planning
transport
design
environment
infrastructure

APPENDIX 5.5: Air Quality – Traffic Impacts

Wheelabrator Kemsley Generating Station (K3) and Wheelabrator Kemsley North (WKN) Waste to Energy Facility DCO

S42 Draft ES

PINS ref: EN010083

Appendix 5.5: Traffic-Related Emissions

Methodology

Atmospheric Dispersion Modelling of Pollutant Concentrations

1.1 The ADMS-Roads model has been used in this assessment to predict the air quality impacts from changes in traffic on the local road network. This is a version of the Atmospheric Dispersion Modelling System (ADMS), a formally validated model developed in the UK by Cambridge Environmental Research Consultants Ltd (CERC) and widely used in the UK and internationally for regulatory purposes.

Model Input Data

Traffic Flow Data

1.2 Traffic data used in the assessment have been provided by the project's transport consultants, RPS. The traffic flow data provided for this assessment are summarised in Tables 5.5.1 to 5.5.4. The modelled road links are illustrated in Figure 5.2.

Table 5.5.1 Traffic Data Used Within the Assessment – WKN (Construction), 2021

Road Link Name	Speed (km.hr^{-1})	Daily Two Way Vehicle Flow			
		Without Development		With Development	
		LDV	HDV	LDV	HDV
1 - Swale Way East of B2005 Grovehurst Roundabout	64.07	17091	3363	17905	3448
2 - Barge Way North of Swale Roundabout	44.40	5048	2608	5861	2694
3 - Barge Way, East of Fleet End Roundabout	62.70	2353	1243	3166	1329
4 - A249 South of Swale Way Junction	112.65	34594	5429	35373	5515
5 - A249 between the A2 and M2	112.65	49361	6596	50105	6679
6 - M2 West	112.65	62603	7440	62828	7492
7 - M2 East	112.65	58084	5378	58195	5384
8 - Swale Way north of Reams Way Junction	54.07	12876	1114	12876	1114

Road Link Name	Speed (km.hr^{-1})	Daily Two Way Vehicle Flow			
		Without Development		With Development	
		LDV	HDV	LDV	HDV
9 - Swale Way south of Reams Way Junction	54.96	12782	1132	12782	1132
10 - Swale Way south of Ridham Avenue Roundabout	74.19	11921	840	11921	840
11 - A249, North of Swale Way Junction	112.65	33130	2490	33130	2490

Notes: (km.hr^{-1}) = kilometres per hour

HDV = Heavy Duty Vehicle - vehicles greater than 3.5 t gross vehicle weight including buses

LDV = Light Duty Vehicle

Table 5.5.2 Traffic Data Used Within the Assessment – WKN (Operational), 2024

Road Link Name	Speed (km.hr^{-1})	Daily Two Way Vehicle Flow			
		Without Development		With Development	
		LDV	HDV	LDV	HDV
1 - Swale Way East of B2005 Grovehurst Roundabout	64.07	17091	3363	17166	3599
2 - Barge Way North of Swale Roundabout	44.40	5048	2608	5122	2846
3 - Barge Way, East of Fleet End Roundabout	62.70	2353	1243	2428	1481
4 - A249 South of Swale Way Junction	112.65	34594	5429	34665	5663
5 - A249 between the A2 and M2	112.65	49361	6596	49429	6833
6 - M2 West	112.65	62603	7440	62623	7565
7 - M2 East	112.65	58084	5378	58094	5400
8 - Swale Way north of Reams Way Junction	54.07	12876	1114	12877	1124
9 - Swale Way south of Reams Way Junction	54.96	12782	1132	12783	1142

Road Link Name	Speed (km.hr^{-1})	Daily Two Way Vehicle Flow			
		Without Development		With Development	
		LDV	HDV	LDV	HDV
10 - Swale Way south of Ridham Avenue Roundabout	74.19	11921	840	11921	849
11 - A249, North of Swale Way Junction	112.65	33130	2490	33132	2499

