SHEFFIELD AND ROTHERHAM CLEAN AIR ZONE FEASIBILITY STUDY

LOCAL PLAN AIR QUALITY MODELLING METHODOLOGY REPORT (AQ3)

21st June 2019

Sheffield City Council

Rotherham Metropolitan Borough Council

DOCUMENT CONTROL

Version	**Name**		**Position**	**Date**	**Changes**
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1. INTRODUCTION

1.1 Context

1.1.1 The UK Government has named Sheffield and Rotherham as one of 28 areas in England which contains locations where the annual average concentrations of Nitrogen Dioxide (NO_2) exceed statutory limits and are projected to continue to do so over and beyond the next 3-4 years.

1.1.2 The two Councils have therefore been tasked with developing a strategy which will help ensure that their Council areas become compliant with this statutory limit 'in the shortest possible time'.

1.2 Overview of this Document

1.2.1 This document is the Local Plan Air Quality Modelling Report (AQ3) which explains in detail how the Air Quality model has been used to undertake Baseline assessment of air quality and also testing of the forecast scenarios. This report provides information covering the key requirements as listed in the JAQU guidance for the "Evidence Package", which are as follows:

- A summary of the air quality monitoring data collected over recent years at a number of locations in Sheffield and Rotherham;
- The results of the baseline air quality modelling. Alongside this report data files with the 2017 Base Year and 2021 'Business as Usual' (BaU) Road links, referenced using their road census ID are provided for sites which are predicted to be non-compliant in 2021;
- A comparison of the modelled base year concentrations with measurements for both NO_X and NO_2 concentrations (in line with validation, verification and uncertainty requirements as outlined in TG16) - this includes scatter plots and summary statistics for modelled vs measured annual mean concentrations;
- NO_X emissions are presented for all road transport sources for the base year (2017) and 2021 BaU Baseline projections; The evidence submission is accompanied by an Excel file which lists the estimated annual NO_X emissions in 2017 and 2021 for every link in the SCRTM3B traffic model, on a link-by-link basis. These are contained in supporting documents SD04 and SD05. NO_2 concentrations are presented for the subset of receptors relevant for validation and AQD assessment,

1.2.2 This report is part of the **Evidence Submission** pack and after review will be subsequently updated with feedback from JAQU. The current version of this report has been written after the baseline and scenario modelling for the OBC has been carried out. It will be updated to include scheme assessment as they become available and will be resubmitted as part of the **Full Business Case Submissions**.

1.3 Air Quality Model Version

1.3.1 Air dispersion modelling of pollutants from a number of roads, points and diffuse sources within the Rotherham and Sheffield domain has been carried out using the Airviro version v4.00.61_ct64® dispersion model (Estonian Environmental Research Centre (EERC), Eesti

Keskkonnauuringute Keskus OU and Apertum IT AB**)**. The years modelled were 2017 and 2021. There are no transport model outputs available for the intervening years so interpolation is used if necessary.

1.3.2 Airviro has been continuously developed since 1990 and has many users all over the world. It has been used in a number of intra-urban exposure studies in recent years (Korek et al., 2016; Jadaanet et al., 2016; Jerrett et al., 2004; Pierse et al., 2006). Its main advantage is being a web-based environmental management tool with embedded Geographical Information System (GIS) features which enables its application at urban and regional levels. In addition, it contains a dynamic emission database which allows for storage of static as well as dynamic emission characteristics for a large number of pollution sources, the latter is mainly used to characterise time-varying emissions from road, area and industrial sources. For example, Airviro calculates primary pollutant emissions for each road by utilising a database of updated information on the type of vehicle journeys, average daily traffic flows, speeds and vehicle mix.(SMHI, 2004).

1.3.3 Met data for all years from 1999 is stored as a time series for all the key parameters and this is used for the dispersion calculations. Most of the met data has been collected from a local weather mast within Sheffield. A meteorological pre-processor routine within the Airviro software tool analysed the local weather data obtained from the weather mast within Sheffield City, including the wind direction, velocity (see wind rose below) and vertical temperature profiles. These were used to determine the boundary layer scaling parameters – surface friction velocity and the Monin-Obukhov length. The wind fields were simulated using the diagnostic wind model available in the tool, which took into account the effects of topography, surface roughness and surface heating/cooling. Surface roughness describes the amount of near-ground turbulence that arises as a consequence of surface characteristics, such as land use (e.g., agriculture, lakes, urbanisation, woodland, open parkland, etc.). Farming areas may have a surface roughness of approximately 0.2m to 0.3m whereas built up cities, such as Sheffield and Rotherham, and woodlands may have a roughness of 1 to 1.5m. The wind field calculation is based on the concept first described by Danard (1976), "where mesoscale winds are generated by using:

- horizontal momentum equation
- pressure tendency equation
- first thermodynamic equation

This concept assumes that small-scale winds can be seen as a local adaptation of large scale winds (free winds) due to local fluxes of heat and momentum from the sea or earth surface. Any non-linear interaction between the scales is neglected. Danard assumes that the adaptation process is very fast, 1.5 hours for model resolutions of 10*10 km. It is also assumed that horizontal processes can be described by non-linear equations while the vertical processes can be parametrised as linear functions."[1]

The Gauss model cannot resolve buildings and other large elements. These elements, for example, an urban area with buildings and street canyons of many different length scales, are parameterised as increased surface roughness. The wind field generated has one unique resolution regardless of the size or scale of the dispersion area, which depends upon the

[1] Appendix 2A: The Wind Model - Calculation of the Wind Fields. Airviro User's Reference (Apertum): Working with the Dispersion Module

input of topographic and physiographic information. The physiographic information used in the modelling generates a local wind field with a 100m x 100m grid. The topography data allows the wind field generated within the dispersion calculation to better reflect the impact of funnelling effects of land forms and greater resolution of the land use, including building heights on the surface roughness effects.

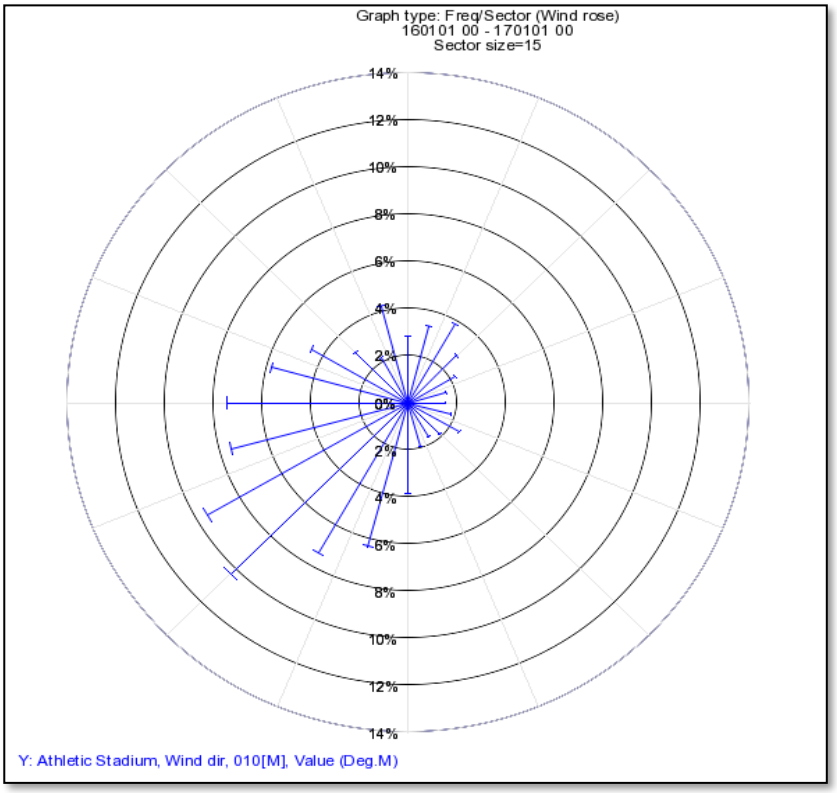


Figure 1 – Wind Rose for year 2016 Weather Data

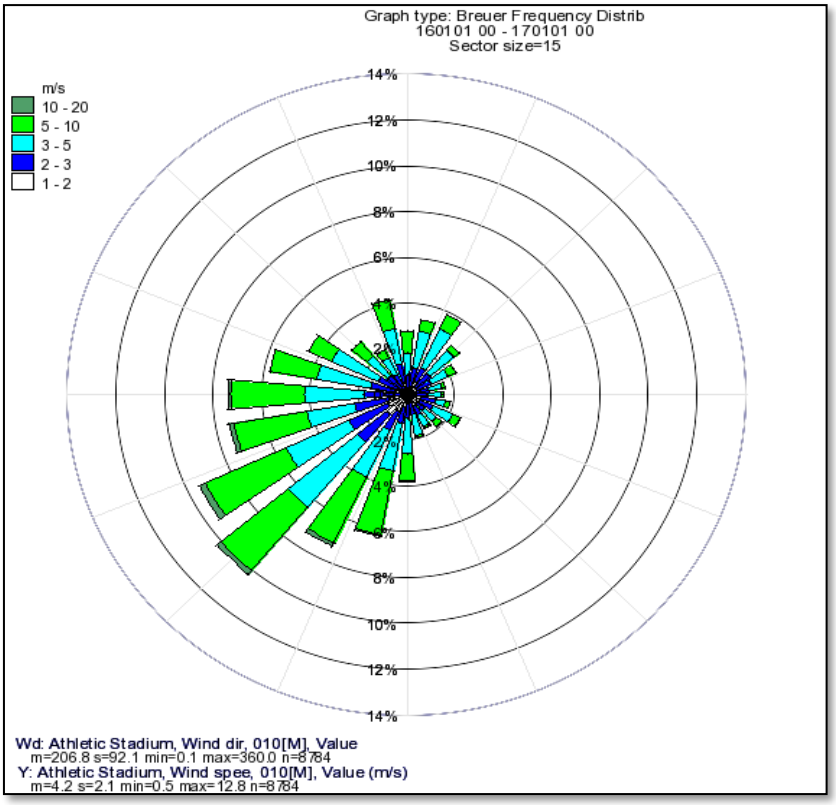


Figure 2 – Breuer Frequency Distribution (Wind Rose) for year 2016 Weather Data, with addition to sub-classes in each wind direction class

- SCC and RMBC have used the Airviro system for air quality modelling, time series data collection and validation continuously for over 18 years, in partnership with Doncaster and Barnsley Councils.

- Rotherham and Sheffield Councils used Airviro version v4.00.61 dispersion modelling to simulate the dispersion of vehicle emissions of NO_X from all major and minor road sources within the area and establish annual mean concentrations. The road links for all the pollution climate mapping (PCM) road links as defined by Defra[2] is contained within the transport model. In accordance with LAQM TG16, the modelled road NOx is factored prior to further analysis. Emissions from industrial (point and area sources) domestic emissions (area sources) and background were simulated in a separate model run. Each simulation run included the area-wide domain, covering Rotherham and Sheffield. The concentrations of NO_X are predicted using Airviro's Gaussian model. The methodology adopted, to model vehicle emissions within Airviro adheres to the modelling criteria agreed with the Joint Air Quality Unit (JAQU) as per the Air Quality Tracking Table AQ1 (appended and previously submitted and agreed with JAQU).

- The 2017 baseline Business as Usual and 2021 Business as Usual years transport model outputs (with projected vehicle fleet composition) were modelled. Current fleet was

[2] Defra PCM data referred to in this document is based on '*2017* NO_2 *projections data (2015 reference year)*', obtained from https://uk-air.defra.gov.uk/library/NO_2ten/2017-NO_2-projections-from-2015-data, accessed October 2017

established from relevant full year ANPR-based fleet profiles. For future years it was updated using EFT-based 'Business as Usual' and 'Do Something' Fleet Assumptions (as per JAQU Guidance). More information on this can be found in the Transport Methodology Report (T4).

