

Model verification studies are undertaken in order to check the performance of dispersion models and, where modelled concentrations are significantly different to monitored concentrations, a factor can be established by which the modelled results can be adjusted in order to improve their reliability. The model verification process is detailed in LAQM.TG(22).

According to TG(22), no adjustment factor is necessary where the results of the model all lie within 25% of the monitored concentrations, but ideally within 10%.

Model verification can only be undertaken where there is sufficient roadside monitoring data in the vicinity of the subject scheme being assessed. TG(22) recommends that a combination of automatic and diffusion tube monitoring data is used; although this may be limited by data availability. For this assessment, nine NO₂ diffusion tube sites were used to verify against. These monitoring locations are located within Kirkby.

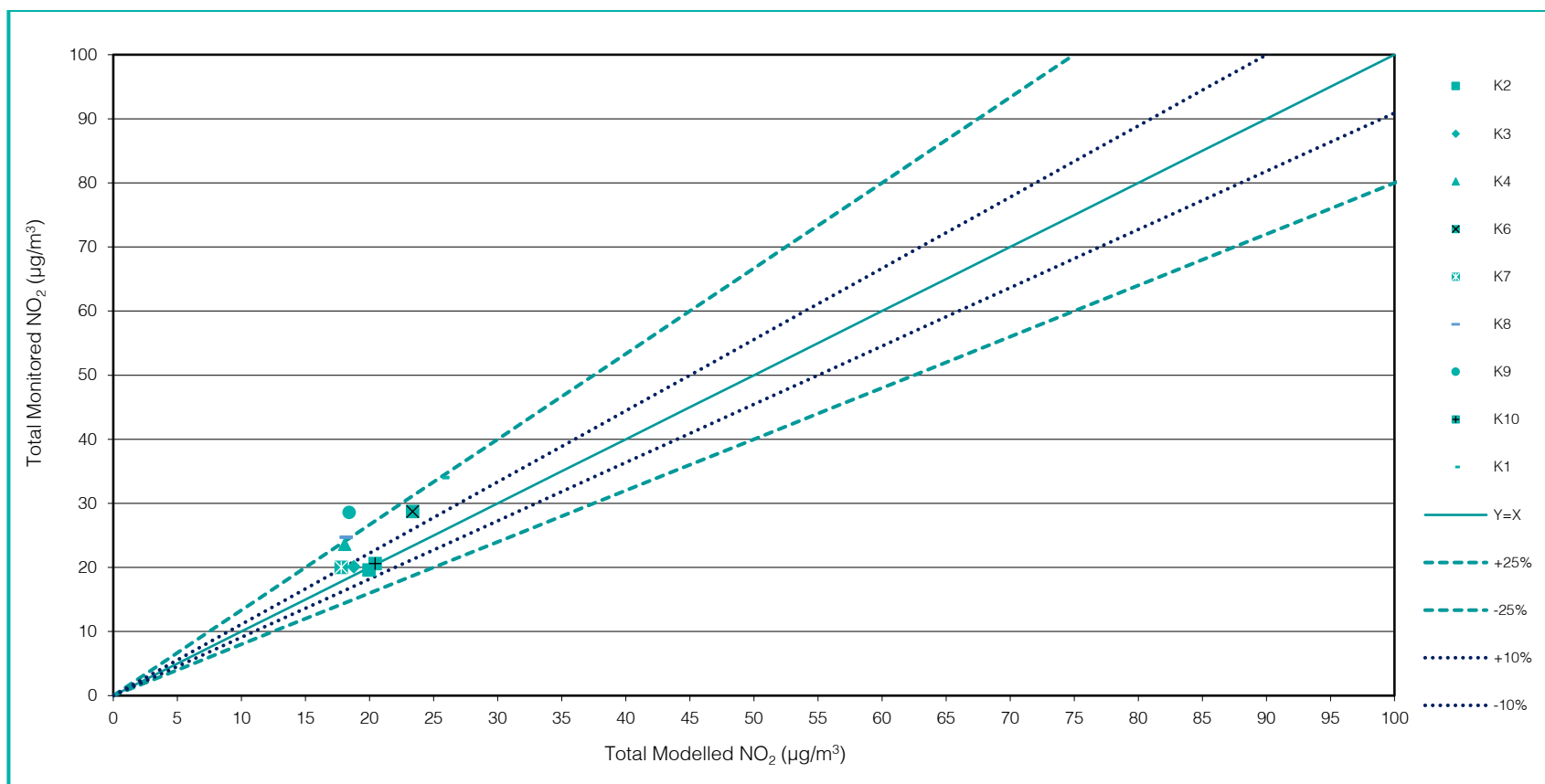
NO₂ Verification

Table 7.5.1 compares the monitored and modelled NO₂ concentrations at these monitoring locations.

