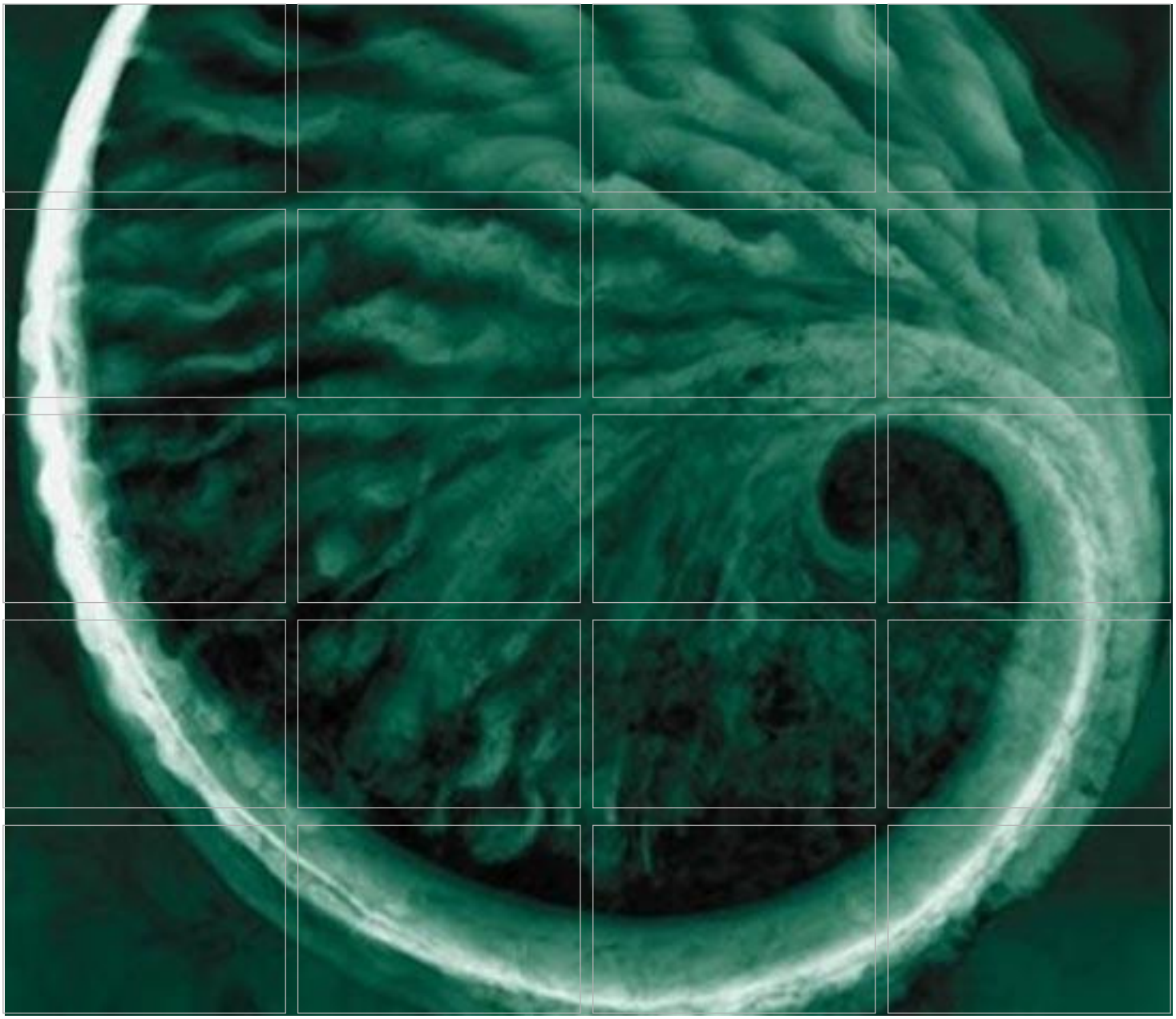

Current and Future Air Quality around Heathrow Airport – Implications for its Further Development

Report

19 March 2015

Gatwick Airport Limited

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For and on behalf of Environmental Resources Management
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1 EXECUTIVE SUMMARY

1.1 INTRODUCTION

The air quality around Heathrow Airport has long been recognised as being poor. The issue that has proved to be most difficult to resolve is compliance with the EU Limit Value for annual average concentrations of the pollutant nitrogen dioxide (NO_2). Indeed, within the context of air quality within Greater London as a whole, the area around Heathrow Airport stands out very prominently as an area of particularly high concentrations of NO_2.

The EU annual average Limit Value for NO_2 is 40 micrograms per cubic metre[1] of air.

1.2 OVERVIEW

- The area around Heathrow has long been in breach of EU and UK regulations in respect of NO_2.
- There is an obligation on the Secretary of State to ensure that these breaches are eliminated.
- The UK is currently the subject of a European Commission investigation and may be subject to potential fines for breach of NO_2 limits in and around London.
- The UK government's National Networks National Policy Statement (NN NPS) of 2014 states that consent for a relevant scheme should be refused where the air quality impacts of the scheme will result in areas breaching the NO_2 limit value or which would affect the ability of an area currently in breach to achieve compliance with existing limits.
- Previous estimates of NO_2 reductions around Heathrow have proved overly optimistic – in fact NO_2 levels have increased in places.
- There is no certainty that the annual mean NO_2 limit value could be met with a Heathrow Scheme being constructed and operated. There are no assurances that the construction and operation of a Heathrow scheme could be undertaken without delaying compliance with NO_2 limits values.
- Neither is there any certainty therefore that a Heathrow Scheme could be delivered and the UK's legal obligations, under the 2008 EU Air Quality Directive and the 2010 Air Quality Regulations, still be met.
- Consequently, if the Commission were to select one of the Heathrow schemes, there must be a significant risk that it may subsequently prove to be undeliverable.

[1] Also written as $\mu g/m^3$

EU Directive 2008/50/EC on ambient air quality and cleaner air for Europe imposed an obligation upon member States to ensure that the NO_2 annual average limit value was met by 2010.

NO_2 is a gas which can cause inflammation of the airways of the lung and exacerbate other respiratory conditions. It is widely regulated around the world for its effects on human health.

The EU Directive on ambient air quality[1] sets out the obligations on member States to meet certain pollutant concentrations over certain averaging periods by 2010. The Directive has been transposed into English law by the Air Quality Standards Regulations 2010 ("the 2010 regulations")

The pollutant and averaging period of most relevance around Heathrow is the annual mean limit value for NO_2, which is 40 micrograms per cubic metre ($\mu g/m^3$) of air.

The 2010 Regulations state that "The Secretary of State must ensure that levels of… nitrogen dioxide… do not exceed the limit values set out in Schedule 2", this Schedule includes the numerical limits and hence the 40 $\mu g/m^3$ as an annual mean for NO_2.

The UK and the Secretary of State are hence under a legal duty to ensure that the EU annual average limit value for NO_2 is not exceeded, in the Heathrow area or indeed elsewhere.

The 2010 Regulations set out what is required in the event that limit values are exceeded. The Secretary of State must "draw up and implement an air quality plan so as to achieve"[2] the relevant limit value. The plan "must include measures intended to ensure compliance with any relevant limit value within the shortest possible time".[3]

The National Networks National Policy Statement (NN NPS) was published in December 2014 and sets out the Government's policies on the development of nationally significant infrastructure projects on the national road and rail networks in England.

The NN NPS states that consent for a relevant scheme should be refused where, after having regard to mitigation, the air quality impacts of the scheme

[1] 2008/50/EC

[2] Regulation 26(1) of the 2010 Regulations

[3] Regulation 26(2)

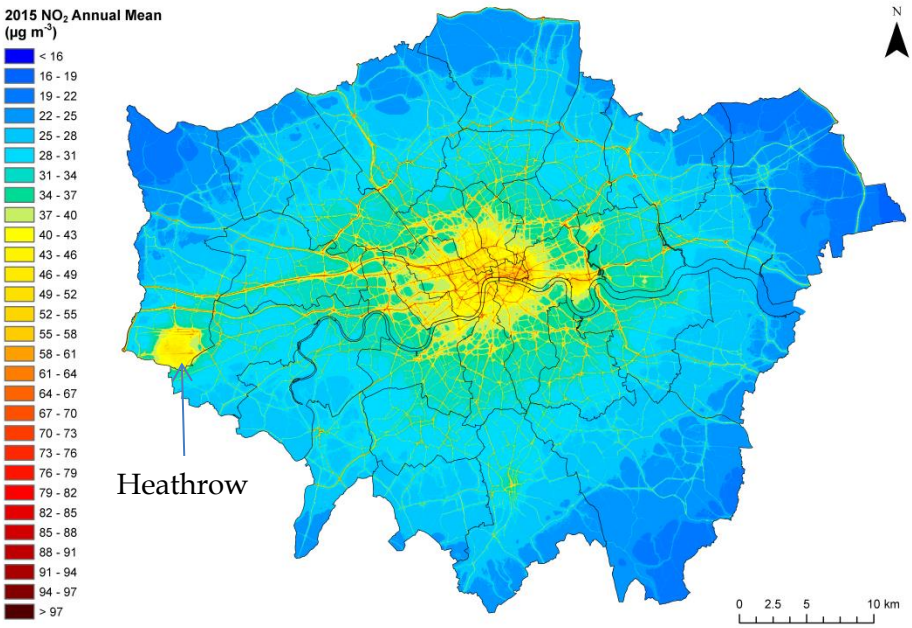
will result in areas currently below a limit value breaching the limit value or which would affect the ability of an area "to achieve compliance within the most recent timescales reported to the European Commission at the time of the decision."

Recent court cases brought by ClientEarth at the UK Supreme Court and the European Court of Justice have confirmed the nature of the obligations upon Member State to ensure compliance with limit values by adopting measures which must "ensure that the period of time during which limit values are exceeded is as short as possible."[1] . The case returns to the UK Supreme Court in April 2015.

1.4 *CURRENT CONDITIONS*

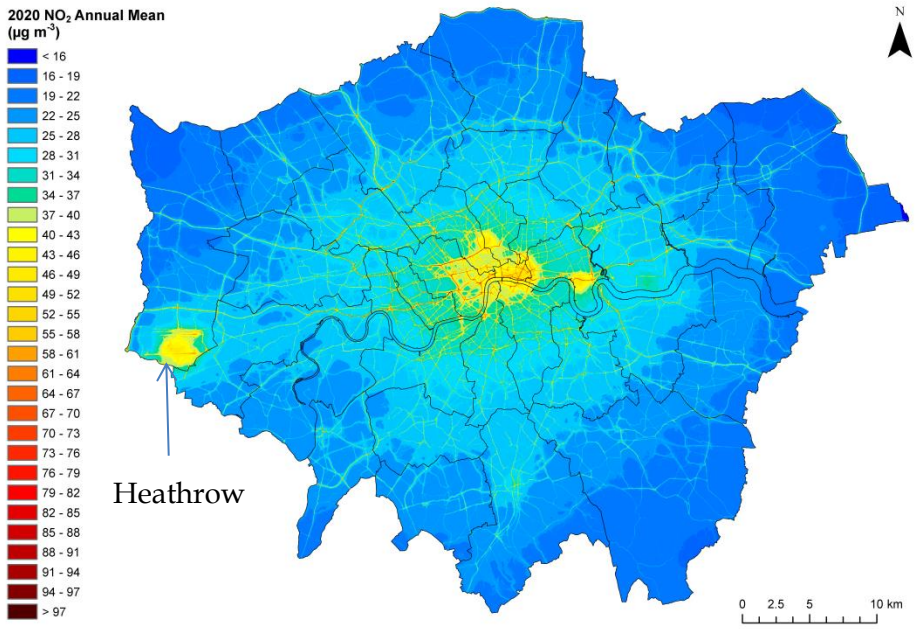
Figures 1.1 and 1.2 show predictions of long-term NO_2 concentrations for 2015 and 2020, originally produced from data in the London Atmospheric Emissions Inventory. These figures illustrate how the NO_2 concentrations near Heathrow airport, as in central London, are predicted to be in excess of the Limit Value in 2015 and in five years' time. This is in a large part due to vehicle exhaust emissions from road traffic, though aircraft movements also contribute.