1.4 Local Fleet

- The vehicle classes within the Rotherham and Sheffield Transport Model were subsequently proportioned into fuel and body type sub classes based on data collected by previously classified traffic counts and the Automatic Number Plate Recognition (ANPR) data across a number of representative sites within Sheffield and Rotherham. As we collected 12 months ANPR data, we had a good understanding of the local vehicle fleet. We flagged taxis and private hire vehicles so we could identify them as separate from private cars (essential for any CAZ Feasibility Study which may target taxis). In terms of the local bus fleet, as DVLA do not hold data on retrofitting and only provide Euro standard based on first registration, we obtained data from the South Yorkshire Passenger Transport Executive, who provide quarterly updates on Euro class in the South Yorkshire fleet.

  Airviro models the dispersion of NO_X emissions from across the whole domain. We used a similar methodology to that used by Leeds City Council for their CAZ Feasibility Study. If a model run was attempted using a 10m grid across the whole domain, the simulation run times became too long to fit with the timescales demanded of this study. Therefore, the base modelled grid size across the domain was a 250m x 250m grid (spatial resolution). This grid size was reduced to a 10m receptor grid when within 50m of a modelled road, point or line source emitting more than 0.000001g/s. This approach resulted in reasonable model run times. To do this, the "Quad Grid" function within Airviro Dispersion module was used, with the threshold emissions value set to > 0.000001 or 1e-06g/(s*m) to ensure all road links with a significant emission rate were included.

- The Defra NO_X to NO_2 calculator v6.1 was used for the conversion of NOx to NO_2. The road NO_X output was factored after the simulation is complete. The factored road NOx was then entered into the Defra NOx:NO_2 calculator with relevant background values for the location and locally derived f-NO_2 (calculated for each road link for the Study) for each location. The Defra NO_X to NO_2 calculator calculates annual mean nitrogen dioxide values for each location. These results are presented later in this report.

1.5 Structure of this Document

- The remainder of this document is structured as follows:

  - **Section 2** presents analysis of the local air quality monitoring data;
  - **Section 3** describes the forecast baseline Air Quality Modelling along with the results for the main scenarios which have been tested to date;
  - presents the NO_X and NO_2 concentrations at all receptor locations relevant for the Air Quality Directive (AQD) for the Base Year, the baseline tests and all scenarios;
  - **Section 4** describes the NO_X to NO_2 conversion for all receptors;
  - **Section 5** provides a summary of road link which are non compliant, a short explanation on target determination and of analytical assurance;

2. MONITORING DATA ANALYSIS

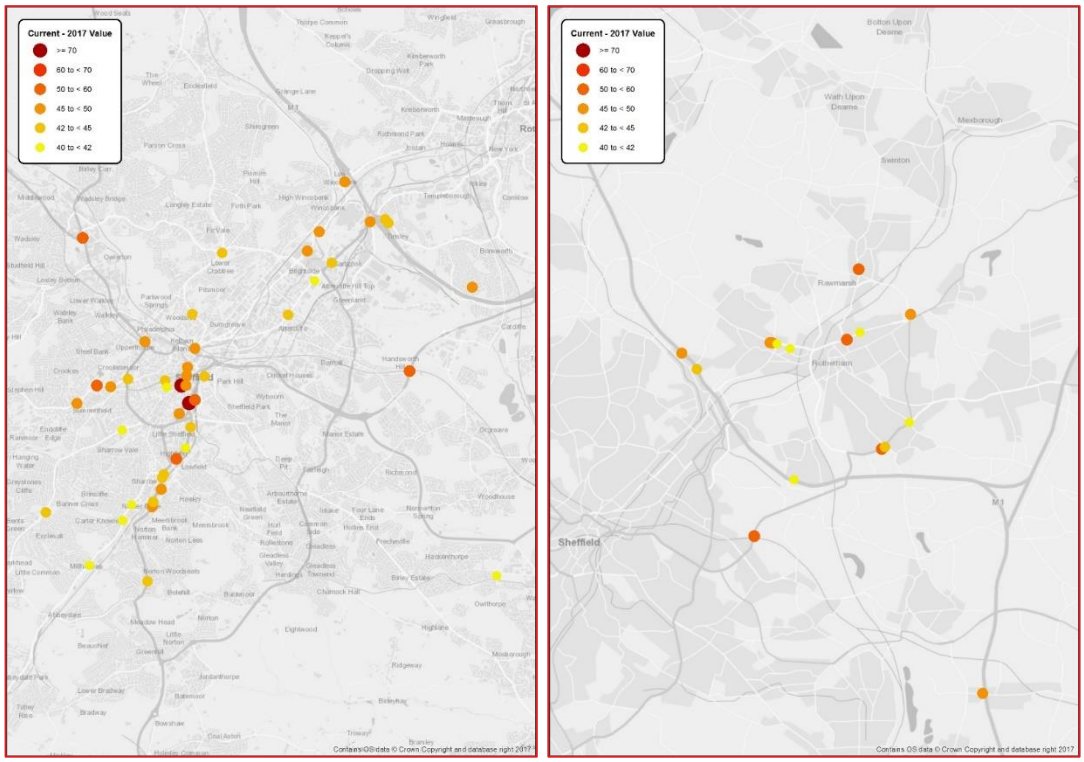
2.1 Introduction

- This section presents a summary of observed data which has been collected from monitoring locations in Sheffield and Rotherham. This data was used to validate the 2017 Base Year Air Quality modelling data.

2.2 Observed Data

- Observed Air Quality data is monitored at a number of sites throughout Sheffield and Rotherham. The figures below show the annual average concentrations of NO_2 at the non-compliant Air Quality Monitoring Sites in Sheffield and Rotherham in 2017. It shows those sites which exceed the EU Limit Value of 40µg/m^3, with the graduated colour scheme highlighting the scale of the current exceedance.

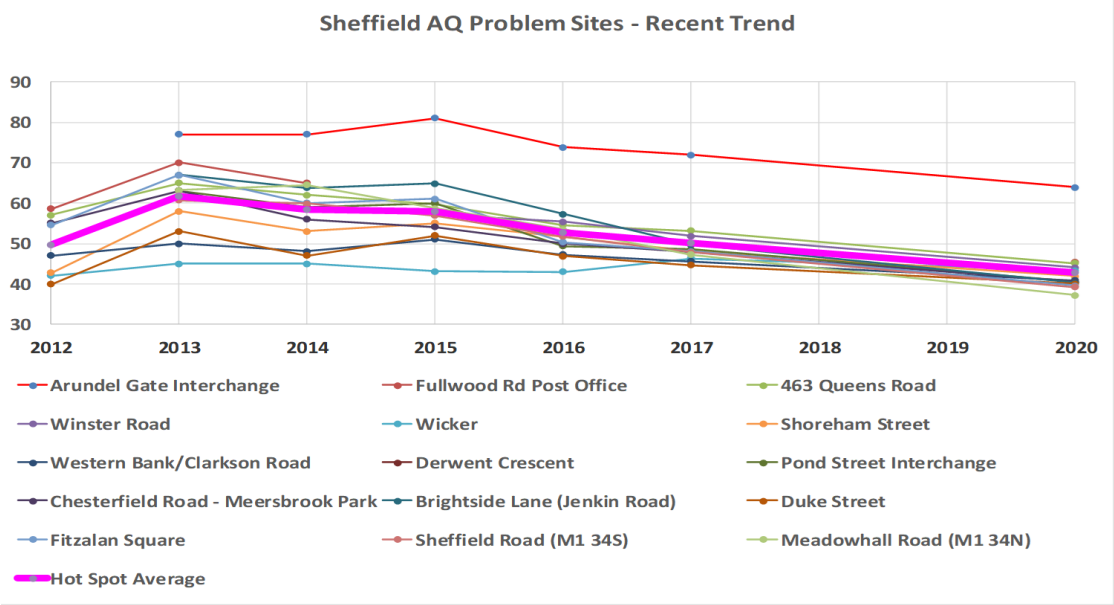
Figure 3 – AQ Monitoring Sites which exceed 40ug/m3 annual mean NO_2 in Sheffield and Rotherham in 2017



Note: **not all these monitoring sites are relevant in terms of where the AQD applies (i.e. most are not located at 4m from the kerb etc.)**

- The recent trend in this annual average NO_2 concentration at Sheffield's monitored Air Quality 'hot-spots' is illustrated in the figure below.

Figure 4 – Sheffield Air Quality Problem Sites – Recent Trend



- The charts above suggest that the NO_2-based air quality is generally improving at most of the hot-spot sites in the region, as would be expected. However, air quality will not improve sufficiently at all locations to meet the AQD. It should be stressed that **The Parkway and Derek Dooley Way (inner ring road), which are dual carriageways with no Local Air Quality Management relevant exposure, had not been monitored until the CAZ Feasibility Study and are not included above.**

3. 2017 BASE YEAR AIR QUALITY MODELLING

3.1 Introduction

- This section describes the results of the Baseline Air Quality Modelling along with the results from that process. It includes how the Base Year Air Quality Model has been validated against the monitored 2017 concentrations in the study area.

3.2 Base Year Air Quality Modelling Results

- For each year modelled a dispersion run for all the point, area and grid sources was undertaken. Another dispersion model run was carried out for the relevant emissions database containing the traffic data.[3]

- The road NO_X output was factored after the simulation is complete. The factored road NOx was then entered into the Defra NOx:NO_2 calculator with relevant background values for the location and locally derived f-NO_2 (calculated for each road link for the Study) for each location. The Defra NO_X to NO_2 calculator calculates annual mean nitrogen dioxide values for each location.

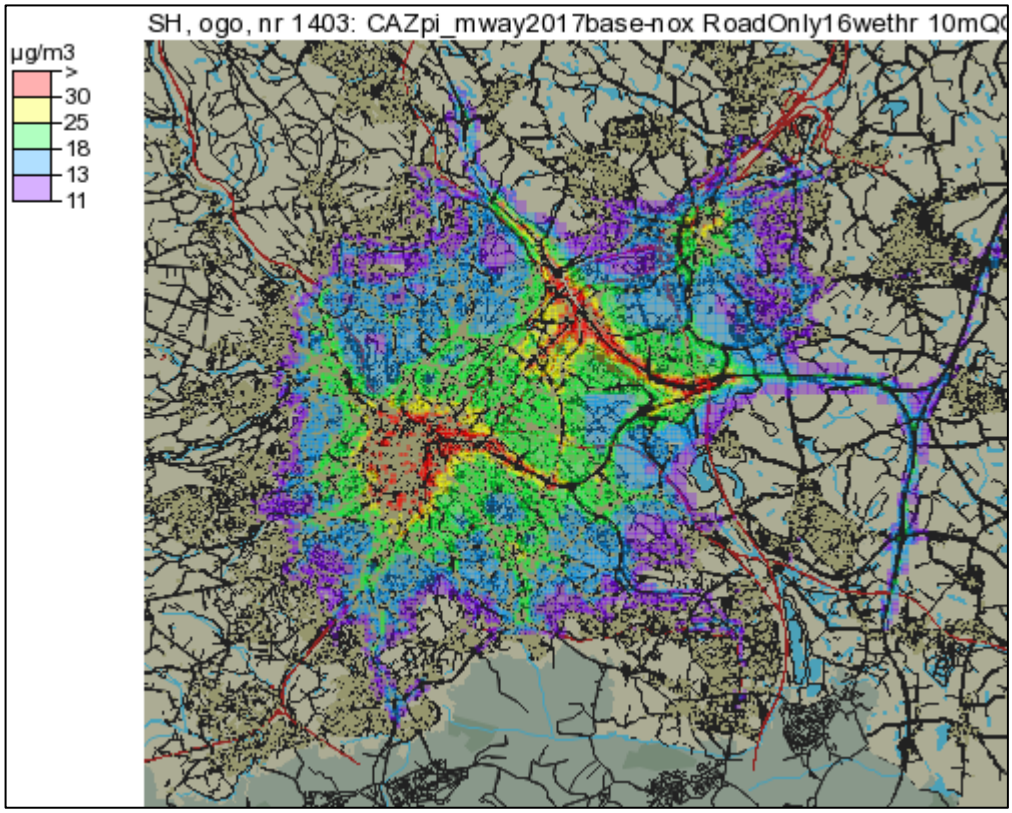
- To validate the modelled road NOx, the road NO_X from diffusion tube monitoring data (see Supporting Document SD01), was calculated using the diffusion tube tab in Defra's NO_X to

[3] The methodology is described in Report AQ2

NO_2 calculator. F-NO_2 for the relevant year and road link were input for each calculation. This methodology is approved by JAQU.

