# AURN QAQC ANNUAL TECHNICAL REPORT 2021

Report for: The Environment Agency

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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 January to 31st December 2021. 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.

Ricardo Energy & Environment (Ricardo) carried out the QAQC activities for the full AURN during the first three quarters of the year. Due to contractual changes, the National Physical Laboratory (NPL) took over QAQC activities for the Automatic London Network (ALN) subset of 16 sites as of 1st October 2021, which included ratification of these sites' data for the second half of the year (July to December 2021).

The number of AURN monitoring stations in operation during part or all of this period was 173 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.

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 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. (These regulations were the means by which the provisions of the European Union's Air Quality Directive (2008/50/EC) were transposed into UK legislation in 2010. All the provisions of the above Directive remain part of UK law following the UK's exit from the EU on 31st January 2020).

The mean data capture for ratified hourly average data was 92.7% (averaged over all pollutants $O_3$, $NO_2$, $SO_2$, CO, $PM_{10}$ and $PM_{2.5}$), for the 12-month reporting period 1st January to 31st December 2021.

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: $NO_2$ 91.89%, $PM_{10}$ 93.66%, $PM_{2.5}$ 92.43% CO 75.26% $O_3$ 93.49%, and $SO_2$ 84.11%. Hence, the mean data captures for all pollutants except CO and $SO_2$ met this target in calendar year 2021. Average data capture for both CO and $SO_2$ was below the target of 85%: this was affected by number of issues such as problems with one instrument's programming, instrument faults, and in some instances because the $SO_2$ analysers are measuring close to the instrument's limit of detection. 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.

Face-to-face LSO training had been put on hold during 2020 due to the Covid-19 pandemic. This remained the case during most of 2021, resuming with the 2022 winter audits in early 2022.

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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]. 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. Contracts are periodically re-tendered, and this was the case during 2021. In 2021 a new contract came into effect as of 1st October 2021. Prior to this date the contractors were as follows; the role of Central Management and Co-ordination Unit (CMCU) for the AURN was contracted to Bureau Veritas. The Environmental Research Group (ERG) of Imperial College London (ICL) was the Management Unit for the AURN monitoring stations that are also part of the London Air Quality Network (LAQN). Ricardo Energy & Environment undertook the role of Quality Assurance and Quality Control Unit (QAQC Unit) for all stations (referred to as sites within this report) within the AURN.

Under the new contract, 25952, which runs from 1st October 2021 to 30th 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 2021 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 173 monitoring stations in the AURN operated during part or all of the year 2021. 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 & 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 January to 31st December 2021 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 (three months for ozone).
- 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. FDMS $k_0$ evaluation, for the small number of FDMS remaining in the AURN during 2021. (The majority of FDMS analysers were replaced with other types between 2018 and 2020, having reached the end of their working lives.) The FDMS analyser uses this factor to calculate mass concentrations, so the value is calculated to determine its accuracy compared to the stated value. This is only required for FDMS particulate monitoring instruments: it is not relevant to the BAM or Fidas™ instruments, as these operate in a different way.
8. 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.
9. 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.
10. 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.
11. 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.

12. 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 BAM and FDMS 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,
- ±2.5 % of the stated $k_0$ value for FDMS analysers (at the small number of sites still using these),
- ±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 FDMS and BAM Particulate Analysers

As part of the routine QAQC audits, BAM and FDMS particulate analysers have zero checks carried out every six months. This is done by placing a HEPA filter on the inlets for a few days, so the instrument is sampling air free from particulate matter. This allows identification of analysers which have high baseline responses to air containing no particulate matter. In the case of the FDMS, this was often due to inefficient dryers. 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 exceed 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 2021 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 2021, 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, and this results in 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 2021:

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

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

Ricardo has undertaken an investigation to quantify the impact on performance of FDMS PM analysers in use in the Automatic Urban and Rural Monitoring Network (AURN), following a series of undocumented design changes on a critical consumable component. These changes to the replaceable measurement filter on Tapered Element Oscillating Microbalance (TEOM) Filter Dynamics Measurement System (FDMS) analysers, caused a significant increase in the number of poor performance tests identified during routine quality control audits undertaken by Ricardo. The worsening of performance was first observed in January 2017. It is not possible to determine which sites used these filters, nor over which time periods. During 2021, the number of

FDMS analysers continued to fall as these obsolete instruments were replaced with other analyser types. By the end of 2021, FDMS analysers remained in use at only one site in the AURN.

### 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

The Covid-19 coronavirus pandemic resulted in ongoing restrictions throughout 2021. Most AURN activities continued uninterrupted, but face-to-face LSO training and audits were mostly put on hold, due to social distancing requirements.

Face-to-face LSO training and audits remained on hold until the 2021/2022 winter audit round. 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). LSO training and audits have been prioritised in 2022 now that restrictions have been lifted.

Although most routine QAQC audits were carried out in 2021, Mace Head could not be audited. This site is in the Republic of Ireland and audit visits were therefore affected by travel restrictions.

# 3. DATA CAPTURE

## 3.1 OVERVIEW

Ratified hourly average data capture for the network averaged 92.7% for all pollutants ($O_3$, $NO_2$, $SO_2$, CO, $PM_{10}$ and $PM_{2.5}$) during the 12-month reporting period January-December 2021. 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 except CO and $SO_2$ 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 2021 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 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 2021

| | $NO_2$ | $PM_{10}$ | $PM_{2.5}$ | CO | $O_3$ | $SO_2$ | All |
|---|---|---|---|---|---|---|---|
| Number of stations | 161 | 93 | 82 | 7 | 76 | 28 | 173 |
| Number of Stations <85% | 20 | 11 | 11 | 5 | 6 | 11 | 19 |
| Number of Stations < 90% | 29 | 15 | 18 | 5 | 8 | 16 | 29 |
| **Average** | **91.9%** | **93.7%** | **92.4%** | **75.3%** | **93.5%** | **84.1%** | **92.7%** |

## 3.3 GENERIC DATA ISSUES

The following generic data quality issues have been identified in 2021:

- Poor performance of some analysers, particularly $SO_2$ analysers, impacted upon data capture. The Environment Agency purchased some replacement $SO_2$ analysers which were installed during 2020 and 2021. However, technical problems with these new instruments resulted in a significant loss at many stations. Following engagement with the EA and the instrument supplier a switch of manufacturer has now occurred with the problematic instruments being replaced.
- Leaks in the BAM analysers, where the nozzle does not properly seal against the tape.
- Poor performance of some of the aging CO analysers. The small number of CO analysers in the network means that data loss from any one of these has a significant impact on the average data capture. A small number of aged instruments have now been replaced.

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.

## 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 now the QAQC contractor (as of 1st October 2021). 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 2021

| Site Name | $NO_2$ | $PM_{10}$ | $PM_{2.5}$ | CO | $O_3$ | $SO_2$ | Average |
|---|---|---|---|---|---|---|---|
| Barnsley Gawber | 88.9% | | | | 97.8% | 97.7% | 94.8% |
| Barnstaple A39 | | 82.4% | 83.1% | | | | 82.8% |
| Bath A4 Roadside | 99.1% | | | | | | 99.1% |
| Billingham | 99.3% | | | | | | 99.3% |
| Birkenhead Borough Road | 90.9% | | | | | | 90.9% |
| Birmingham A4540 Roadside | 99.1% | 99.4% | 99.4% | | 97.7% | | 98.9% |
| Birmingham Acocks Green | 68.9% | 68.8% | 68.8% | | 69.0% | | 68.9% |
| Birmingham Ladywood | 97.4% | 99.9% | 99.9% | | 98.0% | 86.1% | 96.3% |
| Blackburn Accrington Road | 95.6% | | | | | | 95.6% |
| Blackpool Marton | 99.0% | 99.6% | 99.6% | | 99.2% | | 99.4% |
| Borehamwood Meadow Park * | 74.6% | | | | | | 74.6% |
| Bournemouth | 85.0% | | 95.2% | | 95.1% | | 91.8% |
| Bradford Mayo Avenue | 97.4% | | | | | | 97.4% |
| Brighton Preston Park | 98.6% | | 63.6% | | 97.4% | | 86.5% |
| Bristol St Paul's | 97.7% | 96.8% | 96.5% | | 97.5% | | 97.1% |
| Bristol Temple Way | 98.5% | 95.5% | | | | | 97.0% |
| Burton-on-Trent Horninglow | 97.6% | | | | | | 97.6% |
| Bury Whitefield Roadside | 98.7% | 96.6% | | | | | 97.6% |
| Cambridge Roadside | 98.9% | | | | | | 98.9% |
| Cannock A5190 Roadside | 96.4% | | | | | | 96.4% |
| Canterbury | 97.6% | | | | 99.3% | | 98.5% |
| Carlisle Morton A595 | 46.9% | 54.5% | 51.8% | | | | 51.1% |
| Carlisle Roadside | 97.2% | 95.9% | 95.3% | | | | 96.1% |
| Charlton Mackrell | 99.2% | | | | 93.8% | | 96.5% |
| Chatham Roadside | 99.1% | 96.8% | 95.1% | | | | 97.0% |
| Chesterfield Loundsley Green | 71.1% | 99.9% | 99.9% | | | | 90.3% |
| Chesterfield Roadside | 95.1% | 99.9% | 99.9% | | | | 98.3% |
| Chilbolton Observatory | 99.0% | 99.1% | 99.1% | | 98.1% | 97.9% | 98.6% |
| Christchurch Barrack Road | 98.9% | | 94.7% | | | | 96.8% |
| Coventry Allesley | 95.5% | 98.1% | 98.1% | | 99.5% | | 97.8% |

