JACOBS®

6. Air Quality: Baseline

Prepared for the Airports Commission

November 2014

Jacobs U.K. Limited

Contents

Executive Summary **i**
Gatwick Airport Second Runway Scheme - Baseline ii
Heathrow Airport Northwest Runway Scheme - Baseline iii
Heathrow Airport Extended Northern Runway Scheme - Baseline iii

1 Introduction **5**
1.1 Purpose of Report 5
1.2 Appraisal Framework Requirements 5
1.3 Report Structure 9

2 Methodology and Legislation **10**
2.1 Methodology 10
2.2 Legislation 17
2.3 Assumptions and Limitations 19
2.4 Exclusions 20

3 Gatwick Airport Second Runway **22**
3.1 Baseline Study Area 22
3.2 National 22
3.3 Local 24
3.4 Conclusions 29

4 Heathrow Airport Northwest Runway **32**
4.1 Baseline Study Area 32
4.2 National 32
4.3 Local 34
4.4 Conclusions 40

5 Heathrow Airport Extended Northern Runway **42**
5.1 Baseline Study Area 42
5.2 National 42
5.3 Local 44
5.4 Conclusions 50

6 Further Work **52**

References **53**
Glossary **55**
Appendix A: Key Air Pollutants and Health Effects **57**
Appendix B: Background Information for the Methodology **58**
B1 Airport Mass Emissions Sources 58
B2 Detailed Assumptions and Limitations 61
Appendix C: Monitoring Site Locations **65**
Appendix D: Figures **72**

Executive Summary

This report has been prepared in accordance with the Airports Commission Appraisal Framework (April 2014) to consider the implications of the following schemes on air quality.

- Gatwick Airport Second Runway (Gatwick 2R) promoted by Gatwick Airport Limited (GAL);
- Heathrow Airport Northwest Runway (Heathrow NWR) promoted by Heathrow Airport Limited (HAL); and,
- Heathrow Airport Extended Northern Runway (Heathrow ENR) promoted by Heathrow Hub Limited (HH).

The emissions which impact on air quality are emitted from various sources including: cars, goods vehicles, aircraft, biomass boilers, incinerators and many more. The combination of total emissions from the sources and the distance to the receptor influences air pollution concentrations and air quality impacts on receptors. The most common emission source within close proximity to sensitive receptors is road traffic. Consequently, road traffic is the dominant emission source causing poor air quality and is an important aspect to consider with the development of the scheme.

Currently available surface access modelling information is based on a static traffic model which is not suitable as a basis for determining the dispersion of pollutants, their concentrations in the air, or for assessing the impacts of these on sensitive receptors. As such, a two stage approach will be taken to meet the Appraisal Framework requirements to assess air quality impacts: See section 2.2 for more details on the second stage approach.

Each scheme is assessed in accordance with the Airports Commission: Appraisal Framework (April 2014). The Appraisal Framework sets out recommended methods, guidance documents and datasets to facilitate the assessment. The Appraisal Framework identifies two parts to the assessment:

- National assessment of pollution at a national scale, including performance in relation to emissions ceilings and
- Local air quality assessment, including an assessment of the risk of exceeding limit values.

The National and Local assessments are undertaken for the baseline to allow a comparative assessment between the ‘do minimum’ (without airport expansion) and ‘do something’ (with airport expansion) scenarios for the 2030, 2040 and 2050 baseline years.

At the National scale the assessment considers the total mass emission of key pollutants associated with airport activity. These are nitrogen oxide (NO_x), and Particulate Matter (PM_{10} and $PM_{2.5}$) – particles with aerodynamic diameters of less than 10 and 2.5 microns respectively. These are evaluated to compare with the national emissions ceilings.

At the Local scale the assessment considers the proportions of mass emissions of these same key pollutants associated with airport activity. In addition, likely future local pollutant concentrations were established for the baseline using results from an existing Department for Environment and Rural Affairs (Defra) National Compliance model (the Pollution Climate Mapping (PCM) model) for 2030 and also projecting locally monitored pollution concentrations for 2030. These concentrations included adjustment for expected improvements to vehicle emission technology but not for other potential government policy measures or scheme promoter mitigation measures to reduce local concentrations.

The DEFRA National compliance model and projected Design Manual for Roads and Bridges (DMRB) Interim Advisory Notes (IAN)/170/12v3 projection factors are based on a series of models of future conditions, each subject to its own inherent degree of uncertainty. These include monitoring data used for verification, the future predicted road traffic and aircraft movements and fleet mixes, and the emissions from aircraft and road traffic

With both Heathrow and Gatwick operating without airport expansion, UK emissions of NO_x are expected to be 86.1% and 82.8% of 2020 Gothenburg Protocol[1] emission targets in 2025 and 2030, respectively. UK emissions of $PM_{2.5}$ are expected to be 100% and 103.5% of 2020 Gothenburg Protocol emission targets in 2025 and 2030, respectively. By 2030 UK emissions of $PM_{2.5}$ are expected to exceed the target by 3.5%

The baseline results for each scheme area are summarised below.

Gatwick Airport Second Runway Scheme - Baseline

National

The National Atmospheric Emissions Inventory (NAEI) projects UK total emissions of NO_x and $PM_{2.5}$ up to and including the year 2030. These projections include emissions from Gatwick Airport.

The estimated emissions from Gatwick as a single runway airport in 2030 are 0.7% of total national NO_x and 0.1% of total national $PM_{2.5}$ emissions.

Local

The mass emissions of NO_x, PM_{10} and $PM_{2.5}$ from baseline airport activities are projected to increase with increased passenger demand. These have been calculated for 2030, 2040 and 2050. In terms of the different sources of airport emissions, aircraft engine emissions are the dominant source for NO_x, and airport only road traffic is the dominant source for PM_{10} in all baseline years. Conversely $PM_{2.5}$ has varying dominant emission sources, with Auxiliary Power Units (APUs) the dominant source in 2030 to 2040 and airport only road traffic, the dominant source in 2050.

Even after the reductions in NO_2 concentrations associated with less polluting vehicles constituting a larger proportion of the fleet mix, projected local monitoring

[1] The Gothenburg Protocol to Abate Acidification, Eutrophication and Ground-level Ozone was first agreed in 1999 (through the UN Economic Commission for Europe), setting mandatory emission reductions for four major air pollutants (sulphur dioxide, nitrogen oxides, volatile organic compounds and ammonia), to be achieved by 2010. A revised protocol agreed in 2012 specifies further commitments in terms of percentage reductions from base 2005 to 2020, and has been extended to cover one additional air pollutant, namely particulate matter ($PM_{2.5}$).

indicates NO_2 concentrations are close to the annual mean NO_2 air quality objectives (AQOs). Whilst national modelling indicates NO_2 concentrations to be below annual mean NO_2 EU Limit Values (EULVs) within Gatwick 2R baseline study area. The projected local monitoring and PCM modelled baseline concentrations for 2030, however, do not take account of potential additional governmental or airport mitigation measures that could be put in place in the future.

On the basis of available information it is considered unlikely that there is any risk of PM_{10} and $PM_{2.5}$ AQOs being exceeded in the baseline year within the baseline study area for Gatwick 2R.

Heathrow Airport Northwest Runway Scheme - Baseline

National

The National Atmospheric Emissions Inventory (NAEI) projects UK total emissions of NO_x and $PM_{2.5}$ up to and including the year 2030. These projections include emissions from Heathrow Airport.

The estimated emissions from a two-runway Heathrow in 2030 are 1.8% of total national NO_x and 0.2% of total national $PM_{2.5}$ emissions.

Local

Emissions of NO_x, PM_{10} and $PM_{2.5}$ are projected to increase with increased passenger demand. Aircraft engines are the dominant emission source of NO_x across all baseline years. Aircraft brake and tyre wear is the dominant source of PM_{10} until 2050 when road traffic – airport only becomes the dominant source. Aircraft brake and tyre wear is the dominant source of $PM_{2.5}$ from 2030 to 2040, when road traffic – airport only becomes the dominant source in 2050.

After reductions in NO_2 concentrations have been applied from improvements in vehicle emission abatement technology, two DEFRA National compliance model (PCM) road links are well below the NO_2 annual mean EU Limit Value. However, two DEFRA National compliance model road links are predicted to exceed the NO_2 annual mean EU Limit Value. The projected local monitoring and PCM modelled baseline concentrations for 2030, however, do not take account of potential additional governmental or airport mitigation measures that could be put in place in the future.

On the basis of available information it is considered unlikely that there is any risk of PM_{10} and $PM_{2.5}$ AQOs being exceeded in the baseline year within the baseline study area for Heathrow Airport.

Heathrow Airport Extended Northern Runway Scheme - Baseline

National

The National Atmospheric Emissions Inventory (NAEI) projects UK total emissions of NO_x and $PM_{2.5}$ up to and including the year 2030. These projections include emissions from Heathrow Airport.

The estimated emissions from a two-runway Heathrow in 2030 are 1.8% of total national NO_x and 0.2% of total national $PM_{2.5}$ emissions.

Local

Emissions of NO_x, PM_{10} and $PM_{2.5}$ are projected to increase with increased passenger demand. Aircraft engines are the dominant emission source of NO_x across all baseline years. Aircraft brake and tyre wear is the dominant source of PM_{10} until 2050 when road traffic – airport only becomes the dominant source. Aircraft brake and tyre wear is the dominant source of $PM_{2.5}$ from 2030 to 2040, when road traffic – airport only becomes the dominant source in 2050.

After reductions in NO_2 concentrations have been applied from improvements in vehicle emission abatement technology, two DEFRA National compliance model (PCM) road links are well below the NO_2 annual mean EU Limit Value. However, two DEFRA National compliance model road links are predicted to exceed the NO_2 annual mean EU Limit Value. The projected local monitoring and PCM modelled baseline concentrations for 2030, however, do not take account of potential additional governmental or airport mitigation measures that could be put in place in the future.

On the basis of available information it is considered unlikely that there is any risk of PM10 and PM2.5 AQOs being exceeded in the baseline years within the baseline study area.

1 Introduction

This Section covers:

- The Airports Commission's Appraisal Framework requirements for air quality assessment and the purpose of the baseline assessment
- Context for air quality issues and the approach to the assessment
- An outline of the approach to be taken and how the report is structured.

1.1 Purpose of Report

This report identifies baseline information relating to air quality within study areas in 2030, 2040 and 2050 for the following airport expansion schemes.

- Gatwick Airport Second Runway (Gatwick R2) promoted by Gatwick Airport Limited (GAL);
- Heathrow Airport Northwest Runway (Heathrow NWR) promoted by Heathrow Airport Limited (HAL); and
- Heathrow Airport Extended Northern Runway (Heathrow ENR) promoted by Heathrow Hub Limited (HH).

The baseline provides the 'do minimum' (without airport expansion) scenario taking account of proposed changes to the existing airports as indicated in the respective current airport master plans but without the airport expansion schemes in place.

1.2 Appraisal Framework Requirements

The Airports Commission's Appraisal Framework (April 2014) sets out requirements for 'National' and 'Local' air quality impact assessments. The same National and Local requirements are applied to the baseline and the scheme assessment to allow a comparative assessment between the 'do minimum' and 'do something' (with airport expansion) scenarios. This comparison is presented in a separate report; Air Quality: Assessment, Jacobs 2014.

A two stage approach is being taken to meet the Appraisal Framework requirements to assess air quality impacts.

Currently available surface access modelling information is based on a static traffic model which is not suitable as a basis for determining the dispersion of pollutants, their concentrations in the air, or for assessing the impacts of these on sensitive receptors. As such, a two stage approach will be taken to meet the Appraisal Framework requirements to assess air quality impacts:

The first stage of assessment is covered in this report, and has focused on:

- Capturing data in relation to the emission sources identified within the Appraisal Framework;
- Calculating the change in emissions as a result of the respective schemes; and
- Monetisation of baseline mass emissions for the valued change in air quality to enable assessment against the impact assessment as reported in Air Quality: National and Local Assessment, Jacobs 2014.

To enable the second stage of assessment, a dynamic traffic model is being developed which will provide the basis for pollutant dispersion modelling and the assessment of resultant receptor impacts. The scope of this second stage is set out in more detail in Chapter 6: Further Work.

(a) Scope of Baseline Air Quality Assessment

The baseline air quality report includes both National and Local assessments.

At the National scale the assessment considers the total mass emission of key pollutants associated with airport activity. These are nitrogen oxide (NO_x), and Particulate Matter (PM_{10} and $PM_{2.5}$) – particles with aerodynamic diameters of less than 10 and 2.5 microns respectively. Background information on these pollutants and why they are of concern is summarised in section 1.2.2 'context for the air quality assessment' and provided in more detail in Appendix A.

At the Local scale the assessment considers the proportions of mass emissions of these same key pollutants associated with airport activity. In addition, the Local scale assessment also considers local ambient air quality monitoring of nitrogen dioxide (NO_2), and Particulate Matter (PM_{10} and $PM_{2.5}$), as current concentrations of these pollutants are at risk of exceeding their respective European Union Limit Values (EULVs) or National Air Quality Objectives (AQOs).

The National and Local air quality baseline assessments are presented together as they share a common mass emission methodology.

1.2.2 Context for the air quality assessment

Clean air is essential to human health and ecosystems. The pollutants within the UK which are the greatest threat to these are NO_2, PM_{10} and $PM_{2.5}$ for human health and NO_x to ecosystems. NO_x is a term for all nitrogen oxides, which include NO_2 (nitrogen dioxide) and NO (Nitric Oxide).

NO_2 is shown to be hazardous to those particularly susceptible to changes in air quality such as asthmatics. NO_2 is usually also seen as a precursor to more harmful particulates, such as PM_{10} and $PM_{2.5}$, as these are more harmful because these pollutants can penetrate deep into the lungs causing cardiovascular problems.

NO_x is a pollutant that impacts on sensitive habitats and vegetation as it has the potential to alter nutrient availability and cause acid rain. As a result NO_x is a catalyst for change in composition of species, which could materially alter the original habitat type and species which depend on it. NO_x is a primary pollutant, but through photochemical reactions with other pollutants can form secondary pollutants such as ozone. The key chemical reaction of concern for NO_x is the oxidation of NO into NO_2, as this increases the conversion ratio between NO_x and NO_2 and subsequently increases NO_2 concentrations.

The issue of these pollutants is particularly pertinent in areas sensitive to change, often referred to as 'sensitive receptors'. For human health, it is areas of long term exposure which are more susceptible such as dwellings, hospitals and schools. For ecosystems, the focus is on designated sites e.g. Special Protection Areas (SPA), Special Areas of Conservation (SAC) or Sites of Special Scientific Interest (SSSIs), which contain habitat types that are also sensitive to changes in nitrogen oxides.

Close proximity of the emission source to the 'sensitive receptor' causes poor air quality because there is less opportunity for dispersion of emissions between the source and receptor resulting in greater concentrations of pollutants. Local air quality is evaluated by comparing concentrations of pollutants against EU ambient air quality directive limit values (EULVs) or air quality objectives (AQOs) set at locations where exposure harm to human health and ecosystems is thought to occur.

The anthropogenic emission sources directly associated with the airport are the main concern of the appraisal framework and are emitted from various including sources such as road traffic (cars and heavy goods vehicles), aircraft, biomass boilers, incinerators and onsite power sources. However, exposure locations are also influenced by non-airport related sources again including road traffic and power generation, but also other sources such as industry, waste plants and domestic heating. Put simply, it is a combination of the total emissions from the sources and the distance to the receptor which influences the concentrations of pollutants in the air and impacts air quality. As such, the most common emission source within close proximity to sensitive receptors is road traffic. Consequently, based upon studies of source apportionment at monitoring locations along major roads close to airports (Colvile et al, 2000; Airports Council International, 2010), road traffic will tend to be the dominant emission source causing poor air quality.

The calculation of cumulative emissions of pollutants from all sources will give the total National emissions. A country's National emissions can be carried long distances by winds and can have trans-boundary effects. The National Emission Ceilings Directive (NECD) sets national emissions ceilings to reduce the likelihood and effect of trans-boundary pollution. The cumulative mass emission increase from airport expansion will be compared against the National Atmospheric Emissions Inventory projections to determine whether the scheme could change the date of compliance.

The emission sources contributing to the total concentration at a specific receptor are broadly comprised of four main groups:

- Airport related road transport (vehicle access including car parking):
- Airport activities (such as aircraft movements, heat & power generation):
- Non-Airport related road transport (vehicles on the surrounding roads); and
- Other emissions (such as industry and energy production).

The relative proportion from each source will be dependent on the specific location of a given receptor, particularly in relation to the distance and direction from local sources.

At locations very close to the airport activities, i.e. properties at the boundary and adjacent to airport activities, then the airport itself is likely to comprise a significant proportion of total concentrations. However, because residential locations are more likely to be in close proximity to roads than the airport boundary, then road transport (including airport related traffic) across the wider road network is typically the greatest contributor to overall exposure. As receptors are located further from the airport then the influence of vehicles accessing the airport would also tend to diminish with distance. Analysis of the impacts of the Icelandic volcanic eruption during 2010, which prevented air traffic in Europe for several days, allowed analysis of sources of air pollution which is not normally practicable. This indicated that at locations outside of airport boundaries changes in air concentrations appeared more attributable to the reduction of vehicle traffic than airport activities (Airports Council International, 2010).

Assessment of exposure to air quality pollution involves representation of a large number of emission sources and their impact at specific locations, and also needs to consider how emissions change over time. Calculation of concentrations in future years requires predictions of how emission sources may change, such as the level of aircraft activity or road traffic movements, and the air quality impact per given unit of activity, such as fleet type or engine technology. There are various regulations and policies that will drive predicted reductions in emissions from road traffic and industry, particularly the tightening road vehicle emission limits implemented by the Euro 6/VI standards which started to come into effect in 2013. These emissions reductions are expected to lead to reductions in ambient concentrations of air quality pollutants into the future. Therefore, locations with existing poor air quality, and current exceedances of EULVs or AQOs, are expected to improve and may no longer exceed in the opening year of a scheme. Whilst there is uncertainty in all future predictions, this report takes into account changes to vehicle technology and fleet mix, based on published best practice tools and guidance.

Mass emission calculations will be used as inputs into dispersion modelling in the second stage of this work, to determine how all emission sources impact (through the pollutant pathway of measured meteorological conditions) to predict pollutant concentrations at relevant receptors (human health and vegetation).

1.2.3 Baseline Air Quality Assessment Process

The National and Local baseline assessments have been undertaken following the processes shown in Figure 1 and Figure 2 below.

Figure 1 – National Baseline Assessment Process

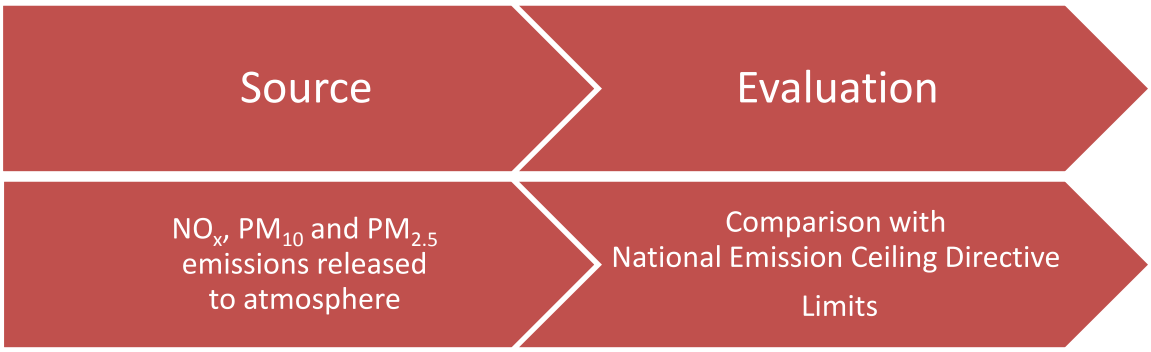
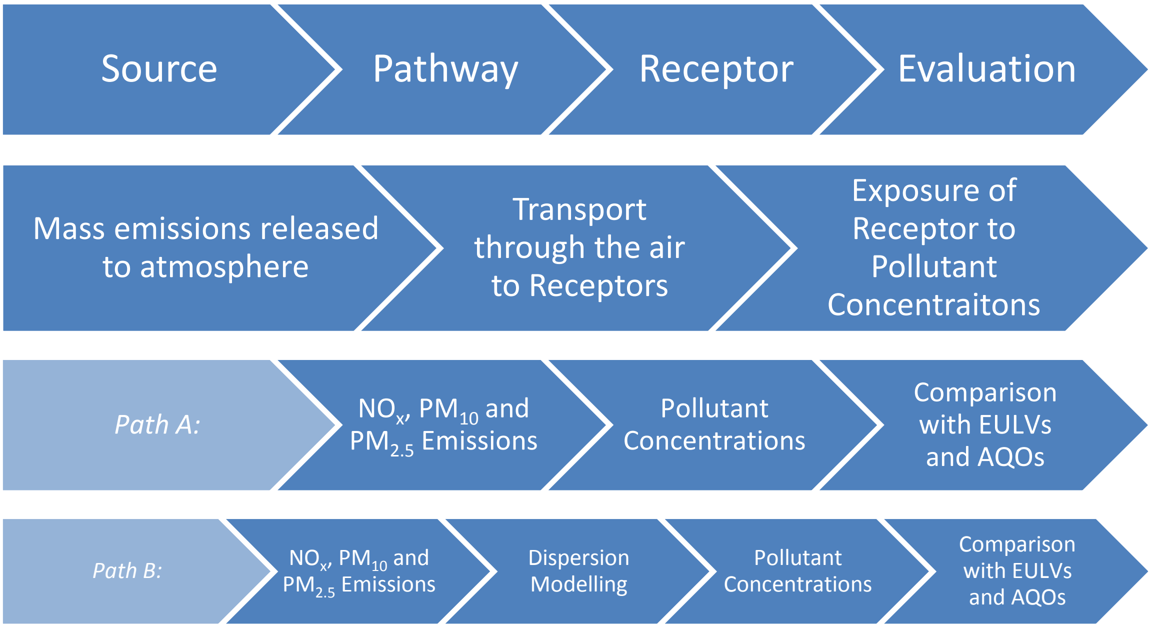


Figure 2 – Local Baseline Assessment Process



The local baseline assessment has been undertaken following Process Path A for the first stage assessment. This will be enhanced by also undertaking Process Path B for a second stage assessment on the release of the dynamic traffic models currently in development for the schemes.