- An illustration of the dispersion model output is shown below:

Figure 5 – An Illustration of the 2017 Road NOx Dispersion Model Output



- The model runs are verified by comparing monitored with modelled road NO_X. The first step is to examine the calculated ratio of monitored road contribution to modelled road contribution NOx. This is a useful guide for identifying sites that are performing differently than others. High ratios could suggest the presence of street canyons, sites with a busy bus interchange, a busy taxi rank or sites with steep gradients used by buses and taxis. The next step is to prepare a graph of modelled versus monitored road contribution NOx and from the equation of the trend line, the correction factor is obtained. The road NOx is then factored.

- Sites were considered in terms of zones and some in terms of having similar ratios. The calculated ratio for sites in the Sheffield area ranged between 1.10 to 2.87, with one anomaly at Census_ID 56863 which has a value of 0.45. This is thought to be due to a rather high Defra Background Map NOx value for this site, put into the NOx to NO_2 calculator. Calculated ratios that ranged between 1.70 to 2.87 and 1.00 to 1.60 were considered separately and graphs from these sites gave correction factors of 1.30 (R^2 of 0.85) and 2.25 (R^2 of 0.82) respectively.

- Below are illustrations of ratios for various site locations across Sheffield.

Table 1 – Sheffield Road NOx adjustment Factors: 1.70 to 2.33

Census_ID	4m X	4m Y	Site	2017 Ratio: Monitored / Modelled
C710	435598	387298	*Arundel Gate Interchange 4m C710	2.87
47396	434290	386197	Ecclesall Rd/Pear Str A625	2.33
n/a	433332	390854	Fielding Road	2.08
17718	438610	390617	Brightside Lane (Jenkin Road) A6109	2.07
47855	437759	387473	SCC Parkway Layby 2 A57	1.92
n/a	433413	386746	Glossop Rd/Westbourne Rd B6547	1.88
17728	435839	388817	73 Burngreave Road A6135	1.87
n/a	433248	391120	Beeley Wood Road	1.86
17718	438353	390191	Brightside Lane (Forgemaster) A6109	1.82
8144	433494	387010	Whitham Rd/Moor Oaks Rd A57	1.82
57875	436492	390149	Barnsley Road, Fir Vale A6135	1.80
36588	440015	386727	SCC Defra's target determn Parkway A57	1.76

Table 2 – Sheffield Road NOx adjustment Factors: 1.00 to 1.60

37898	435494	385693	Queens Road - Edmund Rd A61	1.56
37898	435692	385890	Queens Road – Asda A61	1.55
47860	434401	386985	Upper Hanover Street A61	1.54
47855	437346	387691	SCC Parkway Layby 1 A57	1.50
47826	439171	391727	Meadowhall Road (M1 34N) A6109	1.49
37441	439717	390827	Sheffield Road (M1 34S) A6178	1.40
7817	437667	390107	Upwell Street A6102	1.36
n/a	435288	387228	Barkers Pool Taxi Rank	1.30
17332	440115	390799	98 Bawtry Road A631	1.30
17809	434808	388215	Penistone Road A61	1.25
17332	440199	390750	109 Bawtry Road A631	1.22
17718	437461	389315	Brightside Lane (Stevenson Road) A6109	1.13
60030	435800	387000	Sheaf St at Train Station PCM A61	1.11
37898	435809	386349	Queens Rd / G Casino A61	1.10
56863	*436322*	*388234*	*Attercliffe Road (Tesco) A6109***	*0.45*

- *Arundel Gate operates as a busy bus interchange and has a distinctly high ratio, therefore the correction factor of 2.25 for its range has been used.
- **Background NOx value from DEFRA Background Map is anomalous.

Table 3 - Rotherham Road NOx adjustment Factors

Zone	A630 Parkway AQMA1	A629 AQMA2	A630 Fitzwilliam Road AQMA3	A633 Rawmarsh Hill AQMA4	Average Town Centre/Inner road links	Average Outer road links
Modelled road NOx vs monitored roads NOx Factor	1.68	3.297	1.645	5.329	1.846	2.822

Explanation of the Factors

The transport emissions from the transport model do not account for all the monitored roadside NOx at 4m from the kerb (JAQU requirement). Therefore the roadside NOx modelled was factored to verify against monitored roadside NOx values across the domain. For roads where compliance is not currently achieved, it is particularly important to factor the roadside NOx by the correct road link specific factor.

Rawmarsh Hill has a relatively high road NOx adjustment factor, this is explained by the steep gradient (which is not accounted for in the emissions data from the transport model), acceleration from standing at traffic lights uphill, and the presence of buildings close to the road (street canyon). Annual mean nitrogen dioxide is predicted for locations which meet JAQU's requirements i.e. >25m from a junction, and 4m from the kerb.

The A629 also has a steep gradient and vehicles accelerating between buildings (street canyon) from a roundabout. This accounts for the relatively high factor necessary to adjust the modelled data.

The Parkway and A630 Fitzwilliam Road are relatively flat roads. The Parkway is a busy dual carriageway and both it and the A630 Fitzwilliam Road experience peak time congestion. The Parkway (A630) in particular experiences congestion during the pm peak period when commuters are leaving Sheffield Centre and heading for M1 J33. The road NOx adjustment factor has been updated as we now have monitoring data from this location (there is no LAQM exposure, so monitoring started in 2018 as part of the CAZ FS.)

- For **Sheffield,** the following table and graph show the results of the Baseline 2017 modelling:

3.3 Sheffield Baseline Dispersion Modelling Results

- The following table and graphs show the results of the Baseline 2017 modelling.

Table 4 – Sheffield: Monitored vs Modelled NO_X and NO_2 2017 at 4m to the Road

Site name	Census_ID_(if applicable)	Grid_ref		Annual mean NO_X modelled_2017	Annual mean NO_X monitored_2017	Annual mean NO_2 modelled_2017	Annual mean NO_2 monitored 2017
		X	Y				
Arundel Gate Interchange 4m	C710	435598	387298	204.6	204.6	**70.3**	**72.0**
Ecclesall Rd/Pear Street A625	47396	434290	386197	62.7	62.7	42.8	40.3
Fielding Road	n/a	433332	390854	63.6	63.7	43.6	37.7
Brightside Lane (Jenkin Road) A6109	17718	438610	390617	72.5	72.6	46.7	49.7
SCC Parkway Layby 2	47855	437759	387473	105.8	105.9	61.4	59.0
Glossop Rd/Westbourne Rd	n/a	433413	386746	57.0	57.0	37.3	36.3
73 Burngreave Road A6135	17728	435839	388817	62.8	62.7	40.8	42.2
Beeley Wood Road	n/a	433248	391120	54.5	54.6	39.9	37.9
Brightside Lane (Forgemaster)	17718	438353	390191	61.0	60.9	42.2	45.2
Whitham Rd/Moor Oaks Rd	8144	433494	387010	54.6	54.5	39.2	36.7
Barnsley Road, Fir Vale A6135	57875	436492	390149	65.5	65.4	42.9	43.8
SCC Defra's target determination Parkway	36588	440015	386727	69.3	69.4	46.4	43.9
Queens Road - Edmund Rd	37898	435494	385693	54.8	54.7	39.6	40.0
Queens Road - Asda	37898	435692	385890	57.8	57.7	40.8	40.4
Upper Hanover Street A61	47860	434401	386985	55.6	55.6	42.0	39.2
SCC Parkway Layby 1	47855	437346	387691	86.0	85.8	53.8	54.0
Meadowhall Road (M1 34N) A6109	47826	439171	391727	74.4	74.5	45.9	47.3
Sheffield Road (M1 34S)	37441	439717	390827	85.8	86.0	51.5	47.8

Upwell Street A6102	7817	437667	390107	44.1	43.9	35.4	35.3
Barkers Pool Taxi Rank	n/a	435288	387228	67.2	67.5	41.8	42.0
98 Bawtry Road A631	17332	440115	390799	60.7	60.8	42.7	42.6
Penistone Road A61	17809	434808	388215	70.8	70.5	46.6	46.2
109 Bawtry Road	17332	440199	390750	50.6	50.5	38.5	38.4
Brightside Lane (Stevenson Road)	17718	437461	389315	33.9	34.0	30.9	38.2
Sheaf St at Train Station PCM A61	60030	435800	387000	108.6	108.3	**60.4**	**60.5**
Queens Rd / G Casino A61	37898	435809	386349	62.3	62.4	42.7	43.1
*Attercliffe Road (Tesco)***	*56863*	*436322*	*388234*	22.7	*22.8*	*25.5*	*38.3*

- **Background NOx value from DEFRA Background Map is anomalous.

