AURN QAQC ANNUAL TECHNICAL REPORT 2022

Report for: The Environment Agency

Ref. 25952 Lot 2&5 ATR 2022

Ricardo ref. ED12695201_ATR_2022 Issue 1 26/07/2023

Customer:
The Environment Agency

Customer reference:
25952

Ricardo reference:
ED12695100_ATR_2022

Contact:
Alison Loader
Ricardo Energy & Environment
Gemini Building, Harwell, Didcot, OX11 0QR, United Kingdom

T: +44 (0) 1235 753 632
E: Alison.Loader@ricardo.com

Author:
Sion Carpenter

Approved by:
Alison Loader

Signed

Date:
26/07/2023

Ricardo is certified to ISO9001, ISO14001, ISO27001 and ISO45001.

Executive summary

The Automatic Urban and Rural Network (AURN) is the UK's main automatic air quality monitoring network. This annual technical report summarises the quality assurance and quality control (QAQC) activities carried out for the Automatic Urban and Rural Network (AURN) over the period 1st of January to 31st of December 2022. It summarises the key data capture and data quality statistics and highlights any issues that have been identified relating to the QAQC activities associated with the AURN during this period.

The number of AURN monitoring stations in operation during part or all of this period was 170 separate locations. There were also three co-located gravimetric particulate samplers in operation for part or all of the year, one located at Port Talbot Margam (measuring PM_{10}) and two at London Marylebone Road (measuring $PM_{2.5}$ and PM_{10}). The gravimetric samplers are counted as separate stations for the purpose of this report.

Ricardo Energy & Environment (Ricardo) carried out the QAQC activities for the majority of the monitoring stations in the network. The National Physical Laboratory (NPL) carried out the QAQC activities for the Automatic London Network (ALN) – a subset of 16 sites, mostly within the Greater London area.

During this year, two full intercalibration exercises (winter and summer) were carried out, involving comprehensive performance tests on every analyser in the network. In addition, two ozone-only intercalibration exercises (spring and autumn) were carried out. This programme of intercalibrations allows the accuracy of the measured results to be determined, and a measurement uncertainty for each analyser to be calculated, as required by the Data Quality Objectives of the Air Quality Standards Regulations. Whilst the UK has now left the European Union, in 2022, it still followed the requirements set out in the European Union's Air Quality Directive (2008/50/EC), in England via the Air Quality Standards Regulations (AQSR 2010), and variations of these for the Devolved Administrations, i.e. the Scottish Government, Welsh Government and the Northern Ireland Assembly (collectively referred to as the Air Quality Standards Regulations within this report).

The mean data capture for ratified hourly average data was 93.8% (averaged over all pollutants O_3, NO_2, SO_2, CO, PM_{10} and $PM_{2.5}$), for the 12-month reporting period 1st of January to 31st of December 2022.

The data capture target of the Air Quality Standards Regulations is 90% (excluding periods of planned maintenance e.g., calibrations, audits and servicing). An allowance of 5% is made for this, hence a target of 85%. Mean data captures for individual pollutants were as follows: NO_2 93.5%, PM_{10} 96.1%, $PM_{2.5}$ 95.4%, CO 90.8% O_3 92.6%, SO_2 91.5%. Hence, the mean data captures for all pollutants met this target in calendar year 2022. The small number of CO and SO_2 instruments within the network means that single site issues can have significant impacts on overall data capture statistics.

CONTENTS

1. INTRODUCTION

1.1 BACKGROUND

The UK Automatic Urban and Rural Network (AURN) was established to provide information on air quality throughout the UK for a range of pollutants. The primary function of the AURN is to provide data in compliance with the requirements of the Air Quality Standards Regulations [1], [2], [3], [4], [5], [6], [7] [8], [9], [10], [11]. The data and information from the AURN are also used by scientists, policy makers and planners to enable them to make informed decisions on managing and improving air quality for the benefit of human health and the natural environment.

A number of organisations are involved in the day-to-day running of the network, under contract 25952 which runs from 1st of October 2021 to 30th of September 2024, the role of Central Management and Co-ordination Unit (CMCU) for the entire AURN was contracted to Bureau Veritas in two lots (Lot 1 and Lot 3). The role of QAQC Unit was split into three lots for this contract: Lot 2 (QAQC of National AURN sites)) and Lot 5 (spring and autumn ozone audits at all AURN sites) are contracted to Ricardo Energy & Environment. Lot 4 (QAQC of those sites that are also on the Automatic London Network – the ALN) was awarded to the National Physical Laboratory (NPL).

The responsibility for day-to-day operation of individual monitoring stations is assigned to Local Site Operators (LSOs): local organisations with relevant experience in the field under the direct management of (and contract to) the CMCU. Calibration gases for the network were supplied by BOC during 2022 and were provided with an ISO17025 certificate of calibration by Ricardo Energy & Environment (under a separate contract). The monitoring equipment was serviced and maintained by a number of Equipment Support Units, under contract to the CMCU in the case of fully EA funded stations.

Data from the AURN are disseminated to the public, the scientific community and other users via UK-AIR (the online UK-AIR Information Resource, http://uk-air.defra.gov.uk/) and other media such as social media and freephone services. This is the responsibility of the Data Dissemination Unit (DDU) under a separate contract. The DDU is also responsible for producing a summary report of the data from this and other UK air quality monitoring networks. This is published annually as the "*Air Pollution in the UK*" series of reports, available on UK-AIR.

Approximately half of the stations in the AURN are fully funded by the Environment Agency, and the management of all aspects of these stations is carried out by the CMCU. The remainder are owned by third parties (mostly local authorities) but affiliated to the AURN; and the stations and monitoring equipment remain the responsibility of local authorities or other organisations. This includes servicing and maintenance, and LSO activities. The distinction between fully funded and affiliate monitoring stations is no longer clear-cut, as a number of otherwise LA-owned affiliate stations have one or more fully funded analysers installed. However, all AURN stations benefit from centralised data ratification, six-monthly QAQC audits, certified gas mixtures for analyser calibrations, and centralised data collection and dissemination.

A total of 170 monitoring stations in the AURN operated during part or all of the year 2022. This does not include the two stations where gravimetric particulate samplers were co-located with automatic particulate analysers. The gravimetric data are used in validating the performance of the automatic analysers. For data processing purposes, in these cases the gravimetric sampler is treated as a separate station; and they are shown, and counted, separately in the data capture tables in section 3.

This report includes information on performance of the AURN site at London Harlington although the QAQC work is not conducted on behalf of the Environment Agency and Defra.

Mace Head is a remote monitoring station on the western coast of the Republic of Ireland: it is included in the UK AURN to provide information on background ozone levels unaffected by local pollution sources.

1.2 WHAT THE AURN DATA ARE USED FOR

The AURN and its forerunners has been in operation since 1992, although some automatic air quality monitoring has been undertaken in the UK since 1973. The network has expanded and developed over many years. Provisional data are disseminated hourly (i.e., in near real time) by the Data Dissemination Unit (DDU) via the Defra UK Air Information Resource, UK-AIR, at http://uk-air.defra.gov.uk/. The QAQC Units carry out data ratification quarterly in arrears, and report the ratified dataset quarterly, also via UK-AIR.

The major objectives of the network are as follows:

- Monitoring compliance with relevant statutory air quality standards, objectives, limit values and target values (e.g., the Air Quality Standards Regulations and the UK Air Quality Strategy [7]);
- Informing the public about air quality;
- Providing information for local air quality management within the UK Air Quality Strategy;
- Identifying long-term trends in air pollution concentrations; and
- Assessing the effectiveness of policies to control pollution.

The data from the AURN are used for:

- Reporting compliance with the Air Quality Standards Regulations.
- Comparison with air quality objectives as laid out in the Air Quality Strategy.
- Providing the public with information through air quality bulletins.
- Forecasting future air quality levels.
- Policy development for human health and ecosystem protection.
- The European Monitoring and Evaluation Programme (EMEP).
- The UK Local Air Quality Management regime under Part IV of the Environment Act 1995.
- National Indicators on environmental quality.

1.3 WHAT THIS REPORT COVERS

This report explains and reports the main QAQC activities carried out by both QAQC contractors over the twelve-month period 1st of January to 31st of December 2022 at all AURN stations. It includes a summary of QAQC methodology applied, and an overview of data capture.

2. METHODOLOGY

2.1 OVERVIEW OF QAQC ACTIVITIES

The QAQC activities consist of the following key parts:

- QAQC audits of all analysers in the network every six months. These are carried out in January-February (the winter audit round) and July-September (the summer audit round). In addition, all ozone analysers are also audited in spring (April) and autumn (October) each year. (Please note that the ‘winter’ audits in each year happen before the ‘summer’ audits.)
- Ratification of the data on a three-monthly basis, and upload of ratified data to the Data Dissemination Unit.
- Investigation of instances of suspected poor-quality data.
- Where necessary, assessment of new station locations in conjunction with the CMCU, and assessment of compliance with the siting criteria in the Air Quality Standards Regulations.
- This contract also includes the role of Health and Safety Coordinator for all national air quality monitoring networks.

2.2 QAQC ACTIVITIES

2.2.1 Purpose of Intercalibration

The QAQC intercalibration audits fulfil a number of important functions:

- Validation of the production of provisionally scaled data, which is rapidly disseminated to the public soon after collection.
- Identification of poorly performing analysers and infrastructure (for example housings and air conditioning units), together with recommendations for corrective action.
- A measure of network performance, by examining for example, how different NOx analysers around the network respond to a common gas standard. This tests the harmonisation of the AURN, e.g., that a 200ppb NO_2 pollution episode at any given monitoring station would be reported in exactly the same way at every other station in the UK, regardless of the location or the analyser used to record the event.
- Assessment of the area around the monitoring station: has the environment changed in the last six months? Is the location still representative of the station classification?