| Site Name | $NO_2$ | $PM_{10}$ | $PM_{2.5}$ | CO | $O_3$ | $SO_2$ | Average |
|---|---|---|---|---|---|---|---|
| Coventry Binley Road | 98.7% | 96.8% | | | | | 97.7% |
| Crewe Coppenhall | 97.6% | | | | | | 97.6% |
| Derby St Alkmund's Way | 89.3% | | | | | | 89.3% |
| Dewsbury Ashworth Grove | 91.9% | | | | | | 91.9% |
| Doncaster A630 Cleveland Street | 99.4% | | | | | | 99.4% |
| Eastbourne | 91.0% | 99.8% | 99.8% | | | | 96.9% |
| Exeter Roadside | 99.1% | | | | 98.5% | | 98.8% |
| Glazebury | 99.0% | | | | 94.3% | | 96.6% |
| Hartlepool St Abbs Walk | 98.6% | | | | | | 98.6% |
| High Muffles | 99.0% | | | | 93.9% | | 96.5% |
| Honiton | 98.3% | | | | | | 98.3% |
| Horley * | 94.9% | | | | | | 94.9% |
| Hull Freetown | 99.1% | 99.4% | 99.4% | | 99.2% | 94.5% | 98.3% |
| Hull Holderness Road | 99.4% | 88.0% | | | | | 93.7% |
| Immingham Woodlands Avenue | 99.3% | | | | | | 99.3% |
| Ladybower | 98.6% | | | | 98.6% | 79.2% | 92.1% |
| Leamington Spa | 94.2% | 97.7% | 97.7% | | 93.9% | | 95.9% |
| Leamington Spa Rugby Road | 98.8% | 99.5% | 99.5% | | | | 99.3% |
| Leeds Centre | 96.4% | 99.2% | 99.2% | 94.4% | 98.4% | 98.7% | 97.7% |
| Leeds Headingley Kerbside | 87.4% | 95.6% | 97.7% | | | | 93.5% |
| Leicester A594 Roadside | 94.4% | 94.8% | | | | | 94.6% |
| Leicester University | 86.5% | 99.0% | 99.0% | | 98.6% | | 95.8% |
| Leominster | 94.5% | | | | 99.7% | | 97.1% |
| Lincoln Canwick Road | 91.9% | | | | | | 91.9% |
| Liverpool Speke | 28.8% | 23.2% | 23.9% | | 28.9% | 28.8% | 26.7% |
| Lullington Heath | 18.7% | | | | 89.8% | 50.3% | 52.9% |
| Luton A505 Roadside | 98.9% | | | | | | 98.9% |
| Manchester Piccadilly | 96.3% | 99.3% | 99.3% | | 99.0% | 81.2% | 95.0% |
| Manchester Sharston | 99.1% | | | | 99.2% | | 99.1% |
| Middlesbrough | 98.8% | 95.4% | 94.3% | | 98.9% | 82.3% | 94.0% |
| Newcastle Centre | 99.2% | 97.0% | 97.4% | | 99.2% | | 98.2% |
| Newcastle Cradlewell Roadside | 99.3% | 94.4% | | | | | 96.8% |

| Site Name | $NO_2$ | $PM_{10}$ | $PM_{2.5}$ | CO | $O_3$ | $SO_2$ | Average |
|---|---|---|---|---|---|---|---|
| Northampton Spring Park | 91.3% | | 96.9% | | 93.0% | | 93.7% |
| Norwich Lakenfields | 87.9% | 97.5% | 97.5% | | 96.7% | | 94.9% |
| Nottingham Centre | 94.9% | 99.3% | 99.3% | | 99.0% | 82.4% | 95.0% |
| Nottingham Western Boulevard | 98.6% | 97.2% | | | | | 97.9% |
| Oldbury Birmingham Road | 96.5% | | | | | | 96.5% |
| Oxford Centre Roadside | 99.7% | | | | | | 99.7% |
| Oxford St Ebbes | 99.7% | 99.9% | 99.9% | | | | 99.8% |
| Plymouth Centre | 98.9% | 97.2% | 96.6% | | 99.0% | | 97.9% |
| Plymouth Tavistock Road | 96.7% | | | | | | 96.7% |
| Portsmouth | 65.4% | 63.5% | 63.5% | | 66.1% | | 64.6% |
| Portsmouth Anglesea Road | 99.1% | 94.0% | | | | | 96.6% |
| Preston | 94.3% | 99.5% | 99.5% | | 99.3% | | 98.1% |
| Reading London Road | 99.4% | 97.3% | | | | | 98.3% |
| Reading New Town | 91.3% | 96.1% | 93.9% | | 64.6% | | 86.5% |
| Rochester Stoke | 96.2% | 99.4% | 99.4% | | 99.2% | 81.7% | 95.2% |
| Salford Eccles | 99.6% | 99.9% | 99.9% | | | | 99.8% |
| Saltash Callington Road | | 98.1% | 96.7% | | | | 97.4% |
| Sandy Roadside * | 71.4% | 68.5% | 70.3% | | | | 70.1% |
| Scunthorpe Town | 99.3% | 95.7% | | | | 89.9% | 95.0% |
| Shaw Crompton Way | 96.5% | | | | | | 96.5% |
| Sheffield Barnsley Road | 87.2% | | 82.6% | | | | 84.9% |
| Sheffield Devonshire Green | 32.1% | 99.5% | 99.5% | | 99.2% | | 82.6% |
| Sheffield Tinsley | 99.2% | | | | | | 99.2% |
| Sibton | | | | | 96.2% | | 96.2% |
| Southampton A33 | 99.2% | 93.2% | | | | | 96.2% |
| Southampton Centre | 79.7% | 98.7% | 98.7% | | 98.8% | 88.8% | 93.0% |
| Southend-on-Sea | 79.3% | 99.5% | 99.5% | | 97.9% | | 94.1% |
| St Helens Linkway | 98.3% | 96.9% | | | | | 97.6% |
| St Osyth | 94.4% | | | | 99.5% | | 97.0% |
| Stanford-le-Hope Roadside * | 99.1% | 86.0% | 89.0% | | | | 91.4% |
| Stockton-on-Tees A1305 Roadside | 96.6% | | 87.4% | | | | 92.0% |

| Site Name | $NO_2$ | $PM_{10}$ | $PM_{2.5}$ | CO | $O_3$ | $SO_2$ | Average |
|---|---|---|---|---|---|---|---|
| Stockton-on-Tees Eaglescliffe | 98.4% | 94.8% | 89.9% | | | | 94.4% |
| Stoke-on-Trent A50 Roadside | 99.2% | 96.7% | | | | | 97.9% |
| Stoke-on-Trent Centre | 98.8% | 99.0% | 99.0% | | 98.9% | | 99.0% |
| Storrington Roadside | 97.1% | | | | | | 97.1% |
| Sunderland Silksworth | 12.9% | 98.6% | 98.6% | | 99.2% | | 77.3% |
| Sunderland Wessington Way | 98.2% | | | | | | 98.2% |
| Swindon Walcot | 98.7% | | | | | | 98.7% |
| Telford Hollinswood | 99.4% | | | | | | 99.4% |
| Thurrock | 97.6% | 88.5% | | | 95.2% | 96.2% | 94.4% |
| Walsall Woodlands | 99.1% | | | | 98.7% | | 98.9% |
| Warrington | 97.6% | 96.6% | 95.8% | | | | 96.7% |
| West Bromwich Kenrick Park | 99.2% | | | | | | 99.2% |
| Weybourne | | | | | 99.9% | | 99.9% |
| Wicken Fen | 97.4% | | | | 99.1% | 96.6% | 97.7% |
| Widnes Milton Road | 98.4% | | | | | | 98.4% |
| Wigan Centre | 99.8% | 99.9% | 99.9% | | 99.3% | | 99.7% |
| Wirral Tranmere | 91.4% | 99.5% | 99.5% | | 99.1% | | 97.4% |
| Worthing A27 Roadside | 98.0% | | 96.7% | | | | 97.3% |
| Yarner Wood | 89.8% | | | | 99.5% | | 94.7% |
| York Bootham | 91.2% | 89.4% | 88.0% | | | | 89.6% |
| York Fishergate | 99.1% | 95.0% | 94.2% | | | | 96.1% |
| **Number of Stations** | **110** | **61** | **54** | **1** | **49** | **16** | **114** |
| **Number of Stations < 85%** | **13** | **6** | **8** | **0** | **4** | **7** | **11** |
| **Number of Stations <90%** | **20** | **10** | **12** | **0** | **5** | **10** | **15** |
| **Average** | **91.51%** | **93.15%** | **91.76%** | **94.38%** | **93.81%** | **82.38%** | **93.13%** |

## 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 2021

| Site Name | $NO_2$ | $PM_{10}$ | $PM_{2.5}$ | CO | $O_3$ | $SO_2$ | Average |
|---|---|---|---|---|---|---|---|
| Camden Kerbside | 69.8% | 61.6% | 63.9% | | | | 65.1% |
| Ealing Horn Lane | | 90.2% | | | | | 90.2% |
| Haringey Roadside | 96.1% | | | | | | 96.1% |
| London Bexley | 96.0% | | | | | | 96.0% |
| London Bloomsbury * | 98.1% | 96.4% | 35.7% | | 99.1% | 81.6% | 82.2% |
| London Eltham | 90.3% | 74.7% | 89.6% | | 87.9% | | 84.9% |
| London Haringey Priory Park South | 90.6% | | | | 92.6% | | 91.6% |
| London Harlington * | 99.2% | 99.4% | 99.4% | | 97.1% | | 98.7% |
| London Hillingdon * | 99.5% | | | | 99.5% | | 99.5% |
| London Honor Oak Park | | 96.7% | 96.7% | | | | 96.7% |
| London Marylebone Road | 93.6% | 75.8% | 85.6% | 83.7% | 92.7% | 94.7% | 87.7% |
| London N. Kensington | 99.2% | 99.9% | 99.9% | 39.5% | 98.2% | 68.6% | 84.2% |
| London Teddington Bushy Park | | 99.0% | 99.0% | | | | 99.0% |
| London Westminster * | 96.7% | | 81.3% | | | | 89.0% |
| Southwark A2 Old Kent Road | 97.4% | 95.6% | | | | | 96.5% |
| Tower Hamlets Roadside | 98.7% | | | | | | 98.7% |
| **Number of Stations** | **13** | **10** | **9** | **2** | **7** | **3** | **16** |
| **Number of Stations < 85%** | **1** | **3** | **3** | **2** | **0** | **2** | **4** |
| **Number of Stations <90%** | **1** | **3** | **5** | **2** | **1** | **2** | **6** |
| **Average** | **94.2%** | **88.9%** | **83.5%** | **61.6%** | **95.3%** | **81.6%** | **91.0%** |