1.3 Report Structure

This report is structured to address each of the core components in turn for each shortlisted scheme (Gatwick 2R, Heathrow NWR and Heathrow ENR) as follows:

- Methodology and Legislation
  - An outline of the methodology used to inform the baseline, local and national assessments; and
  - Key legislation and relevant guidance applicable to inform the baseline conditions.
- Scheme Baseline Assessments
  - Baseline Study Areas
  - National Assessment
    - Total mass emissions of key pollutants associated with airport activity
  - Local Assessment
    - Proportions of mass emissions of key pollutants associated with airport activity
    - Road traffic emissions sensitivity
    - 2030 modelled concentrations from the National Pollution Climate Modelling (PCM) model to identify EU Limit Value compliance risks; and
    - Projected local ambient monitoring data to 2030 concentrations
    - Conclusion
- Further Work
- Appendices
  - Background information on pollutants
  - Supporting information for the Methodology
  - Monitoring site locations

2 Methodology and Legislation

This Section covers:

- An outline of the methodology used to inform the national and local baseline assessments; and
- Key legislation and relevant guidance applicable to inform the baseline conditions.

2.1 Methodology

2.1.1 Baseline Study Areas

The geographical scope of the baseline assessment is currently defined as the proposed airport boundaries and environs, including potentially high risk zones along the routes of any existing surface access. High risk zones include locations with the potential for exceedance of regulatory standards for the protection of human health and/or sensitive habitats, in the initial and/or mature operations years. Each scheme study is described in the relevant section, (section 3.1 for Gatwick R2, section 4.1 for Heathrow NWR and section 5.1 for Heathrow ENR).

Locations for the protection of human health include residential properties, care homes, hospitals and schools; whereas locations for the protection of sensitive habitats include statutory designated sites (such as sites of special scientific interest (SSSIs), special areas of conservation (SACs), special protection areas (SPAs), and Ramsar sites.

Surface access emissions are captured across the entire extent of the Jacobs' current traffic data network (see Appendix D: Figures 1 to 3 included at the end of the report). This is a conservative approach as it includes all major roads and all emission changes as a result of the proposed schemes. Selecting the study area in this way avoids exclusion of 'local roads' which may experience poor air quality.

Note: It is not just the total mass of emissions, but also the distance from the source to the receptor which causes poor air quality. This is why air quality surrounding roads is currently the focal point for air quality studies. Consequently, sensitive receptors (human health and ecosystems) within close proximity to heavily polluting roads will experience poor air quality (NO_2, NO_x and PM concentrations).

.

2.1.2 Sensitive habitats

Statutory designated sites of nature conservation importance, as identified within DMRB HA207/07 (SSSIs, SACs, SPAs and Ramsars), have been identified within the scheme study areas. These sites have been reviewed to identify whether they are sensitive to changes in air quality using the Air Pollution Information System (APIS) which provides information on current sensitivity to atmospheric pollutants. In addition, Natural England's Aviation Sensitivity Maps (provided in Jacobs' Biodiversity: Assessment 2014b) have also been reviewed and additional potentially sensitive sites are taken into account.

2.1.3 Mass Emissions

(i) National

Baseline mass emissions have been calculated to enable a comparison to be made with National scale air quality impacts for each scheme option.

UK emissions of NO_x and PM_{10} have been obtained from the National Atmospheric Emissions Inventory (NAEI) which compiles estimates of emissions to the atmosphere from UK sources such as power stations, traffic, household heating, agriculture and industrial processes.

Total mass emissions of key pollutants, namely NO_x, PM_{10} and $PM_{2.5,}$ have been calculated for the following associated airport activities:

- Aircraft Engine Emissions from landing and take-off (LTO) cycle;
- Aircraft brake and tyre wear
    - Fugitive Particulate Patter (PM) only;
- Surface access brake and tyre wear
    - Fugitive PM only;
- Surface access emissions from airport associated traffic only (this includes passenger and employee traffic and derived contributions from freight traffic)
- Auxiliary Power Unit (APU) emissions; and
- Ground Support Equipment (GSE).

For a summary of the methodology behind the mass emission calculations, the process has been disaggregated into three tables:

- Table 2.1 provides an overview of the International Civil Aviation Organization (ICAO) approach adopted for the calculation of mass emissions from each source assessed;
- Table 2.2 shows the inputs and data sources used whilst following the ICAO approach; and
- Table 2.5 provides information on the assumptions used to fulfil the data input requirements and the limitations upon the conclusions.

The tables are not an exhaustive step-by-step approach through the methodology and greater detail behind the mass emission calculations is provided in Appendix B.

Table 2.1 - ICAO approach adopted for mass emissions calculations

Source Activity	Guidance Level
Aircraft Engine Emissions from landing and take-off (LTO) cycle	ICAO Simple – Approach 'A' Basic knowledge required; necessary data are easy, standardised and available; straightforward methodology (ICAO, 2011). Includes engine exhaust emissions in the landing and take-off (LTO) cycle below 915m (3000 feet) including take off, landing, approach and idling. Uses ICAO reference emission rates and times in mode rather than Approach 'B' which used airport specific emission rates and times in mode.
Fugitive Particulate Matter (PM) emissions from surface access brake and tyre wear	ICAO Simple Basic knowledge required; necessary data are easy, standardized and available; straightforward methodology (ICAO, 2011).
Surface access emissions from airport associated traffic only	ICAO Simple - major road networks and railways, including engine exhaust Basic knowledge required; necessary data are easy, standardized and available; straightforward methodology (ICAO, 2011).
Auxiliary Power Unit (APU) emissions	ICAO Simple Basic knowledge required; necessary data are easy, standardized and available; straightforward methodology (ICAO, 2011).
Ground Support Equipment (GSE) Emissions	Screened out as not being significant. ICAO Simple complete as evidence. Basic knowledge required; necessary data are easy, standardized and available; straightforward methodology (ICAO, 2011).

Table 2.2 – Baseline mass emissions inputs and data sources

Airport Associated Activity	Inputs/Data Source
Aircraft Engine Emissions from LTO cycle	• Forecast aircraft fleet mix and ATMs from Assessment of Need Carbon Capped (AoN Carbon Capped) scenario Demand Forecast 2014 • Engine emissions data from European Aviation Safety Agency ICAO certification databank 2014
Fugitive PM emission from aircraft brake and tyre wear	• Forecast aircraft fleet mix and ATMs from (AoN Carbon Capped) scenario Demand Forecast 2014 • National environmental technology centre (NETCEN) method to determine PM emissions from brake and tyre wear (Curran, 2006)
Fugitive PM emission from surface access brake and tyre wear	• (AoN Carbon Capped) scenario demand, fleet mix and ATMs forecast 2014 • Annual average daily traffic (AADT) Jacobs 2014 static traffic model forecasts including; passengers and employees only • Speed data from roads current speed limits • Heavy goods vehicles (HGVs) from the Department for Transport's (DfT's) national transport model regional HGVs forecast (DfTa, 2014)
Surface access emissions from airport associated traffic only	• (Scheme promoters' passenger demand forecasts (these were used as the basis for the traffic model forecasts) • AoN Carbon Capped scenario passenger demand forecast, Airports Commission 2014 (these were used in the traffic model forecasts for sensitivity testing the scheme promoter passenger forecast based traffic) • AADT Jacobs 2014 static traffic model forecasts • Speed data from roads current speed limits • HGVs from DfT's national transport model regional HGVs forecast (DfTa, 2014)
APU emissions	• Scheme promoters' APU run times 2014 • Forecasted aircraft fleet mix and ATMs from Airports Commission Demand Forecast 2014 • Emission rates of APU models commonly fitted to aircraft (NETCEN, 2004) • APU efficiency improvements (Hamilton Sundstrand, 2014)
GSE emissions	• Forecast aircraft fleet mix and ATMs from Airports Commission Demand Forecast 2014

(ii) Local

Baseline mass emissions have also been calculated at the local scale to enable air quality impacts for each scheme to be compared against these.

Proportions of mass emissions of the same key pollutants, NO_x, PM_{10} and $PM_{2.5}$ have been calculated for the same associated airport activities:

- Aircraft Engine Emissions from landing and take-off (LTO) cycle;
- Aircraft brake and tyre wear
  - Fugitive PM only;
- Surface access brake and tyre wear
  - Fugitive PM only;
- Surface access emissions from airport associated traffic only;
- Auxiliary Power Unit (APU) emissions; and
- Ground Support Equipment (GSE).

The ICAO approach adopted for the calculation of mass emission proportions from each source assessed is the same as those presented in Table 2.1. The inputs and data sources used when making the baseline mass emission calculations at the Local scale are also the same as those presented in Table 2.2.

Note: Mass emissions from airport associated activities are broadly dispersed within the airport confines. Despite their relative total size compared to other airport associated emission sources, those that contribute most to local air quality issues are predominantly related to road traffic at locations outside the airport boundary.

2.1.4 Modelling/Monitoring

Likely future local pollutant concentrations were established for the baseline without scheme using results from an existing Department for Environment and Rural Affairs (Defra) National Compliance model (the Pollution Climate Mapping (PCM) model) for 2030 and also by projecting locally monitored pollution concentrations for 2030. These 2030 baseline concentrations include adjustment for expected improvements to vehicle emission technology and fleet mix but not for other potential government policy measures or airport mitigation measures to reduce local concentrations.

The DEFRA National compliance model and projected Design Manual for Roads and Bridges (DMRB) Interim Advisory Notes (IAN)/170/12v3 projection factors are based on a series of models of future conditions, each subject to its own inherent degree of uncertainty. These include monitoring data used for verification, the future predicted road traffic and aircraft movements and fleet mixes, and the emissions from aircraft and road traffic. These methods to determine likely baseline air quality have been followed in the absence of sufficiently detailed model inputs for dispersion modelling. This will be undertaken in the second stage assessment, for more information refer to the further work section.

(a) National Modelling and EU Limit Values

The PCM model, operated by Defra, is the air quality model used to report the UK's status on compliance with EU Ambient Air Quality Directive (2008/50/EC[3]). Highways Agency's Interim Advice Note (IAN) 175/13 is the only published methodology for assessing the potential impact of a scheme or development on Defra's reported position with respect to compliance.

IAN 175/13 specifies that two air quality models are required to assess the risk of significant impacts on compliance with the 2008/50/EC[3]:

- The PCM model outputs issued by Defra (Version: ukmjrrds09); and
- An air quality model assessment predicting the concentrations of pollutants with and without development to establish the change in a receptor's ambient air quality.

PCM model predictions from Defra are only available up to and including 2030 and it is not currently possible to project PCM concentrations to 2040 and 2050. Consequently 2030 predicted PCM concentrations have been used as the baseline for 2040 and 2050, as this is a conservative approach given the forecast reduction in concentrations in future years.

Note: Current Department for Environment and Rural Affairs (Defra) PCM modelling has been undertaken with the Emission Factor Toolkit (EFT) V5.2c, which was superseded in June 2014 by EFTV6. The latest EFT includes revisions to the uptake of Euro VI vehicles in the future fleet mix and will change projected emissions.

The PCM model predicts concentrations within 4m of the kerbside of the national road network located within each scheme's baseline study area have been used to establish the baseline National compliance model concentrations. The 4m distance relates to the distance at which EULV compliance is determined by Defra.

In accordance with relevant air quality guidance, PCM road links have been selected within 200 metres of the traffic network (for which 4m pollutant concentrations were predicted), with an additional selection of PCM links that intersect routes used for surface access to the airport.

EU Limit Values are legally binding EU parameters that must not be exceeded by Member States. Limit values are set for individual pollutants and are made up of a concentration value, an averaging time over which it is to be measured, the number of exceedances allowed per year, if any, and a date by which it must be achieved. Some pollutants have more than one limit value covering different endpoints or averaging times.

Recently consolidated into Directive 2008/50/EC on Ambient Air Quality and Cleaner Air for Europe (CAFE) and transposed into national legislation in England by the Air Quality Standards Regulations 2010, the responsibility for ensuring air quality limit values are complied with lies solely with the Secretary of State (SoS) for the Environment.

(b) Local Monitoring and National Air Quality Objectives

It is a statutory requirement (Environment Act 1995) for local authorities to Review and Assess air quality within their jurisdiction. Air quality monitoring data has been collated from quality controlled local authorities' monitoring campaigns to establish existing air quality concentrations. Should the monitoring identify exceedances of AQOs, Air Quality Management Areas (AQMAs) are established with the aim of reducing concentrations. The baseline study areas relevant to the assessment of local air quality impacts are consistent with those used by the scheme promoters.

In July 2011, Defra published a report examining the long term air quality trends in NOx and NO2 concentrations, which identified that there has been a clear decrease in NO_2 concentrations between 1996 and 2002, and that NO_2 concentrations have stabilised with little to no reduction between 2004 and 2012. It concluded that for long term trends there is now a gap between current projected vehicle emission reductions and measurements on the annual rate of improvements in ambient air quality. The HA developed the Gap Analysis methodology to adjust model predictions based on the method in Local Air Quality Management (LAQM) TG(09) to account for the long term NOx and NO_2 profiles. The current trends in air quality are based on measurements of emissions from the existing vehicle fleet. New vehicles will need to comply with the more stringent Euro 6/VI emissions standards from September 2014 onwards. However, vehicles complying with the Euro 6/VI emissions standard have not been on the road network long enough for their performance to be capture in the long term air quality monitoring trends. If the Euro 6/VI fleet emissions perform as predicted, it should result in substantial reductions in predicted future roadside air quality concentrations.

The Gap Analysis methodology (IAN 170/12v3) factors assume that the measured air quality trends continue to occur for all pre-Euro6/VI fleet. They also take a precautionary approach to account for uncertainty associated with Euro 6/VI performance and fleet mix in the future, rather than assuming full reductions in emissions occur as predicted by Euro 6/VI, which has not been observed by air quality monitoring trends associated with recent Euro standards. This is implemented into long term trends by taking the mid-point between the measured air quality monitoring trends (which assume no improvement in emissions associated with Euro 6/VI) and predicted Euro 6/VI uptake and vehicle emissions meeting the Euro standards.

European emission standards (Euro standards) define the acceptable limits for exhaust emissions of new vehicles sold in EU member states. The emission standards are defined in a series of EU directives staging the progressive introduction of increasingly stringent standards.

Currently, emissions of nitrogen oxides (NO_x), total hydrocarbon (THC), non-methane hydrocarbons (NMHC), carbon monoxide (CO) and Particulate Matter (PM) are regulated for most vehicle types.

Projection factors are only available up to 2030; however by this time the vast majority of vehicles on the roads are predicted to be Euro VI and current emission forecasts are unable to account for any ‘more stringent’ vehicle emissions standards which may follow. Therefore concentrations comprising road traffic emissions for 2030 are also used to estimate the 2040 and 2050 baselines, demonstrating a conservative approach.

Air Quality Objectives (AQO) are nationally set policy targets established by the Air Quality Strategy for England, Scotland, Wales and Northern Ireland often expressed as a maximum ambient concentration not to be exceeded, either without exception or with a permitted number of exceedances, within a specified timescale. They are based on standards which are the concentrations of pollutants in the atmosphere which can broadly be taken to achieve a certain level of environmental quality. The standards are based on assessment of the effects of each pollutant on human health including the effects on sensitive subgroups or on ecosystems.

(c) National Modelling vs. Local Monitoring

The two sources of air pollution concentration data described above are mutually exclusive; a summary comparison is provided in Table 2.3.

Table 2.3 - Summary comparison of National Modelling and Local Monitoring

National Modelling	Local Monitoring
Undertaken by Central Government (Defra) for reporting compliance with EU limit values to the European Commission	Undertaken by local authorities for comparison against AQOs
Undertaken up to 4m from the kerbside of national road network (A- Roads and Major Roads only). Note: some local roads are excluded from the model.	Undertaken at 'hot-spot' locations identified under the Local Air Quality management (LAQM) regime
Verified using high quality data capture national Automatic Urban and Rural Network (AURN) air quality monitoring sites	Excludes high quality AURN sites
Estimates air pollution concentrations at locations where no local monitoring is available	Provides measured air pollution concentrations representative of the immediate vicinity of the monitoring site only

The two sources of air pollution concentration data described above are non-comparable due to the intent behind each method's air quality predictions. As such there may be locations where projected locally monitored pollution concentrations and forecast nationally modelled pollution concentrations do not agree; this represents uncertainty in predicting future air quality.

Given the potential for uncertainty in air quality predictions, both air pollution concentration sources are used to identify the potential risk of exceeding EU Limit Values or AQOs with the airport expansion schemes in the Air quality: Assessment (Jacobs, 2014a). If either source of data indicates a potential for risk, the assessment assumes the potential for risk at that location exists.

2.2 Legislation

2.2.1 National Emissions Ceiling Directive (NECD)

The 2001 National Emissions Ceiling Directive[2] (NECD) set binding limits on Member States for the national emissions of four pollutants (NO_x, sulphur dioxide (SO_2), ammonia (NH_3) and non-volatile organic compounds), to be achieved by 2010 and not to be exceeded thereafter. The revision of the NECD is part of the implementation of the Thematic Strategy on Air Pollution[3] The proposal to amend the NECD is still under preparation and should set emission ceilings to be respected by 2020 for the four already regulated substances and for the primary emissions of Particulate Matter ($PM_{2.5}$) as well.

[2] Directive 2001/81/EC of the European Parliament and of the Council of 23 October 2001 on national emission ceilings for certain atmospheric pollutants, Official Journal of the European Communities L309, pp 22-30

[3] Directive 2001/81/EC of the European Parliament and of the Council of 23 October 2001 on national emission ceilings for certain atmospheric pollutants, Official Journal of the European Communities L309, pp 22-30 http://ec.europa.eu/environment/archives/cafe/index.htm.

The UK met the NECD 2010 target for NO_x; achieving emissions of 1,151 kilotonnes (Kt) per annum compared to a target of 1,167 Kt per annum. It has continued to meet the target through to the latest reported year (2012) with emissions of 1,062 Kt per annum.

The Gothenburg Protocol[4] is part of the Convention on Long-Range Transboundary Air Pollution which is itself an international agreement to protect human health and the environment from air pollution by control and reduction of local and long-range air pollution. The agreement covers Europe, North America and countries of Eastern Europe, Caucasus and Central Asia as it is widely recognised that air pollutants can be carried long distances, and cross-boundaries, by winds.

