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2017 PLAN UPDATE TO AIR QUALITY RE-ANALYSIS

IMPACT OF 2017 AIR QUALITY PLAN AND ASSOCIATED POLLUTION CLIMATE MAPPING SENSITIVITY TESTING

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Department for Transport

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TABLE OF CONTENTS

TABLES

APPENDICES

1 EXECUTIVE SUMMARY

1.1 BACKGROUND

1.1.1 The Airports Commission (AC) undertook a Sustainability Appraisal to support its independent examination of three shortlisted options to increase aviation capacity in the UK, namely:

- Gatwick Second Runway (2R),
- Heathrow Northwest Runway (NWR), and
- Heathrow Extended Northern Runway (ENR).

1.1.2 The Sustainability Appraisal included a detailed assessment of the impacts of the options on air quality. 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.

1.1.3 Since the publication of the AC's detailed air quality assessment, the UK's national assessment of compliance with limit values has been updated; the latest update was undertaken during the development of the 2017 Air Quality Plan (the 2017 Plan)[1].

1.1.4 The purpose of this document is to report on the findings of a quantified assessment of the impact of the 2017 Plan on EU limit value compliance with increased airport capacity, taking into account the Department for Transport's (DfT) new demand forecasts for aviation.

1.1.5 The study is a follow-up to the previous WSP | Parsons Brinckerhoff Re-analysis and Updated Re-analysis studies and should be read in conjunction with those reports.[2,3]

1.2 SUMMARY OF UPDATED RE-ANALYSIS

1.2.1 The outcome of the re-analysis of the impact of increased airport capacity on limit value compliance is summarised in Table 1-1. The table takes into account the Government's 2017 Air Quality Plan and associated Pollution Climate Mapping (PCM) projections[4], and the latest aviation demand forecasts.

[1] Defra,2017, *UK plan for tackling roadside nitrogen dioxide concentrations: Detailed Plan*, July 2017

[2] https://www.gov.uk/government/uploads/system/uploads/attachment_data/file/562180/air-quality-re-analysis-impact-of-new-pollution-climate-mapping-projections-and-national-air-quality-plan.pdf

[3] https://www.gov.uk/government/publications/airport-expansion-updated-air-quality-re-analysis

[4] The 2017 Plan was supported by projections using both the PCM model and the streamlined PCM model (SL-PCM). This is a version of the PCM model which is used as a screening model for policy assessments but which does not incorporate all of the complexities of the full model. In this report, the 2017 Plan projections with the PCM and SL-PCM models are, for conciseness, referred to collectively as PCM model projections.

Table 1-1 Summary of conclusions on impact of increased airport capacity on limit value compliance

Option	Conclusion	Commentary
Gatwick Second Runway	The option is at ***low risk*** of impacting on compliance with limit values.	The conclusion has ***low vulnerability*** to uncertainties associated with the projection of future pollution concentrations and to the rate of growth in demand from a 2025 opening year since the scheme is only at risk of triggering non-compliance with EU Directive limit values when maximum levels of uncertainty are applied to the Government's PCM model projections.
Heathrow Northwest Runway	With the implementation of actions as set out in the 2017 Plan, the option ***does not impact*** on modelled compliance with limit values in any potential opening year (2026 onwards). Given the inherent uncertainties in air quality modelling, there remains, however, ***a risk that the option could delay compliance*** with limit values.	The risk of an impact on compliance with limit values increases the earlier the assumed opening year for the option. The risk of impact on compliance is high up to 2029 since the option potentially impacts on compliance in central London and exists whether or not the Government's 2017 Plan actions are fully implemented. From 2030 onwards, the risk falls to medium. The level of risk is primarily dependent on the timing of the introduction of, and effectiveness of, actions in the Government's 2017 Plan to reduce emissions from vehicles on the wider road network, together with effective Real-Driving Emissions (RDE) legislation[5]. It is largely independent of assumptions relating to the impact of the option itself or the direct mitigation of option-related emissions. Impacts near the airport do not, in general, affect zone compliance. Additional measures aimed at targeting high nitrogen dioxide (NO_2) concentrations at the local level and across London could potentially mitigate this risk further.

[5] Real-Driving Emissions – EU legislation requiring vehicles to be subject to more stringent emissions testing procedures than at present, improving the real-world control of emissions.

Option	Conclusion	Commentary
Heathrow Extended Northern Runway	The option ***impacts*** on compliance with limit values in all potential opening years. ***With the updated surface access strategy (Iteration 3)*** and the actions as set out in the Government's 2017 Plan, the option ***does not impact*** on modelled compliance with limit values in any potential opening year (2026 onwards). Given the inherent uncertainties in air quality modelling, there remains, however, ***a risk that the option could delay compliance*** with limit values, irrespective of the surface access strategy	The risk of an impact on compliance with limit values increases the earlier the assumed opening year for the option. Without the updated surface access strategy, the compliance risk is very high in all years. With the updated surface access strategy, the risk of impact on compliance is reduced but remains high up to 2029 since the option potentially impacts on compliance in central London, and exists whether or not the Government's 2017 Plan actions are fully implemented. From 2030 onwards, the risk falls to medium. A risk exists due to impacts in central London whether or not the updated surface access strategy is implemented, but the updated strategy is required to reduce risks on roads in the vicinity of the airport. With the updated surface access strategy, the level of risk is primarily dependent on the timing of the introduction, and effectiveness of, actions in the Government's 2017 Plan to reduce emissions from vehicles on the wider road network together with effective RDE legislation. It is largely independent of assumptions relating to the impact of the option itself or the direct mitigation of airside emissions. Additional measures aimed at targeting high NO_2 concentrations at the local level and across London could potentially mitigate this risk further.

1.3 DISCUSSION

1.3.1 The overall conclusion of the study is that, with the effective implementation of the Government's 2017 Plan measures (as represented by the PCM model projections in the 2017 Plan), increased airport capacity will not affect modelled compliance with EU limit values. This applies whichever option is in operation, although for Heathrow ENR the updated surface access strategy Iteration

3[6] must be in place. In terms of timing, this conclusion applies in any expected opening year i.e. 2026 onwards for Heathrow-NWR and Heathrow ENR, 2025 onwards for Gatwick 2R.

1.3.2 Taking into account the inherent uncertainties in air quality modelling there remains, however, a risk that the options could delay or worsen compliance with limit values, albeit decreasing over time. This risk is low for Gatwick 2R and high for the Heathrow options. For Heathrow ENR without the updated surface access strategy in place, the risk of impacting on compliance is very high. For Heathrow ENR with updated surface access strategy, the risk is high for operation in years prior to 2030 and medium thereafter. Finally, for Heathrow NWR the risk is high (again until 2030 when the risk drops to medium).

1.3.3 The risks relate to uncertainties in the modelling of future concentrations, primarily relating to vehicle emissions and the conformity of light duty diesel vehicles with emission standards, and to the ability of the models to capture small scale variations in dispersion conditions, such as in street canyons. This applies to the impact of the airport expansion option, but more significantly to the 2017 Plan PCM model projections.

1.3.4 For Gatwick 2R, the risks relate to pollutant concentrations alongside the A23 Airport Way/London Road. Impacts arise from emissions from both airside sources and road transport. The risk of impacting on compliance is low because only in scenarios based on the most conservative assumptions does the option trigger non-compliance with limit values. Since the impacts occur in the vicinity of the airport, an air quality management strategy could be developed by the scheme promoters that would minimise any risks to compliance with EU limit values.

1.3.5 Both Heathrow options increase pollutant concentrations on roads across London, including the roads giving the highest concentrations in the Greater London zone in the PCM modelling. Whilst this increase is small in magnitude, the opening of any option between 2026 and 2030 is coincident with the period over which the Greater London zone moves from non-compliance to compliance in the PCM model projections. As such, concentrations alongside some roads in central London, including the key A40 Westway, sit at or close to the limit value in all years and emissions scenarios and the small impact from airport expansion risks worsening exceedances of limit values on some routes or delaying compliance with limit values.

1.3.6 There are limited actions that the scheme promoters can take to reduce the impacts of the schemes in central London, and the mitigation of risks relies on the effective implementation of the Government's 2017 Plan measures and RDE legislation to reduce emissions from road transport.

1.3.7 The Heathrow schemes also impact on concentrations alongside roads in the vicinity of Heathrow itself and, for Heathrow ENR, potentially impact on compliance. The adoption of the updated surface access strategy (Iteration 3) is required to reduce compliance risks with the Heathrow ENR option. Air quality management strategies have been proposed for both options that will act to potentially reduce the risk of non-compliance with limit values alongside roads near Heathrow.

[6] WSP, 2017. *Airports National Policy Statement Appraisal of Sustainability: Appendix D Assessment of Variations*

2 PROJECT BACKGROUND

2.1 OVERVIEW

2.1.1 The AC undertook a Sustainability Appraisal to support its independent examination of 3 shortlisted options to increase aviation capacity in the UK, namely:

- Gatwick Second Runway (2R);
- Heathrow Northwest Runway (NWR); and
- Heathrow Extended Northern Runway (ENR).

2.1.2 In relation to ambient air quality, the AC's Appraisal Framework required that the Air Quality Local Assessment[7] considered the impacts of the options on nitrogen oxides (NOx including NO_2) and particulate matter (as PM_{10} and $PM_{2.5}$).

2.1.3 The AC's local air quality assessments used a 'worst' case scenario. They were based on projections of future activity levels taken from demand forecasts 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 2R; and
- Carbon Traded Global Growth for Heathrow NWR and ENR.

EU LIMIT VALUE COMPLIANCE

2.1.4 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 (NO_2) and particulate matter (PM_{10}). 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.

2.1.5 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 European Commission[8]. 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 1km x 1km 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.

2.1.6 The UK is divided into 43 zones and agglomerations (hereafter referred to only as zones) for limit value compliance reporting purposes. A zone is defined as being compliant when the maximum monitored or modelled concentration within that zone is less than or equal to the limit value.

2.1.7 In the latest compliance report[8], the UK reported that the limit value for annual mean NO_2 was exceeded in 37 out of the 43 zones. A key aspect of the AC's air quality assessment was

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

[8] Defra's most recent compliance report for the UK is available at: https://uk-air.defra.gov.uk/library/annualreport/

consideration of the likely impact of the options for increased airport capacity on the UK's compliance with the limit values for NO_X and NO_2.

2.1.8 The methodology used by the AC followed guidance set out in the Design Manual for Roads and Bridges[9]. It is a screening approach which treats the Government's PCM model 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 for comparison with the limit value.

2.1.9 The AC's compliance assessment was based on the PCM model projections undertaken in 2013, taking into account measures in the Government's 2011 Air Quality Plan for improving air quality in the UK.

2.2 FURTHER WORK UNDERTAKEN SINCE AIRPORTS COMMISSION REPORTING

2.2.1 The following sections summarise further work undertaken since the publication of the AC's air quality assessment in July 2015, either directly related to or potentially impacting on EU limit value compliance.

2015 AIR QUALITY PLAN

2.2.2 In December 2015, the Government published its 2015 Air Quality Plan (the 2015 Plan) for reducing nitrogen oxides emissions and improving air quality, together with supporting technical evidence. The evidence base included revised compliance projections using the PCM model showing all areas of the UK meeting the limit values by 2025.

2.2.3 COPERT[10] emission factors are the recommended method for calculating emissions inventories in the EMEP (European Monitoring and Evaluation Programme) guidebook[11], and they are regularly updated as new evidence on vehicle emissions emerges.

2.2.4 The PCM model projections used in the AC's assessment were based on COPERT version v4.10 (issued in November 2012). The 2015 Plan was based on COPERT v4.11. COPERT v4.11 included updated emission factors for Euro[12] 5/V and Euro 6/VI for cars, Light Goods Vehicles (LGV), Heavy Goods Vehicles (HGV) and buses/coaches, as well as emission factors for the second stage of Euro 6 vehicles, referred to as Euro 6c (although Euro 6c emissions were not fully incorporated into the PCM modelling).

SURFACE ACCESS ITERATIONS

2.2.5 The AC's shortlisted scheme promoters continued to refine their schemes following the formal submission of scheme designs to the AC in May 2014.

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[9] 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)

[10] COPERT – Computer Programme to calculate Emissions from Road Transport, http://emisia.com/products/copert/documentation

[11] EMEP/EEA air pollutant emission inventory guidebook, 2016, https://www.eea.europa.eu//publications/emep-eea-guidebook-2016

[12] European emissions standards for vehicles are known as 'Euro' standards. Standards for light duty vehicles are denoted by arabic numbers (1, 2, 3 etc); heavy duty vehicle standards are denoted by roman numerals (I, II, III etc). The latest standards are the Euro 6/VI standards.

2.2.6 Variations to the scheme designs were discussed between Government and the scheme promoters and recorded in the form of a Statement of Principles (SoP) for each scheme option[13]. The principal changes to scheme design as described in the SoPs comprise:

- Gatwick 2R: Change in phasing of construction; the first phase of the new terminal would open at the same time as the new runway in 2025.
- Heathrow ENR: Two variations to the surface access plans included in the AC report were described in the SoP. They are described in more detail in Appendix D of the Assessment of Sustainability. The principal changes are: that the M4 would not require widening to cope with the increased demand resulting from expansion; surface access proposals comprising M25 works and tunnelling (J14 to the south and J15 to the north) (on a like for like replacement basis); local road diversions and improvements including the A4 and A3044.
- Heathrow NWR: The M4 would not require widening to cope with the increased demand resulting from expansion.

2.2.7 Of these variations, the alternative surface access schemes for Heathrow ENR, termed Iteration 3 and Iteration 4, are relevant to consideration of EU limit value compliance since they directly affect critical roads in the assessment.

WSP | PARSONS BRINCKERHOFF RE-ANALYSIS STUDY

2.2.8 WSP | Parsons Brinckerhoff were commissioned to assess the implications of the 2015 Plan and PCM modelling on the conclusions of the AC's air quality assessment in relation to EU limit value compliance. Specifically, the study considered:

- The change in projected roadside nitrogen dioxide concentrations with the 2015 Plan PCM modelling,
- Whether the new projections indicate that the shortlisted 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 model 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.

2.2.9 No new modelling was undertaken for the study, rather it was based on the re-analysis of the AC's modelling work and the Government's PCM modelling (undertaken in 2015).

2.2.10 This report (termed WSP | Parsons Brinckerhoff Re-analysis study) was published in October 2016[2].

COPERT UPDATE

2.2.11 In September 2016, subsequent to the publication of the Government's 2015 Plan and the completion of the WSP | Parsons Brinckerhoff Re-analysis study, updated COPERT emission factors were released (v4.11.4). The update included new NO_X emission factors for Euro 6

[13] The Secretary of State for Transport and Gatwick Airport Limited, 2016. *Statement of Principles;* The Secretary of State for Transport and Heathrow Hub Limited and Runway Innovations Limited, 2016. *Statement of Principles;* The Secretary of State for Transport and Heathrow Airport Limited, 2016. *Statement of Principles*

passenger cars and light commercial vehicles and Euro 5 light commercial vehicles. The new factors were based on the latest emission information collected by ERMES (European Research on Mobile Emission Sources) parties and individual EU Member States[14]. The emission factors for the current generation of Euro 6 vehicles in the updated dataset were significantly higher than those incorporated into the 2015 Plan PCM modelling, although emissions from future Euro 6 vehicles were lower.

2.2.12 The updated COPERT factors were supplied as an interim set of emissions factors aimed at reflecting average measured emissions levels and a best estimate of future technology progress. With the introduction of RDE regulations from 2017 onwards, diesel emissions improve over time in the factors but the likely rate of improvement is the subject of ongoing research.

2.2.13 The potential impact of the 2016 update to COPERT emission factors was assessed qualitatively in a foreword to the final issue of the WSP | Parsons Brinckerhoff Re-analysis study.

2.2.14 The factors have subsequently been finalised in the September 2016 release of COPERT v5, taking into account real driving emissions testing. In this dataset, emissions from Euro 6 vehicles decrease significantly over time.