## 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 2021

| Site Name | $NO_2$ | $PM_{10}$ | $PM_{2.5}$ | CO | $O_3$ | $SO_2$ | Average |
|---|---|---|---|---|---|---|---|
| Aberdeen | 93.6% | 96.5% | 96.5% | | 92.6% | | 94.8% |
| Aberdeen Erroll Park | 97.6% | 99.9% | 99.9% | | 97.2% | | 98.7% |
| Aberdeen Union Street Roadside | 98.0% | | | | | | 98.0% |
| Aberdeen Wellington Road | 99.7% | | | | | | 99.7% |
| Auchencorth Moss | | 99.8% | 99.8% | | 95.6% | | 98.4% |
| Bush Estate | 98.3% | | | | 98.5% | | 98.4% |
| Dumbarton Roadside | 96.7% | | | | | | 96.7% |
| Dumfries | 98.1% | | | | | | 98.1% |
| Dundee Mains Loan | 98.5% | | | | | | 98.5% |
| Edinburgh Nicolson Street | 50.5% | | | | | | 50.5% |
| Edinburgh St Leonards | 61.7% | 99.3% | 99.3% | 61.1% | 98.3% | 91.4% | 85.2% |
| Eskdalemuir | 41.1% | | | | 24.4% | | 32.8% |
| Fort William | 95.7% | | | | 91.8% | | 93.7% |
| Glasgow Great Western Road | 98.6% | | | | | | 98.6% |
| Glasgow High Street | 98.0% | 99.6% | 99.6% | | | | 99.1% |
| Glasgow Kerbside | 98.0% | | | | | | 98.0% |
| Glasgow Townhead | 99.0% | 99.5% | 99.5% | | 96.6% | | 98.6% |
| Grangemouth | 52.6% | 84.8% | 93.6% | | | 51.5% | 70.6% |
| Grangemouth Moray | 88.6% | | | | | | 88.6% |
| Greenock A8 Roadside | 56.3% | 99.7% | 99.7% | | | | 85.2% |
| Inverness | 92.9% | 99.8% | 99.8% | | | | 97.5% |
| Lerwick | | | | | 39.6% | | 39.6% |
| Peebles | 81.5% | | | | 98.8% | | 90.1% |
| Strath Vaich | | | | | 90.1% | | 90.1% |
| **Number of Stations** | **21** | **9** | **9** | **1** | **11** | **2** | **24** |
| **Number of Stations < 85%** | **6** | **1** | **0** | **1** | **2** | **1** | **4** |
| **Number of Stations <90%** | **0** | **0** | **0** | **0** | **0** | **0** | **0** |
| **Average** | **85.5%** | **97.6%** | **98.6%** | **61.1%** | **84.0%** | **71.5%** | **87.5%** |

## 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 2021

| Site Name | $NO_2$ | $PM_{10}$ | $PM_{2.5}$ | CO | $O_3$ | $SO_2$ | Average |
|---|---|---|---|---|---|---|---|
| Aston Hill | 88.1% | | | | 93.4% | | 90.8% |
| Cardiff Centre | 93.5% | 96.6% | 95.5% | 79.7% | 98.7% | 88.3% | 92.1% |
| Cardiff Newport Road | 98.9% | 95.9% | | | | | 97.4% |
| Chepstow A48 | 98.8% | 96.3% | 94.9% | | | | 96.7% |
| Cwmbran Crownbridge | 98.8% | | | | 99.2% | | 99.0% |
| Hafod-yr-Ynys Roadside | 99.1% | | | | | | 99.1% |
| Narberth | 98.3% | 98.6% | 98.6% | | 98.4% | 94.9% | 97.7% |
| Newport | 99.4% | 99.8% | 99.8% | | | | 99.7% |
| Port Talbot Margam | 98.6% | 91.9% | 94.7% | 98.6% | 99.3% | 99.0% | 97.0% |
| Swansea Roadside | 98.4% | 83.1% | 86.6% | | | | 89.4% |
| Wrexham | 99.1% | 99.9% | 99.9% | | | 73.6% | 93.1% |
| **Number of Stations** | **11** | **8** | **7** | **2** | **5** | **4** | **11** |
| **Number of Stations < 85%** | **0** | **1** | **0** | **1** | **0** | **1** | **0** |
| **Number of Stations <90%** | **1** | **1** | **1** | **1** | **0** | **2** | **1** |
| **Average** | **97.4%** | **95.3%** | **95.7%** | **89.2%** | **97.8%** | **89.0%** | **95.6%** |

## 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 2021

| Site Name | $NO_2$ | $PM_{10}$ | $PM_{2.5}$ | CO | $O_3$ | $SO_2$ | Average |
|---|---|---|---|---|---|---|---|
| Armagh Roadside | 99.2% | 94.4% | | | | | 96.8% |
| Ballymena Antrim Road | 96.9% | | | | | | 96.9% |
| Ballymena Ballykeel | 98.1% | | | | | 89.9% | 94.0% |
| Belfast Centre | 90.6% | 99.4% | 99.4% | 69.8% | 99.1% | 93.2% | 91.9% |
| Belfast Stockman's Lane | 99.3% | 97.1% | | | | | 98.2% |
| Derry Rosemount | 99.0% | 95.9% | 96.0% | | 97.6% | 95.9% | 96.9% |
| Lough Navar | | 96.8% | 96.8% | | 99.6% | | 97.7% |
| Mace Head | | | | | 99.8% | | 99.8% |
| **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%** | **0** | **0** | **0** | **1** | **0** | **0** | **0** |
| **Number of stations <90%** | **0** | **0** | **0** | **1** | **0** | **1** | **0** |
| **Average** | **97.3%** | **96.7%** | **97.4%** | **69.8%** | **99.0%** | **93.0%** | **96.5%** |

## 3.9 GRAVIMETRIC DATA CAPTURE

Three gravimetric samplers operated within the AURN during 2021. These were Partisol[TM] samplers at London Marylebone Road ($PM_{2.5}$ and $PM_{10}$) and a Leckel SEQ at Port Talbot Margam ($PM_{10}$ only). Data capture for these are given in Table 3-7.

At London Marylebone Road, the $PM_{10}$ Partisol[TM] (which was very old) broke down part way through the year and was beyond economic repair. It remained out of operation until the scheduled replacement of both the Partisols at this site, in 2022.

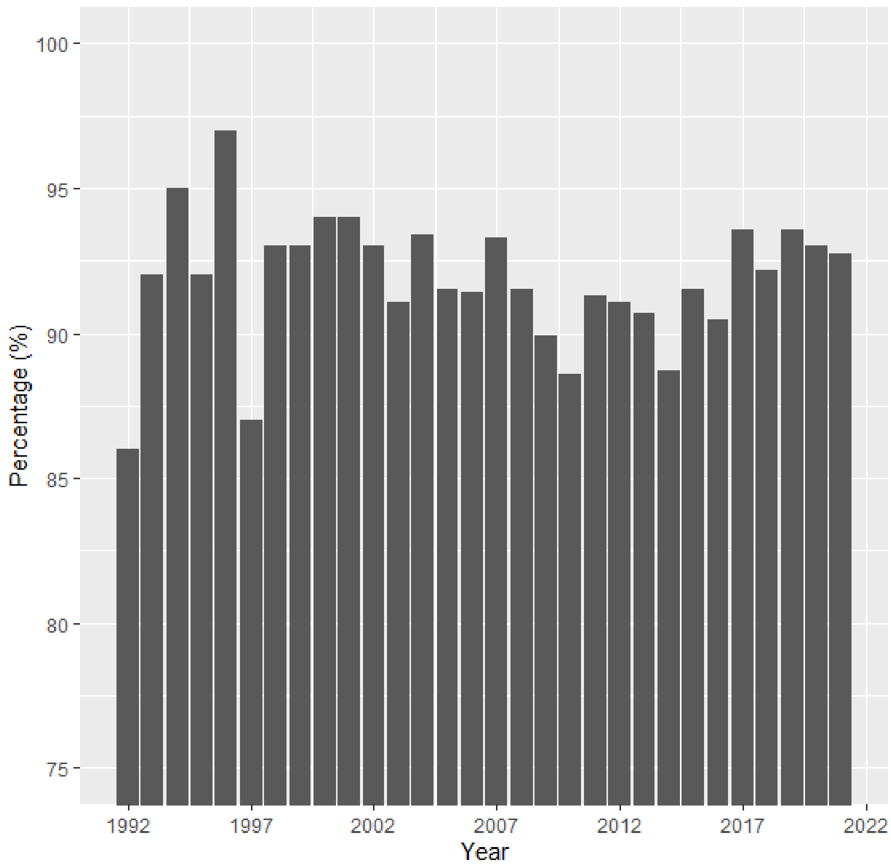
Table 3-7 Gravimetric Data Capture, January – December 2021

| Site Name | $PM_{10}$ | $PM_{2.5}$ | Average |
|---|---|---|---|
| London Marylebone Road | 29.6 | 90.1 | 59.9 |
| Port Talbot Margam | 99.5 | | 99.5 |
| **Number of Stations** | **2** | **1** | **2** |
| **Number of stations < 85 %** | **1** | **0** | **1** |
| **Number of stations < 90%** | **1** | **0** | **1** |
| **Average** | **64.5%** | **90.1%** | **79.78%** |

## 3.10 TRENDS IN DATA CAPTURE

The overall annual AURN data captures from 1992-2021 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 2021

Table 4-1 shows the changes to the AURN, i.e. monitoring stations started up or closed down, during 2021. Carlisle Morton A595 replaced Carlisle Roadside as the latter no longer met siting criteria. Aberdeen Erroll Park replaced Aberdeen, due to demolition and rebuilding of local housing.

Table 4-1 AURN Stations that Started Up or Closed Down During 2021

| Station | Pollutants Measured | Start Date | Close Date |
|---|---|---|---|
| Carlisle Roadside | $NO_2$, $PM_{10}$, $PM_{2.5}$ | - | 21st June 2021 |
| Carlisle Morton A595 | $NO_2$, $PM_{10}$, $PM_{2.5}$ | 1st October 2021 | - |
| Aberdeen | $NO_2$, $O_3$, $PM_{10}$, $PM_{2.5}$ | - | 20th September 2021 |
| Aberdeen Erroll Park | $NO_2$, $O_3$, $PM_{10}$, $PM_{2.5}$ | 1st October 2021 | - |

## 4.2 CHANGES TO INSTRUMENTATION

### 4.2.1 PM Upgrades from FDMS to Fidas™ and BAM

A programme of upgrade and renewal of particulate analysers was started in 2018 and continued through 2019 and 2020 into 2021. The old FDMS instruments, which used to be widely used in the AURN for monitoring PM, were approaching the end of their useful lives, and nearing the point at which they would no longer be supported by the manufacturer. The upgrade programme, which is now complete, removed the obsolete FDMS analysers from the network and replaced them with new instruments. The new instruments are a mixture of Beta Attenuation Monitors (BAMs) and Fidas™ 200 (referred to here as 'Fidas™') instruments. There have been BAMs in the AURN for many years, but the Fidas was a relatively new addition. The Fidas™ is an aerosol spectrometer that uses a light scattering method to detect airborne particles in a range of size fractions. The sample inlet system is heated to prevent interference by water vapour. Data are reported as hourly averages.

As Fidas™ analysers are capable of measuring several size fractions at the same time, where a single FDMS analyser (measuring either $PM_{10}$ or $PM_{2.5}$) was replaced by a Fidas™ (which measures both fractions), both $PM_{2.5}$ and $PM_{10}$ have been reported from the date of installation of the Fidas™.

The majority of the FDMS analysers had been replaced during the previous years, with only four sites still operating FDMS by the end of 2020. All had ceased operation by the end of 2021. The replacement dates are listed in Table 4-2. There are no longer any FDMS in operation in the AURN.