Notes: (km.hr^{-1}) = kilometres per hour
HDV = Heavy Duty Vehicle - vehicles greater than 3.5 t gross vehicle weight including buses
LDV = Light Duty Vehicle

Table 5.5.3 Traffic Data Used Within the Assessment – WKN (Construction Phase) + K3 (Operation) + Cumulative Developments, 2021

Road Link Name	Speed (km.hr^{-1})	Daily Two Way Vehicle Flow			
		Without Development		With Development	
		LDV	HDV	LDV	HDV
1 - Swale Way East of B2005 Grovehurst Roundabout	64.07	17447	3444	18260	3594
2 - Barge Way North of Swale Roundabout	44.40	5048	2682	5861	2833
3 - Barge Way, East of Fleet End Roundabout	62.70	2353	1318	3166	1468
4 - A249 South of Swale Way Junction	112.65	34934	5510	35714	5659
5 - A249 between the A2 and M2	112.65	49686	6676	50431	6824
6 - M2 West	112.65	62701	7488	62926	7581
7 - M2 East	112.65	58133	5385	58244	5403
8 - Swale Way north of Reams Way Junction	54.07	13233	1122	13233	1131
9 - Swale Way south of Reams Way Junction	54.96	13139	1140	13139	1149
10 - Swale Way south of Ridham Avenue Roundabout	74.19	11940	847	11940	857

Road Link Name	Speed (km.hr^{-1})	Daily Two Way Vehicle Flow			
		Without Development		With Development	
		LDV	HDV	LDV	HDV
11 - A249, North of Swale Way Junction	112.65	33131	2491	33131	2500

Notes: (km.hr^{-1}) = kilometres per hour
HDV = Heavy Duty Vehicle - vehicles greater than 3.5 t gross vehicle weight including buses
LDV = Light Duty Vehicle

Table 5.5.4 Traffic Data Used Within the Assessment – WKN (Operational) + K3 (Operational) + Cumulative Developments, 2024

Road Link Name	Speed (km.hr^{-1})	Daily Two Way Vehicle Flow			
		Without Development		With Development	
		LDV	HDV	LDV	HDV
1 - Swale Way East of B2005 Grovehurst Roundabout	64.07	17164	3372	17238	3672
2 - Barge Way North of Swale Roundabout	44.40	5048	2608	5122	2911
3 - Barge Way, East of Fleet End Roundabout	62.70	2353	1243	2428	1546
4 - A249 South of Swale Way Junction	112.65	35975	5495	36047	5792
5 - A249 between the A2 and M2	112.65	52023	6677	52091	6980
6 - M2 West	112.65	63288	7475	63308	7641
7 - M2 East	112.65	58261	5406	58271	5440
8 - Swale Way north of Reams Way Junction	54.07	12949	1124	12949	1143
9 - Swale Way south of Reams Way Junction	54.96	12855	1142	12855	1161
10 - Swale Way south of Ridham Avenue Roundabout	74.19	11993	849	11994	868

Road Link Name	Speed ($km.hr^{-1}$)	Daily Two Way Vehicle Flow			
		Without Development		With Development	
		LDV	HDV	LDV	HDV
11 - A249, North of Swale Way Junction	112.65	33635	2490	33637	2509

Notes: ($km.hr^{-1}$) = kilometres per hour
HDV = Heavy Duty Vehicle - vehicles greater than 3.5 t gross vehicle weight including buses
LDV = Light Duty Vehicle

1.3 The average speed on each road has been reduced by 10 $km.hr^{-1}$ to take into account the possibility of slow moving traffic near junctions and at roundabouts in accordance with LAQM.TG16.

Vehicle Emission Factors

1.4 The modelling has been undertaken using Defra's 2017 emission factor toolkit (version 8.0) which draws on emissions generated by the European Environment Agency (EEA) COPERT 5 emission calculation tool.

