Logika GROUP

Report

West and East Greenwich Neighbourhood Traffic Management Scheme

Air Quality Modelling Study

For Royal Borough of Greenwich

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Air Quality CONSULTANTS | PART OF Logika Group

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1 Introduction

1.1 This report presents the results of dispersion modelling carried out to assess the air quality impacts of the West and East Greenwich Neighbourhood Management Scheme (hereafter referred to as 'the Scheme'). The assessment has been carried out by Air Quality Consultants Ltd. I Part of Logika Group (AQC) on behalf of the Royal Borough of Greenwich Council (RBG).

1.2 Appendix A1 summarises the professional experience of the authors of this report. Appendix A2 sets out the monitoring methodology. Appendix A3 describes air quality monitoring carried out pre- and post-implementation of the Scheme. It is not possible to use these measurements directly to assess the effect of the Scheme on air quality. This is because the Scheme is not the only variable which will have changed concentrations between the two periods of measurements. Air quality changes hour-by-hour, day-by-day, and month-by-month, simply because of the weather. Air quality is also affected by both temporary and permanent changes to emissions, for example as wider-scale policies to improve air quality take effect. This means that a direct comparison of measurements made before vs after an intervention (such as this Scheme) are unlikely to show the true effect of that intervention.

1.3 The UK Government's Air Quality Expert Group (AQEG, 2020) explains that the most robust way to assess the effectiveness of an intervention is to combine information on changes to activity with information on changes to air quality. This current modelling study therefore combines the pre- and post-implementation air quality measurements with traffic flows also measured pre- and post-implementation of the Scheme. It considers temporal weather patterns and controls for the influence of ongoing changes to air quality across London. It uses dispersion modelling to quantify the effect of the Scheme on concentrations of nitrogen dioxide (NO_2) and fine particulate matter (PM_{10} and $PM_{2.5}$), which are the main pollutants of concern associated with road traffic emissions.

2 Assessment Criteria

2.1 The Government has established a set of air quality standards and objectives to protect human health. The 'standards' are based on assessment of the effects of each pollutant on human health, including the effects on sensitive sub-groups. The 'objectives' set out the extent to which the Government expects the standards to be achieved *taking account of practical considerations.* The objectives for use by local authorities are prescribed within the Air Quality (England) Regulations (2000) and the Air Quality (England) (Amendment) Regulations (2002).

2.2 The UK-wide objectives for nitrogen dioxide and PM_{10} were to have been achieved by 2005 and 2004 respectively, and continue to apply in all future years thereafter. Measurements across the UK have shown that the 1-hour mean nitrogen dioxide objective is unlikely to be exceeded at roadside locations where the annual mean concentration is below 60 µg/m^3 (Defra, 2025a). Measurements have also shown that the 24-hour mean PM_{10} objective could be exceeded at roadside locations where the annual mean concentration is above 32 µg/m^3 (Defra, 2025a). The predicted annual mean PM_{10} concentrations are thus used as a proxy to determine the likelihood of an exceedance of the 24-hour mean PM_{10} objective. Where predicted annual mean concentrations are below 32 µg/m^3 it is unlikely that the 24-hour mean objective will be exceeded.

2.3 The objectives apply at locations where members of the public are likely to be regularly present and are likely to be exposed over the averaging period of the objective. The GLA explains where these objectives will apply in London (GLA, 2019). The annual mean objectives for nitrogen dioxide and PM_{10} are considered to apply at the façades of residential properties, schools, hospitals and care homes etc., the gardens of residential properties, school playgrounds and the grounds of hospitals and care homes. The 24-hour mean objective for PM_{10} is considered to apply at the same locations as the annual mean objective, as well as at hotels. The 1-hour mean objective for nitrogen dioxide applies wherever members of the public might regularly spend 1-hour or more, including outdoor eating locations and pavements of busy shopping streets.

2.4 For $PM_{2.5}$, the objective set by Defra for local authorities is to work toward reducing concentrations without setting any specific numerical value. In the absence of a numerical objective, it is convention to assess local air quality impacts against the limit value (see Paragraph 2.7), originally set at 25 µg/m^3 and currently set at 20 µg/m^3.

2.5 Defra has also set two new targets, and two new interim targets, for $PM_{2.5}$ concentrations in England. One set of targets focuses on absolute concentrations. The long-term target is to achieve an annual mean $PM_{2.5}$ concentration of 10 µg/m^3 by the end of 2040 (referred to as the annual mean concentration target or AMCT), with the interim target being a value of 12 µg/m^3 by the start of 2028[1]. The second set of targets relate to reducing overall population exposure to $PM_{2.5}$. By the end of 2040, overall population exposure to $PM_{2.5}$ should be reduced by 35% compared with 2018 levels (referred to as the population exposure reduction target or PERT), with the interim target being a reduction of 22% by the start of 2028 (Table 2-1).

[1] Meaning that it will be assessed using measurements from 2027. The 2040 target will be assessed using measurements from 2040. National targets are assessed against concentrations expressed to the nearest whole number, for example a concentration of 10.4 µg/m^3 would not exceed the 10 µg/m^3 target.

Table 2-1: Environment Act $PM_{2.5}$ Targets

Metric	Target	Target year
AMCT	Interim target: 12 µg/m³	2028
	Legally binding target: 10 µg/m³	2040
PERT	Interim target: 22% reduction in exposure compared to 2018	2028
	Legally binding target: 35% reduction in exposure compared to 2018	2040

2.6 The GLA has set a target to achieve an annual mean $PM_{2.5}$ concentration of 10 µg/m³ by 2030. This target was derived from an air quality guideline set by WHO in 2005. In 2021, WHO updated its guidelines, but the London Environment Strategy (GLA, 2018) considers the 2005 guideline of 10 µg/m³.

2.7 EU Directive 2008/50/EC (The European Parliament and the Council of the European Union, 2008) sets limit values for nitrogen dioxide, PM_{10} and $PM_{2.5}$, and is implemented in UK law through the Air Quality Standards Regulations (2010)[2]. The limit values for nitrogen dioxide and PM_{10} are the same numerical concentrations as the UK objectives, but achievement of the limit values is a national obligation rather than a local one and concentrations are reported to the nearest whole number. In the UK, only monitoring and modelling carried out by UK Central Government meets the specification required to assess compliance with the limit values. Central Government does not normally recognise local authority monitoring or local modelling studies when determining the likelihood of the limit values being exceeded, unless such studies have been audited and approved by Defra and DfT's Joint Air Quality Unit (JAQU).

2.8 The relevant air quality criteria for this assessment are provided in Table 2-2

Table 2-2: Air Quality Criteria for Nitrogen Dioxide, PM_{10} and $PM_{2.5}$

Pollutant	Time Period	Value
Nitrogen Dioxide	1-hour Mean	200 µg/m³ not to be exceeded more than 18 times a year
	Annual Mean	40 µg/m³
PM_{10}	24-hour Mean	50 µg/m³ not to be exceeded more than 35 times a year
	Annual Mean	40 µg/m³ [a]
$PM_{2.5}$	Annual Mean	20 µg/m³ [b]
	Annual Mean	10 µg/m³ by 2030

[a] A proxy value of 32 µg/m³ as an annual mean is used in this assessment to assess the likelihood of the 24-hour mean PM_{10} objective being exceeded. Measurements have shown that, above this concentration, exceedances of the 24-hour mean PM_{10} objective are possible (Defra, 2025a).

[b] There is no numerical $PM_{2.5}$ objective for local authorities (see Paragraph 2.4). Convention is to assess against the UK limit value which is currently 20 µg/m³.

[2] As amended through The Air Quality Standards (Amendment) Regulations 2016 and The Environment (Miscellaneous Amendments) (EU Exit) Regulations 2020.

3 Assessment Approach

Study Area

3.1 The study area for the assessment has been based on the distribution of Automatic Traffic Counters (ATCs) deployed by RBG as part of the project. These are shown in Figure 3-1. Details of the sites, and the surveys, are reported separately by RBG. The study area includes all roads on which an ATC was located.

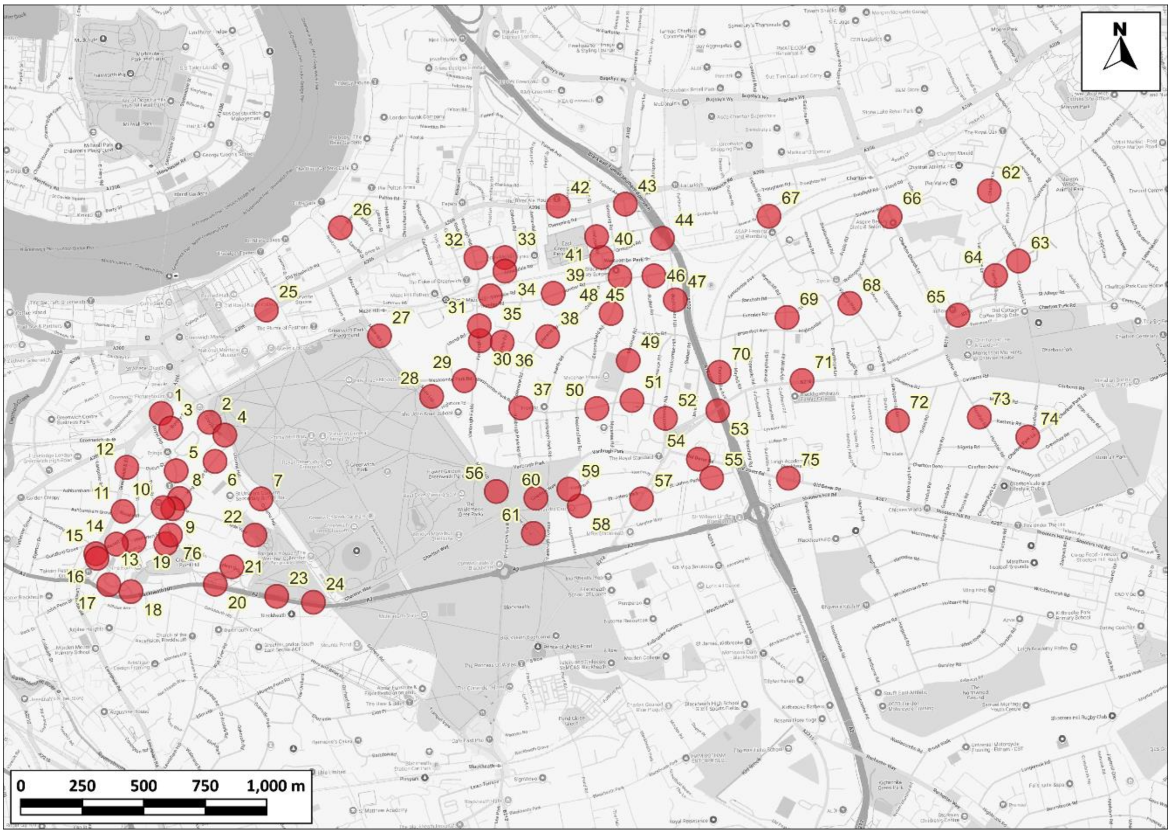

Figure 3-1: ATCs Operated for this Project

Map data ©2025

Traffic Data

3.2 Traffic flows have been taken from records provided by RBG for the 76 ATCs shown in Figure 3-1. For most sites, traffic flows and speeds were recorded for two weeks pre-implementation of the Scheme (from late September to mid October 2024) and two weeks post-implementation (from late February to mid March 2025). Roadworks in the western part of the study area during the week commencing 24th February 2025 meant that measurements made during one week needed discarding; sites in this area were extended by one week to allow for two weeks unaffected by roadworks (which do not represent typical traffic conditions, and which would interfere with the analysis of the effect of the Scheme). This study has used all the ATC monitoring except the measurements identified as potentially affected by the roadworks. In most cases this provides two weeks of data for each site, but in some cases only one week of valid data are available.

3.3 There are some roads (such as the A2, Blackwall Tunnel Approach) which are not included in the ATC surveys. These roads are unlikely to be affected by the Scheme but may themselves affect air quality within the study area. For these roads, traffic data have been taken from the London Atmospheric Emissions Inventory (LAEI) (GLA, 2023). It has been assumed that the Scheme did not affect traffic on these roads. There are some minor roads in the study area which are not covered by either ATCs or the LAEI. Traffic flows on these roads have been excluded from the study. Receptors have only been placed alongside roads with ATCs (see Paragraph 3.5, below).

3.4 While the ATC data (in particular the recorded speeds) strictly relate to a point along each road, the measurements made at these points have been used to characterise flows along the entire link length shown in Figure 3-2.

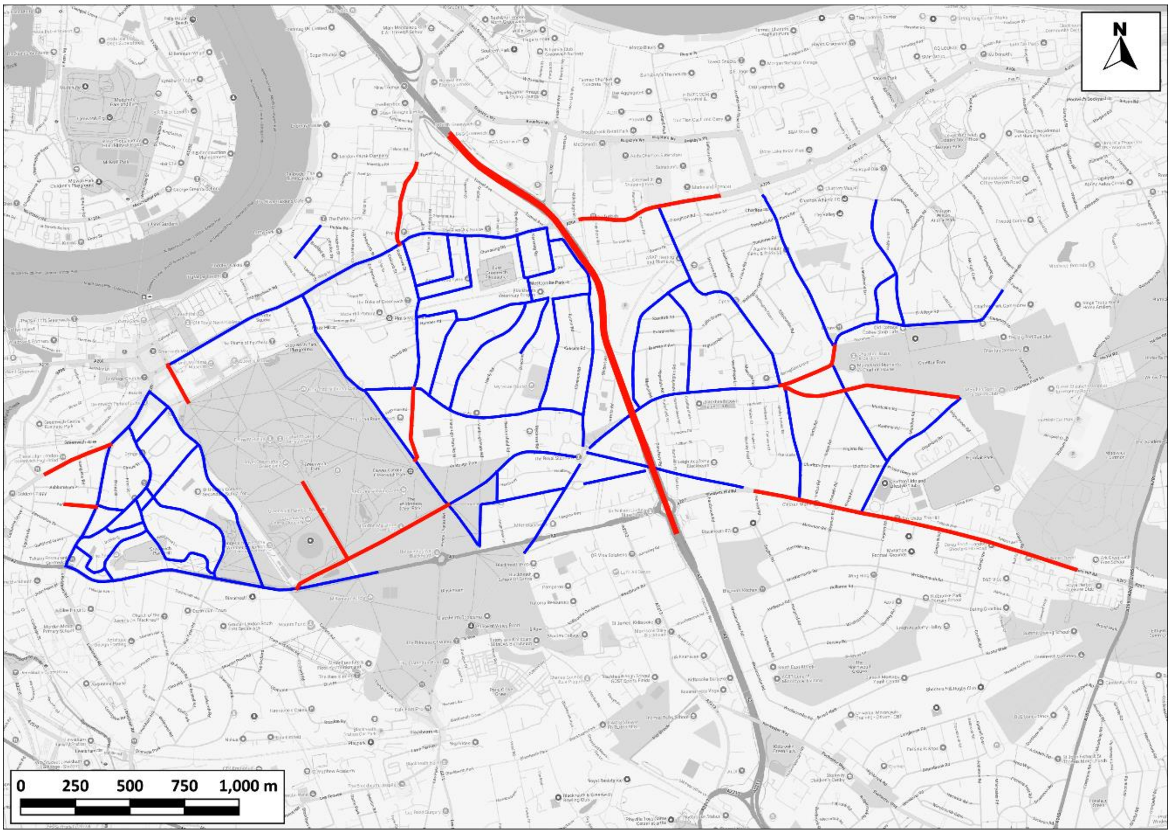

Figure 3-2: Roads Included in the Study Derived from ATC data (blue) and the LAEI (red)

Map data ©2025

Receptors

3.5 Concentrations of nitrogen dioxide, PM_{10} and $PM_{2.5}$ have been predicted alongside all the roads included in the ATC surveys. Receptors have been identified to represent the closest roadside façade of every building adjacent to these roads. Building façades close to junctions with roads for which traffic data are unavailable have not been included. From this set of more than 4,000 receptor points, 74 'individual receptors' have been selected; these represent worst-case locations close to each ATC and are labelled with the same number as the corresponding ATC. Two of the ATCs were on roads with no relevant exposure and so receptors have not been included for these links. All receptors have been modelled at a height of 1.5 m above ground to represent typical breathing height. The receptors are shown in Figure 3-3.

