Appendix A12.2

Road Traffic Emissions Assessment Methodology

Road Traffic Emissions Assessment Methodology

A12.2.1 The general ADMS-Roads model conditions are listed in Table A12.2 and described in the following text.

Table A12.2: ADMS Roads Model Conditions

Variable	ADMS Roads Model
Surface roughness at source	1.5 m
Minimum Monin-Obukhov length for stable conditions	100 m
Terrain type	Flat
Receptors	x,y coordinates determined by GIS z height determined from site visits and online resources. Selected receptors, as listed in Table 12.2.
Canyon Effects	Incorporated into model where appropriate
Emissions	NO_X, $PM_{2.5}$, PM_{10}
Emission rates	DfT Emission Factor Toolkit Version 5.2
Emission profiles	Profiles obtained for local road network as shown in Appendix 12B
Meteorological data	1 year (2013) hourly sequential data from Heathrow Airport meteorological station
Model output	Long-term annual mean NO_X concentrations Short-term annual mean NO_X concentrations

Traffic Data

A12.2.2 The air quality assessment has used traffic data from the Transport Assessment (TA) (Appendix A8.1; as summarised in Chapter 8: Transport and Movement), supplemented with data sourced from the DfT online resource (DfT, 2013). The Annual Average Daily Traffic (AADT) flow data from traffic counts used in the TA and this assessment was undertaken in 2013. The DfT online resource (DfT, 2013) provided traffic data in AADT flow format for 2012. Evidence suggests that there is anticipated to be little growth in traffic flow in Central London over the coming years. Therefore, the data sourced from the transport team and DfT online resource (DfT, 2013) has been used to represent traffic flow in the year of peak construction (2017). A summary of the traffic data used in the assessment is provided in Tables A12.3, A12.4, A12.5 and A12.6

Table A12.3: Traffic Data used in Dispersion Model Summary

Link	Baseline			Construction		
	AADT	LDV	HDV	AADT	LDV	HDV
Arthur Street	3,255	2,438	817	60	0	60
A3211 Upper Thames St (e)	46,661	39,395	7,266	46,721	39395	7,326
A3211 Upper Thames St (w)	46,589	39,592	6,997	47,599	40124	7,475
King William St (n)	27,533	22,313	5,220	29,926	24296	5,630
King William St (s)	29,900	24,277	5,623	30,073	24277	5,796
Arthur Street	2,776	2,002	774	60	0	60
Eastcheap	7,784	6,548	1,236	7,844	6548	1,296
A3 King Willliam Street	26,945	21,556	5,389	29,576	23539	6,037
Cannon St	10,224	8,144	2,080	12,839	10127	2,712
A1213 Gracechurch Street	17,989	15,039	2,950	18,049	15039	3,010
Cannon St (W)	10,195	8,090	2,105	12,998	10245	2,753
Cannon St (E)	10,306	8,195	2,111	12,921	10178	2,743
Cannon Street west	10,378	8,277	2,101	13,325	10604	2,721
Cannon Street east	10,640	8,519	2,121	13,587	10846	2,741
A3211 west	40,850	35,804	5,046	43,131	37504	5,627
A3211 east	47,706	40,540	7,166	49,728	42179	7,549
Queen Street Pl	10,277	7,861	2,416	10,036	7800	2,236
A3211 Lower Thames Street	43,909	36,954	6,955	43,969	36954	7,015
A3211 Upper Thames Street	46,166	38,887	7,279	46,226	38887	7,339
A3211 Lower Thames Street	42,326	35,530	6,796	42,386	35530	6,856

[a] Where speeds were not provided by the URS transport team, they have been sourced from the current version London Atmospheric Emissions Inventory

[b] Where appropriate, the LAEI speeds have been reduced to simulate queues within the ADMS Roads model.

