for non-woodland habitats on a 1km grid square based upon the mineralogy and chemistry of the dominant soil series present in the grid square, and the simple mass balance (SMB) equation for both managed and unmanaged woodland habitats.

3 Assessment Methodology

3.1 Model Setup

3.1.1 Detailed atmospheric dispersion modelling has been undertaken using the most recent version (v.19191) of the AERMOD dispersion model which has been developed in conjunction with, and approved for use by, the US EPA. The dispersion modelling has been undertaken with due consideration to relevant guidance. The modelling approach is based upon the following stages:

- identification of sensitive receptors;
- review of process design and emission sources;
- compilation of the existing air quality baseline and review of LAQM status; and
- calculation of process contribution to ground level concentrations and evaluation against relevant environmental standards for both human and ecological receptors.

3.1.2 The AERMOD model calculates time-averaged ground level concentrations over any set of distances from the source. A 3km x 3km Cartesian grid with 20m spacing was used to predict the maximum predicted contribution to ground level (1.5m flagpole) concentrations. The pollutant concentrations were also predicted at specific human and ecological receptor locations.

3.1.3 The model requires inputs for:

- building effects;
- nature of the surface;
- physical characteristics of the emissions; and
- meteorology.

Building Effects

3.1.4 Buildings can influence the dispersion of pollutants from sources and can increase the maximum predicted ground level concentrations. The main effect of a building is to entrain pollutants into the cavity region in the immediate leeward side of the building, bringing them rapidly down to ground level. Therefore, concentrations near the building are increased but further away concentrations are decreased.

3.1.5 The buildings that are nearest (or attached) to the sources have been considered in the model. Buildings located horizontally within the distance equivalent to five stack heights of the stack and taller than approximately a third of the stack height have been included, in accordance with advice from the software provider. Details of buildings input to the model are provided in **Table 3-1** and **Table 3-2** below and shown in **Figure 2, Appendix E**. Building heights were obtained from OS Mastermap.

Table 3-1 Building Parameters – Rectangular Buildings

Building ID	X	Y	X Length (m)	Y Length (m)	Height above Ground (m)
B03	444577.6	394443.2	17.5	9.4	5
B04	444596	394436.8	9.9	7.2	5.2
B05	444605.2	394431.2	4	2.5	3.7
B06	444618.8	394425.4	9.6	3.3	3.9
B07	444622.1	394425.5	9.6	3.7	3.8
B08	444625.8	394425.6	9.6	3.8	3.7
B09	444629.7	394425.7	9.6	3.1	4.3
B12	444580.1	394393	7.8	3.6	3.5
B13	444575.6	394379.9	10.1	9	5.5

Table 3-2 Building Parameters – Circular Buildings

Building ID	X	Y	Radius (m)	Height above Ground (m)
B01	444569.3	394446.9	6.9	8.1
B02	444569.5	394429.9	6.9	8.1
B10	444559.8	394401.8	4.1	9.7
B11	444562.9	394386.2	9.2	16.2
B14	444563.3	394363.4	9.0	16.2

Terrain

3.1.6 Topographical data covering the extent of the receptor grid and specific receptor locations has been included in the model and was obtained from the OS LandForm Panorama dataset.

Meteorology

3.1.7 The model utilises a meteorological dataset that contains hourly values for wind speed, wind direction, and atmospheric stability to compute the dispersion of the emissions.

3.1.8 The assessment has used the five-year (2016 to 2020) sequential meteorological data from Doncaster Sheffield Airport which is considered to be representative of meteorological conditions at the site due to its proximity (approximately 22 km) and similar elevation to the site. The 2016 to 2020 windroses from Doncaster Sheffield Airport meteorological station are provided in **Appendix A**.

3.2 Emissions to Atmosphere

3.2.1 The technical specifications of the combustion plant are:

- CHP 1 – 875 kW thermal input and 307 kW electrical output.
- CHP 2 – 470 kW thermal input and 165 kW electrical output.
- Boiler 1 and 2 – 765 kW thermal input and 650 kW output.

3.2.2 There is also a biogas flare at the site, although this rarely operates (<10% of the year) as there is sufficient biogas combustion capacity provided by the installed CHP plant and boilers and NOx emissions will be less from a flare. Therefore, the flare has not been included as an emission source in the dispersion modelling.

3.2.3 The quantification of the flue gas flow rates for the two CHP units and Boiler 2 has been based on physical discharge characteristics and stack emissions testing data (Element, 2021a, Element, 2021b, Element, 2021c). The quantification of gas flow rates for Boiler 1 has been based on typical physical discharge characteristics and standard operating parameters included within AEA's 'Biomass Unit Conversion and Screening Assessment Tool' (AEA, 2008).

3.2.4 The emission release rates for the combustion plant have been calculated from the 'normalised' flue gas flow rates (see **Table 3-3**) and the relevant ELVs. The use of ELV values represents a worst-case assessment assumption as emission concentrations below these values have been recorded during emission testing (Element, 2021a, Element, 2021b and Element, 2021c) for the CHPs and boiler 2.

3.2.5 The source parameters and emission rates used for the assessment of emissions are provided in **Table 3-3**. Emissions from the CHP plant and boilers are discharged via individual stacks (i.e. four stacks in total). All stacks have been modelled as regular point sources.

Table 3-3 Applied Physical Discharge Characteristics to Estimate Emissions and Estimated Emission Rates

Parameter / Source	CHP 1 Flue	CHP 2 Flue	Boiler 1 Flue	Boiler 2 Flue
Stack Location (x, y)	444583,394386	444607,394428	444600,394435	444600,394433
Stack Release Height (m AGL)	5	5	7.5	7.5
Emission Temperature (ºC)	101	93	120	363
Stack Internal Diameter (m)	0.2	0.1	0.3	0.3
Emission Velocity (m/s)	11.4	14.3	6.9	10.3
Actual flow rate (Am^3/s)	0.36	0.11	0.49	0.73
Normalised flow rate, dry, 15% oxygen (Nm^3/s)	0.38	0.20	-	-
Normalised flow rate, dry, 3% oxygen (Nm^3/s)	-	-	0.20	0.19
Measured NOx Concentration (mg/Nm^3)	185[a]	75[a]	-	105[b]
Measured SO_2 Concentration (mg/Nm^3)	13[a]	11[a]	-	4.8[b]
NOx ELV (mg/Nm^3)	190[a]	190[a]	250[b]	250[b]
SO_2 ELV (mg/Nm^3)	60[a]	60[a]	200[b]	200[b]

Parameter / Source	CHP 1 Flue	CHP 2 Flue	Boiler 1 Flue	Boiler 2 Flue
NOx Emission Rate (g/s)	0.0721[c]	0.0386[c]	0.0509[e]	0.0476[e]
SO_2 Emission Rate (g/s)	0.0228[d]	0.0122[d]	0.0407[f]	0.0381[f]

a @ 273K, 101.3kPa, dry gas, 15% O_2).
b @ 273K, 101.3kPa, dry gas, 3% O_2).
c The NOx emission rate has been calculated using the MCPD ELV of 190 mg/Nm^3 (@STP, dry, 15% O_2).
d The SO_2 emission rate has been calculated using the MCPD ELV of 60 mg/Nm^3 (@STP, dry, 15% O_2).
e The NOx emission rate has been calculated using an ELV of 250 mg/Nm^3 (@STP, dry, 3% O_2).
f The SO_2 emission rate has been calculated using the MCPD ELV of 200 mg/Nm^3 (@STP, dry, 3% O_2).

3.3 Assessment of Impacts on Air Quality

NOx to NO_2 Conversion

3.3.1 Emissions of NOx from combustion sources include both NO_2 and NO, with the majority being in the form of NO. In ambient air, NO is oxidised to form NO_2, and it is NO_2 which has the greater potential health impacts. For this assessment, the conversion of NO to NO_2 has been estimated using the worst-case assumptions set out in EA AERA guidance, namely that:

- For the assessment of long term (annual mean) impacts at receptors, 70% of NOx is NO_2; and
- For the assessment of short term (hourly mean) impacts at receptors, 35% of NOx is NO_2.

3.3.2 The oxidation of NO to NO_2 is not, however, an instantaneous process and where the maximum impacts occur within close proximity to the stacks, the EA AERA guidance assumptions lead to a conservative assessment.

15-minute SO_2 Concentrations

3.3.3 In this assessment, the 99.9th percentiles of 1-hour mean SO_2 concentrations have been converted into 99.9th percentiles of 15-minute mean concentrations using a conversion factor 1.34, as recommended in the EA AERA guidance.

Assessment of Impact and Significance

3.3.4 To assess the potential impact on air quality, the predicted exposure is compared to the EALs, and the results of the dispersion modelling have been presented in the form of:

- tabulated concentrations at discrete receptor locations to facilitate the discussion of results; and
- illustrations of the impact as isopleths (contours of concentration) for the criteria selected enabling determination of impact at any locations within the study area.

3.3.5 In accordance with the EA's AERA guidance, the impact is considered to be insignificant or negligible if:

- the long-term process contribution is <1% of the long term EAL; and
- the short-term process contribution is <10% of the short term EAL.

3.3.6 For process contributions that cannot be considered insignificant further assessment has been undertaken and the Predicted Environmental Concentration (PEC: PC + existing background pollutant concentration) determined for comparison as a percentage of the relevant EAL. DEFRA 2018-based background maps for 2021 (DEFRA, 2020) have been applied to calculate the NO_2 PECs at receptor locations, whilst background monitoring data from DEFRA's Barnsley Gawber Automatic Urban and Rural Network (AURN) monitoring site has been applied to calculate the SO_2 PECs at receptor locations.

3.3.7 The EA's AERA guidance indicates that no further assessment is required, and impacts do not constitute 'significant pollution' if the resulting PEC is below the EAL and the applied emission levels comply with the BAT requirements.

3.4 Assessment of Impacts on Vegetation and Ecosystems

Calculation of Deposition Rates

3.4.1 Deposition rates were calculated using empirical methods recommended by the EA AQTAG06 (EA, 2014). Dry deposition flux was calculated using the following equation:

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

3.4.2 Wet deposition occurs via the incorporation of the pollutant into water droplets which are then removed in rain or snow and is not considered significant over short distances (AQTAG06) compared with dry deposition. Therefore, for the purposes of this assessment, wet deposition has not been considered.

3.4.3 The dry deposition velocities and conversion factors for NO_2 and SO_2 were taken from the EA's guidance document AQTAG 06 (EA, 2014) and are set out in **Table 3-4**.

Table 3-4 Applied Deposition Velocities

Chemical Species	Habitat	Recommended deposition velocity (m/s)	Conversion µg/m^2/s to kgN/ha/yr	Conversion µg/m^2/s to keq/ha/yr
NO_2	Grassland	0.0015	96.0	6.84
	Woodland	0.003		
SO_2	Grassland	0.012	-	9.84
	Woodland	0.024		

Assessment of Impact and Significance

3.4.4 In addition to the AERA guidance, the EA's Operational Instruction 66_12 (EA, 2012a) details how the air quality impacts on ecological sites should be assessed. This guidance provides risk-based screening criteria to determine whether impacts will have 'no likely significant effects (alone and in-combination)' for European sites, 'no likely damage' for SSSI's and 'no significant pollution' for other sites, as follows:

- PC <1% long-term C_{Le} and/or C_{Lo} or that the PEC <70% long-term C_{Le} and/or C_{Lo} for European sites and SSSIs;
- PC <10% short-term C_{Le} for NOx for European sites and SSSIs;
- PC <100% long-term C_{Le} and/or C_{Lo} other conservation sites; and
- PC <100% short-term C_{Le} for NOx (if applicable) for other conservation sites.

3.4.5 Where impacts cannot be classified as resulting in 'no likely significant effect', more detailed assessment may be required depending on the sensitivity of the feature in accordance with EAs Operational Instruction 67_12 (EA, 2012b). This can require the consideration of the potential for in-combination effects, the actual distribution of sensitive features within the site, and local factors (such as the water table).

3.4.6 The guidance provides the following further criteria:

- if the PEC <100% of the appropriate limit, it can be assumed there will be no adverse effect;
- if the background is below the limit, but a small PC leads to an exceedance – decision based on local considerations;
- if the background is currently above the limit and the additional PC will cause a small increase – decision based on local considerations;
- if the background is below the limit, but a significant PC leads to an exceedance – cannot conclude no adverse effect; and
- if the background is currently above the limit and the additional PC is large - cannot conclude no adverse effect.

