AURN QAQC ANNUAL TECHNICAL REPORT 2023

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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 2023. 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 175 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 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 2023, 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 92.3% (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 2023.

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 92.0%, PM_{10} 95.5%, $PM_{2.5}$ 94.4%, CO 84.6% O_3 93.1%, SO_2 87.5%. Hence, the mean data captures for all pollutants met this target in calendar year 2023 with the exception of CO. 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.

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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. 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 2023 and were provided with an ISO17025 certificate of calibration by Ricardo (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 Environment Agency (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 175 monitoring stations in the AURN operated during part or all of the year 2023. 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 the Department for Environment, Food and Rural Affairs (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 have 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 2023 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 measured NO_2 concentration of 200ppb 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.
11. Zero "calibration" of all automatic particulate matter (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™ PM analysers which use an optical technique.

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 2023 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 2023, there were a small number of analysers where the calculated uncertainty was higher than that stipulated by the Data Quality Objectives (DQOs). 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 specified by the DQOs during 2023:

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

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.

3. DATA CAPTURE

3.1 OVERVIEW

Ratified hourly average data capture for the network averaged 92.3% for all pollutants (O_3, NO_2, SO_2, CO, PM_{10} and $PM_{2.5}$) during the 12-month reporting period January-December 2023. 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, with the exception of CO, 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 2023 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 2023

	NO_2	PM_{10}	$PM_{2.5}$	CO	O_3	SO_2	All
Number of stations	159	117	107	7	95	28	175
Number of Stations <85%	22	7	10	3	10	7	23
Number of Stations < 90%	32	11	18	3	16	11	40
Average	**92.0%**	**95.5%**	**94.4%**	**84.6%**	**93.1%**	**87.5%**	**92.3%**

3.3 GENERIC DATA ISSUES

The following generic data quality issues have been identified in 2023:

- 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 2023. 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 2023

Site Name	NO_2	PM_{10}	$PM_{2.5}$	CO	O_3	SO_2	Average
Barnsley Gawber	95.5%	99.4%	99.4%		**76.0%**	**51.9%**	84.4%
Barnstaple A39		92.3%	87.6%				90.0%
Bath A4 Roadside	**66.6%**						66.6%
Billingham	97.2%						97.2%
Birkenhead Borough Road	88.9%						88.9%
Birmingham A4540 Roadside	97.4%	99.8%	99.8%		95.4%		98.1%
Birmingham Ladywood	98.8%	97.2%	97.2%		95.8%	**54.6%**	87.9%
Blackburn Accrington Road	97.4%						97.4%
Blackburn Audley Park		100.0%	100.0%		95.9%		98.6%
Blackpool Marton	97.6%	99.9%	99.9%		97.7%		98.8%
Borehamwood Meadow Park*	98.5%	97.7%	97.7%				98.0%
Bournemouth	95.1%		93.7%		95.7%		94.8%
Bradford Mayo Avenue	97.9%						97.9%
Brighton Preston Park	97.2%		**58.3%**		93.2%		82.9%
Bristol St Paul's	96.7%	97.5%	**76.9%**		89.8%		92.2%
Bristol Temple Way	92.8%	95.5%					94.2%
Burton-on-Trent Horninglow	97.5%	98.9%	98.9%		97.4%		98.2%
Bury Whitefield Roadside	97.6%	95.1%					96.3%
Cambridge Roadside	94.0%						94.0%
Cannock A5190 Roadside	95.7%						95.7%
Canterbury	**84.5%**	95.3%	95.3%		92.8%		91.8%
Carlisle Morton A595	96.3%	94.5%	95.4%				95.4%
Charlton Mackrell	96.1%	99.0%	99.0%		94.2%		97.9%
Chatham Roadside	97.2%	97.4%	97.1%				97.24
Chesterfield Loundsley Green	95.5%	99.9%	99.9%		96.7%		98.0%
Chesterfield Roadside	88.3%	99.5%	99.5%				95.8%

Site Name	NO_2	PM_{10}	$PM_{2.5}$	CO	O_3	SO_2	Average
Chilbolton Observatory	**61.7%**	85.3%	85.3%		96.6%	96.0%	84.7%
Christchurch Barrack Road	97.6%		85.2%				91.4%
Coventry Allesley	95.2%	99.9%	99.9%		96.9%		98.0%
Coventry Binley Road	97.5%	96.7%					97.2%
Crewe Coppenhall	97.0%	99.3%	99.3%		97.2%		98.2%
Derby St Alkmund's Way	**67.4%**						67.4%
Derby Stockbrook Park		98.4%	98.4%		93.0%		96.6%
Dewsbury Ashworth Grange	87.9%	99.5%	99.5%		97.2%		96.5 %
Doncaster A630 Cleveland Street	97.0%						97.0%
Eastbourne	**56.5%**	**61.8%**	**61.8%**		95.3%		68.9%
Exeter Roadside	**75.4%**				**59.5%**		67.4%
Glazebury	94.8%	99.3%	99.3%		91.2%		96.1%
Hartlepool St Abbs Walk	97.2%	99.5%	99.5%		97.0%		98.5%
High Muffles	95.5%	99.8%	99.8%		98.0%		98.4%
Honiton	**68.6%**	99.4%	99.4%		97.3%		91.2%
Horley*	89.9%						89.9%
Hull Freetown	99.7%	99.9%	99.9%		97.1%	**82.6%**	94.1%
Hull Holderness Road	**61.8%**	93.2%					76.8%
Immingham Woodlands Avenue	91.7%	99.6%	99.7%		89.2%		95.3%
Ladybower	96.7%				97.6%	95.9%	96.7%
Leamington Spa	96.8%	99.9%	99.4%		98.4%		98.7%
Leamington Spa Rugby Road	95.9%	98.5%	98.5%				95.9%
Leeds Centre	93.4%	99.9%	99.9%	95.1%	95.2%	96.5%	96.6%
Leeds Headingley Kerbside	89.9%	**43.6%**	85.9%				72.9%
Leicester A594 Roadside	93.8%	95.5%					94.6%
Leicester University	93.3%	99.4%	99.5%		97.2%		97.3%
Leominster	93.5%				96.3%		95.0%
Lincoln Canwick Road	**75.7%**						75.7%
Liverpool Speke	94.4%	97.1%	96.2%		97.8%	96.9%	96.3%
Lullington Heath	96.5%	99.9%	99.9%		97.6%	**82.0%**	95.2%
Luton A505 Roadside	97.9%						97.9%
Manchester Piccadilly	97.5%	**82.6%**	**82.6%**		96.8%	96.3%	91.2%

