Logika Noise Air Quality CONSULTANTS

# Quantifying the impact of Euro 7 options in six European cities

for Transport & Environment

08 June 2023

TRANSPORT & ENVIRONMENT

## Document Control

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# Contents

# 1 Introduction

The European Commission has recently set out proposals for regulating the type approval of emissions from motor vehicles under the Euro 7 standard, covering cars, vans, lorries and buses[1]. The purpose of this report is to provide real-world context and analysis to inform decisions on the Euro 7 standard. It quantifies the effects that changes to the Euro 7 specification might have on ambient air quality in six major European cities. The report builds on previous work carried out on behalf of the Clean Cities Campaign and Transport & Environment which quantified the benefits that future Low Emissions Zones (LEZs)[2,3] and Zero Emissions Zones (ZEZs)[4] might have on air quality at worst-case locations within these same cities[5].

The work has been carried out by Air Quality Consultants Ltd (AQC), on behalf of Transport and Environment (T&E). Additional data has been kindly provided by the Clean Cities Campaign, International Council on Clean Transportation (ICCT) and The Real Urban Emissions (TRUE) Initiative.

The Ambient Air Quality Directive 2008/50/EC, abbreviated as AAQD, requires that limit value compliance must be achieved at all relevant locations within each member state, and the Court of Justice of the European Union has clarified that compliance must be assessed at monitoring states where people's exposure is greatest, and not based on an average across an area[6]. Within each member state, the location with the maximum reported concentration thus defines when and if a limit value is achieved. While a range of assessment methods might ultimately be required, the most common approach in reporting compliance with the AAQD limit values is to use measurements made at fixed monitoring sites. This study thus focusses on air quality conditions at the fixed monitor measuring the highest concentrations within each city, and predicts the effect that changes to the Euro 7 specification would have in these locations. The cities considered are:

- Madrid;
- Paris;
- Brussels;
- Milan;
- Warsaw; and

[1] Roman numerals have not been used to describe the Euro 7 standard for heavy duty vehicles within the Commission's Euro 7 Proposal and so are not used here. Euro 7 thus describes revised standards for cars, vans, lorries and buses.
[2] LEZs regulate access to urban areas based on the emissions of motorised vehicles[3].
[3] https://cleancitiescampaign.org/wp-content/uploads/2022/07/The-development-trends-of-low-emission-and-zero-emission-zones-in-Europe-1.pdf
[4] ZEZs restrict the use of vehicles with internal combustion engines[3].
[5] https://www.transportenvironment.org/wp-content/uploads/2023/05/zones-compressed.pdf
[6] https://www.clientearth.org/latest/latest-updates/news/clean-air-closer-for-brussels-after-top-eu-court-ruling/

- London[7].

The European Commission's Impact Assessment[8] into its Euro 7 proposals (the IA) considered several alternative Policy Options (POs), and predicted the reductions in total EU27 traffic emissions of NOx and primary $PM_{2.5}$ associated with each PO in the future (to 2050). Rather than using detailed local modelling, this study has taken the approach of combining recent ambient measurements with the projections within the Commission's Impact Assessment to:

- predict the future city-specific reductions in concentrations that could be delivered by the Euro 7 proposals;
- consider the sensitivity of this modelling to NOx exhaust emissions assumptions in the context of alternative evidence on real-world emissions from Euro 6 and earlier vehicles;
- consider the differences in concentrations in relation to brake wear emissions likely to be delivered by the Proposal when compared with the POs modelled in the IA, and to consider the effects of bringing forward the introduction of the more stringent brake emissions limit of 3 mg/km; and
- show the effects on concentrations of different potential tyre wear limits.

[7] While London is outside of the EU27, it is still of interest to consider the potential effects of Euro 7 on air quality in London.
[8] https://op.europa.eu/en/publication-detail/-/publication/213be66d-5f1c-11ed-92ed-01aa75ed71a1/language-en

# 2 Methodology

## 2.1 Conceptual Overview

Air quality modelling can often be complex, combining multiple threads of highly detailed assumptions. The relative uncertainty around different assumptions is not always the same and it is not always obvious that the additional complexity gives more accurate results.

The approach taken here seeks to cut through much of the complexity often associated with predictive air quality modelling. It forecasts ambient concentrations without recourse to dispersion algorithms. It uses recent measured concentrations, combined with the relative changes to predicted future transport emissions, to estimate future ambient concentrations. While such a simplified approach does have clear limitations, which are identified in Section 2.8 and are intended to be fully transparent, the outcomes are suitable to demonstrate the effects that different Euro 7 options might have on worst-case concentrations within each city. While more complex modelling might add detail, it would not necessarily result in more accurate future-year predictions or change the outcomes of this study.

The approach taken can be summarised as:

1) Define the road increment to measured annual mean $NO_2$ and $PM_{2.5}$ concentrations – in most cases this is taken as the maximum measured concentration minus the measured concentration from a representative local background monitoring site;
2) Predict the change in traffic-related NOx and $PM_{2.5}$ emissions over time and associated with the Euro 7 options – this was done using the reported emissions in the IA; and
3) Assume that the relative change to local traffic-related NOx and $PM_{2.5}$ emissions will translate directly as a relative change to the local increment of NOx and $PM_{2.5}$ concentrations.

It has also been necessary to make some broad assumptions regarding changes over time to the concentration increment from other sources (i.e. the local background), but this is not the focus of the study and so these assumptions are coarse and intended to be conservative.

The measured concentrations, their source-apportionment, and the approach to projecting future trends in concentrations from other sources, are those used in the study which considered the effects of LEZs and ZEZs. These are described in detail within that report[5].

The current study uses the same approach, as described in the LEZ/ZEZ report[5], of linearly-scaling the measured local road concentration increments based on relative forecast changes to total traffic emissions. However, in this case, the forecast changes to traffic emissions are not derived from locally-derived fleet data and bottom-up emissions calculations. Instead, they are derived directly from the IA.

The overall approach has thus been to use the emissions results presented in the IA to:

a) calculate the relative change in emissions from 2018 in each scenario; and

b) approximate the equivalent emissions changes which would result from T&E's suggested policy alternatives.

The relative changes to emissions from the IA's 2018 baseline have then been applied directly to the 2019-measured local road increments.

The effects of using alternative NOx emissions factors, derived by Mulholland et al., 2022[9] (see Section 2.4 of the LEZ/ZEZ study[5]) has also been tested, by scaling the IA projections by the relative differences between COPERT-based and Mulholland et al.,-based predictions in each city calculated during the LEZ/ZEZ study.

In carrying out this analysis, a number of inconsistencies have been identified in the emissions data reported in the IA itself. These have necessitated some subtly different approaches around specific details. The approaches used are set out in detail in Sections 2.3 to 2.7. The relevant inconsistencies in the IA are summarised in Section 2.2.

## 2.2 Inconsistencies in Commission's Impact Assessment

Table 13 of Annex 4 to the IA does not contain total $PM_{2.5}$ emissions savings for lorries and buses. The numbers in the rows labelled as $PM_{2.5}$ total are for NOx.

Table 11, of Annex 4 to the IA sets out predicted emissions savings of total $PM_{2.5}$ from cars and vans under Policy Option (PO)1. However, these values appear to be inconsistent with other figures presented in the same document. They suggest, for example, total baseline $PM_{2.5}$ emissions from cars and vans of ca 14 kt in 2040, while Figure 2 in the main IA document puts the value at more than twice this figure. While it is possible that the values have been mislabelled (equivalent tables in Annex 4 list $PM_{2.5}$ from brake wear only), the values also do not appear to represent brake wear emissions. It is not clear what they do describe.

Tables 12, 13 and 14 of Annex 4 to the IA all set out emissions savings for total $PM_{2.5}$ and for exhaust $PM_{2.5}$ from lorries and buses. Notwithstanding the incorrect data for total $PM_{2.5}$ in Table 13 (see above), these figures do not appear to be consistent with Figure 2 in the main IA document. For example, the reported emissions savings in Tables 12, and 14 of Annex 4 suggest baseline emissions of total $PM_{2.5}$ of ca 16.2 kt in 2040 (i.e. 3.88 x 100/23.88), with the exhaust component being ca. 7.1 kt (3.88 x 100/54.35). This means that the combined non-exhaust component in the baseline must be ca. 9.1 kt. Repeating the same calculation for each year in the tables shows that the non-exhaust component in the modelled baseline reduces from 11.2 kt in 2018 to 5.9 kt in 2050. Speculatively, this downward trajectory might be caused by some assumptions regarding use of regenerative braking in lorries, but these assumptions do not appear to be mentioned in the report. In fact, Table 8C of Annex 4 suggests that no such assumptions have been made for lorries. In any event the downward trajectory for total non-exhaust emissions from buses and lorries does

[9] https://www.sciencedirect.com/science/article/pii/S2666691X22000318

not appear to be consistent with Figure 2 in the main IA document. It is thus unclear why the results in Tables 12, 13 and 14 suggest this strong trend of reducing non-exhaust $PM_{2.5}$ emissions from lorries and buses in the baseline case.

## 2.3 Calculating the Relative Changes to Emissions over Time from the IA Data

Total 2018 predicted baseline traffic emissions from the EU27 are set out in Tables 11 and 12 of the main IA document[10]. Tables 11 to 14 predict the emissions savings compared with the concurrent future baselines (i.e. Policy Option 0 – 'PO 0'). These are presented both in kt and as a percentage. The kt change multiplied by the percentage change gives the concurrent baseline (i.e. the baseline from which the percentage change was calculated). The absolute and relative changes have thus been combined to calculate the equivalent future baseline in each year, and from this, the absolute total emissions associated with each scenario were calculated. As a check on this approach, the calculated 2035 baseline figures have been compared with those set out in Tables 11 and 12. This shows that back-calculating the future baseline figures for each year provides a good representation of those used in the IA. The total EU27 emissions trajectories derived in this way are set out in Figure 2-1 to Figure 2-3.

[10] This contained all the 2018 emissions data needed except for total PM2.5 from lorries and buses, which was extracted from Figure 2 in the main IA document.

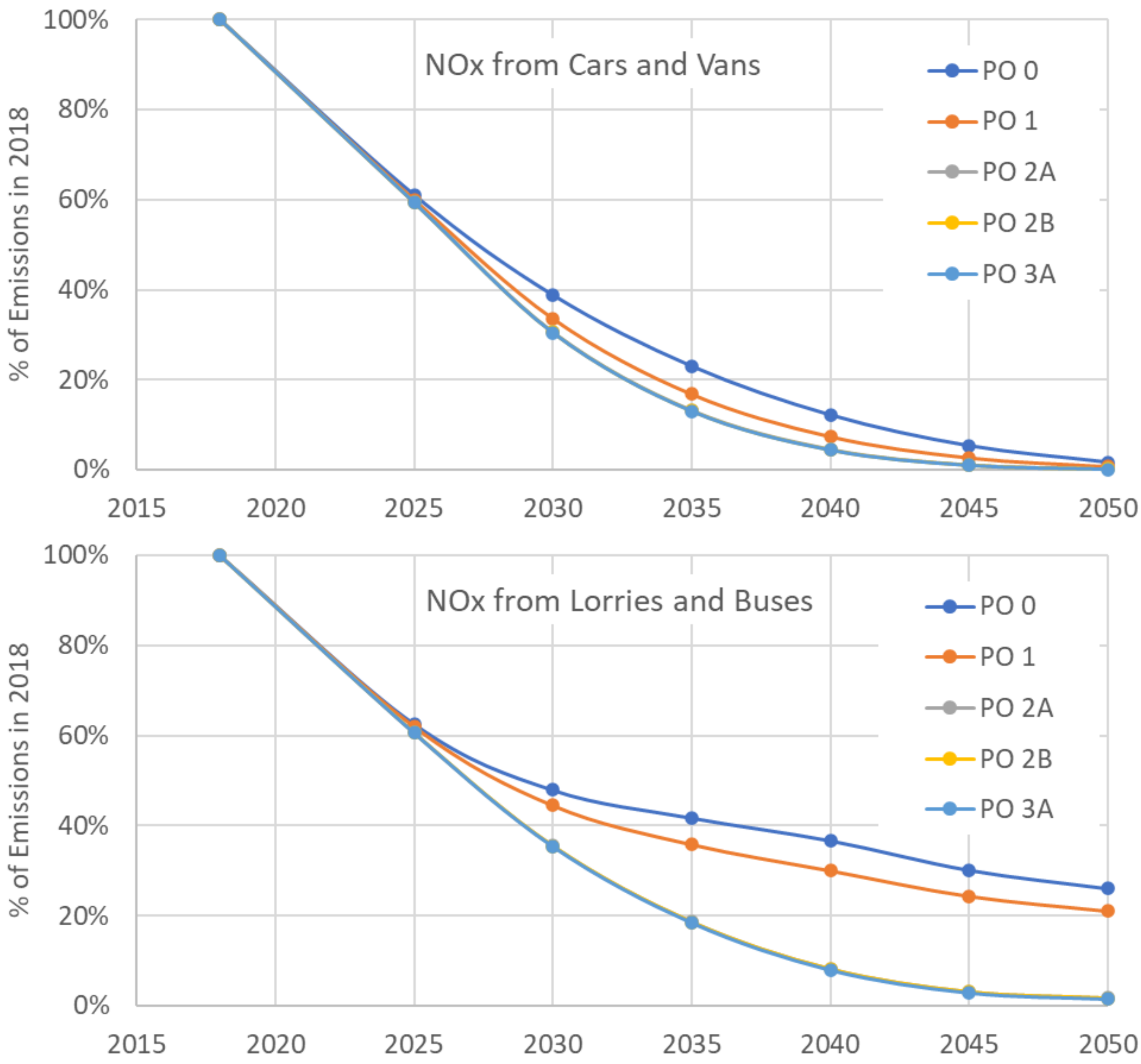
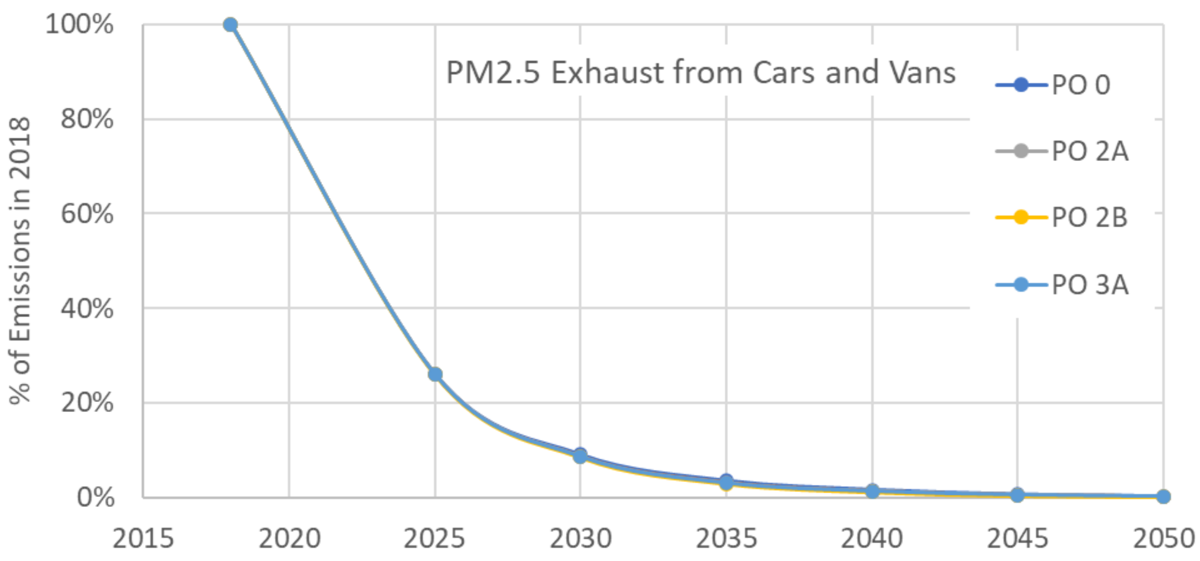



**Figure 2-1: NOx Emissions Projections Taken from the IA**



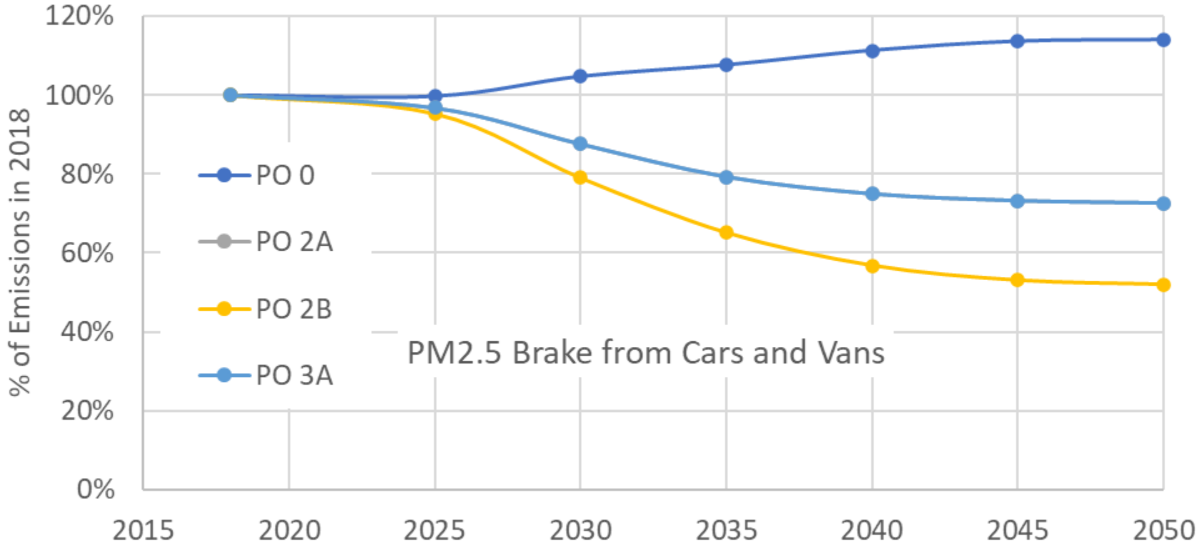




**Figure 2-2: Exhaust and Brake $PM_{2.5}$ Emissions Projections from Cars and Vans Taken from the IA**

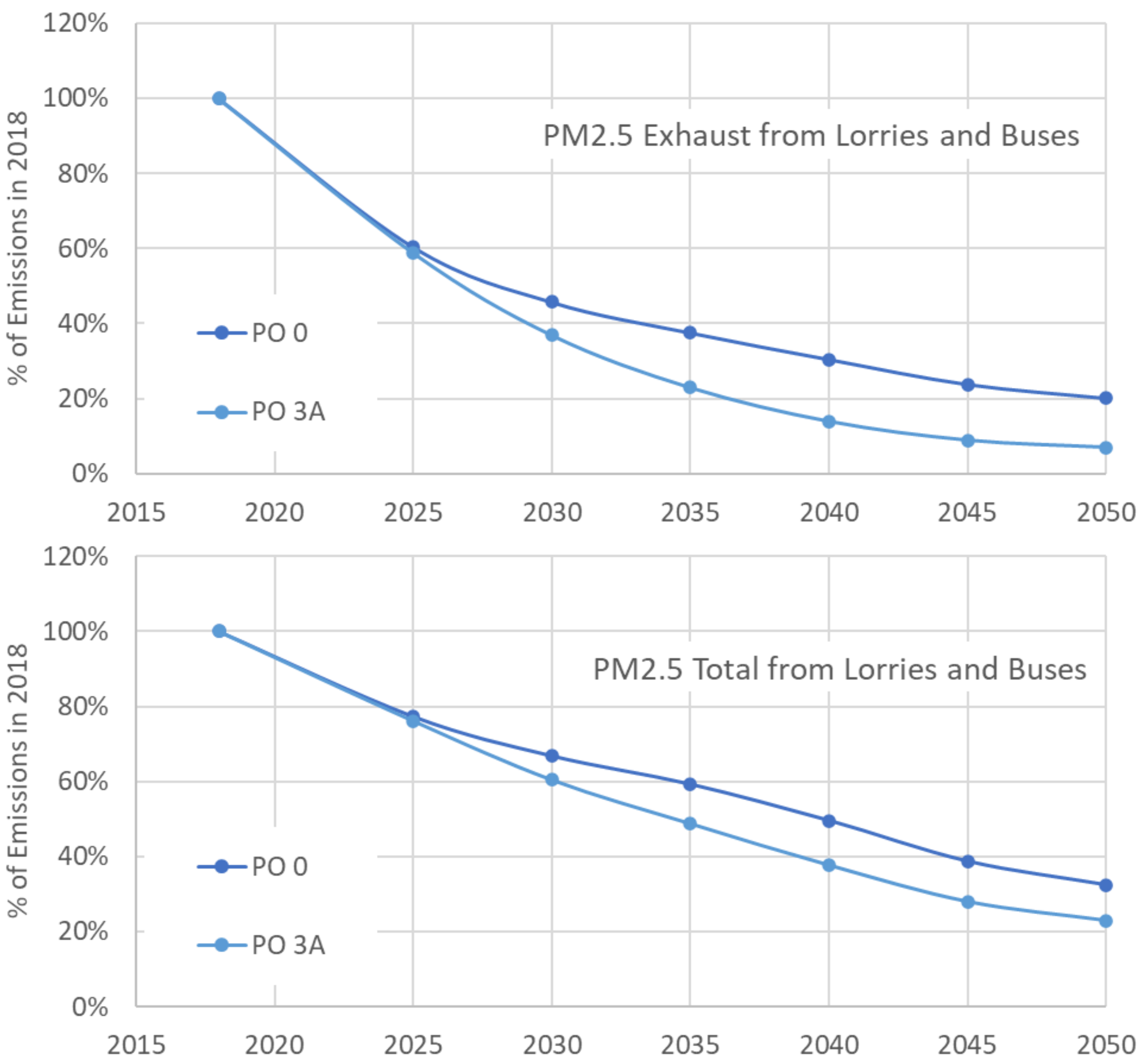



**Figure 2-3: Exhaust and Total $PM_{2.5}$ Emissions Projections from Lorries and Buses Taken from the IA**

## 2.4 Predicting Future $NO_2$ Concentrations

The values shown in Figure 2-1 have been used to scale the car and van emissions component of road-$NO_2$ concentrations measured in 2019. The relative contributions to locally-measured concentrations have been calculated following the approach set out in Section 2 of the LEZ/ZEZ study[5]. The relative contributions of cars and vans to total NOx emissions from road traffic in 2018/2019 in each city are set out in Table 2-1.