4 Baseline Environment

4.1 Site Setting and Sensitive Receptors

4.1.1 The installation boundary is shown in **Figure 1, Appendix E**. The north of the WwTW site is bound by the Aldwarke Sewage Treatment Works LWS and the area beyond the LWS is occupied by industrial and commercial uses. The south of the site is bound by the River Don, beyond which the area is also industrial and commercial. The A6123 Aldwarke Lane bounds the east of the site, and further to the east, the land is occupied by a steel works. The modelled sensitive human and ecological receptor locations in proximity to the installation are described in the following sections.

Human Receptors

4.1.2 According to LAQM.TG(16), air quality standards should apply to locations where members of the public may be reasonably likely to be exposed to air pollution for the duration of the relevant limit value. The dispersion modelling has been completed using a receptor grid which allows the maximum ground level impact to be assessed including potential short-term exposure locations. As such, the impact concentration has been assessed at all potential exposure locations surrounding the site. In addition, fifteen sensitive existing residential properties and a school have been modelled, details of which are shown in **Table B-1, Appendix B** and their locations are shown in **Figure 3, Appendix E**.

Ecological Receptors

4.1.3 Locally designated sites within the relevant AERA guidance screening distances are presented in **Table B-2, Appendix B** and shown in **Figure 4, Appendix E**. There are no nationally or internationally designated sites within the relevant AERA screening distances.

4.2 Ambient Air Quality

Local Air Quality Management

4.2.1 RBC has investigated air quality within its area as part of its responsibilities under the LAQM regime. The Council currently has five Air Quality Management Areas (AQMAs). The Wales M1, A629 (Bradgate) and Fitzwilliam Road / A630 AQMAs have been declared due to exceedances of the annual and one-hour mean NO_2 AQOs, whilst the M1 2001 (amended 2010) and Rawmarsh Hill / Parkgate AQMAs have been declared due to exceedances of the annual mean NO_2 AQO only. The closest AQMAs are the Fitzwilliam Road / A630 AQMA, approximately 200m south of the installation boundary, and the Rawmarsh Hill / Parkgate AQMA, approximately 520m northwest.

Local Air Quality Monitoring Data

4.2.2 RBC carries out monitoring of NO_2 concentrations at a number of locations across the borough. The closest and most representative locations are shown in **Figure 1, Appendix E**. 2015 to 2019 monitoring data for these sites are presented in **Table 4-1** and **Table 4-2**. Data for 2020 and 2021 have not been included in **Table 4-1** and **Table 4-2** as they are not considered to be representative of 'normal' conditions due to the impact of COVID-19 travel restrictions.

4.2.3 **Table 4-1** shows that there were exceedances of the annual mean AQO for NO_2 in recent years at monitoring locations within the Fitzwilliam Road / A630 and Rawmarsh Hill / Parkgate AQMAs in close proximity to the installation. **Table 4-2** indicates that there have been exceedances of the hourly mean AQO for NO_2 in recent years at the closest automatic monitoring station to the site, located within the Fitzwilliam Road / A630 AQMA.

Table 4-1 Measured Annual Mean NO_2 concentrations 2015 - 2019

Site ID	Site Type	Annual Mean (µg/m^3)				
		2015	2016	2017	2018	2019
Automatic Monitoring Site						
St Ann's	Roadside	36.7	39.7	39	38	36
Diffusion Tubes						
RDT1	Roadside	**44.2**	**42.8**	38.9	**42.8**	37.2
RDT25	Roadside	28.5	25.9	27.3	24.0	21.8
RDT26	Roadside	-	-	30.1	27.5	29.6
RDT27	Roadside	-	-	35.8	34.9	33.2
RDT40	Roadside	-	-	36.3	36.7	28.5
RDT41	Roadside	-	-	32.3	31.4	32.2
RDT78	Roadside	24.4	23.2	21.8	24.9	25.5
RDT86	Roadside	**42.6**	**47.7**	**45.9**	**45.5**	36.6
RDT88	Roadside	39.5	37.1	**41.6**	39.1	37.5
RDT90	Roadside	**48.8**	**45.2**	**51.6**	**49.5**	**51.7**
RDT91	Roadside	-	-	**41.8**	39.4	38.2
RDT92	Roadside	33.1	32.4	30.3	29.8	29.8
RDT93	Roadside	37.9	30.6	33.1	32.3	34.9
RDT94	Roadside	35.4	32.3	33.8	34.1	32.5
RDT95	Roadside	-	-	**40.6**	39.2	37.7
AQO		**40**				

Data obtained from the RBC 2020 Air Quality Annual Status Report (RBC, 2020).
Exceedances of the AQO are highlighted in bold.

Table 4-2 Measured Hourly Mean NO_2 concentrations 2015 - 2019

Site ID	Site Type	Number of Hours >200 µg/m^3				
		2015	2016	2017	2018	2019
St Ann's	Roadside	**27**	**52**	**40**	**19**	**39**
AQO		**18 (hours >200 µg/m^3)**				

Data obtained from the RBC 2020 Air Quality Annual Status Report (RBC, 2020).
Exceedances of the AQO are highlighted in bold.

4.3 Predicted Background Concentrations

4.3.1 Modelled background pollutant concentration data on a 1km x 1km spatial resolution is provided by DEFRA through the UK AIR website (DEFRA, 2020). These data are routinely used to support LAQM and Air Quality Assessments.

4.3.2 The latest available background pollutant concentrations for NO_2 are based upon a 2018 base year and projected to future years. The projected 2021 background concentrations for the grid squares containing the installation and modelled receptor locations have been applied in this AERA and are provided in **Table 4-3**. Background NO_2 concentrations are well below the AQO.

Table 4-3 Estimated Annual Mean NO_2 Background Concentrations 2021 (µg/m^3)

Location (x_y)	Annual Mean (µg/m^3)	
	NOx	NO_2
443_393	25.1	17.7
444_393	21.2	15.3
444_394	24.7	17.4
444_395	20.2	14.6
444_396	17.1	12.7
445_394	21.0	15.2
446_394	16.9	12.6

4.3.3 The latest available modelled background pollutant data for SO_2 available from DEFRA is for 2001. Therefore, it has been considered more appropriate to use more recent SO_2 background monitoring data available from DEFRA's AURN.

4.3.4 The 2019 annual mean SO_2 concentration from the Barnsley Gawber background AURN monitoring site is provided in **Table 4-4**. The Barnsley Gawber AURN site is the closest and most representative SO_2 monitoring site to the installation with sufficient data capture in 2019. The measured annual mean SO_2 background concentration from the Barnsley Gawber monitoring site has been applied to all modelled human receptor locations in this AERA.

Table 4-4 Annual Mean SO_2 Measured Background Concentration

Site Name	Location (x,y)	2019 Annual Mean SO_2 Concentration (µg/m^3)
Barnsley Gawber AURN	432524,407478	1.36

4.4 Baseline Air Quality at Ecological Receptors

4.4.1 The APIS website, a support tool for assessment of potential effects of air pollutants on habitats and species developed in partnership by the UK conservation agencies and regulatory agencies and the Centre for Ecology and Hydrology, has been used to provide information on relevant C_{Lo} and current deposition rates for nutrient nitrogen and for acidity. These are provided in **Table 4-5** and **Table 4-6**. Baseline concentrations of NOx and SO_2 are also provided in **Table 4-6** and have been obtained from the APIS website.

Table 4-5 Nitrogen and Acid Deposition Critical Loads

Receptor	Designated Site	Assigned Habitat	Critical Load	
			Nitrogen Deposition (kgN/ha/yr)	Acid Deposition (keqN/ha/yr)
LWS1a	Aldwarke Sewage Works	Acid grassland	10	2.128
LWS1b	Aldwarke Sewage Works	Acid grassland	10	2.128
LWS1c	Aldwarke Sewage Works	Acid grassland	10	2.128
LWS1d	Aldwarke Sewage Works	Acid grassland	10	2.128
LWS1e	Aldwarke Sewage Works	Acid grassland	10	2.128
LWS1f	Aldwarke Sewage Works	Acid grassland	10	2.128
LWS1g	Aldwarke Sewage Works	Acid grassland	10	2.128
LWS1h	Aldwarke Sewage Works	Acid grassland	10	2.128
LWS1i	Aldwarke Sewage Works	Acid grassland	10	2.128
LWS1j	Aldwarke Sewage Works	Acid grassland	10	2.128
LWS1k	Aldwarke Sewage Works	Acid grassland	10	2.128
LWS1l	Aldwarke Sewage Works	Acid grassland	10	2.128
LWS1m	Aldwarke Sewage Works	Acid grassland	10	2.128
LWS1n	Aldwarke Sewage Works	Acid grassland	10	2.128
LWS1o	Aldwarke Sewage Works	Acid grassland	10	2.128
LWS1p	Aldwarke Sewage Works	Acid grassland	10	2.128
LWS1q	Aldwarke Sewage Works	Acid grassland	10	2.128
LWS2a	Thrybergh Tip	Acid grassland	10	2.068
LWS2b	Thrybergh Tip	Acid grassland	10	2.068
LWS2c	Thrybergh Tip	Acid grassland	10	2.068
LWS2d	Thrybergh Tip	Acid grassland	10	2.068
LWS2e	Thrybergh Tip	Acid grassland	10	2.068
LWS3	Listerdale Wood	Broadleaved, mixed and yew woodland	10	3.135
LWS4	New Stubbin Colliery & Stubbin Incline	Broadleaved, mixed and yew woodland	10	3.182

Table 4-6 Baseline Deposition Rates and Concentrations

Receptor	Nitrogen Deposition (kgN/ha/yr)	Acid Deposition		Annual Mean Concentration ($\mu g/m^3$)	
		Nitrogen (keq N/ha/yr)	Sulphur (keq S/ha/yr)	NOx	SO_2
LWS1a	22.7	1.6	0.3	29.43	2.97
LWS1b	22.7	1.6	0.3	29.43	2.97
LWS1c	22.7	1.6	0.3	29.43	2.97
LWS1d	22.7	1.6	0.3	29.43	2.97
LWS1e	22.7	1.6	0.3	29.43	2.97
LWS1f	22.7	1.6	0.3	29.43	2.97
LWS1g	22.7	1.6	0.3	29.43	2.97
LWS1h	22.7	1.6	0.3	29.43	2.97
LWS1i	22.7	1.6	0.3	29.43	2.97
LWS1j	22.7	1.6	0.3	29.43	2.97
LWS1k	22.7	1.6	0.3	29.43	2.97
LWS1l	22.7	1.6	0.3	29.43	2.97
LWS1m	22.7	1.6	0.3	29.43	2.97
LWS1n	22.7	1.6	0.3	29.43	2.97
LWS1o	22.7	1.6	0.3	29.43	2.97
LWS1p	22.7	1.6	0.3	29.43	2.97
LWS1q	22.7	1.6	0.3	29.43	2.97
LWS2a	19.0	1.4	0.2	20.16	2.17
LWS2b	19.0	1.4	0.2	20.16	2.17
LWS2c	19.0	1.4	0.2	20.16	2.17
LWS2d	19.0	1.4	0.2	20.16	2.17
LWS2e	19.0	1.4	0.2	20.16	2.17
LWS3	22.9	2.8	0.3	22.85	2.16
LWS4	33.6	2.4	0.3	24.08	2.01

5 Assessment Results

5.1.1 Dispersion modelling has been undertaken using the input data specified in this report. **Figure 5** to **Figure 9, Appendix E** should be referred to for graphical visualisations of modelling results. The impacts at modelled human and ecological receptor locations are described in the following sections.

5.2 Impacts on Sensitive Human Receptors

5.2.1 Impact predictions have been based on a worst-case assessment scenario of the boilers and CHP plant operating constantly throughout the year and emitting the maximum permitted NOx and SO_2 concentration (as shown in **Table 3-3**, the measured NOx and SO_2 concentrations are lower than the ELVs). Therefore, the predicted concentrations presented in this report for this scenario are likely to be significant overestimations of the actual impacts of the Installation.

Nitrogen Dioxide (NO_2)

5.2.2 **Figure 5, Appendix E** illustrates the predicted annual mean NO_2 PC contour whilst **Figure 6, Appendix E** shows the 1-hour mean NO_2 PC contour. Contours are presented for the year of the maximum PC which is 2017 for annual mean NO_2 and 2020 for 1-hour mean NO_2. Predicted annual mean NO_2 concentrations at sensitive receptor locations are summarised in **Table C-1, Appendix C,** whilst predicted 1-hour mean NO_2 concentrations are provided in **Table C-2, Appendix C**. Results for the worst-case meteorological year (i.e. maximum impact at each receptor) of the five years assessed (2016 - 2020) are presented.