Site Name	NO_2	PM_{10}	$PM_{2.5}$	CO	O_3	SO_2	Average
Manchester Sharston	95.9%				95.2%		95.6%
Middlesbrough	96.9%	95.2%	**83.1%**		**79.6%**	96.7%	93.4%
Milton Keynes Civic Centre		99.7%	99.7%		93.9%		97.7%
Newcastle Centre	97.5%	96.9%	93.5%		97.9%		96.1%
Newcastle Cradlewell Roadside	97.2%	94.9%					96.1%
Northampton Spring Park	97.0%		89.9%		97.4%		94.8%
Norwich Lakenfields	**76.3%**	94.8%	94.8%		87.6%		88.4%
Nottingham Centre	87.9%	99.8%	99.8%		97.3%	92.5%	95.5%
Nottingham Western Boulevard	97.4%	94.9%					95.7%
Oldbury Birmingham Road	95.9%						95.9%
Oxford Centre Roadside	85.8%						85.8%
Oxford St Ebbes	97.7%	99.9%	99.9%		95.4%		98.3%
Plymouth Centre	97.3%	99.9%	99.9%		97.4%		98.6%
Plymouth Tavistock Road	**67.2%**						67.2%
Portsmouth	98.9%	100.0%	100.0%		97.5%		99.7%
Portsmouth Anglesea Road	97.5%	97.8%					97.7%
Preston	96.4%	99.9%	99.9%		97.7%		98.5%
Reading London Road	97.7%	95.3%					96.5%
Reading New Town	96.0%	96.9%	98.8%		97.2%		93.7%
Rochester Stoke	95.1%	98.5%	98.5%		93.9%	85.1%	93.4%
Salford Eccles	97.6%	99.9%	99.9%		82.7%		95.0%
Saltash Callington Road		96.5%	93.3%				94.9%
Sandy Roadside*	97.7%	95.6%	93.0%				94.5%
Scunthorpe Town	91.7%	89.2%				92.4%	91.1%
Shaw Crompton Way	98.4%						98.4%
Sheffield Barnsley Road	95.3%		96.5%				95.9%
Sheffield Devonshire Green	97.5%	99.3%	99.3%		97.1%		98.4%
Sheffield Tinsley	96.7%	99.3%	99.3%		97.6%		98.2%
Sibton					97.2%		97.2%
Southampton A33	94.6%	96.8%					95.7%
Southampton Centre	97.0%	99.9%	99.9%		96.9%	95.9%	97.9%

Site Name	NO_2	PM_{10}	$PM_{2.5}$	CO	O_3	SO_2	Average
Southend-on-Sea	96.6%	99.3%	99.3%		98.0%		98.3%
St Helens Linkway	97.5%	91.8%					94.6%
St Osyth	96.8%	99.9%	99.9%		95.3%		97.9%
Stanford-le-Hope Roadside*	96.2%	91.9%	89.6%				92.6%
Stockton-on-Tees A1305 Roadside	97.2%		93.5%				93.7%
Stockton-on-Tees Eaglescliffe	94.5%	92.0%	**81.3%**				89.3%
Stoke-on-Trent A50 Roadside	96.7%	96.6%					96.7%
Stoke-on-Trent Centre	95.7%	99.9%	99.9%		97.7%		98.4%
Storrington Roadside	88.6%						88.6%
Sunderland Silksworth	96.2%	94.9%	94.9%		97.5%		95.9%
Sunderland Wessington Way	97.2%						97.2%
Swindon Walcot	96.3%	99.6%	99.6%		94.9%		97.6%
Tallington		97.3%	97.3%		93.9%		96.0%
Telford Hollinswood	97.3%	99.4%	99.4%		97.0%		98.3%
Toft Newton	95.7%	99.2%	99.2%		96.2%		97.6%
Walsall Woodlands	96.1%				94.7%		93.3%
Warrington	**83.5%**	93.9%	94.2%				89.5%
West Bromwich Kenrick Park	93.6%				84.6%		88.9%
Weybourne		87.9%	88.0%		92.6%		88.9%
Wicken Fen	96.9%	99.8%	99.8%		91.9%	91.5%	95.9%
Widnes Milton Road	96.6%						96.6%
Wigan Centre	97.6%	99.9%	99.9%		96.3%		98.4%
Wirral Tranmere	98.4%	99.8%	99.8%		97.5%		96.6%
Worthing A27 Roadside	**83.2%**		**48.2%**				65.7%
Yarner Wood	92.8%	99.2%	99.2%		96.7%		97.2%
York Bootham	97.3%	96.4%	97.9%		97.2%		97.2%
York Fishergate	96.6%	97.3%	93.4%				95.8%
Number of Stations	**108**	**83**	**77**	**1**	**67**	**15**	**116**
Number of Stations < 85%	**13**	**3**	**7**	**0**	**5**	**4**	**12**
Number of Stations <90%	**21**	**6**	**14**	**0**	**8**	**5**	**23**
Average	**92.8%**	**96.2%**	**94.8%**	**95.1%**	**94.4%**	**87.1%**	**93.2%**

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 2023

Site Name	NO_2	PM_{10}	$PM_{2.5}$	CO	O_3	SO_2	Average
Camden Kerbside	99.5%	**72.7%**	95.7%				89.3%
Ealing Horn Lane		95.3%					95.3%
Haringey Roadside	85.8%						85.8%
London Bexley	98.4%	99.8%	99.8%				99.3%
London Bloomsbury*	97.2%	97.1%	97.1%		88.7%	89.6%	93.9%
London Eltham	**33.0%**	**46.7%**	**46.7%**		**39.5%**		41.5%
London Haringey Priory Park South	95.5%				**83.5%**		89.5%
London Harlington*	97.6%	99.9%	99.9%		97.6%		98.7%
London Hillingdon*	97.2%	97.5%	97.4%		97.5%		97.2%
London Honor Oak Park		99.6%	99.6%				99.6%
London Marylebone Road	95.4%	94.2%	94.1%	93.8%	94.9%	94.7%	94.5%
London N. Kensington	99.2%	99.6%	99.6%	98.9%	94.3%	**79.8%**	95.2%
London Teddington Bushy Park		**75.3%**	**75.3%**				75.3%
London Westminster*	97.2%		96.5%		86.3%		93.2%
Southwark A2 Old Kent Road	98.4%	99.0%					94.7%
Thurrock	99.2%	92.7%	92.7%		97.1%	85.2%	93.4%
Tower Hamlets Roadside	98.6%						98.6%
Number of Stations	**14**	**13**	**12**	**2**	**9**	**4**	**17**
Number of Stations < 85%	**1**	**3**	**2**	**0**	**2**	**1**	**2**
Number of Stations <90%	**2**	**3**	**2**	**0**	**4**	**3**	**5**
Average	**92.3%**	**90.0%**	**91.2%**	**96.4%**	**86.6%**	**87.3%**	**90.3%**

