

# Air Quality Impact Assessment for New Energy Provision

Barnsley Metrodome

**Ameresco**

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## 1. Introduction

Ameresco are currently working to upgrade the Energy Centre for the Barnsley Metrodome Leisure Centre, Barnsley, South Yorkshire. The current heating provision for the Barnsley Metrodome is provided by three 1.45MWth coal-fired boilers, which are approaching the end of their life. It is therefore planned that these will be replaced by three new 1.2MWth output gas-fired boilers and a 190kWe gas-fired Combined Heat and Power (CHP) plant.

Planning permission is required to enable the installation of the CHP (due to it being an external container outside the existing building), and also due to the addition of the new stack for the CHP unit.

This report has been prepared to confirm that the proposed release heights will provide suitable dispersion of the boiler and CHP emissions and to summarise the potential air quality impacts in order to assist the planning process.

## 2. Proposed Development

### 2.1 Current Site Heating Arrangements

The current method of providing heating and hot water to the Barnsley Metrodome complex is from three coal-fired boilers, each rated at 1.45MWth output. Coal-fired boilers result in combustion emissions of oxides of nitrogen (NO<sub>x</sub>), carbon monoxide (CO), sulphur dioxide (SO<sub>2</sub>) and particulates, although there is no data available on the current emission concentrations from these units.

The three boilers release emissions via three 30m flues (one per boiler), which are co-located in a stack cluster. The position of the stack cluster is to the south of the Barnsley Metrodome complex.

The boilers are approaching the end of their life and are considered to be slightly over-sized for their duty and are inefficient compared to more modern plant. It is considered that the existing boilers will be approximately 70% efficient compared to the new boilers which shall be approximately 85% efficient.

### 2.2 Proposed New Energy Centre

It is intended that all three of the current boilers will be decommissioned and replaced with three new 1.2MWth output gas-fired boilers within the existing boiler house building. The existing 30m above ground level stack cluster will be replaced with three 15m stacks at the same location.

In addition, a 190kWe CHP plant will be installed within a new dedicated building, to be located adjacent to the existing boiler house. A new dedicated stack for the release of the waste gases from the CHP will be required. The release of the new stack will be 15m above ground level.

As the new boilers and CHP are gas-fired, combustion emissions will comprise of NO<sub>x</sub> and CO only. Emissions of SO<sub>2</sub> and particulates from gas-fired plant are considered to be insignificant due to the inherent nature of natural gas as a fuel compared to coal.

The efficiency of the new boiler plant will be approximately 85%, which is considered to be a significant improvement on the existing coal-fired plant. The CHP plant will provide both hot water and electricity to the Barnsley Metrodome, which will replace some of the site's current grid use (although it should be noted that no export to the grid is planned). The proposed CHP plant will generate electricity from a single spark ignition engine and use the waste heat to generate hot water. Conventional power plants generate electricity from fossil fuel combustion and then dissipate the excess heat, either through cooling towers or via the flue gas. CHP plant however captures the excess heat, for example for use in heating purposes, therefore increasing the thermal efficiency.

## 3. Legislation and Planning Policy

### 3.1 National Planning Policy

The revised National Planning Policy Framework (NPPF)<sup>1</sup> concisely sets out national policies and principles on land use planning. Air quality is considered as an important element of the natural environment. On conserving and enhancing the natural environment, paragraph 170 of the NPPF states that:

*“Planning policies and decisions should contribute to and enhance the natural and local environment by: ...*

*e) preventing new and existing development from contributing to, being put at unacceptable risk from, or being adversely affected by, unacceptable levels of soil, air, water or noise pollution or land instability. Development should, wherever possible, help to improve local environmental conditions such as air and water quality...”*

Air quality in the UK has been managed through the Local Air Quality Management regime using national objectives. The effect of a proposed development on the achievement of such policies and plans are matters that may be a material consideration by planning authorities, when making decisions for individual planning applications. Paragraph 181 of the NPPF states that:

*“Planning policies and decisions should sustain and contribute towards compliance with relevant limit values or national objectives for pollutants, taking into account the presence of Air Quality Management Areas and Clean Air Zones, and the cumulative impacts from individual sites in local areas. Opportunities to improve air quality or mitigate impacts should be identified, such as through traffic and travel management, and green infrastructure provision and enhancement. So far as possible these opportunities should be considered at the plan-making stage, to ensure a strategic approach and limit the need for issues to be reconsidered when determining individual applications. Planning decisions should ensure that any new development in Air Quality Management Areas and Clean Air Zones is consistent with the local air quality action plan”.*

### 3.2 Local Planning Policy

Barnsley Metropolitan Borough Council’s (BMBC) Local Plan was adopted on 3<sup>rd</sup> January 2019<sup>2</sup>. Policy GD1: General Development states:

*“Proposals for developments will be approved if:*

*Any adverse impact on the environment, natural resources, waste and pollution is minimised and mitigated...”*

Policy Poll1: Pollution Control and Protection:

*“Development will be expected to demonstrate that it is not likely to result, directly or indirectly, in an increase in air, surface water and groundwater, noise, smell, dust, vibration, light or other pollution which would unacceptably affect or cause a nuisance to the natural and built environment or to people.”*

Policy AQ1: Development in Air Quality Management Areas:

*“Development which impacts on areas sensitive to air pollution in air quality management areas will be expected to demonstrate that it will not have a harmful effect on health or*

<sup>1</sup> Ministry of Housing, Communities and Local Government. 2019. National Planning Policy Framework.

<sup>2</sup> Available at: <https://www.barnsley.gov.uk/media/9924/local-plan-adopted.pdf> (accessed 12<sup>th</sup> December 2019).

*living conditions of any future users of the development in terms of air quality (including residents, employees, visitors and customers), taking into account any suitable and proportionate mitigation required for the development.”*

The BMBC Air Quality Action Plan was updated in 2019<sup>3</sup> and is primarily concerned with road traffic emissions, and their impact on local air quality. However, it also recognises that the Medium Combustion Plant Directive has been implemented within the UK as a means to ensure that plant, such as that proposed for the Barnsley Metrodome, does not lead to exceedances of the UK air quality objectives/ EU limit values, and that where this is predicted, additional mitigation is required.

### 3.3 Environmental Permitting Regulations

The Environmental Permitting Regulations 2016 (as amended) transposes the Medium Combustion Plant Directive (MCPD) into UK legislation. The legislation requires Medium Combustion Plant (MCP) and specified generators with a capacity more than or equal to 1MWth and less than 50MWth to apply for an Environmental Permit to operate. MCP and specified generator environmental permits protect air only.

The CHP has a thermal input of 608kW and therefore falls outwith the regulations.

The thermal input of each of the boilers is 1.4MWth and therefore they do fall under the regulations. It is considered that the boilers meet the requirements of the Standard Rules Permit SR2018 No 7 (v2.0) – being new, low risk, stationary Medium Combustion Plant between 1 to less than 20MWth (in operation on or after 20/12/2018).

## 4. Air Emissions Impact Assessment

In order to assess the potential impact of the emissions to air from the new boilers and CHP plant, detailed dispersion modelling has been undertaken utilising the new generation model ADMS5.2, which has been developed for regulatory use.

An assessment has been made of the potential impact of emissions on identified residential receptors in the locality, as well as Habitat sites identified within 5km of the Barnsley Metrodome.

