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AIR QUALITY RE-ANALYSIS

IMPACT OF NEW POLLUTION CLIMATE
MAPPING PROJECTIONS AND NATIONAL AIR
QUALITY PLAN

OCTOBER 2016

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IMPACT OF NEW POLLUTION CLIMATE MAPPING PROJECTIONS AND NATIONAL AIR QUALITY PLAN

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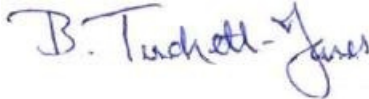
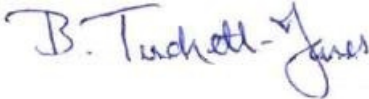
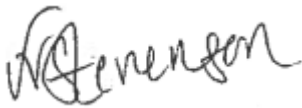
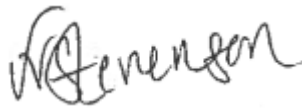
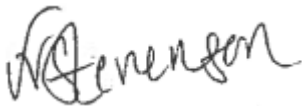
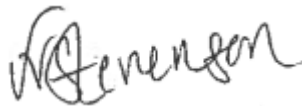
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FOREWORD

Since the publication of the UK Government's 2015 Air Quality Plan and the completion of the WSP|Parsons Brinckerhoff Re-analysis Study considering the impact of the Plan on EU limit value compliance with increased airport capacity, the COPERT emission factors on which the Plan and associated Pollution Climate Mapping (PCM) modelling were based have been updated.

The updated COPERT factors have not yet been incorporated into PCM projections and, therefore, this foreword provides an initial qualitative review of the potential implications of the update for the conclusions of the Re-analysis Study presented in this document.

The principal driver for the update to the COPERT factors was emerging evidence suggesting that whilst real world emissions of nitrogen oxides from Euro 5 diesel cars are correctly estimated in the previous issue of the factors, current emissions from Euro 6 diesel cars and Euro 5 and Euro 6 light commercial vehicles are significantly underestimated.

The updated COPERT factors take account of this underestimation of emissions but show improvements over time in the performance of new Euro 6 cars and light commercial vehicles, particularly for vehicles entering the fleet post 2020/21. New airport capacity is expected to be operational between 2025 and 2030.

The update to the COPERT factors indicates that vehicle emissions, and resulting roadside pollutant concentrations, are potentially underestimated in the Baseline PCM model projections¹. Using the updated COPERT factors, new vehicles entering the fleet after 2020 have emissions equivalent to those modelled in the Baseline PCM modelling, but older vehicles in the fleet have emissions higher than modelled in the Baseline PCM model and this would mean that the fleet-averaged emissions were likely to be higher than modelled.

It should be noted that the new COPERT factors do not take full account of the Real Driving Emissions (RDE) testing², particularly during phase 2 which is due to be implemented for all new car registrations in 2021 and all new van registrations in 2022. This will mandate that manufacturers must comply with the limits specified in the RDE regulations, subject to a margin of measurement error. The full and effective implementation of RDE would result in significant emission reductions, particularly post 2025, compared to the updated COPERT factors.

The impact of modelling using updated COPERT factors

The WSP|Parsons Brinckerhoff Re-analysis Study considered a sensitivity test for airport opening in 2025, in which emissions from Euro 6 cars were increased in relation to the Baseline PCM projections. This test was based on increased emissions from Euro 6 cars, implemented using a conservative method³ and was undertaken to take account of potential uncertainties in emissions estimates for some vehicle types. Taking into account the conservative design of these tests, it is likely that the PCM projections used in the sensitivity tests would continue to over-estimate any

¹ Scenarios 1B, 2B and 2C, and 4C and 4D in the Re-analysis Study. These scenarios do not take into account the measures set out in the 2015 Air Quality Plan.

² RDE tests vehicles in the real world. It will be implemented in two stages: RDE phase 1, which for cars applies to all new registrations in 2019 and RDE phase 2, which applies to all new registrations in 2021. It is implemented a year later for vans. http://europa.eu/rapid/press-release_IP-15-5945_en.htm

³ This modelled the impact of higher emissions in 2020 and then linearly interpolated between this value and the 'with 2015 Plan measures' values in 2030. This significantly slows down assumptions on fleet turnover resulting in a conservative estimate of emissions in 2025. Scenarios 3A-3C, 4E and 4F in the Re-analysis Study.

revisions to the Baseline projections made using the updated COPERT factors. Whilst no such sensitivity tests were explicitly undertaken for 2030, the trends across the various scenarios assessed in the Re-analysis Study are sufficient to draw conclusions as to the likely implications of the update to the COPERT factors for the post 2030 period. That is to say, taking into account the update to the COPERT factors, the likely impacts of the airport expansion options on compliance with EU limit values can be assessed by making reference to the range of scenarios which exclude 2015 Plan measures (i.e. baseline and sensitivity scenarios only) considered in the Re-analysis Study. This leads to the following conclusions for 2025 and 2030:

→ With emissions following the September 2016 update to the COPERT factors:

- Gatwick Second Runway is at **very low risk** of impacting on the UK's compliance with EU limit values
- Heathrow Northwest Runway is at **risk of worsening exceedances** of limit values alongside some roads within Greater London, but this would be **unlikely** to affect the overall zone compliance. However, the overall risk has increased compared to the WSP|Parsons Brinckerhoff Re-analysis Study.
- Heathrow Extended Northern Runway is at **high risk of worsening exceedances** of limit values alongside some roads within Greater London, and that this would be **likely** to affect the overall zone compliance post 2030. Subsequent to the Airport Commission's (AC) work and modelling on air quality, further iterations of surface access plans have been proposed by the promoter of the Heathrow Extended Northern Runway scheme. Most elements of their plans have remained unchanged, but there have been some changes to road layout. Although these iterations have not been considered in the Re-analysis Study, or indeed this foreword, it is acknowledged that they were developed with one aim being to reduce air quality impacts associated with the proposal considered by the AC.

The impact of modelling using updated COPERT factors and including full implementation of RDE

As noted previously, the updated COPERT factors show reductions in emissions from Euro 6 vehicles over time, but in the post 2020 period these do not fully capture the potential reduction of emissions with RDE, particularly during phase 2. As such, if RDE is fully effective, then in the post 2020 period the updated COPERT factors may be seen as increasingly conservative.

In 2025, with RDE fully effective but some older and RDE non-compliant vehicles remaining in the fleet, the impacts of the airport expansion options on EU compliance could lie between the scenarios including the 2015 Plan measures (termed 'New PCM with Measures')⁴ and the sensitivity scenarios⁵. The Re-analysis Study demonstrated that only a modest increase in vehicle emissions over the 'New PCM with Measures' scenarios would significantly increase the risk of Heathrow Northwest Runway or Heathrow Extended Northern Runway impacting on EU limit value compliance. As such, in 2025, risks remain that the Heathrow Northwest Runway or Heathrow Extended Northern Runway schemes could impact on EU limit value compliance.

By 2030, assuming that the majority of the fleet is fully RDE compliant and with the influence of older non-RDE compliant vehicles reducing over time, it is possible that the projected compliance with EU limit values in the 'New PCM with Measures' projections could be maintained, even with expanded airport capacity i.e. following or even bettering the projections in scenarios 1A, 4A and 4B in the Re-analysis Study.

⁴ Scenarios 2A/B in the Re-analysis Study

⁵ Scenarios 3A-3C, 4E and 4F in the Re-analysis Study

This conclusion does, however, rely on the fully effective implementation of both RDE and the 2015 Plan measures. As such, the final conclusion of the review of the impacts of the updated COPERT factors is that:

→ **A combination of the measures set out in the 2015 Plan and the effective implementation of RDE has *the potential to reduce, or even remove, the risk of any option for expanded airport capacity impacting on the UK's compliance with EU limit values***

The direct mitigation of airport impacts, with measures considered by the AC, also reduces the risks. However, significant reductions in risk rely on the mitigation of impacts from vehicle emissions on the overall and wider road network.

A range of additional measures exist which go beyond the mitigations reviewed in the Re-analysis Study, for instance tighter access restrictions that only allow Euro 6 RDE compliant vehicles. These could be implemented to further improve emissions on wider road network links.

WSP|Parsons Brinckerhoff

12th October 2016

1 EXECUTIVE SUMMARY

INTRODUCTION

- 1.1.1 The Airports Commission (AC) undertook a local air quality assessment to support the independent examination of 3 short listed options to increase aviation capacity in the UK.
- 1.1.2 These options are
 - Gatwick Second Runway (2R),
 - Heathrow Northwest Runway (NWR), and
 - Heathrow Extended Northern Runway (ENR).
- 1.1.3 Under the EU Ambient Air Quality Directive, the UK Government has a legal obligation to achieve air quality limit values. A key aspect of the AC's air quality assessment was consideration of the likely impact of the options on the UK's compliance with the limit values.
- 1.1.4 In April 2015, the Supreme Court ruled that the UK Government should develop a new Air Quality Plan (the Plan) to meet limit values for nitrogen dioxide. At the time of the ruling, the plans in place indicated that some areas of the UK would not achieve compliance with limit values until 2030. The AC's assessment was based on these original plans.
- 1.1.5 The Government published its new Plan and supporting technical evidence in December 2015. The evidence base included revised compliance projections using the Pollution Climate Mapping (PCM) model showing all areas of the UK meeting the limit values by 2025.

MODELLING FOR COMPLIANCE ASSESSMENT

- 1.1.6 The UK Government assesses compliance with EU limit values using a combination of monitoring and modelling with the PCM model. The UK is divided into 43 zones and agglomerations for reporting purposes. A zone or agglomeration is defined as being compliant when the maximum monitored or modelled concentration within that zone or agglomeration is less than or equal to the limit value.
- 1.1.7 The PCM model is used to estimate pollutant concentrations at background and roadside locations throughout the UK. Background concentrations are modelled on a 1km grid covering the entire UK; roadside concentrations are modelled for locations adjacent to approximately 9000 roads (A-roads and motorways) across the UK.

SCOPE AND LIMITATIONS

- 1.1.8 The Government's new Air Quality Plan was published after the AC's work was concluded. This study assesses the implications of the new Plan and PCM modelling on the conclusions of the AC's air quality assessment in relation to EU limit value compliance. Specifically, it considers:
 - The change in projected roadside nitrogen dioxide concentrations with the new PCM modelling,
 - Whether the new projections indicate that the short-listed options will or will not cause or contribute to exceedances of EU limit values,
 - The potential impacts of mitigation on compliance with EU limit values (from either the national Plan or scheme-specific measures identified by the AC),

- Whether the new projections will change the conclusions of the AC's compliance assessment, and
- Uncertainties in the future PCM projections and in the AC's modelling of impacts, including the opening date for the option, the rate of growth and operations at full capacity.

1.1.9 No new modelling work has been undertaken for the study. Rather, it is based on a re-analysis of existing datasets that have been published in summary, graphical or tabular form in:

- AC's air quality local assessment⁶, and
- UK Government's 2015 Air Quality Plan and supporting technical reports⁷

1.1.10 The methodology used follows the guidance set out in the Design Manual for Roads and Bridges⁸. This is the same method that was used by the AC.

1.1.11 In summary, the method is a screening approach to the assessment of future pollution levels with increased airport capacity. It treats the Government's new PCM projections for roadside concentrations as the future baseline without airport expansion. The impacts of the options for airport expansion, as modelled by the AC, are then added to this future baseline to estimate total concentrations with increased capacity.

1.1.12 The study combines the Government's projections for future air quality without airport expansion with the AC's modelling of the impacts of airport expansion. The Government's projections are based on the PCM model; the AC's modelling is based on the ADMS-Airports model⁹. This approach – summing the outputs from two distinct and independent models - has limitations and, as such, an important aspect of the study has been to consider the implications of uncertainties in the projections and modelled impacts through the use of sensitivity testing.

1.1.13 The study has considered annual mean nitrogen dioxide only. Airports have been shown to be relatively small contributors to ambient concentrations of particulate matter, and the Government's new Air Quality Plan is itself targeted at reducing nitrogen dioxide concentrations.

1.1.14 Subsequent to the AC's work and modelling on air quality, further iterations of surface access plans have been proposed by the promoter of the Heathrow Extended Northern Runway scheme. Most elements of their plans have remained unchanged, but there have been some changes to road layout. Although these iterations have not been considered in this study, it is acknowledged that they were developed with one aim being to reduce air quality impacts associated with the proposal considered by the AC.

ASSESSMENT METHODOLOGY

1.1.15 This study considers the impact of the options for airport expansion on compliance with EU limit values by comparing the estimated future concentrations of nitrogen dioxide with the limit value.

1.1.16 In the first instance, and following the UK Government's compliance assessment reporting to the European Union, we consider the maximum predicted concentration within each of the various

⁶ <https://www.gov.uk/government/publications/airports-commission-final-report-air-quality>

⁷ <https://www.gov.uk/government/publications/air-quality-in-the-uk-plan-to-reduce-nitrogen-dioxide-emissions>

⁸ Interim Advice Note 175/13, updated advice on risk assessment related to compliance with the EU Directive on ambient air quality and on the production of Scheme Air Quality Action Plans for users of DMRB Volume 11, Section 3, Part 1 Air Quality (HA207/07)

⁹ www.cerc.co.uk

zones affected by the options (primarily the South-East Zone and the Greater London Urban Area Agglomeration) with and without the option.

- 1.1.17 If the maximum concentration in a zone is above the limit value and increases with the option or if the option causes the maximum concentration in a zone to increase from a level below the limit value to above the limit value, the option is considered to impact on compliance within that zone.
- 1.1.18 In all other cases, the option is not considered to impact on zone compliance. However, in describing the impacts of an option where the zone compliance is unaffected, we distinguish between cases where all road links affected by an option have predicted concentrations below the limit value and cases where options contribute to worsening of existing exceedances of the limit values or create new exceedances without affecting the maximum concentration in the zone.
- 1.1.19 To identify the vulnerability of the assessment conclusions to uncertainties in the future projection of pollutant concentrations and airport activities, a number of sensitivity testing scenarios were devised. The scenarios tested the impact of the opening of the airport option prior to 2030 (the earliest plausible opening date lying between 2025 and 2030) and the implications of any disparity between vehicle emissions standards and emissions from vehicles under real, on-road, driving conditions.
- 1.1.20 The impact of each option was assessed against the following criteria:
- Criteria A: Does the option cause a compliance zone/agglomeration to become non-compliant
 - Criteria B: Does the option cause a delay to compliance within a non-compliant zone/agglomeration, or a worsening of the zone compliance assessment
 - Criteria C: Does the option cause a worsening of exceedances of the limit value alongside one or more PCM links without delaying compliance of the zone/agglomeration
- 1.1.21 Table 1-1 shows a summary of the Scenarios tested and a grading of the options against these criteria using the following classes, as against a specified year:
- **No impact on zone compliance**
 - *Green Shading = Scenario does not cause or contribute to exceedances of EU limit values (Answer to all criteria = 'No')*
 - *Yellow Shading = Scenario causes a new exceedance on a road or worsens an existing exceedance, but does not affect the maximum concentration within a zone (Answer to Criteria A and B = 'No'; Criteria C = 'Yes')*
 - **Impact on zone compliance**
 - *Red Shading = Scenario impacts on compliance status of zone or introduces new non-compliances by increasing the maximum predicted concentration within a zone (Answer to Criteria A or B = 'Yes')*
- 1.1.22 In terms of total predicted pollutant concentrations, moving from Scenario 1 through to Scenario 3, the assumptions employed become increasingly conservative, i.e. leading to higher pollutant concentrations.
- 1.1.23 For example, Scenario 1A is based on the Government's new PCM projections for 2030, taking into account the measures in the 2015 Plan. Scenario 1B is based on new PCM projections for 2030, but without taking into account the 2015 Plan measures and, therefore, considers a higher future baseline concentration than Scenario 1A.

- 1.1.24 Scenario 2 relates to airport expansion opening prior to 2030. Since pollutant concentrations and emissions per vehicle are generally expected to fall over time, Scenario 2 considers higher future baseline concentrations than Scenario 1.
- 1.1.25 Scenario 3 relates to potential increased future disparity between vehicle emissions standards and emissions under real world driving conditions. With opening of the airport assumed for 2025, Scenario 3 considers both higher future baseline concentrations and significantly higher vehicle emissions than Scenario 1. This Scenario is potentially overly conservative in that post 2020, the introduction of more realistic drive cycles for emissions testing should result in significantly reduced disparity between fleet averaged vehicle emissions and the emissions standards.
- 1.1.26 Scenario 4 considers the potential for mitigation of impacts using option specific measures, identified in the AC's air quality local assessment.

Table 1-1 Summary of assessment of sensitivity testing Scenarios.