**Table 2-1: Relative Contribution of Different Sources to total NOx Emissions from Road Traffic in the Existing Baseline**

| Vehicle Category | Madrid | Paris | Brussels | Milan | Warsaw | London |
|---|---|---|---|---|---|---|
| **exhaust - cars and vans** | 66% | 71% | 59% | 55% | 63% | 87%[a] |
| **exhaust - lorries and buses** | 33% | 29% | 41% | 41% | 35% | 13% |
| **exhaust - L category vehicles** | 1% | 1% | 0.2% | 3% | 1% | -[a] |

[a] emissions from L category vehicles are included in the car and van figures for London.

## 2.5 Predicting $NO_2$ Concentrations Associated with Alternative Emissions Factors

To test whether the projections in the IA (and consequently those presented here, based on the IA and Proposal figures) are overly optimistic by virtue of the NOx emissions factors used, tests have been carried out which incorporate the emissions factors derived from remote sensing campaigns across Europe presented by Mulholland et al., 2022[9] (see Figure 2-1 of the LEZ/ZEZ study[5]). For the LEZ study in Madrid, Paris, Brussels, Milan and Warsaw, NOx emissions in 2019, 2025, and 2030 were calculated first using the COPERT emissions functions and then using data provided directly by Mulholland et al.. For each city, and for each of these years, the relative difference between the road-$NO_2$ predictions using each method was calculated. The road-$NO_2$ concentrations predicted using the IA figures have then been multiplied by these values. For London, the Mulholland : COPERT ratios for Paris have been used.

In practice, the city-specific road-$NO_2$ concentrations predicted using the Mulholland et al., 2022 data are extremely similar to those derived using COPERT. This means that the adjustments applied in this test are very small.

## 2.6 Predicting Emissions Associated with Alternative Brake Wear Scenarios

The aim of this part of the analysis is to:

a) predict brake-wear emissions associated the Proposal;

b) predict the effect on emissions of bringing forward the more stringent brake emissions limit of 3 mg/km so that it comes into force in 2030 instead of 2035 in the Proposal; and

c) predict the effect on emissions of bringing forward the more stringent brake emissions limit of 3 mg/km so that it comes into force in 2025 (i.e. the same as ‘b’ but 5 years earlier).

The Proposal is for the same emission limit to apply equally to passenger cars (M1) and vans (N1). This will be a limit of 7 mg/km ($PM_{10}$) until 2035, and 3 mg/km thereafter ($PM_{10}$). The IA did not, however, apply the same emission limit to both cars and vans. In all POs considered in the IA, brake wear emissions from vans were assumed to be 75% higher than those from cars.

The IA assumed that the emissions limits of 7 mg/km $PM_{10}$ (PO2a and PO2b) would also effectively be emissions factors for $PM_{10}$, with the emissions factor for $PM_{2.5}$ being 39.8% of the emissions limit[11]. The emissions factors for $PM_{2.5}$ used in the IA are set out in Table 2-2.

**Table 2-2: Brake Wear $PM_{2.5}$ Emissions Factors used in Commission's Impact Assessment (mg/km) [a]**

| Vehicle Class | PO 0 and PO 1 | PO 2a and PO 3a | PO $2_b$ |
|---|---|---|---|
| **Cars** | 4.37 | 2.8 | 2.0 |
| **Vans** | 7.71 | 4.9 | 3.5 |
| **$PM_{10}$ Emissions Limit** | N/A | 7 | 5 |

[a] Taken from Table 9 of Annex 4 to the Impact Assessment

These values can be compared with the assumptions (for slow-speed roads) in the 2019 Guidebook, which are summarised in Table 2-1 of the LEZ/ZEZ study[5]. The baseline (PO 0/PO 1) factors for cars are within the range of those for hybrid vehicles in the Guidebook, while those for vans are lower than suggested in the Guidebook.

Because the ratio between brake emissions from vans and cars (for both $PM_{10}$ and $PM_{2.5}$) was held constant across all POs, and thus all assessment years considered in the IA, it is not possible to extrapolate the effect of applying a more stringent emissions limit to vans without separately predicting the relative contribution made by cars and vans to the IA results.

The first step was, thus, to quantify the rate at which each PO in the IA was predicted to take effect. This calculation is shown in Table 2-3. The bottom half of Table 2-3 shows that the rate at which the different POs were assumed to take effect over the vehicle fleet is the same; this is interpreted as a measure of penetration into the fleet of vehicles meeting the new standard. This rate of change is shown in Figure 2-4.

[11] Which aligns with the 0.39/0.98 ratio in the 2019 Emissions Inventory Guidebook (https://www.eea.europa.eu/publications/emep-eea-guidebook-2019).

**Table 2-3: Total Brake Wear Emissions of $PM_{2.5}$ from EU27 Predicted in the Impact Assessment**

| Policy Option | 2018 | 2025 | 2030 | 2035 | 2040 | 2045 | 2050 |
|---|---|---|---|---|---|---|---|
| **Total Brake Wear Emissions from EU27 kt [a]** | | | | | | | |
| **Baseline** | 14.9 | 14.9 | 15.6 | 16.0 | 16.6 | 16.9 | 17.0 |
| **PO 2A/PO 3A** | 14.9 | 14.4 | 13.1 | 11.8 | 11.2 | 10.9 | 10.8 |
| **PO 2B** | 14.9 | 14.2 | 11.8 | 9.7 | 8.5 | 7.9 | 7.7 |
| **Total Brake Wear Emissions from EU27 as a Percentage of those in the Concurrent Baseline (PO 0/PO 1)** | | | | | | | |
| **PO 2A/PO 3A** | 100% | 97% | 84% | 74% | 67% | 64% | 64% |
| **PO 2B** | 100% | 96% | 75% | 61% | 51% | 47% | 46% |
| **Percent of Reduction from PO 0/PO 1 Achieved in 2050 [b]** | | | | | | | |
| **PO 2A/PO 3A** | 0% | 7% | 41% | 69% | 88% | 98% | 100% |
| **PO 2B** | 0% | 7% | 41% | 69% | 88% | 98% | 100% |

[a] 2018 values given in Table 11 of the Impact Assessment main report. Future-year values calculated from the values in Tables 11 to 14 of Annex 4 to the Impact Assessment.

[b] e.g. PO2B brings a 9.2 kt reduction in 2050 (17.0 - 7.7). The reduction in 2030 (15.6 – 11.8 = 3.8 kt) is 41% of this value.

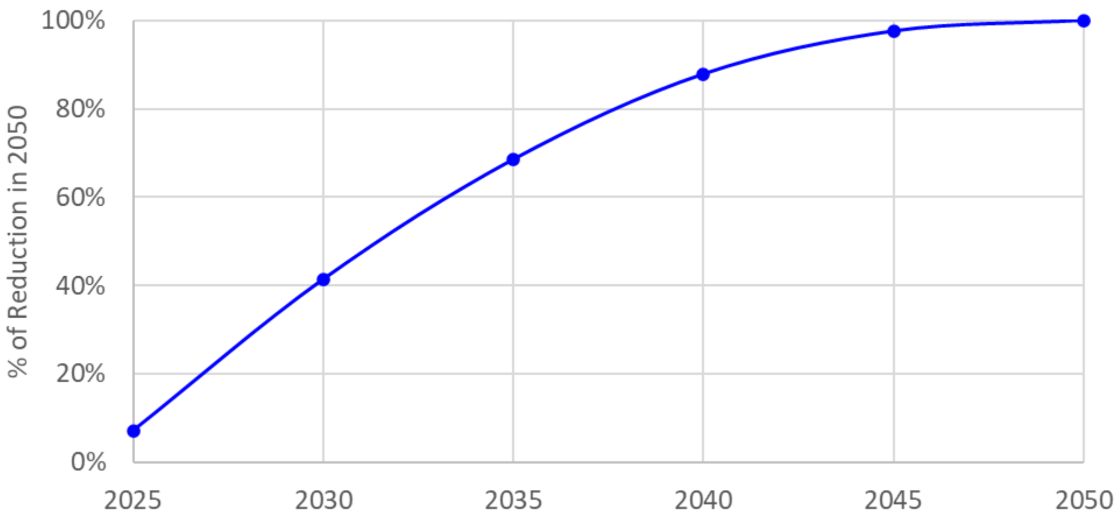



**Figure 2-4: Reduction from PO 0/PO 1 Brake Wear $PM_{2.5}$ Emissions as A Percentage of the Reduction in 2050 (the same curve describes PO 2A, PO 3A, and PO 2B)**

The next step used the compiled traffic data for the five member states considered for the LEZ/ZEZ study[5]. The emissions factors in Table 2-2 (i.e. those used in the IA) were multiplied by the total urban vehicle kilometres of cars and vans in each member state, assuming full penetration of vehicles conforming with each emission limit (e.g. for PO 2a, assuming that 100% of cars emit an average of 2.0 mg/km $PM_{2.5}$). This showed that, while there were some minor (sub-decimal point) differences between the countries, brake $PM_{2.5}$ emissions derived using the PO 2a/PO 3a emissions factors were all 64% of those derived using the baseline (PO 0/PO 1) emissions factors. Emissions derived using the PO 2b emissions factors were all 46% of those derived using the baseline (PO 0/PO 1) emissions factors. As would be expected, these are the same numbers which appear in the 2050 column of Table 2-3, which were derived from the IA predictions. The fact that the values are the same confirms that: a) the urban data for the five member states considered here are broadly representative of the EU27 data upon which the IA was based; and b) any differences between complete fleet penetration and the position for 2050 assumed in the IA is trivial.

Using the urban traffic data compiled for the LEZ study, it has then been possible to re-calculate the total emissions in 2050, applying the PO 2a/PO 3a brake wear emissions factor for cars in Table 2-2 equally to both cars and vans (since both would be subject to the same emissions limit in the Proposal). It has also been possible to calculate the equivalent values with a $PM_{10}$ emissions limit of 3 mg/km, simply following the same approach used in the IA, for limits of 7 and 5 mg/km (i.e. assuming that the average emissions factor for $PM_{10}$ will be 3 mg/km, of which 39.8% (1.19 mg/km) will be $PM_{2.5}$). Applying these emissions factors, $PM_{2.5}$ brake wear emissions in 2050 would be 57% of those in the 2050 baseline if a $PM_{10}$ emission limit of 7 mg/km were applied equally to both cars and vans (with no further tightening to 3 mg/km). This would reduce to 24% if the $PM_{10}$ emission limit (enforced in 2025) were reduced to 3 mg/km.

The rate of penetration of these lower emission limits has been inferred from the modelling in the IA, essentially scaling the revised 2050 figures using the curve in Figure 2-4. Finally, the infiltration rate of vehicles meeting the 3 mg/km emission limit has been offset to simulate introduction dates of January 2030 and 2035. This has used the same curve shown in Figure 2-4, but with the start point delayed from January 2025 as assumed in the IA.

Table 2-4 shows the calculated reductions in $PM_{2.5}$ brake wear emissions, from the concurrent baseline, in each year. These numbers are also shown in Figure 2-5. The five lines shown are:

- **PO 2a/PO 3a:** $PM_{10}$ emissions limits[12] from car brakes of 7 mg/km from 2025, with emissions from van brakes being 75% higher; as reported in Tables 11 to 14 of Annex 4 to the IA;
- **PO 2b:** $PM_{10}$ emissions limits[12] (and factors) from car brakes of 5 mg/km from 2025, with emissions from van brakes being 75% higher; as reported in Tables 11 to 14 of Annex 4 to the IA;
- **Proposal:** $PM_{10}$ emissions limits[12] from car and van brakes of 7 mg/km from 2025 and 3 mg/km from 2035;
- **3 mg/km by 2030**: $PM_{10}$ emissions limits[12] from car and van brakes of 7 mg/km from 2025 and 3 mg/km from 2030; and
- **3 mg/km by 2025:** $PM_{10}$ emissions limits[12] from car and van brakes of 3 mg/km from 2025.

The values for PO2a/PO3a and PO2b are those reported in Tables 11 to 14 of Annex 4 to the IA. The values for the Proposal assumes that the 7 mg/km ($PM_{10}$) emission limit will apply equally to

[12] and emissions factors.

both cars and vans until 2035, before being reduced to 3 mg/km. The blue and grey lines show the effect that an earlier reduction to 3 mg/km would have.

**Table 2-4: Reduction in Brake Wear $PM_{2.5}$ Emissions as a Percentage of those in the Concurrent Baseline**

| Policy Option | 2025 | 2030 | 2035 | 2040 | 2045 | 2050 |
|---|---|---|---|---|---|---|
| **PO 2A/PO 3A** | 3% | 16% | 26% | 33% | 36% | 36% |
| **PO 2B** | 4% | 24% | 39% | 49% | 53% | 54% |
| **Proposal** [a] | 4% | 19% | 34% | 52% | 65% | 72% |
| **3 mg/km by 2030** [b] | 4% | 22% | 45% | 62% | 71% | 75% |
| **3 mg/km by 2025** [c] | 6% | 34% | 55% | 68% | 74% | 76% |

[a] Assuming LCV emissions are no higher than those from cars.

[b] i.e. an emission limit of 7 mg/km ($PM_{10}$) before 2030, and a limit of 3 mg/km ($PM_{10}$) thereafter, with both limits applied equally to cars and vans.

[c] applied equally to cars and vans.

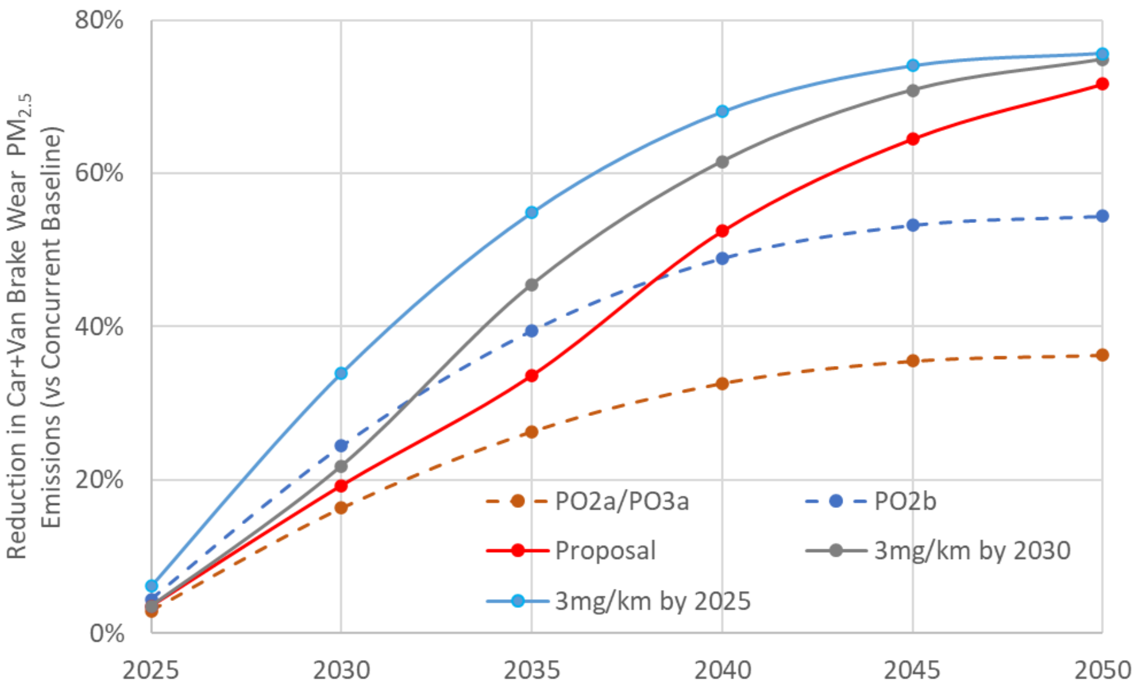



**Figure 2-5: Reduction in Brake Wear $PM_{2.5}$ Emissions as a Percentage of those in the Concurrent Baseline**

The values in Figure 2-5 can then be expressed as a function of the predicted emissions in 2018, as shown in Figure 2-6. It is these values which have been used to scale the car and van brake wear component of concentrations measured in 2019. The brake wear components of measured 2019 concentrations have been calculated following the approach set out in Section 2 of the LEZ/ZEZ study[5]. In particular, Table 2-1 of the LEZ/ZEZ study[5] sets out the various non-exhaust emissions functions which have been combined with the local vehicle fleets to apportion non-exhaust $PM_{2.5}$ concentrations in the base year. The relative contributions of different sources to total $PM_{2.5}$ emissions from road traffic in each city in the 2018/2019 baseline are set out in Table 2-5, below.

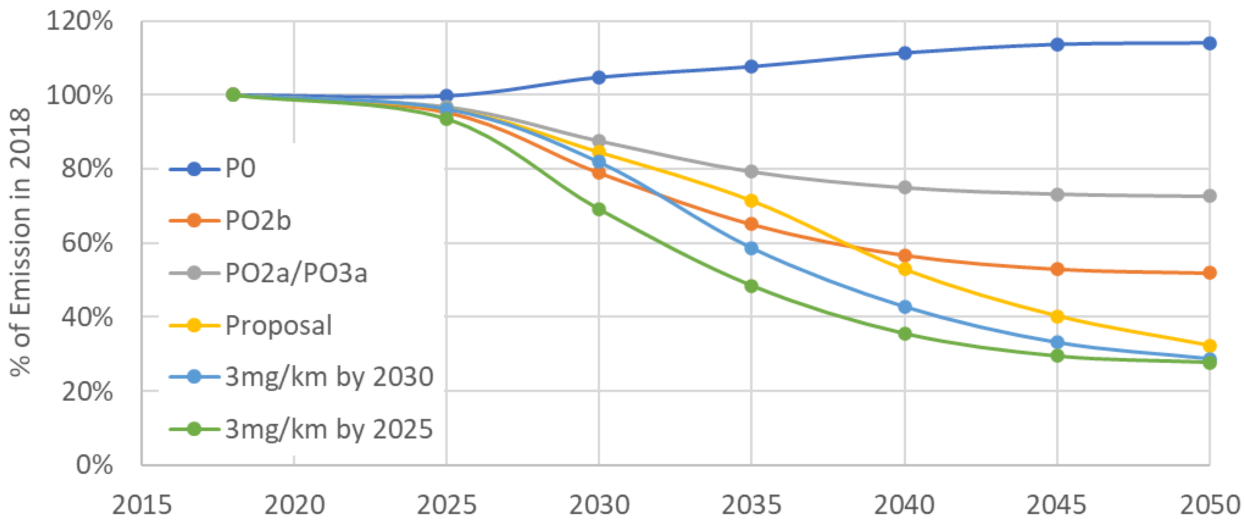



**Figure 2-6: Changes to Brake Wear $PM_{2.5}$ Emissions from Cars and Vans as a Percentage of those in 2018**

**Table 2-5: Relative Contribution of Different Sources to total $PM_{2.5}$ Emissions from Road Traffic in the Existing Baseline**

| Vehicle Category | Madrid | Paris | Brussels | Milan | Warsaw | London |
|---|---|---|---|---|---|---|
| **exhaust - cars and vans** | 34% | 30% | 19% | 25% | 24% | 17%[a] |
| **exhaust - lorries and buses** | 9% | 8% | 13% | 14% | 10% | 2% |
| **exhaust - L category vehicles** | 3% | 1% | 0.3% | 6% | 3% | -[a] |
| **brake wear - cars and vans** | 19% | 23% | 23% | 19% | 23% | 25%[a] |
| **tyre wear - cars and vans** | 16% | 18% | 19% | 16% | 19% | 20%[a] |
| **road wear - cars and vans** | 9% | 11% | 11% | 9% | 11% | 12%[a] |
| **tyre wear - lorries and buses** | 3% | 3% | 5% | 3% | 3% | 8% |
| **brake and road wear - lorries and buses** | 6% | 6% | 10% | 5% | 6% | 16% |
| **Brake, tyre and road wear – L category vehicles** | 1.1% | 0.7% | 0.3% | 3.1% | 1.4% | -[a] |

[a] emissions from L category vehicles are included in the car and van figures for London.