Table 4-2 Network Changes, January - December 2021

| Station | Existing Pollutants | Replacement Analyser Type | Effective Date |
|---|---|---|---|
| London Eltham | $PM_{2.5}$ | Fidas™ ($PM_{10}$ & $PM_{2.5}$) | 11th Mar 2021 |
| Plymouth Centre | $PM_{10}$ & $PM_{2.5}$ | Fidas™ ($PM_{10}$ & $PM_{2.5}$) | 17th May 2021 |
| Marylebone Road | $PM_{10}$ & $PM_{2.5}$ | BAM ($PM_{10}$ & $PM_{2.5}$) | 22nd December 2021 |
| Camden Kerbside | $PM_{10}$ & $PM_{2.5}$ | BAM ($PM_{10}$ & $PM_{2.5}$) | 14th September 2021 (removed when the site was closed for cabin refurbishment, but new instruments not installed until April 2022) |

# 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 173. 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 2021) and summer (July-September 2021). In addition, audits of ozone analysers were also carried out in spring (April) and autumn (October). Ongoing restrictions from Covid-19 continued into 2021, preventing any audits of Mace Head until summer 2021.

Face-to-face LSO training also had to be put on hold due to Covid restrictions: Ricardo produced a series of LSO training videos which are available on the AURN Hub. Other QAQC activities continued largely uninterrupted in 2021, with the exception of the audits of Mace Head.

The mean data capture for ratified hourly average data was 92.74% (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 2021. Mean data captures for individual pollutants were as follows: $NO_2$ 91.9%, $PM_{10}$ 93.7%, $PM_{2.5}$ 92.4% CO 75.3% $O_3$ 93.5%, $SO_2$ 84.1%. Hence, the mean data captures for all pollutants, with the exception of $SO_2$ and CO met this target in calendar year 2021. There were 29 stations out of 173 with mean data capture below 90% and one gravimetric site with mean data capture below 90%.

There were only six analysers out of 877 which operated in the network (counting Fidas™ 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 2021 was supplied to the Monitoring of Ambient Air Quality (MAAQ) Team by the end of May 2022. 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 2021 to Defra and the Devolved Administrations by their deadline of 30th September 2022.

# 7. REFERENCES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# APPENDICES

## APPENDIX 1 GLOSSARY OF TERMS

- Air Quality Standards Regulations

The UK legislation by which ambient air quality is regulated.

- 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.

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.

- 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.

- FDMS.

This stands for 'Filter Dynamic Measurement System' and refers to a type of instrument for monitoring concentrations of particulate matter. The FDMS is a modified form of TEOM. This technique uses a vibrating filter, the vibration frequency changing as mass builds up. This method can measure the concentration of volatile and non-volatile particles.

- 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.

- 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 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 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 | 11-Jan-21 | 11.2 | | | 12.2 | 10.0 | | | |
| Aberdeen Union Street Roadside | 12-Jan-21 | | | | 12.2 | | | | |
| Aberdeen Wellington Road | 12-Jan-21 | | | | 12.2 | 10.3 | | | |
| Armagh Roadside | 30-Apr-21 | | | | 12.4 | 10.0 | | | |
| Aston Hill | 02-Mar-21 | 8.3 | | | 12.2 | | | | |
| Auchencorth Moss | 17-Feb-21 | 11.2 | | | | 8.2 | | | |
| Ballymena Antrim Road | 28-Apr-21 | | | | 12.6 | | | | |
| Ballymena Ballykeel | 27-Apr-21 | | | 12.2 | 12.2 | | | | |
| Barnsley Gawber | 21-Jan-21 | 8.3 | | 11.6 | 9.9 | | | | |
| Barnstaple A39 | 20-Jan-21 | | | | | 9.3 | 12.7 | | |
| Bath A4 Roadside | 05-Jan-21 | | | | 12.2 | | | | |
| Belfast Centre | 04-May-21 | 8.3 | 8.3 | 12.2 | 12.4 | 7.6 | | | |
| Belfast Stockman's Lane | 26-Apr-21 | | | | 12.5 | 9.5 | | | |
| Billingham | 05-Feb-21 | | | | 12.2 | | | | |
| Birkenhead Borough Road | 10-Feb-21 | | | | 12.3 | | | | |
| Birmingham Acocks Green | 02-Feb-21 | 11.2 | | | 12.2 | 8.1 | | | |
| Birmingham A4540 Roadside | 02-Feb-21 | 11.2 | | | 12.2 | 7.5 | | | |
| Birmingham Ladywood | 03-Feb-21 | 7.4 | | 12.5 | 13.0 | 7.5 | | | |
| Blackburn Accrington Road | 08-Feb-21 | | | | 12.2 | | | | |
| Blackpool Marton | 20-Jan-21 | 8.4 | | | 9.9 | 7.5 | | | |
| Borehamwood Meadow Park | 02-Feb-21 | | | | 9.8 | | | | |
| Bournemouth | 10-Feb-21 | 11.2 | | | 12.2 | | 12.6 | | |
| Bradford Mayo Avenue | 15-Feb-21 | | | | 12.2 | | | | |
| Brighton Preston Park | 26-Jan-21 | 11.2 | | | 12.2 | | 12.6 | | |

| Site | Date of audit | $O_3$ | CO | $SO_2$ | $NO_2$ | $PM_{10}$ | $PM_{2.5}$ | $GR_{10}$ | $GR_{2.5}$ |
|---|---|---|---|---|---|---|---|---|---|
| Bristol St Paul's | 06-Jan-21 | 11.2 | | | 13.4 | 9.4 | 12.6 | | |
| Bristol Temple Way | 05-Jan-21 | | | | 12.9 | 9.3 | | | |
| Burton-on-Trent Horninglow | 05-Feb-21 | | | | 12.2 | | | | |
| Bury Whitefield Roadside | 18-Jan-21 | | | | 12.2 | 9.3 | | | |
| Bush Estate | 17-Feb-21 | 11.2 | | | 12.2 | | | | |
| Cambridge Roadside | 01-Feb-21 | | | | 12.2 | | | | |
| Camden Kerbside | 18-Jan-21 | | | | 13.1 | 8.7 | 16.4 | | |
| Cannock A5190 Roadside | 05-Feb-21 | | | | 12.2 | | | | |
| Canterbury | 24-Feb-21 | 11.2 | | | 12.2 | | | | |
| Cardiff Centre | 14-Jan-21 | 11.2 | 8.5 | 12.2 | 12.2 | 9.6 | 12.7 | | |
| Cardiff Newport Road | 14-Jan-21 | | | | 12.2 | 9.3 | | | |
| Carlisle Roadside | 27-Jan-21 | | | | 12.2 | 24.6 | 12.6 | | |
| Charlton Mackrell | 20-Jan-21 | 11.2 | | | 12.2 | | | | |
| Chatham Centre Roadside | 10-Feb-21 | | | | 12.2 | 9.9 | 13.0 | | |
| Chepstow A48 | 07-Jan-21 | | | | 12.2 | 9.3 | 12.6 | | |
| Chesterfield Loundsley Green | 26-Jan-21 | | | | 12.2 | 9.0 | | | |
| Chesterfield Roadside | 26-Jan-21 | | | | 12.4 | 8.3 | | | |
| Chilbolton | 14-Jan-21 | 11.2 | | 10.1 | 12.3 | | | | |
| Christchurch Barrack Road | 10-Feb-21 | | | | 12.2 | | 13.6 | | |
| Coventry Allesley | 16-Feb-21 | 8.3 | | | 9.8 | 8.1 | | | |
| Coventry Binley Road | 16-Feb-21 | | | | 12.3 | 9.6 | | | |
| Crewe Coppenhall | 20-Jan-21 | | | | 12.2 | | | | |
| Cwmbran Crownbridge | 12-Jan-21 | 8.3 | | | 12.2 | | | | |
| Derby St Alkmunds Way | 22-Feb-21 | | | | 12.2 | | | | |
| Derry Rosemount | 28-Apr-21 | 11.2 | | 12.5 | 12.2 | 24.4 | 12.6 | | |
| Dewsbury Ashworth Grove | 15-Feb-21 | | | | 12.2 | | | | |
| Doncaster A630 Cleveland Street | 22-Feb-21 | | | | 12.2 | | | | |
| Dundee Mains Loan | 25-Jan-21 | | | | 12.2 | 7.5 | | | |

| Site | Date of audit | $O_3$ | CO | $SO_2$ | $NO_2$ | $PM_{10}$ | $PM_{2.5}$ | $GR_{10}$ | $GR_{2.5}$ |
|---|---|---|---|---|---|---|---|---|---|
| Dumbarton Roadside | 20-Jan-21 | | | | 12.7 | | | | |
| Dumfries | 01-Mar-21 | | | | 12.3 | | | | |
| Ealing Horn Lane | 18-Jan-21 | | | | | 9.3 | | | |
| Eastbourne | 28-Jan-21 | | | | 13.4 | 7.5 | | | |
| Edinburgh Nicolson Street | 18-Jan-21 | | | | 12.2 | 7.9 | | | |
| Edinburgh St Leonards | 18-Jan-21 | 11.2 | 7.7 | 11.7 | 12.7 | 8.2 | | | |
| Eskdalemuir | 10-Feb-21 | 11.6 | | | 12.4 | | | | |
| Exeter Roadside | 18-Jan-21 | 7.2 | | | 13.0 | | | | |
| Fort William | 27-Jan-21 | 11.2 | | | 13.9 | | | | |
| Glasgow Great Western Road | 20-Jan-21 | | | | 12.8 | | | | |
| Glasgow High Street | 18-Jan-21 | | | | 13.4 | 9.4 | | | |
| Glasgow Kerbside | 18-Jan-21 | | | | 9.8 | | | | |
| Glasgow Townhead | 20-Jan-21 | 8.3 | | | 12.6 | 7.5 | | | |
| Glazebury | 11-Jan-21 | 11.2 | | | 12.5 | | | | |
| Grangemouth | 11-Jan-21 | | | 12.2 | 12.3 | 9.8 | 12.9 | | |
| Grangemouth Moray | 22-Jan-21 | | | 12.4 | 12.2 | | | | |
| Greenock A8 Roadside | 19-Jan-21 | | | | 12.4 | 9.0 | | | |
| Hafod-yr-ynys Roadside | 12-Jan-21 | | | | 12.2 | | | | |
| Haringey Roadside | 21-Jan-21 | | | | 13.6 | | | | |
| Hartlepool St Abbs Walk | 05-Feb-21 | | | | 12.3 | | | | |
| High Muffles | 18-Feb-21 | 11.2 | | | 12.2 | | | | |
| Honiton | 19-Jan-21 | | | | 12.5 | | | | |
| Horley | 26-Jan-21 | | | | **17.9** | | | | |
| Hull Freetown | 23-Feb-21 | 8.3 | | 12.2 | 9.8 | 10.4 | | | |
| Hull Holderness Road | 22-Feb-21 | | | | 12.2 | 9.4 | | | |
| Immingham Woodlands Avenue | 23-Feb-21 | | | | 12.2 | | | | |
| Inverness | 26-Jan-21 | | | | 12.2 | 11.6 | | | |
| Ladybower | 25-Jan-21 | 11.2 | | 12.2 | 12.2 | | | | |
| Leamington Spa | 17-Feb-21 | 11.2 | | | 12.2 | 7.5 | | | |
| Leamington Spa Rugby Road | 17-Feb-21 | | | | 12.4 | 8.9 | | | |
| Leeds Centre | 19-Feb-21 | 8.3 | 7.5 | 11.6 | 9.8 | 7.5 | | | |
| Leeds Headingley Kerbside | 19-Feb-21 | | | | 12.2 | 9.3 | 12.6 | | |

