Annexure J - Dispersion model evaluation

J.1 Approach

The overall performance of the GRAMM-GRAL system was evaluated by comparing the predicted and measured concentrations at multiple OEH, Roads and Maritime, and SMC air quality monitoring stations in 2015. The model predictions were based upon the WRTM data for the 2015 Base Year scenario.

The monitoring stations considered in the evaluation were those located within the GRAL domain, and included a mixture of background and near-road sites. The characteristics of the stations are summarised in Table J-1, and for those located near roads the traffic volumes are also given. Of the 20 stations listed in the Table, thirteen (M01 to M13) had data for the whole of 2015, whereas the remaining seven (M14 to M20) had data for part of 2015. To simplify the presentation, only the results for stations M01 to M13 are shown in this Annexure. However, the findings for these stations were also broadly representative of stations M14 to M20. The performance of GRAL was not investigated at the project-specific (i.e. M4-M5 Link) monitoring stations as no data from these were available for 2015.

Few dispersion model evaluation exercises have previously been conducted for road projects in Sydney, and such an evaluation was therefore considered to be of value. However, the limitations of the evaluation should be understood. For example:

- This was not a comprehensive model validation and verification exercise; such exercises have been undertaken in detail by the GRAL developers. Rather, the analysis was used to demonstrate the performance of the overall model chain (e.g. background + GRAL + conversion of NO_X to NO_2) as applied in the M4-M5 Link assessment.
- The ability to test the performance of GRAL in Sydney was quite limited on account of the small number of monitoring stations very close to major roads, as well as the absence of detailed local model inputs such as real-world hourly traffic data.
- There were issues with some of the monitoring stations which meant that they were not ideal for model evaluation. For example, the RMS F1 and M1 stations were both located behind noise barriers. A study in Austria by Öttl et al. (2006) noted that, at a model evaluation site where the monitoring station was located just behind a 4-metre high dam with an additional 4-metre high noise barrier on top, GRAL led to a 50 per cent overestimation of the observed concentration.

In the following sections, the results of the evaluation are presented by pollutant. In order to cover different characteristics of the data, three statistical metrics were used: the annual mean concentration, the maximum short-term concentration, and the 98th percentile[1] short-term concentration.

GRAL was configured to predict hourly concentrations of NO_X, NO_2, CO and PM_{10} at the various stations. For PM_{10}, daily average concentrations were also calculated, and these are presented here. The emphasis was on NO_X and NO_2, as the road traffic increment for CO and PM_{10} tends to be small relative to the background. $PM_{2.5}$ was not assessed as the road increment tends to be rather small. In addition, fewer measurement sites near roads were available for $PM_{2.5}$ than for the other pollutants.

A number of different approaches have been used here to account for the background contribution to the predicted concentrations, and to compare the effects of different assumptions. This is because the approaches for calculating short-term concentrations in the M4-M5 Link were quite conservative, and therefore unlikely to give an accurate impression of model accuracy. The different approaches are summarised by pollutant and statistic in Table J-2. For annual mean NO_X and PM_{10}, a background map was used (see Annexure F). Annual mean CO was not considered in the M4-M5 Link assessment as there is no corresponding air quality criterion, and therefore no background map was developed. Rolling 8-hour CO concentrations were not included either, as the test for 1-hour CO is more stringent.

[1] The selection of the 98th percentile was arbitrary. The intention of using this statistic was to provide an indication of the performance of GRAL at high concentrations, but with the most extreme values excluded.

Table J-1 Characteristics of monitoring stations used for model evaluation

Organisation	Project	Station name	Location	Suburb	Code for GRAL evaluation	Station type	Nearest busy road(s) (road sites only)			Monitoring for full calendar year of 2015	Notes
							Road(s)	Distance to kerb (m)	Traffic vol. (vpd)		
OEH	N/A	Earlwood	Beaman Park	Earlwood	**M01**	Background	-	-	-	Yes	-
		Rozelle	Rozelle Hospital	Rozelle	**M02**	Background	-	-	-	Yes	-
RMS	M5 East tunnel	M5E:CBMS	Gipps Street	Bardwell Valley	**M03**	Background	-	-	-	Yes	-
		M5E:T1	Thompson Street	Turrella	**M04**	Background	-	-	-	Yes	Vegetation around monitoring station. Site is near a distribution centre with truck activity.
		M5E:U1	Jackson Place	Earlwood	**M05**	Background	-	-	-	Yes	Station surrounded by thick vegetation.
		M5E:X1	Wavell Parade	Earlwood	**M06**	Background	-	-	-	Yes	-
		M5E:F1	Flat Rock Road	Kingsgrove	**M07**	Peak (road)	M5 East Freeway	~23	~110,000	Yes	Noise barrier between M5 East and station.
		M5E:M1	M5 East portal	Arncliffe	**M08**	Peak (road)	Off-ramp, M5 East tunnel	~8	~20,000	Yes	Noise barrier, trees and cutting between M5 East and station.
SMC	WestConnex M4 East	M4E:01	Wattle Street	Haberfield	**M09**	Peak (road)	Wattle Street	~15	~50,000	Yes	-
		M4E:02	Edward Street	Concord	**M10**	Peak (road)	M4 Western Motorway Concord Road	~35 ~50	~35,000 ~30,000	Yes	-
		M4E:03	Bill Boyce Reserve	Homebush	**M11**	Peak (road)	M4 Western Motorway	~40	~35,000	Yes	Station close to vegetation and elevated relative to M4 by around 5 m.
		M4E:04	Concord Oval	Concord	**M12**	Peak (road)	Parramatta Road	~11	~85,000	Yes	-
		M4E:05	St Lukes Park	Concord	**M13**	Background	-	-	-	Yes	-
	WestConnex New M5	NewM5:01	St Peters Public School	St Peters	**M14**	Background	-	-	-	No (Aug-Dec)	-
		NewM5:02	Princes Highway	St Peters	**M15**	Peak (road)	Princes Highway Campbell Street	~5 ~20	~35,000 ~5,000	No (Jul-Dec)	-
		NewM5:03	West Botany Street	Arncliffe	**M16**	Peak (road)	West Botany Street On-ramp, M5 East tunnel	~11 ~35	~32,000 ~30,000	No (Aug-Dec)	-
		NewM5:04	Bestic Street	Rockdale	**M17**	Background	-	-	-	No (Jul-Dec)	-
		NewM5:05	Bexley Road	Kingsgrove	**M18**	Peak (road)	Bexley Road M5 East Freeway	~8 ~150	~45,000 ~110,000	No (Jul-Dec)	-
		NewM5:06	Beverly Hills Park	Beverly Hills	**M19**	Background	-	-	-	No (Jul-Dec)	-
		NewM5:07	Canal Road	St Peters	**M20**	Peak (road/industrial)	Canal Road	~5	~45,000	No (Jul-Dec)	-

Table J-2 Approaches used to incorporate background contributions

Pollutant	Statistic	Approaches presented in this Annexure	NO_X to NO_2 conversion	Used in M4-M5 Link assessment
NO_X	Annual	Mapped[(a)]	-	Yes
	Maximum 1-h	Average contemporaneous[(b)]	-	No
		Maximum contemporaneous[(c)]	-	Yes
	98th percentile 1-h	Average contemporaneous	-	No
		Maximum contemporaneous	-	Yes
NO_2	Annual	Mapped (NO_X)	Empirical	Yes
			OLM	No
	Maximum 1-h	Average contemporaneous (NO_X)	Empirical	Yes
			OLM	No
		Maximum contemporaneous (NO_X)	Empirical	Yes
			OLM	No
	98th percentile 1-h	Average contemporaneous (NO_X)	Empirical	Yes
			OLM	No
		Maximum contemporaneous (NO_X)	Empirical	Yes
			OLM	No
CO	Annual	Average contemporaneous	-	-
		Maximum contemporaneous	-	-
	Maximum 1-h	Average contemporaneous	-	No
		Maximum contemporaneous	-	Yes
	98th percentile 1-h	Average contemporaneous	-	No
		Maximum contemporaneous	-	Yes
PM_{10}	Annual mean	Mapped	-	Yes
	Maximum 24-h	Average contemporaneous	-	No
		Maximum contemporaneous	-	Yes
	98th percentile 24-h	Average contemporaneous	-	No
		Maximum contemporaneous	-	Yes

(a) GRAL annual value added to a mapped annual background.
(b) 1-hour GRAL value (24-hour for PM_{10}) added to corresponding 1-hour background (24-hour for PM_{10}) from average synthetic profile.
(c) 1-hour GRAL value (24-hour for PM_{10}) added to corresponding 1-hour background (24-hour for PM_{10}) from maximum synthetic profile.

For short-term metrics the contemporaneous method was used, based on both 'average' and 'maximum' synthetic background profiles. The average synthetic background profiles were constructed in a similar way to those described in Annexure F, but to enable a more direct comparison with the monitoring data, they were calculated using an average value for each hour of the year across several monitoring stations rather than the maximum value used in the assessment (where an element of conservatism was required for short-term concentrations). NO_2 was calculated using the empirical methods described in Annexure G. The ozone limiting method (OLM – see Annexure G) was also applied for comparison, as this is widely used in NSW.

J.1.1 Results for NO_X

Figure J-1 and Figure J-2 show examples of the modelled 1-hour mean NO_X concentrations for a background station (Rozelle) and a road station (F1, alongside the M5 East Freeway), along with the measured NO_X concentrations at these stations. The modelled concentration includes both the background contribution and the GRAL prediction. At the road station there was a much larger modelled contribution from GRAL.

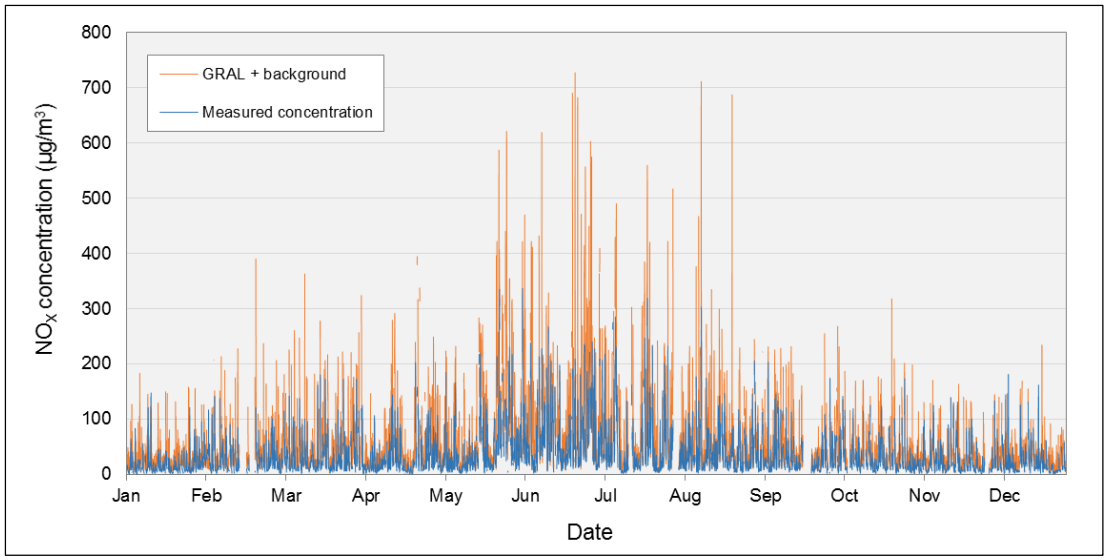


Figure J-1 **Measured 1-hour mean NO_X concentrations and GRAL predictions (including background) for the OEH Rozelle background monitoring station**

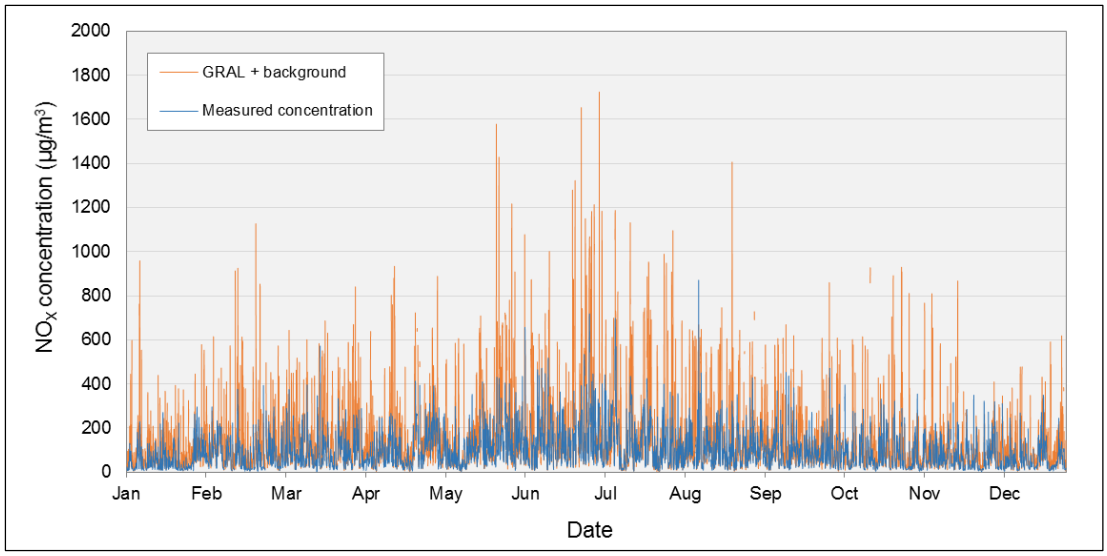


Figure J-2 **Measured 1-hour mean NO_X concentrations and GRAL predictions (including background) for the RMS F1 monitoring station**

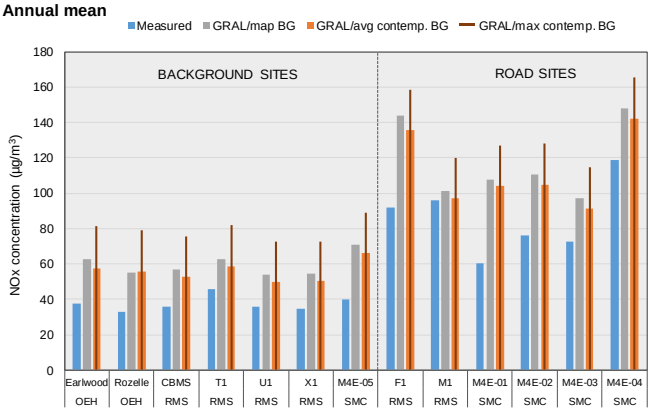
In Figure J-3 the measured and predicted NO_X concentration statistics are compared for each of the monitoring stations. For the annual mean, a calculation based on the contemporaneous background approaches are also included for comparison with the mapped background approach. The orange column shows the contemporaneous result for the 'average' synthetic background profile, and the thin brown line shows the contemporaneous result for the 'maximum' synthetic background profile (as used in the M4-M5 Link assessment.

For annual mean concentrations there was a reasonably good agreement between the measured concentrations and those predicted using the mapped approach. However, there was an overestimation of concentrations at all stations.

For the purpose of the air quality assessment it was assumed that the background stations were not influenced by road transport sources, and therefore in principle the concentrations predicted by GRAL at these stations should have been zero. In practice, dispersion models will often give non-zero values at background stations, and this was also the case here. This overestimation of annual mean NO_X at the background sites ranged from around 17 µg/m^3 to 31 µg/m^3, or 37 per cent to 77 per cent, based

on the mapped background. Part of this overestimation was due to the background map itself; the mapped NO_X concentrations at the background stations were generally slightly higher than the measured concentrations at the same sites by around 2-4 µg/m^3. At the background stations the bulk of the overestimation was due to GRAL.

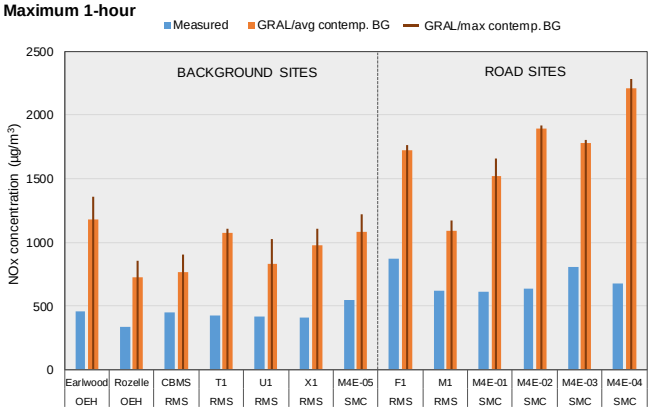
Annual mean



Site type *	Site	Concentration (µg/m^3)			Pred. (map) - meas. (µg/m^3)	Pred. (map) / meas.
		Measured	Predicted (map)	Predicted (contemp)		
BG	OEH Earlwood	37.6	62.7	57.5	25.1	1.67
	OEH Rozelle	32.8	54.9	55.6	22.0	1.67
	RMS CBMS	35.8	57.0	52.8	21.2	1.59
	RMS T1	45.7	62.6	58.8	17.0	1.37
	RMS U1	35.8	53.9	49.8	18.1	1.51
	RMS X1	34.9	54.3	50.2	19.4	1.56
	SMC M4E-05	40.1	70.9	65.9	30.8	1.77
RD	RMS F1	91.8	143.9	135.8	52.2	1.57
	RMS M1	95.9	100.9	97.3	5.1	1.05
	SMC M4E-01	60.2	107.6	104.1	47.4	1.79
	SMC M4E-02	76.2	110.7	104.6	34.4	1.45
	SMC M4E-03	72.9	97.2	91.2	24.2	1.33
	SMC M4E-04	118.9	147.8	142.2	28.9	1.24

*BG = background, RD = road

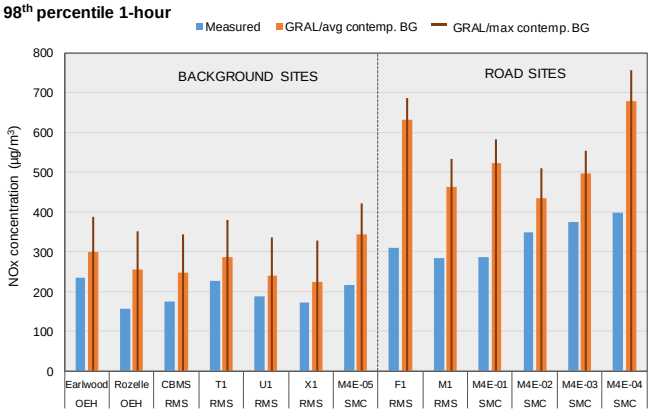
Maximum 1-hour



Site type *	Site	Concentration (µg/m^3)		Pred. - meas. (µg/m^3)	Pred. / meas.
		Measured	Predicted (contemp)		
BG	OEH Earlwood	459.7	1176.6	716.9	2.56
	OEH Rozelle	336.6	727.5	390.9	2.16
	RMS CBMS	449.6	763.4	313.8	1.70
	RMS T1	424.1	1074.9	650.8	2.53
	RMS U1	419.0	827.1	408.2	1.97
	RMS X1	407.5	974.4	566.9	2.39
	SMC M4E-05	548.8	1081.8	533.1	1.97
RD	RMS F1	870.6	1724.4	853.7	1.98
	RMS M1	619.6	1093.6	473.9	1.76
	SMC M4E-01	609.4	1518.8	909.4	2.49
	SMC M4E-02	632.0	1888.4	1256.4	2.99
	SMC M4E-03	805.7	1778.4	972.7	2.21
	SMC M4E-04	676.9	2211.9	1535.0	3.27

*BG = background, RD = road

98th percentile 1-hour



Site type *	Site	Concentration (µg/m^3)		Pred. - meas. (µg/m^3)	Pred. / meas.
		Measured	Predicted (contemp)		
BG	OEH Earlwood	234.0	298.4	64.5	1.28
	OEH Rozelle	156.0	255.8	99.8	1.64
	RMS CBMS	175.4	248.4	72.9	1.42
	RMS T1	226.0	286.9	60.9	1.27
	RMS U1	187.0	239.3	52.3	1.28
	RMS X1	172.6	223.7	51.1	1.30
	SMC M4E-05	216.1	343.9	127.7	1.59
RD	RMS F1	310.3	631.0	320.7	2.03
	RMS M1	285.1	462.7	177.7	1.62
	SMC M4E-01	287.5	521.3	233.8	1.81
	SMC M4E-02	349.1	435.5	86.5	1.25
	SMC M4E-03	373.8	496.0	122.1	1.33
	SMC M4E-04	398.1	676.9	278.9	1.70

*BG = background, RD = road

Figure J-3 Comparison between measured and predicted total NO_X concentrations

There was also an overestimation of NO_X at most of the road stations. Although there was a good agreement at the RMS M1 station (5 per cent overestimation), the total NO_X concentration was overestimated by between 24 per cent and 79 per cent at the other stations.

The GRAL overestimation of annual mean NO_X is shown more clearly in Figure J-4, where the mapped background concentrations and GRAL contributions are shown separately. If it is assumed that the mapped backgrounds at the road stations are representative of the actual background at the road monitoring stations, then it can be concluded that there is a substantial over-prediction of the road component at the road stations other than M1. As noted earlier, some of these stations were not ideal for model evaluation.

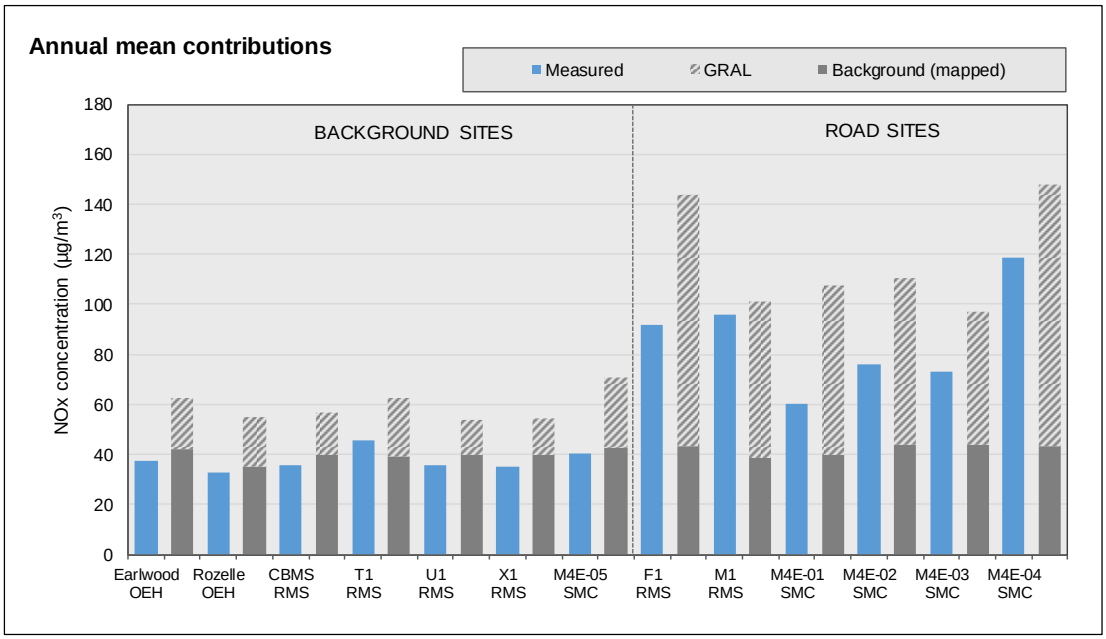


Figure J-4 Contributions to modelled annual mean NO_X concentrations

Returning to Figure J-3, it can be seen that there was little difference between the mapped and average contemporaneous approaches for predicting annual mean NO_X. The maximum synthetic profile gives higher values, of course.