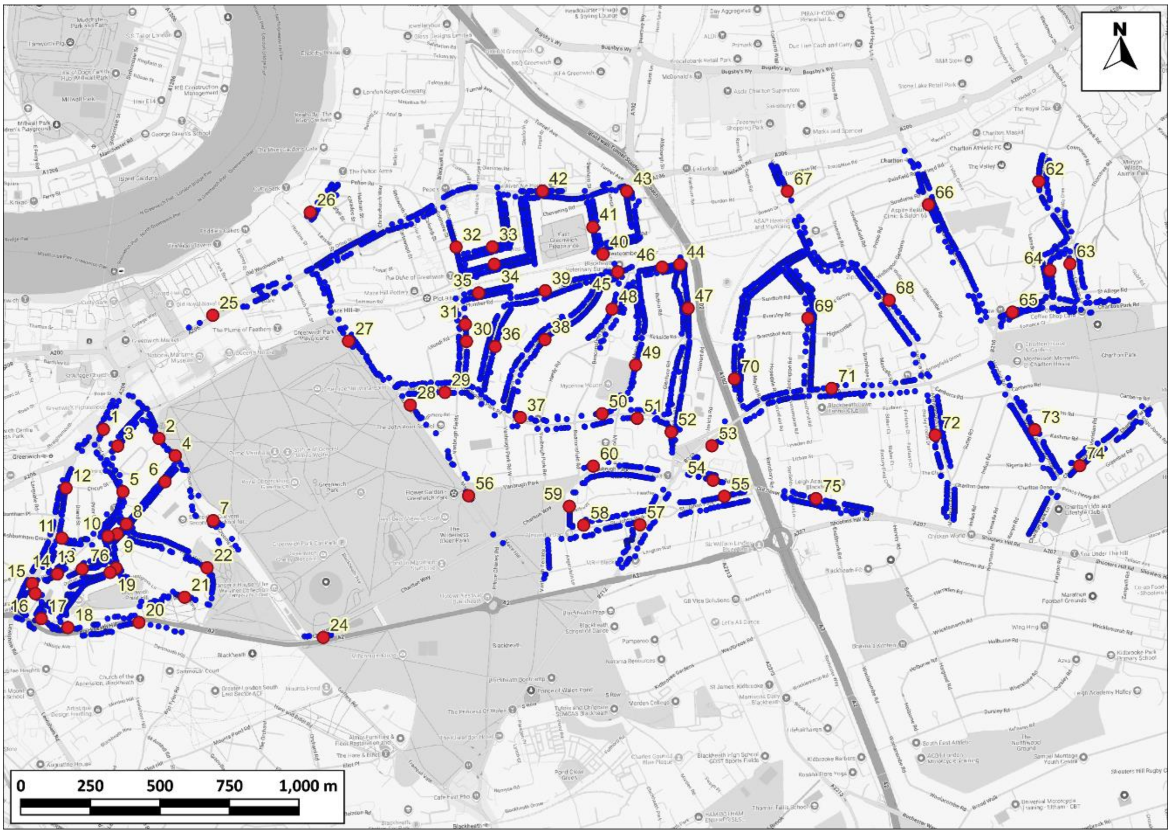

Figure 3-3: All Receptors (blue) and Individual Receptors (red). Also showing the numbers assigned to each Individual Receptor

Map data ©2025

Background Concentrations

3.6 background concentrations have been defined using Defra's 2021-based background maps (Defra, 2025b). These cover the whole of the UK on a 1x1 km grid. These predicted concentrations have been interpolated across the study area to avoid step-changes. The background maps for annual mean nitrogen dioxide concentrations have been calibrated against measurements made by RBG at background monitoring sites as explained in Appendix A2. There are insufficient local data to robustly calibrate the maps for PM_{10} and $PM_{2.5}$, but these maps have been shown to be without overall bias when compared with measurements from across the UK (AQC, 2025). It is considered that there are insufficient roads included in the study to warrant removing any sources from the background maps.

Modelling Methodology

3.7 As explained in Section 2, the principal air quality objectives of relevance relate to annual average concentrations. This assessment has therefore predicted the concentrations for a full calendar year (2024) assuming that:

A) the Scheme was not in place during that year ('no Scheme'); and

B) the Scheme was in place during that year ('with Scheme').

3.8 Emissions per vehicle are currently falling across London and so it is reasonable to expect some improvement in air quality within the study area between 2024 and 2025 irrespective of the Scheme. To calculate the effect of the Scheme without the confounding effect of concurrent changes in vehicle emissions, the assessment has predicted concentrations in 2024 for both the 'no Scheme' and 'with Scheme' scenarios (i.e. it has been assumed first that the Scheme was not in place for the whole of 2024, and then it has been assumed that the Scheme was in place for the whole of 2024).

3.9 Each ATC recorded 15-minute average traffic flows and speeds, separated by direction, for a minimum of one week. Separate flows were recorded for motorcycles, cars, Light Goods Vehicles (LGVs), rigid Heavy Goods Vehicles (HGVs), articulated HGVs, and buses. The ATC records were compiled to calculate 1-hour average flows, by vehicle type, and speeds during each weekday hour and each hour during Saturday and Sunday. This was done separately for each direction[3]. The traffic flows used in the assessment are too numerous to include within this report but can be made available on request.

3.10 These hour-by-hour flows and speeds were input to Defra's Emissions Factors Toolkit (EFT) (v13.1) (Defra, 2025b) to calculate the emissions of nitrogen oxides (NOx), PM_{10} and $PM_{2.5}$ during each hour of an average weekday and each hour during Saturday and Sunday. The EFT was set to predict emissions per vehicle in 2024 for both the pre- and post-implementation traffic datasets. The hour-specific emissions were used to generate:

- average hourly emissions for NOx, PM_{10}, and $PM_{2.5}$; and
- diurnal emissions profiles for NOx, PM_{10}, and $PM_{2.5}$.

3.11 This approach of calculating emissions for each hour separately, as opposed to first averaging the traffic flows by day and then calculating daily average emissions, allows a more precise use of the speed data measured by the ATCs and therefore allows greater accuracy in calculating the effect of the Scheme.

3.12 For the LAEI roads, the traffic flows have been adjusted from 2019 (the year for which data are published) to 2024 using growth factors derived using the TEMPro System v8.1 (DfT, 2023), with emissions calculated from daily average flows. Diurnal profiles for the LAEI roads have been derived from the national flow profiles published by DfT (2024).

3.13 The average hourly emissions and diurnal emissions profiles were entered into the ADMS-Roads dispersion model, alongside monthly flow profiles derived from DfT (2024) data, and hour-by-hour meteorological data for the 2024 calendar year measured at London City Airport. ADMS-Roads simulated dispersion from each road, during each hour, and predicted annual mean concentrations at each receptor.

3.14 The model results have been verified against:

- air quality measurements made within the study area during 2024 by RBG (using the 'no Scheme' model outputs);
- the pre-implementation monitoring (Appendix A3), which was adjusted to represent the 2024 calendar year (using the 'no Scheme' model outputs); and
- the post-implementation monitoring (Appendix A3), which was also adjusted to represent the 2024 Calendar year (using the 'with Scheme' model outputs).

[3] A large language model was used to assist in writing scripts in the python programming language to automate this task. The python script, and results that it generated, were verified by hand.

3.15 Further details of the modelling method and verification are provided Appendix A2.

Impact Description

3.16 The approach developed jointly by Environmental Protection UK (EPUK) and the Institute of Air Quality Management (IAQM)[4] (Moorcroft and Barrowcliffe et al, 2017) has been used in describing the modelled impacts. The approach identifies impacts at individual receptors based on the percentage change in concentrations relative to the relevant air quality objective, rounded to the nearest whole number, and the absolute concentration relative to the objective. Table 3-1 sets out the method for determining the impact descriptor for annual mean concentrations at individual receptors, having been adapted from the table presented in the guidance document. For the assessment criterion the term Air Quality Assessment Level or AQAL has been adopted, as it covers all pollutants, i.e. those with and without formal standards. Typically, as is the case for this assessment, the AQAL will be the air quality objective value or the GLA target. Note that impacts may be adverse or beneficial, depending on whether the change in concentration is positive or negative.

Table 3-1: Air Quality Impact Descriptors for Individual Receptors for All Pollutants [a]

Long-Term Average Concentration at Receptor in Assessment Year [b]	Change in concentration relative to AQAL [c]				
	0%	1%	2-5%	6-10%	>10%
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	Substantial
110% or more of AQAL	Negligible	Moderate	Substantial	Substantial	Substantial

[a] Values are rounded to the nearest whole number.

[b] This is the "Without Scheme" concentration where there is a decrease in pollutant concentration and the "With Scheme" concentration where there is an increase.

[c] AQAL = Air Quality Assessment Level, which may be an air quality objective, limit or target value, GLA target or an Environment Agency 'Environmental Assessment Level (EAL)'.

Uncertainty

3.17 There are many components that contribute to the uncertainty of modelling predictions. The road traffic emissions dispersion model used in this assessment is dependent upon the traffic data that have been input, which will have inherent uncertainties associated with them. There are then additional uncertainties, as models are required to simplify real-world conditions into a series of algorithms.

3.18 An important stage in the process is model verification, which involves comparing the model output with measured concentrations (see Appendix A2). Because the model has been verified and adjusted taking account of traffic counts and air quality measurements carried out both pre- and post-implementation, there can be reasonable confidence in the predicted concentrations. It is, however, noted that some of the measurements against which the model has been verified were collected over very short periods, which increases the uncertainty.

[4] The IAQM is the professional body for air quality practitioners in the UK.

Assumptions

3.19 It is necessary to make a number of assumptions when carrying out an air quality assessment. Key assumptions made in carrying out this assessment include:

- that pre- and post-implementation traffic counts carried out over periods of one to two weeks are representative of a full calendar year;
- that the air quality monitoring is fully representative;
- that the London City Airport meteorological monitoring station appropriately represents conditions in the study area (this is discussed further in Appendix A2);
- that all receptors are at 1.5 m above ground and all roads are at ground level;
- that the Scheme will not affect traffic flows beyond those roads recorded by ATCs;
- that roads with neither ATCs or LAEI data have no significant contribution to concentrations at receptors other than that included in Defra's background maps; and
- that those roads included explicitly in the modelling do not have a significant effect on Defra's background maps.

Assessment of Significance

3.20 There is no official guidance in the UK on how to assess the significance of air quality impacts. The approach developed jointly by Environmental Protection UK (EPUK) and the Institute of Air Quality Management (IAQM) (Moorcroft and Barrowcliffe et al, 2017) has therefore been used. The overall significance of the air quality impacts is determined using professional judgement, taking account of the impact descriptors; the experience of the consultants preparing the report is set out in Appendix A1.

4 Impacts of the Scheme

Nitrogen Dioxide

4.1 Figure 4-1 shows the predicted nitrogen dioxide concentrations without and with the Scheme at all receptors, as well as the change caused by the Scheme (in µg/m^3), and the IAQM impact descriptor. Table 4-1 shows the results at the individual receptors.

4.2 No exceedances of the objective are predicted either without or with the Scheme. The highest predicted concentrations in both scenarios are along the A206 and A2, where roadside concentrations range between 24 µg/m^3 and 34 µg/m^3. Close to more minor roads, concentrations are much lower, and usually less than half the 40 µg/m^3 objective.

4.3 The biggest reductions with the Scheme are along the A206 to the west of Greenwich Park (e.g. Receptor 1), with reductions of more than 5 µg/m^3. These are associated with the counts made at ATC 1, which measured a reduction in total weekday average traffic of more than 1,000 AADT, alongside changes to speeds and diurnal profiles which also contributed to the improvement. Smaller improvements (<5 µg/m^3) are predicted along a large number of minor roads across the study area. There are no locations where increases greater than 1.1 µg/m^3 are predicted but increases (between 0.2 and 1.1 µg/m^3 [5]) are predicted around the junctions of Greenwich Street and the A2 (ATCs 15 and 20), the B210 (ATC 71), Victoria Way (ATCs 67 and 68), Eastcombe Ave (ATC 70), Marlborough Lane (ATC 72), and Charlton Lane (ATC 62). Many more properties are predicted to experience reductions in nitrogen dioxide concentrations than increases.

4.4 Using the IAQM impact descriptors, all of the impacts are negligible apart from slight to moderate beneficial impacts along the A206 (ATCs 1 and 25), isolated slight beneficial impacts along Royal Hill (ATC 5), Crooms Hill (ATCs 4 and 7), and Westcombe Hill (ATC 52), and slight adverse impacts along the A2 at Blackheath Hill (ATC 20).

[5] 0.2 is used since it represents one half of one percent of the objective.

