Air Quality Review & Assessment – Stage 4

A report produced for London Borough of Hillingdon

AEAT/R/ENV/1433
March 2003

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Title	Air Quality Review and Assessment – Stage 4
Customer	London Borough of Hillingdon
Customer reference	
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File reference	**ENTC ED48123**
Report number	**AEAT/R/ENV/1433**
Report status	Unrestricted

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Executive Summary

BACKGROUND TO THIS REPORT

This report comprises the Stage 4 air quality review and assessment for the London Borough of Hillingdon prepared in compliance with statutory duties under the Environment Act 1995.

The strategic policy framework for air quality management, the National Air Quality Strategy, passed into statute in the Environment Act, 1995. The Air Quality Strategy provides a framework for air quality management through polices aimed at achieving human health-based air quality standards[1]. The Act requires Local Authorities to undertake air quality reviews and assessments that identify locations where the achievement of air quality objectives[2] is not likely. Local Authorities are then required to designate these locations Air Quality Management Areas (AQMAs) and to implement an Air Quality Action Plan (AQAP) aimed at improving air quality to the level that the objectives are then achieved.

The objectives concern standards of seven pollutants but the ones of particular concern in the London Borough of Hillingdon are:

Pollutant	**Concentration limits** (**mg / m^3**)	**Averaging period**	**Objective** [Number of permitted exceedances per year and equivalent percentile] (m**g / m^3**)	date for objective
nitrogen dioxide, NO_2	200	**1 hour** mean	**200**	by 31.12.2005 [maximum of 18 exceedances per year or equivalent to the 99.8th percentile]
	40	**annual** mean	**40**	by 31.12.2005
particulate matter, PM_{10} (**gravimetric**)	50	**24-hour** mean	**50**	by 31.12.2004 [maximum of 35 exceedances per year or equivalent to the 90.4th percentile]
	40	**annual** mean	**40**	by 31.12.2004

Complying with its statutory duties, the London Borough of Hillingdon has undertaken and completed three stages of review and assessment. Results of these studies indicated that the achievement of objectives for one pollutant, namely nitrogen dioxide (NO_2) is unlikely over large areas of the borough. As a result, London Borough of Hillingdon designated an AQMA based on NO_2 from the A40 corridor to the southern borough boundary. The boundary includes the A40 Road corridor from the western boundary along to and incorporating Northolt Aerodrome up to the Chiltern mainline railway then following the

[1] Refers to standards recommended by the Expert Panel on Air Quality Standards. Recommended standards are set purely with regard to scientific and medical evidence on the effects of the particular pollutants on health, at levels at which risks to public health, including vulnerable groups, are very small or regarded as negligible.

[2] Refers to objectives in the Strategy for each of the eight pollutants. The objectives provide policy targets by outlining what should be achieved in the light of the air quality standards and other relevant factors and are expressed as a given ambient concentration to be achieved within a given timescale.

railway line to the eastern boundary of the borough. Particulate matter was also identified as a pollutant for continued assessment although the 2004 objectives would probably be achieved.

Because of designating the AQMA, London Borough of Hillingdon is required to complete a further review and assessment of air quality – a Stage 4 review and assessment – as specified under Section 84 of the Environment Act (1995).

REQUIREMENTS OF THE STAGE 4 REVIEW & ASSESSMENT

Essentially, Stage 4 review and assessment provides technical justification for the measures an authority implements in its action plan. Following guidance from DEFRA, the report should:

- Respond to relevant comments made by statutory consultees;
- Take account of recent local policy developments. For example, new transport schemes in the vicinity of the AQMA or of any new major housing or commercial developments;
- Take account of national policy developments that have come to light since the AQMA was designated;
- Report on monitoring in the problem areas in relationship to earlier findings;
- Corroborate other assumptions on which the designation of the AQMA was based and to check that the original designation is still valid, and does not need amending;
- Calculate more accurately how much of an improvement in air quality is needed to deliver the air quality objectives within the AQMA;
- Refine knowledge of the sources of pollution so that AQAPs can be properly targeted;

APPROACH TAKEN IN THIS REPORT

The general approach taken in this Stage 4 assessment and reported on here was to:

- Consider new relevant information that had a bearing on the assessment of air quality within the borough. These comprised, revised emission factors for vehicles, an updated emission inventory for London and recognition that development at Heathrow airport would impact on air quality;
- Consider recent NO_2 and PM_{10} measurements made within the borough in relation to current objectives;
- Consider recent model predictions of future air quality in the borough, made on the basis of the most up to date information regarding emissions, and their relation to NO_2 and PM_{10} objectives;
- Conclude on any changes needed to the existing AQMA;
- Identify the improvement needed in concentrations of NO_2 at selected receptors in the AQMA, including the receptors where the greatest improvements are needed;

- Identify the contributions of different sources (local traffic, aircraft and other relevant activities) to exceedances of the air quality objectives through a source apportionment study;

- Indicate the scale of emission reductions needed to achieve the objectives by reference to the results of abatement scenario calculations.

RESULT OF THE STAGE 4 ASSESSMENT

Monitoring

Measurements made since the completion of the Stage 3 assessment are consistent with earlier measurements and predict that the objectives for NO_2 will not be achieved at some locations within the borough. Measurements of PM_{10} confirm that it is likely that the objectives by 2004 for this pollutant shall be achieved in all monitoring locations within the borough.

Model Predictions

Model results have been generated in partnership with neighbouring authorities for a consistent approach and have been verified against relevant monitoring data. The results have been analysed with reference to the locations at which people may experience relevant exposure to the pollutants. The results predict that:

- Particulate matter objectives for 2004 should be achieved in all relevant locations within the borough;

- NO_2 objectives for 2005 will be exceeded by greater amounts and over larger areas of the borough than was expected previously but that these changes do not affect more of the population than is already present within the AQMA.

Conclusion

It has been concluded that the designated AQMA should not be varied or amended.

FURTHER CHARACTERISATION OF THE AQMA

Required improvement in air quality

Model results at 11 relevant receptors (including the maximally exposed locations) have been used to predict the improvement in air quality required within the AQMA in order to achieve the objectives. The improvement varies across the AQMA since some locations are closer to the largest sources of pollution than others. The estimated range of reduction in NO_2 required at the receptors is 0.4-11.9$\mu g/m^3$.

Results of a source apportionment study

NO_2 is one member of a larger group of pollutants called oxides of nitrogen (NO_X). The properties of this group are complex and it is, therefore, more convenient to determine how much different sources contribute to total NO_X rather than to total NO_2. It was found that the proportionate contributions of sources (such as road vehicles or aircraft) to total NO_X concentration vary widely across the borough. However, it may be concluded that there is a region south of the M4 motorway where activity associated with Heathrow airport is a significant contributor to total NO_X concentration (around 30%). Around 60% of this specific contribution results from emissions from airborne aircraft at the point of takeoff and landing (0-50m above ground level).

At the 11 receptor locations studied, road traffic contributes generally between 30-50% of the total NO_X concentration. This share is mostly due to cars and HGVs and to traffic not associated with Heathrow airport. The road traffic contribution is found to mainly come from roads regulated by Transport for London and the Highways Agency in some cases but from roads regulated by the Local Authority in others.

Indicative scenarios demonstrating the level of action required to achieve objectives in the AQMA

Improvement in air quality can be achieved by reducing emissions of relevant pollutants. However, it is recognised that the behaviour of NO_2 and NO_X in the atmosphere is complex and depends on the presence of and mixture with other gases in the air. So that it does not automatically follow that a, say, 20% reduction in NO_2 or NO_X emissions at source will result in a 20% reduction in levels of NO_2 in the air.

Three hypothetical scenarios have been studied in which emissions of NO_X from the major sources within the borough (aircraft and road transport) have been reduced in order to predict what the resulting improvement in NO_2 concentration is likely to be.

A 50% reduction in NO_X emissions from airborne aircraft is predicted to bring about up to an 8% reduction in NO_2 in parts of the borough, which would mean that some receptor locations then achieve the annual mean objective.

A 30% reduction in NO_X emissions from road transport is predicted to bring about a 3-7% reduction in NO_2 over the borough, which would mean that some receptor locations then achieve the annual mean objective.

Creation of a Low Emission Zone in the AQMA, in which all vehicles other than private cars are required to comply with Euro II exhaust emission standards for NO_X, is predicted to bring about a 1% reduction in NO_2 over the borough, which is insufficient to cause any exceeding receptor locations to achieve the annual mean objective.

Combination of the effects of scenarios 1 and 2 is predicted to lead to a greater improvement in NO_2 concentration and to more receptors achieving the annual mean objective than for either scenario implemented in isolation.

Conclusion

Characterisation of the predicted level of NO2 in the AQMA reveals that:

- Required improvements to achieve objectives vary from small to large;
- Airport activities, cars and HGVs are the main contributors to high levels of $NO_{2;}$
- BAA, airline operators, the Highways Agency, Transport for London, the Local Authority and individuals will all need to act to achieve the objectives.

FUTURE ACTIONS

As a result of this Stage 4 assessment and other requirements under section 84 of the Environment Act 1995, London Borough of Hillingdon will be taking the following actions:

- Submitting this assessment to DEFRA for approval;
- Completing the action plan for the AQMA and submitting to DEFRA for approval;
- Carrying out appropriate consultation with stakeholders on the Stage 4 assessment and the action plan;
- Preparing annual updates on progress with the action plan and on the air quality in the borough;
- Monitoring the impact of Heathrow Airport - Terminal 5 construction activity;
- Taking due account of revisions to emissions data due to the operation of Terminal 5 and other changes to the Heathrow and London Atmospheric Emissions Inventories;
- Undertaking further reviews and assessments including assessment of air quality against stringent PM_{10} objectives to be achieved by 2010.

Acronyms and definitions

ADMS	an atmospheric dispersion model
AQDD	an EU directive (part of EU law) - Common Position on Air Quality Daughter Directives, commonly referred to as the Air Quality Daughter Directive
AQMA	Air Quality Management Area
AQS	Air Quality Strategy
AP	Action Plan
AURN	Automatic Urban and Rural Network (DEFRA funded pollutant monitoring network)
CERC	Cambridge Environmental Research Consultants
DETR	Department of the Environment Transport and the Regions (now DEFRA)
DEFRA	Department of the Environment, Farming and Rural Affairs
EA	Environment Agency
EPA	Environmental Protection Act
EPAQS	Expert Panel on Air Quality Standards (UK panel)
EU	European Union
GIS	Geographical Information System
GLA	Greater London Authority
HA	Highways Agency
kerbside	0 to 1 m from the kerb
LAEI	London Atmospheric Emissions Inventory
Limit Value	An EU definition for an air quality standard of a pollutant listed in the air quality directives
NAEI	National Atmospheric Emission Inventory
NO_2	Nitrogen dioxide
NO_x	Oxides of nitrogen
NRTF	National Road Traffic Forecast
ppm	parts per million
receptor	In the context of this study, the relevant location where air quality is assessed or predicted (for example, houses, hospitals and schools)
roadside	1 to 5 m from the kerb
TfL	Transport for London

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APPENDICES

1 Introduction to this Stage 4 air quality assessment

This section outlines the reason that the Stage 4 air quality review and assessment was commissioned, and briefly explains the purpose of the assessment.

1.1 PURPOSE OF THE STUDY

The London Borough of Hillingdon completed a Stage 3 Air Quality Review and Assessment in 2000. The results of this indicated that exceedances of air quality objectives for nitrogen dioxide (NO_2) are likely in the borough, with particular problems in the southern half of the borough due to the presence of Heathrow airport, the M4 and the A40 road corridors. As a result of the Stage 3 air quality review and assessment, Hillingdon Council declared an air quality management area.

The designation order for the AQMA is reproduced in Appendix 1 to this report. The AQMA boundary includes the A40 Road corridor from the western boundary along to and incorporating Northolt Aerodrome up to the Chiltern mainline railway then follows this railway line to the eastern boundary of the borough.

As a result of designating the AQMA, London Borough of Hillingdon is required to complete a further review and assessment of air quality – a Stage 4 review and assessment – as specified under Section 84 of the Environment Act (1995).

1.2 BRIEF EXPLANATION OF A STAGE 4 AIR QUALITY REVIEW AND ASSESSMENT

The 1995 Environment Act places duties on local authorities with regard to local air quality review and, where potential problems are identified, the management of local air quality. The air quality review is designed as a multi-stage process, with progressively more complex assessments at each stage.

If a local authority declares an air quality management area, Section 84(1) of the Environment Act 1995 requires that local authority to carry out a further assessment of existing and likely future air quality in the AQMA. This further assessment is called a Stage 4 air quality review and assessment, and is intended to supplement information gathered during the earlier Stages 1-3.

For each pollutant where there is a predicted exceedance of air quality objectives, the Stage 4 should:

- Review new relevant data to decide whether the original AQMA should be varied;
- Quantify how great a reduction in emissions of pollutants is needed to comply with objectives;
- Quantify the extent to which different pollutant sources contribute to predicted exceedances (source apportionment).

1.3 OVERVIEW OF APPROACH TAKEN

The general approach taken to this Stage 4 assessment was to:

- Consider new relevant information that has a bearing on the assessment of air quality within the borough. These include national and local air quality management policies and improved scientific understanding of key factors in ambient air quality assessment;
- Consider recent NO_2 and PM_{10} measurements made within the borough in relation to current objectives;
- Consider recent model predictions of future air quality in the borough and their relation to NO_2 and PM_{10} objectives;
- Conclude on any changes needed to the existing Air Quality Management Area;
- Identify the improvement needed in concentrations of NO_2 at selected receptors in the Air Quality Management Area, including the receptors where the greatest improvements are needed;
- Identify the contributions of different sources (local traffic, aircraft and other relevant activities) to exceedances of the air quality objectives;
- Indicate the scale of emission reductions needed to achieve the objectives by reference to the results of abatement scenario calculations.

1.4 POLLUTANTS CONSIDERED IN THIS REPORT

Based on the conclusion of their Stage 3 report, the London Borough of Hillingdon has declared an AQMA for NO_2.

However,PM_{10} is still of some concern in the borough although the levels were not expected to exceed the objectives. Since the Stage 4 modelling work takes account of updated emissions data it is appropriate to discuss the implications of this on the predicted PM_{10} levels.

1.5 RELEVANT GUIDANCE USED

This report has used the latest technical guidance in LAQM.TG(03) (DEFRA 2003), as well as specific guidance for further assessments of air quality (DEFRA 2001a).

1.6 CONCENTRATION UNITS ADOPTED

This report presents concentrations in units of mass ($\mu g/m^3$) that are consistent with those used in the current UK Air Quality Strategy and Regulations.

1.7 COPYRIGHT OF MAPS

1.8 STRUCTURE OF THE REPORT

The report is structured as follows:

- **Section 1** (this section) gives an overview of the work;
- **Section 2** gives the background to this study; summarises the UK Air Quality Strategy and the function of a Stage 4 air quality review and assessment;
- **Section 3** discusses the relationship between the Stage 4 review and assessment and the air quality action plan;
- **Section 4** lists the information referred to in preparing the Stage 4 review and assessment report;
- **Section 5** contains the Stage 4 assessment for $NO_{2;}$
- **Section 6** contains the Stage 4 assessment for $PM_{10;}$
- **Section 7** contains further characterisation of the pollutant sources;
- **Section 8** summarises the implications of the Stage 4 assessment;
- **Section 9** proposes the next steps the borough should take;
- **Section 10** lists sources of information referred to in the report;
- **Section 11** reproduces the Stage 4 appraisal checklist used by DEFRA;
- **Appendices** provide supporting information to the Stage 4 assessment.

2 The Air Quality Strategy

2.1 THE UK STRATEGY

The Government published its proposals for review of the National Air Quality Strategy in early 1999 (DETR, 1999). These proposals included revised objectives for many of the regulated pollutants. A key factor in the proposals to revise the objectives was the agreement in June 1998 at the European Union Environment Council of a Common Position on Air Quality Daughter Directives (AQDD).

Following consultation on the Review of the National Air Quality Strategy, the Government published the Air Quality Strategy for England, Scotland, Wales and Northern Ireland in January 2000 (DETR, 2000a).

This study essentially forms part of the requirements of Section 84 of the Part IV Air Quality of the Environment Act 1995 (Table 2.1).

Table 2.1 Major elements of the Environment Act 1995

Part IV Air Quality	Commentary
Section 80	Obliges the Secretary of State (SoS) to publish a National Air Quality Strategy as soon as possible.
Section 81	Obliges the Environment Agency to take account of the strategy.
Section 82	Requires local authorities, any unitary or district, to review air quality and to assess whether the air quality standards and objectives are being achieved. Areas where standards fall short must be identified.
Section 83	Requires a local authority, for any area where air quality standards are not being met, to issue an order designating it an air quality management area (AQMA).
Section 84	Imposes duties on a local authority with respect to AQMAs. ***The local authority must carry out further assessments*** and draw up an action plan specifying the measures to be carried out and the timescale to bring air quality in the area back within limits.
Section 85	Gives reserve powers to cause assessments to be made in any area and to give instructions to a local authority to take specified actions. Authorities have a duty to comply with these instructions.
Section 86	Provides for the role of County Councils to make recommendations to a district on the carrying out of an air quality assessment and the preparation of an action plan.
Section 87	Provides the SoS with wide ranging powers to make regulations concerning air quality. These include standards and objectives, the conferring of powers and duties, the prohibition and restriction of certain activities or vehicles, the obtaining of information, the levying of fines and penalties, the hearing of appeals and other criteria. The regulations must be approved by affirmative resolution of both Houses of Parliament.
Section 88	Provides powers to make guidance which local authorities must have regard to.

2.2 OVERVIEW OF THE PRINCIPLES AND MAIN ELEMENTS OF THE UK AIR QUALITY STRATEGY

The main elements of the AQS can be summarised as follows:

- The use of a health effects based approach using national air quality standards and objectives;
- The use of policies by which the objectives can be achieved and which include the input of important actors such as industry, transportation bodies and local authorities;
- The predetermination of timescales (with target dates of 2003, 2004 and 2005) for the achievement of objectives and a commitment to review the Strategy every three years.

It is intended that the NAQS will provide a framework for the improvement of air quality that is both clear and workable. In order to achieve this, the Strategy is based on several principles that include:

- The provision of a statement of the Government's general aims regarding air quality;
- Clear and measurable targets;
- A balance between local and national action;
- A transparent and flexible framework.

Co-operation and participation by different economic and governmental sectors is also encouraged within the context of existing and potential future international policy commitments.

2.2.1 National Air Quality Standards

At the centre of the AQS is the use of national air quality standards to enable air quality to be measured and assessed. These also provide the means by which objectives and timescales for the achievement of objectives can be set. Most of the proposed standards have been based on the available information concerning the health effects resulting from different ambient concentrations of selected pollutants and are the consensus view of medical experts on the Expert Panel on Air Quality Standards (EPAQS). These standards and associated specific objectives to be achieved between 2003 and 2008 are shown in Table 2.2. The table shows the standards in ppb and $\mu g/m^3$ with the number of exceedances that are permitted (where applicable) and the equivalent percentile.

2.2.2 The difference between 'standards' and 'objectives' in the UK AQS

Air quality *standards* (in the UK AQS) are the concentrations of pollutants in the atmosphere that can broadly be taken to achieve a certain level of environmental quality. The standards are based on assessment of the effects of each pollutant on human health including the effects on sensitive subgroups. The standards have been set at levels to avoid significant risks to health.

The *objectives* of the UK air quality policy are framed on the basis of the recommended standards. The objectives are based on the standards, but take into account feasibility, practicality, and the costs and benefits of fully complying with the standards.

Specific objectives relate either to achieving the full standard or, where use has been made of a short averaging period, objectives are sometimes expressed in terms of percentile compliance. The use of percentiles means that a limited number of exceedances of the air quality standard over a particular timescale, usually a year, are permitted. This is to account for unusual meteorological conditions or particular events such as November 5th. For example, if an objective is to be complied with at the 99.9th percentile, then 99.9% of measurements at each location must be at or below the level specified.