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 2023

Site Name	NO_2	PM_{10}	$PM_{2.5}$	CO	O_3	SO_2	Average
Aberdeen Erroll Park	97.1%	95.7%	95.7%		97.5%		96.5%
Aberdeen Union Street Roadside	97.7%						97.7%
Aberdeen Wellington Road	**67.5%**						67.5%
Auchencorth Moss		99.9%	99.9%		97.4%		99.1%
Bush Estate	97.5%				97.9%		97.7%
Dumbarton Roadside	**84.9%**						84.9%
Dumfries	96.2%						96.2%
Dundee Mains Loan	96.9%						96.9%
Edinburgh Nicolson Street	94.1%						94.1%
Edinburgh St Leonards	96.2%	100.0%	100.0%	**83.8%**	97.2%	95.4%	95.4%
Eskdalemuir	**37.8%**				95.5%		66.4%
Fort William	91.4%				97.7%		94.5%
Glasgow Great Western Road	96.8%						96.8%
Glasgow High Street	97.6%	99.9%	99.9%				99.1%
Glasgow Kerbside	**79.0%**						79.0%
Glasgow Townhead	97.4%	99.5%	99.5%		96.4%		98.8%
Grangemouth	86.9%	96.6%	97.8%			93.3%	93.6%
Grangemouth Moray	**76.2%**						76.2%
Greenock A8 Roadside	97.7%	99.7%	99.7%				99.5%
Inverness	96.8%	97.6%	97.6%				97.3%
Lerwick					**83.8%**		83.8%
Peebles	97.2%				98.3%		97.7%
Strathvaich					87.0%		87.0%
Number of Stations	**20**	**8**	**8**	**1**	**10**	**2**	**23**
Number of Stations < 85%	**5**	**0**	**0**	**1**	**1**	**0**	**6**
Number of Stations <90%	**0**	**0**	**0**	**0**	**0**	**0**	**0**
Average	**89.1%**	**98.6%**	**98.8%**	**83.8%**	**94.9%**	**94.3%**	**91.1%**

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 2023

Site Name	NO_2	PM_{10}	$PM_{2.5}$	CO	O_3	SO_2	Average
Aston Hill	96.0%				**77.6%**		86.9%
Cardiff Centre	92.9%	93.5%	**49.9%**	**46.2%**	97.4%	**69.3%**	74.9%
Cardiff Newport Road	97.9%	97.4%					97.6%
Chepstow A48	93.4%	96.5%	96.4%				95.4%
Cwmbran Crownbridge	**41.2%**				**41.3%**		41.2%
Hafod-yr-Ynys Hill Roadside	97.3%						97.3%
Narberth	93.2%	99.6%	99.6%		95.7%	93.7%	96.3%
Newport	97.7%	99.6%	99.6%				99.0%
Port Talbot Margam	92.4%	92.9%	95.4%	**82.0%**	94.3%	94.5%	91.7%
Swansea Roadside	97.3%	95.5%	88.2%				93.7%
Wrexham	92.8%	99.9%	99.9%			96.6%	97.3%
Number of Stations	**11**	**8**	**7**	**2**	**5**	**4**	**11**
Number of Stations < 85%	**1**	**0**	**1**	**2**	**2**	**1**	**2**
Number of Stations <90%	**1**	**0**	**2**	**2**	**2**	**1**	**3**
Average	**90.2%**	**96.9%**	**89.9%**	**64.1%**	**81.3%**	**88.5%**	**88.3%**

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 2023

Site Name	NO_2	PM_{10}	$PM_{2.5}$	CO	O_3	SO_2	Average
Armagh Roadside	96.6%	93.3%					94.9%
Ballymena Antrim Road	95.5%						95.5%
Ballymena Ballykeel	91.8%					86.0%	88.9%
Belfast Centre	68.9%	99.9%	99.9%	92.4%	97.1%	96.5%	92.5%
Belfast Stockman's Lane	97.2%	86.8%					92.0%
Derry Rosemount	83.5%	73.3%	94.5%		96.9%	69.3%	83.5%
Lough Navar		99.8%	99.8%		97.5%		99.0%
Mace Head					99.7%		99.7%
Number of stations	**6**	**5**	**3**	**1**	**4**	**3**	**8**
Number of Stations < 85%	**2**	**1**	**0**	**0**	**0**	**1**	**1**
Number of stations <90%	**2**	**2**	**0**	**0**	**0**	**2**	**2**
Average	**88.9%**	**90.6%**	**98.1%**	**92.4%**	**97.8%**	**83.9%**	**93.2%**

3.9 GRAVIMETRIC DATA CAPTURE

Three gravimetric samplers operated within the AURN during 2023. 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.

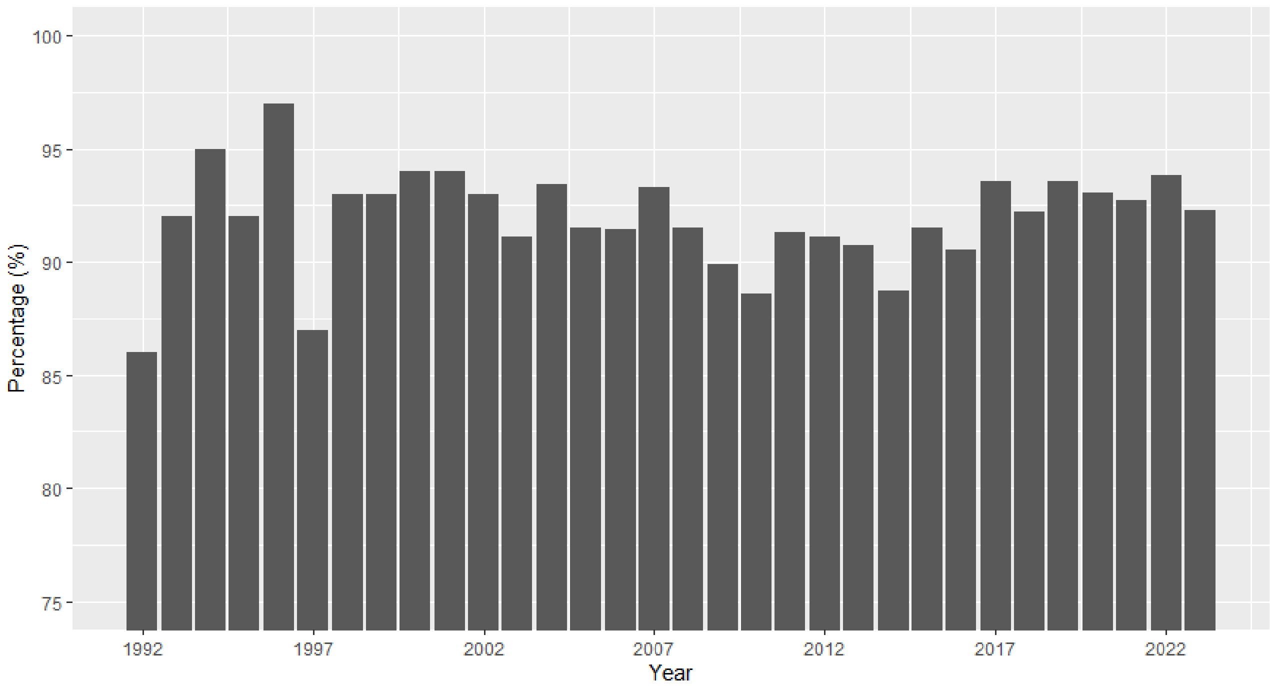
Table 3-7 Gravimetric Data Capture, January – December 2023

Site Name	PM_{10}	$PM_{2.5}$	Average
London Marylebone Road	96.2	97.3	96.8
Port Talbot Margam	97.5		97.5
Number of Stations	**2**	**1**	**2**
Number of stations < 85 %	**0**	**0**	**0**
Number of stations < 90%	**0**	**0**	**0**
Average	**96.9%**	**97.3%**	**97.2%**

3.10 TRENDS IN DATA CAPTURE

The overall annual AURN data captures from 1992-2023 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 21 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 2023

Table 4-1 shows the changes to the AURN, i.e., monitoring stations started up or closed down and additional instruments installed, during 2023.

