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Heathrow Airport Limited

Heathrow’s North-West Runway

Air Quality Assessment

AMEC Environment & Infrastructure UK Limited

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RICARDO-AEA

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Non-Technical Summary

This report contains an assessment of the likely air quality levels around Heathrow Airport in the future years 2030 and 2040, without (2R) and with (3R) a third runway in operation. The content of the report has been assembled to provide the type and detail of information required by the Airports Commission in order to facilitate the Commission's sustainability appraisal of the proposed development at Heathrow, alongside a comparison with other proposals for the provision of additional runway capacity in the south-east of the UK. The report also provides the technical background for the Mitigation Strategy that was submitted to the Airports Commission in May 2014.

The situation at present is that the airport is a small but material contributor to air pollution levels in the area. However, by far the greatest contribution arises from non-airport road traffic and background levels of air pollution blown into the area from Greater London and the rest of the UK. Heathrow is working with its partners to reduce emissions to help to meet annual average nitrogen dioxide (NO_2) EU Limit Values at local air quality monitoring stations within 2km of the airport. At these monitoring stations, the contribution of airport related sources varies between approximately 5% and 25%. In 2013, only one of the air quality monitoring stations within 2km of the airport recorded an infringement of the legal limit for annual average NO_2[1]; this location is in West Drayton adjacent to the M4 Motorway. At this monitoring station the contribution of airport related sources is around 20%. Levels of fine particulate matter (PM_{10} and $PM_{2.5}$) in the atmosphere already meet legal limits.

The methodology and procedures that have been used to assess likely future air quality represent the best available techniques and are based upon the outcome recommendations of the Project for the Sustainable Development of Heathrow (PSDH), combined with the most up-to-date information on current and future air quality and emissions of air pollutants from airport and non-airport related sources in the Heathrow area. In estimating what the level of emissions from road traffic and aircraft would be in 2030 and 2040, the assessment has taken account of likely improvements in the road vehicle fleet over the next 16 and 26 years and has also accounted for the continued introduction of cleaner aircraft into the fleet using Heathrow and other additional mitigation measures that will be introduced by Heathrow Airport Ltd (HAL).

A key undertaking in this is that there will be no growth in airport-related traffic on the nearby road and motorway network, facilitated by enhanced public transport as part of the Airport Surface Access Strategy (ASAS). Furthermore, additional air quality mitigation measures have been considered, as outlined in Heathrow's Mitigation Strategy document. These measures involve replacing petrol and diesel ground support equipment on the airport with electric vehicles, further reducing the use of aircraft auxiliary power units, encouraging the use of electric

[1] http://www.heathrowairport.com/about-us/community-and-environment/responsible-heathrow/reducing-environmental-impacts/local-air-pollution

vehicles for journeys to the airport by staff and customers and incentivising airlines to use cleaner aircraft and "Green Slots".

The results of this assessment, incorporating the measures detailed in the Mitigation Strategy, demonstrate that, by 2030 with a third runway in operation at Heathrow, there will be no infringements of the legal limit for annual average NO_2 at locations outside the airport perimeter where members of the public may be exposed, that is, at residential and other places of relevant exposure. Even in 2040, with annual air transport movements (ATM) increased to 740,000 and passenger throughput at an estimated 130 million, the legal limits for nitrogen dioxide will be complied with. Legal limits for PM_{10} and $PM_{2.5}$ will also be met.

Ecological receptors can be sensitive to the deposition of nitrogen compounds, which can affect the character of the habitat through eutrophication (nutrient enrichment) and acidification. Deposition rates have been modelled as part of the air quality assessment and an evaluation of these changes and their significance is included in the Biodiversity Assessment.

Consideration has also been given to emissions from Heathrow in the context of the UK's national emissions of air pollutants. The total airport related NO_X emissions (LTO) in 2030 for the 3RNW scenario are estimated at 3,992 t/yr. In 2040, the total airport related NO_X emissions for the 3RNW scenario increase to 4,713 t/ yr. Both of these values are equivalent to less than 0. 1% of the UK National Emissions Ceiling for NO_X.

It is concluded that a third runway development at Heathrow can go ahead without breaching health-related air quality limits.

Glossary and Abbreviations

ADMS-Airport	Atmospheric Dispersion Modelling System, developed for modelling airport related emissions to atmosphere
APF	Aviation Policy Framework
APU	Auxiliary Power Unit
AQMAs	Air Quality Management Areas
AQOs	Air Quality Objectives
ASAS	Airport Surface Access Strategy
ATM	Air Transport Movement
ATM	Air Transport Movement - Landings or take-offs of aircraft engaged on the transport of passengers, freight or mail on commercial terms. All scheduled movements, including those operated empty, loaded charter and air taxi movements are included.
Background	A concentration that exists well away from sources of pollution. In the context of the modelling assessment, background concentration can also be used to describe the concentration of a pollutant that is derived from all sources excluding those that are explicitly modelled.
CAA	Civil Aviation Authority
CDM	Collaborative Decision Making
CEMP	Construction Environmental Management Plan
CO	Carbon Monoxide
Defra	Department for Food, Environment and Rural Affairs
Deposition	Atmospheric mechanism by which nitrogen (in various chemical forms) in the atmosphere is deposited onto the ground or onto vegetation. This can occur as wet deposition (washout by rainfall) or dry deposition (direct interaction of gaseous nitrogen compounds with the ground or vegetation)
DfT	Department for Transport
EGR	Engine Ground Running

Fugitive Emissions	Gaseous emissions that are lost to atmosphere through leakage, spillage and other accidental releases
FEGP	Fixed Electrical Ground Power
GPU	Ground Power Unit
GRE	Ground Running Enclosure
GSE	Ground Support Equipment
HDV	Heavy Duty Vehicles
Hydrocarbons	Compound containing the elements carbon and hydrogen only
ICAO	International Civil Aviation Organisation
ICAO	International Civil Aviation Organization
Inventory	Is an estimate of the amounts and the type of pollutants that are emitted to the air from defined sources over a given period (typically one year. In the context of this environmental statement sources of air pollution, include aircraft, other airside activities and landside surface access activities
Landside	The areas of the airport which do not require full security screening for people to access
LAQM	Local Air Quality Management
LDVs	Light Duty Vehicles
LTO	Landing and Take Off
Model Test	A verification study designed to compare modelled concentrations arising from emissions calculated from activity data recorded during a specified period with actual measured concentrations measure during the same period
Model	A mathematical model that simulates the atmospheric processes that transports and dilute pollutant emission to calculate the resulting ground-level concentrations at specified receptors or receptor grid
mppa	Million Passengers Per Annum
Mppa	Million passengers per annum
NO	Nitric Oxide

NO_2	Nitrogen Dioxide
NO_X	Oxides of Nitrogen
PCA	Pre-Conditioned Air
PM_{10}	Particulate matters less than 10 micrometers
$PM_{2.5}$	Particulate matters less than 2.5 micrometers
PSDH	Project for the Sustainable Development of Heathrow
Receptor	Locations where members of the public are likely to be regularly present and are likely to be exposed over the averaging period of the objective
SA	Sustainable Aviation
SAF	The Airports Commission's Sustainability Appraisal Framework
Slot	A 'slot' is a permission for a planned operation to use the full range of airport infrastructure necessary to arrive or depart at the airport at a specific date and time.
SO_2	Sulphur Dioxide
TAAM	Total Airspace and Airport Modeller
	The landing and take-off cycle describes aircraft operations from the ground up to a height of 3000 feet (approximately 1000m). It includes the approach, landing, taxi-in from the runway to the stand, taxi-out from the stand to the runway, take off roll and climb phases. These phases are linked to different engine thrust (power) settings and times in each operating mode.

Contents

1. Introduction

1.1 Background

This report has been prepared by AMEC Environment & Infrastructure on behalf of Heathrow Airport Limited (HAL) and the emissions inventory and dispersion modelling have been undertaken by Ricardo-AEA Limited. To meet the growing need for additional air capacity, HAL has proposed an extension to the existing Heathrow Airport[1]. The proposed development would include:

- A 3,500m runway to the north-west;
- Two new terminal buildings;
- Aircraft movement areas and taxiways;
- Various aircraft stands (pier serviced stands and remote stands);
- Car parking; and
- Ancillary uses.

Further details of the development can be found in HAL's submission to the Airports Commission[1].

This report provides the technical assessment and details underlying the Air Quality strategy presented in Volume 1 of HAL's submission to the Airports Commission[1]. The assessment of potential effects with and without mitigation was undertaken in accordance with the Commission's Sustainability Appraisal Framework (SAF) as described in Section 1.2[2].

In the UK there are a total of 573 Air Quality Management Areas (AQMAs) that have been declared owing to exceedences of the annual average nitrogen dioxide (NO_2) UK air quality standard (AQS)[3]. At present, 258 Local Authorities, roughly 64% of those in the UK, have one or more AQMAs[4]. Most AQMAs in the UK are in urban areas and result from traffic emissions of NO_2 or PM_{10}. Emissions from transport (road and other types) are the main source in 97% of the AQMAs declared for NO_2.The Mayor of London's Air Quality Strategy[5] highlights elevated concentrations of NO_2 that are a problem across most of inner London and in the Heathrow area. There are 33 NO_2 AQMAs in London and concerns have existed for a number of years over the levels of NO_2 in the atmosphere in the Heathrow area of West London and the potential effects that operation of a third runway at Heathrow Airport could have on the ability to meet the UK AQS and EU Limit Value for this air pollutant.

[1] Heathrow (2014) Taking Britain further – Heathrow's plan for connecting the UK to growth. Available at http://www.heathrowairport.com/about-us/company-news-and-information/airports-commission/our-reports
[2] Airports Commission (2014) Appraisal Framework. April 2014. Available at https://www.gov.uk/government/uploads/system/uploads/attachment_data/file/300223/airports-commission-appraisal-framework.pdf
[3] http://uk-air.defra.gov.uk/aqma/summary
[4] http://uk-air.defra.gov.uk/library/annualreport/viewonline?year=2012_issue_1
[5] http://www.heathrowairport.com/about-us/community-and-environment/responsible-heathrow/reducing-environmental-impacts/local-air-pollution

This report contains the detailed results of the assessment of the likely air quality effects arising from operation of a third runway at Heathrow by 2030, in comparison to the position in 2030 with only two runways. In addition, an assessment of the likely impacts that would arise in 2040 from a two-runway (2R) and three-runway (3R) Heathrow has been undertaken. This information is submitted to the Airports Commission in accordance with the requirements of its overall appraisal process.

1.2 Requirements of the Airports Commission

The Commission's Appraisal Framework document, published initially in January 2014 and in final form in April 2014[2] sets out the methodology which the Commission will apply in appraising the various submissions for additional runway capacity that it has moved forward to Phase 2 of the process. The objectives of the Commission's process are clearly defined in the source document and the over-riding objective for air quality is:

"To improve air quality consistent with EU standards and local planning policy requirements".

In carrying out its appraisal, the Commission will assess the degree of sustainability that can be achieved whilst attaining the stated objective and will also carry out a cost-benefit analysis, which will feed into the Economic Case appraisal, where the air quality impacts can be monetised for this purpose.

In summary, the Commission's sustainability appraisal framework (SAF) for air quality covers an evaluation of the following issues:

- Local and national air quality impacts of proposals, including assessment of surface access strategies;
- Potential impacts upon human health, biodiversity and any exceedences of EU air quality Limit Values;
- Modelling of future concentrations of nitrogen oxides (NO_x), nitrogen dioxide (NO_2) and fine particulate matter (PM_{10} and $PM_{2.5}$) for initial operations and mature operations phases of the proposed development;
- Assessments of proposed scheme developments should be undertaken with reference to a "do-minimum" scenario - in this case this will involve comparing a 2030 2R case with the 2030 3R case, representing initial operations - and a 2040 2R case with a 2040 3R case, representing mature operations;
- The costs and/ or benefits of changes in population exposure to air pollution, in relation to changes in public health impacts;
- An assessment of total emissions of air pollutants from the proposed scheme developments in relation to the UK National Emissions Ceiling (NEC) agreed under the terms of the EU National Emissions Ceiling Directive (NECD); and
- The potential effects of air pollutant emissions upon ecosystems.

Accordingly, this report contains the following information:

- A review of current national and local planning policies relevant to air quality (Section 2);
- A review of current air quality in the area around Heathrow, identifying the main contributors to air pollution and, specifically, the contribution the airport makes (Section 3);
- An overview of Heathrow's Mitigation Strategy (Section 4);
- An explanation of the methodology and procedures that have been applied to assess the likely future air quality impacts arising from operation of the airport (Section 5), including:
  - Quantification of emissions of NO_x, NO_2, PM_{10} and $PM_{2.5}$ from sources on the airport and in the surrounding area, including background emissions from Greater London and the rest of the UK, for 2030 and 2040;
  - Dispersion modelling of emissions to produce a detailed air quality impact assessment at individual receptor locations close to the airport and across the wider area;
  - Evaluation of the magnitude of changes in air quality between the 2030/ 2040 2R and 3R development cases;
  - A comparison of the projected air quality levels with national AQS and the EU Limit Values;
  - Assessment of potential harm to sensitive ecological resources; and
  - Consideration of emissions in the context of the UK's national emission ceilings.
- Assessment conclusions (Section 6).

In overall terms, the assessment methodology for calculating emissions and modelling ground-level pollutant concentrations is in strict accordance with the procedures identified in the PSDH study (Project for the Sustainable Development of Heathrow[6]), incorporating refinements and improvements since the conclusion of the original studies.

1.3 Scope of the Work

To determine the potential for likely air quality effects to arise from three-runway operations at Heathrow Airport, a desk-based dispersion modelling assessment was undertaken. Baseline air quality data in the vicinity of the Airport were evaluated, and nearby sensitive receptor locations that could be affected by the operation of a three-runway Heathrow were identified.

Three-runway operations were evaluated in terms of the potential to affect emissions of exhaust gases and ground-level concentrations and deposition rates of air pollutants.

[6] DfT (2006) Project for the Sustainable Development of Heathrow: Report of the Airport Air Quality Technical Panels.

During construction there is the potential for annoyance related to emissions of dust. In addition, exhaust emissions from plant and vehicles during construction can affect ambient air quality. Construction-related air quality effects are temporary and are not included in the scope of assessment as these are not a requirement of the Airports Commission. Potential air quality effects during construction would be managed through a site-specific Construction Environmental Management Plan (CEMP).

2. Legislative and Policy Context

2.1 Summary

The legislative and policy context is included in detail in Appendix B.

The general objectives and aims of the regional and local planning policies and supplementary planning guidance are clear. There is an overwhelming presumption that any proposed developments should not merely achieve compliance with air quality standards and Limit Values but should also aim to bring about improvements in air quality to enhance the quality of life for residents.

This has, accordingly, shaped the way in which HAL has approached the design of additional runway capacity, seeking to go further than just meeting the air quality limits.

3. Baseline

3.1 Summary of Current Air Quality

There are many sources of air pollution in the UK, including power stations, traffic, household heating and agricultural and industrial processes. In the area around Heathrow, the main sources of emissions that contribute to air quality are, in decreasing order of influence:

- The ambient background (arising from emissions outside the activities of Heathrow airport);
- Road traffic (airport and non-airport related vehicles); and
- Emissions from airport activities.

The air pollutants of most concern to public health are NO_2, PM_{10} and $PM_{2.5}$, which arise from burning fossil fuels. In the Heathrow area, it is NO_2 that is the pollutant of most concern to health.

Heathrow Airport sits within the southern part of the London Borough of Hillingdon AQMA. The third runway would lie mainly within Hillingdon, with the western end extending over the M25 into the Borough of Slough.

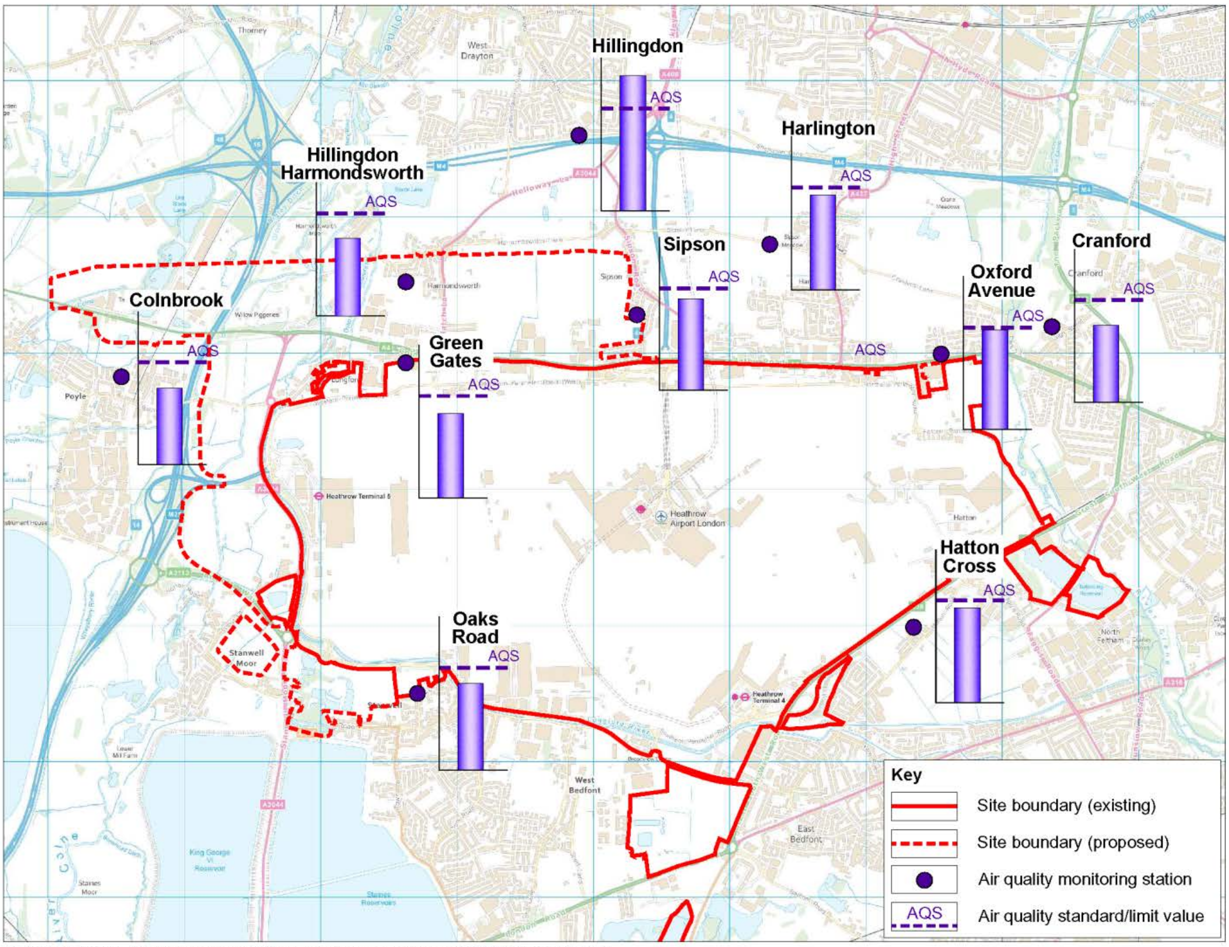
The Hillingdon AQMA was declared in 2001 and was subsequently extended in 2003 to cover all parts of the Borough south of the Chiltern-Marylebone railway line. The AQMA was declared because annual average concentrations of NO_2 were found to be above European and national air quality limits at certain locations, including those close to busy roads and motorways. It is, however, not the case that the NO_2 limit is exceeded everywhere within the Borough.