| Site | Date of audit | $O_3$ | CO | $SO_2$ | $NO_2$ | $PM_{10}$ | $PM_{2.5}$ | $GR_{10}$ | $GR_{2.5}$ |
|---|---|---|---|---|---|---|---|---|---|
| Leicester A594 Roadside | 23-Feb-21 | | | | 12.3 | 9.6 | | | |
| Leicester University | 09-Mar-21 | 8.3 | | | 9.8 | 9.6 | | | |
| Leominster | 04-Feb-21 | 11.2 | | | 12.2 | | | | |
| Lerwick | 08-Apr-21 | 12.8 | | 11.1 | 12.2 | | | | |
| Lincoln Canwick Road | 28-Jan-21 | | | | 12.2 | | | | |
| Liverpool Speke | Out of action | | | | | | | | |
| London Bexley | 13-Jan-21 | | | | 12.2 | 9.1 | | | |
| London Bloomsbury | 11-Jan-21 | 11.2 | | 10.0 | 12.3 | 9.6 | 12.6 | | |
| London Eltham | 25-Jan-21 | 10.4 | | | 11.1 | | 18.3 | | |
| London Haringey Priory Park South | 21-Jan-21 | 10.8 | | | 13.1 | | | | |
| London Harlington | 20-Jan-21 | 11.2 | | | 12.6 | 7.8 | | | |
| London Honor Oak Park | 25-Jan-21 | | | | | 7.5 | | | |
| London Hillingdon | 20-Jan-21 | 8.7 | | | 9.8 | | | | |
| London Marylebone Road | 26-Jan-21 | 12.0 | 7.5 | 10.0 | 12.2 | 8.7 | 16.4 | 8.0 | 11.0 |
| London N. Kensington | 27-Jan-21 | 11.2 | 7.5 | 10.1 | 12.2 | 7.7 | | | |
| London Teddington Bushy Park | 28-Jan-21 | | | | | 8.7 | 16.7 | | |
| London Westminster | 19-Jan-21 | | | | 12.2 | | 12.6 | | |
| Lough Navar | 29-Apr-21 | 11.2 | | | | 7.5 | | | |
| Lullington Heath | 27-Jan-21 | 11.3 | | 10.0 | 12.4 | | | | |
| Luton A505 Roadside | 01-Feb-21 | | | | 12.3 | | | | |
| Mace Head | Covid restrictions | | | | | | | | |
| Manchester Piccadilly | 17-Feb-21 | | | | | 7.6 | | | |
| Manchester Sharston | 17-Feb-21 | 11.2 | | 10.0 | 12.2 | 10.7 | | | |
| Middlesbrough | 03-Feb-21 | 11.2 | | 12.2 | 12.2 | 9.9 | 13.4 | | |
| Narberth | 13-Jan-21 | 11.2 | | 12.2 | 12.2 | 7.5 | | | |
| Newcastle Centre | 01-Feb-21 | 8.3 | | | 10.7 | **43.6** | 12.6 | | |
| Newcastle Cradlewell Roadside | 01-Feb-21 | | | | 12.2 | 9.4 | | | |
| Newport | 07-Jan-21 | | | | 12.2 | 7.9 | | | |
| Northampton Spring Park | 15-Feb-21 | 7.2 | | | 13.2 | | 12.6 | | |

| Site | Date of audit | $O_3$ | CO | $SO_2$ | $NO_2$ | $PM_{10}$ | $PM_{2.5}$ | $GR_{10}$ | $GR_{2.5}$ |
|---|---|---|---|---|---|---|---|---|---|
| Norwich Lakenfields | 03-Feb-21 | 8.3 | | | 10.2 | 8.1 | | | |
| Nottingham Centre | 04-Mar-21 | 8.3 | | 12.4 | 10.0 | 10.9 | | | |
| Nottingham Western Boulevard | 22-Feb-21 | | | | 12.5 | 9.3 | | | |
| Oldbury Birmingham Road | 03-Feb-21 | | | | 13.0 | | | | |
| Oxford Centre Roadside | 07-Jan-21 | | | | 12.2 | | | | |
| Oxford St Ebbes | 07-Jan-21 | 10.4 | | | 12.2 | 8.9 | | | |
| Peebles | 20-Jan-21 | 11.2 | | | 12.2 | | | | |
| Plymouth Tavistock Road | 18-Jan-21 | | | | 12.2 | | | | |
| Plymouth Centre | 19-Jan-21 | 9.0 | | | 10.4 | 8.7 | 16.4 | | |
| Port Talbot Margam | 11-Jan-21 | 8.3 | 11.5 | 11.6 | 9.8 | 10.1 | 12.9 | 8.7 | |
| Portsmouth | 26-May-21 | 8.4 | | | | 7.5 | | | |
| Portsmouth Anglesea Road | 09-Feb-21 | | | | 12.2 | 9.7 | | | |
| Preston | 25-Feb-21 | | | | 9.8 | | | | |
| Reading London Road | 06-Jan-21 | | | | 13.6 | 9.3 | | | |
| Reading New Town | 06-Jan-21 | 8.3 | | | 9.8 | 9.3 | 12.6 | | |
| Rochester Stoke | 17-Feb-21 | 11.2 | | 10.2 | 12.3 | 11.1 | | | |
| Salford Eccles | 11-Jan-21 | | | | 12.2 | 7.9 | | | |
| Saltash Callington Road | 19-Jan-21 | | | | | 9.3 | 12.6 | | |
| Sandy Roadside | 15-Apr-21 | | | | 12.2 | 9.4 | 12.6 | | |
| Scunthorpe Town | 24-Feb-21 | | | 10.0 | 12.2 | 9.3 | | | |
| Shaw Crompton Way | 13-Jan-21 | | | | 13.2 | 10.6 | | | |
| Sheffield Barnsley Road | 25-Jan-21 | | | | 12.2 | | 13.0 | | |
| Sheffield Devonshire Green | 27-Jan-21 | 8.3 | | | 9.8 | 7.5 | | | |
| Sheffield Tinsley | 27-Jan-21 | | | | 12.1 | | | | |
| Sibton | 03-Feb-21 | 11.2 | | | | | | | |
| Southampton Centre | 09-Feb-21 | 8.3 | | 12.2 | 9.8 | 9.5 | | | |
| Southampton A33 Roadside | 08-Feb-21 | | | | 12.2 | | | | |
| Southend-on-Sea | 08-Feb-21 | 8.3 | | | 9.8 | 7.6 | | | |
| Southwark A2 Old Kent Road | 19-Jan-21 | | | | 13.1 | 9.3 | | | |

| Site | Date of audit | $O_3$ | CO | $SO_2$ | $NO_2$ | $PM_{10}$ | $PM_{2.5}$ | $GR_{10}$ | $GR_{2.5}$ |
|---|---|---|---|---|---|---|---|---|---|
| St Helens Linkway | 11-Feb-21 | | | | 12.2 | 9.3 | | | |
| St Osyth | 04-Feb-21 | 8.3 | | | 9.8 | | | | |
| Stanford-le-Hope Roadside | 09-Feb-21 | | | | 12.2 | 9.5 | 13.1 | | |
| Stockton on Tees A1035 Roadside | 11-Feb-21 | | | | 12.3 | | 12.6 | | |
| Stockton-on-Tees Eaglescliffe | 11-Feb-21 | | | | 12.2 | 10.2 | 12.6 | | |
| Stoke-on-Trent Centre | 14-Jan-21 | 8.3 | | | 9.8 | 8.0 | | | |
| Stoke on Trent A50 Roadside | 14-Jan-21 | | | | 12.3 | 9.3 | | | |
| Storrington Roadside | 25-Jan-21 | | | | 9.8 | | | | |
| Strath Vaich | 19-Jan-21 | 11.2 | | | | | | | |
| Sunderland Silksworth | 12-Feb-21 | 11.2 | | | 12.3 | 9.3 | | | |
| Sunderland Wessington Way | 12-Feb-21 | | | | 12.3 | | | | |
| Swansea Roadside | 11-Jan-21 | | | | 12.2 | 9.5 | 13.1 | | |
| Swindon Walcot | 04-Jan-21 | | | | 12.2 | | | | |
| Telford Hollinswood | 04-Feb-21 | | | | 12.2 | | | | |
| Thurrock | 09-Feb-21 | 11.2 | | 10.0 | 12.2 | 9.3 | | | |
| Tower Hamlets Roadside | 12-Jan-21 | | | | 12.3 | | 12.6 | | |
| Walsall Woodlands | 04-Feb-21 | 11.2 | | | 12.2 | | | | |
| Warrington | 11-Feb-21 | | | | 12.2 | 10.8 | 12.6 | | |
| West Bromwich Kenrick Park | 11-Feb-21 | | | | | 10.8 | 12.6 | | |
| West Bromwich Kenrick Park | 03-Feb-21 | | | | 12.2 | | | | |
| Weybourne | 02-Feb-21 | 8.3 | | | | | | | |
| Wicken Fen | 02-Feb-21 | 11.2 | | 10.1 | 12.2 | | | | |
| Widnes Milton Road | 18-Jan-21 | | | | 12.2 | | | | |
| Wigan Centre | 09-Feb-21 | 8.3 | | | | 9.0 | | | |
| Wirral Tranmere | 10-Feb-21 | 8.4 | | | 9.8 | 9.1 | | | |
| Worthing A27 Roadside | 25-Jan-21 | | | | 12.3 | | 12.6 | | |
| Wrexham | 19-Jan-21 | | | 12.2 | 12.2 | 7.5 | | | |
| Yarner Wood | 21-Jan-21 | 11.2 | | | 12.2 | | | | |
| York Bootham | 05-Jan-21 | | | | 12.2 | 9.3 | 12.6 | | |
| York Fishergate | 05-Jan-21 | | | | 12.2 | 10.2 | 13.1 | | |
| Aberdeen | 20-Jul-21 | 11.2 | | | 12.2 | 7.9 | 7.9 | | |