2023 saw the continuation of the expansion of the particulate monitoring network within the AURN and the expansion of the networks Ozone measuring capabilities, as part of this several existing sites had a new instrument installed to measure Ozone, 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 2023

Station		Pollutants Measured	Start Date	Close Date
Milton Keynes Civic Centre	UKA00963	New site for PM_{10} and $PM_{2.5}$	01/03/2023	-
Burton-on-Trent Horninglow	UKA00652	Addition of ozone	22/02/2023	-
Chesterfield Loundsley Green	UKA00604	Addition of ozone	09/02/2023	-

Station		Pollutants Measured	Start Date	Close Date
Crew Coppenhall	UKA00659	Addition of ozone	24/01/2023	-
Dewsbury Ashworth Grove	UKA00654	Addition of ozone	27/02/2023	-
Hartlepool St. Abbs Walk	UKA00645	Addition of ozone	07/03/2023	-
Immingham Woodlands Avenue	UKA00647	Addition of ozone	08/02/2023	-
London Westminster	UKA00435	Addition of ozone	06/02/2023	-
Salford Eccles	UKA00339	Addition of ozone	21/02/2023	-
Sheffield Tinsley	UKA00181	Addition of ozone	20/02/2023	-
Swindon Walcot	UKA00650	Addition of ozone	07/03/2023	-
Telford Hollinswood	UKA00648	Addition of ozone	23/02/2023	-
West Bromwich Kenrick Park	UKA00658	Addition of ozone	22/02/2023	-
York Bootham	UKA00523	Addition of ozone	26/05/2023	-
Milton Keynes Civic Centre	UKA00963	Addition of ozone	24/08/2023	-
Thurrock	UKA00272	Addition of PM_{10}, $PM_{2.5}$	01/01/2023	-
Barnsley Gawber	UKA00353	Addition of PM_{10}, $PM_{2.5}$	06/04/2023	-
Blackburn Audley Park	UKA01025	O_3, PM_{10}, $PM_{2.5}$	01/09/2023	-
Toft Newton	UKA01026	NOx, O_3, PM_{10}, $PM_{2.5}$	26/09/2023	-
Hafod-yr-Ynys Roadside	UKA01037	NOx	-	15/09/2023
Tallington	UKA01038	O_3, PM_{10}, $PM_{2.5}$	11/12/2023	-
Hafod-yr-Ynys Hill Roadside	UKA01037	NOx	01/10/2023	-
Derby Stockbrook Park	UKA01027	O_3, PM_{10}, $PM_{2.5}$	24/11/2023	-

4.2 CHANGES TO INSTRUMENTATION

Multiple sites within the network saw their NOx instrument replaced with a Numaview API.

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 175. 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 2023) and summer (July-September 2023). 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 92.3% (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 2023. Mean data captures for individual pollutants were as follows: NO_2 92.0%, PM_{10} 95.5%, $PM_{2.5}$ 94.4% CO 84.6% O_3 93.1%, SO_2 87.5%. Hence, the mean data captures for all pollutant, with the exception of CO, met this target in calendar year 2023. There were 40 stations out of 175 with mean data capture below 90%.

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

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 2023 was supplied to the Monitoring of Ambient Air Quality (MAAQ) Team by the end of May 2024. 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 2023 to Defra and the Devolved Administrations by their deadline of 30th of September 2024.

7. REFERENCES

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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.

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 A1, cases where these objectives were not met are shown in **bold red** font.

Table A1 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 Errol Park	14-Feb	11.2			12.2	7.5			
Aberdeen Union Street Roadside	16-Feb				12.2	7.5			
Aberdeen Wellington Road	14-Feb				12.8	9.4			
Armagh Roadside	07-Feb				12.3	**31.6**			
Aston Hill	30-Jan	8.3			12.2				
Auchencorth Moss	01-Feb	11.2				9.0			
Ballymena Antrim Road	10-Feb				12.2				
Ballymena Ballykeel	13-Feb			10.8					
Barnsley Gawber	08-Feb	8.3		11.6	9.8				
Barnstaple A39	09-Jan					9.3	12.6		
Bath A4 Roadside	16-Jan				14.0				
Belfast Centre	08-Feb	11.2	7.5	10.0	9.8	7.5			
Belfast Stockman's Lane	08-Feb				12.2	9.3			
Billingham	17-Jan				12.2				
Birkenhead Borough Road	15-Feb				12.2				
Birmingham A4540 Roadside	23-Jan	11.2			12.2	7.5	12.7		
Birmingham Ladywood	23-Jan	7.7		12.4	13.2	7.6			
Blackburn Accrington Road	06-Jan				12.4				
Blackpool Marton	06-Jan	8.3			9.9	7.6			
Bournemouth	07-Feb	11.2			12.2		13.0		
Bradford Mayo Avenue	13-Feb				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	09-Feb	11.2			12.2		12.8		
Bristol St Paul's	18-Jan	11.2			14.7	9.3	12.6		
Bristol Temple Way	18-Jan				13.0	10.7			
Burton-on-Trent Horninglow	26-Jan				12.2	7.5			
Bury Whitefield Roadside	20-Feb				12.2	9.3			
Bush Estate	01-Feb	11.2			12.2				
Cambridge Roadside	30-Jan				12.2				
Cannock A5190 Roadside	25-Jan				12.3				
Canterbury	25-Jan	11.2			12.2	7.5			
Cardiff Centre	19-Jan	11.3	7.5	10.0	12.2	9.6	12.8		
Cardiff Newport Road	18-Jan				12.2	9.3			
Carlisle Morton A595	21-Feb				12.2	9.3	12.6		
Charlton Mackrell	09-Jan	11.2			12.7	8.4			
Chatham Roadside	24-Jan				12.2	9.5	12.7		
Chepstow A48	17-Jan				14.0	9.3	12.7		
Chesterfield Loundsley Green	19-Jan				12.4	8.8			
Chesterfield Roadside	19-Jan				12.2	7.5			
Chilbolton	11-Jan	11.2		10.0	12.2	8.1	12.6		
Christchurch Barrack Road	07-Feb				12.5		12.6		
Coventry Allesley	15-Feb	8.4			9.8	8.2			
Coventry Binley Road	13-Feb				12.2	9.3			
Crewe Coppenhall	23-Feb	11.2			12.2	9.1			
Cwmbran Crownbridge	20-Jan	8.3			12.9				
Derby St Alkmunds Way	15-Feb				13.6				
Derry Rosemount	09-Feb	11.2		12.4	12.3	9.3	12.6		