SCENARIO		OPTION		
		GATWICK SECOND RUNWAY	HEATHROW NORTHWEST RUNWAY	HEATHROW EXTENDED NORTHERN RUNWAY
YEAR				
Airport Commission (Sustainability Appraisal)				
Unmitigated	2030			
Mitigated	2030			
Scenario 1: New PCM Projections and 2015 Plan				
1A: With 2015 Measures	2030			
1B: Baseline (2011 Measures only)	2030			
Scenario 2: Opening Year Assessment				
2A: With 2015 Measures	2025			
2B: Baseline (2011 Measures only)	2025		*	a
2C: Baseline plus adjusted airport impact	2025		*	a
Scenario 3: Emissions Sensitivity Testing				
3A: – Sensitivity	2025			a
3B: – Sensitivity + Airport Impact Adjustment (1)	2025			a
3C: – Sensitivity + Airport Impact Adjustment (2)	2025			a
Scenario 4 Scheme Impact Mitigation				
4A: – With 2015 Measures + Impact Mitigated (Low)	2030			
4B: – With 2015 Measures + Impact Mitigated (High)	2030			
4C: – Baseline (2011 Measures) + Impact Mitigated (Low)	2025		*	
4D: – Baseline + Impact Mitigated (High)	2025		*	**
4E: – Sensitivity + Impact Mitigated (Low)	2025		*	
4F: – Sensitivity + Impact Mitigated (High)	2025		*	

* Worsened exceedances occur only in central London where airport impacts are very small

** Worsened exceedances occur in central London and in the vicinity of the airport, but the latter exceedances are marginal

a These scenarios are analysed for 2025 but, in 2030, would impact on compliance status of a zone or introduce new non-compliances by increasing the maximum predicted concentration within a zone

SUMMARY OF FINDINGS

- 1.1.27 Table 1-2 shows a comparison of the AC's EU limit value compliance assessment and the conclusions of this study.
- 1.1.28 The Government's 2015 Air Quality Plan reduces the risks of non-compliance with the EU limit value for annual mean NO₂ with airport expansion. This is a direct consequence of the reduction in nitrogen dioxide concentrations brought about in part by updated assumptions in the PCM model but also by the measures in the Plan.
- 1.1.29 With the Government's 2015 Air Quality Plan and the opening of expanded capacity after or between 2025 and 2030, the following options are predicted to have **no impact on the UK's compliance with limit values**:
- Gatwick Second Runway, and
 - Heathrow Northwest Runway.
- The Heathrow Extended Northern Runway option, as considered by the AC commission, remains **at risk of impacting the UK's compliance with limit values**. As noted earlier, subsequent to the AC's work and modelling, further iterations of surface access plans have been proposed by the promoter of the Heathrow Extended Northern Runway scheme. Most elements of their plans have remained unchanged, but there have been some changes to road layout. Although these iterations have not been considered in this study, it is acknowledged that they were developed with one aim being to reduce air quality impacts associated with the proposal considered by the AC.

DISCUSSION

- 1.1.30 The sensitivity testing showed that the Gatwick Second Runway does not cause or worsen exceedances of EU limit values in any of the scenarios considered, with the exception of Scenario 3C in which a marginal exceedance of the limit value is recorded on the A23. This demonstrates that the conclusion that the option will not affect compliance with EU limit values is robust and largely independent of the option opening date and/or uncertainties relating to future vehicle emissions. Given the marginal exceedance of the limit value predicted in Scenario 3C, it is likely that local mitigation measures could remove the risk of exceedance.
- 1.1.31 For Heathrow Northwest Runway the analysis showed that in 2030 or 2025, with the 2015 Air Quality Plan measures, the operation of the option neither causes nor worsens exceedances of EU limit values. The sensitivity testing demonstrated that this conclusion is robust in relation to the overall zone compliance since none of the scenarios tested resulted in either new non-compliance or delayed compliance for the Greater London Urban Area. There is a risk that the option results in worsened exceedances of limit values alongside some roads within London, but this would not affect the zone compliance since the maximum concentration within the zone is unaffected.
- 1.1.32 The Heathrow Extended Northern Runway option has a high risk of causing a new exceedance of the EU limit values in Greater London, particularly for scenarios with the 2015 Plan measures in place. In scenarios with the 2015 Plan measures, the impact of the extended Northern Runway on Bath Road results in new exceedances of the limit value. As more conservative assumptions are made in relation to the option opening date and vehicle emissions, e.g. Scenario 3A to 3C, total pollutant concentrations across all roads increase but this increase is greatest in central London. In these circumstances, the zone compliance is not worsened with the option (since roads unaffected by the airport determine the compliance date), but the length of road exceeding the limit value within the agglomeration increases. However, as noted earlier, subsequent to the AC's work and modelling, further iterations of surface access plans have been proposed by the

promoter of the Heathrow Extended Northern Runway scheme. Most elements of their plans have remained unchanged, but there have been some changes to road layout. Although these iterations have not been considered in this study, it is acknowledged that they were developed with one aim being to reduce air quality impacts associated with the proposal considered by the AC.

Table 1-2 Summary of AC Report Conclusions on limit value compliance and the updated conclusions based on the 2015 Air Quality Plan and new projections of concentrations

Scheme	AC Report Conclusions	Conclusions based on UK Government's New Compliance Assessment and 2015 Air Quality Plan	Commentary on Conclusions
Gatwick Second Runway	No impact on zone compliance in 2030 noted; although formal compliance assessment not undertaken	With 2015 plan measures no impact on compliance with any limit values	The conclusion has <i>low vulnerability</i> to uncertainties, since only in the most pessimistic emissions scenario does the option risk triggering non-compliance within the South East Zone
Heathrow Northwest Runway	Without option specific mitigation, there is a risk that the option would delay compliance in Greater London due to impacts on Bath Road. The risk is marginal and likely to be removed with mitigation	With 2015 plan measures no impact on compliance with any limit values	Scheme specific mitigation measures, as identified in the AC's air quality local assessment, can reduce the impacts in the vicinity of the airport. In scenarios without the 2015 Plan measures, the option does not delay compliance within the Greater London Zone but increases the length of roads exceeding the limit. This conclusion is <i>robust</i> since all sensitivity tests show the same conclusion
Heathrow Extended Northern Runway	There is a high risk that the option would delay compliance in Greater London due to impacts on Bath Road. It is unlikely that the risk would be removed with mitigation	There is a high risk that with 2015 plan measures the option would impact compliance with limit values.	Scheme specific mitigation measures, as identified in the AC's air quality local assessment, can reduce the impacts in the vicinity of the airport.

1.1.33

The compliance assessment presented in Table 1-2 makes no reference to the magnitude of the impact of the airport expansion option where an exceedance of the limit value is worsened or created. However, a distinction can be made between impacts in the vicinity of the airports, where the contribution of airport-related sources is relatively high, and impacts at some distance from the airport, where the contribution of the airport option is very small. In the latter case, the impacts will be uncertain, not least due to uncertainties in the forecast of future traffic flows.

- 1.1.34 This effect is of particular note for the two Heathrow options. In some scenarios, worsened exceedances with airport expansion are related primarily to very small airport-related impacts on roads within central London, with no exceedances or marginal exceedances in the vicinity of the airport. Scenarios where this is the case are marked with single or double asterisks in Table 1-1. As set out below, this has implications for the potential mitigation of impacts.
- 1.1.35 For Heathrow NWR and ENR, the proposed mitigation measures are expected to significantly reduce concentrations at the most affected receptors and roads in vicinity of the airport. However, the roads in the vicinity of the airport are not the only ones relevant when determining the impact of the option on compliance. The mitigation measures for aircraft emissions would not have an impact on central London but, arguably, the impact of the measures on road transport may have an impact, albeit substantially reduced from the effects close to Heathrow.

2 PROJECT BACKGROUND

2.1 OVERVIEW

- 2.1.1 The Airports Commission (AC) undertook a Sustainability Appraisal¹⁰ to support its independent examination of shortlisted options to increase aviation capacity in the UK. The AC made a recommendation of a preferred option on 1st July 2015.
- 2.1.2 In December 2015 the government accepted the AC's case for airport expansion in the south-east and the shortlist of options for expansion. They have continued to work on environmental impacts and develop the best possible package of measures to mitigate the impacts on local people and the environment.

EU LIMIT VALUE COMPLIANCE

- 2.1.3 The European Union's Ambient Air Quality Directive 2008 (2008/50/EC) sets health-based limit values for the concentration of pollutants in ambient air, including nitrogen dioxide (NO₂) and particulate matter (PM₁₀). Under the Directive, the UK Government is responsible for ensuring that the air quality across the UK improves over time and meets the limit values set out in the Directive in the shortest possible time.
- 2.1.4 The UK uses a combined monitoring and modelling approach to assess current and future compliance with limit values and to make annual air quality compliance returns to the EU Commission. The collection of models used in the compliance assessment process is known as the Pollution Climate Mapping (PCM) model. The model provides pollution concentration output on a 1x1km grid of 'background' locations covering the whole of the UK, plus roadside concentrations from around 18,000 representative road links on 9,000 roads. The PCM model baseline and future projections are updated on an annual basis. A streamlined version of the model (SL-PCM) is run at additional times, as required, to undertake sensitivity testing of policy options and specific local action plans.
- 2.1.5 Of the pollutants included within the EU Directive, the AC's Appraisal Framework required that the Air Quality Local Assessment¹¹ consider only nitrogen oxides (including NO₂) and particulate matter (as PM₁₀ and PM_{2.5}). However, the focus of the assessment was NO_x and NO₂. This is appropriate because NO_x is the pollutant most affected by emissions from airport related sources and previous studies¹² had demonstrated that airports have little impact on PM₁₀ or PM_{2.5} concentrations. Moreover, NO₂ is the pollutant more at risk of exceeding the EU's limit values.
- 2.1.6 For compliance assessment and reporting purposes, the UK is divided into 43 zones and agglomerations. As part of the latest UK submission on air quality to the European Commission¹³, it was reported that:
- The UK met the limit value for hourly mean NO₂ in all but two zones
 - 30 zones exceeded the limit value (or limit value plus margin of tolerance¹⁴) for annual mean NO₂

¹⁰ <https://www.gov.uk/government/collections/airports-commission-final-report-and-supporting-documents>

¹¹ Module 6: Air Quality Local Assessment, Detailed Emissions Inventory and Dispersion Modelling, prepared by Jacobs for the Airports Commission, May 2015

¹² DfT, 2006, project for the Sustainable Development of Heathrow (PSDH). Final Report

¹³ Defra, Air Pollution in the UK 2014 Compliance Assessment Summary, September 2015

→ The UK met the limit values for PM₁₀ and current (Stage 1) limit value for PM_{2.5}

2.1.7 In 2015 the UK set out an updated Plan for improving the UK's air quality (the 2015 Plan), including new projections for future compliance.

2.1.8 The 2015 Plan identified that non-compliant zones had projected compliance dates between 2020 and 2030 with the air quality improvement measures set out in the existing (2011) air quality plan, or between 2020 and 2025 with the additional measures set out in the 2015 Plan.

2.1.9 Given the focus of the AC's work and the UK Government's air quality plan, this study considers NO₂ only and, in particular, annual mean NO₂¹⁵. The EU limit value for annual mean NO₂ is 40µg/m³.

AC SUSTAINABILITY APPRAISAL AND EU LIMIT VALUE COMPLIANCE

2.1.10 The local air quality assessment undertaken for the AC's Sustainability Appraisal considered the potential impact of each shortlisted option on the UK's compliance with EU limit values.

2.1.11 The PCM model itself is not freely publicly available. As such, the AC's appraisal could not evaluate the impact of the options on EU limit value compliance using the same methodology used by the UK Government for the formal compliance assessments. Rather, a screening method was used that followed the Highways Agency's Interim Advice Note IAN 175/13¹⁶.

2.1.12 The principal steps in the IAN 175/13 methodology, as applied to the AC's work for each option, were:

- Roads included in both the Government's PCM modelling and the AC's study area were identified (affected PCM links)
- For the affected PCM links, future NO₂ concentrations without airport expansion were obtained from the PCM Projections for 2030
- For locations alongside the affected PCM links, the impact of the airport on NO₂ concentrations in 2030 was modelled by AC using the ADMS model
- For all affected PCM links, the modelled airport impact was then added to the PCM projection to give total future NO₂ concentrations with airport expansion
- For each option, the future NO₂ concentrations with airport expansion were compared with the limit value and determine whether the option would result in:
 - A compliant zone becoming non-compliant i.e. maximum concentrations within the zone moving from below the limit value in the PCM Projections to above the limit value with airport expansion; and/or
 - A delay to Defra's projected compliance date for a zone/agglomeration i.e. the option would result in concentrations alongside a PCM model link that would be higher than the existing maximum PCM concentration in the zone.

¹⁴ Where a time extension for zone compliance has been granted by the EU, in the years prior to the revised compliance date, compliance is assessed against the limit value plus a margin of tolerance that decreases to zero by the revised compliance date

¹⁵ In general, the annual mean limit value for NO₂ is more stringent than the hourly mean limit value. That is to say, zones with monitored exceedances of the hourly mean limit value also exceed the annual mean limit value, but only a small fraction of zones exceeding the annual mean limit value exceed the hourly mean limit value.

¹⁶ Risk assessment of compliance with the EU Directive on ambient air quality and production of Scheme Air Quality Action Plans, 2013, Highways Agency

2.1.13 The AC's application of the Highways Agency's compliance risk rating is related to the compliance of a zone or agglomeration as a whole rather than compliance alongside individual links. The IAN itself also considers whether an option increases the length of roads within a zone that exceed the limit value and/or whether an option results in an overall increase in concentration on roads that exceed the limit value.

2.1.14 The conclusions of the AC's appraisal of impacts on EU compliance (for annual mean NO₂) were as follows:

Scheme	Conclusion
Gatwick Second Runway	No impact on zone/agglomeration compliance in 2030 noted; although formal compliance assessment not undertaken
Heathrow Northwest Runway	Without option specific mitigation, there is a risk that the option would delay compliance in Greater London due to impacts on Bath Road. The risk is marginal and likely to be removed with mitigation
Heathrow Extended Northern Runway	There is a high risk that the option would delay compliance in Greater London due to impacts on Bath Road. It is unlikely that the risk would be removed with mitigation

2.1.15 No risk of exceedance of the hourly mean NO₂, annual mean PM₁₀ or daily mean PM₁₀ limit values was identified. As such, the remainder of this report considers annual mean NO₂ only.

2.2 STUDY OBJECTIVES

2.2.1 The AC's local air quality assessment and compliance assessment was based on PCM projection data issued in 2014 (termed AC Report PCM data in the remainder of this report¹⁷).

2.2.2 In the period following the completion of the AC's Sustainability Appraisal, and during the scoping stage of the DfT's Appraisal of Sustainability, the UK Government issued its 2015 Plan and new PCM projections. Projections were issued assuming 2011 plan measures only (termed New PCM Baseline) and with additional 2015 Plan measures (termed New PCM with Measures).

2.2.3 The overall objective of this study is to review the impact that the revised Air Quality Plan and PCM projections are likely to have on the compliance assessment of the AC's options. In particular the study addresses:

- The change in projected roadside nitrogen dioxide concentrations with the new PCM modelling,
- Whether the new projections indicate that the short-listed options will or will not cause or contribute to exceedances of EU limit values,

¹⁷ Note: This term is used for this report only and is not intended to infer ownership of the data by the AC Commission. It is simply used to distinguish between the latest PCM projections and the data used by the AC during their appraisal process.

- The potential impacts of mitigation on compliance with EU limit values (from either the national Plan or scheme-specific measures identified by the AC),
- Whether the new projections will change the conclusions of the AC's compliance assessment, and
- Uncertainties in the future PCM projections and in the AC's modelling of impacts, including the opening date for the option, the rate of growth and operations at full capacity.

2.2.4 In undertaking the study, the following analyses have been considered:

- Impacts of increased airport capacity on compliance based on the new PCM datasets (With Measures and Baseline) and their direct comparison with the assessment presented by the AC using the AC Report PCM data (later termed Scenario 1 (New PCM data) comparisons)
- Compliance in years prior to 2030 i.e. an opening date for expanded capacity between 2025 and 2030 (Scenario 2 (Opening Year) comparisons)
- Compliance in years prior to 2030 with sensitivity analysis to test vulnerability of assessment to future uncertainty in vehicle emissions standard performance (Scenario 3 (Sensitivity) comparisons)
- Impacts of mitigation on compliance (Scenario 4 (Mitigation) comparisons)

2.3 STUDY AREAS

2.3.1 For each option for increased airport capacity, the AC's air quality local assessment considered three study areas:

- Principal Study Area – selected to focus on sensitive properties and habitats likely to be substantially affected by the Scheme and encompassing a 2km radius around each Scheme boundary
- Wider Study Area – defined for the assessment of potential exceedances of the EU limit values and for potential impacts on ecosystems
- Traffic Model Simulation Area – area included all roads considered within the traffic simulation model

2.3.2 The criteria used to define the Wider Study Area were set out in the AC's report and were all purely traffic based. However, in relation to the assessment of EU limit value compliance, the impacts of the airport options were only considered at receptors alongside roads within the Wider Study Area where the PCM model predicted an exceedance or a risk of exceedance of the limit value in 2030 (defined by AC as a concentration of $>32\mu\text{g}/\text{m}^3$ annual mean NO_2 in the AC Report PCM data).