Figure 1.1 Modelled Annual Mean NO_2 Concentrations in 2015 (source: Greater London Authority and Transport for London)



[1] See ClientEarth Case C-404/13 at paragraph 57.

Figure 1.2 *Modelled Annual Mean NO_2 Concentrations in 2020 (source: Greater London Authority and Transport for London)*



The UK is currently the subject of an investigation by the European Commission with a view to the institution of infraction proceedings and thus potential fines for breach of the NO_2 limit value in London (and elsewhere).

1.5 *PREVIOUS MODELLING*

This issue of non-compliance with the NO_2 Limit Value around Heathrow has been well known for some time. Ten years ago, it was thought that compliance would have been achieved by now and the modelling studies of that time indicated that this would be the case. It is instructive to look back over some of the significant modelling work undertaken to understand why this has not proved to be the case.

The 'Project for the Sustainable Development of Heathrow' (PSDH) in 2004-2007 was a major undertaking by the Department for Transport and included a review of techniques to model air quality around Heathrow. In the latter stages, a modelling study was carried out that examined the compliance issue, for both baseline (i.e. two runway) and third runway scenarios.

Perhaps understandably, much of the modelling was focused on the treatment of aircraft emissions and other non-road sources on the airport itself.

However, beyond about 1 kilometre from the airport boundary, the 'on-airport' sources, such as aircraft operations, are no longer the largest contributors to NO_2 ground level concentrations. For many local residents, it is

road traffic, including that which is generated by Heathrow Airport, which largely determines their exposure to NO_2.

To simulate the NO_2 concentrations at inhabited properties using modelling, the emissions from vehicles on the road network have to be well understood and accurately defined. Since the PSDH work was completed, and the proposal for a third runway at Heathrow made in 2007, understanding of the *actual* emissions emitted by some classes of vehicles has changed considerably and previous expectations on improvements from new vehicle technology have proved to have been much too optimistic.

The modelling carried out as part of PSDH in 2007 indicated that the NO_2 concentrations around Heathrow would be approaching compliance with the NO_2 limit value by 2015. However, measurements now show that this is not the case. The situation has improved at some of the locations close to the airport itself, but many residential areas close to the M4, for example, are exposed to NO_2 concentrations in excess of the Limit Value. The contribution to NO_2 concentrations from the road network has clearly not reduced as expected.

1.6 WHY EMISSIONS HAVE NOT REDUCED AS EXPECTED

The Euro emission standards for motor vehicles have become increasingly stringent for total oxides of nitrogen (NO_x, which includes NO_2 and nitric oxide which can go on to form NO_2). The most recent set of standards is Euro 6 for cars and Euro VI for heavy duty vehicles. It is now clear, however, that NO_x emissions from vehicles with diesel engines have not have not reduced in line with these progressively stringent Euro standards. Many diesel-fuelled vehicles do not comply with the standards in practice and are emitting NO_x at higher rates than originally expected – and hence higher than previously modelled. Consequently, overall emissions in NO_x are not reducing as might be expected and this explains, at least in part, why NO_2 concentrations at many locations have not also declined, as was expected a decade ago.

This is illustrated very clearly by the measurements made at a DEFRA monitoring station approximately 30 metres from the M4 motorway roadside at West Drayton. This site is part of the national monitoring network ("Automatic Urban and Rural Network" or AURN) and known as 'London Hillingdon'. The PSDH modelling carried out in 2007 predicted that the NO_2 concentration at this location for a two-runway Heathrow would reduce from 47.3 $\mu g/m^3$ in 2002 (the base case) to 36 $\mu g/m^3$ in 2015. In fact, the annual average NO_2 concentration at this site have been i*ncreasing* since about 2005 rather than decreasing. In 2014, the annual average NO_2 concentration at this site was recorded as 57 $\mu g/m^3$ which is nearly 20 $\mu g/m^3$ above the legal limit value of 40 $\mu g/m^3$ and almost 8 $\mu g/m^3$ higher than was measured in 2005.

1.7 *CONSTRUCTION PHASE EFFECTS*

Additional construction traffic and major changes to the highway network, for instance the proposed M25/M4/A4 reconfigurations, which form part of the proposals for a third runway submitted by Heathrow Airport Ltd, will further reduce the likelihood of compliance in the shorter term, i.e. over the 2020-2025 period when compliance is already less likely than later years. A study by Arup of the likely effects of the construction activity associated with development of Heathrow on traffic flows on the road network by Arup has shown that there would be many roads where the average traffic flows would increase by more than 2,000 vehicles daily and several where the increase would be 10,000. As road traffic congestion is a major influence on NO_x emissions, this can only mean that the rate of anticipated improvement in roadside NO_2 concentrations would be slowed or even reversed during this construction period.

1.8 *OPERATIONAL EFFECTS AND PROPOSED MITIGATION MEASURES*

Modelling undertaken by Arup has examined the effects of likely NO_x sources from an expanded Heathrow and the expected effects on the local road network. Applying optimistic assumptions about the background concentrations of NO_2 in 2025, Arup concluded that there would be over 20 inhabited locations where the NO_2 limit value would be exceeded in that year. In some cases the exceedance was as much as 25% above the limit value. Applying more conservative assumptions showed that the NO_2 limit value would be exceeded at some 70 inhabited locations.

Heathrow Airport Ltd's proposals to the Airports Commission suggests a range of mitigation measures related to the airside sources of NO_x, such as incentivising aircraft with lower NO_x emissions, a low emission operational vehicle fleet and providing all aircraft with fixed electrical ground power and pre-conditioned air when on stands. These measures, whilst potentially beneficial, will have little effect on the risk of non-compliance with the NO_2 limit value at locations near the road network. Further, such measures can be adopted in any event across the airport. As such they should form part of the baseline measures within any air quality plan and should not benefit only the expansion scheme.

Mitigation measures proposed that might reduce the contribution to locations near the road network from airport related sources include the provision of incentives for access to the airport by zero or ultra-low emission vehicles and, as a last resort, the use of a congestion charge to drive down airport-only related road traffic. HAL's proposals do not describe how these mitigation measures might be implemented in detail, nor do they provide any quantification of the expected reduction in NO_2 concentrations near the road network that they might afford. Neither do the proposals address the potential consequential effects on, for example, road traffic distribution in the wider area around Heathrow. It could well be that the introduction of these sorts of measures results in road traffic around Heathrow shifting onto other roads

with a consequent increase in traffic flows on those roads and potentially increased congestion. Thus, it may be that the effect of the proposed road traffic mitigation measures could simply be to transfer the air quality problems to other areas.

1.9 CONCLUSIONS

The principal issue regarding air quality in the Heathrow area and the proposed Heathrow schemes is whether it can be established that they can be constructed and operated without delaying the attainment of the annual mean NO_2 limit value for a longer period than would occur if those schemes were not constructed and operated.

There is significant evidence available that establishes that even without a Heathrow scheme coming forward the attainment of the limit value in the Heathrow area will not occur for many years (potentially up to and beyond 2030 in the worst affected locations) and will be difficult to achieve.

Accordingly, the construction and operation of a Heathrow scheme would inevitably introduce substantial additional sources of NOx (leading to additional NO_2) into an area that is already struggling to attain the limit value.

The mitigations proposed, whilst potentially beneficial in relation to airside sources, are available in a baseline situation in any event. Mitigation proposed in relation to road traffic sources is generalised in nature and its potential effects have not been examined or quantified. At present there is no evidence available that establishes that either of the Heathrow schemes can be constructed and operated on a basis that ensures that attainment of the annual mean NO_2 limit value in the Heathrow area will occur and will not be delayed by such a scheme being implemented.

There is no certainty that the annual mean NO_2 limit value could be met with a Heathrow Scheme being constructed and operated. There are no assurances that the construction and operation of a Heathrow scheme could be undertaken without delaying compliance with NO_2 limits values.

Neither is there any certainty therefore that a Heathrow Scheme could be delivered and the UK's legal obligations, under the 2008 EU Air Quality Directive and the 2010 Air Quality Regulations, still be met.

ERM and Clear Air Thinking have prepared this report for Gatwick Airport Limited. The purpose of the report is to review the proposition that expanding development of Heathrow Airport with an additional runway is possible without compromising compliance with the EU limit value for nitrogen dioxide (NO_2).

This issue could be critical for any decision taken on the two proposals for Heathrow submitted to and shortlisted by the Airports Commission, since it is not simply a matter of the magnitude of the environmental impact but of legality. It is clear from recent court rulings that the Government cannot allow any major developments to take place which would either delay achieving compliance with the EU Directive on ambient air quality or cause a breach of the limit values to occur. This would not be consistent with its commitments to achieve compliance with such limits as soon as possible, against a background of infraction proceedings by the European Commission.

The Airports Commission and its consultants have already concluded that there is a high risk of the annual mean NO_2 concentration at some locations around Heathrow being in excess of the annual mean limit value of 40 $\mu g/m^3$ in 2030 (1) , even without any development and that the expansion of Heathrow would lead to further deterioration in air quality. To understand this risk, it is necessary to consider the current concentrations of NO_2 around Heathrow and how these might change in the next decade.

Projections of future emissions and concentrations are routinely made by DEFRA and these are one source of evidence. Dispersion modelling has also been carried out on behalf of Heathrow Airport Limited. Both of these predictions rely on DEFRA's view of the way in which NO_x emissions from road vehicles will decline in future years with the introduction of cleaner vehicles into the national fleet. However, DEFRA's past expectations of the performance of road vehicles have not been matched by their actual, 'real world' performance with regard to oxides of nitrogen (NO_x) emissions, which is a significant part of the reason why ambient NO_2 concentrations have not declined as expected and are extensively non-compliant with the Directive.

To examine the nature and magnitude of the risk of non-compliance around Heathrow, this report has focused on a few key locations around Heathrow and investigated the available and relevant evidence to reach a conclusion on this key question of compliance. The reference year has been taken as 2025, because this year is stated by Heathrow as being the target year for the initial operation of the new runway, and would mark the end of the first main construction phase.

(1) Jacobs (2014) 6.Air Quality: National and Local Assessment. Report prepared for the Airports Commission

Further into the future beyond 2025, it might reasonably be expected that NO_2 concentrations will be lower as progressively cleaner vehicles constitute an ever-greater proportion of the national fleet and so the risk of non-compliance diminishes. However, as will be discussed, DEFRA's projections of conditions near the A4 near Heathrow suggest that compliance will not be achieved at all locations by 2030, which is the furthest future year currently examined.

The risk of non-compliance by 2030 or even later is greatest at locations next to the road network and, in particular, near those roads that are most heavily trafficked. The key road sections where compliance is in most doubt are those parts of the M4, A4 and A30, where there are residential properties within 50 metres of the road and local air quality is hence strongly influenced by traffic on those roads.

The report is structured as follows:

- The legal context and relevant policy;
- Current NO_2 concentrations around Heathrow;
- Previous studies of air quality around Heathrow impacts on;
- Future NO_2 concentrations around Heathrow;
- Air quality impacts of Heathrow with a third runway; (during construction, operation and the effectiveness of proposed mitigation); and
- Conclusions.

Air Quality Directives and Regulations

The EU Directive on ambient air quality [1]sets out the obligations on member States to meet certain pollutant concentrations over certain averaging periods by 2010. The Directive has been transposed into English law by the Air Quality Standards Regulations 2010 ("the 2010 regulations")

The pollutant and averaging period of most relevance around Heathrow is the annual mean limit value for NO_2, which is 40 micrograms per cubic metre ($\mu g/m^3$) of air.

The 2010 Regulations state that "The Secretary of State must ensure that levels of… nitrogen dioxide… do not exceed the limit values set out in Schedule 2", this Schedule includes the numerical limits and hence the limit of 40 $\mu g/m^3$ as an annual mean for NO_2.

The UK and the Secretary of State are hence under a legal duty to ensure that the EU annual average limit value for NO_2 is not exceeded, in the Heathrow area or indeed elsewhere.