Concentrations of the other significant air pollutants, including PM_{10} and $PM_{2.5}$, in the boroughs of Hillingdon, Hounslow, Spelthorne and Slough, already meet air quality limits and are forecast to continue to do so into the future.

Air quality monitoring results for NO_2 at the monitoring stations within 2km of the Airport are shown in Figure 3.1 below. The bars indicate the measured annual average NO_2 concentration at the different site locations during 2013 and the dotted line shows the 40 $\mu g\ m^{-3}$ annual average limit that is set in European and national legislation.

Consistent with the findings of the local authorities, the main areas of poor air quality are locations close to major roads and motorways. At these locations, the NO_2 levels are only just above the permitted value. In comparison, typical levels of NO_2 in central London areas during 2013 have averaged between 45 and 85 $\mu g\ m^{-3}$ which is up to more than twice the legal limit.

Figure 3.1 Measured Annual Average NO_2 Concentrations around Heathrow Airport, 2013



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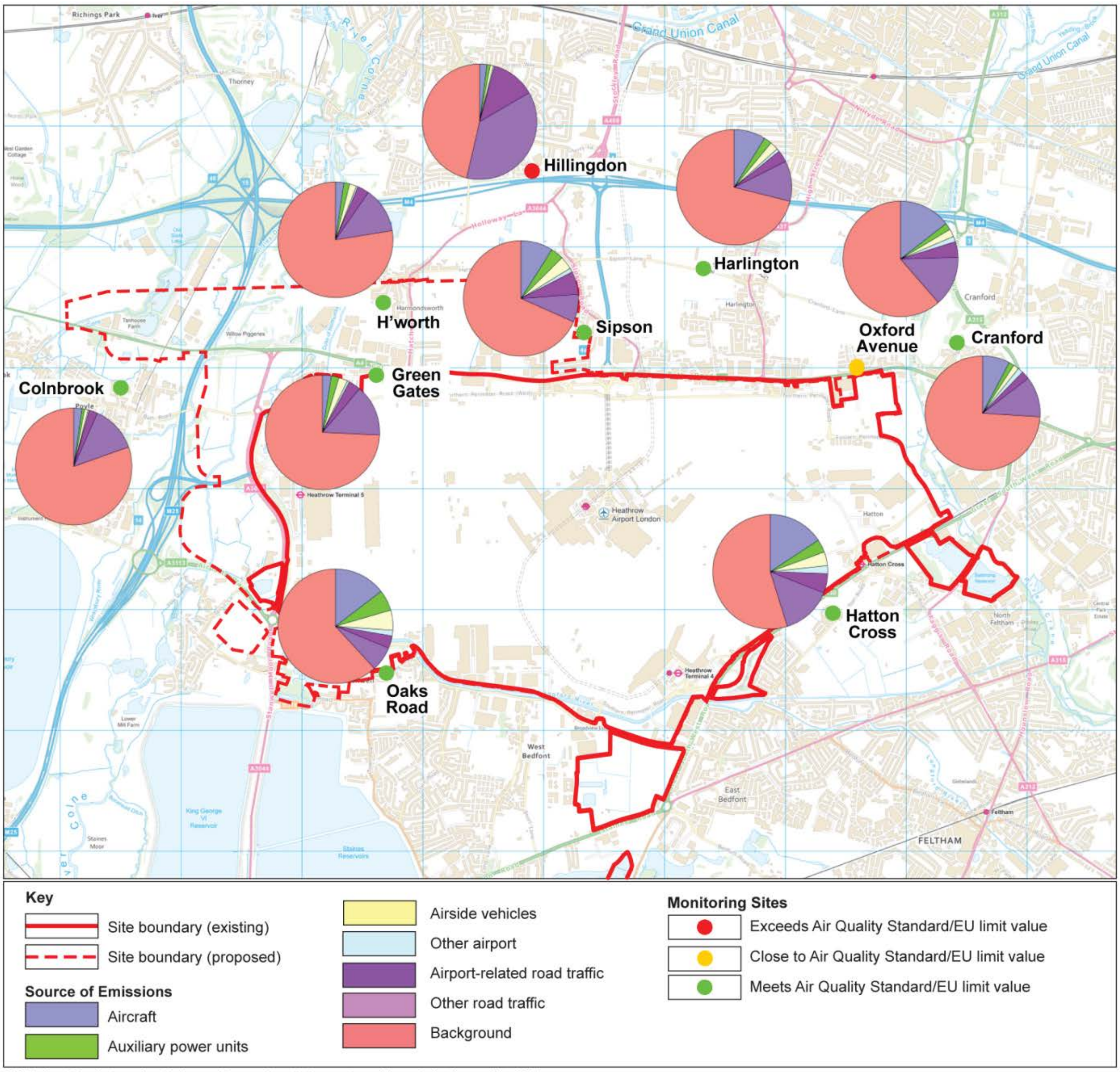
Emissions from airport activities are on a steady downward trend and concentrations of NO_2 in the Heathrow area have fallen by 20% over the past 20 years. The influence of the airport on air quality falls quickly with distance from it. Within two kilometres of the airport, the only air quality monitoring site to exceed the EU limit value is located alongside the M4 (London Hillingdon). The exceedence at that location is largely as a result of road traffic, approximately three quarters of which is not airport-related.

The extent to which emissions from Heathrow Airport and other sources contribute to levels of nitrogen oxides in the air at these monitoring locations is shown in Figure 3.2, where the different coloured sections of the pie-charts show the origins of the contributions. The charts show that the contribution of the airport to NO_X levels varies between approximately 4% and 31%, depending upon how close to Heathrow the monitoring stations are and whether they are situated down-prevailing-wind of the airport.

The majority of the contribution by a significant margin comes from the background source of pollution, which is blown into the Heathrow region from outside, containing emissions from the rest of London, England and, occasionally, as has been seen as recently as spring 2014, from continental Europe.

Figure 3.2 Modelled NO_X Emission Contributions from Airport and Non-airport Sources, 2008/9.



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3.2 Air Quality Management at Heathrow

Air quality management is a key priority for Heathrow and the Airport implemented its first Air Quality Strategy and Action Plan in 2002, and reviewed and updated it in 2007. Heathrow's current Air Quality Strategy runs from 2011 to 2020 and has been designed to complement the measures being implemented by the four local authorities in the area, the Mayor of London's Air Quality Strategy and national initiatives.

Heathrow has carried out continuous air quality monitoring at locations on and around the airport since 1993 and all of the data collected can be found on the Heathrow Airwatch website[7]. In the last decade the Airport has achieved significant reductions in emissions, even though the numbers of people and aircraft using Heathrow have increased. Emissions of NO_X from airside vehicles have reduced by 25% from 2002 and NO_X emissions from aircraft auxiliary power units have decreased by around 50% over the same period. There have also been significant reductions (~50%) over this same period in NO_X emissions from car parks, car rental and staff car parking. NO_X emissions from the local road and motorway network have fallen by over 50% in this period.

It is expected that the areas closest to Heathrow, typically within 2km, where the airport's contribution to total NO_2 concentrations is higher, will meet the European limits before 2020.

[7] http://www.heathrowairwatch.org.uk/

4. Mitigation Strategy

This chapter repeats much of the content within the masterplan submission so that this report can be read as a 'stand-alone' document.

These mitigation measures have been incorporated into the dispersion modelling assessment, as described in Section 5.

4.1 Avoiding Effects through Design

Since Heathrow's July 2013 submission to the Airports Commission[8], the masterplan has been altered to further reduce emissions of NO_X, NO_2, PM_{10} and $PM_{2.5}$ and concentrations of these key pollutants at locations outside the airport boundary.

The third runway has been positioned as close to the existing northern runway as operationally possible. This will avoid cumulative air quality effects from aircraft and road traffic at properties located to the north of the M4 motorway. The alignment of new roads has also ensured that they are kept as far away as possible from nearby communities to limit the effects of road traffic emissions. This has, in part, led to the proposal for re-routing the A4 to the north of the airport and providing a bypass to the north and east of Sipson.

4.2 Managing the Effects of the Masterplan

4.2.1 Physical Mitigation

The airport has been designed to minimise distances between runways, taxiways, aprons and stands and to make aircraft movements on the ground as efficient, and therefore as low emission, as possible. In addition, the surface access road and motorway links have been designed to protect air quality at sensitive locations as far as possible. Also, the Surface Access Strategy (ASAS), which sits alongside the masterplan, has been specifically designed to generate no more road traffic than there is today with a two-runway airport. Given that vehicle technology is becoming cleaner, based on government forecasts of future technology take-up, total emissions from road vehicles travelling to and from the airport will be lower in 2030 and 2040 than today.

4.2.2 Operational Mitigation

As well as masterplan design features, a number of measures have been incorporated into the future operation of a three-runway airport to reduce emissions of air pollutants.

[8] Heathrow Airport Limited (July 2013, updated January 2014), A New Approach: Heathrow's options for connecting the UK to growth. http://www.heathrowairport.com/static/HeathrowAboutUs/Downloads/PDF/a_new_approach_2014.pdf

These are discussed further below and include the following:

- Cleaner aircraft technology;
- Cleaner aircraft operations in the sky;
- Cleaner aircraft operations on the ground;
- Cleaner airside vehicles; and
- The Airport Surface Access Strategy.

Cleaner Aircraft Technology

The size and the nature of the markets served by Heathrow mean that it generally attracts the latest and the therefore the cleanest and quietest aircraft. Furthermore, Heathrow further encourages its airline partners to use the latest and cleanest aircraft through the application of emission-based landing charges. This provides an incentive for operators to use aircraft that are the lowest emitting of their type. In order to encourage a quicker take-up and operation of cleaner aircraft by airlines, HAL introduced a NO_X charge as part of its landing charges in 2004 and is committed to its continual review. In the Air Quality Action Plan, published by HAL in 2011, a target was set for 55% of aircraft to be CAEP/ 6[9] by 2020. By 2030 it is the expectation that over 98% of the aircraft fleet using a three-runway Heathrow will be a minimum of CAEP/ 6 compliant and, by 2040, this will increase to 100%.

Cleaner Aircraft Operations in the sky

A three-runway Heathrow will operate with displaced runway thresholds and steeper approach glide slopes. While these are principally noise mitigation measures, they also have benefits for air quality. For instance, steeper glide slopes will result in lower air quality effects at places close to the airport boundary at the ends of the runways, as aircraft will spend less time in approach close to the ground and displaced runway thresholds will enable aircraft to land on the runway at a position further in from the airport boundary and further away from nearby residential areas.

Cleaner Aircraft Operations on the Ground

In May 2012, Heathrow began implementing Airport Collaborative Decision Making (A-CDM), which is to be progressively rolled-out to improve the efficiency of movements on the airfield. A-CDM is a management process that involves co-operation between pilots, airlines, ground crew, air traffic control and airspace management agencies, with the aim of eliminating flight delays both in the sky (no stacking) and on the ground (reduced hold and taxi times). Reducing flight delays will help to reduce emissions from aircraft both on the ground and in the sky, making a future two or three runway airport more efficient, thus delivering improvements in emissions of air pollutants and reducing airborne concentrations of air pollutants.

[9] The CAEP standards are expressed as a percentage reduction in aircraft engine NOx emissions in comparison to aircraft engines manufactured in 1986 (pre-CAEP). CAEP/6 aircraft engines display a NOx emission that is a 70% reduction on CAEP/1.

Heathrow will provide fixed electrical ground power (FEGP) and pre-conditioned air (PCA) at all new aircraft stands, to avoid the need for prolonged use of aircraft Auxiliary Power Units (APUs). Today, FEGP is fitted to all pier served stands and its availability is currently over 98%. PCA is currently fitted at all Terminal 2 and Terminal 5 stands and to some stands on Terminal 3, covering over 50% of all stands. Where aircraft are unable to benefit from PCA they need to run their APUs for longer. In the future, with PCA fitted across all new stands, the usage of APUs is expected to reduce further.

Cleaner Airside Vehicles

To incentivise their uptake, Heathrow will provide fuel and charging infrastructure (electric charging points and hydrogen fuelling) to support the requirements of airside ultra-low emission vehicles (ULEV) and equipment.

The Government publication 'Driving the Future Today - A strategy for ultra-low emission vehicles in the UK' (published in September 2013) describes the UK's approach[10]. The technology for low- and zero-emission vehicle technology is developing and costs are falling.

As highlighted in the Government's strategy, as emissions targets become tighter and technologies continue to develop it is expected that ULEVs, including plug-in vehicles and hydrogen fuel cell electric vehicles, will take an increasing share of the market for cars and vans. Although the speed of uptake is unknown and there are uncertainties surrounding whether the market will provide ultra-low emission specialist airport vehicles and equipment, Heathrow is currently exploring the measures that can be taken to actively incentivise the uptake of ULEVs. Heathrow's long-term goal is to progress towards a fully ULEV airside vehicle fleet and the Airport will continue to provide fuel and charging infrastructure as it develops a third runway.

HAL is also currently in the process of developing airside vehicle and GSE pooling. This has the potential to further lower emissions from this source by reducing the overall size of the airside fleet, reducing fleet-wide running times and increasing the proportion of ULEVs and equipment.

Surface Access

Heathrow Airport has committed to adding a third runway with no more airport-related traffic on the road than today and to increase the proportion of passengers who use public transport to access the airport from 40% today to more than 50% by 2030. Those commitments make an important contribution to improving air quality in the area around Heathrow. In HAL's May 2014 submission to the Airports Commission, it outlined that there may be a case for introducing a congestion charge for people travelling to the airport, once improvements in public transport have been delivered. A congestion charge would reduce traffic congestion levels, help ensure there is the minimum number of airport related vehicles on the road and, therefore, help improvements in air quality. It is envisaged that there could be exemptions in place for the greenest vehicles. Funds could be ring-fenced to contribute towards major rail, London Underground and road improvements, as well as pay for further sustainable travel initiatives, public transport schemes and community transport improvements.

[10] https://www.gov.uk/government/uploads/system/uploads/attachment_data/file/239317/ultra-low-emission-vehicle-strategy.pdf

The Airport is also committed to encouraging customers who do choose to drive to and from the airport to do so in as sustainable a manner as possible. Heathrow currently hosts the UK's first publicly accessible hydrogen refuelling site and has installed electric vehicle charging points at passenger car parks. As the technology for low and zero-emission vehicle technology develops and costs fall, it is planned to further develop the infrastructure to support customers using these vehicles. The Airport is also currently exploring the measures that could be taken to actively incentivise the uptake of low and zero-emission vehicles at the airport today.

5. Assessment of Effects

5.1 Methodology for the Assessment of Effects

5.1.1 Overview

Atmospheric pollutants arise principally from the combustion of hydrocarbon fuel (by aircraft engines, road vehicles, etc), although fugitive emissions of particulate matter also contribute. The key pollutants that have been assessed are:

- Nitrogen oxides (NO_X) which comprise nitric oxide (NO) and nitrogen dioxide (NO_2); and
- Particulate matter (PM_{10} and $PM_{2.5}$; particles with an aerodynamic diameter of less than 10 and 2.5 micrometres (µm) respectively).

The assessment of the effects on air quality can be divided into a number of stages, namely:

- Identification of air quality standards and criteria for the evaluation of any changes;
- Establishment of existing air quality and forecast air quality in the future baseline year(s) when three-runway operations would occur (2030 and 2040);
- Calculation of airborne pollutant concentrations arising from emissions from airport activity for the future baselines in 2030 and 2040 (i.e. without three-runway operations) and occurring after construction is complete and full three-runway operations are in place; and
- Assessment of the modelled change in concentrations brought about by the three-runway operations relative to two-runway operations.

The comparison of future baseline and with-development scenarios requires, firstly, the development of an emissions inventory to quantify the emissions arising from airport and non-airport sources. Dispersion modelling is then used to calculate ground-level concentrations and deposition rates at sensitive human and ecological receptors, based on the calculated emissions, having due regard to their spatial distribution. Background concentrations are taken into account in the calculation of total concentrations.

The magnitude of the change in airborne concentrations has been determined using the ADMS-Airport atmospheric dispersion model. This is a mathematical modelling tool that simulates the dilution and dispersion of pollutants emitted into the atmosphere from both stationary (e.g. boiler plant chimneys) and mobile (e.g. aircraft and road traffic) sources. The effects of changes in emissions of pollutants from different sources on ambient air quality can then be evaluated.

The assessment methodology and the key assumptions underpinning the assessment that are described in this section should be read in conjunction with the following supporting documents that are available to the

Airports Commission on request from HAL:

- Heathrow Airport Emission Inventory 2008/9. Report by AEA Energy & Environment on behalf of BAA, July 2010. AEAT/ENV/R/2906 Issue 2;
- Air Quality Modelling for Heathrow Airport 2008/9: Methodology. Report by AEA Energy & Environment on behalf of BAA, July 2010. AEAT/ENV/R/2915/Issue 1; and
- Heathrow Airport Air Quality Modelling for 2008/9: Results and Model Evaluation. Report by AEA Energy & Environment on behalf of BAA, July 2010. AEAT/ENV/R/2948/Issue 1.

5.1.2 Detailed Methodology

This section describes the methodology used for the operational air quality assessment, in terms of the approach for calculating emissions and airborne concentrations of air pollutants.

Overall, the methodology has involved a conservative (worst-case) approach to calculating emissions and, therefore, the results presented are most likely to be overstated. This is especially the case for the 2040 assessment year, where a number of parameters, such as ambient background concentrations of NO_X, NO_2, PM_{10} and $PM_{2.5}$ have been assumed to remain at 2030 levels, although in practice further reductions in emissions and concentrations would be expected between 2030 and 2040.

The methodology for the quantification of the emissions of each pollutant from each source and the calculation of the resulting ground-level concentrations (and nitrogen deposition rates) is common to both the 2030 and 2040 baseline (2R) and development cases (3R).

A detailed air quality assessment for Heathrow Airport in 2008/9, with a model evaluation against monitoring data, was completed in July 2010[11,12,13]. The 2008/9 assessment followed the recommendations of the PSDH. The 2008/9 model evaluation study, which compared the modelling results with monitoring data, concluded that there was confidence that the model provides a good basis for investigating the potential impact on residential areas of operational changes at the Airport that affect the magnitude and spatial distribution of emissions.

This current assessment uses a similar methodology to the 2008/9 study, with some updates where newer information has become available (mainly in relation to aircraft times in mode) and has been modified as necessary to reflect that it is modelling future years rather than historic years.

The International Civil Aviation Organization (ICAO) has also published guidance on methodologies for airport air quality assessment[14] , offering 'simple', 'advanced' and 'sophisticated' approaches. However, the ICAO

[11] Heathrow Airport Emission Inventory 2008/9. Report by AEA on behalf of BAA, July 2010. AEAT/ENV/R/2906 Issue 2.

[12] Air Quality Modelling for Heathrow Airport 2008/9: Methodology. Report by AEA on behalf of BAA, July 2010. AEAT/ENV/R/2915/Issue 1.

[13] Heathrow Airport Air Quality Modelling for 2008/9: Results and Model Evaluation. Report by AEA on behalf of BAA, July 2010. AEAT/ENV/R/2948/Issue 1.

[14] International Civil Aviation Organization (2011) Airport Air Quality Manual. Doc 9889.

document is almost entirely focused on historic assessments, with only brief consideration of modelling future cases. For example, the sophisticated methodology requires movement-by-movement data on engines and detailed operational characteristics, which cannot be available for future cases. Therefore, this assessment for HAL most closely resembles ICAO's advanced approach, with elements of the sophisticated approach incorporated where possible.