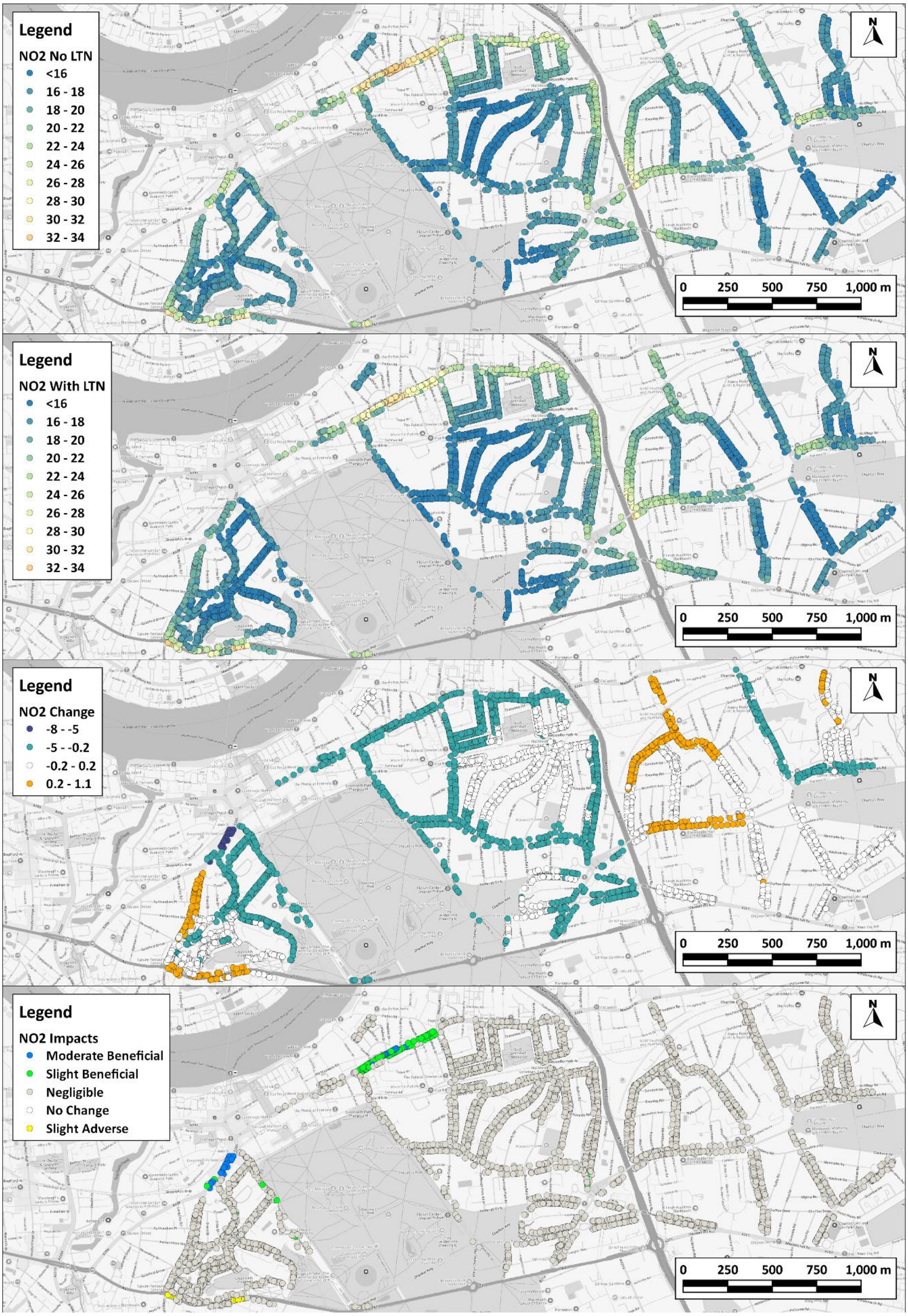

Figure 4-1: Predicted Concentrations of Nitrogen Dioxide in 2024 (μg/m³) (Scheme is denoted 'LTN' in this figure)
Map data ©2025

Table 4-1: Predicted Annual Mean Nitrogen Dioxide Concentrations in 2024 Without and With the Scheme (μg/m³)

R [a]	'No Scheme'	'With Scheme'	% Ch[b]	Impact Descriptor	R [a]	'No Scheme'	'With Scheme'	% Ch[b]	R [a]
1	25.0	19.1	-15	Moderate Beneficial	39	15.5	15.4	0	Negligible
2	19.0	17.3	-4	Negligible	40	18.6	18.4	-1	Negligible
3	16.4	15.8	-1	Negligible	41	18.5	18.4	0	Negligible
4	18.1	16.5	-4	Negligible	42	26.1	24.3	-4	Negligible
5	17.8	16.3	-4	Negligible	43	24.4	23.0	-3	Negligible
6	16.3	15.8	-1	Negligible	44	24.2	23.6	-1	Negligible
7	18.8	16.9	-5	Negligible	45	17.7	17.6	0	Negligible
8	18.1	16.2	-5	Negligible	46	19.3	19.3	0	No Change
9	16.0	15.8	0	Negligible	47	23.6	23.1	-1	Negligible
10	16.2	16.0	-1	Negligible	48	16.4	16.2	0	Negligible
11	16.5	16.4	0	Negligible	49	16.6	16.4	0	Negligible
12	18.5	18.9	1	Negligible	50	17.5	16.8	-2	Negligible
13	16.1	15.9	0	Negligible	51	18.0	17.3	-2	Negligible
14	16.7	16.4	-1	Negligible	52	24.7	22.4	-6	Slight Beneficial
15	19.2	19.2	0	Negligible	53	21.6	21.3	-1	Negligible
16	16.6	16.5	0	Negligible	54	21.0	19.9	-3	Negligible
17	17.5	17.6	0	Negligible	55	17.8	17.5	-1	Negligible
18	18.5	18.7	1	Negligible	56	17.2	16.2	-2	Negligible
19	16.3	16.0	-1	Negligible	57	18.4	17.5	-2	Negligible
20	29.4	30.3	2	Slight Adverse	58	15.5	15.3	0	Negligible
21	17.1	17.0	0	Negligible	59	15.6	15.4	-1	Negligible
22	17.1	16.3	-2	Negligible	60	17.7	17.5	0	Negligible
24	28.6	27.7	-2	Negligible	62	16.2	16.4	1	Negligible
25	24.1	22.7	-3	Negligible	63	16.4	16.3	0	Negligible
26	17.9	17.7	0	Negligible	64	16.1	16.1	0	No Change
27	18.6	17.5	-3	Negligible	65	24.5	23.3	-3	Negligible
28	16.0	15.5	-1	Negligible	66	19.6	18.9	-2	Negligible
29	16.1	15.7	-1	Negligible	67	19.6	20.0	1	Negligible
30	16.5	15.8	-2	Negligible	68	15.7	15.6	0	Negligible

R [a]	'No Scheme'	'With Scheme'	% Ch [b]	Impact Descriptor	R [a]	'No Scheme'	'With Scheme'	% Ch [b]	R [a]
31	16.6	16.0	-2	Negligible	69	17.1	17.0	0	Negligible
32	21.0	19.9	-3	Negligible	70	27.0	27.1	0	Negligible
33	18.1	17.8	-1	Negligible	71	20.7	21.0	1	Negligible
34	17.2	17.0	-1	Negligible	72	16.1	16.3	0	Negligible
35	15.3	15.2	0	Negligible	73	15.2	15.1	0	Negligible
36	15.2	15.0	0	Negligible	74	16.4	16.5	0	Negligible
37	16.4	15.6	-2	Negligible	75	20.2	20.2	0	Negligible
38	15.3	15.3	0	Negligible	76	16.7	16.6	0	Negligible
O [c]	40	40	-		O [c]	40	40	-	

[a] R = Individual Receptor. Receptor nomenclature aligns with that used for the ATCs. There are no relevant receptors close to ATCs 23 or 61 and therefore no receptors 23 or 61.

[b] % Ch = % Change. These are expressed relative to the objective and have been rounded to the nearest whole number.

[c] O = Objective

PM_{10}

4.5 Figure 4-2 shows the predicted PM_{10} concentrations without and with the Scheme at all receptors, as well as the change caused by the Scheme (in µg/m^3), and the IAQM impact descriptor. Table 4-2 shows the results at the individual receptors.

4.6 All the predicted PM_{10} concentrations are less than half the 40 µg/m^3 objective level, even alongside the A206 and A2. There are some locations around ATC 1, ATC 4, ATC 5 and ATC 27 where PM_{10} concentrations are predicted to have fallen by more than 0.2 µg/m^3, and around ATCs 15 and 20 where similar increases are predicted. Using the IAQM impact descriptors, all the impacts are negligible.

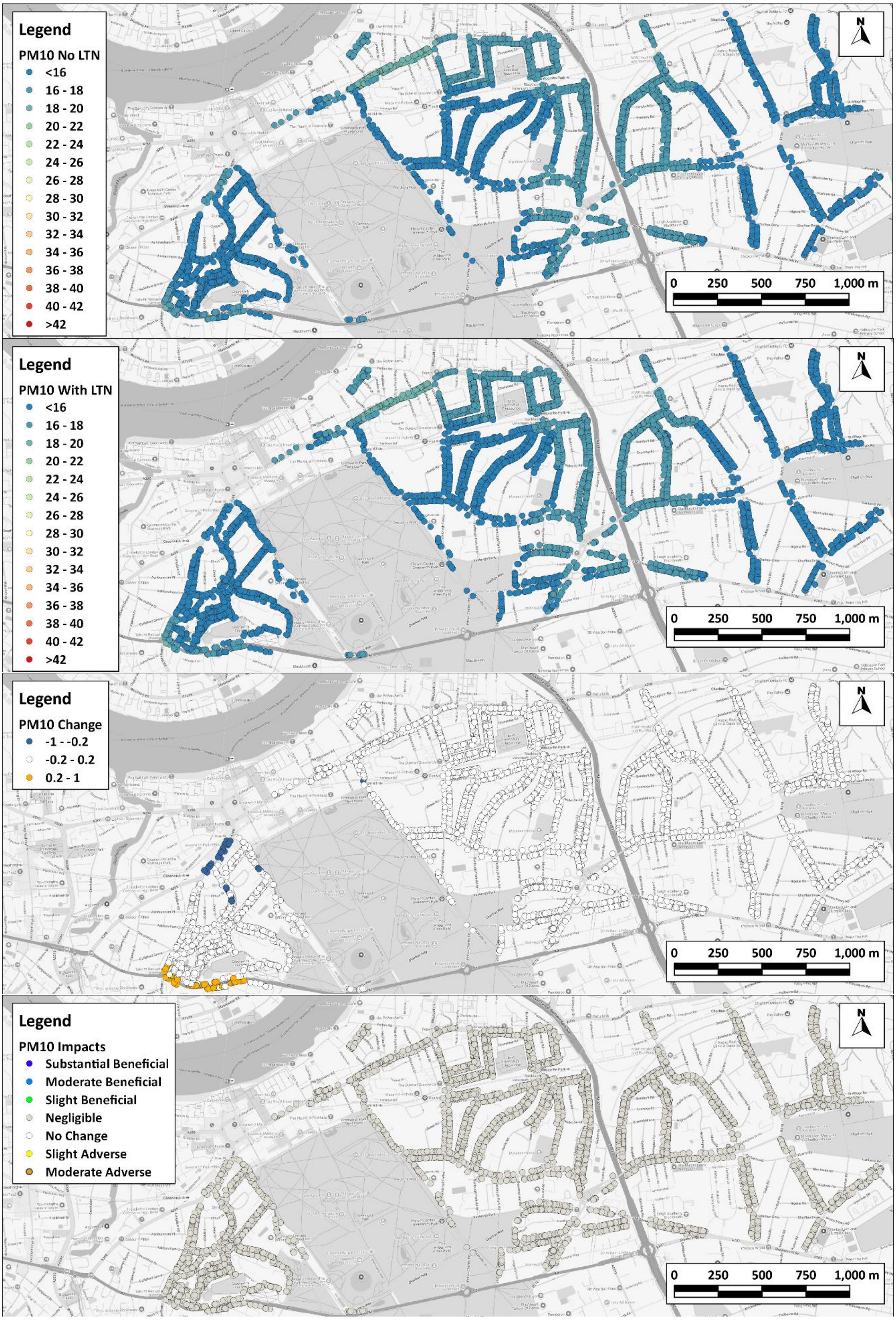

Figure 4-2: Predicted Concentrations of PM_{10} in 2024 Without and With the Scheme ($\mu g/m^3$) (Scheme is denoted 'LTN' in this figure) Map data ©2025

Table 4-2: Predicted Annual Mean PM_{10} Concentrations in 2024 Without and With the Scheme (µg/m³)

R [a]	'No Scheme'	'With Scheme'	% Ch[b]	Impact Descriptor	R [a]	'No Scheme'	'With Scheme'	% Ch[b]	R [a]
1	16.5	15.8	-2	Negligible	39	14.6	14.6	0	Negligible
2	15.6	15.5	0	Negligible	40	16.2	16.2	0	Negligible
3	15.4	15.3	0	Negligible	41	16.3	16.2	0	Negligible
4	15.5	15.4	0	Negligible	42	17.5	17.5	0	Negligible
5	15.5	15.4	0	Negligible	43	16.8	16.7	0	Negligible
6	15.3	15.3	0	Negligible	44	16.8	16.7	0	Negligible
7	15.6	15.5	0	Negligible	45	16.1	16.1	0	Negligible
8	15.5	15.4	-1	Negligible	46	16.3	16.2	0	Negligible
9	15.3	15.3	0	Negligible	47	16.7	16.6	0	Negligible
10	15.3	15.3	0	Negligible	48	16.0	16.0	0	Negligible
11	15.4	15.4	0	Negligible	49	16.0	16.0	0	Negligible
12	15.7	15.7	0	Negligible	50	16.1	16.1	0	Negligible
13	15.3	15.3	0	Negligible	51	16.2	16.1	0	Negligible
14	15.4	15.4	0	Negligible	52	17.0	16.9	0	Negligible
15	15.9	16.0	0	Negligible	53	16.6	16.6	0	Negligible
16	15.5	15.5	0	Negligible	54	16.5	16.4	0	Negligible
17	15.5	15.6	0	Negligible	55	16.1	16.1	0	Negligible
18	15.6	15.7	0	Negligible	56	14.9	14.8	0	Negligible
19	15.4	15.3	0	Negligible	57	16.3	16.2	0	Negligible
20	17.2	17.6	1	Negligible	58	15.2	15.1	0	Negligible
21	15.4	15.5	0	Negligible	59	14.7	14.6	0	Negligible
22	15.5	15.4	0	Negligible	60	15.9	15.9	0	Negligible
24	16.5	16.6	0	Negligible	62	15.0	15.0	0	Negligible
25	16.5	16.4	0	Negligible	63	14.9	14.9	0	Negligible
26	16.5	16.5	0	Negligible	64	14.8	14.8	0	Negligible
27	15.0	14.9	0	Negligible	65	15.8	15.7	0	Negligible
28	14.7	14.7	0	Negligible	66	15.4	15.4	0	Negligible
29	14.7	14.7	0	Negligible	67	16.3	16.4	0	Negligible
30	14.8	14.7	0	Negligible	68	14.6	14.6	0	Negligible

R [a]	'No Scheme'	'With Scheme'	% Ch[b]	Impact Descriptor	R [a]	'No Scheme'	'With Scheme'	% Ch[b]	R [a]
31	14.8	14.7	0	Negligible	69	16.1	16.1	0	Negligible
32	16.8	16.7	0	Negligible	70	17.0	17.0	0	Negligible
33	16.5	16.5	0	Negligible	71	16.6	16.6	0	Negligible
34	16.0	16.0	0	Negligible	72	14.6	14.7	0	Negligible
35	14.6	14.6	0	Negligible	73	14.5	14.5	0	Negligible
36	14.6	14.6	0	Negligible	74	14.7	14.7	0	Negligible
37	14.7	14.7	0	Negligible	75	16.4	16.4	0	Negligible
38	14.6	14.6	0	Negligible	76	15.4	15.4	0	Negligible
O[c]	40	40	-		O[c]	40	40	-	

[a] R = Individual Receptor. Receptor nomenclature aligns with that used for the ATCs. There are no relevant receptors close to ATCs 23 or 61 and therefore no receptors 23 or 61.