2016 SL-PCM MODEL SENSITIVITY TESTS

2.2.15 In November 2016, Defra undertook sensitivity testing of the PCM model projections based on the updated COPERT emissions factors.

2.2.16 The testing was undertaken with the Streamlined PCM (SL-PCM) mode and COPERT v4.11.4. The SL-PCM model does not fully incorporate the complexities of atmospheric science included in the full PCM suite of models. It is specifically designed for use as a screening tool for the impacts of local mitigation measures on road transport sources and for undertaking sensitivity testing and policy development[15].

WSP | PARSONS BRINCKERHOFF UPDATED RE-ANALYSIS STUDY

2.2.17 Subsequent to the issue revised COPERT emission factors, WSP | Parsons Brinckerhoff were commissioned to assess

→ The impact of the 2016 update to the COPERT emission factors as incorporated in the 2016 SL-PCM sensitivity testing on EU limit value compliance.

2.2.18 The overall conclusion of the updated study was that, with the Government's 2015 Plan measures and taking into account the updated COPERT emission factors, increased airport capacity will not affect compliance with EU limit values in 2030. This applies whichever option is in operation, although for Heathrow ENR the updated surface access strategy Iteration 3[16] must be in place.

2.2.19 The study did, however, identify a risk that the options will delay or worsen compliance with limit values. This risk was assessed to be lowest for Gatwick 2R and highest for the Heathrow

[14] Leonidas Ntziachristos, Giannis Papadimitriou, Norbert Ligterink, Stefan Hausberger, Implications of diesel emissions control failures to emission factors and road transport NOx evolution, Atmospheric Environment, Volume 141, September 2016, Pages 542-551

[15] 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

[16] Appraisal of Sustainability, Appendix D

options, in particular Heathrow ENR without the updated surface access strategy in place. Furthermore, the risk increases the earlier the option is assumed to come into operation.

2.2.20 This report (termed WSP | Parsons Brinckerhoff Updated Re-analysis study) was published in February 2017[3].

2017 AIR QUALITY PLAN

2.2.21 In November 2016, following a challenge to the 2015 Plan, the High Court ordered the Government to produce a modified Air Quality Plan and to publish the final, modified plan by 31 July 2017.

2.2.22 The modified Plan (the 2017 Plan) was published in July 2017[1] together with supporting technical evidence[17] and revised compliance projections using the PCM model. It proposes a revised package of measures / actions to achieve compliance in the shortest possible time.

NEW DFT FORECASTS OF AVIATION DEMAND

2.2.23 DfT has produced new forecasts that have been used in the assessment of airport capacity in the South East (UK Aviation Forecasts 2017). Updated projections for air transport movements (ATM) for years 2025 to 2050 for each of the shortlisted options[18] have been produced for three demand scenarios: low, central and high, based on the same assumptions of airport capacity as defined by the AC. As before, this analysis uses the high scenario to assess air quality impacts, rather than the central scenario, to provide a conservative assessment.

2.2.24 The new forecasts show different rates of growth in demand in comparison to the AC's demand forecasts. Compared to the AC's high demand scenarios (Global Growth for Heathrow and Low Cost is King for Gatwick), the DfT 2017 high forecast shows more rapid growth in demand than assumed in the AC assessment and previous re-analysis studies for both Heathrow options, whereas for Gatwick the rate of growth is slower.

2.3 SCOPE AND STRUCTURE OF 2017 PLAN UPDATE TO AIR QUALITY RE-ANALYSIS

2.3.1 This study is a follow-up to the WSP | Parsons Brinckerhoff Re-analysis and Updated Re-analysis studies and should be read in conjunction with those reports[2,3].

2.3.2 Specifically, the scope of this assessment is:

- A quantified assessment of the impact of the 2017 Plan on EU limit value compliance with increased airport capacity, taking into account DfT's new aviation demand forecasts

2.3.3 As for the original study, no new modelling work has been undertaken for this assessment; rather, it is based on:

- AC's local air quality assessment;
- Defra's 2017 Plan PCM and SL-PCM model projections for 2025 to 2030; and
- DfT's new 2017 forecasts of aviation demand.

[17] Defra, 2017, *UK plan for tackling roadside nitrogen dioxide concentrations: Technical Report*, July 2017
[18] Department for Transport, 2017, UK Aviation Forecasts 2017.

2.3.4 In the following sections, we provide further details on the 2017 Plan PCM and SL-PCM model projections (jointly referred to as PCM model projections for conciseness) where they relate to the impacts of increased airport capacity, and set out the methodology used for the re-analysis, and the results and conclusions of the study.

2.3.5 The scope of this study is limited to consideration of the implications of the 2017 Plan PCM modelling on EU limit value compliance with revised airport capacity. The scope does not extend to consideration of impacts on local air quality during construction, or to impacts on compliance with the UK's air quality objectives[19].

[19] The UK's air quality objectives for nitrogen dioxide are numerically the same as the EU limit values. They are, however, policy targets rather than mandatory limits. Furthermore, compliance with air quality objectives is assessed at locations of relevant exposure to pollution, as set out in Defra's technical guidance TG(16), without recourse to Defra's PCM modelling. The AC undertook separate assessments of compliance with EU limit values and compliance with air quality objectives. The latter are reported in the AC's local air quality assessment[7].

3 2017 AIR QUALITY PLAN PCM MODEL PROJECTIONS

3.1 INTRODUCTION

3.1.1 For this study, the following PCM model datasets for NO_2 were considered

→ **PCM *Datasets*** issued in 2017:

- ***2017 Plan PCM Baseline*** – PCM model data, generated from a 2015 base year, based on COPERT v5 emissions factors and ongoing measures to improve air quality (2025 to 2030);
- ***2017 Plan PCM CAZ Scenario*** – SL-PCM model data, generated from the Baseline Scenario with an assumed network of Clean Air Zones (CAZs) in urban areas (including Greater London) implemented in 2021 at the latest (2025 to 2030); and
- ***2017 Plan PCM CAZ + ZEZ/Additional Measures*** – SL-PCM model data, generated from the CAZ Scenario with a high level estimate of potential local measures and the proposed Zero Emission Zone (ZEZ) in central London from 2025 (2025 to 2030) (denoted CAZ+ZEZ subsequently).

3.1.2 For the 2017 Plan, the PCM models were run with greater temporal detail than for previous reporting, providing better information on compliance with limit values in specific years. As such, PCM model data were available for the study on an annual basis rather than on the 5 yearly basis previously employed.

3.1.3 During the development of the 2017 Plan, Defra undertook sensitivity testing of these projections using the SL-PCM model and an analysis of the overall uncertainty in the PCM model projections. The results of the testing are set out in Chapter 4 of the Technical Report accompanying the Plan[17].

3.2 COMPARISON WITH EARLIER STUDIES

3.2.1 The PCM and SL-PCM datasets used in the previous re-analysis study are considered in this section only to illustrate the impact of revisions to the PCM model projections. No further re-analysis of these datasets has been undertaken for this study.

3.2.2 Figures A-1 to A-3 show the original (AC and 2015 Plan) and revised (2017 Plan) PCM model projections for the key PCM model links in the relevant study areas for the options.

3.2.3 The projected concentrations for 2030 are generally lower in the 2017 Plan than with the 2015 Plan (or the AC Assessment). This is in accord with the aims of the 2017 Plan.

3.2.4 Links potentially affected by the airport expansion options sit in the South East zone (Gatwick 2R) and Greater London Urban Area (Heathrow NWR and ENR). Table 3-1 sets out the latest projected compliance dates for these zones. The earliest potential opening of any of the airport options post-dates the South East zone becoming compliant but, for the Heathrow options, coincides with the years in which the Greater London zone is projected to become compliant across the various scenarios.

Table 3-1 Summary of zone compliance dates in 2017 Plan PCM Modelling Scenarios

Zone	Current Status	Baseline	With CAZ	With CAZ+ZEZ
Greater London	Non-compliant	2028	2026	2025
South East	Non-compliant	2023	2022	2022

*Assessed against compliance with 40µg/m^3 (rounded to zero decimal places)

3.2.5 Figure A-4.1 and Figure A-4.2 in Appendix A to this report show the projected decrease in PCM model concentrations, for the Baseline and With CAZ scenarios, on key roads for this study. They include links in central London (70181 and 74534 – both on the A40), near Heathrow (56114 and 16112, on the A4) and near Gatwick (18231 and 78155, on the A23) and also show the maximum concentrations within the Greater London and South East zones. The figures show a near linear decrease in concentrations between 2026 and 2030 on all links in both scenarios but importantly the figures show that the South East zone (in which Gatwick is located) is expected to be compliant with the limit values well before 2025, whereas concentrations in the Greater London zone fall into compliance between 2026 and 2028, depending on the scenario.

3.3 UNCERTAINTY

3.3.1 The degree of uncertainty within the air quality modelling conducted for the 2017 Plan was assessed by an expert panel[17]. The panel concluded that the principal uncertainties in the modelling were, ranked in order of greatest impact:

- Emission factors, including the question of conformity for light duty diesel vehicles;
- Dispersion modelling, particularly within street canyons;
- The proportion of emissions emitted as primary NO_2; and
- Traffic composition, in particular the projection of future traffic volume forecasts.

3.3.2 On the advice of the panel, Defra undertook a statistical analysis of the base year PCM model concentrations against independently measured NO_2 concentrations. The analysis indicated that the overarching uncertainty in the air quality modelling conducted for the Plan was +/-29% (95% confidence interval).

3.3.3 Figures A-4.1 and 2 show these confidence intervals for the links of key importance to this study. In the baseline projections, the Greater London zone is compliant by 2028 and the South East zone compliant before 2025. With concentrations at the low ends of the uncertainty range, both zones and the important assessment links are compliant with the limit value, whilst with concentrations at the upper ends of the uncertainty range, the South East zone does not become compliant until 2028 and the Greater London zone remains well in exceedance of the limit value beyond 2030.

3.3.4 The impact on South East zone compliance at the upper end of the uncertainty range has little significance to this assessment since the impacts of Gatwick 2R do not occur in the area of maximum concentrations within the zone.

3.3.5 However, the impact of this uncertainty on roads within central London is of critical importance to the assessment and is, essentially, the principal driver for uncertainty within the re-analysis study. That is to say, the proposed opening years for the airport schemes at Heathrow coincide with the years in which the Greater London zone moves from non-compliance into compliance. As a result, multiple roads within the zone that are impacted by the airport growth have projected PCM concentrations in the potential opening years for the Heathrow options (2026 onwards) that sit

either just above or just below the limit value, and are thus susceptible to impact by relatively small changes (all Scenarios).

3.3.6 This results in a heightened risk of impacts of non-compliance for the earlier opening years of the Heathrow schemes, albeit a risk that decreases over time.

3.3.7 It is possible that the uncertainty range relating to emissions factors will decrease over time as a result of the implementation of Real Driving Emissions (RDE) legislation that is intended to progressively reduce the disparity between vehicle emissions standards and on-road emissions.

3.3.8 However, this may be balanced by a corresponding increase in the uncertainty surrounding traffic flow and composition forecasts.

3.3.9 Notwithstanding this, since it is reasonable in the face of recent evidence from emissions testing to conclude that NO_2 concentrations will decline over time, the implications associated with the uncertainty will decline in the future since fewer road links will have projected concentrations that are close to the limit value and at risk of impact by airport expansion.

3.3.10 As acknowledged in the 2017 Plan, a +/-29% uncertainty range suggests that any analysis of impacts is highly uncertain and that the ability of measures presented in the Plan to tackle poor air quality is open to challenge. In this regard, the 2017 Plan states that[17]:

> *"the measures will be implemented in such a way that discrepancies in the modelling conducted for this Plan are accounted for. All local authorities with persistent exceedances will undertake feasibility studies and as such, will perform their own local air quality modelling. This will indicate whether JAQU's[20] modelling constituted an overestimate or underestimate of concentrations within the local area and local plans can be adapted to reflect this. To support this, the UK government will consider further steps to ensure that air quality improves in areas that are modelled to be below but close to the legal limit and to ensure that forecast levels remain compliant. These steps could include preferential access to funding and government support to access and build on best practice*"

3.3.11 It is, for the purposes of this compliance risk assessment exercise, useful to consider the implications of the uncertainty on the robustness of the assessment conclusions.

3.3.12 Defra undertook sensitivity testing of the various uncertainties identified by the expert panel[17]. The sensitivity analysis was undertaken with the SL-PCM model and demonstrated that the critical parameters associated with the assessment of the future impact of airport expansion – vehicle emissions factors and traffic flows – are key contributors to the overall uncertainty within the PCM forecasts. As such, a similar uncertainty range (+/-29%) is likely to apply to the AC's modelling.

3.3.13 Notwithstanding this, the application of a straight +/- 29% uncertainty range to the future projections of compliance, with or without airport expansion, adds little to the data interpretation since it simply pushes the underlying PCM model projections either well above the limit value or well below the limit. However, assuming that the analysis of modelled versus monitored concentrations follows a statistical normal distribution[21], it is useful to note that a 95% confidence limit of +/-29% equates to the following observations:

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[20] Defra and DfT's Joint Air Quality Unit

[21] A statistical normal distribution is a way of describing a population of numbers (in this case, the difference between modelled and monitored concentrations) that is concentrated around the mean value and with fewer observations at

- approximately 90% of modelled concentrations will underestimate concentrations by less than 20% (or overestimate concentrations);
- approximately 75% of modelled concentrations will underestimate concentrations by less than 10% (or overestimate concentrations); and
- over 60% of modelled concentrations will underestimate concentrations by less than 5% (or overestimate concentrations).

3.3.14 As such, it is considered that where modelled concentrations are less than 20% of the limit value, it is unlikely that the limit value will be exceeded (low risk) – because this would mean that 90% of modelled concentrations would be likely to be within the limit value - but that a high risk of exceedance exists when the modelled concentrations lie within 10% of the limit value – in this case, 25% of modelled concentrations would be likely to exceed the limit value.

the extremes. It is sometimes called a bell-shaped distribution because the distribution curve is shaped like a bell and symmetrical about the mean.

4 METHODOLOGY

4.1 OVERVIEW

4.1.1 The scope of this updated air quality reanalysis study mirrored that of the WSP Re-analysis study and Updated Re-analysis study. That is to say, its purpose was to re-analyse existing datasets to assess the implications of the 2017 Plan and associated updates to the SL-PCM model projections on the conclusions of the AC's work in relation to EU limit value compliance. Specifically, the scope stated that no new modelling was to be undertaken.

4.1.2 Therefore, the study has been based on:

- the AC's air quality local assessment for 2030;
- the 2017 Plan PCM model projections; and
- DfT's new forecasts for aviation demand.

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.

4.1.4 In line with the approach used in the previous analyses[23], the methodology selected for the study followed the guidance set out in the Design Manual for Roads and Bridges[9]. 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.

4.1.5 In summary, the method treats the 2017 Plan PCM model projections for roadside concentrations (which do not account for expanded airport capacity) 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:

$$Total\ Concentration_{With\ Option,Est.} = PCM\ Concentration_{2017\ Plan} + AC\ Impact\ of\ Option_{Adj}$$

4.1.6 The principal challenge of the re-analysis concerns the adjustment of the modelled AC Impact to reflect the latest available information.

4.1.7 The study combines projections and modelling of future air quality from two different sources/models: the Government's projections are based on the PCM model; and the AC's modelling is based on the ADMS-Airports model[22]. 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 its Sustainability Assessment. This issue is to a large extent mitigated by the fact that the impact of airport capacity options on concentrations on the majority of links at risk of exceeding the limit value is small.

4.1.8 Further details on the assessment methodology are available in the WSP | Parsons Brinckerhoff Re-analysis study[2].

[22] www.cerc.co.uk

4.2 SCENARIOS

4.2.1 The risks of non-compliance with EU air quality limit values has been assessed under the same scenarios for which 2017 Plan PCM model projections were made, namely

- Baseline projections, which incorporate ongoing measures to improve air quality;
- With CAZ projections, which incorporate CAZ in urban areas (including Greater London); and
- With CAZ + ZEZ/Additional Measures (termed CAZ+ZEZ), which incorporate all measures in the CAZ scenario plus potential local measures and the proposed Zero Emission Zone in central London.