Table A12.4: Diurnal Profile 1 Summary – King William Street

Hour	24-1	1-2	2-3	3-4	4-5	5-6	6-7	7-8
Week	0.030	0.020	0.014	0.013	0.017	0.023	0.045	0.058
Sat	0.053	0.049	0.038	0.029	0.023	0.022	0.031	0.040
Sun	0.051	0.049	0.049	0.040	0.027	0.020	0.029	0.030
Hour	**8-9**	**9-10**	**10-11**	**11-12**	**12-13**	**13-14**	**14-15**	**15-16**
Week	0.070	0.052	0.042	0.041	0.041	0.043	0.045	0.045
Sat	0.044	0.042	0.041	0.044	0.047	0.046	0.046	0.045
Sun	0.029	0.035	0.037	0.043	0.051	0.052	0.053	0.052
Hour	**16-17**	**17-18**	**18-19**	**19-20**	**20-21**	**21-22**	**22-23**	**23-24**
Week	0.048	0.057	0.061	0.050	0.048	0.046	0.046	0.044
Sat	0.049	0.046	0.048	0.048	0.044	0.040	0.043	0.045
Sun	0.051	0.055	0.054	0.049	0.039	0.035	0.035	0.037

Table A12.5: Diurnal Profile 2 Summary – Cannon Street

Hour	24-1	1-2	2-3	3-4	4-5	5-6	6-7	7-8
Week	0.021	0.015	0.011	0.012	0.018	0.034	0.045	0.058
Sat	0.038	0.035	0.028	0.024	0.019	0.022	0.040	0.044
Sun	0.052	0.045	0.041	0.031	0.024	0.024	0.028	0.027
Hour	**8-9**	**9-10**	**10-11**	**11-12**	**12-13**	**13-14**	**14-15**	**15-16**
Week	0.056	0.056	0.054	0.052	0.051	0.053	0.053	0.052
Sat	0.049	0.054	0.053	0.056	0.045	0.045	0.044	0.046
Sun	0.033	0.041	0.051	0.043	0.058	0.058	0.054	0.059
Hour	**16-17**	**17-18**	**18-19**	**19-20**	**20-21**	**21-22**	**22-23**	**23-24**
Week	0.055	0.060	0.057	0.044	0.039	0.037	0.035	0.032
Sat	0.044	0.049	0.042	0.046	0.042	0.045	0.045	0.046
Sun	0.054	0.060	0.054	0.041	0.038	0.032	0.025	0.029

Table A12.6: Diurnal Profile 3 Summary – Eastcheap

Hour	24-1	1-2	2-3	3-4	4-5	5-6	6-7	7-8
Week	0.020	0.014	0.011	0.010	0.013	0.018	0.030	0.054
Sat	0.042	0.028	0.018	0.024	0.020	0.019	0.035	0.028
Sun	0.055	0.042	0.025	0.025	0.022	0.026	0.023	0.035
Hour	**8-9**	**9-10**	**10-11**	**11-12**	**12-13**	**13-14**	**14-15**	**15-16**
Week	0.077	0.063	0.055	0.054	0.052	0.055	0.053	0.054
Sat	0.034	0.048	0.043	0.050	0.059	0.060	0.047	0.047
Sun	0.027	0.027	0.044	0.057	0.054	0.063	0.064	0.053
Hour	**16-17**	**17-18**	**18-19**	**19-20**	**20-21**	**21-22**	**22-23**	**23-24**
Week	0.048	0.054	0.059	0.060	0.042	0.035	0.033	0.035
Sat	0.053	0.043	0.055	0.053	0.054	0.047	0.042	0.052
Sun	0.058	0.049	0.050	0.045	0.056	0.036	0.040	0.025

A12.2.3 Due to the current uncertainty in the projected improvements in vehicle emission rates made by the Department for Transport (DfT), this assessment includes a sensitivity test that assumes no improvement in emission rates from 2013 onwards (Appendix A12.4).

Meteorology

A12.2.4 As well as the emissions characteristics described above, the dispersion of emissions from road traffic is also determined by local meteorological conditions. This assessment has used hourly sequential meteorological data from Heathrow Airport in 2013, supplied by ADM Ltd, the UK agent for Trinity Consultants. The meteorological station at Heathrow Airport is located approximately 23km to the west of the BSCU and is considered to be representative of meteorological conditions within the air quality study area.

Background Air Quality

A12.2.5 The background pollutant concentration data used in this assessment has been sourced from Defra's background pollutant maps (Defra, 2012). The annual mean background NO_2, PM_{10}, concentrations used in this assessment at the selected air quality sensitive receptors are provided in Table A12.7.