1.5 Emission factors for 2021 have been used for the traffic data shown in Table 5.5.1 and 5.5.3.

1.6 Emission factors for 2023, rather than 2024, have been used for the traffic data shown in Table 5.5.2 and 5.5.4. This is worse case as emissions from road vehicles are forecast to decrease over time. This is because less polluting, newer vehicles will become an increasing proportion of the traffic using the local road network.

Long-Term Pollutant Predictions

1.7 Annual-mean NO_x and PM_{10} concentrations have been predicted at representative sensitive receptors using ADMS-Roads, then added to relevant background concentrations. Primary NO in the NO_X emissions is converted to NO_2 to a degree determined by the availability of atmospheric oxidants locally and the strength of sunlight. For road traffic sources, annual-mean NO_2 concentrations have been derived from the modelled road-related annual-mean NO_x concentration using Defra's calculator [1].

Short-Term Pollutant Predictions

1.8 In order to predict the likelihood of exceedances of the hourly-mean AQS objectives for NO_2 and the daily-mean AQS objective for PM_{10}, the following relationships between the short-term and the annual-mean values at each receptor have been considered.

Hourly-Mean AQS Objective for NO_2

1.9 Research undertaken in support of LAQM.TG16 has indicated that the hourly-mean limit value and objective for NO_2 is unlikely to be exceeded at a roadside location where the annual-mean NO_2 concentration is less than 60 µg.m^{-3}. The threshold of 60 µg.m^{-3} NO_2 has been used the guideline for considering a likely exceedance of the hourly-mean nitrogen dioxide objective.

Daily-Mean AQS Objective for PM_{10}

1.10 The number of exceedances of the daily-mean AQS objective for PM_{10} of 50 µg.m^{-3} may be estimated using the relationship set out in LAQM.TG16:

*Number of Exceedances of Daily Mean of 50 µg.m^{-3} = -18.5 + 0.00145 * (Predicted Annual-mean PM_{10})^3 + 206 / (Predicted Annual-mean PM_{10} Concentration)*

1.11 This relationship indicates that the daily-mean AQS objective for PM_{10} is likely to be met if the predicted annual-mean PM_{10} concentration is 31.8 µg.m^{-3} or less.

1.12 The daily mean objective is therefore not considered further within this assessment if the annual-mean PM_{10} concentration is predicted to be less than 31.5 µg.m^{-3}.

Fugitive PM_{10} Emissions

1.13 Transport PM_{10} emissions arise from both the tailpipe exhausts and from fugitive sources such as brake and tyre wear and re-suspended road dust. Improvements in vehicle technologies are reducing PM_{10} exhaust emissions; therefore, the relative importance of fugitive PM_{10} emissions is increasing. Current official vehicle emission factors for particulate matter include brake dust and tyre wear which studies suggest may account for approximately one-third of the total particulate emissions from road transport; but not re-suspended road dust (which remains unquantified.)

Significance Criteria for Development Impacts on the Local Area

1.14 The EPUK & IAQM Land-Use Planning & Development Control: Planning For Air Quality document [**Error! Bookmark not defined.**] advises that:

"The significance of the effects arising from the impacts on air quality will depend on a number of factors and will need to be considered alongside the benefits of the development in question. Development under current planning policy is required to be sustainable and the definition of this includes social and economic dimensions, as well as environmental. Development brings opportunities for reducing emissions at a wider level through the use of more efficient technologies and better designed buildings, which could well displace emissions elsewhere, even if they increase at the development site. Conversely, development can also have adverse consequences for air quality at a wider level through its effects on trip generation."

1.15 When describing the air quality impact at a sensitive receptor, the change in magnitude of the concentration should be considered in the context of the absolute concentration at the sensitive receptor. Table 5.5.5 provides the EPUK & IAQM approach for describing the long-term air quality impacts at sensitive human-health receptors in the surrounding area.