## 2.7 Predicting Emissions Associated with Alternative Tyre Wear Scenarios

The IA did not model alternative tyre wear assumptions, and while the Proposal contains a 'placeholder' for future limits on tyre wear rates, no values have currently been proposed.

A short literature review has been carried out to determine the current variability in tyre wear rates, which might suggest the extent to which the new limits can readily affect emissions. Large uncertainties exist in the measurement of tyre wear rates[13]. While wear rates have been evaluated by two main methods, loss in tyre weight and changes in tyre-tread depth, a wide range of parameters influences the outcome. These includes vehicle type, tyre properties, driving behaviour, season of the year, and to some extent the road/traffic flow characteristics[14,15].

One study[16] has shown that while improving the driving safety characteristics tends to increase wear rates, with a range of increases up to 77% observed, achieving a balance of both driving safety and lower wear rate is not unattainable. The same study showed variations in average wear rates between manufacturers of >40%, suggesting that average wear rates could potentially be reduced by several tens of percent if there were sufficient incentive to do so.

Following the literature review, a series of calculations has been carried out to test the effects of sequentially reduced tyre wear emissions. The effect of reducing tyre-wear emissions by 10%, 20%, 30%, 40%, 50%, 60%, 70%, 80%, 90%, and 100% has been tested. These reductions have been assumed to be driven by wear rate limits that would be introduced in 2025. The penetration of these new tyre-wear limits has then been assumed to follow that used for brake wear in the IA for cars and vans (see Figure 2-4). For example, a 10% reduction in tyre wear emissions would affect all vehicles in 2050, 88% of vehicles in 2040, and 41% of vehicles in 2030, etc.. The effects of these reductions, compared with the concurrent baseline, are shown in Figure 2-7.

Without any policy intervention, total tyre wear emissions are expected to increase in proportion with total traffic volumes. However, since the IA did not separate out this component of the emissions, and because of the apparent inconsistencies in the IA trajectories for non-exhaust emissions from lorries and buses noted in Section 2.2 above, it has not been possible to reliably infer the IA's assumed trajectory for tyre wear emissions in the future baseline PO 0 scenario. For the tyre wear analysis, no growth in traffic volumes has been assumed after 2030 for the tyre-wear component of emissions from lorries and buses. The residual (non-tyre) emissions from lorries and buses have then been adjusted to retain consistency with the total $PM_{2.5}$ emissions from lorries and buses forecast in the IA. The contribution of tyre wear to existing measured concentrations has

[13] Non-exhaust vehicle emissions of particulate matter and VOC from road traffic: A review - ScienceDirect
[14] http://dx.doi.org/10.1016/j.scitotenv.2022.156950
[15] Impact of change in traffic flow on vehicle non-exhaust $PM_{2.5}$ and $PM_{10}$ emissions: A case study of the M25 motorway, UK
[16] https://assets.adac.de/image/upload/v1639663105/ADAC-eV/KOR/Text/PDF/Tyre_wear_particles_in_the_environment_zkmd3a.pdf

been calculated following the approach set out in Section 2 of the LEZ/ZEZ study[5] study and using the values set out in Table 2-1, above.

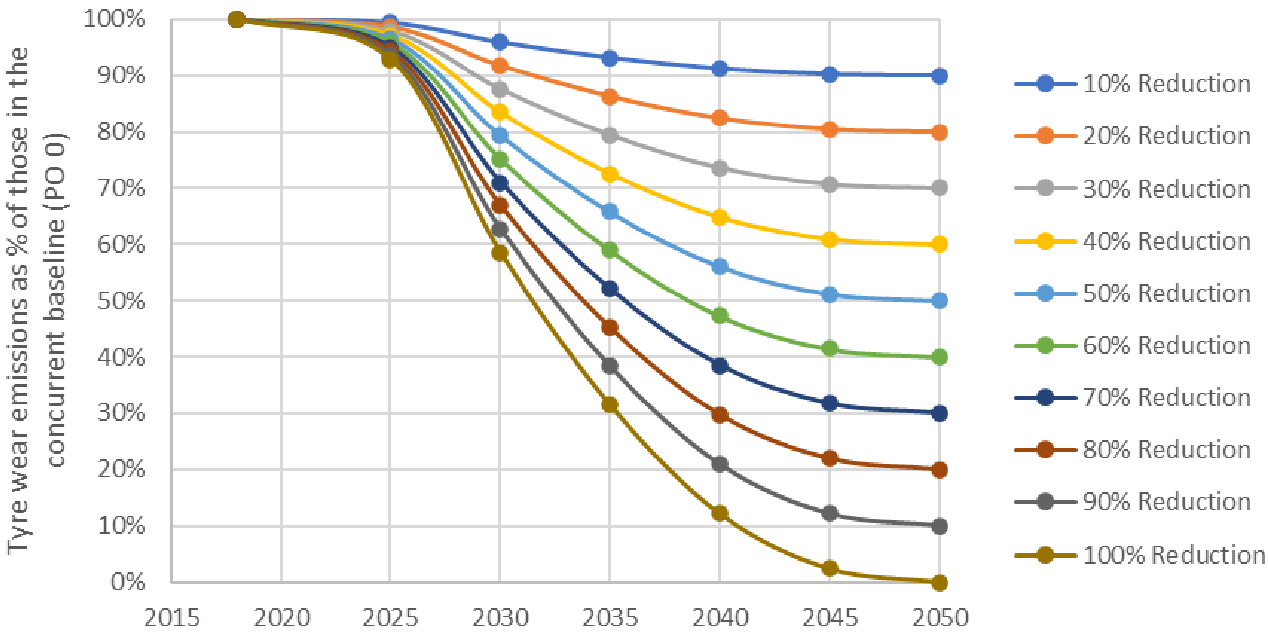



**Figure 2-7: Tyre Wear $PM_{2.5}$ Emissions as a Percentage of those in the Concurrent Baseline under 10 hypothetical emissions-reductions scenarios**

## 2.8 Limitations

An important limitation relates to an assumption that the local road concentration increment at the fixed monitoring sites in each city is apportioned directly in line with, and will thus follow, the future trajectories of the EU27-average emissions. There will inevitably be national, regional, and local variations in emissions trajectories over time, but the approach of transcribing the projections derived from the IA directly onto local concentrations is nevertheless considered to provide a reasonable indication of the effects that the IA projections would have on concentrations. As for the LEZ/ZEZ study[5], the worst-case measurements in each city are used here to represent worst-case conditions which might occur generally within that city and are not tied specifically to the geographic location of that monitor.

Another implicit assumption is of a linear NOx to $NO_2$ relationship. In practice, this assumption will cause a small over-prediction in the $NO_2$ savings which can be expected in the future.

The limitations in projecting background concentrations to 2030, which were highlighted in the LEZ/ZEZ study[5], are compounded by the approach for the Euro 7 analysis of predicting concentrations in 2050. It is anticipated that background concentrations in the future could be much lower than have been predicted here. However, there is no way to reliably predict background concentrations in 2050, particularly for $PM_{2.5}$.

While much of the data used here were those developed for the LEZ/ZEZ study[5], that study used local vehicle fleet projections and an assumption of no traffic growth. This current study uses EU27-average forecasts of both fleet renewal and traffic growth. This means that the future baseline values used in the two studies do not align. It was considered that further data manipulation to ensure alignment implies more accuracy in the data than exists, and would in practice weaken the validity of the projections. The necessary approach also means that there is an inconsistency around assumptions of traffic growth between the tyre-wear analysis and the other elements of the Euro 7 analysis.

The rate of penetration of a new tyre-wear emissions limit has been based on that used in the IA for brake wear from cars and vans. This is unlikely to be wholly appropriate for lorries and buses and may also be inappropriate for tyre wear from cars and vans.

The forecasts here are based on those in the IA and are subject to limitations of those projections. They will also be sensitive to all underlying uncertainties regarding emissions per vehicle of NOx and $PM_{2.5}$.

Notwithstanding these limitations, these projections are considered to provide a reasonable representation of the improvements in city-specific concentrations that might be expected as a result of implementation of the Euro 7 proposals, and of the elements of those proposals which might be changed.

# 3 Results

## 3.1 Madrid

### $NO_2$

Table 3-1 sets out the predicted annual mean $NO_2$ concentrations at a worst-case location in Madrid in the future baseline and under PO 3A modelled in the IA[17]. The predicted $NO_2$ concentrations from local roads using COPERT modelling are also shown in Figure 3-1. Road increments to $NO_2$ concentrations are expected to fall appreciably in the future in any event, but implementing Euro 7 as modelled as PO 3A in the IA would significantly accelerate the improvements. Annual mean $NO_2$ concentrations at a worst-case location in Madrid would be 4.5 µg/m$^3$ lower in 2040 with this implementation of Euro 7 than without Euro 7, and the road increment to concentrations in 2050 would be 84% lower than would otherwise be the case.

The relative reductions to total $NO_2$ concentrations (i.e. including the contributions from other sources) are smaller, but as explained in Section 2, the main focus of this study has been on the local road component, with the contributions from other sources most likely to have been over-predicted, particularly beyond 2030. Combined with action to reduce emissions from other sectors, the PO 3A version of Euro 7 has the potential to deliver significant reductions to $NO_2$ concentrations in Madrid.

**Table 3-1: Predicted Annual Mean $NO_2$ Concentrations at a Worst-case Location in Madrid under Three Alternative Specifications for the Euro 7 Emissions Standard**

| Pollutant | Scenario | 2019 | 2025 | 2030 | 2035 | 2040 | 2045 | 2050 |
|---|---|---|---|---|---|---|---|---|
| **$NO_2$ from Local Roads (COPERT)** | **PO 0** | 30.8 | 19.1 | 13.1 | 9.3 | 6.6 | 4.5 | 3.4 |
| | **PO 3A** | 30.8 | 18.6 | 10.1 | 4.9 | 2.1 | 0.9 | 0.5 |
| **$NO_2$ from Local Roads (Mulholland et al., 2022[9])** | **PO 0** | 30.8 | 19.2 | 13.1 | 9.3 | 6.6 | 4.5 | 3.4 |
| | **PO 3A** | 30.8 | 18.6 | 10.1 | 4.9 | 2.1 | 0.9 | 0.5 |
| **Total $NO_2$ (COPERT)** | **PO 0** | 53.4 | 36.9 | 26.9 | 22.2 | 19.5 | 17.4 | 16.3 |
| | **PO 3A** | 53.4 | 36.4 | 24.0 | 17.8 | 15.0 | 13.8 | 13.4 |
| **Total $NO_2$ (Mulholland et al., 2022[9])** | **PO 0** | 53.4 | 37.0 | 26.9 | 22.2 | 19.5 | 17.4 | 16.3 |
| | **PO 3A** | 53.4 | 36.5 | 24.0 | 17.8 | 15.0 | 13.8 | 13.4 |

[17] Values are shown using COPERT and Mulholland et al., 2022[9] emissions factors, but in practice the results are not materially different.

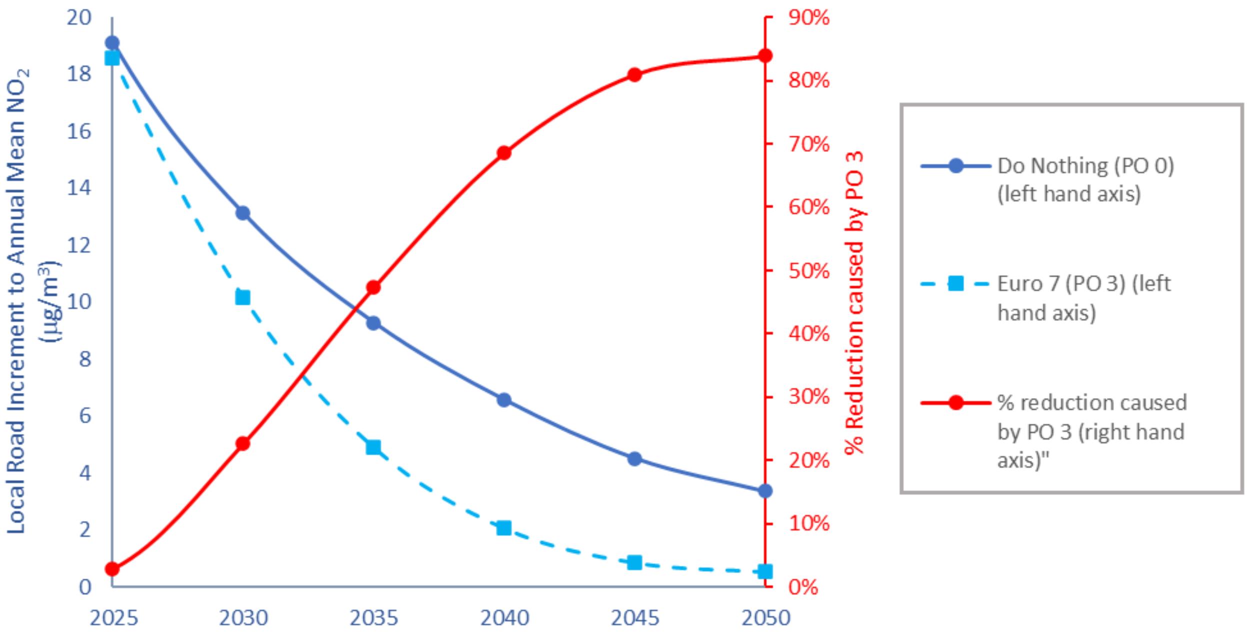



**Figure 3-1: Predicted Annual Mean $NO_2$ Concentrations from Local Roads at a Worst-case Location in Madrid with and Without Euro 7 (Option 3A)**

## $PM_{2.5}$ from Brakes

Table 3-2 summarises the predicted annual mean $PM_{2.5}$ concentrations at a worst-case location in Madrid. It tests the effect of different assumptions regarding Euro 7 brake-wear emissions limits for cars and vans. The predicted $PM_{2.5}$ increments from local roads are also shown in Figure 3-2. The values shown relate to total road-$PM_{2.5}$ (and total $PM_{2.5}$ from all sources) and not only the brake component of concentrations.

As explained in Section 2, the Proposal is predicted to deliver savings over and above those in PO 3A of the IA owing to applying the same emission limit for both cars and vans, while the IA made different assumptions for cars vs vans. $PM_{2.5}$ from roads is expected to reduce considerably in the future baseline (Do Nothing = PO 0), mainly because of reductions in the exhaust component, but also with the widespread adoption of regenerative braking by 2050. The Proposal is expected to deliver further savings, amounting to a 27% reduction in the 2050 baseline local road $PM_{2.5}$. These savings would be accelerated if the 3 mg/km limit were brought forward; for example introducing the 3 mg/km limit in 2025 would reduce local road $PM_{2.5}$ by 8% in 2035 when compared with the Proposal.

When compared with total concentrations, the relative improvements are smaller, but it must be recognised that this study has not considered the potential effects of actions to address emissions from other sources. Addressing current elevated $PM_{2.5}$ concentrations will require positive action to be taken across a broad range of sources, including brake wear from road vehicles.

**Table 3-2: Predicted Annual Mean $PM_{2.5}$ Concentrations at a Worst-case Location in Madrid under Three Alternative Specifications for the Brake Wear Component of the Euro 7 Emissions Standard**

| Pollutant | Scenario | 2019 | 2025 | 2030 | 2035 | 2040 | 2045 | 2050 |
|---|---|---|---|---|---|---|---|---|
| $PM_{2.5}$ from Local Roads | **PO 0** | 4.2 | 3.0 | 2.7 | 2.6 | 2.6 | 2.5 | 2.5 |
| | **PO 2b** | 4.2 | 3.0 | 2.5 | 2.3 | 2.1 | 2.0 | 2.0 |
| | **PO 2a/PO 3a** | 4.2 | 3.0 | 2.6 | 2.4 | 2.3 | 2.2 | 2.1 |
| | **Proposal** | 4.2 | 3.0 | 2.6 | 2.3 | 2.1 | 1.9 | 1.8 |
| | **3 mg/km by 2030** [a] | 4.2 | 3.0 | 2.5 | 2.2 | 2.0 | 1.9 | 1.8 |
| | **3 mg/km by 2025** [b] | 4.2 | 2.9 | 2.4 | 2.1 | 1.9 | 1.8 | 1.8 |
| Total $PM_{2.5}$ | **PO 0** | 11.9 | 10.6 | 10.4 | 10.2 | 10.2 | 10.2 | 10.1 |
| | **PO 2b** | 11.9 | 10.6 | 10.1 | 9.9 | 9.7 | 9.7 | 9.6 |
| | **PO 2a/PO 3a** | 11.9 | 10.6 | 10.2 | 10.0 | 9.9 | 9.8 | 9.8 |
| | **Proposal** | 11.9 | 10.6 | 10.2 | 9.9 | 9.7 | 9.6 | 9.4 |
| | **3 mg/km by 2030** [a] | 11.9 | 10.6 | 10.2 | 9.8 | 9.6 | 9.5 | 9.4 |
| | **3 mg/km by 2025** [b] | 11.9 | 10.6 | 10.1 | 9.8 | 9.6 | 9.5 | 9.4 |

[a] i.e. $PM_{10}$ emissions limits from car and van brakes of 7 mg/km from 2025 and 3 mg/km from 2030

[b] i.e. $PM_{10}$ emissions limits from car and van brakes of 3 mg/km from 2025.

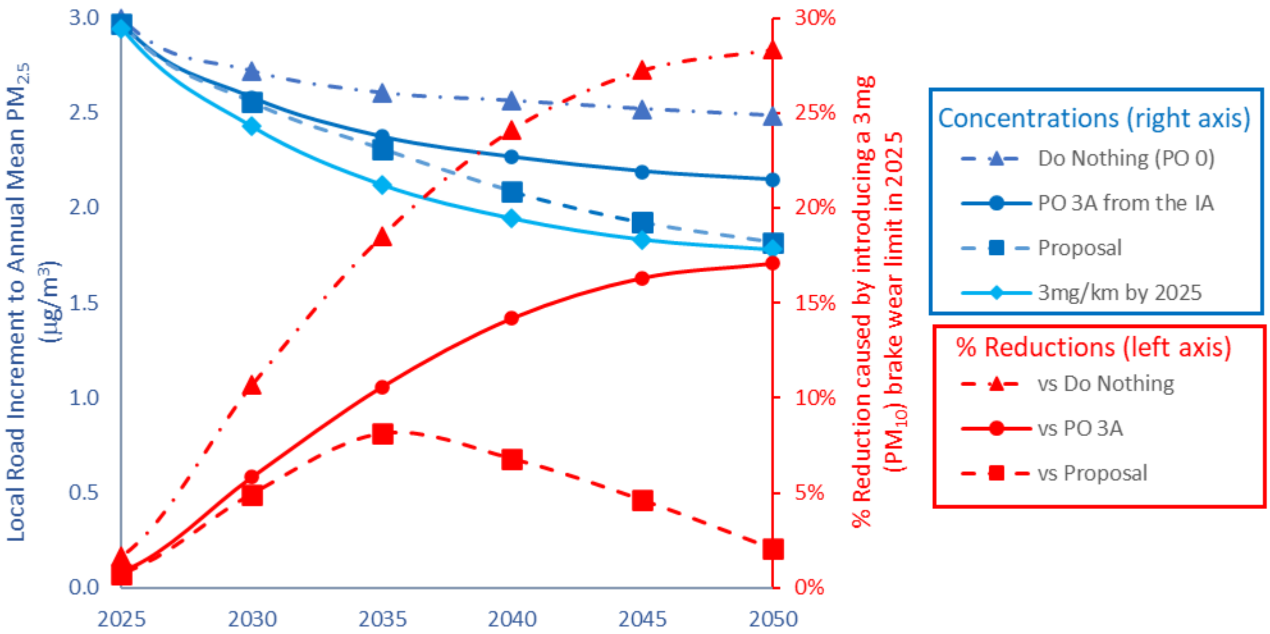



**Figure 3-2: Predicted Annual Mean $PM_{2.5}$ Concentrations from Local Roads at a Worst-case Location in Madrid without Euro 7 and with Alternative Specifications for the Brake Wear Component of the Euro 7 Emissions Standard**

## $PM_{2.5}$ from Tyres

Table 3-3 shows the predictions for annual mean $PM_{2.5}$ under different assumed effects of tyre wear rate limits. In each case, brake wear, road wear, and exhaust emissions are assumed to align with the Proposal. The specification of the tyre wear limits in the Proposal is not yet known, but a literature search (see Section 2) suggests that an ambitious limit on tyre wear rates might reduce overall tyre wear by several tens of percent. For the purpose of this analysis, it is assumed that this will have an equivalent effect on tyre wear $PM_{2.5}$ emissions. Table 3-3 shows the effects that a range of different reductions would deliver. The % reductions refer to the average reduction in wear rates (and thus assumed emissions) from a regulated tyre when compared with an unregulated model.