For assessing the contribution from all explicitly modelled sources, the following steps are undertaken for each category of source:

- Quantification of total annual emissions;
- Specification of the spatial distribution of the emissions;
- Specification of the temporal variation in emissions, for example in terms of the diurnal and monthly profiles of emissions; and
- Dispersion modelling to generate the contribution to annual mean concentrations and deposition rates at a set of grid points throughout the assessment area and at a number of specified receptor locations.

The methodology considers the effect at nearby receptors of the change in emissions (quantity and spatial distribution) and has quantified the change in airborne concentrations of NO_x, PM_{10} and $PM_{2.5}$ that would result from three-runway operations. Emissions have been input to the ADMS-Airport atmospheric dispersion model and predicted concentrations of NO_x, PM_{10} and $PM_{2.5}$ arising from these emissions have been determined at sensitive receptor locations around the Airport. Annual mean concentrations of NO_2 have been derived from NO_x concentrations, taking account of the interaction between nitrogen oxides and background ozone. Nitrogen deposition rates have also been calculated, which are considered in the Biodiversity report.

5.1.3 Spatial Scale

The assessment area (i.e. the area over which concentration contours are calculated) was chosen to be a 10km x 9km rectangle[15], centred on the Airport, with concentrations calculated on a fine spatial grid throughout this domain. The airport contribution to pollutant concentrations outside this area will form a very low proportion of total concentrations.

5.1.4 Selection of Sensitive Receptors

In addition to the grid of receptors used for concentration contours, specific receptors were selected at which a more detailed examination of concentration differences has been undertaken.

This set of receptors includes current monitoring sites close to the Airport and other off-airport locations with relevant public exposure, chosen because of their proximity to airport-related sources. In addition, a number of ecological sites have been included as receptors in the modelling assessment.

[15] Ordnance survey co-ordinates of contoured area: x=502000 to 512000 and y = 172000 to 181000.

5.1.5 Emissions

Annual emissions are quantified for the following source categories:

- Aircraft main engines in the landing and take-off (LTO) flight phases on the ground and up to 3,000ft (~1,000m) above aerodrome level;
- Ground test-running of aircraft engines;
- Aircraft auxiliary power units (APUs);
- Airside ground support equipment (GSE - vehicles and plant);
- Road vehicles on Airport landside roads and on the road network around the Airport within the assessment area (see 5.1.3 above);
- Vehicles in car parks and car rental pounds;
- Airport heating plant and the fire training ground; and
- Other off-airport (background) sources.

Aircraft emissions are only considered in the LTO flight phases to 3,000ft height as, after the aircraft leaves the runway and starts to climb, the contribution of the engine emissions to ground-level concentrations decreases with increasing height. Once the aircraft reaches a height of a few hundred metres it makes little contribution to ground-level concentrations.

The methodology is very closely based on that used for the 2008/9 air quality assessments for Heathrow Airport that were completed in July 2010[11,12,13], with updates where new information is available. These assessments follow the recommendations of the PSDH.

The 2008/9 air quality assessment and model verification were based on actual flight-by-flight records. These data were provided by BAA/HAL from their BOSS (Business Objective Search System) database, that includes data on aircraft registration number and type; flight date and time; runway identifier (and whether arrival or departure); and stand number.

On the basis of the requirement to forecast emissions for future years (2030 and 2040) some changes to the methodology used for historic cases are necessary to account for the fact that the level of detail available in forecast airport activity and operational data is necessarily lower than that in recorded data.

This section describes the overall methodology used for the operational air quality assessment, in terms of the approach for calculating emissions and airborne concentrations.

Quantification of Aircraft Emissions

For 2030 and 2040, emission calculations were derived from fleet data provided by HAL in the form of forecast whole-day flight schedules that detail a day's movements, representative of a busy summer day's operation in the respective years. For each movement, the schedule provides the aircraft type, terminal and hour of day. Different schedules were provided for 2030 and 2040 and for 2R and 3R scenarios.

Annual emissions were obtained by scaling the one day emissions by the ratio of the total annual number of movements to the number of movements in the one day schedule. Therefore, the fleet mix was assumed to be constant throughout the year. The scenarios assessed are for 480,000 movements in 2R 2030 and 2R 2040 (do-minimum) scenarios, 570,000 movements in 3R 2030 (initial operation of the proposed scheme), and 740,000 movements in 3R 2040 (mature operation).

The diurnal profile of movements was derived from the schedule. The monthly profile of movements was a flat profile, with the same number of movements assumed each day of the year; sensitivity modelling undertaken as part of the air quality modelling work for Heathrow[12] has shown this assumption to be conservative.

The engines fitted to each aircraft type, and their emissions characteristics, were derived using a fleet rollover model similar to that used for PSDH. For most of the jet engines currently in service, emissions characteristics can be found in the ICAO databank[16], which gives certification test results at four standard thrust settings (7%, 30%, 85% and 100%) for NOx and Smoke Number. By 2030 and 2040, few current engines will still be in service. Therefore, the rollover model assumes that new engine models are introduced on an eight-year cycle, with improvements in NOx and fuel performance consistent (but conservative) with historic trends.

The First Order Approximation (version 3) is used to convert from smoke number to PM_{10}. The engine exhaust $PM_{2.5}$ emission indices were taken to be the same as those for PM_{10} as a study of particle size distribution showed that most PM in aircraft engine exhaust is $PM_{2.5}$.

Estimates of take-off roll and landing roll times-in-mode are based on the 2008/9 study, which were themselves based on data extracted from the NATS (National Air Traffic Services) ground-radar data via its Airport Playback Tool (APT). For the 2008/9 assessment, BAA/HAL provided flight-by-flight APT information; to populate missing data, tables of average times were prepared, retaining the key parameters of the flight (such as aircraft type and runway exit point). These tables of averages were used for modelling the future years.

Taxiing times in the 2R cases were derived from tables of averaged data from Electronic Flight Progress Strips. These tables were calculated from a full year's worth of movement-by-movement taxiing times for 2013, with times being averaged over each apron/ runway taxi route. For the 3R cases, the substantial changes to the airfield layout mean that it is problematic to use historic data for taxiing times, so instead, times were derived from Total Airspace and Airport Modeller (TAAM) simulations of the 3R airfield operations that were undertaken by NATS. In both 2R and 3R, it is intended that flights are managed using Collaborative Decision Making (CDM) which will make it possible to manage hold queues.

[16] https://www.caa.co.uk/default.aspx?catid=1437&pagetype=90&pageid=13449

APU emissions (kg) from a given aircraft movement were calculated as the product of the APU running time(s), the fuel consumption (kg/s) and the emission factors (kg pollutants per kg fuel consumed) appropriate to the APU model fitted on the aircraft. Separate APU running times were assigned to wide-bodied and narrow-bodied aircraft. It is intended that a new instruction will come into effect from 2015 which will further reduce the maximum permitted APU running times at Heathrow. To provide a worst-case assessment for 2030 and 2040, the 2015 limit times were assumed; in practice, there is expected to be further improvement in APU running times as the availability of FEGP across the Airport increases. For each LTO cycle, narrow-bodied aircraft APUs were assumed to operate for 20 minutes, while wide-bodied aircraft APUs were assumed to operate for 40 minutes.

The methodology for estimating take-off thrust was unchanged from that used in the PSDH work. Settings for reduced thrust on take-off are based on HAL survey data that have been used to derive mean aircraft take-off thrust settings for each main aircraft type, with the average taken over the calculated values of all movements of that type in the 2008/9 period. Corrections for ambient conditions, forward-speed effects and engine spool-up are as per PSDH.

The emissions from engine ground runs (engine testing) were based on recorded information on ground runs carried out in 2013, which provided a statistical summary for each month of the period, giving both the number of tests and the total number of engine-minutes of running, separately for high-power and idle operation. The 2013 emissions were scaled up for the future cases using the ratio of the total LTO main-engine emissions for the respective cases.

The contribution to emissions of particulate matter from aircraft brake and tyre wear have been included in the assessment, applying the same methodology as the PSDH, which essentially links the mass of particles eroded on landing to aircraft weight.

Spatial Representation of Aircraft Emissions

For the 3R cases, the spatial representation of the airport was taken from drawings provided by Heathrow, which included displaced runway thresholds and reconfiguration of Terminal 3 as well as changes associated with the third runway and new terminal. For the 2R cases, the layout was assumed to be as at present but with the completion of the current works on the eastern apron and works associated with full alternation in easterly operations.

The choice of easterly or westerly operations for a given hour of the year were chosen from the 2013 Business Objective Search System (BOSS) database, to align with the meteorological conditions (2013 meteorological data are used for the future year assessments as the prevailing conditions are unlikely to change substantially over this timescale). The meteorological conditions (primarily the wind direction) determine the direction in which aircraft arrive and depart. For the 3R cases, runway assignments (north/centre/south) were taken from the schedules for each of the four modes of operation (MDL, MLD, DLM and LDM), which are assumed to be used equally often. For the 2R cases, the two modes of operation (LD and DL) are assumed to be used equally often (including in easterlies, which is to say that it is assumed that the Cranford Agreement has been ended and full easterly alternation implemented).

Airside Ground Support Equipment (Vehicles and Plant)

This source category includes all vehicles and plant that generate exhaust emissions airside, principally vehicles associated with aircraft turn-around (vehicles operated by caterers, cleaners and fuel handlers, Ground Power Units, buses, etc) but also vehicles associated with runway maintenance etc. The calculation of emissions was based on the principles of the 2008/9 assessment.

The equipment fleet was projected to the future years using a rollover model and the age profile of the equipment was assumed to be the same in future years as it is today; this determines the mix of emissions abatement technologies fitted and the proportion of ULEVs in the fleet. For 2030 and 2040, activity data (fuel consumption by fuel type and equipment/ vehicle type) were scaled from the baseline emission inventory by the ratio of passenger numbers. The proportions of different equipment types are unchanged in 2030/ 2040 relative to today; in particular, it is conservatively assumed that there is no increase in the proportion of low-emission equipment (e.g. electric vehicles). In practice, the proportion of ULEVs in the Heathrow fleet is expected to increase in both 2030 and 2040, as new, more cost-effective, technologies become available that will lead to higher proportions of ULEVs in the UK vehicle fleet in general, but also in relation to specialist airside vehicles that are used at Heathrow.

For off-road (specialist) vehicles, exhaust emission factors were taken from the latest issue of the EMEP/CORINAIR Guidebook, available on the European Environment Agency website[17]; the same emissions were applied per vehicle type for the 2030 and 2040 assessments.

For airside road vehicles, the same emission factors were used as for the landside roads discussed below and, therefore, include assumptions for the uptake of ULEVs in 2030 and 2040 that are in line with national fleet projections included in the current NAEI.

As described in Section 4.2.2, although the speed of uptake of ULEVs is unknown and there are uncertainties surrounding whether the market will provide ultra low emission specialist airport vehicles and equipment, Heathrow is currently exploring the measures that can be taken to actively incentivise the uptake of ULEVs. Heathrow's long-term goal is to progress towards a fully ULEV airside vehicle fleet and the Airport will continue to provide fuel and charging infrastructure as it develops a third runway. Emissions in 2030 and 2040 are therefore expected to be lower than those that have been incorporated into this assessment; in most cases the emission factors are based on current known engine and fuel technologies and emission factors are typically not published beyond 2030.

Road Vehicles on the Wider Network

Road vehicle emissions for future cases were calculated for the major roads within the 10km by 9km study area around the Airport. Traffic data were provided in the form of daily average flows by AECOM. Traffic data were provided separately for a number of trip categories, separating airport related from non-airport related traffic and

[17] www.eea.europa.eu/publications,

distinguishing vehicle categories (e.g. cars, taxis, LGV, HGV, etc.) that have different emission factors per vehicle kilometre travelled.

Road vehicle emissions have been calculated using fleet-weighted road transport emission factors by vehicle type from COPERT 4v8.1 and the Base 2011 vehicle fleet composition projections issued by Defra in 2013[18] as version 5.2 of the Emission Factor Toolkit. For PM_{10} and $PM_{2.5}$, the emissions quantification includes not only exhaust emissions but also fugitive emissions from brake, tyre and road wear for road vehicles and from re-suspended road dust. The current version of the vehicle fleet projections upon which this assessment is based does not include any low-emission vehicles, and will, therefore, over-estimate emissions calculated in this assessment for 2030 and 2040.

Road Vehicles in Landside Car Parks and Car Rental Pounds

The additional emissions associated with vehicles finding a car parking space on entry to car parks and driving to the exit on departure are included in the modelling assessment. Cold start emissions have been included for vehicles that park on the Airport.

Airport Heating Plant and Fire Training Ground

A number of changes in the configuration of the heating plant have been made since the 2008/ 9 inventory, following advice from HAL. The major changes include the closing of the Thames Valley Power CHP unit; the introduction of a new energy centre with biomass-powered boilers; and associated changes to the assumed usage of the (building) 448, T5 and BA Cargo units.

Emissions from the fire training ground have been included for completeness, although the annual emissions of the pollutants of interest are negligible compared to other airport sources. The emissions for the future cases were assumed to be the same as in 2008/ 9 which were calculated from the volume of liquid petroleum gas (LPG) used per year in training activities.

Background (LAEI and NAEI) Emissions

Emissions from off-airport sources other than the explicitly-modelled roads were taken from the London Atmospheric Emissions Inventory (LAEI) and the National Atmospheric Emissions Inventory (NAEI), using the same methodology as the 2008/ 9 assessment. The 2012 version of the LAEI was used for sources within the M25, which includes the latest policy on the Congestion Charge and the Low Emission Zone. The LAEI gives emissions projections for 2020; these were projected further to 2030 using national emissions[19]. Emissions from a region to the west of the M25 were taken from the 2011 NAEI[20] emissions, scaled using national emissions projections.

National projections are only available out to 2030. Although emissions are generally declining, it was conservatively assumed that emissions in 2040 are the same as in 2030.

[18] http://naei.defra.gov.uk/data/ef-transport
[19] A Misra et al, (2012) UK Emission Projections of Air Quality Pollutants to 2030, AEA/ENV/R/3337, March 2012.
[20] http://naei.defra.gov.uk/data/map-uk-das, retrieved June 2013.

Large point sources were assumed to be the same as in 2008/ 9. Emissions from the Great Western Main Line were set to zero, as this is expected to be electrified before 2030.

Dispersion Modelling

ADMS-Airport version 3.2 was used for the modelling assessment to determine concentrations of airborne pollutants emitted from the sources described above. This computer software was recommended for Heathrow air quality modelling by the PSDH and adopted for other Heathrow work by HAL in agreement with local authority stakeholders. A key development in the modelling of aircraft sources in ADMS-Airport is a module for treating the near-field dispersion of aircraft engine exhaust plumes (emitted with significant fluxes of heat and momentum) from moving aircraft.

The methodology was aimed at calculating concentrations of NO_X, PM_{10} and $PM_{2.5}$ averaged over a 12-month period. The total annual mean concentration was calculated as the sum of a contribution from sources modelled explicitly using ADMS-Airport, such as aircraft, airside vehicles and road vehicles on the designated road network, and LAEI and NAEI background source. A rural contribution term was added to the resulting concentrations; this was derived from monitoring at three rural stations.

The dispersion modelling uses meteorological data for the 2013 calendar year, from a synoptic observing station at Heathrow Airport.

The revised Jenkin methodology[21] was used to estimate annual mean NO_2 concentrations from annual mean NOx concentrations, as in the 2008/ 9 study. The factor representing regional background oxidant was projected to 2030 assuming that it increases by 0.1 ppb/year from its 2008/ 9 value (33.5 ppb), giving a value of 35.7 ppb in 2030. The same value was used for 2040.

To establish how well the modelling methodology is able to predict concentrations, and in line with best-practice in dispersion modelling assessments, a model test (or model verification) was undertaken as part of the 2008/ 9 modelling study[12,13] comparing calculated concentrations for the period against measured concentrations recorded at monitoring stations in the Heathrow area. This found generally good agreement between modelled concentrations and those recorded by monitoring. In particular, the study gave confidence that the model provides a good basis for investigating the potential impact on residential areas of operational changes on the Airport that affect the magnitude and spatial distribution of emissions.

However, the study found evidence that the modelling under-estimates the contribution to period mean NO_x concentrations from emissions on the major road network around Heathrow. This was considered to arise largely from the traffic data used, which had not been fully evaluated, although uncertainty in emission factors may also be relevant. It was recommended that a scaling factor of 1.21 be applied to the contribution from landside roads to period-mean NO_x concentrations. However, since the road traffic data used in the current assessment was not generated on the same basis as the 2008/ 9 data, and the new set of emission factors is believed to account for earlier issues with NO_x emissions, no scaling procedures were used in the current assessment.

[21] Jenkin M E (2004) Analysis of sources and partitioning of oxidant in the UK – Part 1: the NOx-dependence of annual mean concentrations of nitrogen dioxide and ozone.

Calculation of Nitrogen Deposition

For estimating the Airport's contribution to local nitrogen deposition, it is assumed that only the direct deposition of nitrogen oxides is relevant. Clearly, for the total deposition of nitrogen from all sources, other nitrogen species are important (such as nitrate and ammonium ions). However, these species are not directly released by airport sources and the atmospheric transformation of locally emitted nitrogen oxides into these species takes some time, so little of the transformed nitrogen will be deposited locally. Although ammonia is released in small quantities by road vehicles, previous work has shown that the additional contribution to local nitrogen deposition from this source is negligible.

It was assumed that both dry and wet deposition of nitric oxide (NO) are negligible. In relation to dry deposition, soil is often a source of NO rather than a sink, so the contribution of NO to direct deposition of nitrogen is generally ignored. NO is poorly soluble in water and its wet deposition is also usually ignored in long-range modelling. On an annual mean basis, wet deposition of NO_2 can be ignored compared to dry deposition as NO_2 is only moderately soluble in water. Although its effective partition coefficient may be enhanced by liquid phase reactions, its washout coefficient is still considered negligible and direct wet deposition of NO_2 (prior to transformation in the atmosphere) is usually not considered in long-range models[22].

Thus, calculation of the Airport's contribution to the local dry deposition of NO_2 is assumed to provide an adequate estimate of the Airport's effect on local nitrogen deposition. The deposition velocity was set at 0.002 m/s, the value adopted for the Stansted G1 air quality assessment [23].

It is not possible to identify the precise fraction of the NO_2 concentration at any given receptor that is attributable to airport sources because both NO and NO_2 are released by all sources and there is continuous interchange between the two species in the presence of background ozone and sunlight.

In this assessment, as in the Stansted G1 study, it has been assumed that the fraction of total NO_2 concentration that can be attributed to the Airport emissions (including airport-related traffic on landside roads) is the same as the fraction of total NO_X concentrations that is calculated to be due to the Airport emissions. This assumption is likely to overestimate the incremental contribution to NO_2 deposition and, hence, to nitrogen deposition, from airport sources.

From the NO_X concentrations the total annual mean dry deposition rate of NO_2 is given by the product of the deposition velocity and the calculated ground-level airborne concentration of NO_2. With concentrations given in $\mu g\ m^{-3}$ and deposition velocity expressed in m/s, the resulting deposition rate has units of $\mu g\ NO_2$ per m^2 per second, which is readily converted into the standard units of 'kg N per hectare per year'.

To provide some context for the calculated nitrogen deposition, rates from airport sources have been added to the estimated total nitrogen deposition from all sources at the selected locations, using Defra's $5km^2$ gridded averages for 2012[24].

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[22] NEGTAP (2001) Transboundary air pollution: acidification, eutrophication and ground-level ozone in the UK.

[23] Pratt M.S. (2007) Proof of Evidence Air Quality Stansted Generation 1 Inquiry (BAA/4/A) April.