### 4.1.1 Assessment Criteria

The assessment parameters chosen for determining the impact of the dispersion model results have been taken from the statutory limit values for NO<sub>2</sub>, NO<sub>x</sub> and CO which are specified in the Air Quality Standards (Amendment) Regulations 2010 (as amended).

In addition, the Environment Agency (EA) have defined an Environmental Assessment Level (EAL) for hourly CO in their Risk Assessment for Specific Activities: Environmental Permits Guidance<sup>4</sup>.

The predicted results from the dispersion model (Process Contributions, or PCs) are compared to the appropriate Air Quality Standards (AQSs) for human health impacts or Critical Levels for the protection of vegetation and ecosystems (CLs) to quantify the potential impact on the surrounding environment. AQSs, EALs and CLs are here-on-in referred to as Air Quality Assessment Levels (AQALs). The AQALs relevant to the assessment are presented in Table 4.1.

<sup>3</sup> Barnsley MBC. (2017, updated 2019). Air Quality Action Plan.

<sup>4</sup> Available at: <https://www.gov.uk/government/collections/risk-assessments-for-specific-activities-environmental-permits>

**Table 4.1: Air Quality Assessment Levels (AQALs)**

Pollutant	AQALs			To be Met By
	Objective ( $\mu\text{g}/\text{m}^3$ )	Averaging Period	Percentile	
Nitrogen Dioxide (NO <sub>2</sub> )	200	1-Hour Mean	99.79 <sup>th</sup> (or not to be exceeded more than 18 times/year)	31 Dec 2005
	40	Annual Mean	-	31 Dec 2005
Oxides of Nitrogen (NO <sub>x</sub> )	75	24-Hour Mean	100 <sup>th</sup> Percentile	NA
	30	Annual Mean	-	31 Dec 2005
Carbon Monoxide (CO)	30,000	1-Hour Mean	100 <sup>th</sup> Percentile	NA
	10,000	8-Hour Rolling Mean	100 <sup>th</sup> Percentile	31 Dec 2003

Since the emissions from the boilers and CHP will be mixed into the ambient air, an assessment must also include the contribution to pollutant levels derived from the ambient background levels. The Process Contribution (PC) must therefore be added to an appropriate Background Concentration (BC) to give the total Predicted Environmental Concentration (PEC). The PEC can then be compared with the appropriate AQAL to ensure that air quality is not being significantly affected.

## 4.1.2 Planning Significance Criteria

### Human Health Impacts

For a change of a given magnitude, the Institute of Air Quality Management (IAQM) has published recommendations<sup>5</sup> for describing the magnitude of impacts at individual receptors and describing the significance of such impacts. Table 4.2 summarises the descriptors used in the assessment for long term impacts.

**Table 4.2: Effects Descriptors at Individual Receptors – Annual Mean Impacts**

Long Term Average Concentration at Receptor	Percentage Change in Annual Mean Concentration				
	Up to 0.5% Imperceptible	0.5-1% Very low	2-5% Low	6-10% Medium	>10% High
75% or less of AQAL	Negligible	Negligible	Negligible	Slight	Moderate
76-94% of AQAL	Negligible	Negligible	Slight	Moderate	Moderate
95-102% of AQAL	Negligible	Slight	Moderate	Moderate	Substantial
103-109% of AQAL	Negligible	Moderate	Moderate	Substantial	Major
110% or more of AQAL	Negligible	Moderate	Substantial	Major	Major

AQAL = Air Quality Assessment Level (AQS, EAL or CL)

In addition to the criteria set out in the IAQM guidance, as shown in Table 4.2, the EA outline the criteria in their Environmental Permitting Regulations (EPR) Risk Assessment Guidance<sup>6</sup>. The EA's EPR Risk Assessment screening criteria for comparison of process contributions with AQAL state that an emission may be considered 'imperceptible' (or negligible) where:

- Short-term PC  $\leq$  10% of the AQAL; and
- Long-term PC  $\leq$  1% of the AQAL.

<sup>5</sup> <http://www.iaqm.co.uk/text/guidance/air-quality-planning-guidance.pdf>: accessed 13<sup>th</sup> December 2019

<sup>6</sup> <https://www.gov.uk/guidance/air-emissions-risk-assessment-for-your-environmental-permit>: accessed 13<sup>th</sup> December 2019

Where the PEC is not predicted to exceed the AQAL the emissions are generally considered acceptable by the EA.

The IAQM guidance indicates that the EA's threshold criterion of 10% of the short term AQAL is sufficiently small in magnitude to be regarded as having an 'insignificant' effect. The IAQM guidance differs from the EA guidance with respect to the background contribution; the IAQM guidance indicates that magnitude of peak short-term concentrations can be described without the need to reference background concentrations as the process contribution (PC) is used to measure impact, not the overall concentration at a receptor. The peak short term PC from an elevated source is described in Table 4.3.

**Table 4.3: Effects Descriptors at Individual Receptors – Short-term Impacts**

Criteria	Predicted Peak Hourly Mean NO <sub>2</sub> Process Contribution (µg/m <sup>3</sup> )	Effect Descriptor
<10% of AQAL	< 20	Negligible
10 – 20% of AQAL	20 – 40	Slight
20 – 50% of AQAL	40 – 100	Medium
>50% of AQAL	> 100	Substantial

AQAL = Air Quality Assessment Level (AQS, EAL or CL)

The IAQM guidance is explicit that the judgement of significance only applies to an overall effect and not to an effect at an individual receptor; consequently, a 'moderate' adverse effect at one receptor may not mean that the overall effect is significant; other factors need to be considered. However, it indicates further that 'negligible' impacts are likely to lead to effects that are 'not significant' and 'major' impacts describe the potential for 'significant' effects.

Impacts of the boilers and CHP plant have been assessed relative to both the adapted IAQM criteria and the EA's screening criteria.

### Ecological Impacts

The impact of point source emissions on ecological receptors with statutory designation e.g. SACs, SPAs, RAMSAR and Sites of Special Scientific Interest (SSSI) has been evaluated using the EA's criteria for short-term and long-term objectives for ecological receptors; for short-term impacts, where the PC >100% of the objective the Environment Agency guidance indicates such an impact would not be acceptable without additional mitigation.

**Table 4.4: Effects Descriptors at SPA/ SAC/ Ramsar/ SSSI**

Averaging Period	Percentage Change	Effect Descriptor
Annual mean PC/AQAL	<1%	Imperceptible
Annual mean PEC/AQAL	<70%	Negligible
Short term PC/AQAL	<10%	Negligible
Short term PC/AQAL	10-100%	Minor
Short term PC/AQAL	>100%	Moderate

AQAL = Air Quality Assessment Level or CL

For all other nature conservation sites, i.e. Local Wildlife Sites (LWS), the assessment needs to determine whether the installation will result in "significant pollution" i.e. where Critical Levels are exceeded. Therefore, if the long and short term PC is less than 100% of the relevant standard, the impact is considered to be not significant.

**Table 4.5: Effects Descriptors at LWS**

Averaging Period	Percentage Change	Effect Descriptor
Annual mean PC/AQAL	<100%	Negligible
Short term PC/AQAL	<100%	Negligible

### 4.1.3 Background Concentrations

BMBC have currently declared six Air Quality Management Areas (AQMAs) within their borough for annual mean nitrogen dioxide due to traffic emissions. The closest AQMA to the Barnsley Metrodome (AQMA 4) is located along the uphill carriageway of the A61 Harborough Hill Road approximately 200m to the west of the Barnsley Metrodome. It should be noted that the measured concentrations within AQMA 4 currently include a process contribution from the existing energy plant.