Figure 3-3 summarises some of the results from Table 3-3. It shows the predicted $PM_{2.5}$ concentrations from local roads under various assumptions regarding reductions in wear from regulated tyres. It also shows the relative changes to the concentrations predicted without any limits on tyre wear.

As explained above, $PM_{2.5}$ from local roads is expected to fall considerably in the future as a result of reductions in exhaust emissions, with further reductions expected through changes to brakes. A tyre wear standard which delivered a 40% reduction in emissions from the affected tyres would cause a further 20% reduction in $PM_{2.5}$ from local roads in 2050.

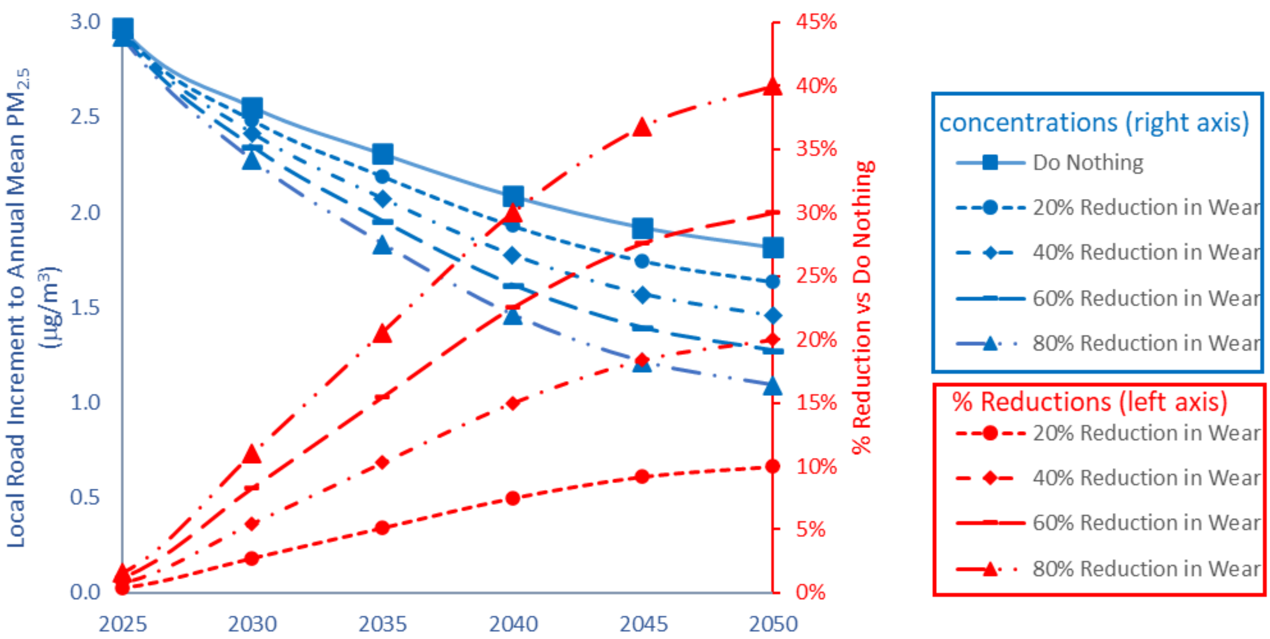



**Figure 3-3: Predicted Annual Mean $PM_{2.5}$ Concentrations from Local Roads at a Worst-case Location in Madrid with Alternative Assumptions for Tyre Wear Limits ('Do Nothing' here assumes the Proposal is enacted for brake wear)**

As noted for controls on brake wear, when compared with total concentrations, the relative improvements are smaller, but this study has not considered the potential effects of actions to address emissions from other sources.  Addressing current elevated $PM_{2.5}$ concentrations will require positive action to be taken across a broad range of sectors, and limiting emissions from tyres is an important component of this.

**Table 3-3: Predicted Annual Mean $PM_{2.5}$ Concentrations at a Worst-case Location in Madrid under Alternative Assumed Effects of the Tyre Wear Component of the Euro 7 Emissions Standard**

| Pollutant | % Reduction in Average $PM_{2.5}$ Emissions from Fully-Regulated Tyres [a] | 2019 | 2025 | 2030 | 2035 | 2040 | 2045 | 2050 |
|---|---|---|---|---|---|---|---|---|
| $PM_{2.5}$ from Local Roads | 0% | 4.2 | 3.0 | 2.6 | 2.3 | 2.1 | 1.9 | 1.8 |
| | 10% | 4.2 | 3.0 | 2.5 | 2.3 | 2.0 | 1.8 | 1.7 |
| | 20% | 4.2 | 3.0 | 2.5 | 2.2 | 1.9 | 1.7 | 1.6 |
| | 30% | 4.2 | 3.0 | 2.5 | 2.1 | 1.9 | 1.7 | 1.5 |
| | 40% | 4.2 | 2.9 | 2.4 | 2.1 | 1.8 | 1.6 | 1.5 |
| | 50% | 4.2 | 2.9 | 2.4 | 2.0 | 1.7 | 1.5 | 1.4 |
| | 60% | 4.2 | 2.9 | 2.3 | 2.0 | 1.6 | 1.4 | 1.3 |
| | 70% | 4.2 | 2.9 | 2.3 | 1.9 | 1.5 | 1.3 | 1.2 |
| | 80% | 4.2 | 2.9 | 2.3 | 1.8 | 1.5 | 1.2 | 1.1 |
| | 90% | 4.2 | 2.9 | 2.2 | 1.8 | 1.4 | 1.1 | 1.0 |
| Total $PM_{2.5}$ | 0% | 11.9 | 10.6 | 10.2 | 9.9 | 9.7 | 9.6 | 9.4 |
| | 10% | 11.9 | 10.6 | 10.2 | 9.9 | 9.6 | 9.5 | 9.4 |
| | 20% | 11.9 | 10.6 | 10.1 | 9.8 | 9.6 | 9.4 | 9.3 |
| | 30% | 11.9 | 10.6 | 10.1 | 9.8 | 9.5 | 9.3 | 9.2 |
| | 40% | 11.9 | 10.6 | 10.0 | 9.7 | 9.4 | 9.2 | 9.1 |
| | 50% | 11.9 | 10.6 | 10.0 | 9.6 | 9.3 | 9.1 | 9.0 |
| | 60% | 11.9 | 10.6 | 10.0 | 9.6 | 9.2 | 9.0 | 8.9 |
| | 70% | 11.9 | 10.6 | 9.9 | 9.5 | 9.2 | 8.9 | 8.8 |
| | 80% | 11.9 | 10.6 | 9.9 | 9.5 | 9.1 | 8.8 | 8.7 |
| | 90% | 11.9 | 10.5 | 9.9 | 9.4 | 9.0 | 8.8 | 8.6 |

[a] assuming equivalent effective reductions from C1, C2, and C3 tyres.

## 3.2 Paris

### $NO_2$

Table 3-4 sets out the predicted annual mean $NO_2$ concentrations at a worst-case location in Paris in the future baseline and under PO 3A modelled in the IA[17]. The predicted $NO_2$ concentrations from local roads using COPERT modelling are also shown in Figure 3-4. Road increments to $NO_2$ concentrations are expected to fall appreciably in the future in any event, but implementing Euro 7 as modelled as PO 3A in the IA would significantly accelerate the improvements. Annual mean $NO_2$ concentrations at a worst-case location in Paris would be 6.2 µg/m$^3$ lower in 2040 with this implementation of Euro 7 than without Euro 7, and the road increment to concentrations in 2050 would be 88% lower than would otherwise be the case.

The relative reductions to total $NO_2$ concentrations (i.e. including the contributions from other sources) are smaller, but as explained in Section 2, the main focus of this study has been on the local road component, with the contributions from other sources most likely to have been over-predicted, particularly beyond 2030. Combined with action to reduce emissions from other sectors, the PO 3A version of Euro 7 has the potential to deliver significant reductions to $NO_2$ concentrations in Paris.

**Table 3-4: Predicted Annual Mean $NO_2$ Concentrations at a Worst-case Location in Paris under Three Alternative Specifications for the Euro 7 Emissions Standard**

| Pollutant | Scenario | 2019 | 2025 | 2030 | 2035 | 2040 | 2045 | 2050 |
|---|---|---|---|---|---|---|---|---|
| **$NO_2$ from Local Roads (COPERT)** | **PO 0** | 44.8 | 27.7 | 18.7 | 12.9 | 8.8 | 5.8 | 4.1 |
| | **PO 3A** | 44.8 | 26.9 | 14.5 | 6.8 | 2.7 | 0.9 | 0.5 |
| **$NO_2$ from Local Roads (Mulholland et al., 2022[9])** | **PO 0** | 44.8 | 27.8 | 18.7 | 12.9 | 8.8 | 5.8 | 4.1 |
| | **PO 3A** | 44.8 | 27.0 | 14.5 | 6.8 | 2.7 | 0.9 | 0.5 |
| **Total $NO_2$ (COPERT)** | **PO 0** | 73.3 | 51.7 | 39.0 | 29.5 | 23.4 | 20.4 | 18.7 |
| | **PO 3A** | 73.3 | 50.9 | 34.8 | 23.3 | 17.2 | 15.5 | 15.1 |
| **Total $NO_2$ (Mulholland et al., 2022[9])** | **PO 0** | 73.3 | 51.8 | 39.0 | 29.5 | 23.4 | 20.4 | 18.7 |
| | **PO 3A** | 73.3 | 51.0 | 34.8 | 23.3 | 17.2 | 15.5 | 15.1 |

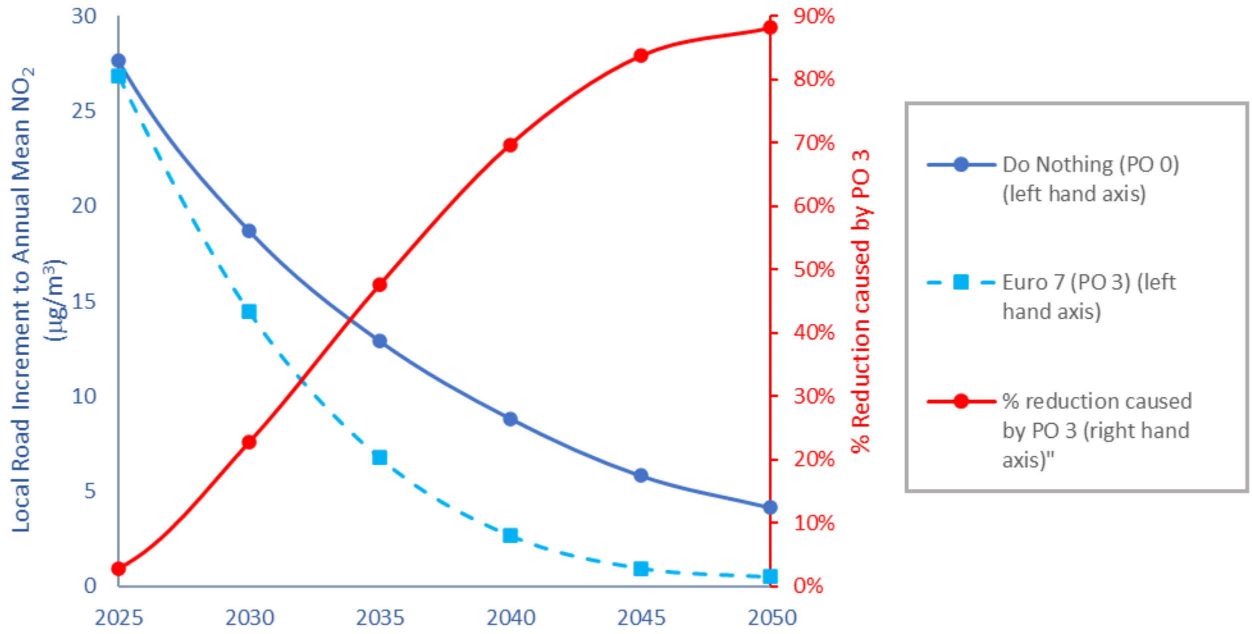



**Figure 3-4: Predicted Annual Mean $NO_2$ Concentrations from Local Roads at a Worst-case Location in Paris with and Without Euro 7 (Option 3A)**

## $PM_{2.5}$ from Brakes

Table 3-5 summarises the predicted annual mean $PM_{2.5}$ concentrations at a worst-case location in Paris. It tests the effect of different assumptions regarding Euro 7 brake-wear emissions limits for cars and vans. The predicted $PM_{2.5}$ increments from local roads are also shown in Figure 3-5. The values shown relate to total road-$PM_{2.5}$ (and total $PM_{2.5}$ from all sources) and not only the brake component of concentrations.

As explained in Section 2, the Proposal is predicted to deliver savings over and above those in PO 3A of the IA owing to applying the same emission limit for both cars and vans, while the IA made different assumptions for cars vs vans. $PM_{2.5}$ from roads is expected to reduce considerably in the future baseline (Do Nothing = PO 0), mainly because of reductions in the exhaust component, but also with the widespread adoption of regenerative braking by 2050. The Proposal is expected to deliver further savings, amounting to a 29% reduction in the 2050 baseline local road $PM_{2.5}$. These savings would be accelerated if the 3 mg/km limit were brought forward; for example introducing the 3 mg/km limit in 2025 would reduce local road $PM_{2.5}$ by 9% in 2035 when compared with the Proposal.

When compared with total concentrations, the relative improvements are smaller, but it must be recognised that this study has not considered the potential effects of actions to address emissions from other sources. Addressing current elevated $PM_{2.5}$ concentrations will require positive action to be taken across a broad range of sources, including brake wear from road vehicles.

**Table 3-5: Predicted Annual Mean $PM_{2.5}$ Concentrations at a Worst-case Location in Paris under Three Alternative Specifications for the Brake Wear Component of the Euro 7 Emissions Standard**

| Pollutant | Scenario | 2019 | 2025 | 2030 | 2035 | 2040 | 2045 | 2050 |
|---|---|---|---|---|---|---|---|---|
| $PM_{2.5}$ from Local Roads | PO 0 | 6.0 | 4.4 | 4.1 | 4.0 | 4.0 | 3.9 | 3.9 |
| | PO 2b | 6.0 | 4.4 | 3.8 | 3.4 | 3.2 | 3.1 | 3.0 |
| | PO 2a/PO 3a | 6.0 | 4.4 | 3.9 | 3.6 | 3.5 | 3.4 | 3.3 |
| | Proposal | 6.0 | 4.4 | 3.8 | 3.5 | 3.2 | 2.9 | 2.8 |
| | 3 mg/km by 2030 [a] | 6.0 | 4.4 | 3.8 | 3.3 | 3.0 | 2.8 | 2.7 |
| | 3 mg/km by 2025 [b] | 6.0 | 4.3 | 3.6 | 3.2 | 2.9 | 2.8 | 2.7 |
| Total $PM_{2.5}$ | PO 0 | 13.6 | 12.1 | 11.7 | 11.6 | 11.6 | 11.6 | 11.5 |
| | PO 2b | 13.6 | 12.0 | 11.4 | 11.0 | 10.8 | 10.7 | 10.7 |
| | PO 2a/PO 3a | 13.6 | 12.0 | 11.5 | 11.2 | 11.1 | 11.0 | 10.9 |
| | Proposal | 13.6 | 12.0 | 11.5 | 11.1 | 10.8 | 10.6 | 10.4 |
| | 3 mg/km by 2030 [a] | 13.6 | 12.0 | 11.4 | 10.9 | 10.7 | 10.5 | 10.3 |
| | 3 mg/km by 2025 [b] | 13.6 | 12.0 | 11.3 | 10.8 | 10.6 | 10.4 | 10.3 |

[a] i.e. $PM_{10}$ emissions limits from car and van brakes of 7 mg/km from 2025 and 3 mg/km from 2030

[b] i.e. $PM_{10}$ emissions limits from car and van brakes of 3 mg/km from 2025.

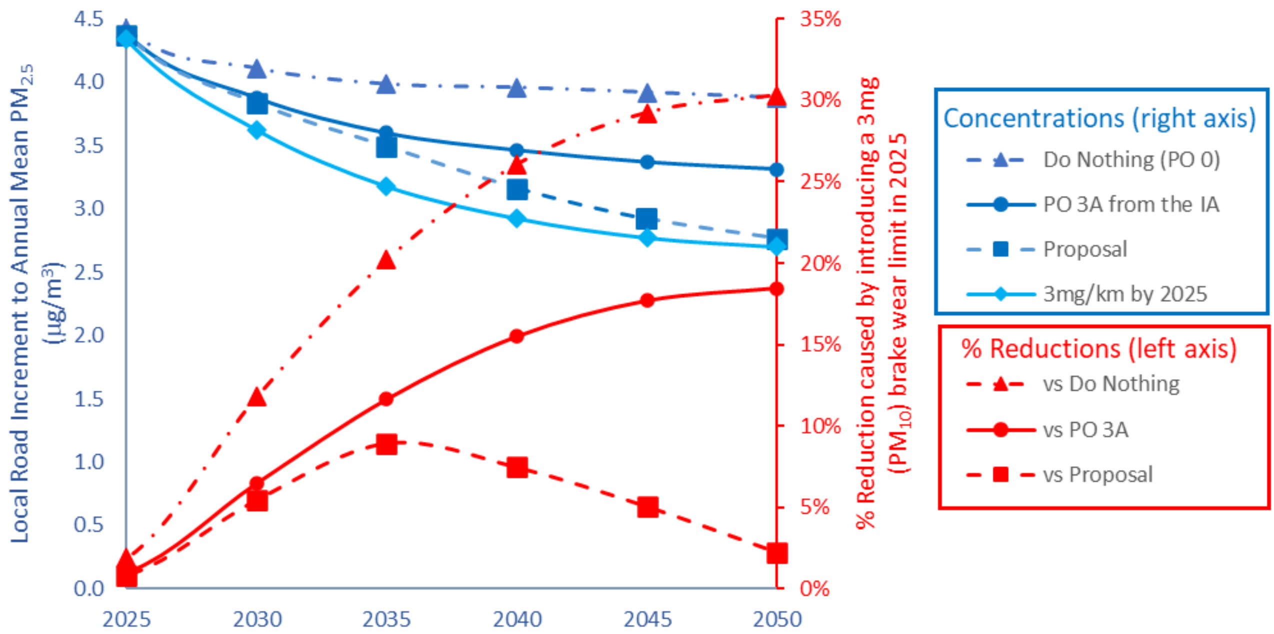



**Figure 3-5: Predicted Annual Mean $PM_{2.5}$ Concentrations from Local Roads at a Worst-case Location in Paris without Euro 7 and with Alternative Specifications for the Brake Wear Component of the Euro 7 Emissions Standard**

## $PM_{2.5}$ from Tyres

Table 3-6 shows the predictions for annual mean $PM_{2.5}$ under different assumed effects of tyre wear rate limits. In each case, brake wear emissions are assumed to align with the Proposal. The specification of the tyre wear limits in the Proposal is not yet known, but a literature search (see Section 2) suggests that an ambitious limit on tyre wear rates might reduce overall tyre wear by several tens of percent. For the purpose of this analysis, it is assumed that this will have an equivalent effect on tyre wear $PM_{2.5}$ emissions. Table 3-6 shows the effects that a range of different reductions would deliver. The % reductions refer to the average reduction in wear rates (and thus assumed emissions) from a regulated tyre when compared with an unregulated model.

Figure 3-6 summarises some of the results from Table 3-6. It shows the predicted $PM_{2.5}$ concentrations from local roads under various assumptions regarding reductions in wear from regulated tyres. It also shows the relative changes to the concentrations predicted without any limits on tyre wear.

As explained previously, $PM_{2.5}$ from local roads is expected to fall considerably in the future as a result of reductions in exhaust emissions, with further reductions expected through changes to brakes. A tyre wear standard which delivered a 40% reduction in emissions from the affected tyres would cause a further 21% reduction in $PM_{2.5}$ from local roads in 2050.