Table 7.5.1: Comparison of Monitored and Modelled NO₂ Concentrations

Site ID	Type	Concentrations (µg/m ³)		
		Monitored	Modelled	% Difference
K2a, K2b	Diffusion Tube	19.6	20.0	1.8
K3a, K3b	Diffusion Tube	20.1	18.8	-6.6
K4a, K4b	Diffusion Tube	23.6	18.1	-23.5
K6a, K6b	Diffusion Tube	28.7	23.4	-18.6
K7a, K7b	Diffusion Tube	20.0	17.8	-11.1
K8a, K8b	Diffusion Tube	24.7	18.2	-26.4
K9a, K9b	Diffusion Tube	28.6	18.4	-35.7
K10a, K10b	Diffusion Tube	20.6	20.4	-0.8
K1a, K1b	Diffusion Tube	34.0	25.7	-24.4

Figure 7.5.1: Comparison of Monitored and Modelled NO₂ Concentrations Before Adjustment



The data in Table 7.5.1 shows that the model is largely under-predicting NO₂ concentrations. This is not unusual and is likely to be the result of local dispersion conditions.

As the difference for a number of sites is greater than +/- 10%, an adjustment factor has been derived to ensure a conservative assessment is undertaken.

As it is primary NO_x rather than secondary NO₂ emissions that are modelled, an adjustment factor must be derived for the road contribution of NO_x. A ratio of the modelled versus monitored NO_x concentrations using the least squares statistical method has been undertaken to derive an adjustment factor, as set out in Table 7.5.2.

Table 7.5.2: Deriving the Adjustment Factor

Site ID	Monitored Road NO _x (µg/m ³)	Modelled Road NO _x (µg/m ³)	Adjustment Factor
K2a, K2b	9.4	10.1	1.827
K3a, K3b	12.9	10.4	
K4a, K4b	17.2	6.5	
K6a, K6b	27.5	16.7	
K7a, K7b	10.2	6.0	
K8a, K8b	19.4	6.7	
K9a, K9b	27.3	7.2	
K10a, K10b	6.8	6.4	
K1a, K1b	33.9	16.7	

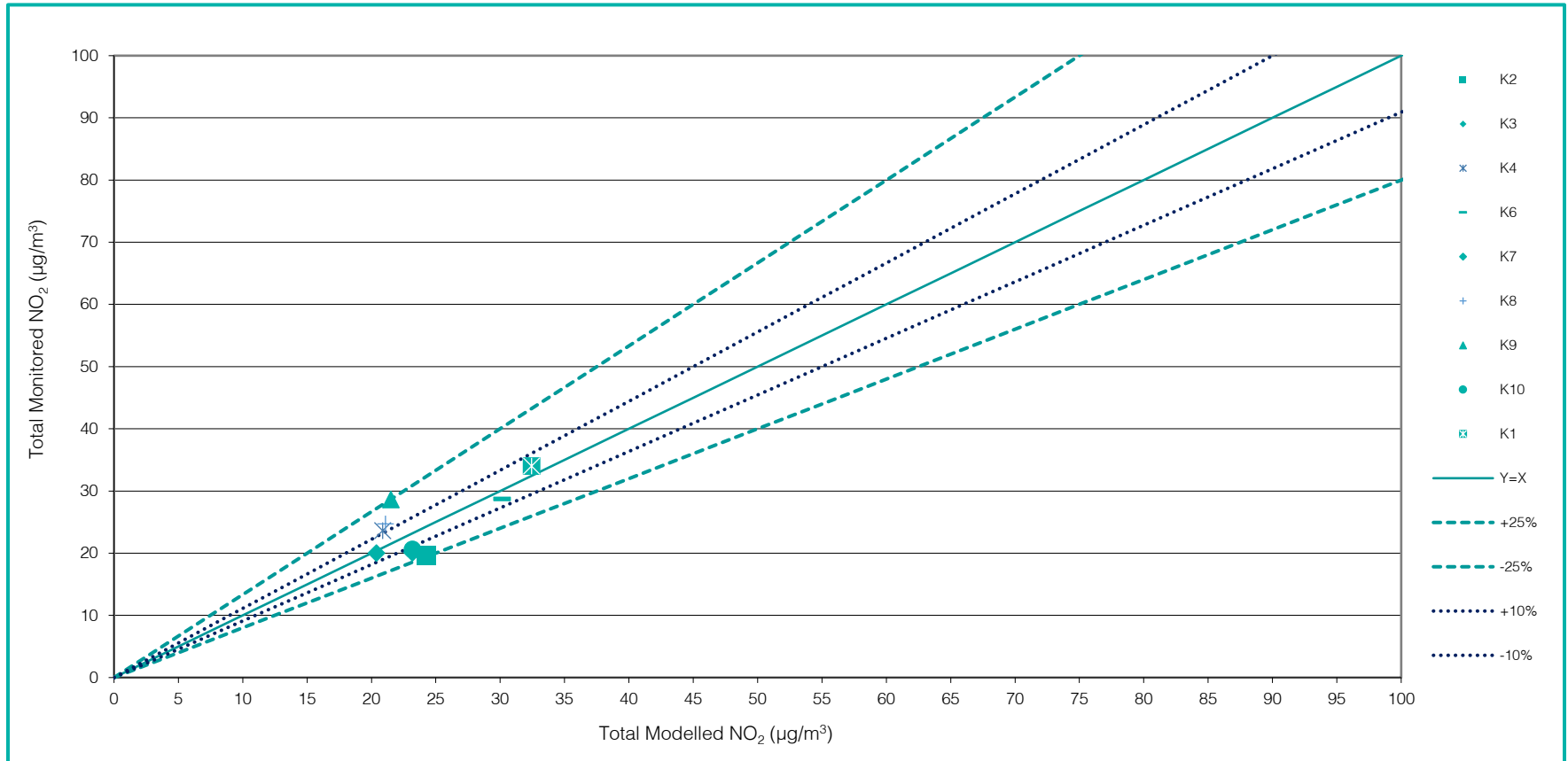
Table 7.5.3 compares monitored and modelled NO₂ concentrations at the monitoring locations after the adjustment factor has been applied.