2.3.3 The study areas used in this assessment follow the AC report definitions and include both the AC Principal and Wider Study Areas for all options.

2.3.4 As such, for Heathrow Northwest Runway and Heathrow Extended Northern Runway, limit value compliance was only considered alongside road links within the PCM model that were identified by the AC report as exceeding or at risk of exceeding the limit value.

2.3.5 For Gatwick Second Runway, the AC report identified only a single link at risk of exceeding the limit value and, moreover, due to uncertainties over future route alignment did not formally assess compliance alongside the link. This report, in attempting to undertake equivalent assessments for all options, considers future compliance alongside this link (which sits within the Principal Study Area) and extends the study area to a zone 2km outside the Principal Study Area to ensure that no PCM links that are potentially affected by the option are excluded from the analysis.

2.3.6 Given the rationale for undertaking the study – updated PCM projections – defining the study areas on the basis of the AC Report PCM data potentially risked missing some links at risk of exceedance in the new projections. However, it was apparent in the analysis that this was not a significant limitation since the number of links at risk of exceedance was reduced in the New PCM Baseline and New PCM With Measures datasets in comparison to the AC Report PCM data. A small number of additional ‘at risk’ links were identified in the PCM Sensitivity dataset but these were generally adjacent to links included in the analysis and their inclusion would not have altered the report’s conclusions.

2.3.7 Subsequent to the AC’s work and modelling on air quality, further iterations of surface access plans have been proposed by the promoter of the Heathrow Extended Northern Runway scheme. Most elements of their plans have remained unchanged, but there have been some changes to road layout. Although these iterations have not been considered in this study, it is acknowledged that they were developed with one aim being to reduce air quality impacts associated with the proposal considered by the AC.

2.4 UNCERTAINTIES IN AIRPORT ACTIVITY LEVELS

2.4.1 The AC’s local air quality assessments of the airport expansion options were based on projections of future activity levels taken from demand forecasts that maximised growth in passenger numbers. That is to say, the projections were based on the AC’s demand models that resulted in the greatest likely air quality impacts consistent with the Promoters’ preferred business models, namely:

- Carbon Traded Low Cost is King for Gatwick Second Runway and
- Carbon Traded Global Growth for Heathrow NWR and ENR.

2.4.2 Forecasts of future activity levels will always be subject to a degree of uncertainty. In the case of the AC’s assessment and, by implication this assessment, this uncertainty begins with the uncertainty in the projections of future economic conditions, road traffic volumes, including any effects of induced and suppressed demand, modal shift and aircraft movements. Undertaking assessments based on the optimum business models should ensure that the resulting air quality impact assessments are representative of maximum likely impacts.

2.4.3 Within the air quality assessment itself, these uncertainties in the basic activity data are then compounded by uncertainties associated with the future fleet mix for surface access and aircraft types, and the emissions per vehicle / aircraft and background pollutant concentrations. These uncertainties are taken into account in this study through appropriately selected sensitivity studies.

2.4.4 It should also be reiterated that subsequent to the AC’s work and modelling on air quality, further iterations of surface access plans have been proposed by the promoter of the Heathrow Extended Northern Runway scheme. Most elements of their plans have remained unchanged, but there have been some changes to road layout. Although these iterations have not been considered in this study, it is acknowledged that they were developed with one aim being to reduce air quality impacts associated with the proposal considered by the AC.

2.5 LIMITATIONS AND CONSTRAINTS

2.5.1 The main constraint on the study is that it has been based on data that has been published (whether in summary, graphical or tabular format) from:

- AC’s local air quality assessment
- UK Government’s compliance assessment reporting, PCM projections and National Air Quality Plan, and

→ Defra's sensitivity analyses on the PCM projections

No new or study-specific modelling was undertaken. It is solely a re-analysis and re-interpretation of existing data. Moreover, the spatial coverage of the various datasets was not uniform.

- 2.5.2 As such, the assessment has not taken into account the multitude of non-linearities and inter-dependencies that are inherent in detailed modelling studies of the impacts of development options on air quality. For the purposes of this study, it is neither practical nor indeed necessary, to undertake such modelling.
- 2.5.3 Given the scale of the development, the selected option will require an Environmental Impact Assessment during application for a Development Consent Order (DCO). Detailed modelling of impacts will be undertaken by the scheme promoter at this time and the Secretary of State would have regard to the outcome of the modelling in deciding whether to grant the DCO.
- 2.5.4 Further details of these constraints and their implications are provided in the following sections.

3 POLLUTION CLIMATE MAPPING

3.1 INTRODUCTION

3.1.1 For this study, the following PCM model datasets for NO₂ were considered

- **AC PCM Report** – Original PCM data, generated from a 2013 base year, as issued in 2014
 - Data provided by Defra for a subset of links within 3 zones/agglomerations¹⁸ within the South-East of England, for 2015 and 2030. These data were provided to the AC for their Sustainability Appraisal
- **New PCM Baseline** – Updated PCM data, generated from a 2013 base year, issued in 2015, including updated vehicle emissions estimates and the measures identified in the UK's 2011 Air Quality Plan
 - Data provided by Defra for all links within 2 zones/agglomerations, for 2020, 2025 and 2030
- **New PCM With Measures** – Revision to the updated PCM data, taking into account the additional measures identified in the UK's 2015 Plan, issued in 2015
 - Data provided by Defra for all links within 2 zones/agglomerations, for 2020, 2025 and 2030
- **PCM Sensitivity** – Sensitivity testing of the updated PCM projections¹⁹, in which emissions from new (Euro 6) diesel cars have been increased to a conformity factor of 5²⁰
 - Data provided by Defra for all links within 2 zones/agglomerations, for 2020

3.1.2 The AC PCM Report and New PCM Baseline data were generated using the full PCM suite of models. Given the complexity of the full model and the extensive run time, the New PCM With Measures and Sensitivity datasets were, in part, generated using a rationalised version of the model, Streamlined PCM. The Streamlined PCM model does not fully incorporate the complexities of atmospheric science but, in particular, it is useful for use as a screening tool for the impacts of local mitigation measures on road transport sources and for undertaking sensitivity testing²¹.

3.1.3 COPERT emission factors are the recommended method for calculating emissions inventories in the EMEP (European Monitoring and Evaluation Programme) guidebook, and they are regularly updated as new evidence on vehicle emissions emerges.

¹⁸ Primarily from Greater London Urban Area and South East Zone, but a small number of links were also included from Eastern Zone

¹⁹ It should be noted that Defra's sensitivity test of the PCM model was based on the PCM modelling undertaken for the 2015 consultation exercise (<https://consult.defra.gov.uk/airquality/draft-aq-plans>). The baseline modelling was subsequently updated for the final 2015 submission to the European Commission (the New PCM Baseline and New PCM With Measures datasets, <https://www.gov.uk/government/collections/air-quality-plan-for-nitrogen-dioxide-no2-in-uk-2015>). As such, it is not possible to conclude with any certainty that changes between the New PCM Baseline and PCM Sensitivity tests are wholly related to the increase in conformity factor

²⁰ The conformity factor is a measure of the comparison of emissions from emissions factors with the standard for that vehicle class.

²¹ Details on the Streamlined PCM are available from: [http://uk-air.defra.gov.uk/assets/documents/reports/cat09/1511260938_AQ0959_Streamlined_PCM_Technical_Report_\(Nov_2015\).pdf](http://uk-air.defra.gov.uk/assets/documents/reports/cat09/1511260938_AQ0959_Streamlined_PCM_Technical_Report_(Nov_2015).pdf)

- 3.1.4 In the past, vehicle performance and emissions in the real world have not corresponded with those measured in European test cycles and NO_x emissions from diesel cars have been significantly higher than the European standards would suggest. The COPERT emissions factors include conformity factors to account for this observation.
- 3.1.5 Vehicle emissions estimates in the original 2013 PCM data, a subset of which was supplied to the AC (i.e. the AC PCM Report data), were calculated using vehicle emissions factors from COPERT 4v10 (issued in November 2012).
- 3.1.6 Updated emissions data were subsequently issued, COPERT 4v11 (released in September 2014) and have been used in all successive modelling. In particular, COPERT 4v11.0 included updated emission factors for Euro 5/V and Euro 6/VI for cars, LGVs, HGVs and buses/coaches, as well as emission factors for the second stage of Euro 6 vehicles, referred to as Euro 6c.
- 3.1.7 The emission factors in COPERT for Euro 6c are emissions expected following the introduction of a Real Driving Emissions (RDE) test as part of the test procedure. Assumptions around reduction in emissions from Euro 6c vehicles in comparison to Euro 6a/b vehicles were not fully incorporated in the 2015 PCM modelling. It is possible, therefore, that future emissions from Euro 6c vehicles are overestimated in the PCM modelling, most notably in the Sensitivity test, and that, as a consequence, the future projections of NO₂ concentrations are overestimated.
- 3.1.8 However, uncertainties in emissions estimates for some current and future vehicle types and Euro standards continue to exist. As such, sensitivity testing was undertaken to consider the implications of this uncertainty on future pollutant concentrations for 2020. This modelling was undertaken using the Streamlined PCM and provided indicative estimates on the change in maximum concentrations within zones²².
- 3.1.9 As noted above, the COPERT emissions factors make allowance for the disparity between standards and real world performance of vehicles. That is to say, the use of the COPERT emissions factors results in emissions that are higher than the standard for the vehicle type. In the sensitivity testing undertaken by Defra (PCM Sensitivity dataset), the conformity factor implicit in the COPERT data for Euro 6 diesel passenger cars was increased to 5 i.e. emissions from Euro 6 vehicles were increased by a factor of just under 2²³. The use of a conformity factor of 5 in the sensitivity test should not be taken to be representative of likely future conformity factors. Rather, the Streamlined PCM model run was designed as a tool for screening purposes only.

3.2 LATEST COMPLIANCE ASSESSMENT

- 3.2.1 Given the locations of the AC options, the relevant zones for consideration in the local air quality assessment were identified as:
- Greater London Urban Area Agglomeration
 - South-East Zone
- 3.2.2 The current (2015) compliance information for these zones is provided in Table 3-1 for annual mean NO₂, together with the assessment for the base year (2013). In 2020, the South East Zone is projected to be compliant with the limit value without the need for additional measures.

²² Available from https://www.gov.uk/government/uploads/system/uploads/attachment_data/file/492901/aq-plan-2015-technical-report.pdf

²³ The conformity factor is the ratio between actual vehicle emissions and the emissions standard for that vehicle. It is, therefore, speed dependent. Defra defines the conformity factor on the ratio at 33.6kph (this is the average speed of the test cycle). In COPERT, the conformity factor for Euro 6 vehicles is 2.8. In the sensitivity testing, this factor was increased to 5.

3.2.3

Whilst projections for 2016 are not available, the above data indicate that, at present, the South East Zone is likely to be close to fully compliant with the limit value whereas a significant extent of the road network within the Greater London Agglomeration will continue to exceed the limit value.

Table 3-1 Annual mean NO₂ compliance information for Greater London Agglomeration and South East Zone using the new PCM projections

ZONE	2013 ASSESSMENT (BASE YEAR)			NEW PCM BASELINE PROJECTIONS FOR 2020		COMPLIANCE ASSESSMENT	
	Maximum annual mean limit value exceedance	Km of road exceeding limit value	Maximum annual mean ($\mu\text{g}/\text{m}^3$)	Km of road exceeding limit value	Maximum annual mean ($\mu\text{g}/\text{m}^3$)	Compliance with NO ₂ limit values (New PCM Baseline), with just 2011 plan	Compliance estimate based on 2015 Plan (New PCM With Measures)
Greater London Urban Area	Y	1078.5	126	240.3	71	2030	2025
South East Zone	Y	107.4	59	0.0	37	2020	2020
<i>Data based on Defra, 2015, Improving Air Quality in the UK</i> <i>Note: PCM modelling is carried out in 5 year intervals; the compliance year for a zone is described as the first 5 year interval when modelled concentrations have reached 40$\mu\text{g}/\text{m}^3$</i>							

3.3

IMPACT OF THE 2015 UPDATE TO PCM IN THE STUDY AREAS

OVERVIEW

3.3.1

Overall, the new PCM projections show marked reductions in concentration in comparison to the original AC Report PCM data. With the available data, a direct comparison can only be made for 2030, and for a limited length of the network (~74% of the network²⁴), but this is sufficient to determine the trend between the AC Report PCM data and the new data (Table 3-2).

3.3.2

Overall, the new PCM projected concentrations are lower than those in the AC Report PCM data, both in the Baseline and the With Measures datasets. In the Greater London Urban Area, the New PCM Baseline concentrations are on average 8% lower than the AC Report PCM data, and the maximum concentration in the agglomeration in 2030 is 40.5 $\mu\text{g}/\text{m}^3$ in comparison to 48.6 $\mu\text{g}/\text{m}^3$ (as reported by the AC). The additional measures of the 2015 Plan reduce this maximum concentration to 37.3 $\mu\text{g}/\text{m}^3$, bringing the zone into full compliance with the limit value.

²⁴ The limit on the network length is determined by the data coverage of the PCM outputs supplied to the AC for their assessment.

Table 3-2 Comparison of the AC Report PCM Data and the New PCM Data for 2030

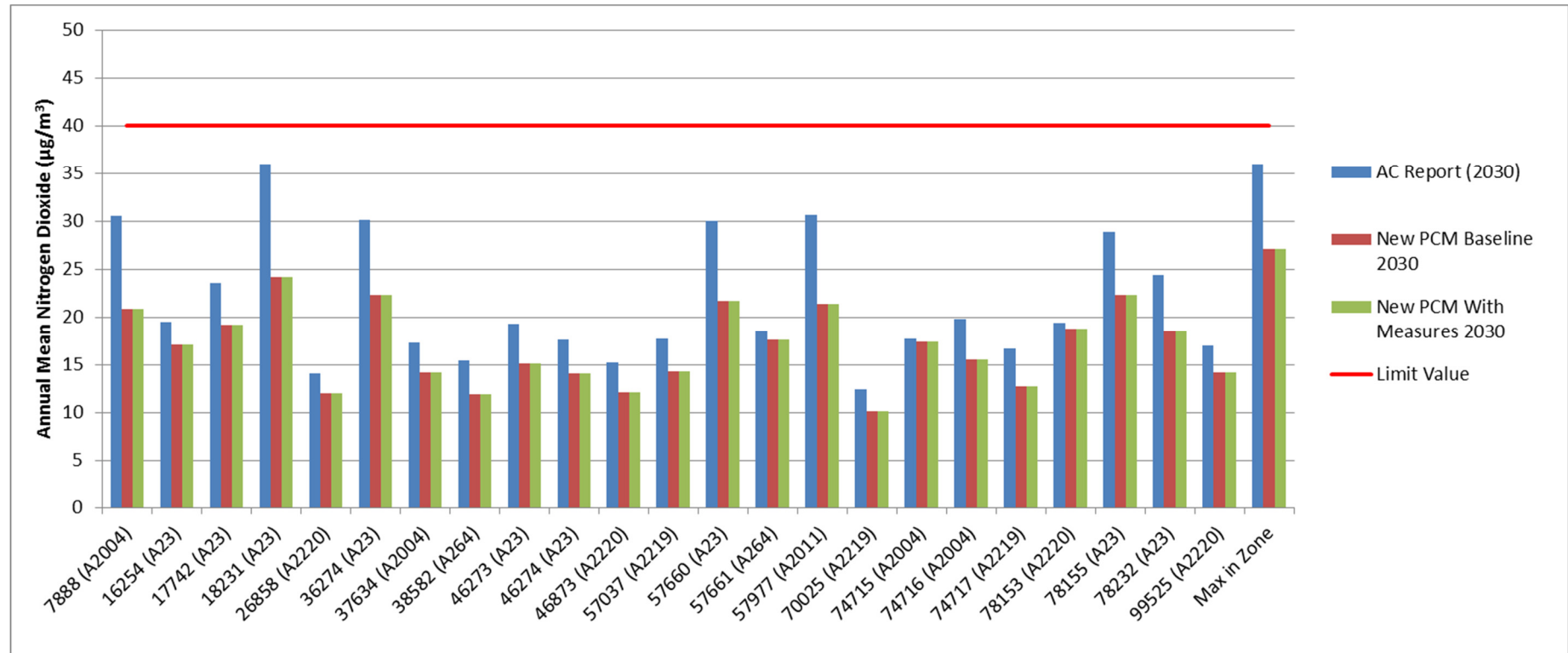
ZONE	AC REPORT DATA		NEW PCM BASELINE			NEW PCM WITH MEASURES		
	Km of road exceeding limit	Maximum annual mean	Km of road exceeding limit	Maximum annual mean	Mean Reduction wrt AC Report	Km of road exceeding limit	Maximum annual mean	Mean Reduction wrt AC Report
Greater London Urban Area	27	48.6	1	40.5	8%	0	37.3	11%
South East Zone	0	35.9	0	24.2	14%	0	24.2	14%

- 3.3.3 The New PCM Baseline projected concentrations for the South East Zone are around 14% lower than the AC Report PCM data. The Zone is projected to be compliant with the limit values (by some considerable margin) in the New PCM Baseline. The additional measures set out in the 2015 Plan were aimed at bringing non-compliant zones in compliance in the quickest possible time and no specific measures were targeted at the South East Zone. Consequently, the new PCM Baseline and With Measures datasets are identical.

