

# **The emissions and air quality impacts of the 2012 Olympic Route Network and related traffic management arrangements**

Assessment methodology and key results

**March 2012**



This report summarises the analysis undertaken to understand the potential impacts for air quality of the Olympic Route and Paralympic Route Networks. Section 1 sets out the background to this and the assumptions underpinning the modelling and key technical issues. Section 2 examines potential impacts within London and section 3 explores appropriate mitigation.

## 1. Background

- 1.1 Directive 2008/50/EC – the Air Quality Directive sets standards for a variety of pollutants that are considered harmful to human health and the environment. These standards, which are based on WHO guidelines, include limit values, which are legally binding and must not be exceeded.
- 1.2 This Directive, including the emission concentration limit values, has been transposed into English law by the Air Quality Standards Regulations 2010 (the 2010 Regulations). The 2010 Regulations impose duties on the Secretary of State relating to air quality. The Secretary of State for the Environment, Food and Rural Affairs is responsible for carrying out these duties which comprise:
  - Regulation 17 Duty in relation to limit values
  - Regulation 18 Duty in relation to target values
  - Regulation 20 Duty in relation to long-term objectives for ozone
  - Regulation 21 Duty in relation to information and alert thresholds
  - Regulation 22 Duty in relation to critical levels for the protection of vegetation
- 1.3 For the Greater London area, the Mayor has a legal responsibility to prepare and to keep under review the Mayor's Air Quality Strategy (the MAQS), which was published in December 2010. The Greater London Authority Act 1999 (the GLA Act) requires the Mayor to include in his MAQS policies and proposals:
  - For the implementation in Greater London of the policies contained in the strategy prepared and published by the Secretary of State in accordance with Section 80 of the Environment Act 1995 (National Air Quality Strategy)
  - For the achievement in Greater London of the air quality standards and objectives prescribed in regulations made under section 87(2)(a) and (b) of that Act; this is done in the Air Quality (England) Regulations 2000 (the 2000 Regulations)
- 1.4 The pollutants in question are sulphur dioxide, nitrogen dioxide, benzene, carbon monoxide, lead and particulate matter. Five of these pollutants, most notably sulphur dioxide and lead, which have historically been a problem in Greater London are now at concentrations that do not affect human health. However, particulate matter (PM<sub>10</sub>) and nitrogen dioxide (NO<sub>2</sub>) are now the focus of most concern. Levels of PM<sub>10</sub> declined in the 1990s though the rate of improvement has been slower in the last decade. Similarly, levels of NO<sub>2</sub> in London fell until 2002 but have been relatively unchanged since, a trend that has also been experienced throughout Europe.
- 1.5 The beginning of 2012 saw the implementation of a range of measures from the Mayor's Air Quality Strategy which focused on reducing emissions and delivering

health benefits for Londoners, including the third and fourth phases of the Low Emission Zone (LEZ) scheme and age limits for taxis and private hire vehicles. London is forecast to meet the limit values for PM<sub>10</sub>, although a small number of areas have been identified as potentially 'at risk', where a number of additional targeted measures are currently being applied. For NO<sub>2</sub>, however, many areas of London still exceed the relevant limit values – as is the case in other large urban agglomerations across the UK and Europe.

- 1.6 The challenge of cleaning London's air is made more difficult because a significant amount of the pollution sources do not originate within London. Much is blown in from the surrounding regions, but some comes from further away – from the European continent or as far afield as the Sahara Desert. Around 40 per cent of NO<sub>2</sub> pollution in London comes from emission sources outside London. Equally, data from central London indicates that about 40 per cent of PM<sub>10</sub> originates from outside London.
- 1.7 Ozone is another pollutant for which concentrations are still too high and which causes summer smog during hot, sunny periods. Ozone-related events are driven by the prevailing weather patterns rather than local emissions. The Government monitors pollution levels to help manage this issue. If an episode occurs, the Government will provide advice to members of the public to help them manage any risks to their health. The Health Protection Agency will also be providing daily updates to the International Olympic Committee on this during the Games.
- 1.8 The Olympic Games will be held between 25 July and 12 August 2012, and the Paralympic Games between 29 August and 9 September. The word 'Games' collectively refers to both. The roads forming the Olympic Route Network (ORN) have been formally designated by the Secretary of State by the Olympic Route Network Designation Order 2009 (SI2009/1573) with minor changes being made by the Olympic Delivery Authority (ODA) in 2011 (SI 2011/1656). The ORN in London is expected to be operational from a couple of days before the Games to a few days after they end. A subset of these roads will form a smaller scale Paralympic Route Network (PRN) for which a similar pattern of operation will apply in connection with the Paralympic Games.
- 1.9 In accordance with the Environmental Assessment of Plans and Programmes Regulations 2004 (SI 2004 No 1633), the ODA prepared an environmental report under those regulations containing a Strategic Environmental Assessment (SEA) of the Olympic Transport Plan (second edition) that was put out for public and stakeholder consultation. This assessment did not identify any significant adverse environmental effects that will be likely to arise from the operation of the measures contained in the Olympic Transport Plan. In relation to air quality, the SEA concluded there should be minor temporary beneficial effects generally, but with minor temporary adverse effects in some specific locations from the operation of the ORN and PRN.
- 1.10 This report is concerned with these potential impacts for air quality of the ORN and PRN (considered here as a sub-set of the ORN – see methodology details below) and considers the following Games-related factors:

- The use of the ORN roads by Games Family traffic and the measures being applied on sections of the ORN to prioritise Games Family traffic
- Related traffic diversion away from the ORN, reflecting reduced capacity for general traffic, to other roads in the vicinity
- An assumed level of general traffic reduction, arising through both active and passive travel demand management (TDM) during the Games period

1.11 The design of the routes aims to minimise the overall disruptive impact on London's traffic – which should in turn also help reduce impacts on air quality. The traffic management measures proposed will be of limited duration and their effects temporary. A strategy for managing background (non-Games) traffic is being implemented, involving a wide variety of demand management measures to reduce background travel during the Games. Evidence from previous Games host cities indicates that background traffic reduction in the range of between 10 and 30 per cent can take place during Games time.

1.12 During stakeholder engagement on the ORN and PRN proposals, respondents raised concerns about increases in traffic congestion, disruption, impact on local roads and/or raised levels of pollution. The Campaign for Clean Air in London has also raised a challenge in relation to the intention to make the Traffic Regulation Orders for the proposed ORN traffic measures, on the grounds that these measures will cause traffic congestion and in turn have potential adverse impacts on air quality.

1.13 As detailed development of the London 2012 Surface Projects, including the ORN/PRN, Central London Zone (CLZ), Venue and Travel Demand Management (TDM) arrangements progressed, Transport for London (TfL) commissioned further air quality assessment work. This report summarises the findings of this assessment.

## **Overview of the approach**

1.14 This further assessment was undertaken by Kings College London (Environmental Research Group) in conjunction with TfL. The assessment used recognised tools and is fully compatible, in terms of both methodology and outputs, with the assessments undertaken in 2010 for the Mayor's Air Quality Strategy.

1.15 The outputs from this further assessment are usable both at the strategic and more local levels, to understand both the overall impact of the proposals on emissions and air quality in London, and the specific impact of individual proposed Traffic Regulation Orders (TROs) for specific parts of the ORN/PRN. They have also been used to inform potential mitigation measures.

1.16 It must be recognised that any intervention, however minor, that affects the disposition of traffic would be likely to have some impacts in some locations – both positive and negative – on emissions and pollutant concentrations.

## **Basis for assessment**

- 1.17 The traffic impacts considered by this assessment are the net result of the following four Games-related changes or factors:
- The segmentation of the ORN and its use by Games Family traffic
  - Related traffic diversion away from the ORN, reflecting reduced capacity for general traffic, to other roads in the vicinity
  - An assumed level of general traffic reduction, arising through both active and passive TDM during the Games period
  - Other Games-time measures in relation to Active Traffic Management, venue plans and the Central London Zone
- 1.18 The 2010 Regulations include criteria for determining how achievement with the limit values should be assessed, including consideration of locations and length of exposure in relation to the averaging period of the limit values. These state that compliance with limit values does not need to be assessed at:
- Any location situated within areas where members of the public do not have access and there is no fixed habitation
  - On the carriageway of roads and on the central reservations of roads, except where there is normally pedestrian access to the central reservation

### **Traffic assumptions**

- 1.19 The basis for the assessment was outputs, in the form of assigned highway networks, from the CORNETO traffic model that has been used by TfL to assess the wide area highway effects of the ORN/PRN proposals. This model, developed from previously-validated models, provides a link-by-link quantification of the net traffic impacts of the above identified Games-related changes/factors.
- 1.20 The CORNETO model scenario used for this assessment was based on Day 7 of the Olympic Games (Friday 3 August). This has been used as the basis for all the highway modelling of the Olympics to date and is when the maximum impacts on the transport network are assumed, with full competitions taking place at eleven of the 13 London Olympics venues. The scenario used was that which was current at the end October 2011.
- 1.21 Traffic estimates are available from the model on the basis of a notional 'peak' hour in the AM peak, inter-peak (average hour) and PM peak hour (weekday) periods. Reliable estimates are provided within the 'simulation area' of the model, which includes the large majority of the ORN/PRN in central, Inner and Outer East London.
- 1.22 The CORNETO scenario selected (TDM –10 per cent) assumed, in addition to the direct ORN-related traffic changes (which included both Games Family traffic and diversion of other traffic to alternative routes) a general TDM-related reduction of 10 per cent across the network during these hours (7 am to 7 pm), against that in the model 'base case', which best reflected an 'ordinary' August 2012 non-Games day. The -10 per cent scenario was selected from a range of no change to -30 per

cent as representing a prudent scenario towards the bottom of TfL's range of prior expectation for the TDM reduction.

