

Appendix 8.3 Air Quality Assessment Appendices

Appendix 8.3A: Air Quality Figures

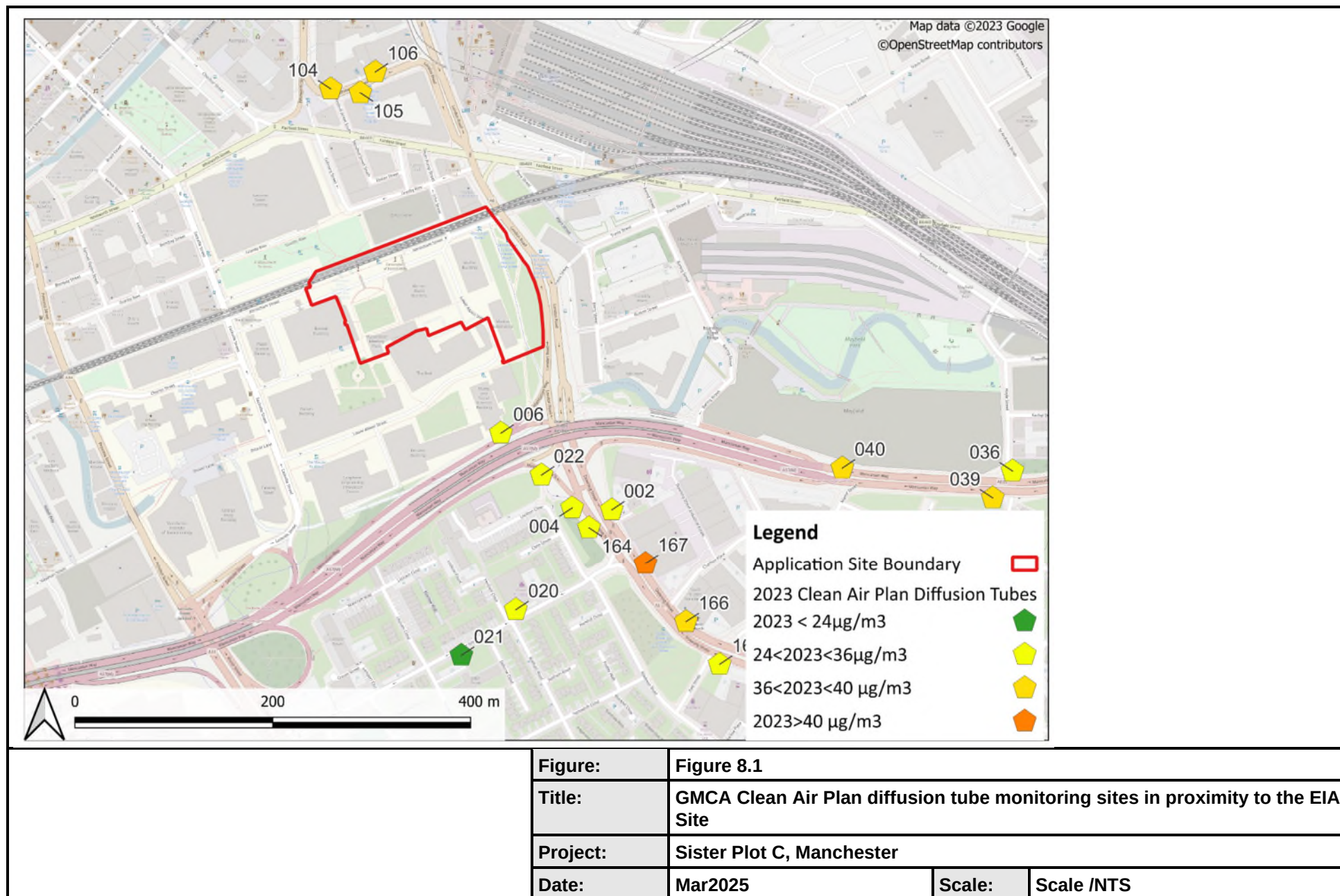
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Appendix 8.3A Air Quality Figures