5.2.3 In relation to the Rawmarsh Hill / Parkgate AQMA, sensitive receptor location R05 is located on the southern boundary of the AQMA and is therefore representative of a worst-case receptor location for the AQMA. The annual mean NO_2 PC at R05 is 0.6% of the EAL, and the 1-hour mean NO_2 PC is 2.6% of the EAL. As the annual mean NO_2 PC is less than 1% of the EAL, and the 1-hour mean NO_2 PC is less than 10% of the EAL, the NO_2 impacts at R05 can therefore be classed as 'insignificant' in accordance with EA guidance. As R05 is representative of a worst-case receptor location for the AQMA, annual and 1-hour mean impacts across the Rawmarsh Hill / Parkgate AQMA are also considered to be 'insignificant'.

5.2.4 In relation to the Fitzwilliam Road / A630 AQMA, the 1-hour mean NO_2 PCs are less than 10% of the EAL at all of the modelled sensitive receptor locations within the AQMA (R03, R13, R14, R15 and R16) and can therefore be considered to be 'insignificant' in accordance with EA guidance. The annual mean NO_2 PCs at the majority of modelled sensitive receptor locations within the AQMA (R03, R13 and R15) are less than 1% of the EAL and can therefore be considered to be 'insignificant' at these receptor locations. The annual mean NO_2 PC at R14 is 1.02% of the EAL and at R16 it is 1.1%. When using the DEFRA background concentrations to calculate the PEC, the PECs at these locations are less than 40% of the EAL. When applying the measured 2019 concentrations from representative monitoring sites within the AQMA to calculate the PEC at these receptor locations (monitoring location RDT91 for receptor R14 and monitoring location RDT88 for receptor R16), the PECs are below the EAL (96.5% of the EAL for R14 and 94.9% of the EAL for R16). It is therefore considered that the predicted annual mean NO_2 impacts on the Fitzwilliam Road / A630 AQMA do not constitute 'significant pollution'.

5.2.5 For sensitive receptor locations outside of the AQMAs, the predicted annual mean NO_2 PC exceeds 1% of the EAL, and the predicted 1-hour mean PC exceeds 10% of the EAL, at one receptor locations (R01). At the remaining receptor locations, the PCs are less than 1% of the EAL for annual mean NO_2 and 10% of the EAL for 1-hour mean NO_2 and can therefore be classified as 'insignificant' in accordance with EA guidance. The annual mean NO_2 PEC at receptor location R01 is less than 50% of the EAL and the 1-hour mean NO_2 PEC is less than 30% of the EAL. Therefore, the predicted NO_2 impacts are not considered to constitute 'significant pollution' at this location.

Sulphur Dioxide (SO_2)

5.2.6 **Figure 7, Appendix E** illustrates the predicted 24-hour mean SO_2 PC contour, **Figure 8, Appendix E** shows the 1-hour mean SO_2 PC contour and **Figure 9, Appendix E** shows the 15-minute mean SO_2 contour. Contours are presented for the year of the maximum PC which is 2018 for 24-hour mean SO_2, 2016 for 1-hour mean SO_2 and 2019 for 15-minute mean SO_2. Predicted SO_2 concentrations at sensitive receptor locations are summarised in **Table C-3 – C-6, Appendix C**. Results for the worst-case meteorological year of the five years assessed (2016 - 2020) are presented.

5.2.7 The predicted 24-hour and 1-hour mean SO_2 PCs are less than 10% of the EAL at all sensitive receptor locations and can therefore be classified as 'insignificant' in accordance with EA guidance.

5.2.8 The predicted 15-minute SO_2 PC exceeds 10% of the EAL at one sensitive receptor location (R01), however the PEC at this location is less than 15% of the EAL. At all of the remaining sensitive receptor locations, the PCs are less than 10% of the EAL and can therefore be classified as 'insignificant' in accordance with EA guidance.

5.2.9 The predicted 24-hour, 1-hour and 15-minute mean SO_2 PECs are well below the relevant EALs and therefore are not considered to constitute 'significant pollution'.

5.3 Impacts on Ecological Receptors

5.3.1 Impact predictions have been based on a worst-case assessment scenario assuming the boilers and CHP plant are operating constantly throughout the year and emitting at the maximum NOx and SO_2 emission concentrations defined previously.

Nitrogen Oxides (NO_x)

5.3.2 Predicted annual and 24-hour mean NO_x concentrations at sensitive ecological receptor locations are summarised in **Table D-1** and **Table D-2, Appendix D.** Results for the worst-case meteorological year of the five years assessed (2016 - 2020) are presented.

5.3.3 The predicted annual and 24-hour mean NOx PCs are less than 100% of the C_{Le} at all locally designated sites. There are no international or national designated sites within the relevant AERA screening distances. Therefore, the annual mean NOx impacts are classified as 'insignificant' at all ecological receptor locations.

Sulphur Dioxide (SO_2)

5.3.4 Predicted annual mean SO_2 concentrations at sensitive ecological receptor locations are summarised in **Table D-3, Appendix D.**

5.3.5 The predicted annual mean SO_2 PCs are less than 100% of the C_{Le} at all of the locally designated ecological receptor locations and can therefore be considered 'insignificant'. There are no international or national designated sites within the relevant AERA screening distances.

Nitrogen and Acid Deposition

5.3.6 Predicted annual mean nitrogen and acid deposition rates at sensitive ecological receptor locations are summarised in **Table D-4** and **Table D-5, Appendix D.**

5.3.7 The predicted annual nitrogen and acid deposition PCs are less than 100% of the C_{Lo} at all locally designated sites. There are no international or national designated sites within the relevant AERA screening distances. Therefore, the impacts on annual nitrogen and acid deposition are considered to be 'insignificant', in accordance with EA guidance.

6 Summary and Conclusions

6.1.1 An Air Emission Risk Assessment (AERA) utilising atmospheric dispersion modelling has been undertaken to support the EP application for Anaerobic Digestion activities at Aldwarke STF. The installation includes biogas combustion plant comprising two CHP plant units and two gas-fired boilers.

6.1.2 In relation to human health, where impacts are not classified as 'insignificant' (i.e. a PC less than 1% of the EAL for long-term concentrations or 10% for short-term) the predicted impacts of the installation do not lead to any exceedances of EALs and therefore are not considered to constitute 'significant pollution'.

6.1.3 In relation to the impact of the installation on ecologically sensitive sites, at all locally designated sites, the predicted PCs from the installation are less than 100% of the applicable C_{Le} or C_{Lo}. There are no international or national designated sites within the relevant AERA screening distances. Therefore, the impacts of the installation are considered 'insignificant' at all designated ecological sites.

References

AEA (2008). '*Biomass Unit Conversion and Screening Assessment Tool'*. V1.0.

Air Pollution Information System (APIS) (2022). The UK Air Pollution Information System. Available at: http://www.apis.ac.uk/

DEFRA in partnership with the Scottish Executive, Welsh Assembly Government and Department of Environment Northern Ireland (2007). *'The Air Quality Strategy for England, Scotland, Wales and Northern Ireland'*.

DEFRA in partnership with the Scottish Executive, The National Assembly for Wales and the Department of the Environment for Northern Ireland (2016). '*Local Air Quality Management Technical Guidance, LAQM.TG(16)'.* HMSO, London.

Department of the Environment, Food and Rural Affairs (DEFRA) (2018). '*UK Plan for tackling Roadside Nitrogen Dioxide Concentrations: Detailed Plan'.* Available at: https://www.gov.uk/government/publications/air-quality-plan-for-nitrogen-dioxide-no2-in-uk-2017

Department of the Environment, Food and Rural Affairs (DEFRA) (2019). '*Clean Air Strategy 2019*'.

DEFRA (2020). '2018 Based Background Maps for NO_x, NO_2, PM_{10} and $PM_{2.5}$'.

Department of the Environment, Transport and the Regions (DETR, 2007) in Partnership with the Welsh Office, Scottish Office and Department of the Environment for Northern Ireland (2007). '*The Air Quality Strategy for England, Scotland, Wales, Northern Ireland'* HMSO, London.

Element (2021a). *'Stack Emissions Testing Report Commissioned by Yorkshire Water Services Ltd. Stack Reference CHP 1. Yorkshire water Services Ltd. Aldwarke Lane, Rotherham, S65 3SR'*. 26th January 2021, V1.

Element (2021b). '*Stack Emissions Testing Report Commissioned by Yorkshire Water Services Ltd. Stack Reference CHP 2. Yorkshire water Services Ltd. Aldwarke Lane, Rotherham, S65 3SR'* . 25th January 2021, V1.

Element (2021c). *'Stack Emissions Testing Report Commissioned by Yorkshire Water Services Ltd. Stack Reference Boiler 2. Yorkshire water Services Ltd. Aldwarke Lane, Rotherham, S65 3SR'*. 25th January 2021, V1.

Environment Agency (2008). '*Regulating to Improve Air Quality'*. AQPG3, version 1.

Environment Agency (2012a). *'Operational Instruction 66_12 - Simple assessment of the impact of aerial emissions from new or expanding IPPC regulated industry for impacts on nature conservation.'*

Environment Agency (2012b). '*Operational Instruction 67_12 - Detailed assessment of the impact of aerial emissions from new or expanding IPPC regulated industry for impacts on nature conservation'.*

Environment Agency (2014). '*AQTAG06 – Technical Guidance on detailed modelling approach for an appropriate assessment for emissions to air*.' March 2014 version.

Environment Agency (2022). '*Air Emissions Risk Assessment for your Environmental Permit'*. Available at: https://www.gov.uk/guidance/air-emissions-risk-assessment-for-your-environmental-permit

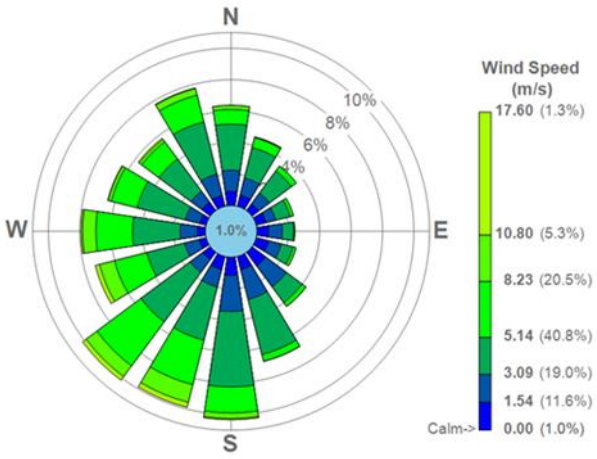
Environmental Act 1995, Part IV.

Medium Combustion Plant Directive. Directive (EU) 2015/2193 of the European Parliament and the Council of 25 November 2015

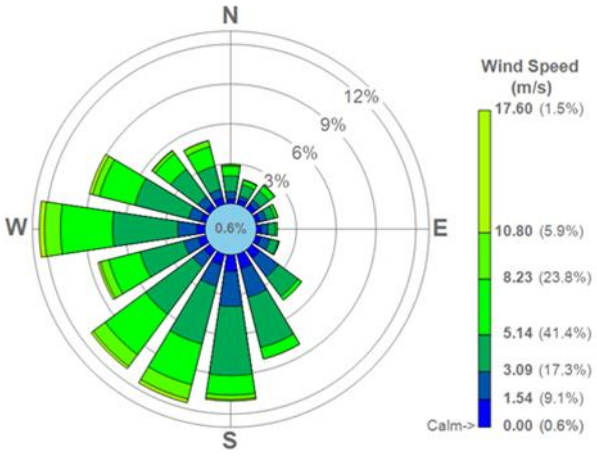
Rotherham Borough Council (2020). *'2020 Air Quality Annual Status Report (ASR).*'

Statutory Instrument 2010, No 1001, '*The Air Quality Standards Regulations 2010'* HMSO, London.