GATWICK SECOND RUNWAY

- 3.3.4 Graph 3-1 shows the projected concentrations for 2030 in the AC Report PCM data together with the New PCM Baseline and With Measures data for PCM links within the Gatwick Second Runway study area.
- 3.3.5 In comparison to the AC Report PCM data, the new PCM datasets show substantial reductions on all links within the study area. In the AC Report PCM dataset, the maximum concentration in the South East zone is $35.9\mu\text{g}/\text{m}^3$ on the A23, to the north of the airport and within the Gatwick study area. The maximum concentration within the South East Zone reduces to $27.1\mu\text{g}/\text{m}^3$ in the New PCM Baseline and With Measures datasets, but this link is on the A4 in Slough and well outside of the Gatwick Second Runway study area. The maximum concentration in the study area remains the A23, but the concentration in the new datasets (both Baseline and With Measures) is $24.2\mu\text{g}/\text{m}^3$, well below the limit value.
- 3.3.6 As noted previously, there are no specific national measures in the 2015 Plan measures targeted at the South East Zone because projections indicate it will be compliant by 2020, however local measures are set out in an appendix to the 2015 Plan.

Graph 3-1 Impact of revision to PCM data within Gatwick Second Runway study area for 2030



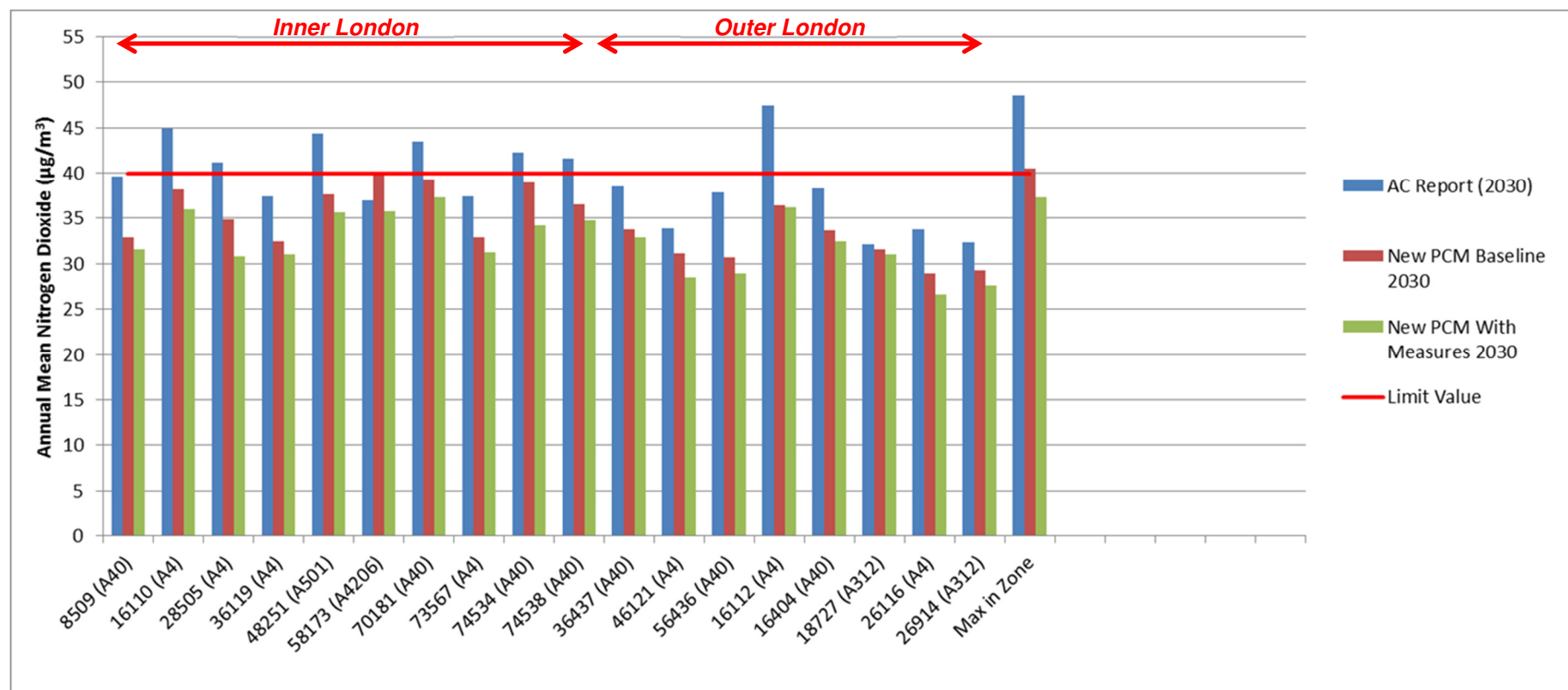
HEATHROW NORTHWEST RUNWAY

- 3.3.7 Graph 3-2 shows the concentrations in 2030 in the AC Report PCM data together with the New PCM Baseline and With Measures data for the links considered by the AC in the Heathrow NWR study area.
- 3.3.8 In the AC Report PCM dataset, the maximum concentration in the Greater London Urban Area is $48.6\mu\text{g}/\text{m}^3$ on the A501, Marylebone Road, in central London. Of the links considered in the compliance assessment, the maximum concentration is seen on the A4 (Bath Road) to the north of the airport - $47.4\mu\text{g}/\text{m}^3$, well above the limit value.
- 3.3.9 In comparison to the AC Report PCM data, the New PCM Baseline dataset shows reductions on the majority of links within the study area, including substantial reductions on the A4 (Bath Road) where concentrations decrease to within the limit value ($36.4\mu\text{g}/\text{m}^3$). The maximum concentration on the links considered for the Heathrow NWR compliance assessment, i.e. links within the study area and identified as being at risk of exceedance by the AC, is $40.0\mu\text{g}/\text{m}^3$ on the A4206 (which joins the A501 around 0.5km to the east).
- 3.3.10 Within London the 2015 Plan measures are largely targeted at the non-compliant areas in the centre though they also help reduce concentrations on links within the vicinity of Heathrow (e.g. a $0.2\mu\text{g}/\text{m}^3$ reduction on Bath Road). Concentrations on links towards the centre of London show larger decreases. The maximum concentration in the zone reduces from $40.5\mu\text{g}/\text{m}^3$ (A501) in the New PCM Baseline dataset to $37.3\mu\text{g}/\text{m}^3$ (A40) in the With Measures dataset, the latter being in the study area.

HEATHROW EXTENDED NORTHERN RUNWAY

- 3.3.11 Graph 3-3 shows the concentrations in 2030 in the AC Report PCM data together with the New PCM Baseline and With Measures data for the links considered by the AC in the Heathrow Extended Northern Runway study area.
- 3.3.12 The impact of the revision to the PCM model on the Heathrow ENR links is largely the same as that described for the Heathrow NWR runway, although there are some changes to the links included in the compliance assessment. That is to say, the maximum concentration in the Greater London Urban Area decreases from $48.6\mu\text{g}/\text{m}^3$ in the AC Report PCM dataset to $37.3\mu\text{g}/\text{m}^3$ in the New PCM With Measures dataset. In the study area for Heathrow ENR, the maximum concentration decreases from $47.6\mu\text{g}/\text{m}^3$ in the AC Report PCM data to $37.3\mu\text{g}/\text{m}^3$ in the New PCM With Measures projections.

Graph 3-2 Impact of revision to PCM data within Heathrow Northwest Runway study area for 2030. Links are identified as being in either Inner or Outer London.



Graph 3-3 Impact of revision to PCM data within Heathrow Extended Northern Runway study area for 2030. Links are identified as being in either Inner or Outer London.



3.4 IMPACT OF PCM SENSITIVITY TESTING WITHIN OPTION STUDY AREAS

- 3.4.1 Table 3-3 shows a summary of the compliance assessment for the new PCM datasets in 2020, including the PCM Sensitivity test. In the New PCM Baseline dataset, 258km of the PCM road network in the Greater London area exceeds the limit value. This length decreases to 44km with measures. In the sensitivity testing, 429km of the network is modelled to exceed the limit value and there is a corresponding increase in the maximum modelled NO₂ concentration in the Zone.

Table 3-3 Comparison of the New PCM Baseline, With Measures and Sensitivity datasets for 2020

ZONE	NEW PCM BASELINE	NEW PCM WITH MEASURES	PCM SENSITIVITY ^A
Greater London Urban Area	258	44	429
South East Zone	0	0	8

^A As noted in footnote 19, the sensitivity test data is not directly comparable with the New PCM Baseline and New PCM With Measures datasets since it was based on the consultation PCM model rather than the PCM modelling undertaken for the 2015 Plan.

- 3.4.2 In the South East Zone, there is relatively little difference between the AC Report data for 2030 and the new PCM data for 2020, including the Sensitivity testing. This is due to the focus of the 2015 Plan on non-compliant areas. Over the majority of the Zone, concentrations in the New PCM Baseline and Sensitivity tests for 2020 are higher, but not substantially so, than the AC Report PCM for 2030. Given the improvements predicted in vehicle emissions over time, this is to be expected.
- 3.4.3 Maximum concentrations within the Gatwick study area are well within the limit value in 2020, in both the New PCM Baseline and PCM Sensitivity datasets. Outside of the study area, there are no exceedances of the limit value in both the New PCM With Measures and Baseline datasets. Even with the conservative assumptions employed in the PCM Sensitivity tests, only a highly limited extent of the road network (<10km) exceeds the limit value in 2030.
- 3.4.4 In the Greater London Urban Area, maximum concentrations occur in central London and modelled concentrations in 2020 in both the New PCM Baseline and Sensitivity datasets are markedly higher than the 2030 AC Report PCM data.
- 3.4.5 Both the New PCM Baseline and Sensitivity concentrations show widespread exceedances of the limit value, including on links in the Heathrow NWR and ENR study areas.

3.5 COMMENTARY ON PCM REVISIONS

- 3.5.1 The PCM model is underpinned by an emissions inventory, the National Atmospheric Emissions Inventory (NAEI), generated from the combination of emissions factors and activity data, which is regularly updated as new data become available. For emissions from road transport, as noted previously, the PCM model output provided to the AC Sustainability Appraisal was based on emissions calculated using COPERT 4v10 emissions, whereas the new datasets were based on the subsequent COPERT 4v11.
- 3.5.2 The COPERT 4v10 emissions factors are incorporated into the Emissions Factor Toolkit, EFT v6.0.2, issued by Defra and used by the AC to model traffic emissions. The EFT is also updated

regularly and a new version, incorporating COPERT 4v11, will be released in 2016, but this was not available at the time of the AC's work.

- 3.5.3 The analysis of Carslaw *et al*, 2011²⁵, highlighted that ambient measurements of nitrogen oxides and nitrogen dioxide have not decreased at the rate that would have been expected from the progressive tightening of emissions standards for new vehicles. Their report, and many subsequent studies, identified that the disparity largely related to the on-road performance of diesel vehicles.
- 3.5.4 The COPERT 4v10 emissions factors made allowance for this disparity, and emissions from diesel vehicles were several times higher than the standard e.g. for Euro 6 cars, emissions at 33.6kph (the standard used by Defra) were 3.2 times the Euro standard.
- 3.5.5 The COPERT 4v11 factors include a smaller allowance in emissions for Euro 5/V and Euro 6/VI standard vehicles, with some account made for Euro 6c standards. (The COPERT assumptions around Euro 6c were not, however, incorporated in the new PCM modelling). It is important to note that the COPERT 4v11 factors do not assume that vehicle emissions never exceed the Euro standard. Rather, they simply reduce the conformity factor between emissions factors and on-road emissions included in the 4v10 dataset.
- 3.5.6 Evidence of the likely level of emissions from Euro 6 vehicles under on-road conditions continues to emerge. DfT recently published the results of their on-road emissions testing²⁶ and a summary of other recent testing can be found in a report published by Air Quality Consultants (AQC, 2016)²⁷.
- 3.5.7 These studies remain based on relatively few vehicles and show high variability in the performance of vehicles, both between manufacturers and in terms of performance under differing test conditions (ambient temperature, engine temperature etc). Drawing absolute conclusions on the realism of the various PCM revisions is, therefore, near impossible.
- 3.5.8 There are, however, a number of consistent themes across the various datasets that provide important information. The main conclusion that can be drawn from the studies is that Euro 6 vehicles have significantly lower emissions than Euro 5 vehicles. As such it is reasonable to conclude that there will be a decrease in roadside pollutant concentrations over time.
- 3.5.9 The DfT and AQC reports demonstrate that the majority, but not all, of Euro 6 diesel vehicles exceeded the standard under on-road conditions. This exceedance of the standards is covered to some degree by the conformity factor allowance in COPERT 4v11 (2.8 for Euro 6 vehicles), but the tests also serve to demonstrate that it is possible to meet the new limits with current abatement technology.
- 3.5.10 The RDE legislation will introduce a much more stringent test procedure for vehicle emissions. It will complement the existing laboratory test and will serve to ensure that emissions measured in the laboratory test are confirmed in real driving conditions. This will involve vehicles being driven outside and on a real road according to random acceleration and deceleration patterns with pollutant emissions measured at the tail pipe using portable emission measuring systems.

²⁵ Carslaw, D., Beevers, S., Westmoreland, E. and Williams, M. (2011) Trends in NO_x and NO₂ emissions and ambient measurements in the UK, 2011.

²⁶ <https://www.gov.uk/government/publications/vehicle-emissions-testing-programme-conclusions>

²⁷ Air Quality Consultants, Emissions of Nitrogen Oxides from Modern Diesel Vehicles, January 2016

- 3.5.11 The average conformity factor in the datasets analysed by AQC (2016) was 3.9. Whilst the data were collected under various conditions, this suggests that the Sensitivity tests with the conformity factor of 5 may over-estimate future pollutant concentrations.
- 3.5.12 Moreover, the current RDE legislation requires real driving emissions to be capped at 2.1 times the standard by 2017 and 1.5 times the standard by 2020 (to account for measurement uncertainty). Since the PCM modelling did not take into account RDE, the Sensitivity tests are potentially overly conservative.
- 3.5.13 It is therefore concluded that the Sensitivity test data should be viewed cautiously. The projections should not be interpreted as a likely future scenario but rather, exactly as the test was designed, as a pessimistic projection at the upper limit of possible outcomes. It should be balanced against an optimistic scenario (which has not been explicitly considered in this study) in which the introduction of RDE results in a conformity factor of less than 1.5 and pollutant concentrations are lower than predicted in the New PCM With Measures projections.

4 METHODOLOGY

4.1 OVERVIEW

- 4.1.1 The scope of the assessment was to re-analyse existing datasets to assess the implications of the UK Government's new Air Quality Plan on the conclusions of the AC's work. Specifically, the scope stated that no new modelling was to be undertaken.
- 4.1.2 Therefore, the study has been based on data published in summary, graphical or tabular form in:
- AC's air quality local assessment⁶, and
 - UK Government's 2015 Air Quality Plan and supporting technical reports⁷
- 4.1.3 The UK uses the PCM model, in combination with monitoring, to assess and report on compliance for submission to the EU. No other models are used for this purpose. Therefore, this assessment of the impact of airport expansion on compliance had to take account of PCM model projections. However, since the PCM model itself is not freely publicly available, it was not possible to directly include the options for airport expansion within the PCM projections.
- 4.1.4 Detailed information on the input data required for re-modelling of impacts in any scenario other than that considered by the AC, e.g. opening in years prior to 2025, is not available. Therefore, direct re-modelling of airport expansion impacts with the ADMS-model was also not possible within the required timeframe.
- 4.1.5 As such, the methodology selected for the study followed the guidance set out in the Design Manual for Roads and Bridges⁸. The method is a screening approach to the assessment of future compliance with EU limit values, applicable to situations where the impacts of a scheme or development have only been modelled outside of the PCM model itself.
- 4.1.6 In summary, the method treats the Government's new PCM projections for roadside concentrations as the future baseline without airport expansion. The impacts of the options for airport expansion, as modelled by the AC, are then added to this future baseline to estimate total concentrations with increased capacity.
- 4.1.7 The study therefore combines projections and modelling of future air quality from two different sources/models: the Government's projections are based on the PCM model; the AC's modelling is based on the ADMS-Airports model²⁸. This approach introduces uncertainty into the assessment but, as set out above, is the only practicable method for the study. It is the same method that was used by the AC in their sustainability assessment.
- 4.1.8 In the following descriptions, the term 'projections' is applied to outputs from the PCM model and the term 'modelled impact' or 'Airport NO₂ impact' is applied to outputs from the AC's modelling using ADMS-Airports.