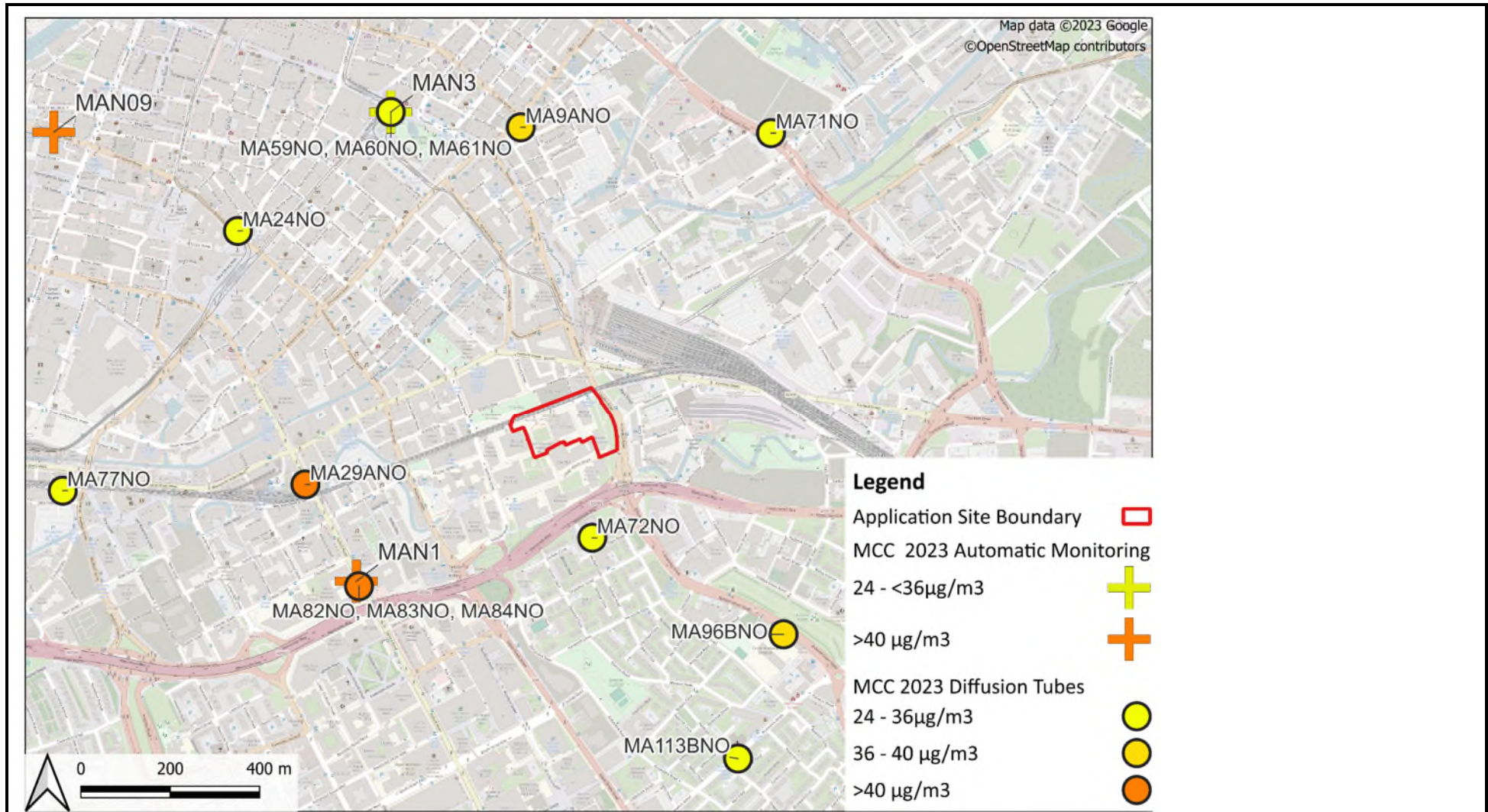


	Figure:	Figure 8.2		
	Title:	GMCA Local Air Quality Management automatic and diffusion tube monitoring sites in proximity to the EIA Site		
	Project:	Sister Plot C, Manchester		
	Date:	Mar2025	Scale:	Scale /NTS