Site	Date of audit	O_3	CO	SO_2	NO_2	PM_{10}	$PM_{2.5}$	GR_{10}	$GR_{2.5}$
Dewsbury Ashworth Grange	13-Feb				12.2	8.3			
Doncaster A630 Cleveland Street	16-Jan				12.4				
Dundee Mains Loan	20-Feb				12.2				
Dumbarton Roadside	02-Feb				12.2				
Dumfries	21-Feb				12.2				
Eastbourne	08-Feb				12.2	8.6			
Edinburgh Nicolson Street	31-Jan				12.2	7.9			
Edinburgh St Leonards	02-Feb	11.2	7.5	10.4	12.3	7.5			
Eskdalemuir	03-Feb	11.2			12.4				
Exeter Roadside	12-Jan	7.5			13.1				
Fort William	08-Feb	11.2			12.3				
Glasgow Great Western Road	26-Jan				13.1				
Glasgow High Street	25-Jan				12.2	7.5			
Glasgow Kerbside	25-Jan				10.6	7.5			
Glasgow Townhead	26-Jan	8.3			12.2	8.0			
Glazebury	05-Jan	11.2			12.3	7.5			
Grangemouth	27-Jan			10.0	12.3	9.4	12.6		
Grangemouth Moray	03-Feb			12.7	12.5				
Greenock A8 Roadside	02-Feb					8.2			
Hafod-yr-ynys Roadside	20-Jan				12.4				
Hartlepool St Abbs Walk	18-Jan				12.3	9.4			
High Muffles	09-Jan	11.2			12.2	14.3			
Honiton	11-Jan				13.9	8.0			
Hull Freetown	17-Jan	8.3		10.0	9.8	11.1			
Hull Holderness Road	16-Jan				12.4	9.3			
Immingham Woodlands Avenue	18-Jan	11.2			13.4	7.7			
Inverness	10-Feb				12.2	7.5			
Ladybower	09-Feb	11.2		10.0	12.2				

Site	Date of audit	O_3	CO	SO_2	NO_2	PM_{10}	$PM_{2.5}$	GR_{10}	$GR_{2.5}$
Leamington Spa	14-Feb	11.2			12.2	7.8			
Leamington Spa Rugby Road	14-Feb				12.3	7.7			
Leeds Centre	14-Feb	8.3	7.5	11.6	12.2	7.5			
Leeds Headingley Kerbside	13-Feb				12.2	**27.9**	**21.6**		
Leicester A594 Roadside	15-Feb				13.8	9.4			
Leicester University	16-Feb	8.3			11.0	7.7			
Leominster	31-Jan	11.2			12.2				
Lerwick	15-Feb	11.2							
Lincoln Canwick Road	18-Jan				12.6				
Liverpool Speke	02-Feb	8.3		10.9	10.6	10.5	12.6		
London Bloomsbury	25-Jan	11.2		10.0	12.2	8.3			
London Harlington	20-Feb	11.2			14.3	7.5			
London Hillingdon	24-Jan	8.3			9.8	9.9			
London Teddington Bushy Park	26-Jan					9.3	9.3		
London Westminster	21-Feb	11.2			12.4				
Lough Navar	07-Feb	11.2				7.5			
Lullington Heath	09-Feb	11.2		10.2	12.4	7.5			
Luton A505 Roadside	01-Feb				12.2				
Mace Head	Audit not possible due to demolition work on site.								
Manchester Piccadilly	22-Feb	8.3		10.1	9.8	9.4	12.6		
Manchester Sharston	22-Feb	11.2		10.1	12.2	7.5			
Middlesbrough	17-Jan	11.2		10.5	12.2	12.6	14.5		
Narberth	16-Jan	12.7		10.3	12.2	12.4			
Newcastle Centre	19-Jan	8.3			9.8	9.3	12.6		
Newcastle Cradlewell Roadside	19-Jan				12.3	12.6			
Newport	17-Jan				12.3	9.9			
Northampton Spring Park	16-Feb	7.2			13.8	9.8			

Site	Date of audit	O_3	CO	SO_2	NO_2	PM_{10}	$PM_{2.5}$	GR_{10}	$GR_{2.5}$
Norwich Lakenfields	01-Feb	8.3			9.8	7.5			
Nottingham Centre	15-Feb	8.3		10.5	11.7	7.5			
Nottingham Western Boulevard	14-Feb				12.8	9.3			
Oldbury Birmingham Road	24-Jan				13.1				
Oxford Centre Roadside	09-Jan				12.2				
Oxford St Ebbes	09-Jan	8.3			12.3	7.7			
Peebles	31-Jan	11.2			12.2				
Plymouth Tavistock Road	10-Jan				12.9				
Plymouth Centre	10-Jan	8.3			12.3	7.5			
Port Talbot Margam	17-Jan	8.3	11.5	11.6	9.9	14.9	**17.5**	9	
Portsmouth	06-Feb	8.3			13.0	7.5			
Portsmouth Anglesea Road	06-Feb				12.3	10.0			
Preston	31-Jan	8.3			9.8	7.5			
Reading London Road	10-Jan				12.2	9.3			
Reading New Town	10-Jan	8.3			10.0	9.3	12.6		
Rochester Stoke	24-Jan	11.2		10.5	12.2	7.5			
Salford Eccles	13-Jan				12.2	7.9			
Saltash Callington Road	10-Jan					9.3	12.6		
Scunthorpe Town	17-Jan			10.0	12.3	**35.7**			
Shaw Crompton Way	20-Feb				12.2	10.0			
Sheffield Barnsley Road	06-Feb				12.2		12.8		
Sheffield Devonshire Green	07-Feb	8.3			9.8	10.5			
Sheffield Tinsley	06-Feb				12.2	7.9			
Sibton	02-Feb	11.2							
Southampton Centre	09-Feb	8.3		11.7	9.8	9.8			

Site	Date of audit	O_3	CO	SO_2	NO_2	PM_{10}	$PM_{2.5}$	GR_{10}	$GR_{2.5}$
Southampton A33 Roadside	09-Feb				12.2	9.6			
Southend-on-Sea	23-Jan	8.3			**20.7**				
St Helens Linkway	30-Jan				12.3	**22.9**			
St Osyth	03-Feb	8.3			12.2	7.5			
Stockton on Tees A1035 Roadside	16-Jan				12.3		12.6		
Stockton-on-Tees Eaglescliffe	16-Jan				12.4	10.3	12.6		
Stoke-on-Trent Centre	04-Jan	8.3			9.8	9.0			
Stoke on Trent A50 Roadside	04-Jan				12.2	9.3			
Storrington Roadside	06-Feb				9.9	7.5	12.6		
Strathvaich	09-Feb	11.2							
Sunderland Silksworth	18-Jan				12.2	9.3			
Sunderland Wessington Way	18-Jan				12.2				
Swansea Roadside	18-Jan				12.3	9.3	12.6		
Swindon Walcot	16-Jan				13.0	12.4			
Telford Hollinswood	25-Jan				12.2	7.5			
Walsall Woodlands	25-Jan	11.2			12.2				
West Bromwich Kenrick Park	14-Feb				12.2	9.3	12.6		
West Bromwich Kenrick Park	24-Jan				12.2				
Weybourne	31-Jan	8.3				7.5			
Wicken Fen	31-Jan	11.2		10.0	12.2	8.2			
Widnes Milton Road	30-Jan				12.2				
Wigan Centre	31-Jan	8.3			12.2	7.5			
Wirral Tranmere	15-Feb	8.3			10.5	7.5			
Wrexham	21-Feb			10.0	12.2	7.6			
Yarner Wood	11-Jan	11.2			12.4	8.1			
York Bootham	10-Jan				12.2	11.1	14.4		
Aberdeen Errol Park	21-Aug	11.2			12.3	7.5			