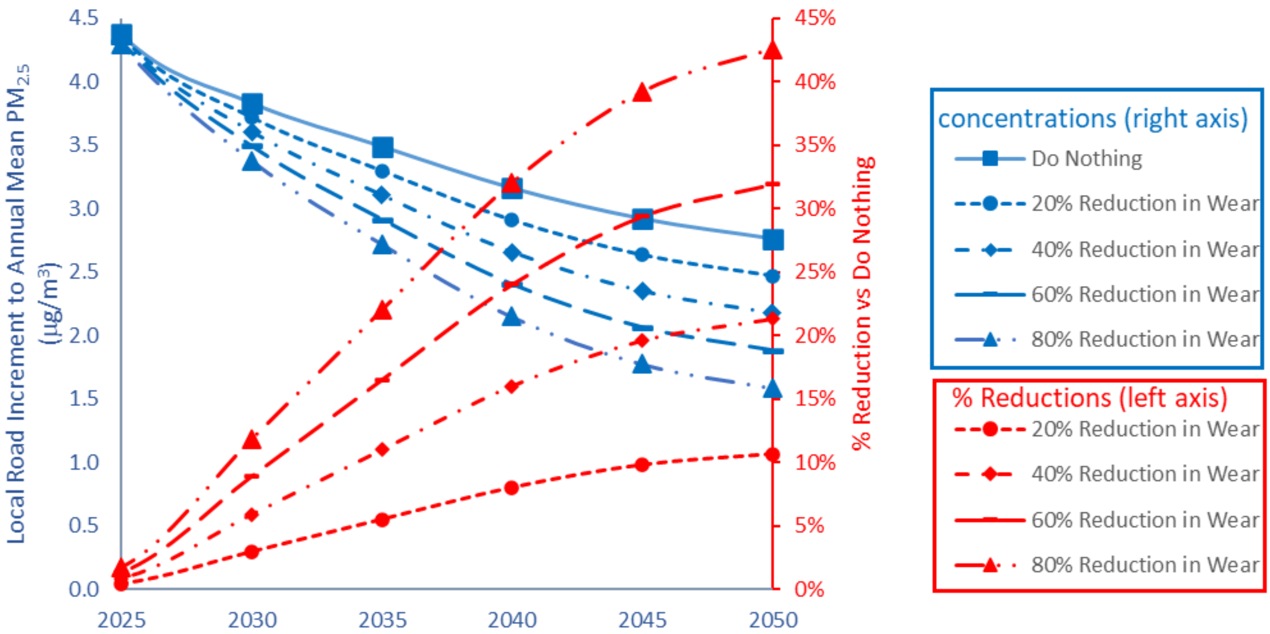



**Figure 3-6: Predicted Annual Mean $PM_{2.5}$ Concentrations from Local Roads at a Worst-case Location in Paris with Alternative Assumptions for Tyre Wear Limits ('Do Nothing' here assumes the Proposal is enacted for brake wear)**

As noted for controls on brake wear, when compared with total concentrations, the relative improvements are smaller, but this study has not considered the potential effects of actions to address emissions from other sources. Addressing current elevated $PM_{2.5}$ concentrations will require positive action to be taken across a broad range of sectors, and limiting emissions from tyres is an important component of this.

**Table 3-6: Predicted Annual Mean $PM_{2.5}$ Concentrations at a Worst-case Location in Paris under Alternative Assumed Effects of the Tyre Wear Component of the Euro 7 Emissions Standard**

| Pollutant | % Reduction in Average $PM_{2.5}$ Emissions from Fully-Regulated Tyres [a] | 2019 | 2025 | 2030 | 2035 | 2040 | 2045 | 2050 |
|---|---|---|---|---|---|---|---|---|
| $PM_{2.5}$ from Local Roads | 0% | 6.0 | 4.4 | 3.8 | 3.5 | 3.2 | 2.9 | 2.8 |
| | 10% | 6.0 | 4.4 | 3.8 | 3.4 | 3.0 | 2.8 | 2.6 |
| | 20% | 6.0 | 4.4 | 3.7 | 3.3 | 2.9 | 2.6 | 2.5 |
| | 30% | 6.0 | 4.3 | 3.7 | 3.2 | 2.8 | 2.5 | 2.3 |
| | 40% | 6.0 | 4.3 | 3.6 | 3.1 | 2.7 | 2.3 | 2.2 |
| | 50% | 6.0 | 4.3 | 3.6 | 3.0 | 2.5 | 2.2 | 2.0 |
| | 60% | 6.0 | 4.3 | 3.5 | 2.9 | 2.4 | 2.1 | 1.9 |
| | 70% | 6.0 | 4.3 | 3.4 | 2.8 | 2.3 | 1.9 | 1.7 |
| | 80% | 6.0 | 4.3 | 3.4 | 2.7 | 2.1 | 1.8 | 1.6 |
| | 90% | 6.0 | 4.3 | 3.3 | 2.6 | 2.0 | 1.6 | 1.4 |
| Total $PM_{2.5}$ | 0% | 13.6 | 12.0 | 11.5 | 11.1 | 10.8 | 10.6 | 10.4 |
| | 10% | 13.6 | 12.0 | 11.4 | 11.0 | 10.7 | 10.4 | 10.2 |
| | 20% | 13.6 | 12.0 | 11.4 | 10.9 | 10.5 | 10.3 | 10.1 |
| | 30% | 13.6 | 12.0 | 11.3 | 10.8 | 10.4 | 10.1 | 10.0 |
| | 40% | 13.6 | 12.0 | 11.2 | 10.7 | 10.3 | 10.0 | 9.8 |
| | 50% | 13.6 | 12.0 | 11.2 | 10.6 | 10.2 | 9.8 | 9.7 |
| | 60% | 13.6 | 11.9 | 11.1 | 10.5 | 10.0 | 9.7 | 9.5 |
| | 70% | 13.6 | 11.9 | 11.1 | 10.5 | 9.9 | 9.6 | 9.4 |
| | 80% | 13.6 | 11.9 | 11.0 | 10.4 | 9.8 | 9.4 | 9.2 |
| | 90% | 13.6 | 11.9 | 11.0 | 10.3 | 9.7 | 9.3 | 9.1 |

[a] assuming equivalent effective reductions from C1, C2, and C3 tyres.

## 3.3 Brussels

### $NO_2$

Table 3-7 sets out the predicted annual mean $NO_2$ concentrations at a worst-case location in Brussels in the future baseline and under PO 3A modelled in the IA[17]. The predicted $NO_2$ concentrations from local roads using COPERT modelling are also shown in Figure 3-7. Road increments to $NO_2$ concentrations are expected to fall appreciably in the future in any event, but implementing Euro 7 as modelled as PO 3A in the IA would significantly accelerate the improvements. Annual mean $NO_2$ concentrations at a worst-case location in Brussels would be 4.4 µg/m$^3$ lower in 2040 with this implementation of Euro 7 than without Euro 7, and the road increment to concentrations in 2050 would be 92% lower than would otherwise be the case.

The relative reductions to total $NO_2$ concentrations (i.e. including the contributions from other sources) are smaller, but as explained in Section 2, the main focus of this study has been on the local road component, with the contributions from other sources most likely to have been over-predicted, particularly beyond 2030. Combined with action to reduce emissions from other sectors, the PO 3A version of Euro 7 has the potential to deliver significant reductions to $NO_2$ concentrations in Brussels.

**Table 3-7: Predicted Annual Mean $NO_2$ Concentrations at a Worst-case Location in Brussels under Three Alternative Specifications for the Euro 7 Emissions Standard**

| Pollutant | Scenario | 2019 | 2025 | 2030 | 2035 | 2040 | 2045 | 2050 |
|---|---|---|---|---|---|---|---|---|
| **$NO_2$ from Local Roads (COPERT)** | **PO 0** | 26.8 | 16.5 | 11.4 | 8.2 | 6.0 | 4.2 | 3.2 |
| | **PO 3A** | 26.8 | 16.0 | 8.7 | 4.1 | 1.6 | 0.5 | 0.2 |
| **$NO_2$ from Local Roads (Mulholland et al., 2022[9])** | **PO 0** | 26.8 | 16.6 | 11.4 | 8.2 | 6.0 | 4.2 | 3.2 |
| | **PO 3A** | 26.8 | 16.1 | 8.7 | 4.1 | 1.6 | 0.5 | 0.2 |
| **Total $NO_2$ (COPERT)** | **PO 0** | 51.5 | 34.8 | 24.4 | 18.7 | 16.5 | 14.7 | 13.7 |
| | **PO 3A** | 51.5 | 34.4 | 21.7 | 14.6 | 12.1 | 11.0 | 10.7 |
| **Total $NO_2$ (Mulholland et al., 2022[9])** | **PO 0** | 51.5 | 34.9 | 24.4 | 18.7 | 16.5 | 14.7 | 13.7 |
| | **PO 3A** | 51.5 | 34.4 | 21.7 | 14.6 | 12.1 | 11.0 | 10.7 |

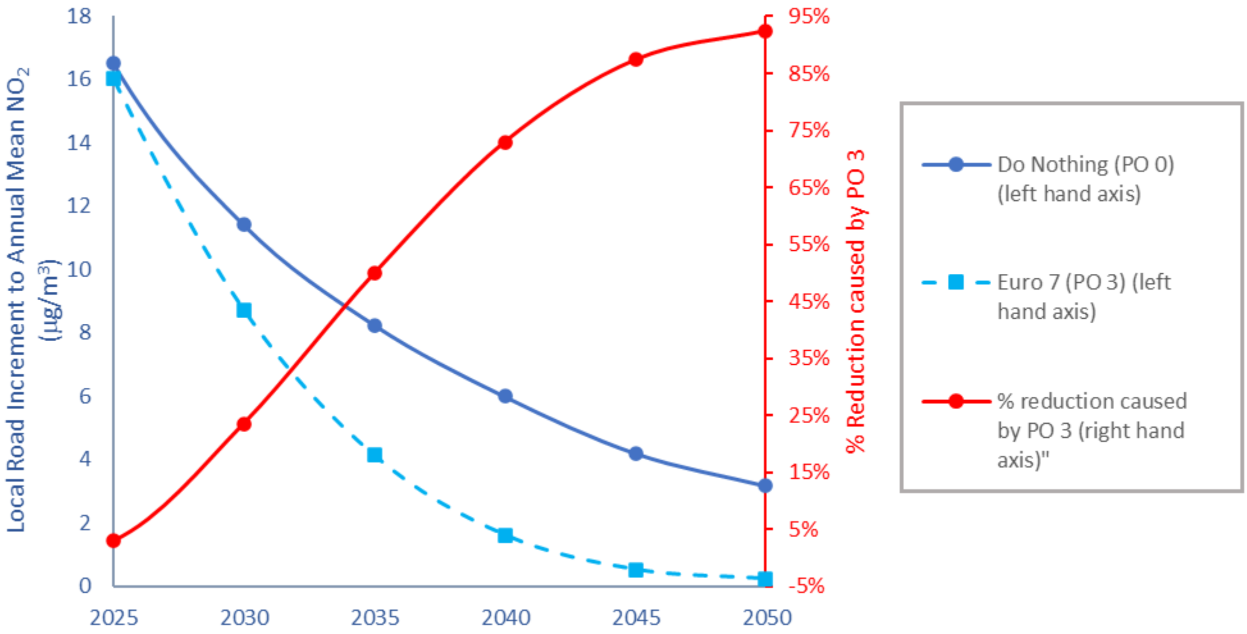



**Figure 3-7: Predicted Annual Mean $NO_2$ Concentrations from Local Roads at a Worst-case Location in Brussels with and Without Euro 7 (Option 3A)**

## $PM_{2.5}$ from Brakes

Table 3-8 summarises the predicted annual mean $PM_{2.5}$ concentrations at a worst-case location in Brussels. It tests the effect of different assumptions regarding Euro 7 brake-wear emissions limits for cars and vans. The predicted $PM_{2.5}$ increments from local roads are also shown in Figure 3-8. The values shown relate to total road-$PM_{2.5}$ (and total $PM_{2.5}$ from all sources) and not only the brake component of concentrations.

As explained in Section 2, the Proposal is predicted to deliver savings over and above those in PO 3A of the IA owing to applying the same emission limit for both cars and vans, while the IA made different assumptions for cars vs vans. $PM_{2.5}$ from roads is expected to reduce considerably in the future baseline (Do Nothing = PO 0), mainly because of reductions in the exhaust component, but also with the widespread adoption of regenerative braking by 2050. The Proposal is expected to deliver further savings, amounting to a 28% reduction in the 2050 baseline local road $PM_{2.5}$. These savings would be accelerated if the 3 mg/km limit were brought forward; for example introducing the 3 mg/km limit in 2025 would reduce local road $PM_{2.5}$ by 8% in 2035 when compared with the Proposal.

When compared with total concentrations, the relative improvements are smaller, but it must be recognised that this study has not considered the potential effects of actions to address emissions from other sources. Addressing current elevated $PM_{2.5}$ concentrations will require positive action to be taken across a broad range of sources, including brake wear from road vehicles.

**Table 3-8: Predicted Annual Mean $PM_{2.5}$ Concentrations at a Worst-case Location in Brussels under Three Alternative Specifications for the Brake Wear Component of the Euro 7 Emissions Standard**

| Pollutant | Scenario | 2019 | 2025 | 2030 | 2035 | 2040 | 2045 | 2050 |
|---|---|---|---|---|---|---|---|---|
| $PM_{2.5}$ from Local Roads | **PO 0** | 3.2 | 2.5 | 2.4 | 2.3 | 2.2 | 2.2 | 2.1 |
| | **PO 2b** | 3.2 | 2.5 | 2.2 | 2.0 | 1.8 | 1.7 | 1.7 |
| | **PO 2a/PO 3a** | 3.2 | 2.5 | 2.2 | 2.1 | 2.0 | 1.9 | 1.8 |
| | **Proposal** | 3.2 | 2.5 | 2.2 | 2.0 | 1.8 | 1.6 | 1.5 |
| | **3 mg/km by 2030** [a] | 3.2 | 2.5 | 2.2 | 1.9 | 1.7 | 1.6 | 1.5 |
| | **3 mg/km by 2025** [b] | 3.2 | 2.5 | 2.1 | 1.8 | 1.7 | 1.6 | 1.5 |
| Total $PM_{2.5}$ | **PO 0** | 10.8 | 10.2 | 10.0 | 9.9 | 9.9 | 9.8 | 9.8 |
| | **PO 2b** | 10.8 | 10.1 | 9.8 | 9.6 | 9.5 | 9.4 | 9.3 |
| | **PO 2a/PO 3a** | 10.8 | 10.1 | 9.9 | 9.7 | 9.6 | 9.5 | 9.5 |
| | **Proposal** | 10.8 | 10.1 | 9.8 | 9.6 | 9.4 | 9.3 | 9.2 |
| | **3 mg/km by 2030** [a] | 10.8 | 10.1 | 9.8 | 9.5 | 9.4 | 9.2 | 9.1 |
| | **3 mg/km by 2025** [b] | 10.8 | 10.1 | 9.7 | 9.5 | 9.3 | 9.2 | 9.1 |

[a] i.e. $PM_{10}$ emissions limits from car and van brakes of 7 mg/km from 2025 and 3 mg/km from 2030

[b] i.e. $PM_{10}$ emissions limits from car and van brakes of 3 mg/km from 2025.

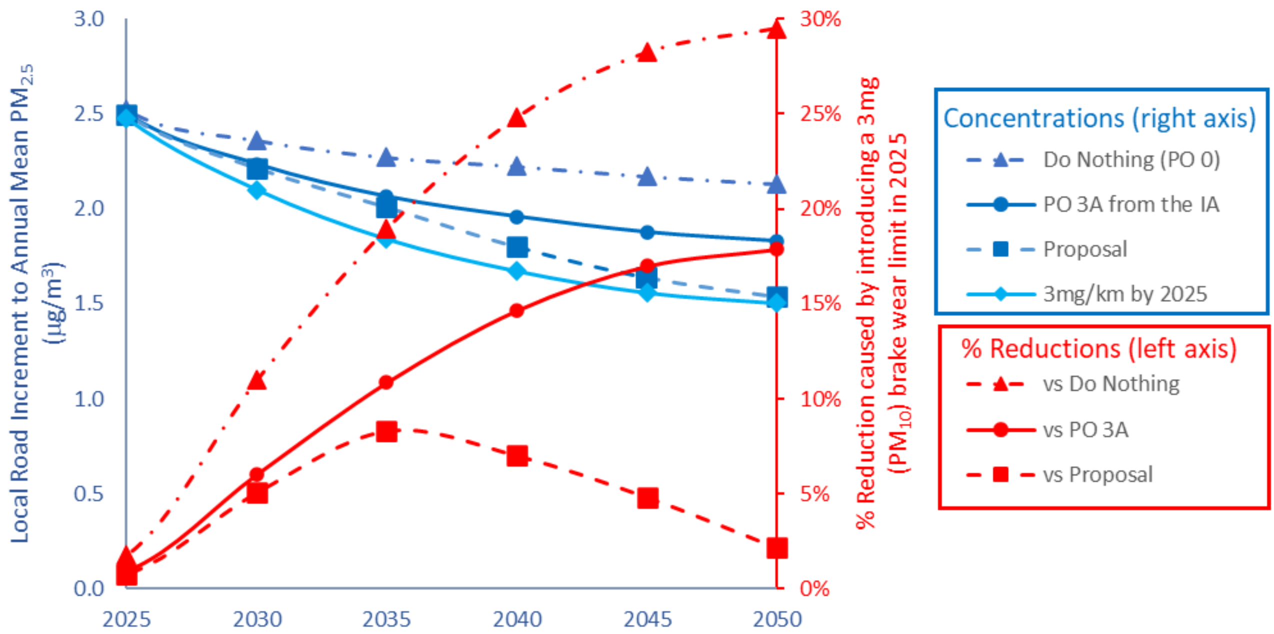



**Figure 3-8: Predicted Annual Mean $PM_{2.5}$ Concentrations from Local Roads at a Worst-case Location in Brussels without Euro 7 and with Alternative Specifications for the Brake Wear Component of the Euro 7 Emissions Standard**

## $PM_{2.5}$ from Tyres

Table 3-9 shows the predictions for annual mean $PM_{2.5}$ under different assumed effects of tyre wear rate limits. In each case, brake wear emissions are assumed to align with the Proposal. The specification of the tyre wear limits in the Proposal is not yet known, but a literature search (see Section 2) suggests that an ambitious limit on tyre wear rates might reduce overall tyre wear by several tens of percent. For the purpose of this analysis, it is assumed that this will have an equivalent effect on tyre wear $PM_{2.5}$ emissions. Table 3-9 shows the effects that a range of different reductions would deliver. The % reductions refer to the average reduction in wear rates (and thus assumed emissions) from a regulated tyre when compared with an unregulated model.

Figure 3-9 summarises some of the results from Table 3-9. It shows the predicted $PM_{2.5}$ concentrations from local roads under various assumptions regarding reductions in wear from regulated tyres. It also shows the relative changes to the concentrations predicted without any limits on tyre wear.

As explained previously, $PM_{2.5}$ from local roads is expected to fall considerably in the future as a result of reductions in exhaust emissions, with further reductions expected through changes to brakes. A tyre wear standard which delivered a 40% reduction in emissions from the affected tyres would cause a further 23% reduction in $PM_{2.5}$ from local roads in 2050.

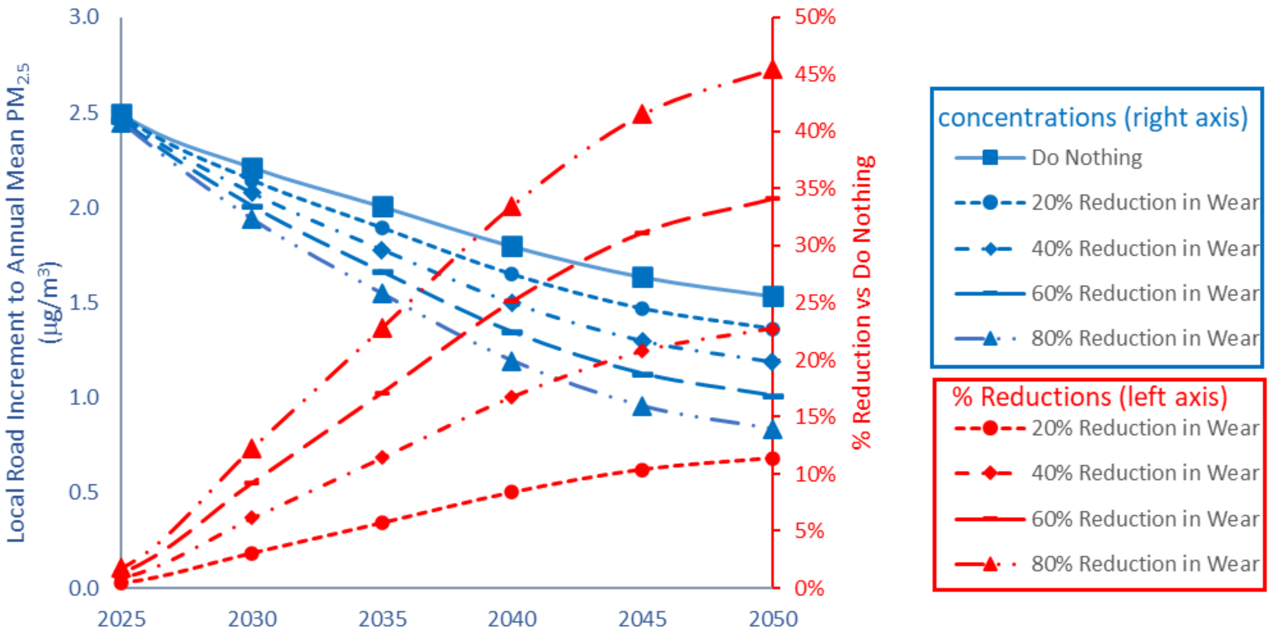



**Figure 3-9: Predicted Annual Mean $PM_{2.5}$ Concentrations from Local Roads at a Worst-case Location in Brussels with Alternative Assumptions for Tyre Wear Limits ('Do Nothing' here assumes the Proposal is enacted for brake wear)**

As noted for controls on brake wear, when compared with total concentrations, the relative improvements are smaller, but this study has not considered the potential effects of actions to address emissions from other sources. Addressing current elevated $PM_{2.5}$ concentrations will require positive action to be taken across a broad range of sectors, and limiting emissions from tyres is an important component of this.