[b] % Ch = % Change. These are expressed relative to the objective and have been rounded to the nearest whole number.

[c] O = Objective

$PM_{2.5}$

4.7 Figure 4-3 shows the predicted $PM_{2.5}$ concentrations without and with the Scheme at all receptors, as well as the change caused by the Scheme (in µg/m^3), and the IAQM impact descriptor. Table 4-3 shows the results at the individual receptors. The IAQM impact descriptors in Figure 4-3 and Table 4-3 are expressed in relation to the GLA target for annual mean $PM_{2.5}$ concentrations (10 µg/m^3).

4.8 The only places where the GLA target was exceeded without the Scheme were along the A206 (ATC 25). The Scheme has removed some of these exceedances and not created any new ones. Changes to annual mean $PM_{2.5}$ concentrations caused by the Scheme range from reductions of up to 0.48 µg/m^3, to increases of up to 0.24 µg/m^3. The largest reductions are predicted around the A205 while the largest increases are predicted around the A2. There are also predicted reductions greater than 0.05 µg/m^3 (0.5% of the GLA target) along a large number of local roads, and increases greater than 0.05 µg/m^3 along some roads (Greenwich S Street (ATCs 15 and 12) and Victoria Way (ATCs 67 and 68)).

4.9 In terms of the IAQM impact descriptors, impacts range from moderate beneficial to moderate adverse, although beyond the A206 and A2, all impacts are predicted to be negligible,

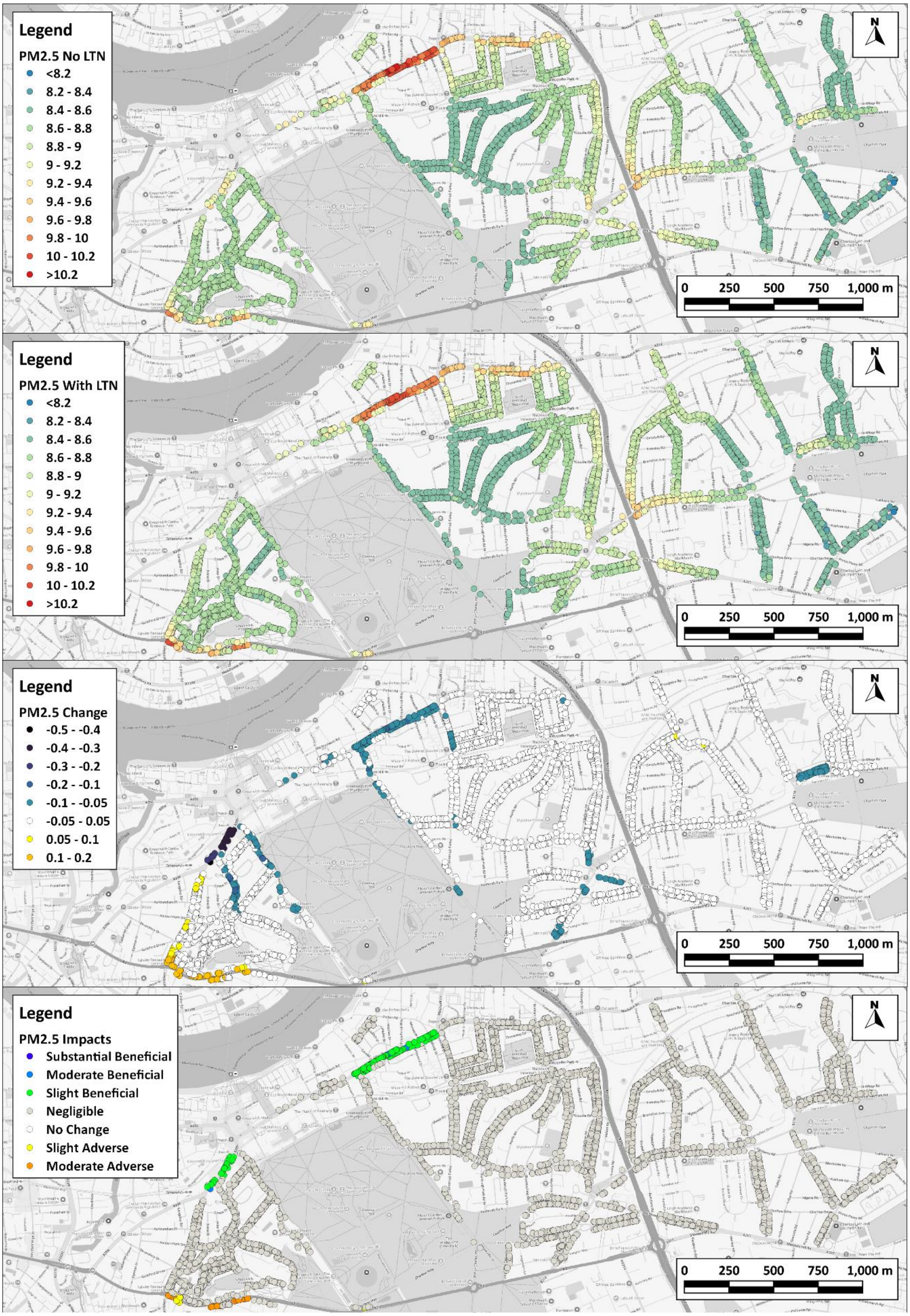

Figure 4-3: Predicted Concentrations of $PM_{2.5}$ in 2024 ($\mu g/m^3$) (Impacts in relation to GLA Target) (Scheme is denoted 'LTN' in this figure)

Map data ©2025

Table 4-3: Predicted Annual Mean $PM_{2.5}$ Concentrations in 2024 Without and With the Scheme (µg/m³)

R [a]	'No Scheme'	'With Scheme'	% Ch[b]	Impact Descriptor	R [a]	'No Scheme'	'With Scheme'	% Ch[b]	R [a]
1	9.2	8.9	-4	Slight Beneficial	39	8.5	8.5	0	Negligible
2	8.8	8.7	-1	Negligible	40	8.7	8.7	0	Negligible
3	8.6	8.6	0	Negligible	41	8.8	8.8	0	Negligible
4	8.7	8.7	-1	Negligible	42	9.5	9.5	0	Negligible
5	8.7	8.6	-1	Negligible	43	9.1	9.0	0	Negligible
6	8.6	8.6	0	Negligible	44	9.1	9.1	0	Negligible
7	8.8	8.7	-1	Negligible	45	8.8	8.8	0	Negligible
8	8.7	8.6	-1	Negligible	46	8.8	8.8	0	Negligible
9	8.6	8.6	0	Negligible	47	9.1	9.1	0	Negligible
10	8.6	8.6	0	Negligible	48	8.7	8.7	0	Negligible
11	8.6	8.6	0	Negligible	49	8.7	8.7	0	Negligible
12	8.8	8.8	0	Negligible	50	8.8	8.8	0	Negligible
13	8.6	8.6	0	Negligible	51	8.8	8.8	0	Negligible
14	8.7	8.6	0	Negligible	52	9.3	9.2	-1	Negligible
15	8.9	9.0	1	Negligible	53	9.1	9.1	0	Negligible
16	8.7	8.7	0	Negligible	54	9.0	9.0	-1	Negligible
17	8.7	8.7	0	Negligible	55	8.8	8.8	0	Negligible
18	8.8	8.8	0	Negligible	56	8.6	8.6	-1	Negligible
19	8.6	8.6	0	Negligible	57	8.9	8.8	0	Negligible
20	9.6	9.8	2	Moderate Adverse	58	8.6	8.6	0	Negligible
21	8.7	8.7	0	Negligible	59	8.5	8.5	0	Negligible
22	8.7	8.6	0	Negligible	60	8.8	8.8	0	Negligible
24	9.5	9.5	1	Slight Adverse	62	8.5	8.5	0	Negligible
25	9.2	9.1	-1	Negligible	63	8.5	8.5	0	Negligible
26	9.0	9.0	0	Negligible	64	8.5	8.5	0	Negligible
27	8.7	8.6	-1	Negligible	65	9.1	9.0	-1	Negligible
28	8.5	8.5	0	Negligible	66	8.7	8.7	0	Negligible
29	8.5	8.5	0	Negligible	67	8.8	8.8	0	Negligible
30	8.6	8.5	0	Negligible	68	8.4	8.4	0	Negligible

R [a]	'No Scheme'	'With Scheme'	% Ch[b]	Impact Descriptor	R [a]	'No Scheme'	'With Scheme'	% Ch[b]	R [a]
31	8.6	8.5	0	Negligible	69	8.8	8.8	0	Negligible
32	9.2	9.1	-1	Negligible	70	9.3	9.3	0	Negligible
33	9.0	9.0	0	Negligible	71	9.1	9.1	0	Negligible
34	8.8	8.8	0	Negligible	72	8.5	8.5	0	Negligible
35	8.5	8.5	0	Negligible	73	8.4	8.4	0	Negligible
36	8.5	8.5	0	Negligible	74	8.5	8.5	0	Negligible
37	8.5	8.5	0	Negligible	75	9.0	9.0	0	Negligible
38	8.5	8.5	0	Negligible	76	8.6	8.6	0	Negligible
T[c]	10	10	-		O[c]	10	10	-	

[a] R = Individual Receptor. Receptor nomenclature aligns with that used for the ATCs. There are no relevant receptors close to ATCs xx or yy and therefore no receptors xx or yy.

[b] % Ch = % Change. These are expressed relative to the objective and have been rounded to the nearest whole number.

[c] T = GLA Target

Overall Significance

4.10 Judging the overall significance of the air quality effects requires balancing the predicted adverse changes with the predicted benefits. More people are expected to experience improved air quality as a result of the Scheme than will experience disbenefits. However, in most cases, the impacts are negligible, particularly along local roads. Taking this into account, the overall effect of the Scheme on air quality is judged to be not significant.

5 Summary and Conclusions

5.1 Dispersion modelling has been used to quantify and assess the effect of the Scheme on air quality. This assessment combines pre- and post-implementation traffic counts and pre- and post-implementation air quality measurements.

5.2 The Scheme has affected annual mean concentrations of nitrogen dioxide, PM_{10} and $PM_{2.5}$. More locations have experienced improved air quality than worsened air quality as a result of the Scheme. In most cases these changes are classed as negligible, but on the main A roads at the periphery of the Scheme (the A206 and A2), there have been impacts ranging from moderate beneficial to moderate adverse. There have also been some slight beneficial impacts in relation to annual mean nitrogen dioxide concentrations alongside some roads within the Scheme. On balance, the overall effect of the Scheme on air quality is judged to be not significant.

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7 Appendices

A1 Professional Experience

Dr Ben Marner, BSc (Hons) PhD CSci MIEnvSc MIAQM

Dr Marner is the Director of Air Quality Modelling and Assessment at AQC and has more than 25 years' relevant experience. He has been responsible for air quality and greenhouse gas assessments of road schemes, rail schemes, airports, power stations, waste incinerators, commercial developments and residential developments in the UK and abroad. He has acted as expert witness at public inquiries, where he has presented evidence on health-related air quality impacts, the impacts of air quality on sensitive ecosystems, and greenhouse gas impacts. He has developed a range of widely-used air quality models and contributed to the development of best practice. Dr Marner has provided support and advice to foreign governments, Highways England, Transport Scotland, Transport for London, Greater London Authority, the Joint Nature Conservation Committee, the Environment Agency, and numerous local authorities. He is a Member of the Institute of Air Quality Management and a Chartered Scientist. He currently advises the UK Government on air quality as part of its Air Quality Expert Group (AQEG), where his specific area of expertise relates to air quality assessment in the development control process, and has separately provided advice on air quality issues to Defra's Chief Scientific Adviser, the UK Chief Medical Officer, and the UK Chief Planner.

Dr Denise Evans, BSc (Hons) PhD MIEnvSc MIAQM

Dr Evans is a Technical Director with AQC, with more than 25 years' relevant experience. She has prepared air quality review and assessment reports for local authorities, and has appraised local authority air quality assessments on behalf of the UK governments, and provided support to the Review and Assessment helpdesk. She has extensive modelling experience, completing air quality and odour assessments to support applications for a variety of development sectors including residential, mixed use, urban regeneration, energy, commercial, industrial, and road schemes, assessing the effects of a range of pollutants against relevant standards for human and ecological receptors. Denise has acted as an Expert Witness and is a Member of the Institute of Air Quality Management.