Table 2.2 Air Quality Objectives in the Air Quality Regulations (2000) and (Amendment) Regulations 2002 for the purpose of LAQM

Pollutant	Limit Concentration ($\mu g/m^3$)	Averaging period	Objective [number of permitted exceedances a year and equivalent percentile] To be achieved by
Benzene All authorities	16.25	**running annual** mean	31.12.2003
Authorities in England and Wales only	5.00	**annual** mean	31.12.2010
Authorities in Scotland and Northern Ireland only[a]	3.25	**running annual** mean	31.12.2010
1,3-butadiene	2.25	**running annual** mean	31.12.2003
Carbon monoxide Authorities in England, Wales and Northern Ireland only[a]	10,000	**maximum daily running 8-hour** mean	31.12.2003
Authorities in Scotland only	10,000	**running 8-hour** mean	31.12.2003
Pb	0.5	**annual** mean	31.12.2004
	0.25	**annual** mean	31.12.2008
NO_2 (see note b)	200	**1 hour** mean	31.12.2005 [maximum of 18 exceedances a year or equivalent to the 99.8th percentile]
	40	**annual** mean	31.12.2005
Particles (PM_{10}) (gravimetric)[c] All authorities	50	**24-hour** mean	31.12.2004 [maximum of 35 exceedances a year or ~ equivalent to the 90th percentile]
	40	**annual** mean	31.12.2004
Authorities in Scotland only[d]	50	**24 hour** mean	31.12.2010 [maximum of 7 exceedances a year]
	18	**annual** mean	31.12.2010
SO_2	266	**15 minute** mean	31.12.2005 [maximum of 35 exceedances a year or equivalent to the 99.9th percentile]
	350	**1 hour** mean	31.12.2004 [maximum of 24 exceedances a year or equivalent to the 99.7th percentile]
	125	**24 hour** mean	31.12.2004 [maximum of 3 exceedances a year or equivalent to the 99th percentile]

Notes

a. In Northern Ireland none of the objectives are currently in regulation. Air Quality (Northern Ireland) Regulations are scheduled for consultation early in 2003.
b. The objectives for nitrogen dioxide are provisional.
c. Measured using the European gravimetric transfer sampler or equivalent.
d. These 2010 Air Quality Objectives for PM10 apply in Scotland only, as set out in the Air Quality (Scotland)Amendment Regulations 2002.

2.2.3 Relationship between the UK National Air Quality Standards and EU air quality Limit Values

As a member state of the EU, the UK must comply with European Union Directives.

There are three EU ambient air quality directives that the UK has transposed in to UK law. These are:

- **96/62/EC** Council Directive of 27 September 1996 on ambient air quality assessment and management (the Ambient Air Framework Directive);

- **1999/30/EC** Council Directive of 22 April 1999 relating to limit values for sulphur dioxide, NO_2, oxides of nitrogen, PM_{10} and lead in ambient air (the First Daughter Directive);

- **2000/69/EC** Directive of the European Parliament and the Council of 16 Nov 2000 relating to limit values for benzene and CO in ambient air (the Second Daughter Directive).

The first and second daughter directives contain air quality Limit Values for the pollutants that are listed in the framework directive. The United Kingdom (i.e. Great Britain and Northern Ireland) must comply with these Limit Values. The UK air quality strategy should allow the UK to comply with the EU Air Quality Daughter Directives, but the UK air quality strategy also includes some stricter national objectives for some pollutants, for example, sulphur dioxide.

The Government is ultimately responsible for achieving the EU limit values. However, it is important that Local Air Quality Management is used as a tool to ensure that the necessary action is taken at local level to work towards achieving the EU limit values by the dates specified in those EU Directives.

2.2.4 Recent proposed changes to the UK National Air Quality Standards

Proposals to make changes to the UK AQS were published in 2001 (DEFRA 2001b). The proposed changes are:

For **PM_{10}** new provisional objectives of

- for **all parts of the UK**, except London and Scotland, a **24-hour mean of 50 $\mu g/m^3$ not to be exceeded more than 7 times per year** and an **annual mean of 20 $\mu g/m^3$**, both to be achieved by the end of 2010;
- for **London, a 24-hour mean of 50 $\mu g/m^3$ not to be exceeded more than 10 times per year** and an **annual mean of 23 $\mu g/m^3$, both to be achieved by the end of 2010**. Also an **annual mean objective of 20 $\mu g/m^3$ to be achieved by the end of 2015**.

2.2.5 Policies in place to allow the objectives for the pollutants in AQS to be achieved

The policy framework to allow these objectives to be achieved is one that that takes a local air quality management approach. This is superimposed upon existing national and international regulations in order to effectively tackle local air quality issues as well as issues relating to wider spatial scales. National and EC policies that already exist provide a good basis for progress towards the air quality objectives set for 2003 to 2008. For example, the Environmental Protection Act 1990 allows for the monitoring and control of emissions from industrial processes and various EC Directives have ensured that road transport emission and fuel standards are in place. These policies are being developed to include more stringent controls. Recent developments in the UK include the announcement by the Environment Agency in January 2000 on controls on emissions of SO_2 from coal and oil fired power stations. This system of controls means that by the end of 2005 coal and oil fired power stations will meet the air quality standards set out in the AQS.

Local air quality management provides a strategic role for local authorities in response to particular air quality problems experienced at a local level. This builds upon current air quality control responsibilities and places an emphasis on bringing together issues relating to transport, waste, energy and planning in an integrated way. This integrated approach involves a number of different aspects. It includes the development of an appropriate local framework that allows air quality issues to be considered alongside other issues relating to polluting activity. It should also enable co-operation with and participation by the general public in addition to other transport, industrial and governmental authorities.

An important part of the Strategy is the requirement for local authorities to carry out air quality reviews and assessments of their area against which current and future compliance with air quality standards can be measured. Over the longer term, these will also enable the effects of policies to be studied and therefore help in the development of future policy. The Government has prepared guidance to help local authorities to use the most appropriate tools and methods for conducting a review and assessment of air quality in their District. This is part of a package of guidance being prepared to assist with the practicalities of implementing the AQS. Other guidance covers air quality and land use planning, air quality and traffic management and the development of local air quality action plans and strategies.

2.2.6 Timescales to achieve the objectives for the pollutants in AQS

In most local authorities in the UK, objectives will be met for most of the pollutants within the timescale of the objectives shown in Table 2.2. It is important to note that the objectives for NO_2 remain provisional. The Government has recognised the problems associated with achieving the standard for ozone and this will not therefore be a statutory requirement. Ozone is a secondary pollutant and transboundary in nature and it is recognised that local authorities themselves can exert little influence on concentrations when they are the result of regional primary emission patterns.

2.3 OVERVIEW OF THE PRINCIPLES AND ELEMENTS OF THE AIR QUALITY STRATEGY FOR LONDON

The London Air Quality Strategy was published in 2002 (GLA 2002) in response to recognition that the air quality is predicted to exceed the air quality objectives for PM_{10} and NO_2 over large areas of the Greater London area. Also, actions aimed at achieving the objectives will necessarily be required and coordinated over the whole of Greater London and not just in those areas at risk of exceeding the objectives.

London Boroughs such as Hillingdon have a statutory requirement to have regard to the objectives of the London AQS. They are that the Mayor shall work towards the achievement of the national air quality objectives by working in partnership with the London Boroughs and the Government.
The proposals and policies that will be undertaken by the Mayor to minimise the adverse effects of air pollution on human health can be broadly grouped as targeting the following sources:

- Road transport;
- Other modes of transport;
- Industrial sources;
- Construction and fires;
- Energy and heating.

The strategy contains 87 proposals, for understanding and improving air quality, targeted at key agencies, such as the London boroughs, public transport providers, businesses and individuals. The proposals generally match the policies of the national strategy but with an emphasis on dealing with the London-specific context and encouraging a consistent approach between the efforts of the relevant agencies.

2.4 AIR QUALITY REVIEWS – THE APPROACHES AND EXPECTED OUTCOMES

Revised technical guidance was issued in February 2003 to enable air quality to be monitored, modelled, reviewed and assessed in an appropriate and consistent fashion (LAQM.TG (03)). This replaced previous guidance note LAQM. TG4(00) (DETR 2000b).

This review and assessment report has been completed with due reference to this latest technical guidance.

The primary objective of undertaking a review of air quality is to identify any areas that are unlikely to meet national air quality objectives and ensure that air quality management is considered in local authority decision-making processes. The complexity and detail required in a review depends on the risk of failing to achieve air quality objectives and it has been proposed therefore that reviews should be carried out in three stages. All three stages of review and assessment may be necessary and every authority is expected to undertake at least a first stage review and assessment of air quality in their authority area. The Stages are briefly described in the following table, Table 2.3.

Table 2.3 Brief details of Stages in the Air Quality Review and Assessment process

Stage	Objective	Approach	Outcome
First Stage Review and Assessment	• Identify all significant pollutant sources within or outside of the authority's area.	• Compile and collate a list of potentially significant pollution sources using the assessment criteria described in the Pollutant Specific Guidance	
	• Identify those pollutants where there is a **risk** of exceeding the air quality objectives, and for which further investigation is needed.	• Identify sources requiring further investigation.	• Decision about whether a Stage 2 Review and Assessment is needed for one or more pollutants. If not, no further review and assessment is necessary.
Second Stage Review and Assessment	• Further screening of significant sources to determine whether there is a significant risk of the air quality objectives being exceeded.	• Use of screening models or monitoring methods to assess whether there is a risk of exceeding the air quality objectives.	
	• Identify those pollutants where there is a **risk** of exceeding the objectives, and for which further investigation is needed.	• The assessment need only consider those locations where the highest likely concentrations are expected, and where public exposure is relevant.	• Decision about whether a Stage 3 Review and Assessment is needed for one or more pollutants. If, as a result of estimations of ground level concentrations at suitable receptors, a local authority judges that there is no significant risk of not achieving an air quality objective, it can be confident that an Air Quality Management Area (AQMA) will not be required. • However, if there is doubt that an air quality objective will be achieved a third stage review should be conducted.

Table 2.3 (contd.) Brief details of Stages in the Review and Assessment process

Stage	Objective	Approach	Outcome
Third Stage Review and Assessment	• Accurate and detailed assessment of both current and future air quality. Assess the **likelihood** of the air quality objectives being exceeded.	• Use of validated modelling and quality-assured monitoring methods to determine current and future pollutant concentrations.	
	• Identify the geographical boundary of any exceedances, and description of those areas, if any, proposed to be designated as an AQMA.	• The assessment will need to consider all locations where public exposure is relevant. For each pollutant of concern, it may be necessary to construct a detailed emissions inventory and model the extent, location and frequency of potential air quality exceedances.	• Determine the location of any necessary Air Quality Management Areas (AQMAs). Once an AQMA has been identified, there are further sets of requirements to be considered. • A further assessment of air quality in the AQMA is required within 12 months, which will enable the degree to which air quality objectives will not be met, and the sources of pollution that contribute to this to be determined. A local authority must also prepare a written action plan for achievement of the air quality objective. Both air quality reviews and action plans are to be made publicly available.

Table 2.3 (contd.) Brief details of Stages in the Review and Assessment process

Stage	Objective	Approach	Outcome
Fourth Stage Review and Assessment **(to support the action plan)**	• Further accurate and detailed assessment of both current and future air quality. Should concentrate on areas where the Stage 3 assessment indicated exceedances of the objectives are likely.	• Use of validated modelling and quality-assured monitoring methods to determine current and future pollutant concentrations.	• Confirm outcome of original AQMA designation and alter if necessary (for example, as a result of changes in the emission factors used in the modelling)
	• Source apportionment in regions where there are exceedances. Understand contributions from traffic, industrial, domestic and background sources.	• Analyse modelling results.	• Understand the contributions from the various sources, and therefore select the source where action can be taken to reduce emissions
	• Assess a range of scenarios to improve air quality and reduce or eliminate the risk of air quality objectives being exceeded.	• Liase with stakeholders such as the Highways Agency, the Environment Agency and the local industry to help define scenarios	• Identify the most likely scenarios to improve air quality and use these in the modelling. Incorporate scenarios into any action plan produced.
	• Identify the geographical boundaries of any exceedances in the scenarios.	• Analyse modelling results.	• Incorporate modelling results of the scenarios into any action plan produced. Consider how to implement any action plan to improve air quality.

2.5 RELEVANT LOCATIONS FOR REVIEW AND ASSESSMENT

For the purpose of review and assessment, the authority should focus their work on locations where members of the public are likely to be exposed over the averaging period of the objective. Table 2.4 summarises the locations where the objectives should and should not apply.

Table 2.4 Typical locations where the objectives apply

Averaging Period	**Pollutants**	**Objectives *should* apply at ...**	**Objectives should *not* generally apply at ...**
Annual mean	• 1,3 Butadiene • Benzene • Lead • Nitrogen dioxide • Particulate Matter (PM_{10})	• All background locations where members of the public might be regularly exposed.	• Building facades of offices or other places of work where members of the public do not have regular access.
		• Building facades of residential properties, schools, hospitals, libraries etc.	• Gardens of residential properties.
			• Kerbside sites (as opposed to locations at the building facade), or any other location where public exposure is expected to be short term
24 hour mean and 8-hour mean	• Carbon monoxide • Particulate Matter (PM_{10}) • Sulphur dioxide	• All locations where the annual mean objective would apply.	• Kerbside sites (as opposed to locations at the building facade), or any other location where public exposure is expected to be short term.
		• Gardens of residential properties.	

Table 2.4 (contd.) Typical locations where the objectives apply

Averaging Period	Pollutants	Objectives should apply at …	Objectives should generally not apply at …
1 hour mean	• Nitrogen dioxide • Sulphur dioxide	• All locations where the annual mean and 24 and 8-hour mean objectives apply.	• Kerbside sites where the public would not be expected to have regular access.
		• Kerbside sites (e.g. pavements of busy shopping streets).	
		• Those parts of car parks and railway stations etc. that are not fully enclosed.	
		• Any outdoor locations to which the public might reasonably expected to have access.	
15 minute mean	• Sulphur dioxide	• All locations where members of the public might reasonably be exposed for a period of 15 minutes or longer.	

It is unnecessary to consider exceedances of the objectives at any location where public exposure over the relevant averaging period would be unrealistic, and the locations should represent non-occupational exposure.

3 Stage 4 Air Quality Review and Assessment and Action Planning

This section contains information about Stage 4 Air Quality Review and Assessments and action plans. It explains the relationships between the Stage 4 and action plans, what each document should contain, and the timescales for producing the documents.

3.1 THE RELATIONSHIP BETWEEN A STAGE 4 AIR QUALITY REVIEW AND ASSESSMENT AND AN ACTION PLAN

If a local authority declares an air quality management area, Section 84(1) of the Environment Act 1995 requires that local authority to carry out a further assessment of existing and likely future air quality in the AQMA. This further assessment is called a Stage 4 air quality review and assessment, and is intended to supplement information the authority already has. It is a duty of the LA to complete this Stage 4 air quality review and assessment.

For each pollutant where there is an exceedance of the air quality, the Stage 4 should calculate:

- How great a reduction in emissions of pollutants is needed;
- The extent to which different pollutant sources contribute to the exceedance (source apportionment of traffic, industrial, domestic and background – if appropriate).

This should give a clear picture of the sources that authorities can control or influence. This information comprises the baseline from which an action plan can be developed in which various proposals are adopted that are aimed at bringing about the achievement of the air quality objectives.

3.2 RECENT DEFRA GUIDANCE ON STAGE 4 AIR QUALITY REVIEW AND ASSESSMENT

Along with LAQM.TG(03) DEFRA issued guidance on what is expected to be required of a Stage 4 assessment (DEFRA 2001a). Essentially, the Stage 4 provides the technical justification for the measures an authority includes in its action plan. DEFRA expects that the Stage 4 will allow Local Authorities:

- To calculate more accurately how much of an improvement in air quality is needed to deliver the air quality objectives within the AQMA;
- To refine their knowledge of the sources of pollution so that AQAPs can be properly targeted;
- To take account of national policy developments that may come to light after the AQMA declaration (the revision of the vehicle emission factors is an example of this kind of policy development);
- To take account of local policy developments, for example, new transport schemes in the vicinity of the AQMA or of any new major housing or commercial developments;
- To carry out more intensive monitoring in the problem areas to confirm earlier findings;

- To corroborate other assumptions on which the designation of the AQMA was based and to check that the original designation is still valid, and does not need amending;
- To respond to comments made by statutory consultees (if there were any relevant comments made).

3.3 ACTION PLANS

Local authorities are required to prepare a written action plan for each AQMA setting out the actions they intend to take in pursuit of the air quality objectives. This has to include a timetable for implementing the plan.

Action plans should strike a balance between actions that local authorities instigate and actions that the other parties must manage. An action plan should identify the desired actions in industrial, transport and other sectors in a cost effective and proportionate manner.

The action plan should also contain simple estimates of the costs and feasibilities of implementing those scenarios. The action plan may also consider the non-health benefits of implementing scenarios in the action plan, for example, reductions in road traffic accident deaths as a result of road improvements that also reduce vehicle emissions.

The LA can then identify which scenario(s) offer the most cost-effective or cost-beneficial way of improving air quality.

3.4 STAGE 4 AND ACTION PLAN TIMESCALES

The Environment Act does not set any deadline for completing action plans, but the Government expects authorities to begin preparing them as soon as they have designated an AQMA, and in parallel with their further assessment of air quality required under section 84(1) of the Environment Act. Authorities should not wait until they have completed their further assessment of air quality before beginning their action plans. They should aim to consult on their draft AQAPs within 9-12 months of designation, and should have AQAPs in place within 12-18 months of designation.

Local authorities are required under section 84(2)(a) of the Environment Act to report on the further assessment of air quality (i.e. the Stage 4 Air Quality Review and Assessment) within 12 months of designating the Air Quality Management Area.

4 Information used to support this assessment

4.1 AMBIENT MONITORING

4.1.1 Nitrogen dioxide

Nitrogen dioxide concentrations are monitored at:

- A suburban class continuous monitor in West Drayton (Site name – AURN site) which is part of DEFRA's Automatic Urban and Rural Monitoring Network (AURN);

- A roadside continuous monitor at West End Road, South Ruislip (site name – south Ruislip);

- A third roadside continuous monitor at the junction of Colham Road and Pield Heath Road(site name - Hillingdon Hospital). This site has only been in operation since November 2002 so that there are insufficient results to influence the stage 4 assessment. Results from this site are not discussed in this report;

- A continuous monitor owned by BAA plc within Heathrow airport (site name – LHR2);

- 5 continuous monitors owned by BAA plc in place around the proposed terminal 5 (T5) construction site at Heathrow airport. These will allow the continuous monitoring of the T5 project during its construction phase and through to its final operation. Data from these sites are scrutinised by the borough's designated officers and it is hoped that, in the future, data from these stations will be able to be used to verify future review and assessments;

- 9 locations within the London Borough of Hillingdon using diffusion tube samplers, which provide monthly average pollutant concentrations. A further 12 sites are now included in the diffusion tube survey but there are very few data for these sites at present so that they are not included in this report.

Figure 4.1 illustrates the locations of the continuous monitors and Figure 4.2 shows the diffusion tube locations.

4.1.2 Other pollutants

All of the continuous monitoring sites listed above also record hourly mean PM_{10} concentrations. The London Hillingdon AURN site and the LHR2 site also both monitor CO concentrations. London Hillingdon AURN site also continuously monitors ambient ozone and SO_2 concentrations.

Due to the introduction of more stringent air quality objectives for benzene for 2010, Hillingdon also now monitors for this pollutant at five sites within the Borough. The location of these monitors is also illustrated in Figure 4.2.