The QAQC audits test the following aspects of analyser performance:

1. Analyser accuracy and precision. These are basic checks to ensure analysers respond to known concentrations of gases in a reliable manner.
2. Instrument linearity. This test refines the response checks on analysers, by assessing whether (for example) doubling a concentration of gas to the analyser results in a doubling of the analyser signal response. If an analyser's response characteristics are not linear, data cannot be reliably scaled into concentrations.
3. Instrument signal noise. This test checks that an analyser responds to calibration gases in a stable manner with time. A "noisy" analyser may not provide high quality data which may be difficult to process at lower concentrations.
4. Analyser response time. This test checks that the analyser responds quickly to a change in gas concentrations. If analyser response is too slow, data may not accurately reflect ambient concentrations.
5. Leak and flow checks. These tests ensure that ambient air reaches the analysers, without being compromised in any way. Leaks in the sampling system can affect the ability of the analyser to sample ambient air reliably.
6. NOx analyser converter efficiency. This test evaluates the ability of the analyser to measure NO_2. An inefficient converter severely compromises the data from the analyser.
7. Calibration of ozone analysers. Ozone is not stable, so it is not possible to calibrate ozone analysers using traceable gas standards in the same way as those for other pollutants. Instead, ozone analyser calibrations are undertaken with recently calibrated ozone photometers.
8. Particulate analyser flow rate checks. These tests ensure that the flow rates through critical parts of the analyser are within specified limits. There are specific analyser flow rates that are set to make sure particle size fractions and mass concentration calculations are performed correctly.
9. Evaluation of station cylinder concentrations. These tests use a set of certified cylinders that are taken to all the stations. The concentrations of the station cylinders are used to scale pollution datasets, so it is important to ensure that the concentrations of gases in the cylinders do not change.
10. Competence of Local Station Operators (LSOs) in undertaking calibrations. As it is the calibrations by the LSOs that are used to scale pollution datasets, it is important to check that these are undertaken competently. The Covid-19 pandemic greatly restricted face-to-face LSO training and competence audits: these were carried out only in exceptional cases during 2020 and 2021. Routine face-to-face LSO training resumed in early 2022.
11. Zero "calibration" of all automatic PM analysers. This test allows the baseline performance of PM analysers to be evaluated, to determine whether any remedial action is required to the analyser or baseline to be corrected during ratification. In the case of Beta Attenuation Monitor (BAM) instruments this is carried out by placing a high efficiency particulate absorbing (HEPA) filter on the instrument's inlet, usually for a period of a few days. A different procedure is used for the Fidas™.

Once all data have been collected, a "Network Intercalibration" is conducted by both QAQC units. This utilises the audit gas cylinders transported to each station in the Network. These cylinders will have been recently calibrated using ISO 17025 accredited procedures. This exercise allows us to examine how different station analysers respond when they are supplied with the same gas used at other stations. For ozone analysers, the calibration is undertaken with recently calibrated ozone photometers.

The technique used to process the intercalibration results is broadly as follows:

- The analyser responses to audit gas are converted into concentrations, using provisional calibration factors obtained from the CMCU on the day of the intercalibration. These factors are also used for the provisional data supplied to UK-AIR.

- These individual results are tabulated, and statistical analyses undertaken (e.g., network average result, network standard deviation, deviation of individual stations from the network mean etc.).

These results are then used to identify any problem analysers, or "outliers", which are investigated further to determine reasons and investigate possible remedies for the outliers. The definition of an outlier is an analyser result that falls outside the following limits:

- ±10% of the network average for NOx, CO and SO_2 analysers,
- ±5% of the reference standard photometer for ozone analysers,
- ±10% for particulate analyser flow rates,
- Particulate analyser average zero response within ±3.0 µg m^{-3}.
- ±10% for the recalculation of station cylinder concentrations.

Thus, the intercalibration investigates the quality of provisional data output by the Management Unit as provided to the UK-AIR website. It also provides input into the ratification process by highlighting stations where close scrutiny of datasets is likely to be required.

Any outliers that are identified are rigorously checked to determine the cause, and any required corrective action to be taken, if necessary. There are a number of likely main causes for outlier results, as discussed below:

- Drift of an analyser between scheduled LSO calibrations. This is by far the most common cause of an outlier result, and one that is simply corrected for during ratification of data.
- Drift of station cylinder concentrations between intercalibrations. Station cylinders can sometimes become unstable, especially at low pressures. All station cylinder concentrations are checked every six months and are replaced as necessary.
- Erroneous calibration factors. It can occasionally happen that an analyser calibration is unsuccessful, and results in unsuitable scaling factors being used to produce pollution datasets. These are identified and corrected during ratification.
- Pressurisation of the sampling system at the audit. Occasionally, an analyser can be very sensitive to small changes in applied flow rates of calibration gas. This is more difficult to identify and correct and may have consequences for data quality.
- Leaks, sample switching valves, etc. Outliers can be generated if an analyser is not sampling ambient air properly. It is likely that if a leaking analyser is identified, data losses will result.

Full audits of all analysers are carried out at six-monthly intervals in the winter (January-March) and summer (July-September). In addition, audits of ozone analysers are also carried out in spring (April) and autumn (October).

2.2.2 Baseline Checks for BAM Particulate Analysers

As part of the routine QAQC audits BAM analysers have zero checks carried out every six months. This is done by placing a HEPA filter on the inlet for a few days, so the instrument is sampling air free from particulate matter. This quantifies the instrument's zero baseline response and allows identification of analysers which have high baseline responses to air containing no particulate matter. The CEN standard method for ambient particulate matter EN16450 states that action must be taken when the baseline response is higher than 3 µg m^{-3} but does not state what the action should be. Originally, the only agreed action was to delete the data. However, as part of ongoing improvement activities a protocol was agreed in 2015 to enable baselines to be corrected where baseline responses are outside the range ±3 µg m^{-3}. (The zero baseline check for the Fidas™ instrument is carried out using a different testing procedure: zero baseline correction is not applicable to the Fidas™).

2.2.3 Uncertainties of Measurement

The measured uncertainties of measurement are determined at each QAQC audit, and the results for the winter and summer 2022 audits are given in Appendix 2.

The European Committee for Normalisation (CEN) has prepared a series of documents prescribing how analysers must be operated, to produce datasets that conform to the Data Quality Objectives of the EC Directives. These Data Quality Objectives continue to apply in the UK, via the Air Quality Standards Regulations. The CEN documents for operation of air pollution analysers; BS EN14211:2012 (NOx), BS EN14212:2012 (SO_2), BS EN14626:2012 (CO) and BS EN14625:2012 (O_3) set out a series of performance criteria for analysers which must be achieved, both in the field and under laboratory conditions. The test requirements have been extensively reported in previous intercalibration summaries and should be referenced for further information. To this end, the procedures used for the intercalibrations have been fully compliant with the CEN protocols since January 2006.

To comply with the Data Quality Objectives, the expanded measurement uncertainty for gaseous analyser measurements must not exceed ±15%. For PM analysers, the required expanded measurement uncertainty must not exceed ±25%. For stations that have CEN-compliant instrumentation, it is possible to calculate the overall uncertainty of measuring air quality, at the point they are audited.

In 2022, there were a small number of analysers where the calculated uncertainty was higher than that stipulated by the Data Quality Objectives. In Appendix 2, these are shown in bold red font. The most common cause of this is 'noisy' response as measured during the audit. This is generally an indication of poor instrument performance, and these cases are reviewed at the Quality Circle (see section 2.3) to assess the impact on reported data. High noise levels on particulate analysers are reported to CMCU and ESUs prior to each service to ensure the necessary repair procedures are carried out by the engineer.

It should be noted that these uncertainties are applicable ***only on the day of test***. They are therefore a snapshot only, and it should not necessarily be inferred that these values apply to the entire year's dataset. In particular, a high uncertainty measured at audit may be as a result of a fault, which would be reported to CMCU who would request an ESU visit to repair the instrument. The QAQC Unit then decides whether to report the data for the affected period or delete them, as appropriate.

The following analysers were outside the maximum uncertainties during 2022:

- Winter: one NOx, four PM_{10}, three $PM_{2.5}$
- Summer: two NOx, one O_3, three PM_{10}, one $PM_{2.5}$

In these cases, analyser faults were identified, and some data deleted during ratification.

2.2.4 Certification and Accreditation

Both of the QAQC Units hold ISO/IEC17025 accreditation for the field calibration of gaseous analysers, performance tests of particulate analysers and calibration of the gas mixtures used for regular LSO calibrations. Ozone analysers receive quarterly multipoint calibrations from a certified photometer, as required by the Air Quality Standards Regulations.

Certified calibrations of ozone photometers used by the ESUs are provided by the QAQC Unit prior to six-monthly service schedules.

2.3 OVERVIEW OF DATA RATIFICATION

Data for each station are supplied monthly by the CMCU. Once initial monthly data files have been received, checked and loaded into the QAQC contractor's data handling system, the process of data ratification begins. This process is required to refine data scaling based on all the calibration and audit data available, and to identify, withdraw or flag anomalous data due to instrument or sampling faults or where data fall outside the Uncertainties or Limits of Detection defined by the Data Quality Objectives (DQOs) of the Air Quality Standards Regulations. Once a site's dataset has been ratified, it is checked once more by a senior member of the ratification team. Any issues that require further attention or discussion are then forwarded to the Quality Circle, a meeting which is attended by all senior ratifiers as well as representatives from the CMCU.

2.4 IMPACTS OF COVID-19 PANDEMIC ON QAQC ACTIVITES

Face-to-face LSO training and LSO competence audits were severely restricted throughout 2019, 2020 and into 2021 due to the Covid pandemic. To address the potential impact on LSO competence, Ricardo produced a series of LSO training videos to help LSOs maintain their skill levels until restrictions were lifted. These were made available to LSOs on the AURN Hub (an online resource for LSOs). During 2022, face-to-face LSO training was prioritised and at the time of writing (May 2023) over 87% of AURN sites have had at least one LSO trained or provided with refresher training in the past 12 months.

3. DATA CAPTURE

3.1 OVERVIEW

Ratified hourly average data capture for the network averaged 93.8% for all pollutants (O_3, NO_2, SO_2, CO, PM_{10} and $PM_{2.5}$) during the 12-month reporting period January-December 2022. Data capture statistics are calculated using the actual data capture as hourly averages (daily for gravimetric analysers) against the total number of hours (or days) in the relevant period; service and maintenance are counted as lost data. It is permissible to discount routine service and calibration from achievable data capture targets, but this is not calculated. All pollutants achieved 85% or higher data capture on average. The data capture target for the purposes of monitoring compliance with the Air Quality Standards Regulations is 90% excluding planned servicing and maintenance. For practical purposes in the AURN, planned maintenance is assumed to be 5% so a target of 85% data capture is used.

3.2 OVERALL DATA CAPTURE

The overall data capture for all stations for 2022 is given in Table 3-1. Note that where an instrument starts or stops measuring during the year, the quoted data capture is that for the part of the year in which the instrument was operating; for example, an instrument commissioned on 30th of June which then operated for the rest of the year without interruption would have a data capture of 100% for the year.

Table 3-1 Summary of Data Capture for the AURN, January - December 2022

	NO_2	PM_{10}	$PM_{2.5}$	CO	O_3	SO_2	All
Number of stations	158	111	100	7	74	28	170
Number of Stations <85%	15	8	11	1	10	5	13
Number of Stations < 90%	26	9	14	2	14	9	26
Average	**93.5%**	**96.1%**	**95.4%**	**90.8%**	**92.6%**	**91.5%**	**93.8%**

3.3 GENERIC DATA ISSUES

The following generic data quality issues have been identified in 2022:

- Poor performance of some analysers impacted upon data capture.
- Leaks in the BAM analysers, where the nozzle does not properly seal against the tape.