Figure 6 – Sheffield Observed vs Modelled NO_2 2017

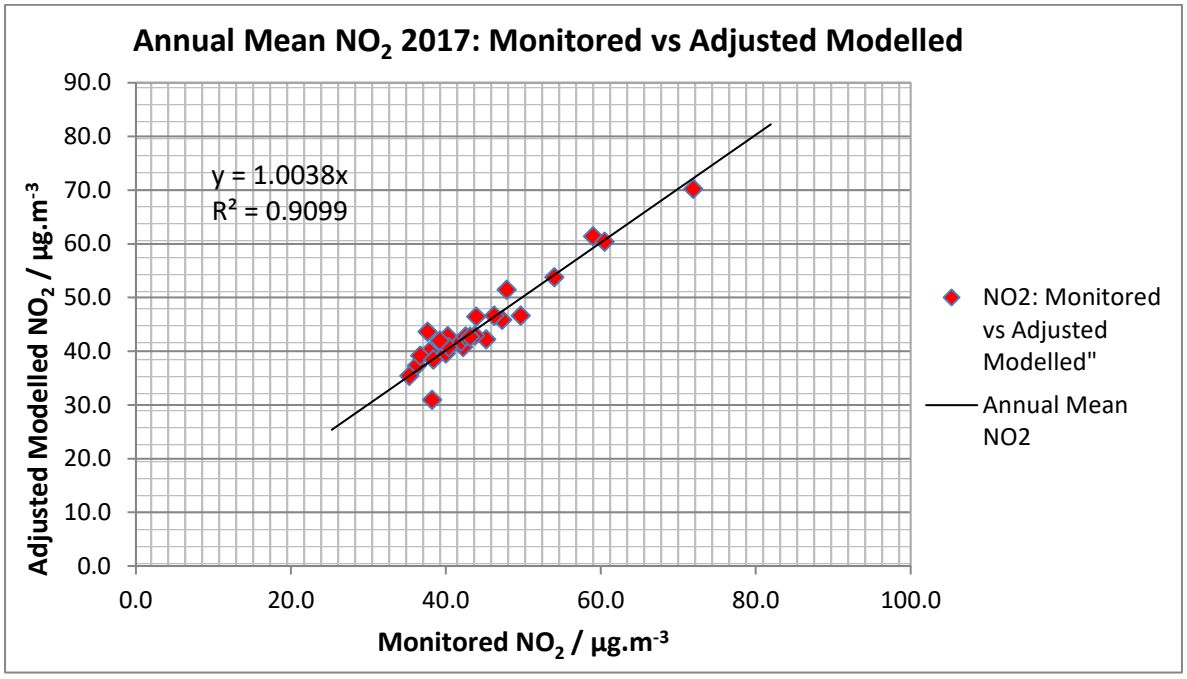
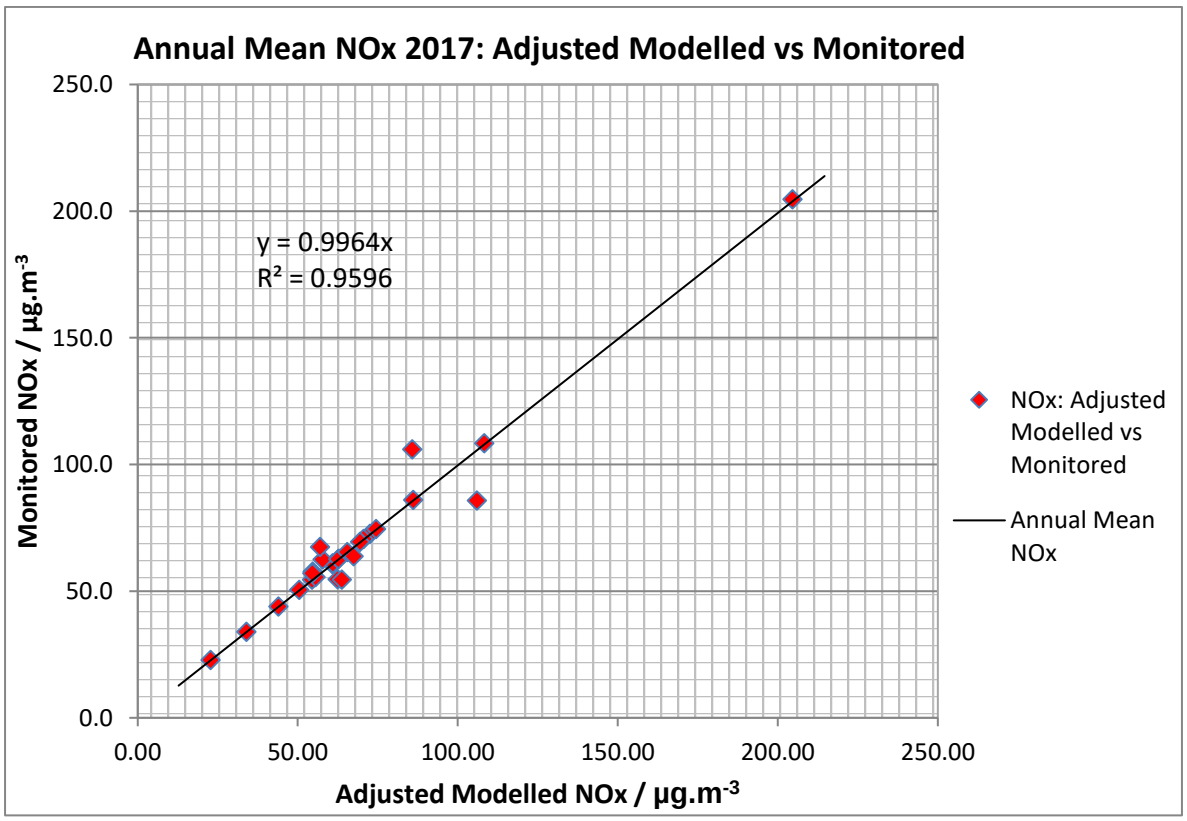


Figure 7 – Sheffield Adjusted Modelled vs Monitored Road NO_X 2017



- The f-NO_2 values for input into the NO_X to NO_2 calculator were derived from the EFT and are shown in the table below for key road links.

Table 5 – Locally derived f-NO_2 values – Sheffield

Location_Census_ID	Local Authority	fNO_2_2017	fNO_2_2021 _BaU Final Baseline	fNO_2_2021_C3 _(S)_C+ with Through Trips	fNO_2_2021_C3 _(S)_C+_VDM	fNO_2_2021_C3 _(S)_D_VDM	fNO_2_2021_C2 _(S)_D	fNO_2_2021_C1 _(R+S)_D
7355	Sheffield City Council	0.220	0.210	0.227	0.225	0.225	0.221	0.226
7380	Sheffield City Council	0.220	0.207	0.216	0.211	0.210	0.204	0.201
7817	Sheffield City Council	0.261	0.253	0.250	0.246	0.257	0.250	0.238
7818	Sheffield City Council	0.303	0.291	0.285	0.283	0.286	0.293	0.292
8144	Sheffield City Council	0.243	0.233	0.238	0.233	0.202	0.200	0.209
8710	Sheffield City Council	0.202	0.199	0.225	0.222	0.218	0.206	0.205
8744	Sheffield City Council	0.246	0.236	0.246	0.240	0.186	0.211	0.188
8758	Sheffield City Council	0.241	0.225	0.224	0.218	0.159	0.202	0.188
16007	Sheffield City Council	0.261	0.263	0.263	0.271	0.271	0.255	0.260
16580	Sheffield City Council	0.277	0.264	0.266	0.261	0.256	0.266	0.264
16581	Sheffield City Council	0.220	0.211	0.226	0.223	0.205	0.197	0.195
17332	Sheffield City Council	0.271	0.260	0.261	0.261	0.261	0.252	0.247
17718	Sheffield City Council	0.256	0.247	0.251	0.249	0.244	0.249	0.247
17728	Sheffield City Council	0.207	0.200	0.228	0.223	0.237	0.180	0.169
17809	Sheffield City Council	0.296	0.280	0.275	0.271	0.219	0.272	0.243
18546	Sheffield City Council	0.271	0.257	0.259	0.255	0.254	0.261	0.263
18721	Sheffield City Council	0.247	0.237	0.236	0.231	0.234	0.241	0.231
27373	Sheffield City Council	0.185	0.178	0.195	0.191	0.203	0.178	0.184
27381	Sheffield City Council	0.229	0.224	0.235	0.230	0.216	0.214	0.214
27393	Sheffield City Council	0.181	0.174	0.200	0.198	0.212	0.160	0.161
27821	Sheffield City Council	0.292	0.278	0.270	0.264	0.269	0.276	0.273
27822	Sheffield City Council	0.291	0.278	0.271	0.268	0.275	0.269	0.261
27857	Sheffield City Council	0.215	0.204	0.217	0.213	0.193	0.197	0.194
28052	Sheffield City Council	0.255	0.257	0.257	0.265	0.267	0.249	0.251

28172	Sheffield City Council	0.296	0.281	0.276	0.269	0.257	0.285	0.277
28868	Sheffield City Council	0.249	0.223	0.226	0.219	0.220	0.250	0.251
36588	Sheffield City Council	0.276	0.268	0.267	0.269	0.262	0.266	0.256
37441	Sheffield City Council	0.255	0.248	0.250	0.247	0.249	0.245	0.241
37898	Sheffield City Council	0.253	0.241	0.245	0.241	0.236	0.236	0.241
37902	Sheffield City Council	0.274	0.266	0.264	0.261	0.266	0.266	0.260
37913	Sheffield City Council	0.255	0.257	0.257	0.266	0.267	0.250	0.251
38549	Sheffield City Council	0.216	0.204	0.209	0.205	0.209	0.203	0.198
46619	Sheffield City Council	0.262	0.246	0.249	0.244	0.231	0.248	0.243
46620	Sheffield City Council	0.243	0.236	0.252	0.249	0.244	0.237	0.236
47393	Sheffield City Council	0.266	0.255	0.263	0.259	0.228	0.237	0.230
47396	Sheffield City Council	0.255	0.245	0.259	0.255	0.247	0.243	0.242
47405	Sheffield City Council	0.233	0.222	0.237	0.234	0.236	0.228	0.228
47826	Sheffield City Council	0.228	0.215	0.222	0.219	0.215	0.201	0.198
47855	Sheffield City Council	0.293	0.283	0.289	0.290	0.264	0.277	0.266
47856	Sheffield City Council	0.261	0.246	0.251	0.247	0.244	0.250	0.251
47860	Sheffield City Council	0.309	0.295	0.285	0.283	0.244	0.287	0.255
48531	Sheffield City Council	0.272	0.261	0.267	0.265	0.266	0.262	0.261
48804	Sheffield City Council	0.257	0.249	0.247	0.244	0.249	0.246	0.239
48805	Sheffield City Council	0.288	0.268	0.266	0.265	0.207	0.237	0.226
56608	Sheffield City Council	0.276	0.267	0.267	0.263	0.214	0.244	0.231
56862	Sheffield City Council	0.237	0.230	0.241	0.239	0.241	0.236	0.231
56863	Sheffield City Council	0.231	0.212	0.232	0.230	0.180	0.193	0.193
57330	Sheffield City Council	0.220	0.211	0.212	0.208	0.209	0.219	0.227
57861	Sheffield City Council	0.298	0.284	0.282	0.278	0.231	0.273	0.252
57875	Sheffield City Council	0.233	0.224	0.242	0.236	0.239	0.227	0.233
58427	Sheffield City Council	0.269	0.261	0.260	0.254	0.257	0.260	0.253

60030	Sheffield City Council	0.271	0.259	0.260	0.255	0.198	0.235	0.222
73909	Sheffield City Council	0.273	0.273	0.273	0.281	0.282	0.263	0.264
75194	Sheffield City Council	0.283	0.267	0.274	0.269	0.213	0.250	0.242
75195	Sheffield City Council	0.269	0.259	0.262	0.256	0.207	0.238	0.224
75196	Sheffield City Council	0.268	0.259	0.262	0.255	0.205	0.244	0.224
75197	Sheffield City Council	0.257	0.246	0.252	0.245	0.191	0.227	0.200
75198	Sheffield City Council	0.135	0.144	0.147	0.147	0.147	0.150	0.150
75199	Sheffield City Council	0.277	0.268	0.277	0.271	0.224	0.266	0.260
76044	Sheffield City Council	0.199	0.196	0.208	0.201	0.134	0.173	0.162
76045	Sheffield City Council	0.295	0.281	0.281	0.277	0.224	0.262	0.252
76046	Sheffield City Council	0.307	0.293	0.283	0.279	0.233	0.282	0.264
77544	Sheffield City Council	0.269	0.255	0.264	0.260	0.258	0.260	0.273
77547	Sheffield City Council	0.248	0.238	0.254	0.250	0.255	0.243	0.249
77551	Sheffield City Council	0.235	0.229	0.248	0.243	0.239	0.228	0.225
77553	Sheffield City Council	0.280	0.269	0.270	0.267	0.270	0.277	0.280
77557	Sheffield City Council	0.261	0.250	0.261	0.257	0.260	0.257	0.263
81155	Sheffield City Council	0.215	0.207	0.225	0.221	0.200	0.190	0.183
81162	Sheffield City Council	0.291	0.279	0.279	0.273	0.233	0.264	0.256
81227	Sheffield City Council	0.263	0.249	0.258	0.254	0.260	0.254	0.257
81228	Sheffield City Council	0.281	0.268	0.269	0.264	0.269	0.275	0.280
81229	Sheffield City Council	0.230	0.219	0.235	0.233	0.240	0.220	0.220
81230	Sheffield City Council	0.263	0.249	0.262	0.259	0.263	0.256	0.259
81236	Sheffield City Council	0.290	0.270	0.277	0.274	0.228	0.266	0.254
81237	Sheffield City Council	0.300	0.286	0.282	0.279	0.236	0.278	0.259
81238	Sheffield City Council	0.276	0.262	0.273	0.269	0.222	0.255	0.252
99303	Sheffield City Council	0.297	0.288	0.291	0.293	0.277	0.280	0.267
Arundel Gate, C710	Sheffield City Council	0.161	0.156	0.153	0.150	0.120	0.134	0.132