Table 5.5.5 Impact Descriptors for Individual Sensitive Receptors

Long term average concentration at receptor in assessment year	% Change in concentration relative to Air Quality Assessment Level			
	1	2-5	6-10	>10
75 % or less of AQAL	Negligible	Negligible	Slight	Moderate
76 -94 % of AQAL	Negligible	Slight	Moderate	Moderate
95 - 102 % of AQAL	Slight	Moderate	Moderate	Substantial
103 – 109 % of AQAL	Moderate	Moderate	Substantial	Substantial
110 % or more than AQAL	Moderate	Substantial	Substantial	Substantial

1. AQAL = Air Quality Assessment Level, which may be an air quality objective, EU limit or target value, or an Environment Agency 'Environmental Assessment Level (EAL)'.
2. The table is intended to be used by rounding the change in percentage pollutant concentration to whole numbers, which then makes it clearer which cell the impact falls within. The user is encouraged to treat the numbers with recognition of their likely accuracy and not assume a false level of precision. Changes of 0%, i.e. less than 0.5% will be described as negligible.
3. The table is only designed to be used with annual mean concentrations.
4. Descriptors for individual receptors only; the overall significance is determined using professional judgement. For example, a 'moderate' adverse impact at one receptor may not mean that the overall impact has a significant effect. Other factors need to be considered.
5. When defining the concentration as a percentage of the AQAL, use the 'without scheme' concentration where there is a decrease in pollutant concentration and the 'with scheme;' concentration for an increase.
6. The total concentration categories reflect the degree of potential harm by reference to the AQAL value. At exposure less than 75% of this value, i.e. well below, the degree of harm is likely to be small. As the exposure approaches and exceeds the AQAL, the degree of harm increases. This change naturally becomes more important when the result is an exposure that is approximately equal to, or greater than the AQAL.
7. It is unwise to ascribe too much accuracy to incremental changes or background concentrations, and this is especially important when total concentrations are close to the AQAL. For a given year in the future, it is impossible to define the new total concentration without recognising the inherent uncertainty, which is why there is a category that has a range around the AQAL, rather than being exactly equal to it.

1.16 The human-health impact descriptors above apply at individual receptors. The EPUK & IAQM guidance states that the impact descriptors *"are not, of themselves, a clear and unambiguous guide to reaching a conclusion on significance. These impact descriptors are intended for application at a series of individual receptors. Whilst it maybe that there are 'slight', 'moderate' or 'substantial' impacts at one or more receptors, the overall effect may not necessarily be judged as being significant in some circumstances."*

1.17 Professional judgement by a competent, suitably qualified professional is required to establish the significance associated with the consequence of the impacts. This judgement is likely to take into account the extent of the current and future population exposure to the impacts and the influence and/or validity of any assumptions adopted during the assessment process.

Uncertainty

1.18 All air quality assessment tools, whether models or monitoring measurements, have a degree of uncertainty associated with the results. The choices that the practitioner makes in setting-up the model, choosing the input data, and selecting the baseline monitoring data will decide whether the final predicted impact should be considered a central estimate, or an estimate tending towards the upper bounds of the uncertainty range (i.e. tending towards worst-case).

1.19 The atmospheric dispersion model itself contributes some of this uncertainty, due to it being a simplified version of the real situation: it uses a sophisticated set of mathematical equations to approximate the complex physical and chemical atmospheric processes taking place as a pollutant is released and as it travels to a receptor. The predictive ability of even the best model is limited by how well the turbulent nature of the atmosphere can be represented.

1.20 Each of the data inputs for the model, listed earlier, will also have some uncertainty associated with them. Where it has been necessary to make assumptions, these have mainly been made towards the upper end of the uncertainty range informed by an analysis of relevant, available data.

1.21 The atmospheric dispersion model used for this assessment, ADMS Roads, has been validated by its supplier and is widely used by professionals in the UK and overseas. A site-specific verification (calibration) provides additional certainty and is particularly important when air quality levels are close to exceeding the objectives/limit values.