The protocol is a multi-pollutant protocol designed to reduce acidification, eutrophication and ground-level ozone by setting emissions ceilings for sulphur dioxide (SO_2), nitrogen oxides (NO_x), volatile organic compounds (VOCs) and ammonia (NH_3) which were to be met by 2010. The UK met these targets and in 2012 Member States, including the UK, agreed a set of revisions to the Protocol to reduce targets for national emissions of the four pollutants, along with Particulate Matter ($PM_{2.5}$), for 2020 and beyond. The UK has agreed to reduce its NO_x emissions relative to 2005 (1580 kilo tonnes) by 55% in 2020 (711 kilo tonnes), similarly $PM_{2.5}$ (81 kilo tonnes) emissions to be reduced by 30% (57 kilo tonnes). The Gothenburg Protocol National emission targets are currently under review and could be lowered.

2.2.2 European Air Quality Management

In 1996 the European Commission published the Air Quality Framework Directive on ambient air quality assessment and management (96/62/EC)[5]. This Directive defined the policy framework for 12 air pollutants including NO_2 known to have harmful effects on human health and the environment. Limit Values (pollutant concentrations not to be exceeded by a certain date) for each specified pollutant were set through a series of Daughter Directives, including Directive 1999/30/EC (the 1st Daughter Directive)[6] which set Limit Values for nitrogen dioxide (NO_2) and particulate matter (PM) (amongst other pollutants) in ambient air.

In May 2008 the Directive 2008/50/EC[7] on ambient air quality and cleaner air for Europe (CAFE) came into force. This Directive consolidates previous Directives (apart from the 4th Daughter Directive) and makes provision for extended compliance deadlines for NO_2 and PM_{10}. The Directive has been transposed into national legislation in England by the Air Quality Standards Regulations 2010[8]. The Secretary of State (SoS) for the Environment has the duty of ensuring the air quality Limit Values are complied with.

[4] The Gothenburg Protocol to Abate Acidification, Eutrophication and Ground-level Ozone was first agreed in 1999 (through the UN Economic Commission for Europe), setting mandatory emission reductions for four major air pollutants (sulphur dioxide, nitrogen oxides, volatile organic compounds and ammonia), to be achieved by 2010. A revised protocol agreed in 2012 specifies further emission reduction commitments in terms of percentage reductions from base 2005 to 2020, and has been extended to cover one additional air pollutant, namely particulate matter ($PM_{2.5}$).

[5] Directive 96/62/EC of 27 September 1996 on ambient air quality assessment and management

[6] Directive 1999/30/EC of 22 April 1999 relating to limit values for sulphur dioxide, nitrogen dioxide and oxides of nitrogen, particulate matter and lead in ambient air

[7] Directive 2008/50/EC of the European Parliament and of the Council of 21 May 2008 on ambient air quality and cleaner air for Europe

[8] The Air Quality Standards Regulations 2010, SI 2010/1001

2.2.3 Local Air Quality Management

Part IV of the Environment Act 1995[9] places a duty on the SoS for the Environment to develop, implement and maintain an air quality strategy with the aim of reducing atmospheric emissions and improving air quality. The national air quality strategy for England, Scotland, Wales and Northern Ireland[10] provides the framework for ensuring that air quality Limit Values are complied with based on a combination of international, national and local measures to reduce emissions and improve air quality. This includes the statutory duty, also under Part IV of the Environment Act 1995, for local authorities to undergo a process of local air quality management and declare Air Quality Management Areas (AQMAs) where necessary.

(a) European Union Limit Values and National Air Quality Objectives

The air quality Limit Values set by the European Union and transposed into national law as Air Quality Objectives are based on recommended guideline values from the World Health Organization. Some pollutants have Standards expressed as annual mean concentrations due to the chronic way in which they affect health (i.e. effects occur after a prolonged period of exposure to elevated concentrations) and others have Standards expressed as 24-hour, 1-hour or 15-minute mean concentrations due to the acute way in which they affect health (i.e. after a relatively short period of exposure). Some pollutants have Standards expressed in terms of both long-term and short-term concentrations.

Table 2.4 sets out the air quality Standards for the pollutants relevant to this baseline assessment (NO_2, PM_{10} and $PM_{2.5}$).

Table 2.4 - Air quality standards for NO_2, PM_{10} and $PM_{2.5}$

Pollutant	Averaging Period	EU Limit Value	Air Quality Objective
Nitrogen dioxide (NO_2)	Annual Mean	40 µg/m^3	40 µg/m^3
	1-hour Mean	200 µg/m^3 [1]	200 µg/m^3 [1]
Particulate Matter (PM_{10})	Annual Mean	40 µg/m^3	40 µg/m^3
	24-hour Mean	50 µg/m^3 [2]	50 µg/m^3 [2]
Particulate Matter ($PM_{2.5}$)	Annual Mean	25 µg/m^3 [3]	25 µg/m^3 [3]
[1] not to be exceeded more than 18 times a year (99.8th percentile) [2] not to be exceeded more than 35 times a year (90.4th percentile) [3] to be complied with by 2015			

2.3 Assumptions and Limitations

The first stage assessment has enabled the quantification of unmitigated mass emissions and the impact at a national scale to be determined. More sophisticated methods will be used to establish air quality concentrations in the second stage baseline once dynamic traffic modelling information is available. Should these methods indicate, further modelling will be also undertaken to gauge the effectiveness of the scheme promoters' mitigation measures.

[9] Environment Act 1995, Chapter 25, Part IV Air Quality
[10] The Air Quality Strategy for England, Scotland, Wales and Northern Ireland, Volume 1, July 2007

Key assumptions and their consequent limitations are presented in Table 2.5 for each emissions source. Further details can be found in Appendix B.2.

Table 2.5 – Key assumptions and limitations

Issue	Key Assumption	Key Limitation
Airports Commission air transport movements (ATM) forecasts	Research by LeighFisher and the Civil Aviation Authority into the DfT forecast fleet mixes found that 'domestic freight' and 'international freight' are best represented by the B737 and B747, respectively. Aircraft listed as 'other' were assigned the forecast fleet mix's weighted average emission rate for each respective baseline year.	May over or under predict emissions
2030 Traffic flow, Heavy Duty Vehicles (HDV)and speed forecasts	The traffic flow forecasts are the outputs of a 'static model'; this only forecasts the change in total traffic flow in the annual average daily flow (AADF) and has not forecasted the change in the HDV% or speed change. The change in total traffic flows do not factor in the effect of congestion upon traveller's route choice, therefore the traffic flow forecasts should be treated with caution	The forecasts of vehicle numbers, types and speed on road links are likely to differ from dynamic traffic model (more accurate forecasts), therefore emissions are likely to under or over predict.
Aircraft engines and APU	To determine the proportion of $PM_{2.5}$ within PM_{10} it has been assumed that $PM_{2.5}$ makes up 100% of total PM_{10}.	May under or over predict.
Reliability of established tools for use within air quality assessments	Tools such as: • Emission Factor Toolkit V6 • National Compliance Model (PCM) • ICAO emission certificates • ICAO emission equations Are thought to be robust and subject to quality controls.	May under or over predict

2.4 Exclusions

Construction related emissions have not been assessed. It is assumed that all schemes will employ best practice construction methods, with appropriate control of dust. Insufficient information exists to estimate emissions from construction vehicles and mobile equipment.

Potential changes in infrastructure, such as alterations to the M23 slip road, have not been assessed. Such changes will be taken into account in detailed dynamic traffic modelling currently in development. Infrastructure changes such as proposals for tunnelling parts of the M25 have also not been considered in detail; although such changes are likely to alter local pollutant dispersion conditions and may give rise to increased local concentrations.

Future development that may add or remove public exposure within the study areas, such as residential dwellings has not been assessed.

Potential future mitigation measures to reduce emissions which might be undertaken in response to government policy and regulations and airport actions have not been taken into account in the baseline projections.

Non-airport related sources of pollutants of concern have not been currently identified.

Dispersion modelling has not been currently undertaken due to the lack of necessary data inputs, such as detailed dynamic traffic modelling.

The Do Minimum and Do Something scenarios will continue to be refined during the consultation period taking advantage of any additional relevant information that feeds into the assessment process.

Details of how these first stage assessment exclusions will be addressed through proposed and additional assessment stages are provided in Chapter 6

3 Gatwick Airport Second Runway

This Section covers:

- Baseline Study Area
- National Assessment
  - Total mass emissions of key pollutants associated with airport activity
- Local Assessment
  - Proportions of mass emissions of key pollutants associated with airport activity
  - 2030 modelled concentrations from the National PCM model to identify EU Limit Value compliance risks; and
  - Projected local ambient monitoring data to 2030 concentrations to identify National Air Quality Objective compliance risks.

3.1 Baseline Study Area

There are a number of populated areas within the 8km x 8km baseline study area centred on Gatwick Airport Second Runway (Gatwick 2R), see Appendix D: Fig. 1.

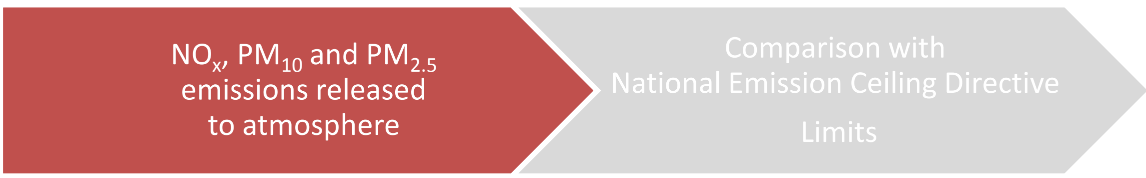
Statutory designated sites of nature conservation importance within the study area have been reviewed using the APIS to identify those potentially sensitive to changes in air quality. Glovers Wood SSSI was identified as a site that is potentially sensitive to air quality.

Natural England's Aviation Sensitivity Mapping identifies Glover's Wood SSSI, and also House Copse SSSI and Buchan Hill Ponds SSSI, as potentially sensitive to air quality.

For the sensitive sites identified, it will be necessary to establish baseline nitrogen deposition as part of the second stage assessment.

3.2 National

3.2.1 Total Mass Emissions



National Atmospheric Emissions Inventory (NAEI) projections have been used to report the UK's status on compliance with the NECD and Gothenburg Protocol. NAEI projections up to 2030 (AEA, 2012) are presented in Table 3.1. There are no NAEI projections for PM_{10} as this pollutant is not prescribed under the NECD or Gothenburg Protocols. However, the EC is currently revising its National Emissions Ceilings Directive for EU countries, with much tighter ceilings proposed for 2030. The UK could have tighter limits in 2030 meaning that targets may be more difficult to achieve.

Table 3.1 – NAEI NO_x and $PM_{2.5}$ emission projections for the UK

kilo tonnes / year (kt/y)	NO_x		$PM_{2.5}$	
	2025	2030	2025	2030
Gothenburg Protocol's 2020 emission targets	711		57	
NAEI emission pollutant projections	612	589	57	59
NAEI projection % of Gothenburg Protocol targets	86.1%	82.8%	100%	103.5%

Observations:

- UK emissions of NO_x are projected to meet current 2020 Gothenburg Protocol targets in both 2025 and 2030;
- UK emissions of $PM_{2.5}$ are however only projected to meet 2020 Gothenburg Protocol targets in 2025. By 2030 emissions are projected to exceed the target by 3.5%; and
- Projected UK emissions implicitly include emissions from Gatwick Airport; however it is not known to what degree.

To establish the potential extent of emissions associated with airport activities at Gatwick, total mass emissions have been estimated. Table 3.2 presents the total mass emissions (kilo tonnes per annum) that have been calculated and attributed to associated airport activities in the Gatwick Second Runway baseline.

Table 3.2 - Gatwick total annual air pollutant mass emissions

kt/y	NO_x			PM_{10}			$PM_{2.5}$		
	1R 2030	1R 2040	1R 2050	1R 2030	1R 2040	1R 2050	1R 2030	1R 2040	1R 2050
Total	4.4	4.3	3.9	0.091	0.093	0.093	0.072	0.074	0.073
% of Total UK Projection	0.7	-	-	-	-	-	0.1	-	-

Observations:

- While NO_x is the largest annual emission by mass in the Gatwick 2R baseline, it represents seven tenths of a percent of the entire NO_x emissions projected for the UK in 2030;
- $PM_{2.5}$ emissions are a sub-set of PM_{10} emissions and represent one tenth of a percent of the entire $PM_{2.5}$ emissions projected for the UK in 2030;
- Emissions of Particulate Matter increase between 2030 and 2040; this is due to increases in airport activity offsetting improvements in emissions from using a cleaner aircraft fleet; and
- Emissions of all pollutants stay constant or decrease between 2040 and 2050; this is due to a slowing of the rate of increase in airport activity that no longer offsets improvements in emissions from using a cleaner fleet.

3.2.2 Comment on sensitivity to change

2030 NAEI NO_x emissions can be accommodated within the current 2020 Gothenburg emission target reduction. However, leading up to 2020 the emissions target will be reviewed, potentially leading to more stringent targets. The current 2030 NAEI projections (589 kt/y) can accommodate up to a 62% reduction in the national emission target relative to 2005 (1580 kt/y) UK emissions.

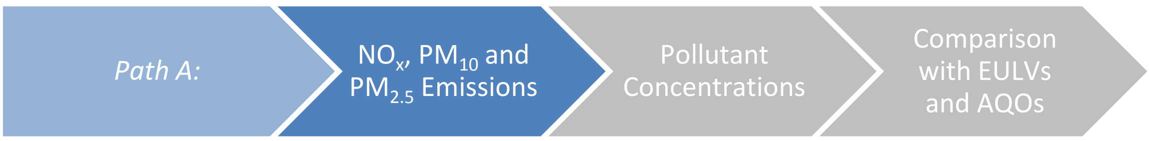
Regardless of whether the UK is on track to meet current 2020 Gothenburg Protocol NO_x targets, it would be expected that GAL pursue minimisation of unnecessary NO_x emissions through the implementation of an appropriate emissions management plan.

Emission of $PM_{2.5}$ attributed to associated airport activities in the Gatwick 2R baseline in 2030 represent approximately 4% (0.072 kt/y from the airport ÷ 3.5% exceedance) of the current 2020 Gothenburg Protocol target.

Given that NAEI projections show that UK will exceed $PM_{2.5}$ emission targets in 2030 and the targets will be under review leading up to 2020. It is necessary for GAL to pursue minimisation of unnecessary $PM_{2.5}$ emissions through the implementation of an emissions management plan.

3.3 Local

3.3.1 Mass Emissions broken down into proportions



Note: It is not just the total mass of emissions, but also the distance from the source to the receptor which causes poor air quality. This is why air quality surrounding roads is currently the focal point for air quality studies. Consequently, sensitive receptors (human health and ecosystems) within close proximity to heavily polluting roads will experience poor air quality (NO_2, NO_x and PM concentrations).

Table 3.3 presents the mass emissions (tonnes per annum) that have been calculated and attributed to associated airport activities in the baselines.

These will be compared with airport expansion mass emissions in the Air Quality: National and Local Assessment report (Jacobs 2014) to evaluate potential impacts.

Table 3.3 - Gatwick projected annual air pollutant mass emissions by source

tonnes / year(t/y)	NO_x			PM_{10}			$PM_{2.5}$		
Emission Source	1R 2030	1R 2040	1R 2050	1R 2030	1R 2040	1R 2050	1R 2030	1R 2040	1R 2050
Aircraft engine	3,473.5	3,429.6	3,020.9	14.9	15.4	14.8	14.9	15.4	14.8
Brake and tyre wear	-	-	-	18.2	17.6	16.5	12.7	12.4	11.6
APU	475.3	468.2	452.1	18.3	18.4	18.8	18.3	18.4	18.8
GSE	176.8	169.9	165.1	10.9	10.5	10.2	9.5	9.1	8.8
Road traffic – airport only*	261.8	281.9	296.9	28.7	30.9	32.6	16.9	18.2	19.1
Total	4,387.4	4,349.6	3,935.0	91.0	92.9	92.8	72.3	73.5	73.1

** irport only includes fugitive emissions from surface access*

(a) Road traffic emissions – Sensitivity Testing

Road traffic - airport only emissions provided in Table 3.3 are based on passenger growth estimates provided by the Scheme Promoter. Sensitivity testing of road traffic emissions estimates was undertaken using the Assessment of Need Carbon Capped (AoN Carbon Capped) scenario. The testing showed that AoN Carbon Capped emission estimates were 16.4% lower than scheme promoter estimates for mass emission of NO_x in all assessment years; while AoN Carbon Capped emission estimates of Particulate Matter (PM_{10} and $PM_{2.5}$) were 16.1% lower in all assessment years. Due to the limitations within the static model only traffic flow could be forecasted, as such it is the passenger demand forecast used by GAL which has resulted in greater vehicle numbers forecast and in turn greater mass emission predictions.

(b) Emissions contributions from the different airport Sources

Figures 3.1 to 3.3 show the source apportionment across the different airport emissions sources for each of the three pollutants.

Figure 3.1 - NO_x annual mass emissions source apportionment

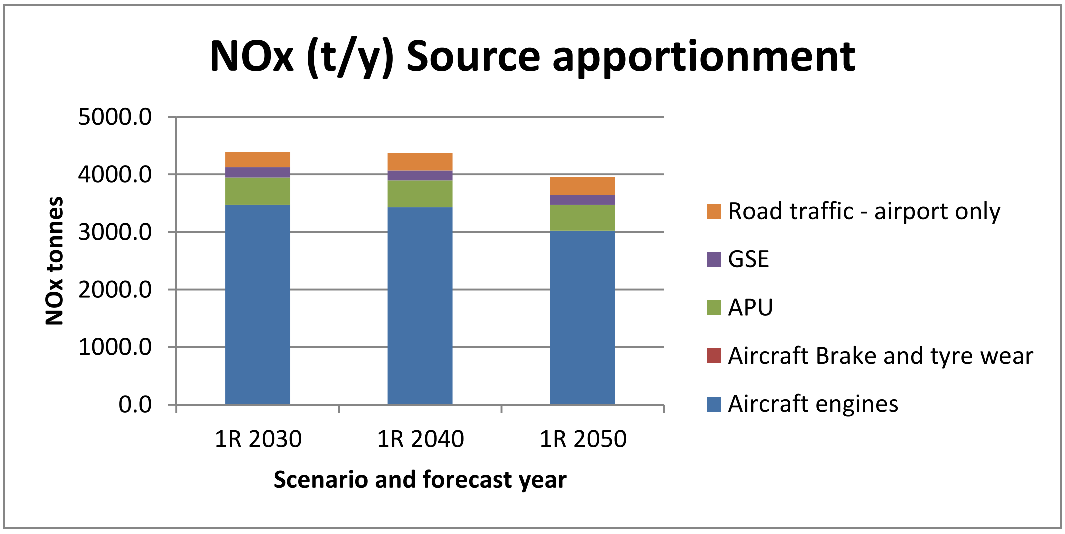


Figure 3.2 - PM_{10} annual mass emissions source apportionment

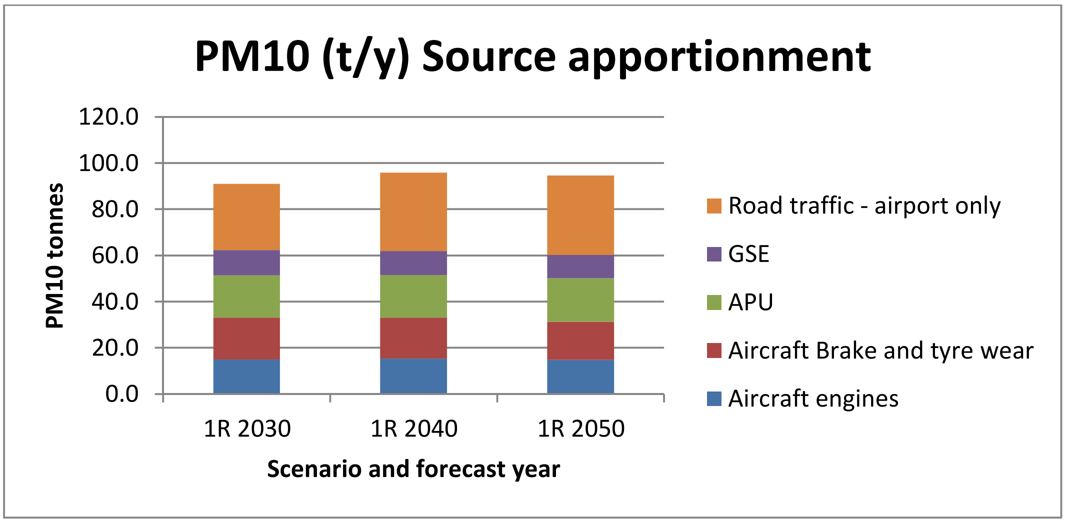
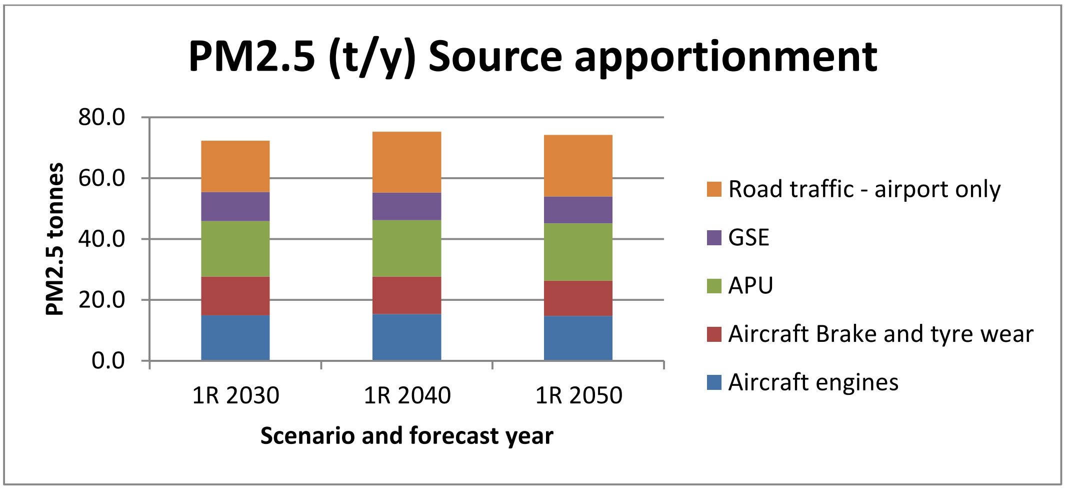


Figure 3.3 - $PM_{2.5}$ annual mass emissions source apportionment



For each baseline year assessed, the dominant emission source at Gatwick for each pollutant of concern is presented in Table 3.4.