| 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 | 11-Aug-21 | | | | | 7.7 | 7.7 | | |
| Aberdeen Wellington Road | 19-Jul-21 | | | | 13 | 7.9 | 7.9 | | |
| Armagh Roadside | 05-Aug-21 | | | | 12.2 | 9.3 | | | |
| Aston Hill | 04-Aug-21 | 8.3 | | | 12.2 | | | | |
| Auchencorth Moss | 07-Jul-21 | 11.2 | | | | 7.5 | 7.5 | | |
| Ballymena Antrim Road | 04-Aug-21 | | | | 12.2 | | | | |
| Ballymena Ballykeel | 05-Aug-21 | | | 12.2 | 12.2 | | | | |
| Barnsley Gawber | 20-Jul-21 | 8.4 | | 11.6 | 9.8 | | | | |
| Barnstaple A39 | 25-Aug-21 | | | | | 9.3 | 12.6 | | |
| Bath A4 Roadside | 07-Jul-21 | 12.2 | | | | | | | |
| Belfast Centre | 12-Aug-21 | 8.3 | 7.5 | 12.2 | 9.8 | 7.5 | 7.5 | | |
| Belfast Stockman's Lane | 11-Aug-21 | | | | 13.6 | 9.3 | | | |
| Billingham | 13-Jul-21 | | | | 12.2 | | | | |
| Birkenhead Borough Road | 18-Aug-21 | | | | 12.5 | | | | |
| Birmingham Acocks Green | 03-Aug-21 | 11.2 | | | 12.5 | 7.5 | 7.5 | | |
| Birmingham A4540 Roadside | 03-Aug-21 | 11.2 | | | 12.2 | 7.5 | 7.5 | | |
| Birmingham Ladywood | 04-Aug-21 | 7.8 | | 12.6 | 13.4 | 8.4 | 8.4 | | |
| Blackburn Accrington Road | 16-Aug-21 | | | | 12.2 | | | | |
| Blackpool Marton | 19-Jul-21 | 8.3 | | | 9.8 | 7.5 | 7.5 | | |
| Borehamwood Meadow Park | 03-Aug-21 | | | | 9.8 | | | | |
| Bournemouth | 18-Aug-21 | 11.2 | | | 12.4 | | 12.7 | | |
| Bradford Mayo Avenue | 12-Aug-21 | | | | 12.2 | | | | |
| Brighton Preston Park | 02-Sep-21 | 11.2 | | | 12.2 | | 12.6 | | |
| Bristol St Paul's | 07-Jul-21 | 11.3 | | | 12.2 | 9.3 | 12.7 | | |
| Bristol Temple Way | 07-Jul-21 | | | | 12.2 | 9.3 | | | |
| Burton-on-Trent Horninglow | 19-Aug-21 | | | | 12.2 | | | | |
| Bury Whitefield Roadside | 07-Jul-21 | | | | 12.2 | 9.8 | | | |
| Bush Estate | 07-Jul-21 | 11.2 | | | 12.2 | | | | |
| Cambridge Roadside | 02-Aug-21 | | | | 12.2 | | | | |

| Site | Date of audit | $O_3$ | CO | $SO_2$ | $NO_2$ | $PM_{10}$ | $PM_{2.5}$ | $GR_{10}$ | $GR_{2.5}$ |
|---|---|---|---|---|---|---|---|---|---|
| Camden Kerbside | 19-Jul-21 | | | | 13.1 | 8.7 | 17.1 | | |
| Cannock A5190 Roadside | 19-Aug-21 | | | | 12.4 | | | | |
| Canterbury | 12-Aug-21 | 11.2 | | | 12.2 | | | | |
| Cardiff Centre | 15-Jul-21 | 11.2 | 7.5 | 12.2 | 12.2 | 9.4 | 12.6 | | |
| Cardiff Newport Road | 14-Jul-21 | | | | 12.2 | 9.3 | | | |
| Carlisle Morton A595 | 25-Aug-21 | | | | 12.2 | 9.3 | 12.9 | | |
| Charlton Mackrell | 23-Aug-21 | 11.2 | | | 12.2 | | | | |
| Chatham Centre Roadside | 11-Aug-21 | | | | 12.2 | 10 | 12.9 | | |
| Chepstow A48 | 08-Jul-21 | | | | 12.9 | 9.3 | 12.6 | | |
| Chesterfield Loundsley Green | 13-Aug-21 | | | | 12.2 | 7.9 | 7.9 | | |
| Chesterfield Roadside | 10-Aug-21 | | | | 12.2 | 7.5 | 7.5 | | |
| Chilbolton | 09-Jul-21 | 11.3 | | 10 | 12.2 | | | | |
| Christchurch Barrack Road | 18-Aug-21 | | | | 12.3 | | 12.6 | | |
| Coventry Allesley | 17-Aug-21 | 8.3 | | | 9.8 | 7.5 | 7.5 | | |
| Coventry Binley Road | 17-Aug-21 | | | | 12.3 | 9.6 | | | |
| Crewe Coppenhall | 19-Jul-21 | | | | 12.2 | | | | |
| Cwmbran Crownbridge | 14-Jul-21 | 8.3 | | | 12.4 | | | | |
| Derby St Alkmunds Way | 23-Aug-21 | | | | 12.3 | | | | |
| Derry Rosemount | 04-Aug-21 | 11.2 | | 12.2 | 12.2 | 13.7 | 17.8 | | |
| Dewsbury Ashworth Grove | 12-Aug-21 | | | | 12.2 | | | | |
| Doncaster A630 Cleveland Street | 24-Aug-21 | | | | 12.2 | | | | |
| Dundee Mains Loan | 05-Aug-21 | | | | 9.8 | | | | |
| Dumbarton Roadside | 09-Jul-21 | | | | 13.3 | | | | |
| Dumfries | 07-Jul-21 | | | | 12.3 | | | | |
| Ealing Horn Lane | 19-Jul-21 | | | | | **61.1** | | | |
| Eastbourne | 30-Jul-21 | | | | 12.2 | 7.5 | 7.5 | | |
| Edinburgh Nicolson Street | 06-Jul-21 | | | | 12.2 | | | | |
| Edinburgh St Leonards | 05-Jul-21 | 11.2 | 7.7 | 12.2 | 13.5 | 7.5 | 7.5 | | |
| Eskdalemuir | Out of action | | | | | | | | |

| Site | Date of audit | $O_3$ | CO | $SO_2$ | $NO_2$ | $PM_{10}$ | $PM_{2.5}$ | $GR_{10}$ | $GR_{2.5}$ |
|---|---|---|---|---|---|---|---|---|---|
| Exeter Roadside | 26-Aug-21 | 7.2 | | | 13.1 | | | | |
| Fort William | 20-Aug-21 | 11.2 | | | 12.2 | | | | |
| Glasgow Great Western Road | 03-Aug-21 | | | | 12.2 | | | | |
| Glasgow High Street | 02-Aug-21 | | | | 12.4 | 7.5 | 7.5 | | |
| Glasgow Kerbside | 02-Aug-21 | | | | 9.8 | | | | |
| Glasgow Townhead | 03-Aug-21 | 8.3 | | | 12.2 | 7.5 | 7.5 | | |
| Glazebury | 29-Jul-21 | 11.2 | | | 12.2 | | | | |
| Grangemouth | 09-Jul-21 | | | 12.2 | 12.2 | 9.3 | 12.6 | | |
| Grangemouth Moray | 22-Jul-21 | | | 10 | 13.9 | | | | |
| Greenock A8 Roadside | 06-Jul-21 | | | | 9.8 | 7.5 | 7.5 | | |
| Hafod-yr-ynys Roadside | 14-Jul-21 | | | | 12.2 | | | | |
| Haringey Roadside | 22-Jul-21 | | | | 13.1 | | | | |
| Hartlepool St Abbs Walk | 14-Jul-21 | | | | 12.3 | | | | |
| High Muffles | 23-Jul-21 | 11.2 | | | 12.2 | | | | |
| Honiton | 23-Aug-21 | | | | 12.2 | | | | |
| Horley | 27-Jul-21 | | | | **16.6** | | | | |
| Hull Freetown | 27-Jul-21 | 8.3 | | 12.2 | 9.9 | 7.5 | 7.5 | | |
| Hull Holderness Road | 28-Jul-21 | | | | 12.3 | 9.3 | | | |
| Immingham Woodlands Avenue | 20-Aug-21 | | | | 12.4 | | | | |
| Inverness | 26-Jul-21 | | | | 12.6 | 7.5 | 7.5 | | |
| Ladybower | 13-Aug-21 | 11.2 | | 12.2 | 12.2 | | | | |
| Leamington Spa | 19-Aug-21 | 11.5 | | | 12.3 | 7.5 | 7.5 | | |
| Leamington Spa Rugby Road | 19-Aug-21 | | | | 12.2 | 7.7 | 7.7 | | |
| Leeds Centre | 26-Jul-21 | 8.3 | 8.8 | 11.6 | 10.9 | 10.2 | 10.2 | | |
| Leeds Headingley Kerbside | 27-Jul-21 | | | | 12.2 | 23.2 | 12.7 | | |
| Leicester A594 Roadside | 24-Aug-21 | | | | 12.5 | 9.9 | | | |
| Leicester University | 24-Aug-21 | 8.4 | | | 9.9 | 8 | 8 | | |
| Leominster | 05-Aug-21 | 11.2 | | | 12.4 | | | | |
| Lerwick | 12-Aug-21 | 11.2 | | | | | | | |
| Lincoln Canwick Road | 22-Jul-21 | | | | 12.2 | | | | |
| Liverpool Speke | Out of action | | | | | | | | |
| London Bexley | 14-Jul-21 | | | | 12.4 | 7.5 | 7.5 | | |