The ambient concentrations of NO<sub>2</sub>, NO<sub>x</sub> and CO are available from the Defra background pollutant database (<http://uk-air.defra.gov.uk/>), and are averaged over 1km<sup>2</sup> grids across the UK. Ambient concentrations in the vicinity of the Barnsley Metrodome for 2019 (based on the 2017 baseline maps) are shown in Table 4.6.

CO background maps have not been updated since 2001, and therefore this data is provided in Table 4.6 (CO has appropriate year adjustment factors applied<sup>7</sup>).

In addition, NO<sub>x</sub> concentrations have been determined from the Defra background maps at the habitat sites likely to experience the worst case impacts from emissions from the site. These are the Dearne Valley Park Local Nature Reserve (LNR) and Stairfoot Brickworks Site of Special Scientific Interest (SSSI), further details of which are provided in Section 4.3.3.

**Table 4.6: Annual Average Background Concentrations**

Location	Annual Average Term Background Concentration (µg/m <sup>3</sup> )		
	Oxides of Nitrogen (NO <sub>x</sub> )	Nitrogen Dioxide (NO <sub>2</sub> )	Carbon Monoxide (CO)
Site and Closest Human Health Receptors (NGR 1km <sup>2</sup> 435500, 406500)	18.21	13.14	179
Dearne Valley Park LNR (NGR 1km <sup>2</sup> 435500, 406500)	18.21	-	-
Stairfoot Brickworks SSSI (NGR 1km <sup>2</sup> 438500, 404500)	14.65	-	-

In addition, baseline conditions in the vicinity of the Barnsley Metrodome site have been determined through a review of local air quality management reports and available information from Barnsley Metropolitan Borough Council (BMBC)<sup>8</sup>. Figure 5.1 illustrates the location of measurement locations of relevance to this assessment.

BMBC has a three automatic monitors within the borough, two of which measure NO<sub>2</sub> and NO<sub>x</sub> concentrations (the other monitors particulates only). Information on the two sites is provided in Table 4.7.

<sup>7</sup> Available at: <https://uk-air.defra.gov.uk/data/laqm-background-home> accessed 13<sup>th</sup> December 2019

<sup>8</sup> Available at: <https://www.barnsley.gov.uk/media/11986/asrtemplateengland2019vonebarnsleymbc.pdf> accessed 12<sup>th</sup> December 2019

**Table 4.7: BMBC Automatic Monitoring Stations 2018 Data**

Location	Type of Site	Distance from Metrodome	Annual Concentration ( $\mu\text{g}/\text{m}^3$ )	
			Oxides of Nitrogen ( $\text{NO}_x$ )	Nitrogen Dioxide ( $\text{NO}_2$ )
Barnsley A628 Pogmoor Road	Roadside	2.5km Northwest	75	32
Barnsley Gawber (AURN)	Urban background	2.5km West	22	16

There is also a network of 55  $\text{NO}_2$  diffusion tube sites mainly located at road and kerbside locations. There are three diffusion tubes (DT10, DT29 and DT45) that are located at urban background locations, but these are all greater than 5km from the Barnsley Metrodome.

Diffusion tubes DT41, DT43 and DT44 are all located on the A61 Harborough Hill Road in the AQMA and in 2018 reported annual average  $\text{NO}_2$  concentrations between  $37.2\mu\text{g}/\text{m}^3$  and  $59.7\mu\text{g}/\text{m}^3$ . Tube DT41 is the closest to the Barnsley Metrodome, 280m to the northwest of the boiler flues and measured a concentration of  $59.3\mu\text{g}/\text{m}^3$  in 2018.

DT42 is also at a roadside location, but not within the AQMA. It is located 475m northwest of the boiler flues and in 2018 measured  $\text{NO}_2$  concentrations of  $31.4\mu\text{g}/\text{m}^3$ .

It is therefore considered that for the majority of human health receptors, the most appropriate baseline data for the background concentrations of  $\text{NO}_2$  is from the DT42 diffusion tube ( $31.4\mu\text{g}/\text{m}^3$ ), due to its proximity to the Barnsley Metrodome, and the fact that it is higher than the Defra mapping data and therefore will ensure that a conservative assessment is carried out.

## 5. Dispersion Modelling

Dispersion modelling has been used to assess the impact of emissions on the environment by calculating the predicted ground level concentrations arising from the emissions to atmosphere, based on Gaussian approximation techniques. The worst-case concentration has been compared with appropriate air quality standards to determine whether releases from the new boilers and CHP plant stack is likely to cause a significant impact on the receiving environment.

The degree of turbulence in the atmosphere affects the rate at which pollutants from point sources are dispersed in the environment. The more unstable the atmosphere – for example due to high solar insolation – the greater the degree of mixing. While this is in principle the desired effect for the release of pollutants through stacks at elevated heights, this can also lead to localised peak concentrations if the plume is rapidly brought to ground level.

Various parameters can affect the degree of dispersion from a source, and these are accounted for in the modelling scenario where appropriate. The presence of elevated or complex terrain in the vicinity of the source can affect the flow pattern of the wind field, which can in turn bring a plume to ground more rapidly. Buildings of sufficient height located close to the emissions sources can affect dispersion – inducing downwash in the emitted plume and entraining pollutants towards ground level.

ADMS5.2 utilises site-specific hourly sequential meteorological data to enable a realistic assessment of dispersion from point sources to be conducted for weather conditions that are directly applicable to the site.

### 5.1.1 Emissions Inventory

Emissions from the boilers and CHP have been determined from datasheets provided by the manufacturers.

It is envisaged that the CHP will be operational for up to 91% of the time and the boilers that the normal heating and hot water provision will be met by the CHP and 1 boiler, however at peak times it may be necessary for all 3 boilers to operate together. Therefore, the operation of the CHP and 1 boiler has been used to determine the annual average impacts associated with the site's operations, and the operation of the CHP and 3 boilers has been used to represent short-term (hourly average) impacts. This is considered to be very conservative.

Table 5.1 shows the design data for emissions from the proposed boilers and CHP plant. The emission concentrations stated are maximum values, and it is anticipated that average emissions will be less than those provided. Therefore it is considered that the use of these emission values for the assessment of long term impacts in particular, is very conservative.

**Table 5.1: Future Scenario Modelled Emissions**

Source	Stack Height (m)	Stack Diameter (m)	Temp (°C)	Flow Rate (Nm <sup>3</sup> /s)	Exit Velocity (m/s)	Pollutant	Emission Conc <sup>a</sup> (mg/m <sup>3</sup> )	Release Rate (g/s)
Boiler 1	15	0.4	179	0.25	4.3	NO <sub>x</sub> (as NO <sub>2</sub> )	65	0.020
Boiler 2	15	0.4	179	0.25	4.3	NO <sub>x</sub> (as NO <sub>2</sub> )	65	0.020
Boiler 3	15	0.4	179	0.25	4.3	NO <sub>x</sub> (as NO <sub>2</sub> )	65	0.020
New CHP	15	0.15	120	0.47	14.3	NO <sub>x</sub> (as NO <sub>2</sub> )	190	0.088
						CO	110	0.053

Boiler emissions provided at 3% O<sub>2</sub>, dry and corrected for temperature and pressure. CHP emissions provided at 15% O<sub>2</sub>, dry and corrected for temperature and pressure.