**Table 3-9: Predicted Annual Mean $PM_{2.5}$ Concentrations at a Worst-case Location in Brussels under Alternative Assumed Effects of the Tyre Wear Component of the Euro 7 Emissions Standard**

| Pollutant | % Reduction in Average $PM_{2.5}$ Emissions from Fully-Regulated Tyres [a] | 2019 | 2025 | 2030 | 2035 | 2040 | 2045 | 2050 |
|---|---|---|---|---|---|---|---|---|
| $PM_{2.5}$ from Local Roads | 0% | 3.2 | 2.5 | 2.2 | 2.0 | 1.8 | 1.6 | 1.5 |
| | 10% | 3.2 | 2.5 | 2.2 | 2.0 | 1.7 | 1.6 | 1.4 |
| | 20% | 3.2 | 2.5 | 2.1 | 1.9 | 1.6 | 1.5 | 1.4 |
| | 30% | 3.2 | 2.5 | 2.1 | 1.8 | 1.6 | 1.4 | 1.3 |
| | 40% | 3.2 | 2.5 | 2.1 | 1.8 | 1.5 | 1.3 | 1.2 |
| | 50% | 3.2 | 2.5 | 2.0 | 1.7 | 1.4 | 1.2 | 1.1 |
| | 60% | 3.2 | 2.5 | 2.0 | 1.7 | 1.3 | 1.1 | 1.0 |
| | 70% | 3.2 | 2.5 | 2.0 | 1.6 | 1.3 | 1.0 | 0.9 |
| | 80% | 3.2 | 2.4 | 1.9 | 1.5 | 1.2 | 1.0 | 0.8 |
| | 90% | 3.2 | 2.4 | 1.9 | 1.5 | 1.1 | 0.9 | 0.8 |
| Total $PM_{2.5}$ | 0% | 10.8 | 10.1 | 9.8 | 9.6 | 9.4 | 9.3 | 9.2 |
| | 10% | 10.8 | 10.1 | 9.8 | 9.6 | 9.4 | 9.2 | 9.1 |
| | 20% | 10.8 | 10.1 | 9.8 | 9.5 | 9.3 | 9.1 | 9.0 |
| | 30% | 10.8 | 10.1 | 9.7 | 9.5 | 9.2 | 9.0 | 8.9 |
| | 40% | 10.8 | 10.1 | 9.7 | 9.4 | 9.1 | 8.9 | 8.8 |
| | 50% | 10.8 | 10.1 | 9.7 | 9.4 | 9.1 | 8.8 | 8.7 |
| | 60% | 10.8 | 10.1 | 9.6 | 9.3 | 9.0 | 8.8 | 8.6 |
| | 70% | 10.8 | 10.1 | 9.6 | 9.2 | 8.9 | 8.7 | 8.6 |
| | 80% | 10.8 | 10.1 | 9.6 | 9.2 | 8.8 | 8.6 | 8.5 |
| | 90% | 10.8 | 10.1 | 9.5 | 9.1 | 8.8 | 8.5 | 8.4 |

[a] assuming equivalent effective reductions from C1, C2, and C3 tyres.

## 3.4 Milan

### $NO_2$

Table 3-10 sets out the predicted annual mean $NO_2$ concentrations at a worst-case location in Milan in the future baseline and under PO 3A modelled in the IA[17]. The predicted $NO_2$ concentrations from local roads using COPERT modelling are also shown in Figure 3-10. Road increments to $NO_2$ concentrations are expected to fall appreciably in the future in any event, but implementing Euro 7 as modelled as PO 3A in the IA would significantly accelerate the improvements. Annual mean $NO_2$ concentrations at a worst-case location in Milan would be 3.3 µg/m$^3$ lower in 2040 with this implementation of Euro 7 than without Euro 7, and the road increment to concentrations in 2050 would be 73% lower than would otherwise be the case.

The relative reductions to total $NO_2$ concentrations (i.e. including the contributions from other sources) are smaller, but as explained in Section 2, the main focus of this study has been on the local road component, with the contributions from other sources most likely to have been over-predicted, particularly beyond 2030. Combined with action to reduce emissions from other sectors, the PO 3A version of Euro 7 has the potential to deliver significant reductions to $NO_2$ concentrations in Milan.

**Table 3-10: Predicted Annual Mean $NO_2$ Concentrations at a Worst-case Location in Milan under Three Alternative Specifications for the Euro 7 Emissions Standard**

| Pollutant | Scenario | 2019 | 2025 | 2030 | 2035 | 2040 | 2045 | 2050 |
|---|---|---|---|---|---|---|---|---|
| **$NO_2$ from Local Roads (COPERT)** | **PO 0** | 20.6 | 13.0 | 9.2 | 6.9 | 5.2 | 3.9 | 3.1 |
| | **PO 3A** | 20.6 | 12.6 | 7.2 | 3.7 | 1.9 | 1.0 | 0.8 |
| **$NO_2$ from Local Roads (Mulholland et al., 2022[9])** | **PO 0** | 20.6 | 13.0 | 9.1 | 6.8 | 5.2 | 3.8 | 3.1 |
| | **PO 3A** | 20.6 | 12.6 | 7.1 | 3.7 | 1.9 | 1.0 | 0.8 |
| **Total $NO_2$ (COPERT)** | **PO 0** | 57.6 | 44.3 | 35.7 | 28.6 | 26.9 | 25.6 | 24.8 |
| | **PO 3A** | 57.6 | 43.9 | 33.7 | 25.5 | 23.6 | 22.8 | 22.6 |
| **Total $NO_2$ (Mulholland et al., 2022[9])** | **PO 0** | 57.6 | 44.3 | 35.7 | 28.6 | 26.9 | 25.6 | 24.8 |
| | **PO 3A** | 57.6 | 44.0 | 33.7 | 25.5 | 23.6 | 22.8 | 22.6 |

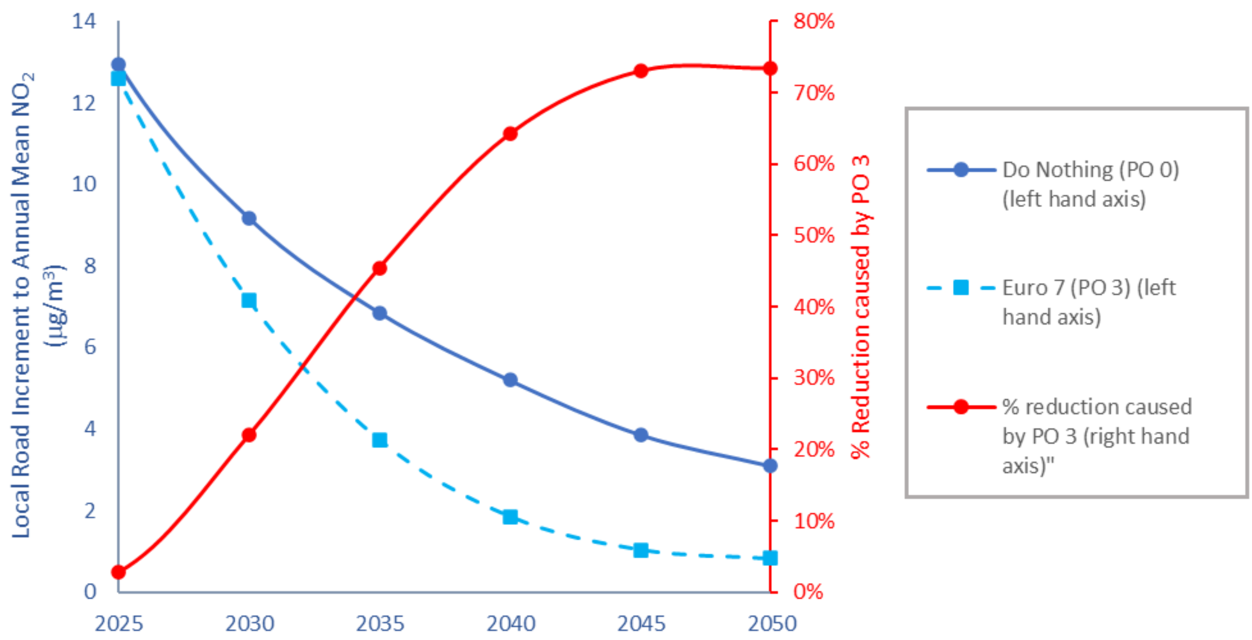



**Figure 3-10: Predicted Annual Mean $NO_2$ Concentrations from Local Roads at a Worst-case Location in Milan with and Without Euro 7 (Option 3A)**

## $PM_{2.5}$ from Brakes

Table 3-11 summarises the predicted annual mean $PM_{2.5}$ concentrations at a worst-case location in Milan. It tests the effect of different assumptions regarding Euro 7 brake-wear emissions limits for cars and vans. The predicted $PM_{2.5}$ increments from local roads are also shown in Figure 3-11. The values shown relate to total road-$PM_{2.5}$ (and total $PM_{2.5}$ from all sources) and not only the brake component of concentrations.

As explained in Section 2, the Proposal is predicted to deliver savings over and above those in PO 3A of the IA owing to applying the same emission limit for both cars and vans, while the IA made different assumptions for cars vs vans. $PM_{2.5}$ from roads is expected to reduce considerably in the future baseline (Do Nothing = PO 0), mainly because of reductions in the exhaust component, but also with the widespread adoption of regenerative braking by 2050. The Proposal is expected to deliver further savings, amounting to a 24% reduction in the 2050 baseline local road $PM_{2.5}$. These savings would be accelerated if the 3 mg/km limit were brought forward; for example introducing the 3 mg/km limit in 2025 would reduce local road $PM_{2.5}$ by 7% in 2035 when compared with the Proposal.

When compared with total concentrations, the relative improvements are smaller, but it must be recognised that this study has not considered the potential effects of actions to address emissions from other sources. Addressing current elevated $PM_{2.5}$ concentrations will require positive action to be taken across a broad range of sources, including brake wear from road vehicles.

**Table 3-11: Predicted Annual Mean $PM_{2.5}$ Concentrations at a Worst-case Location in Milan under Three Alternative Specifications for the Brake Wear Component of the Euro 7 Emissions Standard**

| Pollutant | Scenario | 2019 | 2025 | 2030 | 2035 | 2040 | 2045 | 2050 |
|---|---|---|---|---|---|---|---|---|
| $PM_{2.5}$ from Local Roads | **PO 0** | 2.8 | 2.1 | 2.0 | 1.9 | 1.9 | 1.8 | 1.8 |
| | **PO 2b** | 2.8 | 2.1 | 1.8 | 1.7 | 1.6 | 1.5 | 1.5 |
| | **PO 2a/PO 3a** | 2.8 | 2.1 | 1.9 | 1.7 | 1.7 | 1.6 | 1.6 |
| | **Proposal** | 2.8 | 2.1 | 1.9 | 1.7 | 1.5 | 1.4 | 1.4 |
| | **3 mg/km by 2030** [a] | 2.8 | 2.1 | 1.8 | 1.6 | 1.5 | 1.4 | 1.3 |
| | **3 mg/km by 2025** [b] | 2.8 | 2.1 | 1.8 | 1.6 | 1.5 | 1.4 | 1.3 |
| Total $PM_{2.5}$ | **PO 0** | 10.4 | 9.8 | 9.6 | 9.5 | 9.5 | 9.5 | 9.4 |
| | **PO 2b** | 10.4 | 9.7 | 9.5 | 9.3 | 9.2 | 9.1 | 9.1 |
| | **PO 2a/PO 3a** | 10.4 | 9.7 | 9.5 | 9.4 | 9.3 | 9.2 | 9.2 |
| | **Proposal** | 10.4 | 9.7 | 9.5 | 9.3 | 9.2 | 9.1 | 9.0 |
| | **3 mg/km by 2030** [a] | 10.4 | 9.7 | 9.5 | 9.3 | 9.1 | 9.0 | 9.0 |
| | **3 mg/km by 2025** [b] | 10.4 | 9.7 | 9.4 | 9.2 | 9.1 | 9.0 | 9.0 |

[a] i.e. $PM_{10}$ emissions limits from car and van brakes of 7 mg/km from 2025 and 3 mg/km from 2030

[b] i.e. $PM_{10}$ emissions limits from car and van brakes of 3 mg/km from 2025.

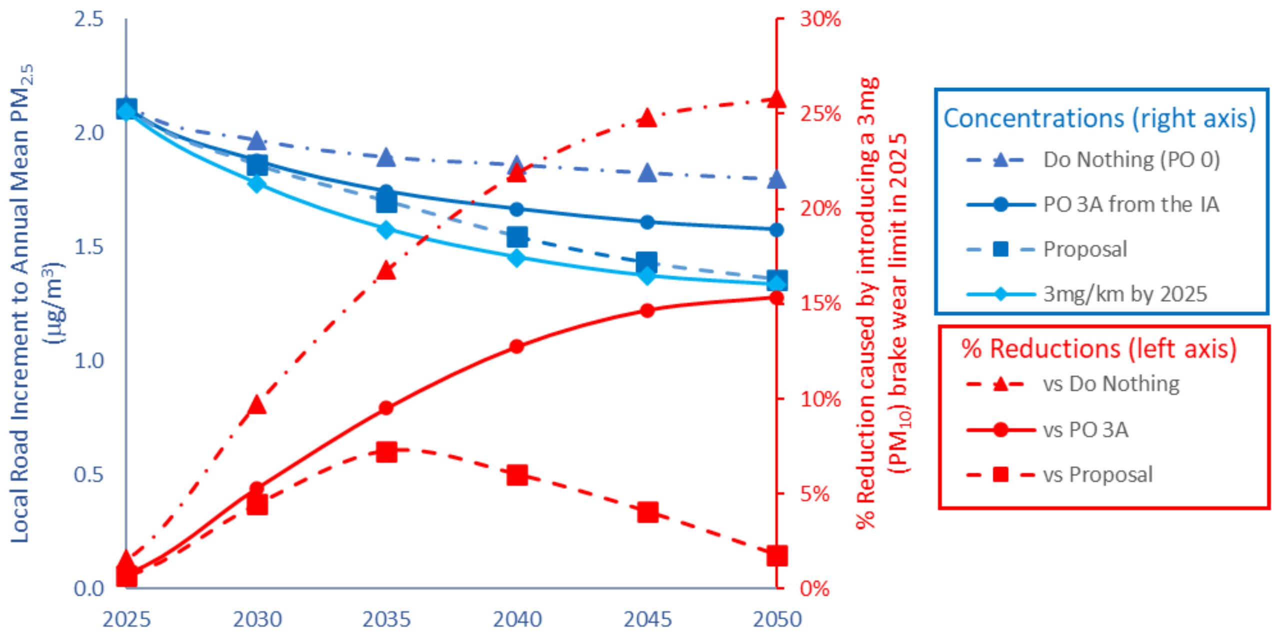



**Figure 3-11: Predicted Annual Mean $PM_{2.5}$ Concentrations from Local Roads at a Worst-case Location in Milan without Euro 7 and with Alternative Specifications for the Brake Wear Component of the Euro 7 Emissions Standard**

## $PM_{2.5}$ from Tyres

Table 3-12 shows the predictions for annual mean $PM_{2.5}$ under different assumed effects of tyre wear rate limits. In each case, brake wear emissions are assumed to align with the Proposal. The specification of the tyre wear limits in the Proposal is not yet known, but a literature search (see Section 2) suggests that an ambitious limit on tyre wear rates might reduce overall tyre wear by several tens of percent. For the purpose of this analysis, it is assumed that this will have an equivalent effect on tyre wear $PM_{2.5}$ emissions. Table 3-12 shows the effects that a range of different reductions would deliver. The % reductions refer to the average reduction in wear rates (and thus assumed emissions) from a regulated tyre when compared with an unregulated model.

Figure 3-12 summarises some of the results from Table 3-12. It shows the predicted $PM_{2.5}$ concentrations from local roads under various assumptions regarding reductions in wear from regulated tyres. It also shows the relative changes to the concentrations predicted without any limits on tyre wear.

As explained previously, $PM_{2.5}$ from local roads is expected to fall considerably in the future as a result of reductions in exhaust emissions, with further reductions expected through changes to brakes. A tyre wear standard which delivered a 40% reduction in emissions from the affected tyres would cause a further 17% reduction in $PM_{2.5}$ from local roads in 2050.

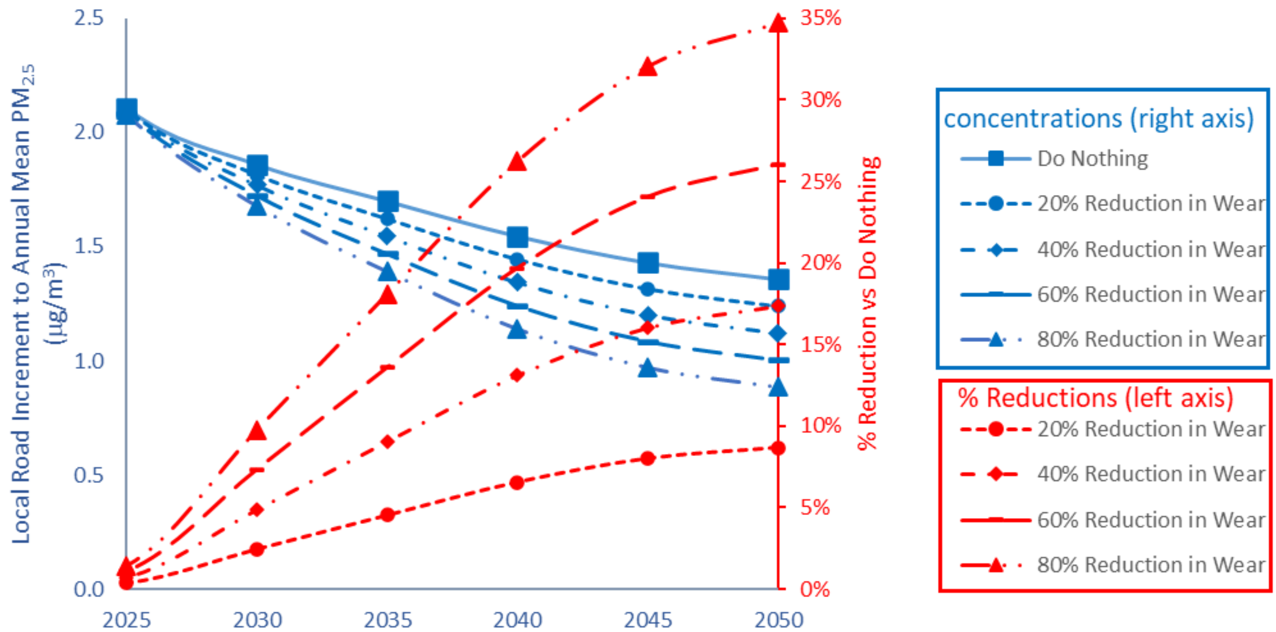



**Figure 3-12: Predicted Annual Mean $PM_{2.5}$ Concentrations from Local Roads at a Worst-case Location in Milan with Alternative Assumptions for Tyre Wear Limits ('Do Nothing' here assumes the Proposal is enacted for brake wear)**

As noted for controls on brake wear, when compared with total concentrations, the relative improvements are smaller, but this study has not considered the potential effects of actions to address emissions from other sources. Addressing current elevated $PM_{2.5}$ concentrations will require positive action to be taken across a broad range of sectors, and limiting emissions from tyres is an important component of this.