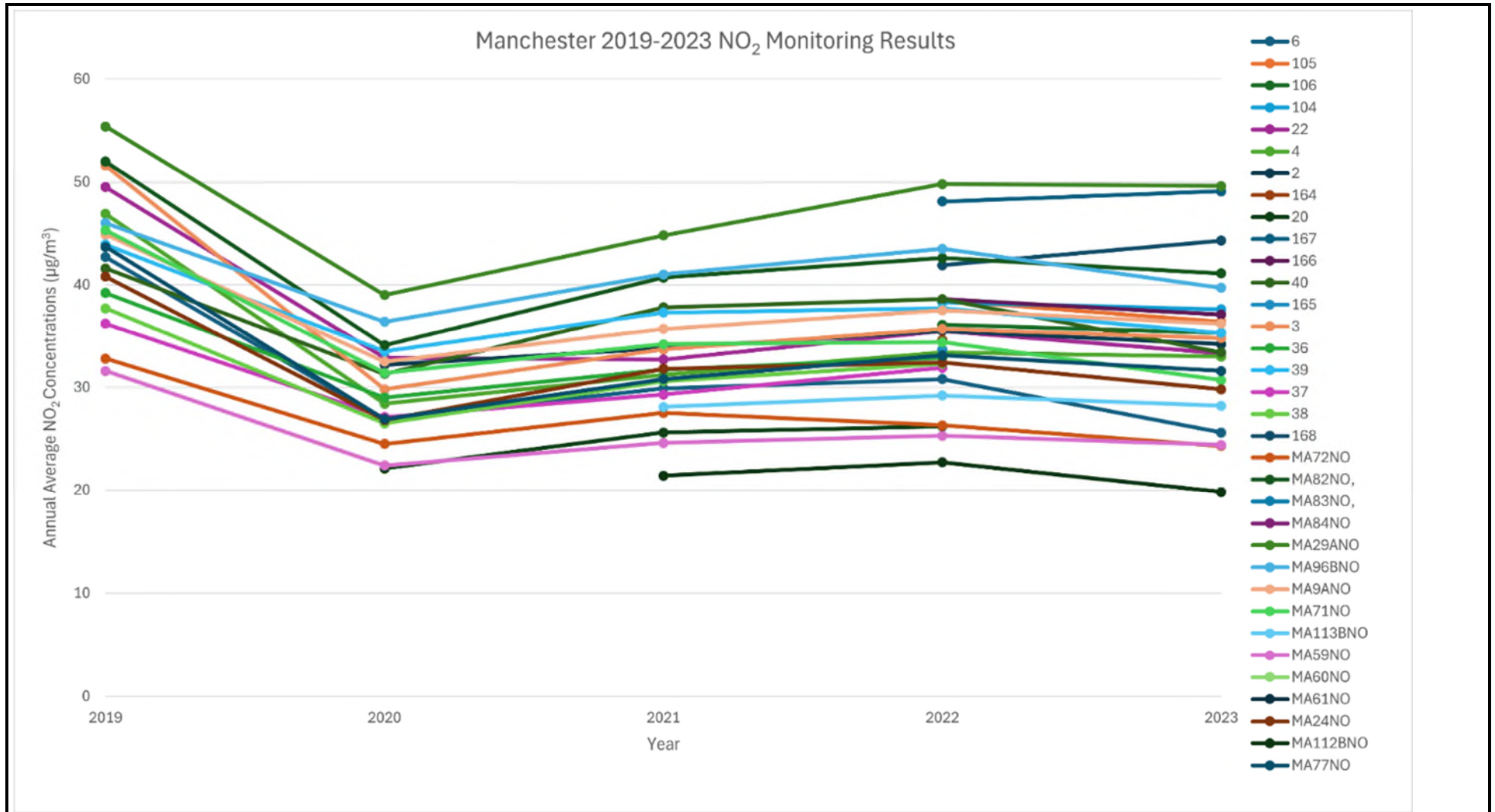


	Figure:	Figure 8.3		
	Title:	Variation of NO ₂ annual average monitoring results from LAQM and CAP monitoring sites in proximity to the EIA Site.		
	Project:	Sister Plot C, Manchester		
	Date:	Mar2025	Scale:	Scale /NTS

Appendix 8.3B Traffic Emissions Modelling Methodology

The impact of emissions from nearby road links has been predicted at sensitive receptor locations, in proximity to impacted roads, using the dispersion model ADMS-Roads (v5)¹.

Dispersion Model Set Up and Parameters

Hourly sequential meteorological data from Manchester Airport for 2023 has been input into the model. The dataset provides hourly temperature, wind speed, wind direction and cloud cover. Data was obtained from the NOAA Integrated Surface Database², via the wormlet R package. This meteorological station is 14 km to the southwest of the Site, so is deemed to be representative of conditions on-site. Due to there being low cloud cover data availability at Manchester Airport, the cloud cover has been gap filled using data from Rostherne meteorological station. This ensures that data availability is high (>92%) for all key parameters. A wind rose at this station in 2023 is presented in Figure 1.

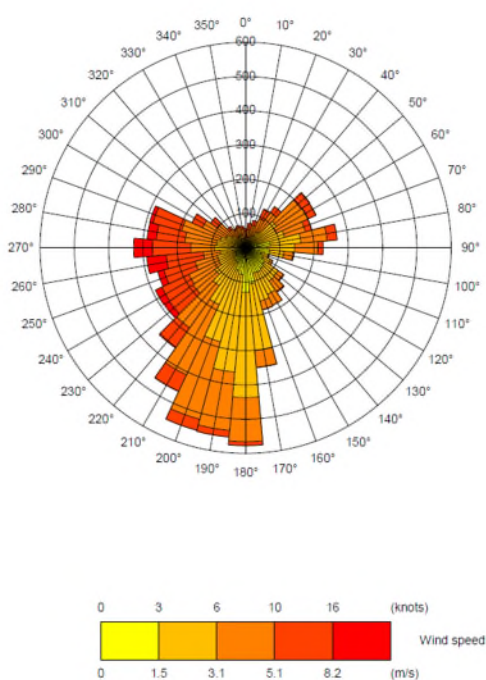


Figure 1 Windrose for Manchester Airport 2023.

Surface roughness represents the extent of mechanical turbulence in the atmosphere caused by the roughness of the ground over which the air is passing. A surface roughness of 0.8 m has been used for the Site, which is a rule of thumb approximation of value between suburbia and large city centre, and 0.5 at the meteorological site, a rule of thumb value for open suburbia and parkland.

The Monin-Obukhov length represents the stability of the atmosphere. In urban areas, there is a significant amount of heat generated by buildings and traffic which warms the air above the city creating an effect called urban heat island. This additional heat prevents the atmosphere from becoming very stable in urban areas, meaning the Obukhov length will never fall below a certain value in stable conditions. A minimum Obukhov length of 30 m was used for the Site, which is a rule of thumb value for cities and large towns.

Background concentrations

Defra model grid background concentrations across the UK on 1km x 1km grid squares, utilising a base year of 2021. Estimated pollutant concentrations for the existing baseline year 2023 in the OS grid square in which the Site lies (centred at 384500,397500) are shown in Table 1.

Table 1 Defra modelled background concentrations that will be utilised in the assessment

2023 annual mean background concentrations used (µg/m ³)			
NO ₂	NO _x	PM ₁₀	PM _{2.5}
19.6	27.9	11.6	7.8

Model Input Parameters

The model input parameters are summarised in Table 2.