### 5.1.2 NO<sub>x</sub> to NO<sub>2</sub> Conversion

Emissions of NO<sub>x</sub> from all emission stacks will consist mainly of nitric oxide (NO) at the point of release, oxidising within the atmosphere to form NO<sub>2</sub> as it disperses. At the point of release, approximately 90% of the NO<sub>x</sub> emission will be in the form of NO, with the other 10% consisting of NO<sub>2</sub>. The oxidation of NO to NO<sub>2</sub> is a relatively slow process and it is considered that the screening assumption of 70% conversion within the modelled domain over annual time scales and 35% over hourly time scales is conservative, in line with EA guidance.

### 5.1.3 Modelled Domain and Sensitive Receptors

The dispersion modelling has been carried out using a grid extending 500m from the site, in order to obtain maximum concentrations at the closest receptor locations. Impacts have also been predicted at a number of selected discrete receptors, including local residences in the vicinity of the Barnsley Metrodome and Habitat sites up to 5km from the site. The discrete receptors considered in the assessment are presented in Table 5.2.

**Table 5.2: Location of Sensitive Receptors**

Receptor I.D.	Receptor Name	Receptor Type	Grid Reference (approx.) x, y	Distance from stacks (m)
R1	Allotments 1	Transient Receptor	435045, 406685	190m Northwest
R2	Allotments 2	Transient Receptor	435020, 406600	145m Northwest
R3	Queens Road Academy	School	434985, 406555	150m West
R4	56 Queens Road	Residential	435035, 406470	120m Southwest
R5	5 Belgrave Road	Residential	435080, 406400	150 South
R6	Rockingham Court	Residential	435145, 406400	150 South

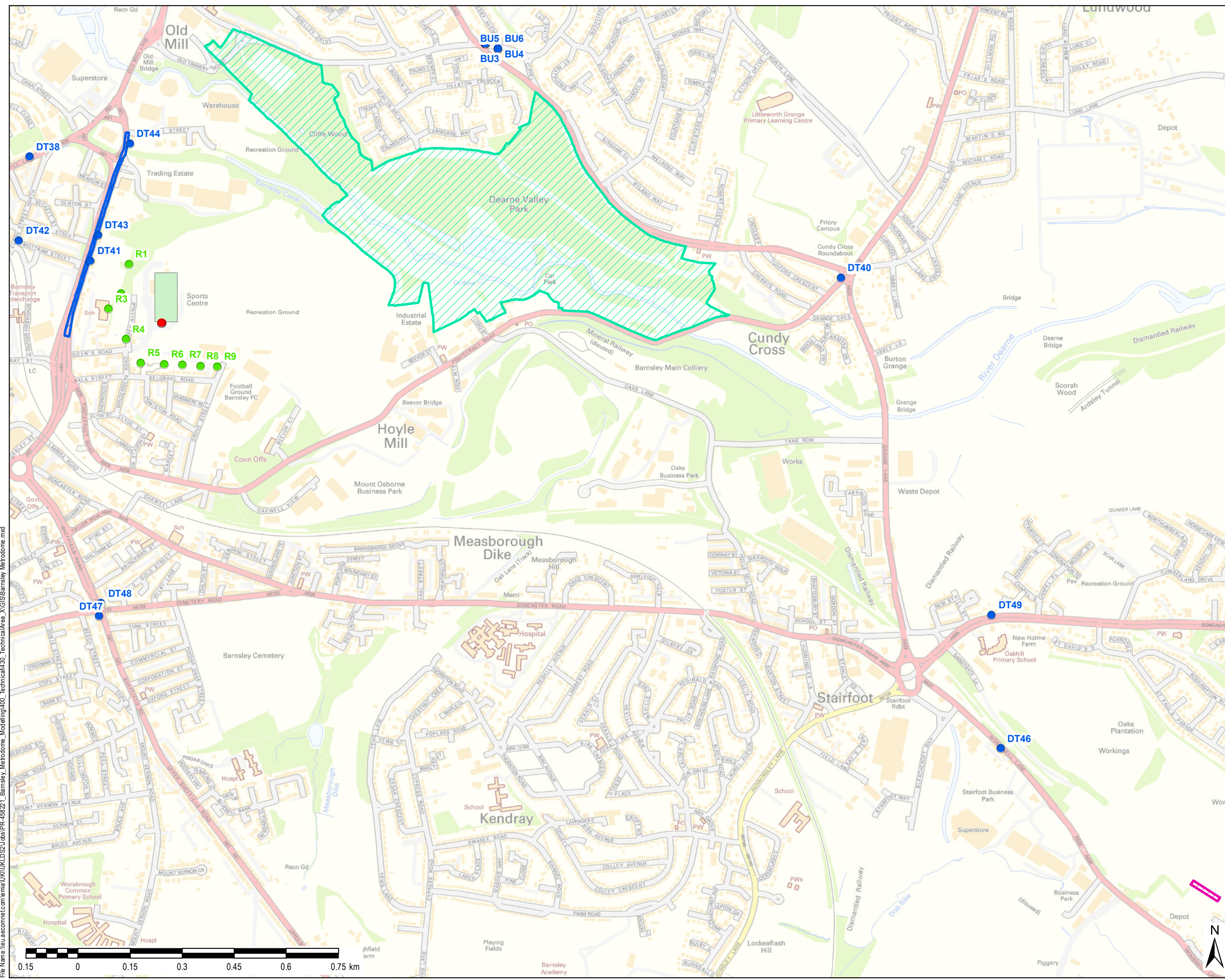
Receptor I.D.	Receptor Name	Receptor Type	Grid Reference (approx.) x, y	Distance from stacks (m)
R7	16 Belgrave Road	Residential	435200, 406395	150 South
R8	30 Belgrave Road	Residential	435250, 406390	150m Southeast
R9	78 Grove Street Road	Residential	435300, 406390	200m Southeast
AQMA 4	AQMA 4	AQMA	434933, 406733 <sup>9</sup>	200m West
E1	Dearne Valley Park	LNR	435600, 406820	460m Northeast
E2	Stairfoot Brickworks	SSSI	438100, 404900	3.4km Southeast

Figure 5.1 shows the locations of the receptors included in the model.

<sup>9</sup> Point of maximum impact within the AQMA.