Site	Date of audit	O_3	CO	SO_2	NO_2	PM_{10}	$PM_{2.5}$	GR_{10}	$GR_{2.5}$
Aberdeen Union Street Roadside	22-Aug				12.3	7.5			
Aberdeen Wellington Road	22-Aug				12.3	7.5			
Armagh Roadside	22-Aug				12.2	9.3			
Aston Hill	14-Aug	8.6			12.2				
Auchencorth Moss	02-Aug	11.2				15.0			
Ballymena Antrim Road	22-Aug				12.3				
Ballymena Ballykeel	22-Aug			10.7	12.2	7.5			
Barnsley Gawber	09-Aug	11.2		10.7	12.3	7.5			
Barnstaple A39	11-Jul					9.3	12.6		
Bath A4 Roadside	17-Jul				13.1				
Belfast Centre	17-Aug	11.2	7.5	10.0	12.2	7.9			
Belfast Stockman's Lane	18-Aug				12.2	9.3			
Billingham	02-Aug				12.4				
Birkenhead Borough Road	13-Jul				13.4				
Birmingham A4540 Roadside	31-Jul	11.2			12.2		12.8		
Birmingham Ladywood	31-Jul	7.2		10.0	13.1	8.8			
Blackburn Accrington Road	11-Jul				12.4				
Blackpool Marton	12-Jul	8.3			10.0	7.8			
Bournemouth	09-Aug	11.2			12.2		12.6		
Bradford Mayo Avenue	18-Jul				12.2				
Brighton Preston Park	29-Aug	11.2			12.2		13.2		
Bristol St Paul's	19-Jul	11.2			12.5	9.3	12.8		
Bristol Temple Way	18-Jul				14.0	10.0			

Site	Date of audit	O_3	CO	SO_2	NO_2	PM_{10}	$PM_{2.5}$	GR_{10}	$GR_{2.5}$
Burton-on-Trent Horninglow	05-Jul	11.2			12.2	7.5			
Bury Whitefield Roadside	21-Aug				12.2	9.4			
Bush Estate	02-Aug	11.2			12.4				
Cambridge Roadside	24-Jul				12.2				
Cannock A5190 Roadside	04-Jul				12.2				
Canterbury	12-Jul	11.2			12.2	7.8			
Cardiff Centre	02-Aug	11.2	7.5	10.3	12.2	13.3	18.4		
Cardiff Newport Road	01-Aug				13.5	9.4			
Carlisle Morton A595	24-Aug				12.2	9.3	12.6		
Charlton Mackrell	10-Jul	11.2			12.2	7.5			
Chatham Roadside	11-Jul				12.4	9.4	12.7		
Chepstow A48	18-Jul				12.2	9.3	12.8		
Chesterfield Loundsley Green	16-Aug	11.2			12.2	7.5			
Chesterfield Roadside	16-Aug				12.2	7.5			
Chilbolton Observatory	05-Jul	11.2		11.0	12.3	7.5			
Christchurch Barrack Road	09-Aug				12.2		15.5		
Coventry Allesley	21-Aug	11.2			12.2	7.5			
Coventry Binley Road	22-Aug				12.2	9.3			
Crewe Coppenhall	15-Aug	11.2			12.4	7.5			
Cwmbran Crownbridge	03-Aug	11.2			13.5				
Derby St Alkmunds Way	07-Aug				13.8				
Derry Rosemount	16-Aug	11.2		10.0	12.2	9.7	12.9		
Dewsbury Ashworth Grove	18-Jul	11.2			12.2	7.5			
Doncaster A630	25-Jul				12.2				

Site	Date of audit	O_3	CO	SO_2	NO_2	PM_{10}	$PM_{2.5}$	GR_{10}	$GR_{2.5}$
Cleveland Street									
Dundee Mains Loan	08-Aug				12.3				
Dumbarton Roadside	29-Jun				12.2				
Dumfries	24-Aug				12.2				
Eastbourne									
Edinburgh Nicolson Street	01-Aug				12.2	10.4			
Edinburgh St Leonards	03-Aug	11.2	7.5	10.0	12.3	7.7			
Eskdalemuir	25-Aug	11.2			12.2				
Exeter Roadside	12-Jul	11.2			12.3				
Fort William	09-Aug	11.2			12.2				
Glasgow Great Western Road	24-Jul				12.2				
Glasgow High Street	25-Jul				12.2	7.6			
Glasgow Kerbside	25-Jul				9.8	7.5	12.6		
Glasgow Townhead	24-Jul	11.2			12.2	7.8			
Glazebury	15-Aug	11.2			12.2	7.7			
Grangemouth	11-Jul			10.4	12.2	9.3	12.6		
Grangemouth Moray	11-Jul				12.2				
Greenock A8 Roadside	29-Jun				12.2	7.5			
Hafod-yr-Ynys Roadside	02-Aug				13.8				
Hartlepool St Abbs Walk	03-Aug	11.3			12.2	7.5			
High Muffles	15-Aug	11.2			12.2	10.6			
Honiton	13-Jul	11.2			13.3	7.9			
Hull Freetown	27-Jul	8.3		10.0	12.2	7.7			
Hull Holderness Road	26-Jul				12.2	9.3			
Immingham Woodlands Avenue	26-Jul	11.2			12.3	8.0			
Inverness	09-Aug				12.3	7.5			

Site	Date of audit	O_3	CO	SO_2	NO_2	PM_{10}	$PM_{2.5}$	GR_{10}	$GR_{2.5}$
Ladybower	07-Aug	11.2		10.0	12.2				
Leamington Spa	23-Aug	11.2			12.2	7.5			
Leamington Spa Rugby Road	22-Aug				12.6	7.5			
Leeds Centre	19-Jul	8.3	8.5	11.6	12.2	7.5			
Leeds Headingley Kerbside	19-Jul				12.2	20.4	12.7		
Leicester A594 Roadside	24-Aug				13.8	9.8			
Leicester University	24-Aug	8.3			14.4	8.0			
Leominster	15-Aug	11.2			13.0				
Lerwick	23-Aug	11.2							
Lincoln Canwick Road	24-Jul				12.5				
Liverpool Speke	10-Jul	8.3		10.1	9.9	9.3	12.6		
London Bloomsbury	18-Jul	11.2		10.0	12.2	7.5			
London Harlington	17-Jul	11.2			12.2	7.5			
London Hillingdon	17-Jul	8.3			9.9	7.5			
London Teddington Bushy Park	19-Jul					7.5	12.7		
London Westminster	18-Jul	11.2			12.2				
Lough Navar	14-Aug	**15.7**				8.5			
Lullington Heath	28-Aug	11.2		11.5	12.2	8.2			
Luton A505 Roadside	16-Aug				12.2				
Mace Head	15 - Aug	8.5							
Manchester Piccadilly	17-Aug	8.5		10.1	9.8	9.8	12.6		
Manchester Sharston	16-Aug	11.2		10.0	12.2	8.4			
Market Harborough									
Middlesbrough	02-Aug	11.2		10.4	12.2	9.4	13.1		
Narberth	31-Jul	11.2		10.1	13.4	7.7			