4.2.2 For the purposes of this re-analysis, the With CAZ scenario is considered to be the core scenario, since it takes account of actions which the Government is confident can be achieved.

4.2.3 The Baseline scenario shows the situation if none of the 2017 Plan measures were implemented or effective; the With CAZ+ZEZ projections take account of the CAZ together with potential additional measures (such as the ZEZ in central London) outlined in the 2017 Plan. These scenarios have been included to cover upper and lower bounds on the 2017 Plan projections respectively.

4.2.4 In addition, as noted earlier, Defra has assessed the overall uncertainty in its PCM model projections to be +/-29%. As such, additional 'Low' and 'High' emissions uncertainty sensitivity tests have been considered for each of the above scenarios, in which PCM projections are either decreased or increased by 29% respectively. The PCM forecasts as presented in the 2017 Plan are, where required for clarity, referred to as 'Central' emissions scenarios.

4.3 ADJUSTMENT OF AIRPORTS COMMISSION MODELLED IMPACTS

4.3.1 As noted above, the DMRB methodology for assessing compliance with EU limit values is based on adding the ***impact*** of an option to PCM model projections that do not include the option in question. The adjustment process therefore applies to the AC modelled ***impact only*** and not to the total predicted pollutant concentrations in the AC's air quality assessment.

4.3.2 Modelled impacts of airport expansion are available for 2030 only. The adjustment of these impacts to take account of changes since the time of the AC's assessment[7] and the potential for opening in years prior to 2030 follows the same basic methodology as used in the previous WSP | Parsons Brinckerhoff Re-analysis studies. That is to say, factors are used to scale the AC's modelled impact from 2030 to any other year of interest assuming a linear relationship between change in emissions and change in ambient pollution concentrations.

4.3.3 This neglects some complexity in the conversion of emissions of NO to NO_2, but within the limitations of the study this is unlikely to be significant.

4.3.4 For this 2017 Plan update to the re-analysis, scaling factors are generated to adjust the 2030 AC modelled impact of airport expansion to take account of the following:

- Revisions to vehicle emissions factors (driven by updates to the COPERT emission factors); and
- Revisions to the growth scenarios.

4.3.5 The first of these effects applies to impacts from road transport only, the second to both road transport and airside emissions.

4.3.6 As in both Re-Analysis study and the Updated Re-analysis study, the impacts of the 2017 Plan on background projections for NOx/NO_2, and subsequent indirect impacts on total predicted pollution

levels in the future are not explicitly modelled in this study. Since the methodology for considering compliance is based on the difference between future year pollutant concentrations with and without airport expansion, any effects are likely to be marginal and unlikely to affect the conclusions of the report.

ADJUSTMENT FOR CHANGES TO VEHICLE EMISSIONS FACTORS

4.3.7 The AC air quality assessment was based on emissions from COPERT 4v10 (as incorporated into Defra's Emissions Factor Toolkit (EfT) v6.02).

4.3.8 Since the AC's assessment, the COPERT factors have been updated on several occasions. COPERT v4.11.0 was used for the 2015 Plan PCM model projections, whereas a further update (v4.11.4) was incorporated into a revised EfT (v7.0). The former were considered in the WSP | Parsons Brinckerhoff Re-Analysis Study[2]; the latter were considered in the Updated Re-Analysis Study[3].

4.3.9 COPERT emissions factors include 'conformity factors' to account for the fact that vehicle performance and emissions in the real world do not, in general, correspond with those measured in European test cycles and in particular NO_X emissions from diesel cars have been significantly higher than the European standards would suggest.

4.3.10 The conformity factors are the ratios between actual vehicle emissions and the emissions standard for that vehicle and are, therefore, speed dependent. For ease of reference, Defra defines the conformity factor as the ratio at 33.6kph (this is the average speed of the current vehicle emissions test cycle) and this definition is used in the discussion below. It is of note that the conformity factors increase at lower speeds.

4.3.11 The PCM baseline modelling undertaken for the 2015 Plan was based on emissions from light duty diesel vehicles with conformity factors of 2.6 – 2.8[23] (COPERT v4.11.0). These factors were constant over time and, therefore, reductions in average vehicle emissions over time were driven by the replacement of older vehicles (Euro 5 standard and earlier) in the fleet with Euro 6 standard vehicles, rather than improvements in Euro 6 vehicles over time.

4.3.12 In the 2016 update to COPERT (v4.11.4), the conformity factors for Euro 6 vehicles (and the emissions on which they are based) decreased over time. For example, for vehicles entering the fleet between 2016 and 2019, the updated factors are significantly higher than the previous factors but, for vehicles released after 2020, the updated factors are lower than previous.

4.3.13 As such, with the updated COPERT factors, average emissions per vehicle across the UK fleet are currently higher than previously estimated. However, this disparity will decrease over time and, as the turnover of the fleet progresses post 2020, average emissions will fall below previously estimated levels.

4.3.14 COPERT v5, as used for the 2017 Plan PCM modelling, whilst using the same emissions factor methodology as COPERT v4.11.4, was based on further evidence as to likely rate of improvement in vehicle emissions over time with further decreases in conformity factors over time.

4.3.15 The new Real Driving Emissions (RDE) regulations should ensure that NOx emissions from vehicles are controlled during all normal driving conditions and that, as represented in the

[23] A lower conformity factor was used in some of the 2015 Plan SL-PCM modelling for the 2025 'With Measures' scenario to take account of the benefits of RDE.

COPERT v5 factors, that future Euro 6 vehicles will have lower emissions than the current Euro 6 vehicles.

4.3.16 However, there are limited numbers of the vehicles that will be required to meet this future legislation available for testing and the estimation of future vehicle emissions remains subject to uncertainty. As such, no scaling factor has been applied to the AC's modelled impacts to take account of the variations in the conformity factor for vehicles over time. If RDE is fully and effectively implemented, this will be a conservative assumption.

4.3.17 Notwithstanding this, whether or not emissions from Euro 6 vehicles improve in the future, vehicle emissions are expected to decline over time due to the replacement of older, more polluting vehicles. As a result, it is reasonable to expect that emissions per vehicle will be greater in 2025 than in the 2030 assessment year.

4.3.18 The previous WSP | Parsons Brinckerhoff re-analysis studies took this into account by applying a scaling factor of *1.25* to the 2030 impacts to estimate impacts in 2025. This factor was based on the rate of improvement over time seen in the EfT v6.0 and EfT v7.0 for indicative roads (both datasets, independently, showing emissions in 2025 around 1.25 higher than in 2030). On the available evidence, this remains an appropriate factor for scaling from 2030 to 2025 impacts, and was applied to impacts from road transport in this report.

ADJUSTMENT FOR SCHEME OPENING PRIOR TO 2030

4.3.19 The 2030 to 2025 scaling factor applies to emissions *per vehicle* and takes no account of rates of growth in the demand for air capacity. That is to say, emissions per vehicle may be higher in 2025 than 2030, but the numbers of aircraft movements and vehicle journeys may be lower. However, since the demand and the growth in demand vary over time, it is appropriate to take account of variations between the assumed growth in the AC's assessment and the new DfT 2017 forecasts.

4.3.20 The UK Aviation Forecasts 2017 provide a revised set of forecasts of the increase in air transport movements (ATMs) over time with each of the options and were used by DfT to produce revised sets of forecasts of highways trips generation. These revised forecasts were compared to the AC ATM forecasts and trip generation (using AC forecasts in DfT's surface access models) to derive a set of scaling factors to take account of realistic growth scenarios.

4.3.21 Various datasets were provided by DfT to WSP relating to changed demand growth, namely:

- Forecast Air Traffic Movements (ATM) for 2025 to 2050 for the AC and DfT 2017 high forecasts;
- Forecast Surface Access Trip Generation for 2026 to 2030 (for passengers and employees, by zones across the UK, plus 2025 for Gatwick) (generated using the DfT surface access model) i.e. forecasts of the numbers of highway trips as a function of geographical area, but without assignment to a particular road; and
- Estimated assignment of Vehicle Trips to Road Network for 2026 and 2030 for Heathrow NWR Option (generated using the DfT surface access model) i.e. forecasts of the additional vehicles *on particular roads* associated with access to the airport.

4.3.22 It is important to note again that in the following discussion on the derivation of scaling factors, we are aiming to scale the AC's *modelled impact for 2030* to other growth scenarios and years. Therefore, the scaling factors are derived by comparing the ratio of the increase in either ATM or

highways trips resulting from a particular option in the DfT 2017 forecasts *in the year of interest* to the corresponding increase in the AC's demand model or trip generation *for 2030*[24].

4.3.23 Table B.1 in Appendix B to this report shows the forecast Air Transport Movements (ATMs) used by the AC and in the DfT's new forecasts. In 2030, when compared to the AC demand, DfT's latest forecasts show a 9% increase (factor = 1.09) in the growth of annual ATMs associated with the Heathrow NWR option, but a 53% decrease in annual ATMs (factor = 0.47) associated with the Gatwick 2R option.

4.3.24 Table B.2 in Appendix B to this report shows the forecast trip generation (cars) across all zones in the UK (passengers and employees), from zones in central London and from employees. It is important to note that the model does not take account of any measures which might be put in place to manage road traffic demand or mitigate the growth in car trips.

4.3.25 In 2030, DfT's forecast of unmitigated trip generation gives 17% more growth in total highways trips than the AC's forecast (in the DfT's surface access model) for the Heathrow NWR Option, but 24% fewer trips for the Gatwick 2R option. In comparison to the AC's forecasts for 2030, the DfT 2017 forecasts generate 1% more growth in traffic in 2026 with the NWR option, but over 50% less traffic in the Gatwick 2R option.

4.3.26 The growth in highway trips is close to double the growth in ATM i.e. for Heathrow NWR, in 2030, 9% growth in ATM equates to 17% growth in highways trips generation. This strongly suggests that in relation to this study, which focusses on the change in impact, different scaling factors should be applied to airside sources and roadside sources.

4.3.27 The previous WSP re-analysis studies showed that impacts in central London were key drivers of compliance risks with the Heathrow NWR and ENR options. It was, therefore, instructive to assess whether there was any evidence in the DfT 2017 forecasts for a bias in the changed demand for central London. There was, however, no evidence of this in relation to total trip generation with 17% growth in overall highways trip generation but just 7% growth in trips in central London.

4.3.28 For Heathrow NWR, DfT has provided an estimate of the assignment of vehicle trips onto the strategic road network. This has been used to assess how the revised trip generation could potentially impact on vehicle numbers on individual links considered within the re-analysis exercise. Table B.3 in Appendix B shows the DfT estimated change in vehicle numbers on roads that correspond to PCM model links identified by the AC as being at risk of non-compliance with limit values (i.e. extra trips associated with an option). These data include roads in the vicinity of the airport and in central London.

4.3.29 In 2030, the maximum ratio of option-related growth in traffic on a link is 1.48, on Westway in central London, with the range of 1.11 to 1.48. The maximum ratio in growth is significantly higher than for the overall growth in trip generation (1.17) but the absolute increase in flow on the particular link with airport expansion is modest (Table B.3, link 74538) and small changes in flow can result in large percentage changes. Notwithstanding this, the data illustrate that maximum impacts on individual road links can be significantly higher than the mean growth.

4.3.30 Table 4-1 shows a summary of the scaling factors derived by considering growth in ATM and growth in trip generation with the options.

[24] The AC modelled impacts in 2030 only. Therefore, in scaling this 2030 impact to earlier years, it is the necessary to generate year-specific factors that compare the AC assumed growth in 2030 to the new, year specific, growth in the DfT 2017 forecasts.

Table 4-1 Summary of scaling factors for impact adjustment

METRIC		2025	2026	2027	2028	2029	2030	COMMENT
Gatwick 2R								
Growth in ATM		0.06	0.28	0.33	0.37	0.44	0.47	Table B.1, Used for airside
Growth in Total Trips		0.10	0.46	0.53	0.61	0.68	0.76	Table B.2
Factor Used for Roads		**0.13**	**0.58**	**0.67**	**0.77**	**0.86**	**0.96**	Growth in trips multiplied by 1.26
Heathrow ENR								
Growth in ATM			1.03	1.01	1.01	1.03	1.04	Table B.1, Used for airside
Growth in Total Trips			1.01	1.03	1.05	1.07	1.09	Table B.2
Trips in Cent. London			0.84	0.88	0.92	0.96	1.00	Table B.2
Maximum Trip Generation			1.01	1.03	1.05	1.07	1.09	
Factor Used for Roads			**1.27**	**1.30**	**1.32**	**1.35**	**1.38**	Maximum growth in trips multiplied by 1.26
Heathrow NWR								
Growth in ATM			1.03	1.13	1.12	1.07	1.09	Table B.1, Used for airside
Growth in Total Trips			1.01	1.05	1.09	1.13	1.17	Table B.2
Trips in Cent. London			0.81	0.87	0.94	1.00	1.07	Maximum of ATM & Trips
PCM Link	16112 (A4)		1.02	1.06	1.10	1.15	1.19	
	18727 (A312)		1.00	1.03	1.05	1.08	1.11	
	26914 (A312)		0.89	0.96	1.02	1.09	1.16	
	8509 (A40)		0.89	0.96	1.02	1.09	1.16	
	16110 (A4)		0.98	1.05	1.13	1.20	1.27	
	16404 (A40)		0.89	0.96	1.02	1.09	1.16	
	26116 (A4)		0.98	1.05	1.13	1.20	1.27	
	28505 (A4)		0.95	1.00	1.06	1.12	1.18	
	36119 (A4)		0.98	1.05	1.12	1.20	1.27	
	36437 (A40)		0.89	0.96	1.02	1.09	1.16	
	46121 (A4)		0.98	1.05	1.13	1.20	1.27	
	56436 (A40)		0.90	0.95	1.00	1.06	1.11	
	73567 (A4)		0.98	1.05	1.12	1.20	1.27	
	74538 (A40)		1.11	1.20	1.29	1.39	1.48	
	48251 (A501)		1.08	1.16	1.24	1.32	1.40	
	58173 (A4206)		1.08	1.16	1.24	1.32	1.40	
	70181 (A40)		1.08	1.16	1.24	1.32	1.40	
	74534 (A40)		0.89	0.96	1.02	1.09	1.15	
Factor Used for Roads			**1.11**	**1.20**	**1.29**	**1.39**	**1.48**	Maximum Ratio to Trip Growth is 1.26

4.3.31 The AC modelled impacts include both contributions from airside and roadside emissions. For the majority of PCM links considered, the contribution from airside emissions is imperceptibly small i.e. the links are located in central London. However, for PCM model links in the vicinity of the new ENR runway (16112, 26914, 56114), and in the vicinity of Gatwick (18231, 78155), the impacts from the airside and roadside emissions were scaled separately using the factors set out below. Impacts alongside all other PCM model links were scaled using the roadside factors only.

4.3.32 Taking into account the uncertainty in the assignment of trips onto the road network, and the variability in the ratio of trip growth modelled by the different demand models, the factor used to scale road transport related impacts for the Heathrow NWR has been set at the maximum growth ratio seen on any affected link (e.g. 1.11 in 2026, 1.48 in 2030, etc). This is greater than the ratio for overall trip generation and represents a conservative approach. The scaling factor for airside emissions is taken from the growth in ATM (e.g. 1.03 in 2026, 1.09 in 2030, etc).

4.3.33 For Heathrow ENR and Gatwick 2R, the factor for scaling road transport impacts was derived by taking the ratio for the growth in total trips (which exceeds the growth in ATM for both options, except ENR in 2026) and applying an additional factor (1.26) to account for the observed variation in link by link trip assignment seen in the data for NWR, i.e. in 2030 the ratio of overall growth in trip generation between DfT and AC forecasts was 1.17, the maximum ratio on any individual link was 1.48, and 1.48/1.17 = 1.26. Again this represents a conservative approach in that the growth in traffic on any individual link is maximised.