In some cases, the ESU may choose to avoid significant data loss by removing an instrument for workshop repair and install a temporary loan instrument at the station. This is termed a “hotspare” analyser. This may not be of the same type of analyser, which has implications for LSO calibration procedures, and also for the reporting of instrument types in the annual data submission.

The QAQC audits continued to identify high zero baseline responses for some particle analysers in the network; some data were deleted as a result. These zero tests provide evidence for internal leaks (for BAMs) at some stations. As explained in section 2.2.2, the results of zero baseline tests can be used to apply correction to data where high baselines have been identified.

The tables in the following sections 3.4 to 3.8 list the data capture for each pollutant at each site in 2022. Where data capture was less than the target of 85%, the site is included in Appendix 3, which explains the reasons for the reduced data capture.

3.4 DATA CAPTURE – ENGLAND (EXCLUDING LONDON)

The data capture statistics for stations within England (excluding Greater London) are given in Table 3-2. Four of these sites – Borehamwood Meadow Park, Horley, Sandy Roadside and Stanford-le-Hope Roadside - are marked with an asterisk (*): these are part of the Lot 4 group of sites for which NPL is the QAQC contractor. Annual data capture statistics for these sites was provided by NPL.

Table 3-2 Data Capture for Stations in England Excluding Greater London, January - December 2022

Site Name	NO_2	PM_{10}	$PM_{2.5}$	CO	O_3	SO_2	Average
Barnsley Gawber	95.2%				99.3%	99.0%	97.8%
Barnstaple A39		45.9%	45.0%				45.5%
Bath A4 Roadside	96.1%						96.1%
Billingham	99.3%						99.3%
Birkenhead Borough Road	90.6%						90.6%
Birmingham A4540 Roadside	99.3%	99.4%	99.4%		98.8%		99.2%
Birmingham Ladywood	93.0%	99.8%	99.8%		97.9%	90.1%	96.1%
Blackburn Accrington Road	90.6%						90.6%
Blackpool Marton	99.4%	99.9%	99.9%		97.6%		99.2%
Borehamwood Meadow Park*	97.1%	99.9%	99.9%				99.0%
Bournemouth	89.2%		95.9%		99.3%		94.8%
Bradford Mayo Avenue	90.5%						90.5%
Brighton Preston Park	99.5%		94.2%		77.5%		90.4%
Bristol St Paul's	96.1%	93.8%	94.5%		96.5%		95.2%
Bristol Temple Way	97.1%	76.7%					86.9%
Burton-on-Trent Horninglow	76.2%	99.9%	99.9%				92.0%
Bury Whitefield Roadside	92.0%	95.9%					94.0%
Cambridge Roadside	75.5%						75.5%
Cannock A5190 Roadside	98.9%						98.9%
Canterbury	87.4%	96.7%	96.7%		99.1%		95.0%
Carlisle Morton A595	95.2%	93.9%	97.0%				95.4%
Charlton Mackrell	98.7%	97.1%	97.1%		97.1%		97.5%
Chatham Roadside	98.9%	97.2%	97.2%				97.7%
Chesterfield Loundsley Green	97.7%	99.9%	99.9%				99.2%
Chesterfield Roadside	97.6%	99.9%	100.0%				99.2%
Chilbolton Observatory	96.4%	99.0%	99.0%		98.4%	90.3%	96.6%

Site Name	NO_2	PM_{10}	$PM_{2.5}$	CO	O_3	SO_2	Average
Christchurch Barrack Road	88.3%		93.1%				90.7%
Coventry Allesley	99.3%	99.5%	99.5%		99.4%		99.4%
Coventry Binley Road	99.0%	96.9%					97.9%
Crewe Coppenhall	99.7%	99.6%	99.6%				99.6%
Derby St Alkmund's Way	98.1%						98.1%
Dewsbury Ashworth Grove	98.5%	99.9%	99.9%				99.4%
Doncaster A630 Cleveland Street	93.1%						93.1%
Eastbourne	81.1%	96.7%	96.7%				91.5%
Exeter Roadside	96.9%				76.8%		86.9%
Glazebury	89.5%	99.5%	99.5%		73.8%		90.6%
Hartlepool St Abbs Walk	98.5%	98.9%	98.9%				98.8%
High Muffles	98.0%	97.4%	97.4%		99.3%		98.0%
Honiton	93.1%	98.7%	98.7%				96.8%
Horley*	92.4%						92.4%
Hull Freetown	99.0%	99.6%	99.6%		99.1%	94.3%	98.3%
Hull Holderness Road	98.4%	95.5%					96.9%
Immingham Woodlands Avenue	93.5%	99.6%	99.6%				97.6%
Ladybower	97.6%				78.6%	99.1%	91.8%
Leamington Spa	89.5%	99.9%	99.9%		98.7%		97.0%
Leamington Spa Rugby Road	76.8%	99.8%	99.8%				92.1%
Leeds Centre	97.6%	99.3%	99.3%	95.5%	99.0%	98.8%	98.3%
Leeds Headingley Kerbside	93.9%	96.2%	96.2%				95.5%
Leicester A594 Roadside	95.8%	96.7%					96.3%
Leicester University	99.1%	99.7%	99.7%		99.2%		99.4%
Leominster	99.1%				95.0%		97.1%
Lincoln Canwick Road	94.7%						94.7%
Liverpool Speke	99.1%	93.5%	64.8%		99.1%	93.5%	90.0%
Lullington Heath	96.3%	99.2%	99.2%		98.7%	70.6%	92.8%
Luton A505 Roadside	97.8%						97.8%
Manchester Piccadilly	99.1%	98.1%	98.1%		99.0%	96.9%	98.2%
Manchester Sharston	98.7%				99.2%		98.9%
Middlesbrough	98.9%	95.9%	93.7%		98.8%	94.7%	96.4%
Newcastle Centre	99.0%	97.1%	97.3%		99.0%		98.1%

Site Name	NO_2	PM_{10}	$PM_{2.5}$	CO	O_3	SO_2	Average
Newcastle Cradlewell Roadside	96.9%	93.2%					95.1%
Northampton Spring Park	96.6%		97.2%		94.8%		96.2%
Norwich Lakenfields	99.2%	97.4%	97.4%		99.1%		98.3%
Nottingham Centre	98.9%	99.3%	99.3%		90.7%	82.3%	94.1%
Nottingham Western Boulevard	99.4%	96.6%					98.0%
Oldbury Birmingham Road	99.7%						99.7%
Oxford Centre Roadside	99.7%						99.7%
Oxford St Ebbes	99.6%	99.9%	99.9%				99.8%
Plymouth Centre	99.2%	99.4%	99.4%		97.0%		98.8%
Plymouth Tavistock Road	95.2%						95.2%
Portsmouth	98.7%	81.9%	82.0%		99.3%		90.5%
Portsmouth Anglesea Road	99.2%	96.3%					97.8%
Preston	87.9%	99.9%	99.9%		99.0%		96.7%
Reading London Road	96.0%	97.7%					96.9%
Reading New Town	53.2%	94.0%	95.7%		99.1%		85.5%
Rochester Stoke	98.1%	96.5%	96.5%		99.0%	83.2%	94.6%
Salford Eccles	97.7%	99.9%	99.9%				99.2%
Saltash Callington Road		96.2%	97.1%				96.6%
Sandy Roadside*	97.6%	87.7%	86.8%				90.7%
Scunthorpe Town	98.3%	79.0%				95.3%	90.9%
Shaw Crompton Way	99.5%						99.5%
Sheffield Barnsley Road	93.9%		93.9%				93.9%
Sheffield Devonshire Green	99.3%	98.3%	98.3%		99.4%		98.8%
Sheffield Tinsley	69.1%	97.5%	97.5%				88.1%
Sibton					99.9%		99.9%
Southampton A33	99.3%	91.1%					95.2%
Southampton Centre	99.2%	99.6%	99.6%		99.2%	97.0%	98.9%
Southend-on-Sea	99.2%	99.5%	99.5%		99.2%		99.3%
St Helens Linkway	99.7%	94.4%					97.0%
St Osyth	86.4%	99.6%	99.6%		96.2%		95.4%
Stanford-le-Hope Roadside*	97.1%	92.8%	87.8%				92.6%

Site Name	NO_2	PM_{10}	$PM_{2.5}$	CO	O_3	SO_2	Average
Stockton-on-Tees A1305 Roadside	97.7%		93.9%				95.8%
Stockton-on-Tees Eaglescliffe	98.9%	95.7%	95.6%				96.7%
Stoke-on-Trent A50 Roadside	98.2%	95.5%					96.9%
Stoke-on-Trent Centre	98.0%	99.6%	99.6%		99.5%		99.1%
Storrington Roadside	70.4%						70.4%
Sunderland Silksworth	90.5%	99.3%	99.3%		92.3%		95.4%
Sunderland Wessington Way	86.6%						86.6%
Swindon Walcot	99.1%	99.2%	99.2%				99.2%
Telford Hollinswood	98.9%	99.3%	99.3%				99.2%
Walsall Woodlands	99.1%				99.1%		99.1%
Warrington	30.6%	95.8%	95.5%				74.0%
West Bromwich Kenrick Park	93.4%						93.4%
Weybourne		94.9%	94.9%		99.9%		96.5%
Wicken Fen	97.0%	99.1%	99.1%		98.8%	71.2%	93.1%
Widnes Milton Road	93.9%						93.9%
Wigan Centre	97.4%	99.9%	99.9%		91.2%		97.1%
Wirral Tranmere	97.4%	98.3%	98.3%		99.4%		98.4%
Worthing A27 Roadside	95.0%		93.0%				94.0%
Yarner Wood	94.3%	92.1%	92.1%		91.1%		92.4%
York Bootham	99.0%	97.8%	97.6%				98.1%
York Fishergate	98.6%	97.7%	96.1%				97.5%
Number of Stations	**107**	**77**	**71**	**1**	**47**	**15**	**111**
Number of Stations < 85%	**8**	**4**	**3**	**0**	**4**	**4**	**4**
Number of Stations <90%	**16**	**5**	**5**	**0**	**4**	**4**	**9**
Average	**94.3%**	**96.2%**	**96.1%**	**95.5%**	**96.1%**	**90.4%**	**94.7%**

3.5 DATA CAPTURE – LONDON

The data capture statistics for stations within London are given in Table 3-3. Most of these are ALN sites, so these data capture statistics have been provided by NPL. The exceptions (London Bloomsbury, London Harlington, London Hillingdon and London Westminster) are indicated by an asterisk (*).