1.23 Various measures are being implemented in order to deliver these reductions. The TDM measures are geographically focused at hot spot locations where at certain times demand is likely to exceed capacity. Measures are aimed at four 'audiences' (spectators, businesses, the freight industry and 'background demand'). In relation to road travel, TDM will work alongside operational and traffic management measures. Specific planned TDM interventions include:

- An integrated national marketing campaign to ensure business/freight and background audiences are aware of transport impacts and restrictions
- A dedicated website giving detailed information on areas to avoid, enabling users to estimate road journey time increases and tools to plan alternative travel
- Daily and real-time information to highlight travel hotspot times and locations
- One to one advice to significant trip generators affecting hotspot areas

### **Emissions assessment: the London Atmospheric Emissions Inventory (LAEI)**

1.24 The emissions assessment used the well-established London Atmospheric Emissions Inventory (LAEI), jointly sponsored by TfL and the GLA, that has formed the basis for all emissions and air quality assessment in London for the past decade. The emissions inventory includes a representation of the London road network, similar in characteristics to that provided by the CORNETO model, alongside including emissions from all other sources in London (domestic, industry, other transport etc).

1.25 The LAEI road network includes quantified traffic flows, largely based on observed data and classified by vehicle type, as well as average link speeds, again based on observed data. Furthermore, the LAEI includes fully-disaggregated classification by vehicle type (fuel, body type, Euro emissions standard etc), corresponding to an accredited set of emissions factors. It is therefore suitable for the detailed testing of policies affecting these parameters (traffic volumes, speeds, composition and emissions performance).

### **Obtaining a 'base' emissions scenario for this assessment**

1.26 The LAEI is updated in detail on a bi-annual basis. However, previous updates can readily be updated to represent near-future years through the application of recognised growth factors (for traffic volumes) and vehicle fleet profiles.

1.27 To ensure the best compatibility with the assessment underlying the Mayor's Air Quality Strategy the assessment used for this report was based on the 2008 version of the LAEI. This reflected the position in 2008 but also included future projections to 2011 and 2015. It was relatively straightforward to develop a 2012 version of this inventory from these projections, using established growth factors and other adjustments (eg to reflect the impact of policies in the MAQS).

- 1.28 Furthermore, the LAEI includes data by which it is possible to develop a version of the Inventory specific to the month of August. This is important as general traffic flows at this time of the year are several per cent lower than the annual average, reflecting seasonal factors (eg school holidays). This August 2012, emissions scenario was used as the 'base case' for this report's assessment and is directly analogous to the CORNETO model 2012 base, which was also calibrated to reflect general traffic levels in the month of August 2012. Both of these scenarios assumed no Games in August 2012, thereby providing the basis for the assessment of Games-time effects.
- 1.29 Given this equivalence between the two models, the approach to reflecting the net effect of the Games-time traffic management and demand changes on the LAEI was to replicate the changes (both absolute and percentage, as appropriate) between the relevant CORNETO scenarios (base and TDM -10 per cent) on the LAEI base, such as to generate a new LAEI scenario that reflected the CORNETO TDM -10 per cent scenario. The difference between these two LAEI scenarios would therefore be analogous to that between the two relevant CORNETO scenarios. The remainder of the emissions sources in the LAEI base (other transport and non-transport) remained unchanged.
- 1.30 Therefore, the combined traffic impacts of the Games traffic management arrangements and demand effects were now reflected in the context of emissions from all other sources in London, such as those from non-transport sources, and the differences between the two emissions scenarios provides a basis for the quantification of the emissions impacts of the Games traffic changes.

### **Key features and limitations of the assessment affecting the interpretation of outputs**

- 1.31 The assessment process was technically complex. It required the interfacing of two distinct models; these being broadly, but not exactly, compatible. It also required estimating certain details (about traffic flows and duration of effects) that were not explicitly provided by the traffic model used as input, for example conditions in the evening and outside the CORNETO simulation area.
- 1.32 In all cases where judgements needed to be made, these were either based on established precedents (eg growth factors, traffic flow and vehicle profiles, reflecting MAQS assumptions) or reflected 'conservative pragmatic' assumptions (see further below).
- 1.33 Furthermore, any modelling exercise designed to assess both strategic and local scale effects such as these will be subject to estimation and other inaccuracies at the small spatial scale. The basis for analysing the outputs of the pollution concentration modelling used in this case was a 20m<sup>2</sup> grid, in part to allow for these estimation uncertainties at the very small spatial scale.
- 1.34 Key features and assumptions under this heading included:

- **TDM assumptions:** the assumed level of general TDM of -10 per cent is towards the lower end of what TfL considers to be achievable. This is for reductions in the range -10 per cent to -30 per cent against a non-Games August day. This will vary between locations, but it is considered that the -10 per cent scenario provides a prudent 'worse case' outcome from this point of view.
- **Duration of effects:** the emissions and air quality modelling assumed that the Games traffic effects persisted at their (representative) Olympic Games Day 7 levels throughout the calendar month of August 2012 (31 days). This is considered to be a pragmatic compromise to the assessment of overall Games effects, which persist at different intensities over a period of six weeks. Again, it reflects an assessment at the 'worse case' end of the range of reasonable possibilities. Use of Day 7 impacts as representative, however, does mean that localised temporary impacts on days/in locations other than Day 7 will not be specifically represented in the modelling.
- **Out of hours/out of simulation area traffic:** the CORNETO model only provides quantified impacts estimates during weekday working hours. It was therefore necessary to make judgments about the Games' impact on traffic during the overnight/weekend period. For the purpose of this assessment, traffic flows during these hours were left unchanged from those in the emissions base case (2012 August non-Games). This was considered to represent a 'best estimate in the absence of more specific information' – reflecting the likely balance between additional Games-related traffic at this time and the overall level of TDM-related general traffic reduction expected. Similarly, the emissions and air quality assessment tools most readily provide assessments that cover the whole of the Greater London area. It was therefore necessary to make judgments as to the likely changes in general traffic outside of the CORNETO model simulation area. For weekday working hours (those corresponding to the CORNETO simulations), a global traffic reduction equivalent to half the assumed TDM reduction (in this case -5 per cent) was applied. For hours outside these times, flows were left unchanged from those in the base case. These are again considered to reflect 'pragmatic worse-case assumptions'.

1.35 In summary, therefore, the emissions and air quality scenario that has been assessed for this work reflects a 'pragmatic worse case' of the combined Games traffic demand and management arrangements – and the model outputs should be interpreted in that context.



## 2 Results – impact of combined Games traffic management arrangements on emissions of key air pollutants

- 2.1 The impact of the combined Games-time traffic management arrangements on air quality can be assessed in terms of changes to the emissions of the two key pollutants, and the resulting change to concentrations of these pollutants in the air. This section considers the first of these two elements.
- 2.2 The relative impact of the Games traffic management arrangements on emissions is best appreciated in terms of changes to the tonnages of the relevant pollutants emitted, and visually as ‘emissions change’ maps for the London road network (all major roads explicitly modelled in the inventory, not just the ORN). Any increases are of particular concern if they are in areas where pollutant concentrations are already high (see following sections).
- 2.3 Table 1 below summarises the change in emissions (on an annualised basis for the whole of Greater London) from the combined Games traffic management arrangements, according to the assumptions described above. In interpreting this table it must be recognised that Games-time impacts will be in force for around one-twelfth of the full calendar year (the ‘nominal August’ assumption described above), and that the ORN/PRN comprises just one per cent of all roads in Greater London (by length), and is focused on connecting the key Games venues. Negative percentage differences in the right-hand column represent a reduction in emissions.