Table 3.4 – Gatwick R2 baseline years' dominant airport emission sources

Pollutant	Dominant source 2030	Dominant source 2040	Dominant source 2050
NO_x	Aircraft engines	Aircraft engines	Aircraft engines
PM_{10}	Road traffic – airport only	Road traffic – airport only	Road traffic – airport only
$PM_{2.5}$	APU	APU	Road traffic – airport only

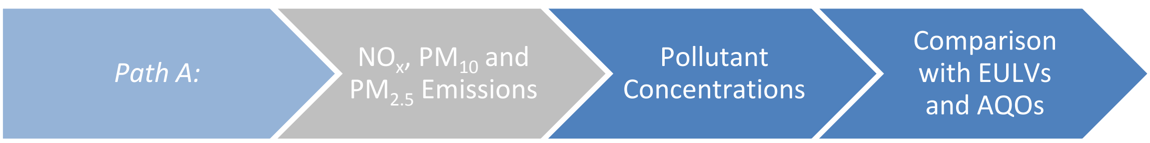
Aircraft engine emissions are projected to be the dominant source of NO_x and airport only road traffic is projected to be the dominant source of PM_{10} for airport emissions in all baseline years assessed. Up to 2050 Auxiliary Power Units (APUs) are forecast to be to dominant source of $PM_{2.5}$, after which airport only road traffic becomes the dominant source of all PM.

Observations:

- Aircraft engines are the biggest source of NO_x in all baseline years with total mass emissions of approximately 3,474 tonnes predicted to be emitted in 2030 with aircraft engine mass emissions decreasing between 2030 and 2050 to approximately 3021 tonnes per annum which takes into account a projected future fleet mix that includes less polluting aircraft
- Surface access from airport road traffic only is the biggest source of PM_{10} across all baseline years with approximately 29 tonnes predicted to be emitted in 2030 with mass emissions increasing between 2030 and 2050 to approximately 33 tonnes per annum
- Assuming the airport doesn't change the APUs used, these are the biggest source of $PM_{2.5}$ in 2030 with approximately 18 tonnes predicted to be emitted with emissions increasing by approximately 0.1 tonnes. The succeeding dominant emission source changes to road traffic – airport only in 2050 with approximately 19 tonnes predicted to be emitted. The two drivers behind this change are cleaner aircraft with cleaner APUs in 2050 as a result of fleet rollover and an increase in emissions from road traffic – airport only.

3.3.2 Potential sensitivity of receiving environment

(a) National Modelling and EULVs



The Defra PCM model is used to report the UK's status on compliance with EULVs. Table 3.5 shows annual mean NO_2 predictions from the PCM modelled road links within the baseline study area for Gatwick 2R airport. The locations and extent of the

PCM links can be seen in Appendix D: Figure 4. For more information about the version, contents and uncertainty of the PCM model refer to section 2.1.3.

Table 3.5 - PCM modelled road links within the baseline study area for Gatwick Airport

Road	2030 Modelled PCM Annual Mean NO_2 ($\mu g/m^3$)
AIRPORT WAY, A23	31.8
LONDON ROAD, A23	31.0

PCM modelled road links within the baseline study area for Gatwick 2R airport, show that annual mean NO_2 concentrations are predicted to be below the NO_2 EU limit value of $40\mu g/m^3$ in 2030.

Note: Current Department for Environment and Rural Affairs (Defra) PCM modelling has been undertaken with the Emission Factor Toolkit (EFT) V5.2c, which was superseded in June 2014 by EFT V6.01. The latest EFT revises overly optimistic uptake rates of Euro VI vehicles in the future fleet mix, which is likely to increase projected emissions and predict higher pollution concentrations.

Defra's latest report to the EU on EULV compliance confirms that EULVs for PM_{10} are currently being met in all Zones within the UK. It also confirms that the target value for $PM_{2.5}$ is also being met; but concedes that by 2020 one Zone (Greater London Urban Area) is unlikely to currently meet the Stage 2 EULV, even after the subtraction of the natural contribution. In the latest available year (2012), the PCM model has calculated there were no roadside locations within the baseline study area for Gatwick 2R that exceed the annual mean PM_{10} or $PM_{2.5}$ EULVs. While the PCM model does predict concentrations of PM in future years, these data are not currently published.

(b) Local Monitoring and AQOs

Note: Air pollution concentration data described by PCM modelling and local monitoring are incomparable concentrations. There may be locations where projected locally monitored pollution concentrations and forecast nationally modelled pollution concentrations do not agree; this represents uncertainty in predicting future air quality.

Local Authorities are required to Review and Assess air quality within their jurisdiction. If the findings of this review determine that air quality concentrations are exceeding AQOs then Air Quality Management Areas (AQMAs) need to be established to an Action Plan to actively manage factors causing poor air quality. AQMAs have not formed the basis to establish areas at risk of or exceeding AQOs, as these are based upon current monitoring data. The monitoring locations that are within an AQMA have been identified with an asterix within Table 3.6, the rest of the monitoring locations are set out within Appendix C: Table C1.

As the areas of sensitivity to air quality within the appraisal years are likely to change as a result of Euro VI vehicles penetrating the UK fleet mix (as of September 2014), the monitoring data that has had the IAN/170/12v3 projection factors applied takes account of associated reduction and is considered a more realistic identification of areas sensitive to changes in NO_2 concentrations.

Table 3.6 shows recent (2011-2012) local pollution monitoring concentrations projected to equivalent 2030 values for nitrogen dioxide (NO_2) within the baseline study area for Gatwick 2R. For more information on how expected reductions in NO_2 have been applied to projecting monitoring data and uncertainties of the method refer to section 2.1.4. These monitoring locations and the complete set of monitoring data within the Gatwick R2 study area are in Table C1 of Appendix C. The monitoring locations can be seen in Appendix D: Figure 7.

Table 3.6 - Projected annual mean NO_2 air quality monitoring data concentration: 2030

Local Authority Site ID	Monitoring Location	2030 Annual Mean NO_2 ($\mu g/m^3$)
Craw5	Lynhurst Cottage	15.7
Craw6	Charlwood Nursery	11.1
Craw15	Woodfield Lodge (Hazelwick roundabout)	35.9
ContRG2*	Horley Gardens Estate, Horley South	18.8

* denotes monitoring locations that are within AQMAs

In 2030 projected annual mean NO_2 concentrations are predicted to be close to the NO_2 annual mean AQO in locations along the A2011/Hazelwick Roundabout (Craw15).

One Particulate Matter monitoring site has been identified within the baseline study area for Gatwick 2R at Horley approximately 0.4km north east from the existing airport boundary. This site uses monitoring equipment that provides results that can be directly compared with AQOs without further processing.

Additional Particulate Matter monitoring sites have also been identified within the baseline study area for Gatwick 2R. While the results at these sites indicate there to be no risk of exceedance, the results from these sites currently cannot directly be compared with AQOs. This is due to monitoring equipment used at these locations not having successfully met equivalency requirements for reporting to the same Standards as Gravimetric-type devices (measure the mass of particulates). These sites are to be subject to further review by Jacobs in order to confirm this position. The PM_{10} monitoring results can be found within Appendix C Table C2.

While there is no well-established method for projecting local PM_{10} monitoring data to future years, concentrations are anticipated to decline as can be seen in national background mapping[11] and emission factor projections[12].

3.4 Conclusions

3.4.1 National

The National Atmospheric Emissions Inventory (NAEI) projects UK total emissions of NO_x and $PM_{2.5}$ up to and including the year 2030. These projections include emissions from Gatwick Airport.

[11] http://uk-air.defra.gov.uk/data/laqm-background-maps?year=2011
[12] http://laqm.defra.gov.uk/review-and-assessment/tools/emissions-factors-toolkit.html

UK emissions of NO_x are expected to meet current 2020 Gothenburg Protocol targets in both 2025 and 2030. UK emissions of $PM_{2.5}$ are however only projected to meet current 2020 Gothenburg Protocol targets in 2025. By 2030 emissions are expected to exceed the target by 3.5%. However, Gothenburg Protocol emission targets are currently under review and should they become more stringent, achievement of the target will be more difficult.

NAEI NO_x emissions can be accommodated within the current 2020 Gothenburg emission target reduction. The current NAEI projections can accommodate a further 62% reduction in the national emission target relative to 2005 emissions.

Emissions of $PM_{2.5}$ attributed to associated airport activities in the Gatwick 2R baseline in 2030 represent approximately 4% (0.072 kt/y from the airport / 3.5% of the projected exceedance of the current 2020 Gothenburg Protocol target.

Delivery of target emissions are best addressed at a national level through a coordinated effort across all Industry, as further emissions reductions may be more easily achieved elsewhere. While such contributions are likely to be accommodated in the context of the current Protocol targets; there remains a risk that the Protocol targets themselves may become much tighter making any accommodation a greater challenge; it would still be expected that GAL pursue minimisation of unnecessary NO_x and $PM_{2.5}$ emissions through the implementation of an appropriate emissions management plan.

(a) Local

Currently, air quality of surrounding roads are typically the focal point for air quality studies as motor vehicles are the dominant source of oxides of nitrogen (NOx) and nitrogen dioxide (NO_2). Therefore sensitive receptors (human health and ecosystems) within close proximity to heavily polluting roads will experience poor air quality (NO_2, NO_x and PM concentrations).

Airport associated activities, both traffic on the road network and activities within the airport boundary, and the change to mass emissions and the effects on air quality concentrations at sensitive receptors, are not always directly proportional. The influence of the non-airport road traffic is also important. These aspects will be examined further through the dispersion modelling planned for the second stage assessment as identified within section 6 on further work.

Emissions of NO_x, PM_{10} and $PM_{2.5}$ are projected to increase with increased passenger demand. Aircraft engine emissions are the dominant emission source for NO_x, and road traffic is the dominant source for PM_{10} in all baseline years. Conversely $PM_{2.5}$ has varying dominant emission sources, with APUs the dominant source in 2030 to 2040 and road traffic – airport only the dominant source in 2050. Whilst it is counter-intuitive that APU emissions are the dominant source of $PM_{2.5}$ Gatwick Airport's predicted APU run times are long. This is when aircraft environmental systems, such as lighting and heating, etc., are powered externally rather than by the aircraft engines.

Even after the reductions in NO_2 concentrations associated with less polluting vehicles constituting a larger proportion of the fleet mix (see section 2.3.1), projected local monitoring indicates NO_2 concentrations are close to the annual mean NO_2 AQO. Whilst national modelling indicates NO_2 concentrations to be below annual mean NO_2 EULVs within the baseline study area for Gatwick 2R within the same area. The projected local monitoring and PCM modelled baseline concentrations for

2030, however, other than uptake of the Euro VI vehicle emission technology, the results presented do not take into consideration potential future mitigation measures.

On the basis of available information it is considered unlikely that there is any risk of PM_{10} and $PM_{2.5}$ AQOs being exceeded in the baseline years within the baseline study area for Gatwick 2R.

4 Heathrow Airport Northwest Runway

This Section covers:

- Baseline Study Area
- National Assessment
  - Total mass emissions of key pollutants associated with airport activity
- Local Assessment
  - Proportions of mass emissions of key pollutants associated with airport activity
  - 2030 modelled concentrations from the National PCM model to identify EU Limit Value compliance risks; and
  - Projected local ambient monitoring data to 2030 concentrations to identify National Air Quality Objective compliance risks.

4.1 Baseline Study Area

There are a number of populated areas within the 9km x 9km baseline study area centred on Heathrow Airport Northwest Runway (Heathrow NWR)(see Appendix D: Figure 2). In addition, there are also a number of statutory designated sites of nature conservation importance.

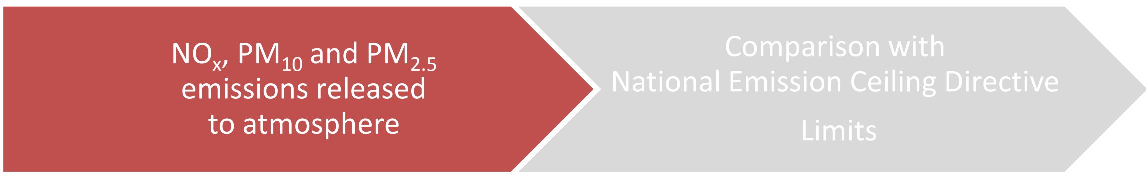
A review of statutory designated sites of nature conservation importance within the baseline study area that might be sensitive to changes in air quality, using the APIS, identified the following sites: Staines Moor (SSSI), Wraysbury Reservoir (SSSI) and South West London Waterbodies (SPA).

Natural England's Aviation Sensitivity Mapping identified the following sites as potentially sensitive to air quality changes: Wraysbury No.1 Gravel Pit, Wraysbury & Hythe End Gravel Pits, Staines Moor and Kempton Park Reservoirs.

For the sites identified, it will be necessary to establish baseline Nitrogen deposition as part of the second stage assessment.

4.2 National

4.2.1 Total Mass Emissions



National Atmospheric Emissions Inventory (NAEI) projections have been used to report the UK's status on compliance with the NECD and Gothenburg Protocol. NAEI projections up to 2030 (AEA, 2012) are presented in Table 4.2. There are no NAEI projections for PM_{10} as this pollutant is not prescribed under the NECD or Gothenburg Protocols. However, the EC is currently revising its National Emissions Ceilings Directive for EU countries, with much tighter ceilings proposed for 2030. The UK is likely to have much tighter limits in 2030 meaning that targets may be more difficult to achieve.

Table 4.2 – NAEI NO_x and $PM_{2.5}$ emission projections for the UK

kilo tonnes / year (kt/y)	NO_x		$PM_{2.5}$	
	2025	2030	2025	2030
Gothenburg Protocol's 2020 emission targets	711		57	
NAEI emission pollutant projections	612	589	57	59
NAEI projection % of Gothenburg Protocol targets	86.1%	82.8%	100%	103.5%

Observations:

- UK emissions of NO_x are projected to meet current 2020 Gothenburg Protocol targets in both 2025 and 2030;
- UK emissions of $PM_{2.5}$ are however only projected to meet current 2020 Gothenburg Protocol targets in 2025. By 2030 emissions are projected to exceed the target by 3.5%; and
- Projected UK emissions implicitly include emissions from Heathrow Airport; however it is not know to what degree.

To establish the potential extent of emissions associated with airport activities at Heathrow, total mass emissions have been estimated. Table 4.3 presents the total mass emissions (kilo tonnes per annum) that have been calculated and attributed to associated airport activities in the Heathrow NWR baseline.

Table 4.3 - Heathrow total annual air pollutant mass emissions

kt/y	NO_x kt/y			PM_{10} kt/y			$PM_{2.5}$ kt/y		
	2R 2030	2R 2040	2R 2050	2R 2030	2R 2040	2R 2050	2R 2030	2R 2040	2R 2050
O b Total	11.0	10.3	8.7	0.134	0.124	0.110	0.104	0.097	0.086
s e r % of Total UK Projection v	1.8	-	-	-	-	-	0.2	-	-

Observations:

- While NO_x is the largest annual emission by mass in the Heathrow NWR baseline, it represents 1.8 percent of the entire NO_x emissions projected for the UK in 2030;
- $PM_{2.5}$ emissions are a sub-set of PM_{10} emissions and represent 0.2 percent of the entire $PM_{2.5}$ emissions projected for the UK in 2030; and
- Emissions of all pollutants decrease between 2030 and 2050; this is due to improvements in emissions from using a cleaner fleet offsetting any growth in airport activity.

4.2.2 Comment on sensitivity to change

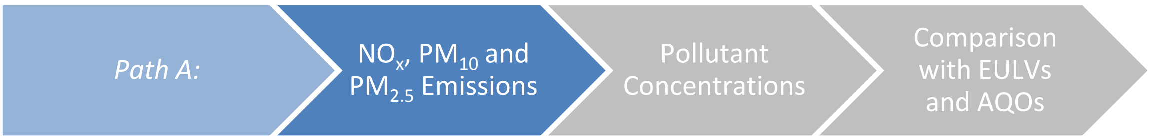
2030 NAEI NO_x emissions can be accommodated within the current 2020 Gothenburg emission target reduction. However, leading up to 2020 the emissions target will be reviewed, potentially leading to more stringent targets. The current 2030 NAEI projections (589 kt/y) can accommodate up to a 62% reduction in the national emission target relative to 2005 (1580 kt/y) UK emissions.

Regardless of whether the UK is on track to meet current 2020 Gothenburg Protocol NO_x targets, it would be expected that HAL pursue minimisation of unnecessary NO_x emissions through the implementation of an appropriate emissions management plan.

Emission of $PM_{2.5}$ attributed to associated airport activities in the Heathrow NWR baseline in 2030 represent approximately 5.2% (0.104 kt/y from the airport ÷ 3.5% exceedance) of the projected exceedance of the current 2020 Gothenburg Protocol target. Given that NAEI projections show that UK will exceed $PM_{2.5}$ emission targets in 2030 and the targets will be under review leading up to 2020. It is necessary for HAL to pursue minimisation of unnecessary $PM_{2.5}$ emissions through the implementation of an emissions management plan.

4.3 Local

4.3.1 Mass Emissions broken down into proportions



Note: It is not just the total mass of emissions, but also the distance from the source to the receptor which causes poor air quality. This is why air quality surrounding roads are currently the focal point for air quality studies. Consequently, sensitive receptors (human health and ecosystems) within close proximity to heavily polluting roads will experience poor air quality (NO_2, NO_x and PM concentrations).

Table 4.5 presents the mass emissions (tonnes per annum) that have been calculated and attributed to associated airport activities in the baselines. These will be compared with airport expansion mass emissions in the Air Quality: National and Local Assessment report (Jacobs 2014) to evaluate potential impacts.

Table 4.5 - Heathrow projected annual air pollutant mass emissions by source

tonnes / year (t/y)	NO_x			PM_{10}			$PM_{2.5}$		
Emission Source	2R 2030	2R 2040	2R 2050	2R 2030	2R 2040	2R 2050	2R 2030	2R 2040	2R 2050
Aircraft engine	10,168.8	9,544.2	7,924.7	27.9	27.8	26.2	27.9	27.8	26.2
Brake and tyre wear	-	-	-	51.8	41.8	26.7	36.2	29.2	18.7
APU	293.7	233.0	217.2	7.7	7.6	7.3	7.7	7.6	7.3
GSE	278.6	258.0	281.2	17.2	16.0	17.4	15.0	13.9	15.1
Road traffic – airport only*	248.7	259.5	273.9	29.6	30.9	32.6	17.2	17.9	18.9
Total	10,989.8	10,294.6	8,696.9	134.2	124.1	110.2	104.0	96.5	86.2

**irport only includes fugitive emissions from surface access*

(a) Road traffic emissions – Sensitivity Testing

Road traffic - airport only emissions provided in Table 4.5 are based on passenger growth estimates provided by the Scheme Promoter. Sensitivity testing of road traffic emissions estimates was undertaken using the Assessment of Need Carbon capped (AoN Carbon Capped) scenario. The testing showed that AoN Carbon Capped emission estimates were 14% higher than scheme promoter estimates for mass emission of NO_x in all assessment years; while AoN Carbon Capped emission estimates of Particulate Matter (PM_{10} and $PM_{2.5}$) were 13.4 and 13.5% higher respectively in all assessment years. The modal share adjusts the passenger demand forecast into number of trips by passengers using certain modes of transport. The modal share for HAL shows that more passengers will be inter-lining[13] than in the AoN Carbon Capped. As a result greater traffic flows are forecasted for AoN Carbon Capped which in turn increases emissions.