Table 7.5.3: Comparison of Monitored and Adjusted Modelled NO₂ Concentrations

Site ID	Type	Concentrations (µg/m ³)		
		Monitored	Modelled	% Difference
K2a, K2b	Diffusion Tube	19.6	24.2	23.7
K3a, K3b	Diffusion Tube	20.1	23.2	15.3
K4a, K4b	Diffusion Tube	23.6	20.9	-11.6
K6a, K6b	Diffusion Tube	28.7	30.1	5.0

Site ID	Type	Concentrations (µg/m³)		
		Monitored	Modelled	% Difference
K7a, K7b	Diffusion Tube	20.0	20.4	1.9
K8a, K8b	Diffusion Tube	24.7	21.1	-14.6
K9a, K9b	Diffusion Tube	28.6	21.5	-24.8
K10a, K10b	Diffusion Tube	20.6	23.2	12.5
K1a, K1b	Diffusion Tube	34.0	32.4	-4.6

Figure 7.5.2: Comparison of Monitored and Modelled NO₂ Concentrations After Adjustment



The data in Table 7.5.3 shows that the majority of NO₂ concentrations in the model are within 25% of the monitored concentration, indicating that the model is performing acceptably. However, this will be determined by calculating the Root Mean Square Error.

Root Mean Square Error

A Root Mean Square Error (RMSE) has been calculated in Table 7.5.4 to determine the error within the calculations before Road-NO_x adjustment, based upon the following calculation:

$$RMSE = \sqrt{\frac{1}{N} \sum_{i=1}^N (obs_i - Pred_i)^2}$$

Table 7.5.4: Root Mean Squared Error

Site ID	Concentrations (µg/m ³)		
	Predictions	Observations	% Difference
K2a, K2b	24.2	19.6	23.7
K3a, K3b	23.2	20.1	15.3
K4a, K4b	20.9	23.6	-11.6
K6a, K6b	30.1	28.7	5.0
K7a, K7b	20.4	20.0	1.9
K8a, K8b	21.1	24.7	-14.6
K9a, K9b	21.5	28.6	-24.8
K10a, K10b	23.2	20.6	12.5
K1a, K1b	32.4	34.0	-4.6

The calculated RMSE is 3.5 µg/m³, which correlates to a 8.9% error ratio. The RMSE means that modelled results could be under or over predicting pollution concentrations between +/- 3.5 µg/m³. The RMSE means that modelled results are acceptable, as they are within a 10% margin of error (as advised in TG(22)), and therefore no further adjustment factor is required.

Fractional Bias

The fractional bias has been calculated to identify if the model shows a systematic tendency to over or under-predict. The following formula has been used to calculate the fractional bias:

$$FB = \frac{(\text{Avg.Obs} - \text{Avg.Pred})}{0.5 (\text{Avg.Obs} + \text{Avg.Pred})}$$

Table 7.5.5: Fractional Bias

Average Predicted Values	Average Observed Values	Fractional Bias
24.1	24.4	0.013

The calculated fractional bias is 0.013, which indicates that the model is slightly overpredicting. However, the fraction bias is close to the ideal value of 0, which suggests that the model is performing acceptably.

Particulate Matter Verification

As there are no appropriate PM₁₀ or PM_{2.5} monitoring locations within the study area, the predicted road-PM₁₀ and road-PM_{2.5} components have been adjusted using the road EFT NO_x factor before adding the appropriate background concentration.