**Table 1: Changes in emissions for combined 2012 Games traffic management arrangements. Tonnes per year, whole of Greater London**

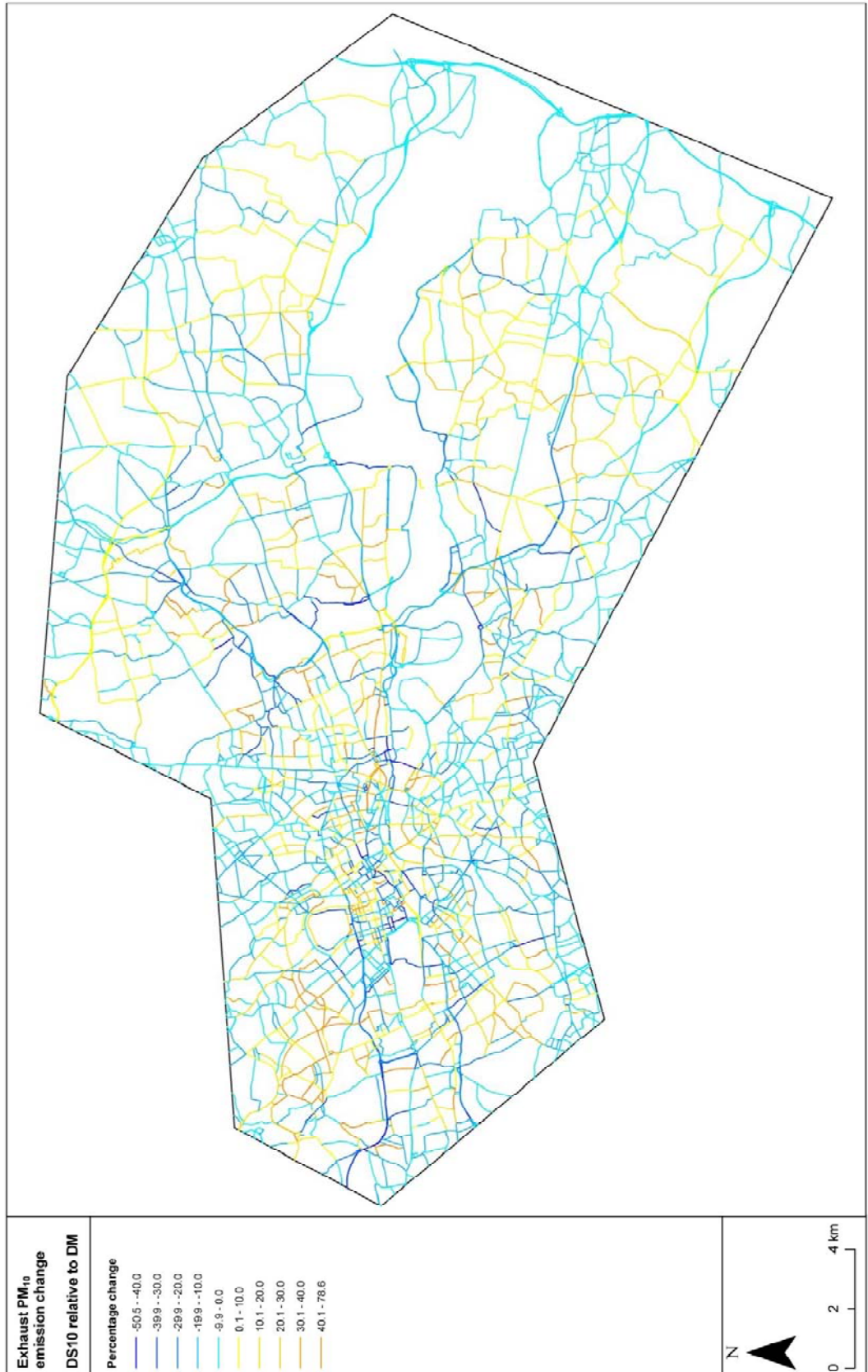
Pollutant	2012 non Games	2012 with Games	Difference (%)
PM <sub>10</sub> all sources	2183.72	2178.92	-0.22
PM <sub>10</sub> all road traffic	1201.20	1196.40	-0.40
PM <sub>10</sub> exhaust only	469.93	468.32	-0.34
Oxides of nitrogen (NO <sub>x</sub> ) all sources	42066.04	42012.00	-0.13
NO <sub>x</sub> road traffic	15174.52	15120.48	-0.36

- 2.4 Looking at Table 1 the key point is that the overall emissions impact at the annual Greater London scale is very small – and in all cases is marginally beneficial (ie a reduction in emissions).
- 2.5 While annualised London-scale impacts are informative and give a good sense of the overall balance and scale of Games-time impacts in terms of pollution concentrations and relevant annual air quality limit values in London, it is also necessary to consider changes at the more local scale and specifically during Games-time in summer 2012.

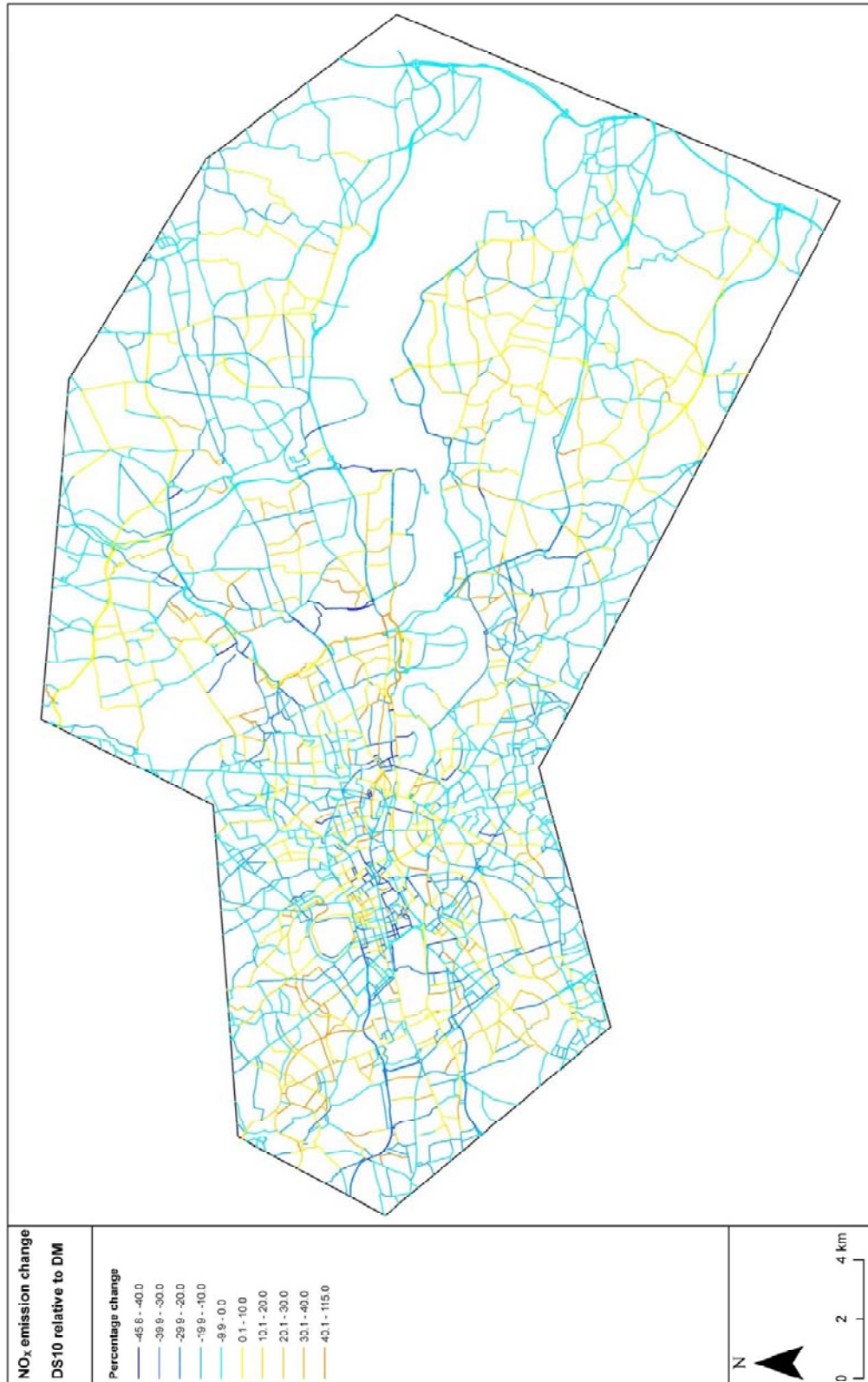
2.6 A better appreciation of these can be gained through maps of emissions change, focusing on the simulation area of the CORNETO model, and looking specifically at the month of August 2012, which as described above is taken as being representative of total Games-time impacts.