**Table 3-12: Predicted Annual Mean $PM_{2.5}$ Concentrations at a Worst-case Location in Milan under Alternative Assumed Effects of the Tyre Wear Component of the Euro 7 Emissions Standard**

| Pollutant | % Reduction in Average $PM_{2.5}$ Emissions from Fully-Regulated Tyres [a] | 2019 | 2025 | 2030 | 2035 | 2040 | 2045 | 2050 |
|---|---|---|---|---|---|---|---|---|
| $PM_{2.5}$ from Local Roads | 0% | 2.8 | 2.1 | 1.9 | 1.7 | 1.5 | 1.4 | 1.4 |
| | 10% | 2.8 | 2.1 | 1.8 | 1.7 | 1.5 | 1.4 | 1.3 |
| | 20% | 2.8 | 2.1 | 1.8 | 1.6 | 1.4 | 1.3 | 1.2 |
| | 30% | 2.8 | 2.1 | 1.8 | 1.6 | 1.4 | 1.3 | 1.2 |
| | 40% | 2.8 | 2.1 | 1.8 | 1.5 | 1.3 | 1.2 | 1.1 |
| | 50% | 2.8 | 2.1 | 1.7 | 1.5 | 1.3 | 1.1 | 1.1 |
| | 60% | 2.8 | 2.1 | 1.7 | 1.5 | 1.2 | 1.1 | 1.0 |
| | 70% | 2.8 | 2.1 | 1.7 | 1.4 | 1.2 | 1.0 | 0.9 |
| | 80% | 2.8 | 2.1 | 1.7 | 1.4 | 1.1 | 1.0 | 0.9 |
| | 90% | 2.8 | 2.1 | 1.7 | 1.4 | 1.1 | 0.9 | 0.8 |
| Total $PM_{2.5}$ | 0% | 10.4 | 9.7 | 9.5 | 9.3 | 9.2 | 9.1 | 9.0 |
| | 10% | 10.4 | 9.7 | 9.5 | 9.3 | 9.1 | 9.0 | 8.9 |
| | 20% | 10.4 | 9.7 | 9.4 | 9.3 | 9.1 | 8.9 | 8.9 |
| | 30% | 10.4 | 9.7 | 9.4 | 9.2 | 9.0 | 8.9 | 8.8 |
| | 40% | 10.4 | 9.7 | 9.4 | 9.2 | 9.0 | 8.8 | 8.8 |
| | 50% | 10.4 | 9.7 | 9.4 | 9.1 | 8.9 | 8.8 | 8.7 |
| | 60% | 10.4 | 9.7 | 9.4 | 9.1 | 8.9 | 8.7 | 8.6 |
| | 70% | 10.4 | 9.7 | 9.3 | 9.1 | 8.8 | 8.7 | 8.6 |
| | 80% | 10.4 | 9.7 | 9.3 | 9.0 | 8.8 | 8.6 | 8.5 |
| | 90% | 10.4 | 9.7 | 9.3 | 9.0 | 8.7 | 8.5 | 8.5 |

[a] assuming equivalent effective reductions from C1, C2, and C3 tyres.

## 3.5 Warsaw

### $NO_2$

Table 3-13 sets out the predicted annual mean $NO_2$ concentrations at a worst-case location in Warsaw in the future baseline and under PO 3A modelled in the IA[17]. The predicted $NO_2$ concentrations from local roads using COPERT modelling are also shown in Figure 3-13. Road increments to $NO_2$ concentrations are expected to fall appreciably in the future in any event, but implementing Euro 7 as modelled as PO 3A in the IA would significantly accelerate the improvements. Annual mean $NO_2$ concentrations at a worst-case location in Warsaw would be 4.2 µg/m$^3$ lower in 2040 with this implementation of Euro 7 than without Euro 7, and the road increment to concentrations in 2050 would be 83% lower than would otherwise be the case.

The relative reductions to total $NO_2$ concentrations (i.e. including the contributions from other sources) are smaller, but as explained in Section 2, the main focus of this study has been on the local road component, with the contributions from other sources most likely to have been over-predicted, particularly beyond 2030. Combined with action to reduce emissions from other sectors, the PO 3A version of Euro 7 has the potential to deliver significant reductions to $NO_2$ concentrations in Warsaw.

**Table 3-13: Predicted Annual Mean $NO_2$ Concentrations at a Worst-case Location in Warsaw under Three Alternative Specifications for the Euro 7 Emissions Standard**

| Pollutant | Scenario | 2019 | 2025 | 2030 | 2035 | 2040 | 2045 | 2050 |
|---|---|---|---|---|---|---|---|---|
| **$NO_2$ from Local Roads (COPERT)** | **PO 0** | 27.5 | 17.1 | 11.8 | 8.4 | 6.1 | 4.2 | 3.2 |
| | **PO 3A** | 27.5 | 16.6 | 9.1 | 4.4 | 1.9 | 0.8 | 0.5 |
| **$NO_2$ from Local Roads (Mulholland et al., 2022[9])** | **PO 0** | 27.5 | 17.1 | 11.8 | 8.4 | 6.1 | 4.2 | 3.2 |
| | **PO 3A** | 27.5 | 16.6 | 9.1 | 4.4 | 1.9 | 0.8 | 0.5 |
| **Total $NO_2$ (COPERT)** | **PO 0** | 49.7 | 39.2 | 33.9 | 30.6 | 28.2 | 26.4 | 25.3 |
| | **PO 3A** | 49.7 | 38.8 | 31.3 | 26.6 | 24.0 | 23.0 | 22.7 |
| **Total $NO_2$ (Mulholland et al., 2022[9])** | **PO 0** | 49.7 | 39.2 | 33.9 | 30.6 | 28.2 | 26.4 | 25.3 |
| | **PO 3A** | 49.7 | 38.7 | 31.3 | 26.6 | 24.0 | 23.0 | 22.7 |

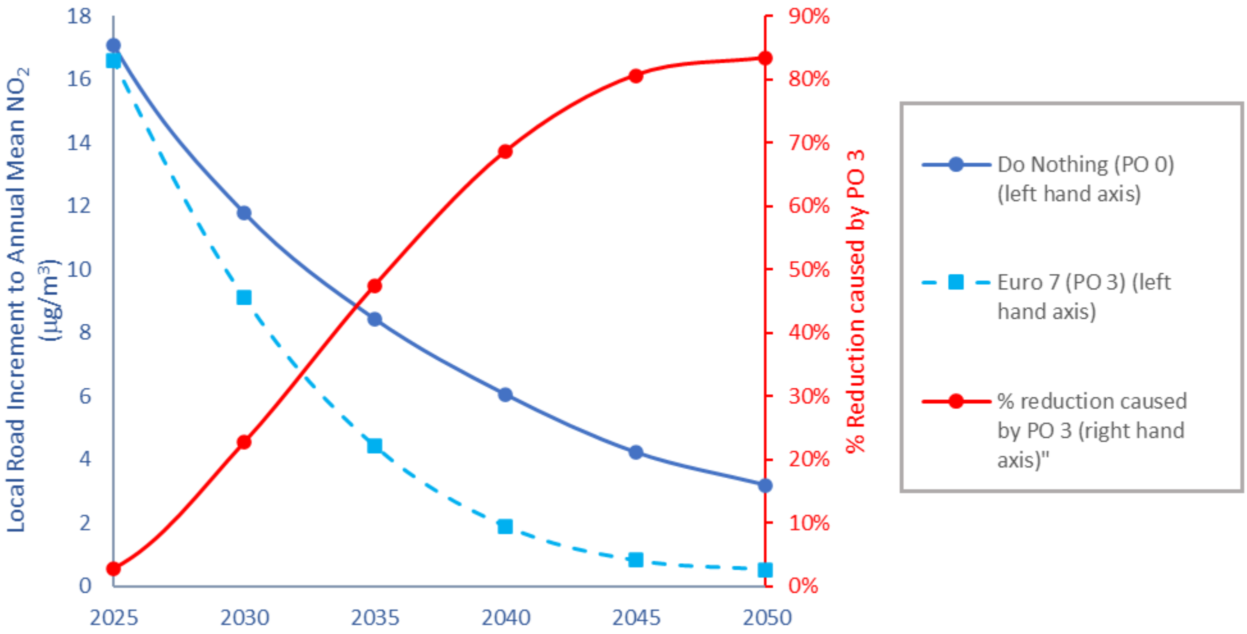



**Figure 3-13: Predicted Annual Mean $NO_2$ Concentrations from Local Roads at a Worst-case Location in Warsaw with and Without Euro 7 (Option 3A)**

## $PM_{2.5}$ from Brakes

Table 3-14 summarises the predicted annual mean $PM_{2.5}$ concentrations at a worst-case location in Warsaw. It tests the effect of different assumptions regarding Euro 7 brake-wear emissions limits for cars and vans. The predicted $PM_{2.5}$ increments from local roads are also shown in Figure 3-14. The values shown relate to total road-$PM_{2.5}$ (and total $PM_{2.5}$ from all sources) and not only the brake component of concentrations.

As explained in Section 2, the Proposal is predicted to deliver savings over and above those in PO 3A of the IA owing to applying the same emission limit for both cars and vans, while the IA made different assumptions for cars vs vans. $PM_{2.5}$ from roads is expected to reduce considerably in the future baseline (Do Nothing = PO 0), mainly because of reductions in the exhaust component, but also with the widespread adoption of regenerative braking by 2050. The Proposal is expected to deliver further savings, amounting to a 27% reduction in the 2050 baseline local road $PM_{2.5}$. These savings would be accelerated if the 3 mg/km limit were brought forward; for example introducing the 3 mg/km limit in 2025 would reduce local road $PM_{2.5}$ by 8% in 2035 when compared with the Proposal.

When compared with total concentrations, the relative improvements are smaller, but it must be recognised that this study has not considered the potential effects of actions to address emissions from other sources. Addressing current elevated $PM_{2.5}$ concentrations will require positive action to be taken across a broad range of sources, including brake wear from road vehicles.

**Table 3-14: Predicted Annual Mean $PM_{2.5}$ Concentrations at a Worst-case Location in Warsaw under Three Alternative Specifications for the Brake Wear Component of the Euro 7 Emissions Standard**

| Pollutant | Scenario | 2019 | 2025 | 2030 | 2035 | 2040 | 2045 | 2050 |
|---|---|---|---|---|---|---|---|---|
| | **PO 0** | 4.3 | 3.3 | 3.1 | 3.0 | 3.0 | 3.0 | 2.9 |
| | **PO 2b** | 4.3 | 3.3 | 2.9 | 2.6 | 2.5 | 2.4 | 2.3 |
| | **PO 2a/PO 3a** | 4.3 | 3.3 | 2.9 | 2.7 | 2.6 | 2.6 | 2.5 |
| | **Proposal** | 4.3 | 3.3 | 2.9 | 2.7 | 2.4 | 2.2 | 2.1 |
| | **3 mg/km by 2030 [a]** | 4.3 | 3.3 | 2.9 | 2.5 | 2.3 | 2.2 | 2.1 |
| **$PM_{2.5}$ from Local Roads** | **3 mg/km by 2025 [b]** | 4.3 | 3.2 | 2.8 | 2.4 | 2.3 | 2.1 | 2.1 |
| | **PO 0** | 11.9 | 10.9 | 10.7 | 10.7 | 10.6 | 10.6 | 10.5 |
| | **PO 2b** | 11.9 | 10.9 | 10.5 | 10.2 | 10.1 | 10.0 | 9.9 |
| | **PO 2a/PO 3a** | 11.9 | 10.9 | 10.6 | 10.4 | 10.3 | 10.2 | 10.1 |
| | **Proposal** | 11.9 | 10.9 | 10.5 | 10.3 | 10.1 | 9.9 | 9.8 |
| | **3 mg/km by 2030 [a]** | 11.9 | 10.9 | 10.5 | 10.2 | 10.0 | 9.8 | 9.7 |
| **Total $PM_{2.5}$** | **3 mg/km by 2025 [b]** | 11.9 | 10.9 | 10.4 | 10.1 | 9.9 | 9.8 | 9.7 |

[a] i.e. $PM_{10}$ emissions limits from car and van brakes of 7 mg/km from 2025 and 3 mg/km from 2030

[b] i.e. $PM_{10}$ emissions limits from car and van brakes of 3 mg/km from 2025.

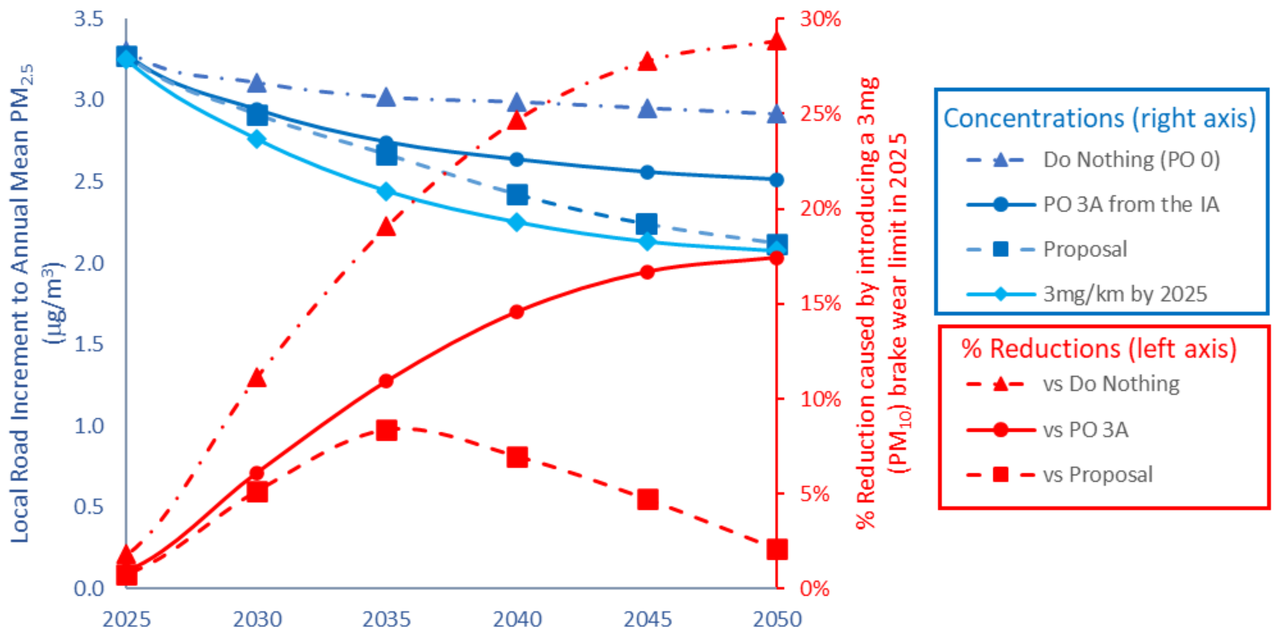



**Figure 3-14: Predicted Annual Mean $PM_{2.5}$ Concentrations from Local Roads at a Worst-case Location in Warsaw without Euro 7 and with Alternative Specifications for the Brake Wear Component of the Euro 7 Emissions Standard**

## $PM_{2.5}$ from Tyres

Table 3-15 shows the predictions for annual mean $PM_{2.5}$ under different assumed effects of tyre wear rate limits. In each case, brake wear emissions are assumed to align with the Proposal. The specification of the tyre wear limits in the Proposal is not yet known, but a literature search (see Section 2) suggests that an ambitious limit on tyre wear rates might reduce overall tyre wear by several tens of percent. For the purpose of this analysis, it is assumed that this will have an equivalent effect on tyre wear $PM_{2.5}$ emissions. Table 3-15 shows the effects that a range of different reductions would deliver. The % reductions refer to the average reduction in wear rates (and thus assumed emissions) from a regulated tyre when compared with an unregulated model.

Figure 3-15 summarises some of the results from Table 3-15. It shows the predicted $PM_{2.5}$ concentrations from local roads under various assumptions regarding reductions in wear from regulated tyres. It also shows the relative changes to the concentrations predicted without any limits on tyre wear.

As explained previously, $PM_{2.5}$ from local roads is expected to fall considerably in the future as a result of reductions in exhaust emissions, with further reductions expected through changes to brakes. A tyre wear standard which delivered a 40% reduction in emissions from the affected tyres would cause a further 20% reduction in $PM_{2.5}$ from local roads in 2050.

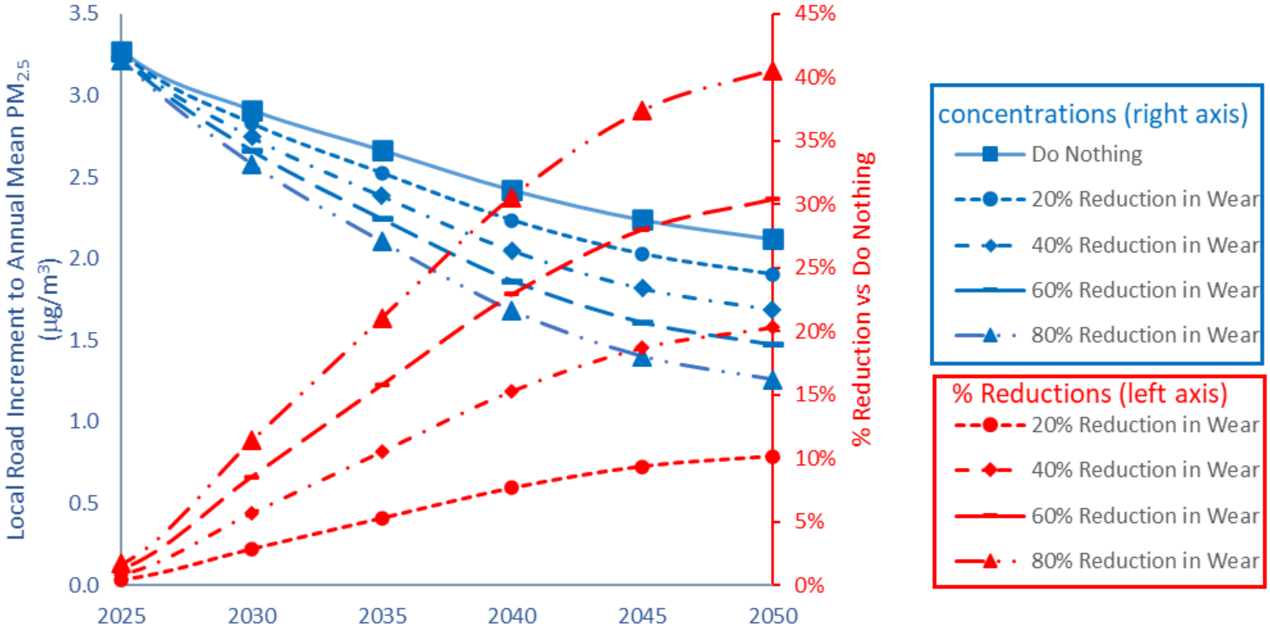



**Figure 3-15: Predicted Annual Mean $PM_{2.5}$ Concentrations from Local Roads at a Worst-case Location in Warsaw with Alternative Assumptions for Tyre Wear Limits ('Do Nothing' here assumes the Proposal is enacted for brake wear)**

As noted for controls on brake wear, when compared with total concentrations, the relative improvements are smaller, but this study has not considered the potential effects of actions to address emissions from other sources. Addressing current elevated $PM_{2.5}$ concentrations will require positive action to be taken across a broad range of sectors, and limiting emissions from tyres is an important component of this.

**Table 3-15: Predicted Annual Mean $PM_{2.5}$ Concentrations at a Worst-case Location in Warsaw under Alternative Assumed Effects of the Tyre Wear Component of the Euro 7 Emissions Standard**

| Pollutant | % Reduction in Average $PM_{2.5}$ Emissions from Fully-Regulated Tyres [a] | 2019 | 2025 | 2030 | 2035 | 2040 | 2045 | 2050 |
|---|---|---|---|---|---|---|---|---|
| $PM_{2.5}$ from Local Roads | 0% | 4.3 | 3.3 | 2.9 | 2.7 | 2.4 | 2.2 | 2.1 |
| | 10% | 4.3 | 3.3 | 2.9 | 2.6 | 2.3 | 2.1 | 2.0 |
| | 20% | 4.3 | 3.3 | 2.8 | 2.5 | 2.2 | 2.0 | 1.9 |
| | 30% | 4.3 | 3.3 | 2.8 | 2.5 | 2.1 | 1.9 | 1.8 |
| | 40% | 4.3 | 3.2 | 2.7 | 2.4 | 2.1 | 1.8 | 1.7 |
| | 50% | 4.3 | 3.2 | 2.7 | 2.3 | 2.0 | 1.7 | 1.6 |
| | 60% | 4.3 | 3.2 | 2.7 | 2.2 | 1.9 | 1.6 | 1.5 |
| | 70% | 4.3 | 3.2 | 2.6 | 2.2 | 1.8 | 1.5 | 1.4 |
| | 80% | 4.3 | 3.2 | 2.6 | 2.1 | 1.7 | 1.4 | 1.3 |
| | 90% | 4.3 | 3.2 | 2.5 | 2.0 | 1.6 | 1.3 | 1.2 |
| Total $PM_{2.5}$ | 0% | 11.9 | 10.9 | 10.5 | 10.3 | 10.1 | 9.9 | 9.8 |
| | 10% | 11.9 | 10.9 | 10.5 | 10.2 | 10.0 | 9.8 | 9.6 |
| | 20% | 11.9 | 10.9 | 10.5 | 10.2 | 9.9 | 9.7 | 9.5 |
| | 30% | 11.9 | 10.9 | 10.4 | 10.1 | 9.8 | 9.6 | 9.4 |
| | 40% | 11.9 | 10.9 | 10.4 | 10.0 | 9.7 | 9.5 | 9.3 |
| | 50% | 11.9 | 10.9 | 10.3 | 9.9 | 9.6 | 9.3 | 9.2 |
| | 60% | 11.9 | 10.9 | 10.3 | 9.9 | 9.5 | 9.2 | 9.1 |
| | 70% | 11.9 | 10.9 | 10.3 | 9.8 | 9.4 | 9.1 | 9.0 |
| | 80% | 11.9 | 10.9 | 10.2 | 9.7 | 9.3 | 9.0 | 8.9 |
| | 90% | 11.9 | 10.8 | 10.2 | 9.7 | 9.2 | 8.9 | 8.8 |

[a] assuming equivalent effective reductions from C1, C2, and C3 tyres.