As expected, the results for the maximum 1-hour concentrations were more variable than the annual means. Maximum pollutant concentrations are inherently very difficult to predict, and the comparisons here reflect this. Nevertheless, there was a clear tendency towards the overestimation of maximum and (to a lesser degree) 98th percentile concentrations.

Because there is generally a stronger road traffic signal for NO_X than for other criteria pollutants, the model performance at the road stations was examined in detail using the 'timeVariation' function in the Openair software. Figure J-5 to Figure J-10 show the results from the timeVariation function for the predicted ('GRAL') and monitored ('MON') hourly NO_X concentrations. The hours with low numbers of values (typically less than 20) associated with, for example, periods of instrument calibration, have been removed from the datasets.

The variation of a pollutant by time of day and day of week can reveal useful information concerning the likely sources. For example, road vehicle emissions tend to follow very regular patterns both on a daily and weekly basis. The timeVariation function produces four plots: day of the week variation, mean hour of day variation, a combined hour of day – day of week plot, and a monthly plot. Also shown on the plots is the 95 per cent confidence interval in the mean. For model evaluation it is important to consider the difference between observations and modelled values over these different time scales (Carslaw, 2015).

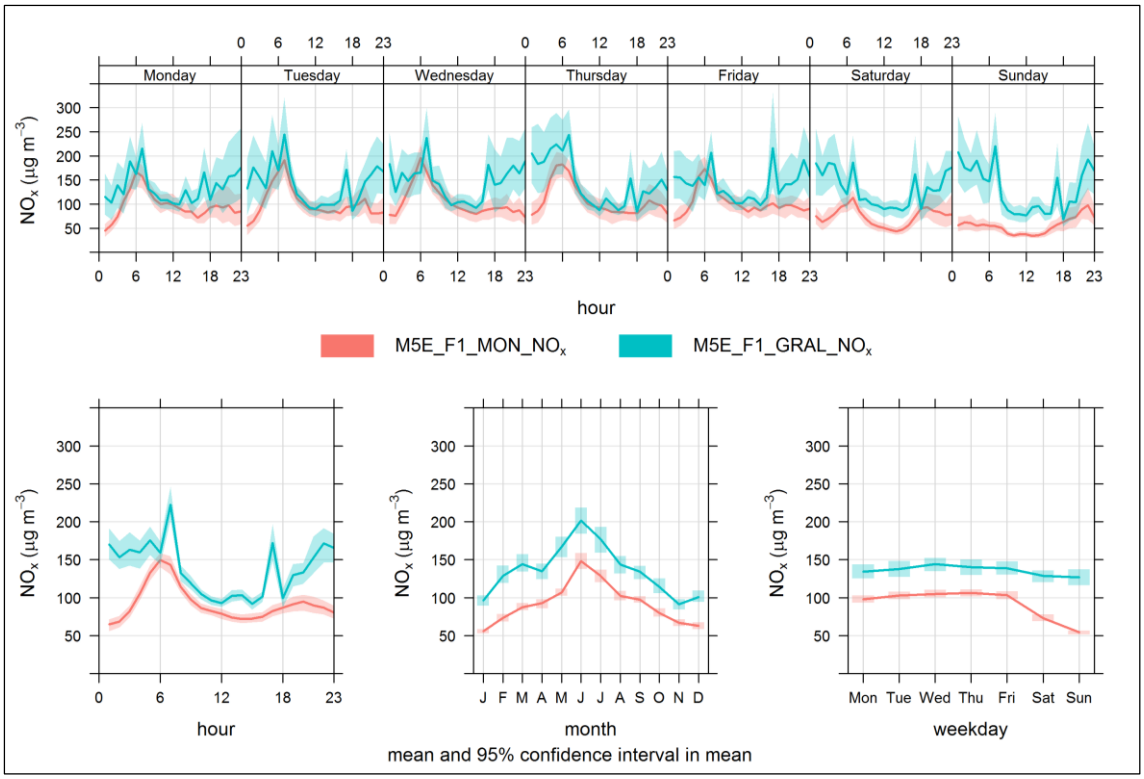


Figure J-5 **Time variation of measured and predicted total NO_X concentrations at RMS F1 monitoring station**

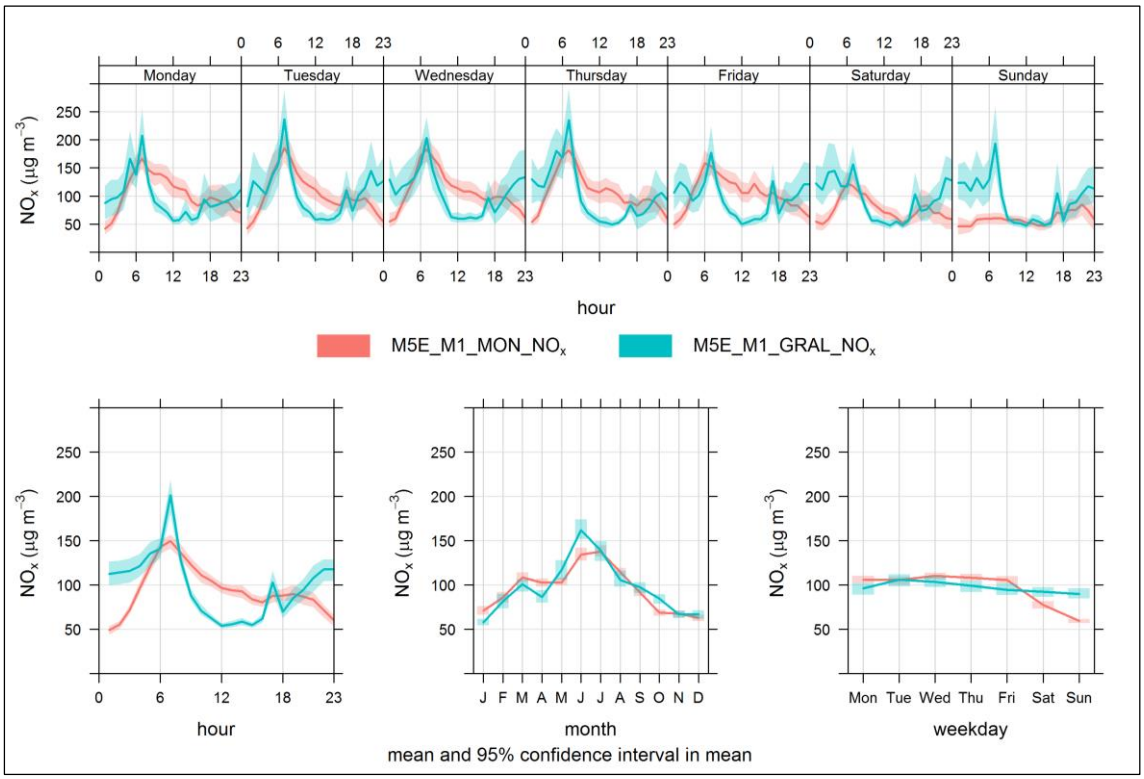


Figure J-6 **Time variation of measured and predicted total NO_X concentrations at RMS M1 monitoring station**

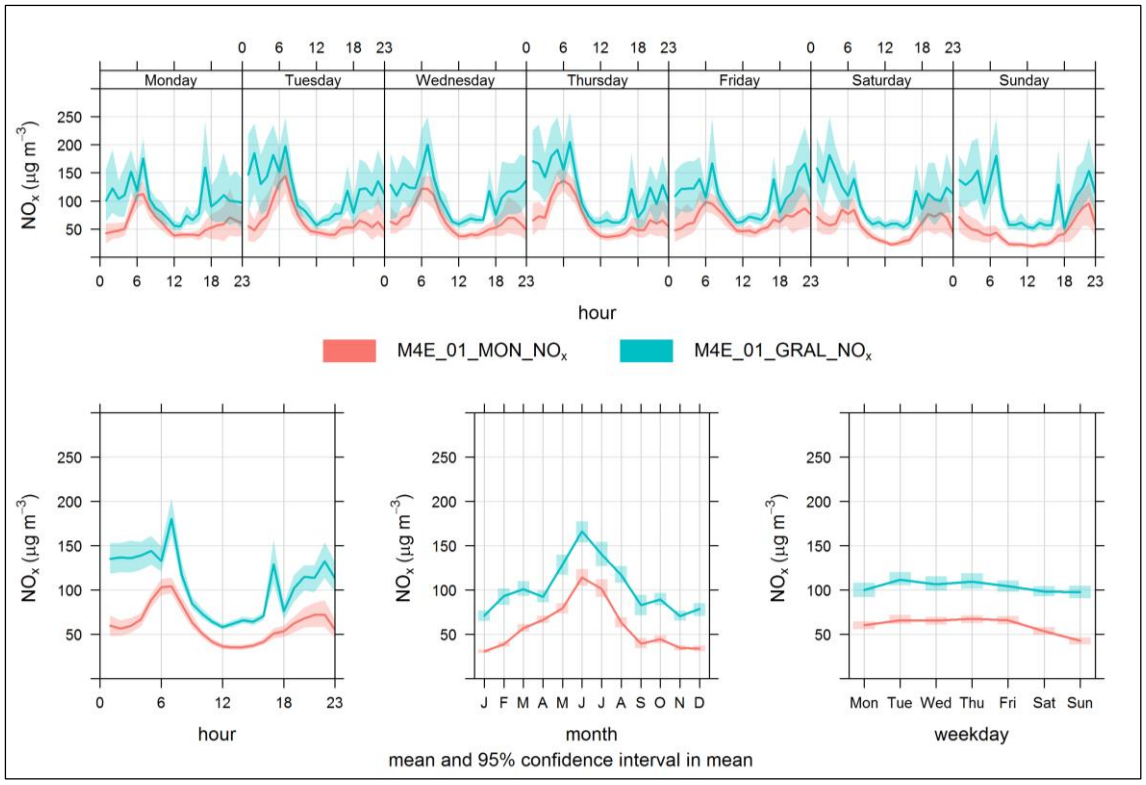


Figure J-7 **Time variation of measured and predicted total NO_X concentrations at SMC M4 East Wattle Street monitoring station**

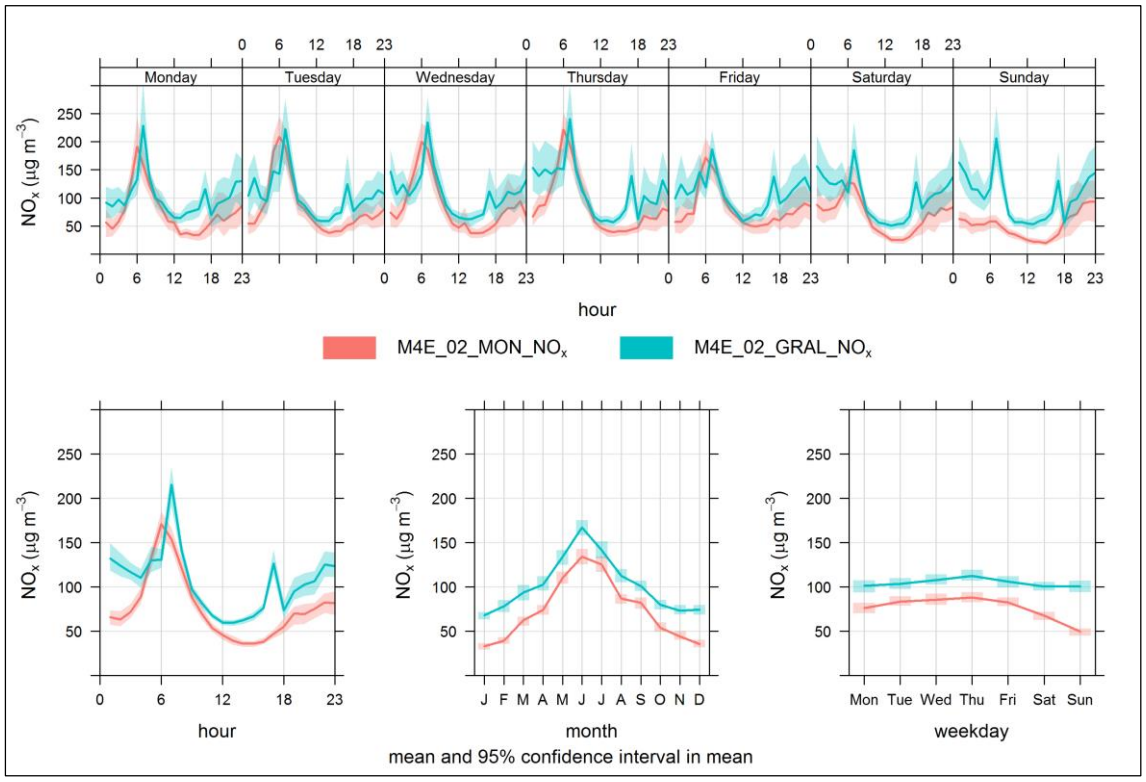


Figure J-8 **Time variation of measured and predicted total NO_X concentrations at SMC M4 East Edward Street monitoring station**

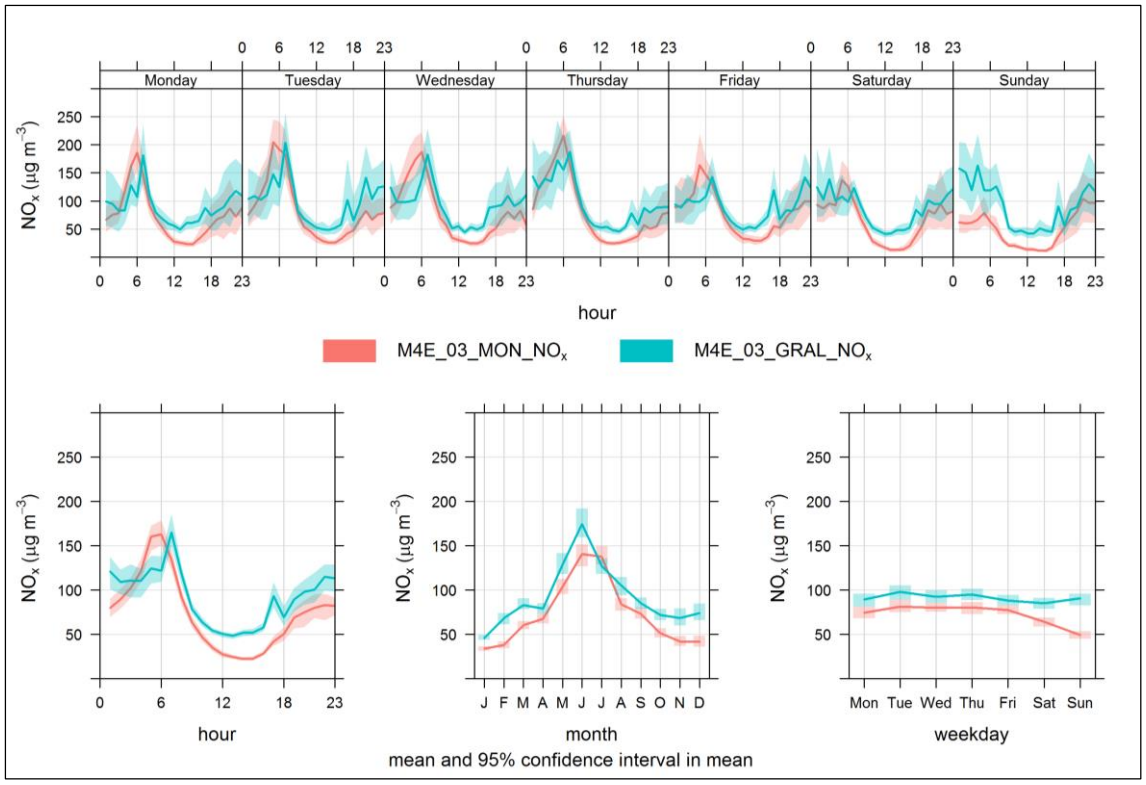


Figure J-9 **Comparison between time variation of measured and predicted total NO_X concentrations at SMC M4 East Bill Boyce Reserve monitoring station**

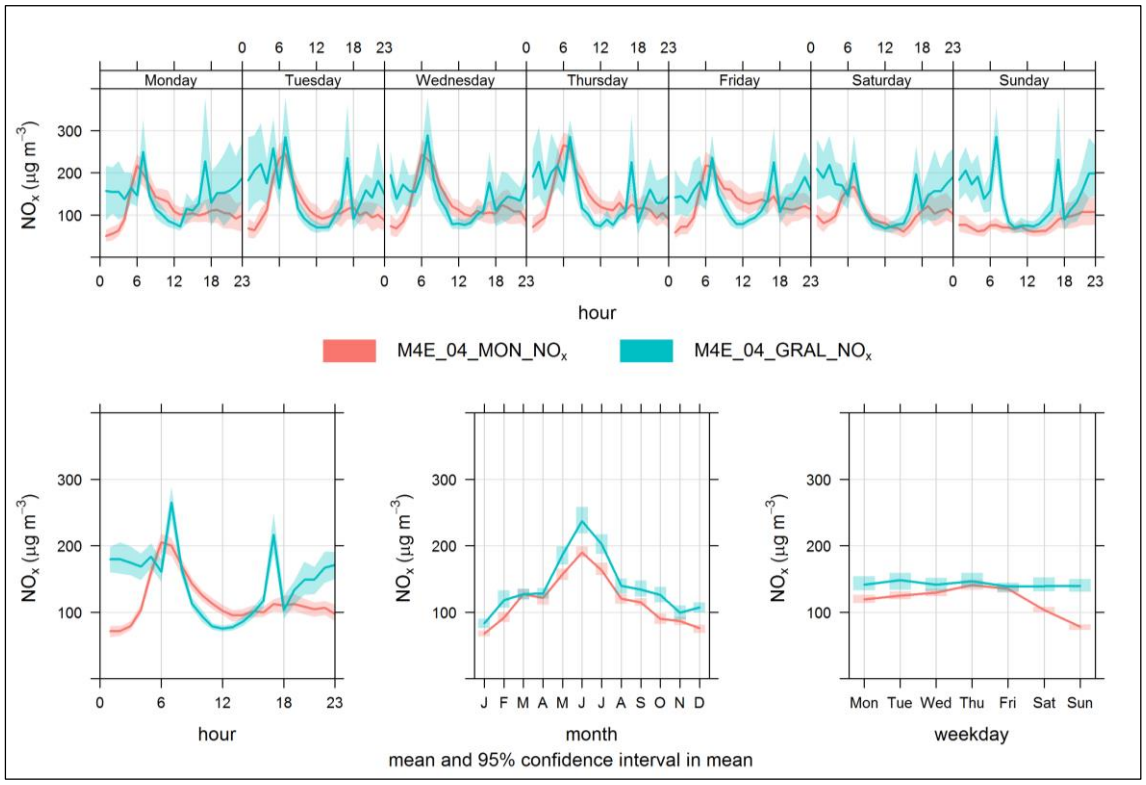


Figure J-10 **Comparison between time variation of measured and predicted total NO_X concentrations at SMC M4 East Concord Oval monitoring station**

The plots reveal the following:

- At all stations there was a pronounced overestimation of NO_X concentrations at night-time and during peak traffic periods. The main exception to this was at Bill Boyce Reserve on Thursdays, where the morning peak concentration was slightly underestimated.
- At most stations the inter-peak concentrations were reasonably well reproduced, although there was still a marked overestimation at some stations (e.g. Wattle Street) and underestimation at others (e.g. M1).
- The seasonal variation in concentrations was, on average, well reproduced, with the under- and overestimation during the day being cancelled out at some stations. There was generally a consistent overestimation of the monthly average concentration.
- The overestimation was larger at the weekend than on weekdays. This is likely to be due in large part to the assumption of weekday traffic volumes on every day of the year in the modelling.

Overall, the results for NO_X suggest that the estimated total annual mean and short-term NO_X concentrations ought to be somewhat conservative for most of the modelling domain. The selected approaches should introduce a clear margin of safety into the M4-M5 Link assessment.

J.1.2 Results for NO_2

Figure J-11 shows the measured and predicted NO_2 concentrations. NO_2 calculated using the OLM for converting NO_X to NO_2 are shown for comparison with the empirical methods used in the assessment.

The annual mean NO_2 values were obtained using a background map for NO_X. The OLM calculations were contemporaneous, based on the synthetic (average) background profiles for NO_2 and O_3, and the *f*-NO_2 value of 0.16 recommended by NSW EPA.

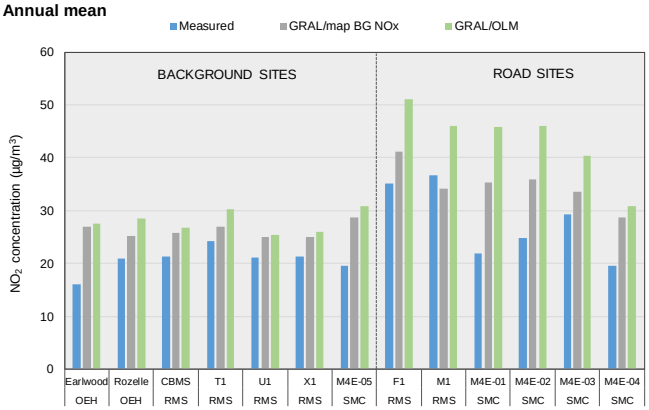
For annual mean NO_2 the predicted concentrations based on the use of background maps for NO_X tended to be higher than the measured values, with the exception of the M1 station. The overestimation ranged from 12 per cent to 68 per cent. When the OLM was used to determine NO_2 for each hour of the year, considerably higher annual mean values were predicted for the road stations. For the background stations the OLM gave slightly higher results than the mapping approach.

A similar pattern was observed for the maximum 1-hour mean NO_2 concentration. In this case the predicted concentrations at all the road stations were less than 50 per cent higher than the measured values, and again the OLM gave values which were much higher, with large overpredictions of concentrations at the road stations in particular.

These findings reinforce the statements in Annexure G concerning the unsuitability of the OLM for road projects.

The results for the 98th percentile 1-hour mean concentration were interesting, as the OLM gave results that were closer to the measurements than the contemporaneous method developed for the assessment. Because the latter is designed to give a conservative estimate for the maximum NO_2 concentration for each hour of the year, so that the overall maximum for the year is not underestimated. This means that the whole distribution is skewed towards high values. Although this is useful for determining the maximum value during a year, it is clearly not well suited to the estimation of other NO_2 statistics such as means and percentiles.