2.7 Map 1 shows the emissions change for PM<sub>10</sub>, and Map 2 is a similar map for NO<sub>x</sub> emissions.

**Map 1: Changes in PM<sub>10</sub> emissions for combined 2012 Games traffic management arrangements. Month of August 2012 for CORNETO model simulation area within Greater London. Vehicle exhaust emissions only.**



**Map 2: Changes in NO<sub>x</sub> emissions for combined 2012 Games traffic management arrangements. Month of August 2012 for CORNETO model simulation area within Greater London. Vehicle exhaust emissions only.**



- 2.8 The maps show the percentage difference in emissions for each road link explicitly represented in the LAEI model, for the month of August in 2012. The maps show only emissions from road traffic exhaust. They do not show emissions from other sources and emissions on minor roads, although these have been estimated in the emissions model (as point and area sources) and are included in the concentrations modelling. For clarity, the PM<sub>10</sub> maps also exclude emissions from tyre and brake wear – a significant source of PM<sub>10</sub>, although the scale of change to this component of the total emission is very similar to that for exhaust PM<sub>10</sub>.
- 2.9 Map 1, for exhaust PM<sub>10</sub>, shows that the impacts on emissions are quite varied across the road network, as might be expected given the complex nature of Games-time changes. Because the map deals with percentage changes on roads that have widely differing levels of emissions (in the 'base case') it is not possible to get an accurate sense from the map of the overall balance of impacts, except that the number of roads seeing increased emissions (yellows and oranges) is broadly-balanced (in the simulation area) by those seeing decreased emissions (shades of blue), and that the large majority of road links see emissions changes within the range plus/minus 10 per cent.
- 2.10 Noticeable also from the map is that links seeing increased emissions are focused around Games venues, particularly in Inner and Outer East London, while many high-volume links and key links in central London see decreased emissions. This is particularly relevant for PM<sub>10</sub>, with general compliance with the daily mean and annual mean limit values expected everywhere in London in 2012, but with a small number of locations adjacent to busy roads in central London projected to achieve compliance by only a relatively small margin. Changes to emissions in these locations are therefore of particular significance.
- 2.11 Map 2, for NO<sub>x</sub> emissions (the main emission giving rise to NO<sub>2</sub> concentrations) shows a similar pattern, and scale of change, to that for PM<sub>10</sub>. This is as would be expected given that emissions of both pollutants reflect the same changes in road traffic (overall traffic volumes, traffic speeds and vehicle type mix). However, the significance of the spatial pattern of change for NO<sub>x</sub> differs from that for PM<sub>10</sub>, as – outside the context of the Olympics – exceedences of the limit values for NO<sub>2</sub> in 2012 are projected to occur fairly widely near to major roads in central and Inner London.
- 2.12 Table 2, in a similar way to Table 1 (above), summarises the overall changes to emissions of both pollutants, this time looking only at the notional month of August, and only at the CORNETO simulation area within Greater London. As would be expected, the percentage changes indicated are larger than those at the annual/whole Greater London level, and represent again, in all cases, overall reductions to emissions.

**Table 2: Changes in emissions for combined 2012 Games traffic management arrangements. Tonnes per notional month of August 2012, CORNETO model simulation area only.**

Pollutant	2012 non Games	2012 with Games	Difference (%)
PM <sub>10</sub> all sources	70.64	68.19	-3.47
PM <sub>10</sub> all road traffic	38.38	35.93	-6.38
PM <sub>10</sub> tyre and brake	23.93	22.29	-6.85
PM <sub>10</sub> exhaust only	14.45	13.64	-5.61
NO <sub>x</sub> all sources	1081.17	1059.03	-2.05
NO <sub>x</sub> exhaust	516.56	494.42	-4.29

2.13 In interpreting the relative significance of these changes, it is necessary to bear in mind the level of absolute emissions in the 'base case'. In many cases where road traffic emissions increase, they are on roads with comparatively low emissions in the 'base case'. Furthermore, the increase in emissions takes place within the road carriageway itself – an important consideration when assessing the pollutant concentration maps (see below) that relate to these emissions scenarios (as highlighted in paragraph 1.18).

#### **Air quality (pollution concentrations) assessment**

2.14 The LAEI interfaces directly to the London Air Quality Model. This is a sophisticated and recognised state-of-the-art model that simulates the concentration of pollutants across Greater London, based on the input emissions scenarios and a range of other assumptions, principally the effect of the weather on dispersion, chemical reactions in the atmosphere, and urban topology (street canyons, buildings etc).

2.15 The model used for this assessment is a detailed representation of the observed weather during the 2008 calendar year. This reflects established good practice of using a 'recent historic year with weather patterns close to the long-run average', and is also the same as the year (2008) that was used for the MAQS assessment, therefore ensuring compatibility with that assessment.

2.16 Both the LAEI and the London Air Quality Model most readily produce outputs that are expressed on an annual total or annual average basis, these according most directly with the limit values for air quality against which legal compliance for air quality is assessed.

2.17 To take into account the fact that the Games' traffic arrangements will apply over a number of weeks in 2012 only but that the London Air Quality Model works on an annual basis, two 'annualised' runs were made. The first corresponded to a 2012 year without the Games, specifically including an August without the Games and directly analogous to the August 2012 emissions base. The second corresponded to

a 2012 year with the Games August scenario instead of the equivalent non-Games scenario.

2.18 The assessment method for pollutant concentrations therefore consisted of running the air quality model for both the 'base' and TDM – 10 per cent emissions scenarios (above), the difference between the two reflecting the combined effect of the Games-traffic demand and management proposals, as with the emissions assessment, expressed on an annualised basis so as to be meaningful in terms of the key air quality limit value metrics.

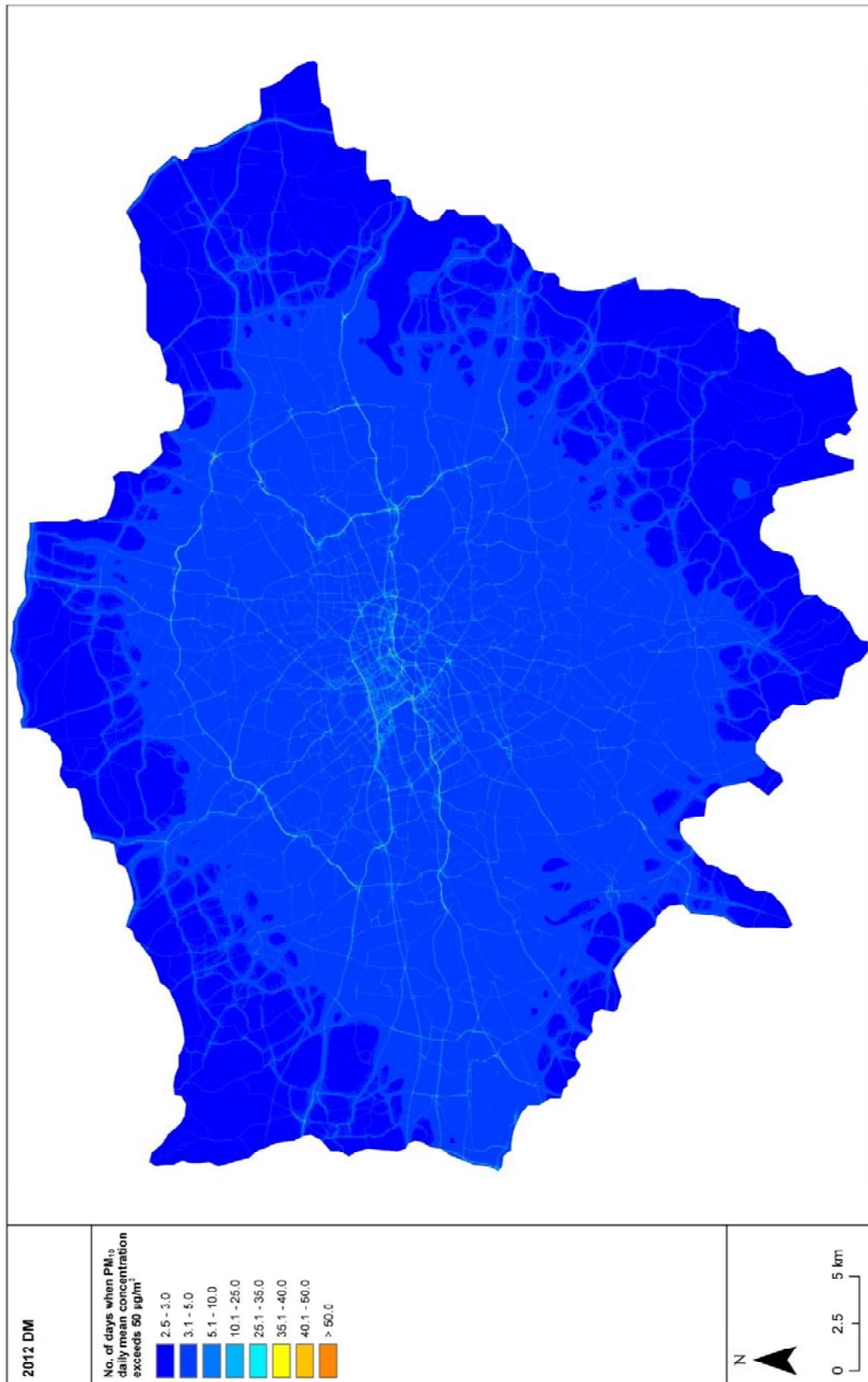
2.19 There are several important factors to note when interpreting the outputs of the air quality model:

- The assessment is based on emissions from all sources that contribute to pollution. Changes in road traffic emissions are only a proportion of overall emissions and will therefore have a proportionally smaller impact on out-turn concentrations
- The concentrations maps are expressed in terms of the difference between the 'base' and 'Games' cases, and reflect an annualised assessment in terms of the relevant air quality limit values for PM<sub>10</sub> and NO<sub>2</sub>
- For the purposes of this report maps focus on the CORNETO simulation area and include the carriageway of roads (which, as highlighted previously, are not assessed in terms of compliance with the limit values)
- For the remainder of Greater London, not shown by the maps, concentrations of both pollutants show small reductions in line with the TDM assumptions, as described above

### **PM<sub>10</sub> concentrations**

2.20 Looking first at PM<sub>10</sub>, Map 3a shows projected exceedences of the daily mean limit value for 2012 assuming no Games. As would be expected, the patterns seen are broadly comparable to those for 2011 as previously published in the MAQS – taking into account various improvements reflecting changes between 2011 and 2012, as detailed in the Strategy, such as the introduction of Phases 3 and 4 of the London Low Emissions Zone in January 2012.

2.21 In 2012 without the Games, the whole of London is forecast to comply with the daily mean exceedence limit value where this applies (ie outside of the road carriageways themselves). However the margin by which compliance is projected to be achieved in relevant locations is, in a small number of central London locations close to busy roads, relatively small.



**Map 3a. PM<sub>10</sub> concentrations: 2012 non-Games base case. Number of days when average PM<sub>10</sub> concentrations are projected to exceed 50ug/m<sup>3</sup> in 2012**



**Map 3b. Change in PM<sub>10</sub> concentrations: difference between 2012 non-Games base case and 2012 with Games. Change in number of days when average PM<sub>10</sub> concentrations are projected to exceed 50ug/m<sup>3</sup> in 2012**



2.22 Map 3b shows the impact of the Games, in terms of the change in days on which the daily mean limit value is projected to be exceeded in 2012. Blue colours indicate a reduction in exceedence days, yellows and oranges an increase.

2.23 The main points from Map 3b are:

- The majority of the simulation area sees small reductions in exceedence days, reflecting reduced concentrations. In locations remote from the ORN/PRN and surrounding roads, this primarily reflects the assumed level of background traffic reduction achieved through TDM measures. So the overall effect of the combined Games traffic management arrangements on PM<sub>10</sub> in central/Inner London is projected to be marginally beneficial
- The magnitude of the indicated changes is relatively small. Although the entire range of changes (20 metre grid squares) extends from a reduction of 5.3 exceedence days (for 2012) to an increase of 3.0 exceedence days, the large majority of indicated changes are within a much smaller range – typically much less than plus/minus 1 exceedence day
- On the ORN/PRN itself it is generally the case that exceedence days, and PM<sub>10</sub> concentrations, are reduced. This reflects the nature of the ORN/PRN traffic management measures, where general traffic at ‘normal daily volumes’ is replaced by Games Family traffic at volumes that are in aggregate generally lower than those that would be experienced on a non-Games August day
- In some cases the reduction in exceedence days is projected to be up to around five days. This is significantly beneficial on these otherwise busy roads and in locations that are known to have relatively elevated concentrations, such as the Marylebone Road, albeit at levels projected to be within the prevailing limit value. Overall, therefore, the effect of the combined Games traffic management arrangements on the ORN/PRN specifically is beneficial
- There are a small number of locations on the ORN/PRN, however, where the modelling suggests an increase in concentrations, leading to a potential increase in the number of days where the daily mean limit value is projected to be exceeded. The most significant occurrence of this is along the A13 corridor from the east into the City, and the A12 corridor north from the Blackwall Tunnel
- Considering the ‘base’ concentrations in Map 3a and the relevant locations outside of the main carriageway of the roads, the increase in concentrations/exceedence days is not such as to cause a material change to the compliance status (in relation to the relevant limit values) of the locations concerned. Nevertheless, it is considered that appropriate mitigation of these small increases should be considered, based on the ‘precautionary principle’, in these locations
- Finally, the effect of general traffic diverting away from the ORN/PRN can be seen across many parts of central and Inner London, in terms of very small increases to the number of days that locations are projected to exceed the daily mean limit value. It is clear from the maps that, firstly, these increases overwhelmingly occur in locations where the limit value for PM<sub>10</sub> in 2012 is projected to be met with a comfortable margin of tolerance. Secondly, the actual

magnitude of the changes projected are very small – typically a small fraction of an exceedence day

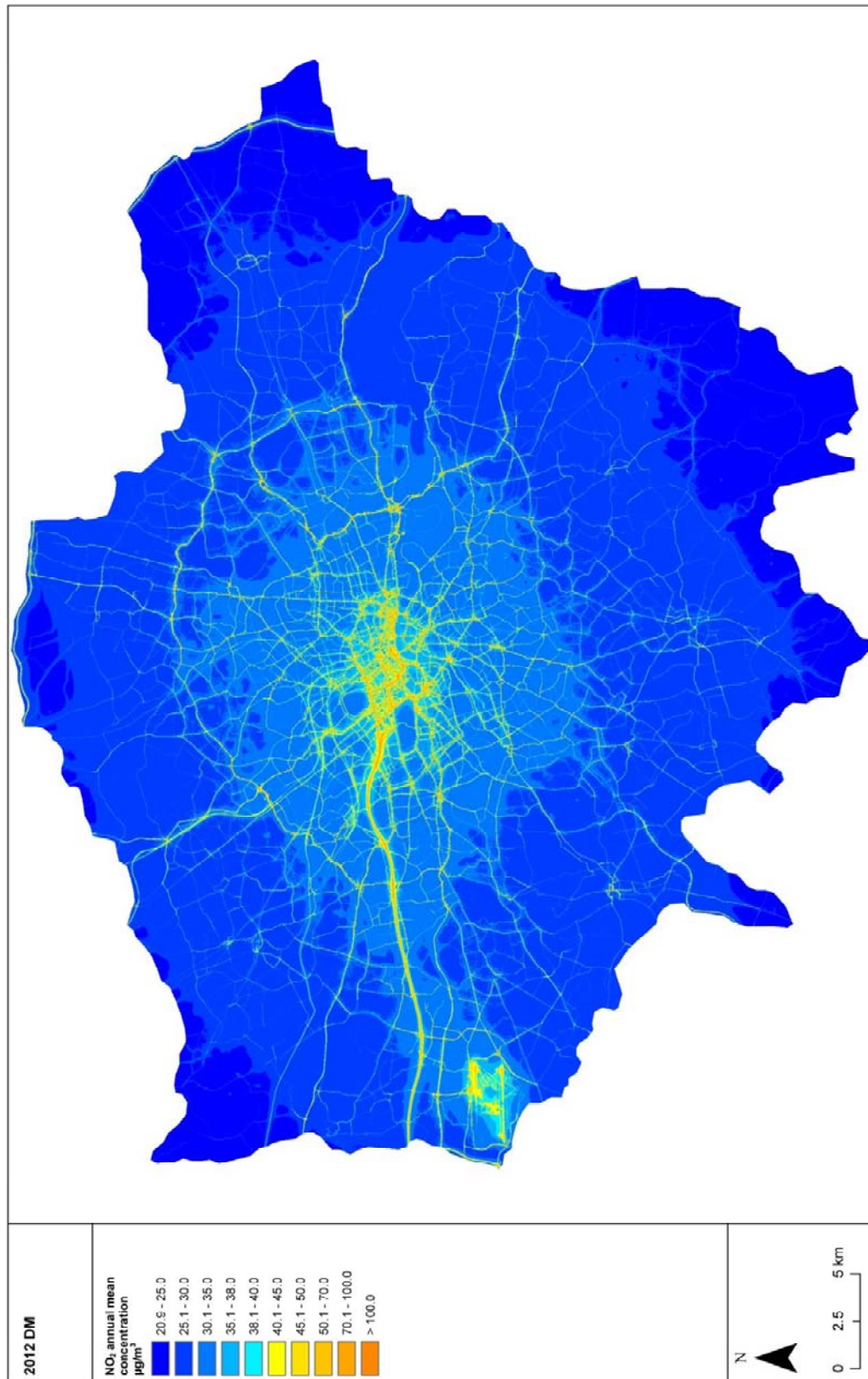
- In general therefore, the effect on PM<sub>10</sub> concentrations of traffic diverting away from the ORN/PRN to nearby roads is minor and does not give rise directly to material changes in concentrations. However, in common with parts of the ORN/PRN that are projected to see increased concentrations, potential mitigation could be considered in areas where these (albeit very small) increases are relatively widespread and/or concentrations are already relatively high. The areas proposed for potential mitigation are the Olympic Park environs, an area to the North-West of the central zone and an area around Waterloo up towards Victoria Embankment
- Overall, for PM<sub>10</sub>, no new exposure-relevant locations (based on a 20m<sup>2</sup> grid) are projected to exceed the limit value as a consequence of the Games-time traffic management arrangements in comparison with the 2012 non-Games base