Dr Frances Marshall, MSci PhD CSci MIEnvSc MIAQM

Dr Marshall is a Principal Consultant with AQC with ten years' relevant experience. Prior to joining AQC, she spent four years carrying out postgraduate research into atmospheric aerosols at the University of Bristol. Dr Marshall has experience preparing air quality assessments for a range of projects, including residential and commercial developments, road traffic schemes, energy centres, energy from waste schemes and numerous power generation schemes. She has experience in producing air quality assessments for EIA schemes, and has also assessed the impacts of Local Plans on designated ecological areas, prepared Annual Status Reports for Local Authorities, and undertaken diffusion tube monitoring studies. She is a is a Chartered Scientist and Member of both the Institute of Air Quality Management and the Institution of Environmental Sciences.

A2 Modelling Methodology

Model Inputs

A2.1 Predictions have been carried out using the ADMS-Roads dispersion model (v5). The model requires the user to provide various input data, including emissions from each section of road and the road characteristics (including road width, street canyon width, street canyon height and porosity, where applicable). Model input parameters are summarised in Table A2-1 and, where necessary, discussed further below.

Table A2-1: Summary of Model Inputs

Model Parameter	Value Used
Terrain Effects Modelled?	No
Variable Surface Roughness File Used?	Yes – 12km x 12km Cartesian grid at 50m resolution
Urban Canopy Flow Used?	No
Advanced Street Canyons Modelled?	Yes
Noise Barriers Modelled?	No
Meteorological Monitoring Site	London City Airport
Meteorological Data Year	2024
Dispersion Site Surface Roughness Length (m)	N/A (variable surface roughness file used)
Dispersion Site Minimum MO Length (m)	100
Met Site Surface Roughness Length (m)	0.2
Met Site Minimum MO Length (m)	75
Gradients?	No

A2.2 It has been assumed that dispersion will be affected by buildings around all roads with ATCs and with buildings within 30 m of the road centre. These roads (which comprises most of the study) have therefore, been modelled as street canyons using ADMS-Roads' advanced canyon module. Input parameters have been determined from the surrounding building footprints and heights determined from Light Detection and Ranging (LIDAR) data. The roads without ATCs were not modelled as canyons since there are no receptors alongside them. The modelled canyons are shown in Figure A2-1.

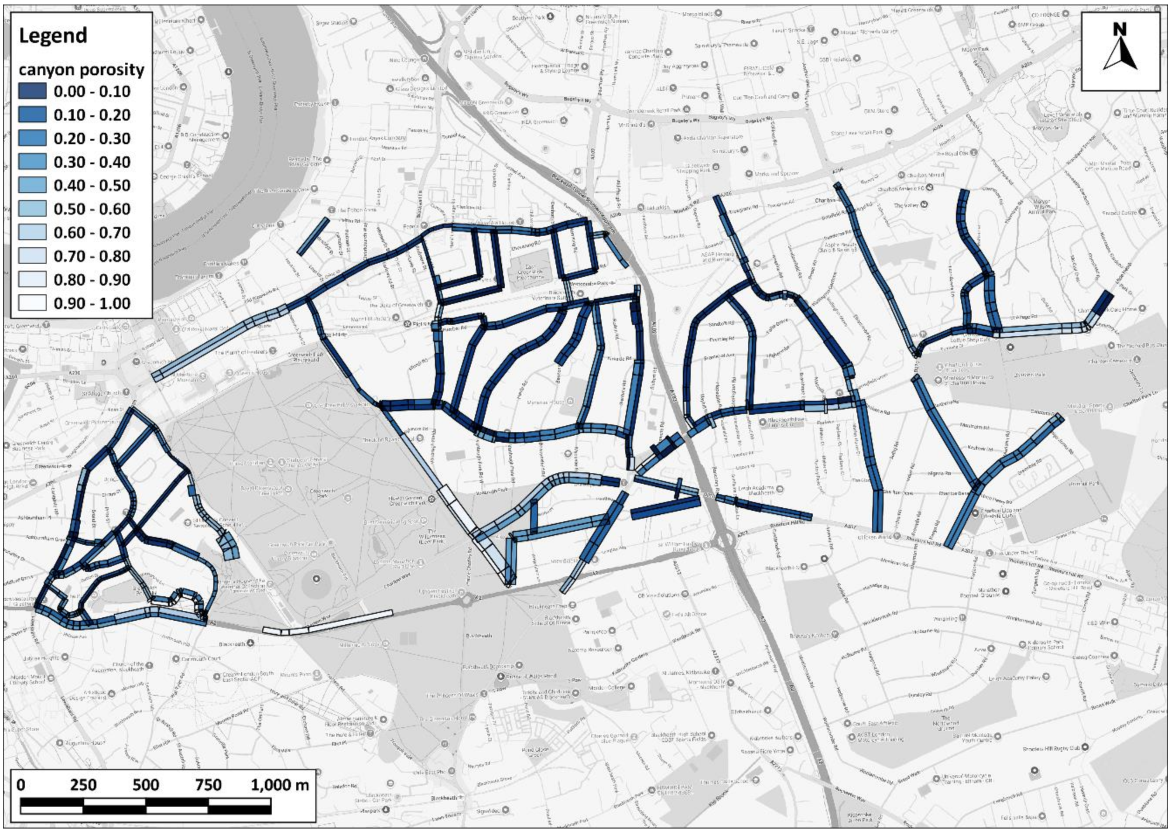

Figure A2-1: Modelled Canyons, Showing Assumed Width and Porosity

Map data ©2025

A2.3 Hourly sequential meteorological data in sectors of 10 degrees from London City Airport for 2024 have been used in the model. The London City Airport meteorological monitoring station is located approximately 2 km northeast of the study area, and measurements from this site provide the most robust basis to predict meteorology within the model domain. A wind rose for the site for the year 2024 is provided in Figure A6-5. Raw data were provided by the Met Office and processed by AQC for use in ADMS.

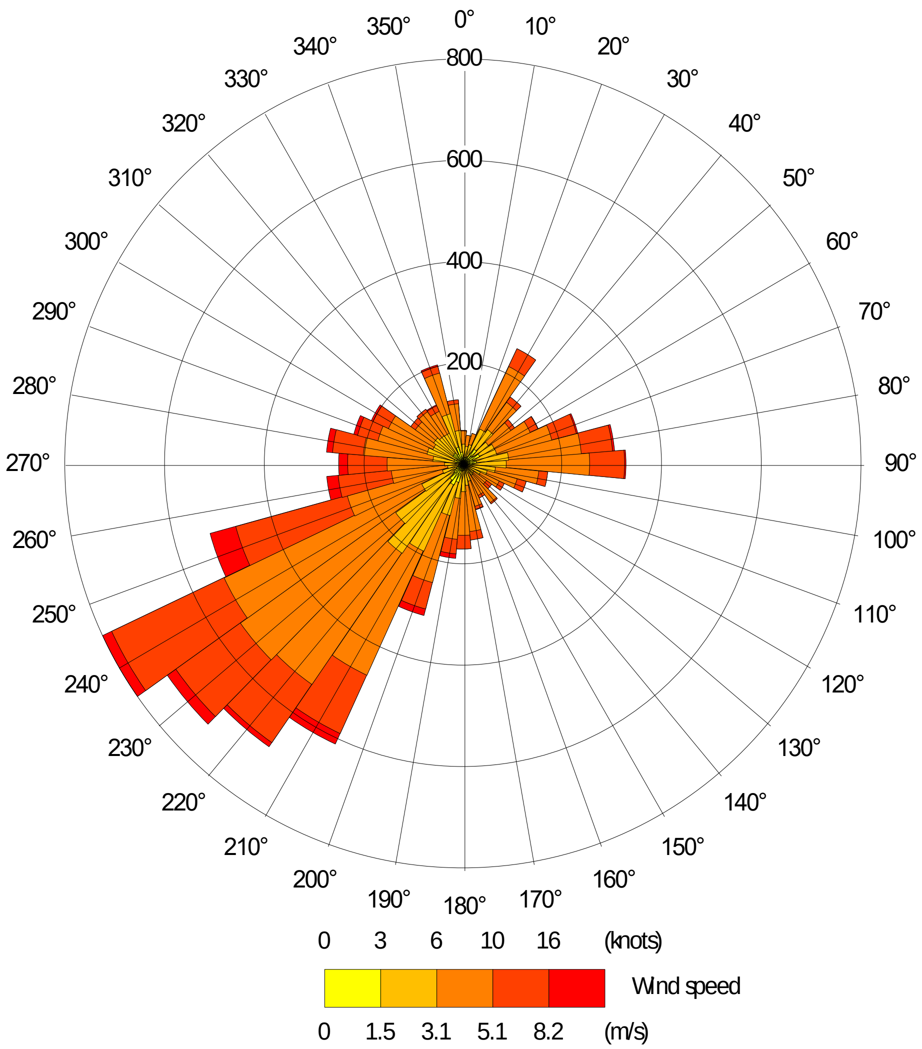

Figure A2-2: Wind Rose

Calibrating Background Nitrogen Dioxide Maps

A2.4 As explained in Paragraph 3.6, Defra predicts background concentrations of nitrogen dioxide across the whole of the UK. RBG operates one automatic background monitoring site and four background diffusion tube sites (Figure A2-3). The automatic monitor achieved poor data capture during 2024 and cannot therefore be used to calibrate the national data. One of RBGs background diffusion tube sites (GW38) is approximately 30 m from the A205 and is therefore not appropriate for use. It is, however, appropriate to compare Defra's predictions against the measurements made during 2024 at the three remaining diffusion tube sites.

A2.5 Defra's gridded predictions have first been interpolated to avoid step changes in the data. They have then been compared with the concurrent annual mean measurements (Table A2-2, Figure A2-4). Figure A2-4 shows that Defra's predictions consistently over-predicted background annual mean nitrogen dioxide concentrations in Greenwich in 2024. All predicted background concentrations used in this study have therefore been multiplied by 0.7801 to remove this bias.

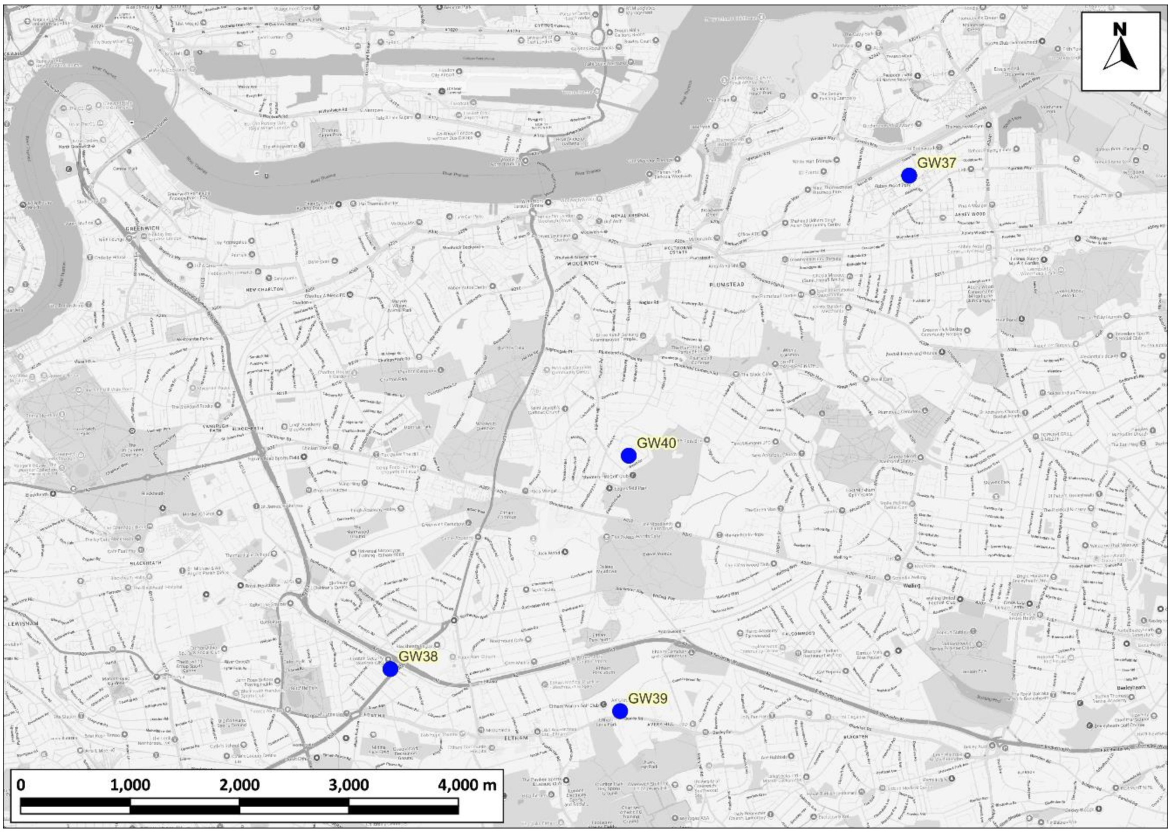

Figure A2-3: Background Air Quality Monitoring Sites in Greenwich

Map data ©2025

Table A2-2: Annual Mean Nitrogen Dioxide Concentrations in 2024 Measured at and Predicted at Four Background Monitoring Sites in Greenwich [a]

Site Name	Predicted by Defra (µg/m³)	Measured (µg/m³)
GW37	16.2	14.7
GW38[b]	17.0	17.2
GW39	14.7	10.7
GW40	15.4	10.7

[a] Diffusion tubes operated by RBG, with tubes prepared and analysed by Gradko International using the 50% acetone method. Data provided by RBG and adjusted for bias using a nationally-derived factor of 0.88. Where relevant, triplicates have been averaged.

[b] Classified as a background site but close to a main road and so not included in the calibration.

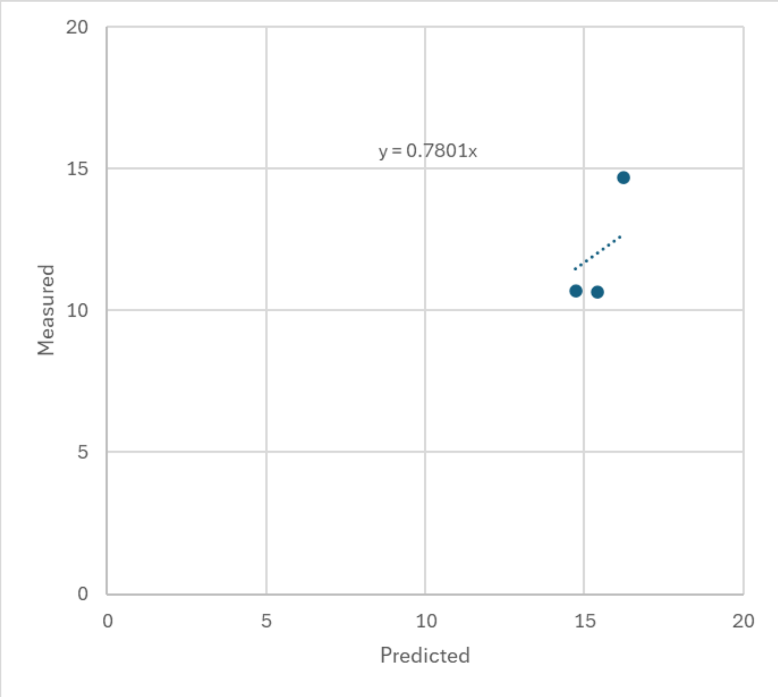

Figure A2-4: Comparison of Measured and Predicted Annual Mean NO_2 (µg/m³) at Three Relevant Background Monitoring Sites in Greenwich.