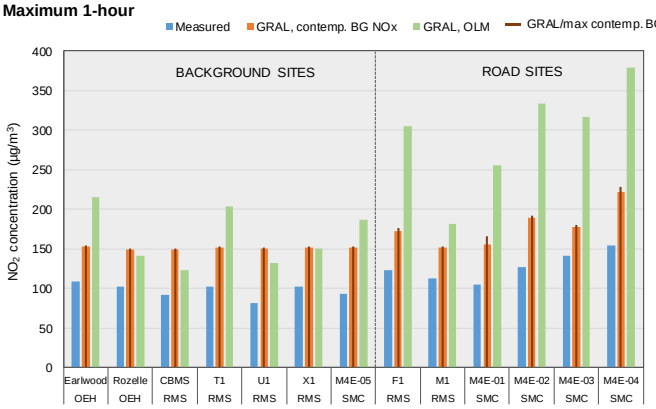
Annual mean



Site type*	Site	Concentration (µg/m^3) Measured	Predicted (NOx map)	Predicted (OLM)	Pred. (map) - meas. (µg/m^3)	Pred. (map) / meas.
BG	OEH Earlwood	16.1	27.0	27.5	10.9	1.68
	OEH Rozelle	20.9	25.2	28.6	4.3	1.21
	RMS CBMS	21.3	25.7	26.8	4.4	1.21
	RMS T1	24.2	27.0	30.3	2.8	1.12
	RMS U1	21.1	25.0	25.4	3.8	1.18
	RMS X1	21.3	25.0	26.0	3.7	1.17
	SMC M4E-05	19.6	28.7	30.8	9.1	1.47
RD	RMS F1	35.1	41.1	51.0	6.0	1.17
	RMS M1	36.7	34.2	46.0	-2.5	0.93
	SMC M4E-01	21.9	35.3	45.8	13.5	1.62
	SMC M4E-02	24.7	35.8	46.0	11.1	1.45
	SMC M4E-03	29.2	33.6	40.4	4.3	1.15
	SMC M4E-04	19.6	28.7	30.8	9.1	1.47

*BG = background, RD = road

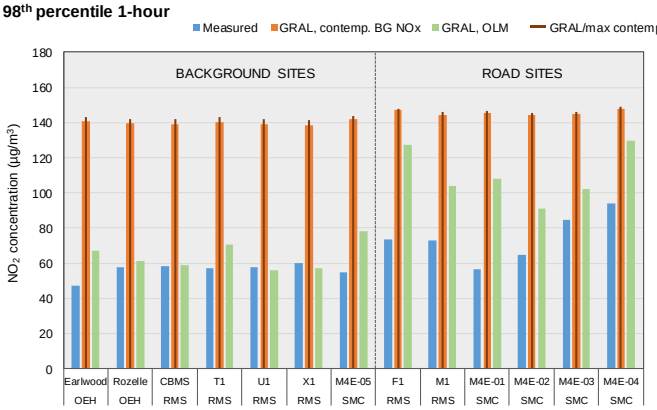
Maximum 1-hour



Site type*	Site	Concentration (µg/m3) Measured	Predicted (contemp.)	Predicted (OLM)	Pred. (contemp.) - meas. (µg/m^3)	Pred. (map) / meas.
BG	OEH Earlwood	108.8	152.8	215.3	44.1	1.41
	OEH Rozelle	102.6	148.5	141.5	45.9	1.45
	RMS CBMS	91.7	148.9	123.0	57.2	1.62
	RMS T1	102.7	152.0	203.5	49.3	1.48
	RMS U1	81.5	149.6	131.6	68.2	1.84
	RMS X1	102.0	151.1	150.3	49.1	1.48
	SMC M4E-05	93.5	152.1	186.1	58.6	1.63
RD	RMS F1	123.2	172.4	305.0	49.2	1.40
	RMS M1	112.1	152.2	181.9	40.1	1.36
	SMC M4E-01	104.3	155.2	256.1	50.9	1.49
	SMC M4E-02	126.2	188.8	333.7	62.6	1.50
	SMC M4E-03	141.2	177.8	316.0	36.7	1.26
	SMC M4E-04	153.8	221.2	378.8	67.4	1.44

*BG = background, RD = road

98th percentile 1-hour



Site type*	Site	Concentration (µg/m3) Measured	Predicted (contemp.)	Predicted (OLM)	Pred. (contemp.) - meas. (µg/m^3)	Pred. (map) / meas.
BG	OEH Earlwood	47.2	140.8	66.9	93.6	2.98
	OEH Rozelle	57.5	139.5	61.0	82.0	2.43
	RMS CBMS	58.0	139.2	58.6	81.2	2.40
	RMS T1	56.8	140.4	70.8	83.6	2.47
	RMS U1	57.5	138.9	56.0	81.4	2.42
	RMS X1	59.7	138.3	57.2	78.6	2.32
	SMC M4E-05	54.9	142.0	78.0	87.1	2.59
RD	RMS F1	73.4	147.2	127.2	73.8	2.01
	RMS M1	73.1	144.5	104.2	71.4	1.98
	SMC M4E-01	56.6	145.6	108.1	88.9	2.57
	SMC M4E-02	64.9	144.0	91.0	79.1	2.22
	SMC M4E-03	84.5	145.1	102.2	60.6	1.72
	SMC M4E-04	94.2	147.9	129.8	53.7	1.57

*BG = background, RD = road

Figure J-11 Comparison between measured and predicted total NO_2 concentrations

J.1.3 Results for CO

Figure J-12 and Figure J-13 show examples of the 1-hour mean CO concentrations predicted by GRAL for the Rozelle and F1 stations. The GRAL predictions include the background contribution. The GRAL concentration was, however, generally much lower than the measured background. The measured background at Rozelle also had a slight offset on the y-axis, indicating that there is a degree of uncertainty in the measured data. However, this would not have had a large impact on the results of the evaluation. At the RMS F1 station there was a larger contribution from GRAL than at Rozelle, although the difference was not great.

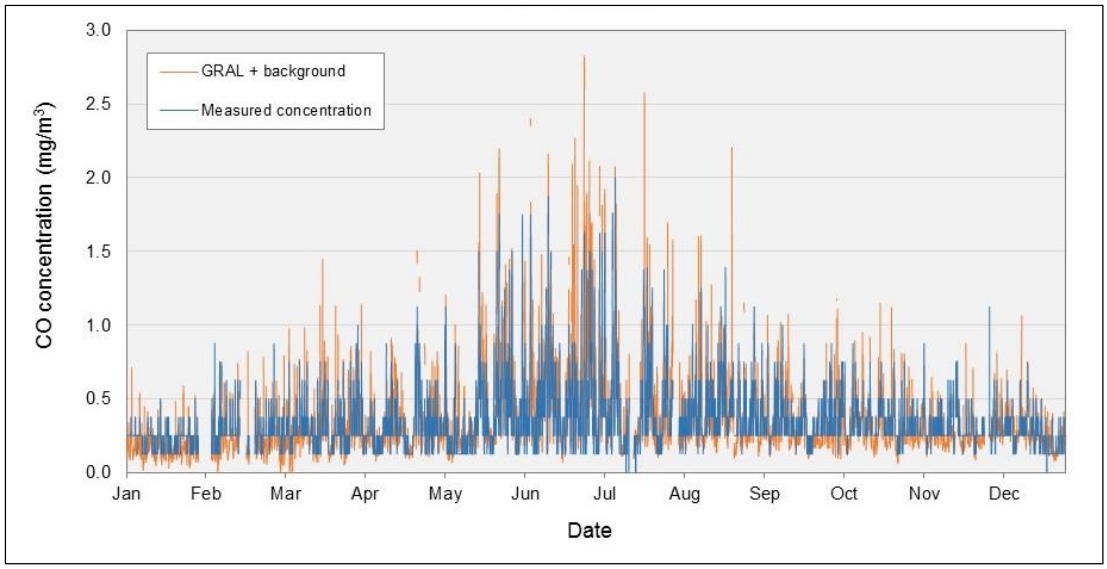


Figure J-12 **Measured 1-hour mean CO concentrations and GRAL predictions (including background) for the OEH Rozelle background monitoring station**

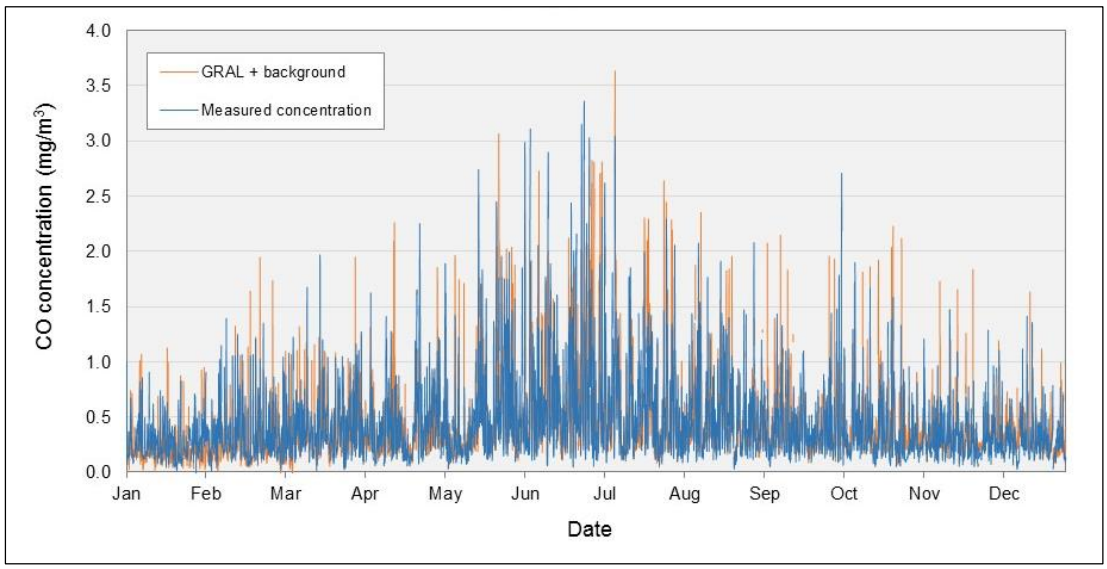


Figure J-13 **Measured 1-hour mean CO concentrations and GRAL predictions (including background) for the RMS F1 monitoring station**

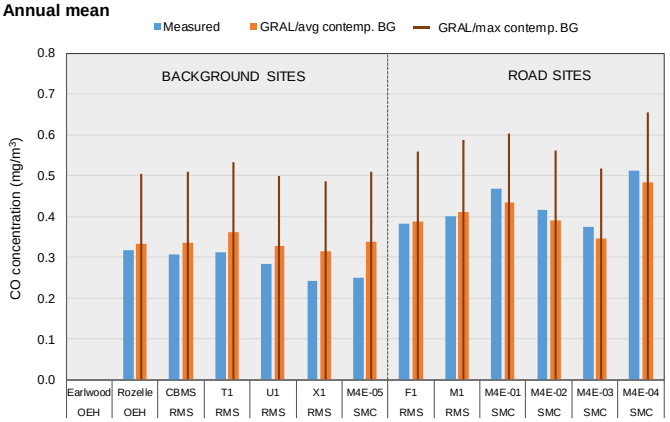
The statistics for the measured and predicted total CO concentrations are compared in Figure J-14. For the Earlwood background station data were only available for a limited period, and therefore the results are not shown. Again, the predictions include both the GRAL contribution and the estimated background contribution. The two contributions were combined using a contemporaneous approach, whereby the GRAL contribution was added to the corresponding contribution from the (average or maximum) synthetic background profile for each hour of the year.

For annual mean concentrations the predictions based on the average synthetic profile generally showed a good agreement with the measurements, especially at the road stations. At these locations the predictions were within 7 per cent of the measurements. When the maximum synthetic background profile was used – as in the M4-M5 Link assessment – the predictions were considerably higher.

As with NO_X, the results for the maximum and 98th percentile concentrations were more variable. Nevertheless, the model predictions were good at some stations.

In Figure J-15 the background and GRAL contributions to the annual mean CO concentration are shown separately. The background here is simply an average for the synthetic CO profile. Even at the road stations the background contributed between 60 per cent and 80 per cent of the total CO concentration.

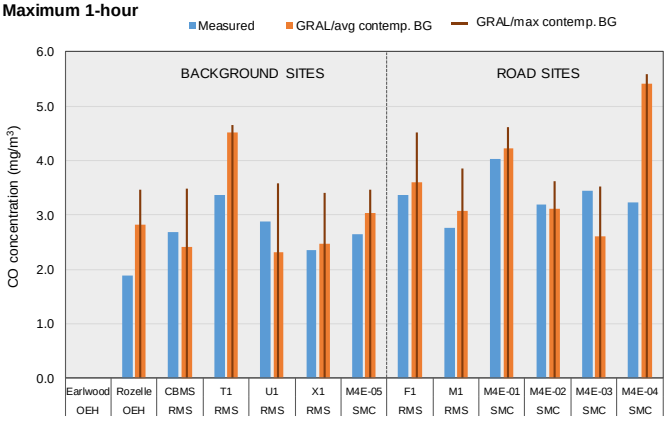
Annual mean



Site type*	Site	Concentration (mg/m^3) Measured	Concentration (mg/m^3) Predicted (contemp)	Pred. - meas. (mg/m^3)	Pred. / meas.
BG	OEH Earlwood	N/A	N/A	N/A	N/A
	OEH Rozelle	0.32	0.33	0.02	1.05
	RMS CBMS	0.31	0.34	0.03	1.10
	RMS T1	0.31	0.36	0.05	1.16
	RMS U1	0.28	0.33	0.04	1.16
	RMS X1	0.24	0.31	0.07	1.29
	SMC M4E-05	0.25	0.34	0.09	1.35
RD	RMS F1	0.38	0.39	0.01	1.01
	RMS M1	0.40	0.41	0.01	1.03
	SMC M4E-01	0.47	0.43	-0.04	0.93
	SMC M4E-02	0.42	0.39	-0.03	0.93
	SMC M4E-03	0.38	0.35	-0.03	0.92
	SMC M4E-04	0.51	0.48	-0.03	0.95

*BG = background, RD = road

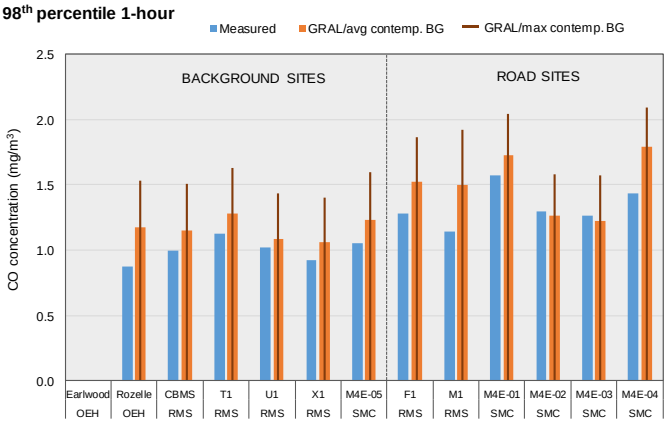
Maximum 1-hour



Site type*	Site	Concentration (mg/m^3) Measured	Concentration (mg/m^3) Predicted (contemp)	Pred. - meas. (mg/m^3)	Pred. / meas.
BG	OEH Earlwood	N/A	N/A	N/A	N/A
	OEH Rozelle	1.9	2.8	1.0	1.51
	RMS CBMS	2.7	2.4	-0.3	0.90
	RMS T1	3.4	4.5	1.1	1.34
	RMS U1	2.9	2.3	-0.6	0.80
	RMS X1	2.3	2.5	0.1	1.05
	SMC M4E-05	2.6	3.0	0.4	1.15
RD	RMS F1	3.4	3.6	0.2	1.07
	RMS M1	2.8	3.1	0.3	1.11
	SMC M4E-01	4.0	4.2	0.2	1.05
	SMC M4E-02	3.2	3.1	-0.1	0.97
	SMC M4E-03	3.4	2.6	-0.8	0.76
	SMC M4E-04	3.2	5.4	2.2	1.68

*BG = background, RD = road

98th percentile 1-hour



Site type*	Site	Concentration (mg/m^3) Measured	Concentration (mg/m^3) Predicted (contemp)	Pred. - meas. (mg/m^3)	Pred. / meas.
BG	OEH Earlwood	N/A	N/A	N/A	N/A
	OEH Rozelle	0.9	1.2	0.3	1.34
	RMS CBMS	1.0	1.1	0.1	1.15
	RMS T1	1.1	1.3	0.2	1.13
	RMS U1	1.0	1.1	0.1	1.07
	RMS X1	0.9	1.1	0.1	1.15
	SMC M4E-05	1.0	1.2	0.2	1.18
RD	RMS F1	1.3	1.5	0.2	1.19
	RMS M1	1.1	1.5	0.4	1.32
	SMC M4E-01	1.6	1.7	0.2	1.10
	SMC M4E-02	1.3	1.3	0.0	0.97
	SMC M4E-03	1.3	1.2	0.0	0.97
	SMC M4E-04	1.4	1.8	0.4	1.25

*BG = background, RD = road

Figure J-14 Comparison between measured and predicted total CO concentrations

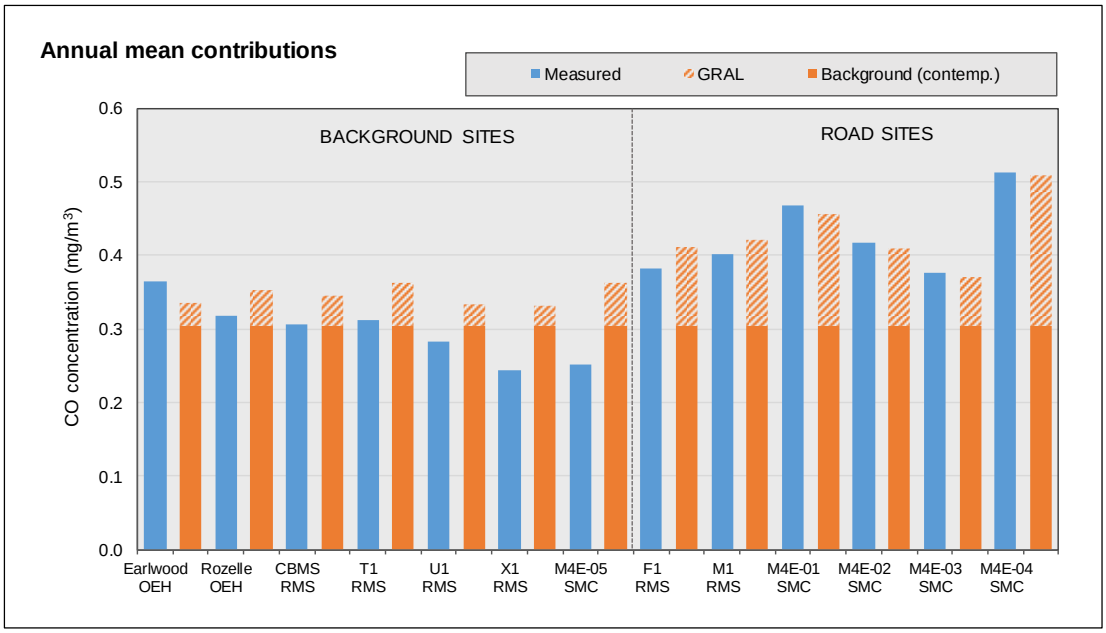


Figure J-15 Contributions to modelled annual mean CO concentrations

J.1.4 Results for PM_{10}

Figure J-16 compares the measured 24-hour mean PM_{10} concentrations with those predicted by GRAL for the Rozelle background station, and Figure J-17 shows the results for the RMS F1 station. Unsurprisingly there was a good agreement at Rozelle, but at the F1 station there was an over-prediction that was most pronounced in winter months.

The summary plots and statistics for the PM_{10} comparisons at all stations are provided in Figure J-18. As with NO_X, calculations based on the contemporaneous background approaches are also included for comparison with the mapped background approach. The average contemporaneous approach gave similar predictions to the mapping approach at all stations.

In Figure J-19 the background and GRAL contributions to the annual mean PM_{10} concentration are shown separately. The importance of the background is clear; at the background stations the background contribution was around 90-95 per cent of the total, and at the road stations it was around 75-85 per cent. At the background stations, the predicted concentrations effectively therefore represented the combination of the values from the monitoring stations and a small GRAL contribution, so it is not surprising that they agree well with the measurements (i.e. the measured and predicted values are hardly independent). At the road stations the there was a larger contribution from GRAL than at the background stations, but the measured concentrations were similar to those at the background stations. The model therefore overestimated annual mean PM_{10} concentrations at the road stations by between 6 per cent and 45 per cent.

The maximum and 98th percentile 24-hour mean PM_{10} concentrations were not systematically overestimated when the average synthetic background profile was used, and in fact the agreement with measurements was quite good. This is again largely due to the high background contribution. However, the maximum synthetic profile, as used in the M4-M5 Link assessment, gave much higher values.

In general, the results suggest that the use of GRAL and the background mapping approach should give good (and slightly conservative) estimates of the annual PM_{10} concentration. The predictions for the maximum and 98th percentile concentrations are more conservative.

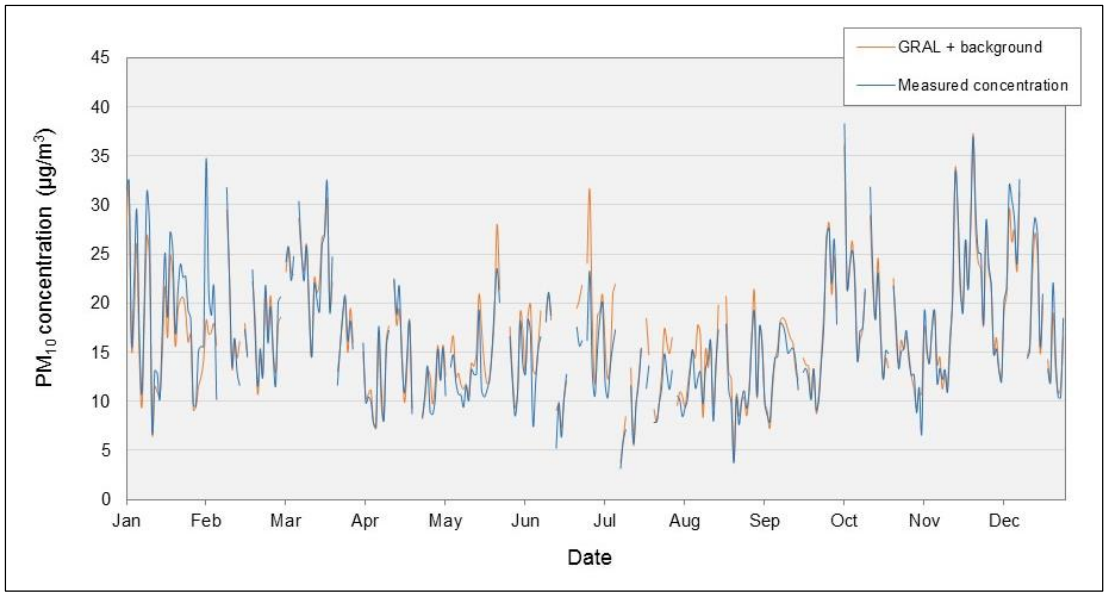


Figure J-16 **Measured 24-hour mean PM_{10} concentrations and GRAL predictions (including background) for the OEH Rozelle background monitoring station**

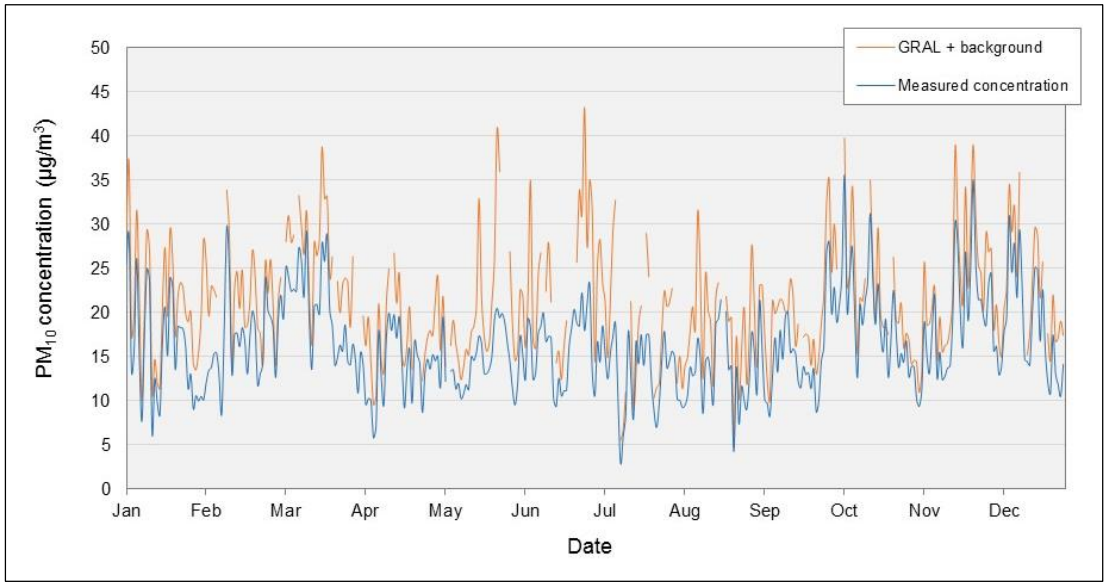
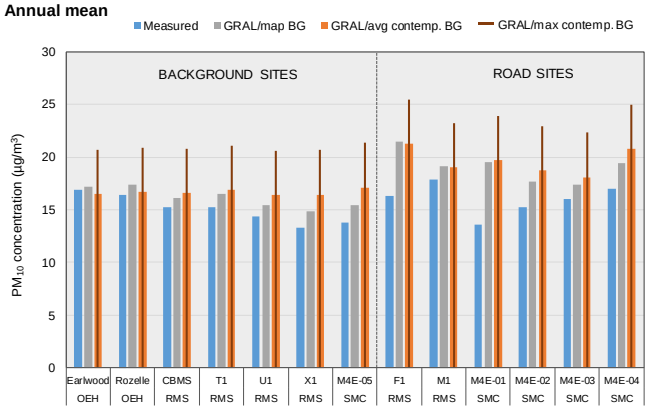