Total nitrogen deposition rates are forecast to fall in the future in response to national and international commitments to reduce emissions of key precursor nitrogen species, and results of modelling to 2010 are given in the NEGTAP report. Based on the NEGTAP modelling, an HA Guidance Note[25] suggests a 2% reduction per year in nitrogen deposition. This is an approximate average value for the country as a whole for the period 1997-2010, and there is no guarantee that the rate will continue to be the same in later years (although ongoing reductions are expected). Therefore, for this assessment, a conservative approach was adopted and the 2012 nitrogen deposition rates were applied in future years.

5.2 Summary of Air Quality Effects

5.2.1 Emissions of Air Pollutants

2030

A summary of the predicted emissions from the 2R and 3RNW scenarios for each pollutant in 2030 are set out in **Table 5.1** and the differences between them are set out in **Table 5.2**.

Table 5.1 Atmospheric Emissions (tonnes/ year) for 2R and 3RNW in 2030

Source Group		NO_X (te/y)		PM_{10} (te/y)		$PM_{2.5}$ (te/y)	
		2R 2030	3R 2030	2R 2030	3R 2030	2R 2030	3R 2030
Aircraft		3201.65	3991.67	36.95	47.12	28.79	36.72
Airside Vehicles/ Plant/ Stationary Sources		244.99	293.58	17.50	19.97	14.81	16.71
Road Network	**Airport (inc car parks)**	81.18	91.85	30.05	32.43	15.80	17.11
	Non-Airport	545.68	545.61	182.03	183.03	95.93	96.41
TOTAL		4073.50	4922.71	266.53	282.55	155.33	166.95

[24] http://pollutantdeposition.defra.gov.uk/data

[25] Highways Agency (2005) Guidance for undertaking environmental assessment of air quality for sensitive ecosystems in internationally designated nature conservation sites and SSSIs (Supplement to DMRB 11.3.1) Interim Advice Note 61/05. March 2005.

Table 5.2 Difference in Atmospheric Emissions (tonnes/ year) for 2R and 3RNW in 2030

		Difference 2030 (te/y)			Percentage Difference 2030 (%)		
		NO_X	PM_{10}	$PM_{2.5}$	NO_X	PM_{10}	$PM_{2.5}$
Aircraft		790.02	10.17	7.93	24.68	27.52	27.54
Airside Vehicles/ Plant/ Stationary Sources		48.59	2.47	1.90	19.83	14.11	12.83
Road Network	**Airport (inc car parks)**	10.67	2.38	1.31	13.14	7.92	8.29
	Non-Airport	-0.07	1.00	0.48	-0.01	0.55	0.50
TOTAL		849.21	16.02	11.62	20.85	6.01	7.48

In 2030 overall emissions of NO_X in the assessment area increase by 849 tonnes with three-runway operations, from 4074 tonnes per annum to 4923 tonnes per annum, an increase of just over 20 %. The increase is largely associated with the net impact of changes in aircraft emissions. Overall emissions of PM_{10} in the assessment area increase by 16 tonnes in 2030 with three-runway operations, from 267 tonnes per annum to 283 tonnes per annum, an increase of just below 6%. Emissions of $PM_{2.5}$ increase by 12 tonnes in 2030 with three-runway operations, from 155 tonnes per annum to 167 tonnes per annum, an increase of 7.5%.

2040

A summary of the predicted emissions from the 2R and 3RNW scenarios for each pollutant in 2040 are set out in **Tables 5.1** and the differences between them are set out in **Table 5.2**.

Table 5.3 Atmospheric Emissions (tonnes/ year) for 2R and 3RNW in 2040

Source Group		NO_X (te/y)		PM_{10} (te/y)		$PM_{2.5}$ (te/y)	
		2R 2040	3R 2040	2R 2040	3R 2040	2R 2040	3R 2040
Aircraft		3052.17	4712.95	37.64	59.52	29.18	46.06
Airside Vehicles/ Plant/ Stationary Sources		253.26	350.82	18.07	23.83	15.24	19.59
Road Network	**Airport (inc car parks)**	80.53	93.49	30.19	32.99	15.88	17.46
	Non-Airport	606.30	618.10	205.63	211.07	108.37	111.19
TOTAL		3992.26	5775.36	291.53	327.41	168.67	194.30

Table 5.4 Difference in Atmospheric Emissions (tonnes/ year) for 2R and 3RNW in 2040

		Difference 2040 (te/y)			Percentage Difference 2040 (%)		
		NO_X	PM_{10}	$PM_{2.5}$	NO_X	PM_{10}	$PM_{2.5}$
Aircraft		1600.78	21.88	16.88	54.41	58.13	57.85
Airside Vehicles/ Plant/ Stationary Sources		97.56	5.76	4.35	38.52	31.88	28.54
Road Network	**Airport (inc car parks)**	12.96	2.80	1.58	16.09	9.27	9.95
	Non-Airport	11.80	5.44	2.82	1.95	2.65	2.60
TOTAL		1783.10	35.88	25.63	44.66	12.31	15.20

In 2040 overall emissions of NO_X in the assessment area increase by 1783 tonnes with three-runway operations, from 3992 tonnes per annum to 5775 tonnes per annum, an increase of just less than 45 %. The increase is largely associated with the net impact of changes in aircraft emissions. Overall emissions of PM_{10} in the assessment area increase by just less than 36 tonnes in 2040 with three-runway operations, from less than 291 tonnes per annum to just over 327 tonnes per annum, an increase of approximately 12%. Emissions of $PM_{2.5}$ increase by nearly 26 tonnes in 2040 with three-runway operations, from nearly 169 tonnes per annum to 194 tonnes per annum, an increase of approximately 15%.

Comparison with National Emissions

The national emission ceiling for NO_X in the UK is 6,519 kt. The latest estimations, calculated for 2012, indicate that the UK's emissions are approximately 9% below this value. Member States of the EU are required to meet emission targets as set out in the NEC Directive.

The total airport related NO_X emissions (LTO) in 2030 for the 3R scenario are estimated at 3.99 kt/yr. In 2040, the total airport related NO_X emissions for the 3RNW scenario increase to 4.71 kt/yr. Both of these values are equivalent to less than 0. 1% of the UK NEC for NO_X.

5.2.2 Concentrations of Air Pollutants at Human Health Receptors

As shown by the contours for each pollutant (Appendix A) concentrations are predicted to increase to the immediate north-west of the Airport owing to the operation of the third runway.

NO_2 2030

The maximum predicted annual mean NO_2 concentration at a modelled residential receptor is 31.62 µg m^{-3} in 2030; this is predicted in the area of Hatton and is comfortably below the 40 µg m^{-3} Limit Value. At this receptor location the predicted 2030 2R baseline concentration was 30.81 µg m^{-3}, increasing by 0.81 µg m^{-3} with the operation of the third runway.

The maximum predicted increase in annual mean NO_2 concentration at a modelled residential receptor is 5.25 µg m^{-3} in 2030; this magnitude of change is predicted in the area of Harmondsworth. At this receptor location the predicted 2030 2R baseline concentration was 24.20 µg m^{-3}, increasing to 29.45 µg m^{-3} with the operation of the third runway, and is therefore under the Limit Value of 40 µg m^{-3}.

Across the modelled area, as concentrations of annual mean NO_2 are well below 60 µg m^{-3} there are not anticipated to be any exceedences of the 1-hour mean NO_2 Air Quality Objective[26]. The assessment has therefore focussed on reporting annual mean concentrations of NO_2.

There are no modelled exceedences of the NO_2 Limit Values in 2030 at locations that are relevant in terms of exposure.

PM_{10} 2030

The maximum predicted annual mean PM_{10} concentration at a modelled residential receptor is 23.69 µg m^{-3} in 2030; this is predicted in the area of Cranford and is comfortably below the 40 µg m^{-3} Limit Value. At this receptor location the predicted 2030 2R baseline concentration is 22.92 µg m^{-3}, increasing by 0.77 µg m^{-3} with the operation of the third runway.

The maximum predicted increase in annual mean PM_{10} concentration at a modelled residential receptor is 1.09 µg m^{-3} in 2030; this magnitude of change is predicted in the area of Colnbrook. At this receptor location the predicted 2030 2R baseline concentration is 20.54 µg m^{-3}, increasing to 21.63 µg m^{-3} with the operation of the third runway, and is therefore under the Limit Value of 40 µg m^{-3}.

The highest number of predicted annual exceedences of the 24-hour mean PM_{10} limit value of 50 µg m^{-3} is 9.4. This is predicted in the area of Cranford and is well below the maximum permitted number of exceedences, which is 35. The maximum predicted increase in the number of 24-hour mean exceedences at a modelled receptor in 2030 is 1.6; this magnitude of change is predicted in the area of Harmondsworth.

There are no modelled exceedences of the PM_{10} Limit Values in 2030 at locations that are relevant in terms of exposure.

$PM_{2.5}$ 2030

The maximum predicted annual mean $PM_{2.5}$ concentration at a modelled residential receptor is 12.92 µg m^{-3} in 2030; this is predicted in the area of Cranford and is comfortably below the 25 µg m^{-3} Limit Value. At this receptor

[26] Defra (2009) *Local Air Quality Management: Technical Guidance.* London: Defra Publications

location the predicted 2030 2R baseline concentration is 12.52 µg m^{-3}, increasing by 0.40 µg m^{-3} with the operation of the third runway.

The maximum predicted increase in annual mean $PM_{2.5}$ concentration at a modelled residential receptor is 0.67 µg m^{-3} in 2030; this magnitude of change is predicted in the area of Harmondsworth. At this receptor location the predicted 2030 2R baseline concentration is 11.10 µg m^{-3}, increasing to 11.78 µg m^{-3} with the operation of the third runway, and is therefore under the Limit Value of 25 µg m^{-3}.

There are no modelled exceedences of the $PM_{2.5}$ Limit Values in 2030 at locations that are relevant in terms of exposure.

NO_2 2040

The maximum predicted annual mean NO_2 concentration at a modelled residential receptor is 33.48 µg m^{-3} in 2040; this is predicted in the area of Hatton and is comfortably below the 40 µg m^{-3} Limit Value. At this receptor location the predicted 2040 2R baseline concentration is 30.83 µg m^{-3}, increasing by 2.65 µg m^{-3} with the operation of the third runway.

The maximum predicted increase in annual mean NO_2 concentration at a modelled residential receptor is 6.28 µg m^{-3} in 2040; this magnitude of change is predicted in the area of Harmondsworth. At this receptor location the predicted 2040 2R baseline concentration is 24.36 µg m^{-3}, increasing to 30.64 µg m^{-3} with the operation of the third runway, and is therefore under the Limit Value of 40 µg m^{-3}.

There are no modelled exceedences of the NO_2 Limit Values in 2040 at locations that are relevant in terms of exposure.

PM_{10} 2040

The maximum predicted annual mean PM_{10} concentration at a modelled residential receptor is 24.24 µg m^{-3} in 2040; this is predicted in the area of Cranford and is comfortably below the 40 µg m^{-3} Limit Value. At this receptor location the predicted 2040 2R baseline concentration is 23.38 µg m^{-3}, increasing by 0.86 µg m^{-3} with the operation of the third runway.

The maximum predicted increase in annual mean PM_{10} concentration at a modelled residential receptor is 1.40 µg m^{-3} in 2040; this magnitude of change is predicted in the area of Harmondsworth. At this receptor location the predicted 2040 2R baseline concentration is 20.27 µg m^{-3}, increasing to 21.67 µg m^{-3} with the operation of the third runway, and is therefore under the Limit Value of 40 µg m^{-3}.

The highest number of predicted annual exceedences of the 24-hour mean PM_{10} limit value of 50 µg m^{-3} is 10.7. This is predicted in the area of Cranford and is well below the maximum permitted number of exceedences, which is 35. The maximum predicted increase in the number of 24-hour mean exceedences at a modelled receptor in 2030 is 2.1; this magnitude of change was predicted in the area of Harmondsworth.

There are no modelled exceedences of the PM_{10} Limit Values in 2040 at locations that are relevant in terms of exposure.

$PM_{2.5}$ 2040

The maximum predicted annual mean $PM_{2.5}$ concentration at a modelled residential receptor is 13.22 µg m^{-3} in 2040; this is predicted in the area of Cranford and is comfortably below the 25 µg m^{-3}Limit Value. At this receptor location the predicted 2040 2R baseline concentration is 12.76 µg m^{-3}, increasing by 0.46 µg m^{-3} with the operation of the third runway.

The maximum predicted increase in annual mean $PM_{2.5}$ concentration at a modelled residential receptor is 0.87 µg m^{-3} in 2040; this magnitude of change is predicted in the area of Harmondsworth. At this receptor location the predicted 2040 2R baseline concentration is 11.18 µg m^{-3}, increasing to 12.05 µg m^{-3} with the operation of the third runway, and is therefore under the Limit Value of 25 µg m^{-3}.

There are no modelled exceedences of the $PM_{2.5}$ Limit Values in 2040 at locations that are relevant in terms of exposure.

5.2.3 NO_x Concentrations at Ecological Receptors

As discussed in Section 2/ Appendix B, all ecological sites in the study area are excluded from the Objective on the basis that at least one or more of the four exclusion criteria apply.

5.2.4 Nitrogen Deposition at Ecological Receptors

Critical Loads, including those for nitrogen deposition, are a tool for assessing the risk of air pollution impacts to ecosystems. They are not statutory standards which are to be achieved, but are an indicator of when the risk of harmful effects can increase for different habitat types. The atmospheric dispersion modelling assessment has enabled rates of nitrogen deposition in 2030 and 2040 to be estimated.

The maximum predicted increase in nitrogen deposition in 2030 at an ecological receptor is 4.50 kg ha^{-1} yr^{-1}, from 18.92 kg ha^{-1} yr^{-1} in the 2R baseline to 23.42 kg ha^{-1} yr^{-1} for 3R. These values of nitrogen deposition include the total deposition figure from Defra of 12.18 kg ha^{-1} yr^{-1} at this receptor.

The maximum predicted increase in nitrogen deposition in 2040 at an ecological receptor is 5.40 kg ha^{-1} yr^{-1}, from 19.03 kg ha^{-1} yr^{-1} in the 2R baseline to 24.43 kg ha^{-1} yr^{-1} for 3R. These values of nitrogen deposition include the total deposition figure from Defra of 12.18 kg ha^{-1} yr^{-1} at this receptor.

Equally, at other receptors in 2030 and 2040, there are changes in deposition rates of similar magnitudes.

6. Conclusions

This report provides the technical assessment and details underlying the Air Quality strategy presented in Volume 1 of HAL's submission to the Airports Commission[1]. The assessment of the potential air quality effects of a third runway at Heathrow was undertaken in accordance with the Commission's Sustainability Appraisal Framework (SAF) as described in Section 1.2.

The results of this assessment, incorporating the measures detailed in the Mitigation Strategy, demonstrate that, by 2030 with a third runway in operation at Heathrow, there will be no infringements of the legal limit for annual average NO_2 at locations outside the airport perimeter where members of the public may be exposed, that is, at residential and other places of relevant exposure.

Overall, the methodology has involved a conservative (worst-case) approach to calculating emissions and, therefore, the results presented are most likely to be overstated. This is especially the case for the 2040 assessment year, where a number of parameters, such as ambient background concentrations of NO_X, NO_2, PM_{10} and $PM_{2.5}$ have been assumed to remain at 2030 levels, although in practice further reductions in emissions and concentrations would be expected between 2030 and 2040.

The maximum predicted annual mean NO_2 concentration at a modelled residential receptor is 31.62 µg m^{-3} in 2030; this is predicted in the area of Hatton and is comfortably below the 40 µg m^{-3} Limit Value. At this receptor location the predicted 2030 2R baseline concentration is 30.81 µg m^{-3}, increasing by 0.81 µg m^{-3} with the operation of the third runway. The maximum predicted increase in annual mean NO_2 concentration at a modelled residential receptor is 5.25 µg m^{-3} in 2030. At this receptor location the predicted 2030 2R baseline concentration is 24.20 µg m^{-3}, increasing to 29.45 µg $m^{-3}$with the operation of the third runway, and is therefore under the Limit Value of 40 µg m^{-3}.

Even in 2040, with annual air transport movements increased to 740,000 and passenger throughput at an estimated 130 million, the legal limits for nitrogen dioxide will be complied with. The maximum predicted annual mean NO_2 concentration at a modelled residential receptor is 33.48 µg m^{-3} in 2040; this is comfortably below the 40 µg m^{-3} Limit Value. At this receptor location the predicted 2040 2R baseline concentration is 30.83 µg m^{-3}, increasing by 2.65 µg m^{-3} with the operation of the third runway. The maximum predicted increase in annual mean NO_2 concentration at a modelled residential receptor is 6.28 µg m^{-3} in 2040. At this receptor location the predicted 2040 2R baseline concentration is 24.36 µg m^{-3}, increasing to 30.64 µg m^{-3} with the operation of the third runway, and is therefore under the Limit Value of 40 µg m^{-3}.

Legal limits for PM_{10} and $PM_{2.5}$ will also be met. The maximum predicted annual mean PM_{10} concentration at a modelled residential receptor is 23.69 µg m^{-3} in 2030; this is comfortably below the 40 µg m^{-3} Limit Value. At this receptor location the predicted 2030 2R baseline concentration is 22.92 µg m^{-3}, increasing by 0.77 µg m^{-3} with the operation of the third runway. The maximum predicted increase in annual mean PM_{10} concentration at a modelled residential receptor is 1.09 µg m^{-3} in 2030. At this receptor location the predicted 2030 2R baseline concentration is 20.54 µg m^{-3}, increasing to 21.63 µg m^{-3} with the operation of the third runway, and is therefore under the Limit

Value of 40 µg m^{-3}. The highest number of predicted annual exceedences of the 24-hour mean PM_{10} limit value of 50 µg m^{-3} is 9.4, which is well below the maximum permitted number of exceedences, which is 35.

In 2040 the maximum predicted annual mean PM_{10} concentration at a modelled residential receptor is 24.24 µg m^{-3}. At this receptor location the predicted 2040 2R baseline concentration is 23.38 µg m^{-3}, increasing by 0.86 µg m^{-3} with the operation of the third runway. The maximum predicted increase in annual mean PM_{10} concentration at a modelled residential receptor is 1.40 µg m^{-3} in 2040. The highest number of predicted annual exceedences of the 24-hour mean PM_{10} limit value of 50 µg m^{-3} is 10.7; this is well below the maximum permitted number of exceedences, which is 35.