Attercliffe Road A6109	Sheffield City Council	0.216	0.208	0.218	0.215	0.208	0.184	0.183
Barkers Pool, S1	Sheffield City Council	0.168	0.163	0.169	0.166	0.137	0.138	0.137
Barnsley Road A6135	Sheffield City Council	0.266	0.255	0.264	0.261	0.265	0.267	0.272
Bawtry Road A631	Sheffield City Council	0.262	0.254	0.259	0.257	0.257	0.243	0.227
Beeley Wood Road, S6	Sheffield City Council	0.264	0.251	0.256	0.252	0.254	0.257	0.260
Brightside Lane A6109	Sheffield City Council	0.261	0.253	0.257	0.254	0.250	0.253	0.251
Burngreave Road A6135	Sheffield City Council	0.207	0.201	0.234	0.230	0.244	0.183	0.182
Ecclesall Rd A625	Sheffield City Council	0.234	0.221	0.238	0.232	0.218	0.201	0.210
Glossop Road B6547	Sheffield City Council	0.194	0.191	0.197	0.194	0.167	0.167	0.168
Meadowhall Road A6109	Sheffield City Council	0.228	0.215	0.222	0.219	0.215	0.201	0.198
Penistone Road A61	Sheffield City Council	0.279	0.265	0.268	0.265	0.244	0.263	0.258
Queens Road A61	Sheffield City Council	0.261	0.250	0.252	0.250	0.236	0.245	0.250
Sheaf Street A61	Sheffield City Council	0.271	0.258	0.259	0.254	0.196	0.233	0.219
Sheffield Parkway A57	Sheffield City Council	0.293	0.284	0.291	0.292	0.259	0.277	0.267
Sheffield Road A6178	Sheffield City Council	0.189	0.177	0.177	0.172	0.173	0.171	0.162
Upper Hanover Street A61	Sheffield City Council	0.280	0.266	0.267	0.266	0.217	0.254	0.217
Upwell Street A6102	Sheffield City Council	0.244	0.230	0.225	0.220	0.230	0.222	0.213
Whitham Rd A57	Sheffield City Council	0.250	0.239	0.247	0.243	0.205	0.209	0.216

3.4 Rotherham Baseline Dispersion Modelling Results

- The following table and graphs show the results of the Baseline 2017 modelling.

Table 6 – Rotherham: Monitored vs Modelled NO_X and NO_2 2017

Site name	Census id (if applicable)	Grid ref	Annual mean NO_X modelled 2017	Annual mean NO_X monitored 2017	Annual mean NO_2 modelled 2017	Annual mean NO_2 monitored 2017
Blackburn	n/a	438696 392816	**47.6**	**46.7**	**27.0**	**27.6**
Howarth School	n/a	442524 389134	**62.5**	**62.1**	**28.7**	**28.9**
Kirkstead Road	n/a	438611 392862	**75.19**	**75.2**	**47.9**	**47.2**
Blackburn School Entrance	n/a	438705 392845	**46.2**	**45.77**	**26.4**	**26.3**
Grange Farm Close	n/a	442866 389161	**58.7**	**55.6**	**36.2**	**34.4**
Doncaster Gate	n/a	443039 392855	**59.2**	**56.3**	**30.5**	**31**
Broom Road	27799	443969 392041	**49.2**	**47.1**	**25.3**	**25.3**
Wellgate Masonic Hall	60031	443072 392668	**62.2**	**61.8**	**37.6**	**38.2**
Bradgate A629	77552	441006 393338	**79.3**	**79.3**	**39.8**	**39.9**
St Ann's A630	58395	443347 393394	**73.4**	**78.3**	**40.5**	**39**
152 Fitz Rd	58395	443724 393628	**64.4**	**61.2**	**41.8**	**41.6**
Bawtry Rd	73908	441283 390309	**71.8**	**70.5**	**35.9**	**35.7**
Brinsworth Rd	n/a	442623 388976	**70.6**	**67.1**	**38.9**	**38.2**
Catcliffe Chemist	n/a	442587 388594	**57.2**	**55.5**	**31.4**	**31.7**
4m to Parkway A630 (tube Rotherham)	73910	442804 388927	**104.1**	**104.1**	**49.4**	**49.3**

Figure 8 – Rotherham Observed vs Adjusted Modelled NO_2 2017

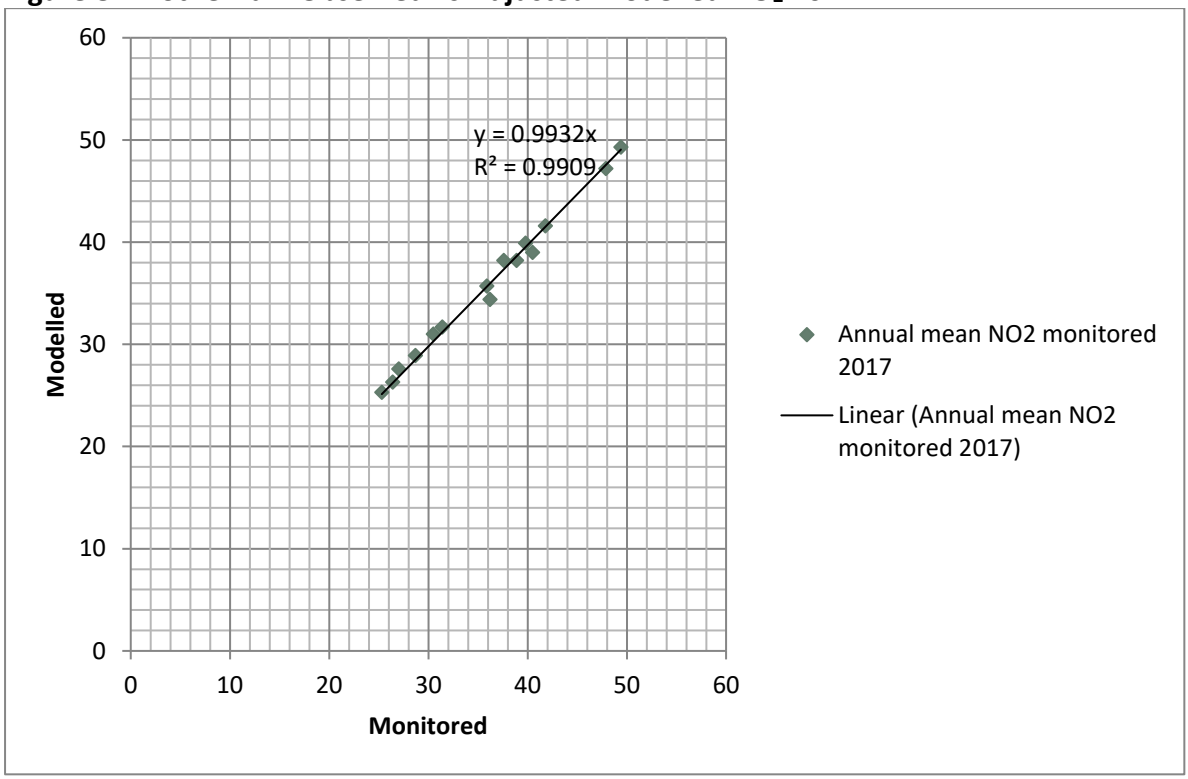
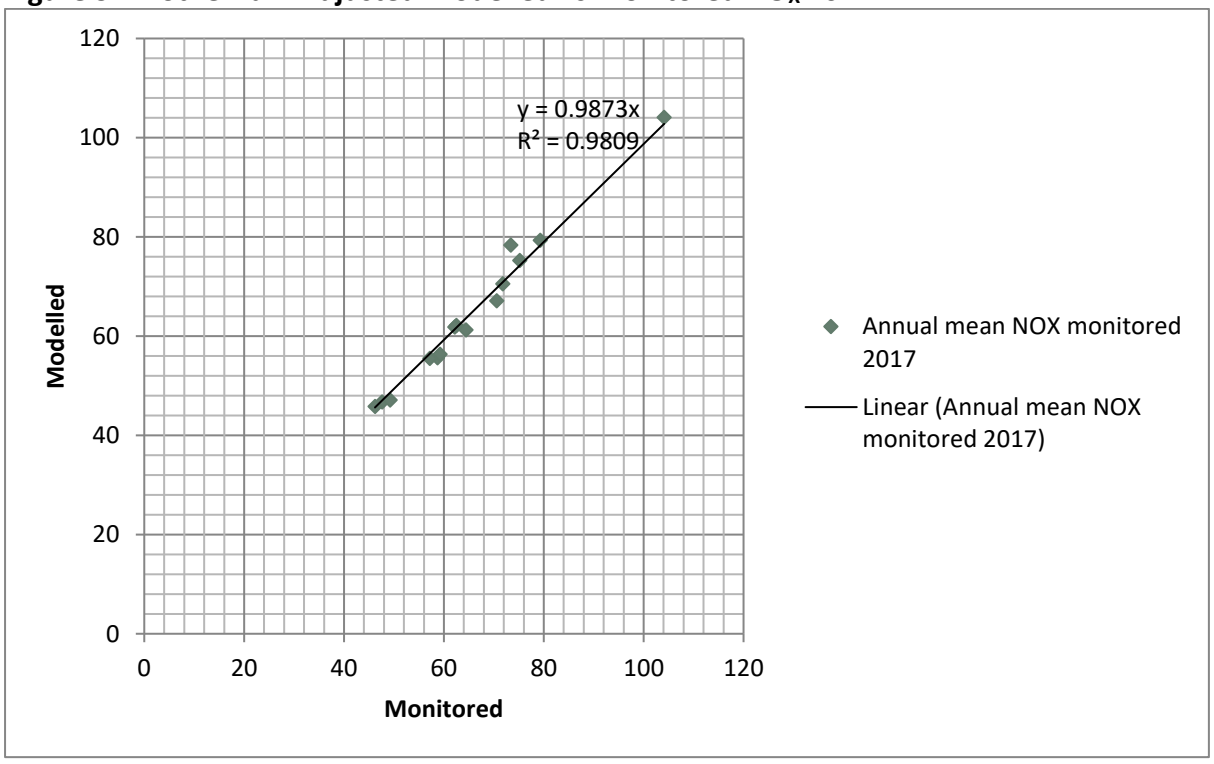


Figure 9 – Rotherham Adjusted Modelled vs Monitored NO_X 2017



- The f-NO_2 values for entering into the NO_X:NO_2 calculator were derived from the EFT and are shown below for key road links.