1.22 LAQM.TG16 requires that local authorities verify the results of any detailed modelling undertaken for the purposes of fulfilling their R&A duties. Model verification refers to the checks that are carried out on model performance at a local level. Modelled concentrations are compared with the results of monitoring. Where there is a disparity between modelled and monitored concentrations, the first step is to review the appropriateness of the data inputs to determine whether the performance of the model can be improved. Once reasonable efforts have been made to reduce the uncertainties in the data inputs, an adjustment may be established and applied to reduce any remaining disparity between modelled and monitored concentrations. No adjustment factor is deemed necessary where the modelled concentrations are within 25% of the monitored concentrations.

1.23 For the verification and adjustment of NOx/NO_2 concentrations for R&A purposes, it is recommended that the comparison involves a combination of automatic and diffusion monitoring, rather than a single automatic monitor. This is to ensure any adjustment factor derived is representative of all locations modelled and not unduly weighted towards the characteristics at a single site. Where only diffusion tubes are used for the model verification, the study should consider a broad spread of monitoring locations across the study area to provide sufficient information relating to the spatial variation in pollutant concentrations.

1.24 Local Authorities generally implement a broad spread of monitoring, particularly in areas that are known to be sensitive to changes in air quality. Consequently, Local Authorities are usually able to verify the models they use for R&A purposes; however for individual developments, there is less likely to be a broad range of monitoring locations within the relevant study area. Notwithstanding this, a small number of monitoring locations have been identified within the study area and a model verification study has been undertaken for the proposed development and is included in the section below.

1.25 The analysis of the component uncertainties indicates that, overall, the predicted total concentration is likely to be towards the top of the uncertainty range rather than being a central estimate. The actual concentrations that will be found when the development is operational are unlikely to be higher than those presented within this report and are more likely to be lower.

Model Verification

1.26 For the verification and adjustment of NO_x/NO_2 concentrations, the LAQM.TG16 guidance recommends that the comparison considers a broad spread of automatic and diffusion monitoring. Swale Borough Council monitors roadside NO_2 concentrations passively using diffusion tubes at 14 locations in the vicinity of the Application Site.

1.27 The concentrations monitored over recent years are provided in Table 5.5.6.

Table 5.5.6 Measured Annual-mean NO_2 Concentrations ($\mu g.m^{-3}$)

Site Code	Site Name	Annual Mean NO_2 Concentration				
		2011	2012	2013	2014	2015
ZW6	Newington (3)	28.5	30.4	34.8	32.9	29.7
SW76	155 Canterbury Road	37.9	40.7	33.8	30.7	31.6
SW75	109 Canterbury Road	26.7	26.9	24.6	22.4	21.0
SW90	Jncn Canterbury Road/ Goodnestone Road	ND	ND	31.6	29.1	30.7
SW56	126 East Street	46.5	39.8	42.8	42.5	38.7
SW58	Dover Street Filling Station	36.8	31.1	28.6	39.8	33.5
SW53	114 East Street. Sittingbourne	38.8	41	33.6	34.5	33.9
SW87	Canterbury Road	ND	36	33.2	31.7	33.8
SW62	Key Street	46.5	47.5	39.9	37.1	37.2
SW66	96/94 High Street	45	39.2	40.9	42.6	36.2
SW45	64 High Street	44.4	42	40.4	41.3	39.6
SW38	15a High Street	35.4	34.7	36.4	33.4	31.4
SW37	32 High Street	40.7	41.5	36.5	36.7	31.4
SW20	Newington Co-Op	37.3	34.2	33.4	35.3	31.2