Table 3-3 Data Capture for Stations in Greater London, January - December 2022

Site Name	NO_2	PM_{10}	$PM_{2.5}$	CO	O_3	SO_2	Average
Camden Kerbside	99.3%	98.1%	98.5%				98.6%
Ealing Horn Lane		93.5%					93.5%
Haringey Roadside	99.8%						99.8%
London Bexley	95.9%	99.4%	99.4%				98.2%
London Bloomsbury*	86.9%	96.0%	60.4%		94.8%	94.4%	86.5%
London Eltham	57.9%	62.1%	62.1%		56.7%		59.7%
London Haringey Priory Park South	99.2%				74.2%		86.7%
London Harlington*	99.6%	99.2%	99.3%		98.2%		99.1%
London Hillingdon*	99.8%	99.2%	99.2%		85.3%		95.8%
London Honor Oak Park		99.2%	99.2%				99.2%
London Marylebone Road	99.2%	95.5%	85.3%	77.9%	98.9%	99.2%	92.7%
London N. Kensington	98.1%	98.4%	98.4%	88.3%	98.4%	86.4%	94.7%
London Teddington Bushy Park		97.5%	97.5%				97.5%
London Westminster*	87.7%		82.2%				84.9%
Southwark A2 Old Kent Road	97.6%	95.4%					96.5%
Thurrock	98.9%	90.2%			97.0%	98.3%	96.1%
Number of Stations	**14**	**13**	**11**	**2**	**8**	**4**	**17**
Number of Stations < 85%	**1**	**1**	**3**	**1**	**2**	**0**	**2**
Number of Stations <90%	**3**	**1**	**4**	**2**	**3**	**1**	**4**
Average	**94.2%**	**94.1%**	**89.2%**	**83.1%**	**87.9%**	**94.6%**	**92.9%**

3.6 DATA CAPTURE SCOTLAND

The data capture statistics for stations within Scotland are given in Table 3-4.

Table 3-4 Data Capture for Stations in Scotland, January - December 2022

Site Name	NO_2	PM_{10}	$PM_{2.5}$	CO	O_3	SO_2	Average
Aberdeen Erroll Park	99.5%	100.0%	100.0%		95.3%		98.7%
Aberdeen Union Street Roadside	99.4%						99.4%
Aberdeen Wellington Road	99.7%						99.7%
Auchencorth Moss		99.8%	99.8%		93.9%		97.8%
Bush Estate	99.6%				86.7%		93.1%
Dumbarton Roadside	99.7%						99.7%
Dumfries	95.6%						95.6%
Dundee Mains Loan	52.8%						52.8%
Edinburgh Nicolson Street	99.7%						99.7%
Edinburgh St Leonards	97.8%	99.3%	99.3%	94.7%	46.1%	94.1%	88.5%
Eskdalemuir	0.0%				0.0%		0.0%
Fort William	98.2%				99.7%		98.9%
Glasgow Great Western Road	95.5%						95.5%
Glasgow High Street	94.6%	99.7%	99.7%				98.0%
Glasgow Kerbside	99.3%						99.3%
Glasgow Townhead	99.1%	99.4%	99.4%		99.5%		99.3%
Grangemouth	62.1%	96.4%	83.1%			89.7%	82.8%
Grangemouth Moray	99.2%						99.2%
Greenock A8 Roadside	79.1%	94.4%	94.4%				89.3%
Inverness	95.0%	98.6%	98.6%				97.4%
Lerwick					85.4%		85.4%
Peebles	99.3%				99.1%		99.2%
Strathvaich					99.1%		99.1%
Number of Stations	**20**	**8**	**8**	**1**	**10**	**2**	**23**
Number of Stations < 85%	**4**	**0**	**1**	**0**	**2**	**0**	**3**
Number of Stations <90%	**0**	**0**	**0**	**0**	**0**	**0**	**0**
Average	**88.2%**	**98.4%**	**96.8%**	**94.7%**	**80.5%**	**91.9%**	**89.9%**

3.7 DATA CAPTURE WALES

The data capture statistics for stations within Wales are given in Table 3-5.

Table 3-5 Data Capture for Stations in Wales, January - December 2022

Site Name	NO_2	PM_{10}	$PM_{2.5}$	CO	O_3	SO_2	Average
Aston Hill	97.1%				79.4%		88.2%
Cardiff Centre	88.0%	96.0%	96.7%	90.3%	93.7%	89.0%	92.3%
Cardiff Newport Road	97.5%	96.2%					96.8%
Chepstow A48	97.6%	92.2%	97.0%				95.6%
Cwmbran Crownbridge	98.8%				70.4%		84.6%
Hafod-yr-Ynys Roadside	99.0%						99.0%
Narberth	97.2%	99.6%	99.6%		99.2%	89.6%	97.0%
Newport	70.2%	99.2%	99.2%				89.5%
Port Talbot Margam	97.6%	94.1%	95.7%	92.4%	97.2%	97.7%	95.8%
Swansea Roadside	93.3%	91.1%	83.1%				89.1%
Wrexham	98.9%	97.5%	97.5%			98.1%	98.0%
Number of Stations	**11**	**8**	**7**	**2**	**5**	**4**	**11**
Number of Stations < 85%	**1**	**0**	**1**	**0**	**2**	**0**	**1**
Number of Stations <90%	**2**	**0**	**1**	**0**	**2**	**2**	**4**
Average	**94.1%**	**95.7%**	**95.5%**	**91.3%**	**88.0%**	**93.6%**	**93.3%**

3.8 DATA CAPTURE NORTHERN IRELAND AND MACE HEAD

The data capture statistics for stations within Northern Ireland, plus Mace Head (Republic of Ireland), are given in Table 3-6.

Table 3-6 Data Capture for Stations in Northern Ireland and Mace Head, January - December 2022

Site Name	NO_2	PM_{10}	$PM_{2.5}$	CO	O_3	SO_2	Average
Armagh Roadside	98.7%	96.4%					97.6%
Ballymena Antrim Road	91.5%						91.5%
Ballymena Ballykeel	91.2%					90.4%	90.8%
Belfast Centre	84.1%	96.4%	96.4%	96.5%	89.9%	96.7%	93.3%
Belfast Stockman's Lane	99.1%	97.6%					98.4%
Derry Rosemount	99.1%	96.7%	95.3%		99.3%	83.6%	94.8%
Lough Navar		99.1%	99.1%		95.5%		97.9%
Mace Head					99.9%		99.9%
Number of stations	**6**	**5**	**3**	**1**	**4**	**3**	**8**

Site Name	NO_2	PM_{10}	$PM_{2.5}$	CO	O_3	SO_2	Average
Number of Stations < 85%	**1**	**0**	**0**	**0**	**0**	**1**	**0**
Number of stations <90%	**1**	**0**	**0**	**0**	**1**	**1**	**0**
Average	**94.0%**	**97.2%**	**96.9%**	**96.5%**	**96.2%**	**90.2%**	**95.5%**

3.9 GRAVIMETRIC DATA CAPTURE

Three gravimetric samplers operated within the AURN during 2022. These were Partisol™ samplers at London Marylebone Road ($PM_{2.5}$ and PM_{10}), until the 11th of March 2022 when they were replaced by Digitel™ DPA14s, and a Leckel SEQ at Port Talbot Margam (PM_{10} only). Data capture for these are given in Table 3-7.

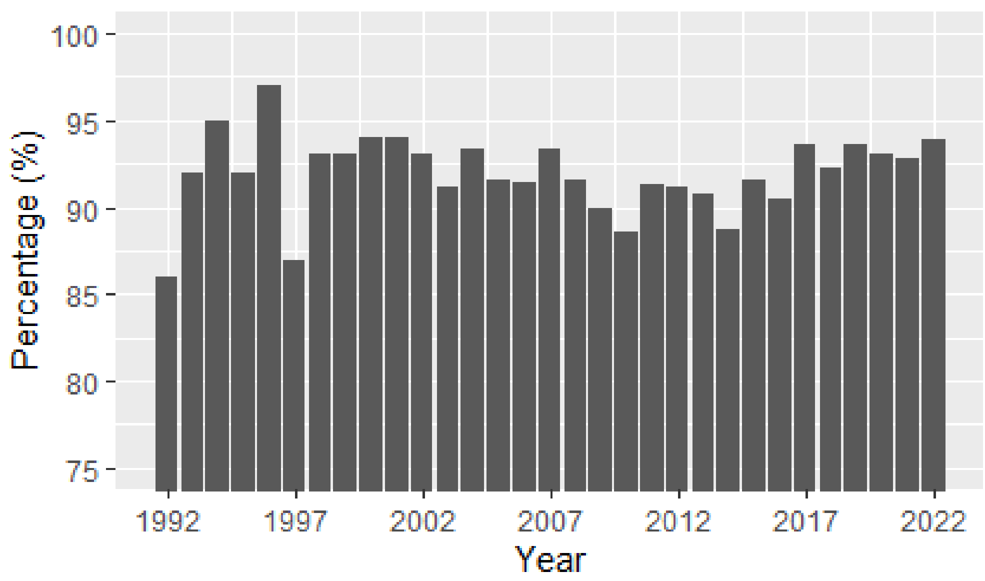
Table 3-7 Gravimetric Data Capture, January – December 2022

Site Name	PM_{10}	$PM_{2.5}$	Average
London Marylebone Road	88.9	94.3	91.6
Port Talbot Margam	98		98
Number of Stations	**2**	**1**	**2**
Number of stations < 85 %	**0**	**0**	**0**
Number of stations < 90%	**1**	**0**	**0**
Average	**93.5%**	**94.3%**	**94.8%**

3.10 TRENDS IN DATA CAPTURE

The overall annual AURN data captures from 1992-2022 averaged over all sites and all pollutants, are shown in Figure 3-1.

Figure 3-1 AURN Overall Annual Data Captures (%) - Mean of All Sites, All Pollutants



The annual data capture has remained above the 85% data capture limit for the last 20 years, despite an increase in the number of stations, analysers and measurements made in the network. New technologies have been incorporated over this time, which have provided both improvements and challenges in data capture terms.

4. DATA REPORTING

4.1 CHANGES TO THE NETWORK DURING 2022

Table 4-1 shows the changes to the AURN, i.e., monitoring stations started up or closed down and additional instruments installed, during 2022. Birmingham Acocks Green was closed during Q4 of 2021: it is now in the process of relocation and the replacement site will have a new name. It therefore does not appear in this report.

2022 saw the beginning of the expansion of the particulate monitoring network within the AURN, as part of this several existing sites had a new instrument installed to measure PM_{10} and $PM_{2.5}$ particulate matter, in addition to the pollutants they were already measuring.