## **NO<sub>2</sub> concentrations**

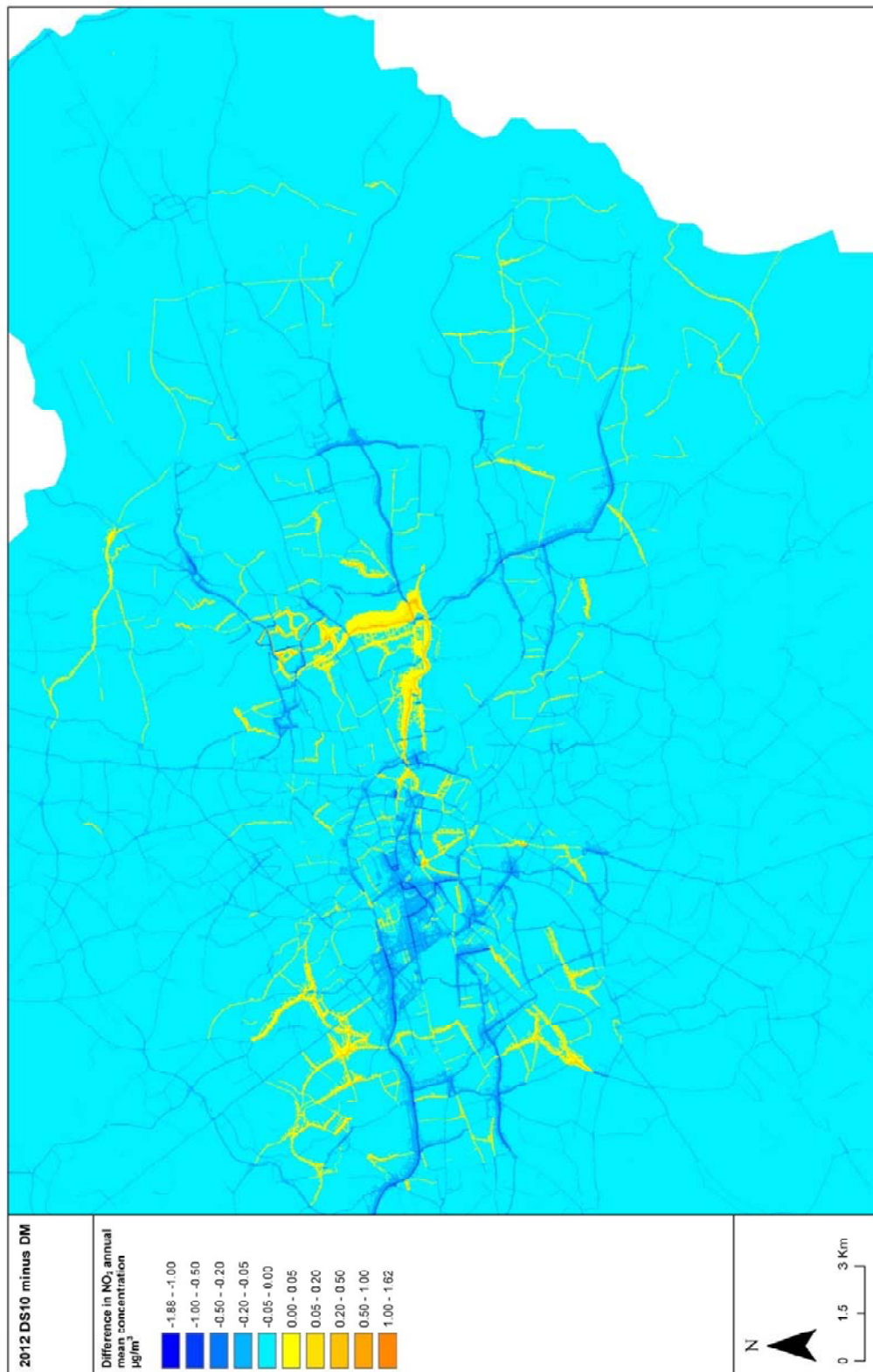
2.24 Turning to NO<sub>2</sub>, Map 4a shows the projected annual mean limit values for 2012 assuming no Games. Locations that are projected to exceed the limit value are coloured yellow/orange. Again, the patterns seen are broadly comparable to those for 2011 as previously published in the Mayor's Air Quality Strategy – taking into account various improvements reflecting changes between 2011 and 2012, as detailed in the Strategy.

2.25 Map 4b shows the impact of the Games, in terms of the change in annual mean concentrations in 2012. Blue colours indicate a reduction in concentrations, and yellow/orange colours an increase. The overall scale and pattern of changes to concentrations of NO<sub>2</sub> resulting from the Games traffic management and demand arrangements are similar to those described above for PM<sub>10</sub>. However, the 'base' concentrations on which they act are different in that, in the 2012 base, exceedences of the annual mean limit value are projected to be widespread alongside major roads in central and Inner London (Map 4a).

Map 4a. NO<sub>2</sub> concentrations: 2012 non-Games base case. Annual mean concentrations



Map 4b. Change in NO<sub>2</sub> concentrations: difference between 2012 non-Games base case and 2012 with Games



## 2.26 The main points from Map 4b are:

- The majority of the simulation area sees small reductions in concentrations. In locations remote from the ORN/PRN and surrounding roads, this primarily reflects the assumed level of background traffic reduction achieved through TDM measures. So the overall effect of the combined Games traffic management arrangements on NO<sub>2</sub> in central/Inner London is projected to be beneficial
- The magnitude of the indicated changes is relatively small. Although the entire range of projected change (20 metre grid squares) extends from a reduction 1.88 micrograms (annual mean, 2012) to an increase of 1.62 micrograms, the large majority of indicated changes are within a much smaller range – typically much less than plus/minus 1 microgram
- On the ORN/PRN itself it is generally the case that NO<sub>2</sub> concentrations are reduced as a result of the Games-time traffic management arrangements. As with PM<sub>10</sub> (above), this reflects the nature of the ORN/PRN traffic demand and management measures, where general traffic at ‘normal daily volumes’ is replaced by Games Family traffic at volumes that are in aggregate generally lower than those that would be experienced on a non-Games August day
- There are nevertheless a small number of locations on the ORN/PRN where the modelling projects an increase in NO<sub>2</sub> concentrations. The most significant of these are again along the A13 corridor east from central London, and the A12 corridor north from the Blackwall Tunnel – the main southern approaches to the Olympic Park. Increases to NO<sub>2</sub> concentrations are also projected on some other roads in the vicinity of the ORN/PRN, reflecting traffic diversion away from these roads to nearby alternative routes, with again the area north west of central London, around Maida Vale, the most apparent
- For NO<sub>2</sub>, therefore, there are a small number of locations (20 metre grid squares) where concentrations are, in the base case, projected to be below the limit value in 2012, where the projected changes take concentrations above the limit value. These are however heavily outweighed, by a factor of approximately eight-to-one, by locations that are projected in the 2012 base to have concentrations above the limit value, that reduce to below the limit value as a result of the Games traffic changes
- There are also some areas that are projected to be in breach of the limit values in the 2012 base which may see an increase in NO<sub>2</sub> concentrations for the limited time period of the Games. Again, however, the number of areas that is projected to see a fall is much larger. Any similar traffic intervention would also have such redistributive impacts - both negative and positive. In this case the balance of impacts is expected to be positive
- The picture in relation to the limit value for hourly NO<sub>2</sub> concentrations is similar to that for annual mean NO<sub>2</sub>, with widespread projected exceedences close to kerbsides of main roads (of the 18 permitted hours when concentrations exceed 200 micrograms per cubic metre) in the 2012 base case, and a mixture of positive and negative effects from the Games traffic demand and management arrangements, with the overall balance being positive
- As with PM<sub>10</sub>, potential mitigation for NO<sub>2</sub> could be considered in areas where these small increases to concentrations are comparatively widespread