Figure 4.1 Locations of Continuous Monitoring Sites in the London Borough of Hillingdon

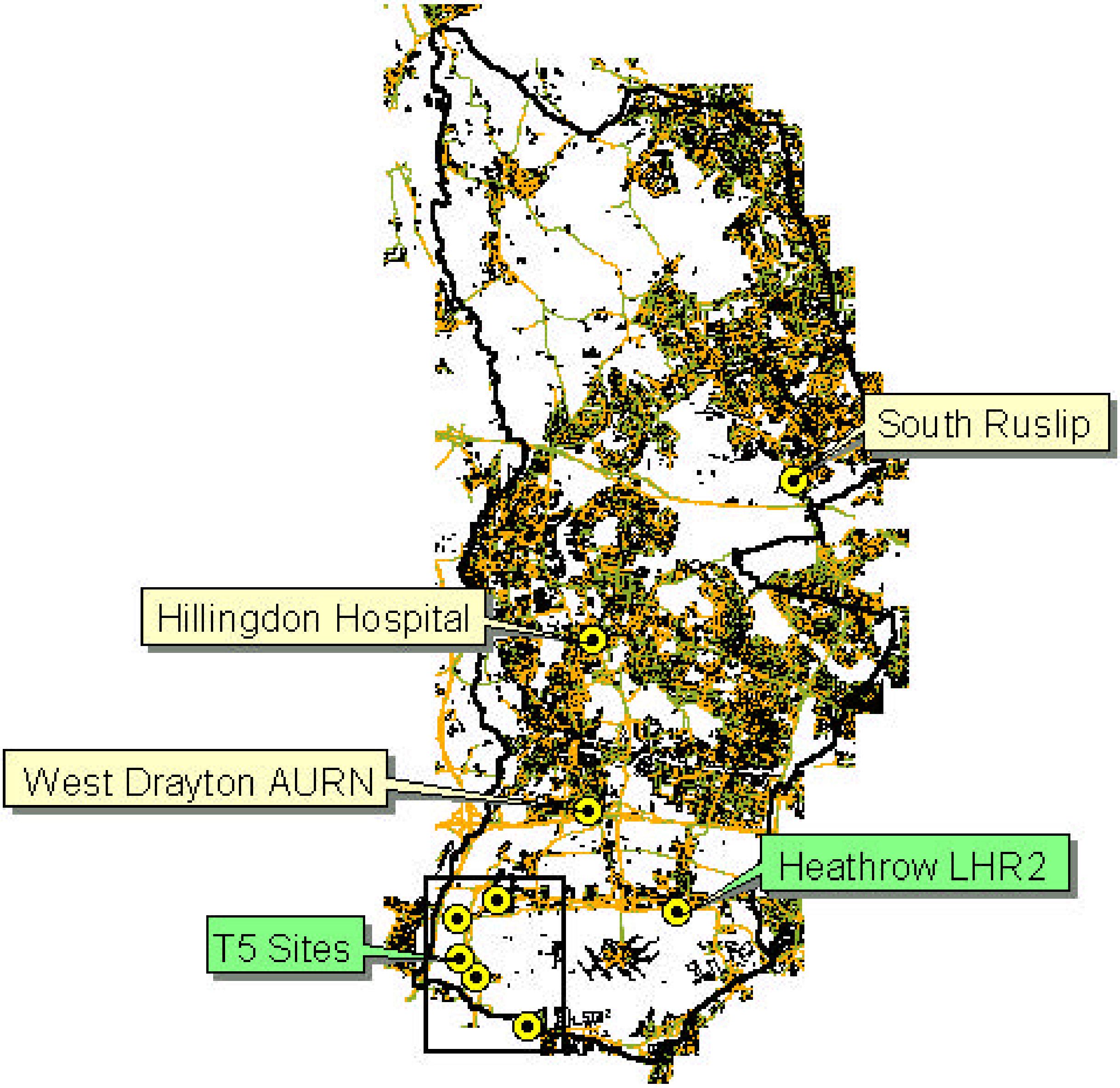
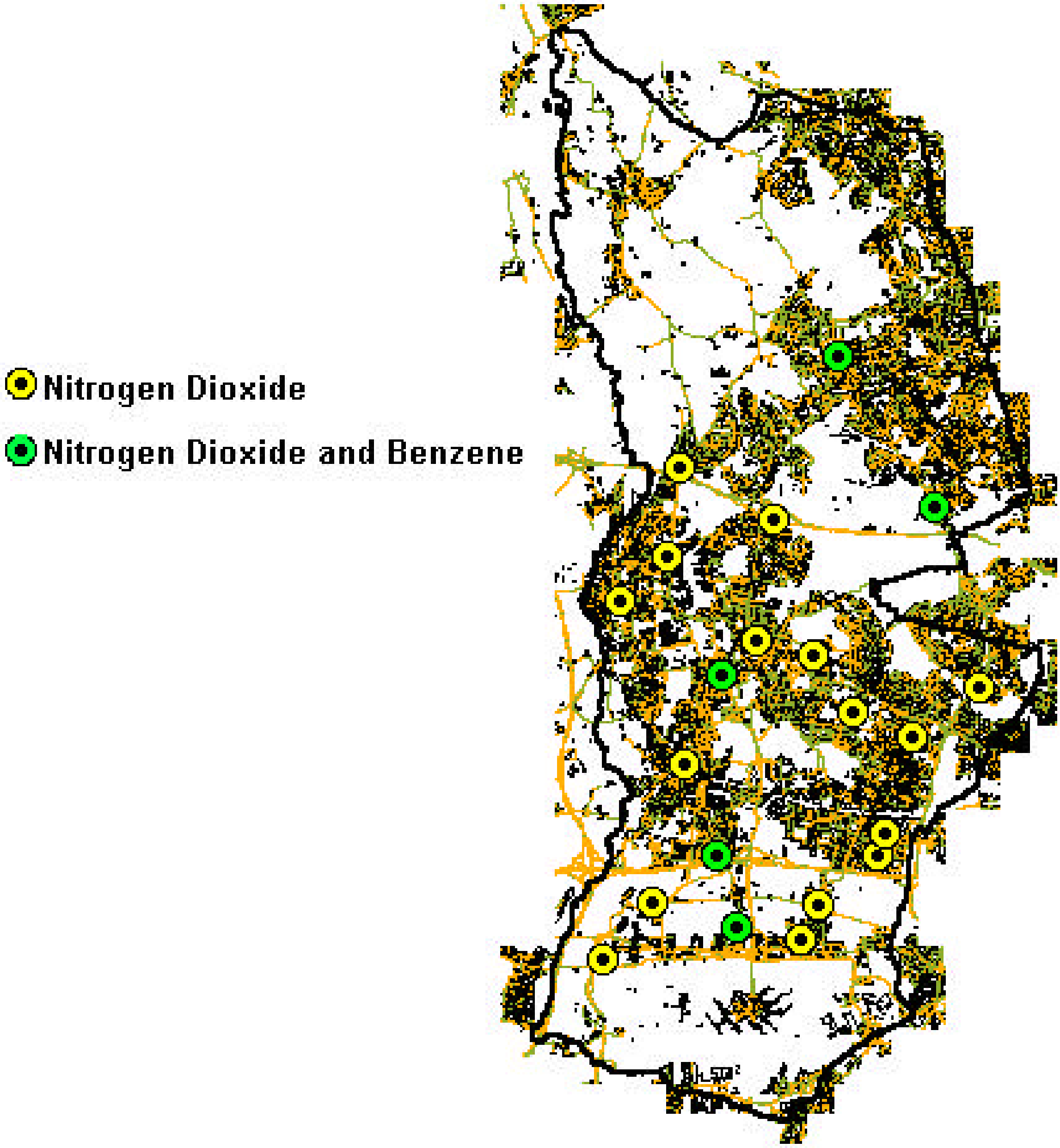


Figure 4.2 Locations of Diffusion Tube Monitoring Sites in the London Borough of Hillingdon



4.2 REVISED VEHICLE EMISSION FACTORS

UK vehicle emission factors were recently revised by DEFRA[3] in response to tests on road vehicles that showed emissions of NO_X from new diesel and petrol cars to be higher than originally estimated.

DEFRA has considered the effect that the new factors may have on predictions of pollutant concentrations made using the old factors. They suggest that forecast emissions of most pollutants (including CO, and volatile organic compounds (VOCs)) will have been largely unaffected by the new factors. However, there have been significant changes to forecast NO_x emissions the sizes of which vary according to the baseline year chosen for calculations. As a rule of thumb, DEFRA suggest the following generalisations are helpful.

Forecast emissions of NO_x in 2005 from newer petrol and diesel vehicles may increase by anything up to 36% using the new factors, with the main change being to the performance of Euro 2 vehicles. But emissions from road transport in the base year will also need to be adjusted upwards, and the modelling of these and other emissions will then need to be re-calibrated. This means that NO_x forecasts from road transport for 2005 are likely to be out by between 10 and 20%. It also means that NO_x emissions from other sources (such as industry) may have been overestimated.

The emission factors will now not be altered again until the next round of local air quality review and assessment has passed, in other words, until after 31stDecember 2003. Modelled predictions of NO_2 annual mean concentrations in 2005 in the Stage 3 Report used older, now superseded, road transport emission factors. However Stage 4 modelling for the borough has used the new road transport emission factors.

4.3 THE LONDON ATMOSPHERIC EMISSION INVENTORY

1999 emission data in the London Atmospheric Emissions Inventory (LAEI) became available in February 2002 and are currently the most complete and detailed for emissions from road transport, air traffic and other sources in Hillingdon. The inventory was produced by the Greater London Authority (GLA) and Transport for London (TfL) and updated an earlier LRC database in various categories such as traffic flows, industrial sources and vehicle emissions technology

This database was used for the Stage 4 review and assessment modelling work.

4.4 RESULTS OF FURTHER MODELLING STUDIES

Results of modelling studies, that took account of the available emissions data described, were verified against the Hillingdon monitoring data. The evidence of the final maps of predicted ambient concentrations then helped draw the conclusions of the stage 4 review and assessment.

[3] The new set of emission factors on the NAEI website (www.naei.org.uk/emissions/index.php) approved by DEFRA and DTLR for use in emissions and air quality modelling, following consultation of the TRL Report "Exhaust Emission Factors 2001: Database and Emission Factors" by TJ Barlow, AJ Hickman and P Boulter, TRL, September 2001

5 Stage 4 Review and Assessment for nitrogen dioxide

This section summarises

- Results of the Stage 3 review and assessment and the areas of exceedance of the air quality objectives for NO_2 that were identified in that assessment;
- Results of the additional monitoring that has been done since the Stage 3 Report was completed;
- Results of the further NO_2 modelling study completed by CERC;
- Results of a source apportionment study done by CERC.

5.1 LATEST STANDARDS AND OBJECTIVES FOR NITROGEN DIOXIDE

In June 1998, the Common Position on Air Quality Daughter Directives (AQDD) agreed at Environment Council included the following objectives to be achieved by 31 December 2005 for NO_2:

- An annual average concentration of 40 $\mu g/m^3$ (21 ppb);
- 200 $\mu g/m^3$ (100 ppb) as an hourly average with a maximum of 18 exceedances in a year.

The National Air Quality Strategy was reviewed in 1999 (DETR, 1999). The Government proposed that the annual objective of 40 $\mu g/m^3$ be retained as a provisional objective and that the original hourly average be replaced with the AQDD objective. The revised Air Quality Strategy for England, Scotland, Wales and Northern Ireland (DETR, 2000) and the Air Quality Regulations (2000) include the proposed changes.

The new hourly objective is more stringent than the original hourly objective. Modelling studies suggest that in general achieving the annual mean of 40 $\mu g/m^3$ is more demanding than achieving either the former or current hourly objective. If the annual mean is achieved, evidence suggests the hourly objectives will also be achieved.

5.2 KEY FINDINGS OF THE STAGE 3 REVIEW AND ASSESSMENT

On the basis of the conclusions from the Stage 1 and 2 report and consultation process, the Stage 3 review and assessment reported on further detailed work aimed at assessing NO_2, sulphur dioxide and PM_{10} CO concentrations.

Work was scoped and progressed via collaboration with London Borough of Hounslow and Spelthorne District Council using Cambridge Environmental Research Consultants (CERC) as contractor.

Several modelling studies were carried out taking account of changes to the input data and to the objectives. The final stage 3 technical report from CERC was published in September 2000, concluding that although concentrations of NO_2 would fall significantly between 1998 and 2004/2005:

- Annual average NO_2 objective for 2005 would not be met across the southern third of the borough and near major roads in the central area of the borough such as along the A40, the highest exceedances being around Heathrow Airport. There is relevant public exposure at these locations;

- Hourly objective for NO_2 in 2005 would be exceeded near parts of the M4 and M25. There is no relevant public exposure at these locations.

In addition, the relevant monitoring results for Hillingdon were found to be in general agreement with these conclusions.

5.3 AREA DECLARED BY HILLINGDON AS THE AIR QUALITY MANAGEMENT AREA

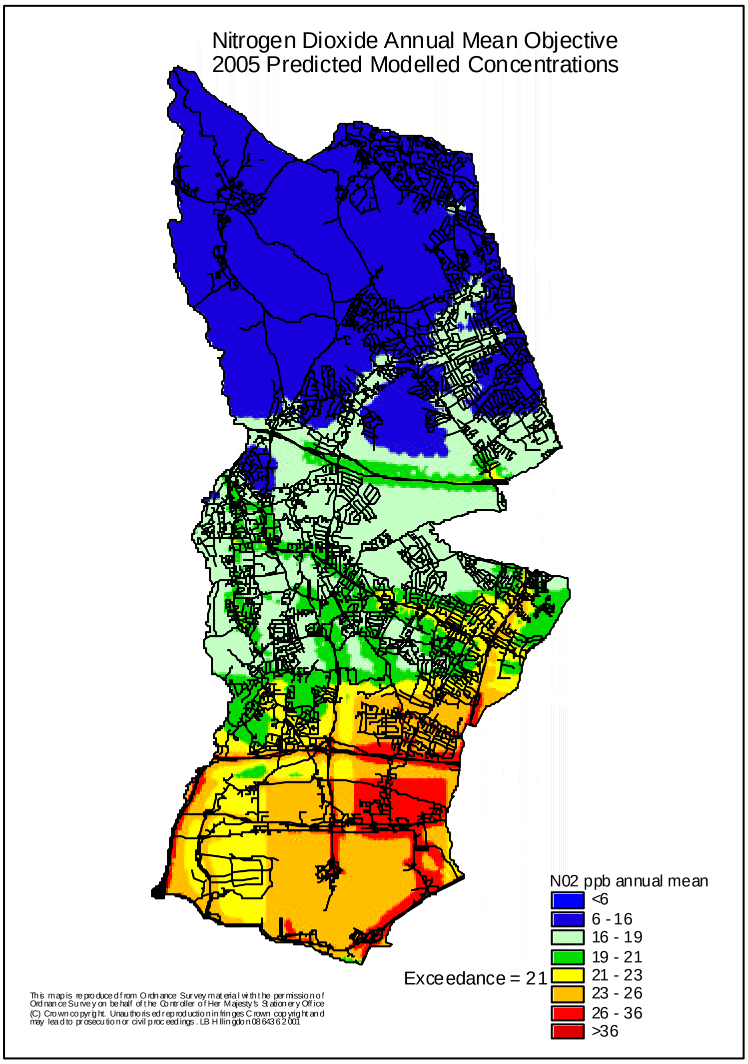
The Stage 3 report was published for consultation, and in May 2001, taking on board comments made during the consultation period, an Air Quality Management Area (AQMA) was declared, for the pollutant NO_2. The AQMA Order was made on the 1st May 2001 (the Order is attached as Appendix 1)

It was agreed, during consultation, that although PM_{10} was not the basis of the AQMA designation, this would continue to be closely monitored at each review and assessment stage.

Figure 5.1 illustrates the mapped result of the Stage 3 NO_2 assessment and indicates the area that has been declared by Hillingdon as an AQMA. In the Figure, areas coloured yellow, orange or red are those in which the predictions indicate the objective will be exceeded. Since these areas are widespread across the borough and since the management of air quality requires a wider region than these areas to be considered, the declared AQMA is relatively large.

The AQMA runs from the A40 corridor to the southern borough boundary. The boundary includes the A40 Road corridor from the western boundary along to and incorporating Northolt Aerodrome up to the Chiltern mainline railway then following the railway line to the eastern boundary of the borough.

Figure 5.1 Estimated Annual Mean Concentrations of NO_2 in the London Borough of Hillingdon in 2005 indicating the AQMA.



5.4 MONITORING RESULTS

Results are available for three continuous air quality monitors and 9 diffusion tube locations in the London Borough of Hillingdon. These include three co-located diffusion tubes at both the AURN and South Ruislip continuous monitor sites.

5.4.1 Treatment of data

QA/QC of monitoring data

The data from the three continuous monitors are ratified to the QA/QC standards used in the DEFRA network. The diffusion tubes are analysed by Gradko International Limited who participate in the National Diffusion Tube Survey. Details of diffusion tube QA/QC calculations are presented in Appendix 2, Tables A2.1-2.7.

Method of adjustment of bias in the reported diffusion tube concentrations

Diffusion tube results have been corrected for bias. In this Stage 4 Review and Assessment, average bias has been calculated for 2000-2002 at each co-location site.

The continuous monitor at West Drayton is a suburban site, at South Ruislip, a roadside site. The remaining diffusion tube sites in the borough have then been assigned a relevant bias based on their location (roadside, urban background, etc).

Factors used to predict future concentrations from current concentrations

The DEFRA guidance, LAQM.TG4(00) and LAQM.TG(03), provides factors for projecting future concentrations, based on the concentrations measured in recent years. Table A2.1 presents the factors have been used in this assessment for NO_2, depending on the location of the monitor site.

5.4.2 Continuous monitoring results

Annual average concentrations recorded by the three continuous monitors in the borough in 2002 and summary statistics are shown in Table 5.1. A summary of exceedance of the hourly mean objective based on concentrations recorded at these sites is shown in Table 5.2.

Table 5.1 Annual average NO_2 concentrations (mg/m^3) recorded by continuous monitors in the borough and predicted concentration in 2005.

Location Year	AURN (suburban site)			South Ruislip (roadside site)			Heathrow (background site)		
	Conc. ($\mu g/m^3$)	Data capture %	Conc. 2005	Conc. ($\mu g/m^3$)	Data capture %	Conc. 2005	Conc. ($\mu g/m^3$)	Data capture %	Conc. 2005
1997	59.2	97	45.6	-	-	-	60.5	95	46.7
1998	51.6	75	41.0	-	-	-	54.2	96	43.2
1999	50.2	45	42.3	46.8	27	38.8	55.4	98	47.3
2000	47.8	98	42.3	43.9	98	37.9	56.5	97	50.1
2001	46.4	96	42.2	45.1	97	40.2	54.1	97	49.1
2002	45.3	97	42.3	43.9	97	37.9	52.0	95	48.5
mean			**42.5**			**38.7**			**47.5**

Notes: 2002 figures are provisional and may be subject to change.

Table 5.2 Summary of hourly mean NO_2 concentrations ($\mu g/m^3$) recorded by continuous monitors in the borough

Location Year	AURN (suburban site)			South Ruislip (roadside site)			Heathrow (background site)		
	Max. conc. ($\mu g/m^3$)	Data capture %	No. of exceedances[1]	Max. conc. ($\mu g/m^3$)	Data capture %	No. of exceedances[1]	Max. conc. ($\mu g/m^3$)	Data capture %	No. of exceedances[1]
1997	329	97	18	-	-	-	268	95	27
1998	201	75	1	-	-	-	180	96	0
1999	161	45	0	151	27	0	388	98	12
2000	187	98	0	175	98	0	174	97	0
2001	159	96	0	172	97	0	153	97	0
2002[2]	140	97	0	127	97	0	138	95	0

Notes:
1. of the 200$\mu g/m^3$ objective (up to 18 exceedances are permitted)
2. 2002 figures are provisional and may be subject to change.

5.4.3 Diffusion tube results

Nitrogen dioxide concentrations have been monitored by diffusion tube at 9 locations (Table 5.3).

Table 5.3 Locations of diffusion tubes exposed in the Borough of Hillingdon

Site name	Grid Ref	Type
Uxbridge Technical College	510417 180752	Roadside
Barra Hall, Hayes	509358 181215	Background
Allotment site	507927 184678	Background
Uxbridge Day Nursery	505996 184058	Roadside
Co-located with AURN Site	506926 178614	Suburban
Co-located with South Ruislip Site	510821 184923	Roadside
Hillingdon Primary School	507617 182506	Roadside
Citizens Advice Bureau	509094 187645	Roadside
83 Hayes End Drive	508651 182274	Background

Bias adjustments

Diffusion tubes have been co-located in triplicate at the AURN site and the South Ruislip automatic site since 2000. Using these data the co-location bias of the diffusion tube results can be calculated. The co-located bias calculations are presented in Appendix 2, tables A2.2-2.4.

The diffusion tube results all display a bias showing that the diffusion tubes are under reading relative to the automatic sites. Results for all diffusion tubes have been adjusted for bias for each year. Results from background and suburban sites have been adjusted using the co-location bias factor from the AURN site. Results from roadside and intermediate sites have been adjusted using the factor from the South Ruislip site.

Results

Appendix 2, tables A2.5-2.7 present the details of the diffusion tube adjustments. Table 5.4 presents the summarised adjusted diffusion tube results and the predicted NO_2 concentration in 2005 at each site.