Table 7 – Locally derived f-NO_2 values – Rotherham

Location_Census_ID	Rotherham	fNO_2_2017	fNO_2_2021_BaU Final Baseline	fNO_2_2021_C3_(S)_C+ with Through Trips	fNO_2_2021_C3_(S)_D_VDM	fNO_2_2021_C2_(S)_D	fNO_2_2021_C1_(R+S)_D
17339	Rotherham Metropolitan Borough Council	0.270	0.256	0.266	0.268	0.269	0.268
17805	Rotherham Metropolitan Borough Council	0.287	0.273	0.269	0.274	0.288	0.264
17807	Rotherham Metropolitan Borough Council	0.272	0.260	0.272	0.275	0.261	0.255
17808	Rotherham Metropolitan Borough Council	0.292	0.275	0.271	0.275	0.284	0.282
18689	Rotherham Metropolitan Borough Council	0.263	0.251	0.255	0.253	0.243	0.244
27396	Rotherham Metropolitan Borough Council	0.281	0.269	0.271	0.275	0.271	0.265
27401	Rotherham Metropolitan Borough Council	0.302	0.302	0.299	0.306	0.299	0.299
27799	Rotherham Metropolitan Borough Council	0.264	0.250	0.256	0.262	0.260	0.258
27858	Rotherham Metropolitan Borough Council	0.265	0.252	0.256	0.262	0.262	0.256
28002	Rotherham Metropolitan Borough Council	0.299	0.284	0.279	0.283	0.292	0.272
36007	Rotherham Metropolitan Borough Council	0.271	0.274	0.274	0.282	0.266	0.268
37443	Rotherham Metropolitan Borough Council	0.273	0.261	0.263	0.268	0.270	0.268
37868	Rotherham Metropolitan Borough Council	0.294	0.280	0.276	0.281	0.288	0.288
38673	Rotherham Metropolitan Borough Council	0.275	0.262	0.262	0.272	0.286	0.233
47409	Rotherham Metropolitan Borough Council	0.300	0.286	0.283	0.286	0.290	0.259
56055	Rotherham Metropolitan Borough Council	0.292	0.280	0.277	0.280	0.285	0.273
57857	Rotherham Metropolitan Borough Council	0.272	0.257	0.253	0.258	0.272	0.252
58395	Rotherham Metropolitan Borough Council	0.253	0.238	0.238	0.245	0.269	0.241
60031	Rotherham Metropolitan Borough Council	0.258	0.243	0.246	0.252	0.254	0.254
60032	Rotherham Metropolitan Borough Council	0.219	0.207	0.227	0.234	0.214	0.220
60033	Rotherham Metropolitan Borough Council	0.306	0.292	0.287	0.290	0.295	0.299
60034	Rotherham Metropolitan Borough Council	0.249	0.235	0.248	0.254	0.256	0.261
73410	Rotherham Metropolitan Borough Council	0.215	0.214	0.234	0.247	0.225	0.215
7360	Rotherham Metropolitan Borough Council	0.257	0.246	0.258	0.264	0.251	0.255

7382	Rotherham Metropolitan Borough Council	0.273	0.262	0.260	0.266	0.272	0.283
7388	Rotherham Metropolitan Borough Council	0.293	0.280	0.279	0.283	0.288	0.287
73907	Rotherham Metropolitan Borough Council	0.249	0.236	0.239	0.243	0.245	0.235
73908	Rotherham Metropolitan Borough Council	0.278	0.265	0.263	0.270	0.275	0.257
73910	Rotherham Metropolitan Borough Council	0.285	0.278	0.269	0.272	0.276	0.273
73911	Rotherham Metropolitan Borough Council	0.285	0.276	0.276	0.275	0.284	0.289
77384	Rotherham Metropolitan Borough Council	0.298	0.288	0.291	0.294	0.293	0.295
7750	Rotherham Metropolitan Borough Council	0.273	0.252	0.245	0.257	0.279	0.244
77542	Rotherham Metropolitan Borough Council	0.278	0.263	0.269	0.274	0.271	0.273
77548	Rotherham Metropolitan Borough Council	0.260	0.248	0.252	0.258	0.255	0.257
77549	Rotherham Metropolitan Borough Council	0.307	0.293	0.284	0.293	0.305	0.305
77552	Rotherham Metropolitan Borough Council	0.262	0.250	0.254	0.273	0.293	0.252
77554	Rotherham Metropolitan Borough Council	0.261	0.245	0.244	0.251	0.273	0.281
77563	Rotherham Metropolitan Borough Council	0.232	0.228	0.267	0.270	0.250	0.229
77615	Rotherham Metropolitan Borough Council	0.253	0.261	0.262	0.272	0.255	0.252
77759	Rotherham Metropolitan Borough Council	0.199	0.191	0.179	0.184	0.201	0.207
7973	Rotherham Metropolitan Borough Council	0.272	0.261	0.262	0.269	0.272	0.277
80807	Rotherham Metropolitan Borough Council	0.275	0.262	0.261	0.266	0.272	0.279
8345	Rotherham Metropolitan Borough Council	0.284	0.268	0.267	0.273	0.278	0.246
8590	Rotherham Metropolitan Borough Council	0.222	0.208	0.219	0.217	0.208	0.161
99965	Rotherham Metropolitan Borough Council	0.232	0.228	0.267	0.270	0.250	0.229
A629 Wortley Road	Rotherham Metropolitan Borough Council	0.266	0.253	0.254	0.270	0.294	0.222
A630 Fitzwilliam Road	Rotherham Metropolitan Borough Council	0.260	0.244	0.244	0.250	0.273	0.251
A630 Parkway	Rotherham Metropolitan Borough Council	0.285	0.278	0.269	0.272	0.276	0.273
A633 Rawmarsh Hill	Rotherham Metropolitan Borough Council	0.266	0.254	0.265	0.271	0.275	0.257

3.5 NO_X Emissions for All Road Transport Sources – 2017

- The evidence submission is accompanied by an Excel file which lists the estimated annual NO_X emissions in 2017 and 2021 for every link in the SCRTM3B traffic model, on a link-by-link basis. These are contained in supporting documents SD04 and SD05.

3.6 SCENARIO PROJECTIONS - 2021

- This section describes the air quality modelling predicted values for the 2021 'Business as Usual', Scenarios for different Clean Air Zones 2021 with different 'Do Something' measures.

- NO_2 concentrations are also presented in this section for the 2017 Business as Usual forecasts. This is presented for validation receptors those where the AQD (Air Quality Directive) is forecast to be non-compliant in 2021, and also for other predicted compliant receptors.

Table 8 –Sheffield's modelled annual mean nitrogen dioxide results for the following:

Site Name	Census id	Road ID	x-co-ord	y co-ord	Modelled NO_2 annual mean 2017 BaU	Modelled NO_2 annual mean 2021 BaU (new) Baseline	Modelled NO_2 annual mean 2021 Cordon 3 CAZ C+ with additional measures (FPO) 'new'	Modelled NO_2 annual mean 2021 Cordon 3 CAZ D with additional measures	Modelled NO_2 annual mean 2021 Cordon 2 CAZ D with additional measures	Modelled NO_2 annual mean 2021 Cordon 1 CAZ D with additional measures
PCM Link A6135	7355	A6135	438506	384878	38.63	31.97	29.09	29.32	30.83	32.25
PCM Link A6178	7380	A6178	438009	388893	44.11	36.69	33.57	32.84	28.64	32.17
PCM Link A6102	7817	A6102	437667	390107	38.48	32.19	30.39	31.52	26.32	29.04
PCM Link A6102	7818	A6102	436003	381661	32.51	26.84	25.75	26.23	24.99	26.39
PCM Link A57	8144	A57	433584	387108	36.30	30.37	26.00	24.44	27.38	29.91
PCM Link A621	8710	A621	431992	380867	19.58	16.74	15.84	15.78	16.40	16.68
PCM Link A61	8744	A61	435362	386383	62.38	51.56	39.93	31.64	41.31	44.93
PCM Link A61	8758	A61	435742	386706	63.73	52.13	39.82	31.92	42.76	46.47
PCM Link M1	16007	M1	438018	393370	50.37	40.84	39.36	41.16	39.00	40.15
PCM Link A61	16580	A61	433563	389991	40.00	32.87	30.08	29.60	31.80	33.15
PCM Link A61	16581	A61	435009	384805	33.37	27.45	24.11	23.15	25.47	26.84

PCM Link A631	17332	A631	440115	390799	47.91	39.38	37.20	37.86	35.00	36.48
PCM Link A6109	17718	A6109	438610	390617	46.59	38.82	35.85	35.38	31.32	34.96
PCM Link A6315	17728	A6315	435839	388817	37.41	31.34	29.39	31.27	27.53	28.97
PCM Link A61	17809	A61	434808	388215	53.76	44.9	35.95	30.33	38.10	40.58
PCM Link A61	18546	A61	433471	390523	40.72	33.45	30.72	30.69	32.59	33.89
PCM Link A6102	18721	A6102	439374	388259	41.33	34.36	33.04	32.72	27.19	30.33
PCM Link A6135	27373	A6135	437947	385193	38.06	31.72	28.84	30.66	29.71	31.59
PCM Link A621	27381	A621	434749	385004	34.18	28.15	24.87	23.85	25.93	27.63
PCM Link A6178	27393	A6178	437082	388345	39.41	33.08	30.03	30.69	27.09	29.61
PCM Link A6101	27821	A6101	433358	389729	40.17	32.93	30.23	31.01	32.67	33.73
PCM Link A6102	27822	A6102	438729	386001	36.28	29.8	28.42	29.82	25.24	27.88
PCM Link A61	27857	A61	435758	385993	43.27	36.12	30.67	28.35	31.57	34.74
PCM Link M1	28052	M1	439531	391348	55.37	46.1	43.79	45.57	42.48	43.10
PCM Link A6102	28172	A6102	433243	390478	38.20	31.34	27.68	26.79	30.01	31.03
PCM Link A631	28868	A631	439676	389992	40.05	31.53	30.08	29.95	27.41	29.78
PCM Link 630	36588	A630	440015	386727	43.57	35.67	32.24	31.56	27.82	32.05
PCM Link A6178	37441	A6178	439717	390829	49.62	41.3	38.99	39.41	34.60	37.99
PCM Link A61	37898	A61	435809	386349	58.23	48.08	37.34	31.35	39.07	44.34
PCM Link A6102	37902	A6102	438286	389811	39.43	32.71	30.68	31.08	26.63	29.31
PCM Link A631	37913	A631	439519	391480	56.79	47.2	44.89	46.79	43.83	44.29
PCM Link A6178	38549	A6178	438601	389692	47.71	40.03	37.68	37.68	31.48	34.76
PCM Link A61	46619	A61	433978	389419	44.10	36.24	32.05	30.00	33.35	35.11
PCM Link A61	46620	A61	434987	381693	32.27	26.4	23.92	23.66	25.70	26.48
PCM Link A621	47393	A621	435240	386002	47.10	39.06	32.50	29.11	33.19	36.97
PCM Link A625	47396	A625	434290	386197	42.83	35.34	31.74	31.96	34.70	38.33
PCM Link A629	47405	A629	435534	396240	34.21	28.33	25.80	25.89	27.63	28.04
PCM Link A6109	47826	A6109	439171	391727	47.38	39.18	37.29	37.51	33.97	35.28
PCM Link A57	47855	A57	437766	387454	57.99	46.95	39.43	32.03	36.97	42.36
PCM Link A61	47856	A61	433380	390693	39.13	32.23	29.38	29.07	31.43	32.67
PCM Link A61	47860	A61	434401	386985	47.33	38.71	31.44	26.88	32.97	35.66
PCM Link A61	48531	A61	435191	381000	35.54	28.89	26.62	26.70	27.69	28.63
PCM Link A6102	48804	A6102	439088	389152	43.03	35.24	32.45	32.64	28.63	31.78