Table A12.7: Annual Mean Background Pollutant Concentrations (2017)

Receptor	NO_2 Conc. (µg/m^3)	PM_{10} Conc. (µg/m^3)	$PM_{2.5}$ Conc. (µg/m^3)
R1	40.2	22.1	15.2
R2	40.2	22.1	15.2
R3	40.2	22.1	15.2
R4	40.2	22.1	15.2
R5	40.2	22.1	15.2
R6	40.2	22.1	15.2
R7	40.2	22.1	15.2
R8	40.2	22.1	15.2
R9	36.5	21.3	14.6
R10	36.5	21.3	14.6
R11	40.2	22.1	15.2
R12	38.8	21.9	15.1
R13	38.8	21.9	15.1
R14	40.2	22.1	15.2
R15	40.2	22.1	15.2

A12.2.6 Due to the current uncertainty in the projected improvements in background pollutant concentrations made by Defra, this assessment includes a sensitivity test that assumes no improvement in background pollutant rates from 2013 onwards (Appendix A12.4).

Canyon Effects

A12.2.7 The air quality study area is dominated by tall buildings overlooking the road sources included within the dispersion model. These buildings act as a canyon that can trap road traffic emitted pollutants, limiting the rate at which they can disperse away from the source.

A12.2.8 To account for this effect, the ‘canyons’ that are present within the air quality study area have been incorporated with the ADMS-Road model. The width and height of the canyons was estimated from information gathered during site visits and online mapping resources.

Model Verification

A12.2.9 It is standard practice in air quality assessments for models quantifying the impact of road traffic emissions to be verified against measured data gathered within the air quality study area. The aim of the verification exercise is to correct for model bias.

A12.2.10 The City of London Corporation operate a single automatic continuous monitoring station that monitors concentrations of NO_2 within the air quality study area, at Walbrook Wharf (CT6). This station is located immediately adjacent to Upper Thames Street (as shown in Figure 12.1, ES Figures Volume), a heavily congested dual carriageway that passes through the City. Whilst data from this continuous monitoring station is representative of conditions at locations near to Upper and Lower Thames Street, it is not representative of conditions at other locations within the study area, where traffic flow is considerably less. As such, URS undertook a three month nitrogen dioxide survey, gathering data that is representative of other areas within the study area, to supplement the existing baseline NO_2 data available. The location of the diffusion tube sampling points is shown in Figure 12.1 (ES Figures Volume).

A12.2.11 The verification process has been undertaken in line with the methodology described within Local Air Quality Management Technical Guidance (09) (LAQM TG(09) (Defra, 2009). Modelled predictions have been made for annual mean NO_2 concentrations at the location of the automatic continuous monitoring station adjacent to Upper Thames Street (Walbrook Wharf (CT6)) and at a series of diffusion tubes located adjacent to other roads within the air quality study area (DT1 to DT10). The location of the automatic continuous monitoring station and diffusion tubes are displayed in Figure 12.1.

A12.2.12 The data obtained from the diffusion tubes was gathered over a period of six months from October 2013 to April 2014. This data was annualised to a projected annual mean for 2013 following the approach described in LAQM TG(09) (Defra, 2009). A summary of the annualisation process is provided in Table A12.8.

A12.2.13 The data obtained at the diffusion tube locations DT5 and DT8 was omitted from the verification exercise as these tubes were located adjacent to roads that were beyond the extent of the Transport Assessment. The data obtained at the diffusion tube locations DT1, DT2, DT9 and DT10 was also omitted from the verification exercise. These tubes were located adjacent to Upper and Lower Thames Street, where a full annual mean dataset for 2013 was available from the automatic continuous monitoring station at Walbrook Wharf.

A12.2.14 A comparison of unadjusted modelled NO_2 concentrations against the monitored and measured values at the automatic continuous monitoring station and the remaining diffusion tubes (DT3, DT4, DT6 and DT7) is illustrated in Figure A12.1, by the red dots and trend line. It shows that the unadjusted model under-predicted annual mean concentrations of NO_2 by around 14 per cent. It also shows that there is a large discrepancy between

model performance at the location adjacent to Upper and Lower Thames Street and model performance elsewhere, away from that road. As such, the bias-adjustment of the model was required.