Table 5.4 Annual average NO_2 diffusion tube measurements ($\mu g/m^3$) corrected for co-located bias and predictions for 2005.

Location	Site Type & bias used	Adjusted annual mean ($\mu g/m^3$)			Bias corrected values ($\mu g/m^3$)			Predicted 2005 mean ($\mu g/m^3$)		
		2000	2001	2002	2000	2001	2002	2000	2001	2002
AURN site	S - AURN	37.7	27.2	34.4	47.8	46.4	45.3	42.3	42.2	42.3
Allotments, Granville Road	B - AURN	28.4	25.0	22.8	36.0	42.7	30.0	31.9	38.7	28.0
83 Hayes End Drive	B - AURN		20.8	24.2		35.5	31.9		32.2	29.7
Barra Hall	B - AURN	27.4	21.9	23.3	34.7	37.3	30.6	30.7	33.9	28.6
Citizens Advice Bureau	B - AURN		25.0	26.8		42.8	35.3		38.8	32.9
South Ruislip automatic site	R - South Ruislip	43.4	33.0	37.4	44.4	45.1	43.2	38.3	40.3	39.8
Uxbridge Day Nursery	R - South Ruislip	29.0	28.8	35.7	29.6	39.4	41.3	25.6	35.2	38.0
Uxbridge Technical College	R - South Ruislip	30.0	30.8	30.9	30.6	42.1	35.7	26.5	37.6	32.9
Hillingdon Primary School	R - South Ruislip		23.3	30.7		31.9	35.5		28.4	32.7

Notes: R=roadside, B=background, S=suburban

5.4.4 Comparison of the monitoring results with the relevant air quality objectives

The 2002 continuous monitoring data at present is un-ratified. However, the process of ratification will be unlikely to significantly change the measured annual mean at each site.

At the continuous monitoring sites the annual average NO_2 concentrations show a steady decline from 1997 to 2002. However, annual mean concentrations during 2001 and 2002 were still greater than 40 $\mu g/m^3$ as an annual mean in 2002. If the results are projected forward to 2005 then the AURN and Heathrow sites consistently predict that the NO_2 annual mean objective will be exceeded at these sites.

Table 5.3 shows that, since 1998, monitored hourly mean concentrations are such that the 200$\mu g/m^3$ standard is very rarely exceeded (not once during and since 2000). This means that it is likely that this NO_2 objective shall be achieved at these sites by 2005.

A large co-location bias was found between the triplicate diffusion tubes placed at the continuous monitoring sites as shown in Table 5.3 above. In all cases, diffusion tubes substantially under predicted NO_2 concentrations. Table 5.4 shows the diffusion tube results corrected for co-located bias and projections for 2005. Only the co-located tubes at the AURN site show a predicted exceedance of the objective in 2005 although results at other sites are very close to exceeding the objective.

In summary, recent monitoring results are consistent with the findings of earlier monitoring in that they predict that the annual average NO_2 objective shall be exceeded in 2005 at locations within the London Borough of Hillingdon.

5.5 STAGE 4 MODELLING

In 2002, CERC carried out a further modelling study as part of a Stage 4 Review and Assessment for Hillingdon (CERC 2002a). The report is attached as Appendix 3. Version 1.17 of their ADMS-Urban package was used to predict concentrations. The method differed from the Stage 3 report in that it used the latest road transport emission factors and used up to date emissions data taken from the GLA Emissions Inventory for London. Furthermore, the method used an improved representation of aircraft emissions from

Heathrow Airport data, in which aircraft flight paths were represented as volume sources to more realistically predict the impact of the airport.

Comparisons of modelled and measured NO_2 and PM_{10} data for 1999 were made at monitoring sites within the borough and predicted future concentrations for 2004 for PM_{10} and 2005 for NO_2 were calculated for comparison with Air Quality Strategy (AQS) objective values.

5.5.1 Model verification

Table 5.5 compares the 1999 monitored and modelled results at the Hillingdon continuous monitoring sites.

Table 5.5 Measured and calculated NO_2 concentration ($\mu g/m^3$) at continuous monitoring sites.

Monitoring sites	Annual average		Standard deviation		NMSE (objective 0)	Correlation (objective 1)	FA2 (objective 1)	Normalised bias (objective 0)
	Monitored	Calculated	Monitored	Calculated				
AURN	50.2	68.6	22.9	33.2	0.30	0.61	0.83	-0.31
South Ruislip	46.8	44.7	21.0	21.8	0.17	0.61	0.87	0.04
Heathrow 2	55.4	74.7	28.3	28.1	0.35	0.31	0.73	-0.30

Source: CERC, 2002a

In addition to the annual average concentrations the table presents the following statistics calculated for each site:

1. **Standard deviation**. This is a measure of the variability of the data sets. A small standard deviation implies the data are clustered closely around their mean, a large standard deviation implies that the data are much more scattered.
2. **Normalised mean square error (NMSE)**. This is a measure of how much the mean of the calculated concentrations differs from the observed mean. The NMSE would be zero if the two means were the same.
3. **Correlation**. When there is no similarity between the observed and calculated concentrations, the correlation will take a value close to zero. When there is strong correlation between the two values, the value will be near to 1.
4. **FA2**. This is the fraction of calculated concentrations within a factor of two of the observations.
5. **Fractional or normalised bias**. This is a measure of how the calculated mean differs from the observed mean. A value of zero indicates no difference, positive values indicate the underestimate in calculated concentrations and negative values indicate the overestimate.

The CERC report concludes that it is difficult to quantify uncertainty in the model predictions because the relationship between the modelled and actual values is not straightforward. Therefore the estimate of uncertainty should be treated with caution.

The square root of the normalised mean square error gives an indication of the overall uncertainty in model predictions. From table 5.5 this statistic suggests an uncertainty for the annual average concentrations of NO_2 of about 20-30%. The normalised or fractional bias is an indication of the tendency of the model to over- or under- predict. A negative bias indicates that the model is over-predicting. From table 5.5 this statistic suggests that the annual average concentrations of NO_2 generally overestimated by as much as 30%. These two results suggest that uncertainty in model predictions is dominated by bias.

The low data capture rates at the AURN and South Ruislip site during 1999 increase the difficulty in clearly interpreting the results of the uncertainty analysis. However, 1999 data capture at the Heathrow site was high and the result at this location indicates that the model may overestimate concentrations by as much as 30% at the most significant source of emissions in the borough. Overall the results indicate that the model generally overestimates concentrations.

This means that the predicted area where the objective is exceeded would be defined on the conservative side, an advantage since the model uncertainty is high. This builds a precautionary approach into the process and allows a degree of confidence that the exceedances are contained within plotted contours.

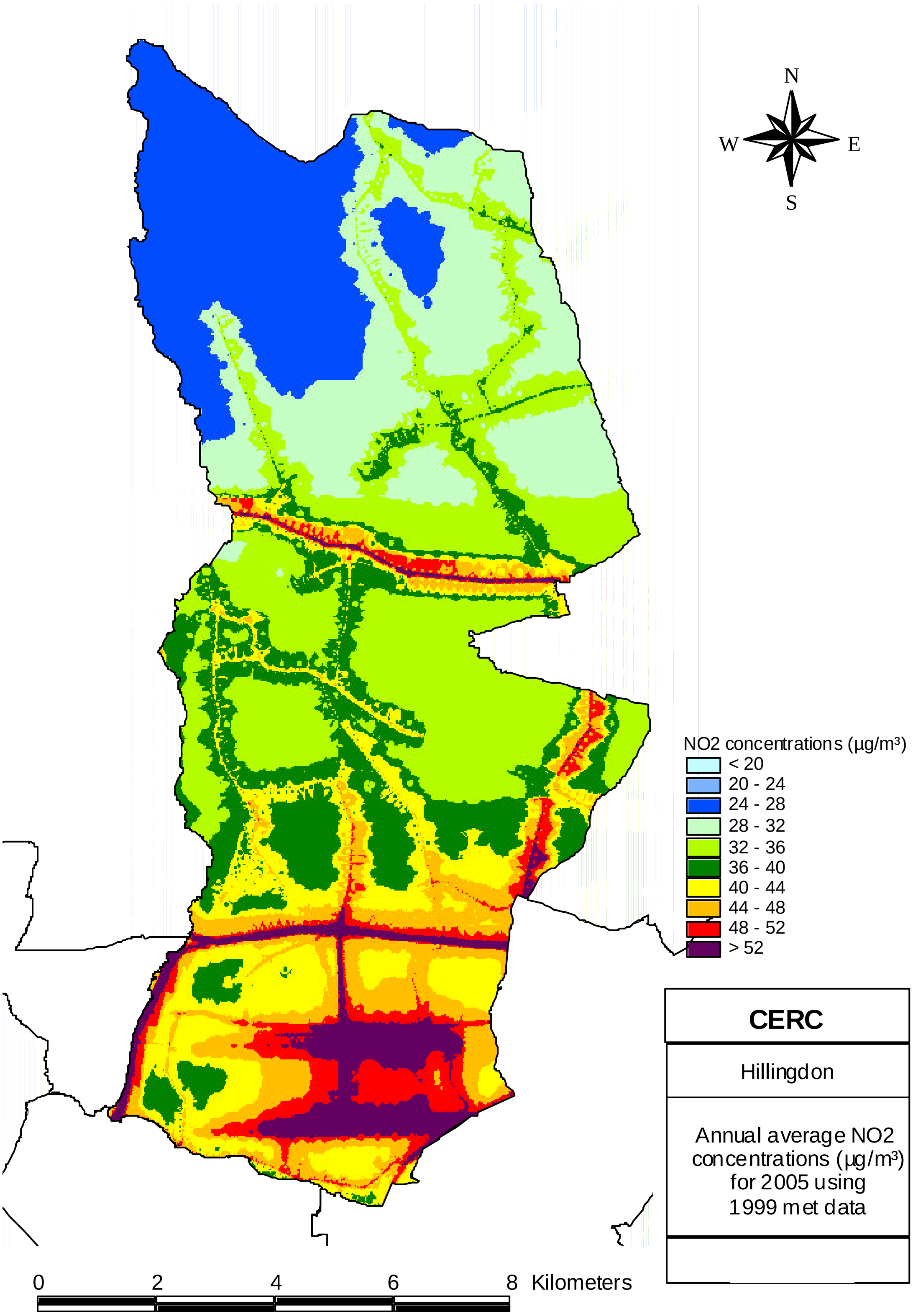
Prediction of high percentile values requires precise calculation of relatively rare events. Consequently uncertainty associated with these values is greater.

This discussion of uncertainty assumes that the measured data reliably represent the true pollution concentrations at the receptor point locations. However, there is also significant uncertainty in the measured concentrations due, for example, to the low percentage of data capture at some sites. In addition, the comparison between measured and modelled data has been carried out at a relatively small number of locations.

5.5.2 Model results

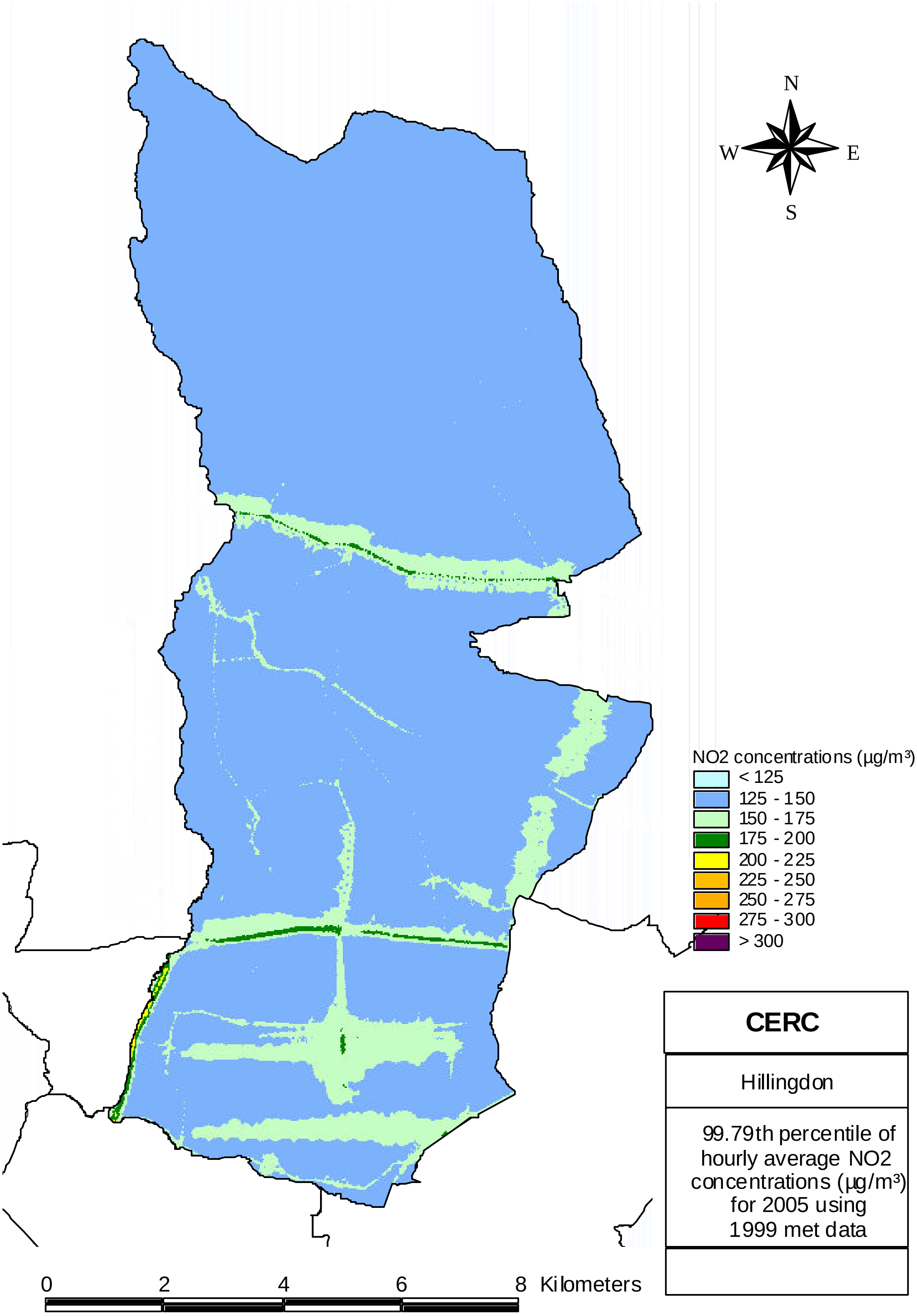
Using 1999 met. data, the predicted annual average and 99.79th percentile of hourly average NO_2 concentrations for Hillingdon for 2005 is shown in figures 5.2 and 5.3 respectively. Yellow and red areas illustrate those areas where exceedance of the AQS objectives in 2005 is possible.

Figure 5.2 – Predicted annual mean NO_2 concentration in 2005



Source CERC 2002a

Figure 5.3 Predicted 99.79th percentile of hourly mean NO_2 concentration in 2005



Source CERC 2002a

The CERC results highlight that annual average concentrations of NO_2 are predicted to be highest in the south of the borough, reaching more than 50µg/m^3 around Heathrow Airport and along adjacent motorways. Concentrations are predicted to exceed the AQS objective value of 40µg/m^3 over most of the southern half of the borough and along the A40. In the north of the borough, concentrations are generally predicted to be below the AQS objective value, except in the immediate vicinity of the busiest roads and junctions.

The 99.79th percentiles of hourly average NO_2 concentrations are predicted to be below the AQS objective value of 200µg/m^3 over most of the borough, with the exception of the M25 motorway. Concentrations are predicted to be below 180µg/m^3 over most of the borough, except along the motorways, the A40 and at Heathrow Airport.

CERC also predicted 2005 concentrations using 1997 met. data, which was the year during which the worst level of air quality was recorded in the borough. As expected, predicted concentrations are worse than those shown in figures 5.2 and 5.3 but the areas of exceedance, although larger, are very similarly distributed throughout the borough. The significant difference in terms of the declared AQMA is slightly greater exceedance along busy roads north of the A40.

5.6 CONCLUSION

Results from the Stage 4 modelling study were examined using ArcView to ascertain the potential for public exposure in areas relevant to the objectives.

The level of the mapped exceedances is slightly higher than those found in the Stage 3 modelling results and the extent of the areas is increased slightly around the major road systems. However, all exceedances, with relevant public exposure, are still contained within the original AQMA boundary. Where there are small exceedances along roads in the north of the borough, only predicted using 1997 met data, these are confined to the road itself and do not encroach on residential properties or other relevant exposure locations.

There was no relevant public exposure to exceedances of the hourly objective.

In conclusion, modelling has shown that exceedance of the annual mean NO_2 objective is predicted to be more widespread throughout the borough and of a higher level than previously predicted but that there is no evidence to suggest that the boundary of the AQMA should be changed.

6 Stage 4 Review and Assessment for particulate matter

This section summarises

- Results of the Stage 3 review and assessment for PM_{10} that were identified in that assessment;
- Results of the additional monitoring that has been done since the Stage 3 Report was completed;
- Results of the further PM_{10} modelling study completed by CERC.

6.1 STANDARDS AND OBJECTIVES FOR PM_{10}

The standards that apply for PM_{10} with the objective of being achieved by 31st December 2004 are:

- An annual average concentration (gravimetric) of 40 $\mu g / m^3$;
- 50 $\mu g / m^3$ as a 24-hour average (gravimetric) with a maximum of 35 exceedances in a year.

New provisional objectives have been set for London, of a 24-hour mean of 50 $\mu g/m^3$ not to be exceeded more than 10 times per year and an annual mean of 23 $\mu g/m^3$, both to be achieved by the end of 2010 and finally, an annual mean objective of 20 $\mu g/m^3$ to be achieved by the end of 2015 has also been set. Future review and assessment work will examine the implications (in terms of potential exceedance, changes to the AQMA and action planning) of these objectives in the London Borough of Hillingdon.

6.2 KEY FINDINGS OF THE STAGE 3 REVIEW AND ASSESSMENT

On the basis of the conclusions from the Stage 1 and 2 report and consultation process, the Stage 3 review and assessment reported on further detailed work aimed at assessing NO_2, sulphur dioxide and PM_{10} CO concentrations.

Work was scoped and progressed via collaboration with London Borough of Hounslow and Spelthorne District Council using Cambridge Environmental Research Consultants (CERC) as contractor.

Several modelling studies were carried out taking account of changes to the input data and to the objectives. The final stage 3 technical report from CERC was published in September 2000, concluding that concentrations of PM_{10} would fall significantly between 1998 and 2004/2005 and that although:

- Annual Mean objective for PM_{10} in 2004 would be exceeded near parts of the M4 and M25, there is no relevant public exposure at these locations;
- 24-hour objective for PM_{10} in 2004 would be exceeded in limited areas: along the M4/M25, Heathrow Spur Road and Hayes Bypass, there is no relevant public exposure at these locations.

In addition, the relevant monitoring results for Hillingdon were found to be in general agreement with these conclusions.

It was agreed, during consultation, that although PM_{10} would not the basis of the AQMA designation, this would continue to be closely monitored at each review and assessment stage.

6.3 MONITORING RESULTS

Results are available for three continuous air quality monitors in the London Borough of Hillingdon.

6.3.1 Treatment of data

QA / QC of monitoring data

The data from the three continuous monitors are ratified to the QA/QC standards used in the DEFRA network. Results obtained from TEOM-type monitors are factored by 1.3 as per guidance to convert results to the required gravimetric equivalent.

6.3.2 Continuous monitoring results

Annual average gravimetric concentrations recorded by the three continuous monitors in the borough in 2002 and summary statistics are shown in Table 6.1. A summary of exceedance of the hourly mean objective based on concentrations recorded at these sites is shown in Table 6.2.

Table 6.1 Annual average PM_{10} concentrations ($\mu g/m^3$) recorded by continuous monitors in the borough.

Location Year	AURN (suburban site)		South Ruislip (roadside site)		Heathrow (background site)	
	Conc. ($\mu g/m^3$)	Data capture %	Conc. ($\mu g/m^3$)	Data capture %	Conc. ($\mu g/m^3$)	Data capture %
1997	32.6	97			32.7	95
1998	26.8	75			29.5	96
1999	26.7	45	24	26	29.2	98
2000	25.4	98	27	93	27.5	97
2001	25.9	96	29	93	29.3	97
2002	24.7	97	29	96	27.3	95

Notes: 2002 figures are provisional and may be subject to change.