4.3.34 Impacts from airside emissions were scaled using the growth in ATMs. The scaling factor for airside emissions does not change over time. This is because the AC's modelling did not make allowance for improvements in aircraft engines over time in the way in which vehicle emissions were assumed to improve.

MITIGATION

4.3.35 The WSP | Parsons Brinckerhoff 2016 Re-analysis study demonstrated that, whilst the direct mitigation of the increase in emissions with increased airport capacity (through, for example, air quality management strategies) reduces the potential impacts of any of the options, the overall conclusions of the re-analysis were relatively insensitive to such direct mitigation of airport impacts; for Gatwick 2R risks to compliance were low whether or not mitigation was in place, and for the Heathrow options, whilst mitigation was effective in the vicinity of the airport, risks also existed in central London. As such, the data presented in this report relate to the airport options prior to the application of mitigation measures by the scheme promoters, including any commitments made in relation to use of public transport.

4.3.36 The exception to this is consideration of the updated surface access strategy for Heathrow ENR. Impacts are considered without the strategy and, separately, with Iteration 3 of the updated strategy. Taking into account the nature of Iteration 3 in relation to the PCM modelling (namely diversion of traffic away from key PCM model link – 56114 (A4)), impacts for Heathrow ENR with Iteration 3 are assumed to follow those presented for Heathrow NWR which incorporated a similar diversion of traffic. As such, Iteration 3 affects the compliance risk re-analysis in the vicinity of the airport only and does not affect impacts in central London.

4.4 IMPACT ASSESSMENT

4.4.1 The impact is assessed against the following criteria:

- Criteria A: Does the option cause a compliant 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? And

- 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?

4.4.2 It should be noted that where an option causes a delay to compliance within a non-compliant zone (Criteria B = Yes), it may also cause a worsening of compliance alongside other links that do not, on their own, delay the zone compliance. In this case, Criteria C is also answered yes. This allows a distinction to be made between a case where only a single link is affected and where multiple links are affected.

RISK ASSESSMENT

4.4.3 The criteria above are simple binary criteria, Yes or No, and make no allowance for the margin of exceedance or compliance associated with an option. The assessment of risk therefore takes into account the headroom between the estimated PCM concentration with an option and the limit value.

4.4.4 The headroom is defined as a percentage of the limit value; where the value is expressed as a positive number, concentrations are below the limit value, and where the value is expressed as a negative number, concentrations are above the limit value.

4.4.5 Professional judgement is used to assess the risk taking into account:

- the headroom in scenarios using the central estimate of PCM model projections, i.e. direct from the 2017 Plan PCM model projections:
- the variation in headroom between the Baseline, CAZ and CAZ+ZEZ scenarios: and
- the available headroom with maximum uncertainty limits (+29%) applied to the air quality projections.

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.

5.1.2 The assessment is provided by option, for the years 2026 through to 2030. It is possible that Gatwick 2R could open in 2025. However, the projected growth is very small at this stage and, for Gatwick, the risk of non-compliance is not significantly greater than in the following years. As such, the analysis focuses on 2026 through to 2030 for all options.

5.1.3 As set out at paragraphs 2.2.23 and 2.2.24, all schemes are assessed using a higher demand scenario rather than the central. The intention is to provide a conservative assessment of air quality impacts.

5.1.4 The data are presented in tabular format in this chapter and in graphical format in Appendix C.

5.1.5 In the following sections, reference to the 'airport impact' refers to the AC modelled impact of airport expansion, scaled by taking into account any adjustments required for the assessment year and growth scenario. PCM model projection refers to the PCM model projections undertaken for the 2017 Plan and all discussion is limited to impacts on NO_2 concentrations.

5.1.6 This study, and the WSP | Parsons Brinckerhoff 2016 Re-analysis study and Updated Re-analysis study, considered **all** PCM/SL-PCM links included in the AC's limit value compliance assessment. In this section, data are presented for the critical links only. These are selected, as appropriate, to represent those links which delay compliance for the zone or see a reintroduction of non-compliance, or worsened exceedance. In particular, for Heathrow options the study considered links in the vicinity of the airport and links in central London, but for some scenarios the critical links are in central London.

5.1.7 All scenarios and options were assessed against criteria A to C outlined in Section 4.4. The following tables include colour gradings using the following classes:

- **No impact on limit value compliance**
  - ***Green Shading = Scenario does not cause or contribute to exceedances of EU limit values (Answer to all criteria = 'No')***
- **Impact on limit value compliance**
  - ***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')***
  - ***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')***

5.1.8 In the tables:

- Criteria A is answered 'Yes' if the Total NO_2 concentration on the critical link is increased by the option **and** is **greater than** the limit value (40µg/m^3) **and** the Maximum NO_2 concentration in zone (without the option) is **less than** or equal to the limit value;

- Criteria B is answered 'Yes' if the Total NO_2 concentration on the critical link is increased by the option **and** is **greater than** the limit value (40µg/m^3) **and** greater than the Maximum NO_2 concentration in zone (without the option), such that the option causes a delay to compliance; and
- Criteria C is answered 'Yes' if the Total NO_2 concentration on the critical link and/or any other link is increased by the option **and** is **greater than** the limit value (40µg/m^3) but **less than or equal to** the Maximum NO_2 concentration in zone (without the option)[25]. (If this applies to links other than the critical link, then this Criteria may be triggered at the same time as Criteria B).

5.2 GATWICK 2R

5.2.1

5.2.2 Table 5-1 shows the compliance assessment for all scenarios for the Gatwick 2R option with the new DfT 2017 forecasts of the growth in demand.

5.2.3 There are no projected exceedances of the limit values in any year, in any 2017 Plan scenario (Baseline, CAZ or CAZ+ZEZ), and the available headroom is more than 15% in all years.

5.2.4 The only scenarios in which compliance with limit values is impacted are those for which maximum uncertainty (+29%) is applied to the PCM model projections. In these cases, concentrations on the most affected link exceed the limit value in all years, but the magnitude of the exceedance is low (4% of the limit value in 2026, falling to 2% of the limit value in 2030). The critical link in all years is the A23 (London Road and Airport Way). This road currently runs alongside the airport boundary but would be re-aligned with the Gatwick 2R option. Details of the realignment are not available at this time.

5.2.5 In the high uncertainty scenarios, the risk of exceedance of the limit value decreases over time since the impact of decreasing PCM model projections more than offsets the increasing impact of the airport with increasing growth.

5.2.6 In low emission scenarios (uncertainty of -29%), the risk of exceedance is very low, with projected concentrations less than 70% of the limit value in all cases.

[25] It is possible that Criteria C may be triggered by links not shown in the table. This could happen, for example, where the critical link causes a delay to compliance but there are other links where exceedances of limit values are worsened. These cases are captured in the Tables in Section 5.

Table 5-1 Compliance assessment for the critical links for the Gatwick 2R option.

KEY: N=No = does not trigger criteria; Y = Yes = Triggers criteria. Conc = Concentration in µg/m^3 The shading in the criteria column reflects the overall grading of the impact of the option in the sensitivity test. Headroom = difference between total conc and limit value

Scenario	Critical PCM Link	Change in Conc due to Option (AC Modelled Impact)	PCM Model Projected Conc	Total NO_2 Conc	%Head-room (as % of Limit Value)	Max NO_2 conc in zone (without Option)	Criteria		
							A: Zone becomes noncompliant	B: Delay to zone Compliance	C: worsened exceedances
2026 Scenarios									
Baseline	18231	5.3	28.4	33.7	16	33.3	N	N	N
	78155	5.7	24.3	30.0	25				
With CAZ	18231	5.3	28.2	33.4	16	32.8	N	N	N
	78155	5.7	24.1	29.8	26				
With CAZ+ZEZ	18231	5.3	28.2	33.4	16	32.5	N	N	N
	78155	5.7	24.1	29.8	26				
2027 Scenarios									
Baseline	18231	6.0	27.6	33.6	16	31.7	N	N	N
	78155	6.4	23.6	30.0	25				
With CAZ	18231	6.0	27.4	33.4	16	31.4	N	N	N
	78155	6.4	23.5	29.8	26				
With CAZ+ZEZ	18231	6.0	27.4	33.4	16	31.0	N	N	N
	78155	6.4	23.5	29.8	26				
2028 Scenarios									
Baseline	18231	6.6	26.9	33.5	16	30.4	N	N	N
	78155	7.0	23.0	30.0	25				
With CAZ	18231	6.6	26.8	33.4	16	30.1	N	N	N
	78155	7.0	22.9	29.9	25				
With CAZ+ZEZ	18231	6.6	26.8	33.4	16	29.7	N	N	N
	78155	7.0	22.9	29.9	25				

Scenario	Critical PCM Link	Change in Conc due to Option (AC Modelled Impact)	PCM Model Projected Conc	Total NO_2 Conc	%Head-room (as % of Limit Value)	Max NO_2 conc in zone (without Option)	Criteria		
							A: Zone becomes noncompliant	B: Delay to zone Compliance	C: worsened exceedances
2029 Scenarios									
Baseline	18231	7.2	26.3	33.6	16	29.2	N	N	N
	78155	7.5	22.5	30.0	25				
With CAZ	18231	7.2	26.2	33.5	16	29.0	N	N	N
	78155	7.5	22.4	29.9	25				
With CAZ+ZEZ	18231	7.2	26.2	33.5	16	28.6	N	N	N
	78155	7.5	22.4	29.9	25				
2030 Scenarios									
Baseline	18231	7.7	25.8	33.5	16	28.3	N	N	N
	78155	7.9	22.0	30.0	25				
With CAZ	18231	7.7	25.8	33.4	16	28.1	N	N	N
	78155	7.9	22.0	29.9	25				
With CAZ+ZEZ	18231	7.7	25.8	33.4	16	27.6	N	N	N
	78155	7.9	22.0	29.9	25				

5.3 HEATHROW NWR

5.3.1 Table 5-2 shows the compliance assessment for the critical link(s) for all scenarios for the Heathrow NWR option with new DfT forecasts of growth of demand. As set out in the methodology, all links in the PCM model at risk of exceeding the limit value and for which the option is predicted to result in an increase in concentrations are considered in the compliance risk assessment. For clarity in reporting, only the key links in the compliance assessment are reported in the table. For Heathrow NWR, this includes links in the vicinity of the airport and links towards the centre of London.

5.3.2 With the actions set out in the 2017 Plan, Heathrow NWR option has no impact on modelled compliance with limit values in any year (CAZ or CAZ+ZEZ). With early opening, however, there is very little headroom (<1%) without the London ZEZ and the risk of impacting on compliance is high.

5.3.3 In the Baseline scenarios, the option causes a delay to the compliance of the zone with opening prior to 2029, although the exceedance of the standard is marginal in 2028 (headroom ~1%). In 2029, projected PCM concentrations with the option are <95% of the standard in the CAZ scenario and <90% of the standard in the CAZ+ZEZ scenario. By 2030, in the core CAZ scenario concentrations are <90% of the standard, and the risk of non-compliance is considered to fall to medium.

5.3.4 The critical link in all years is the A40 (Westway, 70181) in central London – over 15 km away from the airport boundary. On this road, the impact of the airport is small and the risk of non-compliance is determined to a large degree by the magnitude of the PCM model projection rather than the magnitude of the airport impact. On the critical link, the impact of the airport is small and related entirely to highway trips to the airport. The impact of airside emissions on the link, and on the compliance risks for the option overall, is negligible.

5.3.5 With maximum uncertainty applied to the 2017 Plan PCM model projections, the option impacts on limit value compliance in all years, by worsening exceedances on links and/or by causing a delay to compliance. With the low range of uncertainty, the zone is compliant in all scenarios.

Table 5-2 Compliance assessment for the critical links for the Heathrow NWR option.

KEY: N=No = does not trigger criteria; Y = Yes = Triggers criteria. Conc = Concentration in µg/m³ The shading in the criteria columns reflects the overall grading of the impact of the option in the sensitivity test

Scenario	Critical PCM Link	Change in Conc due to Option (AC Modelled Impact)	PCM Model Projected Conc	Total NO_2 Conc	%Head-room (as % of Limit Value)	Max NO_2 conc in zone (without Option)	Criteria		
							A: Zone becomes noncompliant	B: Delay to zone Compliance	C: worsened exceedances
2026 Scenarios									
Baseline	16112	1.4	35.4	36.8	8	**44.6**	N	Y	Y
	70181	0.3	**44.6**	**44.8**	-12				
With CAZ	16112	1.4	34.8	36.2	10	**40.2**	N	N	N
	70181	0.3	39.7	39.9	0				
With CAZ+ZEZ	16112	1.4	34.8	36.2	10	38.1	N	N	N
	70181	0.3	37.4	37.6	6				
2027 Scenarios									
Baseline	16112	1.5	35.0	36.5	9	**42.4**	N	Y	Y
	70181	0.3	**42.4**	**42.7**	-7				
With CAZ	16112	1.5	34.6	36.1	10	38.8	N	N	N
	70181	0.3	38.5	38.8	3				
With CAZ+ZEZ	16112	1.5	34.6	36.1	10	37.2	N	N	N
	70181	0.3	36.3	36.6	9				
2028 Scenarios									
Baseline	16112	1.5	34.6	36.1	10	**40.3**	N	Y	N
	70181	0.3	**40.3**	**40.6**	-1				
With CAZ	16112	1.5	34.6	36.1	10	37.5	N	N	N
	70181	0.3	37.5	37.8	6				

Scenario	Critical PCM Link	Change in Conc due to Option (AC Modelled Impact)	PCM Model Projected Conc	Total NO_2 Conc	%Head-room (as % of Limit Value)	Max NO_2 conc in zone (without Option)	Criteria		
							A: Zone becomes noncompliant	B: Delay to zone Compliance	C: worsened exceedances
With CAZ+ZEZ	16112	1.5	34.6	36.1	10	36.5	N	N	N
	70181	0.3	35.2	35.5	11				
2029 Scenarios									
Baseline	16112	1.5	34.2	35.7	11	38.5	N	N	N
	70181	0.3	38.5	38.8	3				
With CAZ	16112	1.5	34.2	35.7	11	36.4	N	N	N
	70181	0.3	36.4	36.7	8				
With CAZ+ZEZ	16112	1.5	34.2	35.7	11	35.5	N	N	N
	70181	0.3	34.2	34.5	14				
2030 Scenarios									
Baseline	16112	1.5	33.9	35.4	11	36.8	N	N	N
	70181	0.3	36.8	37.1	7				
With CAZ	16112	1.5	33.9	35.4	11	35.4	N	N	N
	70181	0.3	35.4	35.6	11				
With CAZ+ZEZ	16112	1.5	33.9	35.4	11	34.5	N	N	N
	70181	0.3	33.2	33.5	16				

5.3.7 In the vicinity of the airport, impacts on Bath Road (A4, 16112) and the A312 (18727, 26914) are assessed but the links are not the critical link in that, for this option, they do not trigger non-compliance of the zone or experience a worsening of exceedance of the limit value in any scenario.

5.3.8 Modelled roadside pollutant concentrations in Greater London are elevated across a wide area. Typically, the highest concentrations are consistent across a number of PCM links, although the maximum concentration in the zone can switch between links on the A40 (as seen in the PCM modelling used in the AC's assessment) and other roads such as the A4 in central London. The former were included in the AC's assessment, but the latter were not since they did not experience a significant change in traffic with the option. As such, in some scenarios the links in central London that are affected by the airport option (albeit by a relatively small impact, <1µg/m^3) coincide with the maximum concentration in the zone or have concentrations very close to the maximum in the zone. Taking into account uncertainties in the PCM modelling on a link-by-link basis, it should, therefore, be assumed that wherever PCM concentrations in central London exceed the limit value, the option is at risk of causing a delay to the compliance of the zone.

5.4 HEATHROW ENR

5.4.1 Table 5-3 shows the compliance assessment for all scenarios for the Heathrow ENR option for increased airport capacity for key links in the PCM model. Data are shown for links in the vicinity of the Airport (A4) and towards central London (A40). These links are less than 1km and over 15km from the airport boundary respectively.