4.2 SCENARIOS

- 4.2.1 The risks of non-compliance with EU air quality limit values have been assessed under the following scenarios. The scenarios allow for the new PCM projections, the possibility of airport

²⁸ www.cerc.co.uk

expansion schemes opening prior to 2030 and the sensitivity to the disparity between the performance of some diesel vehicles under real world driving conditions and emissions standards.

- Scenario 1: New PCM Projections and 2015 Plan (2030)
 - 1A New PCM₂₀₃₀ With Measures + AC₂₀₃₀ Impact
 - 1B New PCM₂₀₃₀ Baseline + AC₂₀₃₀ Impact
- Scenario 2: Opening Year Assessment (2025)
 - 2A New PCM₂₀₂₅ With Measures + AC₂₀₃₀ Impact
 - 2B New PCM₂₀₂₅ Baseline + AC₂₀₃₀ Impact
 - 2C New PCM₂₀₂₅ Baseline + AC₂₀₃₀ (ADJ TO 2025) Impact
- Scenario 3: Sensitivity Testing (2025)
 - 3A PCM₂₀₂₀ (Adjusted to 2025) Sensitivity + AC₂₀₃₀ Impact
 - 3B PCM₂₀₂₀ (Adjusted to 2025) Sensitivity+ AC₂₀₃₀ (ADJ TO 2025) Impact
 - 3C PCM₂₀₂₀ (Adjusted to 2025) Sensitivity+ AC₂₀₃₀ (ADJ TO 2025+ EMISSIONS ADJ) Impact
- Scenario 4: Impact Mitigation
 - 4A New PCM₂₀₃₀ With Measures + AC₂₀₃₀ (MITIGATED LOW) Impact
 - 4B New PCM₂₀₃₀ With Measures + AC₂₀₃₀ (MITIGATED HIGH) Impact
 - 4C New PCM₂₀₂₅ Baseline + AC₂₀₃₀ (ADJ TO 2025, MIT LOW) Impact
 - 4D New PCM₂₀₂₅ Baseline + AC₂₀₃₀ (ADJ TO 2025, MIT HIGH) Impact
 - 4E PCM₂₀₂₀ (Adjusted to 2025) Sensitivity+ AC₂₀₃₀ (ADJ TO 2025+ EMISSIONS ADJ, MIT LOW) Impact
 - 4F PCM₂₀₂₀ (Adjusted to 2025) Sensitivity)+ AC₂₀₃₀ (ADJ TO 2025+ EMISSIONS ADJ, MIT HIGH) Impact

where

PCM_{XXXX} refers to a PCM projection to the year XXXX (2030 or 2025)

PCM_{XXXX} (Adjusted to YYYY) refers to PCM data that has been adjusted to another year, YYYY

AC_{XXXX} refers to the modelled impact from the Airport-related sources in the year XXXX

AC_{XXXX} (ADJ TO YYYY, EMISSIONS ADJ, MIT ZZZ) refers to the adjustments to the airport contribution to pollution levels, adjusted to the year YYYY, adjusted for emissions data testing (increase conformity factor) and with or without mitigation, MIT_{ZZZ} where zzz is HIGH or LOW and High = Upper limit of likely mitigation impacts; Low = Lower range of likely mitigation impacts.

- 4.2.2 These scenarios are summarised in Table 4-1 overleaf. The rationale for the scenarios is explained in the following sections.
- 4.2.3 Scenario 1A is the core projection of zone compliance and air impact used in the assessment.
- 4.2.4 In terms of total predicted pollutant concentrations, as you move from Scenario 1 through to Scenario 3, the assumptions employed become increasingly conservative, i.e. leading to higher pollutant concentrations. As outlined in the previous chapter, Scenario 3 is possibly overly conservative.
- 4.2.5 Scenario 1A is based on the new PCM projections for 2030, taking into account the measures in the 2015 Plan. Scenario 1B is based on new PCM projections for 2030, but without taking into account the 2015 Plan measures and, therefore, considers a higher future baseline concentration than Scenario 1A.

Table 4-1 Dataset combinations used to undertake the assessment

ScenarioYear		PCM Projection				Option Impact			
		With Measures (2025 & 2030)	Baseline (2025 & 2030)	Sensitivity (2020)	Sensitivity (Year Adj.) (2025)	AC (2030)	AC (Year Adjusted, (2025)	AC (Year and Emiss. Adj), (2025)	AC (Mitigated)
Scenario 1									
1A	2030	✓				✓			
1B	2030		✓			✓			
Scenario 2									
2A	2025	✓				✓			
2B	2025		✓			✓			
2C	2025		✓				✓		
Scenario 3									
3A	2025				✓	✓			
3B	2025				✓		✓		
3C	2025				✓			✓	
Scenario 4									
4A	2030	✓							✓ (L)
4B	2030	✓							✓ (H)
4C	2025	✓							✓ (L)
4D	2025	✓							✓ (H)
4E	2025				✓				✓ (L)
4F	2025				✓				✓ (H)

4.2.6

Scenario 2 relates to airport expansion prior to 2030. Since pollutant concentrations and emissions per vehicle are generally expected to fall over time, Scenario 2 considers higher future baseline concentrations than Scenario 1A. A realistic opening year for increased airport capacity is sometime between 2025 and 2030. Assessment of impacts in 2025 is, therefore, at the limit of what could be achieved in practice. Scenarios 2A and 2B consider variations in the PCM projections only; Scenario 2C accounts for the likely trend in vehicle emissions over time (decreasing) or rather accounts for the modelled impacts from airport related traffic being larger in 2025 than in 2030.

4.2.7

Scenario 3 relates to potential future disparity between vehicle emissions standards and emissions under real world driving conditions. With opening of the airport assumed for 2025, Scenario 3 considers both higher future baseline concentrations and significantly higher vehicle emissions than Scenario 1A. All Scenario 3 assessments consider the same PCM projection. The difference between assessments lies in adjustments to the modelled impact of the airport. Scenario 3A uses the AC's modelled impact for 2030; Scenario 3B takes account of trends over time to increase the AC's modelled impact for an opening year of 2025 (as in Scenario 2C);

Scenario 3C takes account of both trends over time and the disparity between vehicle emissions standards and real driving emissions to further increase the AC's modelled impact.

- 4.2.8 Scenario 4 considers scenarios in which the impact of the airport is mitigated using scheme specific mitigation, with the level of mitigation being assessed either at the upper (High) or lower (Low) end of the mitigation considered by the AC.

4.3 SPECIFIC METHODS

FUTURE CONCENTRATION WITH OPTION

- 4.3.1 For this assessment, as for the AC's Sustainability Appraisal, the future concentration of NO₂ alongside any link included within the PCM model is calculated as:

$$\begin{aligned}
 \textbf{Total NO}_2 \textbf{ Concentration} \\
 &= \textbf{Future Baseline NO}_2 \textbf{ Concentration} + \textbf{Airport NO}_2 \textbf{ Impact} \\
 &= \textbf{PCM Link NO}_2 \textbf{ Projection} + \textbf{AC Airport NO}_2 \textbf{ Impact}
 \end{aligned}$$

where the PCM Link Projection is taken from the relevant PCM model dataset, and the Airport Impact is the impact of the option as modelled by the AC. In some cases, the Airport Impact is taken directly from the AC Sustainability Appraisal, in other scenarios it is adjusted as described in the following sections.

- 4.3.2 It is a limitation of the available datasets (and the Design Manual for Roads and Bridges (DMRB) methodology for undertaking the compliance risk assessment¹⁶) that this calculation must be performed using NO₂ concentrations only. Non-linearities associated with, for example, NO_x to NO₂ conversion or traffic route reassignment/speed changes with airport growth, add a level of uncertainty. This applies to both this assessment and the AC's compliance assessment.
- 4.3.3 The AC's assessment of impacts from airport expansion uses outputs from the PCM model in two ways:
- Method 1: The roadside projections for NO₂ concentrations are used directly in the compliance assessment calculations (as in the equation above)
 - Method 2: The background projections for NO_x concentrations are used in the calculation of the airport impacts on NO₂ through their inclusion in the method for calculating the proportion of NO_x in the form of NO₂
- 4.3.4 This assessment considers Method 1 only and therefore neglects any impacts associated with Method 2. This is due to a limitation of the available data. Namely, that the impact of the airport was made available to the study as a change in NO₂ concentrations only. To account for the impact of the new PCM projections on the modelled change in NO₂ concentration, the airport impact on NO_x would also have been required.
- 4.3.5 In general, as the concentration of total NO_x increases, the overall proportion of the NO_x that is present in the form of NO₂ decreases. With the new PCM projections giving generally lower pollutant concentrations than the original PCM projections used by the AC, it is possible that the

impact of the airport sources is underestimated slightly in this study²⁹. However, within the overall uncertainties in the assessment, this second order effect is unlikely to be significant.

ADJUSTMENT FOR SCHEME OPENING PRIOR TO 2030

- 4.3.6 The AC air quality assessment considered impacts in the year 2030 only. This was determined by the availability of surface access data rather than a fixed airport opening date. The opening date for any expanded airport option is likely to be between 2025 and 2030. As such, as part of the study scope, the theoretical scenario of accelerated development of the airport has been considered. With the PCM modelling including projections at 5 year intervals, the accelerated development scenario was based on New PCM data for 2025.
- 4.3.7 This study considers the potential impact of the options if a similar level of airport activity to that modelled by AC for 2030 occurs in 2025.
- 4.3.8 To estimate the effects of early development, it has been assumed that the main effect on the impact of the airport relates to the changing fleet composition for road vehicles and corresponding vehicle emission standards³⁰ i.e. the proportion of Euro 5 vehicles in the fleet will be higher in 2025 than 2030. To adjust the AC modelled impact for 2030 to the assumed opening year, the impact was multiplied by 2030 impact by a generic factor derived from the ratio of average NO_x emissions in the current EFT (v6.0.2) in the various years.
- 4.3.9 Sensitivity tests demonstrated that the dominant factor determining the average ratio between emissions in the various years was the fleet composition (%Heavy Duty and Light Duty Vehicles) rather than the vehicle speed. Graph 4-1 shows the vehicle emissions as a function of year and vehicle speed for a typical fleet mix in Outer London of 95% Light Duty Vehicles and 5% Heavy Duty Vehicles (and representative of the impacts of the options). The ratio of 2025 to 2030 emissions varies from 1.24 at 5kph to 1.26 at 30kph, and 1.25 at 55kph – a variation of +/- 2% about the mean of 1.25g/km/s. However, for light duty vehicles alone, the mean ratio is 1.24, whereas the ratio for heavy duty vehicles alone is 1.39.
- 4.3.10 Given the fleet mix on routes within the option study areas, the generic ratio for time adjustment of impacts was calculated using the fleet mix of 5% HDV. As such, the future impact on NO₂ alongside any link in a year other than 2030 is calculated as:

$$\text{Airport NO}_2 \text{ Impact (Adjusted Year)} \\ = \text{Airport NO}_2 \text{ Impact(2030)} \times \text{EYR (Adjusted Year to 2030)}$$

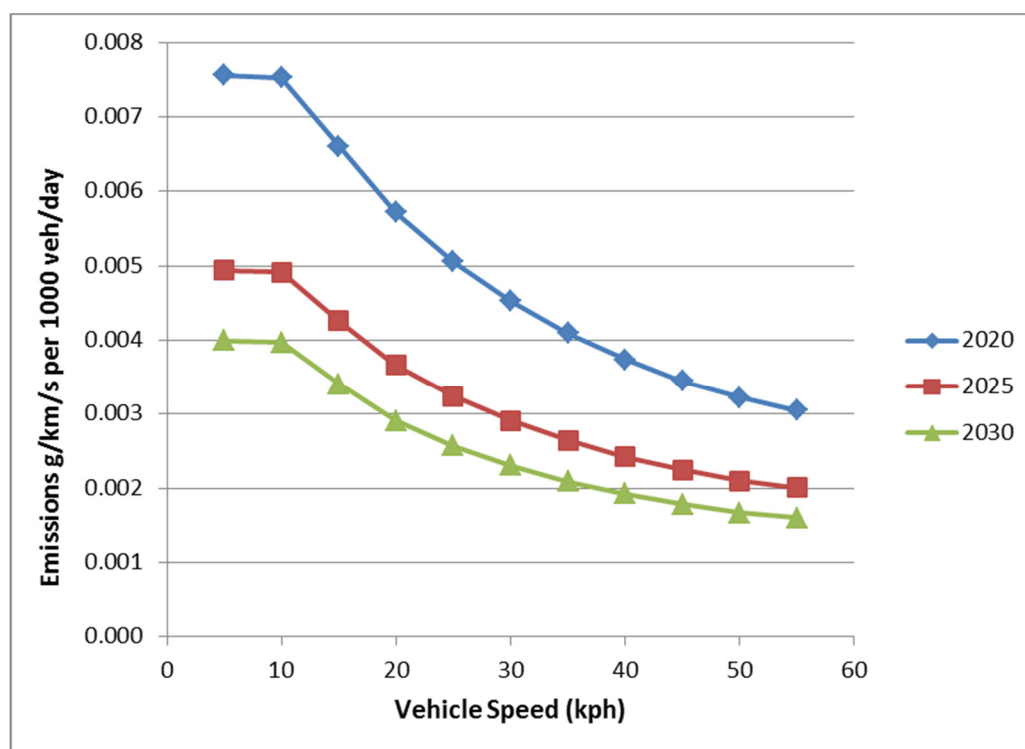
where EYR (Emission Year Ratio) is

→ 1.25 for adjusting from 2030 to 2025

²⁹ Lower PCM projections would mean lower total NO_x concentrations with the airport contribution and, potentially, a higher proportion of the NO_x in the form of NO₂ with the new PCM projections i.e. for each 1µg/m³ of NO_x added by airport sources, a greater proportion of the 1µg/m³ would be converted to NO₂ with the new, lower, PCM projections than with the original, higher, PCM projections.

³⁰ The primary driver for improved emissions over time is the incursion of newer, less polluting, vehicles into the UK fleet mix. In the EFT, some allowance is made for the age of cars and deterioration with age, but its effects on emissions are much less significant than the straight upgrade of the fleet with new vehicles.

Graph 4-1 Nitrogen Oxides emissions from vehicles as a function of speed and year



Data calculated using EFT v6.0.2; Outer London; for 1000 vehicles per day

4.3.11

This adjustment is applied to the proportion of the impact attributable to impacts from surface transport only. No adjustment is applied to emissions from airport activities. The AC's air quality assessment took into account improved emissions from aircraft over time. However, this effect is marginal in comparison to the impact on road emissions; moreover the turnover of the aircraft fleet mix is much slower than for road traffic. For the majority of receptors considered in the compliance risk assessment, the impact of the airport sources is judged to be negligible and the airport contribution to the impact is considered to be zero. However, for a subset of the receptors, including those on Bath Road near Heathrow and on the A23 near Gatwick, the adjustment is significant. For these receptors, the proportion of the NO₂ impact attributable to road sources and airport sources respectively is assumed to be the same as the proportion of the NO_x impact set out by AC for key receptors (or the closest available data point). The future impact calculation then becomes:

$$\text{Airport NO}_2 \text{ Impact (Adjusted Year)} = (\text{Airport NO}_2 \text{ Impact (2030)} \times \text{EYR}) \times \text{Roadside Proportion} + \text{Airport NO}_2 \text{ Impact (2030)} \times (1 - \text{Roadside Proportion})$$

4.3.12

As for the DMRB risk assessment method, it is acknowledged that this approach represents a simplification of the likely reality, but the assessment is constrained by the available data.

4.3.13

Further details are available in Appendix A.

ADJUSTMENT OF AIRPORT IMPACT FOR DISPARITY BETWEEN STANDARDS AND ON-ROAD PERFORMANCE

4.3.14

In undertaking the sensitivity testing of the PCM model, Defra identified new evidence suggesting that the COPERT emissions factors might underestimate emissions from some vehicles (diesel passenger cars in particular). To assess the potential significance of this uncertainty a sensitivity

test was undertaken with a conformity factor of 5 for Euro 6 diesel vehicles. Defra used this sensitivity analysis to assess the potential significance of changes in the performance of these vehicles and therefore this factor should not be misinterpreted as a prediction of the likely outcome of the review of these emission factors. Defra consider this scenario unlikely to materialise for a range of reasons such as that once RDE is introduced (2017) the emissions from this source are expected to fall significantly beneath a conformity factor of 5.