(b) Emissions contributions from the different airport sources

Figures 4.1 to 4.3 show the source apportionment across the different airport emissions sources for each of the three pollutants.

[13] Inter-lining refers to passengers travelling through an airport by virtue of their ticket being issued as part of an agreement between individual airlines to handle passengers on itineraries requiring multiple airlines to get from journey origin to ultimate destination.

Figure 4.4 - NO_x annual mass emissions source apportionment

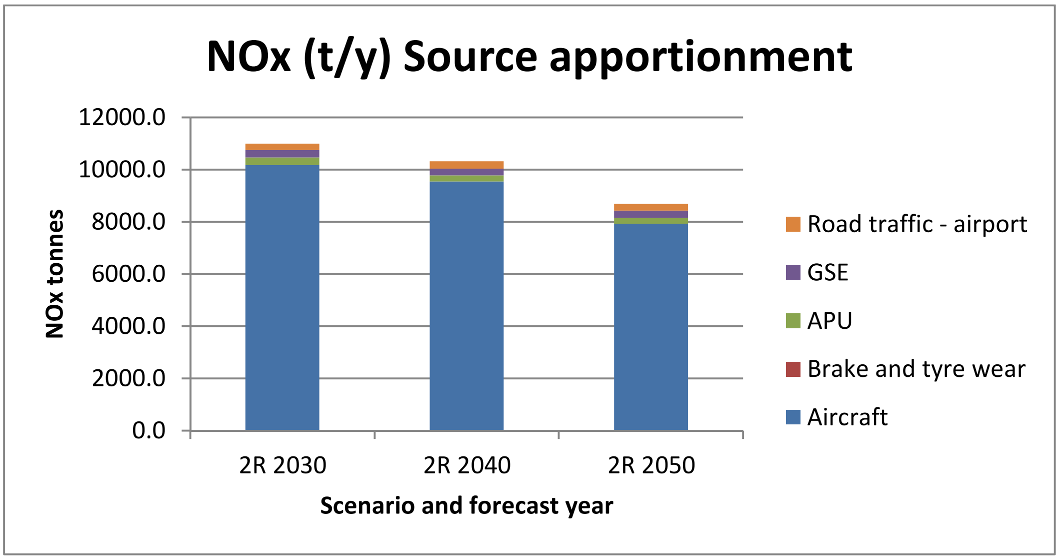


Figure 4.5 - PM_{10} annual mass emissions source apportionment

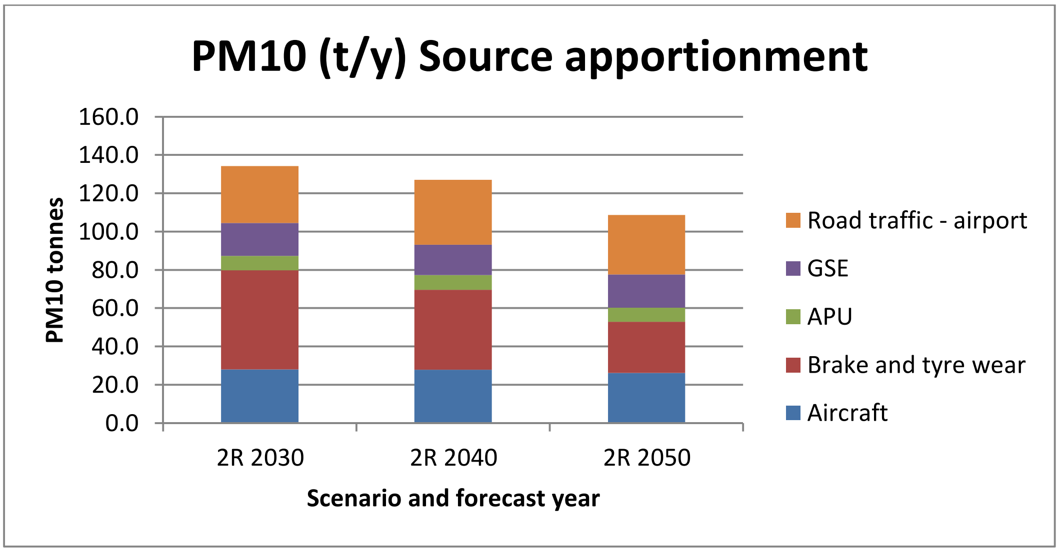
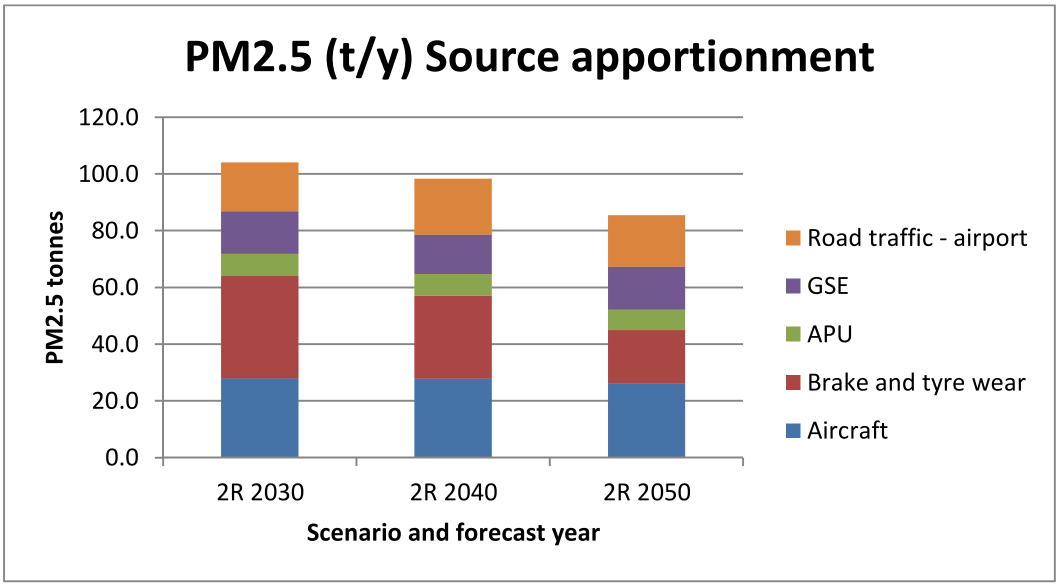


Figure 4.6 - $PM_{2.5}$ annual mass emissions source apportionment



For each baseline year assessed, the dominant emission source at Heathrow for each pollutant of concern is presented in Table 4.6.

Table 4.6 – Heathrow baseline years' dominant emission sources

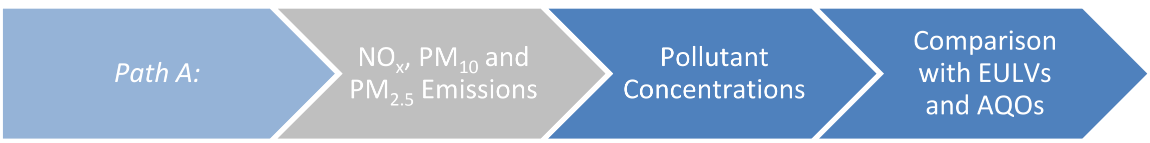
Pollutant	Dominant source 2030	Dominant source 2040	Dominant source 2050
NO_x	Aircraft engines	Aircraft engines	Aircraft engines
PM_{10}	Aircraft brake and tyre wear	Aircraft brake and tyre wear	Road traffic – airport only
$PM_{2.5}$	Aircraft brake and tyre wear	Aircraft brake and tyre wear	Aircraft engines

Aircraft engine emissions are projected to be the dominant source of oxides of nitrogen (NO_x). Up to 2050 aircraft brake and tyre wear is projected to be the dominant source of PM_{10} and $PM_{2.5}$, after which airport only road traffic becomes the dominant source of all PM.

Observations:

- Aircraft engines are the biggest source of NO_x across all baseline years with total mass emissions of approximately 10,169 tonnes per annum predicted to be emitted in 2030 with emissions decreasing to approximately 7,925 tonnes per annum in 2050. This takes into account a projected future fleet mix that includes less polluting aircraft but not other potential mitigation measures;
- Aircraft brake and tyre wear is the biggest source of PM_{10} with approximately 52 tonnes per annum predicted to be emitted in 2030 with emissions decreasing to approximately 42 tonnes per annum 2040. The dominant source of PM_{10} changes to road traffic – airport only in 2050 with approximately 33 tonnes per annum predicted. The reduction in brake and tyre emissions is anticipated to be a product of smaller emission rates applied to the forecasted future aircraft fleet mix, based on known emissions rates for specific craft; despite an observed increase in air transport movements (ATM).
- Aircraft brake and tyre wear is the dominant source of $PM_{2.5}$ from 2030 to 2040 with approximately 36 tonnes per annum predicted to be emitted in 2030 with emissions decreasing to 29 tonnes per annum in 2040. Aircraft engines only become the dominant emissions source in 2050 with approximately 26 tonnes per annum emitted.

4.3.2 Potential sensitivity of receiving environment



(a) National Modelling and EULVs

The PCM model is used to report the UK's status on compliance with EULVs. Table 4.7 shows annual mean NO_2 predictions from the PCM modelled road links within the baseline study area for Heathrow NWR. For more information about the version, contents and uncertainty of the PCM model refer to section 2.1.3. The locations and extent of the PCM links can be seen in Figure 5.

Table 4.7 - PCM modelled road links within the baseline study area for Heathrow NWR

Road	2030 Modelled PCM Annual Mean NO_2 ($\mu g/m^3$)
BATH ROAD, A4	43.2
COLNBROOK BY-PASS, A4	42.9
THE PARKWAY, A312	31.2
GREAT SOUTH-WEST ROAD, A30	30.0

Two Defra National compliance model links are predicted to be well below the NO_2 annual mean EU Limit Value and two are in exceedance of NO_2 annual mean EU Limit Value within the study area for Heathrow NWR without additional mitigation in place, whether it be from the promoter or as a result of wider government policy.

Note: Current PCM projections have been undertaken with the Emission Factor Toolkit (EFT) V5.2c, which was superseded in June 2014 by EFTV6. The latest EFT includes revisions to the uptake of Euro VI vehicles in the future fleet mix and will change projected emissions.

Defra's latest report to the EU on EULV compliance confirms that EULVs for PM_{10} are currently being met in all Zones within the UK. It also confirms that the target value for PM2.5 is also being met; but concedes that by 2020 one Zone (Greater London Urban Area) is unlikely to currently meet the Stage 2 EULV, even after the subtraction of the natural contribution. In the latest available year (2012) the PCM model has calculated there were no roadside locations within the baseline study area for Heathrow NWR that exceed the annual mean PM_{10} or $PM_{2.5}$ EULVs. While the PCM model does predict concentrations of PM in future years, these data are not currently published.

(b) Local Monitoring and AQOs

Note: Air pollution concentration data described by PCM modelling and local monitoring are incomparable concentrations. There may be locations where projected locally monitored pollution concentrations and forecast nationally modelled pollution concentrations do not agree; this represents uncertainty in predicting future air quality.

Local Authorities are required to Review and Assess air quality within their jurisdiction. If the findings of this review determine that air quality concentrations are exceeding AQOs then Air Quality Management Areas (AQMAs) need to be established to an Action Plan to actively manage factors causing poor air quality. AQMAs have not formed the basis to establish areas at risk of or exceeding AQOs, as these are based upon current monitoring data. The monitoring locations that are within an AQMA have been identified with an asterix within Table 4.8, the rest of the monitoring locations are set out within Appendix C: Table C3.

As the areas of sensitivity to air quality within the appraisal years are likely to change as a result of Euro VI vehicles penetrating the UK fleet mix (as of September 2014), the monitoring data that has had the IAN/170/12v3 projection factors applied takes account of associated reduction and is considered a more realistic identification of areas sensitive to changes in NO_2 concentrations.

Table 4.8 shows recent (2011-2012) local pollution monitoring concentrations projected to equivalent 2030 values for nitrogen dioxide (NO_2) within the baseline study area for Heathrow NWR. For more information on how expected reductions in NO_2 have been applied to projecting monitoring data and uncertainties of the method refer to section 2.1.4. These monitoring locations and the complete set of monitoring data within Heathrow NWR study area are in Table C3 of Appendix C and Appendix D: Figure 8, respectively.

Table 4.8 – Baseline Study Area for Heathrow NWR Projected annual mean NO_2 air quality monitoring data concentration: 2030

Local Authority Site ID	Monitoring Location	Annual Mean NO_2 ($\mu g/m^3$) 2030
HD71*	Oxford Avenue, Cranford	24.3
Cont_HD1*	London Heathrow LHR2	31.7
Cont_HD2*	London Hillingdon	37.8
SP14*	Flintlock Close, Stanwell	19.0
SP48*	Riverside Road, Stanwell	21.8

* denotes monitoring locations that are within AQMAs

Projected NO_2 concentrations are close to current AQOs in locations along the M4 (Cont_HD2) at London Hillingdon, approximately 1.8km from the existing site boundary. Cont_HD1 is the closest monitoring location north of Heathrow with ambient air quality well below AQOs. This location is approximately 0.2km from the runway and is representative of ambient air quality on the leeward fringes of the airport boundary.

Eighteen PM_{10} or $PM_{2.5}$ monitoring sites have been identified within the baseline study area for Heathrow NWR. Six of these sites can be directly compared with AQOs and currently do not indicate a risk of exceedances of PM AQOs. Twelve of these sites use monitoring equipment that provides results that cannot be directly compared with AQOs without further processing. This is due to monitoring equipment used at these locations not having successfully met equivalency requirements for reporting to the same standards as Gravimetric-type devices. While the results at these sites do indicate there to be no risk of exceedance, these sites are to be subject to further review by Jacobs in order to confirm this position.

PM_{10} and $PM_{2.5}$ monitoring data results reviewed within the study area can be seen in Appendix C Table 4 and Table 5, respectively.

While there is no well-established method for projecting local PM_{10} monitoring data to future years, concentrations are anticipated to decline as can be seen in national background mapping[14] and emission factor projections[15]. As such it is reasonable to

[14] http://uk-air.defra.gov.uk/data/laqm-background-maps?year=2011
[15] http://laqm.defra.gov.uk/review-and-assessment/tools/emissions-factors-toolkit.html

conclude that there will also continue to be no risk of exceeding PM_{10} AQOs in the future.

4.4 Conclusions

4.4.1 National

The National Atmospheric Emissions Inventory projects UK total emissions of NO_x and $PM_{2.5}$ up to and including the year 2030. These projections include emissions from Heathrow Airport.

UK emissions of NO_x are expected to meet current 2020 Gothenburg Protocol targets in both 2025 and 2030. 2030 NAEI NO_x emissions can be accommodated within the current 2020 Gothenburg emission target reduction. The current NAEI projections can accommodate a further 62% reduction in the NO_x Gothenburg Protocol emission target relative to 2005 emissions.

UK emissions of $PM_{2.5}$ are however only projected to meet current 2020 Gothenburg Protocol targets in 2025. By 2030 emissions are expected to exceed the target by 3.5%. Emissions of $PM_{2.5}$ attributed to associated airport activities in the Heathrow NWR baseline in 2030 represent 5.2% of the projected exceedance of the 2020 Gothenburg Protocol target. However, leading up to 2020 the emissions targets for NO_x and PM will be reviewed, potentially leading to more stringent targets.

Regardless of whether the UK is on track to meet Gothenburg Protocol targets, it would be expected that HAL pursue minimisation of unnecessary NO_x emissions through the implementation of an appropriate emissions management plan. Given that NAEI projections show that UK will exceed $PM_{2.5}$ emission targets in 2030 and the targets will be under review leading up to 2020. It is necessary for Heathrow NWR to pursue minimisation of unnecessary $PM_{2.5}$ emissions through the implementation of an emissions management plan.

4.4.2 Local

Currently air quality surrounding roads are typically the focal point for air quality studies as motor vehicles are the dominant source of oxides of nitrogen (NO_x) and nitrogen dioxide (NO_2). Therefore sensitive receptors (human health and ecosystems) within close proximity to heavily polluting roads will experience poor air quality (NO_2, NO_x and PM concentrations).

Airport associated activities both on the road network and within the airport boundary change in mass emissions and its relationship with air quality concentrations at sensitive receptors is not always directly proportional. This will be established with dispersion modelling, as identified within the further work section.

Emissions of NO_x, PM_{10} and $PM_{2.5}$ are projected to increase with increased passenger demand. Aircraft engines are the dominant emission source of NO_x across all baseline years. Aircraft brake and tyre wear is the dominant source of PM_{10} until 2050 when road traffic – airport only becomes the dominant source. Aircraft brake and tyre wear is the dominant source of $PM_{2.5}$ from 2030 to 2040, when road traffic – airport only becomes the dominant source in 2050.

After reductions in NO_2 concentrations have been applied from improvements in vehicle emission abatement technology two DEFRA National compliance model (PCM) road links are predicted to be well below the NO_2 annual mean EU Limit

Value. However, two DEFRA National compliance model road links are predicted to exceed the NO_2 annual mean EU Limit Value. Other than uptake of the Euro VI vehicle emission technology, the results presented do not take into consideration potential future mitigation measures.

Projected local monitoring also indicates that NO_2 concentrations are close to the annual mean NO_2 AQO within the same baseline study area.

On the basis of available information it is considered unlikely that there is any risk of PM_{10} and $PM_{2.5}$ AQOs being exceeded in the baseline years within the baseline study area for Heathrow NWR.

5 Heathrow Airport Extended Northern Runway

This Section covers:

- Baseline Study Area
- National Assessment
    - Total mass emissions of key pollutants associated with airport activity
- Local Assessment
    - Proportions of mass emissions of key pollutants associated with airport activity
    - 2030 modelled concentrations from the National PCM model to identify EU Limit Value compliance risks; and
    - Projected local ambient monitoring data to 2030 concentrations to identify National Air Quality Objective compliance risks.

5.1 Baseline Study Area

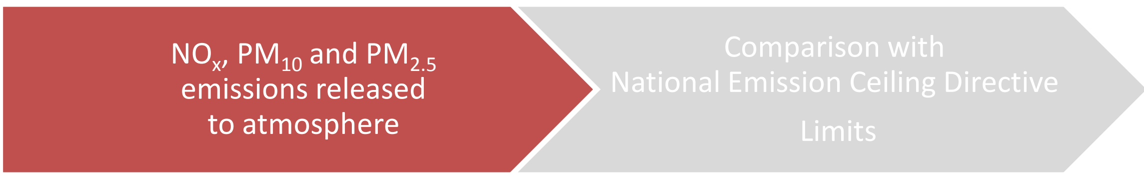
There are populated areas within the 9km x 9km baseline study area centred on Heathrow Airport Extended Northern Runway (Heathrow ENR) (see Appendix D: Figure 3). In addition, there are also a number of statutory sites of nature conservation importance.

A review of designated sites sensitive to changes in air quality within the baseline study area, using APIS, identified the following sites: Staines Moor (SSSI), Wraysbury Reservoir (SSSI) and South West London Waterbodies (SPA).

Natural England's Aviation Sensitivity Mapping identified as potentially sensitive to air quality impacts: Wraysbury No.1 Gravel Pit, Wraysbury & Hythe End Gravel Pits, Staines Moor and Kempton Park Reservoirs.

For the sites identified, it will be necessary to establish baseline Nitrogen deposition as part of the second stage assessment.

5.2 National



5.2.1 Total Mass Emissions

National Atmospheric Emissions Inventory (NAEI) projections have been used to report the UK's status on compliance with the NECD and Gothenburg Protocol. NAEI projections up to 2030 (AEA, 2012) are presented in Table 5.2. There are no NAEI projections for PM_{10} as this pollutant is not prescribed under the NECD or Gothenburg Protocols. However, the EC is currently revising its National Emissions Ceilings Directive for EU countries, with much tighter ceilings proposed for 2030. The UK is likely to have much tighter limits in 2030 meaning that targets may be more difficult to achieve.