Table 4-1 AURN Sites and Instrumentation that Started Up or Closed Down During 2022

Station		Pollutants Measured	Start Date	Close Date
Burton-on-Trent Horninglow	UKA00652	PM_{10} and $PM_{2.5}$	21/07/2022	-
Canterbury	UKA00424	PM_{10} and $PM_{2.5}$	27/05/2022	-
Charlton Mackrell	UKA00537	PM_{10} and $PM_{2.5}$	07/06/2022	-
Crewe Coppenhall	UKA00659	PM_{10} and $PM_{2.5}$	21/07/2022	-
Dewsbury Ashworth Grove	UKA00654	PM_{10} and $PM_{2.5}$	23/06/2022	-
Glazebury	UKA00170	PM_{10} and $PM_{2.5}$	01/06/2022	-
Hartlepool St. Abbs Walk	UKA00645	PM_{10} and $PM_{2.5}$	11/05/2022	-
High Muffles	UKA00169	PM_{10} and $PM_{2.5}$	25/05/2022	-
Honiton	UKA00566	PM_{10} and $PM_{2.5}$	28/03/2022	-
Immingham Woodlands Avenue	UKA00647	PM_{10} and $PM_{2.5}$	16/05/2022	-
London Hillingdon	UKA00266	PM_{10} and $PM_{2.5}$	05/05/2022	-
Sheffield Tinsley	UKA00181	PM_{10} and $PM_{2.5}$	05/05/2022	-
St Osyth	UKA00445	PM_{10} and $PM_{2.5}$	30/03/2022	-
Swindon Walcot	UKA00650	PM_{10} and $PM_{2.5}$	10/06/2022	-
Telford Hollinswood	UKA00648	PM_{10} and $PM_{2.5}$	03/08/2022	-
Weybourne	UKA00433	PM_{10} and $PM_{2.5}$	19/12/2022	-
Wicken Fen	UKA00362	PM_{10} and $PM_{2.5}$	07/06/2022	-
Yarner Wood	UKA00168	PM_{10} and $PM_{2.5}$	27/07/2022	-

4.2 CHANGES TO INSTRUMENTATION

There were no changes to the type of instrumentation used within the AURN network.

5. WHERE TO FIND MORE INFORMATION

The ratified dataset has been provided to the Data Dissemination Unit on a quarterly basis during the year. These may be viewed on UK-AIR https://uk-air.defra.gov.uk/ .

Further information on the AURN can be found in the following:

- UK-AIR at https://uk-air.defra.gov.uk/, which contains information on individual stations along with real-time hourly data, graphs and statistics.
- The "*Air Pollution in the UK*" series of annual reports, available on UK-AIR.

A glossary of commonly used terms is given in Appendix 1.

6. SUMMARY AND CONCLUSIONS

The number of AURN monitoring stations in operation during part or all of this period was 170. In addition, gravimetric particulate samplers were co-located at two stations; Port Talbot Margam (PM_{10}) and London Marylebone Road ($PM_{2.5}$ and PM_{10}).

Full audits were carried out at six-monthly intervals in the winter (January-March 2022) and summer (July-September 2022). In addition, audits of ozone analysers were also carried out in spring (April) and autumn (October).

The mean data capture for ratified hourly average data was 93.4% (averaged over all pollutants O_3, NO_2, SO_2, CO, PM_{10} and $PM_{2.5}$), for the 12-month reporting period January to December 2022. Mean data captures for individual pollutants were as follows: NO_2 93.5%, PM_{10} 95.0%, $PM_{2.5}$ 94.2% CO 90.8% O_3 92.6%, SO_2 91.5%. Hence, the mean data captures for all pollutant met this target in calendar year 2022. There were 26 stations out of 170 with mean data capture below 90%.

There were 15 analysers which operated in the network (counting Fidas^{TM} instruments as two at each site since this instrument produces PM_{10} and $PM_{2.5}$ datasets), whose measured expanded uncertainty at the summer or winter QAQC audits was outside the requirement of the Air Quality Standards Regulations.

The main reasons for data loss at the monitoring stations were predominantly due to instrument or air conditioning faults, response instability or problems associated with the replacement of analysers and infrastructure.

The data were reported to UK-AIR on a quarterly basis. The finalised dataset for 2022 was supplied to the Monitoring of Ambient Air Quality (MAAQ) Team by the end of May 2023. This has enabled them to begin the annual assessment of compliance with the Air Quality Standards Regulations, with the aim of submitting the compliance report for 2022 to Defra and the Devolved Administrations by their deadline of 30th of September 2023.

7. REFERENCES

[1] UK Government, “UK Air Quality Standards Regulations 2010,” 2010. [Online]. Available: http://www.legislation.gov.uk/uksi/2010/1001/contents/made. [Accessed 3 August 2022].

[2] UK Government, “The Air Quality Standards (Amendment) Regulations 2016,” 2016. [Online]. Available: https://www.legislation.gov.uk/uksi/2016/1184/contents/made. [Accessed 3 August 2022].

[3] Welsh Government, “The Air Quality Standards (Wales) Regulations,” 2010. [Online]. Available: http://www.legislation.gov.uk/wsi/2010/1433/contents/made. [Accessed 3 August 2022].

[4] Scottish Government, “The Air Quality Standards (Scotland) Regulations,” 2010. [Online]. Available: http://www.legislation.gov.uk/ssi/2010/204/made. [Accessed 3 August 2022].

[5] Scottish Government, “The Air Quality Standards (Scotland) Amendment Regulations 2016,” 2016. [Online]. Available: https://www.legislation.gov.uk/ssi/2016/376/contents/made. [Accessed 3 August 2022].

[6] Department of Environment Northern Ireland, “The Air Quality Standards Regulations (Northern Ireland) 2010,” 2010. [Online]. Available: http://www.legislation.gov.uk/nisr/2010/188/contents/made. [Accessed 3 August 2022].

[7] DAERA, “The Air Quality Standards (Amendment) Regulations (Northern Ireland) 2017,” 2017. [Online]. Available: https://www.legislation.gov.uk/nisr/2017/2/contents/made. [Accessed 7 July 2021].

[8] UK Government, “The Air Quality (Amendment of Domestic Regulations) (EU Exit) Regulations 2019,” 2019. [Online]. Available: https://www.legislation.gov.uk/uksi/2019/74/contents.

[9] Welsh Government, “The Air Quality Standards (Wales) (Amendment) (EU Exit) Regulations 2019,” 2019. [Online]. Available: https://www.legislation.gov.uk/wsi/2019/390/contents .

[10] DAERA, “The Air Quality (Amendment, etc.) Regulations (Northern Ireland) 2018,” 2018. [Online]. Available: https://www.legislation.gov.uk/nisr/2018/215/contents/made.

[11] DAERA, “The Air Quality (Amendment) (Northern Ireland Protocol) (EU Exit) (No. 2) Regulations 2020,” 2020. [Online]. Available: https://www.legislation.gov.uk/uksi/2020/1352/regulation/2/made.

[12] Defra, “The Air Quality Strategy for England, Scotland, Wales and Northern Ireland (Volume 1),” 2007. [Online]. Available: https://www.gov.uk/government/publications/the-air-quality-strategy-for-england-scotland-wales-and-northern-ireland-volume-1. [Accessed 21 July 2022].

APPENDICES

APPENDIX 1 GLOSSARY OF TERMS

Air Quality Standards Regulations

Whilst the UK has now left the European Union, in 2022, it still followed the requirements set out in European Union's Air Quality Directive 2008/50/EC, in England via the Air Quality Standards Regulations (AQSR 2010), and variations of these for the Devolved Administrations i.e. the Scottish Government, Welsh Government and the Northern Ireland Assembly, by which ambient air quality is regulated. It is noteworthy these are amended by The Air Quality (Amendment of Domestic Regulations) (EU Exit) Regulations 2019, and variations of similar EU exit legislation for the aforementioned Devolved Administrations.

Air Quality Standards

Standards are the concentrations of pollutants in the atmosphere which can broadly be taken to achieve a certain level of environmental quality. The standards are based on assessment of the effects of each pollutant on human health including the effects on sensitive sub-groups.

Air Quality Strategy [12].

The United Kingdom's National Air Quality Strategy, containing policies for assessment and management of air quality in the UK. This was first published in 1997, as a requirement of The Environment Act 1995. The Air Quality Strategy for England, Scotland, Wales and Northern Ireland describes the plans drawn up by the Government and the devolved administrations to improve and protect ambient air quality in the UK in the medium-term. The Strategy sets objectives for the main air pollutants to protect health. Performance against these objectives will be monitored where people are regularly present and might be exposed to air pollution.

Air Quality Strategy Objective.

The Air Quality Strategy sets objectives for the maximum concentrations of eight pollutants. These are at least as stringent as the limit values of the Air Quality Standards Regulations and of the EU Directive from which these were derived.

Beta Attenuation Monitor (BAM).

A type of instrument used for monitoring concentrations of particulate matter. Particulate matter is deposited on a filter paper, and the attenuation of beta rays by the deposited matter is measured to determine the amount of material present.

Carbon Monoxide (CO)

A colourless, odourless gas resulting from the incomplete combustion of hydrocarbon fuels. CO interferes with the blood's ability to carry oxygen to the body's tissues and results in adverse health effects.

Digitel™ , Digitel™ DPA14

A type of gravimetric particulate sampler which collects aerosol onto pre-weighed filters. The filter changes automatically at midnight, and thus gives daily average concentrations.

ESU (Equipment Support Unit)

Commercial organisations contracted by the EA or affiliated station owners to carry out specialist service and repair to the air quality monitoring equipment.

Fidas™ 200, Fidas™

A type of instrument which uses an optical technique for monitoring concentrations of particulate matter. This can measure several size fractions simultaneously.

ISO/IEC17025

General requirements for the competence of testing and calibration laboratories, is the international reference for testing and calibration laboratories wanting to demonstrate their capacity to deliver reliable results. It enables laboratories to demonstrate that they operate competently and generate valid results, thereby promoting confidence in their work both nationally and around the world.

Leckel SEQ™, SEQ

A type of gravimetric particulate sampler which collects aerosol onto pre-weighed filters. The filter changes automatically at midnight, and thus gives daily average concentrations.

LSO (Local Site Operator)

A nominated individual or organisation who carry out regular instrument calibrations, filter changes and other routine station tasks.

Oxides of Nitrogen (NOx)

Combustion processes emit a mixture of oxides of nitrogen, primarily nitric oxide (NO) and nitrogen dioxide (NO_2), collectively termed NOx. In the presence of sunlight, it reacts with hydrocarbons to produce photochemical pollutants such as ozone. Nitrogen dioxide emissions can also be further oxidised in air to acid gases, which contribute to the production of acid rain.

Ozone (O_3)

A pollutant gas which is not emitted directly from any source in significant quantities but is produced by reactions between other pollutants in the presence of sunlight. (This is what is known as a ‘secondary pollutant’.) Ozone concentrations are greatest in the summer. O_3 can travel long distances and reach high concentrations far away from the original pollutant sources.

Particulate Matter (PM)

Small airborne particles. PM may contain many different materials such as soot, wind-blown dust or secondary components, which are formed within the atmosphere as a result of chemical reactions. Some PM is natural and some is man-made.

Partisol™

A type of gravimetric particulate sampler which collects aerosol onto pre-weighed filters. The filter changes automatically at midnight, and thus gives daily average concentrations.