Site	Date of audit	O_3	CO	SO_2	NO_2	PM_{10}	$PM_{2.5}$	GR_{10}	$GR_{2.5}$
Newcastle Centre	31-Jul	8.3			10.0	9.3	12.6		
Newcastle Cradlewell Roadside	31-Jul				12.3	9.7			
Newport	18-Jul				13.5	7.7			
Northampton Spring Park	09-Aug	11.2			12.2		13.7		
Norwich Lakenfields	26-Jul	11.2			12.7	8.6			
Nottingham Centre	10-Aug	8.3		11.8	11.4	7.5			
Nottingham Western Boulevard	07-Aug				13.9	9.5			
Oldbury Birmingham Road	01-Aug				13.0				
Oxford Centre Roadside	03-Jul				12.3				
Oxford St Ebbes	03-Jul	8.3			12.2	7.5			
Peebles	01-Aug	11.2			12.2				
Plymouth Tavistock Road	11-Jul				**15.6**				
Plymouth Centre	11-Jul	8.3			11.3	7.5			
Port Talbot Margam	01-Aug	8.3	11.7	11.6	12.5	9.3	12.6	11	
Portsmouth	07-Aug	8.3			13.0	8.1			
Portsmouth Anglesea Road	07-Aug				12.3	9.3			
Preston	12-Jul	8.3			9.8	7.7			
Reading London Road	04-Jul				12.2	9.4			
Reading New Town	04-Jul	8.3			9.8	7.5			
Rochester Stoke	11-Jul	11.2		10.1	12.5	8.9			
Salford Eccles	07-Jul	11.2			12.2	7.5			
Saltash Callington Road	12-Jul					9.3	15.0		
Scunthorpe Town	25-Jul			10.3	12.2	9.3			
Shaw Crompton Way	10-Aug				12.2	16.9			

Site	Date of audit	O_3	CO	SO_2	NO_2	PM_{10}	$PM_{2.5}$	GR_{10}	$GR_{2.5}$
Sheffield Barnsley Road	07-Aug				12.2		12.6		
Sheffield Devonshire Green	10-Aug	11.2			9.8	7.5			
Sheffield Tinsley	10-Aug	11.2			12.2	8.5			
Sibton	25-Jul	11.2							
Southampton Centre	10-Aug	8.3		10.1	9.8	7.5			
Southampton A33 Roadside	10-Aug				12.2	9.3			
Southend-on-Sea	10-Jul	8.3			9.9	7.8			
St Helens Linkway	14-Jul				12.2	9.3			
St Osyth	27-Jul	11.2			12.2	7.7			
Stockton on Tees A1035 Roadside	01-Aug				12.2		13.7		
Stockton-on-Tees Eaglescliffe	01-Aug				12.4	10.5	12.8		
Stoke-on-Trent Centre	04-Jul	8.3			9.8	10.0			
Stoke on Trent A50 Roadside	05-Jul				12.2	9.3			
Storrington Roadside	30-Aug				12.3	7.5	13.0		
Strathvaich	09-Aug	8.3							
Sunderland Silksworth	03-Aug	11.2			12.2	8.1			
Sunderland Wessington Way	04-Aug				12.3				
Swansea Roadside	31-Jul				13.9	9.5	12.6		
Swindon Walcot	17-Jul	11.2			12.3	9.5			
Telford Hollinswood	02-Aug	11.2			12.3	7.6			
Walsall Woodlands	02-Aug	11.2			12.2				
West Bromwich Kenrick Park	14-Jul				12.2	9.3	12.6		
West Bromwich Kenrick Park	01-Aug	11.2			12.2				
Weybourne	10-Aug	8.4				8.9			

Site	Date of audit	O_3	CO	SO_2	NO_2	PM_{10}	$PM_{2.5}$	GR_{10}	$GR_{2.5}$
Wicken Fen	25-Jul	11.2		10.0	12.4	9.9			
Widnes Milton Road	10-Jul				12.3				
Wigan Centre	11-Jul	11.2			12.8	10.2			
Wirral Tranmere	13-Jul	8.3			9.9	7.5			
Worthing A27 Roadside	29-Aug				12.9		12.6		
Wrexham	09-Aug			10.0	12.2	7.6			
Yarner Wood	13-Jul	11.2			12.3	7.5			
York Bootham	15-Aug	11.2			12.2	11.6	14.6		

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 A2 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	12.6				7.8	9.5		
Camden Kerbside	5.8				13.5	11.8		
Haringey Roadside	13.9							
Horley	9.7							
London Bexley	7.1				7.8	9.5		
London Ealing Horn Lane					13.5			
London Eltham	**19.6**			9.8	7.8	9.5		
London Haringey Priory Park South	14.9			5.6				
London Honor Oak Park					7.8	9.5		
London Marylebone Road	10.1	9.9	5.2	9.1	13.5	11.8	9.1	16.2
London N. Kensington	6.4	10.3	5.3	10.3	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	13.6				13.5	11.8		
Southwark A2 Old Kent Road	14.3				13.5			
Stanford-le-Hope Roadside	6.6				13.5	11.8		
Thurrock	12.8		4.9	10.4	7.8	9.5		
Tower Hamlets Roadside	7.8							

Table A3 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	7.9				7.8	9.5		
Camden Kerbside	5.6				13.5	11.8		
Haringey Roadside	9.2							
Horley	7.7							
London Bexley	9.9				7.8	9.5		
London Ealing Horn Lane					13.5			
London Eltham	11.2			9.8	7.8	9.5		
London Haringey Priory Park South	9.8			6.7				
London Honor Oak Park					7.8	9.5		
London Marylebone Road	13.2	9.5	6.4	9.2	13.5	11.8	9.1	16.2
London N. Kensington	8.0	9.5	5.7	11.0	7.8	9.5		
Sandy Roadside	12.9				13.5	11.8		

Site	NO / NO_2*	CO	SO_2	O_3	PM_{10}	$PM_{2.5}$	GR_{10}	$GR_{2.5}$
Southwark A2 Old Kent Road	13.5				13.5			
Stanford-le-Hope Roadside	12.6				13.5	11.8		
Thurrock	10.1		5.9	11.2	7.8	9.5		
Tower Hamlets Roadside	14.2							

Table A4 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	7.3				7.8	9.5		
Camden Kerbside	5.7				13.5	11.8		
Haringey Roadside	9.5							
Horley	8.5							
London Bexley	6.9				7.8	9.5		
London Ealing Horn Lane					13.5			
London Eltham	11.2			9.8	7.8	9.5		
London Haringey Priory Park South	9.8			7.1				
London Honor Oak Park					7.8	9.5		
London Marylebone Road	6.4	9.5	6.4	9.2	13.5	11.8	9.1	16.2
London N. Kensington	6.7	9.4	4.8	9.3	7.8	9.5		
Sandy Roadside	8.2				13.5	11.8		
Southwark A2 Old Kent Road	13.6				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	13.0				13.5	11.8		
Thurrock	9.5		5.9	10.0	7.8	9.5		
Tower Hamlets Roadside	14.1							