Table 5.2 – NAEI NO_x and $PM_{2.5}$ emission projections for the UK

kilo tonnes / year (kt/y)	NO_x		$PM_{2.5}$	
	2025	2030	2025	2030
Gothenburg Protocol's 2020 emission targets	711		57	
NAEI emission pollutant projections	612	589	57	59
NAEI projection % of Gothenburg Protocol targets	86.1%	82.8%	100%	103.5%

Observations:

- UK emissions of NO_x are projected to meet current 2020 Gothenburg Protocol targets in both 2025 and 2030;
- UK emissions of $PM_{2.5}$ are however only projected to meet current 2020 Gothenburg Protocol targets in 2025. By 2030 emissions are projected to exceed the target by 3.5%; and
- Projected UK emissions implicitly include emissions from Heathrow Airport; however it is not know to what degree.

To establish the potential extent of emissions associated with airport activities at Heathrow, total mass emissions (unmitigated) have been estimated. Table 5.3 presents the total mass emissions (kilo tonnes per annum) that have been calculated and attributed to associated airport activities in the Heathrow ENR baseline.

Table 5.3 - Heathrow total annual air pollutant mass emissions

kt/y	NO_x			PM_{10}			$PM_{2.5}$		
	2R 2030	2R 2040	2R 2050	2R 2030	2R 2040	2R 2050	2R 2030	2R 2040	2R 2050
Total	11.0	10.3	8.7	0.135	0.124	0.111	0.104	0.097	0.086
% of Total UK Projection	1.8	-	-	-	-	-	0.2	-	-

Observations:

- While NO_x is the largest annual emission by mass in the Heathrow ENR baseline, it represents 1.8 percent of the entire NO_x emissions projected for the UK in 2030;
- $PM_{2.5}$ emissions are a sub-set of PM_{10} emissions and represent 0.2 percent of the entire $PM_{2.5}$ emissions projected for the UK in 2030; and

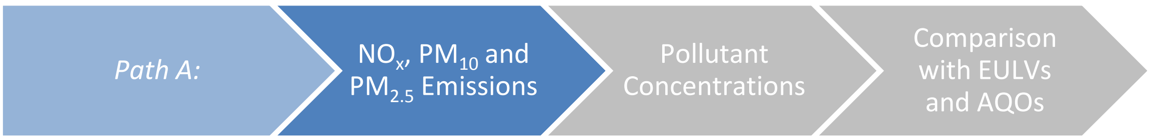
- Emissions of all pollutants decrease between 2030 and 2050; this is due to improvements in emissions from using a cleaner fleet offsetting any growth in airport activity.

5.2.2 Comment on sensitivity to change

2030 NAEI NO_x emissions can be accommodated within the current 2020 Gothenburg emission target reduction. However, leading up to 2020 the emissions target will be reviewed, potentially leading to more stringent targets. The current 2030 NAEI projections (589 kt/y) can accommodate up to a 62% reduction in the national emission target relative to 2005 (1580 kt/y) UK emissions.

Emissions of $PM_{2.5}$ attributed to associated airport activities in the Heathrow ENR baseline in 2030 represent 5.2% of the projected exceedance of the current 2020 Gothenburg Protocol target. Given that NAEI projections show that UK will exceed $PM_{2.5}$ emission targets in 2030 and the targets will be under review leading up to 2020. It is necessary for RLI to pursue minimisation of unnecessary $PM_{2.5}$ emissions through the implementation of an emissions management plan.

5.3 Local



5.3.1 Mass Emissions broken down into proportions

Note: It is not just the total mass of emissions, but also the distance from the source to the receptor which causes poor air quality. This is why air quality surrounding roads are currently the focal point for air quality studies. Consequently, sensitive receptors (human health and ecosystems) within close proximity to heavily polluting roads will experience poor air quality (NO_2, NO_x and PM concentrations).

Table 5.4 presents the mass emissions (tonnes per annum) that have been calculated and attributed to associated airport activities in the baselines. These will be compared with airport expansion mass emissions in the Air Quality: Assessment Report (Jacobs, 2014) to evaluate potential impacts.

Table 5.4 - Heathrow projected annual air pollutant mass emissions by source *

tonnes / year (t/y)	NO_x			PM_{10}			$PM_{2.5}$		
Emission Source	2R 2030	2R 2040	2R 2050	2R 2030	2R 2040	2R 2050	2R 2030	2R 2040	2R 2050
Aircraft engine	10,168.8	9,544.2	7,924.7	27.9	27.8	26.2	27.9	27.8	26.2
Brake and tyre wear	-	-	-	51.8	41.8	26.7	36.2	29.2	18.7
APU	293.7	233.0	217.2	7.7	7.6	7.3	7.7	7.6	7.3
GSE	278.6	258.0	281.2	17.2	16.0	17.4	15.0	13.9	15.1
Road traffic – airport only*	253.7	264.7	279.4	30.0	31.3	33.0	17.4	18.2	19.2
Total	10,994.8	10,299.9	8,702.5	134.5	124.4	110.5	104.2	96.7	86.5

**irport only includes fugitive emissions from surface access*

(a) Road traffic emissions – Sensitivity Testing

Road traffic - airport only emissions provided in Table 5.4 are based on passenger growth estimates provided by the scheme promoter. Sensitivity testing of road traffic emissions estimates was undertaken using the Assessment of Need Carbon capped (AoN Carbon Capped) scenario. The testing showed that AoN Carbon Capped emission estimates were 12.3% higher than scheme promoter estimates for mass emission of NO_x in all assessment years; while AoN Carbon Capped emission estimates of Particulate Matter (PM_{10} and $PM_{2.5}$) were 11.9 and 12% higher respectively in all assessment years. The modal share adjusts the passenger demand forecast into number of trips by passengers using certain modes of transport. The modal share for HH shows that more passengers will be inter-lining[16] than under the AoN Carbon Capped scenario. As a result, greater traffic flows are forecast for AoN Carbon Capped which in turn increases emissions.

(b) Emissions contributions from the different airport sources

Figures 5.1 to 5.3 show the source apportionment across the different airport emissions sources for each of the three pollutants.

[16] Inter-lining refers to passengers travelling through an airport by virtue of their ticket being issued as part of an agreement between individual airlines to handle passengers on itineraries requiring multiple airlines to get from journey origin to ultimate destination.

Figure 5.7 - NO_x annual mass emissions source apportionment

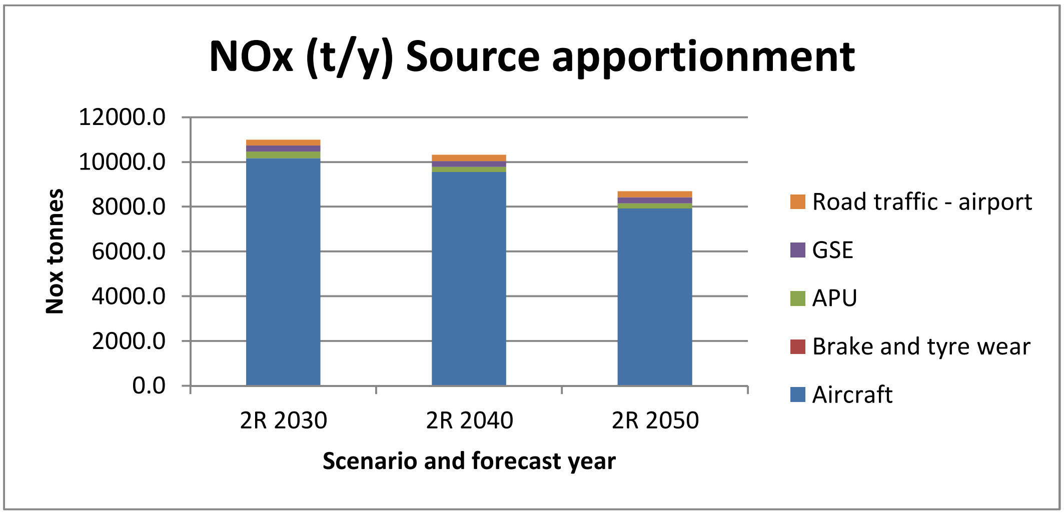


Figure 5.8 - PM_{10} annual mass emissions source apportionment

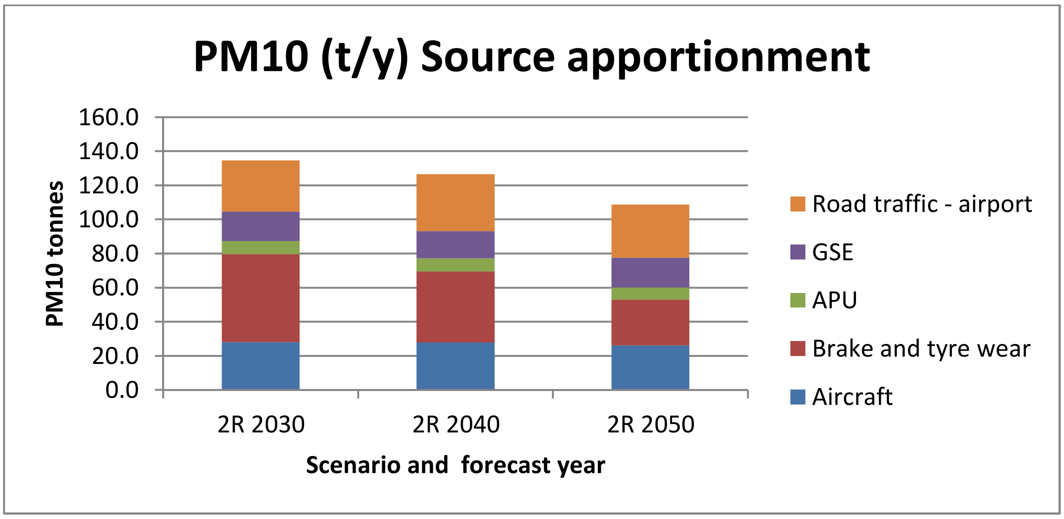
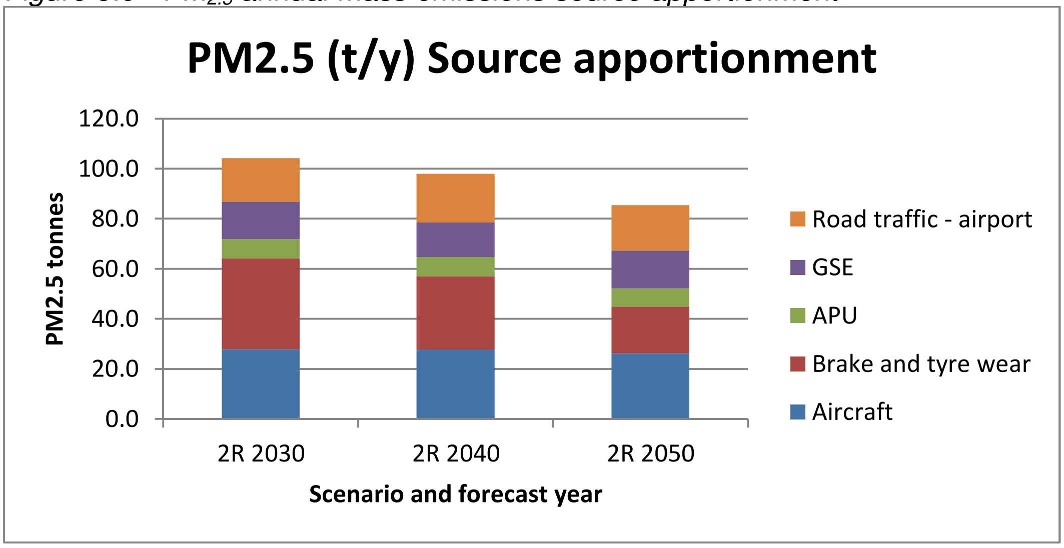


Figure 5.9 - $PM_{2.5}$ annual mass emissions source apportionment



For each baseline year assessed, the dominant emission source at Heathrow for each pollutant of concern is presented in Table 5.5.

Table 5.5 – Heathrow ENR baseline years' dominant emission sources

Pollutant	Dominant source 2030	Dominant source 2040	Dominant source 2050
NO_x	Aircraft engines	Aircraft engines	Aircraft engines
PM_{10}	Aircraft brake and tyre wear	Aircraft brake and tyre wear	Road traffic – airport only
$PM_{2.5}$	Aircraft brake and tyre wear	Aircraft brake and tyre wear	Aircraft engines

Aircraft engine emissions are projected to be the dominant source of oxides of nitrogen (NO_x). Up to 2050 aircraft brake and tyre wear is projected to be the dominant source of PM_{10} and $PM_{2.5}$, after which airport only road traffic becomes the dominant source of all PM.

Observations:

- Aircraft engines are the biggest source of NO_x across all baseline years with total mass emissions of approximately 10,169 tonnes per annum predicted to be emitted in 2030 with emissions decreasing to approximately 7,925 tonnes per annum in 2050. This takes into account a projected future fleet mix that includes less polluting aircraft.
- Aircraft brake and tyre wear is the biggest source of PM_{10} with approximately 52 tonnes per annum predicted to be emitted in 2030 with emissions decreasing to approximately 42 tonnes per annum 2040. The dominant source of PM_{10} changes to road traffic – airport only in 2050 with approximately 33 tonnes per annum predicted. The reduction in brake and tyre emissions is anticipated to be a product of improving emission factor applied to the projected future aircraft fleet mix, based on known emissions rates for specific craft; despite an observed increase in air transport movements (ATM).
- Aircraft brake and tyre wear is the dominant source of $PM_{2.5}$ from 2030 to 2040 with approximately 36 tonnes per annum predicted to be emitted in 2030 with emissions decreasing to 29 tonnes per annum in 2040. Aircraft engines become the dominant emissions source in 2050 with approximately 26 tonnes per annum emitted.

5.3.2 Potential sensitivity of receiving environment

(a) National Modelling and EULVs

The PCM model is used to report the UK's status on compliance with EULVs. Table 5.6 shows annual mean NO_2 predictions from the PCM modelled road links within the baseline study area for Heathrow ENR. For more information about the version, contents and uncertainty of the PCM model refer to section 2.1.3.The locations and extent of the PCM links can be seen in Appendix D: Figure 6.

Table 5.6 - PCM modelled road links within the baseline study area for Heathrow airport

Road	2030 Modelled PCM Annual Mean NO_2 (µg/m^3)
BATH ROAD, A4	43.2
COLNBROOK BY-PASS, A4	42.9
THE PARKWAY, A312	31.2
GREAT SOUTH-WEST ROAD, A30	30.0

Two DEFRA National compliance model links are predicted to be well below the NO_2 annual mean EU Limit Value and two are in exceedance of NO_2 annual mean EU Limit Value within the baseline study area for Heathrow ENR without additional mitigation in place whether it be from the promoter or as a result of wider government policy.

Note: Current PCM projections have been undertaken with the Emission Factor Toolkit (EFT) V5.2c, which was superseded in June 2014 by EFTV6. The latest EFT includes revisions to the uptake of Euro VI vehicles in the future fleet mix and will change projected emissions.

Defra's latest report to the EU on EULV compliance confirms that EULVs for PM_{10} are currently being met in all Zones within the UK. It also confirms that the target value for PM2.5 is also being met; but concedes that by 2020 one Zone (Greater London Urban Area) is unlikely to currently meet the Stage 2 EULV, even after the subtraction of the natural contribution. In the latest available year (2012) the PCM model has calculated there were no roadside locations within the baseline study area for Heathrow ENR that exceed the annual mean PM_{10} or $PM_{2.5}$ EULVs. While the PCM model does predict concentrations of PM in future years, these data are not currently published.

(b) Local Monitoring and AQOs

Note: Air pollution concentration data described by PCM modelling and local monitoring are incomparable concentrations. There may be locations where projected locally monitored pollution concentrations and forecast nationally modelled pollution concentrations do not agree; this represents uncertainty in predicting future air quality.

Local Authorities are required to Review and Assess air quality within their jurisdiction. If the findings of this review determine that air quality concentrations are exceeding AQOs then Air Quality Management Areas (AQMAs) need to be established to an Action Plan to actively manage factors causing poor air quality. AQMAs have not formed the basis to establish areas at risk of or exceeding AQOs, as these are based upon current monitoring data. The monitoring locations that are within an AQMA have been identified with an asterix within Table 4.8, the rest of the monitoring locations are set out within Appendix C: Table C3.

As the areas of sensitivity to air quality within the appraisal years are likely to change as a result of Euro VI vehicles penetrating the UK fleet mix (as of September 2014), the monitoring data that has had the IAN/170/12v3 projection factors applied takes account of associated reduction and is considered a more realistic identification of areas sensitive to changes in NO_2 concentrations.

Table 5.7 shows recent (2011-2012) local pollution monitoring concentrations projected to equivalent 2030 values for nitrogen dioxide (NO_2) (unmitigated) within the baseline study area for Heathrow ENR. For more information on how expected reductions in NO_2 have been applied to projecting monitoring data and uncertainties of the method refer to section 2.1.4.These monitoring locations and the complete set of monitoring data within Heathrow ENR are in Table C2 of Appendix C can be seen in Appendix D: Figure 9.

Table 12 - Projected annual mean NO_2 air quality monitoring data concentration: 2030

Local Authority Site ID	Monitoring Location	Annual Mean NO_2 ($\mu g/m^3$) 2030
HD71*	Oxford Avenue, Cranford	24.3
Cont_HD1*	London Heathrow LHR2	31.7
Cont_HD2*	London Hillingdon	37.8
SP14*	Flintlock Close, Stanwell	19.0
SP48*	Riverside Road, Stanwell	21.8

* denotes monitoring locations that are within AQMAs

Projected NO_2 concentrations are close to current AQOs in locations along the M4 (Cont_HD2) at London Hillingdon, approximately 1.8km from the existing site boundary. Cont_HD1 is the closest monitoring location north of Heathrow with ambient air quality well below AQOs. This location is approximately 0.2km from the runway and is representative of ambient air quality on the leeward fringes of the airport boundary.

Eighteen PM_{10} or $PM_{2.5}$ monitoring sites have been identified within the baseline study area for Heathrow ENR. Six of these sites can be directly compared with AQOs and currently do not indicate a risk of exceedance of PM AQOs. Twelve of these sites use monitoring equipment that provides results that cannot be directly compared with AQOs without further processing. This is due to monitoring equipment used at these locations not having successfully met equivalency requirements for reporting to the same standards as Gravimetric-type devices.

PM_{10} and $PM_{2.5}$ monitoring data results reviewed within the study area can be seen in Appendix C Table 4 and Table 5, respectively.

While there is no well-established method for projecting local PM_{10} monitoring data to future years, concentrations are anticipated to decline as can be seen in national background mapping[17] and emission factor projections[18]. As such it is reasonable to conclude that there will also continue to be no risk of exceeding PM_{10} AQOs in the future.

[17] http://uk-air.defra.gov.uk/data/laqm-background-maps?year=2011
[18] http://laqm.defra.gov.uk/review-and-assessment/tools/emissions-factors-toolkit.html

5.4 Conclusions

5.4.1 National

The National Atmospheric Emissions Inventory projects UK total emissions of NO_x and $PM_{2.5}$ up to and including the year 2030. These projections include emissions from Heathrow Airport.

UK emissions of NO_x are expected to meet current 2020 Gothenburg Protocol targets in both 2025 and 2030. 2030 NAEI NO_x emissions can be accommodated within the current 2020 Gothenburg emission target reduction. The current NAEI projections can accommodate a further 62% reduction in the NO_x Gothenburg Protocol emission target relative to 2005 emissions.

UK emissions of $PM_{2.5}$ are however only projected to meet current 2020 Gothenburg Protocol targets in 2025. By 2030 emissions are expected to exceed the target by 3.5%. Emissions of $PM_{2.5}$ attributed to associated airport activities in the Heathrow ENR baseline in 2030 represent 5.2% of the projected exceedance of the 2020 Gothenburg Protocol target. However, leading up to 2020 the emissions targets for NO_x and PM will be reviewed, potentially leading to more stringent targets.

Regardless of whether the UK is on track to meet Gothenburg Protocol targets, it would be expected that Heathrow pursue minimisation of unnecessary NO_x emissions through the implementation of an appropriate emissions management plan. Given that NAEI projections show that UK will exceed $PM_{2.5}$ emission targets in 2030 and the targets will be under review leading up to 2020. It is necessary for Heathrow ENR to pursue minimisation of unnecessary $PM_{2.5}$ emissions through the implementation of an emissions management plan.