Table 2 Model Input Parameters

Parameter	Description	Input Variable
Surface Roughness	Surface roughness of the modelling domain as a function of land use	A surface roughness length (z_0) of 0.8m was used for the dispersion site and 0.5 m at the meteorological site. These values are considered appropriate for the surface roughness of the dispersion modelling assessment.
Road Source Emissions	Source of the emission factors used	EFT v.13.0
Verification Year	Modelling year used to calculate verification factor for the traffic emissions	2023 for the verification year and all future years.

Parameter	Description	Input Variable
NO_x to NO₂ Conversion	Conversion from NO _x concentrations to NO ₂ concentrations	NO _x to NO ₂ calculator v9.1. General inputs – Manchester, All other urban UK traffic.
Road Type	Road type within the EFT emission database	Urban (not London)
Elevation of Road	Height of the road link above ground level	Road elevations were set to 0, 3, 7 and 10 m along Mancunian Way where applicable. Measured in Google Earth ⁵ .
Road Width	Width of the road link	Road width measured from satellite imagery.
Road Speed	Road speed in km/h	As provided by Civic Engineers, speeds reduced at junctions in line with LAQM TG22 guidance.
Meteorology	Representative hourly sequential meteorological data	Manchester Airport 2023. Cloud cover gap filled with data from Rostherne 2023.
Background	Background pollutant concentration considered during the modelling	2023 Defra background maps 1km x 1km grid squares as set out in Table 1.
Output	Output as gridded or specified points	At specified points as detailed in Table 6
Pollutant Output	Pollutants modelled and averaging time	NO ₂ , PM ₁₀ and PM _{2.5} annual mean

Emissions factors

Emissions were calculated using the most recent version of the Emissions Factor Toolkit (EFT) v13.0. The traffic data was entered into the EFT in order to calculate a combined emission rate for each of the road links in the modelled network.

To understand whether air quality is improving in Manchester, a five-year regression analysis has been undertaken on average annual mean NO₂ concentrations recorded at all roadside and kerbside monitoring locations in MCC's administrative area between 2019 and 2023, as shown in Figure 3. When calculating the trends, 2020 and 2021 were excluded due to the impact of COVID-19 restrictions on concentrations in these years.

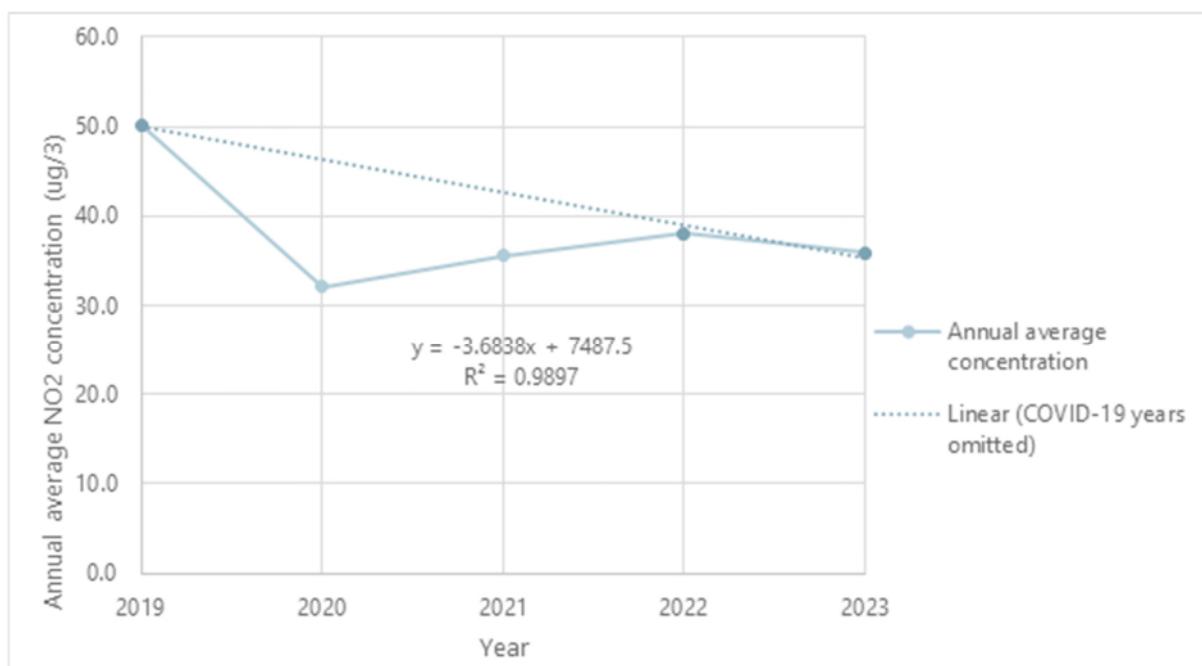


Figure 2 Five-year linear regression analysis for roadside monitoring locations in MCC's administrative area.

The regression analysis indicates that NO₂ concentrations recorded at roadside monitoring locations in Manchester over the last five years have been reducing at an average rate of 3.7 µg/m³ per year. This trend is statistically significant (R² value of 0.99) and therefore suggests a significant improvement in air quality has been recorded across Manchester over the last five years. Therefore, it is deemed robust to utilise emissions factors for future years.