Figure J-17 **Measured 24-hour mean PM_{10} concentrations and GRAL predictions (including background) for the RMS F1 monitoring station**

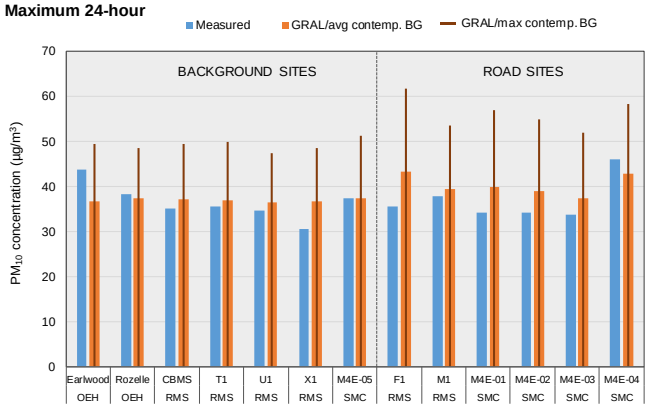
Annual mean



Site type*	Site	Concentration (µg/m^3)			Pred. (map) - meas. (µg/m^3)	Pred. / meas.
		Measured	Predicted (map)	Predicted (contemp)		
BG	OEH Earlwood	16.87	17.16	16.46	-0.41	0.98
	OEH Rozelle	16.44	17.41	16.66	0.22	1.01
	RMS CBMS	15.28	16.07	16.60	1.32	1.09
	RMS T1	15.20	16.55	16.86	1.66	1.11
	RMS U1	14.40	15.44	16.39	1.99	1.14
	RMS X1	13.32	14.81	16.41	3.08	1.23
	SMC M4E-05	13.82	15.47	17.13	3.31	1.24
RD	RMS F1	16.27	21.50	21.25	4.98	1.31
	RMS M1	17.89	19.14	19.03	1.14	1.06
	SMC M4E-01	13.62	19.50	19.70	6.07	1.45
	SMC M4E-02	15.23	17.64	18.72	3.49	1.23
	SMC M4E-03	16.03	17.42	18.09	2.06	1.13
	SMC M4E-04	17.00	19.43	20.77	3.77	1.22

*BG = background, RD = road

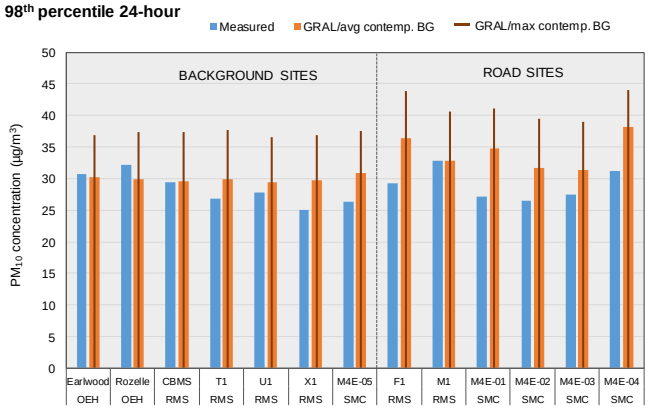
Maximum 24-hour



Site type*	Site	Concentration (µg/m^3)		Pred. - meas. (mg/m^3)	Pred. / meas.
		Measured	Predicted (contemp)		
BG	OEH Earlwood	43.7	36.6	-7.0	0.84
	OEH Rozelle	38.3	37.3	-1.0	0.97
	RMS CBMS	34.9	37.0	2.1	1.06
	RMS T1	35.5	36.8	1.3	1.04
	RMS U1	34.7	36.4	1.8	1.05
	RMS X1	30.5	36.7	6.2	1.20
	SMC M4E-05	37.3	37.4	0.1	1.00
RD	RMS F1	35.5	43.2	7.7	1.22
	RMS M1	37.7	39.3	1.6	1.04
	SMC M4E-01	34.1	39.8	5.8	1.17
	SMC M4E-02	34.2	38.9	4.7	1.14
	SMC M4E-03	33.6	37.4	3.8	1.11
	SMC M4E-04	46.0	42.9	-3.2	0.93

*BG = background, RD = road

98th percentile 24-hour



Site type*	Site	Concentration (µg/m^3)		Pred. - meas. (mg/m^3)	Pred. / meas.
		Measured	Predicted (contemp)		
BG	OEH Earlwood	30.7	30.2	-0.5	0.98
	OEH Rozelle	32.2	29.9	-2.2	0.93
	RMS CBMS	29.4	29.6	0.2	1.01
	RMS T1	26.9	30.0	3.1	1.12
	RMS U1	27.9	29.5	1.6	1.06
	RMS X1	25.0	29.8	4.8	1.19
	SMC M4E-05	26.3	30.9	4.6	1.17
RD	RMS F1	29.3	36.4	7.1	1.24
	RMS M1	32.7	32.8	0.0	1.00
	SMC M4E-01	27.1	34.7	7.6	1.28
	SMC M4E-02	26.5	31.7	5.1	1.19
	SMC M4E-03	27.5	31.4	4.0	1.14
	SMC M4E-04	31.2	38.2	6.9	1.22

*BG = background, RD = road

Figure J-18 Comparison between measured and predicted total PM_{10} concentrations

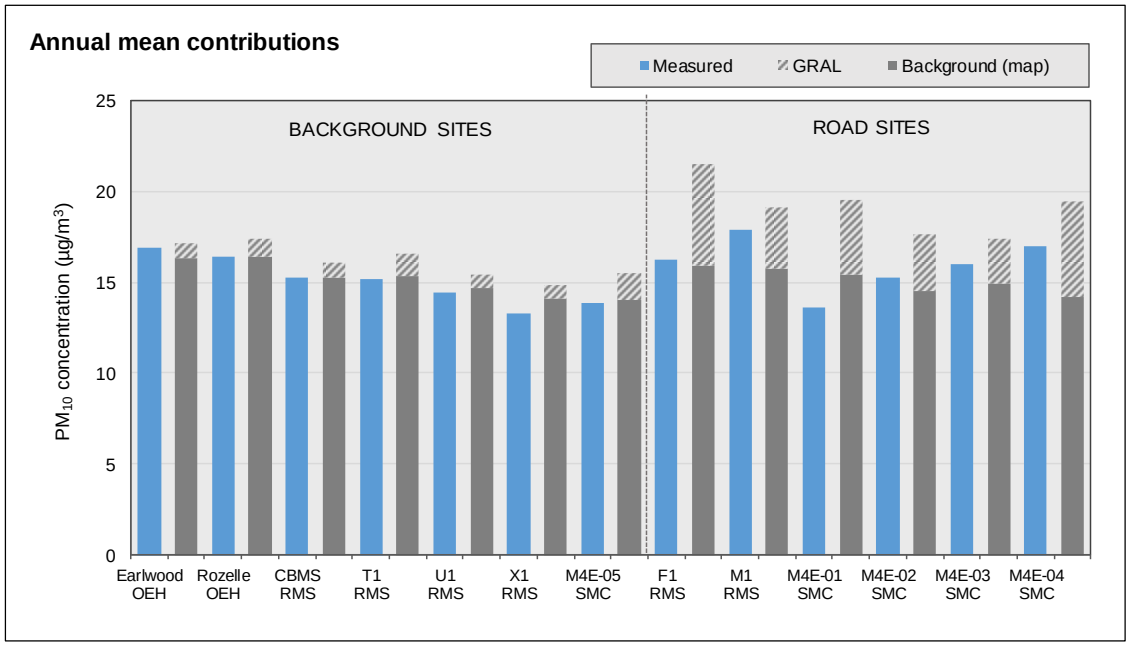


Figure J-19 Contributions to modelled annual mean PM_{10} concentrations

Annexure K - All results of dispersion modelling

This Annexure provides all results of the dispersion modelling for the **expected traffic** scenarios. The following notes apply:

- Data are not presented for the 2015-BY scenario, as this scenario was designed primarily for model evaluation.
- In the Tables any grey shading indicates where no value was obtained. For example, where the top ten increases in concentration are ranked, there may have been fewer than ten receptors that actually had an increase in concentration.
- In the contour plots for the full GRAL model domain, minor road tunnels are shown as surface roads. These include the Airport Tunnel on General Holmes Drive and the Cooks River Tunnel. These tunnels are located well away from sensitive receptors, and therefore this was not considered to be important.
- For short-term air quality criteria, such as the maximum 1-hour NO_2 concentrations, the contour plots should be viewed as indicative. This is a consequence of the difficulties associated with the prediction of short-term concentrations.

K.1 Carbon monoxide (maximum 1-hour mean)

Table K-1 Maximum 1-hour mean CO concentration at community receptors

Receptor	Maximum 1-hour CO concentration (mg/m^3)							Change relative to Do Minimum (mg/m^3)				Change relative to Do Minimum (%)			
	2015-BY	2023-DM	2023-DS	2023-DSC	2033-DM	2033-DS	2033-DSC	2023-DS	2023-DSC	2033-DS	2033-DSC	2023-DS	2023-DSC	2033-DS	2033-DSC
CR01	-	3.39	3.48	3.39	3.41	3.38	3.38	0.08	-0.01	-0.04	-0.03	2.4%	-0.2%	-1.0%	-1.0%
CR02	-	3.37	3.37	3.37	3.37	3.37	3.37	0.00	0.00	0.00	0.00	0.0%	0.0%	0.0%	0.0%
CR03	-	3.51	3.61	3.56	3.45	3.51	3.40	0.10	0.05	0.06	-0.05	2.8%	1.4%	1.8%	-1.4%
CR04	-	3.54	3.53	3.56	3.52	3.42	3.45	-0.01	0.02	-0.10	-0.07	-0.4%	0.5%	-2.8%	-1.9%
CR05	-	3.39	3.40	3.39	3.41	3.39	3.40	0.01	-0.01	-0.02	-0.01	0.2%	-0.2%	-0.5%	-0.3%
CR06	-	3.39	3.43	3.52	3.39	3.40	3.44	0.04	0.13	0.02	0.05	1.3%	3.8%	0.5%	1.4%
CR07	-	3.53	3.57	3.59	3.63	3.44	3.48	0.04	0.06	-0.19	-0.15	1.1%	1.7%	-5.2%	-4.1%
CR08	-	3.42	3.47	3.54	3.39	3.40	3.37	0.04	0.11	0.01	-0.02	1.2%	3.2%	0.3%	-0.5%
CR09	-	3.45	3.43	3.47	3.38	3.39	3.38	-0.02	0.02	0.01	0.00	-0.5%	0.5%	0.4%	0.1%
CR10	-	3.88	3.69	4.12	3.73	3.73	3.66	-0.19	0.24	0.00	-0.07	-4.8%	6.3%	0.0%	-1.9%
CR11	-	3.42	3.42	3.44	3.42	3.42	3.49	0.00	0.02	0.00	0.07	-0.1%	0.4%	0.0%	2.1%
CR12	-	4.12	3.42	3.86	3.39	3.84	3.44	-0.70	-0.25	0.44	0.05	-16.9%	-6.2%	13.1%	1.5%
CR13	-	3.40	3.40	3.45	3.39	3.37	3.39	0.00	0.05	-0.02	0.00	0.0%	1.5%	-0.6%	0.0%
CR14	-	3.48	3.42	3.41	3.40	3.42	3.43	-0.05	-0.07	0.02	0.03	-1.5%	-2.0%	0.6%	0.8%
CR15	-	3.42	3.37	3.37	3.40	3.41	3.41	-0.05	-0.05	0.01	0.01	-1.4%	-1.4%	0.3%	0.1%
CR16	-	3.48	3.43	3.40	3.41	3.50	3.39	-0.05	-0.09	0.09	-0.02	-1.4%	-2.5%	2.5%	-0.6%
CR17	-	3.43	3.49	3.39	3.38	3.38	3.39	0.06	-0.04	0.00	0.01	1.8%	-1.2%	0.0%	0.3%
CR18	-	3.38	3.38	3.37	3.37	3.39	3.39	0.00	-0.01	0.02	0.02	0.0%	-0.3%	0.6%	0.6%
CR19	-	3.39	3.42	3.44	3.38	3.40	3.43	0.03	0.05	0.02	0.05	0.8%	1.5%	0.6%	1.5%
CR20	-	3.46	3.46	3.50	3.43	3.39	3.42	0.00	0.04	-0.04	-0.01	0.1%	1.1%	-1.2%	-0.4%
CR21	-	3.50	3.45	3.42	3.45	3.40	3.39	-0.05	-0.08	-0.05	-0.07	-1.5%	-2.3%	-1.5%	-1.9%
CR22	-	3.39	3.42	3.37	3.40	3.40	3.37	0.03	-0.02	0.00	-0.02	0.8%	-0.6%	0.1%	-0.7%
CR23	-	3.38	3.48	3.37	3.40	3.38	3.37	0.10	-0.01	-0.02	-0.03	3.0%	-0.3%	-0.7%	-0.9%
CR24	-	3.53	3.49	3.46	3.46	3.39	3.47	-0.04	-0.07	-0.07	0.01	-1.1%	-1.9%	-2.0%	0.3%
CR25	-	3.40	3.46	3.44	3.49	3.41	3.39	0.06	0.03	-0.08	-0.10	1.8%	1.0%	-2.2%	-2.8%
CR26	-	3.39	3.39	3.45	3.40	3.45	3.41	0.00	0.06	0.04	0.01	0.1%	1.8%	1.3%	0.2%
CR27	-	3.53	3.49	3.44	3.43	3.43	3.41	-0.05	-0.10	0.00	-0.02	-1.3%	-2.7%	0.1%	-0.5%
CR28	-	3.40	3.41	3.38	3.38	3.40	3.38	0.01	-0.01	0.02	0.00	0.3%	-0.4%	0.7%	0.0%
CR29	-	3.42	3.40	3.40	3.40	3.40	3.39	-0.02	-0.02	0.00	-0.01	-0.5%	-0.4%	0.1%	-0.3%
CR30	-	3.73	3.46	3.48	3.44	3.44	3.46	-0.27	-0.25	0.00	0.02	-7.2%	-6.7%	0.0%	0.6%
CR31	-	3.44	3.41	3.53	3.39	3.42	3.37	-0.03	0.09	0.03	-0.02	-0.9%	2.6%	0.8%	-0.5%
CR32	-	3.42	3.43	3.46	3.45	3.42	3.40	0.01	0.04	-0.03	-0.05	0.3%	1.1%	-0.8%	-1.4%
CR33	-	3.37	3.41	3.37	3.44	3.39	3.37	0.04	0.00	-0.05	-0.07	1.1%	0.0%	-1.4%	-2.0%
CR34	-	3.46	3.47	3.41	3.39	3.45	3.41	0.00	-0.06	0.06	0.02	0.1%	-1.6%	1.9%	0.7%
CR35	-	3.37	3.43	3.45	3.39	3.39	3.43	0.06	0.08	0.00	0.04	1.8%	2.3%	0.0%	1.1%
CR36	-	3.38	3.41	3.47	3.45	3.39	3.41	0.03	0.09	-0.06	-0.04	0.9%	2.7%	-1.7%	-1.1%
CR37	-	3.42	3.45	3.41	3.44	3.55	3.42	0.04	-0.01	0.11	-0.02	1.1%	-0.3%	3.2%	-0.5%
CR38	-	3.43	3.53	3.46	3.45	3.42	3.46	0.10	0.03	-0.03	0.00	2.9%	0.9%	-0.9%	0.1%
CR39	-	3.47	3.48	3.59	3.42	3.59	3.38	0.01	0.12	0.17	-0.05	0.2%	3.4%	4.8%	-1.3%
CR40	-	3.48	3.46	3.44	3.38	3.45	3.45	-0.02	-0.04	0.08	0.07	-0.5%	-1.1%	2.2%	2.1%

Table K-2 Maximum 1-hour mean CO concentration at community receptors, ranked by concentration

Rank	Ranking by concentration (mg/m^3)						
	2015-BY	2023-DM	2023 DS	2023 DSC	2033-DM	2033-DS	2033-DSC
1	-	4.12	3.69	4.12	3.73	3.84	3.66
2	-	3.88	3.61	3.86	3.63	3.73	3.49
3	-	3.73	3.57	3.59	3.52	3.59	3.48
4	-	3.54	3.53	3.59	3.49	3.55	3.47
5	-	3.53	3.53	3.56	3.46	3.51	3.46
6	-	3.53	3.49	3.56	3.45	3.50	3.46
7	-	3.53	3.49	3.54	3.45	3.45	3.45
8	-	3.51	3.49	3.53	3.45	3.45	3.45
9	-	3.50	3.48	3.52	3.45	3.45	3.44
10	-	3.48	3.48	3.50	3.45	3.44	3.44

Table K-3 Maximum 1-hour mean CO concentration at community receptors, ranked by increase and by decrease in concentration

Rank	Ranking by increase in concentration relative to Do Minimum (mg/m^3)				Ranking by decrease in concentration relative to Do Minimum (mg/m^3)			
	2023-DS	2023-DSC	2033-DS	2033-DSC	2023-DS	2023-DSC	2033-DS	2033-DSC
1	0.10	0.24	0.44	0.07	-0.70	-0.25	-0.19	-0.15
2	0.10	0.13	0.17	0.07	-0.27	-0.25	-0.10	-0.10
3	0.10	0.12	0.11	0.05	-0.19	-0.10	-0.08	-0.07
4	0.08	0.11	0.09	0.05	-0.05	-0.09	-0.07	-0.07
5	0.06	0.09	0.08	0.05	-0.05	-0.08	-0.06	-0.07
6	0.06	0.09	0.06	0.04	-0.05	-0.07	-0.05	-0.07
7	0.06	0.08	0.06	0.03	-0.05	-0.07	-0.05	-0.05
8	0.04	0.06	0.04	0.02	-0.05	-0.06	-0.04	-0.05
9	0.04	0.06	0.03	0.02	-0.04	-0.05	-0.04	-0.05
10	0.04	0.05	0.02	0.02	-0.03	-0.04	-0.03	-0.04

Table K-4 Maximum 1-hour mean CO concentration at community receptors, ranked by percentage increase and by decrease in concentration

Rank	Ranking by % increase in concentration relative to Do Minimum				Ranking by % decrease in concentration relative to Do Minimum			
	2023-DS	2023-DSC	2033-DS	2033-DSC	2023-DS	2023-DSC	2033-DS	2033-DSC
1	3.0%	6.3%	13.1%	2.1%	-16.9%	-6.7%	-5.2%	-4.1%
2	2.9%	3.8%	4.8%	2.1%	-7.2%	-6.2%	-2.8%	-2.8%
3	2.8%	3.4%	3.2%	1.5%	-4.8%	-2.7%	-2.2%	-2.0%
4	2.4%	3.2%	2.5%	1.5%	-1.5%	-2.5%	-2.0%	-1.9%
5	1.8%	2.7%	2.2%	1.4%	-1.5%	-2.3%	-1.7%	-1.9%
6	1.8%	2.6%	1.9%	1.1%	-1.4%	-2.0%	-1.5%	-1.9%
7	1.8%	2.3%	1.8%	0.8%	-1.4%	-1.9%	-1.4%	-1.4%
8	1.3%	1.8%	1.3%	0.7%	-1.3%	-1.6%	-1.2%	-1.4%
9	1.2%	1.7%	0.8%	0.6%	-1.1%	-1.4%	-1.0%	-1.3%
10	1.1%	1.5%	0.7%	0.6%	-0.9%	-1.2%	-0.9%	-1.1%

Table K-5 Maximum 1-hour mean CO concentration at RWR receptors, ranked by concentration

Rank	Ranking by concentration (mg/m^3)						
	2015-BY	2023-DM	2023 DS	2023 DSC	2033-DM	2033-DS	2033-DSC
1	-	7.8	7.7	7.4	6.4	6.9	6.0
2	-	7.7	7.1	7.3	6.3	6.5	5.9
3	-	7.6	7.1	7.2	6.3	6.3	5.9
4	-	7.5	7.1	7.2	6.2	6.3	5.8
5	-	7.5	7.0	7.1	6.2	6.2	5.7
6	-	7.5	7.0	6.9	6.2	6.2	5.7
7	-	7.4	7.0	6.8	6.1	6.2	5.6
8	-	7.3	6.9	6.8	6.1	6.1	5.6
9	-	7.2	6.9	6.8	6.1	6.0	5.6
10	-	7.2	6.9	6.7	6.1	6.0	5.6

Table K-6 Maximum 1-hour mean CO concentration at RWR receptors, ranked by increase and by decrease in concentration

Rank	Ranking by increase in concentration relative to Do Minimum (mg/m^3)				Ranking by decrease in concentration relative to Do Minimum (mg/m^3)			
	2023-DS	2023-DSC	2033-DS	2033-DSC	2023-DS	2023-DSC	2033-DS	2033-DSC
1	1.6	1.5	1.6	1.0	-2.1	-1.9	-1.3	-1.2
2	1.3	1.4	1.4	0.9	-2.1	-1.9	-1.2	-1.1
3	1.2	1.3	1.4	0.9	-2.0	-1.8	-1.1	-1.1
4	1.2	1.3	1.3	0.9	-1.6	-1.7	-1.1	-1.1
5	1.0	1.2	1.1	0.9	-1.5	-1.5	-1.1	-1.1
6	1.0	1.2	1.1	0.8	-1.5	-1.5	-1.1	-1.1
7	1.0	1.2	1.1	0.7	-1.5	-1.5	-1.0	-1.0
8	1.0	1.2	1.0	0.7	-1.4	-1.5	-1.0	-1.0
9	1.0	1.1	1.0	0.7	-1.4	-1.5	-1.0	-1.0
10	1.0	1.1	0.9	0.7	-1.4	-1.5	-0.9	-0.9

Table K-7 Maximum 1-hour mean CO concentration at RWR receptors, ranked by percentage increase and by decrease in concentration

Rank	Ranking by % increase in concentration relative to Do Minimum				Ranking by % decrease in concentration relative to Do Minimum			
	2023-DS	2023-DSC	2033-DS	2033-DSC	2023-DS	2023-DSC	2033-DS	2033-DSC
1	31.7%	32.1%	32.4%	21.0%	-28.8%	-27.2%	-21.8%	-21.4%
2	24.7%	27.9%	30.2%	20.9%	-28.5%	-26.8%	-21.3%	-19.9%
3	23.8%	27.7%	29.1%	20.0%	-27.3%	-25.7%	-21.3%	-19.8%
4	23.3%	25.8%	26.5%	18.6%	-27.0%	-24.8%	-20.1%	-19.7%
5	22.2%	25.7%	23.7%	17.7%	-25.2%	-24.7%	-19.5%	-18.6%
6	21.9%	25.2%	22.7%	17.7%	-25.1%	-24.5%	-18.1%	-18.6%
7	21.7%	24.2%	22.7%	17.0%	-23.0%	-24.1%	-17.6%	-18.5%
8	21.2%	24.2%	21.4%	17.0%	-22.8%	-23.4%	-17.2%	-18.4%
9	21.1%	23.9%	21.0%	16.7%	-22.4%	-23.2%	-17.1%	-17.5%
10	21.0%	23.4%	20.1%	16.3%	-22.3%	-22.5%	-17.1%	-17.1%