5.4.2 Local

Currently air quality surrounding roads are typically the focal point for air quality studies as motor vehicles are the dominant source of oxides of nitrogen (NO_x) and nitrogen dioxide (NO_2). Therefore sensitive receptors (human health and ecosystems) within close proximity to heavily polluting roads will experience poor air quality (NO_2, NO_x and PM concentrations).

Airport associated activities both on the road network and within the airport boundary change in mass emissions and its relationship with air quality concentrations at sensitive receptors is not always directly proportional. This will be established with dispersion modelling, as identified within the further work section.

Emissions of NO_x, PM_{10} and $PM_{2.5}$ are projected to increase with increased passenger demand. Aircraft engines are the dominant emission source of NO_x across all baseline years. Aircraft brake and tyre wear is the dominant source of PM_{10} until 2050 when road traffic – airport only becomes the dominant source. Aircraft brake and tyre wear is the dominant source of $PM_{2.5}$ from 2030 to 2040, when road traffic – airport only becomes the dominant source in 2050.

After reductions in NO_2 concentrations have been applied from forecasted improvements in vehicle emission abatement technology two DEFRA National compliance model (PCM) road links are well below the NO_2 annual mean EU Limit Value. However, two DEFRA National compliance model road links are predicted to exceed the NO_2 annual mean EU Limit Value. Other than uptake of the Euro VI vehicle emission technology, the results presented do not take into consideration potential future mitigation measures.

Projected local monitoring also indicates that NO_2 concentrations are close to the annual mean NO_2 AQO within the same baseline study area.

On the basis of available information it is considered unlikely that there is any risk of PM_{10} and $PM_{2.5}$ AQOs being exceeded in the baseline years within the baseline study area for Heathrow NWR.

6 Further Work

This Section describes the additional work which will be undertaken when dynamic traffic modelling data is available, which will allow further analysis to be completed including advanced dispersion modelling.

The Do Minimum and Do Something scenarios will continue to be refined during the consultation period taking advantage of any additional relevant information that feeds into the assessment process.

This work will include:

- Study areas
    - The geographical scope of the baseline and impact assessments will be refined during the consultation period taking advantage of any additional relevant information that feeds into the assessment process. This will include an extended desk-based review of existing ambient air quality conditions across the entire extent of the current traffic data network using local monitoring data.
    - A review of traffic changes on routes of new proposed surface access (such as alterations to the M23 slip road, and the introduction of an M25 tunnel) and all existing surface access routes will also be undertaken.
- Advanced dispersion modelling
    - The mass emissions methodology will be enhanced to incorporate detailed dispersion modelling of all emission sources required to calculate exposure to pollutant concentrations at relevant receptors (human health and sensitive habitats).
    - This will be conducted in accordance with the processes, practices and datasets specified in Local Air Quality Management, Technical Guidance LAQM.TG(09) (DEFRA, 2009).
- Non-airport related sources in the local area surrounding the airport
    - Non-airport related sources of pollutants of concern will be identified using national maps of background concentrations. These concentrations will be included as part of the advanced dispersion modelling.

References

Air Quality (England) Regulations 2010.

Airports Council International (2010), Effects of Air Traffic on Air Quality in the Vicinity of European Airports

Colvile R N, Hutchinson E J, Mindell J S, Warren R A (2000) The Transport Sector as a source of air pollution, Millenium Review for submission to Atmospheric Environment, http://eprints.ucl.ac.uk/894/1/Millennium_rvw_final_october.pdf accessed October 2014.

Curran (2006) Method for estimating particulate emissions from aircraft brakes and tyres, NETCEN, 2006

Defra (2007).The Air Quality Strategy for England, Scotland, Wales and Northern Ireland, The Stationery Office, July 2007.

Defra (2009). Local Air Quality Management. Technical Guidance LAQM.TG(09), February 2009.

Defra (2013a). Background air quality maps. http://laqm.defra.gov.uk/review-and-assessment/tools/background-maps.html
Defra (2013b) Emission factor toolkit (version 5.2c) accessed from: http://laqm.defra.gov.uk/review-and-assessment/tools/emissions.html#eft

Department for Transport (2013) Draft National Networks National Policy Statement Environment Act 1995, HMSO.

DFTa (2014). Traffic counts. Available: http://www.dft.gov.uk/traffic-counts/download.php. Last accessed 13/08/2014.

DFTb (2006), Programme for sustainable development at Heathrow emissions inventory, DFT

European Community (2008). Directive 2008/50/EC - Ambient Air Quality and Cleaner Air for Europe.

European Environment Agency (2013) Road vehicle tyre and brake wear road surface wear, EEA, 2013

Hamilton Sundstrand (2014) Auxiliary power unit product line, https://hsapps.utc.com/powersystems/prodindex.htm

Highways Agency (2007). Design Manual for Roads and Bridges (DMRB), Volume 11, Section 3, Part 1 Air Quality, HA207/07. Highways Agency, Scottish Executive, The National Assembly for Wales and The Department of Regional Development Northern Ireland

Highways Agency (2013a) Interim Advice Note 170/12v3 - Updated air quality advice on the assessment of future NOx and NO2 projections for users of DMRB Volume 11, Section 3, Part 1 'Air Quality, June 2013.Highways Agency, Scottish Executive, The National Assembly for Wales and The Department of Regional Development Northern Ireland

Highways Agency (2013c). Interim Advice Note 175/13 - Updated air quality 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 user of DMRB Volume 11, Section 3, Part 1 'Air Quality', June 2013. Highways Agency, Scottish Executive, The National Assembly for Wales and The Department of Regional Development Northern Ireland

ICAO (2011) International Civil Aviation Organisation, airport air quality manual, 2011

IPPC (1999) Intergovernmental Panel on Climate Change, aviation and the global atmosphere, 1999, UNFCCC

Jacobs, (2014a) Module 6 Air Quality: Assessment, Prepared for the Airports Commission, Jacobs

Jacobs, (2014b) Module 7 Biodiversity: Assessment, Prepared for the Airports Commission, Jacobs

NETCEN (2004) Revision to the Method of Estimating Emissions from Aircraft in the UK Greenhouse Gas Inventory, NETCEN, 2004

SA (2012) Sustainable Aviation CO2 Road Map, Sustainable Aviation, 2012

Glossary

The following table lists and explains key technical terms used in this report.

GLOSSARY	
AADT	Annual Average Daily Traffic (vehicles per day)
AADF	Annual Average Daily Flow (vehicles per day)
AQMA	Air Quality Management Area
AURN	Automatic Urban and Rural Network (air quality monitoring)
BAM	Beta Attenuation Monitor
CO	Carbon Monoxide
Defra	Department for Environment, Food and Rural Affairs
DfT	Department for Transport
DMRB	Design Manual for Roads and Bridges, produced by the Highways Agency
EF	Emission Factor
EFD	Emissions Factor Database
EFT	Emissions Factor Toolkit
EPER	European Pollutant Emissions Register
GIS	Geographical Information Systems
Gothenburg Protocol	Part of the Convention on Long-Range Transboundary Air Pollution, setting limits for four, then five air quality pollutants
GPS	Global Positioning System
HDV Vehicles	Heavy Duty Vehicles, ie, all vehicles more than 3.5 tonnes including Heavy Goods and buses
HGV	Heavy Goods Vehicles
IPC	Intergrated Pollution Control
IPPC	Integrated Pollution Prevention and Control
kmh / kph	Kilometres per hour
LAEI	London Atmospheric Emission Inventory
LAPPC	Local Air Pollution Prevention and Control
LAQM	Local Air Quality Management
LDF	Local Development Framework
LDV	Light Duty Vehicles
LGV	Light Goods Vehicles
mppa	million passengers per annum
NATS	National Air Traffic Services
NAEI	National Atmospheric Emissions Inventory
NFR	Nomenclature For Reporting

NO	Nitrogen monoxide, also termed Nitric oxide
NO_2	Nitrogen dioxide
NOX	Nitrogen oxides (NO + NO_2)
NTM	National Traffic Model
O_3	Ozone
OS	Ordnance Survey
PAHs	polycyclic aromatic hydrocarbons
PM_{10}	Airborne particulate matter passing a sampling inlet with a 50% efficiency cut-off 10 µm aerodynamic diameter and which transmits particles of below this size
$PM_{2.5}$	Airborne particulate matter passing a sampling inlet with a 50% efficiency cut-off 2.5 µm aerodynamic diameter and which transmits particles of below this size
ppb	Parts per billion (1,000,000,000)
ppm	Parts per million (1,000,000)
QA/QC	Quality Assurance and Quality Control
RDS	Regional Development Strategy
RMSE	Root Mean Square Error
RSD	Relative Standard Deviation
SO2	Sulphur dioxide
SSF	Smokeless Solid Fuel
STP	Standard Temperature and Pressure
TEOM	Tapered Element Oscillating Microbalance
TRAMAQ	TRAffic Management and Air Quality Research Programme
TRC	Traffic Regulation Condition
TSP	Total Suspended Particulate
UVF	Ultra-Violet Fluorescence
VCM	Volatile Correction Model
VOC	Volatile organic compound

Appendix A: Key Air Pollutants and Health Effects

Nitrogen oxide (NO_x),

NO_2 is a colourless, odourless gas which has been shown to have adverse health effects including causing respiratory irritation in asthmatics. There is believed to be a threshold at which it has an impact. It is formed principally from the oxidation of nitric oxide (NO) through the action of ozone in the atmosphere. Combustion in air forms mainly NO and with some NO_2 (collectively termed 'NO_x') from the combination of atmospheric nitrogen and oxygen. NOx emitted from internal combustion engines as well as other forms of combustion and formed from natural sources such as lightning. NO_x is a precursor to PM_{10}.

Particulate Matter (PM_{10} and $PM_{2.5}$)

PM_{10} and $PM_{2.5}$ is the fraction of particulate matter (dust) in the air with an average aerodynamic diameter of less than 10 µm and 2.5 µm, respectively. This size range of particulate matter can penetrate deep into the lungs and has been shown to have a range of adverse health effects. These include a causal association with cardiovascular and respiratory illnesses. According to the AQS, 'it is not currently possible to discern a threshold concentration below which there are no effects on the whole population's health' as scientific research cannot say whether any concentration of PM_{10} or $PM_{2.5}$ at all does no harm. There is no proven safe threshold. In terms of harm, Defra's damage costs values PM_{10} up to 238 times more than NO_x. PM_{10} and $PM_{2.5}$ is formed from both man-made and natural sources. Primary PM_{10} and $PM_{2.5}$ is formed from the incomplete combustion of fuel (e.g. soot from diesel exhausts), sea-salt and wind-blown dust. Secondary PM_{10} and $PM_{2.5}$ is formed in the atmosphere from other pollutants such as NO_x and sulphur oxides, and in certain circumstances in photochemical smog. PM_{10} and $PM_{2.5}$ has a residence time of several days in the atmosphere, so pollution events occur in southern England when polluted air is blown from the continent.

Appendix B: Background Information for the Methodology

This appendix includes additional background information on the approach taken for the baseline air quality assessment including more detailed explanations of the different mass emission sources and the assumptions and limitations relevant to the methodology applied.

B1 Airport Mass Emissions Sources

Aircraft Engine Emissions from landing and take-off (LTO) cycle

Aircraft-related emissions, including engine exhaust emissions in the landing and take-off cycle below 915m (3,000 feet) (e.g. take off, landing, approach and idle) have been calculated with the ICAO 'Simple Approach A' (ICAO, 2011), which is strongly influenced by the change in ATMs.

The PM emissions rate was derived using the PM emission source method within the ICAO airport air quality manual (ICAO, 2011). This follows the first order of approximation method Version 3 developed by the Federal Aviation Authority (FAA) which allows for the calculation of PM from aircraft engines using smoke numbers measured during engine emissions certification. The ICAO 'Simple Approach – A' uses ICAO reference testing times time in mode for the calculation of NO_x and PM emission rates per landing and take-off cycle (LTO). These are provided in Table B2.1.

Table B1.1 - ICAO emission certification testing procedure time in mode

Modal movement	Duration (minutes)	Thrust %
Taxi/Idle	26	7
Take-off	0.7	100
Climb-out	2.2	85
Approach	4	30

Aircraft models within the fleet mix forecasts that did not have NO_x or PM emission rates within the 'Simple Approach - A' emission rate table were assigned an average weighted emission rate for the year in which that aircraft was forecasted to appear. The average weighted emission rate was established by multiplying the aircraft's annual ATM by the emission rate for an engine, where there was an ICAO emission rate[19] (ICAO, 2011), then taking that forecast year's total annual mass emissions and dividing by the total number of ATMs.

A more detailed 'Simple Approach' is currently in development to eliminate the use of weighted averages and use scheme specific times in mode. Further to this, Sustainable Aviation's fuel burn efficiency trajectories indicated within the carbon dioxide (CO_2) Road Map (SA, 2012) have been used to account for improvements in airframes and engines.

Fugitive PM emissions from aircraft brake and tyre wear

Emissions from aircraft brake and tyre wear follows the Programme for Sustainable Development at Heathrow (PSDH) (DfTb, 2006) methodology used to quantify PM_{10}

[19] Attachment B – Table 1

emissions from aircraft landings. The National Environment Technology Centre (NETCEN)[20] undertook research into PM_{10} emission rates from aircraft brake and tyres in 2006. This was based on the relationship between the aircraft weight and commonly fitted tyres developed with NETCEN research (Curran, 2006).

The NETCEN research has only a partial assignment of aircraft brake and tyre wear emission rates for PM_{10} to all the aircraft within the fleet mix. A weighted average has been established for each baseline year following the same weighted average approach applied to aircraft engines and assigned to the remaining non-assigned aircraft.

In order to estimate the $PM_{2.5}$ fraction of PM_{10} emissions, the particle size distribution of total Particulate Matter emitted from brake and tyre wear has been derived following particle size distribution of motor vehicles (EEA, 2013). The PSDH methodology also used research into particle size distribution of motor vehicles brake and tyre wear to aircraft.

Fugitive PM emissions from surface access brake and tyre wear

The fugitive emissions from surface access brake and tyre wear are included within the total Particulate Matter emissions for 'road traffic – airport only' for all schemes. These emissions are the total of fugitive brake and tyre and volatile and non-volatile emissions released from vehicles exhausts.

Surface access emissions from airport associated traffic only

The ICAO 'Advanced Approach - A' has been followed to compile an emissions inventory of traffic associated with the airport on the strategic road network within the traffic forecast baseline study area (Appendix D: Figures 1 to 3).

The Annual Average Daily Traffic (AADT) and Heavy Duty Vehicle (HDV) flows have been sourced from the DfT's traffic counts on strategic routes (DfTa, 2014). In the absence of speed data from the traffic forecast, speed data was taken from 2012 speed limits and all vehicles were assigned the maximum speed for each road section within all baseline years. The AADT, speed (kph) and HDV proportions sourced following the above methodology were used to populate the Emissions Factors Toolkit version 6 (EFTV6) released June 2014 (DEFRA, 2014).

The EFT is published by Defra and the Devolved Administrations to assist local authorities in carrying out Review and Assessment of local air quality as part of their duties under the Environmental Act 1995. The EFT allows users to calculate road vehicle pollutant emission rates for NO_x, PM_{10}, $PM_{2.5}$ and hydrocarbons for a specified year, road type, vehicle speed and vehicle fleet composition.

Car park emissions constitute a small proportion of total surface access emissions. Therefore it is not anticipated that including supplementary car park emissions will substantially increase surface access emission impacts.

Emissions from railways have not been calculated as the routes serving the airports are electrified, with all train services to Heathrow and the vast majority of train services to Gatwick provided by electric trains. By 2030 it is assumed this will be 100% in both locations.

[20] A previous trading name for a Ricardo-AEA company

Auxiliary Power Unit (APU) Emissions

It has been assumed that on-board facilities power requirement will be supplied solely by APU across all three schemes. This is a conservative assumption as it is expected that power used for on-board environmental control systems and electrics whilst at the terminal stand will more frequently be sourced from fixed electrical ground power (FEGP).

A detailed ICAO 'Simple Approach' has been used for the calculation of NO_x from APUs. A less detailed 'Simple Approach' has been used for the calculation of PM_{10}. The APU emissions database from a NETCEN assessment of airports surrounding London (NETCEN, 2004) has been used within this assessment and assigned to the aircraft that these APUs are commonly fitted to.

As the manufacture's APU emission database does not contain PM emission rates the 'Simple Approach' has been adopted. The 'Simple Approach' assigns an emission rate to narrow- and wide-bodied aircraft. The split of aircraft into short and long haul was carried out following guidance provided by ICAO and assumes the following for the DfT aircraft ATM fleet mix: Narrow2 (single aisle aircraft with 2 engines), regional jet, domestic, other and turboprop are short haul aircraft and wide (2) (double aisle aircraft with two engines), wide (3)4 (double aisle aircraft with 3 or 4 engines) and international are long haul aircraft. This was carried out following the Civil Aviation Authority's long-haul and short-haul use for specific aircraft.

APU run times used within the emissions calculations are as stated by the scheme promoters within their response to a data request. The APU run times were derived from the existing operations in 2012 for Gatwick and anticipated operation restrictions in 2015 for Heathrow, respectively. For Gatwick and Heathrow it is anticipated that both improved infrastructure for Fixed Electrical Ground Power (FEGP) and stricter controls will be put in place for APU run times by 2030; therefore the APU run times are conservative predictions for 2030. In Gatwick's scheme promoter's APU run time data submission, the same APU run times were assigned to both short-haul and long-haul aircraft. In Heathrow Airport Limited scheme, promoter's APU run time data submission, different APU run times were assigned to short-haul and long-haul aircraft. Table B1.2 displays APU run times received from the scheme promoters.

Table B1.2 - APU run times for all airports with and without expansion

Scheme	Long-Haul APU run times (s)	Short-Haul APU run times (s)
Gatwick Airport Limited Second Runway	7142	7142
Heathrow Airport Northwest Runway	2400	1200
Heathrow Airport Extended Northern Runway	2400	1200

Heathrow Airport Northwest Runway scheme's APU run times are considered to be similar to Heathrow Airport Extended Northern Runway APU run times from Jacobs' high level analysis of forecasted aircraft flows. Consequently the same run times were used for both.

Ground Support Equipment (GSE)

It is anticipated that ground support will be from electrically powered vehicles by 2030. As a sensitivity test an ICAO 'Simple Approach' has been undertaken to capture the changes in mass emissions associated with GSE should they be powered by combustion engines.

B2 Detailed Assumptions and Limitations

Additional explanation on the assumptions and limitations for the baseline assessment approach is set out below.

Aircraft engine emissions

The ICAO 'Simple Approach - A' uses the assumptions made in Table B2.1 for aircraft engine emissions.

Table B1.3 - Aircraft engines emissions activity assumptions and limitations

Aircraft engine emissions activity	Assumption	Limitation
PM emissions	The 'ICAO' most commonly installed engine for a specific aircraft was referenced for emissions data.	Does not calculate emissions based upon actual engine installed.
Times in mode	The ICAO reference testing times in mode were used.	The emissions do not capture the airports aircraft movement operating times and emissions reflect changes in ATMs only.
Department for Transports ATM forecasts	Research by LeighFisher and the Civil Aviation Authority into the DfT forecast fleet mixes found that 'domestic freight' and 'international freight' are best represented by the B737 and B747, respectively. Aircraft listed as 'other' were assigned the forecast fleet mix's weighted average emission rate for each respective baseline year.	May over or under predict emissions

Fugitive particulate matter emissions from aircraft brake and tyre wear

For fugitive PM emissions associated with aircraft brake and tyre wear, the ICAO 'Simple Approach' uses the assumptions made in Table B2.2.

Table B2.2 - Fugitive Particulate Matter emissions from aircraft brake and tyre wear activity assumptions and limitations

Fugitive particulate matter emissions	Assumption	Limitation
PM particle size distribution	Little is known about aircraft brake and tyre wear particle size distribution. Subsequently, car brake and tyre wear particulate size distributions have been adopted. $PM_{2.5}$ has been assumed to be 70% of PM_{10} emissions (EEA, 2013)	This may over or under predict $PM_{2.5}$ emissions.

Fugitive Particulate Matter emissions from surface access brake and tyre wear and airport associated traffic only

The ICAO 'Simple Approach' uses the assumptions made for fugitive PM emissions associated with surface access brake and tyre wear and airport associated traffic only (Table B2.3).