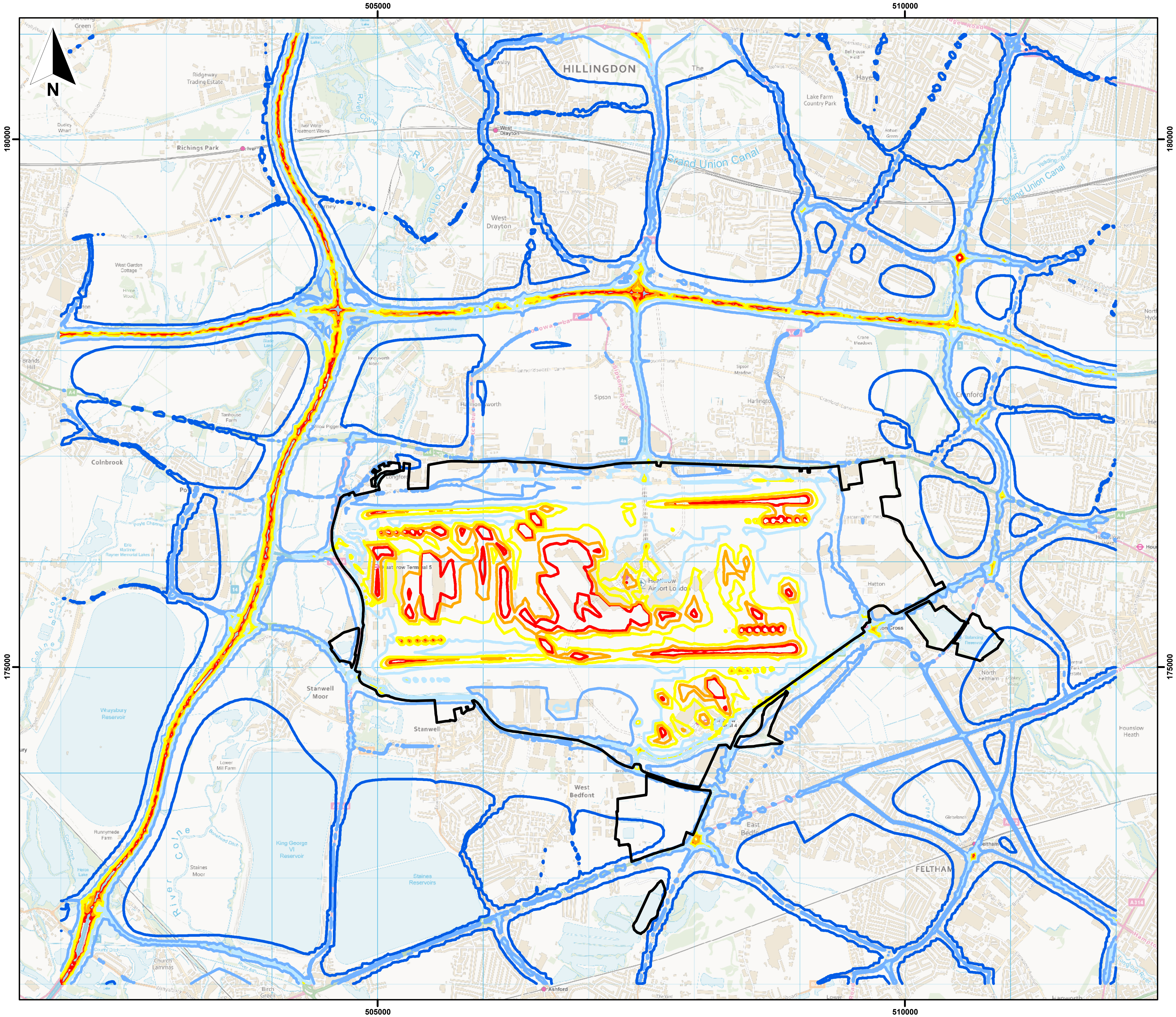
The maximum predicted increase in annual mean $PM_{2.5}$ concentration at a modelled residential receptor is 0.68 µg m^{-3} in 2030. In 2040 the maximum predicted increase in annual mean $PM_{2.5}$ concentration at a modelled residential receptor is 0.87 ug m^{-3}. The maximum modelled $PM_{2.5}$ concentrations at receptor locations are 12.92 µg m^{-3} in 2030 and 13.22 µg m^{-3} in 2040 with the operation of the third runway. Concentrations would therefore be comfortably below the Limit Value of 25 µg m^{-3}.

Ecological receptors can be sensitive to the deposition of nitrogen compounds, which can affect the character of the habitat through eutrophication (nutrient enrichment) and acidification. Deposition rates have been modelled as part of the air quality assessment and an evaluation of these changes and their significance is included in the Biodiversity Assessment.

Consideration has also been given to emissions from Heathrow in the context of the UK's national emissions of air pollutants. The total airport related NO_X emissions (LTO) in 2030 for the 3RNW scenario are estimated at 3,992 t/yr. In 2040, the total airport related NO_X emissions for the 3RNW scenario increases to 4,713 t/yr. Both of these values are equivalent to less than 0. 1% of the UK National Emissions Ceiling for NO_X.

It is concluded that a third runway development at Heathrow can go ahead without breaching health-related air quality limits.

Appendix A
Figures



Key

Existing Site Boundary

Annual Mean NO_2 Ground Level Concentrations ($\mu g\ m^{-3}$).

- 25
- 30
- 35
- 40
- 45
- 50

0 1 2 Km

Scale: 1:35,000 @ A3

H:\Projects\35310 LON Heathrow Masterplan & Sustainability Appraisal\Drawings\GIS\Figures\35310-Lon188.mxd

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Air Quality Assessment

Figure A1
Annual Mean NO_2 Ground Level Concentrations 2R 2030

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35310-Lon188 browj

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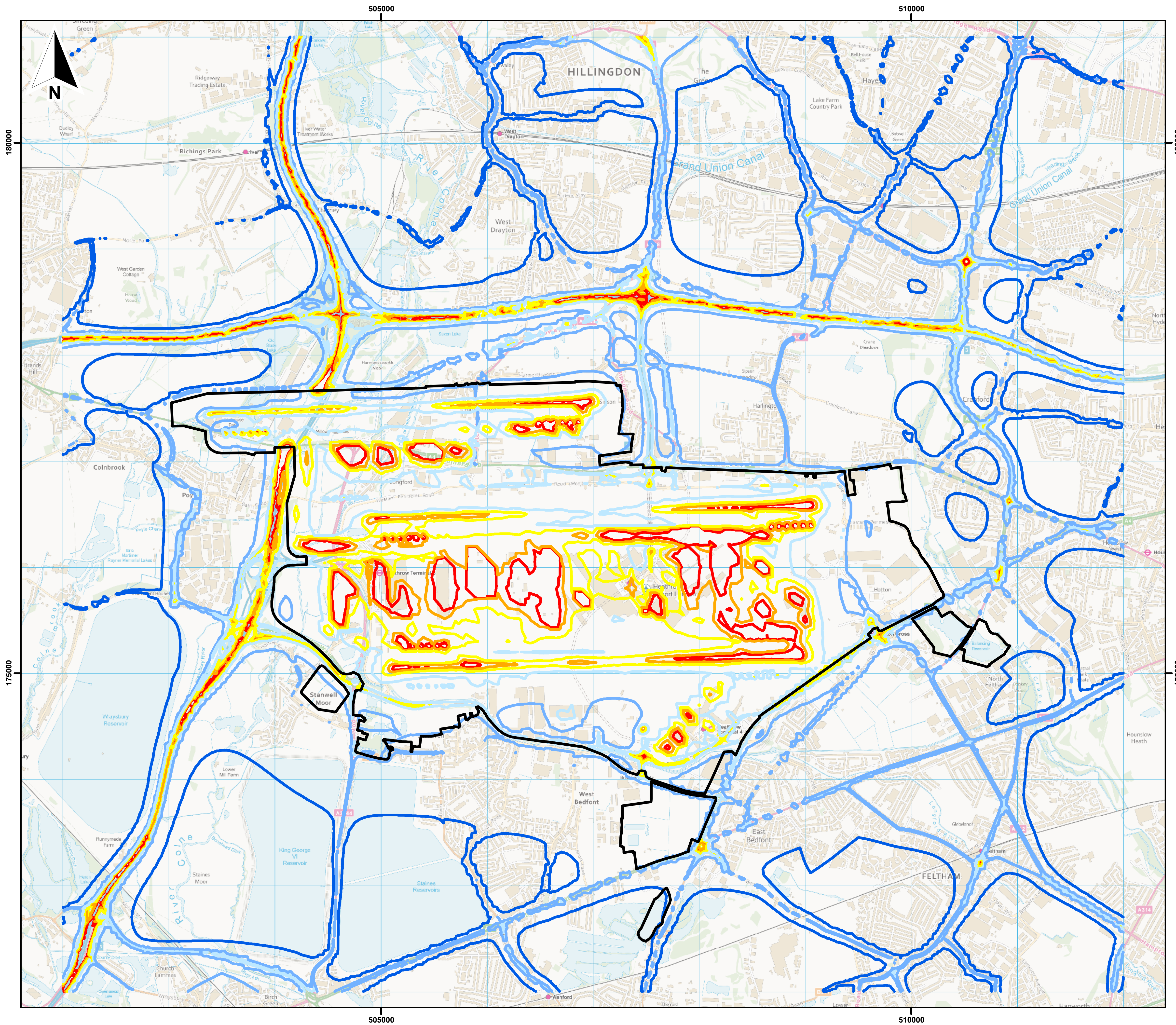

Key

Site boundary

Annual Mean NO_2 Ground Level Concentrations (µg m^{-3}).

- 25
- 30
- 35
- 40
- 45
- 50

0 1 2 Km

Scale: 1:35,000 @ A3

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Figure A2
Annual Mean NO_2 Ground Level Concentrations 3RNW 2030

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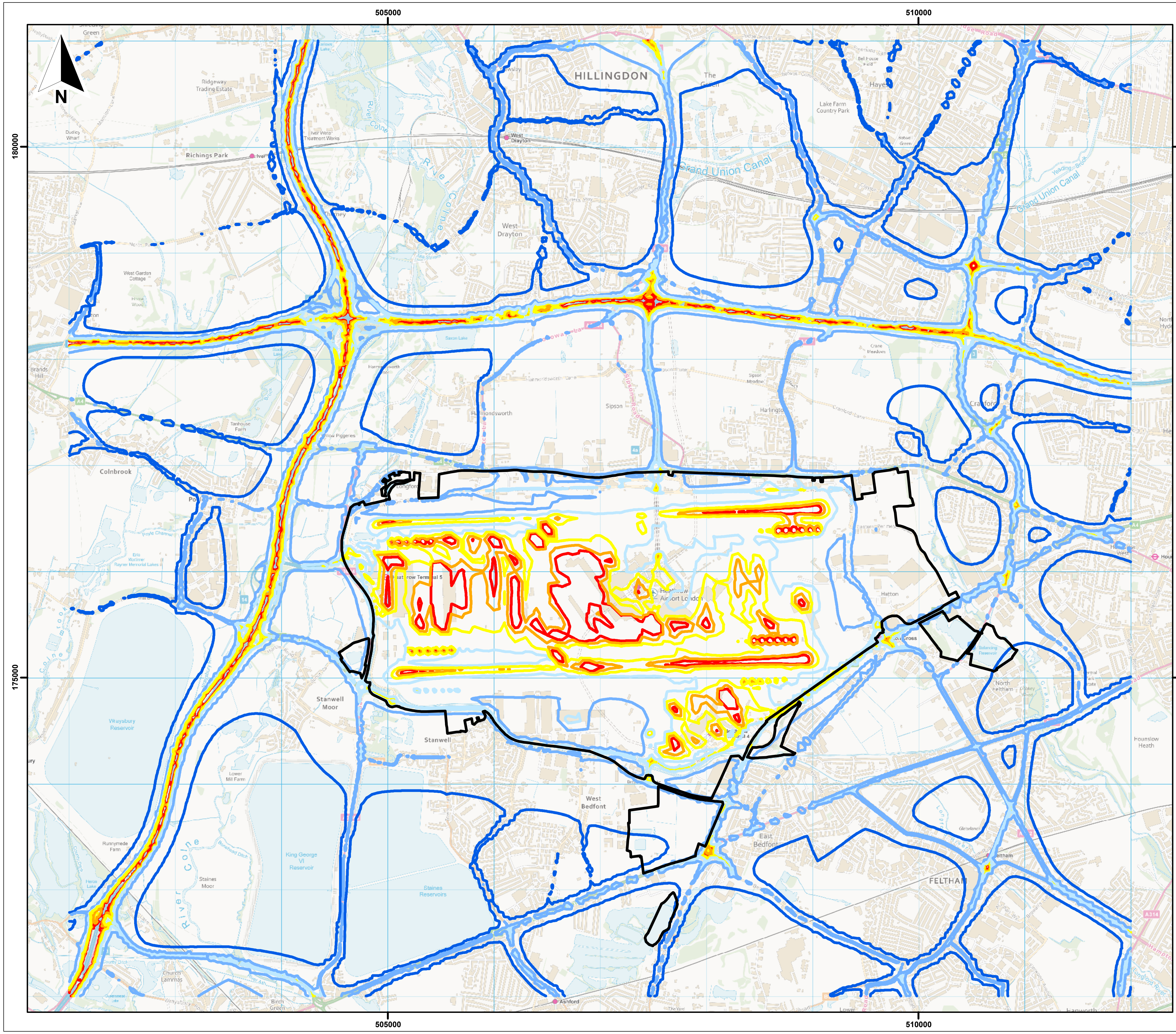
amec



Key

Existing site boundary

Annual Mean NO_2 Ground Level Concentrations (µg m^{-3}).

- 25
- 30
- 35
- 40
- 45
- 50

0 1 2 Km

Scale: 1:35,000 @ A3

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Figure A3
Annual Mean NO_2 Ground Level Concentrations 2R 2040

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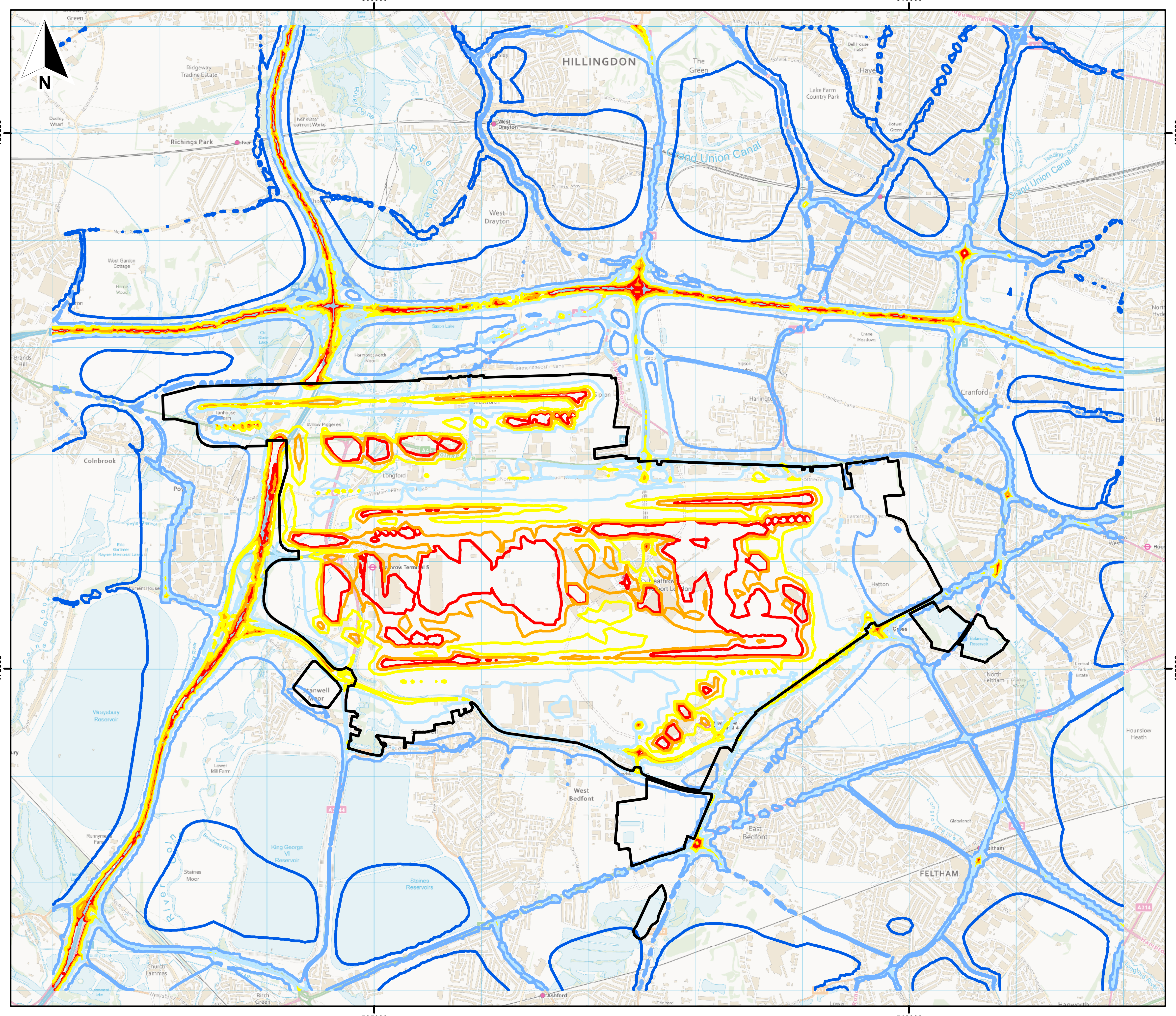

Key

Site boundary

Annual Mean NO2 Ground Level Concentrations (µg m-3).

- 25
- 30
- 35
- 40
- 45
- 50

0 1 2 Km

Scale: 1:35,000 @ A3

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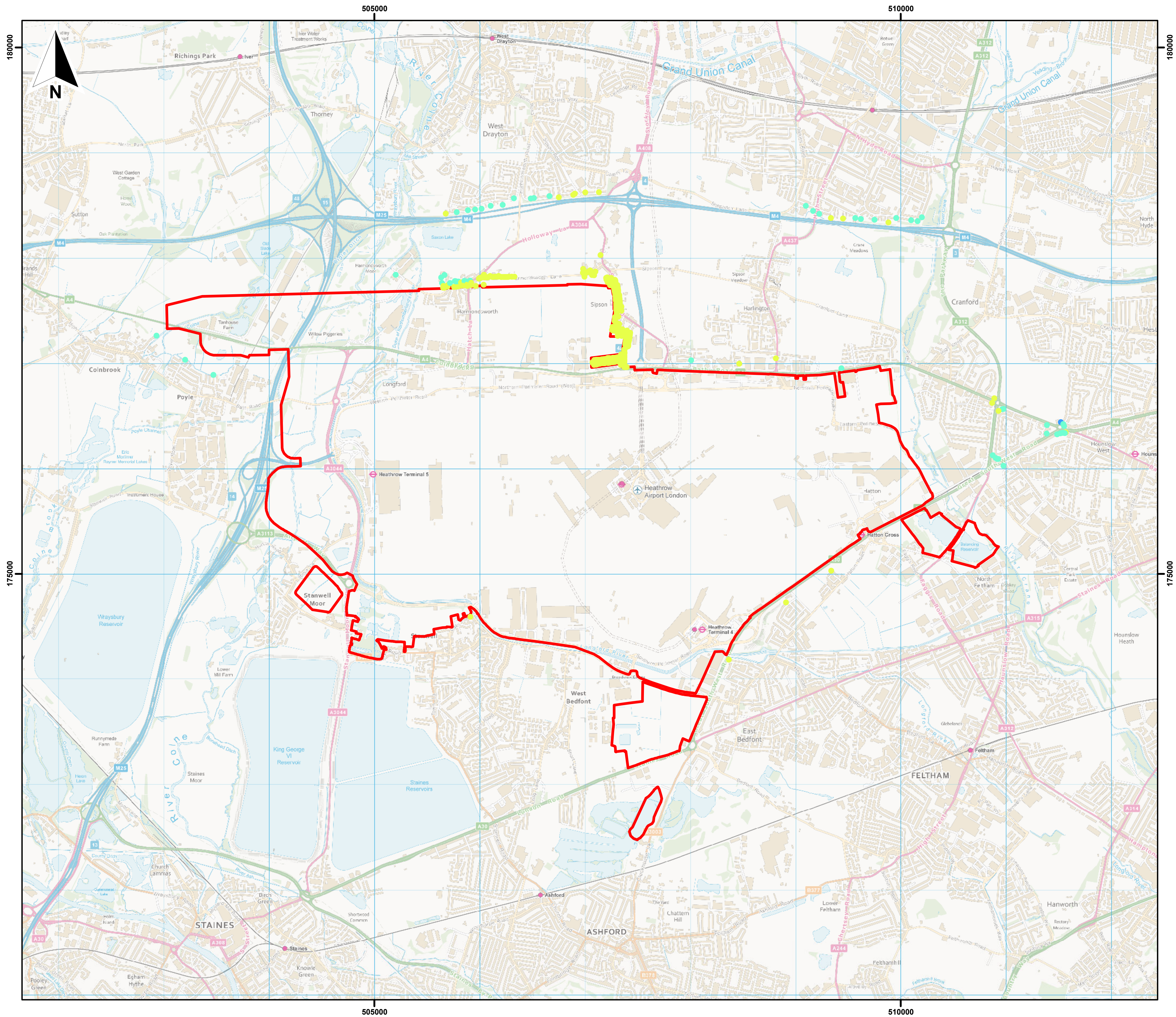
Air Quality Assessment