| Site | Date of audit | $O_3$ | CO | $SO_2$ | $NO_2$ | $PM_{10}$ | $PM_{2.5}$ | $GR_{10}$ | $GR_{2.5}$ |
|---|---|---|---|---|---|---|---|---|---|
| London Bloomsbury | 12-Jul-21 | 11.2 | | 10 | 12.2 | 9.3 | 12.6 | | |
| London Eltham | 28-Jul-21 | 11.2 | | | 11.9 | 7.5 | 7.5 | | |
| London Haringey Priory Park South | 21-Sep-21 | 10.4 | | | 13.0 | | | | |
| London Harlington | 21-Jul-21 | 11.2 | | | 12.2 | 7.5 | 7.5 | | |
| London Honor Oak Park | 16-Jul-21 | | | | | 8.9 | 8.9 | | |
| London Hillingdon | 21-Jul-21 | 8.3 | | | 9.8 | | | | |
| London Marylebone Road | 26-Jul-21 | 11.2 | 7.6 | 10 | 12.6 | 8.8 | 16.4 | | |
| London N. Kensington | 29-Jul-21 | 11.2 | 7.5 | 10 | 12.2 | 9.9 | 9.9 | | |
| London Teddington Bushy Park | 27-Jul-21 | | | | | 9.5 | 12.6 | | |
| London Westminster | 20-Jul-21 | | | | 12.3 | | 12.6 | | |
| Lough Navar | 03-Aug-21 | 12.9 | | | | 7.5 | 7.5 | | |
| Lullington Heath | 26-Jul-21 | 11.2 | | 12.2 | 12.2 | | | | |
| Luton A505 Roadside | 03-Aug-21 | | | | 12.3 | | | | |
| Mace Head | 10-Aug-21 | 8.3 | | | | | | | |
| Manchester Piccadilly | 23-Aug-21 | 8.3 | | 12.2 | 9.8 | 7.5 | 7.5 | | |
| Manchester Sharston | 23-Aug-21 | 11.2 | | 10 | 12.2 | 7.5 | 7.5 | | |
| Middlesbrough | 13-Jul-21 | 11.2 | | 12.2 | 12.2 | 9.3 | 12.9 | | |
| Narberth | 12-Jul-21 | 11.2 | | 12.2 | 12.8 | 7.5 | 7.5 | | |
| Newcastle Centre | 16-Jul-21 | 8.3 | | | 9.9 | **30.3** | 12.9 | | |
| Newcastle Cradlewell Roadside | 15-Jul-21 | | | | 12.2 | 10.3 | | | |
| Newport | 08-Jul-21 | | | | 12.2 | 7.8 | 7.8 | | |
| Northampton Spring Park | 16-Aug-21 | 7.3 | | | 13.1 | | 12.6 | | |
| Norwich Lakenfields | 04-Aug-21 | 8.3 | | | 10.8 | 8.5 | 8.5 | | |
| Nottingham Centre | 26-Aug-21 | 8.3 | | 12.2 | 9.8 | 7.5 | 7.5 | | |
| Nottingham Western Boulevard | 23-Aug-21 | | | | 12.3 | 9.3 | | | |
| Oldbury Birmingham Road | 04-Aug-21 | | | | 13.2 | | | | |
| Oxford Centre Roadside | 08-Jul-21 | | | | 12.2 | | | | |

| Site | Date of audit | $O_3$ | CO | $SO_2$ | $NO_2$ | $PM_{10}$ | $PM_{2.5}$ | $GR_{10}$ | $GR_{2.5}$ |
|---|---|---|---|---|---|---|---|---|---|
| Oxford St Ebbes | 08-Jul-21 | | | | 12.6 | 7.8 | 7.8 | | |
| Peebles | 08-Jul-21 | 11.2 | | | 12.2 | | | | |
| Plymouth Tavistock Road | 24-Aug-21 | | | | 12.2 | | | | |
| Plymouth Centre | 24-Aug-21 | 8.3 | | | 12.2 | 7.6 | 7.6 | | |
| Port Talbot Margam | 13-Jul-21 | 8.3 | 11.5 | 11.6 | 9.8 | 9.3 | 12.7 | | |
| Portsmouth | 16-Aug-21 | 8.3 | | | 13.1 | 7.5 | 7.5 | | |
| Portsmouth Anglesea Road | 16-Aug-21 | | | | 12.2 | 9.7 | | | |
| Preston | 16-Aug-21 | 8.7 | | | 9.8 | 7.9 | 7.9 | | |
| Reading London Road | 22-Jul-21 | | | | 12.5 | 9.3 | | | |
| Reading New Town | 05-Jul-21 | 8.3 | | | 10.3 | 9.3 | 12.6 | | |
| Rochester Stoke | 11-Aug-21 | 11.2 | | 12.2 | 12.3 | 7.5 | 7.5 | | |
| Salford Eccles | 29-Jul-21 | | | | 12.2 | 8 | 8 | | |
| Saltash Callington Road | 24-Aug-21 | | | | | 9.6 | 12.9 | | |
| Sandy Roadside | 02-Aug-21 | | | | 12.2 | 9.3 | 12.6 | | |
| Scunthorpe Town | 28-Jul-21 | | | 10 | 12.3 | 9.3 | | | |
| Shaw Crompton Way | 07-Jul-21 | | | | 12.2 | | | | |
| Sheffield Barnsley Road | 09-Aug-21 | | | | 13.5 | | 14.3 | | |
| Sheffield Devonshire Green | 11-Aug-21 | 8.5 | | | 9.8 | 7.5 | 7.5 | | |
| Sheffield Tinsley | 11-Aug-21 | | | | 12.3 | | | | |
| Sibton | 04-Aug-21 | 11.2 | | | | | | | |
| Southampton Centre | 17-Aug-21 | 8.3 | | 12.2 | 9.8 | 7.5 | 7.5 | | |
| Southampton A33 Roadside | 17-Aug-21 | | | | 12.2 | 14.3 | | | |
| Southend-on-Sea | 09-Aug-21 | 8.3 | | | **16.9** | 7.6 | 7.6 | | |
| Southwark A2 Old Kent Road | 20-Jul-21 | | | | 11.6 | 23.7 | | | |
| St Helens Linkway | 26-Jul-21 | | | | 12.2 | 13.5 | | | |
| St Osyth | 05-Aug-21 | 8.3 | | | 9.8 | | | | |
| Stanford-le-Hope Roadside | 10-Aug-21 | | | | 12.2 | 9.3 | 12.6 | | |
| Stockton on Tees A1035 Roadside | 12-Jul-21 | | | | 12.2 | | 12.8 | | |
| Stockton-on-Tees Eaglescliffe | 12-Jul-21 | | | | 12.2 | 9.4 | 19.5 | | |

| Site | Date of audit | $O_3$ | CO | $SO_2$ | $NO_2$ | $PM_{10}$ | $PM_{2.5}$ | $GR_{10}$ | $GR_{2.5}$ |
|---|---|---|---|---|---|---|---|---|---|
| Stoke-on-Trent Centre | 06-Jul-21 | 8.3 | | | 10 | 7.5 | 7.5 | | |
| Stoke on Trent A50 Roadside | 06-Jul-21 | | | | 12.2 | 9.3 | | | |
| Storrington Roadside | 28-Jul-21 | | | | 10.9 | | | | |
| Strath Vaich | 26-Jul-21 | 11.2 | | | | | | | |
| Sunderland Silksworth | 14-Jul-21 | 11.2 | | | 12.2 | 7.5 | 7.5 | | |
| Sunderland Wessington Way | 15-Jul-21 | | | | 12.2 | | | | |
| Swansea Roadside | 13-Jul-21 | | | | 12.2 | 9.3 | 12.6 | | |
| Swindon Walcot | 05-Jul-21 | | | | 12.3 | | | | |
| Telford Hollinswood | 05-Aug-21 | | | | 12.4 | | | | |
| Thurrock | 10-Aug-21 | 11.2 | | 10 | 12.2 | 10.2 | | | |
| Tower Hamlets Roadside | 16-Jul-21 | | | | 13.1 | | | | |
| Walsall Woodlands | 05-Aug-21 | 11.2 | | | 12.2 | | | | |
| Warrington | 26-Jul-21 | | | | 12.2 | 12.4 | 12.7 | | |
| West Bromwich Kenrick Park | 06-Aug-21 | | | | 12.3 | | | | |
| Weybourne | 03-Aug-21 | 8.3 | | | | | | | |
| Wicken Fen | 03-Aug-21 | 11.2 | | 10 | 12.3 | | | | |
| Widnes Milton Road | 14-Jul-21 | | | | 12.2 | | | | |
| Wigan Centre | 17-Aug-21 | 8.3 | | | 13.8 | 8.3 | 8.3 | | |
| Wirral Tranmere | 18-Aug-21 | 8.3 | | | 12 | 7.7 | 7.7 | | |
| Worthing A27 Roadside | 28-Jul-21 | | | | 12.2 | | 12.7 | | |
| Wrexham | 14-Jul-21 | | | 12.2 | 12.2 | 7.6 | 7.6 | | |
| Yarner Wood | 25-Aug-21 | 11.2 | | | 12.4 | | | | |
| York Bootham | 21-Jul-21 | | | | 12.2 | 9.3 | 12.6 | | |
| York Fishergate | 21-Jul-21 | | | | 12.2 | 10.4 | 13.1 | | |

# APPENDIX 3 SITES WITH LESS THAN 85% DATA CAPTURE

Table A 3 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 | 82.4% | 83.1% | | | | | 82.8% |
| Birmingham Acocks Green | 68.9% | 68.8% | 68.8% | | 69.0% | | 68.9% |
| Borehamwood Meadow Park | 74.6% | | | | | | 74.6% |
| Brighton Preston Park | 98.6% | | 63.6% | | 97.4% | | 86.5% |
| Camden Kerbside | 69.8% | 61.6% | 63.9% | | | | 65.1% |
| Carlisle Morton A595 | 46.9% | 54.5% | 51.8% | | | | 51.1% |
| Derby St Alkmund's Way | 89.3% | | | | | | 89.3% |
| Edinburgh Nicolson Street | 50.5% | | | | | | 50.5% |
| Edinburgh St Leonards | 61.7% | 99.3% | 99.3% | 61.1% | 98.3% | 91.4% | 85.2% |
| Eskdalemuir | 41.1% | | | | 24.4% | | 32.8% |
| Grangemouth | 52.6% | 84.8% | 93.6% | | | 51.5% | 70.6% |
| Grangemouth Moray | 88.6% | | | | | | 88.6% |
| Greenock A8 Roadside | 56.3% | 99.7% | 99.7% | | | | 85.2% |
| Lerwick | | | | | 39.6% | | 39.6% |
| Liverpool Speke | 28.8% | 23.2% | 23.9% | | 28.9% | 28.8% | 26.7% |
| London Bloomsbury | 98.1% | 96.4% | 35.7% | | 99.1% | 81.6% | 82.2% |
| London Eltham | 90.3% | 74.7% | 89.6% | | 87.9% | | 84.9% |
| London Marylebone Road | 93.6% | 75.8% | 85.6% | 83.7% | 92.7% | 94.7% | 87.7% |
| London Marylebone Road (Gravimetric) | | 29.6% | 90.1% | | | | 59.9% |
| London N. Kensington | 99.2% | 99.9% | 99.9% | 39.5% | 98.2% | 68.6% | 84.2% |
| London Westminster | 96.7% | | 81.3% | | | | 89.0% |
| Lullington Heath | 18.7% | | | | 89.8% | 50.3% | 52.9% |
| Portsmouth | 65.4% | 63.5% | 63.5% | | 66.1% | | 64.6% |
| Reading New Town | 91.3% | 96.1% | 93.9% | | 64.6% | | 86.5% |
| Sandy Roadside | 71.4% | 68.5% | 70.3% | | | | 70.1% |
| Sheffield Barnsley Road | 87.2% | | 82.6% | | | | 84.9% |
| Sheffield Devonshire Green | 32.1% | 99.5% | 99.5% | | 99.2% | | 82.6% |
| Sunderland Silksworth | 12.9% | 98.6% | 98.6% | | 99.2% | | 77.3% |

| Site Name | $NO_2$ | $PM_{10}$ | $PM_{2.5}$ | CO | $O_3$ | $SO_2$ | Average |
|---|---|---|---|---|---|---|---|
| Swansea Roadside | 98.4% | 83.1% | 86.6% | | | | 89.4% |
| York Bootham | 91.2% | 89.4% | 88.0% | | | | 89.6% |

These data capture statistics are based on the whole year. Aberdeen, Aberdeen Errol Park, Carlisle Morton A595 and Carlisle did not operate for the entire year, 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 ($PM_{10}$, $PM_{2.5}$)**

Both BAMs had a number of problems involving leaking nozzles. Damage to the hut caused by Storm Arwen allowed water ingress and the site was turned off on the 30th November for the remainder of the quarter.