THIS DRAWING IS TO BE USED ONLY FOR THE PURPOSE OF ISSUE THAT IT WAS ISSUED FOR AND IS SUBJECT TO AMENDMENT

- BMBC Monitoring
- Receptors
- Emission Sources
- Stairfoot Brickworks SSSI
- BMBC AQMA No.
- Dearne Valley Park LNR
- Modelled Building



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Purpose of Issue  
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**BARNSELY METRODOME**

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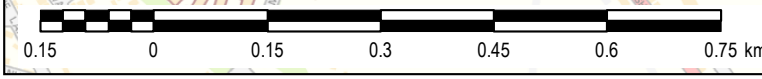
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**FIGURE 5.1**

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**01**

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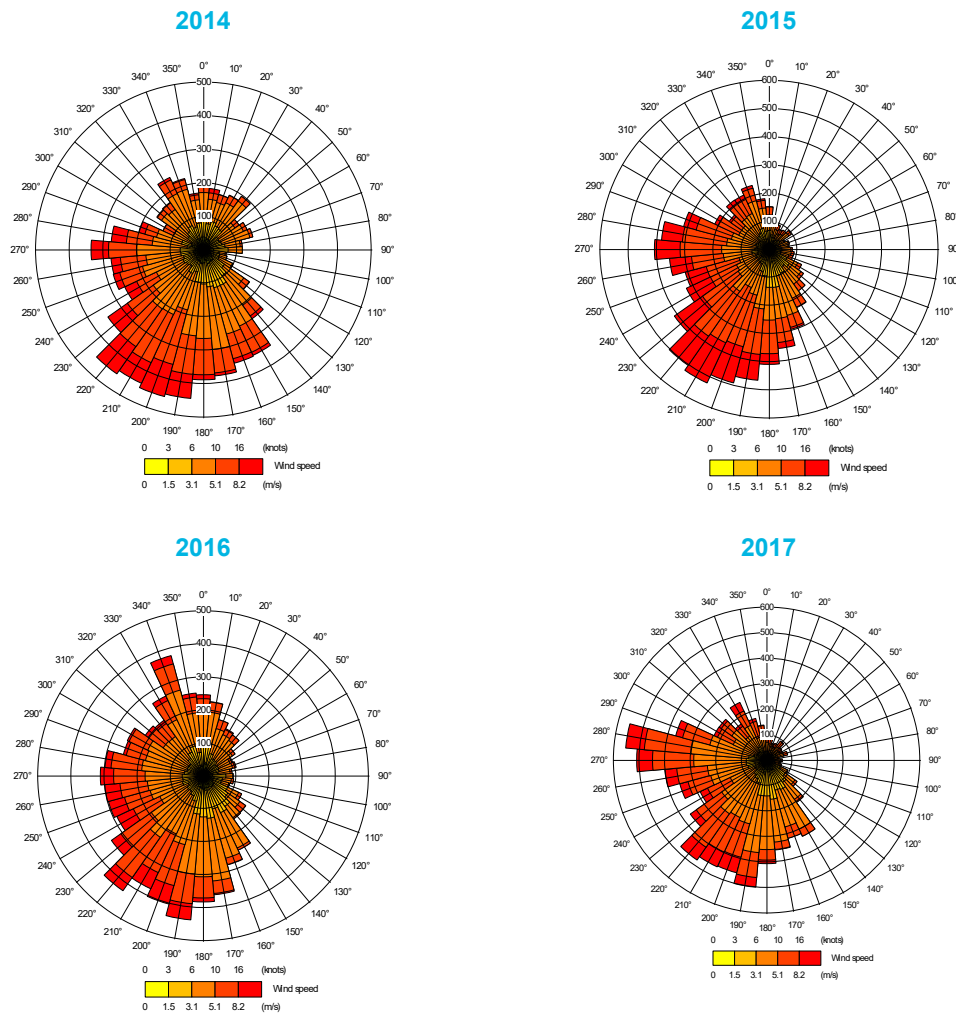
### 5.1.4 Meteorology

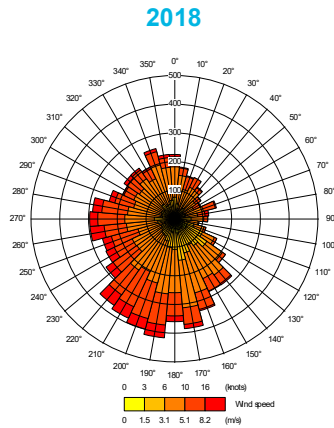
The dispersion of emissions from a point source is largely dependent on atmospheric stability and turbulent mixing in the atmosphere, which in turn are dependent on wind speed and direction, ambient temperature, cloud cover and the friction created by buildings and local terrain.

Actual measured hourly-sequential meteorological data is available for input into dispersion models, and it is important to select data as representative as possible for the site that is modelled. This is usually achieved by selecting a meteorological station as close to the site as possible, although other stations may be used if the local terrain and conditions vary considerably or if the station does not provide sufficient data. This assessment has used meteorological data from Doncaster Robin Hood airport, which is located 32km to the east of the Barnsley Metrodome, and is considered to be representative of meteorological conditions at the Metrodrome site.

Guidance on hourly modelling recommends using at least five years of recent meteorological data, in order to account for yearly variations in weather patterns. AECOM has data available for the Doncaster Robin Hood airport meteorological station for the years 2014 – 2018 and these have been used in the modelling, with the worst case result for all meteorological years being presented in the assessment. The wind-roses for the Doncaster Robin Hood airport meteorological station are shown in Figure 5.2.

Figure 5.2: Meteorological Data for Gravesend





### 5.1.5 Building and Terrain Effects

The presence of buildings or structures near to the emissions points can have a significant effect on the dispersion of emissions. The main effect, which buildings can have on pollutant dispersion, is to entrain released pollutants into the cavity (the region in the immediate leeward side) of the building, which is isolated from the flow and in which a reversal of flow can actually occur. This can result in the grounding of poorly dispersed plumes.

In accordance with the modelling criteria for ADMS5.2, building effects are typically considered where a structure of height greater than 40% of the stack height is situated within 8-10 stack heights of the emissions source.

Site plans were reviewed and it is considered that the main Metrodome building meets the criteria outlined above for affecting the dispersion of the boiler and CHP emissions, and therefore it has been included in the model simulation. All the building parameters used in the modelling are shown in Table 5.3, and a visualisation of the building is shown in Figure 5.1.

**Table 5.3: Modelled Building Parameters**

Building	Grid Reference x, y	Height (m)	Length (m)	Width (m)	Angle (°)
Barnsley Metrodome	435151, 406590	10	64	140	270

The ADMS model is capable of including topographical data, if required. There are two parameters (surface roughness and terrain) which can be employed in the model to describe local topography.

Surface roughness describes the degree of ground turbulence caused by the passage of winds across surface structures. Ground turbulence is greater in urban areas than in rural areas, for example, due to the presence of tall buildings.

The site is situated to the east of Barnsley town centre. A surface roughness of 0.5m, which is representative of parkland and open suburbia, has been selected to represent the local area.

The presence of elevated or complex terrain in the vicinity of the source can also affect the flow pattern of the wind field and therefore the dispersion of emissions. A gradient of 1:10 or greater is normally taken as the criteria for inclusion of terrain in a modelling assessment. The terrain in the vicinity of the installation can be considered to be relatively flat, with no steep gradients or pronounced changes in height and therefore no terrain data has been included within the model.

## 6. Predicted Results

The results of the dispersion modelling of emissions from the site are shown in Table 6.1. The predicted concentrations (Process Contributions or PC) of pollutants have been taken directly from the model output, and have been determined for the worst case (maximum) location, and at specific identified off-site receptors, where appropriate.

The relevant PC has been added to the background concentrations discussed in Section 4.1.3, to determine the likely Predicted Environmental Concentration (PEC).

The predicted concentrations have been compared with AQAL (Air Quality Standards or objectives, Environmental Assessment Levels and the Critical Levels for vegetation and ecosystems).

The impacts for the operation of the boilers and the CHP are shown in Table 6.1, and isopleths of the dispersed emissions of NO<sub>2</sub> and NO<sub>x</sub> are shown in Figures A1 – A4 in Appendix A.