Table 6.2 Summary of 24-hour mean PM_{10} concentrations ($\mu g/m^3$) recorded by continuous monitors in the borough

Location / Year	AURN (suburban site)			South Ruislip (roadside site)			Heathrow (background site)		
	Max. conc. ($\mu g/m^3$)	Data capture %	No. of exceedances[1]	Max. conc. ($\mu g/m^3$)	Data capture %	No. of exceedances[1]	Max. conc. ($\mu g/m^3$)	Data capture %	No. of exceedances[1]
1997	114.4	97	50				148.2	95	48
1998	78.0	75	15				75.4	96	29
1999	70.2	45	12	N/D	23	2	68.9	98	28
2000	70.2	98	12	N/D	93	16	66.3	97	20
2001	78.0	96	12	N/D	93	17	89.7	97	21
2002[2]	62.4	97	7	N/D	96	16	78.0	95	15

Notes:
1. of the $50\mu g/m^3$ objective (up to 35 exceedances are permitted)
2. 2002 figures are provisional and may be subject to change.
3. N/D = data not available

6.3.3 Comparison of the monitoring results with the relevant air quality objectives

The 2002 continuous monitoring data at present is un-ratified. However, the process of ratification will be unlikely to significantly change the measured annual mean at each site.

At the continuous monitoring sites the annual average PM_{10} concentrations show a steady decline from 1997 to 2002 and that concentrations have never been greater than 28 $\mu g/m^3$, which is well below the objective level for 2004. Table 6.2 shows that, since 1998, monitored hourly mean concentrations are such that the $50\mu g/m^3$ 24-hour mean standard is consistently exceeded fewer times than the 35 allowable occurrences.

Assuming that concentrations continue to diminish then, in summary, all results are consistent with the findings of earlier monitoring in that it is not likely that the PM_{10} objectives shall be exceeded in 2004 at monitoring locations within the London Borough of Hillingdon.

6.4 STAGE 4 MODELLING

In 2002, CERC carried out a further modelling study as part of a Stage 4 Review and Assessment for Hillingdon (CERC 2002a). The report is attached as Appendix 3. Version 1.17 of their ADMS-Urban package was used to predict concentrations. The method differed from the Stage 3 report in that it used the latest road transport emission factors and used up to date emissions data taken from the GLA Emissions Inventory for London. Furthermore, the method used an improved representation of aircraft emissions from Heathrow Airport data, in which aircraft flight paths were represented as volume sources to more realistically predict the impact of the airport.

Comparisons of modelled and measured PM_{10} data for 1999 were made at monitoring sites within the borough and predicted future concentrations for 2004 for PM_{10} were calculated for comparison with Air Quality Strategy (AQS) objective values.

6.4.1 Model verification

Table 6.3 compares the 1999 monitored and modelled results at the Hillingdon continuous monitoring sites.

Table 6.3 Measured and calculated PM_{10} concentration ($\mu g/m^3$) at continuous monitoring sites.

Monitoring sites	Annual average		Standard deviation		NMSE (objective 0)	Correlation (objective 1)	FA2 (objective 1)	Normalised bias (objective 0)
	Monitored	Calculated	Monitored	Calculated				
West Drayton	26.7	35.0	16.6	16.7	0.29	0.63	0.81	-0.27
South Ruislip	24.0	23.7	14.9	9.3	0.18	0.73	0.90	0.01
Heathrow 2	29.2	33.3	16.9	14.5	0.21	0.63	0.87	-0.13

Source: CERC, 2002a

In addition to the annual average concentrations the table presents the following statistics calculated for each site:

1. **Standard deviation**. This is a measure of the variability of the data sets. A small standard deviation implies the data are clustered closely around their mean, a large standard deviation implies that the data are much more scattered.
2. **Normalised mean square error (NMSE)**. This is a measure of how much the mean of the calculated concentrations differs from the observed mean. The NMSE would be zero if the two means were the same.
3. **Correlation**. When there is no similarity between the observed and calculated concentrations, the correlation will take a value close to zero. When there is strong correlation between the two values, the value will be near to 1.
4. **FA2**. This is the fraction of calculated concentrations within a factor of two of the observations.
5. **Fractional or normalised bias**. This is a measure of how the calculated mean differs from the observed mean. A value of zero indicates no difference, positive values indicate the underestimate in calculated concentrations and negative values indicate the overestimate.

The CERC report concludes that it is difficult to quantify uncertainty in the model predictions because the relationship between the modelled and actual values is not straightforward. Therefore the estimate of uncertainty should be treated with caution.

The square root of the normalised mean square error gives an indication of the overall uncertainty in model predictions. From table 6.3 this statistic suggests an uncertainty for the annual average concentrations of PM_{10} of about 20-30%. The normalised or fractional bias is an indication of the tendency of the model to over- or under- predict. A negative bias indicates that the model is over-predicting. From table 6.3 this statistic suggests that the annual average concentration of PM_{10} is generally overestimated by as much as 30%. These two results suggest that uncertainty in model predictions is dominated by bias.

The low data capture rates at the AURN and South Ruislip site during 1999 increase the difficulty in clearly interpreting the results of the uncertainty analysis. However, 1999 data capture at the Heathrow site was high and the result at this location indicates that the model may overestimate concentrations by around 15% at the most significant source of emissions in the borough. Overall the results indicate that the model generally overestimates concentrations.

This means that an area where the objective is exceeded would be defined on the conservative side, an advantage since the model uncertainty is high. This builds a precautionary approach into the process and allows a degree of confidence that any exceedances are contained within plotted contours.

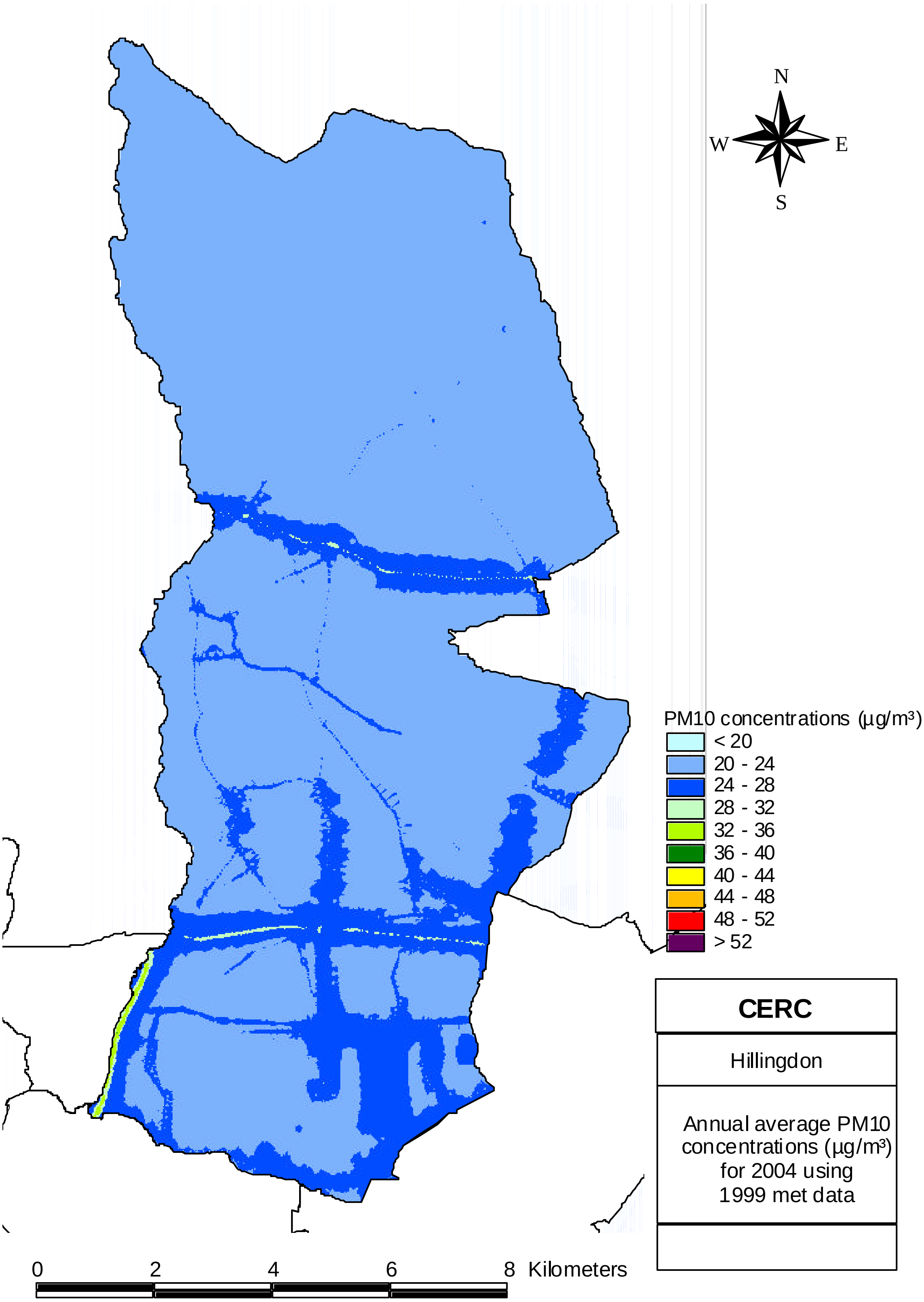
Prediction of high percentile values requires precise calculation of relatively rare events. Consequently uncertainty associated with these values is greater.

This discussion of uncertainty assumes that the measured data reliably represent the true pollution concentrations at the receptor point locations. However, there is also significant uncertainty in the measured concentrations due, for example, to the low percentage of data capture at some sites. In addition, the comparison between measured and modelled data has been carried out at a relatively small number of locations.

6.4.2 Model results

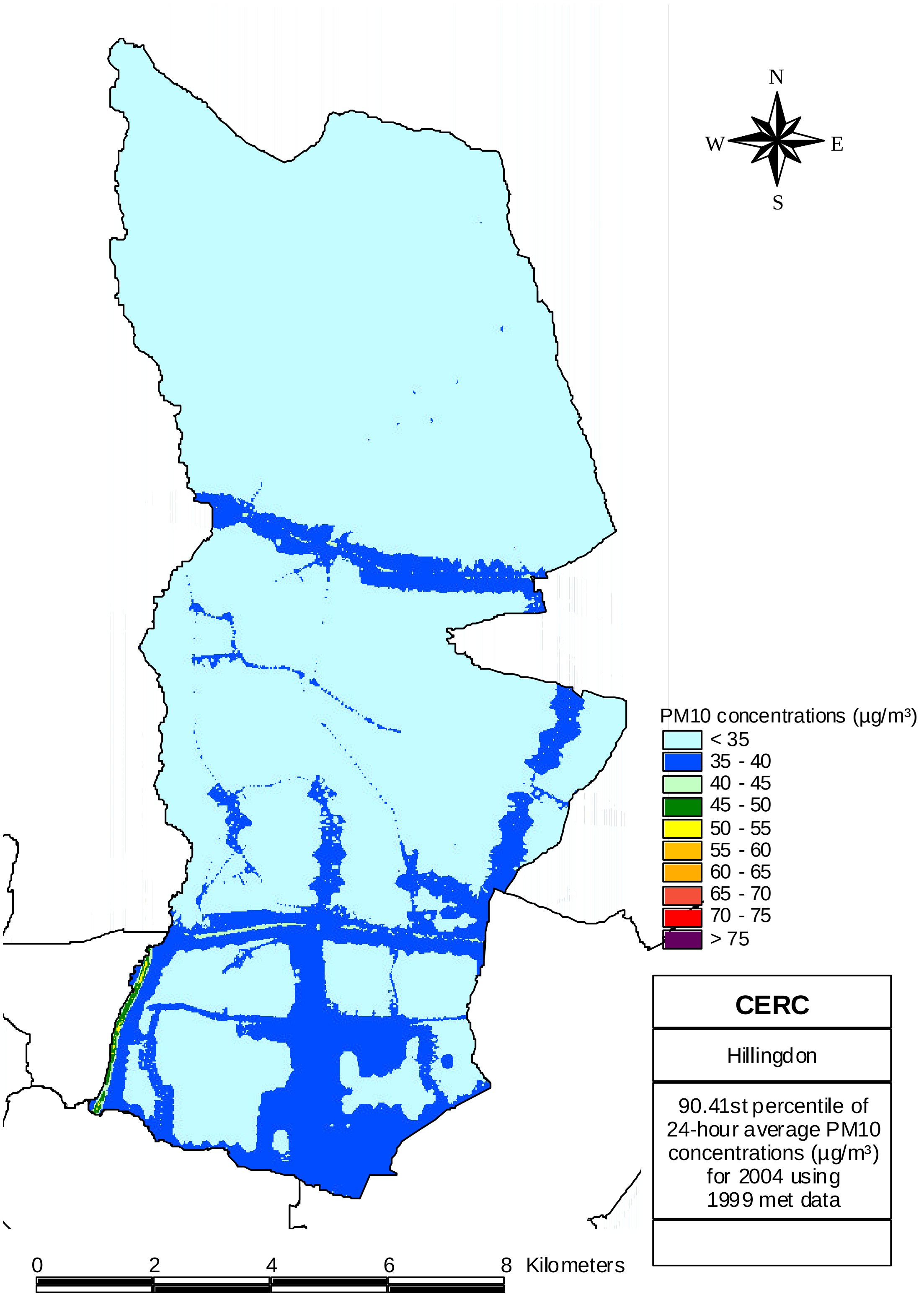
Using 1999 met. data, the predicted annual average and 90.4^{th} percentile of 24-hour means (equivalent of 36^{th} highest values) of PM_{10} concentrations for Hillingdon for 2005 are shown in figures 6.1 and 6.2 respectively. Yellow and red areas illustrate those areas where exceedance of the AQS objectives in 2005 is possible.

Figure 6.1 – Predicted annual mean PM_{10} concentration in 2005



Source CERC 2002a

Figure 6.2 Predicted 90.4th percentile of 24-hour mean PM_{10} concentration in 2005



Source CERC 2002a

The CERC results highlight concentrations of PM_{10} are predicted to be highest along the M25 and M4 motorways being up to 36µg/m^3 at these roads. In the rest of the borough annual average PM_{10} concentrations are predicted to be below 28µg/m^3.

The 90.41st percentiles of 24-hour average PM_{10} concentrations are predicted to exceed the AQS objective value of 50µg/m^3 over small areas on the M25. Away from the motorways, concentrations are predicted to be below 40µg/m^3.

6.5 CONCLUSION

Results from the Stage 4 modelling study were examined using ArcView to ascertain the potential for public exposure in areas relevant to the objectives. Examination of these areas where exceedance may occur has not shown any relevant public exposure for the objectives.

Therefore the 2004 objectives for PM_{10} are likely to be met throughout Hillingdon.

In conclusion, monitoring and modelling has shown that the objectives for PM_{10} should be met within the London Borough of Hillingdon so that there is no evidence to suggest an AQMA should be declared on the basis of this pollutant.

7 Further characterisation of the AQMA

7.1 APPROACH

Examination of monitoring and modelling data leads to the conclusion that the previously declared AQMA (required on the basis of predicted public exposure to exceedances of NO_2 objectives) is still valid and requires no amendment or variation. In order to inform the London Borough of Hillingdon's approach to formulating an action plan aimed at reducing or eliminating the level of exceedance, it is a requirement of the Stage 4 review and assessment process that the improvement needed in emissions, so that the objectives would be achieved, is quantified. Furthermore, it is also required to identify how much each source of emissions contributes to the ambient total.

This section presents the results of:

- Study into the improvement in air quality required for compliance with objectives;
- A source apportionment study;
- Predictions of the improvement in air quality resulting from indicative strategies of emissions abatement.

Information presented in this section will form part of the data used in defining the AQAP for the London Borough of Hillingdon. This shall be published separately.

7.2 REQUIRED IMPROVEMENT IN AIR QUALITY

7.2.1 The improvement that is needed – general discussion

A key step in the Stage 4 Review and Assessment process is to identify the improvements needed in air quality, when there are exceedances of the UK air quality objectives.

An important point to note is that the Local Authority does not need to attempt to improve air quality beyond the air quality objective that is being exceeded. This applies even if that authority has taken a precautionary approach and deliberately set the boundary of their AQMA at, for example, the 36 $\mu g/m^3$ contour rather than the 40 $\mu g/m^3$ contour, in the case of the annual mean NO_2 objective.

For example, an AQMA may have been declared for NO_2, and for administrative reasons, the boundary of the AQMA may include houses where the concentrations of NO_2 are not predicted to exceed the annual mean objective of 40 $\mu g/m^3$. Let us say the maximum exceedance of the annual mean NO_2 objective at a relevant receptor in the AQMA was 43 $\mu g/m^3$. The maximum improvement that would be needed in this example AQMA will therefore be 3 $\mu g/m^3$. In this example, this will mean that some houses in the AQMA will experience concentrations of NO_2 possibly much lower than the annual mean objective.

7.2.2 Areas and magnitude of predicted exceedance of the air quality objectives considered in this Stage 4 assessment

The modelling study by CERC predicted the area in which the annual mean objective for NO_2 is likely to be exceeded. This area is illustrated in Figure 5.2 and the area declared as an AQMA described previously.

The predicted annual mean NO_2 concentrations at 11 receptors in the AQMA are shown in table 7.1 along with the improvement required to achieve the objective. Receptor sites were chosen to represent points of maximum exposure at relevant locations. As the primary emission source and the degree of exceedance, varies across the AQMA from Heathrow Airport and motorway sources in the south to mainly major roads in the north, further receptors throughout the AQMA were chosen to help inform the action planning process. The locations of the receptors are illustrated in Figure 7.1.

The improvement required to achieve the NO_2 annual mean objective shown in Table 7.1 has been calculated by taking the predicted concentration at a receptor location and then subtracting the annual mean objective of 40 $\mu g/m^3$.

Table 7.1 Improvement in annual mean concentrations of NO_2 needed at receptors exposed to the highest predicted concentrations

Specific receptors identified	Maximum annual mean concentration of NO_2 in that location (from modelling) (mg/m^3)	Improvement required to achieve annual mean objective of 40 mg/m^3 (mg/m^3)
Masson Avenue	39.3	-
Eider Close	40.4	0.4
Coleridge Way	35.4	-
Botwell Primary School	40.5	0.5
Mendip Close	47.0	7.0
Bomber Close	45.0	5.0
Pinglestone Close	45.6	5.6
Heathrow Close	42.1	2.1
West Drayton Primary School	37.7	-
AURN Site[1]	51.9	11.9
Whitehall Infant School	36.8	-

Note 1: based on 2005 model-based rather than monitor-based value.

Improvement in annual mean NO_2 is required at 7 of the 11 receptors; ranging from 0.4-11.9$\mu g/m^3$. The NO_2 concentrations result from a proportion of total NO_X emissions but also from the transformation of another proportion of NO_X in the atmosphere. This complex situation means that an improvement of, say, 20% in NO_X emissions does not simply result in an improvement of 20% in NO_2 concentrations.