Model Verification

Nitrogen Dioxide

A2.6 Evidence collected over many years has shown that, in most urban areas, dispersion modelling relying upon Defra's EFT has tended to systematically under-predict roadside nitrogen dioxide concentrations. To account for this, it is necessary to adjust the model against local measurements. The model has been run to predict annual mean nitrogen dioxide concentrations during 2024 at the long-term monitoring sites operated by RBG which are within the study area, and at the monitoring sites operated as part of this study (Appendix A3). The locations of these monitoring sites are shown in Figure A2-5. Annual mean concentrations measured during 2024 at RBG's long-term sites are shown in Table A2-2. Pre-implementation measurements made at the short-term monitoring sites are shown in Table A2-3, while the post-implementation measurements are shown in Table A2-4. The pre- and post-implementation measurements have all been adjusted to represent the full 2024 calendar year (i.e. they separately represent conditions in 2024 if the Scheme was not present and present for the whole year).

Figure A2-5: Roadside Air Quality Monitoring Sites within the Study Area. Long-term Sites in Green, Short-term sites in Red.

Map data ©2025

Table A2-3: Annual Mean Nitrogen Dioxide Concentrations in 2024 Measured at Long-term Monitoring Sites in the Study Area [a]

Site Name	Site Type	Concentration
GN5	Automatic	29.0
GR7	Automatic	26.0
GW27	Diffusion Tube	22.7
GW35	Diffusion Tube	28.9
GW48	Diffusion Tube	28.0
GW53	Diffusion Tube	20.3
GW57	Diffusion Tube	20.5
GW58	Diffusion Tube	25.0

[a] Automatic data taken from https://www.londonair.org.uk. Diffusion tubes operated by RBG, with tubes prepared and analysed by Gradko International using the 50% acetone method. Data provided by RBG and adjusted for bias using a nationally-derived factor of 0.88. Where relevant, triplicates have been averaged.

Table A2-4: Annual Mean Nitrogen Dioxide Concentrations in 2024 Measured at Short-term Monitoring Sites

Site ID	Location	Pre-implementation Annual Mean NO_2 Concentration (µg/m³) [a]	Post-implementation Annual Mean NO_2 Concentration (µg/m³)
1	47 Hyde Vale	17.4	16.1
2	11 Crooms Street	18.5	17.5
3	115 Maze Hill	-	18.4
4	7 Beaconsfield Road	18.1	17.2
5	The Pointer School	30.9	28.4
6	149 Charlton Church Lane	24.3	22.9
7	1-22 Champion House	21.0	18.2
8	Old Dover Road / Sunfields Place	-	19.6
9	122 Victoria Way	-	17.4
10	16 Eastcombe Avenue	22.2	21.6
11	3 Victoria Way	-	19.9
12	1b Ashburnham Grove	16.5	15.8
Objective		**40**	**40**

[a] Where data are not available (due to the loss of the diffusion tube during the monitoring period), this is indicated by a dash ('-').

A2.7 Most nitrogen dioxide (NO_2) is produced in the atmosphere by reaction of nitric oxide (NO) with ozone. It is therefore most appropriate to verify the model in terms of primary pollutant emissions of nitrogen oxides ($NOx = NO + NO_2$).

A2.8 The model output of road-NOx (i.e. the component of total NOx coming from road traffic) has been compared with the 'measured' road-NOx. Measured road-NOx has been calculated from the measured NO_2 concentrations and the predicted background NO_2 concentration using the NOx from NO_2 calculator (Version 9.1) available on the Defra LAQM Support website (Defra, 2025b). Modelled road-NOx at RBG's monitoring sites, and for comparison with the pre-implementation measurements, have been taken from the 'No Scheme' predictions, while those for comparison with the post-implementation measurements have been taken from the 'with Scheme' predictions.

A2.9 The unadjusted model has under predicted the road-NOx contribution; this is a common experience with this and most other road traffic emissions dispersion models. An adjustment factor has been determined as the slope of the best-fit line between the 'measured' road contribution and the model derived road contribution, forced through zero (Figure A2-6). The calculated adjustment factor of 5.0109 has been applied to the modelled road-NOx concentration for each receptor to provide adjusted modelled road-NOx concentrations.

A2.10 The total nitrogen dioxide concentrations have then been determined by combining the adjusted modelled road-NOx concentrations with the predicted background NO_2 concentration within the NOx to NO_2 calculator. Figure A2-7 compares final adjusted modelled total NO_2 at each of the monitoring sites to measured total NO_2 and shows a close agreement.

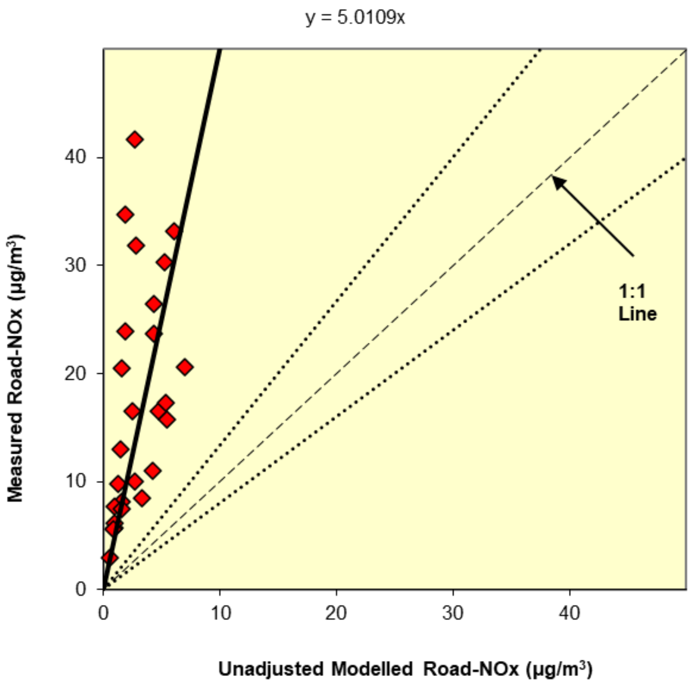

Figure A2-6: Comparison of Measured Road NOx to Unadjusted Modelled Road NOx Concentrations. The dashed lines show ± 25%.

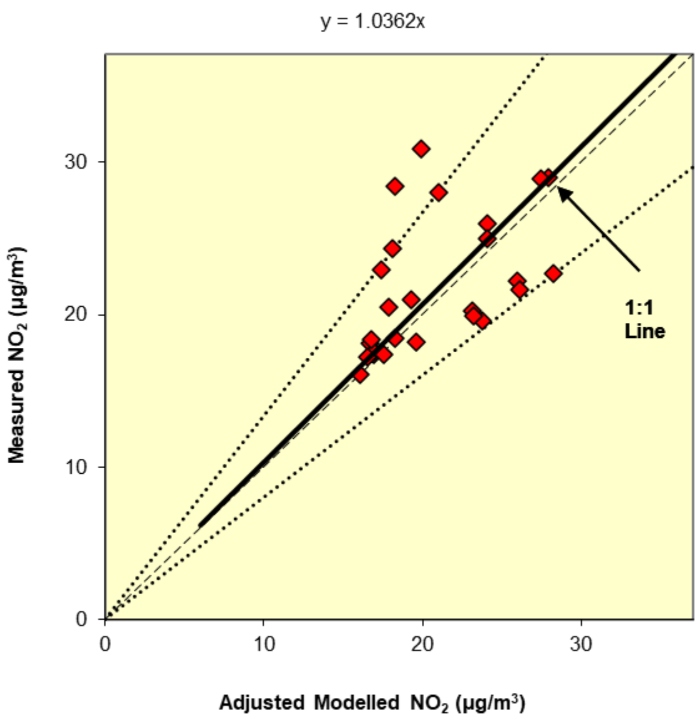

Figure A2-7: Comparison of Measured Total NO_2 to Final Adjusted Modelled Total NO_2 Concentrations. The dashed lines show ± 25%.

A2.11 Table A2-5 shows the statistical parameters relating to the performance of the model, as well as the 'ideal' values (Defra, 2025a). Although there is very little residual bias, the performance of the adjusted model is not ideal. This is shown by the relatively low correlation coefficient, the relatively high Root Mean Square Error value, and the fact that several of the points in Figure A2-7 fall outside of the ± 25% lines. It is also the case that the adjustment factor of 5.0109 is higher than would often be expected for a study of this type. However, most of the air quality measurements were carried out over relatively short periods (Appendix A3), which adds considerable uncertainty to the measurements. Also, the approach to configuring street canyons was largely automated and has therefore relied on the verification process to remove any bias. Taking account of these points, the performance of the model is acceptable.

Table A2-5: Statistical Model Performance

Statistical Parameter	Model-Specific Value	'Ideal' Value
Correlation Coefficient [a]	0.51	1
Root Mean Square Error (RMSE) [b]	4.24	0
Fractional Bias [c]	0.05	0

[a] Used to measure the linear relationship between predicted and observed data. A value of zero means no relationship and a value of 1 means absolute relationship.

[b] Used to define the average error or uncertainty of the model. The units of RMSE are the same as the quantities compared (i.e. µg/m^3). TG22 (Defra, 2025a) outlines that, ideally, a RMSE value within 10% of the air quality objective (4 µg/m^3) would be derived. If RMSE values are higher than 25% of the objective (10 µg/m^3) it is recommended that the model is revisited.

[c] Used to identify if the model shows a systematic tendency to over or under predict. Negative values suggest a model over-prediction and positive values suggest a model under-prediction.

A2.12 Performance of the model is not significantly affected by the inclusion of the pre-implementation measurements. Therefore, although these measurements are particularly uncertain, they are not driving the calculated adjustment factor. The residual site-specific biases shown in Figure A2-7 are largely consistent between the pre- and post-implementation data; for example the predictions at Site ID 5, which is where the model exhibits the largest bias, shows 33 % bias[6] in both the pre- and post-implementation datasets.

A2.13 The predicted road-NOx concentrations at each receptor location have been adjusted using the adjustment factor set out above, which, along with the background NO_2, has been processed through the NOx to NO_2 calculator V9.1 available on the Defra LAQM Support website (Defra, 2025b). The traffic mix within the calculator has been set to "All London traffic", which is considered suitable for the study area. The calculator predicts the component of NO_2 based on the adjusted road-NOx and the background NO_2.

PM_{10} and $PM_{2.5}$

A2.14 The approach described above for NOx and nitrogen dioxide determines the road increment of concentrations by subtracting the predicted local background from the roadside measurements. This works well for NOx because the differences between roadside and background concentrations typically represent a large proportion of the total measured value. The same is not true for PM_{10} and $PM_{2.5}$ concentrations, which are dominated by non-road emissions, even at the roadside. In practice, the influence of a local road on concentrations can often be smaller than the uncertainty in the mapped background concentration. As an example of this, 31% of all roadside and kerbside sites in London which measured $PM_{2.5}$ in 2019 with >75% data capture, recorded an annual mean

[6] Calculated here as the difference between measured and modelled values expressed as a percentage of the measured value.

concentration lower than the equivalent Defra mapped background value. Using measured background concentrations does not provide any significant benefit, owing largely to the spatial resolution of available measurements, but also because of measurement uncertainty. For example, hourly-mean $PM_{2.5}$ concentrations measured at roadside sites are often lower than those measured at nearby urban background sites, while concentrations at urban background sites are often lower than those measured at rural sites.

A2.15 For these reasons, it is not appropriate to calculate the annual mean road-increment to PM_{10} and $PM_{2.5}$ concentrations by subtracting either the mapped background or a local measured background concentration. This, in turn, means that the approach to model adjustment which is described for NOx and NO_2 is not appropriate for PM_{10} and $PM_{2.5}$. Historically, many studies have derived a model adjustment factor for NOx and applied this to PM_{10} and $PM_{2.5}$. This is also not appropriate, since there is no reason to expect the same bias in emissions of NOx, PM_{10} and $PM_{2.5}$.

A2.16 While there is very strong evidence that EFT-based models have consistently under-predicted road-NOx concentrations in urban areas, there is no equivalent evidence for PM_{10} and $PM_{2.5}$. There is currently no strong basis for applying any adjustment to the model outputs. Predicted concentrations of PM_{10} and $PM_{2.5}$ have thus not been adjusted.

A2.17 PM_{10} is measured at two locations within the study area (RBG monitoring sites GN5 and GR7). Figure 4-3 compares the measured and predicted PM_{10} concentrations at these sites. The model shows a slight tendency to overpredict on average, but overall is considered to perform well for PM_{10}. $PM_{2.5}$ concentrations are not measured in the study area.

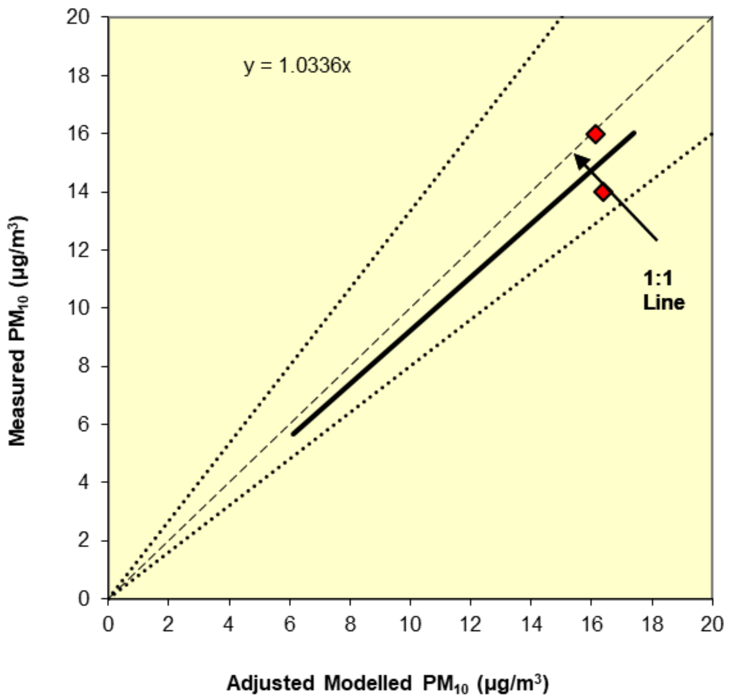

Figure A2-8: Comparison of Measured and Modelled Total PM_{10} Concentrations. The dashed lines show the 1:1 line and ± 25%.