**Table 6.1: Predicted Modelled Concentrations**

Pollutant	Measured as	AQAL µg/m <sup>3</sup>	PC µg/m <sup>3</sup>	PC/ AQAL	BC µg/m <sup>3</sup>	PEC µg/m <sup>3</sup>	PEC/ AQAL
NO <sub>2</sub>	Max Annual mean (anywhere)	40	1.9	4.6%	31.4	35.3%	88%
	Annual Mean Worst-case Residential Receptor	40	0.6	1.6%	31.4	32.0	80%
	Annual Mean at AQMA	40	0.2	0.5%	31.4	31.6	79%
	Max 1-hour mean (99.8 <sup>th</sup> %ile)	200	11.4	5.7%	62.8	78.2	39%
	1-hour mean (99.8 <sup>th</sup> %ile) Worst-case Receptor	200	6.2	3.1%	62.8	69.0	34%
NO <sub>x</sub>	Annual mean Dearne Valley Park	30	0.1	0.5%	18.2	18.3	61%
	Daily mean (100 <sup>th</sup> %ile) Dearne Valley Park	75	2.3	3.0%	36.4	38.7	52%
	Annual mean Stairfoot Brickworks	30	<0.1	<0.1%	14.7	14.7	49%
	Daily mean (100 <sup>th</sup> %ile) Stairfoot Brickworks	75	0.2	0.2%	29.4	29.6	39%
CO	Max Hourly Average	30,000	51.3	0.2%	358	409.3	1%
	Max 8-hourly rolling average	10,000	16.8	0.2%	358	374.8	4%

AQAL = Air Quality Assessment Level (AQS objective, EAL or CL)

PC = Process Contribution, BC = Background Concentration, PEC = Predicted Environmental Concentration

It can be seen from Table 6.1 that the maximum impacts at sensitive human health receptor locations from the proposed boilers and CHP can be considered to have a low magnitude of impact. When the maximum predicted concentrations that occur anywhere are considered in combination with the background concentrations, they are below the relevant AQAL at the point of maximum impact and indeed at all modelled receptor locations. Changes in pollutant concentration of this magnitude are considered to be slight adverse, and the effects are not considered to be significant.

At the Stairfoot Brickworks SSSI, predicted changes in oxides of nitrogen concentrations are less than 1% of the AQAL for long term effects, and less than 10% of the AQAL for short term effects. Predicted PECs at the Dearne Valley Park LNR are less than 100% of the AQAL. These impacts are not considered to give rise to significant effects at ecological receptors, and are screened out from further assessment.

## 7. Conclusions

Ameresco commissioned AECOM to provide an impact assessment for a replacement Energy Centre for the Barnsley Metrodome comprising of three gas-fired boilers and a gas-fired CHP plant. The Energy Centre is replacing three coal-fired boilers, which are over 20 years old.

The proposed new boilers and CHP will improve site heating and energy provision. The emissions are proposed to be released to atmosphere via 15m stacks.

Dispersion modelling of the proposed new emissions has been carried out to determine the potential impact of the new releases. The assessment included the use of meteorological data from five years of data from Doncaster Robin Hood airport meteorological station, with the highest results from all years used being reported, resulting in a conservative assessment.

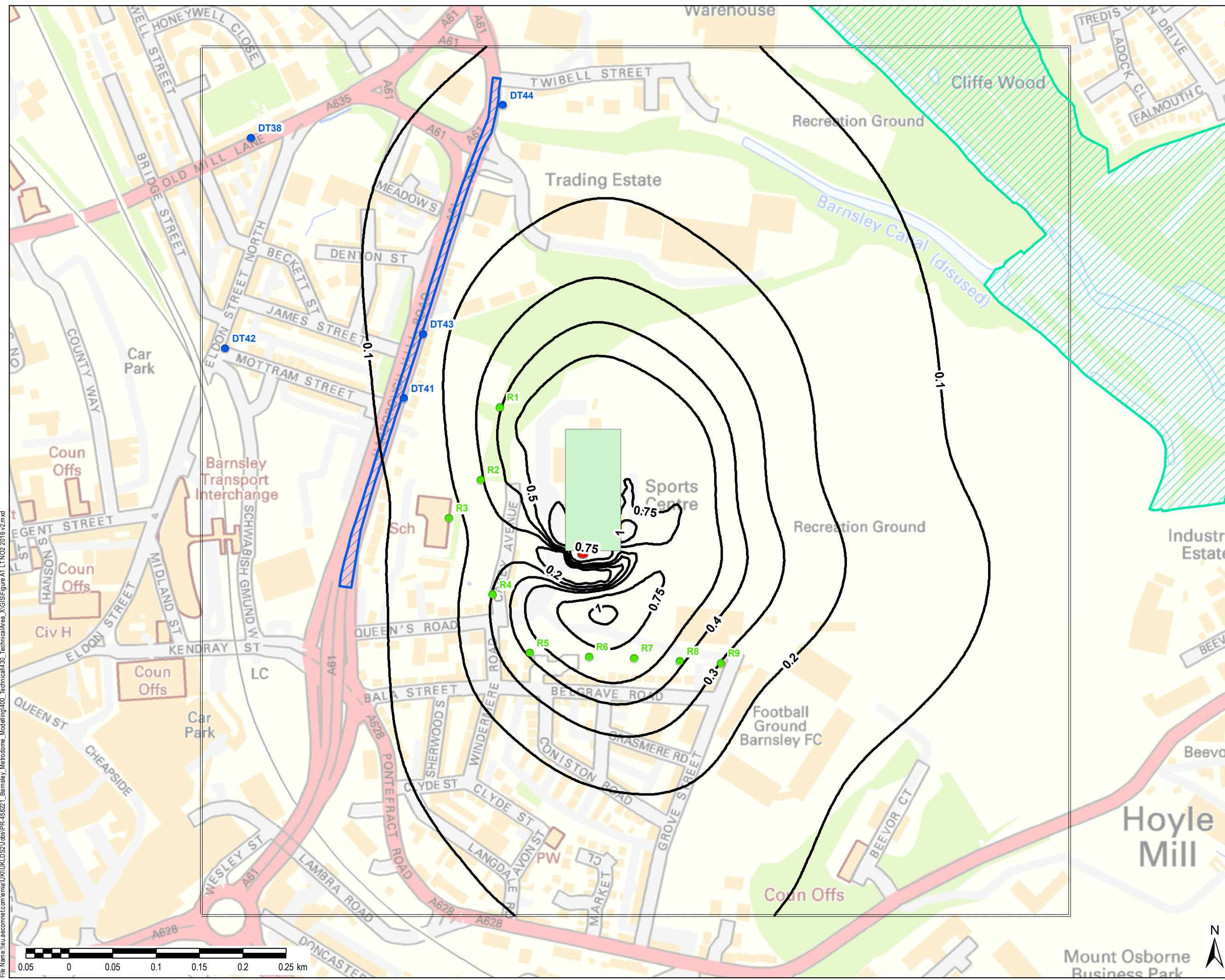
The results of the dispersion modelling assessment indicated that the effects of the proposed new emission at identified sensitive receptors are predicted to be slight adverse at the highest impacted receptor. These effects are considered to be not significant.