The 2010 Regulations set out what is required in the event that limit values are exceeded. The Secretary of State must "draw up and implement an air quality plan so as to achieve"[2] the relevant limit value. The plan "must include measures intended to ensure compliance with any relevant limit value within the shortest possible time".[3]

DEFRA reports annually to the European Commission (EC) on compliance with all limit values including annual mean NO_2. The UK is divided into 43 zones for this purpose. The Greater London zone, which includes Heathrow, is not currently in compliance with the Directive. Whilst the EC has allowed derogations for a number of zones up to 2015 to demonstrate compliance, the derogated zones do not include Greater London.

DEFRA does not expect the Greater London zone to comply until beyond 2030 on the basis of current projections. Given that the deadline for compliance was 2010, the UK is now subject to legal proceedings by the European Commission for chronic non-compliance.

[1] 2008/50/EC

[2] Regulation 26(1) of the 2010 Regulations

[3] Regulation 26(2)

Additionally, the non-governmental organisation ClientEarth has brought legal proceedings against the UK Government on its failure to meet the NO_2 limit value. The case was first heard in 2011 in the High Court and has since has been heard by the Supreme Court and the European Court of Justice (ECJ).

In its judgement of 19 November 2014 the ECJ held that the UK was in breach of its obligations under the 2008 Directive and that the UK courts must now order the UK Government to produce plans to achieve the limit value "as soon as possible". Essentially, all limit values must be met all over the UK, as quickly as possible and compliance, once achieved, must be maintained.

Planning policy

Planning policy has always recognised the need to comply with air quality standards, as exemplified by the National Planning Policy Framework, published in 2012, which states the following:

"Planning policies should sustain compliance with and contribute towards EU limit values or national objectives for pollutants, taking into account the presence of Air Quality Management Areas and the cumulative impacts on air quality from individual sites in local areas. Planning decisions should ensure that any new development in Air Quality Management Areas is consistent with the local air quality action plan."

This position has recently been reinforced by the National Policy Statement on National Networks, which also makes very clear that not only is compliance with the limit value a legal requirement, but that any scheme that delays compliance with the limit values should not be consented by the Secretary of State.

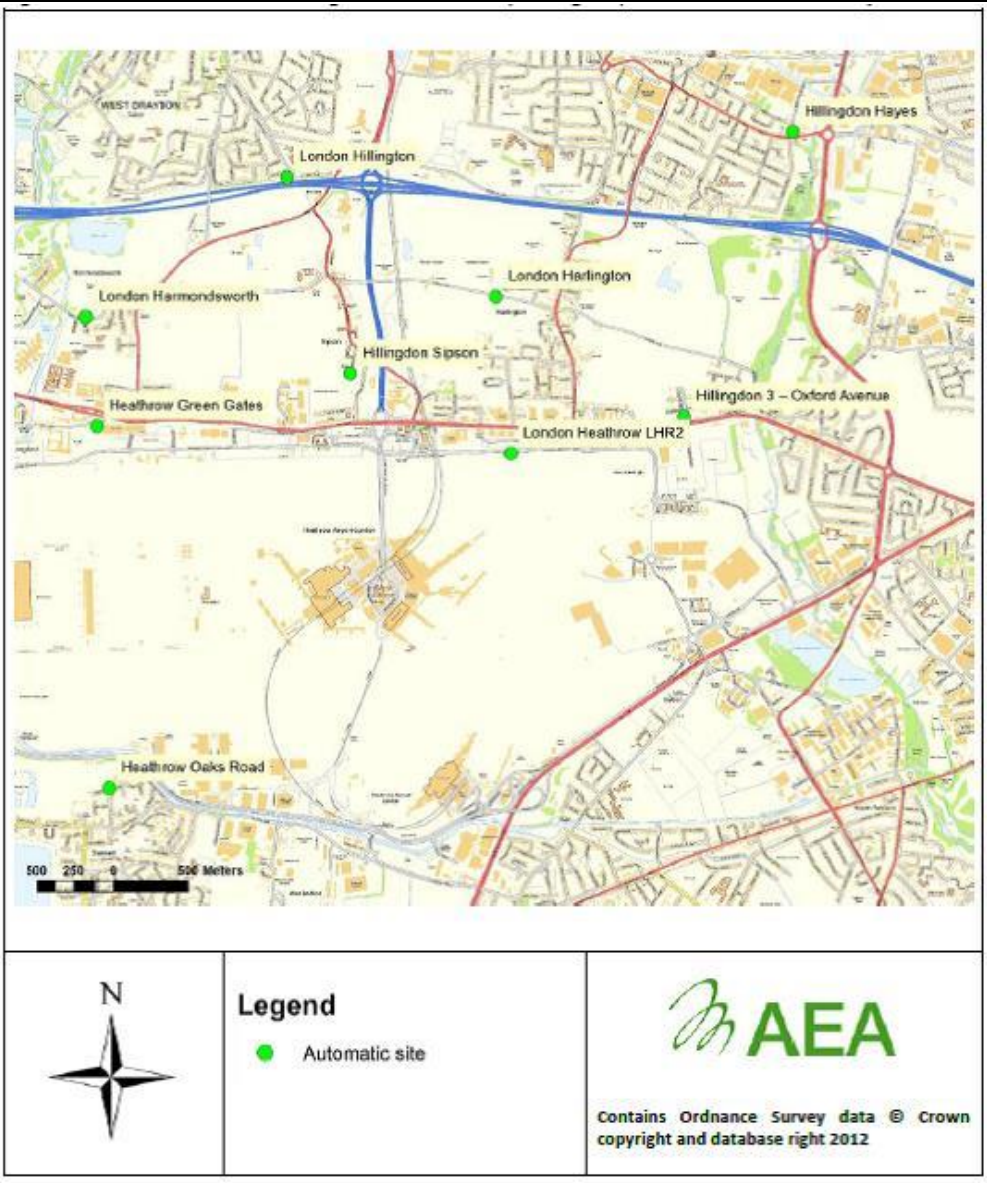
Summary

The UK Government is obliged to take action to meet EU limit values and many parts of the UK, including areas surrounding Heathrow, do not currently comply with the EU limit value for annual mean nitrogen dioxide concentrations. This obligation is a potential constraint to development at Heathrow, if there is a risk that the construction or operation of the scheme could cause non-compliance or further delay compliance with the limit values.

A considerable amount of air quality monitoring is undertaken around Heathrow airport, both by HAL and by the four Boroughs that have a direct interest, i.e. LB Hillingdon, LB Hounslow, Spelthorne Borough Council and Slough Borough Council. In particular, there is a network of automatic monitoring stations that provide high quality data on concentrations of several pollutants, including NO and NO_2.

The locations of those stations operated by HAL and LB Hillingdon are shown below, extracted from the LB Hillingdon Updating and Screening Assessment 2012:

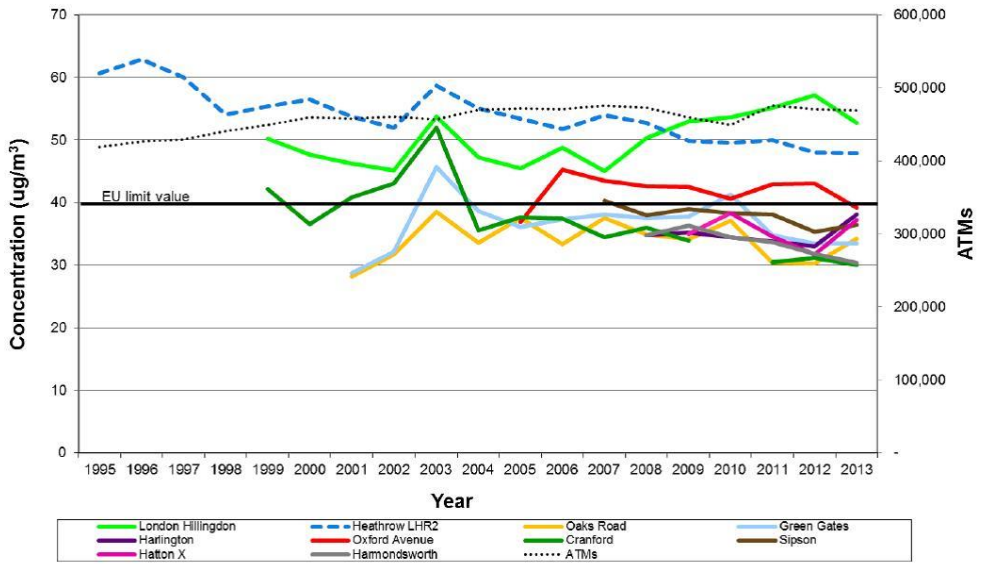
Figure 4.1 Locations of real-time monitoring stations



In addition, there are automatic sites operated by the other Boroughs in useful locations, as well as an extensive array of diffusion tubes measuring long term average concentrations of NO_2. The most relevant monitoring sites are also part of 'Heathrow Airwatch', a partnership of the four Boroughs, HAL and British Airways. (http://www.heathrowairwatch.org.uk/)

The most recent Heathrow Airwatch results summary provides a trend plot for all automatic sites measuring NO_2 in recent years, as reproduced below for years up to and including 2013.

Figure 4.2 NO_2 trend plot (source: Heathrow Airwatch AQ Briefing 2014 Q3)



This plot displays some features of the local pollution climate that are highly relevant:

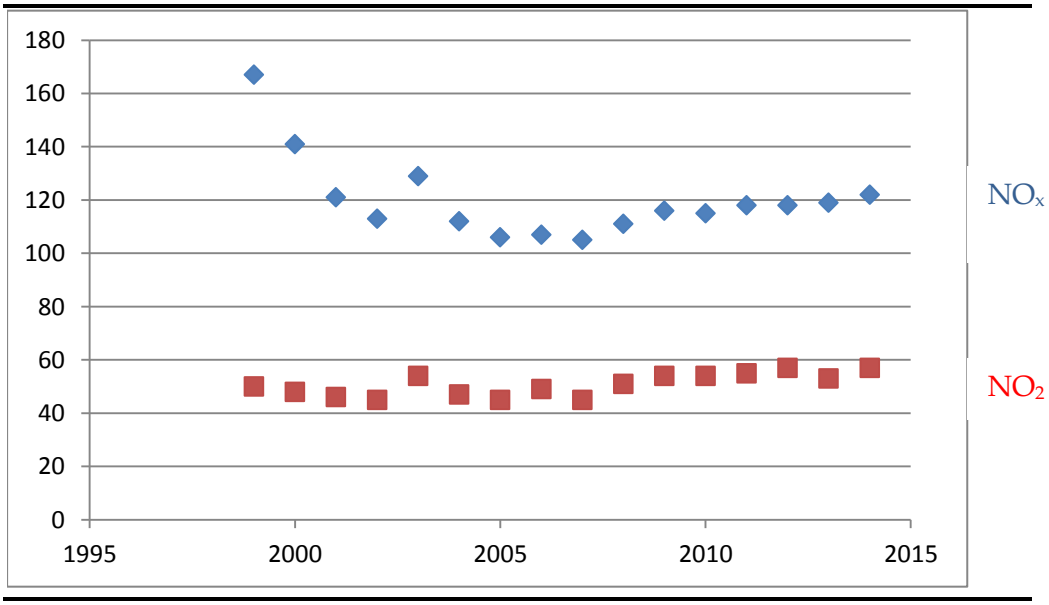
- Two sites are currently recording NO_2 concentrations that exceed the limit value. These are LHR2 (adjacent to the northern runway) and London Hillingdon (heavily influenced by the M4 road traffic)
- A third site, Oxford Avenue (next to the A4) has, in 2013 only just achieved compliance for the first time since 2005
- At a number of other sites compliance is achieved, but where there is very limited headroom below the limit value and where trends are indistinct.
- There has been a very gentle decline in concentrations at most sites in the last decade, whilst at other sites increases have occurred.
- Where there have been reductions, concentrations have not decreased nearly as much as was originally anticipated when investigated 10 years ago (See Section 5).
- Concentrations have declined at LHR2, next to the runway, suggesting that the airport contribution has decreased somewhat over this period.

- The site where concentrations have been rising most is London Hillingdon, located 30 metres from the M4 roadside. This is thought to be attributable to the increasing contribution of the diesel fuelled cars using this road. This is a consequence of the proportion of diesel cars in the fleet increasing and the failure of these vehicles to conform to Euro 3-5 emission standards, as will be discussed in Section 6.1. The monitoring data for this site are shown in Table 4.1and plotted in Figure 4.3.