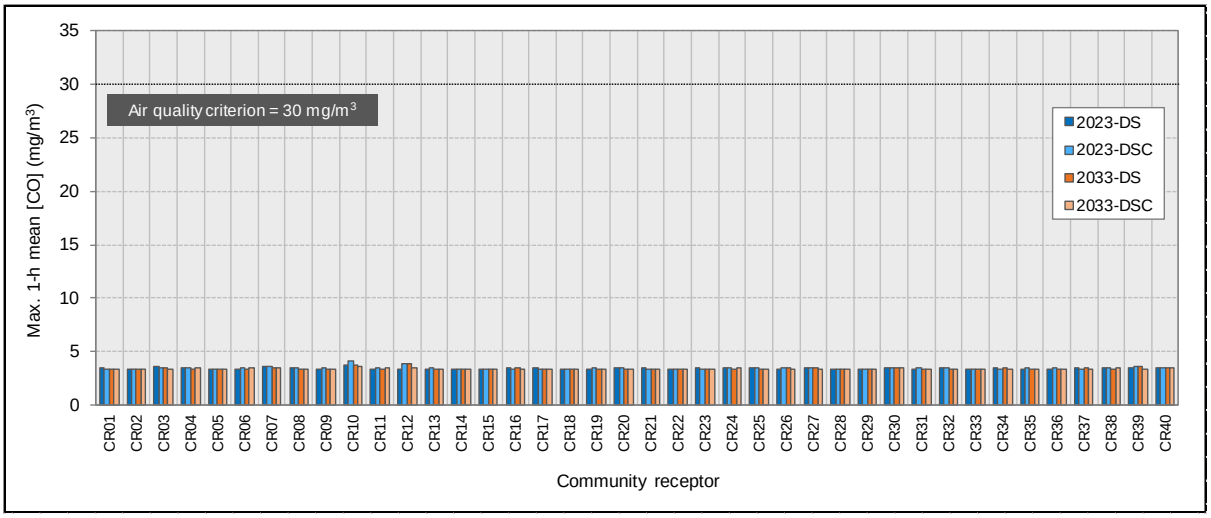


Figure K-1 **Maximum 1-hour mean CO concentration at community receptors (with-project and cumulative scenarios)**

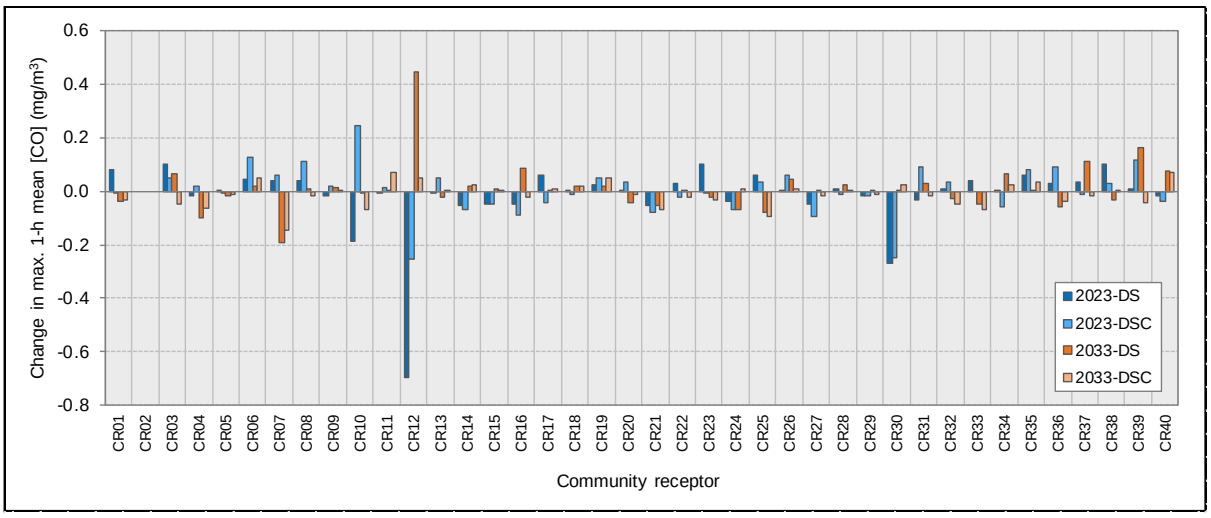


Figure K-2 **Change in maximum 1-hour mean CO concentration at community receptors (with-project and cumulative scenarios, relative to Do Minimum scenarios)**

Figure K-3 **Source contributions to maximum 1-hour mean CO concentration at community receptors (with-project and cumulative scenarios)**

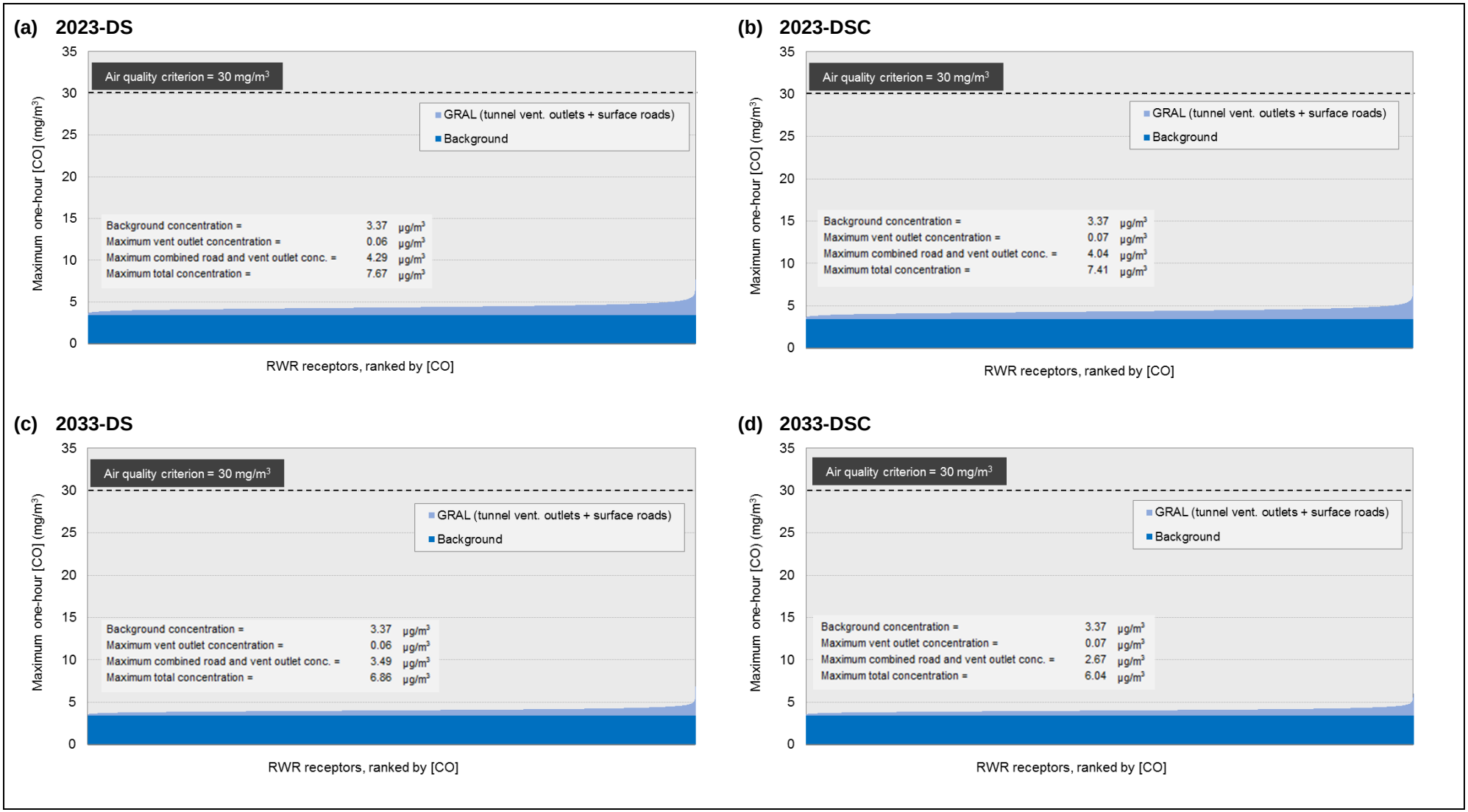


Figure K-4 Source contributions to maximum 1-hour CO concentration at RWR receptors (with-project and cumulative scenarios)

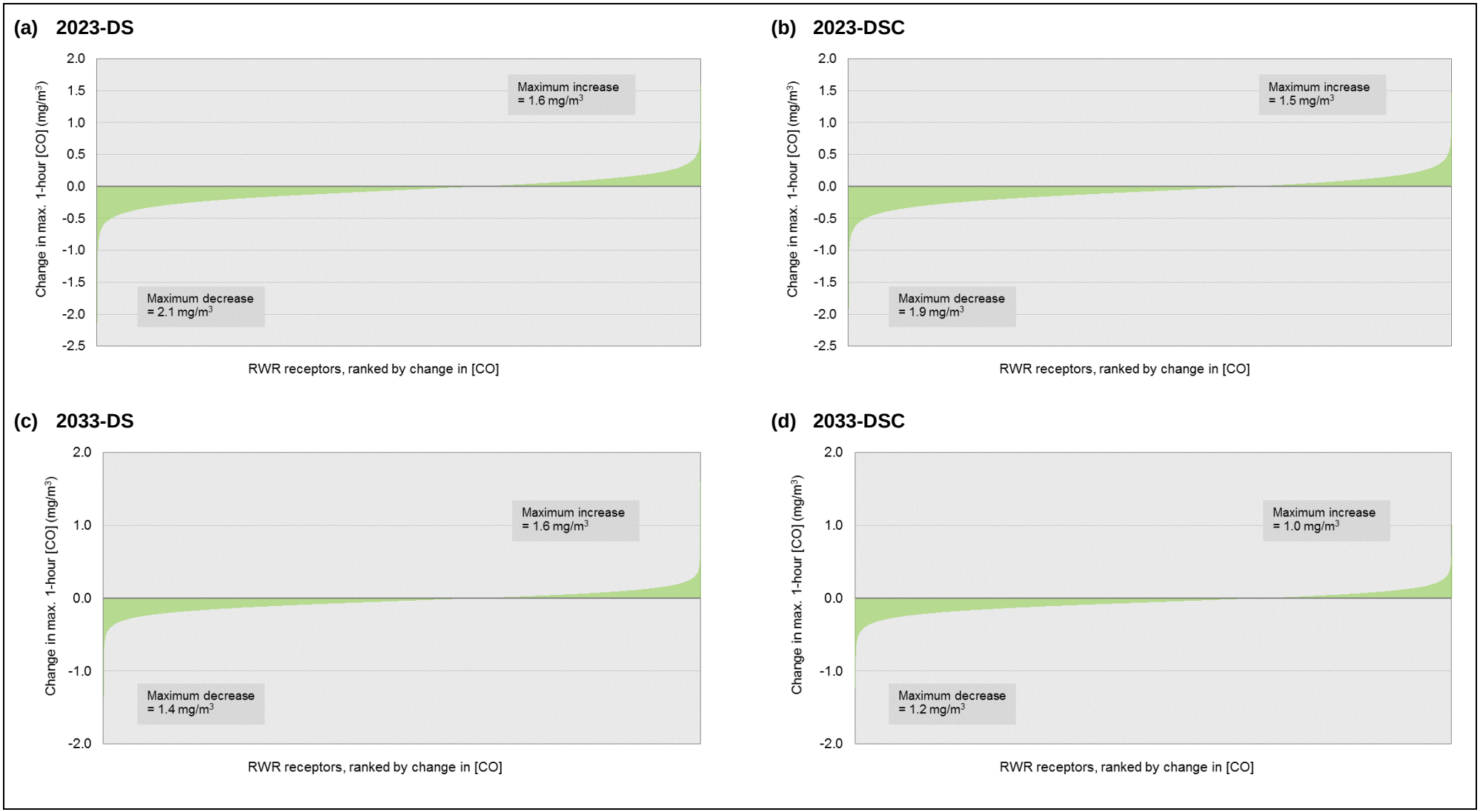


Figure K-5 Change in maximum 1-hour CO concentration at RWR receptors (with-project and cumulative scenarios, relative to Do Minimum scenarios)

K.2 Carbon monoxide (maximum rolling 8-hour mean)

Table K-8 Maximum rolling 8-hour mean CO concentration at community receptors

Receptor	Maximum rolling 8-hour CO concentration (mg/m^3)							Change relative to Do Minimum (mg/m^3)				Change relative to Do Minimum (%)			
	2015-BY	2023-DM	2023-DS	2023-DSC	2033-DM	2033-DS	2033-DSC	2023-DS	2023-DSC	2033-DS	2033-DSC	2023-DS	2023-DSC	2033-DS	2033-DSC
CR01	-	2.34	2.75	2.30	2.31	2.30	2.28	0.40	-0.05	-0.01	-0.02	17.3%	-1.9%	-0.3%	-0.9%
CR02	-	2.46	2.32	2.34	2.30	2.31	2.36	-0.14	-0.12	0.01	0.06	-5.7%	-4.8%	0.5%	2.7%
CR03	-	2.43	2.44	2.30	2.47	2.30	2.29	0.01	-0.13	-0.17	-0.18	0.5%	-5.5%	-6.8%	-7.1%
CR04	-	2.55	2.29	2.52	2.48	2.31	2.31	-0.26	-0.03	-0.16	-0.16	-10.3%	-1.2%	-6.6%	-6.5%
CR05	-	2.57	2.27	2.28	2.28	2.28	2.46	-0.30	-0.29	0.00	0.18	-11.6%	-11.2%	0.1%	7.7%
CR06	-	2.52	2.41	2.50	2.35	2.33	2.35	-0.11	-0.02	-0.02	0.00	-4.2%	-0.8%	-0.9%	0.1%
CR07	-	2.88	2.91	2.50	2.70	2.45	2.38	0.03	-0.38	-0.25	-0.32	1.0%	-13.2%	-9.4%	-12.0%
CR08	-	2.47	2.39	2.62	2.40	2.35	2.47	-0.08	0.15	-0.05	0.08	-3.1%	6.2%	-2.0%	3.2%
CR09	-	2.40	2.29	2.29	2.32	2.28	2.30	-0.11	-0.11	-0.04	-0.02	-4.5%	-4.6%	-1.7%	-0.9%
CR10	-	2.66	2.56	2.67	2.53	2.61	2.65	-0.09	0.01	0.08	0.12	-3.5%	0.3%	3.2%	4.8%
CR11	-	2.43	2.31	2.52	2.33	2.55	2.32	-0.11	0.10	0.22	-0.01	-4.6%	4.0%	9.6%	-0.5%
CR12	-	2.82	2.61	2.70	2.49	3.08	2.75	-0.20	-0.11	0.60	0.26	-7.2%	-4.1%	24.0%	10.5%
CR13	-	2.29	2.40	2.53	2.28	2.31	2.31	0.12	0.24	0.03	0.03	5.0%	10.6%	1.2%	1.2%
CR14	-	2.37	2.65	2.33	2.35	2.41	2.44	0.28	-0.04	0.06	0.09	11.9%	-1.8%	2.8%	4.0%
CR15	-	2.44	2.40	2.48	2.30	2.32	2.32	-0.04	0.04	0.01	0.02	-1.7%	1.5%	0.6%	0.7%
CR16	-	2.44	2.32	2.44	2.47	2.40	2.34	-0.12	0.00	-0.07	-0.12	-5.1%	0.1%	-2.8%	-5.0%
CR17	-	2.36	2.27	2.33	2.34	2.28	2.34	-0.09	-0.02	-0.06	0.00	-3.8%	-1.0%	-2.4%	-0.2%
CR18	-	2.38	2.31	2.36	2.34	2.32	2.28	-0.07	-0.01	-0.02	-0.06	-2.9%	-0.6%	-0.6%	-2.4%
CR19	-	2.38	2.29	2.29	2.32	2.34	2.31	-0.10	-0.09	0.02	-0.01	-4.0%	-3.9%	0.9%	-0.3%
CR20	-	2.35	2.36	2.35	2.35	2.31	2.32	0.00	0.00	-0.04	-0.03	0.2%	-0.2%	-1.7%	-1.5%
CR21	-	2.40	2.39	2.40	2.29	2.36	2.43	-0.01	0.00	0.08	0.15	-0.6%	-0.2%	3.4%	6.4%
CR22	-	2.73	2.51	2.33	2.56	2.30	2.47	-0.23	-0.40	-0.26	-0.09	-8.3%	-14.7%	-10.2%	-3.7%
CR23	-	2.64	2.42	2.37	2.49	2.43	2.36	-0.21	-0.26	-0.07	-0.13	-8.1%	-10.0%	-2.7%	-5.4%
CR24	-	2.54	2.40	2.58	2.36	2.40	2.36	-0.14	0.04	0.04	0.00	-5.5%	1.4%	1.6%	-0.1%
CR25	-	2.44	2.48	2.34	2.35	2.32	2.32	0.04	-0.10	-0.03	-0.02	1.7%	-4.1%	-1.3%	-1.0%
CR26	-	2.54	2.36	2.44	2.36	2.34	2.34	-0.18	-0.10	-0.02	-0.01	-7.0%	-3.9%	-0.8%	-0.6%
CR27	-	2.41	2.33	2.34	2.28	2.31	2.32	-0.09	-0.07	0.03	0.04	-3.6%	-2.9%	1.4%	1.9%
CR28	-	2.49	2.54	2.31	2.34	2.29	2.37	0.05	-0.18	-0.04	0.03	1.9%	-7.1%	-1.8%	1.3%
CR29	-	2.36	2.48	2.30	2.32	2.48	2.46	0.12	-0.06	0.16	0.14	4.9%	-2.7%	6.7%	6.0%
CR30	-	2.40	2.31	2.33	2.46	2.30	2.31	-0.09	-0.06	-0.16	-0.15	-3.6%	-2.6%	-6.4%	-6.2%
CR31	-	2.60	2.28	2.39	2.35	2.30	2.32	-0.32	-0.21	-0.05	-0.03	-12.1%	-8.2%	-2.0%	-1.3%
CR32	-	2.38	2.37	2.39	2.41	2.37	2.30	-0.01	0.01	-0.05	-0.11	-0.4%	0.4%	-1.9%	-4.6%
CR33	-	2.55	2.41	2.61	2.61	2.39	2.39	-0.14	0.06	-0.22	-0.22	-5.6%	2.3%	-8.4%	-8.5%
CR34	-	2.37	2.35	2.56	2.36	2.27	2.27	-0.02	0.19	-0.09	-0.08	-0.7%	8.2%	-3.8%	-3.5%
CR35	-	2.53	2.49	2.42	2.33	2.41	2.31	-0.04	-0.11	0.08	-0.02	-1.6%	-4.3%	3.4%	-0.7%
CR36	-	2.45	2.33	2.46	2.41	2.38	2.27	-0.12	0.01	-0.03	-0.14	-5.1%	0.3%	-1.2%	-5.9%
CR37	-	2.41	2.33	2.30	2.28	2.37	2.44	-0.08	-0.11	0.09	0.16	-3.4%	-4.6%	4.1%	7.0%
CR38	-	2.44	2.35	2.33	2.30	2.39	2.41	-0.09	-0.11	0.09	0.11	-3.7%	-4.7%	3.7%	4.6%
CR39	-	2.32	2.47	2.40	2.32	2.34	2.47	0.15	0.08	0.02	0.15	6.4%	3.3%	0.7%	6.3%
CR40	-	2.47	2.43	2.31	2.48	2.32	2.40	-0.04	-0.16	-0.16	-0.07	-1.8%	-6.6%	-6.4%	-3.0%

Table K-9 Maximum rolling 8-hour mean CO concentration at community receptors, ranked by concentration

Rank	Ranking by concentration (mg/m^3)						
	2015-BY	2023-DM	2023 DS	2023-DSC	2033-DM	2033-DS	2033-DSC
1	-	2.88	2.91	2.70	2.70	3.08	2.75
2	-	2.82	2.75	2.67	2.61	2.61	2.65
3	-	2.73	2.65	2.62	2.56	2.55	2.47
4	-	2.66	2.61	2.61	2.53	2.48	2.47
5	-	2.64	2.56	2.58	2.49	2.45	2.47
6	-	2.60	2.54	2.56	2.49	2.43	2.46
7	-	2.57	2.51	2.53	2.48	2.41	2.46
8	-	2.55	2.49	2.52	2.48	2.41	2.44
9	-	2.55	2.48	2.52	2.47	2.40	2.44
10	-	2.54	2.48	2.50	2.47	2.40	2.43

Table K-10 Maximum rolling 8-hour mean CO concentration at community receptors, ranked by increase and by decrease in concentration

Rank	Ranking by increase in concentration relative to Do Minimum (mg/m^3)				Ranking by decrease in concentration relative to Do Minimum (mg/m^3)			
	2023-DS	2023-DSC	2033-DS	2033-DSC	2023-DS	2023-DSC	2033-DS	2033-DSC
1	0.40	0.24	0.60	0.26	-0.32	-0.40	-0.26	-0.32
2	0.28	0.19	0.22	0.18	-0.30	-0.38	-0.25	-0.22
3	0.15	0.15	0.16	0.16	-0.26	-0.29	-0.22	-0.18
4	0.12	0.10	0.09	0.15	-0.23	-0.26	-0.17	-0.16
5	0.12	0.08	0.09	0.15	-0.21	-0.21	-0.16	-0.15
6	0.05	0.06	0.08	0.14	-0.20	-0.18	-0.16	-0.14
7	0.04	0.04	0.08	0.12	-0.18	-0.16	-0.16	-0.13
8	0.03	0.04	0.08	0.11	-0.14	-0.13	-0.09	-0.12
9	0.01	0.01	0.06	0.09	-0.14	-0.12	-0.07	-0.11
10	0.00	0.01	0.04	0.08	-0.14	-0.11	-0.07	-0.09

Table K-11 Maximum rolling 8-hour mean CO concentration at community receptors, ranked by percentage increase and by decrease in concentration

Rank	Ranking by % increase in concentration relative to Do Minimum				Ranking by % decrease in concentration relative to Do Minimum			
	2023-DS	2023-DSC	2033-DS	2033-DSC	2023-DS	2023-DSC	2033-DS	2033-DSC
1	17.3%	10.6%	24.0%	10.5%	-12.1%	-14.7%	-10.2%	-12.0%
2	11.9%	8.2%	9.6%	7.7%	-11.6%	-13.2%	-9.4%	-8.5%
3	6.4%	6.2%	6.7%	7.0%	-10.3%	-11.2%	-8.4%	-7.1%
4	5.0%	4.0%	4.1%	6.4%	-8.3%	-10.0%	-6.8%	-6.5%
5	4.9%	3.3%	3.7%	6.3%	-8.1%	-8.2%	-6.6%	-6.2%
6	1.9%	2.3%	3.4%	6.0%	-7.2%	-7.1%	-6.4%	-5.9%
7	1.7%	1.5%	3.4%	4.8%	-7.0%	-6.6%	-6.4%	-5.4%
8	1.0%	1.4%	3.2%	4.6%	-5.7%	-5.5%	-3.8%	-5.0%
9	0.5%	0.4%	2.8%	4.0%	-5.6%	-4.8%	-2.8%	-4.6%
10	0.2%	0.3%	1.6%	3.2%	-5.5%	-4.7%	-2.7%	-3.7%