**Birmingham Acocks Green (NOx, $PM_{10}$, $PM_{2.5}$, $O_3$)**

The power supply failed on 25th February and repairs were delayed due to vandalism. Monitoring was restored on 16th March however the site was later turned off due to anti-social behaviour around the site and the potential presence of asbestos in the neighbouring building. The monitoring site is to be relocated elsewhere in the grounds of the leisure centre in which it is situated.

**Borehamwood Meadow Park (NOx)**

The detector cooler was found to have failed on 12th February, and the analyser was removed for workshop repair. This was returned to site on 15th April, and the Local Authority involved had no contractual provision for a hotspare loan.

**Brighton Preston Park ($PM_{2.5}$)**

The $PM_{2.5}$ data from 1st to 6th January were rejected as they were very low and not in line with other local stations. Several other spurious spikes were also rejected during quarter 1.

During quarter 2 the instrument only recorded patchy data, which were deemed unrepresentative, leading to all $PM_{2.5}$ data from the 13th July until the end of the quarter being rejected.

The $PM_{2.5}$ data rejection continued from quarter 3 until a hotspare BAM was installed on 7th October. However, the data continued to be unrepresentative resulting in all $PM_{2.5}$ data being rejected up until the original instrument was re-installed on 18th November.

**Camden Kerbside (NOx, $PM_{10}$, $PM_{2.5}$)**

The FDMS $PM_{10}$ analyser suffered frequent spikes in data, probably due to excessive cabin temperatures. In addition, the $PM_{2.5}$ data did not compare well with other stations from 6th to 28th April, and these data have been rejected. Camden Kerbside stopped monitoring on 14th September for the hut to be refurbished.

**Carlisle Morton A595 (NOx, $PM_{10}$, $PM_{2.5}$)**

Due to an issue with the site modem the data between the 13th and 31st December the data were unrecoverable.

**Derby St Alkmund's Way (NOx)**

An instrument fault identified at the end of May led to a period of low data being rejected.

**Edinburgh Nicolson Street (NOx)**

The ESU reported that the main valve broke during the service on 25th January. A hotspare was installed on 18th February, but this appeared to have a flow fault, and data have been rejected into April. It was removed for workshop repair on 15th April but that did not rectify the fault. Data returned to satisfactory quality when the original analyser was reinstalled on 25th May.

**Edinburgh St Leonards (NOx, CO)**

The NOx analyser produced poor quality data following service on 24th February. A hotspare was installed in March, but data did not improve. The original analyser was reinstalled on 9th April, but again data remained of poor quality. The analyser developed multiple alarm faults and required workshop repair once again, and the hotspare was still unstable.

The CO analyser was removed for workshop repair at the service on 24th January. The ESU were unable to repair it and there were no hotspares available. A new analyser was installed on 1st July.

**Eskdalemuir (NOx, $O_3$)**

Following concerns about spuriously high ozone data, the ESU visited on 23rd June and found it was likely the main valve was blocked. Some dirt and flies were found inside. Data from 31st March to 23rd June have been rejected.

The site experienced air conditioning problems throughout quarter 3 and all instruments were turned off on 4th August. Any patches of data prior to this were rejected due to the impact of high hut temperatures.

**Grangemouth (NOx, $PM_{10}$, $SO_2$)**

Internal sampling issues led to $NO_x$ data being rejected between the summer 2021 service in July and the winter 2022 service in January.

The $SO_2$ instrument drifted significantly following the service on the 22nd January and an instrument call out on the 26th February. On review the Quality Circle decided to reject the data.

The $PM_{10}$ instrument experienced tape and leak issues during quarter 2.

**Grangemouth Moray (NOx)**

Spurious data between the LSO calibrations on 22nd June to 12th July have been rejected due to suspected internal sampling as were data between 20th and 22nd July.

**Greenock A8 Roadside (NOx)**

All $NO_x$ data in quarter 4 were rejected due to the LSO using the instrument permeation tube for calibrations rather than the cylinder. Due to this there were no usable calibration points to correctly scale the data too.

**Lerwick ($O_3$)**

A partial blockage within the analyser was discovered at the audit, corresponding with high data compared to other remote stations. Data from 5th April to 2nd June have been rejected.

The failure of the air conditioning system led to the site being switched off, data from the 10th August onwards were determined to be impacted by the failure and so were rejected.

Following the failure of the air conditioning system the $O_3$ instrument suffered a blockage resulting in unrepresentative data being rejected from the start of quarter 4 up until the 21st October when the power supply failed. The instrument began recording data again on the 10th November.

**Liverpool Speke (NOx, $PM_{10}$, $PM_{2.5}$, $O_3$, $SO_2$)**

The station remained out of commission until 7th September when the cabin was replaced.

Both BAM instruments experienced tape issues in the first week of October and were left in Maintenance mode between the 8th and 12th October. A further data gap between the 18th and 29th December was due to internal fuses of both instruments blowing.

**London Bloomsbury ($PM_{2.5}$, $SO_2$)**

Interference spikes were evident in the $PM_{2.5}$ ambient data (also reflected in diagnostics) from the 15th May onwards and the data was rejected.

The $SO_2$ instrument began reporting unstable data after the service in October, leading to data being rejected until a hotspare was installed on the 15th December.

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

The CMCU noted that the $PM_{2.5}$ FDMS frequently read higher than the co-located non-AURN $PM_{10}$ analyser. Data from 1st to 11th January, and 25th to 29th January were rejected. The $PM_{2.5}$ FDMS was replaced by a Fidas™ on 8th March.

The ozone analyser continued to suffer from data logging issues, resulting in frequent short gaps. All data for this quarter have been rejected.

The ozone analyser had been deemed unrepairable following persistent memory problems. A new analyser was installed on 2nd July.

**London Marylebone Road ($PM_{10}$, $PM_{2.5}$, CO)**

From 10th July 2021 to 24th September 2021 the $PM_{10}$ FDMS was giving results that were less than the $PM_{2.5}$ FDMS instrument, and hence these data were deleted. Over the same period the site also suffered from air conditioning failure for 11 days, which resulted in instruments being turned off to reduce the heat load in the cabin.

From the end of May, the CO analyser baseline drifted down and the data became truncated. Data from 28th May to the end of the quarter have been rejected.

**Marylebone Road Gravimetric ($PM_{10}$)**

Monitoring stopped on 28th May 2021 due to repeated instrument failures followed by a failed electrical safety test. The instrument was not replaced until March 2022.

**London N. Kensington (CO, $SO_2$)**

Although a new set of analysers was installed in February, the CO analyser was not set up correctly and as the baseline gradually drifted down at the end of Q1, the data flatlined for most of Q2. All data for Q2 have been rejected.

**London Westminster ($PM_{2.5}$)**

The $PM_{2.5}$ instrument had multiple tape and leak issues that led to data being rejected.

**Lullington Heath (NOx, $O_3$, $SO_2$)**

The NOx analyser was suspected to be internally sampling and the service identified a fault with the reaction cell.

The ozone instrument was removed for workshop repair on the 19th August due to a valve leak. On the 25th August a hotspare was installed and the original reinstalled on the 21st September.

A communications issue meant that no data were collected from the 8th September until the 5th October.

**Portsmouth (NOx, $PM_{10}$, $PM_{2.5}$, $O_3$)**

Following decommissioning for cabin replacement in 2020, the station was finally recommissioned on 28th April.

**Reading New Town ($O_3$)**

During ratification of the data, it was seen that the ozone data for Reading New Town was noticeably lower than other stations. A blockage in the sample line was found by the ESU on 19th May. Data have been rejected from 14th January to the callout in May.

**Sandy Roadside (NOx, $PM_{10}$, $PM_{2.5}$)**

The station was inaccessible for several weeks due to the Covid-related closure of the car dealership in whose premises the station is located. During that time, both BAM tapes ran out, and the NOx analyser developed a fault. A hotspare was installed on 24th March, but this was also faulty, and a repair to the original analyser took place on 14th April.

**Sheffield Barnsley Road (NOx, $PM_{2.5}$)**

An electrical fault within the cabin caused numerous power trips. Power was switched off while repairs were carried out. The site was turned back on again on 23rd July.

**Sheffield Devonshire Green (NOx)**

A leak in the NOx sampling system was identified at an ESU callout on 13th September, at the Quality Circle it was decided that the suspect data began on 13th April and so the data were rejected due to internal sampling. A further callout was completed on 5th of October where a leak within the instrument was identified leading to the data between the callout on13th September and 5th October being rejected.

**Sunderland Silksworth (NOx)**

During ratification a sampling issue was identified in the data, at the quality circle it was decided that all data needed to be rejected from the service on the 18th February until the sample line was fixed on 24th January 2022.

**Swansea Roadside ($PM_{10}$, $PM_{2.5}$)**

Both $PM_{10}$ and $PM_{2.5}$ BAMs had significant flow leaks during the quarter. Data from the $PM_{2.5}$ were rejected from the 1st to the 27th July. Data from the $PM_{10}$ were rejected from the 1st July to the 11th August.

**York Bootham ($PM_{10}$, $PM_{2.5}$)**

Site experienced a power issue between the 29th July and the 24th August resulting in no data being collected in this period.

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