5.4.2 The option impacts on compliance with limit values in all 2017 Plan scenarios, for opening between 2026 and 2030, irrespective of the implementation of Government 2017 Plan actions and irrespective of the level of uncertainty applied to the PCM model projections.

5.4.3 With the updated surface access strategy, the impact of Heathrow ENR follows that of Heathrow NWR, with risks to compliance largely dictated by the impacts of surface access on roads in central London, and the critical link in all years is the A40 (Westway) in central London, over 15 km away.

5.4.4 With the actions set out in the 2017 Plan and the surface access strategy, the option has no impact on modelled compliance with limit values in any year (CAZ or CAZ+ZEZ). With early opening, however, there is very little headroom (i.e. following Heathrow NWR, <1 in 2026, <5% in 2027 and <10% in 2027 - 2029) without the London ZEZ and the risk of impacting on compliance is high.

5.4.5 The risks decrease with time such that, with opening in 2030 or later, the risk levels have fallen to medium (with >10% headroom in the core CAZ scenario).

5.4.6 Without the updated surface access strategy (Iteration 3), the impact of the option on Bath Road near the airport is also significant, particularly in years after 2028 when total concentrations in central London are relatively lower and, even with the Government's ZEZ and additional measures, the option perpetuates the non-compliance of the Greater London zone. On Bath Road, the option impacts result from a combination of both airside and surface access emissions. Without the surface access strategy, the risks to EU compliance are very high (core CAZ scenario exceeds the limit value by over 5% in all years).

Table 5-3 Compliance assessment for the critical links for the Heathrow ENR option (AC option, without surface access strategy).

Key: N=No = does not trigger criteria; Y = Yes = Triggers criteria. Conc = Concentration in µg/m^3. The shading in the criteria columns reflects the overall grading of the impact of the option

Scenario	Critical PCM Link	Change in Conc due to Option (AC Modelled Impact)	PCM Model Projected Conc	Total NO_2 Conc	%Head-room (as % of Limit Value)	Max NO_2 conc in zone (without Option)	Criteria		
							A: Zone becomes noncompliant	B: Delay to zone Compliance	C: worsened exceedances
2026 Scenarios									
Baseline	56114	9.8	34.1	**43.8**	-10	**44.6**	N	Y	Y
	70181	0.3	**44.6**	**44.9**	-12				
With CAZ	56114	9.8	33.6	**43.3**	-8	**40.2**	N	Y	N
	70181	0.3	39.7	40.0	0				
With CAZ+ZEZ	56114	9.8	33.6	**43.3**	-8	38.1	Y	N	N
	70181	0.3	37.4	37.7	6				
2027 Scenarios									
Baseline	56114	9.6	33.6	**43.2**	-8	**42.4**	N	Y	Y
	70181	0.3	**42.4**	**42.7**	-7				
With CAZ	56114	9.6	33.3	**42.9**	-7	38.8	Y	N	N
	70181	0.3	38.5	38.8	3				
With CAZ+ZEZ	56114	9.6	33.3	**42.9**	-7	37.2	Y	N	N
	70181	0.3	36.3	36.6	9				
2028 Scenarios									
Baseline	56114	9.5	33.2	**42.7**	-7	**40.3**	N	Y	Y
	70181	0.3	**40.3**	**40.6**	-1				
With CAZ	56114	9.5	33.2	**42.6**	-7	37.5	Y	N	N
	70181	0.3	37.5	37.8	6				
With CAZ+ZEZ	56114	9.5	33.2	**42.6**	-7	36.5	Y	N	N
	70181	0.3	35.2	35.5	11				

Scenario	Critical PCM Link	Change in Conc due to Option (AC Modelled Impact)	PCM Model Projected Conc	Total NO_2 Conc	%Head-room (as % of Limit Value)	Max NO_2 conc in zone (without Option)	Criteria		
							A: Zone becomes noncompliant	B: Delay to zone Compliance	C: worsened exceedances
2029 Scenarios									
Baseline	56114	9.5	32.9	**42.4**	-6	38.5	Y	N	N
	70181	0.3	38.5	38.8	3				
With CAZ	56114	9.5	32.8	**42.3**	-6	36.4	Y	N	N
	70181	0.3	36.4	36.7	8				
With CAZ+ZEZ	56114	9.5	32.8	**42.3**	-6	35.5	Y	N	N
	70181	0.3	34.2	34.5	14				
2030 Scenarios									
Baseline	56114	9.4	32.6	**42.0**	-5	36.8	Y	N	N
	70181	0.3	36.8	37.0	7				
With CAZ	56114	9.4	32.5	**42.0**	-5	35.4	Y	N	N
	70181	0.3	35.4	35.6	11				
With CAZ+ZEZ	56114	9.4	32.5	**42.0**	-5	34.5	Y	N	N
	70181	0.3	33.2	33.5	16				

6 CONCLUSIONS

6.1 OVERVIEW

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

- Criteria A: Does the option cause a compliant 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? And
- 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 In the following sections, the tables show the summary of the Scenarios tested and a grading of the options against these criteria using the following classes:

- **No impact on zone or limit value compliance**
  - ***Green Shading = Scenario does not cause or contribute to exceedances of EU limit values (Answer to all criteria = 'No')***
- **Impact on limit value compliance**
  - ***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')***
  - ***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')***

6.1.3 In the following discussion, it is assumed that the core scenario for all options is the combination of the 2030 With CAZ PCM model projection and the 2030 airport modelled impact (AC modelled impact adjusted for opening year and DfT 2017 forecasts).

6.2 GATWICK 2R

6.2.1 Table 6-1 shows a summary of the results of the assessment for Gatwick 2R. The overall conclusion on compliance for the option is as follows:

Option	Conclusion	Commentary
Gatwick Second Runway	The option is at ***low risk*** to impact on compliance with limit values.	The conclusion has ***low vulnerability*** to uncertainties associated with the projection of future pollution concentrations and to the rate of growth in demand from a 2025 opening year since the scheme is only at risk of triggering non-compliance with EU Directive limit values when maximum levels of uncertainty are applied to the Government's PCM model projections.

6.2.2 All Gatwick 2R scenarios with central emissions estimates (that is to say, no allowance for model uncertainty) have ***no impact on zone compliance*** in any year. High emissions scenarios assume a +29% uncertainty in the PCM model projections.

Table 6-1 Summary of assessment of Scenarios for Gatwick 2R. Headroom is the difference between the EU limit value and the maximum concentrations, expressed as a % of the limit value

SCENARIO / YEAR	BASELINE	CAZ	CAZ+ZEZ
2026	Zone Compliant; 16% Headroom with Central Emissions; (4% Exceedance with High Emissions); Max Conc: 33.7µg/m^3; Max Impact: 5.7µg/m^3;	Zone Compliant; 16% Headroom with Central Emissions; (3% Exceedance with High Emissions); Max Conc: 33.4µg/m^3; Max Impact: 5.7µg/m^3;	Zone Compliant; 16% Headroom with Central Emissions; (3% Exceedance with High Emissions); Max Conc: 33.4µg/m^3; Max Impact: 5.7µg/m^3;
2027	Zone Compliant; 16% Headroom with Central Emissions; (4% Exceedance with High Emissions); Max Conc: 33.6µg/m^3; Max Impact: 6.4µg/m^3;	Zone Compliant; 16% Headroom with Central Emissions; (3% Exceedance with High Emissions); Max Conc: 33.4µg/m^3; Max Impact: 6.4µg/m^3;	Zone Compliant; 16% Headroom with Central Emissions; (3% Exceedance with High Emissions); Max Conc: 33.4µg/m^3; Max Impact: 6.4µg/m^3;
2028	Zone Compliant; 16% Headroom with Central Emissions; (3% Exceedance with High Emissions); Max Conc: 33.5µg/m^3; Max Impact: 7.0µg/m^3;	Zone Compliant; 16% Headroom with Central Emissions; (3% Exceedance with High Emissions); Max Conc: 33.4µg/m^3; Max Impact: 7.0µg/m^3;	Zone Compliant; 16% Headroom with Central Emissions; (3% Exceedance with High Emissions); Max Conc: 33.4µg/m^3; Max Impact: 7.0µg/m^3;
2029	Zone Compliant; 16% Headroom with Central Emissions; (3% Exceedance with High Emissions); Max Conc: 33.6µg/m^3; Max Impact: 7.5µg/m^3;	Zone Compliant; 16% Headroom with Central Emissions; (3% Exceedance with High Emissions); Max Conc: 33.5µg/m^3; Max Impact: 7.5µg/m^3;	Zone Compliant; 16% Headroom with Central Emissions; (3% Exceedance with High Emissions); Max Conc: 33.5µg/m^3; Max Impact: 7.5µg/m^3;
2030	Zone Compliant; 16% Headroom with Central Emissions; (2% Exceedance with High Emissions); Max Conc: 33.5µg/m^3; Max Impact: 7.9µg/m^3;	Zone Compliant; 16% Headroom with Central Emissions; (2% Exceedance with High Emissions); Max Conc: 33.4µg/m^3; Max Impact: 7.9µg/m^3;	Zone Compliant; 16% Headroom with Central Emissions; (2% Exceedance with High Emissions); Max Conc: 33.4µg/m^3; Max Impact: 7.9µg/m^3;

6.2.3 The critical link for the assessment is the A23 London Road/Airport Way. The impact of the Gatwick 2R option accounts for between 23% (in 2026) and 36% (in 2030) of the total future year concentrations, with road emissions accounting for up to 90% of the emissions.

6.2.4 The headroom between the EU limit value and the future concentration with the central emissions estimate (up to 16% of the limit value) equates to approximately 18% of the total estimated pollutant concentration or 180% of the scaled airport impact.

6.2.5 The +/-29% uncertainty bounds on the PCM model projections represent a worst case (95% confidence interval) upper bound on likely uncertainty in the model results, and the distribution of the uncertainty is likely to demonstrate a Gaussian distribution. The available headroom, which equates to a 20% uncertainty in the predicted maximum concentration, implies that it is unlikely that the limit value will be exceeded, even when taking into account a +/-29% uncertainty in both PCM and ADMS dispersion model.

6.2.6 Moreover, the significant contribution from airport-related sources to the total future concentration implies that mitigation of impacts, and reductions in the risk of non-compliance, are possible.

6.2.7 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 a similar magnitude of reductions to those expected at Heathrow and has the potential to reduce concentrations to within the limit value in all scenarios.

6.2.8 Overall, therefore, it is concluded that the Gatwick 2R option is at low risk of impacting on compliance with EU limit values.

6.4 HEATHROW NWR

6.4.1 Table 6.2 shows a summary of the results of the assessment for Heathrow NWR. The overall conclusion on compliance for the option is as follows:

Option	Conclusion	Commentary
Heathrow Northwest Runway	With the actions as set out in the 2017 Plan, the option ***does not impact*** on modelled compliance with limit values in any potential opening year (2026 onwards). Given the inherent uncertainties in air quality modelling, there remains, however, ***a risk that the option could delay compliance*** with limit values.	The risk of an impact on compliance with limit values increases the earlier the assumed opening year for the option. The risk of impact on compliance is high up to 2029 since the option potentially impacts on compliance in central London and exists whether or not the Government's 2017 Plan actions are fully implemented. From 2030 onwards, the risk falls to medium. The level of risk is primarily dependent on the timing of the introduction of, and effectiveness of, actions in the Government's 2017 Plan to reduce emissions from vehicles on the wider road network. It is largely independent of assumptions relating to the impact of the option itself or the direct mitigation of option-related emissions. Impacts near the airport do not, in general, affect zone compliance. Additional measures aimed at targeting high NO_2 concentrations at the local level and across London could potentially mitigate this risk further.

6.4.2 For Heathrow NWR, with the 2017 Plan actions implemented and fully effective, the option does not affect the compliance status of the Greater London zone, in any potential opening year.

6.4.3 However, the uncertainty in this conclusion must be noted.

6.4.4 The critical link in the modelling is 70181 (A40, Westway). The scaled contribution of the airport expansion option to pollutant concentrations on this link is very small (~0.3µg/m^3).

6.4.5 In 2026, in the 2017 Plan CAZ scenario, there is no available headroom between the limit value of the projected PCM concentration with the option. Therefore, any underestimate in either the PCM model or the AC's modelled impact is likely to move the Greater London zone into non-compliance.

6.4.6 The available headroom is less than 5% for the Baseline scenario and less than 10% for the CAZ scenario until 2029 (inclusive). As such, with the opening of NWR prior to 2030, a high risk of an impact on the compliance status of the Greater London zone is identified.

Table 6-2 Summary of assessment of Scenarios for Heathrow NWR. Headroom is the difference between the EU limit value and the maximum concentrations, expressed as a % of the limit value

SCENARIO / YEAR	BASELINE	CAZ	CAZ+ZEZ
2026	Delay to Compliance; 4 Links with Worsened Exceedances; 12% Exceedance with Central Emissions; (44% Exceedance with High Emissions); Max Conc: 44.8µg/m³; Max Impact: 1.4µg/m³;	No Impact on Zone Compliance; 0% Headroom with Central Emissions; (29% Exceedance with High Emissions); Max Conc: 39.9µg/m³; Max Impact: 1.4µg/m³;	Zone Compliant; 5% Headroom with Central Emissions; (21% Exceedance with High Emissions); Max Conc: 37.6µg/m³; Max Impact: 1.4µg/m³;
2027	Delay to Compliance; 2 Links with Worsened Exceedances; 7% Exceedance with Central Emissions; (37% Exceedance with High Emissions); Max Conc: 42.7µg/m³; Max Impact: 1.5µg/m³;	Zone Compliant; 3% Headroom with Central Emissions; (25% Exceedance with High Emissions); Max Conc: 38.8µg/m³; Max Impact: 1.5µg/m³;	Zone Compliant; 9% Headroom with Central Emissions; (18% Exceedance with High Emissions); Max Conc: 36.6µg/m³; Max Impact: 1.5µg/m³;
2028	Delay to Compliance; 1% Exceedance with Central Emissions; (31% Exceedance with High Emissions); Max Conc: 40.6µg/m³; Max Impact: 1.5µg/m³;	Zone Compliant; 6% Headroom with Central Emissions; (22% Exceedance with High Emissions); Max Conc: 37.8µg/m³; Max Impact: 1.5µg/m³;	Zone Compliant; 10% Headroom with Central Emissions; (15% Exceedance with High Emissions); Max Conc: 36.1µg/m³; Max Impact: 1.5µg/m³;
2029	Zone Compliant; 3% Headroom with Central Emissions; (25% Exceedance with High Emissions); Max Conc: 38.8µg/m³; Max Impact: 1.5µg/m³;	Zone Compliant; 8% Headroom with Central Emissions; (18% Exceedance with High Emissions); Max Conc: 36.7µg/m³; Max Impact: 1.5µg/m³;	Zone Compliant; 11% Headroom with Central Emissions; (14% Exceedance with High Emissions); Max Conc: 35.7µg/m³; Max Impact: 1.5µg/m³;
2030	Zone Compliant; 7% Headroom with Central Emissions; (19% Exceedance with High Emissions); Max Conc: 37.1µg/m³; Max Impact: 1.5µg/m³;	Zone Compliant; 11% Headroom with Central Emissions; (15% Exceedance with High Emissions); Max Conc: 35.6µg/m³; Max Impact: 1.5µg/m³;	Zone Compliant; 11% Headroom with Central Emissions; (13% Exceedance with High Emissions); Max Conc: 35.4µg/m³; Max Impact: 1.5µg/m³;

6.4.7 The proposed opening of the scheme between 2026 and 2030 coincides with the years in which the actions in the 2017 Plan are projected to move the zone from non-compliance to compliance and, by definition, there are PCM road links in these years that are projected to be at or close to the limit value.

6.4.8 Moreover, the roads likely to be affected by airport-related traffic e.g. the A40, include some of the PCM model links that have the highest projected future year concentrations in central London, both at present and in the future, i.e. the links that are the determiners of future zone compliance. Therefore, any impact on these road links could potentially result in a delay to the date of compliance for the zone.