ND= No data

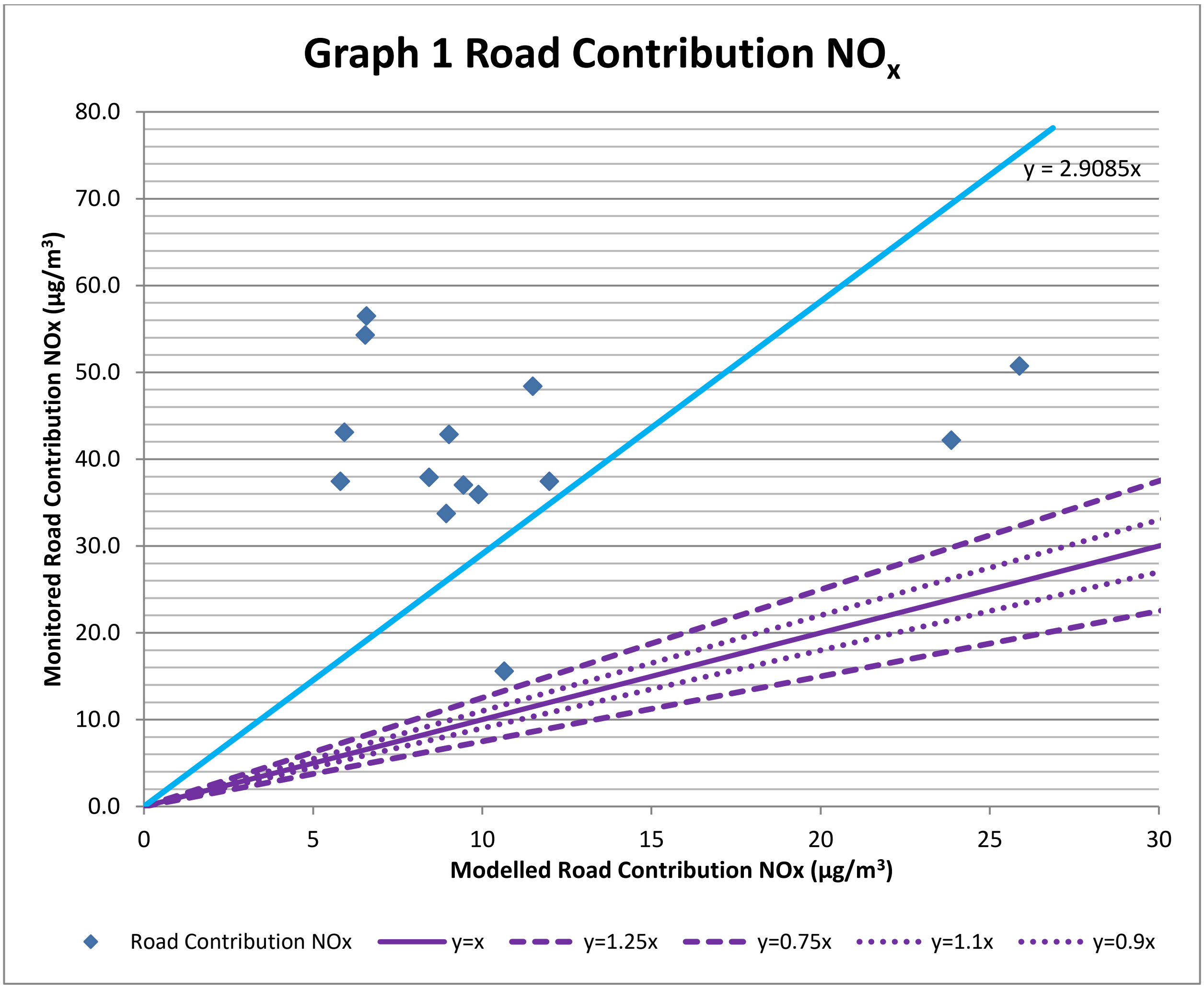
1.28 The monitored annual-mean NO_x road contributions have been derived from the monitored annual-mean NO_2 concentrations using the LAQM.TG16 calculator. The monitored annual-mean NO_X road contributions have then been compared with the modelled annual-mean NO_x road contributions. This comparison is provided in Table 5.5.7 below.