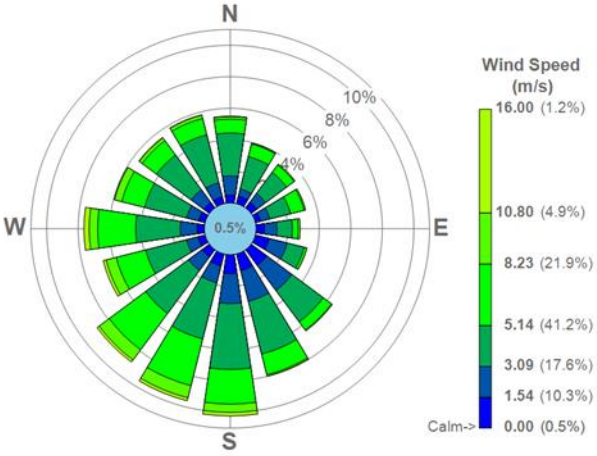
Appendix A 2016 – 2020 Doncaster Sheffield Windroses



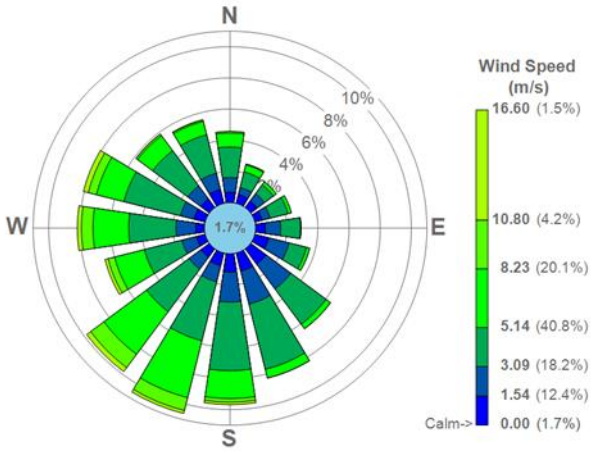
2016



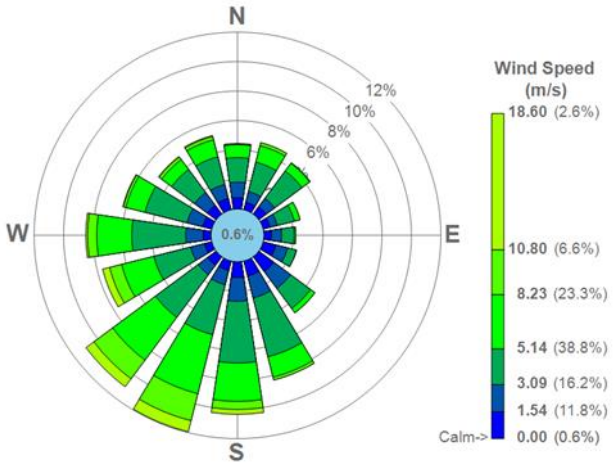
2017



2018



2019


N
W
E
S
12%
10%
8%
6%
0.6%
Wind Speed
(m/s)
18.60 (2.6%)
10.80 (6.6%)
8.23 (23.3%)
5.14 (38.8%)
3.09 (16.2%)
1.54 (11.8%)
Calm-> 0.00 (0.6%)

2020

Appendix B Modelled Receptor Locations

Table B-1 Modelled Human Receptor Locations

Receptor	Description	X Coordinate	Y Coordinate	Height (m)	Approximate Distance and Direction from Modelled Stack Locations
R01	1, Waterside Cottages	444446.4	394289.9	1.5	168m southwest
R02	Dwelling at Frank Price Lock	444055.1	394250	1.5	545m west
R03	483, Fitzwilliam Road	444440.3	393905.4	1.5	502m southwest
R04	Eastwood Village School	443691.7	393928.3	1.5	1,002m southwest
R05	33 to 43, Durham Way	444080.9	395098.3	1.5	842m northwest
R06	138, Victoria Road	444238.3	395559.1	1.5	1,180m northwest
R07	Thorpe Lea, Green Acres	444383.7	396061.1	1.5	1,641m north
R08	52, Roundwood Grove	444642.7	396171.2	1.5	1,736m north
R09	St Gerard's Catholic Primary School, Park Nook	446145.7	394906.8	1.5	1,615m northeast
R10	Silex, Doncaster Road	446044.3	394663.9	1.5	1,461m east
R11	Millhouse Court, Doncaster Road	445474.1	394304.5	1.5	883m east
R12	10 to 20, Lady Oak Way	445218.2	394115.3	1.5	695m southeast
R13	Foljambe Court,	445002.9	394057.4	1.5	552m southeast
R14	33, Oakmeadows	444718.7	393946.7	1.5	502m south
R15	12, Ashwell Grove	444611.5	393928.6	1.5	507m south
R16	200, Fitzwilliam Road	444523.0	393974.0	1.5	417m south

Table B-2 Modelled Ecological Sites

Receptor	Grid Reference		Site Name (Designation)	Interest Status	Approximate Distance and Direction from Modelled Stack Locations
	X	Y			
LWS1a	444491.3	394284.5	Aldwarke Sewage Works	Local	137m southwest
LWS1b	444464.7	394321.3	Aldwarke Sewage Works	Local	135m southwest
LWS1c	444464	394371.3	Aldwarke Sewage Works	Local	120m west
LWS1d	444463.1	394421.3	Aldwarke Sewage Works	Local	138m west

LWS1e	444462	394471.3	Aldwarke Sewage Works	Local	144m northwest
LWS1f	444459.6	394519.8	Aldwarke Sewage Works	Local	165m northwest
LWS1g	444455.1	394564.5	Aldwarke Sewage Works	Local	195m northwest
LWS1h	444504	394574.7	Aldwarke Sewage Works	Local	171m northwest
LWS1i	444554	394576.2	Aldwarke Sewage Works	Local	150m north
LWS1j	444602.8	394570.7	Aldwarke Sewage Works	Local	137m north
LWS1k	444650.9	394561.3	Aldwarke Sewage Works	Local	137m northeast
LWS1l	444700.9	394564.2	Aldwarke Sewage Works	Local	165m northeast
LWS1m	444747.6	394567.7	Aldwarke Sewage Works	Local	199m northeast
LWS1n	444796.9	394575.6	Aldwarke Sewage Works	Local	242m northeast
LWS1o	444846.2	394584	Aldwarke Sewage Works	Local	288m northeast
LWS1p	444895	394594.6	Aldwarke Sewage Works	Local	335m northeast
LWS1q	444942.9	394608.8	Aldwarke Sewage Works	Local	385m northeast
LWS2a	446054.9	395463.9	Thrybergh Tip	Local	1,782m northeast
LWS2b	446147.3	395432.9	Thrybergh Tip	Local	1,841m northeast
LWS2c	446206.6	395354.3	Thrybergh Tip	Local	1,851m northeast
LWS2d	446295.1	395308.9	Thrybergh Tip	Local	1,907m northeast
LWS2e	446384.4	395264.4	Thrybergh Tip	Local	1, 967m northeast
LWS3	445965.2	393208.8	Listerdale Wood	Local	1,833m southeast
LWS4	443328	395663	New Stubbin Colliery & Stubbin Incline	Local	1,769m northwest

Appendix C Modelled Human Receptor Results

Table C-1 Predicted Annual Mean NO_2 Concentrations

Receptor	Annual Mean NO_2 Concentration ($\mu g/m^3$)			
	PC	PC as % of EAL	PEC	PEC as % of EAL
R01	1.1	2.8%	18.5	46.2%
R02	0.2	0.5%	17.6	43.9%
R03	0.3	0.8%	15.6	39.1%
R04	0.1	0.2%	17.8	44.5%
R05	0.2	0.6%	14.9	37.2%
R06	0.1	0.3%	14.8	36.9%
R07	0.1	0.2%	12.8	31.9%
R08	0.1	0.2%	12.8	31.9%
R09	0.0	0.1%	12.6	31.5%
R10	0.1	0.2%	12.6	31.5%
R11	0.2	0.5%	15.4	38.5%
R12	0.2	0.6%	15.5	38.6%
R13	0.3	0.8%	15.5	38.9%
R14	0.4	1.0%	15.7	39.3%
R15	0.4	1.0%	15.7	39.2%
R16	0.4	1.1%	15.8	39.4%

Table C-2 Predicted 1-hour Mean NO_2 Concentrations

Receptor	99.79%ile 1-Hour Mean NO_2 Concentration (µg/m^3)			
	PC	PC as % of EAL	PEC	PEC as % of EAL
R01	24.2	12.1%	59.0	29.5%
R02	6.5	3.2%	41.2	20.6%
R03	9.7	4.9%	40.4	20.2%
R04	3.3	1.7%	38.8	19.4%
R05	5.1	2.6%	34.4	17.2%
R06	3.5	1.7%	32.7	16.4%
R07	2.3	1.2%	27.7	13.8%
R08	2.4	1.2%	27.7	13.9%
R09	1.2	0.6%	26.3	13.2%
R10	2.0	1.0%	27.1	13.6%
R11	4.5	2.2%	34.9	17.4%
R12	6.1	3.0%	36.5	18.3%
R13	8.1	4.1%	38.5	19.3%
R14	8.5	4.3%	39.1	19.6%
R15	8.2	4.1%	38.8	19.4%
R16	10.2	5.1%	40.8	20.4%

Table C-3 Predicted 24-hour Mean SO_2 Concentrations

Receptor	99.19%ile 24-Hour Mean SO_2 Concentration (µg/m^3)			
	PC	PC as % of EAL	PEC	PEC as % of EAL
R01	6.6	5.3%	8.3	6.6%
R02	1.8	1.4%	3.4	2.7%
R03	1.8	1.4%	3.4	2.7%
R04	0.7	0.6%	2.3	1.9%
R05	1.4	1.1%	3.0	2.4%
R06	0.9	0.7%	2.5	2.0%
R07	0.5	0.4%	2.1	1.7%
R08	0.5	0.4%	2.1	1.7%
R09	0.3	0.2%	1.9	1.5%
R10	0.4	0.3%	2.0	1.6%
R11	1.0	0.8%	2.6	2.1%
R12	1.5	1.2%	3.1	2.5%
R13	2.0	1.6%	3.6	2.8%
R14	2.4	1.9%	4.0	3.2%
R15	2.4	1.9%	4.0	3.2%
R16	2.9	2.3%	4.5	3.6%

Table C-4 Predicted 1-Hour Mean SO_2 Concentrations

Receptor	99.73%ile 1-Hour Mean SO_2 Concentration (µg/m^3)			
	PC	PC as % of EAL	PEC	PEC as % of EAL
R01	24.6	7.0%	27.3	7.8%
R02	7.8	2.2%	10.6	3.0%
R03	10.2	2.9%	12.9	3.7%
R04	4.2	1.2%	6.9	2.0%
R05	6.8	1.9%	9.5	2.7%
R06	4.9	1.4%	7.6	2.2%
R07	3.4	1.0%	6.2	1.8%
R08	3.1	0.9%	5.8	1.7%
R09	1.8	0.5%	4.5	1.3%
R10	2.5	0.7%	5.2	1.5%
R11	4.8	1.4%	7.6	2.2%
R12	7.2	2.0%	9.9	2.8%
R13	8.9	2.5%	11.6	3.3%
R14	10.0	2.8%	12.7	3.6%
R15	9.6	2.8%	12.4	3.5%
R16	11.5	3.3%	14.2	4.1%

Table C-5 Predicted 15-minute Mean SO_2 Concentrations

Receptor	99.9%ile 15-Minute Mean SO_2 Concentration (µg/m^3)			
	PC	PC as % of EAL	PEC	PEC as % of EAL
R01	38.6	14.5%	42.2	15.9%
R02	16.8	6.3%	20.4	7.7%
R03	17.6	6.6%	21.2	8.0%
R04	7.6	2.8%	11.2	4.2%
R05	10.2	3.8%	13.9	5.2%
R06	8.3	3.1%	11.9	4.5%
R07	6.2	2.3%	9.9	3.7%
R08	5.7	2.2%	9.4	3.5%
R09	3.0	1.1%	6.6	2.5%
R10	5.4	2.0%	9.1	3.4%
R11	9.1	3.4%	12.8	4.8%
R12	12.5	4.7%	16.1	6.1%
R13	15.3	5.7%	18.9	7.1%
R14	16.1	6.0%	19.7	7.4%
R15	16.1	6.0%	19.7	7.4%
R16	19.8	7.5%	23.5	8.8%