### 3 Potential mitigation

- 3.1 It is important to note that at the beginning of 2012, the Mayor implemented two more phases of the London-wide Low Emission Zone, affecting 150,000 vehicles. Age limits for taxis and private hire vehicles were also introduced. These are delivering important reductions in air pollutant emissions in the lead up to the Games and beyond.
- 3.2 The analysis suggests that, overall, the combination of controlled traffic on the ORN/PRN and wider traffic reduction through TDM should give a small net positive effect on air quality during Games time. In virtually all cases where traffic diverts away from the ORN/PRN to alternative routes the local impact on air quality is projected to be small, temporary in nature, and not such as to have a substantive impact on compliance with the relevant air quality limit values.
- 3.3 However, there are some areas where potential increases in emissions and concentrations of pollutants are projected. Where these areas of potential increase coincide with locations where concentrations are already high, it is prudent to consider measures to mitigate potential air quality effects.
- 3.4 This is also important given the inevitable uncertainty in relation to the actual meteorology (including trans-boundary pollution) to be experienced during the Games period. Although the modelling indicates that compliance should be achieved for PM<sub>10</sub>, it necessarily has to use meteorology from a past (representative) year. While the assessment considered a cautious scenario in terms of the potential impacts of travel demand management, and traffic volumes and air quality implications, it is not possible to predict the actual weather to be experienced during the Games period itself (and also the rest of the year) which can significantly affect concentrations over the short term.
- 3.5 There is a range of measures that could in principle reduce emissions and help reduce concentrations within particular areas or across a wider area. These include more localised initiatives, such as the application of dust suppressants and changes to buses on particular routes, as well as larger scale measures such as the introduction of an Inner London Low Emission Zone or bans on specific vehicles. These are considered below.
- 3.6 Work was undertaken in 2010/11 by TfL to consider the feasibility of a LEZ within central or Inner London, partly in light of the implementation of schemes in cities such as Berlin and the calls by some stakeholder groups for a similar scheme here (these schemes discourage or prevent the entry of highly polluting vehicles by means of a daily charge or restriction on those that exceed specified Euro standards). Any such scheme would be in addition to the existing London-wide LEZ, and would thus require standards higher than the Euro IV PM standard (for buses, coaches and HGVs) and Euro III PM standard (for LGVs and minibuses), which are already in place, if it were to have any effect. The analysis suggested that the social and economic impacts of such an option - due to the high compliance costs for owners and operators of vehicles - would far outweigh the environmental benefits. There were also significant implementation obstacles to delivering a Berlin-type scheme. TfL's feasibility report is available [here](#).

- 3.7 In light of this, the introduction of a further LEZ scheme has not been progressed. In the specific context of the Olympics, any such measure would seem disproportionate given the very high compliance costs involved compared with the small air quality impacts projected and their limited duration. It is not considered that the costs involved would be justified by the small scale impacts seen in a limited number of locations.
- 3.8 Options such as a vehicle ban have also not been progressed as they are also not considered proportionate in terms of the costs and benefits involved and raise significant practical concerns. Odd and even number plate bans and other similar vehicle restrictions would be likely to cause major disruption, particularly to vital freight and servicing activity. For this reason these measures are not considered appropriate for London where schemes such as the LEZ have been designed to provide some flexibility, e.g. non compliant vehicles can still pay a daily charge to drive in the LEZ.
- 3.9 However, TfL considers that some 'mitigation measures' would be prudent to provide additional confidence in relation to limit values and health and help further minimise the small scale of projected impacts. In light of the scale and nature of the projected impacts of the ORN and PRN and related traffic-management arrangements, and taking into account issues such as compliance costs, measures considered proportionate and feasible are targeted road cleansing with the application of dust suppressants and bus retrofit. Alongside this, TfL will continue to target no-idling activities and urban greening to help reduce emissions during this period and beyond.
- 3.10 These measures are in addition to the major programme of strategic measures and initiatives designed to manage traffic and reduce background travel demand across London during the Games period, which include:
- Active Traffic Management – Extensive area-wide traffic signal coordination and control to balance the needs of the ORN with keeping London moving for planned and unplanned
  - Clearway 2012 – moratorium on roadworks on the ORN and strategic roads during the Games in partnership with London highway authorities and Statutory Undertakers (ie utilities and their contractors)
  - Travel Demand Measures, including:
    - An integrated national marketing campaign to ensure business/freight and background audiences are aware of transport impacts and restrictions
    - A dedicated website giving detailed information on areas to avoid, enabling users to estimate road journey time increases and tools to plan alternative travel ('Get Ahead of the Games' which was recently launched ([www.getaheadofthegames.com](http://www.getaheadofthegames.com)))
    - Daily and real-time information to highlight travel hotspot times and locations
    - One-to-one advice to significant trip generators affecting hot spot areas



- 3.11 More broadly, TfL will continue to operate and implement the measures in the Mayor's Air Quality Strategy, including the Clean Air Fund (CAF) Programme, which will help deliver continued reductions in emissions. The CAF programme is delivering a range of innovative local measures at PM<sub>10</sub> hot spots in central London. This programme was previously scheduled to end in March 2012, but the Department for Transport (DfT) has agreed to extend the timescale for the implementation of some local measures until autumn 2012.
- 3.12 TfL and the GLA will also continue to work with central Government, boroughs and other stakeholders to investigate ways in which air quality can be improved further in London – particularly to consider how to bridge the large NO<sub>2</sub> gap. This is an issue beyond the specific context of the Olympics – the traffic management arrangements for the Olympics have relatively limited impacts and are not material in the achievement, or otherwise, of the NO<sub>2</sub> limit values. It is not considered that there are any feasible measures that could be implemented in the Olympics timeframe that would enable the achievement of the NO<sub>2</sub> limit values across London. This is a challenge across Europe and is exacerbated by the poor performance of Euro standards for vehicle emissions which also limits the effectiveness of many potential policy levers.

#### **PM<sub>10</sub>**

- 3.13 As highlighted in the previous sections, the projected increases in PM<sub>10</sub> are limited in both scope and scale and are not of an order as to cause a material change to the compliance status in relation to the relevant limit values of the locations concerned. Nevertheless, it is considered that appropriate mitigation of these small increases should be considered, based on the 'precautionary principle', in relevant locations.
- 3.14 For the corridors or areas that are projected to see increases in PM<sub>10</sub> concentrations during Games-time, targeted Cleaning and Application of Dust Suppressants (CADS) could be applied to try to help minimise impacts. This involves treating carriageways with a biodegradable saline solution, Calcium Magnesium Acetate (CMA). This causes particulates to bond to the carriageway, removing them from the air. Winter service vehicles spread the CMA in very small amounts evenly on road surfaces late at night when traffic is at a minimum.
- 3.15 Interim reporting on the application of CMA demonstrated measurable decreases in PM<sub>10</sub> at the trial location (initial results of the earlier trials are available [here](#)). TfL is continuing to trial this measure over an expanded area. The results from the further monitoring and evaluation are not due until April/May – the findings from this will be integrated into the ongoing programme.
- 3.16 The areas identified as potentially benefitting from the application of CADS are shown below (A13/A12 corridors; Strand/Victoria Embankment/Waterloo area; Olympic Park environs; and an area to the north-west of the central zone). This is considered feasible since the necessary machinery would be available and TfL has experience of implementation. TfL is now undertaking more detailed planning for implementing this.

3.17 TfL will keep this under review in the context of air quality monitoring ahead of, and during, the Games – in effect CADS could be applied where and when necessary.