Traffic Data

Traffic data provided by the project transport consultant (Civic engineers). The modelled road links are presented in Figure 3. The relevant traffic data supplied by the project transport consultant is presented in Table 3.

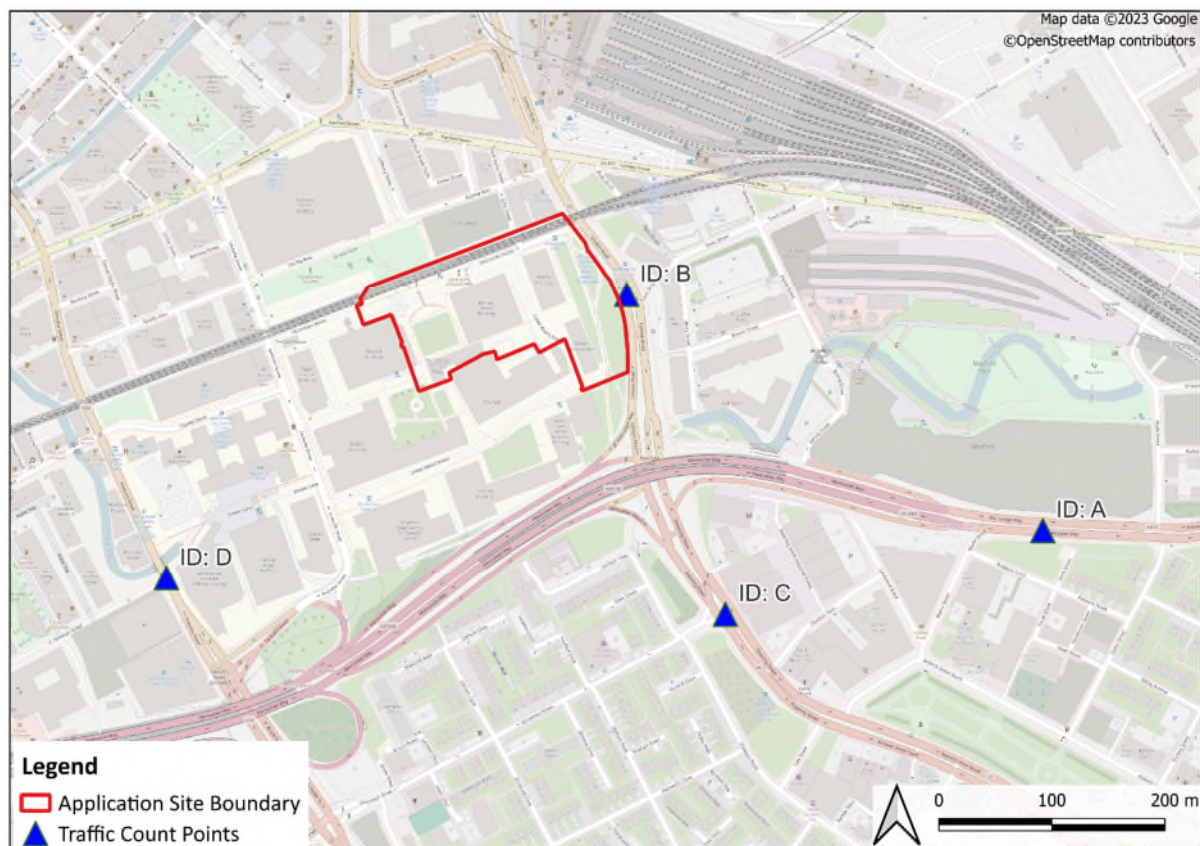


Figure 3 Traffic data point ID locations

Table 3 Traffic data (AADT) supplied by the project traffic consultant.

ID	Location	Existing Baseline (2023)		2028 peak construction year- Do Minimum (DM)		2028 peak construction year - Do Something (DS)		Trip generation due to Proposed Development - construction	
		Total	HDV	Total	HDV	Total	HDV	Total	HDV
A	Mancunian Way	40089	1244	44129	1750	44247	1792	118	42
B	A6 London Road north	12518	212	12518	212	12518	212	0	0
C	A6 Downing Street, Ardwick Green South	22118	536	22118	536	22236	578	118	42
D	Princess Street	6858	83	6858	83	6976	125	118	42

Appendix 8C Model Verification

The roads within the ADMS model have undergone a detailed adjustment and verification process which followed the methodology set out in Defra LAQM TG(22) Box 7-17 and 7-18.

The roads, drawn in QGIS, were adjusted following a detailed review of the road layout using satellite imagery and mapping software. The drawn road layout considers:

- Road width;
- Layout and expected slow-down at junctions; and
- Speed adjustment where queuing is expected.

The verification process follows the following steps:

- Identify all roadside monitoring sites within a relevant proximity to road links within the modelled domain;
- Appraise monitoring sites using Google Streetview and ensure the location and height given in the Clean Air Plan hub by Greater Manchester Combined Authority (GMCA) are as accurate as possible;
- Remove sites that are not suitable for model verification (i.e. located in close proximity to a bus stop, inappropriate diffusion tube siting, poor data capture, etc.);
- Calculate adjustment factor and check difference between modelled and monitored NO₂ concentrations; and
- If the modelled and monitored concentrations are not within 25% of each other at all sites, reassess model set up and assumptions.