A3 Nitrogen Dioxide Diffusion Tube Monitoring Survey

Report

West and East Greenwich Neighbourhood Management Scheme

Nitrogen Dioxide Diffusion Tube Monitoring Survey

For Royal Borough of Greenwich

3 July 2025

Air Quality Consultants | Part of Logika Group

Document Control

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01	16/06/2025	
02	03/07/2025	Addition of RBG monitoring data

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1 Introduction

1.1 This report presents the results of a six-month period of nitrogen dioxide (NO_2) monitoring carried out between 25th October 2024 and 30th April 2025 to inform the West and East Greenwich Neighbourhood Management Scheme project (hereafter referred to as 'the Scheme'), on behalf of the Royal Borough of Greenwich (RBG). The results presented cover two different monitoring periods:

- before the implementation of the Scheme (Pre-Scheme), covering the period from 25th October 2024 to 27th November 2024; and
- after the implementation of the Scheme (Post-Scheme), covering the period from 27th November 2024 to 30th April 2025.

1.2 This report outlines the monitoring methodology and summarises the findings, comparing the measured concentrations to the NO_2 objectives, set to protect human health, as described in Appendix A1.

2 Monitoring Methodology

Monitoring Method

2.1 Monitoring for NO_2 was undertaken using passive diffusion tubes. This method involves the use of small plastic tubes containing a media (in this case a 50:50 mixture of triethanolamine (TEA) and acetone) which reacts with NO_2 in the atmosphere and allows average atmospheric NO_2 concentrations over the course of the exposure period to be determined via laboratory analysis.

2.2 The diffusion tubes are mounted on lampposts and other street furniture for a period of one month, after which they are sealed and returned to a laboratory for analysis. The diffusion tubes used in this study have been prepared and analysed by Gradko, a UKAS accredited laboratory.

2.3 The media and laboratory were chosen to be the same as used by the RBG in its monitoring across the borough.

Monitoring Locations

2.4 Monitoring of NO_2 was undertaken for six months, between 25th October 2024 and 30th April 2025. Thirteen locations within and around the Scheme were chosen, including a co-located triplicate site at the 'GN5' automatic monitor. A description of each site location, including the approximate monitor height and its distance from the road, is provided in Table 2-1, while the locations of the sites are shown in Figure 2-1. Photos of the monitoring locations are included in Appendix A2.

Table 2-1: Description of Diffusion Tube Monitoring Locations

Site ID	Location	X	Y	Distance from Road (m)	Mounted Height (m)
1	47 Hyde Vale	538518	177011	1.4	2.3
2	11 Crooms Street	538450	177443	0.9	2.6
3	115 Maze Hill	539254	177616	0.4	2.1
4	7 Beaconsfield Road	540133	177922	0.4	2.4
5	The Pointer School	540128	176932	1.5	2.2
6	149 Charlton Church Lane	541377	177975	1.2	2.0
7	1-22 Champion House	541059	177586	3.2	2.1
8	Old Dover Road / Sunfields Place	540726	177198	1.2	2.9
9	122 Victoria Way	541019	177951	1.8	1.8
10	16 Eastcombe Avenue	540551	177579	0.7	2.3
11	3 Victoria Way	540681	178378	2.0	2.0
12	1b Ashburnham Grove	537807	177093	2.0	1.8
13a/b/c (triplicate site)	Co-located with GN5 Hoskins Street (Trafalgar Road)	539019	178013	6.5	2.9

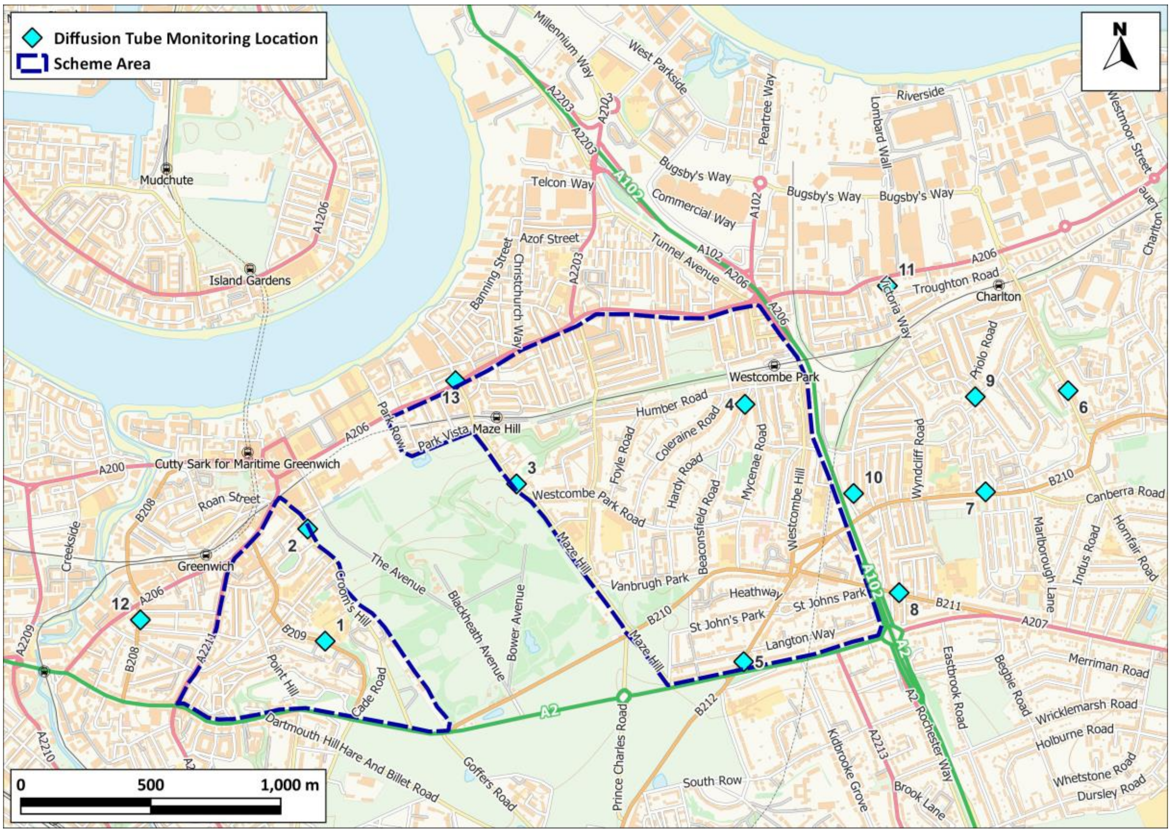


Figure 2-1: NO_2 Diffusion Tube Monitoring Locations

Additional data sourced from third parties, including public sector information licensed under the Open Government Licence v3.0.

Data Processing

Annualisation

2.5 The NO_2 diffusion tube monitoring has been undertaken for a period of six months; however, the key air quality objective with respect to NO_2 is an annual mean objective. NO_2 concentrations vary seasonally and are typically higher in winter months than summer months. It is, therefore, necessary to undertake a correction known as 'annualisation' in order to adjust the results from the respective pre- and post-Scheme monitoring periods into equivalent annual means.

2.6 The Defra method involves the use of a number of nearby automatic[1] background NO_2 monitoring stations to calculate a ratio between the annual mean NO_2 concentration and the period means (covering the length of deployment) NO_2 concentration. The ratios have then been applied to the raw, period mean diffusion tube monitoring results from the monitoring study in order to provide an equivalent annual mean concentration at each site.

2.7 Sites have been annualised to a 12-month period covering January to December 2024. It is necessary to annualise to a 2024 equivalent, since 2025 annual mean concentrations are not yet available.

[1] Automatic nitrogen dioxide monitoring is a more accurate monitoring method than diffusion tube monitoring. It utilises automatic analysers that are capable of recording average nitrogen dioxide concentrations over much shorter time periods (typically 15-minutes to 1-hour).

2.8 Defra LAQM.TG(22) guidance (Defra, 2025) states that a minimum of three months of monitoring data is required to undertake annualisation. As only one month of monitoring data is available for the pre-Scheme period, the annualised pre-Scheme concentrations should be viewed with caution and should only be considered as indicative.

2.9 Details of the diffusion tube annualisation are presented in Appendix A3.

Bias Adjustment

2.10 Diffusion tubes are also known to show systematic bias in relation to automatic (reference) monitors, and it is therefore necessary to carry out a correction known as 'bias adjustment'.

2.11 The annualised pre- and post-Scheme implementation NO_2 concentrations have been bias-adjusted using factors calculated using the data collected from triplicate diffusion tubes '13a/b/c' co-located with the RBG automatic monitor 'GN5' for the corresponding period.

2.12 The calculated bias adjustment factors are presented in Appendix A4.

3 Results

3.1 The annualised and bias-adjusted annual mean NO_2 concentrations for each monitoring site for the pre- and post-Scheme implementation period are shown in Table 3-1. As discussed above, the pre-Scheme concentrations should be viewed with caution as they have been annualised based on only one month of available data.

3.2 The raw monthly results and unadjusted period means are provided in Appendix A5.

Table 3-1: Annual Mean NO_2 Monitoring Results

Site ID	Location	Pre-Scheme Annual Mean NO_2 Concentration (µg/m^3) [a]	Post-Scheme Annual Mean NO_2 Concentration (µg/m^3)
1	47 Hyde Vale	17.4	16.1
2	11 Crooms Street	18.5	17.5
3	115 Maze Hill	-	18.4
4	7 Beaconsfield Road	18.1	17.2
5	The Pointer School	30.9	28.4
6	149 Charlton Church Lane	24.3	22.9
7	1-22 Champion House	21.0	18.2
8	Old Dover Road / Sunfields Place	-	19.6
9	122 Victoria Way	-	17.4
10	16 Eastcombe Avenue	22.2	21.6
11	3 Victoria Way	-	19.9
12	1b Ashburnham Grove	16.5	15.8
Objective		**40**	**40**

[a] Where data are not available (due to the loss of the diffusion tube during the monitoring period), this is indicated by a dash ('-').

4 Summary

4.1 Six-months of NO_2 monitoring were carried out between 25th October 2024 to 30th April 2025 to inform the West and East Greenwich Neighbourhood Management Scheme project, including one month pre-implementation of the Scheme and five months post-implementation.

4.2 Tubes were also co-located with the RBG's automatic monitor 'GN5' to allow for the calculation of study-specific bias adjustment factors.

4.3 The results will be used, alongside long-term monitoring undertaken by RBG (see Appendix A6), to inform a modelling study, which will analyse the effects of the Scheme across the study area.

5 References

Defra (2025) *Review & Assessment: Technical Guidance LAQM.TG22 May 2025 Version*, [Online], Available: https://laqm.defra.gov.uk/wp-content/uploads/2025/05/LAQM-TG22-May-25-v2.0.pdf.

GLA (2019) 'London Local Air Quality Management Technical Guidance 2019', no. https://www.london.gov.uk/sites/default/files/llaqm_technical_guidance_2019.pdf.

The Air Quality (England) (Amendment) Regulations 2002, Statutory Instrument 3043 (2002), HMSO, Available: https://www.legislation.gov.uk/uksi/2002/3043/contents/made.

The Air Quality (England) Regulations 2000 Statutory Instrument 928 (2000), HMSO, Available: http://www.legislation.gov.uk/uksi/2000/928/contents/made.

6 Appendices

A1 Air Quality Objectives

A1.1 The Government has established a set of air quality standards and objectives to protect human health. The 'standards' are set as concentrations below which effects are unlikely even in sensitive population groups, or below which risks to public health would be exceedingly small. They are based purely upon the scientific and medical evidence of the effects of an individual pollutant. The 'objectives' set out the extent to which the Government expects the standards to be achieved by a certain date. They take account of economic efficiency, practicability, technical feasibility and timescale. The objectives for use by local authorities are prescribed within the Air Quality (England) Regulations (2000) and the Air Quality (England) (Amendment) Regulations (2002).

A1.2 The annual mean objective for NO_2 was to have been achieved by 2005 and continues to apply in all future years thereafter. Measurements across the UK have shown that the 1-hour mean nitrogen dioxide objective is unlikely to be exceeded at roadside locations where the annual mean concentration is below 60 µg/m^3 (Defra, 2025).

A1.3 The objectives apply at locations where members of the public are likely to be regularly present and are likely to be exposed over the averaging period of the objective. The Greater London Authority (GLA) explains where these objectives will apply in London (GLA, 2019). The annual mean objective for NO_2 is considered to apply at the façades of residential properties, schools, hospitals and care homes etc., the gardens of residential properties, school playgrounds and the grounds of hospitals and care homes; it does not apply at hotels. The 1-hour mean objective for nitrogen dioxide applies wherever members of the public might regularly spend 1-hour or more, including outdoor eating locations and pavements of busy shopping streets.

A1.4 Diffusion tubes only allow the measurement of a monthly mean, and are not able to measure hourly concentrations. Thus, a proxy value of 60 µg/m^3 is used to assess the potential for exceedances of the 1-hour mean objective (see paragraph A1.2).

A1.5 The relevant air quality criteria for the monitoring set out in this report are provided in Table A1-1.

Table A1-1: Annual Mean Criteria for NO_2

Pollutant	Time Period	Objective
NO_2	Annual Mean	40 µg/m^3
	1-hour Mean	60 µg/m^3 [a]

[a] See paragraph A1.2.