Table K-12 Maximum rolling 8-hour mean CO concentration at RWR receptors, ranked by concentration

Rank	Ranking by concentration (mg/m^3)						
	2015-BY	2023-DM	2023 DS	2023-DSC	2033-DM	2033-DS	2033-DSC
1	-	5.4	5.3	5.2	4.4	4.8	4.1
2	-	5.3	4.9	5.1	4.4	4.6	4.0
3	-	5.3	4.9	5.0	4.3	4.4	4.0
4	-	5.2	4.9	5.0	4.3	4.4	4.0
5	-	5.2	4.9	4.9	4.3	4.3	3.9
6	-	5.2	4.9	4.8	4.3	4.3	3.9
7	-	5.2	4.8	4.8	4.3	4.3	3.9
8	-	5.1	4.8	4.7	4.2	4.2	3.9
9	-	5.0	4.8	4.7	4.2	4.2	3.8
10	-	5.0	4.8	4.7	4.2	4.2	3.8

Table K-13 Maximum rolling 8-hour mean CO concentration at RWR receptors, ranked by increase and by decrease in concentration

Rank	Ranking by increase in concentration relative to Do Minimum (mg/m^3)				Ranking by decrease in concentration relative to Do Minimum (mg/m^3)			
	2023-DS	2023-DSC	2033-DS	2033-DSC	2023-DS	2023-DSC	2033-DS	2033-DSC
1	1.1	1.0	1.1	0.6	-1.5	-1.3	-0.9	-0.9
2	0.9	1.0	1.0	0.6	-1.4	-1.3	-0.8	-0.8
3	0.8	0.9	1.0	0.6	-1.4	-1.3	-0.8	-0.8
4	0.8	0.9	0.9	0.6	-1.1	-1.2	-0.8	-0.8
5	0.7	0.9	0.8	0.5	-1.1	-1.1	-0.7	-0.8
6	0.7	0.9	0.8	0.5	-1.1	-1.0	-0.7	-0.8
7	0.7	0.8	0.8	0.5	-1.0	-1.0	-0.7	-0.7
8	0.7	0.8	0.7	0.5	-1.0	-1.0	-0.7	-0.7
9	0.7	0.7	0.7	0.5	-1.0	-1.0	-0.7	-0.7
10	0.7	0.7	0.6	0.4	-1.0	-1.0	-0.6	-0.7

Table K-14 Maximum rolling 8-hour mean CO concentration at RWR receptors, ranked by percentage increase and by decrease in concentration

Rank	Ranking by % increase in concentration relative to Do Minimum				Ranking by % decrease in concentration relative to Do Minimum			
	2023-DS	2023-DSC	2033-DS	2033-DSC	2023-DS	2023-DSC	2033-DS	2033-DSC
1	31.7%	32.1%	32.4%	19.4%	-28.8%	-27.2%	-21.8%	-22.4%
2	24.7%	27.9%	30.2%	19.3%	-28.5%	-26.8%	-21.3%	-20.9%
3	23.8%	27.7%	29.1%	18.5%	-27.3%	-25.7%	-21.3%	-20.9%
4	23.3%	25.8%	26.5%	17.0%	-27.0%	-24.8%	-20.1%	-20.8%
5	22.2%	25.7%	23.7%	16.2%	-25.2%	-24.7%	-19.5%	-19.6%
6	21.9%	25.2%	22.7%	16.2%	-25.1%	-24.5%	-18.1%	-19.6%
7	21.7%	24.2%	22.7%	15.5%	-23.0%	-24.1%	-17.6%	-19.6%
8	21.2%	24.2%	21.4%	15.5%	-22.8%	-23.4%	-17.2%	-19.5%
9	21.1%	23.9%	21.0%	15.2%	-22.4%	-23.2%	-17.1%	-18.6%
10	21.0%	23.4%	20.1%	14.8%	-22.3%	-22.5%	-17.1%	-18.2%

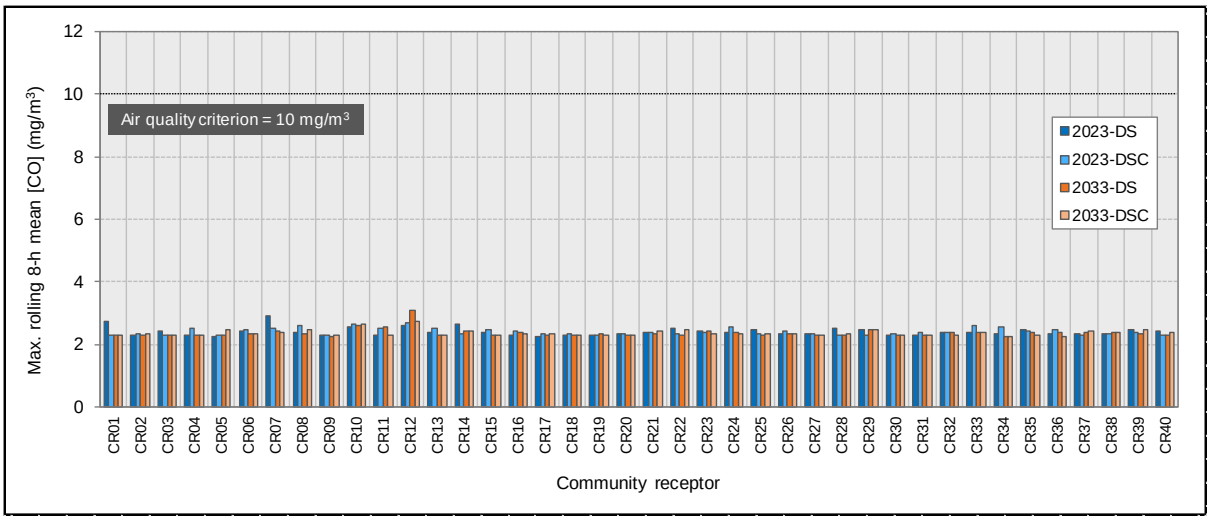


Figure K-6 **Maximum rolling 8-hour mean CO concentration at community receptors (with-project and cumulative scenarios)**

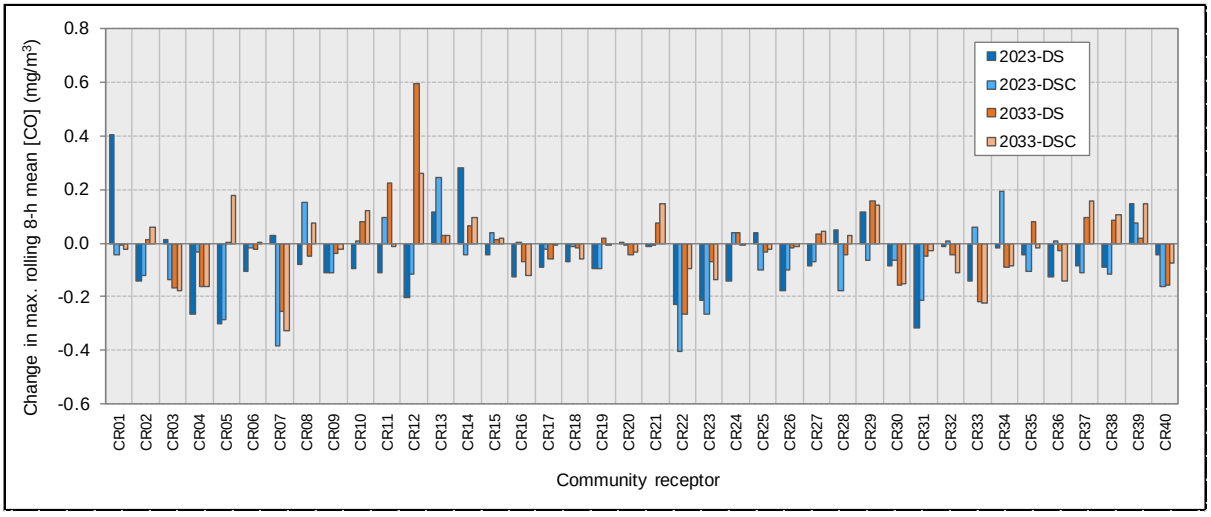


Figure K-7 **Change in maximum rolling 8-hour mean CO concentration at community receptors (with-project and cumulative scenarios, relative to Do Minimum scenarios)**

Figure K-8 **Source contributions to maximum rolling 8-hour mean CO concentration at community receptors (with-project and cumulative scenarios)**

K.3 Nitrogen dioxide (annual mean)

Table K-15 Annual mean NO_2 concentration at community receptors

Receptor	Annual mean NO_2 concentration (µg/m^3)							Change relative to Do Minimum (µg/m^3)				Change relative to Do Minimum (%)			
	2015-BY	2023-DM	2023-DS	2023-DSC	2033-DM	2033-DS	2033-DSC	2023-DS	2023-DSC	2033-DS	2033-DSC	2023-DS	2023-DSC	2033-DS	2033-DSC
CR01	-	24.4	23.5	23.7	23.1	22.7	22.8	-0.8	-0.6	-0.5	-0.4	-3.3%	-2.6%	-2.1%	-1.6%
CR02	-	23.9	23.5	24.0	23.5	22.6	22.8	-0.4	0.1	-0.9	-0.7	-1.7%	0.6%	-3.9%	-3.0%
CR03	-	30.2	27.0	27.3	28.0	25.5	25.6	-3.1	-2.9	-2.4	-2.4	-10.3%	-9.5%	-8.7%	-8.6%
CR04	-	27.3	26.1	26.7	25.4	24.6	24.7	-1.2	-0.7	-0.9	-0.7	-4.5%	-2.4%	-3.4%	-2.9%
CR05	-	24.3	24.1	24.3	23.1	23.0	23.2	-0.2	0.0	0.0	0.2	-0.7%	0.0%	-0.2%	0.7%
CR06	-	25.2	24.6	25.2	23.6	23.7	23.6	-0.6	-0.1	0.1	0.0	-2.4%	-0.3%	0.4%	0.0%
CR07	-	27.6	26.3	27.0	26.0	25.4	25.1	-1.4	-0.6	-0.6	-1.0	-5.0%	-2.3%	-2.3%	-3.7%
CR08	-	26.2	25.5	25.1	24.9	24.0	24.0	-0.6	-1.0	-0.9	-0.8	-2.3%	-3.8%	-3.5%	-3.2%
CR09	-	25.1	24.6	24.6	24.0	23.5	23.8	-0.6	-0.5	-0.4	-0.1	-2.3%	-2.1%	-1.7%	-0.6%
CR10	-	32.2	31.8	31.3	29.6	29.3	28.8	-0.4	-0.9	-0.3	-0.8	-1.3%	-2.9%	-1.1%	-2.7%
CR11	-	24.6	24.7	24.0	24.2	23.5	23.2	0.1	-0.6	-0.7	-0.9	0.4%	-2.4%	-2.8%	-3.9%
CR12	-	28.9	29.7	28.6	27.7	27.5	27.6	0.8	-0.3	-0.2	-0.1	2.9%	-1.2%	-0.6%	-0.5%
CR13	-	24.9	24.3	23.8	23.8	23.7	23.4	-0.6	-1.1	-0.1	-0.4	-2.4%	-4.3%	-0.2%	-1.7%
CR14	-	27.1	26.6	26.2	26.0	25.2	24.8	-0.6	-0.9	-0.8	-1.1	-2.1%	-3.4%	-2.9%	-4.4%
CR15	-	25.1	24.8	24.4	24.3	23.2	23.0	-0.3	-0.6	-1.0	-1.2	-1.2%	-2.6%	-4.2%	-5.1%
CR16	-	24.5	23.7	24.2	23.4	23.0	23.0	-0.8	-0.3	-0.3	-0.4	-3.4%	-1.1%	-1.5%	-1.5%
CR17	-	23.7	23.7	23.5	23.4	22.6	23.1	0.0	-0.3	-0.8	-0.3	0.0%	-1.2%	-3.3%	-1.4%
CR18	-	24.4	23.9	23.8	23.3	22.6	22.6	-0.5	-0.7	-0.6	-0.7	-2.1%	-2.7%	-2.7%	-2.8%
CR19	-	24.5	23.5	23.9	23.5	22.8	23.0	-0.9	-0.5	-0.7	-0.5	-3.8%	-2.2%	-2.9%	-2.0%
CR20	-	25.8	24.3	24.3	24.0	23.4	23.8	-1.5	-1.5	-0.6	-0.2	-6.0%	-5.9%	-2.3%	-0.9%
CR21	-	24.3	24.1	23.7	23.0	23.2	23.3	-0.2	-0.5	0.2	0.3	-0.8%	-2.2%	0.9%	1.5%
CR22	-	28.2	24.5	25.0	26.1	23.6	24.0	-3.7	-3.2	-2.5	-2.1	-13.0%	-11.3%	-9.4%	-8.2%
CR23	-	31.0	28.1	27.2	29.0	26.3	26.2	-3.0	-3.8	-2.7	-2.8	-9.6%	-12.2%	-9.3%	-9.6%
CR24	-	26.2	27.1	26.1	24.6	25.3	24.8	0.9	-0.1	0.7	0.3	3.6%	-0.3%	2.8%	1.1%
CR25	-	24.7	24.6	24.3	23.9	23.5	23.4	-0.1	-0.4	-0.4	-0.5	-0.5%	-1.8%	-1.8%	-1.9%
CR26	-	24.1	23.5	23.5	23.1	22.9	23.1	-0.6	-0.6	-0.2	0.0	-2.5%	-2.4%	-0.8%	-0.1%
CR27	-	25.1	24.9	24.4	24.1	23.5	23.6	-0.3	-0.7	-0.6	-0.5	-1.0%	-2.7%	-2.4%	-2.1%
CR28	-	24.4	24.2	23.8	23.7	23.2	23.3	-0.2	-0.6	-0.5	-0.4	-1.0%	-2.5%	-2.3%	-1.6%
CR29	-	26.2	25.6	25.9	24.6	24.4	24.8	-0.6	-0.3	-0.2	0.2	-2.1%	-1.0%	-0.9%	0.7%
CR30	-	25.8	26.0	26.2	24.7	25.7	25.0	0.2	0.4	1.0	0.3	0.9%	1.5%	4.0%	1.4%
CR31	-	28.9	25.5	25.8	27.4	24.4	24.3	-3.4	-3.2	-3.1	-3.2	-11.9%	-11.0%	-11.2%	-11.6%
CR32	-	23.7	23.2	23.4	22.8	22.6	22.5	-0.4	-0.3	-0.2	-0.3	-1.8%	-1.1%	-0.8%	-1.4%
CR33	-	25.3	25.5	25.2	23.9	24.3	23.9	0.2	-0.1	0.4	-0.1	1.0%	-0.5%	1.7%	-0.2%
CR34	-	25.1	25.0	24.7	24.0	23.7	23.4	-0.1	-0.3	-0.3	-0.5	-0.3%	-1.4%	-1.1%	-2.3%
CR35	-	25.4	25.2	24.9	24.3	23.7	24.3	-0.2	-0.6	-0.5	0.0	-1.0%	-2.2%	-2.2%	0.1%
CR36	-	25.5	25.5	25.9	24.6	24.5	24.9	0.1	0.4	0.0	0.3	0.2%	1.6%	-0.2%	1.4%
CR37	-	25.2	25.7	25.8	24.5	24.7	24.8	0.5	0.6	0.3	0.4	2.0%	2.4%	1.1%	1.5%
CR38	-	26.5	28.1	26.4	25.6	27.2	25.4	1.6	-0.1	1.6	-0.2	6.1%	-0.5%	6.2%	-0.7%
CR39	-	25.9	25.8	25.7	24.8	25.1	25.0	-0.1	-0.3	0.3	0.1	-0.4%	-1.0%	1.2%	0.5%
CR40	-	25.6	25.2	25.2	24.6	24.2	24.5	-0.4	-0.5	-0.3	-0.1	-1.6%	-1.8%	-1.3%	-0.4%

Table K-16 Annual mean NO_2 concentration at community receptors, ranked by concentration

Rank	Ranking by concentration (µg/m^3)						
	2015-BY	2023-DM	2023 DS	2023-DSC	2033-DM	2033-DS	2033-DSC
1	-	32.2	31.8	31.3	29.6	29.3	28.8
2	-	31.0	29.7	28.6	29.0	27.5	27.6
3	-	30.2	28.1	27.3	28.0	27.2	26.2
4	-	28.9	28.1	27.2	27.7	26.3	25.6
5	-	28.9	27.1	27.0	27.4	25.7	25.4
6	-	28.2	27.0	26.7	26.1	25.5	25.1
7	-	27.6	26.6	26.4	26.0	25.4	25.0
8	-	27.3	26.3	26.2	26.0	25.3	25.0
9	-	27.1	26.1	26.2	25.6	25.2	24.9
10	-	26.5	26.0	26.1	25.4	25.1	24.8

Table K-17 Annual mean NO_2 concentration at community receptors, ranked by increase and by decrease in concentration

Rank	Ranking by increase in concentration relative to Do Minimum (µg/m^3)				Ranking by decrease in concentration relative to Do Minimum (µg/m^3)			
	2023-DS	2023-DSC	2033-DS	2033-DSC	2023-DS	2023-DSC	2033-DS	2033-DSC
1	1.62	0.61	1.58	0.37	-3.67	-3.80	-3.08	-3.18
2	0.94	0.40	0.98	0.35	-3.44	-3.18	-2.70	-2.79
3	0.85	0.39	0.69	0.35	-3.11	-3.17	-2.46	-2.42
4	0.51	0.14	0.40	0.34	-2.98	-2.86	-2.45	-2.13
5	0.25	0.00	0.29	0.28	-1.53	-1.52	-1.01	-1.25
6	0.24	-0.08	0.27	0.17	-1.37	-1.06	-0.92	-1.14
7	0.10	-0.09	0.20	0.17	-1.22	-1.01	-0.88	-0.96
8	0.06	-0.13	0.09	0.12	-0.94	-0.93	-0.85	-0.93
9	0.00	-0.14	-0.04	0.03	-0.82	-0.93	-0.77	-0.80
10	-0.07	-0.26	-0.05	0.01	-0.81	-0.69	-0.75	-0.79

Table K-18 Annual mean NO_2 concentration at community receptors, ranked by percentage increase and by decrease in concentration

Rank	Ranking by % increase in concentration relative to Do Minimum				Ranking by % decrease in concentration relative to Do Minimum			
	2023-DS	2023-DSC	2033-DS	2033-DSC	2023-DS	2023-DSC	2033-DS	2033-DSC
1	6.1%	2.4%	6.2%	1.5%	-13.0%	-12.2%	-11.2%	-11.6%
2	3.6%	1.6%	4.0%	1.5%	-11.9%	-11.3%	-9.4%	-9.6%
3	2.9%	1.5%	2.8%	1.4%	-10.3%	-11.0%	-9.3%	-8.6%
4	2.0%	0.6%	1.7%	1.4%	-9.6%	-9.5%	-8.7%	-8.2%
5	1.0%	0.0%	1.2%	1.1%	-6.0%	-5.9%	-4.2%	-5.1%
6	0.9%	-0.3%	1.1%	0.7%	-5.0%	-4.3%	-3.9%	-4.4%
7	0.4%	-0.3%	0.9%	0.7%	-4.5%	-3.8%	-3.5%	-3.9%
8	0.2%	-0.5%	0.4%	0.5%	-3.8%	-3.4%	-3.4%	-3.7%
9	0.0%	-0.5%	-0.2%	0.1%	-3.4%	-2.9%	-3.3%	-3.2%
10	-0.3%	-1.0%	-0.2%	0.0%	-3.3%	-2.7%	-2.9%	-3.0%

Table K-19 Annual mean NO_2 concentration at RWR receptors, ranked by concentration

Rank	Ranking by concentration (µg/m^3)						
	2015-BY	2023-DM	2023 DS	2023-DSC	2033-DM	2033-DS	2033-DSC
1	-	44.3	43.7	42.9	40.3	37.3	39.1
2	-	43.4	42.7	42.8	39.6	37.2	38.9
3	-	43.3	42.6	42.2	39.4	37.2	38.7
4	-	43.3	42.1	41.9	39.2	36.5	38.5
5	-	43.2	41.9	41.2	39.2	36.4	38.1
6	-	42.9	40.8	40.2	38.6	36.3	37.6
7	-	42.5	40.7	40.2	38.1	36.2	37.5
8	-	42.5	40.6	40.1	38.1	36.1	37.1
9	-	42.5	40.4	40.1	38.1	36.0	37.0
10	-	42.4	40.2	40.1	38.0	36.0	36.8

Table K-20 Annual mean NO_2 concentration at RWR receptors, ranked by increase and by decrease in concentration

Rank	Ranking by increase in concentration relative to Do Minimum (µg/m^3)				Ranking by decrease in concentration relative to Do Minimum (µg/m^3)			
	2023-DS	2023-DSC	2033-DS	2033-DSC	2023-DS	2023-DSC	2033-DS	2033-DSC
1	5.7	8.8	6.3	8.7	-10.3	-10.0	-8.3	-8.3
2	4.9	6.5	5.4	6.8	-8.1	-7.7	-6.1	-6.2
3	4.3	6.2	4.6	6.5	-7.9	-7.6	-6.1	-6.2
4	4.2	6.1	4.4	6.4	-7.0	-7.4	-5.7	-6.0
5	4.1	6.0	4.1	6.4	-6.8	-7.1	-5.7	-5.8
6	4.0	5.9	4.0	6.0	-6.7	-7.0	-5.4	-5.7
7	4.0	5.8	3.8	5.6	-6.6	-7.0	-5.4	-5.6
8	3.7	5.8	3.7	5.6	-6.6	-6.8	-5.3	-5.6
9	3.7	5.4	3.7	4.8	-6.4	-6.5	-5.0	-5.6
10	3.6	4.8	3.6	4.6	-6.4	-6.3	-5.0	-5.4

Table K-21 Annual mean NO_2 concentration at RWR receptors, ranked by percentage increase and by decrease in concentration

Rank	Ranking by % increase in concentration relative to Do Minimum				Ranking by % decrease in concentration relative to Do Minimum			
	2023-DS	2023-DSC	2033-DS	2033-DSC	2023-DS	2023-DSC	2033-DS	2033-DSC
1	20.8%	35.7%	23.9%	36.8%	-24.2%	-23.5%	-21.4%	-21.6%
2	17.8%	25.9%	20.5%	28.1%	-21.9%	-20.7%	-18.0%	-18.2%
3	14.2%	24.1%	17.3%	27.0%	-21.1%	-20.4%	-17.9%	-17.8%
4	13.8%	23.7%	16.9%	26.6%	-19.7%	-20.3%	-17.6%	-17.7%
5	13.4%	23.4%	14.8%	25.6%	-19.4%	-19.9%	-17.2%	-17.7%
6	13.4%	23.4%	14.6%	24.3%	-18.8%	-19.6%	-16.5%	-17.7%
7	13.3%	22.3%	14.1%	23.4%	-18.7%	-19.5%	-16.4%	-17.5%
8	12.8%	20.9%	14.1%	22.8%	-18.6%	-19.4%	-15.9%	-17.3%
9	12.6%	20.6%	13.8%	18.8%	-18.6%	-18.0%	-15.9%	-17.2%
10	12.4%	18.3%	13.5%	18.6%	-18.4%	-17.9%	-15.8%	-16.6%