6.4.9 Impacts on roads near the airport with this option have relatively little impact on compliance with limit values. This is due, in part, to changes to the alignment of sections of the Bath Road further to the north and away from the airport, which reduces the potential for combined impacts from airside and landside (surface access) emissions.

6.4.10 The risks of an impact are also largely unrelated to the magnitude of the impact of the airport option, although clearly the duration of any delay to compliance of the Greater London zone would be proportional to the magnitude of the impact. In fact, the impacts on links in central London are all relatively small, <1µg/m^3, whereas the maximum (numerical) impacts with the option occur near that airport (~1 - 2µg/m^3).

6.4.11 There is relatively little direct action that can be taken by the airport to reduce the risk of an impact on zone or individual link compliance with limit values in central London. Whilst it might be possible for the airport to offer various inducement measures to encourage sustainable transport by passengers and staff, the reduction in compliance risks is primarily dependent on the measures taken by national and local government to reduce emissions on the wider road network, including those in the 2017 Plan. The actions set out in the government's 2017 Plan and the effective implementation of RDE should minimise the risks that the Heathrow NWR option would impact on the compliance of the Greater London zone in any potential opening year (2026 onwards). Similarly, any additional actions undertaken at local or London level to improve air quality may reduce the risks.

6.4.12 The risk of an impact on compliance decreases over time, primarily due to the anticipated decreases in pollutant concentrations. The available evidence on vehicle emissions from the latest Euro 6/VI vehicles and the impacts of existing RDE legislation (and the introduction of zero-emission vehicles) suggests that it is possible to be confident that roadside NO_2 concentrations will fall in the future. It is the rate of decrease that is in question and the point in the future at which the downward trend is established. The further in the future projections are made, the more likely it becomes that concentrations alongside roads affected by airport related traffic are below the limit value. With proposed opening of the scheme between 2026 and 2030 it is unlikely that concentrations in central London will have fallen sufficiently to remove the risk of the airport expansion impacting on EU limit value compliance.

6.5 HEATHROW ENR

6.5.1 Table 6.3 shows a summary of the results of the assessment for ENR. The overall conclusion on compliance for the option is as follows:

Scheme	Conclusion	Commentary
Heathrow Extended Northern Runway	The option ***impacts*** on compliance with limit values in all potential opening years without the updated surface access strategy (Iteration 3) ***With the updated surface access strategy (Iteration 3)*** and the actions as set out in the Government's 2017 Plan, the option ***does not impact*** on modelled compliance with limit values in any potential opening year (2026 onwards). Given the inherent uncertainties in air quality modelling, there remains, however, ***a risk that the option could delay compliance*** with limit values, even with the access strategy.	The risk of an impact on compliance with limit values increases the earlier the assumed opening year for the option. Without the updated surface access strategy, the compliance risk is very high in all years. With the updated surface access strategy, the risk of impact on compliance is reduced but remains high up to 2029 since the option potentially impacts on compliance in central London, and exists whether or not the Government's 2017 Plan actions are fully implemented. From 2030 onwards, the risk falls to medium. A risk exists due to impacts in central London whether or not the updated surface access strategy is implemented, but the updated strategy is required to reduce risks on roads in the vicinity of the airport. With the updated surface access strategy, the level of risk is primarily dependent on the timing of the introduction, and effectiveness of, actions in the Government's 2017 Plan to reduce emissions from vehicles on the wider road network. It is largely independent of assumptions relating to the impact of the option itself or the direct mitigation of airside emissions. Additional measures aimed at targeting high NO_2 concentrations at the local level and across London could potentially mitigate this risk further.

6.5.2 In the absence of actions in the surface access strategy Iteration 3, the option results in either a delay to the compliance of the Greater London Urban Area with limit values or it results in moving the zone from compliance back into non-compliance. This applies in all potential opening years.

6.5.3 This is due to significant impacts from the airport (9µg/m^3) on Bath Road, due to a combination of surface access impacts and airside emission sources.

Table 6-3 Summary of assessment of Scenarios for Heathrow ENR. Headroom is the difference between the EU limit value and the maximum concentrations, expressed as a % of the limit value

SCENARIO / YEAR	BASELINE	CAZ	CAZ+ZEZ	CAZ + SURFACE ACCESS ITERATION 3
2026	Delay to Compliance; 6 Links with Worsened Exceedances; 12% Exceedance with Central Emissions; (44% Exceedance with High Emissions); Max Conc: 44.9µg/m^3; Max Impact: 9.8µg/m^3;	Delay to Compliance; 8% Exceedance with Central Emissions; (33% Exceedance with High Emissions); Max Conc: 43.3µg/m^3; Max Impact: 9.8µg/m^3;	Zone Made Non-Compliant; 8% Exceedance with Central Emissions; (33% Exceedance with High Emissions); Max Conc: 43.3µg/m^3; Max Impact: 9.8µg/m^3;	No Impact on Zone Compliance; Very low headroom; High risk of causing Delay to Compliance
2027	Delay to Compliance; 4 Links with Worsened Exceedances; 8% Exceedance with Central Emissions; (38% Exceedance with High Emissions); Max Conc: 43.2µg/m^3; Max Impact: 9.6µg/m^3;	Zone Made Non-Compliant; 7% Exceedance with Central Emissions; (31% Exceedance with High Emissions); Max Conc: 42.9µg/m^3; Max Impact: 9.6µg/m^3;	Zone Made Non-Compliant; 7% Exceedance with Central Emissions; (31% Exceedance with High Emissions); Max Conc: 42.9µg/m^3; Max Impact: 9.6µg/m^3;	No Impact on Zone Compliance; Low headroom; High risk of causing Delay to Compliance
2028	Delay to Compliance; 1 Links with Worsened Exceedances; 7% Exceedance with Central Emissions; (31% Exceedance with High Emissions); Max Conc: 42.7µg/m^3; Max Impact: 9.5µg/m^3;	Zone Made Non-Compliant; 7% Exceedance with Central Emissions; (31% Exceedance with High Emissions); Max Conc: 42.6µg/m^3; Max Impact: 9.5µg/m^3;	Zone Made Non-Compliant; 7% Exceedance with Central Emissions; (31% Exceedance with High Emissions); Max Conc: 42.6µg/m^3; Max Impact: 9.5µg/m^3;	No Impact on Zone Compliance; Low headroom; High risk of causing Delay to Compliance
2029	Zone Made Non-Compliant; 6% Exceedance with Central Emissions; (30% Exceedance with High Emissions); Max Conc: 42.4µg/m^3; Max Impact: 9.5µg/m^3;	Zone Made Non-Compliant; 6% Exceedance with Central Emissions; (30% Exceedance with High Emissions); Max Conc: 42.3µg/m^3; Max Impact: 9.5µg/m^3;	Zone Made Non-Compliant; 6% Exceedance with Central Emissions; (30% Exceedance with High Emissions); Max Conc: 42.3µg/m^3; Max Impact: 9.5µg/m^3;	No Impact on Zone Compliance; Medium headroom; Medium risk of causing Delay to Compliance
2030	Zone Made Non-Compliant; 5% Exceedance with Central Emissions; (29% Exceedance with High Emissions); Max Conc: 42.0µg/m^3; Max Impact: 9.4µg/m^3;	Zone Made Non-Compliant; 5% Exceedance with Central Emissions; (29% Exceedance with High Emissions); Max Conc: 42.0µg/m^3; Max Impact: 9.4µg/m^3;	Zone Made Non-Compliant; 5% Exceedance with Central Emissions; (29% Exceedance with High Emissions); Max Conc: 42.0µg/m^3; Max Impact: 9.4µg/m^3;	No Impact on Zone Compliance; Medium headroom; Medium risk of causing Delay to Compliance

6.5.4 The level of exceedance of the air quality limit value with the scheme, particularly in early years, is such that there is reasonable confidence that concentrations are likely to exceed the limit value. That is to say, only if the current modelling represents a significant overestimation of impacts from

either the airport or within the PCM model would future concentrations with the ENR option fall below the limit value. As such, there is a very high risk of an impact on compliance with the scheme.

6.5.5 Iteration 3 of the surface access strategy for Heathrow ENR does not reduce overall emissions from traffic. Rather it diverts traffic from the existing A4 Bath Road, which runs along the northern boundary of the airport, close to airside emission sources, onto a more northerly route. This reduces the potential for a significant combined effect from airside emission and emissions from road traffic. This iteration effectively mimics the impacts for Heathrow NWR and, with NWR, it was assumed by the AC that the diversion of the A4 would remove the road link from consideration in the PCM model and the compliance assessment.

6.5.6 It is possible that, in future PCM models, the diversion route itself would be included as a compliance assessment link. However, it is reasonable to conclude that the impacts would be lower than those modelled by the AC for the Bath Road without the surface access variation since, as stated above, the contribution from airside emissions would be lower alongside the diversion route.

6.5.7 Notwithstanding this, even with the surface access variation in place, the risks of impact on limit value compliance with ENR are not removed, since risks remain in relation to the increase in traffic on roads in central London. These risks have been set out in the discussion for the Heathrow NWR scheme.

6.5.8 In summary, with the updated surface access strategy (Iteration 3), the risk of the scheme impacting on the EU limit value compliance status of the Greater London Urban Area is high, but reduces over time. There is little direct action that the airport can take to mitigate these risks and mitigation of airside emissions will have no perceptible effect on the risk. Whilst it might be possible for the airport to offer various inducement measures to encourage sustainable transport, the reduction in compliance risks is primarily dependent on the measures taken by national and local government to reduce emissions on the wider road network, including those in the 2017 Plan. The actions set out in the Government's 2017 Plan and the effective implementation of RDE should minimise the risks that the Heathrow ENR option would impact on the compliance of the Greater London zone in any potential opening year (2026 onwards). Similarly, any additional actions undertaken at local or London level to improve air quality may reduce the risks further.

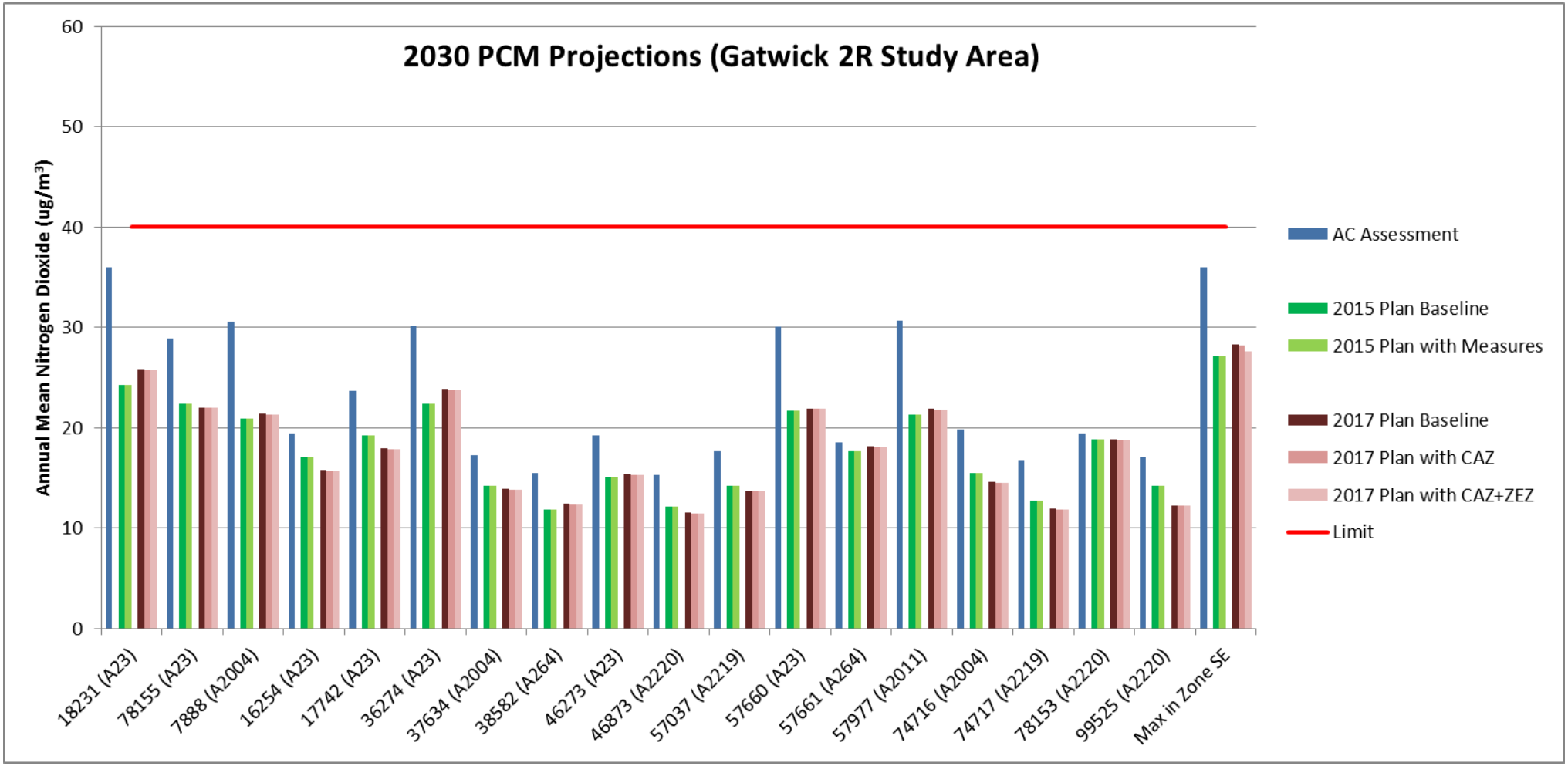
Appendix A

PCM MODEL PROJECTIONS FOR OPTION STUDY AREAS

APPENDIX A-1

GATWICK 2R

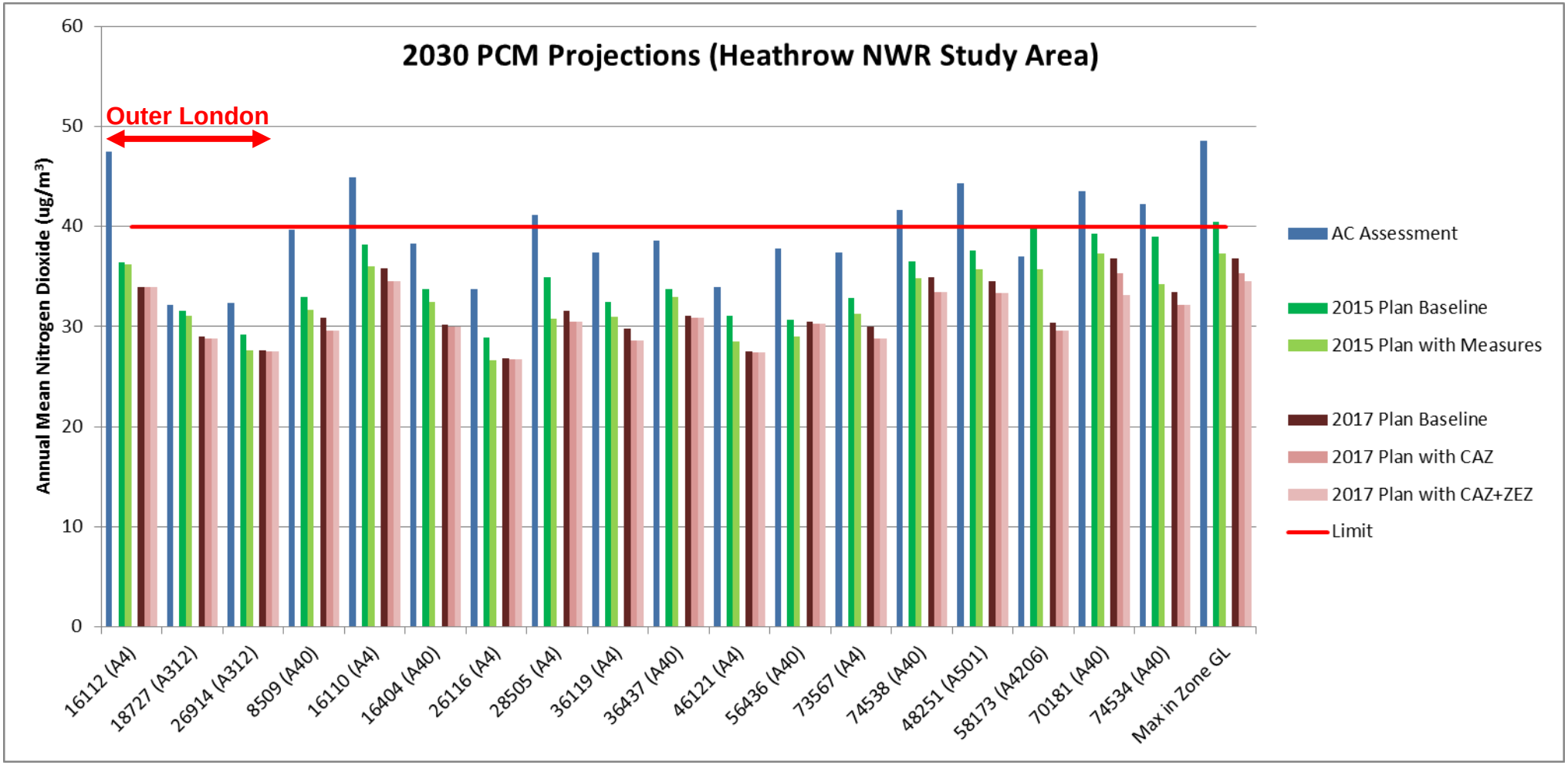
Figure A-1.2 PCM Model Projections for 2030. Bars show the PCM concentrations from the AC Assessment, the 2015 Plan (Baseline and with Measures) and the 2017 Plan (Baseline, CAZ, and CAZ+ZEZ) Scenarios. (µg/m^3 NO_2)