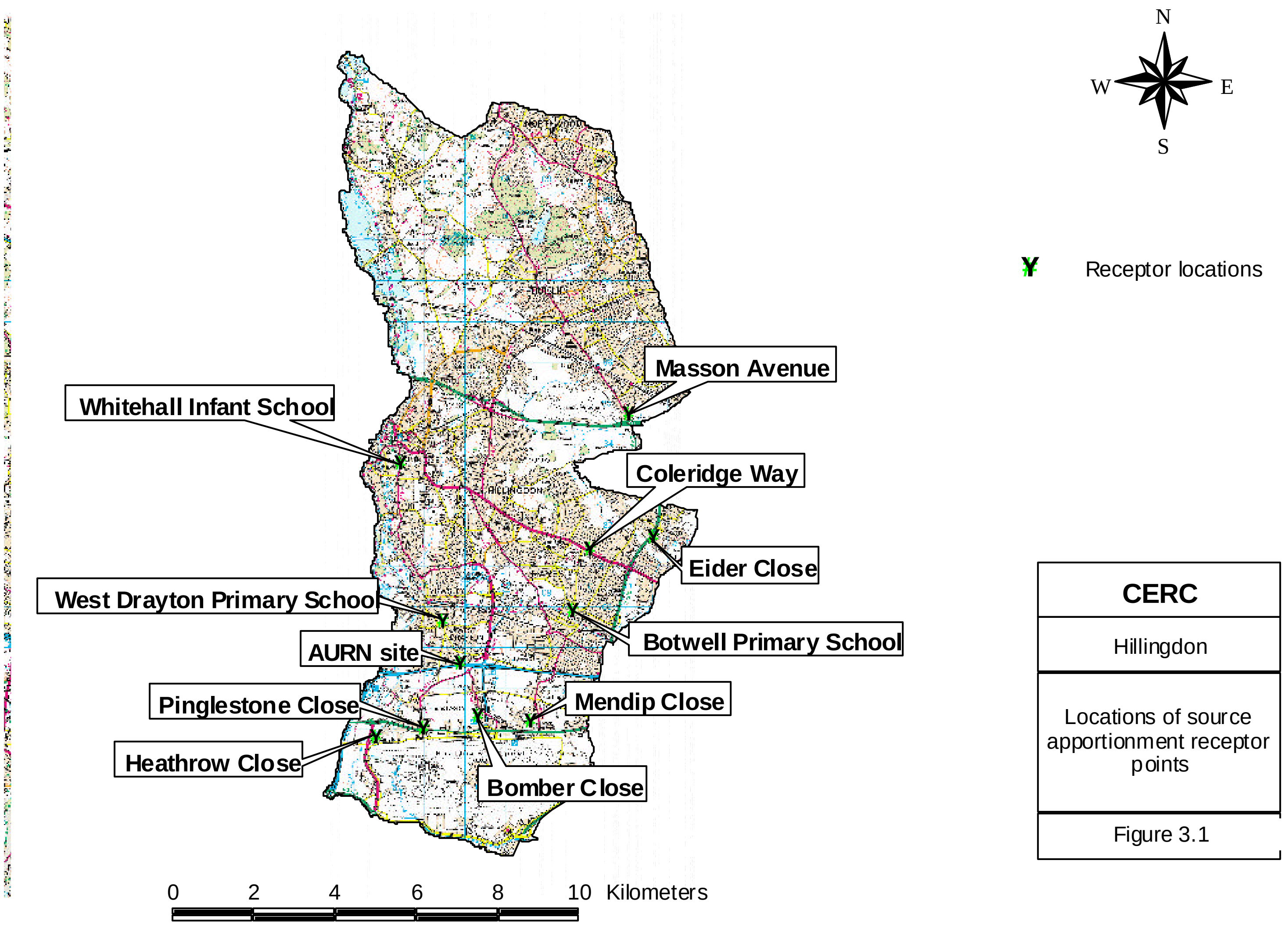
7.3 SOURCE APPORTIONMENT STUDY

7.3.1 Introduction

Source apportionment is the process whereby the contributions from the sources of a pollutant are determined. In local air quality, the relevant sources could include: traffic; local background; industrial and domestic. Contributions from the different types of vehicles (for example, cars, lorries and buses) can also be considered to highlight which class of vehicle is contributing most to the emissions from traffic. Source apportionment allows the most important source or sources to be identified and options to reduce ambient concentrations of pollutants can then be considered and assessed.

However, the NO_2 & NO_X transformations in the atmosphere are complex, meaning that the break down of NO_2 concentrations is complex. Therefore, following the recommended guidance, source apportionment results have been derived on the basis of reporting NO_X (as NO_2) concentrations.

Figure 7.1 Locations of source apportionment receptor points (source CERC 2002b)



A source apportionment study has been carried out by CERC on behalf of The London Borough of Hillingdon (CERC 2002b). Using the same approach as their work on predicting concentrations in 2005 (Appendix 3).

The work quantified the relative contribution of each source group both to the base case emissions and resulting annual average ground level concentrations at the 11 receptor locations. The base case in this assessment is defined as the annual mean concentrations of NO_2 that are predicted in the absence of any measures to improve air quality in Hillingdon, i.e. they are the concentrations on which the current extent of the Air Quality Management Area has been defined.

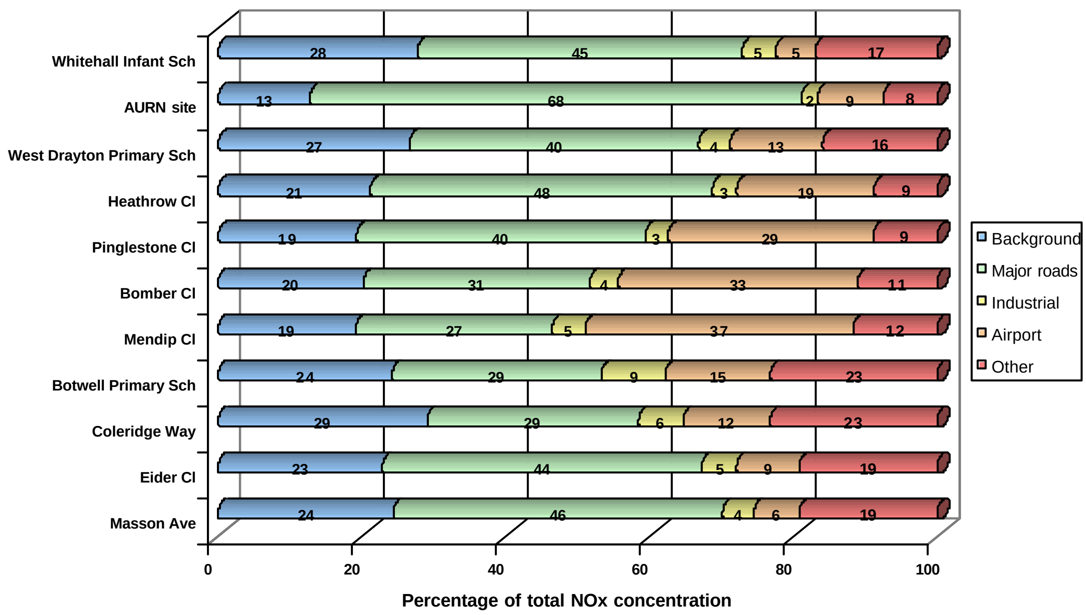
Annual average concentrations were apportioned in the following ways:

- By major source group;
- Breakdown of traffic sources by vehicle type;
- Breakdown of traffic sources by road type i.e. which organisation has responsibility;
- Breakdown of traffic sources into Heathrow and non Heathrow traffic;
- Breakdown of Heathrow Airport sources,
- Breakdown of Heathrow airborne aircraft sources by height.

This report summarises the breakdown by the first three categories plus the breakdown of Heathrow Airport sources. For further information on the other categories, the complete report is attached as appendix 3.

7.3.2 Apportionment by source group

Figure 7.2 Percentage contributions of major source groups to annual average NO_X concentrations



Source: CERC 2002b

The data suggest that traffic on major roads is the dominant contributor to NO_X concentrations across the borough. At sites close to Heathrow the airport has an equal significance as a source. It is of much less significance for all sites north of the M4 motorway although it does continue to contribute to NO_X concentrations (5%) even at the northern edge of the AQMA.

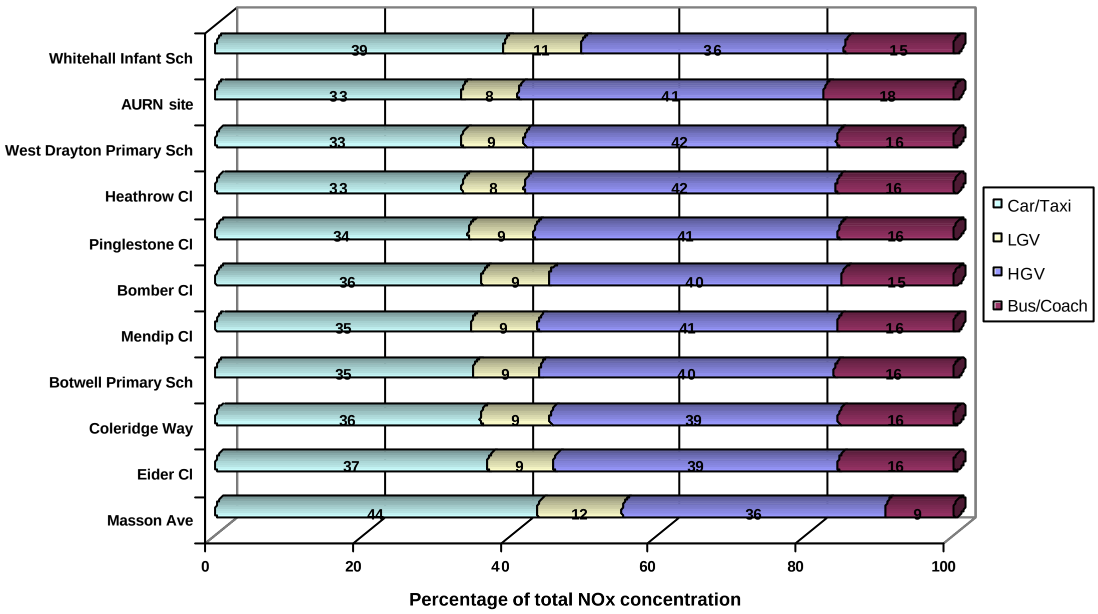
Of the receptor sites, the largest improvement required is at the AURN site. Here the contributions to NO_X concentration are very much dominated by major road transport on the M4 motorway (68%). Regarding the other receptors in Figure 7.1 where improvements are necessary to achieve compliance, it is apparent that a combination of major road and airport emissions are contributing 40-70% to NO_X concentrations.

7.3.3 Breakdown of traffic emissions by vehicle type

CERC used the following vehicle categories in their source apportionment work:

- Cars and motorcycles;
- Light goods vehicles (LGV);
- Heavy Goods Vehicles (HGV);
- Buses & coaches.

Figure 7.3 Percentage contributions of different vehicle types to annual average NO_X concentrations

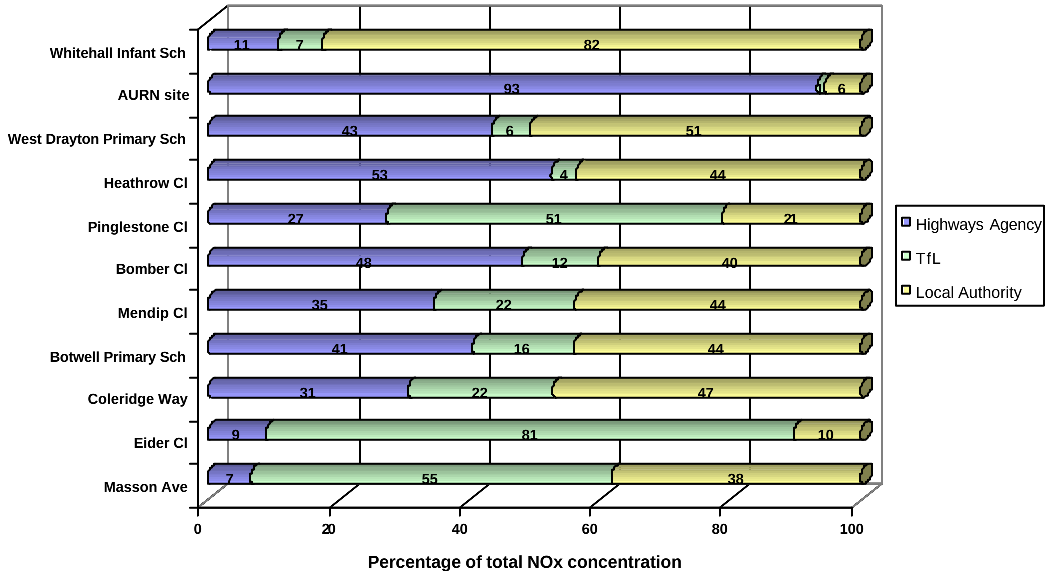


Source: CERC 2002b

The contributions of different vehicle types to the annual average NO_X concentration varies depending on the receptor location. However, the percentage contribution of each traffic type to the annual average NO_X concentration is approximately the same at each of the receptor locations with cars and HGVs contributing to at least 74% of the concentration in each case.

7.3.4 Breakdown of traffic sources by road type i.e. which organisation has responsibility

Figure 7.4 Percentage contributions of different road types to annual average NO_X concentrations from major roads.

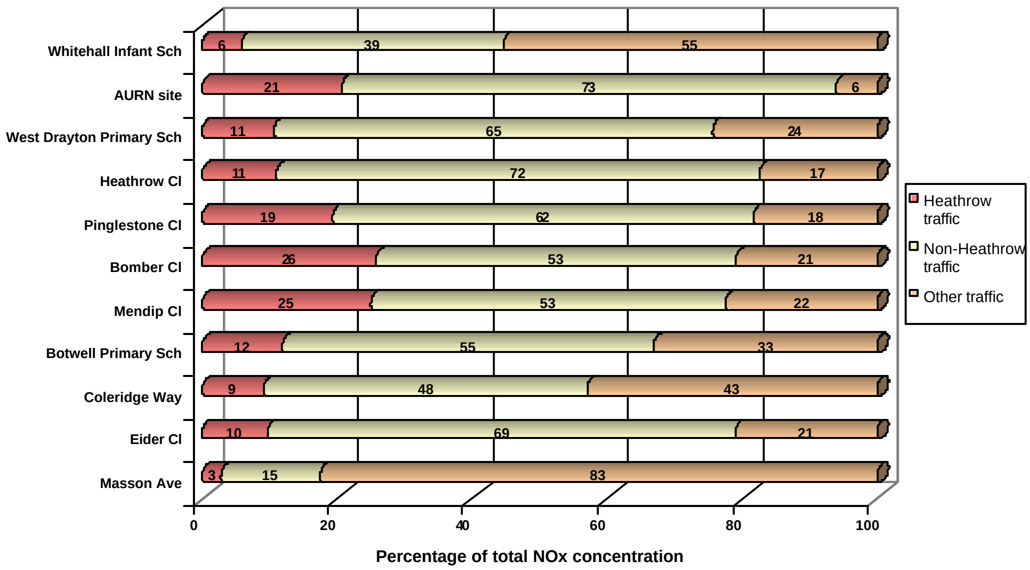


Source: CERC 2002b

Figures show that the road type dominating contributions varies widely across the borough. Contributions from road traffic at some receptors are clearly impacted on almost solely by one road type (e.g. the AURN site) while others receive significant contributions from all road types (e.g. Mendip Close). Clearly, proportionate action by all three organisations would be required to reduce the share from road transport in the borough and to achieve the objective.

7.3.5 Breakdown of traffic sources into Heathrow and non Heathrow traffic

Figure 7.5 Percentage contributions of Heathrow sources to annual average NO_X concentrations from major roads.

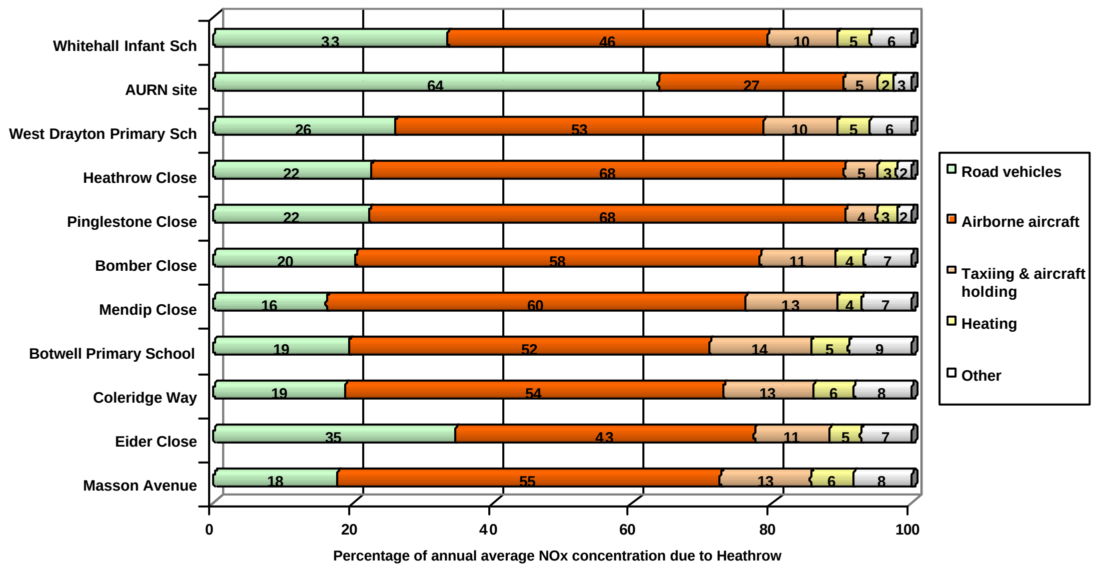


Source: CERC 2002b

The CERC result predicts that specific Heathrow road traffic is not the dominant road traffic source contributing to NO_X concentrations at any of the receptor locations, although its contribution is significant and varies across the borough.

7.3.6 Breakdown of Heathrow airport sources

Table 7.6 Percentage contributions of Heathrow sources to annual average NO_X concentrations from Heathrow



Source: CERC 2002b

At receptors close to the airport and at which improvement in NO_2 is required (Heathrow Close, Pinglestone Close, Bomber Close and Mendip Close) airborne aircraft contribute around 60-70% the total Heathrow contribution to NO_X. Data in the CERC report predict that it is aircraft in the 0-50m altitude range that contributes around 80-95% of the airborne aircraft total. Airport road vehicles are the second most significant Heathrow source.

7.3.7 Discussion of source apportionment results

In summary, it is clear that the proportionate contribution to total NO_X concentration varies widely across the borough with the predicted exceedance at one receptor being due to a very different set of sources to that at another. However, it may be concluded that there is a region south of the M4 motorway where activity associated with Heathrow airport is a significant contributor to total NO_X concentration (around 30%). The majority of this specific contribution (around 50-60%) is produced by emissions from airborne aircraft at the point of takeoff and landing (0-50m above ground level).

At receptor locations, road traffic contributes generally between 30-50% of the total NO_X concentration. This share is mostly due to cars and HGVs and to traffic not associated with Heathrow airport. The road traffic contribution is found to mainly come from roads regulated by Transport for London and the Highways Agency in some cases but from roads regulated by the Local Authority in others.

7.4 RESULTS OF SCENARIO MODELLING

In recognition that the source apportionment report identified road and airport sources of emissions as the major contributors to predicted levels of NO_2 in the borough, a study looking at the impact of implementing 3 emission reduction scenarios for these sources was completed by CERC (the full report is reproduced in Appendix 5).

The three scenarios defined were:

- 50% reduction in airborne aircraft NO_X emissions by 2005;
- 30% reduction in total road vehicle NO_X emissions by 2005;
- Creation of a Low Emissions Zone (LEZ) by 2005, in which all vehicles (other than private cars) must comply with the EURO II standards for exhaust NO_X emissions.

The scenarios chosen are not intended to be viewed as definitive cost-effective, feasible action plan measures but they are illustrative of the scale of NOx emissions reductions required to achieve significant reductions in ambient NO_2 concentrations.

The approach to predicting concentrations as a result of the reduction scenarios used the same input data (other than emissions) and approach as the West London model study (Appendix 3). Results have been compared with those results where no action is taken (see Table 7.1) at the same 11 receptor points.

7.4.1 Results of Scenario 1 - reducing airborne aircraft emissions by 50%

Table 7.2 Predicted effect on annual mean NO_2 concentration due to scenario 1

Receptor	Conc. as a result of scenario 1 ($\mu g/m^3$)	Change in conc. compared to 'no-action taken' ($\mu g/m^3$)	%
Whitehall Infant School	36.4	-0.4	-1
AURN Site	50.8	-1.1	-2
West Drayton Primary School	36.5	-1.2	-3
Heathrow Close	39.8	-2.3	-5
Pinglestone Close	41.9	-3.7	-8
Bomber Close	41.3	-3.7	-8
Mendip Close	43.1	-4.0	-8
Botwell Primary School	39.2	-1.3	-3
Coleridge Way	34.4	-1.0	-3
Eider Close	39.6	-0.7	-2
Masson Avenue	38.8	-0.5	-1

At locations close to Heathrow the emission reduction scenario is predicted to bring about an improvement in annual mean NO_2 concentration equivalent to an 8% reduction compared with the 'no action taken' case. The reduction is predicted to bring 3 receptors into compliance with the objective; however, it is insufficient to achieve the objectives in 2005 at all receptor sites. Further from the airport, the reduction scenario is only predicted to cause an improvement of around 1% compared with the 'no action taken' case.