Table 4.1 *Annual mean NO_2 concentrations measured at the London Hillingdon AURN site*

Year	NO_2 Concentration (µg/ m^3)
2001	46.3
2002	45.2
2003	53.8
2004	47.3
2005	45.5
2006	48.6
2007	45. 1
2008	50.5
2009	54.1
2010	53.5
2011	55.1
2012	57.3
2013	52.8
2014	57.3[1]

Figure 4.3 *Annual Average NO_x (blue) and NO_2 (red) Concentration at the London Hillingdon Monitoring Site (data taken from DEFRA's UK-Air website)*



[1] Includes some unratified data as of February 2015. The ratification process rarely leads to material change.

This site and its measurements has been the subject of the conditional analysis study, reported by Malby *et al* in Atmospheric Environment [(1)]. By filtering the data and thereby isolating the motorway contribution, they showed very clearly and convincingly that the NO_2 signal from the motorway has been increasing in recent years, attributable to an increase in NO_2 contribution per vehicle from 5 nanograms per cubic metre (ng/ m^3) to 8 ng/ m^3. This increase was particularly associated with non-HGV traffic in congested conditions, a finding consistent with the observations reported elsewhere of the non-conformity of diesel cars with their Euro emission standards.

In summary, our knowledge of NO_2 concentrations around Heathrow tells us that it is realistic to assume that, in future (possibly by 2030), in the absence of the construction and operation of a third runway, most locations around the airport will comply with the NO_2 limit value, as they do now, but that there will still be uncertainty regarding the compliance of NO_2 concentrations at locations close to the strategic road network and the M4 in particular.

At such locations near the M4 the influence of the airport's direct emissions (such as aircraft and apron vehicles) on these concentrations is minimal. The NO_2 concentration is dominated by the contribution of road traffic, a significant proportion of which is related to the use of Heathrow. Meaningful mitigation measures must therefore focus primarily on reducing the contribution from road traffic.

(1) Malby, Andrew J, Whyatt Duncan and Timmis Roger J (2013) Conditional extraction of air pollutant source signals from air quality monitoring Atmospheric Environment 74 112-122

5 PREVIOUS STUDIES OF AIR QUALITY AROUND HEATHROW

5.1 PSDH

Air quality has been recognised as a critical issue for the expansion of Heathrow for some considerable time and most notably in the period between 2003 (when the White Paper 'The Future of Aviation' was produced) and 2009 (when the Secretary of State announced a policy decision on the development of Heathrow). In particular, this period was characterised by the 'Project for the Sustainable Development of Heathrow (PSDH)' - a programme of work designed to consider how the development of Heathrow could be achieved within the environmental conditions laid down in the White Paper. PSDH included Technical Panels on air quality, which examined in detail the methods used for measuring air pollutants, assembling an emission inventory and modelling the dispersion of pollutants from the airport and its related activities. The Panels reported on their findings on these topics in 2006; the report is both a useful source of information and also the foundation for much of the subsequent work on air quality modelling for Heathrow.

In 2007, the Department for Transport (DfT) consulted on proposals to develop Heathrow by adding a third runway (1). Using the findings of the PSDH work on air quality modelling, it concluded that '*the airport could operate with three runways from around 2020, with around 702,000 ATMs, and fully meet the air quality limits*'.

The modelling work that underpinned this conclusion made some key assumptions regarding the effect of vehicle emission reductions with the progressive introduction of Euro standards. (The modelling work was undertaken and reported on by CERC (2).) As discussed in the following Section, these assumptions can now be examined with the benefit of recent evidence on the actual emission performance of vehicles. For the reasons set out below it seems clear that the DfT's 2007 conclusions were almost certainly wrong – had Heathrow been expanded it is highly unlikely that air quality limits "would be met from around 2020".

The modelling work was carried out on the basis that there would be a 49% reduction in NO_x emissions in the Heathrow area between 2002 and 2030, even with the addition of a third runway. This led to a prediction that, in 2015, there would only be 22 properties (with a third runway, segregated mode and 540,000 ATMs per annum) at which the annual average NO_2 concentration was in excess of 40 µg/ m^3. These properties are those close to the M4 in West Drayton, in the vicinity of Junction 4.

(1) Department for Transport (2007) Adding Capacity at Heathrow

(2) Cambridge Research Consultants (2007) Air Quality Studies for Heathrow: Base Case, Segregated Mode, Mixed Mode and Third Runway Scenarios modelled Using ADMS Airport. Final report prepared for Department of Transport 15 November 2007

Now that we are in 2015, this prediction can be examined. The current activity at the two-runway airport is much lower than in this modelled scenario, at approximately 450,000 ATMs per annum, but the aircraft contribution to the NO_2 concentration at these key locations on the M4 is quite low, perhaps no more than 10% according to the PDSH report.

The current situation is a reasonable test of the model predictions with regard to near road concentrations. The most recent annual average NO_2 concentration at the London Hillingdon monitoring station, very near to properties in West Drayton, was, as shown In Table 4.1 above, 57 $\mu g/m^3$ in 2014. The PSDH prediction for the London Hillingdon site in 2015 with two runways operating in segregated mode was for the NO_2 concentration to be 36 $\mu g/m^3$, i.e. about 20 $\mu g/m^3$ lower than it actually is today. This suggests that the predictions made in 2007 were much too optimistic with regard to the assumptions made regarding vehicle emissions - a common feature of air quality assessments of the time that is not restricted to the Heathrow modelling.

There is to date no directly comparable modelling study in the public domain that has quantified the number of properties around Heathrow where the NO_2 concentration is in excess of 40 $\mu g/m^3$, so the degree to which the 2007 modelling is optimistic cannot be expressed in these terms. There is no doubt though that events have not unfolded as anticipated and that the 2007 modelling cannot be relied upon as a guide to the date at which the NO_2 limit value will be met for locations close to the strategic road network around Heathrow, and far more than 22 properties are in exceedance of the NO_2 limit value as it stands in 2015.

The 2007 DfT consultation documents described a number of potential measures to mitigate the possibility of not meeting the limit value. Some of these were aimed at reducing the airport related traffic and others were aimed at reducing non-airport related traffic, especially traffic using the M4. Possible measures to reduce airport-related traffic were cited as follows:

- Providing additional rail services;
- Providing a higher frequency of coach services with lower fares;
- Introducing various forms of charging air passengers for access to the airport;
- Increased parking charges; and
- Reducing parking spaces for employees or charging for access to parking.

For non-airport related traffic, several measures were considered in 2007, some of which were quite bold. These included:

- closure or restricted use of eastbound slip roads on the M4;

- a widespread motorway ramp metering strategy (where access is controlled by traffic lights on slip roads);
- charging road users on the public network around Heathrow as they entered a cordon; and
- charging HGV users to cross a cordon around Heathrow, including the M4.

The effectiveness of these various measures was evaluated in more detail in a 2007 Surface Access report [(1)]. This report concludes that the most effective options were those that required HGVs to pay a £3 charge to enter a cordon around Heathrow, including the M4. One of these options also proposed a £20 airport forecourt charge; in effect a road charging scheme for airport passengers.

The precise impact on NO_2 concentrations at areas in exceedance that these mitigation proposals were predicted to have on air quality is hard to discern from the various reports taken together. The 2007 Surface Access report identifies that there would be no properties experiencing NO_2 concentration in excess of 40 $\mu g/m^3$ in 2015 with a £3 charge for HGVs. This is an improvement over the base case 2015 scenario of mixed operation of a two runway airport, which was predicted to have 27 properties (at West Drayton by the M4) with an NO_2 concentration in excess of 40 $\mu g\ m^3$. As has been noted previously, this prediction for the 2015 scenario has not been realised in practice for locations near M4 with its current traffic flows and vehicle emissions.

The 2007 CERC report includes a prediction that the scenario of a Mixed Mode two runway airport with road traffic-related mitigation would have resulted in NO_2 concentrations at locations near the M4 being up to 2 $\mu g/m^3$ lower in 2015 than the equivalent scenario without this mitigation. Unfortunately, it is not clear from the CERC report which of the mitigation measures are included in this modelled scenario. What is clear, however, is that the reduction expected from these mitigations would not come close to achieving compliance at the properties discussed in West Drayton, given the actual recent NO_2 measurements at the London Hillingdon site.

5.2 *COMPARISON OF PSDH WITH RECENT WORK*

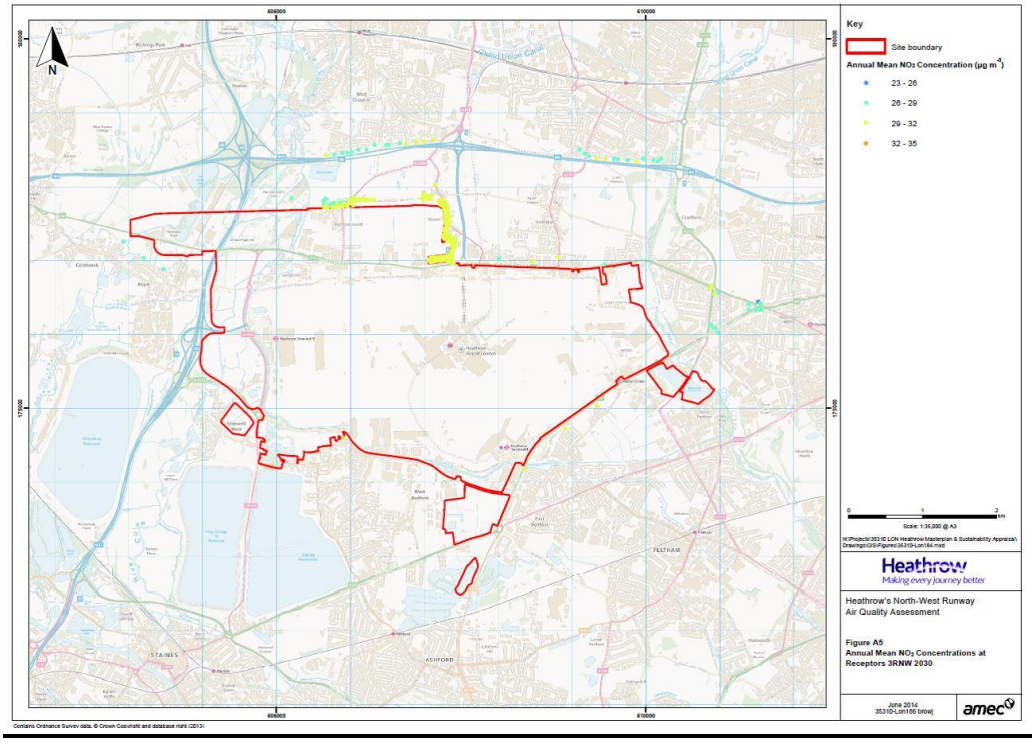
Impact Assessment for the 2014 HAL R3 proposal

The assessment of the air quality impacts associated with the Heathrow North West Runway (3RNW) proposal, as submitted to the Airports Commission in July 2014[2] provides predictions of future NO_2 concentrations at selected locations around the airport. The methodology followed on from the PSDH work in many respects. The relevant Figure is reproduced below as Figure 5.1.

(1) BAA (2007) Project for the Sustainable Development of Heathrow Surface Access Report (report prepared for BAA by the Denvil Coombe Practice, with source material from several other consulting companies)

[2] Heathrow Airport Ltd: Heathrow's North-West Runway Air Quality Assessment, AMEC & Ricardo-AEA, June 2014

Figure 5.1 ***Annual Mean NO_2 concentrations in 2030 (Extracted from the AMEC report on the air quality assessment of the 3RNW proposal)***



The implication of this presentation of the results is that the NO_2 concentration at or near the London Hillingdon monitoring station would be in the range 29-32 µg/m^3 with the 3RNW proposals in 2030. For comparison, the 2007 CERC report gave a predicted NO_2 concentration at this location of 27.7 µg/m^3 for the scenario where the airport is operating in 2030 with 2 runways in mixed mode and 31.3 µg/ m^3 for the 3 runway scenario. The two sets of modelling, i.e. 2007 CERC and 2014 AMEC for 3RNW, are therefore reasonably consistent for this important location alongside the M4. This is surprising, given the recent improvement in our knowledge of the actual emission performance of vehicles, relative to the expected performance indicated by standards as discussed in Section 6, and perhaps indicates that AMEC have used assumptions on emissions similar to those used for PSDH which subsequently proved to be erroneous.