Table 5.5.7 Comparison of Monitored and Modelled Annual-mean Road NO_x Contribution ($\mu g.m^{-3}$)

Site Code	Site Name	Annual-mean Road NO_X Contribution ($\mu g.m^{-3}$)	
		Monitored	**Modelled**
ZW6	Newington (3)	33.7	8.9
SW76	155 Canterbury Road	37.9	8.4
SW75	109 Canterbury Road	15.6	10.6
SW90	Jncn Canterbury Road/ Goodnestone Road	35.9	9.9
SW56	126 East Street	54.3	6.5
SW58	Dover Street Filling Station	42.2	23.9
SW53	114 East Street. Sittingbourne	43.1	5.9
SW87	Canterbury Road	42.9	9.0
SW62	Key Street	50.7	25.9
SW66	96/94 High Street	48.4	11.5
SW45	64 High Street	56.5	6.6
SW38	15a High Street	37.5	12.0
SW37	32 High Street	37.5	5.8
SW20	Newington Co-Op	37.0	9.4

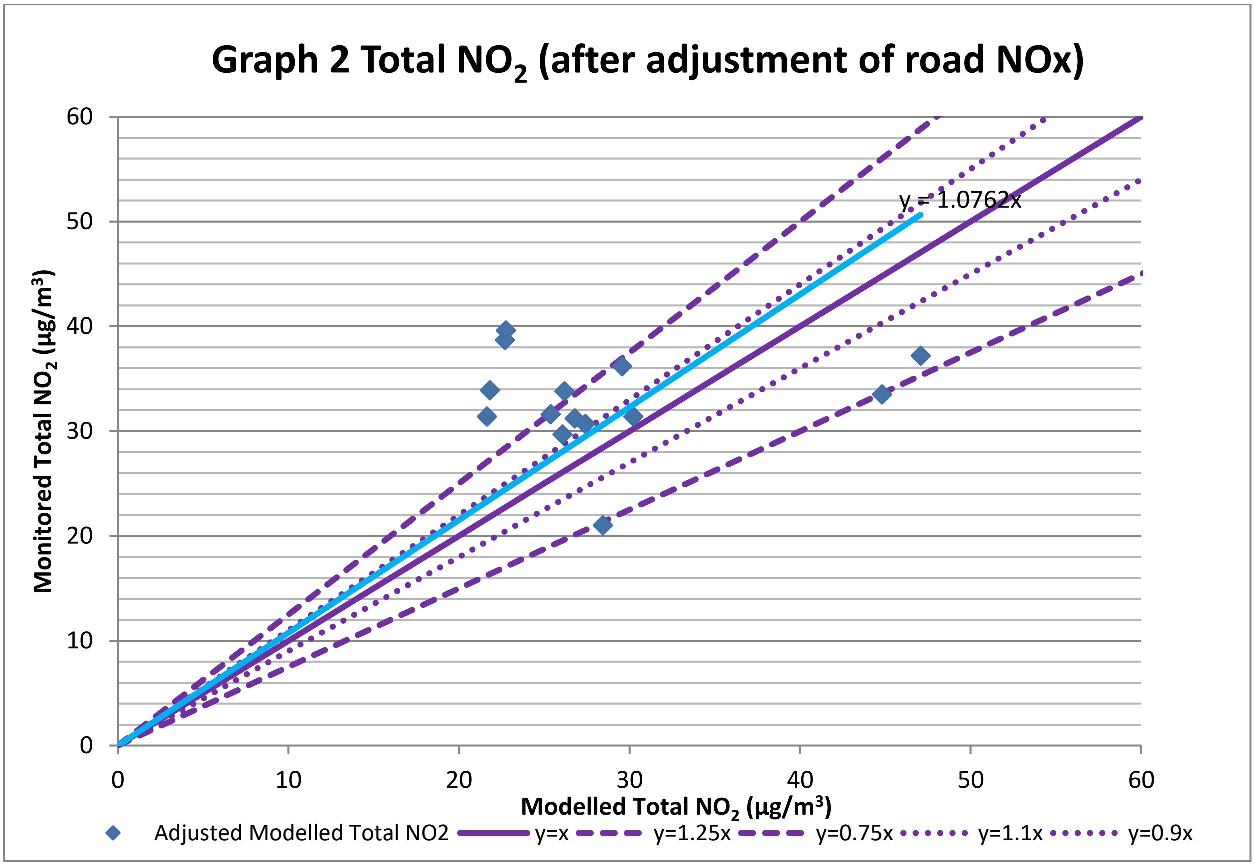
1.29 It should be borne in mind that the monitored concentrations are themselves only estimates to the true concentrations at each point; the EU Directive on air quality designates passive NO_2 samplers indicative measures with a potential uncertainty of +/-30 %. Ignoring any uncertainty errors in the monitoring results, Table 5.5.7 above indicates that the model is under-predicting at all monitoring locations.