PCM Link A61	48805	A61	435531	386560	60.27	48.69	37.95	30.56	38.87	43.54
PCM Link A61	56608	A61	435009	388014	53.57	44.41	35.64	29.10	36.12	39.96
PCM Link A629	56862	A629	436006	395739	24.46	20.45	19.43	19.50	19.68	20.00
PCM Link A6109	56863	A6109	436322	388234	47.82	39.5	33.77	30.89	31.95	35.34
PCM Link A6178	57330	A6178	440015	391185	42.97	35.57	33.61	33.84	31.52	32.13
PCM Link A61	57861	A61	435003	386381	60.04	49.51	39.16	30.40	39.31	44.60
PCM Link A6135	57875	A6135	436492	390149	42.94	35.6	31.31	31.47	33.11	34.88
PCM Link A6102	58427	A6102	439171	386995	40.52	33.49	31.73	31.10	27.06	30.31
PCM Link A61	60030	A61	435809	387001	60.26	49.01	37.19	29.82	40.42	44.30
PCM Link M1	73909	M1	440833	389848	55.72	44.97	43.26	45.47	42.88	44.60
PCM Link A61	75194	A61	435548	386632	61.52	50.1	39.09	31.37	40.49	45.65
PCM Link A61	75195	A61	435810	386626	65.23	53.38	40.27	32.13	42.75	47.08
PCM Link A61	75196	A61	435753	386520	64.58	53.06	40.46	31.72	42.35	46.47
PCM Link A61	75197	A61	435573	386464	58.82	48.1	37.44	30.13	39.01	42.14
PCM Link A61	75198	A61	435737	386648	49.05	42.76	34.23	29.44	36.47	40.45
PCM Link A61	75199	A61	435592	386538	57.89	47.57	37.04	30.11	39.01	43.83
PCM Link A6135	76044	A6135	435936	388031	54.38	46.08	37.04	29.85	37.93	41.55
PCM Link A61	76045	A61	436210	387645	58.79	48.23	38.74	30.70	38.54	43.75
PCM Link A61	76046	A61	436246	387844	54.43	44.92	36.14	29.03	35.97	40.29
PCM Link A57	77544	A57	431994	387127	26.58	22.01	20.43	20.36	21.15	22.25
PCM Link A6101	77547	A6101	433005	389489	45.48	37.45	33.50	34.06	36.71	37.92
PCM Link A6102	77551	A6102	432723	391009	31.56	26.26	23.63	23.33	25.40	26.10
PCM Link A61	77553	A61	433793	392251	32.12	26.47	24.68	24.78	26.08	26.93
PCM Link A6135	77557	A6135	435631	396500	25.49	21.3	20.12	20.29	21.09	21.45
PCM Link A6135	81155	A6135	436829	386425	40.00	33.22	28.74	27.31	29.14	31.45
PCM Link A61	81162	A61	435402	388018	59.26	49.66	39.65	31.49	38.92	44.65
PCM Link A6102	81227	A6102	435013	390701	43.35	35.65	33.14	34.20	33.54	35.01
PCM Link A6102	81228	A6102	433571	390669	42.77	35.13	32.38	33.01	34.09	35.47
PCM Link A6102	81229	A6102	433482	390875	37.35	30.97	28.66	29.12	29.96	30.99
PCM Link A6102	81230	A6102	433152	390852	39.28	32.3	29.54	29.85	31.65	32.63
PCM Link A61	81236	A61	435658	388179	58.71	50.28	39.75	30.98	39.09	44.38
PCM Link A61	81237	A61	435810	388040	60.48	50.06	39.05	31.85	40.78	44.93

PCM Link A6109	81238	A6109	435861	388168	45.38	37.88	30.81	26.27	31.24	34.74
PCM Link A57	99303	A57	439254	386597	52.51	42.93	39.08	37.28	32.76	38.05
Glossop Road B6547	n/a	Glossop Rd B6547	435288	387228	40.50	32.02	29.08	24.31	26.20	27.59
Barkers Pool Taxi Rank	n/a	Barkers Pool Taxi Rank	433413	386746	38.30	33.58	27.10	29.01	35.41	38.08
C710 Arundel Gate	n/a	C710	435601	387255	53.35	45.47	35.49	31.62	40.10	42.57
Beeley Wood Rd, S6	n/a	Beeley Wood Rd	433248	391120	39.91	32.88	30.06	30.10	32.55	33.68

Note: if Cordon 1 CAZ D option is taken forward some sites will require additional mitigation measures as there are some remaining non-compliances along stretches of the A61.

- Sheffield has a city wide Air Quality Management Area, which mainly covers the urban area except the Peak District. In terms of compliance with the AQD, the significant locations for Sheffield are:
  - The A630 Parkway (Census ID 76045, 47855, 99309), which was also identified by Defra's modelling and one of the sites which led to the Council being mandated
  - A61 Sheaf Street (Census ID 36588) close to Sheffield train station and a link on the east side of the inner ring road
  - A61 St Mary's Gate (Census ID 57861) and A61 St Mary's Road (Census ID 75196) both links on the west side of the inner ring road
  - A61 Suffolk Road (Census IDs 75195, 8757) which are links close to the train station and on the southeast side of the inner ring road
  - A6178 Sheffield Road (Census ID 37441) is close to J34S M1 Motorway
  - A61 Derek Dooley Way an inner ring road link (Census IDs 81236, 81237, 81238), which was also identified by Defra's modelling and one of the sites which led to the Council being mandated
  - The following links are locations within the city centre: A61 Shoreham Street (Census IDs 48805, 75194), A61 Fornham Street (Census ID 75198), A61 Matilda Street (Census ID 75199) and Arundel Gate (C710), which does not have a Census ID
  - A61 Shalesmoor (Census ID 81162), A61 Hoyle Street (Census ID 17809) and A61 Morfields (Census ID 56608), which are on the north side of the inner ring road
  - A6135 The Wicker (Census ID 76044) is a link to the north of the city centre and just outside the inner ring road
  - A6109 Savile Street (Census ID 81238), A6178 Attercliffe Common (Census ID 38549) and A6109 Meadowhall Road (Census ID 47826) are links to the northeast and form part of the arterial route into and out of the city
  - A621 Bramall Lane (Census ID 47393) and A61 Queens Road are links south of the city centre and just outside the inner ring road, and form part of the arterial route into and out of the city
  - The M1 (Census IDs 73909, 16007, 28052) and A631 Tinsley Viaduct (Census ID 37913) are also links to the northeast. However, they are the responsibility of Highways England to deal with their compliance

  The above identified locations are likely to have non-compliant (or close to non-compliant) annual average NO_2 concentrations in 2021, under 'Business as Usual' assumptions.
- In particular, Arundel Gate (C710) operates as a busy bus interchange and is exposing a significant number of pedestrians and bus passengers to its non-compliant levels of NO_X / NO_2 and will therefore need to be treated as a 'special case'.
- The locations for target determination in Sheffield are Parkway (A57), Sheaf Street (A61), Sheffield Road (A6178), Derek Dooley Way (A61) and Arundel Gate (C710). Further details are contained in Supporting Document SD02.

- Table 9 shows modelled annual mean nitrogen dioxide for the following:
  - **2017 BaU**
  - **2021 BaU**
  - **2021 Cordon 3 CAZ C+ with additional measures**
  - **2021 Cordon 3 CAZ D with additional measures**
  - **2021 Cordon 2 CAZ D with additional measures**
  - **2021 Cordon 1 CAZ D with additional measures**

Table 9 – Rotherham's 2017, 2021 BaU and Scenario Annual Mean NO_2 Modelled Results

Site Name	Census id	Road ID	x-co-ord	y co-ord	Modelled NO_2 annual mean 2017 BaU	Modelled NO_2 annual mean 2021 BaU (new) Baseline	Modelled NO_2 annual mean 2021 Cordon 3 CAZ C+ with additional measures (FPO) 'new'	Modelled NO_2 annual mean 2021 Cordon 3 CAZ D with additional measures	Modelled NO_2 annual mean 2021 Cordon 2 CAZ D with additional measures	Modelled NO_2 annual mean 2021 Cordon 1 CAZ D with additional measures
Parkway (4m)	73910	A630	442410	388750	48.4	42.8	40.3	39.91	36.23	38.5
Rawmarsh Hill (4m)	17339	A633	443695	395454	49.3	44.1	40.2	38.19	39.4	39.1
Wortley Road (4m)	77552	A629	441075	393332	44.9	43.2 (tbc)	39.8 (tbc)	39.25	36.2	35.8
Fitzwilliam Road (4m)	58395	A630	443317	393399	45	41.96	38.7	39.31	39.03	39.1
PCM link -A6022 (4m)	27858	A6022	445311	389216	31.13	26.46	25.61	26.21	25.52	26.29
PCM Link -M1, (4m)Blackburn, Rotherham **Highways England**	36007 (location 1)	M1	438607	392848	50.51 *(new data provided by HE)*	*40.56*	37.35	62.4	60.03	61.78
PCM link - A631 (4m)	37443	A631	444569	390295	32.26	29.12	27.51	27.33	27.23	27.96
PCM link -A631 (4m)	47409	A631	444315	390127	32.76	24.92	23.9	23.99	26.28	27.72
PCM link -A631 (4m)	56055	A631	443414	389547	38.24	25.28	24.17	32.58	30.13	30.15
PCM link -A6123 (4m)	60033	A6123	443026	394710	31.13	38.45	36.28	23.99	25.32	26.34
PCM link -A6023 (4m)	73410	A6023	443241	401486	29.06	31.86	29.64	27.68	23.51	24.52
PCM link -A633 (4m)	7388	A633	443599	400946	31.13	21.35	20.54	27.5	23.51	24.42
PCM link -A631 (4m)	73908	A631	441279	390306	33.2	32.49	31	27.21	26.43	27.21
PCM link -A57 (4m)	73911	A57	444630	384371	35.28	31.31	29.07	28.27	28.83	29.93

PCM link -A618 (4m)	77548	A618	443927	389895	30.09	33.48	31.15	24.83	24.24	24.83
PCM link -A634 (4m)	77549	A634	453402	392141	21.84	21.2	20.38	18.51	18.61	18.53
PCM link -A630 (4m)	77554	A630	446010	394518	34.24	33.23	31.03	21.71	21.36	21.43
PCM link -A633 (4m)	77563	A633	443972	400994	31.13	32.74	31.05	28.27	23.51	24.5
PCM link -A57 (4m)	77759	A57	451754	383960	30.09	34.47	32.43	24.83	23.51	24.9
PCM link -A633 (4m)	99965	A633	444029	401284	31.13	32.17	29.61	21.71	23.51	21.86
PCM link -A630 (4m)	17805	A630	442271	392395	34.24	31.83	28.5	36.68	35.38	33.75
PCM link -A631 (4m)	17807	A631	445708	391334	37.36	21.38	20.69	30.18	30.64	30.95
PCM link -A6123 (4m)	17808	A6123	445231	391301	24.93	28.57	25.91	20.78	20.78	21.12
PCM link -A6109 (4m)	18689	A6109	439518	391958	35.28	25.48	23.74	31.5	30.25	30.25
PCM link -A631 (4m)	27396	A631	444990	390817	39.45	24.51	23.27	31.71	31.71	32.53
PCM link -A6021 (4m)	27799	A6021	445004	391582	37.36	29.11	27.35	29.56	30.54	30.15
PCM link -M1 Brinsworth (4m)	36007 (location 2)	M1	441743	389240	63	28.26	26.8	62.4	63.29	65.78
PCM link -A631 (4m)	37443	A631	451176	392055	37.36	32.81	31.4	33.63	30.75	31.06
PCM link -A6123 (4m)	37868	A6123	445026	392002	24.93	25.68	24.34	20.66	31.48	29.27
PCM link -A629 (4m)	38673	A629	441997	393118	38.4	35.35	33.49	31.6	32.81	31.97
PCM link -A631 (4m)	47409	A631	443592	389965	39.45	25.48	24.1	32.59	32.03	30.14
PCM link -A631 (4m)	56055	A631	443009	390122	39.45	21.11	20.18	31.67	32.11	30.44
PCM link -A630 (4m)	57857	A630	442268	392799	39.45	21.14	20.25	32.76	30.83	30.61
PCM link -A6021 (4m)	60031	A6021	443354	392480	37.36	26.5	24.95	28.75	30.73	30.92
PCM link -A6021 (4m)	60032	A6021	443201	392992	35.28	29.88	28.05	31.67	31.15	32.13
PCM link -A6023 (4m)	60033	A6123	444952	394587	24.93	26.95	25.67	20.98	27.38	26.3
PCM link - A633 (4m)	60034	A633	443521	394689	34.24	26.46	25.61	26.35	24.65	25.03
PCM link -A618 (4m)	7360	A618	444009	390804	30.09	25.48	25.85	24.12	23.11	23.04
PCM link - A631 (4m)	7382	A631	447994	391929	28.02	29.12	27.51	23.58	26.12	25.8
PCM link -A6178 (4m)	73907	A6178	442004	391870	34.24	24.92	23.9	27.58	27.01	27.13
PCM link -A631 (4m)	73908	A631	441885	390419	33.2	25.28	24.17	27.21	31.99	33.26
PCM link - A57 (4m)	73911	A57	444666	384363	38.4	38.45	36.28	31.33	24.8	25.59
PCM link -A618 (4m)	77384	A618	445591	385008	30.09	31.86	29.64	24.51	32.54	30.5
PCM link - A630 (4m)	7750	A630	442592	393155	39.45	21.35	20.54	33.37	24.72	25.24
PCM link - A618 (4m)	77542	A618	445268	385995	30.09	32.49	31	24.4	20.76	20.67
PCM link - A6021 (4m)	7973	A6021	445495	391527	24.93	31.31	29.07	20.47	20.31	20.25
PCM link - A6023 (4m)	80807	A6123	442713	394219	24.93	33.48	31.15	20.44	24.95	24.25