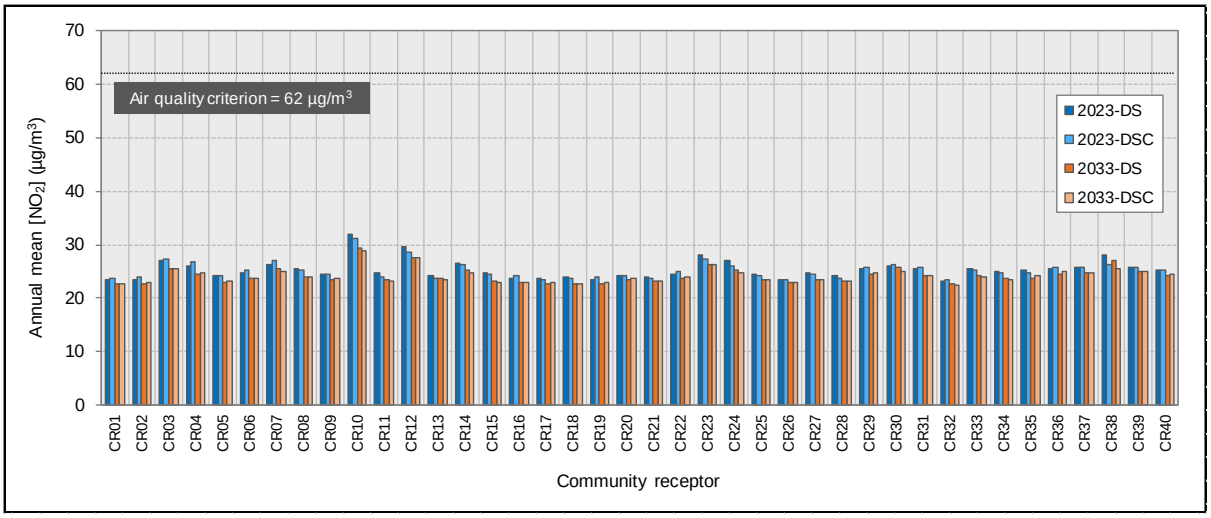


Figure K-9 **Annual mean NO_2 concentration at community receptors (with-project and cumulative scenarios)**

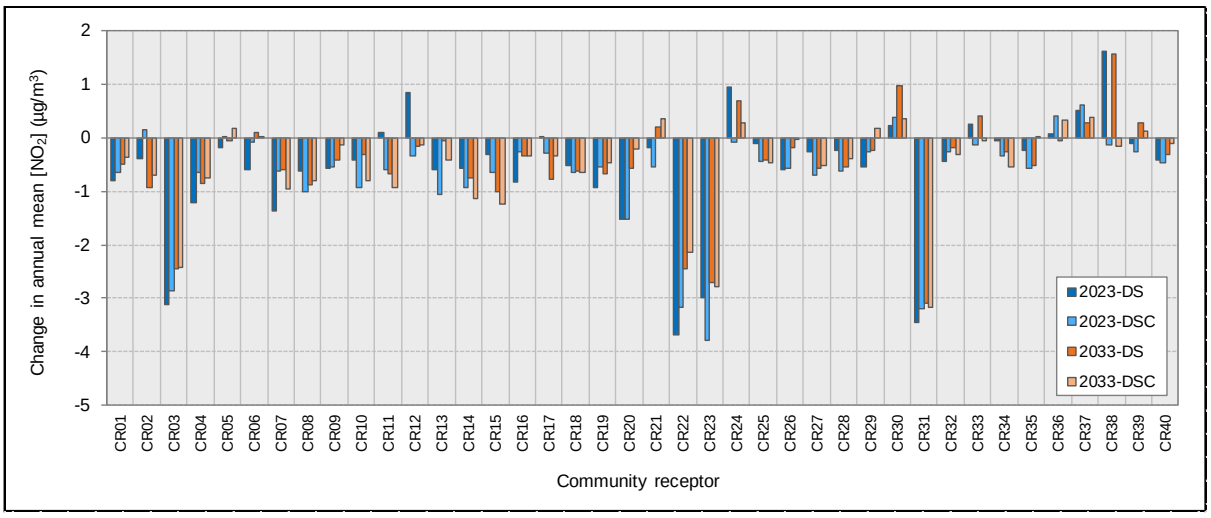


Figure K-10 **Change in annual mean NO_2 concentration at community receptors (with-project and cumulative scenarios, relative to Do Minimum scenarios)**

Figure K-11 Source contributions to annual mean NO_2 concentration at community receptors (with-project and cumulative scenarios)

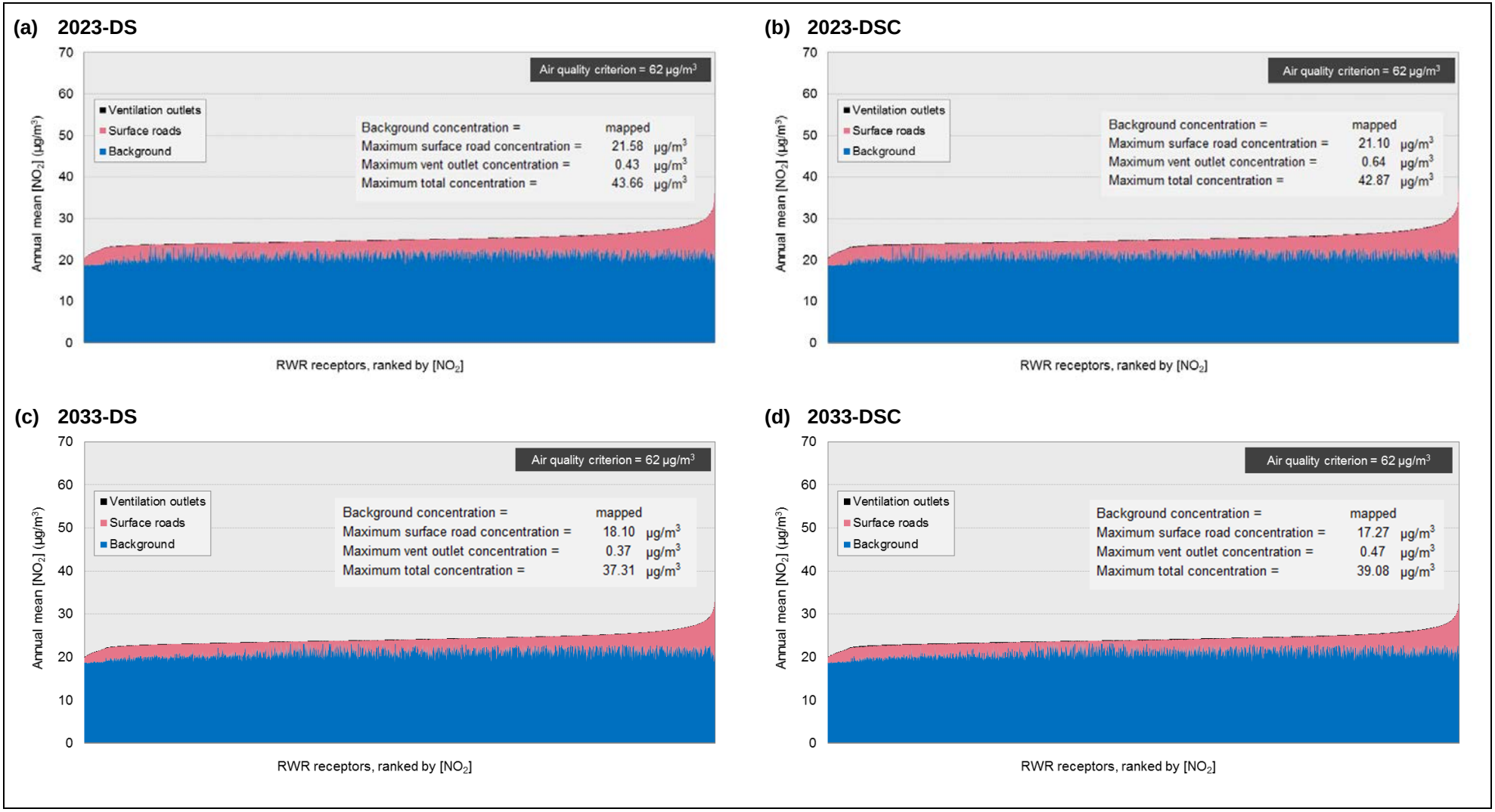


Figure K-12 Source contributions to annual mean NO_2 concentration at RWR receptors (with-project and cumulative scenarios)

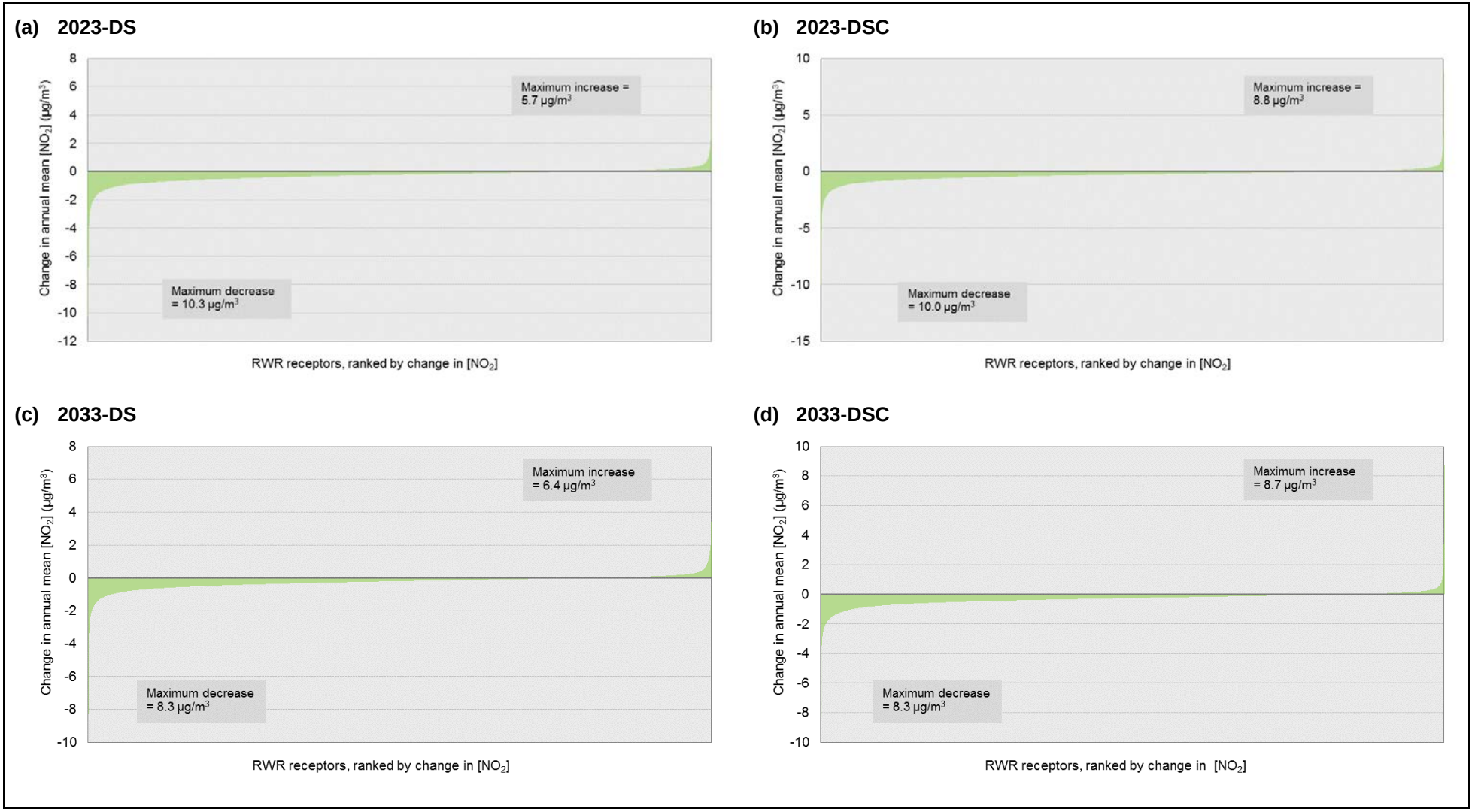


Figure K-13 Change in annual mean NO_2 concentration at RWR receptors (with-project and cumulative scenarios, relative to Do Minimum scenarios)

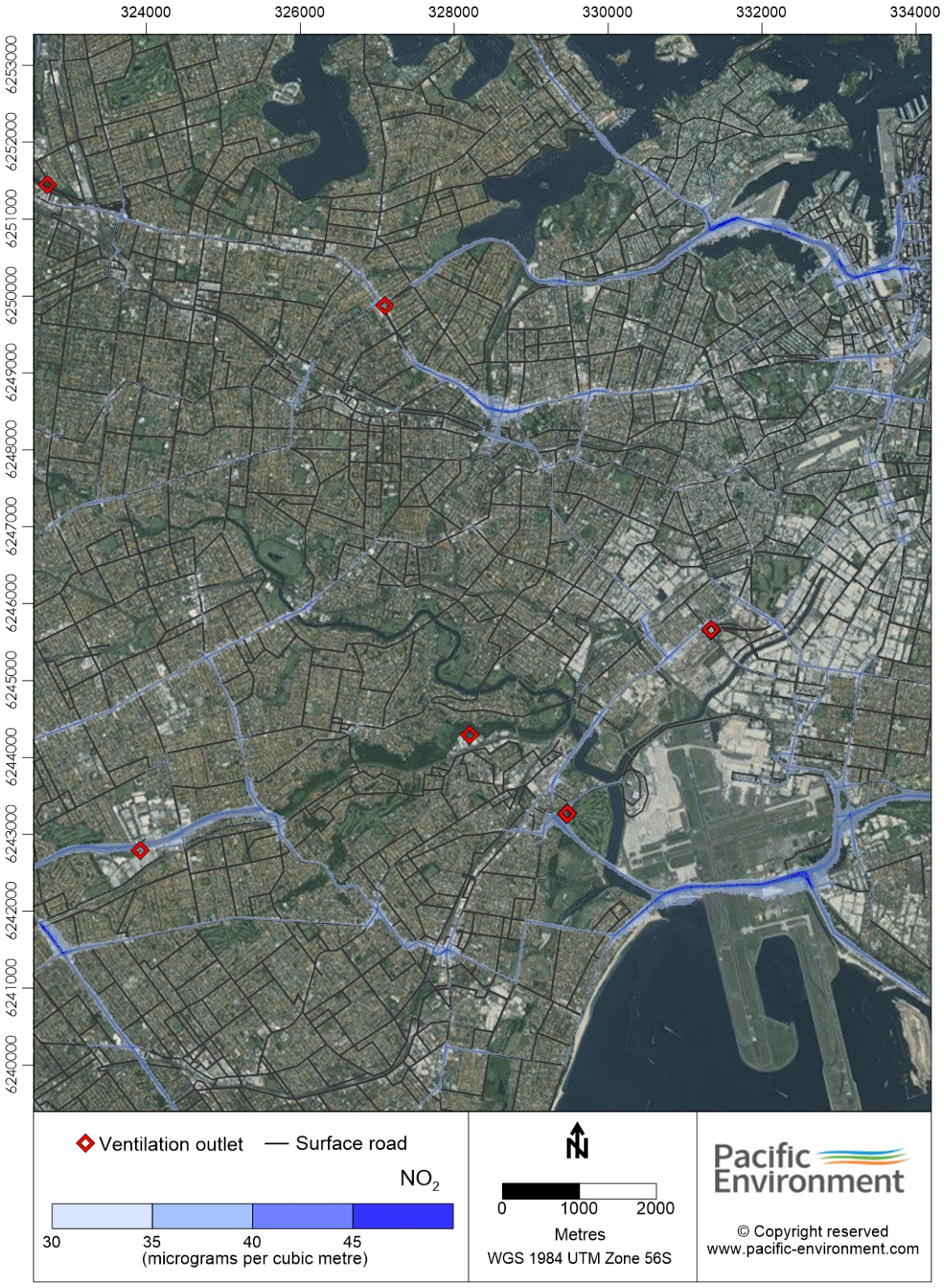


Figure K-14 Contour plot of annual mean NO_2 concentration in the 2023 Do Minimum scenario (all sources, 2023-DM)

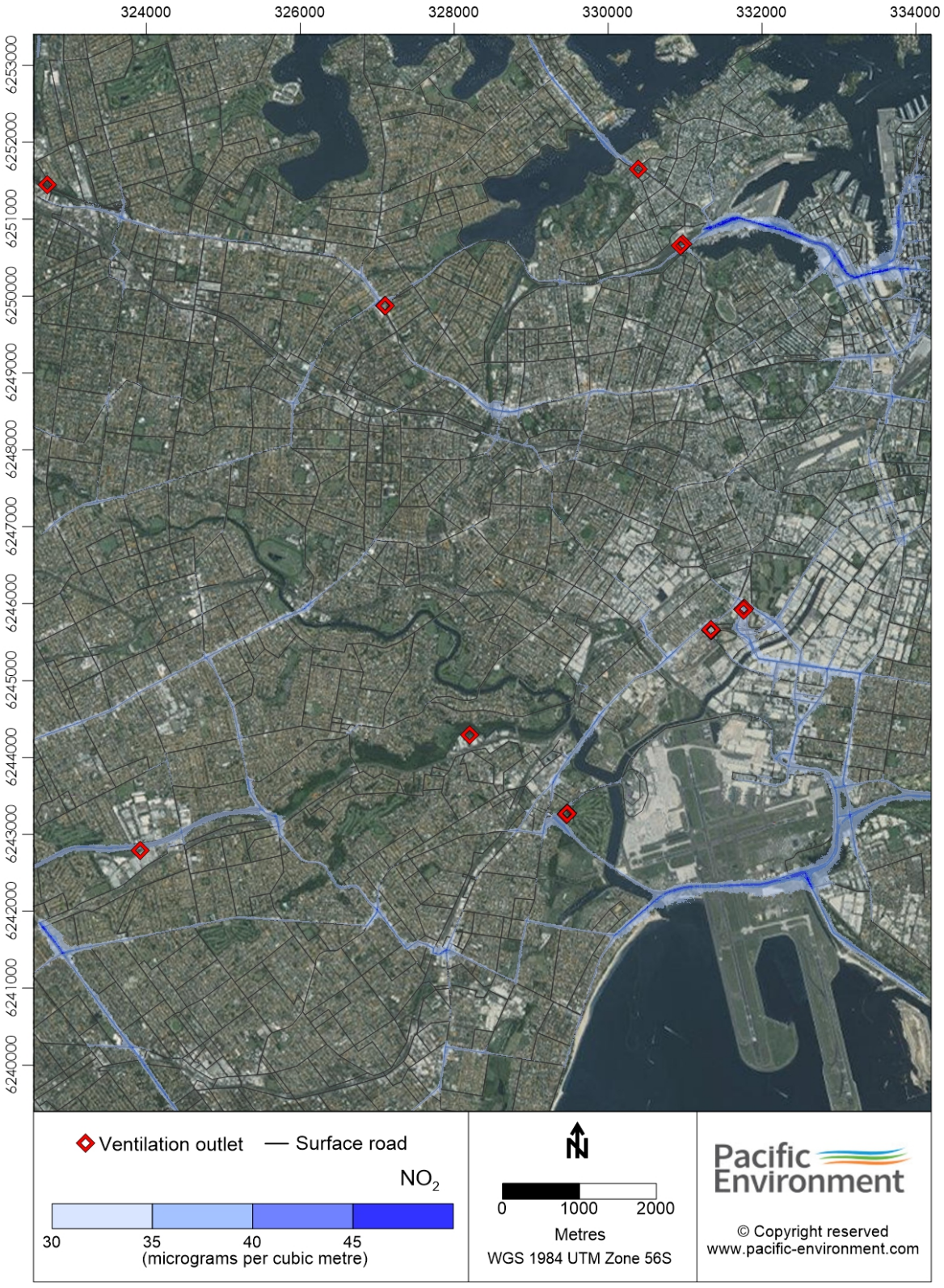


Figure K-15 **Contour plot of annual mean NO_2 concentration in the 2023 Do Something scenario (all sources, 2023-DS)**

Figure K-16 **Contour plot of change in annual mean NO_2 concentration in the 2023 Do something scenario (all sources, 2023-DS minus 2023-DM)**

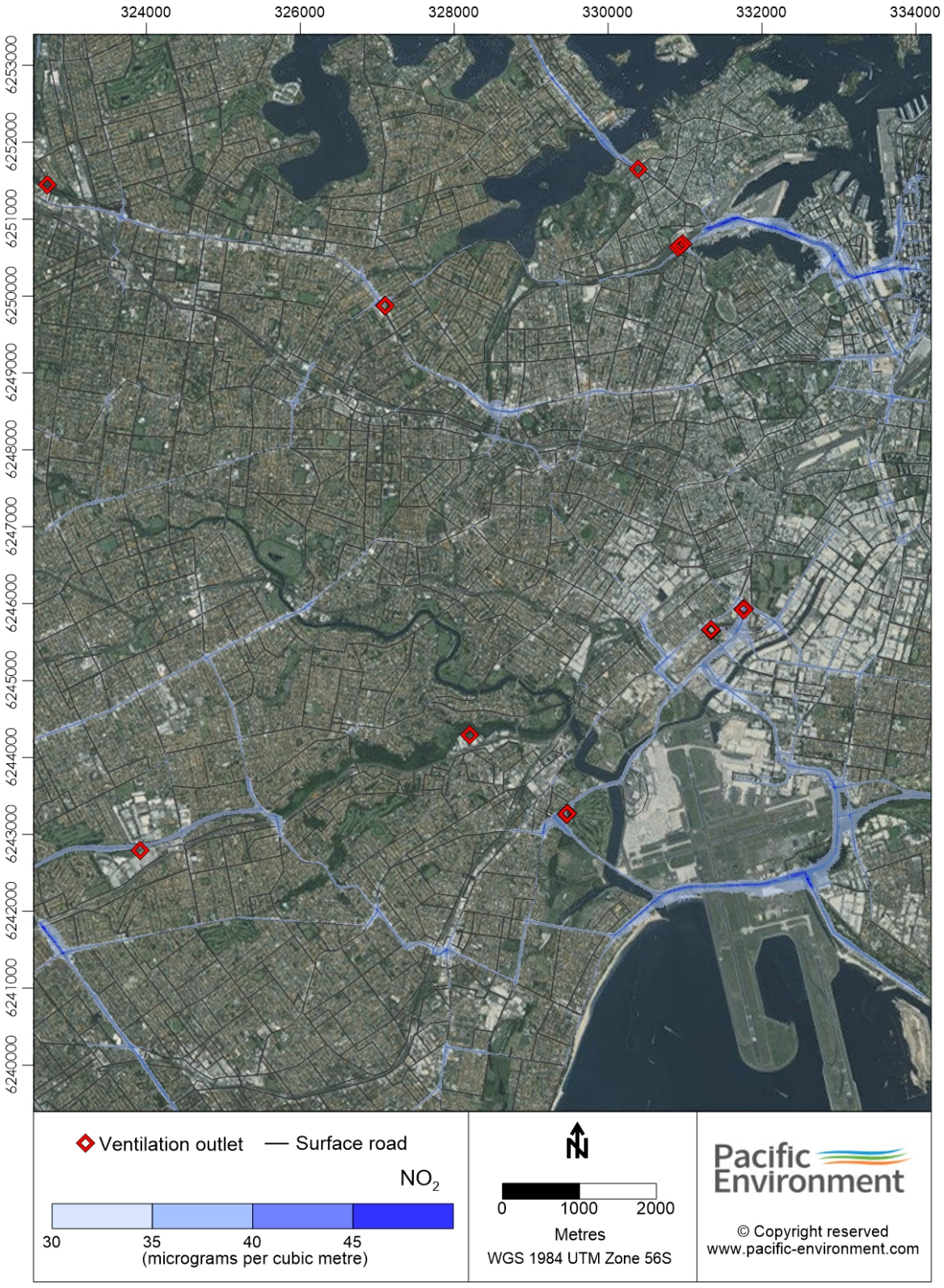


Figure K-17 Contour plot of annual mean NO_2 concentration in the 2023 cumulative scenario (all sources, 2023-DSC)