Appendix D Modelled Ecological Receptor Results

Table D-1 Predicted Annual Mean NO_x Concentrations

Receptor	Designated Site	Annual Mean NOx			
		PC (µg/m^3)	PC as % of C_{Le}	PEC (µg/m^3)	PEC as % of C_{Le}
LWS1a	Aldwarke Sewage Works	2.3	7.8%	31.8	105.9%
LWS1b	Aldwarke Sewage Works	2.0	6.6%	31.4	104.7%
LWS1c	Aldwarke Sewage Works	2.4	8.0%	31.8	106.1%
LWS1d	Aldwarke Sewage Works	2.8	9.3%	32.2	107.4%
LWS1e	Aldwarke Sewage Works	3.0	10.1%	32.4	108.2%
LWS1f	Aldwarke Sewage Works	3.4	11.3%	32.8	109.4%
LWS1g	Aldwarke Sewage Works	3.0	9.9%	32.4	108.0%
LWS1h	Aldwarke Sewage Works	3.9	12.8%	33.3	110.9%
LWS1i	Aldwarke Sewage Works	4.7	15.6%	34.1	113.7%
LWS1j	Aldwarke Sewage Works	5.8	19.2%	35.2	117.3%
LWS1k	Aldwarke Sewage Works	5.6	18.5%	35.0	116.6%
LWS1l	Aldwarke Sewage Works	4.3	14.4%	33.8	112.5%
LWS1m	Aldwarke Sewage Works	3.1	10.4%	32.5	108.5%
LWS1n	Aldwarke Sewage Works	2.2	7.3%	31.6	105.4%
LWS1o	Aldwarke Sewage Works	1.6	5.3%	31.0	103.4%
LWS1p	Aldwarke Sewage Works	1.2	4.1%	30.7	102.2%
LWS1q	Aldwarke Sewage Works	1.0	3.3%	30.4	101.4%
LWS2a	Thrybergh Tip	0.1	0.2%	20.2	67.4%
LWS2b	Thrybergh Tip	0.1	0.2%	20.2	67.4%
LWS2c	Thrybergh Tip	0.1	0.2%	20.2	67.4%
LWS2d	Thrybergh Tip	0.1	0.2%	20.2	67.4%
LWS2e	Thrybergh Tip	0.1	0.2%	20.2	67.4%
LWS3	Listerdale Wood	0.0	0.1%	22.9	76.3%
LWS4	New Stubbin Colliery & Stubbin Incline	0.1	0.3%	24.2	80.6%

Table D-2 Predicted 24-hour Mean NOx Concentrations

Receptor	Designated Site	24-Hour Mean NOx			
		PC (µg/m^3)	PC as % of C_{Le}	PEC (µg/m^3)	PEC as % of C_{Le}
LWS1a	Aldwarke Sewage Works	29.7	39.6%	88.6	118.1%
LWS1b	Aldwarke Sewage Works	26.2	34.9%	85.1	113.4%
LWS1c	Aldwarke Sewage Works	33.8	45.1%	92.7	123.6%
LWS1d	Aldwarke Sewage Works	28.7	38.2%	87.5	116.7%
LWS1e	Aldwarke Sewage Works	35.9	47.8%	94.7	126.3%
LWS1f	Aldwarke Sewage Works	32.9	43.9%	91.8	122.4%
LWS1g	Aldwarke Sewage Works	26.3	35.1%	85.2	113.6%
LWS1h	Aldwarke Sewage Works	30.3	40.4%	89.2	118.9%
LWS1i	Aldwarke Sewage Works	27.9	37.2%	86.8	115.7%
LWS1j	Aldwarke Sewage Works	39.4	52.6%	98.3	131.1%
LWS1k	Aldwarke Sewage Works	31.1	41.4%	89.9	119.9%
LWS1l	Aldwarke Sewage Works	35.5	47.4%	94.4	125.8%
LWS1m	Aldwarke Sewage Works	24.9	33.3%	83.8	111.7%
LWS1n	Aldwarke Sewage Works	13.7	18.2%	72.5	96.7%
LWS1o	Aldwarke Sewage Works	10.5	14.0%	69.4	92.5%
LWS1p	Aldwarke Sewage Works	10.0	13.3%	68.9	91.8%
LWS1q	Aldwarke Sewage Works	8.5	11.3%	67.4	89.8%
LWS2a	Thrybergh Tip	0.7	0.9%	41.0	54.7%
LWS2b	Thrybergh Tip	0.7	1.0%	41.0	54.7%
LWS2c	Thrybergh Tip	0.8	1.1%	41.1	54.8%
LWS2d	Thrybergh Tip	0.8	1.1%	41.2	54.9%
LWS2e	Thrybergh Tip	0.9	1.2%	41.2	54.9%
LWS3	Listerdale Wood	0.4	0.5%	46.1	61.4%
LWS4	New Stubbin Colliery & Stubbin Incline	1.7	2.3%	49.9	66.5%

Table D-3 Predicted Annual Mean SO_2 Concentrations

Receptor	Designated Site	Annual Mean SO_2			
		PC (µg/m^3)	PC as % of C_{Le}	PEC (µg/m^3)	PEC as % of C_{Le}
LWS1a	Aldwarke Sewage Works	1.02	5.1%	4.0	19.9%
LWS1b	Aldwarke Sewage Works	0.87	4.3%	3.8	19.2%
LWS1c	Aldwarke Sewage Works	1.07	5.4%	4.0	20.2%
LWS1d	Aldwarke Sewage Works	1.18	5.9%	4.2	20.8%
LWS1e	Aldwarke Sewage Works	1.29	6.4%	4.3	21.3%
LWS1f	Aldwarke Sewage Works	1.52	7.6%	4.5	22.4%
LWS1g	Aldwarke Sewage Works	1.37	6.9%	4.3	21.7%
LWS1h	Aldwarke Sewage Works	1.83	9.1%	4.8	24.0%
LWS1i	Aldwarke Sewage Works	2.27	11.3%	5.2	26.2%
LWS1j	Aldwarke Sewage Works	2.78	13.9%	5.7	28.7%
LWS1k	Aldwarke Sewage Works	2.80	14.0%	5.8	28.8%
LWS1l	Aldwarke Sewage Works	2.15	10.7%	5.1	25.6%
LWS1m	Aldwarke Sewage Works	1.53	7.6%	4.5	22.5%
LWS1n	Aldwarke Sewage Works	1.07	5.4%	4.0	20.2%
LWS1o	Aldwarke Sewage Works	0.80	4.0%	3.8	18.9%
LWS1p	Aldwarke Sewage Works	0.62	3.1%	3.6	18.0%
LWS1q	Aldwarke Sewage Works	0.50	2.5%	3.5	17.3%
LWS2a	Thrybergh Tip	0.03	0.2%	2.2	11.0%
LWS2b	Thrybergh Tip	0.03	0.2%	2.2	11.0%
LWS2c	Thrybergh Tip	0.03	0.1%	2.2	11.0%
LWS2d	Thrybergh Tip	0.03	0.1%	2.2	11.0%
LWS2e	Thrybergh Tip	0.03	0.1%	2.2	11.0%
LWS3	Listerdale Wood	0.02	0.1%	2.2	10.9%
LWS4	New Stubbin Colliery & Stubbin Incline	0.05	0.3%	2.1	10.3%

Table D-4 Predicted Annual Nitrogen Deposition Rates

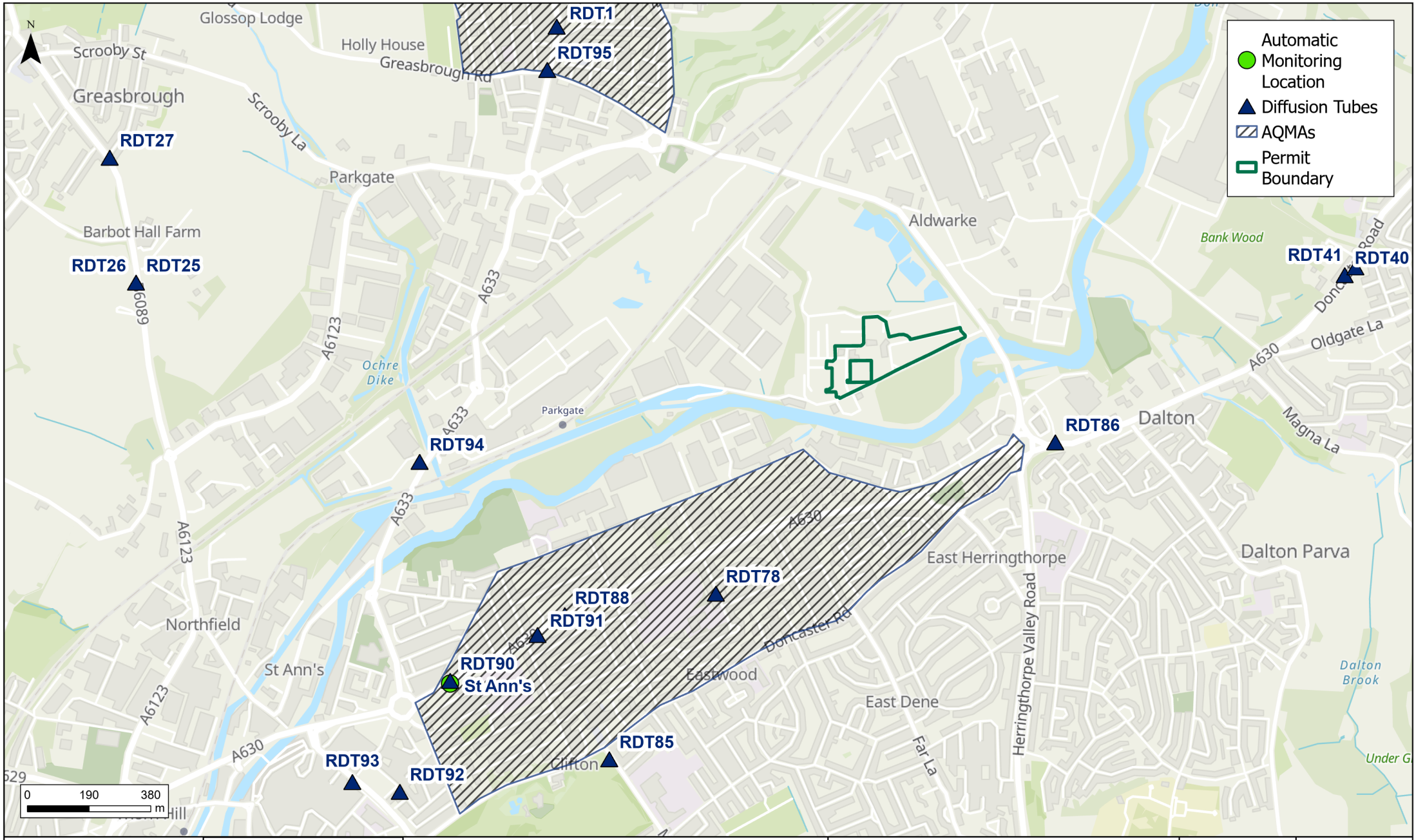
Receptor	Designated Site	Annual Nitrogen Deposition			
		PC (kgN/ha/yr)	PC as % of C_{Lo}	PEC (kgN/ha/yr)	PEC as % of C_{Lo}
LWS1a	Aldwarke Sewage Works	0.23	2.3%	22.9	229.1%
LWS1b	Aldwarke Sewage Works	0.20	2.0%	22.9	228.8%
LWS1c	Aldwarke Sewage Works	0.24	2.4%	22.9	229.2%
LWS1d	Aldwarke Sewage Works	0.28	2.8%	23.0	229.6%
LWS1e	Aldwarke Sewage Works	0.30	3.0%	23.0	229.8%
LWS1f	Aldwarke Sewage Works	0.34	3.4%	23.0	230.2%
LWS1g	Aldwarke Sewage Works	0.30	3.0%	23.0	229.8%
LWS1h	Aldwarke Sewage Works	0.39	3.9%	23.1	230.7%
LWS1i	Aldwarke Sewage Works	0.47	4.7%	23.2	231.5%
LWS1j	Aldwarke Sewage Works	0.58	5.8%	23.3	232.6%
LWS1k	Aldwarke Sewage Works	0.56	5.6%	23.2	232.4%
LWS1l	Aldwarke Sewage Works	0.44	4.4%	23.1	231.2%
LWS1m	Aldwarke Sewage Works	0.31	3.1%	23.0	229.9%
LWS1n	Aldwarke Sewage Works	0.22	2.2%	22.9	229.0%
LWS1o	Aldwarke Sewage Works	0.16	1.6%	22.8	228.4%
LWS1p	Aldwarke Sewage Works	0.12	1.2%	22.8	228.0%
LWS1q	Aldwarke Sewage Works	0.10	1.0%	22.8	227.8%
LWS2a	Thrybergh Tip	0.01	0.1%	19.0	190.5%
LWS2b	Thrybergh Tip	0.01	0.1%	19.0	190.5%
LWS2c	Thrybergh Tip	0.01	0.1%	19.0	190.5%
LWS2d	Thrybergh Tip	0.01	0.1%	19.0	190.5%
LWS2e	Thrybergh Tip	0.01	0.1%	19.0	190.5%
LWS3	Listerdale Wood	0.01	0.1%	22.9	228.6%
LWS4	New Stubbin Colliery & Stubbin Incline	0.02	0.2%	33.6	336.2%