4.3.15 Since the AC report was based on emissions from the COPERT 4v10 (as applied in the EFT v6.0.2) which have an implicit conformity factor of 3.2³¹ for Euro 6 vehicles, it is logical to include a scenario in this study in which the impacts of the airport options are adjusted to the same conformity factor as used by Defra (i.e. CF = 5). This adjustment applies to Euro 6 diesel vehicles only.

4.3.16 The conformity adjustment is undertaken by multiplying the roadside proportion of the airport NO₂ impact by a generic factor derived from the ratio of average total NO_x emissions in the EFT for the default settings and the total emissions with the Euro 6 diesel emissions uplifted to a conformity factor of 5. The factor was calculated for a fleet mix of 5% HDV, driving at 30kph in outer London, as for the year adjustment. A generic factor was used since insufficient information was available to make the calculation link specific.

4.3.17 The future impact on NO₂ is then calculated as:

$$\begin{aligned} &\textbf{Airport NO}_2\textbf{Impact (Adjusted Year, Emission Adjusted)} \\ &= \textbf{Airport NO}_2\textbf{Impact (2030)} \times \textbf{EYR} \times \textbf{CA} \times \textbf{Roadside Proportion} \\ &+ \textbf{Airport NO}_2\textbf{Impact (2030)} \times (1 - \textbf{Roadside Proportion}) \end{aligned}$$

where EYR is the emission year ratio as set out above, and CA is the conformity adjustment factor which equals

→ 1.33 in 2025

4.3.18 This approach is consistent with that recommended in the recent publication by Air Quality Consultants (AQC) (2016)²⁷. The resulting projections are considered by AQC to be conservative since the average conformity factor for Euro 6 vehicles in emissions testing is significantly less than 5.

4.3.19 A factor for 2030 is not provided since it has been assumed that in the longer term, the effects of the improved vehicle testing regime (RDE) will reduce the disparity between the emissions standards and on-road emissions to below the levels implicitly included in the EFT. As such, Sensitivity testing is undertaken for 2025 only.

4.3.20 PCM Sensitivity data was generated by Defra for the year 2020 only. In subsequent years, any uncertainty over emissions is expected to reduce such that, as explained above, by 2030 the COPERT emissions factors are expected to represent emissions from traffic in the real world.

4.3.21 Since Defra did not undertake sensitivity testing for 2025, it was necessary for this study to estimate PCM data for the 2025 sensitivity tests. Several options for undertaking this estimation were considered including:

→ 1) Linear interpolation of *total pollutant concentrations* from PCM Sensitivity data for 2020 to New PCM With Measures for 2030

³¹ Conformity factor defined as the ratio between emission factor and the emission standard at 33.6kph.

- 2) Linear interpolation of *total pollutant concentrations* from PCM Sensitivity data for 2020 to New PCM Baseline for 2030
- 3) Linear interpolation of *the impact of the increase in conformity factor on pollutant concentrations* in 2020 and an assumed impact of zero in 2030, added to the New PCM With Measures for 2025
- 4) Linear interpolation of *the impact of the increase in conformity factor on pollutant concentrations* in 2020 and an assumed impact of zero in 2030, added to the New PCM Baseline for 2025
- 5) Various non-linear rates of decrease between PCM Sensitivity data for 2020 to 2030 projections

- 4.3.22 Whilst there are significant uncertainties associated with all options, Option 1 was eventually selected and the PCM Sensitivity link data for 2025 were estimated by assuming a linear transition over time between the 2020 PCM Sensitivity dataset and the 2030 New PCM With Measures dataset.
- 4.3.23 There were a number of reasons for selecting Option 1, primarily related to providing a conservative estimate of concentrations i.e. tending to over-estimate concentrations. This is appropriate for a sensitivity test.
- 4.3.24 Assuming a linear rather than non-linear decrease in either concentrations or impact is likely to be conservative in 2025. In the New PCM projections, pollutant concentrations fall rapidly between 2020 and 2025, with a somewhat slower decrease between 2025 and 2030. This is evidenced by, for example, New PCM Baseline projections for the A4206 in central London. Concentrations decrease from 66µg/m³ in 2020 to 46µg/m³ in 2025 and to 40µg/m³ in 2030.
- 4.3.25 Assuming a linear decrease in concentrations between 2020 and 2030 is therefore effectively assuming that the effects of reductions in emissions over time are significantly delayed in comparison to the current COPERT forecasts. With RDE expected to be fully operational post-2020, this is a conservative assumption.
- 4.3.26 Option 1 was selected in preference to Option 2, since it was considered appropriate that the sensitivity test data take partial account of the 2015 measures.
- 4.3.27 Linear interpolation of total pollutant concentrations rather than impacts between the PCM Sensitivity and Baseline concentrations was selected for the previously noted conclusion that the PCM Sensitivity test was based on the consultation PCM datasets rather than the final PCM datasets.
- 4.3.28 It should be noted however, that whilst the total pollutant concentration varies considerably with the various options for estimation, the overall conclusions of the sensitivity test are largely unaffected.
- 4.3.29 Further details are available in Appendix A.

COMPLIANCE ASSESSMENT FOR GATWICK AIRPORT

- 4.3.30 The AC Sustainability Appraisal did not formally assess compliance alongside PCM links in the vicinity of Gatwick, citing uncertainty over the future alignment of the A23 approach roads to the airport.
- 4.3.31 This study has attempted to address this shortcoming using the following assumptions:
- Impacts alongside the future, realigned A23 will be equivalent to those modelled by the AC for an indicative alignment

- The impacts predicted in the AC Report for the closest receptors to the indicative A23 to the north and south of the airport can be adjusted (using Defra's calculator) to a distance of 4m from the side of the A23 for compatibility with the PCM

4.3.32 The receptors in the Gatwick assessment selected for adjustment were 2R-L (for the PCM model link 18231) and 2R-H (for the PCM model link 78155). Source apportionment data are available for these receptors in the AC Report and, therefore, the adjustment to 4m from the roadside could be applied to the traffic-related component (albeit by assuming that the proportion of NO₂ in the total airport impact attributable to traffic was the same as the proportion of NO_x in the total NO_x impact).

4.3.33 Table 4-2 shows the estimated impact of the Gatwick 2R option for use in the compliance assessment. The estimated total impact, adjusted to 4m from the roadside (final column in table) was subsequently subject to the adjustments set out above for time and conformity.

Table 4-2 Adjustment of AC Report 2030 NO₂ impact at Gatwick for Compliance Risk Assessment. Concentrations in µg/m³

PCM LINK	RECEPTOR	TOTAL NO ₂ IMPACT	AIRPORT RELATED NO ₂ INCREASE	ROAD TRAFFIC RELATED INCREASE	MODELLED DISTANCE FROM A23	ROAD IMPACT ADJUSTED TO 4M	EST. TOTAL IMPACT
18231	2R-L	6.06	4.29	1.77	50	5.90	10.19
78155	2R-H	7.38	1.22	6.16	8	7.70	8.92

4.3.34 As a result of the requirement for the above estimation of total impact, it is acknowledged that the compliance assessment for Gatwick is subject to greater uncertainty than the assessment for the Heathrow options. The latter was based on the direct output of dispersion modelling, for PCM-specific receptors set at 4m from the roadside.

4.3.35 The impacts at receptors in the Gatwick study area are greater than those in both Heathrow Assessments. This is likely to be due to the proximity of the Gatwick receptors to the airport and to the limited route selection available to traffic accessing the airport.

4.3.36 Further details are available in Appendix B.

4.4 IMPACT ASSESSMENT

4.4.1 The impact is assessed against the following criteria:

- Criteria A: Does the option cause a compliance zone/agglomeration to become non-compliant
- Criteria B: Does the option cause a delay to compliance within a non-compliant zone/agglomeration, or a worsening of the zone compliance assessment
- Criteria C: Does the option cause a worsening of exceedances of the limit value alongside one or more PCM links without delaying compliance of the zone/agglomeration

5

ASSESSMENT FINDINGS

5.1 OVERVIEW

- 5.1.1 This section provides an overview of the compliance assessment for the various options and scenarios on a link by link basis. A summary of the assessment is provided in the next Section.

5.2 SCENARIO SET 1 – NEW PCM PROJECTIONS AND 2015 PLAN

- 5.2.1 Scenarios 1A and 1B consider the addition of the airport impact determined from the AC report to the New PCM With Measures and New PCM Baseline datasets respectively. The AC airport impact is not adjusted in any way.
- 5.2.2 Table 5-1 shows the compliance assessment for the critical link(s) under Scenario 1A and 1B. The assessment is undertaken with respect to the criteria set out in Section 4.4 above, namely:
- Criteria A: Does the option cause a compliance zone/agglomeration to become non-compliant
 - Criteria B: Does the option cause a delay to compliance within a non-compliant zone/agglomeration, or a worsening of the zone compliance assessment
 - Criteria C: Does the option cause a worsening of exceedances of the limit value alongside one or more PCM links without delaying compliance of the zone/agglomeration
- 5.2.3 For Gatwick 2R, the estimated maximum pollutant concentrations on PCM links are less than the limit value for NO₂, whether applied to the New PCM Baseline or With Measures projections for 2030.
- 5.2.4 For both Heathrow options, the projected 2030 concentrations with the New PCM data are lower than the concentrations reported by the AC.
- 5.2.5 For Heathrow, it is important to distinguish impacts in the vicinity of the airport (where the contribution of airport related activity to total pollutant concentrations is largest) from impacts within central London (which are smaller, but where PCM concentrations are generally larger).
- 5.2.6 For Heathrow NWR, with the New PCM With Measures projections (Scenario 1A), pollutant concentrations on all links are projected to be less than the limit value in 2030. The maximum pollutant concentration with this option is predicted on Bath Road (16112), to the north of the airport, where the total NO₂ concentration is 37.5µg/m³.
- 5.2.7 However, if we consider the New 2030 PCM projections with just the 2011 plan measures (i.e. concentrations with the New PCM Baseline modelling), then the critical link for compliance purposes switches to a link on the A4206 towards central London (58173). On this link, New PCM baseline concentrations are at the limit value 40.0µg/m³ and any increase in concentration has the potential to cause an exceedance of the limit value.
- 5.2.8 This link is, however, quite distant from the airport and the impact of the airport is relatively small (0.2µg/m³). Moreover, the pollutant concentration on the link is less than the maximum in the zone as a whole. An impact of 0.2µg/m³ would be considered 'insignificant' under the DMRB assessment criteria, but the formal compliance assessment undertaken by Defra on an annual basis does not make reference to exceedances of the limit value that are insignificant i.e. a concentration of 40.4µg/m³ is an exceedance of the limit value.

5.2.9 Under EU reporting guidance, NO₂ concentrations are reported as whole numbers only (as the limit value is set at 40µg/m³), with standard mathematical rounding of data applied³². Therefore, a theoretical initial concentration of 40.4µg/m³ (technically at the limit value with data rounding) could become non-compliant with the addition of an option impact of 0.2µg/m³ i.e. a total pollutant concentration of 40.6µg/m³, rounded to 41 for reporting. As such, the impact on the A4206 cannot be screened out of the assessment and must be considered a risk.

5.2.10 For Heathrow ENR, Bath Road is the critical road link for all metrics. The large impact of the option on the road (>8µg/m³), results in either a compliant zone becoming non-compliant (Scenario 1A) or a delay to compliance within the Greater London Area (Scenario 1B). This is to say that, whilst overall concentrations with the New PCM model data for 2030 (Baseline or With Measures) are significantly lower than predicted by the AC, the decrease is not large enough to remove the significant risk of exceedance of the limit value on Bath road. Indeed, with the 2015 Plan measures in place, the impact of the ENR on Bath road would return the Greater London Area from compliance (in 2025 without ENR) to non-compliance (in 2030 with the ENR).

Table 5-1 Compliance assessment for the critical links for all options under Scenarios 1A – New PCM With Measures plus Option and 1B – New PCM Baseline plus Option, 2030.

SCENARIO 2030	CRITICAL PCM LINK	CHANGE IN CONC DUE TO OPTION (AC MODELLED IMPACT)	PCM PROJECTED CONC	TOTAL NO ₂ CONC	MAX NO ₂ CONC IN ZONE	CRITERIA		
						A: ZONE BECOMES NONCOMPLIANT	B: DELAY TO ZONE COMPLIANCE	C LENGTH OF NON- COMPLIANT LINKS INCREASED
GATWICK 2R								
AC Report	Not assessed				35.9			
1A With Measures	18231 A23	10.2	24.2	34.4	27.1	N	N	N
1B: Baseline	18231 A23	10.2	24.2	34.4	27.1	N	N	N
HEATHROW NWR								
AC Report	16112 Bath Rd	1.3	47.4	48.7	48.6	N	Y	Y
1A With Measures	16112 Bath Rd	1.3	36.2	37.5	37.3	N	N	N
1B: Baseline	58173 (A4206)	0.2	40.0	40.2	40.5	N	N	Y
HEATHROW ENR								
AC Report	56114 Bath Rd	8.3	47.6	55.9	48.6	N	Y	Y
1A With Measures	56114 Bath Rd	8.3	36.4	44.7	37.3	Y	Y	Y
1B: Baseline	56114 Bath Rd	8.3	36.5	44.8	40.5	N	Y	Y

5.2.11 These scenarios assume that the impact of each option remains constant at the value set out in the AC's Appraisal. In particular, the scenarios do not take into account the further iterations of surface access plans that have been proposed by the promoter of the Heathrow Extended Northern Runway scheme subsequent to the AC's work and modelling on air quality. Most

³² Taking a precautionary approach, this assessment does not apply rounding to zero decimal places, but considers a concentration of 40.1µg/m³ to be a potential exceedance of the limit value of 40µg/m³. This is appropriate given the level of uncertainty in the PCM projections and the modelled impacts

elements of their plans have remained unchanged, but there have been some changes to road layout. Although these iterations have not been considered in this study, it is acknowledged that they were developed with one aim being to reduce air quality impacts associated with the proposal considered by the AC.

- 5.2.12 Potential increases in the impact if, for example, the development is accelerated and/or diesel vehicles continue to emit more nitrogen oxides than expected, are considered in subsequent sections.
- 5.2.13 It is also possible, however, that the option impact will be lower than modelled by AC since their modelling was based on the same COPERT 4v10 factors (as incorporated in the Emissions Factor Toolkit v6.0.2) that were updated between the AC Report PCM Projections and the New PCM Projections.
- 5.2.14 However, even if the option impacts provided in Table 5-1 are reduced by the 10 – 15% reduction seen in the PCM model predictions of concentrations between the AC Report and New PCM Baseline, the conclusions of the assessment remain unchanged i.e. that Heathrow ENR runway is highly likely to cause exceedances of the EU limit value whereas the risk of exceedance is lower, but not negligible, with Heathrow NWR. In the latter case, the risk relates to worsening of exceedances on individual links rather than delays to compliance of the whole zone.

5.3 SCENARIO SET 2 – CHANGES TO OPTION OPENING YEAR

- 5.3.1 The various tests under Scenario 2 are designed to identify any constraints associated with the rate at which the airport expansion is delivered, and in particular of development prior to 2030, taking into account that pollutant concentrations and emissions per vehicle are generally expected to fall over time. Scenarios 2A to 2C consider airport activities in 2025; the contribution of the option is adjusted to take account of the early development of the option.
- 5.3.2 Table 5-2 shows the compliance assessment for the critical link(s) under Scenario 2A – 2C. The assessment is undertaken with respect to the criteria set out in Section 4.4 above, namely:
 - Criteria A: Does the option cause a compliance zone/agglomeration to become non-compliant
 - Criteria B: Does the option cause a delay to compliance within a non-compliant zone/agglomeration, or a worsening of the zone compliance assessment
 - Criteria C: Does the option cause a worsening of exceedances of the limit value alongside one or more PCM links without delaying compliance of the zone/agglomeration
- 5.3.3 For Gatwick 2R, the predicted concentrations on the critical PCM links are within the EU limit values for all 2025 development scenarios.
- 5.3.4 For Heathrow NWR, the critical PCM links are on the A40 and the A4206 in central London. Whilst the impact of the NWR option is relatively small on the links (largely imperceptible by DMRB criteria), the total pollutant concentration with the option is higher than in the immediate vicinity of Heathrow. In this case, whether the option results affect compliance alongside roads in the Greater London Urban Area then depends on how the 2015 Plan affects concentrations on links within central London rather than on the impact of the airport activities. That is, with the 2015 Plan measures, concentrations on link 70181 (and all other affected PCM links) are below 40µg/m³ whether or not NWR is operating. If the 2015 plan measures are less effective than predicted or their implementation is delayed, concentrations on affected links are above 40µg/m³ whether or not NWR is operating. Concentrations on Bath Road, where the impacts of the airport sources are higher, in all scenarios are up to 10µg/m³ lower than concentrations on links in central London.