1.30 The modelled annual-mean NO_x road contributions for the 14 concentrations have been plotted against the monitored annual-mean NO_x road contributions in Graph 1.



1.31 The modelled NO_x contributions have been multiplied by the gradient of the trend line (2.9085) to determine the corrected NO_x contributions.

1.32 Modelled annual-mean NO_2 concentrations have been derived from the corrected modelled annual-mean NO_x road contributions. The corrected modelled annual-mean NO_2 concentrations have been plotted against the monitored annual-mean NO_2 concentrations in Graph 2.



1.33 The majority of the corrected modelled annual-mean NO_2 concentrations are within 25% of the monitored annual-mean NO_2 concentrations. The correction factor therefore improves the modelled concentrations and has been applied to all predictions used within the assessment.

1.34 The fractional bias can also be used to determine whether the corrected model has a tendency to over or under-predict. The fractional bias is calculated as:

(Average Monitored NO_X Concentration – Average Predicted NO_x Concentration) / 0.5 x (Average Monitored NO_X + Average Predicted NOx Concentration)

1.35 Fractional bias values vary between +2 and -2 and has an ideal value of zero. A negative value suggests a model over-prediction and a positive value suggests a model under-prediction.

1.36 Table 5.5.8 sets out the average monitored concentration and the average predicted concentration.

Table 5.5.8 Comparison of Monitored and Adjusted Modelled Annual-mean Road NO_X Contribution ($\mu g.m^{-3}$)

Site Code	Site Code	Annual-mean Road NO_X Contribution ($\mu g.m^{-3}$)	
		Monitored	Corrected Modelled
ZW6	Newington (3)	33.7	26.0
SW76	155 Canterbury Road	37.9	24.5

Site Code	Site Code	Annual-mean Road NO_X Contribution ($\mu g.m^{-3}$)	
		Monitored	Corrected Modelled
SW75	109 Canterbury Road	15.6	31.0
SW90	Jncn Canterbury Road/ Goodnestone Road	35.9	28.8
SW56	126 East Street	54.3	19.0
SW58	Dover Street Filling Station	42.2	69.4
SW53	114 East Street. Sittingbourne	43.1	17.2
SW87	Canterbury Road	42.9	26.2
SW62	Key Street	50.7	75.2
SW66	96/94 High Street	48.4	33.4
SW45	64 High Street	56.5	19.1
SW38	15a High Street	37.5	34.8
SW37	32 High Street	37.5	16.9
SW20	Newington Co-Op	37.0	27.4
Average		**40.9**	**32.1**

1.37 The fractional bias for this study is therefore (40.9 – 32.1) / (0.5 x (40.9 + 32.1)) = 0.24. As the fractional bias is close to zero, the model is performing well.

References

1 http://laqm.defra.gov.uk/review-and-assessment/tools/tools.html