Table B2.3 - Fugitive Particulate Matter emissions from surface access brake and tyre wear activity assumptions and limitations

Fugitive particulate matter emissions	Assumption	Limitation
2030 Traffic flow, HDV and speed forecasts	The traffic flow forecasts are the outputs of a 'static model'; this only forecasts the change in total traffic flow in the Annual Average Daily Traffic (AADF)and has not forecasted the change in the HDV% or speed change. The change in total traffic flows do not factor in the effect of congestion upon traveller's route choice, therefore the traffic flow forecasts should be treated with caution	The forecasts of vehicle numbers, types and speed on road links are likely to differ from dynamic traffic model (more accurate forecasts), therefore emissions are likely to under or over predict.

Fugitive particulate matter emissions	Assumption	Limitation
2025/2026, 2040 and 2050 Traffic flow, HDV and speed forecasts	Traffic flow Annual Average Daily Traffic (AADT) forecasts were only carried out for 2030. Therefore, traffic flows were derived for the aforementioned appraisal years with the following assumptions: A constant modal share of 34% of passengers travelling by car was applied to all appraisal years The Airports Commission passenger demand for the aforementioned years was used to derive the traffic flows Speed limits for 2012 have been applied to all appraisal years HDV% of traffic flows remain the same as 2012 DfT measured traffic counts	Traffic flow reductions from 2030 to 2025/2026 are reduced equally on all road links. Conversely for 2040 and 2050, traffic flow growth is equal on all road links. In reality the reduction/growth may not occur equally across all road links. Cars % of modal share is expected to fall. Speed limits are likely to vary between appraisal years, due to varying levels of capacity on roads HDV% are likely to decrease due to modal shift of goods delivery. Due to the conservative approach for many traffic data parameters, it is likely that emissions will be over predicted.
Emissions rates applied to cars for 2040 and 2050	In the absence of any forecast fleet mixes beyond 2030. Emission rates from the 2030 fleet mix have been applied to 2040 and 2050.	No new Euro standard vehicles are currently forecast to be brought in to the fleet mix after 2025. Between 2025 and 2030 there are anticipated to be an increased number of Euro VI vehicles operating under failed catalyst conditions. This is expected to deteriorate emissions to 2030. It is however likely that there will be further improvements in emission rates beyond 2030, therefore this approach will likely over predict emissions.

Auxiliary Power Units (APU)

The assumptions and limitations of APU activity used in the ICAO 'Simple Approach' are outlined in Table B2.4.

Table B2.4 - APU activity assumptions and limitations

APU Activity	Assumption	Limitation
Traffic flow, HDV and speed forecasts	To determine the proportion of $PM_{2.5}$ within PM_{10} it has been assumed that $PM_{2.5}$ makes up 100% of total PM_{10}.	May under or over predict.

Appendix C: Monitoring Site Locations

C1 Baseline Gatwick 2RStudy Area

Table C1 NO_2 Monitoring data within Gatwick's study area projected to 2030

Site ID	Location description	X	Y	Projected 2030 NO_2 ($\mu g/m^3$)
Craw1	BarMed High Street	526770	136780	24.2
Craw2	Furnace Farm Rd	528410	135628	13.7
Craw3	Birch Lea	528501	138377	14.4
Craw4	Headley Close	529864	138204	14.4
Craw5	Lynhurst Cottage	527110	139530	15.7
Craw6	Charlwood Nursery	526320	139860	11.1
Craw7	Rowley Cottage	527760	140070	13.1
Craw8	Balcombe Rd	529490	141460	16.3
Craw9	Steers Lane	529307	139611	17.5
Craw10	Gatwick Airport Tri-location	529411	141493	18.3
Craw11	11 Tinsley Close	528446	138084	28.1
Craw12	10 Tinsley Close	528445	138094	26.1
Craw13	6 Tinsley Close	528385	138064	22.9
Craw14	Pegler Way	526761	136949	20.9
Craw15	Woodfield Lodge(Hazelwick RÆbout	528153	137912	35.9
Craw16	Woodfield Lodge (Northgate Ave)	528153	137871	26.8
Craw17	Brighton Road Level crossing	526743	136349	24.8
Craw18	West Green Drive	526599	136638	18.3
Craw19	5 High Street	526752	136420	20.2
ContCraw1	Gatwick East CRI	529411	141493	31.3
ContCraw2	Gatwick Airport (LGW3)	528583	140825	20.9
ContCraw3*	Michael Crescent, Horley (RG1)	528204	142330	13.7
ContCraw4*	Horley Gardens Estate, Horley South (RG2)	528552	141855	18.9
ContCraw5	Poles Lane, Crawley (RG3)	526419	139640	11.8
MSAQ7	Crabbet Park, Worth	530440	137280	19.0
RB11*	RB11: Riverside	528103	142228	17.5
RB12*	Horley Police Station,	528424	142934	21.2

Site ID	Location description	X	Y	Projected 2030 NO_2 (µg/m^3)
	Massetts Road, Horley			
RB13	Public Car Park, off Massetts Road, Horley	528362	142983	18.4
RB24_25_26*	Urban Background Michael Crescent	528208	142337	17.1
RB51*	Wolverton Gardens	527873	142606	18.8
RB52*	Wolverton Gardens	527892	142463	19.6
RB53*	Cheyne Walk	528030	142373	22.5
RB54*	Crescent Way	528112	142321	19.2
RB55*	Crescent Way	528254	142196	20.4
RB56*	The Crescent	528386	142080	19.9
RB57*	The Crescent	528499	141953	19.3
RB58*	The Crescent	528538	141897	20.6
RB59*	The Crescent	528602	141789	21.0
RB60*	The Crescent	528607	141910	21.0
RB61*	The Crescent	528578	142006	17.3
RB64*	The Drive	528589	142552	19.6
RB65*	The Drive	528581	142635	21.0
RB66*	Fairfield Avenue	528499	142512	18.8
RB67*	Fairfield Avenue	528462	142366	19.3
RB68*	Fairfield Avenue	528505	142246	19.2
RB69*	Upfield	528335	142224	19.0
RB70*	Upfield	528360	142384	18.0
RB73*	Upfield	528172	142679	18.6
RB74*	Meadowcroft Close	529149	141953	18.5
RB75*	Roundabout, The Coronet	529203	142192	17.5
RB76*	Limes Avenue	528958	142468	16.4
RB77*	Staffords Place	528789	142570	17.3
RB78_79_80*	The Crescent	528553	141857	20.4
RB98*	16/17 Woodroyd Gardens	527931	142231	21.3
RB99_100_101	Rural: Poles Lane Pumping Station, Crawley	526421	139639	14.6
RB102	Field near Bridleway, Hathersham Farm, Horley	530937	144272	21.7
RB128*	Between 83 and 85 Victoria Road, Horley	528502	142952	27.1
RB129*	1, Russell's Crescent,	528250	142806	23.1

Site ID	Location description	X	Y	Projected 2030 NO_2 ($\mu g/m^3$)
	Horley.			
RB131*	15, Russell's Crescent, Horley.	528402	142737	17.5
RB132*	32, Russell's Crescent, Horley.	528533	142779	19.2
ContRG 1*	Michael Crescent, Horley	528208	142337	18.8
ContRG 2*	74 The Crescent, Horley	528554	141855	20.3
ContRG 3	Poles Lane Pumping Station, Crawley	526420	139638	13.3

* denotes monitoring locations that are within AQMAs

Table C2 Existing PM_{10} Monitoring data within Gatwick R2 study area

Site ID	Location description	2012 annual average PM_{10} ($\mu g/m^3$)	Gravimetrically equivalent
CRI	Gatwick East	21	N
LGW3	Gatwick Airport	22	N
RH1*	Horley	19	Y

* denotes monitoring locations that are within AQMAs

C 2 Baseline Heathrow Airport study Area

Table C3 Heathrow NO_2 monitoring data projected to 2030

Site ID	Location description	X	Y	Projected 2030 NO_2 ($\mu g/m^3$)
HD31*	AURN Monitoring Station	506951	178605	29.3
HD31*	AURN Monitoring Station	506951	178605	28.9
HD31*	AURN Monitoring Station	506951	178605	27.3
HD42*	Uxbridge Technical College	510417	180752	22.5
HD51*	4 Colham Avenue	506334	180266	22.5
HD55*	Harold Avenue	509917	179015	25.5
HD56*	15 Phelps Way	509796	178633	23.3
HD57*	25 Cranford Lane	508756	177717	24.9
HD58*	Brendan Close	508412	177124	25.2
HD59*	7 Bomber Close	507294	177322	23.3
HD60*	Harmonsworth Green	505753	177760	20.4
HD61*	Heathrow Close	504848	176770	24.6
HD62*	1 North Hyde Gardens, Hayes	510283	178878	25.3
HD63*	370 Sipson Road, Sipson,	507150	178028	15.7
HD64*	34 Hatch Lane, Sipson	505875	177610	21.2
HD65*	28 Pinglestone Close, Sipson	506081	177071	20.7

Site ID	Location description	X	Y	Projected 2030 NO_2 ($\mu g/m^3$)
HD66*	486 Sipson Road, Sipson	507305	177518	21.9
HD67*	31 Tavistock Road	505729	180290	19.6
HD71*	Oxford Avenue, Cranford	509557	176974	24.3
HD72*	2 Vineries Close	507236	177927	20.7
HD79a*	Rear Garden of 86 Stormount Drive (Attached to building)	508310	179577	22.2
HD79b*	Corner of Swallowfield Way and Kestrel Way (Railside)	508310	179600	20.7
HD80a*	Rear Garden of 86Stormount Drive (Attached to railside fence)	508537	179606	22.1
HD80b*	Corner of Swallowfield Way and Kestrel Way (Roadside)	508542	179650	22.9
HD81*	61 Windsor Park R	509721	177082	22.7
HD82*	Hall Lane	508811	177118	30.8
HD83*	81 Pennine Way	508577	177272	25.8
HD84*	26 Rayner Close	508151	177360	22.8
HD85*	296-298 High Street	508769	177463	35.0
HD86*	331 High Street	508750	177534	35.3
HD87*	1 Pondside Close	508674	177485	24.2
HD88*	9 Sipson Lane	508648	177713	27.8
HD89*	293 High Street	508705	177681	33.4
HD90*	22 Richards Close	508839	177782	22.5
HD91*	118 High Street	508771	178071	25.6
HD92*	57 Bedweel Gardens	509224	178525	28.6
HD93*	29 Bedwell Gardens	509251	178619	27.0
HD94*	19 Dudley Place	508842	178796	21.9
HD95*	100 Sipson Road	506720	178964	28.8
HD96*	Station Rd / Porters Way Junction	506503	179469	33.2
HD97*	33 Harmondsworth Rd	506435	178886	24.5
HD98*	1 Laurel Lane	506152	178908	22.8
HD99*	120 The Brambles	506225	178510	25.4
HD100*	1-2 Littlefield Ct	505920	177189	25.3
HA81*	M4 Roadside û Cranford Drive	509815	178355	33.1
HA82*	M4 Residential û Cranford Drive	509808	178326	30.8
HD200*	49 Zealand Avenue Lamp Post (1)	505920	177188	27.3
HD202*	49 Silverdale Gardens, Hayes Lamp Post (8)	510361	179820	23.5
HD203*	Blyth Road, Hayes Lamp Post (4)	509683	179486	28.5
HD204*	Side of 104 Yiewsley High Street (front of 1A Fairfield	506108	180493	25.1

Site ID	Location description	X	Y	Projected 2030 NO_2 ($\mu g/m^3$)
	Road) Lamp Post (2)			
HD205*	1 Porters Way (corner with Kingston Lane) Lamp Post (1)	506503	179510	26.2
HD206*	5-7 Mulberry Crescent, West Drayton Lamp Post (18)	507141	179628	19.2
HD207*	35 Emden Close, West Drayton Lamp Post (14)	507580	179812	23.1
HD208*	Side of 50 St. Christopher's Drive Lamp Post (13)	510761	180766	19.4
HD213*	10 West End Lane, Harlington Lamp Post (2)	508773	177352	26.5
HD214*	R/O 130 Cleave Avenue, Hayes Lamp Post (33)	509499	178370	29.2
Cont_HD1*	London Heathrow LHR2	508399	176746	31.7
Cont_HD2*	London Hillingdon	506900	178600	37.8
Cont_HD5*	Hillingdon 3 û Oxford Avenue	509557	176994	25.8
Cont_HD6*	London Harlington	508300	177800	22.8
Cont_HD7*	Hillingdon Sipson	507325	177282	24.2
Cont_HD8*	London Harmondsworth	505561	177661	20.1
Cont_HD9*	Heathrow Green Gates	505630	176930	22.0
Cont_HD10*	Heathrow Oaks Road	505714	174503	19.9
HS51*	Marjory Kinnon School	509127	174568	18.2
HS52*	Bedfont Library	508873	173722	19.1
HS53*	Church of the good shepherd	510986	176032	21.5
HS54*	Cranford Community School	510810	177667	29.9
HS55*	Cranford Library	510747	176687	28.8
HS65*	Eastbourne Road	511840	172745	21.9
HS66*	Brainton Avenue	510975	173646	26.8
HSCRANA*	Cranford Avenue Park	510370	178198	19.3
HSCRANB*	Cranford Avenue Park	510370	178198	18.2
HSCRANC*	Cranford Avenue Park	510370	178198	18.2
HS73*	Browells Lane, Feltham	510578	172857	22.9
HS75*	Cardinal Road	510678	173247	27.4
HS76*	Clements Court	511570	175015	20.9
HS77*	Beaversfield Park	511990	175973	17.4
HS86*	Jolly Waggoners	510955	176567	31.6
HS87a*	Henleys Roundabout	511545	176430	31.0
MYR1*	Myrtle Road	509334	174997	22.9
MYR2*	Myrtle Road	509334	174997	23.8
MYR3*	Myrtle Road	509334	174997	23.2
FELT 1*	Hanworth Road	510676	173245	29.1
FELT 2*	Hanworth Road	510676	173245	27.8
FELT 3*	Hanworth Road	510676	173245	27.2
Cont_HS1*	Cranford	510370	177195	19.9
Cont_HS5*	Hatton Cross	509355	174989	24.6
Cont_HS6*	Feltham	510683	173259	29.0
StBuck1	Iver, Old Slade Lane	503679	178566	21.6
StBuck2	Iver, Victoria Cres	504056	180901	24.7
Eal81*	Featherstone Primary School, Western Road, Southall, UB2	511475	178899	29.5

Site ID	Location description	X	Y	Projected 2030 NO_2 ($\mu g/m^3$)
	5JT			
Eal82*	Featherstone Primary School, Western Road, Southall, UB2 5JT	511475	178899	29.8
Eal83*	Featherstone Primary School, Western Road, Southall, UB2 5JT	511475	178899	29.4
Eal84*	150 Brent Road, Southall, UB2	511170	179251	28.0
Eal102*	Blair Peach School, Beaconsfield Road	511680	180071	20.1
Eal103*	Blair Peach School, Beaconsfield Road	511680	180071	18.7
Eal104*	Blair Peach School, Beaconsfield Road	511680	180071	19.2
Cont_Eal3*	Southall	511677	180071	21.8
RY10*	M25B Staines	502730	173480	39.8
RY11*	M25B Staines	502730	173480	38.9
RY12*	M25B Staines	502730	173480	44.7
Slough5	ColnbrookáBy-pass	503196	177349	30.6
Slough7	ElbowáMeadows	503856	176538	29.6
Slough13	HortonáRoadá(CaravanáPark)	503136	175654	24.3
Slough15	LakesideáRoad	503877	177459	33.6
Slough21	Pippins	503542	176827	23.2
Cont_Slough2	SLH 3 & SLH6 - Slough Colnbrook (Pippins)	503542	176827	19.6
Cont_Slough4	SLH 5 - Slough Colnbrook (Lakeside, Tan Hse Farm)	503551	177258	21.5
Cont_Slough5	SLH8 and 9	503569	177385	20.5
SP12*	Stanwell New Road, Stanwell North	504538	172318	21.2
SP13*	Shortwood County Infant School, Stanwell North	504494	172098	19.6
SP14*	Flintlock Close, Stanwell	504228	175098	19.0
SP15*	Horton Road, Stanwell Moor	504161	175123	18.7
SP16*	Oaks Road/Russell Drive, Stanwell South (3 tubes)	505729	174496	19.1
SP17*	Oaks Road/Russell Drive, Stanwell South (3 tubes)	505729	174496	19.8
SP18*	Oaks Road/Russell Drive, Stanwell South (3 tubes)	505729	174496	19.7
SP19*	Bedfont Road/Long lane, Stanwell South	506850	174253	25.4
SP24*	Yeoveney Close, Staines	502577	172777	18.5
SP25*	Moor Lane, Staines	503188	172063	16.0
SP26*	St MaryÆs Crescent, Staines	505635	173949	21.4
SP30*	Horton Road, Stanwell Moor	504030	175272	19.9
SP31*	Ashford Hospital, Stanwell	506265	172681	25.8
SP47*	Hadrian Way, Stanwell	506194	173445	18.7
SP48*	Riverside Road, Stanwell	506010	174516	21.8
SP49*	Runnymede Cottages, Moor	502605	173274	23.5

Site ID	Location description	X	Y	Projected 2030 NO_2 (µg/m^3)
	Lane, Staines			
WM13	Wraysbury Road	502009	172544	25.2
WM13a	Wraysbury Road	502108	172461	26.3
WM15	Wraysbury Road	502261	172318	32.7
WM15a	Wraysbury Road	502257	172339	29.7
WM15b	Wraysbury Road	502577	172098	28.8

* denotes monitoring locations that are within AQMAs

Table C4 Existing PM_{10} Monitoring data within Heathrow NWR and Heathrow ENR study area

Site ID	Location description	2013 annual average PM_{10} (µg/m^3)	Gravimetrically equivalent
LHR2*	Northern perimeter of Heathrow Airport	26.1	N
EA7*	Ealing - Southall	20.5	Y
LH0*	Hillingdon - Harlington	19.8	N
RHE*	Richmond Upon Thames - Hanworth Road	24.9	Y
EI7*	Ealing - Southall FDMS	21.4	N
EI2*	Ealing - Southall Railway	22.8	Y
HS2*	Hounslow Cranford	19.3	N
HS9*	Hounslow Feltham	23.0	N
HS7*	Hounslow Hatton Cross	20.8	N
HS6*	Hounslow Heston	28.4	N
HIL4*	Hillingdon Harmondsworth OS	17.4	N
HIL1*	Hillingdon Harmondsworth	21.8	Y
HIL5*	Hillingdon Hayes	29.3	Y
HI3*	Hillingdon Oxford Avenue	21.3	N
SLH6	Slough Colnbrook	18.9	N
SLH5*	Slough Lakeside 1 Osiris	18.7	N
SL59	Slough Lakeside 2	20.4	Y
SL59	Slough Lakeside 2 Osiris	24.6	N

* denotes monitoring locations that are within AQMAs

Table C5 Existing $PM_{2.5}$ Monitoring data within Heathrow NWR and Heathrow ENR study area

Site ID	Location description	2013 annual average PM_{10} (µg/m^3)	Gravimetrically equivalent
LHR2*	Northern perimeter of Heathrow	10.9	Y
TDO*	Richmond-Upon-Thames	16.7	Y
HIL4*	Hillingdon Harmondsworth OS	8.1	Y
SLH5*	Slough Lakeside 1 Osiris	7.5	Y
SL59	Slough Lakeside 2 Osiris	9.7	Y

* denotes monitoring locations that are within AQMAs

Appendix D: Figures

1. Gatwick Airport Second Runway (Gatwick R2) One Runway Road Traffic - Airport Only NO_x, PM_{10} and $PM_{2.5}$ Emissions (t/y)
2. Heathrow Airport Northwest Runway (Heathrow NWR) Two Runways Road Traffic - Airport Only NO_x, PM_{10} and $PM_{2.5}$ Emissions (t/y
3. Heathrow Airport Extended Northern Runway (Heathrow ENR) Two Runways Road Traffic - Airport Only NO_x, PM_{10} and $PM_{2.5}$ Emissions (t/y)
4. 2030 Pollution Climate Mapping (PCM) NO_2 Modelled Results Within Gatwick Airport Second Runway (Gatwick R2)
5. 2030 Pollution Climate Mapping (PCM) NO_2 Modelled Results Within Heathrow Airport Northwest Runway (Heathrow NWR) Study Area
6. 2030 Pollution Climate Mapping (PCM) NO_2 Modelled Results Within Heathrow Airport Extended Northern Runway (Heathrow ENR) Study Area
7. NO_2 Projected to 2030 Within Gatwick Airport Second Runway (Gatwick 2R) Study Area
8. NO_2 Projected to 2030 Within Heathrow Airport Northwest Runway (Heathrow NWR) Study Area
9. NO_2 Projected to 2030 Within Heathrow Airport Extended Northern Runway (Heathrow ENR) Study Area