PM_{10}

Particles which pass through a size-selective inlet with a 50 % efficiency cut-off at 10 µm aerodynamic diameter, as defined in ISO 7708:1995, Clause 6. This size fraction is important in the context of human health, as these particles are small enough to be inhaled into the airways of the lung – described as the ‘thoracic convention’ in the above ISO standard. PM_{10} is often described as ‘particles of less than 10 micrometres in diameter’ though this is not strictly correct.

$PM_{2.5}$

Particles which pass through a size-selective inlet with a 50 % efficiency cut-off at 2.5 µm aerodynamic diameter, as defined in ISO 7708:1995, Clause 7.1. This size fraction is important in the context of human health, as these particles are small enough to be inhaled very deep into the lung – described as the ‘high risk respirable convention’ in the above ISO standard. $PM_{2.5}$ is often described as ‘particles of less than 2.5 micrometres in diameter’ though this is not strictly correct.

Sulphur dioxide (SO_2)

An acid gas formed when fuels containing sulphur impurities are burned.

APPENDIX 2 MEASUREMENT UNCERTAINTY TABLE

To comply with the Data Quality Objectives, the expanded measurement uncertainty for gaseous analyser measurements must not exceed ±15%. For PM instruments, the expanded measurement uncertainty must not exceed ±25%. In Table A2, cases where these objectives were not met are shown in **bold red** font.

Table A2 Expanded Relative Uncertainty of Measurement (%) for gaseous and particulate pollutants (GR_{10} and $GR_{2.5}$ are used here to refer to gravimetric measurements of PM_{10} and $PM_{2.5}$ respectively).

Site	Date of audit	O_3	CO	SO_2	NO_2	PM_{10}	$PM_{2.5}$	GR_{10}	$GR_{2.5}$
Aberdeen	08-Feb	11.2			12.2	9.5	11.0		
Aberdeen Union Street Roadside	22-Feb				12.2				
Aberdeen Wellington Road	07-Feb				12.2				
Armagh Roadside	07-Feb				12.2	**126.3**			
Aston Hill	08-Feb	8.3			12.7				
Auchencorth Moss	16-Feb	11.2				7.6	9.4		
Ballymena Antrim Road	03-Feb				12.4				
Ballymena Ballykeel	03-Feb			12.2	12.3				
Barnsley Gawber	25-Jan	8.3		11.6	9.8				
Barnstaple A39									
Bath A4 Roadside	19-Jan				12.3				
Belfast Centre	04-Feb	8.3	7.8	12.2	10.5	7.5	9.3		
Belfast Stockman's Lane	08-Feb				12.4	10.3			
Billingham	18-Jan				12.2				
Birkenhead Borough Road	20-Jan				12.2				
Birmingham A4540 Roadside	31-Jan	11.3			12.2	8.2	9.8		
Birmingham Ladywood	31-Jan	7.3		12.7	13.0	7.7	9.4		
Blackburn Accrington Road	17-Jan				12.7				
Blackpool Marton	17-Jan	8.3			9.9	11.3	12.6		
Bournemouth	25-Feb	11.2			9.8		13.0		
Bradford Mayo Avenue	02-Mar				12.2				
Brighton Preston Park	01-Feb				12.5	10.2	12.6		
Bristol St Paul's	20-Jan	11.2			12.3	9.7	12.6		
Bristol Temple Way	19-Jan				12.4	9.3			
Burton-on-Trent Horninglow	03-Feb				12.2				

Site	Date of audit	O_3	CO	SO_2	NO_2	PM_{10}	$PM_{2.5}$	GR_{10}	$GR_{2.5}$
Bury Whitefield Roadside	27-Jan				12.2	9.7			
Bush Estate	16-Feb	11.2			12.4				
Cambridge Roadside	14-Feb				12.2				
Cannock A5190 Roadside	03-Feb				12.2				
Canterbury	10-Feb	11.2			12.3				
Cardiff Centre	13-Jan	11.2	7.8	12.2	12.2	9.3	13.1		
Cardiff Newport Road	13-Jan				12.3	9.3			
Carlisle Morton A595	17-Feb				12.9	10.5	12.9		
Charlton Mackrell	27-Jan	11.2			12.2				
Chatham Centre Roadside	08-Feb				12.2	10.0	13.2		
Chepstow A48	18-Jan				12.3	9.3	12.6		
Chesterfield Loundsley Green	04-Mar				12.2				
Chesterfield Roadside	04-Mar				12.2				
Chilbolton	13-Jan	11.2		10.2	12.6				
Christchurch Barrack Road	15-Feb				12.2		12.6		
Coventry Allesley	23-Feb	8.3			10.7	8.8	10.4		
Coventry Binley Road	22-Feb				12.8	10.0			
Crewe Coppenhall	24-Jan				12.2				
Cwmbran Crownbridge	12-Jan	8.3			14.4				
Derby St Alkmunds Way	24-Feb				13.8				
Derry Rosemount	02-Feb	11.2			12.3	9.8	**39.8**		
Dewsbury Ashworth Grove	02-Mar				12.2				
Doncaster A630 Cleveland Street	18-Feb				12.2				
Dundee Mains Loan	15-Feb				12.5				
Dumbarton Roadside	24-Jan				13.4				
Dumfries	17-Feb				12.4				
Eastbourne	03-Feb				12.2	8.6	10.2		
Edinburgh Nicolson Street	11-Jan				12.2	8.8	10.4		
Edinburgh St Leonards	13-Jan	11.2	7.5	12.2	9.8	8.1	9.8		

Site	Date of audit	O_3	CO	SO_2	NO_2	PM_{10}	$PM_{2.5}$	GR_{10}	$GR_{2.5}$
Exeter Roadside	25-Jan				13.3				
Fort William	24-Feb	11.2			12.2				
Glasgow Great Western Road	18-Jan				12.3				
Glasgow High Street	19-Jan				9.8	8.2	9.9		
Glasgow Kerbside	19-Jan				9.8	8.3	9.9		
Glasgow Townhead	18-Jan	9.0			12.2	11.7	12.9		
Glazebury	10-Jan	11.2			12.2				
Grangemouth	12-Jan			12.2	12.2	9.3	13.1		
Grangemouth Moray	12-Jan			12.6	12.2				
Greenock A8 Roadside	24-Jan				12.2	10.7	12.1		
Hafod-yr-Ynys Roadside	12-Jan				12.8				
Hartlepool St Abbs Walk	19-Jan				12.2				
High Muffles	17-Feb	11.2			12.2				
Honiton	26-Jan				13.0				
Horley	01-Feb				**19.5**				
Hull Freetown	15-Feb	8.3		12.2	9.8	8.5	10.2		
Hull Holderness Road	15-Feb				12.2	9.3			
Immingham Woodlands Avenue	15-Feb				12.2				
Inverness	20-Jan				12.3	9.8	11.2		
Ladybower	11-Feb	11.2			12.2				
Leamington Spa	23-Feb	11.2			12.6	7.5	9.3		
Leamington Spa Rugby Road	22-Feb				12.8	8.6	10.2		
Leeds Centre	14-Feb	8.3	7.5	11.6	9.8	8.3	9.9		
Leeds Headingley Kerbside	14-Feb				12.2	9.3	12.6		
Leicester A594 Roadside	23-Feb				12.9	9.3			
Leicester University	23-Feb	8.3			9.8	11.0	12.3		
Leominster	09-Feb	11.2			12.8				
Lerwick	23-Feb	11.2		10.0	12.2				
Lincoln Canwick Road	10-Feb				12.3				
Liverpool Speke	26-Jan	8.3		12.2	9.8	12.0	12.6		
London Bloomsbury	11-Feb	11.2		10.2	12.6	9.4	12.7		
London Harlington	26-Jan	11.2			12.7	14.0	**15.1**		

Site	Date of audit	O_3	CO	SO_2	NO_2	PM_{10}	$PM_{2.5}$	GR_{10}	$GR_{2.5}$
London Honor Oak Park									
London Hillingdon	26-Jan	8.3			10.2				
London Teddington Bushy Park	17-Jan					8.7	**16.5**		
London Westminster	24-Jan				13.0		12.7		
Lough Navar	31-Jan	11.3				7.5	9.3		
Lullington Heath	31-Jan	11.2		12.2	12.5				
Luton A505 Roadside	07-Feb				12.4				
Mace Head	01-Feb	8.3							
Manchester Piccadilly	28-Feb	8.3		12.2	9.8	9.3	12.6		
Manchester Sharston	28-Feb	11.2		10.0	12.2	7.5	9.3		
Middlesbrough	18-Jan	11.2		10.0	12.2	9.6	13.1		
Narberth	11-Jan			12.2	13.2	9.4	10.9		
Newcastle Centre	21-Jan	8.3			9.8	9.9	12.9		
Newcastle Cradlewell Roadside	20-Jan				12.2	**21.0**			
Newport	18-Jan				12.2	11.3	12.6		
Northampton Spring Park	21-Feb	7.3			13.6		13.1		
Norwich Lakenfields	16-Feb	8.3			11.6	7.9	9.7		
Nottingham Centre	22-Feb	8.7		12.2	9.8	10.8	12.1		
Nottingham Western Boulevard	21-Feb				12.3	9.3			
Oldbury Birmingham Road	02-Feb				13.1				
Oxford Centre Roadside	11-Jan				12.5				
Oxford St Ebbes	11-Jan	11.2			12.3	8.8	10.3		
Peebles	11-Jan	11.2			12.3				
Plymouth Tavistock Road	25-Jan				12.2				
Plymouth Centre	24-Jan	8.3			11.8	10.9	12.2		
Port Talbot Margam	14-Jan	8.3	11.5	11.6	9.8	9.3	12.6	8	
Portsmouth	14-Feb	8.3			13.1	7.5	9.3		
Portsmouth Anglesea Road	14-Feb				12.2	9.9			
Preston	18-Jan	8.3			9.9	10.1	11.5		