The AMEC report describes many other aspects of the impacts on local air quality, but these are not discussed here; the focus is on the potential for the NO_2 limit value being met or not met and this potential is most dependent on the road traffic contribution at locations near to the strategic road network.

6 FUTURE NO_2 CONCENTRATIONS AROUND HEATHROW

6.1 THE ROLE OF VEHICLE EMISSIONS AND THE FAILURE OF PREVIOUS EURO STANDARDS

The widespread non-compliance with the NO_2 limit value referred to in Section 4 is a clear indication that the emission reductions anticipated from road vehicles have not materialised. For air quality at locations influenced by the major roads around Heathrow, this has had significant implications and will continue to do so for some years. The rate at which an improvement in NO_2 concentrations will take place is highly dependent on the success of new Euro emission standards and the rate at which vehicles that conform to this standard enter the national fleet. To understand the risk of non-compliance with the NO_2 limit value alongside roads around Heathrow, it is necessary to understand the issues surrounding the previous failure of Euro standards, the likelihood that that this failure will not be repeated, and the speed at which previous failures are likely to be addressed.

More than twenty years ago, the European Commission began the introduction of a series of Directives designed to limit pollutant emissions from road vehicles. For passenger cars with petrol engines, these have been very successful. Following the introduction of three way catalyst technology in 1992 NO_x emissions from these vehicles reduced progressively such that they had been virtually eliminated as a significant national source by 2000.

Equivalent reductions were not achieved for other vehicles classes. Notably, diesel engines continued to be higher emitters. Not only do diesel engines emit at greater rates than a petrol equivalent with a three way catalyst, but some of the vehicles manufactured in the last decade have been shown to emit at significantly higher rates 'on the road' than implied by the type approval limit – which is to say that even when new, they are emitting certain pollutants at rates higher than the maximum allowable under the Euro standard.

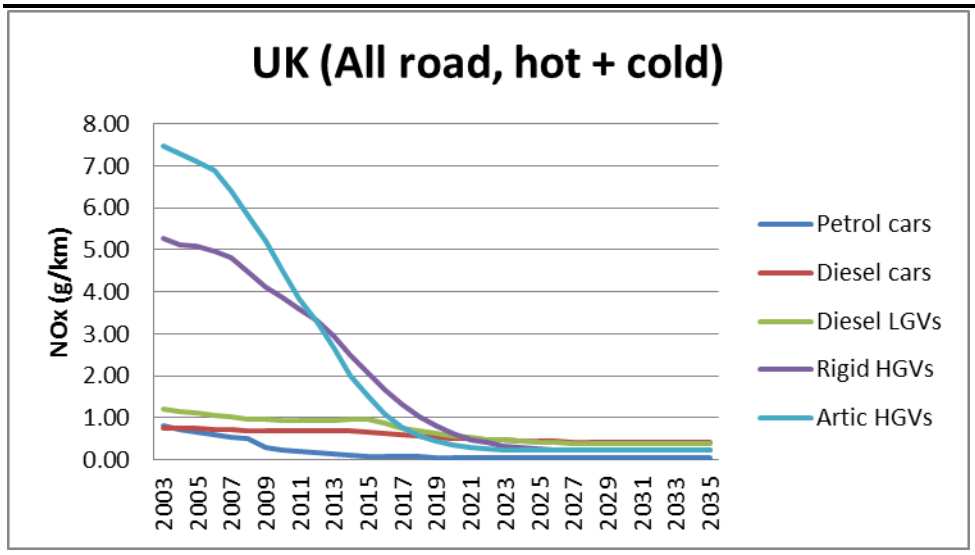
This has been revealed by remote sensing measurements of vehicles using roads in the UK. These findings are presented in more detail in Annex B.

In order to bring down ambient NO_2 concentrations in the next decade, especially at the roadside and in urban areas, NO_x emissions from the vehicle fleet need to fall substantially.

The expectation of DEFRA is that the new Euro standards (Euro 6 for light duty vehicles and Euro VI for heavy duty vehicles) will achieve substantial emission reductions. This belief is based partly on the fact that manufacturers will have to demonstrate compliance for vehicles in service and not just as manufactured. Test cycles used for this purpose will be more representative of real world driving conditions than previously.

The most recent DEFRA projections for NO_x emission factors for the national road transport fleet can be expressed as fleet weighted averages, as follows:

Figure 6.1 Projected NO_x emissions factors



The contribution from Articulated and Rigid HGVs is expected to fall sharply, such that their contribution will be indistinguishable in time from other vehicles with diesel engines (i.e. light goods vehicles and cars). As the newer Euro VI HGVs enter the fleet, it is anticipated by DEFRA that by 2020 the majority of this benefit will have been realised. If this projection is correct, then ambient NO_2 concentrations should fall to reflect this.

However, given the failure of previous Euro standards to deliver real emission reductions of NO_x from diesel engines, it might reasonably be asked why Euro 6/VI should be any more successful, or at least what level of confidence exists that the improvements will be as great and as quick as projected. As yet, few data exist for 'on road' measurements that would confirm that the newer vehicles were able to perform better than their predecessors.

Evidence from the US, where similar standards for HGVs were introduced in 2010, suggests that the Selective Catalytic Reduction control technology for NO_x from HGVs can be effective and reliable. The limited evidence for diesel cars and light goods vehicles is more equivocal. A recent TNO (the Dutch Organisation for Applied Scientific Research) report (1) found that the measured NO_x emissions from production cars were highly variable between models and in some cases substantially greater than the type approval limit.

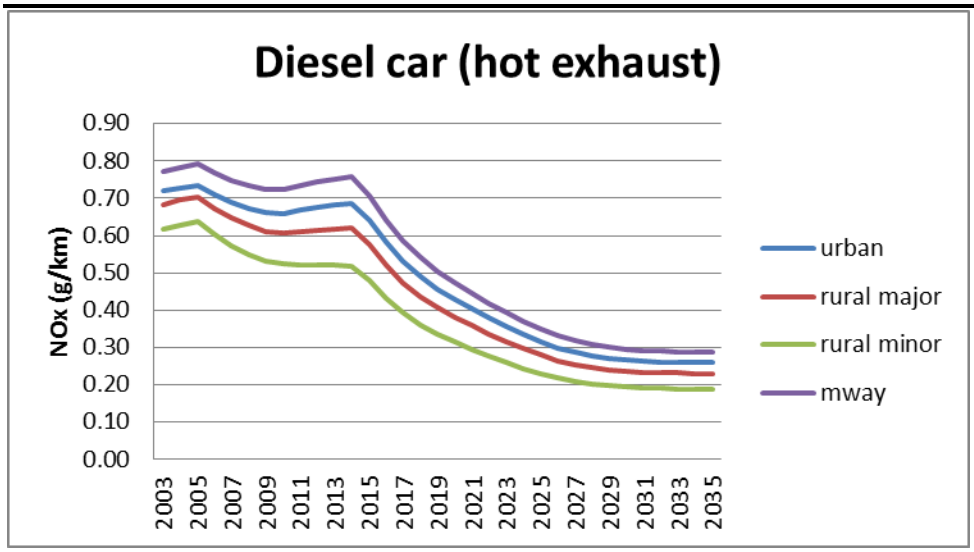
(1) Ligterink N et al (2013) Investigations and real world emission performance of Euro 6 light duty vehicles TNO report 2013 R11891

Analysis of emissions data of Euro 6 cars published by the International Council on Clean Transportation (ICCT) in October 2014 (1) has also highlighted some variable results, with only one out of 15 vehicles tested conforming to the Euro 6 standard. The worst performing vehicles were emitting at nearly 2 g/km, as compared with the required standard of 0.08 g/km.

If the NO_2 limit value for ambient air alongside the major roads around Heathrow is to be met by 2025, the actual emissions of NO_x from the diesel car and LGV fleet will need to be significantly lower than they are today, given that they represent a substantial fraction of the overall vehicle fleet. (DEFRA projections are for 43% of the urban fleet and 50% of the motorway fleet to be diesel cars in 2025.)

The DEFRA projections assume the following trend in emission factors for diesel cars:

Figure 6.2 ***Diesel emission factor projections***



This incorporates some pessimism in the ability of the newer vehicles on the road to perform according to the Euro 6 type approval limit of 0.08 g/km. It is not, however, consistent with the Dutch measurements of emissions for Euro 6 cars and the ICCT report. These differences are clear to see in Annex B, Figure B3.

The Euro 6 vehicles will represent an improvement over previous Euro classes, but like the previous vehicles do not conform to type approval limits in practice.

(1) International Council on Clean Transportation (2014) Real World Emissions from Modern Diesel Cars

If the long term average NO_2 concentrations near the roads around Heathrow are ever to fall below 40 µg/ m^3, then the actual emissions will need to be at least in line with the DEFRA fleet weighted emission factors. Crucially, traffic will also need to remain at least as free flowing as it is currently. Without additional capacity being created for the road network, it is difficult to envisage how flows will remain unchanged given the general year-on-year increases in vehicle traffic expected by the Department for Transport in addition to that which would arise from expansion of Heathrow.

Heathrow 3RNW construction related road traffic will also increase vehicle numbers during the construction period, and construction related disruptions caused by the substantial changes that are proposed to critical parts of the road network would also have an effect on air quality which would be for an extended period of time:

One important feature of the behaviour of diesel engines with regard to emissions is that they are strongly related to engine load. Emissions are effectively a function of vehicle acceleration as the engine is put under load. This means that emissions rise considerably in congested traffic flows relative to a free flowing state. Increasing congestion will therefore be a mechanism for increasing emissions.

6.2 SMART MOTORWAY SCHEME FOR THE M4

The Highways Agency is currently consulting on a proposal to operate a 'smart motorway scheme' on the M4, from Junction 3 to Junction 12. This will entail 4 lane running on most of this length, with 5 lane running between Junction 4 and Junction 4b (i.e. the section next to West Drayton). One consequence of this would be that the road vehicles on the M4 would be closer to the residential properties identified as being at risk with regard to non-compliance with the NO_2 air quality objective. Decreasing this separation distance has the potential to increase NO_2 concentrations at these receptors. Studies will need to be undertaken to examine whether therefore the proposals would comply with the duties in the 2010 Regulations, the 2008 Directive and the relevant policy contained in the NNNPS.

6.3 PREDICTIONS MADE BY THIRD PARTIES

ULEZ predictions

The Ultra Low Emission Zone (ULEZ), proposed by the Mayor of London for implementation in 2020, will have little direct influence on the road traffic emissions around Heathrow, as the zone is confined to a small area in central London. Of interest, however, is the modelling work for this proposal that encompasses all of Greater London, including Heathrow. The Integrated Impact Assessment undertaken for the public consultation shows air quality modelling results for 2020, 2025 and 2030[1].

[1] https://consultations.tfl.gov.uk/environment/ultra-low-emission-zone/user_uploads/ulez-iia_ea_final.pdf-1

These results illustrate the fact that the Greater London Authority anticipates that NO_2 concentrations at several properties alongside the road network around Heathrow will be still in excess of the limit value in 2025.

In particular, the ULEZ modelling shows several sites in Hayes where the annual mean concentration of NO_2 is predicted to be in excess of 40 µg/m^3 in 2025, for the baseline scenario. These are clustered around the Hillingdon Hayes monitoring site on North Hyde Road, which recorded an annual mean concentration of NO_2 of 53 µg/m^3 in 2014. There are other individual properties around Heathrow where this modelling also shows an NO_2 concentration above 40 µg/m^3 in 2025, notably along the A30 on the southern perimeter and along the A4. One property near the London Hillingdon monitoring site is also in this category.

DEFRA projections

DEFRA has released a summary of its projections of NO_2 compliance for the 43 reporting zones in July 2014[1]. These show that, for the Greater London Urban Area, there will be 60 kilometres of the road network in 2025 where the limit value is not met and still 25 kilometres remaining in 2030. A recent disclosure by DEFRA under the Environmental Information Regulations confirms that these affected parts of the network include the A4 near Heathrow.