Modelled results have been verified against monitored concentrations from GMCA Clean Air Plan monitoring stations in proximity to the Site. The verification sites used in the assessment are presented in Figure 1. The sites are all duplicate or triplicate diffusion tubes. These sites were selected based on the availability of traffic data on surrounding roads, high availability of air quality data in the verification year and being representative of modelled receptor locations.

Comparison of modelled and monitored NO₂ concentrations at verification sites along London Road are presented Table 1. The total NO₂ modelled by the dispersion model is plotted against the total NO₂ monitored by diffusion tubes in Figure 2. This shows that the model under-predicts the total NO₂ concentrations. Therefore, to achieve higher accuracy, it is necessary to apply an adjustment factor of 3.80 (derived from the gradient of the line of best fit of the modelled and monitored road contribution NO_x) in order to obtain more accurate modelled concentrations.

The adjustment factor has subsequently been applied to all modelled NO₂ concentrations (Table 5). Adjusted NO₂ plotted against monitored NO₂ is presented in Figure 3. The adjusted total modelled NO₂ is within 25% of the monitored at all sites.

The root mean square error (RMSE) in the modelled NO₂ is 4.14 µg/m³, which equates to an error percentage of 10% of the annual average NO₂ objective. Defra LAQM TG22 states that ideally the RMSE will be within 10% of air quality objective. Therefore, the level of error complies with this quality check, indicating that the model performs well at these locations when the verification factor is applied.

Table 4 Unadjusted modelled NO₂ compared to monitored NO₂.

Monitoring Site ID	Modelled total NO ₂ (µg/m ³)	Monitored total NO ₂ (µg/m ³)	% Difference
CAP_MANC_004	26.9	33.4	19.5
CAP_MANC_002	27.66	34.2	19.1
CAP_MANC_003	25.72	34.8	26.1
CAP_MANC_166	28.06	37.1	24.4
CAP_MANC_167	28.9	49.1	41.1

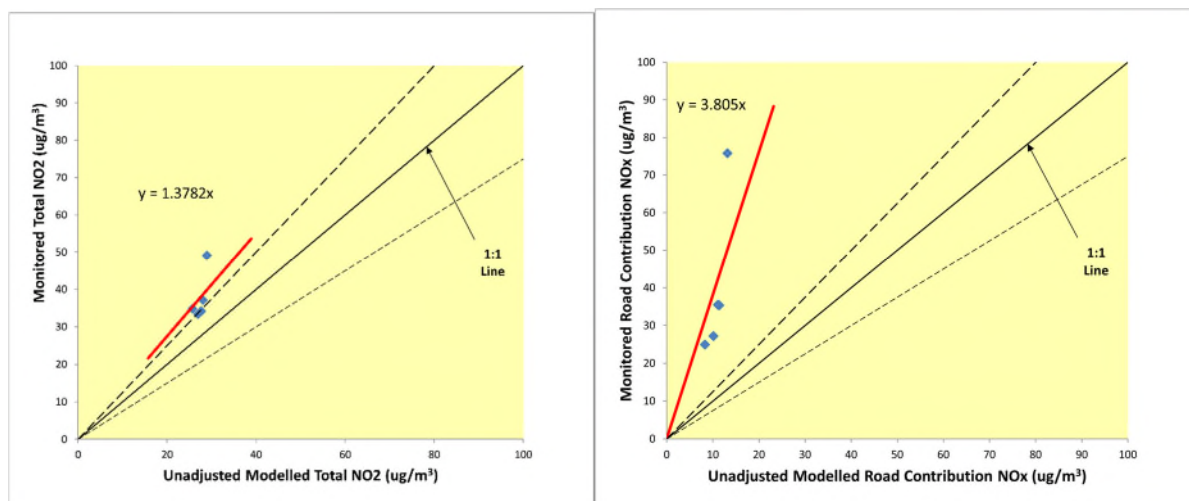


Figure 4 Monitored and unadjusted modelled road NO₂ and road NO_x.

Table 5 Unadjusted modelled NO₂ compared to monitored NO₂.

Monitoring Site ID	Background (µg/m ³)		Monitored road NO ₂ (µg/m ³)	Monitored Road NO _x (µg/m ³)	Modelled Road NO _x (µg/m ³)	Adjusted Modelled Road NO _x (µg/m ³)	Adjusted modelled total NO ₂ (µg/m ³)	Total NO ₂ Difference after adjustment	% NO ₂ RMSE (µg/m ³)
	NO _x	NO ₂							
CAP_MANC_004	34.5	23.4	33.4	25.0	8.3	31.5	35.7	-7.0	4.14
CAP_MANC_002	34.5	23.4	34.2	27.2	10.1	38.5	38.1	-11.5	
CAP_MANC_003	30.0	20.8	34.8	35.4	11.4	43.3	37.5	-7.8	
CAP_MANC_166	34.5	23.4	37.1	35.5	11.1	42.2	39.4	-6.1	
CAP_MANC_167	34.5	23.4	49.1	75.8	13.2	50.2	41.9	14.7	