Table A5 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	8.8				7.8	9.5		
Camden Kerbside	8.5				13.5	11.8		
Haringey Roadside	12.5							
Horley	8.0							
London Bexley	14.2				7.8	9.5		
London Ealing Horn Lane					13.5			
London Eltham	N/A			N/A	N/A	N/A		
London Haringey Priory Park South	10.5			8.6				
London Honor Oak Park					7.8	9.5		
London Marylebone Road	8.3	9.5	6.9	10.6	13.5	11.8	9.1	16.2
London N. Kensington	8.7	9.4	4.3	13.8	7.8	9.5		
Sandy Roadside	8.7				13.5	11.8		
Southwark A2 Old Kent Road	13.5				13.5			
Stanford-le-Hope Roadside	9.6				13.5	11.8		

Site	NO / NO_2*	CO	SO_2	O_3	PM_{10}	$PM_{2.5}$	GR_{10}	$GR_{2.5}$
Thurrock	5.8		4.8	10.7	7.8	9.5		
Tower Hamlets Roadside	7.3							

APPENDIX 3 SITES WITH LESS THAN 85% DATA CAPTURE

Table A6 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
Aberdeen Wellington Road	67.46%						67.46%
Barnsley Gawber	95.54%	99.38%	99.37%		75.95%	51.85%	84.41%
Bath A4 Roadside	66.6%						66.6%
Brighton Preston Park	97.19%		58.30%		93.18%		82.86%
Cardiff Centre	92.87%	93.52%	49.93%	46.18%	97.39%	69.29%	74.85%
Chilbolton Observatory	61.71%	85.33%	85.33%		96.57%	95.96%	84.66%
Cwmbran Crownbridge	41.19%				41.27%		41.23%
Derby St Alkmund's Way	67.39%						67.39%
Derry Rosemount	83.5%	73.3%	94.5%		96.9%	69.3%	83.5%
Dumbarton Roadside	84.90%						84.90%
Eastbourne	56.53%	61.84%	61.84%		95.26%		68.85%
Eskdalemuir	37.82%				95.49%		66.44%
Exeter Roadside	75.39%				59.45%		67.43%
Glasgow Kerbside	78.98%						78.98%
Grangemouth Moray	76.20%						76.20%
Hull Holderness Road	61.80%	93.24%					76.75%
Leeds Headingley Kerbside	89.93%	43.60%	85.91%				72.87%
Lerwick					83.77%		83.77%
Lincoln Canwick Road	75.74%						75.74%
London Eltham	33.00%	46.70%	46.70%		39.50%		41.48%
London Teddington Bushy Park		75.31%	75.31%				75.31%
Plymouth Tavistock Road	67.17%						67.17%
Worthing A27 Roadside	83.21%		48.22%				65.72%

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:

Aberdeen Wellington Road (NOx)

A sampling issue was identified with NOx data being rejected between the 5th of May until the 24th of August.

Barnsley Gawber (O_3, SO_2)

Data was rejected for SO_2 between the 18th of April and the 16th of August due to a lack of reliable calibrations. Data was rejected between the 30th of August and the 11th of September due to a sampling issue. Data was rejected between the 3rd of October and the 7th of November due to an instrument issue.

Data was rejected for O_3 between 1st of July and 14th of August and then between the 19th of September and until the 16th of October due to sampling issues.

Bath A4 Roadside (NOx)

Site cylinder instability resulted in a lack of reliable calibration data. Due to the lack of usable calibration data for a greater than 3-month period data rejection was undertaken from the 1st of August until the 13th of December.

Brighton Preston Park ($PM_{2.5}$)

Erroneous $PM_{2.5}$ data was rejected from a gap on the 13th of March until an engineer visit on the 22nd of March. Rejection of the $PM_{2.5}$ data, due to a fault with the BAM nozzle, was undertaken from the 19th of June to the 18th of October.

Cardiff Centre ($PM_{2.5}$, CO and SO_2)

The data from the $PM_{2.5}$ instrument was rejected between the 18th of March and the 8th of August due to multiple instrument faults.

The data from the CO instrument was rejected between the 31st of January and the 11th August due to multiple instrument faults.

The SO_2 data was deemed to be erroneous due to an instrument fault and so was rejected between the 9th of June and the 20th of September.

Chilbolton Observatory (NOx)

NOx data rejection occurred due to a sampling fault between the 27th of July and the 11th of December.

Cwmbran Crownbridge (NOx, O_3)

An issue that was identified with the sampling system resulted in all data for both NOx and O_3 being rejected between the 4th of June and the end of the year.

Derby St Alkmund's Way (NOx)

Due to an unstable site cylinder, there were no valid NOx calibrations for more than three months. This resulted in data being rejected between the 16th of August and when the cylinder was replaced in February of 2024.

Derry Rosemount (NOx, PM_{10}, SO_2)

Instrument faults resulted in NOx data being rejected from the 10th of March to the 2nd of May
A leak in the PM10 instrument resulted in data being rejected from the 26th of May to the 21st of August.
An instrument and sampling fault resulted in SO_2 data being rejected from the 11th of October to the end of the year.

Dumbarton Roadside (NOx)

An instrument fault led to the rejection of NOx data from the 24th of May to the 12th of July.

Eastbourne (NOx, PM_{10}, $PM_{2.5}$)

The site was turned off on the 27th of July to allow for a cabin upgrade, which was completed on the 1st of December.

Eskdalemuir (NOx)

Due to Instrument errors NOx data was rejected from the start of the year to the 1st of August.

Exeter Roadside (NOx, O_3)

An instrument fault led to O_3 data being rejected from the 20th of April, until the instrument was replaced on the 19th of June.
Construction work was being undertaken at the site and the sampling inlet was surrounded by scaffolding. This meant the inlet was not open to the sky above or getting a free flow of air, and so data for both instruments was rejected from the 12th of October to the end of the year.

Glasgow Kerbside (NOx)

A fault with the cabins air conditioning unit resulted in NOx data rejection from the 31st of May to the 13th of June, when the instrument was turned off for the rest of the quarter with data resuming on the 14th of July.

Grangemouth Moray (NOx)

An issue that was identified with the calibration system resulted in there being a greater than 3 month period with no reliable calibrations and so NOx data was rejected from the 25th of October to the end of the year.

Hull Holderness Road (NOx)

Significant instrument drift resulted in NOx data continuing to be rejected from the 27th of July to the 7th of December.

Leeds Headingley Kerbside (PM_{10})

Continuing leaks in the PM_{10} instrument resulted in data being rejected from the start of the year to the 25th of July.

Lerwick (O_3)

An instrument fault resulted in O_3 data being rejected between the 24th of April and the 30th of June.

Lincoln Canwick Road (NOx)

Multiple issues with the site sampling system resulted in data being rejected from the 13th of October to the end of the year.

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

The power supply to the site was turned off by the supplier on 4th July due to bills remaining unpaid. The Environment Agency has agreed to meet the electricity costs for the site and the CMCU is in the process of transferring the accounts.

London Teddington Bushy Park (PM_{10}, $PM_{2.5}$)

The site was shut down on the 9th of October and remained off until the end of the year.

Plymouth Tavistock Road (NOx)

Multiple instrument faults led to NOx data being rejected between the 4th of May and the 31st of July.

Worthing A27 Roadside (NOx, $PM_{2.5}$)

The site was switched off between the 4th of January and the 27th of February to allow for the site hut to be upgraded.
An instrument fault resulted in the rejection of $PM_{2.5}$ data between the 6th of June and the 5th of October.

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