This analysis takes no account of the cost or the feasibility of implementing such a reduction strategy by 2005.

7.4.2 Results of Scenario 2 – reducing road vehicle emissions by 30%

Table 7.3 Predicted effect on annual mean NO_2 concentration due to scenario 2

Receptor	Conc. as a result of scenario 2 ($\mu g/m^3$)	Change in conc. compared to 'no-action taken' ($\mu g/m^3$)	%
Whitehall Infant School	35.4	-1.5	-4
AURN Site	48.6	-3.4	-7
West Drayton Primary School	36.0	-1.6	-4
Heathrow Close	39.3	-2.8	-7
Pinglestone Close	43.6	-2.0	-5
Bomber Close	43.5	-1.5	-3
Mendip Close	45.8	-1.2	-3
Botwell Primary School	39.3	-1.3	-3
Coleridge Way	34.3	-1.1	-3
Eider Close	38.2	-2.2	-5
Masson Avenue	36.9	-2.5	-6

The emission reduction scenario is predicted to bring about an improvement in annual mean NO_2 concentration equivalent to between 3-7% reduction compared with the 'no action taken' case. The reduction is predicted to bring 3 receptors into compliance with the objective; however, it is insufficient to achieve the objectives in 2005 at all receptor sites.

This analysis takes no account of the cost or the feasibility of implementing such a reduction strategy by 2005.

7.4.3 Results of Scenario 3 – creation of a 'Euro II' LEZ

Table 7.4 Predicted effect on annual mean NO_2 concentration due to scenario 3

Receptor	Conc. as a result of scenario 3 ($\mu g/m^3$)	Change in conc. compared to 'no-action taken' ($\mu g/m^3$)	%
Whitehall Infant School	36.7	-0.1	-<1
AURN Site	21.4	-0.5	-1
West Drayton Primary School	37.4	-0.3	-1
Heathrow Close	41.7	-0.4	-1
Pinglestone Close	45.3	-0.3	-1
Bomber Close	44.8	-0.2	-1
Mendip Close	46.8	-0.2	-<1
Botwell Primary School	40.3	-0.2	-1
Coleridge Way	35.2	-0.2	-<1
Eider Close	40.0	-0.3	-1
Masson Avenue	39.1	-0.2	-1

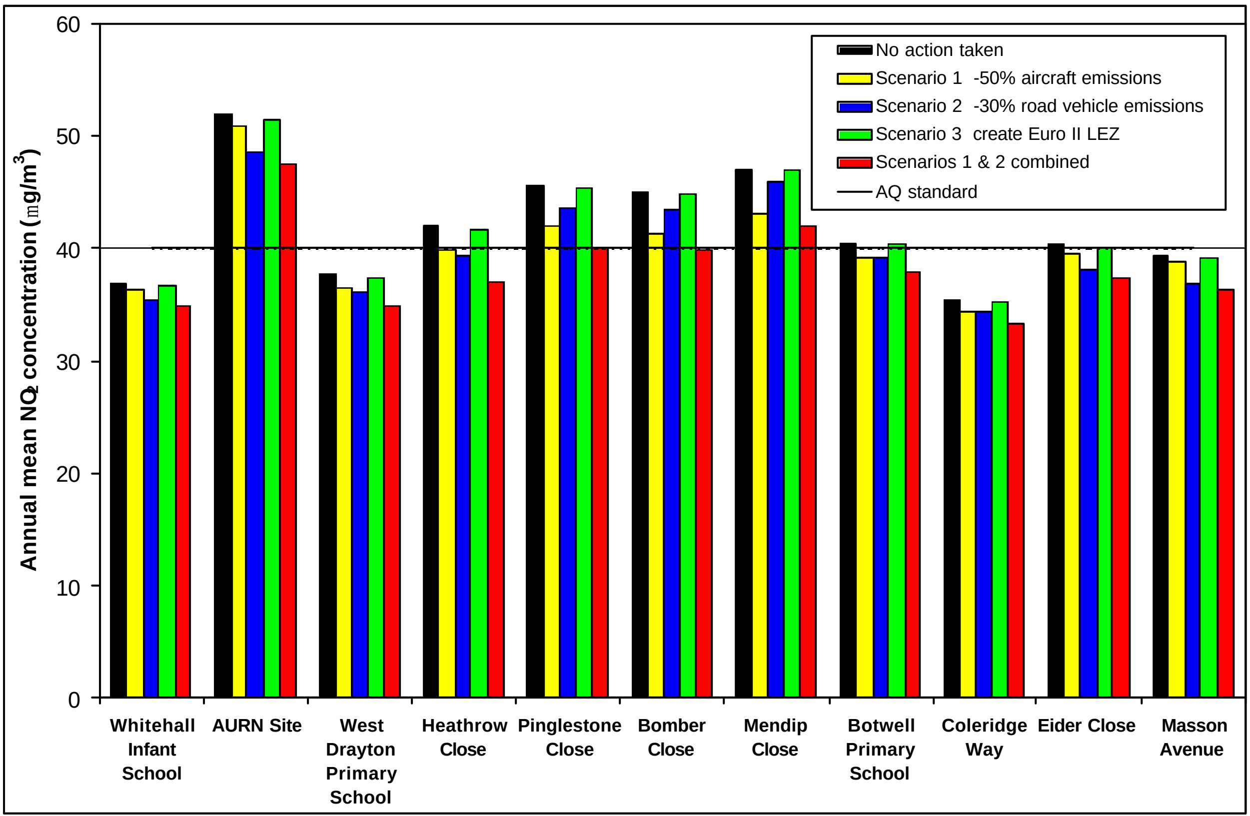
The emission reduction scenario is predicted to bring about an improvement in annual mean NO_2 concentration equivalent to around 1% reduction compared with the 'no action taken' case. The reduction is predicted to bring no receptors into compliance with the objective and is therefore insufficient to achieve the objectives in 2005 at all receptor sites.

This analysis takes no account of the cost or the feasibility of implementing such a reduction strategy by 2005.

7.4.4 Conclusion

The results of the emission reduction scenarios discussed above are presented in Figure 7.7, which also includes information regarding the effect of implementing scenarios 1 & 2 for a combined effect.

Figure 7.7 Effects of individual and combined emission reduction strategies on annual mean NO_2 concentration at receptor sites



Results for each scenario and in the Figure 7.7 show that, individually, scenarios 1 and 2 have a significant effect in bringing concentrations at 3 receptor sites towards compliance with the annual mean objective for NO_2. However, if both scenarios are combined then results predict compliance is then achieved at 5 receptor sites that would not have done if no action were taken. Results predict that the objective would still not be achieved at some sites even with these reduction strategies being combined.

This analysis has taken no account of the cost or the feasibility of implementing such reduction strategies by 2005. However, it has demonstrated two points. Firstly, that very significant reduction in NO_X emissions are required in the major sources (aircraft and road vehicles) to bring about even a modest improvement in annual mean NO_2 concentration. Secondly, that combination of emission reduction measures shall be required to achieve air quality objectives at some sites.

Options for reducing concentrations of NO_2 in the AQMA will be additionally discussed in the AQAP report from London Borough of Hillingdon.

8 Implications of this Stage 4 air quality review and assessment for Hillingdon

This section highlights the implications of this Stage 4 assessment for Hillingdon; and

- Explains conclusions arrived at concerning the current Air Quality Management Area;
- Comments on the results of the source apportionment and scenario modelling studies.

8.1 CONCLUSION REGARDING THE AIR QUALITY MANAGEMENT AREA

This Stage 4 assessment has shown that both monitoring and modelling results predict exceedance of the annual mean NO_2 objective in 2005 over large areas of the borough. The level of the exceedances and the area over which they occur is greater than that found during the Stage 3 review and assessment. Investigation of the relevant exposure to these exceedances has shown that the currently defined boundary of the AQMA is still valid and requires neither amendment nor variation.

8.2 CONCLUSIONS OF SOURCE APPORTIONMENT AND SCENARIO MODELLING STUDIES

Source apportionment study confirms that improvements in NO_2 concentration in the order of 0.4-11.9$\mu g/m^3$ are required in the borough and that cars and HGVs on all types of roads are the main sources. Also, in the south of the borough, Heathrow airport is a major source with aircraft at the point of takeoff and landing being the activity contributing most to the total airport impact.

Model results have been generated for scenarios in which up to a 50% reduction of NO_X emissions in aircraft and up to a 30% reduction in road transport sources have been assumed. Results suggest that such large emission reductions result in much smaller improvements in NO_2 concentration. However, the effect of individual and combined reduction strategies can bring about compliance with the air quality objective for annual mean NO_2 concentration at receptor locations that would not achieve the objective if no action were taken.

London Borough of Hillingdon should therefore prepare their AQAP on the basis of the technical conclusions and findings of this Stage 4 assessment.

9 The next steps for Hillingdon

9.1 OBTAINING DEFRA AND THE GLA APPROVAL

Defra and the GLA will need to approve this Stage 4 assessment. Hillingdon should now send a copy of this report to Defra and the GLA. Defra will then forward this report to their external assessors who will comment on the work. Defra will then forward the critique of the work to Hillingdon.

Hillingdon should then forward a copy of this critique to **netcen**. Hillingdon should also consider if they could answer any of the questions directly.

9.2 LOCAL CONSULTATION ON THIS STAGE 4 ASSESSMENT

Hillingdon can ask for feedback from stakeholders who may be interested in the outcome of this Stage 4 air quality review and assessment. Important local stakeholders may include:

- London Borough of Hillingdon;
    - Environmental Services;
    - Transport Planning Services;
    - Development Planning Services;
    - LA21 Officers;
    - Elected councillors;
- Residents of the borough;
- Commerce and Industry within the borough;
- The Highways Agency;
- Transport for London;
- Neighbouring local authorities;
- BAA;
- BA;
- The Environment Agency;
- Other statutory consultees.

It is recognised that consultation with these agencies will also be required during the development of the AQAP (to assess the cost-effectiveness and feasibility of potential actions) and that consideration should be given to most effective way of managing the consultative process for reports on both the assessment and the action plan.

Hillingdon is already involved in working groups looking at the issues of two of the illustrative emission reduction scenarios, namely;

- **Aircraft Emissions Technical Working Group**
  This includes the local authorities surrounding Heathrow (Hillingdon, Hounslow, Slough and Spelthorne), members of the Environment teams from British Airways

and BAA Heathrow, Government departments (DEFRA, DfT) and academia. Among several targets, the aims to improve the current emissions inventories with regard to aircraft emissions, to ensure the accuracy of future modelling studies and to understand more fully the impact of aircraft emissions on local air quality. It is anticipated that this group will consult with representatives from the manufacturing industry to gain an understanding of the future improvements in aircraft technology with regard to emissions to air.

- **London Low Emission Zone Study**
  This is a joint study designed to allow the Mayor, in conjunction with the Association of London Government (ALG), London boroughs and the Government to assess the feasibility of the introduction of a Low Emission Zone in London. Hillingdon is a member of the Steering Group for this study. It is anticipated that the final phase of the study will be completed in early 2003.

9.3 FUTURE REVIEW AND ASSESSMENT

London Borough of Hillingdon has an ongoing duty to review and assess air quality. In particular a second round of review and assessment has commenced in which an Updating and Screening Assessment and a Detailed Assessment will be completed during 2003/04 that will continue to characterise the air quality in the borough. Also, annual progress reports are required that report on progress made in implementing the AQAP and achieving the required improvements in air quality. These assessments will be required to take account of new information regarding air quality at each stage.

Against this background, several issues that are foreseen to be highly relevant to air quality assessment in the borough have been identified.

Heathrow Airport - Terminal 5
The decision to allow the construction of Terminal 5 was given in November 2001. The construction phase for this project is about to start and is predicted to last for 5 to 6 years.

London Borough of Hillingdon is currently negotiating with BAA Heathrow to set the levels for control on dust emissions during construction. The controls will be based on monitoring results carried out in the area in the year preceding construction works. Air quality monitoring will continue throughout the construction phase. Officers from Hillingdon have access to the data via a password-protected web-site. Officers will liase with DEFRA should any future amendments to the AQMA designation be needed due to the scale of the construction project.

The terminal will allow more passengers and aircraft movements to pass through the airport. Future air quality assessments should take account of the increased activity at the airport.

Heathrow Airport - Emissions Inventory Update for 2000
The 1998 Heathrow Emissions Inventory (HEI), currently used for Hillingdon's modelling work, is being updated by BAA Heathrow plc. This update is anticipated to include refinements to the 1998 inventory to help to ensure greater accuracy of input data for use in modelling studies. When the updated HEI is publicly available, Hillingdon will undertake to re-model for NO_2 and PM_{10} to assess any potential changes to the areas of exceedance for these pollutants.

London Atmospheric Emissions Inventory Updates

One of the London Mayor's proposals within his Air Quality Strategy is to revise the emissions inventory annually. Future modelling studies should take therefore take account of developments in this area.

Assessments for objectives to be achieved by 2010

When the Emissions Inventory for Heathrow, including future predictions for an operational T5, is released, Hillingdon will undertake further modelling in order to ascertain the impact of Heathrow with 5 operational terminals. This is scheduled to be in 2008. As this date is after the 2004 PM_{10} objectives and 2005 NO_2 NAQS objectives will need to be achieved, future assessment work will be focused on compliance with the 2010 European Union provisional NO_2 limit and the PM_{10} objectives for 2010. Hillingdon will also, along with all London authorities, work towards achieving a PM_{10} standard of $20\mu g/m^3$ as an annual average by 2015.

It is expected that these objectives for PM_{10} may be harder to achieve than the ones to be achieved by 2004.

10 References

CERC (2002a) Air quality modelling for West London: Hillingdon, Hounslow, Spelthorne and Slough, Final report prepared for London Borough of Hillingdon.

CERC (2002b) Source apportionment for Hillingdon, Hounslow and Spelthorne, Final report prepared for London Borough of Hillingdon

DEFRA (2001a) Guidance to local authorities on the further (“stage 4”) assessments of air quality required under section 84 of the Environment Act 1995

DEFRA (2001b) The air quality strategy for England, Scotland, Wales and Northern Ireland. A consultation document on proposals for air quality objectives for air quality objectives for particles, benzene, CO and polycyclic hydrocarbons. Published by DEFRA in partnership with the Scottish Executive, The National Assembly for Wales and the Department of the Environment for Northern Ireland.

DEFRA (2003) Part IV of the Environment Act 1995, Local Air Quality Management, Technical Guidance, TG(03).

DETR (1999) Review of the United Kingdom National Air Quality Strategy. Department of the Environment, Transport and the Regions.

DETR (2000a) The Air Quality Strategy for England, Scotland, Wales and Northern Ireland. Department of the Environment, Transport and the Regions. Cm 4548, SE 2000/3, NIA 7.

DETR (2000b) Review and Assessment: Pollutant Specific Guidance. Part IV of the Environment Act 1995. Local Air Quality Management. LAQM.TG(00) May 2000.

GLA (2002) Cleaning London’s Air, The Mayor’s Air Quality Strategy, ISBN 1 85261 403 X, September 2002.

11 DEFRA compliance checklist

Review & Assessment Summary Checklist

Previous documents submitted	Report status	Decision by authority to stop	Accepted by appraiser	Authority have responded to report	Response accepted
Stage 1	Draft / Final	Y / N	Y / N	Y / N	Y / N
Comments					
Stage 2	Draft / Final	Y / N	Y / N	Y / N	Y / N
Comments					
Stage 3	Draft / Final	Y / N	Y / N	Y / N	Y / N
Comments					
COMMENTS BY DEFRA / NAFW / SE / NI / GLA					

Stage 4 Review & Assessment Checklist

Nitrogen dioxide	Response	Comments
Monitoring		
• Has further monitoring been undertaken?	Yes	See Section 5.4
• Is the totality of the monitoring effort sufficient?	Yes	
• Has monitoring confirmed 2005 exceedances?	Yes	See Section 5.4.4
• Has sufficient detail of QA/QC procedures been provided?	Yes	See Section 5.4 and Appendix 2
• Has monitoring amended the conclusion of Stage 3?	No	See Section 5.6
Modelling		
• Has further modelling been undertaken?	Yes	See Section 5.5 and Appendix 3
• Is the further modelling considered appropriate?		
• Has the model been appropriately validated?	Yes	.
• Has modelling confirmed 2005 exceedances?	Yes	See Section 5.5
• Has modelling amended the conclusions of the Stage 3?	No	See Section 5.6
General		
• Have both the magnitude and geographical extent of any exceedance been further changed?	Yes	See Section 5.5
• Has the decision to declare an AQMA been reversed at Stage 4?	No	See Section 5.6
• Is this decision soundly based ?		
• Has the authority taken account of the new vehicle emission factors ?	Yes	See Section 5.5 and Appendix 3
• Has the authority considered source apportionment?	Yes	See Section 7.3 and Appendix 4
• Has the authority considered the cost effectiveness of different abatement options?	No	See Section 7.4 and Appendix 5. Fuller treatment to be included in action plan
• Has the authority considered feasibility and effectiveness of different abatement options?	No	See Section 7.4 and Appendix 5. Fuller treatment to be included in action plan
• Has the authority considered the extent to which air quality improvement is required?	Yes	See Section 7.3

Stage 4 Review & Assessment Checklist

MONITORING & MODELLING WORK	Response	Comments
• Have monitoring uncertainties been addressed fully?	Yes	The diffusion tubes have been corrected for co-located bias. See Section 5.4 and Appendix 2
• Does the additional monitoring assessment appear sufficiently robust?		
• Have modelling uncertainties been addressed?	Yes	See Section 5.4.1
• Has the model been carefully validated?	Yes	
• Does the overall modelling assessment appear sufficiently robust?		
AQO EXCEEDANCES & AQMA DECLARATION	**Response**	**Comments**
• Have areas of exceedance been further defined?	No	
• Is the decision to amend or revoke the AQMA(s) at Stage 4, soundly based?	Yes	
• Is the decision reached based principally on monitoring?		Both the results of the modelling and monitoring suggest that further areas of the borough are likely to exceed the NO_2 objective.
• Is the decision reached based principally on modelling?		See above.
GENERAL	**Response**	**Comments**
• Has the authority focused on areas already identified as predicted to exceed objectives?		
• Has consideration been given to the exposure of individuals in relevant locations?	Yes	See section 5.5
• Has the authority considered new national policy developments?	Yes	See Section 4
• Has the authority considered new local developments?	Yes	See Section 4
• Does the report reach the expected conclusions? (in part/full?)		
• Has the authority undertaken further liaison with other agencies (in particular HA and EA?)		

Appendices

CONTENTS

Appendix 1
AQMA Designation Order

CONTENTS

LONDON BOROUGH OF HILLINGDON

ENVIRONMENT ACT 1995 PART IV SECTION 83

London Borough of Hillingdon Air Quality Management Area Order 2001

The London Borough of Hillingdon, Civic Centre, High Street, Uxbridge UB8 1UW ("the Council") in exercise of powers conferred upon it by the Environment Act 1995 Part IV Section 83 hereby makes the following Order.

1. This Order shall be cited as the London Borough of Hillingdon Air Quality Management Area 2001 and shall come into force on the 1st May 2001.

2. The area shown hatched in black on the attached map shall be declared the Air Quality Management Area. This comprises the area from the southern borough boundary north to the border defined by, the A40 corridor from the western borough boundary, east to the intersection with the Yeading Brook, following the Yeading Brook north until its intersection with the Chiltern-Marylebone railway line and then east along the railway line to the eastern borough boundary.