## 3.6 London

### $NO_2$

Table 3-16 sets out the predicted annual mean $NO_2$ concentrations at a worst-case location in London in the future baseline and under PO 3A modelled in the IA[17]. The predicted $NO_2$ concentrations from local roads using COPERT modelling are also shown in Figure 3-16. Road increments to $NO_2$ concentrations are expected to fall appreciably in the future in any event, but implementing Euro 7 as modelled as PO 3A in the IA would significantly accelerate the improvements. Annual mean $NO_2$ concentrations at a worst-case location in London would be 4.1 µg/m$^3$ lower in 2040 with this implementation of Euro 7 than without Euro 7, and the road increment to concentrations in 2050 would be 93% lower than would otherwise be the case.

The relative reductions to total $NO_2$ concentrations (i.e. including the contributions from other sources) are smaller, but as explained in Section 2, the main focus of this study has been on the local road component, with the contributions from other sources most likely to have been over-predicted, particularly beyond 2030. Combined with action to reduce emissions from other sectors, the PO 3A version of Euro 7 has the potential to deliver significant reductions to $NO_2$ concentrations in London.

**Table 3-16: Predicted Annual Mean $NO_2$ Concentrations at a Worst-case Location in London under Three Alternative Specifications for the Euro 7 Emissions Standard**

| Pollutant | Scenario | 2019 | 2025 | 2030 | 2035 | 2040 | 2045 | 2050 |
|---|---|---|---|---|---|---|---|---|
| **$NO_2$ from Local Roads (COPERT)** | **PO 0** | 35.4 | 21.7 | 14.2 | 9.0 | 5.4 | 3.0 | 1.7 |
| | **PO 3A** | 35.4 | 21.1 | 11.0 | 4.9 | 1.7 | 0.4 | 0.1 |
| **$NO_2$ from Local Roads (Mulholland et al., 2022[9])** | **PO 0** | 35.4 | 21.8 | 14.2 | 9.0 | 5.4 | 3.0 | 1.7 |
| | **PO 3A** | 35.4 | 21.2 | 11.0 | 4.9 | 1.7 | 0.4 | 0.1 |
| **Total $NO_2$ (COPERT)** | **PO 0** | 62.7 | 44.6 | 33.4 | 24.6 | 18.4 | 16.0 | 14.7 |
| | **PO 3A** | 62.7 | 44.0 | 30.3 | 20.5 | 14.7 | 13.4 | 13.1 |
| **Total $NO_2$ (Mulholland et al., 2022[9])** | **PO 0** | 62.7 | 44.7 | 33.5 | 24.7 | 18.4 | 16.0 | 14.7 |
| | **PO 3A** | 62.7 | 44.1 | 30.3 | 20.5 | 14.7 | 13.4 | 13.1 |

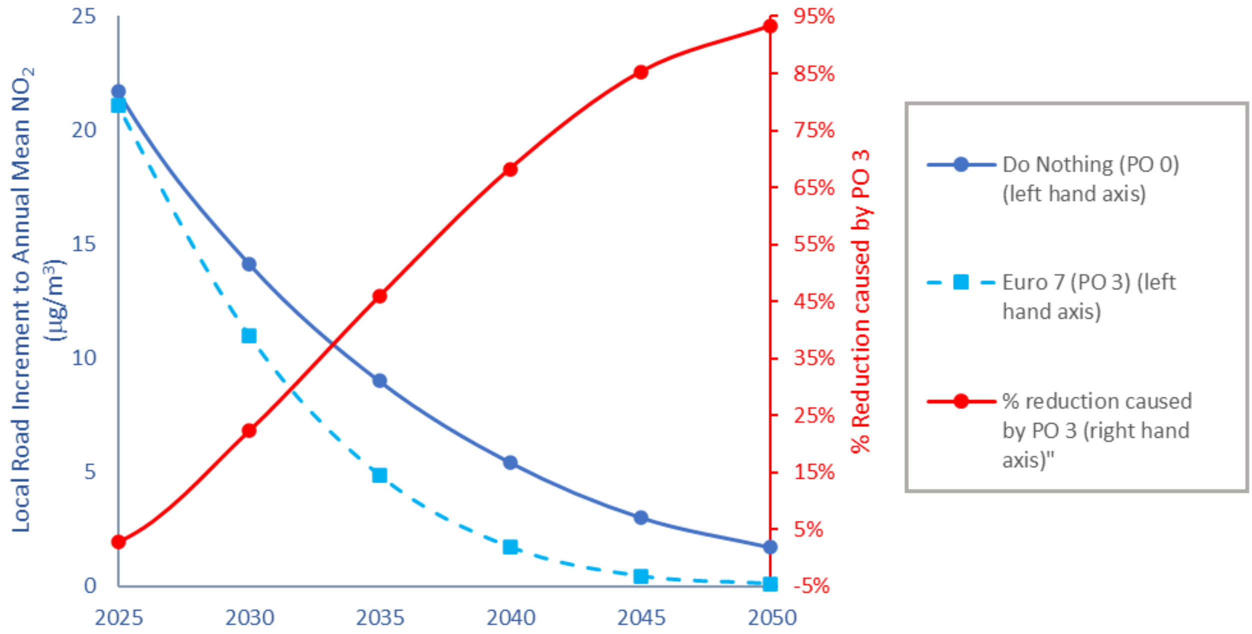



**Figure 3-16: Predicted Annual Mean $NO_2$ Concentrations from Local Roads at a Worst-case Location in London with and Without Euro 7 (Option 3A)**

## $PM_{2.5}$ from Brakes

Table 3-17 summarises the predicted annual mean $PM_{2.5}$ concentrations at a worst-case location in London. It tests the effect of different assumptions regarding Euro 7 brake-wear emissions limits for cars and vans. The predicted $PM_{2.5}$ increments from local roads are also shown in Figure 3-17. The values shown relate to total road-$PM_{2.5}$ (and total $PM_{2.5}$ from all sources) and not only the brake component of concentrations.

As explained in Section 2, the Proposal is predicted to deliver savings over and above those in PO 3A of the IA owing to applying the same emission limit for both cars and vans, while the IA made different assumptions for cars vs vans. $PM_{2.5}$ from roads is expected to reduce considerably in the future baseline (Do Nothing = PO 0), mainly because of reductions in the exhaust component, but also with the widespread adoption of regenerative braking by 2050. The Proposal is expected to deliver further savings, amounting to a 29% reduction in the 2050 baseline local road $PM_{2.5}$. These savings would be accelerated if the 3 mg/km limit were brought forward; for example introducing the 3 mg/km limit in 2025 would reduce local road $PM_{2.5}$ by 9% in 2035 when compared with the Proposal.

When compared with total concentrations, the relative improvements are smaller, but it must be recognised that this study has not considered the potential effects of actions to address emissions from other sources. Addressing current elevated $PM_{2.5}$ concentrations will require positive action to be taken across a broad range of sources, including brake wear from road vehicles.

**Table 3-17: Predicted Annual Mean $PM_{2.5}$ Concentrations at a Worst-case Location in London under Three Alternative Specifications for the Brake Wear Component of the Euro 7 Emissions Standard**

| Pollutant | Scenario | 2019 | 2025 | 2030 | 2035 | 2040 | 2045 | 2050 |
|---|---|---|---|---|---|---|---|---|
| | **PO 0** | 4.8 | 3.9 | 3.7 | 3.6 | 3.5 | 3.4 | 3.4 |
| | **PO 2b** | 4.8 | 3.8 | 3.4 | 3.1 | 2.9 | 2.7 | 2.7 |
| | **PO 2a/PO 3a** | 4.8 | 3.8 | 3.5 | 3.2 | 3.1 | 3.0 | 2.9 |
| | **Proposal** | 4.8 | 3.8 | 3.4 | 3.1 | 2.8 | 2.6 | 2.4 |
| | **3 mg/km by 2030** [a] | 4.8 | 3.8 | 3.4 | 3.0 | 2.7 | 2.5 | 2.4 |
| **$PM_{2.5}$ from Local Roads** | **3 mg/km by 2025** [b] | 4.8 | 3.8 | 3.2 | 2.9 | 2.6 | 2.4 | 2.4 |
| | **PO 0** | 14.3 | 11.9 | 11.7 | 11.6 | 11.5 | 11.4 | 11.4 |
| | **PO 2b** | 14.3 | 11.8 | 11.4 | 11.1 | 10.9 | 10.7 | 10.7 |
| | **PO 2a/PO 3a** | 14.3 | 11.8 | 11.5 | 11.2 | 11.1 | 11.0 | 10.9 |
| | **Proposal** | 14.3 | 11.8 | 11.4 | 11.1 | 10.8 | 10.6 | 10.4 |
| | **3 mg/km by 2030** [a] | 14.3 | 11.8 | 11.4 | 11.0 | 10.7 | 10.5 | 10.4 |
| **Total $PM_{2.5}$** | **3 mg/km by 2025** [b] | 14.3 | 11.8 | 11.2 | 10.9 | 10.6 | 10.4 | 10.4 |

[a] i.e. $PM_{10}$ emissions limits from car and van brakes of 7 mg/km from 2025 and 3 mg/km from 2030

[b] i.e. $PM_{10}$ emissions limits from car and van brakes of 3 mg/km from 2025.

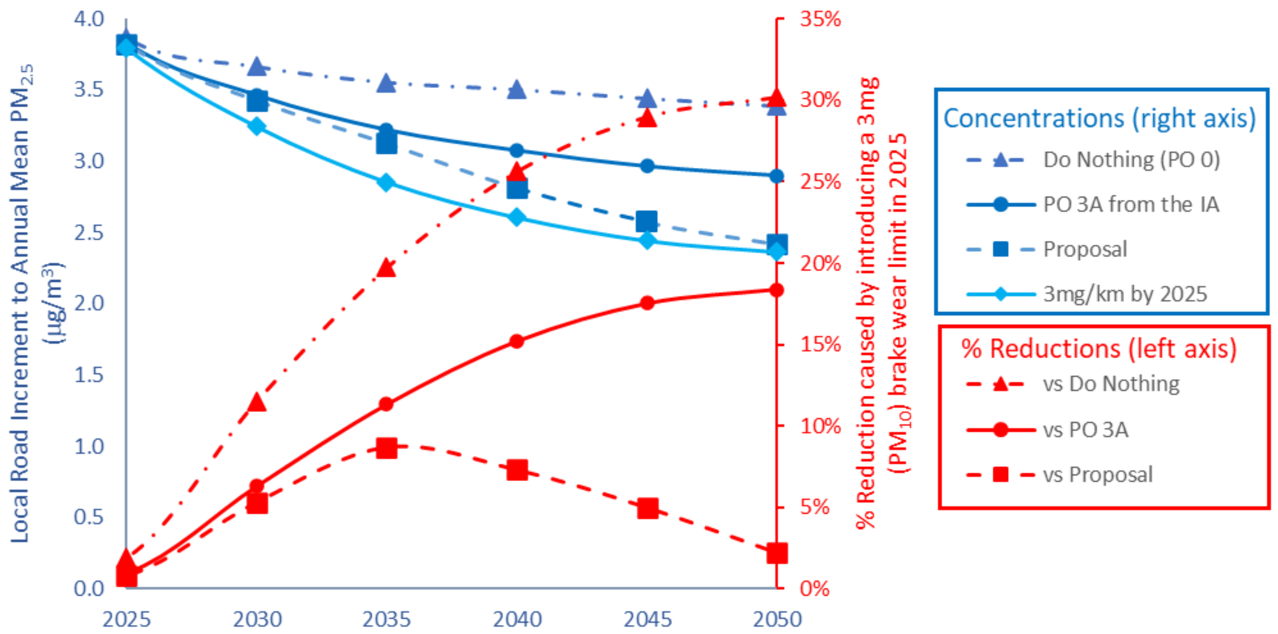



**Figure 3-17: Predicted Annual Mean $PM_{2.5}$ Concentrations from Local Roads at a Worst-case Location in London without Euro 7 and with Alternative Specifications for the Brake Wear Component of the Euro 7 Emissions Standard**

## $PM_{2.5}$ from Tyres

Table 3-18 shows the predictions for annual mean $PM_{2.5}$ under different assumed effects of tyre wear rate limits. In each case, brake wear emissions are assumed to align with the Proposal. The specification of the tyre wear limits in the Proposal is not yet known, but a literature search (see Section 2) suggests that an ambitious limit on tyre wear rates might reduce overall tyre wear by several tens of percent. For the purpose of this analysis, it is assumed that this will have an equivalent effect on tyre wear $PM_{2.5}$ emissions. Table 3-18 shows the effects that a range of different reductions would deliver. The % reductions refer to the average reduction in wear rates (and thus assumed emissions) from a regulated tyre when compared with an unregulated model.

Figure 3-18 summarises some of the results from Table 3-18. It shows the predicted $PM_{2.5}$ concentrations from local roads under various assumptions regarding reductions in wear from regulated tyres. It also shows the relative changes to the concentrations predicted without any limits on tyre wear.

As explained previously, $PM_{2.5}$ from local roads is expected to fall considerably in the future as a result of reductions in exhaust emissions, with further reductions expected through changes to brakes. A tyre wear standard which delivered a 40% reduction in emissions from the affected tyres would cause a further 26% reduction in $PM_{2.5}$ from local roads in 2050.

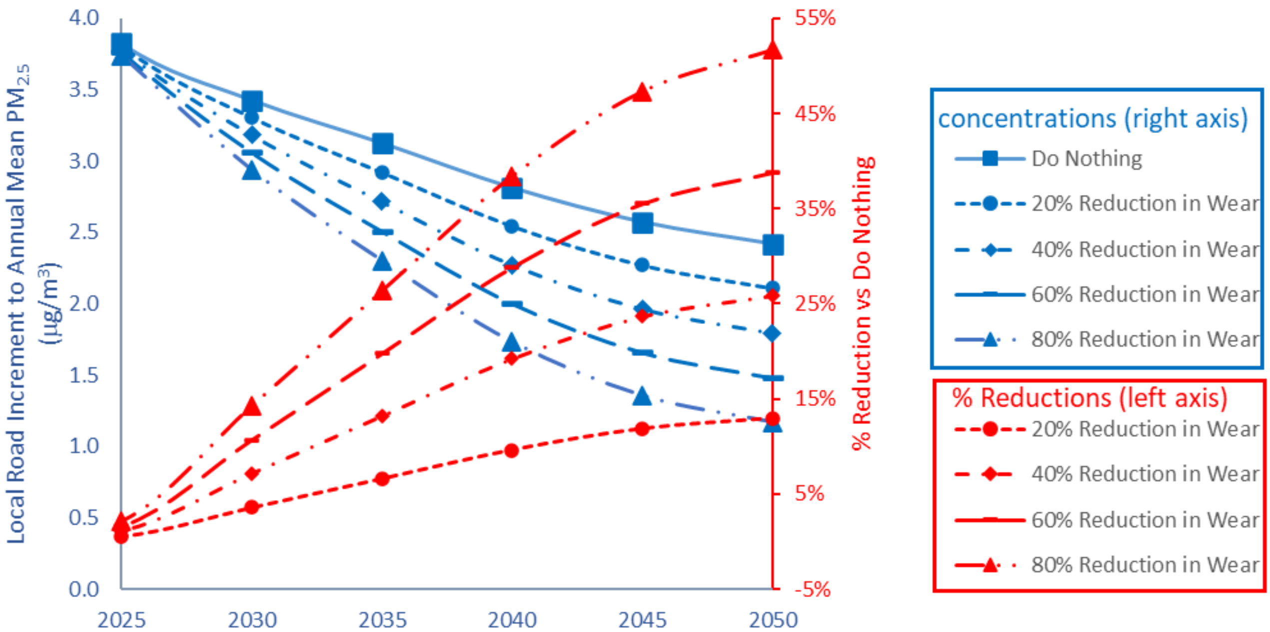



**Figure 3-18: Predicted Annual Mean $PM_{2.5}$ Concentrations from Local Roads at a Worst-case Location in London with Alternative Assumptions for Tyre Wear Limits ('Do Nothing' here assumes the Proposal is enacted for brake wear)**

As noted for controls on brake wear, when compared with total concentrations, the relative improvements are smaller, but this study has not considered the potential effects of actions to address emissions from other sources. Addressing current elevated $PM_{2.5}$ concentrations will require positive action to be taken across a broad range of sectors, and limiting emissions from tyres is an important component of this.

**Table 3-18: Predicted Annual Mean $PM_{2.5}$ Concentrations at a Worst-case Location in London under Alternative Assumed Effects of the Tyre Wear Component of the Euro 7 Emissions Standard**

| Pollutant | % Reduction in Average $PM_{2.5}$ Emissions from Fully-Regulated Tyres [a] | 2019 | 2025 | 2030 | 2035 | 2040 | 2045 | 2050 |
|---|---|---|---|---|---|---|---|---|
| $PM_{2.5}$ from Local Roads | **0%** | 4.8 | 3.8 | 3.4 | 3.1 | 2.8 | 2.6 | 2.4 |
| | **10%** | 4.8 | 3.8 | 3.4 | 3.0 | 2.7 | 2.4 | 2.3 |
| | **20%** | 4.8 | 3.8 | 3.3 | 2.9 | 2.5 | 2.3 | 2.1 |
| | **30%** | 4.8 | 3.8 | 3.2 | 2.8 | 2.4 | 2.1 | 2.0 |
| | **40%** | 4.8 | 3.8 | 3.2 | 2.7 | 2.3 | 2.0 | 1.8 |
| | **50%** | 4.8 | 3.8 | 3.1 | 2.6 | 2.1 | 1.8 | 1.6 |
| | **60%** | 4.8 | 3.8 | 3.1 | 2.5 | 2.0 | 1.7 | 1.5 |
| | **70%** | 4.8 | 3.8 | 3.0 | 2.4 | 1.9 | 1.5 | 1.3 |
| | **80%** | 4.8 | 3.7 | 2.9 | 2.3 | 1.7 | 1.4 | 1.2 |
| | **90%** | 4.8 | 3.7 | 2.9 | 2.2 | 1.6 | 1.2 | 1.0 |
| Total $PM_{2.5}$ | **0%** | 12.4 | 11.5 | 11.1 | 10.8 | 10.4 | 10.2 | 10.1 |
| | **10%** | 12.4 | 11.4 | 11.0 | 10.7 | 10.3 | 10.1 | 9.9 |
| | **20%** | 12.4 | 11.4 | 10.9 | 10.6 | 10.2 | 9.9 | 9.7 |
| | **30%** | 12.4 | 11.4 | 10.9 | 10.4 | 10.0 | 9.7 | 9.6 |
| | **40%** | 12.4 | 11.4 | 10.8 | 10.3 | 9.9 | 9.6 | 9.4 |
| | **50%** | 12.4 | 11.4 | 10.8 | 10.2 | 9.8 | 9.4 | 9.3 |
| | **60%** | 12.4 | 11.4 | 10.7 | 10.1 | 9.6 | 9.3 | 9.1 |
| | **70%** | 12.4 | 11.4 | 10.6 | 10.0 | 9.5 | 9.1 | 9.0 |
| | **80%** | 12.4 | 11.4 | 10.6 | 9.9 | 9.4 | 9.0 | 8.8 |
| | **90%** | 12.4 | 11.4 | 10.5 | 9.8 | 9.2 | 8.8 | 8.6 |

[a] assuming equivalent effective reductions from C1, C2, and C3 tyres.

# 4 Summary and Conclusions

This report quantifies the benefits that Euro 7, and changes to its specification, might have on ambient air quality within six major European Cities (Madrid, Paris, Brussels, Milan, Warsaw and London). The focus has been on concentrations at the fixed monitor within each city measuring the highest concentrations in the baseline year (2019). This is broadly taken to represent the worst-case air quality across the city as a whole, in terms of compliance with the limit values.

The purpose of the study has been to:

- Predict the future city-specific reductions in concentrations that could be delivered by the Euro 7 proposals and those modelled in the IA;
- Consider the sensitivity of this modelling to NOx exhaust emissions assumptions in the context of alternative evidence on real-world emissions from Euro 6 and earlier vehicles;
- Consider the differences in concentrations in relation to brake wear emissions likely to be delivered by the Commission's Proposal when compared with the POs modelled in the IA, and to consider the effects of bringing forward the introduction of the more stringent brake emissions limit of 3 mg/km; and
- Show the effects on concentrations of different potential tyre wear limits.

The precise results are different for each city, but the following general conclusions can be drawn:

- $NO_2$ concentrations are expected to fall appreciably in the future in any event, but implementing Euro 7 as modelled in the IA would significantly accelerate the improvements and result in greater overall reductions. Reductions in $NO_2$ concentrations of several µg/m$^3$ are predicted in each city as a result of implementing the IA version of Euro 7;
- Euro 7 is expected to reduce the local roads component of $PM_{2.5}$ concentrations by several tens of percent by 2050, and these savings would be accelerated if the 3 mg/km limit for brake wear were brought forward to 2025. While many other sources contribute to urban $PM_{2.5}$, there would nevertheless be tangible benefits to achieving greater reductions to brake wear emissions in this way; and
- The specification for Euro 7 tyre wear limits is not yet known, but emissions reductions of several tens of percent appear to be readily achievable. Reductions in tyre wear of this scale would deliver a considerable improvements to roadside $PM_{2.5}$ concentrations.