It is therefore considered that the proposed emissions would be consistent with the NPPF and with BMBC's planning policies with regards to air quality, and are not considered likely to impact on BMBC actions to improve air quality.

## Appendix A Isoleth Plots

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- LEGEND**
- BMBC Monitoring
  - Receptors
  - Emission Sources
  - Annual Mean NO<sub>2</sub> PC (µg/m<sup>3</sup>)
  - Modelled Building
  - ▨ BMBC AQMA No. 4
  - ▨ Dearne Valley Park LNR
  - ▭ Modelled Domain



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Client  
**AMERESCO**

Project Title  
**BARNSELY METRODOME**

Drawing Title  
**ANNUAL MEAN NITROGEN DIOXIDE  
PROCESS CONTRIBUTION  
2016 METEOROLOGICAL YEAR**

Drawn MH	Checked HW	Approved HW	Date 06/02/2020
AECOM Internal Project No. 60620090		Scale @ A3 1:4,000	

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**FIGURE A1**

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- LEGEND**
- BMBC Monitoring
  - Receptors
  - Emission Sources
  - 99.79<sup>th</sup>ile 1Hr  
— Mean NO<sub>2</sub> PC  
(µg/m<sup>3</sup>)
  - Modelled Building
  - ▨ BMBC AQMA No. 4
  - ▨ Dearne Valley Park LNR
  - ▭ Modelled Domain

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Project Title  
**BARNSELY METRODOME**

Drawing Title  
**99.79<sup>TH</sup>ILE OF 1 HOUR MEAN  
NITROGEN DIOXIDE  
PROCESS CONTRIBUTION  
2018 METEOROLOGICAL YEAR**

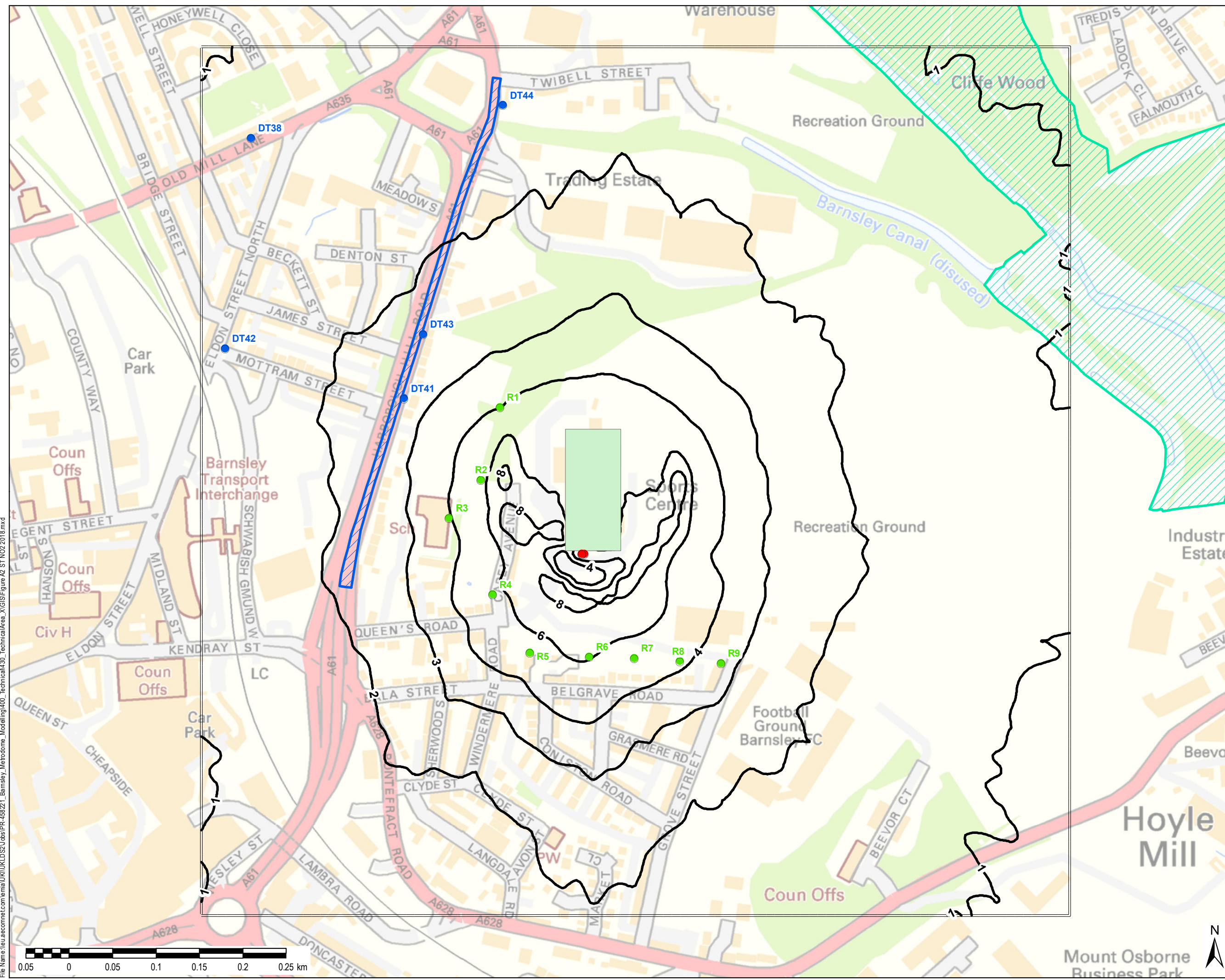
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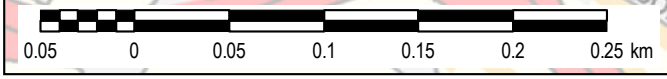
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**FIGURE A2**