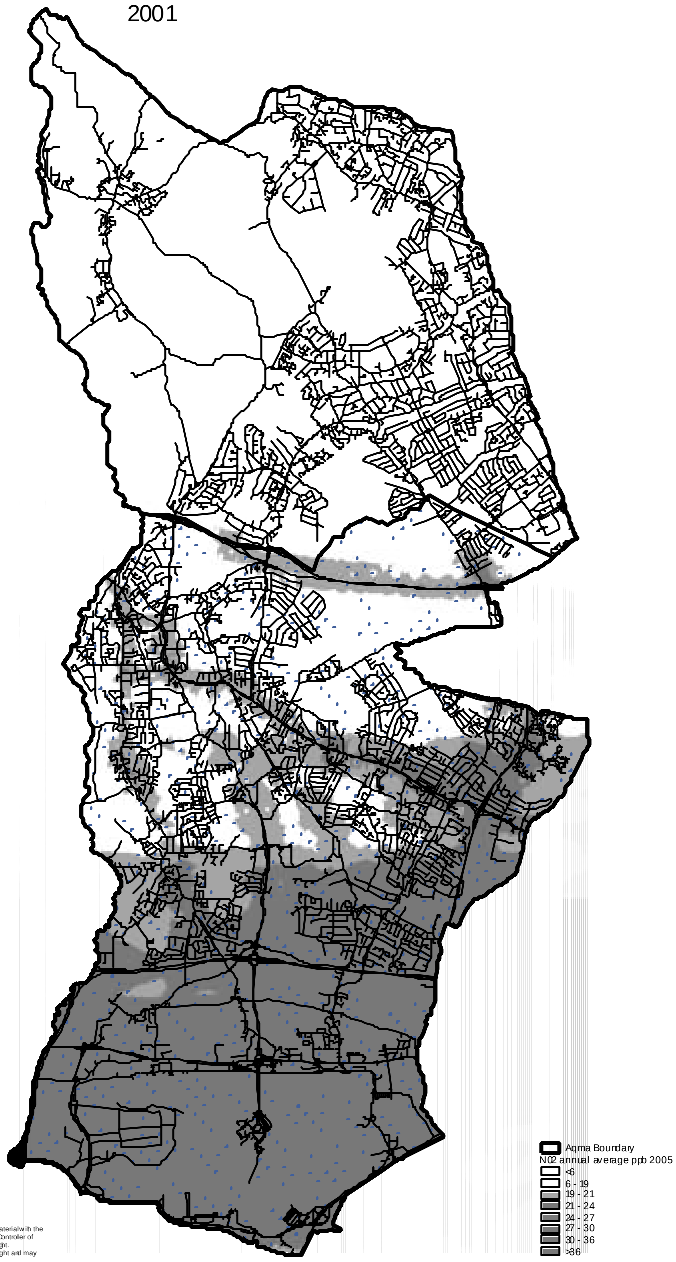
3. This Order is made specifically for the pollutant, nitrogen dioxide.

4. This Order shall remain in force until it is varied or revoked by a subsequent Order.

By Order of the Council

Kathryn Sparkes Dated 1st May 2001
Head of Consumer Protection Services

Hillingdon's Air Quality Management Area 2001



Appendix 2
Diffusion tube monitor results

CONTENTS

Table A2.1 Future year correction factors for NO_2 concentration

Adjustment	Background sites	Kerbside/roadside sites
1997 to 2005[1]	0.74/0.96 = 0.771	0.79/0.97 = 0.814
1998 to 2005[1]	0.74/0.93 = 0.796	0.79/0.94 = 0.840
1999 to 2005[2]	0.908/1.066 = 0.852	0.892/1.075 = 0.830
2000 to 2005[2]	0.908/1.025 = 0.886	0.892/1.033 = 0.864
2001 to 2005[2]	0.908	0.892
2002 to 2005[2]	0.908 / 0.973 = 0.933	0.892 / 0.969 = 0.921

Notes:
1. factors from LAQM.TG4 (00)
2. factors from LAQM.TG(03)

Table A2.2 Diffusion tube bias adjustment factors for 2000 data

Site	AURN site						South Ruislip site					
Type	Automatic monitor		Co-located diffusion tubes				Automatic monitor		Co-located diffusion tubes			
			1	2	3	Mean			1	2	3	Mean
Monthly mean	(µg/m^3)	Data capture	(µg/m^3)	(µg/m^3)	(µg/m^3)	(µg/m^3)	(µg/m^3)	Data capture	(µg/m^3)	(µg/m^3)	(µg/m^3)	(µg/m^3)
Jan-2000	50.0	90%					49.8	100%				
Feb-2000	53.5	99%					44.5	79%				
Mar-2000	46.4	100%					51.6	100%				
Apr-2000	52.8	100%					50.3	100%				
May-2000	43.1	99%	30.3	24.8	34.1	29.7	42.8	100%				
Jun-2000	51.9	99%	26.6	42.5		34.5	47.1	100%				
Jul-2000	37.3	92%	22.5	29.3	19.7	23.8	39.9	100%	42.0	26.7		34.3
Aug-2000	43.1	99%	32.6	34.1	30.0	32.2	39.7	100%	29.0	35.7		32.3
Sep-2000	47.1	99%	40.1	50.1	47.1	45.8	37.4	100%	50.6	39.2		44.9
Oct-2000	49.1	99%	34.1	32.2	31.4	32.6	39.8	100%	34.8	34.2		34.5
Nov-2000	54.8	99%	54.0	56.1	54.8	54.9	48.4	100%	49.5	54.0		51.8
Dec-2000	44.4	96%	37.7	43.6	35.6	38.9	41.0	100%	53.1	33.4		43.2
No. of months co-located[1]						8						6
Co-location period mean	46.3	98%				36.6	41.0	100%				40.2
Annual mean	47.8	98%					44.4	98%				
Period adjustment factor						1.031						1.081
Adjusted annual mean						37.7						43.4
Bias adjustment factor						**1.268**						**1.022**

Note:

1. Months where there is a diffusion tube mean result based on at least two individual tube results AND automatic monitor data capture is at least 90%

Table A2.3 Diffusion tube bias adjustment factors for 2001 data

Site	AURN site						South Ruislip site					
Type	Automatic monitor		Co-located diffusion tubes				Automatic monitor		Co-located diffusion tubes			
			1	2	3	Mean			1	2	3	Mean
Monthly mean	($\mu g/m^3$)	Data capture	($\mu g/m^3$)	($\mu g/m^3$)	($\mu g/m^3$)	($\mu g/m^3$)	($\mu g/m^3$)	Data capture	($\mu g/m^3$)	($\mu g/m^3$)	($\mu g/m^3$)	($\mu g/m^3$)
Jan-2001	48.8	89%					50.1	100%	36.8	50.1		43.4
Feb-2001	55.3	92%	25.3	35.1	31.3	30.6	47.7	100%	44.4	28.3		36.4
Mar-2001	55.9	99%	28.2	54.5	34.9	39.2	51.9	84%	52.7	41.8		47.2
Apr-2001	44.0	99%	32.7	27.1	25.9	28.6	43.0	100%	16.6	37.5		27.0
May-2001	39.1	99%	18.5	14.0	17.5	16.7	43.0	100%	27.1	19.6		23.3
Jun-2001	48.3	88%					43.5	100%	47.0	34.4		40.7
Jul-2001	42.5	92%	20.1	26.8	47.0	31.3	42.1	100%	22.0	30.0		26.0
Aug-2001	49.6	99%	40.5	15.7		28.1	43.3	99%	29.5	21.9		25.7
Sep-2001	34.5	100%	24.6	22.3	20.6	22.5	35.0	99%	35.0	39.1		37.0
Oct-2001	51.8	98%	24.4	17.8	22.6	21.6	44.5	79%	32.0	22.9		27.5
Nov-2001	44.3	99%	29.9	24.8	12.4	22.4	50.1	100%	35.1	32.8		33.9
Dec-2001	43.1	99%	27.6	23.6	34.5	28.6	47.6	99%	31.7	32.3		32.0
No. of months co-located[1]						10						10
Co-location period mean	46.0	98%				26.9	44.5	100%				32.6
Annual mean	46.4	96%					45.1	97%				
Period adjustment factor						1.009						1.014
Adjusted annual mean						27.2						33.0
Bias adjustment factor						**1.708**						**1.368**

Note:

1. Months where there is a diffusion tube mean result based on at least two individual tube results AND automatic monitor data capture is at least 90%

Table A2.4 Diffusion tube bias adjustment factors for 2002 data

Site	AURN site						South Ruislip site					
Type	Automatic monitor[1]		Co-located diffusion tubes				Automatic monitor[1]		Co-located diffusion tubes			
			1	2	3	Mean			1	2	3	Mean
Monthly mean	($\mu g/m^3$)	Data capture	($\mu g/m^3$)	($\mu g/m^3$)	($\mu g/m^3$)	($\mu g/m^3$)	($\mu g/m^3$)	Data capture	($\mu g/m^3$)	($\mu g/m^3$)	($\mu g/m^3$)	($\mu g/m^3$)
Jan-2001	51.0	92%	42.7	37.5	47.9	42.7	47.7	100%	43.3	64.0		53.7
Feb-2001	39.8	99%	17.3	38.6	22.4	26.1	33.2	96%	29.0	35.7		32.4
Mar-2001	54.0	99%					50.3	74%	19.8	32.6		26.2
Apr-2001	47.3	99%	57.1	28.6	23.8	36.5	42.3	100%	19.1	35.4		27.2
May-2001	48.6	99%	28.3	15.7	21.8	21.9	39.9	100%	26.5	20.8		23.7
Jun-2001	41.1	86%					34.6	100%	21.8	33.1		27.5
Jul-2001	35.4	99%	38.6	31.1	24.8	31.5	37.1	100%	33.9	26.4		30.1
Aug-2001	34.7	97%					40.5	100%				
Sep-2001	40.9	92%	35.3	42.7	33.0	37.0	45.3	100%	46.2	42.8		44.5
Oct-2001	51.7	99%	30.7	46.0	45.4	40.7	49.3	100%	41.9	38.4	48.4	40.1
Nov-2001	55.2	99%	44.6	44.6	45.5	44.9	53.9	100%	41.5	46.4	53.6	44.0
Dec-2001	43.8	100%	27.2	32.2	40.2	33.2	44.8	100%	48.2	45.7	55.0	47.0
No. of months co-located[2]						9						10
Co-location period mean	46.0	98%				34.9	42.8	100%				37.0
Annual mean	45.3	97%					43.2	97%				
Period adjustment factor						0.985						1.010
Adjusted annual mean						34.4						37.4
Bias adjustment factor						**1.316**						**1.157**

Note:

1. 2002 automatic monitor data is not yet ratified and may be subject to change
2. Months where there is a diffusion tube mean result based on at least two individual tube results AND automatic monitor data capture is at least 90%

Table A2.5 Predicted 2005 concentrations at monitoring sites based on 2000 data

Monitor	Automatic monitors				Diffusion tube locations								
Site	AURN site		South Ruislip site		AURN site	Allotments, Granville Road	83 Hayes End Drive	Barra Hall	Citizens Advice Bureau	South Ruislip	Uxbridge Day Nursery	Uxbridge Technical College	Hillingdon Primary School
Type[1]	S		R		S	B	B	B	B	R	R	R	R
Monthly mean	(μg/m³)	Data capture	(μg/m³)	Data capture	(μg/m³)	(μg/m³)	(μg/m³)	(μg/m³)	(μg/m³)	(μg/m³)	(μg/m³)	(μg/m³)	(μg/m³)
Jan-2000	50.0	90%	49.8	100%		40.1		28.4			32.5		
Feb-2000	53.5	99%	44.5	79%		32.7		30.5			45.4	33.9	
Mar-2000	46.4	100%	51.6	100%		38.1		39.7			31.0	41.6	
Apr-2000	52.8	100%	50.3	100%		27.5		25.7			30.7	33.0	
May-2000	43.1	99%	42.8	100%	29.7	25.9		22.0			30.3	24.6	
Jun-2000	51.9	99%	47.1	100%	34.5			18.9			16.7	25.5	
Jul-2000	37.3	92%	39.9	100%	23.8			19.4		34.3	38.2	30.4	
Aug-2000	43.1	99%	39.7	100%	32.2	28.1		24.1		32.3	30.2	28.7	
Sep-2000	47.1	99%	37.4	100%	45.8	13.6		33.6		44.9	25.2		
Oct-2000	49.1	99%	39.8	100%	32.6	18.5		28.7		34.5			
Nov-2000	54.8	99%	48.4	100%	54.9	30.2		30.4		51.8		40.1	
Dec-2000	44.4	96%	41.0	100%	38.9	33.3		26.9		43.2		20.0	
No. months concurrent [2]					8	10	0	12	0	6	8	8	0
Concurrent period mean					36.6	28.8		27.4		40.2	29.3	30.5	
Adjusted annual mean[3]					37.7	28.42		27.4		43.4	29.0	30.0	
Bias adjustment factor[4]					1.268	1.268		1.268		1.022	1.022	1.022	
Annual mean	47.8	98%	44.4	98%	47.8	36.0		34.7		44.4	29.6	30.6	
Future year correction factor[5]	0.886		0.864		0.886	0.886		0.886		0.864	0.864	0.864	
Predicted annual mean 2005	**42.3**		**38.3**		**42.3**	**31.9**		**30.7**		**38.3**	**25.6**	**26.5**	

Notes:

1. S=suburban, B=background, R=roadside. Predictions at the suburban and background sites are derived on the basis of the AURN site. Predictions at the roadside sites are derived on the basis of the South Ruislip automatic monitor
2. i.e. number of months where there is a diffusion tube result AND the monthly mean result at the automatic site is based on at least 90% data capture
3. adjusted by the ratio of the annual mean to the concurrent period mean at the relevant automatic monitoring site
4. See table A2.2
5. See table A2.1

Table A2.6 Predicted 2005 concentrations at monitoring sites based on 2001 data

Monitor	Automatic monitors				Diffusion tube locations								
Site	AURN site		South Ruislip site		AURN site	Allotments, Granville Road	83 Hayes End Drive	Barra Hall	Citizens Advice Bureau	South Ruislip	Uxbridge Day Nursery	Uxbridge Technical College	Hillingdon Primary School
Type[1]	S		R		S	B	B	B	B	R	R	R	R
Monthly mean	(μg/m³)	Data capture	(μg/m³)	Data capture	(μg/m³)	(μg/m³)	(μg/m³)	(μg/m³)	(μg/m³)	(μg/m³)	(μg/m³)	(μg/m³)	(μg/m³)
Jan-2001	48.8	89%	50.1	100%		32.6		29.6		43.4	41.0	38.0	
Feb-2001	55.3	92%	47.7	100%	30.6	26.1		26.1		36.4	25.0	26.2	32.3
Mar-2001	55.9	99%	51.9	84%	39.2	27.5		24.2		47.2	39.9		
Apr-2001	44.0	99%	43.0	100%	28.6	17.8		12.9		27.0	30.7		
May-2001	39.1	99%	43.0	100%	16.7	20.6		19.6	17.1	23.3	39.6	30.6	
Jun-2001	48.3	88%	43.5	100%		14.4	14.9	13.8	27.6	40.7		23.8	29.4
Jul-2001	42.5	92%	42.1	100%	31.3	23.2	17.7	14.6	23.2	26.0	17.7		19.5
Aug-2001	49.6	99%	43.3	99%	28.1	18.6	19.5	26.3	35.2	25.7	18.1	35.8	16.2
Sep-2001	34.5	100%	35.0	99%	22.5	25.5	21.3	21.9	16.0	37.0	25.5	30.2	
Oct-2001	51.8	98%	44.5	79%	21.6	30.9	33.8	32.6	38.9	27.5	40.0	44.1	
Nov-2001	44.3	99%	50.1	100%	22.4	28.6	16.1	15.6	9.2	33.9	30.0	16.6	7.4
Dec-2001	43.1	99%	47.6	99%	28.6	40.3	17.3	31.7		32.0	28.8	31.0	36.8
No. months concurrent[2]					10	10	7	10	6	10	8	8	6
Concurrent period mean					26.9	24.9	20.1	21.8	23.9	32.6	28.5	30.7	23.6
Adjusted annual mean[3]					27.2	25.0	20.8	21.9	25.0	33.0	28.8	30.8	23.3
Bias adjustment factor[4]					1.708	1.708	1.708	1.708	1.708	1.368	1.368	1.368	1.368
Annual mean	46.4	96%	45.1	97%	46.4	42.7	35.5	37.3	42.8	45.1	39.4	42.1	31.9
Future year correction factor[5]	0.908		0.892		0.908	0.908	0.908	0.908	0.908	0.892	0.892	0.892	0.892
Predicted annual mean 2005	**42.2**		**40.3**		**42.2**	**38.7**	**32.2**	**33.9**	**38.8**	**40.3**	**35.2**	**37.6**	**28.4**

Notes:

1. S=suburban, B=background, R=roadside. Predictions at the suburban and background sites are derived on the basis of the AURN site. Predictions at the roadside sites are derived on the basis of the South Ruislip automatic monitor
2. i.e. number of months where there is a diffusion tube result AND the monthly mean result at the automatic site is based on at least 90% data capture
3. adjusted by the ratio of the annual mean to the concurrent period mean at the relevant automatic monitoring site
4. See table A2.2
5. See table A2.1

Table A2.7 Predicted 2005 concentrations at monitoring sites based on 2002 data

Monitor	Automatic monitors[1]				Diffusion tube locations								
Site	AURN site		South Ruislip site		AURN site	Allotments, Granville Road	83 Hayes End Drive	Barra Hall	Citizens Advice Bureau	South Ruislip	Uxbridge Day Nursery	Uxbridge Technical College	Hillingdon Primary School
Type[2]	S		R		S	B	B	B	B	R	R	R	R
Monthly mean	(µg/m³)	Data capture	(µg/m³)	Data capture	(µg/m³)	(µg/m³)	(µg/m³)	(µg/m³)	(µg/m³)	(µg/m³)	(µg/m³)	(µg/m³)	(µg/m³)
Jan-2002	51.0	92%	47.7	100%	42.7	31.7	38.1	30.5	32.8	53.7	44.9	36.4	50.8
Feb-2002	39.8	99%	33.2	96%	26.1	16.8	25.6	18.5	14.0	32.4	19.6	27.4	
Mar-2002	54.0	99%	50.3	74%		24.3	16.5	11.5	31.7	26.2	26.6	18.4	
Apr-2002	47.3	99%	42.3	100%	36.5	16.2	16.2	20.9	14.5	27.2		17.8	15.6
May-2002	48.6	99%	39.9	100%	21.9	32.2	13.9	15.2	50.4	23.7	30.0	16.5	17.8
Jun-2002	41.1	86%	34.6	100%			20.1	14.8	18.3	27.5	26.6	27.2	8.9
Jul-2002	35.4	99%	37.1	100%	31.5		16.1	20.7	19.5	30.1		16.7	30.5
Aug-2002	34.7	97%	40.5	100%									
Sep-2002	40.9	92%	45.3	100%	37.0		26.3	30.3	28.0	44.5	43.9	41.8	45.7
Oct-2002	51.7	99%	49.3	100%	40.7		21.2	30.6	31.3	40.1	36.6		35.9
Nov-2002	55.2	99%	53.9	100%	44.9		37.9	31.7	21.9	44.0	49.1		40.6
Dec-2002	43.8	100%	44.8	100%	33.2		38.3	30.3	32.8	47.0		48.2	34.6
No. months concurrent[3]					10	10	7	10	6	10	8	8	6
Concurrent period mean					34.9	24.2	25.0	24.0	27.7	37.0	35.8	29.0	31.2
Adjusted annual mean[4]					34.4	22.8	24.2	23.3	26.8	37.4	35.7	30.9	30.7
Bias adjustment factor[5]					1.316	1.316	1.316	1.316	1.316	1.157	1.157	1.157	1.157
Annual mean	45.3	97%	43.2	97%	45.3	30.0	31.9	30.6	35.3	43.2	41.3	35.7	35.5
Future year correction factor[6]	0.933		0.921		0.933	0.933	0.933	0.933	0.933	0.921	0.921	0.921	0.921
Predicted annual mean 2005	**42.3**		**39.8**		**42.3**	**28.0**	**29.7**	**28.6**	**32.9**	**39.8**	**38.0**	**32.9**	**32.7**

Notes:

1. 2002 data are not yet ratified and may be subject to change
2. S=suburban, B=background, R=roadside. Predictions at the suburban and background sites are derived on the basis of the AURN site. Predictions at the roadside sites are derived on the basis of the South Ruislip automatic monitor
3. i.e. number of months where there is a diffusion tube result AND the monthly mean result at the automatic site is based on at least 90% data capture
4. adjusted by the ratio of the annual mean to the concurrent period mean at the relevant automatic monitoring site
5. See table A2.2
6. See table A2.1

Appendix 3
Air Quality Modelling for West London

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Appendix 4
Source Apportionment for Hillingdon

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Source apportionment for Hillingdon, Hounslow and Spelthorne, Final report prepared for London Borough of Hillingdon by CERC. 2002

Appendix 5
Scenario modelling for Hillingdon

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