Table D-5 Predicted Annual Acid Deposition Rates

Receptor	Designated Site	Annual Acid Deposition			
		PC (keq/ha/yr)	PC as % of C_{Le}	PEC (keq/ha/yr)	PEC as % of C_{Le}
LWS1a	Aldwarke Sewage Works	0.137	6.4%	2.0	96.2%
LWS1b	Aldwarke Sewage Works	0.117	5.5%	2.0	95.2%
LWS1c	Aldwarke Sewage Works	0.144	6.8%	2.1	96.5%
LWS1d	Aldwarke Sewage Works	0.160	7.5%	2.1	97.3%
LWS1e	Aldwarke Sewage Works	0.174	8.2%	2.1	97.9%
LWS1f	Aldwarke Sewage Works	0.204	9.6%	2.1	99.3%
LWS1g	Aldwarke Sewage Works	0.184	8.6%	2.1	98.4%
LWS1h	Aldwarke Sewage Works	0.244	11.5%	2.2	101.2%
LWS1i	Aldwarke Sewage Works	0.302	14.2%	2.2	104.0%
LWS1j	Aldwarke Sewage Works	0.370	17.4%	2.3	107.2%
LWS1k	Aldwarke Sewage Works	0.371	17.4%	2.3	107.2%
LWS1l	Aldwarke Sewage Works	0.285	13.4%	2.2	103.1%
LWS1m	Aldwarke Sewage Works	0.203	9.6%	2.1	99.3%
LWS1n	Aldwarke Sewage Works	0.143	6.7%	2.1	96.5%
LWS1o	Aldwarke Sewage Works	0.106	5.0%	2.0	94.7%
LWS1p	Aldwarke Sewage Works	0.083	3.9%	2.0	93.6%
LWS1q	Aldwarke Sewage Works	0.066	3.1%	2.0	92.9%
LWS2a	Thrybergh Tip	0.004	0.2%	1.6	77.6%
LWS2b	Thrybergh Tip	0.004	0.2%	1.6	77.6%
LWS2c	Thrybergh Tip	0.004	0.2%	1.6	77.5%
LWS2d	Thrybergh Tip	0.004	0.2%	1.6	77.5%
LWS2e	Thrybergh Tip	0.004	0.2%	1.6	77.6%
LWS3	Listerdale Wood	0.004	0.1%	3.1	97.7%
LWS4	New Stubbin Colliery & Stubbin Incline	0.014	0.5%	2.7	86.2%

Appendix E Figures

Document Path: J:\331001762\YorkshireWaterIED\Aldwarke\Air Quality\Plans and Figures\ArcGIS\Aldwarke\Aldwarke.aprx



Stantec

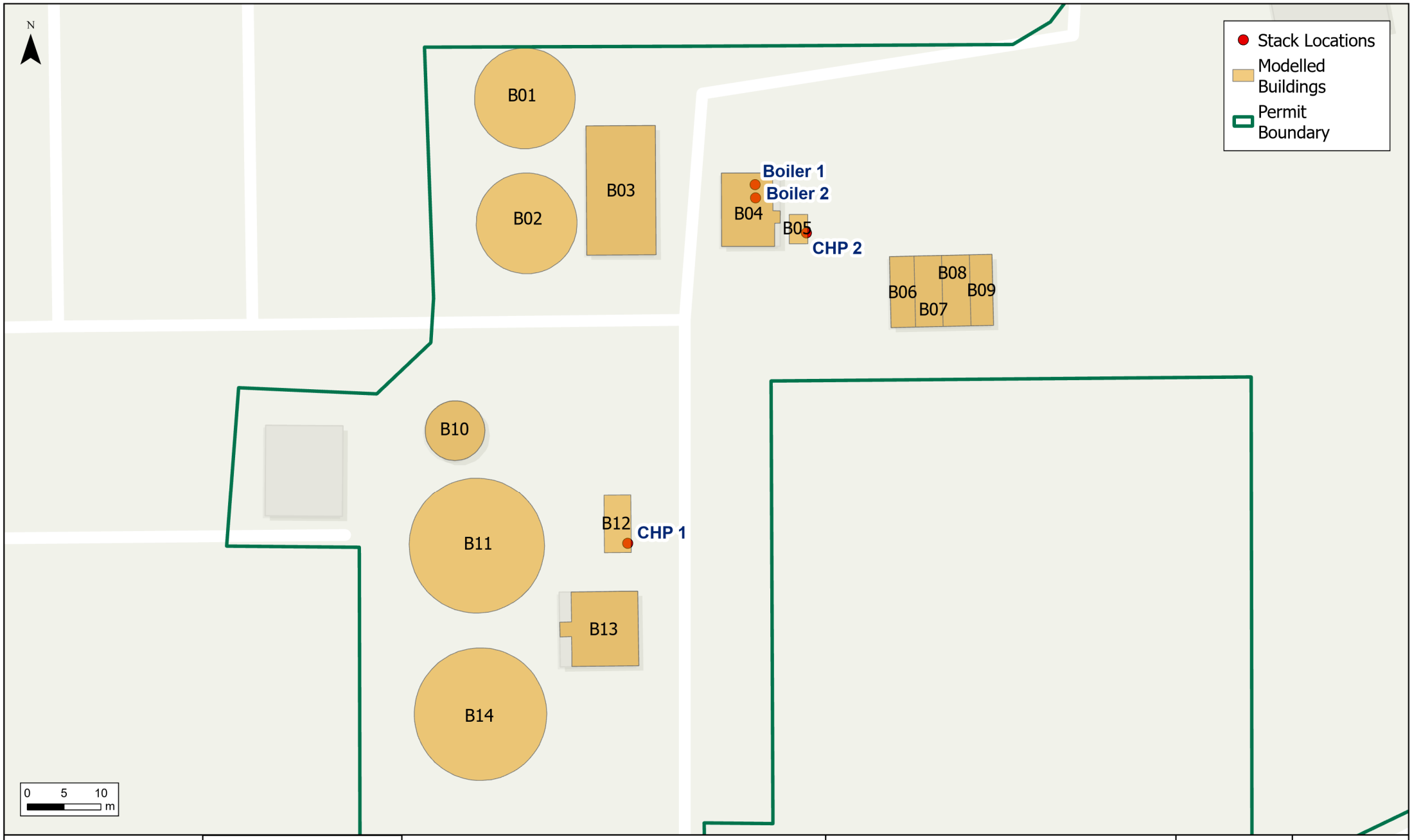
YorkshireWater

Aldwarke Sludge Treatment Facility

Rotherham Borough Council Air Quality Monitoring Locations

1:15,000 @ A4	Date: 20/09/2022
Drawn: LS	Checked: PB
Figure 01	Rev B

Document Path: J:\331001762\YorkshireWaterIED\Aldwarke\Air Quality\Plans and Figures\ArcGIS\Aldwarke\Aldwarke.aprx



Stantec

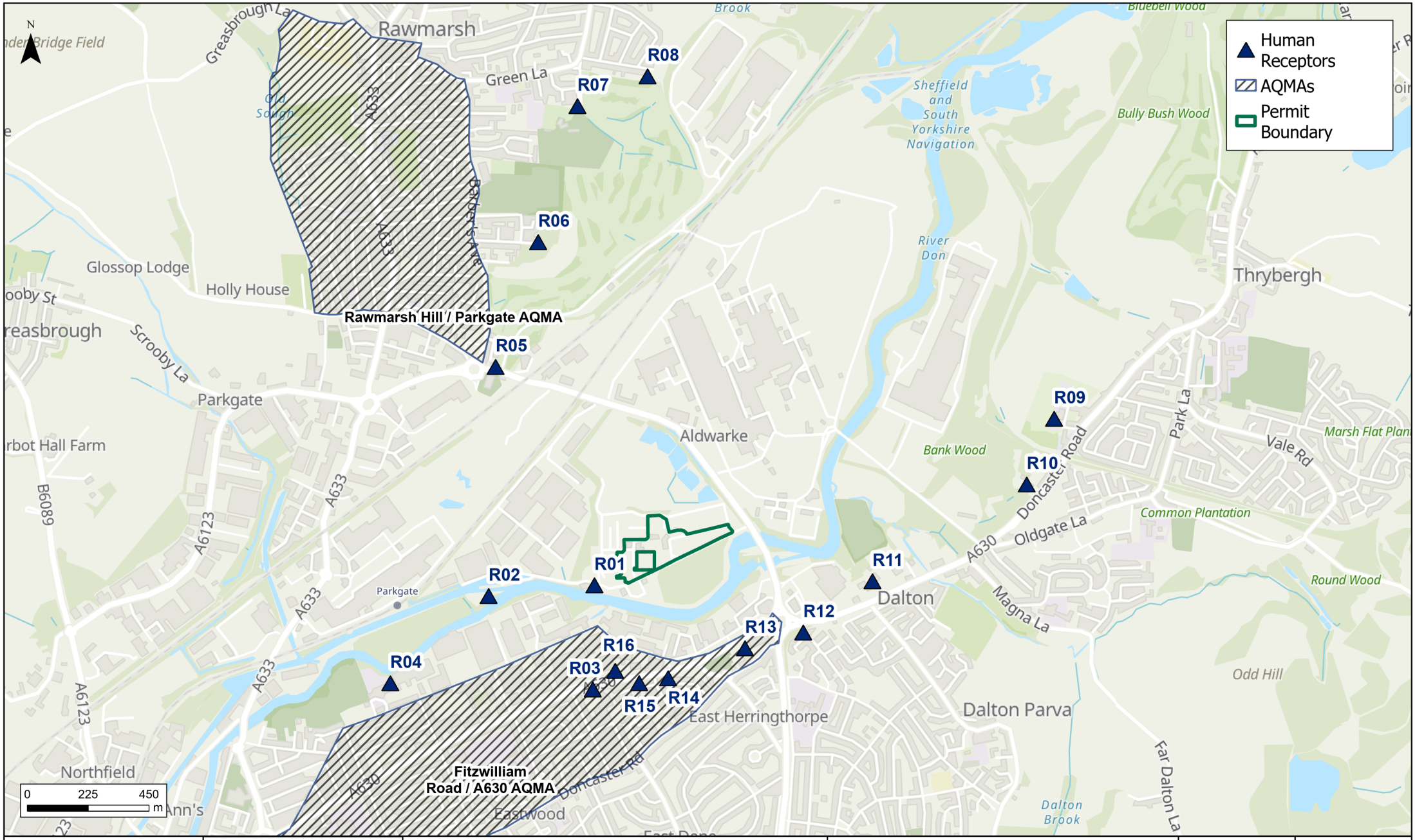
YorkshireWater

Aldwarke Sludge Treatment Facility

Modelled Buildings and Stack Locations

1:660 @ A4	Date: 20/09/2022
Drawn: LS	Checked: PB
Figure 02	Rev B

Document Path: J:\331001762\YorkshireWaterIED\Aldwarke\Air Quality\Plans and Figures\ArcGIS\Aldwarke\Aldwarke.aprx