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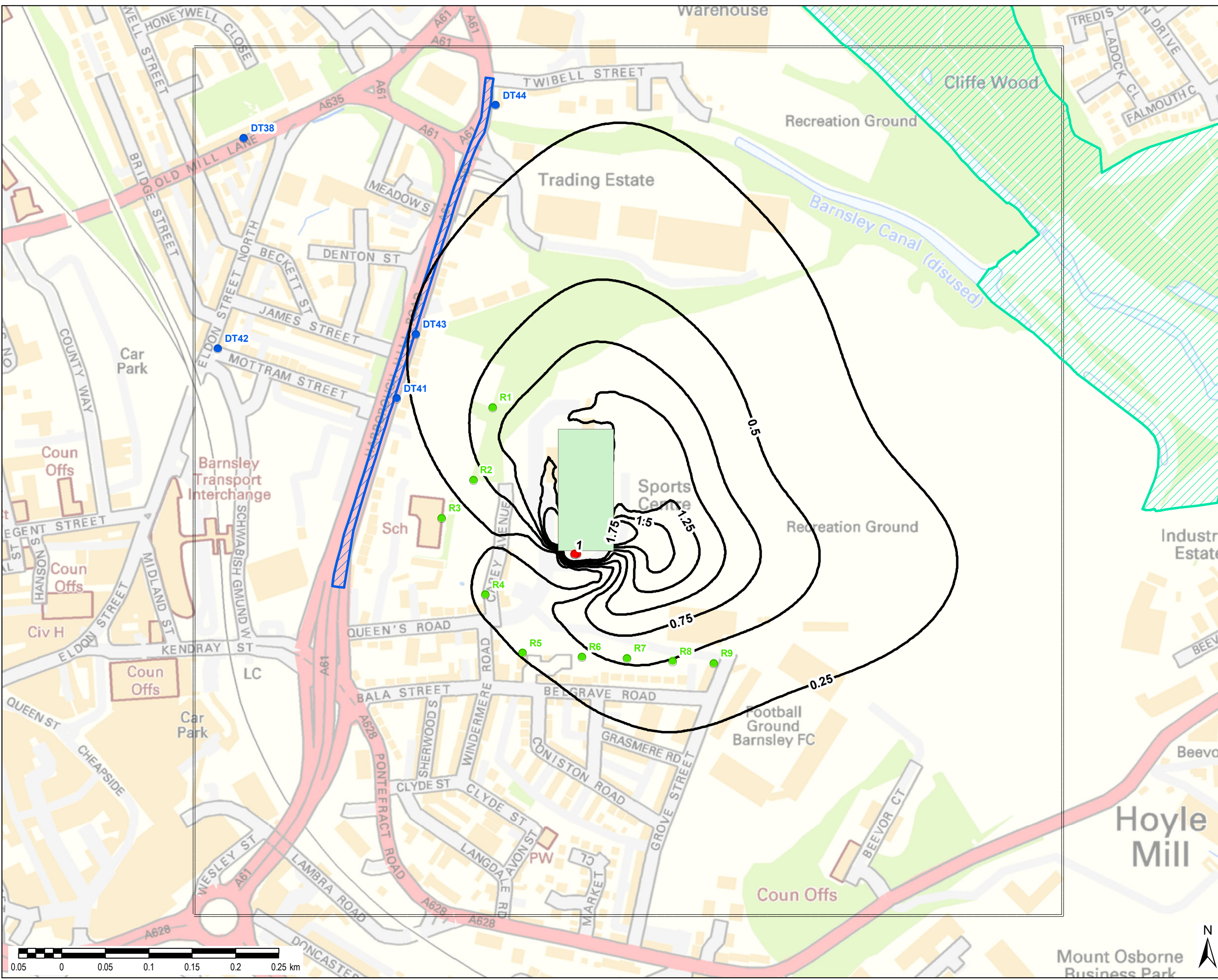


Mount Osborne  
Business Park



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- LEGEND**
- BMBC Monitoring
  - Receptors
  - Emission Sources
  - Annual Mean NOx PC ( $\mu\text{g}/\text{m}^3$ )
  - Modelled Building
  - ▨ BMBC AQMA No. 4
  - ▨ Dearne Valley Park LNR
  - ▭ Modelled Domain



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**ANNUAL MEAN  
OXIDES OF NITROGEN  
PROCESS CONTRIBUTION  
2017 METEOROLOGICAL YEAR**

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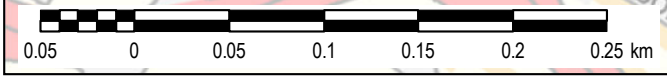
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**FIGURE A3**

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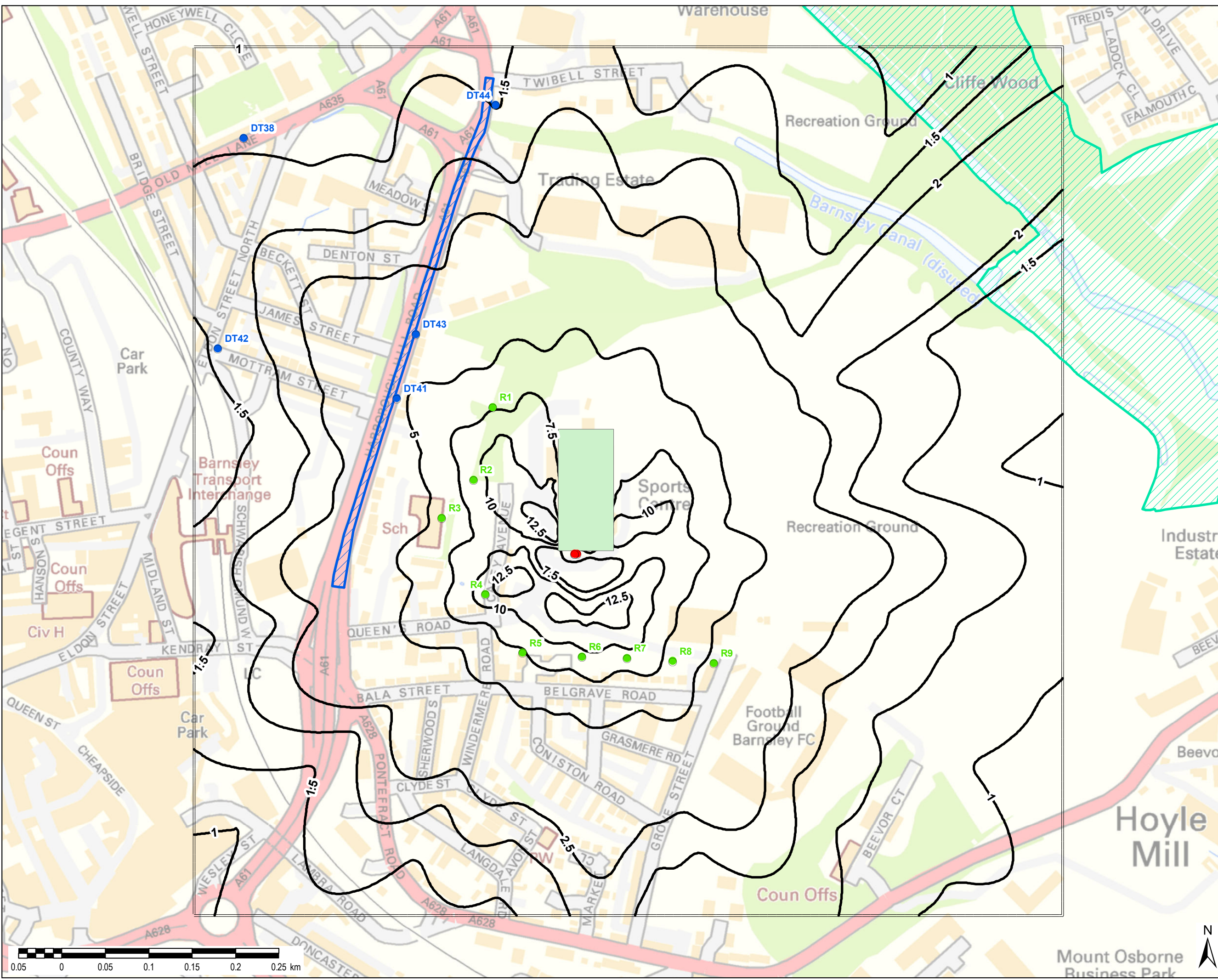
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**LEGEND**

- BMBC Monitoring
- Receptors
- Emission Sources
- Max 24hr Mean NOx PC ( $\mu\text{g}/\text{m}^3$ )
- Modelled Building
- ▨ BMBC AQMA No. 4
- ▨ Dearne Valley Park LNR
- ▭ Modelled Domain



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**BARNSELY METRODOME**

Drawing Title  
**MAXIMUM 24 HOUR MEAN  
OXIDES OF NITROGEN  
PROCESS CONTRIBUTION  
2018 METEOROLOGICAL YEAR**

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**FIGURE A4**

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