5.3.5

For Heathrow ENR, the critical PCM links switch between links in central London (when 2015 Plan measures are not effective or concentrations are generally high) and Bath Road (when the impact of the airport activities dominates the compliance assessment). Significantly, if the 2015 Plan measures are effective and proceed to the planned timescale, the ENR option could lead to the zone becoming non-compliant in 2025 – although the level of exceedance of the limit value is marginal.

Table 5-2 Compliance assessment for the critical links for all options under Scenario 2 – Opening year assessment in 2025; Adjusted impact = Year adjustment only

SCENARIO 2025	CRITICAL PCM LINK	CHANGE IN CONC DUE TO OPTION (AC MODELLED IMPACT)	PCM PROJ. CONC	TOTAL NO ₂ CONC	MAX NO ₂ CONC IN ZONE	CRITERIA		
						A: ZONE BECOMES NONCOMPLIANT	B: DELAY TO ZONE COMPLIANCE	C LENGTH OF NON-COMPLIANT LINKS INCREASED
GATWICK 2R								
AC Report	Not assessed				35.9			
2A With Measures	18231 A23	10.2	25.9	36.1	29.6	N	N	N
2B Baseline	18231 A23	10.2	25.9	36.1	29.6	N	N	N
2C Baseline plus adjusted impact	18231 A23	10.9	25.9	36.9	29.6	N	N	N
HEATHROW NWR								
AC Report	16112 Bath Rd	1.3	47.4	48.7	48.6	N	Y	Y
2A With Measures	70181 A40	0.2	38.2	38.4	38.2	N	N	N
2B Baseline	58173 A4206	0.2	46.6	46.8	47.7	N	N	Y
2C Baseline plus adjusted impact	58173 A4206	0.25	46.6	46.8	47.7	N	N	Y
HEATHROW ENR								
AC Report	56114 Bath Road	8.3	47.6	55.8	48.6	N	Y	Y
2A With Measures	56114 Bath Road	8.3	32.1	40.4	38.2	Y	N	N
2B Baseline	58173 A4206	0.1	46.6	46.7	47.7	N	N	Y
2C Baseline plus adjusted impact	58173 A4206	0.13	46.6	46.7	47.7	N	N	Y

5.3.6

However, it must be noted that even if Heathrow ENR does not cause or delay non-compliance in 2025, it would under Scenarios 1A and 1B cause a delay to compliance in 2030. This is counterintuitive but is, in part, due to the PCM projections for 2030 showing an increase in concentrations on Bath Road with 2015 Plan measures in place between 2025 (32.1µg/m³) and 2030 (36.5µg/m³). In general, PCM concentrations within Greater London decrease between

2025 and 2030, in line with expected reductions in vehicle emissions. We do not have access to the PCM models to be able to ascertain the reason for the increase seen on Bath Road.

5.3.7 Furthermore, this assessment does not take into account the revision to the Heathrow ENR surface access strategy provided by the promoters subsequent to the AC's reporting.

5.4 SCENARIO SET 3 – SENSITIVITY TO INCREASED VEHICLE EMISSIONS

5.4.1 The various tests under Scenario 3 are designed to identify any constraints associated with the disparity between the performance of diesel vehicles under on-road driving conditions and the emissions standards. They are based on the worst case conformity testing of the PCM model, undertaken by Defra for 2020, extrapolated to 2025.

5.4.2 It is considered likely that, over time, the effects of non-conformance with emissions standards will decrease i.e. as Euro 6c and subsequent vehicles dominate the fleet mix and RDE testing is introduced. As such, the Scenario 3 tests have been limited to airport activities in 2025. The PCM Sensitivity concentrations for 2025 have been estimated by assuming a linear decrease in concentrations, on a link by link basis, between the 2020 PCM Sensitivity data and the New PCM With Measures for 2030. As noted in Section 4.3, this is a conservative approach and the estimation of emissions for 2025 is associated with significant uncertainty.

5.4.3 Scenarios 3A to 3C consider airport activities in 2025. The contribution of the option to total pollutant concentration is adjusted for the early opening of the option in 3B; and for both emissions disparity and early opening in Scenarios 3C. In terms of total pollutant concentrations, Scenario 3C is the most conservative considered in the assessment.

5.4.4 Table 5-3 shows the compliance assessment for the critical link(s) under Scenario 3A – 3C. The assessment is undertaken with respect to the criteria set out in Section 4.4 above, namely:

- Criteria A: Does the option cause a compliance zone/agglomeration to become non-compliant
- Criteria B: Does the option cause a delay to compliance within a non-compliant zone/agglomeration, or a worsening of the zone compliance assessment
- Criteria C: Does the option cause a worsening of exceedances of the limit value alongside one or more PCM links without delaying compliance of the zone/agglomeration

5.4.5 For Gatwick 2R, in 2025, worst case impact assumptions and worst case PCM projections are required to move the zone from compliance to non-compliance (e.g. Scenario 3C only).

5.4.6 If PCM concentrations are taken from the PCM Sensitivity dataset, the critical PCM links are all in central London for both Heathrow NWR and Heathrow ENR. Furthermore, in all cases, the NWR and ENR options result in an increase in concentrations on links where concentrations exceed the limit value but the compliance status of the zone as a whole is not affected. The options result in new exceedances of the limit value on Bath Road, most noticeably with Heathrow ENR, but the concentrations on Bath Road are lower than those in central London and will not delay the overall zone compliance.

5.4.7 As for Scenario Set 2, it should be noted that this assessment relates to 2025 only and Heathrow ENR would delay compliance with limit values in 2030 in the Greater London Urban Area. By 2030, pollutant concentrations in central London are projected to have decreased to within the limit values, whereas the impact of the Heathrow ENR option would result in concentrations on Bath Road continuing to exceed the limit value.

Table 5-3 Compliance assessment for the critical links for all options under Scenario 3 in 2025.
Impact Adjustment (1) = Year Adjustment only; Impact Adjustment (2) = Year and Emissions Adjustment

SCENARIO 2025 SENSITIVITY	CRITICAL PCM LINK	CHANGE IN CONC DUE TO OPTION (AC MODELLED IMPACT)	PCM PROJ. CONC	TOTAL NO ₂ CONC	MAX NO ₂ CONC IN ZONE	CRITERIA		
						A: ZONE BECOMES NONCOMPLIANT	B: DELAY TO ZONE COMPLIANCE	C LENGTH OF NON- COMPLIANT LINKS INCREASED
GATWICK 2R								
AC Report	Not assessed							
3A – 2025 Sensitivity	18231 A23	10.2	28.7	38.9	35.2	N	N	N
3B – 2025 Sensitivity + Impact Adjustment (1)	18231 A23	10.9	28.7	39.7	35.2	N	N	N
3C – 2025 Sensitivity + Impact Adjustment (2)	18231 A23	12.2	28.7	40.9	35.2	Y	N	N
HEATHROW NWR								
AC Report	16112 Bath Rd	1.3	47.4	48.7	48.6	N	Y	Y
3A – 2025 Sensitivity	58173 A4206	0.2	57.0	57.2	59.8	N	N	Y
3B – 2025 Sensitivity + Impact Adjustment (1)	58173 A4206	0.25	57.0	57.3	59.8	N	N	Y
3C – 2025 Sensitivity + Impact Adjustment (2)	58173 A4206	0.34	57.0	57.3	59.8	N	N	Y
HEATHROW ENR								
AC Report	56114 Bath Rd	8.3	47.6	55.8	48.6	N	Y	Y
3A – 2025 Sensitivity	58173 A4206	0.1	57.0	57.1	59.8	N	N	Y
3B – 2025 Sensitivity + Impact Adjustment (1)	58173 A4206	0.13	57.0	57.1	59.8	N	N	Y
3C – 2025 Sensitivity + Impact Adjustment (2)	58173 A4206	0.17	57.0	57.2	59.8	N	N	Y

Note: PCM Sensitivity data are estimated, using the method set out in Section 4.3, and not taken directly from the PCM model. Also, the Sensitivity data for 2020, used in the estimation, are based on the modelling undertaken at the consultation rather than the final submissions with the 2015 Plan. Absolute concentrations are, therefore, subject to significant uncertainty.

5.5 SCENARIO 4 – IMPACT MITIGATION

- 5.5.1 The various tests under Scenario 4 are designed to identify the potential for option-specific mitigation measures, identified in the AC's air quality local assessment, to reduce any air quality impacts on compliance with EU limit values.
- 5.5.2 The impacts of national and 2015 Plan measures have been considered with the previous scenarios and are not the focus of this section of the assessment although they obviously play a part in any overall strategy for air quality.
- 5.5.3 The AC air quality local assessment proposed a range of mitigation measures for each of the Heathrow options and provided a high level estimate of the potential reduction in impact at the most affected receptor for the option. No mitigation measures were proposed for Gatwick.
- 5.5.4 As a result it is not possible to undertake a full link by link assessment of the impacts of potential mitigation measures. However, a screening exercise has been undertaken in which the upper and lower bands of mitigation proposed by AC are removed from the airport contribution in the various scenarios, termed High and Low mitigation scenarios. The assessment for Gatwick is purely qualitative.
- 5.5.5 The only Scenario which shows a potential exceedance of the limit value for the Gatwick 2R Option is Scenario 3C – PCM Sensitivity data plus Year and Emission adjusted airport impact. In this scenario, which is considered to be highly conservative and possibly overly pessimistic, the concentration on the A23 is $40.9\mu\text{g}/\text{m}^3$. Given the scale of the quantified mitigation measures at Heathrow ($>1.5\mu\text{g}/\text{m}^3$), and the overall greater impact of the airport related sources on the Gatwick PCM links, it is considered plausible that a mitigation strategy focussing on reducing emissions from both aircraft and surface access could remove the risk of exceedance of the limit value in Scenario 3C (and improve air quality in the other Scenarios).
- 5.5.6 For Heathrow NWR and ENR, the proposed mitigation measures are expected to significantly reduce concentrations at the most affected receptors and PCM links in vicinity of the airport i.e. with the AC's Principal Study Area. However, the PCM links in the vicinity of Heathrow, (most importantly Bath Road), are not necessarily the links that determine whether compliance within the Greater London Urban Area is delayed or worsened. This is because as the contribution from the airport decreases in the Principal Study Area, the critical links for the compliance assessment switch to links in central London. The mitigation measures for aircraft emissions would definitely not have an impact on central London but, arguably, the impact of the mitigation measures on road transport may have an impact, albeit substantially reduced from the effects close to Heathrow.
- 5.5.7 Therefore, in conclusion, the mitigation of impacts at Heathrow would have definite air quality benefits, since pollutant concentrations would be reduced. However, whether this affects the compliance assessment is dependent on impacts in central London where PCM model concentrations are high but the airport impact is very small and possibly should be considered insignificant. Impacts in central London in any future modelling of options are likely to be highly variable, since they are a product of relatively small changes in traffic flow. Large percentage differences are possible from the AC reported impacts, although the absolute change in concentration is unlikely to be significant in any case.

6

SUMMARY AND DISCUSSION

6.1 SUMMARY OF IMPACTS

6.1.1 All scenarios and options were assessed against the following criteria:

- Criteria A: Does the option cause a compliance zone/agglomeration to become non-compliant
- Criteria B: Does the option cause a delay to compliance within a non-compliant zone/agglomeration, or a worsening of the zone compliance assessment
- Criteria C: Does the option cause a worsening of exceedances of the limit value alongside one or more PCM links without delaying compliance of the zone/agglomeration

6.1.2 Table 6-1 shows a summary of the Scenarios tested and a grading of the options against these criteria using the following classes, as against a specified year:

→ **No impact on zone compliance**

- *Green Shading = Scenario does not cause or contribute to exceedances of EU limit values (Answer to all criteria = 'No')*
- *Yellow Shading = Scenario causes a new exceedance on a road or worsens an existing exceedance, but does not affect the maximum concentration within a zone (Answer to Criteria A and B = 'No'; Criteria C = 'Yes')*

→ **Impact on zone compliance**

- *Red Shading = Scenario impacts on compliance status of zone or introduces new non-compliances by increasing the maximum predicted concentration within a zone (Answer to Criteria A or B = 'Yes')*

Table 6-1 Summary of assessment of sensitivity testing scenarios.

Scenario	Year	Option		
		Gatwick Second Runway	Heathrow Northwest Runway	Heathrow Extended Northern Runway
Airport Commission (Sustainability Appraisal)				
Unmitigated	2030			
Mitigated	2030			
Scenario 1 (New PCM)				
1A With Measures	2030			
1B: Baseline	2030			
Scenario 2 (New PCM plus Accelerated Development)				
2A With Measures	2025			
2B Baseline	2025		*	a
2C Baseline plus adjusted impact	2025		*	a
Scenario 3 (Conformity PCM _{SL} plus Accelerated Development and Emissions Adjustment)				
3A: – 2025 Sensitivity	2025			a
3B: – 2025 Sensitivity + Impact Adjustment (1)	2025			a
3C: – 2025 Sensitivity + Impact Adjustment (2)	2025			a
Scenario 4 (Impact Mitigation)				
4A: – 2030 With Measures + Impact Mitigated (Low)	2030			
4B: – 2030 With Measures + Impact Mitigated (High)	2030			
4C: – 2025 Baseline + Impact Mitigated (Low)	2025		*	
4D: – 2025 Baseline + Impact Mitigated (High)	2025		*	**
4E: – 2025 Sensitivity + Impact Mitigated (Low)	2025		*	
4F: – 2025 Sensitivity + Impact Mitigated (High)	2025		*	
* Worsened exceedances occur only in central London where airport impacts are very small				
** Worsened exceedances occur in central London and in the vicinity of the airport, but the latter exceedances are marginal				
a These scenarios are analysed for 2025 but, in 2030, would impact on compliance status of a zone or introduce new non-compliances by increasing the maximum predicted concentration within a zone				

6.1.3 The overall conclusions on compliance for the options are as follows:

Scheme	Conclusion	Commentary
Gatwick Second Runway	With 2015 plan measures no impact on compliance with any limit values	The conclusion has <i>low vulnerability</i> to uncertainties, since only in the most pessimistic emissions scenario does the option risk triggering non-compliance within the South East Zone
Heathrow Northwest Runway	With 2015 plan measures no impact on compliance with any limit values.	Scheme specific mitigation measures, as identified in the AC's air quality local assessment, can reduce the impacts in the vicinity of the airport. In scenarios without the 2015 Plan measures, the option does not delay compliance within the Greater London Zone but increases the length of roads exceeding the limit. This conclusion is <i>robust</i> since all sensitivity tests show the same conclusion
Heathrow Extended Northern Runway	There is a high risk that with 2015 plan measures the option would impact compliance with limit values.	Scheme specific mitigation measures, as identified in the AC's air quality local assessment, can reduce the impacts in the vicinity of the airport.

6.1.4 As noted earlier, subsequent to the AC's work and modelling on air quality, further iterations of surface access plans have been proposed by the promoter of the Heathrow Extended Northern Runway scheme. Most elements of their plans have remained unchanged, but there have been some changes to road layout. Although these iterations have not been considered in this study, it is acknowledged that they were developed with one aim being to reduce air quality impacts associated with the proposal considered by the AC.