Stantec

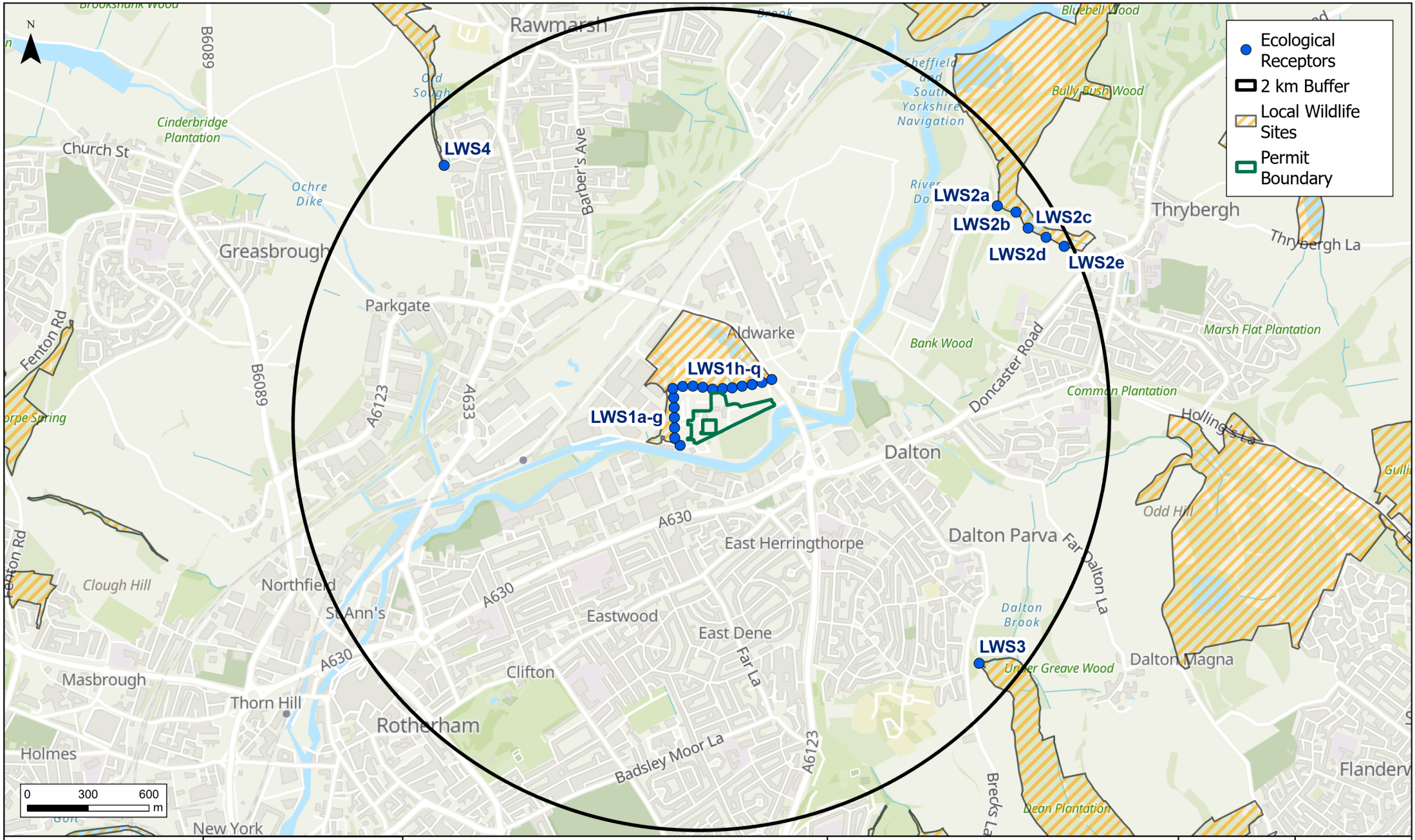
YorkshireWater

Aldwarke Sludge Treatment Facility

Modelled Discrete Human Receptor Locations

1:18,000 @ A4	Date: 20/09/2022
Drawn: LS	Checked: PB
Figure 03	Rev B

Document Path: J:\331001762\YorkshireWaterIED\Aldwarke\Air Quality\Plans and Figures\ArcGIS\Aldwarke\Aldwarke.aprx



Stantec

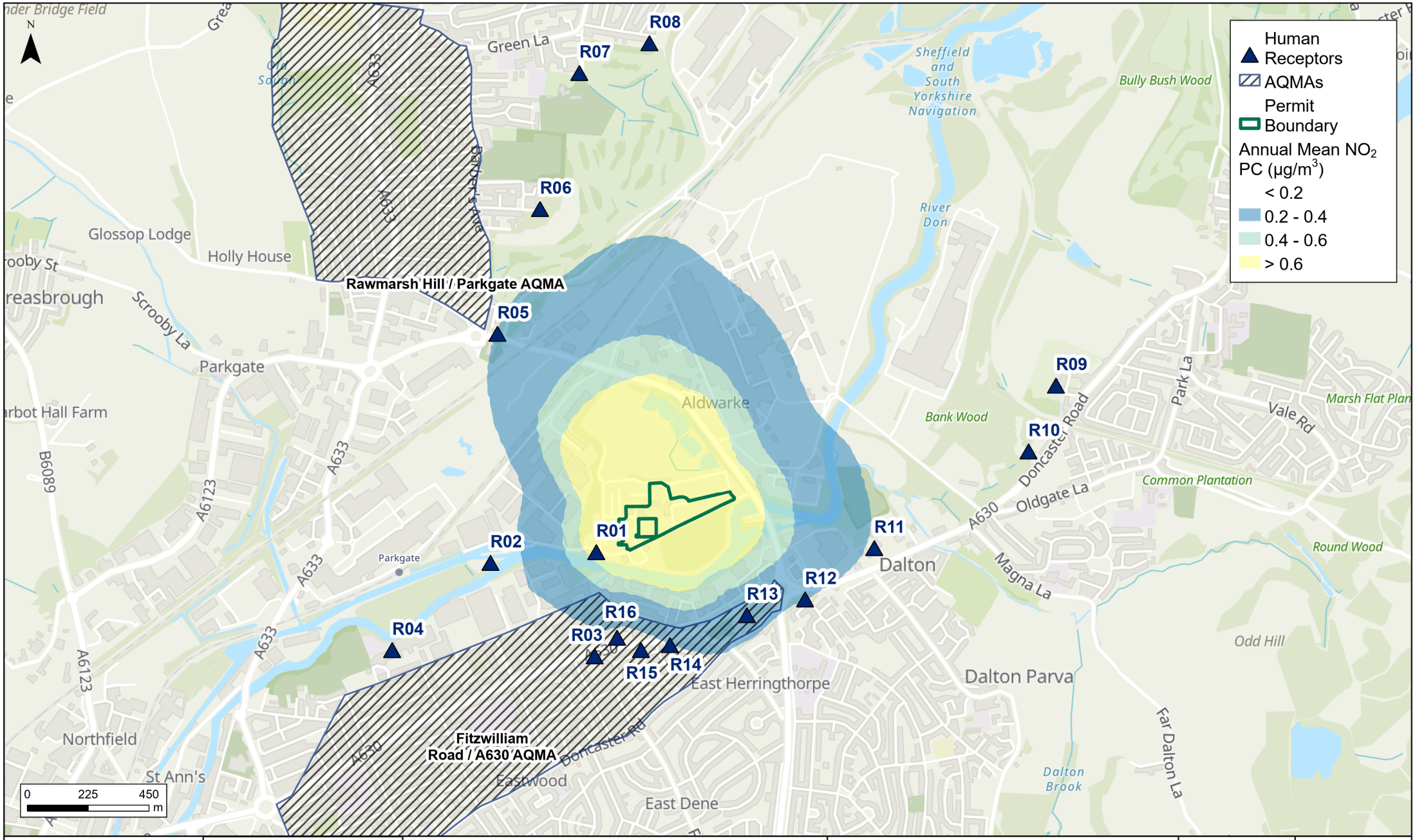
YorkshireWater

Aldwarke Sludge Treatment Facility

Modelled Ecological Receptor Locations

1:24,000 @ A4	Date: 20/09/2022
Drawn: LS	Checked: PB
Figure 04	Rev B

Document Path: J:\331001762\YorkshireWaterIED\Aldwarke\Air Quality\Plans and Figures\ArcGIS\Aldwarke\Aldwarke.aprx



Stantec

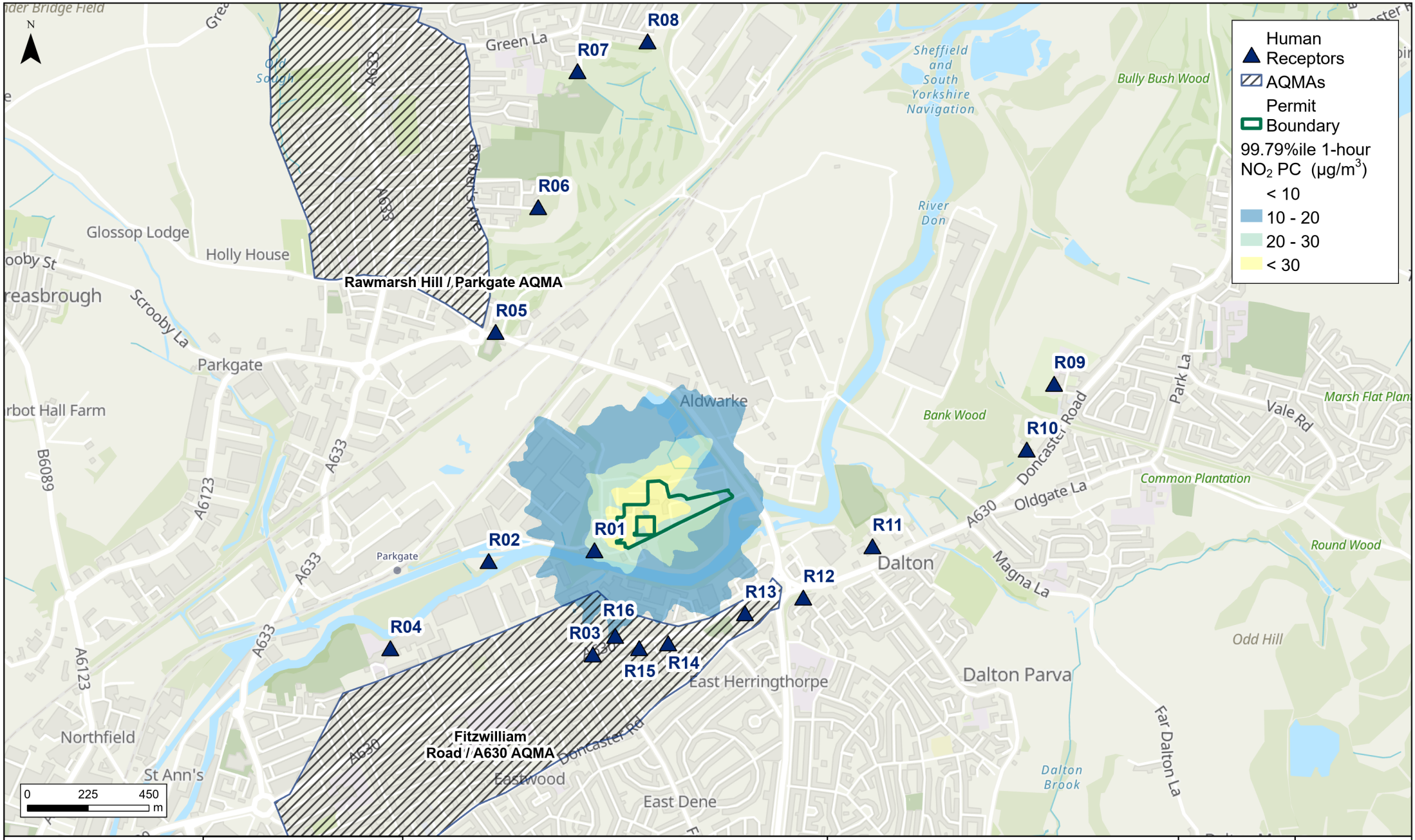
YorkshireWater

Aldwarke Sludge Treatment Facility

2017 Predicted Annual Mean NO_2 Process Contribution (PC) Contours

1:18,000 @ A4	Date: 20/09/2022
Drawn: LS	Checked: PB
Figure 05	Rev B

Document Path: J:\331001762\YorkshireWaterIED\Aldwarke\Air Quality\Plans and Figures\ArcGIS\Aldwarke\Aldwarke.aprx