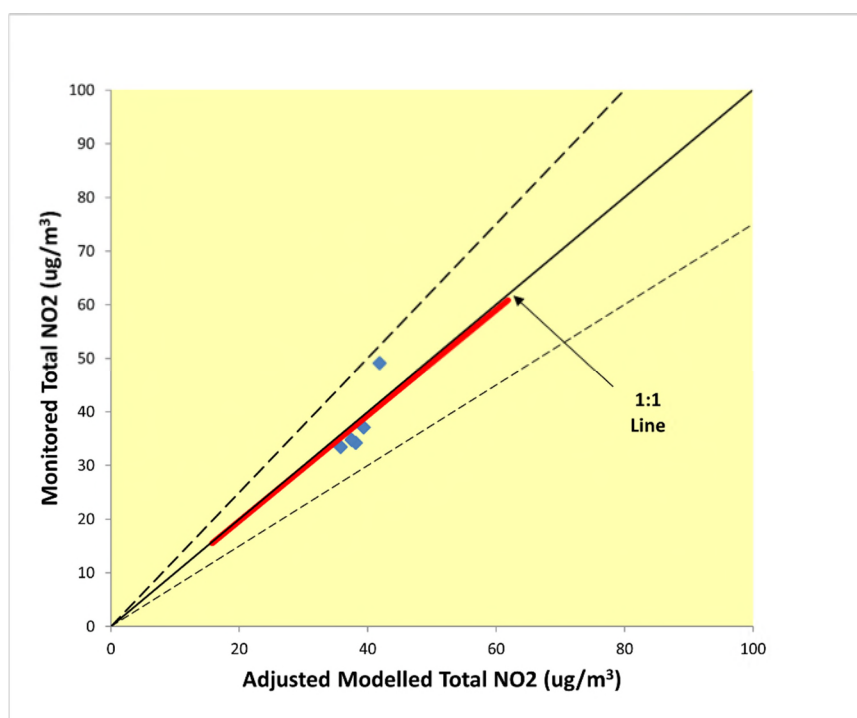


Figure 5 Monitored and modelled road NO₂ with verification factor applied to modelled concentrations.

PM₁₀ and PM_{2.5}

The model outputs of road-PM have been adjusted by applying the adjustment factor calculated for road NO_x in line with LAQM.TG(22) as there is no suitable PM₁₀ or PM_{2.5} monitoring data suitable for model verification within the vicinity of the Site.

Appendix 8D Model Results

- Pollutant concentrations were predicted at human receptor locations adjacent to roads predicted to experience an increase in AADT flows above the IAQM screening criteria for detailed assessment during the construction phase. Modelled receptors are shown in Table 6 and visual representation shown in Figure 6.

Table 6 Modelled Receptors

ID	X	Y	Height (m)
R1	384824	397406	1.5
R2	384735	397422	7
R3	384658	397434	7
R4	384305	397266	1.5
R5	384314	397225	1.5
R6	385080	397233	1.5
R7	385162	397133	1.5
R8	384428	397386	1.5
R9	384382	397446	1.5
R10	384824	397406	1.5
R11	384735	397422	7