ERM modelling

It has been mentioned that no detailed modelling of future air quality around the Heathrow area has been published since the PSDH models. ERM has examined the M4 between Junction 4 and 4b to further investigate the effect on the nearby properties in West Drayton using a simple model on the ADMS-Roads platform. The model took empirical traffic data from the Highways Agency TRADS database (which records real-time traffic flows captured by gantry cameras), meteorological data from Heathrow Airport and Highways Agency guidance on expected growth in traffic flows[2] and the expected future NO_2 background concentrations[3].

The results are not intended to be definitive; rather the should be seen as a relatively coarse sketch. Nevertheless, the scenario developed for 2025 on the above basis suggests that the NO_2 limit value will continue to be breached for many properties near the M4 without any further traffic attracted to an expanded Heathrow.

This is illustrated further in Annex C.

[1] http://uk-air.defra.gov.uk/assets/documents/no2ten/140708_N02_projection_tables_FINAL.pdf

[2] Department for Transport 2013 Regional Traffic Growth Forecasts

[3] Highway Agency Interim Advice Note 170v3

7 AIR QUALITY IMPACTS OF HEATHROW WITH A THIRD RUNWAY

7.1 EFFECTS OF CONSTRUCTION ACTIVITY ON LOCAL AIR QUALITY

The scale and duration of the construction activity associated with the further development of Heathrow would be considerable. Not only would it entail a substantial amount of additional HGV movements on the local road network, but the reconfiguration of the M4/M25 junction and widening of the M4 and M25 would entail substantial additional congestion from these works on roads that are already largely operating at capacity for many periods of a typical day. Construction related traffic will increase congested flow conditions on these roads, leading to higher NOx emission and also increased flows on other roads on the network as drivers seek alternative routes.

A study of the likely effect on traffic flows has been undertaken by Arup and has confirmed that traffic flows will increase on some roads in the wider network by more than 10,000 vehicles daily. Additionally, construction activity will result in more than 200 HGV daily movements on some roads. Part of the analysis by Arup assumes that the M4 works cannot be completed without closure of the M4 for a period, in the worst case. This would be a trigger for large increase in traffic flows on alternative routes, such as the A40. This route passes though some densely populated areas, for instance Acton. The result would be to delay compliance with the NO_2 limit value and in some cases reverse compliance which might otherwise be expected by 2025. Arup concluded that in 2020, during intense construction activity at Heathrow, between 51 and 112 nearby properties would exceed the limit value, depending on the degree of pessimism in the background concentration projections assumed.

Even if it is unnecessary to close the M4, any increases in traffic flows on the road network around Heathrow, coupled with additional congestion, would add to NO_x emissions and strongly influence NO_2 concentrations at properties near these roads.

At any of these locations where the NO_2 concentration in the period 2020-2025 is at or near 40 $\mu g/m^3$, this will compromise compliance with the limit value either in terms of causing a delay to achievement of the limit value or leading to a location that is marginally achieving compliance becoming non-compliant

7.2 OPERATIONAL EFFECTS ON AIR QUALITY

The recent Environmental Information Regulations disclosure by DEFRA highlights that for many parts of the road network near Heathrow, the limit value is expected to continue to breach the NO_2 limit value in 2025 with some exceedances along the A4 still expected in 2030. It is difficult to envisage an expanded Heathrow doing anything other than exacerbating this situation. This is borne out by modelling undertaken by Arup, which has examined the

effects of likely NOx sources from an expanded Heathrow and the expected effects on the local road network. Arup concluded that in 2025, there would be between 20 and 70 inhabited locations where the NO_2 limit value would be exceeded and in some cases by more than 25%.

7.3 MITIGATION

The 3RNW proposal submitted by HAL suggests that the associated air quality impacts arising from its entry into operation (as opposed to construction works) can be mitigated and describes what some of these mitigation measures might be. In its Sustainability Assessment, the Airports Commission has stated that mitigation might reduce the scheme performance from being 'significantly adverse' to 'adverse', with regard to the 'objective of improving air quality consistent with EU air quality standards and planning policy requirements'.

The effectiveness of any mitigation is therefore very important for reaching a conclusion about whether the proposed scheme will be acceptable with regard to its air quality impacts.

To date, none of the documents submitted to the Airports Commission, or produced by the Airports Commission, quantify the effectiveness of the suggested mitigation measures and the question of their efficacy is still uncertain. As a result it is difficult to understand how the Commission can have reached the conclusions that it has in its Sustainability Assessment.

Further, no study has been undertaken by the Commission examining the impacts of the Heathrow scheme or proposed mitigation in terms of ground level concentrations.

Most of the mitigation measures relate to the airside sources of NO_x, such as the use of financial incentives to expedite the use of aircraft with lower NO_x emissions, providing all aircraft with fixed electrical ground power and pre-conditioned air when parked on stands and low emission operational vehicles. These measures would be beneficial, but

a) are measures that should be reflected in the baseline in any event and as such are likely to be included in any air quality plan that seeks compliance with the limit value in the shortest possible timescale; and

b) are not directly useful to the principal issue being considered in this report, namely the risk of non-compliance with the NO_2 limit value at locations near the road network.

Mitigation measures proposed in relation to the reduction of emissions from airport-related road traffic sources include the provision of incentives for access to the airport by zero or ultra-low emission vehicles and, as a last resort, the use of a congestion charge to drive down airport -only related road traffic.

The Airports Commission has observed in its Sustainability Assessment that,

'the strong influence of related and unrelated road transport to air quality performance of any airport expansion scheme means that critical assumptions over matters outside the airport's control will determine the fundamental and underlying air quality performance of the area.

Currently, the UK is breaching concentration limits in specific urban areas (including around Heathrow) and, by the time of scheme opening, action at both national and local level will have been considered to ensure these limits …are respected. These include any changes to the road network, including orbital and access routes to London. Such action would fundamentally alter the context in which the scheme's performance on this issue should be viewed, resulting in reduced emissions and potentially improved performance nationally from national level policy measures.'

'The emissions from the airport are likely to add risk to that which already exists around future breaches. Action to tackle this existing risk will need to be taken across a wider area than just the airport but will be significantly enhanced if it is combined with action at the airport. Additional mitigation at the airport would therefore be necessary to ensure that action to improve the background performance is not undone by additional emissions from the airport and so ensure that expansion is not adding to the problem. There is even the potential for very effective mitigation measures to improve performance beyond the level of additional emission created by the scheme and further contribute to reducing the problem, but it is not going to resolve the background issues.'

The Airports Commission recognises that not only is effective mitigation required, but that solving the problem of a risk of non-compliance near the road network associated with a Heathrow scheme is reliant on the effectiveness of national policies to reduce vehicle emissions being successful. It also implicitly recognises that additional mitigation to reduce emissions on the road network around Heathrow might be required in order to enable a Heathrow scheme to proceed. Such action, including for example changes to orbital and access routes to London will not happen quickly. It seems clear that action at both national and local level of this scale, complexity and cost is unlikely to deliver the necessary improvements by 2025, nor quite possibly by 2030.

The Heathrow Airport Limited submission states that,

'we have committed to adding a third runway with no more airport related traffic on the road than today and to increase the proportion of passengers who use public transport to access the airport from 40% today to more than 50% by 2030. ….We also outline that there may be a case for introducing a congestion charge for people travelling to the airport once improvements in public transport have been delivered.'

The submission also states that,

'As a result of our surface access strategy, there will be no more Heathrow related vehicles on the road than there is today. Those vehicles that are travelling to the airport will be cleaner. Combined with new aircraft technology, this means that levels of nitrogen dioxide would be within EU limits.'

The only part of this latter statement that is unquestionably true is that vehicles will be cleaner in the future. The other points are simply assertive and without evidential foundation - they may well not prove to be correct. The prediction regarding numbers of passengers and workers arriving at Heathrow by car is particularly uncertain. It cannot reasonably be guaranteed, as it will depend on the acceptability of the proposed measures to local communities, as well as on the response and alternative actions taken by airport users to the dis-incentives applied.[1] This is a key aspect of the proposed mitigation and warrants further consideration.

The reported 85% increase in air passengers and 45% increase in employees by 2040 means that additional road traffic must reasonably generated even allowing for their public transport mode share targets. Heathrow cannot themselves guarantee the increase in rail capacity which would be required, which are not necessarily deliverable.

In terms of road traffic, the Airport's Commission Consultants – Jacobs, forecast a net impact of up to 1,200 additional car/taxi trips to the airport in the morning peak hour in 2030 as a result of the new North West Runway, with up to 600 additional car and taxi trips leaving the airport[2].

Within the Airports Commission report, Jacobs further question the impact on local roads around the airport as they did not find enough information in the Heathrow submission to be able to adequately assess local traffic impacts, particularly around the southern boundary of the airport, where significant growth in goods traffic is proposed by Heathrow[3].
The idea of the congestion charge, as suggested in the Heathrow Airport submission, appears to be the only realistic means of meeting the objective of 'no additional car trips generated by a third runway' , but it is not described in any detail. For example, it is unclear what its boundaries would be and whether it would apply to the airport itself or include the wider network. To be effective, the congestion charge would have to be suitably high (perhaps in the range of as high as £30-40) and would need to be accompanied by a range of other measures to drastically reduce vehicle trips in the area.

[1] The Heathrow Airport submission (Part 4, at page 235) includes a recognition that 'kiss and fly' drop-offs and trips by taxi will reduce significantly in the future because of congestion on the wider road network.

[2] Appraisal Framework Module 4 , Surface Access – Heathrow Airport North West Runway, p8 and p77, Airports Commission 5th November 2014 by Jacobs).

[3] Appraisal Framework Module 4 , Surface Access – Heathrow Airport North West Runway, p65, Airports Commission 5th November 2014 by Jacobs

No predictions are provided as to its impact on the traffic flows on the affected roads or those surrounding this zone, nor for that matter is any assessment made on how it may alter road travel patterns of airport users leading to creation of new and unforeseen consequences for ground level concentrations on other parts of the network.
In the PSDH work completed in 2007, the impact of a charge applied to HGVs on the wider road network was evaluated in terms of the reduction in vehicle emissions and the consequent impact on local NO_2 concentrations. (See Section 4.) This was the only mitigation measured examined at that time that would have helped prevent a predicted future non-compliance with the NO_2 limit value at the critical locations, e.g. the properties alongside the M4 in West Drayton.

This emphasises the point that it is not the airside related mitigation measures that are really important in this context. What matters for eliminating the risk of non-compliance with the NO_2 limit value in 2025 is providing a suite of mitigation measures and interventions that provides certainty that there will be a substantial reduction in road traffic emissions relative to those of today and without adverse secondary consequences for other areas. At the London Hillingdon site, this translates to bringing down the NO_2 concentration by 15-20 $\mu g/m^3$ relative to the existing concentration being recorded. The Heathrow Airport submission does not explain how this might be achieved with a Heathrow expansion scheme being constructed and operated and without any additional delay in compliance. Instead, the Heathrow Airport submission concentrates mainly on measures that will reduce NO_2 concentrations around the airport boundary.

At many places in the UK, the trend is for concentrations of NO_2 to decrease and air quality is improving gradually. However, the rate of any improvement has not been as high as previously expected, and non-compliance with the requirements of the Directive is widespread, as exemplified by DEFRA's acknowledgement that there are 43 'zones' where action is required to achieve compliance as soon as possible. It is against this background that the European Commission has initiated infraction proceedings against the UK Government for failing to meet the NO_2 limit value by 2015, as originally intended.

This is unquestionably an important issue for UK Government and any nationally significant infrastructure project must be designed such that it does not cause non-compliance with, or delay the achievement of, the NO_2 limit value in any way. The issue of whether the expansion of Heathrow can be achieved without causing or giving rise to any such delay can be distilled into one aspect of its impact on local air quality.

The principal issue regarding air quality in the Heathrow area and the proposed Heathrow schemes is whether or not it can be established that they can be constructed and operated without delaying the attainment of the annual mean NO_2 limit value for a longer period than would occur if those schemes were not constructed and operated.

There is significant evidence available that establishes that even without a Heathrow scheme coming forward the attainment of the limit value in the Heathrow area will not occur until after 2025 and will be difficult to achieve.