Figure A4
Annual Mean NO_2 Ground Level Concentrations 3RNW 2040

June 2014
35310-Lon191 montg

amec



Key

Site boundary

Annual Mean NO2 Concentration (µg m-3)

- 23 - 26
- 26 - 29
- 29 - 32
- 32 - 35

0 1 2 km

Scale: 1:35,000 @ A3

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Air Quality Assessment

Figure A5
Annual Mean NO_2 Concentrations at Receptors 3RNW 2030

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35310-Lon186 browj

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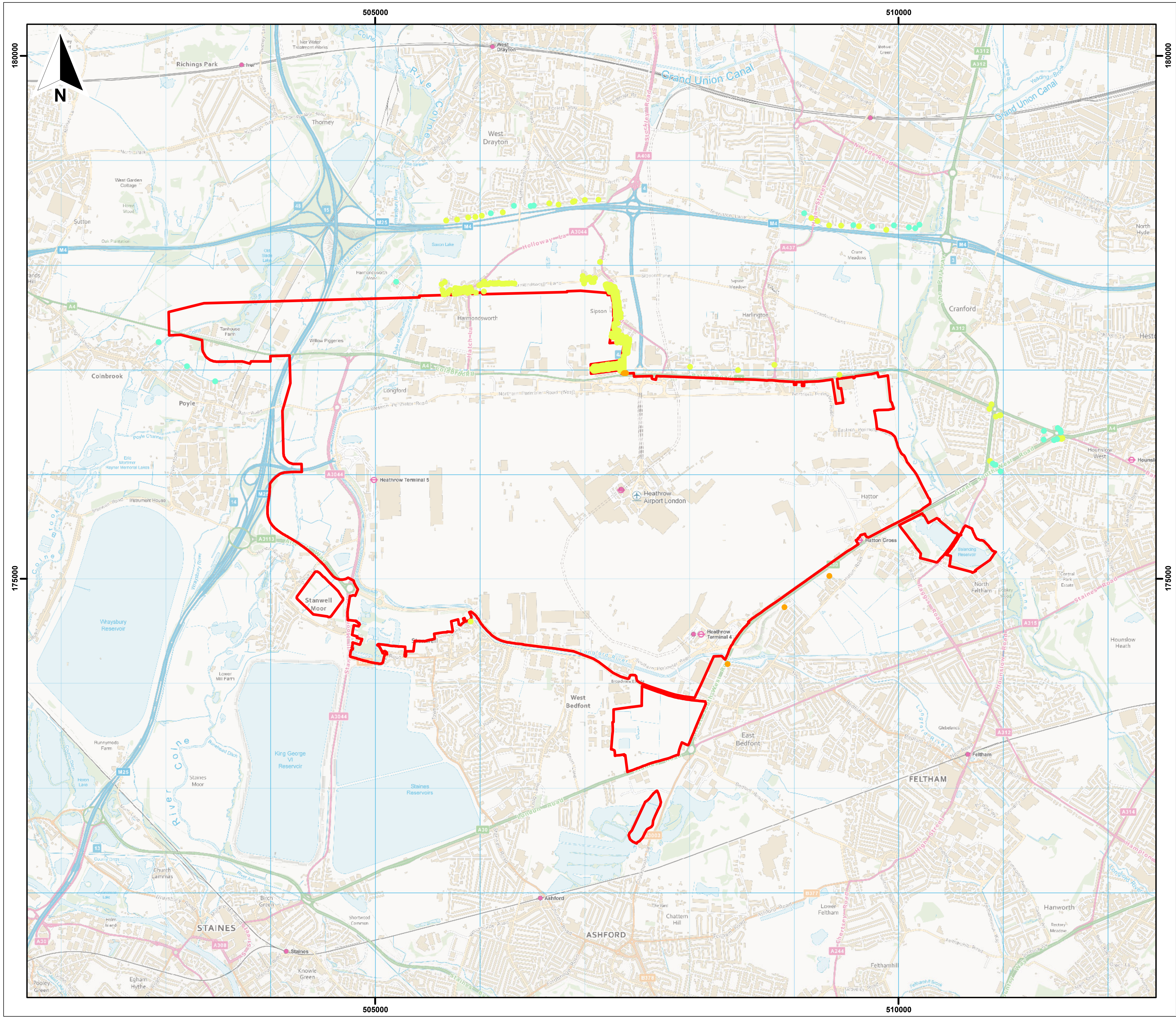

Key

Site boundary

Annual Mean NO2 Concentration ($\mu g\ m^{-3}$)

- 26 - 29
- 29 - 32
- 32 - 35
- 35 - 37

0 1 2 km

Scale: 1:35,000 @ A3

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Figure A6
Annual Mean NO_2 Concentrations at Receptors 3RNW 2040

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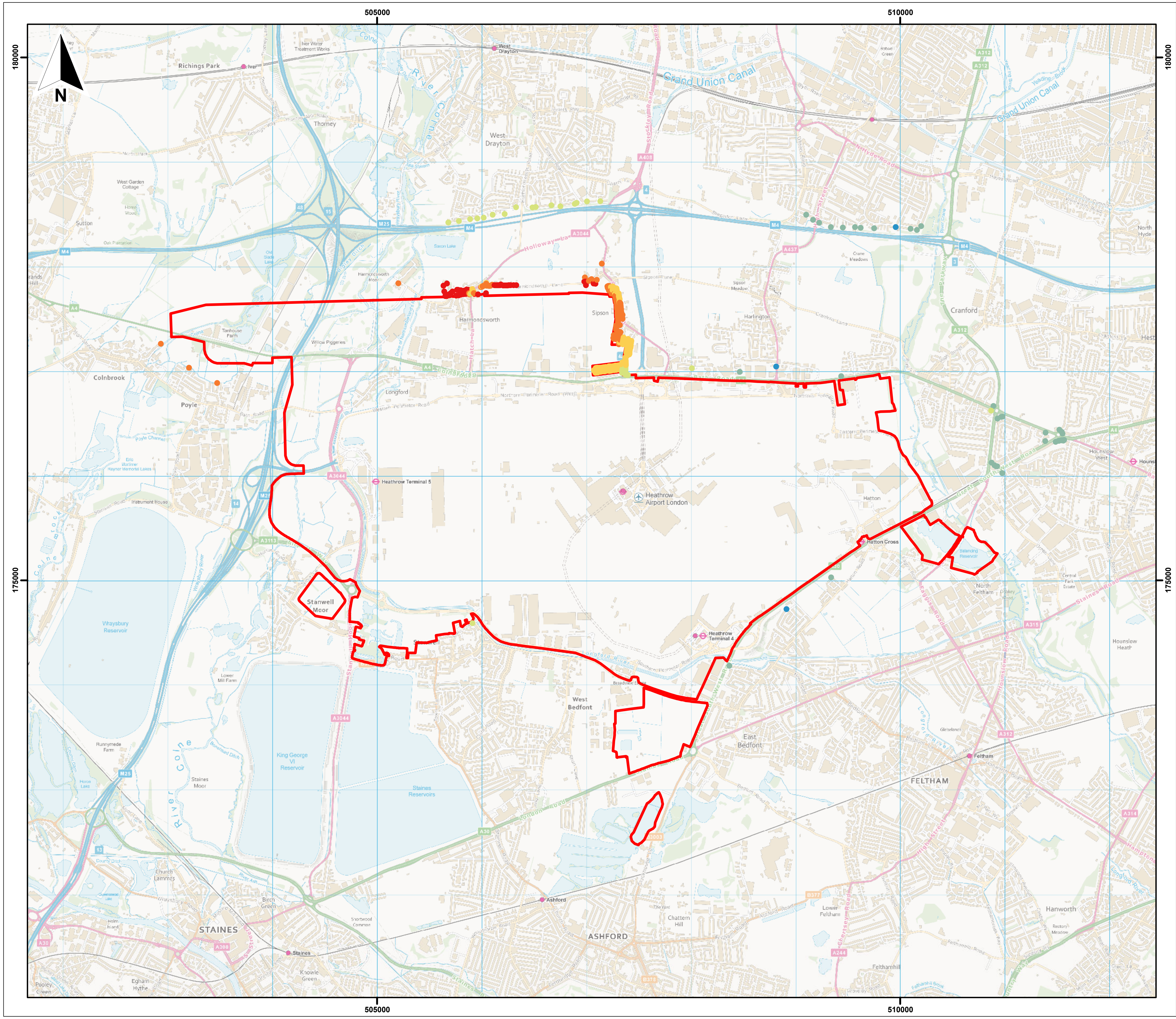

Key

Site boundary

Difference in Annual Mean NO_2 Concentration ($\mu g\ m^{-3}$)

- -1 - 0.00
- 0.01 - 1.00
- 1.01 - 2.00
- 2.01 - 3.00
- 3.01 - 4.00
- > 4.01

0 1 2 km

Scale: 1:35,000 @ A3

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Figure A7
Difference in Annual Mean NO_2 Concentrations at Receptors 2030 3RNW Compared to 2R

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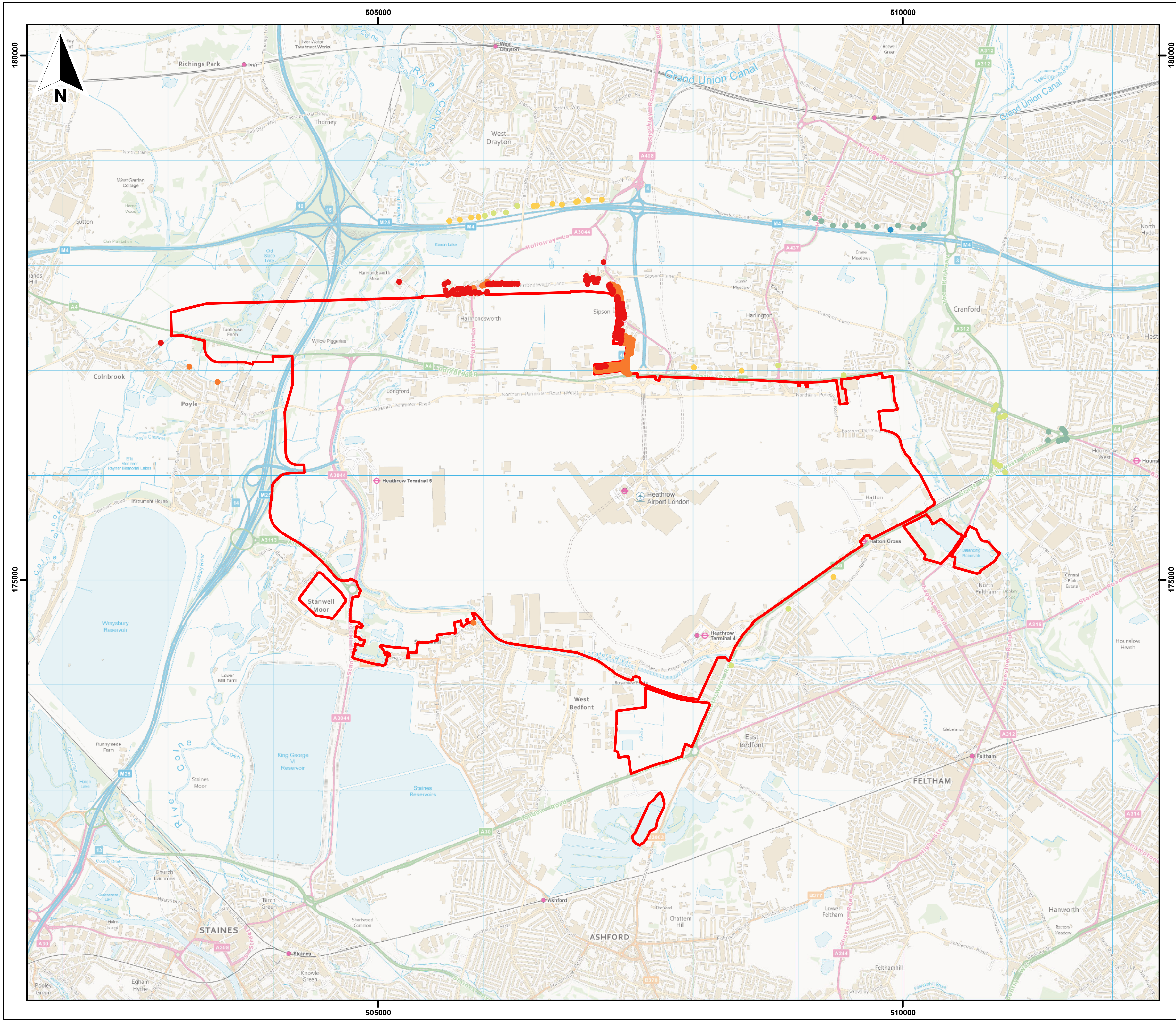

Key

Site boundary

Difference in Annual Mean NO_2 Concentration ($\mu g\ m^{-3}$)

- -1 - 0.00
- 0.01 - 1.00
- 1.01 - 2.00
- 2.01 - 3.00
- 3.01 - 4.00
- > 4.01

0 1 2 km

Scale: 1:35,000 @ A3

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Figure A8
Difference in Annual Mean NO_2 Concentrations at Receptors 2040 3RNW Compared to 2R

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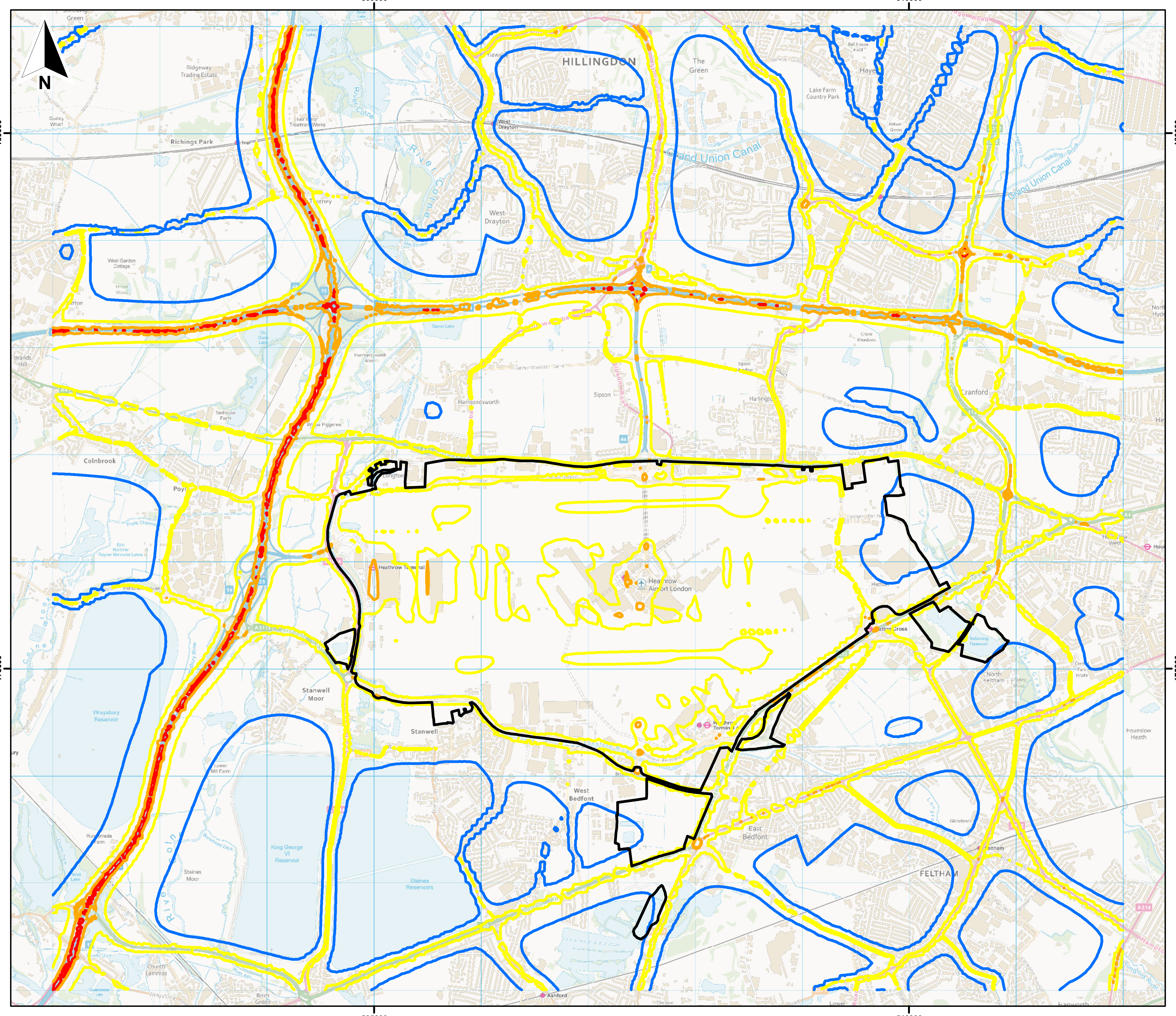
amec



Key

Existing Site Boundary

Annual Mean PM_{10} Ground Level Concentrations (µg m^{-3}).

- 20
- 22
- 30
- 40

0 1 2 Km

Scale: 1:35,000 @ A3

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Figure A9
Annual Mean PM_{10} Ground Level Concentrations 2R 2030

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Key

Site boundary

Annual Mean PM_{10} Ground Level Concentrations ($\mu g\ m^{-3}$).