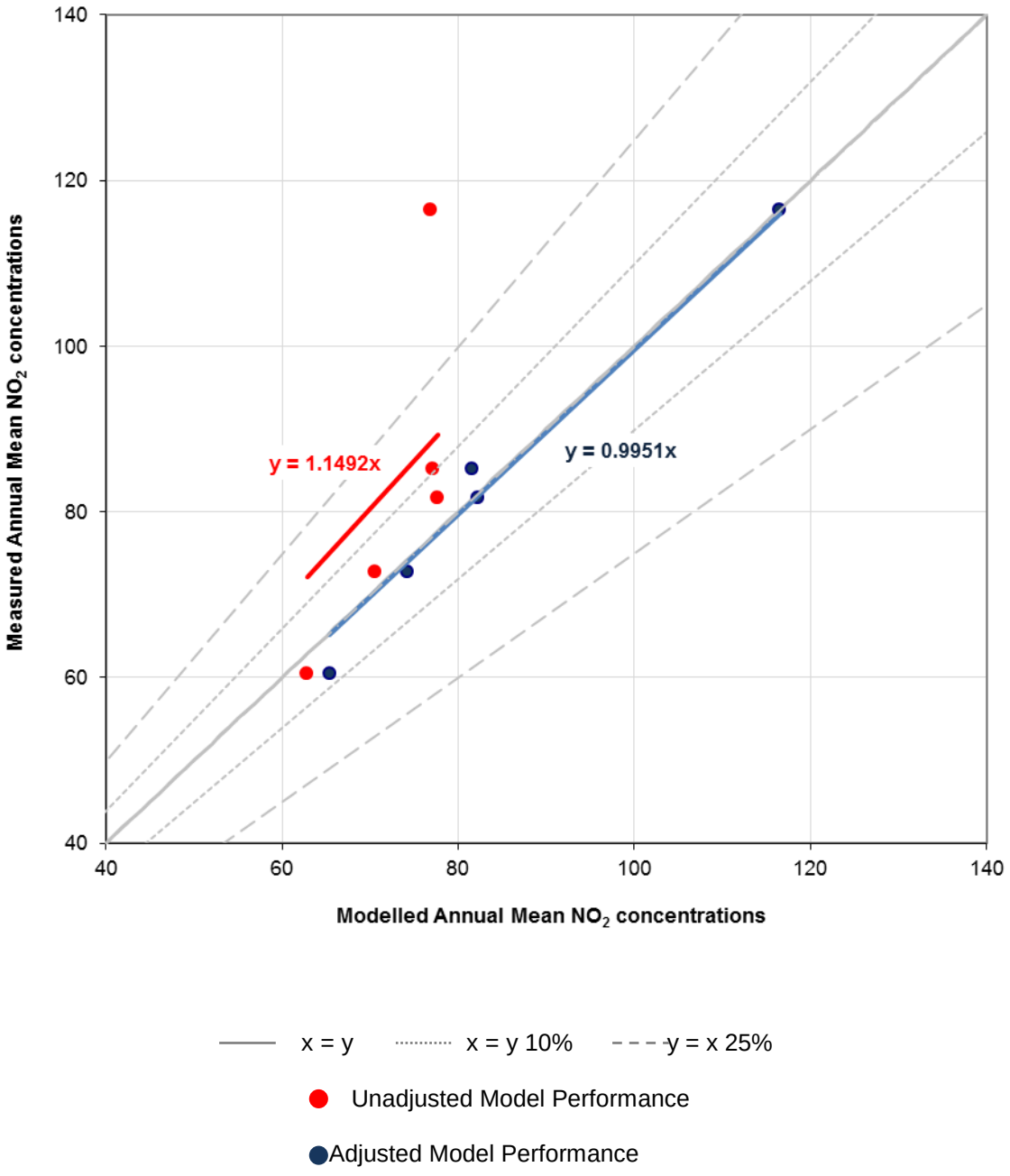
Table A12.8: Annualisation of Period Mean NO_2 Diffusion Tube Data

Diffusion Tube	Period Mean[a] ($\mu g/m^3$)	Annualised Mean (2012)[b] ($\mu g/m^3$)	Bias-Adjusted Annualised Mean ($\mu g/m^3$)[c]
DT1	99.3	101.6	96.5
DT2	57.4	56.9	54.1
DT3	64.2	63.7	60.5
DT4	77.3	76.7	72.8
DT5	69.5	68.9	65.5
DT6	87.7	89.7	85.2
DT7	86.6	85.9	81.6
DT8	66.9	66.4	63.1
DT9	77.9	73.5	69.8
DT10	76.6	76.0	72.2