Site	Date of audit	O_3	CO	SO_2	NO_2	PM_{10}	$PM_{2.5}$	GR_{10}	$GR_{2.5}$
Reading London Road	10-Jan				12.7	9.9			
Reading New Town	10-Jan	8.3			10.8	9.6	12.8		
Rochester Stoke	08-Feb	11.2		10.0	12.3	7.9	9.6		
Salford Eccles	10-Jan				12.2	8.9	10.5		
Scunthorpe Town	16-Feb			10.0	12.2	9.4			
Shaw Crompton Way	27-Jan				12.2	**32.3**			
Sheffield Barnsley Road	01-Mar				12.2		13.0		
Sheffield Devonshire Green	03-Mar	8.3			9.8				
Sheffield Tinsley	03-Mar				12.2				
Sibton	16-Feb	11.2							
Southampton Centre	16-Feb	8.3		12.2	9.9	7.5	9.3		
Southampton A33 Roadside	16-Feb				12.3	9.8			
Southend-on-Sea	07-Feb	8.3			9.8	8.3	9.9		
St Helens Linkway	20-Jan				12.8	**25.8**			
St Osyth	17-Feb	8.3			10.2				
Stockton on Tees A1035 Roadside	17-Jan				12.8		12.6		
Stockton-on-Tees Eaglescliffe	17-Jan				12.2	9.5	12.6		
Stoke-on-Trent Centre	07-Jan	8.3			9.9	7.7	9.5		
Stoke on Trent A50 Roadside	07-Jan				12.3	9.3			
Storrington Roadside	02-Feb				9.8				
Strath Vaich	21-Jan	11.2							
Sunderland Silksworth	19-Jan	11.2			12.2	8.2	9.9		
Sunderland Wessington Way	20-Jan				12.2				
Swansea Roadside	10-Jan				12.2	9.3	12.6		
Swindon Walcot	17-Jan				12.2				
Telford Hollinswood	02-Feb				12.2				
Walsall Woodlands	01-Feb	11.2			12.2				
Warrington	19-Jan				12.2	9.6	14.5		

Site	Date of audit	O_3	CO	SO_2	NO_2	PM_{10}	$PM_{2.5}$	GR_{10}	$GR_{2.5}$
West Bromwich Kenrick Park	02-Feb				12.2				
Weybourne	15-Feb	8.3							
Wicken Fen	17-Feb	11.2		10.3	12.7				
Widnes Milton Road	26-Jan				12.2				
Wigan Centre	18-Jan	8.3			12.2	11.5	12.8		
Wirral Tranmere	19-Jan	8.3			9.8	9.0	10.5		
Worthing A27 Roadside	02-Feb				13.0		12.6		
Wrexham	24-Jan				12.2	9.7	11.2		
Yarner Wood	26-Jan	11.2			13.5				
York Bootham	11-Jan				12.2	9.3	12.6		
York Fishergate	11-Jan				12.2	13.8	13.6		
Aberdeen Errol Park	17-Aug	11.2			12.2	8.2			
Aberdeen Union Street Roadside	16-Aug				12.2	8.6			
Aberdeen Wellington Road	16-Aug				12.3	11.5			
Armagh Roadside	08-Aug				12.2	15.2			
Aston Hill	02-Aug	8.4			12.2				
Auchencorth Moss	20-Jul					7.5			
Ballymena Antrim Road	09-Aug				12.2				
Ballymena Ballykeel	10-Aug			12.2	12.6	7.5			
Barnsley Gawber	10-Aug	8.3		12.3	11.4				
Barnstaple A39	25-Jul					9.3	12.6		
Bath A4 Roadside	18-Jul				12.2				
Belfast Centre	05-Aug	8.3	7.5	12.2	**18.1**	7.5			
Belfast Stockman's Lane	09-Aug				12.3	17.6			
Billingham	19-Jul				12.3				
Birkenhead Borough Road	15-Jul				12.2				
Birmingham A4540 Roadside	01-Aug	11.2			12.2	7.6	12.9		
Birmingham Ladywood	02-Aug	7.3		12.4	13.2	8.2			
Blackburn Accrington Road	11-Jul				12.2				
Blackpool Marton	11-Jul	8.3			9.8	7.5			
Bradford Mayo Avenue	28-Jul				12.2				

Site	Date of audit	O_3	CO	SO_2	NO_2	PM_{10}	$PM_{2.5}$	GR_{10}	$GR_{2.5}$
Brighton Preston Park	11-Aug	11.2			12.8		12.6		
Bristol St Paul's	22-Jul	11.2			13.8	9.3	12.6		
Bristol Temple Way	20-Jul				12.2	9.3			
Burton-on-Trent Horninglow	04-Aug				12.2	7.5			
Bury Whitefield Roadside	15-Aug				12.2	10.9			
Bush Estate	21-Jul	11.2			12.2				
Cambridge Roadside	02-Aug				12.3				
Cannock A5190 Roadside	03-Aug				12.2				
Canterbury	27-Jul	11.2			12.2	7.5			
Cardiff Centre	12-Jul	11.3	8.7	13.5	12.9	9.3	12.7		
Cardiff Newport Road	12-Jul				13.9	9.3			
Carlisle Morton A595	27-Jul				12.5	9.3	12.6		
Charlton Mackrell	25-Jul	11.2			12.3	7.5			
Chatham Centre Roadside	26-Jul				12.2	9.4	12.8		
Chepstow A48	19-Jul				12.4	9.3	12.8		
Chesterfield Loundsley Green	20-Jul				12.2	7.5			
Chesterfield Roadside	20-Jul				12.2	7.6			
Chilbolton	22-Jul	11.2		10.0	12.2	7.5	12.6		
Christchurch Barrack Road	16-Aug				12.2	9.3	12.6		
Coventry Allesley	24-Aug	8.3			10.9	7.5			
Coventry Binley Road	22-Aug				12.2	9.3			
Crewe Coppenhall	16-Aug				12.2	7.5			
Cwmbran Crownbridge	14-Jul	8.3			14.1				
Derby St Alkmunds Way	16-Aug				12.2				
Derry Rosemount	04-Aug	11.2		13.0	12.5	11.7	16.2		
Dewsbury Ashworth Grove	28-Jul				12.2	7.6			
Doncaster A630 Cleveland Street	18-Jul				12.3				
Dundee Mains Loan	23-Aug				12.3				

Site	Date of audit	O_3	CO	SO_2	NO_2	PM_{10}	$PM_{2.5}$	GR_{10}	$GR_{2.5}$
Dumbarton Roadside	05-Aug				13.4				
Dumfries	28-Jul				12.2				
Eastbourne	10-Aug				12.8	7.5			
Edinburgh Nicolson Street	15-Jul				13.1	7.5			
Edinburgh St Leonards	12-Jul	11.2	7.5	12.2	12.4	7.5			
Exeter Roadside	28-Jul	7.2			13.5				
Fort William	10-Aug	11.2			13.1				
Glasgow Great Western Road	25-Jul				12.2				
Glasgow High Street	26-Jul				12.2	7.5			
Glasgow Kerbside	26-Jul				9.8	8.2	9.9		
Glasgow Townhead	27-Jul	8.3			12.2	7.6			
Glazebury	07-Jul	11.2			12.2	7.5			
Grangemouth	08-Jul			10.3	12.3	12.0	12.9		
Grangemouth Moray	08-Jul			12.6	12.2				
Greenock A8 Roadside	18-Aug				12.2	7.5			
Hafod-yr-Ynys Roadside	14-Jul				14.0				
Hartlepool St Abbs Walk	20-Jul				12.3	7.5			
High Muffles	25-Jul	11.2			12.2	8.6			
Honiton	27-Jul				12.4	7.8			
Hull Freetown	19-Jul	8.3		11.6	9.8	7.5			
Hull Holderness Road	18-Jul				12.2	9.4			
Immingham Woodlands Avenue	19-Jul				12.2	9.6			
Inverness	15-Aug				12.2	7.6			
Ladybower	11-Aug	11.2		10.0	12.2				
Leamington Spa	23-Aug	11.2			12.2	7.7			
Leamington Spa Rugby Road	23-Aug				12.4	11.7			
Leeds Centre	27-Jul	8.3	7.5	11.6	9.8	7.5			
Leeds Headingley Kerbside	27-Jul				12.3	10.0	13.0		
Leicester A594 Roadside	24-Aug				12.7	9.5			
Leicester University	17-Aug	8.3			11.8	7.6			
Leominster	01-Aug	11.2			12.2				

Site	Date of audit	O_3	CO	SO_2	NO_2	PM_{10}	$PM_{2.5}$	GR_{10}	$GR_{2.5}$
Lincoln Canwick Road	20-Jul				12.2				
Liverpool Speke	13-Jul	8.3		10.0	9.8	10.0	14.0		
London Bloomsbury	28-Jul	11.2		10.0	12.2	7.8			
London Harlington	03-Aug	**19.3**			12.2	7.5			
London Hillingdon	20-Jul	11.3			9.8	7.5			
London Teddington Bushy Park	21-Jul					9.6	9.6		
London Westminster	18-Jul				12.2		12.6		
Lough Navar	02-Aug	11.2				7.5			
Lullington Heath	08-Aug	11.2		12.2	13.2	7.5			
Luton A505 Roadside	04-Aug				12.2				
Mace Head	03-Aug								
Manchester Piccadilly	17-Aug	8.3		10.0	10.0	10.5	12.6		
Manchester Sharston	17-Aug	11.2		10.0	12.2	7.5			
Market Harborough									
Middlesbrough	20-Jul	11.2		10.0	12.2	11.5	13.7		
Narberth	07-Jul	11.2		12.2	12.5	8.1			
Newcastle Centre	19-Jul	8.3			10.2	9.3	12.6		
Newcastle Cradlewell Roadside	19-Jul				12.2	12.5			
Newport	19-Jul				12.3	7.5			
Northampton Spring Park	17-Aug	7.2			13.2	10.1	12.6		
Norwich Lakenfields	01-Aug	8.3			9.8	8.3			
Nottingham Centre	18-Aug	8.3		10.4	9.8	7.5			
Nottingham Western Boulevard	16-Aug				14.1	9.3			
Oxford Centre Roadside	11-Jul				12.5				
Oxford St Ebbes	11-Jul	8.3			12.2	7.5			
Peebles	13-Jul	12.1			12.2				
Plymouth Tavistock Road	26-Jul				13.6				
Plymouth Centre	26-Jul	9.5			12.2	7.6			
Port Talbot Margam	13-Jul	8.3	12.0	11.7	11.3	9.3	12.6	8	

Site	Date of audit	O_3	CO	SO_2	NO_2	PM_{10}	$PM_{2.5}$	GR_{10}	$GR_{2.5}$
Portsmouth	15-Aug	8.3			13.0	7.5			
Portsmouth Anglesea Road	15-Aug				12.2	9.3			
Preston	12-Jul	8.3			9.8	7.5			
Reading London Road	12-Jul				12.3	9.3			
Reading New Town	12-Jul	8.3			10.0	9.3	12.6		
Rochester Stoke	26-Jul	11.2		10.0	12.2	7.5			
Salford Eccles	08-Jul				12.2	7.7			
Saltash Callington Road	26-Jul					10.3	12.6		
Scunthorpe Town	19-Jul			10.0	12.2	10.2			
Shaw Crompton Way	15-Aug				12.2	22.2			
Sheffield Barnsley Road	08-Aug				12.2		12.6		
Sheffield Devonshire Green	09-Aug	8.3			9.8	7.5			
Sheffield Tinsley	11-Aug				12.2	7.9			
Sibton	04-Aug	11.2							
Southampton Centre	17-Aug	8.3		12.2	10.0	7.5			
Southampton A33 Roadside	16-Aug				12.3	9.3			
Southend-on-Sea	25-Jul	8.3			9.8	7.5			
St Helens Linkway	14-Jul				12.2	9.3			
St Osyth	29-Jul	8.3			9.8	7.5			
Stockton on Tees A1035 Roadside	20-Jul				**15.2**		12.7		
Stockton-on-Tees Eaglescliffe	21-Jul				12.2	11.9	12.6		
Stoke-on-Trent Centre	07-Jul	8.3			9.8	7.6			
Stoke on Trent A50 Roadside	06-Jul				12.2	9.3			
Storrington Roadside	09-Aug				10.4	7.7	12.6		
Strath Vaich	15-Aug	13.5							
Sunderland Silksworth	26-Jul	11.3			12.3	8.1			
Sunderland Wessington Way	27-Jul				12.4				
Swansea Roadside	11-Jul				12.5	9.3	12.6		