Stantec

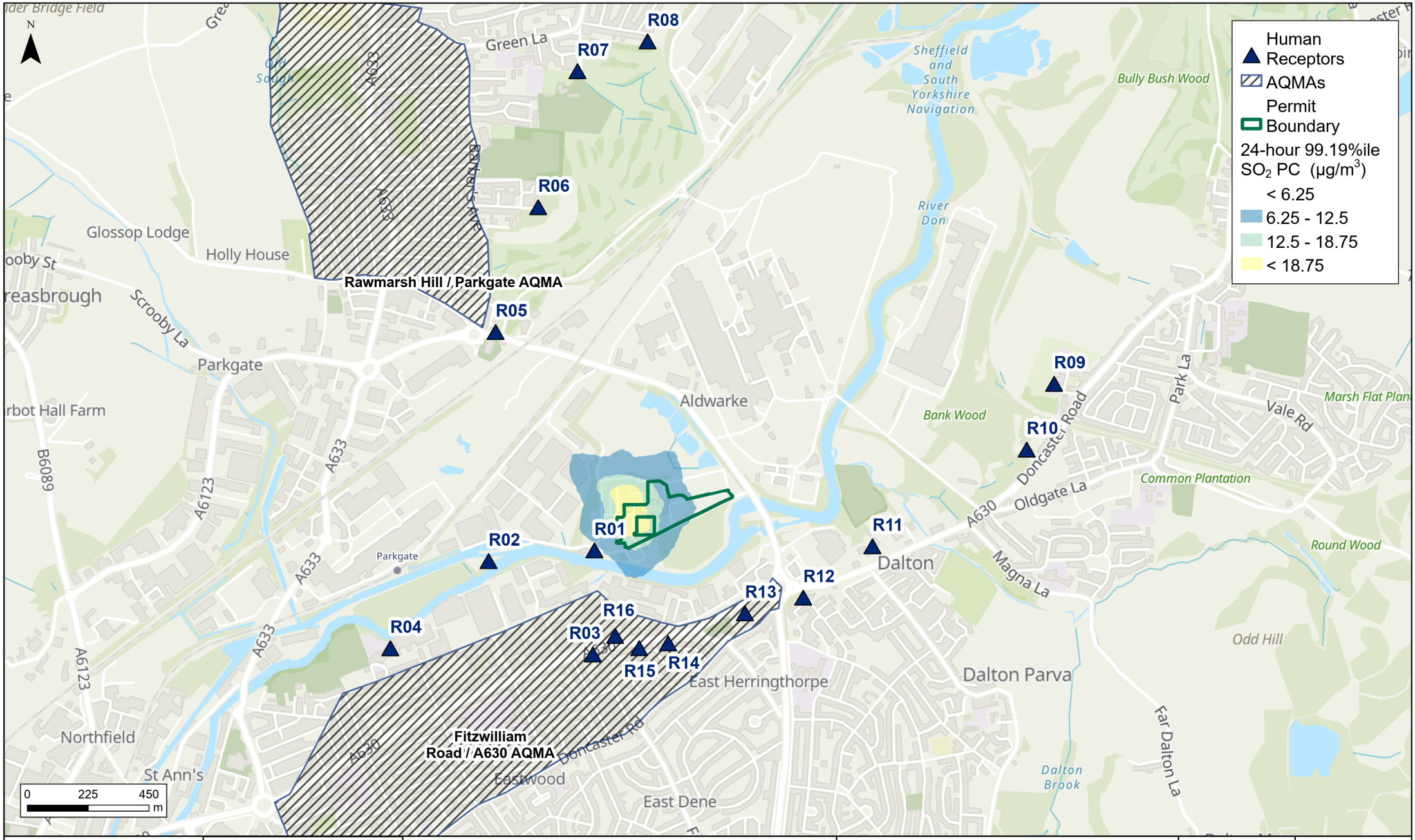
YorkshireWater

Aldwarke Sludge Treatment Facility

2020 Predicted 1-hour Mean NO_2 (99.79%ile) Process Contribution (PC) Contours

1:18,000 @ A4	Date: 20/09/2022
Drawn: LS	Checked: PB
Figure 06	Rev B

Document Path: J:\331001762\YorkshireWaterIED\Aldwarke\Air Quality\Plans and Figures\ArcGIS\Aldwarke\Aldwarke.aprx



Stantec

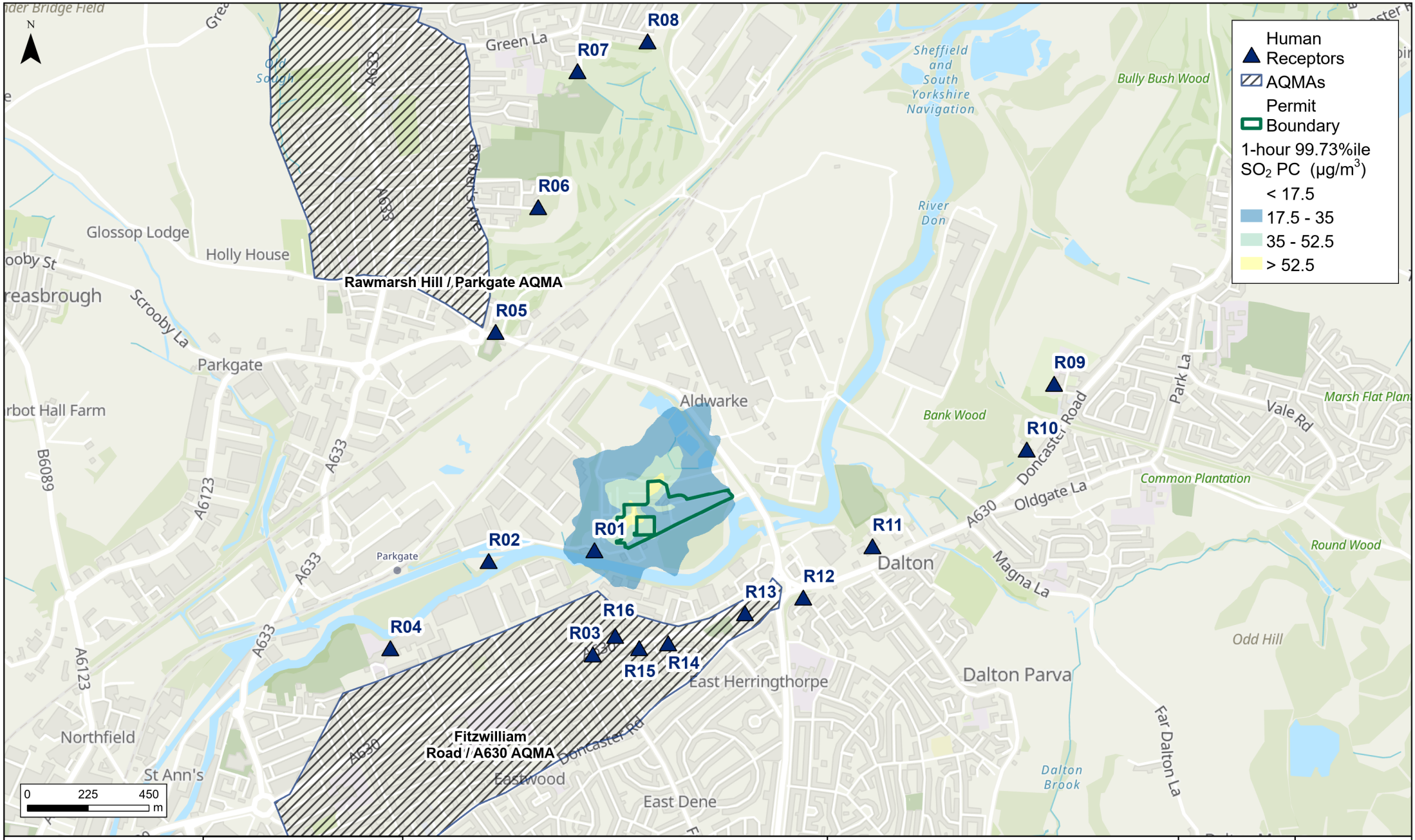
YorkshireWater

Aldwarke Sludge Treatment Facility

2018 Predicted 24-hour Mean SO_2 (99.19%ile) Process Contribution (PC) Contours

1:18,000 @ A4	Date: 20/09/2022
Drawn: LS	Checked: PB
Figure 07	Rev B

Document Path: J:\331001762\YorkshireWaterIED\Aldwarke\Air Quality\Plans and Figures\ArcGIS\Aldwarke\Aldwarke.aprx



Stantec

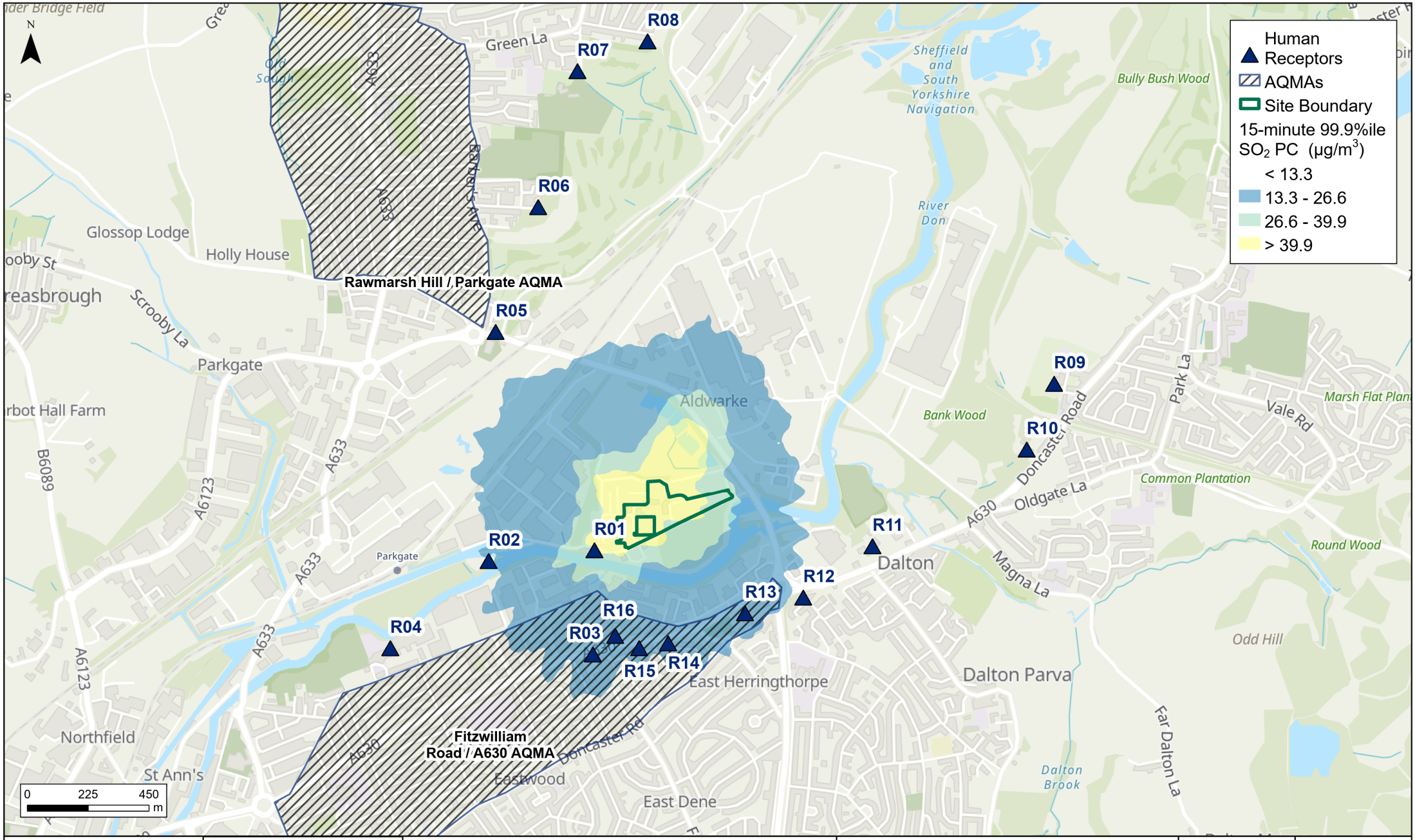
YorkshireWater

Aldwarke Sludge Treatment Facility

2016 Predicted 1-hour Mean SO_2 (99.73%ile) Process Contribution (PC) Contours

1:18,000 @ A4	Date: 20/09/2022
Drawn: LS	Checked: PB
Figure 08	Rev B

Document Path: J:\331001762\YorkshireWaterIED\Aldwarke\Air Quality\Plans and Figures\ArcGIS\Aldwarke\Aldwarke.aprx



Stantec

YorkshireWater

Aldwarke Sludge Treatment Facility

2019 Predicted 15-minute Mean SO_2 (99.9%ile) Process Contribution (PC) Contours

1:18,000 @ A4	Date: 20/09/2022
Drawn: LS	Checked: PB
Figure 09	Rev B