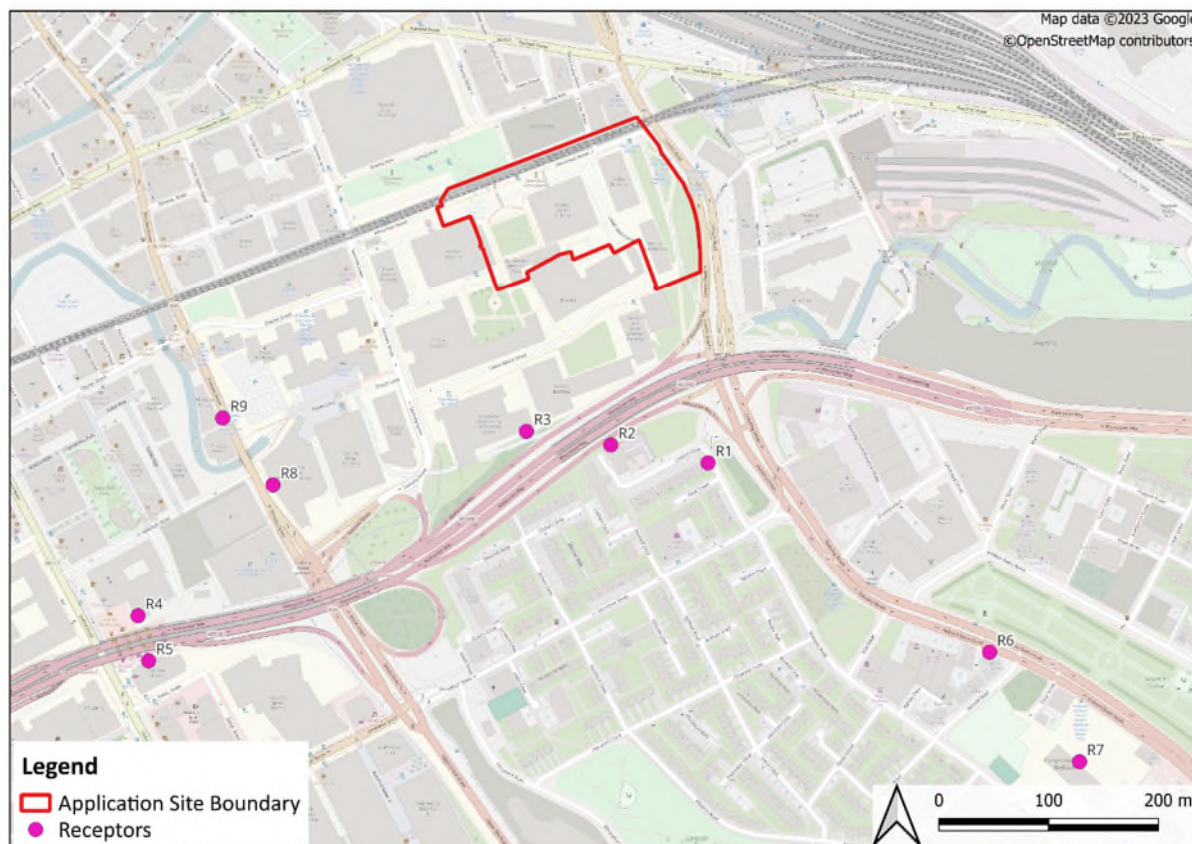


Figure 6 Sensitive receptor locations

Peak Construction modelling results

Modelled changes in concentrations of NO₂, PM₁₀ and PM_{2.5} for the 2028 peak construction year of the Proposed Development are presented in Table 7, Table 8 and Table 9, respectively.

- At some receptors the change between Do nothing and Do something scenario is very minimal and rounds down to 0% of the objective.

All presented modelling utilizes 2023 background concentrations, which is a worst case assumption as Defra modelled background concentrations are predicted to decrease in future years.

Table 7 Modelled change in annual average NO₂ concentrations at human receptors due to the construction of the Proposed Development.

ID	Annual average NO ₂ Concentrations (µg/m ³)				
	Do nothing (2028)	Do something (2028)	% of AQO	% Change	IAQM impact descriptor
R1	28.4	28.5	71.2	0.7	Negligible
R2	29.4	29.5	73.6	0.7	Negligible
R3	32.2	32.2	80.5	0.8	Negligible
R4	26.3	26.3	65.7	0.7	Negligible
R5	25.6	25.6	64.1	0.6	Negligible
R6	30.3	30.4	76.1	0.8	Negligible
R7	22.9	22.9	57.4	0.6	Negligible
R8	32.2	32.5	81.2	0.8	Negligible
R9	30.5	30.7	76.8	0.8	Negligible

Table 8 Modelled change in annual average PM₁₀ concentrations at human receptors due to the construction of the Proposed Development.

ID	Annual average PM ₁₀ Concentrations (µg/m ³)				
	Do nothing (2028)	Do something (2028)	% of AQO	% Change	IAQM impact descriptor
R1	17.2	17.2	43.0	<0.1	Negligible
R2	17.7	17.7	44.3	<0.1	Negligible
R3	19.0	19.0	47.5	<0.1	Negligible
R4	16.3	16.3	40.8	<0.1	Negligible
R5	16.1	16.1	40.2	<0.1	Negligible
R6	18.0	18.1	45.2	<0.1	Negligible
R7	14.7	14.7	36.9	<0.1	Negligible

ID	Annual average PM ₁₀ Concentrations (µg/m ³)				
	Do nothing (2028)	Do something (2028)	% of AQO	% Change	IAQM impact descriptor
R8	18.8	18.9	47.2	<0.1	Negligible
R9	18.12	18.19	45.5	<0.1	Negligible

Table 9 Modelled change in annual average PM_{2.5} concentrations at human receptors due to the construction of the Proposed Development.

ID	Annual average PM ₁₀ Concentrations (µg/m ³)				
	Do nothing (2026)	Do something (2026)	% of AQO	% Change	IAQM impact descriptor
R1	9.3	9.3	46.4	<0.1	Negligible
R2	9.6	9.6	47.8	<0.1	Negligible
R3	10.2	10.2	51.2	<0.1	Negligible
R4	8.8	8.8	44.2	<0.1	Negligible
R5	8.7	8.7	43.4	<0.1	Negligible
R6	10.2	10.2	51.0	<0.1	Negligible
R7	8.4	8.4	42.1	<0.1	Negligible
R8	10.1	10.2	50.9	<0.1	Negligible
R9	9.8	9.8	49.0	<0.1	Negligible

Appendix 8.3E Glossary of Terms

Term	Definition
AADT	Annual average daily traffic
AQA	Air Quality Assessment
AQAP	Air Quality Action Plan
AQFA	Air Quality Focus Area
AQMA	Air Quality Management Area
AQO	Air Quality Objective
AQS	Air Quality Strategy
ASR	Annual Status Report
CAP	Clean Air Plan
EPUK	Environmental Protection UK
GMCA	Greater Manchester Combined Authority
HDV	Heavy Duty Vehicles
IAQM	Institute of Air Quality Management
LAQM	Local Air Quality Management
LDV	Light Duty Vehicles
LPA	Local planning authority
MCC	Manchester City Council
NAEI	National Atmospheric Emissions Inventory

Term	Definition
NO ₂	Nitrogen dioxide
NO _x	Nitrogen oxides
NPPF	National Planning Policy Framework
PfE	Places for Everyone Joint Development Plan 2022 to 2039
PM	Particulate matter
PPG	Planning Practice Guidance