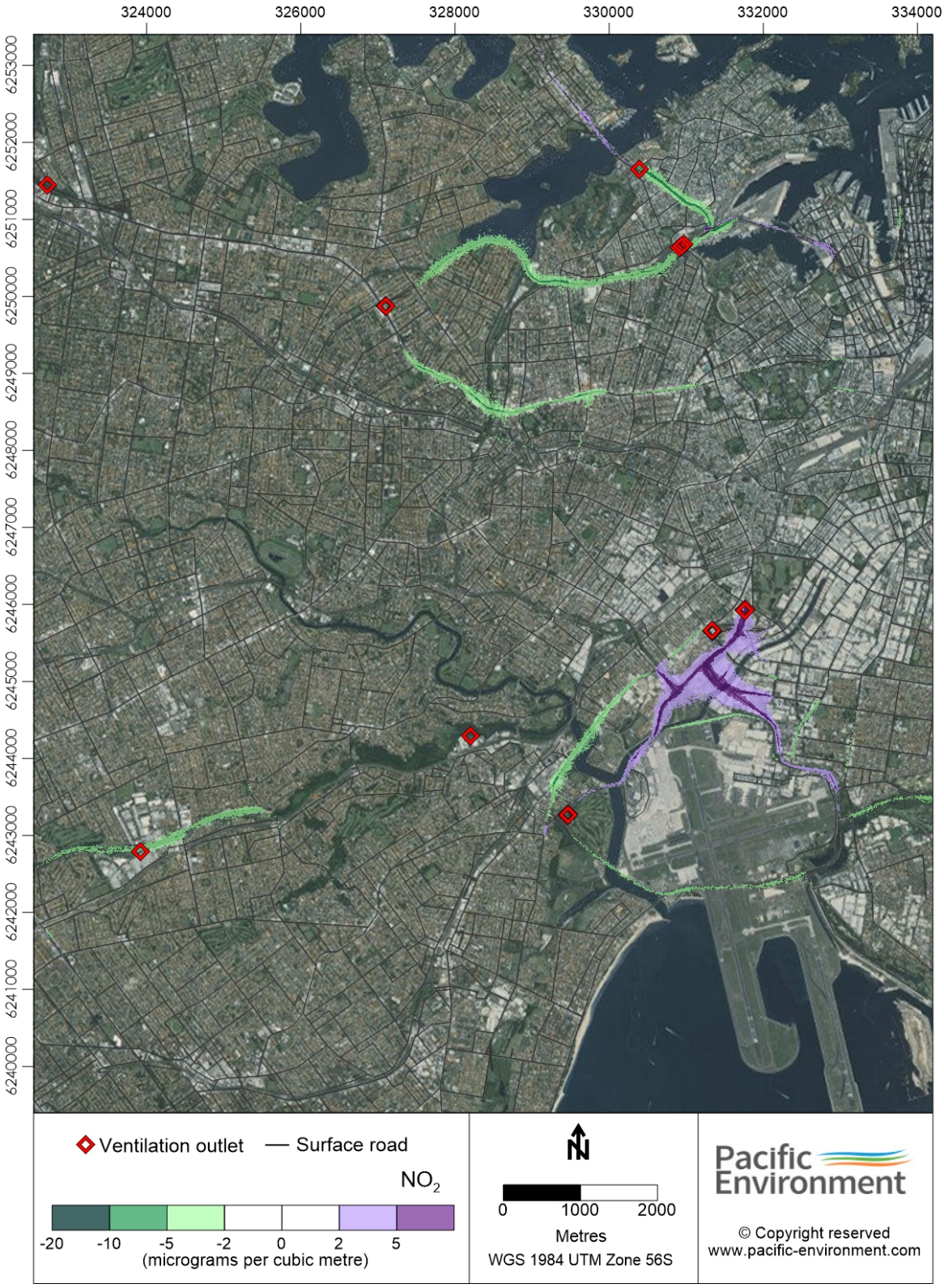


Figure K-18 **Contour plot of change in annual mean NO_2 concentration in the 2023 cumulative scenario (all sources, 2023-DSC minus 2023-DM)**

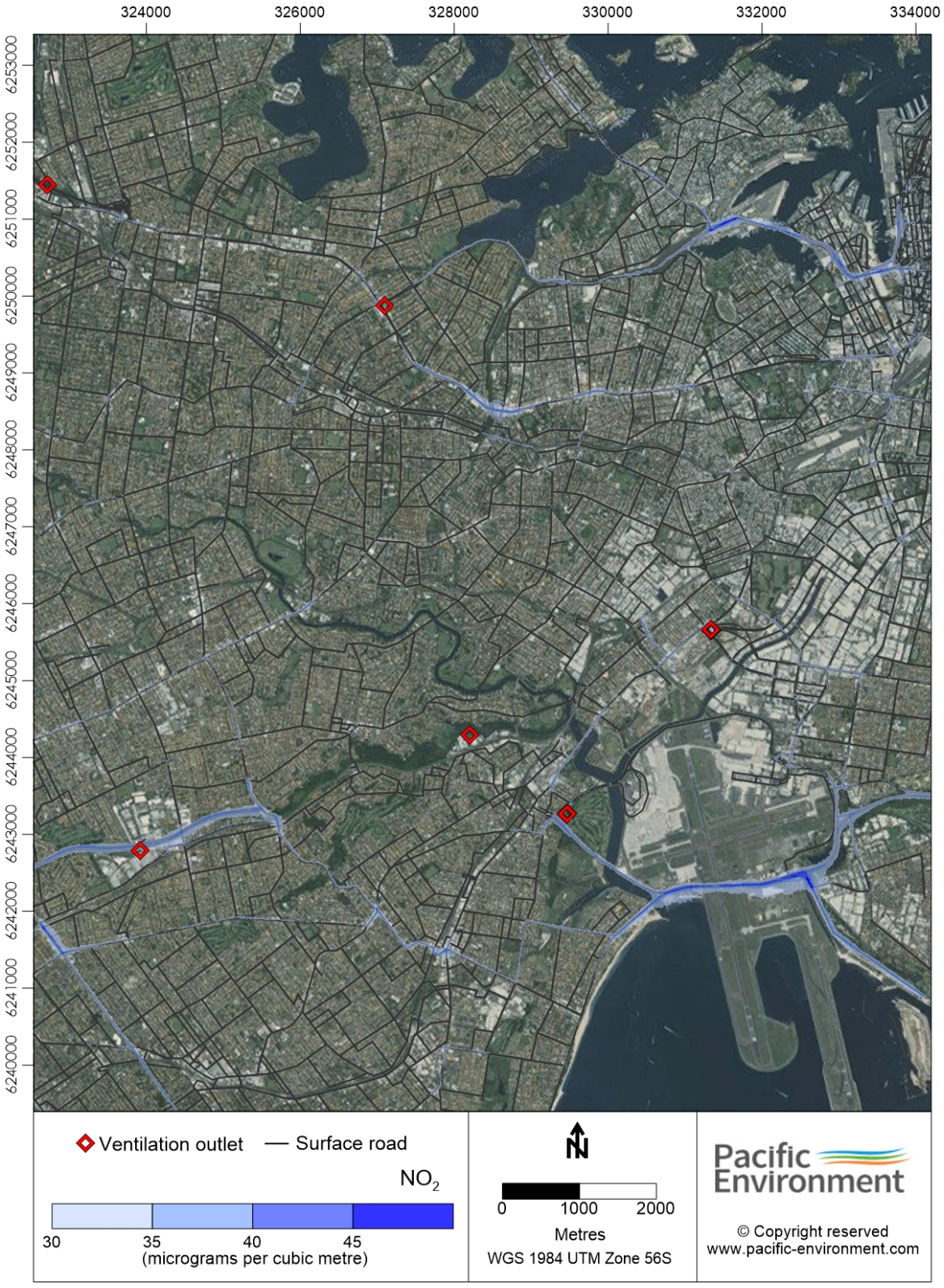


Figure K-19 Contour plot of annual mean NO_2 concentration in the 2033 Do Minimum scenario (all sources, 2033-DM)

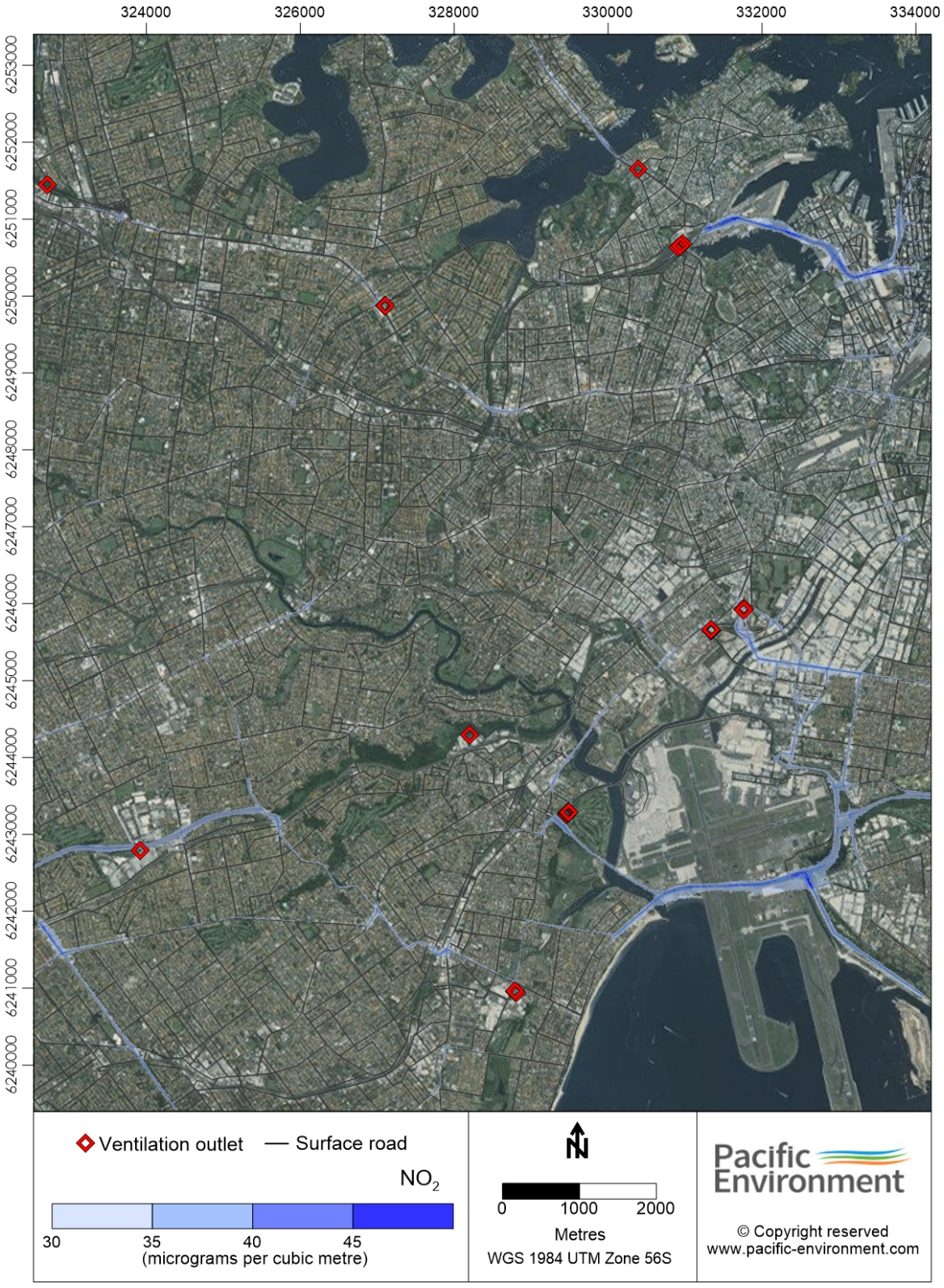


Figure K-20 Contour plot of annual mean NO_2 concentration in the 2033 Do Something scenario (all sources, 2033-DS)

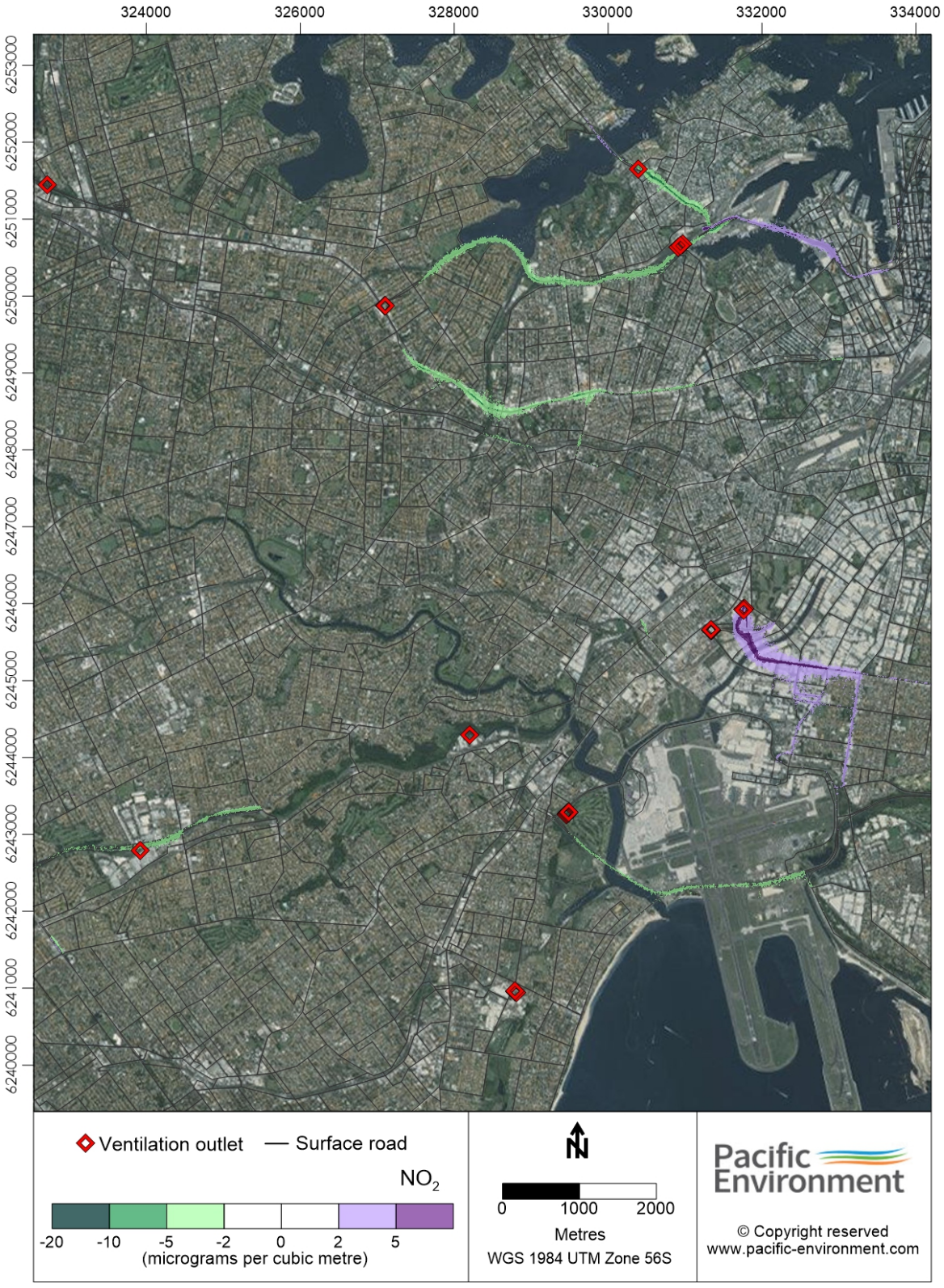


Figure K-21 Contour plot of change in annual mean NO_2 concentration in the 2033 Do Something scenario (all sources, 2033-DS minus 2033-DM)

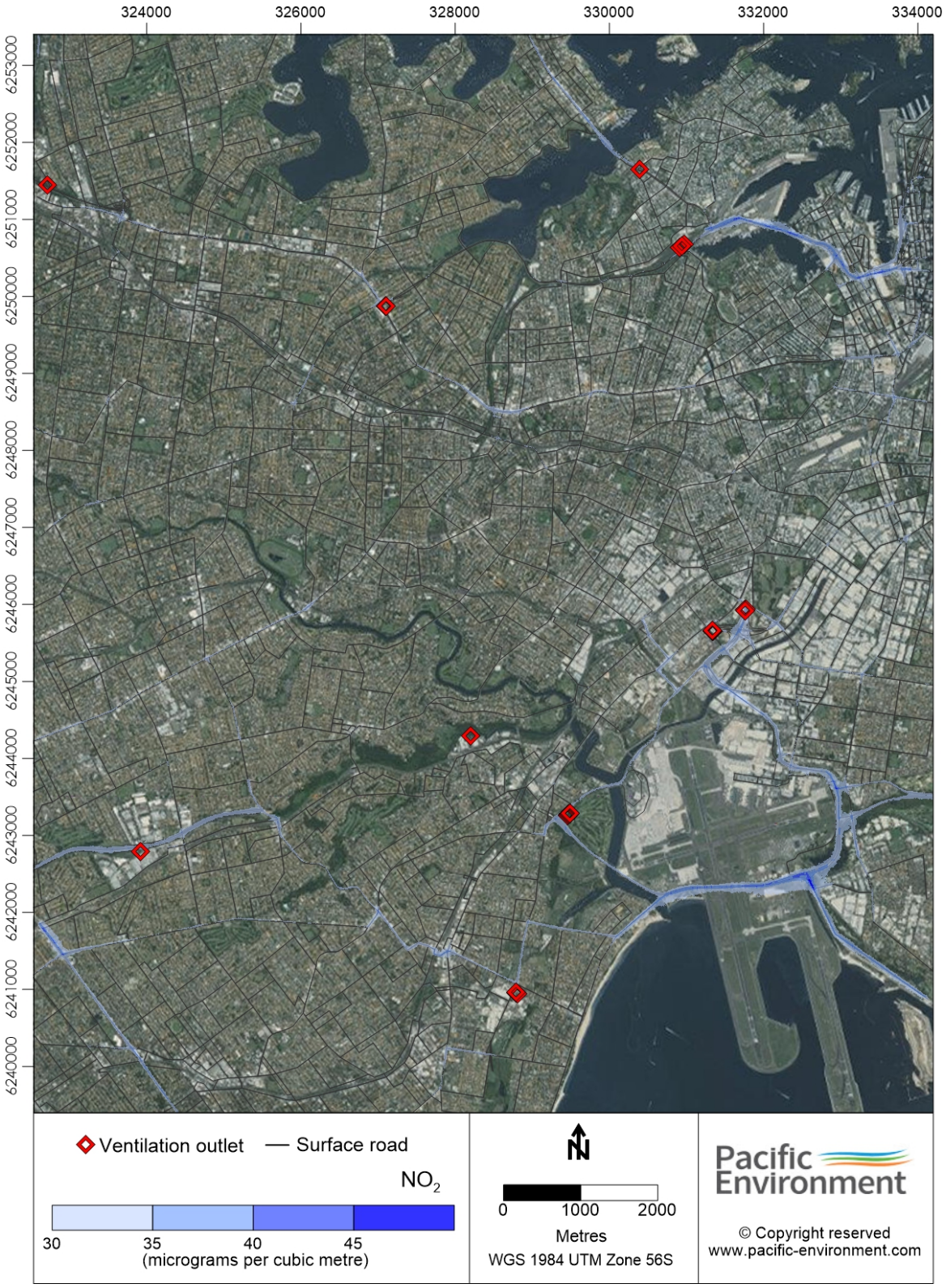


Figure K-22 Contour plot of annual mean NO_2 concentration in the 2033 cumulative scenario (all sources, 2033-DSC)

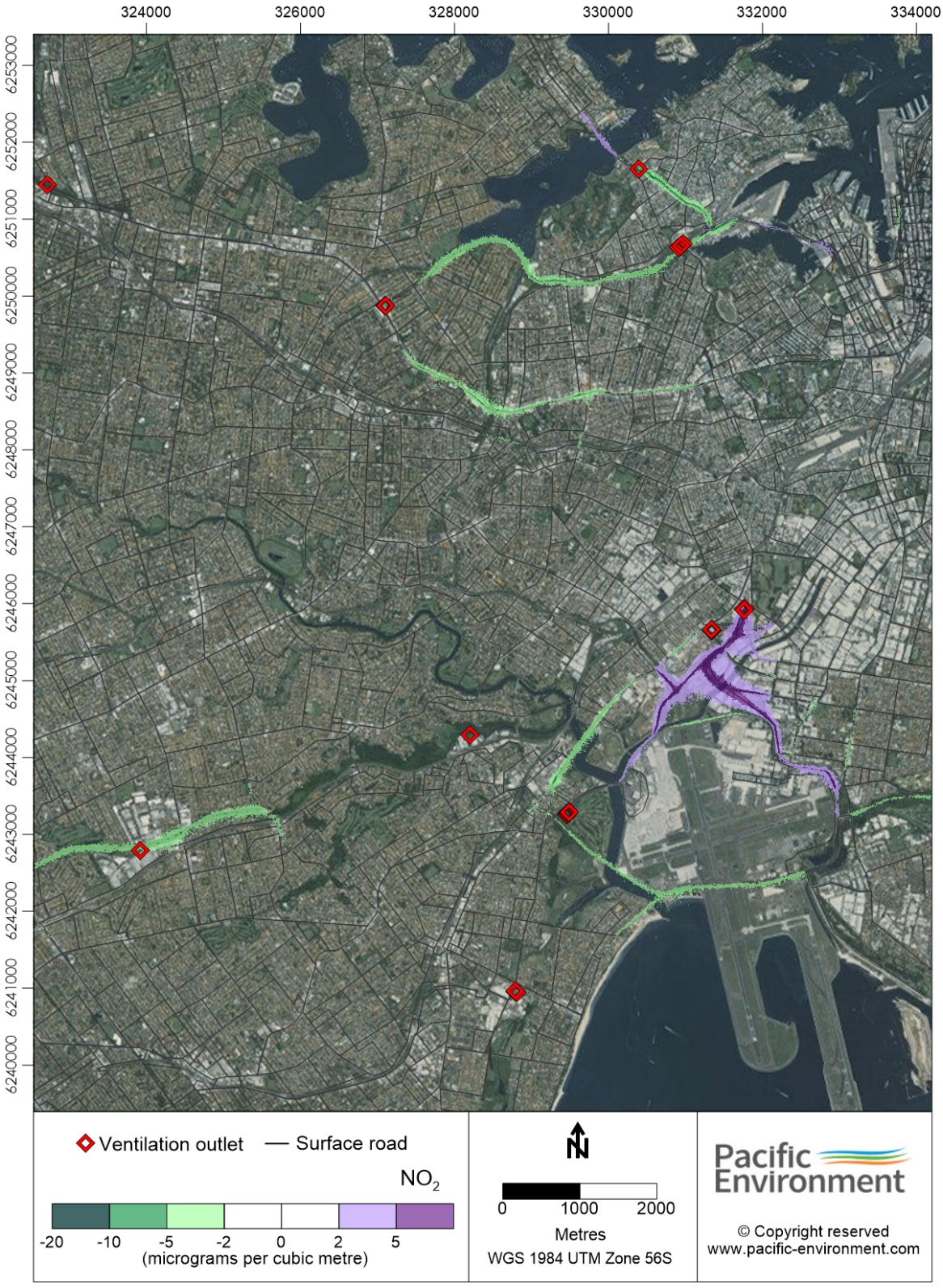


Figure K-23 **Contour plot of change in annual mean NO_2 concentration in the 2033 cumulative scenario (all sources, 2033-DSC minus 2033-DM)**