APPENDIX A-2

HEATHROW - NWR

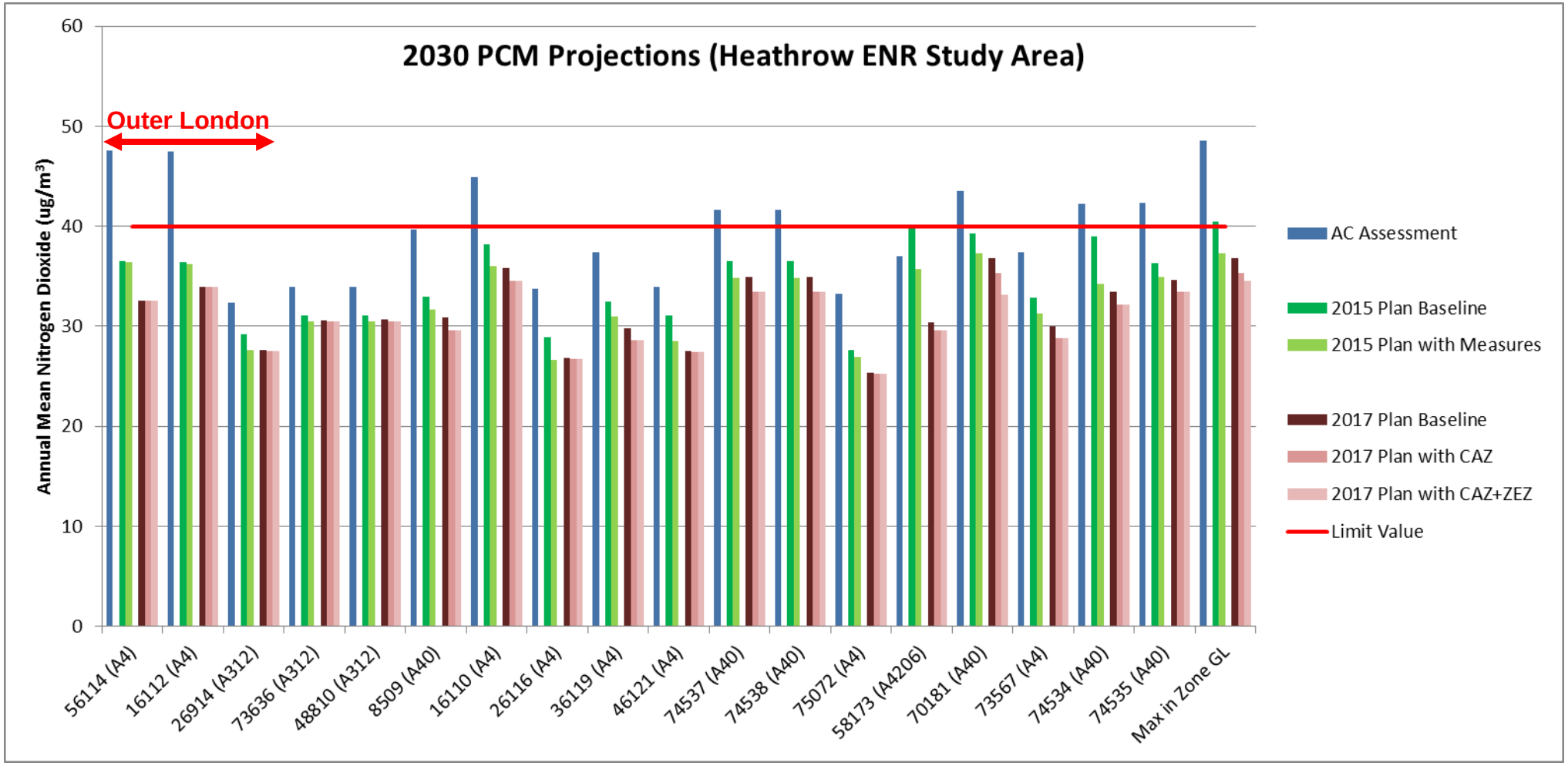
Figure A-2.1 PCM Model Projections for 2030. Bars show the PCM concentrations from the AC Assessment, the 2015 Plan (Baseline and with Measures) and the 2017 Plan (Baseline, CAZ, and CAZ+ZEZ) Scenarios. Links in central London except where indicated.



APPENDIX A-3

HEATHROW - ENR

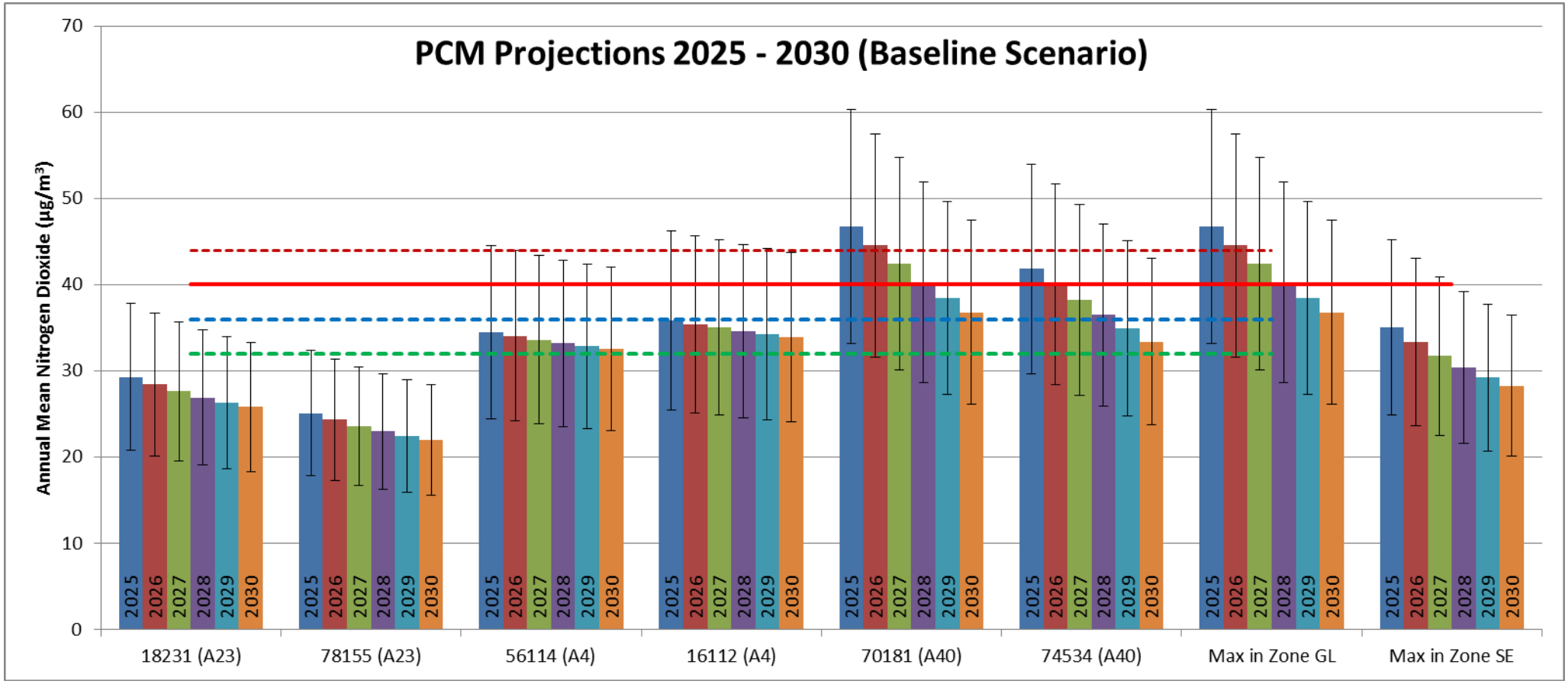
Figure A-3.1 PCM Model Projections for 2030. Bars show the PCM concentrations from the AC Assessment, the 2015 Plan (Baseline and with Measures) and the 2017 Plan (Baseline, CAZ, and CAZ+ZEZ) Scenarios. Links in central London except where indicated.



APPENDIX A-4

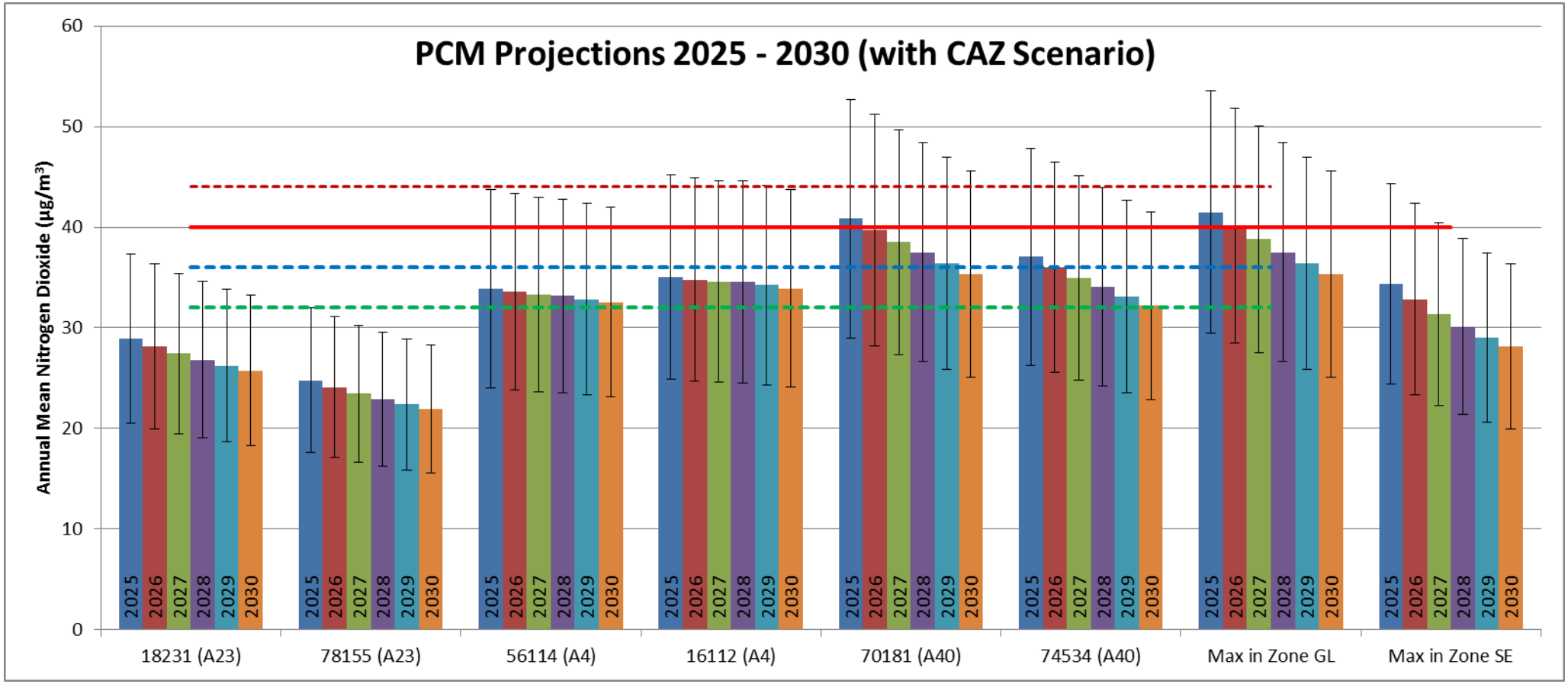
TIME SERIES

Figure A-4.1 2017 Plan Baseline CM Projections for 2025 – 2030 for key links for the schemes. Error bars are set to the +/-29% uncertainty range reported in the 2017 Plan



*Red solid line = Limit Value; Red dashed line = Limit Value +10%; Blue dashed line = Limit Value – 10%; Green dashed line = Limit Value – 20%

Figure A-4.2 2017 Plan 'With CAZ' PCM Model Projections for 2025 – 2030 for key links for the schemes. Error bars are set to the +/-29% uncertainty range reported in the 2017 Plan



*Red solid line = Limit Value; Red dashed line = Limit Value +10%; Blue dashed line = Limit Value – 10%; Green dashed line = Limit Value – 20%

Appendix B

DEMAND MODEL SCALING FACTORS

Table B.1 AC and New DfT (2017 High) forecasts of annual Air Transport Movements (ATM). DM = Do Minimum (Future Baseline).