6.2 DISCUSSION

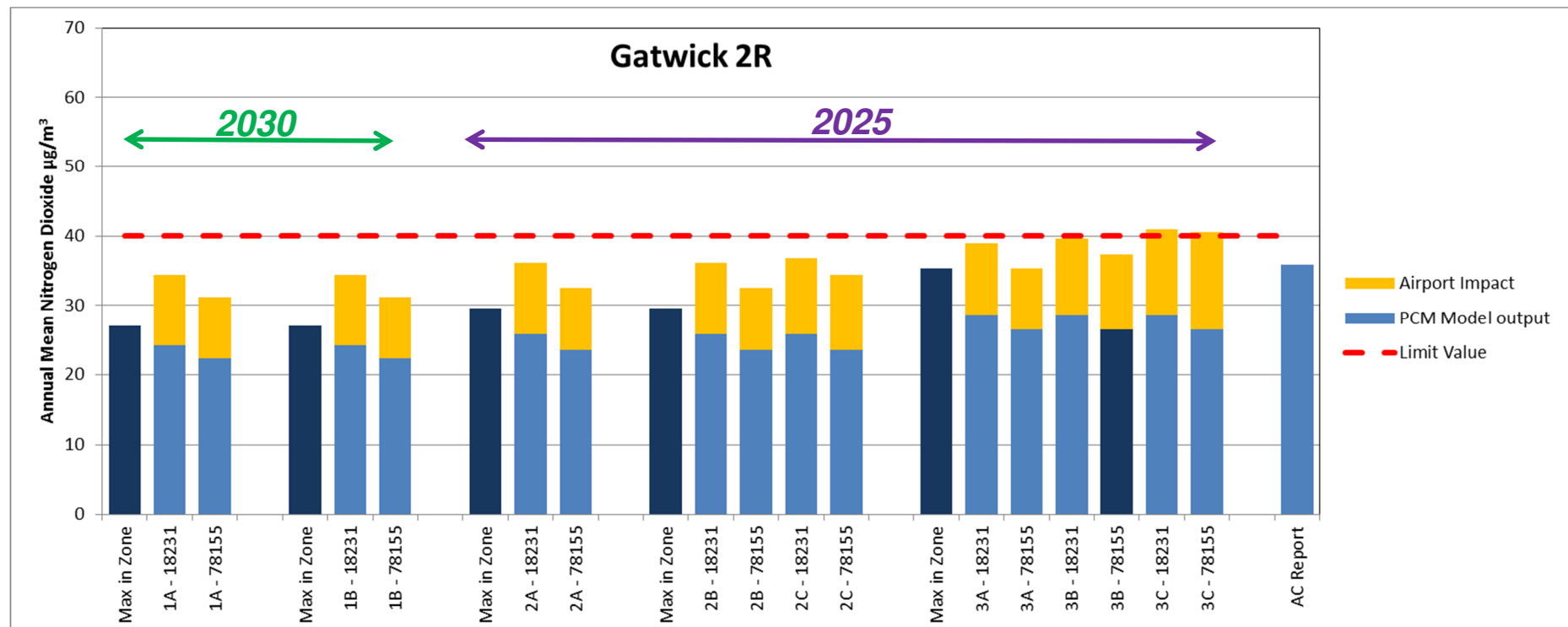
6.2.1 The range of impacts under each option can provide information on the level of risk of impact on the compliance status for the three shortlisted options. In the following discussion, the core scenario for all options is the 2030 New PCM With Measures data plus the 2030 AC Impact.

6.2.2 For Gatwick, all scenarios tested for development in 2030 result in no impact on compliance status i.e. there are no new exceedances of the limit value or any worsening of existing exceedances. A summary of all Scenarios for Gatwick is shown in Graph 6-1.

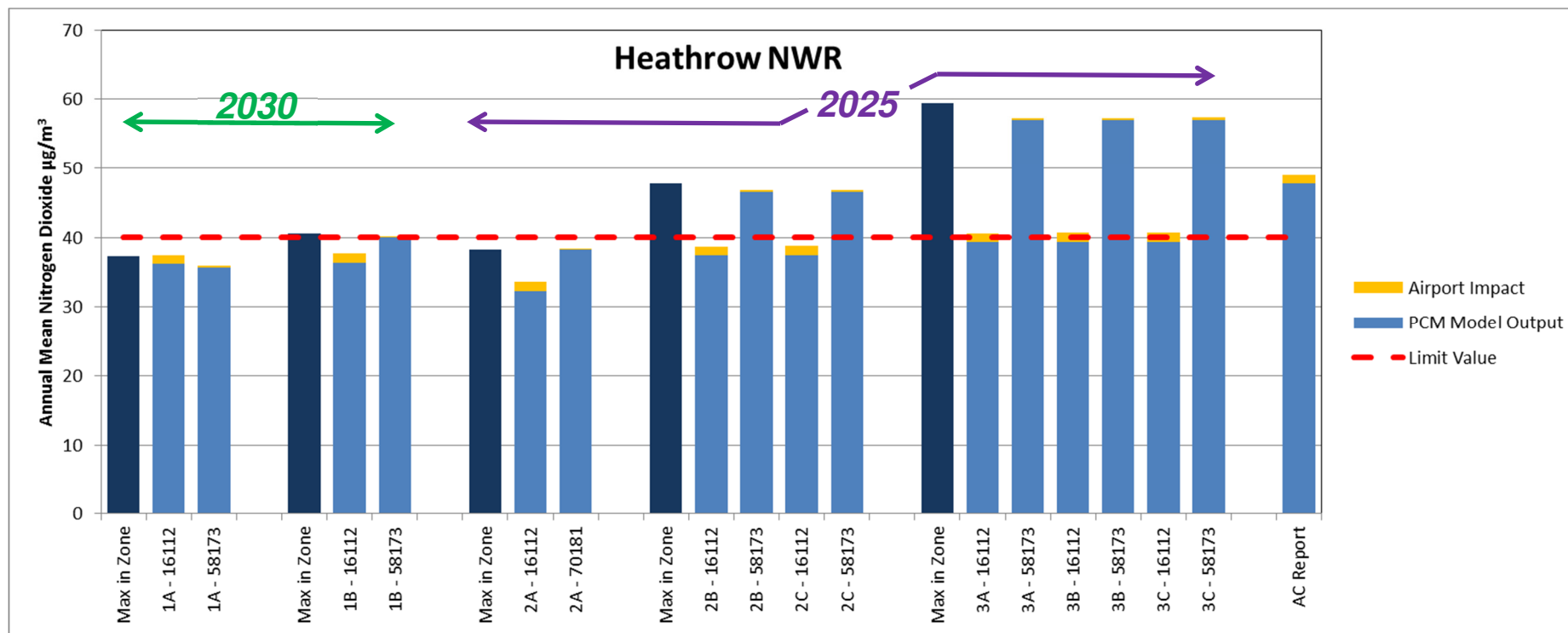
6.2.3 If the most conservative assumptions are made in relation to the disparity between the real world performance of diesel cars and emissions standards, coupled with opening of the airport pre 2030, then it is possible that non-compliance with limit values could be introduced on the A23 pre 2030 – the predicted concentration is 40.9µg/m³. However, this scenario is possibly overly pessimistic.

- 6.2.4 For Gatwick, the risk of an impact on the compliance status of the South East zone will be influenced by the eventual decision on route realignment for the A23. Consideration of these effects is beyond the scope of this assessment. However, as noted above, the only scenario in which Gatwick is at risk of introducing non-compliance is based on highly conservative assumptions and should not, therefore, be given significant weight.
- 6.2.5 No mitigation measures were proposed for Gatwick in the AC's assessment. However, it is reasonable to assume that an air quality management strategy could be developed for Gatwick, focussing on both landside and airside emission sources. This strategy could result in similar magnitude reductions to those expected at Heathrow. This would reduce concentrations to within the limit value in all scenarios.
- 6.2.6 For Heathrow NWR, with the 2015 Plan measures and opening in 2030, the option does not affect the compliance status of the Greater London Urban Area. This conclusion has a low vulnerability to uncertainties in the future projections. In all scenarios considered without the 2015 Plan measures, the option results in an increase in the length of links that exceed the limit value but does not affect the overall compliance status of the Zone. Graph 6-2 shows a summary of the impacts for Heathrow NWR.
- 6.2.7 The mitigation options could reduce impacts in the vicinity of the airport, but are likely to have less significant impacts further from the airport and may not prevent links within central London from seeing worsened exceedances of limit values.
- 6.2.8 For Heathrow ENR, the most likely impact of the option is that the compliance of the Greater London Urban Area with limit values would be delayed. For scenarios in which the PCM concentrations are particularly high i.e. for early development (2025) and sensitivity testing, the critical PCM links tend to be links in central London. However, as the PCM concentrations reduce i.e. scenarios with development in 2030 and all 2015 Plan measures in place, the impact of the option on concentrations on Bath Road becomes the critical PCM links. Graph 6-3 shows a summary of the impacts for Heathrow ENR. These conclusions do not, however, take into account the revised surface access strategy for Heathrow ENR.
- 6.2.9 Heathrow NWR and ENR show a similar trend in terms of the compliance assessment outcome. That is, the critical links vary between links close to the airport, where the impact of the options is relatively large, and links in central London where the impact of the airport is minimal (and probably insignificant) but the PCM model concentrations are high. When the overall PCM concentrations are at their lowest e.g. in the 2030 New PCM With Measures dataset, the impact of the airport-related emissions become more significant in determining compliance with limit values. As the PCM concentrations increase e.g. in the 2025 PCM Sensitivity or New PCM Baseline datasets, the impacts on links in central London, albeit very small, become dominant.
- 6.2.10 Scenarios were also considered in the assessment (but not formally reported) in which the growth of the airport was more rapid than anticipated by 2030, and for the operation of the options at full capacity (post-2040). With 2015 Plan measures, increased airport activity in 2030 has no impact on the compliance assessment provided above.
- 6.2.11 The risks associated with non-compliance with limit values are expected to decline over time, and uncertainties associated with the rate of improvement in vehicle technology have been considered in the scenarios described in this report. Taking into account the scales of the impacts of the options modelled by the AC and the projected PCM concentrations for 2030, it is highly likely that any risks associated with non-compliance at the time of operation of an option at full capacity (post 2040) are lower than those identified for scenarios in 2030.

Graph 6-1 Summary of impacts for Gatwick 2R

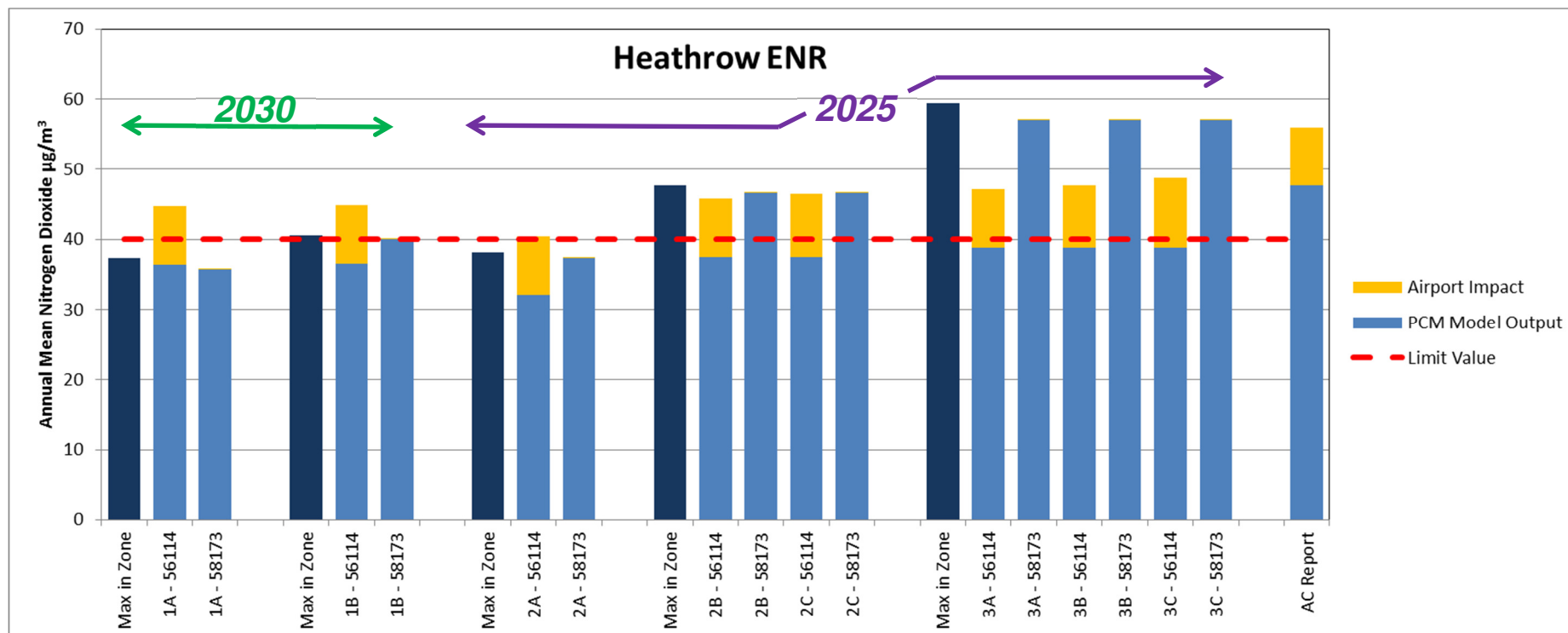


Graph 6-2 Summary of impacts for Heathrow NWR



Link 16112 is on Bath Road to the north of the Airport and representative of locations with relatively high airport impact; Link 58173 is in Central London and representative of locations with low airport impact but potential high PCM concentrations.

Graph 6-3 Summary of impacts for Heathrow ENR



Link 56114 is on Bath Road to the north of the Airport and representative of locations with relatively high airport impact; Link 58173 is in Central London and representative of locations with low airport impact but potential high PCM concentrations.

Appendix A

SENSITIVITY STUDY

Recently, it has been found that NO_x emissions from road vehicles operating under real world conditions are considerably higher than European Standards for a number of Euro vehicle classes. A number of studies have compared emissions measurements with the emissions standards to try to understand the impact this has on future year projections of emissions. A study by Air Quality Consultants (AQC, 2016)³³ has drawn together the results of a large number of studies, and concludes that the current version of the EFT is likely to under-predict emissions from Euro 6 diesel cars, but that there is limited evidence of under-prediction for other vehicle classes. As the proportion of Euro 6 vehicles within the fleet increases over time, the disparity between predicted emissions and the likely actual emissions increases.

In order to consider the potential effect of this apparent under-estimation, a sensitivity study has been carried out. This study utilises data produced by Defra to consider the impact on their PCM projections of emissions higher than currently predicted (PCM Sensitivity data).

The predicted Scheme impacts have also been adjusted. Using the EFT, the default NO_x emission factor (in g/km) at 30kph for cars has been calculated. Following guidance set out within the AQC 2016 report, the proportion of this emission which relates to Euro 6 diesel vehicles has been adjusted by a factor of 1.6 (corresponding to a total Conformity Factor of 5). The ratio of the default and adjusted factors has then been calculated.

The factor was then applied to the change in NO₂ concentration predicted at each receptor, taking into account the proportion of the change which was attributable to road traffic emissions associated with each of the Schemes (where suitable data were available). It was assumed that the majority of the road traffic associated with each of the Schemes was cars. Whilst it is not strictly appropriate to apply the factor to the predicted changes in NO₂, in the absence of NO_x data, this approach was deemed to be adequate.

YEAR	DEFAULT EMISSION FACTOR (G/KM)	ADJUSTED EMISSION FACTOR (G/KM)	RATIO
2025	0.27355	0.26238	1.3366

³³ Emissions of Nitrogen Oxides from Modern Diesel Vehicles, January 2016. Available at: www.aqconsultants.co.uk/getattachment/Resources/Download-Reports/Emissions-of-Nitrogen-Oxides-from-Modern-Diesel-Vehicles-210116.pdf.aspx

Appendix B

ESTIMATION OF SCHEME IMPACT – GATWICK 2R

The AC Report did not present the impact of the proposed 2R Scheme on PCM links as the only links identified as being affected within the vicinity of the airport are to be realigned as part of the Scheme.

However, based on information relating to those receptors which have been removed from the assessment as they are within 200m of a road which is to be realigned, it is possible to estimate what the impact of the Scheme is likely to be at 4m from the road. Although the alignment will change, the Scheme impact will be similar at the same distance from the realigned road.

Using the fall off with distance calculator provided by Defra³⁴, the 2030 PCM data have been used to estimate the concentration at the identified receptor. The Scheme contribution in 2030 has then been added onto the distance adjusted PCM value. This total concentration has then been used to determine the total concentration at 4m from the kerb (equivalent to the location of the PCM receptor). The impact of the Scheme at 4m from the kerb has then been estimated as the difference between the two values.

One limitation is that the fall off with distance calculator only works up to distances of 50m. Where receptors are further from the kerb than 50m, the impact of the Scheme is potentially underestimated.

PCM LINK ID	18231	78155
Closest Receptor	2R-L	2R-H
Predicted Scheme Impact ($\mu\text{g}/\text{m}^3$)	6.06	7.38
Proportion attributable to Road Sources (%)	29.22	83.49
Proportion attributable to Non-Road Sources (%)	70.78	16.51
Distance to kerb of PCM Link	>50m	8.2m
AC Report PCM ($\mu\text{g}/\text{m}^3$) 2030	35.9	28.9
AC Report PCM Estimated at Receptor (fall off with distance) 2030 ($\mu\text{g}/\text{m}^3$)	21.8	25.5
Total at Receptor (excluding non-road proportion) 2030 ($\mu\text{g}/\text{m}^3$)	23.6	31.7
Total estimated at 4m from kerb (fall off with distance) 2030 ($\mu\text{g}/\text{m}^3$)	41.8	36.6
Total estimated at 4m from kerb including Non-Road Contribution 2030 ($\mu\text{g}/\text{m}^3$)	46.1	37.8
Scheme Impact 2030 ($\mu\text{g}/\text{m}^3$) at 4m from kerb	10.19	8.92

The estimated 2030 impact for the two identified PCM Links was then adjusted as described in Appendix A as required.

³⁴ NO₂ fall off with distance tool. Available at: <http://laqm.defra.gov.uk/documents/NO2withDistancefromRoadsCalculatorIssue4.xls>