PCM link - A6021 (4m)	8345	A6021	442594	392182	31.13	21.2	20.38	25.28	28.36	27.02
PCM link - A6109 (4m)	8590	A6109	441152	393010	35.28	33.23	31.03	28.36	24.97	24.58
PCM link - A633 (4m)	27401	A633	442509	401861	29.1	32.74	31.05	26.31	24.65	25.13
PCM link - A630 (4m)	28002	A630	442517	391650	33.6	34.47	32.43	25.28	23.75	24.23
PCM Link - A631 (4m)	77550	A631	n/a	n/a	n/a Not in modelled area	n/a	n/a	n/a	n/a	n/a
Blackburn School (monitoring site)			438696	392816	27.6	22.42	21.86	22.01	21.8	22.06
Bradgate Lane (monitoring site)			441006	393338	39.9	32.72	30.19	31.14	30.54	28.78
Brinsworth Howarth School (monitoring site)			442524	389134	28.6	23.5	22.82	24	22.69	23.27
St Ann's Fitzwilliam Road (monitoring site)			443347	393394	41.79	36.36	34.67	35.62	34.74	34.56
Wales School Road (monitoring site)			447368	382900	41.39	32.39	29.42	30.26	32.17	32.65
Doncaster Gate (monitoring site)			443039	392855	31	26.2	24.37	25.2	25.56	26.06
75 Broom Road (monitoring site)			443969	392041	25.32	20.97	20.05	21.01	20.55	20.44
Broom Avenue (monitoring site)			444565	391641	26.27	21.59	20.54	21.52	20.95	21.02
152 Fitzwiliam Road (monitoring site)			443724	393628	41.61	34.7	32.67	33.8	32.57	31.79
31 York Road (monitoring site)			443365	393357	31.17	26.5	25.22	26.15	25.43	25.54
Wellgate, Masonic Hall (monitoring site)			443072	392668	38.19	32.03	29.23	30.21	31.21	31.79
Kirkstead Road TUBE (monitoring site)			438611	392862	47.24	38.00	36.64	38.48	36.51	36.97
Moorgate Road (monitoring site)			443764	391283	31.5	25.8	23.94	25.11	25.03	25.11
Rawmarsh Library (monitoring site)			443699	395439	38.9	31.26	36.64	28.68	29.42	31.64

42 Rawmarsh Hill (monitoring site)			443677	395545	54.2	43.88	41.3	39.94	41.14	41.35
227 Wortley Road (monitoring site)			441049	393331	48.07	39.66	36.2	37.19	36.76	34.21
Blackburn School Building Entrance (monitoring site)			438705	392845	26.34	21.43	20.91	21.99	20.84	21.08
169 Bawtry Rd Brinsworth (monitoring site)			441283	390309	35.66	28.75	28.95	29.87	28.55	29.18
Derwent Crescent, Brinsworth (monitoring site)			441765	389248	40.94	33.36	32.41	34.03	32.41	33.43
Brinsworth Road (monitoring site)			442623	388976	38.7	31.38	30.13	31.8	29.75	30.92
Grange Farm Close (monitoring site)			442866	389161	34.4	28.48	27.56	29.07	27.52	28.4
Catcliffe Rotherham Road (monitoring site)			442587	388594	31.7	26.06	24.76	25.83	24.05	24.99

- The key locations in terms of compliance with the AQD are the A629 Wortley Road (Census ID 77552), A633 (Rawmarsh Hill Census ID 17339), A630 Fitzwilliam Road (Census ID 58395) and the A630 Parkway (Census ID 73910), which was also identified by Defra's modelling and the site which led to the Councils being mandated.

- Two of these roads have significant gradient issues (A629 and A633). Additional Information on the non-compliant road links 2021 follows

- The A633 census id 17339 Rawmarsh Hill has a steep uphill gradient (which is not accounted for in the emissions data from the transport model), acceleration from standing at traffic lights uphill (it should be stressed that we do not assess compliance within 25m of a junction as per JAQU requirements), and the presence of buildings close to the road (street canyon). The link which is forecast to be non- compliant in 2021 without measures is in an Air Quality Management Area. The Council has monitored data going back many years. The highest measured nitrogen dioxide roadside annual mean 2017 was 54 ug/m^3, however, this monitoring location is not the point with the highest level of nitrogen dioxide annual mean along the route. The road is close to a major shopping centre which attracts a significant number of vehicle trips. For 2017, buses have been calculated to contribute 20 % of NOx emissions at roadside.

- The A629 census 77552 has a steep uphill gradient (which is not accounted for in the emissions data from the transport model), acceleration from a roundabout uphill and is a route used by HGVs to the M1 J35, in spite of signage directing them to J34 (N) being present. The link which is forecast to be non-compliant in 2021 without measures is in an Air Quality Management Area. We have monitored data going back many years. The highest measured nitrogen dioxide roadside annual mean 2017 was 48 ug/m^3, however, this monitoring location is not the point with the highest level of nitrogen dioxide annual mean along the route. The proposed CAZ measure for this link is to divert HGVs along the alternative route to M1 J34(N) using a TRO. The residents living on this route have contacted the Council with their concerns about HGVs over the past few years.

- The Parkway (A630) 73910 is the main route from J33 of the M1 to Sheffield City Centre. It has no sensitive receptors in terms of LAQM within 4m of the carriageway. The only possible pedestrian public exposure in the section which goes through Rotherham is a footpath crossing. The speed in that section is currently 70mph, so it is highly unlikely that anyone would attempt to cross the road. The road experiences congestion, in particular during the pm peak period when drivers are heading for M1 J33 from Sheffield City Centre. A major scheme which will reduce congestion and reduce speed to 50mph is programmed.

- A630 Fitzwilliam Rd (census 58395) is on the main route from east to west through Rotherham town centre. The link which is forecast to be non- compliant in 2021 without measures is in an Air Quality Management Area. We have monitored data going back many years showing exceedance of the AQD. It is also close to one of the largest steelworks in the UK (Aldwarke) and many other major industrial sources of NOx such as large glass works.

- Levels of nitrogen dioxide at 4m from M1 (census 36007) are the highest in the borough and much higher than any of the levels at 4m from local roads. In Rotherham we have relevant exposure of resident at distances of around 20m from the carriageway and the Council has declared several Air Quality Management Areas as a result of emissions from the M1.

- These four sites in Rotherham (A629, A630 (Parkway), A630 (Fitzwilliam Road) and A633 (Rawmarsh Hill) were included in JAQU's target determination process (See Supporting

Document SD03). The M1 was also included, however it is the responsibility of Highways England to deal with this issue.

- **Determination of the Preferred Option, Outline Business Case**

- The preferred option is the Cordon 3 (Sheffield Inner Ring Road) CAZ C+ with additional Rotherham and Sheffield Specific measures to achieve compliance in the most cost effective and timely manner.

- Our 'preferred option' is to introduce a charging Clean Air Zone (CAZ) Class C in an area covering Sheffield city centre from the inner ring road inwards.

- Class C charging applies to non-compliant buses, taxis/private hire vehicles, Heavy Goods Vehicles (HGVs) and Light Goods Vehicles (LGVs). It will not apply to private cars.

- We are proposing that the charge is £50 a day for non-compliant buses and HGVs and £10 a day for non-compliant vans and taxis/private hire vehicles.

- Our preferred option is for the charging zone to be accompanied by a suite of support packages, to enable owners and drivers to replace older, polluting vehicles more quickly than they otherwise would. We have made clear that we do not want people to pay the CAZ charge, as this would increase their outgoings whilst not delivering the air quality improvements that we need. The charging zone is designed to encourage people to move away from dirty vehicles ('the stick'), while the proposed supporting packages are designed to provide positive incentives to finance, support and enable that change ('the carrot').

- This will bring significant improvements to the buses, taxis, lorries and vans on Sheffield and Rotherham's roads, reducing emissions and improving the air that our communities breathe across the area (ie. cleaner buses, taxis, vans run across the city, not just within the CAZ).

4. NO_X TO NO_2 CONVERSION

- The methodology used was to model the traffic-related NO_X emissions (on a link-by-link basis), to derive concentrations of road NOx annual mean at receptor locations. The road NOx was factored (as above) and entered into Defra's NO_X to NO_2 calculator with the relevant f-NO_2 value for the road link and year, and background (all other sources) NOx. The calculator produces annual mean NO_2 for each location. This process is described in other sections of AQ3 and in AQ2.

5. SUMMARY

5.1 Introduction

- This section provides a summary of the baseline, BaU forecast and scenario testing.

- Compliance Summary

- The SRTM3B-based traffic emissions and local Airviro-based air quality modelling has identified a total of twenty four roads, twenty in Sheffield and four in Rotherham, which are not predicted to be compliant with the AQD for annual average NO_2 levels in 2021, under Business as Usual assumptions.

- In decreasing order of predicted annual average NO_2 levels in 2021, these twenty four road links are:

    - M1 from J35 to J31 in Rotherham (60 µg/m^3)
    - Suffolk Road Sheffield (54.8 µg/m^3)
    - St Mary's Road (53.0 – 49.3 µg/m^3)
    - Derek Dooley Way Sheffield (51.7 – 46.1 µg/m^3)
    - Shoreham Street (51.5 – 50.0 µg/m^3)
    - Shalesmoor (51.0 µg/m^3)
    - St Mary's Gate Sheffield (50.9 µg/m^3)
    - Sheaf Street Sheffield (50.2 µg/m^3);
    - A630 Parkway Sheffield (49.9 – 44.6 µg/m^3)
    - Hawke Street (49.3 µg/m^3)
    - Matilda Street (48.6 µg/m^3)
    - Tinsley Viaduct (M1) (48.4 µg/m^3)
    - The Wicker Sheffield (47.7 µg/m^3)
    - M1 from J35 to J31 in Sheffield (47.2 – 42.2 µg/m^3)
    - Arundel Gate Sheffield (46.7 µg/m^3)
    - Hoyle Street (45.7 µg/m^3)
    - Moorfields (45.6 µg/m^3)
    - A630 Parkway Rotherham (43.6 µg/m^3)
    - Attercliffe Common Sheffield (43.1 – 41.1 µg/m^3)
    - Fornham Street (43.0 µg/m^3)
    - Rawmarsh Hill Rotherham (42.4 µg/m^3)
    - A629 Bradgate - Wortley Road (Rotherham) (41.5 – 41.3 µg/m^3)
    - Bawtry Road (41.0 µg/m^3); and
    - Meadowhall Road (40.6 µg/m^3)

5.2 Target Determination

- The required target determination is provided in spreadsheets which go alongside this report. These can be found in Supporting Documents SD02 (for Sheffield) and SD03 (for Rotherham).

5.3 Analytical Assurance Statement

- An updated 'Analytical Assurance Statement' has been provided as a stand-alone document as part of the **Initial Evidence Submission.**