Site	Date of audit	O_3	CO	SO_2	NO_2	PM_{10}	$PM_{2.5}$	GR_{10}	$GR_{2.5}$
Swindon Walcot	18-Jul				12.2	7.9			
Telford Hollinswood	03-Aug				12.2	7.5			
Walsall Woodlands	03-Aug	11.2			12.2				
Warrington	14-Jul				12.3	9.5	13.6		
West Bromwich Kenrick Park	02-Aug				12.2				
Weybourne	01-Aug	8.3							
Wicken Fen	03-Aug	11.2		10.2	12.3	7.5			
Widnes Milton Road	13-Jul				12.2				
Wigan Centre	12-Jul	8.3			12.2	7.5			
Wirral Tranmere	15-Jul	8.3			9.8	7.5			
Worthing A27 Roadside	09-Aug				13.0		12.7		
Wrexham	16-Aug			10.0	12.2	7.5			
Yarner Wood	27-Jul	11.9			12.3	7.5			
York Bootham	26-Jul				12.2	11.7	14.0		
York Fishergate	26-Jul				12.2	10.5	12.8		

The following sites were audited by NPL, who report combined audit and ratification uncertainties for each quarter, with the exception of gravimetric measurements which are reported the same as Ricardo.

Table A3 Quarter 1 Expanded Relative Uncertainty of Measurement (%) for gaseous and particulate pollutants (GR_{10} and $GR_{2.5}$ are used here to refer to gravimetric measurements of PM_{10} and $PM_{2.5}$ respectively).

Site	NO / NO_2*	CO	SO_2	O_3	PM_{10}	$PM_{2.5}$	GR_{10}	$GR_{2.5}$
Borehamwood Meadow Park	9.4				7.8	9.5		
Camden Kerbside								
Haringey Roadside	13.4							
Horley	10.7							
London Bexley	12.9				7.8	9.5		
London Ealing Horn Lane					13.5			
London Eltham								
London Haringey Priory Park South	10.7			10.2				
London Honor Oak Park					7.8	9.5		

Site	NO / NO_2*	CO	SO_2	O_3	PM_{10}	$PM_{2.5}$	GR_{10}	$GR_{2.5}$
London Marylebone Road	11.8	9.7	5.3	8.8	13.5	11.8	8	11
London N. Kensington	6.9	9.6	5.1	9.2	7.8	9.5		
Sandy Roadside	12.9				13.5	11.8		
Southwark A2 Old Kent Road	14.8				13.5			
Stanford-le-Hope Roadside	11.3				13.5	11.8		
Thurrock	10.1		5.2	10.6	13.5			

Table A4 Quarter 2 Expanded Relative Uncertainty of Measurement (%) for gaseous and particulate pollutants (GR_{10} and $GR_{2.5}$ are used here to refer to gravimetric measurements of PM_{10} and $PM_{2.5}$ respectively).

Site	NO / NO_2*	CO	SO_2	O_3	PM_{10}	$PM_{2.5}$	GR_{10}	$GR_{2.5}$
Borehamwood Meadow Park	8.1				7.8	9.5		
Camden Kerbside	8.9				13.5	11.8		
Haringey Roadside	11.6							
Horley	10.3							
London Bexley	7.0				7.8	9.5		
London Ealing Horn Lane					13.5			
London Eltham	13.0			8.6	7.8	9.5		
London Haringey Priory Park South	10.7			9.4				
London Honor Oak Park					7.8	9.5		
London Marylebone Road	10.8	10.5	4.8	9.2	13.5	11.8	8	11
London N. Kensington	7.4	9.5	7.3	10.4	7.8	9.5		

Site	NO / NO_2*	CO	SO_2	O_3	PM_{10}	$PM_{2.5}$	GR_{10}	$GR_{2.5}$
Sandy Roadside	6.1				13.5	11.8		
Southwark A2 Old Kent Road	14.4				13.5			
Stanford-le-Hope Roadside	10.1				13.5	11.8		
Thurrock	9.3		5.8	10.2	13.5			

Table A5 Quarter 3 Expanded Relative Uncertainty of Measurement (%) for gaseous and particulate pollutants (GR_{10} and $GR_{2.5}$ are used here to refer to gravimetric measurements of PM_{10} and $PM_{2.5}$ respectively).

Site	NO / NO_2*	CO	SO_2	O_3	PM_{10}	$PM_{2.5}$	GR_{10}	$GR_{2.5}$
Borehamwood Meadow Park	7.7				7.8	9.5		
Camden Kerbside	8.3				13.5	11.8		
Haringey Roadside	11.6							
Horley	9.0							
London Bexley	9.1				7.8	9.5		
London Ealing Horn Lane					13.5			
London Eltham	14.2			8.7	7.8	9.5		
London Haringey Priory Park South	10.9			9.4				
London Honor Oak Park					7.8	9.5		
London Marylebone Road	11.2	10.0	5.0	9.5	13.5	11.8	8	11
London N. Kensington	6.0	9.5	6.9	10.2	7.8	9.5		
Sandy Roadside	9.0				13.5	11.8		
Southwark A2 Old Kent Road	14.2				13.5			

Site	NO / NO_2*	CO	SO_2	O_3	PM_{10}	$PM_{2.5}$	GR_{10}	$GR_{2.5}$
Stanford-le-Hope Roadside	6.2				13.5	11.8		
Thurrock	10.6		5.6	10.5	13.5			

Table A6 Quarter 4 Expanded Relative Uncertainty of Measurement (%) for gaseous and particulate pollutants (GR_{10} and $GR_{2.5}$ are used here to refer to gravimetric measurements of PM_{10} and $PM_{2.5}$ respectively).

Site	NO / NO_2*	CO	SO_2	O_3	PM_{10}	$PM_{2.5}$	GR_{10}	$GR_{2.5}$
Borehamwood Meadow Park	10.8				7.8	9.5		
Camden Kerbside	5.8				13.5	11.8		
Haringey Roadside	13.5							
Horley	9.6							
London Bexley	14.6				7.8	9.5		
London Ealing Horn Lane					13.5			
London Eltham	**18.3**			8.9	7.8	9.5		
London Haringey Priory Park South	13.5							
London Honor Oak Park					7.8	9.5		
London Marylebone Road	9.9	9.8	5.1	9.1	13.5	11.8	8	11
London N. Kensington	6.1	10.3	6.0	10.4	7.8	9.5		
Sandy Roadside	13.3				13.5	11.8		
Southwark A2 Old Kent Road	13.8				13.5			
Stanford-le-Hope Roadside	6.9				13.5	11.8		
Thurrock	11.6		5.7	10.5	13.5			

APPENDIX 3 SITES WITH LESS THAN 85% DATA CAPTURE

Table A7 List of Stations with Annual Mean Data Capture less than 85%

Site Name	NO_2	PM_{10}	$PM_{2.5}$	CO	O_3	SO_2	Average
Barnstaple A39		45.9%	45.0%				45.5%
Cambridge Roadside	75.5%						75.5%
Cwmbran Crownbridge	98.8%				70.4%		84.6%
Dundee Mains Loan	52.8%						52.8%
Eskdalemuir	0.0%				0.0%		0.0%
Grangemouth	62.1%	96.4%	83.1%			89.7%	82.8%
London Eltham	57.9%	62.1%	62.1%		56.7%		59.7%
London Westminster	87.7%		82.2%				84.9%
Storrington Roadside	70.4%						70.4%
Warrington	30.6%	95.8%	95.5%				74.0%

These data capture statistics are based on the whole year with the exception of those which were only installed part way though, so their data capture is calculated based on the part of the year when they were in operation - see Section 3.2.

The principal reasons for the data losses in the above table are as follows:

Barnstaple A39 (PM_{10}, $PM_{2.5}$)

Damage to the hut caused by Storm Arwen allowed water ingress and the site was turned off on the 30th of November 2021, only being turned back on the 22nd of June 2022.

Cambridge Roadside (NOx)

Water ingress into the sampling system led to a sampling fault that required NO_2 data from the 10th of October into 2023 to be rejected.

Cwmbran Crownbridge (O_3)

A sampling issue resulted in data being rejected from the 28th of July until the 11th of November.

Dundee Mains Loan (NOx)

A fault with the air conditioning system resulted in a number of instrument faults led to data being rejected from the 28th of April until the 5th of September.

Eskdalemuir (NOx, O_3)

The site experienced air conditioning problems in 2021 and all instruments were turned off on 4th of August 2021. The site was found to have and issue with the power supply, and it was decided that the cabin would be replaced, this was completed with data returning on the 20th of December in Quarter 4 of 2022. However, the data for both pollutants was deemed too unstable and therefore erroneous and was rejected until the end of the quarter.

Grangemouth (NOx, $PM_{2.5}$)

Internal sampling issues led to NO_x data being rejected between the 1st and 19th of January with the instrument then being removed before being replaced on the 4th of February. A further sampling issue was identified which led to data being rejected between the 21st of June to the 10th of October.

The data for the $PM_{2.5}$ was judged to be too noisy and unrepresentative and so was rejected from the 27th of May to the 12th of July.

London Eltham (NOx, PM_{10}, $PM_{2.5}$, O_3)

Power to the site went off on 13th of December 2021 due to unpaid electricity bills and was only restored on 16th of May 2022.

The NO_x analyser had an unstable zero and span response when the power was restored, and this did not settle until 29th of May leading to data being rejected.

No data was recorded by the ozone analyser between the 28th of September and the 20th of October.

London Westminster ($PM_{2.5}$)

The power to the instrument cabin failed on the 5th of August and following this the site was moved to a new location a short distance away within the same premises. The instruments were reinstalled on the 23rd of August and data collection began on the 25th of August post instrument servicing.

Storrington Roadside (NOx)

A sampling fault resulted in data rejection from the 16th of June until the 29th of September.

Warrington (NOx)

Due to a lack of valid LSO calibrations data from the 9th of February until the 7th of April were rejected.

A sampling fault resulted in data rejection from the 16th of June until the 29th of September.

T: +44 (0) 1235 75 3000
E: enquiry@ricardo.com
W: ee.ricardo.com