	2025		2026		2027		2028		2029		2030	
	DM	With Option	DM	With Option	DM	With Option	DM	With Option	DM	With Option	DM	With Option
Gatwick 2R												
AC Low Cost is King	281,418	347,101	279,019	354,601	279,794	364,381	282,775	370,533	279,057	411,706	279,677	464,066
2017 High	288,071	299,816	287,715	338,988	288,626	349,933	289,027	358,130	285,914	366,758	287,736	373,953
Ratio* of DfT Impact to AC 2030 Impact on ATM		0.06		0.28		0.33		0.37		0.44		0.47
Heathrow NWR												
AC Carbon Traded Global Growth	479,915	479,915	481,399	567,832	481,245	629,622	480,137	664,064	486,697	692,009	484,208	722,534
2017 High	484,667	484,667	479,441	723,990	481,250	751,234	489,367	756,591	488,021	741,929	481,714	741,246
Ratio* of DfT Impact to AC 2030 Impact on ATM		0.00		1.03		1.13		1.12		1.07		1.09
Heathrow ENR												
AC Carbon Traded Global Growth	479,915	479,915	481,399	568,069	481,245	630,054	480,137	664,919	486,697	693,331	484,208	702,967
2017 High	484,667	484,667	479,441	705,737	481,250	701,929	489,367	709,960	488,021	713,364	481,714	709,553
Ratio* of DfT Impact to AC 2030 Impact on ATM		0.00		1.03		1.01		1.01		1.03		1.04

*Ratio = Impact of Expansion in DfT (2017) model in specific years (i.e. ATM With Option – ATM in DM) / Impact of Expansion in AC model in 2030

Table B.2 AC and New DfT (2017 High) forecasts of growth* in total highway trip generation with option (trips/day). Ratio = DfT (2017 High) Forecast in specific years / AC Forecast in 2030 (daily trips)

OPTION	2026		2030		RATIO*** DfT 2026 / AC 2030	RATIO*** DfT 2030 / AC 2030
	AC	2017 High	AC	2017 High		
Growth* in Total Highway Trip Generation with Option (Passenger + Employee)						
G2R	12,962	10,226	22,353	17,091	0.46	0.76
NWR	11,881	43,306	42,736	50,077	1.01	1.17
ENR	11,939	41,033	40,620	44,318	1.01	1.09
Growth* in central London Trip Generation with Option**						
G2R	866	681	1,567	1,250	0.43	0.80
NWR	1,695	4,862	6,014	6,412	0.81	1.07
ENR	1,694	4,842	5,781	5,795	0.84	1.00
Growth* in Total Employee Trip Generation with Option						
G2R	2,963	1,719	5,292	2,732	0.32	0.52
NWR	3,811	12,585	10,860	12,817	1.16	1.18
ENR	3,820	11,580	10,274	11,336	1.13	1.10

*Growth in Trip Generation with Option = Trip Generation With Option – Trip Generation Without Option (DM)

**Central London = Trip Generation Zones covering Camden, City of London, Hammersmith and Fulham, Kensington & Chelsea, Westminster i.e. zones potentially loading directly onto the A40 Westway

*** AC growth in 2026 is presented for reference only, it is not used in any calculation of ratios for scaling since the AC air quality assessment considered only impacts in 2030

Table B.3 AC and Revised DfT (2017 High) forecasts of growth* in trips (veh/day) on 'at risk' PCM links for Heathrow NWR Option. Ratio = DfT (2017 High) Forecast in specific years / AC Forecast in 2030 (daily trips)

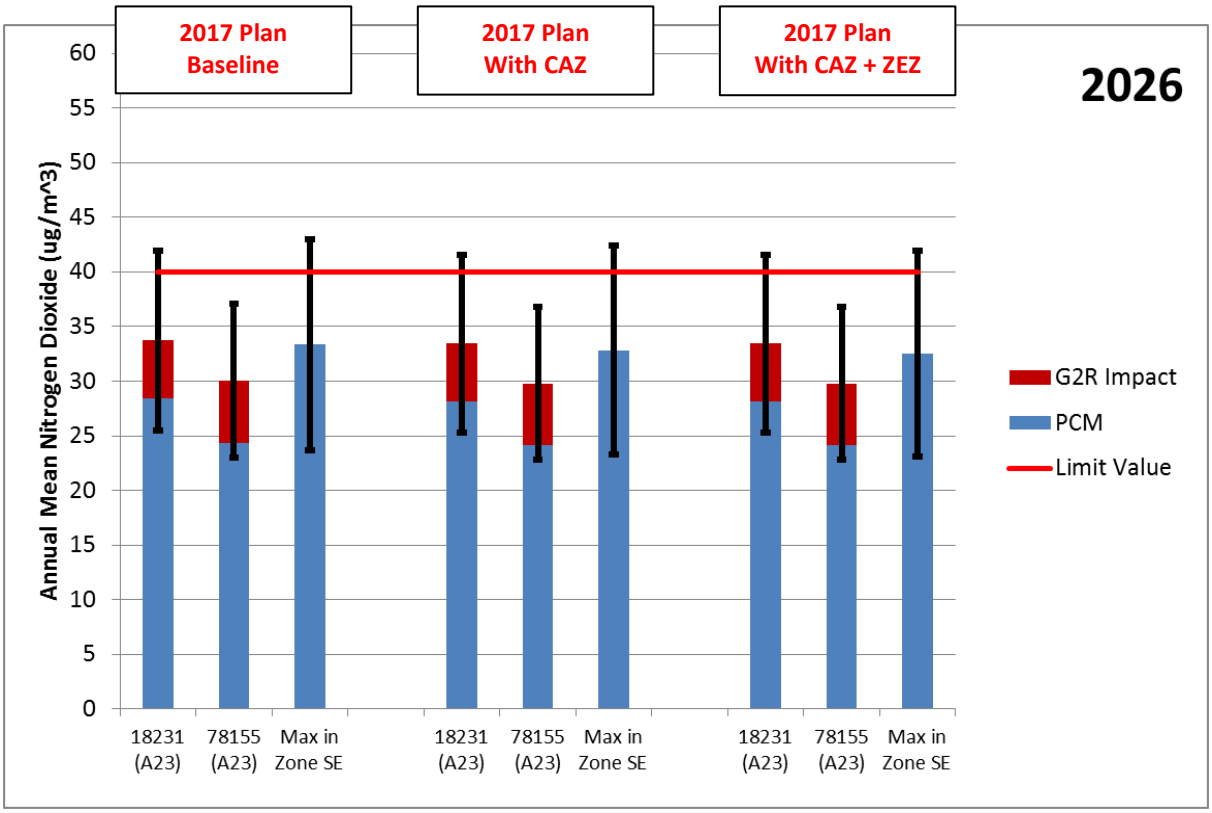
PCM LINK ID	AC		2017 High		DfT 2026 / AC 2030	DfT 2030 / AC 2030
	2026	2030	2026	2030		
16112 (A4)	10,917	39,766	40,550	47,251	1.02	1.19
18727 (A312)	990	2,832	2,828	3,143	1.00	1.11
26914 (A312)	No Data / Assigned to nearest link 16112				0.89	1.16
8509 (A40)	307	936	832	1,084	0.89	1.16
16110 (A4)	525	1,695	1,660	2,158	0.98	1.27
16404 (A40)	613	1,873	1,663	2,167	0.89	1.16
26116 (A4)	4,118	13,431	13,197	17,079	0.98	1.27
28505 (A4)	445	1,332	1,259	1,568	0.95	1.18
36119 (A4)	287	926	904	1,179	0.98	1.27
36437 (A40)	864	2,632	2,340	3,041	0.89	1.16
46121 (A4)	231	745	731	947	0.98	1.27
56436 (A40)	189	557	502	616	0.90	1.11
73567 (A4)	505	1,628	1,588	2,067	0.98	1.27
74538 (A40)	154	488	541	720	1.11	1.48
48251 (A501)	222	683	735	955	1.08	1.40
58173 (A4206)	No Data, Assigned to nearest ink 70181				1.08	1.40
70181 (A40)	222	683	735	955	1.08	1.40
74534 (A40)	250	759	677	874	0.89	1.15
Maximum On Single Link					1.11	1.48

*Growth in Trips with LHR-NWR Option = Vehicles per Day With LHR-NWR Option – Vehicle per Day Without Option

Appendix C

CRITICAL LINKS ANALYSIS

Figure C.1 Gatwick 2R Compliance Summary Graphs for 2026 and 2030.



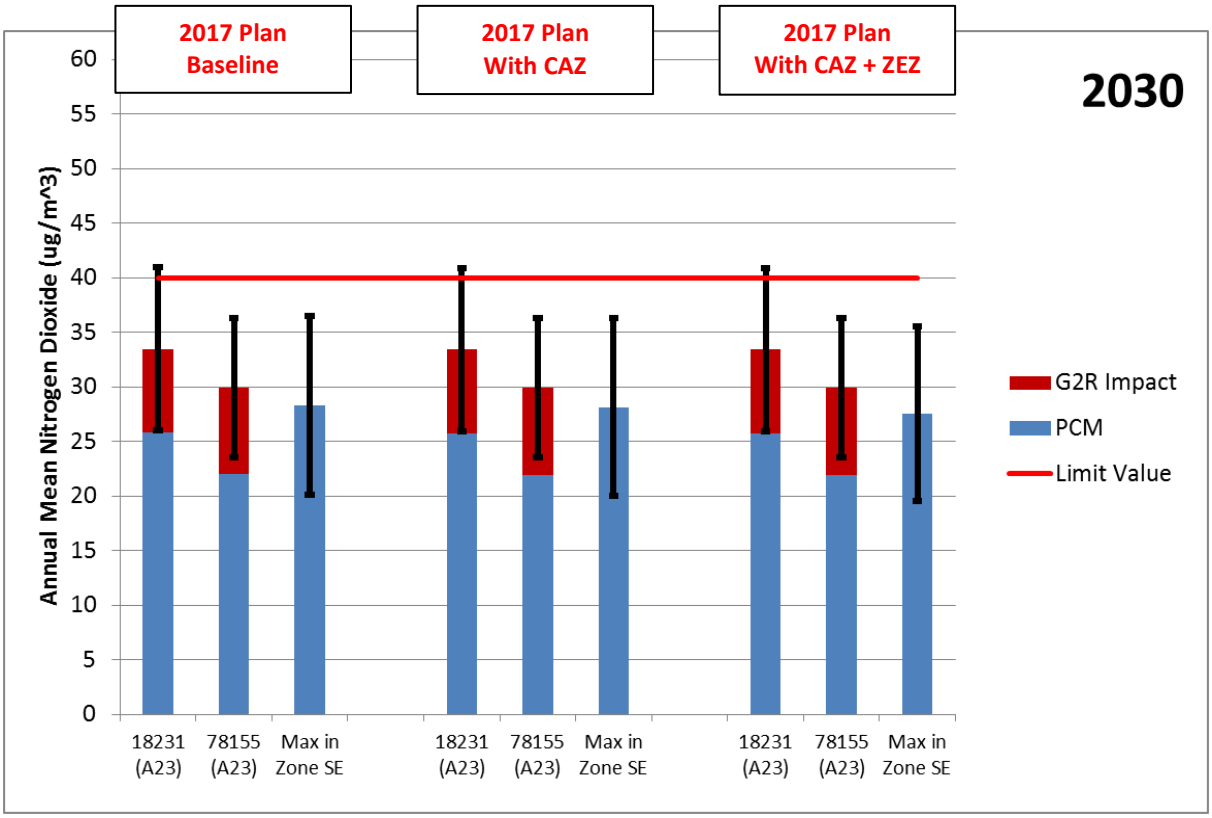
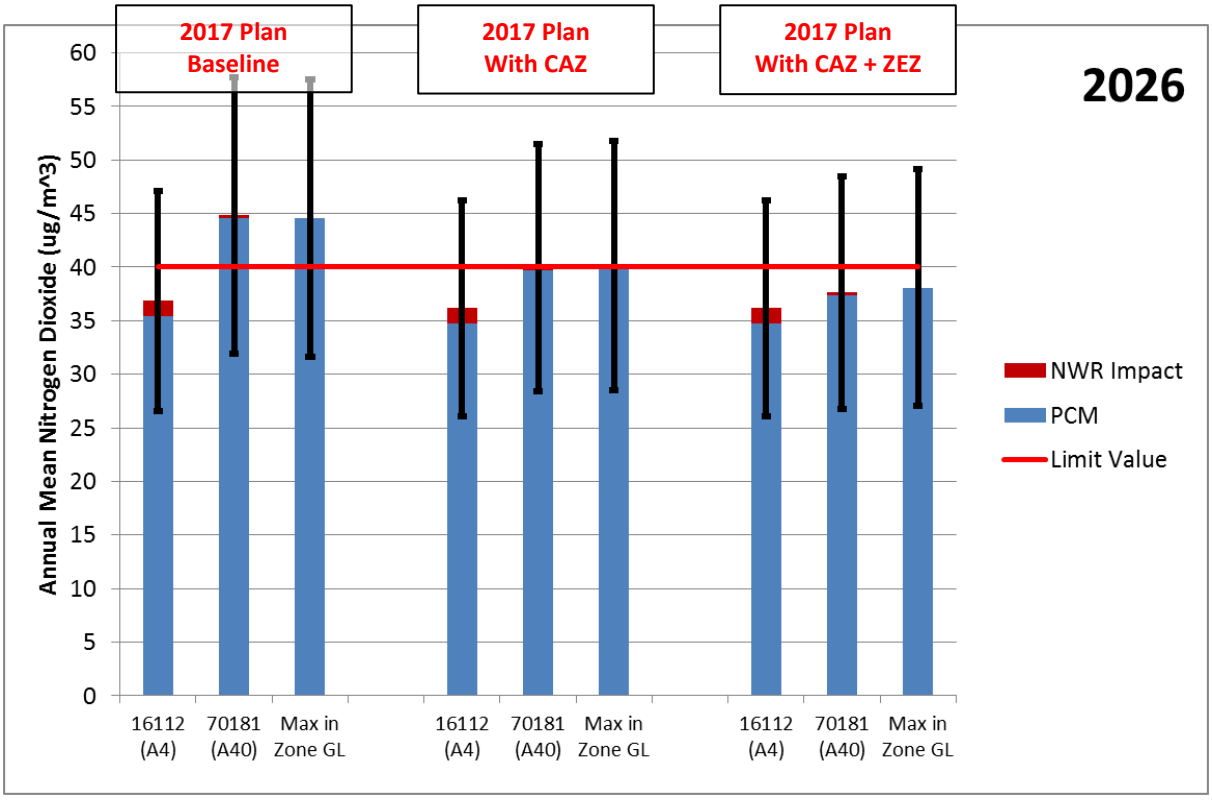


Figure C.2 Heathrow NWR Compliance Summary Graphs for 2026 and 2030



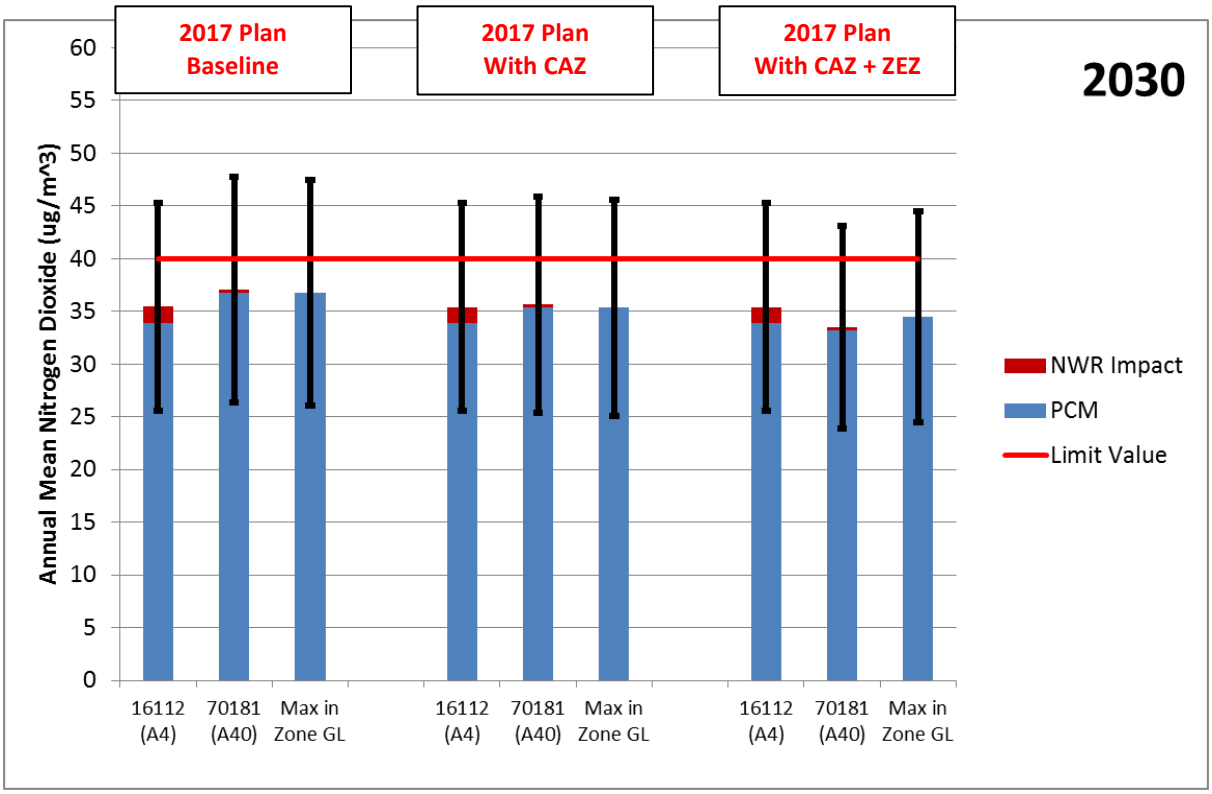


Figure C.3 Heathrow ENR Compliance Summary Graphs for 2026 and 2030