The construction and operation of a Heathrow scheme would thus introduce additional sources of NOx into an area that is already struggling to attain the limit value.

The mitigations proposed by Heathrow, whilst potentially beneficial in relation to airside sources, are available in the baseline 2 runway situation in any event. Mitigation proposed in relation to road traffic sources, which are the more important issue where compliance with limit values is concerned, is generalised in nature and its potential effects have not been examined or quantified in any detail.

There is no certainty that the annual mean NO_2 limit value could be met with a Heathrow Scheme being constructed and operated. There are no assurances that the construction and operation of a Heathrow scheme could be undertaken without delaying compliance with NO_2 limits values.

Neither is there any certainty therefore that a Heathrow Scheme could be delivered and the UK's legal obligations, under the 2008 EU Air Quality Directive and the 2010 Air Quality Regulations, still be met.

If the Commission was to recommend one of the Heathrow schemes, there is a significant risk that the scheme will prove to be undeliverable.

Annex A

Detailed analysis of NO_2 concentrations near Heathrow

The air quality around Heathrow has been examined by numerous groups to date. In addition to the work of the PSDH, research papers can be found in the scientific literature that have used monitoring data to learn more about the influence of the airport. The results of one such paper are summarised below.

The monitoring sites around Heathrow are influenced to varying degrees by the airport related emissions. Modelling provides one method of apportioning the NO_2 contributions, but the monitoring data also provide good evidence as to the airport's influence. A relatively old example of this kind of analysis is seen in the work of Carslaw *et al* (1), in which the monitoring data from the sites closest to the airport were 'selected conditionally' to highlight the airport as a source, as the following Figure of bivariate plots of NO_2 concentrations by wind direction shows.

Figure A1 ***Bivariate NO_2 plots***

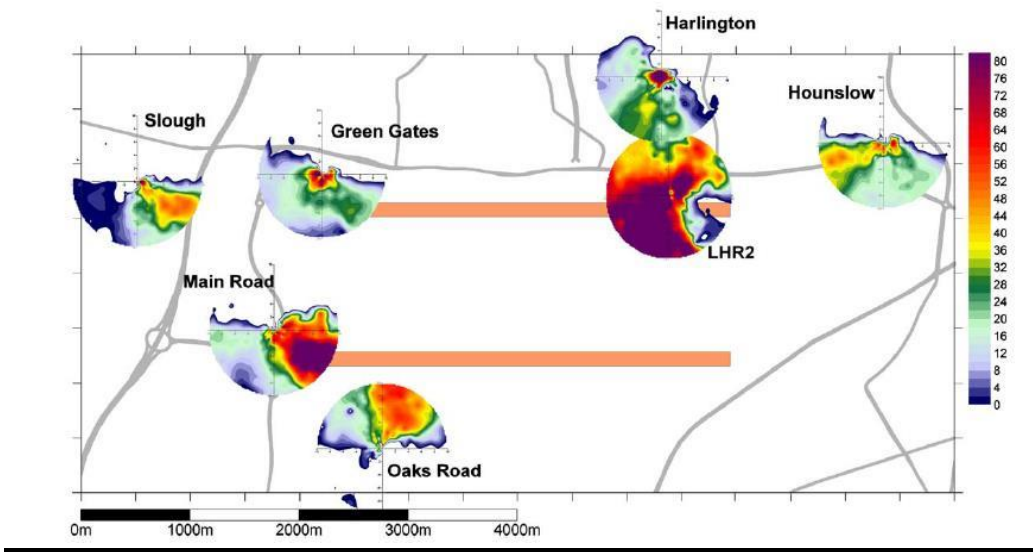


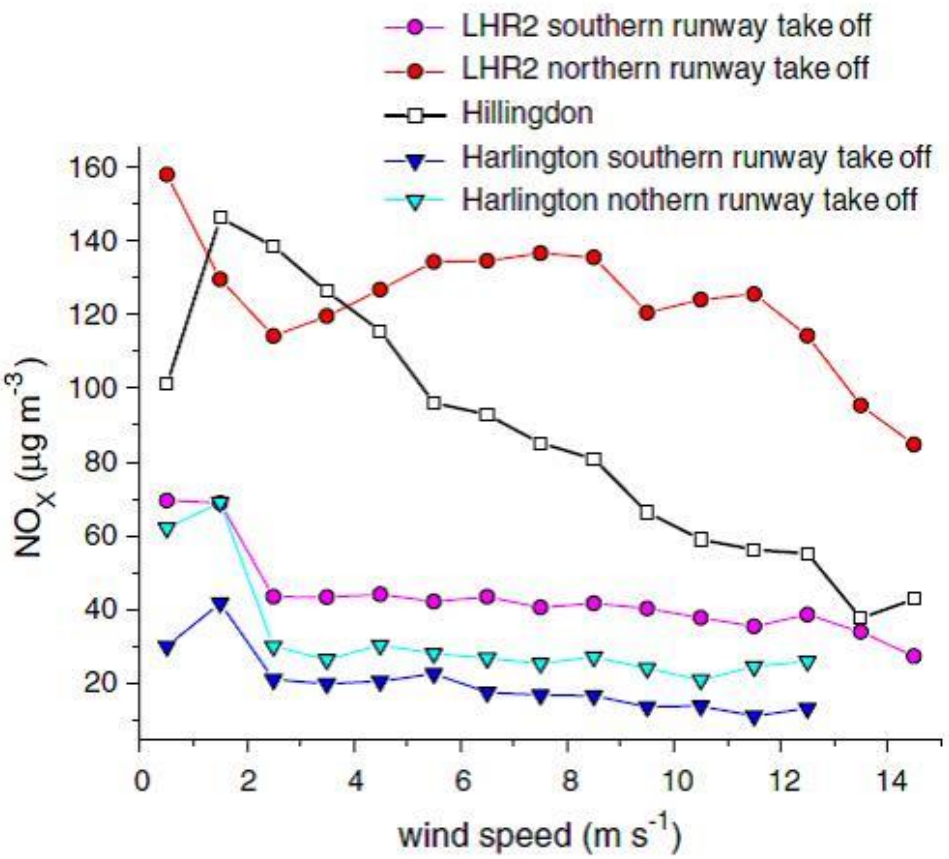
Table A1 ***Airport NO_x and NO_2 contribution at monitoring sites***

Location	Upper limit for airport NO_x contribution (µg/ m^3)	Upper limit for airport NO_x contribution (%)	NO_x range (µg/ m^3)	Upper limit for NO_2 contribution (µg/ m^3)
LHR2	33.9	26.7	21.5-33.9	15.0
Harlington	9.9	14.0	5.7-9.9	6.6
Hounslow	9.5	12.0	5.7-9.9	6.5
Main Road	7.1	8.8	3.3-7.1	4.2
Oaks Road	5.9	8.9	2.2 -5.9	2.0
Green Gates	3.0	4.0	1.1-3.0	1.5
Slough	1.8	2.6	1.7-1.8	1.5

(1) Carslaw D, Beevers S, Ropkins K and Bell M (2006) Detecting and quantifying aircraft and other on-airport contributions to ambient nitrogen dioxides in the vicinity of a large international airport Atmospheric Environment 40 5424-5434

The authors state that the aircraft influence on NO_x measurements can be unambiguously detected 2.6 km from the runways, although it is clear from the measurements that the contribution is not large beyond 1 km. There is one other result from this analysis of Carslaw *et al* that provides some additional insight and this relates to the different behaviour of dispersing aircraft emissions to the road traffic emissions and the ability to discern the modes of runway operation. The following Figure shows the wind speed dependence of the measured concentrations and the effect of runway operation. (All results have been filtered and are not annual average concentrations.)

Figure A2 ***Wind speed dependence illustration***



This result shows that the impacts of buoyant aircraft plumes are not dependent on wind speed, whereas those from the non-buoyant road traffic emissions at the Hillingdon site next to the M4 are. The results also demonstrate that NO_x is diluted by a factor of 5 between the LHR2 site and the Harlington site for take-off on the northern runway, a separation of 1km. Harlington is a distance of 1230 m and 2670 m from the northern and southern runways respectively.

The analysis presented by Carslaw *et al* is for measurement data that are over ten years old (2001-2004), but the results are highly relevant in the context of the airport contribution. The number of ATMs is broadly similar to those of today and the aircraft emissions are also similar in aggregate terms, even if on a per aircraft basis they have fallen slightly. Therefore, in respect of the existing and future airport's impact on NO_2 concentrations at locations around the airport, they are a useful guide that is independent of the modelling results produced by HAL.

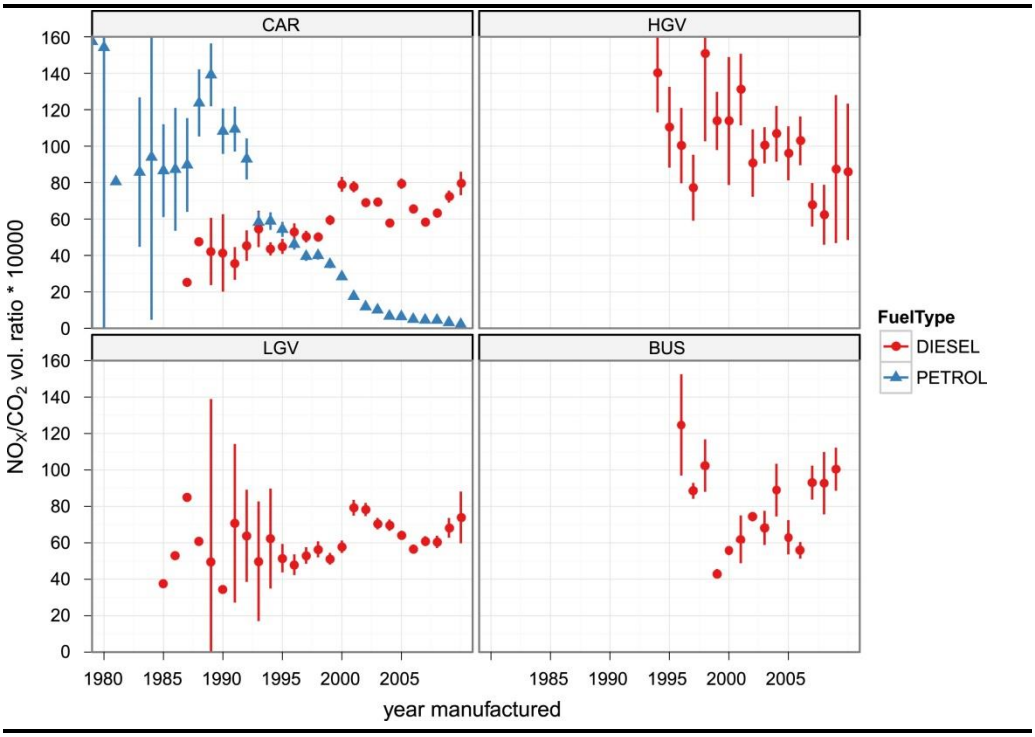
Annex B

Actual Emission Performance against Euro Categories

The most compelling research data in recent times in the UK that reveal the widespread non-conformity with Euro emission standards has been obtained using a remote sensing technique to measure the actual 'on road' emission concentrations from many thousands of vehicles. The following is a summary of the key points.

The following diagram, taken from DEFRA commissioned research and reported by Carslaw *et al* (1) , shows how the NO_x emission trend for vehicles with diesel engines behaved very differently to that for petrol cars over the period when successive Euro emission standards were being introduced.