- 20
- 22
- 30
- 40

0 1 2 Km

Scale: 1:35,000 @ A3

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Figure A10
Annual Mean PM_{10} Ground Level Concentrations 3RNW 2030

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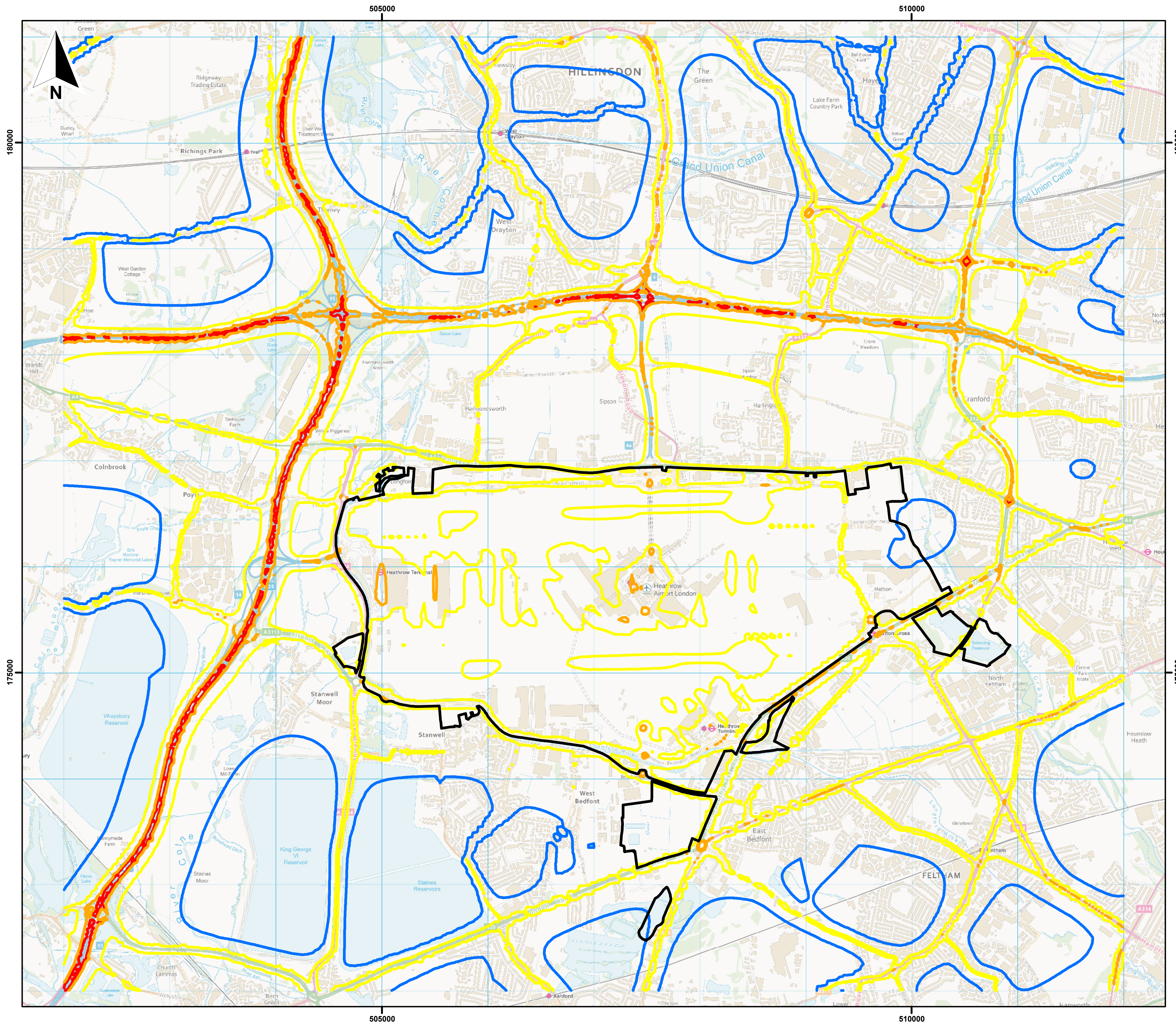

Key

Existing Site Boundary

Annual Mean PM_{10} Ground Level Concentrations ($\mu g\ m^{-3}$).

- 20
- 22
- 30
- 40

0 1 2 Km

Scale: 1:35,000 @ A3

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Air Quality Assessment

Figure A11
Annual Mean PM_{10} Ground Level Concentrations 2R 2040

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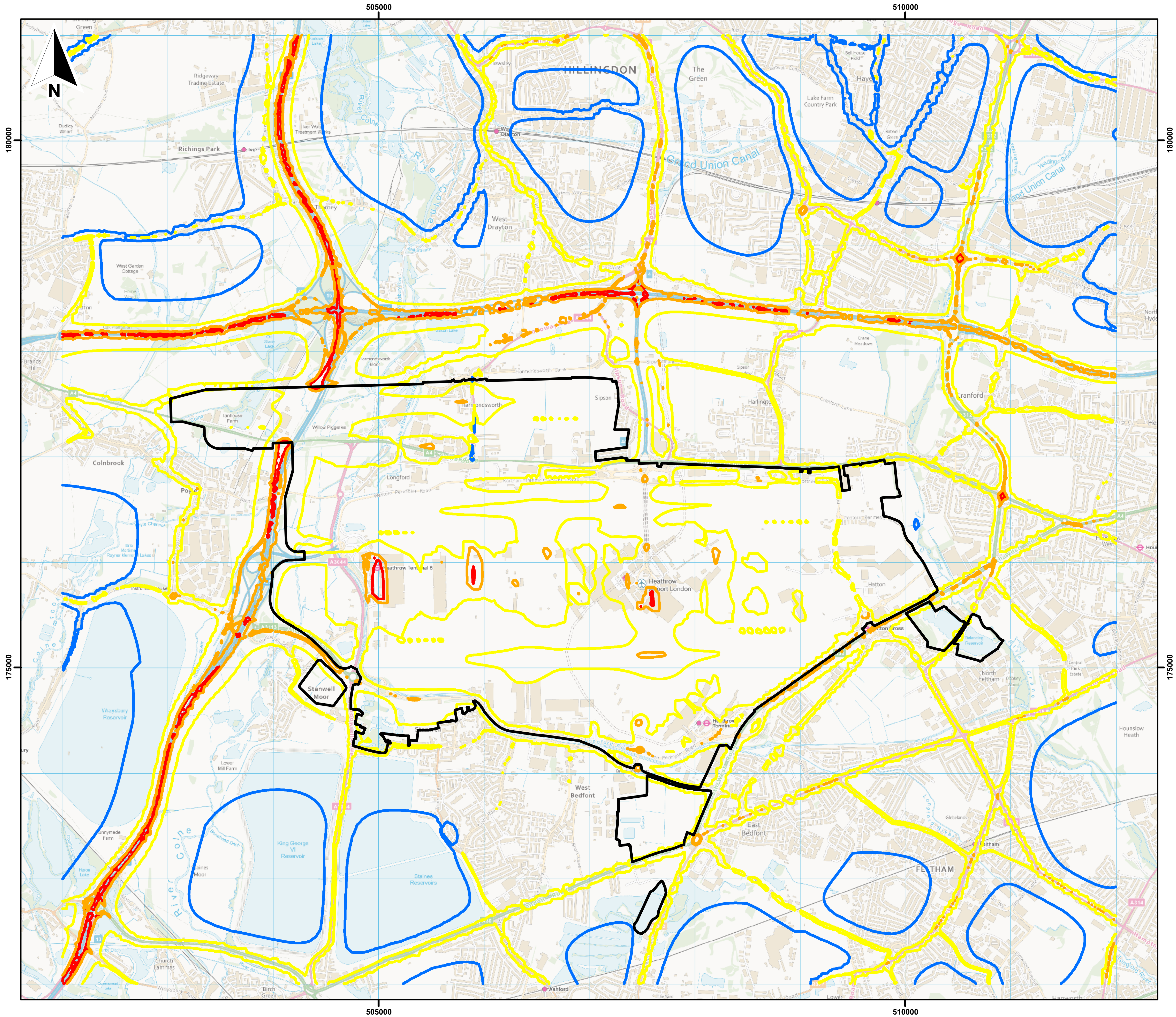

Key

Site boundary

Annual Mean PM_{10} Ground Level Concentrations ($\mu g\ m^{-3}$).

- 20
- 22
- 30
- 40

0 1 2 Km

Scale: 1:35,000 @ A3

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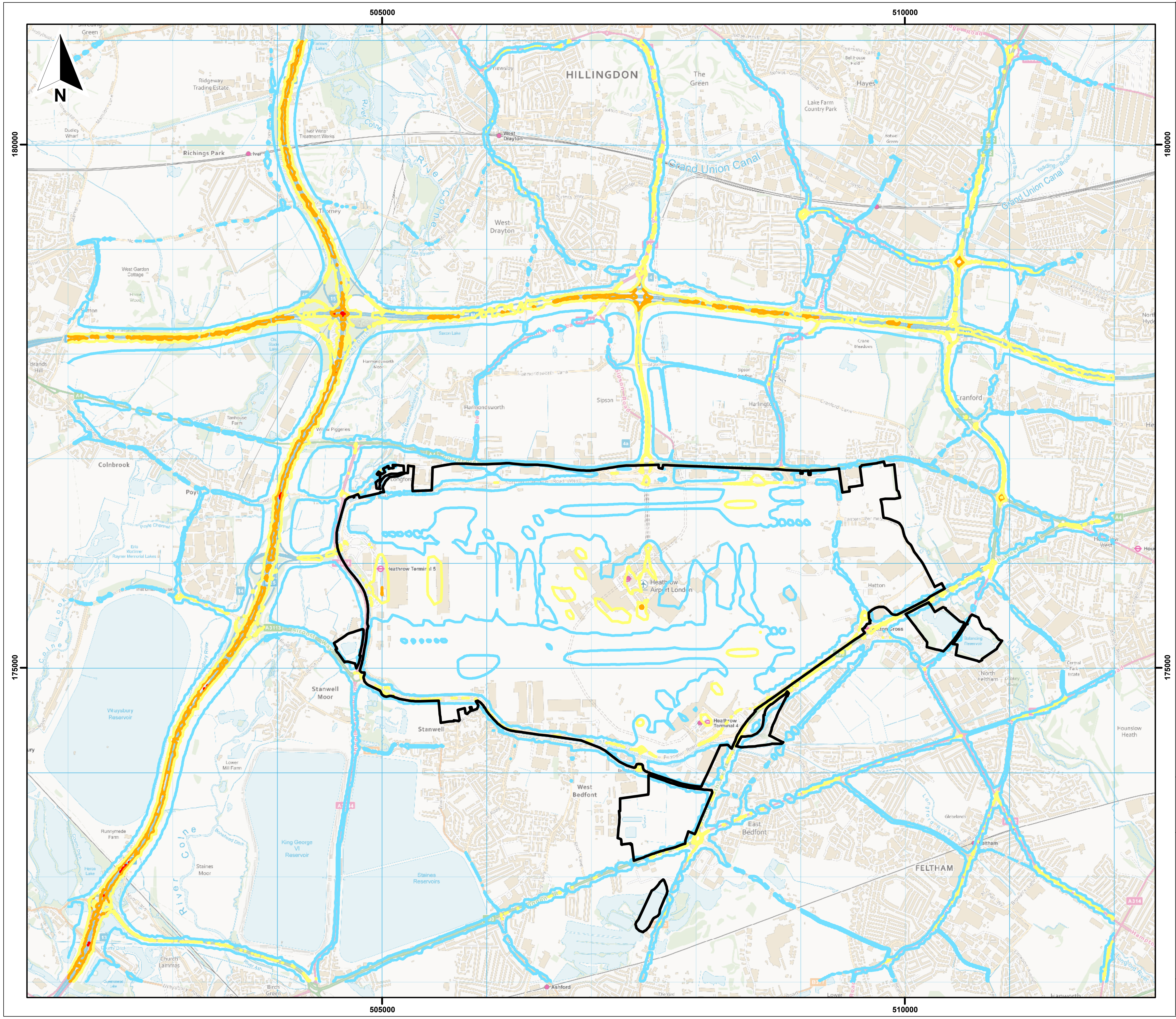
Figure A12
Annual Mean PM_{10} Ground Level Concentrations 3RNW 2040

June 2014
35310-Lon213 browj

amec



Key

Existing Site Boundary

Annual Mean $PM_{2.5}$ Ground Level Concentrations (µg m^{-3}).

- 12
- 15
- 20
- 25

0 1 2 Km

Scale: 1:35,000 @ A3

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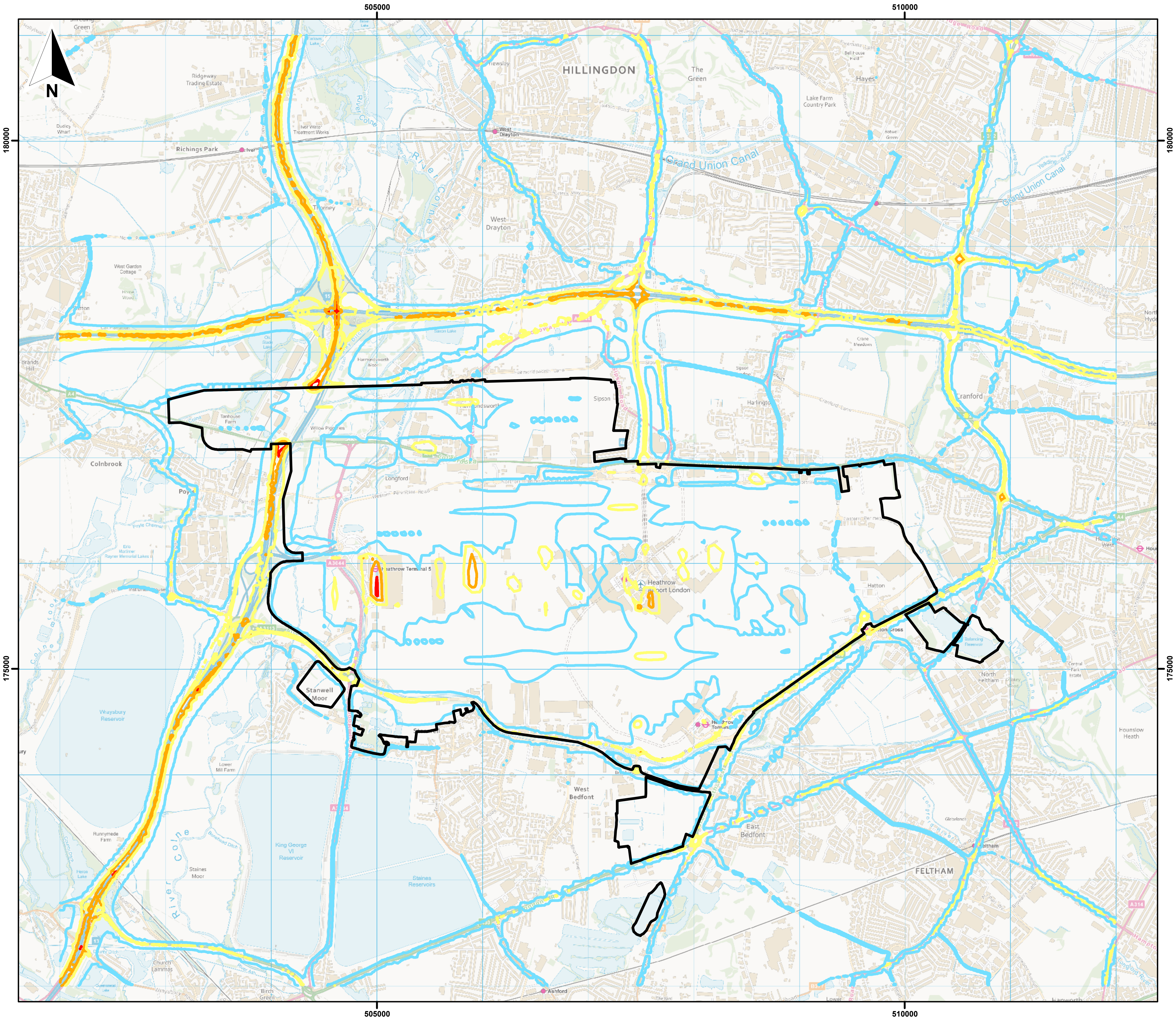
Air Quality Assessment

Figure A13
Annual Mean $PM_{2.5}$ Ground Level Concentrations 2R 2030

June 2014
35310-Lon214 browj

amec



Key

- Site boundary

Annual Mean $PM_{2.5}$ Ground Level Concentrations ($\mu g\ m^{-3}$).

- 12
- 15
- 20
- 25

0 1 2 Km

Scale: 1:35,000 @ A3

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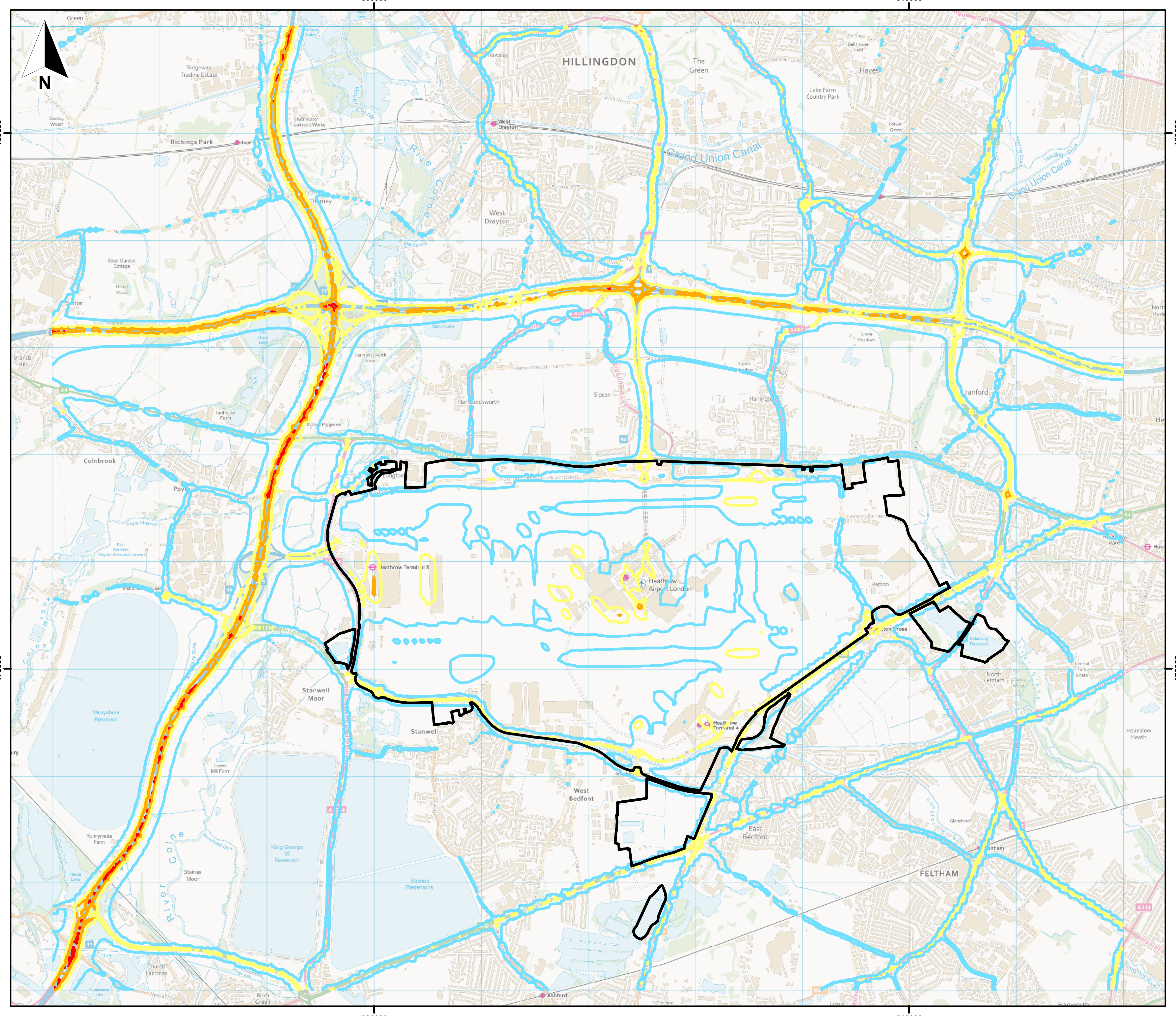
Figure A14
Annual Mean $PM_{2.5}$ Ground Level Concentrations 3RNW 2030

June 2014
35310-Lon215 browj

amec



Key

Existing Site Boundary

contour_2r_pm25_2040_v2

Annual Mean $PM_{2.5}$ Ground Level Concentrations (µg m^{-3}).