[a] Period means: DT1 11/10/13 to 03/01/14 and 11/02/14 to 11/03/14; DT2 – DT5, DT7 – DT8 and DT9 11/10/13 to 03/01/14 and 11/02/14 to 08/04/14; DT6 11/10/13 to 03/01/14; DT9 08/11/13 to 03/01/14 and 11/02/14 to 08/04/14.
[b] Annualised using period mean and annual mean (2013) data from the automatic continuous monitoring stations located at Bloomsbury, Horseferry and Sir John Cass School.
[c] Bias-adjustment factor of 0.95 obtained for 2013 from Defra's National Diffusion Tube Bias Adjustment Factor Spreadsheet.

A12.2.15 Model bias adjustment was undertaken by comparing the monitored and measured road NO_X contribution with the modelled road NO_X contribution at the same locations. Due to the difference in model performance at the Walbrook Wharf site (CT6), compared to elsewhere, this comparison was done separately for the monitoring station adjacent to Upper Thames Street, and collectively for the remaining diffusion tubes. The factor of the difference between the values was then applied to the modelled road NO_X contributions at those locations (Walbrook Wharf (CT6): 2.67, diffusion tubes (DT3, DT4, DT6 and DT7): 1.15).

Figure A12.1: Comparison of Measured and Modelled NO_2



A12.2.16 The comparison of the monitored and measured annual mean NO_2 concentrations with the modelled annual mean NO_2 concentrations, after adjustment, is shown by the blue dots and trend line in Figure A12.1. It shows that the adjusted model predicts concentrations that are within 1 per cent of monitored and measured values. The accuracy of the model has been considered with the calculation of the Root Mean Square Error (RMSE). Guidance (Defra, 2009) suggests that an RMSE of less than 10 per cent of the relevant air quality objective as being ideal (4µg/m^3). In this instance, the RMSE is 2.8µg/m^3, so the model is considered to be robust.

NOX to NO_2 Conversion

A12.2.17 To accompany the publication of the guidance document *LAQM TG(09)* (Defra, 2009), a NO_X to NO_2 converter was made available as a tool to calculate the road NO_2 contribution from modelled road NO_X contributions. The tool comes in the form of an MS Excel spreadsheet and uses Local Authority specific data to calculate annual mean concentrations of NO_2 from dispersion model output values of annual mean concentrations of NO_X.

Predicting the Number of Days in which the PM_{10} 24hr-mean Objective is Exceeded

A12.2.18 The guidance document *LAQM.TG(03)* (Defra, 2003) set out the method by which the number of days in which the PM_{10} 24-hr objective is exceeded can be obtained based on a relationship with the predicted PM_{10} annual mean concentration. The most recent guidance *LAQM.TG(09)* (Defra, 2009) suggests no change to this method. As such, the formula used within this assessment is:

$$\text{No. of } Exceedances = 0.0014 * C^3 + \frac{206}{C} - 18.5$$

Where C is the annual mean concentration of PM_{10}.

Predicting the Number of Days in which the NO_2 Hourly Mean Objective is Exceeded

A12.2.19 Research projects completed on behalf of Defra and the Devolved Administrations (Laxen and Marner (2003) and (AEAT, 2008)) have concluded that the hourly mean NO_2 objective is unlikely to be exceeded if annual mean concentrations are predicted to be less the 60µg/m^3.

A12.2.20 In 2003, Laxen and Marner concluded:

> *…local authorities could reliably base decisions on likely exceedances of the 1-hour objective for nitrogen dioxide alongside busy streets using an annual mean of 60 µg/m^3 and above.*

A12.2.21 The findings presented by Laxen and Marner are further supported by AEA Technology (2008) who revisited the investigation to complete an updated analysis including new monitoring results and additional monitoring sites. The recommendations of this report are:

> *Local authorities should continue to use the threshold of 60 µg/m^3 NO_2 as the trigger for considering a likely exceedance of the hourly mean nitrogen dioxide objective.*

A12.2.22 Therefore this assessment will evaluate the likelihood of exceeding the hourly mean NO_2 objective by comparing predicted annual mean NO_2 concentrations at all receptors to an annual mean equivalent threshold of 60µg/m^3 NO_2. Where predicted concentrations are below this value, it can be concluded that the hourly mean NO_2 objective (200µg/m^3 NO_2 not more than 18 times per year) will be achieved.