A2 Monitoring Locations

Figure A2-1: Site 1

Figure A2-2: Site 2

Figure A2-3: Site 3

Figure A2-4: Site 4

Figure A2-5: Site 5

Figure A2-6: Site 6

Figure A2-7: Site 7

Figure A2-8: Site 8

Figure A2-9: Site 9

Figure A2-10: Site 10

Figure A2-11: Site 11

Figure A2-12: Site 12

Figure A2-13: Site 13a/b/c GN5 Triplicate Co-location

A3 Adjustment of Short-Term Data to Annual Mean

A3.1 This report describes the results of nitrogen dioxide monitoring that was carried out for less than a full calendar year (both pre- and post-implementation of the Scheme). Therefore, in accordance with the procedure in Box 7.9 of Defra's LAQM.TG(22) guidance, the data have been adjusted to represent an equivalent annual mean concentration (Defra, 2025). This calculation is based on the ratio of concentrations over the pre-Scheme and post-Scheme implementation monitoring periods (25th October 2024 to 27th November 2024, and 27th November 2024 to 30th April 2025, respectively), and the annual mean concentration between the 1st January 2024 and 31st December 2024 at three urban background sites operated as part of the Automatic Urban and Rural Network (AURN), where long-term data are available. This provides an annualisation factor, which is then applied to the time-weighted mean[2] measured at each diffusion tube for the appropriate monitoring period.

A3.2 The annual mean nitrogen dioxide concentrations and the period means from which each of the required adjustment factors have been calculated are presented in the following tables.

Table A3-1: Data used to Adjust Pre-Scheme Monitoring Data (All Sites)

AURN Urban Background Site	Annual Mean Concentration (µg/m³)	Period Mean Concentration (µg/m³)	Annual Mean Data Capture (%)	Adjustment Factor
London Bexley	15.3	23.5	87.7	0.649
London Westminster	20.1	29.9	98.3	0.673
London North Kensington	15.4	23.4	99.0	0.657
Average Factor [a]				**0.660**

[a] Calculated from unrounded values.

Table A3-2: Data used to Adjust Post-Scheme Monitoring Data (Sites 1, 2, 4, 5, 8, 9, 10)

AURN Urban Background Site	Annual Mean Concentration (µg/m³)	Period Mean Concentration (µg/m³)	Annual Mean Data Capture (%)	Adjustment Factor
London Bexley	15.3	24.6	87.7	0.620
London Westminster	20.1	26.8	98.3	0.750
London North Kensington	15.4	21.7	99.0	0.708
Average Factor [a]				**0.693**

[a] Calculated from unrounded values.

Table A3-3: Data used to Adjust Post-Scheme Monitoring Data (Site 3)

AURN Urban Background Site	Annual Mean Concentration (µg/m³)	Period Mean Concentration (µg/m³)	Annual Mean Data Capture (%)	Adjustment Factor
London Bexley	15.3	27.0	87.7	0.566

[2] The mean based on diffusion tube exposure periods.

AURN Urban Background Site	Annual Mean Concentration (µg/m³)	Period Mean Concentration (µg/m³)	Annual Mean Data Capture (%)	Adjustment Factor
London Westminster	20.1	27.9	98.3	0.719
London North Kensington	15.4	23.2	99.0	0.661
Average Factor [a]				**0.649**

[a] Calculated from unrounded values.

Table A3-4: Data used to Adjust Post-Scheme Monitoring Data (Site 6)

AURN Urban Background Site	Annual Mean Concentration (µg/m³)	Period Mean Concentration (µg/m³)	Annual Mean Data Capture (%)	Adjustment Factor
London Bexley	15.3	24.1	87.7	0.632
London Westminster	20.1	29.0	98.3	0.694
London North Kensington	15.4	23.2	99.0	0.662
Average Factor [a]				**0.663**

[a] Calculated from unrounded values.

Table A3-5: Data used to Adjust Post-Scheme Monitoring Data (Sites 7 and 12)

AURN Urban Background Site	Annual Mean Concentration (µg/m³)	Period Mean Concentration (µg/m³)	Annual Mean Data Capture (%)	Adjustment Factor
London Bexley	15.3	23.5	87.7	0.649
London Westminster	20.1	25.6	98.3	0.784
London North Kensington	15.4	20.3	99.0	0.759
Average Factor [a]				**0.731**

[a] Calculated from unrounded values.

Table A3-6: Data used to Adjust Post-Scheme Monitoring Data (Site 11)

AURN Urban Background Site	Annual Mean Concentration (µg/m³)	Period Mean Concentration (µg/m³)	Annual Mean Data Capture (%)	Adjustment Factor
London Bexley	15.3	22.2	87.7	0.688
London Westminster	20.1	23.4	98.3	0.859
London North Kensington	15.4	18.6	99.0	0.827
Average Factor [a]				**0.791**

[a] Calculated from unrounded values.

A4 Bias Adjustment Factor Calculation

Pre-Scheme Implementation Monitoring Period

Checking Precision and Accuracy of Triplicate Tubes — AEA Energy & Environment, From the AEA group

Period	Start Date dd/mm/yyyy	End Date dd/mm/yyyy	Tube 1 µgm-3	Tube 2 µgm-3	Tube 3 µgm-3	Triplicate Mean	Standard Deviation	Coefficient of Variation (CV)	95% CI of mean	Automatic Method: Period Mean	Automatic Method: Data Capture (% DC)	Data Quality Check: Tubes Precision Check	Data Quality Check: Automatic Monitor Data Capture
1	25/10/2024	27/11/2024	35.71998	35.5296	37.3468	36.2	1.0	3	2.5	36.9	100.0	Good	Good
2													
3													
4													
5													
6													
7													
8													
9													
10													
11													
12													
13													

It is necessary to have results for at least two tubes in order to calculate the precision of the measurements

Overall survey --> Good precision | Good Overall DC

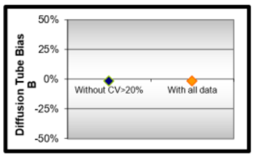
Site Name/ ID:

Precision: 1 out of 1 periods have a CV smaller than 20%

(Check average CV & DC from Accuracy calculations)

Accuracy (with 95% confidence interval) without periods with CV larger than 20%	
Bias calculated using 1 periods of data	
Bias factor A	
Bias B	
Diffusion Tubes Mean:	36 µgm-3
Mean CV (Precision):	3
Automatic Mean:	37 µgm-3
Data Capture for periods used:	100%
Adjusted Tubes Mean:	µgm-3

Accuracy (with 95% confidence interval) WITH ALL DATA	
Bias calculated using 1 periods of data	
Bias factor A	
Bias B	
Diffusion Tubes Mean:	36 µgm-3
Mean CV (Precision):	3
Automatic Mean:	37 µgm-3
Data Capture for periods used:	100%
Adjusted Tubes Mean:	µgm-3



Jaume Targa, for AEA
Version 04 - February 2011

There is too little data (one-month) for the spreadsheet to calculate a value, however, the bias adjustment factor can be calculated manually as the Automatic Method Period Mean value divided by the Triplicate Mean. This gives a factor of 1.02.

Post-Scheme Implementation Monitoring Period

Checking Precision and Accuracy of Triplicate Tubes — AEA Energy & Environment, From the AEA group

Period	Start Date dd/mm/yyyy	End Date dd/mm/yyyy	Tube 1 µgm-3	Tube 2 µgm-3	Tube 3 µgm-3	Triplicate Mean	Standard Deviation	Coefficient of Variation (CV)	95% CI of mean	Automatic Method: Period Mean	Automatic Method: Data Capture (% DC)	Data Quality Check: Tubes Precision Check	Data Quality Check: Automatic Monitor Data Capture
1	27/11/2024	03/01/2025	28.2	28.7	31.8	29.6	2.0	7	4.9	31.5	99.8	Good	Good
2	03/01/2025	04/02/2025	39.8	42.1	36.9	39.6	2.6	7	6.4	44.8	99.9	Good	Good
3	04/02/2025	05/03/2025	34.2	36.0	26.9	32.4	4.8	15	12.0	35.0	99.6	Good	Good
4	05/03/2025	01/04/2025	32.9	38.4	31.7	34.3	3.6	10	8.9	34.1	99.2	Good	Good
5	01/04/2025	30/04/2025	28.1	26.6	25.5	26.7	1.3	5	3.1	26.3	100.0	Good	Good
6													
7													
8													
9													
10													
11													
12													
13													

It is necessary to have results for at least two tubes in order to calculate the precision of the measurements

Overall survey --> Good precision | Good Overall DC

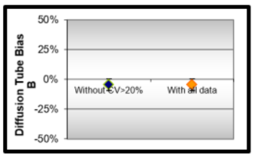
Site Name/ ID:

Precision: 5 out of 5 periods have a CV smaller than 20%

(Check average CV & DC from Accuracy calculations)

Accuracy (with 95% confidence interval) without periods with CV larger than 20%	
Bias calculated using 5 periods of data	
Bias factor A	1.06 (1 - 1.11)
Bias B	-5% (-10% - 0%)
Diffusion Tubes Mean:	33 µgm-3
Mean CV (Precision):	9
Automatic Mean:	34 µgm-3
Data Capture for periods used:	100%
Adjusted Tubes Mean:	34 (33 - 36) µgm-3

Accuracy (with 95% confidence interval) WITH ALL DATA	
Bias calculated using 5 periods of data	
Bias factor A	1.06 (1 - 1.11)
Bias B	-5% (-10% - 0%)
Diffusion Tubes Mean:	33 µgm-3
Mean CV (Precision):	9
Automatic Mean:	34 µgm-3
Data Capture for periods used:	100%
Adjusted Tubes Mean:	34 (33 - 36) µgm-3



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Version 04 - February 2011

A5 Raw NO_2 Diffusion Tube Data

A5.1 Raw monthly diffusion tube data for each of the six monthly exposure periods are presented in Table A5-1.

Table A5-1: Raw Monthly NO_2 Diffusion Tube Data (µg/m³)

Site ID	Monthly Concentration (µg/m³)					
	25/10/2024 27/11/2024	27/11/2024 03/01/2025	03/01/2025 04/02/2025	04/02/2025 05/03/2025	05/03/2025 01/04/2025	01/04/2025 30/04/2025
1	25.79	19.65	28.26	24.61	21.71	15.54
2	27.44	17.18	30.90	29.16	23.72	19.63
3	n/a	n/a	29.99	27.58	28.83	20.46
4	26.98	15.49	28.32	28.50	26.86	20.04
5	45.89	35.39	48.17	37.84	36.48	35.29
6	36.12	23.35	38.40	33.49	37.53	n/a
7	31.24	14.69	33.98	n/a	n/a	23.25
8	n/a	22.65	35.21	29.44	24.88	21.18
9	n/a	15.85	28.69	28.40	23.75	15.87
10	33.07	24.88	36.10	30.58	28.05	28.13
11	n/a	21.15	n/a	31.28	n/a	19.44
12	24.50	16.72	27.75	n/a	n/a	17.06
Co-location 13a	35.72	28.20	39.80	34.22	32.91	28.06
Co-location 13b	35.53	28.71	42.06	36.04	38.45	26.61
Co-location 13c	37.35	31.84	36.89	26.94	31.69	25.54

n/a - diffusion tube was missing upon collection, therefore no data are available for this month.

A6 RBG NO_2 Monitoring Data in Study Area

A6.1 The model will also be run to predict annual mean nitrogen dioxide concentrations during 2024 at the long-term monitoring sites operated by RBG within the study area. The locations of these sites are shown in Figure A6-1, whilst the annual mean concentrations are presented in Table A6-1.

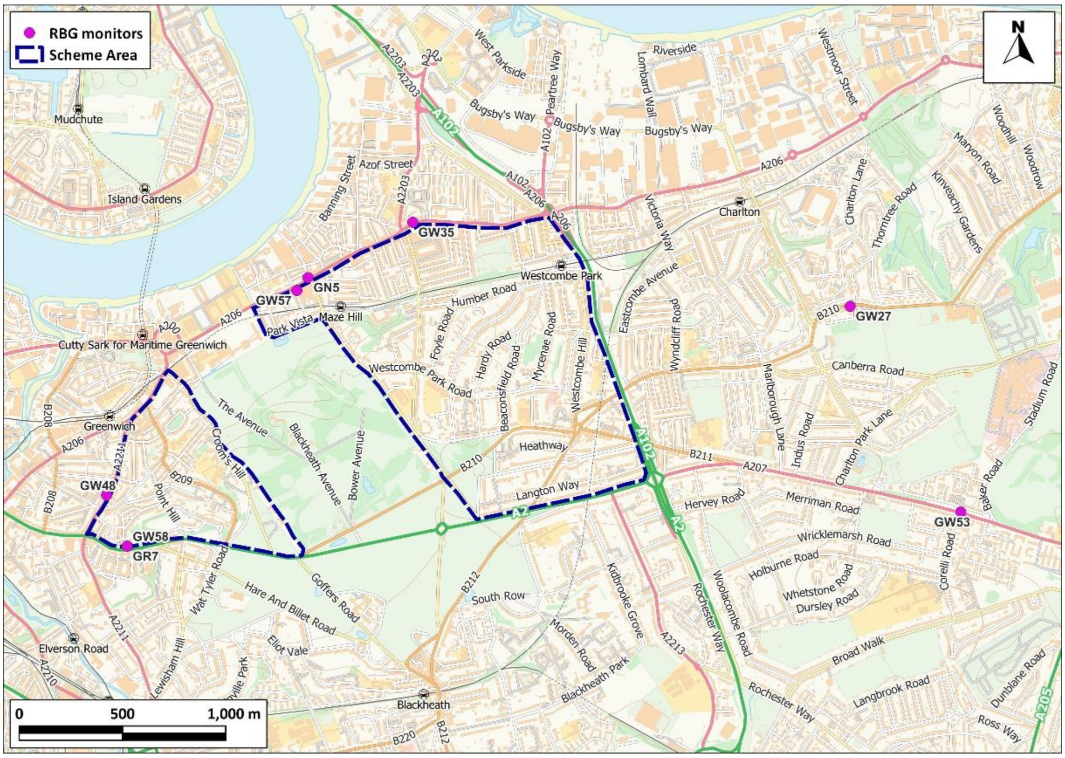

Figure A6-1: RBG Monitoring Sites within the Study Area

Additional data sourced from third parties, including public sector information licensed under the Open Government Licence v3.0.

Table A6-1: Annual Mean NO_2 Concentrations at RBG Monitoring Sites in the Study Area [a]

Site Name	Site Type	2024 Concentration (µg/m^3)
GN5	Automatic	29.0
GR7	Automatic	26.0
GW27	Diffusion Tube	22.7
GW35	Diffusion Tube	28.9
GW48	Diffusion Tube	28.0
GW53	Diffusion Tube	20.3
GW57	Diffusion Tube	20.5
GW58	Diffusion Tube	25.0

[a] Automatic data taken from https://www.londonair.org.uk. Diffusion tubes operated by RBG, with tubes prepared and analysed by Gradko International using the 50% acetone method. Data provided by RBG and adjusted for bias using a nationally-derived factor of 0.88. Where relevant, triplicates have been averaged.

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