- 12
- 15
- 20
- 25

0 1 2 Km

Scale: 1:35,000 @ A3

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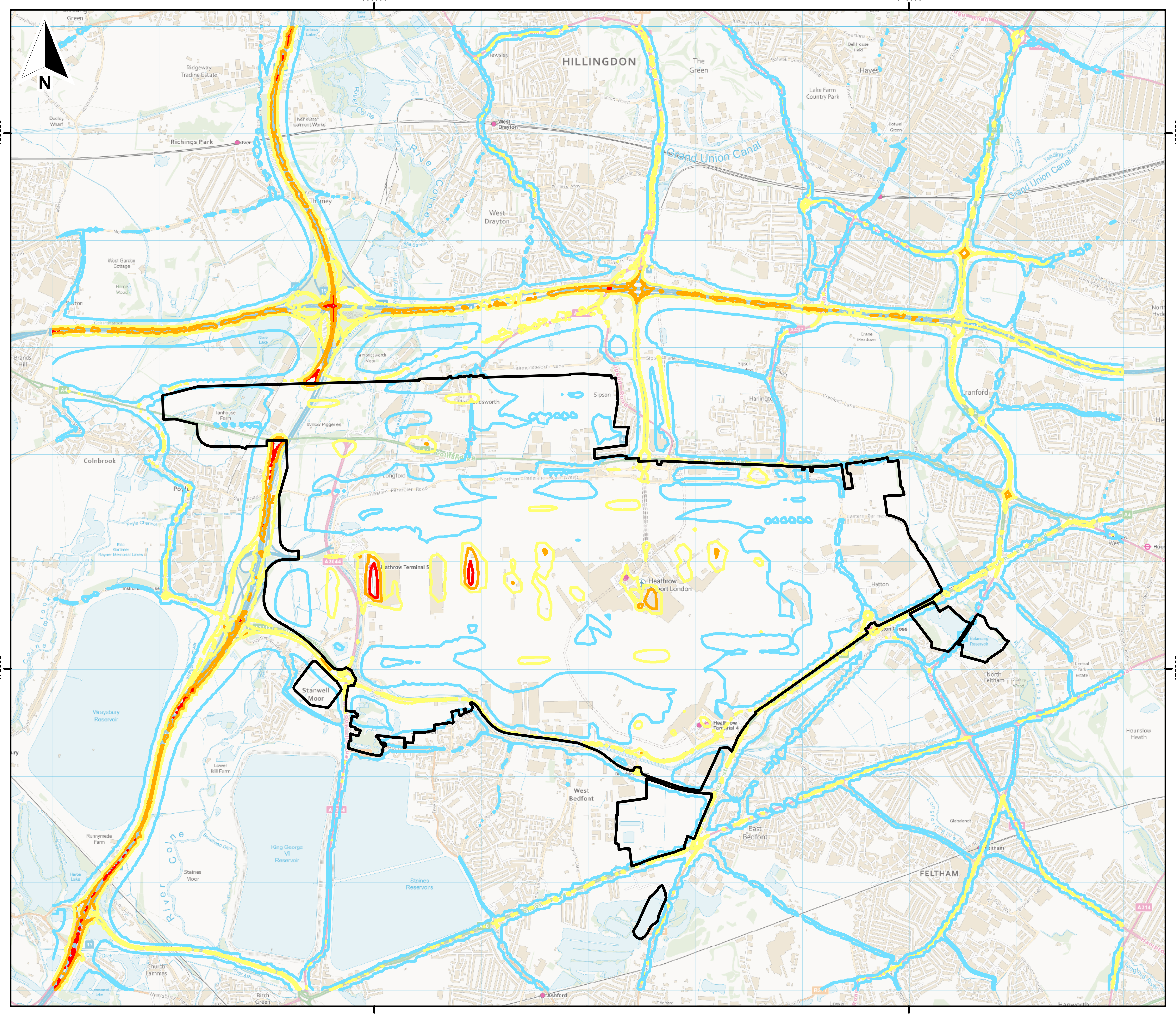
Figure A15
Annual Mean $PM_{2.5}$ Ground Level Concentrations 2R 2040

June 2014
35310-Lon216 browj

amec



Key

Site boundary

Annual Mean $PM_{2.5}$ Ground Level Concentrations (µg m^{-3}).

- 12
- 15
- 20
- 25

0 1 2 Km

Scale: 1:35,000 @ A3

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Air Quality Assessment

Figure A16
Annual Mean $PM_{2.5}$ Ground Level Concentrations 3RNW 2040

June 2014
35310-Lon217 browj

amec

Appendix B
Legislative and Policy Background

National Planning Policy

National Planning Policy Framework (NPPF)

The NPPF states that:

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

Heathrow sits within the southern part of the Air Quality Management Area (AQMA) declared by the London Borough of Hillingdon and annual average ambient concentrations of NO_2 at a number of locations are consistently close to or in excess of the EU Limit Value and are only slowly improving or static. This Limit Value was supposed to be complied with from the beginning of 2010 but, London, in common with many other European cities, has continued to breach the Limit Value. The new Directive 2008/50/EC on ambient air quality and cleaner air for Europe recognises that a number of Member States have difficulties in meeting the Limit Value. Upon receiving official notification that the Limit Value for NO_2 cannot be achieved, the EC postponed the Limit Value from January 2010 to January 2015. The implication of this National Policy for any proposed development at Heathrow is that it should not in itself cause any future breaches of the air quality Limit Value and should actively contribute to improving air quality in this area of West London, particularly since it is within an AQMA. By these means, consistency with the policy can be demonstrated.

Aviation Policy Framework (APF)

The APF states at paragraph 19:

"For aviation's other local environmental impacts, such as air pollution, our overall objective is to ensure appropriate health protection by focusing on meeting relevant legal obligations."

At paragraph 3.48:

"Our policy on air quality is to seek improved international standards to reduce emissions from aircraft and vehicles and to work with airports and local authorities as appropriate to improve air quality, including encouraging HGV, bus and taxi operators to replace or retrofit with pollution-reducing technology older, more polluting vehicles. There will be additional air quality (and noise pollution) benefits as the UK progresses to a low carbon economy with the likely increase in the proportion of electric vehicles and plug-in hybrid vehicles."

As well as demonstrating that development at Heathrow can proceed without resulting in breaches of the air quality Limit Values, it is implicit that investing in strategies to actively encourage airlines using the airport to use less polluting aircraft will be essential, as will be the airport's role in achieving an increased modal shift from private car to public transport and encouraging the use of low-emission and zero-emission modes of transport. All of these issues have been high-up on HAL’s agenda for some time now and the airport is already, overall, on a downward emissions trajectory.

Legislative Controls

Ambient Air Quality Regulations

The European directive on air quality and cleaner air for Europe (2008/50/EC) and the European directive relating to arsenic, cadmium, mercury, nickel, and polycyclic aromatic hydrocarbons in ambient air (2004/107/EC) are the principal instruments governing outdoor ambient air quality policy in the EU. They set binding Limit Values that the Government must meet in relation to concentrations of pollutants in the air we breathe.

The Air Quality Standards Regulations 2010 transpose into English legislation these two European directives, the council’s decision on exchange of information, and replaced the Air Quality Standards Regulations 2007. The Air Quality Standards Regulations 2010 came into force in the UK on 11th June 2010. The Air Quality Limit Values are transposed into the updated Regulations as Air Quality Standards (AQS) with attainment dates in line with the European Directives.

In the UK, action on air quality is driven by the health-based Objectives as set out in the 2007 Air Quality Strategy for England, Scotland, Wales and Northern Ireland. The Air Quality Objectives (AQOs) are based on medical and scientific reports on how and at what concentration each pollutant affects human health. The AQOs are based on the Air Quality Standards/ Air Quality Limit Values, with interim target dates to help the UK move toward the achievement of the Air Quality Limit Values. The AQOs in the Air Quality Strategy are a statement of policy intentions or policy targets and as such, there is no legal requirement to meet these objectives except as far as these mirror any equivalent legally binding Limit Values in EU legislation. **Table B.1** sets out the air quality objectives that are relevant to this assessment, and the dates by which they are to be achieved.

Table B1 Summary of Relevant Air Quality Standards and Objectives

Pollutant	Objective (UK)	Averaging period	Date to be achieved by and maintained thereafter (UK)
NO_2	200 µg m^{-3} not to be exceeded more than 18 times a year	1-hour mean	31 Dec 2005
	40 µg m^{-3}	Annual mean	31 Dec 2005
PM_{10}	50 µg m^{-3} not to be exceeded more than 35 times a year	24-hour mean	31 Dec 2004
	40 µg m^{-3}	Annual mean	31 Dec 2004
$PM_{2.5}$	25 µg m^{-3}	Annual mean	2020
	Target of 15% reduction in concentration at urban background locations	3 year mean	Between 2010 and 2020.

Protection of Vegetation and Habitats

In addition to the objectives for human health, a national objective relating to the protection of vegetation and ecosystems is prescribed for nitrogen oxides as shown in **Table B2**. The 30 µg m^{-3} Limit Value is not a threshold in the sense that damage to vegetation is likely to occur when this concentration is exceeded, rather, that above this concentration, there is an increased risk of damage.

Table B2 National Air Quality Objectives for the Protection of Vegetation and Ecosystems

Pollutant	Objective (UK)	Averaging period	Date to be achieved by and maintained thereafter (UK)
NO_X	30 µg m^{-3}	Annual Mean	31 Dec 2000

The Government and the Devolved Administrations intend that these limits are treated as national objectives, against which compliance is monitored at a national level, not ones that are included in the Regulations for the purpose of local air quality management. These objectives apply at locations which are:

- More than 20km from an agglomeration i.e. an area with a population of more than 250,000;
- More than 5km away from industrial sources regulated under Part A of the 1990 Environment Act;
- More than 5km away from motorways; and
- More than 5km away from built up areas of more than 5,000 people.

At ecological receptors in the Heathrow study area, the NO_x Objective does not, therefore, apply. All ecological sites are excluded from the Objective on the basis that at least one or more of the four exclusion criteria listed above applies.

Nitrogen Deposition

The predominant route by which emissions will affect the land in the vicinity of an airport is by deposition of atmospheric emissions. Potential ecological receptors can be sensitive to the deposition of pollutants, particularly nitrogen compounds, which can affect the character of the habitat through eutrophication (nutrient enrichment) and acidification.

Critical loads for nitrogen are a quantitative estimate of the level of exposure (via deposition) below which significant harmful effects on sensitive elements of the environment do not occur, according to present knowledge. It should be noted that critical loads are not statutory standards which are to be achieved, but are an indicator of when harmful effects can occur for different habitat types.

Local Air Quality Management (LAQM)

Part IV of the Environment Act 1995 requires local authorities to periodically review concentrations of the UK Air Quality Strategy pollutants within their areas and to identify areas where the AQOs may not be achieved by their relevant target dates. This process of Local Air Quality Management (LAQM) is an integral part of delivering the Government's AQOs detailed in the Regulations. When areas are identified where some or all of the Objectives might potentially be exceeded and where there is relevant public exposure, i.e. where members of the public would regularly be exposed over the appropriate averaging period, the local authority has a duty to declare an AQMA and to implement an Air Quality Action Plan (AQAP) to reduce air pollution levels towards the AQOs, to the extent that emission sources are under their control.

National Emissions Ceiling Directive.

The National Emissions Ceilings Directive (2001/81/EC) came into force in 2001, and has been transposed into UK legislation as The National Emission Ceilings Regulations 2002. The Directive sets national emission limits or "ceilings" for the four main air pollutants responsible for the acidification and eutrophication (nutrient enrichment) of the natural environment, and the formation of ground level ozone which impacts both human health and the environment. The ceilings, which are different for each Member State, had to be met by 2010. Emissions of these pollutants can impact either locally or far from their source, which is known as transboundary air pollution. The four pollutants for which national emission ceilings are set are:

- Sulphur dioxide (SO_2);
- Oxides of nitrogen (NO_X);
- Volatile organic compounds (VOCs); and
- Ammonia (NH_3)

Regional and Local Planning Policies

Regional Policy Context

The London Mayor's Air Quality Strategy[27], published in 2010, aims to develop measures already in place, including those related to transport which will: promote alternative travel choices; encourage technological change and cleaner vehicles; identify priority locations and improve air quality through a series of local measures; and reduce emissions from certain sources within the public transport fleet.

The London Plan[28] includes policies that specifically address the spatial implications of the Air Quality Strategy and, in particular, how development and land use can help achieve its objectives.

Policy 7.14 seeks to achieve reductions in pollutant emissions and minimise public exposure to pollution and implement the Mayor's Air Quality and Transport strategies. It requires development proposals to minimise increased exposure to existing poor air quality and make provision to address local problems of air quality and promote sustainable design and construction to reduce emissions from the demolition and construction of buildings.

It also introduces the aim for development proposals to be 'air quality neutral' and not lead to further deterioration of existing poor air quality (such as areas designated as Air Quality Management Areas). Where provision needs to be made to reduce emissions from a development this should usually be made on-site.

Local Planning Policies

Hillingdon Local Plan (adopted November 2012)

Strategic Objectives SO10 of the Plan aim to:

"Improve and protect air and water quality, reduce adverse impacts from noise including the safeguarding of quiet areas and reduce the impacts of contaminated land."

"Address the impacts of climate change, and minimise emissions of carbon and local air quality pollutants from new development and transport."

Whilst Strategic Objective SO23 aims to:

"Develop and implement a strategy for the Heathrow Opportunity Area, in order to ensure that local people benefit from economic and employment growth and social and environmental improvements including reductions in noise and poor air quality."

Policy EM8, land, Water Air and Noise, contains the following text on air quality:

[27] Greater London Authority (2010) Clearing the Air: The Mayor's Air Quality Strategy
[28] Greater London Authority (2011) The London Plan

"All development should not cause deterioration in the local air quality levels and should ensure the protection of both existing and new sensitive receptors."

"All major development within the Air Quality Management Area (AQMA) should demonstrate air quality neutrality (no worsening of impacts) where appropriate; actively contribute to the promotion of sustainable transport measures such as vehicle charging points and the increased provision for vehicles with cleaner transport fuels; deliver increased planting through soft landscaping and living walls and roofs; and provide a management plan for ensuring air quality impacts can be kept to a minimum."

"The Council seeks to reduce the levels of pollutants referred to in the Government's National Air Quality Strategy and will have regard to the Mayor's Air Quality Strategy. London Boroughs should also take account of the findings of the Air Quality Review and Assessments and Actions plans, in particular where Air Quality Management Areas have been designated."

"The Council has a network of Air Quality Monitoring stations but recognises that this can be widened to improve understanding of air quality impacts. The Council may therefore require new major development in an AQMA to fund additional air quality monitoring stations to assist in managing air quality improvements."

"The following documents are also due to be adopted as part of the Local Plan but are still in the pre-production stage: Site Allocations Development Plan Document (DPD), Development Management DPD, Heathrow Area DPD, Air Quality SPD."

Air Quality Supplementary Planning Guidance (SPG) Document - London Borough of Hillingdon (April 2006)

The SPG was prepared to provide additional guidance on the relevant UDP policies. It identifies those circumstances when an air quality assessment will be required to accompany a development proposal; provides technical guidance on the process of air quality assessment; and provides guidance on the circumstances when air quality conditions and S106 planning obligations will be sought in accordance with national guidance and Hillingdon's UDP policies for air quality. The guidance is to ensure that air quality has been considered in enough depth and to help minimise any potential impacts.

Ealing Unitary Development Plan (UDP) (saved policies) (2004)

Policy 2.6 seeks reductions in the level of the air pollutants referred to in the National Air Quality Strategy, and will seek to achieve the statutory limits and consider the tolerability of any increased air pollution when considering proposals for development. Development proposals will be considered for their effect on air quality and the exposure of people to air pollutants. Permission will be refused where development hinders the achievement of local air quality objectives, or there is likely to be a significant increase in air pollutants. Developments will not be permitted in areas where air quality objectives are not currently being achieved, unless the effects on people can be demonstrated as acceptable in relation to air quality objectives. The cumulative effect of individual developments will be taken into account, both in terms of impact and remedial measures.

Ealing Draft Core Strategy Development Plan Document (DPD) (Adopted April 2012)

New development will be expected to contribute to improving the quality of life in the borough through the reduction of noise pollution, protecting soundscape quality, reducing pollutant emissions and minimising public exposure to pollution.

Policy 2.8 aims to develop and implement a low emission strategy for Southall Gas Works site.

Policies 3.1 and 3.8 aim to realise the potential of the A40 corridor and Park Royal and further explore opportunities to reduce exposure to air and noise pollution for existing residents. Poor air quality and high ambient noise levels are recognised as major challenges to improvements in the residential environment within the A40 corridor.

Policy 3.4 seeks to apply vertical mixing of uses to mitigate air quality issues at the Southern Gateway development.

Policy 5.3 seeks to reduce the adverse effects of air quality on green corridors.

London Borough of Hounslow Air Quality Action Plan – Progress Report 2010

Hounslow's Air Quality Action Plan is aligned well with the Mayor's Air Quality Strategy. The Action Plan is actively supported by other Council plans such as the LIP (Local Implementation Plan) and UDP (Unitary Development Plan). It includes use of S106 agreements to mitigate the effect of developments on air quality by allocation of revenues to projects to improve air quality; development and use of guidance to control emissions from construction and demolition sites (e.g. regarding bonfires).

Saved policies of the Hounslow Unitary Development Plan (UDP) September 2007 and emerging Local Development Framework (LDF) policies

Objective ENV-N.2 seek to protect, provide, enhance and promote Sites of Special Scientific Interest, Local Nature Reserves, other areas of nature conservation interest, with reference to the Hounslow Local Biodiversity Action Plan, and areas of high amenity value.

Objective ENV-P.1 seeks to protect residents and workers in the Borough from further detrimental effects due to noise, poor air quality, contaminated land and general environmental pollution.

Objective ENV-P1.6 states that the Council will give detailed consideration to air pollution matters when considering development proposals, will continue to monitor air quality and will seek reductions in the levels of specific airborne pollutants, particularly pollution caused by road and air transport.

Air Quality, Supplementary Planning Document to the Hounslow Local Development Framework – March 2008

The Supplementary Planning Document aims to:

- Identify those circumstances when an air quality assessment will be required to accompany a development proposal;
- Provide technical guidance on the process of air quality assessment;
- Provide guidance on the circumstances when air quality conditions and S106 planning obligations will be sought in accordance with national guidance, The London Plan, saved UDP policies and Hounslow's emerging LDF policies for air quality. The guidance is aimed at ensuring that air quality has been considered in enough depth and to help minimise any potential impacts.

Richmond Core Strategy (2009)

Policy CP1 deals with local environmental impacts of development with respect to factors such as air quality and requires that these should be minimised. Environmental gain required to compensate for any environmental cost of development will be sought.

Policy CP5 aims to reduce the impact of traffic on pollution by traffic reduction and management.

Slough Core Strategy (2008)

Policy 8 states that development shall not give rise to unacceptable levels of pollution including air pollution.

South Bucks Core Strategy (2011)

Generally seeks improvements in air quality, especially in the Air Quality Management Area adjacent to the motorways and close to Burnham Beeches SAC. Specifically, Policy 13 states that new development will be directed away from existing sources of noise and air pollution to avoid adverse impacts on local communities.

The Royal Borough of Windsor and Maidenhead Local Plan (Incorporating Alterations Adopted June 2003) (saved policies)

Policy NAP3 states that the council will not grant planning permission for proposals likely to emit unacceptable levels of fumes beyond the site boundaries.

Spelthorne Core Strategy and Policies Development Plan Document (2009)

Policy ENV5 aims to improve the air quality of the Borough and minimise harm from poor air quality by refusing development where the adverse effects on air quality are of a significant scale, either individually or in combination with other proposals, and which are not outweighed by other important considerations or effects and cannot be appropriately and effectively mitigated.