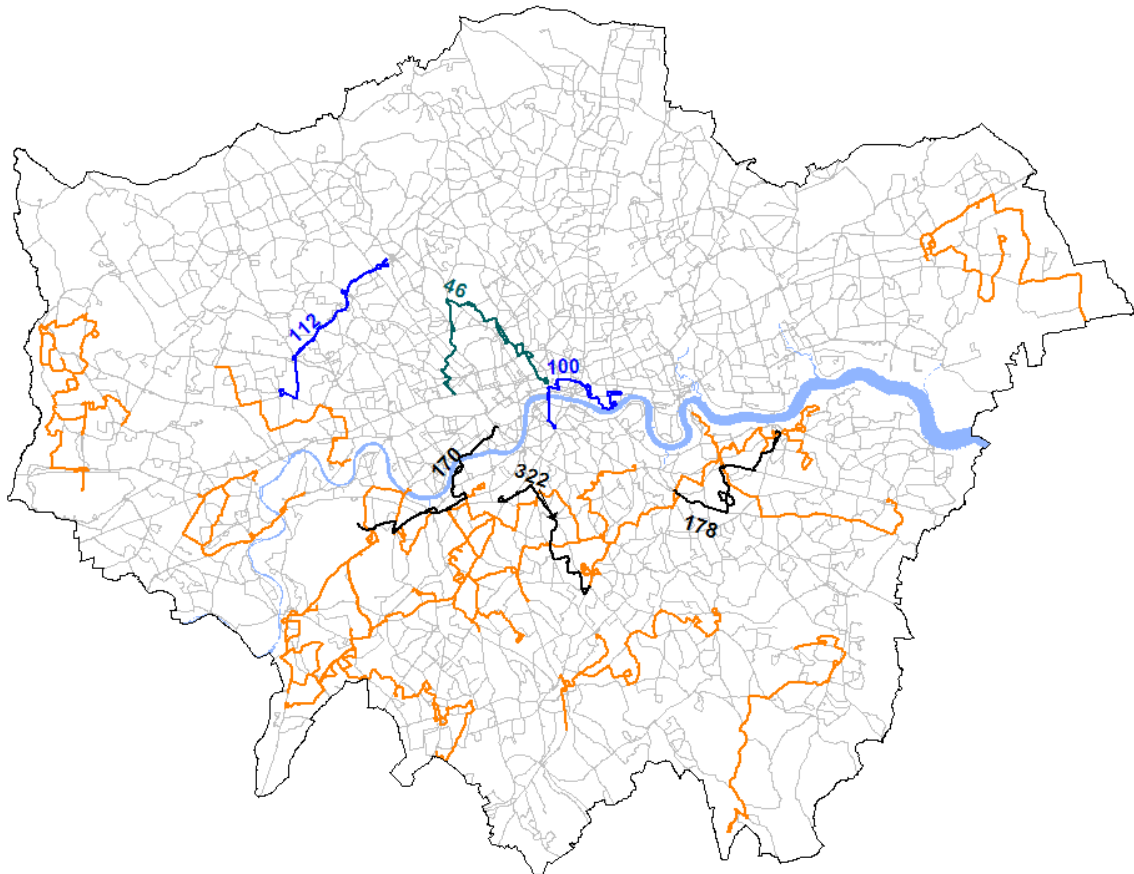
3.18 TfL will also work with LOCOG, boroughs and others to promote no engine idling activity and messages, continuing to build on the recent London-wide campaign. This will be focused on both Games vehicles and the Games more broadly as well as in particular locations.

## **NO<sub>2</sub>**

3.19 As highlighted, mitigation in relation to NO<sub>2</sub> is difficult. Retrofitting buses on routes which pass through or intersect with NO<sub>2</sub> exceedance areas that potentially experience increased concentrations as a result of the ORN, with Selective Catalytic Reduction technology, would deliver benefits. Trials of SCR retrofit equipment for buses in London are ongoing. To date, the technology has been fully developed and tested for single-decker vehicles and we plan to roll-out this technology on appropriate buses and routes to reduce local NO<sub>x</sub> emissions.

3.20 On this basis, five Euro 3 single-decker routes have been identified as candidates for retrofit in relation to the Games. The map below shows these routes – the 100, 112, 170, 178 and 322. The grey lines show the wider bus network and the orange lines other single-decker routes (so possible candidates for retrofit) – but those selected are considered the most relevant on the basis of the analysis undertaken. The timescales for this are tight, but for routes 100, 170, 178 and 322 it should be possible to deliver retrofitted buses on street ahead of the start of the Olympics. For route 112, the timescales may be just after the Games period itself.

In the context of yearly limit values, this would still help to mitigate some impacts seen during the Games but also deliver ongoing air quality legacy benefits. Meanwhile, new buses (Euro V) are also being introduced on Route 46 ahead of the Olympics.



3.21 SCR reduces NO<sub>x</sub> emissions from these buses by a minimum of 70 per cent and depending on the bus model potentially more. This would provide some benefits during the Games time by reducing NO<sub>x</sub> emissions and helping offset some of the potential increases – although this is not a ‘direct mitigation’ as in the case of dust suppressants, given that buses are only a proportion of the emissions in these areas. But, significantly, it would provide ongoing and legacy benefits. The retrofitting of the five routes covering 54 buses should save around 25 tonnes of NO<sub>x</sub> per year.

3.22 Since we are limited to single-decker buses and so a relatively small number of routes where we can take action this would not address all the areas identified as potentially impacted. TfL is also therefore exploring the potential for re-deploying existing cleaner buses – the scope for this is limited given contractual issues and the concern about impacting adversely on areas from which the buses are redeployed, but there may be some opportunities for the limited period of the Games in a small number of areas.

3.23 While these measures will not directly mitigate the impacts in the locations which could experience an increase in concentrations, we consider that they represent a

practicable means of reducing NO<sub>x</sub> emissions in key areas and in a way that provides ongoing benefits.

3.24 Owing to highly transient, low temperature duty cycles and vehicle packaging complications, SCR technology has to be carefully designed to meet specific bus requirements and be extensively tested to ensure its effectiveness and durability. While this work has been completed for single-decker buses it is still ongoing for double-decker buses. TfL is currently working on this and it is expected to be able to include double-decker buses soon as part of the TfL and DfT bus retrofit programme. This will not be in time for the Games itself, but the wider roll-out on specified double-decker routes should start shortly after. The programme for the further routes to be targeted (covering up to 1,000 buses) is currently being finalised and the retrofitting will take place through 2012/13 and 2013/14. This will deliver ongoing reductions in NO<sub>x</sub> emissions of around 400 tonnes per year.

### **Other issues/measures**

3.25 AirTEXT is a service in London that provides free air pollution alerts and health advice to those who are most likely to be affected by air pollution. More than 10,000 users are currently registered. There is the potential for air pollution episodes to occur during the Games as a result of factors beyond our control – particularly meteorological conditions and/or trans-boundary pollution.

3.26 It is important that this service operates effectively during the Games period. The GLA is working with airTEXT, Department for Environment, Food and Rural Affairs (Defra) and Olympics boroughs to promote the service in relation to the Games.

### **Next steps**

3.27 In light of the analysis, officers do not consider that the projected air quality impacts should affect implementation of the ORN/PRN. The overall pattern of impacts seen, where some locations see decreased concentrations and others see an increase, would be typical of any intervention (however minor) which affected the volume or pattern of traffic. In the case of the Games traffic management measures, the locations with a forecast decrease in concentrations outweigh those with a forecast increase by a significant factor. Furthermore, the adverse impacts are small in magnitude and of a temporary nature.

3.28 TfL and the ODA are currently working to finalise the set of measures outlined above to help further minimise impacts, including:

- Liaising with relevant London boroughs in relation to the analysis and recommended mitigations
- Finalising detailed planning for implementation
- Ongoing monitoring of air quality ahead of and during the Games and if necessary further review of mitigations

## **4. Conclusion**

- 4.1 The assessment has indicated some small increases in PM<sub>10</sub> and NO<sub>2</sub> concentrations in a number of locations – these are limited in magnitude and duration and are not considered likely to give rise to material changes in relation to compliance with the relevant air quality limit values.
- 4.2 Mitigation measures will further minimise impacts. The view of TfL and GLA officers is that there are not likely to be any material adverse air quality impacts (PM<sub>10</sub> and NO<sub>2</sub>) resulting from the operation of the ORN/PRN and associated TDM, but it is considered prudent, nevertheless, for TfL and the boroughs (as the relevant highways/ traffic authorities) to put in place proportionate mitigation measures as far as practicable and appropriate. In line with this, the measures we propose to implement are dust suppressants and retrofitting of a number of bus routes.
- 4.3 It is important to highlight that the overall pattern of impacts seen, where some locations experience decreased concentrations and others an increase, would be typical of any intervention (however minor) which affected the volume or pattern of traffic. In the case of the implementation of the ORN and PRN and associated traffic demand and management arrangements, the assessment indicates that the number of locations with a forecast decrease in concentrations substantially outweighs those with a forecast increase. Given the small magnitude and temporary nature of any adverse impacts, TfL considers that on balance the implementation of the ORN/PRN and associated measures should not have adverse impacts on health.