Figure B1 ***NO_x performance by vehicle age (taken from Carslaw et al 2011)***



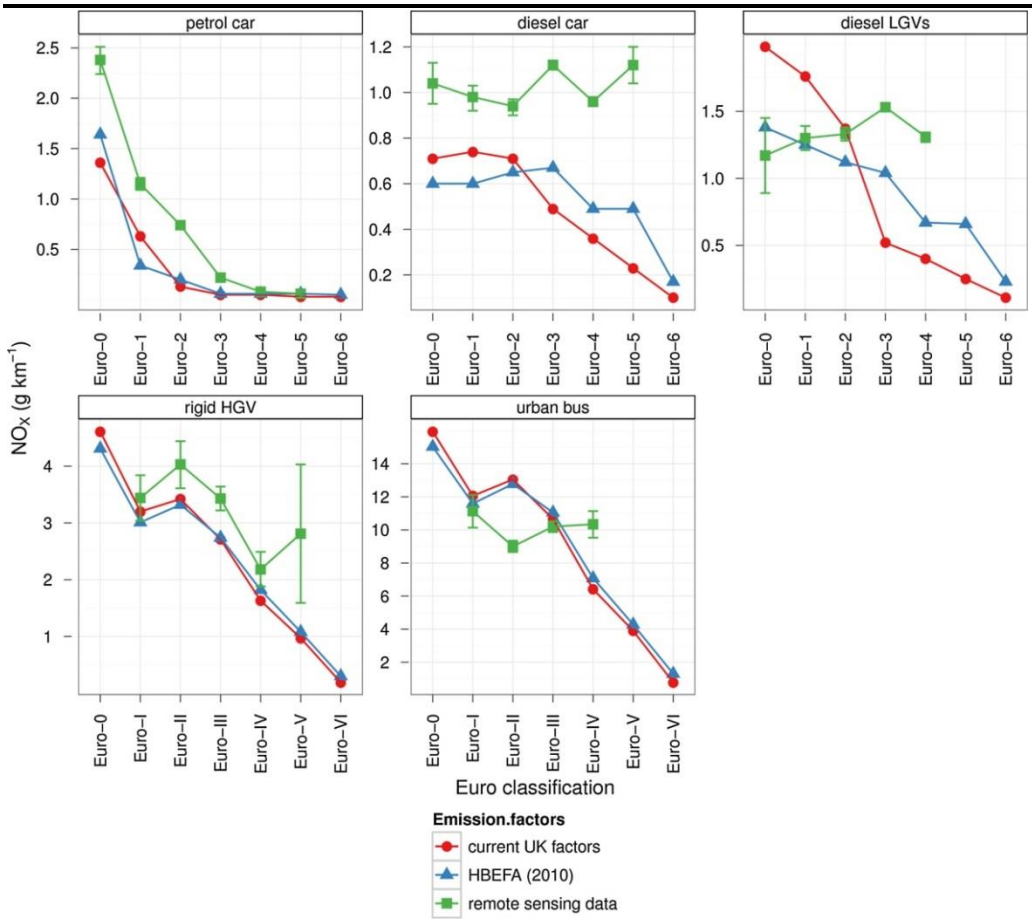
This plot shows the results obtained from many measurements made of vehicles on the road and relates the relative NO_x emissions to year of manufacture by use of number plate recognition technology. The inference is very clear; whereas the NO_x emissions from diesel engines should have been falling in line with progressively tighter standards, as has been observed for petrol engines, they have remained largely static.

The same experimental technique has been used to compare actual 'on the road' emissions with the emission factors used in dispersion modelling studies, such as those in PSDH and as set out in DEFRA's Emission Factor Toolkit. The following series of plots, taken from Carslaw *et al* (2011) (2),

(1) Carslaw D, Beevers S, Tate J, Westmoreland E and Williams M (2011) Recent Evidence concerning higher NOx emissions from passenger cars and light duty vehicles Atmospheric Environment 45 7053-7063

shows how these emission factors have underestimated substantially the contribution from diesel engines from some classes of vehicle. (Contrast the green measurements with the red emission factors used in the UK.)

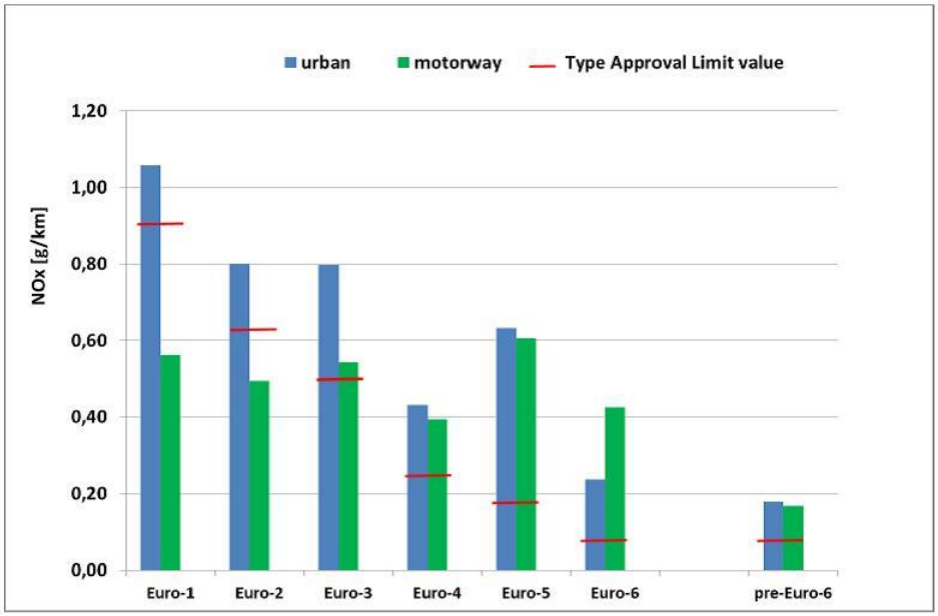
Figure B2 ***Illustration of difference between emission factors and measurements (taken from Carslaw et al (2011))***



Finally, Figure B3 shows the performance of Euro 1-6 vehicles under urban and motorway conditions against the actual type approval limit value for tailpipe emissions. As has been the case since the introduction of the Euro 3 category, compliance with the limit in either a motorway or urban setting has not been demonstrated.

(2) Carslaw D, Beevers S, Tate J, Westmoreland E and Williams M (2011) Recent Evidence concerning higher NOx emissions from passenger cars and light duty vehicles Atmospheric Environment 45 7053-7063

Figure B3 Measured vs assumed NO_x emission rates from TNO Report R11891



Annex C

ERM Modelling Work

Introduction

Atmospheric dispersion modelling was undertaken on a section of the M4 motorway adjacent to London Heathrow Airport, to predict the existing pollutant concentrations from road traffic at residential properties in West Drayton, London Borough of Hillingdon.

The inclusive road network within the model comprised the M4 motorway carriageways between junctions 4 and 4b (eastbound and westbound); together with the associated entry and exit slip roads only.

The dispersion model ADMS Roads (Version 3.4.2) was used for the study.

Scenarios

The following scenarios were modelled in the study:

- Existing baseline 2013; and
- Projected baseline 2025 (No third runway; Highways Agency gap adjustment method).

Methodology

Pollutant concentrations for the baseline year of 2013 and future year of 2025 were forecast at locations next to the motorway for the pollutants nitrogen dioxide (NO_2) and oxides of nitrogen (NO_x).

Existing pollutant concentrations in the area were obtained from DEFRA's London Hillingdon monitoring site (UKA00266), which forms part of their national Automatic Urban and Rural Network (AURN). The site, which is classified as an Urban Background, is located approximately 30 metres from the eastbound carriageway of the M4 between junctions 4 and 4b, within a residential area.

The modelled baseline year of 2013 was selected so that model verification could be undertaken against ratified 2013 Hillingdon monitoring data. Ratified monitoring data for 2014 from the Hillingdon site were not available at the time of the study. The verification of the modelling was done using concentrations of NO_x.

Monitored 24-hour annual average daily traffic (AADT) flows for the year 2013 were obtained from the UK Highways Agency's Traffic Information System (HATRIS) and entered into the ADMS model as a series of spatially correct road links. The traffic data comprised a breakdown of vehicle classes allowing the proportion of Light Duty Vehicles (LDV) (<3.5t) and Heavy Duty Vehicles (HDV) (>3.5t) to be entered directly into the model.

Growth in traffic numbers from 2013 to 2025 were calculated using the factors provided within the DfT 2013 Regional Traffic Forecasts. An adjustment factor

was obtained and used for the following attributes; London region, motorway type and all traffic, and applied to all modelled links.

Vehicle speeds of 112 kilometres per hour (approximately 70 miles per hour) were assumed for all links.

Vehicle emission factors from the Emissions Factors Toolkit (EFT) (version 6.0.1), published by DEFRA and the Devolved Administrations were used within the modelling which are built into ADMS-Roads 3.4[1]. Concentrations of NO_x only were forecast for the years 2013 and 2025. The forecast emission factors take into account the predicted improvement in vehicle technology, the penetration of alternative-powered vehicles and the removal of older vehicles in the fleet.

Five years of sequential meteorological data from London Heathrow Airport were used for the years 2006 to 2010 to understand the variability in data years.

Pollutant concentrations were forecast across a Cartesian gridded receptor network created between M4 junctions 4 and 4b extending up to 300 metres away from each carriageway. The 'intelligent gridding' module within ADMS was also utilised to provide a greater near-field resolution of predicted impacts, by increasing the number of receptors positioned alongside the emission sources.

Estimated background pollutant concentrations were obtained through DEFRA's published background maps for the years 2013 and 2025. The maps, which provide an estimated breakdown of the relative sources of pollution in each grid square, allow the estimated motorway contribution to be removed from the total. This prevents the double counting of emission sources within the modelling. Background NO_2 concentrations were then recalculated using DEFRA's accompanying '*NO_2 adjustment for NO_x Sector Removal Tool'*.

As NO_x was the only pollutant emitted within the modelling, the conversion of NO_x to NO_2 was done at the post-processing stage using the Hillingdon AURN NO_x to NO_2 monitored relationship in 2013.

Further to this, the Highways Agency's published Interim Advice Note (IAN) (170/12 v3) related to long term trends in NO_x and NO_2 was also accounted for. This IAN suggests that forecast improvements in emission factors are unrealistic and presents an alternative NO_x and NO_2 projection for consideration.

[1] It is acknowledged that the most up-to-date version of the EFT at the time of the study was version 6.0.2. As v6.0.2 simply made amendments to the Alternative Vehicles advanced input option (not used in this study), the use of v6.0.1 was still considered appropriate.

The model shows several properties in exceedance of the annual mean NO_2 limit value in 2025, based on DfT growth figures and the Highways Agency approach for projecting future emission rates.

Figure C1 Annual mean NO_2 concentrations (2013)

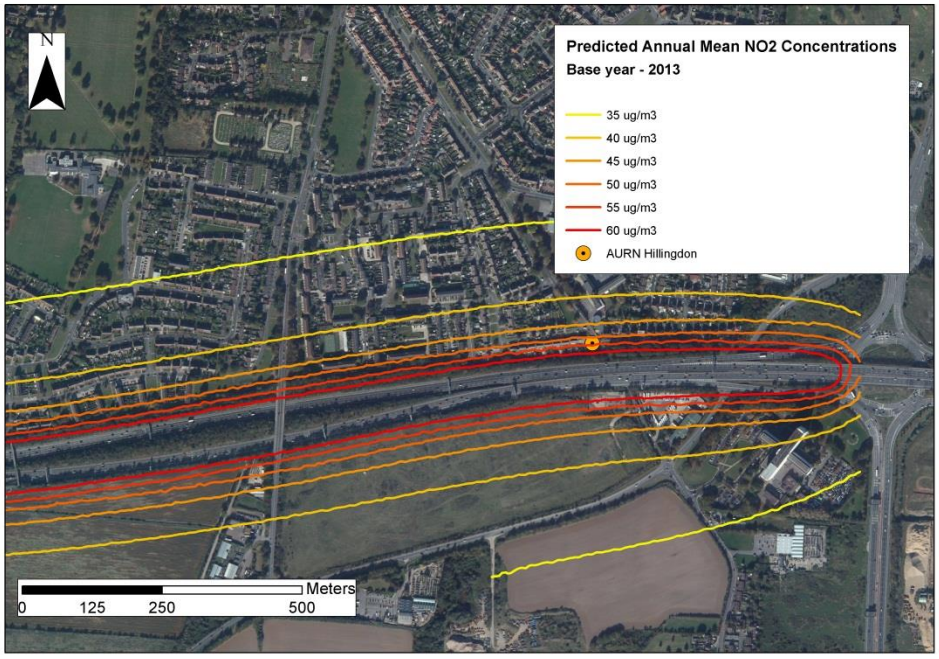


Figure C2 Annual mean NO_2 concentrations (2025, no third runway at Heathrow)